Former Holloway Prison

Flood Risk Assessment and Drainage Report (incl. Foul Drainage and Surface Water Drainage Pro-forma)

Peabody

Former Holloway Prison

Flood Risk Assessment and Drainage Report including foul drainage

October 2021

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Client Name: Peabody Construction Limited
Document Reference: WIE15702-100-R-1-2-1-FRA
Project Number: WIE15702

Quality Assurance – Approval Status

This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2015, BS EN ISO 14001: 2015 and BS EN ISO 45001:2018)

Issue	Date	Prepared by	Checked by	Approved by
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Comments		Preliminary		
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Comments		For planning		

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1. Executive Summary

1.1. Waterman was commissioned by Peabody Construction Limited to undertake a Flood Risk Assessment to support the planning application for the proposed demolition of Former Holloway Prison and construction of 985 residential homes including 60 extra care homes (Use Class C3), a Women's Building (Use Class F.2) and flexible commercial floorspace (Use Class E).

1.2. The site is located entirely within Flood Zone 1 indicating a low risk of flooding. Whilst areas of the site are indicated to be at 'low' to 'high' risk of surface water flooding, significant regrading of the site and use of SuDS will ensure the risk of flooding remains low. The risk of flooding from tidal, groundwater and artificial sources has also been assessed and is considered to be low.

1.3. The site has been sub-divided into a number of sub-catchments as part of the Drainage Strategy. Through the provision of permeable paving, plinth tanks and undergrounds storage, sufficient storage (3222m3) will be provided to attenuate surface water runoff from the site to the 1 in 100 year greenfield rate (48.5 l/s). Surface water will discharge from the site into the Thames Water combined sewer in Parkhurst Road.

1.4. Rain gardens and green roofs will also be utilised throughout the development. In combination with the proposed permeable paving, these SuDS will provide sufficient treatment for surface water runoff from each of the proposed buildings and surrounding amenity. SuDS will be utilised where possible to manage pollution from the access road through the site, though additional pollution control measures (i.e. petrol interceptors) can be specified at the detailed design stage.

1.5. The rate of foul discharge from the existing site has been estimated to be 3.8l/s based on an inmate population of 500 persons. The Development proposes to utilise the existing connection to the combined public sewer, discharging at a rate of 8.9l/s. When this increase is considered alongside the significant reduction in surface water runoff rates as a result of the proposed SuDS, the development can be seen to provide a betterment.

1.6. This report demonstrates that the proposed Development has a low probability of flooding from all sources. The report also confirms that surface water runoff from the site will not be affected by the development proposals thereby ensuring that flood risk is not increased elsewhere. It is considered that the information provided within this report satisfies the requirements of the National Planning Policy Framework and local policy.

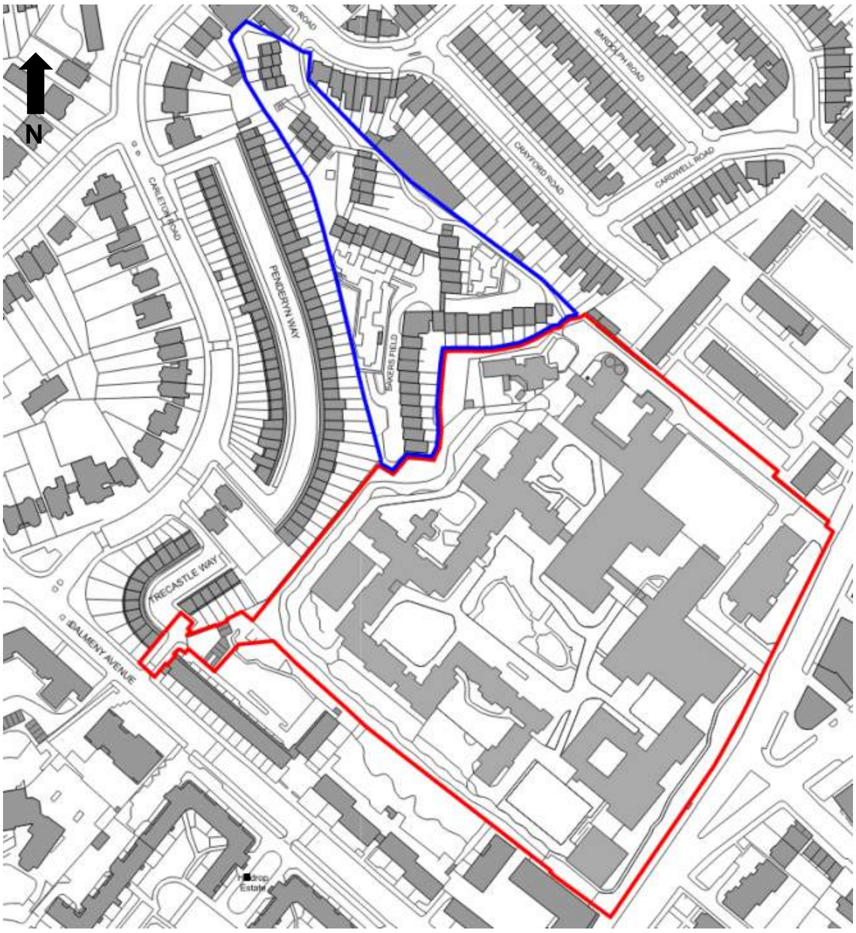
2. Introduction

2.1. Waterman Infrastructure and Environment have been commissioned by Peabody Construction Limited (the Applicant) to undertake a Flood Risk Assessment (FRA) for the Holloway Prison re-development (hereafter referred to as ‘the Site’), located in the London Borough of Islington (LBI).

Site Description

2.2. The Site (Figure 1) covers 4.16ha, and currently comprises decommissioned prison buildings and associated landscaping. The Site is located in the urban setting of North London, bounded to the east by Camden Road/Parkhurst Road to the south by Dalmeny Avenue, to the west by residential properties fronting Trecastle Way, Penderyn Way, and Bakersfield Way, and by existing properties to the north.

Figure 1: Site Location



Key

Site Boundary

Land in ownership of the applicant

2.3. The topographic survey (Appendix A) shows that the Site slopes significantly towards the north and northeast boundaries. The highpoint is in the west of the Site at 42.0m Above Ordnance Datum

(AOD), falling towards the southeast to 40.0m AOD and towards the north to 35.0m AOD, reaching a low point in the north-eastern corner adjacent to Parkhurst Road at approximately 34.0m AOD.

Development Proposals

2.4. The proposals include for a phased comprehensive redevelopment including demolition of existing structures; site preparation and enabling works; and the construction of 985 residential homes including 60 extra care homes (Use Class C3), a Women's Building (Use Class F.2) and flexible commercial floorspace (Use Class E) in buildings of up to 14 storeys in height; highways/access works; landscaping; pedestrian and cycle connections, publicly accessible park; car (blue badge) and cycle parking; and other associated works.

Scope of the Report

2.5. This report assesses the potential effects of tidal, fluvial, pluvial, groundwater and artificial sources of flooding upon the development, in line with national and local planning policy. In addition, the management of foul and surface water runoff is also assessed, so as not to have a detrimental effect on the Site or its surroundings.

3. Planning Policy Guidance

National Planning Policy Framework

3.1. The National Planning Policy Framework[i] (NPPF), last revised in July 2021 states that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere.

3.2. The NPPF states that when determining planning applications, Local Planning Authorities (LPA) should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific FRA. Development should only be allowed in areas at risk of flooding where, in light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:

- Within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;
- The development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;
- It incorporates Sustainable Drainage Systems (SuDS), unless there is clear evidence that this would be inappropriate;
- Any residual risk can be safely managed; and
- Safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

3.3. Major developments should incorporate SuDS unless there is clear evidence that this would be inappropriate. The systems used should:

- Take account of advice from the Lead Local Flood Authority (LLFA);
- Have appropriate proposed minimum operational standards;
- Have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and
- Where possible, provide multifunctional benefits.

Planning Practice Guidance

3.4. The Planning Practice Guidance (PPG)[ii] provides additional guidance to LPAs to ensure effective implementation of the planning policies set out within the NPPF regarding development in areas at risk of flooding.

3.5. The PPG states that developers and LPAs should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of SuDS. Referencing information provided by the Environment Agency (EA), the PPG provides advice on taking account of climate change, setting out recommended contingency allowances for net sea level rise and peak rainfall intensities, which should be increased by between 5% and 105% from now until the year 2115. It also advises on flood resilience and resistance measures when dealing with the residual risks remaining after applying the sequential approach and mitigating actions.

3.6. The PPG also includes advice on flood risk vulnerability and flood zone compatibility. The following flood zones refer to the probability of river and sea flooding, without the presence of defences:

- Zone 1 - low probability: less than 1 in 1000 annual probability of river or sea flooding (<0.1%) in any year;
- Zone 2 - medium probability: between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% to 0.1%) or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% to 0.1%) in any year;
- Zone 3a - high probability: 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability flooding from the sea (>0.5%) in any year; and
- Zone 3b - the functional floodplain: where water has to flow or be stored in times of flood; identification should take account of local circumstances but would typically flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme 1 in 1,000 (0.1%) flood.

3.7. Flood risk vulnerability is split into five classifications in Table 2 of the PPG, as follows, and the compatibility of these within each Flood Zone is set out in Table 3 of the PPG:

- Essential Infrastructure, e.g. essential transport and utility infrastructure, wind turbines;
- Highly Vulnerable, e.g. emergency services (those required to be operational during flooding), basement dwellings;
- More Vulnerable, e.g. residential dwellings, hospitals, schools, hotels, drinking establishments;
- Less Vulnerable, e.g. retail, offices, storage and distribution, leisure, restaurants, car parks; and
- Water-Compatible Development, e.g. docks, marinas, wharves.

Non-statutory Technical Standards for Sustainable Drainage Systems

3.8. The Non-Statutory Technical Standards for Sustainable Drainage Systems[iii] was published in March 2015 and is the current guidance for the design, maintenance, and operation of SuDS.

3.9. The standards set out that the peak runoff rate should be as close as is reasonably practicable to the greenfield rate but should never exceed the pre-development runoff rate.

3.10. The standards also set out that the drainage system should be designed so that flooding does not occur on any part of the Site for a 1 in 30 year rainfall event, and that no flooding of a building (including basement) would occur during a 1 in 100 year rainfall event.

3.11. It is also noted within the standards that pumping should only be used when it is not reasonably practicable to discharge by gravity.

London Plan

3.12. The London Plan[iv] sets out the Mayor's policies for development in London and was published in December 2020 and adopted in March 2021.

3.13. Policy SI 12 Flood Risk Management, indicates the following:

- Current and expected flood risk from all sources across London should be managed in a sustainable and cost-effective way in collaboration with the Environment Agency (EA), Lead Local Flood Authority (LLFA), developer and providers.

- Development proposals should ensure that flood risk is minimised and mitigated, and that residual risk is addressed. This should include, where possible, making space for water and aiming for development to be set back from the banks of watercourses.
- Developments Plans and development proposals should contribute to the delivery of the measures set out in Thames Estuary 2100 Plan. The Mayor will work with the EA and relevant LPA's, including authorities outside London, to safeguard an appropriate location for a new Thames Barrier.
- Development proposals for utility services should be designed to remain operational under flood conditions and buildings should be designed for quick recovery following a flood.
- Development proposals adjacent to flood defences will be required to protect the integrity of flood defences and allow access for future maintenance and upgrading. Unless exceptional circumstances are demonstrated for not doing so, development proposals should be set back from flood defences to allow for any foreseeable future maintenance and upgrades in a sustainable and cost-effective way.
- Natural flood management methods should be employed in development proposals due to their multiple benefits including increasing flood storage and creating recreational areas and habitat.

3.14. Policy SI 13 regarding Sustainable Drainage indicates that Development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible. There should also be a preference for green over grey features. Furthermore, the policy outlines a specific drainage hierarchy and indicates that permeable paving should be used unless there are robust justifications, these items are discussed in further detail under Section 5 of this report.

Holloway Prison Site Supplementary Planning Document

3.15. The Holloway Prison Supplementary Planning Document (SPD) was adopted in January 2018 and provides the key planning and development objectives for the Site, setting out how the existing planning policies relate to the Site. It states that the Site will be included within the emerging Local Plan, which is currently undergoing examination.

3.16. With regards to drainage, the SPD states that the design of the scheme should take into account an integrated approach to water management. Proposals should incorporate rain/grey water recycling linked to SuDS. The approach to SuDS should achieve greenfield runoff rates and maximise amenity and biodiversity benefits with the scheme design taking a holistic approach to landscape, water management and green infrastructure. Proposals should maximise the provision of green roofs for biodiversity, sustainable drainage, and cooling.

London Borough of Islington Adopted Local Plan

3.17. The London Borough of Islington's (LBI) adopted Local Plan is made up of the Core Strategy and the Development Management Policies (DMP).

3.18. The Islington Core Strategy was adopted in 2011 and presents a plan for the future of the Borough. Relevant policies are:

- CS10 Sustainable Design: requiring all development to demonstrate that it is designed to be adapted to climate change, particularly through design which incorporates SuDS

- CS15 Open Space and Green Infrastructure: Maximising the contribution of new and existing open spaces to broader sustainability objectives including SuDS, climate change adaptation and biodiversity.

3.19. The Islington Development Management Policies were published in 2013 and present policies which are used to determine planning applications in the Borough. Relevant policies are:

- Applications for major developments creating new floorspace and major Change of Use that are likely to result in an intensification of water use are required to include details to demonstrate that SuDS have been incorporated to provide benefits in water quantity, quality, amenity and biodiversity.
- All minor new build developments of one unit or more are required to reduce existing run off levels as far as possible, and as a minimum maintain existing run-off levels, including through the incorporation of SuDS.

London Borough of Islington Emerging Local Plan

3.20. A new local plan is currently under review.

3.21. Although holding limited weight as not yet adopted, it is important to consider the emerging policies to aid in the development of a sustainable and suitable scheme. The Local Plan Strategic and Development Management Policies Regulation 19 Draft was published in September 2019, and states that the Holloway Prison site is the key local housing site which will help to meet identified housing need in the borough. It states the following with regard to drainage and flood risk:

- Policy G4: Biodiversity, Landscape Design, and Trees: include green roofs, incorporate SuDS into landscape design as part of an integrated approach which maximises biodiversity and water use efficiency, amenity and recreation.
- Policy G5: Green roofs and vertical greening: development proposals must use all available roof space to incorporate biodiversity-based extensive green roofs, subject to other planning considerations. Major development proposals must accommodate surface water storage by incorporating blue roof stormwater attenuation, unless it can be demonstrated that this is not possible

Islington Strategic Flood Risk Assessment

3.22. The Islington Strategic Flood Risk Assessment[v] (SFRA) was published in 2018 and outlines the relevant regional and local policy relating to flood risk and drainage and provides an overview of the risks of flooding to the Borough. Findings from the SFRA are outlined in Chapter 3 of this report.

3.23. The SFRA shows the areas defined as Critical Drainage Areas (CDAs), which are discrete geographic areas where multiple and interlinked sources of flood risk cause flooding during severe weather thereby affecting people, property, or local infrastructure. Appropriate surface water management should be incorporated into the development to reduce runoff from site post-development.

4. Flood Risk

Tidal/Fluvial

4.1. The EA Flood Map for Planning (extract provided in Figure 2) shows that the Site is located in Flood Zone 1, denoting a low risk of flooding from tidal or fluvial sources (less than 0.1% annual probability).

Figure 2: Environment Agency Flood Map for Planning

Key

Site Boundary

Source: https://flood-map-for-planning.service.gov.uk/

4.2. The Islington SFRA states that all main rivers historically located within the Borough are no longer present and there are no Ordinary Watercourses within the Borough. It further states that the EA's Historic Flood map shows that no flooding has occurred from fluvial sources.

4.3. On this basis, there is considered to be a very low risk of flooding from both tidal and fluvial sources.

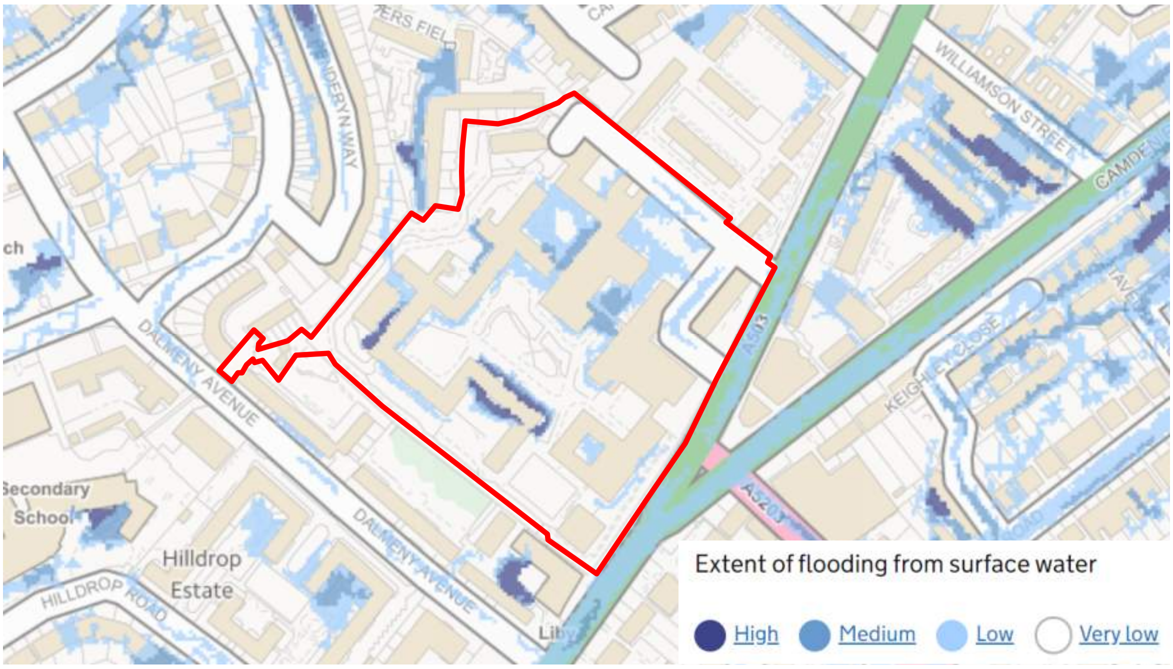
Pluvial

4.4. Pluvial flooding occurs when natural and/or engineered systems lack the capacity to manage the volume of rainfall. Pluvial flooding can occur in urban areas during an extreme, high intensity, low duration summer rainfall event which overwhelms the local surface water drainage system. This flood water would then be conveyed via overland flow routes based on the local topography.

Overland Surface Water

4.5. The EA's Flood Risk from Surface Water mapping (Figure 3 overleaf) shows that the majority of the Site is at 'very low' risk of surface water flooding (less than 0.1% annual probability), with areas at ‘low’ risk (between 1% and 0.1% annual probability) to ‘medium’ risk (between 1% and 3.3% annual probability) adjacent to the existing buildings in the north of the Site. There are three areas denoting as at ‘high’ risk (greater than 3.3% annual probability) adjacent to existing buildings in the south of the Site.

Figure 3: Environment Agency Flood Risk from Surface Water Map



Key

Site Boundary

Source: https://flood-warning-information.service.gov.uk/

4.6. The areas at risk of surface water flooding do not form part of overland flood flow routes and correspond to topographic low points within the Site. Further interrogation of the flood maps shows that in the ‘medium’ and ‘high’ risk scenario, the flood depths could range between 300 – 900mm.

4.7. A review of the topographic survey (Appendix A) confirms that there are low points adjacent to the buildings which could result in ponding up to 700mm in the south of the site and up to 400mm in the north of the Site.

4.8. The proposals would comprise a significant re-grading of levels, to generally fall towards the north-east. Localised low points in topography would be removed and all rainwater falling onto the Site would be managed in the proposed drainage strategy. Post-development, surface water would therefore no longer pond adjacent to buildings.

4.9. SFRA mapping (Appendix C) confirms that the Site is not located within an area at high risk of surface water flooding. The risk of flooding to the Site due to overland surface water flows is low.

Sewer

4.10. Sewer flooding is typically caused by heavy rainfall or blockages in the existing sewer network.

4.11. The Islington SFRA states that the majority of sewer flooding incidents have occurred in the south of the Borough over the last 20 years, which is not where the Site is located. SFRA mapping (Appendix C) shows that there were no sewer flood records within or adjacent to the Site since publication of the SFRA in 2018. Thames Water has also confirmed (Appendix D) that they hold no records of sewer flooding in the vicinity of the Site.

4.12. The surface water runoff arising from the proposed development would be restricted to the greenfield runoff rate (further detail provided in Chapter 4), alleviating the Thames Water sewers of flows, which provides a benefit to the public sewer capacity in the area.

4.13. The risk of sewer flooding to the Site is therefore considered to be low.

Groundwater

4.14. Groundwater flooding occurs when water emerges from the ground when the water table is high following heavy rainfall and is generally associated with porous sub-surface geology.

4.15. The British Geological Survey (BGS) 1:50:000 scale mapping shows that the Site is underlain by London Clay with no superficial deposits. The SFRA mapping (Appendix C) confirms this. London Clay is generally an impermeable stratum that does not support groundwater.

4.16. The Islington SFRA states that the areas within the Borough that are likely to have the greatest potential for groundwater flooding are in the south of the borough and the areas which have the potential for groundwater flooding to occur at surface are concentrated along the eastern boundary with Hackney and along the western boundary with Camden.

4.17. The risk of groundwater flooding to the Site is therefore considered to be low.

Artificial Sources

4.18. The EA's Flood Risk from Reservoir mapping (Figure 4 overleaf) shows that the Site would not be affected by flooding if a reservoir were to fail.

4.19. There are no other significant artificial bodies of water in the vicinity of the Site, and the risk of flooding from artificial sources is therefore considered to be low.

Figure 4: Environment Agency Flood Risk from Reservoir Map

Key

Site Boundary

Source: https://flood-warning-information.service.gov.uk/

5. Drainage Strategy

Existing Drainage

5.1. Thames Water asset plans (Appendix D) indicate the presence of several public sewers in the vicinity of the Site. These are summarised in Table 1 below.

Table 1: Existing Thames Water Sewers

Sewer	Location
1200 x 750mm combined sewer	Camden Road
1600 x 770mm combined sewer	Parkhurst Road
1600mm diameter combined sewer	Camden Road/Tollington Road

5.2. Survey information indicates that the Site currently drains both foul water and surface water into the existing 1600 x 770mm diameter Thames Water combined sewer located within Parkhurst Road.

Proposed Surface Water Discharge

5.3. The proposed surface water drainage system would be designed to convey surface water only, with foul water being discharged separately. The design would be in accordance with BS EN 752 – Drain and Sewer Systems Outside Buildings[vi], BS EN 12056 – Gravity Drainage Systems Inside Buildings[vii], and Approved Document H of Building Regulations[viii].

5.4. In line with the drainage hierarchy set out in Policy SI 13 of the London Plan 2021, the following hierarchy of surface water disposal should be adhered to, in decreasing order of preference:

I. rainwater use as a resource (for example rainwater harvesting, blue roofs for irrigation)

II. rainwater infiltration to ground at or close to source

III. rainwater attenuation in green infrastructure features for gradual release (for example green roofs, rain gardens).

IV. rainwater discharge direct to a watercourse (unless not appropriate)

V. controlled rainwater discharge to a surface water sewer or drain

VI. controlled rainwater discharge to a combined sewer.

Discharge to Ground

5.5. As discussed in Section 4 of this report, the Site is likely underlain by London Clay Formation, which is typically impermeable. Therefore, discharging to ground is not considered feasible.

Discharge to a Surface Water Body

5.6. The Islington SFRA confirms there are no watercourses within the Borough. As there are no surface water bodies in the vicinity of the Site, this option is precluded.

Discharge to a Surface Water Sewer

5.7. There are no surface water sewers in the vicinity of the Site, therefore, this option is precluded.

Discharge to a Combined Water Sewer

5.8. Due to the lack of suitable surface water bodies and sewers in the vicinity of the Site, and the spatial constraints precluding discharge to ground, it is proposed to discharge surface water runoff into the existing Thames Water sewer network located within Parkhurst Road, mimicking the existing situation.

Sustainable Drainage Systems

5.9. The most sustainable way to drain surface water runoff is through the use of SuDS, which need to be considered in relation to Site-specific constraints.

5.10. SuDS mimic the natural drainage system and provide a method of surface water drainage which can decrease the quantity of water discharged, and hence reduce the risk of flooding. In addition to reducing flood risk, SuDS features can improve water quality, and provide biodiversity and amenity benefits.

5.11. A variety of SuDS are available to reduce or temporarily hold back the discharge of surface water runoff. The potential for SuDS was considered throughout the design development. Table 4 outlines SuDS devices and their constraints and opportunities at the Site.

