Former Tata Steelworks Site
Pontarddulais

Walters Land Limited

Drainage Strategy

Rev -

October 2023

PHOENIX DESIGN
Partnership Ltd.

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1. Introduction

This Drainage Strategy report has been prepared by Phoenix Design Partnership Limited on behalf of Walters Land Limited to support an Outline planning application at the former steelworks, Pontarddulais for residential development of up to 150 homes.

The report provides a high-level overview of the site and the proposed drainage strategy.
The scheme will need to comply with the Statutory Standards for Sustainable Drainage Systems produce by Welsh Government and the CIRIA SuDS Manual C753.

1.1. Site Location

The site is located along the North of High Street and West of Woodville Street in Pontarddulais. A National Grid Reference of SN 59031 04254 can be used to locate the site. The site excluding non-developable area is approximately 4ha. The development is bound by an existing railway line to the West, residential to the South and East and the industrial estate to the North.
The site location can be seen below in Figure 1. A detailed plan can be seen in **Appendix A**.

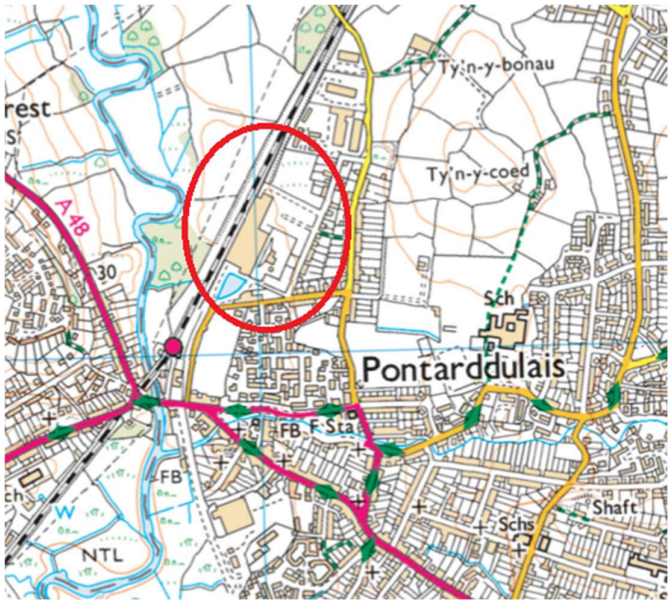


Figure 1 – Site Location

1.2. Current Land Use

The site is currently unoccupied but is considered brownfield and was previously used as a steelworks.

1.3. Site Topography

Site levels fall generally from Northeast to Southwest with a range of 12.2m to 8.3m. Gradients vary across the site due to a large area of the site consisting of existing buildings.
A topographical survey can be found in **Appendix B**.

1.4. Site Geology

Site investigation works have been carried out by Integral Geotechnique along with soakaway testing.
The site comprises a mix of surface materials including topsoil, made ground and various hardstanding's. Depths of made ground vary across the site from 0.6m to 3.2m which are underlain by sands and gravels.
Soakaway testing was carried out across the site with the most promising results coming from the undeveloped area to the North of the existing buildings. The permeability rates in the North ranged from $2.6x10^{-4}$ to $8.8x10^{-5}$.
In the central and Southern parts of the site the permeability rates varied between 0 and $3.08x10^{-5}$.

The shallowest groundwater level was found to be near the South-West part of the site, at the transition between the underlying silty sandy gravelly clay soils above and gravelly sands below. The groundwater level at this part was found to be at approximately 5.7m AOD i.e. at approximately 2.2m depth below existing ground level.

Please refer to Integral Geotechnique report 14180/FG/23/SI for further information.

1.5. Existing Drainage

Welsh Water plans show an existing surface water sewer crossing the site in the Southern area from East to West which ultimately discharges through an existing culvert that outfalls on the opposite side of the railway line. At this stage the exact size and location of the sewer is unknown, but survey works can be carried out following demolition of the buildings and the required ground remediation. Assumptions made in detail design could then be confirmed following these survey works.

From site observations and existing services plans it has been confirmed that the surface water drainage that serves the existing buildings and hardstanding discharges into the culverted system that runs to the West under the existing railway line. There is also an existing pond located in dense vegetation at the Southern end of the site with a headwall that connects into the existing culvert. The proposed survey works above should also provide the necessary information regarding the interaction and connectivity between these existing drainage features.

The River Loughor is located approximately 140m to the West of the site. A site walkover has confirmed that once the culvert outfalls on the opposite side of the railway line a ditch system then conveys flows directly to the river.

A Welsh Water sewer plan and existing drainage plan can be seen in **Appendix C**.

2. Flood Risk

2.1. Overview

NRW development advice maps have classified areas of the site as being within Zone C1. Detailed flood modelling has been undertaken by JBA Consulting and a minimum ground level has been set for the development area of 9.03mAOD. For further information and recommendations please refer to JBA report JQE-JBAU-XX-XX-RP-Z-0001-S3-P01-Tata_Steel_Site_FCA.

