SOCG003

Flintshire Local Development Plan 2015-2030

Statement of Common Ground

HN1.8 Ash Lane Hawarden

January 2021

Contents

1. Introduction

1.1 This Statement of Common Ground (SoCG) has been prepared by Flintshire County Council (FCC) in conjunction with the agent for the landowner Hawarden Estates. It has been prepared to assist and inform the Examination of the Flintshire Local Development Plan (LDP) in respect of the housing allocation HN1.8 Ash Lane, Hawarden. The purpose of the document is to determine the matters agreed between the parties as well as any matters yet to be resolved.

2. Site Context

2.1 The site is located between the settlements of Hawarden which is a Tier 2 Main Service Centre and Mancot which is a Tier 3 Sustainable Settlement in the LDP. It adjoins existing residential development at Park Lane, Hawarden to the west, Ash Lane, Mancot to the east and a mix of residential development, recreation and community facilities at Mancot Lane, Mancot to the north. The site comprises 10.9ha of land and is made up of candidate site HWN005 and a small parcel of land, between the candidate site and the recreation ground / The Paddock, which was included in the allocation following Preferred Strategy representations from the site promoter.

3. Current Planning Status

3.1 In the adopted Flintshire Unitary Development Plan (UDP) the site is located outside of but adjoining the settlement boundaries of both Hawarden and Mancot and within the green barrier GEN4(14). A review of the green barrier has been undertaken and the reasoning for the drawing back of the green barrier is set out in Background Paper 01 Green Barrier, which accompanied the Deposit Plan. The land to the south west and south east of the site remains as green barrier in the LDP as part of EN11.13.

3.2 There is no planning history relating to the site in terms of planning applications. However, the bulk of the site was recommended for allocation in the UDP Inspector’s Report, although not included in the adopted UDP.

4. Background and Technical Studies

4.1The allocation of the site is informed by a number of background and technical studies undertaken and prepared by the site promoters:

- Agricultural Land Quality Report 2010 LDP-EBD-HN1.8.1
- Agricultural Statement LDP-EBD-HN1.8.2
- Cofnod Environmental Information Search 2018 LDP-EBD-HN1.8.3

- Ecological Assessment 2018 LDP-EBD-HN1.8.4
- Great Crested Newt Site Assessment 2019 LDP-EBD-HN1.8.5
- Transport Assessment 2018 LDP-EBD-HN1.8.6
- Transport Assessment 2018 Appendices 2018 LDP-EBD-HN1.8.7
- Heritage Asset Setting Assessment LDP-EBD-HN1.8.9

5. Development Parameters

5.1 The site is allocated in HN1.8 for 298 units which represents a density of 30 units per hectare. Not all of the total site area is proposed for development as approximately 1ha of land is to be undeveloped in order to provide a buffer to the listed St Deiniols Ash Farm.

5.2 The site falls within the Connah's Quay, Queensferry and Broughton Housing Market Area as defined in the Flintshire Local Housing Market Assessment which, in conjunction with the Viability Study, requires the provision of 35% affordable Housing. The Affordable Housing Background Paper 7 identifies 101 affordable units being delivered on the site. This updates the 40% / 115 units incorrectly quoted in Background Paper 3 Infrastructure Plan. In terms of size of units the Local Housing market Assessment identifies that 45.6% of need is for smaller 1-2 be units, 28.3% for 3 bed general needs, 12% for 4 bed or more and 14.1% for older persons.

5.3 In accordance with the findings of the LHMA the development should comprise a mix of housing by type and size. Table 5.7 of the Local Housing Market Assessment (Update) identifies the following breakdown for open market dwellings which represents a guide to the likely mix of dwellings by type and size within the development:

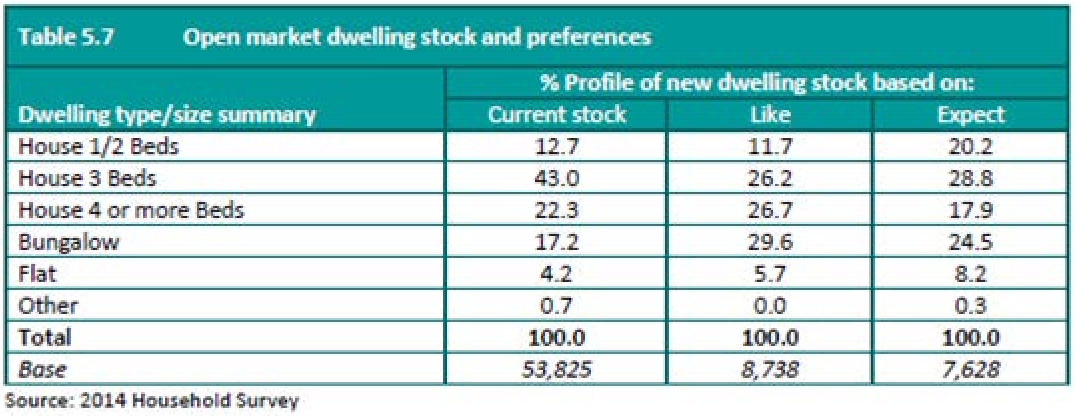

Table 5.7 Open market dwelling stock and preferences

Dwelling type/size summary	% Profile of new dwelling stock based on:		
	Current stock	Like	Expect
House 1/2 Beds	12.7	11.7	20.2
House 3 Beds	43.0	26.2	28.8
House 4 or more Beds	22.3	26.7	17.9
Bungalow	17.2	29.6	24.5
Flat	4.2	5.7	8.2
Other	0.7	0.0	0.3
Total	**100.0**	**100.0**	**100.0**
Base	*53,825*	*8,738*	*7,628*

Source: 2014 Household Survey

5.4 The owner / agent has referenced in their supporting Deposit representations a report by Savills, expressing concerns about the affordable housing requirements in the Council's Viability Study. Following robust scrutiny at Examination, the owner / agent are committed to delivering the Inspector's recommendations in respect of affordable housing requirements. The level of affordable housing therefore represents an area of disagreement between the parties.

6. Development Trajectory

6.1 The site owner is in negotiation with Anwyl Homes as their preferred developer. The development of the site, as detailed in the Background Paper 10 Housing Land Supply is capable of proceeding at the following rate of development:

Year	Completions
2023-24	18
2024-25	45
2025-26	45
2026-27	45
2027-28	45
2028-29	45
2029-30	45

7. Infrastructure

Highways

7.1 The development of the site will have a primary access off the A550 Gladstone Way in the form of a T-junction and a secondary access off Ash Lane also with a simple T-junction. No through route shall be provided between Gladstone Way and Ash Lane.

Links to Active Travel / Public Transport

7.2 The development should embrace the concepts of Active Travel and incorporate walking and cycling routes which facilitate links with route MA2/13 in the Councils Active Travel Integrated Network Map Schedules. This route runs along Park Avenue and Mancot Lane and provides links with Ewloe, Hawarden and through to Deeside. The development should facilitate safe and convenient links to bus stops on the A550 Gladstone Way and Mancot Lane. The planning application should include a Travel Plan setting out the measures to promote and facilitate sustainable travel choices for residents. These measures will maximize the opportunities for future residents to undertake sustainable transport choices.

Education

7.3 The Infrastructure Plan (Background Paper LDP03 provides a commentary in respect of Education. The Local Education Authority has not formally objected to the proposed development and the LDP continues the approach adopted in the UDP and existing SPG23 Developer Contributions to Education in seeking financial contributions whereby new development places pressure on the capacity of existing schools. Utilising this methodology the Local Education Authority presently seeks a financial contribution of £845,733 to Hawarden Village School and £923,450 to Hawarden High School. However, this will need to be reviewed in the light of up to date information at the time of a planning application.

Public Open Space / Green Infrastructure / Right of Way

7.4 The development will deliver a high quality green infrastructure framework for the site comprising:

- Play and recreation space including
    - An equipped neighbourhood play area
    - Signage / seating / picnic tables / litter bins / bike racks
    - Multi use Games Area (MUGA) 30m x 16m
    - Either free standing or combined with existing Mancot Lane play area
- Structural landscaping
- Creation of attractive pedestrian and cycling routes through the site as part of a green infrastructure network and linking with existing recreational and community facilities.

8. Other Matters

Placemaking

8.1 The development must embrace the Placemaking principles embodied within PPW10 in order to deliver a sustainable high quality living environment.

Indicative Layout

8.2 An indicative layout has been provided as part of the agents Deposit representation which shows how the site could be laid out. This will be subject to further refinement.

Noise

8.3 Noise survey to be undertaken at planning application stage to determine noise attenuation measures for the site and individual dwellings

SuDS

8.4 A Sustainable Drainage Scheme based approach to the surface water drainage of the site will be required in accordance with the Flood Water Management Act 2010. The scheme should be designed from the outset as an integral part of the overall design in accordance with the Statutory SuDS Standards and capable of being adopted by the SuDS Approval Body (SAB) which is FCC. The landowner has recently prepared a Surface Water Drainage Strategy which is attached at Appendix 1.

Ecology

8.5 The development should retain and strengthen, wherever possible, existing hedgerows and trees which are both ecological and landscape features. Where the loss of such existing features is unavoidable, compensatory planting will be required. In addition to the existing Ecological Appraisal, an Ecological Impact Assessment will be required to inform a masterplan approach for the site at planning application stage supported by appropriate avoidance and mitigation measures for both species and habitats. Overall, the proposed development should enhance biodiversity on the site.

Trees and Hedgerows

8.6 Mature trees on the site will need to be retained and protected. Hedgerows should also be retained but where required to be removed they shall be replanted using indigenous species. Further advice is contained in adopted SPG4 Trees and Development.

Historic Environment

8.7 The development should provide an open landscaped buffer to preserve the setting of St Deiniols Ash Farm.

Parking

8.8 Parking provision shall be made within the development in line with the current parking standards in SPG11 Parking Standards.

Space Around Dwellings

8.9 The development will ensure adequate separation distances between existing and proposed dwellings and adequate private amenity spaces in dwellings in line with existing SPG2 Space Around Dwellings to ensure that adequate living standards or amenity is established.

Mining

8.10 The overall design and layout of the site will incorporate avoidance and mitigation measures in respect of previous mining activity.