Table 2: Sustainable Drainage Techniques

Device	Description	Constraints/Comments	✓/✗
Green/brown roofs (source control)	Provide soft landscaping at roof level which reduces surface water runoff.	Green roofs are proposed across a number of roofs within the development where other constraints permit (i.e. plant, structural).	✓
Infiltration devices & Soakaways (source control)	Store runoff and allow water to percolate into the ground via natural infiltration.	The low permeability of the underlying strata precludes the use of infiltration techniques.	✗
Pervious surfaces (source control)	Storm water is allowed to infiltrate through the surface into a storage layer, from which it can either infiltrate and/or slowly release to sewers.	Permeable surfaces (i.e. permeable paving and porous surfacing with aggregate sub-base storage) are proposed throughout the Proposed Development.	✓
Rainwater harvesting (source control)	Reduces the annual average rate of runoff from the site by reusing water for non-potable uses e.g. toilet flushing or water butts.	Water butts are proposed to be utilised for irrigation use across the public gardens.	✓
Swales (permeable conveyance)	Broad shallow channels that convey / store runoff, and allow infiltration (ground conditions permitting).	Due to the spatial constraints at the Site, swales are not considered feasible.	✗

Device	Description	Constraints/Comments	✓/×
Filter drains & perforated pipes (permeable conveyance)	Trenches filled with granular materials (which are designed to take flows from adjacent impermeable areas) that convey runoff while allowing infiltration (ground conditions permitting).	It is considered that the other SuDS features proposed are more fitting to the Proposed Development.	×
Filter Strips (permeable conveyance)	Wide gently sloping areas of grass or dense vegetation that remove pollutants from runoff from adjacent areas.	It is considered that the other SuDS features are more fitting to the Proposed Development.	×
Infiltration basins (end of pipe treatment)	Depressions in the surface designed to store runoff and allow infiltration through the base.	The low permeability of the underlying strata precludes the use of infiltration techniques.	×
Bioretention Systems / Rain Garden (end of pipe treatment)	A shallow landscaped depression which allows runoff to pond temporarily on the surface before filtering through vegetation and underlying soils.	Rain gardens and tree pits are proposed along the majority of the roadways within the Proposed Development.	✓
Ponds (end of pipe treatment)	Depressions in the surface designed to store runoff without infiltration through the base.	Due to spatial constraints at the Site, including existing trees, ponds are not considered feasible.	×
Attenuation Underground (end of pipe treatment)	Oversized pipes or geo-cellular tanks designed to store water below ground level.	To promote attenuating runoff at source, geo-cellular storage tanks are proposed to be incorporated within the podium build-up. Due to the attenuation volume required, a geo-cellular attenuation tank is required beneath the central landscaping area to supplement the volume available for storage.	✓

Green Roofs

5.12. Green roofs would provide a bio-diverse habitat, water quality benefits, as well as capturing rainwater and naturally slowing the rate of runoff. Green roofs are incorporated throughout the Proposed Development (Appendix B).

Permeable Paving

5.13. Permeable paving/porous surfacing would provide water quality benefits as well as attenuating flows with the aggregate sub-base storage. The inclusion of permeable paving is proposed throughout the Proposed Development.

Rainwater Harvesting

5.14. The inclusion of rainwater harvesting would decrease demand on potable water and could be used for irrigation of the proposed landscaping. Water butts are proposed to be integrated into the communal areas of the development, for example the Womens' Garden, to reduce the reliance on potable water. However, it cannot be guaranteed that there would always be sufficient demand for recycled water to ensure an empty tank is available prior to a high intensity rainfall event, when the storage is most required. Therefore, this has not been taken into account in the surface water runoff calculations.

Rain Gardens

5.15. Rain gardens are planted areas where surface water percolates through the soil and aggregates, providing treatment of the water prior to being conveyed into the surface water piped system. Rain gardens also provide amenity and biodiversity benefits. Lined rain gardens are proposed to provide treatment to the runoff arising from the hardstanding areas and roads where possible.

Geo-cellular Attenuation Tank

5.16. Due to the constrained urban nature of the Site, tanks would also need to be incorporated in order to restrict surface water runoff sufficiently. The size of these tanks may be able to be reduced at the detailed design stage once the extent of other SuDS attenuation on site is known. However, at this stage tanks have been shown to prove that the required attenuation volume is achievable.

5.17. If required, the geo-cellular attenuation tanks could contain a floating biomat to pick up any potential residual pollution contained within the runoff. This would be confirmed at the detailed design stage.

Proposed Surface Water Drainage Strategy

5.18. The total Site area within the red line boundary is approximately 4.16ha. Based on land level information, the following calculations have been undertaken based on a proposed site area to be positively drained of 3.815ha.

5.19. The existing discharge rate for the Site has been calculated using the Modified Rational Method to be 46.9 l/s for the 1 in 1 year 60 minute event and 252.5 l/s for the 1 in 100 year 60 minute event (Appendix F).

5.20. In line with London Plan requirements, it is proposed to restrict surface water runoff from the Site to the greenfield rate for all events up to and including the 1 in 100 year rainfall event (Q100), which has been calculated to be 48.5 l/s (Appendix F). This approach has been agreed with the London Borough of Islington.

5.21. MicroDrainage Source Control Module has been used to undertake a preliminary design of the required attenuation volume at the Site in order to restrict surface water runoff to 48.5 l/s for all events up to and including the Q100 plus 40% climate change event. The soft landscaped areas would naturally drain to ground. The calculations indicate that approximately 3222m^3 of attenuation would be required on-site.

5.22. Rain gardens and green roofs are also proposed throughout the development to provide an additional level of treatment for runoff.

5.23. The Site has been split into a number of drainage catchments for each plot as well as the public garden and the road. A plan showing each catchment is included in Appendix E.

5.24. The storage volume would be provided through a combination of storage within the granular sub-base of permeable paving, plinth tanks and underground storage tanks. The attenuation proposed for each catchment is shown in Table 3 below. An indicative proposed surface water drainage layout is included within Appendix E.

Table 3: Attenuation Summary

Catchment	Drains to:	Attenuation (m^3)	Discharges to:
A	Permeable Paving	167	Catchment B Tank
	Underground Tank	228	
R1 & R2	Plinth Tank	68	Catchment A Tank
B	Permeable Paving	117	Public sewer
	Underground Tank	539	
R3 & R4	Plinth Tank	96	Catchment B Tank
C	Permeable Paving	203	Public Garden Tank
D	Permeable Paving	270	Public Garden Tank
E	Permeable Paving	198	Catchment A Tank
Public Garden	Permeable Paving	329	Catchment B Tank
Road	Underground Tanks	242	Public Sewer
	Total:	**3222**	

5.25. It is currently proposed to make a new connection to the 300mm combined sewer that crosses the Site through a Section 106 Agreement with Thames Water, under the Water Industry Act 1991. Whilst the level of the 300mm combined sewer is not known at this stage, due to the depth of the nearby trunk sewer it is currently assumed that a gravity connection would be achievable. This would be confirmed following additional surveys to be undertaken post planning.

5.26. The on-Site drainage networks and SuDS would be privately managed and maintained, ensuring they remain fit for purpose and function appropriately. Exact maintenance responsibilities would be confirmed at a later stage, with the potential management company / operator appointed post-planning.

Water Quality

5.27. Appropriate treatment would be incorporated into the drainage system to ensure that the quality of water discharged is acceptable. Treatment would be predominantly provided by the permeable paving at ground level, but rain gardens and green roofs are also incorporated into the Development. Table 6 below summarises the pollution indices on-site and the pollution mitigation capabilities of permeable paving, rain garden and green roofs.

Table 4: Pollution Hazard Levels and Mitigation Indices

Pollutant	Roof Level Hazard - Very Low Hazard Level	Car Parks and Low Traffic Roads – Low Hazard Level	Commercial delivery areas and non-residential car parking – Medium Hazard Level	Total Mitigation index provided by Green Roofs and Rain Gardens and Permeable Paving
Total Suspended Solids	0.2	0.5	0.7	**1.15**
Metals	0.2	0.4	0.6	**1.1**
Hydrocarbons	0.05	0.4	0.7	**1.15**

5.28. The permeable paving alone provides sufficient pollution control for the roof and the ground level uses.

5.29. The road is drained via a separate system. Whilst SuDS will be used where possible adjacent to the highway, it may be necessary to specify additional pollution control measures for the highway runoff (e.g. petrol interceptor).

Exceedance Routes

5.30. In the unlikely event of a severe blockage in the local drainage system or a storm greater than the 1 in 100 year plus 40% climate change design storm, the proposed drainage system could exceed its capacity and overflow. These exceedance flow routes and flooded areas must be managed to minimise risks to the development and adjacent areas.

5.31. The exceedance flow routes would be confirmed post planning once the full levels design and detailed drainage strategy has been completed. However, at this stage the likely flow routes have been indicated on Figure 5: Exceedance flood flow routingFigure 5 overleaf.

Figure 5: Exceedance flood flow routing

Key

Exceedance flood flow route

Sustainable Drainage System Maintenance Plan

5.32. The PPG sets out the requirements for developers to consider the operation, management and maintenance of all SuDS.

5.33. Post construction, the on-Site management company would be responsible for the SuDS included in the scheme. Table 5 (overleaf) outlines what maintenance is anticipated for the proposed SuDS features, in line with guidance from the CIRIA SuDS Manual.

Table 5: Maintenance plan for SuDS

SuDS and Task	Frequency
Permeable Paving	
Initial inspection	Monthly for 3 months after installation
Inspect silt accumulation rates and establish appropriate brushing frequencies	Once a year
Stabilise contributing adjacent areas	As required
Removal of weeds or management using glyphosphase applied directly into the weeds	As required
Remediate work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
Inspect for evidence of poor operation and/or weed growth, if required, take remedial action	3-monthly, 48 hours after large storms in first six months
Monitor inspection chambers	Annually
Green Roofs	
Inspect system to replace dead plants as required and ensure plants are sufficiently watered (during establishment period)	As required
Inspect system to replace dead plants (post establishment period)	Annually (in autumn)
Remove nuisance and invasive vegetation, including weeds	Six monthly or as required
Inspect system to ensure substrate is not eroded and inlet/outlet drains are not blocked	Annually or as required (after severe storms)
Rain Gardens	
Check operation of the underdrains by inspection of flows after rain	Annually
Assess plants for disease infection, poor growth, invasive species etc., and replace as necessary	Quarterly
Inspect inlets and outlets for blockage	Quarterly
Remove litter and surface debris and weeds	Quarterly
Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch	As required
Remove and replace filter medium and vegetation above	As required but likely to be > 20 years
Underground Attenuation	

SuDS and Task	Frequency
Inspection of silt traps, manholes and pipework, and remove any sediment/debris	Quarterly or as required
Jetting of main structure to remove any sediment build up	Annually or as required

6. Foul Drainage

6.1. The proposed foul drainage would be designed in accordance with BS EN 752 – Drain and Sewer Systems Outside Buildings, BS EN 12056 – Gravity Drainage Systems Inside Buildings, and Approved Document H of Building Regulations.

6.2. The former prison has a capacity of approximately 500 inmates and the existing foul flow rate has been calculated to be 3.8l/s. The proposed foul discharge rate has been calculated at 8.9 l/s (Appendix F), a new connection would be made to the combined sewer beneath Parkhurst Road through a S106 Agreement with Thames Water, under the Water Industry Act 1991.

6.3. A pre-development enquiry has been submitted to Thames Water to determine whether there is sufficient capacity within the sewer network to accept combined flows from the development. The response is currently awaited.

6.4. While there is a 5.1 l/s increase in foul flows resulting from the development, this marginal increase is fully compensated through the substantial reduction in peak surface water flows from the site, which means the development overall provides a large betterment in Thames Water sewer capacity in the local area.

7. Conclusion

7.1. The Site is located in Flood Zone 1 and the risk of flooding due to fluvial, tidal, groundwater and artificial sources has been assessed and is considered to be low.

7.2. Whilst the Site is currently shown to be at 'low' to 'high' risk of flooding from surface water, the proposals would include significant regrading of land levels and the use of SuDS. Consequently, the risk of flooding to the Development is considered to be low.

7.3. The Drainage Strategy for the Site has been divided into sub-catchments for each Plot (and the Landscaping area and Road). It is proposed that a total attenuation storage volume of 3222m^3 would be required. This will be provided through a combination of permeable paving, plinth tanks and underground tanks. Rain gardens and green roofs will also be incorporated throughout the Development Site. Runoff from the Site to the public combined sewer would be restricted to the Q100 greenfield runoff rate of 48.5l/s for all storm events up to and including the 1 in 100 year plus 40% climate change scenario.

7.4. Appropriate treatment would be incorporated into the drainage system to ensure that the quality of water discharged is acceptable. This would be achieved through the use of permeable paving in combination with green roofs and rain gardens. If required, a biomat filtration system, downstream defender or other hard engineered solution could also be incorporated to ensure discharge is appropriately treated. This report sets out the principles of the SuDS scheme, and the final strategy would be confirmed at the detailed design stage.

7.5. The on-site drainage network and SuDS would be privately managed and maintained for the lifetime of the development, ensuring that they remain fit for purpose and function appropriately. The management company/operator would be appointed post-planning.

7.6. The rate of foul discharge from the existing site has been estimated to be 3.8l/s based on an inmate population of 500 persons. The Development proposes to utilise the existing connection to the combined public sewer, discharging at a rate of 8.9l/s.

7.7. This report demonstrates that the proposed Development has a low probability of flooding from all sources. The report also confirms that surface water runoff from the site will not be affected by the development proposals thereby ensuring that flood risk is not increased elsewhere. It is considered that the information provided within this report satisfies the requirements of the National Planning Policy Framework and local policy.

[i] Ministry of Housing, Communities and Local Government, February 2019. *National Planning Policy Framework.*

[ii] Ministry of Housing, Communities and Local Government, March 2014. Planning Practice Guidance.

[iii] Department for Environment, Food and Rural Affairs, March 2015. Non-statutory technical standards for sustainable drainage systems.

[iv] London Plan, March 2021. London Plan.

[v] CVU, August 2018. London Borough of Islington Strategic Flood Risk Assessment.

[vi] British Standards Institution, April 2008. BS EN 752:2008 – Drain and Sewer Systems Outside Buildings

[vii] British Standards Institution, September 2000. BS EN 12056-2:2000 – Gravity Drainage Systems Inside Buildings

[viii] HM Government, 2010. The Building Regulations 2010: H, Drainage and Waste Disposal

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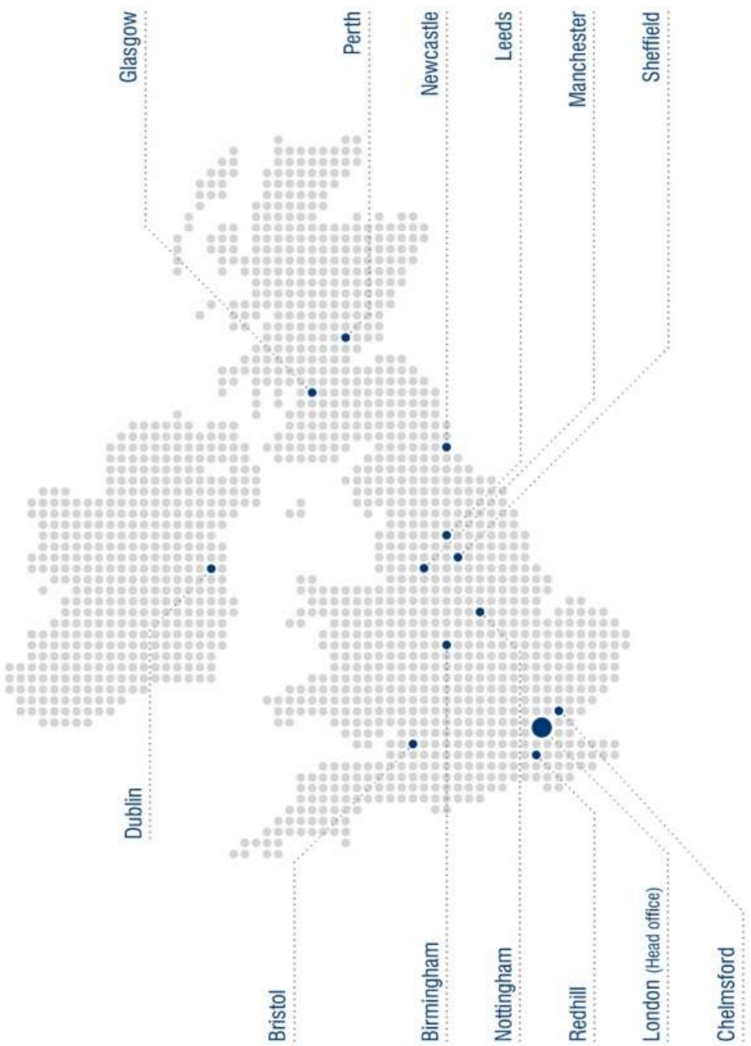
APPENDICES

A. Topographic Survey

Point	Easting	Northing	Elevation	Description
1	530129.184	185684.171	35.039	CS Nail
2	530215.145	185601.914	34.306	CS Nail
3	530110.615	185699.202	34.988	CS Nail
4	530143.633	185663.803	35.117	CS Nail
5	530197.604	185616.540	34.703	CS Nail
6	530208.502	185606.214	34.582	CS Nail
7	530116.528	185658.032	35.189	CS Nail
8	530156.608	185571.001	34.988	CS Nail
9	530158.998	185614.854	34.630	CS Nail
10	530169.355	185508.451	37.440	CS Nail
11	530175.288	185564.413	35.152	CS Nail
12	530113.442	185441.639	41.271	CS Nail
13	530129.117	185594.754	34.728	CS Nail
14	530094.498	185529.348	38.670	CS Nail
15	530125.891	185531.440	37.863	CS Nail
16	530047.109	185571.090	38.900	CS Nail
17	530023.052	185584.661	38.253	CS Nail
18	530074.215	185583.302	37.878	CS Nail
19	530100.352	185566.857	36.673	CS Nail
20	530105.343	185618.319	34.762	CS Nail
21	530086.506	185661.239	35.684	CS Nail
22	530101.685	185532.726	38.400	CS Nail
23	530076.124	185473.150	41.301	CS Nail
24	530047.424	185564.521	38.826	CS Nail
25	530028.035	185541.735	40.976	CS Nail
26	530004.419	185560.749	39.704	CS Nail
27	530019.375	185581.624	38.244	CS Nail
28	530036.816	185511.715	40.993	CS Nail
29	529987.375	185552.264	41.787	CS Nail
30	530050.101	185518.600	40.672	CS Nail
31	529972.693	185558.030	42.064	CS Nail
32	529967.684	185577.824	41.554	CS Nail
33	529993.599	185606.559	38.654	CS Nail
34	530008.054	185621.344	38.185	CS Nail
35	530044.627	185629.097	35.781	CS Nail
36	530061.503	185653.472	35.812	CS Nail
37	530008.263	185593.648	38.281	CS Nail
38	529987.199	185568.107	38.302	CS Nail
39	530055.884	185622.064	35.660	CS Nail

UK and Ireland Office Locations



waterman

B. Scheme Drawings

P:\LONDON PROJECTS\2019\1947_PROJECT OSPREY\01 CAD\02 SHEET LAYOUT\1947-EXA-ZZ-ZZ-DR-L-00110.DWG

LEGEND

PLANNING APPLICATION BOUNDARY

HARD LANDSCAPE

SURFACE TYPE 02 - CONCRETE BLOCK PAVING
To footpaths and circulation areas

SURFACE TYPE 06: PERMEABLE RESIN BOUND GRAVEL
To self-grow areas

SURFACE TYPE 10: COMPOSITE TIMBER DECKING
To seating areas

SURFACE TYPE 11: RESIDENTIAL PAVING
To residential terraces

SOFT LANDSCAPE

PERENNIAL PLANTING IN RAISED PLANTER

PROPOSED SHRUB OR TREE

PREPARED SELF-GROW BEDS

GREEN/BROWN ROOF - REFER TO ARCHITECTS DRAWINGS

SEATING AND SEAT ELEMENTS

BUILT-IN TIMBER SEATING AND RECLINERS AN ARRAY OF TYPOLOGIES AND FORMS ATTACHED TO PROPOSED RAISED STEEL PLANTERS

SEATING ELEMENTS AN ARRAY OF TYPOLOGIES COMPRISING COMMUNITY TABLES, LOUNGERS AND LOUNGE SETS, MEETING TABLES

Client
PEABODY

NOTES:

1. THIS PLAN INCLUDES COMMUNAL SPACE ONLY. REFER TO ARCHITECTURAL INFORMATION FOR PROVISION OF PRIVATE AMENITY SPACES

Rev	Description	Date
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P01	PLANNING SUBMISSION	01.11.2021

EXTERIOR ARCHITECTURE

LONDON
Unit 17.1, The Leather Market, 11-13 Weston Street, London, SE1 3ER
MANCHESTER
Studio 537, The Royal Exchange, St Anns Square, Manchester, M2 7DH

E-MAIL office@exteriorarchitecture.com
WEB www.exteriorarchitecture.com

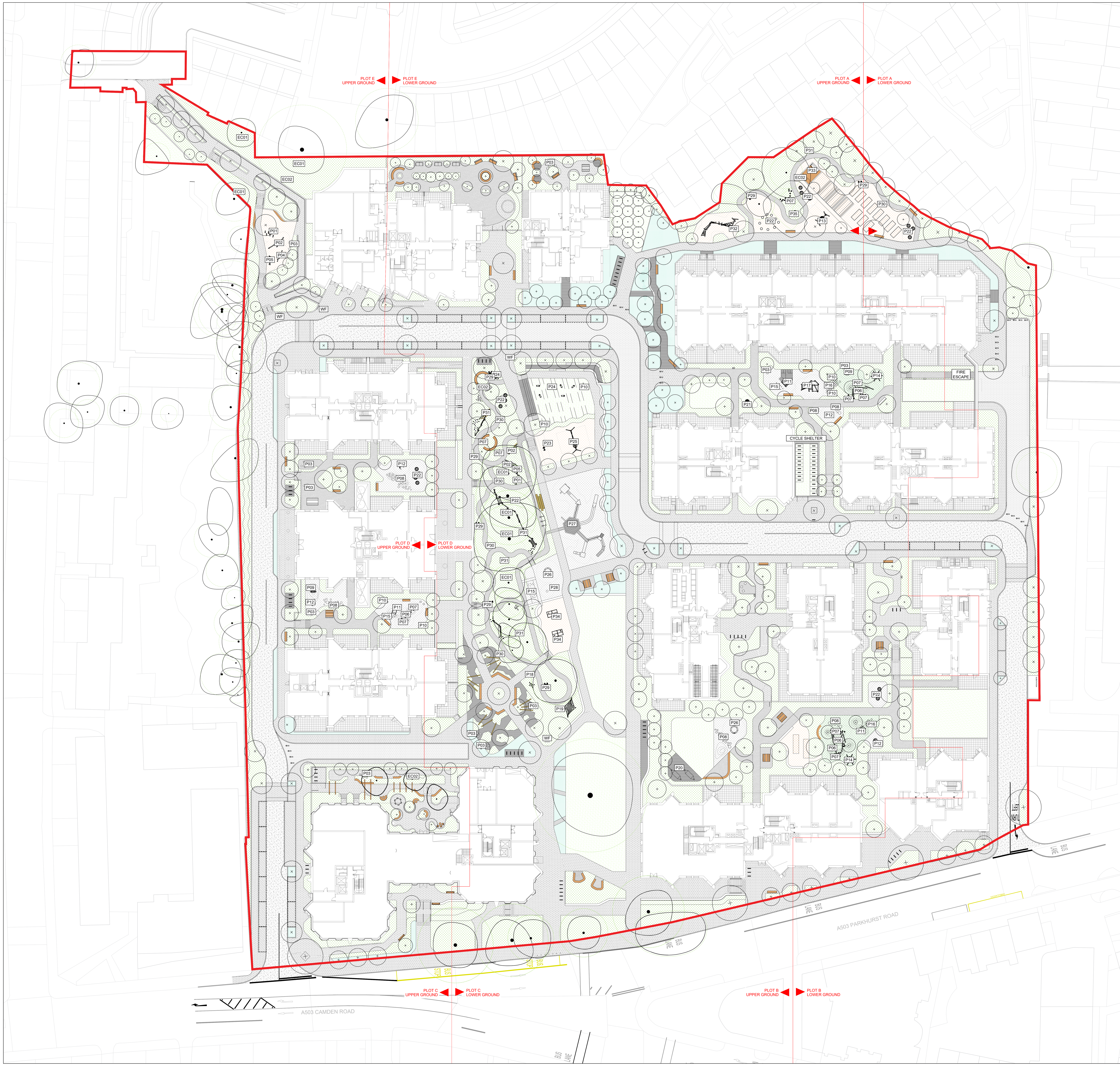
Project title
PROJECT HOLLOWAY

Drawing title
Landscape General Arrangement Plan_Roof

Issued By	London	T: 020 7978 2101	
Scale	1:500 @ A1	Drawn	EXA
Status	PLANNING	Checked	TOD
Date	01.11.2021	Approved	LP

Drawing number
1947-EXA-ZZ-ZZ-DR-L-00110

Revision
P01



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LEGEND

PLANNING APPLICATION BOUNDARY

HARD LANDSCAPE

SURFACE TYPE 01 - TARMAC ROAD

SURFACE TYPE 02 - CONCRETE BLOCK PAVING
To all primary footpaths along internal roads and within Trecastle connection

SURFACE TYPE 03: PERMEABLE BLOCK PAVING
To all main internal pedestrian routes and footways

SURFACE TYPE 04: PERMEABLE BLOCK PAVING
To differentiate shared surface road adjacent to park and refuse route near women's garden

SURFACE TYPE 05: PERMEABLE BLOCK PAVING
To carparking and loading bays

SURFACE TYPE 06: PERMEABLE RESIN BOUND GRAVEL
To harstanding areas within park, play spaces and secondary paths, and courtyards

SURFACE TYPE 07: CONCRETE SETTS
To memory garden, cycle parking areas and smaller static spaces

SURFACE TYPE 08: PERMEABLE PLAY SURFACING
Rubber bark mulch or wet pour to play areas

SURFACE TYPE 09: SELF-BINDING GRAVEL
To Trecastle play area

SURFACE TYPE 10: COMPOSITE TIMBER DECKING
To eco-swale garden, spillout space near Plane Tree Gate, and within residential amenity areas

SURFACE TYPE 11: RESIDENTIAL PAVING
To private residential terraces

SOFT LANDSCAPE

SPECIES RICH LAWN

IN-GROUND PERENNIAL PLANTING

PREPARED SELF-GROW BEDS

FILTRATION GARDEN / RAINGARDEN

EXISTING TREE TO BE RETAINED

PROPOSED TREE OR SHRUB

INDICATIVE SMOOTH MOUNDING IN PLAY SPACES

WALLS, EDGES, STEPS AND FURNITURE

BRICK WALLS AND STEPS TO MATCH ADJACENT SURFACE TREATMENT. ALL STEPS TO INCLUDE HANDRAILS AND TACTILES

RESIDENTIAL STEPS AND BRICK WALLS WITH GATE TO MATCH ADJACENT SURFACE TREATMENT. ALL STEPS TO INCLUDE HANDRAILS. GATES TO BE 1100mm IN HEIGHT, GATE METALALWORK TO MATCH

ECOLOGICAL CRIB WALL BOUNDARY TO RATIONALISE LEVEL CHANGE.