3. Proposed Surface Water Drainage

The proposed development will consist of circa 150 dwellings including infrastructure (carriageways, footpaths, car parking etc). Following legislation enforcing Schedule 3 in January 2019 the proposed surface water system will be designed in accordance with the requirements of the council SAB team and the CIRIA SuDS Manual.

3.1. 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 produced by Welsh Government. It is the role of each council's 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

3.2. 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.

B. Runoff Infiltrated to the Ground

As mentioned earlier in the report Integral Geotechnique have carried out soakaway testing which has shown an area in the North of the development would be suitable for permeable solutions however the remainder of the site would need to drain via other means.

C. Surface Run off Discharged to Water Body

Due to the distance and the existing railway line a direct outfall to the River Loughor is not considered feasible.

D. Surface Run off Discharged to a surface Water Sewer, highway drain or another drainage system.

The central and Southern areas of the site are proposed to drain out through the existing culvert which crosses underneath the existing railway as per the existing site drainage system.

3.3. S2 – Surface Water Runoff Hydraulic Control

Standard S2 requires that all developments look to control the rate of discharge off site. This is dependent on the site being classified as greenfield or brownfield. In this case the site is brownfield and therefore an initial proposal of a 30% betterment will be provided in line with the Welsh Government standards.

As the Northern area of the site is going to infiltrate this has been removed from both the existing run off calculations and the attenuation calculations.

The existing site run off is unrestricted into the existing culvert. FEH software has been used to determine the existing QBAR run off factoring in the urban extent within the existing site. The calculation shows an existing QMED flow rate of 20l/s which when converted to QBAR (via the FSSR 14 method i.e. x1.08) gives 21.6l/s. As we are to provide a 30% betterment a proposed flow rate of 15.1l/s has been used to estimate the attenuation requirement.

The attenuation calculation has used an assumption of 60% of the non-infiltrating area of the site to be hard standing and has used a climate change allowance of 40%. The estimated attenuation is circa 800m^3 although detailed calculations with exact impermeable areas will need to be carried out at detailed design and will likely result in a lower volume.

The Welsh Government standards also require interception to be provided which can be defined as capturing the first 5mm of rainfall on site with no site run off. This is achieved using SuDS features and can be quantified through calculations. As the Northern area is infiltrating there will be no requirement to provide interception here but the remainder of the site that discharges to the existing culvert will be required to provide interception.

Plans showing the drainage areas can be seen in **Appendix C**. The QBAR and attenuation calculations can be seen in **Appendix E** and the proposed attenuation can be seen in **Appendix D**.

3.4. S3 – Water Quality

Standard S3 aims to ensure that hardstanding run off is treated prior to discharge off site to ensure pollution of downstream waterbodies is reduced or removed.

The 'Pollution Hazard Level' for each of the hardstanding 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.
It is proposed to use SuDS features such as rain gardens, permeable paving, swales, and basins to contribute to the removal of sediment, hydrocarbons, and metals.

3.5. S4 – Amenity

This standard will need to be considered as part of the detailed design by other disciplines within the project team. The Welsh Government standards require that amenity benefits across the site integrating SuDS features are maximised.

3.6. S5 – Biodiversity

This standard will need to be considered as part of the detailed design by other disciplines within the project team. The Welsh Government standards require that biodiversity benefits are incorporated throughout the site and SuDS features.

3.7. S6 – Design of drainage for construction, operation, and maintenance

Standard S6 aims to ensure that the whole site drainage system is designed with future maintenance and operation in mind. The proposed development will be subject to SAB adoption and therefore maintenance regimes will be in line with Swansea SAB requirements. Plans detailing access and maintenance operations will need to be provided at detailed design and commuted sums will be calculated based on these.
Construction management plans and documents will also be required to detail how surface water will be managed during the construction phase.

4. Proposed Foul Drainage

Discussions with Welsh Water are currently being undertaken. Existing flows from infiltration into the foul network along with the sites previous use have been estimated and put forward for review. It is proposed to utilise the existing connection onto the combined network in the Southwest corner of the site at the corner of Station Road and High Street.

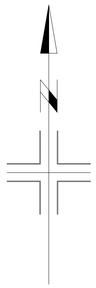
5. Summary

- Site is located within Flood Zone C1, minimum ground level of 9.03mAOD has been set.

- Existing Welsh Water surface water sewer crosses through the South of the development.
- Existing site surface water drainage discharges through an existing culvert to the West through the railway line.
- Site investigation and soakaway testing has been carried out. Northern section of site will be able to infiltrate.
- Site drainage system will require SAB approval and adoption.
- Discharge into the existing culvert will be reduced as flows will be restricted to a calculated QBAR rate which considers existing urban extents. A 30% betterment will be required as per the Welsh Government standards.
- Foul drainage will discharge via existing connection into the combined sewer to the South.

Appendix A

Site Plan



GENERAL NOTES
1. DO NOT SCALE FROM THIS DRAWING.
2. THIS DRAWING IS FOR INFORMATION PURPOSES ONLY.

