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CONSULTING ENGINEERS

RESIDENTIAL DEVELOPMENT AT KILNAP, OLD WHITECHURCH ROAD, CORK

DRAINAGE IMPACT ASSESSMENT

DATE 25/06/2024

REVISION 2

JOB NO. 6254

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1 *Introduction*

DOSA Consulting Engineers were engaged as Engineers for the proposed development at Old Whitechurch Road, Kilnap, Cork. The purpose of this Drainage Impact Assessment report is to provide details of the SuDS strategy for the proposed development.

1.1 Existing Lands

The Council is the owner of the site at Kilnap off the Old Whitechurch Road (OWR). It comprises of some 22 hectares (54 acres) of a southerly sloping site zoned residential in the Cork City Development Plan located in the North of the City ("Development Site"). The Development Site is ideally located at the north-western gateway to the City near the proposed North Ring Road. It is located within a reasonable cycling and walking distance of the Blackpool Retail and Business Park while at the same time bounding the Glenamought Valley. The Development Site should create a sustainable residential neighbourhood, which would derive character from its location, topography, amenity, urban design quality and would be a most attractive place to live at the Northern gateway to the City.

Pre-enabling works have been carried out by the Council and the site has been fully serviced from an infrastructural aspect.

The site currently has the following infrastructure in place

- Access
- Foul Connection Infrastructure
- Stormwater Connection Infrastructure
- Water Connection Infrastructure
- Utility Infrastructure

A snapshot of the overall council landholding is outlined in Figure 2.1 below.

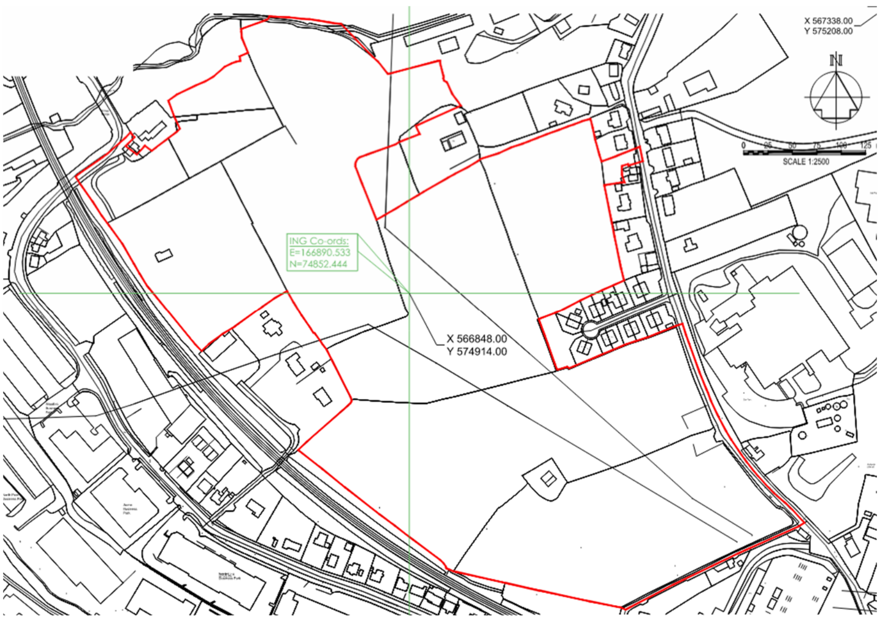


Figure 2.1 – Context Map

1.2 Development Description

Phase one of the development is 3.7 ha, with a developable area of 2.74 ha. It is situated approximately 3.5 km north of Cork City Centre, in an area characterised by commercial and residential use. It is located off the N20 and a new road that meanders through the site to connect Old Mallow Road in the north with Old Whitechurch Road in the Southeast.

The proposed development will consist of 1 no. accessible 4 bed detached, 72 no. 3 bed semi-detached, 8 no. 3 be townhouses, 6 no. 2 bed townhouses, 4 no. 3 bd duplex apartments & 4 no. 1 bed apartments. The form, architecture and scale of the development is consistent with the immediate context and it will enhance the visual amenity of the site as a whole.

1.3 Scope of Assessment

This report deals with the following aspects associated with this development:

- Existing Site
- Site Investigations
- Soil Type Classification
- Storm Water Drainage Design
- Sustainable urban Drainage Systems (SuDS)
- Flood Risk Assessment and Exceedance Flows
- SuDS Maintenance

1.4 Site Topography

The topography of the site slopes from the southwest in a north and easterly direction as per the contouring below.

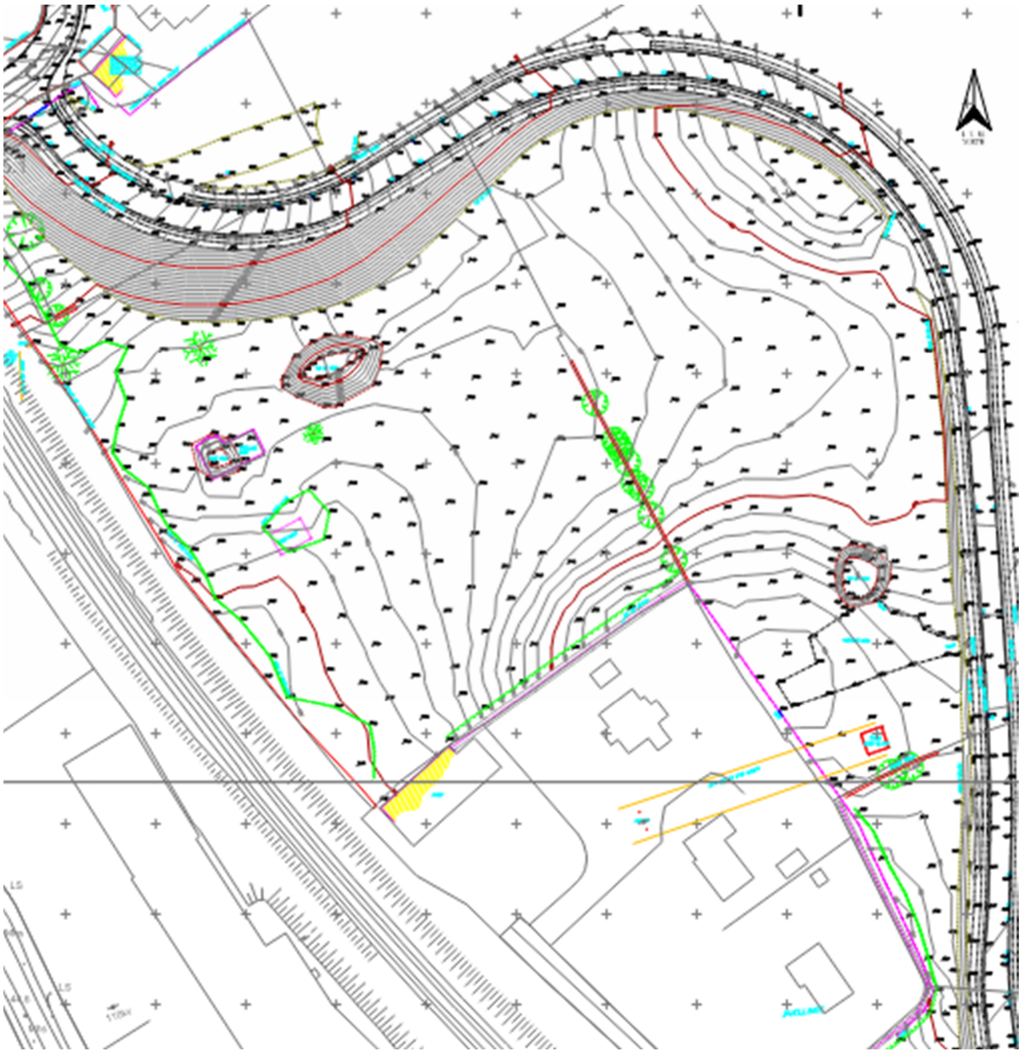


Figure 1.3 – Site Topography

1.5 Principle Design Considerations

During the design of the storm water drainage for the proposed site, including SuDS, the following key documents / standards were taken into consideration.

- Cork City Council Development Plan specifically

  Section 9.8 of Chapter 9 – Environmental Infrastructure of the Cork City Development Plan "The traditional method of disposing of surface water runoff from impermeable surfaces such as roofs, roads and carparks is collection and redirection to drainage systems. This can result in localised flooding, higher waste treatment costs and the transfer of contaminants (such as oil from carparks) directly to water courses, resulting in pollution and affecting a river's ability to recharge naturally. Sustainable Urban Drainage Systems (SUDS) offer a more integrated approach to rainwater management. It involves a method of replicating the natural characteristics of rainfall runoff from any site, ensuring water is infiltrated or conveyed more slowly to the drainage system and ultimately to water courses via permeable paving, swales, green roofs, rain water harvesting, detention basins, ponds and wetlands. Chapter 5 Climate and Environment includes more detail in terms of the types of SUDS that can be used to achieve these goals. Where appropriate and possible, Cork City Council will *encourage the use of SUDS and will prepare guidance on how SUDS can be applied to developments over the period of the plan."*

- CIRIA report C753 The SuDS Manual-v6
- Greater Dublin Strategic Drainage Study (GDSDS)
- Nature-based Solutions to the Management of Rainwater and Surface Water Runoff in Urban Areas Water Sensitive Urban Design - Best Practice Interim Guidance Document, (CDP Objective 9.4) - The Department of Housing, Local Government and Heritage.
- Inland Fisheries Irelands Planning for Watercourses in the Urban Area – (CDP Para 11.221)- IFI

It should be noted however that the site is a serviced site with works completed over 10 years ago. Attenuation has been provide but this is being upgraded as part of tis proposal. Whilst the requirement to adopt the use of SuDs and NBS features the current site constraints limit the flexibility of the design. We have endeavoured to incorporate as many features as possible given these constraints.

