Drainage Strategy Report for

Proposed Residential Development at:

Land South of Llancarfan Primary School,

Llancarfan,

Vale of Glamorgan.

Prepared for:

Newydd Housing Association Ltd.

4th November 2019

REF: 6682-01
Document Control

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<th>Status</th>
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</tr>
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<td>4\textsuperscript{th} November 2019</td>
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1.0 Introduction

Vale Consultancy are the appointed Civil and Structural Engineers by Newydd Housing Association Ltd to produce a drainage strategy report in support of a planning application for the proposed residential development land south of Llancarfan Primary School, Llancarfan, Vale of Glamorgan. The proposed development is located on a currently undeveloped parcel of land, on the south eastern edge of Llancarfan, and is understood to have not been the location of any past development. **NGR: 305266 170169, Appendix A.**

The proposed development is sited on land which measures approximately 0.32ha, and the site is located in the rural residential setting of Llancarfan, Vale of Glamorgan. The site is south of Llancarfan primary School, and at the south eastern edge of Llancarfan, and accessed from the centre of Llancarfan by an unclassified road.

The site comprises of previously undeveloped land (UDL) and is classed as “Greenfield”.

The drainage strategy covers the hydraulic design criteria of the separate foul and surface water drainage network serving the development expectations of the planning proposals, within the constraints of the site layout and access and landscaping requirements.

1.1 Limitations

This drainage appraisal report is prepared in support of a planning application, and is for the exclusive benefit of the Client. It may not be assigned to or relied upon by third party without the agreement of Vale Consultancy in writing. Vale Consultancy retains all copyright and other intellectual property rights in the document and its contents unless transferred by written agreement between Vale Consultancy and the Client.

The findings and opinions expressed are based on the conditions encountered and/or the information reasonably available at the date of issue.

1.2 Purpose of the Report

The purpose of the report is to describe the proposed strategies for the discharge of both foul and surface water emanating from the development proposals’, the report will identify the following:

- Define flow rates for foul water discharge, and appropriate method management and discharge.
- Provide information about the design storm period and intensity, and the solutions to manage and control the rates of surface water discharging from the site.
- Provide a Management and Maintenance Plan for the proposed system.
- Provide the additional information required to support SAB Pre-App and Full App submissions.

2.0 Background

The candidate site is a parcel of undeveloped land (**Greenfield**) which is irregular in plan area and with a sloping topography for the north east to the south west of circa 28.5m to 21.5m AOD. A review of the available data indicates that the there are no existing comprehensive drainage systems within the immediate vicinity of the candidate site. With only highway gullies in the unclassified highway to the
west of the site, and private fouls drainage serving Llancarfan Primary School, to the north of the site to the east of the site. A names water course (Nant Llancarfan) flows in a southerly direction through the centre of Llancarfan, which is crosses by a highway bridge, some 80m south west of the proposed site entrance.

2.1 Existing Drainage

As noted above, a review of the available records indicates that there are no existing comprehensive drainage systems within the immediate vicinity of the candidate site, with only highway gullies in the unclassified highway to the west of the site disposing of highway surface water, and private fouls drainage serving Llancarfan Primary School, to the northwest of the site.

The Dwr Cymru Welsh Water (DCWW) apparatus record plan for the wider area surrounding the candidate site shows the proximity of existing adopted public sewers. Based on these records and a visual inspection of the wider area surrounding the site, a drainage CCTV investigation was then undertaken. Ref: Appendix B. The nearest identified DCWW foul manhole (Ref: ST05701102), is situated west of the candidate site, in open space adjacent to the river bridge. From that manhole the foul sewer crosses the river south of the highway bridge, and continues in a southerly direction.

The school foul drainage discharges to the south west, in the direction of St Cadoc’s Church, although the point of connection to the DCWW foul sewer has not been identified. It has been demonstrated that there is no foul drainage infrastructure in the unclassified highway fronting the candidate site. As could be expected from a rural residential setting, the surface water (SW) infrastructure serving the area is minimal. Highway gullies have been identified in the unclassified highway fronting the site, which are located between the southernmost school building (to the north) and the community tennis courts (to the south), and are a ‘gulley to gulley’ type system, of 150mm diameter vitrified clay pipes. Due to pipe silting, the discharge point downstream of Gulley 3 has not been identified.

From the above, it has been assessed that a new foul sewer will be required from the candidate site to existing manhole (REF: ST05701102). Also that the road gulley drainage system, which is under the control of Vale of Glamorgan (VoG) Highways Dept, should independent for the candidate site SW drainage. A new and independent SW sewer system to be designed, with an offsite SW discharge is deemed appropriate in the SW drainage assessment below.
3.0 Proposed Foul Water Drainage

The new foul water system drainage will be designed in accordance Part H1 and H2 of the Building Regulations and BS EN 752:2008.

In the proposed scheme, no surface water drainage will be discharging into proposed foul water drainage system.

The hydraulic design of the domestic water component generated by the proposed site development, has been based on the current Code of Practice produced by The British Water Flows and Loads-Sizing Criteria, Treatment Capacity for Sewage Treatment Systems, which is based on the relationship between water usage and wastewater production. Adequate cover and protection will be provided to the proposed foul water drainage system.

British Water Table of Loadings for Sewage Treatment Systems based on per person/activity/day for the classification and selection of the flowing classifications within the proposed building:

- Residential = 150 l/person/day (0.00175 l/sec**)

The residential units with a peak flow multiple for sewage treatment plant of 6 DWF (Dry Weather Flow) and 10% infiltration based on 4000 litres per dwelling per day (based on 3 persons/dwelling 200 litres per head per day): 0.046 litres/second: Sewers for Adoption 7th Edition B5.1.

Dwr Cymru Welsh Water wastewater profile assessment uses the design figure per capita return to sewer flow of 180l/hd/day design standard for 3 persons per dwelling x 6 DWF + 10% Infiltration = \(0.042 \text{ l/sec}^{**}/\text{dwelling}\).

Therefore, applying the same maxim to the proposed development, flow rates and volumes are as calculated below.

3.1 Design Flow Rates from Proposed Development

Category of Building: Residential use

Wastewater Flows based on the following Schedule of Accommodation:

Walk Up Flats
- 4 No 1 bed

Houses
- 8 No 2 bed

Bungalow
- 1 No 2 bed

Total No of dwelling (up to and including 2 bedrooms) = 13

Discharged rate = 13 x 0.042 l/sec = \(0.546 \text{ l/sec}\)

Total wastewater load for the site = \(0.546 \text{ l/sec}\)
Total gross daily flow entering the sewerage network from the site = 47,175 litres per day (@ 0.546 l/sec)

Therefore, the total daily net foul water flow emanating from the building based on 90% of cold-water demand is: 47175 l/day x 0.90 = 42,460 l/day (0.49 l/sec) **This figure is a design peak flow rate and not an average water usage and represents the peak flow rate from a number of appliances.

42,460 l/day total flow / 1000 = 42.5 cubic metres per day effluent discharge to public sewerage system

Design note:
Peak flow rate may also be determined by the application of a diurnal wastewater flow pattern resulting in a variable peak factor so that attenuation and diversification effects tend to reduce peak flow, and so the ratio of peak to average flow generally decreases from top to bottom of the new drainage network.

A new gravity drainage system serving the development proposals will be constructed to effectively manage the flow rates defined above. The design options for the proposed foul water layout serving the development expectations are as follows:

3.2 Foul Water Drainage (Ref: Appendix C.)

After site clearance, a new drainage system serving the development proposals will be constructed. In the absence of any available connection/discharge to a public sewerage asset it is the design intent to provide a new separate foul water drainage serving the new development.

In line with the best practice methods of design identified within Part H of the Buildings Regulations and Sewers for Adoption 7th Edition, the proposed development drainage will be a separate foul water and surface water system.

Due to the lack of existing drainage infrastructure in the area surrounding the site, the point the new foul water site drainage will connect to the public sewerage network at DCWW manhole Ref: ST05701102.