KEY

DEVELOPMENT BOUNDARY

Revision: -

Project: Existing Steelworks
Pontarddulais

Client: WALTERS
CIVIL ENGINEERING · PLANT · DEVELOPMENT

Drawing: Site Plan

Scale: 1:500 @ A0 Date: July 2023 Drawn by: JM

Drawing No: 10373 - 100 Rev: -

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Drg.Status: PLANNING

Appendix B

Topographical Survey

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Revision:

Project: Existing Steelworks
Pontarddulais

Client:

WALTERS
CIVIL ENGINEERING · PLANT · DEVELOPMENT

Drawing: Topographical Survey

Scale: 1:250 @ A0 Date: June 2023 Drawn by: JM

Drawing No: 10373 - 101 - 01 Rev: -

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Drawing No: 10373 - 101 - 02 Rev: -

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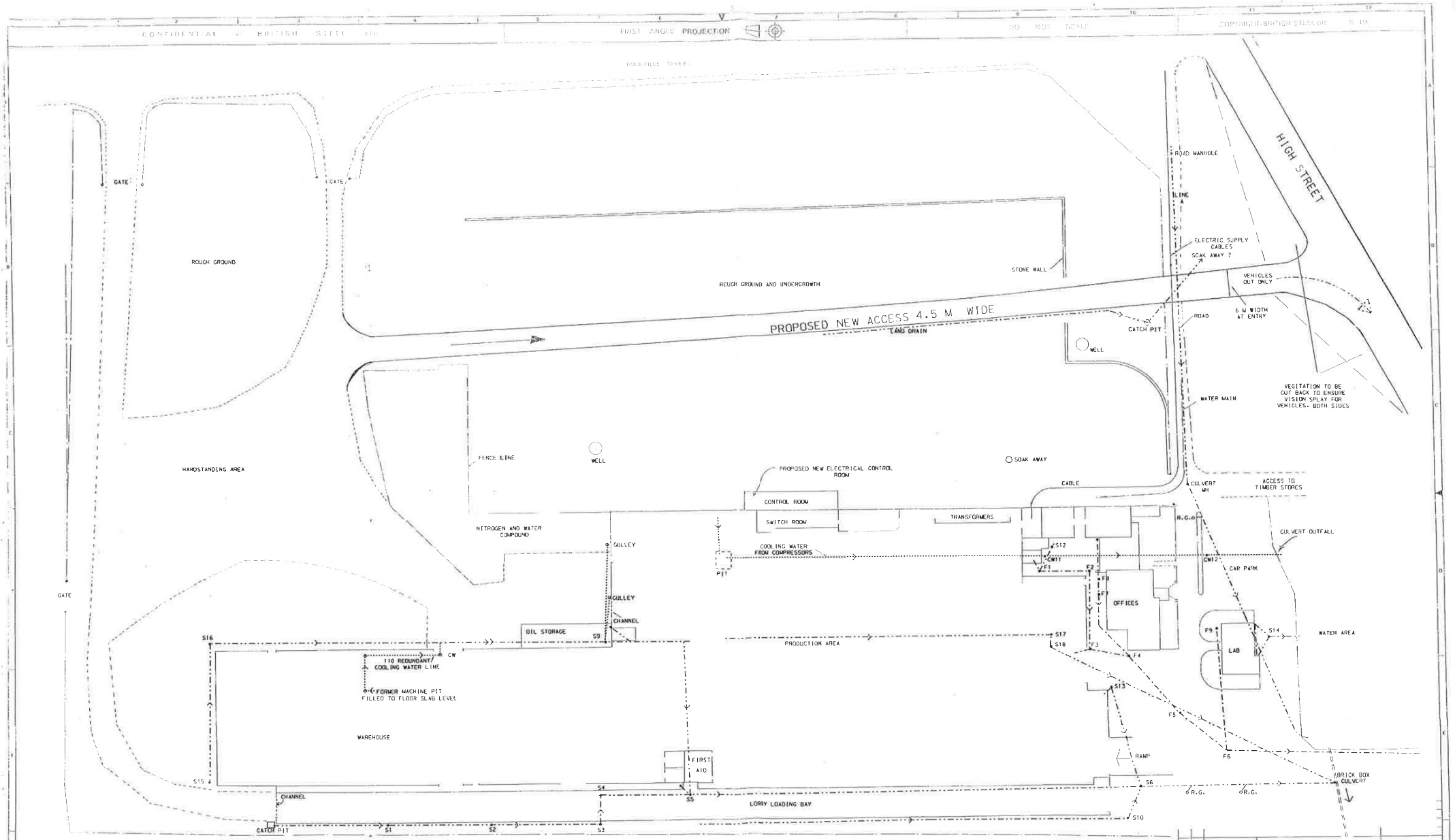
Appendix C

Existing Drainage Plans



KEY:-

WELL / COOLING WATER

FOUL WATER

STORM WATER

NO.	DRG No OR MATL	DESCRIPTION
1	RJ Freeman 18 Jan 02	Soakaway & drains added on CAD

SCALE	1:1250
DRAWN	A H DREW
CHECKED	
DATE	
PLANT CODE	
PLANT IDENT	
PLANT	COATED PRODUCTS PONTARDULAIS
SECTION	
DESCRIPTION	SITE LAYOUT SHOWING BUILDINGS ROADS AND BOUNDARIES