2 *Surface Water Design Overview*

The completed development site is a mix of soft landscaping and hard paving or roofing. The existing topography is a single catchment. Groundwater flow direction is interpreted to be to the north / northeast, providing baseflow to the Glennamought River (which is directly north of the site.)

The runoff from the entire developed site will however discharge to the Glennamought River. . The increased runoff flows will be attenuated to greenfield runoff rates prior to discharging to watercourse.

Discharge from Phase 1 will be into the existing stormwater network and attenuation infrastructure provided by Cork City Council as part of an enabling works package.

The proposed storm water drainage system has been designed to cater for all surface water runoff from all hard surfaces within the proposed development including roadways, roofs, parking areas and green areas etc. The development has been split into a number of catchment areas. The only areas excluded from the catchment areas is the green areas downstream of the development.

The proposed surface water drainage network will collect surface water runoff from the site via a piped network prior to discharging off site via the attenuation tanks, flow control devices and separator arrangement. Final discharge rates will be at Qbar greenfield run-off rates.

Prior to entering the system, the stormwater generated will be treated through a number of nature-based solutions in line with adopted SuDS measures.

The storm sewer network was designed using Innovyze Micro Drainage modelling software. Outputs from the storm sewer design can be found in the Appendices of the Infrastructure Report.

Refer to DOSA Drawings for details of the proposed surface water network.

All flow velocities within the network fall within the limits of 0.75 and 3m/sec as set out in "Recommendations for Site Development Works" as published by the Department of Environment. The storm water network and infiltration basin are designed to accommodate the 100-year return period plus an additional 20% to account for the effects of climate change.

2.1 Proposed Sustainable Urban Drainage (SuDS) Strategy

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

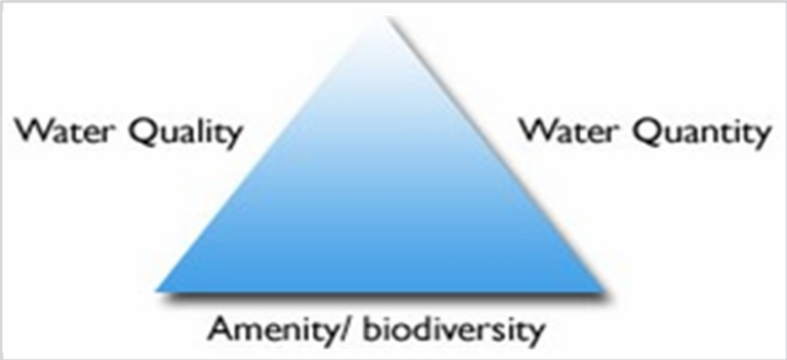


Figure 2.1– SuDS Triangle

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 where possible for those using the area (including wildlife).

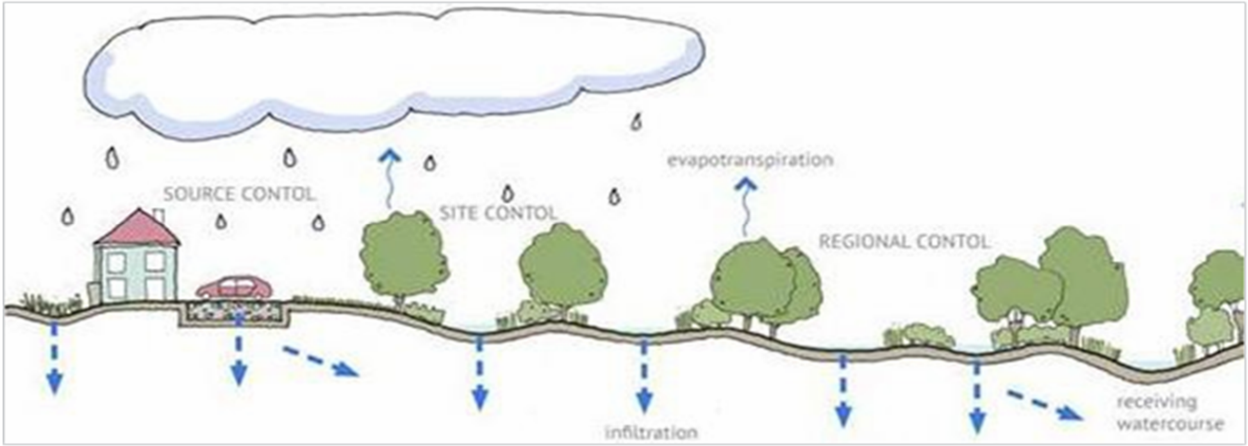


Figure 2.2– SuDS Treatment Train

The principles of a SuDS treatment train were used during the design of the surface water drainage system. The treatment train as illustrated in the image below provides an understanding of prevention and source control to reduced water run-off from a site and improve water quality.

Criterion 1: River Water Quality Protection

Satisfied by providing stormwater attenuation tanks and treatment of surface water run-off by SUDS features such full retention fuel/oil separators at surface water discharge points.

Criterion 2: River Regime Protection

Satisfied by attenuating surface water run-off in association with flow control devices prior to discharge off site at Greenfield runoff rate. Site critical duration storm used to assess attenuation volume.

Criterion 3: Level of Service (Flooding) for the Site

Satisfied by reviewing available flood hazard information (e.g., Lee CFRAM Study) relating to the site's proximity to tidal and fluvial flood plains (up to 1 in 100-year flood event).

Criterion 4: River Flood Protection

Satisfied by attenuating surface water discharge to greenfield runoff rates, addressing flood risk associated with the 1 in 100-year storm and avoiding development in flood plains.

Following a comprehensive review of the design of the storm water drainage system we considered all options under the SuDS guidance policies referred to in the Greater Dublin Drainage Strategy. A preliminary feasibility of the applicable SuDS Techniques was conducted. The preliminary analysis indicated that the following techniques were suitable Attenuation Tanks, Basins, Permeable Paving, Soakaways, Swales and Rainwater Harvesting.

Each proposal was examined and evaluated on its merits / suitability under site specific constraints for use in the proposed development site. Our design approach summary is as follows:

2.2 SuDS Appraisal

The SUDS selection process used for this site is in accordance with SUDS selection flow chart, Volume 3, Section 6.5, Figure 48 of the GDSDS. The characteristics of the site are used to select the various SUDS techniques that would be applicable.

The following methodologies are being implemented as part of a SuDS treatment train approach:

2.2.1 Permeable Pavement

Permeable pavement reduces the overall impermeable area of the hard-standing area, which will reduce the impact of the discharge and improve the quality of the effluent from the proposed development.

Permeable paving has been proposed in private driveways. No area containing permeable paving will be included in areas that will be taken in charge by council. Driveways are in individual private and not therefore proposed to be taken in charge. In order to propose permeable paving, the detailed design required obtaining infiltration results. Infiltration testing was conducted previously by OCB geotechnical on behalf of Cork City Council. The infiltration coefficient as calculated as 6.0E-06ms'-1. It is proposed to infiltrate runoff through the subsurface media. An average of 30 m^2 of paving will be provided to each private dwelling. In order to infiltrate the runoff a permeable sub-stratum of approximately 300mm permeable stone with a void ratio of approximately 30% is required.

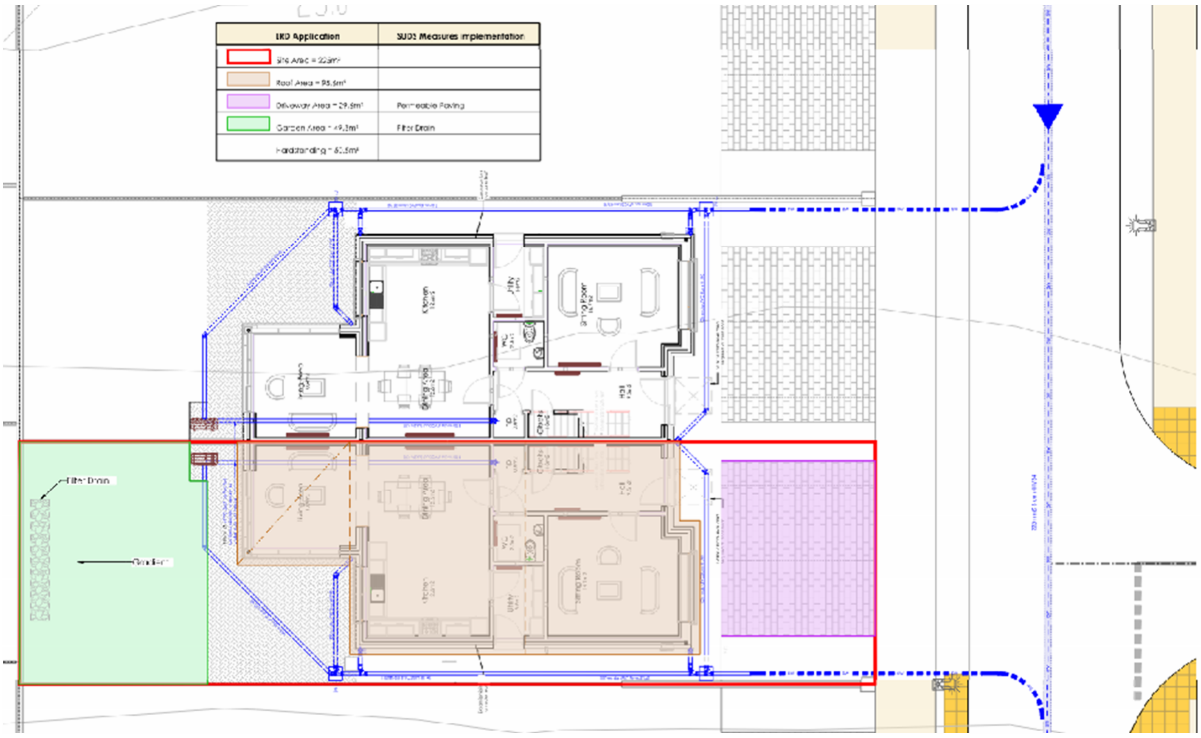


Figure 2.3– Typical Private Dwelling Layout

LRD Application	SUDS Measures implementation
Site Area = 225m²	
Roof Area = 95.6m²	
Driveway Area = 29.6m²	Permeable Paving
Garden Area = 49.3m²	Filter Drain
Hardstanding = 50.5m²	

Figure 2.4– Typical Private Dwelling Site and Breakdown of Areas

The inclusion of permeable paving (approx. 30 m^2 reduces the impermeable area of each private dwelling site by approx. 13% and has a direct correlation and reduction in net contributing runoff areas to be attenuated).