9. Conclusion

9.1 The Council and the landowner consider that the allocation is sustainable, viable and deliverable.

Andrew Roberts Andrew Roberts, Service Manager Strategy, Environment Directorate, FCC 07/01/21

Helen Howie Helen Howie, Senior Planning Consultant, Berrys (Agent on behalf of Landowner) 07/01/20

Surface Water Drainage Strategy

Proposed Residential Development

Ash Lane, Mancot, Deeside, CH5 2BR

Issue 1.0 December 2020

SA37263

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Contents

1. Introduction

1.1 This Surface Water Drainage Strategy has been prepared by Richard Harman, an Incorporated Engineer, and a Fellow of the Institute of Highway Engineers with over 18 years industry experience of working in both the public and private sector.

1.2 This report has been prepared with respect to a proposed residential development on greenfield agricultural land forming part of St Deiniols Ash Farm at Mancot, Deeside, CH5 2BR. The site location is as shown in Figure 1 below. The proposed development site has been submitted by the landowner to Flintshire County Council for allocation under the proposed Local Plan Review (LPR). The LPR allocations process has considered development sites to meet development demand for the period between 2015 to 2030. The LDR has now been approved and is due to be submitted to the Welsh Government and Planning Inspectorate Wales for examination. The proposed development site is included in the proposed LPR for a residential development for up to 298 dwellings and is given the reference number HWN005.

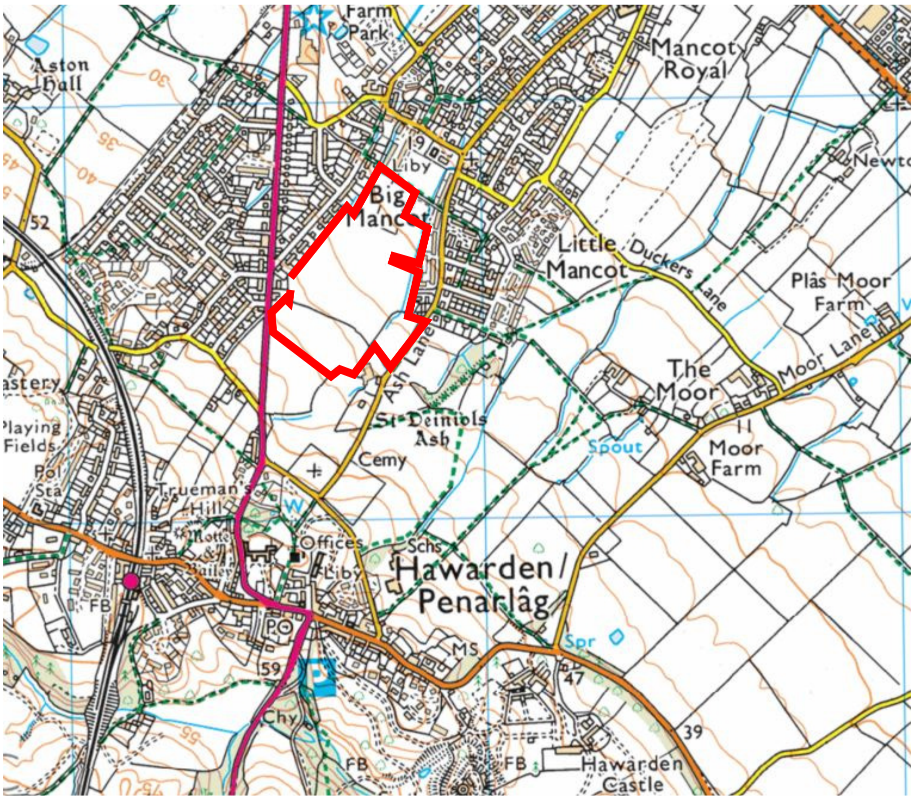


Figure 1: Site location and approximate development boundary (map credit: Ordnance Survey 2020).

1.3 This report will document the process followed to develop an outline surface water drainage strategy for the proposed development site. The existing site hydrology will be explored and discussed, and this has been informed by on site intrusive testing and a topographic land survey. The site hydrology review has been used to develop broad conceptual outline sustainable surface water drainage (SuDS) design options. These are intended to provide evidence and confidence that the site can be developed without increasing local and wider catchment flood risk. The information and details contained in this report should be used to help inform the design of the proposed site layout at the planning stage. Whilst early masterplan drawings have been submitted to the council for this site, they are very early 'massing' concept drawings, developed without the knowledge of the full site constraints. Therefore, any findings of this report which may be in conflict with the earlier conceptual layouts will not prejudice the delivery of development at this site, which will require a more detailed design process prior to a layout-based planning application being lodged.

1.4 The scope of this report focuses on the surface water drainage and SuDS for a proposed residential development at the site. Foul drainage is out of scope, as the landowner is discussing public sewer communication options and requirements with Welsh Water. Under the Water Industry Act 1991 Welsh Water are obliged to allow a communication with the public sewer, where this complies with the relevant standards and guidance. We understand that some capacity improvements may be required to the public sewer network to accommodate the development foul water flows.

1.5 The Welsh Government implemented Schedule 3 of the Flood and Water Management Act in January 2019, which formed SuDS Approving Bodies (SABs) within local authority areas. All developments and construction work of 100m2 or more now require SAB approval before construction can commence, which is a sperate process to planning consent. Also, SABs now have a statutory function to adopt and maintain SuDS where they serve more than one property. Early discussions with SABs are therefore critical when planning and designing adoptable SuDS schemes. A scoping meeting has held with the SAB in December 2020 to help inform the parameters and constraints of this drainage strategy.

1.6 This drainage strategy has been produced to demonstrate how the drainage for the proposed development will be designed, constructed and maintained, in accordance with section 6.6 of Planning Policy Wales Edition 10 and the Sustainable Drainage Systems Standards for Wales.

1.7 This report (including any attachments) has been prepared with care and due diligence in relation to the drainage strategy for the proposed development site at Ash Lane, Mancot, and solely for the purpose for which it is provided. Unless we provide express prior written consent, no part of this report should be reproduced, distributed or communicated to any third party. We do not accept any liability if this report is used for an alternative purpose from which it is intended, nor to any third party in respect of this report.

2. Existing Site Hydrology

Topography and Site Use

2.1 A topographic survey has been carried out of the proposed development site, which has an overall area of 11.06ha. The site falls from the south west near the boundary with Gladstone Way from a level of 40.5m AOD, down to the north eastern boundary with the adjacent recreation ground to a level of 22.75m AOD. The site therefore has an overall fall of 17.75m and a gradient of 1 in 26.6. The site contours and levels can be viewed on the Site Drainage Appraisal plan in Appendix A.

2.2 The site area forms part of St Deiniols Ash Farm and is presently pasture ground, with hedgerows and trees located along the field boundaries. There are presently no visible developed areas within the site boundary, although parts of the site have been subject to past coal mine workings, which are being investigated as part of another study. A Coal Mining Risk Assessment has previously been carried out and the identified historical mine locations have been included on the appraisal plan shown in Appendix A, as the identified mineshafts may form constraints to the SuDS feature designs. The majority of the recorded mine shafts are located in the northern part of the site. For the purposes of the SuDS assessment and design, the site is considered to be a greenfield, undeveloped site.

2.3 An ordinary watercourse is located along the eastern site boundary, which runs at the edge of the development land and the adjacent residential curtilages. The highest recorded bed level of the watercourse is 30.5m AOD and the lowest recorded bed level before flowing away from the site is 23.04 AOD. Short sections of the watercourse are culverted through 450mm diameter precast concrete pipes along the eastern boundary. The watercourse emerges at a point to the north of the farm, where the watercourse is culverted from the south to bypass its original alignment around the edge of the field boundaries. Historic records show that the full length of the watercourse passing through the site was once in an open channel, as indicated in the following Figure 2. It is recommended that the upstream culverted section of the existing watercourse passing through the site is restored back to an open channel, in order to reduce local flood risk and to maximise the wider environmental benefits of the watercourse.

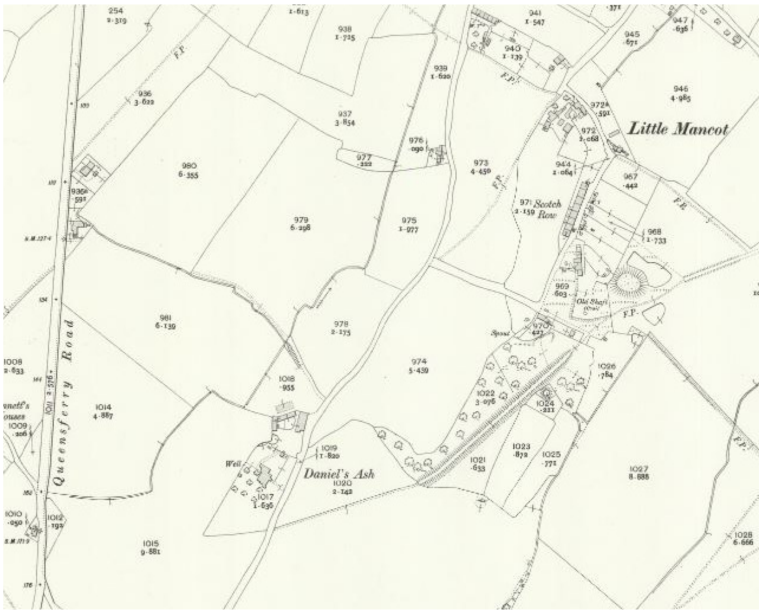


Figure 2: 1912 historic map showing the open watercourse running around the St Deiniols Ash Farm field boundaries.

2.4 The watercourse sits within a reasonably shallow channel and is understood to normally carry flow throughout the seasons. An image of the watercourse taken at the end of the culvert passing beneath and area of garden extending into the site is shown in Figure 3 below. Historic land drains are believed to be provided beneath the site in order to drain the land to the watercourse. Whilst the condition of these is unknown, drains have been exposed during recent intrusive site investigation works, proving that land drains are present.

Figure 3: image facing to the south (upstream) of the watercourse as it emerges from a culvert passing beneath a finger of land extending into the site along the eastern boundary.

2.5 The ordinary watercourse leaves the site at the boundary with the adjacent bowling green and property number 38 Ash Lane. From here the watercourse runs in a generally northern direction through Mancot and is understood to be culverted beneath the rear gardens of the properties to the west of Ash Lane and Hawarden Lane. The maintenance responsibility of the downstream watercourse and culvert therefore sits with the individual property owners as 'riparian owners'. Through discussions with Flintshire County Council as the SAB and Lead Local Flood Authority (LLFA) we understand that flood events of the downstream watercourse have been reported in the past, and these have been mostly related to maintenance issues restricting flow capacity. A survey has been previously carried out on sections of the downstream culverted watercourse by the LLFA and the survey plan is included in Appendix B for information.