BRITISH STEEL STRIP PRODUCTS
SPOTTON WORKS, DEESIDE, CLWYD, CH5 2NH

(Instr. of C Writtens) PT 1687

DRG. No. DRAINAGE 305999

REVISION 1

NO.	DRG No OR MATL	DESCRIPTION
1		
2		
3		
4		

Dŵr Cymru
Welsh Water

SA4 8RX

N
W E
S

LEGEND(Representative of most common features)

Waste network:

- Foul chamber
- Surface water chamber
- Combined chamber
- Combined sewer overflow
- Special purpose chamber
- Treatment works
- Pumping station
- Outfall
- Lamphole
- Storm Overflow
- Rising main
- Gravity sewer
- Private sewer
- Private sewer subject to Sect. 104 adoption agreement
- Private Sewer Transfer
- Lateral Drain
- Inspection Chamber

NB: Sewer symbol colour indicates the type.

RED - Combined
GREEN - Surface Water
BROWN - Foul
Purple - Former S24 sewers (for indicative purposes only)

Notes:

Whilst every reasonable effort has been taken to correctly record the pipe material of DCWW assets, there is a possibility that in some cases pipe material (other than Asbestos Cement or Pitch Fibre) may be found to be asbestos cement (AC) or Pitch Fibre (PF) . It is therefore advisable that the possible presence of AC or PF pipes be anticipated and considered as part of any risk assessment prior to excavation

EXACT LOCATIONS OF ALL APPARATUS TO BE DETERMINED ON SITE.

Map Ref:	259014,204291
Map scale:	1:2000
Printed by:	Stephen Burton
Printed on:	26 Jan 2023

Appendix D

Proposed Drainage Strategy

GENERAL NOTES
1. DO NOT SCALE FROM THIS DRAWING.
2. THIS DRAWING IS FOR INFORMATION PURPOSES ONLY.

KEY

DEVELOPMENT BOUNDARY
TOTAL AREA = 39555m²

INFILTRATION BOUNDARY AREA
TOTAL AREA = 15975m²

TRIAL PIT LOCATIONS

TP07
DESIGN SOIL INFILTRATION RATE:
2.8E-04m/s
AREA ACCEPTABLE FOR INFILTRATION.

TP08
DESIGN SOIL INFILTRATION RATE:
8.8E-05m/s
AREA ACCEPTABLE FOR INFILTRATION.

TP09
DESIGN SOIL INFILTRATION RATE: 7.5E-05m/s
GROUND WATER STANDING AT 2.0m BELOW GROUND LEVEL. PARTIAL AREA ACCEPTABLE FOR INFILTRATION.

TP11
INSUFFICIENT INFILTRATION TO CALCULATE DESIGN INFILTRATION RATE.
AREA NOT ACCEPTABLE FOR INFILTRATION.

TP12
DESIGN SOIL INFILTRATION RATE:
3.0E-05m/s
GROUND WATER STANDING AT 2.0m BELOW GROUND LEVEL.
AREA NOT ACCEPTABLE FOR INFILTRATION.

TP14
INSUFFICIENT INFILTRATION TO CALCULATE DESIGN INFILTRATION RATE. AREA NOT ACCEPTABLE FOR INFILTRATION.

PROPOSED ATTENUATION BASIN
TOTAL VOLUME AREA = 804m³
BASIN DISCHARGE TO BE RESTRICTED TO A RATE OF 15.1l/s.

SITE DRAINAGE CONNECTS ONTO EXISTING CULVERT VIA THIS RUN

EXISTING WELSH WATER SEWER. EXACT LOCATION/CONNECTION AND DEPTH/SIZE TO BE CONFIRMED

EXISTING CULVERT, EXACT LOCATION AND DEPTH/SIZE TO BE CONFIRMED

EXISTING POND UNDER DENSE VEGETATION

FINAL FOUL MANHOLE BEFORE CONNECTING ONTO EXISTING COMBINED SEWER

13.9m

WOODVILLE STREET

HIGH STREET

NANT DAWI

Club

ESS

Revision:

Project: Existing Steelworks
Pontarddulais

Client: WALTERS
CIVIL ENGINEERING - PLANT - DEVELOPMENT

Drawing: Drainage Strategy Plan

Scale: 1:500 @ A0
Date: June 2023
Drawn by: JM

Drawing No: 10373 - 102
Rev: -

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Appendix E

Calculations

UK Design Flood Estimation

Generated on Friday, May 12, 2023 10:47:53 AM by NickL
Printed from the ReFH2 Flood Modelling software package, version 3.2.7650.24314

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH2)

Site details Checksum: FD38-201B

Site name: Pont Small Catchment

Easting: 259500

Northing: 204050

Country: England, Wales or Northern Ireland

Catchment Area (km²): 0.02 [0.55]*

Using plot scale calculations: No

Model: 2.2 (legacy)

Site description: None

Model run: 2 year

Summary of results

Rainfall - FEH 2013 model (mm):	20.79	Total runoff (ML):	0.11
Total Rainfall (mm):	19.30	Total flow (ML):	0.19
Peak Rainfall (mm):	3.51	Peak flow (m³/s):	0.02

