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Gravity

Smart Campus

Gravity LDO Environmental Statement

Volume 2 – Appendices

Appendix 13.1 Flood Risk Assessment

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Document Control Sheet

Project Name: **This is Gravity**

Project Ref: **332310102/4002**

Report Title: **Flood Risk Assessment**

Doc Ref: **Revision H**

Date: **January 2022**

	Name	**Position**	**Signature**	**Date**
Prepared by:	Kirstie Thistlethwaite	Assistant Engineer	K.Thistlethwaite	17.01.2022
Reviewed by:	Andrew Johns	Senior Associate		17.01.2022
Approved by:	Paul Jenkin	Director of Water Management		17.01.2022
For and on behalf of Stantec UK Limited				

Revision	**Date**	**Description**	**Prepared**	**Reviewed**	**Approved**
A	30.07.21	Draft for Internal Review	LWD	AJ	-
B	19.08.21	Draft for Client Review	LWD	AJ	-
C	24.09.2021	For Planning	KT	AJ	PJ
D	18.10.2021	Updated Flood Modelling	KT	AJ	PJ
E	26.10.2021	DRAFT	KT	AJ	-
F	03.11.2021	Draft for Consultation	KT	AJ	PJ
G	15.11.2021	Revised Draft for Consultation	KT	AJ	PJ
H	17.01.2022	For Adoption	KT	AJ	PJ

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Executive Summary

This Flood Risk Assessment (FRA) has been prepared by Stantec to support a Local Development Order (LDO) for the Gravity Smart Campus, an industrial-led mixed-use development at the Former Royal Ordnance Factory (ROF) Puriton in Somerset.

In accordance with the fundamental objectives of the National Planning Policy Framework (NPPF), this FRA demonstrates that:

i. The development is safe.

ii. The development does not increase flood risk.

iii. The development does not detrimentally affect third parties.

Existing ground levels of site vary between 4.5mAOD and 15.5mAOD. Flood Modelling (approved as part of the extant planning permission 42/12/00010) was updated to account for revised EA Climate Change allowances. It is proposed that Finished Floor Levels will be set for less vulnerable development at a minimum of 2102 Upper End Breach modelled depth plus suitable freeboard and for more vulnerable development at a minimum of 2132 Upper End Breach modelled level plus suitable freeboard or 300mm above existing ground, whichever is greater.

The Environment Agency (EA) '*Flood Map for Planning'* shows the majority of the site lies within Flood Zone 3, with higher elevations towards the south being within Flood Zone 1. There is an intermediary zone between the two shown as Flood Zone 2. The *'Flood Map for Planning'* also indicates that all areas of Flood Zone 3 benefits from flood defences along the Parrett Estuary.

The mixed-use proposals on site constitute *Essential Infrastructure, More Vulnerable, Less Vulnerable* and *Water-compatible development* land uses (reference PPG: Tables 2 in *Paragraph 066 Reference ID: 7-067-20140306* and Table 3 in *Paragraph: 067 Reference ID: 7-067-20140306*). The sequential approach has been applied to parameters plan as such all built development is located in a compatible flood risk defined by the flood risk vulnerability.

The site currently benefits from a prior industrial use, enterprise zone status, allocation in the Core Strategy for redevelopment, and has an extant outline planning consent. As this LDO does not significantly vary the proposed land uses on site, the requirements of the Sequential Test are met. This FRA and the findings within it are sufficient to meet the requirements of the Exception Test.

A Surface Water Drainage Strategy (SWDS) has been developed using best practice Sustainable Drainage System (SuDS) techniques. Guidance on suitable techniques and methods has been obtained from the EA, the Non-Statutory Technical Standards for Sustainable Drainage Systems, Somerset County Council's Strategic Flood Risk Assessment (SFRA) and CIRIA C753 "The SuDS Manual" amongst other sources. Information regarding the proposed SWDS can be found in the separate SWDS report.

In summary, the FRA demonstrates that the proposed development is safe and in accordance with the requirements of national and local planning policy.

1 Introduction

1.1 Scope of Report

1.1.1 This Flood Risk Assessment (FRA) has been prepared by Stantec of behalf of our Client, **This is Gravity Ltd**. This Local Development Order (LDO) seeks consent for a Smart Campus at the Former Royal Ordnance Factory (ROF) Puriton in Somerset.

1.1.2 The report is based on available information for the site as detailed in **Section 1.2** and prepared in accordance with the planning policy requirements set out in **Section 1.3**. The scope of the FRA is consistent with the 'site specific Flood Risk Assessment Checklist' from the National Planning Policy Framework (NPPF) Planning Practice Guidance (PPG).

1.2 Sources of Information

Previous Work Completed

1.2.1 Stantec has been involved in assessing Flood Risk and Drainage at this site for over 10 years (formerly operating at Peter Brett Associates LLP (PBA)), including in support of an extant Outline Planning Consent in 2017 (ref: 42/13/00010). As such, a number of reports and assessments have been completed to date. These are listed below:

- Royal Ordnance Factory Puriton TUFLOW Modelling Report (July 2007)
- Royal Ordnance Factory Puriton TUFLOW Modelling Addendum to Technical Modelling Report (October 2007)
- Royal Ordnance Factory Puriton TUFLOW Modelling Addendum NO.2 of Technical Modelling Report (January 2008)
- Huntspill Energy Park Remediation Application – Flood Risk Assessment (October 2011)
- Borrow Pit Angling Club Flood Risk Assessment (October 2012)
- Huntspill Energy Park Remediation Phase 1 Drainage Scheme (March 2013)
- Huntspill Energy Park Flood Risk Assessment (April 2013)
- Huntspill Energy Park Surface Water Management Strategy (April 2013)
- Huntspill Energy Park Addendum to Surface Water Management Strategy (October 2013)
- Huntspill Energy Park Remediation Application Surface Water Management Strategy (October 2013)
- Huntspill Energy Park Remediation Works Drainage Scheme for Plots J-K (January 2014)
- Puriton Solar Farm Drainage Strategy Technical Note (February 2015)
- Huntspill Solar Park Surface Water Management Strategy (December 2015)
- Land at Puriton Abstraction Assets Assessment (March 2018)
- Huntspill Energy Park Tidal Flood Risk Summary Note (June 2018)

1.2.2 It should be noted that whilst many of the findings and conclusions of the previously completed works will inform this FRA, these documents were undertaken in relation to the extant consent. Hence, the area assessed by these documents is smaller in extent than the proposed LDO area. Where relevant, the findings of these documents have been referenced and/or updated within this FRA to reflect this new site extent.

Additional or Updated Information

1.2.3 To provide an up-to-date assessment of flood risk, this FRA has also been prepared based on the following sources of publicly available information, which have been updated since the preparation of the previously completed works:

- Topographic survey of the site undertaken by Lewis Brown Chartered Land Surveyors;
- Parameter plans by LDA Design;
- British Geological Survey (BGS) mapping;
- Magic Map;
- Environment Agency (EA) *Flood Map for Planning;*
- EA *Long Term Flood Risk*;
- EA *Historic Flood Map;*
- EA *South West River Basin Management Plan;*
- EA *North and Mid Somerset Catchment Flood Management Plan* EA
- Sedgemoor District Council (SDC) *Level 1 Strategic Flood Risk Assessment;*
- SDC *Level 2 Strategic Flood Risk Assessment* (Scott Wilson, 2009)
- Flood Estimation Handbook (FEH) 13 rainfall data and point descriptors, extracted from the FEH online service;
- Remediation Verification Report Huntspill Energy Park – Phase 1 (March 2019);
- Groundwater Remediation Verification TNT Section Huntspill Energy Park (October 2019); and
- Remediation Verification Report Huntspill Energy Park – Phase 2 (September 2020).

1.3 Relevant Planning Policy

1.3.1 This FRA has been prepared in accordance with the relevant national, regional and local planning policy and statutory authority guidance as follows:

- National policy contained within the revised **NPPF** dated July 2021, issued by Ministry of Housing, Communities and Local Government, with reference to Section 14 '*Meeting the challenge of climate change, flooding and coastal change*'.
- The **PPG** for Flood Risk and Coastal Change released in March 2014 and updated in July 2021 to incorporate the EA **'Flood Risk Assessments: Climate Change Allowances'** guidance.

- The **Water Framework Directive** (WFD) (Commission of the European Communities, released 2000) (ref 13.2) establishes a framework for a European-wide approach to action in the field of water policy. Its ultimate aim is to ensure all inland and near shore watercourses and water bodies (including groundwater) are of *'Good'* status or better, in terms of ecology, and also chemical, biological and physical parameters, by the year 2027. Therefore, any activities or developments that could cause detriment to a nearby water resource or prevent the future ability of a water resource to reach its potential status, must be mitigated so as to reduce the potential for harm and allow the aims of the Directive to be realised.

1.3.2 The local planning authority will make decisions with regards to any LDO application within any floodplain or flood risk area. The EA is a designated statutory consultee for areas within Flood Zones, areas with critical drainage problems, and plays a key role in providing advice on development and flood risk issues. The Lead Local Flood Authority (LLFA) is a statutory consultee for major developments which have surface water or other local flooding impacts.

1.3.3 This FRA should be read in conjunction with other LDO application supporting documents.

1.4 Caveats and Exclusions

1.4.1 This FRA has been prepared in accordance with the NPPF, PPG and Local Planning Policy. The proposed flood management (including ground floor level recommendations) and surface water management strategies are based on the relevant British Standards (BS8533:2017), the standing advice provided by the EA or based on common practice.

1.4.2 The Construction (Design and Management) Regulations 2015 (CDM Regulations) will apply to any future development of this site which involves "construction" work, as defined by the CDM Regulations. As such it is the responsibility of the proposed developer (ultimate client) to fulfil its duties under the CDM Regulations.

1.4.3 The approach for the FRA and proposals for the surface water management strategy are based on the requirements of the EA and Somerset County Council (SCC) in its role as Lead Local Flood Authority (LLFA).

1.4.4 The findings of this FRA are based on data available at the time of the study and on the subsequent assessment that has been undertaken in relation to the development proposals.

1.4.5 It should be noted that the insurance market applies its own tests to properties in terms of determining premiums and the insurability of properties for flood risk. Those undertaking development in areas which may be at risk of flooding are advised to contact their insurers or the Association of British Insurers (ABI) to seek further guidance prior to commencing development. Stantec does not warrant that the advice in this report will guarantee the availability of flood insurance either now or in the future.

1.5 Flood Risk Assessment Credentials

1.5.1 Stantec has many years of experience in, amongst other areas, the assessment of flood risk, hydrology, flood defence and river engineering. The authors and reviewers of the document are all experienced engineers and members of chartered institutions such as the Chartered Institution of Water and Environmental Management (CIWEM) or the Institution of Civil Engineers (ICE).

2 Proposed Development Site

2.1 Site Description

2.1.1 The 249-hectare (ha) (616acre) site is located north-east of Puriton and north-west of Woolavington in Somerset. Both villages lie north of Bridgwater and east of the M5 motorway. The site has an approximate central Ordnance Survey (OS) grid reference 333328m E, 142437m N. The site lies within the administrative boundaries of Somerset County Council and Sedgemoor District Council.

2.1.2 The site consists primarily of brownfield land currently unused following remediation of the ROF site.

2.1.3 Generally, the site is bordered by agricultural land, specifically on three of the four sides. There is also some agricultural land to the south of the former BAE systems main fenced site. The Huntspill River flows east to west adjacent to the northern boundary and Woolavington Road, the road that connects Puriton and Woolavington is located to the south.

2.1.4 A site location plan is provided in **Appendix A**.

2.2 Existing Topography

2.2.1 The site is relatively flat, with nominal fall from the south to the north.

2.2.2 The topography is steepest near to the southern boundary of the site, with an average elevation of 15.5mAOD, although the far southern extremity of the site LDO boundary reaches an elevation of 40mAOD. This then falls to an average elevation of between 5mAOD and 6.5mAOD across the majority of the site. The far northern extremity of the site's boundary has an approximate elevation of 4.5mAOD. Despite these elevation changes, the scale of the site gives rise to the relative flatness.

2.2.3 Topographical information can be found in **Appendix B**.

2.3 Hydrological Setting

2.3.1 There are no main rivers within the LDO boundary itself, although there are open surface water drainage systems present as part of the existing drainage of the site (see **Section 2.5**).

2.3.2 The Huntspill River lies approximately 900m north of the major area of the site and 50m north of the LDO boundary itself. The Huntspill River is designated as a Main River by the EA and is essentially a large reservoir originally constructed to supply water to the former ROF site. Water levels are managed by the EA to be 3.5mAOD in the summer and 2.9mAOD in the winter.

2.3.3 In a northern arm of the site, there are a series of constructed reed beds. When the site was operational these were used for treating effluent prior to discharge from the site, however following the removal of effluent sources following the closure and remediation of the site this is no longer the case. Therefore, the reed beds are now a surface water-based system within the site's boundary. For further details of their former operation, refer to **Section 2.5**.

2.3.4 The site is bounded by a number of rhynes, typical of the area, which are viewed i.e., managed by the Somerset Drainage Boards Consortium (SDBC). The northern boundary of the site is formed by the Black Ditch, which runs from east to west, whilst close to the eastern boundary of the site is the Stoning Pound Rhyne. Both these rhynes discharge into the Huntspill River. There is also an unnamed viewed rhyne close to the western boundary of the site, which appears to flow north and westwards towards an existing railway and the M5 motorway.

2.3.5 Although approximately 4.5km to the west of the site's boundary, the River Parrett, its estuary and Bridgwater Bay do have influence on the hydrology of the site and vicinity. The Huntspill River discharges into the Parrett Estuary via the Huntspill Sluice (approx. 4.4km west of the site), which manages water levels in the Huntspill River by controlling the rate of discharge from the Huntspill but also impeding high tidal water levels continuing further upstream.

Water Framework Directive

2.3.6 The Water Framework Directive (WFD) establishes a framework for a European-wide approach to action in the field of water policy. The EA Catchment Data Explorer [1] website has water quality data relating to the WFD targets for 2027.

2.3.7 The quality of the Huntspill River is monitored by the EA against the objectives of the WFD. The nearest WFD designated water body is the Huntspill (GB108052021210). This is currently (Cycle 2, 2019) classified as overall 'Moderate' status, with 'Moderate' ecological status and 'Fail' chemical Status.

2.3.8 The site does not currently lie within a WFD groundwater management catchment; therefore, no status is provided regarding groundwater.

2.4 Geology and Hydrogeology

2.4.1 Review of British Geological Survey (BGS) online mapping indicates that the site is underlain by bedrock geology of the Langport Member, Blue Lias Formation and Charmouth Mudstone Formation (undifferentiated), which are describe as *"porcellanous limestone below, calcareous mudstone above"*, *"thinly interbedded limestone (laminated, nodular or massive and persistent) and calcareous mudstone or siltstone (local laminated)"* and *"dark grey laminated shales, and dark, pale bluish grey mudstone"* respectively. The BGS online viewer also indicates that the Charmouth Mudstone Formation and Langport Member form the upper and lower boundaries to the Blue Lias Formation respectively.

2.4.2 Superficial deposits are indicated to be Tidal Flat Deposits, comprising clay, silt and sand, for the majority of the site. Higher elevations in the southern part of the site do not have superficial deposits recorded.

2.4.3 A review of EA mapping indicates that the bedrock geology underneath the site is a Secondary A Aquifer. A Secondary A Aquifer is defined by the EA as "permeable layer capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of baseflow to rivers".

2.4.4 The Tidal Flat Deposits are classified as a Secondary (undifferentiated) Aquifer by the EA. A Secondary (undifferentiated) Aquifer is defined as "where it has not been possible to attribute either category A or B".

2.4.5 The site lies within a Groundwater Vulnerability Zone of 'Medium – High'. 'Medium' vulnerability is defined as "areas that offer some groundwater protection", whilst 'High' is defined as "areas able to easily transmit pollution to groundwater…characterised by high leaching soils and the absence of low permeability superficial deposits".

2.4.6 The Remediation verification reports confirm the geology and states groundwater levels are typically 0.5m and 1.5m below ground level.

[1] https://environment.data.gov.uk/catchment-planning/

2.5 Existing Drainage Arrangements

On-Site Drainage

2.5.1 The site consists of brownfield land that currently benefits from an existing drainage system. This system has been assessed and forms seven surface water drainage sub-catchments on site.

- Sub-Catchment A – A small section of land on western boundary, and another north-west of centre, discharges into the Black Ditch directly.
- Sub-Catchment B – The majority of the western parts of the site drain to the "Site Acid Ditch".
- Sub-Catchment C – A small section of land located centrally in the north of site drains to the "Site Acid Ditch".
- Sub-Catchment D – Central areas, representing a significant proportion of the site, drain to a south-to-north rhyne which continues parallel to (but separate from) an existing reed bed system before discharging into the Huntspill River via the "North Water Outfall".
- Sub-Catchment E – Eastern parts of the site drain north-eastwards to the Stoning Pound Rhyne.
- Sub-Catchment F – South-western areas of the site which drain to the unnamed viewed rhyne to the west. This area is associated with Gravity Link Road, which has been consented as part of the previous outline consent and is currently under construction.
- Sub-Catchment G – North-western areas of the site associated with the existing railway, which appear to discharge into adjacent rhynes and ditches before conveying flows westwards to either the Huntspill River or Parrett Estuary.

2.5.2 The Site Acid Ditch, reed beds and North Water Outfall lie within the site, whilst the Black Ditch lies on the northern boundary.

2.5.3 While the ROF was operational, effluent was piped or pumped to a large treatment tank in the centre of the Site, known as the "Lido", and then pumped to the reed beds. The Lido also has an overflow to the Site Acid Ditch which flows through the site and discharges into the reed beds. Following passage through the reed beds, treated effluent was pumped into a ditch immediately to the north of the reed beds, which runs west and flows parallel to (but separate from) the Huntspill River and discharges into the Parrett Estuary. This ditch is referred to as the "Acid Ditch" and lies outside of the site boundary. The Lido and overflow are still in-situ but owing to the ceasing of operations on site, no longer receives effluent discharge, therefore no effluent is discharged into either the Site Acid Ditch or the Acid Ditch and these are now surface water only systems.

2.5.4 Remediation of the site is now complete; however, the existing surface water drainage principles have not been altered from the undeveloped condition. The layout of rhynes and ditches has been altered to accommodate the proposed building platforms, but continuity of flows through the site of upstream and the outfall arrangements remain unaffected.

2.5.5 The existing drainage regime and remediated drainage scheme is indicated within **Appendix C**.

Public Sewers

2.5.6 As part of the previous work undertaken by Stantec on this site, Wessex Water (WW) mapping of sewerage infrastructure for the site and surrounding area has been reviewed. Plans show there to be no surface water, foul or combined sewers within the site and the surrounding area. This is to be expected given the topography and the existing drainage infrastructure present on site.

3 Development Proposals & Sequential/Exception Tests

3.1 Development Proposals

3.1.1 The LDO is submitted for:

a. *any operations or engineering works necessary to enable the development of the Site, including demolition, excavation and earthworks, the formation of compounds for the stockpiling, sorting and treatment of excavated materials, import of material to create development platforms, piling, and any other operations or engineering necessary for site mobilisation, office and worker accommodation, communications, drainage, utilities and associated environmental, construction and traffic management.*

b. *the development of a smart campus including*

i. *commercial building or buildings with a total Gross External Area of up to 1,000,000m^2 which would sit within current Use Classes E(a) - (g), B2, B8 and sui generis floorspace uses and*

ii. *a range of buildings up to 100,000m2 within use classes C1, C2, E (a) – (g) and F , B8, including restaurants / cafes, shops, leisure, education and sui generis uses and*

iii. *up to 750 homes in use class C3,*

together with associated infrastructure including restoration of the railway line for passenger and freight services, rail infrastructure including terminals, sidings and operational infrastructure and change of use of land to operational rail land, multi-modal transport interchange, energy generation, energy distribution and management infrastructure, utilities and associated buildings and infrastructure, digital infrastructure, car parking, a site wide sustainable water management system and associated green infrastructure, access roads and landscaping.

3.1.2 A copy of the proposed concept plan and parameter plans can be found in **Appendix D**.

3.2 Development Vulnerability

3.2.1 PPG ‘Flood Risk and Coastal Change’ Table 2 (*Paragraph 066 Reference ID: 7-067-20140306)* confirms the *‘Flood risk vulnerability classification’* of a site, depending upon the proposed usage. This classification is subsequently applied to PPG Table 3 (Paragraph: 067 Reference ID: 7-067-20140306) to determine whether:

- The proposed development is suitable for the flood zone in which it is located, and;
- Whether an Exception Test is required for the proposed development.

3.2.2 The proposed development comprises the following uses and vulnerability classes:

- **Essential infrastructure**: Water treatment works, energy generation, distribution and management infrastructure.
- **More vulnerable:** Residential dwellings, education.
- **Less vulnerable:** Commercial building(s), general industry, storage and distribution, restaurants / cafes, shops, leisure.

- **Water-compatible development:** Amenity open space, nature conservation and biodiversity, sewage / water transmission infrastructure and pumping stations.

3.2.3 More Vulnerable land use is considered appropriate within Flood Zone 1 and 2. Less Vulnerable land use, which is considered appropriate within Flood Zone 1, 2 and 3a (reference NPPF PPG Tables 2 and 3). Both Essential Infrastructure and Water Compatible are considered appropriate within Flood Zone 1, 2, 3a and 3b, with the application of the Exception Test for Essential Infrastructure in Flood Zones 3a and b.

3.3 The Sequential Test

3.3.1 The NPPF requires local Planning Authorities to apply the Sequential Test to steer new development towards areas of lowest flood risk.

3.3.2 The site currently benefits from allocation in the Core Strategy, enterprise zone status, permission for remediation and an extant hybrid planning consent for an energy park (and associated infrastructure) development. The proposals within the LDO application do not represent a significant departure from the characteristics of the consented development types on site, it is limited to an increased site area and alterations to the proposed development layout. As such, the Sequential Test has already been applied to the site and the development proposals and determined to have passed by the Local Planning Authority.

3.4 The Exception Test

3.4.1 The NPPF paragraph 102 states:

> *"…For the Exception Test to be passed:*
>
> *it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared; and*
>
> *a site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall."*

3.4.2 The details provided within **Section 4** of this FRA address the second part of the Exception Test and demonstrate that the site is safe for its lifetime. An initial worst case review of potential impacts suggests that there would be no significant increase in flood risk elsewhere, however in the detailed design further analysis will be included to ensure that flood risk is reduced or not increased

3.5 Sequential Approach

3.5.1 The NPPF encourages the application of the 'sequential approach' in the master-planning process for new development, i.e., locating the more sensitive/vulnerable elements of new development in the areas which lie at lowest probability of flooding and, conversely, reserve the areas of the site at greatest risk of flooding for the least vulnerable elements of the development (or, preferably, leave such areas undeveloped or as soft landscaping).

3.5.2 The sequential approach will be applied to the development proposals and their layout, by using any updated tidal flood modelling to inform the location of more vulnerable classes of development in areas with the lowest risk of flooding.

4 Assessment of Flood Risk

4.1 EA Flood Map for Planning

4.1.1 A review of publicly available *'Flood Map for Planning'* produced by the EA was undertaken.

4.1.2 The Flood Zones are predominantly based on hydraulic modelling work ignoring defences, although Flood Zone 2 can extend to include recorded flood outlines. Where detailed modelling has not been carried out, the Flood Zones are based on the 'National Generalised Flood Model'. This model does not explicitly represent channel geometry or structures such as culverts, bridges and weirs and hence may not provide an accurate estimation of the probability of flooding.

4.1.3 The majority of the site is shown by the EA's 'Flood Map for Planning' to lie within Flood Zone 3 'High Probability', but as an Area Benefitting from Flood Defences. These defences are located alongside the Parrett Estuary. Areas of the site at higher elevations, towards the south of the site, are shown to Flood Zone 2 'Medium Probability' and then Flood Zone 1 'Low Probability' as levels rise further towards the Woolavington Road.

4.1.4 The source of flood risk in this mapping is tidal from the Parrett Estuary, rather than fluvial from the Huntspill River or other watercourses.

4.1.5 In addition, the EA mapping is based on national-scale modelling and does not take account of the likely impacts of climate change or flood defences. To provide a robust assessment of site-specific flood risk and facilitate a resilient development, these impacts have be considered as part of the site-specific flood risk modelling and therefore supersede the flood zone mapping (Section 4.3 and 4.4).

4.2 Impact of Climate Change

4.2.1 As part of the assessment of flood risk to the site, it is necessary to fully consider the potential impacts of climate change for the lifetime of the development within the mitigation measures.

4.2.2 In February 2016, the EA released guidance on the application of climate change allowances in flood risk assessments [2] and it was updated in July 2021 to reflect up to date information on climate change allowances from the latest climate change projections (UKCP18).

Tidal

4.2.3 Table 3 in the EA's guidance provides a range of allowances for areas of the coastline and various epoch for sea level rise. The sea level allowances provide a range of allowances based on percentile (i.e. the degree of certainty of an event occurring, based on the range of climate change scenarios assessed through scientific investigations). The provided allowances are also subject to the river basin district of the site.

4.2.4 The conditions at the site and consequent sea level allowances considered as part of the FRA are as detailed in **Table 4.1**. The sea level rises are given in mm per year for each epoch, whilst total sea level rise for each epoch is in brackets.

[2] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

River Basin District	Allowance	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative rise 2000 to 2125 (metres)
South West	*Higher Central*	*5.8 (203)*	*8.8 (264)*	*11.7 (351)*	*13.1 (393)*	*1.21*
South West	*Upper End*	*7 (245)*	*11.4 (342)*	*16 (480)*	*18.4 (552)*	*1.62*

Table 4.1 Climate Change Allowances for Sea Level Rise in South West (July 2021)

Peak Rainfall Intensities

4.2.5 Increases in rainfall intensities would require consideration in a Surface Water Drainage Strategy (SWDS) for new development are detailed in **Table 4.2**. The strategy is discussed in a separate accompanying SWDS report.

Applies Across All of England	Total Potential Change Anticipated for the '2080s' (2010 to 2115)
Upper end	40%
Central	20%

Table 4.2 Climate Change Allowances for Peak Rainfall Intensity

Peak River Flow Allowances

4.2.6 Peak river flow allowances show the anticipated changes to peak flow by management catchment and the range of allowances is based on percentiles. The South and West Somerset Management Catchment peak river flow allowances are detailed in **Table 4.3**.

South and West Somerset Management Catchment	Total Potential Change Anticipated for the '2080s'
Upper	82%
Higher	50%
Central	37%

Table 4.3 Climate Change Allowances for Peak River Flow

4.2.7 Given the principal flood risk to the site is that of tidal inundation, tidal climate change allowances were adopted within flood modelling as outlined in **Section 4.3**.

4.3 Previous Flood Modelling

4.3.1 TUFLOW modelling reports and the FRAs previously completed in support of the extant planning permission on site made several assessments of the tidal flood risk, taking account of a potential breach of the existing defences.

4.3.2 The July 2007 TUFLOW modelling report assessed the five flood defence scenarios and determined the following:

- The existing tidal defences provide a 1 in 200 year level of protection from extreme tidal events, except for a few minor places where limited overtopping occurs.
- The present-day 1 in 1,000 year extreme tidal event overtops the defences, but the floodwater is contained within the low lying area next to the defences.
- Allowing for sea level rise as a result of climate change would result in more extensive flooding. The road, railway and motorway provide a significant barrier to inland flow. The land within ROF fence is not affected by tidal flooding, even including for climate change.
- Breaching of the tidal defences would result in more extensive flooding, but the analysis has demonstrated that floodwater would still not reach the site, even allowing for climate change up to the year 2070.

4.3.3 In October 2007, the EA requested that additional modelling was undertaken for the 1 in 1,000 year (0.1% AEP) extreme tidal level for both present-day and with climate change at the breach location where the most extensive flooding was previously generated. The conclusion remained the same, that the site would not experience tidal flooding in this scenario.

4.3.4 In January 2008, the modelling was updated to account for potential residential development at the site. This meant that the development would have a longer design life and therefore the climate change allowances applied needed to be amended. The results indicated that during the 2110 climate change scenario for the 1 in 200-year event, flooding occurs in the northeast corner of the site. The 1 in 1,000-year event results in flooding from the northeast of the Site and from the low-lying lands to the west of the site.

4.3.5 By the time of the October 2011 remediation application FRA, climate change allowances had been revised. The modelling assessment was updated to account for these as well as increasing the defence breach width from 40m to 50m. The results confirmed that floodwater will not reach the site during a breach of the tidal defences coincident with a 1,000-year tide during the period of the remediation works.

4.3.6 This assessment was repeated for the April 2013 FRA supporting the extant consent on site. The results confirm that during the present-day scenario, floodwater will not reach the site during a breach of the tidal defences coincident with a 1 in 200-year tide. The TUFLOW model was re-run to consider the predicted effects of climate change up to the year 2075. The modelled results for the 1 in 200-year breach scenario show no floodwater reaching the site due to the natural protection of the local topography.

4.3.7 The modelled results for the predicted 1 in 1,000-year overtopping scenario for the year 2075 show some shallow flooding beginning to encroach into the north-east corner of the site with a peak water level of 5.06m AOD.

4.4 Updated Flood Modelling

4.4.1 There have been no significant changes in the modelling software, data or policy and practice since the aforementioned works and so the baseline model used for the previously consented scheme (42/13/00010) is considered to be suitable to support the LDO.

4.4.2 The exception is the updated estimated Climate Change allowances, where new estimates were released in July 2021 (presented in Table 3.1). An updated assessment has been completed regarding the tidal flood risk onsite using these updated climate change allowances.

4.5 Present day

4.5.1 The scenario applied was the defended conditions with a breach location, agreed with the EA, for the 1 in 200-year event with an allowance for climate change as defined by EA guidance (Table 4.1).

4.5.2 The model extents for the 1 in 200yr 2021 Higher Central (Defended and Breach), as well as the 1 in 200yr 2021 Upper End (Defended and Breach) scenarios show no flood extents within the LDO boundary. The Upper End represents the worst case as part of this assessment and are shown in Figure 4.1 below (Appendix E).

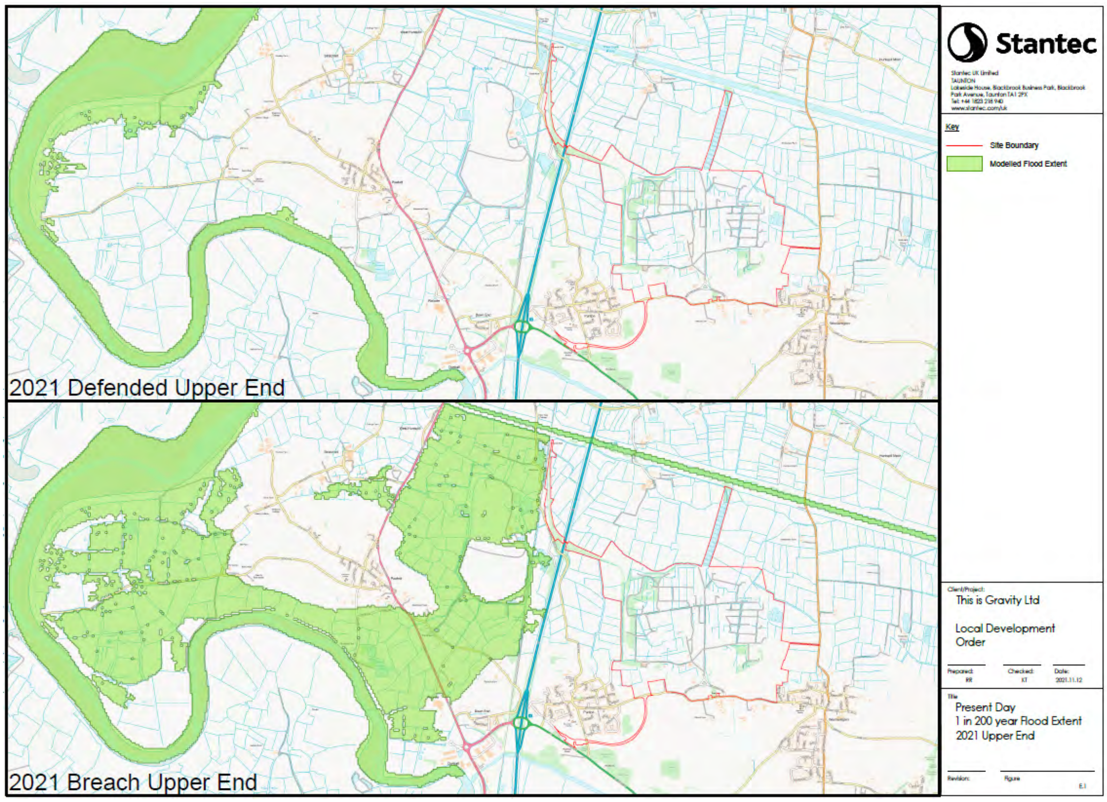


Figure 4.1 Present Day (2021) Modelled Flood Extents

4.6 Design Scenarios

4.6.1 The design scenarios derived are for the defended conditions with a breach location, as agreed with the EA, for the 1 in 200-year event with an allowance for climate change as defined by EA guidance (Table 4.1). H++ scenario has been used as a sensitivity test.

4.6.2 The PPG 'Flood Risk and Coastal Change' (*Paragraph 026 Reference ID: 7-026-20140306)* outlines that the lifetime of residential development should be considered as 100 years. For this assessment the design life of commercial and other less vulnerable development is considered to be 70years.

4.6.3 As a worst-case scenario, the lifetime of development has been considered post estimated completed construction which is anticipated to be 2032.

4.6.4 Pre-development scenarios (assuming no development) have been modelled based on the ground levels within the baseline model. Post-development scenarios (assuming the site is developed as proposed) have been assessed based on the ground levels proposed in LDO parameters plans of land uses and building heights.

4.6.5 It is recommended that additional post-development modelling in undertaken at detailed design stages to ensure any flood resilient and resistant measures are designed to a suitable level.

4.6.6 Plans of modelled flood extents of provided in Appendix E.

4.7 Design Scenario – Commercial Development

4.7.1 The LDO parameters plans indicate that the majority of the proposed development is commercial building(s), general industry, storage and distribution, which are all considered to be less vulnerable development. Given the development type, the design life is 70 years from 2032. The design scenario is 1 in 200year 2102 Upper End Breach, thus assessing for a 70year design life post estimated completed construction in 2032.

4.7.2 In the pre-development 2102 design scenario, flood extents begin to the encroach on the north east and north west fringes. In all pre-development scenarios, the southern portion of the LDO boundary remains dry. Figure 4.2 shows the modelled extents

4.7.3 Post-development scenarios have been assessed based on the ground levels proposed in LDO parameters plans of land uses and building heights.

4.7.4 For this development type, the FFLs should be set above the 1 in 200-year 2102 Upper End Breach flood level. In this scenario, the greatest modelled flood depths are observed on along the western edge of the LDO boundary at 5.80mAOD, as such based on the current model this would be set at minimum of 6.10mAOD which includes a suitable 300mm freeboard.

4.7.5 Therefore, the post-development 2102 design scenario, the flood extents show appropriate levels of mitigation for all less vulnerable development.

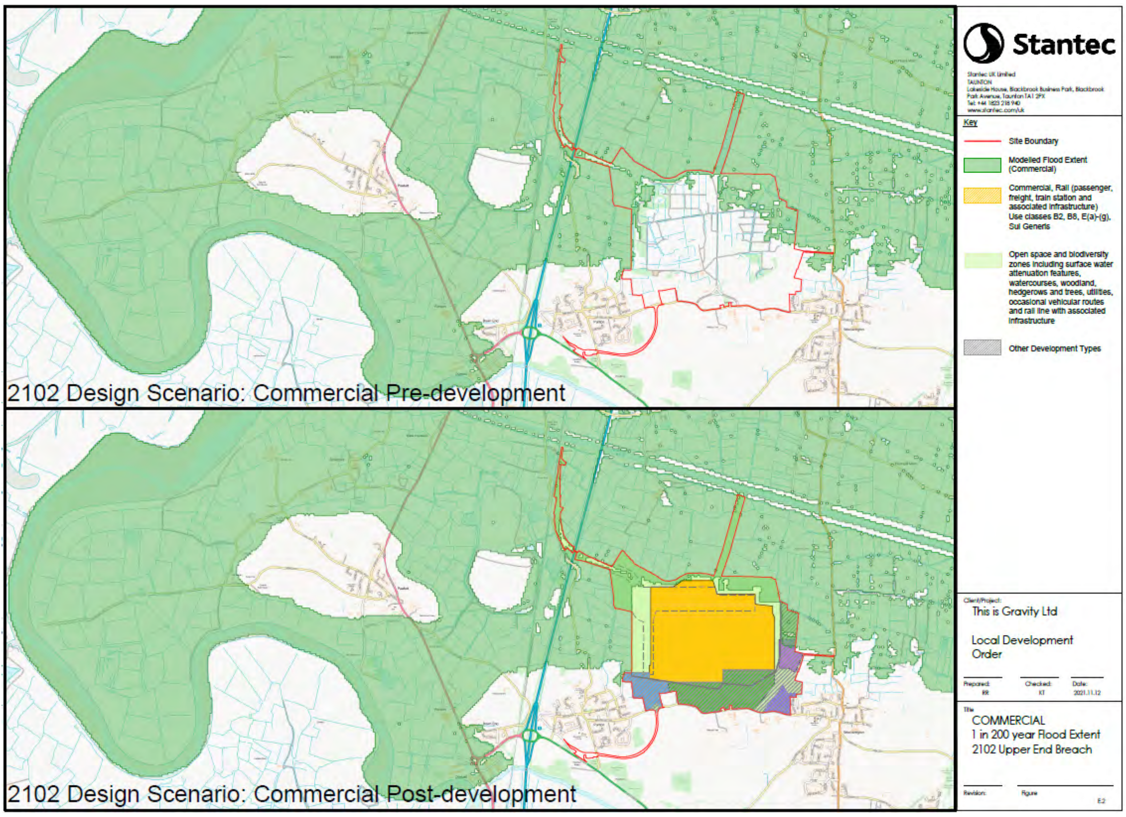


Figure 4.2 Commercial Design scenario Modelled Flood Extents

4.8 Design Scenario – Residential Development

4.8.1 The LDO parameters plans indicate that parts of the southern portion of the site (south of the original ROF boundary) could contain residential dwellings and educational uses, which are considered to be more vulnerable development. Given the development type, the design life is 100 years from 2032. The design scenario is 1 in 200year 2132 Upper End Breach, thus assessing for a 100year design life post estimated completed construction in 2032.

4.8.2 Through the pre-development 2132 design scenario, the extents follow a similar trend of encroaching from the north, east and west of the LDO boundary. In all pre-development scenarios, the south of the LDO remains dry. Figure 4.3 shows the modelled extents.

4.8.3 As outlined by the buildings heights plan, the LDO has visual impact constraints meaning that any development north of the original ROF boundary cannot be raised higher than 6.5mAOD. Therefore, post-development scenarios have been assessed based on the ground levels proposed in LDO parameters plans of land uses and building heights.

4.8.4 For this type of development, the FFLs should be set above the 1 in 200-year 2132 Upper End Breach flood level. In this scenario, the greatest modelled flood depths are observed on along the western edge of the LDO boundary at 7.30mAOD, as such based on the current model this would be set at minimum of 7.60mAOD which includes a suitable 300mm freeboard.

4.8.5 Blue green zones areas to the south of the ROF boundary contain proposals for a mixture of vulnerabilities. Therefore, the sequential approach will be applied to locate any more vulnerable classes to be outside any modelled extents in these areas as shown in Figure 4.3.

4.8.6 Therefore, in the 2132 design scenario, the flood extents show appropriate levels of mitigation of all more vulnerable development.

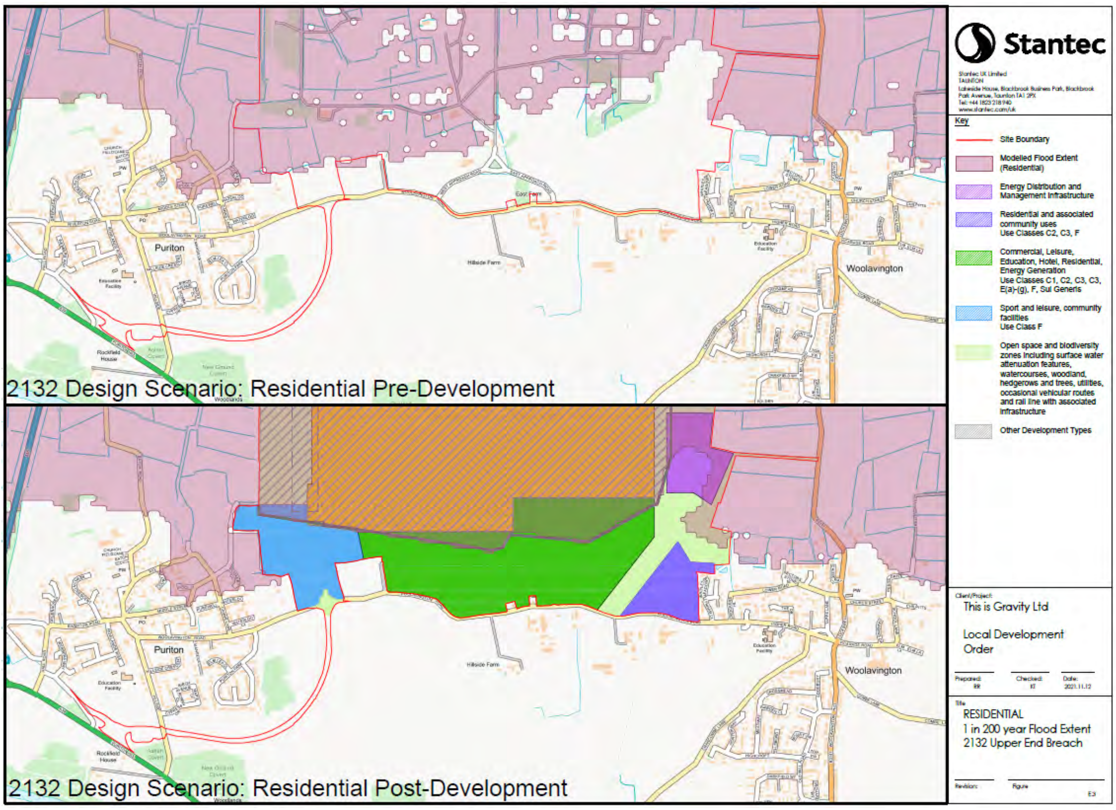


Figure 4.3 Residential Design scenario Modelled Flood Extents

Sensitivity

4.8.7 The 1 in 200-year 2100 H++, defended and breach, scenario has been assessed as a sensitivity test. Due to the extreme nature of the event, there is by definition more extensive flooding. In the H++ scenarios, the southern portion of the LDO boundary remains dry.

4.9 Residual Risk

4.9.1 From the post-development extents, the residual risk offsite has been considered. The post development modelling is based on the worst-case scenario and show negligible impact off site. It is recommended that additional post-development modelling in undertaken at detailed design stages to ensure appropriate flood resilient and resistant measures are in place.

5 Additional EA Flood Data

5.1 Flood Risk from Surface Water mapping

5.1.1 The '*Flood Risk from Surface Water'* mapping hosted on the flood warning information service website[1], show areas which could be potentially susceptible to surface water flooding in extreme rainfall events.

5.1.2 The mapping has been derived by broadscale modelling using ground levels defined on a 2m square grid with building footprints raised by 0.3m, roads lowered by 0.125m and variable roughness values used to account for different land uses. Rainfall events of various likelihoods and durations were then simulated to determine likely flood depths and velocities for different risk categories.

- **High** - *each year, the area has a chance of flooding of greater than 1 in 30 (3.3%)*
- **Medium** - *each year, the area has a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%)*
- **Low** - *each year, the area has a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%)*
- **Very low** - *each year, the area has a chance of flooding of less than 1 in 1000 (0.1%)*

5.1.3 The surface water maps are generated using a generic methodology on a national scale, whereby rainfall is routed over a ground surface model. The analysis does not take account of any specific local information on below-ground drainage infrastructure and infiltration, although an adjustment is included in urban areas to account for the impact of sewerage and a standard infiltration allowance based on soil type. Consequently, the mapping provides a guide to potentially vulnerable areas based on the general topography of an area. As the site contains no existing sewerage no adjustment is required in this case.

5.1.4 The mapping indicates that the site is predominately at *'Very Low'* risk of surface water flooding. There are limited areas of surface water flood risk ranging from *'Low'* to *'High'* across the site, however these appear to correspond with the location of onsite drainage features e.g., ditches, field drains etc. and therefore represent a local depression.

5.1.5 The mapping also indicates a number of overland flow paths initiating to the south of the site and flowing north through the site. These flow paths form part of the upstream catchment which drains through the site via the existing rhyne network. Conveyance of these flows through the site post-remediation and post-development will be maintained (see **Appendix A** for the proposed remediation SWDS and refer to separate SWDS report for further information regarding the post-development SWDS).

5.1.6 A copy of the Risk of Flooding from Surface Water map is included within **Appendix F**.

5.1.7 Further information on the Flood Risk Maps for Surface Water can be found in *Risk of flooding from surface water - Understanding and using the map* document hosted on the GO V.UK website[2].

[1] https://flood-warning-information.service.gov.uk/long-term-flood-risk/map

[2] https://www.gov.uk/government/publications/flood-risk-maps-for-surface-water-how-to-use-the-map

Flood Risk from Reservoirs Mapping

5.1.8 The '*Flood Risk from Reservoirs Mapping'* is hosted on the flood warning information service website [1] and present extents, depths, and velocities of flooding for simulated, hypothetical '*credible worst case'* dam breaches for reservoirs with a capacity of 25,000m^3 or greater. These reservoirs fall under the *Reservoir Act 1975*.

5.1.9 The mapping indicates that the site is not at risk of flooding from reservoirs. A copy of the Risk of Flooding from Reservoirs map is included within **Appendix F**.

5.2 Groundwater Flooding

5.2.1 During the information gathering for this FRA, no records of groundwater flooding were found to have occurred within the site.

5.2.2 Groundwater levels were recorded on site between 2006 and 2011 over a range of months. The range of recorded values are indicated in **Appendix C**.

5.2.3 The Sedgemoor District Council Strategic Flood Risk Assessment (SFRA) Level 1 mapping indicates that the site and surround area lie outside an area susceptible to groundwater flood emergence.

5.2.4 The North and Mid Somerset Catchment Flood Management Plan (CFMP) does not identify groundwater as being a significant source of flood risk.

5.2.5 Mapping indicates the site does not lie within a Source Protection Zone (SPZ). A copy of the SPZ map is included within **Appendix F**.

5.3 Sewer Flooding

5.3.1 Given that WW have indicated that no sewers are located within or the vicinity of the site, existing flood risk from sewers is considered negligible on site.

5.4 Flooding from Artificial Sources

5.4.1 No artificial sources of flooding, such as canals, lakes and ponds, have been identified within the vicinity of the site and therefore flood risk from these sources can be considered negligible for the site.

5.5 Historic Flood Records

5.5.1 The Sedgemoor District Council SFRA Level 1 indicates a number of historic flood events in the region, however none are recorded as impacting the proposed built development within the LDO boundary.

5.5.2 The event included within the SFRA are as follows:

- *October/November 1960 – prolonged rainfall caused widespread flooding across the Levels and Moors.*
- *December 1981 – very high tidal levels resulted in overtopping of sea defences, inundating approximately 3,570ha.*
- *August 1997 – intense summer rainfall caused significant vegetation damage and pollution on the Levels and Moors.*

- *November 2012 – exceptionally high groundwater levels were observed on the Levels and Moors and surrounding villages. This was due to wetter than typical weather between April and October of that year. Up to 150mm fell across some areas through late November, leading to extensive flooding and road closures.*

- *December 2013 to February 2014 – heavy prolonged rainfall led to extensive flooding across the Levels and Moors affecting property and agricultural land. During January, southern England experienced the highest rainfall since records began. The extent of flooding led to a major incident being declared by Somerset County Council.*

5.5.3 The Environment Agency's 'Historic Flood Map' and 'Recorded Flood Outlines' identifies the maximum extent of recorded flood outlines from rivers, the sea and groundwater springs. A review of this mapping identifies there are three recorded historic flood events either within or close proximity of the site's boundary.

- The mapped extents indicate that an area of the north-west of the site, corresponding with the existing railway in the LDO boundary (outside the ROF fence), was affected by the December 1981 event noted in the SFRA (section 5.5.2 above).

- Mapping and anecdotal evidence from operatives on site indicates that the site was unaffected in 2012 and 2013-2014, although the 2012 event does indicate localised flood areas close to the LDO western boundary which are generally associated with existing bodies of water or natural low points in the topography.

5.5.4 The historic flood mapping and recorded flood outlines are shown in **Figure 5.1** and included in **Appendix F**.

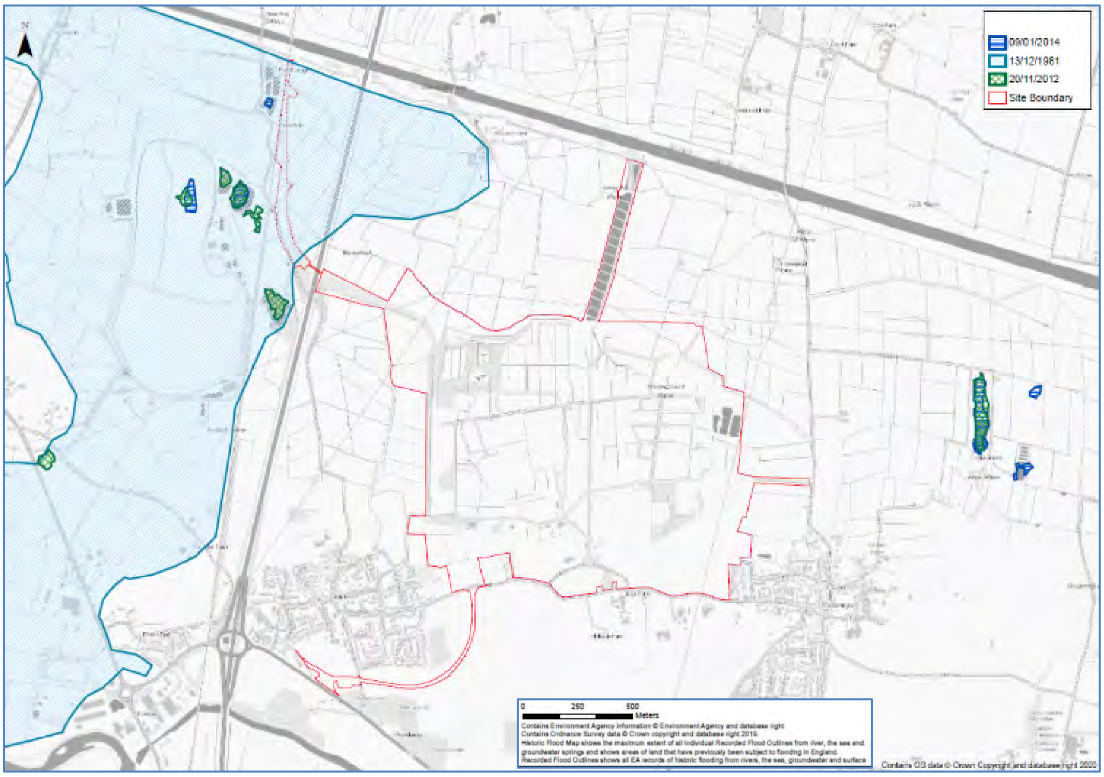


Figure 5.1 EA Dated Historic Flood Extents

6 Flood Resistant and Resilient Measures

Flood Resistant Measures

6.1.1 Because of the residual risk to the ground floor levels of the commercial properties, it is proposed that flood resistant measures will be incorporated in the construction of the development in line with the current recommendations from the DEFRA/EA document 'Improving the Flood Performance of New Buildings – Flood Resilient Construction'.

6.1.2 Flood resistant measures aim to keep flood water out of the building by providing barriers and incorporating low permeability measures in the wall and floors. Such measures include demountable defences, water resistant wall rendering, the sealing of ground level vents and anti-flood valves fitted to all drainage runs exiting the building. Typically, flood resistance measures are effective up to a maximum flood depth of approximately 500mm, with suitable measures incorporated up to the flood level.

6.1.3 Although the building plot levels and FFLs will be situated above the modelled flood level, owing to the risk of high groundwater levels in addition to tidal flood risk, it is recommended that flood resistant measures are incorporated into the ground floor construction of buildings. Where essential infrastructure is located in Flood Zone 3, such measures will be required to help seek that they remain operational and safe during a flood event.

Flood Resilient Measures

6.1.4 Because of the residual risk to the ground floor levels, it is proposed that flood resilient techniques will be incorporated in the construction of the development in line with the current recommendations from the Defra/EA document 'Improving the Flood Performance of New Buildings – Flood Resilient Construction'.

6.1.5 Flood resilient measures are incorporated where it is accepted that, in severe floods in excess of the design event, water may enter parts of the building so it is necessary to ensure the building will remain useable after the floodwater has receded and the area has been cleaned. Therefore, the key issue is to incorporate materials that retain their structural integrity and have good drying and cleaning properties (e.g., the use of suitable tiling over areas, with water resilient grout). It is also recommended that services are secured and sockets etc. are located a suitable freeboard above floor level.

6.2 Safe Access

6.2.1 It is necessary to consider and incorporate safe access arrangements as part of the mitigation, to ensure the users/occupants of the development are safe in times of flooding.

6.2.2 Consideration of the safety of any pedestrian route has been based on the guidance in the EA document '*Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purpose – Clarification of the Table 13.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1*'.

6.2.3 The building plot levels and FFLs provide an adequate level of safe refuge for occupants to remain within the respective building in the event of a flood.

6.2.4 Emergency safe access will also be provided to Flood Zone 1 via the main site entrance to the south-west. Therefore, emergency safe access and egress from the site will be available at all times.

7 Managing Surface Water

7.1 Overview

7.1.1 A key requirement for the proposed development is to seek that flood risk downstream is not increased. The potential is associated with additional runoff generated by the introduction of roofs and hard-paved surfaces as part of the development. These surfaces replace natural ground where water can percolate into soil pores and to a greater or lesser extent infiltrate into the underlying rock. Additionally, natural ground is more uneven, promoting localised ponding while vegetation intercepts rainfall by collecting water. Lastly, natural ground is generally more resistant to flow, reducing the velocity of overland flow and the time that it takes to leave the site.

7.1.2 The replacement of natural surfaces has two principal effects on the land's response to rainfall:

- An increase in the rate of runoff;
- An increase in the volume of runoff.

Both of these impacts have the potential to increase the flood risk downstream. The rate of runoff is normally of principal concern as it can impact on the peak flow rate in the receiving watercourse or drainage network. Increasing the volume of runoff can also increase flood risk in particular situations.

7.1.3 The NPPF recognises that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface water runoff from development sites and recommended that priority is given to the use of Sustainable Drainage Systems (SuDS) in new development.

7.2 Surface Water Drainage Strategy

7.2.1 Details of the proposed SWDS for the LDO application are provided in a separate, accompanying SWDS report. Please refer to this report for further details of how the SWDS will contribute to managing surface water flood risk on and off site.

8 Conclusion

8.1 Local Development Order

8.1.1 This FRA has been prepared to support a LDO for the development of the Gravity Smart Campus at the Former ROF Puriton site in Somerset.

8.2 Flood Risk

8.2.1 This FRA concludes that:

- The proposed mitigation strategy demonstrates the development is safe through a number of measures as follows:
  - The development and definition of the parameters plans follows the sequential approach.
  - Finished Floor Levels will be set for less vulnerable development at a minimum of 2102 Upper End Breach modelled depth plus suitable freeboard and for more vulnerable development at a minimum of 2132 Upper End Breach modelled level plus suitable freeboard or 300mm above existing ground, whichever is greater.
  - Flood resistant measures will be incorporated into buildings' ground floor design where appropriate, to mitigate against the residual risk of an exceedance flood event and high groundwater levels. These measures will be required for all essential infrastructure located in areas identified as at higher flood risk, so that they remain safe and operational during a flood event.
  - The main site access being located in Flood Zone 1, emergency safe access and egress will be available during flood events.

8.2.2 This FRA demonstrates that the proposals are in accordance with the Sequential Test and the Exception Test.

8.3 Surface Water Drainage Strategy

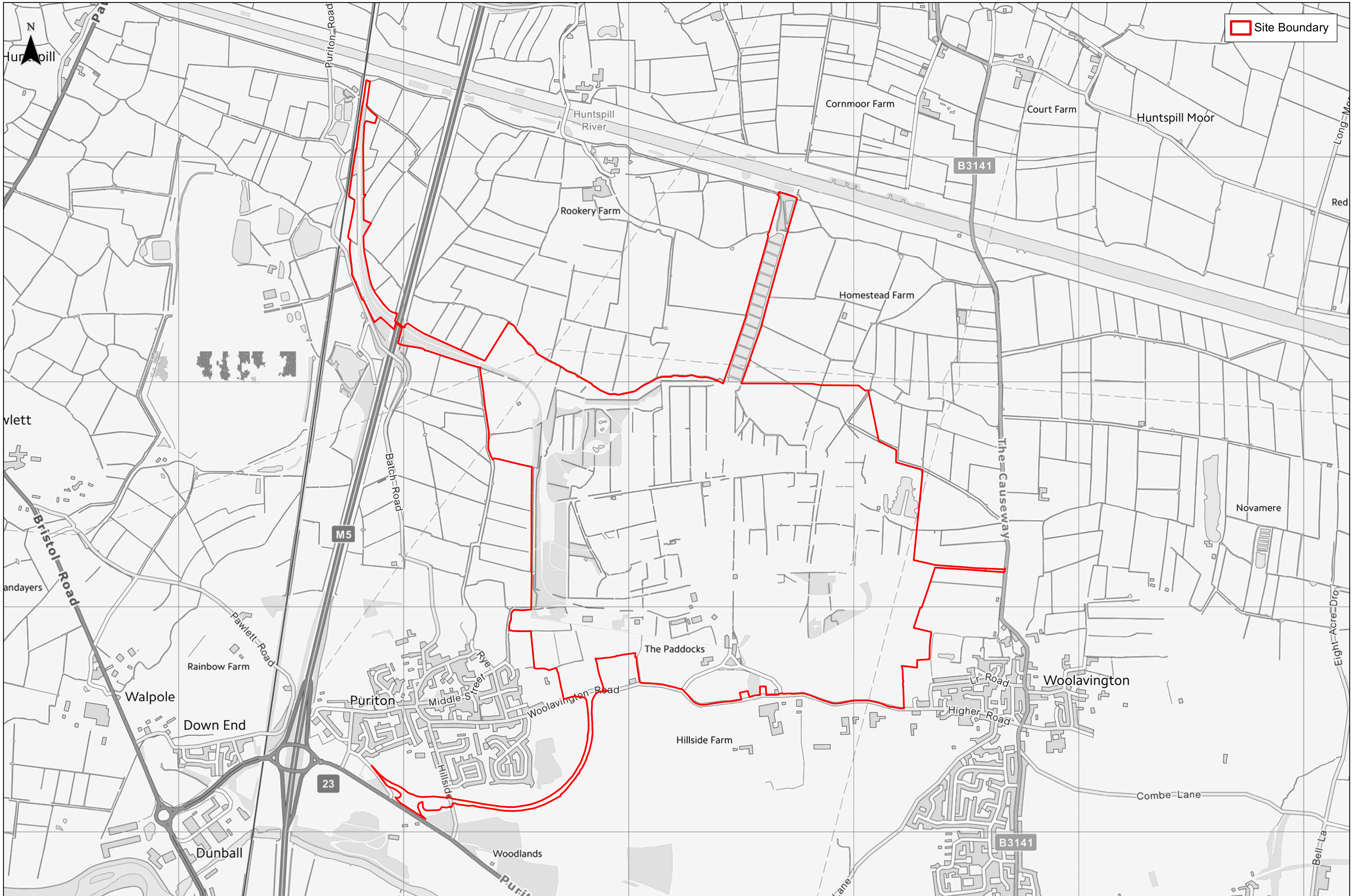
8.3.1 Matters relating to surface water drainage on site are covered by a separate, accompanying SWDS report. Please refer to this report for further details.

8.4 Policy

8.4.1 In conclusion, the future occupants and users of the proposed development will be safe from flooding and there will be no detrimental impact on third parties. The proposal complies with the NPPF and local planning policy with respect to flood risk and is an appropriate development at this location.

Appendix A Baseline

Figure 1 - Site Location Plan
Figure 2 - Site Location Aerial



Stantec

Client: G

GRAVITY

Site Location

0 250 500 m

Contains Ordnance Survey data © Crown copyright and database right 2019.

1:15,000 @ A3	Date: 18/08/2021
Drawn: CE	Checked: RR
Figure 001	Rev A

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Stantec	Client: G	**GRAVITY** Site Location (Aerial)	0 250 500 m Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community Contains Ordnance Survey data (c) Crown copyright and database right 2019.	1:15,000 @ A3 — Date: 18/08/2021 Drawn: CE — Checked: RR Figure 002 — Rev A

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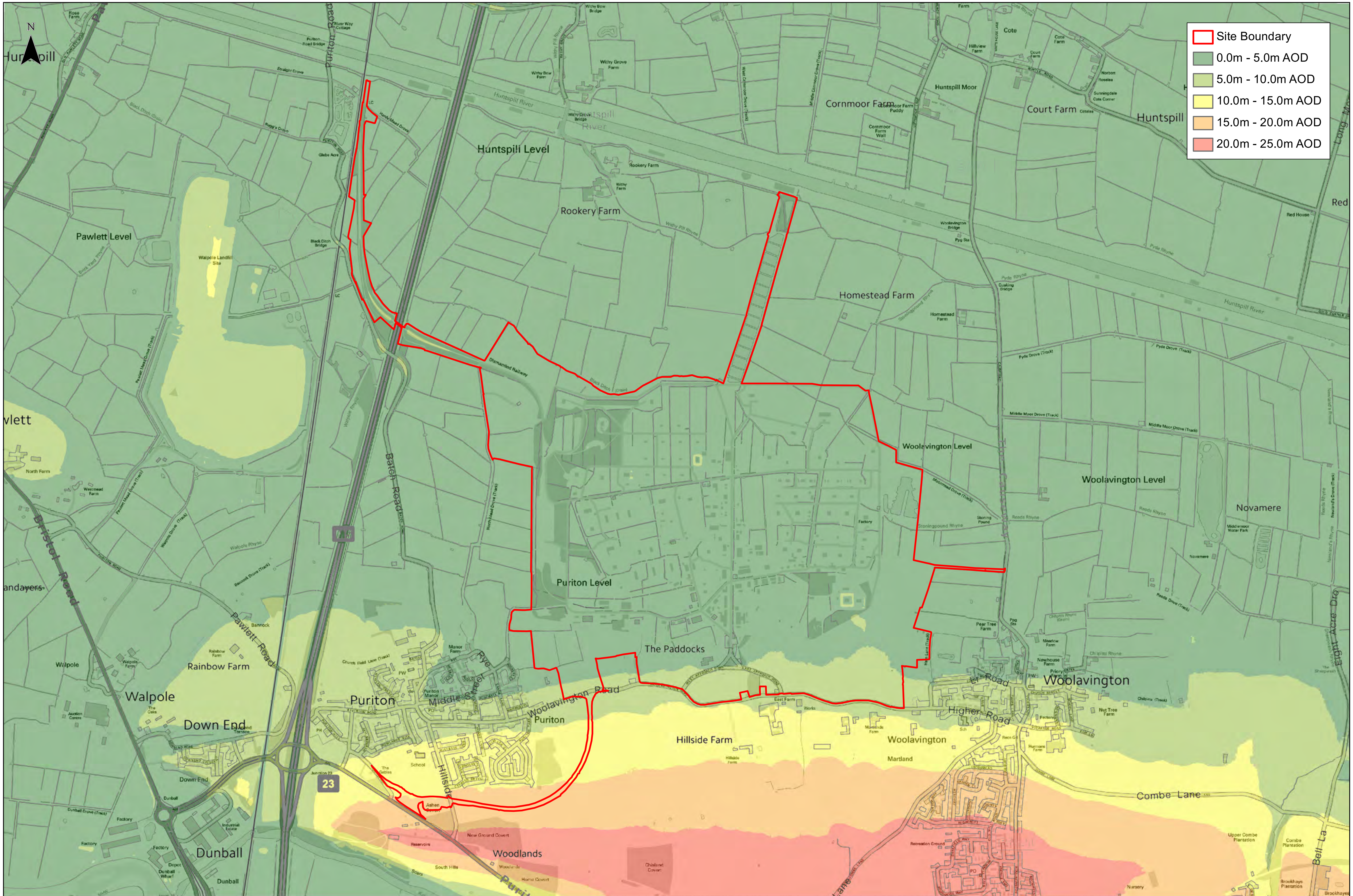
Appendix B Topography

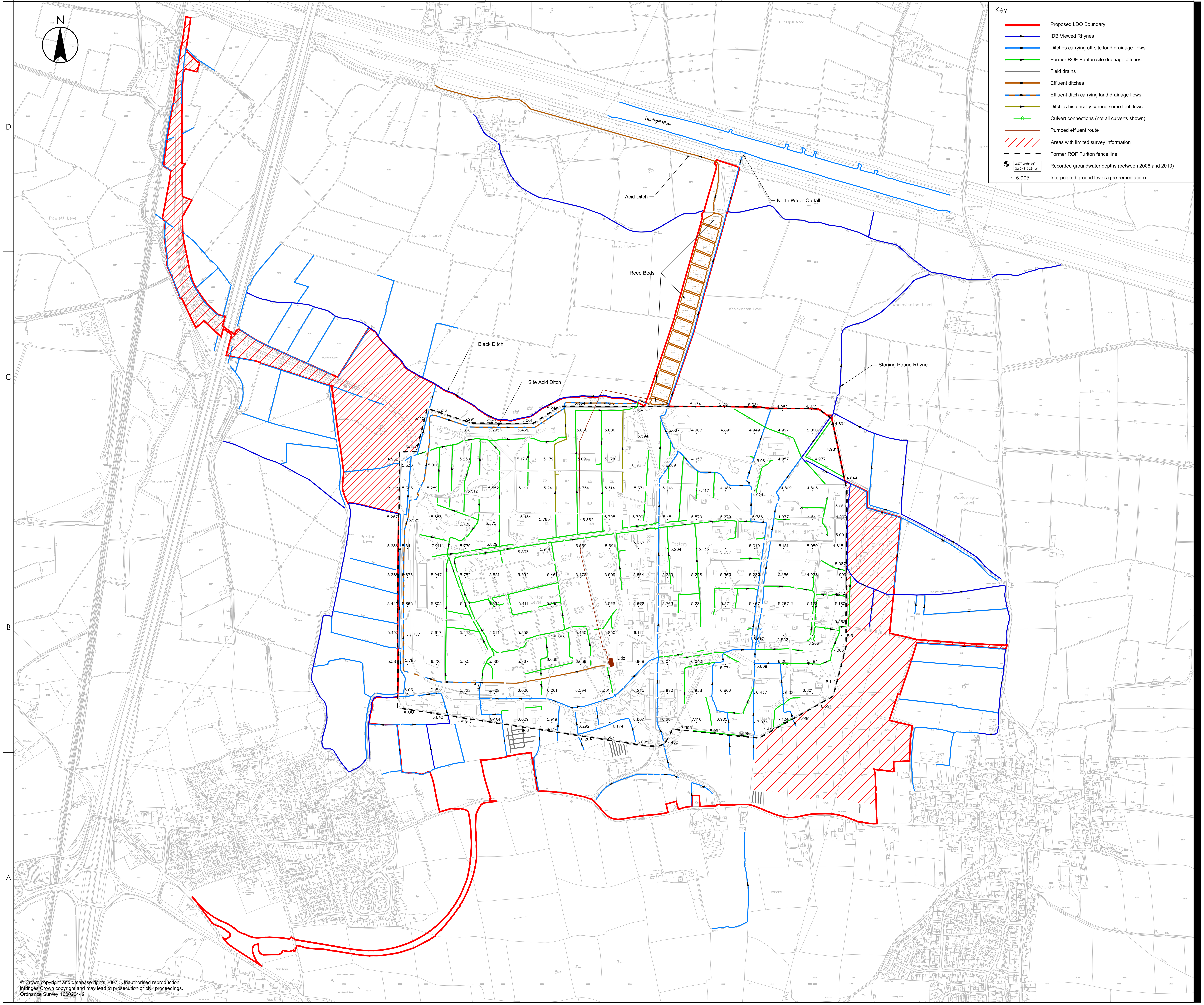
Figure 3 – Topography



Stantec	Client: G	GRAVITY Topography	0 250 500 m Contains Environment Agency information Environment Agency and/or database right Contains Ordnance Survey data © Crown copyright and database right 2019.	1:15,000 @ A3	Date: 09/09/2021
				Drawn: CE	Checked: RR
				Figure 003	Rev A

Appendix C Existing Drainage

332310092-4002-SK01 Existing Drainage Conditions



Stantec

Stantec UK Limited
TAUNTON
Lakeside House, Blackbrook Business Park, Blackbrook
Park Avenue, Taunton TA1 2PX
Tel: +44 1823 218 940
www.stantec.com/uk

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Notes

UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake their own investigation where the presence of any existing sewers, services, plant or apparatus may affect their operations.

1. This drawing is to be read in conjunction with all other Engineer's and Architect's drawings.
2. All dimensions are in metres unless noted otherwise.
3. All levels are in metres above Ordnance Datum (AOD).
4. The location of ditches and rhynes has been determined based on Ordnance Survey data and topographical surveys undertaken by Lewis Brown Chartered Land Surveyors (ref: N07029, date: Sep 2007 and ref: B02002, date: Feb 2020).
5. Areas of the site where topographical survey information is limited are indicated and it is recommended that more detailed surveys of these areas are undertaken prior to detailed design works commencing.

A	REMOVED PROJECT GROVE PLATFORM BOUNDARY	TM	RAS	2021.10.15
Issued/Revision		By	Appd	YYYY.MM.DD
	LWD	-	AJ	2021.08.19
	Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Issue Status

FOR INFORMATION

This document is suitable only for the purpose noted above.
Use of this document for any other purpose is not permitted.

Client/Project Logo

Gravity

Client/Project
This is Gravity Ltd

Former ROF Puriton, Somerset, United Kingdom

Title
Existing Drainage Conditions

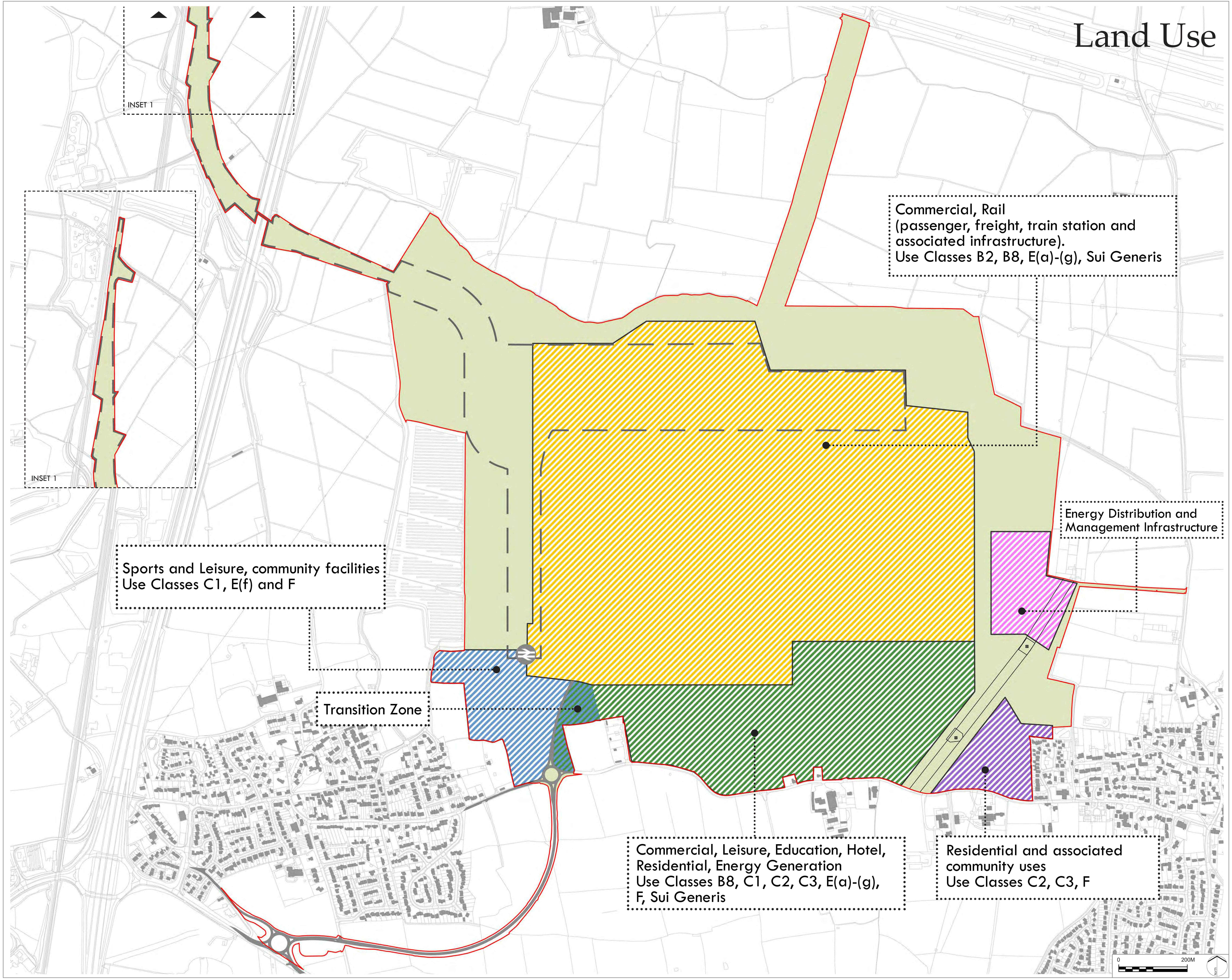
Project No.	Scale
332310092	NTS
Revision	**Drawing No.**
A	332310092/4002/SK01

Appendix D Development Proposals

6599_PP201L_Land Uses
6599_PP204H_Building Heights

Z:\6599_Puriton_Gravity Masterplan Development\5graphics\Plans_Images\Parameter Plans\6599_PP101_Land Uses.indd

Land Use



LEGEND

- LDO Boundary
- Commercial, Rail (passenger, freight, train station and associated infrastructure). Use Classes B2, B8, E(a)-(g), Sui Generis
- Energy Distribution and Management Infrastructure
- Residential and associated community uses Use Classes C2, C3, F
- Commercial, Leisure, Education, Hotel, Residential, Energy Generation Use Classes B8, C1, C2, C3, E(a)-(g), F, Sui Generis
- Sports and Leisure, community facilities Use Classes C1, E(f) and F
- Transition Zone
- Open space and biodiversity zones Including surface water attenuation features, watercourses, woodland, hedgerows and trees, utilities, occasional vehicular routes and rail line with associated infrastructure.
- Rail corridor - Freight and Passenger, and associated infrastructure
- Passenger Station (indicative location)

REV.	DESCRIPTION	APP.	DATE
L	Changes to title block	RF	08.09.21
K	Key updated	RF	25.08.21
J	Key updated	RF	16.08.21
I	Key updated	RF	16.08.21
H	Key updated	RF	16.08.21
G	Uses zones updated	RF	13.08.21
F	Key updated and train station logo relocated	RF	13.08.21
E	Key updated following comments from JH	RF	08.06.21
D	Key updated following comments from CP	RF	04.06.21
C	Rail corridor; plan inset	RF	03.06.21
B	Use classes	RF	24.05.21
A	Format of key amended	RF	24.05.21
-	First Issue	RF	21.05.21

LDĀDESIGN

PROJECT TITLE
GRAVITY

DRAWING TITLE
PARAMETER PLAN
Land Uses

ISSUED BY	Exeter	T: 01392 260430	
DATE	May 2021	DRAWN	KS/DA
SCALE@A1	1:5,000	CHECKED	RF
STATUS	LDO	APPROVED	FO

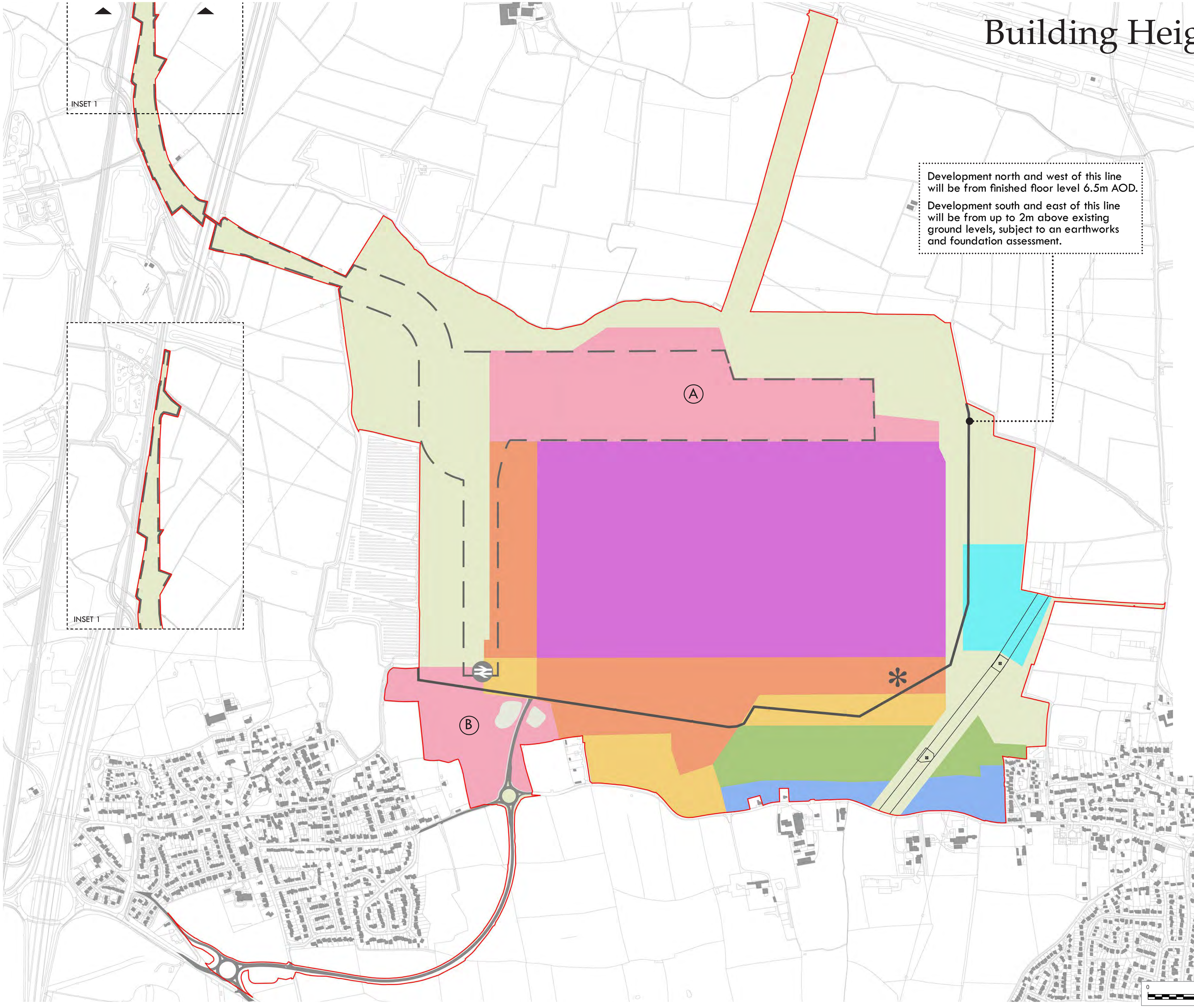
DWG. NO. 6599_PP201L

No dimensions are to be scaled from this drawing.
All dimensions are to be checked on site.
Area measurements for indicative purposes only.

Sources: Ordnance Survey

v2018.0

Building Heights



LEGEND

- LDO Boundary
- Open space and biodiversity zones Including surface water attenuation features, watercourses, woodland, hedgerows and trees, utilities, occasional vehicular routes and rail line with associated infrastructure.
- Indicative location for Energy Generation. The height and number of flues associated with the Energy Generation will be determined by dispersion modeling. Typically 3m higher than adjacent building height.
- Rail corridor - Freight and Passenger, and associated infrastructure
- Passenger Station (indicative location)
- Development north and west of this line will be from finished floor level 6.5m AOD.
  Development south and east of this line will be from up to 2m above existing ground levels, subject to an earthworks and foundation assessment.
- Overhead powerlines 400 kVA
- 11 m — Up to 11m ridge height from up to 2m above existing ground level.
- 11 m — Up to 11m ridge height from up to 2m above existing ground level. Up to 50% of the zone will accommodate buildings, the remainder will be: (A) associated infrastructure such as rail, including mobile gantry cranes, roads and/ or green infrastructure. (B) green infrastructure, community uses, sports, leisure or associated infrastructure such as roads, footpaths and cycle routes.
- 15 m — Up to 15m ridge height from up to 2m above existing ground level.
- 23 m — Up to 23m ridge height from up to 2m above existing ground level.
- 25 m / 35 m — Up to 35m ridge height from up to 2m above existing ground level. An additional 25m permitted for stacks.
- 9 m — Up to 9m ridge height, with limited areas (up to 5% of the height zone), of up to 12m ridge height in key locations, from up to 2m above existing ground level.
- 12 m — Up to 12m ridge height from up to 2m above existing ground level.

Note: Infrastructure associated with utilities and rail such as cranes and other structures are not included within the parameters set out as they are likely to be mobile uses and location and number are to be determined by the end user.

REV.	DESCRIPTION	APP.	DATE
H	Changes to title block	RF	08.09.21
G	Train station logo relocated	RF	13.08.21
F	Key updated following comments from JH	RF	12.07.21
E	Key updated to include +2m for ground reprofiling	RF	09.06.21
D	Key updated following comments from JH	RF	08.06.21
C	Key updated following comments from CP	RF	04.06.21
B	Cranes and rail line; key; plan inset	RF	03.06.21
A	Format of key amended	RF	24.05.21
-	First Issue	RF	21.05.21

LDĀ DESIGN

PROJECT TITLE
GRAVITY

DRAWING TITLE
PARAMETER PLAN
Building Heights

ISSUED BY	Exeter	T: 01392 260430	
DATE	May 2021	DRAWN	KS/DA
SCALE@A1	1:5,000	CHECKED	RF
STATUS	LDO	APPROVED	FO

DWG. NO. 6599_PP204H

No dimensions are to be scaled from this drawing.
All dimensions are to be checked on site.
Area measurements for indicative purposes only.