Design note:
Confirmation of the invert level of the connection manhole is a critical consideration prior to the detail design process as this value will have a direct influence of the lower end of the new offsite drainage network. However it is noted that due to the steep gradient of the unnamed highway, between the site and the point of connection to the DCWW public sewer, there are no foreseen design constraints.

Any offsite work regarding drainage will involve the application to Vale of Glamorgan Council for a license under Section 50 of The New Roads and Street Works Act 1991 to excavate a trench to place apparatus (sewer pipe).

The construction of the new carrier drains would provide self-cleansing velocity for the relative pipe diameter as per BS EN 752:2008, Building Regulation 2010 Part H1 and H2, and or comply with minimum gradients requirement for the relevant pipe diameter.
The proposed foul water layout serving the development expectations will be based on Sewers for Adoption 7th Edition where the offsite gravity drain will be a demarcation chamber at the site boundary, and will be offered for adoption under the provisions of a Section 104 Water Industry Act 1991 (WIA91).

The legal right of connection under a Section 106 of the WIA91 will not exist until a Section 104 Agreement is in place for the proposed sewer.

*Confirmation of the invert level of the connection manhole is a critical consideration prior to the detail design of lower off site element of the proposed foul sewer system.*
4.0 Proposed Surface Water Drainage (Ref: Appendix C)

The Flood and Water Management Act 2010 (Schedule 3), which requires new developments to include a Sustainable Drainage System (SuDS) features that comply with national standards. The Welsh Governments published statutory standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems (2018), which became mandatory as of 7th January 2019, and determines the most effective way of embedding SuDS principles in new developments. The statutory national standards are accepted by local authorities that they have taken account of the Welsh Government planning advice on Development and Flood Risk, and the impact of surface water runoff from the development, which is based on limiting the peak runoff rate and runoff volume for extreme events for the 1:100-year return period plus climate change events. In aiming to replicate greenfield runoff rates for extreme events, this will help to ensure that flood risk is not increased by the development proposals, for either the site or immediate surrounding area.

The site is undeveloped land and therefore classified as “Greenfield”.

4.1 Post -Development Surface Water Drainage:

The design approach of the post development surface water drainage strategy will be based on the following recommendations contained within the following publications:

In accordance with best practice and the Welsh Government Publication Titled: “Statutory standards for sustainable drainage (SuDS) in Wales -designing, constructing, operating and maintaining surface water drainage” systems published in January 2018: G2:20 and G2:23. Runoff rates for previously undeveloped sites should mimic the mean average peak flow rate (QBAR). Greenfield rate based on 2 l/sec/ha, and deemed to be the lowest theoretical discharge rate that can be effectively controlled, which is applied to the 1:100-year return period plus climate change rainfall event is the criterion normally used.

4.2 Building Regulation Hierarchy

In line with current best practice, priority consideration for means of surface water discharge should be given firstly to the use of infiltration. There are two factors determining whether infiltration can be utilised onsite.

The first is the geological constraints determined by the underlying geology. Percolation field testing to BRE 365 is required to be undertaken across the site to determine the infiltration characteristics of the ground underlying the site, and the viability of SW drainage infiltration systems as a means of managing SW runoff generated on site.

Percolation tests have been carried out as part of a wider site investigation, which was undertaken by Ian Farmer Associates with conclusions given in report Ref: 70505. Percolation test were carried out at 3 locations across the site, the test location plan and test results are included in Appendix F. The tests did not yield a significant fall in water level during the tests, which is consistent with the stratum description recorded in the trail pit logs, implications of which is discussed in detail in Section 4.3 below.

The second is the physical constraints determined by land use and the proposed development masterplan. Building regulations requires a minimum 5m standoff distance of point source soakaways from any structure, building or public highway. The drainage strategy does not propose the use of
point source soakaways where infiltration can be concentrated to one specific location, sometimes resulting in localised sub-flows.

As noted above, the site has a steep sloping topography which will require significant re-profiling (and with retaining wall elements to the lower site boundary to adjoining land the southwest) to realise the proposed development. As such profiling of the existing landscape, may impact on the opportunities to incorporate certain SuDS methods into the final scheme.

4.3 Surface Water Runoff Destination

In compliance with the Welsh Government publication “Statutory standards for sustainable drainage (SuDS) in Wales-designing, constructing, operating and maintaining surface water drainage systems”

Surface water runoff destination have been considered in order of Priority Level.

The following receptors have been considered for surface water runoff in order of preference.

1. **Discharge by infiltration into ground**
2. **Discharge into open surface water body**
3. **Discharge into surface water sewer, highway drain, or other drainage system**
4. **Discharge into combined sewer.**

As defined above, the candidate site is classes as ‘greenfield’, and has no existing drainage infrastructure within the boundary of the site and due to the rural residential setting the immediate off site drainage and sewer systems are limited.

By exploring the Surface Water destination in line with the SuDS Standards which are aimed at ensuring that the most effective drainage scheme is delivered with the most preferred levels of surface water destination has been determined by demonstrating that the exception criteria for each of the respective Priority Level 1-5 has been applied.

**Priority Level 1: Surface water collected for use:**

**Exception criteria:**

- **Large scale rainwater harvesting has not been used as there is no foreseeable demand for non-potable water within the development proposals. However rainwater butts will be provided within the demise of each plot for use during garden maintenance.**
- **There is no foreseeable need to harvest water at the site as DCWW has not identified any potential stresses on the mains water supply.**
- **The use of rainwater harvesting is not a cost-effective /viable option for managing surface water runoff in comparison to the water supply benefit by installing/maintaining such a system and would only be realised when the tank is full. However as indicated above rainwater butts will be provided within the demise of each plot for use during garden maintenance, which will provide some nominal reduction in water demand, and provide a subsequent environmental benefit.**

**Move to next Priority Level**
Priority Level 2: Discharge Surface Water to Ground.

Exception Criteria

- **Permeability:** Percolation tests have been carried out as part of a wider site investigation, which were undertaken by Ian Farmer Associates, with conclusions given in report Ref: 70505. Percolation test were carried out at 3 locations across the site, the test location plan and test results are included in Appendix F. The tests did not yield a significant fall in water level during the tests, which is consistent with the stratum description recorded in the trial pit logs. As such, the use of soakaways as a means of surface water disposal is not recommended due to the poor ground infiltration characteristics. The suitability of this discharge method is further discounted due to amount of cut and fill that will be required to realise the proposed residential scheme.

Move to next Priority Level

Priority Level 3: Discharge to Surface water body

Exception Criteria

- **The nearest water course is the Nant Llancarfan located approximately 55m south west from the sites west boundary.**
- **The conveyancing route would involve crossing third-party land ownership on the intervening land between the site and the watercourses (locally at the bank of the Nant Llancarfan) including rights of access which would need to be resolved and overcome. In this instance the site fronts directly onto an adopted highway, so although an agreement would be required with Vale of Glamorgan CBC it would be expected that consent would be given, with only a license under Section 50 of The New Roads and Street Works Act 1991 being required. The land ownership of the parcel of land adjacent to the river bank and river bridge over the Nant Llancarfan would need to be confirmed and any relevant legal agreements entered into.**
- **For a priority Level 3 discharge to be realised an element of new surface water drain will be required to link the candidate site to the Nant Llancarfan. This will include appropriate attenuation to replicate the QBAR discharge rate.**

Priority Level attained in conjunction with Priority Level 4.

Priority Level 4: Discharge to surface water or highway drain.

Exception Criteria.

- **The DCWW sewer records indicate that there is no public surface water sewers available in the unclassified highway fronting the candidate site.**
- **The road gulley drainage system that serves the unnamed highway west of the site have been deemed unsuitable to utilise to connect the surface water discharge from the candidate site, as such a new surface water sewer between the candidate site and Nant Llancarfan has been proposed.**
- **The new SW sewer will be designed in accordance with Sewers for Adoption 7th Edition, with SW discharge attenuated to replicate QBAR rates where practicable, and attenuation storage provided to meet SAB requirements.**
Priority Level attained in conjunction with Priority Level 3.

