Land North of the Railway Line
Rhoose

Drainage Technical Note

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Introduction

This Technical Note has been prepared by Phoenix Design Partnership Limited on behalf of Persimmon Homes East Wales to support planning application of 256 dwellings North of railway line, Rhoose.

The purpose of this Technical Note is to update the core principles of the Drainage Design Statement by Shear Design dated 23rd August 2013 in line with current best practice with reference to accommodate the Sustainable Drainage Systems Standards for Wales (SDSSfW) of Schedule 3 of the Flood and Water Management Act 2010. A copy of the Shear Design 'Design Statement' can be seen in Appendix A.

Development Proposals

The proposed development will consist of 256 dwellings including all infrastructure (carriageways, footpaths, car parking etc). The proposals will no longer need to make allowances for the neighbouring site of 250 units referenced in the Shear Design report as the development has now been built and obtained its own drainage solutions (both foul and surface water).

Following the legislation enforcing Schedule 3 in January 2019 the proposed surface water system will be designed at ground level in accordance with best practice and the Ciria SuDS Manual.

Infiltration Testing

Earth Science Partnership (ESP) carried out soakaway testing in accordance with BRE 365 in April 2022 along the Southern portion. ESP excavated 6 number trial pits to depths of between 2.1 and 2.5m. ESP noted maximum topsoil depths of 300mm consisting of soft brown to light brown silty gravelly clay overlaying the Porthkerry bedrock as predominantly limestone bedrock interbedded with mudstone becoming decreasingly weathered with depth.

A summary of results can be seen below Table 1 below:

Test ID	Test Depth (m)	Average Infiltration rate (m/s)
SP1	2.3	1.090×10^{-5}
SP2	2.2	8.710×10^{-6}
SP3	2.1	4.800×10^{-6}
SP4	2.1	3.368×10^{-6}
SP5	Test Failed	N/A
SP6	Test Failed	N/A

Table 1 – Summary of BRE 365 testing

Based upon the results, it is deemed that infiltration will not suffice as a sole method of surface water disposal, consequently a positive discharge location is required as a ‘leaky system’.

Schedule 3 (Flood and Water Management Act 2010) and the Sustainable Drainage Approval Body (SAB)

Under Schedule 3 all developments in Wales over 100m² now require surface water drainage to be designed in accordance with the statutory standards for Sustainable Drainage Systems Standards for Wales (SDSSfW) produced by Welsh Government. It is the role of each councils SAB team to assess and approve the design proposals which are reviewed against these standards.

The standards aim to mimic the natural drainage characteristics of a site to help control the volume and rate of run off from the proposed development. This is achieved by managing the runoff at or close to the surface and as close to the sources as possible while also providing additional benefits such as biodiversity and amenity.

There are six standards that need to be met as follows.

- S1 – Surface Water runoff destination
- S2 – Surface Water runoff hydraulic control
- S3 – Water Quality
- S4 – Amenity
- S5 – Biodiversity
- S6 – Design of drainage for construction, operation and maintenance

S1 – Surface Water Runoff Destination

The hierarchy of outfall solutions within the Welsh Government guideance is as follows;

A. Surface water runoff is collected for use
B. Surface water runoff is infiltrated to ground
C. Surface water runoff is discharged to a surface water body
D. Surface water runoff is discharged to a surface water sewer, highway drain or another drainage system
E. Surface water runoff is discharged to a combined sewer

A. Runoff Collection for Use

Collecting runoff for re-use usually comes in the form of rainwater harvesting systems such as tanks. It is widely accepted that these systems are not commercially viable on residential projects due to their cost, reliability and future maintenance. It is therefore not proposed to install these systems.

It is proposed that the developer will install a rainwater butts to the rear of each property where possible to allow for rainwater reuse.

B. Runoff Infiltrated to the Ground

Given poor infirltration results, it is anticpated that the drainage solution will be to utilise a positive discharge in addition to infilrtration by means of a ‘leaky system’.

C. Surface Run off Discharged to Water Body

The proposed surface water strategy is to drain to the former quarry to the south of Pentir Y De within VoG land which offers a conveyance directly to the sea. Details can be seen in the Shear Design ‘Design Statement’

Consequently, S1 is deemed to have been achieved via discharged to a surface water body.

S2 – Surface water runoff hydraulic control

The proposed development will drain into the sea at an unrestricted rate which has been agreed in principle with the VoG SAB team (see email between Adam Spiller of Persimmon Homes and Gareth Thelwell-Davies of VOG SAB can be seen in Appendix B); however, the development will utilise various SAB features which will ultimately slow down the flow of water and through interception reduce low levels of run off.

The following features are proposed within the layout:

1.0. Permeable Surfaces

This system is proposed to be used in limited areas where alternative solutions are not viable due to layout constraints. Permeable surface systems are efficient at managing surface water at source by intercepting and storing runoff in the substructure which helps to slow down the flows but also provides a medium where treatment can take place. Permeable surface systems have been proven to decrease concentrations of a range of surface water pollutants such as heavy metals, oils and sediment.

Permeable surfaces to be block paviour construction.

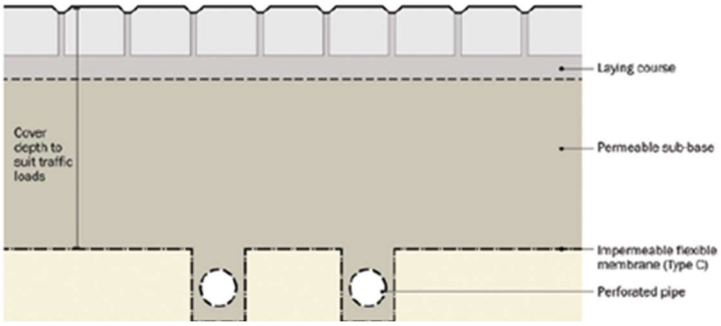

Figure 3 – Typical Permeable Paving System

2.0. Macro Pervious Paving Systems

Macro pervious paving' systems consist of traditional tarmac/ block paving surface layers overlaying a no fines subbase (4-20mm aggregate as used in typical permeable surfaces), the key difference between 'macro pervious' systems and permeable paving is how the water is conveyed to the subbase. In this instance, water will be captured by traditional systems such as linear drainage or gullies which discharge directly to the subbase by means of distribution units. The water cleaning measures are consistent with traditional permeable surfaces as stated in the Ciria SuDS Manual heading 20.1.6.

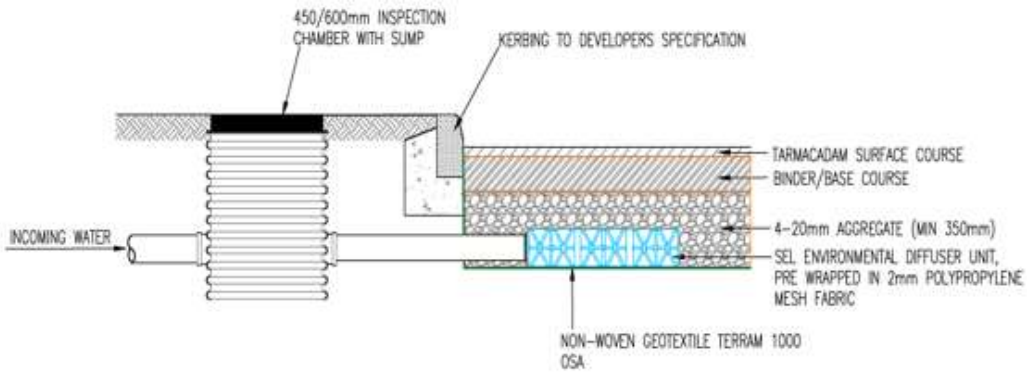

Figure 4 – typical Macropervious Paving

Given that the water is conveyed directly to the subbase, it is proposed that a primary water cleaning feature is incorporated as close to source as possible which will aid in the removal of contaminants and solids such as the catchpits, Funke Gruppe 'D-Rainclean' filter media and the SEL 'Raintana'.

3.0. Rain Gardens/ Bioretention Systems

These systems are proposed alongside main access routes as build outs or verges. Rain gardens are shallow areas or depressions that can be landscaped to help treat pollution and inherently slow down the flows.

Rain garden systems are effective at providing interception for the frequent rainfall events. The systems will include an element of storage in the soil make up allowing surface water to both evapotranspiration and be used by the planting within them.

Water quality is provided by sediment being captured at surface level while the base media removes associated pollutants such as nutrients, oils and metals.

Biodiversity is provided through the planting / landscaping used. The systems are flexible and can have a variety of base media mixes used.

Rain gardens will be designed using the SuDS Manual as well as 'Designing Rain Gardens: A Practical Guide' by Urban Design London (UDL).

Figure 5 – Typical Bioretention System/ Rain Garden

4.0 Interception Basins

These systems will be used as the final interception feature which will be located along the southern part of the site prior to draining to the quarry. These are vegetated systems that will provide another level of treatment and slow down flows with shallow

gradients. Basins will normally be dry and in frequent rainfall events water levels will not be significant.