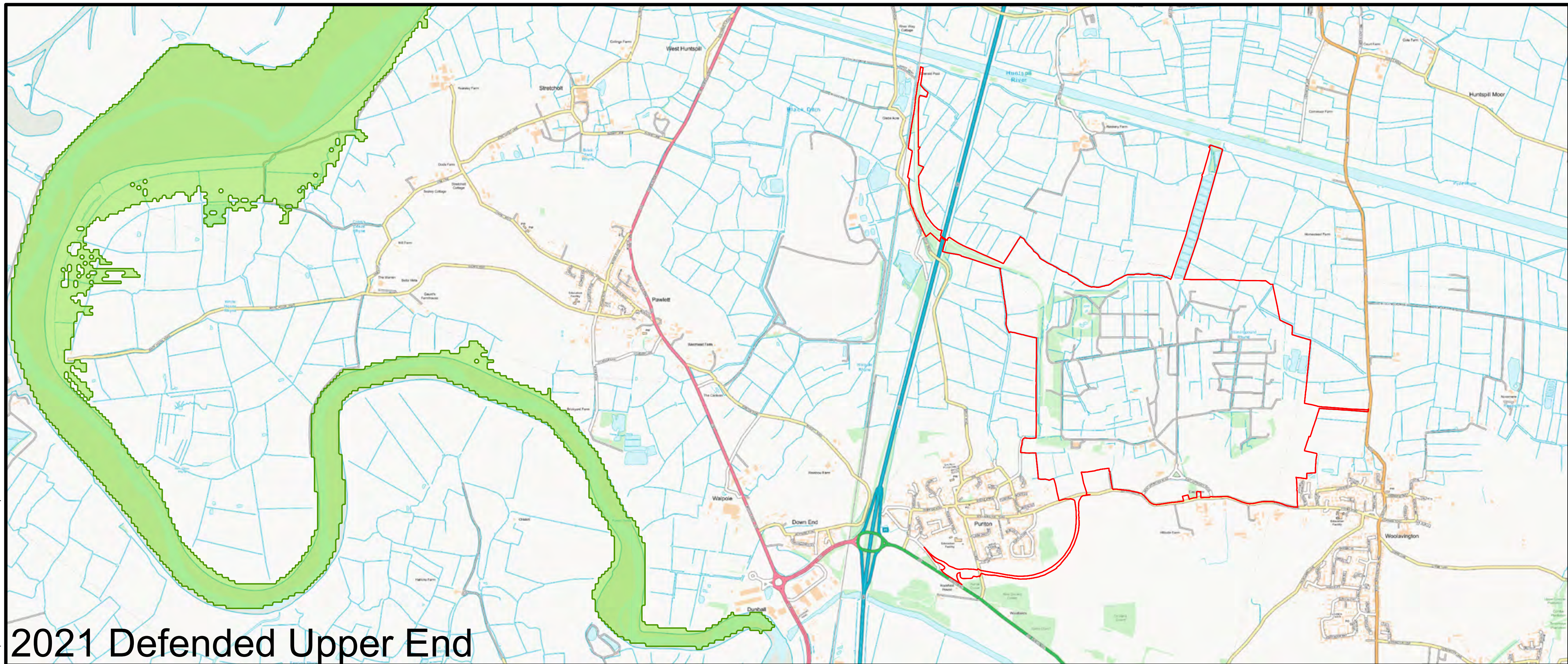
Sources: Ordnance Survey

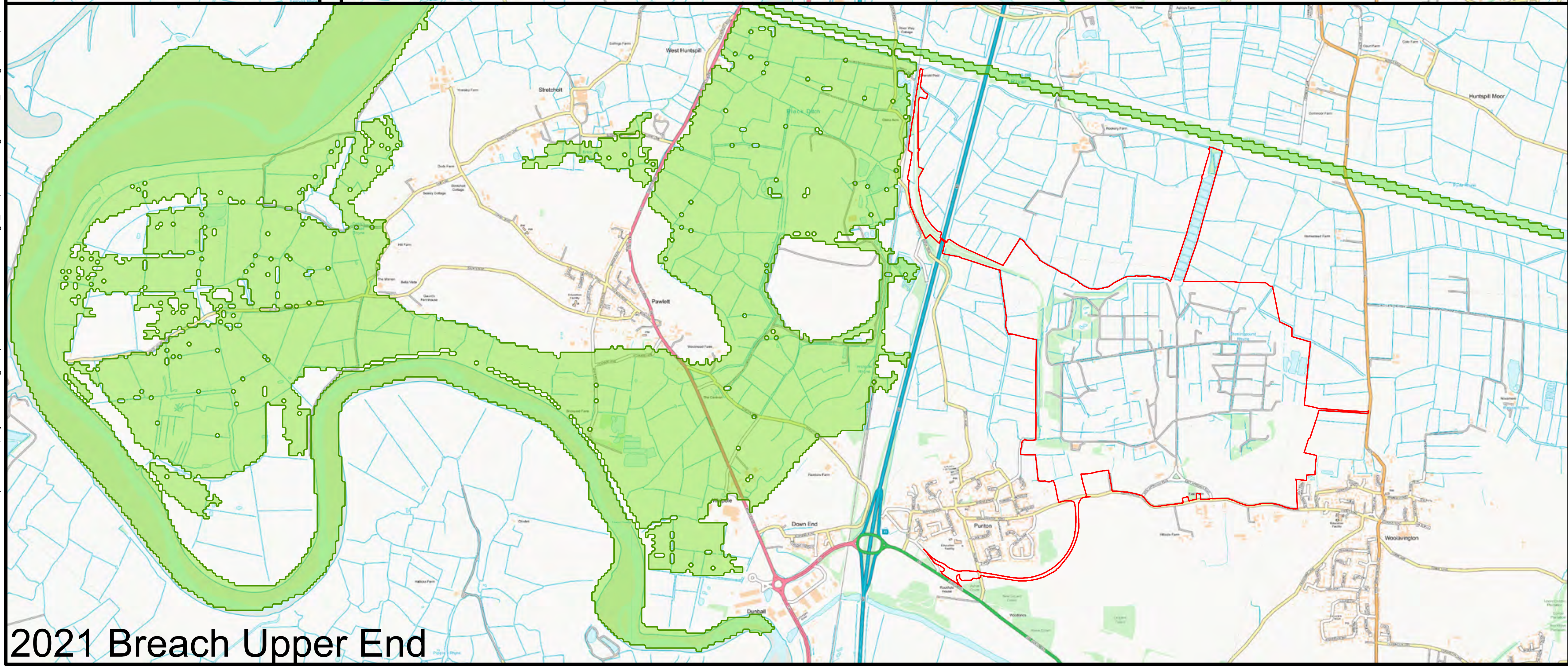
Z:\6599_Purton_Gravity Masterplan Development\Graphics\Plans_Images\Parameter Plans\6599_PP105_Building Heights.indd

v2018.0

Appendix E 2021 Modelled Extents

Figure E.1 – 1in200yr Flood Extent 2021 UE Beach and Overtopping
Figure E.2 – Pre and Post Development 1in200yr Flood Extent 2102 UE Breach
Figure E.3 – Pre and Post Development 1in200yr Flood Extent 2132 UE Breach





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TAUNTON
Lakeside House, Blackbrook Business Park, Blackbrook Park Avenue, Taunton TA1 2PX
Tel: +44 1823 218 940
www.stantec.com/uk

Key

Site Boundary

Modelled Flood Extent

Client/Project:
This is Gravity Ltd

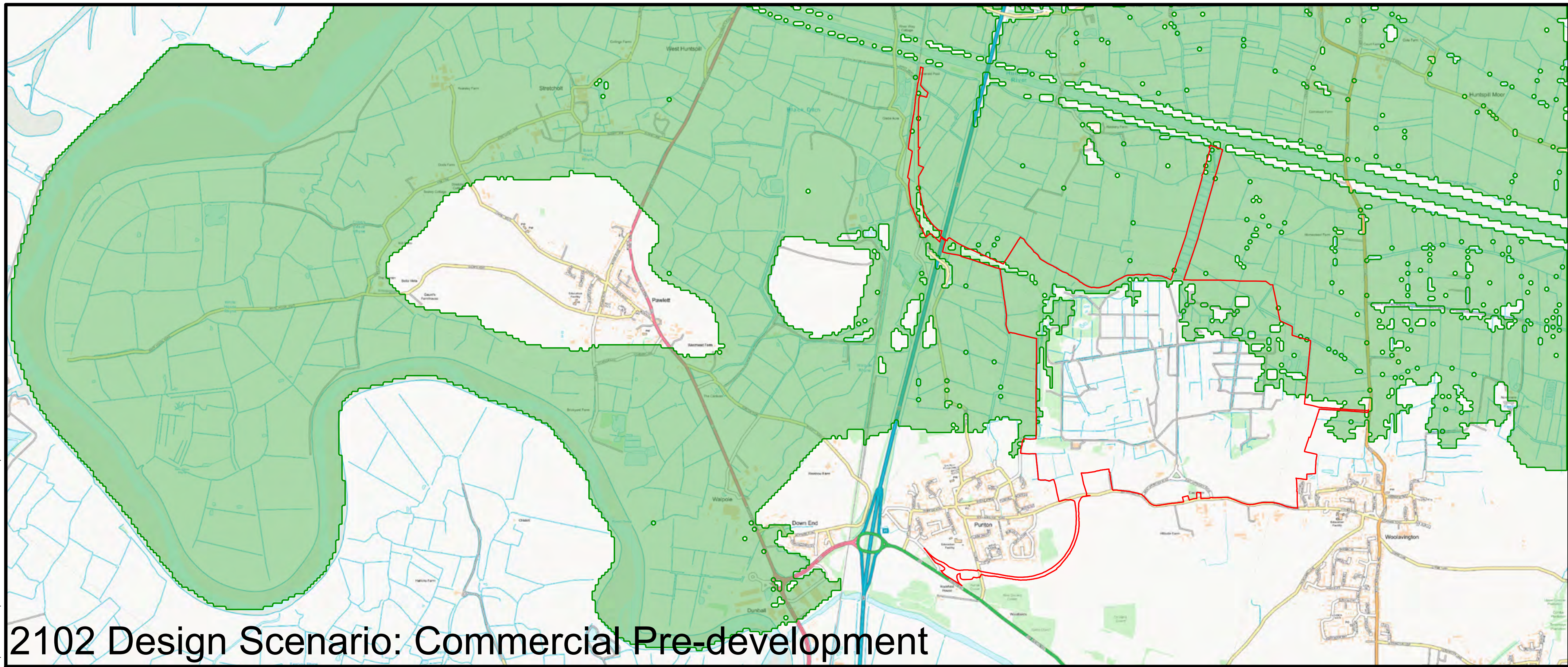
Local Development Order

Prepared: RR
Checked: KT
Date: 2021.11.12

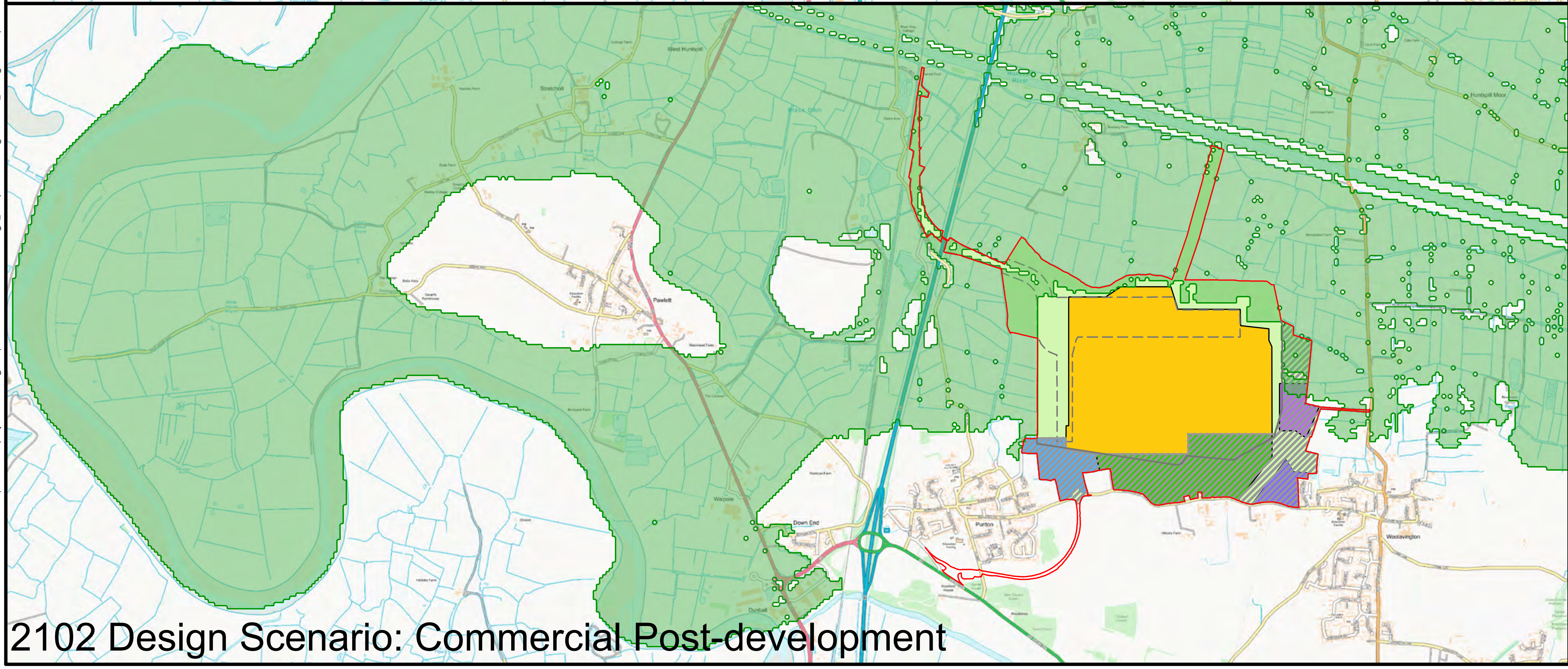
Title
Present Day
1 in 200 year Flood Extent
2021 Upper End

Revision:
Figure E.1

Plotted: 15.11.2021 2021.11.15 11:51:55 AM By: Derrick, Lewis
ORIGINAL SHEET - ISOA3
\\tnt-vfps-001\tnt\projects\49102 gravity ldo\4002 flood risk & drainage_fa-hyd\cad\dwgs\211111_fra\figure e1 - pre development modelled flood extent 200yr 2021 ue



2102 Design Scenario: Commercial Pre-development



2102 Design Scenario: Commercial Post-development

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Key

- Site Boundary
- Modelled Flood Extent (Commercial)
- Commercial, Rail (passenger, freight, train station and associated infrastructure) Use classes B2, B8, E(a)-(g), Sui Generis
- Open space and biodiversity zones including surface water attenuation features, watercourses, woodland, hedgerows and trees, utilities, occasional vehicular routes and rail line with associated infrastructure
- Other Development Types

Client/Project:
This is Gravity Ltd

Local Development Order

Prepared:	Checked:	Date:
RR	KT	2021.11.12

Title
COMMERCIAL
1 in 200 year Flood Extent
2102 Upper End Breach

Revision:	Figure
	E.2

Plotted: 15.11.2021 2021.11.15 11:55:42 AM By: Derrick, Lewis
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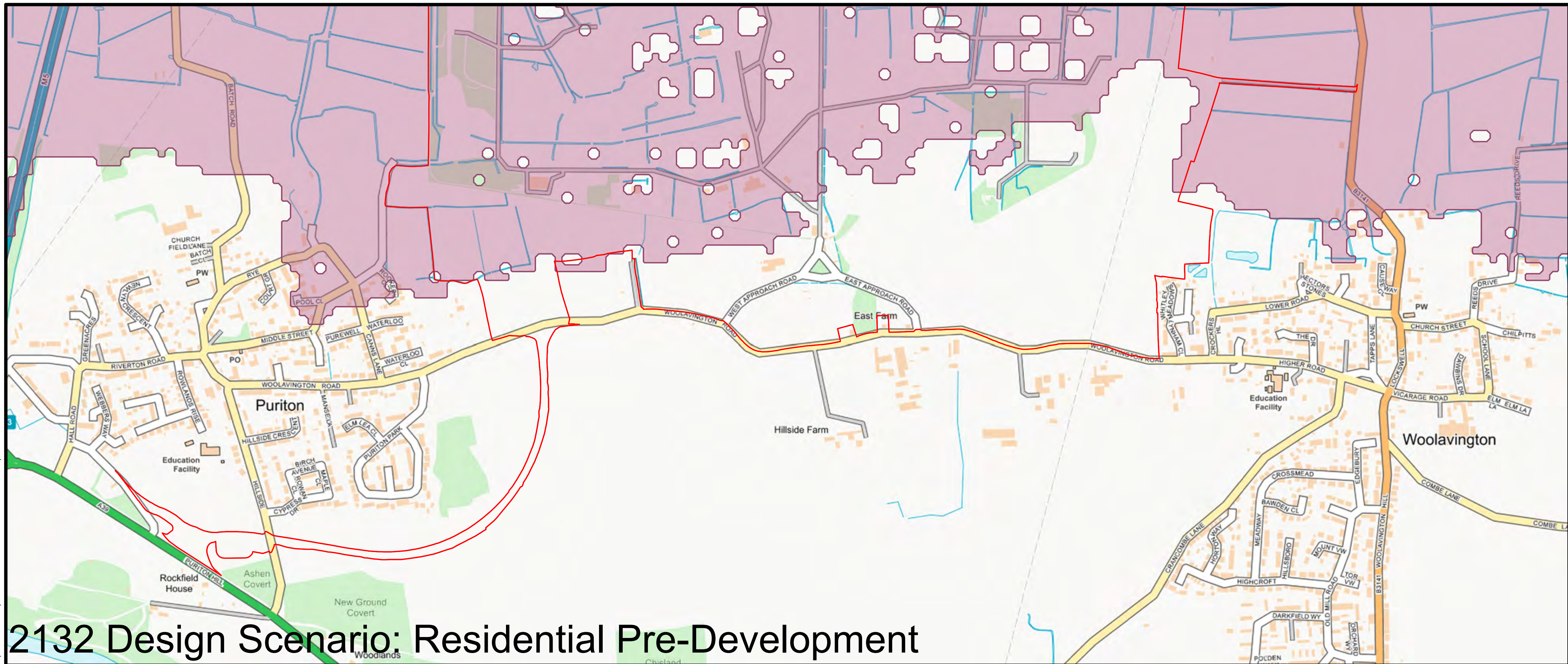
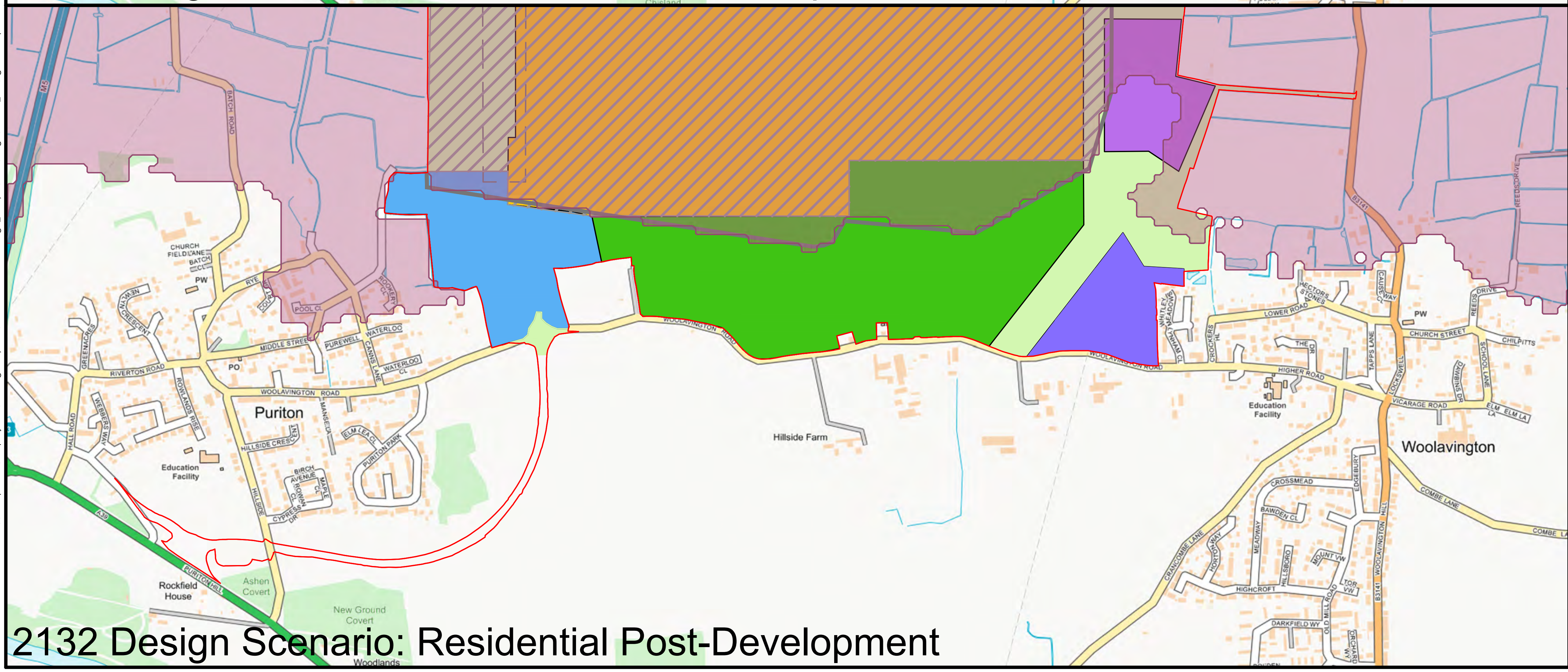


2132 Design Scenario: Residential Pre-Development



2132 Design Scenario: Residential Post-Development

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Key

- Site Boundary
- Modelled Flood Extent (Residential)
- Energy Distribution and Management Infrastructure
- Residential and associated community uses Use Classes C2, C3, F
- Commercial, Leisure, Education, Hotel, Residential, Energy Generation Use Classes C1, C2, C3, C3, E(a)-(g), F, Sui Generis
- Sport and leisure, community facilities Use Class F
- Open space and biodiversity zones including surface water attenuation features, watercourses, woodland, hedgerows and trees, utilities, occasional vehicular routes and rail line with associated infrastructure
- Other Development Types

Client/Project:
This is Gravity Ltd

Local Development Order

Prepared:	Checked:	Date:
RR	KT	2021.11.12

Title
RESIDENTIAL
1 in 200 year Flood Extent
2132 Upper End Breach

Revision:

Figure
E.3

Plotted: 15.11.2021 2021.11.15 11:57:42 AM By: Derrick, Lewis
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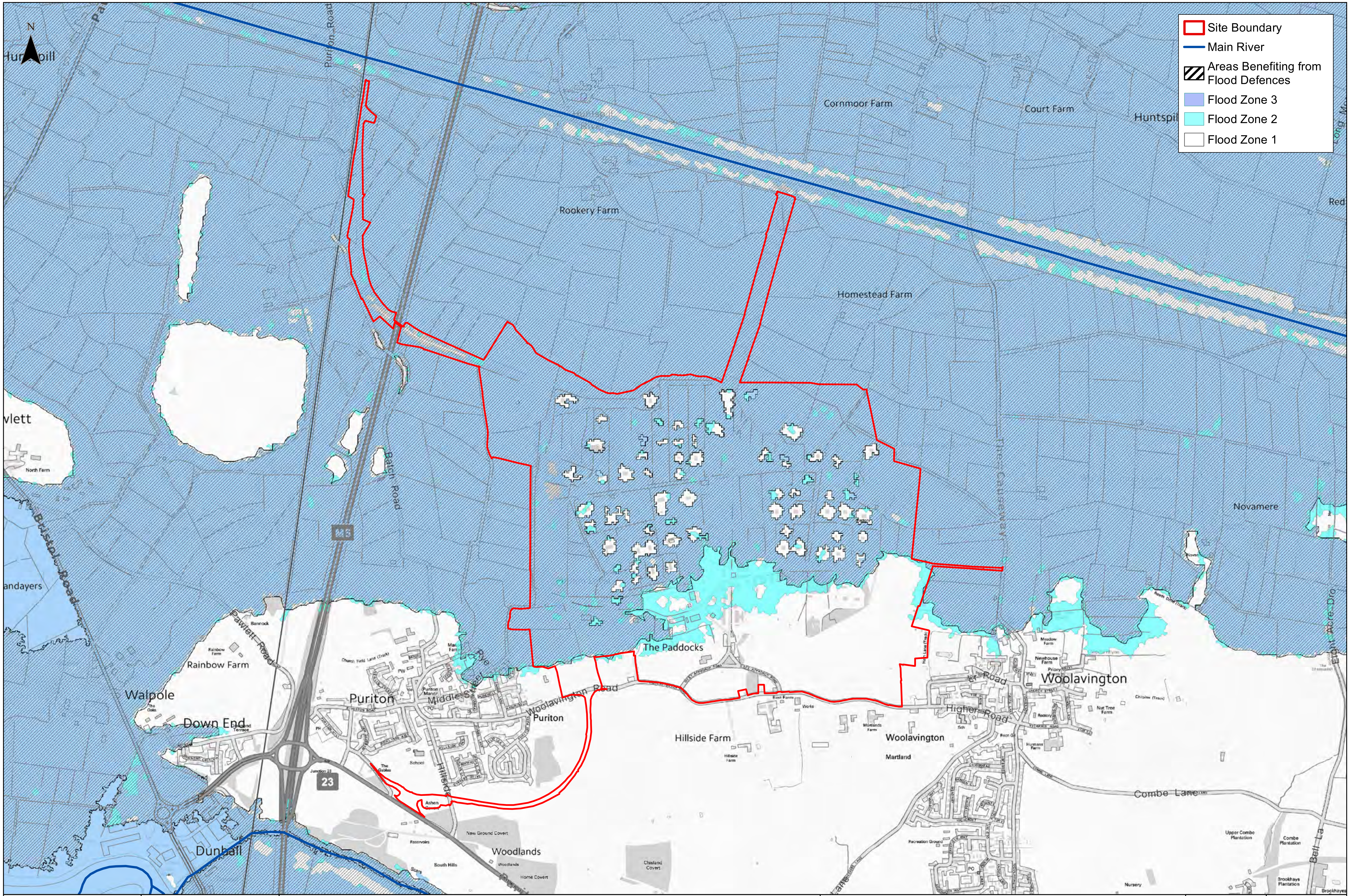
Appendix F Flood Risk



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				Drawn: CE	Checked: RR
				Figure 004	Rev A

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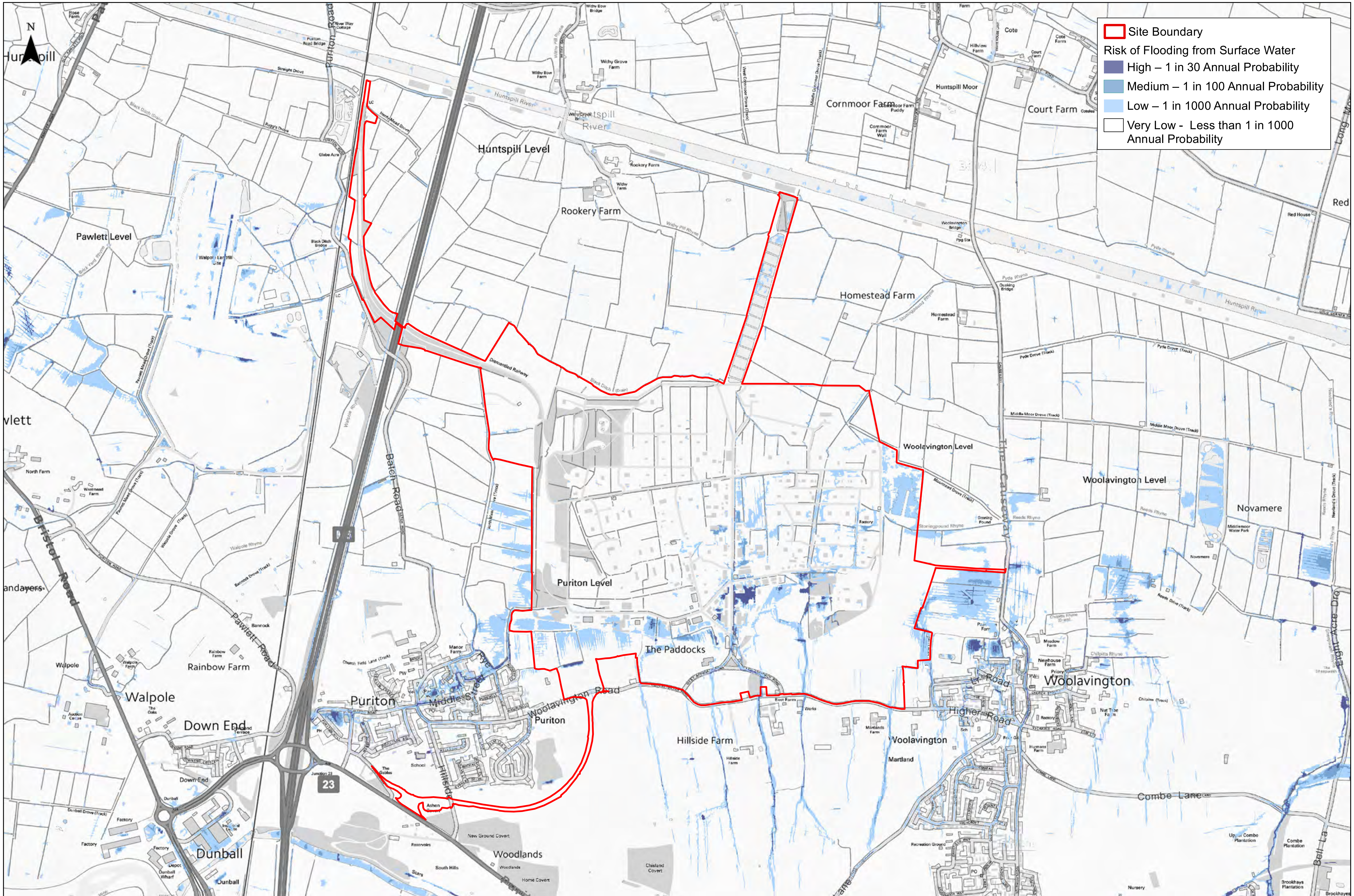


Client:

G

GRAVITY

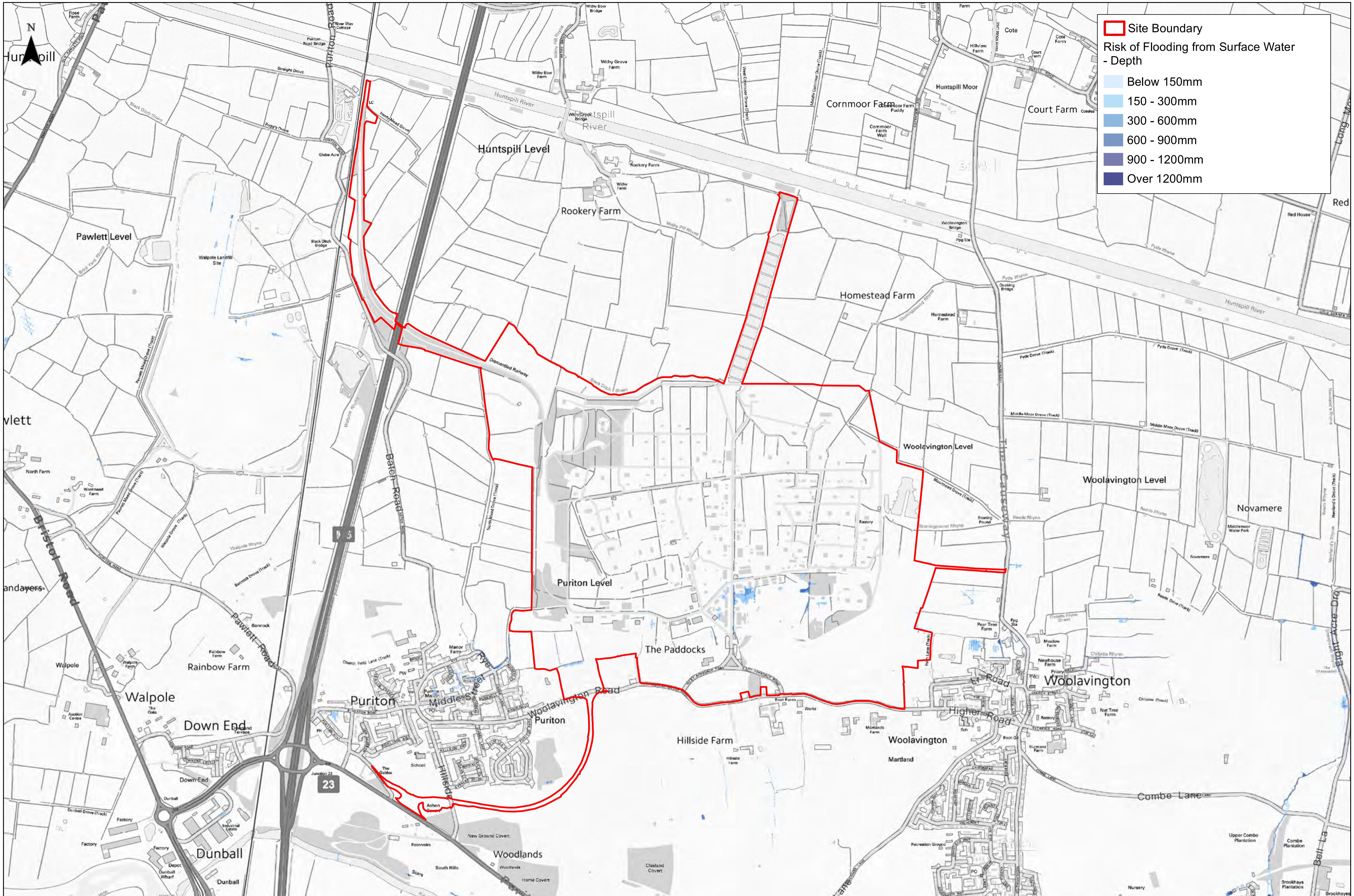
EA Surface Water Flood Risk

0 250 500 m

Contains Environment Agency information © Environment Agency and database right
Contains Ordnance Survey data © Crown copyright and database right 2019.
Maps based on EA updated 'Flood Map for Surface Water' ('uFMfSW') released in 2013 as the latest iteration of a national scale surface water modelling exercise

1:15,000 @ A3	Date: 20/08/2021
Drawn: CE	Checked: RR
Figure 005	Rev A

Document Path: \\pba.int\cbh\GIS\GIS_central\Projects\332310102\02_mxd\FRA\mxd\Figure005_SurfaceWaterFloodRisk.mxd



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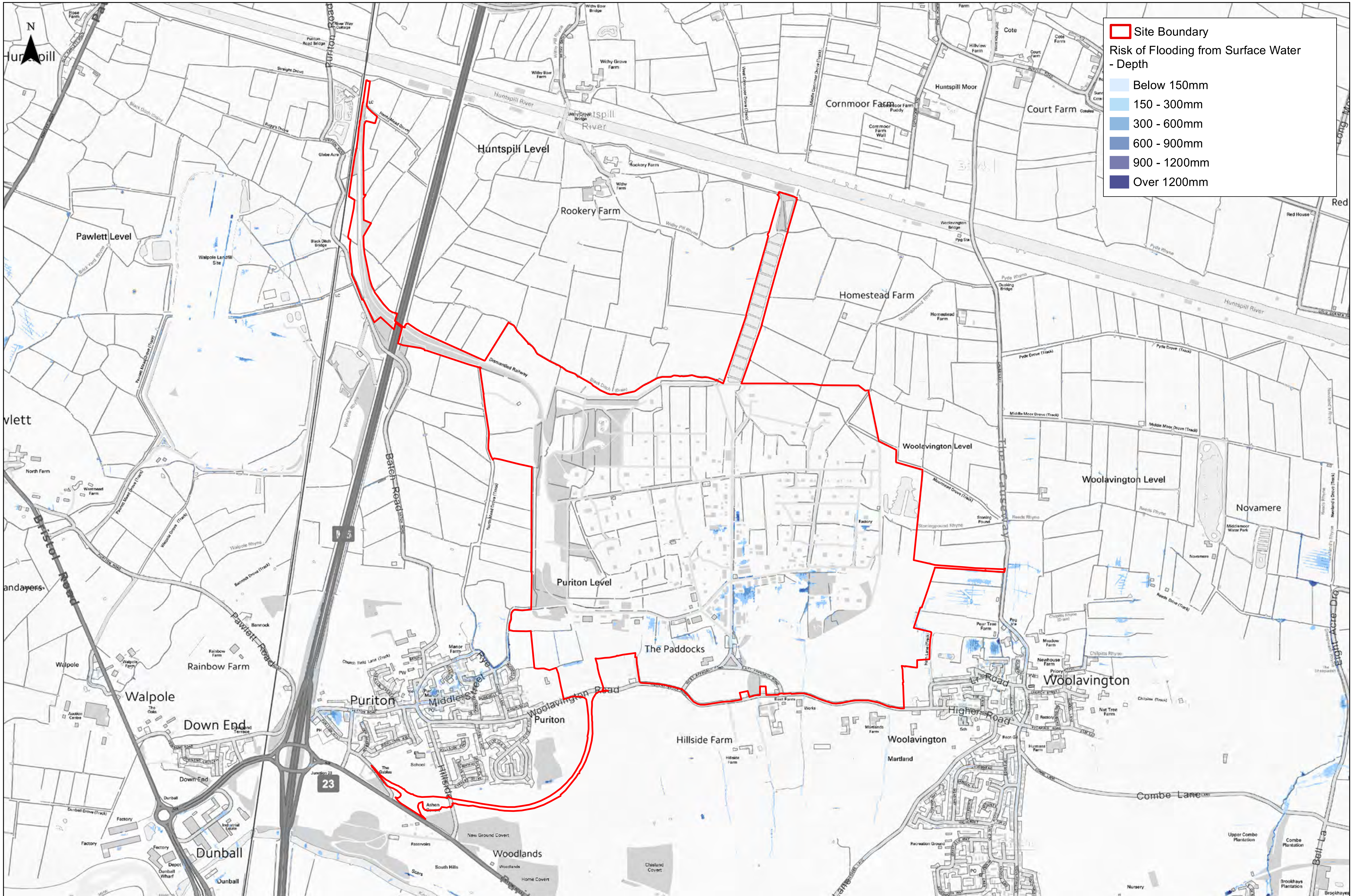
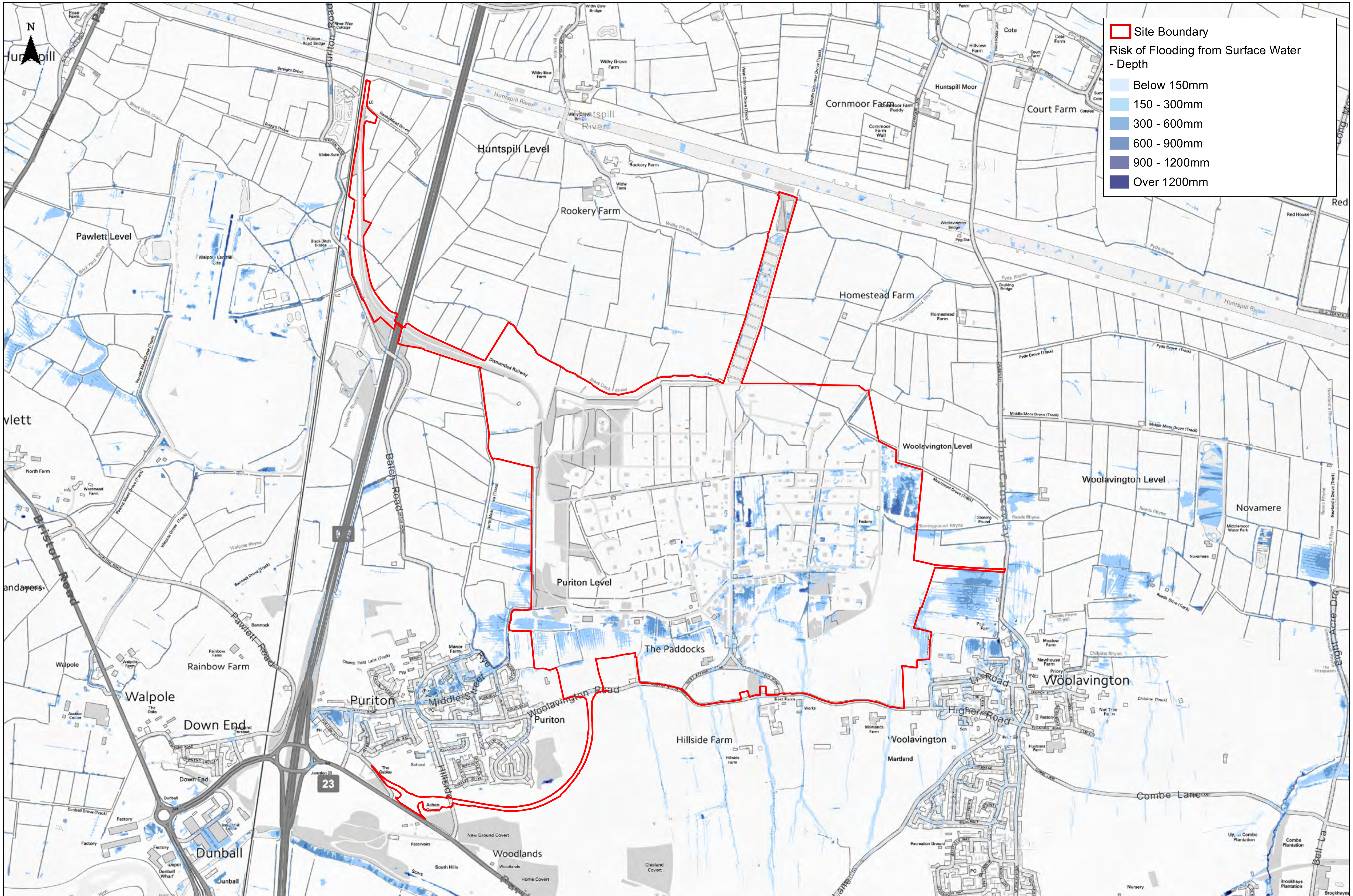


Stantec	Client: G	**GRAVITY** EA Surface Water Flood Risk - Depth 1.0 Percent Chance	0 250 500 m Contains Environment Agency information © Environment Agency and database right Contains Ordnance Survey data (c) Crown copyright and database right 2019. Maps based on EA updated 'Flood Map for Surface Water' ('uFMfSW') released in 2013 as the latest iteration of a national scale surface water modelling exercise	1:15,000 @ A3	Date: 20/08/2021
				Drawn: CE	Checked: RR
				Figure 005b	Rev A

Document Path: Z:\Projects\332310102\02_mxd\FRA\mxd\Figure005b_SurfaceWaterFloodRiskDepth_1.mxd



Stantec

Client:

G

GRAVITY

EA Surface Water Flood Risk - Depth

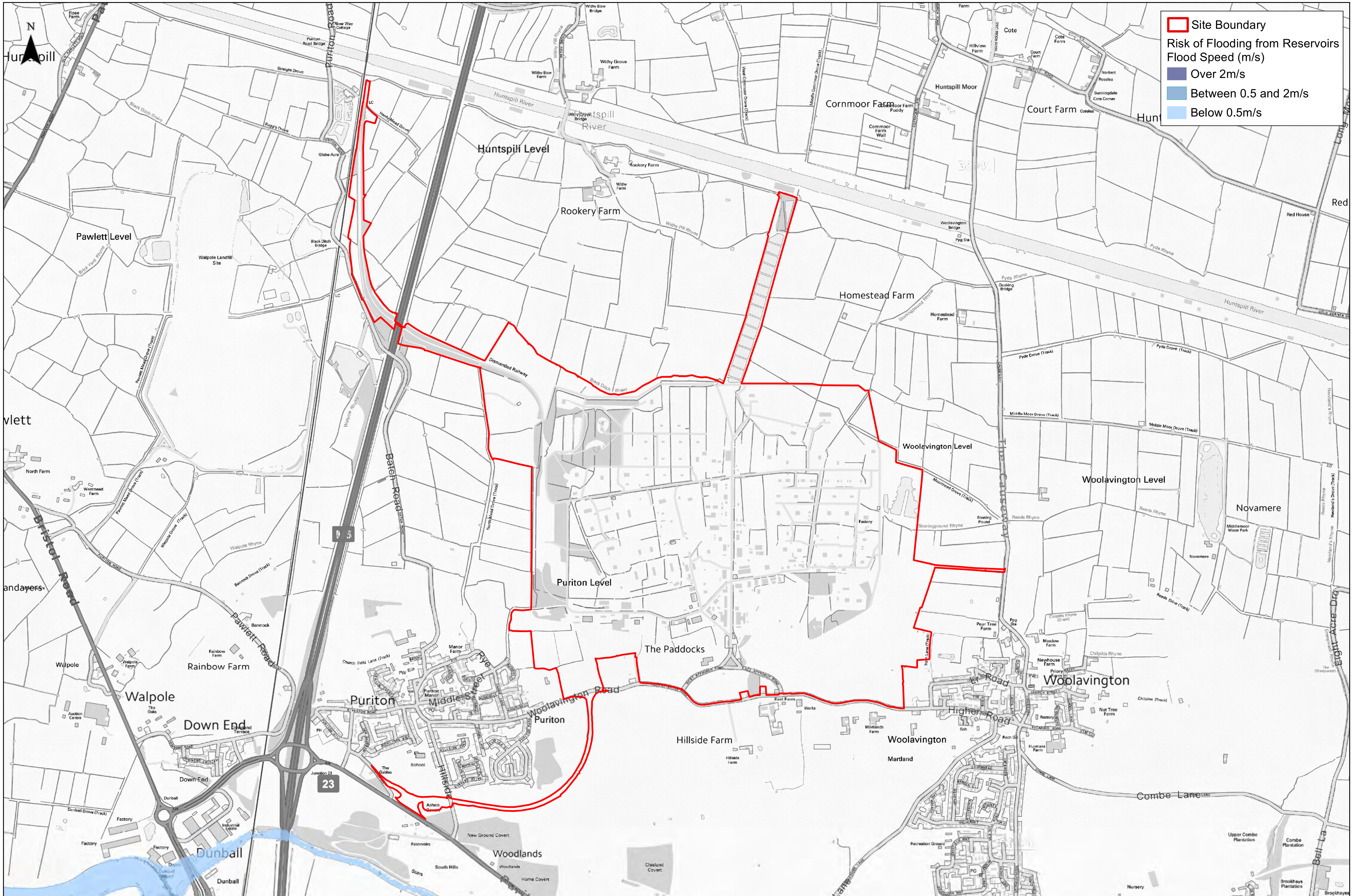
0.1 Percent Chance

0 250 500 m

Maps based on EA updated 'Flood Map for Surface Water' ('uFMfSW') released in 2013 as the latest iteration of a national scale surface water modelling exercise

1:15,000 @ A3	Date: 20/08/2021
Drawn: CE	Checked: RR
Figure 005c	Rev A

Document Path: Z:\Projects\332310102\02_mxd\FRA\mxd\Figure005c_SurfaceWaterFloodRiskDepth_0_1.mxd



Client: G

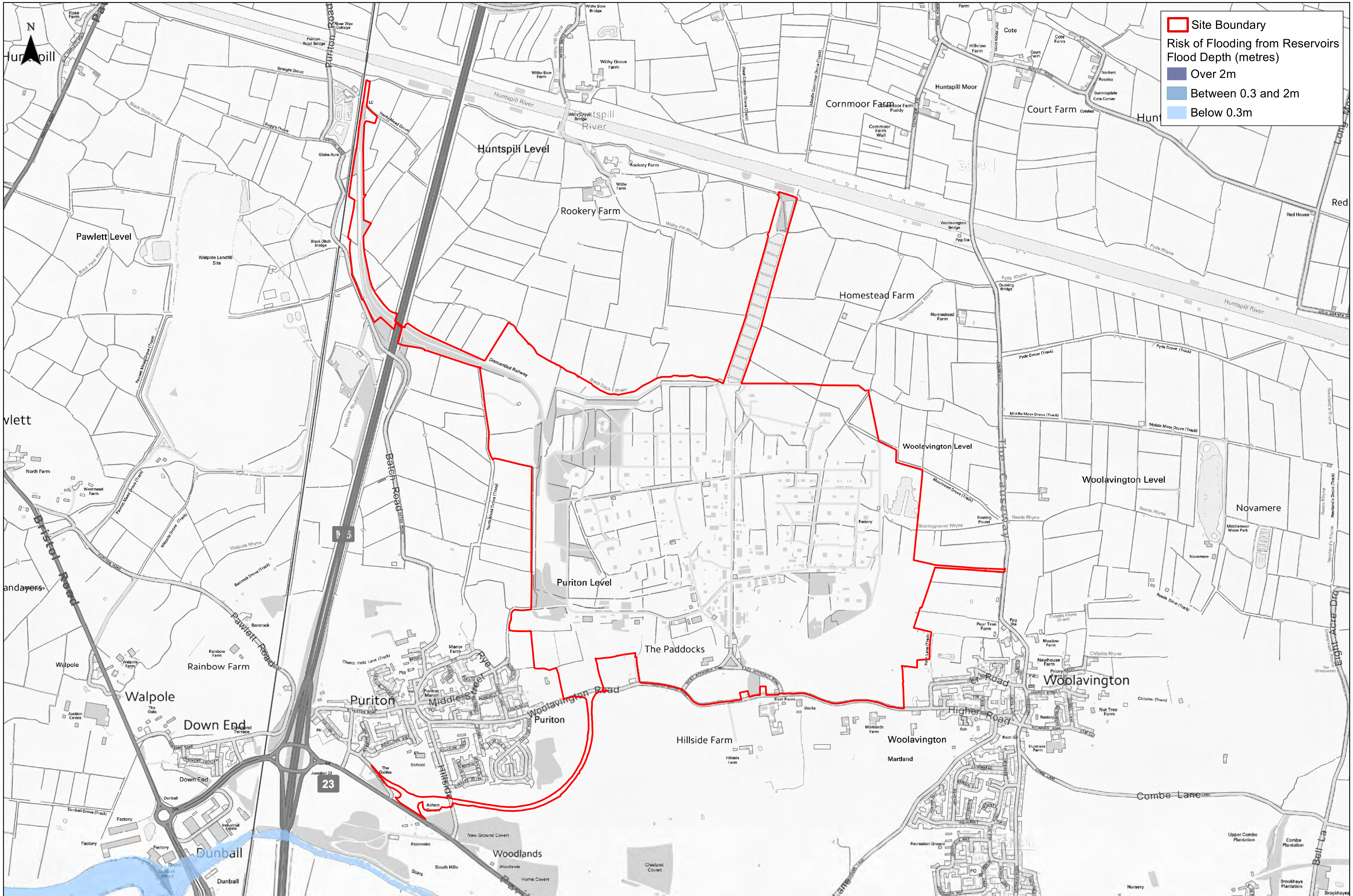
GRAVITY

Risk of Flooding from Reservoirs - Maximum Flood Speed (m/s)

0 250 500 m

1:15,000 @ A3	Date: 20/08/2021
Drawn: CE	Checked: RR
Figure 006	Rev A

Document Path: Z:\Projects\332310102\02_mxd\FRA\mxd\Figure006_ReservoirFloodRisk_FloodSpeed.mxd



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Client: G

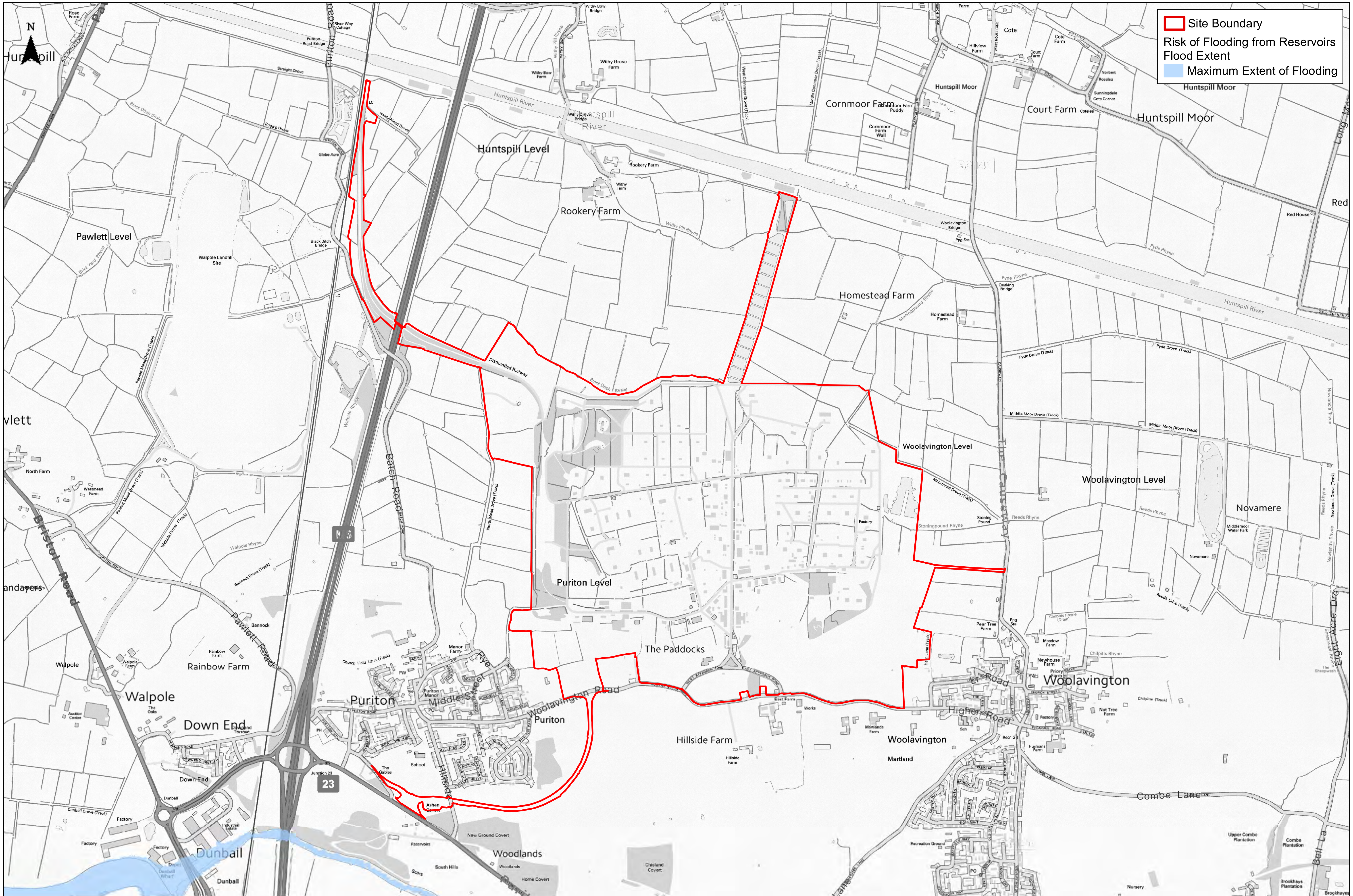
GRAVITY

Risk of Flooding from Reservoirs - Maximum Flood Depth (m)

0 250 500 m

1:15,000 @ A3	Date: 20/08/2021
Drawn: CE	Checked: RR
Figure 006a	Rev A

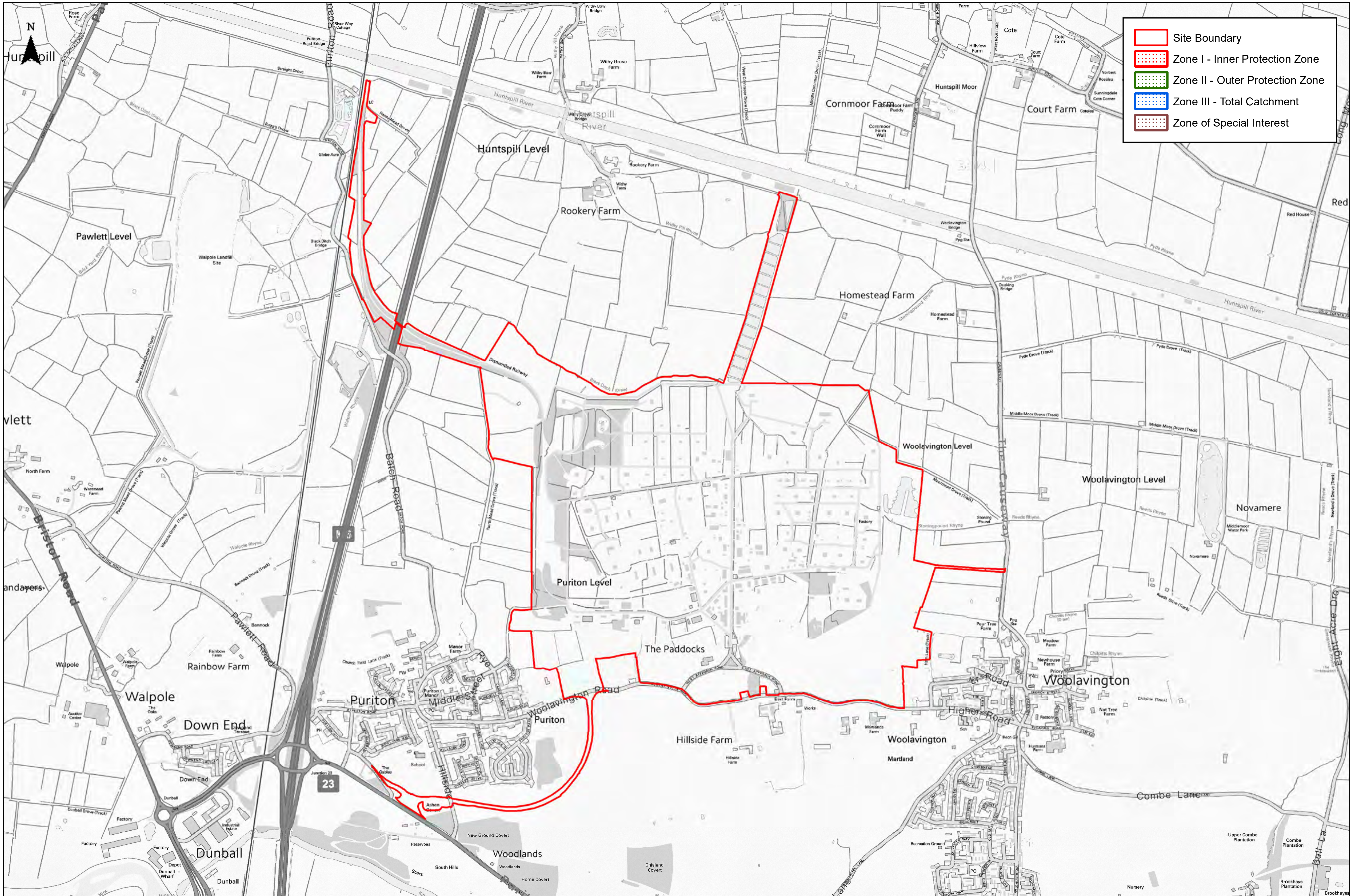
Document Path: Z:\Projects\332310102\02_mxd\FRA\mxd\Figure006a_ReservoirFloodRisk_FloodDepth.mxd



Contains Environment Agency information © Environment Agency and database right 2019.
Contains Ordnance Survey data © Crown copyright and database right 2019.

Stantec	Client: G	GRAVITY Risk of Flooding from Reservoirs - Maximum Flood Extent	1:15,000 @ A3	Date: 20/08/2021
			Drawn: CE	Checked: RR
			Figure 006b	Rev A

Document Path: Z:\Projects\332310102\02_mxd\FRA\mxd\Figure006b_ReservoirFloodRisk_FloodExtent.mxd



Client:

G

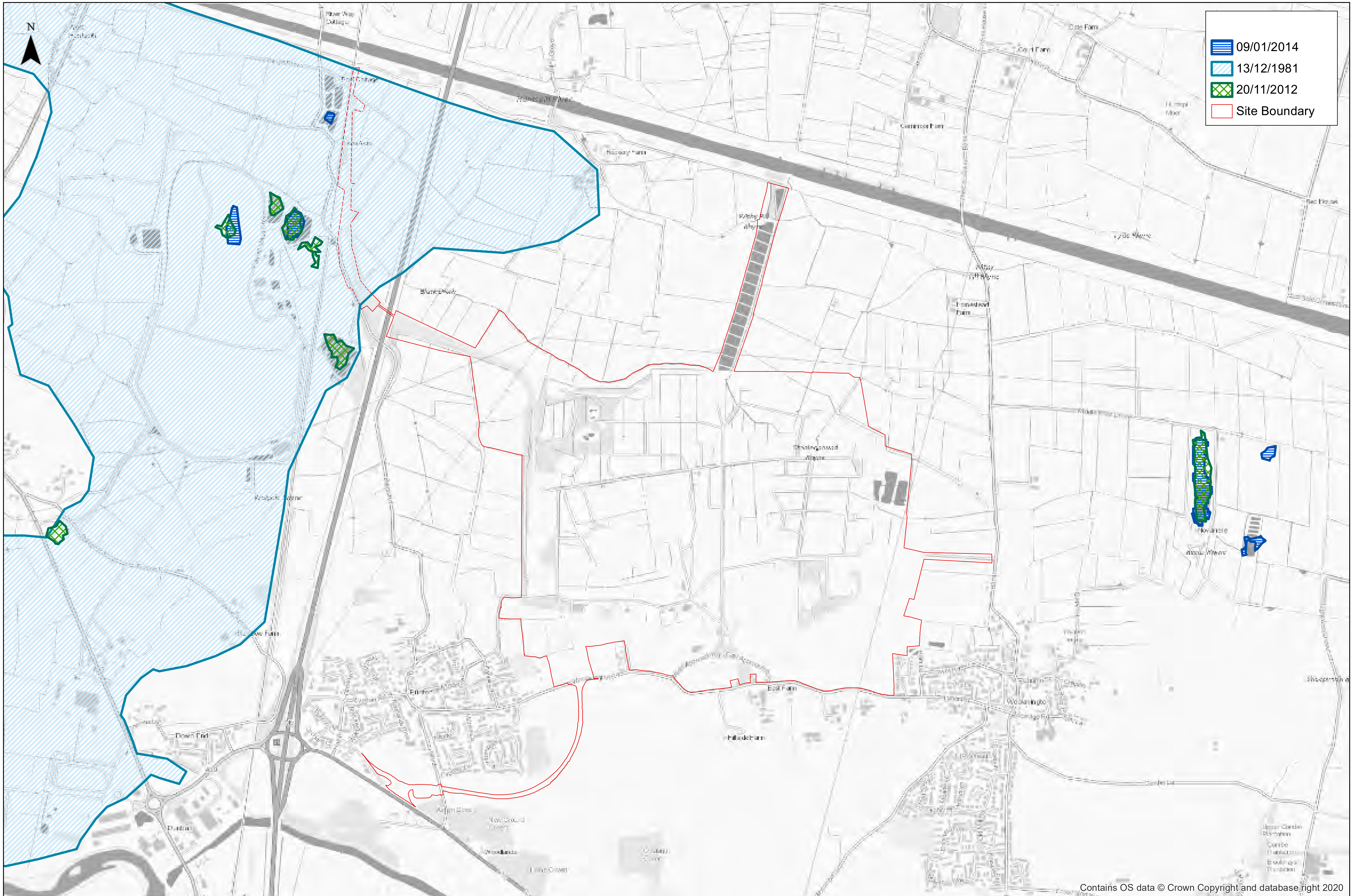
GRAVITY

EA Ground Water Source Protection Zones

0 250 500 m

1:15,000 @ A3	Date: 20/08/2021
Drawn: CE	Checked: RR
Figure 007	Rev A

Document Path: Z:\Projects\332310102\02_mxd\FRA\mxd\Figure007_SourceProtectionZone.mxd



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Client

G

GRAVITY

EA Dated Record Historic Flood Extents

0 250 500 Meters

Contains Environment Agency information © Environment Agency and database right
Contains Ordnance Survey data © Crown copyright and database right 2019.
Historic Flood Map shows the maximum extent of all individual Recorded Flood Outlines from river, the sea and groundwater springs and shows areas of land that have previously been subject to flooding in England.
Recorded Flood Outlines shows all EA records of historic flooding from rivers, the sea, groundwater and surface

1:15,000 @ A3	Date: 22/09/2021
Drawn: KT	Checked: PJ
Figure 08a	Rev A

Document Path: J:\49102 Gravity LDO\4002 Flood Risk & Drainge_TA-HYD\GIS\49102_Gravity LDO_FRA_Figure 8a.mxd

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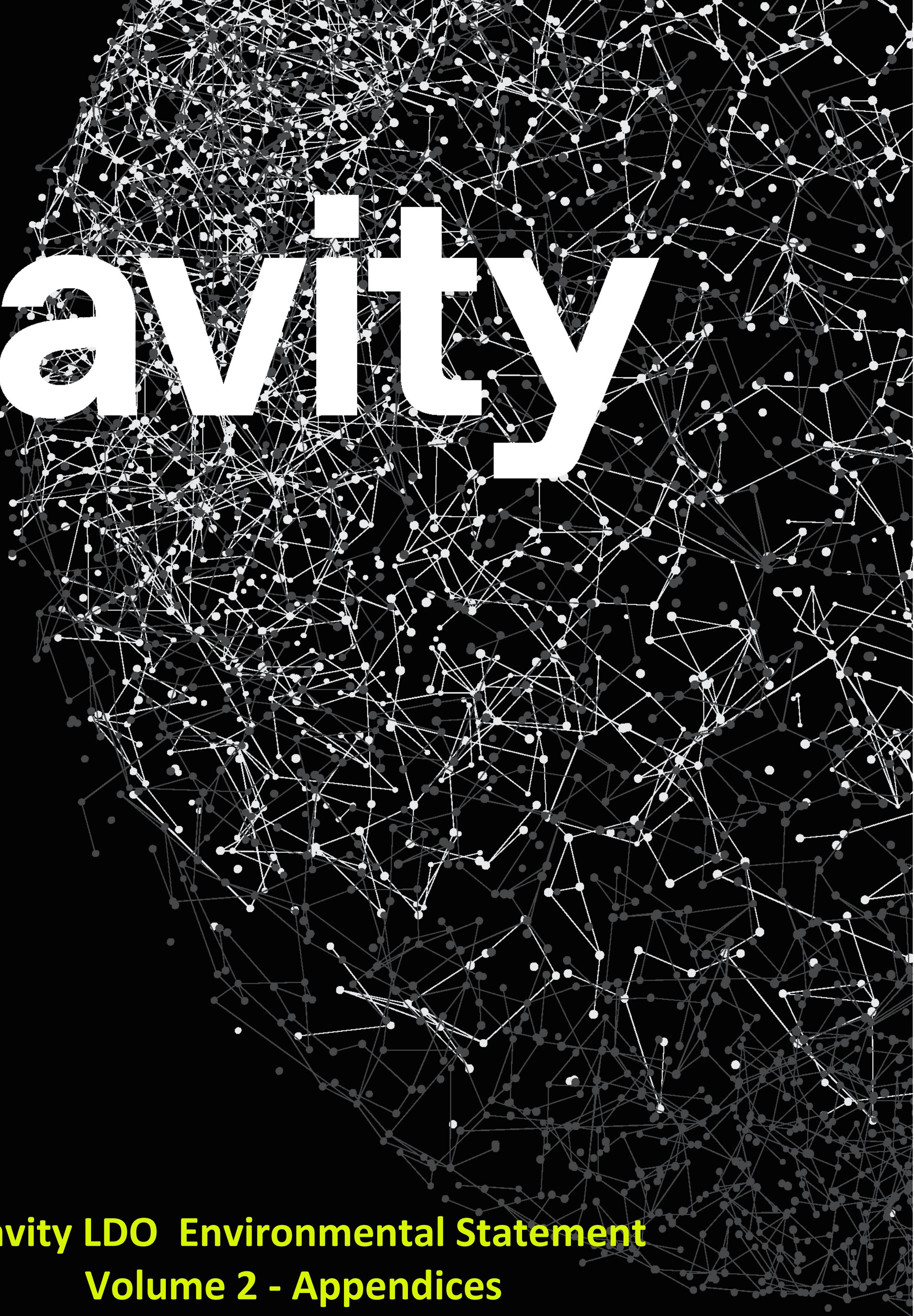
Smart Campus



Gravity LDO Environmental Statement
Volume 2 - Appendices
Appendix 13.2 Surface Water Drainage Strategy

Document Control Sheet

Project Name: **This is Gravity**
Project Ref: **332310102/4002**
Report Title: **Surface Water Drainage Strategy**
Doc Ref: **Revision C**
Date: **September 2021**

	Name	Position	Signature	Date
Prepared by:	Kirstie Thistlethwaite	Assistant Engineer		24.09.21
Reviewed by:	Andrew Johns	Senior Associate		24.09.21
Approved by:	Paul Jenkin	Director of Water Management		24.09.21
For and on behalf of Stantec UK Limited				

Revision	Date	Description	Prepared	Reviewed	Approved
A	03.08.21	Draft for Internal Review	LWD	AJ	-
B	19.08.21	Draft for Client Review	LWD	AJ	-
C	24.09.21	For Planning	KT	AJ	PJ

Contents

Tables

Appendices

Executive Summary

This Surface Water Drainage Strategy (SWDS) has been prepared by Stantec to support a Local Development Order (LDO) for industrial-led mixed-use development at the Former Royal Ordnance Factory (ROF) Puriton in Somerset.

In accordance with the fundamental objectives of the National Planning Policy Framework (NPPF), this SWDS, in conjunction with a separate Flood Risk Assessment (FRA) produced by Stantec, demonstrates that:

i. The development is safe.

ii. The development does not increase flood risk.

iii. The development does not detrimentally affect third parties.

The SWDS has been developed using best practice Sustainable Drainage System (SuDS) techniques. Guidance on suitable techniques and methods has been obtained from the Environment Agency (EA), the Non-Statutory Technical Standards for Sustainable Drainage Systems, Somerset County Council's Strategic Flood Risk Assessment and CIRIA C753 "The SuDS Manual" amongst other sources.

The SWDS proposes a free discharge into the Huntspill River, which has been agreed by the EA and Somerset Drainage Boards Consortium (SDBC). This will require an amendment to the existing surface water drainage outfall on site to now pass through the existing reed beds, which no longer need to treat effluent, and off site via the North Water Outfall by modifying the outfall from the reed beds. Adequate temporary storage of surface water can be provided by the reed beds in the event of a tide lock within the Huntspill River.

Surface water runoff will be managed by the modified / realigned rhynes and ditches on site. These have been designed to continue to accommodate the flows generated upstream from the site but also to manage a free discharge of runoff from the proposed development plots. These in combination with the reed beds provide sufficient water quality treatment prior to discharge into the Huntspill River.

In summary, the SWDS demonstrates that the proposed development is safe and in accordance with the requirements of national and local planning policy.

1 Introduction

1.1 Scope of Report

1.1.1 This Surface Water Drainage Strategy (SWDS) has been prepared by Stantec of behalf of our Client, This is Gravity Ltd. It accompanies a Flood Risk Assessment (FRA) also completed by Stantec for the same site, both to support a Local Development Order (LDO), Gravity Smart Campus, at the Former Royal Ordnance Factory (ROF) Puriton in Somerset.

1.1.2 The report is based on available information for the site as detailed in **Section 1.2** and prepared in accordance with the planning policy requirements set out in **Section 1.3**. The scope of the SWDS is consistent with the requirements of the National Planning Policy Framework (NPPF) Planning Practice Guidance (PPG).

1.2 Sources of Information

Previous Work Completed

1.2.1 Stantec has been involved in assessing Flood Risk and Drainage at this site for over 10 years, including in support of an extant Outline Planning Consent in 2017 (ref: 42/13/00010). As such, a number of reports and assessments have been completed to date. These are listed below:

- Royal Ordnance Factory Puriton TUFLOW Modelling Report (July 2007)
- Royal Ordnance Factory Puriton TUFLOW Modelling Addendum to Technical Modelling Report (October 2007)
- Royal Ordnance Factory Puriton TUFLOW Modelling Addendum NO.2 of Technical Modelling Report (January 2008)
- Huntspill Energy Park Remediation Application – Flood Risk Assessment (October 2011)
- Borrow Pit Angling Club Flood Risk Assessment (October 2012)
- Huntspill Energy Park Remediation Phase 1 Drainage Scheme (March 2013)
- Huntspill Energy Park Flood Risk Assessment (April 2013)
- Huntspill Energy Park Surface Water Management Strategy (April 2013)
- Huntspill Energy Park Addendum to Surface Water Management Strategy (October 2013)
- Huntspill Energy Park Remediation Application Surface Water Management Strategy (October 2013)
- Huntspill Energy Park Remediation Works Drainage Scheme for Plots J-K (January 2014)
- Puriton Solar Farm Drainage Strategy Technical Note (February 2015)
- Huntspill Solar Park Surface Water Management Strategy (December 2015)
- Land at Puriton Abstraction Assets Assessment (March 2018)
- Huntspill Energy Park Tidal Flood Risk Summary Note (June 2018)

1.2.2 It should be noted that whilst many of the findings and conclusions of the previously completed works will inform this SWDS, these documents were undertaken in relation to the extant consent. Hence, the area assessed by these documents is smaller in extent than the proposed LDO area. Where relevant, the findings of these documents has been referenced and/or updated within this SWDS to reflect this new site extent.

Additional or Updated Information

1.2.3 To seek that the assessment of flood risk is up to date, this SWDS has also been prepared based on the following sources of publicly available information, which have been updated since the preparation of the previously completed works:

- Topographic survey of the site undertaken by Lewis Brown Chartered Land Surveyors;
- Parameter plans by LDA Design;
- British Geological Survey (BGS) mapping;
- Magic Map;
- Environment Agency (EA) *Flood Map for Planning;*
- EA *Long Term Flood Risk*;
- EA *Historic Flood Map;*
- EA *South West River Basin Management Plan;*
- EA *North and Mid Somerset Catchment Flood Management Plan* EA
- Sedgemoor District Council (SDC) *Level 1 Strategic Flood Risk Assessment;*
- SDC *Level 2 Strategic Flood Risk Assessment* (Scott Wilson, 2009)*;*
- Flood Estimation Handbook (FEH) 13 rainfall data and point descriptors, extracted from the FEH online service;
- Remediation Verification Report Huntspill Energy Park – Phase 1 (March 2019);
- Groundwater Remediation Verification TNT Section Huntspill Energy Park (October 2019); and
- Remediation Verification Report Huntspill Energy Park – Phase 2 (September 2020).

1.3 Relevant Planning Policy

1.3.1 This SWDS has been prepared in accordance with the relevant national, regional and local planning policy and statutory authority guidance as follows:

- National policy contained within the revised **NPPF** dated July 2021, issued by Ministry of Housing, Communities and Local Government, with reference to Section 14 '*Meeting the challenge of climate change, flooding and coastal change*';
- The **PPG** for Flood Risk and Coastal Change released in March 2014 and updated in July 2021 to incorporate the EA **'Flood Risk Assessments: Climate Change Allowances'** guidance;

- The **Water Framework Directive** (WFD) (Commission of the European Communities, released 2000) (ref 13.2) establishes a framework for a European-wide approach to action in the field of water policy. Its ultimate aim is to ensure all inland and near shore watercourses and water bodies (including groundwater) are of *'Good'* status or better, in terms of ecology, and also chemical, biological, and physical parameters, by the year 2027. Therefore, any activities or developments that could cause detriment to a nearby water resource or prevent the future ability of a water resource to reach its potential status, must be mitigated so as to reduce the potential for harm and allow the aims of the Directive to be realised.

1.3.2 The local planning authority will make decisions with regards to any LDO application within any floodplain or flood risk area. The EA is a designated statutory consultee for areas within Flood Zones, areas with critical drainage problems, and plays a key role in providing advice on development and flood risk issues. The Lead Local Flood Authority (LLFA) is a statutory consultee for major developments which have surface water or other local flooding impacts.

1.3.3 This FRA should be read in conjunction with other LDO application supporting documents.

1.4 Caveats and Exclusions

1.4.1 This SWDS has been prepared in accordance with the NPPF and Local Planning Policy. The proposed flood management (including ground floor level recommendations) and surface water management strategies are based on the relevant British Standards (BS8533:2017), the standing advice provided by the EA or based on common practice.

1.4.2 The Construction (Design and Management) Regulations 2015 (CDM Regulations) will apply to any future development of this site which involves "construction" work, as defined by the CDM Regulations. As such it is the responsibility of the proposed developer (ultimate client) to fulfil its duties under the CDM Regulations.

1.4.3 The approach for the SWDS and proposals for the surface water management strategy are based on the requirements of the EA and Somerset County Council (SCC) in its role as LLFA.

1.4.4 The findings of this SWDS are based on data available at the time of the study and on the subsequent assessment that has been undertaken in relation to the development proposals.

1.4.5 It should be noted that the insurance market applies its own tests to properties in terms of determining premiums and the insurability of properties for flood risk. Those undertaking development in areas which may be at risk of flooding are advised to contact their insurers or the Association of British Insurers (ABI) to seek further guidance prior to commencing development. Stantec does not warrant that the advice in this report will guarantee the availability of flood insurance either now or in the future.

1.5 Flood Risk Assessment Credentials

1.5.1 Stantec has many years of experience in, amongst other areas, the assessment of flood risk, hydrology, flood defence and river engineering. The authors and reviewers of the document are all experienced engineers and members of chartered institutions such as the Chartered Institution of Water and Environmental Management (CIWEM) or the Institution of Civil Engineers (ICE).

2 Proposed Development Site

2.1 Site Description

2.1.1 The 249 hectare (ha) (616 acre) site is located north-east of Puriton and north-west of Woolavington in Somerset. Both villages lie north of Bridgwater and east of the M5 motorway. The site has an approximate central Ordnance Survey (OS) grid reference 333328m E, 142437m N. The site lies within the administrative boundary of SCC.

2.1.2 The site consists largely of brownfield land currently unused following remediation of the ROF site.

2.1.3 Generally, the site is bordered on all sides by agricultural land. The Huntspill River lies adjacent to the northern boundary, flowing east to west. Woolavington Road, the road that connects Puriton and Woolavington is located to the south.

2.1.4 A site location plan is provided in **Appendix A**.

2.2 Existing Topography

2.2.1 A topographic survey of the site has been undertaken and indicates topography of the site is relatively flat, with nominal fall from the south to the north.

2.2.2 The topography is steepest near to the southern boundary of the site, with an average elevation of 15.5mAOD, although the far southern extremity of the site LDO boundary reaches an elevation of 40mAOD. This then falls to an average elevation of between 5mAOD and 6.5mAOD across the majority of the site. The far northern extremity of the site's boundary has an approximate elevation of 4.5mAOD. Despite these elevation changes, the scale of the site gives rise to the relative flatness.

2.2.3 Topographical information can be found in **Appendix B**.

2.3 Hydrological Setting

2.3.1 There are no main rivers within the LDO boundary itself, although there are open surface water drainage systems present as part of the existing drainage of the site (see Section 2.5).

2.3.2 The Huntspill River lies approximately 900m north of the major area of the site and 50m north of the LDO boundary itself. The Huntspill River is designated as a Main River by the EA. The Huntspill River is essentially a large reservoir originally constructed to supply water to the former ROF site and its levels are managed by the EA to be 3.5mAOD in the summer and 2.9mAOD in the winter.

2.3.3 In a northern arm of the site, there are a series of constructed reed beds. When the site was operational these were used for treating effluent prior to discharge from the site, however following the removal of effluent sources following the closure and remediation of the site this is no longer the case. Therefore, the reed beds are now a surface water based system within the site's boundary. For further details of their former operation, refer to **Section 2.5**.

2.3.4 The site is bounded by a number of rhynes, typical of the area, which are viewed, i.e., managed, by the Somerset Drainage Boards Consortium (SDBC). The northern boundary of the site is formed by the Black Ditch, which runs from east to west, whilst close to the eastern boundary of the site is the Stoning Pound Rhyne. Both these rhynes discharge into the Huntspill River. There is also an unnamed viewed rhyne close to the western boundary of the site, which appears to flow north and westwards towards an existing railway and the M5 motorway.

2.3.5 Although approximately 4.5km to the west of the site's boundary, the River Parrett, its estuary and Bridgwater Bay do have influence on the hydrology of the site and vicinity. The Huntspill River discharges into the Parrett Estuary via the Huntspill Sluice (approx. 4.4km west of the site), which manages water levels in the Huntspill River by controlling the rate of discharge from the Huntspill but also impeding high tidal water levels continuing further upstream.

Water Framework Directive

2.3.6 The Water Framework Directive (WFD) establishes a framework for a European-wide approach to action in the field of water policy. The EA Catchment Data Explorer [1] website has water quality data relating to the WFD targets for 2027.

2.3.7 The quality of the Huntspill River is monitored by the EA against the objectives of the WFD. The nearest WFD designated water body is the Huntspill (GB108052021210). This is currently (Cycle 2, 2019) classified as overall 'Moderate' status, with 'Moderate' ecological status and 'Fail' chemical Status.

2.3.8 The site does not currently lie within a WFD groundwater management catchment, therefore no status is provided regarding groundwater.

2.4 Geology and Hydrogeology

2.4.1 Review of British Geological Survey (BGS) online mapping indicates that the site is underlain by bedrock geology of the Langport Member, Blue Lias Formation and Charmouth Mudstone Formation (undifferentiated), which are describe as *"porcellanous limestone below, calcareous mudstone above"*, *"thinly interbedded limestone (laminated, nodular or massive and persistent) and calcareous mudstone or siltstone (local laminated)"* and *"dark grey laminated shales, and dark, pale bluish grey mudstone"* respectively The BGS online viewer also indicates that the Charmouth Mudstone Formation and Langport Member form the upper and lower boundaries to the Blue Lias Formation respectively.

2.4.2 Superficial deposits are indicated to be Tidal Flat Deposits, comprising clay, silt and sand, for the majority of the site. Higher elevations in the southern part of the site do not have superficial deposits recorded.

2.4.3 A review of EA mapping indicates that the bedrock geology underneath the site is a Secondary A Aquifer. A Secondary A Aquifer is defined by the EA as "permeable layer capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of baseflow to rivers".

2.4.4 The Tidal Flat Deposits are classified as a Secondary (undifferentiated) Aquifer by the EA. A Secondary (undifferentiated) Aquifer is defined as "where it has not been possible to attribute either category A or B".

2.4.5 The site lies within a Groundwater Vulnerability Zone of 'Medium – High'. 'Medium' vulnerability is defined as "areas that offer some groundwater protection", whilst 'High' is defined as "areas able to easily transmit pollution to groundwater… characterised by high leaching soils and the absence of low permeability superficial deposits".

2.4.6 The Remediation verification reports confirm the geology and states groundwater levels are typically 0.5m and 1.5m below ground level.

[1] https://environment.data.gov.uk/catchment-planning/

2.5 Existing Drainage Arrangements

On-Site Drainage

2.5.1 The site consists of brownfield land that currently benefits from an existing drainage system. This system has been assessed and forms seven surface water drainage sub-catchments on site.

- Sub-Catchment A – A small section of land on western boundary, and another north-west of centre, discharges into the Black Ditch directly.
- Sub-Catchment B – The majority of the western parts of the site drain to the “Site Acid Ditch”.
- Sub-Catchment C – A small section of land located centrally in the north of site drains to the “Site Acid Ditch”.
- Sub-Catchment D – Central areas, representing a significant proportion of the site, drain to a south-to-north rhyne which continues parallel to (but separate from) an existing reed bed system before discharging into the Huntspill River via the “North Water Outfall”.
- Sub-Catchment E – Eastern parts of the site drain north-eastwards to the Stoning Pound Rhyne.
- Sub-Catchment F – South-western areas of the site which drain to the unnamed viewed rhyne to the west. This area is associated with Gravity Link Road, which has been consented as part of the previous outline consent and is currently under construction.
- Sub-Catchment G – North-western areas of the site associated with the existing railway, which appear to discharge into adjacent rhynes and ditches before conveying flows westwards to either the Huntspill River or Parrett Estuary.

2.5.2 The Site Acid Ditch, reed beds and North Water Outfall lie within the site, whilst the Black Ditch, lies on the northern boundary.

2.5.3 While the ROF was operational, effluent was piped or pumped to a large treatment tank in the centre of the Site, known as the “Lido”, and then pumped to the reed beds. The Lido also has an overflow to the Site Acid Ditch which flows through the site and discharges into the reed beds. Following passage through the reed beds, treated effluent was pumped into a ditch immediately to the north of the reed beds, which runs west and flows parallel to (but separate from) the Huntspill River and discharges into the Parrett Estuary. This ditch is referred to as the “Acid Ditch” and lies outside of the site boundary. The Lido and overflow are still in-situ but owing to the ceasing of operations on site, no longer receives effluent discharge, therefore no effluent is discharged into either the Site Acid Ditch or the Acid Ditch and these are now surface water only systems.

2.5.4 Remediation of the site is now complete, however the existing surface water drainage principle has not been altered from the undeveloped condition. The layout of rhynes and ditches has been altered to accommodate the proposed building platforms, but continuity of flows through the site of upstream and the outfall arrangements remain unaffected.

2.5.5 The existing drainage regime and remediated drainage scheme is indicated within **Appendix C**.

Public Sewers

2.5.6 As part of the previous work undertaken by Stantec on this site, Wessex Water (WW) provided copies of its sewerage infrastructure plans for the site and surrounding area. The plans show there to be no surface water, foul or combined sewers within the site and the surrounding area. This is to be expected given the topography and the existing private drainage infrastructure present on site.

3 Surface Water Drainage Principles

3.1 Surface Water Drainage Objectives

3.1.1 The design principles for the surface water drainage system are detailed in the following documents:

- NPPF and PPG;
- DEFRA 'Non-Statutory Technical Standards for Sustainable Drainage Systems';
- CIRIA C753 'The SuDS Manual';
- SCC 'Local Flood Risk Management Strategy'.

3.1.2 A key requirement for the proposed development is to seek that flood risk downstream is not increased. The potential is associated with additional runoff generated by the introduction of roofs and hard-paved surfaces as part of the development. These surfaces replace natural ground where water can percolate into soil pores and to a greater or lesser extent infiltrate into the underlying rock. Additionally, natural ground is more uneven, promoting localised ponding while vegetation intercepts rainfall by collecting water. Lastly, natural ground is generally more resistant to flow, reducing the velocity of overland flow and the time that it takes to leave the site.

3.1.3 The replacement of natural surfaces has two principal effects on the land's response to rainfall:

- An increase in the rate of runoff;
- An increase in the volume of runoff.

Both of these impacts have the potential to increase the flood risk downstream. The rate of runoff is normally of principal concern as it can impact on the peak flow rate in the receiving watercourse or drainage network. Increasing the volume of runoff can also increase flood risk in particular situations.

3.1.4 In addition, the development of any site can introduce sources of pollution to downstream surface water bodies and groundwater, through both the introduction/change of impermeable surfaces and human activity.

3.1.5 The NPPF and CIRIA C753 recognise that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface water runoff and maintaining or improving water quality discharged from development sites. It is recommended that priority is given to the use of Sustainable Drainage Systems (SuDS) in new development.

3.2 Outfall Destination

3.2.1 Based on the CIRIA C753 guidance, consistent with the PPG and Building Regulations Part H, the aim should be to discharge surface water runoff as high up the following hierarchy of drainage options as reasonably practical:

i. *Into the ground (infiltration);*

ii. *To a surface water body;*

iii. *To a surface water sewer, highway drain or another drainage system;*

iv. To a combined sewer.

3.2.2 The hierarchy is considered in order below.

Discharge into the Ground (Infiltration)

3.2.3 Based on the hierarchy, the preferred method for disposal of surface water from the new development is via infiltration drainage.

3.2.4 The local geology has been identified as principally clay/silt deposits over mudstone bedrock (see Section 2.4). These underlying ground conditions typically have low permeability characteristics, which is supported by the historic use of land drainage rhynes and ditches on site and the local area.

3.2.5 Groundwater levels were monitored on site between 2006 and 2010, indicating that the site currently experiences a shallow groundwater table i.e. groundwater levels were shown to be on average 1.5m below existing ground levels. However, many locations indicated groundwater levels could reach less than 1m below the existing ground level, in some cases being at ground level itself.

3.2.6 In order to ensure adequate drainage during storm events, CIRIA C753 requires a minimum head difference between the base of an infiltration feature and the seasonal high groundwater level of 1m. Given the observed groundwater levels on site, this design requirement is not achievable. Therefore, discharge of surface water via infiltration has been discounted as a viable option for the proposed development.

Discharge to a Surface Water Body

3.2.7 In areas where infiltration is not possible, the next preference in the hierarchy is to discharge to a surface water body.

3.2.8 As discussed in Section 2.5, currently the site is served by a network of ditches that convey surface water generally northwards to the Huntspill River north of the site, via the North Water Outfall which runs parallel to the existing reed beds.