Ground Conditions

2.6 We have consulted British Geological Survey (BGS) data for the locality, which shows that the site is underlain with the Pennine Middle Coal Measures Formation, which consists of mudstone, siltstone and sandstone deposits. Coal seams also cross the site in a generally north west to south east direction. These bedrock types are considered to have a variable and generally lower level of permeability.

2.7 On site infiltration tests in accordance with BRE Digest 365 have been carried out to inform this drainage strategy. The test report by Your Environment Limited can be viewed in Appendix C. A total of four test pits were excavated across the site to depths ranging from 1.08m to 1.44m. It was found that the site is underlain by brown glacial fluvial clays and as a result, the tests failed as water did not drain down between the required 75% to 25% depths. The site ground therefore has poor permeability and is not suitable for infiltration drainage. Groundwater seepage was reported in two of the test pits, so this should be investigated further at the detailed design stage.

Existing Site Flow Routes

2.8 Given the site profile falls generally from the south west to the north east and considering the less-permeable nature of the ground, much of the rainfall falling on the site will ultimately run to the watercourse on the eastern boundary. Indicative flow routes have been added to the drainage appraisal plan shown in Appendix A. The system of land drainage will also facilitate the movement of shallow groundwater in this direction. During periods of intense rainfall, we anticipate that water will run at the surface across saturated ground into the watercourse. Therefore, in the assessment of any SuDS features, it can be reasonably be assumed that the site area is already draining to the on-site watercourse.

2.9 The above assumption is corroborated by the Flood Estimation Handbook (FEH) catchment data, which shows the site sits wholly within a localised catchment draining to the on site watercourse, as shown in Figure 4 below.

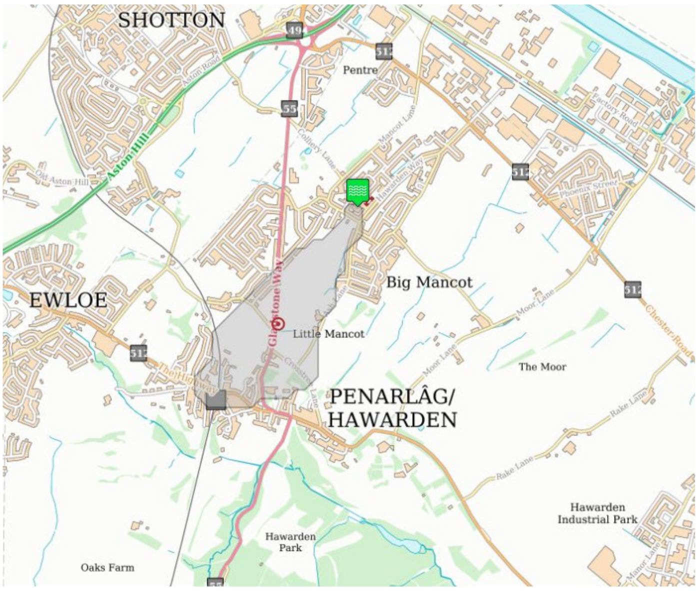


Figure 4: local catchment data shown on the FEH web service, showing the site sits within a localised catchment discharging to the ordinary watercourse.

Flood Risk

2.10 The development site is located within Flood Zone A and is therefore at a very low overall risk of flood risk from fluvial, reservoir or coastal sources. The Natural Resources Wales (NRW) Long term flood risk map does show some areas of localised surface water (pluvial) flood risk within the site, as shown in Figure 5. These areas sit around the watercourse and in low spots or hollows in the site topography. Whilst these areas are not significant, they do require consideration during the site layout and level design to ensure flood risk to the development is minimised. Also, the effects of climate change may impact the significance of these flow routes in terms of volumes, depths and velocity of flood water. The development layout will need to be planned to ensure that exceedance routes are provided to direct surface water during intense storms towards areas of roads, open space and surface water conveyance features. Interception ditches and channels may be required at appropriate points to direct any surface water entering or leaving the site to protect the existing surrounding properties and the future properties.

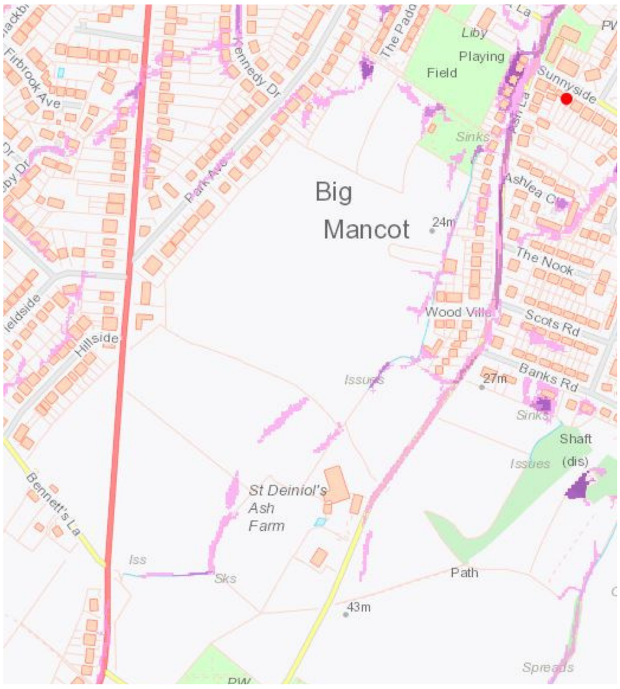


Figure 5: NRW Long term flood risk map showing areas of predicted surface water flooding.

2.11 The development SuDS design will need to ensure that downstream flood risk is not increased by discharging high rates of flow to the ordinary watercourse. In accordance with the national SuDS standards and Ciria C753, discharge rates for positively drained areas should never exceed the equivalent greenfield rate of discharge for a given return period for that area. It may be prudent for a lower rate of discharge to the set from the site SuDS to prevent downstream flood risk. Accepted industry best practice is to restrict SuDS outflows as close to the 1 in 1 year greenfield run off rate for the drained area, as is reasonably practicable to achieve for a given site.

2.12 A Flood Consequence Assessment may be required to accompany a formal planning application for development at the site. However, at this time we consider that there are no significant flood risk issues associated with the proposed development.

Rainfall

2.13 As required by Flintshire County Council for the assessment and design of SuDS schemes, FEH-13 rainfall data has been obtained for the site to inform this strategy. The rainfall graph obtained for the site catchment is shown in Figure 6 below.

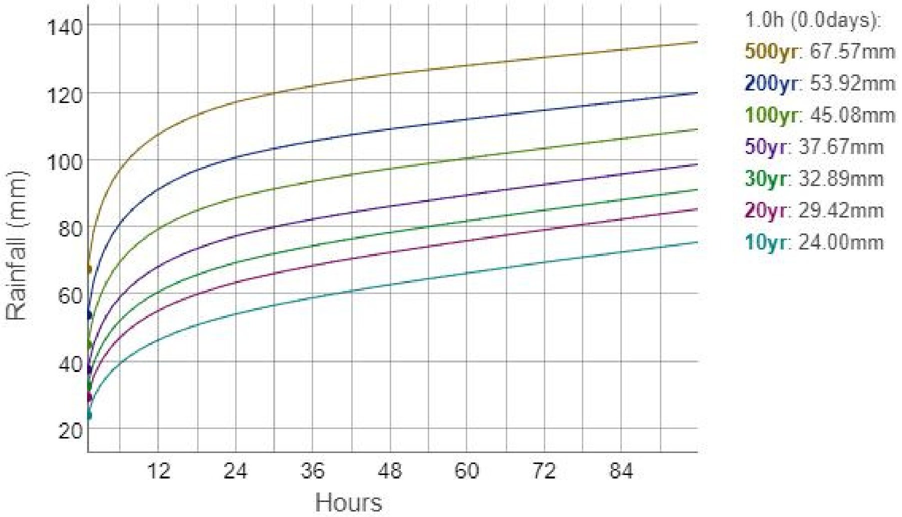


Figure 6: FEH-13 rainfall graph for the site catchment.

3. Outline SuDS Requirements

Overview

3.1 The design of SuDS should be a integral part of the full site layout design process, as where practical the site layout should be designed around flow routes which mimic naturally occurring drainage features. The topography of this site lends itself well to a drainage scheme incorporating landscaped surface storage and conveyance features such as swales. The Sustainable Drainage Systems Standards for Wales sets out the requirements for the process of investigating and designing SuDS. The design process should refer to the Principles, Hierarchy Standards and Fixed Standards contained within the document.

3.2 Broadly, SuDS schemes should aim to:

- Manage surface water as close to the surface and as close to the runoff source as possible.
- Treat rainfall as a valuable resource (reuse, habitat etc)
- Prevent pollution at source and provide a ‘treatment train’
- Manage rainfall to prevent flood risk
- Consider the effects of climate change
- Maximise amenity and biodiversity benefits of SuDS
- Perform safely through their design life with minimal maintenance
- Be affordable to construct and maintain
- Avoid the need for pumping

3.3 As has been found from the hydrology assessment, the site ground has poor permeability and is therefore unsuitable for infiltration drainage systems. Therefore, a system of positively drained SuDS is required with attenuation and a controlled discharge to the onsite watercourse.

3.4 The developer should consider the provision of rainwater harvesting to reduce the level of runoff at source, although these systems generally cannot be included in the storage calculations. Source control can also be provided in the form of permeable surfaces, rain gardens or filter strips and swales, as all of these methods provide a level of treatment and upstream storage. The SuDS design should look to provide a much upstream storage and control within the drainage network as is practicable, as this will ultimately reduce the volume of attenuation required. We consider that this site is suitable for providing some conveyance swales as an alternative to pipes. The swales could be constructed with check dams and slot weirs when running down the contours, which add upstream storage and control to the network, along with treating runoff. Potential swale corridors have been identified on the drainage appraisal plan in Appendix A, so these could be used to guide the development design. Further conveyance swales with shallow gradients could be added across the site contours, where space permits.

