VERSION 3.00 LRD

15 MARCH , 2023

ENGINEERING SERVICES REPORT

In respect of LANDS AT CORNAMADDY & BALLYKEERAN ATHLONE

On behalf of AKIYDA LIMITED

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1.0 INTRODUCTION

Akyida Limited propose a Large Scale Residential Development (LRD) at Cornamaddy and Ballykeern (townlands), Athlone, Co. Westmeath



FIGURE 1 SITE LOCATION

The site is zoned for residential development there are no flood constraints which limit the amount of land available for residential use.

The development will consist of the provision of a total of 332no. residential units along with provision of a crèche. Particulars of the development comprise as follows:

(a) Site excavation works to facilitate the proposed development to include excavation and general site preparation works.
(b) The provision of a total of 172no. 2storey residential dwellings which will consisting of 152no. 3 bed units and 20no. 4 bed units.
(c) The provision of a total of 160no. apartments/duplex units consisting of 36no.1 bed units,
99no.2bed units and 25no. 3bed units. The apartment blocks range in height from 2 storey to 4 storey and the duplex blocks range from 2 storey to 3 storey in height.
(d) Provision of a 2 storey creche.
(e) Provision of associated car parking at surface level via a combination of in-curtilage parking for dwellings and via on-street parking for the creche, duplexes and apartment units.
(f) Provision of electric vehicle charge points with associated site infrastructure ducting to provide charge points for residents throughout the site.

(g) Provision of associated bicycle storage facilities at surface level throughout the site and bin storage facilities.
(h) The provision of a new link road via adjacent lands to the west to provide for vehicular, pedestrian and cyclist access.
(i) The provision of internal culverts and associated bridges along with a realignment of a section of an existing drainage channel within the site to facilitate internal access roads along with associated crossing points across the drainage channel (to facilitate pedestrian, cyclist and vehicular crossing points).

(j) The creation of a pedestrian footpath alongside the local road which will connect to the existing footpath aligning the N55 National road;
(k) Provision of associated open space areas, residential communal open space areas to include formal play areas along with all hard and soft landscape works for private gardens and amenity spaces along with public lighting, planting and boundary treatments to include boundary walls, railings & fencing;
(l) Provision of 2no. ESB substations.
(m) Internal site works and attenuation systems.
(n) All ancillary site development/construction works to facilitate foul, water and service networks for connection to the existing foul, water and ESB networks.
An Environmental Impact Assessment (EIAR) and Natura Impact Statement have been prepared and accompany this application.

The application may also be inspected online at the following website set up by the applicant:

www.ballykeerangardens.com

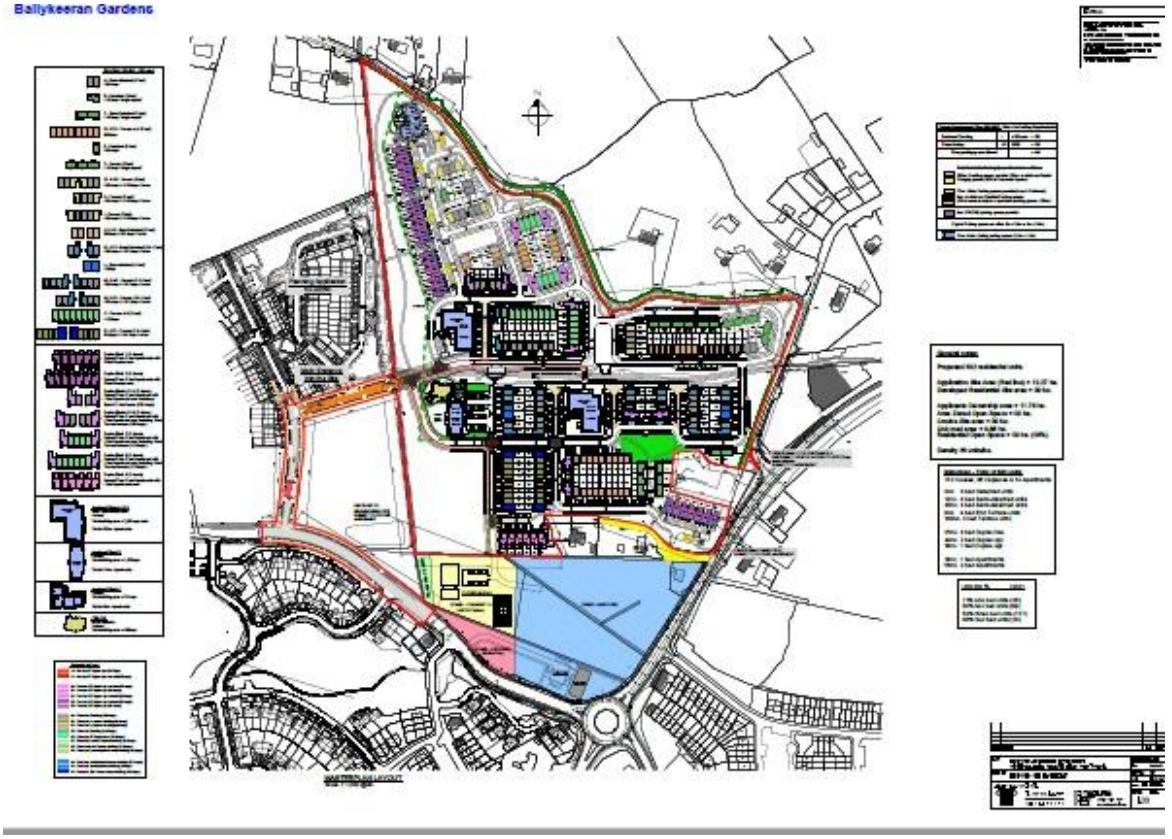


FIGURE 2 ARCHITECTS MASTERPLAN

2.0. PLANNING OVERVIEW

The following is extracted from the planning statement prepared by Genesis Planning.

The site is zoned as:

- proposed residential
- existing residential
- open space

Proposal Overview & Unit Mix

Description	Number	Percentage
1 Bed Units	36	11%
2 Bed Unit	99	30%
3 Bed Unit	177	53%
4 Bed Unit	20	6%
Total	332	100%

Building typologies are broken down into blocks ranging from 2 storey dwellings, 3 storey duplex/ apartment units to 4 storey apartment buildings.

All units have been designed to fully accord with the guidelines 'Sustainable Urban Housing: Design Standards for New Apartments' (2020 & 2022) and also the Guidelines 'Quality Housing for Sustainable Communities' as appropriate.

For a more complete description of the scheme refer to the Planning Statement under separate cover.

3.0 LAYOUT AND SITE ACCESS

Of relevance to the proposal is the adjacent application under reference 22/253 by Marina Quarter Ltd which proposes a residential scheme on adjoining lands along with a link road that will provide access to the lands.

Vehicular access to the site is proposed via a new link road to service the lands, and which utilises the same entrance road as proposed under application 22/253.

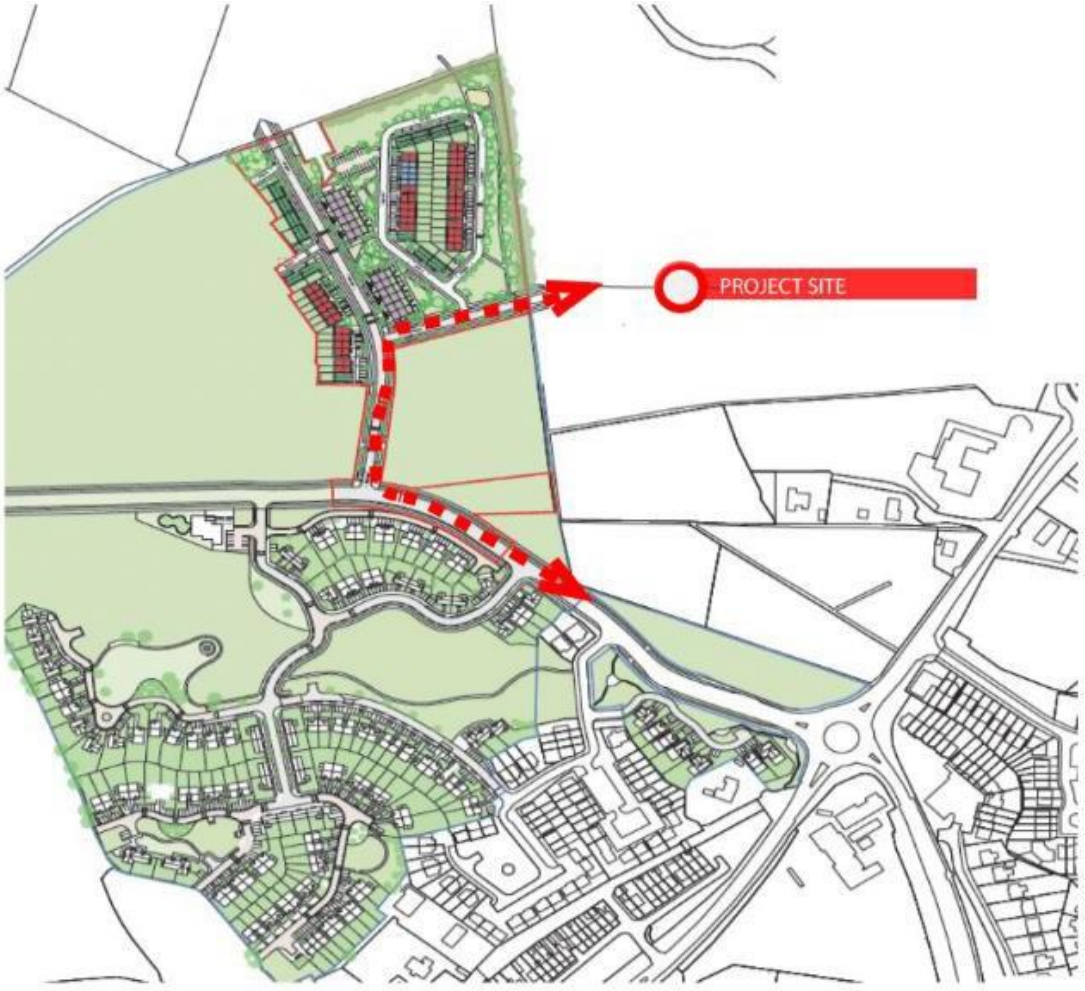


FIGURE 3 ACCESS TO LINK ROAD AND ROUNDABOUT

DMURS seeks to put well-designed streets at the heart of sustainable communities and supports boarder government policies on the environment, planning and transportation. DMURS provides the practical measures to achieve:

- Highly connected street which allow people to walk and cycle to key destinations in a direct and user friendly manner.
- A safe and comfortable street environment for pedestrians and cyclists of all ages.

- Streets that contribute to the creation of attractive and lively communities.
- Streets that calm traffic via a range of design measures that make drivers more aware of their environment.

DMURS provides guidance relating to the design of urban roads and streets. The Design Manual for Urban Roads and Streets seeks to achieve an integration of both physical dimensions of the site with the social character leading to a more sustainable approach to the design of access and roads. Better street design in urban areas will facilitate the implementation of policy on sustainable living by achieving a better balance between all modes of transport and road users. It will encourage more people to choose to walk, cycle or use public transport by making the experience safer and more pleasant. It will lower traffic speeds, reduce unnecessary car use and create a built environment that promotes healthy lifestyles and responds more sympathetically to the distinctive nature of individual communities and places.

The geometric features of the street are designed to complement the built form and further slow down traffic without the use of more intrusive measures such as speed ramps or excessive signage. The design of streets calm traffic by providing:

- Frequent crossing points and junctions;
- Horizontal and vertical deflections;
- Minimising formal signage and road markings;
- Narrower carriageways;
- On-Street parking;
- Reduced visibility splays;
- Shared street surfaces;
- Tighter corner radii.

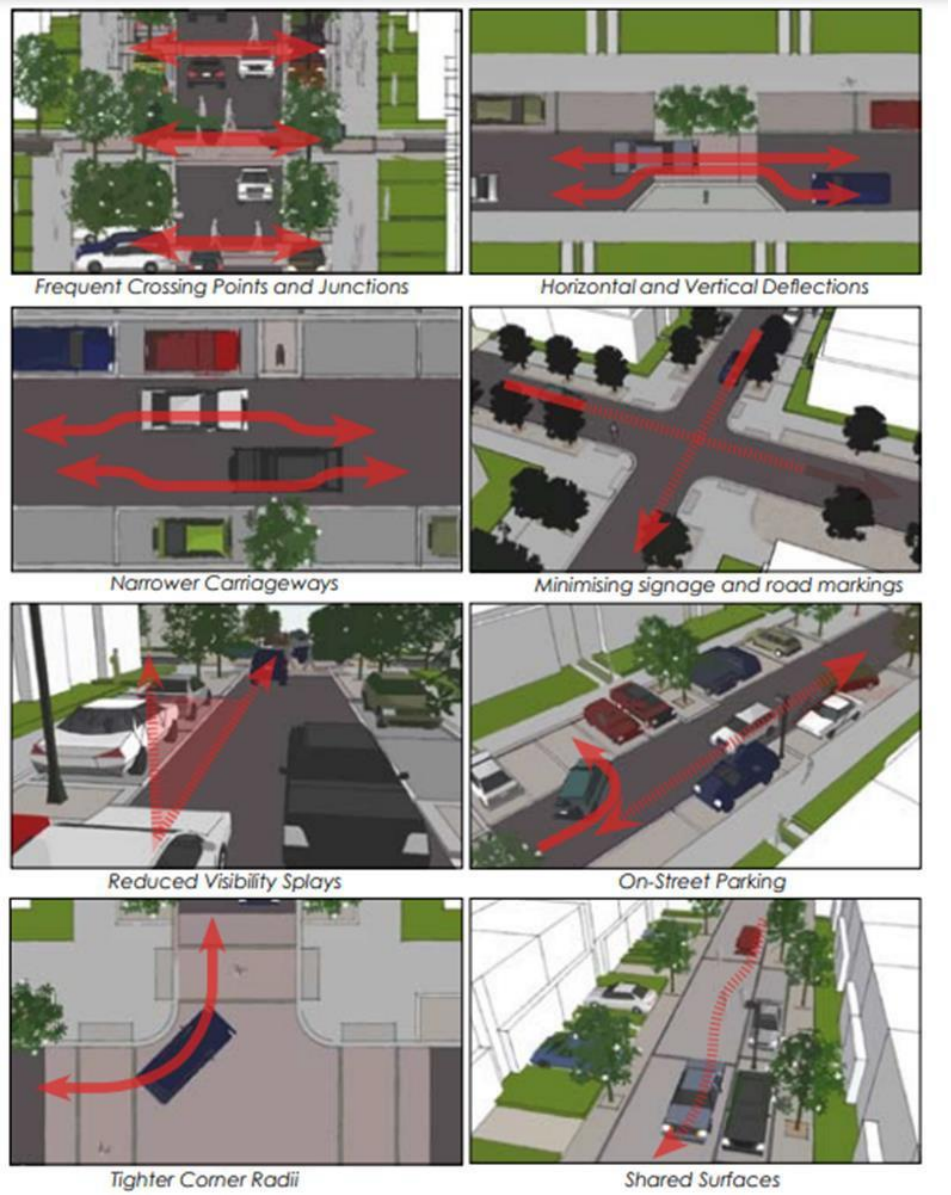


FIGURE 4

For further discussion on DMURS principles incorporated into the layout we refer to the accompanying DMURS Street Audit and DMURS Statement.

Construction

The roads, footpaths, sewers, drains and water mains shall be constructed in accordance with the "Recommendations for Site Development Works for Housing Areas" - Department of the Environment and Local Government. We must also make allowance for emergency and service vehicles, providing for them means certain minimum widths.

Road Surfacing

Standard course 60mm thickness (compacted) dense bitumen macadam basecourse (20mm nominal size aggregate) will be utilized in accordance with Clause 902 "Specification for Roadwork's" by the Department of Environment.

Sub-base:150mm thickness (compacted) granular material Type B in accordance with Clause 804 "Specification for Roadworks" by Department of Environment.

Capping Layer: 300mm thickness min (compacted) rock (hardcore) material. The material should have a maximum size of 100mm and the maximum allowable passing the 75-micron sieve should be 10%. The material should be well graded throughout the sizes. The construction depth will be based on CBR values carried out by the contractor. COMPLIANCE SUPPLEMENTED BY IN-SITU TESTING TO DEMONSTRATE A BEARING CAPACITY OF AT LEAST 15% CBR (OR EQUIVALENT); CONTRACTORS SHALL FOLLOW THE REQUIREMENTS OF TABLE 6/4 METHOD 6 FOR COMPACTION IN ALL CIRCUMSTANCES. MATERIAL WITHIN 450MM OF THE FINISHED ROAD SURFACE SHALL BE NON FROST SUSCEPTIBLE.

Footpaths will be constructed of insitu concrete with precast kerbs shall be laid on edge and not on the flat.

Wheelchair/pram accesses shall be provided at all roadway junctions.

There shall be no steps incorporated in the footpath construction. Where necessary, a ramp shall be provided with a maximum gradient of 1 in 20.

Lighting

The lighting design, will comply with ESB technical requirements.

(Refer to accompanying Lighting Proposals by Veelite).

The lanterns for the lights shall be one of the following types:

- Thorn 55 watt Sox Low Pressure Sodium Beta &

  Philips 55 watt Sox Low Pressure Sodium

All Street Lighting Schemes must meet the requirements of

- CEN code of practice EN 13201-1: 2003 (due to be updated in 2016)
- CEN code of practice EN 13201-5 relating to Energy Benchmarking (currently in development)
- BS5489: 2013 (and any future updates to these documents).
- ET101: 2008 and ET211:2003.
- ESB National Code of Practice for Customer Interface 4th Edition 2008 (http://www.esb.ie/esbnetworks/en/downloads/national_code_of_practice.pdf)
- Commission for Electricity Regulation (CER)

On completion, a certificate from the electricity company that the public lighting complies with BS5489 and indicating the specific category and that all underground network and services are to their satisfaction will be supplied.

4.0 FOUL SEWAGE

Pre-connection application was submitted to Irish Water and confirmation of feasibility was issued 13/11/2020 CDS20001202 (please refer to Appendix C).

The foul and surface water systems would be designed to comply with BS EN 752-4, BS 8301 (guidance only), and the Technical Guidance Document *'H Drainage and Waste Water Disposal ARNA FHOILSIÚ AG OIFIG AN tSOLÁTHAIR'*.

Design

Minimum depth

1.2m cover under highways

0.9m elsewhere

Maximum depth Normally 5m

Minimum sewer size150 normally 225mm

Domestic Wastewater Flow PHASE						
Usage	**Quantity**		**Total Population**		Consumption	Loading
			No./unit	Population	(G) (l/h/day)	(PxG) (l/day)
Houses	172	no.	2.7	464.4	150	69660
Appartments	160	no	2.7	432	150	64800
					Total	134460 l/day

Flow rate per day (l/s)		1.556 l/s
Growth Rate	1	1
Infiltration	10%	0..156 l/s
DWF	PG + I	1.712 l/s
Peaking Factor (Pf_{Dom})	6	
Design Foul Flow (l/s)	Pf_{Dom} x DWF	10.27 l/s

Please refer to EOB drawings for the proposed foul drainage layout and longitudinal sections showing cover and invert levels.

Also refer to design calculations attached in Appendix A.

5.0 STORMWATER

It is proposed to provide a separate gravity storm sewer to discharge at a rate of 18.98.00 litres per second to accord with the pre-development greenfield discharge conditions: (9.49 at 2 lit/ha = 18.98 l/sec greenfield flow). The development provides three catchments corresponding to the phasing arrangements however it should be noted catchment No 2 is subdivided in two North and South.

These catchments and their sub divisions each have a separate outfall

The drainage will be designed in accordance with the principles of Sustainable Urban Drainage Systems (SUDs) as detailed in Chapter 6 of Volume 3 Environmental Management, of the Greater Dublin Strategies Drainage Study (GD SDS). Storm flows will be attenuated to pre-development greenfield conditions.



FIGURE 5 STORM CATCHMENTS

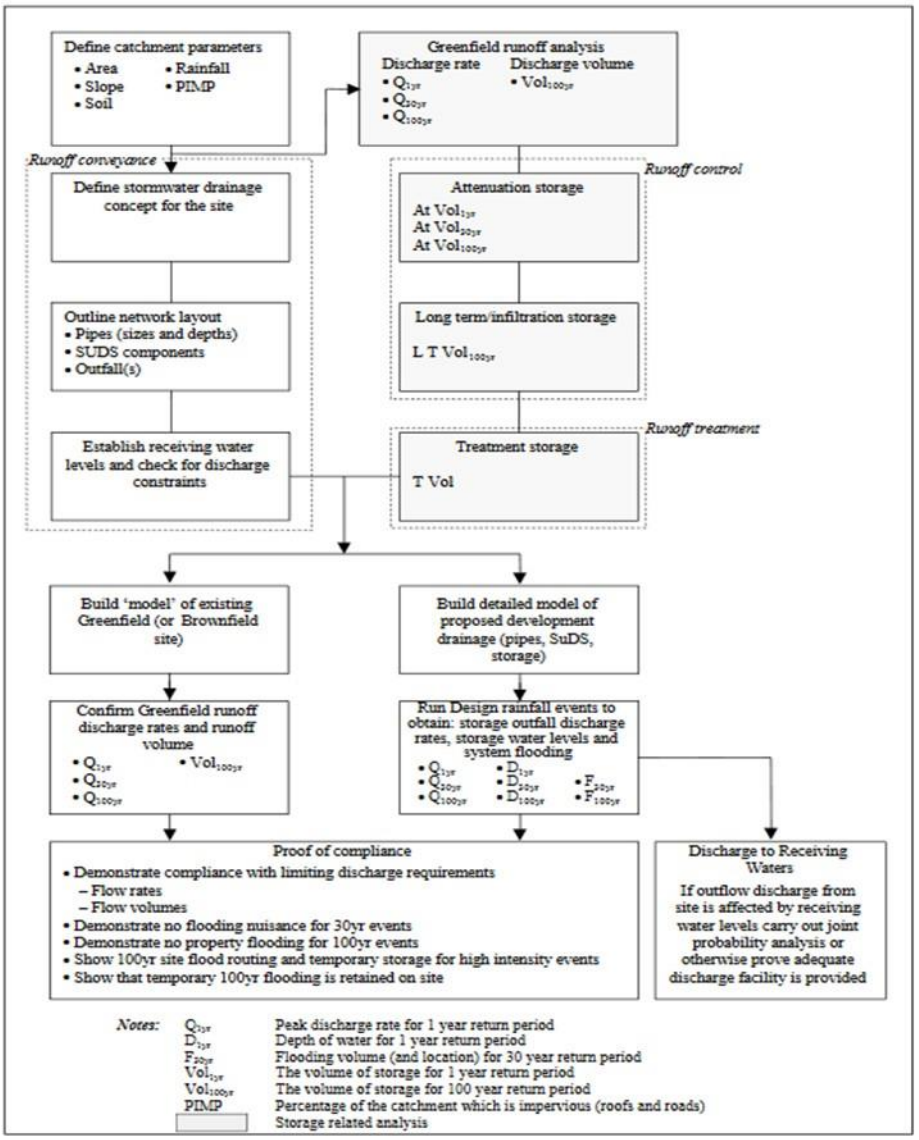


Figure E3 Initial and Detailed Design of Stormwater Drainage for New Developments

FIGURE 6

In respect of SUDs storm flows will be attenuated to greenfield runoff flows using a hydro-brake. Each of the catchment areas will in addition to the permeable paving and bio retention areas have an attenuation tank These storage tanks are sized based on the catchment characteristics and located as per figure 7 below.