3.2.9 The "Addendum to the SWMS" produced for the extant planning consent indicated through liaison with the relevant stakeholder, including the EA and SDBC, that the preferred option for discharging surface water from the site would be via the reed beds and then directly into the Huntspill River.

3.2.10 At present, the reed beds have a pumped discharge into the Acid Ditch which runs parallel to the Huntspill River (but separate from it) and discharges into the Parrett Estuary. The Acid Ditch is currently subject to a legal agreement whereby the EA maintain it. However, to discharge directly into the Huntspill River, it was agreed as part of the extant planning consent that this arrangement would be amended. Surface water from the reed beds would discharge directly into the Huntspill River via the existing North Water Outfall, which currently runs parallel, but separate, to the reed beds. A free discharge would be permissible into the Huntspill River due to its effective operation as a tidally influenced feature with very significant storage capacity. Therefore, with this option no attenuation storage would be required within the site.

3.2.11 The SWDS within this report proposes to maintain this agreed strategy, which has been confirmed following more recent liaison with the EA regarding this LDO application.

3.2.12 The "Addendum to the SWMS" also indicated that once the reed beds' function of treating effluent from the site was no longer needed and the new outfall constructed, the Acid Ditch would be redundant as an outfall route. However, it has been identified by the EA that the Acid

Ditch provides excellent water vole habitat, and, at the time, the desire was expressed to create a link for sweetening flow to preserve this. The existing outfall from the reed beds to the Acid Ditch could be modified as part of the proposed scheme to direct some surface water into the Acid Ditch. The details of this connection need to be established in further discussion with the EA, but the future of the water vole habitat can be protected by these means.

3.2.13 In summary, surface water runoff will be discharged from the proposed development into the Huntspill River via the reed beds and North Water Outfall, following modification of the outfall arrangements. Further modifications could be made to maintain a sweetening flow in the now redundant Acid Ditch to preserve water vole habitat.

3.2.14 No other points of discharge e.g., to a public sewer, have been considered as part of this SWDS.

3.3 Discharge Rate Control

3.3.1 As part of the extant hybrid planning permission, it was agreed with the EA and the SDBC that the site is permissible to freely discharge into the Huntspill River due to its effective operation as a tidally influenced reservoir with significant storage capacity.

3.3.2 Therefore, there are no discharge rate control requirements for surface water runoff leaving the site. The impact of a free discharge during periods of 'tide lock' has been considered below.

Tide Lock

3.3.3 The proposed free discharge into the Huntspill River from the reed beds could be restricted or even prevented during periods of tide lock (when high tide in the Parrett Estuary prevents outflow from the Huntspill River).

3.3.4 If an extreme rainfall event coincides with the period of tide lock the development's discharge could increase flood risk to the open farmland downstream of the site. It is therefore proposed that a suitable storage volume to retain runoff within the development's SWDS is provided so that no additional runoff volume enters the surrounding land drainage network during this scenario.

3.3.5 The parameters for calculating this storage volume were agreed with the EA within the "Addendum to the SWMS" produced in support of the extant outline consent. The worst-case duration of tide lock was provided by the EA as 6 hours. Therefore, the design rainfall event considered was the 100 year, 6 hour event, including a 20% allowance for climate change.

3.3.6 Calculations were made for two distinct catchments within the site as follows:

The existing surface water catchment draining to the reed beds:

- This catchment is currently independent from the Huntspill River because it drains to the Parrett Estuary via the Acid Ditch. Under the proposals, all runoff from this catchment will be additional flow to the Huntspill River and thus tide lock storage is required for the total runoff volume.

The remainder of the site:

- The rest of the site currently drains to the Huntspill River via North Water Outfall. Therefore, there is no increase in catchment area to consider and only the proposed increase in impermeable surfacing as a result of development.

3.3.7 The total combined tide lock storage requirement has been calculated as 38,200m³. It is proposed to accommodate this volume within the existing reed beds by defining an appropriate outfall level.

3.3.8 An assessment of the reed beds current condition and means in which this tide lock storage volume can be accommodated are included in a separate report, which can be found in Appendix D.

3.3.9 In the unlikely event that the capacity of the reed beds is exceeded, water would overtop the eastern bank and spill into the adjacent land drainage rhyne. In discussion with the SDBC it was identified that any overspill could be managed within the existing system whereby flows head eastward to the South Drain. When necessary, water is pumped from the South Drain into the Huntspill River to control flood levels in the land drainage system.

3.3.10 Under the Flood and Water Management Act 2010, a storage feature would be regulated as a Reservoir if it is "capable of holding 25,000 cubic metres of water above the natural level of any part of the surrounding land". Natural ground levels around the reed beds are generally equivalent to the east bank crest levels at around 4.5m AOD.

3.3.11 Calculations for the tide lock storage volume and implications regarding potential storage of tide locked water above the natural ground level (4.5m AOD) are also provided in **Appendix D**.

3.4 Discharge Volume Control

3.4.1 As previously discussed, it was agreed with EA and SDBC as part of the extant planning consent that the site is permissible to freely discharge into the Huntspill River due to its effective operation as a tidally influenced reservoir with significant storage capacity. More recent liaison with both parties has indicated their position remains the same.

3.4.2 Therefore, owing to there being no discharge rate control requirements (aside from the storage provided by the reed beds in the event of tide lock), there are also no discharge volume control requirements for surface water runoff leaving the site.

3.5 Water Quality Control

3.5.1 All sites have a requirement to protect downstream water quality and contribute to the aims of the WFD. Therefore, the SWDS for the site will need to demonstrate that adequate water quality treatment is provided within the system. To achieve this, priority is given to the use of SuDS techniques, as recommended in the NPPF and CIRIA C753.

3.5.2 Furthermore, as part of the "Addendum to the SWMS" produced in support of the extant planning consent, and assessment of the impact on water quality in the Huntspill River as a result of the unrestricted surface water drainage was agreed with the EA and SDBC.

3.5.3 The Huntspill River is a National Nature Reserve (NNR) and therefore adequate treatment of site runoff is important to avoid any detrimental effects on ecology. The proposed strategy includes bringing the existing reed beds into the surface water system as the final element of the SWDS before discharge from site. The reed beds cover an area of 3.7 hectares and were originally designed to provide treatment for up to 25,000m³ per day of effluent from the former ROF. The reed beds would therefore make a suitable treatment facility for surface water.

3.5.4 The reed bed system includes a small separate lagoon at the south. This previously collected the pumped and gravity-drained effluent flows from the site. From this lagoon water is pumped along a manifold pipe into each bay of the reed beds, with final discharge from the reed beds into the Acid Ditch. When the reed beds are converted to the surface water system, the lagoon at the southern end can be used to in effect as a sediment forebay. In addition, a new gravity connection into the reed beds will replace the existing pump/manifold arrangement, with water allowed to flow through the entire system towards the site's outfall in the north.

3.5.5 In addition to the treatment provided by the reed beds, each development plot / occupier parcel will discharge runoff into the proposed rhyne and ditch network, which will in turn convey flows to the reed bed facility. Being an open and vegetated system, this network will also provide inherent treatment of surface water.

3.5.6 This constitutes a two-stage treatment process, utilising the rhyne and ditch network, and the reed beds as two substantial SuDS features. The degree of treatment provided by these features is considered further in Section 4.6.

3.5.7 It is important to note that in order to bring the reed beds into optimum condition to serve the surface water network some improvement works will likely be required. A condition survey of the reed beds has been undertaken (see **Appendix D**). The required improvement works will be subject to further design in collaboration with an ecologist and landscape architect, following receipt of consent for this LDO application.

4 Managing Surface Water On-Site

4.1 Overview

4.1.1 Based on the existing site information and surface water drainage principles previously, a strategic-level SWDS has been developed to demonstrate a viable surface water drainage option for the proposals.

4.1.2 This has been developed to a suitable level of detail to support a LDO application and will be subject to further design following grant of consent. Where further design/details will be required in the future, this is indicated within this report.

4.2 Development Proposals

4.2.1 The LDO application is submitted for:

a. *any operations or engineering works necessary to enable the development of the Site, including demolition, excavation and earthworks, the formation of compounds for the stockpiling, sorting and treatment of excavated materials, import of material to create development platforms, piling, and any other operations or engineering necessary for site mobilisation, office and worker accommodation, communications, drainage, utilities and associated environmental, construction and traffic management.*

b. *the development of a smart campus including*

   i. *commercial building or buildings with a total Gross External Area of up to 1,000,000m^2 which would sit within current Use Classes E(a) - (g), B2, B8 and sui generis floorspace uses and*

   ii. *a range of buildings up to 100,000m2 within use classes B8, C1, C2, E (a) – (g) and F , including restaurants / cafes, shops, leisure, education and sui generis uses and*

   iii. *up to 750 homes in use class C3,*

together with associated infrastructure including restoration of the railway line for passenger and freight services, rail infrastructure including terminals, sidings and operational infrastructure and change of use of land to operational rail land, multi-modal transport interchange, energy generation, energy distribution and management infrastructure, utilities and associated buildings and infrastructure, digital infrastructure, car parking, a site wide sustainable water management system and associated green infrastructure, access roads and landscaping.

4.2.2 A copy of the land use parameters plan layout can be found in **Appendix E**.

4.3 Impermeable Areas and Urban Creep

4.3.1 CIRIA C753 recommends that an urban creep factor is applied to residential property impermeable areas, to account for future land use changes such as paving front gardens for parking, building conservatories, increasing patio areas etc. Applying an urban creep factor therefore adds another degree of robustness to the SWDS. Based on the Local Authority SuDS Officer Organisation (LASOO) (now called the Association of SuDS Authorities (ASA)) “Non-Statutory Technical Standards for Sustainable Drainage: Practice Guidance” and an approximate housing density of 35dph, an urban creep uplift of 6% has been applied to the indicated residential roof and patio areas shown in the proposed layout.

4.3.2 Impermeability percentages (PIMP) have been applied to each proposed land use as follows:

- Areas of hardstanding e.g., roads, rail etc. – 100% PIMP.
- Industrial, commercial and educational areas – 80% PIMP
- Residential areas – 66% PIMP (inc. urban creep)

4.3.3 These values are considered to be moderately robust as they do not account for any losses due to evapotranspiration, infiltration through cracks etc.

4.4 Remediation Surface Water Drainage Strategy

4.4.1 The remediation drainage strategy included the diversion or infilling of existing rhynes and ditches to serve the proposed development layout for the sequent planning consent (42/13/00010), alongside new and temporary routes created on the plots themselves order to preserve the system capacity and protect water quality prior to construction of the proposed development.

4.4.2 The remediation drainage strategy was devised so that it could also serve the proposed development on site for the sequent planning consent (42/13/00010), seeking to minimise additional works to the strategic rhynes and ditches that will convey flows through the site (both from arising on site and upstream off site) to the outfall. The remediation works do not include for the amendments to the surface water outfall into the Huntspill River, as this will be subject to further design in liaison with the EA and SDBC following consent of the LDO application, and do not fully align with the LDO parameters plans.

4.4.3 The proposed remediation drainage strategy is illustrated in Appendix A and was based on the following general principles:

- Rhynes carrying flow through the site from the upstream catchment will be preserved with diversions around proposed plot outlines where necessary.
- Drainage ditches within the proposed development plot areas to be filled in.
- Drainage ditches outside of the proposed development area retained.
- Temporary drainage ditches within the proposed development plot areas to be constructed, serving as interim plot drainage prior to construction of the proposed development.
- Culverts on retained rhynes and ditches to be opened up, wherever possible.
- Culverts on redundant rhynes and ditches to be broken out and filled in.
- New / retained culverts at proposed development plot area's access locations to be installed.
- Pollution control measures required for the construction phase to be installed.

4.5 Proposed Development Surface Water Drainage Strategy

Strategic Rhynes and Ditches

4.5.1 The proposed SWDS builds upon the remediation drainage strategy to serve the future development. It is proposed for each development plot to discharge into the site's rhyne and ditch network, as constructed during remediation, which in turn will convey flows into existing reed beds located north of the site and then directly into the River Huntspill.

4.5.2 These features are considered as strategic infrastructure on site and will be clearly separated from on-plot development drainage. Following grant of consent of this LDO application, the layout and principles of these strategic features will not alter, although further details (including for construction details) will be provided in the near future. Future on-plot development drainage designs will be required to discharge into these strategic rhynes and ditches, in a way that is analogous to discharging to a nearby watercourse.

4.5.3 Calculations have been undertaken for these strategic rhynes and ditches so that they are adequately sized to cater for the upstream catchment which drains for the site but also the development itself. These have allowed for free discharge from the proposed development plots, in accordance with the overall SWDS. These calculations can be found in Appendix F.

4.5.4 The strategic rhynes and ditches have proposed to maintain the character of the existing drainage system on site, which is also in accordance with the ecological requirements on site. As such, side slopes will be between 1:1 and 1:2 and the depth of these features will be approximately 0.75m, although this will vary on site. The width of these channels also varies on site, increasing as they flow northwards through the site and therefore manage surface water from an increasing area.

4.5.5 Planting and vegetation of the strategic rhynes and ditches will be subject to the relevant Landscape Architect’s design, but for the purpose of flood risk and drainage design, it has been assumed that post-development the vegetation will be consistent with what currently exists on site. The only requirement is that the planting should not be so significant that it impedes flows, which could be achieved either through plant choice or regular maintenance.

Large Commercial Building(s)

4.5.6 The SWDS has been developed to accommodate a single, large commercial building within the centre of the site. Owing to the need to convey flows from off-site through the development in addition to a generally flat topography, the strategy has been developed to capture flows and realign the existing rhynes and ditches to flow around this building rather than culvert them underneath it. This removes the need for access points within the building for maintenance whilst also reducing the maintenance burden of access to de-silt the culvert, which would have significant health and safety constraints. As this represents a significant diversion from the existing rhyne and ditch routes, this scenario is effectively viewed as “worst case scenario” from a surface water drainage perspective.

4.5.7 In addition, owing to the large scale of the scenario building, and therefore potential high volume/velocity discharges from its roof area, a perimeter rhyne surrounding the plot has been proposed to manage runoff from this plot only, prior to discharge into the wider strategic network.

4.5.8 Should this scenario of a single commercial building be split into multiple, separate buildings, there is an opportunity to retain and improve existing rhynes and ditches which currently flow through the centre of the plot. Depending on the scale of these buildings as they emerge through the LDO compliance process, it may be possible to reduce the scale or remove entirely the need for the perimeter rhyne or indeed keep it as a contingency measure. This would provide additional space for waterside amenity and habitat for flora and fauna on site. In addition, it would provide additional resilience to the proposed SWDS as the overall drainage would include additional drainage routes to the outfall. In the event of significant potential maintenance or remedial works (e.g. following a pollution event) this result in the works having less of an impact on the functioning of the SWDS.

4.5.9 The nature of the large commercial building(s) is subject to confirmation following consent of this LDO application, therefore final designs of the diverted rhynes and ditches, as well as perimeter rhyne, will be provided as part of further detailed design of the site at the LDO compliance stage.

4.6 Water Quality Treatment

4.6.1 The need for water quality control has been previously identified by this SWDS report.

4.6.2 Based on the strategic components alone, surface water runoff will flow through rhynes and ditches and the reed beds prior to discharge from site. An assessment of the water quality treatment provision provided by the reed beds has been undertaken using the Simple Indices Approach, as set out in the CIRIA C753. The results of the assessment are set out below.

4.6.3 **Table 4.1** indicates the Pollution Hazard Indices for the proposed land uses within the development.

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Residential roofs	Very low	0.2	0.2	0.05
Residential car parking, access road, cul de sacs, homezones etc.	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change, all roads except low traffic roads and trunk roads/motorways	Medium	0.7	0.6	0.7
Sites with heavy pollution, site where chemicals and fuels are to be delivered, handled, stored, used or manufactured, industrial sites and trunk roads/motorways	High	0.8	0.8	0.9

Table 4.1 - Pollution Hazard Indices

4.6.4 At this stage, it is not clear whether the eventual operations on site will include activities viewed as having a “high” pollution hazard level by the Simple Indices Approach. However, it has been included in our assessment for robustness should this come to reality in the future.

4.6.5 Based on the strategic provision of the rhynes and ditches and reed beds, **Table 4.2** indicates Pollution Mitigation Indices for these respectively.

Type of SuDS Components	TSS	Metals	Hydrocarbons
Rhynes and Ditches (Swale)	0.5	0.6	0.6
Reed Beds (Wetland)	0.8	0.8	0.8

Table 4.2 - Pollution Mitigation Indices

4.6.6 The Simple Indices Approach assumes that a conventional, i.e. dry, swale is implemented for treatment purposes. However, wet and vegetated habitats are generally considered by CIRIA C753 to have improved water quality treatment provision. Furthermore, the flat topography and thus shallow longitudinal slopes of the rhynes and ditches will increase retention time for these treatment processes to take place. Therefore, it is considered that by assessing the rhynes and ditches as swales, this represents a conservative approach to the treatment they provide.

4.6.7 Finally, **Table 4.3** provides a summary of the water quality treatment sufficiency of the strategic features for each land use in each scenario after calculating the Total Mitigation Index as set out in CIRIA C753.

Land Use	TSS	Metals	Hydrocarbons
Residential roofs	Sufficient	Sufficient	Sufficient
Residential car parking, access road, cul de sacs, homezones etc.	Sufficient	Sufficient	Sufficient
Commercial yard and delivery areas, non-residential car parking with frequent change, all roads except low traffic roads and trunk roads/motorways	Sufficient	Sufficient	Sufficient
Sites with heavy pollution, site where chemicals and fuels are to be delivered, handled, stored, used or manufactured, industrial sites and trunk roads/motorways	Sufficient	Sufficient	Sufficient

Table 4.2 - Water Quality Treatment Sufficiency Results

4.6.8 The results above indicated that strategic rhynes and ditches and reed bed will be sufficient in providing the required water quality treatment for the proposed development’s surface water runoff. The on-plot SuDS also recommended as part of the SWDS (see Section 5) will provide additional treatment, contributing to improving water quality on site and downstream.

5 On-Plot SuDS

5.1 Overview

5.1.1 Although beyond the scope of this LDO application at this stage, some consideration has been made in this SWDS with regard to on-plot SuDS features which can help inform the design guide and the compliance processes. The inclusion of on-plot SuDS will ultimately be determined by future development design for each plot as they come forward.

5.1.2 Although on-plot SuDS are not required to meet discharge rate, discharge volume or water quality control requirements, they will provide a degree of attenuation i.e. "slowing the flow", of surface water runoff by temporarily storing it in discrete locations. The potential for large areas of hardstanding draining to the strategic rhynes could introduce high-velocity point inflows which could generate bank erosion and more onerous maintenance requirements. This is because the rhyne system has developed over time to manage slow overland flows generated by a flat topography and is not adapted for a formal drainage system. On-plot SuDS would reduce these velocities, better mimicking the existing drainage regime on site and therefore reducing potential future maintenance requirements.

5.1.3 Moreover, on-plot SuDS will add further climate change resilience to the proposed SWDS as well as contributing to the wider ecological and landscape aims on site i.e. forming part of holistic Green-Blue Infrastructure.

5.1.4 On-plot SuDS would provide "source control" and interception of rainfall close to the point in which it reaches the ground. Their inclusion better mimics the drainage characteristics of an undeveloped site, in accordance with SuDS principles, but is also shown to be the most effective method to provide surface water quality treatment.

5.1.5 As mentioned, additional treatment beyond the reed beds and rhynes and ditches is not a requirement for day-to-day flows, but due to the potential industrial uses on different plots, the ability to partition the SWDS i.e. close off sections of the system, to prevent a potential pollution incident entering the strategic network would be beneficial.

5.1.6 Additionally, by providing further improvement of the quality of surface water runoff in the everyday scenario prior to reaching the rhynes and ditches, this will facilitate generation of a better habitat for flora and fauna whilst also improving the aesthetic, and thus amenity benefit, of these features. As the rhynes and ditches will be fully integrated throughout the development, it is a key objective that these are attractive spaces for people.

5.1.7 There are a number of SuDS features that could be included on individual plots, but their respective appropriateness will be dependent on the final design of each plot. Below is a summary of the different types of SuDS that could be implemented. It is likely that a more detailed assessment of the on-plot SuDS options will be undertake following grant of consent of this LDO application and included within the subsequent compliance applications.

5.2 Rainwater Harvesting

5.2.1 Rainwater harvesting (RWH) is the collection of rainwater runoff for use, as opposed to directing runoff to a surface water drainage system immediately. Runoff can be collected from impermeable areas within the development e.g., roofs, hardstanding etc. and then stored and treated (where required) before being re-used for non-potable purposes, such as flushing toilets, washing machines and external uses.

5.2.2 In the UK, private water supplies for locations not connected to main water supply networks have to comply with the Private Water Supplies Regulations 2009.

5.2.3 There are three main types of RWH system:

- Gravity-based systems
- Pumped systems
- Composite systems

5.2.4 In addition, a RWH system (regardless of type) can have one of the following design objectives:

- Water conservation / supply
- Water conservation / supply and surface water management (passive systems)
- Water conservation / supply and surface water management (active systems)

5.2.5 RWH systems could be implemented to serve individual properties and buildings or small groups of properties and buildings. However, larger contributing areas and demands will likely result in larger tanks and associated infrastructure. Care should be taken that where RWH systems are shared, the properties or buildings which the RWH serves should be constructed at the same time i.e. as part of the same phase of development. Otherwise, onerous construction requirements may be enforced on earlier phases.

5.2.6 Albion Water will operate and maintain the surface water and effluent drainage following development of the site. As part their overall scheme, there has been an opportunity identified for a high-level off-take of surface water into an offline pond near to the reed beds which could provide water for non-potable uses. This would augment the other opportunity identified for recycling water from effluent (following treatment to the necessary standards) and re-use as non-potable water across the site. This would represent a strategic RWH option which may render the use of on-plot RWH systems redundant or of less benefit. However, this strategic RWH option is subject to ongoing review and design and will be confirmed as part of future detailed design works on site.

5.3 Green / Blue Roofs

5.3.1 Green roofs are areas of living vegetation installed on the top of buildings / structures for a range of reasons including visual benefit, ecological value, enhanced building performance and the reduction of surface water runoff.

5.3.2 Types of green roof are typically categorised as:

- Extensive – low substrate depths, simple planting and low maintenance requirements.
- Intensive – deeper substrate depths that can support a wide variety of planting but require more maintenance.

5.3.3 Blue roofs are explicitly designed to store water. This can be designed as attenuation storage (rainfall stored and released in a controlled manner), use for irrigation (potentially of adjacent green roof areas), cooling water (reducing roof temperatures during hot days or for cooling plant) or non-potable use within the building. Storage in blue roofs can be provided as open water surfaces, storage within or beneath a porous medium or below a raised decking surface or impermeable cover.

5.3.4 Green roofs that include reservoir storage zones beneath the growing medium could also be termed blue roofs. This form of blue roof can also be used for RWH, examples of which are common in Germany and Switzerland, however guidance is limited and due to filtering through the substrate, the water available is often discoloured. Furthermore, uptake from vegetation will reduce the yield from the roof area.

5.3.5 Green and blue roofs would be constructed as part of individual structures and are therefore well suited to the likely modular implementation of the proposed development. In addition, their use would not be limited to commercial or residential buildings; there are many cases of green roofs being constructed as part of transport infrastructure e.g. bus stops. This again is easily incorporated into a modular implementation.

5.3.6 Consideration should be given to the scale of the building whereby a green or blue roof is implemented. Water can impose significant loads on structures when stored for a prolonged period, which may make use of these systems where large roof spans existing technically and financially unviable.

5.4 Green Walls / Facades

5.4.1 Green walls and façades are similar to green roofs in that they are areas of living vegetation, however in this case they are installed as vertical systems on walls building faces. Their benefits span water management, heat reduction, biodiversity enhancement and improved air quality.

5.4.2 They can be used to protect a building against storms by intercepting rainfall and reducing soil moisture around a building’s foundations, effects which are more pronounced when evergreen plants are used. However, buildings that may be affected by humidity (due to their use) can be damaged by vegetation due to inhibited evapotranspiration from the building itself. In this instance, adequate ventilation of the building would be required.

5.4.3 Vertical vegetation protects the building from direct solar radiation, resulting in the façade heating up less, absorbing less heat and emitting less heat at night. The plants also emit water vapour through evapotranspiration which enhances the cooling effect. Furthermore, if evergreen plants are utilised, they can provide a degree of insulation during cooler months, protecting the façade from cooling. By tempering the building temperatures in both winter and summer, the green wall or façade can contribute to saving on energy demands for the building.

5.4.4 By providing additional vegetation within the urban environment, there is also a significant contribution to enhancing the biodiversity and ecology. Green walls and façades can provide habitat and shelter for birds and insects as well as providing a food source. Occupants can be concerned that birds and insects will enter the building via the vegetation, but the likelihood of this can be reduced if windows and other openings are kept clear of vegetation.

5.4.5 As with green roofs, green walls and façades can easily be implemented across the site. They are not reliant on any other features for their function and their water management capabilities are not such that they would form a strategic part of the surface water drainage strategy for the site.

5.4.6 Therefore, green walls and façades can be installed across the site on a case by case basis. Furthermore, they could easily be retrofitted to buildings across the site at a future date if required.

5.5 Swales

5.5.1 Swales are shallow, flat bottomed, vegetated open channels designed to convey, treat and sometimes store surface water runoff. When incorporated into site design, they can contribute to enhancing the natural landscape and provide aesthetic and biodiversity benefits. Swales can have a variety of profiles, can be uniform or non-uniform, and can incorporate a range of different planting strategies, depending on the site characteristics and site aims and aspirations.

5.5.2 Being linear features, they are often used to drain roads, paths or car parks, where it is convenient to collect distributed inflows of runoff or as a means of conveying runoff around a site. Swales can replace conventional pipework and the use of adjacent filter strips and/or flow spreaders can also remove the need for kerbs and gullies. This is particularly useful on flat sites where the use of pipework would lead to significantly deeper drainage infrastructure, resulting in cost and health and safety implications.

5.5.3 Given the retention of a strategic rhyne and ditch network on site and the obvious similarity between those and swales, the use of swale on site will likely be limited. However, they may be used where there are significant drainage pathways or adjacent to transport links where a rhyne or ditch is not already present.

5.6 Rills / Channels

5.6.1 Rills and channels are open surface water features with hard edges and can be commonly found in some existing cities, towns and villages. They can have a variety of cross-sections to suit their setting, lending them to urban areas particularly well, and can also be planted to provide water quality treatment and amenity value.

5.6.2 The terms “rill” and “channel” can also be extended to include hollow roads and gutters (which itself can include fluted, open or covered gutters).

5.6.3 These features are often best employed when draining large impermeable areas, such as streets, parking or communal squares, without the need for below ground infrastructure as they are easily integrated into the overall design with minimal land take. That said, this often means they are small features so may need to be augmented with another drainage feature. They also provide limited ecological benefit, although this is to the benefit of their amenity value.

5.7 Bioretention Systems / Rain Gardens / Tree Pits

5.7.1 Bioretention systems (including rain gardens) are shallow landscaped depressions that can reduce runoff rates and volumes whilst treating runoff pollution through the use of engineered soils and vegetation. They are a flexible surface water management component which can be used in a variety of development landscapes. For example, in low density development the system might have softer edges whilst in higher density development the edges may be harder and more linear.

5.7.2 Runoff collected by the bioretention system temporarily ponds on the surface before filtering through the vegetation and underlying soils, where the majority of water quality treatment takes places. Submerged anaerobic zones can also be included to promote better nutrient removal. The filtered runoff is then collected by an underdrain system or infiltrates to the ground.

5.7.3 There are many different approaches to the design of bioretention systems, which can be broadly broken down into the following types:

- Rain garden
- Raised planter
- Bioretention tree pit
- Anaerobic bioretention system

5.7.4 Rain gardens are typically small systems that are likely to be less engineered than typically bioretention components.

5.7.5 Raised planters are boxed systems constructed above the surrounding ground surface, providing an alternative to a rain garden. Raised planters are easily retrofitted.

5.7.6 Bioretention tree pits have enhanced performance when compared to conventional tree pits. This is achieved through extra surface planting. Trees and large shrubs are beneficial in bioretention systems as they intercept precipitation and allow water to evaporate from leaf surfaces, dissipate rainfall-runoff energy, facilitate infiltration and groundwater recharge (because of the their more extensive root systems), provide shade and can reduce runoff temperatures and provide further amenity and biodiversity benefits.

5.7.7 An anaerobic bioretention system has the outlet piped design so that there is a permanent water level within the drainage layer, allowing vegetation to access it during dry periods. This also assists with the treatment of some pollutants such as nitrogen. These systems are particularly good where trees are planted.

5.7.8 Given that bioretention systems are best suited to managing and treating surface water runoff at source and best serve smaller catchments, they are naturally suited towards a modular implementation. In addition, the various forms of system available mean that their design can be easily adapted to suit the surrounding development character. They can easily be incorporated into areas of hardstanding, alongside transport corridors or as part of a building or dwelling frontage.

5.7.9 All forms of bioretention can contribute to integrating biodiversity enhancement and amenity provision within the site, with multiple studies indicating that connection and visibility of green spaces improving the wellbeing of occupants and site users.

5.8 Pervious Pavements

5.8.1 Pervious pavements provide a hard surface suitable for pedestrian and/or vehicular traffic, while allowing rainfall to infiltrate through the surface and into the underlying structural layers. The water is temporarily stored underground before infiltrating to the ground or controlled discharge downstream. They are an effective means of managing surface water runoff close to source – intercepting runoff, reducing the volume and frequency of runoff and providing an effective method of treatment.

5.8.2 There are two types of pervious pavements:

- Porous pavements – Infiltrate water across their entire surface material
- Permeable pavements – Surface is formed of material that itself is impervious to water, but the materials are laid to provide void space through the surface to the sub-base.

5.8.3 The main types of surfaces used as part of pervious pavement construction are:

- Modular permeable paving – The most common modular permeable paving surface is concrete block permeable paving. The joints are widened and filled with grit to allow water into the underlying bedding layer and sub-base.
- Porous asphalt – This can be used as an independent surface or to provide a stronger base to concrete block permeable pavements under high traffic loadings.
- Grass reinforcement – Uses plastic or concrete grids infilled with grass or gravel.

- Resin bound gravel – Provide a range of finish colours, making them well suited to public or recreational spaces.
- Porous concrete – Can be applied in a similar manner to porous asphalt.
- Macro pervious – These systems are where normally impermeable surfaces are drained to channels or other collection systems designed to trap oil and silt before being directed to the sub-base for storage and further treatment.
- Sports surfaces – Either and aggregate sub-base or plastic sub-base replacement unit system can be used below turf or porous surfaces to manage surface water runoff.
- Block porous paving – Utilises porous block materials rather than water permeating through widened joints.

5.8.4 Pervious pavements can be used in most ground conditions and can replace proposed hardstanding. Therefore, they are well suited to be implemented across the site, with no additional requirements necessary to facilitate their use.

6 Residual Risks

6.1.1 The predominant residual risk to the proposed development and downstream are overland flows. These could be generated potential blockages of drainage infrastructure and/or the occurrence of (rare) storm events which exceed the design conditions.

6.2 Overland Flows

Potential Blockage

6.2.1 The risk associated with a potential blockage for the main drainage system onsite is considered to be small, given that the majority of drainage on site will comprise open systems. Routine inspection and maintenance procedures as described in **Section 7** of this report will minimise the risk of the accumulation of detritus and debris as well as ensuring that the drainage systems continue to operate efficiently. However, the residual risk of these events needs to be managed. The principles of dealing with these is set out below.

Exceedance Storm Event

6.2.2 In the event of a rare storm (beyond the design condition), the capacity of the drainage network could be temporarily exceeded, and drainage inlets could be bypassed creating overland flow. To minimise and manage the impact of these events at source the SuDS features for the scheme will be designed with controlled overflows such as spillways and weirs.

6.3 Designing for Overland Flows

6.3.1 It is recommended that an overland flow assessment is undertaken once a completed proposed ground model, including FFLs, highway levels, landscaping etc., for each proposed development plot as they are designed. This is so that any hotspots can be identified and designed out to demonstrate that properties are not at risk.

6.3.2 In finalising the proposed ground model for the proposed development plots, the following principles should be followed to cater for overland flows:

- All buildings should be provided with internal threshold levels raised above surrounding ground levels and designated flow paths created around the buildings to the lower lying levels. Localised grading may be required to achieve level access criteria. Exceedance flows would then naturally be directed around the buildings to lower ground.
- Gutters and hollow roads can be employed to direct overland flows via defined and managed routes.
- Divert flows to any present landscaped areas (e.g., natural depressions) away from critical infrastructure and buildings to further mitigate the impact.
- In certain circumstances it may be necessary to utilise road corridors to deliver this function. This, however, should not be considered the preferred option and should still facilitate safe access and egress as well as taking reasonable steps to protect property.

7 Operation and Maintenance

7.1 Aims & Objectives

7.1.1 To ensure the ongoing performance of the existing surface water management system on the site, there will be a requirement for regular maintenance over its lifetime. The SWDS has been developed based on the principles of SuDS, therefore the performance criteria of the SWDS is not limited to managing water quantities (discharge rates and volumes), but also improving water quality, providing amenity and enhancing biodiversity.

7.1.2 Typically, the maintenance of SuDS within a surface water management system involves regular removal of litter/debris in the system and general landscaping. Final designs of SuDS, outfalls, inlets etc. will need to be designed with regard for future maintenance, details of which will be appended to this report in accordance with **1.2**. All areas will need to be easily accessible and safe for maintenance operatives without compromising the performance criteria requirements.

7.1.3 Responsibility for maintenance of the SWDS will lie with This is Gravity Ltd and their partners Albion Water, who will retain an overall management responsibility of the developed site. It is likely that operation and maintenance activities for all surface water drainage infrastructure on site will be contracted by This is Gravity Ltd and Albion Water to a management company (details of this are yet to be confirmed). It is also likely that this management company’s responsibility will extend to the hard and soft landscaping of the site to ensure a consistent, holistic management regime.

7.2 Operation & Maintenance Details

7.2.1 Operation and maintenance activities for the rhynes and ditches and reed beds will primarily concern the management of their respective vegetation. However, following regular inspections, it may also be required that sediments are removed from these systems occasionally.

7.2.2 A separate draft Operation & Maintenance Manual for the strategic SWDS components on site has been produced and can be found in Appendix G. This contains further details regarding the types of maintenance activities, their purpose and the frequency in which they would need to be undertaken.

8 Conclusion

8.1 Planning Submission

8.1.1 This SWDS has been prepared to support an LDO application, the Gravity Smart Campus, at the Former ROF in Puriton, Somerset.

8.2 Surface Water Drainage

8.2.1 The SWDS detailed as part of the LDO application, comprises utilising the diverted and realigned systems constructed as part of the remediation of the site. These have been designed to accommodate the upstream catchment flows they currently already manage, as well as proposed surface water runoff from the development proposals.

8.2.2 As previously agreed with the EA and SDBC, the site will discharge freely into the Huntspill River via an alteration to its current outfall. Surface water flows will be directed into the existing reed beds, which are no longer required to treat effluent, before an amended outfall will direct surface water to the existing North Water Outfall into the Huntspill River. The reed beds will no longer need to discharge via a pump into the Acid Ditch, however modifications could be made to maintain a sweetening flow and preserve the water vole habitat in that watercourse.

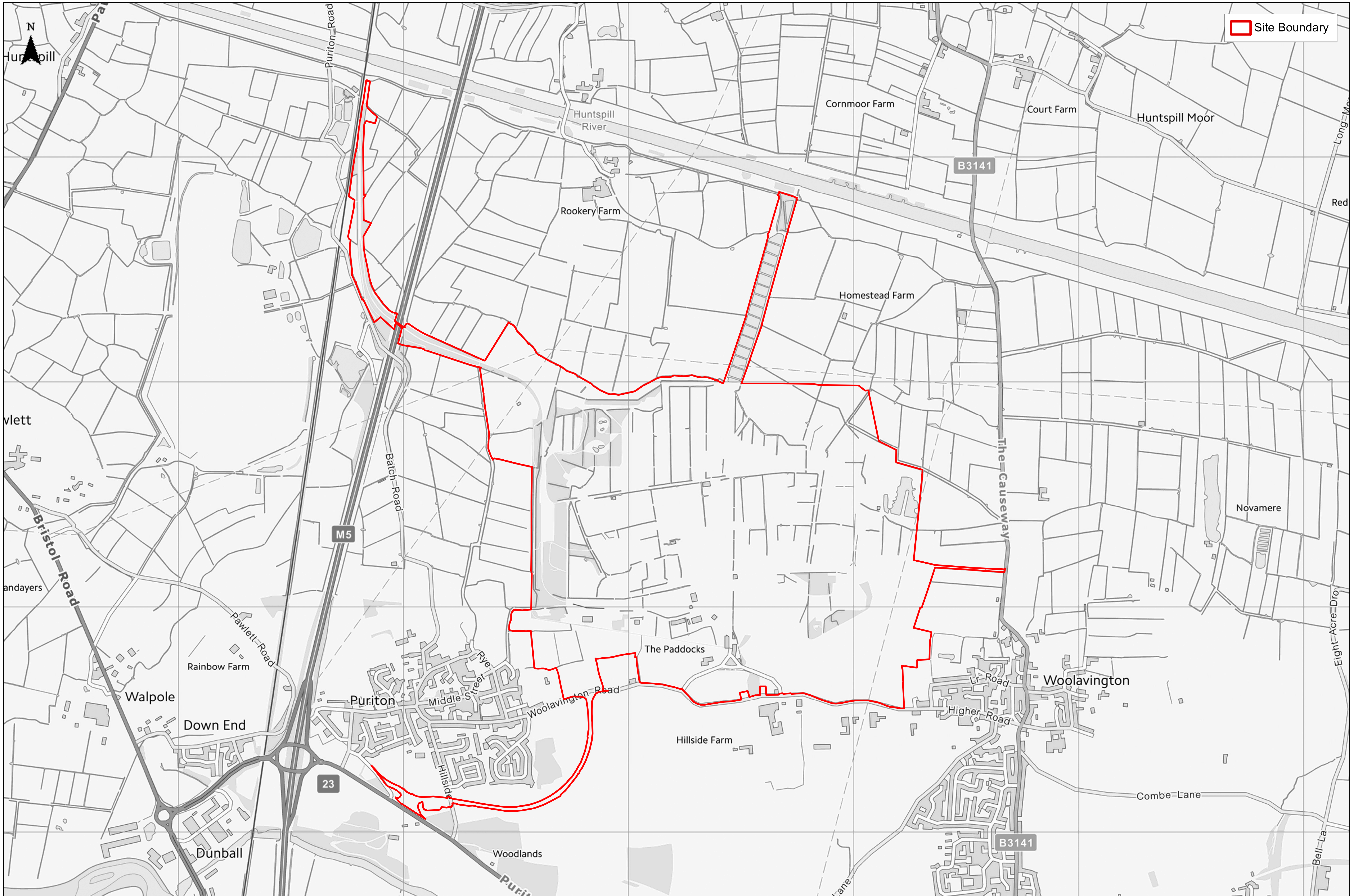
8.2.3 An assessment has been undertaken to determine that there is adequate storage within the reed beds to temporarily store surface water runoff in the event of a tide lock in the Huntspill River.

8.2.4 Given that there is no discharge rate restriction required, there is also no requirement to manage discharge volumes on site, above that provided for a tide lock scenario.

8.2.5 The Huntspill River is an NNR, therefore the water quality discharge from the site must be adequate so that there is no negative impact as a result of the development proposals. This report has demonstrated that the strategic rhynes and ditches and reed beds provide adequate water quality treatment for all potential land uses on site.

8.2.6 In spite of adequate water quality treatment provision, this SWDS report recommends that on-plot SuDS are implemented to further add robustness to the management of surface water runoff on site, but also to contribute to the ecological and placemaking aims and objectives of the development proposals by forming part of an integrated Green-Blue Infrastructure strategy.

Appendix A Baseline



Stantec

Client: G

GRAVITY

Site Location

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Drawn: CE	Checked: RR
Figure 001	Rev A

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Stantec

Client:

G

GRAVITY

Site Location (Aerial)

0 250 500
m

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Contains Ordnance Survey data (c) Crown copyright and database right 2019.

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Figure 002	Rev A

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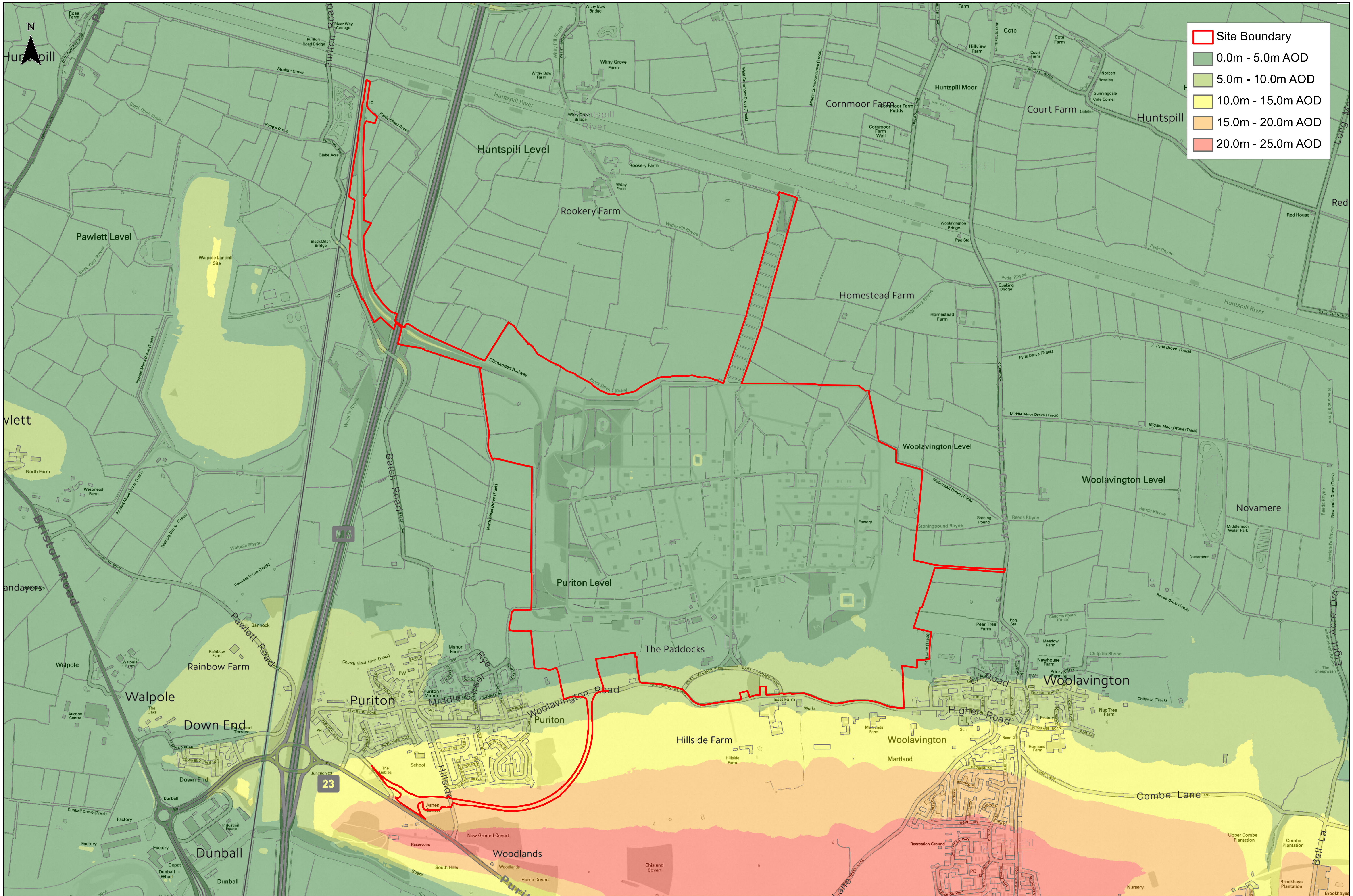
Appendix B Topography

Figure 3 - Topography



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Client:

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GRAVITY

Topography

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Figure 003	Rev A

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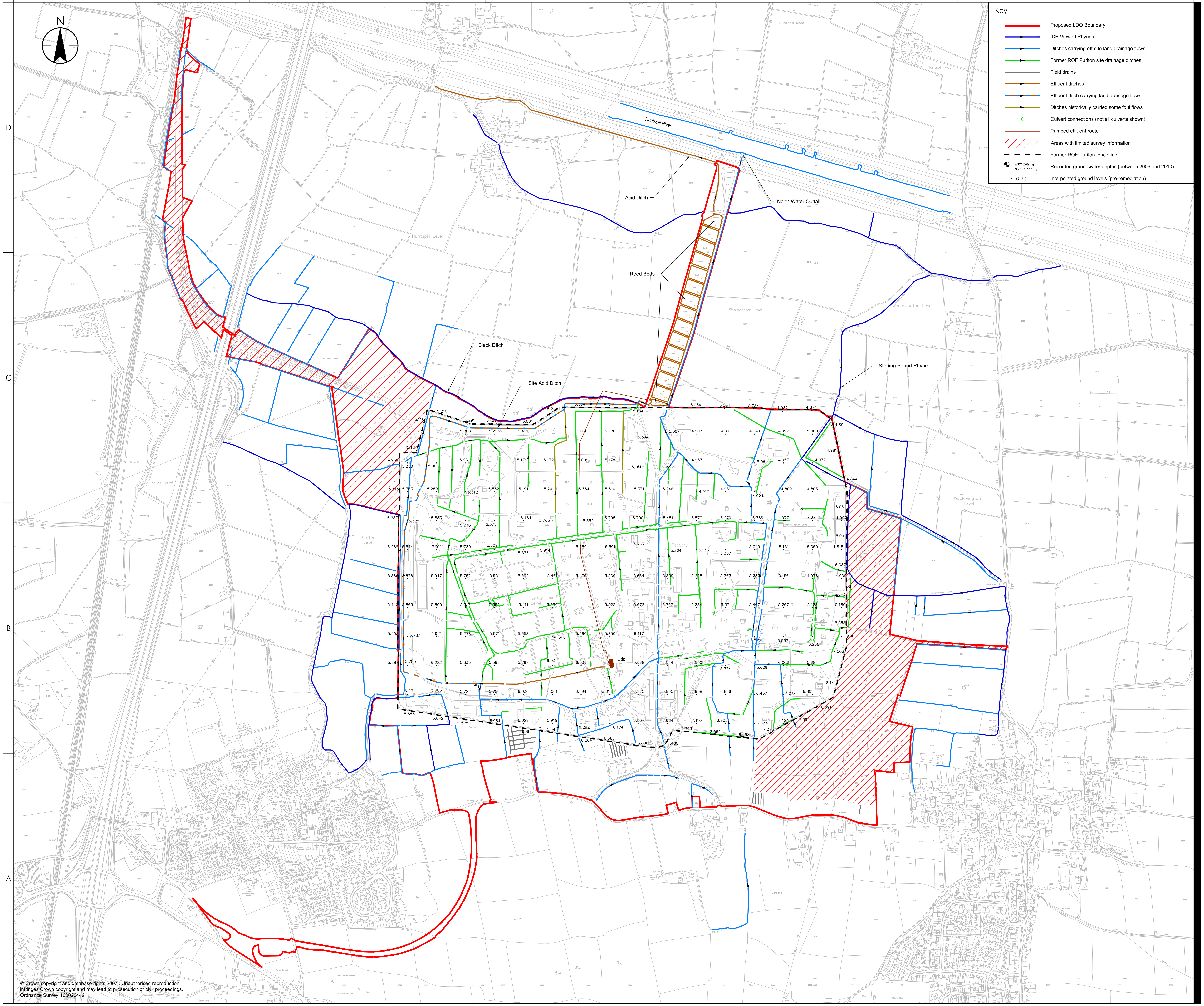
Appendix C Existing Drainage

332310092-4002-SK01 Existing Drainage Conditions



Stantec

Stantec UK Limited
TAUNTON
Lakeside House, Blackbrook Business Park, Blackbrook
Park Avenue, Taunton TA1 2PX
Tel: +44 1823 218 940
www.stantec.com/uk

Notes

UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake their own investigation where the presence of any existing sewers, services, plant or apparatus may affect their operations.

1. This drawing is to be read in conjunction with all other Engineer's and Architect's drawings.
2. All dimensions are in metres unless noted otherwise.
3. All levels are in metres above Ordnance Datum (AOD).
4. The location of ditches and rhynes has been determined based on Ordnance Survey data and topographical surveys undertaken by Lewis Brown Chartered Land Surveyors (ref: N07029, date: Sep 2007 and ref: B02002, date: Feb 2020).
5. Areas of the site where topographical survey information is limited are indicated and it is recommended that more detailed surveys of these areas are undertaken prior to detailed design works commencing.

A	REMOVED PROJECT GROVE PLATFORM BOUNDARY	TM		RAS	2021.10.15
Issued/Revision		By		Appd	YYYY.MM.DD
		LWD	-	AJ	2021.08.19
		Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Issue Status

FOR INFORMATION

This document is suitable only for the purpose noted above.
Use of this document for any other purpose is not permitted.

Client/Project Logo

Gravity

Client/Project
This is Gravity Ltd

Former ROF Puriton, Somerset, United Kingdom

Title
Existing Drainage Conditions

Project No.	Scale
332310092	NTS
Revision	**Drawing No.**
A	332310092/4002/SK01

Appendix D Reed Bed Assessment

Existing Surface Water & Effluent Infrastructure Assessment

Gravity

A Smart Campus and Community

Local Development Order
Surface Water Drainage Strategy
Existing Surface Water & Effluent Infrastrucure Assessment

Document Control Sheet

Project Name: **This is Gravity**

Project Ref: **332310102/4002**

Report Title: **Existing Surface Water & Effluent Infrastructure Assessment**

Doc Ref: **Revision B**

Date: **September 2021**

	Name	Position	Signature	Date
Prepared by:	Lewis Derrick	Engineer		24.09.2021
Reviewed by:	Andrew Johns	Senior Associate		24.09.2021
Approved by:	Paul Jenkin	Director of Water Management		24.09.2021
For and on behalf of Stantec UK Limited				

Revision	Date	Description	Prepared	Reviewed	Approved
A	19.08.21	Issue for Client Review	LWD	AJ	-
B	24.09.21	For Planning	LW	AJ	PJ

Contents

Tables

Appendices

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1 Introduction

1.1 Scope of Report

1.1.1 This Existing Surface Water & Effluent Infrastructure Assessment (henceforth referred to as *"report"*) has been produced by Stantec UK (Stantec) as an appendix to the Surface Water Drainage Strategy (SWDS), also produced by Stantec, in support of a Local Development Order (LDO) application. The LDO application is made by our Client, This is Gravity Ltd, for an industrial-led multi use development at the Former Royal Ordnance Factory (ROF) Puriton in Somerset.

1.1.2 This report is intended to provide a summary of the on-site water management regime, covering surface water and foul drainage, for both the pre-remediation and post-remediation condition. This report also assesses the capacity and condition of the reed bed and lagoon system to the north of the site.

1.1.3 Some documentation relevant to the surface water management plan, and which have been developed in the context of the preparation of a LDO, has already been produced and approved by the relevant authorities, where required, including: the Strategic Design Code, Strategic Landscape Masterplan and the Clean and Inclusive Growth Strategy.

1.2 Source of Information

1.2.1 Stantec has been involved in assessing Flood Risk and Drainage at this site for over 10 years, including in support of an extant Outline Planning Consent in 2017 (ref: 42/13/00010). As such, a number of reports and assessments have been completed to date. These are listed below:

- Royal Ordnance Factory Puriton TUFLOW Modelling Report (July 2007)
- Royal Ordnance Factory Puriton TUFLOW Modelling Addendum to Technical Modelling Report (October 2007)
- Royal Ordnance Factory Puriton TUFLOW Modelling Addendum NO.2 of Technical Modelling Report (January 2008)
- Huntspill Energy Park Remediation Application – Flood Risk Assessment (October 2011)
- Borrow Pit Angling Club Flood Risk Assessment (October 2012)
- Huntspill Energy Park Remediation Phase 1 Drainage Scheme (March 2013)
- Huntspill Energy Park Flood Risk Assessment (April 2013)
- Huntspill Energy Park Surface Water Management Strategy (April 2013)
- Huntspill Energy Park Addendum to Surface Water Management Strategy (October 2013)
- Huntspill Energy Park Remediation Application Surface Water Management Strategy (October 2013)
- Huntspill Energy Park Remediation Works Drainage Scheme for Plots J-K (January 2014)
- Puriton Solar Farm Drainage Strategy Technical Note (February 2015)
- Huntspill Solar Park Surface Water Management Strategy (December 2015)

- Land at Puriton Abstraction Assets Assessment (March 2018)
- Huntspill Energy Park Tidal Flood Risk Summary Note (June 2018)

1.2.2 Additionally, a survey report undertaken by Duntech Environmental Services in January 1994 and a topographical survey of the reed bed system north of the site undertaken by Lewis Brown Chartered Land Surveyors in March 2020 have been reviewed.

1.2.3 As part of the LDO application, Stantec have produced updated Flood Risk Assessment (FRA) and SWDS reports, with this report forming an appendix to the SWDS. It should be noted that whilst many of the findings and conclusions of the previously completed works have informed the SWDS, these documents were undertaken in relation to the extant consent. Hence, the area assessed by these documents is smaller in extent than the proposed LDO area. Where relevant, the findings of these documents has been referenced and/or updated to reflect this new site extent.

2 Pre-Remediation

2.1 The Site

2.1.1 Prior to the commencement of the remediation works, the former ROF comprised of a number of factory buildings and ancillary office buildings located centrally within the site. Munitions production buildings enclosed by blast mounds were located within the remainder of the site. In addition, there were several greenfield, wooded areas.

2.1.2 The surface water and foul water management regime, and potable water supply conditions for the site prior to remediation have been outlined in the following sections.

2.2 Surface Water Management

2.2.1 Prior to remediation, the site was drained by a network of ditches and rhynes that conveyed surface water generally northwards. The ditches within the site fall into two categories; those that convey flows through the site from the upstream catchment, and those that only serve the site itself.

2.2.2 A Surface Water Management Strategy (SWMS) was prepared in 2013 to support the outline planning application for the remediation works. As part of the SWMS, a detailed inspection of the existing ditch network within the site was carried out to understand the flow routes and connections across the site. The inspection also confirmed the sub-catchment areas and various outfall locations.

2.2.3 The pre-remediation drainage patterns including sub-catchments and outfall locations are described as below:

- Sub-Catchment A – A small section of land on western boundary, and another north-west of centre, discharges into the Black Ditch directly.
- Sub-Catchment B – The majority of the western parts of the site drain to the "Site Acid Ditch".
- Sub-Catchment C – A small section of land located centrally in the north of site drains to the "Site Acid Ditch".
- Sub-Catchment D – Central areas, representing a significant proportion of the site, drain to a south-to-north rhyne which continues parallel to (but separate from) an existing reed bed system before discharging into the Huntspill River via the "North Water Outfall".
- Sub-Catchment E – Eastern parts of the site drain north-eastwards to the Stoning Pound Rhyne.
- Sub-Catchment F – South-western areas of the site which drain to the unnamed viewed rhyne to the west. This area is associated Gravity Link Road, which has been consented as part of the previous outline consent and is currently under construction.
- Sub-Catchment G – North-western areas of the site associated with the existing railway, which appear to discharge into adjacent rhynes and ditches before conveying flows westwards to either the Huntspill River or Parrett Estuary.

2.2.4 The Black Ditch and the Stoning Pound Rhyne are managed by the Somerset Drainage Board Consortium, while the Huntspill River is managed by the Environment Agency.

2.2.5 Water levels in the Huntspill and the upstream rhyne network are managed seasonally. In winter, water levels in the rhynes are lowered to reduce the risk of flooding by provided greater storage and conveyance capacity. In summer, water levels are maintained at a higher level to provided irrigation and water supply for nearby agricultural land. Prior to remediation works, the typical water level in the Huntspill was approximately 3.5mAOD in the summer, and 2.9mAOD in the winter. Water levels within the rhynes are managed through the use of pens and stop-logs.

2.2.6 It is assumed that water levels within the on-site ditches and rhynes were of a comparable level, given the flat topography and therefore limited hydraulic head.

2.3 Foul Water Management

2.3.1 When the ROF site was operational, large volumes of process effluent were treated and discharged each day. Effluent was piped or pumped to a large treatment tank, known as 'The Lido' in the centre of the site. The effluent was then pumped from the Lido towards the large reed bed facility in the north of the site. The Lido also has an overflow to a ditch which runs west towards the site boundary before turning north and circumnavigating the site clockwise as far as the reed beds. This ditch is known as the 'Acid Ditch'.

2.3.2 The reed bed system requires the use of inter-stage pumping to utilise the reed bed system. This circulation and transfer pumping station is located just south of the reed bed locations

2.3.3 Following the passage through the reed beds, treated flows are then pumped into an outfall ditch immediately north of the reed beds. This ditch then turns west and flows parallel to (but separate from) the Huntspill all the way to the Parrett Estuary. The ditch is subject to a maintenance agreement with the EA and the outfall from the reed beds falls under a discharge consent license.

2.3.4 The outfall ditch from the reed beds is also known as the 'Acid Ditch'. To avoid confusion, the ditch within the site is referred to as the 'Site Acid Ditch'.

2.4 Potable Water Supply

2.4.1 During operation of the ROF site, potable water supply was not provided by the local water company, in this instance Wessex Water. Instead, water demands were met via abstraction and treated privately before distribution across the site.

2.4.2 A water treatment works for the site was located approximately 1.2km south of the site on Knowle Hill. This site included two combined covered reservoirs, which are assumed to have supplied both potable and process/demineralised water to the site. In combination, these reservoirs had a capacity of 250,000 gallons (approximately 1,140m^3 or 1,140,000 litres). There were two 250mm (10'') diameter pipes for supplying process water to the site and two 150mm (6'') diameter pipes for potable water supply.

2.4.3 There are two abstractions associated with the ROF. Firstly, there is a licence 16/52/011/S/048 for the abstraction of water from the Huntspill River at ST 344 436. This is for industrial purposes and the maximum quantity of the water permitted is 3,500m^3 per day and 420,000m^3 per year. The licence also states that the annual abstraction shall be regarded as the maximum to be taken from the Huntspill River but shall be within the maximum aggregated quantity of water authorised to be abstracted in any year under licence number 16/52/008/S/122 relating to abstraction from the Kings Sedgemoor Drain.

2.4.4 The second licence is 16/52/008/S/122 for the abstraction of water from the Kings Sedgemoor Drain at ST 330 400. This is for general cooling water and the maximum quantity permitted is 700m^3 per hour, 3,000m^3 per day and 1,000,000m^3 per year. The licence states that it is linked to 16/52/011/S/048 with an aggregate annual licence quantity of 1,000,000m^3. It also states that abstraction must stop when the level in the Kings Sedgemoor Drain drops below that required to meet agricultural needs or the flow over the Dunball Clyst stops.

3 Post-Remediation

3.1 Nature of Completed Remediation Works

3.1.1 The completed remediation works have been undertaken cognisant of the layout supporting the approved hybrid planning application 42/13/00010 and the separate remediation works planning application 42/11/00017.

3.1.2 The scope of the remedial works completed to dates is as follows:

- Demolition of remaining buildings;
- Treatment of contaminated material;
- Creation of a landscaped mound at the west of the site;

3.1.3 Importantly, the principles of the remediated strategy remain the same as previously consented but updated to better reflect the proposed development plots as proposed within the LDO application. A plan of the remediated surface water drainage strategy can be found appended to this report.

3.1.4 Subject to planning approval, it is intended the remediation works are completed in 2022.

3.2 Surface Water Management

3.2.1 The remediation of the former ROF site involves modification of the existing site land drainage network including realignment or diversion of existing rhyne and ditch routes around the plot areas. The remediation strategy originally proposed in 2013 was prepared based on five key objectives. These have been maintained as part of the current S73 application to vary Condition 9. They are as follows:

1. To provide treatment and pollution prevention measures during the remediation works.
2. To preserve the function and hydraulic continuity in the land drainage network through the site.
3. To reflect/accommodate the emerging future developments surface water management strategy.
4. To provide sufficient land drainage including temporary drainage features to serve the site in its remediated condition prior to the commencement of the future development construction.
5. To ensure adequate maintenance of the drainage system including the existing outfall routes.

3.2.2 The drainage scheme proposed as part of the remediation strategy intended to reflect the pre-remediation drainage characteristics while preserving the flexibility for the design of any future development.

3.2.3 It is understood that pre-remediation whilst the ROF site was operational the ditches and rhynes within the site were well maintained and thought to have been of sufficient capacity. During the decommissioning of the ROF site the maintenance of the ditches has understandably become less frequent. Despite this, the network was still seen to be preforming well, which suggests the layout and size of the ditches are adequate to serve the site.

3.2.4 The arterial ditch routes will be diverted to accommodate the plots within the development proposals. Ultimately, all drainage on site, both post-remediation and post-development, will drain to these ditches, therefore these will be diverted during the initial remediation works to provide the necessary plot layouts as the development is progressed. This will also avoid individual plots being reliant on one another, allowing greater flexibility regarding the development programme.

3.2.5 Where ditches are to be diverted it will be important to design the new connections with sufficient capacity so as to avoid impeding the existing flows. Some of the diversion routes make use of existing ditches. These ditches will be cleared and profiles upgraded as required to ensure capacity is undiminished.

3.2.6 It is proposed to infill all ditches within the proposed plot boundaries as part of the works. As each plot is brought forward for development in the future, an on-plot drainage system will be required linking into the overall surface water strategy for the development proposals. However, a temporary/interim land drainage system will be needed to drain the plot and this will be installed as part of the remediation works.

3.2.7 Ditch modifications is based on the following principles:

- All existing ditches within the plot boundaries to be infilled.
- Where ditches that convey flows from upstream pass through the plot area, these will be diverted around the perimeter of the plot.
- A network of ditches will be provided on-plot to serve as land drainage in the remediated condition.
- Existing catchments and outfall locations will be preserved as far as practicable in order to avoid impacts on the downstream drainage regime.

3.2.8 The existing site ditches are generally spaced around 100m apart and the proposed layout of on-plot ditches has been prepared with a similar spacing.

3.2.9 Material will be imported on site to form the proposed LDO development platforms, raising levels above existing. Ground levels will be defined to provide a slight fall into the plot from the boundaries towards the ditches. Watersheds within the plot will be defined between the ditches.

3.2.10 A minimum interim earthworks level of 5.25m AOD has been identified based on the FRA work previously carried out by Stantec (in support of the extant outline planning permission, not the LDO). This will be the lowest ground level on all plots upon completion of the remediation works. This will form a level in which the design levels stated in the FRA and Surface Water Drainage Strategy for the LDO can be constructed above.

3.2.11 Therefore, the proposed ditch top-of-bank levels have been set to 5.25m AOD, except where existing ground levels are greater than this. In those locations, the proposed top-of-bank level is based on the existing ground level to avoid being in ‘cut’.

3.2.12 A general ditch profile based on the existing ditch characteristics has been applied to the new ditch design. This profile comprises a 1m bed width, around 0.7m deep, with 1:1 bank slopes. A bed gradient of 1 in 1,000 has generally been used, with depths a little greater than 0.7m at the downstream end and a little less than 0.7m at the upstream end.

3.2.13 Culverts on retained watercourses will be opened up wherever possible although some new culverts/bridges may be required at plot access locations.

3.2.14 The remediation works do not include any introduction of hardstanding areas. Conversely, existing buildings and hardstanding areas at the site are being demolished. Therefore, there will be no increase in runoff rates and volumes from the site as a result of the works. Hence, there is no requirement to limit discharge rates and provide attenuation storage.

3.3 Foul Water Management

3.3.1 As the ROF is no longer operational, it has been assumed that any remaining foul drainage infrastructure on site has been decommissioned and removed from the site or is no longer fit for purpose. In any case, the remaining foul drainage infrastructure is no longer carrying foul drainage as there is no effluent generated on the site in its post-remediation condition.

3.3.2 However, the retained buildings and 37 Club drain to a package treatment plant that is located in an area of land just outside the main access gate to the site. The treated effluent is discharged to the main ditch under licence from the EA.

3.4 Potable Water Supply

3.4.1 As with the foul water management on site, there is no longer demand for potable water supply on site. Therefore, it is again assumed that potable water supply infrastructure on site has either been decommissioned and removed from the site or is no longer fit for purposed.

3.4.2 The off-site infrastructure at Knowle Hill remains in place and is unaffected by the remediation works but is not fit for purpose and is not required for the purposes of the Gravity site for future use.

4 Reed Bed Survey Information

4.1 1994 Survey

4.1.1 A survey of the reed bed system was undertaken by Duntech Environmental Services in January 1994, on behalf of then site owners British Aerospace Defence Limited. This not only recorded the condition of the reed beds but also made recommendations for future maintenance.

4.1.2 The survey indicated that the reed bed is approximately 700m long and has an average width of 70m, covering and area of 4.9ha. At the time of this survey, the base of the reed bed was stated as alluvial clay overlain by varying amounts of sediment topped by up to 0.5m of degrading peat and reed detritus. The depth of the water channel along the reed bed's western edge varied between 0.5-1.2m, with an average depth of 0.78m given.

4.1.3 Commentary was provided on the geology and hydrogeology of the area in which the reed bed is located, and it was noted that both of these were typical of what is recorded in the Somerset Levels. The combination of the alluvial grey clay (resulting in a low permeability soil) and flat topography accounts for the poor drainage in the area and the high groundwater levels, which were indicated to never be more than 1.5m below the soil surface. The reed bed is isolated from adjacent watercourses by clay banks. It was noted that the levels in the reed bed are lower than the surrounding water table and in a number of cases, surface water runoff flows from adjacent fields into the reed bed.

4.1.4 The survey stated that the reed beds were generally well established, with an increase in vegetation compared to a previous survey of the system. It did, however, comment that the reeds were not fully established across the system, particularly where effluent enters the reed beds. The conclusion was that the conditions, both nutrient-wise and pH levels, within the system were generally favourable for the health of the reed bed system, although low levels of potassium and phosphates (key nutrients) have been replaced by sulphate which was found to be in high levels across the system and resulted in poorer growth towards the southern end.

4.1.5 The survey report indicates that without intervention, eventually the reed bed detritus will exceed the water level resulting in self-extinguishing of the reed bed system. This can be prevented either by increasing the water level or burning back the reeds. However, at the time of the survey the detritus build-up was not of a sufficient level to enable efficient effluent treatment.

4.1.6 The 1994 report proposed the following design:

- Construction of an inlet lagoon to act as a buffer and permit the further establish of the reed beds in the southern end of the system. This would occupy the whole width of the bed and be approximately 20m north to south;

- At the north east corner of the lagoon would be a screened inlet chamber with a 300mm diameter PVC pipe running the whole length of the bed;

- The PVC pipe would be fitted with two valved outlets leading into each section of the bed, therefore effluent would flow by gravity from the inlet chamber to the eastern edge of the reed bed;

- In the north west corner of the lagoon, a bypass weir would be constructed to allow excessive surface water runoff to drain into the north to south ditch along the western edge of the reed beds. This would normally be fairly well diluted effluent which would mix with treated effluent coming off the reed beds;

- At the northern end of the reed bed system, where it narrows into a single channel, would be constructed the main lift pump station comprising a screened chamber and three dirty water low lift pumps with a duty of 90m^3/hr each. These will allow water levels to rise concurrently with the detritus level but then still drain the reed beds into their existing outlet.

4.1.7 A copy of the 1994 survey report can be found in **Appendix A**.

4.2 2020 Survey

4.2.1 A new topographical survey of the reed beds was undertaken in January 2020 by Lewis Brown Chartered Land Surveyors to confirm the location and condition of key infrastructure within the reed bed system as well as to determine the levels of siltation within the reed beds themselves.

4.2.2 The 2020 survey generally indicates that the design proposals put forward in the 1994 survey report were constructed. However, as noted in paragraph 3.2.3 the lack maintenance of the overall infrastructure on site in recent years has meant that not all aspects of the 1994 design could be found on site or confirmed without some degree of uncertainty. Nonetheless, the presence of 'hard' infrastructure in locations closely matching the 1994 proposals were identified.

4.2.3 At the southern end of the reed bed system, two chambers were found; one in the east and one in the west, suggesting that that bypass weir overflow into the western channel and 300mm diameter PVC pipe discharging effluent into the reed beds from the east were constructed. This pipe was not observed during the survey, but underground services along the eastern flank of the reed bed system was found, which may corroborate with this pipe.

4.2.4 At the northern end, no outfall pipe was observed, either visually or audibly. However, chambers were observed in the north-eastern corner which may be the location of the uplift pumps.

4.2.5 Not all detritus levels could be determined for all reed beds, but where bed and detritus levels could be measured, the detritus layer across the reed bed system varies from approximately 0.1m deep to 0.5m depth, with one excepting indicating nearly 1.0m depth of detritus.

4.2.6 Much of the reed beds themselves and the surrounding area, including the eastern and western bunds and outfall ditches, were indicated to be overgrown and covered by dense vegetation.

4.2.7 A copy of the 2020 reed bed survey can be found in **Appendix B**.

5 Reed Bed Condition Assessment

5.1 Surveyed Condition

5.1.1 **Table 5.1** below summarises average bed and silt levels within the reed beds, as surveyed in 2020. The reed bed references are also consistent with that survey, with Reed Bed 01 being the most southerly and Reed Bed 15 the most northerly.

Reed Bed Reference	Averaged Measured Bed Level (mAOD)	Averaged Measured Silt Level (mAOD)	Average Accumulated Silt Depth (m)
01	3.24	3.38	0.14*
02	3.42	3.82	0.40
03	3.49	3.80	0.31
04	3.55	3.86	0.31
05	3.40	3.76	0.36
06	3.51	3.82	0.31
07	3.47	3.94	0.47
08	Not obtained	Not obtained	Not obtained
09	Not obtained	Not obtained	Not obtained
10	Not obtained	Not obtained	Not obtained
11	Not obtained	Not obtained	Not obtained
12	Not obtained	Not obtained	Not obtained
13	Not obtained	Not obtained	Not obtained
14	3.47	3.57	0.10
15	3.35	3.59	0.24

Table 5.1: 2020 Survey Summary

**Bed and silt level only provided at one location in Reed Bed 01. Additional bed level provided but no silt level to compare against.*

5.1.2 Bed levels and silt levels were not recorded for all reed beds. However, it is reasonable to assume that the bed levels of the reed beds vary little from Reed Bed 01 in the south and Reed Bed 15 in the north. Based on the information available, the average bed level is 3.45mAOD.

5.1.3 The level of silt accumulation appears to reduce from Reed Bed 01 and Reed Bed 15. This was to be expected as silt is “trapped” upstream by the reeds themselves and thus reducing the sediment load available for siltation further downstream.

5.1.4 Water levels were recorded in Reed Bed 01 (4.44mAOD on 05 March 2020), Reed Bed 02 (4.43mAOD on 05 March 2020), and Reed Bed 15 (4.38mAOD on 04 March 2020 and 4.46mAOD on 18 March 2020).

5.2 Capacity Assessment

5.2.1 For the purpose of assessing the capacity of the of the reed beds following the 2020 survey, the same methodology utilised within the 2013 SWMS. The 2013 SWMS methodology estimated the available storage based on the outfall depth, the minimum crest level and the total area of the reed beds and also accounted for potential “tide-locking” of the reed beds.

5.2.2 In this assessment, the downstream level has been based on the measured bed levels within the reed beds, assessing against the maximum, minimum and average level. The crest level remains the lowest level surveyed. These calculations have been repeated for the maximum, minimum and average measured silt accumulation depth, as this information is now available when compared with the 2013 SWMS. This assessment also accounts for the current outfall depth and the likely impacts of ecological enhancement works within the reed beds.

5.2.3 The 2013 SWMS nor this assessment took account of the current water levels within the reed beds. This is because it is assumed that the existing water volume within the reed beds above the outfall would be “pushed” out by incoming flows and thus does not represent a volume restriction. This point is more relevant as the outfall arrangement, as proposed and consented, changes from a pumped discharge into the Acid Ditch to a gravity discharge via the North Water Outfall into the Huntspill River.

Available Capacity – All Silt Removed

5.2.4 **Table 5.2** provides an assessment of available capacity assuming all silt is removed.

	Minimum	Average	Maximum
Reed Bed Area (m^2)		36,750	
Surveyed Bed Level (mAOD)	2.79	3.45	3.94
Lowest Surveyed Crest Level (mAOD)		4.50	
Reed Bed Capacity (m^3)	62,843	38,588	20,580

Table 5.2: Summary of Available Capacity with All Silt Removed

5.2.5 Based on the storage volume requirement calculated in the 2013 SWMS (38,200m^3), the average surveyed bed level in conjunction with the lowest surveyed crest level will provide adequate storage. However, this assessment does not accurately take account of the volume lost to the banks between each reed bed (although, given the scale, this is likely to be of negligible impact) nor the fact that as an average value, there will be areas with higher bed levels which will reduce this level. Therefore, raising of the reed beds crest level is likely to still be required to provide some freeboard.

Available Capacity – Silt Remains In-situ

5.2.6 The previous assessment does not take account of the level of siltation evident within the reed beds. **Table 5.3** below indicates the available capacity when accounting for silt within the reed beds.

	Minimum	Average	Maximum
Reed Bed Area (m^2)		36,750	
Surveyed Bed Level (mAOD)	2.79	3.45	3.94
Surveyed Silt Level (mAOD)	3.27	3.77	4.06
Lowest Surveyed Crest Level (mAOD)		4.50	
Reed Bed Capacity (m^3)	45,203	26,828	16,170

Table 5.3: Summary of Available Capacity with Silt Remaining In-Situ

5.2.7 Taking account of siltation, there is no longer sufficient capacity within the reed beds based on the average silt level recorded, which indicates a 11,372m^3 shortfall. In a “do nothing” scenario, to provide enough capacity (as per the 2013 SWMS) the crest level across the reed bed area would need to be raised to 4.81mAOD (raised by 0.31m). This again does not take account of the volume lost to the banks nor does this raised crest level include for any freeboard.

5.2.8 By raising the crest level of the reed beds by 0.31m, the volume impounded above natural levels (11,372m^3) would not be considered a Reservoir under the Flood and Water Management Act 2010 and therefore would not fall under the regulations defined in the Reservoirs Act 1975.

5.2.9 However, it is recommended that a risk assessment for the potential breach or failure of the raised crest level is undertaken prior to design. Furthermore, it is also recommended that regular inspection of the raised crest level is undertaken during the site’s operation so that potential.

5.2.10 At this stage, it can be stated that in the event of the available tide lock storage volume being utilised i.e. water temporarily stored above existing natural levels, the surrounding landscape would likely be inundated with tidal waters. Therefore, in the event of a breach or failure of the raised crest level embankment, the impounded waters would flood already flooded land. In the event the surround land was not inundated, this land is used solely for agriculture therefore the risk of people and buildings is minimal. The impounded waters would also drain into the Huntspill River, based on the topography.

5.2.11 This high-level assessment of risk remains true for all potential options discussed where raising of the crest level is required.

Impact of Existing Outfall Level

5.2.12 The current outfall level is 3.5mAOD, therefore as previously calculated in 2013 SWMS the crest level will need to be raised to 4.6mAOD (raised by 0.10m) to provide sufficient capacity (without freeboard). This assumes that all silt is removed to this level or lower and that the reed beds can completely dewater, once the outfall is amended from the current pumped discharge to the Acid Ditch to the consented strategy of a gravity discharge to the Huntspill River via the North Water Outfall.

5.2.13 As with the option of leaving the silt in-situ, raising the crest level of the reed beds by 0.10m, the volume impounded above natural levels (3,675m^3) would not be considered a Reservoir under the Flood and Water Management Act 2010 and therefore would not fall under the regulations defined in the Reservoirs Act 1975.

5.2.14 It is recommended that a risk assessment for the potential breach or failure of the raised crest level is undertaken prior to design. Furthermore, it is also recommended that regular inspection of the raised crest level is undertaken during the site's operation so that potential.

Impact of Biodiversity New Gain Opportunities

5.2.15 It is likely that biodiversity measures could be required within the reed beds, which in turn will require a permanent water level to be present i.e. the reed beds cannot completely dewater. There are two options available for achieving this; lowering the bed level below the outfall invert or raising the outfall invert. The latter option is likely to be the easiest to achieve construction-wise and financially.

5.2.16 Based on the recommendations of CIRIA C753 "The SuDS Manual", water levels within the reed beds should vary between 0.4m and 2.0m deep. For the purpose of this assessment we have assumed an average water depth of 0.5m, as the reed beds are more characteristic of a wetland than a pond and therefore requires a shallower permanent water depth. Therefore, the outfall needs to be raised to 4.0mAOD. Assuming that silt levels are removed to this level or lower, this yields a capacity of 18,375m^3, which indicates a 19,825m^3 shortfall and which would require the crest level to be raised to 5.04mAOD (raised by 0.54m) to mitigate this (without freeboard).

5.2.17 By raising the crest level of the reed beds by 0.54m, the volume impounded above natural levels (19,825m^3) would still not be considered a Reservoir under the Flood and Water Management Act 2010 and therefore would not fall under the regulations defined in the Reservoirs Act 1975.

5.2.18 However, as this is still a large volume and close to the threshold, it is recommended that a risk assessment for the potential breach or failure of the raised crest level is undertaken prior to design. Furthermore, it is also recommended that regular inspection of the raised crest level is undertaken during the site's operation so that potential.

5.2.19 Should the option of lowering the bed levels be preferred, by lowering the bed level to at least 3.0mAOD and ensuring silt accumulation is removed to 3.5mAOD or lower, it will only be necessary to raise the reed bed crest level to 4.6mAOD (raised by 0.10m) (without freeboard) to achieve the necessary volume. Again, the impounded volume stored above existing natural levels in this option would not be considered a Reservoir.

6 Recommended Works

6.1 Hydraulic Capacity

6.1.1 Based on the assessment of available capacity within the reed beds outlined in **Section 5**, it will be necessary to include some bank raising/reinforcement to provide sufficient storage within the reed beds and account for "tide-locking". The following scenarios and degrees to which the banks need raising are as follows:

- "Do Nothing", average silt level remains at 3.77mAOD and the outfall at 3.5mAOD – Raise banks by 0.1m to 4.6mAOD;
- Remove silt to outfall invert level (3.5mAOD) – Raise banks by 0.1m to 4.6mAOD;
- Raise outfall to 4.0mAOD to provide 0.5m permanent water depth – Raise banks by at least 0.44m to 5.04mAOD;
- Lower bed level to provide 0.5m permanent water depth – Raise banks by 0.1m to 4.6mAOD.

6.1.2 Which option is preferred is subject to a technical and financial feasibility assessment beyond the scope of this report. Following that feasibility assessment, the detailed design of the surface water drainage strategy and the reed beds will be undertaken and submitted as part of future stages of work.

6.2 Ecological Considerations

6.2.1 The following section provide a high-level consideration of ecological constraints and opportunities affecting the reed bed works. The details of these considerations will be subject to further input from an ecologist, but this is beyond the scope of this report.

6.2.2 It is understood that the raising of the reed beds banks can be undertaken at any time of year, provided it does not disturb nesting birds. However, in previous planning processes, the reed beds have been identified as a receptor site for water vole relocation from other areas of the site. In the LDO, Natural England are working with the promotor to considering landscaping issues and it is now possible that water vole relocation off site may be possible. Therefore, the reed bed works require reconsideration.

6.2.3 Furthermore, if silt is to be removed from the reed beds, this will also need to be undertaken in advance of the water vole relocation. The reeds themselves would likely also be removed at this stage, to allow controlled regeneration, which may affect nesting birds. Therefore, silt and reed removal should be undertaken outside of the nesting season. The removal of the reeds may also need an ecological permit for this reason.

6.2.4 It is not a requirement that all reed beds are rehabilitated at the same time, and in fact it may not be beneficial to do so from a practicality and ecological perspective. Therefore, these works can be undertaken in phases.

6.2.5 Removal of the reeds and silt should be undertaken in accordance with the recommendations of the Surface Water Operation and Maintenance Manual.

6.2.6 As part of the ecological enhancement of the reed beds, there will likely be the introduction of varying levels to create a variety of submerged, marginal and dry habitat within the reed beds. These enhancements are subject to further ecological and engineering design. When these are available, an assessment of the reed bed capacity should be undertaken as a check. This would be done as part of a future Reserved Matters Application related to another condition concerned with detailed surface water drainage design, as opposed to the strategic-level of this report.

Appendix A 1994 Reed Bed Survey

Duntech Environmental Services January 1994 *Reed Bed Survey: Royal Ordnance Explosives Division Bridgewater Somerset*

Reed Bed Survey

Royal Ordnance Explosives Division

Bridgewater Somerset

Duntech Environmental Services

Duntech Environmental Services

British Aerospace Defence Limited,
Royal Ordnance Division,
Puriton,
Bridgewater,
Somerset TA7 8AD.

4th January, 1994.
Ref: Q/426/34
Yr.Ref: 93720 TF

For the attention of Trevor Freeston - Environment Coordinator.

Dear Sir,

Existing Reed Bed - Field Study and Development Proposals.

1.00 Base Data.

1.01 The existing reedbed surveyed located on the northern boundary of the Royal Ordnance Division site runs approximately 700 metres north north east to the Huntspill River and has an average width of 70 metres. The overall area is 4.9 hectares comprising a former clay borrow pit now colonised by a growth of common reed (Phragmites australis).

1.02 The geology is typical of the general area of the Somerset levels. Under the topsoil typically 12 to 14 metres of marine clay deposits are interspersed with peat lenses formed during periods of fresh water inundation during the Pleistocene. This alluvial deposit which can vary from 2 - 25 metres thick overlies 60 metres of Blue Lias (Jurassic) and the limestone of the Penarth Group (Upper Triassic). The alluvial grey clay has an extremely small particle size and consequently a very low hydraulic conductivity of the order of less than 10^{-9} metres per second. This characteristic combined with the flat topography of the area accounts for the poor drainage of the levels and the similar area along the Gwent coast. In spite of extensive drainage works the perched water table tends to remain high and is normally never more than 1.5 metres below the soil surface. Shallow wells are not very productive unless a deep peat lens can be exploited and deep boreholes are only productive in the Penarth formation.

1.03 The reedbed is isolated from the adjacent fresh water courses by clay banks which effectively screen the contents from the adjacent agricultural land. In addition the levels maintained in the reedbed are lower than the surrounding water table and in a number of cases surface water is flowing from adjacent fields into the reedbed. The base of the reedbed is alluvial clay overlain by varying amounts of sediment topped by up to 0.5 metre depth of degrading peat and reed detritus.

Lashlake Nurseries, Chinnor Road, Towersey, Thame, Oxon OX9 3QZ
Telephone: 084 421 7233/5411 Facsimile: 0844 261353
VAT REG No. 548 9324 23 Registered in England No. 1789740
(A division of Duntech Irrigation Services Ltd)

There has been a considerable increase in the reed population since the previous survey by the MRM partnership to the extent that over 85% of the area is now colonised. Some of the growth has not reached the optimum stage of development especially where the effluent first flows into the reedbed where die back has occurred. Following the excavation of the channels along the western edge of the reedbed and the outlet channel the static water level in the reedbed has dropped since the previous survey. There is in general only 0.5 metres depth of water over the sediment through which the reeds are growing and in many areas the reed detritus has built up level with the water surface. There are still some areas that have not been colonised by the reeds resulting in open water surfaces 0.5 to 0.7 metres in depth.

2.00 Reedbed Survey.

2.01 The details of the area survey are enclosed, see drawing W93951 at a scale of 1:500 placed on a 50 metre grid. Due to the low flows at the time of survey the hydraulic gradient between the entry ditch and the footbridge at the most northerly end of the drain was only 200mm, over the actual reedbed there was no significant hydraulic gradient. This gave a good indication of overall water depths. The average level of the water surface on the beds was 48.54 metres giving an average depth of about 0.50 metres of water overlying the bed surface to the sediment layer. The depth of reed detritus varied from 0.10 metres below the surface to 0.32 metres above the water surface. The depth of the water channel along the western edge of the reedbed varied in depth between 0.5 metres and 1.20 metres with an average of 0.78 metres.

2.02 A series of sections were plotted across the reed beds at 50 metre centres with the water depth plotted wherever possible using a small boat. In many places the depth of reed detritus was such that it was impossible to cover the full width of the bed. Apart from a small area between 500 and 550 metres where there is a small area of higher ground the majority of the reedbed appears to have a level bottom with depths of 4-500mm of water above the sediment. In places the reed straw is firm enough to walk on but will not support a static weight. The open water areas are marginally deeper than those covered by reeds.

2.03 A series of samples were taken of the sediment and clay below it for analysis in an attempt to determine the factor that has led to die back of the reeds and poor performance of those adjacent to the dead areas. Samples from the good areas were also taken for comparison. Whereas we were expecting a very low pH level overall it was in fact found that the pH was on average 7.84 in the effluent ditch, and varying from a low of 7.15 in the damaged reed areas to a high of 7.49 in the good reed growth areas. Total nitrogen was found to be high in the ditch, up to 0.45% and generally lower in the rest of the bed averaging around 0.17% as would be expected from an effluent high in Nitric Acid. The available Nitrogen in the form of Nitrates is very low at less than 2.0 mg/kg as would be expected in a totally flooded bed in an anoxic state.

It is apparent from the growth of the reeds that sufficient oxidation is occurring to supply the reeds with adequate Nitrate for their growth. The levels of available Potassium and Phosphate were extremely low and appear to have been replaced by Sulphate which was very high in all areas. The lack of these two major plant nutrients in the presence of high Nitrogen levels causes an imbalance and a reduction in root development. In the damaged reed area Sulphate levels were as high as 73,000 mg/kg, averaging between 7,000 and 9,000mg/kg in the better reed areas and as low as 3,000 mg/kg in the ditch. It is probable that the high levels of sulphate and low levels of other plant nutrients that are having a detrimental effect on the reed growth at the southern end of the reed bed. The high levels of Sulphides that are concentrated in the sediment means that the Phosphate will have been released and only anaerobic sulphur chemistry bacteria will be operating to degrade the organic matter this leads to the production of quantities of H_2S which is lethal to plant life at fairly low levels.