2.2.2 Rainwater Harvesting

In relation to rainwater harvesting the design has the potential to possibly provide a water butt to dwellings dwelling. This could be located to the rear of each unit. This water butt will only have the ability to catch the rear sloping side of the dwelling and the reuse would be for watering plants. The intention would be that the homeowner retrospectively provides these.

2.2.3 Infiltration Basins

Infiltration basins are vegetated depressions designed to store runoff on the surface and infiltrate it gradually into the ground. They are normally dry except in periods of heavy rainfall. The infiltration basins proposed are normally located in green areas an. They can be designed so that there would be no water storage at any time. In this case they will act as infiltration only. Note that the basins should have side slopes not exceeding 1:4 so that the areas will be useable. I is proposed to use an infiltration basin in tyeh public open space. This will cater for infiltration associated with this area only.

2.2.4 Filter Drain

Trenches filled with permeable material and a perforated collection pipe at the invert with an optional permeable 'sandy' topsoil at surface. These will treat, convey, and attenuate runoff at source, and can infiltrate to the ground where the subgrade is suitable. These systems will allow some form of storage for small rainfall events and can result in water evaporation and adsorption in small quantities, therefore there will be less run-off from these areas in small rainfall events thus mimicking the natural response for this catchment. Normally it proposed to locate these along the proposed pedestrian/cycle pathways and will allow groundwater to recharge to its natural state. Filter Drains are proposed as per the SuDS schematic drawing in the appendices of this report.

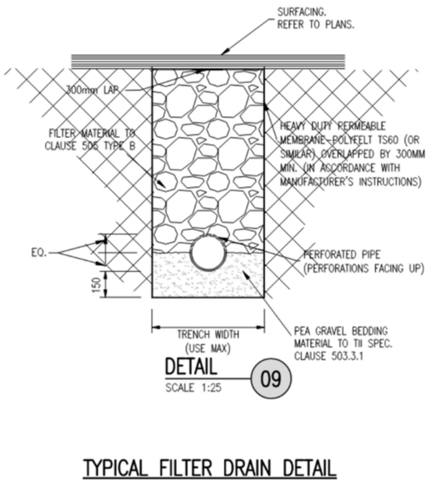


Figure 2.5– Typical Filter Drain Detail

It is now proposed to incorporate additional Filter Drains in the rear gardens of all private dwelling units. The filter drains in the rear gardens have been designed to cater for approximately 50m^2 of green area (average green area per private dwelling unit) as indicated in Fig 2.4 above. It is proposed to install 5/6 linear meters of filter drains in each private rear garden. The introduction of these filter drains is to improve infiltration only and are only to cater for rear garden grassed They will not have any other runoff connected to them and they will not act as soakaways. For clarity the runoff from private garden green areas has been included in the overall design calculations for the stormwater network and overall attenuation volumes.

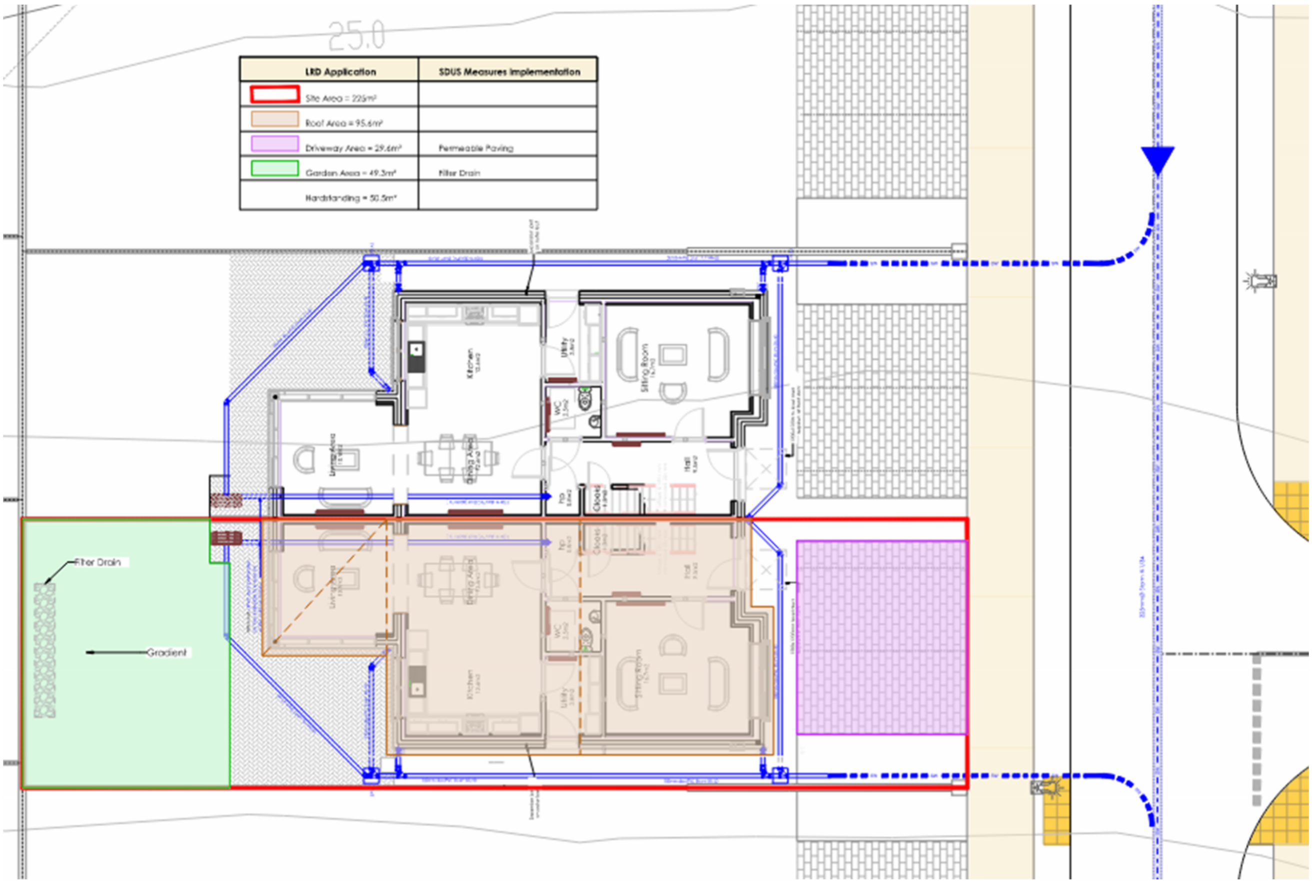


Figure 2.6– Filter Drain in Rear Private Gardens

The runoff and infiltration from the filter drains in the public areas have not been incorporated in any reduction of areas from an attenuation storage calculation perspective. Theoretically the installation of these filter drains in private areas could contribute to a possible volumetric reduction in required attenuation but this potential reduction has not been factored into the attenuation calculations.

2.2.5 Tree Pits

Trees can be planted within a range of infiltration SuDS components to improve their performance, as root growth and decomposition increase soil infiltration capacity. Alternatively, they can be used as standalone within soil-filled tree pits, tree planters or structural soils, collecting and storing runoff and providing treatment via filtration and phytoremediation. Tree pits and planters will be designed to collect and attenuate runoff by providing additional storage within the underlying structure. The soils around trees can also be used to filter out pollutants from runoff directly. Tree pits are proposed to be in green space areas to treat and control runoff, while at the same time providing amenity value to adjacent pedestrian, and residential zones. It is also proposed, where possible to fit tree pits along the estate road to drain and treat surface water runoff from the road network. This will allow for treatment of first flush and low flows while high flows will discharge into the surface water network during extreme rainfall events. Rainwater gullies will still be provided downstream of any tree pit to drain runoff during an extreme rainfall event.

Trees Pits are proposed as indicated on 6254-0023.

The proposed detail is as per Fig 2.7 below.

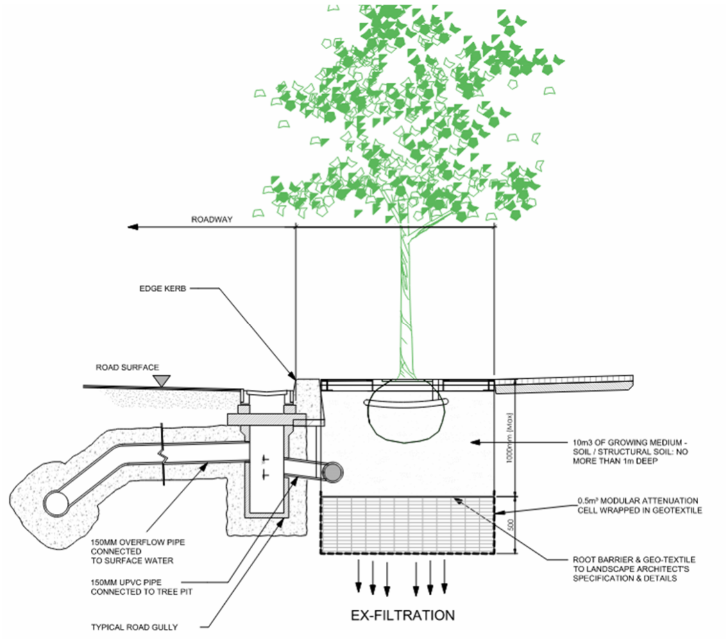


Figure 2.7– Tree Pit Detail

The analysis of these pits and associated infiltration/storage capacity would indicate that these tree pits could cater for the treatment and storage of runoff from approximately 20m^2 of adjacent impermeable pavement. From an overall calculation perspective however, this benefit has been omitted from the proposed attenuation storage required for the proposed development.