The main water quality benefits of interception basins come from the removal of sediment and buoyant material. The longer water takes to leave the basin the higher level of treatment provided.

Interception basins can also double up as amenity space. Biodiversity is provided through the planting/landscape used.

Figure 6 – Typical Detention/ infiltration basin

4.0. Swales/ Ditches

These systems may be used in conjunction with the interception basins as a means of conveyance at various points throughout the site. Swales & ditches tend to be shallow with a flat base which when laid at shallow gradients provides a conveyance method that can handle much larger flows than tradition piped systems.

Water quality can be provided through the planting/landscaping used however the gradient is key to this in reducing the flow velocity and allowing contaminated to be filtered out.

Where steeper gradients occur on this development, check dams will be provided along the ditch length in order provide adequate interception.

Biodiversity is provided through the planting/landscaping used.

All systems will be designed to accommodate the 1 in 100 year + climate change event.

Figure 7 – Newly formed Swale

Interception Criteria

The SDSSfW states that '*when rainfall takes place on greenfield sites there is, for the majority of rainfall events during the year, no discernible surface water runoff to receiving water bodies. The rainwater normally 'evapotranspires', or in winter it can result in river base flow replenishment and/or groundwater recharge. However, impermeable surfaces generate runoff from virtually all rainfall events, and this change in runoff characteristics can have a negative impact on the morphology and ecology of receiving water bodies. Interception aims to mimic greenfield runoff conditions'*.

To comply with S2 of the standards, sufficient SAB features need to be incorporated to prevent the first 5mm of rainfall leaving the site, hence we will incorporate several SAB features including bioretention/ rain garden systems, interception basins and swales/ ditches. Given the infiltration rates provided by ESP it is anticipated that the features will offer maximum interception in line with Table G2.1.

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SAB Feature Calculations

Microdrainage Calculations

It is widely accepted that the provision of SAB features within hydraulic design software is impossible to model accurately given extensive variables, thus our Microdrainage calculations will assume that the SAB features are hydraulically saturated and merely act as a conveyance to the mains drainage, i.e. a rain garden will continue to collect highway run off, however it is considered that water will be conveyed directly to the main carrier drain via the overflow system and by pass the soil.

This methodology ensures that the surface water network is sufficiently sized where failures in a SAB feature occurs.

In addition to the above, we will allow for 10% urban creep (UC) within our calculations in accordance with the SuDS Manual section 24.7.2 which makes allowances for an increase in impermeable areas such as conservatories, extensions, increased paved driveways increasing surface run off.

Our calculations will also make an allowance climate change in accordance with the Welsh Government publication 'Adapting for Climate Change: Guidance for Flood and Coastal Erosion Risk Management Authorities in Wales' April 2021. Table 3 in Section 2 indicates an upper and central estimate of climate change for the years 2070 – 2115 of 40% and 20% respectively. As is widely accepted, a median of 30% will be applied.

Rain Gardens/ Bio - Retention

It is widely accepted that calculating the volume of water that 'escapes' rain gardens is extremely difficult given the variables involved such as current saturation of the soils, current weather conditions, plant uptake, soil porosity and evaporation. Standard guidance for the design of rain gardens is specified within the Ciria SuDS Manual which states a rain garden should be sized at around 2-4% of the area it drains, this is corroborated in the document 'Designing Rain Gardens: A Practical Guide' by Urban Design London (UDL). The UDL document indicates the methodology for designing a rain garden as follows for the 5mm first flush (for the purposes of calculation, we have assumed a catchment area 100sqm with a 5sqm rain garden (equivalent of 5%).

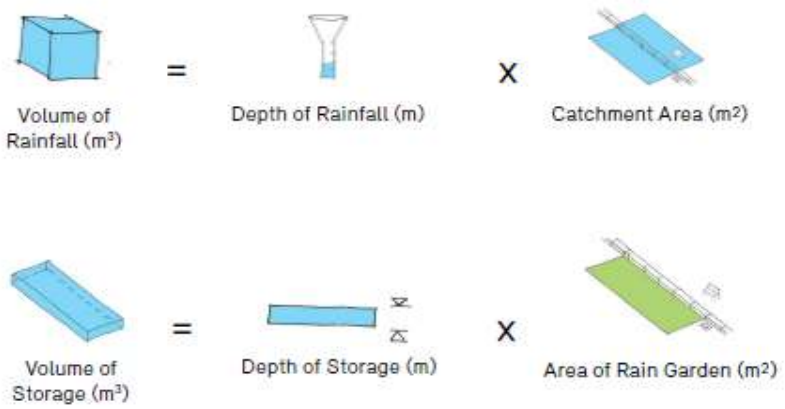


Figure 8 – UDL Calculation for Rain Garden Storage Volume

As per the methodology above, the volume of rainfall during the first flush (5mm) is 0.5m cube (0.005m x 100sqm).

Volume of a typical rain garden on our development with an equivalent surface area of 5% of the catchment area (likely worst case) will have a volume of 2.64 cubic metres (50mm freeboard + 390mm (30% of rain garden depth – 1.30m) x 6sqm area of rain garden)

Given that the average rain garden size will be approximately 20% of the catchment (smallest is 15%), the rain gardens provided in accordance with the above calculations have sufficient volume to accommodate the first flush of 5mm (interception) as per the requirements of the guidance.

S2 - Storm Water Summary

The engineering proposals will utilise the following features to meet the requirements of the SAB:

- Macro Pervious systems will be used in all driveways (private and shared) which will cater for plot roofs (garage and house) and the drive itself.
- Where sufficient space is provided, private shared drives will drain to rain gardens
- Private rain gardens to be used where necessary on plot, sized no greater than 5% of the drained area owing to the above calculations.
- Permeable paving will be utilised where no other feature can be accommodated.
- All SAB features will have connection to a piped network which will discharge to the disused quarry.

S3 Water Quality

The proposed SAB features used on site are to ensure that water quality meets the requirements of S3 of the SDSSfW which refers to the Water Quality Management section of the SUDS Manual. The 'Pollution Hazard Level' for each of the surfaces (Roofs, driveways, shared surfaces & Roads) are categorised in Table 26.2 of the SuDS Manual. Once the areas are identified, Table 26.3 of the SuDS Manual is used to identify the pollutants removal along the drainage train.

Given the nature of the development, it is considered that water quality measures will be met.

S4 - Amenity

The proposed development benefits from the residential amenity provided within the green spaces located throughout the site. The site links into the cycleways and footpaths that connects public open spaces that include large areas of green space. The sustainable urban drainage proposals for the site form an integral part of the wider amenity strategy for the development. The most prominent components of the system, from a resident's perspective, will be the rain gardens & basins. Rain gardens line the main roads and will be experienced by residents on a daily basis. The prominent treatment of water at surface level, directly outside homes, maximises legibility of the wider drainage system while providing a visually attractive element to the roadway that breaks up hard surfacing with green boarders along the street frontage. The visibility of water as it travels through the landscape, and the personal-scale ecosystems created will provide a resource for local environmental education and opportunities for social cohesion.

On-plot landscaping consists of predominantly evergreen shrub species and turf, providing all year colour. Shrubs of varying heights/forms with different foliage structures and flowering

seasons are used to enhance visual interest. Shrubs which provide scent are included adjacent to footpath routes.

The scheme has been designed so that, on reaching maturity, shrubs will require minimal maintenance/management and will not become too big for their location.

Generally, small, low growing shrubs have been used adjacent to footpaths with larger shrubs located at the backs of shrub beds away from pedestrian routes.

S5 – Biodiversity

The most prominent feature of the wider SuDS proposal are the rain gardens units which will be created along the main roads and shared drives. The vegetated rain gardens will create habitat for invertebrates including pollinators, potential refuge and dispersal features for amphibians and foraging for birds.

The rain gardens will provide connectivity across the site for a range of species offering safe dispersal routes away from access roads and will also allow rainwater to be soaked up and filtered by the plants within the gardens, decreasing the amount of surface water runoff experienced across the site. This natural filtration will also contribute towards the provision of cleaner water into the wider environment. The borders of the rain gardens will be planted with a range of grasses and wildflowers which are tolerant of dry conditions with occasional inundation.

The interception basin will be planted with a variety of wildflower seed mixes. The basin will provide potential habitat for invertebrates including pollinators, foraging, perching and nesting habitat for birds and foraging habitat for bats, and will allow the attenuation of surface water run-off. The improved water quality provided by the SuDS scheme will allow important habitats to flourish and support a wide range of species. Additional planting of damp tolerant marginal species will further increase the biodiversity benefits by providing a diverse range of habitats across the scheme, including the provision of shelter and foraging potential for species of reptile and amphibians.

S6 - Design of drainage for construction, operation and maintenance

The site is to be constructed in line with the guidance set out in Ciria C768. A specific Construction Management Plan will be prepared by PHEW at detailed design stage.

Maintenance will be caried out in line with the following schedules taken from the Ciria SuDS Manual.