2.04 It is difficult to determine with any exactitude what is currently happening in terms of degradation pathways in the reedbed as it stands. It is certain that rhizome development in the underlying clay is not as extensive as it should be but it does show improvement down the bed away from the inlet end. Much of the rhizome development is occurring in the sediment and in the peaty layer formed by the dead reed material. It was not possible to estimate the efficiency of the reed root system as this would need a number of excavations in the bed surface once the water level had been lowered. The signs are however encouraging in that the above ground growth is extensive, has achieved a good height and in many areas has produced a high proportion of seed heads indicating that the stand is maturing and stable. The major restriction to further development in terms of treatment efficiency has been the high water levels in the bed which has reduced the ability of the dead reeds to degrade to produce a biologically active layer in which the reeds can produce the volume of rhizomes necessary for good oxygen transfer. The reeds do not perform well in the heavy clay of the base of the bed.

3.00 Development Strategy.

3.01 In the normal course of events in a reedbed which is left untouched for many years and has a static water level, the amount of degrading reed material increases year by year building to a considerable depth to the point at which the reedbed dries out and is no longer wet enough to sustain the reed population. This has happened to many natural reedbeds in East Anglia where the reedbeds have become self extinguishing and natural wetlands are being lost by a combination of modern drainage techniques and natural build up of reedbeds which are no longer managed by burning and harvesting. The ideal hydraulic relationship between the reeds and the water level occurs when the water table is managed on an annual basis such that the water table is maintained between 0.5 metres above the rhizome level in the Spring down as low as 0.5 metres below rhizome level in the Autumn. In the optimum period of growth from late Spring to early Autumn the water level should be maintained at or just below rhizome level.

3.02 Year on year either the water table has to be incrementally raised or every few years the reedbed has to be burnt off back to the water table. In this particular case the water table is well above ground level and the reed detritus has not yet built up sufficiently to enable the system to function as an efficient treatment system with the current water level. To transform this bed into an effluent treatment system the first requirement is to have control over the water levels in the bed.

The only practical method of achieving this appears to be the installation of a pair of lift pumps at the outlet of the system pumping out over a weir. The alternative is to excavate the outlet ditch and increase the depth by one metre which may mean that it will not outfall. The pumps will have to cope both with normal effluent flows and with peak flows during periods of high rainfall unless the natural drainage water can be excluded from the effluent system.

3.03 The topography of the beds is such that it would not be possible to run all the effluent down the length of the bed - 700 metres, without creating a substantial hydraulic gradient. This would mean that the inlet end would be permanently flooded to a depth of 1.0 to 1.4 metres in order to stop the far end from drying out and maintain a proper flow.

To convert the bed to a treatment system requires that the flow direction be changed from the long axis to the short axis. This will mean that the incoming effluent would be rerouted along the eastern edge of the reedbed and designed to take normal effluent flows. An overflow weir would permit storm flows to flow directly into the collection ditch along the western side of the beds. The present drainage ditch would require deepening by between 0.5 and 0.8 metres. To prevent longitudinal flow clay bunds running east/west would be required at about 50 metre intervals and it is possible that a level control device in the form of an adjustable weir will be required at the outlet to each bed section so formed.

3.04 Whereas in our initial proposals we intimated that the reedbed should be burnt off to obtain a fresh start free of reed detritus, following the survey we feel that this may not be so advantageous. As the dead reed mass contains a proportion of the active rhizomes and as the rooting into the clay substrate is poor we feel it would be better to retain the peaty layer and allow it to continue to build up. It may in a number of years raise the level in the beds to the point where the pumping requirement is reduced to storm flow conditions only or even eliminated completely. It would also provide an active layer in which treatment can occur. The underlying clay substrate as mentioned above has a very poor hydraulic conductivity which will take many years to improve by rhizome activity so the best chance of active treatment seems to lie in utilising the self generated peat layer as well.

4.00 Outline Design.

4.01 As the effluent supply tends to arrive at the reedbed in surges it is necessary to construct an inlet lagoon to act as a buffer. This would occupy the whole width of the bed and be about 20 metres from north to south. At the north east corner of the lagoon would be constructed a screened inlet chamber fitted with a 300mm diameter PVC pipe running the whole length of the bed. This pipe would be fitted with two valved outlets leading into each section of the bed. The effluent would flow by gravity from the inlet chamber to the eastern edge of the reedbed. At the north west corner of the lagoon would be constructed a bypass weir to allow excessive floodwater directly into the north/south drainage ditch. This would normally be fairly well diluted effluent which would mix with the treated effluent coming off the treatment beds. From the level readings obtained it should be possible to direct at least 1500m3/day onto the reed beds with flows of over 1800m3/day being directed over the weir.

4.02 In order to carry out the balance of the construction programme it will be necessary to upgrade the road along the western edge of the bed as well as the bridge over the rhynne. All the brick rubble from the inlet lagoon could be used to upgrade the road surface and additional material will have to be brought in to complete the roadway.

4.03 It should be possible to construct the dividing bunds from this road by inserting culverts in the main drainage channel and working over them. The main north/south drain would be excavated by a further 800mm to 1.0m to assist in draining the beds and maintaining adequate levels. Some 5000 cubic metres of clay will be required to construct these bunds either from a borrow pit from within the site or more expensively from outside. The most suitable configuration appears to be units of 50 metres wide. A simple level control device may be required at the effluent exit from each section, this has been costed in but may not be required if the subsurface levels we have determined are accurate.

4.04 At the far end of the reedbed where it narrows into a single channel would be constructed the main lift pump station comprising a screened chamber fitted with three dirty water low lift pumps with a duty of 90m3/hr each. These would be adequate for the highest flows encountered and would be capable of pumping 6480m3/day if necessary. A major cost is the electrical supply cable, specialist advice would be sought regarding the most economical method of power transfer. A weir would be constructed in the channel to prevent return flows into the reedbed. Level control facilities would be incorporated into the chamber to enable the levels to be adjusted according to the season.

4.05 In order to reduce the shading effect and likely incursions by woody plants and to improve access the eastern boundary bank to the reedbed would be cleared of undergrowth and any regeneration sprayed off. In the case of the western bank there are also some young willows that will require removal.

4.06 As there is no longer a requirement to burn off the beds in late winter the construction phase can be left until weather conditions improve in late spring to early summer which provides a time frame to carry out detailed design and pre construction surveying. The estimated time to complete the construction phase would be of the order of 10-12 weeks weather permitting.

4.07 Our current best estimate of the likely cost of the proposed construction programme subject to detailed design approved by yourselves is of the order of £240,000.00. The detailed design and costing would take six to eight weeks including submissions from earthmoving contractors to the presentation of a design and quotation. Our charge for the preparation of the design and detailed costing would be £8,500.00 excl. VAT.

5.00 Management Strategy.

5.01 Once construction is completed and effluent can be transmitted across the beds there will be a release of sulphate as the sulphides become oxidised and enter the effluent stream. It is difficult to determine how long this will continue. It will be necessary to add soluble Potash and Phosphates to the effluent stream as it enters the beds, the former can be applied at any time and the latter would be applied in spring of the following year. This would aid the recovery of the damaged areas and significantly improve the performance of the better areas.

5.02 The sections that contain the damaged reeds will not provide high levels of treatment initially. Very careful management of the water levels will be required from the outset to avoid damage to the rhizomes that are growing in the peat horizon and it is difficult to determine with any accuracy what the overall level of treatment is likely to be in the short term. It will be a matter of responding to the reeds as they recover from a major change in hydraulic regime and adapting them gradually to the new circumstances. If the system is carefully managed from the outset and not exposed to undue pressure in terms of loading then it should develop into a system capable of removing up to 1350kgs of COD per day at full development. As is the case with all reedbed treatment systems we are not in a position to guarantee the performance of the system or how quickly it will be achieved. It is however our experience of other systems that have been adapted in this way that it is more cost effective than developing a system from scratch and tends to reach a satisfactory level of treatment quicker than a newly planted system. Our major concern at this stage is how much the high levels of sulphides in the bed will retard the development of a microbial population that can be adapted to treat your neutralised effluent.

5.03 It is our opinion that a viable system can be developed to at least partially treat your effluent and that it should produce results sooner than developing a new system. We look forward to discussing these proposals with you with a view to making further progress with this development in due course.

R.P. Marks

Appendix 1

Soil Sample Results

APPENDIX 1 - SOIL SAMPLE RESULTS.

BULK SAMPLE Q426-1 Average Drainage Channel Southern End.

Dry Matter %	40.03	Moisture %	59.97
Total Nitrogen %	0.45	pH	7.84
Available Chloride mg/kg	326.00	Total Chloride mg/kg	595.00
Available Nitrate mg/kg	<2.00	Total Nitrate mg/kg	<2.00
Available Sulphate mg/kg	1774.00	Total Sulphate mg/kg	3274.00
Available Phosphorus	2.18	Total Phosphorus mg/kg	5.60
Available Potassium mg/kg	74.00	Available Magnesium	78.00
Available Calcium mg/kg	642.00	Available Sodium mg/kg	346.00

* Available - as water soluble elements

BULK SAMPLE Q426-2 Average Badly Damaged Reed Areas.

Dry Matter %	61.72	Moisture %	38.28
Total Nitrogen %	0.19	pH	7.32
Available Chloride mg/kg	210.00	Total Chloride mg/kg	231.00
Available Nitrate mg/kg	<2.00	Total Nitrate mg/kg	22.00
Available Sulphate mg/kg	1944.00	Total Sulphate mg/kg	72715.00
Available Phosphorus	0.40	Total Phosphorus mg/kg	0.98
Available Potassium mg/kg	76.00	Available Magnesium	110.00
Available Calcium mg/kg	658.00	Available Sodium mg/kg	294.00

* Available - as water soluble elements

BULK SAMPLE Q426-3 Average Slightly Damaged Reed Areas

Dry Matter %	65.30	Moisture %	34.70
Total Nitrogen %	0.18	pH	7.15
Available Chloride mg/kg	188.00	Total Chloride mg/kg	235.00
Available Nitrate mg/kg	<2.00	Total Nitrate mg/kg	<2.00
Available Sulphate mg/kg	4478.00	Total Sulphate mg/kg	13350.00
Available Phosphorus	0.58	Total Phosphorus mg/kg	1.45
Available Potassium mg/kg	96.00	Available Magnesium	196.00
Available Calcium mg/kg	1426.00	Available Sodium mg/kg	228.00

* Available - as water soluble elements

APPENDIX 1 - Contd

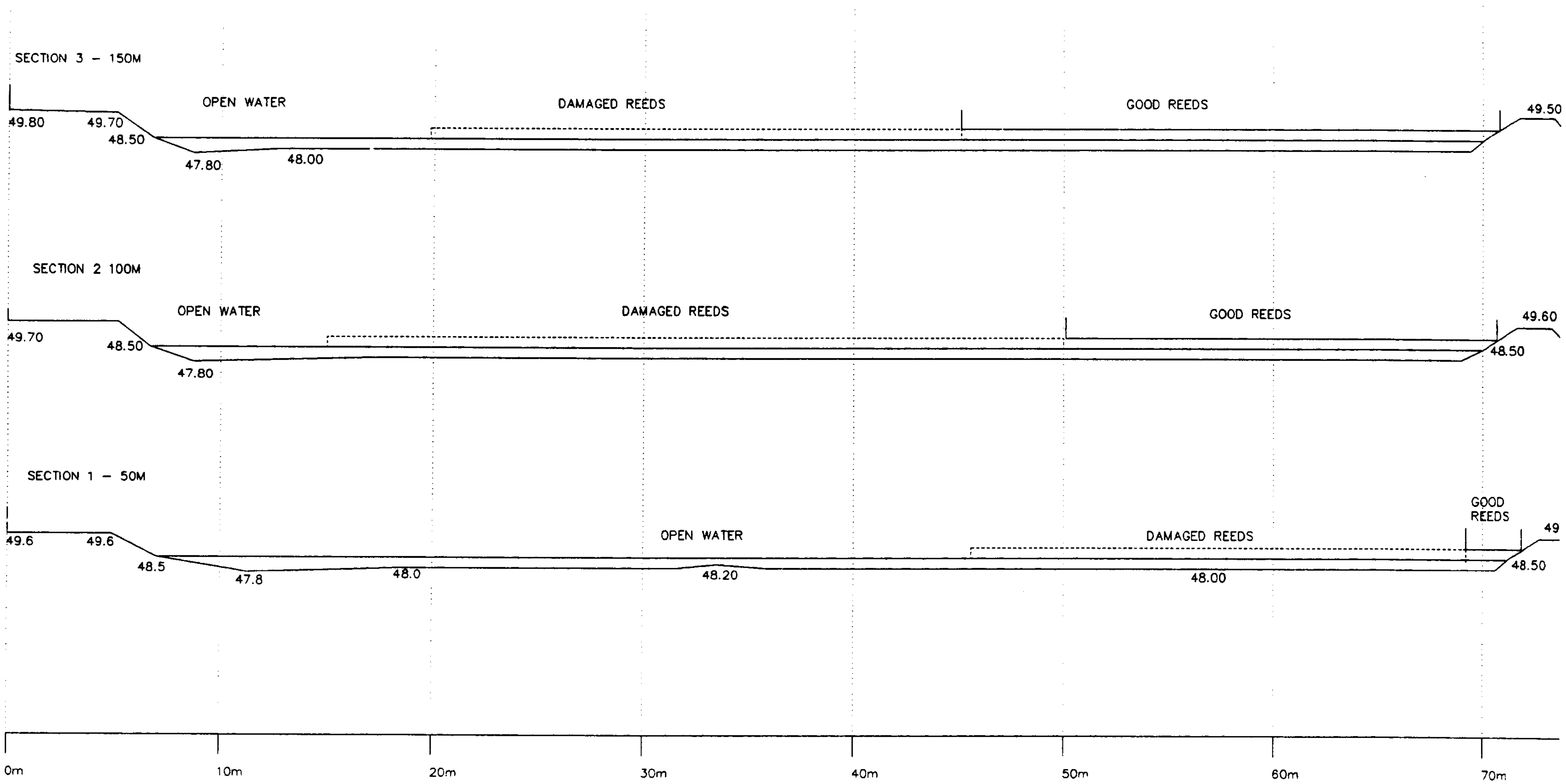
BULK SAMPLE Q426-4 Good Reed Areas

Dry Matter %	68.42	Moisture %	31.58
Total Nitrogen %	0.17	pH	7.49
Available Chloride mg/kg	156.00	Total Chloride mg/kg	462.00
Available Nitrate mg/kg	<2.00	Total Nitrate mg/kg	<2.00
Available Sulphate mg/kg	1676.00	Total Sulphate mg/kg	9402.00
Available Phosphorus	0.25	Total Phosphorus mg/kg	0.81
Available Potassium mg/kg	4.00	Available Magnesium	110.00
Available Calcium mg/kg	622.00	Available Sodium mg/kg	182.00

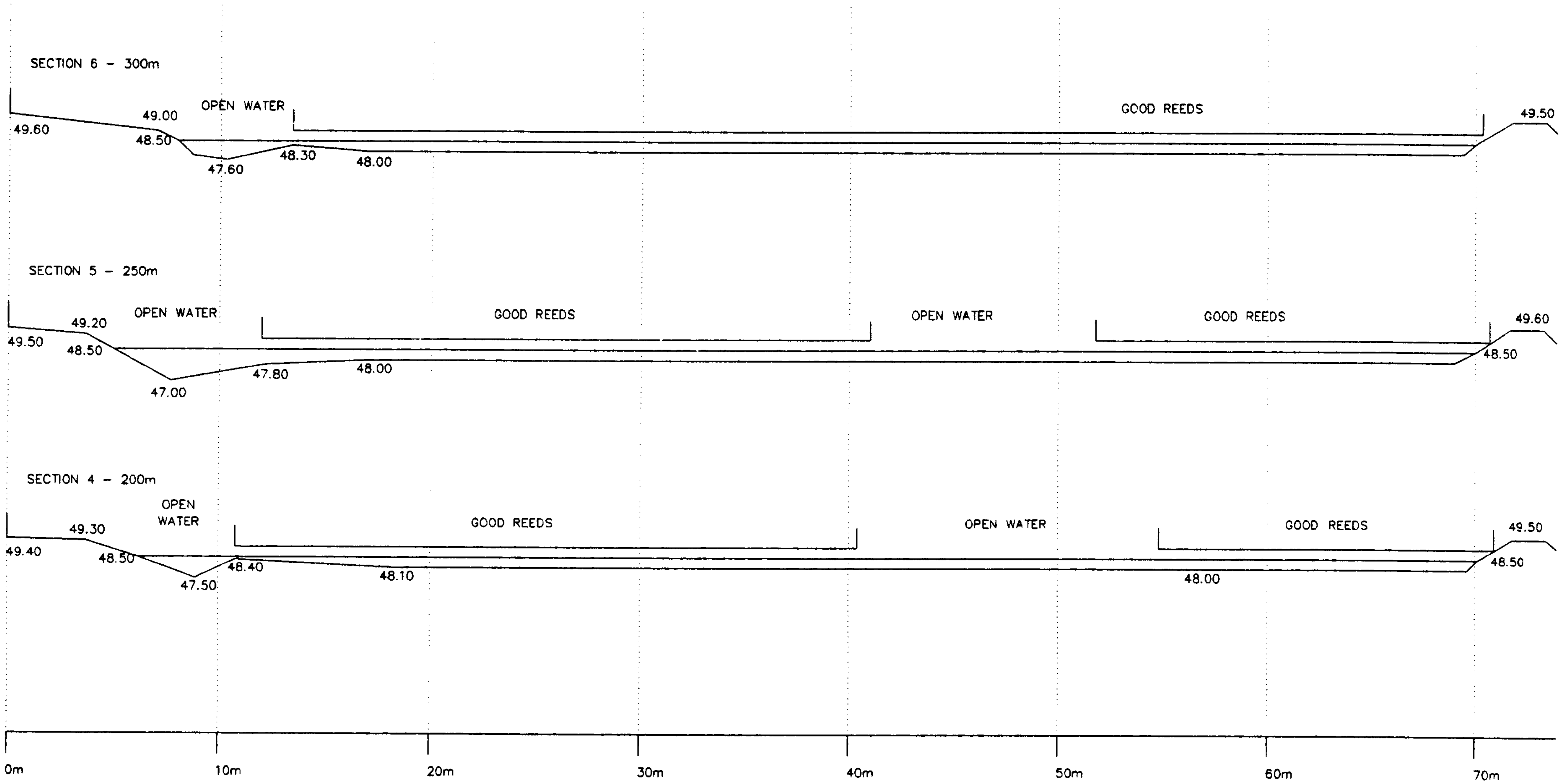
+ Available - as water soluble elements

Appendix 2

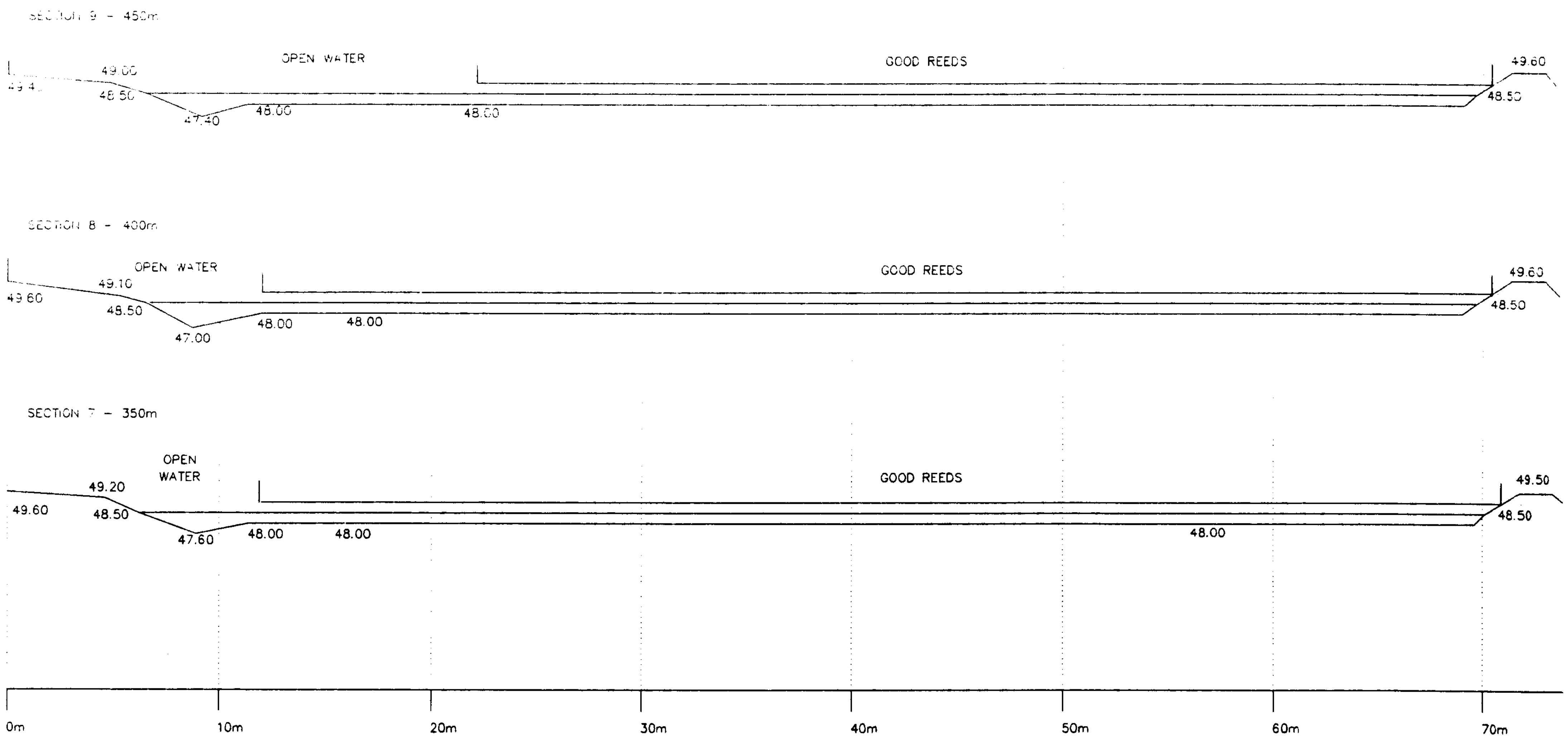
Reed Bed Sections



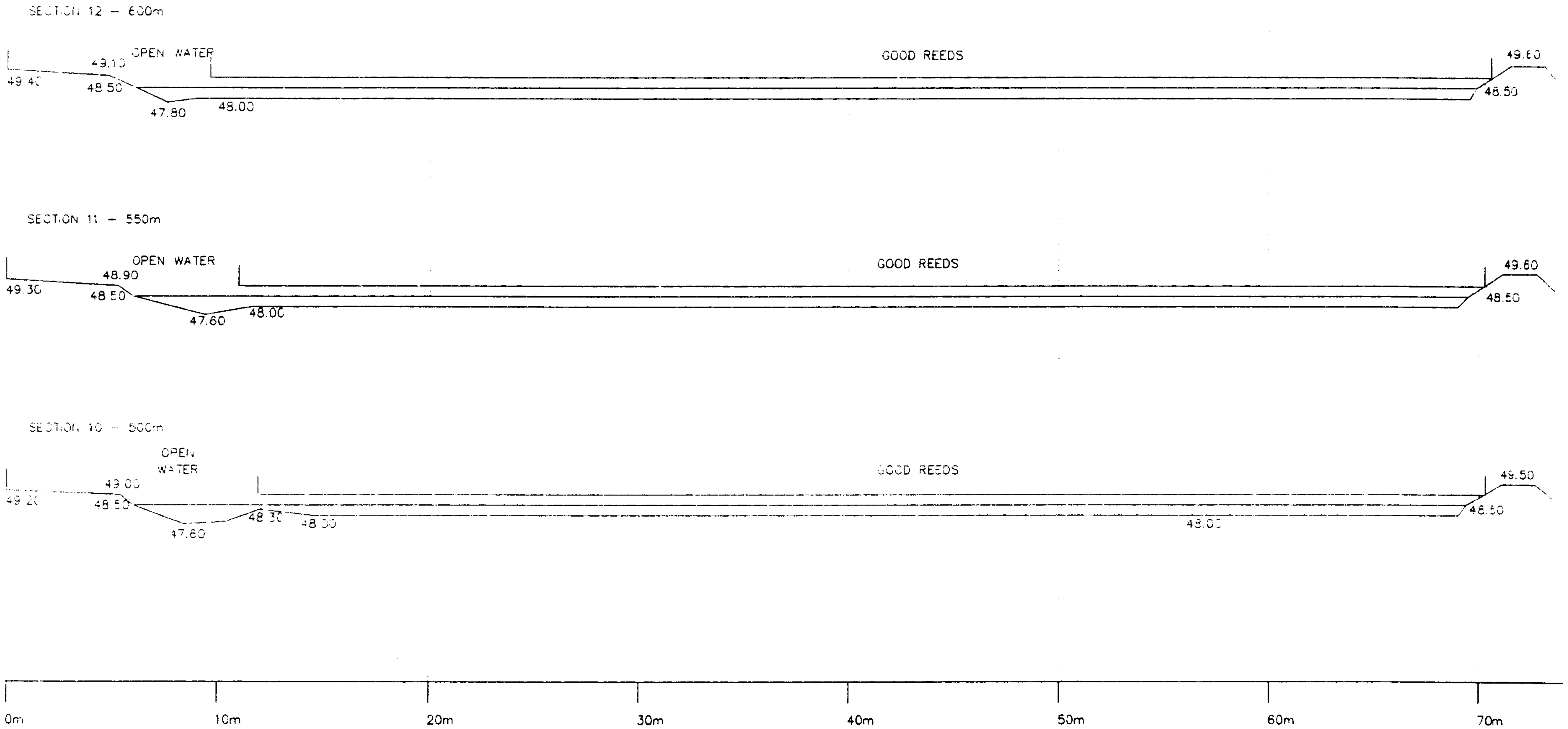
Duntech Environmental Services Lashlake Nurseries, Towersey, Thame, Oxon.	
Royal Ordnance Bridgewater.	Date: 4.01.94 Drawn By: RpM
Reedbed Sections	Scale: As Above
Drawing No. Q/426/20	Rev. A



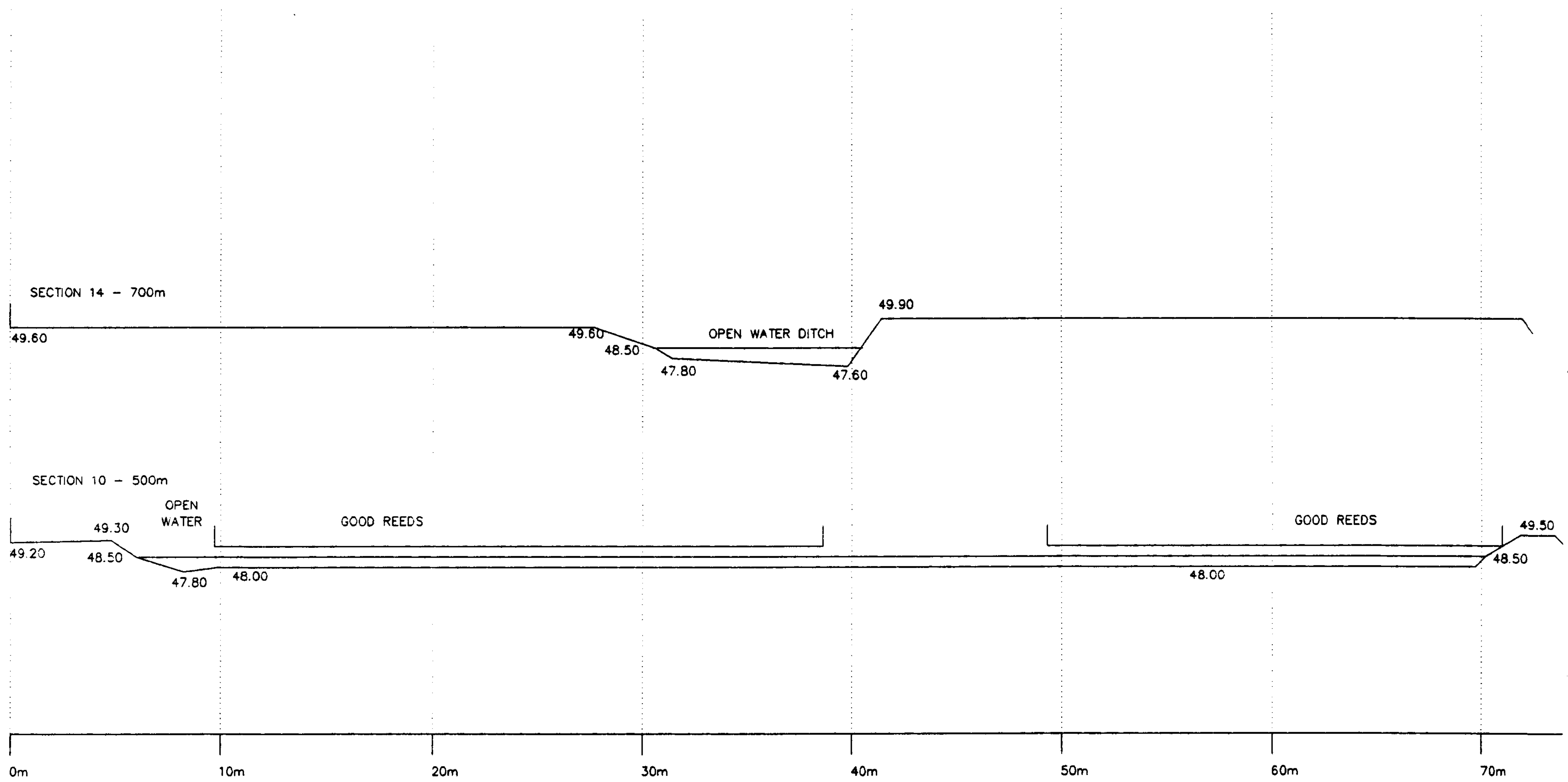
Duntech Environmental Services Lashlake Nurseries, Towersey, Thame, Oxon.	
Royal Ordnance Bridgewater.	Date: 4.01.94 Drawn By: RpM
Reedbed Sections	Scale: As Above
Drawing No. Q/426/21	Rev. A



Duntech Environmental Services Lashlake Nurseries, Towersey, Thame, Oxon.	
Royal Ordnance Bridgewater.	Date: 4.01.94 Drawn By: RpM
Reedbed Sections	Scale: As Above
Drawing No. Q/426/22	Rev. A



Duntech Environmental Services Lashlake Nurseries, Towersey, Thame, Oxon.	
Royal Ordnance Bridgewater.	Date: 4.01.94 Drawn By: RpM
Reedbed Sections	Scale: As Above
Drawing No.Q/426/23	Rev. A



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Royal Ordnance Bridgewater.	Date: 4.01.94 Drawn By: RpM
Reedbed Sections	Scale: As Above
Drawing No. Q/426/24	Rev. A

Appendix 3

Areas of Work

APPENDIX 3 - AREAS OF WORK TO CONVERT EXISTING REEDBED TO EFFLUENT TREATMENT.

1. Excavate inlet lagoon using rubble to part surface roadway.
2. Surface remainder of western roadway.
3. Clear Eastern bank of trees and shrubs.
4. Clear western bank of trees.
5. Strengthen bridge over rhynne.

6. Excavate drainage ditch by 0.8m
7. Supply and fit concrete culverts.
8. Supply and lay clay bunds 5000m3.
9 Construct subsidiary weirs if necessary..

10. Construct inlet chamber with screen, with grids over.
11. Supply and lay supply pipework 700m x 12" pvc in excavation with offtakes to bed sections.
12. Construct overflow weir with stop log controls.

13. Construct lift pump chamber, complete with screen, stop log level controls, grids and housing over.
14. Supply and fit lift pumps
15. Supply and install power cables to pump chamber.

16. Design and supervision of construction.

Appendix B 2020 Reed Bed Survey Plans

B02009_2d_SX-A1 @ 1_500SHEET1OF3
B02009_2d_SX-A1 @ 2_500SHEET1OF3
B02009_2d_SX-A1 @ 3_500SHEET1OF3

LEVEL INFORMATION

Heights in Metres
Datum Derived From: GPS Derived
OSBM Location: ST98
Value: 10.93m A.O.D
Active Station Locations: TAUN;NAS1;OSHQ
Conversions Used: OSTN02;OSGM02;

COORDINATE INFORMATION

Values in Metres
All Coordinates are: TRUE NATIONAL GRID
Scale Factor: 0.999646

SURVEY STATION SCHEDULE

STN	TYPE	EASTINGS	NORTHINGS	LEVEL
BASE1		333213.386	141912.129	6.293
BASE2		333494.130	142986.059	4.998
BASE3		333648.736	141869.469	8.229
BASE5		333442.947	141792.664	7.766
BED03		333432.929	143026.786	5.388
BED02		333525.273	143297.500	5.196
BED01		333624.465	143661.516	4.943
ST97		333459.699	141797.169	7.574
ST98		333306.080	141709.875	10.934

ABBREVIATIONS

General

(A)	Approximate	IC	Inspection Cover
AIF	Angle Iron Fence	IL	Invert Level
(AR)	Assumed Route	IRF	Iron Rail Fence
Avg	Average	IWF	Inter Woven Fence
BD	Bollard	KO	Kerb Outlet
Bin	Litter Bin	Ldr	Ladder
Bld	Building	LP	Lamp Post
BLW	Block Wall	MH	Manhole
BS	Bush	MHR	Metal Hand Rail
BT	British Telecom Inspection Chamber	MK	Marker
BW	Brick Wall	MP	Metal Post
BWF	Barbed Wire Fence	MPRF	Metal Post & Rail Fence
Cab	Cabinet	o/h	Overhead
CB	Crash Barrier	o/l	Outline
CBF	Close Boarded Fence	OSBM	Ordnance Survey Bench Mark
CDC	Concrete Drainage Channel	PalF	Pallisade Fence
CE	Concrete Edging	Pav	Paviors
ChP	Chestnut Paling	PI	Pipe Into Ground
CI	Cable Into Ground	Plt	Pavement Light
CIF	Corrugated Iron Fence	(R)	Records
CL	Cover Level	RE	Rodding Eye
CLF	Chain Link Fence	RS	Road Sign
CM	Cable Marker	RSJ	Rolled Steel Joist
Col	Column	RW	Retaining Wall
Conc	Concrete	SD	Slot Drain
CP	Concrete Post	SE	Stone Edging
CPS	Concrete Paving Slabs	SecF	Security Fence
CT	Cable TV Inspection Chamber	Shb	Shrubs
CW	Concrete Wall	SL	Soffit Level
d	Depth	Slt	Spotlight
Dil	Dilapidated	SN	Sign
DK	Drop Kerb	SV	Stop Valve
DP	Rainwater Down Pipe	SVMK	Stop Valve Marker
DSW	Dry Stone Wall	SW	Stone Wall
Ea	Earth	SWIC	Storm Water Inspection Chamber
EIC	Electricity Inspection Chamber	SY	Stay
EM	Electricity Meter	Tar	Tarmac
EP	Electricity Pole	ThL	Threshold Level
ER	Earth Rod	TL	Traffic Light
ETL	Electricity Transmission Lines	TMIC	Traffic Management IC
F	Fence	TP	Telegraph Pole
FH	Fire Hydrant	TPS	Tactile Paving Slabs
FHMK	Fire Hydrant Marker	TTL	Telephone Transmission Line
FL	Floor Level	u/g	Underground
Flb	Flowerbed	UTL	Unable To Lift
Flt	Floodlight	Veg	Vegetation
FP	Footpath	VP	Vent Pipe
FWIC	Foul Water Inspection Chamber	VT	Vent
GM	Gas Meter	W	Wall
GMK	Gas Marker	WE	Wood Edging
GP	Gate Post	WL	Water Level
Gr	Grass	WM	Water Meter
GV	Gas Valve	WMF	Wire Mesh Fence
Gvl	Gravel	WMK	Water Meter Marker
GY	Gully	WO	Wash Out
h	Height	WP	Wooden Post
Hc	Hardcore	WPR	Wooden Post & Rail Fence
IB	Illuminated Bollard		

Station Abreviations

HN	Hilti Nail	PKN	Parker Kalon Nail
PGM	Permanent Ground Marker	WP	Wooden Peg

NOTES

SCALE
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CONTOURS
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Rev.	Date	Amendments

THE SURVEY ASSOCIATION
LEWIS BROWN
Chartered Land Surveyors
RICS

Quattro House
Castle Road
Chelston Business Park
Wellington
TA21 9JQ

Tel. 01823 667200
Fax. 01823 663266
www.lewisbrown.co.uk
Email. survey@lewisbrown.co.uk

Lewis Brown Limited Registered in England No. 4193534

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THIS IS GRAVITY
3 BURLINGTON GARDENS
LONDON
W12 3EP

TITLE:
PURITON, WOOLAVINGTON
REED BED

TOPOGRAPHICAL SURVEY

Drawing Number:		Revision:
B20009_2D_SX		
Scale:	Sheet:	Survey Date:
1:500	A1 1 OF 3	03/2020
Drawn:	Checked:	Project Number:
MA	RDJB	B20009

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www.lewisbrown.co.uk
Email. survey@lewisbrown.co.uk

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CLIENT:
THIS IS GRAVITY
3 BURLINGTON GARDENS
LONDON
W12 3EP

TITLE:
PURITON, WOOLAVINGTON
REED BED

TOPOGRAPHICAL SURVEY

Drawing Number:		Revision:
B20009_2D_SX		
Scale:	Sheet:	Survey Date:
1:500	A1 2 OF 3	03/2020
Drawn:	Checked:	Project Number:
MA	RDJB	B20009

LEVEL INFORMATION

Heights in Metres
Datum Derived From: GPS Derived
OSBM Location: ST98
Value: 10.93m A.O.D
Active Station Locations: TAUN;NAS1;OSHQ
Conversions Used: OSTN02;OSGM02;

COORDINATE INFORMATION

Values in Metres
All Coordinates are: TRUE NATIONAL GRID
Scale Factor: 0.999646

SURVEY STATION SCHEDULE

STN	TYPE	EASTINGS	NORTHINGS	LEVEL
BASE1		333213.386	141912.129	6.293
BASE2		333494.130	142986.059	4.998
BASE3		333648.736	141869.469	8.229
BASE5		333442.947	141792.664	7.766
BED03		333432.929	143026.786	5.388
BED02		333525.273	143297.500	5.196
BED01		333624.465	143661.516	4.943
ST97		333459.699	141797.169	7.574
ST98		333306.080	141709.875	10.934

ABBREVIATIONS

General

(A)	Approximate	IC	Inspection Cover
AIF	Angle Iron Fence	IL	Invert Level
(AR)	Assumed Route	IRF	Iron Rail Fence
Avg	Average	IWF	Inter Woven Fence
BD	Bollard	KO	Kerb Outlet
Bin	Litter Bin	Ldr	Ladder
Bld	Building	LP	Lamp Post
BLW	Block Wall	MH	Manhole
BS	Bush	MHR	Metal Hand Rail
BT	British Telecom Inspection Chamber	MK	Marker
BW	Brick Wall	MP	Metal Post
BWF	Barbed Wire Fence	MPRF	Metal Post & Rail Fence
Cab	Cabinet	o/h	Overhead
CB	Crash Barrier	o/l	Outline
CBF	Close Boarded Fence	OSBM	Ordnance Survey Bench Mark
CDC	Concrete Drainage Channel	PalF	Pallisade Fence
CE	Concrete Edging	Pav	Paviors
ChP	Chestnut Paling	PI	Pipe Into Ground
CI	Cable Into Ground	Plt	Pavement Light
CIF	Corrugated Iron Fence	(R)	Records
CL	Cover Level	RE	Rodding Eye
CLF	Chain Link Fence	RS	Road Sign
CM	Cable Marker	RSJ	Rolled Steel Joist
Col	Column	RW	Retaining Wall
Conc	Concrete	SD	Slot Drain
CP	Concrete Post	SE	Stone Edging
CPS	Concrete Paving Slabs	SecF	Security Fence
CT	Cable TV Inspection Chamber	Shb	Shrubs
CW	Concrete Wall	SL	Soffit Level
d	Depth	Slt	Spotlight
Dil	Dilapidated	SN	Sign
DK	Drop Kerb	SV	Stop Valve
DP	Rainwater Down Pipe	SVMK	Stop Valve Marker
DSW	Dry Stone Wall	SW	Stone Wall
Ea	Earth	SWIC	Storm Water Inspection Chamber
EIC	Electricity Inspection Chamber	SY	Stay
EM	Electricity Meter	Tar	Tarmac
EP	Electricity Pole	ThL	Threshold Level
ER	Earth Rod	TL	Traffic Light
ETL	Electricity Transmission Lines	TMIC	Traffic Management IC
F	Fence	TP	Telegraph Pole
FH	Fire Hydrant	TPS	Tactile Paving Slabs
FHMK	Fire Hydrant Marker	TTL	Telephone Transmission Line
FL	Floor Level	u/g	Underground
Flb	Flowerbed	UTL	Unable To Lift
Flt	Floodlight	Veg	Vegetation
FP	Footpath	VP	Vent Pipe
FWIC	Foul Water Inspection Chamber	VT	Vent
GM	Gas Meter	W	Wall
GMK	Gas Marker	WE	Wood Edging
GP	Gate Post	WL	Water Level
Gr	Grass	WM	Water Meter
GV	Gas Valve	WMF	Wire Mesh Fence
Gvl	Gravel	WMK	Water Meter Marker
GY	Gully	WO	Wash Out
h	Height	WP	Wooden Post
Hc	Hardcore	WPR	Wooden Post & Rail Fence
IB	Illuminated Bollard		

Station Abreviations

HN	Hilti Nail	PKN	Parker Kalon Nail
PGM	Permanent Ground Marker	WP	Wooden Peg

NOTES

SCALE
Information has been gathered for the quoted scale.
Any enlargement should be verified on site.

DRAINAGE
Pipe sizes and connections are determined from surface level inspection and service records where available.

UNDERGROUND SERVICES
Any underground services shown on this survey are from information on service enquiries and tracing with Electrolocation equipment.
Some underground services may be undetectable, e.g. non-conductive pipes or cables and therefore NOT SHOWN

CONTOURS
Any contours depicted on this drawing have been interpolated from surveyed points, levels and features.
The contour line positions have been generated by ground modelling software and are INDICATIVE only.

Rev.	Date	Amendments

LEWIS BROWN
Chartered Land Surveyors

Quattro House
Castle Road
Chelston Business Park
Wellington
TA21 9JQ

Tel. 01823 667200
Fax. 01823 663266
www.lewisbrown.co.uk
Email. survey@lewisbrown.co.uk
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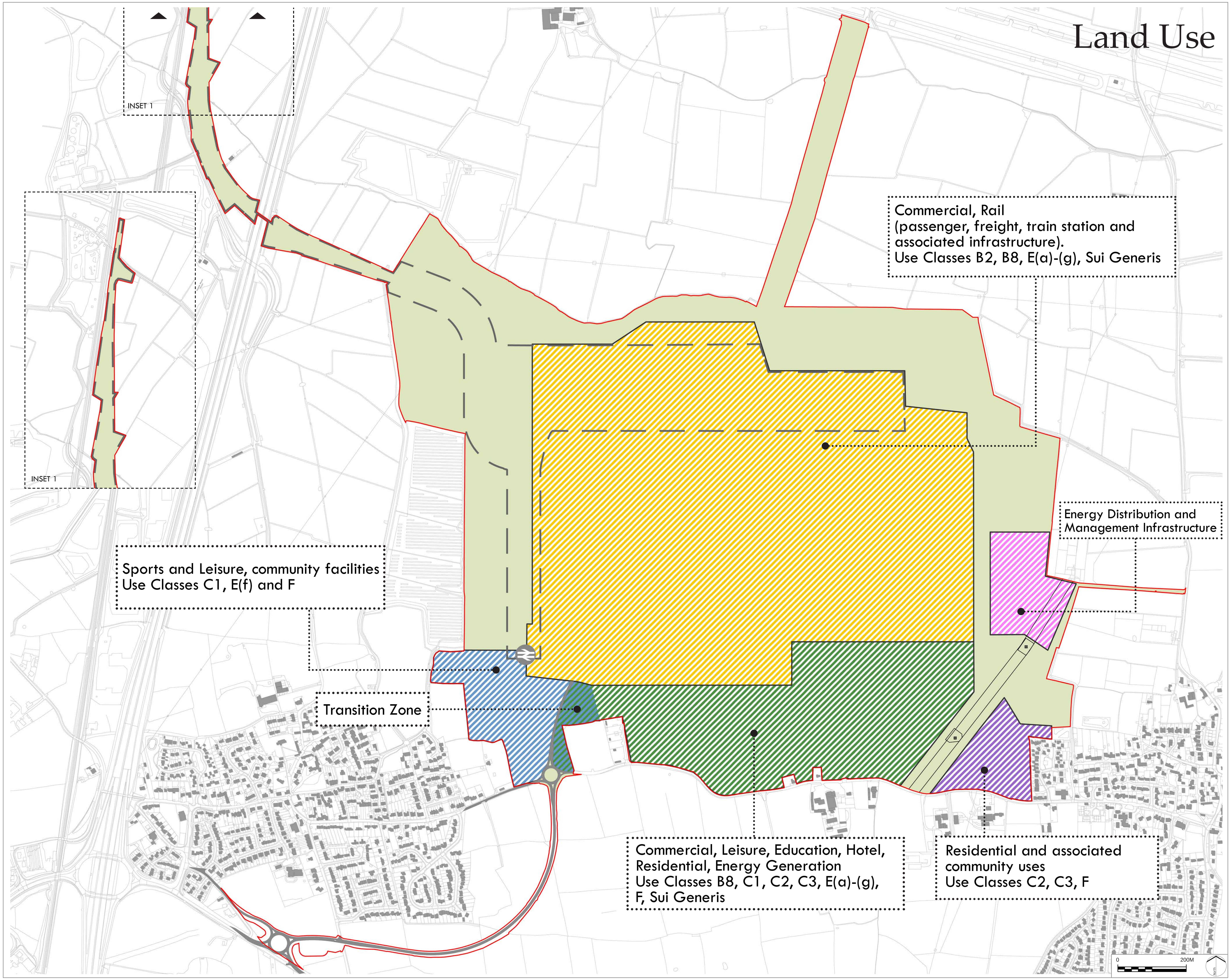
Appendix E Development Proposals

6599_PP201L_Land Uses
6599_PP206F_Strategic Landscape



LEGEND

- LDO Boundary
- Commercial, Rail (passenger, freight, train station and associated infrastructure). Use Classes B2, B8, E(a)-(g), Sui Generis
- Energy Distribution and Management Infrastructure
- Residential and associated community uses Use Classes C2, C3, F
- Commercial, Leisure, Education, Hotel, Residential, Energy Generation Use Classes B8, C1, C2, C3, E(a)-(g), F, Sui Generis
- Sports and Leisure, community facilities Use Classes C1, E(f) and F
- Transition Zone
- Open space and biodiversity zones Including surface water attenuation features, watercourses, woodland, hedgerows and trees, utilities, occasional vehicular routes and rail line with associated infrastructure.
- Rail corridor - Freight and Passenger, and associated infrastructure
- Passenger Station (indicative location)

REV.	DESCRIPTION	APP.	DATE
L	Changes to title block	RF	08.09.21
K	Key updated	RF	25.08.21
J	Key updated	RF	16.08.21
I	Key updated	RF	16.08.21
H	Key updated	RF	16.08.21
G	Uses zones updated	RF	13.08.21
F	Key updated and train station logo relocated	RF	13.08.21
E	Key updated following comments from JH	RF	08.06.21
D	Key updated following comments from CP	RF	04.06.21
C	Rail corridor; plan inset	RF	03.06.21
B	Use classes	RF	24.05.21
A	Format of key amended	RF	24.05.21
-	First Issue	RF	21.05.21

LDĀ DESIGN

PROJECT TITLE
GRAVITY

DRAWING TITLE
PARAMETER PLAN
Land Uses

ISSUED BY	Exeter	T: 01392 260430	
DATE	May 2021	DRAWN	KS/DA
SCALE@A1	1:5,000	CHECKED	RF
STATUS	LDO	APPROVED	FO

DWG. NO. 6599_PP201L

No dimensions are to be scaled from this drawing.
All dimensions are to be checked on site.
Area measurements for indicative purposes only.

Sources: Ordnance Survey

v2018.0

Strategic Landscape

LEGEND

- LDO Boundary
- Greenspace
- Micromobility connections (including pedestrian and cycle)
- East-west landscape corridor to incorporate landscaping such as street trees and rhynes
- Existing trees/ woodland to be retained where possible
- Structural tree and woodland planting (indicative extents)
- Trees to be retained where possible subject to rail alignment and necessary associated infrastructure
- Gravity Park
- Green Edge to Woolavington
- Indicative location of greenspace
- Placemaking Node – important focal points, development should respond appropriately through landscape and built form.
- Green Edge to Woolavington Road – landscaped area adjoining highway to reflect campus feel.
- Landscape bund and planting
- Existing water bodies to be retained
- Indicative location of water attenuation
- Attenuation areas to be delievered as part of the link road
- Existing rhynes, IDB rhynes to be retained, other rhynes to be incorporated into site-wide drainage strategy
- Wellbeing and Arrival Zone Up to 50% of the zone will accommodate buildings, the remainder will be blue and green infrastructure, tree nursery, community uses, sports, leisure or associated infrastructure such as roads, footpaths and cycle routes.
- Rail corridor - Freight and Passenger, and associated infrastructure
- Passenger Station (indicative location)
- Development zone
- Development zone - Up to 50% of the zone will accommodate buildings, the remainder will be associated infrastructure such as rail, including mobile gantry cranes, roads and laydown space and/or green infrastructure.
- Overhead powerlines 400 kVA

REV.	DESCRIPTION	APP.	DATE
F	Changes to title block	RF	08.09.21
E	Woodland and water attenuation areas updated	RF	25.08.21
D	Train station logo relocated	RF	13.08.21
C	Key wording amended following CP comments	RF	04.06.21
B	Paths; graphic representation/ key; plan inset	RF	03.06.21
A	Format of key amended	RF	24.05.21
-	First Issue	RF	21.05.21

LDĀ DESIGN

PROJECT TITLE
GRAVITY

DRAWING TITLE
PARAMETER PLAN
Strategic Landscape

ISSUED BY	Exeter	T: 01392 260430	
DATE	May 2021	DRAWN	KS/DA
SCALE@A1	1:5,000	CHECKED	RF
STATUS	LDO	APPROVED	FO

DWG. NO. 6599_PP206F

No dimensions are to be scaled from this drawing.
All dimensions are to be checked on site.
Area measurements for indicative purposes only.

Sources: Ordnance Survey

v2018.0

Appendix F Proposed Drainage

MicroDrainage Network Model Output
Proposed SW Drainage Strategy Model Schematic 332310102-4002-SK04

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 391363 263985 SO 91363 63985
Data Type	Point
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	174.208	2.500	69.7	9.692	10.00	0.0	0.040	\/	-2	Pipe/Conduit	
S1.001	68.976	0.046	1499.5	0.488	0.00	0.0	0.040	\/	-5	Pipe/Conduit	
S1.002	50.644	0.204	248.3	0.000	0.00	0.0	0.040	\/	-3	Pipe/Conduit	
S1.003	49.705	1.000	49.7	0.000	0.00	0.0	0.040	\/	-3	Pipe/Conduit	
S2.000	23.605	0.500	47.2	8.180	10.00	0.0	0.040	\/	-2	Pipe/Conduit	
S1.004	41.249	0.750	55.0	0.000	0.00	0.0	0.040	\/	-3	Pipe/Conduit	
S1.005	53.899	0.750	71.9	0.000	0.00	0.0	0.040	\/	-3	Pipe/Conduit	
S1.006	27.034	1.250	21.6	0.000	0.00	0.0	0.040	\/	-3	Pipe/Conduit	
S1.007	26.281	2.652	9.9	0.000	0.00	0.0	0.040	\/	-2	Pipe/Conduit	
S3.000	43.816	1.000	43.8	7.418	10.00	0.0	0.040	\/	-2	Pipe/Conduit	
S3.001	80.001	4.750	16.8	0.000	0.00	0.0	0.040	\/	-2	Pipe/Conduit	
S3.002	18.710	0.250	74.8	0.263	0.00	0.0	0.040	\/	-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)
S1.000	50.00	11.33	15.750	9.692	0.0	0.0	0.0	2.18	6541.9	1312.4
S1.001	50.00	13.46	13.250	10.180	0.0	0.0	0.0	0.54	3244.2	1378.6
S1.002	50.00	14.14	13.204	10.180	0.0	0.0	0.0	1.23	4938.1	1378.6
S1.003	50.00	14.44	13.000	10.180	0.0	0.0	0.0	2.76	11035.8	1378.6
S2.000	50.00	10.15	12.500	8.180	0.0	0.0	0.0	2.65	7947.9	1107.7
S1.004	50.00	14.70	12.000	18.360	0.0	0.0	0.0	2.62	10491.3	2486.2
S1.005	50.00	15.10	11.250	18.360	0.0	0.0	0.0	2.29	9177.9	2486.2
S1.006	50.00	15.20	10.500	18.360	0.0	0.0	0.0	4.18	16730.4	2486.2
S1.007	50.00	15.28	9.250	18.360	0.0	0.0	0.0	5.78	17347.5	2486.2
S3.000	50.00	10.27	17.000	7.418	0.0	0.0	0.0	2.75	8250.0	1004.5
S3.001	50.00	10.57	16.000	7.418	0.0	0.0	0.0	4.44	13306.7	1004.5
S3.002	50.00	10.71	11.250	7.682	0.0	0.0	0.0	2.10	6312.5	1040.2

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
S3.003	49.823	0.033	1509.8	0.000	0.00	0.0	0.040	\/	-5	Pipe/Conduit	
S3.004	10.958	0.007	1565.4	0.000	0.00	0.0	0.040	\/	-5	Pipe/Conduit	
S3.005	17.085	0.011	1553.2	0.000	0.00	0.0	0.040	\/	-5	Pipe/Conduit	
S3.006	24.982	0.948	26.4	0.000	0.00	0.0	0.040	\/	-2	Pipe/Conduit	
S3.007	13.386	0.250	53.5	0.183	0.00	0.0	0.040	\/	-2	Pipe/Conduit	
S3.008	22.523	0.500	45.0	0.000	0.00	0.0	0.040	\/	-2	Pipe/Conduit	
S3.009	127.759	0.750	170.3	0.194	0.00	0.0	0.040	\/	-4	Pipe/Conduit	
S3.010	86.536	1.750	49.4	1.885	0.00	0.0	0.040	\/	-4	Pipe/Conduit	
S3.011	163.547	0.109	1500.4	2.593	0.00	0.0	0.040	\/	-11	Pipe/Conduit	
S3.012	65.241	0.044	1482.8	1.973	0.00	0.0	0.040	\/	-11	Pipe/Conduit	
S1.008	78.844	0.053	1487.6	3.258	0.00	0.0	0.040	\/	-10	Pipe/Conduit	
S1.009	145.650	1.618	90.0	0.000	0.00	0.0	0.040	\/	-5	Pipe/Conduit	
S4.000	160.373	0.500	320.7	15.140	10.00	0.0	0.040	\/	-5	Pipe/Conduit	
S4.001	23.446	0.016	1465.4	0.000	0.00	0.0	0.040	\/	-7	Pipe/Conduit	
S4.002	24.295	0.016	1518.4	0.000	0.00	0.0	0.040	\/	-7	Pipe/Conduit	
S4.003	60.127	1.968	30.6	0.000	0.00	0.0	0.040	\/	-2	Pipe/Conduit	
S4.004	37.107	2.500	14.8	0.000	0.00	0.0	0.040	\/	-2	Pipe/Conduit	
S4.005	29.859	2.500	11.9	0.000	0.00	0.0	0.040	\/	-2	Pipe/Conduit	
S4.006	99.059	1.750	56.6	1.564	0.00	0.0	0.040	\/	-2	Pipe/Conduit	
S4.007	110.900	0.074	1498.6	1.330	0.00	0.0	0.040	\/	-8	Pipe/Conduit	
S5.000	41.040	1.574	26.1	0.000	5.00	0.0	0.040	\/	-1	Pipe/Conduit	
S4.008	22.176	0.015	1478.4	1.303	0.00	0.0	0.040	\/	-8	Pipe/Conduit	
S4.009	55.223	1.911	28.9	1.706	0.00	0.0	0.040	\/	-3	Pipe/Conduit	
S4.010	230.261	1.500	153.5	5.962	0.00	0.0	0.040	\/	-4	Pipe/Conduit	
S4.011	242.460	0.162	1496.7	3.475	0.00	0.0	0.040	\/	-10	Pipe/Conduit	
S4.012	242.460	0.162	1496.7	2.304	0.00	0.0	0.040	\/	-10	Pipe/Conduit	
S1.010	294.526	0.464	635.4	2.008	0.00	0.0	0.040	\/	-14	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)
S3.003	50.00	12.26	11.000	7.682	0.0	0.0	0.0	0.54	3233.1	1040.2
S3.004	50.00	12.60	10.967	7.682	0.0	0.0	0.0	0.53	3175.1	1040.2
S3.005	50.00	13.14	10.960	7.682	0.0	0.0	0.0	0.53	3187.6	1040.2
S3.006	50.00	13.25	10.949	7.682	0.0	0.0	0.0	3.55	10638.0	1040.2
S3.007	50.00	13.34	10.001	7.865	0.0	0.0	0.0	2.49	7463.0	1065.0
S3.008	50.00	13.48	9.751	7.865	0.0	0.0	0.0	2.71	8136.6	1065.0
S3.009	50.00	14.85	9.251	8.059	0.0	0.0	0.0	1.56	7780.6	1091.3
S3.010	50.00	15.35	8.501	9.944	0.0	0.0	0.0	2.89	14441.0	1346.5
S3.011	50.00	19.99	6.751	12.537	0.0	0.0	0.0	0.59	7046.2	1697.6
S3.012	50.00	21.83	6.642	14.510	0.0	0.0	0.0	0.59	7088.0	1964.8
S1.008	50.00	24.08	6.598	36.129	0.0	0.0	0.0	0.59	6435.4	4892.3
S1.009	50.00	25.18	6.545	36.129	0.0	0.0	0.0	2.21	13240.7	4892.3
S4.000	50.00	12.29	18.000	15.140	0.0	0.0	0.0	1.17	7014.5	2050.1
S4.001	50.00	12.97	17.500	15.140	0.0	0.0	0.0	0.57	4554.7	2050.1
S4.002	50.00	13.70	17.484	15.140	0.0	0.0	0.0	0.56	4474.4	2050.1
S4.003	50.00	14.00	17.468	15.140	0.0	0.0	0.0	3.29	9879.8	2050.1
S4.004	50.00	14.13	15.500	15.140	0.0	0.0	0.0	4.72	14174.7	2050.1
S4.005	50.00	14.23	13.000	15.140	0.0	0.0	0.0	5.27	15801.7	2050.1
S4.006	50.00	14.91	10.500	16.703	0.0	0.0	0.0	2.42	7258.4	2261.8
S4.007	50.00	18.15	8.750	18.033	0.0	0.0	0.0	0.57	5138.0	2441.9
S5.000	50.00	5.22	10.250	0.000	0.0	0.0	0.0	3.18	6351.5	0.0
S4.008	50.00	18.79	8.676	19.336	0.0	0.0	0.0	0.57	5173.1	2618.4
S4.009	50.00	19.04	8.661	21.042	0.0	0.0	0.0	3.62	14473.6	2849.4
S4.010	50.00	21.38	6.750	27.005	0.0	0.0	0.0	1.64	8196.2	3656.8
S4.011	50.00	28.31	5.250	30.480	0.0	0.0	0.0	0.58	6415.9	4127.4
S4.012	50.00	30.00	5.089	32.784	0.0	0.0	0.0	0.58	6415.9	4439.3
S1.010	50.00	30.00	4.927	70.921	0.0	0.0	0.0	1.05	19987.1	9603.6

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.011	294.662	0.464	635.7	6.089	0.00	0.0	0.040	\/	-14	Pipe/Conduit	
S1.012	54.568	0.036	1515.8	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.013	133.777	0.090	1486.4	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.014	117.224	0.124	945.4	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.015	76.058	0.043	1768.8	0.751	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.016	92.412	0.053	1743.6	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.017	75.260	0.043	1750.2	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.018	38.718	0.022	1759.9	3.137	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.019	10.530	0.006	1755.0	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.020	7.896	0.005	1579.2	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.021	5.390	0.003	1796.7	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.022	14.368	0.008	1796.0	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.023	37.467	0.021	1784.1	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.024	15.192	0.009	1688.0	4.129	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.025	10.836	0.006	1806.0	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.026	11.048	0.006	1841.3	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.027	26.547	0.015	1769.8	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.028	14.888	0.009	1654.2	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.029	50.033	0.029	1725.3	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.030	49.507	0.028	1768.1	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S6.000	550.262	0.366	1503.4	6.801	5.00	0.0	0.040	\/	-7	Pipe/Conduit	
S6.001	272.012	0.181	1502.8	0.000	0.00	0.0	0.040	\/	-6	Pipe/Conduit	
S6.002	272.012	0.181	1502.8	6.801	0.00	0.0	0.040	\/	-6	Pipe/Conduit	
S6.003	282.777	0.188	1504.1	6.775	0.00	0.0	0.040	\/	-6	Pipe/Conduit	
S6.004	282.777	0.188	1504.1	6.801	0.00	0.0	0.040	\/	-6	Pipe/Conduit	
S7.000	549.222	0.366	1500.6	6.801	5.00	0.0	0.040	\/	-7	Pipe/Conduit	
S7.001	272.012	0.091	2989.1	0.000	0.00	0.0	0.040	\/	-6	Pipe/Conduit	
S7.002	272.012	0.182	1494.6	6.801	0.00	0.0	0.040	\/	-6	Pipe/Conduit	
S7.003	277.485	0.232	1196.1	6.801	0.00	0.0	0.040	\/	-6	Pipe/Conduit	
S7.004	276.445	0.232	1191.6	6.801	0.00	0.0	0.040	\/	-6	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)
S1.011	50.00	30.00	4.464	77.010	0.0	0.0	0.0	1.05	19982.4	10428.1
S1.012	50.00	30.00	3.500	77.010	0.0	0.0	0.0	0.76	18796.0	10428.1
S1.013	50.00	30.00	3.464	77.010	0.0	0.0	0.0	0.77	18980.8	10428.1
S1.014	50.00	30.00	3.374	77.010	0.0	0.0	0.0	0.96	23800.5	10428.1
S1.015	50.00	30.00	3.250	77.761	0.0	0.0	0.0	0.70	17399.9	10529.8
S1.016	50.00	30.00	3.207	77.761	0.0	0.0	0.0	0.71	17525.0	10529.8
S1.017	50.00	30.00	3.154	77.761	0.0	0.0	0.0	0.71	17491.9	10529.8
S1.018	50.00	30.00	3.111	80.898	0.0	0.0	0.0	0.70	17443.7	10954.6
S1.019	50.00	30.00	3.089	80.898	0.0	0.0	0.0	0.71	17468.1	10954.6
S1.020	50.00	30.00	3.083	80.898	0.0	0.0	0.0	0.74	18414.7	10954.6
S1.021	50.00	30.00	3.078	80.898	0.0	0.0	0.0	0.70	17264.3	10954.6
S1.022	50.00	30.00	3.075	80.898	0.0	0.0	0.0	0.70	17267.5	10954.6
S1.023	50.00	30.00	3.067	80.898	0.0	0.0	0.0	0.70	17324.8	10954.6
S1.024	50.00	30.00	3.046	85.026	0.0	0.0	0.0	0.72	17811.4	11513.6
S1.025	50.00	30.00	3.037	85.026	0.0	0.0	0.0	0.70	17219.7	11513.6
S1.026	50.00	30.00	3.031	85.026	0.0	0.0	0.0	0.69	17053.7	11513.6
S1.027	50.00	30.00	3.025	85.026	0.0	0.0	0.0	0.70	17394.9	11513.6
S1.028	50.00	30.00	3.010	85.026	0.0	0.0	0.0	0.73	17992.3	11513.6
S1.029	50.00	30.00	3.001	85.026	0.0	0.0	0.0	0.71	17617.9	11513.6
S1.030	50.00	30.00	2.972	85.026	0.0	0.0	0.0	0.70	17403.2	11513.6
S6.000	50.00	21.32	5.350	6.801	0.0	0.0	0.0	0.56	4496.7	921.0
S6.001	50.00	29.52	4.984	6.801	0.0	0.0	0.0	0.55	3867.3	921.0
S6.002	50.00	30.00	4.803	13.602	0.0	0.0	0.0	0.55	3867.3	1841.9
S6.003	50.00	30.00	4.622	20.377	0.0	0.0	0.0	0.55	3865.6	2759.3
S6.004	50.00	30.00	4.434	27.178	0.0	0.0	0.0	0.55	3865.6	3680.3
S7.000	50.00	21.27	5.350	6.801	0.0	0.0	0.0	0.56	4500.9	921.0
S7.001	50.00	30.00	4.984	6.801	0.0	0.0	0.0	0.39	2742.1	921.0
S7.002	50.00	30.00	4.893	13.602	0.0	0.0	0.0	0.55	3878.0	1841.9
S7.003	50.00	30.00	4.711	20.403	0.0	0.0	0.0	0.62	4335.0	2762.9
S7.004	50.00	30.00	4.479	27.204	0.0	0.0	0.0	0.62	4343.1	3683.8

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
S6.005	257.224	0.170	1513.1	0.000	0.00	0.0	0.040	\/	-11	Pipe/Conduit	
S6.006	129.778	0.362	358.5	0.000	0.00	0.0	0.040	\/	-11	Pipe/Conduit	
S1.031	2.873	0.002	1436.5	0.000	0.00	0.0	0.035	\/	-20	Pipe/Conduit	
S1.032	2.881	0.002	1440.5	0.000	0.00	0.0	0.035	\/	-20	Pipe/Conduit	
S1.033	11.659	0.007	1665.6	0.000	0.00	0.0	0.035	\/	-20	Pipe/Conduit	
S1.034	3.876	0.002	1938.0	0.000	0.00	0.0	0.035	\/	-20	Pipe/Conduit	
S1.035	2.832	0.002	1416.0	0.000	0.00	0.0	0.035	\/	-20	Pipe/Conduit	
S1.036	14.804	0.008	1850.5	0.000	0.00	0.0	0.035	\/	-20	Pipe/Conduit	
S1.037	9.386	0.005	1877.2	0.000	0.00	0.0	0.035	\/	-20	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)
S6.005	50.00	30.00	3.976	54.382	0.0	0.0	0.0	0.58	7016.6«	7364.1
S6.006	50.00	30.00	3.806	54.382	0.0	0.0	0.0	1.20	14415.0	7364.1
S1.031	50.00	30.00	2.944	139.409	0.0	0.0	0.0	0.91	29406.4	18877.7
S1.032	50.00	30.00	2.942	139.409	0.0	0.0	0.0	0.91	29365.6	18877.7
S1.033	50.00	30.00	2.940	139.409	0.0	0.0	0.0	0.85	27309.5	18877.7
S1.034	50.00	30.00	2.933	139.409	0.0	0.0	0.0	0.79	25317.4	18877.7
S1.035	50.00	30.00	2.931	139.409	0.0	0.0	0.0	0.92	29618.5	18877.7
S1.036	50.00	30.00	2.929	139.409	0.0	0.0	0.0	0.80	25909.0	18877.7
S1.037	50.00	30.00	2.921	139.409	0.0	0.0	0.0	0.80	25724.1	18877.7

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	27	35.897	9.692	9.692
1.001	User	-	100	0.488	0.488	0.488
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.000	0.000	0.000
2.000	User	-	27	30.296	8.180	8.180
1.004	-	-	100	0.000	0.000	0.000
1.005	-	-	100	0.000	0.000	0.000
1.006	-	-	100	0.000	0.000	0.000
1.007	-	-	100	0.000	0.000	0.000
3.000	User	-	27	27.475	7.418	7.418
3.001	-	-	100	0.000	0.000	0.000
3.002	User	-	100	0.263	0.263	0.263
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
3.007	User	-	100	0.183	0.183	0.183
3.008	-	-	100	0.000	0.000	0.000
3.009	User	-	100	0.194	0.194	0.194
3.010	User	-	100	1.380	1.380	1.380
	User	-	100	0.505	0.505	1.885
3.011	User	-	100	0.232	0.232	0.232
	User	-	100	0.771	0.771	1.003
	User	-	100	1.590	1.590	2.593
3.012	User	-	100	1.247	1.247	1.247
	User	-	100	0.727	0.727	1.973
1.008	User	-	100	0.214	0.214	0.214
	User	-	100	1.167	1.167	1.381
	User	-	100	1.878	1.878	3.258
1.009	-	-	100	0.000	0.000	0.000
4.000	User	-	27	56.073	15.140	15.140
4.001	-	-	100	0.000	0.000	0.000
4.002	-	-	100	0.000	0.000	0.000
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
4.006	User	-	100	1.564	1.564	1.564
4.007	User	-	100	1.330	1.330	1.330
5.000	-	-	100	0.000	0.000	0.000
4.008	User	-	100	1.303	1.303	1.303
4.009	User	-	100	1.706	1.706	1.706
4.010	User	-	100	3.344	3.344	3.344
	User	-	100	1.037	1.037	4.381
	User	-	100	1.581	1.581	5.962
4.011	User	-	100	2.475	2.475	2.475
	User	-	100	1.001	1.001	3.475
4.012	User	-	100	1.163	1.163	1.163
	User	-	100	0.757	0.757	1.920
	User	-	100	0.384	0.384	2.304
1.010	User	-	100	1.355	1.355	1.355
	User	-	100	0.654	0.654	2.008
1.011	User	-	100	6.089	6.089	6.089
1.012	-	-	100	0.000	0.000	0.000
1.013	-	-	100	0.000	0.000	0.000
1.014	-	-	100	0.000	0.000	0.000
1.015	User	-	100	0.751	0.751	0.751
1.016	-	-	100	0.000	0.000	0.000
1.017	-	-	100	0.000	0.000	0.000
1.018	User	-	100	3.137	3.137	3.137
1.019	-	-	100	0.000	0.000	0.000
1.020	-	-	100	0.000	0.000	0.000
1.021	-	-	100	0.000	0.000	0.000
1.022	-	-	100	0.000	0.000	0.000
1.023	-	-	100	0.000	0.000	0.000
1.024	User	-	100	4.129	4.129	4.129
1.025	-	-	100	0.000	0.000	0.000
1.026	-	-	100	0.000	0.000	0.000
1.027	-	-	100	0.000	0.000	0.000
1.028	-	-	100	0.000	0.000	0.000
1.029	-	-	100	0.000	0.000	0.000
1.030	-	-	100	0.000	0.000	0.000
6.000	User	-	100	6.801	6.801	6.801

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
6.001	-	-	100	0.000	0.000	0.000
6.002	User	-	100	6.801	6.801	6.801
6.003	User	-	100	6.775	6.775	6.775
6.004	User	-	100	6.801	6.801	6.801
7.000	User	-	100	6.801	6.801	6.801
7.001	-	-	100	0.000	0.000	0.000
7.002	User	-	100	6.801	6.801	6.801
7.003	User	-	100	6.801	6.801	6.801
7.004	User	-	100	6.801	6.801	6.801
6.005	-	-	100	0.000	0.000	0.000
6.006	-	-	100	0.000	0.000	0.000
1.031	-	-	100	0.000	0.000	0.000
1.032	-	-	100	0.000	0.000	0.000
1.033	-	-	100	0.000	0.000	0.000
1.034	-	-	100	0.000	0.000	0.000
1.035	-	-	100	0.000	0.000	0.000
1.036	-	-	100	0.000	0.000	0.000
1.037	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				248.719	139.409	139.409

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)
S1.037	S	0.000	2.916	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	0.000
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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	0	Number of Storage Structures	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	19.100	Cv (Summer)	0.750
Return Period (years)	1	Ratio R	0.350	Cv (Winter)	0.840
Region	England and Wales	Profile Type	Summer	Storm Duration (mins)	30

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 0.000
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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH Data Type Point
FEH Rainfall Version 2013 Cv (Summer) 0.750
Site Location GB 391363 263985 SO 91363 63985 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2880
Return Period(s) (years) 2, 5, 10, 30, 100
Climate Change (%) 0, 0, 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	15 Winter	2	+0%					16.102	-0.648	0.000
S1.001	S2	15 Winter	2	+0%	100/15 Winter	100/15 Winter			13.730	-0.520	0.000
S1.002	S3	15 Winter	2	+0%					13.597	-0.607	0.000
S1.003	S4	15 Winter	2	+0%					13.241	-0.759	0.000
S2.000	S5	15 Winter	2	+0%					12.785	-0.715	0.000
S1.004	S6	15 Winter	2	+0%					12.341	-0.659	0.000
S1.005	S7	15 Winter	2	+0%					11.617	-0.633	0.000
S1.006	S8	15 Winter	2	+0%					10.757	-0.743	0.000
S1.007	S9	15 Winter	2	+0%					9.508	-0.742	0.000
S3.000	S10	15 Winter	2	+0%					17.261	-0.739	0.000
S3.001	S11	15 Winter	2	+0%					16.194	-0.806	0.000
S3.002	S12	15 Winter	2	+0%					11.566	-0.684	0.000
S3.003	S13	15 Winter	2	+0%					11.445	-0.555	0.000
S3.004	S14	15 Winter	2	+0%					11.354	-0.613	0.000
S3.005	S15	15 Winter	2	+0%					11.334	-0.626	0.000
S3.006	S16	15 Winter	2	+0%					11.169	-0.780	0.000
S3.007	S17	15 Winter	2	+0%					10.278	-0.723	0.000
S3.008	S18	15 Winter	2	+0%					10.013	-0.738	0.000
S3.009	S19	15 Winter	2	+0%					9.512	-0.739	0.000
S3.010	S20	30 Winter	2	+0%					8.686	-0.815	0.000
S3.011	S21	30 Winter	2	+0%	100/30 Winter	100/15 Summer			7.132	-0.619	0.000
S3.012	S22	30 Winter	2	+0%	100/15 Winter				7.085	-0.557	0.000
S1.008	S23	30 Winter	2	+0%	100/15 Summer				7.058	-0.540	0.000
S1.009	S24	30 Winter	2	+0%					6.878	-0.667	0.000
S4.000	S25	15 Winter	2	+0%		100/15 Winter			18.424	-0.576	0.000
S4.001	S26	15 Winter	2	+0%					17.978	-0.522	0.000
S4.002	S27	15 Winter	2	+0%					17.921	-0.563	0.000
S4.003	S28	15 Winter	2	+0%					17.790	-0.678	0.000
S4.004	S29	15 Winter	2	+0%					15.758	-0.742	0.000
S4.005	S30	15 Winter	2	+0%					13.241	-0.759	0.000
S4.006	S31	15 Winter	2	+0%					10.889	-0.611	0.000
S4.007	S32	30 Winter	2	+0%	100/15 Winter	100/15 Winter			9.201	-0.549	0.000
S5.000	S33	15 Summer	2	+0%					10.250	-1.000	0.000
S4.008	S34	30 Winter	2	+0%					9.072	-0.604	0.000
S4.009	S35	30 Winter	2	+0%					8.909	-0.752	0.000
S4.010	S36	30 Winter	2	+0%					7.111	-0.639	0.000
S4.011	S37	60 Winter	2	+0%					5.644	-0.606	0.000
S4.012	S38	60 Winter	2	+0%					5.464	-0.625	0.000
S1.010	S39	60 Winter	2	+0%					5.252	-0.675	0.000
S1.011	S40	60 Winter	2	+0%					4.781	-0.682	0.000
S1.012	S41	120 Winter	2	+0%					4.043	-0.957	0.000
S1.013	S42	120 Winter	2	+0%					3.980	-0.984	0.000

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

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.16			1050.4	OK	
S1.001	S2	0.26			1049.0	OK	2
S1.002	S3	0.20			1007.0	OK	
S1.003	S4	0.09			1001.8	OK	
S2.000	S5	0.12			901.8	OK	
S1.004	S6	0.16			1682.4	OK	
S1.005	S7	0.18			1670.9	OK	
S1.006	S8	0.11			1676.7	OK	
S1.007	S9	0.10			1678.1	OK	
S3.000	S10	0.10			817.8	OK	
S3.001	S11	0.06			817.6	OK	
S3.002	S12	0.13			846.1	OK	
S3.003	S13	0.21			826.8	OK	
S3.004	S14	0.20			805.2	OK	
S3.005	S15	0.29			800.3	OK	
S3.006	S16	0.08			802.8	OK	
S3.007	S17	0.11			809.1	OK	
S3.008	S18	0.11			807.6	OK	
S3.009	S19	0.10			790.3	OK	
S3.010	S20	0.06			855.1	OK	
S3.011	S21	0.11			920.5	OK	7
S3.012	S22	0.11			974.6	OK	
S1.008	S23	0.27			2124.3	OK	
S1.009	S24	0.16			2088.9	OK	
S4.000	S25	0.22			1575.5	OK	
S4.001	S26	0.37			1393.3	OK	
S4.002	S27	0.36			1378.6	OK	
S4.003	S28	0.14			1376.2	OK	
S4.004	S29	0.10			1374.8	OK	
S4.005	S30	0.09			1372.1	OK	
S4.006	S31	0.19			1393.3	OK	
S4.007	S32	0.22			1380.8	OK	2
S5.000	S33	0.00			0.0	OK	
S4.008	S34	0.32			1347.5	OK	
S4.009	S35	0.09			1373.5	OK	
S4.010	S36	0.18			1454.8	OK	
S4.011	S37	0.19			1481.9	OK	
S4.012	S38	0.18			1386.7	OK	
S1.010	S39	0.15			2965.3	OK	
S1.011	S40	0.15			2966.4	OK	
S1.012	S41	0.12			2846.1	OK	
S1.013	S42	0.12			2795.0	OK	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.014	S43	120 Winter	2	+0%					3.892	-0.982	0.000	0.11
S1.015	S44	120 Winter	2	+0%					3.817	-0.933	0.000	0.11
S1.016	S45	120 Winter	2	+0%					3.767	-0.940	0.000	0.11
S1.017	S46	120 Winter	2	+0%					3.712	-0.942	0.000	0.11
S1.018	S47	120 Winter	2	+0%					3.662	-0.949	0.000	0.12
S1.019	S48	120 Winter	2	+0%					3.624	-0.965	0.000	0.10
S1.020	S49	120 Winter	2	+0%					3.620	-0.963	0.000	0.07
S1.021	S50	120 Winter	2	+0%					3.617	-0.961	0.000	0.05
S1.022	S51	120 Winter	2	+0%					3.616	-0.959	0.000	0.14
S1.023	S52	120 Winter	2	+0%					3.608	-0.959	0.000	0.12
S1.024	S53	120 Winter	2	+0%					3.569	-0.977	0.000	0.14
S1.025	S54	120 Winter	2	+0%					3.558	-0.979	0.000	0.10
S1.026	S55	120 Winter	2	+0%					3.553	-0.978	0.000	0.10
S1.027	S56	120 Winter	2	+0%					3.547	-0.978	0.000	0.14
S1.028	S57	120 Winter	2	+0%					3.516	-0.994	0.000	0.14
S1.029	S58	120 Winter	2	+0%					3.505	-0.996	0.000	0.10
S1.030	S59	120 Winter	2	+0%					3.447	-1.025	0.000	0.10
S6.000	S60	15 Winter	2	+0%					5.731	-0.619	0.000	0.11
S6.001	S61	60 Winter	2	+0%					5.212	-0.772	0.000	0.06
S6.002	S62	120 Winter	2	+0%					5.094	-0.709	0.000	0.09
S6.003	S63	120 Winter	2	+0%					4.955	-0.667	0.000	0.13
S6.004	S64	120 Winter	2	+0%					4.769	-0.665	0.000	0.16
S7.000	S65	15 Winter	2	+0%					5.731	-0.619	0.000	0.11
S7.001	S66	60 Winter	2	+0%					5.236	-0.748	0.000	0.05
S7.002	S67	60 Winter	2	+0%					5.169	-0.724	0.000	0.08
S7.003	S68	60 Winter	2	+0%					5.026	-0.685	0.000	0.12
S7.004	S69	120 Winter	2	+0%					4.815	-0.664	0.000	0.16
S6.005	S70	120 Winter	2	+0%					4.328	-0.648	0.000	0.17
S6.006	S71	120 Winter	2	+0%					4.059	-0.747	0.000	0.10
S1.031	S72	120 Winter	2	+0%					3.381	-1.063	0.000	0.04
S1.032	S73	120 Winter	2	+0%		100/2880 Winter			3.367	-1.075	0.000	0.04
S1.033	S74	120 Winter	2	+0%					3.368	-1.072	0.000	0.11
S1.034	S75	120 Winter	2	+0%					3.335	-1.098	0.000	0.05
S1.035	S76	120 Winter	2	+0%					3.322	-1.109	0.000	0.04
S1.036	S77	120 Winter	2	+0%					3.322	-1.107	0.000	0.14
S1.037	S78	120 Winter	2	+0%					3.261	-1.160	0.000	0.09

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.014	S43			2675.3	OK	
S1.015	S44			2576.6	OK	
S1.016	S45			2512.2	OK	
S1.017	S46			2447.5	OK	
S1.018	S47			2417.2	OK	
S1.019	S48			2404.1	OK	
S1.020	S49			2400.6	OK	
S1.021	S50			2397.8	OK	
S1.022	S51			2395.4	OK	
S1.023	S52			2388.0	OK	
S1.024	S53			2384.4	OK	
S1.025	S54			2382.3	OK	
S1.026	S55			2380.4	OK	
S1.027	S56			2376.7	OK	
S1.028	S57			2369.7	OK	
S1.029	S58			2364.3	OK	
S1.030	S59			2348.7	OK	
S6.000	S60			586.1	OK	
S6.001	S61			264.0	OK	
S6.002	S62			419.6	OK	
S6.003	S63			595.2	OK	
S6.004	S64			763.8	OK	
S7.000	S65			613.0	OK	
S7.001	S66			245.9	OK	
S7.002	S67			378.6	OK	
S7.003	S68			567.8	OK	

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

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S7.004	S69			766.5	OK	
S6.005	S70			1493.2	OK	
S6.006	S71			1470.3	OK	
S1.031	S72			3571.7	OK	
S1.032	S73			3563.5	OK	
S1.033	S74			3767.2	OK	
S1.034	S75			3657.4	OK	
S1.035	S76			3621.6	OK	
S1.036	S77			3765.3	OK	
S1.037	S78			3739.6	OK	

5 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	0.000
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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	0	Number of Storage Structures	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH	Data Type	Point
FEH Rainfall Version	2013	Cv (Summer)	0.750
Site Location	GB 391363 263985 SO 91363 63985	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	ON
Analysis Timestep	Fine	Inertia Status	ON
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2880
Return Period(s) (years)	2, 5, 10, 30, 100
Climate Change (%)	0, 0, 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	15 Winter	5	+0%					16.171	-0.579	0.000
S1.001	S2	15 Winter	5	+0%	100/15 Winter	100/15 Winter			13.818	-0.432	0.000
S1.002	S3	15 Winter	5	+0%					13.679	-0.525	0.000
S1.003	S4	15 Winter	5	+0%					13.293	-0.707	0.000
S2.000	S5	15 Winter	5	+0%					12.840	-0.660	0.000
S1.004	S6	15 Winter	5	+0%					12.411	-0.589	0.000
S1.005	S7	15 Winter	5	+0%					11.693	-0.557	0.000
S1.006	S8	15 Winter	5	+0%					10.812	-0.688	0.000
S1.007	S9	15 Winter	5	+0%					9.563	-0.687	0.000
S3.000	S10	15 Winter	5	+0%					17.316	-0.684	0.000
S3.001	S11	15 Winter	5	+0%					16.235	-0.765	0.000
S3.002	S12	15 Winter	5	+0%					11.626	-0.624	0.000
S3.003	S13	15 Winter	5	+0%					11.519	-0.481	0.000
S3.004	S14	15 Winter	5	+0%					11.414	-0.553	0.000
S3.005	S15	15 Winter	5	+0%					11.393	-0.567	0.000
S3.006	S16	15 Winter	5	+0%					11.219	-0.730	0.000
S3.007	S17	15 Winter	5	+0%					10.336	-0.665	0.000
S3.008	S18	15 Winter	5	+0%					10.070	-0.681	0.000
S3.009	S19	15 Winter	5	+0%					9.567	-0.684	0.000
S3.010	S20	30 Winter	5	+0%					8.725	-0.776	0.000
S3.011	S21	30 Winter	5	+0%	100/30 Winter	100/15 Summer			7.230	-0.521	0.000
S3.012	S22	30 Winter	5	+0%	100/15 Winter				7.188	-0.454	0.000
S1.008	S23	30 Winter	5	+0%	100/15 Summer				7.162	-0.436	0.000
S1.009	S24	30 Winter	5	+0%					6.953	-0.592	0.000
S4.000	S25	15 Winter	5	+0%		100/15 Winter			18.511	-0.489	0.000
S4.001	S26	15 Winter	5	+0%					18.060	-0.440	0.000
S4.002	S27	15 Winter	5	+0%					18.005	-0.479	0.000
S4.003	S28	15 Winter	5	+0%					17.856	-0.612	0.000
S4.004	S29	15 Winter	5	+0%					15.815	-0.685	0.000
S4.005	S30	15 Winter	5	+0%					13.296	-0.704	0.000
S4.006	S31	15 Winter	5	+0%					10.973	-0.527	0.000
S4.007	S32	30 Winter	5	+0%	100/15 Winter	100/15 Winter			9.288	-0.462	0.000
S5.000	S33	15 Summer	5	+0%					10.250	-1.000	0.000
S4.008	S34	30 Winter	5	+0%					9.150	-0.526	0.000
S4.009	S35	30 Winter	5	+0%					8.966	-0.695	0.000
S4.010	S36	30 Winter	5	+0%					7.193	-0.557	0.000
S4.011	S37	60 Winter	5	+0%					5.724	-0.526	0.000
S4.012	S38	60 Winter	5	+0%					5.541	-0.548	0.000
S1.010	S39	60 Winter	5	+0%					5.325	-0.602	0.000
S1.011	S40	60 Winter	5	+0%					4.850	-0.613	0.000
S1.012	S41	60 Winter	5	+0%					4.137	-0.863	0.000
S1.013	S42	60 Winter	5	+0%					4.070	-0.894	0.000