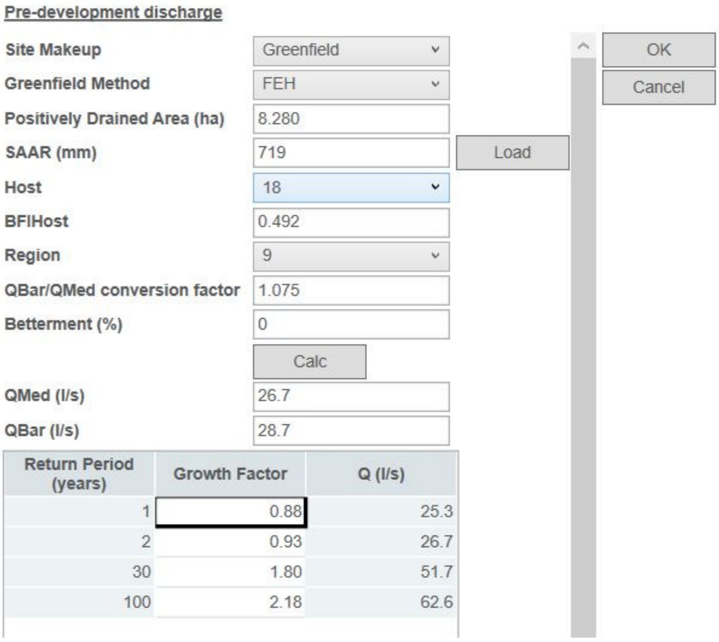
3.5 The site could also be split into sub-catchments with two discreet drainage networks and discharges to the watercourse. This would require separate attenuation and flow control devices within each system. Two potential sub-catchments have been identified on the drainage appraisal plan for information. An area of the site has been identified for a downstream attenuation pond, which would sit around the open space to the north of the site. This would then discharge via flow control chamber to the watercourse in the north eastern corner of the site. We recommend that an open channel is provided through the open space for the outfall. The attenuation pond has been sited around the mine shafts and existing trees located within this area of the site. However, detailed surveys of these features are due to be carried out which could mean that the pond could be shifted to the north further within the open space.

3.6 The design of landscaped SuDS features should be developed in conjunction with a landscape architect, with a view of maximising their wider benefits. This includes improving runoff water quality, maximising the amenity value of the landscaped features, and enhanced habitat and therefore biodiversity. The SuDS should be viewed as an integral part of the design process. Buildability and maintenance are also key considerations to the SuDS. The SAB should be engaged in early discussions in order to discuss any concept designs, as ultimately the SuDS will be subject to an adoption agreement with the SAB.

Design Parameters

3.7 The SuDS will be designed to the latest standards and industry guidance. Presently no local standards or guidance are given, but we understand that Flintshire Council as the LLFA and SAB are presently developing a local SuDS guide, which will set out their requirements. However, from our scoping meeting with the SAB it was set out that the SuDS design must be based around FEH-13 rainfall data, an ‘urban creep’ factor of 10% should be applied to all curtilage impermeable areas, and the overall drainage system should be designed to accommodate a 1 in 100 year plus 30% climate change critical rainfall event, without any flooding to property. No flooding of the system should occur up to and including the 1 in 30 year critical rainfall event. Localised temporary areas of flood to roads and open space may be acceptable within the site area for the 1 in 100 year plus climate change event, provided it can be demonstrated these do not create a flood risk to property or create an unreasonable safety hazard. It was also discussed that rates of discharge for the site should not exceed equivalent pre-developed ‘greenfield’ rates for a given return period. However, the design should be mindful of the potential downstream local flood risk issue along the culverted ordinary watercourse and therefore run off rates should be controlled to as low a rate as is practicable.

3.8 In order to inform calculations for the existing greenfield run off rates and impermeable site areas, we have reviewed the conceptual site masterplan by Baldwin Design. Details of these calculations can be found in Appendix D. The review of the masterplan layout showed that the overall site area is 11.06ha, the drained areas of the site excluding areas of significant open space measure 8.28ha, and the impermeable positively drained areas including all roads and private areas allowing for urban creep total 5.1ha. Existing greenfield run off rates using the FEH method in Causeway Flow software have been calculated based around the drained site area of 8.28ha, as shown in Figure 7 below. It should be noted that as the above figures are based around a very early masterplan layout, the site areas and the rates of run off are subject to review at the design and planning stage.



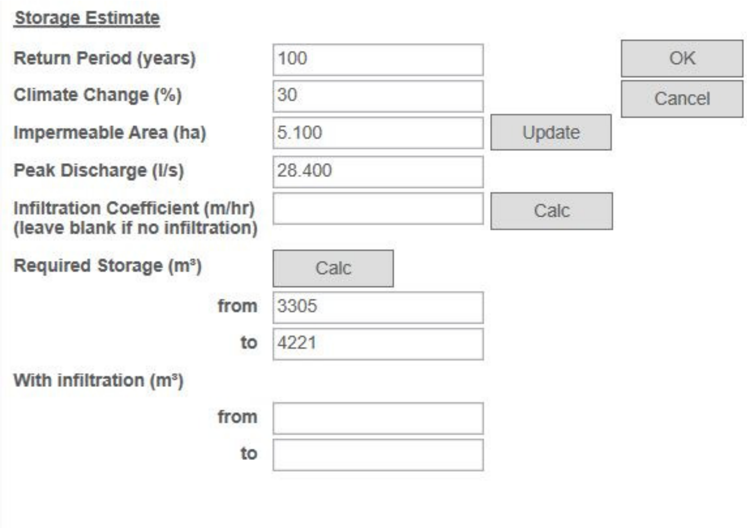
Pre-development discharge

Site Makeup: Greenfield
Greenfield Method: FEH
Positively Drained Area (ha): 8.280
SAAR (mm): 719
Host: 18
BFIHost: 0.492
Region: 9
QBar/QMed conversion factor: 1.075
Betterment (%): 0
QMed (l/s): 26.7
QBar (l/s): 28.7

Return Period (years)	Growth Factor	Q (l/s)
1	0.88	25.3
2	0.93	26.7
30	1.80	51.7
100	2.18	62.6

Figure 7: existing rates of discharge for the drained area of the site calculated in Causeway Flow software.

3.9 The rates of outfall from the site SuDS should be kept as close to the 1 in 1 year return period greenfield rate, with no one return period exceeding the greenfield run off rate for that given period. This will ensure that the development does not negatively impact the hydrology of the existing localised catchment, and therefore does not increase local flood risk. As the rates of discharge are to be kept as low as reasonably practicable, this will provide a betterment to the existing situation. Particularly considering the land is farmed and has little vegetation growth, so is likely to have higher rates of run off. An attenuation storage estimate has been calculated in Flow based around the 1 in 1 year rate of maximum discharge, as a worst-case scenario. The calculated volumes are shown in Figure 8. These figures are for overall system storage capacity and not simply the pond. Therefore, the provision of upstream capacity and reduced flow rates through the SuDS network will ensure the volume requirements for the attenuation pond (or ponds) will be minimised.



Storage Estimate

Return Period (years): 100
Climate Change (%): 30
Impermeable Area (ha): 5.100
Peak Discharge (l/s): 28.400
Infiltration Coefficient (m/hr) (leave blank if no infiltration):
Required Storage (m³)
from: 3305
to: 4221
With infiltration (m³)
from:
to:

Figure 8: storage estimate based around the site impermeable area of 5.1ha and a peak discharge rate of 25.3 l/s

Conceptual Model and Assessment

3.10 A simplistic conceptual SuDS model has been designed in Flow to test the above run off and storage assessment and the attenuation pond shown on the drainage appraisal plan in Appendix A. This has been based around a worst-case scenario of the positively drained area forming a single catchment, discharging to the watercourse at the top north eastern corner of the site via single Hydrobrake vortex flow control chamber. Also, the model has been based around the contributing area of 8.28ha, as opposed to just the positively drained impermeable areas. The model assumes no upstream storage, with a 5-minute time of entry, with two short branches running to the pond. This therefore provides a very robust assessment of the attenuation pond capacity, as indicated on the plan. The design and modelling report can be viewed in Appendix E.

3.11 The conceptual model shows that the rate of discharge will be below equivalent greenfield rates for all return periods, with a peak level of 41.8 l/s recorded for the outfall in the 1 in 100 year plus 30% climate change event. The maximum depth of water recorded in the pond is 2.281m for the same return period; given the modelled pond is relatively deep at 3.0m, this would give an approximate freeboard depth of 0.7m to the top of the pond, which is in line with best practice. However, once upstream storage has been factored in, we would anticipate that the depth and storage volume of the pond can be reduced somewhat. This is likely to have a positive impact on reducing rates of discharge for the higher return periods, due to reduced head acting on the Hydrobrake.