WF WAY-FINDING SIGNAGE

SHEFFIELD CYCLE STANDS ARRANGED IN GROUPS

DROP-DOWN BOLLARDS TO MANAGE VEHICLE MOVEMENT

SEATING AND SEAT ELEMENTS

BUILT-IN TIMBER SEATING ELEMENTS AN ARRAY OF TYPOLOGIES AND FORMS ACROSS THE SCHEME WITH BACKRESTS AND ARMRESTS

SEATING ELEMENTS AN ARRAY OF TYPOLOGIES COMPRISING COMMUNITY TABLES, LOUNGERS AND LOUNGE SETS, MEETING TABLES AND RECLINERS

SENSORY / EXTRA-CARE GARDEN

TIMBER CIRCLE SEATS WITH BACKS AND ARMRESTS RESTS, WITH CENTRAL SCULPTURAL BIRD BATH

WOMENS GARDEN + PUBLIC PARK MEMORIAL GARDEN

STAINLESS STEEL AND TIMBER PERGOLA WITH CLIMBING SPECIES

PLAY EQUIPMENT

PLAY EQUIPMENT AND LAYOUTS OF PLAY AREAS ARE UNDER REVIEW AND ARE SUBJECT TO CHANGE. THE LIST BELOW IS INDICATIVE AND NON-EXHAUSTIVE.

P01 ROBINIA STILTS
SUPPLIER: KOMPAN

P02 ROBINIA BALANCE BEAM ON SPRINGS
SUPPLIER: KOMPAN

P03 CUBE SEATS
SUPPLIER: WOODSCAPE

P04 ROBINIA BALANCE POSTS WITH ROPE
SUPPLIER: KOMPAN

P05 ROBINIA BALANCE PLUS
SUPPLIER: KOMPAN

P06 TROLLS BALANCE BEAM
SUPPLIER: LAPPSET

P07 STEPPING LOGS - CLOVER
SUPPLIER: LAPPSET

P08 EPDM BALLS - VARIOUS SIZES
SUPPLIER: STILUM

P09 SMALL SEE-SAW SPRINGER
SUPPLIER: RICHTER SPIELGERÄTE

P10 TALK TUBES
SUPPLIER: JUPITER PLAY

P11 SLIDE TO MOUNDED PLAY AREA
SUPPLIER: RICHTER SPIELGERÄTE

P12 WOBBLE DISC
SUPPLIER: RICHTER SPIELGERÄTE

P13 BIRDS NEST SWING
SUPPLIER: KOMPAN

P14 TEE-PEE AND TODDLER TABLE
SUPPLIER: DUNCAN AND GROVE

P15 CLIMBING HOLDS AND ROPE
SUPPLIER: CORE CLIMBING

P16 SCRAMBLING CUBE BLOCKS
SUPPLIER: WOODSCAPE

P17 HERONS NEST
SUPPLIER: HANDMADE PLACES

P18 MEMORY GAME
SUPPLIER: RICHTER SPIELGERÄTE

P19 WIDOW'S WEB NEST
SUPPLIER: SOVEREIGN PLAY

P20 RESIDENTIAL HAMMOCKS
SUPPLIER: TO BE CONFIRMED

P21 OUTDOOR MARBLES TABLE
SUPPLIER: RICHTER SPIELGERÄTE

P22 JUMPING DISCS
SUPPLIER: RICHTER SPIELGERÄTE

P23 YOU AND ME SWING
SUPPLIER: KOMPAN

P24 TIMBER ANIMALS
SUPPLIER: RICHTER SPIELGERÄTE

P25 DUAL SWING SET
SUPPLIER: KOMPAN

P26 SUPERNOVA
SUPPLIER: KOMPAN

P27 CUSTOM PLAY TOWER WITH SLIDES, SWING BRIDGES, CLIMBING NETS, HIGH ROPES COURSE, HAND GRIPS AND CLIMABLE MESH, FIREMAN'S POLE, AND FEATURE SLIDES
SUPPLIER: TO BE CONFIRMED

P28 SPINNER BOWL
SUPPLIER: KOMPAN

P29 FOSSIL ROCKS AND CLIMBERS
SUPPLIER: TO BE CONFIRMED

P30 BUG HOTELS AND MAGNIFYING STATIONS
SUPPLIER: TO BE CONFIRMED

P31 TIMBER BALANCING AND CLIMBING ELEMENTS TO CREATE NATURE TRIM TRIAL UNDER EXISTING TREES AND IN NATURE GARDEN
SUPPLIER: KOMPAN
COMPONENT PRODUCTS:
AGILITY TRAIL 5
AGILITY TRAIL 6
BALANCE COMBINATION
SITTING POLES (STEPPING LOGS)

P32 AGILITY TRAIL 9
SUPPLIER: KOMPAN

P33 MUD-KITCHEN AND LEARNING AREA

P34 OUTDOOR TABLE TENNIS TABLES
SUPPLIER: TO BE CONFIRMED

P35 SPINNER
SUPPLIER: KOMPAN

ECOLOGICAL ENHANCEMENT AND HABITAT

ANIMAL HOMES AND FINAL QUANTITIES TO BE SELECTED BY QUALIFIED PROJECT ECOLOGIST. ALL ANIMAL HOMES TO BE LOCATED FACING SOUTH OR WEST. PROPOSED HOMES INTEGRATED WITHIN THE FRAMEWORK OF THE BUILDING FACADE ARE NOT SHOWN.

EC01 STARLING 'TERRACES'
min. 2 or 3m above ground, and placed in groups to accommodate sparrow colonies

EC02 *BUG HOTEL*
To be filled with organic material from removed trees

0 20m

North

Client
PEABODY

Rev	Description	Date
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P01	PLANNING SUBMISSION	01.11.2021

EXTERIOR ARCHITECTURE
LONDON
Unit 17.1, The Leather Market, 11-13 Weston Street, London, SE1 3ER
MANCHESTER
Studio 537, The Royal Exchange, St Anns Square, Manchester, M2 7DH
E-MAIL office@exteriorarchitecture.com
WEB www.exteriorarchitecture.com

Project title
PROJECT HOLLOWAY

Drawing title
Landscape General Arrangement Plan_Ground Floor

Issued By	London	T: 020 7978 2101	
Scale	1:500 @ A1	Drawn	EXA
Status	PLANNING	Checked	TOD
Date	01.11.2021	Approved	LP

Drawing number
1947-EXA-ZZ-ZZ-DR-L-00100

Revision
P01

C. SFRA Mapping

Figure A – Topography

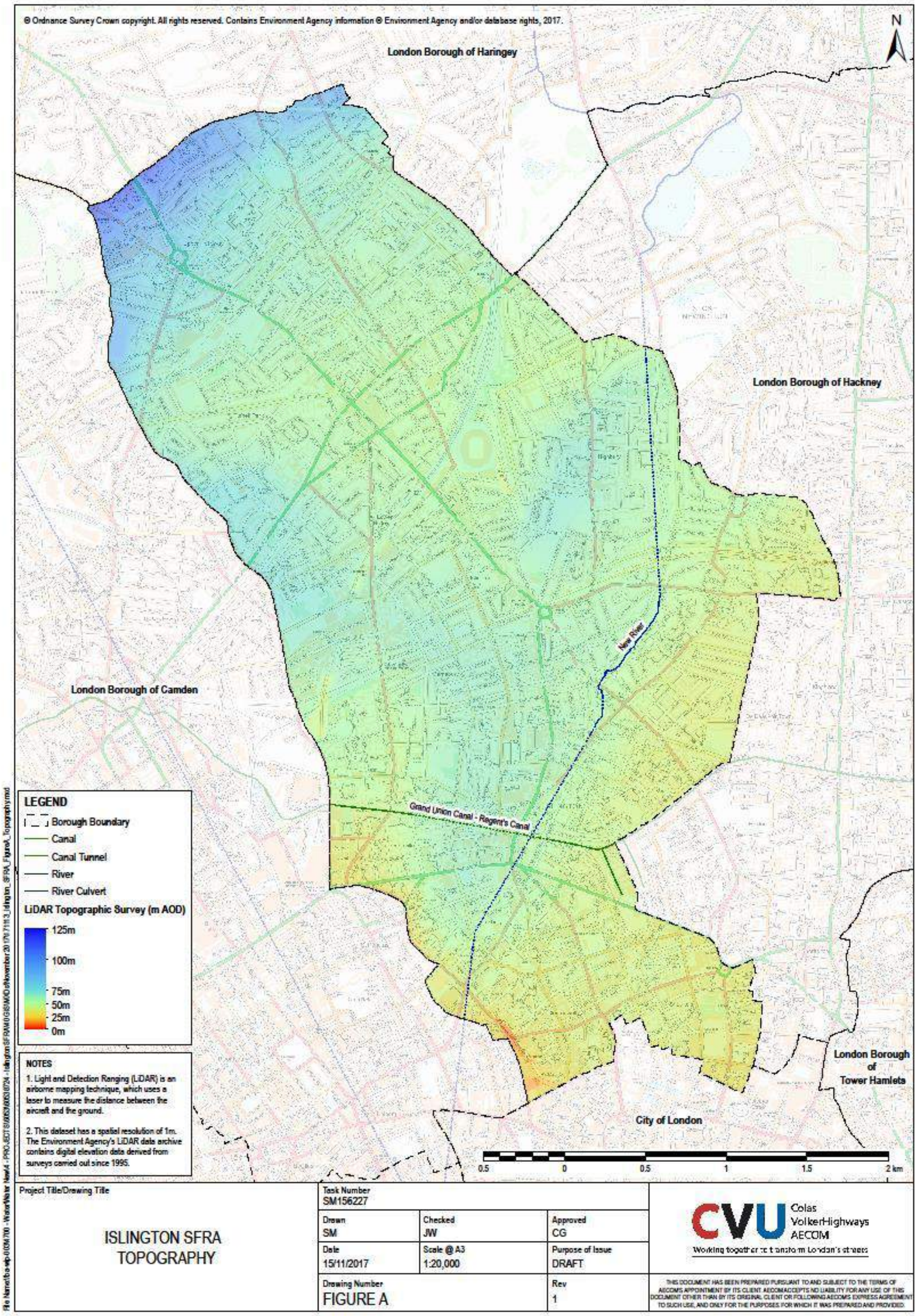


Figure B – Superficial Geology

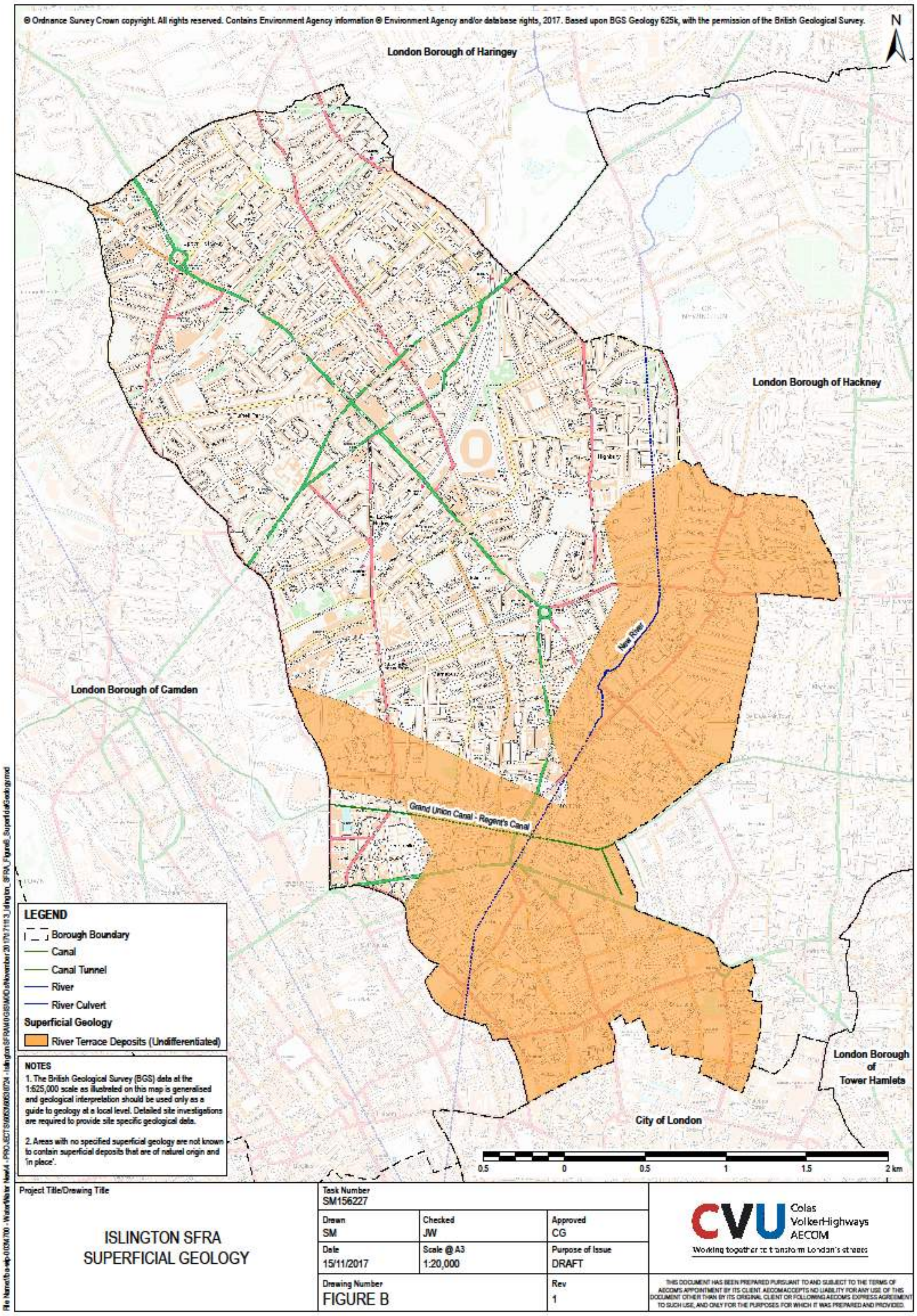


Figure C – Bedrock Geology

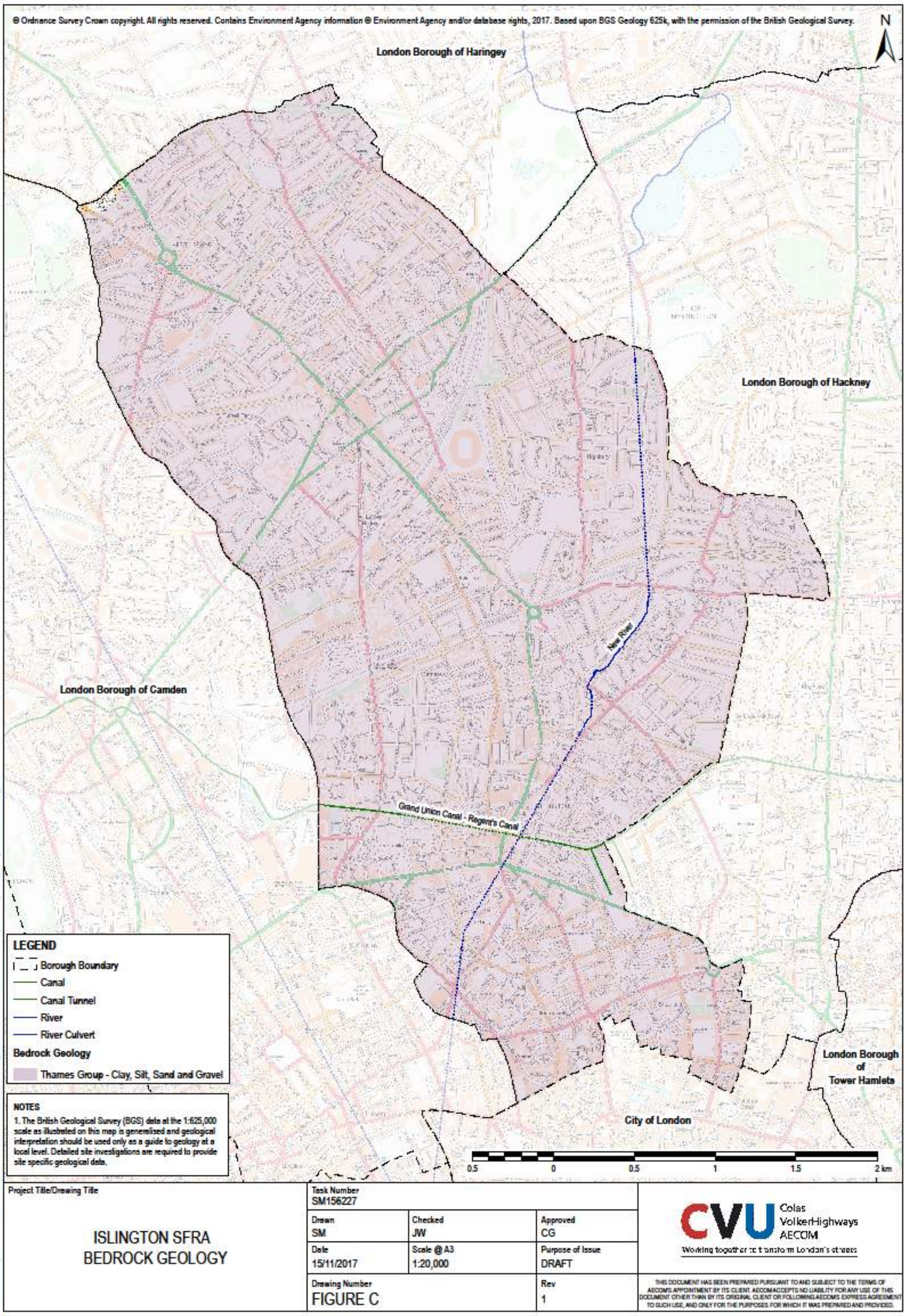
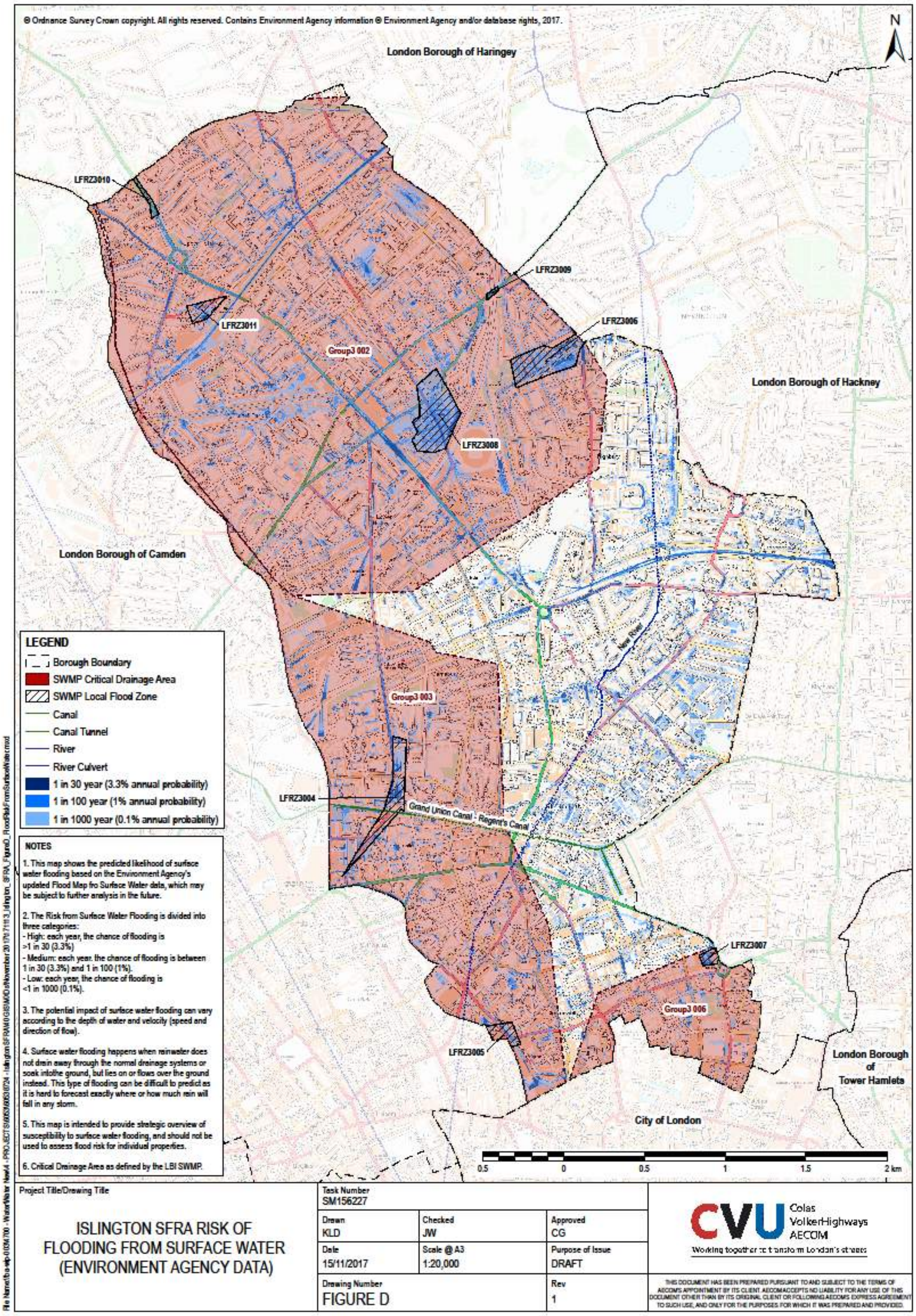


Figure D – Risk of Flooding from Surface Water (Environment Agency data)



Colas VolkerHighways AECOM
Working together to transform London's streets

LONDON HIGHWAYS ALLIANCE

Figure E – Flood Risk from Surface Water (Borough Wide Modelling)

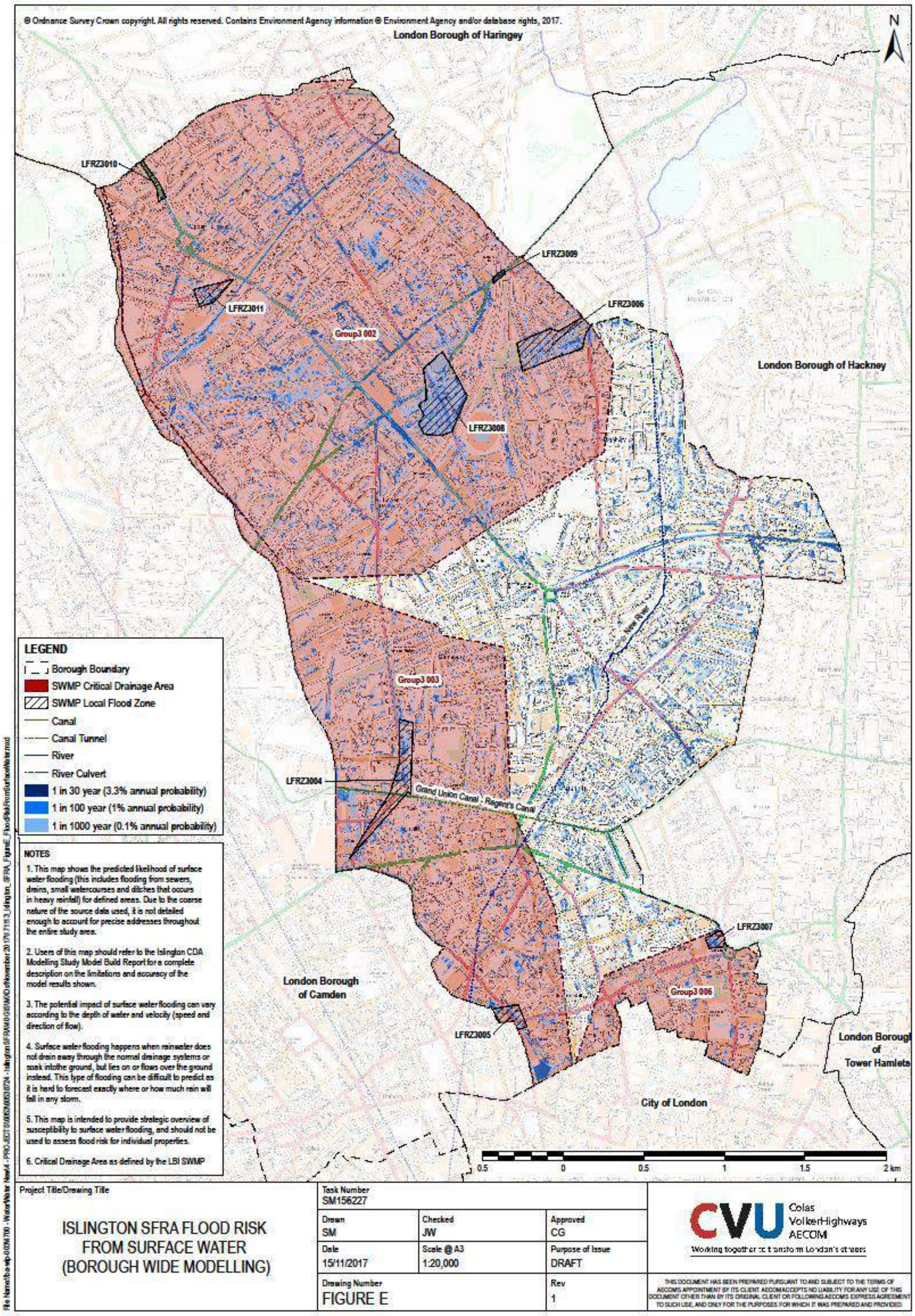


Figure F – Flood Risk from Surface Water including 40% Climate Change Allowance (Borough Wide Modelling)