TABLE 18.3 Operation and maintenance requirements for bioretention systems

Maintenance schedule	Required action	Typical frequency
Regular inspections	Inspect infiltration surfaces for silting and ponding, record de-watering time of the facility and assess standing water levels in underdrain (if appropriate) to determine if maintenance is necessary	Quarterly
	Check operation of underdrains by inspection of flows after rain	Annually
	Assess plants for disease infection, poor growth, invasive species etc and replace as necessary	Quarterly
	Inspect inlets and outlets for blockage	Quarterly
Regular maintenance	Remove litter and surface debris and weeds	Quarterly (or more frequently for tidiness or aesthetic reasons)
	Replace any plants, to maintain planting density	As required
	Remove sediment, litter and debris build-up from around inlets or from forebays	Quarterly to biannually
Occasional maintenance	Infill any holes or scour in the filter medium, improve erosion protection if required	As required
	Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch	As required
Remedial actions	Remove and replace filter medium and vegetation above	As required but likely to be > 20 years

TABLE 20.15 Operation and maintenance requirements for pervious pavements

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphospate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

Foul Water Drainage

The foul drainage is to drain via a purpose-built pumping station as identified in the Shear Design 'Design Statement', albeit the discharge volumes will be smaller given that the development to the West has its own drainage system. The pumping station along with all foul infrastructure will be offered to DCWW under a Section 104. Where DCWW adoptable systems coincide with SAB features such as permeable paving, an easement is applied whereby traditional construction methods are proposed.

Conclusions

- Foul flows are to drain via a pumped solution to the public sewers to the East.
- Under Schedule 3 of the Flood and Water Management Act 2010 the surface water proposals will need to be reviewed and approved by VoG SAB team.
- The proposed surface water flows will drain to the disused quarry to the South, however this is subject to agreeing a methodology with the VoG and Network Rail
- Permeable paving, macro pervious surfaces, rain gardens and interception basins will provide treatment of surface water flows. These systems will also reduce flow velocities, surface water volumes and provide additional biodiversity to the area.
- All systems will be designed for the 1 in 100 year + 30 climate change events.

Appendix A

Shear Design Drainage Design Statement

SHEAR design
Consulting Civil and Structural Engineers

DRAINAGE DESIGN STATEMENT

LAND WEST OF PENTIR Y DE, RHOOSE

Date: 23RD August 2013

Ref: SM/MB/12112.02.03.D110

INDEX

APPENDIX

FLOORS

Issue	Prepared by	Checked by	Date
1	Simon Mason	Dameon Kilgour	23/08/13

1.0 INTRODUCTION

This document has been prepared by Shear Design on behalf of both Bellway Homes and Persimmon Homes as a supporting document for a reserved matters application for the development of houses on land west of Pentir Y De, Rhoose, in the Vale of Glamorgan. Refer to Appendix i for Site Location Plan.

The statement provides the detailed strategy of the proposed foul and surface water drainage to serve approximately 350 properties.

There is another parcel of land west of the proposed development. This land has capacity for a further 250 houses but is not part of the reserved matters application; however under the outline application planning conditions our development must give consideration to servicing foul and surface water drainage for the adjacent land. This aspect is covered within this design statement.

Due to known flooding issues associated with the existing land drainage system a flood alleviation scheme is incorporated in the design statement. This includes provision of a diverted land drainage system to address these issue and to serve the reserved matters application site and future development on the adjacent land.

The following document gives due consideration to the previous reports prepared by WSP and Dwr Cymru Welsh Water (DCWW) for the outline planning application. The detailed design statement has progressed the proposals with further consultations with both DCWW and the Vale of Glamorgan Borough Council Land Drainage Officers.

The proposals contained within this design statement set out the intent for drainage and the detailed design will be subject to relevant technical approvals by the statutory bodies associated with drainage adoptions, and the Building Regulations, following planning approval.

2.0 FOUL WATER DRAINAGE

2.1 OUTLINE APPLICATION PROPOSALS

The site is isolated from any existing gravity foul sewers and previous reports by WSP and DCWW have established that there are offsite foul water drainage capacity issues. These capacity issues relate to downstream peak flow capacity at Porthkerry Park Pump Station, Marine Drive and the Barry Town Pump Station. Refer to DCWW Sewer Map Appendix ii.

The foul water hydraulic modelling of the existing drainage system was previously completed by DCWW's consultants and established 4 options for the design proposal. This modelling included the potential foul flows from the adjacent land and was based on a total of 600 dwellings.

All of these options required a pump station within the new development and ensured that the peak discharge did not cause surcharging of the downstream drainage networks. To achieve this, attenuation of sewage was required for the new development. In essence the forward flows would remain at approximately 120 l/s but to handle the greater volume of effluent during peak flows, a storage volume of 315m^3 was required.

At the time of the outline planning submission, Option 4 from this modelling had been chosen as the preferred solution. This required the construction of a new foul pump station within the site with 315m^3 of storage. This pump station would intercept the existing 300mm diameter foul rising main that passes along the southern boundary of the site and then reconnect to the same rising main.

Option 4 was chosen at that time due to being achievable wholly within the site boundaries and therefore without third party land issues.

2.2 DETAILED FOUL PROPOSALS

Leading up to the submission of the reserved matters Shear Design have met with DCWW and discussed the scale of the engineering works for the new pump station for Option 4.

It has become evident that as the proposed pump station will intercept all of the flows from the Rhoose PS it will need to be sized to deal with a failure event for the whole of the Rhoose catchment plus the 315m^3 storage. This is a substantial infrastructure commitment for DCWW as the adopting authority to maintain and an unnecessary duplication of an existing facility that is less than 1km away.

This is not the most sustainable solution and the past modelling solutions have been revisited. A hybrid is now being proposed as an alternative to Option 4 and is referenced as Option 5.

OPTION 5

This option is to provide a new foul water pumping station to serve the proposed housing developments only. This will be a much smaller pump station but will still incorporate the required attenuation.

The rising main will discharge into the gravity Public Foul Sewers in Porthkerry Road approximately 1200m from the site. The route of the rising main will be either:

a) Across private land parallel to the existing 300mm diameter foul water rising main from the Rhoose Pump Station.

b) Wholly within public highway from the Porthkerry Road/ Pentir Y De roundabout down to the gravity Public Foul Sewer within Porthkerry Road.

The developers are in consultation with the land owners regarding the rising main route but the alternative route through public highway means that the Option 5 proposal is viable without a need to cross third party land.

Discharge from the new pump station will be restricted to a flow rate that will not affect the downstream sewer network. A discharge rate of 10 l/s was noted in the previous hydraulic modelling under Option 2. DCWW are currently commissioned by the developer for an updated hydraulic model that will verify the acceptable peak discharge rate.

The restricted discharge will require the need for storage previously quantified as 315m3. Under the updated DCWW hydraulic modelling this figure will also be reviewed.

A layout of the proposed foul drainage is included in Appendix iii.

2.3 ADJACENT DEVELOPMENT LAND

The adjacent development land, West of the site, will be provided with a 225mm diameter spur for the foul drainage. This will drain by gravity to the new foul water pump station.

From topographical survey data, the adjacent site is lower than the application land and will therefore require its own foul pump station to reach the connection provided by our development.

3.0 EXISTING LAND DRAINAGE

Previous reports by WSP, prepared as part of the outline approval, identified an issue with the surface water regime local to the proposed development leading to flooding of fields immediately adjacent the north of the rail tracks and flooding of new properties to the south of the tracks built as part of the Rhoose Point development.

On-going discussions with the Vale of Glamorgan Borough Council Land Drainage Officers and Shear Design's own assessments from records, have established the existing catchment areas and flood mechanisms. These catchments are described overleaf in Table 1.

For the purposes of surface water run-off rates Q Bar for 1 in 100 year storm events has been calculated as 808.6 l/s for 50 hectares and proportioned to the relevant areas in accordance with FEH guidance. See Appendix iv for Q Bar calculations.

Surface water drainage discharge rates for impermeable areas have been calculated based on 50mm/ hour which is the approximate rainfall intensity for a 1 in 100 year 1 hour storm event in this region.

The above figures do not account for time of entry and therefore are conservative for the assessment purposes. A plan of these catchment areas including the VOG BC Highway Drainage is shown in Appendix v.