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	02:18:00	No
Timestep (hh:mm:ss)	00:06:00	No
SCF (Seasonal correction factor)	0.94	No
ARF (Areal reduction factor)	0.99	No
Seasonality	Summer [Winter]	Yes

Loss model parameters

Name	Value	User-defined?
Cini (mm)	71.73	No
Cmax (mm)	471.28	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No
Use seasonal CIni for equations	Yes	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	1	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	18.76	No
BR	1.85	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0.01 [0.02]	Yes
Urbext 2000	0.3 [0.46]	Yes
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Exporting drained area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.192	0.000	0.044	0.000	0.001	0.001
00:06:00	0.230	0.000	0.053	0.000	0.001	0.001
00:12:00	0.278	0.000	0.064	0.000	0.001	0.001
00:18:00	0.338	0.000	0.078	0.000	0.001	0.001
00:24:00	0.414	0.000	0.095	0.001	0.001	0.001
00:30:00	0.510	0.000	0.118	0.001	0.001	0.002
00:36:00	0.637	0.000	0.148	0.001	0.001	0.002
00:42:00	0.806	0.000	0.189	0.002	0.001	0.003
00:48:00	1.043	0.000	0.246	0.002	0.001	0.003
00:54:00	1.400	0.000	0.333	0.003	0.001	0.004
01:00:00	2.046	0.000	0.493	0.004	0.001	0.005
01:06:00	3.511	0.000	0.864	0.006	0.001	0.006
01:12:00	2.046	0.000	0.514	0.008	0.001	0.008
01:18:00	1.400	0.000	0.356	0.010	0.001	0.011
01:24:00	1.043	0.000	0.268	0.013	0.001	0.014
01:30:00	0.806	0.000	0.208	0.015	0.001	0.016
01:36:00	0.637	0.000	0.165	0.017	0.001	0.018
01:42:00	0.510	0.000	0.133	0.019	0.001	0.020
01:48:00	0.414	0.000	0.108	0.019	0.001	0.020
01:54:00	0.338	0.000	0.089	0.019	0.001	0.020
02:00:00	0.278	0.000	0.073	0.018	0.001	0.019
02:06:00	0.230	0.000	0.061	0.017	0.001	0.018
02:12:00	0.192	0.000	0.051	0.016	0.001	0.017
02:18:00	0.000	0.000	0.000	0.015	0.001	0.016
02:24:00	0.000	0.000	0.000	0.014	0.001	0.015
02:30:00	0.000	0.000	0.000	0.012	0.001	0.014
02:36:00	0.000	0.000	0.000	0.011	0.001	0.012
02:42:00	0.000	0.000	0.000	0.010	0.001	0.011
02:48:00	0.000	0.000	0.000	0.008	0.001	0.010
02:54:00	0.000	0.000	0.000	0.007	0.002	0.009
03:00:00	0.000	0.000	0.000	0.006	0.002	0.008
03:06:00	0.000	0.000	0.000	0.005	0.002	0.007
03:12:00	0.000	0.000	0.000	0.004	0.002	0.006
03:18:00	0.000	0.000	0.000	0.004	0.002	0.006
03:24:00	0.000	0.000	0.000	0.003	0.002	0.005

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
03:30:00	0.000	0.000	0.000	0.003	0.002	0.005
03:36:00	0.000	0.000	0.000	0.003	0.002	0.004
03:42:00	0.000	0.000	0.000	0.002	0.002	0.004
03:48:00	0.000	0.000	0.000	0.002	0.002	0.004
03:54:00	0.000	0.000	0.000	0.002	0.002	0.004
04:00:00	0.000	0.000	0.000	0.002	0.002	0.003
04:06:00	0.000	0.000	0.000	0.001	0.002	0.003
04:12:00	0.000	0.000	0.000	0.001	0.002	0.003
04:18:00	0.000	0.000	0.000	0.001	0.002	0.003
04:24:00	0.000	0.000	0.000	0.001	0.002	0.003
04:30:00	0.000	0.000	0.000	0.001	0.002	0.002
04:36:00	0.000	0.000	0.000	0.001	0.002	0.002
04:42:00	0.000	0.000	0.000	0.000	0.002	0.002
04:48:00	0.000	0.000	0.000	0.000	0.002	0.002
04:54:00	0.000	0.000	0.000	0.000	0.002	0.002
05:00:00	0.000	0.000	0.000	0.000	0.002	0.002
05:06:00	0.000	0.000	0.000	0.000	0.002	0.002
05:12:00	0.000	0.000	0.000	0.000	0.002	0.002
05:18:00	0.000	0.000	0.000	0.000	0.002	0.002
05:24:00	0.000	0.000	0.000	0.000	0.002	0.002
05:30:00	0.000	0.000	0.000	0.000	0.002	0.002
05:36:00	0.000	0.000	0.000	0.000	0.002	0.002
05:42:00	0.000	0.000	0.000	0.000	0.002	0.002
05:48:00	0.000	0.000	0.000	0.000	0.002	0.002
05:54:00	0.000	0.000	0.000	0.000	0.002	0.002
06:00:00	0.000	0.000	0.000	0.000	0.002	0.002
06:06:00	0.000	0.000	0.000	0.000	0.002	0.002
06:12:00	0.000	0.000	0.000	0.000	0.002	0.002
06:18:00	0.000	0.000	0.000	0.000	0.002	0.002
06:24:00	0.000	0.000	0.000	0.000	0.002	0.002
06:30:00	0.000	0.000	0.000	0.000	0.002	0.002
06:36:00	0.000	0.000	0.000	0.000	0.002	0.002
06:42:00	0.000	0.000	0.000	0.000	0.002	0.002
06:48:00	0.000	0.000	0.000	0.000	0.002	0.002
06:54:00	0.000	0.000	0.000	0.000	0.002	0.002
07:00:00	0.000	0.000	0.000	0.000	0.002	0.002