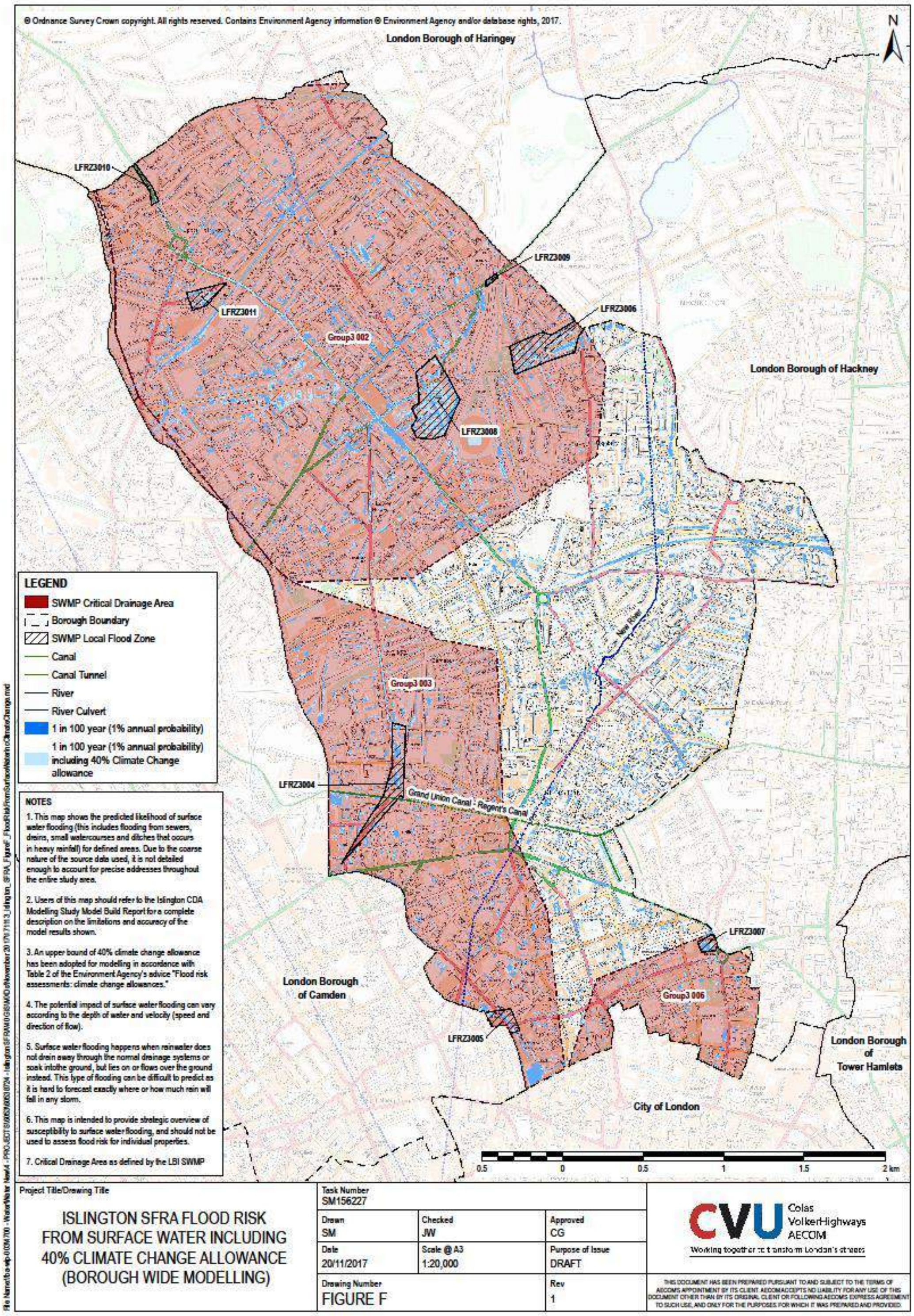


Figure G – Flood Risk from Groundwater

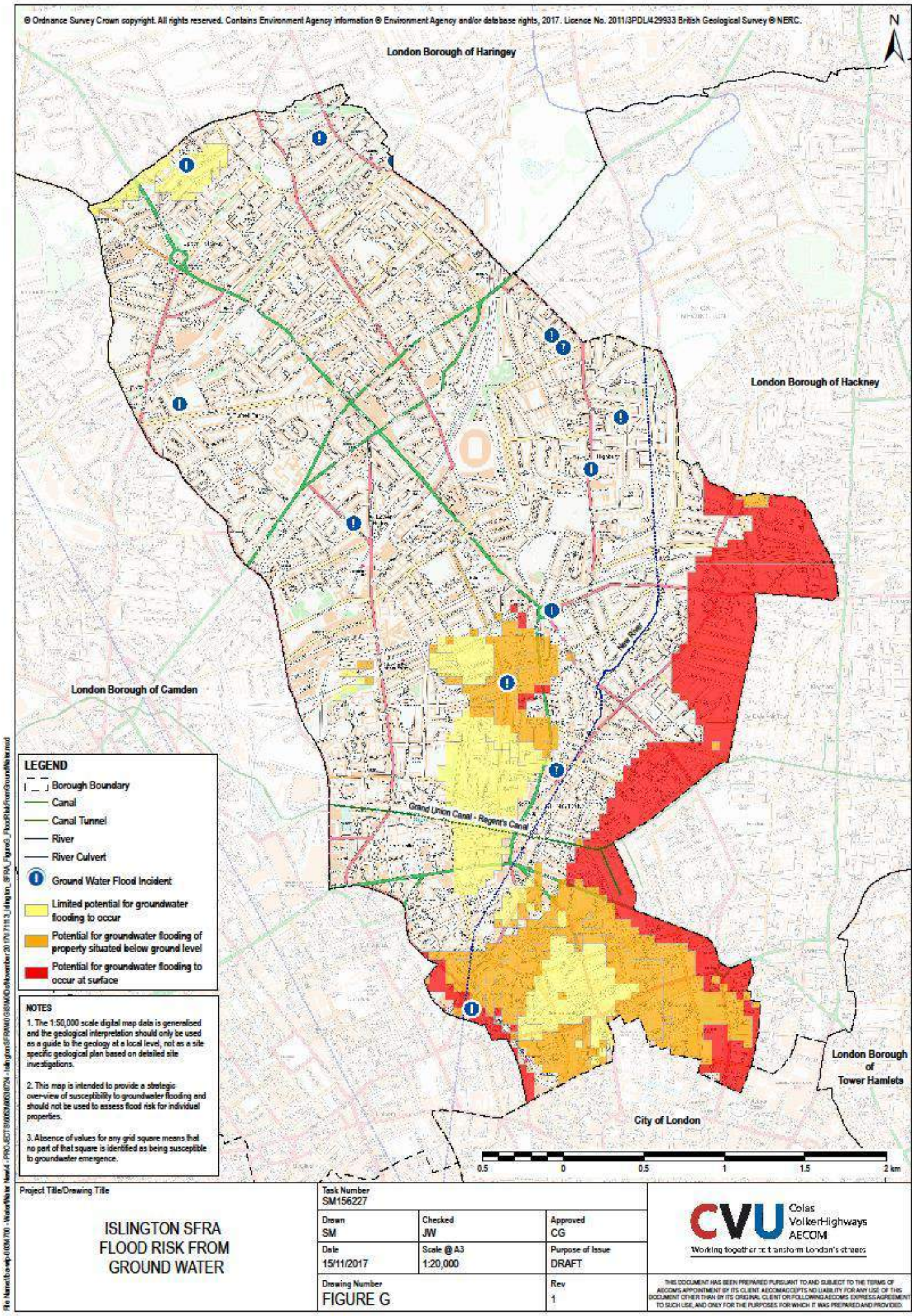


Figure H – Flood Risk from Reservoirs and Artificial Sources

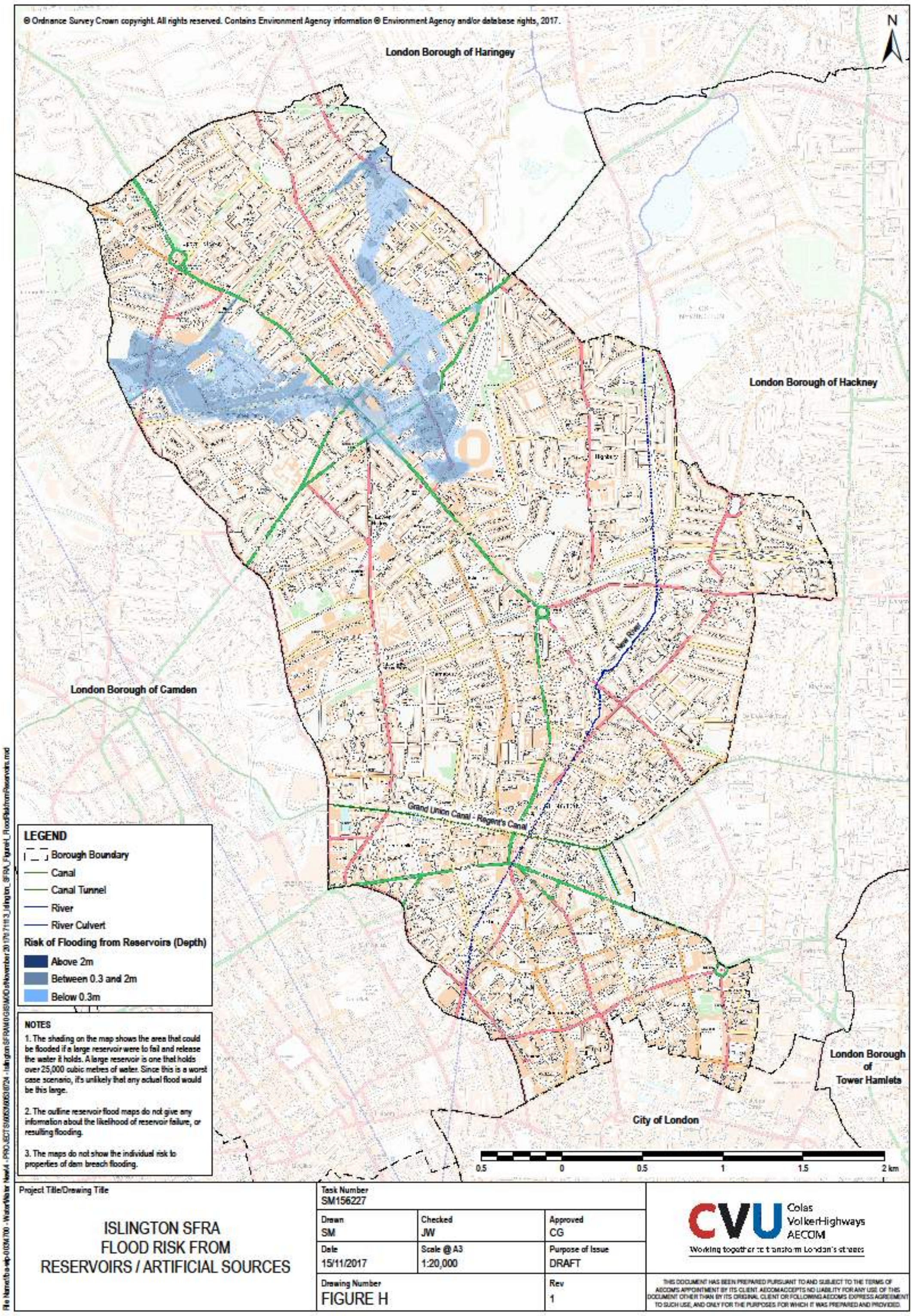
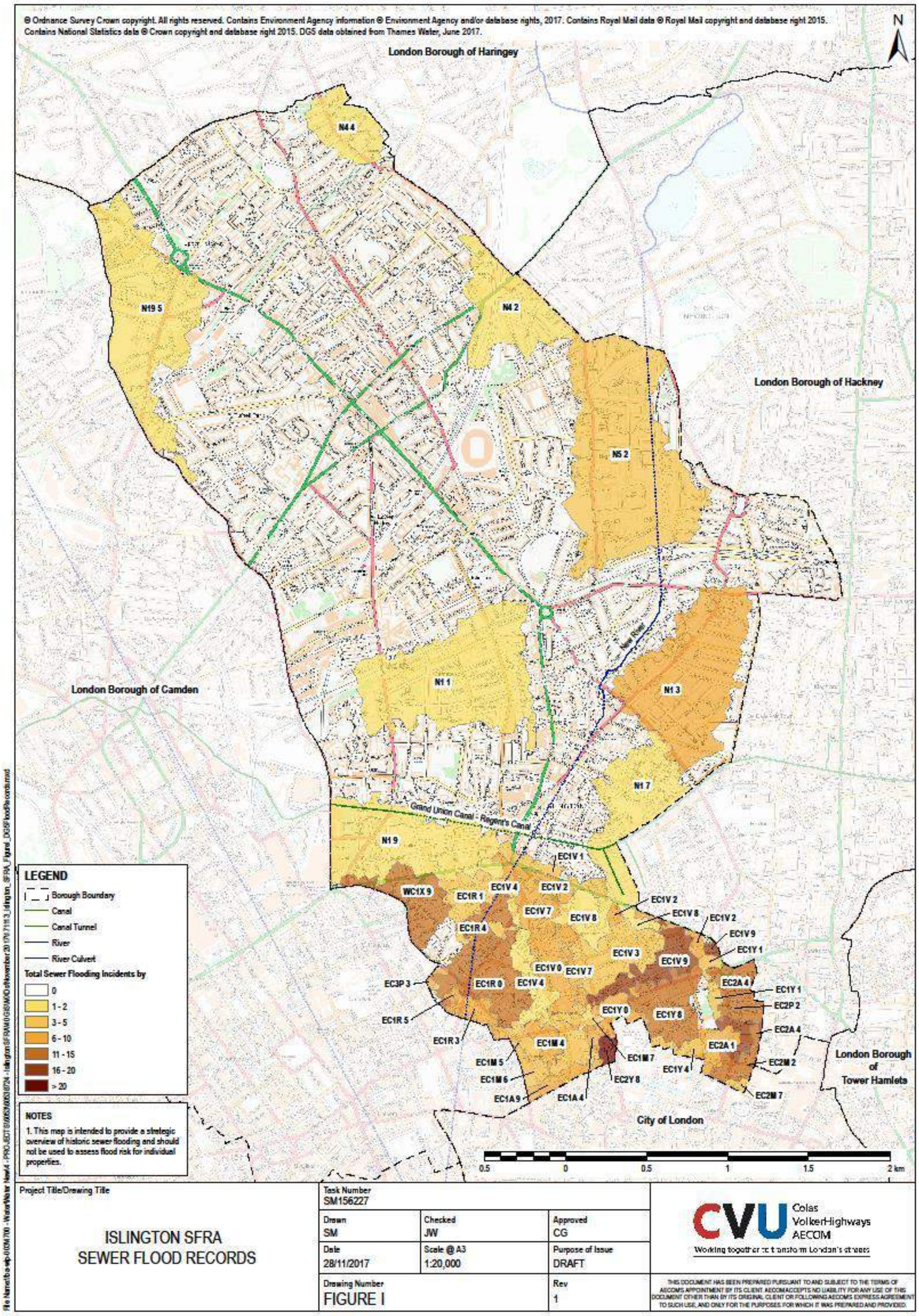


Figure I – Sewer Flood Records



D. Thames Water Asset Location Mapping

Sewer Flooding

History Enquiry

Thames Water Property Searches

Waterman Infrastructure & Environment

Search address supplied	H M Prison Holloway Parkhurst Road London N7 0NU

Your reference	WIE15702 Holloway Prison
Our reference	SFH/SFH Standard/2019_4084061
Received date	**30 September 2019**
Search date	**30 September 2019**

Thames Water Utilities Ltd
Property Searches, PO Box 3189, Slough SL1 4WW
DX 151280 Slough 13

searches@thameswater.co.uk
www.thameswater-propertysearches.co.uk

0845 070 9148

Search address supplied: H M Prison,Holloway,Parkhurst Road,London,N7 0NU

This search is recommended to check for any sewer flooding in a specific address or area

TWUL, trading as Property Searches, are responsible in respect of the following:-

(i) any negligent or incorrect entry in the records searched;

(ii) any negligent or incorrect interpretation of the records searched;

(iii) and any negligent or incorrect recording of that interpretation in the search report

(iv) compensation payments

Thames Water Utilities Ltd
Property Searches, PO Box 3189, Slough SL1 4WW
DX 151280 Slough 13

searches@thameswater.co.uk
www.thameswater-propertysearches.co.uk

0845 070 9148

History of Sewer Flooding

Is the requested address or area at risk of flooding due to overloaded public sewers?

The flooding records held by Thames Water indicate that there have been no incidents of flooding in the requested area as a result of surcharging public sewers.

For your guidance:

- A sewer is "overloaded" when the flow from a storm is unable to pass through it due to a permanent problem (e.g. flat gradient, small diameter). Flooding as a result of temporary problems such as blockages, siltation, collapses and equipment or operational failures are excluded.
- "Internal flooding" from public sewers is defined as flooding, which enters a building or passes below a suspended floor. For reporting purposes, buildings are restricted to those normally occupied and used for residential, public, commercial, business or industrial purposes.
- "At Risk" properties are those that the water company is required to include in the Regulatory Register that is presented annually to the Director General of Water Services. These are defined as properties that have suffered, or are likely to suffer, internal flooding from public foul, combined or surface water sewers due to overloading of the sewerage system more frequently than the relevant reference period (either once or twice in ten years) as determined by the Company's reporting procedure.
- Flooding as a result of storm events proven to be exceptional and beyond the reference period of one in ten years are not included on the At Risk Register.
- Properties may be at risk of flooding but not included on the Register where flooding incidents have not been reported to the Company.
- Public Sewers are defined as those for which the Company holds statutory responsibility under the Water Industry Act 1991.
- It should be noted that flooding can occur from private sewers and drains which are not the responsibility of the Company. This report excludes flooding from private sewers and drains and the Company makes no comment upon this matter.
- For further information please contact Thames Water on Tel: 0800 316 9800 or website www.thameswater.co.uk

Thames Water Utilities Ltd
Property Searches, PO Box 3189, Slough SL1 4WW
DX 151280 Slough 13

searches@thameswater.co.uk
www.thameswater-propertysearches.co.uk

0845 070 9148

Asset location search

Thames Water Property Searches

Waterman Infrastructure & Environment
Pickfords Wharf Pickfords Wharf

LONDON
SE1 9DG

Search address supplied H M Prison
Holloway
Parkhurst Road
London
N7 0NU

Your reference WIE15702 Holloway Prison

Our reference ALS/ALS Standard/2020_4193691

Search date 2 June 2020

Knowledge of features below the surface is essential for every development

The benefits of this knowledge not only include ensuring due diligence and avoiding risk, but also being able to ascertain the feasibility of any development.

Did you know that Thames Water Property Searches can also provide a variety of utility searches including a more comprehensive view of utility providers' assets (across up to 35-45 different providers), as well as more focused searches relating to specific major utility companies such as National Grid (gas and electric).

Contact us to find out more.

Thames Water Utilities Ltd
Property Searches, PO Box 3189, Slough SL1 4WW
DX 151280 Slough 13

searches@thameswater.co.uk
www.thameswater-propertysearches.co.uk

0845 070 9148

Asset location search

Thames Water Property Searches

Search address supplied: H M Prison, Holloway, Parkhurst Road, London, N7 0NU

Dear Sir / Madam

An Asset Location Search is recommended when undertaking a site development. It is essential to obtain information on the size and location of clean water and sewerage assets to safeguard against expensive damage and allow cost-effective service design.

The following records were searched in compiling this report: - the map of public sewers & the map of waterworks. Thames Water Utilities Ltd (TWUL) holds all of these.

This searchprovides maps showing the position, size of Thames Water assets close to the proposed development and also manhole cover and invert levels, where available.

Please note that none of the charges made for this report relate to the provision of Ordnance Survey mapping information. The replies contained in this letter are given following inspection of the public service records available to this company. No responsibility can be accepted for any error or omission in the replies.

You should be aware that the information contained on these plans is current only on the day that the plans are issued. The plans should only be used for the duration of the work that is being carried out at the present time. Under no circumstances should this data be copied or transmitted to parties other than those for whom the current work is being carried out.

Thames Water do update these service plans on a regular basis and failure to observe the above conditions could lead to damage arising to new or diverted services at a later date.

Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0845 070 9148, or use the address below:

Thames Water Utilities Ltd
Property Searches
PO Box 3189
Slough
SL1 4WW

Email: searches@thameswater.co.uk
Web: www.thameswater-propertysearches.co.uk

Waste Water Services

Please provide a copy extract from the public sewer map.

Enclosed is a map showing the approximate lines of our sewers. Our plans do not show sewer connections from individual properties or any sewers not owned by Thames Water unless specifically annotated otherwise. Records such as "private" pipework are in some cases available from the Building Control Department of the relevant Local Authority.

Where the Local Authority does not hold such plans it might be advisable to consult the property deeds for the site or contact neighbouring landowners.

This report relates only to sewerage apparatus of Thames Water Utilities Ltd, it does not disclose details of cables and or communications equipment that may be running through or around such apparatus.

The sewer level information contained in this response represents all of the level data available in our existing records. Should you require any further Information, please refer to the relevant section within the 'Further Contacts' page found later in this document.

For your guidance:

- The Company is not generally responsible for rivers, watercourses, ponds, culverts or highway drains. If any of these are shown on the copy extract they are shown for information only.
- Any private sewers or lateral drains which are indicated on the extract of the public sewer map as being subject to an agreement under Section 104 of the Water Industry Act 1991 are not an 'as constructed' record. It is recommended these details be checked with the developer.

Clean Water Services

Please provide a copy extract from the public water main map.

Enclosed is a map showing the approximate positions of our water mains and associated apparatus. Please note that records are not kept of the positions of individual domestic supplies.

For your information, there will be a pressure of at least 10m head at the outside stop valve. If you would like to know the static pressure, please contact our Customer Centre on 0800 316 9800. The Customer Centre can also arrange for a full flow and pressure test to be carried out for a fee.

For your guidance:

- Assets other than vested water mains may be shown on the plan, for information only.
- If an extract of the public water main record is enclosed, this will show known public water mains in the vicinity of the property. It should be possible to estimate the likely length and route of any private water supply pipe connecting the property to the public water network.

Payment for this Search

A charge will be added to your suppliers account.

Further contacts:

Waste Water queries

Should you require verification of the invert levels of public sewers, by site measurement, you will need to approach the relevant Thames Water Area Network Office for permission to lift the appropriate covers. This permission will usually involve you completing a TWOSA form. For further information please contact our Customer Centre on Tel: 0845 920 0800. Alternatively, a survey can be arranged, for a fee, through our Customer Centre on the above number.