Priority Level 5: Discharge to a combined sewer.

Not Applicable - Priority Level 3 & 4 attained.

It has been demonstrated with the appropriate justification that the most effective drainage scheme by exception can be delivered by the movement from Priority Level 1 through to Priority Level 3/4.” Discharge to an open water course via new SW sewer with a managed discharge rate limited to greenfield runoff.

The proposed drainage scheme will be designed to reflect the identified justification and exception criteria.

4.4 Site Characteristics - Pre-Development

The pre-developed site surface consists of undeveloped open grass land with shrubs and trees to the site boundaries. A review of the site investigation regarding the use of soakaway infiltration/percolation concluded that the ground exhibited characteristics that would not support the use of infiltration as a method of surface water disposal.

4.5 Surface Water Drainage - Post-Development

The design approach of the post development surface water drainage strategy will be based on the following recommendations.

Whilst accommodating for the appropriate design storm scenarios for the site catchment area including climate change and in series incrementally storm profiles to reduce peak flow rate, volume of runoff and reduce pollution, through effective control of runoff at source by the principles of Sustainable Urban Drainage (SUDs) techniques. The site will store, on site, the peak discharge as appropriate and discharge a restricted flow to the onsite surface water sewer, with offsite SW sewer discharging to the Nant Llancarfan.

4.6. The Storage Hierarchy

The final SuDS design will divide the development into sub-catchments where each collection system collects, cleans and stores the whole volume of rainfall and the resulting surface water runoff, prior to final discharge by connection to an offsite water course, which will comprise of:

- **Interception Storage**-Selected to encourage infiltration, evaporation and temporary storage to reduce the frequency of surface water runoff of 5mm of rainfall over the developed areas.
- **Attenuation Storage**-storage within the drainage stone blanket of the permeable paving for the controlled discharge to the offsite water course.
- **Long-term Storage**-storage of exceptional rainfall where the final part of the selected return period is directed to additional storage facilities of the stone drainage blanket thickness.
4.7 Urban Surface Water Management

The SUDs selection criteria have been determined for a drainage solution best suited to the proposed land end use of the area under consideration and draining to the offsite surface water sewer or watercourse, as appropriate.

Soakaways

It has been demonstrated that conventional soakaways will not be feasible for the proposed development as a method of surface water disposal, due to both the ground characteristics and the amount of cut and fill that is required to realise the development, including retaining walls supporting raised ground immediately north of the tennis courts.

Attenuation Storage and Flow Paths

To mitigate the impact of site urbanisation the surface water drainage system for residential plots and access road for the development will be designed based on the principles of *CIRIA SuDS Manual C753*, and to achieve the estimated permissible discharge rate attenuation storage will be required. A storage volume has been determined which will accommodate runoff during the 1 in 100 year plus 30% climate change.

The primary attenuation storage will be provided in the sub base of zones of tanked permeable paving in the development access road, which will be offered for adoption. Due to the topography of the site the permeable paving zones will be at the site entrance and in the vehicle turning head. The remaining areas of the access road will be finished in tarmac to allow zones for service routes and surface water drainage pipes chambers and flow control chambers.

Secondary storage will be provided in private drive tanked permeable paving construction and in tree pits located adjacent to the shared surface access road.

Surface water runoff from roof areas will discharge both directly onto the drive permeable paving surface and into the drive permeable paving sub base, dependant on the relative plot and drive levels of each plot. Surface water will then discharge into the access road permeable paving sub base.

As well as receiving direct rainfall, the access road permeable paving will receive surface water discharge from the tarmac zone of the access road, both as surface water runoff and secondary run off from tree pit surface water interception.

The maximum pass forward to the offsite surface water sewer of via a “Hydrobrake” flow control device which will control the discharge from the overall site SW drainage network, at the define rate, (refer to Section 5.0), with weir wall over flow to manage surface water from exceedance events.

5.0 Discharge Method

5.1 Proposed Post Development Surface Water Runoff

The approach is to provide a managed discharge of surface water runoff with attenuation storage provided in a tanked permeable paving system located in the shared surface access road, as defined in Section 4.7 above.
The runoff rates and volumes from the proposed impermeable catchment areas have been calculated using the Modified Rational (Wallingford) Method. This method allows estimation of the amount of runoff likely to be generated from the development proposals from a range of storm returns. Rainfall depths for various storm return periods have been produced using the *Micro- Drainage Windes (Version 2018.1. Depth –Frequency-Duration)* modelling functions have been used to calculate rainfall intensities for a specific return period. The MRM uses the following equation to calculate peak runoff rate from a given area:

\[ Q = 2.78 \text{ Cv Cr } i \text{ A} \]

Where:
- CV = Volumetric Runoff Coefficient
- CR = 1.3 (Routing Coefficient)
- I = Rainfall Intensity (mm/hr)
- A = Area.
- 2.78 = Coefficient which accounts for the difference in units used for inputs and outputs of the equation.

The variable CV is a coefficient that describes the proportion of rainfall appearing on the surface water drainage system, CR is a routing coefficient added to the Rational Method to represent runoff characteristics of a particular site or area in a more accurate manner.

The Rational Method is recognized as oversimplifying the rainfall runoff process but it considered sufficiently accurate for runoff estimations for small catchment contributing areas. The main assumption being that the rainfall occurs at a uniform intensity for a duration equal to the time of concentration of the catchment and that the rainfall occurs over the entire catchment area, with the rainfall return period being the same as the runoff return period.

### 5.2 Design Approach

**Existing site total area = 0.318 ha**

QBAR Pre-development Surface Water Discharge Rate= 1.5 l/sec

**Proposed Runoff Rate= Based on a permissible discharge rate of 2.0 l/sec**

(Based on minimum practically achievable and manageable discharge rate)

**Total post development impermeable area = 0.12 ha**

**Runoff from developed area - managed volume 58 m³ (32% subbase void storage)**

A surface water discharge with a controlled rate of 2.0 l/sec entering the Nant Llancarfan with a below ground storage for the 1 in 100-year (1.0%) storm event + 30% climate change for the developed area.

**5.2 Three annual probabilities merit specific consideration: 100%, 3.33% and 1%**

The **100% annual probability** (once in one-year event) is the highest probability event to be specifically considered to ensure that the flows to the ordinary watercourse are tightly controlled for these frequent events.
The **3.33% annual probability** (1 in 30-year event) is of importance because of the linkage with the level of service requirements of Sewers for Adoption that requires surface water sewers can convey this storm event within the drainage network without causing flooding to any part of the site.

The **1% annual probability** (1 in 100-year event) has been selected since it represents the boundary between high and medium risk of fluvial flooding defined in PPS25 and recognises it is not practicable to fully limit flows for the most extreme storm events. Also, during storm events of this magnitude, the capacity of the surface water drainage system may be inadequate, however the flood levels of the proposed dwellings will be flood free.

Flood flows up to 1% annual probability are contained within the site and will have little material impact in terms of nuisance and damage. Overland flood flows within the site have been assessed for the short high intensity rainfall events of between 15 mins and 1-hour duration.

### 5.3 Surface Water Drainage Strategy

As part of the drainage strategy we are proposing the following:

- The system is designed not to flood any part of the site in a 1 in 100 + cc year return period design storm.
- The external catchment area of the car parking bays will discharge by a system of line drains and gullies into the new surface water network, to prevent any SW runoff from private areas onto adopted highway footpath and carriageway.
- The development drainage system will be a managed gravity system with a flow control set at a permissible discharge rate of **2.0 l/sec** with on-line storage within the development demise.
- **During the detailed design process**, the proposed network has been simulated by the industry standard drainage design computer software, Micro Drainage - *WinDes*. *WinDes* applies the MRM, analysing each pipe on an individual basis for all storm durations between 15 and 1440 mins (1 day).

**Assumptions:**
- Design Criteria site with average ground slope greater than 1%.
- Global time of entry 5 mins.
- Minimum velocity 0.75m/sec.
- All roof areas and hardscaping to be 100% impermeably.
- Hydraulic pipe roughness 0.6 Ks.
- M5_60 = 19mm.
- Ratio R = 0.317.

