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DRAINAGE STATEMENT

Job Title

66, HIGH STREET, UXBRIDGE

Job No

13446

Sheet No

1

Date

JAN 2017

Revision



FS 29858

This drainage statement has been prepared to satisfy Condition-18 of the current planning permission for the above project.

The questions raised within Condition-18 have been set out in order and we have kept the same regime for the statement.

Condition-18

(i) Provide information on all Suds features including the method employed to delay and control the surface water discharged from the site.

- (a) Attached is a package of information which includes, calculations showing storm period and intensity and volume of storage required to control surface water and size of features to control that volume.
- (b) Due to the raised nature of the site and the falls of the adjacent land, there will be no overland flooding.
- (c) All surface water from new development will to be pumped back into Thames Water Sewer or used for irrigation. See attached drawings.
- (d) Drainage connections will likely be made before completion of building and therefore, all surface water from new development will to be pumped back into Thames Water Sewer in the temporary or permanent condition.

(ii) Provide a management and maintenance plan for the lifetime of the development of arrangements to secure the operation of the scheme throughout its lifetime. Including appropriate details of Inspection regimes, appropriate performance specification, remediation and timescales for the resolving of issues.

Management and maintenance plan will be implemented by a managing agent who has yet to be appointed. Details will be submitted when available.

(iii) Provide details of the body legally responsible for the implementation of the management and maintenance plan.

Management and maintenance plan will be implemented by a managing agent who has yet to be appointed. Details will be submitted when available.

(iv) The scheme shall also demonstrate the use of methods to minimise the use of potable water through water collection, reuse and recycling.

Rainwater: There will be a large amount of planting on the 4th level roof terrace, which will reduce the amount of surface water finding its way into the main drainage.

A small pump chamber will be installed with an inlet from the surface water storage and an outlet to a 'gardeners' tap located close to the entrance to the car park.

Greywater: There will be no greywater recycling on this project in accordance with the Drainage statement dated: November 2015.

**CALCULATIONS
FOR SURFACE WATER and
FOUL WATER DRAINAGE AT
SITE OF 66, HIGH STREET, UXBRIDGE**

JOB No: 13446

SEPTEMBER 2016



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SURFACE WATER STRATEGY

Existing Site Run-Off:

At present the existing site houses single storey building with associated parking (originally use as a community centre). Taken for the existing survey information the overall area of the site is approximately 1700m² or 0.17 ha.

Taken from the existing survey information the existing area of impermeable surface is approximately 760m² or 0.076 ha.

The proposal is for a single 8.5 storey concrete framed block. The block is mainly residential but with a community centre at ground level and a single level of underground car park with ground floor podium over.

Design Rainfall Intensity has been calculated using the Wallingford Procedure and based on a 30 minute storm and I in 100 year event: 65.4l/s

The impermeable area based on the proposed scheme is approximately 1400m² or 0.14 ha.

Based on the above the existing site run off has been calculated as:

$$Q = 2.78 \times 0.076 \times 65.4 = \underline{13.8l/s}$$

It is proposed to restrict the surface water run off to the greenfield run-off rates. The following greenfield run off rates have been calculated using XP solutions Microdrainage. (results attached)

1 in 100 year storm: 0.8 l/s/ha

In accordance with best practice, discharge flow rates which are under 5l/s should be increased to 5l/s to reduce the risk of blockages. Therefore, there will be a significant reduction in run-off rate from 13.8l/s to 5.0l/s.

The proposed drainage scheme is attached, and it the shows the new pump chamber restricting the flow to 5l/s.

Attenuation:

Based on Micro Drainage quick storage estimate within the Source Control Module (see attached), the storage required is between 46m³ and 67m³. Take average of 63m³.

Assuming the use of 'Wavin' Aquacell units or similar with a volume of 0.19m³, use 331 units.

Scheme:

The scheme shown is attached and is for the main drainage runs within the site.

Design:

The basis of the design is to ensure that the proposed scheme does not cause any flooding to the site based on a 1 in 100 year critical storm.



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FOUL WATER STRATEGY

The current scheme allows for 76 apartments over 7 floors, all apartments have the same facilities, comprising: 1 No Bathroom and 1 No Kitchen. There are no en-suites etc.

There is a plan to try and achieve a total of 90 units with 4 No additional at ground level and 10 No at 7th floor and 8th floor

Flow Rates:

Using the above information the flow rates for each apartment will be the same and will be based on the calculation below:

Appliance	Discharge Unit Value
Washbasin	0.5
Bidet	0.5
Shower	0.6
Single urinal with cistern	0.8
Bath	0.8
Sink	0.8
Dishwasher	0.8
Washing Machine	0.8
WC with 7.5 litre cistern	2.0

Formula for calculation of flow rate:

$$Q = k \sqrt{\sum DU}$$

where Q = Flow rate in litres/sec

k = Frequency factor

$\sum DU$ = Sum of discharge units

k = 0.5 for dwellings, guest houses, offices etc.

0.7 for hospitals, schools, restaurants, hotels etc.