Table 1 – Existing catchments and flows

Catchment Reference	Description	Area (m^2)	Discharge (l/s)
A	Existing agricultural land area within the proposed development boundary which is currently greenfield run-off. This flow discharges via a 300mm diameter culvert beneath the rail tracks at the site low spot midway along the southern boundary. The 300mm diameter pipe connects to a 450mm diameter sewer that runs parallel to the boundary, south of the rail tracks and within the current Rhoose Point Development.	146,000	236
B	Murlande Way housing estate. This is reported to have surcharge from existing soakaways during extreme storm events. The excess flows are above ground and enter the site from the northern boundary. These flows follow the site topography leading to the low spot of catchment A noted above. This flow has been treated as greenfield run-off for discharge calculations.	41,000	67
C	Highway Drainage from Porthkerry Road discharging to the lane and land drain north west of the development boundary. This land drain discharges via a 600mm diameter culvert beneath the rail tracks. These flows have been treated as impermeable areas using 50mm/hr rainfall intensity. The 600mm diameter pipe connects to a 450mm diameter sewer that runs parallel to the boundary, as noted under Catchment A	14,000	195
D	Agricultural land to the east of Pentir Y De. The land falls north to south and a portion of this is intercepted midway along the eastern boundary of the development site with 2 No. 300mm diameter outfall pipes passing beneath Pentir Y De through an underpass. Topography of the site takes the flows to the low spot of Catchment A as noted above. This discharge is calculated as green field run-off.	40,500	66
E	Housing development north of Porthkerry Road. It is unclear where this discharges its surface water as there are no surface water sewers shown within the estate, therefore for assessment purposes we have assumed a potential connection of the highways within the estate to the Highway drainage using 20% of the site area as impermeable. The remainder draining via soakaways as Moorlands Way.	41,500	116
F	Agricultural land north of Porthkerry Road. This was noted as causing flooding of the highway in extreme storm events in its south west corner. This includes a land parcel between Porthkerry Road and an unnamed access track. This run-off drains via the highway sewer noted in Catchment C	73,000	118
G	Miscellaneous verges and tracks	30,000	49
H	Land West of the development land. This is the adjacent development land parcel for a further 250 houses. This is outside the development boundary and levels fall away from our site. It is currently agricultural land and drains at its low spot via a 300mm diameter pipe, connecting to the 450mm diameter sewer along the south of the rail tracks serving Catchments A and Catchment C as noted above.	126,000	204
	TOTALS	512,000m^2	1,051 l/s (1.1m^3/s)

From the above Table 1 the following observations can be made:-

Catchments B, D and G discharge to catchment A and therefore the 300mm diameter outfall beneath the rail tracks from catchment A has a potential total discharge rate of 418 l/s. From Hydraulic Research Tables the capacity of a 300mm diameter pipe at an assumed gradient of 1 in 100 has a capacity of only 111 l/s.

Catchments E and F discharge to Catchment C and therefore the 300mm diameter highway outfall from catchment C at the head of the track along the eastern boundary has a potential total discharge rate of 429 l/s. From Hydraulic Research Tables the capacity of a 300mm diameter pipe at an assumed gradient of 1 in 100 has a capacity of only 111 l/s. Note the discharge rate from the highway land alone is 195 l/s. See Appendix vi for Hydraulic Research Table extracts.

Catchment H has a total potential discharge rate of 204 l/s via the 300mm diameter outfall pipe beneath the rail tracks. From Hydraulic Research Tables the capacity of a 300mm diameter pipe at an assumed gradient of 1 in 100 has a capacity of only 111 l/s.

All three outfalls discharge to a 450mm diameter pipe running along the southern boundary which is laid against the gradient of the land and therefore anticipated to be at a flat gradient of circa 1:200. Using the Hydraulic Research Tables a 450mm diameter pipe at an assumed gradient of 1 in 200 has a capacity of 228 l/s.

As noted the above figures and assumptions are extremely conservative which if they were correct would be evident in far more frequent flooding of both Porthkerry Road and the properties in Rhoose Point; however for design purposes these are potential surface water flows that could reach our site and are considered in the design.

One fundamental issue that is clearly evident is that the 450mm diameter land drain to the South of the railway line does not have capacity for the existing land/ highway drainage alone, excluding the additional assumptions we have made for flows from catchments E and F.

On the basis of the above the new development will include a diverted land drain to serve the existing surface run off from catchments A to G inclusive. This will include capacity for the adjacent land parcel to be developed as well as releasing capacity in the existing 450mm land drain.

4.0 PROPOSED LAND AND SURFACE WATER DRAINAGE

From assessment of the existing drainage the proposed land drainage diversion will be sized to accept the flows identified under section 3.0 above. It will also need to include changes in Catchment A for free discharge of surface run off from the proposed roads and houses to be developed under this application.

The adjacent development land will be provided with a connection based on the calculated green field run-off rate of Q Bar. The adjacent development surface water will therefore have to be attenuated within their own land. This will mean that there will be no increased discharge from this site.

Amended catchment flows are listed in Table 2 below:

Table 2 – Existing catchments and proposed flows

Catchment Reference	Description	Area (m^2)	Discharge (l/s)
A	Now 50% development density with roads, roofs and hard standings. 50% as Q Bar	146,000	1132
B	Murlande Way housing estate as before.	41,000	67
C*	Highway Drainage from Porthkerry Road as before.	14,000	195
D	Agricultural land to the east of Pentir Y De as before.	40,500	66
E*	Housing development north of Porthkerry Road estate roads as before.	41,500	116
F*	Agricultural land north of Porthkerry Road as before	73,000	118
G	Miscellaneous verges and tracks as before	30,000	49
H	Land West of the development land connected at Q Bar for 1 in 100 year event.	126,000	204
	TOTALS	512,000m^2	1,947 l/s (2.0m^3/s)

Flows from the catchments marked * total 429 l/s and discharge via an existing 300mm diameter outfall with only capacity for 111 l/s and therefore figures are conservative.

The above total peak discharge has almost doubled compared to the existing but in reality the time of entry for the different catchment areas/types will be variable. Discharge from roofs and roads of the new development will enter the system within 10 minutes, and based on the 1 hour storm, continue to enter for a further 60 minutes, as would flows from the adjacent development once complete.

Time of entry for discharge from green field run-off will be considerably longer and further retarded by being drained via highway drainage that is already at capacity. There are also no considerations for percolation which would actually reduce the volume of water and peak

discharge.

Based on the above it is anticipated that the peak flow will actually be dictated by the peak flows from the impermeable areas which will be catchments A, C and H giving a total peak of approximately 1.5m^3/s.

The diverted land drain will therefore be designed to receive both the existing land drainage flows and also include the hard standing drainage.

Consultation with DCWW has confirmed that they would accept the internal surface water sewers under a S104 adoption if they were to outfall to the diverted land drain system.

PROPOPOSED OUTFALL WORKS

The existing 450mm diameter land drain south of the rail track discharges to a cascade outfall in the former quarry south of Pentir Y De within Vale of Glamorgan land. This outfall does not have capacity for land drainage it currently receives.

The quarry is shelved, with the cascade formed at the upper plateau, discharging to an open ditch. Whilst the cascade itself dissipates energy from the high level outfall, to reduce velocities, the open ditch simply discharges off the cliff edge down to the next terrace. The base of the outfall to the lower terrace is not visible due to heavy over growth. There appears to be no form of erosion control at the existing ditch outfall to the lower terrace or beach below.

The proposed land drain diversion will not be able to use the existing outfall and will be discharging a considerably larger volume of water. A new cascade will need to be formed which is in accordance with the previous WSP reports. The route will have to be tunnelled beneath Network Rail land.

From Shear Design enquiries, the minimum tunnel size for the geology of the site would be 1500mm diameter, which is larger than the 1000mm diameter pipe proposed under the original WSP report.

A 1500mm diameter pipe has capacity for the design flows but the proposed gradients will need to consider the velocity. Based on a maximum 2m/s velocity a 1500mm diameter pipe at 1 in 450 has a capacity of 2.665 m^3/s.

This gradient will mean that the new outfall will discharge out of the cliff face of the open quarry terrace, similar to the existing 450mm diameter outfall.

A baffle system will be used to disperse flows and reduce velocities from the outfall. A formalised erosion protection system will be applied to the base of the cliff faces with a large stone bed for further flow dispersal and velocity reduction to minimise any potential effects of erosion.

All of the outfall proposals will be subject to technical approval from VOG BC.

Statement prepared by:

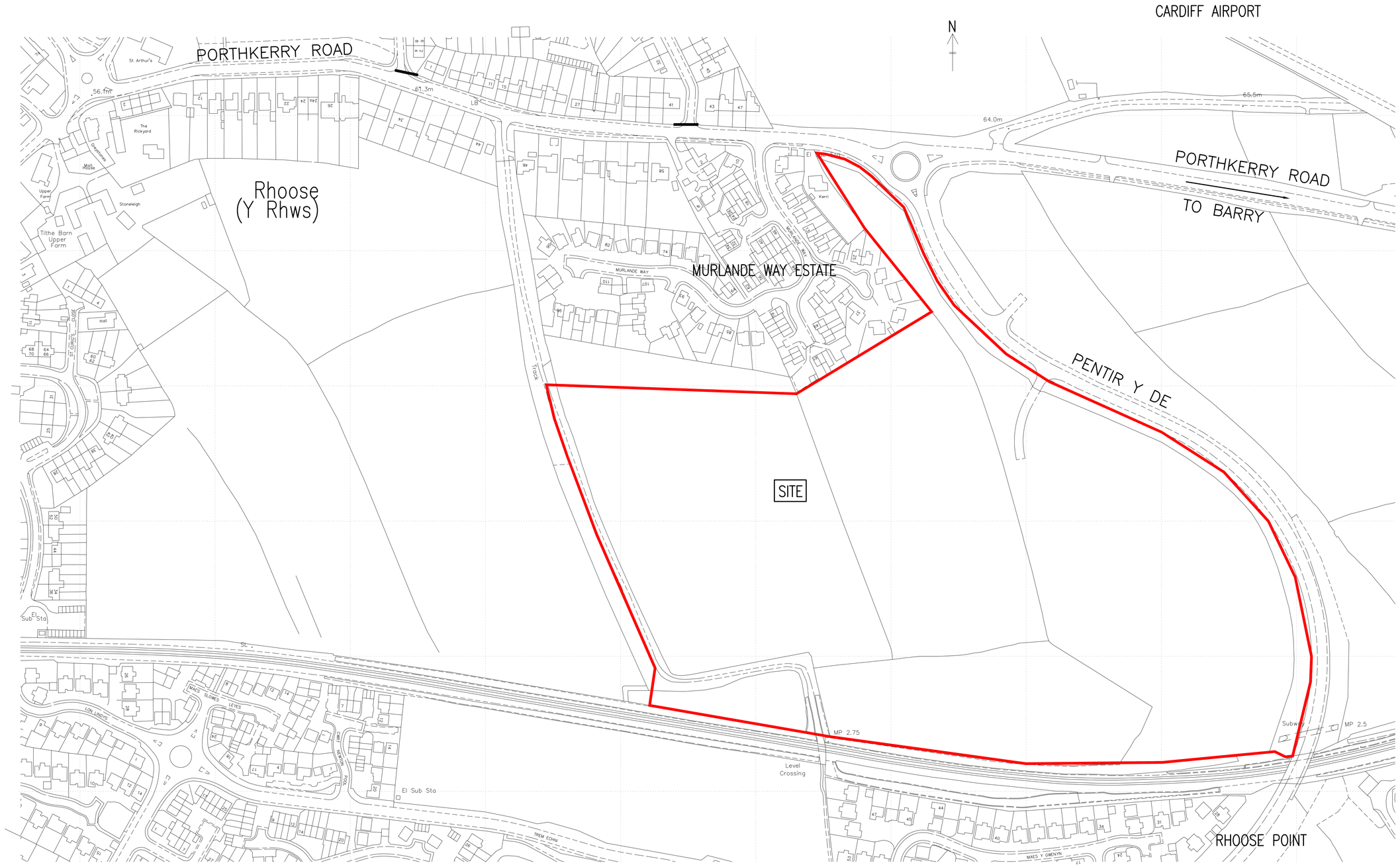
……

SIMON MASON I.ENG, A.M.I STRUCT.E
ON BEHALF OF SHEAR DESIGN LTD
DIRECTOR

23rd August 2013

APPENDIX i

SITE LOCATION PLAN



NOTES

GENERAL

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REV	DATE	DESCRIPTION	BY	CHK
		AMENDMENTS		

CLIENT:
PERSIMMON HOMES AND
BELLWAY HOMES

PROJECT:
LAND WEST OF PENTIR Y DE
RHOOSE

TITLE:
SITE LOCATION PLAN

SHEARdesign
Consulting Civil and Structural Engineers
7 Ashtree Court - Woodsy Close - Cardiff Gate Business Park - Cardiff - CF23 8RW
Tel: 029 2054 7000 - Fax: 029 2054 7001 - www.shear-design.com - enquiries@shear-design.com

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STATUS:	DRAWING NUMBER:	REVISION:
-	FIG-12112-01	-

APPENDIX ii

DCWW SEWER MAP EXTRACT

Sports Ground

Track

Wind Sock

Playground

Hall

El Sub Sta

CERI ROAD

CERI AVENUE

65.5m

64.0m

El Sub Sta

Rhoose

(Y Rhws)

Kerri

PORTHKERRY ROAD

HIGHWAY

Track

SL

MP 2.75

MP 2.5

Crossing

El Sub Sta

Caravan Par

Path (um)

APPENDIX iii

PROPOSED SITE DRAINAGE PLAN 12112-301

NOTES

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NEW CONNECTION INTO EXISTING DCWW GRAVITY SEWER MH REF ST074685 CL 60.38 IL 59.370

NEW MANHOLE WITH OUTGOING 150mmø GRAVITY CONNECTION

FOUL DISCHARGE RATE FOR NEW RISING MAIN SUBJECT TO DCWW REVISED HYDRAULIC MODELING WORKS.

EXISTING LAND DRAINAGE

EXISTING LAND DRAINAGE/OVERLAND ROUTE FROM PORTHKERRY ROAD OUTFALL

BUND TO PROTECT AGAINST OVERLAND FLOWS FROM ADJACENT SITE

PROPOSED LAND DRAINAGE INSIDE SITE BOUNDARY (TO SERVE SURFACE WATER RUNN-OFF FROM MURLAND WAY)

PROPOSED LAND DRAINAGE AT TOE OF HIGHWAY EMBANKMENT

WATER COURSE / DITCH SERVING HIGHWAY DRAINAGE & AIRPORT FLOWS (IN EXTREME EVENT)

PROPOSED PITCH DRAINAGE TO CONNECT IN TO LAND DRAIN (DESIGN BY OTHERS)

EXISTING LAND DRAINAGE

225mm ø SPUR FOR FOUL WATER FROM ADJACENT SITE

225mm ø SPUR FOR SURFACE WATER FROM ADJACENT SITE

15m PROPERTY EXCLUSION ZONE PUMP STATION/ STORAGE OCCURS

EXISTING LAND DRAIN/CULVERT BENEATH RAILWAY TO BE ABANDONED FOLLOWING NEW LAND DRAINAGE DIVERSION WORKS.

EXISTING FOUL RISING MAIN FROM RHOOSE PUMPING STATION

EXISTING LAND DRAIN/CULVERT BENEATH RAILWAY TO BE ABANDONED FOLLOWING NEW LAND DRAINAGE DIVERSION WORKS.

OUTFALL FROM EXISTING HEADWALL TO DISCHARGE IN TO NEW LAND DRAINAGE

EXISTING HIGHWAY DRAINAGE TO CONNECT IN TO NEW LAND DRAINAGE

NEW RISING MAIN THROUGH EXISTING UNDERPASS

EXISTING BRIDGE ABUTMENTS

ROUTE OF PROPOSED 1.5m ø DIVERTED LAND DRAIN TUNNELED BENEATH RAILWAY LINE

PROPOSED CASCADE TO DISCHARGE ON TO UPPER PLATEAU OF OLD QUARRY SITE

INDICATIVE AREA TO BE REGRADED USING ARISINGS FROM TUNNELING TO DISPERSE SURFACE WATER OUTFALL FROM NEW CASCADE. DETAILS SUBJECT TO VOGCC LAND DRAINAGE APPROVALS

PORTHKERRY ROAD

MURLANDE WAY

RAIL LINE

TREM ECHNI

MAES Y GWENYN

PENTIR Y DE

Porthkerry Caravan Park

Path (um)

Shingle

Mean High W

Rock

Posts

Club

The Meadows

Dean Cottage

Paradise

Sea Breeze

Brynawell

The Chalet

El Sub Sta

Duriroamin

The Rose Cottage

Utopia

SL

MP 2.25

Approach Lights

Kerri

65.5m

64.0m

KEY

- SITE BOUNDARY
- FOUL DRAINAGE (PROPOSED)
- RM — FOUL RISING MAIN (PROPOSED)
- RM — RM — RM — FOUL RISING MAIN (EXISTING)
- 12m DIAMETER 5m DEEP FOUL WATER PUMPING STATION, COMPOUND AND BURIED ATTENUATION SYSTEM
- FOUL DRAINAGE (EXISTING)
- HD — HD — EXISTING HIGHWAY DRAINAGE
- LD — LD — EXISTING LAND DRAIN
- PROPOSED LAND DRAINAGE (TO BE ADOPTED BY VOGCC)
- PROPOSED SURFACE WATER DRAINAGE (SUBJECT TO DCWW S104 AGREEMENT)
- PROPOSED EARTH BUND

FOR PLANNING PURPOSE

DRAINAGE LAYOUT IS INDICATIVE ONLY AND SUBJECT TO DETAILED DESIGN AND TECHNICAL APPROVALS BY DCWW AS PART OF A SECTION 104 SEWER ADOPTION. ALL WORKS TO BE IN ACCORDANCE WITH SEWERS FOR ADOPTION 7th EDITION.

REV	DATE	DESCRIPTION	BY	CHK
AMENDMENTS				

CLIENT: PERSIMMON HOMES AND BELLWAY HOMES

PROJECT: LAND WEST OF PENTIR Y DE RHOOSE

TITLE: PROPOSED OVERALL FOUL AND SURFACE WATER GENERAL ARRANGEMENT

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Consulting Civil and Structural Engineers
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STATUS:	DRAWING NUMBER:	REVISION:
A	12112-301	-

APPENDIX iv

Q BAR CALCULATIONS

IH 124 Mean Annual Flood

Input

Return Period (years) 100 SAAR (mm) 901 Urban 0.000
Area (ha) 50.000 Soil 0.500 Region Number Region 9

Results l/s

QBAR Rural	370.9
QBAR Urban	370.9
Q100 years	808.6
Q1 year	326.4
Q2 years	344.5
Q5 years	448.8
Q10 years	526.7
Q20 years	605.0
Q25 years	632.1
Q30 years	654.0
Q50 years	718.1
Q100 years	808.6
Q200 years	916.2
Q250 years	953.3
Q1000 years	1183.3

APPENDIX v

CATCHMENT AREAS

CATCHMENT AND MISCELLANEOUS VERGES, TRACKS & BATTERS G AREA = 30,000m²

HIGHWAY CATCHMENT C AREA 14.000m²

CATCHMENT E AREA 41.500m²

CATCHMENT F AREA 73.000m²

CATCHMENT B AREA 41.000m3

CATCHMENT D AREA 40.500m²

CATCHMENT H AREA 126.000m²

CATCHMENT A AREA 146.000m²

EX 300ø

EX 600ø

EX 450ø

EX 300ø

EX 450ø

TO CASCADE

PORTHKERRY ROAD

Rhoose (Y Rhws)

Level Crossing

Subway

MP 2.75

MP 2.5

NOTES

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6.