The SW network design simulation using Micro Drainage has confirmed the required storage for the development, utilising the permeable paving subbase storage (32% voids).

**Storage volume required** - 58m³ for events up to and including the 1 in 100 year + cc event – refer to calculations in Appendix G.

**Storage format**
- Stone void ratio – **32%**
- Stone plan area – **200m²**
- Stone depth – 0.9m (storage depth not overall permeable paving system depth).
Part H of the Building Regulations and current best practice requires a sequential approach for the disposal of surface water and requires the first choice of surface water disposal to be discharge to infiltration systems where practicable (Ref Section 4.0 Point 1).

6.0 Surface Water Drainage – Exceedance Flows

In line with the design criteria of dealing with exceedance flows, the proposed buildings will not flood for storm events with a return period greater that the 1 in 100 years plus climate change events.

In accordance with best practice (CIRIA C635 Designing for Exceedance), flood waters from storm events that exceed the design storm of 100 years + cc will be channelled toward areas of car parking and soft landscaping within the site boundary, and into the permeable paving systems. The proposed network modelling results based on the Simulation Criteria for a 100-year storm return period for a range of storm durations with the network at pipe full capacity, will indicate the points of storm water escape from the proposed drainage network, which is governed by the flow control chamber overflow weir wall.

The exceedance overland surface conveyance of the flood pathways (default pathways) are directed by design to effectively convey exceedance flow away from the buildings to areas in the development low spots where temporary storage can be incorporated, this can be achieved by the relatively minor detail of kerb heights.

The flow control chamber located within the share surface access road regulates the maximum SW discharge rate, and also incorporates a weir wall overflow. The weir wall is set at the soffit of the permeable paving subbase attenuation layer, so surface water flows generated by events exceeding the 1 in 100 + CC events will freely discharge from the development. These flows will discharge in a south westerly direction along the unnamed adopted highways towards the Nant Llancarfan.

7.0 Pollution Prevention

Water Quality and Treatment Stages.

The proposed surface water drainage system will improve the water quality from the development proposals, entering the surface water drainage system which ultimately outfalls to the Nant Llancarfan which has a degree of environmental sensitivity. This will be achieved by using a treatment chain where each subsequent system within the proposed drainage network is treated to improve water quality.

Infiltration drainage methods are unsuitable for this development and therefore treatment of surface water is controlled by passing through the various elements of the surface water system primary receivers and attenuation systems, prior to discharge into the Nant Llancarfan.

The surface water treatment stage will depend on the potential hazards on the site and the sensitivity of the receiving water body to pollution.

**Catchment: Roof Water**  
**Catchment: Externals Parking Areas**  
**Catchment: Shared Surface Access Road**

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<td>Roof Water</td>
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<tr>
<td>Externals Parking Areas</td>
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The driveways will be constructed from a tanked permeable paving system, with connection to an offsite discharge destination. As well as receiving direct rainfall, the drives will receive surface water discharge from roof areas. With the roof surface water either discharging onto the surface of the drives via dished channels, or piped directly into the paving sub base, (varying by plot and the relative levels of buildings and drives). This will allow surface water to percolate through the tanked paving system sub base and the membranes separating the layers of the permeable paving system, providing contaminant screening.

The areas of access road with tanked permeable paving construction will receive direct rainfall, again with water infiltrating through the membranes separating the layers of the permeable paving system. The surface water runoff from the tarmac surfaced access road will discharge into tree pits at the edges of the shared surface access road, and onto the zones of permeable paving directly. This will provide interception of debris and contaminants prior to discharge into the access road tanked permeable paving subbase.

The above proposals will provide an enhancement of the water quality being discharged from the proposed development into the Nant Llancarfan.

8.0 Status of Ownership of Drainage System

The drainage system serving the development will be offered for adoption, from the point the system crosses a plot boundary serves two or more dwellings, from where it becomes lateral drain and adopted sewer respectively.

9.0 Flooding (Ref :Appendix E)

Vale Consultancy have undertaken a qualitative appraisal of flood risk on site, as required under TAN15 and based on the findings of the sourced information the site is at an elevation where flooding from rivers and sea is low and outside the NRW Flood Risk Zone 2 or Zone 3 flood envelope and therefore unaffected by the fluvial 1 in 100 and 1 in 1000-year flood events.

10.0 Surface Water Drainage Maintenance Strategy

The drainage system has been designed to minimise construction depths. With the reducing topography at the site entrance governing the design parameters. All drains and sewers will be designed in accordance with Sewers for Adoption 7th Edition and Building Regulations Approved Document Part H. Construction details will be in accordance with Sewers for Adoption 7th Edition, and the selected permeable paving system manufacturers construction installation and maintenance requirements.

The permeable paving systems both in the drives and in the access road, by their nature will not have any load capacity issues. The overall depth of the permeable paving systems will be a function of the system manufacturer’s standard construction and CBR values, and in the case of the access road, overall construction depth will be dependent on the total surface water attenuation volume required and variation in finished access road levels.
The plot roof gutters, downpipes, gullies and drive permeable paving will be remain the responsibility of the developer (Newydd Housing Association), who will undertake the associated maintenance of the above elements. With gutters and gullies inspected and cleared on a minimum of an annual basis, similarly the permeable paving drive system should be inspected for defects or build-up of debris and/or vegetation, and also as recommended by the selected permeable paving system supplier. Refer to permeable paving system and maintenance in Appendix H.

The access road and tree pit will be offered for adoption as a combined SAB asset, which will also include the flow control chamber, off site surface water drainage and headwall located on the bank of the Nant Llancarfan. The management of these assets should follow the Vale of Glamorgan Highway Depts. strategy for similar assets that exist across the county, including inspection of tree pits and flow control chamber for debris, and for defects in the permeable paving system, which should reflect the recommendations of the selected permeable paving system supplier. Refer to permeable paving system and maintenance in Appendix H.

The individual plot foul drains will remain the responsibility of the developer (Newydd Housing Association), with the proposed sewer assets managed by Dwr Cymru Welsh Water, as they will be offered for adoption under a S104 agreement.

11.0 Conclusions

The site foul flows will be managed via a new adoptable foul sewer system, which will connect to the existing DCWW network at a manhole situated east of the bridge crossing the Nant Llancarfan.

The site surface water runoff will be controlled by the application of a surface water management strategy with a restricted flow of 2.0 l/sec passing forward to the Nant Llancarfan via a new linking surface water drain, with attenuated storage provided in the subbase of the shared surface access road permeable paving.

The proposed surface water drainage scheme will ensure no increase in runoff over the lifetime of the development.

The on-site development foul and surface water drainage will remain separate, with the surface water and foul systems being offered for adoption under a Section 104 WIA91.

It has been demonstrated that Priory Level 2 of surface water discharge destinations is not reasonably practicable, therefore the lower standard of priority to discharge to the surface water to discharge to an open water course via a new offsite surface water drain, Priority Level 3-4.
Appendix A

Site Location Plan
Topographical Survey
Appendix B

DCWW Sewer Record
Appendix C

Proposed Drainage Concept
TYPICAL MANHOLE DETAIL TYPE 2

(REREF TO FIG. B.12 OF SEWERS FOR ADOPTION 7th ED)

TYPICAL INSPECTION CHAMBER DETAIL - TYPE 4A

WITHIN PAVED AREAS

(TOP OF MANHOLE 400mm BELOW AAD RSN
A2A WRECKED AREA)

TYPICAL DRAINAGE DETAIL IN CLOSE

PROXIMITY OF FOUNDATIONS

ALL FORMATIONS TO BE PROOFT ROLLED WITH SOFT SPOTS REMOVED AND REPLACED WITH SLEEPY MATERIAL OR SUITABLE SITE 8582. MATERIAL AS APPROVED AND DIRECTED BY CIVIL ENGINEER.