1.0 for toilets/showers open to the public

Below is a table showing typical discharge units for a typical apartment:

DISCHARGE UNITS FOR INDIVIDUAL PLOTS:								
NO OF INDIVIDUAL APPLIANCES								
PLOT No.	WASH BASINS	SHOWERS	BATH	SINK	DISHWASHER	WASHING MACHINE	WC	TOTAL DU's PER PLOT:
D.U'S PER APPLIANCE	0.5	0.6	0.8	0.8	0.8	0.8	2	
TYPICAL PLOT	1	1	1	1	1	1	1	6.3



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Date

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Design:

The design of the foul drainage will be based on the information given on page-2 and flow rate (Q) used will be cumulative based on table value of 6.3l/s per apartment and number of apartments on being serviced by each drain run.

Project 66, High Street, Uxbridge				Job no. 13446	
Calcs for Rainfall Intensity				Start page no./Revision # 4	
Calcs by T	Calcs date 08/09/2016	Checked by	Checked date	Approved by	Approved date

DESIGN RAINFALL

In accordance with the Wallingford Procedure

Tedds calculation version 2.0.00

Design rainfall intensity

Location of catchment area London
Storm duration D = 30 min
Return period Period = 100 yr
Ratio 60 min to 2 day rainfall of 5 yr return period $r = 0.440$
5-year return period rainfall of 60 minutes duration $M5_60min = 20.0$ mm
Increase of rainfall intensity due to global warming $p_{climate} = 0$ %
Factor Z1 (Wallingford procedure) $Z1 = 0.82$
Rainfall for 30min storm with 5 year return period $M5_30min_i = Z1 \times M5_60min = 16.3$ mm
Factor Z2 (Wallingford procedure) $Z2 = 2.00$
Rainfall for 30min storm with 100 year return period $M100_30min = Z2 \times M5_30min_i = 32.7$ mm
Design rainfall intensity $I_{max} = M100_30min / D = \underline{\underline{65.4 \text{ mm/hr}}}$

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Train & Kemp LLP		Page 1
10 Kennington Park Place London SE11 4AS		
Date 09/01/2017 14:29 File	Designed by terryr Checked by	
XP Solutions		Source Control 2016.1
<u>ICP SUDS Mean Annual Flood</u> Input Return Period (years) 100 Soil 0.300 Area (ha) 0.170 Urban 0.000 SAAR (mm) 600 Region Number Region 6 Results l/s QBAR Rural 0.3 QBAR Urban 0.3 Q100 years 0.8 Q1 year 0.2 Q30 years 0.6 Q100 years 0.8		
©1982-2016 XP Solutions		

66, HIGH STREET, UXBRIDGE - QUICK STORAGE ESTIMATE

6

Quick Storage Estimate

Micro Drainage

Variables

FSR Rainfall Cv (Summer) 0.750

Return Period (years) 100 Cv (Winter) 0.840

Region England and Wales Impervious Area (ha) 0.140

Map M5-60 (mm) 20.700 Maximum Allowable Discharge (l/s) 5.0

Ratio R 0.437 Infiltration Coefficient (m/hr) 0.00000

Safety Factor 2.0

Climate Change (%) 30

Analyse OK Cancel Help

Enter Climate Change between -100 and 600

Quick Storage Estimate

Micro Drainage

Results

Global Variables require approximate storage of between 46 m³ and 67 m³.

These values are estimates only and should not be used for design purposes.

Variables

Results

Design

Overview 2D

Overview 3D

Vt

Analyse OK Cancel Help

Enter Climate Change between -100 and 600

Designer	Job Title HIGH STREET, UXBRIDGE	Job No. 13446
Date SEPT 16	Section DRAINAGE	Pages No. 9

SURFACE WATER RUNS:

AREAS: (SEE LAYOUT PLAN)

- 1 $11.0 \times 4.5 = 50m^2$
- 2 $11.0 \times 5.5 = 61m^2$
- 3 $11.0 \times 2.0 = 23m^2$
- 4 $11.5 \times 6.0 = 69m^2$
- 5 $9.0 \times 6.0 = 54m^2$
- 6 $13 \times 4.0 = 52m^2$
- 7 $- " - = 52m^2$
- 8 $- " - = 52m^2$
- 9 $(13 \times 9.5) + (3.5 \times 5) = 141m^2$
- 10 $8.5 \times 25 = 213m^2$
- 11 $13.0 \times 10 = 130m^2$
- 12 $(12 \times 8) + (4.5 \times 2) = 105m^2$

Designer	Job Title HIGH STREET, UXBRIDGE	Job No. 13416
Date SEPT 16	Section DRAINAGE.	Pages No. 10

SWMU:- 3-4:

AREAS: 1, 2 & 3 = 134m²

FALL = 225mm

LENGTH = 20.3m

FLOW RATE = $134 \times 65.4 / 3600 = \underline{\underline{2.41/s}}$

SWMU: 4-5:

AREAS: 1, 2, 3 & 4 = 203m²

FALL = 75mm

LENGTH = 6.7m.

FLOW RATE = $203 \times 65.4 / 3600 = \underline{\underline{3.74/s}}$

SWMU: 5-6:

AREAS: 1, 2, 3, 4 & 5 = 257m²

FALL = 50mm.