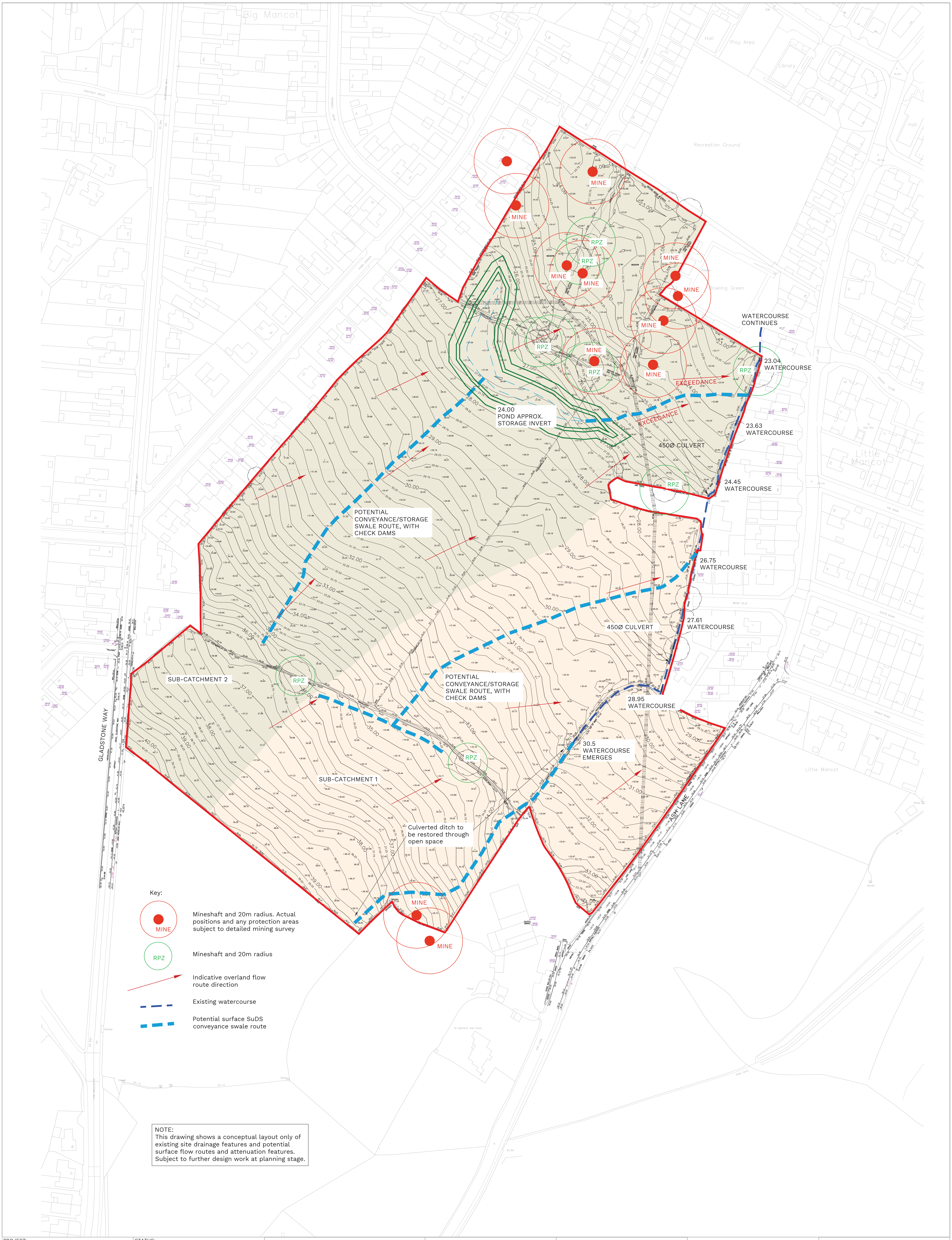
4. Recommendations

4.1 The following recommendations are made as a result of this outline drainage strategy, for the proposed development site at Ash Lane, Mancot, Deeside:

- The existing section of the presumed culverted ordinary watercourse running around the perimeter of St Deiniols Ash Farm should be restored to an open channel, running in open space around the development.
- As the site already drains to the existing on site ordinary watercourse, the SuDS can discharge to this at controlled rates.
- To reduce the risk of downstream flooding, rates of outflow from the SuDS should be restricted as close to the 1 in 1 year greenfield rate as is reasonably practicable, with the flow rates never exceeding those calculated for the given return period.
- Early consultation with Flintshire Council as the SAB is critical to achieving an expedient SuDS technical approval process and an adoptable scheme.
- The design of the development SuDS should be an integral part of the design process, with the site topography helping to inform the design.
- Source control should be provided within the SuDS design where practicable to do so.
- A SuDS ‘treatment-train’ of site runoff will require to be demonstrated to the SAB.
- Consideration should be given to splitting the site into sub-catchments, with landscaped upstream storage features provided in order to minimise the reliance on downstream attenuation and to provide wider water quality, biodiversity and habitat benefits.
- Buildability and maintenance are key considerations for the SuDS design.
- The design parameters given in Chapter 3 of this report should be referred to and updated as required for the SuDS design process.
- Exceedance routes must be designed into the site layout, with water directed to the open conveyance and storage features, with run off ultimately directed to the watercourse.
- Where flood water is to be temporarily stored on site in roads or open space, the designer shall demonstrate that this will not create a flood risk to property and people, with depths being sufficiently shallow and flow velocities low so as not to create a public safety risk.
- The interception of exceedance water both entering the site from the south and potentially leaving the site to the north requires consideration in the site layout design process. This water should be directed to the watercourse via bunds, channels and ditches and should not enter the SuDS network. The use of pipes and culverts should be avoided.

APPENDIX A

Drawing number SA37263-BRY-ST-SK-C-0001 – Site Drainage Appraisal plan



NOTE:
This drawing shows a conceptual layout only of existing site drainage features and potential surface flow routes and attenuation features. Subject to further design work at planning stage.

PROJECT:
Ash Lane, Mancot

CLIENT:
Hawarden Estate

DRAWING:
Site Drainage Appriasal

STATUS:
PRELIMINARY

SCALE @ A1:	DRAWN BY:	CHKD BY:	DATE:
1:1000	RSH	RSH	Dec 2020

DRAWING No: SA37263 -BRY-ST -SK- C - 0001_ -

REVISION:

BERRYS

ORIGINATING OFFICE:

BEECH HOUSE
SHREWSBURY BUSINESS PARK
SHREWSBURY
SHROPSHIRE
SY2 6FG

TEL: 01743 271697
shrewsbury@berrys.uk.com
www.berrys.uk.com

SCALE BAR & NORTH POINT:

10 0 10 20 30 40 50
SCALE 1:1000 m
N

DISCLAIMER NOTES:

DO NOT SCALE THIS DOCUMENT - USE FIGURED DIMENSIONS ONLY

ALL DIMENSIONS MUST BE CHECKED ON SITE PRIOR TO COMMENCEMENT OF ANY RELATED WORKS.

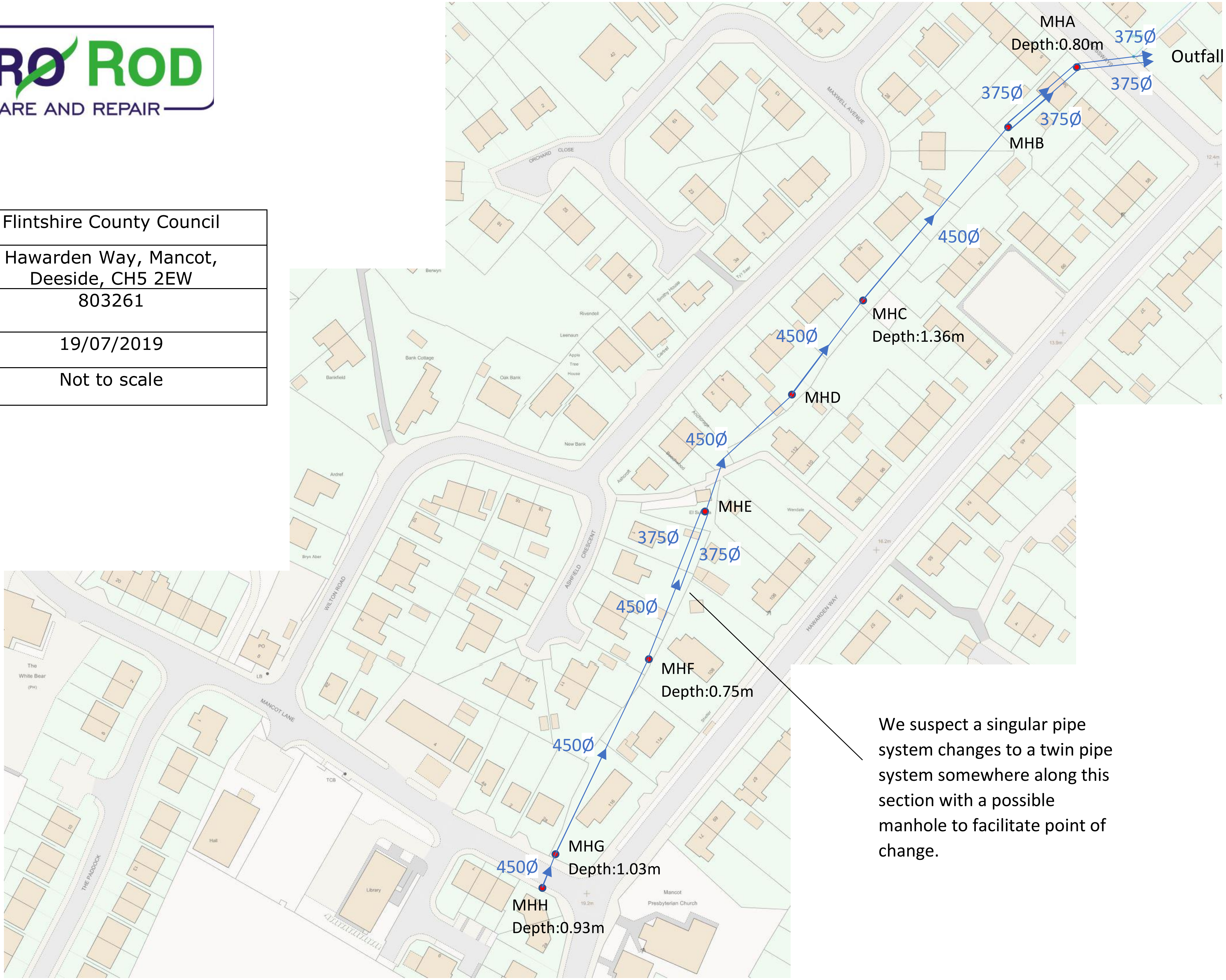
THIS DOCUMENT MUST BE READ IN CONJUNCTION WITH ALL SUPPORTING DOCUMENTS PRODUCED BY THE ORIGINATOR AND OTHER PROJECT DISCIPLINES.

REV	DESCRIPTION	DATE	BY	CHKD
-	-	00.00.00	-	-

APPENDIX B

Hawarden Way, Mancot Watercourse Survey Plan, Flintshire County Council

Client:	Flintshire County Council
Site Address:	Hawarden Way, Mancot, Deeside, CH5 2EW
Job Number:	803261
Date:	19/07/2019
Scale:	Not to scale



We suspect a singular pipe system changes to a twin pipe system somewhere along this section with a possible manhole to facilitate point of change.

APPENDIX C

Infiltration Test Report.

Our Ref: YE8769

20th August 2020

For the attention of Hawarden Estate,

Ref: Hawarden Estate, Deeside CH5 2BH.

We thank you for your request to undertake permeability testing at the above-mentioned site and take pleasure in enclosing the results of this work. The investigation was undertaken on the 6th August 2020 in accordance with your instruction to proceed. This letter describes the work undertaken, presents the data obtained and discusses the results of the tests.

Geology

An examination of the available British Geological Survey data of the area for the site has been examined and indicates that the site is underlain by glaciofluvial material of Till, largely comprising of gravelly clays. Underlying this, solid geology deposits are noted as the Pennine Middle Coal Measures, which comprises interbedded muds, silts and sands with abundant coal seams.