The restriction will be by means of a vortex flow control device and excess flows will be directed and attenuated within an Aquacell Stormwater, or equivalent, attenuation system. Details of the calculation are appended.

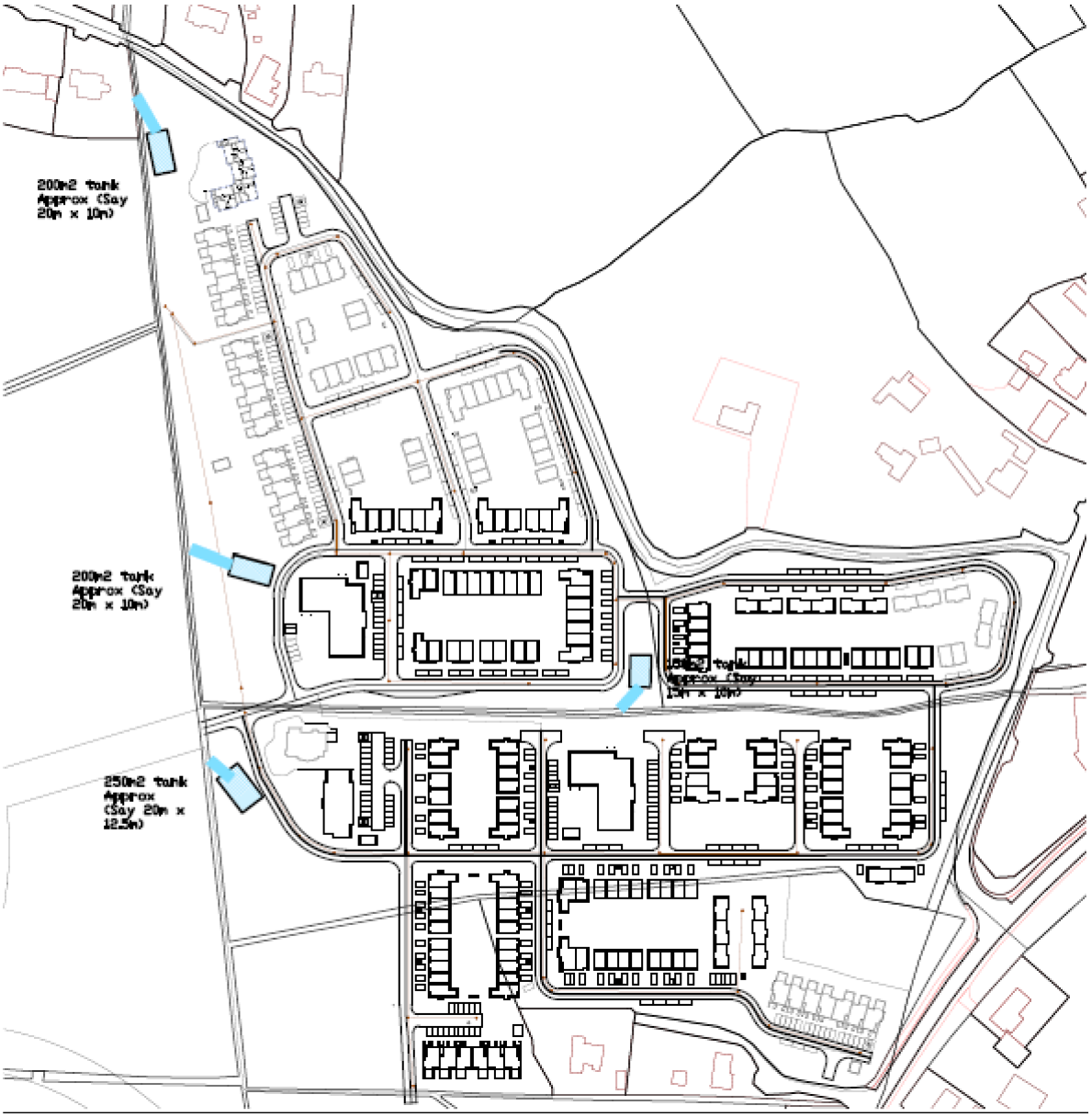


FIGURE 7 ATTENUATION TANKS.

Surface Water Sewers Design Criteria

Minimum depth

-1.2m cover under highways

0.9m elsewhere

-Maximum depth Normally 5m

-Minimum sewer size150mm normally 225mm

-Runoff factors for pipe sizing 100% roof surfaces and paved 80%

-0% off pervious surfaces

-Rainfall for initial pipe sizing 50mm/hr rainfall intensity

-Minimum velocity (pipe full) 0.75m/sec

-Flooding Checks made for adequate protection

-No flooding for return period less than 30 years except where explicitly planned

-Simulation modelling is required for sites greater than24ha

Roughness ks 0.6mm

See design calculation attached in Appendix B.

Petrol Interceptor

It is proposed to install a Klaregester full retention separator (NSFP20) to cater for any accidental or wash down drainage from the site.

Rainwater Harvesting

The sites sustainability following through from the approach adopted in the disposal of storm water, it is proposed to install rainwater harvesting tanks to provide for irrigation and other uses.

There is no Irish standard, as of yet, therefore, we proposed to use BS 8515:2009 which covers the design, installation, water quality, maintenance and risk management of the rainwater harvesting system.

Details of a proprietary Kingspan Rainwater System are appended.

Stream Diversion/Culvert

There is an existing stream flowing through the middle of the site effectively splitting the site in two. This stream joins with a channel along the western boundary of the site to exit the lands in an existing piped culvert under the existing road. The culvert under the existing road taken from the topographical survey is a 900mm diameter concrete pipe at an invert of IL 37.78mOD.

As the flows from any development connected to these channels will be limited to greenfield runoff the 900mm diameter culvert will always remain adequate to cater for the flows in the open channel.

In respect of the open channel crossing the site we intend where necessary to culvert this using a box culvert 1200 x 1200 which will mimic the existing channel characteristics and provide enough air space within the culvert for access and cleaning.

6.0 COMPLIANCE WITH THE PRINCIPLES OF SUSTAINABLE URBAN DRAINAGE STRATEGY

As part of this planning application it is proposed to incorporate a Storm Water Management Plan using SuDS technique to treat and minimise surface water runoff from the development at source. The methodology involved in developing a Storm Water Management Plan for the subject sites is based on recommendations in the Greater Dublin Strategic Drainage Study (GDSDS) and in the SuDS Manual, CIRIA C753.

For the proposed development, a "SuDS triangle" was utilised to ensure all three functions are provided for within the SuDS strategy.

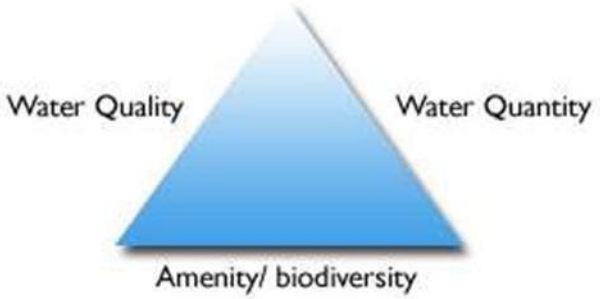


FIGURE 8 SUDS TRIANGLE

By considering the three functions of the triangle, a SuDS system will allow for water quality treatment through natural processes by:

- Encouraging infiltration (where appropriate) and attenuating peak flows
- Improving water quality by providing treatment to storm water prior to discharge
- Providing habitat and function were possible for those using the area.

Base on the site Investigation there is poor permeability on site (refer to Appendix F) and this limits us in respect of our stormwater disposal options to retention and attenuation.

It is therefore proposed that we use permeable paving or porous asphalt and bio retention either tree pits or shrubbery to retain and attenuate flows. It is to noted the overburden locally is a Fen and is not suitable for swales or other overland flow measures.

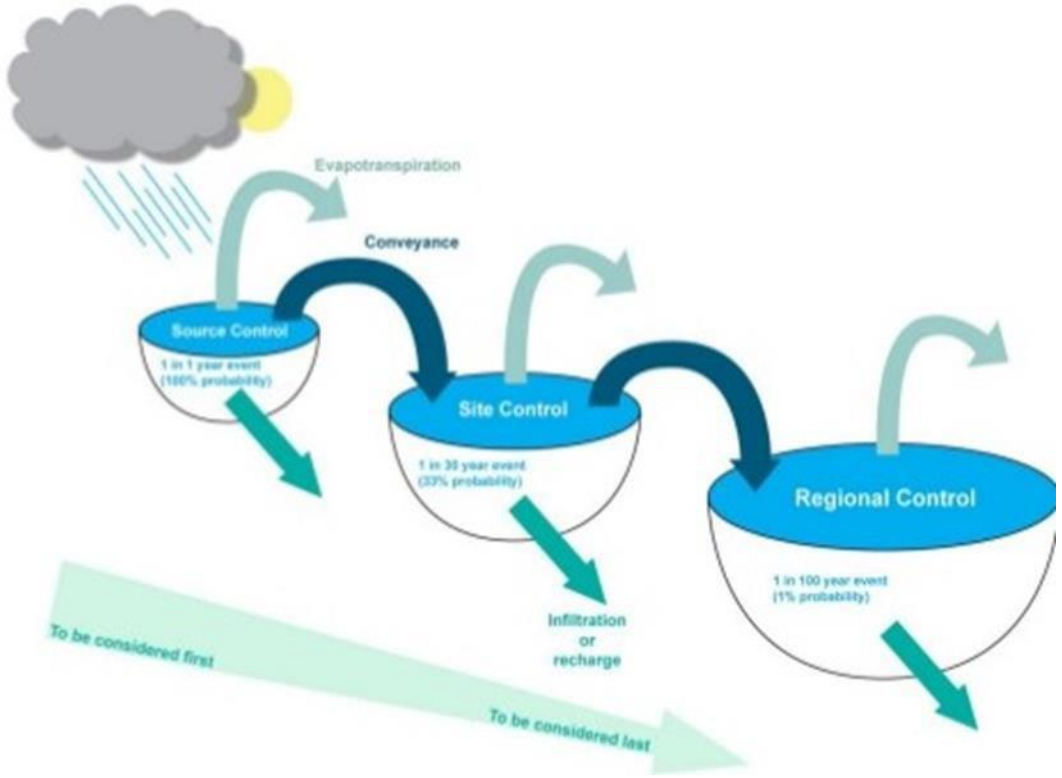


FIGURE 9 SUDS TREATMENT TRAIN

The SUDS treatment train uses a logical sequence of SUDS facilities in series thus allowing run-off to pass through several different SUDS before reaching the receiving watercourse or water bodies.

The GDSDS addresses the issue of sustainability by requiring designs to comply with a set of drainage criteria which aim to minimize the impact of urbanization by replicating the run-off characteristics of the greenfield site. The criteria provide a consistent approach to addressing the increase in both rate and volume of run-off, as well as chasing the environment is protected from any pollution from roads and buildings. These drainage design criteria are as follows:

- Criterion 1 - River Water Quality Protection
- Criterion 2 - River Regime Protection
- Criterion 3 - Flood Risk Assessment
- Criterion 4 - River Flood Protection

The requirements of SUDS are typically addressed by provision of the following:

- Interception storage
- Treatment storage (not required if interception storage is provided)
- Attenuation storage
- Long term storage (not required if growth factors are not applied to A Bar when designing attenuation storage)

6.1 CRITERION 3 GDSDS – SITE FLOODING

The GDSDS requires that no flooding should occur on site for storms up to and including the 1 in 30-year event. The pipe network and the attenuation storage volumes should, therefore, be checked for such storms to ensure that no site flooding occurs although partial surcharging of the system is allowed as long as it does not threaten to flood.

For the 1 in 100 year event, the pipe network can fully surcharge and cause site flooding, but the top water level due to any such flooding must be at least 500mm below any vulnerable internal floor levels, and the flood waters should be contained within the site. In addition, the top water level in any attenuation device during the 100-year storm must be at least 50mm below any vulnerable internal door levels.

The pipes have been sized to ensure the following:

- The system in the roads does not surcharge for the 1 year event;
- The system surcharges but does not flood for the 30 year event;
- The system surcharges but does not flood for the 100 year event.

GDSDS Criterion 3 is therefore complied with.

6.2 CRITERION 2 AND 4 GDSDS – RIVER REGIME AND FLOOD PROTECTION

Regardless of the rainfall event unchecked run-off from the developed site through traditional pipe networks will discharge into receiving waters at rates that are an order of magnitude greater than that prior to development. This can cause flash flow in the outfall river/stream that can cause scour and erosion. Attenuation storage is provided to prevent this occurring by limiting the rate of run off to that which took place from the pre-development greenfield site. In practice, the rate of run-off needs to be appropriately low for the majority of rainfall events, and attenuation storage should be provided for the 1 and 100 year storm event. The rate of outflow from such storage should be controlled so that it does not exceed the greenfield run-off rate of QBAR, which can be factored upwards by factors appropriate to the various return periods if long term storage is provided. Notwithstanding that significant long-term storage will be provided in the form of interception storage, this does not equate to full long-term storage volume provision and so growth factors will not be applied to QBAR when calculating the attenuation storage volume required.

QBAR for the overall site has been calculated in accordance with the H124 method as 26.16 l/s (refer to Appendix B for calculations). A hydrobrake downstream of the attenuation tank will be limited to the maximum site discharge of QBAR, therefore 26.16 l/s.

As the surface runoff flow rate generated on site does not exceed QBAR, there is no requirement for long-term storage to limit the impact on the receiving watercourse.

Criterion 4 is intended to prevent flooding of the receiving system/watercourse by either:

A. Long-term floodwater accommodated on site for development runoff volume which is in excess of the greenfield runoff volume (Option 1);

B. Infiltration storage provided equal in volume to "long term" storage (Option 2);

C. Maximum discharge rate of QBAR or 2 l/s/ha, whichever is the greater, for all attenuation storage where separate "long term" storage cannot be provided (Option 3).

Significant long-term storage will be provided in the form of interception storage. This does not, however, equate to full long-term storage volumes and it is not feasible to provide additional storage areas elsewhere on site to achieve the required volume.

Option 3 has therefore been used to comply with Criterion 4 and an attenuation volume will be provided in the proposed attenuation tanks to limit the rate of discharge to the max QBAR.

6.3 THE PROPOSED SUDS TECHNIQUES

The SUDS techniques proposed within the development are as outlined below:

- Permeable paving will be used within driveways and parking spaces. The permeable paving will allow for attenuation, infiltration to ground, reduction of peak flow rates and improved water quality. Roof run-off from the front roof area of residential housing units will discharge directly into the sub base below each permeable paving area allowing for reduced runoff from these roof areas.

- Cellular Attenuation System: A proprietary modular block or arch structure with a maintenance/inspection tunnel for providing underground surface water attenuation storage and can infiltrate runoff to the ground where the subgrade is suitable.

- Petrol Interceptor: A proprietary oil/water separator which prevents hazardous chemical and petroleum products from entering watercourses and public sewers. This is proposed at the outfall from the site.

- Hydro-Brake flow control device will be used throughout the site to allow for storm water control and reduce peak runoff.

The management train commences with source control through the provision of water efficient fittings within the residential dwellings. This will also reduce the water consumption required for each housing unit.

The second stage of the management train, site control, is provided by the introduction of permeable pavement and tree pits to provide a degree of treatment before discharging to the proposed surface water network and attenuation system. The rate of runoff is controlled through the provision of a flow control device installed in the outfall manhole of each surface water catchment.

The underground attenuation offers the third stage of treatment, regional control, by slowing the storm water discharge down and removes any additional silt which may remain in the storm water.

In conclusion, the water quality from this catchment should be of a high quality due to the above-mentioned measures, which are applied in a treatment train to treat the water before discharge at a restricted rate to the local network.

The above measures ensure a suitable management train is provided.

- Bioretention tree pits where runoff will be both treated and attenuated.

These systems normally are composed of seven elements, each element with a different function:

1. Grass buffer strip- reduces runoff velocity and removes suspended solids.
2. Vegetation –Help remove water through process of evapotranspiration and remove excess nutrients through nutrient cycling.
3. Shallow ponding area –provides storage of excess stormwater flows and its subsequent evaporation, also aids in the additional settlement of particulate matter.
4. Mulch –an organic layer that encourages micro biological degradation of petroleum-based pollutants, aids in pollutant filtration and reduces soil erosion.
5. Engineered soils –to support vegetation growth along with nutrient uptake and provision for water storage. Soils should include some clay to adsorb pollutants such as hydrocarbons, heavy metals and nutrients.
6. Sand bed –provide drainage and aeration of planting soil as well as an aid in flushing pollutants.
7. Underdrain system –removal of excess treated water to storm drain system or receiving waters.

6.4 SUDS MAINTENANCE

Permeable Paving

Paving should be inspected regularly, preferable during and after heavy rainfall to ensure effective operation. Vacuum brushing or jetting of the permeable paving should be carried out once a year. Cleaning is generally carried out after Autumn leaf fall to remove silts and sediments.

Underground attenuation systems

Inspection of the system should be carried out monthly for the first 3 months and then annually to ensure the system is working correctly. Debris should be removed monthly from the catchment surface where is may cause risk to the performance of the underground attenuation system. As required sediment from pre-treatment (catch pit) manholes prior to the attenuation system should be removed to ensure on going performance of the system. The inside of the tank should be surveyed

every 5 years or as required if performance is reduced and sediment build up removed if necessary.

7.0 GEOLOGY, HYDROLOGY & HYDROGEOLOGY

Sources of Information

The assessment consisted of a desk study of available published information from the sources listed below:

Roscommon National Roads Design Office (NRDO)

- N5 Strategic Corridor Constraints Report, December 2006
- Feasible Route Corridors overlaid on Ordnance Survey (OSi) background mapping
- Digital Ground Model Contours overlaid on OSi background mapping
- N5 Strategic Corridor Draft Route Corridor Selection Report, December 2007

Ordnance Survey

- Discovery Series Mapping (1:50,000)
- Six Inch Raster Maps (1:10,560)

Geological Survey of Ireland (GSI)

- Bedrock Geology Mapping
- Aquifer Mapping
- Groundwater Vulnerability Mapping
- Groundwater Source Protection Mapping
- Teagasc Subsoil Classification Mapping
- Well Database
- Karst Features and Tracer Test Database
- Groundwater Protection Schemes (1999). Department of the Environment, Heritage and Local Government (DoEHLG), Environment Protection Agency (EPA) and Geological Survey of Ireland (GSI)
- Geology of Longford and Roscommon: A geological description of Roscommon, Longford, Westmeath, and adjoining parts of Cavan, Leitrim and Galway, to accompany the bedrock geology 1:100,000 scale map series, sheet 12, Longford - Roscommon. GSI 2003
- Geology of Longford – Roscommon Sheet 12. GSI, 1999

Environmental Protection Agency (EPA)

- Teagasc Sub Cover Classification Mapping
- Teagasc Subsoil Classification Mapping
- Water Quality Monitoring Database and Reports
- Water Framework Directive Classification

- Towards Setting Guideline Values for The Protection of Groundwater in Ireland

Roscommon County Council

- Planning Register
- Roscommon County Development Plan (2002 – 2009)
- Water Services – Abstractions, Discharges & Supply Schemes

National Parks and Wildlife Service (NPWS)

- Designated Areas Mapping

Geomorphology

The geomorphology of the landscape and the surrounding area is quite diverse, comprising glacial till deposits overlying either limestone bedrock in the undulating lowlands

Solid Geology

The site is shown to be underlain by undifferentiated limestone (VIS) of Visean, Carboniferous Age. Some of these rocks are non-argillaceous and should meet the NRA specifications for use in road projects. The limestone is well bedded and jointed. The county has been subject to glaciation on a number of occasions resulting in fluvio -glacial deposits upto 25m deep over the bedrock.

Subsoil and Soil Deposits

Soil types take their character from the bed rock , glacial deposits and their topography. Karst features in the landscape have given rise to a diverse and often confused pattern of soil deposits. Locally we have found fen peat Banagher and Pollardstown Series.

Generally the site consists of a poorly drained topsoil indicating a high organic content, the subsoil is limestone till.

Drainage within the site is poor giving rise to pockets of lodged water the soil profile indicates a poorly drained material where the colour, texture and structure indicate a high organic content. Within limestone derived soils there is complex association of soil types with varying characteristics.

In respect of the site we carried out a number of percolation tests with a view to establishing a viable on site disposal strategy in accordance with SUDs ,unfortunately the tests proved that the site has a poor capacity with tests failing due to water logging and retention.

Soils are characterised as the Ratowen 1030RA series with isolated pockets of peat.