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

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.22			1426.7	OK	
S1.001	S2	0.36			1425.3	OK	2
S1.002	S3	0.28			1372.8	OK	
S1.003	S4	0.12			1370.7	OK	
S2.000	S5	0.16			1224.6	OK	
S1.004	S6	0.22			2304.1	OK	
S1.005	S7	0.25			2289.1	OK	
S1.006	S8	0.14			2296.5	OK	
S1.007	S9	0.13			2297.6	OK	
S3.000	S10	0.13			1110.5	OK	
S3.001	S11	0.08			1110.3	OK	
S3.002	S12	0.18			1148.9	OK	
S3.003	S13	0.28			1125.6	OK	
S3.004	S14	0.28			1104.9	OK	
S3.005	S15	0.41			1101.9	OK	
S3.006	S16	0.11			1101.5	OK	
S3.007	S17	0.15			1112.5	OK	
S3.008	S18	0.15			1113.3	OK	
S3.009	S19	0.14			1091.1	OK	
S3.010	S20	0.08			1178.8	OK	
S3.011	S21	0.15			1262.6	OK	7
S3.012	S22	0.16			1376.4	OK	
S1.008	S23	0.38			2972.6	OK	
S1.009	S24	0.22			2932.9	OK	
S4.000	S25	0.30			2139.2	OK	
S4.001	S26	0.51			1922.1	OK	
S4.002	S27	0.50			1909.0	OK	
S4.003	S28	0.19			1900.3	OK	
S4.004	S29	0.13			1901.7	OK	
S4.005	S30	0.12			1900.6	OK	
S4.006	S31	0.26			1922.0	OK	
S4.007	S32	0.30			1889.0	OK	2
S5.000	S33	0.00			0.0	OK	
S4.008	S34	0.45			1870.5	OK	
S4.009	S35	0.13			1910.9	OK	
S4.010	S36	0.25			2028.7	OK	
S4.011	S37	0.26			2025.9	OK	
S4.012	S38	0.24			1914.6	OK	
S1.010	S39	0.21			4131.2	OK	
S1.011	S40	0.21			4098.9	OK	
S1.012	S41	0.17			3961.6	OK	
S1.013	S42	0.17			3860.1	OK	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.014	S43	120 Winter	5	+0%					3.981	-0.893	0.000	0.15
S1.015	S44	120 Winter	5	+0%					3.907	-0.843	0.000	0.14
S1.016	S45	120 Winter	5	+0%					3.855	-0.852	0.000	0.14
S1.017	S46	120 Winter	5	+0%					3.796	-0.858	0.000	0.14
S1.018	S47	120 Winter	5	+0%					3.742	-0.869	0.000	0.16
S1.019	S48	120 Winter	5	+0%					3.700	-0.889	0.000	0.13
S1.020	S49	120 Winter	5	+0%					3.695	-0.888	0.000	0.10
S1.021	S50	120 Winter	5	+0%					3.692	-0.886	0.000	0.07
S1.022	S51	120 Winter	5	+0%					3.690	-0.885	0.000	0.18
S1.023	S52	120 Winter	5	+0%					3.682	-0.885	0.000	0.16
S1.024	S53	120 Winter	5	+0%					3.637	-0.909	0.000	0.19
S1.025	S54	120 Winter	5	+0%					3.627	-0.910	0.000	0.13
S1.026	S55	120 Winter	5	+0%					3.621	-0.910	0.000	0.14
S1.027	S56	120 Winter	5	+0%					3.615	-0.910	0.000	0.19
S1.028	S57	120 Winter	5	+0%					3.583	-0.927	0.000	0.19
S1.029	S58	120 Winter	5	+0%					3.570	-0.931	0.000	0.14
S1.030	S59	120 Winter	5	+0%					3.500	-0.972	0.000	0.14
S6.000	S60	15 Winter	5	+0%					5.809	-0.541	0.000	0.15
S6.001	S61	60 Winter	5	+0%					5.259	-0.725	0.000	0.07
S6.002	S62	60 Winter	5	+0%					5.154	-0.649	0.000	0.11
S6.003	S63	60 Winter	5	+0%					5.021	-0.601	0.000	0.17
S6.004	S64	60 Winter	5	+0%					4.831	-0.603	0.000	0.21
S7.000	S65	15 Winter	5	+0%					5.809	-0.541	0.000	0.15
S7.001	S66	60 Winter	5	+0%					5.291	-0.693	0.000	0.07
S7.002	S67	60 Winter	5	+0%					5.228	-0.665	0.000	0.11
S7.003	S68	60 Winter	5	+0%					5.093	-0.618	0.000	0.16
S7.004	S69	60 Winter	5	+0%					4.880	-0.599	0.000	0.21
S6.005	S70	60 Winter	5	+0%					4.387	-0.589	0.000	0.22
S6.006	S71	120 Winter	5	+0%					4.103	-0.703	0.000	0.13
S1.031	S72	240 Winter	5	+0%					3.394	-1.050	0.000	0.05
S1.032	S73	120 Winter	5	+0%		100/2880 Winter			3.387	-1.055	0.000	0.05
S1.033	S74	120 Winter	5	+0%					3.376	-1.064	0.000	0.14
S1.034	S75	120 Winter	5	+0%					3.357	-1.076	0.000	0.06
S1.035	S76	120 Winter	5	+0%					3.357	-1.074	0.000	0.05
S1.036	S77	120 Winter	5	+0%					3.351	-1.078	0.000	0.17
S1.037	S78	120 Winter	5	+0%					3.302	-1.119	0.000	0.11

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.014	S43			3454.6	OK	
S1.015	S44			3341.1	OK	
S1.016	S45			3269.3	OK	
S1.017	S46			3203.4	OK	
S1.018	S47			3183.5	OK	
S1.019	S48			3170.1	OK	
S1.020	S49			3169.0	OK	
S1.021	S50			3168.8	OK	
S1.022	S51			3168.2	OK	
S1.023	S52			3162.4	OK	
S1.024	S53			3158.9	OK	
S1.025	S54			3154.3	OK	
S1.026	S55			3154.8	OK	
S1.027	S56			3156.9	OK	
S1.028	S57			3156.5	OK	
S1.029	S58			3153.7	OK	
S1.030	S59			3167.7	OK	
S6.000	S60			805.5	OK	
S6.001	S61			345.2	OK	
S6.002	S62			542.3	OK	
S6.003	S63			783.3	OK	
S6.004	S64			996.3	OK	
S7.000	S65			830.4	OK	
S7.001	S66			334.4	OK	
S7.002	S67			501.7	OK	
S7.003	S68			774.3	OK	

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

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S7.004	S69			1017.6	OK	
S6.005	S70			1923.6	OK	
S6.006	S71			1910.7	OK	
S1.031	S72			4288.4	OK	
S1.032	S73			4720.3	OK	
S1.033	S74			4622.8	OK	
S1.034	S75			4740.5	OK	
S1.035	S76			4661.3	OK	
S1.036	S77			4542.5	OK	
S1.037	S78			4568.2	OK	

10 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 0.000
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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH Data Type Point
FEH Rainfall Version 2013 Cv (Summer) 0.750
Site Location GB 391363 263985 SO 91363 63985 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2880
Return Period(s) (years) 2, 5, 10, 30, 100
Climate Change (%) 0, 0, 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	15 Winter	10	+0%					16.236	-0.514	0.000
S1.001	S2	15 Winter	10	+0%	100/15 Winter	100/15 Winter			13.892	-0.358	0.000
S1.002	S3	15 Winter	10	+0%					13.748	-0.456	0.000
S1.003	S4	15 Winter	10	+0%					13.336	-0.664	0.000
S2.000	S5	15 Winter	10	+0%					12.890	-0.610	0.000
S1.004	S6	15 Winter	10	+0%					12.478	-0.522	0.000
S1.005	S7	15 Winter	10	+0%					11.764	-0.486	0.000
S1.006	S8	15 Winter	10	+0%					10.859	-0.641	0.000
S1.007	S9	15 Winter	10	+0%					9.610	-0.640	0.000
S3.000	S10	15 Winter	10	+0%					17.360	-0.640	0.000
S3.001	S11	15 Winter	10	+0%					16.272	-0.728	0.000
S3.002	S12	15 Winter	10	+0%					11.681	-0.569	0.000
S3.003	S13	15 Winter	10	+0%					11.579	-0.421	0.000
S3.004	S14	15 Winter	10	+0%					11.464	-0.503	0.000
S3.005	S15	15 Winter	10	+0%					11.444	-0.516	0.000
S3.006	S16	15 Winter	10	+0%					11.260	-0.689	0.000
S3.007	S17	15 Winter	10	+0%					10.383	-0.618	0.000
S3.008	S18	15 Winter	10	+0%					10.114	-0.637	0.000
S3.009	S19	15 Winter	10	+0%					9.612	-0.639	0.000
S3.010	S20	30 Winter	10	+0%					8.759	-0.742	0.000
S3.011	S21	30 Winter	10	+0%	100/30 Winter	100/15 Summer			7.321	-0.430	0.000
S3.012	S22	30 Winter	10	+0%	100/15 Winter				7.283	-0.359	0.000
S1.008	S23	30 Winter	10	+0%	100/15 Summer				7.255	-0.343	0.000
S1.009	S24	30 Winter	10	+0%					7.021	-0.524	0.000
S4.000	S25	15 Winter	10	+0%		100/15 Winter			18.586	-0.414	0.000
S4.001	S26	15 Winter	10	+0%					18.124	-0.376	0.000
S4.002	S27	15 Winter	10	+0%					18.069	-0.415	0.000
S4.003	S28	15 Winter	10	+0%					17.919	-0.549	0.000
S4.004	S29	15 Winter	10	+0%					15.864	-0.636	0.000
S4.005	S30	15 Winter	10	+0%					13.342	-0.658	0.000
S4.006	S31	15 Winter	10	+0%					11.046	-0.454	0.000
S4.007	S32	30 Winter	10	+0%	100/15 Winter	100/15 Winter			9.360	-0.390	0.000
S5.000	S33	15 Summer	10	+0%					10.250	-1.000	0.000
S4.008	S34	30 Winter	10	+0%					9.209	-0.467	0.000
S4.009	S35	30 Winter	10	+0%					9.014	-0.647	0.000
S4.010	S36	30 Winter	10	+0%					7.268	-0.482	0.000
S4.011	S37	60 Winter	10	+0%					5.796	-0.454	0.000
S4.012	S38	60 Winter	10	+0%					5.611	-0.478	0.000
S1.010	S39	60 Winter	10	+0%					5.391	-0.536	0.000
S1.011	S40	60 Winter	10	+0%					4.913	-0.551	0.000
S1.012	S41	60 Winter	10	+0%					4.228	-0.772	0.000
S1.013	S42	60 Winter	10	+0%					4.161	-0.803	0.000

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

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.28			1801.7	OK	
S1.001	S2	0.45			1775.5	OK	2
S1.002	S3	0.35			1725.3	OK	
S1.003	S4	0.16			1726.1	OK	
S2.000	S5	0.21			1546.3	OK	
S1.004	S6	0.28			2940.0	OK	
S1.005	S7	0.32			2914.1	OK	
S1.006	S8	0.18			2927.1	OK	
S1.007	S9	0.17			2930.5	OK	
S3.000	S10	0.17			1402.4	OK	
S3.001	S11	0.11			1402.1	OK	
S3.002	S12	0.23			1439.8	OK	
S3.003	S13	0.36			1409.3	OK	
S3.004	S14	0.35			1388.8	OK	
S3.005	S15	0.51			1390.9	OK	
S3.006	S16	0.13			1387.9	OK	
S3.007	S17	0.19			1392.4	OK	
S3.008	S18	0.19			1395.8	OK	
S3.009	S19	0.18			1367.3	OK	
S3.010	S20	0.10			1475.7	OK	
S3.011	S21	0.18			1568.3	OK	7
S3.012	S22	0.20			1731.6	OK	
S1.008	S23	0.49			3837.4	OK	
S1.009	S24	0.29			3787.4	OK	
S4.000	S25	0.39			2701.4	OK	
S4.001	S26	0.66			2474.5	OK	
S4.002	S27	0.64			2457.2	OK	
S4.003	S28	0.25			2438.4	OK	
S4.004	S29	0.17			2444.8	OK	
S4.005	S30	0.15			2447.5	OK	
S4.006	S31	0.34			2463.8	OK	
S4.007	S32	0.38			2418.2	OK	2
S5.000	S33	0.00			0.0	OK	
S4.008	S34	0.58			2412.8	OK	
S4.009	S35	0.17			2467.9	OK	
S4.010	S36	0.32			2607.0	OK	
S4.011	S37	0.33			2574.8	OK	
S4.012	S38	0.31			2438.6	OK	
S1.010	S39	0.27			5320.4	OK	
S1.011	S40	0.26			5151.6	OK	
S1.012	S41	0.21			4954.5	OK	
S1.013	S42	0.21			4831.6	OK	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.014	S43	60 Winter	10	+0%					4.071	-0.803	0.000	0.19
S1.015	S44	60 Winter	10	+0%					3.992	-0.758	0.000	0.19
S1.016	S45	60 Winter	10	+0%					3.935	-0.772	0.000	0.18
S1.017	S46	120 Winter	10	+0%					3.871	-0.783	0.000	0.17
S1.018	S47	120 Winter	10	+0%					3.813	-0.798	0.000	0.19
S1.019	S48	120 Winter	10	+0%					3.767	-0.822	0.000	0.16
S1.020	S49	120 Winter	10	+0%					3.762	-0.821	0.000	0.12
S1.021	S50	120 Winter	10	+0%					3.759	-0.819	0.000	0.09
S1.022	S51	120 Winter	10	+0%					3.757	-0.818	0.000	0.22
S1.023	S52	120 Winter	10	+0%					3.749	-0.818	0.000	0.20
S1.024	S53	120 Winter	10	+0%					3.700	-0.846	0.000	0.23
S1.025	S54	120 Winter	10	+0%					3.689	-0.848	0.000	0.17
S1.026	S55	120 Winter	10	+0%					3.684	-0.847	0.000	0.17
S1.027	S56	120 Winter	10	+0%					3.678	-0.847	0.000	0.23
S1.028	S57	120 Winter	10	+0%					3.645	-0.865	0.000	0.23
S1.029	S58	120 Winter	10	+0%					3.632	-0.869	0.000	0.17
S1.030	S59	120 Winter	10	+0%					3.554	-0.918	0.000	0.17
S6.000	S60	15 Winter	10	+0%					5.878	-0.472	0.000	0.19
S6.001	S61	60 Winter	10	+0%					5.305	-0.679	0.000	0.09
S6.002	S62	60 Winter	10	+0%					5.211	-0.592	0.000	0.14
S6.003	S63	60 Winter	10	+0%					5.087	-0.535	0.000	0.21
S6.004	S64	60 Winter	10	+0%					4.898	-0.536	0.000	0.27
S7.000	S65	15 Winter	10	+0%					5.878	-0.472	0.000	0.17
S7.001	S66	60 Winter	10	+0%					5.338	-0.646	0.000	0.09
S7.002	S67	60 Winter	10	+0%					5.278	-0.615	0.000	0.13
S7.003	S68	30 Winter	10	+0%					5.155	-0.556	0.000	0.20
S7.004	S69	60 Winter	10	+0%					4.948	-0.531	0.000	0.27
S6.005	S70	60 Winter	10	+0%					4.448	-0.528	0.000	0.28
S6.006	S71	60 Winter	10	+0%					4.144	-0.662	0.000	0.17
S1.031	S72	120 Summer	10	+0%					3.462	-0.982	0.000	0.06
S1.032	S73	120 Summer	10	+0%		100/2880 Winter			3.460	-0.982	0.000	0.06
S1.033	S74	120 Summer	10	+0%					3.459	-0.981	0.000	0.16
S1.034	S75	120 Summer	10	+0%					3.426	-1.007	0.000	0.07
S1.035	S76	120 Summer	10	+0%					3.425	-1.006	0.000	0.06
S1.036	S77	120 Summer	10	+0%					3.424	-1.005	0.000	0.21
S1.037	S78	120 Winter	10	+0%					3.330	-1.091	0.000	0.14

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.014	S43			4582.9	OK	
S1.015	S44			4379.1	OK	
S1.016	S45			4255.1	OK	
S1.017	S46			3971.1	OK	
S1.018	S47			3967.0	OK	
S1.019	S48			3947.7	OK	
S1.020	S49			3942.9	OK	
S1.021	S50			3936.5	OK	
S1.022	S51			3931.6	OK	
S1.023	S52			3933.0	OK	
S1.024	S53			3934.6	OK	
S1.025	S54			3931.5	OK	
S1.026	S55			3931.1	OK	
S1.027	S56			3926.4	OK	
S1.028	S57			3918.8	OK	
S1.029	S58			3923.1	OK	
S1.030	S59			3937.1	OK	
S6.000	S60			1043.7	OK	
S6.001	S61			438.2	OK	
S6.002	S62			668.0	OK	
S6.003	S63			996.5	OK	
S6.004	S64			1267.6	OK	
S7.000	S65			936.1	OK	
S7.001	S66			428.0	OK	
S7.002	S67			608.9	OK	
S7.003	S68			932.4	OK	

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

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S7.004	S69			1285.0	OK	
S6.005	S70			2414.5	OK	
S6.006	S71			2380.3	OK	
S1.031	S72			5380.8	OK	
S1.032	S73			5440.6	OK	
S1.033	S74			5332.6	OK	
S1.034	S75			5293.3	OK	
S1.035	S76			5391.2	OK	
S1.036	S77			5443.2	OK	
S1.037	S78			5709.2	OK	

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	0.000
Hot Start Level (mm)	0	Inlet Coeffecient	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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	0	Number of Storage Structures	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH	Data Type	Point
FEH Rainfall Version	2013	Cv (Summer)	0.750
Site Location	GB 391363 263985 SO 91363 63985	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	ON
Analysis Timestep	Fine	Inertia Status	ON
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2880
Return Period(s) (years)	2, 5, 10, 30, 100
Climate Change (%)	0, 0, 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	15 Winter	30	+0%					16.327	-0.423	0.000
S1.001	S2	15 Winter	30	+0%	100/15 Winter	100/15 Winter			14.009	-0.241	0.000
S1.002	S3	15 Winter	30	+0%					13.857	-0.347	0.000
S1.003	S4	15 Winter	30	+0%					13.403	-0.597	0.000
S2.000	S5	15 Winter	30	+0%					12.968	-0.532	0.000
S1.004	S6	15 Winter	30	+0%					12.574	-0.426	0.000
S1.005	S7	15 Winter	30	+0%					11.866	-0.384	0.000
S1.006	S8	15 Winter	30	+0%					10.933	-0.567	0.000
S1.007	S9	15 Winter	30	+0%					9.683	-0.567	0.000
S3.000	S10	15 Winter	30	+0%					17.431	-0.569	0.000
S3.001	S11	15 Winter	30	+0%					16.326	-0.674	0.000
S3.002	S12	15 Winter	30	+0%					11.767	-0.483	0.000
S3.003	S13	15 Winter	30	+0%					11.670	-0.330	0.000
S3.004	S14	15 Winter	30	+0%					11.538	-0.429	0.000
S3.005	S15	15 Winter	30	+0%					11.517	-0.443	0.000
S3.006	S16	15 Winter	30	+0%					11.319	-0.630	0.000
S3.007	S17	15 Winter	30	+0%					10.460	-0.541	0.000
S3.008	S18	15 Winter	30	+0%					10.187	-0.564	0.000
S3.009	S19	15 Winter	30	+0%					9.686	-0.565	0.000
S3.010	S20	30 Winter	30	+0%					8.814	-0.687	0.000
S3.011	S21	30 Winter	30	+0%	100/30 Winter	100/15 Summer			7.488	-0.263	0.000
S3.012	S22	30 Winter	30	+0%	100/15 Winter				7.444	-0.198	0.000
S1.008	S23	30 Winter	30	+0%	100/15 Summer				7.399	-0.199	0.000
S1.009	S24	30 Winter	30	+0%					7.125	-0.420	0.000
S4.000	S25	15 Winter	30	+0%		100/15 Winter			18.704	-0.296	0.000
S4.001	S26	15 Winter	30	+0%					18.219	-0.281	0.000
S4.002	S27	15 Winter	30	+0%					18.162	-0.322	0.000
S4.003	S28	15 Winter	30	+0%					18.012	-0.456	0.000
S4.004	S29	15 Winter	30	+0%					15.940	-0.560	0.000
S4.005	S30	15 Winter	30	+0%					13.413	-0.587	0.000
S4.006	S31	15 Winter	30	+0%					11.159	-0.341	0.000
S4.007	S32	30 Winter	30	+0%	100/15 Winter	100/15 Winter			9.469	-0.281	0.000
S5.000	S33	15 Summer	30	+0%					10.250	-1.000	0.000
S4.008	S34	30 Winter	30	+0%					9.298	-0.378	0.000
S4.009	S35	30 Winter	30	+0%					9.092	-0.569	0.000
S4.010	S36	30 Winter	30	+0%					7.384	-0.366	0.000
S4.011	S37	60 Winter	30	+0%					5.915	-0.335	0.000
S4.012	S38	60 Winter	30	+0%					5.725	-0.364	0.000
S1.010	S39	60 Winter	30	+0%					5.495	-0.432	0.000
S1.011	S40	60 Winter	30	+0%					5.015	-0.448	0.000
S1.012	S41	60 Winter	30	+0%					4.369	-0.631	0.000
S1.013	S42	60 Winter	30	+0%					4.301	-0.663	0.000

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

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.37			2438.4	OK	
S1.001	S2	0.61			2411.0	FLOOD RISK*	2
S1.002	S3	0.48			2351.1	OK	
S1.003	S4	0.21			2348.9	OK	
S2.000	S5	0.28			2092.4	OK	
S1.004	S6	0.38			4022.2	OK	
S1.005	S7	0.43			3991.8	OK	
S1.006	S8	0.25			4003.0	OK	
S1.007	S9	0.23			4009.5	OK	
S3.000	S10	0.23			1897.6	OK	
S3.001	S11	0.14			1897.2	OK	
S3.002	S12	0.31			1948.3	OK	
S3.003	S13	0.48			1913.1	OK	
S3.004	S14	0.48			1896.0	OK	
S3.005	S15	0.70			1894.5	OK	
S3.006	S16	0.18			1894.9	OK	
S3.007	S17	0.26			1903.6	OK	
S3.008	S18	0.25			1899.8	OK	
S3.009	S19	0.24			1867.5	OK	
S3.010	S20	0.14			2032.3	OK	
S3.011	S21	0.25			2146.1	FLOOD RISK*	7
S3.012	S22	0.28			2394.9	OK	
S1.008	S23	0.68			5327.9	OK	
S1.009	S24	0.40			5268.1	OK	
S4.000	S25	0.52			3655.8	FLOOD RISK*	
S4.001	S26	0.90			3405.4	FLOOD RISK*	
S4.002	S27	0.88			3377.4	OK	
S4.003	S28	0.34			3373.3	OK	
S4.004	S29	0.24			3364.6	OK	
S4.005	S30	0.21			3364.6	OK	
S4.006	S31	0.47			3414.6	OK	
S4.007	S32	0.53			3346.5	FLOOD RISK*	2
S5.000	S33	0.00			0.0	OK	
S4.008	S34	0.80			3369.7	OK	
S4.009	S35	0.24			3453.2	OK	
S4.010	S36	0.45			3685.6	OK	
S4.011	S37	0.46			3626.5	OK	
S4.012	S38	0.44			3432.6	OK	
S1.010	S39	0.37			7462.6	OK	
S1.011	S40	0.36			7186.4	OK	
S1.012	S41	0.29			6704.8	OK	
S1.013	S42	0.28			6563.4	OK	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.014	S43	60 Winter	30	+0%					4.211	-0.663	0.000	0.26
S1.015	S44	60 Winter	30	+0%					4.132	-0.618	0.000	0.26
S1.016	S45	60 Winter	30	+0%					4.070	-0.637	0.000	0.25
S1.017	S46	60 Winter	30	+0%					3.999	-0.655	0.000	0.25
S1.018	S47	60 Winter	30	+0%					3.931	-0.680	0.000	0.28
S1.019	S48	60 Winter	30	+0%					3.878	-0.711	0.000	0.23
S1.020	S49	60 Winter	30	+0%					3.873	-0.710	0.000	0.18
S1.021	S50	60 Winter	30	+0%					3.869	-0.709	0.000	0.13
S1.022	S51	60 Winter	30	+0%					3.866	-0.709	0.000	0.32
S1.023	S52	60 Winter	30	+0%					3.858	-0.709	0.000	0.28
S1.024	S53	60 Winter	30	+0%					3.800	-0.746	0.000	0.33
S1.025	S54	60 Winter	30	+0%					3.789	-0.748	0.000	0.24
S1.026	S55	60 Winter	30	+0%					3.782	-0.749	0.000	0.24
S1.027	S56	60 Winter	30	+0%					3.776	-0.749	0.000	0.33
S1.028	S57	60 Winter	30	+0%					3.740	-0.770	0.000	0.33
S1.029	S58	120 Winter	30	+0%					3.728	-0.773	0.000	0.23
S1.030	S59	120 Winter	30	+0%					3.640	-0.832	0.000	0.23
S6.000	S60	15 Winter	30	+0%					5.983	-0.367	0.000	0.24
S6.001	S61	60 Winter	30	+0%					5.380	-0.604	0.000	0.13
S6.002	S62	60 Winter	30	+0%					5.300	-0.503	0.000	0.18
S6.003	S63	60 Winter	30	+0%					5.191	-0.431	0.000	0.29
S6.004	S64	60 Winter	30	+0%					5.006	-0.428	0.000	0.37
S7.000	S65	15 Winter	30	+0%					5.983	-0.367	0.000	0.21
S7.001	S66	60 Winter	30	+0%					5.421	-0.563	0.000	0.13
S7.002	S67	30 Winter	30	+0%					5.364	-0.529	0.000	0.15
S7.003	S68	30 Winter	30	+0%					5.257	-0.454	0.000	0.27
S7.004	S69	60 Winter	30	+0%					5.053	-0.426	0.000	0.37
S6.005	S70	60 Winter	30	+0%					4.546	-0.430	0.000	0.38
S6.006	S71	60 Winter	30	+0%					4.214	-0.592	0.000	0.23
S1.031	S72	120 Winter	30	+0%					3.545	-0.899	0.000	0.08
S1.032	S73	120 Winter	30	+0%		100/2880 Winter			3.543	-0.899	0.000	0.09
S1.033	S74	120 Winter	30	+0%					3.542	-0.898	0.000	0.24
S1.034	S75	120 Winter	30	+0%					3.510	-0.923	0.000	0.10
S1.035	S76	120 Winter	30	+0%					3.507	-0.924	0.000	0.09
S1.036	S77	120 Winter	30	+0%					3.505	-0.924	0.000	0.31
S1.037	S78	120 Winter	30	+0%					3.396	-1.025	0.000	0.20

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.014	S43			6259.2	OK	
S1.015	S44			6014.7	OK	
S1.016	S45			5876.9	OK	
S1.017	S46			5748.6	OK	
S1.018	S47			5673.5	OK	
S1.019	S48			5638.5	OK	
S1.020	S49			5629.4	OK	
S1.021	S50			5626.5	OK	
S1.022	S51			5624.3	OK	
S1.023	S52			5610.9	OK	
S1.024	S53			5594.9	OK	
S1.025	S54			5588.8	OK	
S1.026	S55			5583.9	OK	
S1.027	S56			5578.0	OK	
S1.028	S57			5574.7	OK	
S1.029	S58			5288.7	OK	
S1.030	S59			5287.5	OK	
S6.000	S60			1324.7	OK	
S6.001	S61			597.2	OK	
S6.002	S62			874.0	OK	
S6.003	S63			1368.5	OK	
S6.004	S64			1762.4	OK	
S7.000	S65			1161.2	OK	
S7.001	S66			599.9	OK	
S7.002	S67			707.1	OK	
S7.003	S68			1278.0	OK	

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

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S7.004	S69			1771.5	OK	
S6.005	S70			3296.2	OK	
S6.006	S71			3255.3	OK	
S1.031	S72			7896.8	OK	
S1.032	S73			8039.3	OK	
S1.033	S74			8085.9	OK	
S1.034	S75			8002.5	OK	
S1.035	S76			8071.7	OK	
S1.036	S77			8157.5	OK	
S1.037	S78			8105.3	OK	

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	0.000
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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	0	Number of Storage Structures	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH	Data Type	Point
FEH Rainfall Version	2013	Cv (Summer)	0.750
Site Location	GB 391363 263985 SO 91363 63985	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	ON
Analysis Timestep	Fine	Inertia Status	ON
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2880
Return Period(s) (years)	2, 5, 10, 30, 100
Climate Change (%)	0, 0, 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	15 Winter	100	+40%					16.577	-0.173	0.000
S1.001	S2	15 Winter	100	+40%	100/15 Winter	100/15 Winter			14.262	0.012	12.148
S1.002	S3	15 Winter	100	+40%					14.148	-0.056	0.000
S1.003	S4	15 Winter	100	+40%					13.588	-0.412	0.000
S2.000	S5	15 Winter	100	+40%					13.175	-0.325	0.000
S1.004	S6	15 Winter	100	+40%					12.842	-0.158	0.000
S1.005	S7	15 Winter	100	+40%					12.155	-0.095	0.000
S1.006	S8	15 Winter	100	+40%					11.139	-0.361	0.000
S1.007	S9	15 Winter	100	+40%					9.885	-0.365	0.000
S3.000	S10	15 Winter	100	+40%					17.623	-0.377	0.000
S3.001	S11	15 Winter	100	+40%					16.474	-0.526	0.000
S3.002	S12	15 Winter	100	+40%					12.041	-0.209	0.000
S3.003	S13	15 Winter	100	+40%					11.955	-0.045	0.000
S3.004	S14	15 Winter	100	+40%					11.730	-0.237	0.000
S3.005	S15	15 Winter	100	+40%					11.708	-0.252	0.000
S3.006	S16	15 Winter	100	+40%					11.490	-0.459	0.000
S3.007	S17	15 Winter	100	+40%					10.668	-0.333	0.000
S3.008	S18	15 Winter	100	+40%					10.384	-0.367	0.000
S3.009	S19	15 Winter	100	+40%					9.890	-0.361	0.000
S3.010	S20	30 Winter	100	+40%					8.965	-0.536	0.000
S3.011	S21	30 Winter	100	+40%	100/30 Winter	100/15 Summer			7.764	0.013	14.112
S3.012	S22	30 Winter	100	+40%	100/15 Winter				7.718	0.076	0.000
S1.008	S23	30 Winter	100	+40%	100/15 Summer				7.688	0.090	0.000
S1.009	S24	30 Winter	100	+40%					7.474	-0.071	0.000
S4.000	S25	15 Winter	100	+40%		100/15 Winter			19.000	0.000	0.169
S4.001	S26	15 Winter	100	+40%					18.464	-0.036	0.000
S4.002	S27	15 Winter	100	+40%					18.403	-0.081	0.000
S4.003	S28	15 Winter	100	+40%					18.262	-0.206	0.000
S4.004	S29	15 Winter	100	+40%					16.147	-0.353	0.000
S4.005	S30	15 Winter	100	+40%					13.606	-0.394	0.000
S4.006	S31	30 Winter	100	+40%					11.458	-0.042	0.000
S4.007	S32	30 Winter	100	+40%	100/15 Winter	100/15 Winter			9.760	0.010	10.176
S5.000	S33	15 Summer	100	+40%					10.250	-1.000	0.000
S4.008	S34	30 Winter	100	+40%					9.530	-0.146	0.000
S4.009	S35	30 Winter	100	+40%					9.311	-0.350	0.000
S4.010	S36	30 Winter	100	+40%					7.707	-0.043	0.000
S4.011	S37	30 Winter	100	+40%					6.249	-0.001	0.000
S4.012	S38	60 Winter	100	+40%					6.047	-0.042	0.000
S1.010	S39	30 Winter	100	+40%					5.804	-0.123	0.000
S1.011	S40	60 Winter	100	+40%					5.304	-0.160	0.000
S1.012	S41	60 Winter	100	+40%					4.748	-0.252	0.000
S1.013	S42	60 Winter	100	+40%					4.683	-0.281	0.000

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

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.70			4591.9	FLOOD RISK*	
S1.001	S2	1.13			4498.2	FLOOD	2
S1.002	S3	0.90			4445.0	OK	
S1.003	S4	0.40			4430.6	OK	
S2.000	S5	0.52			3939.4	OK	
S1.004	S6	0.74			7730.7	FLOOD RISK*	
S1.005	S7	0.84			7704.5	FLOOD RISK*	
S1.006	S8	0.48			7682.9	OK	
S1.007	S9	0.45			7707.2	OK	
S3.000	S10	0.43			3572.7	OK	
S3.001	S11	0.27			3571.9	OK	
S3.002	S12	0.58			3662.5	FLOOD RISK*	
S3.003	S13	0.91			3616.0	FLOOD RISK*	
S3.004	S14	0.91			3601.5	OK	
S3.005	S15	1.32			3591.3	OK	
S3.006	S16	0.35			3597.4	OK	
S3.007	S17	0.48			3618.6	OK	
S3.008	S18	0.48			3617.0	OK	
S3.009	S19	0.46			3550.4	OK	
S3.010	S20	0.27			3927.6	OK	
S3.011	S21	0.49			4208.6	FLOOD	7
S3.012	S22	0.54			4624.7	FLOOD RISK*	
S1.008	S23	1.50			11763.8	SURCHARGED*	
S1.009	S24	0.87			11567.0	OK	
S4.000	S25	0.98			6878.1	FLOOD	
S4.001	S26	1.74			6557.1	FLOOD RISK*	
S4.002	S27	1.70			6545.8	FLOOD RISK*	
S4.003	S28	0.66			6524.6	FLOOD RISK*	
S4.004	S29	0.46			6533.8	OK	
S4.005	S30	0.41			6533.0	OK	
S4.006	S31	0.92			6668.6	FLOOD RISK*	
S4.007	S32	1.05			6604.4	FLOOD	2
S5.000	S33	0.00			0.0	OK	
S4.008	S34	1.60			6692.8	OK	
S4.009	S35	0.48			6881.0	OK	
S4.010	S36	0.91			7451.9	FLOOD RISK*	
S4.011	S37	0.93			7284.7	FLOOD RISK*	
S4.012	S38	0.88			6909.4	OK	
S1.010	S39	0.73			14545.9	OK	
S1.011	S40	0.72			14393.6	OK	
S1.012	S41	0.57			13149.1	FLOOD RISK*	
S1.013	S42	0.55			12837.7	OK	

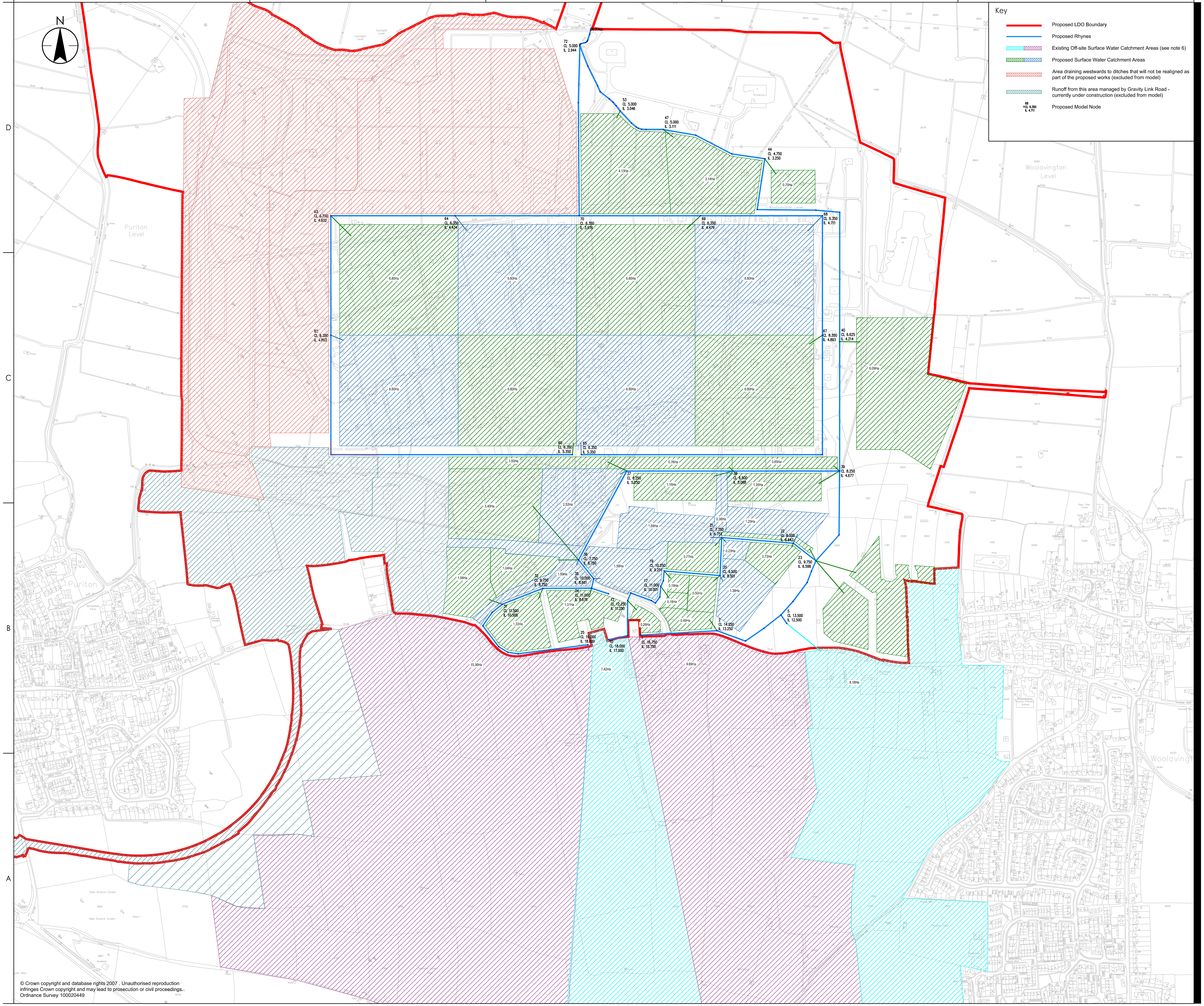
100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.014	S43	60 Winter	100	+40%					4.588	-0.286	0.000	0.52
S1.015	S44	60 Winter	100	+40%					4.498	-0.252	0.000	0.52
S1.016	S45	60 Winter	100	+40%					4.424	-0.283	0.000	0.51
S1.017	S46	60 Winter	100	+40%					4.338	-0.316	0.000	0.50
S1.018	S47	60 Winter	100	+40%					4.253	-0.358	0.000	0.55
S1.019	S48	60 Winter	100	+40%					4.205	-0.384	0.000	0.47
S1.020	S49	60 Winter	100	+40%					4.196	-0.387	0.000	0.35
S1.021	S50	60 Winter	100	+40%					4.189	-0.389	0.000	0.25
S1.022	S51	60 Winter	100	+40%					4.184	-0.391	0.000	0.63
S1.023	S52	60 Winter	100	+40%					4.172	-0.395	0.000	0.56
S1.024	S53	60 Winter	100	+40%					4.119	-0.427	0.000	0.66
S1.025	S54	60 Winter	100	+40%					4.106	-0.431	0.000	0.47
S1.026	S55	60 Winter	100	+40%					4.097	-0.434	0.000	0.48
S1.027	S56	60 Winter	100	+40%					4.087	-0.438	0.000	0.66
S1.028	S57	60 Winter	100	+40%					4.055	-0.455	0.000	0.65
S1.029	S58	60 Winter	100	+40%					4.043	-0.458	0.000	0.48
S1.030	S59	60 Winter	100	+40%					3.933	-0.539	0.000	0.48
S6.000	S60	15 Winter	100	+40%					6.275	-0.075	0.000	0.38
S6.001	S61	60 Winter	100	+40%					5.630	-0.354	0.000	0.26
S6.002	S62	30 Winter	100	+40%					5.557	-0.246	0.000	0.31
S6.003	S63	30 Winter	100	+40%					5.485	-0.137	0.000	0.52
S6.004	S64	60 Winter	100	+40%					5.308	-0.126	0.000	0.73
S7.000	S65	15 Winter	100	+40%					6.275	-0.075	0.000	0.36
S7.001	S66	60 Winter	100	+40%					5.677	-0.307	0.000	0.26
S7.002	S67	30 Winter	100	+40%					5.621	-0.272	0.000	0.30
S7.003	S68	30 Winter	100	+40%					5.552	-0.159	0.000	0.52
S7.004	S69	60 Winter	100	+40%					5.352	-0.127	0.000	0.73
S6.005	S70	60 Winter	100	+40%					4.831	-0.145	0.000	0.74
S6.006	S71	60 Winter	100	+40%					4.416	-0.390	0.000	0.44
S1.031	S72	60 Winter	100	+40%					3.705	-0.739	0.000	0.17
S1.032	S73	60 Winter	100	+40%		100/2880 Winter			3.699	-0.743	0.000	0.17
S1.033	S74	60 Winter	100	+40%					3.696	-0.744	0.000	0.48
S1.034	S75	60 Winter	100	+40%					3.665	-0.768	0.000	0.20
S1.035	S76	60 Winter	100	+40%					3.657	-0.774	0.000	0.17
S1.036	S77	60 Winter	100	+40%					3.652	-0.777	0.000	0.61
S1.037	S78	60 Winter	100	+40%					3.571	-0.850	0.000	0.39

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.014	S43			12310.4	OK	
S1.015	S44			11945.2	FLOOD RISK*	
S1.016	S45			11711.8	OK	
S1.017	S46			11457.3	OK	
S1.018	S47			11282.1	OK	
S1.019	S48			11212.1	OK	
S1.020	S49			11195.0	OK	
S1.021	S50			11181.0	OK	
S1.022	S51			11170.2	OK	
S1.023	S52			11144.1	OK	
S1.024	S53			11094.2	OK	
S1.025	S54			11072.3	OK	
S1.026	S55			11066.5	OK	
S1.027	S56			11061.2	OK	
S1.028	S57			11039.8	OK	
S1.029	S58			11033.8	OK	
S1.030	S59			11018.9	OK	
S6.000	S60			2092.8	FLOOD RISK*	
S6.001	S61			1246.0	OK	
S6.002	S62			1448.2	OK	
S6.003	S63			2462.1	OK	
S6.004	S64			3473.4	OK	
S7.000	S65			2008.5	FLOOD RISK*	
S7.001	S66			1238.7	OK	
S7.002	S67			1421.0	OK	
S7.003	S68			2449.7	OK	

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

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S7.004	S69			3478.1	OK	
S6.005	S70			6404.6	OK	
S6.006	S71			6335.3	OK	
S1.031	S72			15968.4	OK	
S1.032	S73			15866.4	OK	
S1.033	S74			15949.7	OK	
S1.034	S75			15960.4	OK	
S1.035	S76			15916.5	OK	
S1.036	S77			15921.4	OK	
S1.037	S78			15929.1	OK	



Stantec

Stantec UK Limited
TAUNTON
Lakeside House, Blackbrook Business Park, Blackbrook
Park Avenue, Taunton TA1 2PX
Tel: +44 1823 218 940
www.stantec.com/uk

Notes

UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake their own investigation where the presence of any existing sewers, services, plant or apparatus may affect their operations.

1. This drawing is to be read in conjunction with all other Engineer's and Architect's drawings.
2. All dimensions are in metres unless noted otherwise.
3. All levels are in metres above Ordnance Datum (AOD).
4. The location of ditches and rhynes has been determined based on Ordnance Survey data and topographical surveys undertaken by Lewis Brown Chartered Land Surveyors (ref: N07029, date: Sep 2007 and ref: B02002, date: Feb 2020).
5. Proposed ground levels are not yet available, therefore the proposed ditch diversion routes have been based on the assumption that proposed ground levels will be amended to maintain gravity drainage.
6. A Soil Percentage Runoff (SPR) value for off-site catchment areas has been calculated using Flood Estimation Handbook (FEH) data from the FEH Web Service. This has been calculated to be 27.45%.
7. Refer to drawing 332310102/4002/002 for Existing Off-Site Drainage Catchment Plan.
8. Proposed Cover Levels and Invert Levels are indicative based on an approximate MicroDrainage Model.
9. Proposed Impermeable Area's shown are taken at 100% Impermeability, except for existing catchments taken as 27.45% (as per note 6).

Issued/Revision		By	Appd	YYYY.MM.DD
	DG	DG	-	2021.08.10
	Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Issue Status

FOR INFORMATION

This document is suitable only for the purpose noted above.
Use of this document for any other purpose is not permitted.

Client/Project Logo

Gravity

Client/Project
This is Gravity Ltd

Local Development Order

Former ROF Puriton, Somerset, United Kingdom

Title
PROPOSED SURFACE WATER DRAINAGE STRATEGY - MODEL SCHEMATIC

Project No.	Scale
332310102	NTS

Revision	Drawing No.
-	332310102/4002/SK04

Appendix G O&M Manual

O&M Manual

Gravity

A Smart Campus and Community

Local Development Order
Surface Water Drainage Strategy
Surface Water Operation & Maintenance Manual

Document Control Sheet

Project Name: **This is Gravity**

Project Ref: **332310102/4002**

Report Title: **Surface Water Operation & Maintenance Manual**

Doc Ref: **Revision B**

Date: **September 2021**

	Name	Position	Signature	Date
Prepared by:	Lewis Derrick	Engineer		24.09.2021
Reviewed by:	Andrew Johns	Senior Associate		24.09.2021
Approved by:	Paul Jenkin	Director of Water Management		24.09.2021
For and on behalf of Stantec UK Limited				

Revision	Date	Description	Prepared	Reviewed	Approved
A	19.08.21	Issue for Client Review	LWD	AJ	-
B	24.09.21	For Planning	LW	AJ	PJ

Contents

Tables

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1 Introduction

1.1 Purpose of Manual

1.1.1 This Surface Water Operation & Maintenance Manual (henceforth referred to as *“Manual”*) has been produced by Stantec UK (Stantec) as an appendix to the Surface Water Drainage Strategy (SWDS), also produced by Stantec, in support of a Local Development Order (LDO) application. The LDO application is made by our Client, This is Gravity Ltd, for an industrial-led multi use development at the Former Royal Ordnance Factory (ROF) Puriton in Somerset.

1.1.2 The purpose of this Manual is to advise on the operation and maintenance requirements for the strategic elements of the SWDS infrastructure for the developed site. It contains details of standards, philosophy and criteria adopted in the design of components within the proposed development.

1.1.3 The aim is to provide a design schedule for each component and relevant information to facilitate the design of surface water drainage within individual development plots themselves.

1.1.4 Some documentation relevant to the surface water management plan, and which have been developed in the context of the preparation of a LDO, has already been produced and approved by the relevant authorities, where required, including: the Strategic Design Code, Strategic Landscape Masterplan and the Clean and Inclusive Growth Strategy.

1.1.5 The principles outlined in this Manual will provide a framework for the development of a more detailed SWDS for the site through the LDO process.

1.2 Live Status

1.2.1 This Manual, whilst providing sufficient detail for the LDO, should be considered as *“live”* and will be updated regularly as the design and technical approval of the development’s surface water drainage infrastructure progresses. It aims to provide a design schedule for each component which will inform and facilitate the design of on-plot surface water drainage.

1.2.2 As details of on-plot surface water drainage infrastructure are developed, they should be appended to this Manual as a complete record of the development’s surface water drainage infrastructure.

1.2.3 A copy of this Manual should be made freely available to the appointed maintenance and monitoring operatives for each respective surface water drainage component.

2 Design Standards & Philosophy

2.1 Site History

2.1.1 Stantec has been involved in assessing Flood Risk and Drainage at this site for over 10 years, including in support of an extant Outline Planning Consent in 2017 (ref: 42/13/00010). As such, a number of reports and assessments have been completed to date. These are listed below:

- Royal Ordnance Factory Puriton TUFLOW Modelling Report (July 2007)
- Royal Ordnance Factory Puriton TUFLOW Modelling Addendum to Technical Modelling Report (October 2007)
- Royal Ordnance Factory Puriton TUFLOW Modelling Addendum NO.2 of Technical Modelling Report (January 2008)
- Huntspill Energy Park Remediation Application – Flood Risk Assessment (October 2011)
- Borrow Pit Angling Club Flood Risk Assessment (October 2012)
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- Puriton Solar Farm Drainage Strategy Technical Note (February 2015)
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- Land at Puriton Abstraction Assets Assessment (March 2018)
- Huntspill Energy Park Tidal Flood Risk Summary Note (June 2018)

2.1.2 As part of the LDO application, Stantec have produced updated Flood Risk Assessment (FRA) and SWDS reports, with this Manual forming an appendix to the SWDS. Whilst many of the findings and conclusions of the previously completed works have informed the updated SWDS and FRA, these documents were undertaken in relation to the extant consent. Hence, the area assessed by these documents is smaller in extent than the proposed LDO area. Where relevant, the findings of these documents has been referenced and/or updated to reflect this new site extent.

2.2 Surface Water Management Strategy

2.2.1 For details of the SWDS parameters, reference should be made to the updated FRA and SWDS reports. These documents set key surface water drainage parameters including discharge rates and volumes, and attenuation storage volumes. They also provided an strategic-level SWDS as a baseline.

3 Operation & Maintenance Overview

3.1 Aims & Objectives

3.1.1 To ensure the ongoing performance of the existing surface water management system on the site, there will be a requirement for regular maintenance over its lifetime. The SWDS has been developed based on the principles of Sustainable Drainage Systems (SuDS), therefore the performance criteria of the SWDS is not limited to managing water quantities (discharge rates and volumes), but also improving water quality, providing amenity and enhancing biodiversity.

3.1.2 Typically, the maintenance of SuDS within a surface water management system involves regular removal of litter/debris in the system and general landscaping. Final designs of SuDS, outfalls, inlets etc. will need to be designed with regard for future maintenance, details of which will be appended to this report in accordance with **1.2**. All areas will need to be easily accessible and safe for maintenance operatives without compromising the performance criteria requirements.

3.1.3 Responsibility for maintenance of the SWDS will lie with This is Gravity Ltd and their partners Albion Water, who will retain an overall management responsibility of the developed site. It is likely that operation and maintenance activities for all surface water drainage infrastructure on site will be contracted by This is Gravity Ltd and Albion Water to a management company (details of this are yet to be confirmed). It is also likely that this management company's responsibility will extend to the hard and soft landscaping of the site to ensure a consistent, holistic management regime.

3.1.4 This section provides general recommendations and a framework for the operation and maintenance of elements of the SWDS which provide a strategic function i.e. situated off-plot.

3.1.5 **Sections 4 and 5** provide further component-specific detail, which again provides a framework for the operation and maintenance of strategic SWDS components. The tables within this section will be reproduced and refined for named SWDS components as the detailed design of the site progresses (refer to **1.2**).

3.2 Strategic SWDS Component Overview

3.2.1 Strategic components within the surface water management system currently comprise existing/re-aligned/new rhynes and the reed beds north of the site. Drawings indicating the locations of strategic surface water management system components can be found in the SWDS report supporting the LDO application.

3.2.2 All three of these components can be characterised as having permanent water within them as well as a high-level of vegetative cover. As such, the general principles for their maintenance are largely similar, although there will be variations due to the differing performance requirements of each respectively. Furthermore, some rhynes or reed beds will need to be managed differently to other components of the same type depending on the amenity and biodiversity objectives for that particular feature.

3.3 Establishment Maintenance

3.3.1 As predominantly open, vegetated systems, there may be initial one-off maintenance requirements for the planting of SWDS components. These activities will typically include weeding, watering etc. in combination with regular inspection to monitor the establishment of the specified vegetation.

Nuisance / Non-Native Vegetation Management

3.3.2 New rhynes and reed beds can become rapidly dominated by invasive nuisance and non-native plants. It should be ensured that for the first 5 years, while vegetation is establishing, certain plant growth is controlled. After this 5 year period, these features can usually be allowed to develop naturally recognising that, unless the margins are occasionally managed, they are likely to become dominated by trees and shrubs.

3.3.3 The list below provides an indication of likely nuisance and non-native plants that should be controlled; however an exhaustive list of species and their respective management activities will be provided by an ecologist and landscape architect as the design is developed in detail. Further information regarding nuisance and non-native plants can be found on the GB Non-native Species Secretariat website[1].

- Curly waterweed (Lagarosiphon major)
- Floating Pennywort (Hydrocotyle ranuncloides)
- Giant Hogweed (Heracleum mantegazzianum)
- Himalyan Balsam (Impatiens glandulifera)
- Japanese Knotweed (Fallopia japonica)
- Nuttall's Waterweed (Elodea species)
- Parrot's Feather (Myriophyllum aquaticum)
- Water Fern (Azolla filiculoides)

3.3.4 Whilst the management of nuisance and non-native vegetation is particularly important during the initial 5 year establishment phase, it is likely that the monitoring of these species will become a regular maintenance activity after this period and throughout the lifecycle of the SWDS Component. If found to be present, their removal will then be classified as a remedial action.

3.4 Regular Maintenance

3.4.1 Regular maintenance is important for the effective operation of the SWDS Components and encompasses basic tasks which are to be undertaken to a frequent and predictable schedule, ranging from multiple times a year to once annually. Examples of regular maintenance include: inspections and monitoring, sediment and oil removal (if observed to be required more frequently than once a year), vegetation management, and removal of litter and debris

3.4.2 The maintenance of rhynes and reed beds is generally straightforward for landscape contractors and typically there should only be a small amount of additional work required for these features over and above what is necessary for standard public open space.

Inspection and Monitoring

3.4.3 Regular inspections will help to determine optimum future maintenance activities, help establish ongoing performance of the system and allow identification of potential performance failures (e.g. blockage, poor water quality) resulting from a lack of maintenance.

[1] Identification sheets - GB non-native species secretariat

3.4.4 During the first year of operation, inspections should be carried out at least monthly (and after significant storm events) to ensure the system is functioning as designed and no damage has occurred. Typical inspection questions that will indicate when occasional or remedial maintenance are required include:

- Are inlets/outlets blocked?
- Is the vegetation healthy?
- Is there evidence of poor water quality?
- Is there evidence of sediment build-up beyond stated limits?
- Is there evidence of structural damage that requires repair?
- Are there areas of erosion over vegetated surfaces?

3.4.5 Given the large scale of the site, it is recommended that an annual maintenance report and record should be prepared by the maintenance contractor. The report should contain the following:

- Observations resulting from inspections.
- Measure sediment depths (where appropriate).
- Monitoring results, where flow or water quality monitoring is undertaken.
- Confirmation that any penstocks or valves are free and working correctly.
- Maintenance and operation activities undertaken during the year.
- Recommendations for inspection and maintenance programme for the following year.

Litter and Debris Removal

3.4.6 Litter and debris removal reduces the risk of inlet and outlet blockages and minimises pollution risks.

Vegetation Management

3.4.7 The frequency and extent of grass cutting within the SWDS components will largely depend on the aesthetic aims of the site, however, generally grass cutting should be done as infrequently as possible. A general recommendation of maintaining grass lengths between 75-150mm should serve as a baseline for maintenance purposes. Should varying lengths be specified, these will be indicated for various features as the Operation and Maintenance Manual is developed alongside the scheme design.

3.4.8 For the management of weeds, nuisance plants and non-native plants, the use of herbicides and pesticides should be limited. Further information regarding nuisance and non-native plant management is given in paragraphs **3.3.2** to **3.3.4**.

3.4.9 The use of fertilisers should be limited or prohibited to minimise nutrient loadings which can be damaging to water bodies (refer to **3.6.9**).

3.4.10 The management of shrubs will be largely driven by the desired aesthetics of the site and will be specified by a landscape specialist. Mulching is likely to be a regular activity for shrubs, whereby it is not recommended that a bark mulch is used as it floats could cause a potential blockage.

3.4.11 Once aquatic and shoreline vegetation is established, the build-up of dead vegetation from previous seasons should be removed at regular intervals e.g. every 3 years, to reduce organic sediment accumulation. This type of vegetation may also need to be managed to maintain attenuation volumes.

3.4.12 It is recommended that vegetation is to be removed. Up to 25% of vegetation can be removed at one time and this 25% is defined by the plan area covered by that type of vegetation. The vegetation should be cut 100mm above the soil level and bankside vegetation should be cut by hand.

3.4.13 Aquatic vegetation will need to be cut from a reed cutting boat (Truxor or similar to prevent the need for maintenance operatives to enter the water. Where this is not possible or appropriate, a component or vegetation-type specific method statement should be provided for inclusion in the Operation and Maintenance Manual and Health and Safety File, demonstrating how the risks associated with working within water are to be managed. Aquatic vegetation arisings should be stacked near to the water's edge for 48hrs to de-water and allow wildlife to return to the component, before being disposed on in accordance with the landscape management plan for the site.

3.4.14 Owing to the site's historic use, despite remediation of the site, there may still be contamination present within the reeds themselves. The reeds should be tested prior to removal so that they can be disposed of in accordance with current waste management legislation, which should be confirmed with the Environment Agency. Chemical testing will determine the classification and disposal methods.

3.4.15 Care should be taken to avoid the disturbance of nesting birds and target species e.g. great crested newts and water voles, at critical times and may require licencing to undertake the works (this will be specified by an ecologist and included in the Operation and Maintenance Manual as it is developed alongside the scheme design).

3.5 Occasional Maintenance

3.5.1 Occasional maintenance activities comprise tasks that are likely to be required periodically, but much less frequently and predictably than regular maintenance. Examples of occasional maintenance include sediment management and vegetation replacement.

Sediment Management

3.5.2 The frequency of sediment removal will be dependent on many factors, including:

- Design of the upstream system.
- Type of system.
- Design of silt storage.
- Size of upstream catchment in relation to surface area of component.
- Characteristics of upstream catchment (e.g. land use, upstream construction activities, erosion control management, effectiveness of upstream pre-treatment).

3.5.3 Regular inspections should inform the frequency of sediment removal from SWDS components, which is likely to be more frequent whilst construction on site is ongoing and before vegetation is fully established. Graduated markers should be installed at each component to provide a quick, visual indication of sediment build-up without the need to entering the component.

3.5.4 Sediment removal should be undertaken in such a way that no damage is caused to the component itself, particularly where underground liners/geotextiles are used. However, given the scale of the SWDS components it is likely that this activity will be undertaken using an excavator, therefore the use of liners/geotextiles should be minimised to reduce the risk of damage. Where liners/geotextiles are present, a pumped removal system may be more appropriate.

3.5.5 A standing area adjacent to the SWDS component should be provided to allow sediment to de-water prior to removal from site. The sediment should be allowed to de-water for 48hrs.

3.5.6 Sediments excavated should be safely disposed of in accordance with current waste management legislation. However, given the historic use of the site, this should be confirmed with the Environment Agency to confirm appropriate protocols. Chemical testing of the sediment may be required, before excavation, to determine its classification and appropriate disposal methods. Given the proposed commercial and industrial uses of the site, chemical testing is likely to be required. If rhynes and the reed beds are to be drawn down, care should be taken to prevent downstream discharge of sediment and anoxic water and the Environment Agency should be notified prior to the activity taking place. However, it would be preferable that sediment is removed from areas of permanent water without the need for dewatering or entering the water itself e.g. using an excavator or pump from the bank.

3.5.7 General principles for sediment removal are as follows:

i. Avoid damage to any liners or geotextile fabrics used.

ii. Undertake work between September and March to minimise impact on receiving water bodies.

iii. Agree sediment removal and management plan with the environmental regulator.

iv. Undertake the operation in dry weather when the surrounding ground is firm and ideally operate from a hard surface.

v. Use machinery with and extending arm to avoid contact with edges, banks etc. and use a bucket without teeth to avoid damage.

vi. Secure consent for dewatering with environmental regulator, if required.

Vegetation Replacement

3.5.8 Some vegetation replacement may be required during the establishment phase or after extreme storm events. Dead or damaged plants should be removed and replaced to preserve the performance of the system.

3.6 Remedial Actions

3.6.1 Remedial actions are the intermittent tasks that may be required to rectify faults within the system or poor / inadequate performance. The likelihood of remedial actions can be minimised through regular maintenance activities. Where they are required, they are likely to be site or component specific, or due to unforeseen events e.g. events exceeding the design standard of the component, therefore the timings of remedial actions are difficult to predict.

3.6.2 Examples of remedial actions include:

- Inlet and outlet repairs.
- Erosion repairs.
- Reinstatement or realignment of edgings, barriers, rip-rap or other erosion controls.
- Replacement of blocked filter materials/fabrics.
- Construction stage sediment removal (this should be undertaken prior to the commencement of the maintenance contract).
- System rehabilitation immediately following a pollution event.

3.6.3 Where remedial actions are required, an assessment of the damage or reduction in performance should be undertaken as part of inspection / monitoring. Following the outcome of this assessment, the specific remediation required and the method for undertaking these works can be determined. The assessment and remedial action should be recorded within both the Operation & Maintenance Manual and the site's Health and Safety File as a record of the activity but also to inform future maintenance works, with a view of removing or limiting the future need for the action to be undertaken again.

Rehabilitation / Repair of Components

3.6.4 The need for component rehabilitation (e.g. remove clogged geotextiles etc.) will typically be every 10-25 years, depending on the component design, the nature of the upstream catchment and the sediment load. Regular sediment removal will also help to reduce this frequency.

3.6.5 The frequency of inlet, outlet and overflow rehabilitation will be largely driven by the findings of regular monitoring on site. Importantly, through regular silt management, the need to rehabilitating these structures will be reduced. If it is determined that the performance of these structures has been reduced by 20% when compared to their design specification, this should provide the threshold for remedial actions. The threshold for remedial actions may vary between components, depending on how critical its performance is to the overall performance of the SWDS and the consequence of failure. A 20% reduction is therefore a guideline baseline, which will be refined following further detailed design of the SWDS. The level of performance should be determined by comparing the design inlet, outlet or overflow capacity with that measured on site e.g. a reduction in pipe diameter due to silt build-up.

3.6.6 Slope areas that have become bare should be re-vegetated and any eroded areas should be regraded before replanting (in accordance with the original landscape specification). However, it is important to establish the cause of erosion to reduce the likelihood of this occurring again in the future.

Water Quality, Eutrophication and Aeration

3.6.7 Regular inspection and testing of water quality within water bodies will be required to determine whether the Strategic SWDS Components are meeting their design performance standards and if not, identify the nature of the poor water quality. Through testing, it will then be possible to determine what specific remedial action is required to improve water quality to the necessary standard. However, it is important to establish the cause of poor water quality to reduce the likelihood of this occurring again in the future, which may result in additional remedial action elsewhere or a change to management practices.

3.6.8 It is likely that testing will be undertaken by Albion Water as they will be responsible, on behalf of This is Gravity Ltd, to ensure that discharges from the site meet the requirements of the discharge licence provided by the Environment Agency. At the time of writing, an application has been made for this licence the required discharge standards have not yet been set. This report will be updated in due course as that information is made available to specify the water quality standards that must be adhered to.

3.6.9 Eutrophication can occur during summer months. This is best alleviated by controlling sources of nutrients to the features or providing a continuous baseflow. Vegetation management should also seek to limit crowding out of oxygenating species. Unless eutrophication is severe, aeration can be used as a remedial measure to save aquatic animal species and reduce risks to receiving waters. The addition of barley straw bales, dredging or rending the nutrients inactive by chemical (hydrogen peroxide) means can also be successful but less desirable.

3.6.10 It is important to state that the introduction of nutrients to the SWDS could fall outside of the site's control where flows contributing to the SWDS network also comes from adjacent land.

Oils and Hydrocarbons

3.6.11 In a pollution event comprising oils and hydrocarbons, the spillage should be contained immediately to prevent further pollution downstream. This can be done through the use of booms and oil spill kits which should be kept on site alongside other maintenance equipment. As the detailed design of the site progresses, a standard procedure for managing oil and hydrocarbon spillages should be developed and included in the Operation and Maintenance Manual, as well as the site's Health and Safety File.

3.7 Maintenance Access

3.7.1 Access for maintenance should be provided from a public or private road or suitable area of public space adjacent to the SWDS component. It should be at least 8m with a maximum crossfall of 1 in 7, to allow access by necessary equipment and vehicles. Implicitly, this access should be robust enough to withstand the loadings imposed by maintenance access machinery. The access route should extend to any forebays, benching, inlets and outlets.

3.7.2 Any invasive maintenance work, such as silt or vegetation removal, is only required intermittently, but it should be planned to be sympathetic to the biodiversity performance requirements of the rhyne or reed bed. Care should be taken to avoid disturbance to nesting birds during the breeding season and habitats of target species (e.g. great crested newts and water voles at critical times). Invasive silt and vegetation removal should only be carried out to limited areas at one any one time (25-30% of the component's area on one occasion each year) to minimise the impact on biodiversity. These requirements will be provided in update maintenance schedules for each component as the design of the site's SWDS develops (see **1.2**).

4 Rhynes – General Operation & Maintenance

4.1.1 Building upon the Operation & Maintenance Overview provided in **Section 3**, the following **Tables 4.1 - 4.3** more component-specific guidance on the operational and maintenance requirements that may be appropriate for rhynes.

4.1.2 The list of actions is not exhaustive, and some actions may not always be required. Furthermore, the list operational and maintenance requirements may vary from rhyne to rhyne. Therefore, a schedule for named, individual rhyne components will be provided as the design of the SWDS develops and will be appended to this Manual (refer to **Section 1.2**).

	Required Action	Typical Frequency
Regular Maintenance	Remove litter and debris	Monthly (or as required)
	Cut the grass in public areas to a height of 75-150mm, or length specified by Ecologist/Landscape Architect (refer to **3.4.7**)	Monthly (during growing season) or as required (if longer lengths specified)
	Inspect marginal and bankside vegetation and remove nuisance/non-native plants (refer to **3.3** for typical species – exhaustive list to be provided as designs develop)	Monthly (for first 5 years, then as required)
	Inspect inlets, outlets, overflows, bankside, structures, pipework etc. for evidence of blockage and/or physical damage	Monthly
	Inspect and test water body for signs of poor water quality (refer to **3.6.8**)	Monthly (May – October)
	Inspect inlets and main body of rhynes for silt accumulation and establish appropriate silt removal frequencies; undertake contamination testing once some build-up has occurred, to inform management and disposal options	Half yearly
	Check, test and lubricate any mechanical devices e.g., penstocks	Half yearly
	Remove 25% of bank vegetation (based on component's plan area) from one bank only at water's edge to a minimum of 1m above water level (methodology to confirmed following planting specification and component design) (refer to **3.4.12**)	Annually
	Remove all dead growth (scrub clearance) before start of growing season (note: tree maintenance is usually part of overall landscape management contract)	Annually
	Remove sediment (when depth exceeds 250mm) and aquatic planting (when plan area of clear, open water is reduced by 50%) from the main body of rhynes (methodology will be dependent on type of vegetation to be removed) (refer to **3.4.13**)	Annually, or as required

Table 4.1 - General Recommendations for Regular Operation and Maintenance of Rhynes

	Required Action	Typical Frequency
Occasional Maintenance	Remove sediment from the main body of large rhynes when silt accumulates to depth of 250mm or greater (refer to **3.5.2** - **3.5.7**)	With effective pre-treatment, this will only be required rarely e.g. every 25-50 years

Table 4.2 - General Recommendations for Occasional Operation and Maintenance of Rhynes

	Required Action	Typical Frequency
Remedial actions	Repair erosion or other damage	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Replant in accordance with the original landscape planting specification, where necessary	As required
	Aerate rhyne when signs of poor water quality or eutrophication are detected (refer to **3.6.9**)	As required
	Remove and dispose of oils or petrol residues using safe standard practices (refer to **3.6.11**)	As required
	Repair / rehabilitate inlets, outlets and overflows when performance reduction threshold is met or exceeded (refer to **3.6.5**)	As required

Table 4.3 - General Recommendations for Remediation of Rhynes

5 Reed Beds – General Operation & Maintenance

5.1.1 Building upon the Operation & Maintenance Overview provided in Section 3, the following **Tables 5.1 - 5.3** more component-specific guidance on the operational and maintenance requirements that may be appropriate for the reed beds.

5.1.2 The list of actions is not exhaustive, and some actions may not always be required. Furthermore, the list operational and maintenance requirements may vary from reed bed section to reed bed section. Therefore, a schedule for named, individual reed bed sections will be provided as the design of the SWDS develops and will be appended to this Manual (refer to Section **1.2**).

	Required Action	Typical Frequency
Regular Maintenance	Remove litter and debris	Monthly (or as required)
	Cut the grass in public areas to a height of 75-150mm, or length specified by Ecologist/Landscape Architect (refer to refer to **3.4.7**)	Monthly (during growing season) or as required (if longer lengths
	Inspect marginal and bankside vegetation and remove nuisance/non-native plants (refer to **3.3** for typical species – exhaustive list to be provided as designs develop)	Monthly (for first 5 years, then as required)
	Inspect inlets, outlets, overflows, bankside, structures, pipework etc. for evidence of blockage and/or physical damage	Monthly
	Inspect and test water body for signs of poor water quality (refer to **3.6.8**)	Monthly (May – October)
	Inspect silt accumulation rates in any forebay and in main body of the reed beds and establish appropriate removal frequencies; undertake contamination testing once some build-up has occurred, to inform management and disposal options	Half yearly
	Check, test and lubricate any mechanical devices e.g. penstocks	Half yearly
	Cut reeds (at minimum of 0.1m above base) using Truxor or similar (refer to **3.4.13 - 3.4.14**).	Annually, or as advised by Ecologist
	Remove 25% of bank vegetation (based on component's plan area) from one bank only at water's edge to a minimum of 1m above water level (methodology to confirmed following planting specification and component design) (refer to **3.4.12**)	Annually
	Remove 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 forebay (when depth exceeds 250mm) (refer to **3.5.2 - 3.5.7**)	Annually, or as required

Table 5.1 - General Recommendations for Regular Operation and Maintenance of Reed Beds

Occasional Maintenance	Required Action	Typical Frequency
	Remove sediment from reed bed when silt accumulates to depth of 250mm or greater (refer to **3.5.2** - **3.5.7**)	With effective pre-treatment, this will only be required rarely e.g. every 25-50 years It is recommended that sediment is removed from only a limited number of reed beds each year. This number is to be advised by and Ecologist.

Table 5.2 - General Recommendations for Occasional Operation and Maintenance of Reed Beds

	Required Action	Typical Frequency
Remedial actions	Repair erosion or other damage	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Replant in accordance with the original landscape planting specification, where necessary	As required
	Aerate reed beds when signs of poor water quality or eutrophication are detected (refer to **3.6.9**)	As required
	Remove and dispose of oils or petrol residues using safe standard practices (refer to **3.6.11**)	As required
	Repair / rehabilitate inlets, outlets and overflows when performance reduction threshold is met or exceeded (refer to **3.6.5**)	As required

Table 5.3 - General Recommendations for Remediation of Reed Beds

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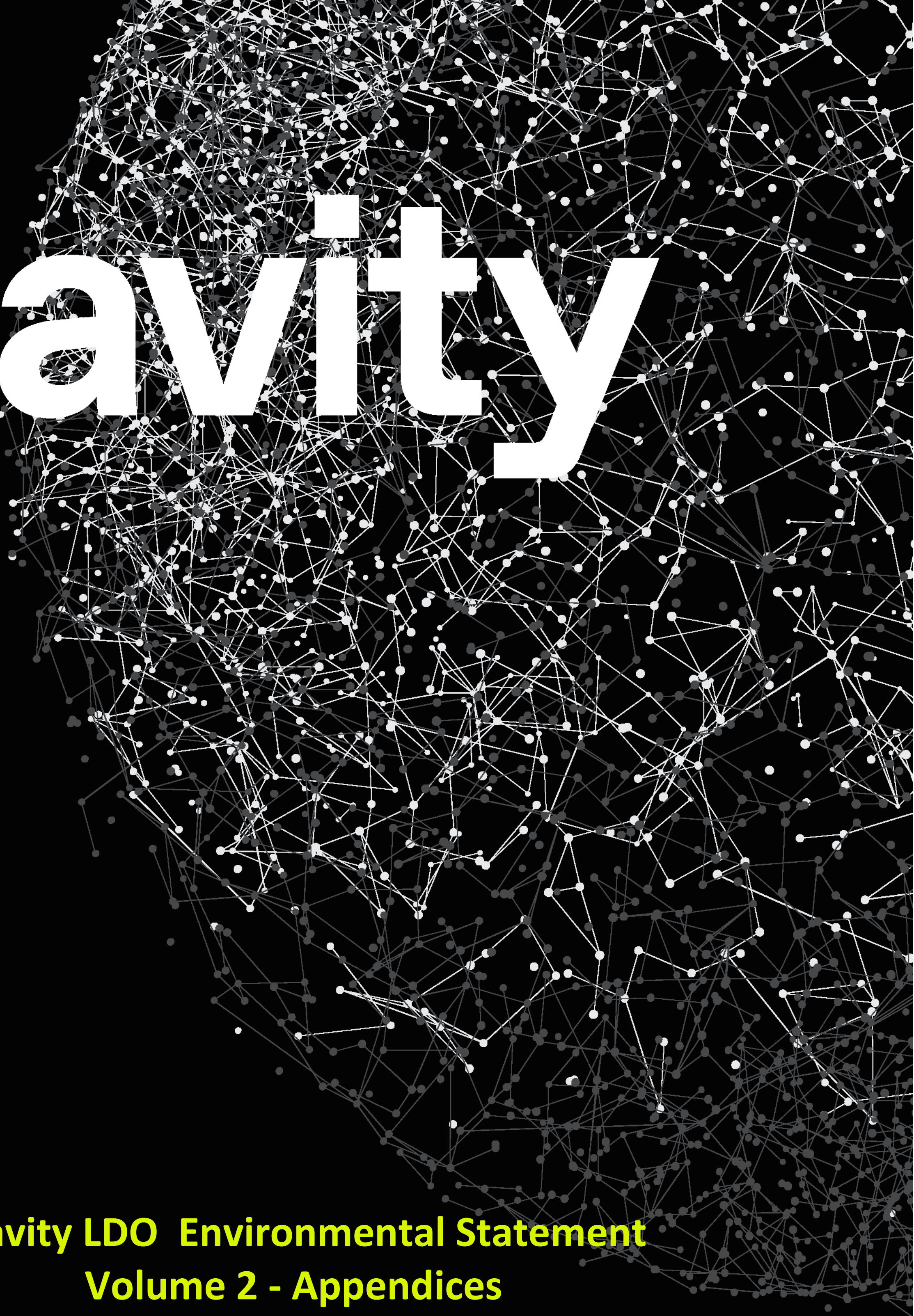

Gravity LDO Environmental Statement

Volume 2 - Appendices

Appendix 13.2 Surface Water Drainage Strategy

Document Control Sheet

Project Name: **This is Gravity**

Project Ref: **332310102/4002**

Report Title: **Surface Water Drainage Strategy**

Doc Ref: **Revision C**

Date: **September 2021**

	Name	Position	Signature	Date
Prepared by:	Kirstie Thistlethwaite	Assistant Engineer		24.09.21
Reviewed by:	Andrew Johns	Senior Associate		24.09.21
Approved by:	Paul Jenkin	Director of Water Management		24.09.21
For and on behalf of Stantec UK Limited				

Revision	Date	Description	Prepared	Reviewed	Approved
A	03.08.21	Draft for Internal Review	LWD	AJ	-
B	19.08.21	Draft for Client Review	LWD	AJ	-
C	24.09.21	For Planning	KT	AJ	PJ

Contents

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Executive Summary

This Surface Water Drainage Strategy (SWDS) has been prepared by Stantec to support a Local Development Order (LDO) for industrial-led mixed-use development at the Former Royal Ordnance Factory (ROF) Puriton in Somerset.

In accordance with the fundamental objectives of the National Planning Policy Framework (NPPF), this SWDS, in conjunction with a separate Flood Risk Assessment (FRA) produced by Stantec, demonstrates that:

i. The development is safe.

ii. The development does not increase flood risk.

iii. The development does not detrimentally affect third parties.

The SWDS has been developed using best practice Sustainable Drainage System (SuDS) techniques. Guidance on suitable techniques and methods has been obtained from the Environment Agency (EA), the Non-Statutory Technical Standards for Sustainable Drainage Systems, Somerset County Council's Strategic Flood Risk Assessment and CIRIA C753 "The SuDS Manual" amongst other sources.

The SWDS proposes a free discharge into the Huntspill River, which has been agreed by the EA and Somerset Drainage Boards Consortium (SDBC). This will require an amendment to the existing surface water drainage outfall on site to now pass through the existing reed beds, which no longer need to treat effluent, and off site via the North Water Outfall by modifying the outfall from the reed beds. Adequate temporary storage of surface water can be provided by the reed beds in the event of a tide lock within the Huntspill River.

Surface water runoff will be managed by the modified / realigned rhynes and ditches on site. These have been designed to continue to accommodate the flows generated upstream from the site but also to manage a free discharge of runoff from the proposed development plots. These in combination with the reed beds provide sufficient water quality treatment prior to discharge into the Huntspill River.

In summary, the SWDS demonstrates that the proposed development is safe and in accordance with the requirements of national and local planning policy.

1 Introduction

1.1 Scope of Report

1.1.1 This Surface Water Drainage Strategy (SWDS) has been prepared by Stantec of behalf of our Client, This is Gravity Ltd. It accompanies a Flood Risk Assessment (FRA) also completed by Stantec for the same site, both to support a Local Development Order (LDO), for Gravity Smart Campus, at the Former Royal Ordnance Factory (ROF) Puriton in Somerset.

1.1.2 The report is based on available information for the site as detailed in **Section 1.2** and prepared in accordance with the planning policy requirements set out in **Section 1.3**. The scope of the SWDS is consistent with the requirements of the National Planning Policy Framework (NPPF) Planning Practice Guidance (PPG).

1.2 Sources of Information

Previous Work Completed

1.2.1 Stantec has been involved in assessing Flood Risk and Drainage at this site for over 10 years, including in support of an extant Outline Planning Consent in 2017 (ref: 42/13/00010). As such, a number of reports and assessments have been completed to date. These are listed below:

- Royal Ordnance Factory Puriton TUFLOW Modelling Report (July 2007)
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- Huntspill Energy Park Tidal Flood Risk Summary Note (June 2018)

1.2.2 It should be noted that whilst many of the findings and conclusions of the previously completed works will inform this SWDS, these documents were undertaken in relation to the extant consent. Hence, the area assessed by these documents is smaller in extent than the proposed LDO area. Where relevant, the findings of these documents has been referenced and/or updated within this SWDS to reflect this new site extent.

Additional or Updated Information

1.2.3 To seek that the assessment of flood risk is up to date, this SWDS has also been prepared based on the following sources of publicly available information, which have been updated since the preparation of the previously completed works:

- Topographic survey of the site undertaken by Lewis Brown Chartered Land Surveyors;
- Parameter plans by LDA Design;
- British Geological Survey (BGS) mapping;
- Magic Map;
- Environment Agency (EA) *Flood Map for Planning;*
- EA *Long Term Flood Risk*;
- EA *Historic Flood Map;*
- EA *South West River Basin Management Plan;*
- EA *North and Mid Somerset Catchment Flood Management Plan* EA
- Sedgemoor District Council (SDC) *Level 1 Strategic Flood Risk Assessment;*
- SDC *Level 2 Strategic Flood Risk Assessment* (Scott Wilson, 2009)*;*
- Flood Estimation Handbook (FEH) 13 rainfall data and point descriptors, extracted from the FEH online service;
- Remediation Verification Report Huntspill Energy Park – Phase 1 (March 2019);
- Groundwater Remediation Verification TNT Section Huntspill Energy Park (October 2019); and
- Remediation Verification Report Huntspill Energy Park – Phase 2 (September 2020).

1.3 Relevant Planning Policy

1.3.1 This SWDS has been prepared in accordance with the relevant national, regional and local planning policy and statutory authority guidance as follows:

- National policy contained within the revised **NPPF** dated July 2021, issued by Ministry of Housing, Communities and Local Government, with reference to Section 14 '*Meeting the challenge of climate change, flooding and coastal change*';
- The **PPG** for Flood Risk and Coastal Change released in March 2014 and updated in July 2021 to incorporate the EA **'Flood Risk Assessments: Climate Change Allowances'** guidance;

- The **Water Framework Directive** (WFD) (Commission of the European Communities, released 2000) (ref 13.2) establishes a framework for a European-wide approach to action in the field of water policy. Its ultimate aim is to ensure all inland and near shore watercourses and water bodies (including groundwater) are of *'Good'* status or better, in terms of ecology, and also chemical, biological, and physical parameters, by the year 2027. Therefore, any activities or developments that could cause detriment to a nearby water resource or prevent the future ability of a water resource to reach its potential status, must be mitigated so as to reduce the potential for harm and allow the aims of the Directive to be realised.

1.3.2 The local planning authority will make decisions with regards to any LDO application within any floodplain or flood risk area. The EA is a designated statutory consultee for areas within Flood Zones, areas with critical drainage problems, and plays a key role in providing advice on development and flood risk issues. The Lead Local Flood Authority (LLFA) is a statutory consultee for major developments which have surface water or other local flooding impacts.

1.3.3 This FRA should be read in conjunction with other LDO application supporting documents.

1.4 Caveats and Exclusions

1.4.1 This SWDS has been prepared in accordance with the NPPF and Local Planning Policy. The proposed flood management (including ground floor level recommendations) and surface water management strategies are based on the relevant British Standards (BS8533:2017), the standing advice provided by the EA or based on common practice.

1.4.2 The Construction (Design and Management) Regulations 2015 (CDM Regulations) will apply to any future development of this site which involves "construction" work, as defined by the CDM Regulations. As such it is the responsibility of the proposed developer (ultimate client) to fulfil its duties under the CDM Regulations.

1.4.3 The approach for the SWDS and proposals for the surface water management strategy are based on the requirements of the EA and Somerset County Council (SCC) in its role as LLFA.

1.4.4 The findings of this SWDS are based on data available at the time of the study and on the subsequent assessment that has been undertaken in relation to the development proposals.

1.4.5 It should be noted that the insurance market applies its own tests to properties in terms of determining premiums and the insurability of properties for flood risk. Those undertaking development in areas which may be at risk of flooding are advised to contact their insurers or the Association of British Insurers (ABI) to seek further guidance prior to commencing development. Stantec does not warrant that the advice in this report will guarantee the availability of flood insurance either now or in the future.

1.5 Flood Risk Assessment Credentials

1.5.1 Stantec has many years of experience in, amongst other areas, the assessment of flood risk, hydrology, flood defence and river engineering. The authors and reviewers of the document are all experienced engineers and members of chartered institutions such as the Chartered Institution of Water and Environmental Management (CIWEM) or the Institution of Civil Engineers (ICE).

2 Proposed Development Site

2.1 Site Description

2.1.1 The 249 hectare (ha) (616 acre) site is located north-east of Puriton and north-west of Woolavington in Somerset. Both villages lie north of Bridgwater and east of the M5 motorway. The site has an approximate central Ordnance Survey (OS) grid reference 333328m E, 142437m N. The site lies within the administrative boundary of SCC.

2.1.2 The site consists largely of brownfield land currently unused following remediation of the ROF site.

2.1.3 Generally, the site is bordered on all sides by agricultural land. The Huntspill River lies adjacent to the northern boundary, flowing east to west. Woolavington Road, the road that connects Puriton and Woolavington is located to the south.

2.1.4 A site location plan is provided in **Appendix A**.

2.2 Existing Topography

2.2.1 A topographic survey of the site has been undertaken and indicates topography of the site is relatively flat, with nominal fall from the south to the north.

2.2.2 The topography is steepest near to the southern boundary of the site, with an average elevation of 15.5mAOD, although the far southern extremity of the site LDO boundary reaches an elevation of 40mAOD. This then falls to an average elevation of between 5mAOD and 6.5mAOD across the majority of the site. The far northern extremity of the site's boundary has an approximate elevation of 4.5mAOD. Despite these elevation changes, the scale of the site gives rise to the relative flatness.

2.2.3 Topographical information can be found in **Appendix B**.

2.3 Hydrological Setting

2.3.1 There are no main rivers within the LDO boundary itself, although there are open surface water drainage systems present as part of the existing drainage of the site (see Section 2.5).

2.3.2 The Huntspill River lies approximately 900m north of the major area of the site and 50m north of the LDO boundary itself. The Huntspill River is designated as a Main River by the EA. The Huntspill River is essentially a large reservoir originally constructed to supply water to the former ROF site and its levels are managed by the EA to be 3.5mAOD in the summer and 2.9mAOD in the winter.

2.3.3 In a northern arm of the site, there are a series of constructed reed beds. When the site was operational these were used for treating effluent prior to discharge from the site, however following the removal of effluent sources following the closure and remediation of the site this is no longer the case. Therefore, the reed beds are now a surface water based system within the site's boundary. For further details of their former operation, refer to **Section 2.5**.