REV	DATE	DESCRIPTION	BY	CHK
		AMENDMENTS		

CLIENT:
PERSIMMON HOMES AND BELLWAY HOMES

PROJECT:
LAND WEST OF PENTIR Y DE RHOOSE

TITLE:
LAND DRAINAGE CATCHMENT PLAN

SHEARdesign
Consulting Civil and Structural Engineers
7 Ashtree Court - Woodsy Close - Cardiff Gate Business Park - Cardiff - CF23 8RW
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-	FIG-12112-02	-

Notes:

See also Draintech Services CCTV survey refs: C3228A & C3228B.

Allotment Gardens

Track

Track

Ground

Wind Sock

El Sub Sta

Cardiff–Wales Airport
Maes Awyr Caerdydd–Cymru

CERI AVENUE

300 x 300 channel covered with paving slabs.

Overland flow from field.

BM 63.01m

MH 1

MH 2

MH 4

MH 5A

MH 5B

MH 54

B 4265

G8

G7

G2

G3

MH 3

MH 5

MH 7

MH 6

MH 8

El Sub Sta

BM 65.40m

64.0m

65.5m

PORTHKERRY ROAD

Kerri

MURLANDE WAY

MURLANDE WAY

Rev	By	Description of Amendment	Chk by	Date

Revisions

VALE of GLAMORGAN
ENVIRONMENTAL AND ECONOMIC REGENERATION
Director
Rob Quick
BA (Hons), DipTP, MRTPI
Head of Visible Services
Miles Punter

BRO MORGANNWG

ENGINEERING DESIGN AND PROCUREMENT

Client
The Vale of Glamorgan Council

Project
LAND DRAINAGE
RHOOSE

Drawing Title
PORTHKERRY ROAD
HIGHWAY DRAIN / WATERCOURSE

Drawn		Scale		Project No.		Drawing No.	
Date							
Checked		File					
Date		Version		Rev			

APPENDIX vi

HYDRAULICS RESEARCH – ESTRACTS FROM TABLES FOR THE HYDRAULIC DESIGN OF PIPES AND SEWERS

TABLE 1 - EXISTING CATCHMENT AREAS & FLOORS
TABLE 2 - PROPOSED CATCHMENT AREAS & FLOORS

300 ϕ PIPE @ 1:100

7 continued

ks = 0·600mm
i = 0·004 to 0·1
ie hydraulic gradient = 1 in 250 to 1 in 10

Water (or sewage) at 15° C full bore conditions.
velocities in m/s
discharges in l/s

Gradient	Pipe diameters in mm · 50	75	80	100	125	150	175	200	225	250	275	300
0.00400	0.298	0.395	0.413	0.480	0.558	0.629	0.697	0.760	0.821	0.879	0.934	0.988
1/ 250	0.586	1.746	2.076	3.773	6.845	11.123	16.756	23.882	32.632	43.131	55.498	69.846
0.00420	0.306	0.405	0.423	0.493	0.572	0.645	0.714	0.779	0.841	0.901	0.958	1.013
1/ 238	0.601	1.790	2.129	3.868	7.018	11.404	17.178	24.482	33.451	44.213	56.888	71.595
0.00440	0.313	0.415	0.434	0.504	0.586	0.661	0.731	0.798	0.861	0.922	0.981	1.037
1/ 227	0.616	1.834	2.180	3.962	7.187	11.678	17.589	25.068	34.251	45.269	58.246	73.303
0.00460	0.321	0.425	0.444	0.516	0.599	0.676	0.748	0.816	0.881	0.943	1.003	1.061
1/ 217	0.630	1.876	2.231	4.053	7.352	11.945	17.992	25.641	35.033	46.301	59.574	74.973
0.00480	0.328	0.434	0.454	0.527	0.612	0.691	0.764	0.834	0.900	0.964	1.025	1.084
1/ 208	0.644	1.918	2.280	4.142	7.514	12.207	18.386	26.202	35.798	47.312	60.873	76.606
0.00500	0.335	0.443	0.463	0.539	0.625	0.705	0.780	0.852	0.919	0.984	1.046	1.106
1/ 200	0.658	1.958	2.328	4.230	7.672	12.464	18.772	26.751	36.548	48.301	62.145	78.206
0.00550	0.352	0.466	0.486	0.566	0.656	0.740	0.819	0.894	0.965	1.033	1.098	1.161
1/ 182	0.691	2.057	2.445	4.441	8.054	13.084	19.704	28.078	38.358	50.692	65.218	82.071
0.00600	0.368	0.487	0.509	0.591	0.686	0.774	0.856	0.934	1.008	1.079	1.147	1.213
1/ 167	0.723	2.151	2.557	4.644	8.420	13.676	20.595	29.345	40.088	52.976	68.155	85.765
0.00650	0.384	0.507	0.530	0.616	0.715	0.806	0.892	0.973	1.050	1.124	1.195	1.263
1/ 154	0.753	2.241	2.664	4.837	8.770	14.244	21.449	30.561	41.748	55.167	70.972	89.307
0.00700	0.399	0.527	0.550	0.640	0.742	0.837	0.926	1.010	1.090	1.167	1.241	1.312
1/ 143	0.783	2.328	2.767	5.024	9.108	14.791	22.271	31.731	43.344	57.276	73.682	92.716
0.00750	0.413	0.546	0.570	0.663	0.769	0.867	0.959	1.046	1.129	1.208	1.285	1.358
1/ 133	0.811	2.411	2.866	5.204	9.433	15.319	23.064	32.860	44.885	59.310	76.298	96.005
0.00800	0.427	0.564	0.589	0.685	0.794	0.896	0.991	1.081	1.166	1.248	1.327	1.403
1/ 125	0.838	2.492	2.962	5.378	9.748	15.829	23.832	33.952	46.375	61.278	78.828	99.187
0.00850	0.441	0.582	0.608	0.706	0.819	0.924	1.022	1.114	1.203	1.287	1.368	1.447
1/ 118	0.865	2.571	3.056	5.547	10.053	16.324	24.576	35.011	47.820	63.185	81.280	102.270
0.00900	0.454	0.599	0.626	0.727	0.843	0.951	1.052	1.147	1.238	1.325	1.409	1.489
1/ 111	0.891	2.647	3.146	5.711	10.349	16.804	25.298	36.038	49.223	65.037	83.660	105.264
0.00950	0.466	0.616	0.643	0.747	0.867	0.977	1.081	1.179	1.272	1.362	1.448	1.530
1/ 105	0.916	2.721	3.234	5.870	10.638	17.271	26.000	37.038	50.587	66.838	85.976	108.176
0.01000	0.479	0.632	0.660	0.767	0.890	1.003	1.109	1.210	1.306	1.397	1.485	1.571
1/ 100	0.940	2.793	3.320	6.025	10.918	17.726	26.684	38.012	51.915	68.593	88.231	111.013
0.01100	0.503	0.664	0.693	0.805	0.934	1.053	1.164	1.270	1.370	1.466	1.559	1.648
1/ 91	0.988	2.933	3.485	6.325	11.459	18.604	28.003	39.889	54.477	71.975	92.579	116.480
0.01200	0.526	0.694	0.725	0.842	0.976	1.100	1.217	1.327	1.432	1.532	1.629	1.722
1/ 83	1.033	3.066	3.643	6.611	11.977	19.442	29.263	41.682	56.924	75.206	96.734	121.705
0.01300	0.548	0.723	0.755	0.877	1.016	1.146	1.267	1.382	1.491	1.595	1.696	1.793
1/ 77	1.076	3.193	3.795	6.885	12.473	20.246	30.472	43.402	59.272	78.306	100.718	126.716
0.01400	0.569	0.751	0.784	0.910	1.055	1.189	1.315	1.434	1.548	1.656	1.760	1.861
1/ 71	1.117	3.316	3.941	7.149	12.950	21.019	31.635	45.057	61.531	81.288	104.553	131.538
0.01500	0.590	0.777	0.812	0.943	1.093	1.232	1.362	1.485	1.602	1.715	1.823	1.927
1/ 67	1.158	3.435	4.081	7.404	13.410	21.766	32.758	46.655	63.710	84.166	108.252	136.191
0.01600	0.609	0.803	0.839	0.974	1.129	1.273	1.407	1.534	1.655	1.771	1.883	1.990
1/ 62	1.196	3.549	4.218	7.650	13.856	22.488	33.843	48.199	65.819	86.950	111.831	140.691
0.01700	0.628	0.829	0.865	1.004	1.164	1.312	1.451	1.582	1.707	1.826	1.941	2.052
1/ 59	1.234	3.660	4.349	7.889	14.288	23.188	34.895	49.697	67.862	89.647	115.299	145.052
0.01800	0.647	0.853	0.891	1.034	1.198	1.351	1.493	1.628	1.757	1.880	1.998	2.112
1/ 56	1.271	3.768	4.478	8.121	14.707	23.867	35.917	51.151	69.846	92.267	118.667	149.287
0.01900	0.665	0.877	0.916	1.063	1.232	1.388	1.535	1.673	1.805	1.932	2.053	2.170
1/ 53	1.306	3.873	4.602	8.347	15.115	24.528	36.911	52.565	71.776	94.815	121.942	153.406
Coefficient for part-full pipes:												
	25	40	40	50	60	80	90	100	120	130	140	150