2.2.6 Attenuation Tanks

Surface water runoff from the overall development lands will be attenuated to allowable greenfield runoff rate (Qbar). The rate of surface water runoff from the site will be restricted to greenfield runoff rates and the attenuation system sized accordingly. This infrastructure has been provided by Cork City Council as part of a previous enabling works contract. However upgrade works to increase storage volumes and retrict the outflow to greenfield runoff rates will be incorporated as part of the proposals.

For storms greater than the 1% AEP, the development's drainage network design will be exceeded and areas with low ground levels may begin to flood. Generally, proposed road levels fall towards the site's north-eastern boundary and overland flow is therefore directed towards the existing stream.

The site currently has the following infrastructure in place

- Stormwater Connection Infrastructure (including Attenuation Tanks)

Figure 2.8– Existing Attenuation Tank Locations

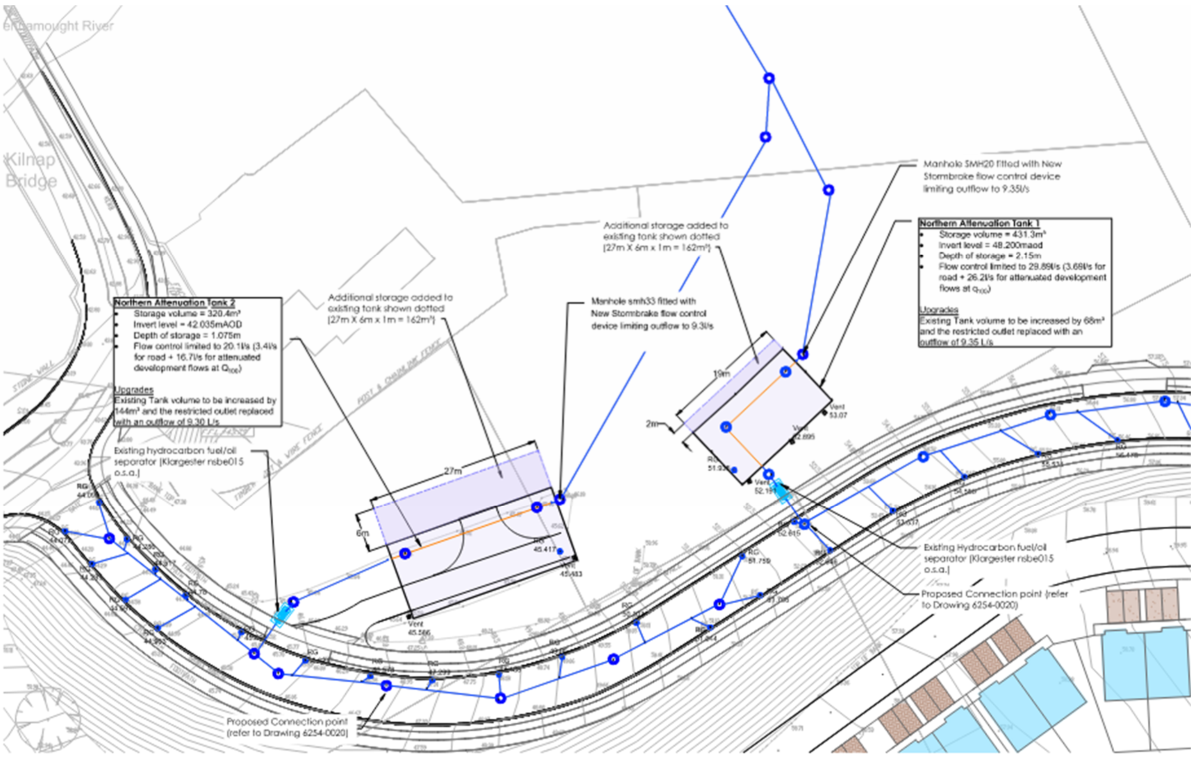


Figure 2.9– Existing Attenuation Details and Proposed Tank Upgrades

The attenuation volume provided by Cork City Council as part of the enabling works would appear to be less than that required to cater for a 1 in 100-year return period for the proposed development design. The current design indicates a revised Qbar and attenuation volume. As a result, it is proposed to increase the storage volumes of the existing tanks and replace the restricted outlets to cater for the revised design.

	Attenuation Volume Provided (Enabling Works)	Allowance for Road (Enabling Works)	Volume dedicated to Development (Enabling Works)
Tank 1	431.3 m^3	54.3 m^3	377 m^3
Tank 2	320.4 m^3	54.4m^3	266 m^3

Table 2.1 – Summary of Existing Attenuation Tanks

	Volume dedicated to Development (Enabling Works)	Revised Attenuation Required for Proposed Development	Additional Attenuation Required for Proposed Development
Tank 1	377 m^3	445 m^3	68 m^3
Tank 2	266 m^3	410 m^3	144 m^3

Table 2.2 – Summary of Additional Attenuation Volumes

2.2.7 Flow Control Device

The existing tanks are provided with a hydro brake at the outfall of the surface water catchment to restrict the outflow of water from the subject site. It is proposed to replace the restricted outlets to cater for the new design (refer to table 2.4 below)

		Restricted Outlet Development (Enabling Works)	Restricted Outlet Road (Enabling Works)	Total (Enabling Works)
Catchment 1	Tank 1	26.2 l/s	3.69 l/s	29.89 l/s
Catchment 2	Tank 2	16.7 l/s	3.4 l/s	20.10 l/s

Table 2.3 – Summary of Existing Restricted Outlets

		Restricted Outlet Development (Proposed Works)	Restricted Outlet Road (Enabling Works)	Revised Total
Catchment 1	Tank 1	5.66 l/s	3.69 l/s	9.35 l/s
Catchment 2	Tank 2	5.90 l/s	3.4 l/s	9.30 l/s

Table 2.4 – Summary of revised Restricted Outlets

Details of existing and proposed amendments are included in the drawings in Appendices C & D.

2.2.8 Petrol Interceptor

Petrol interceptors are provided upstream of the attenuation tanks to ensure that any remaining hydro-carbons or pollutants within the runoff from trafficked areas are treated prior to outfall to the existing watercourse.

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.

		Petrol Interceptor Specification
Catchment 1	Tank No. 1	Klargester NSBE015 O.S.A
Catchment 2	Tank No. 2	Klargester NSBE015 O.S.A

2.2.9 Existing Ditches, Trees and Hedgerows Within Site

Within Site where possible, existing ditches, trees and hedgerows are to be maintained. Incorporating these existing drainage features into the proposed overall SuDS strategy would assist in the conveyance and treatment of the generated surface water runoff. The retention of existing trees and hedgerows will also assist in the reduction of surface water runoff by evapotranspiration.

2.3 Management Train

The management train commences with source control through the provision of permeable paving and rain-water butts (potentially) in the rear gardens. This will also reduce the water consumption required of each housing unit. This employment of these source controls along with the usage of localised tree pits and infiltration/ filter drains will aid to reduce the peak runoff rate, placing less stress on the facilities downstream.

The second stage of the management train, site control, is provided by the introduction of the hydrocarbon interceptors in open areas which provide a degree of treatment before discharging to the attenuation system.

The attenuation tanks offer a third stage of treatment, regional control, by slowing the storm water discharge down and removing additional silts which may remain in the storm water.

2.4 Surface Water System

The existing infrastructure provided by Cork City Council enabling works has been chosen as the suitable surface water discharge point for the proposed development.

To reduce the effects of the surface runoff on potential flooding, a Stormwater Management Plan will be applied to surface water discharges into adjacent watercourses. The Stormwater Management Plan can be applied to control the rate of runoff from new development. The maximum permitted surface water outflow from the new development is to be restricted to that of the existing Greenfield site by the usage of attenuation storage.

Control of runoff by attenuation methods requires a hydraulic control to restrict the magnitude of flows passing downstream, together with an upstream storage capacity to contain the volume of runoff held back by the hydraulic control. The flows are proposed to be attenuated in the surface water system by adopting a flood storage attenuation tank along with restricted outlets as the control devise. The storage volume required has been designed using the computer aided design package Windes 10.4.

The attenuation strategy for the site is for the detention of flows in interlinked attenuation tanks.

2.5 Surface Water Drainage Network

The surface water drainage network for the proposed development was modelled using the Micro drainage software application. The surface water pipe lengths, slopes, contributing impermeable areas, upstream invert levels, upstream cover levels and pipe diameters were entered into the model using the drawings supplied.

2.6 Design Criteria:

The proposed surface water drains have been designed in accordance with the Greater Dublin Strategic Drainage Study (GDSDS), the Department of the Environment's Recommendations for Site Development Works for Housing Areas, the Department of the Environment's Building Regulations "Technical Guidance Document Part H Drainage and Waste Water Disposal" and BS EN 752: 2008 Drain and Sewer Systems Outside Buildings.