RPO17BR01

Reference profile:

Weather: Overcast

TOPOGRAPHY

Position: Upper slope

Form: Convex

Aspect: E

PARENT MATERIAL

Substrate type: Drift

Substrate subgroup: Limestones

TEXTURAL CRITERIA

Texture 1: Fine loamy

Texture 2: -

LAND USE

Land use: Grassland improved

Human technologies: Ploughing

ROCK OUTCROPS - (-)

SURFACE STONE - (-)

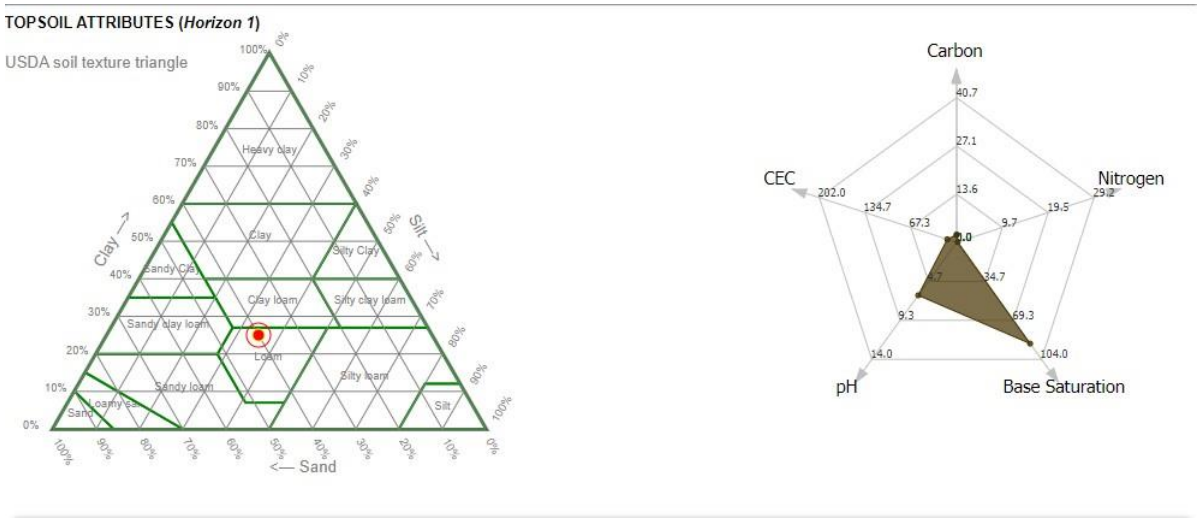
IRISH CLASSIFICATION (2013)

Soil subgroup: 1030 Stagnic Luvisols

National Soil Series: Rathowen

Definition: Fine loamy drift with limestones

TOPSOIL ATTRIBUTES (*Horizon 1*)



Horizon 1: 0 - 30 cm

Humose: No

Matrix colour (moist): 10YR43

Texture: Fine loamy

TOTAL %

Nitrogen: 0.22

Carbon: 2.13

Organic carbon: 1.71

Loss on ignition: -

EXCHANGEABLE COMPLEX

Exchangeable Bases (cmol kg^{-1})

Na:	0.08
K:	0.13
Mg:	1.23
Ca:	10.91

Stones (% total):	Few (2-5 %)
Stones details:	Medium gravels (6mm -2 cm)
Stickiness:	Non-sticky

PARTICLE SIZE %

Sand:	40%
Silt:	35%
Clay:	25%

CEC (cmol kg^{-1}):	13.78
Base saturation:	90%

HCL reaction:	No reaction
Packing density:	Medium
Plasticity:	Non-plastic

Textural Class (USDA):	Loam
Bulk density:	-
pH:	6.34

Horizon 2: 30 - 60 cm

Humose: No

Matrix colour (moist): 10YR54

Texture: Clayey

TOTAL %

Nitrogen: 0.07

Carbon: 0.49

Organic carbon: 0.36

Loss on ignition: -

EXCHANGEABLE COMPLEX

Exchangeable Bases (cmol kg^{-1})

Na: 0.09

K: 0.16

Mg: 1.39

Ca: 13.09

Stones (% total): Few (2-5 %)

Stones details: Stones (6-20 cm)

Stickiness: Sticky

PARTICLE SIZE %

Sand: 28%

Silt: 36%

Clay: 36%

HCL reaction: No reaction

Packing density: Medium

Plasticity: Plastic

Textural Class (USDA): Clay Loam

Bulk density: -

pH: 7.58

Horizon 3: 60 - 80 cm

Humose: No

Matrix colour (moist): 10YR42

Texture: Clayey

TOTAL %

Nitrogen: 0.06

Carbon: 0.47

Organic carbon: 0.29

Loss on ignition: -

EXCHANGEABLE COMPLEX

Exchangeable Bases (cmol kg^{-1})

Na: 0.12

K: 0.23

Mg: 1.41

Ca: 20.40

Stones (% total): Few (2-5 %)

Stones details: Coarse gravels (2-6 cm)

Stickiness: Sticky

PARTICLE SIZE %

Sand: 19%

Silt: 42%

Clay: 39%

CEC (cmol kg^{-1}): 21.65

Base saturation: 100%

HCL reaction: No reaction

Packing density: High

Plasticity: Plastic

Textural Class (USDA): silty Clay Loam

Bulk density: -

pH: 7.95

Horizon 4: 80 - 120 cm

Humose: No

Matrix colour (moist): 10YR43

Texture: Fine loamy

TOTAL %

Nitrogen: 0.04

Carbon: 1.38

Organic carbon: 0.28

Loss on ignition: -

EXCHANGEABLE COMPLEX

Exchangeable Bases (cmol kg^{-1})

Na: 0.10

K: 0.25

Mg: 1.30

Ca: 21.64

Stones (% total): Common (5-15 %)

Stones details: Coarse gravels (2-6 cm)

Stickiness: Non-sticky

PARTICLE SIZE %

Sand: 25%

Silt: 41%

Clay: 34%

CEC (cmol kg^{-1}): 19.03

Base saturation: 100%

HCL reaction: Strongly visible

Packing density: High

Plasticity: Non-plastic

Textural Class (USDA): Clay Loam

Bulk density: -

pH: 8.21

Hydrology

The hydrology of the area is dominated by the Shannon and Boyne Basins with its associated network of lakes and tributaries.

The local hydrology is shown on figure 10 is dominated by a man made channel through the site.

We propose to retain and enhance this channel culverting where appropriate using a precast 1200 x 1200 box culvert (as requested in the LRD Opinion).

There is a section through the stream together with a landscaping proposal.

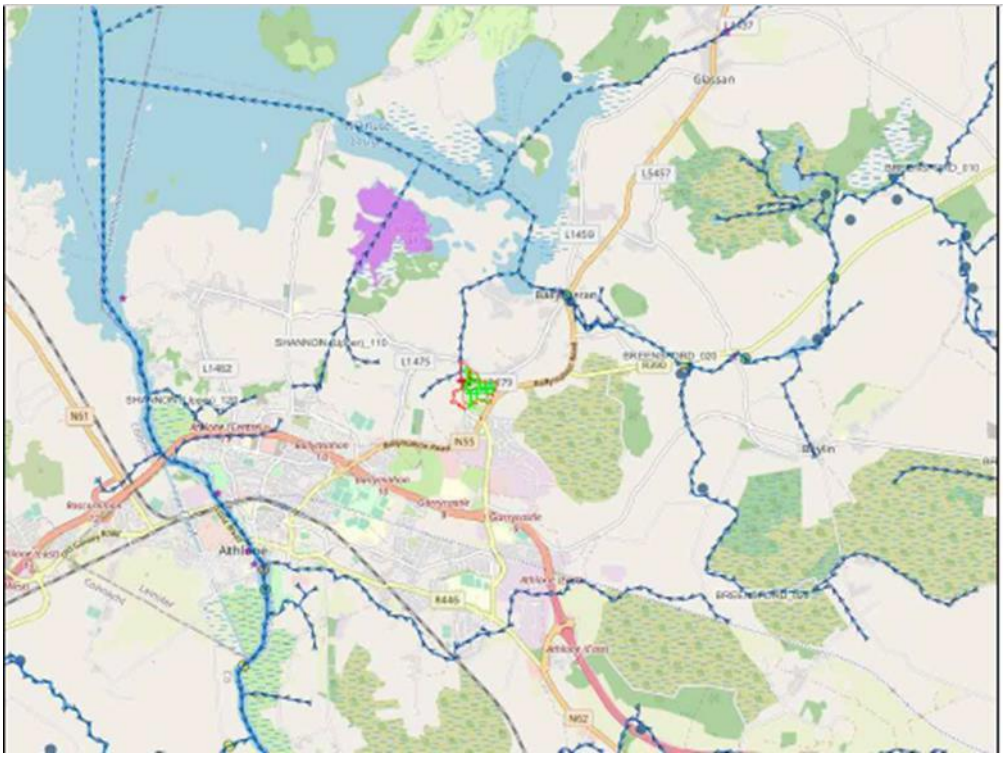


FIGURE 10 LOCAL DRAINAGE

Hydrogeology

Carboniferous limestones are often easily dissolved by surface water or groundwater. This has resulted in the development of many karst features involving underground drainage especially in the Fore area (Seven Springs). Isolated hills like the Rock of Curry and Hill of Uisneach are thought to be residual tower karst landscapes (like that seen today in parts of China and SE Asia). They would have been extensively glaciated in the next major influence on the landscape of Westmeath.

The last development occurred during the last 1.6 million years when ice ages came and went. The last one ended about 10,000 years ago, giving Westmeath some of the finest glacial deposits of sand and gravel across the lowlands. Eskers (the international name for these features comes from the Irish name 'eiscir') formed throughout the county. The formed from rivers flowing beneath the ice, leaving a long narrow ridge of sand and gravel. Around 10% of the county is covered by either eskers or associated outwash deposits of sand and gravel where the rivers came out from under the ice. This is partly why, although low-lying, Westmeath has a very undulating or hummocky terrain in many parts. In some parts, temporary lakes were dammed in by ice and glacial deposits to allow mushroom rocks to form, by dissolving the limestone below the water level leaving a limestone cap on a stalk.

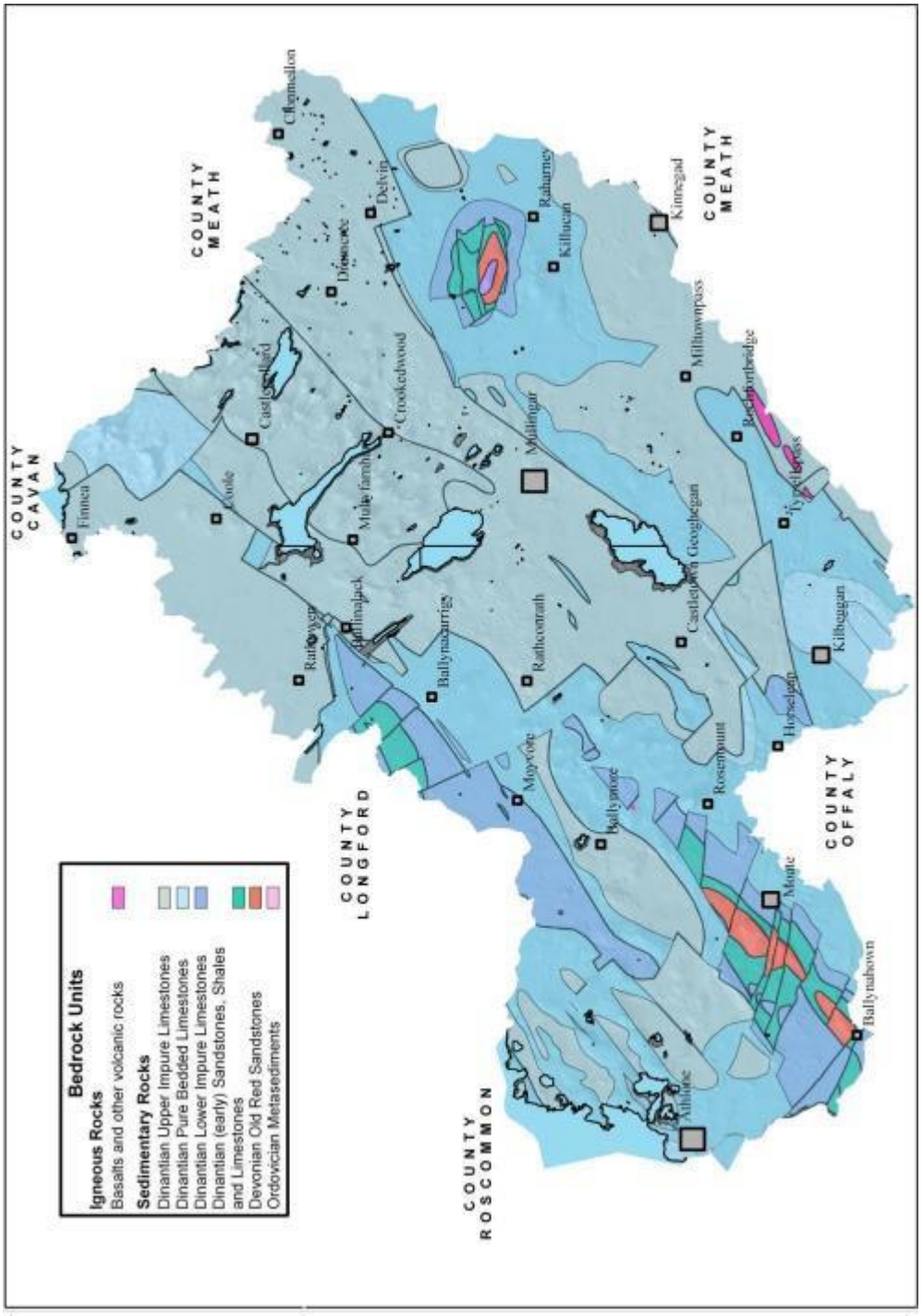


FIGURE 11 SIMPLIFIED GEOLOGY MAP OF WESTMEATH

7.0 WATER SUPPLY

A pre-connection application was submitted to Irish Water and confirmation of feasibility was issued on 13 November 2020.

All water mains shall be a minimum 100mm diameter HDPE as discussed with and agreed with Irish Water. All water service connections shall incorporate a water service control unit (round type).

The WSC unit shall be located in the footpath and shall include a stopcock in the unit. The stopcock shall be capable of being opened/closed without removal of the top of the WSC unit.

Hydrants shall be screw down type to BS 750 with 80mm diameter flanged inlet and 63 mm male thread outlet. The outlet from the hydrant shall not be greater than 200mm below adjoining ground level. Indicator plates conforming to BS 3251 shall be fixed to nearby walls or concrete marker posts.

Water Demand

CALCULATION OF PROPOSED WATER DEMAND									
Description	**Quantity**		**Total Population**		**Per Capita Water Demand**	**Water Demand**	**Average Water Demand**	**Average Peak Demand**	**Peak Demand**
			No./unit	Population	l/h/day	l/day	l/s	l/s	l/s
Houses	172	no.	2.7	464.4	150	69660	0.806	0806	2.016
Apartments	160	no	2.7	432	150	64800	0.750	0.750	1.875
						1344601.556			3.891

Storage of Potable Water

Each dwelling will have attic storage equivalent to 320 liters of water.

Fire Fighting

Each hydrant will comply with fire service requirements, but, as a minimum will be capable of delivering 500 liters per minute at each hydrant.

8.0 ANCILLARY SERVICES

ESB, Telecom, and Public Utility services will be located in consultation with the relevant service providers subject only that all lines and connections will be underground.

APPENDIX A – TYPICAL SUDS TECHNIQUES

Introduction

Sustainable drainage systems {also known as SUDs or Sustainable Urban Drainage Systems) are a collection of water management practices that aim to align modern drainage systems with natural water processes. SUDs efforts make urban drainage systems more compatible with components of the natural water cycle such as storm surge overflows. soil percolation. and bio-filtration. These efforts hope to mitigate the effect human development has had or may have on the natural water cycle. particularly surface runoff and water pollution trends. SUDs have become popular in recent decades as our understanding of how urban development affects natural environments. as well as concern for climate change and sustainability, have increased. SUDs often use built components that mimic natural features in order to integrate urban drainage systems into the natural drainage systems.

It should be noted that not all these systems will be used at Ballykeeran Housing but where appropriate the systems described will be employed.

Athlone/Cornmaddy Local Area Plan.

Sustainable Urban Drainage Systems (SUDS)

SUDS techniques aim to improve water quality, water quantity and amenity. It is a holistic approach to minimising the adverse environmental effects of development on natural water resources. It encompasses measures such as rainwater harvesting for non-potable applications such as toilet flushing so as to reduce the burden on the public water supply.

Roofs and paved areas are major contributors to surface water runoff. Green Roof technologies are encouraged, where appropriate, to reduce surface water runoff. Westmeath County Council favours the adoption of SUDS techniques in the development of the City as part of the policy to encourage sustainable aspects of urban development.

All New Development Proposals will be required to adhere to the following:

The parameters for a Hydraulic Analysis of the proposed storm water sewer network for any development as indicated:

o Rain Fall intensity : 60mm/hr

o Contributing areas: hard surfaces inclusive of roofs, roads, footpaths and any other hard standing area - 100% impermeable.

o Green areas or park land - 20% impermeable.

Storm water drainage sewers shall be designed to cater for a storm return period of a 1:30 year storm without surcharge and to cater for a 1:100 year storm without flooding

Designers shall have regard to 'The Planning System & Flood Risk Management – Guidelines for Planning Authorities' 2009, at the design stage of any possible development site.

Policy WS.7 Sustainable Urban Drainage Systems (SUDS)

It is the policy of Westmeath County Council to ensure that all new developments incorporate sustainable urban drainage systems at the application stage.

Objectives

All new Development Proposals will be required to adhere to the following:

o Complete a percolation and infiltration tests prepared by an Engineer, with a minimum of €2m Professional Indemnity Insurance, for the proposed route of the SUDS and designed to suit site specific requirements.

o Allow sufficient land take for SUDS when planning the site and also consider the region as a whole in association with adjoining lands and their requirements in designing SUDS. Developers may be required to set aside lands to cater for not only their own SUDS but also regional SUDS.

o Designed in accordance with a surface water management train.

o SUDS shall not be used where ground water or a high water table is at risk.

o Avoid pipes where possible and utilize the SWALES concept allowing for maintenance of such SWALES.

o SUDS shall be designed with wildlife in mind.

o Upstream silt traps should be incorporated in SUDS.

o Attenuate run off to pre development values or better.

o A method statement must be produced to identify and mitigate the maintenance hazards and all potential pollution hazards both during construction and operation in the future.

o All SUDS must be designed with all stages of construction approved and certified by a bonded chartered engineer.

Typical SuDS Installations

SuDS systems vary from infiltration trenches/soakways, filter drains and permeable pavements to swales, detention basins and stormwater wetlands. Other options which can also be used to assist stormwater runoff control include water-reuse, roof water collection

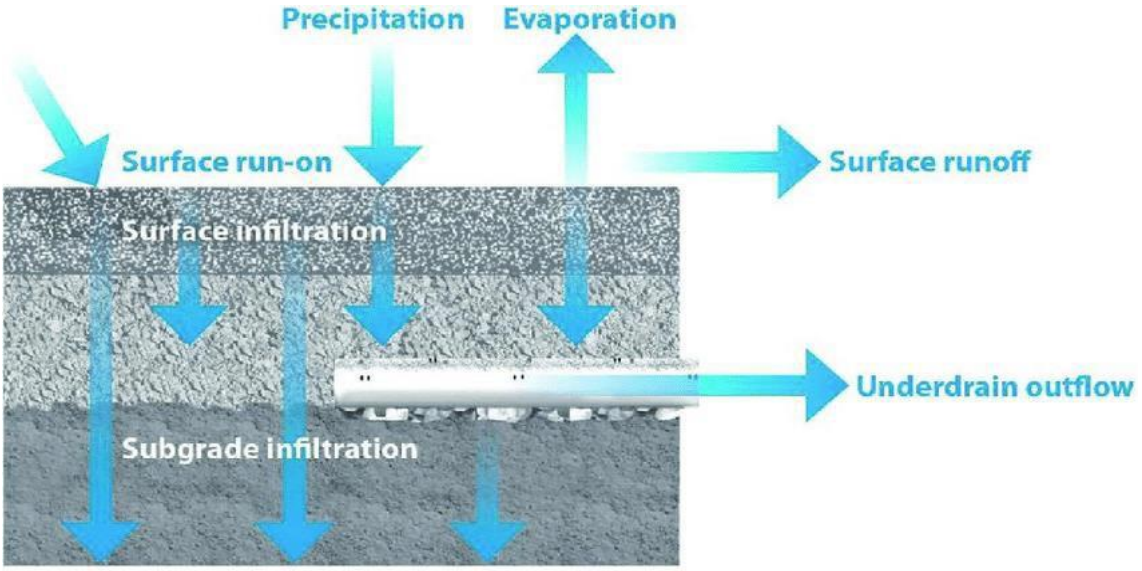
(water butts) and rooftop gardens. Typical examples of SuDS installations and the way they operate are as follows:

Rainwater Harvesting

Rainwater Harvesting will be used to collect water for the care and upkeep of the lawns and gardens

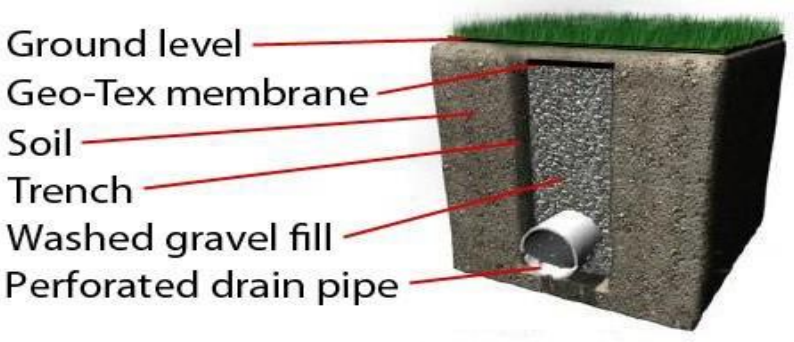
Permeable Pavements

Use of porous asphalt, porous paving or similar concepts to reduce imperviousness thus minimising runoff. Runoff infiltrates to a stone reservoir where some breakdown of pollutants occurs before controlled discharge to a drain or watercourse or direct infiltration.



Filter Drains

A gravel filled trench, generally with a perforated pipe at the base which conveys runoff to a drain or watercourse. These provide attenuation and trap sediments.