ks = 0·600mm i < 0·1

450 ⌀ PIPE @ 1:200

18 continued

ks = 0·600mm
i = 0·004 to 0·1
ie hydraulic gradient = 1 in 250 to 1 in 10

Water (or sewage) at 15° C full bore conditions.
velocities in m/s
discharges in m^3/s

Gradient	Pipe diameters in mm: 350	375	400	450	500	525	600	675	700	750	800	825
0.00400 1/ 250	1.091 0.105	1.140 0.126	1.187 0.149	1.280 0.203	1.368 0.269	1.410 0.305	1.534 0.434	1.651 0.591	1.689 0.650	1.764 0.779	1.836 0.923	1.871 1.000
0.00420 1/ 238	1.118 0.108	1.168 0.129	1.217 0.153	1.311 0.209	1.402 0.275	1.446 0.313	1.572 0.444	1.692 0.606	1.731 0.666	1.808 0.799	1.882 0.946	1.918 1.025
0.00440 1/ 227	1.145 0.110	1.196 0.132	1.246 0.157	1.343 0.214	1.435 0.282	1.480 0.320	1.609 0.455	1.733 0.620	1.772 0.682	1.850 0.817	1.926 0.968	1.963 1.050
0.00460 1/ 217	1.171 0.113	1.223 0.135	1.274 0.160	1.373 0.218	1.468 0.288	1.513 0.328	1.646 0.465	1.772 0.634	1.813 0.698	1.892 0.836	1.970 0.990	2.008 1.073
0.00480 1/ 208	1.196 0.115	1.250 0.138	1.302 0.164	1.403 0.223	1.499 0.294	1.546 0.335	1.682 0.475	1.810 0.648	1.852 0.713	1.933 0.854	2.013 1.012	2.051 1.097
0.00500 1/ 200	1.221 0.117	1.276 0.141	1.329 0.167	1.432 0.228	1.531 0.301	1.578 0.342	1.717 0.485	1.848 0.661	1.890 0.727	1.973 0.872	2.054 1.033	2.094 1.119
0.00550 1/ 182	1.281 0.123	1.339 0.148	1.395 0.175	1.503 0.239	1.606 0.315	1.656 0.359	1.801 0.509	1.939 0.694	1.983 0.763	2.070 0.915	2.155 1.083	2.197 1.174
0.00600 1/ 167	1.339 0.129	1.399 0.155	1.457 0.183	1.570 0.250	1.678 0.330	1.730 0.375	1.882 0.532	2.026 0.725	2.072 0.797	2.163 0.956	2.252 1.132	2.295 1.227
0.00650 1/ 154	1.394 0.134	1.457 0.161	1.518 0.191	1.635 0.260	1.747 0.343	1.802 0.390	1.959 0.554	2.109 0.755	2.157 0.830	2.252 0.995	2.344 1.178	2.390 1.277
0.00700 1/ 143	1.447 0.139	1.512 0.167	1.575 0.198	1.697 0.270	1.814 0.356	1.870 0.405	2.034 0.575	2.189 0.783	2.239 0.862	2.338 1.033	2.433 1.223	2.480 1.326
0.00750 1/ 133	1.499 0.144	1.566 0.173	1.631 0.205	1.757 0.279	1.878 0.369	1.936 0.419	2.106 0.595	2.266 0.811	2.318 0.892	2.420 1.069	2.519 1.266	2.568 1.373
0.00800 1/ 125	1.548 0.149	1.618 0.179	1.685 0.212	1.815 0.289	1.940 0.381	2.000 0.433	2.175 0.615	2.341 0.838	2.395 0.922	2.500 1.105	2.602 1.308	2.653 1.418
0.00850 1/ 118	1.596 0.154	1.668 0.184	1.737 0.218	1.872 0.298	2.000 0.393	2.062 0.446	2.243 0.634	2.414 0.864	2.469 0.950	2.577 1.139	2.683 1.349	2.735 1.462
0.00900 1/ 111	1.643 0.158	1.717 0.190	1.788 0.225	1.926 0.306	2.059 0.404	2.123 0.459	2.308 0.653	2.484 0.889	2.541 0.978	2.653 1.172	2.761 1.388	2.814 1.504
0.00950 1/ 105	1.688 0.162	1.764 0.195	1.838 0.231	1.980 0.315	2.115 0.415	2.181 0.472	2.372 0.671	2.553 0.913	2.611 1.005	2.726 1.204	2.837 1.426	2.892 1.546
0.01000 1/ 100	1.733 0.167	1.810 0.200	1.886 0.237	2.031 0.323	2.171 0.426	2.238 0.485	2.434 0.688	2.619 0.937	2.679 1.031	2.797 1.236	2.911 1.463	2.967 1.586
0.01100 1/ 91	1.818 0.175	1.899 0.210	1.978 0.249	2.131 0.339	2.277 0.447	2.348 0.508	2.553 0.722	2.748 0.983	2.811 1.082	2.934 1.296	3.054 1.535	3.113 1.664
0.01200 1/ 83	1.899 0.183	1.984 0.219	2.067 0.260	2.227 0.354	2.379 0.467	2.453 0.531	2.667 0.754	2.871 1.027	2.936 1.130	3.065 1.354	3.191 1.604	3.252 1.738
0.01300 1/ 77	1.977 0.190	2.066 0.228	2.152 0.270	2.318 0.369	2.477 0.486	2.554 0.553	2.777 0.785	2.989 1.069	3.057 1.176	3.191 1.410	3.321 1.670	3.385 1.810
0.01400 1/ 71	2.053 0.197	2.144 0.237	2.234 0.281	2.406 0.383	2.571 0.505	2.651 0.574	2.882 0.815	3.102 1.110	3.173 1.221	3.312 1.463	3.447 1.733	3.514 1.878
0.01500 1/ 67	2.125 0.204	2.220 0.245	2.313 0.291	2.491 0.396	2.662 0.523	2.745 0.594	2.984 0.844	3.211 1.149	3.285 1.264	3.429 1.515	3.569 1.794	3.638 1.945
0.01600 1/ 62	2.195 0.211	2.294 0.253	2.389 0.300	2.573 0.409	2.750 0.540	2.835 0.614	3.082 0.871	3.317 1.187	3.393 1.306	3.542 1.565	3.686 1.853	3.757 2.009
0.01700 1/ 59	2.263 0.218	2.365 0.261	2.463 0.310	2.653 0.422	2.835 0.557	2.923 0.633	3.177 0.898	3.420 1.224	3.498 1.346	3.651 1.613	3.800 1.910	3.874 2.071
0.01800 1/ 56	2.329 0.224	2.434 0.269	2.535 0.319	2.730 0.434	2.917 0.573	3.008 0.651	3.270 0.925	3.519 1.259	3.600 1.385	3.757 1.660	3.911 1.966	3.986 2.131
0.01900 1/ 53	2.394 0.230	2.501 0.276	2.605 0.327	2.806 0.446	2.998 0.589	3.091 0.669	3.360 0.950	3.616 1.294	3.699 1.423	3.861 1.706	4.019 2.020	4.096 2.190
	Coefficient for part-full pipes:											
	200	200	200	250	250	250	300	350	350	400	400	450

ks = 0·600mm i < 0·1

1500 ϕ PIPE
@ 1 : 455

ks = 0·600mm
i = 0·0001 to 0·003
ie hydraulic gradient =
1 in 10000 to 1in 333

Water (or sewage) at 15° C
full bore conditions.