NOTE

1. JOHN PAGE TO COMMISSION AND FIELD EQUIMENT, SITE FORMS FOR BUILDING

2. ALL OPERATIONS AND SUPPORT MATERIAL TO COMPLIANCE WITH THE BBA/HAPAS SPECIFICATION.

3. SOFT SPOTS TO BE REMOVED AND REPLACED WITH SLEEPY MATERIAL OR SUITABLE SITE 8582. MATERIAL AS APPROVED AND DIRECTED BY CIVIL ENGINEER.

All dimensions are in millimeters (mm), except where otherwise noted.

- Pipes are to be Type Z bedding and mortar bedding and haunching to Class 8 material to achieve the HAPAS specification issued by the BBA.
- Mortar bedding and haunching to Class 5.03.3 (iv).
- All permeable paving cells to house lateral field drain.
- Flexible joints shall be filled with concrete to this specification.
- Where the trench is less than 1 meter, flexible joints shall be filled with concrete to this specification.
- Rocker pipe details shall be provided to the principle contractor prior to the commencement of any works.
- Temporary works design by others (VALE CONSULTANCY) immediately.
- Foundations to be proof rolled with soft spots removed and replaced with sleepier material or suitable site 8582 material as approved and directed by civil engineer.

DRAINS AND BOUNDARIES

- In areas of the rear of flats and parking where depth varies, minimum internal dimensions are 300x300mm if depth of invert of connecting pipe exceeds 600mm.
- In areas of footways to rear of buildings (C250) and footways to front of buildings (D400), minimum internal dimensions shall be 300x300mm if depth of invert of connecting pipe exceeds 600mm.

- For better performance, class B125 see clause E2.29.
- All existing manhole inverts to be checked and reported.
- Refer to clause E6.6.2 for methods by others.

- Self-cleaning toe holes to be provided where channel drainage runs by 300mm to sides.
- Rocker pipe details shall be provided to the principle contractor prior to the commencement of any works.
- Flexible joints shall be filled with concrete to this specification.
- Where the trench is less than 1 meter, flexible joints shall be filled with concrete to this specification.
- Separate will be made to the engineer (VALE CONSULTANCY) immediately.
- Foundations to be proof rolled with soft spots removed and replaced with sleepier material or suitable site 8582 material as approved and directed by civil engineer.

- TYPICAL MANHOLE DETAIL TYPE 2

- TYPICAL DRAINAGE DETAIL IN CLOSE

- TYPICAL INSPECTION CHAMBER DETAIL - TYPE 4A

- Within paved areas

- (Top of manhole 400mm below AAD RN A2A wrecked area)

- Typical drainage detail in close

- Proximity of foundations

- All formations to be proof rolled with soft spots removed and replaced with sleepier material or suitable site 8582 material as approved and directed by civil engineer.

- Note

- 1. John page to commission and field equipment, site forms for building

- 2. All operations and support material to comply with the BBA/HAPAS specification.

- 3. Soft spots to be removed and replaced with sleepier material or suitable site 8582 material as approved and directed by civil engineer.
PERMEABLE PAVING (TANKED)

TYPICAL SECTION THROUGH PARKING BAY

**Hydropave 80mm Thick**

- **Foundation:** 80mm Thick Hydropave Paving Blocks laid in Herringbone Pattern.
- **Layer:** 10mm Thick Class 5 Crushed Gravel CRM
- **Bedding:** 50mm Thick 2-6mm Clean Crushed Stone
- **Drainage:** Full Height upon CBR Test Results
- **Topsoil:** 200mm Thick 4-20mm Open Graded Crushed Rock

**Sealing:**
- **Exit:** 20mm Local to Outlet Details
- **Fin Drain Outlet Details:**
  - **Membrane:** Top of Haunched Edging Kerb and Cut Off Flush with Surface
  - **Fin Drain:** Wrapped in Permeable Housing Development

**Details of Surround for Service & Drainage:**
- **Root Ball:**
- **Manhole Chambers:**
- **Twinwall Geonet Laid over Cells:**
- **Strata Cell Integrated Tree and Root Ball:**
- **Terram Geotextile:**

**Tree Pit Details**
- **Knee Rail:** To Architect’s Details
- **Cell:** Integrated Tree and Strata Cell System – Specifications

**Other Details**
- **Sealing:**
- **Distance Details:**
- **Rainwater:**
- **Pits:**
- **Cells:**

**PERMEABLE PAVING (TANKED)**

- **Typical Section:**
- **Details:**
- **Description:**
- **Construction:**
- **Installation:**

**Drainage Channel Detail**

- **Location:**
- **Pipe:**
- **Grading:**
- **Completion:**

**Typical Tree Pit Detail**

- **Details:**
- **Construction:**
- **Installation:**

**Scale:**
- **1:200**
- **19.09.19**
- **MJ**
- **19.09.19**
- **Rev. d**
- **Drg. no.**

**Client:**
- **Newydd Housing Association**

**Housing Development to Land South of Llanllaw Primary School**

**Drainage Details SH 2**

**Design:**
- **Engineers:**
- **Consultancy:**

**Manhole Chambers:**
- **Location:**
- **Connection:**
- **Depth:**
- **Pipe Type:**

**Details of Surround for Service & Drainage:**
- **Root Ball:**
- **Manhole Chambers:**
- **Twinwall Geonet Laid over Cells:**
- **Strata Cell Integrated Tree and Root Ball:**
- **Terram Geotextile:**

**Tree Pit Details**
- **Knee Rail:** To Architect’s Details
- **Cell:** Integrated Tree and Strata Cell System – Specifications

**Other Details**
- **Sealing:**
- **Distance Details:**
- **Rainwater:**
- **Pits:**
- **Cells:**

**PERMEABLE PAVING (TANKED)**

- **Typical Section:**
- **Details:**
- **Description:**
- **Construction:**
- **Installation:**

**Drainage Channel Detail**

- **Location:**
- **Pipe:**
- **Grading:**
- **Completion:**

**Typical Tree Pit Detail**

- **Details:**
- **Construction:**
- **Installation:**

**Scale:**
- **1:200**
- **19.09.19**
- **MJ**
- **19.09.19**
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**Housing Development to Land South of Llanllaw Primary School**

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**Design:**
- **Engineers:**
- **Consultancy:**

**Manhole Chambers:**
- **Location:**
- **Connection:**
- **Depth:**
- **Pipe Type:**

**Details of Surround for Service & Drainage:**
- **Root Ball:**
- **Manhole Chambers:**
- **Twinwall Geonet Laid over Cells:**
- **Strata Cell Integrated Tree and Root Ball:**
- **Terram Geotextile:**

**Tree Pit Details**
- **Knee Rail:** To Architect’s Details
- **Cell:** Integrated Tree and Strata Cell System – Specifications

**Other Details**
- **Sealing:**
- **Distance Details:**
- **Rainwater:**
- **Pits:**
- **Cells:**

**PERMEABLE PAVING (TANKED)**

- **Typical Section:**
- **Details:**
- **Description:**
- **Construction:**
- **Installation:**

**Drainage Channel Detail**

- **Location:**
- **Pipe:**
- **Grading:**
- **Completion:**

**Typical Tree Pit Detail**

- **Details:**
- **Construction:**
- **Installation:**

**Scale:**
- **1:200**
- **19.09.19**
- **MJ**
- **19.09.19**
- **Rev. d**
- **Drg. no.**
Appendix D

Proposed Development Layout
New junction subject to highways approval

New retaining wall to engineers design

1.8m High timber fence
1.8m timber fence stained green
600mm Recon stone wall with pre cast coping

Indicates proposed street lines; species to be agreed

Schedule of accommodation:

6no. 2b4p Houses
4no. 1b2p walk up flats
3no. 2b3p Bungalows

13 Units total
Appendix E

NRW Flood Maps
Map Title
Map Perygl Llifogydd / Flood Risk Map

Allweddd / Map Key
- High Surface Water Flood Risk - Extent
- Medium Surface Water Flood Risk - Extent
- Low Surface Water Flood Risk - Extent