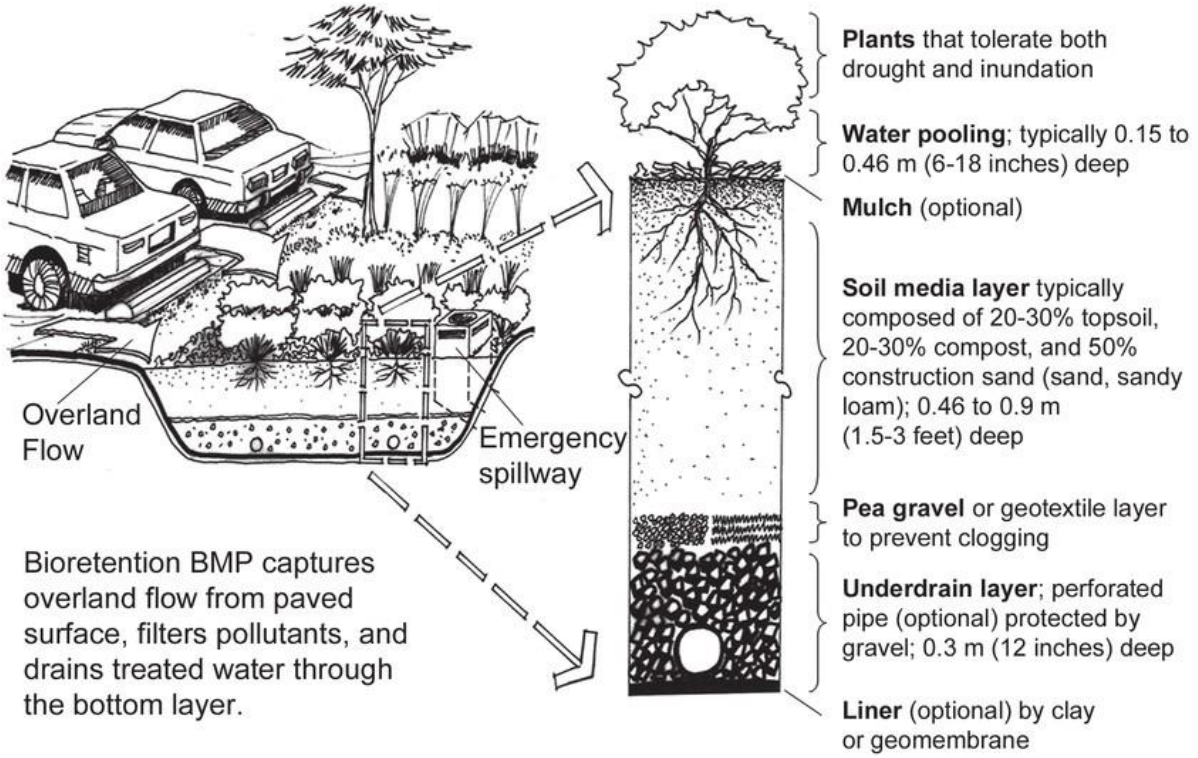
Infiltration Trenches/ Soakways

Gravel or rock filled pits or trenches designed to store runoff while letting it infiltrate slowly to the ground. Provide treatment of runoff through filtration, absorption and microbial decomposition.



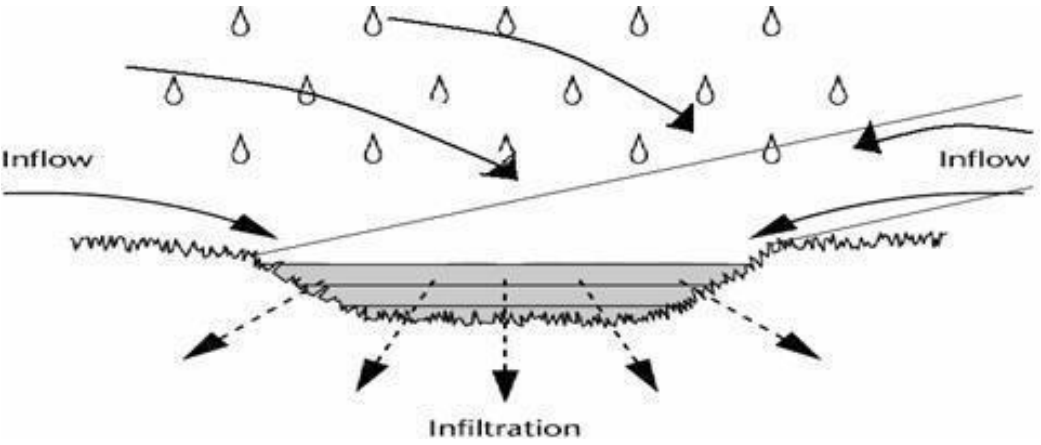
Bio-Retention

These devices are depressions back filled with sand and soil and planted with native vegetation. Provide filtration, settlement and some infiltration. Piped drainage provided at the base to pipe filtered runoff back to the drainage system or watercourse.



Swales

Grass lined channel designed to convey water to infiltration or a watercourse. Delays runoff and traps pollutants via infiltration for filtering effects of vegetation.



Detention Basins

Dry vegetated depressions which impound stormwater during an event and gradually release it. Mostly for volume control but some pollutant removal achieved via settlement of suspended solids and some infiltration.

Retention Ponds

Permanent water bodies which store excess water for long periods allowing particle settlement and biological treatment. Very effective for pollutant removal but limited to larger developments. Have high habitat and aesthetic benefits.

Stormwater Wetlands

Like retention ponds but with more vegetation and less open water area. Excellent for pollutant removal. Also provide aesthetic and habitat benefits.

APPENDIX B – DMURS

1.0 INTRODUCTION

The proposed residential development meets with the principles and guidance outlined within the Design Manual for Urban Roads and Streets (DMURS) 2013. The scheme proposals are the outcome of an integrated design approach between architectural and engineering design. This approach seeks to implement a community connected by well-designed streets which deliver attractive, convenient and safe access in addition to promoting modal shift and viable alternatives to car based journeys.

The following section outlines the specific design features that have been incorporated within the proposed residential scheme with the objective of delivering a design that complies with DMURS.

2.0 SENSE OF PLACE WITHIN THE STREET

There are four characteristics representing the basic measures that should be established in order to comply with DMURS. Each of these characteristics are set out below together with a commentary setting out how the proposed residential development complies with each of these characteristics.

- Connectivity
- Enclosure
- Active Edge
- Pedestrian Priority

2.1 CONNECTIVITY

"The creation of vibrant and active places requires pedestrian activity. This in turn requires walkable street networks that can be easily navigated and are well connected." [Design Manual for Urban Roads and Streets]

In order of importance, DMURS prioritises pedestrians, cyclists, public transport and private cars. Pedestrian connectivity is provided throughout the development with links to the existing public roads to the east and west of the development. There will also be two pedestrian/cycle only access paths to the public area north and east of the site whihrch will ultimately link to the wider road network. All pedestrian access link to existing footpath networks and proposed developments provide a connection to this footpath.

The site will also be served by public transport services through the bus stop within the site and along the N55.

Overall the proposed development has been carefully designed so that the private car does not enjoy the level of connectivity afforded to pedestrians and cyclists. In this regard the journey times and routes for car-based transport are considerably longer and more cumbersome in order to make it more attractive for walking to the local shops and schools. The development is, however, well connected to the surrounding road network.

It is submitted that the proposed development is compliant with the connectivity objectives of DMURS.

2.2 ENCLOSURE

"A sense of enclosure spatially defines streets and creates a more intimate and supervised environment. A sense of enclosure is achieved by orientating buildings toward the street and placing them along its edge. The use of street trees can also enhance the feeling of enclosure."

The proposed development has been designed so that the residential units are overlooking streets and public open spaces which provide passive surveillance. Landscaping and tree planting are provided along the roads/streets which assists in providing a sense of enclosure.

2.3 ACTIVE EDGE

"An active frontage enlivens the edge of the street creating a more interesting and engaging environment. An active frontage is achieved with frequent entrances and openings that ensure the street is overlooked and generate pedestrian activity as people come and go from buildings."

Each unit fronts directly onto the surrounding roads and streets, with entrances to each unit directly from the street, which will ensure that there is plenty of activity as residents come and go. Several landscaped open areas are proposed with pedestrian walkways which will further enhance activity and enliven the streets/roads.

2.4 PEDESTRAIN ACTIVITY/FACILITIES

"The sense of intimacy, interest and overlooking that is created by a street that is enclosed and lined with active frontages enhances a pedestrian's feeling of security and well-being. Good pedestrian facilities (such as wide footpaths and well designed crossings) also make walking a more convenient and pleasurable experience that will further encourage pedestrian activity."

As outlined above, the proposed development has been designed to provide walking routes. The units all front directly onto the roads and streets, which will create activity and provide surveillance to enhance pedestrians feeling of safety and wellbeing.

The proposed development has been designed to reduce traffic speeds. The Development will be a 30kph Slow Zone in line with the recent Department of Tourism and Transport advice note TSAN-2016-02.

The primary pedestrian routes through the site are 2.0 m or wider which allows sufficient space for two people to pass comfortably. DMURS identifies a 1.8 m wide footpath as being suitable for areas of low to medium pedestrian activity which would be considered appropriate for the proposed development. (please refer to DMURS figure 4.34).

3.0 FOR ROADS AND STREETS

DMURS sets out four core design principles which designers must consider in the design of roads and streets. These four core principals are set out below, together with a commentary setting out how these design principals have been incorporated into the design of the proposed development.

3.1 CONNECTED NETWORKS

"Design Principle 1: To support the creation of integrated street networks which promote higher levels of permeability and legibility for all users, and in particular more sustainable forms of transport."

As described above, the proposed development has been carefully designed to ensure that the focus on connectivity is centred on pedestrians and cyclists. The provision of the high levels of connectivity for pedestrians intended to promote walking by making them a more attractive option than the private car. Furthermore, pedestrians and cyclists will be able to access the bus routes the south of the development.

Appropriate clear unobstructed visibility splays, as per DMURS requirements are provided at all internal nodes and at the site access junctions to the external road network.

3.2 MULTI-FUNCTIONAL STREETS

"Design Principle 2: The promotion of multi-functional, place-based streets that balance the needs of all users within a self-regulating environment."

The adopted design approach sets out an appropriate balance between the functional requirements of different network users whilst enhancing the sense of place. The implementation of self-regulating streets actively manages movement by offering real modal and route choices in a low speed, high quality residential environment.

The design of the scheme proposals has actively sought to ensure there are no long straight sections of carriageway with the provision of strategically placed traffic calming features (i.e. junctions, raised tables, raised entries and horizontal deflections) located at an appropriate frequency and distance.

The provision of on-street car parking includes both parallel and perpendicular parking bays along either one or both sides of the internal streets.

Well designed and frequently provided pedestrian crossing facilities will be provided along key travel desire lines throughout the scheme in addition to those located at street nodes. All courtesy crossings will be provided with either dropped kerbs or a raised flat top treatment thereby allowing pedestrians to informally assert a degree of priority.

All street signage and road markings will be in accordance with the Department of Transport Traffic Signs Manual.

3.3 PEDESTRIAN FOCUS

"Design Principle 3: The quality of the street is measured by the quality of the pedestrian environment."

As noted above, the design of the scheme has placed a particular focus on the pedestrian. Connectivity throughout the scheme is heavily weighted towards the pedestrian and away from the private car. The streetscape has been designed to provide a sense of enclosure and to be active with good passive surveillance in order to enhance pedestrians' sense of safety and well-being. The street design incorporates well thought out pedestrian facilities such as generous footpaths, pedestrian crossings and shared spaces.

High quality materials and finishes are proposed throughout the scheme, both in the buildings and hard and soft landscaping. The selected materials will provide a collection and palette of colors and textures which will contrast with each other and enhance the streetscape and pedestrian environment.

3.3 MULTIDISCIPLINARY APPROACH

"*Design Principle 4: Greater communication and co-operation between design professionals through the promotion of a plan-led, multidisciplinary approach to design.*"

The project was created thanks to the close cooperation of engineers, architects, planners and the applicant. Each project member contributed their knowledge to the project and helped to create the design.

APPENDIX C IRISH WATER PRE CONNECTION FEASABILITY

11 The Cresent
Limerick City
Co.Limerick

Uisce Éireann
Bosca OP 448
Oifig Sheachadta na
Cathrach Theas
Cathair Chorcaí

Irish Water
PO Box 448,
South City
Delivery Office,
Cork City

www.water.ie

13th November 2020

Re: CDS20001202 pre-connection enquiry - Subject to contract | Contract denied

Connection for Housing Development of 350 unit(s) at Commaddy, Athlone, Co. Westmeath

Dear Sir/Madam,

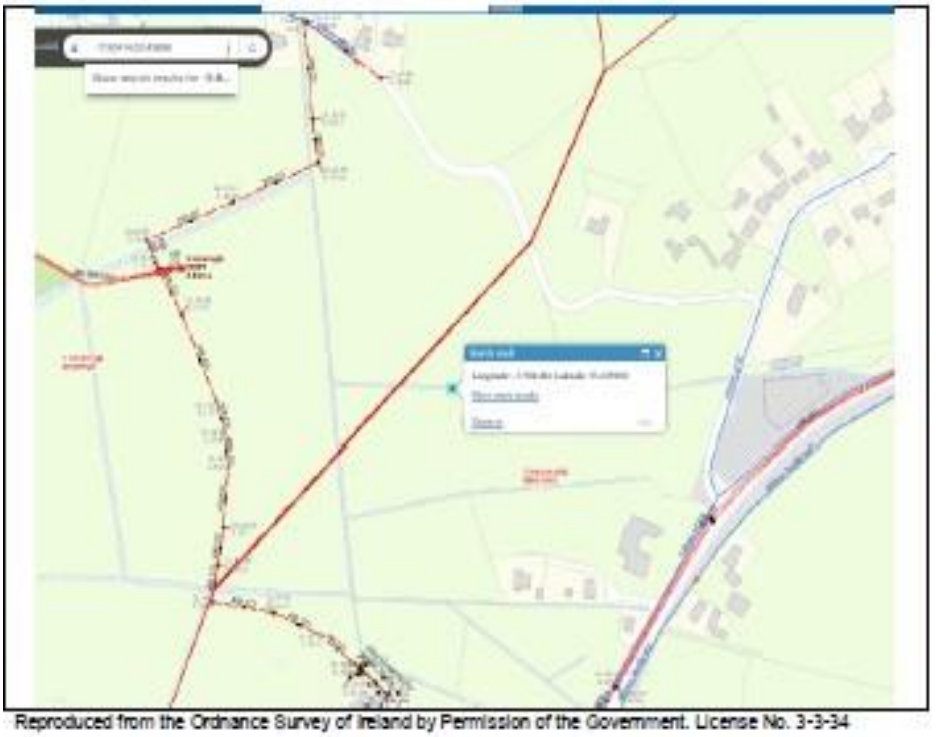
Irish Water has reviewed your pre-connection enquiry in relation to a Water & Wastewater connection at Blyry Court, Clonagh, Athlone, Co. Westmeath (the **Premises**). Based upon the details you have provided with your pre-connection enquiry and on our desk top analysis of the capacity currently available in the Irish Water network(s) as assessed by Irish Water, we wish to advise you that your proposed connection to the Irish Water network(s) can be facilitated at this moment in time.

SERVICE	OUTCOME OF PRE-CONNECTION ENQUIRY THIS IS NOT A CONNECTION OFFER. YOU MUST APPLY FOR A CONNECTION(S) TO THE IRISH WATER NETWORK(S) IF YOU WISH TO PROCEED.
Water Connection	Feasible without infrastructure upgrade by Irish Water
Wastewater Connection	Feasible without infrastructure upgrade by Irish Water
SITE SPECIFIC COMMENTS	
Water Connection	The Athlone Water Treatment Plant upgrade works currently underway will provide additional capacity for development in Athlone. As such there should be no supply issue to this 350-unit development, considering the proposed phasing of the development. A new 150mm diameter water connection from the existing 150mm HDPE water main on the N55 will be required to supply this development.
Wastewater Connection	There is sufficient capacity in the existing downstream network at this time to facilitate the proposed development.

Stiúrthóirí / Directors: Cathal Marley (Chairman), Niall Gleeson, Eamon Gullen, Yvonne Harris, Brendan Murphy, Maria O'Dwyer
Oifig Chláraithe / Registered Office: Teach Colvill, 24-28 Sráid Thalbóid, Baile Átha Cliath 1, D01 NP86 / Colvill House, 24-28 Talbot Street, Dublin 1, D01 NP86
Is cuideachta ghníomhaíochta ainmnithe atá faoi theorainn scaireanna é Uisce Éireann / Irish Water is a designated activity company, limited by shares.
Uimhir Chláraithe in Éirinn / Registered in Ireland No.: 530363

The design and construction of the Water & Wastewater pipes and related infrastructure to be installed in this development shall comply with the Irish Water Connections and Developer Services Standard Details and Codes of Practice that are available on the Irish Water website. Irish Water reserves the right to supplement these requirements with Codes of Practice and these will be issued with the connection agreement.

The map included below outlines the current Irish Water infrastructure adjacent to your site:



Reproduced from the Ordnance Survey of Ireland by Permission of the Government. License No. 3-3-34

Whilst every care has been taken in its compilation Irish Water gives this information as to the position of its underground network as a general guide only on the strict understanding that it is based on the best available information provided by each Local Authority in Ireland to Irish Water. Irish Water can assume no responsibility for and give no guarantees, undertakings or warranties concerning the accuracy, completeness or up to date nature of the information provided and does not accept any liability whatsoever arising from any errors or omissions. This information should not be relied upon in the event of excavations or any other works being carried out in the vicinity of the Irish Water underground network. The onus is on the parties carrying out excavations or any other works to ensure the exact location of the Irish Water underground network is identified prior to excavations or any other works being carried out. Service connection pipes are not generally shown but their presence should be anticipated.

General Notes:

1) The initial assessment referred to above is carried out taking into account water demand and wastewater discharge volumes and infrastructure details on the date of the assessment. **The availability of capacity may change at any date after this assessment.**

2) This feedback does not constitute a contract in whole or in part to provide a connection to any Irish Water infrastructure. All feasibility assessments are subject to the constraints of the Irish Water Capital Investment Plan.
3) The feedback provided is subject to a Connection Agreement/contract being signed at a later date.
4) A Connection Agreement will be required to commencing the connection works associated with the enquiry this can be applied for at https://www.water.ie/connections/get-connected/
5) A Connection Agreement cannot be issued until all statutory approvals are successfully in place.
6) Irish Water Connection Policy/ Charges can be found at https://www.water.ie/connections/information/connection-charges/
7) Please note the Confirmation of Feasibility does not extend to your fire flow requirements.
8) Irish Water is not responsible for the management or disposal of storm water or ground waters. You are advised to contact the relevant Local Authority to discuss the management or disposal of proposed storm water or ground water discharges
9) To access Irish Water Maps email datarequests@water.ie
10) All works to the Irish Water Infrastructure, including works in the Public Space, shall have to be carried out by Irish Water.

If you have any further questions, please contact Peter O'Halloran from the design team on 094 90 43319 or email PeOHalloran@water.ie For further information, visit **www.water.ie/connections**.

Yours sincerely,



Maria O'Dwyer

Connections and Developer Services

APPENDIX D STORM SEWER CALCULATIONS

Print Close Report

Registration successful. You are now logged in.

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by: Pat o Brien

Site name: BallyKeeran Housing

Site location: Athlone

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude: 53.43899° N

Longitude: 7.9028° W

Reference: 2438815917

Date: Feb 07 2023 15:31

Runoff estimation approach: IH124

Site characteristics

Total site area (ha): 12.9

Methodology

Q_{BAR} estimation method: Calculate from SPR and SAAR

SPR estimation method: Calculate from SOIL type

Soil characteristics	Default	Edited
SOIL type:	4	4
HOST class:	N/A	N/A
SPR/SPRHOST:	0.47	0.47

Hydrological characteristics	Default	Edited
SAAR (mm):	1055	1055
Hydrological region:	13	13
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	1.65	1.65
Growth curve factor 100 years:	1.95	1.95
Growth curve factor 200 years:	2.15	2.15

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates	Default	Edited
Q_{BAR} (l/s):	100.64	100.64
1 in 1 year (l/s):	85.55	85.55
1 in 30 years (l/s):	166.06	166.06
1 in 100 year (l/s):	196.25	196.25
1 in 200 years (l/s):	216.38	216.38

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement , which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	5	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	Scotland and Ireland	Connection Type	Level Soffits
M5-60 (mm)	17.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
1	0.058	5.00	44.935	1200	606559.873	743051.579	1.425
2	0.041	5.00	44.237	1200	606519.914	743064.198	0.875
24	0.050	5.00	44.185	1200	606511.679	743114.750	2.211
3	0.144	5.00	43.981	1200	606508.518	743078.493	2.136
4	0.005	5.00	43.083	1200	606419.751	743079.152	1.551
5	0.115	5.00	42.971	1200	606413.292	743089.166	1.563
16	0.107	5.00	42.700	1200	606413.976	743197.106	1.606
17	0.080	5.00	44.200	1200	606602.412	743200.317	1.619
18	0.004	5.00	44.500	1200	606601.793	743150.852	2.094
19	0.043	5.00	44.438	1200	606593.961	743144.051	2.069
22	0.130	5.00	43.474	1200	606538.726	743198.050	1.425
20	0.025	5.00	43.521	1200	606538.681	743143.997	1.347
23	0.035	5.00	42.850	1200	606474.627	743197.638	1.490
21	0.136	5.00	43.039	1200	606472.772	743144.463	1.927
6	0.043	5.00	42.321	1350	606413.305	743144.301	1.884
11	0.099	5.00	42.018	1200	606380.816	743066.414	1.768
13	0.017	5.00	41.800	1200	606351.413	743036.139	1.412
12	0.113	5.00	41.739	1200	606349.935	743066.952	1.598
14	0.108	5.00	41.750	1200	606336.519	743184.604	1.550
15	0.007	5.00	41.750	1200	606349.768	743184.310	1.597
7	0.097	5.00	41.506	1500	606348.958	743143.798	1.936
8	0.024	5.00	41.399	1500	606312.941	743145.487	1.876
9	0.000		41.250	1500	606287.390	743148.098	1.760
10			40.190	1500	606260.466	743169.359	0.770
25			43.991	1200	606528.088	743157.908	2.192
26			42.950	1200	606472.974	743158.744	1.802
27			43.500	1200	606538.645	743162.668	1.660

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	1	2	41.904	0.006	43.510	43.362	0.148	283.1	225	5.70	50.0
1.01	2	3	18.282	0.006	43.362	43.297	0.065	281.3	225	6.00	50.0
21.000	24	3	36.395	0.006	41.974	41.845	0.129	282.1	225	5.60	50.0
1.02	3	4	88.769	0.006	41.845	41.532	0.313	283.6	225	7.48	50.0
1.03	4	5	11.916	0.006	41.532	41.483	0.049	243.2	225	7.66	50.0
1.04	5	6	55.135	0.006	41.408	41.070	0.338	163.1	300	8.22	50.0
17.000	16	6	52.809	0.006	41.094	40.908	0.186	283.9	225	5.88	50.0
18.000	17	18	49.469	0.006	42.581	42.406	0.175	282.7	225	5.82	50.0
18.01	18	19	10.373	0.006	42.406	42.369	0.037	280.3	225	5.99	50.0
18.02	19	20	55.280	0.006	42.369	42.174	0.195	283.5	225	6.91	50.0
19.000	22	27	35.382	0.600	42.049	41.840	0.209	169.3	225	5.59	50.0
18.03	20	25	17.485	0.006	42.174	42.112	0.062	282.0	225	7.20	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	1.002	39.8	7.9	1.200	0.650	0.058	0.0	68	0.783
1.001	1.006	40.0	13.4	0.650	0.459	0.099	0.0	90	0.909
21.000	1.004	39.9	6.8	1.986	1.911	0.050	0.0	63	0.750
1.002	1.001	39.8	39.7	1.911	1.326	0.293	0.0	184	1.139
1.003	1.090	43.3	40.4	1.326	1.263	0.298	0.0	173	1.235
1.004	1.635	115.6	56.0	1.263	0.951	0.413	0.0	147	1.623
17.000	1.001	39.8	14.5	1.381	1.188	0.107	0.0	94	0.921
18.000	1.003	39.9	10.8	1.394	1.869	0.080	0.0	80	0.856
18.01	1.008	40.1	11.4	1.869	1.844	0.084	0.0	82	0.869
18.02	1.001	39.8	17.2	1.844	1.122	0.127	0.0	103	0.965
19.000	1.002	39.8	17.6	1.200	1.435	0.130	0.0	105	0.973
18.03	1.004	39.9	20.6	1.122	1.654	0.152	0.0	115	1.012