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
07:06:00	0.000	0.000	0.000	0.000	0.002	0.002
07:12:00	0.000	0.000	0.000	0.000	0.002	0.002
07:18:00	0.000	0.000	0.000	0.000	0.002	0.002
07:24:00	0.000	0.000	0.000	0.000	0.002	0.002
07:30:00	0.000	0.000	0.000	0.000	0.002	0.002
07:36:00	0.000	0.000	0.000	0.000	0.001	0.001
07:42:00	0.000	0.000	0.000	0.000	0.001	0.001
07:48:00	0.000	0.000	0.000	0.000	0.001	0.001
07:54:00	0.000	0.000	0.000	0.000	0.001	0.001
08:00:00	0.000	0.000	0.000	0.000	0.001	0.001
08:06:00	0.000	0.000	0.000	0.000	0.001	0.001
08:12:00	0.000	0.000	0.000	0.000	0.001	0.001
08:18:00	0.000	0.000	0.000	0.000	0.001	0.001
08:24:00	0.000	0.000	0.000	0.000	0.001	0.001
08:30:00	0.000	0.000	0.000	0.000	0.001	0.001
08:36:00	0.000	0.000	0.000	0.000	0.001	0.001
08:42:00	0.000	0.000	0.000	0.000	0.001	0.001
08:48:00	0.000	0.000	0.000	0.000	0.001	0.001
08:54:00	0.000	0.000	0.000	0.000	0.001	0.001
09:00:00	0.000	0.000	0.000	0.000	0.001	0.001
09:06:00	0.000	0.000	0.000	0.000	0.001	0.001
09:12:00	0.000	0.000	0.000	0.000	0.001	0.001
09:18:00	0.000	0.000	0.000	0.000	0.001	0.001
09:24:00	0.000	0.000	0.000	0.000	0.001	0.001
09:30:00	0.000	0.000	0.000	0.000	0.001	0.001
09:36:00	0.000	0.000	0.000	0.000	0.001	0.001
09:42:00	0.000	0.000	0.000	0.000	0.001	0.001
09:48:00	0.000	0.000	0.000	0.000	0.001	0.001
09:54:00	0.000	0.000	0.000	0.000	0.001	0.001
10:00:00	0.000	0.000	0.000	0.000	0.001	0.001
10:06:00	0.000	0.000	0.000	0.000	0.001	0.001
10:12:00	0.000	0.000	0.000	0.000	0.001	0.001
10:18:00	0.000	0.000	0.000	0.000	0.001	0.001
10:24:00	0.000	0.000	0.000	0.000	0.001	0.001
10:30:00	0.000	0.000	0.000	0.000	0.001	0.001
10:36:00	0.000	0.000	0.000	0.000	0.001	0.001

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
10:42:00	0.000	0.000	0.000	0.000	0.001	0.001
10:48:00	0.000	0.000	0.000	0.000	0.001	0.001
10:54:00	0.000	0.000	0.000	0.000	0.001	0.001
11:00:00	0.000	0.000	0.000	0.000	0.001	0.001
11:06:00	0.000	0.000	0.000	0.000	0.001	0.001
11:12:00	0.000	0.000	0.000	0.000	0.001	0.001
11:18:00	0.000	0.000	0.000	0.000	0.001	0.001
11:24:00	0.000	0.000	0.000	0.000	0.001	0.001
11:30:00	0.000	0.000	0.000	0.000	0.001	0.001
11:36:00	0.000	0.000	0.000	0.000	0.001	0.001
11:42:00	0.000	0.000	0.000	0.000	0.001	0.001
11:48:00	0.000	0.000	0.000	0.000	0.001	0.001
11:54:00	0.000	0.000	0.000	0.000	0.001	0.001
12:00:00	0.000	0.000	0.000	0.000	0.001	0.001
12:06:00	0.000	0.000	0.000	0.000	0.001	0.001
12:12:00	0.000	0.000	0.000	0.000	0.001	0.001
12:18:00	0.000	0.000	0.000	0.000	0.001	0.001
12:24:00	0.000	0.000	0.000	0.000	0.001	0.001
12:30:00	0.000	0.000	0.000	0.000	0.001	0.001
12:36:00	0.000	0.000	0.000	0.000	0.001	0.001
12:42:00	0.000	0.000	0.000	0.000	0.001	0.001
12:48:00	0.000	0.000	0.000	0.000	0.001	0.001
12:54:00	0.000	0.000	0.000	0.000	0.001	0.001
13:00:00	0.000	0.000	0.000	0.000	0.001	0.001
13:06:00	0.000	0.000	0.000	0.000	0.001	0.001
13:12:00	0.000	0.000	0.000	0.000	0.001	0.001
13:18:00	0.000	0.000	0.000	0.000	0.001	0.001
13:24:00	0.000	0.000	0.000	0.000	0.001	0.001
13:30:00	0.000	0.000	0.000	0.000	0.001	0.001
13:36:00	0.000	0.000	0.000	0.000	0.001	0.001
13:42:00	0.000	0.000	0.000	0.000	0.001	0.001
13:48:00	0.000	0.000	0.000	0.000	0.001	0.001
13:54:00	0.000	0.000	0.000	0.000	0.001	0.001
14:00:00	0.000	0.000	0.000	0.000	0.001	0.001
14:06:00	0.000	0.000	0.000	0.000	0.001	0.001
14:12:00	0.000	0.000	0.000	0.000	0.001	0.001