Graddfa / Scale  1:5,001

Dyddiad / Date  18/02/2019

Map Title
Map Perygl Llifogydd / Flood Risk Map

Allwedd / Map Key
Reservoir Depths
- 0 - 0.3m
- 0.3 - 2.0m
- Greater than 2.0m

Graddfa / Scale 1:4,999

Dyddiad / Date 18/02/2019

British_National_Grid Kilometers

Appendix F
Percolation Test Results
Job No: 70505
Site: Llancarfan

Site Plan

Figure A1.1
CALCULATION OF INFILTRATION RATE IN ACCORDANCE WITH BRE DG 365: 2016

Client: Newydd Housing Association
Site: Llancarfan
Job No: 70505
Test No: TP1
Date: 07/11/2018
Weather: Drizzle

INPUT DATA AND CALCULATION

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Depth (m)</th>
<th>Size of Trial Pit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2.30</td>
<td>Length (m) = 1.50</td>
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<td>Width (m) = 0.60</td>
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<td>Depth (m) = 2.80</td>
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<tr>
<td>15</td>
<td>2.30</td>
<td>Depth to water at start of test (m) = 2.30</td>
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<td>2.30</td>
<td>Depth to water at end of test (m) = 2.30</td>
</tr>
<tr>
<td>25</td>
<td>2.30</td>
<td>Depth to water at 75% level (m) = 2.43</td>
</tr>
<tr>
<td>30</td>
<td>2.30</td>
<td>Depth to water at 50% level (m) = 2.55</td>
</tr>
<tr>
<td>40</td>
<td>2.30</td>
<td>Depth to water at 25% level (m) = 2.68</td>
</tr>
<tr>
<td>50</td>
<td>2.30</td>
<td>Base area of pit (m^2) = 0.90</td>
</tr>
<tr>
<td>60</td>
<td>2.30</td>
<td>Effective area of loss a_{50} (m^2) = 1.95</td>
</tr>
<tr>
<td>120</td>
<td>2.30</td>
<td>V_{P75} - V_{P25} (m^3) = 0.23</td>
</tr>
<tr>
<td>180</td>
<td>2.30</td>
<td>From the graph:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>t_{p75} (min) =</td>
</tr>
<tr>
<td></td>
<td></td>
<td>t_{p25} (min) =</td>
</tr>
</tbody>
</table>

Soil infiltration rate, f, (m/s) = normal test
pit with stone

Tested by: DD Date: 07/11/2018
Checked by: WHS Date: 09/11/2018

Notes

Fig A2.10
**CALCULATION OF INFILTRATION RATE IN ACCORDANCE WITH BRE DG 365: 2016**

**Client:** Newydd Housing Association  
**Site:** Llancarfan  
**Job No:** 70505  
**Test No:** TP2  
**Date:** 07/11/2018  
**Weather:** Drizzle

### INPUT DATA AND CALCULATION

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<th>Time (min)</th>
<th>Depth (m)</th>
<th>Size of Trial Pit</th>
</tr>
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<td>0</td>
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<tr>
<td>5</td>
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<td>120</td>
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<td></td>
</tr>
<tr>
<td>180</td>
<td>2.30</td>
<td></td>
</tr>
</tbody>
</table>

- **Depth to water at start of test (m) =** 2.30  
- **Depth to water at end of test (m) =** 2.30  
- **Depth to water at 75% level (m) =** 2.43  
- **Depth to water at 50% level (m) =** 2.55  
- **Depth to water at 25% level (m) =** 2.68  
- **Base area of pit (m²) =** 0.90  
- **Effective area of loss aₜ₅₀ (m²) =** 1.95  
- **Vₜ₇₅ - Vₜ₂₅ (m³) =** 0.23

**Notes**

1.50  
1.70  
1.90  
2.10  
2.30  
2.50  
2.70

- **Water Depth**
- **75%**
- **25%**

**From the graph:**
- **tₜ₇₅ (min) =**  
- **tₜ₂₅ (min) =**

**Soil infiltration rate, f, (m/s) =**

**normal test**  
**pit with stone**

**Tested by:** DD  
**Date:** 07/11/2018  
**Checked by:** WHS  
**Date:** 09/11/2018

**Fig A2.11**
CALCULATION OF INFILTRATION RATE IN ACCORDANCE WITH BRE DG 365: 2016

Client: Newydd Housing Association
Site: Llancarfan
Job No: 70505  Test No: TP3
Date: 07/11/2018  Weather: Drizzle

<table>
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<tbody>
<tr>
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<td>2.50</td>
</tr>
<tr>
<td>120</td>
<td>2.50</td>
</tr>
<tr>
<td>180</td>
<td>2.50</td>
</tr>
</tbody>
</table>

**Size of Trial Pit**

- Length (m) = 1.50
- Width (m) = 0.60
- Depth (m) = 3.00

**Input Data and Calculation**

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<tr>
<th>Time (min)</th>
<th>Depth (m)</th>
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<tbody>
<tr>
<td>0</td>
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<tr>
<td>120</td>
<td>2.50</td>
</tr>
<tr>
<td>180</td>
<td>2.50</td>
</tr>
</tbody>
</table>

**Depth to water at start of test (m) =** 2.50

**Depth to water at end of test (m) =** 2.50

**Depth to water at 75% level (m) =** 2.63

**Depth to water at 50% level (m) =** 2.75

**Depth to water at 25% level (m) =** 2.88

**Base area of pit (m^2) =** 0.90

**Effective area of loss a_{50} (m^2) =** 1.95

**V_{P75} - V_{P25} (m^3) =** 0.23

**Soil infiltration rate, f, (m/s) =**

**Notes**

- 1.50
- 1.70
- 1.90
- 2.10
- 2.30
- 2.50
- 2.70
- 2.90
- 3.10

Tested by: DD  Date: 07/11/2018
Checked by: WHS  Date: 09/11/2018

**Fig A2.12**
Appendix G

Surface Water Drainage Calculations
### ICP SUDS Mean Annual Flood

**Input**

<table>
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<th>Return Period (years)</th>
<th>1</th>
<th>Soil 0.350</th>
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<tbody>
<tr>
<td>Area (ha)</td>
<td>0.318</td>
<td>Urban 0.000</td>
</tr>
<tr>
<td>SAAR (mm)</td>
<td>1170</td>
<td>Region Number 9</td>
</tr>
</tbody>
</table>

**Results l/s**

- QBAR Rural 1.5
- QBAR Urban 1.5
- Q1 year 1.3
- Q1 year 1.3
- Q30 years 2.6
- Q100 years 3.2

©1982–2018 Innovyze
Summery of Results for 100 year Return Period (+30%)

Half Drain Time : 249 minutes.

<table>
<thead>
<tr>
<th>Storm Event</th>
<th>Max Level (m)</th>
<th>Max Depth (m)</th>
<th>Max Infiltration (l/s)</th>
<th>Max Control (l/s)</th>
<th>Max Overflow (l/s)</th>
<th>Max Outflow (l/s)</th>
<th>Max Volume (m³)</th>
<th>Status</th>
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<tbody>
<tr>
<td>15 min Summer</td>
<td>23.162</td>
<td>0.362</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>23.2</td>
<td>O K</td>
</tr>
<tr>
<td>30 min Summer</td>
<td>23.288</td>
<td>0.488</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>31.3</td>
<td>O K</td>
</tr>
<tr>
<td>60 min Summer</td>
<td>23.418</td>
<td>0.618</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>39.5</td>
<td>O K</td>
</tr>
<tr>
<td>120 min Summer</td>
<td>23.521</td>
<td>0.721</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>46.1</td>
<td>O K</td>
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<tr>
<td>180 min Summer</td>
<td>23.551</td>
<td>0.751</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>48.1</td>
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<td>240 min Summer</td>
<td>23.551</td>
<td>0.751</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>48.0</td>
<td>O K</td>
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<td>360 min Summer</td>
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<td>0.740</td>
<td>1.9</td>
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<td>1.9</td>
<td>47.4</td>
<td>O K</td>
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<tr>
<td>480 min Summer</td>
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<td>0.721</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>46.2</td>
<td>O K</td>
</tr>
<tr>
<td>600 min Summer</td>
<td>23.499</td>
<td>0.699</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>44.8</td>
<td>O K</td>
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<tr>
<td>720 min Summer</td>
<td>23.475</td>
<td>0.675</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>43.2</td>
<td>O K</td>
</tr>
<tr>
<td>960 min Summer</td>
<td>23.423</td>
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## Summary of Results for 100 year Return Period (+30%)