2.3.4 The site is bounded by a number of rhynes, typical of the area, which are viewed, i.e., managed, by the Somerset Drainage Boards Consortium (SDBC). The northern boundary of the site is formed by the Black Ditch, which runs from east to west, whilst close to the eastern boundary of the site is the Stoning Pound Rhyne. Both these rhynes discharge into the Huntspill River. There is also an unnamed viewed rhyne close to the western boundary of the site, which appears to flow north and westwards towards an existing railway and the M5 motorway.

2.3.5 Although approximately 4.5km to the west of the site's boundary, the River Parrett, its estuary and Bridgwater Bay do have influence on the hydrology of the site and vicinity. The Huntspill River discharges into the Parrett Estuary via the Huntspill Sluice (approx. 4.4km west of the site), which manages water levels in the Huntspill River by controlling the rate of discharge from the Huntspill but also impeding high tidal water levels continuing further upstream.

Water Framework Directive

2.3.6 The Water Framework Directive (WFD) establishes a framework for a European-wide approach to action in the field of water policy. The EA Catchment Data Explorer [1] website has water quality data relating to the WFD targets for 2027.

2.3.7 The quality of the Huntspill River is monitored by the EA against the objectives of the WFD. The nearest WFD designated water body is the Huntspill (GB108052021210). This is currently (Cycle 2, 2019) classified as overall 'Moderate' status, with 'Moderate' ecological status and 'Fail' chemical Status.

2.3.8 The site does not currently lie within a WFD groundwater management catchment, therefore no status is provided regarding groundwater.

2.4 Geology and Hydrogeology

2.4.1 Review of British Geological Survey (BGS) online mapping indicates that the site is underlain by bedrock geology of the Langport Member, Blue Lias Formation and Charmouth Mudstone Formation (undifferentiated), which are describe as *"porcellanous limestone below, calcareous mudstone above"*, *"thinly interbedded limestone (laminated, nodular or massive and persistent) and calcareous mudstone or siltstone (local laminated)"* and *"dark grey laminated shales, and dark, pale bluish grey mudstone"* respectively The BGS online viewer also indicates that the Charmouth Mudstone Formation and Langport Member form the upper and lower boundaries to the Blue Lias Formation respectively.

2.4.2 Superficial deposits are indicated to be Tidal Flat Deposits, comprising clay, silt and sand, for the majority of the site. Higher elevations in the southern part of the site do not have superficial deposits recorded.

2.4.3 A review of EA mapping indicates that the bedrock geology underneath the site is a Secondary A Aquifer. A Secondary A Aquifer is defined by the EA as "permeable layer capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of baseflow to rivers".

2.4.4 The Tidal Flat Deposits are classified as a Secondary (undifferentiated) Aquifer by the EA. A Secondary (undifferentiated) Aquifer is defined as "where it has not been possible to attribute either category A or B".

2.4.5 The site lies within a Groundwater Vulnerability Zone of 'Medium – High'. 'Medium' vulnerability is defined as "areas that offer some groundwater protection", whilst 'High' is defined as "areas able to easily transmit pollution to groundwater… characterised by high leaching soils and the absence of low permeability superficial deposits".

2.4.6 The Remediation verification reports confirm the geology and states groundwater levels are typically 0.5m and 1.5m below ground level.

[1] https://environment.data.gov.uk/catchment-planning/

2.5 Existing Drainage Arrangements

On-Site Drainage

2.5.1 The site consists of brownfield land that currently benefits from an existing drainage system. This system has been assessed and forms seven surface water drainage sub-catchments on site.

- Sub-Catchment A – A small section of land on western boundary, and another north-west of centre, discharges into the Black Ditch directly.
- Sub-Catchment B – The majority of the western parts of the site drain to the "Site Acid Ditch".
- Sub-Catchment C – A small section of land located centrally in the north of site drains to the "Site Acid Ditch".
- Sub-Catchment D – Central areas, representing a significant proportion of the site, drain to a south-to-north rhyne which continues parallel to (but separate from) an existing reed bed system before discharging into the Huntspill River via the "North Water Outfall".
- Sub-Catchment E – Eastern parts of the site drain north-eastwards to the Stoning Pound Rhyne.
- Sub-Catchment F – South-western areas of the site which drain to the unnamed viewed rhyne to the west. This area is associated with Gravity Link Road, which has been consented as part of the previous outline consent and is currently under construction.
- Sub-Catchment G – North-western areas of the site associated with the existing railway, which appear to discharge into adjacent rhynes and ditches before conveying flows westwards to either the Huntspill River or Parrett Estuary.

2.5.2 The Site Acid Ditch, reed beds and North Water Outfall lie within the site, whilst the Black Ditch, lies on the northern boundary.

2.5.3 While the ROF was operational, effluent was piped or pumped to a large treatment tank in the centre of the Site, known as the "Lido", and then pumped to the reed beds. The Lido also has an overflow to the Site Acid Ditch which flows through the site and discharges into the reed beds. Following passage through the reed beds, treated effluent was pumped into a ditch immediately to the north of the reed beds, which runs west and flows parallel to (but separate from) the Huntspill River and discharges into the Parrett Estuary. This ditch is referred to as the "Acid Ditch" and lies outside of the site boundary. The Lido and overflow are still in-situ but owing to the ceasing of operations on site, no longer receives effluent discharge, therefore no effluent is discharged into either the Site Acid Ditch or the Acid Ditch and these are now surface water only systems.

2.5.4 Remediation of the site is now complete, however the existing surface water drainage principle has not been altered from the undeveloped condition. The layout of rhynes and ditches has been altered to accommodate the proposed building platforms, but continuity of flows through the site of upstream and the outfall arrangements remain unaffected.

2.5.5 The existing drainage regime and remediated drainage scheme is indicated within **Appendix C**.

Public Sewers

2.5.6 As part of the previous work undertaken by Stantec on this site, Wessex Water (WW) provided copies of its sewerage infrastructure plans for the site and surrounding area. The plans show there to be no surface water, foul or combined sewers within the site and the surrounding area. This is to be expected given the topography and the existing private drainage infrastructure present on site.

3 Surface Water Drainage Principles

3.1 Surface Water Drainage Objectives

3.1.1 The design principles for the surface water drainage system are detailed in the following documents:

- NPPF and PPG;
- DEFRA 'Non-Statutory Technical Standards for Sustainable Drainage Systems';
- CIRIA C753 'The SuDS Manual';
- SCC 'Local Flood Risk Management Strategy'.

3.1.2 A key requirement for the proposed development is to seek that flood risk downstream is not increased. The potential is associated with additional runoff generated by the introduction of roofs and hard-paved surfaces as part of the development. These surfaces replace natural ground where water can percolate into soil pores and to a greater or lesser extent infiltrate into the underlying rock. Additionally, natural ground is more uneven, promoting localised ponding while vegetation intercepts rainfall by collecting water. Lastly, natural ground is generally more resistant to flow, reducing the velocity of overland flow and the time that it takes to leave the site.

3.1.3 The replacement of natural surfaces has two principal effects on the land's response to rainfall:

- An increase in the rate of runoff;
- An increase in the volume of runoff.

Both of these impacts have the potential to increase the flood risk downstream. The rate of runoff is normally of principal concern as it can impact on the peak flow rate in the receiving watercourse or drainage network. Increasing the volume of runoff can also increase flood risk in particular situations.

3.1.4 In addition, the development of any site can introduce sources of pollution to downstream surface water bodies and groundwater, through both the introduction/change of impermeable surfaces and human activity.

3.1.5 The NPPF and CIRIA C753 recognise that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface water runoff and maintaining or improving water quality discharged from development sites. It is recommended that priority is given to the use of Sustainable Drainage Systems (SuDS) in new development.

3.2 Outfall Destination

3.2.1 Based on the CIRIA C753 guidance, consistent with the PPG and Building Regulations Part H, the aim should be to discharge surface water runoff as high up the following hierarchy of drainage options as reasonably practical:

i. *Into the ground (infiltration);*

ii. *To a surface water body;*

iii. *To a surface water sewer, highway drain or another drainage system;*

iv. To a combined sewer.

3.2.2 The hierarchy is considered in order below.

Discharge into the Ground (Infiltration)

3.2.3 Based on the hierarchy, the preferred method for disposal of surface water from the new development is via infiltration drainage.

3.2.4 The local geology has been identified as principally clay/silt deposits over mudstone bedrock (see Section 2.4). These underlying ground conditions typically have low permeability characteristics, which is supported by the historic use of land drainage rhynes and ditches on site and the local area.

3.2.5 Groundwater levels were monitored on site between 2006 and 2010, indicating that the site currently experiences a shallow groundwater table i.e. groundwater levels were shown to be on average 1.5m below existing ground levels. However, many locations indicated groundwater levels could reach less than 1m below the existing ground level, in some cases being at ground level itself.

3.2.6 In order to ensure adequate drainage during storm events, CIRIA C753 requires a minimum head difference between the base of an infiltration feature and the seasonal high groundwater level of 1m. Given the observed groundwater levels on site, this design requirement is not achievable. Therefore, discharge of surface water via infiltration has been discounted as a viable option for the proposed development.

Discharge to a Surface Water Body

3.2.7 In areas where infiltration is not possible, the next preference in the hierarchy is to discharge to a surface water body.

3.2.8 As discussed in Section 2.5, currently the site is served by a network of ditches that convey surface water generally northwards to the Huntspill River north of the site, via the North Water Outfall which runs parallel to the existing reed beds.

3.2.9 The “Addendum to the SWMS” produced for the extant planning consent indicated through liaison with the relevant stakeholder, including the EA and SDBC, that the preferred option for discharging surface water from the site would be via the reed beds and then directly into the Huntspill River.

3.2.10 At present, the reed beds have a pumped discharge into the Acid Ditch which runs parallel to the Huntspill River (but separate from it) and discharges into the Parrett Estuary. The Acid Ditch is currently subject to a legal agreement whereby the EA maintain it. However, to discharge directly into the Huntspill River, it was agreed as part of the extant planning consent that this arrangement would be amended. Surface water from the reed beds would discharge directly into the Huntspill River via the existing North Water Outfall, which currently runs parallel, but separate, to the reed beds. A free discharge would be permissible into the Huntspill River due to its effective operation as a tidally influenced feature with very significant storage capacity. Therefore, with this option no attenuation storage would be required within the site.

3.2.11 The SWDS within this report proposes to maintain this agreed strategy, which has been confirmed following more recent liaison with the EA regarding this LDO application.

3.2.12 The “Addendum to the SWMS” also indicated that once the reed beds’ function of treating effluent from the site was no longer needed and the new outfall constructed, the Acid Ditch would be redundant as an outfall route. However, it has been identified by the EA that the Acid

Ditch provides excellent water vole habitat, and, at the time, the desire was expressed to create a link for sweetening flow to preserve this. The existing outfall from the reed beds to the Acid Ditch could be modified as part of the proposed scheme to direct some surface water into the Acid Ditch. The details of this connection need to be established in further discussion with the EA, but the future of the water vole habitat can be protected by these means.

3.2.13 In summary, surface water runoff will be discharged from the proposed development into the Huntspill River via the reed beds and North Water Outfall, following modification of the outfall arrangements. Further modifications could be made to maintain a sweetening flow in the now redundant Acid Ditch to preserve water vole habitat.

3.2.14 No other points of discharge e.g., to a public sewer, have been considered as part of this SWDS.

3.3 Discharge Rate Control

3.3.1 As part of the extant hybrid planning permission, it was agreed with the EA and the SDBC that the site is permissible to freely discharge into the Huntspill River due to its effective operation as a tidally influenced reservoir with significant storage capacity.

3.3.2 Therefore, there are no discharge rate control requirements for surface water runoff leaving the site. The impact of a free discharge during periods of 'tide lock' has been considered below.

Tide Lock

3.3.3 The proposed free discharge into the Huntspill River from the reed beds could be restricted or even prevented during periods of tide lock (when high tide in the Parrett Estuary prevents outflow from the Huntspill River).

3.3.4 If an extreme rainfall event coincides with the period of tide lock the development's discharge could increase flood risk to the open farmland downstream of the site. It is therefore proposed that a suitable storage volume to retain runoff within the development's SWDS is provided so that no additional runoff volume enters the surrounding land drainage network during this scenario.

3.3.5 The parameters for calculating this storage volume were agreed with the EA within the "Addendum to the SWMS" produced in support of the extant outline consent. The worst-case duration of tide lock was provided by the EA as 6 hours. Therefore, the design rainfall event considered was the 100 year, 6 hour event, including a 20% allowance for climate change.

3.3.6 Calculations were made for two distinct catchments within the site as follows:

The existing surface water catchment draining to the reed beds:

- This catchment is currently independent from the Huntspill River because it drains to the Parrett Estuary via the Acid Ditch. Under the proposals, all runoff from this catchment will be additional flow to the Huntspill River and thus tide lock storage is required for the total runoff volume.

The remainder of the site:

- The rest of the site currently drains to the Huntspill River via North Water Outfall. Therefore, there is no increase in catchment area to consider and only the proposed increase in impermeable surfacing as a result of development.

3.3.7 The total combined tide lock storage requirement has been calculated as 38,200m³. It is proposed to accommodate this volume within the existing reed beds by defining an appropriate outfall level.

3.3.8 An assessment of the reed beds current condition and means in which this tide lock storage volume can be accommodated are included in a separate report, which can be found in Appendix D.

3.3.9 In the unlikely event that the capacity of the reed beds is exceeded, water would overtop the eastern bank and spill into the adjacent land drainage rhyne. In discussion with the SDBC it was identified that any overspill could be managed within the existing system whereby flows head eastward to the South Drain. When necessary, water is pumped from the South Drain into the Huntspill River to control flood levels in the land drainage system.

3.3.10 Under the Flood and Water Management Act 2010, a storage feature would be regulated as a Reservoir if it is "capable of holding 25,000 cubic metres of water above the natural level of any part of the surrounding land". Natural ground levels around the reed beds are generally equivalent to the east bank crest levels at around 4.5m AOD.

3.3.11 Calculations for the tide lock storage volume and implications regarding potential storage of tide locked water above the natural ground level (4.5m AOD) are also provided in **Appendix D**.

3.4 Discharge Volume Control

3.4.1 As previously discussed, it was agreed with EA and SDBC as part of the extant planning consent that the site is permissible to freely discharge into the Huntspill River due to its effective operation as a tidally influenced reservoir with significant storage capacity. More recent liaison with both parties has indicated their position remains the same.

3.4.2 Therefore, owing to there being no discharge rate control requirements (aside from the storage provided by the reed beds in the event of tide lock), there are also no discharge volume control requirements for surface water runoff leaving the site.

3.5 Water Quality Control

3.5.1 All sites have a requirement to protect downstream water quality and contribute to the aims of the WFD. Therefore, the SWDS for the site will need to demonstrate that adequate water quality treatment is provided within the system. To achieve this, priority is given to the use of SuDS techniques, as recommended in the NPPF and CIRIA C753.

3.5.2 Furthermore, as part of the "Addendum to the SWMS" produced in support of the extant planning consent, and assessment of the impact on water quality in the Huntspill River as a result of the unrestricted surface water drainage was agreed with the EA and SDBC.

3.5.3 The Huntspill River is a National Nature Reserve (NNR) and therefore adequate treatment of site runoff is important to avoid any detrimental effects on ecology. The proposed strategy includes bringing the existing reed beds into the surface water system as the final element of the SWDS before discharge from site. The reed beds cover an area of 3.7 hectares and were originally designed to provide treatment for up to 25,000m³ per day of effluent from the former ROF. The reed beds would therefore make a suitable treatment facility for surface water.

3.5.4 The reed bed system includes a small separate lagoon at the south. This previously collected the pumped and gravity-drained effluent flows from the site. From this lagoon water is pumped along a manifold pipe into each bay of the reed beds, with final discharge from the reed beds into the Acid Ditch. When the reed beds are converted to the surface water system, the lagoon at the southern end can be used to in effect as a sediment forebay. In addition, a new gravity connection into the reed beds will replace the existing pump/manifold arrangement, with water allowed to flow through the entire system towards the site’s outfall in the north.

3.5.5 In addition to the treatment provided by the reed beds, each development plot / occupier parcel will discharge runoff into the proposed rhyne and ditch network, which will in turn convey flows to the reed bed facility. Being an open and vegetated system, this network will also provide inherent treatment of surface water.

3.5.6 This constitutes a two-stage treatment process, utilising the rhyne and ditch network, and the reed beds as two substantial SuDS features. The degree of treatment provided by these features is considered further in Section 4.6.

3.5.7 It is important to note that in order to bring the reed beds into optimum condition to serve the surface water network some improvement works will likely be required. A condition survey of the reed beds has been undertaken (see **Appendix D**). The required improvement works will be subject to further design in collaboration with an ecologist and landscape architect, following receipt of consent for this LDO application.

4 Managing Surface Water On-Site

4.1 Overview

4.1.1 Based on the existing site information and surface water drainage principles previously, a strategic-level SWDS has been developed to demonstrate a viable surface water drainage option for the proposals.

4.1.2 This has been developed to a suitable level of detail to support a LDO application and will be subject to further design following grant of consent. Where further design/details will be required in the future, this is indicated within this report.

4.2 Development Proposals

4.2.1 The LDO application is submitted for:

a. *any operations or engineering works necessary to enable the development of the Site, including demolition, excavation and earthworks, the formation of compounds for the stockpiling, sorting and treatment of excavated materials, import of material to create development platforms, piling, and any other operations or engineering necessary for site mobilisation, office and worker accommodation, communications, drainage, utilities and associated environmental, construction and traffic management.*

b. *the development of a smart campus including*

   i. *commercial building or buildings with a total Gross External Area of up to 1,000,000m² which would sit within current Use Classes E(a) - (g), B2, B8 and sui generis floorspace uses and*

   ii. *a range of buildings up to 100,000m2 within use classes C1, C2, E (a) – (g) and F, B8, including restaurants / cafes, shops, leisure, education and sui generis uses and*

   iii. *up to 750 homes in use class C3,*

together with associated infrastructure including restoration of the railway line for passenger and freight services, rail infrastructure including terminals, sidings and operational infrastructure and change of use of land to operational rail land, multi-modal transport interchange, energy generation, energy distribution and management infrastructure, utilities and associated buildings and infrastructure, digital infrastructure, car parking, a site wide sustainable water management system and associated green infrastructure, access roads and landscaping.

4.2.2 A copy of the land use parameters plan layout can be found in **Appendix E**.

4.3 Impermeable Areas and Urban Creep

4.3.1 CIRIA C753 recommends that an urban creep factor is applied to residential property impermeable areas, to account for future land use changes such as paving front gardens for parking, building conservatories, increasing patio areas etc. Applying an urban creep factor therefore adds another degree of robustness to the SWDS. Based on the Local Authority SuDS Officer Organisation (LASOO) (now called the Association of SuDS Authorities (ASA)) “Non-Statutory Technical Standards for Sustainable Drainage: Practice Guidance” and an approximate housing density of 35dph, an urban creep uplift of 6% has been applied to the indicated residential roof and patio areas shown in the proposed layout.

4.3.2 Impermeability percentages (PIMP) have been applied to each proposed land use as follows:

- Areas of hardstanding e.g., roads, rail etc. – 100% PIMP.
- Industrial, commercial and educational areas – 80% PIMP
- Residential areas – 66% PIMP (inc. urban creep)

4.3.3 These values are considered to be moderately robust as they do not account for any losses due to evapotranspiration, infiltration through cracks etc.

4.4 Remediation Surface Water Drainage Strategy

4.4.1 The remediation drainage strategy included the diversion or infilling of existing rhynes and ditches to serve the proposed development layout for the sequent planning consent (42/13/00010), alongside new and temporary routes created on the plots themselves order to preserve the system capacity and protect water quality prior to construction of the proposed development.

4.4.2 The remediation drainage strategy was devised so that it could also serve the proposed development on site for the sequent planning consent (42/13/00010), seeking to minimise additional works to the strategic rhynes and ditches that will convey flows through the site (both from arising on site and upstream off site) to the outfall. The remediation works do not include for the amendments to the surface water outfall into the Huntspill River, as this will be subject to further design in liaison with the EA and SDBC following consent of the LDO application, and do not fully align with the LDO parameters plans.

4.4.3 The proposed remediation drainage strategy is illustrated in Appendix A and was based on the following general principles:

- Rhynes carrying flow through the site from the upstream catchment will be preserved with diversions around proposed plot outlines where necessary.
- Drainage ditches within the proposed development plot areas to be filled in.
- Drainage ditches outside of the proposed development area retained.
- Temporary drainage ditches within the proposed development plot areas to be constructed, serving as interim plot drainage prior to construction of the proposed development.
- Culverts on retained rhynes and ditches to be opened up, wherever possible.
- Culverts on redundant rhynes and ditches to be broken out and filled in.
- New / retained culverts at proposed development plot area's access locations to be installed.
- Pollution control measures required for the construction phase to be installed.

4.5 Proposed Development Surface Water Drainage Strategy

Strategic Rhynes and Ditches

4.5.1 The proposed SWDS builds upon the remediation drainage strategy to serve the future development. It is proposed for each development plot to discharge into the site's rhyne and ditch network, as constructed during remediation, which in turn will convey flows into existing reed beds located north of the site and then directly into the River Huntspill.

4.5.2 These features are considered as strategic infrastructure on site and will be clearly separated from on-plot development drainage. Following grant of consent of this LDO application, the layout and principles of these strategic features will not alter, although further details (including for construction details) will be provided in the near future. Future on-plot development drainage designs will be required to discharge into these strategic rhynes and ditches, in a way that is analogous to discharging to a nearby watercourse.

4.5.3 Calculations have been undertaken for these strategic rhynes and ditches so that they are adequately sized to cater for the upstream catchment which drains for the site but also the development itself. These have allowed for free discharge from the proposed development plots, in accordance with the overall SWDS. These calculations can be found in Appendix F.

4.5.4 The strategic rhynes and ditches have proposed to maintain the character of the existing drainage system on site, which is also in accordance with the ecological requirements on site. As such, side slopes will be between 1:1 and 1:2 and the depth of these features will be approximately 0.75m, although this will vary on site. The width of these channels also varies on site, increasing as they flow northwards through the site and therefore manage surface water from an increasing area.

4.5.5 Planting and vegetation of the strategic rhynes and ditches will be subject to the relevant Landscape Architect’s design, but for the purpose of flood risk and drainage design, it has been assumed that post-development the vegetation will be consistent with what currently exists on site. The only requirement is that the planting should not be so significant that it impedes flows, which could be achieved either through plant choice or regular maintenance.

Large Commercial Building(s)

4.5.6 The SWDS has been developed to accommodate a single, large commercial building within the centre of the site. Owing to the need to convey flows from off-site through the development in addition to a generally flat topography, the strategy has been developed to capture flows and realign the existing rhynes and ditches to flow around this building rather than culvert them underneath it. This removes the need for access points within the building for maintenance whilst also reducing the maintenance burden of access to de-silt the culvert, which would have significant health and safety constraints. As this represents a significant diversion from the existing rhyne and ditch routes, this scenario is effectively viewed as “worst case scenario” from a surface water drainage perspective.

4.5.7 In addition, owing to the large scale of the scenario building, and therefore potential high volume/velocity discharges from its roof area, a perimeter rhyne surrounding the plot has been proposed to manage runoff from this plot only, prior to discharge into the wider strategic network.

4.5.8 Should this scenario of a single commercial building be split into multiple, separate buildings, there is an opportunity to retain and improve existing rhynes and ditches which currently flow through the centre of the plot. Depending on the scale of these buildings as they emerge through the LDO compliance process, it may be possible to reduce the scale or remove entirely the need for the perimeter rhyne or indeed keep it as a contingency measure. This would provide additional space for waterside amenity and habitat for flora and fauna on site. In addition, it would provide additional resilience to the proposed SWDS as the overall drainage would include additional drainage routes to the outfall. In the event of significant potential maintenance or remedial works (e.g. following a pollution event) this result in the works having less of an impact on the functioning of the SWDS.

4.5.9 The nature of the large commercial building(s) is subject to confirmation following consent of this LDO application, therefore final designs of the diverted rhynes and ditches, as well as perimeter rhyne, will be provided as part of further detailed design of the site at the LDO compliance stage.

4.6 Water Quality Treatment

4.6.1 The need for water quality control has been previously identified by this SWDS report.

4.6.2 Based on the strategic components alone, surface water runoff will flow through rhynes and ditches and the reed beds prior to discharge from site. An assessment of the water quality treatment provision provided by the reed beds has been undertaken using the Simple Indices Approach, as set out in the CIRIA C753. The results of the assessment are set out below.

4.6.3 **Table 4.1** indicates the Pollution Hazard Indices for the proposed land uses within the development.

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Residential roofs	Very low	0.2	0.2	0.05
Residential car parking, access road, cul de sacs, homezones etc.	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change, all roads except low traffic roads and trunk roads/motorways	Medium	0.7	0.6	0.7
Sites with heavy pollution, site where chemicals and fuels are to be delivered, handled, stored, used or manufactured, industrial sites and trunk roads/motorways	High	0.8	0.8	0.9

Table 4.1 - Pollution Hazard Indices

4.6.4 At this stage, it is not clear whether the eventual operations on site will include activities viewed as having a “high” pollution hazard level by the Simple Indices Approach. However, it has been included in our assessment for robustness should this come to reality in the future.

4.6.5 Based on the strategic provision of the rhynes and ditches and reed beds, **Table 4.2** indicates Pollution Mitigation Indices for these respectively.

Type of SuDS Components	TSS	Metals	Hydrocarbons
Rhynes and Ditches (Swale)	0.5	0.6	0.6
Reed Beds (Wetland)	0.8	0.8	0.8

Table 4.2 - Pollution Mitigation Indices

4.6.6 The Simple Indices Approach assumes that a conventional, i.e. dry, swale is implemented for treatment purposes. However, wet and vegetated habitats are generally considered by CIRIA C753 to have improved water quality treatment provision. Furthermore, the flat topography and thus shallow longitudinal slopes of the rhynes and ditches will increase retention time for these treatment processes to take place. Therefore, it is considered that by assessing the rhynes and ditches as swales, this represents a conservative approach to the treatment they provide.

4.6.7 Finally, **Table 4.3** provides a summary of the water quality treatment sufficiency of the strategic features for each land use in each scenario after calculating the Total Mitigation Index as set out in CIRIA C753.

Land Use	TSS	Metals	Hydrocarbons
Residential roofs	Sufficient	Sufficient	Sufficient
Residential car parking, access road, cul de sacs, homezones etc.	Sufficient	Sufficient	Sufficient
Commercial yard and delivery areas, non-residential car parking with frequent change, all roads except low traffic roads and trunk roads/motorways	Sufficient	Sufficient	Sufficient
Sites with heavy pollution, site where chemicals and fuels are to be delivered, handled, stored, used or manufactured, industrial sites and trunk roads/motorways	Sufficient	Sufficient	Sufficient

Table 4.2 - Water Quality Treatment Sufficiency Results

4.6.8 The results above indicated that strategic rhynes and ditches and reed bed will be sufficient in providing the required water quality treatment for the proposed development’s surface water runoff. The on-plot SuDS also recommended as part of the SWDS (see Section 5) will provide additional treatment, contributing to improving water quality on site and downstream.

5 On-Plot SuDS

5.1 Overview

5.1.1 Although beyond the scope of this LDO application at this stage, some consideration has been made in this SWDS with regard to on-plot SuDS features which can help inform the design guide and the compliance processes. The inclusion of on-plot SuDS will ultimately be determined by future development design for each plot as they come forward.

5.1.2 Although on-plot SuDS are not required to meet discharge rate, discharge volume or water quality control requirements, they will provide a degree of attenuation i.e. "slowing the flow", of surface water runoff by temporarily storing it in discrete locations. The potential for large areas of hardstanding draining to the strategic rhynes could introduce high-velocity point inflows which could generate bank erosion and more onerous maintenance requirements. This is because the rhyne system has developed over time to manage slow overland flows generated by a flat topography and is not adapted for a formal drainage system. On-plot SuDS would reduce these velocities, better mimicking the existing drainage regime on site and therefore reducing potential future maintenance requirements.

5.1.3 Moreover, on-plot SuDS will add further climate change resilience to the proposed SWDS as well as contributing to the wider ecological and landscape aims on site i.e. forming part of holistic Green-Blue Infrastructure.

5.1.4 On-plot SuDS would provide "source control" and interception of rainfall close to the point in which it reaches the ground. Their inclusion better mimics the drainage characteristics of an undeveloped site, in accordance with SuDS principles, but is also shown to be the most effective method to provide surface water quality treatment.

5.1.5 As mentioned, additional treatment beyond the reed beds and rhynes and ditches is not a requirement for day-to-day flows, but due to the potential industrial uses on different plots, the ability to partition the SWDS i.e. close off sections of the system, to prevent a potential pollution incident entering the strategic network would be beneficial.

5.1.6 Additionally, by providing further improvement of the quality of surface water runoff in the everyday scenario prior to reaching the rhynes and ditches, this will facilitate generation of a better habitat for flora and fauna whilst also improving the aesthetic, and thus amenity benefit, of these features. As the rhynes and ditches will be fully integrated throughout the development, it is a key objective that these are attractive spaces for people.

5.1.7 There are a number of SuDS features that could be included on individual plots, but their respective appropriateness will be dependent on the final design of each plot. Below is a summary of the different types of SuDS that could be implemented. It is likely that a more detailed assessment of the on-plot SuDS options will be undertake following grant of consent of this LDO application and included within the subsequent compliance applications.

5.2 Rainwater Harvesting

5.2.1 Rainwater harvesting (RWH) is the collection of rainwater runoff for use, as opposed to directing runoff to a surface water drainage system immediately. Runoff can be collected from impermeable areas within the development e.g., roofs, hardstanding etc. and then stored and treated (where required) before being re-used for non-potable purposes, such as flushing toilets, washing machines and external uses.

5.2.2 In the UK, private water supplies for locations not connected to main water supply networks have to comply with the Private Water Supplies Regulations 2009.

5.2.3 There are three main types of RWH system:

- Gravity-based systems
- Pumped systems
- Composite systems

5.2.4 In addition, a RWH system (regardless of type) can have one of the following design objectives:

- Water conservation / supply
- Water conservation / supply and surface water management (passive systems)
- Water conservation / supply and surface water management (active systems)

5.2.5 RWH systems could be implemented to serve individual properties and buildings or small groups of properties and buildings. However, larger contributing areas and demands will likely result in larger tanks and associated infrastructure. Care should be taken that where RWH systems are shared, the properties or buildings which the RWH serves should be constructed at the same time i.e. as part of the same phase of development. Otherwise, onerous construction requirements may be enforced on earlier phases.

5.2.6 Albion Water will operate and maintain the surface water and effluent drainage following development of the site. As part their overall scheme, there has been an opportunity identified for a high-level off-take of surface water into an offline pond near to the reed beds which could provide water for non-potable uses. This would augment the other opportunity identified for recycling water from effluent (following treatment to the necessary standards) and re-use as non-potable water across the site. This would represent a strategic RWH option which may render the use of on-plot RWH systems redundant or of less benefit. However, this strategic RWH option is subject to ongoing review and design and will be confirmed as part of future detailed design works on site.

5.3 Green / Blue Roofs

5.3.1 Green roofs are areas of living vegetation installed on the top of buildings / structures for a range of reasons including visual benefit, ecological value, enhanced building performance and the reduction of surface water runoff.

5.3.2 Types of green roof are typically categorised as:

- Extensive – low substrate depths, simple planting and low maintenance requirements.
- Intensive – deeper substrate depths that can support a wide variety of planting but require more maintenance.

5.3.3 Blue roofs are explicitly designed to store water. This can be designed as attenuation storage (rainfall stored and released in a controlled manner), use for irrigation (potentially of adjacent green roof areas), cooling water (reducing roof temperatures during hot days or for cooling plant) or non-potable use within the building. Storage in blue roofs can be provided as open water surfaces, storage within or beneath a porous medium or below a raised decking surface or impermeable cover.

5.3.4 Green roofs that include reservoir storage zones beneath the growing medium could also be termed blue roofs. This form of blue roof can also be used for RWH, examples of which are common in Germany and Switzerland, however guidance is limited and due to filtering through the substrate, the water available is often discoloured. Furthermore, uptake from vegetation will reduce the yield from the roof area.

5.3.5 Green and blue roofs would be constructed as part of individual structures and are therefore well suited to the likely modular implementation of the proposed development. In addition, their use would not be limited to commercial or residential buildings; there are many cases of green roofs being constructed as part of transport infrastructure e.g. bus stops. This again is easily incorporated into a modular implementation.

5.3.6 Consideration should be given to the scale of the building whereby a green or blue roof is implemented. Water can impose significant loads on structures when stored for a prolonged period, which may make use of these systems where large roof spans existing technically and financially unviable.

5.4 Green Walls / Facades

5.4.1 Green walls and façades are similar to green roofs in that they are areas of living vegetation, however in this case they are installed as vertical systems on walls building faces. Their benefits span water management, heat reduction, biodiversity enhancement and improved air quality.

5.4.2 They can be used to protect a building against storms by intercepting rainfall and reducing soil moisture around a building's foundations, effects which are more pronounced when evergreen plants are used. However, buildings that may be affected by humidity (due to their use) can be damaged by vegetation due to inhibited evapotranspiration from the building itself. In this instance, adequate ventilation of the building would be required.

5.4.3 Vertical vegetation protects the building from direct solar radiation, resulting in the façade heating up less, absorbing less heat and emitting less heat at night. The plants also emit water vapour through evapotranspiration which enhances the cooling effect. Furthermore, if evergreen plants are utilised, they can provide a degree of insulation during cooler months, protecting the façade from cooling. By tempering the building temperatures in both winter and summer, the green wall or façade can contribute to saving on energy demands for the building.

5.4.4 By providing additional vegetation within the urban environment, there is also a significant contribution to enhancing the biodiversity and ecology. Green walls and façades can provide habitat and shelter for birds and insects as well as providing a food source. Occupants can be concerned that birds and insects will enter the building via the vegetation, but the likelihood of this can be reduced if windows and other openings are kept clear of vegetation.

5.4.5 As with green roofs, green walls and façades can easily be implemented across the site. They are not reliant on any other features for their function and their water management capabilities are not such that they would form a strategic part of the surface water drainage strategy for the site.

5.4.6 Therefore, green walls and façades can be installed across the site on a case by case basis. Furthermore, they could easily be retrofitted to buildings across the site at a future date if required.

5.5 Swales

5.5.1 Swales are shallow, flat bottomed, vegetated open channels designed to convey, treat and sometimes store surface water runoff. When incorporated into site design, they can contribute to enhancing the natural landscape and provide aesthetic and biodiversity benefits. Swales can have a variety of profiles, can be uniform or non-uniform, and can incorporate a range of different planting strategies, depending on the site characteristics and site aims and aspirations.

5.5.2 Being linear features, they are often used to drain roads, paths or car parks, where it is convenient to collect distributed inflows of runoff or as a means of conveying runoff around a site. Swales can replace conventional pipework and the use of adjacent filter strips and/or flow spreaders can also remove the need for kerbs and gullies. This is particularly useful on flat sites where the use of pipework would lead to significantly deeper drainage infrastructure, resulting in cost and health and safety implications.

5.5.3 Given the retention of a strategic rhyne and ditch network on site and the obvious similarity between those and swales, the use of swale on site will likely be limited. However, they may be used where there are significant drainage pathways or adjacent to transport links where a rhyne or ditch is not already present.

5.6 Rills / Channels

5.6.1 Rills and channels are open surface water features with hard edges and can be commonly found in some existing cities, towns and villages. They can have a variety of cross-sections to suit their setting, lending them to urban areas particularly well, and can also be planted to provide water quality treatment and amenity value.

5.6.2 The terms “rill” and “channel” can also be extended to include hollow roads and gutters (which itself can include fluted, open or covered gutters).

5.6.3 These features are often best employed when draining large impermeable areas, such as streets, parking or communal squares, without the need for below ground infrastructure as they are easily integrated into the overall design with minimal land take. That said, this often means they are small features so may need to be augmented with another drainage feature. They also provide limited ecological benefit, although this is to the benefit of their amenity value.

5.7 Bioretention Systems / Rain Gardens / Tree Pits

5.7.1 Bioretention systems (including rain gardens) are shallow landscaped depressions that can reduce runoff rates and volumes whilst treating runoff pollution through the use of engineered soils and vegetation. They are a flexible surface water management component which can be used in a variety of development landscapes. For example, in low density development the system might have softer edges whilst in higher density development the edges may be harder and more linear.

5.7.2 Runoff collected by the bioretention system temporarily ponds on the surface before filtering through the vegetation and underlying soils, where the majority of water quality treatment takes places. Submerged anaerobic zones can also be included to promote better nutrient removal. The filtered runoff is then collected by an underdrain system or infiltrates to the ground.

5.7.3 There are many different approaches to the design of bioretention systems, which can be broadly broken down into the following types:

- Rain garden
- Raised planter
- Bioretention tree pit
- Anaerobic bioretention system

5.7.4 Rain gardens are typically small systems that are likely to be less engineered than typically bioretention components.

5.7.5 Raised planters are boxed systems constructed above the surrounding ground surface, providing an alternative to a rain garden. Raised planters are easily retrofitted.

5.7.6 Bioretention tree pits have enhanced performance when compared to conventional tree pits. This is achieved through extra surface planting. Trees and large shrubs are beneficial in bioretention systems as they intercept precipitation and allow water to evaporate from leaf surfaces, dissipate rainfall-runoff energy, facilitate infiltration and groundwater recharge (because of the their more extensive root systems), provide shade and can reduce runoff temperatures and provide further amenity and biodiversity benefits.

5.7.7 An anaerobic bioretention system has the outlet piped design so that there is a permanent water level within the drainage layer, allowing vegetation to access it during dry periods. This also assists with the treatment of some pollutants such as nitrogen. These systems are particularly good where trees are planted.

5.7.8 Given that bioretention systems are best suited to managing and treating surface water runoff at source and best serve smaller catchments, they are naturally suited towards a modular implementation. In addition, the various forms of system available mean that their design can be easily adapted to suit the surrounding development character. They can easily be incorporated into areas of hardstanding, alongside transport corridors or as part of a building or dwelling frontage.

5.7.9 All forms of bioretention can contribute to integrating biodiversity enhancement and amenity provision within the site, with multiple studies indicating that connection and visibility of green spaces improving the wellbeing of occupants and site users.

5.8 Pervious Pavements

5.8.1 Pervious pavements provide a hard surface suitable for pedestrian and/or vehicular traffic, while allowing rainfall to infiltrate through the surface and into the underlying structural layers. The water is temporarily stored underground before infiltrating to the ground or controlled discharge downstream. They are an effective means of managing surface water runoff close to source – intercepting runoff, reducing the volume and frequency of runoff and providing an effective method of treatment.

5.8.2 There are two types of pervious pavements:

- Porous pavements – Infiltrate water across their entire surface material
- Permeable pavements – Surface is formed of material that itself is impervious to water, but the materials are laid to provide void space through the surface to the sub-base.

5.8.3 The main types of surfaces used as part of pervious pavement construction are:

- Modular permeable paving – The most common modular permeable paving surface is concrete block permeable paving. The joints are widened and filled with grit to allow water into the underlying bedding layer and sub-base.
- Porous asphalt – This can be used as an independent surface or to provide a stronger base to concrete block permeable pavements under high traffic loadings.
- Grass reinforcement – Uses plastic or concrete grids infilled with grass or gravel.

- Resin bound gravel – Provide a range of finish colours, making them well suited to public or recreational spaces.
- Porous concrete – Can be applied in a similar manner to porous asphalt.
- Macro pervious – These systems are where normally impermeable surfaces are drained to channels or other collection systems designed to trap oil and silt before being directed to the sub-base for storage and further treatment.
- Sports surfaces – Either and aggregate sub-base or plastic sub-base replacement unit system can be used below turf or porous surfaces to manage surface water runoff.
- Block porous paving – Utilises porous block materials rather than water permeating through widened joints.

5.8.4 Pervious pavements can be used in most ground conditions and can replace proposed hardstanding. Therefore, they are well suited to be implemented across the site, with no additional requirements necessary to facilitate their use.

6 Residual Risks

6.1.1 The predominant residual risk to the proposed development and downstream are overland flows. These could be generated potential blockages of drainage infrastructure and/or the occurrence of (rare) storm events which exceed the design conditions.

6.2 Overland Flows

Potential Blockage

6.2.1 The risk associated with a potential blockage for the main drainage system onsite is considered to be small, given that the majority of drainage on site will comprise open systems. Routine inspection and maintenance procedures as described in **Section 7** of this report will minimise the risk of the accumulation of detritus and debris as well as ensuring that the drainage systems continue to operate efficiently. However, the residual risk of these events needs to be managed. The principles of dealing with these is set out below.

Exceedance Storm Event

6.2.2 In the event of a rare storm (beyond the design condition), the capacity of the drainage network could be temporarily exceeded, and drainage inlets could be bypassed creating overland flow. To minimise and manage the impact of these events at source the SuDS features for the scheme will be designed with controlled overflows such as spillways and weirs.

6.3 Designing for Overland Flows

6.3.1 It is recommended that an overland flow assessment is undertaken once a completed proposed ground model, including FFLs, highway levels, landscaping etc., for each proposed development plot as they are designed. This is so that any hotspots can be identified and designed out to demonstrate that properties are not at risk.

6.3.2 In finalising the proposed ground model for the proposed development plots, the following principles should be followed to cater for overland flows:

- All buildings should be provided with internal threshold levels raised above surrounding ground levels and designated flow paths created around the buildings to the lower lying levels. Localised grading may be required to achieve level access criteria. Exceedance flows would then naturally be directed around the buildings to lower ground.
- Gutters and hollow roads can be employed to direct overland flows via defined and managed routes.
- Divert flows to any present landscaped areas (e.g., natural depressions) away from critical infrastructure and buildings to further mitigate the impact.
- In certain circumstances it may be necessary to utilise road corridors to deliver this function. This, however, should not be considered the preferred option and should still facilitate safe access and egress as well as taking reasonable steps to protect property.

7 Operation and Maintenance

7.1 Aims & Objectives

7.1.1 To ensure the ongoing performance of the existing surface water management system on the site, there will be a requirement for regular maintenance over its lifetime. The SWDS has been developed based on the principles of SuDS, therefore the performance criteria of the SWDS is not limited to managing water quantities (discharge rates and volumes), but also improving water quality, providing amenity and enhancing biodiversity.

7.1.2 Typically, the maintenance of SuDS within a surface water management system involves regular removal of litter/debris in the system and general landscaping. Final designs of SuDS, outfalls, inlets etc. will need to be designed with regard for future maintenance, details of which will be appended to this report in accordance with **1.2**. All areas will need to be easily accessible and safe for maintenance operatives without compromising the performance criteria requirements.

7.1.3 Responsibility for maintenance of the SWDS will lie with This is Gravity Ltd and their partners Albion Water, who will retain an overall management responsibility of the developed site. It is likely that operation and maintenance activities for all surface water drainage infrastructure on site will be contracted by This is Gravity Ltd and Albion Water to a management company (details of this are yet to be confirmed). It is also likely that this management company's responsibility will extend to the hard and soft landscaping of the site to ensure a consistent, holistic management regime.

7.2 Operation & Maintenance Details

7.2.1 Operation and maintenance activities for the rhynes and ditches and reed beds will primarily concern the management of their respective vegetation. However, following regular inspections, it may also be required that sediments are removed from these systems occasionally.

7.2.2 A separate draft Operation & Maintenance Manual for the strategic SWDS components on site has been produced and can be found in Appendix G. This contains further details regarding the types of maintenance activities, their purpose and the frequency in which they would need to be undertaken.

8 Conclusion

8.1 Planning Submission

8.1.1 This SWDS has been prepared to support an LDO application, for the Gravity Smart Campus, at the Former ROF in Puriton, Somerset.

8.2 Surface Water Drainage

8.2.1 The SWDS detailed as part of the LDO application, comprises utilising the diverted and realigned systems constructed as part of the remediation of the site. These have been designed to accommodate the upstream catchment flows they currently already manage, as well as proposed surface water runoff from the development proposals.

8.2.2 As previously agreed with the EA and SDBC, the site will discharge freely into the Huntspill River via an alteration to its current outfall. Surface water flows will be directed into the existing reed beds, which are no longer required to treat effluent, before an amended outfall will direct surface water to the existing North Water Outfall into the Huntspill River. The reed beds will no longer need to discharge via a pump into the Acid Ditch, however modifications could be made to maintain a sweetening flow and preserve the water vole habitat in that watercourse.

8.2.3 An assessment has been undertaken to determine that there is adequate storage within the reed beds to temporarily store surface water runoff in the event of a tide lock in the Huntspill River.

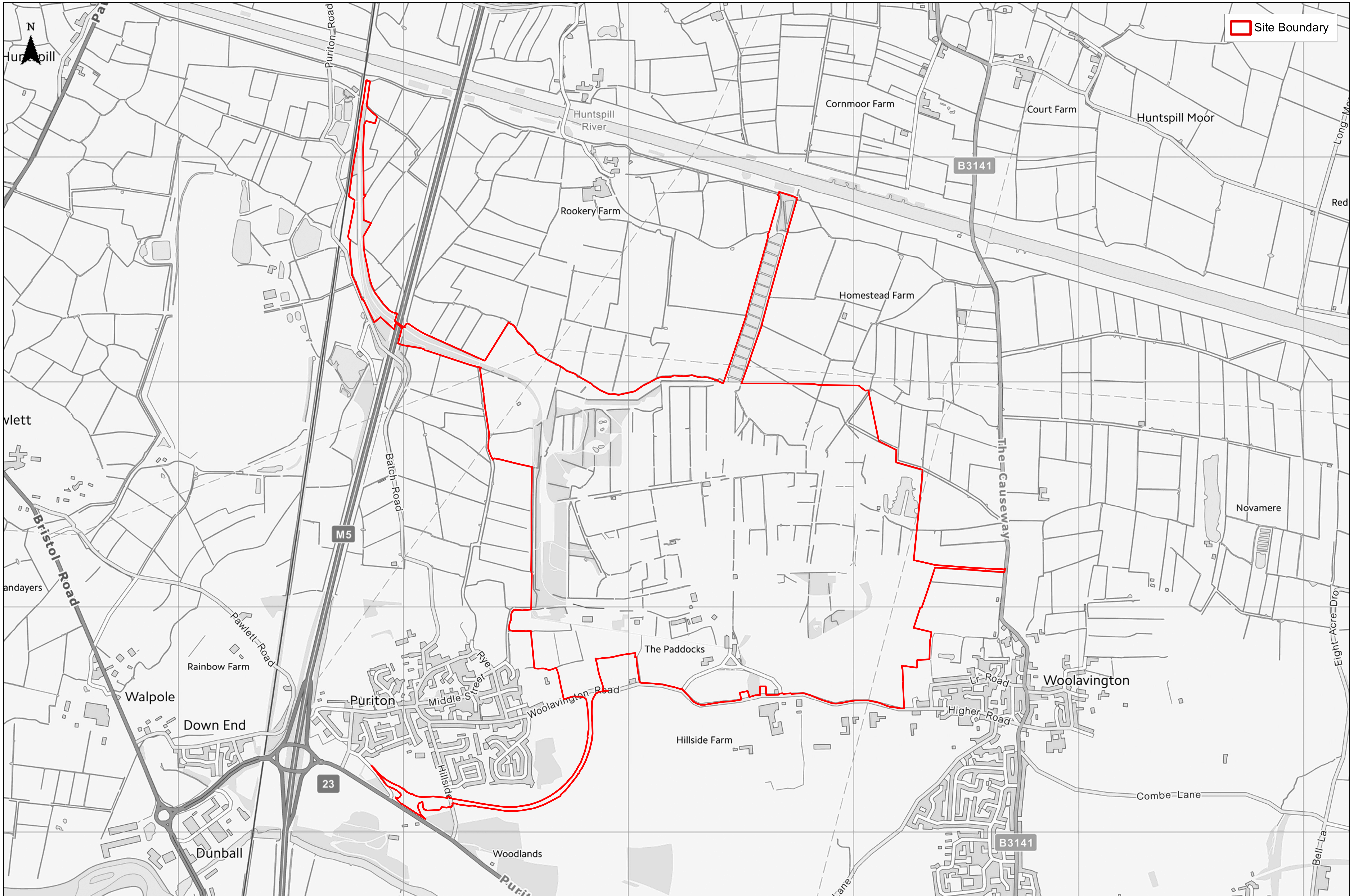
8.2.4 Given that there is no discharge rate restriction required, there is also no requirement to manage discharge volumes on site, above that provided for a tide lock scenario.

8.2.5 The Huntspill River is an NNR, therefore the water quality discharge from the site must be adequate so that there is no negative impact as a result of the development proposals. This report has demonstrated that the strategic rhynes and ditches and reed beds provide adequate water quality treatment for all potential land uses on site.

8.2.6 In spite of adequate water quality treatment provision, this SWDS report recommends that on-plot SuDS are implemented to further add robustness to the management of surface water runoff on site, but also to contribute to the ecological and placemaking aims and objectives of the development proposals by forming part of an integrated Green-Blue Infrastructure strategy.

Appendix A Baseline

Figure 1 - Site Location Plan
Figure 2 - Site Location Aerial



Stantec

Client:

G

GRAVITY

Site Location

0 250 500 m

1:15,000 @ A3	Date: 18/08/2021
Drawn: CE	Checked: RR
Figure 001	Rev A

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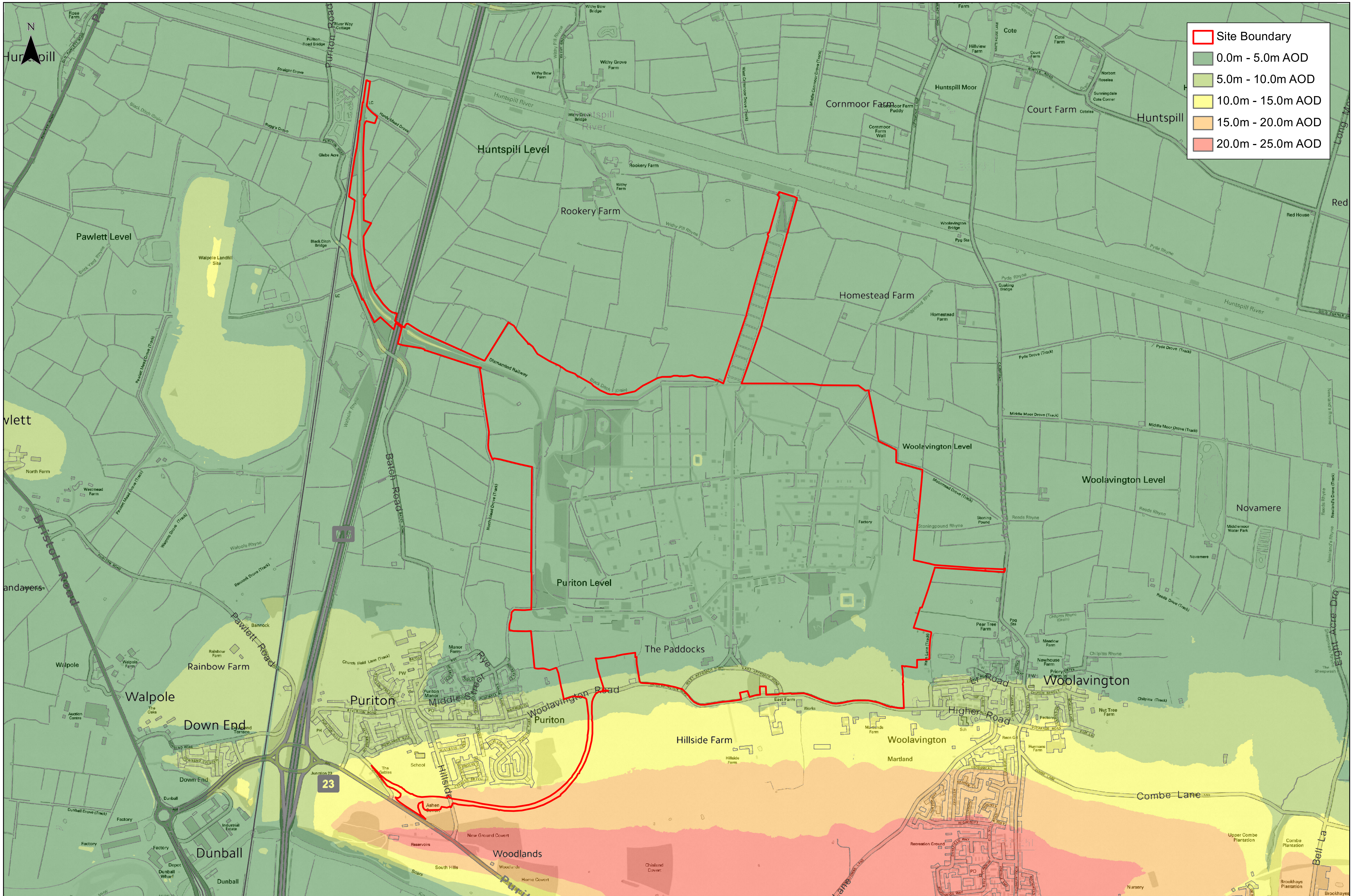
Stantec	Client: G	**GRAVITY** Site Location (Aerial)	0 250 500 m	1:15,000 @ A3	Date: 18/08/2021
			Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community Contains Ordnance Survey data (c) Crown copyright and database right 2019.	Drawn: CE	Checked: RR
				Figure 002	Rev A

Appendix B Topography

Figure 3 - Topography



Stantec	Client: G	**GRAVITY** Topography	0 250 500 m Contains Environment Agency information Environment Agency and/or database right Contains Ordnance Survey data © Crown copyright and database right 2019.	1:15,000 @ A3 Drawn: CE Figure 003	Date: 09/09/2021 Checked: RR Rev A

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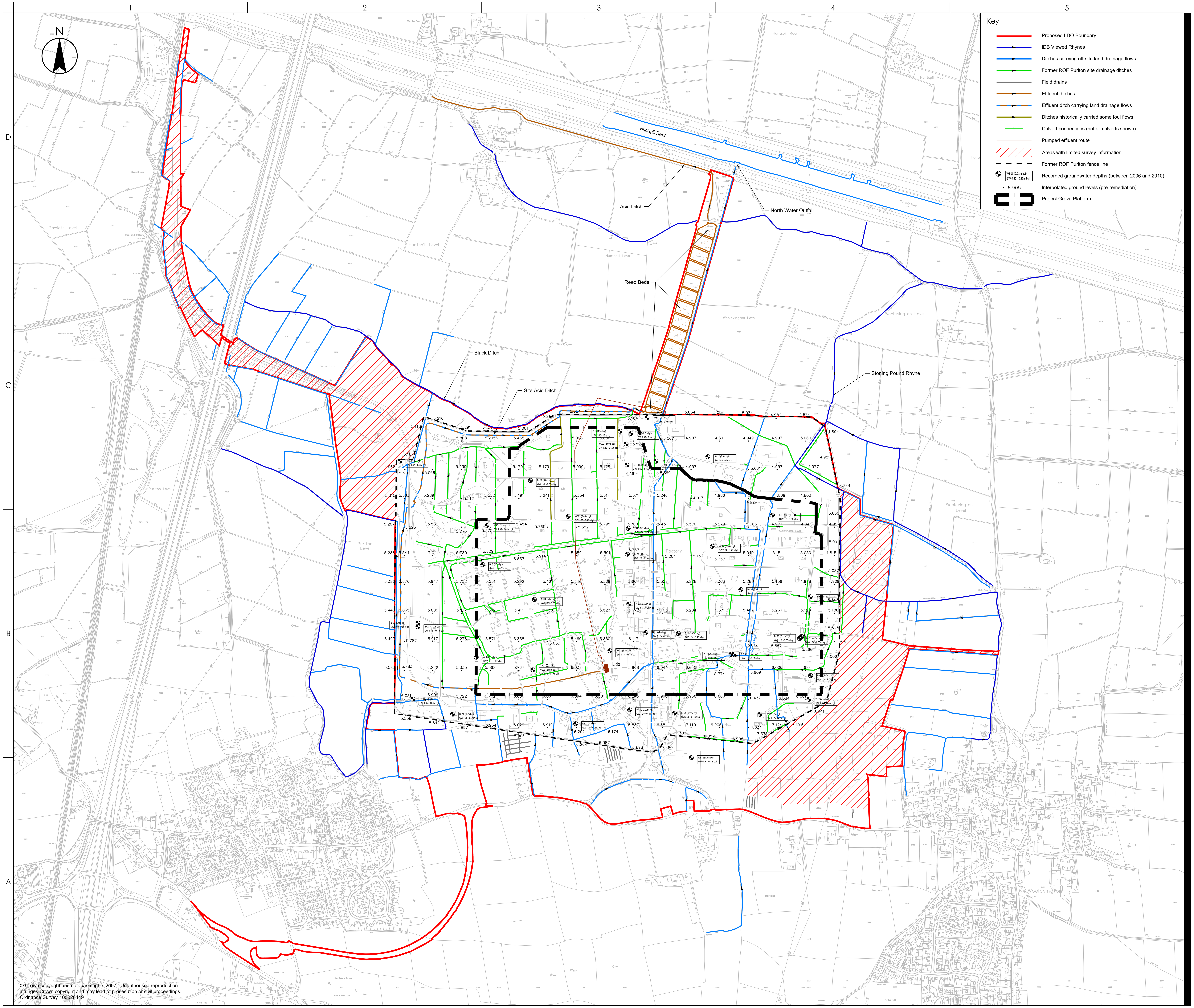
Appendix C Existing Drainage

332310092-4002-SK01 Existing Drainage Conditions



Stantec

Stantec UK Limited
TAUNTON
Lakeside House, Blackbrook Business Park, Blackbrook
Park Avenue, Taunton TA1 2PX
Tel: +44 1823 218 940
www.stantec.com/uk

Notes

UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake their own investigation where the presence of any existing sewers, services, plant or apparatus may affect their operations.

1. This drawing is to be read in conjunction with all other Engineer's and Architect's drawings.
2. All dimensions are in metres unless noted otherwise.
3. All levels are in metres above Ordnance Datum (AOD).
4. The location of ditches and rhynes has been determined based on Ordnance Survey data and topographical surveys undertaken by Lewis Brown Chartered Land Surveyors (ref: N07029, date: Sep 2007 and ref: B02002, date: Feb 2020).
5. Areas of the site where topographical survey information is limited are indicated and it is recommended that more detailed surveys of these areas are undertaken prior to detailed design works commencing.

Issued/Revision	By	Appd	YYYY.MM.DD
LWD	-	AJ	2021.08.19
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Issue Status

FOR INFORMATION

This document is suitable only for the purpose noted above.
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Client/Project Logo

Gravity

Client/Project

This is Gravity Ltd

Former ROF Puriton, Somerset, United Kingdom

Title

Existing Drainage Conditions

Project No.	Scale
332310092	NTS

Revision	Drawing No.
-	332310092/4002/SK01

Appendix D Reed Bed Assessment

Existing Surface Water & Effluent Infrastructure Assessment

Gravity

Smart Campus

Local Development Order
Surface Water Drainage Strategy
Existing Surface Water & Effluent Infrastructure Assessment

Document Control Sheet

Project Name: **This is Gravity**

Project Ref: **332310102/4002**

Report Title: **Existing Surface Water & Effluent Infrastructure Assessment**

Doc Ref: **Revision B**

Date: **September 2021**

	Name	Position	Signature	Date
Prepared by:	Lewis Derrick	Engineer		24.09.2021
Reviewed by:	Andrew Johns	Senior Associate		24.09.2021
Approved by:	Paul Jenkin	Director of Water Management		24.09.2021
For and on behalf of Stantec UK Limited				

Revision	Date	Description	Prepared	Reviewed	Approved
A	19.08.21	Issue for Client Review	LWD	AJ	-
B	24.09.21	For Planning	LW	AJ	PJ

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1 Introduction

1.1 Scope of Report

1.1.1 This Existing Surface Water & Effluent Infrastructure Assessment (henceforth referred to as *"report"*) has been produced by Stantec UK (Stantec) as an appendix to the Surface Water Drainage Strategy (SWDS), also produced by Stantec, in support of a Local Development Order (LDO) application. The LDO application is made by our Client, This is Gravity Ltd, for an industrial-led multi use development at the Former Royal Ordnance Factory (ROF) Puriton in Somerset.

1.1.2 This report is intended to provide a summary of the on-site water management regime, covering surface water and foul drainage, for both the pre-remediation and post-remediation condition. This report also assesses the capacity and condition of the reed bed and lagoon system to the north of the site.

1.1.3 Some documentation relevant to the surface water management plan, and which have been developed in the context of the preparation of a LDO, has already been produced and approved by the relevant authorities, where required, including: the Strategic Design Code, Strategic Landscape Masterplan and the Clean and Inclusive Growth Strategy.

1.2 Source of Information

1.2.1 Stantec has been involved in assessing Flood Risk and Drainage at this site for over 10 years, including in support of an extant Outline Planning Consent in 2017 (ref: 42/13/00010). As such, a number of reports and assessments have been completed to date. These are listed below:

- Royal Ordnance Factory Puriton TUFLOW Modelling Report (July 2007)
- Royal Ordnance Factory Puriton TUFLOW Modelling Addendum to Technical Modelling Report (October 2007)
- Royal Ordnance Factory Puriton TUFLOW Modelling Addendum NO.2 of Technical Modelling Report (January 2008)
- Huntspill Energy Park Remediation Application – Flood Risk Assessment (October 2011)
- Borrow Pit Angling Club Flood Risk Assessment (October 2012)
- Huntspill Energy Park Remediation Phase 1 Drainage Scheme (March 2013)
- Huntspill Energy Park Flood Risk Assessment (April 2013)
- Huntspill Energy Park Surface Water Management Strategy (April 2013)
- Huntspill Energy Park Addendum to Surface Water Management Strategy (October 2013)
- Huntspill Energy Park Remediation Application Surface Water Management Strategy (October 2013)
- Huntspill Energy Park Remediation Works Drainage Scheme for Plots J-K (January 2014)
- Puriton Solar Farm Drainage Strategy Technical Note (February 2015)
- Huntspill Solar Park Surface Water Management Strategy (December 2015)

- Land at Puriton Abstraction Assets Assessment (March 2018)
- Huntspill Energy Park Tidal Flood Risk Summary Note (June 2018)

1.2.2 Additionally, a survey report undertaken by Duntech Environmental Services in January 1994 and a topographical survey of the reed bed system north of the site undertaken by Lewis Brown Chartered Land Surveyors in March 2020 have been reviewed.

1.2.3 As part of the LDO application, Stantec have produced updated Flood Risk Assessment (FRA) and SWDS reports, with this report forming an appendix to the SWDS. It should be noted that whilst many of the findings and conclusions of the previously completed works have informed the SWDS, these documents were undertaken in relation to the extant consent. Hence, the area assessed by these documents is smaller in extent than the proposed LDO area. Where relevant, the findings of these documents has been referenced and/or updated to reflect this new site extent.

2 Pre-Remediation

2.1 The Site

2.1.1 Prior to the commencement of the remediation works, the former ROF comprised of a number of factory buildings and ancillary office buildings located centrally within the site. Munitions production buildings enclosed by blast mounds were located within the remainder of the site. In addition, there were several greenfield, wooded areas.

2.1.2 The surface water and foul water management regime, and potable water supply conditions for the site prior to remediation have been outlined in the following sections.

2.2 Surface Water Management

2.2.1 Prior to remediation, the site was drained by a network of ditches and rhynes that conveyed surface water generally northwards. The ditches within the site fall into two categories; those that convey flows through the site from the upstream catchment, and those that only serve the site itself.

2.2.2 A Surface Water Management Strategy (SWMS) was prepared in 2013 to support the outline planning application for the remediation works. As part of the SWMS, a detailed inspection of the existing ditch network within the site was carried out to understand the flow routes and connections across the site. The inspection also confirmed the sub-catchment areas and various outfall locations.

2.2.3 The pre-remediation drainage patterns including sub-catchments and outfall locations are described as below:

- Sub-Catchment A – A small section of land on western boundary, and another north-west of centre, discharges into the Black Ditch directly.
- Sub-Catchment B – The majority of the western parts of the site drain to the "Site Acid Ditch".
- Sub-Catchment C – A small section of land located centrally in the north of site drains to the "Site Acid Ditch".
- Sub-Catchment D – Central areas, representing a significant proportion of the site, drain to a south-to-north rhyne which continues parallel to (but separate from) an existing reed bed system before discharging into the Huntspill River via the "North Water Outfall".
- Sub-Catchment E – Eastern parts of the site drain north-eastwards to the Stoning Pound Rhyne.
- Sub-Catchment F – South-western areas of the site which drain to the unnamed viewed rhyne to the west. This area is associated Gravity Link Road, which has been consented as part of the previous outline consent and is currently under construction.
- Sub-Catchment G – North-western areas of the site associated with the existing railway, which appear to discharge into adjacent rhynes and ditches before conveying flows westwards to either the Huntspill River or Parrett Estuary.

2.2.4 The Black Ditch and the Stoning Pound Rhyne are managed by the Somerset Drainage Board Consortium, while the Huntspill River is managed by the Environment Agency.

2.2.5 Water levels in the Huntspill and the upstream rhyne network are managed seasonally. In winter, water levels in the rhynes are lowered to reduce the risk of flooding by provided greater storage and conveyance capacity. In summer, water levels are maintained at a higher level to provided irrigation and water supply for nearby agricultural land. Prior to remediation works, the typical water level in the Huntspill was approximately 3.5mAOD in the summer, and 2.9mAOD in the winter. Water levels within the rhynes are managed through the use of pens and stop-logs.

2.2.6 It is assumed that water levels within the on-site ditches and rhynes were of a comparable level, given the flat topography and therefore limited hydraulic head.

2.3 Foul Water Management

2.3.1 When the ROF site was operational, large volumes of process effluent were treated and discharged each day. Effluent was piped or pumped to a large treatment tank, known as 'The Lido' in the centre of the site. The effluent was then pumped from the Lido towards the large reed bed facility in the north of the site. The Lido also has an overflow to a ditch which runs west towards the site boundary before turning north and circumnavigating the site clockwise as far as the reed beds. This ditch is known as the 'Acid Ditch'.

2.3.2 The reed bed system requires the use of inter-stage pumping to utilise the reed bed system. This circulation and transfer pumping station is located just south of the reed bed locations

2.3.3 Following the passage through the reed beds, treated flows are then pumped into an outfall ditch immediately north of the reed beds. This ditch then turns west and flows parallel to (but separate from) the Huntspill all the way to the Parrett Estuary. The ditch is subject to a maintenance agreement with the EA and the outfall from the reed beds falls under a discharge consent license.

2.3.4 The outfall ditch from the reed beds is also known as the 'Acid Ditch'. To avoid confusion, the ditch within the site is referred to as the 'Site Acid Ditch'.

2.4 Potable Water Supply

2.4.1 During operation of the ROF site, potable water supply was not provided by the local water company, in this instance Wessex Water. Instead, water demands were met via abstraction and treated privately before distribution across the site.

2.4.2 A water treatment works for the site was located approximately 1.2km south of the site on Knowle Hill. This site included two combined covered reservoirs, which are assumed to have supplied both potable and process/demineralised water to the site. In combination, these reservoirs had a capacity of 250,000 gallons (approximately 1,140m^3 or 1,140,000 litres). There were two 250mm (10'') diameter pipes for supplying process water to the site and two 150mm (6'') diameter pipes for potable water supply.

2.4.3 There are two abstractions associated with the ROF. Firstly, there is a licence 16/52/011/S/048 for the abstraction of water from the Huntspill River at ST 344 436. This is for industrial purposes and the maximum quantity of the water permitted is 3,500m^3 per day and 420,000m^3 per year. The licence also states that the annual abstraction shall be regarded as the maximum to be taken from the Huntspill River but shall be within the maximum aggregated quantity of water authorised to be abstracted in any year under licence number 16/52/008/S/122 relating to abstraction from the Kings Sedgemoor Drain.

2.4.4 The second licence is 16/52/008/S/122 for the abstraction of water from the Kings Sedgemoor Drain at ST 330 400. This is for general cooling water and the maximum quantity permitted is 700m^3 per hour, 3,000m^3 per day and 1,000,000m^3 per year. The licence states that it is linked to 16/52/011/S/048 with an aggregate annual licence quantity of 1,000,000m^3. It also states that abstraction must stop when the level in the Kings Sedgemoor Drain drops below that required to meet agricultural needs or the flow over the Dunball Clyst stops.

3 Post-Remediation

3.1 Nature of Completed Remediation Works

3.1.1 The completed remediation works have been undertaken cognisant of the layout supporting the approved hybrid planning application 42/13/00010 and the separate remediation works planning application 42/11/00017.

3.1.2 The scope of the remedial works completed to dates is as follows:

- Demolition of remaining buildings;
- Treatment of contaminated material;
- Creation of a landscaped mound at the west of the site;

3.1.3 Importantly, the principles of the remediated strategy remain the same as previously consented but updated to better reflect the proposed development plots as proposed within the LDO application. A plan of the remediated surface water drainage strategy can be found appended to this report.

3.1.4 Subject to planning approval, it is intended the remediation works are completed in 2022.

3.2 Surface Water Management

3.2.1 The remediation of the former ROF site involves modification of the existing site land drainage network including realignment or diversion of existing rhyne and ditch routes around the plot areas. The remediation strategy originally proposed in 2013 was prepared based on five key objectives. These have been maintained as part of the current S73 application to vary Condition 9. They are as follows:

1. To provide treatment and pollution prevention measures during the remediation works.
2. To preserve the function and hydraulic continuity in the land drainage network through the site.
3. To reflect/accommodate the emerging future developments surface water management strategy.
4. To provide sufficient land drainage including temporary drainage features to serve the site in its remediated condition prior to the commencement of the future development construction.
5. To ensure adequate maintenance of the drainage system including the existing outfall routes.

3.2.2 The drainage scheme proposed as part of the remediation strategy intended to reflect the pre-remediation drainage characteristics while preserving the flexibility for the design of any future development.

3.2.3 It is understood that pre-remediation whilst the ROF site was operational the ditches and rhynes within the site were well maintained and thought to have been of sufficient capacity. During the decommissioning of the ROF site the maintenance of the ditches has understandably become less frequent. Despite this, the network was still seen to be preforming well, which suggests the layout and size of the ditches are adequate to serve the site.

3.2.4 The arterial ditch routes will be diverted to accommodate the plots within the development proposals. Ultimately, all drainage on site, both post-remediation and post-development, will drain to these ditches, therefore these will be diverted during the initial remediation works to provide the necessary plot layouts as the development is progressed. This will also avoid individual plots being reliant on one another, allowing greater flexibility regarding the development programme.

3.2.5 Where ditches are to be diverted it will be important to design the new connections with sufficient capacity so as to avoid impeding the existing flows. Some of the diversion routes make use of existing ditches. These ditches will be cleared and profiles upgraded as required to ensure capacity is undiminished.

3.2.6 It is proposed to infill all ditches within the proposed plot boundaries as part of the works. As each plot is brought forward for development in the future, an on-plot drainage system will be required linking into the overall surface water strategy for the development proposals. However, a temporary/interim land drainage system will be needed to drain the plot and this will be installed as part of the remediation works.

3.2.7 Ditch modifications is based on the following principles:

- All existing ditches within the plot boundaries to be infilled.
- Where ditches that convey flows from upstream pass through the plot area, these will be diverted around the perimeter of the plot.
- A network of ditches will be provided on-plot to serve as land drainage in the remediated condition.
- Existing catchments and outfall locations will be preserved as far as practicable in order to avoid impacts on the downstream drainage regime.

3.2.8 The existing site ditches are generally spaced around 100m apart and the proposed layout of on-plot ditches has been prepared with a similar spacing.

3.2.9 Material will be imported on site to form the proposed LDO development platforms, raising levels above existing. Ground levels will be defined to provide a slight fall into the plot from the boundaries towards the ditches. Watersheds within the plot will be defined between the ditches.

3.2.10 A minimum interim earthworks level of 5.25m AOD has been identified based on the FRA work previously carried out by Stantec (in support of the extant outline planning permission, not the LDO). This will be the lowest ground level on all plots upon completion of the remediation works. This will form a level in which the design levels stated in the FRA and Surface Water Drainage Strategy for the LDO can be constructed above.

3.2.11 Therefore, the proposed ditch top-of-bank levels have been set to 5.25m AOD, except where existing ground levels are greater than this. In those locations, the proposed top-of-bank level is based on the existing ground level to avoid being in ‘cut’.

3.2.12 A general ditch profile based on the existing ditch characteristics has been applied to the new ditch design. This profile comprises a 1m bed width, around 0.7m deep, with 1:1 bank slopes. A bed gradient of 1 in 1,000 has generally been used, with depths a little greater than 0.7m at the downstream end and a little less than 0.7m at the upstream end.

3.2.13 Culverts on retained watercourses will be opened up wherever possible although some new culverts/bridges may be required at plot access locations.

3.2.14 The remediation works do not include any introduction of hardstanding areas. Conversely, existing buildings and hardstanding areas at the site are being demolished. Therefore, there will be no increase in runoff rates and volumes from the site as a result of the works. Hence, there is no requirement to limit discharge rates and provide attenuation storage.

3.3 Foul Water Management

3.3.1 As the ROF is no longer operational, it has been assumed that any remaining foul drainage infrastructure on site has been decommissioned and removed from the site or is no longer fit for purpose. In any case, the remaining foul drainage infrastructure is no longer carrying foul drainage as there is no effluent generated on the site in its post-remediation condition.

3.3.2 However, the retained buildings and 37 Club drain to a package treatment plant that is located in an area of land just outside the main access gate to the site. The treated effluent is discharged to the main ditch under licence from the EA.

3.4 Potable Water Supply

3.4.1 As with the foul water management on site, there is no longer demand for potable water supply on site. Therefore, it is again assumed that potable water supply infrastructure on site has either been decommissioned and removed from the site or is no longer fit for purposed.

3.4.2 The off-site infrastructure at Knowle Hill remains in place and is unaffected by the remediation works but is not fit for purpose and is not required for the purposes of the Gravity site for future use.

4 Reed Bed Survey Information

4.1 1994 Survey

4.1.1 A survey of the reed bed system was undertaken by Duntech Environmental Services in January 1994, on behalf of then site owners British Aerospace Defence Limited. This not only recorded the condition of the reed beds but also made recommendations for future maintenance.

4.1.2 The survey indicated that the reed bed is approximately 700m long and has an average width of 70m, covering and area of 4.9ha. At the time of this survey, the base of the reed bed was stated as alluvial clay overlain by varying amounts of sediment topped by up to 0.5m of degrading peat and reed detritus. The depth of the water channel along the reed bed's western edge varied between 0.5-1.2m, with an average depth of 0.78m given.

4.1.3 Commentary was provided on the geology and hydrogeology of the area in which the reed bed is located, and it was noted that both of these were typical of what is recorded in the Somerset Levels. The combination of the alluvial grey clay (resulting in a low permeability soil) and flat topography accounts for the poor drainage in the area and the high groundwater levels, which were indicated to never be more than 1.5m below the soil surface. The reed bed is isolated from adjacent watercourses by clay banks. It was noted that the levels in the reed bed are lower than the surrounding water table and in a number of cases, surface water runoff flows from adjacent fields into the reed bed.

4.1.4 The survey stated that the reed beds were generally well established, with an increase in vegetation compared to a previous survey of the system. It did, however, comment that the reeds were not fully established across the system, particularly where effluent enters the reed beds. The conclusion was that the conditions, both nutrient-wise and pH levels, within the system were generally favourable for the health of the reed bed system, although low levels of potassium and phosphates (key nutrients) have been replaced by sulphate which was found to be in high levels across the system and resulted in poorer growth towards the southern end.

4.1.5 The survey report indicates that without intervention, eventually the reed bed detritus will exceed the water level resulting in self-extinguishing of the reed bed system. This can be prevented either by increasing the water level or burning back the reeds. However, at the time of the survey the detritus build-up was not of a sufficient level to enable efficient effluent treatment.

4.1.6 The 1994 report proposed the following design:

- Construction of an inlet lagoon to act as a buffer and permit the further establish of the reed beds in the southern end of the system. This would occupy the whole width of the bed and be approximately 20m north to south;

- At the north east corner of the lagoon would be a screened inlet chamber with a 300mm diameter PVC pipe running the whole length of the bed;

- The PVC pipe would be fitted with two valved outlets leading into each section of the bed, therefore effluent would flow by gravity from the inlet chamber to the eastern edge of the reed bed;

- In the north west corner of the lagoon, a bypass weir would be constructed to allow excessive surface water runoff to drain into the north to south ditch along the western edge of the reed beds. This would normally be fairly well diluted effluent which would mix with treated effluent coming off the reed beds;

- At the northern end of the reed bed system, where it narrows into a single channel, would be constructed the main lift pump station comprising a screened chamber and three dirty water low lift pumps with a duty of 90m^3/hr each. These will allow water levels to rise concurrently with the detritus level but then still drain the reed beds into their existing outlet.

4.1.7 A copy of the 1994 survey report can be found in **Appendix A**.

4.2 2020 Survey

4.2.1 A new topographical survey of the reed beds was undertaken in January 2020 by Lewis Brown Chartered Land Surveyors to confirm the location and condition of key infrastructure within the reed bed system as well as to determine the levels of siltation within the reed beds themselves.

4.2.2 The 2020 survey generally indicates that the design proposals put forward in the 1994 survey report were constructed. However, as noted in paragraph 3.2.3 the lack maintenance of the overall infrastructure on site in recent years has meant that not all aspects of the 1994 design could be found on site or confirmed without some degree of uncertainty. Nonetheless, the presence of 'hard' infrastructure in locations closely matching the 1994 proposals were identified.

4.2.3 At the southern end of the reed bed system, two chambers were found; one in the east and one in the west, suggesting that that bypass weir overflow into the western channel and 300mm diameter PVC pipe discharging effluent into the reed beds from the east were constructed. This pipe was not observed during the survey, but underground services along the eastern flank of the reed bed system was found, which may corroborate with this pipe.

4.2.4 At the northern end, no outfall pipe was observed, either visually or audibly. However, chambers were observed in the north-eastern corner which may be the location of the uplift pumps.

4.2.5 Not all detritus levels could be determined for all reed beds, but where bed and detritus levels could be measured, the detritus layer across the reed bed system varies from approximately 0.1m deep to 0.5m depth, with one excepting indicating nearly 1.0m depth of detritus.

4.2.6 Much of the reed beds themselves and the surrounding area, including the eastern and western bunds and outfall ditches, were indicated to be overgrown and covered by dense vegetation.

4.2.7 A copy of the 2020 reed bed survey can be found in **Appendix B**.

5 Reed Bed Condition Assessment

5.1 Surveyed Condition

5.1.1 **Table 5.1** below summarises average bed and silt levels within the reed beds, as surveyed in 2020. The reed bed references are also consistent with that survey, with Reed Bed 01 being the most southerly and Reed Bed 15 the most northerly.

Reed Bed Reference	Averaged Measured Bed Level (mAOD)	Averaged Measured Silt Level (mAOD)	Average Accumulated Silt Depth (m)
01	3.24	3.38	0.14*
02	3.42	3.82	0.40
03	3.49	3.80	0.31
04	3.55	3.86	0.31
05	3.40	3.76	0.36
06	3.51	3.82	0.31
07	3.47	3.94	0.47
08	Not obtained	Not obtained	Not obtained
09	Not obtained	Not obtained	Not obtained
10	Not obtained	Not obtained	Not obtained
11	Not obtained	Not obtained	Not obtained
12	Not obtained	Not obtained	Not obtained
13	Not obtained	Not obtained	Not obtained
14	3.47	3.57	0.10
15	3.35	3.59	0.24

Table 5.1: 2020 Survey Summary

**Bed and silt level only provided at one location in Reed Bed 01. Additional bed level provided but no silt level to compare against.*

5.1.2 Bed levels and silt levels were not recorded for all reed beds. However, it is reasonable to assume that the bed levels of the reed beds vary little from Reed Bed 01 in the south and Reed Bed 15 in the north. Based on the information available, the average bed level is 3.45mAOD.

5.1.3 The level of silt accumulation appears to reduce from Reed Bed 01 and Reed Bed 15. This was to be expected as silt is "trapped" upstream by the reeds themselves and thus reducing the sediment load available for siltation further downstream.

5.1.4 Water levels were recorded in Reed Bed 01 (4.44mAOD on 05 March 2020), Reed Bed 02 (4.43mAOD on 05 March 2020), and Reed Bed 15 (4.38mAOD on 04 March 2020 and 4.46mAOD on 18 March 2020).

5.2 Capacity Assessment

5.2.1 For the purpose of assessing the capacity of the of the reed beds following the 2020 survey, the same methodology utilised within the 2013 SWMS. The 2013 SWMS methodology estimated the available storage based on the outfall depth, the minimum crest level and the total area of the reed beds and also accounted for potential "tide-locking" of the reed beds.

5.2.2 In this assessment, the downstream level has been based on the measured bed levels within the reed beds, assessing against the maximum, minimum and average level. The crest level remains the lowest level surveyed. These calculations have been repeated for the maximum, minimum and average measured silt accumulation depth, as this information is now available when compared with the 2013 SWMS. This assessment also accounts for the current outfall depth and the likely impacts of ecological enhancement works within the reed beds.

5.2.3 The 2013 SWMS nor this assessment took account of the current water levels within the reed beds. This is because it is assumed that the existing water volume within the reed beds above the outfall would be "pushed" out by incoming flows and thus does not represent a volume restriction. This point is more relevant as the outfall arrangement, as proposed and consented, changes from a pumped discharge into the Acid Ditch to a gravity discharge via the North Water Outfall into the Huntspill River.

Available Capacity – All Silt Removed

5.2.4 **Table 5.2** provides an assessment of available capacity assuming all silt is removed.

	Minimum	Average	Maximum
Reed Bed Area (m^2)		36,750	
Surveyed Bed Level (mAOD)	2.79	3.45	3.94
Lowest Surveyed Crest Level (mAOD)		4.50	
Reed Bed Capacity (m^3)	62,843	38,588	20,580

Table 5.2: Summary of Available Capacity with All Silt Removed

5.2.5 Based on the storage volume requirement calculated in the 2013 SWMS (38,200m^3), the average surveyed bed level in conjunction with the lowest surveyed crest level will provide adequate storage. However, this assessment does not accurately take account of the volume lost to the banks between each reed bed (although, given the scale, this is likely to be of negligible impact) nor the fact that as an average value, there will be areas with higher bed levels which will reduce this level. Therefore, raising of the reed beds crest level is likely to still be required to provide some freeboard.

Available Capacity – Silt Remains In-situ

5.2.6 The previous assessment does not take account of the level of siltation evident within the reed beds. **Table 5.3** below indicates the available capacity when accounting for silt within the reed beds.

	Minimum	Average	Maximum
Reed Bed Area (m^2)		36,750	
Surveyed Bed Level (mAOD)	2.79	3.45	3.94
Surveyed Silt Level (mAOD)	3.27	3.77	4.06
Lowest Surveyed Crest Level (mAOD)		4.50	
Reed Bed Capacity (m^3)	45,203	26,828	16,170

Table 5.3: Summary of Available Capacity with Silt Remaining In-Situ

5.2.7 Taking account of siltation, there is no longer sufficient capacity within the reed beds based on the average silt level recorded, which indicates a 11,372m^3 shortfall. In a “do nothing” scenario, to provide enough capacity (as per the 2013 SWMS) the crest level across the reed bed area would need to be raised to 4.81mAOD (raised by 0.31m). This again does not take account of the volume lost to the banks nor does this raised crest level include for any freeboard.

5.2.8 By raising the crest level of the reed beds by 0.31m, the volume impounded above natural levels (11,372m^3) would not be considered a Reservoir under the Flood and Water Management Act 2010 and therefore would not fall under the regulations defined in the Reservoirs Act 1975.

5.2.9 However, it is recommended that a risk assessment for the potential breach or failure of the raised crest level is undertaken prior to design. Furthermore, it is also recommended that regular inspection of the raised crest level is undertaken during the site’s operation so that potential.

5.2.10 At this stage, it can be stated that in the event of the available tide lock storage volume being utilised i.e. water temporarily stored above existing natural levels, the surrounding landscape would likely be inundated with tidal waters. Therefore, in the event of a breach or failure of the raised crest level embankment, the impounded waters would flood already flooded land. In the event the surround land was not inundated, this land is used solely for agriculture therefore the risk of people and buildings is minimal. The impounded waters would also drain into the Huntspill River, based on the topography.

5.2.11 This high-level assessment of risk remains true for all potential options discussed where raising of the crest level is required.

Impact of Existing Outfall Level

5.2.12 The current outfall level is 3.5mAOD, therefore as previously calculated in 2013 SWMS the crest level will need to be raised to 4.6mAOD (raised by 0.10m) to provide sufficient capacity (without freeboard). This assumes that all silt is removed to this level or lower and that the reed beds can completely dewater, once the outfall is amended from the current pumped discharge to the Acid Ditch to the consented strategy of a gravity discharge to the Huntspill River via the North Water Outfall.

5.2.13 As with the option of leaving the silt in-situ, raising the crest level of the reed beds by 0.10m, the volume impounded above natural levels (3,675m^3) would not be considered a Reservoir under the Flood and Water Management Act 2010 and therefore would not fall under the regulations defined in the Reservoirs Act 1975.

5.2.14 It is recommended that a risk assessment for the potential breach or failure of the raised crest level is undertaken prior to design. Furthermore, it is also recommended that regular inspection of the raised crest level is undertaken during the site's operation so that potential.

Impact of Biodiversity New Gain Opportunities

5.2.15 It is likely that biodiversity measures could be required within the reed beds, which in turn will require a permanent water level to be present i.e. the reed beds cannot completely dewater. There are two options available for achieving this; lowering the bed level below the outfall invert or raising the outfall invert. The latter option is likely to be the easiest to achieve construction-wise and financially.