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Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
20.000	23	26	38.929	0.006	41.360	41.223	0.137	284.2	225	5.65	50.0
18.004	21	6	59.467	0.006	41.112	40.587	0.525	113.3	300	8.86	50.0
1.005	6	7	64.349	0.006	40.437	40.337	0.100	643.5	450	9.92	50.0
2.000	11	12	30.886	0.006	40.250	40.141	0.109	283.4	225	5.51	50.0
3.000	13	12	30.848	0.006	40.388	40.141	0.247	124.9	225	5.33	50.0
2.001	12	7	76.852	0.006	40.141	39.870	0.271	283.6	225	6.79	50.0
16.000	14	15	13.252	0.006	40.200	40.153	0.047	282.0	225	5.22	50.0
16.001	15	7	40.520	0.006	40.153	39.870	0.283	143.2	225	5.68	50.0
1.06	7	8	36.057	0.006	39.570	39.523	0.047	767.2	525	10.52	50.0
1.07	8	9	25.684	0.006	39.523	39.490	0.033	778.3	525	10.95	50.0
1.08	9	10	34.306	0.006	39.490	39.420	0.070	490.1	525	11.39	50.0
1.004_1	25	26	55.120	0.006	41.799	41.605	0.194	284.1	225	8.12	50.0
1.005_1	26	21	14.282	0.006	41.148	41.112	0.036	396.7	300	8.36	50.0
2.001_1	27	25	11.580	0.006	41.840	41.799	0.041	282.5	225	5.78	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
20.000	1.000	39.8	4.7	1.265	1.502	0.035	0.0	52	0.672
18.004	1.994	140.9	61.4	1.627	1.434	0.453	0.0	139	1.928
1.005	1.005	159.8	137.7	1.434	0.719	1.016	0.0	323	1.127
2.000	1.002	39.8	13.4	1.543	1.373	0.099	0.0	90	0.905
3.000	1.570	62.4	2.3	1.187	1.373	0.017	0.0	29	0.746
2.001	1.001	39.8	31.0	1.373	1.411	0.229	0.0	150	1.106
16.000	1.004	39.9	14.6	1.325	1.372	0.108	0.0	94	0.929
16.001	1.457	57.9	15.6	1.372	1.411	0.115	0.0	80	1.238
1.06	1.008	218.3	197.5	1.411	1.351	1.457	0.0	392	1.138
1.07	1.000	216.6	200.7	1.351	1.235	1.481	0.0	401	1.132
1.08	1.288	278.7	200.7	1.235	0.245	1.481	0.0	330	1.398
1.004_1	1.000	39.8	38.2	1.967	1.120	0.282	0.0	177	1.137
1.005_1	1.006	71.1	43.0	1.502	1.627	0.317	0.0	168	1.052
2.001_1	1.003	39.9	17.6	1.435	1.967	0.130	0.0	105	0.974

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	41.904	283.1	225	Circular Storm	44.935	43.510	1.200	44.237	43.362	0.650
1.01	18.282	281.3	225	Circular Storm	44.237	43.362	0.650	43.981	43.297	0.459
21.000	36.395	282.1	225	Circular Storm	44.185	41.974	1.986	43.981	41.845	1.911
1.02	88.769	283.6	225	Circular Storm	43.981	41.845	1.911	43.083	41.532	1.326
1.03	11.916	243.2	225	Circular Storm	43.083	41.532	1.326	42.971	41.483	1.263
1.04	55.135	163.1	300	Circular Storm	42.971	41.408	1.263	42.321	41.070	0.951
17.000	52.809	283.9	225	Circular Storm	42.700	41.094	1.381	42.321	40.908	1.188
18.000	49.469	282.7	225	Circular Storm	44.200	42.581	1.394	44.500	42.406	1.869
18.01	10.373	280.3	225	Circular Storm	44.500	42.406	1.869	44.438	42.369	1.844
18.02	55.280	283.5	225	Circular Storm	44.438	42.369	1.844	43.521	42.174	1.122
19.000	35.382	169.3	225	Circular	43.474	42.049	1.200	43.500	41.840	1.435
18.03	17.485	282.0	225	Circular Storm	43.521	42.174	1.122	43.991	42.112	1.654
20.000	38.929	284.2	225	Circular Storm	42.850	41.360	1.265	42.950	41.223	1.502
18.04	59.467	113.3	300	Circular Storm	43.039	41.112	1.627	42.321	40.587	1.434
1.005	64.349	643.5	450	Circular Storm	42.321	40.437	1.434	41.506	40.337	0.719
2.000	30.886	283.4	225	Circular Storm	42.018	40.250	1.543	41.739	40.141	1.373

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.00	1	1200	Manhole	Adoptable	2	1200	Manhole	Adoptable
1.01	2	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable
21.000	24	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable
1.02	3	1200	Manhole	Adoptable	4	1200	Manhole	Adoptable
1.03	4	1200	Manhole	Adoptable	5	1200	Manhole	Adoptable
1.04	5	1200	Manhole	Adoptable	6	1350	Manhole	Adoptable
17.000	16	1200	Manhole	Adoptable	6	1350	Manhole	Adoptable
18.00	17	1200	Manhole	Adoptable	18	1200	Manhole	Adoptable
18.01	18	1200	Manhole	Adoptable	19	1200	Manhole	Adoptable
18.02	19	1200	Manhole	Adoptable	20	1200	Manhole	Adoptable
19.000	22	1200	Manhole	Adoptable	27	1200	Manhole	Adoptable
18.003	20	1200	Manhole	Adoptable	25	1200	Manhole	Adoptable
20.000	23	1200	Manhole	Adoptable	26	1200	Manhole	Adoptable
18.004	21	1200	Manhole	Adoptable	6	1350	Manhole	Adoptable
1.005	6	1350	Manhole	Adoptable	7	1500	Manhole	Adoptable
2.000	11	1200	Manhole	Adoptable	12	1200	Manhole	Adoptable

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Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
3.000	30.848	124.9	225	Circular Storm	41.800	40.388	1.187	41.739	40.141	1.373
2.001	76.852	283.6	225	Circular Storm	41.739	40.141	1.373	41.506	39.870	1.411
16.000	13.252	282.0	225	Circular Storm	41.750	40.200	1.325	41.750	40.153	1.372
16.001	40.520	143.2	225	Circular Storm	41.750	40.153	1.372	41.506	39.870	1.411
1.06	36.057	767.2	525	Circular Storm	41.506	39.570	1.411	41.399	39.523	1.351
1.07	25.684	778.3	525	Circular Storm	41.399	39.523	1.351	41.250	39.490	1.235
1.08	34.306	490.1	525	Circular Storm	41.250	39.490	1.235	40.190	39.420	0.245
1.004_1	55.120	284.1	225	Circular Storm	43.991	41.799	1.967	42.950	41.605	1.120
1.005_1	14.282	396.7	300	Circular Storm	42.950	41.148	1.502	43.039	41.112	1.627
2.001_1	11.580	282.5	225	Circular Storm	43.500	41.840	1.435	43.991	41.799	1.967

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
3.000	13	1200	Manhole	Adoptable	12	1200	Manhole	Adoptable
2.001	12	1200	Manhole	Adoptable	7	1500	Manhole	Adoptable
16.00	14	1200	Manhole	Adoptable	15	1200	Manhole	Adoptable
16.01	15	1200	Manhole	Adoptable	7	1500	Manhole	Adoptable
1.06	7	1500	Manhole	Adoptable	8	1500	Manhole	Adoptable
1.07	8	1500	Manhole	Adoptable	9	1500	Manhole	Adoptable
1.08	9	1500	Manhole	Adoptable	10	1500	Manhole	Adoptable
1.004_1	25	1200	Manhole	Adoptable	26	1200	Manhole	Adoptable
1.005_1	26	1200	Manhole	Adoptable	21	1200	Manhole	Adoptable
2.001_1	27	1200	Manhole	Adoptable	25	1200	Manhole	Adoptable

Simulation Settings

Rainfall Methodology	FSR	Additional Storage (m³/ha)	20.0
FSR Region	England and Wales	Check Discharge Rate(s)	✓
M5-60 (mm)	17.000	1 year (l/s)	22.6
Ratio-R	0.400	30 year (l/s)	44.3
Summer CV	0.750	100 year (l/s)	54.1
Analysis Speed	Normal	Check Discharge Volume	✓
Skip Steady State	x	100 year +20% 360 minute (m³)	1831
Drain Down Time (mins)	240		

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 %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	20	10	0	100	20	10	0
30	20	10	0				

Pre-development Discharge Rate

Site Makeup	Greenfield	SPR	0.47	Betterment (%)	10
Greenfield Method	IH124	Region	10	QBar	26.0
Positively Drained Area (ha)	7.990	Growth Factor 1 year	0.87	Q 1 year (l/s)	20.4
SAAR (mm)	500	Growth Factor 30 year	1.70	Q 30 year (l/s)	39.8
Soil Index	4	Growth Factor 100 year	2.08	Q 100 year (l/s)	48.7

Pre-development Discharge Volume

Site Makeup	Greenfield	SPR	0.47	Storm Duration (mins)	360
Greenfield Method	FSR/FEH	CWI	75.556	Betterment (%)	10
Positively Drained Area (ha)	7.990	Return Period (years)	100	PR	0.390
Soil Index	4	Climate Change (%)	20	Runoff Volume (m³)	1831

Node 9 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	x	Sump Available	✓
Invert Level (m)	39.490	Product Number	CTL-SHE-0149-1100-1200-1100
Design Depth (m)	1.200	Min Outlet Diameter (m)	0.225
Design Flow (l/s)	11.0	Min Node Diameter (mm)	1200

Node 9 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	39.490
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

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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	300.0	0.0	1.000	300.0	0.0	1.800	300.0	0.0	1.801	0.0	0.0

Node 11 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	41.250	Slope (1:X)	300.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)		Depth (m)	0.750
Safety Factor	2.0	Width (m)	4.800	Inf Depth (m)	
Porosity	0.40	Length (m)	24.000		

Node 14 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	41.000	Slope (1:X)	500.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)		Depth (m)	0.750
Safety Factor	2.0	Width (m)	4.800	Inf Depth (m)	
Porosity	0.40	Length (m)	62.400		

Node 7 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	40.750	Slope (1:X)	200.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)		Depth (m)	0.750
Safety Factor	2.0	Width (m)	2.400	Inf Depth (m)	
Porosity	0.40	Length (m)	48.000		

Node 23 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	41.360	Slope (1:X)	350.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)		Depth (m)	0.750
Safety Factor	2.0	Width (m)	30.000	Inf Depth (m)	
Porosity	0.40	Length (m)	4.800		

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Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	5	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	Scotland and Ireland	Connection Type	Level Soffits
M5-60 (mm)	17.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
51	0.036	5.00	42.355	1200	606439.410	743307.909	1.425
52	0.016	5.00	42.265	1200	606427.465	743345.303	1.531
53	0.078	5.00	42.064	1200	606416.026	743378.399	1.505
54	0.001	5.00	42.072	1200	606402.445	743385.434	1.589
61	0.084	5.00	41.911	1200	606379.620	743307.224	1.425
22	0.083	5.00	41.356	1200	606358.328	743372.189	1.287
62	0.114	5.00	40.639	1200	606319.530	743306.112	1.425
56	0.104	5.00	40.591	1200	606304.196	743355.098	1.709
63	0.043	5.00	42.023	1200	606347.977	743400.871	1.425
64	0.003	5.00	41.483	1200	606323.494	743437.111	1.104
65	0.037	5.00	41.274	1200	606317.556	743440.020	0.928
68	0.020	5.00	41.364	1200	606294.285	743455.291	1.425
66	0.008	5.00	40.612	1200	606298.284	743434.566	0.779
69	0.043	5.00	40.752	1200	606280.589	743442.080	1.425
67	0.098	5.00	40.250	1200	606284.831	743427.657	1.176
57	0.002	5.00	40.625	1350	606290.968	743400.493	2.012
58	0.000		40.209	1350	606256.183	743390.312	1.708
59	0.000		40.100	1350	606242.505	743417.506	1.693
60			39.600	1350	606231.578	743432.710	1.251

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	51	52	39.255	0.600	40.930	40.734	0.196	200.3	225	5.71	50.0
1.01	52	53	35.017	0.600	40.734	40.559	0.175	200.1	225	6.35	50.0
1.02	53	54	15.295	0.600	40.559	40.483	0.076	201.2	225	6.62	50.0
1.03	54	22	46.062	0.600	40.483	40.253	0.230	200.3	225	7.46	50.0
2.000	61	22	68.365	0.600	40.486	40.144	0.342	199.9	225	6.24	50.0
1.04	22	56	56.766	0.600	40.069	39.837	0.232	244.7	300	8.40	50.0
3.000	62	56	51.330	0.600	39.214	38.957	0.257	199.7	225	5.93	50.0
1.05	56	57	47.283	0.600	38.882	38.688	0.194	243.7	300	9.19	50.0
4.000	63	64	43.735	0.600	40.598	40.379	0.219	199.7	225	5.79	50.0
4.01	64	65	6.612	0.600	40.379	40.346	0.033	200.4	225	5.91	50.0
4.02	65	66	20.029	0.600	40.346	40.246	0.100	200.3	225	6.27	50.0
5.000	68	66	21.107	0.600	39.939	39.833	0.106	199.1	225	5.38	50.0
4.03	66	67	15.123	0.600	39.833	39.683	0.150	100.8	225	6.47	50.0
6.000	69	67	15.034	0.600	39.327	39.074	0.253	59.4	225	5.15	50.0
4.04	67	57	27.849	0.600	39.074	38.763	0.311	89.5	225	6.80	50.0
1.006	57	58	36.244	0.600	38.613	38.501	0.112	323.6	375	9.79	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	0.920	36.6	4.9	1.200	1.306	0.036	0.0	55	0.640
1.01	0.920	36.6	7.0	1.306	1.280	0.052	0.0	66	0.712
1.02	0.918	36.5	17.6	1.280	1.364	0.130	0.0	110	0.910
1.03	0.920	36.6	17.8	1.364	0.878	0.131	0.0	110	0.912
2.000	0.921	36.6	11.4	1.200	0.987	0.084	0.0	86	0.813
1.04	1.000	70.7	40.4	0.987	0.454	0.298	0.0	163	1.033
3.000	0.921	36.6	15.4	1.200	1.409	0.114	0.0	102	0.882
1.05	1.002	70.9	69.9	1.409	1.637	0.516	0.0	244	1.136
4.000	0.921	36.6	5.8	1.200	0.879	0.043	0.0	60	0.675
4.01	0.920	36.6	6.2	0.879	0.703	0.046	0.0	63	0.690
4.02	0.920	36.6	11.2	0.703	0.141	0.083	0.0	86	0.813
5.000	0.923	36.7	2.7	1.200	0.554	0.020	0.0	41	0.540
4.03	1.302	51.8	15.0	0.554	0.342	0.111	0.0	83	1.133
6.000	1.699	67.6	5.8	1.200	0.951	0.043	0.0	44	1.048
4.04	1.382	55.0	34.2	0.951	1.637	0.252	0.0	129	1.455
1.006	1.001	110.6	104.4	1.637	1.333	0.770	0.0	292	1.133

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Pre-development Discharge Rate

Site Makeup	Greenfield	SPR	0.47	Betterment (%)	10
Greenfield Method	IH124	Region	10	QBar	26.0
Positively Drained Area (ha)	7.990	Growth Factor 1 year	0.87	Q 1 year (l/s)	20.4
SAAR (mm)	500	Growth Factor 30 year	1.70	Q 30 year (l/s)	39.8
Soil Index	4	Growth Factor 100 year	2.08	Q 100 year (l/s)	48.7

Pre-development Discharge Volume

Site Makeup	Greenfield	SPR	0.47	Storm Duration (mins)	360
Greenfield Method	FSR/FEH	CWI	75.556	Betterment (%)	10
Positively Drained Area (ha)	7.990	Return Period (years)	100	PR	0.390
Soil Index	4	Climate Change (%)	20	Runoff Volume (m³)	1831

Node 59 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	38.407	Product Number	CTL-SHE-0101-5100-1400-5100
Design Depth (m)	1.400	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	5.1	Min Node Diameter (mm)	1200

Node 59 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	38.407
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	150.0	0.0	1.500	150.0	0.0	1.501	0.0	0.0

Node 57 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	39.900	Slope (1:X)	300.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)		Depth (m)	0.750
Safety Factor	2.0	Width (m)	4.800	Inf Depth (m)	
Porosity	0.40	Length (m)	38.000		

Node 62 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	40.100	Slope (1:X)	300.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)		Depth (m)	0.750
Safety Factor	2.0	Width (m)	4.800	Inf Depth (m)	
Porosity	0.40	Length (m)	30.000		

Node 52 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	41.500	Slope (1:X)	250.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)		Depth (m)	0.750
Safety Factor	2.0	Width (m)	2.400	Inf Depth (m)	
Porosity	0.40	Length (m)	48.000		

Node 67 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	39.500	Slope (1:X)	200.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)		Depth (m)	0.750
Safety Factor	2.0	Width (m)	4.800	Inf Depth (m)	
Porosity	0.40	Length (m)	25.000		

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Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.07	58	59	30.440	0.600	38.501	38.407	0.094	323.8	375	10.30	50.0
1.08	59	60	18.723	0.600	38.407	38.349	0.058	322.8	375	10.61	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.07	1.001	110.6	104.4	1.333	1.318	0.770	0.0	292	1.132
1.08	1.003	110.7	104.4	1.318	0.876	0.770	0.0	291	1.134

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	39.255	200.3	225	Circular	42.355	40.930	1.200	42.265	40.734	1.306
1.01	35.017	200.1	225	Circular	42.265	40.734	1.306	42.064	40.559	1.280
1.02	15.295	201.2	225	Circular	42.064	40.559	1.280	42.072	40.483	1.364
1.03	46.062	200.3	225	Circular	42.072	40.483	1.364	41.356	40.253	0.878
2.000	68.365	199.9	225	Circular	41.911	40.486	1.200	41.356	40.144	0.987
1.04	56.766	244.7	300	Circular	41.356	40.069	0.987	40.591	39.837	0.454
3.000	51.330	199.7	225	Circular	40.639	39.214	1.200	40.591	38.957	1.409
1.05	47.283	243.7	300	Circular	40.591	38.882	1.409	40.625	38.688	1.637
4.000	43.735	199.7	225	Circular	42.023	40.598	1.200	41.483	40.379	0.879
4.01	6.612	200.4	225	Circular	41.483	40.379	0.879	41.274	40.346	0.703
4.02	20.029	200.3	225	Circular	41.274	40.346	0.703	40.612	40.246	0.141
5.000	21.107	199.1	225	Circular	41.364	39.939	1.200	40.612	39.833	0.554
4.03	15.123	100.8	225	Circular	40.612	39.833	0.554	40.250	39.683	0.342
6.000	15.034	59.4	225	Circular	40.752	39.327	1.200	40.250	39.074	0.951
4.04	27.849	89.5	225	Circular	40.250	39.074	0.951	40.625	38.763	1.637
1.06	36.244	323.6	375	Circular	40.625	38.613	1.637	40.209	38.501	1.333
1.07	30.440	323.8	375	Circular	40.209	38.501	1.333	40.100	38.407	1.318
1.08	18.723	322.8	375	Circular	40.100	38.407	1.318	39.600	38.349	0.876

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.00	51	1200	Manhole	Adoptable	52	1200	Manhole	Adoptable
1.01	52	1200	Manhole	Adoptable	53	1200	Manhole	Adoptable
1.02	53	1200	Manhole	Adoptable	54	1200	Manhole	Adoptable
1.03	54	1200	Manhole	Adoptable	22	1200	Manhole	Adoptable
2.000	61	1200	Manhole	Adoptable	22	1200	Manhole	Adoptable
1.004	22	1200	Manhole	Adoptable	56	1200	Manhole	Adoptable
3.000	62	1200	Manhole	Adoptable	56	1200	Manhole	Adoptable
1.005	56	1200	Manhole	Adoptable	57	1350	Manhole	Adoptable
4.00	63	1200	Manhole	Adoptable	64	1200	Manhole	Adoptable
4.01	64	1200	Manhole	Adoptable	65	1200	Manhole	Adoptable
4.02	65	1200	Manhole	Adoptable	66	1200	Manhole	Adoptable
5.000	68	1200	Manhole	Adoptable	66	1200	Manhole	Adoptable
4.003	66	1200	Manhole	Adoptable	67	1200	Manhole	Adoptable
6.000	69	1200	Manhole	Adoptable	67	1200	Manhole	Adoptable
4.004	67	1200	Manhole	Adoptable	57	1350	Manhole	Adoptable
1.06	57	1350	Manhole	Adoptable	58	1350	Manhole	Adoptable
1.07	58	1350	Manhole	Adoptable	59	1350	Manhole	Adoptable
1.08	59	1350	Manhole	Adoptable	60	1350	Manhole	Adoptable

Simulation Settings

Rainfall Methodology	FSR	Additional Storage (m³/ha)	20.0
FSR Region	England and Wales	Check Discharge Rate(s)	✓
M5-60 (mm)	17.000	1 year (l/s)	22.6
Ratio-R	0.400	30 year (l/s)	44.3
Summer CV	0.750	100 year (l/s)	54.1
Analysis Speed	Normal	Check Discharge Volume	✓
Skip Steady State	x	100 year +20% 360 minute (m³)	1831
Drain Down Time (mins)	240		

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 %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	20	10	0	100	20	10	0
30	20	10	0				

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Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	5	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	Scotland and Ireland	Connection Type	Level Soffits
M5-60 (mm)	17.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	x