Fieldworks

The programme of this investigation included the excavation of four trial pits, with tests undertaken in all pits. The location of the soakaway tests were positioned where access was achievable and where water could be pumped. Weather on the day was variable, with some showers taking place during testing.

During this work, the soils encountered were logged in general accordance with BS 5930: 1990, as amended in 2007, and full descriptions are given on the borehole records, which are also appended to this letter.

Soakaway Tests

During the soakaway test the water should have achieved a fall from 75% to 25% of the effective depth of the storage volume. The results obtained from the soakaway tests are summarised below:

Table 1: ***Soakaway Test Results***

WS	Soakage Area Dimensions (m)	Depth (m)	Soil Description (Base of TP)	Infiltration Rate (m/sec)	Drainage Characteristics
TP01 test1	1.500 x 0.600	1.080m	Brown slightly gravelly CLAY.	None	None
TP02 test1	1.650 x 0.60	1.110m	Brown CLAY	None	None
TP03 test1	1.800 x 0.600	1.300m	Brown CLAY	None	None

TP04 test1	1.400 x 0.600	1.440m	Brown CLAY	None	None

Discussion

The soils encountered beneath the site were found to be brown slightly gravelly clays, representative of a glaciofluvial superficial deposit. Within trial pits TP03 and TP04, there was water ingress into the trial pits that resulted in an increase of water over the monitoring period, without any additional water being added. The tests did not achieve a drop between 25% and 75% of the storage volume of the pit. This would suggest a very low infiltration rate and therefore, in this instance, soakaways could not be recommended at this site and alternative drainage systems should be employed.

References

Building Research Establishment (BRE) Digest 365, *Soakaway Design*, September 1991.

British Standards Institution (1999) BS5930: *Code of practice for site investigations*, B.S.I., London.

British Standards Institution (2007), Amendment No 1, BS5930: *Code of practice for site investigations*, B.S.I., London.

We trust that this information is of interest and should you have any other requirements do not hesitate to contact us.

For and on behalf of

*Your*Environment

Yours Faithfully,

Daniel Speight BSc(Hons)

Graduate Engineer

Enc.

Appendix A: Site Investigation Plan
Appendix B: Trial Pit Logs
Appendix C: Soakaway Test Results

APPENDIX A: Site Investigation Plan

Title: **Investigation Location Plan**

Your Environment	Site Name: **Hawarden Estate**	Job No: **YE8769**

APPENDIX B: Trial Pit Logs

TP01

YourGeotechnical

Trial Pit Log

TrialPit No
TP01
Sheet 1 of 1

Project Name:	Hawarden Estate	Project No. YE8769	Co-ords: - Level:	Date 06/08/2020
Location:	Mancot		Dimensions (m): 1.50 0.60 Depth 1.00	Scale 1:25
Client:	Hawarden Estate			Logged

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.20		▨	TOPSOIL: Grass overlying dark brown silty CLAY.
				0.60		▨	Slightly sandy CLAY
				1.00		▨	Grey mottled brown slightly gravelly CLAY.
							End of Pit at 1.00m

Remarks:

Stability:

TP02

YourGeotechnical

Trial Pit Log

TrialPit No
TP02
Sheet 1 of 1

Project Name: Hawarden Estate	Project No. YE8769	Co-ords: - Level:	Date 06/08/2020
Location: Mancot		Dimensions (m): 1.65 × 0.60 Depth 1.11	Scale 1:25
Client: Hawarden Estate			Logged

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.35		▨	TOPSOIL: Grass overlying dark brown silty CLAY.
				0.65		▨	Sandy gravelly CLAY.
				1.11		▤	Brown CLAY
							End of Pit at 1.11m

Remarks:

Stability:

TP03

YourGeotechnical

Trial Pit Log

TrialPit No
TP03
Sheet 1 of 1

Project Name: Hawarden Estate	Project No. YE8769	Co-ords: - Level:	Date 06/08/2020
Location: Mancot		Dimensions (m): 1.80 × 0.60 Depth 1.30	Scale 1:25
Client: Hawarden Estate			Logged

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.20		▨	TOPSOIL: Grass overlying dark brown silty CLAY.
				0.55		⁘	Sandy gravelly CLAY.
				1.30		▤	Brown CLAY
							End of Pit at 1.30m

Remarks: Water in Grass

Stability:

TP04

YourGeotechnical

Trial Pit Log

TrialPit No
TP04
Sheet 1 of 1

Project Name: Hawarden Estate	Project No. YE8769	Co-ords: - Level:	Date 06/08/2020
Location: Mancot		Dimensions (m): 1.40 × 0.60 Depth 1.44	Scale 1:25
Client: Hawarden Estate			Logged

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.30		▨	TOPSOIL: Grass overlying dark brown silty CLAY.
				0.90		▩	MADEGROUND: Brown mottled dark grey gravelly CLAY. Gravel is fine to coarse, angular to sub-angular of brick, ash and mixed lithology.
				1.44		▤	Brown CLAY
							End of Pit at 1.44m

1
2
3
4
5

Remarks: Water is Grass at 1.440m

Stability:

AGS

APPENDIX C: Soakaway Test Results

Your Environment

Soakaway Test

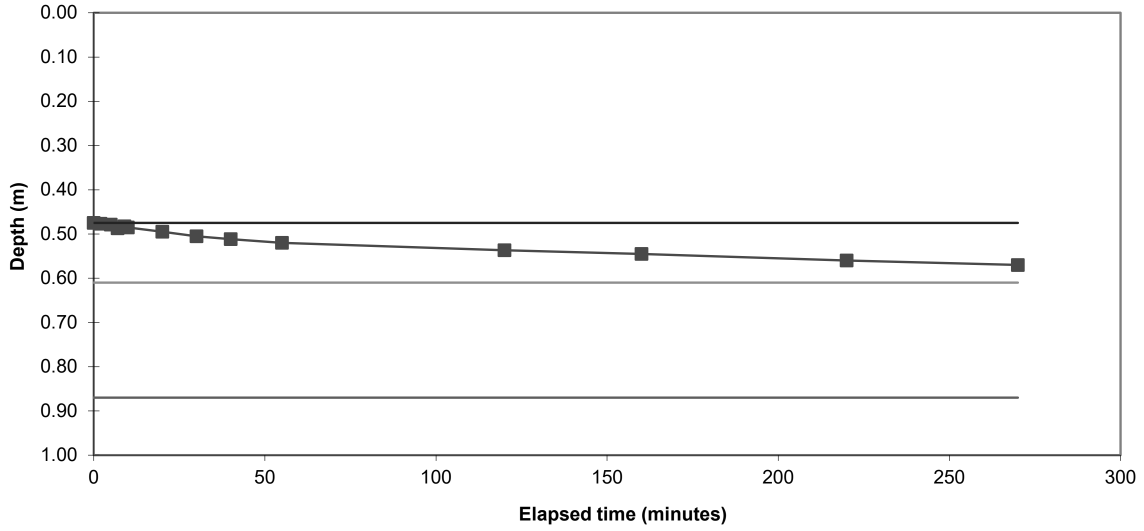
Trial Pit No: TP1 Test No: 1 Date: 06/08/2020

Length (m): 1.500 Datum Height: 0.00 m agl

Width (m): 0.60 Granular infill: None

Depth (m): 1.00 Porosity of infill: 1 (assumed)

Elapsed time (minutes)	Water Depth (m below datum)	Elapsed time (minutes)	Water Depth (m below datum)
0	0.475		
2	0.477		
5	0.479		
7	0.487		
9	0.483		
10	0.485		
20	0.495		
30	0.505		
40	0.512		
55	0.520		
120	0.537		
160	0.545		
220	0.560		
270	0.570		



Start water depth for analysis (mbgl)	0.48		
75% effective depth (mbgl):	0.61	Elapsed time (mins):	#N/A
50% effective depth (mbgl):	0.74		
25% effective depth (mbgl):	0.87	Elapsed time (mins):	#N/A
Base of soakage zone (mbgl):	1.00		

Volume outflow between 75% and 25% effective depth (m^3):

Mean surface area of outflow (m^2): 1.99
(side area at 50% effective depth + base area)

Time for outflow between 75% and 25% effective depth (mins):

Soil infiltration rate (m/s):	**Test incomplete as 25% effective depth not achieved. Unable to reliably determine soil infiltration rate.**

Remarks Results processed following BRE 365 (2007).

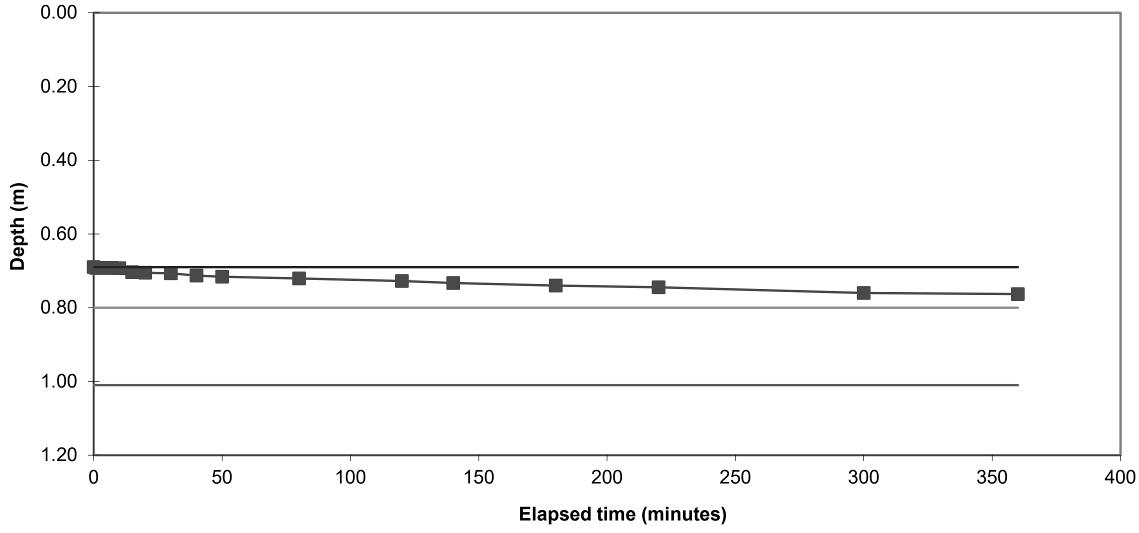
Client:	Shane Beauchamp	**TP1**
Site:	208 London Road	

Your Environment

Soakaway Test

Trial Pit No:	TP02	Test No:	2	Date:	06/08/2020
Length (m):	1.650	Datum Height:		0.00 m agl	
Width (m):	0.60	Granular infill:	None		
Depth (m):	1.11	Porosity of infill:	1	(assumed)	

Elapsed time (minutes)	Water Depth (m below datum)	Elapsed time (minutes)	Water Depth (m below datum)
0	0.690	180	0.740
1	0.692	220	0.745
3	0.692	300	0.760
5	0.692	360	0.763
7	0.692		
10	0.693		
15	0.704		
20	0.705		
30	0.707		
40	0.713		
50	0.716		
80	0.721		
120	0.728		
140	0.733		



Start water depth for analysis (mbgl)	0.69		
75% effective depth (mbgl):	0.80	Elapsed time (mins):	#N/A
50% effective depth (mbgl):	0.90		
25% effective depth (mbgl):	1.01	Elapsed time (mins):	#N/A
Base of soakage zone (mbgl):	1.11		

Volume outflow between 75% and 25% effective depth (m^3):

Mean surface area of outflow (m^2): 1.94

(side area at 50% effective depth + base area)

Time for outflow between 75% and 25% effective depth (mins):

Soil infiltration rate (m/s):	**Test incomplete as 25% effective depth not achieved. Unable to reliably determine soil infiltration rate.**

Remarks Results processed following BRE 365 (2007).