5.2.16 Based on the recommendations of CIRIA C753 "The SuDS Manual", water levels within the reed beds should vary between 0.4m and 2.0m deep. For the purpose of this assessment we have assumed an average water depth of 0.5m, as the reed beds are more characteristic of a wetland than a pond and therefore requires a shallower permanent water depth. Therefore, the outfall needs to be raised to 4.0mAOD. Assuming that silt levels are removed to this level or lower, this yields a capacity of 18,375m^3, which indicates a 19,825m^3 shortfall and which would require the crest level to be raised to 5.04mAOD (raised by 0.54m) to mitigate this (without freeboard).

5.2.17 By raising the crest level of the reed beds by 0.54m, the volume impounded above natural levels (19,825m^3) would still not be considered a Reservoir under the Flood and Water Management Act 2010 and therefore would not fall under the regulations defined in the Reservoirs Act 1975.

5.2.18 However, as this is still a large volume and close to the threshold, it is recommended that a risk assessment for the potential breach or failure of the raised crest level is undertaken prior to design. Furthermore, it is also recommended that regular inspection of the raised crest level is undertaken during the site's operation so that potential.

5.2.19 Should the option of lowering the bed levels be preferred, by lowering the bed level to at least 3.0mAOD and ensuring silt accumulation is removed to 3.5mAOD or lower, it will only be necessary to raise the reed bed crest level to 4.6mAOD (raised by 0.10m) (without freeboard) to achieve the necessary volume. Again, the impounded volume stored above existing natural levels in this option would not be considered a Reservoir.

6 Recommended Works

6.1 Hydraulic Capacity

6.1.1 Based on the assessment of available capacity within the reed beds outlined in **Section 5**, it will be necessary to include some bank raising/reinforcement to provide sufficient storage within the reed beds and account for "tide-locking". The following scenarios and degrees to which the banks need raising are as follows:

- "Do Nothing", average silt level remains at 3.77mAOD and the outfall at 3.5mAOD – Raise banks by 0.1m to 4.6mAOD;
- Remove silt to outfall invert level (3.5mAOD) – Raise banks by 0.1m to 4.6mAOD;
- Raise outfall to 4.0mAOD to provide 0.5m permanent water depth – Raise banks by at least 0.44m to 5.04mAOD;
- Lower bed level to provide 0.5m permanent water depth – Raise banks by 0.1m to 4.6mAOD.

6.1.2 Which option is preferred is subject to a technical and financial feasibility assessment beyond the scope of this report. Following that feasibility assessment, the detailed design of the surface water drainage strategy and the reed beds will be undertaken and submitted as part of future stages of work.

6.2 Ecological Considerations

6.2.1 The following section provide a high-level consideration of ecological constraints and opportunities affecting the reed bed works. The details of these considerations will be subject to further input from an ecologist, but this is beyond the scope of this report.

6.2.2 It is understood that the raising of the reed beds banks can be undertaken at any time of year, provided it does not disturb nesting birds. However, in previous planning processes, the reed beds have been identified as a receptor site for water vole relocation from other areas of the site. In the LDO, Natural England are working with the promotor to considering landscaping issues and it is now possible that water vole relocation off site may be possible. Therefore, the reed bed works require reconsideration.

6.2.3 Furthermore, if silt is to be removed from the reed beds, this will also need to be undertaken in advance of the water vole relocation. The reeds themselves would likely also be removed at this stage, to allow controlled regeneration, which may affect nesting birds. Therefore, silt and reed removal should be undertaken outside of the nesting season. The removal of the reeds may also need an ecological permit for this reason.

6.2.4 It is not a requirement that all reed beds are rehabilitated at the same time, and in fact it may not be beneficial to do so from a practicality and ecological perspective. Therefore, these works can be undertaken in phases.

6.2.5 Removal of the reeds and silt should be undertaken in accordance with the recommendations of the Surface Water Operation and Maintenance Manual.

6.2.6 As part of the ecological enhancement of the reed beds, there will likely be the introduction of varying levels to create a variety of submerged, marginal and dry habitat within the reed beds. These enhancements are subject to further ecological and engineering design. When these are available, an assessment of the reed bed capacity should be undertaken as a check. This would be done as part of a future Reserved Matters Application related to another condition concerned with detailed surface water drainage design, as opposed to the strategic-level of this report.

Appendix A 1994 Reed Bed Survey

Duntech Environmental Services January 1994 *Reed Bed Survey: Royal Ordnance Explosives Division Bridgewater Somerset*

Reed Bed Survey

Royal Ordnance Explosives Division

Bridgewater Somerset

Duntech Environmental Services

Duntech Environmental Services

British Aerospace Defence Limited,
Royal Ordnance Division,
Puriton,
Bridgewater,
Somerset TA7 8AD.

4th January, 1994.
Ref: Q/426/34
Yr.Ref: 93720 TF

For the attention of Trevor Freeston - Environment Coordinator.

Dear Sir,

Existing Reed Bed - Field Study and Development Proposals.

1.00 Base Data.

1.01 The existing reedbed surveyed located on the northern boundary of the Royal Ordnance Division site runs approximately 700 metres north north east to the Huntspill River and has an average width of 70 metres. The overall area is 4.9 hectares comprising a former clay borrow pit now colonised by a growth of common reed (Phragmites australis).

1.02 The geology is typical of the general area of the Somerset levels. Under the topsoil typically 12 to 14 metres of marine clay deposits are interspersed with peat lenses formed during periods of fresh water inundation during the Pleistocene. This alluvial deposit which can vary from 2 - 25 metres thick overlies 60 metres of Blue Lias (Jurassic) and the limestone of the Penarth Group (Upper Triassic). The alluvial grey clay has an extremely small particle size and consequently a very low hydraulic conductivity of the order of less than 10^{-9} metres per second. This characteristic combined with the flat topography of the area accounts for the poor drainage of the levels and the similar area along the Gwent coast. In spite of extensive drainage works the perched water table tends to remain high and is normally never more than 1.5 metres below the soil surface. Shallow wells are not very productive unless a deep peat lens can be exploited and deep boreholes are only productive in the Penarth formation.

1.03 The reedbed is isolated from the adjacent fresh water courses by clay banks which effectively screen the contents from the adjacent agricultural land. In addition the levels maintained in the reedbed are lower than the surrounding water table and in a number of cases surface water is flowing from adjacent fields into the reedbed. The base of the reedbed is alluvial clay overlain by varying amounts of sediment topped by up to 0.5 metre depth of degrading peat and reed detritus.

There has been a considerable increase in the reed population since the previous survey by the MRM partnership to the extent that over 85% of the area is now colonised. Some of the growth has not reached the optimum stage of development especially where the effluent first flows into the reedbed where die back has occurred. Following the excavation of the channels along the western edge of the reedbed and the outlet channel the static water level in the reedbed has dropped since the previous survey. There is in general only 0.5 metres depth of water over the sediment through which the reeds are growing and in many areas the reed detritus has built up level with the water surface. There are still some areas that have not been colonised by the reeds resulting in open water surfaces 0.5 to 0.7 metres in depth.

2.00 Reedbed Survey.

2.01 The details of the area survey are enclosed, see drawing W93951 at a scale of 1:500 placed on a 50 metre grid. Due to the low flows at the time of survey the hydraulic gradient between the entry ditch and the footbridge at the most northerly end of the drain was only 200mm, over the actual reedbed there was no significant hydraulic gradient. This gave a good indication of overall water depths. The average level of the water surface on the beds was 48.54 metres giving an average depth of about 0.50 metres of water overlying the bed surface to the sediment layer. The depth of reed detritus varied from 0.10 metres below the surface to 0.32 metres above the water surface. The depth of the water channel along the western edge of the reedbed varied in depth between 0.5 metres and 1.20 metres with an average of 0.78 metres.

2.02 A series of sections were plotted across the reed beds at 50 metre centres with the water depth plotted wherever possible using a small boat. In many places the depth of reed detritus was such that it was impossible to cover the full width of the bed. Apart from a small area between 500 and 550 metres where there is a small area of higher ground the majority of the reedbed appears to have a level bottom with depths of 4-500mm of water above the sediment. In places the reed straw is firm enough to walk on but will not support a static weight. The open water areas are marginally deeper than those covered by reeds.

2.03 A series of samples were taken of the sediment and clay below it for analysis in an attempt to determine the factor that has led to die back of the reeds and poor performance of those adjacent to the dead areas. Samples from the good areas were also taken for comparison. Whereas we were expecting a very low pH level overall it was in fact found that the pH was on average 7.84 in the effluent ditch, and varying from a low of 7.15 in the damaged reed areas to a high of 7.49 in the good reed growth areas. Total nitrogen was found to be high in the ditch, up to 0.45% and generally lower in the rest of the bed averaging around 0.17% as would be expected from an effluent high in Nitric Acid. The available Nitrogen in the form of Nitrates is very low at less than 2.0 mg/kg as would be expected in a totally flooded bed in an anoxic state.

It is apparent from the growth of the reeds that sufficient oxidation is occurring to supply the reeds with adequate Nitrate for their growth. The levels of available Potassium and Phosphate were extremely low and appear to have been replaced by Sulphate which was very high in all areas. The lack of these two major plant nutrients in the presence of high Nitrogen levels causes an imbalance and a reduction in root development. In the damaged reed area Sulphate levels were as high as 73,000 mg/kg, averaging between 7,000 and 9,000mg/kg in the better reed areas and as low as 3,000 mg/kg in the ditch. It is probable that the high levels of sulphate and low levels of other plant nutrients that are having a detrimental effect on the reed growth at the southern end of the reed bed. The high levels of Sulphides that are concentrated in the sediment means that the Phosphate will have been released and only anaerobic sulphur chemistry bacteria will be operating to degrade the organic matter this leads to the production of quantities of H_2S which is lethal to plant life at fairly low levels.

2.04 It is difficult to determine with any exactitude what is currently happening in terms of degradation pathways in the reedbed as it stands. It is certain that rhizome development in the underlying clay is not as extensive as it should be but it does show improvement down the bed away from the inlet end. Much of the rhizome development is occurring in the sediment and in the peaty layer formed by the dead reed material. It was not possible to estimate the efficiency of the reed root system as this would need a number of excavations in the bed surface once the water level had been lowered. The signs are however encouraging in that the above ground growth is extensive, has achieved a good height and in many areas has produced a high proportion of seed heads indicating that the stand is maturing and stable. The major restriction to further development in terms of treatment efficiency has been the high water levels in the bed which has reduced the ability of the dead reeds to degrade to produce a biologically active layer in which the reeds can produce the volume of rhizomes necessary for good oxygen transfer. The reeds do not perform well in the heavy clay of the base of the bed.

3.00 Development Strategy.

3.01 In the normal course of events in a reedbed which is left untouched for many years and has a static water level, the amount of degrading reed material increases year by year building to a considerable depth to the point at which the reedbed dries out and is no longer wet enough to sustain the reed population. This has happened to many natural reedbeds in East Anglia where the reedbeds have become self extinguishing and natural wetlands are being lost by a combination of modern drainage techniques and natural build up of reedbeds which are no longer managed by burning and harvesting. The ideal hydraulic relationship between the reeds and the water level occurs when the water table is managed on an annual basis such that the water table is maintained between 0.5 metres above the rhizome level in the Spring down as low as 0.5 metres below rhizome level in the Autumn. In the optimum period of growth from late Spring to early Autumn the water level should be maintained at or just below rhizome level.

3.02 Year on year either the water table has to be incrementally raised or every few years the reedbed has to be burnt off back to the water table. In this particular case the water table is well above ground level and the reed detritus has not yet built up sufficiently to enable the system to function as an efficient treatment system with the current water level. To transform this bed into an effluent treatment system the first requirement is to have control over the water levels in the bed.

The only practical method of achieving this appears to be the installation of a pair of lift pumps at the outlet of the system pumping out over a weir. The alternative is to excavate the outlet ditch and increase the depth by one metre which may mean that it will not outfall. The pumps will have to cope both with normal effluent flows and with peak flows during periods of high rainfall unless the natural drainage water can be excluded from the effluent system.

3.03 The topography of the beds is such that it would not be possible to run all the effluent down the length of the bed - 700 metres, without creating a substantial hydraulic gradient. This would mean that the inlet end would be permanently flooded to a depth of 1.0 to 1.4 metres in order to stop the far end from drying out and maintain a proper flow.

To convert the bed to a treatment system requires that the flow direction be changed from the long axis to the short axis. This will mean that the incoming effluent would be rerouted along the eastern edge of the reedbed and designed to take normal effluent flows. An overflow weir would permit storm flows to flow directly into the collection ditch along the western side of the beds. The present drainage ditch would require deepening by between 0.5 and 0.8 metres. To prevent longitudinal flow clay bunds running east/west would be required at about 50 metre intervals and it is possible that a level control device in the form of an adjustable weir will be required at the outlet to each bed section so formed.

3.04 Whereas in our initial proposals we intimated that the reedbed should be burnt off to obtain a fresh start free of reed detritus, following the survey we feel that this may not be so advantageous. As the dead reed mass contains a proportion of the active rhizomes and as the rooting into the clay substrate is poor we feel it would be better to retain the peaty layer and allow it to continue to build up. It may in a number of years raise the level in the beds to the point where the pumping requirement is reduced to storm flow conditions only or even eliminated completely. It would also provide an active layer in which treatment can occur. The underlying clay substrate as mentioned above has a very poor hydraulic conductivity which will take many years to improve by rhizome activity so the best chance of active treatment seems to lie in utilising the self generated peat layer as well.

4.00 Outline Design.

4.01 As the effluent supply tends to arrive at the reedbed in surges it is necessary to construct an inlet lagoon to act as a buffer. This would occupy the whole width of the bed and be about 20 metres from north to south. At the north east corner of the lagoon would be constructed a screened inlet chamber fitted with a 300mm diameter PVC pipe running the whole length of the bed. This pipe would be fitted with two valved outlets leading into each section of the bed. The effluent would flow by gravity from the inlet chamber to the eastern edge of the reedbed. At the north west corner of the lagoon would be constructed a bypass weir to allow excessive floodwater directly into the north/south drainage ditch. This would normally be fairly well diluted effluent which would mix with the treated effluent coming off the treatment beds. From the level readings obtained it should be possible to direct at least 1500m3/day onto the reed beds with flows of over 1800m3/day being directed over the weir.

4.02 In order to carry out the balance of the construction programme it will be necessary to upgrade the road along the western edge of the bed as well as the bridge over the rhynne. All the brick rubble from the inlet lagoon could be used to upgrade the road surface and additional material will have to be brought in to complete the roadway.

4.03 It should be possible to construct the dividing bunds from this road by inserting culverts in the main drainage channel and working over them. The main north/south drain would be excavated by a further 800mm to 1.0m to assist in draining the beds and maintaining adequate levels. Some 5000 cubic metres of clay will be required to construct these bunds either from a borrow pit from within the site or more expensively from outside. The most suitable configuration appears to be units of 50 metres wide. A simple level control device may be required at the effluent exit from each section, this has been costed in but may not be required if the subsurface levels we have determined are accurate.

4.04 At the far end of the reedbed where it narrows into a single channel would be constructed the main lift pump station comprising a screened chamber fitted with three dirty water low lift pumps with a duty of 90m3/hr each. These would be adequate for the highest flows encountered and would be capable of pumping 6480m3/day if necessary. A major cost is the electrical supply cable, specialist advice would be sought regarding the most economical method of power transfer. A weir would be constructed in the channel to prevent return flows into the reedbed. Level control facilities would be incorporated into the chamber to enable the levels to be adjusted according to the season.

4.05 In order to reduce the shading effect and likely incursions by woody plants and to improve access the eastern boundary bank to the reedbed would be cleared of undergrowth and any regeneration sprayed off. In the case of the western bank there are also some young willows that will require removal.

4.06 As there is no longer a requirement to burn off the beds in late winter the construction phase can be left until weather conditions improve in late spring to early summer which provides a time frame to carry out detailed design and pre construction surveying. The estimated time to complete the construction phase would be of the order of 10-12 weeks weather permitting.

4.07 Our current best estimate of the likely cost of the proposed construction programme subject to detailed design approved by yourselves is of the order of £240,000.00. The detailed design and costing would take six to eight weeks including submissions from earthmoving contractors to the presentation of a design and quotation. Our charge for the preparation of the design and detailed costing would be £8,500.00 excl. VAT.

5.00 Management Strategy.

5.01 Once construction is completed and effluent can be transmitted across the beds there will be a release of sulphate as the sulphides become oxidised and enter the effluent stream. It is difficult to determine how long this will continue. It will be necessary to add soluble Potash and Phosphates to the effluent stream as it enters the beds, the former can be applied at any time and the latter would be applied in spring of the following year. This would aid the recovery of the damaged areas and significantly improve the performance of the better areas.

5.02 The sections that contain the damaged reeds will not provide high levels of treatment initially. Very careful management of the water levels will be required from the outset to avoid damage to the rhizomes that are growing in the peat horizon and it is difficult to determine with any accuracy what the overall level of treatment is likely to be in the short term. It will be a matter of responding to the reeds as they recover from a major change in hydraulic regime and adapting them gradually to the new circumstances. If the system is carefully managed from the outset and not exposed to undue pressure in terms of loading then it should develop into a system capable of removing up to 1350kgs of COD per day at full development. As is the case with all reedbed treatment systems we are not in a position to guarantee the performance of the system or how quickly it will be achieved. It is however our experience of other systems that have been adapted in this way that it is more cost effective than developing a system from scratch and tends to reach a satisfactory level of treatment quicker than a newly planted system. Our major concern at this stage is how much the high levels of sulphides in the bed will retard the development of a microbial population that can be adapted to treat your neutralised effluent.

5.03 It is our opinion that a viable system can be developed to at least partially treat your effluent and that it should produce results sooner than developing a new system. We look forward to discussing these proposals with you with a view to making further progress with this development in due course.

R.P. Marks

Appendix 1

Soil Sample Results

APPENDIX 1 - SOIL SAMPLE RESULTS.

BULK SAMPLE Q426-1 Average Drainage Channel Southern End.

Dry Matter %	40.03	Moisture %	59.97
Total Nitrogen %	0.45	pH	7.84
Available Chloride mg/kg	326.00	Total Chloride mg/kg	595.00
Available Nitrate mg/kg	<2.00	Total Nitrate mg/kg	<2.00
Available Sulphate mg/kg	1774.00	Total Sulphate mg/kg	3274.00
Available Phosphorus	2.18	Total Phosphorus mg/kg	5.60
Available Potassium mg/kg	74.00	Available Magnesium	78.00
Available Calcium mg/kg	642.00	Available Sodium mg/kg	346.00

* Available - as water soluble elements

BULK SAMPLE Q426-2 Average Badly Damaged Reed Areas.

Dry Matter %	61.72	Moisture %	38.28
Total Nitrogen %	0.19	pH	7.32
Available Chloride mg/kg	210.00	Total Chloride mg/kg	231.00
Available Nitrate mg/kg	<2.00	Total Nitrate mg/kg	22.00
Available Sulphate mg/kg	1944.00	Total Sulphate mg/kg	72715.00
Available Phosphorus	0.40	Total Phosphorus mg/kg	0.98
Available Potassium mg/kg	76.00	Available Magnesium	110.00
Available Calcium mg/kg	658.00	Available Sodium mg/kg	294.00

* Available - as water soluble elements

BULK SAMPLE Q426-3 Average Slightly Damaged Reed Areas

Dry Matter %	65.30	Moisture %	34.70
Total Nitrogen %	0.18	pH	7.15
Available Chloride mg/kg	188.00	Total Chloride mg/kg	235.00
Available Nitrate mg/kg	<2.00	Total Nitrate mg/kg	<2.00
Available Sulphate mg/kg	4478.00	Total Sulphate mg/kg	13350.00
Available Phosphorus	0.58	Total Phosphorus mg/kg	1.45
Available Potassium mg/kg	96.00	Available Magnesium	196.00
Available Calcium mg/kg	1426.00	Available Sodium mg/kg	228.00

* Available - as water soluble elements

APPENDIX 1 - Contd

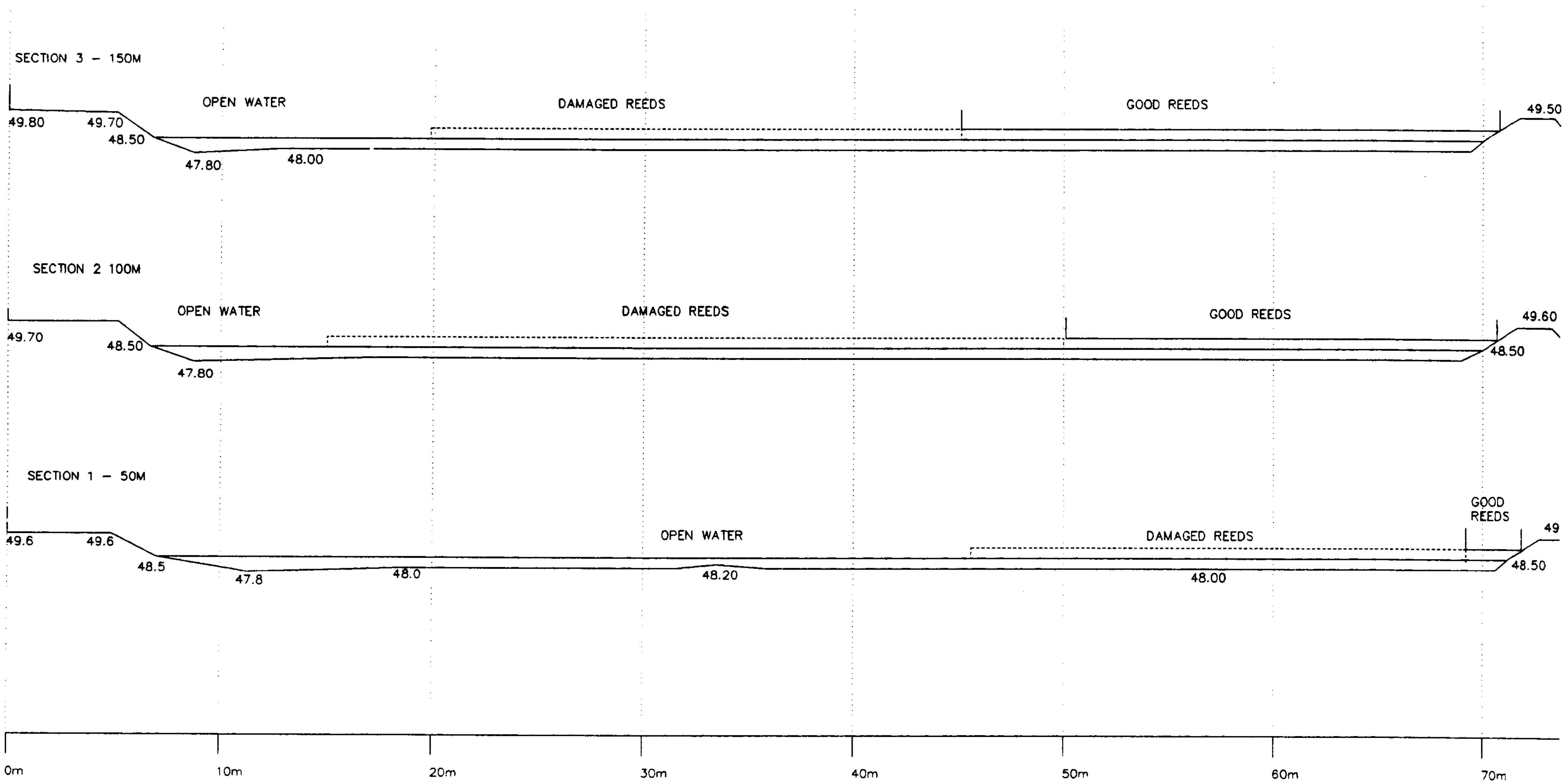
BULK SAMPLE Q426-4 Good Reed Areas

Dry Matter %	68.42	Moisture %	31.58
Total Nitrogen %	0.17	pH	7.49
Available Chloride mg/kg	156.00	Total Chloride mg/kg	462.00
Available Nitrate mg/kg	<2.00	Total Nitrate mg/kg	<2.00
Available Sulphate mg/kg	1676.00	Total Sulphate mg/kg	9402.00
Available Phosphorus	0.25	Total Phosphorus mg/kg	0.81
Available Potassium mg/kg	4.00	Available Magnesium	110.00
Available Calcium mg/kg	622.00	Available Sodium mg/kg	182.00

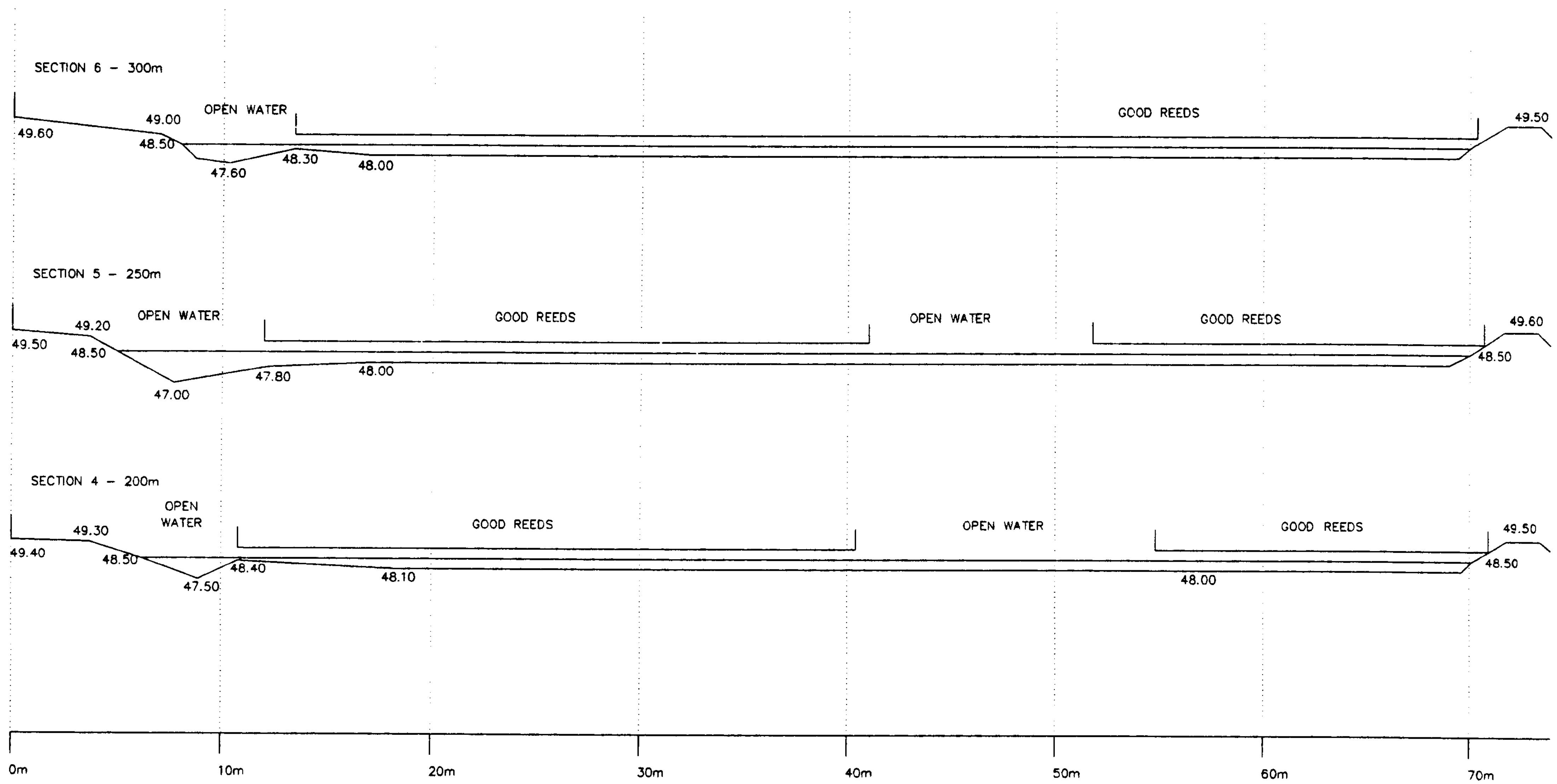
+ Available - as water soluble elements

Appendix 2

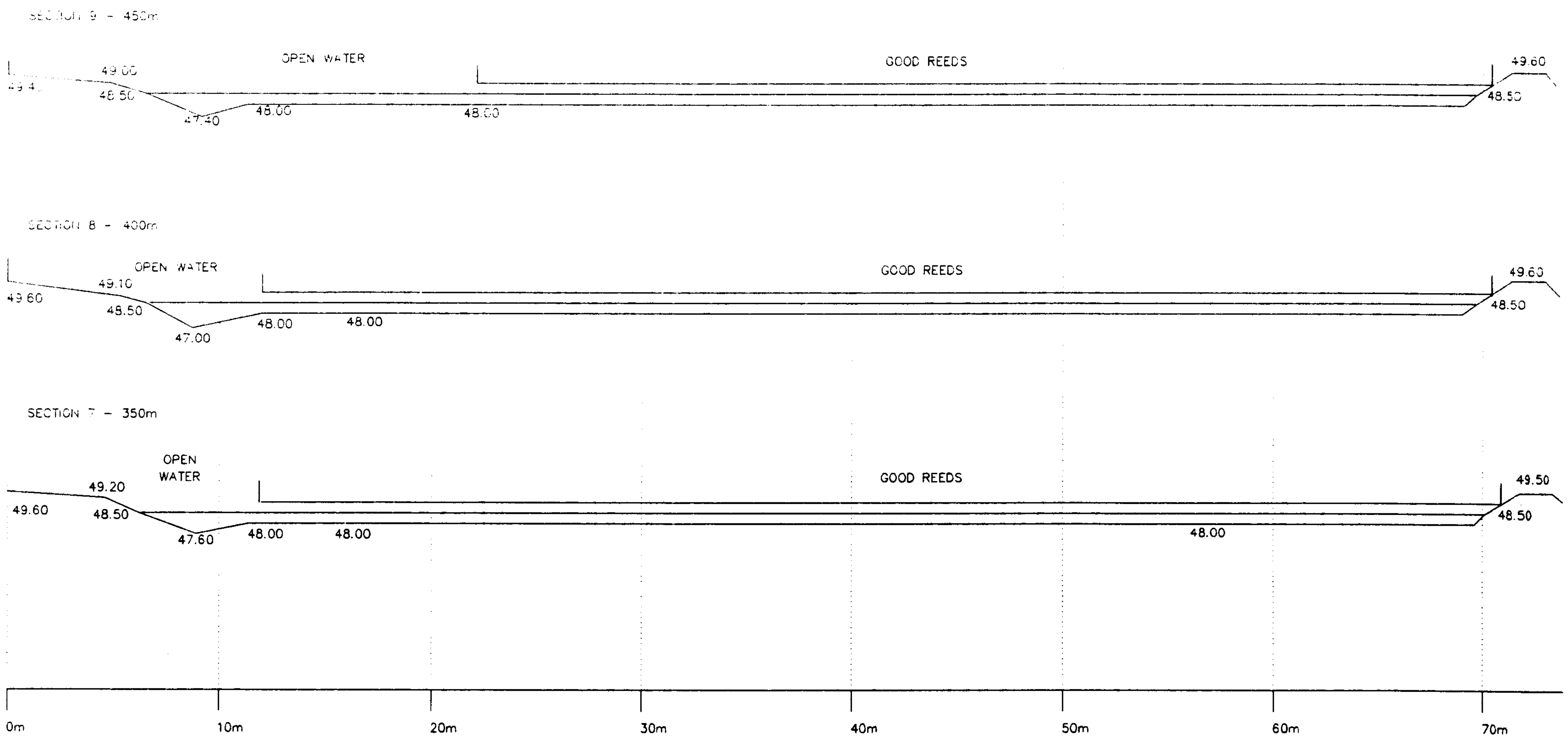
Reed Bed Sections



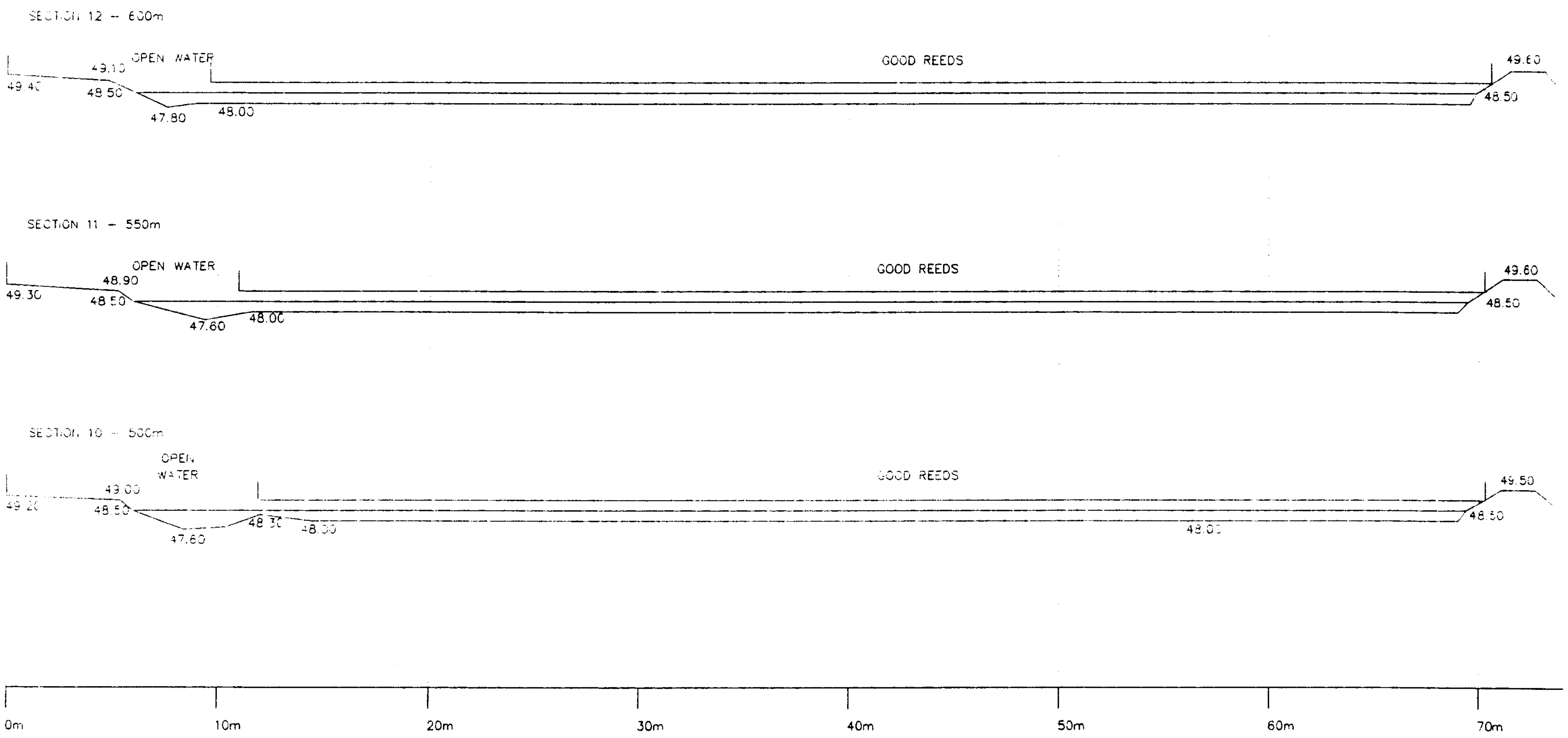
Duntech Environmental Services Lashlake Nurseries, Towersey, Thame, Oxon.	
Royal Ordnance Bridgewater.	Date: 4.01.94 Drawn By: RpM
Reedbed Sections	Scale: As Above
Drawing No. Q/426/20	Rev. A



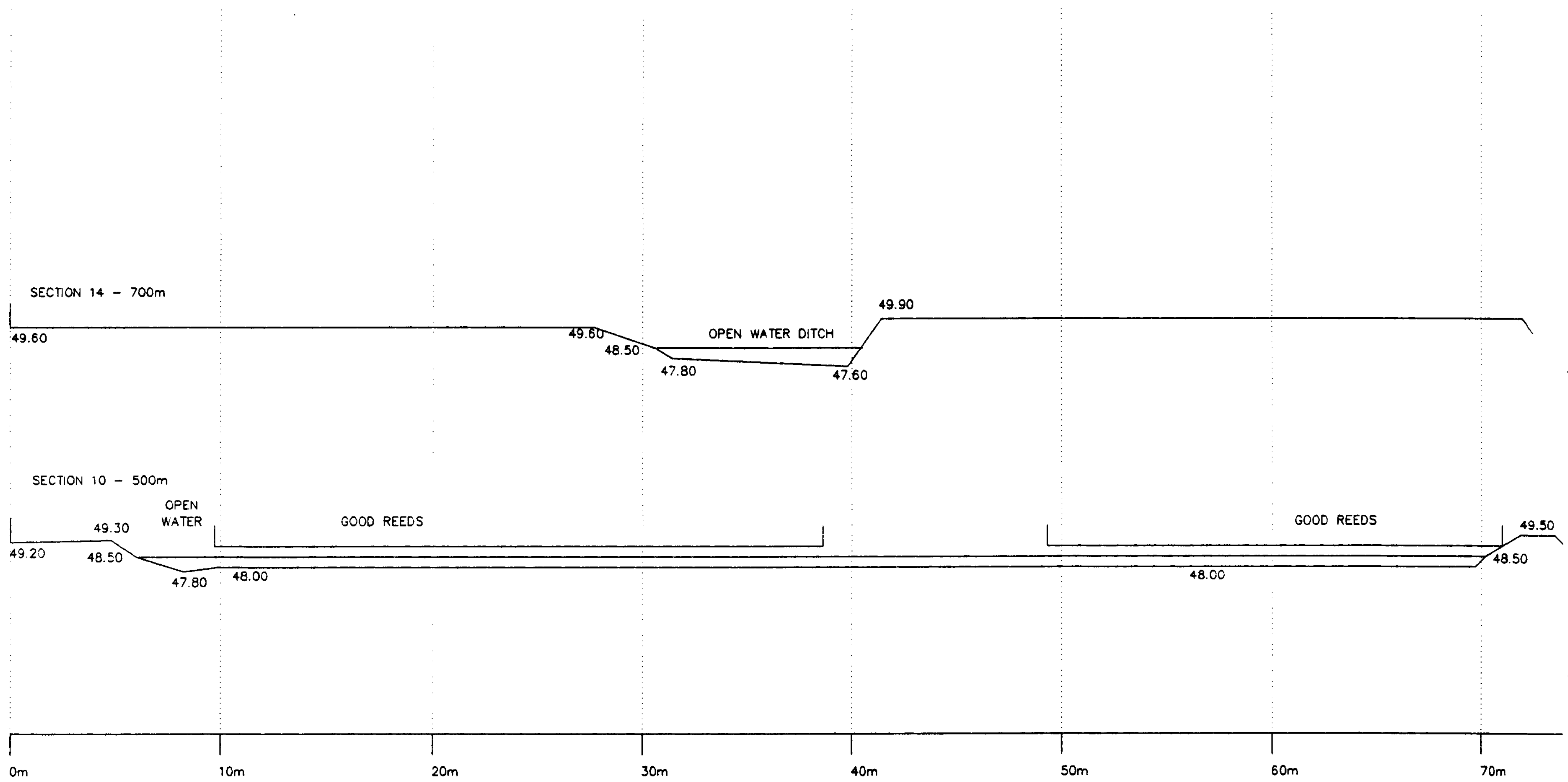
Duntech Environmental Services Lashlake Nurseries, Towersey, Thame, Oxon.	
Royal Ordnance Bridgewater.	Date: 4.01.94 Drawn By: RpM
Reedbed Sections	Scale: As Above
Drawing No. Q/426/21	Rev. A



Duntech Environmental Services Lashlake Nurseries, Towersey, Thame, Oxon.	
Royal Ordnance Bridgewater.	Date: 4.01.94 Drawn By: RpM
Reedbed Sections	Scale: As Above
Drawing No. Q/426/22	Rev. A



Duntech Environmental Services Lashlake Nurseries, Towersey, Thame, Oxon.	
Royal Ordnance Bridgewater.	Date: 4.01.94 Drawn By: RpM
Reedbed Sections	Scale: As Above
Drawing No.Q/426/23	Rev. A



Duntech Environmental Services Lashlake Nurseries, Towersey, Thame, Oxon.	
Royal Ordnance Bridgewater.	Date: 4.01.94 Drawn By: RpM
Reedbed Sections	Scale: As Above
Drawing No. Q/426/24	Rev. A

Appendix 3

Areas of Work

APPENDIX 3 - AREAS OF WORK TO CONVERT EXISTING REEDBED TO EFFLUENT TREATMENT.

1. Excavate inlet lagoon using rubble to part surface roadway.
2. Surface remainder of western roadway.
3. Clear Eastern bank of trees and shrubs.
4. Clear western bank of trees.
5. Strengthen bridge over rhynne.

6. Excavate drainage ditch by 0.8m
7. Supply and fit concrete culverts.
8. Supply and lay clay bunds 5000m3.
9 Construct subsidiary weirs if necessary..

10. Construct inlet chamber with screen, with grids over.
11. Supply and lay supply pipework 700m x 12" pvc in excavation with offtakes to bed sections.
12. Construct overflow weir with stop log controls.

13. Construct lift pump chamber, complete with screen, stop log level controls, grids and housing over.
14. Supply and fit lift pumps
15. Supply and install power cables to pump chamber.

16. Design and supervision of construction.

Appendix B 2020 Reed Bed Survey Plans

B02009_2d_SX-A1 @ 1_500SHEET1OF3
B02009_2d_SX-A1 @ 2_500SHEET1OF3
B02009_2d_SX-A1 @ 3_500SHEET1OF3

LEVEL INFORMATION

Heights in Metres
Datum Derived From: GPS Derived
OSBM Location: ST98
Value: 10.93m A.O.D
Active Station Locations: TAUN;NAS1;OSHQ
Conversions Used: OSTN02;OSGM02;

COORDINATE INFORMATION

Values in Metres
All Coordinates are: TRUE NATIONAL GRID
Scale Factor: 0.999646

SURVEY STATION SCHEDULE

STN	TYPE	EASTINGS	NORTHINGS	LEVEL
BASE1		333213.386	141912.129	6.293
BASE2		333494.130	142986.059	4.998
BASE3		333648.736	141869.469	8.229
BASE5		333442.947	141792.664	7.766
BED03		333432.929	143026.786	5.388
BED02		333525.273	143297.500	5.196
BED01		333624.465	143661.516	4.943
ST97		333459.699	141797.169	7.574
ST98		333306.080	141709.875	10.934

ABBREVIATIONS

General

(A)	Approximate	IC	Inspection Cover
AIF	Angle Iron Fence	IL	Invert Level
(AR)	Assumed Route	IRF	Iron Rail Fence
Avg	Average	IWF	Inter Woven Fence
BD	Bollard	KO	Kerb Outlet
Bin	Litter Bin	Ldr	Ladder
Bld	Building	LP	Lamp Post
BLW	Block Wall	MH	Manhole
BS	Bush	MHR	Metal Hand Rail
BT	British Telecom Inspection Chamber	MK	Marker
BW	Brick Wall	MP	Metal Post
BWF	Barbed Wire Fence	MPRF	Metal Post & Rail Fence
Cab	Cabinet	o/h	Overhead
CB	Crash Barrier	o/l	Outline
CBF	Close Boarded Fence	OSBM	Ordnance Survey Bench Mark
CDC	Concrete Drainage Channel	PalF	Pallisade Fence
CE	Concrete Edging	Pav	Paviors
ChP	Chestnut Paling	PI	Pipe Into Ground
CI	Cable Into Ground	Plt	Pavement Light
CIF	Corrugated Iron Fence	(R)	Records
CL	Cover Level	RE	Rodding Eye
CLF	Chain Link Fence	RS	Road Sign
CM	Cable Marker	RSJ	Rolled Steel Joist
Col	Column	RW	Retaining Wall
Conc	Concrete	SD	Slot Drain
CP	Concrete Post	SE	Stone Edging
CPS	Concrete Paving Slabs	SecF	Security Fence
CT	Cable TV Inspection Chamber	Shb	Shrubs
CW	Concrete Wall	SL	Soffit Level
d	Depth	Slt	Spotlight
Dil	Dilapidated	SN	Sign
DK	Drop Kerb	SV	Stop Valve
DP	Rainwater Down Pipe	SVMK	Stop Valve Marker
DSW	Dry Stone Wall	SW	Stone Wall
Ea	Earth	SWIC	Storm Water Inspection Chamber
EIC	Electricity Inspection Chamber	SY	Stay
EM	Electricity Meter	Tar	Tarmac
EP	Electricity Pole	ThL	Threshold Level
ER	Earth Rod	TL	Traffic Light
ETL	Electricity Transmission Lines	TMIC	Traffic Management IC
F	Fence	TP	Telegraph Pole
FH	Fire Hydrant	TPS	Tactile Paving Slabs
FHMK	Fire Hydrant Marker	TTL	Telephone Transmission Line
FL	Floor Level	u/g	Underground
Flb	Flowerbed	UTL	Unable To Lift
Flt	Floodlight	Veg	Vegetation
FP	Footpath	VP	Vent Pipe
FWIC	Foul Water Inspection Chamber	VT	Vent
GM	Gas Meter	W	Wall
GMK	Gas Marker	WE	Wood Edging
GP	Gate Post	WL	Water Level
Gr	Grass	WM	Water Meter
GV	Gas Valve	WMF	Wire Mesh Fence
Gvl	Gravel	WMK	Water Meter Marker
GY	Gully	WO	Wash Out
h	Height	WP	Wooden Post
Hc	Hardcore	WPR	Wooden Post & Rail Fence
IB	Illuminated Bollard		

Station Abreviations

HN	Hilti Nail	PKN	Parker Kalon Nail
PGM	Permanent Ground Marker	WP	Wooden Peg

NOTES

SCALE
Information has been gathered for the quoted scale.
Any enlargement should be verified on site.

DRAINAGE
Pipe sizes and connections are determined from surface level inspection and service records where available.

UNDERGROUND SERVICES
Any underground services shown on this survey are from information on service enquiries and tracing with Electrolocation equipment.
Some underground services may be undetectable, e.g. non-conductive pipes or cables and therefore NOT SHOWN

CONTOURS
Any contours depicted on this drawing have been interpolated from surveyed points, levels and features.
The contour line positions have been generated by ground modelling software and are INDICATIVE only.

Rev.	Date	Amendments

THE SURVEY ASSOCIATION
LEWIS BROWN
Chartered Land Surveyors
RICS

Quattro House
Castle Road
Chelston Business Park
Wellington
TA21 9JQ

Tel. 01823 667200
Fax. 01823 663266

www.lewisbrown.co.uk
Email. survey@lewisbrown.co.uk
Lewis Brown Limited Registered in England No. 4193534

CLIENT:
THIS IS GRAVITY
3 BURLINGTON GARDENS
LONDON
W12 3EP

TITLE:
PURITON, WOOLAVINGTON
REED BED

TOPOGRAPHICAL SURVEY

Drawing Number:		Revision:
B20009_2D_SX		
Scale:	Sheet:	Survey Date:
1:500	A1 1 OF 3	03/2020
Drawn:	Checked:	Project Number:
MA	RDJB	B20009

LEVEL INFORMATION

Heights in Metres

Datum Derived From: GPS Derived

OSBM Location: ST98

Value: 10.93m A.O.D

Active Station Locations: TAUN;NAS1;OSHQ

Conversions Used: OSTN02;OSGM02;

COORDINATE INFORMATION

Values in Metres

All Coordinates are: TRUE NATIONAL GRID

Scale Factor: 0.999646

SURVEY STATION SCHEDULE

STN	TYPE	EASTINGS	NORTHINGS	LEVEL
BASE1		333213.386	141912.129	6.293
BASE2		333494.130	142986.059	4.998
BASE3		333648.736	141869.469	8.229
BASE5		333442.947	141792.664	7.766
BED03		333432.929	143026.786	5.388
BED02		333525.273	143297.500	5.196
BED01		333624.465	143661.516	4.943
ST97		333459.699	141797.169	7.574
ST98		333306.080	141709.875	10.934

ABBREVIATIONS

General

(A)	Approximate	IC	Inspection Cover
AIF	Angle Iron Fence	IL	Invert Level
(AR)	Assumed Route	IRF	Iron Rail Fence
Avg	Average	IWF	Inter Woven Fence
BD	Bollard	KO	Kerb Outlet
Bin	Litter Bin	Ldr	Ladder
Bld	Building	LP	Lamp Post
BLW	Block Wall	MH	Manhole
BS	Bush	MHR	Metal Hand Rail
BT	British Telecom Inspection Chamber	MK	Marker
BW	Brick Wall	MP	Metal Post
BWF	Barbed Wire Fence	MPRF	Metal Post & Rail Fence
Cab	Cabinet	o/h	Overhead
CB	Crash Barrier	o/l	Outline
CBF	Close Boarded Fence	OSBM	Ordnance Survey Bench Mark
CDC	Concrete Drainage Channel	PalF	Pallisade Fence
CE	Concrete Edging	Pav	Paviors
ChP	Chestnut Paling	PI	Pipe Into Ground
CI	Cable Into Ground	Plt	Pavement Light
CIF	Corrugated Iron Fence	(R)	Records
CL	Cover Level	RE	Rodding Eye
CLF	Chain Link Fence	RS	Road Sign
CM	Cable Marker	RSJ	Rolled Steel Joist
Col	Column	RW	Retaining Wall
Conc	Concrete	SD	Slot Drain
CP	Concrete Post	SE	Stone Edging
CPS	Concrete Paving Slabs	SecF	Security Fence
CT	Cable TV Inspection Chamber	Shb	Shrubs
CW	Concrete Wall	SL	Soffit Level
d	Depth	Slt	Spotlight
Dil	Dilapidated	SN	Sign
DK	Drop Kerb	SV	Stop Valve
DP	Rainwater Down Pipe	SVMK	Stop Valve Marker
DSW	Dry Stone Wall	SW	Stone Wall
Ea	Earth	SWIC	Storm Water Inspection Chamber
EIC	Electricity Inspection Chamber	SY	Stay
EM	Electricity Meter	Tar	Tarmac
EP	Electricity Pole	ThL	Threshold Level
ER	Earth Rod	TL	Traffic Light
ETL	Electricity Transmission Lines	TMIC	Traffic Management IC
F	Fence	TP	Telegraph Pole
FH	Fire Hydrant	TPS	Tactile Paving Slabs
FHMK	Fire Hydrant Marker	TTL	Telephone Transmission Line
FL	Floor Level	u/g	Underground
Flb	Flowerbed	UTL	Unable To Lift
Flt	Floodlight	Veg	Vegetation
FP	Footpath	VP	Vent Pipe
FWIC	Foul Water Inspection Chamber	VT	Vent
GM	Gas Meter	W	Wall
GMK	Gas Marker	WE	Wood Edging
GP	Gate Post	WL	Water Level
Gr	Grass	WM	Water Meter
GV	Gas Valve	WMF	Wire Mesh Fence
Gvl	Gravel	WMK	Water Meter Marker
GY	Gully	WO	Wash Out
h	Height	WP	Wooden Post
Hc	Hardcore	WPR	Wooden Post & Rail Fence
IB	Illuminated Bollard		

Station Abreviations

HN	Hilti Nail	PKN	Parker Kalon Nail
PGM	Permanent Ground Marker	WP	Wooden Peg

NOTES

SCALE

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DRAINAGE

Pipe sizes and connections are determined from surface level inspection and service records where available.

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Some underground services may be undetectable, e.g. non-conductive pipes or cables and therefore NOT SHOWN

CONTOURS

Any contours depicted on this drawing have been interpolated from surveyed points, levels and features.
The contour line positions have been generated by ground modelling software and are INDICATIVE only.

Rev.	Date	Amendments

LEWIS BROWN
Chartered Land Surveyors

Quattro House
Castle Road
Chelston Business Park
Wellington
TA21 9JQ

Tel. 01823 667200
Fax. 01823 663266

www.lewisbrown.co.uk
Email. survey@lewisbrown.co.uk

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MA	RDJB	B20009

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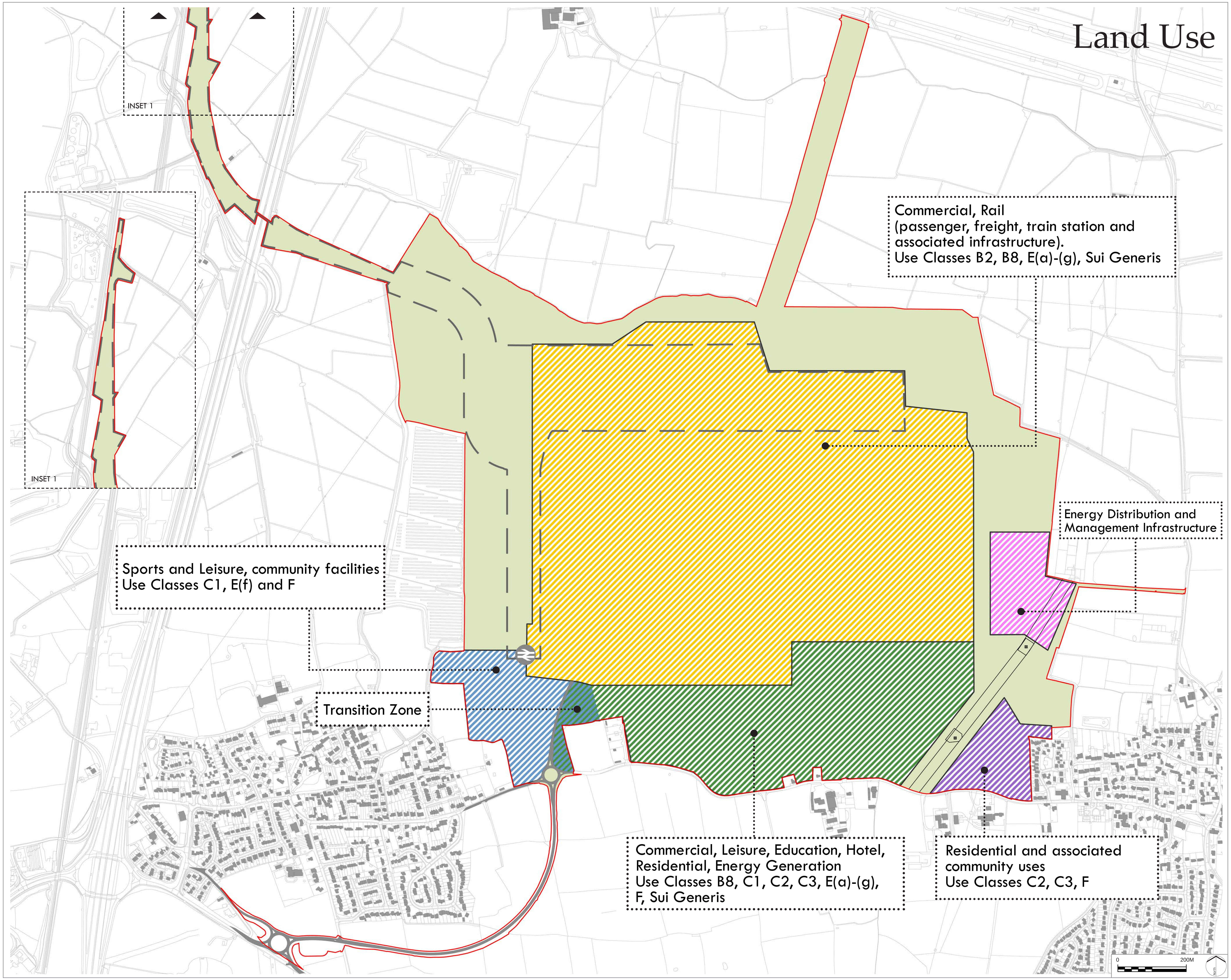
Appendix E Development Proposals

6599_PP201L_Land Uses
6599_PP206F_Strategic Landscape



LEGEND

- LDO Boundary
- Commercial, Rail (passenger, freight, train station and associated infrastructure). Use Classes B2, B8, E(a)-(g), Sui Generis
- Energy Distribution and Management Infrastructure
- Residential and associated community uses Use Classes C2, C3, F
- Commercial, Leisure, Education, Hotel, Residential, Energy Generation Use Classes B8, C1, C2, C3, E(a)-(g), F, Sui Generis
- Sports and Leisure, community facilities Use Classes C1, E(f) and F
- Transition Zone
- Open space and biodiversity zones Including surface water attenuation features, watercourses, woodland, hedgerows and trees, utilities, occasional vehicular routes and rail line with associated infrastructure.
- Rail corridor - Freight and Passenger, and associated infrastructure
- Passenger Station (indicative location)

REV.	DESCRIPTION	APP.	DATE
L	Changes to title block	RF	08.09.21
K	Key updated	RF	25.08.21
J	Key updated	RF	16.08.21
I	Key updated	RF	16.08.21
H	Key updated	RF	16.08.21
G	Uses zones updated	RF	13.08.21
F	Key updated and train station logo relocated	RF	13.08.21
E	Key updated following comments from JH	RF	08.06.21
D	Key updated following comments from CP	RF	04.06.21
C	Rail corridor; plan inset	RF	03.06.21
B	Use classes	RF	24.05.21
A	Format of key amended	RF	24.05.21
-	First Issue	RF	21.05.21

LDĀ DESIGN

PROJECT TITLE
GRAVITY

DRAWING TITLE
PARAMETER PLAN
Land Uses

ISSUED BY	Exeter	T: 01392 260430	
DATE	May 2021	DRAWN	KS/DA
SCALE@A1	1:5,000	CHECKED	RF
STATUS	LDO	APPROVED	FO

DWG. NO. 6599_PP201L

No dimensions are to be scaled from this drawing.
All dimensions are to be checked on site.
Area measurements for indicative purposes only.

Sources: Ordnance Survey

v2018.0

Strategic Landscape

LEGEND

- LDO Boundary
- Greenspace
- Micromobility connections (including pedestrian and cycle)
- East-west landscape corridor to incorporate landscaping such as street trees and rhynes
- Existing trees/ woodland to be retained where possible
- Structural tree and woodland planting (indicative extents)
- Trees to be retained where possible subject to rail alignment and necessary associated infrastructure
- Gravity Park
- Green Edge to Woolavington
- Indicative location of greenspace
- Placemaking Node – important focal points, development should respond appropriately through landscape and built form.
- Green Edge to Woolavington Road – landscaped area adjoining highway to reflect campus feel.
- Landscape bund and planting
- Existing water bodies to be retained
- Indicative location of water attenuation
- Attenuation areas to be delievered as part of the link road
- Existing rhynes, IDB rhynes to be retained, other rhynes to be incorporated into site-wide drainage strategy
- Wellbeing and Arrival Zone Up to 50% of the zone will accommodate buildings, the remainder will be blue and green infrastructure, tree nursery, community uses, sports, leisure or associated infrastructure such as roads, footpaths and cycle routes.
- Rail corridor - Freight and Passenger, and associated infrastructure
- Passenger Station (indicative location)
- Development zone
- Development zone - Up to 50% of the zone will accommodate buildings, the remainder will be associated infrastructure such as rail, including mobile gantry cranes, roads and laydown space and/or green infrastructure.
- Overhead powerlines 400 kVA

REV.	DESCRIPTION	APP.	DATE
F	Changes to title block	RF	08.09.21
E	Woodland and water attenuation areas updated	RF	25.08.21
D	Train station logo relocated	RF	13.08.21
C	Key wording amended following CP comments	RF	04.06.21
B	Paths; graphic representation/ key; plan inset	RF	03.06.21
A	Format of key amended	RF	24.05.21
-	First Issue	RF	21.05.21

LDĀ DESIGN

PROJECT TITLE
GRAVITY

DRAWING TITLE
PARAMETER PLAN
Strategic Landscape

ISSUED BY	Exeter	T: 01392 260430	
DATE	May 2021	DRAWN	KS/DA
SCALE@A1	1:5,000	CHECKED	RF
STATUS	LDO	APPROVED	FO

DWG. NO. 6599_PP206F

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Sources: Ordnance Survey

v2018.0

Appendix F Proposed Drainage

MicroDrainage Network Model Output
Proposed SW Drainage Strategy Model Schematic 332310102-4002-SK04

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 391363 263985 SO 91363 63985
Data Type	Point
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	174.208	2.500	69.7	9.692	10.00	0.0	0.040	\/	-2	Pipe/Conduit	
S1.001	68.976	0.046	1499.5	0.488	0.00	0.0	0.040	\/	-5	Pipe/Conduit	
S1.002	50.644	0.204	248.3	0.000	0.00	0.0	0.040	\/	-3	Pipe/Conduit	
S1.003	49.705	1.000	49.7	0.000	0.00	0.0	0.040	\/	-3	Pipe/Conduit	
S2.000	23.605	0.500	47.2	8.180	10.00	0.0	0.040	\/	-2	Pipe/Conduit	
S1.004	41.249	0.750	55.0	0.000	0.00	0.0	0.040	\/	-3	Pipe/Conduit	
S1.005	53.899	0.750	71.9	0.000	0.00	0.0	0.040	\/	-3	Pipe/Conduit	
S1.006	27.034	1.250	21.6	0.000	0.00	0.0	0.040	\/	-3	Pipe/Conduit	
S1.007	26.281	2.652	9.9	0.000	0.00	0.0	0.040	\/	-2	Pipe/Conduit	
S3.000	43.816	1.000	43.8	7.418	10.00	0.0	0.040	\/	-2	Pipe/Conduit	
S3.001	80.001	4.750	16.8	0.000	0.00	0.0	0.040	\/	-2	Pipe/Conduit	
S3.002	18.710	0.250	74.8	0.263	0.00	0.0	0.040	\/	-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)
S1.000	50.00	11.33	15.750	9.692	0.0	0.0	0.0	2.18	6541.9	1312.4
S1.001	50.00	13.46	13.250	10.180	0.0	0.0	0.0	0.54	3244.2	1378.6
S1.002	50.00	14.14	13.204	10.180	0.0	0.0	0.0	1.23	4938.1	1378.6
S1.003	50.00	14.44	13.000	10.180	0.0	0.0	0.0	2.76	11035.8	1378.6
S2.000	50.00	10.15	12.500	8.180	0.0	0.0	0.0	2.65	7947.9	1107.7
S1.004	50.00	14.70	12.000	18.360	0.0	0.0	0.0	2.62	10491.3	2486.2
S1.005	50.00	15.10	11.250	18.360	0.0	0.0	0.0	2.29	9177.9	2486.2
S1.006	50.00	15.20	10.500	18.360	0.0	0.0	0.0	4.18	16730.4	2486.2
S1.007	50.00	15.28	9.250	18.360	0.0	0.0	0.0	5.78	17347.5	2486.2
S3.000	50.00	10.27	17.000	7.418	0.0	0.0	0.0	2.75	8250.0	1004.5
S3.001	50.00	10.57	16.000	7.418	0.0	0.0	0.0	4.44	13306.7	1004.5
S3.002	50.00	10.71	11.250	7.682	0.0	0.0	0.0	2.10	6312.5	1040.2

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
S3.003	49.823	0.033	1509.8	0.000	0.00	0.0	0.040	\/	-5	Pipe/Conduit	
S3.004	10.958	0.007	1565.4	0.000	0.00	0.0	0.040	\/	-5	Pipe/Conduit	
S3.005	17.085	0.011	1553.2	0.000	0.00	0.0	0.040	\/	-5	Pipe/Conduit	
S3.006	24.982	0.948	26.4	0.000	0.00	0.0	0.040	\/	-2	Pipe/Conduit	
S3.007	13.386	0.250	53.5	0.183	0.00	0.0	0.040	\/	-2	Pipe/Conduit	
S3.008	22.523	0.500	45.0	0.000	0.00	0.0	0.040	\/	-2	Pipe/Conduit	
S3.009	127.759	0.750	170.3	0.194	0.00	0.0	0.040	\/	-4	Pipe/Conduit	
S3.010	86.536	1.750	49.4	1.885	0.00	0.0	0.040	\/	-4	Pipe/Conduit	
S3.011	163.547	0.109	1500.4	2.593	0.00	0.0	0.040	\/	-11	Pipe/Conduit	
S3.012	65.241	0.044	1482.8	1.973	0.00	0.0	0.040	\/	-11	Pipe/Conduit	
S1.008	78.844	0.053	1487.6	3.258	0.00	0.0	0.040	\/	-10	Pipe/Conduit	
S1.009	145.650	1.618	90.0	0.000	0.00	0.0	0.040	\/	-5	Pipe/Conduit	
S4.000	160.373	0.500	320.7	15.140	10.00	0.0	0.040	\/	-5	Pipe/Conduit	
S4.001	23.446	0.016	1465.4	0.000	0.00	0.0	0.040	\/	-7	Pipe/Conduit	
S4.002	24.295	0.016	1518.4	0.000	0.00	0.0	0.040	\/	-7	Pipe/Conduit	
S4.003	60.127	1.968	30.6	0.000	0.00	0.0	0.040	\/	-2	Pipe/Conduit	
S4.004	37.107	2.500	14.8	0.000	0.00	0.0	0.040	\/	-2	Pipe/Conduit	
S4.005	29.859	2.500	11.9	0.000	0.00	0.0	0.040	\/	-2	Pipe/Conduit	
S4.006	99.059	1.750	56.6	1.564	0.00	0.0	0.040	\/	-2	Pipe/Conduit	
S4.007	110.900	0.074	1498.6	1.330	0.00	0.0	0.040	\/	-8	Pipe/Conduit	
S5.000	41.040	1.574	26.1	0.000	5.00	0.0	0.040	\/	-1	Pipe/Conduit	
S4.008	22.176	0.015	1478.4	1.303	0.00	0.0	0.040	\/	-8	Pipe/Conduit	
S4.009	55.223	1.911	28.9	1.706	0.00	0.0	0.040	\/	-3	Pipe/Conduit	
S4.010	230.261	1.500	153.5	5.962	0.00	0.0	0.040	\/	-4	Pipe/Conduit	
S4.011	242.460	0.162	1496.7	3.475	0.00	0.0	0.040	\/	-10	Pipe/Conduit	
S4.012	242.460	0.162	1496.7	2.304	0.00	0.0	0.040	\/	-10	Pipe/Conduit	
S1.010	294.526	0.464	635.4	2.008	0.00	0.0	0.040	\/	-14	Pipe/Conduit	

Network Results Table

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S3.003	50.00	12.26	11.000	7.682	0.0	0.0	0.0	0.54	3233.1	1040.2
S3.004	50.00	12.60	10.967	7.682	0.0	0.0	0.0	0.53	3175.1	1040.2
S3.005	50.00	13.14	10.960	7.682	0.0	0.0	0.0	0.53	3187.6	1040.2
S3.006	50.00	13.25	10.949	7.682	0.0	0.0	0.0	3.55	10638.0	1040.2
S3.007	50.00	13.34	10.001	7.865	0.0	0.0	0.0	2.49	7463.0	1065.0
S3.008	50.00	13.48	9.751	7.865	0.0	0.0	0.0	2.71	8136.6	1065.0
S3.009	50.00	14.85	9.251	8.059	0.0	0.0	0.0	1.56	7780.6	1091.3
S3.010	50.00	15.35	8.501	9.944	0.0	0.0	0.0	2.89	14441.0	1346.5
S3.011	50.00	19.99	6.751	12.537	0.0	0.0	0.0	0.59	7046.2	1697.6
S3.012	50.00	21.83	6.642	14.510	0.0	0.0	0.0	0.59	7088.0	1964.8
S1.008	50.00	24.08	6.598	36.129	0.0	0.0	0.0	0.59	6435.4	4892.3
S1.009	50.00	25.18	6.545	36.129	0.0	0.0	0.0	2.21	13240.7	4892.3
S4.000	50.00	12.29	18.000	15.140	0.0	0.0	0.0	1.17	7014.5	2050.1
S4.001	50.00	12.97	17.500	15.140	0.0	0.0	0.0	0.57	4554.7	2050.1
S4.002	50.00	13.70	17.484	15.140	0.0	0.0	0.0	0.56	4474.4	2050.1
S4.003	50.00	14.00	17.468	15.140	0.0	0.0	0.0	3.29	9879.8	2050.1
S4.004	50.00	14.13	15.500	15.140	0.0	0.0	0.0	4.72	14174.7	2050.1
S4.005	50.00	14.23	13.000	15.140	0.0	0.0	0.0	5.27	15801.7	2050.1
S4.006	50.00	14.91	10.500	16.703	0.0	0.0	0.0	2.42	7258.4	2261.8
S4.007	50.00	18.15	8.750	18.033	0.0	0.0	0.0	0.57	5138.0	2441.9
S5.000	50.00	5.22	10.250	0.000	0.0	0.0	0.0	3.18	6351.5	0.0
S4.008	50.00	18.79	8.676	19.336	0.0	0.0	0.0	0.57	5173.1	2618.4
S4.009	50.00	19.04	8.661	21.042	0.0	0.0	0.0	3.62	14473.6	2849.4
S4.010	50.00	21.38	6.750	27.005	0.0	0.0	0.0	1.64	8196.2	3656.8
S4.011	50.00	28.31	5.250	30.480	0.0	0.0	0.0	0.58	6415.9	4127.4
S4.012	50.00	30.00	5.089	32.784	0.0	0.0	0.0	0.58	6415.9	4439.3
S1.010	50.00	30.00	4.927	70.921	0.0	0.0	0.0	1.05	19987.1	9603.6

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.011	294.662	0.464	635.7	6.089	0.00	0.0	0.040	\/	-14	Pipe/Conduit	
S1.012	54.568	0.036	1515.8	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.013	133.777	0.090	1486.4	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.014	117.224	0.124	945.4	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.015	76.058	0.043	1768.8	0.751	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.016	92.412	0.053	1743.6	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.017	75.260	0.043	1750.2	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.018	38.718	0.022	1759.9	3.137	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.019	10.530	0.006	1755.0	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.020	7.896	0.005	1579.2	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.021	5.390	0.003	1796.7	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.022	14.368	0.008	1796.0	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.023	37.467	0.021	1784.1	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.024	15.192	0.009	1688.0	4.129	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.025	10.836	0.006	1806.0	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.026	11.048	0.006	1841.3	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.027	26.547	0.015	1769.8	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.028	14.888	0.009	1654.2	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.029	50.033	0.029	1725.3	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S1.030	49.507	0.028	1768.1	0.000	0.00	0.0	0.040	\/	-15	Pipe/Conduit	
S6.000	550.262	0.366	1503.4	6.801	5.00	0.0	0.040	\/	-7	Pipe/Conduit	
S6.001	272.012	0.181	1502.8	0.000	0.00	0.0	0.040	\/	-6	Pipe/Conduit	
S6.002	272.012	0.181	1502.8	6.801	0.00	0.0	0.040	\/	-6	Pipe/Conduit	
S6.003	282.777	0.188	1504.1	6.775	0.00	0.0	0.040	\/	-6	Pipe/Conduit	
S6.004	282.777	0.188	1504.1	6.801	0.00	0.0	0.040	\/	-6	Pipe/Conduit	
S7.000	549.222	0.366	1500.6	6.801	5.00	0.0	0.040	\/	-7	Pipe/Conduit	
S7.001	272.012	0.091	2989.1	0.000	0.00	0.0	0.040	\/	-6	Pipe/Conduit	
S7.002	272.012	0.182	1494.6	6.801	0.00	0.0	0.040	\/	-6	Pipe/Conduit	
S7.003	277.485	0.232	1196.1	6.801	0.00	0.0	0.040	\/	-6	Pipe/Conduit	
S7.004	276.445	0.232	1191.6	6.801	0.00	0.0	0.040	\/	-6	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)
S1.011	50.00	30.00	4.464	77.010	0.0	0.0	0.0	1.05	19982.4	10428.1
S1.012	50.00	30.00	3.500	77.010	0.0	0.0	0.0	0.76	18796.0	10428.1
S1.013	50.00	30.00	3.464	77.010	0.0	0.0	0.0	0.77	18980.8	10428.1
S1.014	50.00	30.00	3.374	77.010	0.0	0.0	0.0	0.96	23800.5	10428.1
S1.015	50.00	30.00	3.250	77.761	0.0	0.0	0.0	0.70	17399.9	10529.8
S1.016	50.00	30.00	3.207	77.761	0.0	0.0	0.0	0.71	17525.0	10529.8
S1.017	50.00	30.00	3.154	77.761	0.0	0.0	0.0	0.71	17491.9	10529.8
S1.018	50.00	30.00	3.111	80.898	0.0	0.0	0.0	0.70	17443.7	10954.6
S1.019	50.00	30.00	3.089	80.898	0.0	0.0	0.0	0.71	17468.1	10954.6
S1.020	50.00	30.00	3.083	80.898	0.0	0.0	0.0	0.74	18414.7	10954.6
S1.021	50.00	30.00	3.078	80.898	0.0	0.0	0.0	0.70	17264.3	10954.6
S1.022	50.00	30.00	3.075	80.898	0.0	0.0	0.0	0.70	17267.5	10954.6
S1.023	50.00	30.00	3.067	80.898	0.0	0.0	0.0	0.70	17324.8	10954.6
S1.024	50.00	30.00	3.046	85.026	0.0	0.0	0.0	0.72	17811.4	11513.6
S1.025	50.00	30.00	3.037	85.026	0.0	0.0	0.0	0.70	17219.7	11513.6
S1.026	50.00	30.00	3.031	85.026	0.0	0.0	0.0	0.69	17053.7	11513.6
S1.027	50.00	30.00	3.025	85.026	0.0	0.0	0.0	0.70	17394.9	11513.6
S1.028	50.00	30.00	3.010	85.026	0.0	0.0	0.0	0.73	17992.3	11513.6
S1.029	50.00	30.00	3.001	85.026	0.0	0.0	0.0	0.71	17617.9	11513.6
S1.030	50.00	30.00	2.972	85.026	0.0	0.0	0.0	0.70	17403.2	11513.6
S6.000	50.00	21.32	5.350	6.801	0.0	0.0	0.0	0.56	4496.7	921.0
S6.001	50.00	29.52	4.984	6.801	0.0	0.0	0.0	0.55	3867.3	921.0
S6.002	50.00	30.00	4.803	13.602	0.0	0.0	0.0	0.55	3867.3	1841.9
S6.003	50.00	30.00	4.622	20.377	0.0	0.0	0.0	0.55	3865.6	2759.3
S6.004	50.00	30.00	4.434	27.178	0.0	0.0	0.0	0.55	3865.6	3680.3
S7.000	50.00	21.27	5.350	6.801	0.0	0.0	0.0	0.56	4500.9	921.0
S7.001	50.00	30.00	4.984	6.801	0.0	0.0	0.0	0.39	2742.1	921.0
S7.002	50.00	30.00	4.893	13.602	0.0	0.0	0.0	0.55	3878.0	1841.9
S7.003	50.00	30.00	4.711	20.403	0.0	0.0	0.0	0.62	4335.0	2762.9
S7.004	50.00	30.00	4.479	27.204	0.0	0.0	0.0	0.62	4343.1	3683.8

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
S6.005	257.224	0.170	1513.1	0.000	0.00	0.0	0.040	\/	-11	Pipe/Conduit	
S6.006	129.778	0.362	358.5	0.000	0.00	0.0	0.040	\/	-11	Pipe/Conduit	
S1.031	2.873	0.002	1436.5	0.000	0.00	0.0	0.035	\/	-20	Pipe/Conduit	
S1.032	2.881	0.002	1440.5	0.000	0.00	0.0	0.035	\/	-20	Pipe/Conduit	
S1.033	11.659	0.007	1665.6	0.000	0.00	0.0	0.035	\/	-20	Pipe/Conduit	
S1.034	3.876	0.002	1938.0	0.000	0.00	0.0	0.035	\/	-20	Pipe/Conduit	
S1.035	2.832	0.002	1416.0	0.000	0.00	0.0	0.035	\/	-20	Pipe/Conduit	
S1.036	14.804	0.008	1850.5	0.000	0.00	0.0	0.035	\/	-20	Pipe/Conduit	
S1.037	9.386	0.005	1877.2	0.000	0.00	0.0	0.035	\/	-20	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)
S6.005	50.00	30.00	3.976	54.382	0.0	0.0	0.0	0.58	7016.6«	7364.1
S6.006	50.00	30.00	3.806	54.382	0.0	0.0	0.0	1.20	14415.0	7364.1
S1.031	50.00	30.00	2.944	139.409	0.0	0.0	0.0	0.91	29406.4	18877.7
S1.032	50.00	30.00	2.942	139.409	0.0	0.0	0.0	0.91	29365.6	18877.7
S1.033	50.00	30.00	2.940	139.409	0.0	0.0	0.0	0.85	27309.5	18877.7
S1.034	50.00	30.00	2.933	139.409	0.0	0.0	0.0	0.79	25317.4	18877.7
S1.035	50.00	30.00	2.931	139.409	0.0	0.0	0.0	0.92	29618.5	18877.7
S1.036	50.00	30.00	2.929	139.409	0.0	0.0	0.0	0.80	25909.0	18877.7
S1.037	50.00	30.00	2.921	139.409	0.0	0.0	0.0	0.80	25724.1	18877.7

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	27	35.897	9.692	9.692
1.001	User	-	100	0.488	0.488	0.488
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.000	0.000	0.000
2.000	User	-	27	30.296	8.180	8.180
1.004	-	-	100	0.000	0.000	0.000
1.005	-	-	100	0.000	0.000	0.000
1.006	-	-	100	0.000	0.000	0.000
1.007	-	-	100	0.000	0.000	0.000
3.000	User	-	27	27.475	7.418	7.418
3.001	-	-	100	0.000	0.000	0.000
3.002	User	-	100	0.263	0.263	0.263
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
3.007	User	-	100	0.183	0.183	0.183
3.008	-	-	100	0.000	0.000	0.000
3.009	User	-	100	0.194	0.194	0.194
3.010	User	-	100	1.380	1.380	1.380
	User	-	100	0.505	0.505	1.885
3.011	User	-	100	0.232	0.232	0.232
	User	-	100	0.771	0.771	1.003
	User	-	100	1.590	1.590	2.593
3.012	User	-	100	1.247	1.247	1.247
	User	-	100	0.727	0.727	1.973
1.008	User	-	100	0.214	0.214	0.214
	User	-	100	1.167	1.167	1.381
	User	-	100	1.878	1.878	3.258
1.009	-	-	100	0.000	0.000	0.000
4.000	User	-	27	56.073	15.140	15.140
4.001	-	-	100	0.000	0.000	0.000
4.002	-	-	100	0.000	0.000	0.000
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
4.006	User	-	100	1.564	1.564	1.564
4.007	User	-	100	1.330	1.330	1.330
5.000	-	-	100	0.000	0.000	0.000
4.008	User	-	100	1.303	1.303	1.303
4.009	User	-	100	1.706	1.706	1.706
4.010	User	-	100	3.344	3.344	3.344
	User	-	100	1.037	1.037	4.381
	User	-	100	1.581	1.581	5.962
4.011	User	-	100	2.475	2.475	2.475
	User	-	100	1.001	1.001	3.475
4.012	User	-	100	1.163	1.163	1.163
	User	-	100	0.757	0.757	1.920
	User	-	100	0.384	0.384	2.304
1.010	User	-	100	1.355	1.355	1.355
	User	-	100	0.654	0.654	2.008
1.011	User	-	100	6.089	6.089	6.089
1.012	-	-	100	0.000	0.000	0.000
1.013	-	-	100	0.000	0.000	0.000
1.014	-	-	100	0.000	0.000	0.000
1.015	User	-	100	0.751	0.751	0.751
1.016	-	-	100	0.000	0.000	0.000
1.017	-	-	100	0.000	0.000	0.000
1.018	User	-	100	3.137	3.137	3.137
1.019	-	-	100	0.000	0.000	0.000
1.020	-	-	100	0.000	0.000	0.000
1.021	-	-	100	0.000	0.000	0.000
1.022	-	-	100	0.000	0.000	0.000
1.023	-	-	100	0.000	0.000	0.000
1.024	User	-	100	4.129	4.129	4.129
1.025	-	-	100	0.000	0.000	0.000
1.026	-	-	100	0.000	0.000	0.000
1.027	-	-	100	0.000	0.000	0.000
1.028	-	-	100	0.000	0.000	0.000
1.029	-	-	100	0.000	0.000	0.000
1.030	-	-	100	0.000	0.000	0.000
6.000	User	-	100	6.801	6.801	6.801

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
6.001	-	-	100	0.000	0.000	0.000
6.002	User	-	100	6.801	6.801	6.801
6.003	User	-	100	6.775	6.775	6.775
6.004	User	-	100	6.801	6.801	6.801
7.000	User	-	100	6.801	6.801	6.801
7.001	-	-	100	0.000	0.000	0.000
7.002	User	-	100	6.801	6.801	6.801
7.003	User	-	100	6.801	6.801	6.801
7.004	User	-	100	6.801	6.801	6.801
6.005	-	-	100	0.000	0.000	0.000
6.006	-	-	100	0.000	0.000	0.000
1.031	-	-	100	0.000	0.000	0.000
1.032	-	-	100	0.000	0.000	0.000
1.033	-	-	100	0.000	0.000	0.000
1.034	-	-	100	0.000	0.000	0.000
1.035	-	-	100	0.000	0.000	0.000
1.036	-	-	100	0.000	0.000	0.000
1.037	-	-	100	0.000	0.000	0.000
				Total 248.719	Total 139.409	Total 139.409

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)
S1.037	S	0.000	2.916	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	0.000
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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	0	Number of Storage Structures	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	19.100	Cv (Summer)	0.750
Return Period (years)	1	Ratio R	0.350	Cv (Winter)	0.840
Region	England and Wales	Profile Type	Summer	Storm Duration (mins)	30

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	0.000
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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	0	Number of Storage Structures	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH	Data Type	Point
FEH Rainfall Version	2013	Cv (Summer)	0.750
Site Location	GB 391363 263985 SO 91363 63985	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	ON
Analysis Timestep	Fine	Inertia Status	ON
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2880
Return Period(s) (years)	2, 5, 10, 30, 100
Climate Change (%)	0, 0, 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	15 Winter	2	+0%					16.102	-0.648	0.000
S1.001	S2	15 Winter	2	+0%	100/15 Winter	100/15 Winter			13.730	-0.520	0.000
S1.002	S3	15 Winter	2	+0%					13.597	-0.607	0.000
S1.003	S4	15 Winter	2	+0%					13.241	-0.759	0.000
S2.000	S5	15 Winter	2	+0%					12.785	-0.715	0.000
S1.004	S6	15 Winter	2	+0%					12.341	-0.659	0.000
S1.005	S7	15 Winter	2	+0%					11.617	-0.633	0.000
S1.006	S8	15 Winter	2	+0%					10.757	-0.743	0.000
S1.007	S9	15 Winter	2	+0%					9.508	-0.742	0.000
S3.000	S10	15 Winter	2	+0%					17.261	-0.739	0.000
S3.001	S11	15 Winter	2	+0%					16.194	-0.806	0.000
S3.002	S12	15 Winter	2	+0%					11.566	-0.684	0.000
S3.003	S13	15 Winter	2	+0%					11.445	-0.555	0.000
S3.004	S14	15 Winter	2	+0%					11.354	-0.613	0.000
S3.005	S15	15 Winter	2	+0%					11.334	-0.626	0.000
S3.006	S16	15 Winter	2	+0%					11.169	-0.780	0.000
S3.007	S17	15 Winter	2	+0%					10.278	-0.723	0.000
S3.008	S18	15 Winter	2	+0%					10.013	-0.738	0.000
S3.009	S19	15 Winter	2	+0%					9.512	-0.739	0.000
S3.010	S20	30 Winter	2	+0%					8.686	-0.815	0.000
S3.011	S21	30 Winter	2	+0%	100/30 Winter	100/15 Summer			7.132	-0.619	0.000
S3.012	S22	30 Winter	2	+0%	100/15 Winter				7.085	-0.557	0.000
S1.008	S23	30 Winter	2	+0%	100/15 Summer				7.058	-0.540	0.000
S1.009	S24	30 Winter	2	+0%					6.878	-0.667	0.000
S4.000	S25	15 Winter	2	+0%		100/15 Winter			18.424	-0.576	0.000
S4.001	S26	15 Winter	2	+0%					17.978	-0.522	0.000
S4.002	S27	15 Winter	2	+0%					17.921	-0.563	0.000
S4.003	S28	15 Winter	2	+0%					17.790	-0.678	0.000
S4.004	S29	15 Winter	2	+0%					15.758	-0.742	0.000
S4.005	S30	15 Winter	2	+0%					13.241	-0.759	0.000
S4.006	S31	15 Winter	2	+0%					10.889	-0.611	0.000
S4.007	S32	30 Winter	2	+0%	100/15 Winter	100/15 Winter			9.201	-0.549	0.000
S5.000	S33	15 Summer	2	+0%					10.250	-1.000	0.000
S4.008	S34	30 Winter	2	+0%					9.072	-0.604	0.000
S4.009	S35	30 Winter	2	+0%					8.909	-0.752	0.000
S4.010	S36	30 Winter	2	+0%					7.111	-0.639	0.000
S4.011	S37	60 Winter	2	+0%					5.644	-0.606	0.000
S4.012	S38	60 Winter	2	+0%					5.464	-0.625	0.000
S1.010	S39	60 Winter	2	+0%					5.252	-0.675	0.000
S1.011	S40	60 Winter	2	+0%					4.781	-0.682	0.000
S1.012	S41	120 Winter	2	+0%					4.043	-0.957	0.000
S1.013	S42	120 Winter	2	+0%					3.980	-0.984	0.000