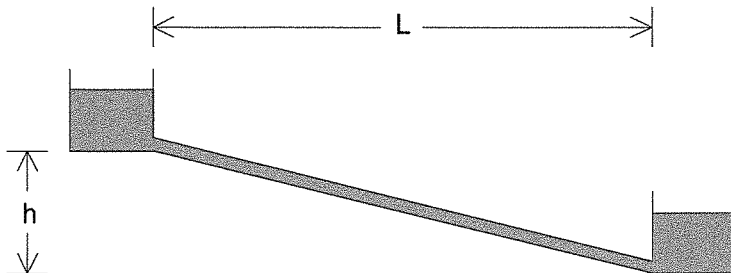
LENGTH = 3.7m

FLOW RATE = $257 \times 65.4 / 3600 = \underline{\underline{4.74/s}}$

Project 66, High Street, Uxbridge				Job no. 13446	
Calcs for Drain: SWMH-3 to SWMH-4				Start page no./Revision //	
Calcs by T	Calcs date 08/09/2016	Checked by	Checked date	Approved by	Approved date

DESIGN OF A SURFACE WATER DRAIN

TEDDS calculation version 1.0.03



Drain design details

Design flow rate	$Q_{\text{design}} = 2.40 \times 10^{-3} \text{ m}^3/\text{s}$
Length of the drain	$L = 20.3 \text{ m}$
Fall along length of drain	$h = 0.2 \text{ m}$
Gradient of drain	$i = h / L = 0.011 \text{ (1 in 90)}$
Minimum flow velocity	$V_{\text{min}} = 0.750 \text{ m/s}$
Minimum pipe diameter	$D_{\text{min}} = 100 \text{ mm}$
Surface roughness	$k_s = 0.6 \text{ mm}$
Mean hydraulic depth factor	$m = 0.25$
Kinematic viscosity of fluid	$\nu = 1.31 \times 10^{-6} \text{ m}^2/\text{s}$

Using the Chezy equation

Constant	$c = 56$
Diameter of pipe required	$D = ((Q_{\text{design}}^2 \times 16) / (\pi^2 \times m \times c^2 \times i \times 1 \text{ m/s}^2))^{0.2} = 64 \text{ mm}$
Nearest pipe diameter	$D_{\text{chezy}} = 100 \text{ mm}$
Flow velocity using Chezy	$V_{\text{chezy}} = c \times \sqrt{(m \times D_{\text{chezy}} \times i \times 1 \text{ m/s}^2)} = 0.932 \text{ m/s}$

Using the Eschritt equation

Diameter of pipe required	$D = (Q_{\text{design}} \times 1000 \times \sqrt{(1 / i) / 0.00035 \text{ m}^3/\text{s}})^{0.382} \times 1 \text{ mm} = 69 \text{ mm}$
Nearest pipe diameter	$D_{\text{eschritt}} = 100 \text{ mm}$
Flow velocity using Eschritt	$V_{\text{eschritt}} = 26.738 \times (D_{\text{eschritt}} / 1 \text{ mm})^{0.62} \times 1 \text{ m/s} / (\sqrt{(1 / i) \times 60}) = 0.815 \text{ m/s}$

Using the Colebrook-White Equation for pipe running full and partially full

Design pipe diameter	$D_{\text{design}} = \max(D_{\text{chezy}}, D_{\text{eschritt}}, D_{\text{min}}) = 100 \text{ mm}$
Constant	$Z = \sqrt{(2 \times (g_{\text{acc}} / 1 \text{ m/s}^2) \times (D_{\text{design}} / 1000 \text{ mm}) \times i)} = 0.147$
Flow velocity	$V_{\text{full}} = -2 \times Z \times \log((k_s / (3.7 \times D_{\text{design}})) + ((2.51 \times \nu) / (D_{\text{design}} \times Z \times 1 \text{ m/s}))) \times 1 \text{ m/s}$ $V_{\text{full}} = 0.806 \text{ m/s}$
Flow rate running full	$Q_{\text{full}} = V_{\text{full}} \times \pi \times D_{\text{design}}^2 / 4 = 6.33 \times 10^{-3} \text{ m}^3/\text{s}$

PASS - Maximum flow rate is greater than design flow rate

From Hydraulics Research Tables 35 and 36

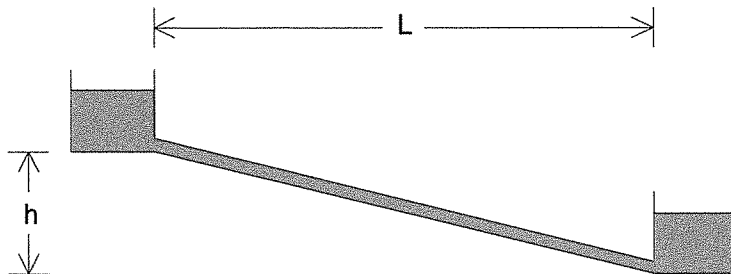
Depth as proportion of D	$x = 0.426$
Flow velocity at design flow rate	$V_{\text{design}} = 0.750 \text{ m/s}$

PASS - Design velocity is greater than 0.750 m/s

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	Calcs for Drain: SWMH-4 to SWMH-5				Start page no./Revision 12	
	Calcs by T	Calcs date 08/09/2016	Checked by	Checked date	Approved by	Approved date