If you have any questions regarding sewer connections, budget estimates, diversions, building over issues or any other questions regarding operational issues please direct them to our service desk. Which can be contacted by writing to:

Developer Services (Waste Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

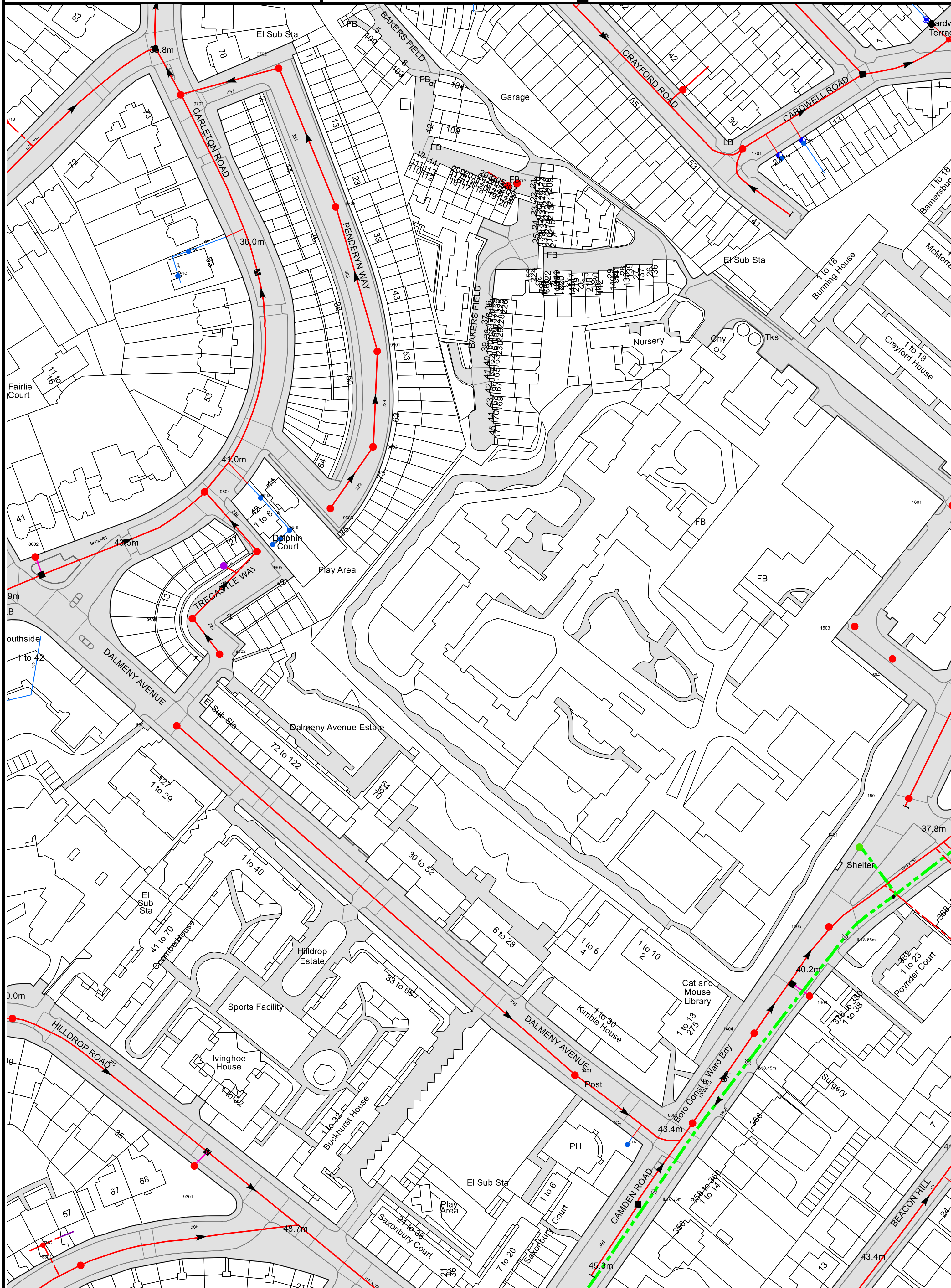
Clean Water queries

Should you require any advice concerning clean water operational issues or clean water connections, please contact:

Developer Services (Clean Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

Asset Location Search Sewer Map - ALS/ALS Standard/2020_4193691



NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey i

Manhole Reference	Manhole Cover Level	Manhole Inve
171C	n/a	n/a
1503	34.91	n/a
1401	n/a	n/a
1504	35.08	n/a
1501	36.76	n/a
171A	n/a	n/a
1601	34.6	n/a
241C	n/a	n/a
241B	n/a	n/a
2704	32.19	27.39
2502	34.05	n/a
2405	n/a	n/a
2601	33.23	n/a
2404	n/a	n/a
2702	32.07	27.29
2505	37.78	n/a
2701	31.67	n/a
2706	31.62	n/a
281B	n/a	n/a
371A	n/a	n/a
3701	31.2	28.75
3802	n/a	n/a
131A	n/a	n/a
2301	41.02	37.84
2302	37.21	n/a
241A	n/a	n/a
3401	35.33	31.47
241D	n/a	n/a
1405	39.38	n/a
961A	n/a	n/a
961B	n/a	n/a
9603	38.79	n/a
9703	33.75	n/a
9602	37.3	n/a
9601	35.16	n/a
071A	n/a	n/a
071B	n/a	n/a
081C	n/a	n/a
0701	n/a	n/a
1701	32.89	28.09
171B	n/a	n/a
871B	n/a	n/a
8602	44.18	n/a
8501	46.93	n/a
871C	n/a	n/a
9701	34.29	31.36
971A	n/a	n/a
9501	44.63	41.88
9604	40.85	39
9502	45.57	42.76
951A	n/a	n/a
9605	41.91	n/a
961D	n/a	n/a
961C	n/a	n/a
9702	33.04	n/a
8301	49.6	n/a
831A	n/a	n/a
9301	49.04	n/a
031A	44.41	43.45
0301	43.12	n/a
0401	45.29	41.29
1404	41.48	n/a
8402	50.03	45.98
1409	40.62	n/a

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

Trunk Surface Water

Trunk Foul

Storm Relief

Trunk Combined

Vent Pipe

Bio-solids (Sludge)

Proposed Thames Surface Water Sewer

Proposed Thames Water Foul Sewer

Gallery

Foul Rising Main

Surface Water Rising Main

Combined Rising Main

Sludge Rising Main

Proposed Thames Water Rising Main

Vacuum

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

Air Valve

Dam Chase

Fitting

Meter

Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

Control Valve

Drop Pipe

Ancillary

Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

Outfall

Undefined End

Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

Public/Private Pumping Station

Change of characteristic indicator (C.O.C.I.)

Invert Level

Summit

Areas

Lines denoting areas of underground surveys, etc.

Agreement

Operational Site

Chamber

Tunnel

Conduit Bridge

Other Sewer Types (Not Operated or Maintained by Thames Water)

Foul Sewer

Surface Water Sewer

Combined Sewer

Gulley

Culverted Watercourse

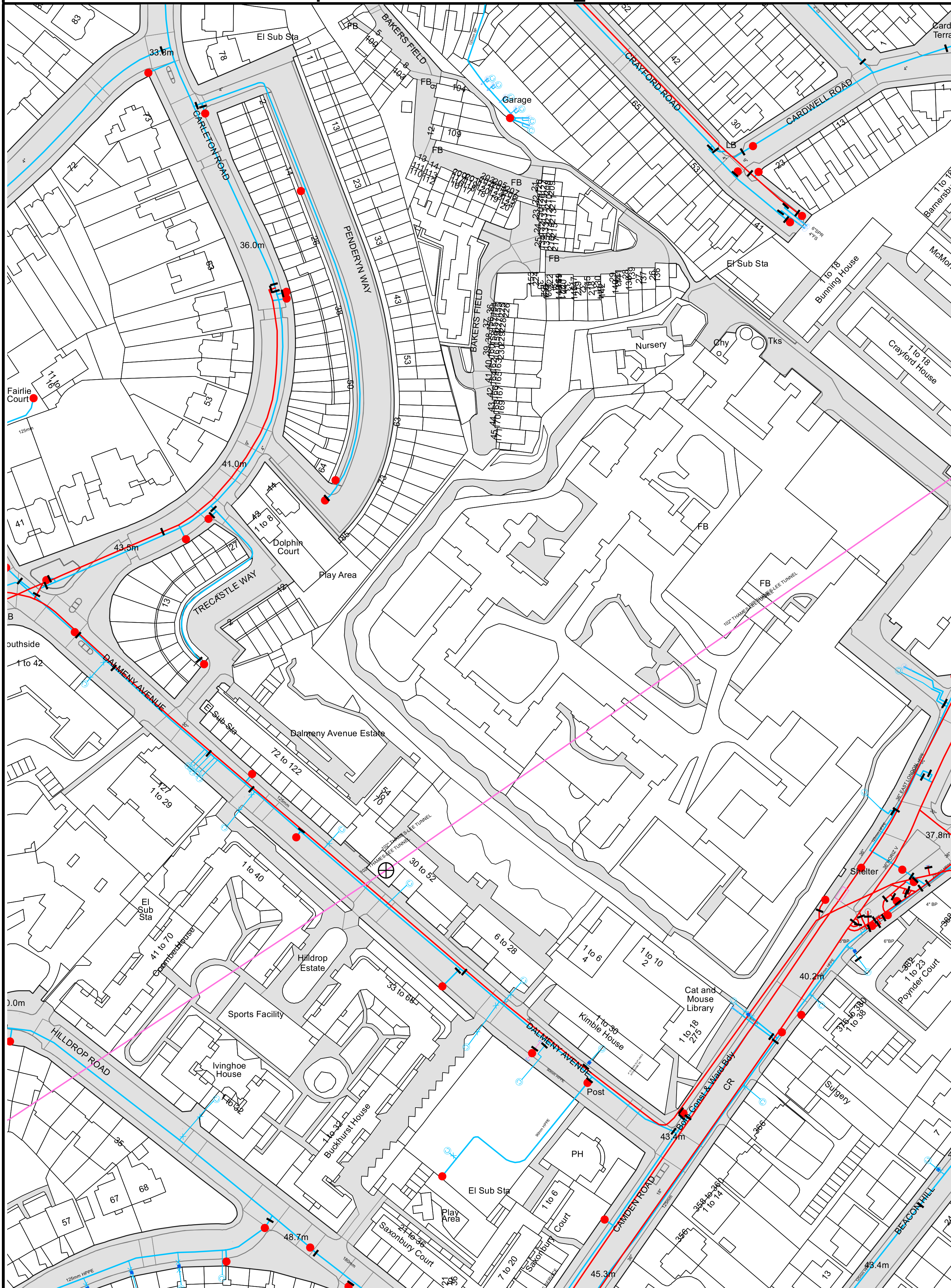
Proposed

Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plans are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
5) 'na' or '0' on a manhole level indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.

Asset Location Search Water Map - ALS/ALS Standard/2020_4193691



ALS Water Map Key

Water Pipes (Operated & Maintained by Thames Water)

4"

Distribution Main: The most common pipe shown on water maps. With few exceptions, domestic connections are only made to distribution mains.

16"

Trunk Main: A main carrying water from a source of supply to a treatment plant or reservoir, or from one treatment plant or reservoir to another. Also a main transferring water in bulk to smaller water mains used for supplying individual customers.

3" SUPPLY

Supply Main: A supply main indicates that the water main is used as a supply for a single property or group of properties.

3" FIRE

Fire Main: Where a pipe is used as a fire supply, the word FIRE will be displayed along the pipe.

3" METERED

Metered Pipe: A metered main indicates that the pipe in question supplies water for a single property or group of properties and that quantity of water passing through the pipe is metered even though there may be no meter symbol shown.

Transmission Tunnel: A very large diameter water pipe. Most tunnels are buried very deep underground. These pipes are not expected to affect the structural integrity of buildings shown on the map provided.

Proposed Main: A main that is still in the planning stages or in the process of being laid. More details of the proposed main and its reference number are generally included near the main.

PIPE DIAMETER	DEPTH BELOW GROUND
Up to 300mm (12")	900mm (3')
300mm - 600mm (12" - 24")	1100mm (3' 8")
600mm and bigger (24" plus)	1200mm (4')

Valves

- General Purpose Valve
- Air Valve
- Pressure Control Valve
- Customer Valve

Hydrants

- Single Hydrant

Meters

- Meter

End Items

Symbol indicating what happens at the end of a water main.

- Blank Flange
- Capped End
- Emptying Pit
- Undefined End
- Manifold
- Customer Supply
- Fire Supply

Operational Sites

- Booster Station
- Other
- Other (Proposed)
- Pumping Station
- Service Reservoir
- Shaft Inspection
- Treatment Works
- Unknown
- Water Tower

Other Symbols

- Data Logger

Other Water Pipes (Not Operated or Maintained by Thames Water)

Other Water Company Main: Occasionally other water company water pipes may overlap the border of our clean water coverage area. These mains are denoted in purple and in most cases have the owner of the pipe displayed along them.

Private Main: Indiates that the water main in question is not owned by Thames Water. These mains normally have text associated with them indicating the diameter and owner of the pipe.

Terms and Conditions

All sales are made in accordance with Thames Water Utilities Limited (TWUL) standard terms and conditions unless previously agreed in writing.

1. All goods remain in the property of Thames Water Utilities Ltd until full payment is received.
2. Provision of service will be in accordance with all legal requirements and published TWUL policies.
3. All invoices are strictly due for payment 14 days from due date of the invoice. Any other terms must be accepted/agreed in writing prior to provision of goods or service, or will be held to be invalid.
4. Thames Water does not accept post-dated cheques-any cheques received will be processed for payment on date of receipt.
5. In case of dispute TWUL`s terms and conditions shall apply.
6. Penalty interest may be invoked by TWUL in the event of unjustifiable payment delay. Interest charges will be in line with UK Statute Law 'The Late Payment of Commercial Debts (Interest) Act 1998'.
7. Interest will be charged in line with current Court Interest Charges, if legal action is taken.
8. A charge may be made at the discretion of the company for increased administration costs.

A copy of Thames Water's standard terms and conditions are available from the Commercial Billing Team (cashoperations@thameswater.co.uk).

We publish several Codes of Practice including a guaranteed standards scheme. You can obtain copies of these leaflets by calling us on 0800 316 9800

If you are unhappy with our service you can speak to your original goods or customer service provider. If you are not satisfied with the response, your complaint will be reviewed by the Customer Services Director. You can write to her at: Thames Water Utilities Ltd. PO Box 492, Swindon, SN38 8TU.

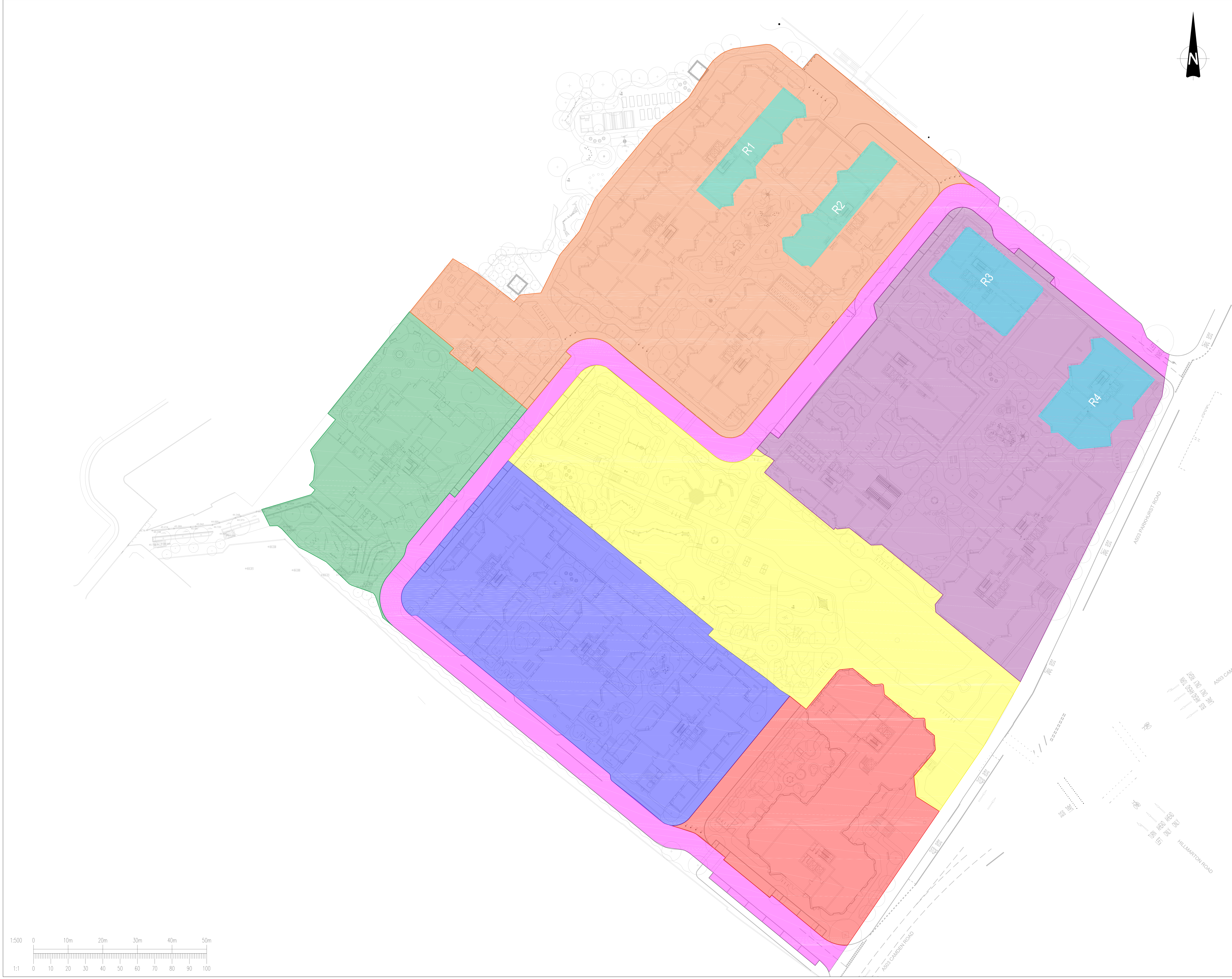
If the Goods or Services covered by this invoice falls under the regulation of the 1991 Water Industry Act, and you remain dissatisfied you can refer your complaint to Consumer Council for Water on 0121 345 1000 or write to them at Consumer Council for Water, 1st Floor, Victoria Square House, Victoria Square, Birmingham, B2 4AJ.

Ways to pay your bill

Credit Card	**BACS Payment**	**Telephone Banking**	**Cheque**
Call **0845 070 9148** quoting your invoice number starting CBA or ADS / OSS	Account number **90478703** Sort code **60-00-01** A remittance advice must be sent to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW.** or email ps.billing@thameswater.co.uk	By calling your bank and quoting: Account number **90478703** Sort code **60-00-01** and your invoice number	Made payable to '**Thames Water Utilities Ltd**' Write your Thames Water account number on the back. Send to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW** or by DX to **151280 Slough 13**

Thames Water Utilities Ltd Registered in England & Wales No. 2366661 Registered Office Clearwater Court, Vastern Rd, Reading, Berks, RG1 8DB.

E. Indicative Surface Water Drainage Layout



GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEER'S, ARCHITECT'S OR OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
2. ALL DIMENSIONS AND LEVELS ARE TO BE CHECKED ON SITE BY THE CONTRACTOR PRIOR TO PREPARING ANY WORKING DRAWINGS OR COMMENCING ON SITE.
3. THE CONTRACTOR MUST ENSURE AND WILL BE HELD RESPONSIBLE FOR THE OVERALL STABILITY OF THE BUILDING/STRUCTURE/EXCAVATION AT ALL STAGES OF THE WORK.
4. ALL WORK BY THE CONTRACTOR MUST BE CARRIED OUT IN SUCH A WAY THAT ALL REQUIREMENTS UNDER THE HEALTH AND SAFETY AT WORK ACT ARE SATISFIED.
5. ALL WORK IS TO BE CARRIED OUT IN COMPLIANCE WITH THE REQUIREMENTS OF THE RELEVANT STATUTORY AUTHORITIES AND REGULATIONS.

KEY

- CATCHMENT A
- CATCHMENT A (ATTENUATED BELOW GROUND)
- CATCHMENT B
- CATCHMENT B (ATTENUATED BELOW GROUND)
- CATCHMENT C (ATTENUATED BELOW GROUND)
- CATCHMENT D (ATTENUATED BELOW GROUND)
- CATCHMENT E (ATTENUATED BELOW GROUND)
- LANDSCAPE AREA (ATTENUATED BELOW GROUND)
- ROOFS DRAINING TO PLINTH TANKS

Rev	Date	Description	By
P04	29.10.21	PLANNING ISSUE	KT
P03	15.09.21	AMENDED MASTERPLAN	KT
P02	09.07.20	AMENDED MASTERPLAN	NB
P01	04.06.20	FIRST ISSUE	NB

Amendments

Project: HOLLOWAY PRISON

Title: DRAINAGE CATCHMENT PLAN

Client: Peabody Construction Limited

Waterman

Office Address
Telephone & Fax numbers
mail@watermangroup.com www.watermangroup.com

Drawing Status: PRELIMINARY

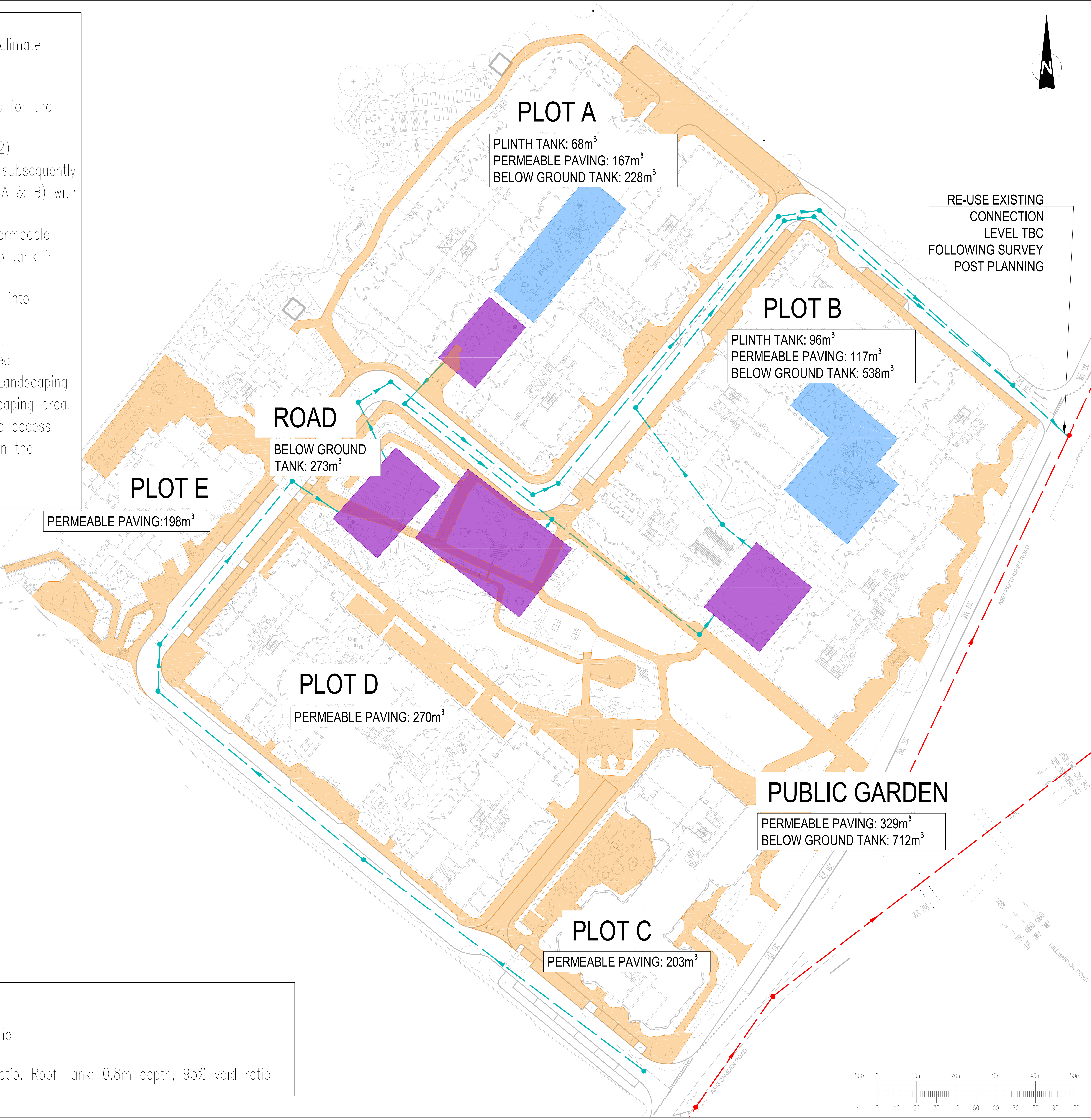
Designed by	KT	Checked by	DO	Project No WIE15702
Drawn by	KT	Date	OCTOBER 2021	
Scales @ A1 work to figured dimensions only		1:500		Computer File No 15702-WIE-ZZ-XX-DR-92002.dwg

Publisher	Zone	Category	Number	Revision
WIE	ZZ	92	002	P04

15702-WIE-ZZ-XX-M1-D-92002, 1947-EXA-ZZ-ZZ-DR-L-00100_WIE, A1-Wat-S

Design Notes:

- Design Storm Event: 1 in 100 year + 40% climate change
- 3.815ha proposed impermeable area
- Greenfield runoff rate: 12.7 l/s/ha, 48.5 l/s for the site
- Runoff from part of roofs (A1, A2, B1 & B2) discharged into plinth tanks (Plot A & B) and subsequently in adjacent permeable paving sub-base (Plots A & B) with runoff from remaining catchment (A & B).
- Runoff from roof of Plot E discharged to permeable paving sub-base (Plot E) and subsequently into tank in Plot A.
- Runoff from roofs (Plots C & D) discharged into permeable paving sub-base (Plots C & D) and subsequently into tank in the Landscaping area.
- Runoff from hardstanding in Landscaping area discharged into permeable paving sub-based (Landscaping area) and subsequently into tank in the Landscaping area.
- Attenuation/discharge via tanks for adoptable access road. Rain gardens either side (not indicated on the drawing) to provide treatment.