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
71	0.047	5.00	42.238	1200	606453.053	743243.755	1.567
72	0.020	5.00	42.003	1200	606450.889	743227.653	1.413
73	0.100	5.00	42.349	1200	606410.199	743224.882	1.963
74	0.037	5.00	41.342	1200	606345.405	743224.286	1.573
75	0.027	5.00	41.052	1200	606297.423	743222.339	1.637
79	0.051	5.00	42.521	1200	606453.192	743269.224	1.622
80	0.004	5.00	42.239	1200	606452.413	743285.197	1.420
81	0.126	5.00	42.288	1200	606447.678	743295.819	1.528
82	0.075	5.00	41.662	1200	606399.811	743290.028	1.425
86	0.070	5.00	41.174	1200	606345.862	743243.534	1.425
83	0.038	5.00	40.962	1200	606345.785	743290.643	1.449
84	0.008	5.00	40.694	1200	606320.927	743291.657	1.518
85	0.009	5.00	40.978	1200	606301.784	743287.825	1.851
76	0.000		40.968	1350	606289.458	743269.922	1.987
77	0.000		40.624	1350	606272.509	743277.459	1.717
78			39.222	1350	606246.930	743293.112	0.435
102			42.300	1200	606435.339	743301.869	1.589

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	71	72	16.247	0.600	40.671	40.590	0.081	200.6	225	5.29	50.0
1.01	72	73	40.784	0.600	40.590	40.386	0.204	199.9	225	6.03	50.0
1.02	73	74	64.797	0.600	40.386	39.769	0.617	105.0	225	6.88	50.0
1.03	74	75	48.021	0.600	39.769	39.415	0.353	135.8	225	7.59	50.0
1.04	75	76	48.245	0.600	39.415	39.131	0.284	169.9	225	8.40	50.0
2.000	79	80	15.992	0.600	40.899	40.819	0.080	199.9	225	5.29	50.0
2.01	80	81	11.630	0.600	40.819	40.760	0.059	197.1	225	5.50	50.0
2.02	102	82	37.450	0.006	40.983	40.671	0.312	120.0	225	6.11	50.0
2.03	82	83	54.029	0.006	40.237	39.787	0.450	120.1	225	6.68	50.0
3.000	86	83	47.109	0.600	39.749	39.513	0.236	199.6	225	5.85	50.0
2.04	83	84	24.879	0.006	39.513	39.251	0.262	95.0	225	6.90	50.0
2.05	84	85	19.523	0.006	39.176	39.127	0.049	398.4	300	7.23	50.0
2.06	85	76	21.736	0.006	39.127	39.056	0.071	306.8	300	7.54	50.0
1.05	76	77	18.549	0.600	38.981	38.907	0.074	250.7	375	8.67	50.0
1.06	77	78	29.988	0.600	38.907	38.787	0.120	249.9	375	9.11	50.0
2.002_1	81	102	13.742	0.006	40.760	40.711	0.049	280.5	225	5.73	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	0.919	36.6	6.4	1.342	1.188	0.047	0.0	64	0.695
1.01	0.921	36.6	9.1	1.188	1.738	0.067	0.0	76	0.766
1.02	1.276	50.7	22.6	1.738	1.348	0.167	0.0	105	1.239
1.03	1.120	44.5	27.6	1.348	1.412	0.204	0.0	129	1.179
1.04	1.000	39.8	31.3	1.412	1.612	0.231	0.0	151	1.104
2.000	0.921	36.6	6.9	1.397	1.195	0.051	0.0	66	0.712
2.01	0.927	36.9	7.5	1.195	1.303	0.055	0.0	68	0.728
2.02	1.604	63.8	24.5	1.092	0.766	0.181	0.0	97	1.504
2.03	1.604	63.8	34.7	1.200	0.950	0.256	0.0	118	1.636
3.000	0.922	36.6	9.5	1.200	1.224	0.070	0.0	78	0.775
2.04	1.823	72.5	49.3	1.224	1.218	0.364	0.0	137	1.958
2.05	1.003	70.9	50.4	1.218	1.551	0.372	0.0	187	1.088
2.06	1.158	81.8	51.6	1.551	1.612	0.381	0.0	173	1.223
1.05	1.139	125.9	82.9	1.612	1.342	0.612	0.0	222	1.213
1.06	1.141	126.1	82.9	1.342	0.060	0.612	0.0	222	1.215
2.002_1	1.007	40.1	24.5	1.303	1.364	0.181	0.0	127	1.057

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Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	16.247	200.6	225	Circular	42.238	40.671	1.342	42.003	40.590	1.188
1.01	40.784	199.9	225	Circular	42.003	40.590	1.188	42.349	40.386	1.738
1.02	64.797	105.0	225	Circular	42.349	40.386	1.738	41.342	39.769	1.348
1.03	48.021	135.8	225	Circular	41.342	39.769	1.348	41.052	39.415	1.412
1.04	48.245	169.9	225	Circular	41.052	39.415	1.412	40.968	39.131	1.612
2.000	15.992	199.9	225	Circular	42.521	40.899	1.397	42.239	40.819	1.195
2.01	11.630	197.1	225	Circular	42.239	40.819	1.195	42.288	40.760	1.303
2.02	37.450	120.0	225	Circular Storm	42.300	40.983	1.092	41.662	40.671	0.766
2.03	54.029	120.1	225	Circular Storm	41.662	40.237	1.200	40.962	39.787	0.950
3.000	47.109	199.6	225	Circular	41.174	39.749	1.200	40.962	39.513	1.224
2.04	24.879	95.0	225	Circular Storm	40.962	39.513	1.224	40.694	39.251	1.218
2.05	19.523	398.4	300	Circular Storm	40.694	39.176	1.218	40.978	39.127	1.551
2.06	21.736	306.8	300	Circular Storm	40.978	39.127	1.551	40.968	39.056	1.612
1.05	18.549	250.7	375	Circular	40.968	38.981	1.612	40.624	38.907	1.342
1.06	29.988	249.9	375	Circular	40.624	38.907	1.342	39.222	38.787	0.060
2.002_1	13.742	280.5	225	Circular Storm	42.288	40.760	1.303	42.300	40.711	1.364

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.00	71	1200	Manhole	Adoptable	72	1200	Manhole	Adoptable
1.01	72	1200	Manhole	Adoptable	73	1200	Manhole	Adoptable
1.02	73	1200	Manhole	Adoptable	74	1200	Manhole	Adoptable
1.03	74	1200	Manhole	Adoptable	75	1200	Manhole	Adoptable
1.04	75	1200	Manhole	Adoptable	76	1350	Manhole	Adoptable
2.00	79	1200	Manhole	Adoptable	80	1200	Manhole	Adoptable
2.01	80	1200	Manhole	Adoptable	81	1200	Manhole	Adoptable
2.02	102	1200	Manhole	Adoptable	82	1200	Manhole	Adoptable
2.03	82	1200	Manhole	Adoptable	83	1200	Manhole	Adoptable
3.000	86	1200	Manhole	Adoptable	83	1200	Manhole	Adoptable
2.04	83	1200	Manhole	Adoptable	84	1200	Manhole	Adoptable
2.05	84	1200	Manhole	Adoptable	85	1200	Manhole	Adoptable
2.06	85	1200	Manhole	Adoptable	76	1350	Manhole	Adoptable
1.05	76	1350	Manhole	Adoptable	77	1350	Manhole	Adoptable
1.06	77	1350	Manhole	Adoptable	78	1350	Manhole	Adoptable
2.002_1	81	1200	Manhole	Adoptable	102	1200	Manhole	Adoptable

Simulation Settings

Rainfall Methodology	FSR	Additional Storage (m³/ha)	20.0
FSR Region	England and Wales	Check Discharge Rate(s)	✓
M5-60 (mm)	17.000	1 year (l/s)	22.6
Ratio-R	0.400	30 year (l/s)	44.3
Summer CV	0.750	100 year (l/s)	54.1
Analysis Speed	Normal	Check Discharge Volume	✓
Skip Steady State	x	100 year +20% 360 minute (m³)	1831
Drain Down Time (mins)	240		

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 %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	20	10	0	100	20	10	0
30	20	10	0				

Pre-development Discharge Rate

Site Makeup	Greenfield	SPR	0.47	Betterment (%)	10
Greenfield Method	IH124	Region	10	QBar	26.0
Positively Drained Area (ha)	7.990	Growth Factor 1 year	0.87	Q 1 year (l/s)	20.4
SAAR (mm)	500	Growth Factor 30 year	1.70	Q 30 year (l/s)	39.8
Soil Index	4	Growth Factor 100 year	2.08	Q 100 year (l/s)	48.7

Pre-development Discharge Volume

Site Makeup	Greenfield	SPR	0.47	Storm Duration (mins)	360
Greenfield Method	FSR/FEH	CWI	75.556	Betterment (%)	10
Positively Drained Area (ha)	7.990	Return Period (years)	100	PR	0.390
Soil Index	4	Climate Change (%)	20	Runoff Volume (m³)	1831

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Node 77 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	38.907	Product Number	CTL-SHE-0089-4300-1600-4300
Design Depth (m)	1.600	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	4.3	Min Node Diameter (mm)	1200

Node 77 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	38.907
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	150.0	0.0	1.500	150.0	0.0	1.501	0.0	0.0

Node 76 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	40.200	Slope (1:X)	300.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)		Depth (m)	0.750
Safety Factor	2.0	Width (m)	4.800	Inf Depth (m)	
Porosity	0.40	Length (m)	20.000		

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Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	5	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	Scotland and Ireland	Connection Type	Level Soffits
M5-60 (mm)	17.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
31	0.036	5.00	43.684	1200	606640.049	743262.239	1.482
32	0.027	5.00	44.086	1200	606633.466	743232.264	2.037
33	0.045	5.00	44.119	1200	606608.217	743224.246	2.202
34	0.084	5.00	43.420	1200	606558.021	743224.069	1.754
35	0.005	5.00	42.350	1200	606480.860	743224.014	1.301
36	0.051	5.00	42.400	1200	606471.771	743232.034	1.412
37	0.000		42.409	1200	606471.511	743255.817	1.651
40	0.051	5.00	44.317	1200	606616.170	743283.484	1.467
41	0.030	5.00	44.181	1200	606576.573	743276.395	1.532
42	0.089	5.00	42.899	1200	606498.947	743276.545	1.910
43	0.005	5.00	42.572	1200	606470.950	743268.668	1.916
38	0.000		42.409	1200	606462.059	743255.674	1.933
39			42.243	1200	606453.413	743214.290	1.941
44	0.000		42.300	1200	606455.284	743223.701	1.958

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	31	32	30.689	0.600	42.202	42.049	0.153	200.6	225	5.56	50.0
1.01	32	33	26.492	0.600	42.049	41.917	0.132	200.7	225	6.04	50.0
1.02	33	34	50.196	0.600	41.917	41.666	0.251	200.0	225	6.95	50.0
1.03	34	35	77.161	0.600	41.666	41.049	0.617	125.1	225	8.05	50.0
1.04	35	36	12.121	0.600	41.049	40.988	0.061	198.7	225	8.27	50.0
1.05	36	37	23.784	0.600	40.988	40.758	0.230	103.3	225	8.57	50.0
1.06	37	38	9.453	0.600	40.758	40.711	0.047	201.1	225	8.75	50.0
2.000	40	41	40.227	0.600	42.850	42.649	0.201	200.1	225	5.73	50.0
2.01	41	42	77.626	0.600	42.649	40.989	1.660	46.8	225	6.40	50.0
2.02	42	43	29.084	0.600	40.989	40.656	0.333	87.4	225	6.75	50.0
2.03	43	38	15.745	0.600	40.656	40.551	0.105	149.9	225	7.00	50.0
1.07	38	44	32.683	0.600	40.476	40.342	0.134	243.9	300	9.29	50.0
1.08	44	39	9.595	0.600	40.342	40.302	0.040	239.9	300	9.45	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	0.919	36.6	4.9	1.257	1.812	0.036	0.0	55	0.640
1.001	0.919	36.5	8.5	1.812	1.977	0.063	0.0	73	0.750
1.002	0.921	36.6	14.6	1.977	1.529	0.108	0.0	99	0.870
1.003	1.167	46.4	26.0	1.529	1.076	0.192	0.0	121	1.201
1.004	0.924	36.7	26.7	1.076	1.187	0.197	0.0	143	1.006
1.005	1.286	51.1	33.6	1.187	1.426	0.248	0.0	133	1.369
1.006	0.918	36.5	33.6	1.426	1.473	0.248	0.0	171	1.038
2.000	0.920	36.6	6.9	1.242	1.307	0.051	0.0	66	0.712
2.001	1.918	76.2	11.0	1.307	1.685	0.081	0.0	58	1.374
2.002	1.399	55.6	23.0	1.685	1.691	0.170	0.0	101	1.334
2.003	1.065	42.4	23.7	1.691	1.633	0.175	0.0	121	1.096
1.007	1.002	70.8	57.3	1.633	1.658	0.423	0.0	205	1.111
1.008	1.011	71.4	57.3	1.658	1.641	0.423	0.0	204	1.119

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Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	30.689	200.6	225	Circular	43.684	42.202	1.257	44.086	42.049	1.812
1.01	26.492	200.7	225	Circular	44.086	42.049	1.812	44.119	41.917	1.977
1.02	50.196	200.0	225	Circular	44.119	41.917	1.977	43.420	41.666	1.529
1.03	77.161	125.1	225	Circular	43.420	41.666	1.529	42.350	41.049	1.076
1.04	12.121	198.7	225	Circular	42.350	41.049	1.076	42.400	40.988	1.187
1.05	23.784	103.3	225	Circular	42.400	40.988	1.187	42.409	40.758	1.426
1.06	9.453	201.1	225	Circular	42.409	40.758	1.426	42.409	40.711	1.473
2.000	40.227	200.1	225	Circular	44.317	42.850	1.242	44.181	42.649	1.307
2.01	77.626	46.8	225	Circular	44.181	42.649	1.307	42.899	40.989	1.685
2.02	29.084	87.4	225	Circular	42.899	40.989	1.685	42.572	40.656	1.691
2.03	15.745	149.9	225	Circular	42.572	40.656	1.691	42.409	40.551	1.633
1.07	32.683	243.9	300	Circular	42.409	40.476	1.633	42.300	40.342	1.658
1.08	9.595	239.9	300	Circular	42.300	40.342	1.658	42.243	40.302	1.641

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.00	31	1200	Manhole	Adoptable	32	1200	Manhole	Adoptable
1.01	32	1200	Manhole	Adoptable	33	1200	Manhole	Adoptable
1.02	33	1200	Manhole	Adoptable	34	1200	Manhole	Adoptable
1.03	34	1200	Manhole	Adoptable	35	1200	Manhole	Adoptable
1.04	35	1200	Manhole	Adoptable	36	1200	Manhole	Adoptable
1.05	36	1200	Manhole	Adoptable	37	1200	Manhole	Adoptable
1.06	37	1200	Manhole	Adoptable	38	1200	Manhole	Adoptable
2.00	40	1200	Manhole	Adoptable	41	1200	Manhole	Adoptable
2.01	41	1200	Manhole	Adoptable	42	1200	Manhole	Adoptable
2.02	42	1200	Manhole	Adoptable	43	1200	Manhole	Adoptable
2.03	43	1200	Manhole	Adoptable	38	1200	Manhole	Adoptable
1.07	38	1200	Manhole	Adoptable	44	1200	Manhole	Adoptable
1.08	44	1200	Manhole	Adoptable	39	1200	Manhole	Adoptable

Simulation Settings

Rainfall Methodology	FSR	Additional Storage (m³/ha)	20.0
FSR Region	England and Wales	Check Discharge Rate(s)	✓
M5-60 (mm)	17.000	1 year (l/s)	22.6
Ratio-R	0.400	30 year (l/s)	44.3
Summer CV	0.750	100 year (l/s)	54.1
Analysis Speed	Normal	Check Discharge Volume	✓
Skip Steady State	x	100 year +20% 360 minute (m³)	1831
Drain Down Time (mins)	240		

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 %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	20	10	0	100	20	10	0
30	20	10	0				

Pre-development Discharge Rate

Site Makeup	Greenfield	SPR	0.47	Betterment (%)	10
Greenfield Method	IH124	Region	10	QBar	26.0
Positively Drained Area (ha)	7.990	Growth Factor 1 year	0.87	Q 1 year (l/s)	20.4
SAAR (mm)	500	Growth Factor 30 year	1.70	Q 30 year (l/s)	39.8
Soil Index	4	Growth Factor 100 year	2.08	Q 100 year (l/s)	48.7

Pre-development Discharge Volume

Site Makeup	Greenfield	SPR	0.47	Storm Duration (mins)	360
Greenfield Method	FSR/FEH	CWI	75.556	Betterment (%)	10
Positively Drained Area (ha)	7.990	Return Period (years)	100	PR	0.390
Soil Index	4	Climate Change (%)	20	Runoff Volume (m³)	1831

Node 44 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	40.342	Product Number	CTL-SHE-0070-2500-1350-2500
Design Depth (m)	1.350	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.5	Min Node Diameter (mm)	1200

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Node 44 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	40.342
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	100.0	0.0	1.500	100.0	0.0	1.501	0.0	0.0

Node 34 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	42.700	Slope (1:X)	200.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)		Depth (m)	
Safety Factor	2.0	Width (m)	2.400	Inf Depth (m)	
Porosity	0.40	Length (m)	60.000		

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APPENDIX E FOUL SEWER CALCULATIONS

Design Settings

Frequency of use (kDU)	1.00	Additional Flow (%)	0	Preferred Cover Depth (m)	1.200
Flow per dwelling per day (l/day)	4000	Minimum Velocity (m/s)	0.75	Include Intermediate Ground	✓
Domestic Flow (l/s/ha)	10.0	Connection Type	Level Soffits		
Industrial Flow (l/s/ha)	5.0	Minimum Backdrop Height (m)	0.200		

Nodes

Name	Dwellings	Cover Level (m)	Manhole Type	Easting (m)	Northing (m)	Depth (m)
1	14	44.995	Adoptable	606565.786	743052.269	1.425
2	0	44.288	Adoptable	606522.828	743064.949	1.241
62	6	44.168	Adoptable	606510.212	743119.395	2.490
3	8	43.996	Adoptable	606508.027	743081.167	2.776
4	3	43.022	Adoptable	606419.943	743081.621	2.242
5	12	43.011	Adoptable	606416.178	743087.702	2.267
16	6	44.198	Adoptable	606599.996	743196.074	2.254
17	2	44.500	Adoptable	606599.317	743150.617	3.086
18	0	44.497	Adoptable	606593.405	743146.450	3.119
21	11	43.396	Adoptable	606536.109	743199.900	1.384
19	0	43.534	Adoptable	606542.309	743146.604	2.411
22	31	42.590	Adoptable	606472.470	743200.090	2.012
20	11	43.018	Adoptable	606471.001	743146.602	2.901
23	7	42.664	Adoptable	606417.200	743200.150	1.476
6	0	42.353	Adoptable	606416.608	743146.718	2.508
24	20	41.707	Adoptable	606352.229	743195.793	2.365
25	4	42.112	Adoptable	606354.656	743036.419	1.501
27	8	42.149	Adoptable	606384.545	743068.684	1.369
26	10	41.783	Adoptable	606352.078	743068.849	1.403
7	0	41.555	Adoptable	606352.198	743146.582	2.459
8	0	41.442	Adoptable	606317.300	743146.715	2.520
9	0	41.297	Adoptable	606296.879	743149.227	2.477
10	0	41.204	Adoptable	606284.022	743166.491	2.491
11	4	40.817	Adoptable	606271.720	743211.879	2.339
12	0	40.405	Adoptable	606269.167	743224.694	1.993
13	0	40.336	Adoptable	606258.844	743311.850	2.363
28	2	43.761	Adoptable	606638.535	743264.924	1.447
29	0	44.103	Adoptable	606631.938	743233.522	2.185
30	8	44.082	Adoptable	606606.357	743226.640	2.296
31	8	43.329	Adoptable	606545.434	743226.739	1.848
32	0	42.044	Adoptable	606480.108	743226.545	1.425
33	5	42.080	Adoptable	606474.196	743233.620	1.507
45	3	44.304	Adoptable	606614.226	743280.681	3.097
46	6	44.138	Adoptable	606577.984	743274.347	3.620
47	0	42.954	Adoptable	606501.382	743274.238	2.819
34	0	42.587	Adoptable	606474.196	743266.671	2.593
59	9	42.127	Adoptable	606450.319	743236.027	1.529
35	0	42.527	Adoptable	606450.462	743266.281	2.652
36	8	42.274	Adoptable	606449.667	743283.749	2.486
37	10	42.257	Adoptable	606446.896	743294.004	2.523
38	8	41.604	Adoptable	606397.588	743288.199	2.160
60	8	42.307	Adoptable	606409.215	743226.857	1.564
61	26	41.291	Adoptable	606343.181	743228.007	1.724
48	0	41.157	Adoptable	606343.283	743256.611	1.733
39	0	40.914	Adoptable	606343.600	743288.009	1.740
40	2	40.747	Adoptable	606318.334	743288.389	1.699
41	12	40.666	Adoptable	606318.313	743303.402	1.693
49	5	42.124	Adoptable	606431.286	743326.179	1.715
50	2	42.019	Adoptable	606412.183	743379.190	2.248
51	6	41.990	Adoptable	606402.150	743383.069	2.273
53	7	41.583	Adoptable	606374.075	743317.360	1.422
52	6	41.236	Adoptable	606356.684	743369.106	1.832
42	12	40.502	Adoptable	606301.810	743351.658	1.784
54	2	41.825	Adoptable	606343.604	743401.879	2.329
55	4	41.298	Adoptable	606318.904	743437.761	2.313
56	0	40.296	Adoptable	606290.414	743429.420	1.459
58	8	40.848	Adoptable	606277.967	743443.626	1.828
57	12	40.228	Adoptable	606284.809	743423.033	1.500
43	1	40.648	Adoptable	606289.093	743397.538	2.168
44	0	40.073	Adoptable	606251.438	743387.157	1.788
14	0	40.166	Adoptable	606240.901	743401.136	2.648
15		40.075	Adoptable	606237.509	743404.698	2.582
63		42.300	Adoptable	606434.811	743299.698	2.640
64		43.499	Adoptable	606528.765	743160.347	2.528

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Nodes

Name	Dwellings	Cover Level (m)	Manhole Type	Easting (m)	Northing (m)	Depth (m)
65		43.510	Adoptable	606536.131	743164.665	1.925
66		42.810	Adoptable	606471.657	743160.767	2.429