- Return period for pipe work design 2 years
- Return period for attenuation design 100 years
- Soil Type 2
- Time of entry 5 minutes
- Ratio "r" 0.250
- Pipe Friction (Ks) 0.6 mm
- Minimum Velocity (based on pipe flowing full) 1.0 m/s
- Rainfall Runoff from Roads and Footpaths 100%
- Rainfall Runoff from Roofs 80%
- Rainfall Runoff from Driveways 80%
- Rainfall Runoff from Green Areas 20%
- Rainfall Depth Factored for Climate Change (as per GDSDS) 20%

(in accordance with GDSDS Volume 2, Chapter 6, Table 6.2 – see below)

Climate Change Category	Characteristics
River flows	20% increase in flows for all return periods up to 100 years
Sea level	400+mm rise (see Climate Change policy document for sea levels as a function of return period)
Rainfall	10% increase in depth (factor all intensities by 1.1)
	Modify time series rainfall in accordance with the GDSDS climate change policy document

Table 6.2 Climate Change Factors to be Applied to Drainage Design

2.7 Storm Water Outfall

Storm water from the proposed development shall discharge into the existing watercourse to the northern boundary of the site via a hydro brake manhole, which will limit the amount of water discharging to the network. The amount of water discharged from the hydro brake manhole will be determined by using the allowable Greenfield Runoff rate for the developable area of the site. It is to be noted that all on site storm water storage facilities have been sized to cater for all storm water generated within the site boundary of the development.

2.8 SuDS Calculations

Preliminary calculations of the various SuDS elements proposed are contained in Appendix B of this report. This report should also be read in conjunction with the Infrastructure Report submitted as part of the application. Attenuation Tank Sizes and Petrol Interceptor Sizing/Specifications have been included in the as-built provided by Cork City Council in Appendix C this report. An increase in volume (as indicated in Section 2.2.6 of this report) is required to the attenuation tanks to cater for the proposed design. The nature-based SuDS principles proposed will have a positive impact from a sustainable impact.

3 *Site Investigations*

Extensive site investigations were carried out by OCB Geo and their findings are extensively documented in Report No. OCB18-050

3.1 Ground Conditions

3.1.1 General

The ground conditions encountered during the investigation are summarised with within the said report.

3.1.2 Groundwater

No groundwater was noted during the investigation.

Based on the information contained within the report, there will be no perceptible impacts from groundwater levels on proposed SuDS throughout the site.

3.1.3 Soil Infiltration Rate

Infiltration testing was carried out as part of the Investigations

OCB Geotechnical Ltd **Whitechurch Phase 2**

Test 1 **IP1** **12/07/18**

length, m **1.6** b, m (WIDTH) **0.65** d, m **1.2** d eff, m **0.58**
length_base, m **0.8**
length_eff, m **1.2**

	Time (min)	Measure (m)	Time (sec)	Depth (m)	Fall (m)	Volume (m^3)	
Start	0	0	0	0.58	0	0	
	1	0.03	60	0.550	0.030	0.0156	
	2	0.04	120	0.540	0.040	0.0208	
	3	0.05	180	0.530	0.050	0.0260	
	4	0.06	240	0.520	0.060	0.0312	
	5	0.07	300	0.510	0.070	0.0364	
	6	0.08	360	0.500	0.080	0.0416	
	7	0.09	420	0.490	0.090	0.0468	
	8	0.1	480	0.480	0.100	0.0520	
	9	0.11	540	0.470	0.110	0.0572	
	10	0.12	600	0.460	0.120	0.0624	
	12	0.14	720	0.440	0.140	0.0728	25%
	14	0.160	840	0.420	0.160	0.0832	
	16	0.17	960	0.410	0.170	0.0884	
	18	0.18	1080	0.400	0.180	0.0936	
	20	0.18	1200	0.400	0.180	0.0936	
	25	0.19	1500	0.390	0.190	0.0988	
	30	0.2	1800	0.380	0.200	0.1040	
	35	0.21	2100	0.370	0.210	0.1092	
	40	0.22	2400	0.360	0.220	0.1144	
	45	0.23	2700	0.350	0.230	0.1196	
	50	0.25	3000	0.330	0.250	0.1300	
	55	0.26	3300	0.320	0.260	0.1352	
	60	0.26	3600	0.320	0.260	0.1352	
	70	0.27	4200	0.310	0.270	0.1404	
	80	0.27	4800	0.310	0.270	0.1404	
	90	0.28	5400	0.300	0.280	0.1456	
	100	0.28	6000	0.300	0.280	0.1456	
	110	0.29	6600	0.290	0.290	0.1508	
	120	0.29	7200	0.290	0.290	0.1508	
	150	0.3	9000	0.280	0.300	0.1560	
	180	0.31	10800	0.270	0.310	0.1612	
	210	0.32	12600	0.260	0.320	0.1664	
	270	0.34	16200	0.240	0.340	0.1768	
	525	0.425	31500	0.155	0.425	0.2210	75%

Area 0.52 m^2
50% Area_eff, a_{p50} 1.593 m^2 $V_{p75-25\,theory}$ volume 0.2262 m^3
V_{p75-25} volume 0.2964
t_{p75-25} time 30780 s

Infiltration Coefficient *f* 6.0E-06 ms^-1

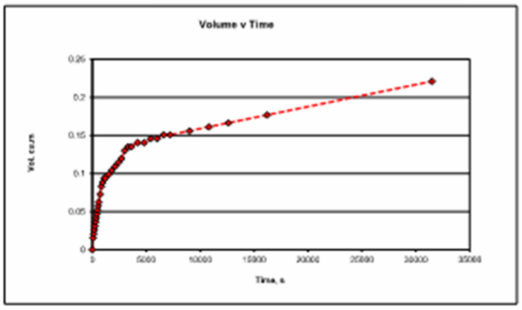


Figure 3.1: Infiltration Calc (Extract from Site Investigations Report)

4 *Maintenance Regime for SuDS Devices*

The SuDS features proposed above for the site will require the following maintenance: It should be noted that as part of the as-builts and taking in charge process, documentation in relation to Operation and maintenance etc will be provided. The proposed SuDS strategy has been developed to try and strike a balance between efficient and robust operation and the minimising of frequent and on-going maintenance requirements. The maintenance of all SuDS features shall remain the responsibility of the developer until such time as any proposed taking in charge has been completed.

4.1.1 Underground attenuation systems

Inspection of the system should be conducted 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 it 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 (if of concrete construction) should be surveyed every 5 years or as required if performance is reduced with any sediment build up removed if necessary.

The locations of the tanks are readily accessible areas adjacent the main spine road. Off road parking for maintenance vehicles and crew is provided for as indicated on relevant drawing in Appendix C. In terms Of Operation and Maintenance the use of attenuation tanks is robust and maintenance free. The typical arrangement is the following train

- A Petrol interceptor which is accessible only via an on-grade heavy duty manhole cover.
- An inlet manhole to the tank will have a sump incorporated to trap silt so as to reduce the need to access the tank.
- The SuDS train is followed by a attenuation tank. This is accessed via a number of heavy-duty manholes covers (anticipated requirement to enter is extremely low). In the unlikely event of entry being necessary only trained personnel in confirmed spaces will be permitted in any tank and this will be detailed and highlighted in any handover/maintenance files at taking in charge stage. There are no moving parts or plant associated with these tanks.
- The outflow should be controlled by a hydro brake located in an outlet manhole abutting the tank. This is normally a vortex arrangement and separate access to that of the tank itself.

4.1.2 Tree Pits

Maintenance of trees will be greatest in the first few years, which will include regular inspection of tree condition including inlets and outlets, removal of invasive vegetation and possibly irrigation during long dry periods. As any handover process (taking in charge) is medium to long term it is anticipated that the Tree Pit regime will be well established and operational with little maintenance required.

4.1.3 Filter Drains

Inspection of the system should be conducted monthly on the inlet / outlet pipework and any control systems for blockages. Inspection of pre-treatment systems including should be conducted every 6 months for catch pits manholes prior to the filter drain with removal of silt or other build-ups. Removal of silt build-up may be required more frequent. Annual cleaning of roof runoff gutters etc should be part of the maintenance of the drainage system to ensure debris is removed prior to entering the network. Perforated pipework should be cleared of blockage if required.

4.1.4 Hydro brake Manhole:

Normally little maintenance is required as there are no moving parts within a hydro brake, however, after installation, hydro brakes should be inspected to ensure the hydro brake orifice is not blocked monthly for three months and thereafter at six monthly intervals and hosed down if required. Remove rubbish or debris from hydro brake if present. Hydro-Brake Flow Controls are fitted with a pivoting by-pass door, which allows the manhole chamber to be drained down should blockages occur. The hydro brake will be located in a manhole separate to the tanks. As a result, any access will be similar to entering a standard manhole.

4.1.5 Petrol Interceptor:

Systems should be visually inspected for every rainfall event for 30 days after installation and the amount of sediment measured to give the operator an idea of the expected rate of deposition. Systems should then be inspected every 6 months to verify the appropriate level of maintenance. Floating debris and solids should be removed, and the sump cleaned with a conventional sump vacuum cleaner. Filter media should be replaced, and sediments, oils and grease should be removed where required.