Attenuation Feature Parameters:

- Pinth Tanks: 150mm depth, 95% void ratio
- Permeable Paving: 0.6m depth, 30% void ratio
- Rain Gardens: 0.5m depth, 30% void ratio
- Underground Tanks: 1.5m depth, 95% void ratio. Roof Tank: 0.8m depth, 95% void ratio

GENERAL NOTES

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KEY

- PERMEABLE PAVING WITH AGGREGATE SUB-BASE
- BELOW GROUND TANKS
- PLINTH TANKS
- PROPOSED SURFACE WATER SEWER
- THAMES WATER COMBINED SEWER

Rev	Date	Description	By
P05	29.10.21	PLANNING ISSUE	KT
P04	15.09.21	AMENDED MASTERPLAN	KT
P03	07.08.20	BLUE ROOFS INCORPORATED	NB
P02	09.07.20	AMENDED MASTERPLAN	NB
P01	04.06.20	FIRST ISSUE	NB

Amendments

Project: HOLLOWAY PRISON

Title: PRELIMINARY DRAINAGE STRATEGY

Client: Peabody Construction Limited

Waterman
Pickfords Wharf Clink Street London SE1 9DG
t 020 7928 7888
mail@watermangroup.com www.watermangroup.com

Drawing Status: PRELIMINARY

Designed by	KT	Checked by	DO	Project No WIE15702
Drawn by	KT	Date	OCTOBER 2021	
Scales @ A1 work to figured dimensions only	1:500			Computer File No 15702-WIE-ZZ-XX-DR-92001.dwg

Publisher	Zone	Category	Number	Revision
WIE	ZZ	92	001	P05

15702-WIE-ZZ-XX-M1-D-92002, 1947-EXA-ZZ-ZZ-DR-L-00100_WIE, A1-Wat-S

waterman

F. Indicative Surface Water Drainage Calculations

waterman

CALCULATIONS

Company:	WIE	Office:	London
Sheet No:	4 of 4	Project No:	WIE15702
By	Kirsty Thomas	Date	29/10/2021
Checked:	Donal O'Donovan	Date	29/10/2021

Project Title: **Holloway Prison**

Calculations Title: **Surface Water Management (M100_60)**

LOCATION	CALCULATIONS				OPTIONS
	Calculations based on: Design and Analysis of urban storm drainage. The Wallingford Procedure, Volume 1 Principles methods and practice.				
	User Input Data				
	Postively drained site area		3.815	ha	
	SAAR (From FEH)		644		
	Rainfall Intensity (From FEH)		49.9		
	PIMP (% impervious)		50	%	
	Soil Type		0.45		
	Very Low Runoff (well drained sandy, loamy or earthy peat soils)		0.15		
	Low Runoff (Very permeable soils (e.g. gravel, sand)		0.30		
	Moderate (Very fine sands, silts and sedimentary clays)		0.40		
	High Runoff (Clayey or loamy soils)		0.45		
	Very High Runoff (Soils of the wet uplands)		0.50		
Fig. 9.7	UCWI (From Figure 9.7 of Wallingford Method)		61		
Eqn. 13	Qp (peak discharge) = 2.78 Cv CR i A				
	Where: Qp (Peak Discharge)	i = rainfall intensity	A = Total Area		
From FEH	Average rainfall Intensity (i)				
	M100_60 is:	49.9	mm		
Eqn 7.20	Cv = PR/100				
Eqn 7.3	PR = (0.829 PIMP) + (25.0 SOIL) + (0.078 UCWI) - 20.7				
	PIMP (Percentage of catchment which is impervious)		50	%	
Page 52	Note: PIMP can not be less than 40%		40	%	
	Thus value of PIMP to be used		50	%	
	Soil: 0.45	UCWI: 60.64			
	PR =		36.73		
	Thus Cv =		0.37		
Sec 7.10	CR (Recommended for simulation and design)		1.3		
	Qp for 1 in 100 year 60 minute duration =	**252.5 l/s**	or 66.2	l/s/ha	

Cascade Summary of Results for Catchment_E.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	Catchment A_Tank.SRCX	(None)

Half Drain Time : 212 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.665	0.265	0.0	8.0	8.0	89.3	O K
30 min Summer	9.736	0.336	0.0	8.0	8.0	113.1	Flood Risk
60 min Summer	9.794	0.394	0.0	8.0	8.0	132.6	Flood Risk
120 min Summer	9.872	0.472	0.0	8.0	8.0	158.8	Flood Risk
180 min Summer	9.898	0.498	0.0	8.0	8.0	167.8	Flood Risk
240 min Summer	9.907	0.507	0.0	8.0	8.0	170.7	Flood Risk
360 min Summer	9.902	0.502	0.0	8.0	8.0	168.9	Flood Risk
480 min Summer	9.881	0.481	0.0	8.0	8.0	162.1	Flood Risk
600 min Summer	9.855	0.455	0.0	8.0	8.0	153.0	Flood Risk
720 min Summer	9.823	0.423	0.0	8.0	8.0	142.3	Flood Risk
960 min Summer	9.761	0.361	0.0	8.0	8.0	121.5	Flood Risk
1440 min Summer	9.661	0.261	0.0	8.0	8.0	87.8	O K
2160 min Summer	9.571	0.171	0.0	7.9	7.9	57.4	O K
2880 min Summer	9.534	0.134	0.0	7.1	7.1	45.3	O K
4320 min Summer	9.505	0.105	0.0	5.3	5.3	35.5	O K
5760 min Summer	9.491	0.091	0.0	4.3	4.3	30.5	O K
7200 min Summer	9.481	0.081	0.0	3.6	3.6	27.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.617	0.0	92.1	18
30 min Summer	114.446	0.0	120.0	33
60 min Summer	69.800	0.0	149.2	62
120 min Summer	44.704	0.0	192.8	120
180 min Summer	33.962	0.0	220.5	172
240 min Summer	27.682	0.0	240.1	200
360 min Summer	20.398	0.0	265.9	262
480 min Summer	16.212	0.0	281.9	330
600 min Summer	13.478	0.0	292.9	400
720 min Summer	11.548	0.0	301.1	464
960 min Summer	8.990	0.0	312.2	590
1440 min Summer	6.269	0.0	325.5	836
2160 min Summer	4.350	0.0	338.6	1168
2880 min Summer	3.359	0.0	347.1	1500
4320 min Summer	2.342	0.0	359.6	2208
5760 min Summer	1.823	0.0	371.5	2936
7200 min Summer	1.509	0.0	381.7	3672

Cascade Summary of Results for Catchment_E.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	9.474	0.074	0.0	3.1	3.1	25.1	O K
10080 min Summer	9.469	0.069	0.0	2.7	2.7	23.4	O K
15 min Winter	9.700	0.300	0.0	8.0	8.0	101.1	Flood Risk
30 min Winter	9.781	0.381	0.0	8.0	8.0	128.2	Flood Risk
60 min Winter	9.848	0.448	0.0	8.0	8.0	151.0	Flood Risk
120 min Winter	9.937	0.537	0.0	8.0	8.0	180.9	Flood Risk
180 min Winter	9.970	0.570	0.0	8.0	8.0	192.0	Flood Risk
240 min Winter	9.978	0.578	0.0	8.0	8.0	194.5	Flood Risk
360 min Winter	9.967	0.567	0.0	8.0	8.0	190.7	Flood Risk
480 min Winter	9.938	0.538	0.0	8.0	8.0	181.1	Flood Risk
600 min Winter	9.901	0.501	0.0	8.0	8.0	168.7	Flood Risk
720 min Winter	9.859	0.459	0.0	8.0	8.0	154.6	Flood Risk
960 min Winter	9.765	0.365	0.0	8.0	8.0	122.9	Flood Risk
1440 min Winter	9.623	0.223	0.0	8.0	8.0	75.2	O K
2160 min Winter	9.535	0.135	0.0	7.2	7.2	45.5	O K
2880 min Winter	9.511	0.111	0.0	5.7	5.7	37.2	O K
4320 min Winter	9.488	0.088	0.0	4.0	4.0	29.5	O K
5760 min Winter	9.475	0.075	0.0	3.1	3.1	25.4	O K
7200 min Winter	9.468	0.068	0.0	2.6	2.6	22.7	O K
8640 min Winter	9.462	0.062	0.0	2.2	2.2	20.9	O K
10080 min Winter	9.458	0.058	0.0	2.0	2.0	19.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.299	0.0	391.5	4408
10080 min Summer	1.149	0.0	400.9	5136
15 min Winter	178.617	0.0	104.0	18
30 min Winter	114.446	0.0	135.3	32
60 min Winter	69.800	0.0	167.9	62
120 min Winter	44.704	0.0	216.8	118
180 min Winter	33.962	0.0	247.8	174
240 min Winter	27.682	0.0	269.8	224
360 min Winter	20.398	0.0	298.7	280
480 min Winter	16.212	0.0	316.6	356
600 min Winter	13.478	0.0	329.0	434
720 min Winter	11.548	0.0	338.2	508
960 min Winter	8.990	0.0	350.8	636
1440 min Winter	6.269	0.0	365.9	866
2160 min Winter	4.350	0.0	380.6	1152
2880 min Winter	3.359	0.0	390.3	1500
4320 min Winter	2.342	0.0	404.8	2208
5760 min Winter	1.823	0.0	418.5	2944
7200 min Winter	1.509	0.0	430.3	3672
8640 min Winter	1.299	0.0	441.8	4360
10080 min Winter	1.149	0.0	452.9	5144

Cascade Rainfall Details for Catchment_E.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 530072 185559 TQ 30072 85559
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.298

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.298

Cascade Model Details for Catchment_E.SRCX

Storage is Online Cover Level (m) 10.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	34.0
Membrane Percolation (mm/hr)	1000	Length (m)	33.0
Max Percolation (l/s)	311.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.400	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0137-8000-0600-8000
Design Head (m)	0.600
Design Flow (l/s)	8.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	137
Invert Level (m)	9.400
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	0.600	8.0
Flush-Flo™	0.219	8.0
Kick-Flo®	0.445	7.0
Mean Flow over Head Range	-	6.6

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

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	4.9	1.200	11.1	3.000	17.1	7.000	25.7
0.200	8.0	1.400	11.9	3.500	18.4	7.500	26.6
0.300	7.8	1.600	12.7	4.000	19.7	8.000	27.5
0.400	7.4	1.800	13.4	4.500	20.8	8.500	28.3
0.500	7.3	2.000	14.1	5.000	21.9	9.000	29.2
0.600	8.0	2.200	14.8	5.500	22.9	9.500	30.0
0.800	9.2	2.400	15.4	6.000	23.9		
1.000	10.2	2.600	16.0	6.500	24.7		

Cascade Summary of Results for Landscape_catchment.SRCX

Upstream Structures	Outflow To	Overflow To
Catchment_C.SRCX Catchment_D.SRCX	Catchment B_Tank.SRCX	(None)

Half Drain Time : 1182 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	8.598	0.498	0.0	10.0	10.0	354.9	O K
30 min Summer	8.765	0.665	0.0	10.0	10.0	473.8	O K
60 min Summer	8.933	0.833	0.0	10.0	10.0	593.8	O K
120 min Summer	9.206	1.106	0.0	10.0	10.0	787.8	O K
180 min Summer	9.381	1.281	0.0	10.0	10.0	912.5	O K
240 min Summer	9.497	1.397	0.0	10.0	10.0	995.7	O K
360 min Summer	9.649	1.549	0.0	10.0	10.0	1098.1	O K
480 min Summer	9.749	1.649	0.0	10.0	10.0	1158.4	Flood Risk
600 min Summer	9.805	1.705	0.0	10.0	10.0	1192.1	Flood Risk
720 min Summer	9.814	1.714	0.0	10.0	10.0	1197.5	Flood Risk
960 min Summer	9.758	1.658	0.0	10.0	10.0	1163.7	Flood Risk
1440 min Summer	9.605	1.505	0.0	10.0	10.0	1072.0	O K
2160 min Summer	9.436	1.336	0.0	10.0	10.0	951.9	O K
2880 min Summer	9.288	1.188	0.0	10.0	10.0	846.5	O K
4320 min Summer	9.013	0.913	0.0	10.0	10.0	650.8	O K
5760 min Summer	8.819	0.719	0.0	10.0	10.0	512.0	O K
7200 min Summer	8.673	0.573	0.0	10.0	10.0	408.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.617	0.0	466.3	137
30 min Summer	114.446	0.0	602.6	182
60 min Summer	69.800	0.0	763.2	234
120 min Summer	44.704	0.0	983.4	324
180 min Summer	33.962	0.0	1121.6	382
240 min Summer	27.682	0.0	1218.1	428
360 min Summer	20.398	0.0	1341.0	502
480 min Summer	16.212	0.0	1411.4	562
600 min Summer	13.478	0.0	1451.1	628
720 min Summer	11.548	0.0	1467.4	724
960 min Summer	8.990	0.0	1452.3	960
1440 min Summer	6.269	0.0	1375.5	1204
2160 min Summer	4.350	0.0	1735.3	1584
2880 min Summer	3.359	0.0	1780.1	1996
4320 min Summer	2.342	0.0	1847.1	2724
5760 min Summer	1.823	0.0	1916.6	3456
7200 min Summer	1.509	0.0	1972.3	4176

Cascade Summary of Results for Landscape_catchment.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	8.566	0.466	0.0	9.9	9.9	331.8	O K
10080 min Summer	8.486	0.386	0.0	9.7	9.7	275.1	O K
15 min Winter	8.669	0.569	0.0	10.0	10.0	405.5	O K
30 min Winter	8.856	0.756	0.0	10.0	10.0	538.9	O K
60 min Winter	9.048	0.948	0.0	10.0	10.0	675.4	O K
120 min Winter	9.361	1.261	0.0	10.0	10.0	898.8	O K
180 min Winter	9.552	1.452	0.0	10.0	10.0	1034.7	O K
240 min Winter	9.695	1.595	0.0	10.0	10.0	1125.7	O K
360 min Winter	9.882	1.782	0.0	10.0	10.0	1238.1	Flood Risk
480 min Winter	9.993	1.893	0.0	10.0	10.0	1304.4	Flood Risk
600 min Winter	10.041	1.941	0.0	10.1	10.1	1349.9	FLOOD
720 min Winter	10.059	1.959	0.0	10.1	10.1	1368.0	FLOOD
960 min Winter	10.031	1.931	0.0	10.1	10.1	1340.3	FLOOD
1440 min Winter	9.876	1.776	0.0	10.0	10.0	1234.7	Flood Risk
2160 min Winter	9.633	1.533	0.0	10.0	10.0	1089.0	O K
2880 min Winter	9.440	1.340	0.0	10.0	10.0	954.8	O K
4320 min Winter	9.049	0.949	0.0	10.0	10.0	676.1	O K
5760 min Winter	8.761	0.661	0.0	10.0	10.0	471.2	O K
7200 min Winter	8.567	0.467	0.0	9.9	9.9	333.1	O K
8640 min Winter	8.441	0.341	0.0	9.6	9.6	242.9	O K
10080 min Winter	8.359	0.259	0.0	9.1	9.1	184.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.299	0.0	2025.8	4848
10080 min Summer	1.149	0.0	2076.2	5552
15 min Winter	178.617	0.0	525.1	153
30 min Winter	114.446	0.0	674.3	204
60 min Winter	69.800	0.0	857.8	262
120 min Winter	44.704	0.0	1103.0	352
180 min Winter	33.962	0.0	1255.9	408
240 min Winter	27.682	0.0	1360.5	454
360 min Winter	20.398	0.0	1482.6	530
480 min Winter	16.212	0.0	1524.1	594
600 min Winter	13.478	41.1	1525.3	646
720 min Winter	11.548	59.3	1516.3	720
960 min Winter	8.990	31.5	1485.9	936
1440 min Winter	6.269	0.0	1406.8	1326
2160 min Winter	4.350	0.0	1948.4	1684
2880 min Winter	3.359	0.0	1999.1	2144
4320 min Winter	2.342	0.0	2076.4	2944
5760 min Winter	1.823	0.0	2155.6	3648
7200 min Winter	1.509	0.0	2219.8	4320
8640 min Winter	1.299	0.0	2281.7	4960
10080 min Winter	1.149	0.0	2341.2	5624

Cascade Rainfall Details for Landscape_catchment.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 530072 185559 TQ 30072 85559
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.628

Time From:	(mins) To:	Area (ha)
0	4	0.628

Cascade Model Details for Landscape_catchment.SRCX

Storage is Online Cover Level (m) 10.000

Complex Structure

Cellular Storage

Invert Level (m)	8.100	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	Area (m^2)	Inf. Area (m^2)	Depth (m)	Area (m^2)	Inf. Area (m^2)
0.000	750.0	0.0	1.501	0.0	0.0
1.500	750.0	0.0			

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	44.7
Membrane Percolation (mm/hr)	1000	Length (m)	44.7
Max Percolation (l/s)	555.0	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.600	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0132-1000-1900-1000
Design Head (m)	1.900
Design Flow (l/s)	10.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	132
Invert Level (m)	8.100
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.900	10.0
Flush-Flo™	0.556	10.0
Kick-Flo®	1.148	7.9
Mean Flow over Head Range	-	8.7

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.8	1.200	8.0	3.000	12.4	7.000	18.6
0.200	8.4	1.400	8.6	3.500	13.3	7.500	19.2
0.300	9.3	1.600	9.2	4.000	14.2	8.000	19.8
0.400	9.8	1.800	9.7	4.500	15.0	8.500	20.4
0.500	10.0	2.000	10.2	5.000	15.8	9.000	20.9
0.600	10.0	2.200	10.7	5.500	16.5	9.500	21.5
0.800	9.7	2.400	11.1	6.000	17.2		
1.000	9.0	2.600	11.6	6.500	17.9		

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 372 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.497	0.297	0.0	5.5	5.5	101.7	O K
30 min Summer	9.575	0.375	0.0	5.5	5.5	128.3	O K
60 min Summer	9.643	0.443	0.0	5.5	5.5	151.4	O K
120 min Summer	9.740	0.540	0.0	5.5	5.5	184.7	Flood Risk
180 min Summer	9.787	0.587	0.0	5.5	5.5	200.9	Flood Risk
240 min Summer	9.808	0.608	0.0	5.5	5.5	207.9	Flood Risk
360 min Summer	9.809	0.609	0.0	5.5	5.5	208.4	Flood Risk
480 min Summer	9.794	0.594	0.0	5.5	5.5	203.2	Flood Risk
600 min Summer	9.773	0.573	0.0	5.5	5.5	196.0	Flood Risk
720 min Summer	9.749	0.549	0.0	5.5	5.5	187.8	Flood Risk
960 min Summer	9.694	0.494	0.0	5.5	5.5	169.0	O K
1440 min Summer	9.599	0.399	0.0	5.5	5.5	136.3	O K
2160 min Summer	9.487	0.287	0.0	5.5	5.5	98.2	O K
2880 min Summer	9.411	0.211	0.0	5.5	5.5	72.2	O K
4320 min Summer	9.334	0.134	0.0	5.2	5.2	45.7	O K
5760 min Summer	9.308	0.108	0.0	4.3	4.3	37.1	O K
7200 min Summer	9.295	0.095	0.0	3.7	3.7	32.5	O K
8640 min Summer	9.286	0.086	0.0	3.3	3.3	29.4	O K
10080 min Summer	9.280	0.080	0.0	2.9	2.9	27.2	O K
15 min Winter	9.534	0.334	0.0	5.5	5.5	114.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.617	0.0	102.9	18
30 min Summer	114.446	0.0	132.4	33
60 min Summer	69.800	0.0	163.6	62
120 min Summer	44.704	0.0	209.9	122
180 min Summer	33.962	0.0	239.3	182
240 min Summer	27.682	0.0	260.1	240
360 min Summer	20.398	0.0	287.5	330
480 min Summer	16.212	0.0	304.7	388
600 min Summer	13.478	0.0	316.7	452
720 min Summer	11.548	0.0	325.6	518
960 min Summer	8.990	0.0	337.9	638
1440 min Summer	6.269	0.0	353.3	896
2160 min Summer	4.350	0.0	369.2	1256
2880 min Summer	3.359	0.0	379.8	1612
4320 min Summer	2.342	0.0	396.5	2252
5760 min Summer	1.823	0.0	412.9	2952
7200 min Summer	1.509	0.0	427.1	3680
8640 min Summer	1.299	0.0	441.0	4408
10080 min Summer	1.149	0.0	454.4	5144
15 min Winter	178.617	0.0	115.5	18

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	9.622	0.422	0.0	5.5	5.5	144.3	O K
60 min Winter	9.700	0.500	0.0	5.5	5.5	171.0	Flood Risk
120 min Winter	9.813	0.613	0.0	5.5	5.5	209.6	Flood Risk
180 min Winter	9.867	0.667	0.0	5.5	5.5	228.2	Flood Risk
240 min Winter	9.893	0.693	0.0	5.5	5.5	237.1	Flood Risk
360 min Winter	9.901	0.701	0.0	5.5	5.5	239.7	Flood Risk
480 min Winter	9.880	0.680	0.0	5.5	5.5	232.5	Flood Risk
600 min Winter	9.853	0.653	0.0	5.5	5.5	223.5	Flood Risk
720 min Winter	9.824	0.624	0.0	5.5	5.5	213.4	Flood Risk
960 min Winter	9.757	0.557	0.0	5.5	5.5	190.6	Flood Risk
1440 min Winter	9.613	0.413	0.0	5.5	5.5	141.1	O K
2160 min Winter	9.454	0.254	0.0	5.5	5.5	86.8	O K
2880 min Winter	9.361	0.161	0.0	5.3	5.3	55.0	O K
4320 min Winter	9.306	0.106	0.0	4.2	4.2	36.3	O K
5760 min Winter	9.288	0.088	0.0	3.3	3.3	30.0	O K
7200 min Winter	9.278	0.078	0.0	2.8	2.8	26.5	O K
8640 min Winter	9.271	0.071	0.0	2.4	2.4	24.2	O K
10080 min Winter	9.266	0.066	0.0	2.1	2.1	22.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	114.446	0.0	148.5	33
60 min Winter	69.800	0.0	183.4	62
120 min Winter	44.704	0.0	235.1	120
180 min Winter	33.962	0.0	268.1	178
240 min Winter	27.682	0.0	291.4	234
360 min Winter	20.398	0.0	322.2	344
480 min Winter	16.212	0.0	341.4	442
600 min Winter	13.478	0.0	354.8	474
720 min Winter	11.548	0.0	364.8	550
960 min Winter	8.990	0.0	378.6	704
1440 min Winter	6.269	0.0	395.8	968
2160 min Winter	4.350	0.0	413.6	1320
2880 min Winter	3.359	0.0	425.6	1620
4320 min Winter	2.342	0.0	444.4	2252
5760 min Winter	1.823	0.0	462.5	2952
7200 min Winter	1.509	0.0	478.5	3672
8640 min Winter	1.299	0.0	494.0	4408
10080 min Winter	1.149	0.0	509.3	5144

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 530072 185559 TQ 30072 85559
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.315

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.315

Model Details

Storage is Online Cover Level (m) 10.000

Cellular Storage Structure

Invert Level (m) 9.200 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	360.0	0.0	0.800	360.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0113-5500-0800-5500
Design Head (m)	0.800
Design Flow (l/s)	5.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	113
Invert Level (m)	9.200
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	5.5
Flush-Flo™	0.243	5.5
Kick-Flo®	0.540	4.6
Mean Flow over Head Range	-	4.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.0	1.200	6.6	3.000	10.2	7.000	15.3
0.200	5.5	1.400	7.1	3.500	11.0	7.500	15.8
0.300	5.4	1.600	7.6	4.000	11.7	8.000	16.3
0.400	5.3	1.800	8.0	4.500	12.4	8.500	16.8
0.500	4.9	2.000	8.4	5.000	13.0	9.000	17.3
0.600	4.8	2.200	8.8	5.500	13.6	9.500	17.7
0.800	5.5	2.400	9.2	6.000	14.2		
1.000	6.1	2.600	9.6	6.500	14.8		

Cascade Summary of Results for Catchment A_Plinth .SRCX

Upstream Structures	Outflow To	Overflow To
(None)	Catchment A_Tank.SRCX	(None)

Half Drain Time : 549 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.909	0.059	0.0	0.7	0.7	26.4	Flood Risk
30 min Summer	9.924	0.074	0.0	0.8	0.8	33.5	Flood Risk
60 min Summer	9.939	0.089	0.0	0.9	0.9	40.1	Flood Risk
120 min Summer	9.960	0.110	0.0	1.1	1.1	49.6	Flood Risk
180 min Summer	9.971	0.121	0.0	1.1	1.1	54.7	Flood Risk
240 min Summer	9.977	0.127	0.0	1.1	1.1	57.5	Flood Risk
360 min Summer	9.982	0.132	0.0	1.2	1.2	59.4	Flood Risk
480 min Summer	9.982	0.132	0.0	1.2	1.2	59.7	Flood Risk
600 min Summer	9.982	0.132	0.0	1.2	1.2	59.3	Flood Risk
720 min Summer	9.980	0.130	0.0	1.2	1.2	58.7	Flood Risk
960 min Summer	9.976	0.126	0.0	1.1	1.1	57.0	Flood Risk
1440 min Summer	9.968	0.118	0.0	1.1	1.1	53.0	Flood Risk
2160 min Summer	9.955	0.105	0.0	1.0	1.0	47.5	Flood Risk
2880 min Summer	9.945	0.095	0.0	1.0	1.0	42.9	Flood Risk
4320 min Summer	9.930	0.080	0.0	0.9	0.9	36.0	Flood Risk
5760 min Summer	9.919	0.069	0.0	0.8	0.8	31.2	Flood Risk
7200 min Summer	9.912	0.062	0.0	0.7	0.7	28.0	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.617	0.0	20.3	19
30 min Summer	114.446	0.0	27.1	33
60 min Summer	69.800	0.0	37.9	64
120 min Summer	44.704	0.0	49.4	122
180 min Summer	33.962	0.0	56.6	182
240 min Summer	27.682	0.0	61.7	240
360 min Summer	20.398	0.0	68.4	344
480 min Summer	16.212	0.0	72.5	396
600 min Summer	13.478	0.0	75.3	454
720 min Summer	11.548	0.0	77.3	520
960 min Summer	8.990	0.0	80.0	654
1440 min Summer	6.269	0.0	82.8	924
2160 min Summer	4.350	0.0	91.2	1320
2880 min Summer	3.359	0.0	93.5	1704
4320 min Summer	2.342	0.0	96.5	2464
5760 min Summer	1.823	0.0	103.5	3176
7200 min Summer	1.509	0.0	106.8	3896