DESIGN OF A SURFACE WATER DRAIN

TEDDS calculation version 1.0.03



Drain design details

Design flow rate	$Q_{\text{design}} = 3.70 \times 10^{-3} \text{ m}^3/\text{s}$
Length of the drain	$L = 6.7 \text{ m}$
Fall along length of drain	$h = 0.1 \text{ m}$
Gradient of drain	$i = h / L = 0.011 \text{ (1 in 89)}$
Minimum flow velocity	$V_{\text{min}} = 0.750 \text{ m/s}$
Minimum pipe diameter	$D_{\text{min}} = 100 \text{ mm}$
Surface roughness	$k_s = 0.6 \text{ mm}$
Mean hydraulic depth factor	$m = 0.25$
Kinematic viscosity of fluid	$\nu = 1.31 \times 10^{-6} \text{ m}^2/\text{s}$

Using the Chezy equation

Constant	$c = 56$
Diameter of pipe required	$D = ((Q_{\text{design}}^2 \times 16) / (\pi^2 \times m \times c^2 \times i \times 1 \text{ m/s}^2))^{0.2} = 76 \text{ mm}$
Nearest pipe diameter	$D_{\text{chezy}} = 100 \text{ mm}$
Flow velocity using Chezy	$V_{\text{chezy}} = c \times \sqrt{(m \times D_{\text{chezy}} \times i \times 1 \text{ m/s}^2)} = 0.937 \text{ m/s}$

Using the Eschritt equation

Diameter of pipe required	$D = (Q_{\text{design}} \times 1000 \times \sqrt{(1 / i) / 0.00035 \text{ m}^3/\text{s}})^{0.382} \times 1 \text{ mm} = 81 \text{ mm}$
Nearest pipe diameter	$D_{\text{eschritt}} = 100 \text{ mm}$
Flow velocity using Eschritt	$V_{\text{eschritt}} = 26.738 \times (D_{\text{eschritt}} / 1 \text{ mm})^{0.62} \times 1 \text{ m/s} / (\sqrt{(1 / i) \times 60}) = 0.819 \text{ m/s}$

Using the Colebrook-White Equation for pipe running full and partially full

Design pipe diameter	$D_{\text{design}} = \max(D_{\text{chezy}}, D_{\text{eschritt}}, D_{\text{min}}) = 100 \text{ mm}$
Constant	$Z = \sqrt{(2 \times (g_{\text{acc}} / 1 \text{ m/s}^2) \times (D_{\text{design}} / 1000 \text{ mm}) \times i)} = 0.148$
Flow velocity	$V_{\text{full}} = -2 \times Z \times \log((k_s / (3.7 \times D_{\text{design}})) + ((2.51 \times \nu) / (D_{\text{design}} \times Z \times 1 \text{ m/s}))) \times 1 \text{ m/s}$ $V_{\text{full}} = 0.810 \text{ m/s}$
Flow rate running full	$Q_{\text{full}} = V_{\text{full}} \times \pi \times D_{\text{design}}^2 / 4 = 6.36 \times 10^{-3} \text{ m}^3/\text{s}$

PASS - Maximum flow rate is greater than design flow rate

From Hydraulics Research Tables 35 and 36

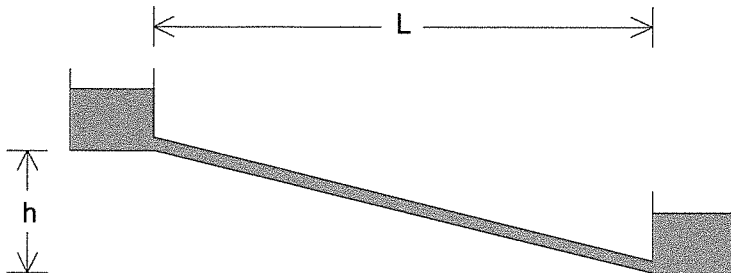
Depth as proportion of D	$x = 0.548$
Flow velocity at design flow rate	$V_{\text{design}} = 0.840 \text{ m/s}$

PASS - Design velocity is greater than 0.750 m/s

Project 66, High Street, Uxbridge				Job no. 13446	
Calcs for Drain: SWMH-5 to SWMH-6				Start page no./Revision 1	
Calcs by T	Calcs date 08/09/2016	Checked by	Checked date	Approved by	Approved date

DESIGN OF A SURFACE WATER DRAIN

TEDDS calculation version 1.0.03



Drain design details

Design flow rate	$Q_{\text{design}} = 4.70 \times 10^{-3} \text{ m}^3/\text{s}$
Length of the drain	$L = 3.7 \text{ m}$
Fall along length of drain	$h = 0.1 \text{ m}$
Gradient of drain	$i = h / L = 0.014 \text{ (1 in 74)}$
Minimum flow velocity	$V_{\text{min}} = 0.750 \text{ m/s}$
Minimum pipe diameter	$D_{\text{min}} = 100 \text{ mm}$
Surface roughness	$k_s = 0.6 \text{ mm}$
Mean hydraulic depth factor	$m = 0.25$
Kinematic viscosity of fluid	$\nu = 1.31 \times 10^{-6} \text{ m}^2/\text{s}$

Using the Chezy equation

Constant	$c = 56$
Diameter of pipe required	$D = ((Q_{\text{design}}^2 \times 16) / (\pi^2 \times m \times c^2 \times i \times 1 \text{ m/s}^2))^{0.2} = 80 \text{ mm}$
Nearest pipe diameter	$D_{\text{chezy}} = 100 \text{ mm}$
Flow velocity using Chezy	$V_{\text{chezy}} = c \times \sqrt{(m \times D_{\text{chezy}} \times i \times 1 \text{ m/s}^2)} = 1.029 \text{ m/s}$