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## Storm Rain Flooding Discharge Overflow Time-Peak

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<th>Discharge Volume (m³)</th>
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## Rainfall Details

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## Time Area Diagram

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Model Details

Storage is Online Cover Level (m) 24.000

Infiltration Blanket Structure

Infiltration Coefficient Base (m/hr) 0.00000 Diameter/Width (m) 8.0
Safety Factor 2.0 Length (m) 25.0
Porosity 0.32 Cap Volume Depth (m) 1.000
Invert Level (m) 22.800

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0067-2000-1000-2000
Design Head (m) 1.000
Design Flow (l/s) 2.0
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 67
Invert Level (m) 22.800
Minimum Outlet Pipe Diameter (mm) 100
Suggested Manhole Diameter (mm) 1200

Control Points

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Mean Flow over Head Range - 1.7

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

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<td>6.000</td>
<td>4.6</td>
</tr>
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<td>6.500</td>
<td>4.7</td>
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</table>

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Flow (l/s)</th>
</tr>
</thead>
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<td>7.000</td>
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</tr>
<tr>
<td>7.500</td>
<td>5.1</td>
</tr>
<tr>
<td>8.000</td>
<td>5.2</td>
</tr>
<tr>
<td>8.500</td>
<td>5.4</td>
</tr>
<tr>
<td>9.000</td>
<td>5.5</td>
</tr>
<tr>
<td>9.500</td>
<td>5.7</td>
</tr>
<tr>
<td>1000</td>
<td>5.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Flow (l/s)</th>
</tr>
</thead>
</table>

Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 23.800
Appendix H

Formpave Material Specification and Maintenance Strategy
Construction Specification

Storm water source control system*
AQUAFLOW® permeable paving

Construction

All construction work on pavements should be carried out following completion of general site works. Top soiling must be completed to adjacent areas to prevent wash down of fine materials.

Sub Grade

- Excavate to sub grade as per the design drawings.
- All soft areas should be removed and filled with suitable replacement material.
- The sub grade should be compacted with a vibrating plate.

Kerbs/Edgings

- The paved areas must be firmly restrained.
- Kerb haunching must extend to a minimum depth of 150mm below the base of the kerb.
- The kerb/edging must extend with sufficient height above the haunching to accommodate the full laying course depth and block height.

SC MEMBRANE® Geosynthetic – (Where the finished system is not required to be 100% watertight)

- SC Membrane® to be laid on formation with 300mm laps between adjoining sheets.
- Joints to be taped using SC Tape.

SC MEMBRANE GT® Geosynthetic – Where 100% watertight system is required (Contaminated land, water harvesting, construction near basements etc.)

- Lay protection fleece or 75mm sand blinding on formation
- Lay SC Membrane GT® on fleece or blinding.
- Joints should be fully welded in accordance with manufacturer guidelines or by specialist sub-contractor - a taped joint will be insufficient.
- Welding can be completed on site or pre-formed off site and delivered ready for installation.
- Lay protection fleece to internal face of the SC Membrane GT® liner.
- SC Membrane GT® should be brought up to the top of laying course level and cut off.

INBITEX® Geotextile – Infiltration Systems

- Lay Inbitex® Geotextile instead of SC Membrane® to provide an infiltration system rather than an attenuation system, overlapping joints by 300mm.
SC INTERGRID® Geogrid

- Laid on the SC Membrane®/Inbitex® Geotextile before placing the sub-base stone.
- Joints should overlap by 300mm.
- Further SC Intergrid® Geogrid layers can be incorporated within the sub-base at 150mm vertical intervals to add stability to thicker sub-base layers.

Sub-base

Lower layer of sub-base (10-63mm)

- Placed in 2 separate layers
- Vibrate each layer to compact
- Final pass taken with no vibration
- Compaction should continue until 97% of the compacted bulk density achievable under laboratory conditions has been reached - measured with a nuclear density gauge.
- The specified 350mm depth of sub-base may be varied by the Engineer to suit site requirements.

INBITEX® Geotextile

- Lay Inbitex® Geotextile on top of the sub-base overlapping joints by 300mm.
- Inbitex should be brought up to the haunched kerb/edging and cut-off flush with the surface of the paving.

Laying Course

- Lay and screed to level approximately 50mm depth of 2-6mm single sized crushed stone to BS EN 13242: 2002.
- Final level of the 2-6mm stone must be accurate - stone will compact down much less than sand when the surface blocks are vibrated.

The particle shape of the 2-6mm stone will also affect the degree of compaction. It is recommended that a small trial area should be laid prior to construction to determine the accuracy of final levels.

Block laying

- Pre-set the block level by 6mm to allow for the effects of settlement when laid against fixed edgings.
- The blocks and slabs must be tightly butt jointed ensuring that a good fit is achieved.
- Single or double stretcher course of Aquaflow® blocks must be used around the periphery of the paved areas.
- It is recommended that lateral restraints (such as forest edging) should be installed in areas where vehicles turn and/or brake.
- The lateral restraints should be properly constructed and haunched with concrete.
Cutting block

- Cut to a tight fit and none are to be smaller than 30% of the unit block size with three machined edges.
- Cut across the 100mm and not the 200mm dimension. Blocks should be cut vertically and not under-scord.
- All block cutting should be carried out with a disc cutter.

Surface Finish

- The blocks should be vibrated with a vibrating plate Type DVP75/22" or similar.
- 2-4mm clean quartzite or gritstone should be applied to the surface and brushed in. The tapers and slots between the blocks should be fully filled.
- Blocks should again be vibrated and any debris brushed off.
Aquaflow Aggregates

**Surface dressing grit**

Surface dressing grit 2-4mm clean Quartzite

**Laying Course**

50mm depth of 2-6mm, single size clean crushed stone to BS EN 13242:2002

**Upper Subbase**

100mm depth 5mm-20mm clean, crushed with well defined edges BS EN 13242:2002

**Lower Subbase**

250mm depth 10–63mm clean crushed stone with well defined edges. Clean 10-63mm crush stone
Surface Dressing

2-4mm Quartzite Gritstone

1. SCOPE

This specification defines the 2-4mm surface dressing to be applied to the surface of Aquaflow Pavers and subsequently brushed/vibrated between pavers.

2. REFERENCE SPECIFICATIONS

BS EN 1097-2:1998
BS EN 1091-8:2000 Annex A

3. MATERIAL SPECIFICATION

Material supplied shall be referred to as 2-4mm Clean Quartzite and conform to the following sieve analysis and aggregate testing.

<table>
<thead>
<tr>
<th>SIEVE SIZE</th>
<th>% PASSING</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3mm</td>
<td>100</td>
</tr>
<tr>
<td>5mm</td>
<td>95-100</td>
</tr>
<tr>
<td>3.35mm</td>
<td>66-90</td>
</tr>
<tr>
<td>1.18mm</td>
<td>0-20</td>
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<tr>
<td>600 microns</td>
<td>0-8</td>
</tr>
<tr>
<td>63 microns</td>
<td>0.0-1.5</td>
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</tbody>
</table>

Aggregate Testing

Los Angeles Coefficient (LA) – Determination of resistance to fragmentation = 20
BS EN 1097-2:1998

Note: Lower values than those specified signifies better resistance to fragmentation and abrasion and is therefore acceptable.