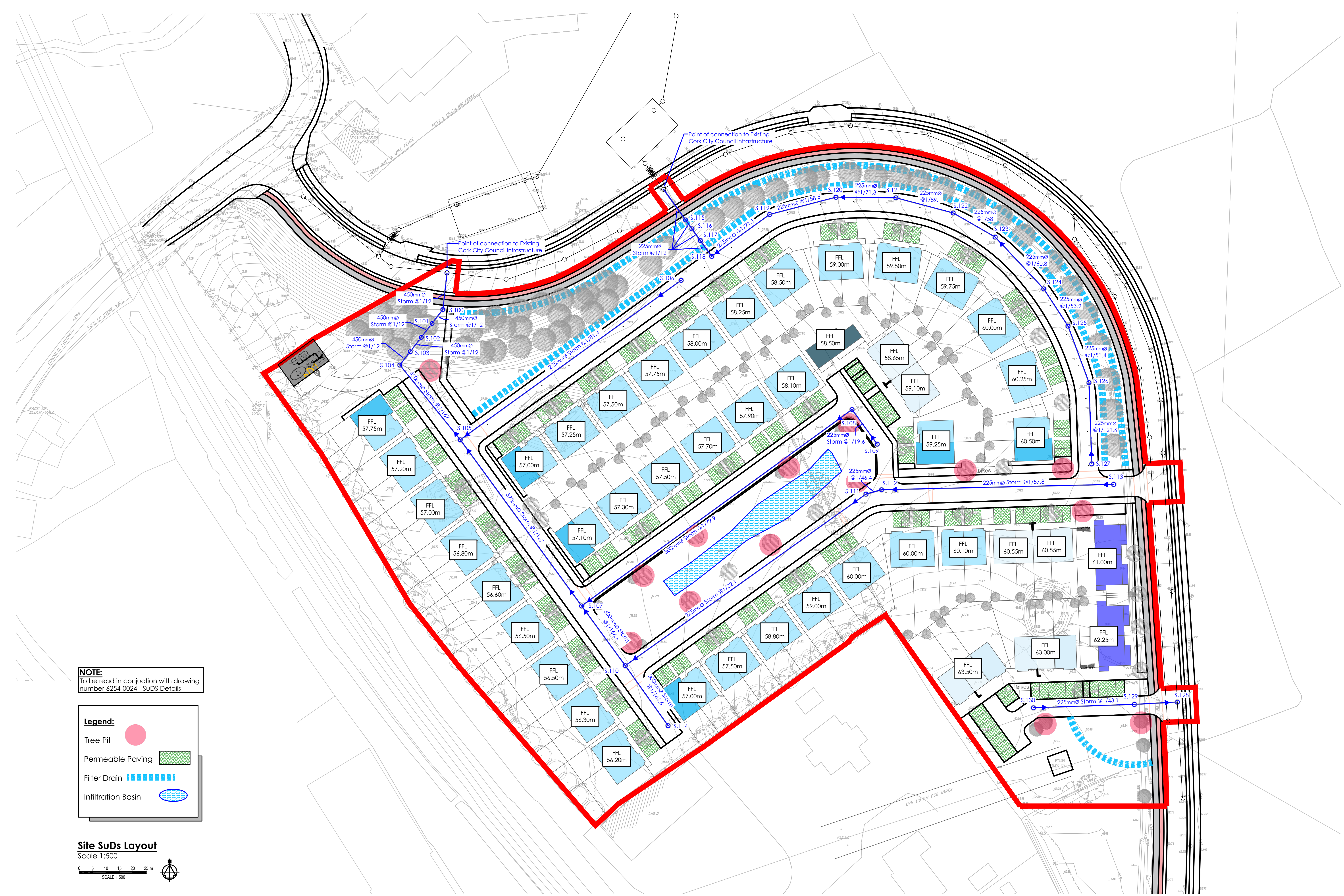
4.1.6 Permeable Paving

The permeable paving has a design life equivalent to standard block paving. The surface blocks require routine maintenance. There are four levels of cleaning that can be conducted on a paved area:

1. General dirt should be removed by regular dry brushing.
2. Where the paving has become dull, showing a loss of colour, a wet wash with a stiff bristle brush and garden hose can be adequate.
3. For more stubborn areas, a power washer can be used, taking care not to remove the jointing materials (sand or mortar). The washer should be on a medium pressure setting or lower and should not be aimed directly at the paving surface, but at an angle of 30° approximately.

Cleaning detergents can be used; however, some detergents are acidic, and overuse can damage some paving products. It is advisable to follow the manufacturer's instructions and rinse the areas fully. The resulting runoff should be carefully channelled to either drainage points or containers from where it can be safely disposed. Replace any washed-out jointing sand with new dried sand once the paving has dried. Permeable Paving is only proposed in private curtilage. As a result, it's maintenance will be the responsibility of private occupants and not that of the council.

Appendix A –Schematic SuDS Train



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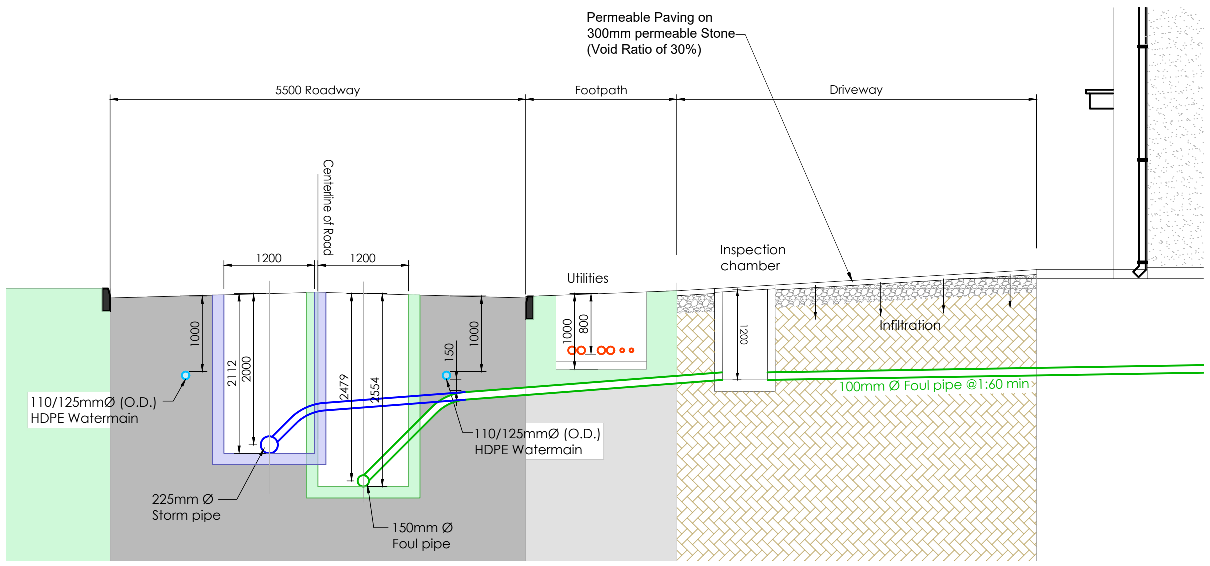
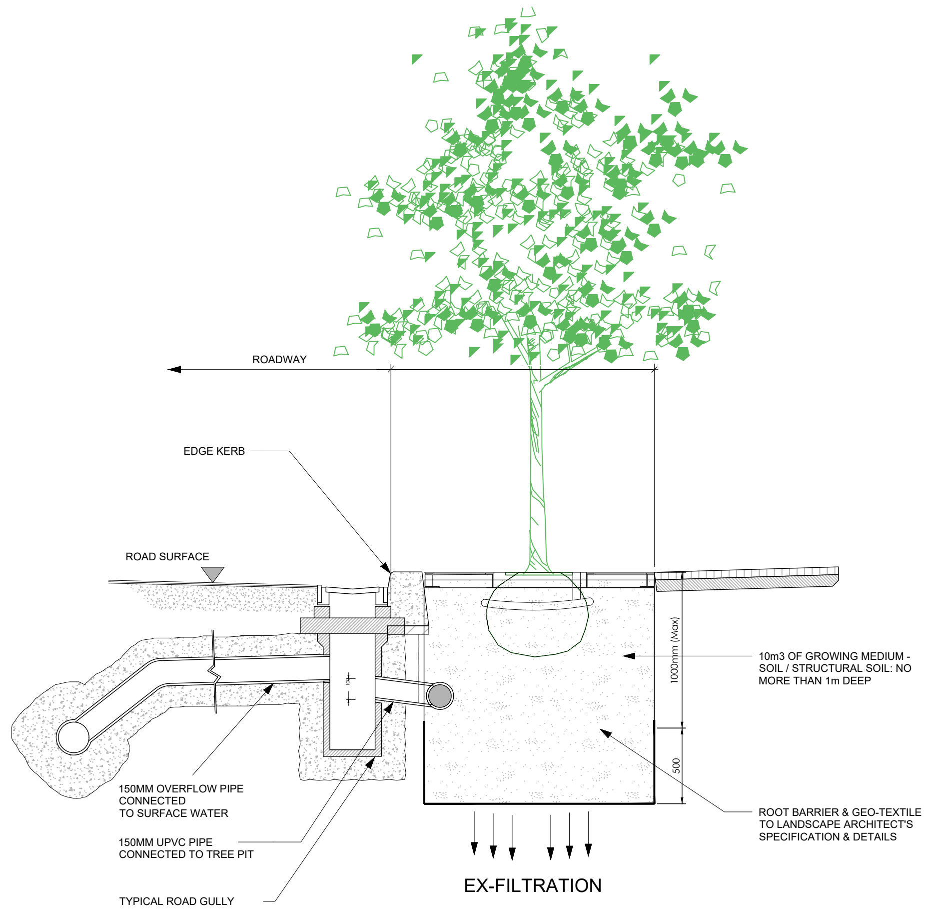
PROJECT
Residential Development at Kilnap, Old Whitechurch road