Using the Eschritt equation

Diameter of pipe required	$D = (Q_{\text{design}} \times 1000 \times \sqrt{(1 / i) / 0.00035 \text{ m}^3/\text{s}})^{0.382} \times 1 \text{ mm} = 86 \text{ mm}$
Nearest pipe diameter	$D_{\text{eschritt}} = 100 \text{ mm}$
Flow velocity using Eschritt	$V_{\text{eschritt}} = 26.738 \times (D_{\text{eschritt}} / 1 \text{ mm})^{0.62} \times 1 \text{ m/s} / (\sqrt{(1 / i) \times 60}) = 0.900 \text{ m/s}$

Using the Colebrook-White Equation for pipe running full and partially full

Design pipe diameter	$D_{\text{design}} = \max(D_{\text{chezy}}, D_{\text{eschritt}}, D_{\text{min}}) = 100 \text{ mm}$
Constant	$Z = \sqrt{(2 \times (g_{\text{acc}} / 1 \text{ m/s}^2) \times (D_{\text{design}} / 1000 \text{ mm}) \times i)} = 0.163$
Flow velocity	$V_{\text{full}} = -2 \times Z \times \log((k_s / (3.7 \times D_{\text{design}})) + ((2.51 \times \nu) / (D_{\text{design}} \times Z \times 1 \text{ m/s}))) \times 1 \text{ m/s}$ $V_{\text{full}} = 0.892 \text{ m/s}$
Flow rate running full	$Q_{\text{full}} = V_{\text{full}} \times \pi \times D_{\text{design}}^2 / 4 = 7.00 \times 10^{-3} \text{ m}^3/\text{s}$

PASS - Maximum flow rate is greater than design flow rate

From Hydraulics Research Tables 35 and 36

Depth as proportion of D	$x = 0.600$
Flow velocity at design flow rate	$V_{\text{design}} = 0.955 \text{ m/s}$

PASS - Design velocity is greater than 0.750 m/s

Designer	Job Title HIGH STREET, UXBRIDGE	Job No. 13446
Date SEPT 16	Section DRAINAGE	Pages No. 13

SUMM: G - BASEMENT: (RUN-1)

AREAS: 1 - 5 incl + 9 = 398m²

FALL = 100mm.

LENGTH = 10m (FROM FACE OF WALL)

FLOW RATE = $398 \times 65.4 / 3600 = \underline{\underline{7.2L/S}}$

INTERNAL BASEMENT RUN-2:

AREAS: 1 - 9 incl = 554m²

FALL: 350mm.

LENGTH: 4.6m.

FLOW RATE = $554 \times 65.4 / 3600 = \underline{\underline{10L/S}}$

INTERNAL BASEMENT RUN-3:

AREAS: AS ABOVE

FALL: 67mm

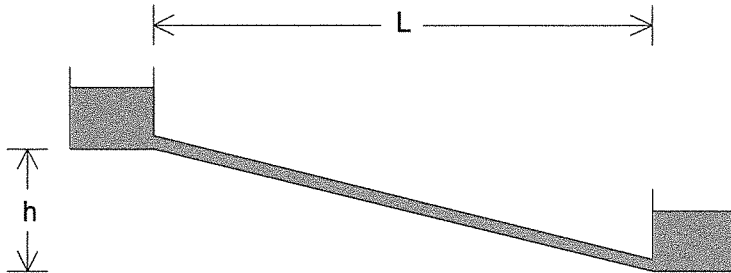
LENGTH: 6m.

FLOW RATE = $554 \times 64.4 / 3600 = \underline{\underline{10L/S}}$

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Calcs for Drain: SWMH-6 to Basement				Start page no./Revision 1/4	
Calcs by T	Calcs date 08/09/2016	Checked by	Checked date	Approved by	Approved date

DESIGN OF A SURFACE WATER DRAIN

TEDDS calculation version 1.0.03



Drain design details

Design flow rate	$Q_{\text{design}} = 7.20 \times 10^{-3} \text{ m}^3/\text{s}$
Length of the drain	$L = 10.0 \text{ m}$
Fall along length of drain	$h = 0.1 \text{ m}$
Gradient of drain	$i = h / L = 0.010 \text{ (1 in 100)}$
Minimum flow velocity	$V_{\text{min}} = 0.750 \text{ m/s}$
Minimum pipe diameter	$D_{\text{min}} = 150 \text{ mm}$
Surface roughness	$k_s = 0.6 \text{ mm}$
Mean hydraulic depth factor	$m = 0.25$
Kinematic viscosity of fluid	$\nu = 1.31 \times 10^{-6} \text{ m}^2/\text{s}$

Using the Chezy equation

Constant	$c = 56$
Diameter of pipe required	$D = ((Q_{\text{design}}^2 \times 16) / (\pi^2 \times m \times c^2 \times i \times 1 \text{ m/s}^2))^{0.2} = 101 \text{ mm}$
Nearest pipe diameter	$D_{\text{chezy}} = 150 \text{ mm}$
Flow velocity using Chezy	$V_{\text{chezy}} = c \times \sqrt{(m \times D_{\text{chezy}} \times i \times 1 \text{ m/s}^2)} = 1.084 \text{ m/s}$