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)
1.000	1	2	44.790	1.500	43.570	43.122	0.448	100.0	150
1.001	2	3	21.957	1.500	43.047	42.937	0.110	199.6	225
21.000	62	3	38.290	1.500	41.678	41.295	0.383	100.0	150
1.002	3	4	88.085	1.500	41.220	40.780	0.440	200.2	225
1.003	4	5	7.152	1.500	40.780	40.744	0.036	198.7	225
1.004	5	6	59.018	1.500	40.744	40.449	0.295	200.1	225
2.000	16	17	45.462	1.500	41.944	41.489	0.455	99.9	150
2.001	17	18	7.233	1.500	41.414	41.378	0.036	200.9	225
2.002	18	19	51.096	1.500	41.378	41.123	0.255	200.2	225
3.000	21	65	35.235	1.500	42.012	41.660	0.352	100.0	150
2.003	19	64	19.295	1.500	41.123	41.026	0.097	199.9	225
4.000	22	66	39.331	1.500	40.578	40.381	0.197	199.7	225
2.004	20	6	54.393	0.006	40.117	39.845	0.272	200.0	225
5.000	23	6	53.435	1.500	41.188	40.921	0.267	200.1	225
1.005	6	7	64.410	0.006	39.845	39.523	0.322	200.0	225
6.000	24	7	49.211	1.500	39.342	39.096	0.246	200.0	225
7.000	25	26	32.532	1.500	40.611	40.448	0.163	199.6	225
8.000	27	26	32.467	1.500	40.780	40.455	0.325	99.9	150
7.001	26	7	77.733	1.500	40.380	39.603	0.777	100.0	225
1.006	7	8	34.898	0.006	39.096	38.922	0.174	200.6	225
1.007	8	9	20.575	0.006	38.922	38.820	0.102	200.9	225
1.008	9	10	21.526	0.006	38.820	38.713	0.107	200.4	225
1.009	10	11	47.026	0.006	38.713	38.478	0.235	199.9	225
1.010	11	12	13.067	0.006	38.478	38.412	0.066	198.0	225
1.011	12	13	87.765	0.006	38.412	37.973	0.439	199.9	225
1.012	13	14	91.071	0.006	37.973	37.518	0.455	200.2	225
9.000	28	29	32.087	1.500	42.314	41.993	0.321	100.0	150
9.001	29	30	26.491	1.500	41.918	41.786	0.132	200.7	225
9.002	30	31	60.923	1.500	41.786	41.481	0.305	199.7	225
9.003	31	32	65.326	1.500	41.481	41.154	0.327	199.8	225

Name	Pro Vel @ 1/3 Q (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Dwellings (ha)	Σ Units (ha)	Σ Add Inflow (ha)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	0.297	0.876	15.5	0.6	1.275	1.016	0.000	14	0.0	0.0	21	0.427
1.001	0.223	0.811	32.2	0.6	1.016	0.834	0.000	14	0.0	0.0	22	0.316
21.000	0.223	0.876	15.5	0.3	2.340	2.551	0.000	6	0.0	0.0	14	0.326
1.002	0.281	0.810	32.2	1.3	2.551	2.017	0.000	28	0.0	0.0	31	0.393
1.003	0.291	0.813	32.3	1.4	2.017	2.042	0.000	31	0.0	0.0	32	0.402
1.004	0.316	0.810	32.2	2.0	2.042	1.679	0.000	43	0.0	0.0	38	0.448
2.000	0.223	0.876	15.5	0.3	2.104	2.861	0.000	6	0.0	0.0	14	0.326
2.001	0.179	0.808	32.1	0.4	2.861	2.894	0.000	8	0.0	0.0	17	0.262
2.002	0.179	0.810	32.2	0.4	2.894	2.186	0.000	8	0.0	0.0	17	0.262
3.000	0.277	0.876	15.5	0.5	1.234	1.700	0.000	11	0.0	0.0	19	0.395
2.003	0.179	0.810	32.2	0.4	2.186	2.248	0.000	8	0.0	0.0	17	0.263
4.000	0.290	0.811	32.2	1.4	1.787	2.204	0.000	31	0.0	0.0	33	0.408
2.004	0.467	1.213	48.2	2.8	2.676	2.283	0.000	61	0.0	0.0	37	0.666
5.000	0.179	0.810	32.2	0.3	1.251	1.207	0.000	7	0.0	0.0	16	0.253
1.005	0.573	1.213	48.2	5.1	2.283	1.807	0.000	111	0.0	0.0	50	0.792
6.000	0.253	0.810	32.2	0.9	2.140	2.234	0.000	20	0.0	0.0	27	0.356
7.000	0.143	0.811	32.2	0.2	1.276	1.110	0.000	4	0.0	0.0	13	0.213
8.000	0.246	0.876	15.5	0.4	1.219	1.178	0.000	8	0.0	0.0	16	0.353
7.001	0.332	1.147	45.6	1.0	1.178	1.727	0.000	22	0.0	0.0	23	0.460
1.006	0.625	1.211	48.2	7.1	2.234	2.295	0.000	153	0.0	0.0	58	0.869
1.007	0.625	1.210	48.1	7.1	2.295	2.252	0.000	153	0.0	0.0	58	0.869
1.008	0.626	1.212	48.2	7.1	2.252	2.266	0.000	153	0.0	0.0	58	0.870
1.009	0.626	1.213	48.2	7.1	2.266	2.114	0.000	153	0.0	0.0	58	0.871
1.010	0.630	1.220	48.5	7.3	2.114	1.768	0.000	157	0.0	0.0	58	0.876
1.011	0.637	1.213	48.2	7.3	1.768	2.138	0.000	157	0.0	0.0	59	0.878
1.012	0.636	1.212	48.2	7.3	2.138	2.423	0.000	157	0.0	0.0	59	0.878
9.000	0.161	0.876	15.5	0.1	1.297	1.960	0.000	2	0.0	0.0	8	0.223
9.001	0.115	0.809	32.1	0.1	1.960	2.071	0.000	2	0.0	0.0	9	0.167
9.002	0.202	0.811	32.2	0.5	2.071	1.623	0.000	10	0.0	0.0	19	0.281
9.003	0.243	0.810	32.2	0.8	1.623	0.665	0.000	18	0.0	0.0	25	0.341

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Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)
9.004	32	33	9.220	1.500	40.619	40.573	0.046	200.4	225
9.005	33	34	33.051	1.500	40.573	40.408	0.165	200.3	225
10.000	45	46	36.791	1.500	41.207	40.593	0.614	59.9	150
10.001	46	47	76.602	1.500	40.518	40.135	0.383	200.0	225
10.002	47	34	28.219	1.500	40.135	39.994	0.141	200.1	225
9.006	34	35	23.737	1.500	39.994	39.875	0.119	199.5	225
16.000	59	35	30.254	1.500	40.598	40.447	0.151	200.4	225
9.007	35	36	17.486	1.500	39.875	39.788	0.087	201.0	225
9.008	36	37	10.623	1.500	39.788	39.734	0.054	197.2	225
10.009	37	63	13.359	0.006	39.734	39.660	0.074	180.0	225
9.010	38	39	53.988	0.006	39.444	39.174	0.270	199.8	225
11.000	60	61	66.044	1.500	40.743	39.642	1.101	60.0	150
11.001	61	48	28.604	1.500	39.567	39.424	0.143	200.0	225
11.002	48	39	31.400	1.500	39.424	39.267	0.157	200.0	225
9.011	39	40	25.269	0.006	39.174	39.048	0.126	200.5	225
9.012	40	41	15.013	0.006	39.048	38.973	0.075	200.2	225
9.013	41	42	51.000	0.006	38.973	38.718	0.255	200.0	225
12.000	49	50	56.348	1.500	40.409	39.846	0.563	100.1	150
12.001	50	51	10.757	1.500	39.771	39.717	0.054	199.2	225
12.002	51	52	47.562	1.500	39.717	39.479	0.238	199.8	225
13.000	53	52	54.590	1.500	40.161	39.479	0.682	80.0	150
12.003	52	42	57.581	1.500	39.404	39.116	0.288	199.9	225
9.014	42	43	47.610	0.006	38.718	38.480	0.238	200.0	225
14.000	54	55	43.562	1.500	39.496	39.060	0.436	99.9	150
14.001	55	56	29.686	1.500	38.985	38.837	0.148	200.6	225
14.002	56	57	8.498	1.500	38.837	38.795	0.042	202.3	225
15.000	58	57	21.700	1.500	39.020	38.803	0.217	100.0	150
14.003	57	43	25.852	1.500	38.728	38.599	0.129	200.4	225
9.015	43	44	39.060	0.006	38.480	38.285	0.195	200.3	225
9.016	44	14	17.505	0.006	38.285	38.197	0.088	198.9	225
1.013	14	15	4.919	0.006	37.518	37.493	0.025	196.7	225
10.010	63	38	38.959	0.006	39.660	39.444	0.216	180.0	225
2.001_1	65	64	8.538	0.006	41.585	40.971	0.614	13.9	225
1.004_1	64	66	57.110	0.006	40.971	40.654	0.317	180.0	225

Name	Pro Vel @ 1/3 Q (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Dwellings (ha)	Σ Units (ha)	Σ Add Inflow (ha)	Pro Depth (mm)	Pro Velocity (m/s)
9.004	0.243	0.809	32.2	0.8	1.200	1.282	0.000	18	0.0	0.0	25	0.340
9.005	0.262	0.809	32.2	1.1	1.282	1.954	0.000	23	0.0	0.0	29	0.371
10.000	0.210	1.133	20.0	0.1	2.947	3.395	0.000	3	0.0	0.0	9	0.304
10.001	0.191	0.810	32.2	0.4	3.395	2.594	0.000	9	0.0	0.0	18	0.272
10.002	0.191	0.810	32.2	0.4	2.594	2.368	0.000	9	0.0	0.0	18	0.272
9.006	0.290	0.811	32.2	1.5	2.368	2.427	0.000	32	0.0	0.0	33	0.408
16.000	0.191	0.809	32.2	0.4	1.304	1.855	0.000	9	0.0	0.0	18	0.272
9.007	0.315	0.808	32.1	1.9	2.427	2.261	0.000	41	0.0	0.0	37	0.440
9.008	0.335	0.816	32.4	2.3	2.261	2.298	0.000	49	0.0	0.0	41	0.470
10.009	0.482	1.285	51.1	2.7	2.298	2.415	0.000	59	0.0	0.0	36	0.686
9.010	0.492	1.214	48.3	3.1	1.935	1.515	0.000	67	0.0	0.0	38	0.676
11.000	0.290	1.132	20.0	0.4	1.414	1.499	0.000	8	0.0	0.0	14	0.422
11.001	0.299	0.810	32.2	1.6	1.499	1.508	0.000	34	0.0	0.0	34	0.415
11.002	0.299	0.810	32.2	1.6	1.508	1.422	0.000	34	0.0	0.0	34	0.415
9.011	0.550	1.211	48.2	4.7	1.515	1.474	0.000	101	0.0	0.0	47	0.766
9.012	0.551	1.212	48.2	4.8	1.474	1.468	0.000	103	0.0	0.0	48	0.775
9.013	0.573	1.213	48.2	5.3	1.468	1.559	0.000	115	0.0	0.0	51	0.800
12.000	0.211	0.875	15.5	0.2	1.565	2.023	0.000	5	0.0	0.0	13	0.307
12.001	0.180	0.812	32.3	0.3	2.023	2.048	0.000	7	0.0	0.0	16	0.254
12.002	0.213	0.810	32.2	0.6	2.048	1.532	0.000	13	0.0	0.0	22	0.308
13.000	0.263	0.980	17.3	0.3	1.272	1.607	0.000	7	0.0	0.0	14	0.365
12.003	0.272	0.810	32.2	1.2	1.607	1.161	0.000	26	0.0	0.0	30	0.386
9.014	0.626	1.213	48.2	7.1	1.559	1.943	0.000	153	0.0	0.0	58	0.871
14.000	0.161	0.876	15.5	0.1	2.179	2.088	0.000	2	0.0	0.0	8	0.223
14.001	0.167	0.809	32.2	0.3	2.088	1.234	0.000	6	0.0	0.0	15	0.243
14.002	0.167	0.805	32.0	0.3	1.234	1.208	0.000	6	0.0	0.0	15	0.242
15.000	0.246	0.876	15.5	0.4	1.678	1.275	0.000	8	0.0	0.0	16	0.353
14.003	0.272	0.809	32.2	1.2	1.275	1.824	0.000	26	0.0	0.0	30	0.386
9.015	0.656	1.212	48.2	8.3	1.943	1.563	0.000	180	0.0	0.0	63	0.906
9.016	0.659	1.217	48.4	8.3	1.563	1.744	0.000	180	0.0	0.0	63	0.910
1.013	0.799	1.224	48.7	15.6	2.423	2.357	0.000	337	0.0	0.0	87	1.091
10.010	0.482	1.285	51.1	2.7	2.415	1.935	0.000	59	0.0	0.0	36	0.686
2.001_1	0.750	5.146	204.6	0.5	1.700	2.303	0.000	11	0.0	0.0	8	1.102
1.004_1	0.346	1.285	51.1	0.9	2.303	1.931	0.000	19	0.0	0.0	21	0.482

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Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)
1.005_1	66	20	14.180	0.006	40.381	40.117	0.264	53.7	225

Name	Pro Vel @ 1/3 Q (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Dwellings (ha)	Σ Units (ha)	Σ Add Inflow (ha)	Pro Depth (mm)	Pro Velocity (m/s)
1.005_1	0.751	2.485	98.8	2.3	2.204	2.676	0.000	50	0.0	0.0	23	1.027

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	44.790	100.0	150	Circular_Default Sewer Type	44.995	43.570	1.275	44.288	43.122	1.016
1.001	21.957	199.6	225	Circular_Default Sewer Type	44.288	43.047	1.016	43.996	42.937	0.834
21.000	38.290	100.0	150	Circular	44.168	41.678	2.340	43.996	41.295	2.551
1.002	88.085	200.2	225	Circular_Default Sewer Type	43.996	41.220	2.551	43.022	40.780	2.017
1.003	7.152	198.7	225	Circular_Default Sewer Type	43.022	40.780	2.017	43.011	40.744	2.042
1.004	59.018	200.1	225	Circular_Default Sewer Type	43.011	40.744	2.042	42.353	40.449	1.679
2.000	45.462	99.9	150	Circular	44.198	41.944	2.104	44.500	41.489	2.861
2.001	7.233	200.9	225	Circular	44.500	41.414	2.861	44.497	41.378	2.894
2.002	51.096	200.2	225	Circular	44.497	41.378	2.894	43.534	41.123	2.186
3.000	35.235	100.0	150	Circular	43.396	42.012	1.234	43.510	41.660	1.700
2.003	19.295	199.9	225	Circular	43.534	41.123	2.186	43.499	41.026	2.248
4.000	39.331	199.7	225	Circular	42.590	40.578	1.787	42.810	40.381	2.204
2.004	54.393	200.0	225	Circular Storm	43.018	40.117	2.676	42.353	39.845	2.283
5.000	53.435	200.1	225	Circular	42.664	41.188	1.251	42.353	40.921	1.207
1.005	64.410	200.0	225	Circular Storm	42.353	39.845	2.283	41.555	39.523	1.807
6.000	49.211	200.0	225	Circular	41.707	39.342	2.140	41.555	39.096	2.234
7.000	32.532	199.6	225	Circular	42.112	40.611	1.276	41.783	40.448	1.110
8.000	32.467	99.9	150	Circular	42.149	40.780	1.219	41.783	40.455	1.178
7.001	77.733	100.0	225	Circular	41.783	40.380	1.178	41.555	39.603	1.727
1.006	34.898	200.6	225	Circular Storm	41.555	39.096	2.234	41.442	38.922	2.295
1.007	20.575	200.9	225	Circular Storm	41.442	38.922	2.295	41.297	38.820	2.252
1.008	21.526	200.4	225	Circular Storm	41.297	38.820	2.252	41.204	38.713	2.266
1.009	47.026	199.9	225	Circular Storm	41.204	38.713	2.266	40.817	38.478	2.114
1.010	13.067	198.0	225	Circular Storm	40.817	38.478	2.114	40.405	38.412	1.768
1.011	87.765	199.9	225	Circular Storm	40.405	38.412	1.768	40.336	37.973	2.138
1.012	91.071	200.2	225	Circular Storm	40.336	37.973	2.138	40.166	37.518	2.423
9.000	32.087	100.0	150	Circular	43.761	42.314	1.297	44.103	41.993	1.960
9.001	26.491	200.7	225	Circular	44.103	41.918	1.960	44.082	41.786	2.071
9.002	60.923	199.7	225	Circular	44.082	41.786	2.071	43.329	41.481	1.623

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	1	1200	Manhole	Adoptable	2	1200	Manhole	Adoptable
1.001	2	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable
21.000	62	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable
1.002	3	1200	Manhole	Adoptable	4	1200	Manhole	Adoptable
1.003	4	1200	Manhole	Adoptable	5	1200	Manhole	Adoptable
1.004	5	1200	Manhole	Adoptable	6	1200	Manhole	Adoptable
2.000	16	1200	Manhole	Adoptable	17	1200	Manhole	Adoptable
2.001	17	1200	Manhole	Adoptable	18	1200	Manhole	Adoptable
2.002	18	1200	Manhole	Adoptable	19	1200	Manhole	Adoptable
3.000	21	1200	Manhole	Adoptable	65	1200	Manhole	Adoptable
2.003	19	1200	Manhole	Adoptable	64	1200	Manhole	Adoptable
4.000	22	1200	Manhole	Adoptable	66	1200	Manhole	Adoptable
2.004	20	1200	Manhole	Adoptable	6	1200	Manhole	Adoptable
5.000	23	1200	Manhole	Adoptable	6	1200	Manhole	Adoptable
1.005	6	1200	Manhole	Adoptable	7	1200	Manhole	Adoptable
6.000	24	1200	Manhole	Adoptable	7	1200	Manhole	Adoptable
7.000	25	1200	Manhole	Adoptable	26	1200	Manhole	Adoptable
8.000	27	1200	Manhole	Adoptable	26	1200	Manhole	Adoptable
7.001	26	1200	Manhole	Adoptable	7	1200	Manhole	Adoptable
1.006	7	1200	Manhole	Adoptable	8	1200	Manhole	Adoptable
1.007	8	1200	Manhole	Adoptable	9	1200	Manhole	Adoptable
1.008	9	1200	Manhole	Adoptable	10	1200	Manhole	Adoptable
1.009	10	1200	Manhole	Adoptable	11	1200	Manhole	Adoptable
1.010	11	1200	Manhole	Adoptable	12	1200	Manhole	Adoptable
1.011	12	1200	Manhole	Adoptable	13	1200	Manhole	Adoptable
1.012	13	1200	Manhole	Adoptable	14	1200	Manhole	Adoptable
9.000	28	1200	Manhole	Adoptable	29	1200	Manhole	Adoptable
9.001	29	1200	Manhole	Adoptable	30	1200	Manhole	Adoptable
9.002	30	1200	Manhole	Adoptable	31	1200	Manhole	Adoptable

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Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
9.003	65.326	199.8	225	Circular	43.329	41.481	1.623	42.044	41.154	0.665
9.004	9.220	200.4	225	Circular	42.044	40.619	1.200	42.080	40.573	1.282
9.005	33.051	200.3	225	Circular	42.080	40.573	1.282	42.587	40.408	1.954
10.000	36.791	59.9	150	Circular	44.304	41.207	2.947	44.138	40.593	3.395
10.001	76.602	200.0	225	Circular	44.138	40.518	3.395	42.954	40.135	2.594
10.002	28.219	200.1	225	Circular	42.954	40.135	2.594	42.587	39.994	2.368
9.006	23.737	199.5	225	Circular	42.587	39.994	2.368	42.527	39.875	2.427
16.000	30.254	200.4	225	Circular	42.127	40.598	1.304	42.527	40.447	1.855
9.007	17.486	201.0	225	Circular	42.527	39.875	2.427	42.274	39.788	2.261
9.008	10.623	197.2	225	Circular	42.274	39.788	2.261	42.257	39.734	2.298
10.009	13.359	180.0	225	Circular Storm	42.257	39.734	2.298	42.300	39.660	2.415
9.010	53.988	199.8	225	Circular Storm	41.604	39.444	1.935	40.914	39.174	1.515
11.000	66.044	60.0	150	Circular	42.307	40.743	1.414	41.291	39.642	1.499
11.001	28.604	200.0	225	Circular	41.291	39.567	1.499	41.157	39.424	1.508
11.002	31.400	200.0	225	Circular	41.157	39.424	1.508	40.914	39.267	1.422
9.011	25.269	200.5	225	Circular Storm	40.914	39.174	1.515	40.747	39.048	1.474
9.012	15.013	200.2	225	Circular Storm	40.747	39.048	1.474	40.666	38.973	1.468
9.013	51.000	200.0	225	Circular Storm	40.666	38.973	1.468	40.502	38.718	1.559
12.000	56.348	100.1	150	Circular	42.124	40.409	1.565	42.019	39.846	2.023
12.001	10.757	199.2	225	Circular	42.019	39.771	2.023	41.990	39.717	2.048
12.002	47.562	199.8	225	Circular	41.990	39.717	2.048	41.236	39.479	1.532
13.000	54.590	80.0	150	Circular	41.583	40.161	1.272	41.236	39.479	1.607
12.003	57.581	199.9	225	Circular	41.236	39.404	1.607	40.502	39.116	1.161
9.014	47.610	200.0	225	Circular Storm	40.502	38.718	1.559	40.648	38.480	1.943
14.000	43.562	99.9	150	Circular	41.825	39.496	2.179	41.298	39.060	2.088
14.001	29.686	200.6	225	Circular	41.298	38.985	2.088	40.296	38.837	1.234
14.002	8.498	202.3	225	Circular	40.296	38.837	1.234	40.228	38.795	1.208
15.000	21.700	100.0	150	Circular	40.848	39.020	1.678	40.228	38.803	1.275
14.003	25.852	200.4	225	Circular	40.228	38.728	1.275	40.648	38.599	1.824
9.015	39.060	200.3	225	Circular Storm	40.648	38.480	1.943	40.073	38.285	1.563
9.016	17.505	198.9	225	Circular Storm	40.073	38.285	1.563	40.166	38.197	1.744
1.013	4.919	196.7	225	Circular Storm	40.166	37.518	2.423	40.075	37.493	2.357
10.010	38.959	180.0	225	Circular Storm	42.300	39.660	2.415	41.604	39.444	1.935
2.001_1	8.538	13.9	225	Circular Storm	43.510	41.585	1.700	43.499	40.971	2.303