DRAWING TITLE
Proposed Drainage Layout

SHEET	SCALE	PROJECT NO.	DRAWING NO.	STATUS/ISSUE
A1	1:500	6254	0023	B

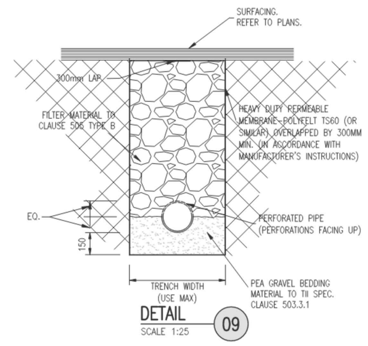


(TYPICAL) DWELLING SECTION INCLUDING PERMEABLE PAVING
SCALE 1:50

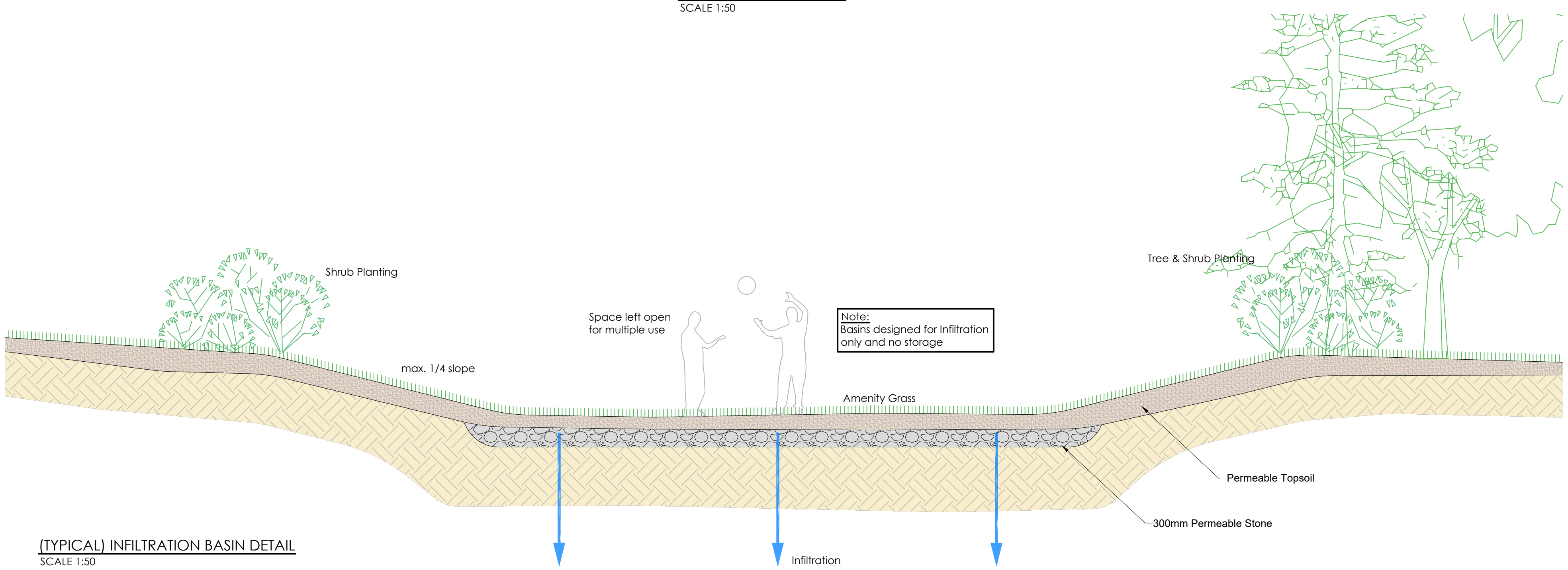


TYPICAL ROAD GULLY TO TREE PIT DETAIL (TYPE 1)

(TYPICAL) Tree Pit Detail
SCALE 1:50



(TYPICAL) Filter Drain Detail
SCALE 1:25



(TYPICAL) INFILTRATION BASIN DETAIL
SCALE 1:50

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CLIENT

PROJECT
Residential Development at Kilnap, Old Whitechurch road

DRAWING TITLE
Proposed SuDs Details

SHEET	SCALE	PROJECT NO.	DRAWING NO.	STATUS/ISSUE
A1	Indicated	6254 _	0024 _	B

Appendix B –SuDS Calculations

SOAKAWAY DESIGN

In accordance with BRE Digest 365 - Soakaway design

Tedds calculation version 2.0.05

Design rainfall intensity

Location of catchment area — Other

Impermeable area drained to the system — A = **9.9** m^2

Return period — Period = **100** yr

Ratio 60 min to 2 day rainfall of 5 yr return period — r = **0.360**

5-year return period rainfall of 60 minutes duration — M5_60min = **18.8** mm

Increase of rainfall intensity due to global warming — $p_{climate}$ = **0** %

Soakaway / infiltration trench details

Soakaway type — Rectangular

Minimum depth of pit (below incoming invert) — d = **300** mm

Width of pit — w = **600** mm

Length of pit — l = **5000** mm

Percentage free volume — V_{free} = **30** %

Soil infiltration rate — f = **24.9×10^{-6}** m/s

Wetted area of pit 50% full — $a_{s50} = l \times d + w \times d$ = **1680000** mm^2

Table equations

Inflow (cl.3.3.1) — $I = M100 \times A$

Outflow (cl.3.3.2) — $O = a_{s50} \times f \times D$

Storage (cl.3.3.3) — $S = I - O$

Note: The following Z2 table values are user defined.

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Inflow (m^3)	Outflow (m^3)	Storage required (m^3)
5	0.36;	6.8;	1.90;	12.9;	0.13;	0.01;	0.11
10	0.51;	9.6;	1.96;	18.8;	0.19;	0.03;	0.16
15	0.62;	11.7;	1.97;	23.0;	0.23;	0.04;	0.19
30	0.79;	14.9;	1.98;	29.4;	0.29;	0.08;	0.21
60	1.00;	18.8;	1.94;	36.5;	0.36;	0.15;	0.21
120	1.22;	22.9;	1.91;	43.7;	0.43;	0.30;	0.13
240	1.48;	27.8;	1.87;	52.0;	0.51;	0.60;	0.00
360	1.67;	31.4;	1.84;	57.7;	0.57;	0.90;	0.00
600	1.90;	35.7;	1.80;	64.4;	0.64;	1.51;	0.00
1440	2.42;	45.5;	1.74;	79.3;	0.78;	3.61;	0.00

Required storage volume — S_{req} = **0.21** m^3

Soakaway storage volume — $S_{act} = l \times d \times w \times V_{free}$ = **0.27** m^3

PASS - Soakaway storage volume

Time for emptying soakaway to half volume — $t_{s50} = S_{req} \times 0.5 / (a_{s50} \times f)$ = 41min 51s

PASS - Soakaway discharge time less than or equal to 24 hours

SOAKAWAY DESIGN

In accordance with BRE Digest 365 - Soakaway design

Tedds calculation version 2.0.05

Design rainfall intensity

Location of catchment area — Other

Impermeable area drained to the system — A = **23.7** m^2

Return period — Period = **100** yr

Ratio 60 min to 2 day rainfall of 5 yr return period — r = **0.360**

5-year return period rainfall of 60 minutes duration — M5_60min = **18.8** mm

Increase of rainfall intensity due to global warming — $p_{climate}$ = **0** %

Soakaway / infiltration trench details

Soakaway type — Rectangular

Minimum depth of pit (below incoming invert) — d = **300** mm

Width of pit — w = **5800** mm

Length of pit — l = **5100** mm

Percentage free volume — V_{free} = **30** %

Soil infiltration rate — f = **24.9×10^{-6}** m/s

Wetted area of pit 50% full — $a_{s50} = l \times d + w \times d$ = **3270000** mm^2

Table equations

Inflow (cl.3.3.1) — $I = M100 \times A$

Outflow (cl.3.3.2) — $O = a_{s50} \times f \times D$

Storage (cl.3.3.3) — $S = I - O$

Note: The following Z2 table values are user defined.

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Inflow (m³)	Outflow (m³)	Storage required (m³)
5	0.36;	6.8;	1.90;	12.9;	0.30;	0.02;	0.28
10	0.51;	9.6;	1.96;	18.8;	0.45;	0.05;	0.40
15	0.62;	11.7;	1.97;	23.0;	0.55;	0.07;	0.47
30	0.79;	14.9;	1.98;	29.4;	0.70;	0.15;	0.55
60	1.00;	18.8;	1.94;	36.5;	0.87;	0.29;	0.57
120	1.22;	22.9;	1.91;	43.7;	1.04;	0.59;	0.45
240	1.48;	27.8;	1.87;	52.0;	1.23;	1.17;	0.06
360	1.67;	31.4;	1.84;	57.7;	1.37;	1.76;	0.00
600	1.90;	35.7;	1.80;	64.4;	1.53;	2.93;	0.00
1440	2.42;	45.5;	1.74;	79.3;	1.88;	7.03;	0.00

Required storage volume — S_{req} = **0.57** m^3

Soakaway storage volume — $S_{act} = l \times d \times w \times V_{free}$ = **2.66** m^3

PASS - Soakaway storage volume

Time for emptying soakaway to half volume — $t_{s50} = S_{req} \times 0.5 / (a_{s50} \times f)$ = 58min 21s

PASS - Soakaway discharge time less than or equal to 24 hours

SOAKAWAY DESIGN

In accordance with BRE Digest 365 - Soakaway design

Tedds calculation version 2.0.05

Design rainfall intensity

Location of catchment area — Other

Impermeable area drained to the system — A = **30.0** m^2

Return period — Period = **100** yr

Ratio 60 min to 2 day rainfall of 5 yr return period — r = **0.360**

5-year return period rainfall of 60 minutes duration — M5_60min = **18.8** mm

Increase of rainfall intensity due to global warming — $p_{climate}$ = **0** %

Soakaway / infiltration trench details

Soakaway type — Rectangular

Minimum depth of pit (below incoming invert) — d = **1000** mm

Width of pit — w = **1000** mm

Length of pit — l = **1000** mm

Percentage free volume — V_{free} = **95** %

Soil infiltration rate — f = **24.9×10^-6** m/s ($f = 24.9 \times 10^{-6}$ m/s)

Wetted area of pit 50% full — $a_{s50} = l \times d + w \times d$ = **2000000** mm^2

Table equations

Inflow (cl.3.3.1) — $I = M100 \times A$

Outflow (cl.3.3.2) — $O = a_{s50} \times f \times D$

Storage (cl.3.3.3) — $S = I - O$

Note: The following Z2 table values are user defined.