Using the Eschritt equation

Diameter of pipe required	$D = (Q_{\text{design}} \times 1000 \times \sqrt{(1 / i) / 0.00035 \text{ m}^3/\text{s}})^{0.382} \times 1 \text{ mm} = 107 \text{ mm}$
Nearest pipe diameter	$D_{\text{eschritt}} = 150 \text{ mm}$
Flow velocity using Eschritt	$V_{\text{eschritt}} = 26.738 \times (D_{\text{eschritt}} / 1 \text{ mm})^{0.62} \times 1 \text{ m/s} / (\sqrt{(1 / i) \times 60}) = 0.996 \text{ m/s}$

Using the Colebrook-White Equation for pipe running full and partially full

Design pipe diameter	$D_{\text{design}} = \max(D_{\text{chezy}}, D_{\text{eschritt}}, D_{\text{min}}) = 150 \text{ mm}$
Constant	$Z = \sqrt{(2 \times (g_{\text{acc}} / 1 \text{ m/s}^2) \times (D_{\text{design}} / 1000 \text{ mm}) \times i)} = 0.172$
Flow velocity	$V_{\text{full}} = -2 \times Z \times \log((k_s / (3.7 \times D_{\text{design}})) + ((2.51 \times \nu) / (D_{\text{design}} \times Z \times 1 \text{ m/s}))) \times 1 \text{ m/s}$ $V_{\text{full}} = 1.001 \text{ m/s}$
Flow rate running full	$Q_{\text{full}} = V_{\text{full}} \times \pi \times D_{\text{design}}^2 / 4 = 17.7 \times 10^{-3} \text{ m}^3/\text{s}$

PASS - Maximum flow rate is greater than design flow rate

From Hydraulics Research Tables 35 and 36

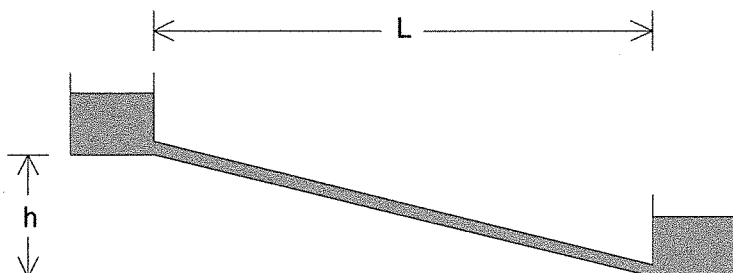
Depth as proportion of D	$x = 0.444$
Flow velocity at design flow rate	$V_{\text{design}} = 0.949 \text{ m/s}$

PASS - Design velocity is greater than 0.750 m/s

Project 66, High Street, Uxbridge				Job no. 13446	
Calcs for Drain: SW Basement Run-2				Start page no./Revision 15	
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DESIGN OF A SURFACE WATER DRAIN

TEDDS calculation version 1.0.03



Drain design details

Design flow rate	$Q_{\text{design}} = 10.0 \times 10^{-3} \text{ m}^3/\text{s}$
Length of the drain	$L = 4.6 \text{ m}$
Fall along length of drain	$h = 0.4 \text{ m}$
Gradient of drain	$i = h / L = 0.076 \text{ (1 in 13)}$
Minimum flow velocity	$V_{\text{min}} = 0.750 \text{ m/s}$
Minimum pipe diameter	$D_{\text{min}} = 150 \text{ mm}$
Surface roughness	$k_s = 0.6 \text{ mm}$
Mean hydraulic depth factor	$m = 0.25$
Kinematic viscosity of fluid	$\nu = 1.31 \times 10^{-6} \text{ m}^2/\text{s}$

Using the Chezy equation

Constant	$c = 56$
Diameter of pipe required	$D = ((Q_{\text{design}}^2 \times 16) / (\pi^2 \times m \times c^2 \times i \times 1 \text{ m/s}^2))^{0.2} = 77 \text{ mm}$
Nearest pipe diameter	$D_{\text{chezy}} = 150 \text{ mm}$
Flow velocity using Chezy	$V_{\text{chezy}} = c \times \sqrt{(m \times D_{\text{chezy}} \times i \times 1 \text{ m/s}^2)} = 2.991 \text{ m/s}$

Using the Eschritt equation

Diameter of pipe required	$D = (Q_{\text{design}} \times 1000 \times \sqrt{(1 / i) / 0.00035 \text{ m}^3/\text{s}})^{0.382} \times 1 \text{ mm} = 82 \text{ mm}$
Nearest pipe diameter	$D_{\text{eschritt}} = 150 \text{ mm}$
Flow velocity using Eschritt	$V_{\text{eschritt}} = 26.738 \times (D_{\text{eschritt}} / 1 \text{ mm})^{0.62} \times 1 \text{ m/s} / (\sqrt{(1 / i) \times 60}) = 2.747 \text{ m/s}$