Cascade Summary of Results for Catchment A_Plinth .SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	9.907	0.057	0.0	0.7	0.7	25.8	Flood Risk
10080 min Summer	9.904	0.054	0.0	0.6	0.6	24.2	Flood Risk
15 min Winter	9.916	0.066	0.0	0.7	0.7	29.6	Flood Risk
30 min Winter	9.933	0.083	0.0	0.9	0.9	37.6	Flood Risk
60 min Winter	9.950	0.100	0.0	1.0	1.0	45.0	Flood Risk
120 min Winter	9.974	0.124	0.0	1.1	1.1	55.8	Flood Risk
180 min Winter	9.986	0.136	0.0	1.2	1.2	61.6	Flood Risk
240 min Winter	9.994	0.144	0.0	1.2	1.2	64.9	Flood Risk
360 min Winter	9.999	0.149	0.0	1.3	1.3	67.4	Flood Risk
480 min Winter	9.999	0.149	0.0	1.3	1.3	67.3	Flood Risk
600 min Winter	9.998	0.148	0.0	1.3	1.3	66.6	Flood Risk
720 min Winter	9.995	0.145	0.0	1.2	1.2	65.6	Flood Risk
960 min Winter	9.990	0.140	0.0	1.2	1.2	63.0	Flood Risk
1440 min Winter	9.977	0.127	0.0	1.1	1.1	57.2	Flood Risk
2160 min Winter	9.959	0.109	0.0	1.0	1.0	49.3	Flood Risk
2880 min Winter	9.945	0.095	0.0	1.0	1.0	43.0	Flood Risk
4320 min Winter	9.925	0.075	0.0	0.8	0.8	34.0	Flood Risk
5760 min Winter	9.913	0.063	0.0	0.7	0.7	28.4	Flood Risk
7200 min Winter	9.906	0.056	0.0	0.6	0.6	25.1	Flood Risk
8640 min Winter	9.901	0.051	0.0	0.6	0.6	23.0	Flood Risk
10080 min Winter	9.897	0.047	0.0	0.5	0.5	21.4	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.299	0.0	109.7	4584
10080 min Summer	1.149	0.0	112.2	5344
15 min Winter	178.617	0.0	23.2	19
30 min Winter	114.446	0.0	30.8	33
60 min Winter	69.800	0.0	42.8	62
120 min Winter	44.704	0.0	55.6	120
180 min Winter	33.962	0.0	63.7	178
240 min Winter	27.682	0.0	69.5	234
360 min Winter	20.398	0.0	76.9	344
480 min Winter	16.212	0.0	81.6	446
600 min Winter	13.478	0.0	84.7	476
720 min Winter	11.548	0.0	87.0	550
960 min Winter	8.990	0.0	90.0	704
1440 min Winter	6.269	0.0	93.1	996
2160 min Winter	4.350	0.0	102.4	1424
2880 min Winter	3.359	0.0	105.1	1816
4320 min Winter	2.342	0.0	108.5	2592
5760 min Winter	1.823	0.0	116.1	3288
7200 min Winter	1.509	0.0	119.8	3968
8640 min Winter	1.299	0.0	123.2	4728
10080 min Winter	1.149	0.0	126.1	5448

Cascade Rainfall Details for Catchment A_Plinth .SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 530072 185559 TQ 30072 85559
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.080

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.080

Cascade Model Details for Catchment A_Plinth .SRCX

Storage is Online Cover Level (m) 10.000

Cellular Storage Structure

Invert Level (m) 9.850 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	475.0	0.0	0.150	475.0	0.0

Orifice Outflow Control

Diameter (m) 0.041 Discharge Coefficient 0.600 Invert Level (m) 9.850

Cascade Summary of Results for Catchment A_Tank.SRCX

Upstream Structures	Outflow To	Overflow To
Catchment A_Plinth .SRCX Catchment_E.SRCX	Catchment B_Tank.SRCX	(None)

Half Drain Time : 175 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.139	1.039	0.0	26.0	26.0	237.0	O K
30 min Summer	9.414	1.314	0.0	26.0	26.0	299.7	O K
60 min Summer	9.616	1.516	0.0	26.0	26.0	348.5	O K
120 min Summer	9.764	1.664	0.0	26.0	26.0	409.4	Flood Risk
180 min Summer	9.817	1.717	0.0	26.0	26.0	431.0	Flood Risk
240 min Summer	9.825	1.725	0.0	26.0	26.0	434.7	Flood Risk
360 min Summer	9.804	1.704	0.0	26.0	26.0	425.9	Flood Risk
480 min Summer	9.761	1.661	0.0	26.0	26.0	408.1	Flood Risk
600 min Summer	9.711	1.611	0.0	26.0	26.0	387.5	Flood Risk
720 min Summer	9.661	1.561	0.0	26.0	26.0	367.1	O K
960 min Summer	9.530	1.430	0.0	26.0	26.0	325.9	O K
1440 min Summer	9.092	0.992	0.0	26.0	26.0	226.2	O K
2160 min Summer	8.656	0.556	0.0	26.0	26.0	126.9	O K
2880 min Summer	8.434	0.334	0.0	24.9	24.9	76.1	O K
4320 min Summer	8.301	0.201	0.0	20.3	20.3	45.7	O K
5760 min Summer	8.266	0.166	0.0	16.2	16.2	37.8	O K
7200 min Summer	8.247	0.147	0.0	13.6	13.6	33.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.617	0.0	359.6	18
30 min Summer	114.446	0.0	466.4	33
60 min Summer	69.800	0.0	580.1	62
120 min Summer	44.704	0.0	747.6	122
180 min Summer	33.962	0.0	854.1	180
240 min Summer	27.682	0.0	929.5	218
360 min Summer	20.398	0.0	1028.5	280
480 min Summer	16.212	0.0	1090.2	344
600 min Summer	13.478	0.0	1132.9	410
720 min Summer	11.548	0.0	1164.5	484
960 min Summer	8.990	0.0	1207.7	626
1440 min Summer	6.269	0.0	1259.9	868
2160 min Summer	4.350	0.0	1316.6	1208
2880 min Summer	3.359	0.0	1351.7	1528
4320 min Summer	2.342	0.0	1404.9	2204
5760 min Summer	1.823	0.0	1457.7	2936
7200 min Summer	1.509	0.0	1502.0	3672

Cascade Summary of Results for Catchment A_Tank.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	8.234	0.134	0.0	11.8	11.8	30.6	O K
10080 min Summer	8.225	0.125	0.0	10.4	10.4	28.4	O K
15 min Winter	9.275	1.175	0.0	26.0	26.0	268.0	O K
30 min Winter	9.583	1.483	0.0	26.0	26.0	338.2	O K
60 min Winter	9.728	1.628	0.0	26.0	26.0	394.5	Flood Risk
120 min Winter	9.911	1.811	0.0	26.0	26.0	469.7	Flood Risk
180 min Winter	9.984	1.884	0.0	26.0	26.0	499.6	Flood Risk
240 min Winter	10.001	1.901	0.0	26.0	26.0	507.6	FLOOD
360 min Winter	9.968	1.868	0.0	26.0	26.0	493.4	Flood Risk
480 min Winter	9.911	1.811	0.0	26.0	26.0	470.0	Flood Risk
600 min Winter	9.841	1.741	0.0	26.0	26.0	441.1	Flood Risk
720 min Winter	9.767	1.667	0.0	26.0	26.0	410.6	Flood Risk
960 min Winter	9.625	1.525	0.0	26.0	26.0	352.3	O K
1440 min Winter	9.007	0.907	0.0	26.0	26.0	206.7	O K
2160 min Winter	8.459	0.359	0.0	25.1	25.1	82.0	O K
2880 min Winter	8.311	0.211	0.0	21.4	21.4	48.2	O K
4320 min Winter	8.259	0.159	0.0	15.3	15.3	36.3	O K
5760 min Winter	8.236	0.136	0.0	12.0	12.0	31.0	O K
7200 min Winter	8.221	0.121	0.0	10.0	10.0	27.7	O K
8640 min Winter	8.211	0.111	0.0	8.6	8.6	25.3	O K
10080 min Winter	8.204	0.104	0.0	7.6	7.6	23.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.299	0.0	1544.8	4400
10080 min Summer	1.149	0.0	1586.4	5120
15 min Winter	178.617	0.0	405.2	18
30 min Winter	114.446	0.0	524.8	33
60 min Winter	69.800	0.0	651.8	62
120 min Winter	44.704	0.0	839.6	118
180 min Winter	33.962	0.0	958.8	176
240 min Winter	27.682	1.3	1043.2	230
360 min Winter	20.398	0.0	1154.2	296
480 min Winter	16.212	0.0	1223.5	368
600 min Winter	13.478	0.0	1271.4	446
720 min Winter	11.548	0.0	1306.8	520
960 min Winter	8.990	0.0	1355.4	674
1440 min Winter	6.269	0.0	1414.3	924
2160 min Winter	4.350	0.0	1477.9	1212
2880 min Winter	3.359	0.0	1517.7	1496
4320 min Winter	2.342	0.0	1578.6	2204
5760 min Winter	1.823	0.0	1638.0	2936
7200 min Winter	1.509	0.0	1688.7	3672
8640 min Winter	1.299	0.0	1737.7	4408
10080 min Winter	1.149	0.0	1785.7	5096

Cascade Rainfall Details for Catchment A_Tank.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 530072 185559 TQ 30072 85559
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.767

Time From:	(mins) To:	Area (ha)
0	4	0.767

Cascade Model Details for Catchment A_Tank.SRCX

Storage is Online Cover Level (m) 10.000

Complex Structure

Cellular Storage

Invert Level (m)	8.100	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	240.0	0.0	1.501	0.0	0.0
1.500	240.0	0.0			

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	37.0
Membrane Percolation (mm/hr)	1000	Length (m)	37.0
Max Percolation (l/s)	380.3	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.600	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0210-2600-1900-2600
Design Head (m)	1.900
Design Flow (l/s)	26.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	210
Invert Level (m)	8.100
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.900	26.0
Flush-Flo™	0.557	26.0
Kick-Flo®	1.205	20.9
Mean Flow over Head Range	-	22.5

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.1	1.200	21.1	3.000	32.3	7.000	48.7
0.200	20.3	1.400	22.5	3.500	34.8	7.500	50.3
0.300	24.4	1.600	23.9	4.000	37.1	8.000	51.9
0.400	25.5	1.800	25.3	4.500	39.3	8.500	53.5
0.500	25.9	2.000	26.6	5.000	41.4	9.000	55.0
0.600	26.0	2.200	27.9	5.500	43.3	9.500	56.4
0.800	25.4	2.400	29.1	6.000	45.2		
1.000	24.2	2.600	30.2	6.500	47.0		

Cascade Summary of Results for Catchment B_Plinth.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	Catchment B_Tank.SRCX	(None)

Half Drain Time : 603 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.907	0.057	0.0	0.8	0.8	36.8	Flood Risk
30 min Summer	9.923	0.073	0.0	1.0	1.0	46.7	Flood Risk
60 min Summer	9.937	0.087	0.0	1.2	1.2	55.9	Flood Risk
120 min Summer	9.958	0.108	0.0	1.3	1.3	69.4	Flood Risk
180 min Summer	9.970	0.120	0.0	1.4	1.4	76.7	Flood Risk
240 min Summer	9.976	0.126	0.0	1.5	1.5	80.9	Flood Risk
360 min Summer	9.981	0.131	0.0	1.5	1.5	84.1	Flood Risk
480 min Summer	9.982	0.132	0.0	1.5	1.5	84.5	Flood Risk
600 min Summer	9.981	0.131	0.0	1.5	1.5	84.2	Flood Risk
720 min Summer	9.980	0.130	0.0	1.5	1.5	83.5	Flood Risk
960 min Summer	9.977	0.127	0.0	1.5	1.5	81.4	Flood Risk
1440 min Summer	9.969	0.119	0.0	1.4	1.4	76.5	Flood Risk
2160 min Summer	9.958	0.108	0.0	1.3	1.3	69.4	Flood Risk
2880 min Summer	9.949	0.099	0.0	1.3	1.3	63.4	Flood Risk
4320 min Summer	9.934	0.084	0.0	1.1	1.1	54.2	Flood Risk
5760 min Summer	9.924	0.074	0.0	1.0	1.0	47.7	Flood Risk
7200 min Summer	9.917	0.067	0.0	1.0	1.0	43.3	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.617	0.0	26.0	19
30 min Summer	114.446	0.0	35.1	34
60 min Summer	69.800	0.0	51.0	64
120 min Summer	44.704	0.0	66.7	122
180 min Summer	33.962	0.0	76.6	182
240 min Summer	27.682	0.0	83.6	242
360 min Summer	20.398	0.0	92.7	360
480 min Summer	16.212	0.0	98.3	410
600 min Summer	13.478	0.0	102.1	470
720 min Summer	11.548	0.0	104.8	528
960 min Summer	8.990	0.0	108.3	662
1440 min Summer	6.269	0.0	111.7	936
2160 min Summer	4.350	0.0	125.1	1340
2880 min Summer	3.359	0.0	128.3	1728
4320 min Summer	2.342	0.0	131.9	2468
5760 min Summer	1.823	0.0	142.9	3224
7200 min Summer	1.509	0.0	147.2	3896

Cascade Summary of Results for Catchment B_Plinth.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	9.913	0.063	0.0	0.9	0.9	40.4	Flood Risk
10080 min Summer	9.909	0.059	0.0	0.8	0.8	38.1	Flood Risk
15 min Winter	9.914	0.064	0.0	0.9	0.9	41.2	Flood Risk
30 min Winter	9.932	0.082	0.0	1.1	1.1	52.3	Flood Risk
60 min Winter	9.948	0.098	0.0	1.3	1.3	62.8	Flood Risk
120 min Winter	9.972	0.122	0.0	1.4	1.4	78.0	Flood Risk
180 min Winter	9.985	0.135	0.0	1.5	1.5	86.3	Flood Risk
240 min Winter	9.992	0.142	0.0	1.6	1.6	91.2	Flood Risk
360 min Winter	9.999	0.149	0.0	1.6	1.6	95.3	Flood Risk
480 min Winter	9.999	0.149	0.0	1.6	1.6	95.6	Flood Risk
600 min Winter	9.997	0.147	0.0	1.6	1.6	94.6	Flood Risk
720 min Winter	9.996	0.146	0.0	1.6	1.6	93.5	Flood Risk
960 min Winter	9.991	0.141	0.0	1.6	1.6	90.3	Flood Risk
1440 min Winter	9.979	0.129	0.0	1.5	1.5	82.9	Flood Risk
2160 min Winter	9.963	0.113	0.0	1.4	1.4	72.7	Flood Risk
2880 min Winter	9.950	0.100	0.0	1.3	1.3	64.3	Flood Risk
4320 min Winter	9.931	0.081	0.0	1.1	1.1	52.1	Flood Risk
5760 min Winter	9.919	0.069	0.0	1.0	1.0	44.3	Flood Risk
7200 min Winter	9.912	0.062	0.0	0.9	0.9	39.8	Flood Risk
8640 min Winter	9.907	0.057	0.0	0.8	0.8	36.6	Flood Risk
10080 min Winter	9.903	0.053	0.0	0.7	0.7	34.1	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.299	0.0	151.2	4664
10080 min Summer	1.149	0.0	154.3	5352
15 min Winter	178.617	0.0	29.9	19
30 min Winter	114.446	0.0	40.2	33
60 min Winter	69.800	0.0	57.7	62
120 min Winter	44.704	0.0	75.3	120
180 min Winter	33.962	0.0	86.4	178
240 min Winter	27.682	0.0	94.3	236
360 min Winter	20.398	0.0	104.5	346
480 min Winter	16.212	0.0	110.8	452
600 min Winter	13.478	0.0	115.0	488
720 min Winter	11.548	0.0	118.0	558
960 min Winter	8.990	0.0	121.9	712
1440 min Winter	6.269	0.0	125.8	1010
2160 min Winter	4.350	0.0	140.6	1428
2880 min Winter	3.359	0.0	144.2	1844
4320 min Winter	2.342	0.0	148.5	2596
5760 min Winter	1.823	0.0	160.3	3288
7200 min Winter	1.509	0.0	165.3	4032
8640 min Winter	1.299	0.0	169.8	4752
10080 min Winter	1.149	0.0	173.6	5544

Cascade Rainfall Details for Catchment B_Plinth.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 530072 185559 TQ 30072 85559
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.111

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.111

Cascade Model Details for Catchment B_Plinth.SRCX

Storage is Online Cover Level (m) 10.000

Cellular Storage Structure

Invert Level (m) 9.850 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	675.0	0.0	0.150	675.0	0.0

Orifice Outflow Control

Diameter (m) 0.047 Discharge Coefficient 0.600 Invert Level (m) 9.850

Cascade Summary of Results for Catchment B_Tank.SRCX

Upstream Structures	Outflow To	Overflow To
Catchment A_Tank.SRCX	(None)	(None)
Catchment A_Plinth .SRCX		
Catchment_E.SRCX		
Catchment B_Plinth.SRCX		
Landscape_catchment.SRCX		
Catchment_C.SRCX		
Catchment_D.SRCX		

Half Drain Time : 131 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	8.753	0.653	0.0	43.0	43.0	234.4	O K
30 min Summer	8.931	0.831	0.0	43.0	43.0	298.5	O K
60 min Summer	9.106	1.006	0.0	43.0	43.0	361.2	O K
120 min Summer	9.399	1.299	0.0	43.0	43.0	466.3	O K
180 min Summer	9.566	1.466	0.0	43.0	43.0	526.4	O K
240 min Summer	9.666	1.566	0.0	43.0	43.0	558.4	O K
360 min Summer	9.742	1.642	0.0	43.0	43.0	580.9	Flood Risk
480 min Summer	9.742	1.642	0.0	43.0	43.0	581.1	Flood Risk
600 min Summer	9.711	1.611	0.0	43.0	43.0	571.8	Flood Risk
720 min Summer	9.659	1.559	0.0	43.0	43.0	556.2	O K
960 min Summer	9.582	1.482	0.0	43.0	43.0	532.1	O K
1440 min Summer	9.546	1.446	0.0	43.0	43.0	519.1	O K
2160 min Summer	9.126	1.026	0.0	43.0	43.0	368.3	O K
2880 min Summer	8.819	0.719	0.0	43.0	43.0	258.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.617	0.0	1080.5	19
30 min Summer	114.446	0.0	1398.3	33
60 min Summer	69.800	0.0	1765.0	64
120 min Summer	44.704	0.0	2274.2	124
180 min Summer	33.962	0.0	2595.4	184
240 min Summer	27.682	0.0	2820.7	242
360 min Summer	20.398	0.0	3111.1	362
480 min Summer	16.212	0.0	3283.4	482
600 min Summer	13.478	0.0	3390.6	600
720 min Summer	11.548	0.0	3454.8	674
960 min Summer	8.990	0.0	3509.4	962
1440 min Summer	6.269	0.0	3520.8	1156
2160 min Summer	4.350	0.0	4018.7	1384
2880 min Summer	3.359	0.0	4124.7	1664

Cascade Summary of Results for Catchment B_Tank.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
4320 min Summer	8.455	0.355	0.0	41.3	41.3	127.5	O K
5760 min Summer	8.360	0.260	0.0	37.4	37.4	93.2	O K
7200 min Summer	8.331	0.231	0.0	32.9	32.9	83.1	O K
8640 min Summer	8.313	0.213	0.0	29.7	29.7	76.5	O K
10080 min Summer	8.301	0.201	0.0	27.3	27.3	72.0	O K
15 min Winter	8.833	0.733	0.0	43.0	43.0	263.2	O K
30 min Winter	9.037	0.937	0.0	43.0	43.0	336.5	O K
60 min Winter	9.239	1.139	0.0	43.0	43.0	409.0	O K
120 min Winter	9.565	1.465	0.0	43.0	43.0	526.2	O K
180 min Winter	9.766	1.666	0.0	43.0	43.0	588.2	Flood Risk
240 min Winter	9.880	1.780	0.0	43.0	43.0	622.1	Flood Risk
360 min Winter	9.977	1.877	0.0	43.0	43.0	651.1	Flood Risk
480 min Winter	9.989	1.889	0.0	43.0	43.0	654.7	Flood Risk
600 min Winter	9.965	1.865	0.0	43.0	43.0	647.4	Flood Risk
720 min Winter	9.918	1.818	0.0	43.0	43.0	633.3	Flood Risk
960 min Winter	9.788	1.688	0.0	43.0	43.0	594.8	Flood Risk
1440 min Winter	9.744	1.644	0.0	43.0	43.0	581.7	Flood Risk
2160 min Winter	9.042	0.942	0.0	43.0	43.0	338.3	O K
2880 min Winter	8.568	0.468	0.0	42.7	42.7	168.2	O K
4320 min Winter	8.351	0.251	0.0	36.1	36.1	90.2	O K
5760 min Winter	8.317	0.217	0.0	30.5	30.5	78.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
4320 min Summer	2.342	0.0	4284.0	2284
5760 min Summer	1.823	0.0	4453.6	2944
7200 min Summer	1.509	0.0	4588.0	3672
8640 min Summer	1.299	0.0	4716.9	4408
10080 min Summer	1.149	0.0	4839.7	5136
15 min Winter	178.617	0.0	1217.1	18
30 min Winter	114.446	0.0	1568.0	33
60 min Winter	69.800	0.0	1983.4	64
120 min Winter	44.704	0.0	2551.8	122
180 min Winter	33.962	0.0	2908.7	180
240 min Winter	27.682	0.0	3156.1	238
360 min Winter	20.398	0.0	3459.9	354
480 min Winter	16.212	0.0	3610.5	468
600 min Winter	13.478	0.0	3692.0	578
720 min Winter	11.548	0.0	3743.2	686
960 min Winter	8.990	0.0	3796.2	812
1440 min Winter	6.269	0.0	3819.1	1186
2160 min Winter	4.350	0.0	4510.9	1400
2880 min Winter	3.359	0.0	4630.9	1624
4320 min Winter	2.342	0.0	4813.6	2220
5760 min Winter	1.823	0.0	5005.1	2968

Cascade Summary of Results for Catchment B_Tank.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
7200 min Winter	8.298	0.198	0.0	26.8	26.8	71.1	O K
8640 min Winter	8.284	0.184	0.0	24.0	24.0	66.2	O K
10080 min Winter	8.274	0.174	0.0	22.0	22.0	62.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	1.509	0.0	5158.9	3680
8640 min Winter	1.299	0.0	5307.1	4416
10080 min Winter	1.149	0.0	5450.0	5208

Cascade Rainfall Details for Catchment B_Tank.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 530072 185559 TQ 30072 85559
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.728

Time From:	(mins) To:	Area (ha)
0	4	0.728

Cascade Model Details for Catchment B_Tank.SRCX

Storage is Online Cover Level (m) 10.000

Complex Structure

Cellular Storage

Invert Level (m)	8.100	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	378.0	0.0	1.501	0.0	0.0
1.500	378.0	0.0			

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	31.0
Membrane Percolation (mm/hr)	1000	Length (m)	32.0
Max Percolation (l/s)	275.6	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.600	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0264-4300-1900-4300
Design Head (m)	1.900
Design Flow (l/s)	43.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	264
Invert Level (m)	8.100
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	2100

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.900	43.0
Flush-Flo™	0.574	43.0
Kick-Flo®	1.259	35.3
Mean Flow over Head Range	-	37.0

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.4	1.200	37.2	3.000	53.5	7.000	80.8
0.200	27.2	1.400	37.1	3.500	57.7	7.500	83.5
0.300	40.1	1.600	39.6	4.000	61.5	8.000	86.2
0.400	42.0	1.800	41.9	4.500	65.2	8.500	88.8
0.500	42.9	2.000	44.0	5.000	68.6	9.000	91.3
0.600	43.0	2.200	46.1	5.500	71.8	9.500	93.7
0.800	42.3	2.400	48.1	6.000	74.9		
1.000	40.7	2.600	50.0	6.500	77.9		

Cascade Summary of Results for Catchment_C.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	Landscape_catchment.SRCX	(None)

Half Drain Time : 132 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.702	0.302	0.0	13.0	13.0	101.8	Flood Risk
30 min Summer	9.778	0.378	0.0	13.0	13.0	127.4	Flood Risk
60 min Summer	9.834	0.434	0.0	13.0	13.0	146.0	Flood Risk
120 min Summer	9.900	0.500	0.0	13.0	13.0	168.3	Flood Risk
180 min Summer	9.921	0.521	0.0	13.0	13.0	175.2	Flood Risk
240 min Summer	9.924	0.524	0.0	13.0	13.0	176.3	Flood Risk
360 min Summer	9.904	0.504	0.0	13.0	13.0	169.6	Flood Risk
480 min Summer	9.867	0.467	0.0	13.0	13.0	157.2	Flood Risk
600 min Summer	9.822	0.422	0.0	13.0	13.0	142.1	Flood Risk
720 min Summer	9.779	0.379	0.0	13.0	13.0	127.6	Flood Risk
960 min Summer	9.703	0.303	0.0	13.0	13.0	102.1	Flood Risk
1440 min Summer	9.604	0.204	0.0	12.9	12.9	68.8	O K
2160 min Summer	9.550	0.150	0.0	10.8	10.8	50.5	O K
2880 min Summer	9.527	0.127	0.0	8.8	8.8	42.8	O K
4320 min Summer	9.503	0.103	0.0	6.3	6.3	34.7	O K
5760 min Summer	9.489	0.089	0.0	5.0	5.0	30.1	O K
7200 min Summer	9.481	0.081	0.0	4.2	4.2	27.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.617	0.0	107.7	18
30 min Summer	114.446	0.0	140.1	32
60 min Summer	69.800	0.0	173.4	62
120 min Summer	44.704	0.0	223.8	110
180 min Summer	33.962	0.0	255.9	140
240 min Summer	27.682	0.0	278.5	172
360 min Summer	20.398	0.0	308.3	242
480 min Summer	16.212	0.0	326.8	312
600 min Summer	13.478	0.0	339.6	374
720 min Summer	11.548	0.0	349.1	436
960 min Summer	8.990	0.0	362.0	558
1440 min Summer	6.269	0.0	377.6	780
2160 min Summer	4.350	0.0	392.7	1124
2880 min Summer	3.359	0.0	402.8	1472
4320 min Summer	2.342	0.0	417.9	2204
5760 min Summer	1.823	0.0	432.0	2936
7200 min Summer	1.509	0.0	444.2	3672