4. APPROVED SUPPLIER LIST

Available direct from Formpave or via our approved Builders Merchants
specification Sheet
Formpave Aquaflow System

Laying Course

2-6mm clean crushed stone

1. SCOPE
This specification defines the 2-6mm laying course.

2. REFERENCE SPECIFICATIONS
BS EN 13242:2002

3. MATERIAL SPECIFICATION
Material supplied shall be referred to as 2-6mm Clean crushed stone typically limestone or granite, gravel is not permitted. The material is to conform to the following sieve analysis and aggregate testing.

<table>
<thead>
<tr>
<th>SIEVE SIZE</th>
<th>% PASSING</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mm</td>
<td>98-100</td>
</tr>
<tr>
<td>6.3mm</td>
<td>80-100</td>
</tr>
<tr>
<td>2mm</td>
<td>0-20</td>
</tr>
<tr>
<td>1</td>
<td>0-5</td>
</tr>
</tbody>
</table>

Aggregate Testing
Los Angeles Coefficient (LA) – Determination of resistance to fragmentation = 20
BS EN 1097-2:1998

Note: Lower values than those specified signifies better resistance to fragmentation and abrasion and is therefore acceptable.

4. APPROVED SUPPLIER LIST
Available from your local quarry.
Where possible suppliers should be registered to BS EN ISO 9000.
Upper Subbase Layer

5-20mm clean crushed stone

1. **SCOPE**

   This specification defines the 5-20 Upper Sub-base.

2. **REFERENCE SPECIFICATIONS**

   BS EN 13242:2002

3. **MATERIAL SPECIFICATION**

   Material supplied shall be referred to as 5-20mm Clean crushed stone and conform to the following sieve analysis and aggregate testing.

<table>
<thead>
<tr>
<th>SIEVE SIZE</th>
<th>% PASSING</th>
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</thead>
<tbody>
<tr>
<td>40mm</td>
<td>100</td>
</tr>
<tr>
<td>20mm</td>
<td>90-100</td>
</tr>
<tr>
<td>10mm</td>
<td>25-70</td>
</tr>
<tr>
<td>4mm</td>
<td>0-15</td>
</tr>
<tr>
<td>2mm</td>
<td>0-5</td>
</tr>
</tbody>
</table>

   **Aggregate Testing**

   Los Angeles Coefficient (LA) – Determination of resistance to fragmentation = 20

   BS EN 1097-2:1998

   Note: Lower values than those specified signifies better resistance to fragmentation and abrasion and is therefore acceptable.

4. **APPROVED SUPPLIER LIST**

   Available from your local quarry.

   Where possible suppliers should be registered to BS EN ISO 9000.
Lower Subbase Layer

10-63mm clean crushed stone

1. **SCOPE**

This specification defines the 10-63 Lower Sub-base.

2. **REFERENCE SPECIFICATIONS**

BS EN 13242:2002

3. **MATERIAL SPECIFICATION**

Material supplied shall be referred to as 10-63mm Clean crushed stone and conform to the following sieve analysis and aggregate testing.

<table>
<thead>
<tr>
<th>SIEVE SIZE</th>
<th>% PASSING</th>
</tr>
</thead>
<tbody>
<tr>
<td>100mm</td>
<td>100</td>
</tr>
<tr>
<td>63mm</td>
<td>90-100</td>
</tr>
<tr>
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<td>60-80</td>
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<tr>
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<td>15-30</td>
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<tr>
<td>10mm</td>
<td>0-5</td>
</tr>
</tbody>
</table>

**Aggregate Testing**

Los Angeles Coefficient (LA) – Determination of resistance to fragmentation = 20
BS EN 1097-2:1998

Note: Lower values than those specified signifies better resistance to fragmentation and abrasion and is therefore acceptable.

4. **APPROVED SUPPLIER LIST**

Available from your local quarry.

Where possible suppliers should be registered to BS EN ISO 9000.
Method of accessing services and reinstatement

General

It is important that access to services in or underneath the Formpave Sustainable urban drainage system is undertaken in a disciplined and progressive way.

Procedure

- Uplift the Aquaflow blocks 1m either side of the line of the relevant underground mains service.

- Take up the bedding course then cut out the underlying Inbitex geotextile. Leave enough Inbitex in place for a 300mm overlap when replacing the Inbitex geotextile at the end of the job. You will now have the beginnings of a trench along the line of the mains service. Dispose of the old laying course stone and Inbitex geotextile.

- Now excavate the sub-base stone and place it adjacent to the trench on a plastic membrane. Prevent wet silt from running over adjacent paving. The sub-base stone can be re-used.

- At the bottom of the Aquaflow system cut away the Intergrid layer and dispose of it. Finally cut through the lower layer of Inbitex geotextile or waterproof membrane at reduced level along the line of the services and dispose of it. Remember to leave enough Intergrid and Inbitex in place for a 300mm overlap when reinstating at the end of the job.

- Excavate material from over and around the mains services and carry out the repairs or service tappings. Once completed, reinstate around the mains, up to formation level. Follow guidelines from the utility undertaker and highway authority.

- To reinstate the Aquaflow system cut fresh Inbitex geotextile or waterproof membrane to size, place on the formation, overlapping the existing geotextile or membrane by 300mm. Tape the new geotextile/membrane in place.

- If a heavy duty welded waterproof membrane is installed due to a high water table, contaminated ground or the presence of methane the replacement membrane will need to be re-welded to the existing membrane.

- Cut and install a fresh SC Intergrid layer allowing 300mm of extra width either side to overlap with the existing SC Intergrid. Spread and compact the first 250mm depth of sub-base stone.

- Spread and compact final 100mm thickness of sub-base.

- Cut fresh Inbitex geotextile to size, again achieving a 300mm overlap using double sided tape.

- Lay and level a 50mm depth of 2-6mm crushed stone bedding to BS EN 13242: 2002.

- Replace surface blocks and vibrate using rubber soled plate compactor. Dress the surface with 2-4mm clean quartzite gritstone to fill the block joints and vibrate again. Continue brushing and vibrating until joints are full. Brush off and dispose of any debris before final vibration.
# Aquaflow Maintenance

<table>
<thead>
<tr>
<th>Maintenance schedule</th>
<th>Action</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regular maintenance</strong></td>
<td>Sweeping surface to remove debris and contamination</td>
<td>1-2 times a year, typically Spring and after leaf fall in Autumn</td>
</tr>
<tr>
<td><strong>Occasional maintenance</strong></td>
<td>Removal of weeds</td>
<td>As required</td>
</tr>
<tr>
<td><strong>Remedial Actions</strong></td>
<td>Remediate areas of rutting and depressions.</td>
<td>As required</td>
</tr>
<tr>
<td></td>
<td>Replace broken/damaged blocks</td>
<td>As required</td>
</tr>
<tr>
<td></td>
<td>Rehabilitate surface with sweeping and reapplication of 2-4mm clean gritstone</td>
<td>As required</td>
</tr>
<tr>
<td><strong>Monitoring</strong></td>
<td>Initial inspection</td>
<td>Within 3 months of installation</td>
</tr>
<tr>
<td></td>
<td>Inspection for poor performance and silting</td>
<td>Annually</td>
</tr>
<tr>
<td></td>
<td>Inspect ancillary drainage components i.e. gullies, outfall pipes etc.</td>
<td>Annually</td>
</tr>
</tbody>
</table>

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**Formpave**

Tufthorn Avenue, Coleford
Gloucestershire GL16 8PR

Tel: 01594 836 999
Fax: 01954 810 577

Email: designservice@formpave.co.uk
Web: www.forterra.co.uk/formpave
A common sense approach to the maintenance of the Aquaflow system should be adopted. The maintenance program should be designed to ensure the structural and hydraulic performance of the Aquaflow system.

Visual inspection of the Aquaflow paved surface is the most important element of a maintenance program.

Sweeping should be carried out when required,

A clean surface will remain permeable and prevent a build-up of debris or vegetation leading to clogging of the joints.

Replacement of the jointing grit may be required after sweeping to maintain surface integrity.

When properly considered, maintenance of the Aquaflow system is just a small part of a project maintenance programme. End users should be sufficiently informed so that an adequate and none costly maintenance programme can be utilised.