Using the Colebrook-White Equation for pipe running full and partially full

Design pipe diameter	$D_{\text{design}} = \max(D_{\text{chezy}}, D_{\text{eschritt}}, D_{\text{min}}) = 150 \text{ mm}$
Constant	$Z = \sqrt{(2 \times (g_{\text{acc}} / 1 \text{ m/s}^2) \times (D_{\text{design}} / 1000 \text{ mm}) \times i)} = 0.473$
Flow velocity	$V_{\text{full}} = -2 \times Z \times \log((k_s / (3.7 \times D_{\text{design}})) + ((2.51 \times \nu) / (D_{\text{design}} \times Z \times 1 \text{ m/s}))) \times 1 \text{ m/s}$ $V_{\text{full}} = 2.789 \text{ m/s}$
Flow rate running full	$Q_{\text{full}} = V_{\text{full}} \times \pi \times D_{\text{design}}^2 / 4 = 49.3 \times 10^{-3} \text{ m}^3/\text{s}$

PASS - Maximum flow rate is greater than design flow rate

From Hydraulics Research Tables 35 and 36

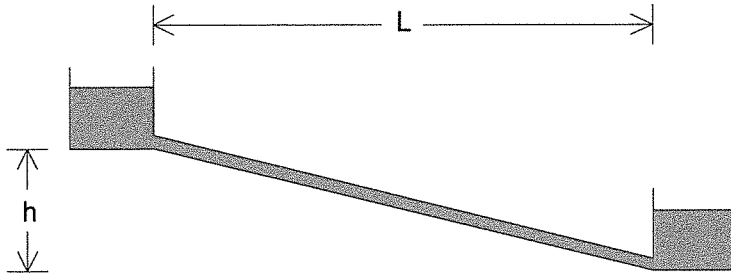
Depth as proportion of D	$x = 0.304$
Flow velocity at design flow rate	$V_{\text{design}} = 2.189 \text{ m/s}$

PASS - Design velocity is greater than 0.750 m/s

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	Calcs for Drain: SW Basement Run-3				Start page no./Revision 15	
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DESIGN OF A SURFACE WATER DRAIN

TEDDS calculation version 1.0.03



Drain design details

Design flow rate	$Q_{\text{design}} = 17.3 \times 10^{-3} \text{ m}^3/\text{s}$
Length of the drain	$L = 6.0 \text{ m}$
Fall along length of drain	$h = 0.1 \text{ m}$
Gradient of drain	$i = h / L = 0.011 \text{ (1 in 90)}$
Minimum flow velocity	$V_{\text{min}} = 0.750 \text{ m/s}$
Minimum pipe diameter	$D_{\text{min}} = 150 \text{ mm}$
Surface roughness	$k_s = 0.6 \text{ mm}$
Mean hydraulic depth factor	$m = 0.25$
Kinematic viscosity of fluid	$\nu = 1.31 \times 10^{-6} \text{ m}^2/\text{s}$

Using the Chezy equation

Constant	$c = 56$
Diameter of pipe required	$D = ((Q_{\text{design}}^2 \times 16) / (\pi^2 \times m \times c^2 \times i \times 1 \text{ m/s}^2))^{0.2} = 141 \text{ mm}$
Nearest pipe diameter	$D_{\text{chezy}} = 150 \text{ mm}$
Flow velocity using Chezy	$V_{\text{chezy}} = c \times \sqrt{(m \times D_{\text{chezy}} \times i \times 1 \text{ m/s}^2)} = 1.146 \text{ m/s}$

Using the Eschritt equation

Diameter of pipe required	$D = (Q_{\text{design}} \times 1000 \times \sqrt{(1 / i) / 0.00035 \text{ m}^3/\text{s}})^{0.382} \times 1 \text{ mm} = 147 \text{ mm}$
Nearest pipe diameter	$D_{\text{eschritt}} = 150 \text{ mm}$
Flow velocity using Eschritt	$V_{\text{eschritt}} = 26.738 \times (D_{\text{eschritt}} / 1 \text{ mm})^{0.62} \times 1 \text{ m/s} / (\sqrt{(1 / i) \times 60}) = 1.052 \text{ m/s}$

Using the Colebrook-White Equation for pipe running full and partially full

Design pipe diameter	$D_{\text{design}} = \max(D_{\text{chezy}}, D_{\text{eschritt}}, D_{\text{min}}) = 150 \text{ mm}$
Constant	$Z = \sqrt{(2 \times (g_{\text{acc}} / 1 \text{ m/s}^2) \times (D_{\text{design}} / 1000 \text{ mm}) \times i)} = 0.181$
Flow velocity	$V_{\text{full}} = -2 \times Z \times \log((k_s / (3.7 \times D_{\text{design}})) + ((2.51 \times \nu) / (D_{\text{design}} \times Z \times 1 \text{ m/s}))) \times 1 \text{ m/s}$ $V_{\text{full}} = 1.059 \text{ m/s}$
Flow rate running full	$Q_{\text{full}} = V_{\text{full}} \times \pi \times D_{\text{design}}^2 / 4 = 18.7 \times 10^{-3} \text{ m}^3/\text{s}$

PASS - Maximum flow rate is greater than design flow rate

From Hydraulics Research Tables 35 and 36

Depth as proportion of D	$x = 0.762$
Flow velocity at design flow rate	$V_{\text{design}} = 1.198 \text{ m/s}$

PASS - Design velocity is greater than 0.750 m/s

Designer	Job Title HIGH STREET, UXBRIDGE	Job No. 1344G
Date SEPT16	Section DRAINAGE	Pages No. 17