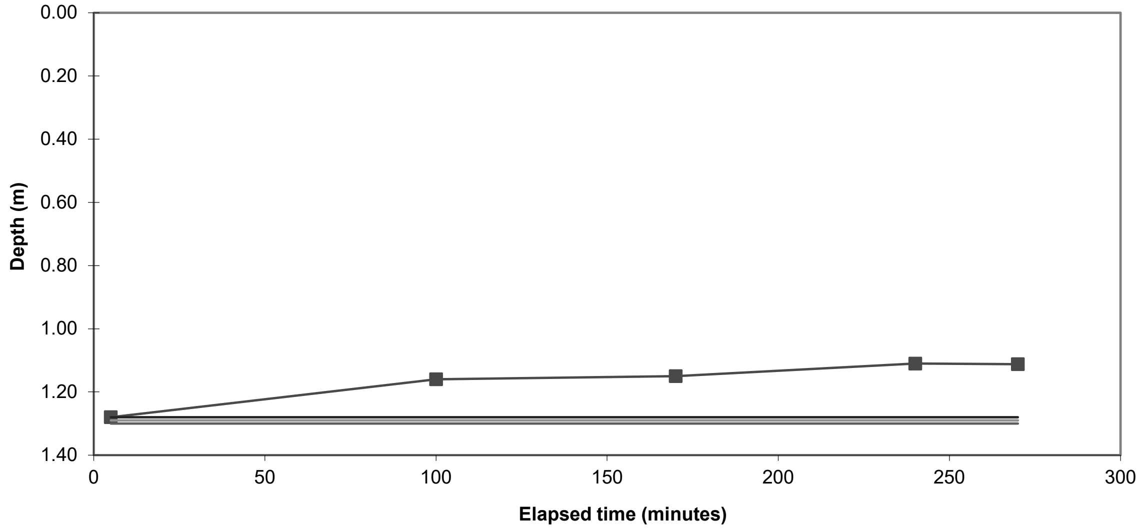
Client:	Shane Beauchamp	**TP1**
Site:	208 London Road	

Your Environment

Soakaway Test

Trial Pit No: TP03
Test No: 3
Date: 06/08/2020
Length (m): 1.800
Datum Height: 0.00 m agl
Width (m): 0.60
Granular infill: None
Depth (m): 1.30
Porosity of infill: 1 (assumed)

Elapsed time (minutes)	Water Depth (m below datum)	Elapsed time (minutes)	Water Depth (m below datum)
5	1.280		
100	1.160		
170	1.150		
240	1.110		
270	1.112		



Start water depth for analysis (mbgl)	1.28		
75% effective depth (mbgl):	1.29	Elapsed time (mins):	#N/A
50% effective depth (mbgl):	1.29		
25% effective depth (mbgl):	1.30	Elapsed time (mins):	#N/A
Base of soakage zone (mbgl):	1.30		

Volume outflow between 75% and 25% effective depth (m³):

Mean surface area of outflow (m^2): 1.13
(side area at 50% effective depth + base area)

Time for outflow between 75% and 25% effective depth (mins):

Soil infiltration rate (m/s):	**Test incomplete as 25% effective depth not achieved. Unable to reliably determine soil infiltration rate.**

Remarks Results processed following BRE 365 (2007).

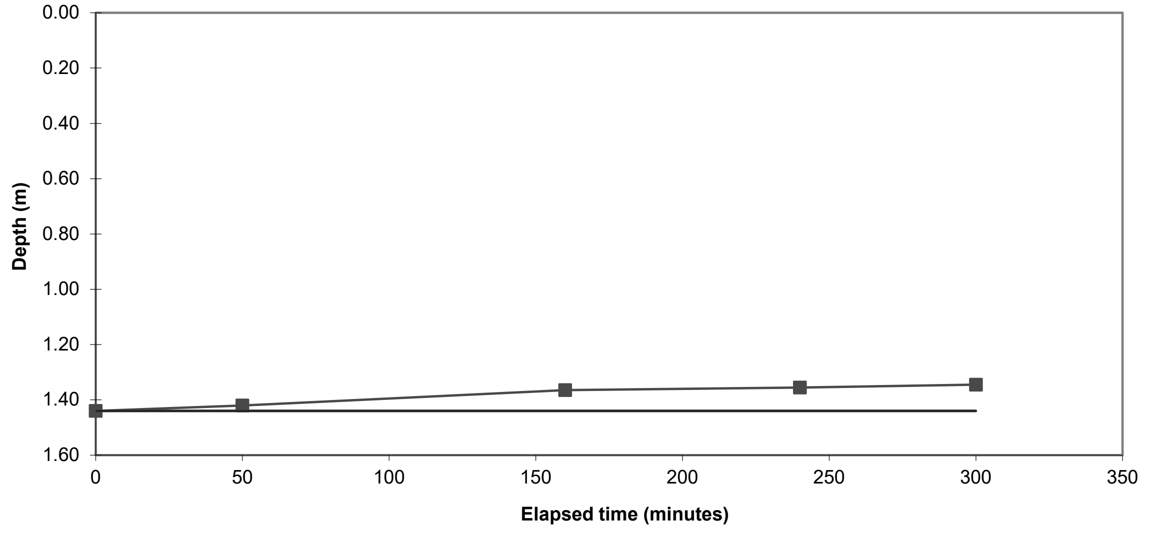
Client:	Shane Beauchamp	**TP1**
Site:	208 London Road	

Your Environment

Soakaway Test

Trial Pit No:	TP04	Test No:	3	Date: 06/08/2020
Length (m):	1.400	Datum Height:	0.00 m agl	
Width (m):	0.60	Granular infill:	None	
Depth (m):	1.44	Porosity of infill:	1	(assumed)

Elapsed time (minutes)	Water Depth (m below datum)	Elapsed time (minutes)	Water Depth (m below datum)
0	1.440		
50	1.420		
160	1.365		
240	1.355		
300	1.345		



Start water depth for analysis (mbgl)	1.44		
75% effective depth (mbgl):	1.44	Elapsed time (mins):	#N/A
50% effective depth (mbgl):	1.44		
25% effective depth (mbgl):	1.44	Elapsed time (mins):	#N/A
Base of soakage zone (mbgl):	1.44		

Volume outflow between 75% and 25% effective depth (m^3):

Mean surface area of outflow (m^2): 0.84
(side area at 50% effective depth + base area)

Time for outflow between 75% and 25% effective depth (mins):

Soil infiltration rate (m/s):	**Test incomplete as 25% effective depth not achieved. Unable to reliably determine soil infiltration rate.**

Remarks Results processed following BRE 365 (2007).

Client:	Shane Beauchamp	**TP1**
Site:	208 London Road	

APPENDIX D

Site area calculations.

CALCULATION SHEET

BERRYS

Project Number:		SA37263	**Site:**	Mancot		
Calcs by:		RSH	**Status** (Prelim/Fina	Prelim	**Page X of Y:**	
Checked by:		RSH	**Date:**	Nov-20		

Design Element: SW Drainage Strategy, calculations based around Baldwin Design Masterplan

Ref	Calculations	Remarks/Output
1	**Overall site area 110,559.7m2 or 11.06ha**	**11.06 ha total site area**
2	**Impermeable areas, private estimates**	
	Plot impermeable areas, 25 units random sample from materplan:	
	75.9m2, 81.1m2, 105.8m2, 76.5m2, 138.5m2, 86.2m2, 129.0m2, 80.2m2, 82.8m2, 92.9m2, 81.0m2, 147.4m2, 156.5m2, 69.2m2, 96.4m2, 85,1m2, 136.7m2, 59.6m2, 125.2m2, 163.3m2, 91.4m2, 87.4m2, 116.5m2, 135.9m2, 162.9m2 sum = 2663.4m2 / 25 = 106.5m2 MEAN PLOT AREA	106.5m2 mean plot area
	Urban creep allowance, Ciria C753 SuDS Manual 10%, 106.5 x 1.1	117.2m2 adjusted mean plot area for urban creep
	Say max 298 units, 250 x 117.2 = 34,926m2 private impermeable areas	**3.49 ha private impermeable**
3	**Adoptable road areas estimate**	
	4.6m width: 10.2, 42.6, 9.1, 32.3 = 94.2m x 4.6m = 433.3m2	433.3m2
	5.0m width: 141.1, 157.4, 19.8, 16.6, 12.8, 113.3, 78.2, 16.5, 156, 19.3, 68.2, 22.3 = 821.5m x 5.0m = 4107.5m2	4107.5m2
	5.5m width: 152.8, 339.8, 246.3, 294.5 = 1033.4m x 5.5 = 5683.7m2	5683.7m2
	Footways, say total length of roads x 1.5	
	1949.1m x 1.5 = 2923.65m x 2.0m = 5847.3m2	5847.3m2
	Total adoptable road areas, sum of above 16,071.8m2	**1.61 ha**
4	**Total impermeable areas**	**5.1 ha**
5	**Assessment of estimated positively drained areas inc. gardens, exc. significant open space**	
	8.58 - 0.3 = 8.28	**8.28 ha drained area**
	NOTE: above calculations based around early site masterplan. Given the SuDS and potential mine exclusion areas, the impermeable areas above are likely to reduce by around 10-20%. Detailed calculations are to be carried out at site planning stage based around the updated layout design. The updated figures will determine the required storage volumes.	