Cascade Summary of Results for Catchment_C.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	9.474	0.074	0.0	3.6	3.6	24.9	O K
10080 min Summer	9.469	0.069	0.0	3.2	3.2	23.3	O K
15 min Winter	9.743	0.343	0.0	13.0	13.0	115.4	Flood Risk
30 min Winter	9.830	0.430	0.0	13.0	13.0	144.8	Flood Risk
60 min Winter	9.897	0.497	0.0	13.0	13.0	167.1	Flood Risk
120 min Winter	9.971	0.571	0.0	13.0	13.0	192.3	Flood Risk
180 min Winter	9.989	0.589	0.0	13.0	13.0	198.1	Flood Risk
240 min Winter	9.989	0.589	0.0	13.0	13.0	198.2	Flood Risk
360 min Winter	9.956	0.556	0.0	13.0	13.0	187.2	Flood Risk
480 min Winter	9.903	0.503	0.0	13.0	13.0	169.3	Flood Risk
600 min Winter	9.837	0.437	0.0	13.0	13.0	147.0	Flood Risk
720 min Winter	9.771	0.371	0.0	13.0	13.0	124.9	Flood Risk
960 min Winter	9.664	0.264	0.0	13.0	13.0	89.0	O K
1440 min Winter	9.563	0.163	0.0	11.9	11.9	54.9	O K
2160 min Winter	9.525	0.125	0.0	8.6	8.6	42.2	O K
2880 min Winter	9.507	0.107	0.0	6.7	6.7	35.8	O K
4320 min Winter	9.486	0.086	0.0	4.7	4.7	29.0	O K
5760 min Winter	9.475	0.075	0.0	3.6	3.6	25.2	O K
7200 min Winter	9.467	0.067	0.0	3.0	3.0	22.7	O K
8640 min Winter	9.462	0.062	0.0	2.6	2.6	20.9	O K
10080 min Winter	9.458	0.058	0.0	2.3	2.3	19.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.299	0.0	456.1	4400
10080 min Summer	1.149	0.0	467.6	5136
15 min Winter	178.617	0.0	121.5	18
30 min Winter	114.446	0.0	157.7	32
60 min Winter	69.800	0.0	195.0	60
120 min Winter	44.704	0.0	251.5	116
180 min Winter	33.962	0.0	287.4	146
240 min Winter	27.682	0.0	312.8	184
360 min Winter	20.398	0.0	346.2	262
480 min Winter	16.212	0.0	367.0	338
600 min Winter	13.478	0.0	381.4	406
720 min Winter	11.548	0.0	392.0	468
960 min Winter	8.990	0.0	406.6	578
1440 min Winter	6.269	0.0	424.2	778
2160 min Winter	4.350	0.0	441.2	1128
2880 min Winter	3.359	0.0	452.7	1480
4320 min Winter	2.342	0.0	470.1	2208
5760 min Winter	1.823	0.0	486.1	2944
7200 min Winter	1.509	0.0	500.3	3680
8640 min Winter	1.299	0.0	514.1	4376
10080 min Winter	1.149	0.0	527.6	5080

Cascade Rainfall Details for Catchment_C.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 530072 185559 TQ 30072 85559
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.344

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.344

Cascade Model Details for Catchment_C.SRCX

Storage is Online Cover Level (m) 10.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	34.0
Membrane Percolation (mm/hr)	1000	Length (m)	33.0
Max Percolation (l/s)	311.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.400	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0169-1300-0600-1300
Design Head (m)	0.600
Design Flow (l/s)	13.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	169
Invert Level (m)	9.400
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	0.600	13.0
Flush-Flo™	0.256	13.0
Kick-Flo®	0.467	11.5
Mean Flow over Head Range	-	10.4

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

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	6.0	1.200	18.1	3.000	28.0	7.000	42.0
0.200	12.8	1.400	19.4	3.500	30.2	7.500	43.5
0.300	12.9	1.600	20.7	4.000	32.2	8.000	44.9
0.400	12.4	1.800	21.9	4.500	34.0	8.500	46.3
0.500	11.9	2.000	23.0	5.000	35.8	9.000	47.7
0.600	13.0	2.200	24.1	5.500	37.5	9.500	49.0
0.800	14.9	2.400	25.1	6.000	39.1		
1.000	16.6	2.600	26.1	6.500	40.5		

Cascade Summary of Results for Catchment_D.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	Landscape_catchment.SRCX	(None)

Half Drain Time : 100 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.680	0.480	0.0	25.0	25.0	161.6	O K
30 min Summer	9.795	0.595	0.0	25.0	25.0	200.1	Flood Risk
60 min Summer	9.867	0.667	0.0	25.0	25.0	224.4	Flood Risk
120 min Summer	9.940	0.740	0.0	25.0	25.0	249.2	Flood Risk
180 min Summer	9.957	0.757	0.0	25.0	25.0	255.0	Flood Risk
240 min Summer	9.949	0.749	0.0	25.0	25.0	252.1	Flood Risk
360 min Summer	9.896	0.696	0.0	25.0	25.0	234.4	Flood Risk
480 min Summer	9.824	0.624	0.0	25.0	25.0	209.9	Flood Risk
600 min Summer	9.740	0.540	0.0	25.0	25.0	181.8	Flood Risk
720 min Summer	9.666	0.466	0.0	25.0	25.0	156.9	O K
960 min Summer	9.549	0.349	0.0	25.0	25.0	117.4	O K
1440 min Summer	9.424	0.224	0.0	24.2	24.2	75.5	O K
2160 min Summer	9.373	0.173	0.0	18.2	18.2	58.3	O K
2880 min Summer	9.348	0.148	0.0	14.5	14.5	49.8	O K
4320 min Summer	9.320	0.120	0.0	10.3	10.3	40.5	O K
5760 min Summer	9.304	0.104	0.0	8.0	8.0	35.1	O K
7200 min Summer	9.294	0.094	0.0	6.7	6.7	31.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.617	0.0	175.6	18
30 min Summer	114.446	0.0	227.0	32
60 min Summer	69.800	0.0	279.3	60
120 min Summer	44.704	0.0	359.4	96
180 min Summer	33.962	0.0	410.4	130
240 min Summer	27.682	0.0	446.4	164
360 min Summer	20.398	0.0	493.8	234
480 min Summer	16.212	0.0	523.5	302
600 min Summer	13.478	0.0	544.0	364
720 min Summer	11.548	0.0	559.2	424
960 min Summer	8.990	0.0	580.1	538
1440 min Summer	6.269	0.0	605.7	752
2160 min Summer	4.350	0.0	630.1	1104
2880 min Summer	3.359	0.0	647.1	1468
4320 min Summer	2.342	0.0	673.5	2204
5760 min Summer	1.823	0.0	697.1	2936
7200 min Summer	1.509	0.0	718.6	3672

Cascade Summary of Results for Catchment_D.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	9.287	0.087	0.0	5.8	5.8	29.1	O K
10080 min Summer	9.281	0.081	0.0	5.1	5.1	27.3	O K
15 min Winter	9.744	0.544	0.0	25.0	25.0	183.2	Flood Risk
30 min Winter	9.876	0.676	0.0	25.0	25.0	227.5	Flood Risk
60 min Winter	9.959	0.759	0.0	25.0	25.0	255.4	Flood Risk
120 min Winter	10.013	0.813	0.0	25.2	25.2	282.6	FLOOD
180 min Winter	10.018	0.818	0.0	25.3	25.3	287.4	FLOOD
240 min Winter	10.012	0.812	0.0	25.2	25.2	280.9	FLOOD
360 min Winter	9.952	0.752	0.0	25.0	25.0	253.1	Flood Risk
480 min Winter	9.845	0.645	0.0	25.0	25.0	217.2	Flood Risk
600 min Winter	9.718	0.518	0.0	25.0	25.0	174.4	Flood Risk
720 min Winter	9.612	0.412	0.0	25.0	25.0	138.7	O K
960 min Winter	9.466	0.266	0.0	24.7	24.7	89.7	O K
1440 min Winter	9.383	0.183	0.0	19.6	19.6	61.5	O K
2160 min Winter	9.344	0.144	0.0	13.8	13.8	48.4	O K
2880 min Winter	9.323	0.123	0.0	10.7	10.7	41.5	O K
4320 min Winter	9.300	0.100	0.0	7.5	7.5	33.8	O K
5760 min Winter	9.287	0.087	0.0	5.8	5.8	29.4	O K
7200 min Winter	9.279	0.079	0.0	4.8	4.8	26.5	O K
8640 min Winter	9.273	0.073	0.0	4.2	4.2	24.4	O K
10080 min Winter	9.268	0.068	0.0	3.7	3.7	22.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.299	0.0	739.6	4400
10080 min Summer	1.149	0.0	760.2	5128
15 min Winter	178.617	0.0	197.5	18
30 min Winter	114.446	0.0	255.1	32
60 min Winter	69.800	0.0	313.6	60
120 min Winter	44.704	13.3	403.3	108
180 min Winter	33.962	18.1	460.4	138
240 min Winter	27.682	11.6	500.8	178
360 min Winter	20.398	0.0	554.0	254
480 min Winter	16.212	0.0	587.2	328
600 min Winter	13.478	0.0	610.2	388
720 min Winter	11.548	0.0	627.3	444
960 min Winter	8.990	0.0	650.8	542
1440 min Winter	6.269	0.0	679.6	752
2160 min Winter	4.350	0.0	707.0	1120
2880 min Winter	3.359	0.0	726.4	1472
4320 min Winter	2.342	0.0	756.4	2204
5760 min Winter	1.823	0.0	783.1	2936
7200 min Winter	1.509	0.0	807.6	3672
8640 min Winter	1.299	0.0	831.5	4392
10080 min Winter	1.149	0.0	855.2	5120

Cascade Rainfall Details for Catchment_D.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 530072 185559 TQ 30072 85559
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.546

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.546

Cascade Model Details for Catchment_D.SRCX

Storage is Online Cover Level (m) 10.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	33.0
Membrane Percolation (mm/hr)	1000	Length (m)	34.0
Max Percolation (l/s)	311.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.200	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0221-2500-0800-2500
Design Head (m)	0.800
Design Flow (l/s)	25.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	221
Invert Level (m)	9.200
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1500

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	0.800	25.0
Flush-Flo™	0.341	25.0
Kick-Flo®	0.620	22.2
Mean Flow over Head Range	-	20.2

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

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	7.4	1.200	30.3	3.000	47.2	7.000	71.2
0.200	21.8	1.400	32.7	3.500	50.8	7.500	73.6
0.300	24.9	1.600	34.8	4.000	54.2	8.000	76.0
0.400	24.9	1.800	36.9	4.500	57.4	8.500	77.8
0.500	24.2	2.000	38.8	5.000	60.4	9.000	80.1
0.600	22.7	2.200	40.6	5.500	63.3	9.500	82.3
0.800	25.0	2.400	42.4	6.000	66.0		
1.000	27.8	2.600	44.0	6.500	68.7		

G. Indicative Foul Drainage Strategy

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Sheet No:	1 of 2	Project No:	WIE15702		
Project Title:	**Former Holloway Prison**	By:	K. Tolson	Date:	16.09.2021
Calculations Title:	**Existing Foul Flow Estimate**	Checked:	D. O'Donovan	Date:	16.09.2021

			Dry Weather Flow Rate (per day)	Source	Number of		Factor	Profile (hours)	Peak Flow Rate (litres/second)
Residential							2.12	24	
Existing property =	*160*	*litres/person/day*	400.0 litres per unit	Thames Water Guidelines (2016)	0	existing units			0.000
New property =	*125*	*litres/person/day*	312.5 litres per unit	Thames Water Guidelines (2016)	0	proposed units			0.000
Occupancy =	*2.5*	*persons*							
Hotel			500.0 litres per room	British Water (2013)	0	rooms	3	24	0.000
Student Accommodation			200.0 litres per bed	Thames Water Guidelines (2016)	500	beds	3	24	3.472
Offices			750.0 litres per 100m^2	Jones (1992)		m^2	3	10	0.000
Retail			400.0 litres per 100m^2	Jones (1992)	0	m^2	3	3 DWF Flat	0.000
Cinema			10.0 litres per seat	Jones (1992)	0	seats*	3	8	0.000
Health Club/Sports Centre			50.0 litres per customer	British Water (2013)	0	customers**	3	16	0.000
Day School			90.0 litres per pupil	British Water (2013)	0	pupils	3	10	0.000
Boarding School			175.0 litres per pupil	British Water (2013)	0	pupils	3	24	0.000
Hospital			750.0 litres per bed	Jones (1992)	0	beds	3	3 DWF Flat	0.000
Nursing Home			350.0 litres per bed	British Water (2013)	0	beds	3	24	0.000
Restaurant			30.0 litres per cover	British Water (2013)	0	covers	3	8	0.000
Pub/Club			15.0 litres per customer	Butler and Davies (2004)	0	customers***	3	12	0.000
Warehouse			150.0 litres per 100m^2	Jones (1992)		m^2	3	3 DWF Flat	0.000
Manufacturing			550.0 litres per 100m^2	Jones (1992)	0	m^2	3	3 DWF Flat	0.000
Commercial			300.0 litres per 100m^2	Jones (1992)	0	m^2	3	3 DWF Flat	0.000
SUB TOTAL									3.5
Infiltration percentage		8%							0.3
TOTAL									**3.8**

* Foul flow rate needs to be calculated based on number of seats. An allowance of 4m^2 has been made for each seat.

Floor area = 0 m^2 4 m^2 per person

** Foul flow rate needs to be calculated based on number of customers. An allowance of 4m^2 has been made for each customer.

Floor area = 0 m^2 4 m^2 per person

*** Foul flow rate needs to be calculated based on number of customers. An allowance of 4m^2 has been made for each customer.

Floor area = 0 m^2 4 m^2 per person

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Project Title:	**Former Holloway Prison**	Sheet No: 2 of 2	Project No: WIE15702
Calculations Title:	**Proposed Foul Flow Estimate**	By: K. Tolson	Date: 16.09.2021
		Checked: D. O'Donovan	Date: 16.09.2021

		Dry Weather Flow Rate (per day)	Source	Number of		Factor	Profile (hours)	Peak Flow Rate (litres/second)
Residential						2.12	24	
Existing property =	*160 litres/person/day*	400.0 litres per unit	Thames Water Guidelines (2016)	0	existing units			0.000
New property =	*125 litres/person/day*	312.5 litres per unit	Thames Water Guidelines (2016)	925	proposed units			7.093
Occupancy =	*2.5 persons*							
Hotel		500.0 litres per room	British Water (2013)	0	rooms	3	24	0.000
Student Accommodation		200.0 litres per bed	Thames Water Guidelines (2016)	0	beds	3	24	0.000
Offices		750.0 litres per $100m^2$	Jones (1992)		m^2	3	10	0.000
Retail		400.0 litres per $100m^2$	Jones (1992)	1484	m^2	3	3 DWF Flat	0.206
Cinema		10.0 litres per seat	Jones (1992)	0	seats*	3	8	0.000
Health Club/Sports Centre		50.0 litres per customer	British Water (2013)	0	customers**	3	16	0.000
Day School		90.0 litres per pupil	British Water (2013)	0	pupils	3	10	0.000
Boarding School		175.0 litres per pupil	British Water (2013)		pupils	3	24	0.000
Hospital		750.0 litres per bed	Jones (1992)	0	beds	3	3 DWF Flat	0.000
Nursing Home		350.0 litres per bed	British Water (2013)	60	beds	3	24	0.729
Restaurant		30.0 litres per cover	British Water (2013)	0	covers	3	8	0.000
Pub/Club		15.0 litres per customer	Butler and Davies (2004)	0	customers***	3	12	0.000
Warehouse		150.0 litres per $100m^2$	Jones (1992)		m^2	3	3 DWF Flat	0.000
Manufacturing		550.0 litres per $100m^2$	Jones (1992)	0	m^2	3	3 DWF Flat	0.000
Commercial		300.0 litres per $100m^2$	Jones (1992)	1818	m^2	3	3 DWF Flat	0.189
SUB TOTAL								8.2
Infiltration percentage	8%							0.7
TOTAL								**8.9**

* Foul flow rate needs to be calculated based on number of seats. An allowance of $4m^2$ has been made for each seat.

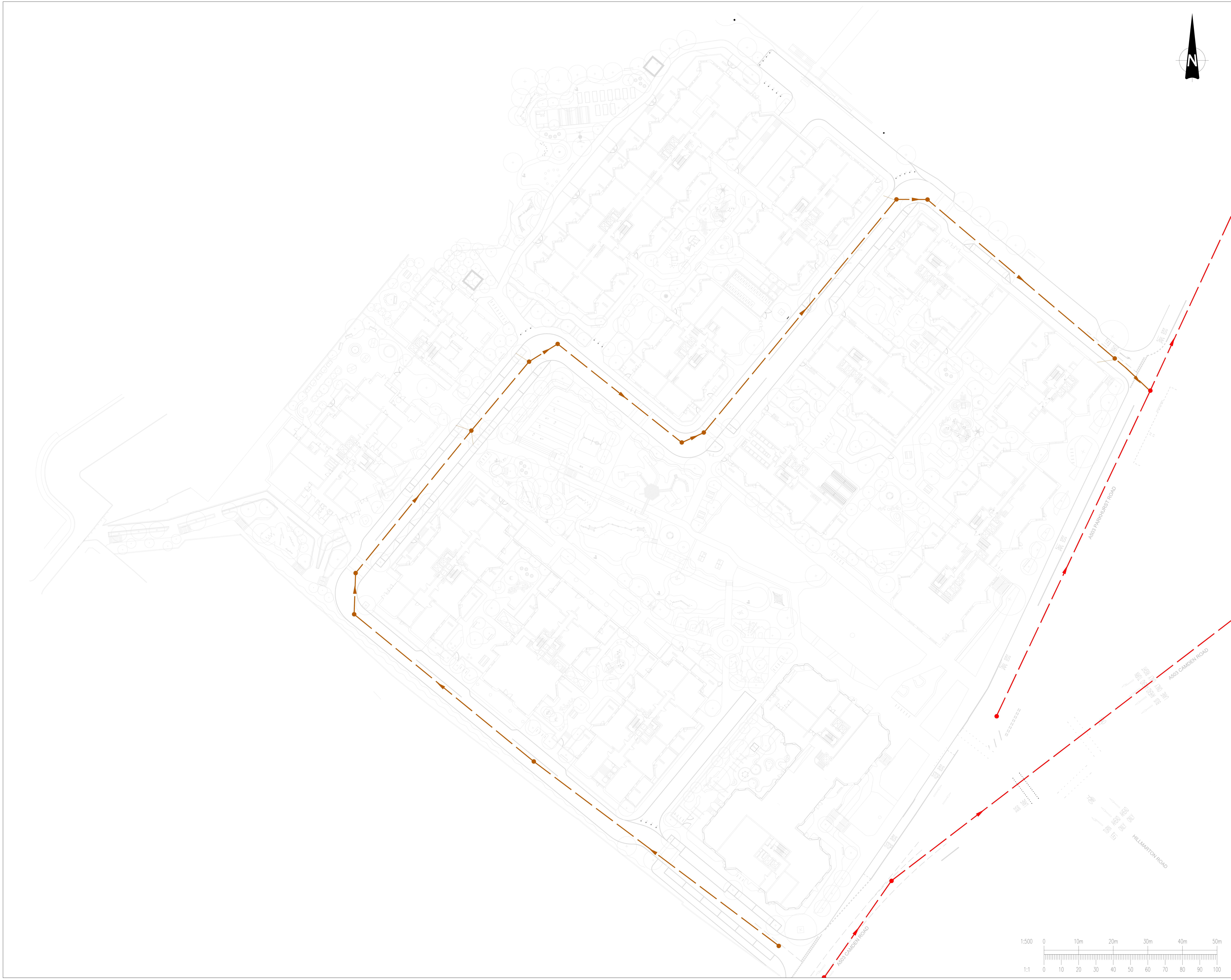
Floor area = 0 m^2 4 m^2 per person

** Foul flow rate needs to be calculated based on number of customers. An allowance of $4m^2$ has been made for each customer.

Floor area = 0 m^2 4 m^2 per person

*** Foul flow rate needs to be calculated based on number of customers. An allowance of $4m^2$ has been made for each customer.

Floor area = 0 m^2 4 m^2 per person



GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEER'S, ARCHITECT'S OR OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
2. ALL DIMENSIONS AND LEVELS ARE TO BE CHECKED ON SITE BY THE CONTRACTOR PRIOR TO PREPARING ANY WORKING DRAWINGS OR COMMENCING ON SITE.
3. THE CONTRACTOR MUST ENSURE AND WILL BE HELD RESPONSIBLE FOR THE OVERALL STABILITY OF THE BUILDING/STRUCTURE/EXCAVATION AT ALL STAGES OF THE WORK.
4. ALL WORK BY THE CONTRACTOR MUST BE CARRIED OUT IN SUCH A WAY THAT ALL REQUIREMENTS UNDER THE HEALTH AND SAFETY AT WORK ACT ARE SATISFIED.
5. ALL WORK IS TO BE CARRIED OUT IN COMPLIANCE WITH THE REQUIREMENTS OF THE RELEVANT STATUTORY AUTHORITIES AND REGULATIONS.

KEY

- PROPOSED FOUL WATER SEWER
- THAMES WATER COMBINED SEWER
- SITE BOUNDARY

Rev	Date	Description	By
P02	29.10.21	PLANNING ISSUE	KT
P01	23.09.21	FIRST ISSUE	KT

Amendments

Project
HOLLOWAY PRISON

Title
PRELIMINARY FOUL DRAINAGE STRATEGY

Client
Peabody Construction Limited

Waterman

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Drawing Status
PRELIMINARY

Designed by KT	Checked by DO	Project No WIE15702
Drawn by KT	Date OCTOBER 2021	
Scales @ A1 work to figured dimensions only	1:500	Computer File No 15702-WIE-ZZ-XX-DR-92003.P02.dwg

Publisher	Zone	Category	Number	Revision
WIE	ZZ	92	003	P02

15702-WIE-ZZ-XX-M1-D-92003, 1947-EXA-ZZ-ZZ-DR-L-00100_WIE, A1-Wat-S

H. Drainage Pro-Forma

1. Project & Site Details		
Project / Site Name (including sub-catchment / stage / phase where appropriate)	Former Holloway Prison - Outline Planning Stage	
Address & post code	Pankhurst Raod, London, N7 0NU	
OS Grid ref. (Easting, Northing)	E 530144	
	N 185552	
LPA reference (if applicable)		
Brief description of proposed work	Phased redevelopment including demolition of existing structures and the construction of residential units and care homes, a women's building and flexible commercial flood space.	
Total site Area	40800	m^2
Total existing impervious area		m^2
Total proposed impervious area	38160	m^2
Is the site in a surface water flood risk catchment (ref. local Surface Water Management Plan)?	N/A	
Existing drainage connection type and location	Existing 1600x770mm diamter combined sewer undereath Pankhurst Road	
Designer Name	Kirsty Tolson	
Designer Position	Senior Flood Risk Consultant	
Designer Company	Waterman Group	

2. Proposed Discharge Arrangements

2a. Infiltration Feasibility		
Superficial geology classification	n/a	
Bedrock geology classification	London Clay	
Site infiltration rate	0	m/s
Depth to groundwater level	0	m below ground level
Is infiltration feasible?	No	

2b. Drainage Hierarchy	*Feasible (Y/N)*	*Proposed (Y/N)*
1 store rainwater for later use	Y	Y
2 use infiltration techniques, such as porous surfaces in non-clay areas	N	N
3 attenuate rainwater in ponds or open water features for gradual release	N	N
4 attenuate rainwater by storing in tanks or sealed water features for gradual release	Y	Y
5 discharge rainwater direct to a watercourse	N	N
6 discharge rainwater to a surface water sewer/drain	N	N
7 discharge rainwater to the combined sewer.	Y	Y

2c. Proposed Discharge Details	
Proposed discharge location	Combined sewer underneath Pankhurst Roa
Has the owner/regulator of the discharge location been consulted?	Yes

3. Drainage Strategy

3a. Discharge Rates & Required Storage

	Greenfield (GF) runoff rate (l/s)	*Existing discharge rate (l/s)*	*Required storage for GF rate (m^3)*	*Proposed discharge rate (l/s)*
Qbar	15.2			
1 in 1	12.9			
1 in 30	34.3			
1 in 100	48.5	270	3222	48.5
1 in 100 + CC			3222	48.5
Climate change allowance used		40%		

3b. Principal Method of Flow Control

Hydrobrake

3c. Proposed SuDS Measures

	Catchment area (m^2)	*Plan area (m^2)*	*Storage vol. (m^3)*
Rainwater harvesting	0		0
Infiltration systems	0		0
Green roofs	0	0	0
Blue roofs	0	0	0
Filter strips	0	0	0
Filter drains	0	0	0
Bioretention / tree pits	0	0	0
Pervious pavements	36000	8654	1336
Swales	0	0	0
Basins/ponds	0	0	0
Attenuation tanks	36000		1886
Total	72000	8654	3222

4. Supporting Information

4a. Discharge & Drainage Strategy	*Page/section of drainage report*
Infiltration feasibility (2a) – geotechnical factual and interpretive reports, including infiltration results	Page 11, Page 13
Drainage hierarchy (2b)	Page 13
Proposed discharge details (2c) – utility plans, correspondence / approval from owner/regulator of discharge location	Page 14 - Page 21
Discharge rates & storage (3a) – detailed hydrologic and hydraulic calculations	Appendix F, page 17
Proposed SuDS measures & specifications (3b)	Page 16, Page 17

4b. Other Supporting Details	*Page/section of drainage report*
Detailed Development Layout	Appendix B
Detailed drainage design drawings, including exceedance flow routes	Section 5.31
Detailed landscaping plans	Appendix B
Maintenance strategy	Section 5.33
Demonstration of how the proposed SuDS measures improve:	
a) water quality of the runoff?	Page 15
b) biodiversity?	Page 15, Page 16
c) amenity?	Page 15, Page 16

UK and Ireland Office Locations