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
9.003	31	1200	Manhole	Adoptable	32	1200	Manhole	Adoptable
9.004	32	1200	Manhole	Adoptable	33	1200	Manhole	Adoptable
9.005	33	1200	Manhole	Adoptable	34	1200	Manhole	Adoptable
10.000	45	1200	Manhole	Adoptable	46	1200	Manhole	Adoptable
10.001	46	1200	Manhole	Adoptable	47	1200	Manhole	Adoptable
10.002	47	1200	Manhole	Adoptable	34	1200	Manhole	Adoptable
9.006	34	1200	Manhole	Adoptable	35	1200	Manhole	Adoptable
16.000	59	1200	Manhole	Adoptable	35	1200	Manhole	Adoptable
9.007	35	1200	Manhole	Adoptable	36	1200	Manhole	Adoptable
9.008	36	1200	Manhole	Adoptable	37	1200	Manhole	Adoptable
10.009	37	1200	Manhole	Adoptable	63	1200	Manhole	Adoptable
9.010	38	1200	Manhole	Adoptable	39	1200	Manhole	Adoptable
11.000	60	1200	Manhole	Adoptable	61	1200	Manhole	Adoptable
11.001	61	1200	Manhole	Adoptable	48	1200	Manhole	Adoptable
11.002	48	1200	Manhole	Adoptable	39	1200	Manhole	Adoptable
9.011	39	1200	Manhole	Adoptable	40	1200	Manhole	Adoptable
9.012	40	1200	Manhole	Adoptable	41	1200	Manhole	Adoptable
9.013	41	1200	Manhole	Adoptable	42	1200	Manhole	Adoptable
12.000	49	1200	Manhole	Adoptable	50	1200	Manhole	Adoptable
12.001	50	1200	Manhole	Adoptable	51	1200	Manhole	Adoptable
12.002	51	1200	Manhole	Adoptable	52	1200	Manhole	Adoptable
13.000	53	1200	Manhole	Adoptable	52	1200	Manhole	Adoptable
12.003	52	1200	Manhole	Adoptable	42	1200	Manhole	Adoptable
9.014	42	1200	Manhole	Adoptable	43	1200	Manhole	Adoptable
14.000	54	1200	Manhole	Adoptable	55	1200	Manhole	Adoptable
14.001	55	1200	Manhole	Adoptable	56	1200	Manhole	Adoptable
14.002	56	1200	Manhole	Adoptable	57	1200	Manhole	Adoptable
15.000	58	1200	Manhole	Adoptable	57	1200	Manhole	Adoptable
14.003	57	1200	Manhole	Adoptable	43	1200	Manhole	Adoptable
9.015	43	1200	Manhole	Adoptable	44	1200	Manhole	Adoptable
9.016	44	1200	Manhole	Adoptable	14	1200	Manhole	Adoptable
1.013	14	1200	Manhole	Adoptable	15	1200	Manhole	Adoptable
10.010	63	1200	Manhole	Adoptable	38	1200	Manhole	Adoptable
2.001_1	65	1200	Manhole	Adoptable	64	1200	Manhole	Adoptable

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Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.04 _1	57.110	180.0	225	Circular Storm	43.499	40.971	2.303	42.810	40.654	1.931
1.05 _1	14.180	53.7	225	Circular Storm	42.810	40.381	2.204	43.018	40.117	2.676

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.04 _1	64	1200	Manhole	Adoptable	66	1200	Manhole	Adoptable
1.05 _1	66	1200	Manhole	Adoptable	20	1200	Manhole	Adoptable

Simulation Settings

Analysis Speed	Normal	Drain Down Time (mins)	240
Skip Steady State	x	Foul Event Duration (mins)	30

Storm Durations

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

Pre-development Discharge Rate

Site Makeup	Greenfield	SPR	0.47	Betterment (%)	10
Greenfield Method	IH124	Region	10	QBar	26.0
Positively Drained Area (ha)	7.990	Growth Factor 1 year	0.87	Q 1 year (l/s)	20.4
SAAR (mm)	500	Growth Factor 30 year	1.70	Q 30 year (l/s)	39.8
Soil Index	4	Growth Factor 100 year	2.08	Q 100 year (l/s)	48.7

Pre-development Discharge Volume

Site Makeup	Greenfield	SPR	0.47	Storm Duration (mins)	360
Greenfield Method	FSR/FEH	CWI	75.556	Betterment (%)	10
Positively Drained Area (ha)	7.990	Return Period (years)	100	PR	0.390
Soil Index	4	Climate Change (%)	20	Runoff Volume (m³)	1831

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APPENDIX F INFILTRATION REPORT

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Athlone

Co Westmeath

Infiltration Investigation

Report 22- 1074

Document Control

Project Title	Proposed Residential Development
Document Title	Factual report on Percolation Test
Reference	22-1074

Revision	Status	Author(s)	Reviewed by	Approved by	Issue Date
01	F	JK	CP	JK	12/08/22

Contents **Page No.**

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2.0 Site Description..... 3

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1.0 Introduction

On the instruction of the applicant Stratex Ltd. was appointed to undertake a Infiltration Testing in relation to the to the site located at Athlone, County Westmeath.

The encountered ground conditions are described in accordance with BS 5930, British Standard Code of Practice for Site Investigations. All comments made in this report are done so on the assumption that the findings are representative of the site area as a whole

2.0 Site Description

The site as located in the image currently comprises of a vacant residential development site.

3.0 Ground Investigation

a. Infiltration Testing

Infiltration testing was conducted and carried out as per British Standard BRE Digest 365 for soakaway testing that covers the design of storm water infiltration testing at locations as indicated on the exploratory hole location plan in figure 1.

The results and analysis of the tests and calculations of the infiltration rates are included.

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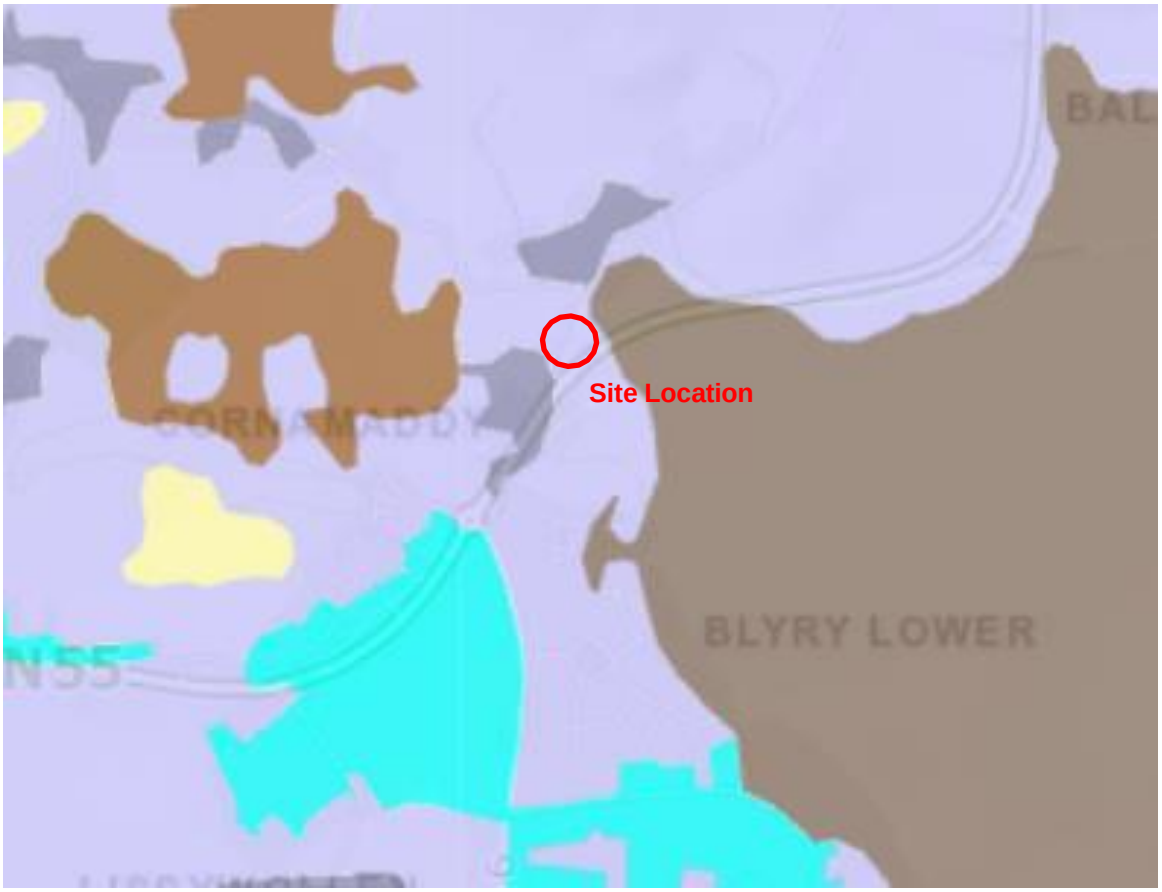
Figure 2 : Superficial Geology



The Geological Survey Ireland Spatial Resources, Teagsac Soils (GSI, 2016) indicates the site superficial deposits to be shallow, rocky, peaty/non peaty mineral complexes (Mainly basic)

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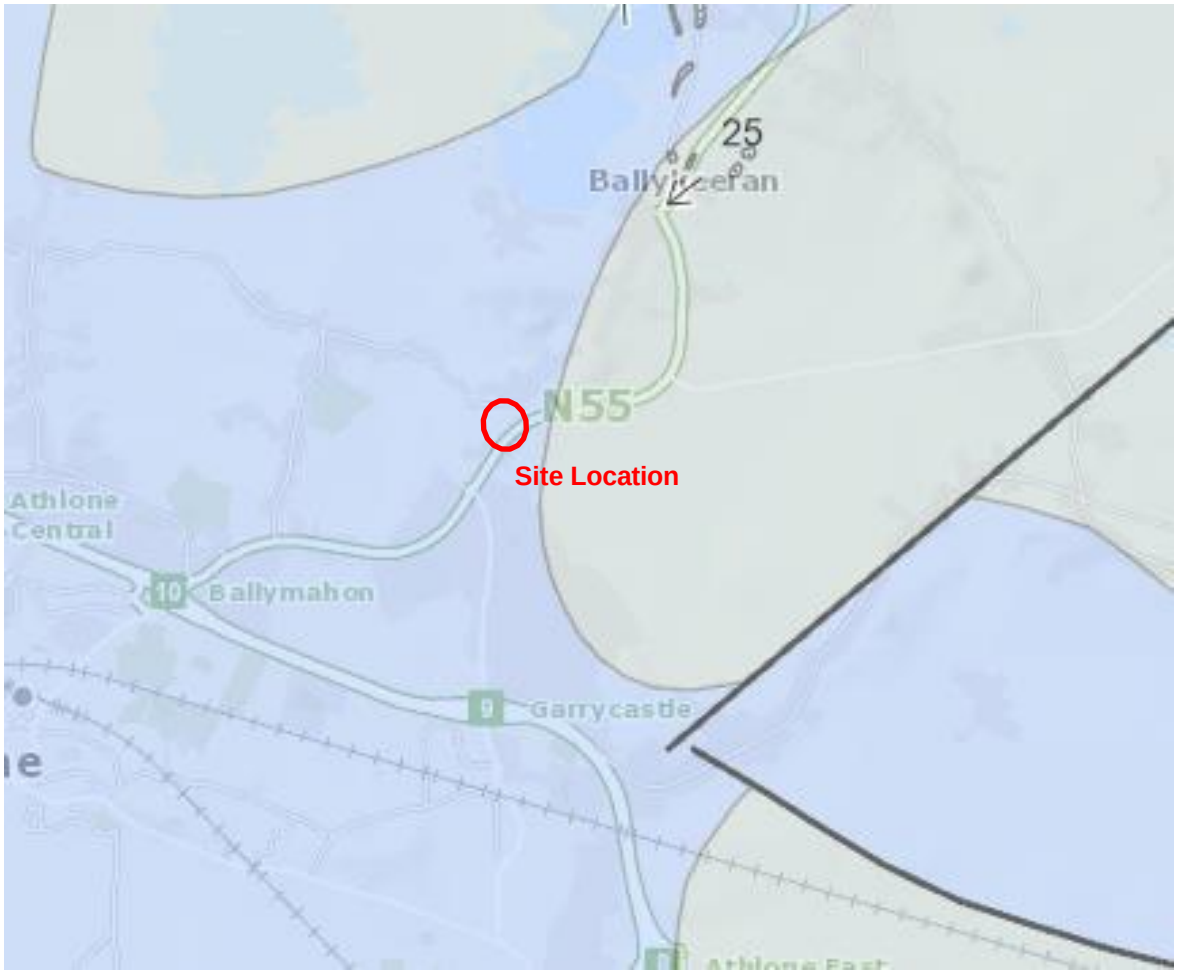
Figure 3: Bedrock Geology



The 1:100,000 Geological Survey Ireland Spatial Resources, Bedrock Geology (GS!, 2016) indicates the site bedrock to be Waulsortian Limestone comprising massive unbedded lime-mudstone.

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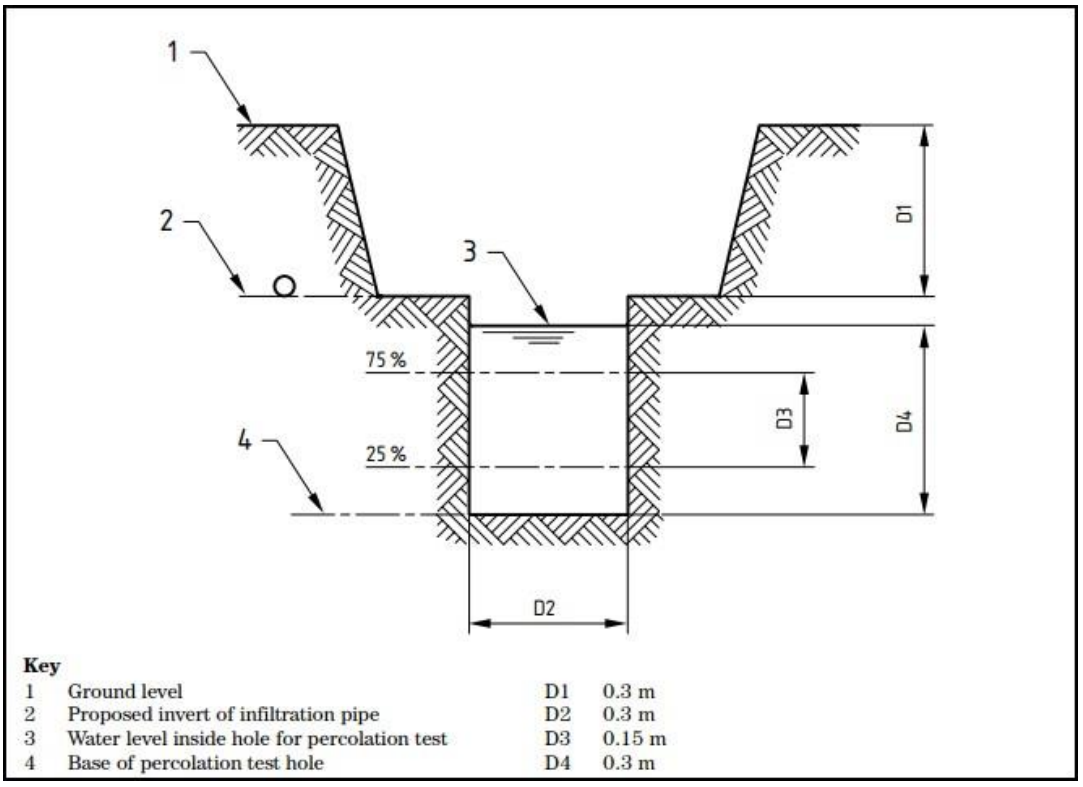
Figure 4:



Key

1	Ground level	D1	0.3 m
2	Proposed invert of infiltration pipe	D2	0.3 m
3	Water level inside hole for percolation test	D3	0.15 m
4	Base of percolation test hole	D4	0.3 m

Figure 4 Cross-section of typical percolation test hole

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***Test Result: PT no.** 1 **Date:** 13 .07 .2022*

***Weather Conditions:** Dry Overcast*

P1	***1***	***2***	***3***
Initial Depth (mm) 75%	*225mm*	*225mm*	*225mm*
Final Depth (mm) 25%	*75mm*	*75mm*	*75mm*
Initial Time (seconds)	*n/a*	*n/a*	*n/a*
Final Time (seconds)	*n/a*	*n/a*	*n/a*
Average Time to fall 1mm (seconds) Vp	*n/a*	*n/a*	*n/a*
Filtration Value (m/s)	***n/a***	***n/a***	***n/a***
Comment: infiltration test not possible due to groundwater inflow at excavation level.			

***Test Result: PT no.** 2 **Date:** 13 .07 .2022*

***Weather Conditions:** Dry Overcast*

P2	***1***	***2***	***3***
Initial Depth (mm) 75%	*225mm*	*225mm*	*225mm*
Final Depth (mm) 25%	*75mm*	*75mm*	*75mm*
Initial Time (seconds)	*n/a*	*n/a*	*n/a*
Final Time (seconds)	*n/a*	*n/a*	*n/a*
Average Time to fall 1mm (seconds) Vp	*n/a*	*n/a*	*n/a*
Filtration Value (m/s)	***n/a***	***n/a***	***n/a***
Comment: infiltration test not possible due to groundwater inflow at excavation level.			

***Test Result: PT no.** 3 **Date:** 13 .07 .2022*

***Weather Conditions:** Dry Overcast*

P3	***1***	***2***	***3***
Initial Depth (mm) 75%	*225mm*	*225mm*	*225mm*
Final Depth (mm) 25%	*75mm*	*75mm*	*75mm*
Initial Time (seconds)	*18,000*	*n/a*	*n/a*
Final Time (seconds)	*36,000*	*n/a*	*n/a*
Average Time to fall 1mm (seconds) Vp	*120*	*n/a*	*n/a*
Filtration Value (m/s)	***$1.0x10^{-6}$***	***n/a***	***n/a***
Average Filtration Value is 0.000001 m/s			

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Test Result: PT no. *4* ***Date:*** *13 .07 .2022*

Weather Conditions: *Dry Overcast*

P4	***1***	***2***	***3***
Initial Depth (mm) 75%	*225mm*	*225mm*	*225mm*
Final Depth (mm) 25%	*75mm*	*75mm*	*75mm*
Initial Time (seconds)	*n/a*	*n/a*	*n/a*
Final Time (seconds)	*n/a*	*n/a*	*n/a*
Average Time to fall 1mm (seconds) Vp	*n/a*	*n/a*	*n/a*
Filtration Value (m/s)	***n/a***	***n/a***	***n/a***
Comment: the water level fell by 10mm in 24hrs, analysis not possible.			

Test Result: PT no. 5 Date: *13 .07 .2022*

Weather Conditions: *Dry Overcast*

P5	***1***	***2***	***3***
Initial Depth (mm) 75%	*225mm*	*225mm*	*225mm*
Final Depth (mm) 25%	*75mm*	*75mm*	*75mm*
Initial Time (seconds)	*4,800*	*5,300*	*5,200*
Final Time (seconds)	*10,800*	*11400*	*11,300*
Average Time to fall 1mm (seconds) Vp	*40*	*40*	*40*
Filtration Value m/s	***$3.0x10^{-6}$***	***$3.0x10^{-6}$***	***$3.0x10^{-6}$***
Average Filtration Value is 0.000003 m/s			

Test Result: PT no. 6 Date: *13 .07 .2022*

Weather Conditions: *Dry Overcast*

P6	***1***	***2***	***3***
Initial Depth (mm) 75%	*225mm*	*225mm*	*225mm*
Final Depth (mm) 25%	*75mm*	*75mm*	*75mm*
Initial Time (seconds)	*n/a*	*n/a*	*n/a*
Final Time (seconds)	*n/a*	*n/a*	*n/a*
Average Time to fall 1mm (seconds) Vp	*n/a*	*n/a*	*n/a*
Filtration Value (m/s)	***n/a***	***n/a***	***n/a***
Comment: the water level fell by 40mm in 24hrs, analysis not possible.			

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Test Result: PT no. *7* ***Date:*** *13 .07 .2022*

Weather Conditions: *Dry Overcast*

P7	***1***	***2***	***3***
Initial Depth (mm) 75%	*225mm*	*225mm*	*225mm*
Final Depth (mm) 25%	*75mm*	*75mm*	*75mm*
Initial Time (seconds)	*n/a*	*n/a*	*n/a*
Final Time (seconds)	*n/a*	*n/a*	*n/a*
Average Time to fall 1mm (seconds) Vp	*n/a*	*n/a*	*n/a*
Filtration Value (m/s)	***n/a***	***n/a***	***n/a***
Comment: the water level fell by 25mm in 24hrs, analysis not possible.			

Test Result: PT no. *8* ***Date:*** *13 .07 .2022*

Weather Conditions: *Dry Overcast*

P8	***1***	***2***	***3***
Initial Depth (mm) 75%	*225mm*	*225mm*	*225mm*
Final Depth (mm) 25%	*75mm*	*75mm*	*75mm*
Initial Time (seconds)	*n/a*	*n/a*	*n/a*
Final Time (seconds)	*n/a*	*n/a*	*n/a*
Average Time to fall 1mm (seconds) Vp	*n/a*	*n/a*	*n/a*
Filtration Value (m/s)	***n/a***	***n/a***	***n/a***
Comment: the water level fell by 60mm in 24hrs, analysis not possible.			

Test Result: PT no. *9* ***Date:*** *13 .07 .2022*

Weather Conditions: *Dry Overcast*

P9	***1***	***2***	***3***
Initial Depth (mm) 75%	*225mm*	*225mm*	*225mm*
Final Depth (mm) 25%	*75mm*	*75mm*	*75mm*
Initial Time (seconds)	*n/a*	*n/a*	*n/a*
Final Time (seconds)	*n/a*	*n/a*	*n/a*
Average Time to fall 1mm (seconds) Vp	*n/a*	*n/a*	*n/a*
Filtration Value (m/s)	***n/a***	***n/a***	***n/a***
Comment: the water level fell by 50mm in 24hrs, analysis not possible.			

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***Test Result: PT no.** 10 **Date:** 13 .07 .2022*

***Weather Conditions:** Dry Overcast*

P10	***1***	***2***	***3***
Initial Depth (mm) 75%	*225mm*	*225mm*	*225mm*
Final Depth (mm) 25%	*75mm*	*75mm*	*75mm*
Initial Time (seconds)	*n/a*	*n/a*	*n/a*
Final Time (seconds)	*n/a*	*n/a*	*n/a*
Average Time to fall 1mm (seconds) Vp	*n/a*	*n/a*	*n/a*
Filtration Value (m/s)	***n/a***	***n/a***	***n/a***
Comment: the water level fell by 55mm in 24hrs, analysis not possible.			