velocities in m/s
discharges in m^3/s

Gradient	Pipe diameters in mm: 900	975	1000	1050	1100	1200	1350	1500	1650	1800	1950	2100
0.00050 1/ 2000	0.690	0.725	0.737	0.759	0.782	0.825	0.888	0.948	1.005	1.061	1.114	1.166
	0.439	0.541	0.579	0.658	0.743	0.934	1.271	1.675	2.150	2.699	3.328	4.039
0.00055 1/ 1818	0.724	0.761	0.773	0.797	0.821	0.866	0.932	0.995	1.055	1.113	1.169	1.224
	0.461	0.568	0.607	0.690	0.780	0.980	1.334	1.758	2.256	2.833	3.492	4.238
0.00060 1/ 1667	0.757	0.796	0.808	0.833	0.858	0.905	0.974	1.040	1.103	1.163	1.222	1.279
	0.481	0.594	0.635	0.721	0.815	1.024	1.394	1.837	2.358	2.960	3.649	4.429
0.00065 1/ 1538	0.788	0.829	0.842	0.868	0.893	0.943	1.014	1.083	1.148	1.211	1.272	1.331
	0.501	0.619	0.661	0.751	0.849	1.066	1.452	1.913	2.455	3.082	3.800	4.611
0.00070 1/ 1429	0.818	0.860	0.874	0.901	0.928	0.979	1.053	1.124	1.192	1.258	1.321	1.382
	0.521	0.642	0.686	0.780	0.881	1.107	1.508	1.986	2.549	3.200	3.945	4.787
0.00075 1/ 1333	0.848	0.891	0.905	0.933	0.961	1.014	1.091	1.164	1.234	1.302	1.368	1.431
	0.539	0.665	0.711	0.808	0.913	1.147	1.561	2.057	2.639	3.314	4.085	4.957
0.00080 1/ 1250	0.876	0.921	0.935	0.964	0.993	1.048	1.127	1.203	1.275	1.345	1.413	1.479
	0.557	0.687	0.735	0.835	0.943	1.185	1.613	2.125	2.727	3.423	4.220	5.121
0.00085 1/ 1176	0.903	0.949	0.965	0.994	1.023	1.080	1.162	1.240	1.315	1.387	1.457	1.525
	0.575	0.709	0.758	0.861	0.973	1.222	1.663	2.191	2.812	3.530	4.351	5.280
0.00090 1/ 1111	0.930	0.977	0.993	1.024	1.054	1.112	1.196	1.276	1.354	1.428	1.500	1.569
	0.591	0.730	0.780	0.886	1.001	1.258	1.712	2.256	2.894	3.633	4.478	5.435
0.00095 1/ 1053	0.956	1.004	1.020	1.052	1.083	1.143	1.229	1.312	1.391	1.467	1.541	1.612
	0.608	0.750	0.801	0.911	1.029	1.293	1.760	2.318	2.974	3.734	4.602	5.585
0.00100 1/ 1000	0.981	1.031	1.047	1.080	1.111	1.173	1.262	1.346	1.427	1.506	1.581	1.655
	0.624	0.770	0.823	0.935	1.056	1.327	1.806	2.379	3.052	3.832	4.723	5.731
0.00110 1/ 909	1.029	1.082	1.099	1.133	1.166	1.231	1.324	1.413	1.498	1.580	1.659	1.736
	0.655	0.808	0.863	0.981	1.108	1.392	1.895	2.496	3.203	4.021	4.956	6.014
0.00120 1/ 833	1.076	1.131	1.149	1.184	1.219	1.286	1.383	1.476	1.565	1.651	1.734	1.814
	0.684	0.844	0.902	1.025	1.158	1.455	1.980	2.608	3.347	4.201	5.178	6.283
0.00130 1/ 769	1.120	1.177	1.196	1.233	1.269	1.339	1.440	1.537	1.630	1.719	1.805	1.889
	0.713	0.879	0.939	1.068	1.206	1.515	2.062	2.716	3.484	4.374	5.391	6.542
0.00140 1/ 714	1.163	1.222	1.242	1.280	1.317	1.390	1.495	1.595	1.692	1.784	1.874	1.961
	0.740	0.913	0.975	1.108	1.252	1.572	2.140	2.819	3.617	4.540	5.596	6.790
0.00150 1/ 667	1.204	1.266	1.286	1.325	1.364	1.440	1.548	1.652	1.751	1.847	1.940	2.030
	0.766	0.945	1.010	1.148	1.296	1.628	2.216	2.919	3.745	4.701	5.794	7.031
0.00160 1/ 625	1.244	1.308	1.328	1.369	1.409	1.487	1.599	1.707	1.809	1.908	2.004	2.097
	0.791	0.976	1.043	1.186	1.339	1.682	2.289	3.016	3.869	4.856	5.985	7.263
0.00170 1/ 588	1.283	1.348	1.370	1.412	1.453	1.533	1.649	1.760	1.866	1.968	2.066	2.162
	0.816	1.007	1.076	1.223	1.381	1.734	2.360	3.109	3.989	5.007	6.171	7.488
0.00180 1/ 556	1.320	1.388	1.410	1.453	1.496	1.578	1.697	1.811	1.920	2.025	2.127	2.225
	0.840	1.036	1.107	1.258	1.421	1.785	2.429	3.200	4.105	5.153	6.351	7.706
0.00190 1/ 526	1.357	1.426	1.449	1.493	1.537	1.622	1.744	1.861	1.973	2.081	2.185	2.286
	0.863	1.065	1.138	1.293	1.461	1.834	2.497	3.289	4.219	5.295	6.526	7.919
0.00200 1/ 500	1.393	1.464	1.487	1.533	1.577	1.664	1.790	1.910	2.025	2.135	2.242	2.346
	0.886	1.093	1.168	1.327	1.499	1.882	2.562	3.375	4.329	5.434	6.697	8.126
0.00220 1/ 455	1.461	1.536	1.560	1.608	1.655	1.746	1.878	2.004	2.124	2.240	2.353	2.461
	0.930	1.147	1.225	1.392	1.573	1.975	2.688	3.541	4.542	5.701	7.026	8.525
0.00240 1/ 417	1.527	1.605	1.630	1.680	1.729	1.825	1.962	2.093	2.219	2.341	2.458	2.571
	0.971	1.198	1.280	1.455	1.643	2.064	2.808	3.699	4.745	5.956	7.340	8.906
0.00260 1/ 385	1.590	1.671	1.697	1.749	1.800	1.900	2.043	2.179	2.310	2.437	2.559	2.677
	1.011	1.247	1.333	1.515	1.711	2.149	2.924	3.851	4.940	6.201	7.642	9.272
0.00280 1/ 357	1.650	1.734	1.762	1.816	1.869	1.972	2.120	2.262	2.398	2.529	2.656	2.779
	1.050	1.295	1.384	1.572	1.776	2.230	3.035	3.998	5.128	6.436	7.932	9.624
Coefficient for part-full pipes:	300	300	300	350	350	400	450	500	500	550	600	650

ks = 0·600mm i < 0·003

Appendix B

VoG Correspondence

Nick Lewis

From: SuDS Approval Body (SAB) <SAB@valeofglamorgan.gov.uk>
Sent: 24 February 2021 14:32
To: Spiller, Adam
Subject: RE: Land North of the Railway Line, Pentir y De, Rhoose

Hi Adam,

Thank you for your email regarding the site at Rhoose.

Although we have no objection with you exploring the use of the existing drainage at this stage, it is my understanding that no improvement works have been undertaken since the previous proposal and as such capacity issues still remain. Where you have mentioned the collection of flows from the neighbouring fields to the east, we would need to understand further what contributing area the system is likely to drain.

Although a free discharge would be applicable where discharging to the sea. Under SAB requirements we would still ask that the system provides interception benefits to manage the majority of rainfall events <5mm.

I hope this answers your query but if you do require anything further please let me know.

Kind regards

Gareth

Gareth Thelwell-Davies
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Visible Services and Transport
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From: Spiller, Adam <adam.spiller@persimmonhomes.com>
Sent: 18 February 2021 12:53
To: Flood and Coastal Erosion Risk Management <fcerm@valeofglamorgan.gov.uk>; SuDS Approval Body (SAB) <SAB@valeofglamorgan.gov.uk>
Cc: Coulson, Nicholas <nicholas.coulson@persimmonhomes.com>; Smith, Matthew <matthew.smith@persimmonhomes.com>
Subject: Land North of the Railway Line, Pentir y De, Rhoose

Good Afternoon

We have a longstanding interest in the above site, which was subject to a RM consent in 2015 (2014/00344/RES). We are currently working up a new proposal which incorporates the whole site, rather than just the element we received consent for previously. This new application would obviously be subject to SAB approval as well as planning so we are reviewing the previous proposals to see if they could be looked at again in light of the new legislation.

My understanding is that the area to the south of the proposed development has suffered from historic issues of flooding. As such the proposal was not to utilise any of the existing drains beneath the railway for discharge, but to bore a new outfall direct to the old quarry site. This was to be free discharge as direct to the sea.

In light of the SAB legislation, and the need to provide source control measures wherever possible, would you think there is any opportunity to revisit the use of any of the existing drains beneath the railway? Or are there still significant issues with flooding in this network?

Things are complicated somewhat by the collection of overland flows from the fields to the east of ours (which appears to be run off from the airport area) and land to the north, so it may be beneficial to undertake the boring of the new outfall to divert the water away completely. However we wanted to understand your position, and your understanding of the current networks, before we progress with any options?

I'd be happy to talk it through with somebody on the phone or even a socially distanced walk around the site to see the issues in situ?

Best Regards
Adam

Adam Spiller MEng CEng MICE
Technical Director

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