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
14:18:00	0.000	0.000	0.000	0.000	0.001	0.001
14:24:00	0.000	0.000	0.000	0.000	0.001	0.001
14:30:00	0.000	0.000	0.000	0.000	0.001	0.001
14:36:00	0.000	0.000	0.000	0.000	0.001	0.001
14:42:00	0.000	0.000	0.000	0.000	0.001	0.001
14:48:00	0.000	0.000	0.000	0.000	0.001	0.001
14:54:00	0.000	0.000	0.000	0.000	0.001	0.001
15:00:00	0.000	0.000	0.000	0.000	0.001	0.001
15:06:00	0.000	0.000	0.000	0.000	0.001	0.001
15:12:00	0.000	0.000	0.000	0.000	0.001	0.001
15:18:00	0.000	0.000	0.000	0.000	0.001	0.001
15:24:00	0.000	0.000	0.000	0.000	0.001	0.001
15:30:00	0.000	0.000	0.000	0.000	0.001	0.001
15:36:00	0.000	0.000	0.000	0.000	0.001	0.001
15:42:00	0.000	0.000	0.000	0.000	0.001	0.001
15:48:00	0.000	0.000	0.000	0.000	0.001	0.001
15:54:00	0.000	0.000	0.000	0.000	0.001	0.001
16:00:00	0.000	0.000	0.000	0.000	0.001	0.001
16:06:00	0.000	0.000	0.000	0.000	0.001	0.001
16:12:00	0.000	0.000	0.000	0.000	0.001	0.001
16:18:00	0.000	0.000	0.000	0.000	0.001	0.001
16:24:00	0.000	0.000	0.000	0.000	0.001	0.001
16:30:00	0.000	0.000	0.000	0.000	0.001	0.001
16:36:00	0.000	0.000	0.000	0.000	0.001	0.001

Appendix

Catchment descriptors *

Name	Value	User-defined value used?
Area (km^2)	0.02 [0.55]	**Yes**
ALTBAR	45	No
ASPBAR	260	No
ASPVAR	0.74	No
BFIHOST	0.6	No
DPLBAR (km)	0.13 [0.73]	**Yes**
DPSBAR (mkm^{-1})	13.03 [77]	**Yes**
FARL	1	No
LDP	1.49	No
PROPWET (mm)	0.57	No
RMED1H	11.4	No
RMED1D	45.8	No
RMED2D	62.4	No
SAAR (mm)	1394	No
SAAR4170 (mm)	1349	No
SPRHOST	40	No
Urbext2000	0.3 [0.46]	**Yes**
Urbext1990	0.06	No
URBCONC	0.65	No
URBLOC	0.58	No
DDF parameter C	-0.03	No
DDF parameter D1	0.45	No
DDF parameter D2	0.38	No
DDF parameter D3	0.41	No
DDF parameter E	0.28	No
DDF parameter F	2.5	No
DDF parameter C (1km grid value)	-0.03	No
DDF parameter D1 (1km grid value)	0.45	No
DDF parameter D2 (1km grid value)	0.38	No
DDF parameter D3 (1km grid value)	0.41	No
DDF parameter E (1km grid value)	0.29	No
DDF parameter F (1km grid value)	2.5	No

Values in square brackets are the original values loaded from the FEH Web Service or FEH CD-ROM