APPENDIX E

Causeway Flow conceptual design model report.

Design Settings

Rainfall Methodology	FEH-13	Minimum Velocity (m/s)	1.00
Return Period (years)	2	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	0.750	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Simulation Settings

Rainfall Methodology	FEH-13	Drain Down Time (mins)	240	30 year (l/s)	51.7
Summer CV	0.750	Additional Storage (m³/ha)	20.0	100 year (l/s)	62.6
Winter CV	0.840	Check Discharge Rate(s)	✓	Check Discharge Volume	✓
Analysis Speed	Normal	1 year (l/s)	25.3	100 year 360 minute (m³)	2739
Skip Steady State	x	2 year (l/s)	26.7		

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
30	0	0	0
100	30	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 year	1.80
Greenfield Method	FEH	Growth Factor 100 year	2.18
Positively Drained Area (ha)	8.280	Betterment (%)	0
SAAR (mm)	719	QMed	26.7
Host	18	QBar	28.7
BFIHost	0.492	Q 1 year (l/s)	25.3
Region	9	Q 2 year (l/s)	26.7
QBar/QMed conversion factor	1.075	Q 30 year (l/s)	51.7
Growth Factor 1 year	0.88	Q 100 year (l/s)	62.6
Growth Factor 2 year	0.93		

Pre-development Discharge Volume

Site Makeup	Greenfield	Return Period (years)	100
Greenfield Method	FSR/FEH	Climate Change (%)	0
Positively Drained Area (ha)	8.280	Storm Duration (mins)	360
Soil Index	4	Betterment (%)	0
SPR	0.47	PR	0.476
CWI	108.000	Runoff Volume (m³)	2739

Node 3 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	24.000	Product Number	CTL-SHE-0222-2530-0800-2530
Design Depth (m)	0.800	Min Outlet Diameter (m)	0.300
Design Flow (l/s)	25.3	Min Node Diameter (mm)	1500

Node 3 Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Main Channel Length (m)	103.000
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	24.000	Main Channel Slope (1:X)	500.0
Safety Factor	2.0	Time to half empty (mins)		Main Channel n	0.300

Inlets
2a

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	815.0	0.0	1.500	2054.0	0.0	1.501	2689.0	0.0	3.000	4234.0	0.0

Approval Settings

Node Size	✓	Minimum Full Bore Velocity (m/s)	
Node Losses	✓	Maximum Full Bore Velocity (m/s)	3.000
Link Size	✓	Proportional Velocity	✓
Minimum Diameter (mm)	150	Return Period (years)	
Link Length	✓	Minimum Proportional Velocity (m/s)	0.750
Maximum Length (m)	100.000	Maximum Proportional Velocity (m/s)	3.000
Coordinates	✓	Surcharged Depth	✓
Accuracy (m)	1.000	Return Period (years)	
Crossings	✓	Maximum Surcharged Depth (m)	0.100
Cover Depth	✓	Flooding	✓
Minimum Cover Depth (m)		Return Period (years)	30
Maximum Cover Depth (m)	3.000	Time to Half Empty	x
Backdrops	✓	Discharge Rates	✓
Minimum Backdrop Height (m)		Discharge Volume	✓
Maximum Backdrop Height (m)	1.500	100 year 360 minute (m³)	
Full Bore Velocity	✓		

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
2 year 15 minute summer	104.948	29.697	2 year 960 minute summer	7.276	1.916
2 year 15 minute winter	73.647	29.697	2 year 960 minute winter	4.820	1.916
2 year 30 minute summer	68.298	19.326	2 year 1440 minute summer	5.295	1.419
2 year 30 minute winter	47.928	19.326	2 year 1440 minute winter	3.558	1.419
2 year 60 minute summer	46.024	12.163	30 year 15 minute summer	275.481	77.952
2 year 60 minute winter	30.578	12.163	30 year 15 minute winter	193.320	77.952
2 year 120 minute summer	30.614	8.090	30 year 30 minute summer	182.556	51.657
2 year 120 minute winter	20.339	8.090	30 year 30 minute winter	128.110	51.657
2 year 180 minute summer	24.194	6.226	30 year 60 minute summer	124.457	32.890
2 year 180 minute winter	15.726	6.226	30 year 60 minute winter	82.686	32.890
2 year 240 minute summer	19.434	5.136	30 year 120 minute summer	74.895	19.793
2 year 240 minute winter	12.912	5.136	30 year 120 minute winter	49.758	19.793
2 year 360 minute summer	15.130	3.894	30 year 180 minute summer	56.940	14.653
2 year 360 minute winter	9.835	3.894	30 year 180 minute winter	37.012	14.653
2 year 480 minute summer	12.011	3.174	30 year 240 minute summer	44.698	11.812
2 year 480 minute winter	7.980	3.174	30 year 240 minute winter	29.696	11.812
2 year 600 minute summer	9.877	2.701	30 year 360 minute summer	33.743	8.683
2 year 600 minute winter	6.748	2.701	30 year 360 minute winter	21.934	8.683
2 year 720 minute summer	8.824	2.365	30 year 480 minute summer	26.327	6.957
2 year 720 minute winter	5.931	2.365	30 year 480 minute winter	17.491	6.957

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
30 year 600 minute summer	21.372	5.846	100 year +30% CC 180 minute summer	100.224	25.791
30 year 600 minute winter	14.603	5.846	100 year +30% CC 180 minute winter	65.148	25.791
30 year 720 minute summer	18.891	5.063	100 year +30% CC 240 minute summer	78.290	20.690
30 year 720 minute winter	12.696	5.063	100 year +30% CC 240 minute winter	52.014	20.690
30 year 960 minute summer	15.276	4.022	100 year +30% CC 360 minute summer	58.552	15.067
30 year 960 minute winter	10.119	4.022	100 year +30% CC 360 minute winter	38.060	15.067
30 year 1440 minute summer	10.800	2.895	100 year +30% CC 480 minute summer	45.327	11.978
30 year 1440 minute winter	7.258	2.895	100 year +30% CC 480 minute winter	30.114	11.978
100 year +30% CC 15 minute summer	481.947	136.374	100 year +30% CC 600 minute summer	36.554	9.998
100 year +30% CC 15 minute winter	338.208	136.374	100 year +30% CC 600 minute winter	24.976	9.998
100 year +30% CC 30 minute summer	323.107	91.428	100 year +30% CC 720 minute summer	32.129	8.611
100 year +30% CC 30 minute winter	226.742	91.428	100 year +30% CC 720 minute winter	21.593	8.611
100 year +30% CC 60 minute summer	221.760	58.605	100 year +30% CC 960 minute summer	25.744	6.779
100 year +30% CC 60 minute winter	147.332	58.605	100 year +30% CC 960 minute winter	17.054	6.779
100 year +30% CC 120 minute summer	132.524	35.022	100 year +30% CC 1440 minute summer	17.942	4.809
100 year +30% CC 120 minute winter	88.046	35.022	100 year +30% CC 1440 minute winter	12.058	4.809

Results for 2 year Critical Storm Duration. Lowest mass balance: 99.47%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	10	26.785	0.285	558.9	7.4678	0.0000	OK
15 minute winter	1a	11	26.059	0.559	551.9	1.4225	0.0000	OK
15 minute winter	2	10	26.752	0.252	306.4	3.7132	0.0000	OK
360 minute winter	2a	304	24.862	0.656	146.5	1.6697	0.0000	OK
360 minute winter	3	304	24.862	0.862	89.9	2.1935	0.0000	SURCHARGED
15 minute summer	4 OUT	1	23.500	0.000	25.3	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	2.000	1a	551.9	2.023	0.250	14.0950	
15 minute winter	1a	2.001	2a	551.4	1.622	0.964	11.5747	
15 minute winter	2	3.000	2a	298.1	2.579	0.278	8.9576	
360 minute winter	2a	Flow through pond	3	89.9	0.035	0.004	859.9010	
360 minute winter	3	Hydro-Brake®	4 OUT	26.2				751.4

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.47%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	10	27.140	0.640	1466.2	16.7603	0.0000	OK
15 minute winter	1a	10	26.636	1.136	1423.3	2.8922	0.0000	SURCHARGED
15 minute winter	2	10	26.963	0.463	803.9	6.8303	0.0000	OK
480 minute winter	2a	464	25.630	1.424	261.6	3.6235	0.0000	OK
480 minute winter	3	464	25.630	1.630	149.1	4.1477	0.0000	SURCHARGED
15 minute summer	4 OUT	1	23.500	0.000	26.7	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	2.000	1a	1423.3	2.748	0.644	25.2575	
15 minute winter	1a	2.001	2a	1429.5	2.693	2.499	17.4471	
15 minute winter	2	3.000	2a	785.4	3.228	0.734	18.8882	
480 minute winter	2a	Flow through pond	3	149.1	0.041	0.007	2247.6160	
480 minute winter	3	Hydro-Brake®	4 OUT	35.6				1242.5

Results for 100 year +30% CC Critical Storm Duration. Lowest mass balance: 99.47%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	11	29.278	2.778	2563.3	72.7875	0.0000	SURCHARGED
15 minute winter	1a	11	27.557	2.057	2448.1	5.2361	0.0000	SURCHARGED
15 minute winter	2	11	28.022	1.522	1405.4	22.4310	0.0000	SURCHARGED
480 minute winter	2a	472	26.281	2.075	450.4	5.2802	0.0000	OK
480 minute winter	3	472	26.281	2.281	260.2	5.8044	0.0000	SURCHARGED
15 minute summer	4 OUT	1	23.500	0.000	32.1	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	2.000	1a	2448.1	4.592	1.108	27.5742	
15 minute winter	1a	2.001	2a	2449.2	4.595	4.282	18.0081	
15 minute winter	2	3.000	2a	1363.2	3.819	1.274	27.1584	
480 minute winter	2a	Flow through pond	3	260.2	0.051	0.013	4207.6802	
480 minute winter	3	Hydro-Brake®	4 OUT	41.8				1468.5