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Inflow (m^3)	Outflow (m^3)	Storage required (m^3)
5	0.36;	6.8;	1.90;	12.9;	0.39;	0.01;	0.37
10	0.51;	9.6;	1.96;	18.8;	0.56;	0.03;	0.53
15	0.62;	11.7;	1.97;	23.0;	0.69;	0.04;	0.65
30	0.79;	14.9;	1.98;	29.4;	0.88;	0.09;	0.79
60	1.00;	18.8;	1.94;	36.5;	1.10;	0.18;	0.92
120	1.22;	22.9;	1.91;	43.7;	1.31;	0.36;	0.95
240	1.48;	27.8;	1.87;	52.0;	1.56;	0.72;	0.84
360	1.67;	31.4;	1.84;	57.7;	1.73;	1.08;	0.66
600	1.90;	35.7;	1.80;	64.4;	1.93;	1.79;	0.14
1440	2.42;	45.5;	1.74;	79.3;	2.38;	4.30;	0.00

Required storage volume — S_{req} = **0.95** m^3

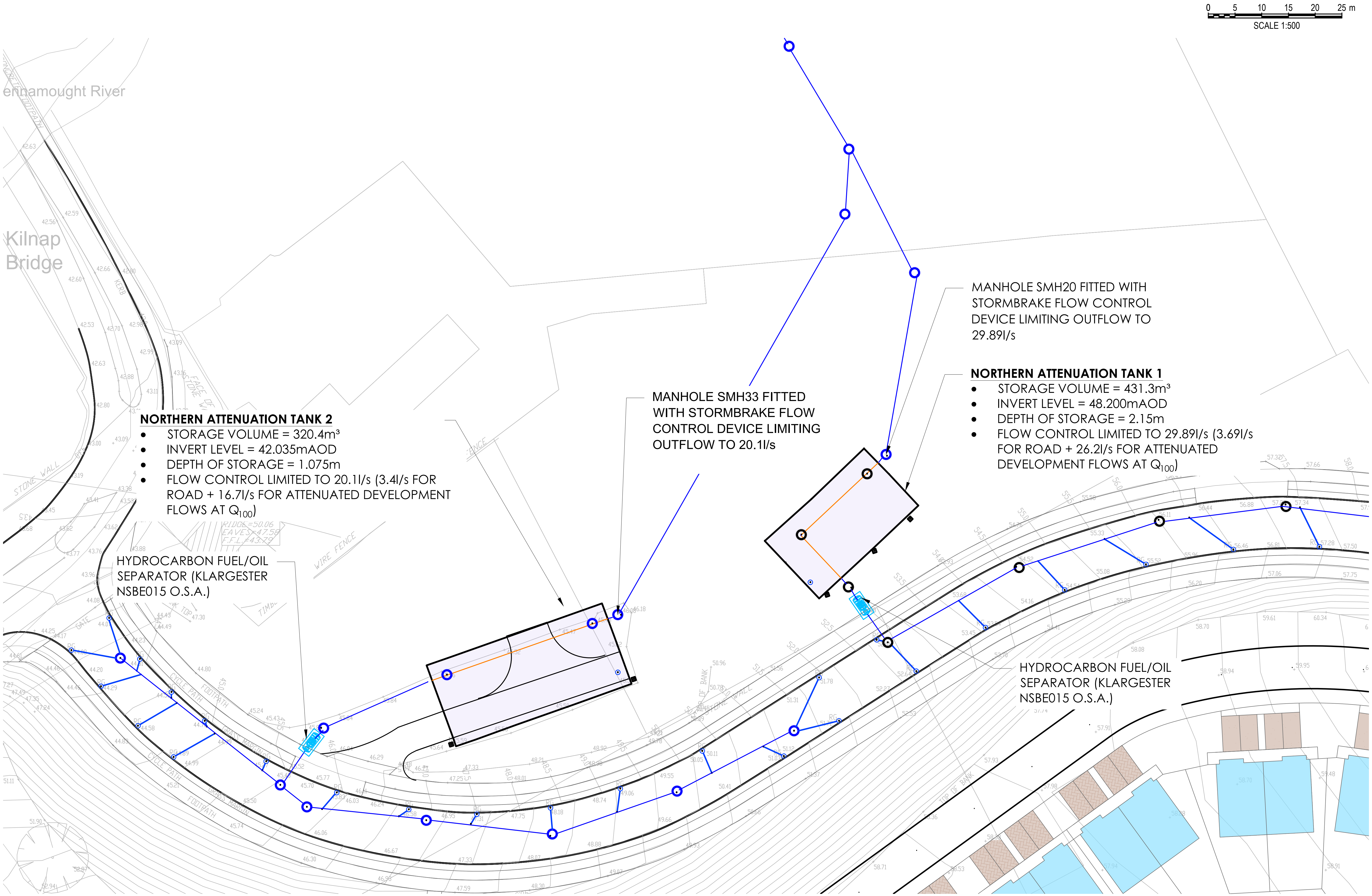
Soakaway storage volume — $S_{act} = l \times d \times w \times V_{free}$ = **0.95** m^3

PASS - Soakaway storage volume

Time for emptying soakaway to half volume — $t_{s50} = S_{req} \times 0.5 / (a_{s50} \times f)$ = 2hr 38min 59s

PASS - Soakaway discharge time less than or equal to 24 hours

Appendix C –Existing Attenuation Tank Infrastructure



Existing Infrastructure

Scale 1:500

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PROJECT: Residential Development at Kilnap, Old Whitechurch road

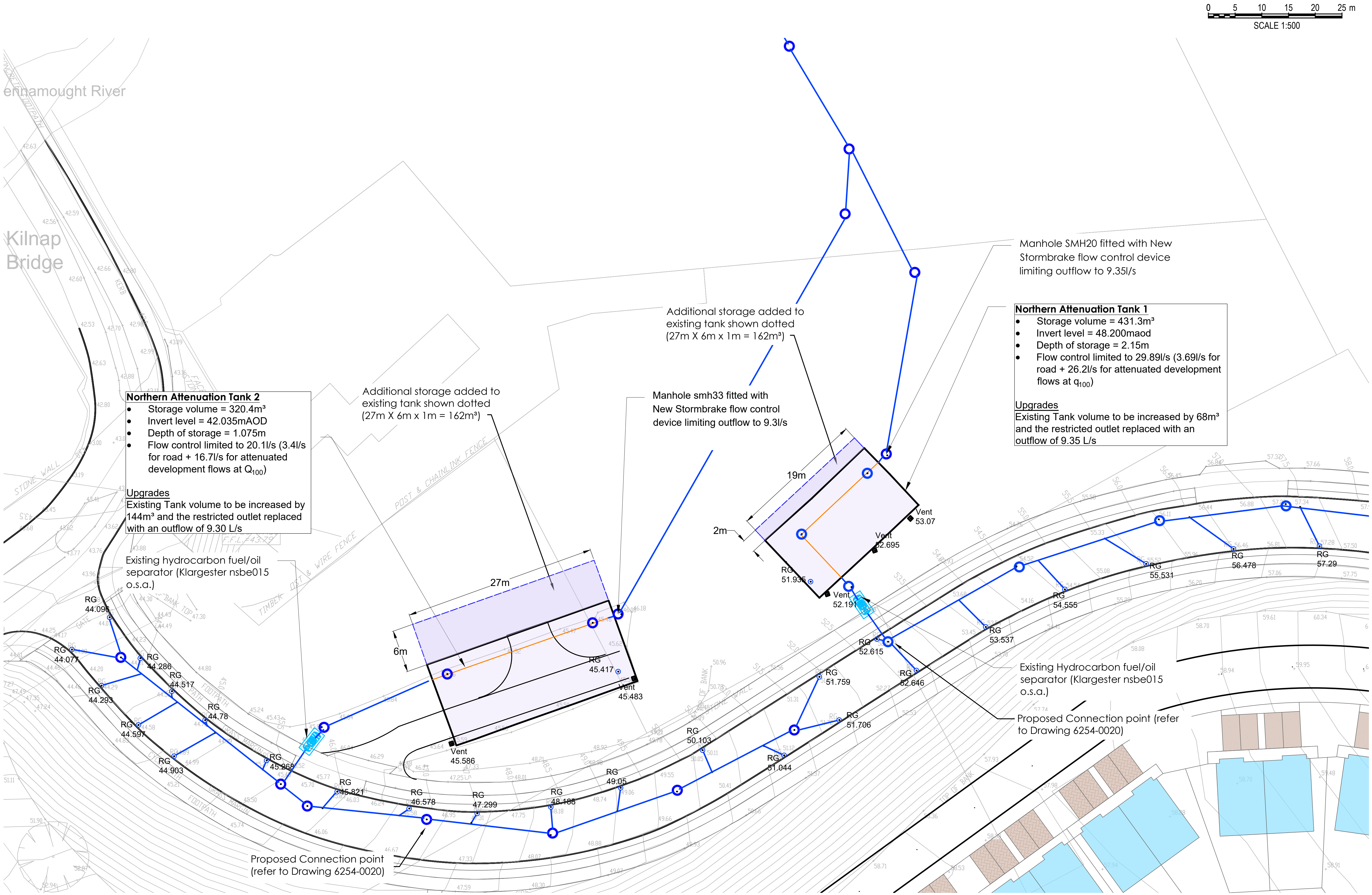
DRAWING TITLE: Existing Cork City Council Infrastructure

SHEET: A3

SCALE: 1/500

PROJECT NO.: 6254 — DRAWING NO.: 0022 — STATUS/ISSUE: B

Appendix D –Proposed Amendments to Existing Attenuation Tank Infrastructure



Existing Infrastructure Upgrades

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PROJECT
Residential Development at Kilnap, Old Whitechurch road

DRAWING TITLE
Proposed upgrade to existing attenuation system

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A3	1/500	6254	0028	A