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

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.16			1050.4	OK	
S1.001	S2	0.26			1049.0	OK	2
S1.002	S3	0.20			1007.0	OK	
S1.003	S4	0.09			1001.8	OK	
S2.000	S5	0.12			901.8	OK	
S1.004	S6	0.16			1682.4	OK	
S1.005	S7	0.18			1670.9	OK	
S1.006	S8	0.11			1676.7	OK	
S1.007	S9	0.10			1678.1	OK	
S3.000	S10	0.10			817.8	OK	
S3.001	S11	0.06			817.6	OK	
S3.002	S12	0.13			846.1	OK	
S3.003	S13	0.21			826.8	OK	
S3.004	S14	0.20			805.2	OK	
S3.005	S15	0.29			800.3	OK	
S3.006	S16	0.08			802.8	OK	
S3.007	S17	0.11			809.1	OK	
S3.008	S18	0.11			807.6	OK	
S3.009	S19	0.10			790.3	OK	
S3.010	S20	0.06			855.1	OK	
S3.011	S21	0.11			920.5	OK	7
S3.012	S22	0.11			974.6	OK	
S1.008	S23	0.27			2124.3	OK	
S1.009	S24	0.16			2088.9	OK	
S4.000	S25	0.22			1575.5	OK	
S4.001	S26	0.37			1393.3	OK	
S4.002	S27	0.36			1378.6	OK	
S4.003	S28	0.14			1376.2	OK	
S4.004	S29	0.10			1374.8	OK	
S4.005	S30	0.09			1372.1	OK	
S4.006	S31	0.19			1393.3	OK	
S4.007	S32	0.22			1380.8	OK	2
S5.000	S33	0.00			0.0	OK	
S4.008	S34	0.32			1347.5	OK	
S4.009	S35	0.09			1373.5	OK	
S4.010	S36	0.18			1454.8	OK	
S4.011	S37	0.19			1481.9	OK	
S4.012	S38	0.18			1386.7	OK	
S1.010	S39	0.15			2965.3	OK	
S1.011	S40	0.15			2966.4	OK	
S1.012	S41	0.12			2846.1	OK	
S1.013	S42	0.12			2795.0	OK	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.014	S43	120 Winter	2	+0%					3.892	-0.982	0.000	0.11
S1.015	S44	120 Winter	2	+0%					3.817	-0.933	0.000	0.11
S1.016	S45	120 Winter	2	+0%					3.767	-0.940	0.000	0.11
S1.017	S46	120 Winter	2	+0%					3.712	-0.942	0.000	0.11
S1.018	S47	120 Winter	2	+0%					3.662	-0.949	0.000	0.12
S1.019	S48	120 Winter	2	+0%					3.624	-0.965	0.000	0.10
S1.020	S49	120 Winter	2	+0%					3.620	-0.963	0.000	0.07
S1.021	S50	120 Winter	2	+0%					3.617	-0.961	0.000	0.05
S1.022	S51	120 Winter	2	+0%					3.616	-0.959	0.000	0.14
S1.023	S52	120 Winter	2	+0%					3.608	-0.959	0.000	0.12
S1.024	S53	120 Winter	2	+0%					3.569	-0.977	0.000	0.14
S1.025	S54	120 Winter	2	+0%					3.558	-0.979	0.000	0.10
S1.026	S55	120 Winter	2	+0%					3.553	-0.978	0.000	0.10
S1.027	S56	120 Winter	2	+0%					3.547	-0.978	0.000	0.14
S1.028	S57	120 Winter	2	+0%					3.516	-0.994	0.000	0.14
S1.029	S58	120 Winter	2	+0%					3.505	-0.996	0.000	0.10
S1.030	S59	120 Winter	2	+0%					3.447	-1.025	0.000	0.10
S6.000	S60	15 Winter	2	+0%					5.731	-0.619	0.000	0.11
S6.001	S61	60 Winter	2	+0%					5.212	-0.772	0.000	0.06
S6.002	S62	120 Winter	2	+0%					5.094	-0.709	0.000	0.09
S6.003	S63	120 Winter	2	+0%					4.955	-0.667	0.000	0.13
S6.004	S64	120 Winter	2	+0%					4.769	-0.665	0.000	0.16
S7.000	S65	15 Winter	2	+0%					5.731	-0.619	0.000	0.11
S7.001	S66	60 Winter	2	+0%					5.236	-0.748	0.000	0.05
S7.002	S67	60 Winter	2	+0%					5.169	-0.724	0.000	0.08
S7.003	S68	60 Winter	2	+0%					5.026	-0.685	0.000	0.12
S7.004	S69	120 Winter	2	+0%					4.815	-0.664	0.000	0.16
S6.005	S70	120 Winter	2	+0%					4.328	-0.648	0.000	0.17
S6.006	S71	120 Winter	2	+0%					4.059	-0.747	0.000	0.10
S1.031	S72	120 Winter	2	+0%					3.381	-1.063	0.000	0.04
S1.032	S73	120 Winter	2	+0%		100/2880 Winter			3.367	-1.075	0.000	0.04
S1.033	S74	120 Winter	2	+0%					3.368	-1.072	0.000	0.11
S1.034	S75	120 Winter	2	+0%					3.335	-1.098	0.000	0.05
S1.035	S76	120 Winter	2	+0%					3.322	-1.109	0.000	0.04
S1.036	S77	120 Winter	2	+0%					3.322	-1.107	0.000	0.14
S1.037	S78	120 Winter	2	+0%					3.261	-1.160	0.000	0.09

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.014	S43			2675.3	OK	
S1.015	S44			2576.6	OK	
S1.016	S45			2512.2	OK	
S1.017	S46			2447.5	OK	
S1.018	S47			2417.2	OK	
S1.019	S48			2404.1	OK	
S1.020	S49			2400.6	OK	
S1.021	S50			2397.8	OK	
S1.022	S51			2395.4	OK	
S1.023	S52			2388.0	OK	
S1.024	S53			2384.4	OK	
S1.025	S54			2382.3	OK	
S1.026	S55			2380.4	OK	
S1.027	S56			2376.7	OK	
S1.028	S57			2369.7	OK	
S1.029	S58			2364.3	OK	
S1.030	S59			2348.7	OK	
S6.000	S60			586.1	OK	
S6.001	S61			264.0	OK	
S6.002	S62			419.6	OK	
S6.003	S63			595.2	OK	
S6.004	S64			763.8	OK	
S7.000	S65			613.0	OK	
S7.001	S66			245.9	OK	
S7.002	S67			378.6	OK	
S7.003	S68			567.8	OK	

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

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S7.004	S69			766.5	OK	
S6.005	S70			1493.2	OK	
S6.006	S71			1470.3	OK	
S1.031	S72			3571.7	OK	
S1.032	S73			3563.5	OK	
S1.033	S74			3767.2	OK	
S1.034	S75			3657.4	OK	
S1.035	S76			3621.6	OK	
S1.036	S77			3765.3	OK	
S1.037	S78			3739.6	OK	

5 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	0.000
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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	0	Number of Storage Structures	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH	Data Type	Point
FEH Rainfall Version	2013	Cv (Summer)	0.750
Site Location	GB 391363 263985 SO 91363 63985	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	ON
Analysis Timestep	Fine	Inertia Status	ON
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2880
Return Period(s) (years)	2, 5, 10, 30, 100
Climate Change (%)	0, 0, 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	15 Winter	5	+0%					16.171	-0.579	0.000
S1.001	S2	15 Winter	5	+0%	100/15 Winter	100/15 Winter			13.818	-0.432	0.000
S1.002	S3	15 Winter	5	+0%					13.679	-0.525	0.000
S1.003	S4	15 Winter	5	+0%					13.293	-0.707	0.000
S2.000	S5	15 Winter	5	+0%					12.840	-0.660	0.000
S1.004	S6	15 Winter	5	+0%					12.411	-0.589	0.000
S1.005	S7	15 Winter	5	+0%					11.693	-0.557	0.000
S1.006	S8	15 Winter	5	+0%					10.812	-0.688	0.000
S1.007	S9	15 Winter	5	+0%					9.563	-0.687	0.000
S3.000	S10	15 Winter	5	+0%					17.316	-0.684	0.000
S3.001	S11	15 Winter	5	+0%					16.235	-0.765	0.000
S3.002	S12	15 Winter	5	+0%					11.626	-0.624	0.000
S3.003	S13	15 Winter	5	+0%					11.519	-0.481	0.000
S3.004	S14	15 Winter	5	+0%					11.414	-0.553	0.000
S3.005	S15	15 Winter	5	+0%					11.393	-0.567	0.000
S3.006	S16	15 Winter	5	+0%					11.219	-0.730	0.000
S3.007	S17	15 Winter	5	+0%					10.336	-0.665	0.000
S3.008	S18	15 Winter	5	+0%					10.070	-0.681	0.000
S3.009	S19	15 Winter	5	+0%					9.567	-0.684	0.000
S3.010	S20	30 Winter	5	+0%					8.725	-0.776	0.000
S3.011	S21	30 Winter	5	+0%	100/30 Winter	100/15 Summer			7.230	-0.521	0.000
S3.012	S22	30 Winter	5	+0%	100/15 Winter				7.188	-0.454	0.000
S1.008	S23	30 Winter	5	+0%	100/15 Summer				7.162	-0.436	0.000
S1.009	S24	30 Winter	5	+0%					6.953	-0.592	0.000
S4.000	S25	15 Winter	5	+0%		100/15 Winter			18.511	-0.489	0.000
S4.001	S26	15 Winter	5	+0%					18.060	-0.440	0.000
S4.002	S27	15 Winter	5	+0%					18.005	-0.479	0.000
S4.003	S28	15 Winter	5	+0%					17.856	-0.612	0.000
S4.004	S29	15 Winter	5	+0%					15.815	-0.685	0.000
S4.005	S30	15 Winter	5	+0%					13.296	-0.704	0.000
S4.006	S31	15 Winter	5	+0%					10.973	-0.527	0.000
S4.007	S32	30 Winter	5	+0%	100/15 Winter	100/15 Winter			9.288	-0.462	0.000
S5.000	S33	15 Summer	5	+0%					10.250	-1.000	0.000
S4.008	S34	30 Winter	5	+0%					9.150	-0.526	0.000
S4.009	S35	30 Winter	5	+0%					8.966	-0.695	0.000
S4.010	S36	30 Winter	5	+0%					7.193	-0.557	0.000
S4.011	S37	60 Winter	5	+0%					5.724	-0.526	0.000
S4.012	S38	60 Winter	5	+0%					5.541	-0.548	0.000
S1.010	S39	60 Winter	5	+0%					5.325	-0.602	0.000
S1.011	S40	60 Winter	5	+0%					4.850	-0.613	0.000
S1.012	S41	60 Winter	5	+0%					4.137	-0.863	0.000
S1.013	S42	60 Winter	5	+0%					4.070	-0.894	0.000

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

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.22			1426.7	OK	
S1.001	S2	0.36			1425.3	OK	2
S1.002	S3	0.28			1372.8	OK	
S1.003	S4	0.12			1370.7	OK	
S2.000	S5	0.16			1224.6	OK	
S1.004	S6	0.22			2304.1	OK	
S1.005	S7	0.25			2289.1	OK	
S1.006	S8	0.14			2296.5	OK	
S1.007	S9	0.13			2297.6	OK	
S3.000	S10	0.13			1110.5	OK	
S3.001	S11	0.08			1110.3	OK	
S3.002	S12	0.18			1148.9	OK	
S3.003	S13	0.28			1125.6	OK	
S3.004	S14	0.28			1104.9	OK	
S3.005	S15	0.41			1101.9	OK	
S3.006	S16	0.11			1101.5	OK	
S3.007	S17	0.15			1112.5	OK	
S3.008	S18	0.15			1113.3	OK	
S3.009	S19	0.14			1091.1	OK	
S3.010	S20	0.08			1178.8	OK	
S3.011	S21	0.15			1262.6	OK	7
S3.012	S22	0.16			1376.4	OK	
S1.008	S23	0.38			2972.6	OK	
S1.009	S24	0.22			2932.9	OK	
S4.000	S25	0.30			2139.2	OK	
S4.001	S26	0.51			1922.1	OK	
S4.002	S27	0.50			1909.0	OK	
S4.003	S28	0.19			1900.3	OK	
S4.004	S29	0.13			1901.7	OK	
S4.005	S30	0.12			1900.6	OK	
S4.006	S31	0.26			1922.0	OK	
S4.007	S32	0.30			1889.0	OK	2
S5.000	S33	0.00			0.0	OK	
S4.008	S34	0.45			1870.5	OK	
S4.009	S35	0.13			1910.9	OK	
S4.010	S36	0.25			2028.7	OK	
S4.011	S37	0.26			2025.9	OK	
S4.012	S38	0.24			1914.6	OK	
S1.010	S39	0.21			4131.2	OK	
S1.011	S40	0.21			4098.9	OK	
S1.012	S41	0.17			3961.6	OK	
S1.013	S42	0.17			3860.1	OK	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.014	S43	120 Winter	5	+0%					3.981	-0.893	0.000	0.15
S1.015	S44	120 Winter	5	+0%					3.907	-0.843	0.000	0.14
S1.016	S45	120 Winter	5	+0%					3.855	-0.852	0.000	0.14
S1.017	S46	120 Winter	5	+0%					3.796	-0.858	0.000	0.14
S1.018	S47	120 Winter	5	+0%					3.742	-0.869	0.000	0.16
S1.019	S48	120 Winter	5	+0%					3.700	-0.889	0.000	0.13
S1.020	S49	120 Winter	5	+0%					3.695	-0.888	0.000	0.10
S1.021	S50	120 Winter	5	+0%					3.692	-0.886	0.000	0.07
S1.022	S51	120 Winter	5	+0%					3.690	-0.885	0.000	0.18
S1.023	S52	120 Winter	5	+0%					3.682	-0.885	0.000	0.16
S1.024	S53	120 Winter	5	+0%					3.637	-0.909	0.000	0.19
S1.025	S54	120 Winter	5	+0%					3.627	-0.910	0.000	0.13
S1.026	S55	120 Winter	5	+0%					3.621	-0.910	0.000	0.14
S1.027	S56	120 Winter	5	+0%					3.615	-0.910	0.000	0.19
S1.028	S57	120 Winter	5	+0%					3.583	-0.927	0.000	0.19
S1.029	S58	120 Winter	5	+0%					3.570	-0.931	0.000	0.14
S1.030	S59	120 Winter	5	+0%					3.500	-0.972	0.000	0.14
S6.000	S60	15 Winter	5	+0%					5.809	-0.541	0.000	0.15
S6.001	S61	60 Winter	5	+0%					5.259	-0.725	0.000	0.07
S6.002	S62	60 Winter	5	+0%					5.154	-0.649	0.000	0.11
S6.003	S63	60 Winter	5	+0%					5.021	-0.601	0.000	0.17
S6.004	S64	60 Winter	5	+0%					4.831	-0.603	0.000	0.21
S7.000	S65	15 Winter	5	+0%					5.809	-0.541	0.000	0.15
S7.001	S66	60 Winter	5	+0%					5.291	-0.693	0.000	0.07
S7.002	S67	60 Winter	5	+0%					5.228	-0.665	0.000	0.11
S7.003	S68	60 Winter	5	+0%					5.093	-0.618	0.000	0.16
S7.004	S69	60 Winter	5	+0%					4.880	-0.599	0.000	0.21
S6.005	S70	60 Winter	5	+0%					4.387	-0.589	0.000	0.22
S6.006	S71	120 Winter	5	+0%					4.103	-0.703	0.000	0.13
S1.031	S72	240 Winter	5	+0%					3.394	-1.050	0.000	0.05
S1.032	S73	120 Winter	5	+0%		100/2880 Winter			3.387	-1.055	0.000	0.05
S1.033	S74	120 Winter	5	+0%					3.376	-1.064	0.000	0.14
S1.034	S75	120 Winter	5	+0%					3.357	-1.076	0.000	0.06
S1.035	S76	120 Winter	5	+0%					3.357	-1.074	0.000	0.05
S1.036	S77	120 Winter	5	+0%					3.351	-1.078	0.000	0.17
S1.037	S78	120 Winter	5	+0%					3.302	-1.119	0.000	0.11

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.014	S43			3454.6	OK	
S1.015	S44			3341.1	OK	
S1.016	S45			3269.3	OK	
S1.017	S46			3203.4	OK	
S1.018	S47			3183.5	OK	
S1.019	S48			3170.1	OK	
S1.020	S49			3169.0	OK	
S1.021	S50			3168.8	OK	
S1.022	S51			3168.2	OK	
S1.023	S52			3162.4	OK	
S1.024	S53			3158.9	OK	
S1.025	S54			3154.3	OK	
S1.026	S55			3154.8	OK	
S1.027	S56			3156.9	OK	
S1.028	S57			3156.5	OK	
S1.029	S58			3153.7	OK	
S1.030	S59			3167.7	OK	
S6.000	S60			805.5	OK	
S6.001	S61			345.2	OK	
S6.002	S62			542.3	OK	
S6.003	S63			783.3	OK	
S6.004	S64			996.3	OK	
S7.000	S65			830.4	OK	
S7.001	S66			334.4	OK	
S7.002	S67			501.7	OK	
S7.003	S68			774.3	OK	

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

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S7.004	S69			1017.6	OK	
S6.005	S70			1923.6	OK	
S6.006	S71			1910.7	OK	
S1.031	S72			4288.4	OK	
S1.032	S73			4720.3	OK	
S1.033	S74			4622.8	OK	
S1.034	S75			4740.5	OK	
S1.035	S76			4661.3	OK	
S1.036	S77			4542.5	OK	
S1.037	S78			4568.2	OK	

10 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 0.000
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 Offline Controls 0   Number of Time/Area Diagrams 0
Number of Online Controls 0   Number of Storage Structures 0   Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH   Data Type Point
FEH Rainfall Version 2013   Cv (Summer) 0.750
Site Location GB 391363 263985 SO 91363 63985   Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0   DVD Status ON
Analysis Timestep Fine   Inertia Status ON
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2880
Return Period(s) (years) 2, 5, 10, 30, 100
Climate Change (%) 0, 0, 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	15 Winter	10	+0%					16.236	-0.514	0.000
S1.001	S2	15 Winter	10	+0%	100/15 Winter	100/15 Winter			13.892	-0.358	0.000
S1.002	S3	15 Winter	10	+0%					13.748	-0.456	0.000
S1.003	S4	15 Winter	10	+0%					13.336	-0.664	0.000
S2.000	S5	15 Winter	10	+0%					12.890	-0.610	0.000
S1.004	S6	15 Winter	10	+0%					12.478	-0.522	0.000
S1.005	S7	15 Winter	10	+0%					11.764	-0.486	0.000
S1.006	S8	15 Winter	10	+0%					10.859	-0.641	0.000
S1.007	S9	15 Winter	10	+0%					9.610	-0.640	0.000
S3.000	S10	15 Winter	10	+0%					17.360	-0.640	0.000
S3.001	S11	15 Winter	10	+0%					16.272	-0.728	0.000
S3.002	S12	15 Winter	10	+0%					11.681	-0.569	0.000
S3.003	S13	15 Winter	10	+0%					11.579	-0.421	0.000
S3.004	S14	15 Winter	10	+0%					11.464	-0.503	0.000
S3.005	S15	15 Winter	10	+0%					11.444	-0.516	0.000
S3.006	S16	15 Winter	10	+0%					11.260	-0.689	0.000
S3.007	S17	15 Winter	10	+0%					10.383	-0.618	0.000
S3.008	S18	15 Winter	10	+0%					10.114	-0.637	0.000
S3.009	S19	15 Winter	10	+0%					9.612	-0.639	0.000
S3.010	S20	30 Winter	10	+0%					8.759	-0.742	0.000
S3.011	S21	30 Winter	10	+0%	100/30 Winter	100/15 Summer			7.321	-0.430	0.000
S3.012	S22	30 Winter	10	+0%	100/15 Winter				7.283	-0.359	0.000
S1.008	S23	30 Winter	10	+0%	100/15 Summer				7.255	-0.343	0.000
S1.009	S24	30 Winter	10	+0%					7.021	-0.524	0.000
S4.000	S25	15 Winter	10	+0%		100/15 Winter			18.586	-0.414	0.000
S4.001	S26	15 Winter	10	+0%					18.124	-0.376	0.000
S4.002	S27	15 Winter	10	+0%					18.069	-0.415	0.000
S4.003	S28	15 Winter	10	+0%					17.919	-0.549	0.000
S4.004	S29	15 Winter	10	+0%					15.864	-0.636	0.000
S4.005	S30	15 Winter	10	+0%					13.342	-0.658	0.000
S4.006	S31	15 Winter	10	+0%					11.046	-0.454	0.000
S4.007	S32	30 Winter	10	+0%	100/15 Winter	100/15 Winter			9.360	-0.390	0.000
S5.000	S33	15 Summer	10	+0%					10.250	-1.000	0.000
S4.008	S34	30 Winter	10	+0%					9.209	-0.467	0.000
S4.009	S35	30 Winter	10	+0%					9.014	-0.647	0.000
S4.010	S36	30 Winter	10	+0%					7.268	-0.482	0.000
S4.011	S37	60 Winter	10	+0%					5.796	-0.454	0.000
S4.012	S38	60 Winter	10	+0%					5.611	-0.478	0.000
S1.010	S39	60 Winter	10	+0%					5.391	-0.536	0.000
S1.011	S40	60 Winter	10	+0%					4.913	-0.551	0.000
S1.012	S41	60 Winter	10	+0%					4.228	-0.772	0.000
S1.013	S42	60 Winter	10	+0%					4.161	-0.803	0.000

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

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.28			1801.7	OK	
S1.001	S2	0.45			1775.5	OK	2
S1.002	S3	0.35			1725.3	OK	
S1.003	S4	0.16			1726.1	OK	
S2.000	S5	0.21			1546.3	OK	
S1.004	S6	0.28			2940.0	OK	
S1.005	S7	0.32			2914.1	OK	
S1.006	S8	0.18			2927.1	OK	
S1.007	S9	0.17			2930.5	OK	
S3.000	S10	0.17			1402.4	OK	
S3.001	S11	0.11			1402.1	OK	
S3.002	S12	0.23			1439.8	OK	
S3.003	S13	0.36			1409.3	OK	
S3.004	S14	0.35			1388.8	OK	
S3.005	S15	0.51			1390.9	OK	
S3.006	S16	0.13			1387.9	OK	
S3.007	S17	0.19			1392.4	OK	
S3.008	S18	0.19			1395.8	OK	
S3.009	S19	0.18			1367.3	OK	
S3.010	S20	0.10			1475.7	OK	
S3.011	S21	0.18			1568.3	OK	7
S3.012	S22	0.20			1731.6	OK	
S1.008	S23	0.49			3837.4	OK	
S1.009	S24	0.29			3787.4	OK	
S4.000	S25	0.39			2701.4	OK	
S4.001	S26	0.66			2474.5	OK	
S4.002	S27	0.64			2457.2	OK	
S4.003	S28	0.25			2438.4	OK	
S4.004	S29	0.17			2444.8	OK	
S4.005	S30	0.15			2447.5	OK	
S4.006	S31	0.34			2463.8	OK	
S4.007	S32	0.38			2418.2	OK	2
S5.000	S33	0.00			0.0	OK	
S4.008	S34	0.58			2412.8	OK	
S4.009	S35	0.17			2467.9	OK	
S4.010	S36	0.32			2607.0	OK	
S4.011	S37	0.33			2574.8	OK	
S4.012	S38	0.31			2438.6	OK	
S1.010	S39	0.27			5320.4	OK	
S1.011	S40	0.26			5151.6	OK	
S1.012	S41	0.21			4954.5	OK	
S1.013	S42	0.21			4831.6	OK	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.014	S43	60 Winter	10	+0%					4.071	-0.803	0.000	0.19
S1.015	S44	60 Winter	10	+0%					3.992	-0.758	0.000	0.19
S1.016	S45	60 Winter	10	+0%					3.935	-0.772	0.000	0.18
S1.017	S46	120 Winter	10	+0%					3.871	-0.783	0.000	0.17
S1.018	S47	120 Winter	10	+0%					3.813	-0.798	0.000	0.19
S1.019	S48	120 Winter	10	+0%					3.767	-0.822	0.000	0.16
S1.020	S49	120 Winter	10	+0%					3.762	-0.821	0.000	0.12
S1.021	S50	120 Winter	10	+0%					3.759	-0.819	0.000	0.09
S1.022	S51	120 Winter	10	+0%					3.757	-0.818	0.000	0.22
S1.023	S52	120 Winter	10	+0%					3.749	-0.818	0.000	0.20
S1.024	S53	120 Winter	10	+0%					3.700	-0.846	0.000	0.23
S1.025	S54	120 Winter	10	+0%					3.689	-0.848	0.000	0.17
S1.026	S55	120 Winter	10	+0%					3.684	-0.847	0.000	0.17
S1.027	S56	120 Winter	10	+0%					3.678	-0.847	0.000	0.23
S1.028	S57	120 Winter	10	+0%					3.645	-0.865	0.000	0.23
S1.029	S58	120 Winter	10	+0%					3.632	-0.869	0.000	0.17
S1.030	S59	120 Winter	10	+0%					3.554	-0.918	0.000	0.17
S6.000	S60	15 Winter	10	+0%					5.878	-0.472	0.000	0.19
S6.001	S61	60 Winter	10	+0%					5.305	-0.679	0.000	0.09
S6.002	S62	60 Winter	10	+0%					5.211	-0.592	0.000	0.14
S6.003	S63	60 Winter	10	+0%					5.087	-0.535	0.000	0.21
S6.004	S64	60 Winter	10	+0%					4.898	-0.536	0.000	0.27
S7.000	S65	15 Winter	10	+0%					5.878	-0.472	0.000	0.17
S7.001	S66	60 Winter	10	+0%					5.338	-0.646	0.000	0.09
S7.002	S67	60 Winter	10	+0%					5.278	-0.615	0.000	0.13
S7.003	S68	30 Winter	10	+0%					5.155	-0.556	0.000	0.20
S7.004	S69	60 Winter	10	+0%					4.948	-0.531	0.000	0.27
S6.005	S70	60 Winter	10	+0%					4.448	-0.528	0.000	0.28
S6.006	S71	60 Winter	10	+0%					4.144	-0.662	0.000	0.17
S1.031	S72	120 Summer	10	+0%					3.462	-0.982	0.000	0.06
S1.032	S73	120 Summer	10	+0%		100/2880 Winter			3.460	-0.982	0.000	0.06
S1.033	S74	120 Summer	10	+0%					3.459	-0.981	0.000	0.16
S1.034	S75	120 Summer	10	+0%					3.426	-1.007	0.000	0.07
S1.035	S76	120 Summer	10	+0%					3.425	-1.006	0.000	0.06
S1.036	S77	120 Summer	10	+0%					3.424	-1.005	0.000	0.21
S1.037	S78	120 Winter	10	+0%					3.330	-1.091	0.000	0.14

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.014	S43			4582.9	OK	
S1.015	S44			4379.1	OK	
S1.016	S45			4255.1	OK	
S1.017	S46			3971.1	OK	
S1.018	S47			3967.0	OK	
S1.019	S48			3947.7	OK	
S1.020	S49			3942.9	OK	
S1.021	S50			3936.5	OK	
S1.022	S51			3931.6	OK	
S1.023	S52			3933.0	OK	
S1.024	S53			3934.6	OK	
S1.025	S54			3931.5	OK	
S1.026	S55			3931.1	OK	
S1.027	S56			3926.4	OK	
S1.028	S57			3918.8	OK	
S1.029	S58			3923.1	OK	
S1.030	S59			3937.1	OK	
S6.000	S60			1043.7	OK	
S6.001	S61			438.2	OK	
S6.002	S62			668.0	OK	
S6.003	S63			996.5	OK	
S6.004	S64			1267.6	OK	
S7.000	S65			936.1	OK	
S7.001	S66			428.0	OK	
S7.002	S67			608.9	OK	
S7.003	S68			932.4	OK	

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

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S7.004	S69			1285.0	OK	
S6.005	S70			2414.5	OK	
S6.006	S71			2380.3	OK	
S1.031	S72			5380.8	OK	
S1.032	S73			5440.6	OK	
S1.033	S74			5332.6	OK	
S1.034	S75			5293.3	OK	
S1.035	S76			5391.2	OK	
S1.036	S77			5443.2	OK	
S1.037	S78			5709.2	OK	

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	0.000
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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	0	Number of Storage Structures	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH	Data Type	Point
FEH Rainfall Version	2013	Cv (Summer)	0.750
Site Location	GB 391363 263985 SO 91363 63985	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	ON
Analysis Timestep	Fine	Inertia Status	ON
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2880
Return Period(s) (years)	2, 5, 10, 30, 100
Climate Change (%)	0, 0, 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	15 Winter	30	+0%					16.327	-0.423	0.000
S1.001	S2	15 Winter	30	+0%	100/15 Winter	100/15 Winter			14.009	-0.241	0.000
S1.002	S3	15 Winter	30	+0%					13.857	-0.347	0.000
S1.003	S4	15 Winter	30	+0%					13.403	-0.597	0.000
S2.000	S5	15 Winter	30	+0%					12.968	-0.532	0.000
S1.004	S6	15 Winter	30	+0%					12.574	-0.426	0.000
S1.005	S7	15 Winter	30	+0%					11.866	-0.384	0.000
S1.006	S8	15 Winter	30	+0%					10.933	-0.567	0.000
S1.007	S9	15 Winter	30	+0%					9.683	-0.567	0.000
S3.000	S10	15 Winter	30	+0%					17.431	-0.569	0.000
S3.001	S11	15 Winter	30	+0%					16.326	-0.674	0.000
S3.002	S12	15 Winter	30	+0%					11.767	-0.483	0.000
S3.003	S13	15 Winter	30	+0%					11.670	-0.330	0.000
S3.004	S14	15 Winter	30	+0%					11.538	-0.429	0.000
S3.005	S15	15 Winter	30	+0%					11.517	-0.443	0.000
S3.006	S16	15 Winter	30	+0%					11.319	-0.630	0.000
S3.007	S17	15 Winter	30	+0%					10.460	-0.541	0.000
S3.008	S18	15 Winter	30	+0%					10.187	-0.564	0.000
S3.009	S19	15 Winter	30	+0%					9.686	-0.565	0.000
S3.010	S20	30 Winter	30	+0%					8.814	-0.687	0.000
S3.011	S21	30 Winter	30	+0%	100/30 Winter	100/15 Summer			7.488	-0.263	0.000
S3.012	S22	30 Winter	30	+0%	100/15 Winter				7.444	-0.198	0.000
S1.008	S23	30 Winter	30	+0%	100/15 Summer				7.399	-0.199	0.000
S1.009	S24	30 Winter	30	+0%					7.125	-0.420	0.000
S4.000	S25	15 Winter	30	+0%		100/15 Winter			18.704	-0.296	0.000
S4.001	S26	15 Winter	30	+0%					18.219	-0.281	0.000
S4.002	S27	15 Winter	30	+0%					18.162	-0.322	0.000
S4.003	S28	15 Winter	30	+0%					18.012	-0.456	0.000
S4.004	S29	15 Winter	30	+0%					15.940	-0.560	0.000
S4.005	S30	15 Winter	30	+0%					13.413	-0.587	0.000
S4.006	S31	15 Winter	30	+0%					11.159	-0.341	0.000
S4.007	S32	30 Winter	30	+0%	100/15 Winter	100/15 Winter			9.469	-0.281	0.000
S5.000	S33	15 Summer	30	+0%					10.250	-1.000	0.000
S4.008	S34	30 Winter	30	+0%					9.298	-0.378	0.000
S4.009	S35	30 Winter	30	+0%					9.092	-0.569	0.000
S4.010	S36	30 Winter	30	+0%					7.384	-0.366	0.000
S4.011	S37	60 Winter	30	+0%					5.915	-0.335	0.000
S4.012	S38	60 Winter	30	+0%					5.725	-0.364	0.000
S1.010	S39	60 Winter	30	+0%					5.495	-0.432	0.000
S1.011	S40	60 Winter	30	+0%					5.015	-0.448	0.000
S1.012	S41	60 Winter	30	+0%					4.369	-0.631	0.000
S1.013	S42	60 Winter	30	+0%					4.301	-0.663	0.000

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

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.37			2438.4	OK	
S1.001	S2	0.61			2411.0	FLOOD RISK*	2
S1.002	S3	0.48			2351.1	OK	
S1.003	S4	0.21			2348.9	OK	
S2.000	S5	0.28			2092.4	OK	
S1.004	S6	0.38			4022.2	OK	
S1.005	S7	0.43			3991.8	OK	
S1.006	S8	0.25			4003.0	OK	
S1.007	S9	0.23			4009.5	OK	
S3.000	S10	0.23			1897.6	OK	
S3.001	S11	0.14			1897.2	OK	
S3.002	S12	0.31			1948.3	OK	
S3.003	S13	0.48			1913.1	OK	
S3.004	S14	0.48			1896.0	OK	
S3.005	S15	0.70			1894.5	OK	
S3.006	S16	0.18			1894.9	OK	
S3.007	S17	0.26			1903.6	OK	
S3.008	S18	0.25			1899.8	OK	
S3.009	S19	0.24			1867.5	OK	
S3.010	S20	0.14			2032.3	OK	
S3.011	S21	0.25			2146.1	FLOOD RISK*	7
S3.012	S22	0.28			2394.9	OK	
S1.008	S23	0.68			5327.9	OK	
S1.009	S24	0.40			5268.1	OK	
S4.000	S25	0.52			3655.8	FLOOD RISK*	
S4.001	S26	0.90			3405.4	FLOOD RISK*	
S4.002	S27	0.88			3377.4	OK	
S4.003	S28	0.34			3373.3	OK	
S4.004	S29	0.24			3364.6	OK	
S4.005	S30	0.21			3364.6	OK	
S4.006	S31	0.47			3414.6	OK	
S4.007	S32	0.53			3346.5	FLOOD RISK*	2
S5.000	S33	0.00			0.0	OK	
S4.008	S34	0.80			3369.7	OK	
S4.009	S35	0.24			3453.2	OK	
S4.010	S36	0.45			3685.6	OK	
S4.011	S37	0.46			3626.5	OK	
S4.012	S38	0.44			3432.6	OK	
S1.010	S39	0.37			7462.6	OK	
S1.011	S40	0.36			7186.4	OK	
S1.012	S41	0.29			6704.8	OK	
S1.013	S42	0.28			6563.4	OK	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.014	S43	60 Winter	30	+0%					4.211	-0.663	0.000	0.26
S1.015	S44	60 Winter	30	+0%					4.132	-0.618	0.000	0.26
S1.016	S45	60 Winter	30	+0%					4.070	-0.637	0.000	0.25
S1.017	S46	60 Winter	30	+0%					3.999	-0.655	0.000	0.25
S1.018	S47	60 Winter	30	+0%					3.931	-0.680	0.000	0.28
S1.019	S48	60 Winter	30	+0%					3.878	-0.711	0.000	0.23
S1.020	S49	60 Winter	30	+0%					3.873	-0.710	0.000	0.18
S1.021	S50	60 Winter	30	+0%					3.869	-0.709	0.000	0.13
S1.022	S51	60 Winter	30	+0%					3.866	-0.709	0.000	0.32
S1.023	S52	60 Winter	30	+0%					3.858	-0.709	0.000	0.28
S1.024	S53	60 Winter	30	+0%					3.800	-0.746	0.000	0.33
S1.025	S54	60 Winter	30	+0%					3.789	-0.748	0.000	0.24
S1.026	S55	60 Winter	30	+0%					3.782	-0.749	0.000	0.24
S1.027	S56	60 Winter	30	+0%					3.776	-0.749	0.000	0.33
S1.028	S57	60 Winter	30	+0%					3.740	-0.770	0.000	0.33
S1.029	S58	120 Winter	30	+0%					3.728	-0.773	0.000	0.23
S1.030	S59	120 Winter	30	+0%					3.640	-0.832	0.000	0.23
S6.000	S60	15 Winter	30	+0%					5.983	-0.367	0.000	0.24
S6.001	S61	60 Winter	30	+0%					5.380	-0.604	0.000	0.13
S6.002	S62	60 Winter	30	+0%					5.300	-0.503	0.000	0.18
S6.003	S63	60 Winter	30	+0%					5.191	-0.431	0.000	0.29
S6.004	S64	60 Winter	30	+0%					5.006	-0.428	0.000	0.37
S7.000	S65	15 Winter	30	+0%					5.983	-0.367	0.000	0.21
S7.001	S66	60 Winter	30	+0%					5.421	-0.563	0.000	0.13
S7.002	S67	30 Winter	30	+0%					5.364	-0.529	0.000	0.15
S7.003	S68	30 Winter	30	+0%					5.257	-0.454	0.000	0.27
S7.004	S69	60 Winter	30	+0%					5.053	-0.426	0.000	0.37
S6.005	S70	60 Winter	30	+0%					4.546	-0.430	0.000	0.38
S6.006	S71	60 Winter	30	+0%					4.214	-0.592	0.000	0.23
S1.031	S72	120 Winter	30	+0%					3.545	-0.899	0.000	0.08
S1.032	S73	120 Winter	30	+0%		100/2880 Winter			3.543	-0.899	0.000	0.09
S1.033	S74	120 Winter	30	+0%					3.542	-0.898	0.000	0.24
S1.034	S75	120 Winter	30	+0%					3.510	-0.923	0.000	0.10
S1.035	S76	120 Winter	30	+0%					3.507	-0.924	0.000	0.09
S1.036	S77	120 Winter	30	+0%					3.505	-0.924	0.000	0.31
S1.037	S78	120 Winter	30	+0%					3.396	-1.025	0.000	0.20

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.014	S43			6259.2	OK	
S1.015	S44			6014.7	OK	
S1.016	S45			5876.9	OK	
S1.017	S46			5748.6	OK	
S1.018	S47			5673.5	OK	
S1.019	S48			5638.5	OK	
S1.020	S49			5629.4	OK	
S1.021	S50			5626.5	OK	
S1.022	S51			5624.3	OK	
S1.023	S52			5610.9	OK	
S1.024	S53			5594.9	OK	
S1.025	S54			5588.8	OK	
S1.026	S55			5583.9	OK	
S1.027	S56			5578.0	OK	
S1.028	S57			5574.7	OK	
S1.029	S58			5288.7	OK	
S1.030	S59			5287.5	OK	
S6.000	S60			1324.7	OK	
S6.001	S61			597.2	OK	
S6.002	S62			874.0	OK	
S6.003	S63			1368.5	OK	
S6.004	S64			1762.4	OK	
S7.000	S65			1161.2	OK	
S7.001	S66			599.9	OK	
S7.002	S67			707.1	OK	
S7.003	S68			1278.0	OK	

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

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S7.004	S69			1771.5	OK	
S6.005	S70			3296.2	OK	
S6.006	S71			3255.3	OK	
S1.031	S72			7896.8	OK	
S1.032	S73			8039.3	OK	
S1.033	S74			8085.9	OK	
S1.034	S75			8002.5	OK	
S1.035	S76			8071.7	OK	
S1.036	S77			8157.5	OK	
S1.037	S78			8105.3	OK	

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	0.000
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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	0	Number of Storage Structures	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH	Data Type	Point
FEH Rainfall Version	2013	Cv (Summer)	0.750
Site Location	GB 391363 263985 SO 91363 63985	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	ON
Analysis Timestep	Fine	Inertia Status	ON
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2880
Return Period(s) (years)	2, 5, 10, 30, 100
Climate Change (%)	0, 0, 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	15 Winter	100	+40%					16.577	-0.173	0.000
S1.001	S2	15 Winter	100	+40%	100/15 Winter	100/15 Winter			14.262	0.012	12.148
S1.002	S3	15 Winter	100	+40%					14.148	-0.056	0.000
S1.003	S4	15 Winter	100	+40%					13.588	-0.412	0.000
S2.000	S5	15 Winter	100	+40%					13.175	-0.325	0.000
S1.004	S6	15 Winter	100	+40%					12.842	-0.158	0.000
S1.005	S7	15 Winter	100	+40%					12.155	-0.095	0.000
S1.006	S8	15 Winter	100	+40%					11.139	-0.361	0.000
S1.007	S9	15 Winter	100	+40%					9.885	-0.365	0.000
S3.000	S10	15 Winter	100	+40%					17.623	-0.377	0.000
S3.001	S11	15 Winter	100	+40%					16.474	-0.526	0.000
S3.002	S12	15 Winter	100	+40%					12.041	-0.209	0.000
S3.003	S13	15 Winter	100	+40%					11.955	-0.045	0.000
S3.004	S14	15 Winter	100	+40%					11.730	-0.237	0.000
S3.005	S15	15 Winter	100	+40%					11.708	-0.252	0.000
S3.006	S16	15 Winter	100	+40%					11.490	-0.459	0.000
S3.007	S17	15 Winter	100	+40%					10.668	-0.333	0.000
S3.008	S18	15 Winter	100	+40%					10.384	-0.367	0.000
S3.009	S19	15 Winter	100	+40%					9.890	-0.361	0.000
S3.010	S20	30 Winter	100	+40%					8.965	-0.536	0.000
S3.011	S21	30 Winter	100	+40%	100/30 Winter	100/15 Summer			7.764	0.013	14.112
S3.012	S22	30 Winter	100	+40%	100/15 Winter				7.718	0.076	0.000
S1.008	S23	30 Winter	100	+40%	100/15 Summer				7.688	0.090	0.000
S1.009	S24	30 Winter	100	+40%					7.474	-0.071	0.000
S4.000	S25	15 Winter	100	+40%		100/15 Winter			19.000	0.000	0.169
S4.001	S26	15 Winter	100	+40%					18.464	-0.036	0.000
S4.002	S27	15 Winter	100	+40%					18.403	-0.081	0.000
S4.003	S28	15 Winter	100	+40%					18.262	-0.206	0.000
S4.004	S29	15 Winter	100	+40%					16.147	-0.353	0.000
S4.005	S30	15 Winter	100	+40%					13.606	-0.394	0.000
S4.006	S31	30 Winter	100	+40%					11.458	-0.042	0.000
S4.007	S32	30 Winter	100	+40%	100/15 Winter	100/15 Winter			9.760	0.010	10.176
S5.000	S33	15 Summer	100	+40%					10.250	-1.000	0.000
S4.008	S34	30 Winter	100	+40%					9.530	-0.146	0.000
S4.009	S35	30 Winter	100	+40%					9.311	-0.350	0.000
S4.010	S36	30 Winter	100	+40%					7.707	-0.043	0.000
S4.011	S37	30 Winter	100	+40%					6.249	-0.001	0.000
S4.012	S38	60 Winter	100	+40%					6.047	-0.042	0.000
S1.010	S39	30 Winter	100	+40%					5.804	-0.123	0.000
S1.011	S40	60 Winter	100	+40%					5.304	-0.160	0.000
S1.012	S41	60 Winter	100	+40%					4.748	-0.252	0.000
S1.013	S42	60 Winter	100	+40%					4.683	-0.281	0.000

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

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.70			4591.9	FLOOD RISK*	
S1.001	S2	1.13			4498.2	FLOOD	2
S1.002	S3	0.90			4445.0	OK	
S1.003	S4	0.40			4430.6	OK	
S2.000	S5	0.52			3939.4	OK	
S1.004	S6	0.74			7730.7	FLOOD RISK*	
S1.005	S7	0.84			7704.5	FLOOD RISK*	
S1.006	S8	0.48			7682.9	OK	
S1.007	S9	0.45			7707.2	OK	
S3.000	S10	0.43			3572.7	OK	
S3.001	S11	0.27			3571.9	OK	
S3.002	S12	0.58			3662.5	FLOOD RISK*	
S3.003	S13	0.91			3616.0	FLOOD RISK*	
S3.004	S14	0.91			3601.5	OK	
S3.005	S15	1.32			3591.3	OK	
S3.006	S16	0.35			3597.4	OK	
S3.007	S17	0.48			3618.6	OK	
S3.008	S18	0.48			3617.0	OK	
S3.009	S19	0.46			3550.4	OK	
S3.010	S20	0.27			3927.6	OK	
S3.011	S21	0.49			4208.6	FLOOD	7
S3.012	S22	0.54			4624.7	FLOOD RISK*	
S1.008	S23	1.50			11763.8	SURCHARGED*	
S1.009	S24	0.87			11567.0	OK	
S4.000	S25	0.98			6878.1	FLOOD	
S4.001	S26	1.74			6557.1	FLOOD RISK*	
S4.002	S27	1.70			6545.8	FLOOD RISK*	
S4.003	S28	0.66			6524.6	FLOOD RISK*	
S4.004	S29	0.46			6533.8	OK	
S4.005	S30	0.41			6533.0	OK	
S4.006	S31	0.92			6668.6	FLOOD RISK*	
S4.007	S32	1.05			6604.4	FLOOD	2
S5.000	S33	0.00			0.0	OK	
S4.008	S34	1.60			6692.8	OK	
S4.009	S35	0.48			6881.0	OK	
S4.010	S36	0.91			7451.9	FLOOD RISK*	
S4.011	S37	0.93			7284.7	FLOOD RISK*	
S4.012	S38	0.88			6909.4	OK	
S1.010	S39	0.73			14545.9	OK	
S1.011	S40	0.72			14393.6	OK	
S1.012	S41	0.57			13149.1	FLOOD RISK*	
S1.013	S42	0.55			12837.7	OK	

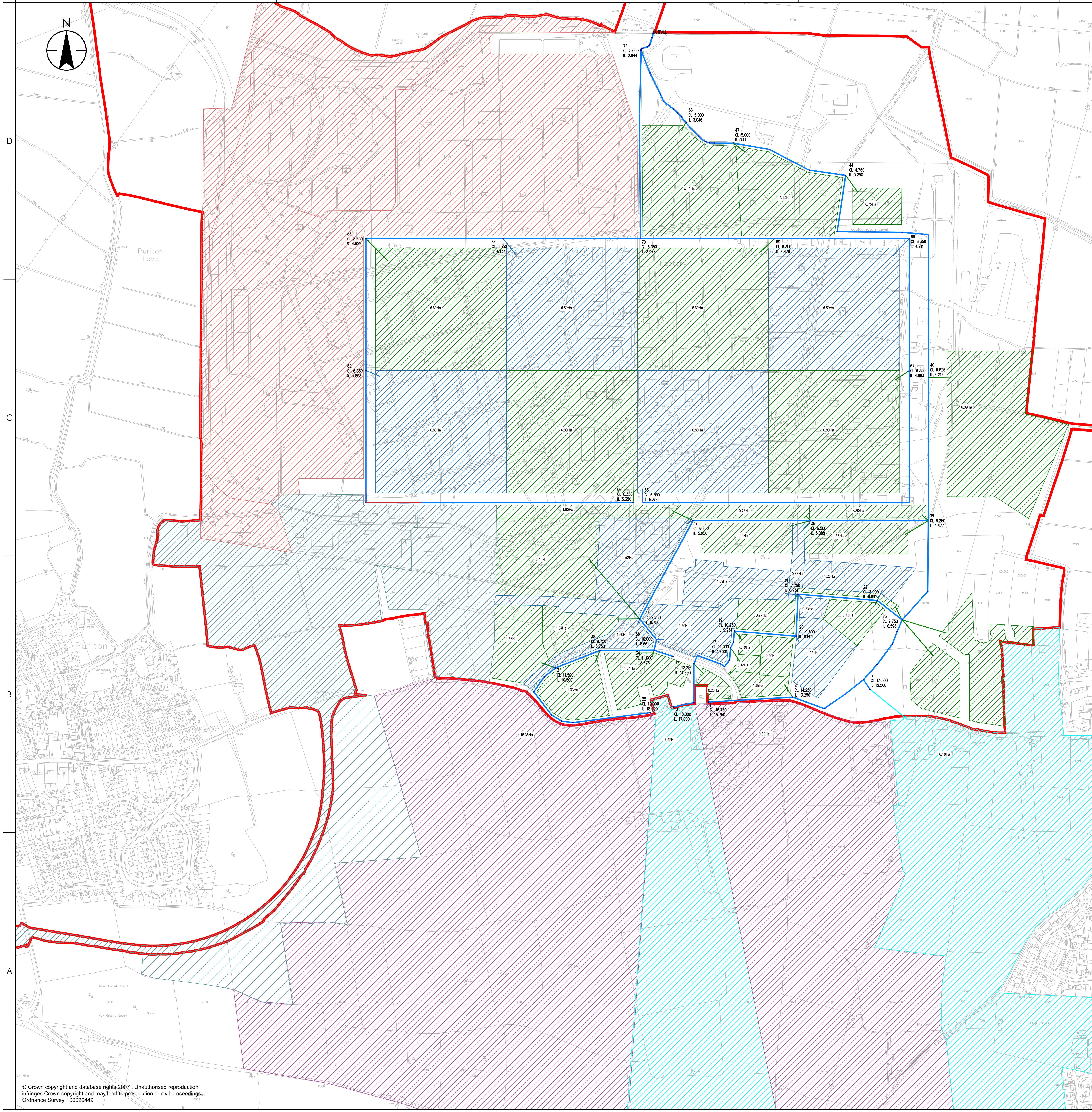
100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.014	S43	60 Winter	100	+40%					4.588	-0.286	0.000	0.52
S1.015	S44	60 Winter	100	+40%					4.498	-0.252	0.000	0.52
S1.016	S45	60 Winter	100	+40%					4.424	-0.283	0.000	0.51
S1.017	S46	60 Winter	100	+40%					4.338	-0.316	0.000	0.50
S1.018	S47	60 Winter	100	+40%					4.253	-0.358	0.000	0.55
S1.019	S48	60 Winter	100	+40%					4.205	-0.384	0.000	0.47
S1.020	S49	60 Winter	100	+40%					4.196	-0.387	0.000	0.35
S1.021	S50	60 Winter	100	+40%					4.189	-0.389	0.000	0.25
S1.022	S51	60 Winter	100	+40%					4.184	-0.391	0.000	0.63
S1.023	S52	60 Winter	100	+40%					4.172	-0.395	0.000	0.56
S1.024	S53	60 Winter	100	+40%					4.119	-0.427	0.000	0.66
S1.025	S54	60 Winter	100	+40%					4.106	-0.431	0.000	0.47
S1.026	S55	60 Winter	100	+40%					4.097	-0.434	0.000	0.48
S1.027	S56	60 Winter	100	+40%					4.087	-0.438	0.000	0.66
S1.028	S57	60 Winter	100	+40%					4.055	-0.455	0.000	0.65
S1.029	S58	60 Winter	100	+40%					4.043	-0.458	0.000	0.48
S1.030	S59	60 Winter	100	+40%					3.933	-0.539	0.000	0.48
S6.000	S60	15 Winter	100	+40%					6.275	-0.075	0.000	0.38
S6.001	S61	60 Winter	100	+40%					5.630	-0.354	0.000	0.26
S6.002	S62	30 Winter	100	+40%					5.557	-0.246	0.000	0.31
S6.003	S63	30 Winter	100	+40%					5.485	-0.137	0.000	0.52
S6.004	S64	60 Winter	100	+40%					5.308	-0.126	0.000	0.73
S7.000	S65	15 Winter	100	+40%					6.275	-0.075	0.000	0.36
S7.001	S66	60 Winter	100	+40%					5.677	-0.307	0.000	0.26
S7.002	S67	30 Winter	100	+40%					5.621	-0.272	0.000	0.30
S7.003	S68	30 Winter	100	+40%					5.552	-0.159	0.000	0.52
S7.004	S69	60 Winter	100	+40%					5.352	-0.127	0.000	0.73
S6.005	S70	60 Winter	100	+40%					4.831	-0.145	0.000	0.74
S6.006	S71	60 Winter	100	+40%					4.416	-0.390	0.000	0.44
S1.031	S72	60 Winter	100	+40%					3.705	-0.739	0.000	0.17
S1.032	S73	60 Winter	100	+40%		100/2880 Winter			3.699	-0.743	0.000	0.17
S1.033	S74	60 Winter	100	+40%					3.696	-0.744	0.000	0.48
S1.034	S75	60 Winter	100	+40%					3.665	-0.768	0.000	0.20
S1.035	S76	60 Winter	100	+40%					3.657	-0.774	0.000	0.17
S1.036	S77	60 Winter	100	+40%					3.652	-0.777	0.000	0.61
S1.037	S78	60 Winter	100	+40%					3.571	-0.850	0.000	0.39

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.014	S43			12310.4	OK	
S1.015	S44			11945.2	FLOOD RISK*	
S1.016	S45			11711.8	OK	
S1.017	S46			11457.3	OK	
S1.018	S47			11282.1	OK	
S1.019	S48			11212.1	OK	
S1.020	S49			11195.0	OK	
S1.021	S50			11181.0	OK	
S1.022	S51			11170.2	OK	
S1.023	S52			11144.1	OK	
S1.024	S53			11094.2	OK	
S1.025	S54			11072.3	OK	
S1.026	S55			11066.5	OK	
S1.027	S56			11061.2	OK	
S1.028	S57			11039.8	OK	
S1.029	S58			11033.8	OK	
S1.030	S59			11018.9	OK	
S6.000	S60			2092.8	FLOOD RISK*	
S6.001	S61			1246.0	OK	
S6.002	S62			1448.2	OK	
S6.003	S63			2462.1	OK	
S6.004	S64			3473.4	OK	
S7.000	S65			2008.5	FLOOD RISK*	
S7.001	S66			1238.7	OK	
S7.002	S67			1421.0	OK	
S7.003	S68			2449.7	OK	

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

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S7.004	S69			3478.1	OK	
S6.005	S70			6404.6	OK	
S6.006	S71			6335.3	OK	
S1.031	S72			15968.4	OK	
S1.032	S73			15866.4	OK	
S1.033	S74			15949.7	OK	
S1.034	S75			15960.4	OK	
S1.035	S76			15916.5	OK	
S1.036	S77			15921.4	OK	
S1.037	S78			15929.1	OK	



Key

- Proposed LDO Boundary
- Proposed Rhynes
- Existing Off-site Surface Water Catchment Areas (see note 6)
- Proposed Surface Water Catchment Areas
- Area draining westwards to ditches that will not be realigned as part of the proposed works (excluded from model)
- Runoff from this area managed by Gravity Link Road - currently under construction (excluded from model)
- 68 CL 6.350 IL 4.711 — Proposed Model Node

Stantec

Stantec UK Limited
TAUNTON
Lakeside House, Blackbrook Business Park, Blackbrook
Park Avenue, Taunton TA1 2PX
Tel: +44 1823 218 940
www.stantec.com/uk

Notes

UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake their own investigation where the presence of any existing sewers, services, plant or apparatus may affect their operations.

1. This drawing is to be read in conjunction with all other Engineer's and Architect's drawings.
2. All dimensions are in metres unless noted otherwise.
3. All levels are in metres above Ordnance Datum (AOD).
4. The location of ditches and rhynes has been determined based on Ordnance Survey data and topographical surveys undertaken by Lewis Brown Chartered Land Surveyors (ref: N07029, date: Sep 2007 and ref: B02002, date: Feb 2020).
5. Proposed ground levels are not yet available, therefore the proposed ditch diversion routes have been based on the assumption that proposed ground levels will be amended to maintain gravity drainage.
6. A Soil Percentage Runoff (SPR) value for off-site catchment areas has been calculated using Flood Estimation Handbook (FEH) data from the FEH Web Service. This has been calculated to be 27.45%.
7. Refer to drawing 332310102/4002/002 for Existing Off-Site Drainage Catchment Plan.
8. Proposed Cover Levels and Invert Levels are indicative based on an approximate MicroDrainage Model.
9. Proposed Impermeable Area's shown are taken at 100% Impermeability, except for existing catchments taken as 27.45% (as per note 6).

Issued/Revision	By	Appd	YYYY.MM.DD
DG	DG	-	2021.08.10
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Issue Status

FOR INFORMATION

This document is suitable only for the purpose noted above.
Use of this document for any other purpose is not permitted.

Client/Project Logo

Gravity

Client/Project

This is Gravity Ltd

Local Development Order

Former ROF Puriton, Somerset, United Kingdom

Title

PROPOSED SURFACE WATER DRAINAGE STRATEGY - MODEL SCHEMATIC

Project No.	Scale
332310102	NTS

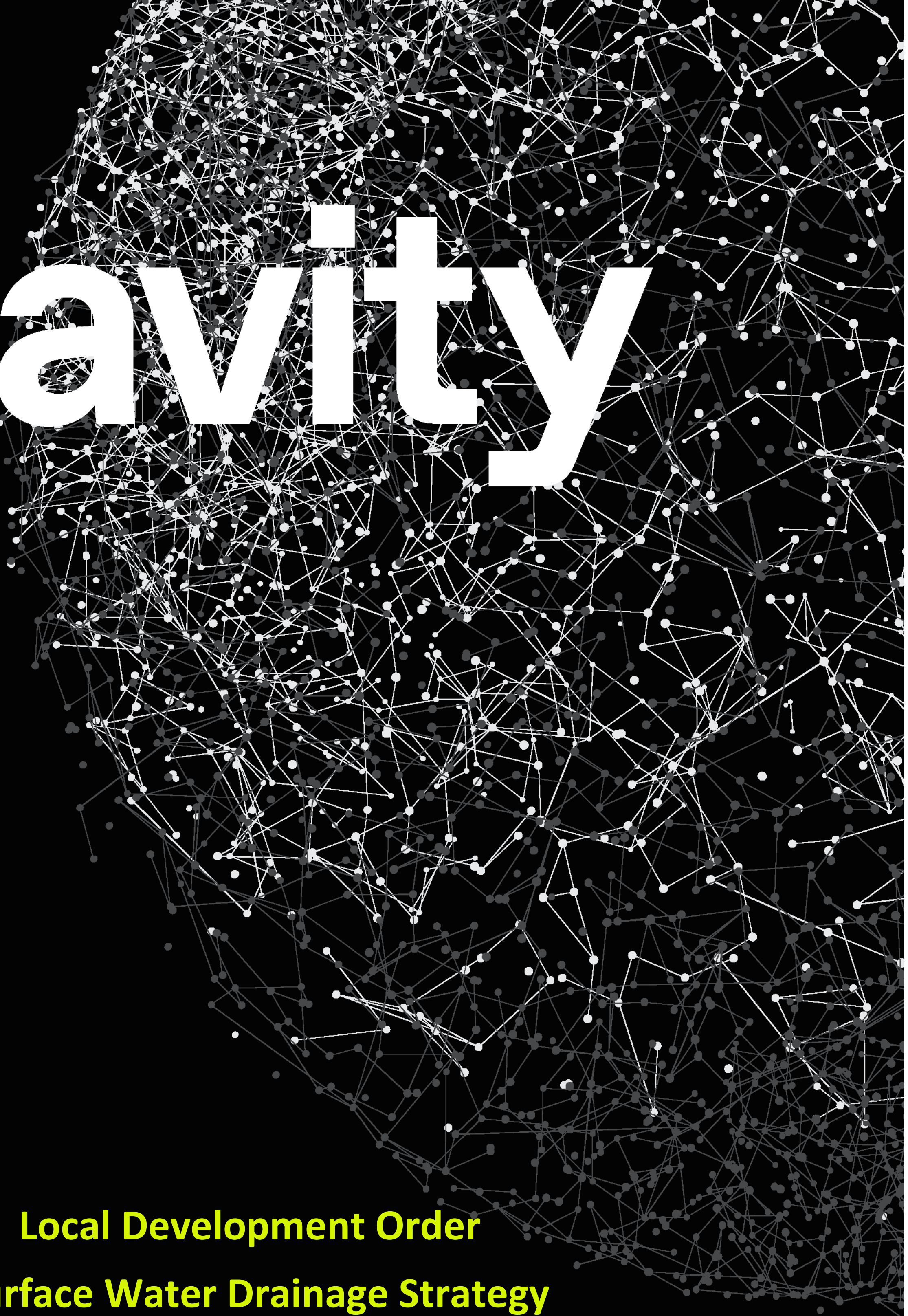
Revision	Drawing No.
-	332310102/4002/SK04

Appendix G O&M Manual

O&M Manual

Gravity

Smart Campus



Local Development Order

Surface Water Drainage Strategy

Surface Water Operation & Maintenance Manual

Document Control Sheet

Project Name: **This is Gravity**

Project Ref: **332310102/4002**

Report Title: **Surface Water Operation & Maintenance Manual**

Doc Ref: **Revision B**

Date: **September 2021**

	Name	Position	Signature	Date
Prepared by:	Lewis Derrick	Engineer		24.09.2021
Reviewed by:	Andrew Johns	Senior Associate		24.09.2021
Approved by:	Paul Jenkin	Director of Water Management		24.09.2021
For and on behalf of Stantec UK Limited				

Revision	Date	Description	Prepared	Reviewed	Approved
A	19.08.21	Issue for Client Review	LWD	AJ	-
B	24.09.21	For Planning	LW	AJ	PJ

Contents

Tables

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1 Introduction

1.1 Purpose of Manual

1.1.1 This Surface Water Operation & Maintenance Manual (henceforth referred to as *"Manual"*) has been produced by Stantec UK (Stantec) as an appendix to the Surface Water Drainage Strategy (SWDS), also produced by Stantec, in support of a Local Development Order (LDO) application. The LDO application is made by our Client, This is Gravity Ltd, for an industrial-led multi use development at the Former Royal Ordnance Factory (ROF) Puriton in Somerset.

1.1.2 The purpose of this Manual is to advise on the operation and maintenance requirements for the strategic elements of the SWDS infrastructure for the developed site. It contains details of standards, philosophy and criteria adopted in the design of components within the proposed development.

1.1.3 The aim is to provide a design schedule for each component and relevant information to facilitate the design of surface water drainage within individual development plots themselves.

1.1.4 Some documentation relevant to the surface water management plan, and which have been developed in the context of the preparation of a LDO, has already been produced and approved by the relevant authorities, where required, including: the Strategic Design Code, Strategic Landscape Masterplan and the Clean and Inclusive Growth Strategy.

1.1.5 The principles outlined in this Manual will provide a framework for the development of a more detailed SWDS for the site through the LDO process.

1.2 Live Status

1.2.1 This Manual, whilst providing sufficient detail for the LDO, should be considered as *"live"* and will be updated regularly as the design and technical approval of the development's surface water drainage infrastructure progresses. It aims to provide a design schedule for each component which will inform and facilitate the design of on-plot surface water drainage.

1.2.2 As details of on-plot surface water drainage infrastructure are developed, they should be appended to this Manual as a complete record of the development's surface water drainage infrastructure.

1.2.3 A copy of this Manual should be made freely available to the appointed maintenance and monitoring operatives for each respective surface water drainage component.

2 Design Standards & Philosophy

2.1 Site History

2.1.1 Stantec has been involved in assessing Flood Risk and Drainage at this site for over 10 years, including in support of an extant Outline Planning Consent in 2017 (ref: 42/13/00010). As such, a number of reports and assessments have been completed to date. These are listed below:

- Royal Ordnance Factory Puriton TUFLOW Modelling Report (July 2007)
- Royal Ordnance Factory Puriton TUFLOW Modelling Addendum to Technical Modelling Report (October 2007)
- Royal Ordnance Factory Puriton TUFLOW Modelling Addendum NO.2 of Technical Modelling Report (January 2008)
- Huntspill Energy Park Remediation Application – Flood Risk Assessment (October 2011)
- Borrow Pit Angling Club Flood Risk Assessment (October 2012)
- Huntspill Energy Park Remediation Phase 1 Drainage Scheme (March 2013)
- Huntspill Energy Park Flood Risk Assessment (April 2013)
- Huntspill Energy Park Surface Water Management Strategy (April 2013)
- Huntspill Energy Park Addendum to Surface Water Management Strategy (October 2013)
- Huntspill Energy Park Remediation Application Surface Water Management Strategy (October 2013)
- Huntspill Energy Park Remediation Works Drainage Scheme for Plots J-K (January 2014)
- Puriton Solar Farm Drainage Strategy Technical Note (February 2015)
- Huntspill Solar Park Surface Water Management Strategy (December 2015)
- Land at Puriton Abstraction Assets Assessment (March 2018)
- Huntspill Energy Park Tidal Flood Risk Summary Note (June 2018)

2.1.2 As part of the LDO application, Stantec have produced updated Flood Risk Assessment (FRA) and SWDS reports, with this Manual forming an appendix to the SWDS. Whilst many of the findings and conclusions of the previously completed works have informed the updated SWDS and FRA, these documents were undertaken in relation to the extant consent. Hence, the area assessed by these documents is smaller in extent than the proposed LDO area. Where relevant, the findings of these documents has been referenced and/or updated to reflect this new site extent.

2.2 Surface Water Management Strategy

2.2.1 For details of the SWDS parameters, reference should be made to the updated FRA and SWDS reports. These documents set key surface water drainage parameters including discharge rates and volumes, and attenuation storage volumes. They also provided an strategic-level SWDS as a baseline.

3 Operation & Maintenance Overview

3.1 Aims & Objectives

3.1.1 To ensure the ongoing performance of the existing surface water management system on the site, there will be a requirement for regular maintenance over its lifetime. The SWDS has been developed based on the principles of Sustainable Drainage Systems (SuDS), therefore the performance criteria of the SWDS is not limited to managing water quantities (discharge rates and volumes), but also improving water quality, providing amenity and enhancing biodiversity.

3.1.2 Typically, the maintenance of SuDS within a surface water management system involves regular removal of litter/debris in the system and general landscaping. Final designs of SuDS, outfalls, inlets etc. will need to be designed with regard for future maintenance, details of which will be appended to this report in accordance with **1.2**. All areas will need to be easily accessible and safe for maintenance operatives without compromising the performance criteria requirements.

3.1.3 Responsibility for maintenance of the SWDS will lie with This is Gravity Ltd and their partners Albion Water, who will retain an overall management responsibility of the developed site. It is likely that operation and maintenance activities for all surface water drainage infrastructure on site will be contracted by This is Gravity Ltd and Albion Water to a management company (details of this are yet to be confirmed). It is also likely that this management company's responsibility will extend to the hard and soft landscaping of the site to ensure a consistent, holistic management regime.

3.1.4 This section provides general recommendations and a framework for the operation and maintenance of elements of the SWDS which provide a strategic function i.e. situated off-plot.

3.1.5 **Sections 4 and 5** provide further component-specific detail, which again provides a framework for the operation and maintenance of strategic SWDS components. The tables within this section will be reproduced and refined for named SWDS components as the detailed design of the site progresses (refer to **1.2**).

3.2 Strategic SWDS Component Overview

3.2.1 Strategic components within the surface water management system currently comprise existing/re-aligned/new rhynes and the reed beds north of the site. Drawings indicating the locations of strategic surface water management system components can be found in the SWDS report supporting the LDO application.

3.2.2 All three of these components can be characterised as having permanent water within them as well as a high-level of vegetative cover. As such, the general principles for their maintenance are largely similar, although there will be variations due to the differing performance requirements of each respectively. Furthermore, some rhynes or reed beds will need to be managed differently to other components of the same type depending on the amenity and biodiversity objectives for that particular feature.

3.3 Establishment Maintenance

3.3.1 As predominantly open, vegetated systems, there may be initial one-off maintenance requirements for the planting of SWDS components. These activities will typically include weeding, watering etc. in combination with regular inspection to monitor the establishment of the specified vegetation.

Nuisance / Non-Native Vegetation Management

3.3.2 New rhynes and reed beds can become rapidly dominated by invasive nuisance and non-native plants. It should be ensured that for the first 5 years, while vegetation is establishing, certain plant growth is controlled. After this 5 year period, these features can usually be allowed to develop naturally recognising that, unless the margins are occasionally managed, they are likely to become dominated by trees and shrubs.

3.3.3 The list below provides an indication of likely nuisance and non-native plants that should be controlled; however an exhaustive list of species and their respective management activities will be provided by an ecologist and landscape architect as the design is developed in detail. Further information regarding nuisance and non-native plants can be found on the GB Non-native Species Secretariat website[1].

- Curly waterweed (Lagarosiphon major)
- Floating Pennywort (Hydrocotyle ranuncloides)
- Giant Hogweed (Heracleum mantegazzianum)
- Himalyan Balsam (Impatiens glandulifera)
- Japanese Knotweed (Fallopia japonica)
- Nuttall’s Waterweed (Elodea species)
- Parrot’s Feather (Myriophyllum aquaticum)
- Water Fern (Azolla filiculoides)

3.3.4 Whilst the management of nuisance and non-native vegetation is particularly important during the initial 5 year establishment phase, it is likely that the monitoring of these species will become a regular maintenance activity after this period and throughout the lifecycle of the SWDS Component. If found to be present, their removal will then be classified as a remedial action.

3.4 Regular Maintenance

3.4.1 Regular maintenance is important for the effective operation of the SWDS Components and encompasses basic tasks which are to be undertaken to a frequent and predictable schedule, ranging from multiple times a year to once annually. Examples of regular maintenance include: inspections and monitoring, sediment and oil removal (if observed to be required more frequently than once a year), vegetation management, and removal of litter and debris

3.4.2 The maintenance of rhynes and reed beds is generally straightforward for landscape contractors and typically there should only be a small amount of additional work required for these features over and above what is necessary for standard public open space.

Inspection and Monitoring

3.4.3 Regular inspections will help to determine optimum future maintenance activities, help establish ongoing performance of the system and allow identification of potential performance failures (e.g. blockage, poor water quality) resulting from a lack of maintenance.

[1] Identification sheets - GB non-native species secretariat

3.4.4 During the first year of operation, inspections should be carried out at least monthly (and after significant storm events) to ensure the system is functioning as designed and no damage has occurred. Typical inspection questions that will indicate when occasional or remedial maintenance are required include:

- Are inlets/outlets blocked?
- Is the vegetation healthy?
- Is there evidence of poor water quality?
- Is there evidence of sediment build-up beyond stated limits?
- Is there evidence of structural damage that requires repair?
- Are there areas of erosion over vegetated surfaces?

3.4.5 Given the large scale of the site, it is recommended that an annual maintenance report and record should be prepared by the maintenance contractor. The report should contain the following:

- Observations resulting from inspections.
- Measure sediment depths (where appropriate).
- Monitoring results, where flow or water quality monitoring is undertaken.
- Confirmation that any penstocks or valves are free and working correctly.
- Maintenance and operation activities undertaken during the year.
- Recommendations for inspection and maintenance programme for the following year.

Litter and Debris Removal

3.4.6 Litter and debris removal reduces the risk of inlet and outlet blockages and minimises pollution risks.

Vegetation Management

3.4.7 The frequency and extent of grass cutting within the SWDS components will largely depend on the aesthetic aims of the site, however, generally grass cutting should be done as infrequently as possible. A general recommendation of maintaining grass lengths between 75-150mm should serve as a baseline for maintenance purposes. Should varying lengths be specified, these will be indicated for various features as the Operation and Maintenance Manual is developed alongside the scheme design.

3.4.8 For the management of weeds, nuisance plants and non-native plants, the use of herbicides and pesticides should be limited. Further information regarding nuisance and non-native plant management is given in paragraphs **3.3.2** to **3.3.4**.

3.4.9 The use of fertilisers should be limited or prohibited to minimise nutrient loadings which can be damaging to water bodies (refer to **3.6.9**).

3.4.10 The management of shrubs will be largely driven by the desired aesthetics of the site and will be specified by a landscape specialist. Mulching is likely to be a regular activity for shrubs, whereby it is not recommended that a bark mulch is used as it floats could cause a potential blockage.

3.4.11 Once aquatic and shoreline vegetation is established, the build-up of dead vegetation from previous seasons should be removed at regular intervals e.g. every 3 years, to reduce organic sediment accumulation. This type of vegetation may also need to be managed to maintain attenuation volumes.

3.4.12 It is recommended that vegetation is to be removed. Up to 25% of vegetation can be removed at one time and this 25% is defined by the plan area covered by that type of vegetation. The vegetation should be cut 100mm above the soil level and bankside vegetation should be cut by hand.

3.4.13 Aquatic vegetation will need to be cut from a reed cutting boat (Truxor or similar to prevent the need for maintenance operatives to enter the water. Where this is not possible or appropriate, a component or vegetation-type specific method statement should be provided for inclusion in the Operation and Maintenance Manual and Health and Safety File, demonstrating how the risks associated with working within water are to be managed. Aquatic vegetation arisings should be stacked near to the water's edge for 48hrs to de-water and allow wildlife to return to the component, before being disposed on in accordance with the landscape management plan for the site.

3.4.14 Owing to the site's historic use, despite remediation of the site, there may still be contamination present within the reeds themselves. The reeds should be tested prior to removal so that they can be disposed of in accordance with current waste management legislation, which should be confirmed with the Environment Agency. Chemical testing will determine the classification and disposal methods.

3.4.15 Care should be taken to avoid the disturbance of nesting birds and target species e.g. great crested newts and water voles, at critical times and may require licencing to undertake the works (this will be specified by an ecologist and included in the Operation and Maintenance Manual as it is developed alongside the scheme design).

3.5 Occasional Maintenance

3.5.1 Occasional maintenance activities comprise tasks that are likely to be required periodically, but much less frequently and predictably than regular maintenance. Examples of occasional maintenance include sediment management and vegetation replacement.

Sediment Management

3.5.2 The frequency of sediment removal will be dependent on many factors, including:

- Design of the upstream system.
- Type of system.
- Design of silt storage.
- Size of upstream catchment in relation to surface area of component.
- Characteristics of upstream catchment (e.g. land use, upstream construction activities, erosion control management, effectiveness of upstream pre-treatment).

3.5.3 Regular inspections should inform the frequency of sediment removal from SWDS components, which is likely to be more frequent whilst construction on site is ongoing and before vegetation is fully established. Graduated markers should be installed at each component to provide a quick, visual indication of sediment build-up without the need to entering the component.

3.5.4 Sediment removal should be undertaken in such a way that no damage is caused to the component itself, particularly where underground liners/geotextiles are used. However, given the scale of the SWDS components it is likely that this activity will be undertaken using an excavator, therefore the use of liners/geotextiles should be minimised to reduce the risk of damage. Where liners/geotextiles are present, a pumped removal system may be more appropriate.

3.5.5 A standing area adjacent to the SWDS component should be provided to allow sediment to de-water prior to removal from site. The sediment should be allowed to de-water for 48hrs.

3.5.6 Sediments excavated should be safely disposed of in accordance with current waste management legislation. However, given the historic use of the site, this should be confirmed with the Environment Agency to confirm appropriate protocols. Chemical testing of the sediment may be required, before excavation, to determine its classification and appropriate disposal methods. Given the proposed commercial and industrial uses of the site, chemical testing is likely to be required. If rhynes and the reed beds are to be drawn down, care should be taken to prevent downstream discharge of sediment and anoxic water and the Environment Agency should be notified prior to the activity taking place. However, it would be preferable that sediment is removed from areas of permanent water without the need for dewatering or entering the water itself e.g. using an excavator or pump from the bank.

3.5.7 General principles for sediment removal are as follows:

i. Avoid damage to any liners or geotextile fabrics used.

ii. Undertake work between September and March to minimise impact on receiving water bodies.

iii. Agree sediment removal and management plan with the environmental regulator.

iv. Undertake the operation in dry weather when the surrounding ground is firm and ideally operate from a hard surface.

v. Use machinery with and extending arm to avoid contact with edges, banks etc. and use a bucket without teeth to avoid damage.

vi. Secure consent for dewatering with environmental regulator, if required.

Vegetation Replacement

3.5.8 Some vegetation replacement may be required during the establishment phase or after extreme storm events. Dead or damaged plants should be removed and replaced to preserve the performance of the system.

3.6 Remedial Actions

3.6.1 Remedial actions are the intermittent tasks that may be required to rectify faults within the system or poor / inadequate performance. The likelihood of remedial actions can be minimised through regular maintenance activities. Where they are required, they are likely to be site or component specific, or due to unforeseen events e.g. events exceeding the design standard of the component, therefore the timings of remedial actions are difficult to predict.

3.6.2 Examples of remedial actions include:

- Inlet and outlet repairs.
- Erosion repairs.
- Reinstatement or realignment of edgings, barriers, rip-rap or other erosion controls.
- Replacement of blocked filter materials/fabrics.
- Construction stage sediment removal (this should be undertaken prior to the commencement of the maintenance contract).
- System rehabilitation immediately following a pollution event.

3.6.3 Where remedial actions are required, an assessment of the damage or reduction in performance should be undertaken as part of inspection / monitoring. Following the outcome of this assessment, the specific remediation required and the method for undertaking these works can be determined. The assessment and remedial action should be recorded within both the Operation & Maintenance Manual and the site's Health and Safety File as a record of the activity but also to inform future maintenance works, with a view of removing or limiting the future need for the action to be undertaken again.

Rehabilitation / Repair of Components

3.6.4 The need for component rehabilitation (e.g. remove clogged geotextiles etc.) will typically be every 10-25 years, depending on the component design, the nature of the upstream catchment and the sediment load. Regular sediment removal will also help to reduce this frequency.

3.6.5 The frequency of inlet, outlet and overflow rehabilitation will be largely driven by the findings of regular monitoring on site. Importantly, through regular silt management, the need to rehabilitating these structures will be reduced. If it is determined that the performance of these structures has been reduced by 20% when compared to their design specification, this should provide the threshold for remedial actions. The threshold for remedial actions may vary between components, depending on how critical its performance is to the overall performance of the SWDS and the consequence of failure. A 20% reduction is therefore a guideline baseline, which will be refined following further detailed design of the SWDS. The level of performance should be determined by comparing the design inlet, outlet or overflow capacity with that measured on site e.g. a reduction in pipe diameter due to silt build-up.

3.6.6 Slope areas that have become bare should be re-vegetated and any eroded areas should be regraded before replanting (in accordance with the original landscape specification). However, it is important to establish the cause of erosion to reduce the likelihood of this occurring again in the future.

Water Quality, Eutrophication and Aeration

3.6.7 Regular inspection and testing of water quality within water bodies will be required to determine whether the Strategic SWDS Components are meeting their design performance standards and if not, identify the nature of the poor water quality. Through testing, it will then be possible to determine what specific remedial action is required to improve water quality to the necessary standard. However, it is important to establish the cause of poor water quality to reduce the likelihood of this occurring again in the future, which may result in additional remedial action elsewhere or a change to management practices.

3.6.8 It is likely that testing will be undertaken by Albion Water as they will be responsible, on behalf of This is Gravity Ltd, to ensure that discharges from the site meet the requirements of the discharge licence provided by the Environment Agency. At the time of writing, an application has been made for this licence the required discharge standards have not yet been set. This report will be updated in due course as that information is made available to specify the water quality standards that must be adhered to.

3.6.9 Eutrophication can occur during summer months. This is best alleviated by controlling sources of nutrients to the features or providing a continuous baseflow. Vegetation management should also seek to limit crowding out of oxygenating species. Unless eutrophication is severe, aeration can be used as a remedial measure to save aquatic animal species and reduce risks to receiving waters. The addition of barley straw bales, dredging or rending the nutrients inactive by chemical (hydrogen peroxide) means can also be successful but less desirable.

3.6.10 It is important to state that the introduction of nutrients to the SWDS could fall outside of the site's control where flows contributing to the SWDS network also comes from adjacent land.

Oils and Hydrocarbons

3.6.11 In a pollution event comprising oils and hydrocarbons, the spillage should be contained immediately to prevent further pollution downstream. This can be done through the use of booms and oil spill kits which should be kept on site alongside other maintenance equipment. As the detailed design of the site progresses, a standard procedure for managing oil and hydrocarbon spillages should be developed and included in the Operation and Maintenance Manual, as well as the site's Health and Safety File.

3.7 Maintenance Access

3.7.1 Access for maintenance should be provided from a public or private road or suitable area of public space adjacent to the SWDS component. It should be at least 8m with a maximum crossfall of 1 in 7, to allow access by necessary equipment and vehicles. Implicitly, this access should be robust enough to withstand the loadings imposed by maintenance access machinery. The access route should extend to any forebays, benching, inlets and outlets.

3.7.2 Any invasive maintenance work, such as silt or vegetation removal, is only required intermittently, but it should be planned to be sympathetic to the biodiversity performance requirements of the rhyne or reed bed. Care should be taken to avoid disturbance to nesting birds during the breeding season and habitats of target species (e.g. great crested newts and water voles at critical times). Invasive silt and vegetation removal should only be carried out to limited areas at one any one time (25-30% of the component's area on one occasion each year) to minimise the impact on biodiversity. These requirements will be provided in update maintenance schedules for each component as the design of the site's SWDS develops (see **1.2**).

4 Rhynes – General Operation & Maintenance

4.1.1 Building upon the Operation & Maintenance Overview provided in **Section 3**, the following **Tables 4.1 - 4.3** more component-specific guidance on the operational and maintenance requirements that may be appropriate for rhynes.

4.1.2 The list of actions is not exhaustive, and some actions may not always be required. Furthermore, the list operational and maintenance requirements may vary from rhyne to rhyne. Therefore, a schedule for named, individual rhyne components will be provided as the design of the SWDS develops and will be appended to this Manual (refer to **Section 1.2**).

	Required Action	Typical Frequency
Regular Maintenance	Remove litter and debris	Monthly (or as required)
	Cut the grass in public areas to a height of 75-150mm, or length specified by Ecologist/Landscape Architect (refer to **3.4.7**)	Monthly (during growing season) or as required (if longer lengths specified)
	Inspect marginal and bankside vegetation and remove nuisance/non-native plants (refer to **3.3** for typical species – exhaustive list to be provided as designs develop)	Monthly (for first 5 years, then as required)
	Inspect inlets, outlets, overflows, bankside, structures, pipework etc. for evidence of blockage and/or physical damage	Monthly
	Inspect and test water body for signs of poor water quality (refer to **3.6.8**)	Monthly (May – October)
	Inspect inlets and main body of rhynes for silt accumulation and establish appropriate silt removal frequencies; undertake contamination testing once some build-up has occurred, to inform management and disposal options	Half yearly
	Check, test and lubricate any mechanical devices e.g., penstocks	Half yearly
	Remove 25% of bank vegetation (based on component's plan area) from one bank only at water's edge to a minimum of 1m above water level (methodology to confirmed following planting specification and component design) (refer to **3.4.12**)	Annually
	Remove all dead growth (scrub clearance) before start of growing season (note: tree maintenance is usually part of overall landscape management contract)	Annually
	Remove sediment (when depth exceeds 250mm) and aquatic planting (when plan area of clear, open water is reduced by 50%) from the main body of rhynes (methodology will be dependent on type of vegetation to be removed) (refer to **3.4.13**)	Annually, or as required

Table 4.1 - General Recommendations for Regular Operation and Maintenance of Rhynes

	Required Action	Typical Frequency
Occasional Maintenance	Remove sediment from the main body of large rhynes when silt accumulates to depth of 250mm or greater (refer to **3.5.2** - **3.5.7**)	With effective pre-treatment, this will only be required rarely e.g. every 25-50 years

Table 4.2 - General Recommendations for Occasional Operation and Maintenance of Rhynes

	Required Action	Typical Frequency
Remedial actions	Repair erosion or other damage	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Replant in accordance with the original landscape planting specification, where necessary	As required
	Aerate rhyne when signs of poor water quality or eutrophication are detected (refer to **3.6.9**)	As required
	Remove and dispose of oils or petrol residues using safe standard practices (refer to **3.6.11**)	As required
	Repair / rehabilitate inlets, outlets and overflows when performance reduction threshold is met or exceeded (refer to **3.6.5**)	As required

Table 4.3 - General Recommendations for Remediation of Rhynes

5 Reed Beds – General Operation & Maintenance

5.1.1 Building upon the Operation & Maintenance Overview provided in Section 3, the following **Tables 5.1 - 5.3** more component-specific guidance on the operational and maintenance requirements that may be appropriate for the reed beds.

5.1.2 The list of actions is not exhaustive, and some actions may not always be required. Furthermore, the list operational and maintenance requirements may vary from reed bed section to reed bed section. Therefore, a schedule for named, individual reed bed sections will be provided as the design of the SWDS develops and will be appended to this Manual (refer to Section **1.2**).

	Required Action	Typical Frequency
Regular Maintenance	Remove litter and debris	Monthly (or as required)
	Cut the grass in public areas to a height of 75-150mm, or length specified by Ecologist/Landscape Architect (refer to refer to **3.4.7**)	Monthly (during growing season) or as required (if longer lengths
	Inspect marginal and bankside vegetation and remove nuisance/non-native plants (refer to **3.3** for typical species – exhaustive list to be provided as designs develop)	Monthly (for first 5 years, then as required)
	Inspect inlets, outlets, overflows, bankside, structures, pipework etc. for evidence of blockage and/or physical damage	Monthly
	Inspect and test water body for signs of poor water quality (refer to **3.6.8**)	Monthly (May – October)
	Inspect silt accumulation rates in any forebay and in main body of the reed beds and establish appropriate removal frequencies; undertake contamination testing once some build-up has occurred, to inform management and disposal options	Half yearly
	Check, test and lubricate any mechanical devices e.g. penstocks	Half yearly
	Cut reeds (at minimum of 0.1m above base) using Truxor or similar (refer to **3.4.13 - 3.4.14**).	Annually, or as advised by Ecologist
	Remove 25% of bank vegetation (based on component's plan area) from one bank only at water's edge to a minimum of 1m above water level (methodology to confirmed following planting specification and component design) (refer to **3.4.12**)	Annually
	Remove 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 forebay (when depth exceeds 250mm) (refer to **3.5.2 - 3.5.7**)	Annually, or as required

Table 5.1 - General Recommendations for Regular Operation and Maintenance of Reed Beds

	Required Action	Typical Frequency
Occasional Maintenance	Remove sediment from reed bed when silt accumulates to depth of 250mm or greater (refer to **3.5.2** - **3.5.7**)	With effective pre-treatment, this will only be required rarely e.g. every 25-50 years It is recommended that sediment is removed from only a limited number of reed beds each year. This number is to be advised by and Ecologist.

Table 5.2 - General Recommendations for Occasional Operation and Maintenance of Reed Beds

	Required Action	Typical Frequency
Remedial actions	Repair erosion or other damage	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Replant in accordance with the original landscape planting specification, where necessary	As required
	Aerate reed beds when signs of poor water quality or eutrophication are detected (refer to **3.6.9**)	As required
	Remove and dispose of oils or petrol residues using safe standard practices (refer to **3.6.11**)	As required
	Repair / rehabilitate inlets, outlets and overflows when performance reduction threshold is met or exceeded (refer to **3.6.5**)	As required

Table 5.3 - General Recommendations for Remediation of Reed Beds

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