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	9.014	0.814	15.1	278.1	O K
30 min Summer	9.275	1.075	15.1	396.5	O K
60 min Summer	9.531	1.331	15.1	528.4	O K
120 min Summer	9.670	1.470	15.1	606.7	O K
180 min Summer	9.739	1.539	15.1	647.3	Flood Risk
240 min Summer	9.776	1.576	15.1	669.5	Flood Risk
360 min Summer	9.799	1.599	15.1	683.4	Flood Risk
480 min Summer	9.793	1.593	15.1	680.2	Flood Risk
600 min Summer	9.784	1.584	15.1	674.3	Flood Risk
720 min Summer	9.772	1.572	15.1	667.2	Flood Risk
960 min Summer	9.748	1.548	15.1	652.5	Flood Risk
1440 min Summer	9.688	1.488	15.1	617.2	O K
2160 min Summer	9.591	1.391	15.1	561.5	O K
2880 min Summer	9.490	1.290	15.1	506.1	O K
4320 min Summer	9.255	1.055	15.1	387.2	O K
5760 min Summer	8.995	0.795	15.1	270.0	O K
7200 min Summer	8.819	0.619	15.1	199.4	O K
8640 min Summer	8.688	0.488	15.1	151.1	O K
10080 min Summer	8.595	0.395	15.0	118.8	O K
15 min Winter	9.097	0.897	15.1	314.0	O K
30 min Winter	9.379	1.179	15.1	448.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	112.000	0.0	297.6	26
30 min Summer	80.080	0.0	425.8	40
60 min Summer	54.600	0.0	580.4	70
120 min Summer	33.180	0.0	705.9	126
180 min Summer	24.884	0.0	794.1	186
240 min Summer	20.300	0.0	863.3	244
360 min Summer	15.213	0.0	971.0	360
480 min Summer	12.380	0.0	1053.6	420
600 min Summer	10.547	0.0	1121.9	484
720 min Summer	9.252	0.0	1181.0	550
960 min Summer	7.525	0.0	1280.4	684
1440 min Summer	5.618	0.0	1433.6	966
2160 min Summer	4.207	0.0	1611.6	1384
2880 min Summer	3.442	0.0	1757.1	1792
4320 min Summer	2.609	0.0	1998.3	2600
5760 min Summer	2.167	0.0	2212.7	3280
7200 min Summer	1.900	0.0	2424.3	3968
8640 min Summer	1.720	0.0	2633.4	4664
10080 min Summer	1.591	0.0	2842.8	5344
15 min Winter	112.000	0.0	333.2	26
30 min Winter	80.080	0.0	477.1	40

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	9.656	1.456	15.1	598.5	O K
120 min Winter	9.813	1.613	15.1	692.1	Flood Risk
180 min Winter	9.895	1.695	15.1	743.8	Flood Risk
240 min Winter	9.942	1.742	15.1	774.4	Flood Risk
360 min Winter	9.982	1.782	15.1	800.7	Flood Risk
480 min Winter	9.985	1.785	15.1	802.3	Flood Risk
600 min Winter	9.969	1.769	15.1	792.1	Flood Risk
720 min Winter	9.953	1.753	15.1	781.5	Flood Risk
960 min Winter	9.919	1.719	15.1	759.1	Flood Risk
1440 min Winter	9.828	1.628	15.1	701.5	Flood Risk
2160 min Winter	9.672	1.472	15.1	607.9	O K
2880 min Winter	9.506	1.306	15.1	514.5	O K
4320 min Winter	9.042	0.842	15.1	290.0	O K
5760 min Winter	8.679	0.479	15.1	147.8	O K
7200 min Winter	8.478	0.278	14.7	80.7	O K
8640 min Winter	8.374	0.174	13.9	48.9	O K
10080 min Winter	8.317	0.117	13.1	32.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	54.600	0.0	650.4	68
120 min Winter	33.180	0.0	790.1	124
180 min Winter	24.884	0.0	889.2	182
240 min Winter	20.300	0.0	966.9	238
360 min Winter	15.213	0.0	1087.2	352
480 min Winter	12.380	0.0	1179.5	458
600 min Winter	10.547	0.0	1256.1	554
720 min Winter	9.252	0.0	1322.4	578
960 min Winter	7.525	0.0	1434.2	734
1440 min Winter	5.617	0.0	1605.9	1044
2160 min Winter	4.207	0.0	1804.7	1496
2880 min Winter	3.442	0.0	1968.3	1936
4320 min Winter	2.609	0.0	2237.8	2684
5760 min Winter	2.167	0.0	2478.0	3288
7200 min Winter	1.900	0.0	2715.0	3896
8640 min Winter	1.720	0.0	2949.2	4576
10080 min Winter	1.591	0.0	3184.0	5240

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 259500 204050 SN 59500 04050
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.418

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.473	4	8	0.473	8	12	0.473

Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 8.200

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	265.0	1.800	668.2

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0162-1510-1900-1510
Design Head (m)	1.900
Design Flow (l/s)	15.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	162
Invert Level (m)	8.100
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.900	15.1
Flush-Flo™	0.557	15.1
Kick-Flo®	1.167	12.0
Mean Flow over Head Range	-	13.2

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.8	1.200	12.1	3.000	18.8	7.000	28.2
0.200	12.8	1.400	13.1	3.500	20.2	7.500	29.1
0.300	14.1	1.600	13.9	4.000	21.5	8.000	30.0
0.400	14.8	1.800	14.7	4.500	22.8	8.500	30.9
0.500	15.0	2.000	15.5	5.000	24.0	9.000	31.8
0.600	15.1	2.200	16.2	5.500	25.1	9.500	32.6
0.800	14.7	2.400	16.9	6.000	26.2		
1.000	13.8	2.600	17.5	6.500	27.2		