INTERNAL BASEMENT RUN-4:

AREAS: 1-10 incl. = 832m²
+ (1/2 x 11)

FALL: 150mm

LENGTH: 14m

FLOW RATE: $832 \times 65.4 / 3600 = \underline{\underline{15.1L/s}}$

INTERNAL BASEMENT RUN-5:

AREAS: 1-12 incl. = 1002m²

FALL: 29mm

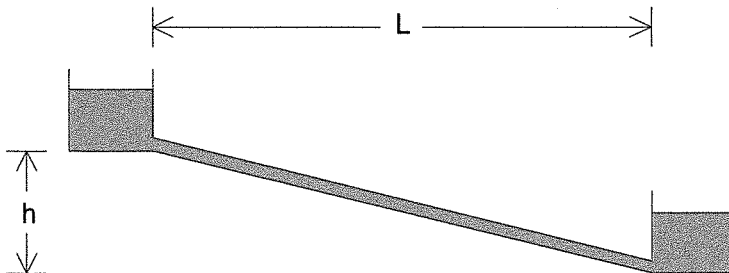
LENGTH: 2.6m

FLOW RATE: $1002 \times 65.4 / 3600 = \underline{\underline{18.2L/s}}$

Project 66, High Street, Uxbridge				Job no. 13446	
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DESIGN OF A SURFACE WATER DRAIN

TEDDS calculation version 1.0.03



Drain design details

Design flow rate	$Q_{\text{design}} = 15.1 \times 10^{-3} \text{ m}^3/\text{s}$
Length of the drain	$L = 14.0 \text{ m}$
Fall along length of drain	$h = 0.2 \text{ m}$
Gradient of drain	$i = h / L = 0.011 \text{ (1 in 90)}$
Minimum flow velocity	$V_{\text{min}} = 0.750 \text{ m/s}$
Minimum pipe diameter	$D_{\text{min}} = 150 \text{ mm}$
Surface roughness	$k_s = 0.6 \text{ mm}$
Mean hydraulic depth factor	$m = 0.25$
Kinematic viscosity of fluid	$\nu = 1.31 \times 10^{-6} \text{ m}^2/\text{s}$

Using the Chezy equation

Constant	$c = 56$
Diameter of pipe required	$D = ((Q_{\text{design}}^2 \times 16) / (\pi^2 \times m \times c^2 \times i \times 1 \text{ m/s}^2))^{0.2} = 133 \text{ mm}$
Nearest pipe diameter	$D_{\text{chezy}} = 150 \text{ mm}$
Flow velocity using Chezy	$V_{\text{chezy}} = c \times \sqrt{(m \times D_{\text{chezy}} \times i \times 1 \text{ m/s}^2)} = 1.145 \text{ m/s}$

Using the Eschritt equation

Diameter of pipe required	$D = (Q_{\text{design}} \times 1000 \times \sqrt{(1 / i)} / 0.00035 \text{ m}^3/\text{s})^{0.382} \times 1 \text{ mm} = 139 \text{ mm}$
Nearest pipe diameter	$D_{\text{eschritt}} = 150 \text{ mm}$
Flow velocity using Eschritt	$V_{\text{eschritt}} = 26.738 \times (D_{\text{eschritt}} / 1 \text{ mm})^{0.62} \times 1 \text{ m/s} / (\sqrt{(1 / i)} \times 60) = 1.051 \text{ m/s}$

Using the Colebrook-White Equation for pipe running full and partially full

Design pipe diameter	$D_{\text{design}} = \max(D_{\text{chezy}}, D_{\text{eschritt}}, D_{\text{min}}) = 150 \text{ mm}$
Constant	$Z = \sqrt{(2 \times (g_{\text{acc}} / 1 \text{ m/s}^2) \times (D_{\text{design}} / 1000 \text{ mm}) \times i)} = 0.181$
Flow velocity	$V_{\text{full}} = -2 \times Z \times \log((k_s / (3.7 \times D_{\text{design}})) + ((2.51 \times \nu) / (D_{\text{design}} \times Z \times 1 \text{ m/s}))) \times 1 \text{ m/s}$ $V_{\text{full}} = 1.057 \text{ m/s}$
Flow rate running full	$Q_{\text{full}} = V_{\text{full}} \times \pi \times D_{\text{design}}^2 / 4 = 18.7 \times 10^{-3} \text{ m}^3/\text{s}$

PASS - Maximum flow rate is greater than design flow rate

From Hydraulics Research Tables 35 and 36

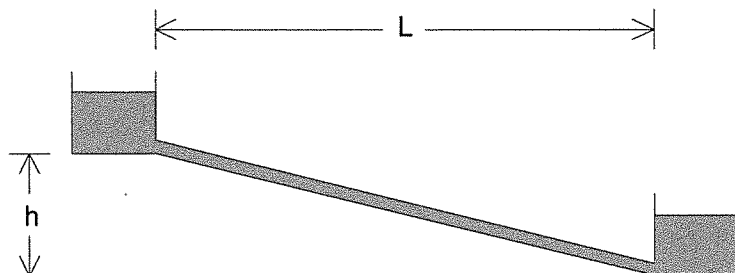
Depth as proportion of D	$x = 0.683$
Flow velocity at design flow rate	$V_{\text{design}} = 1.174 \text{ m/s}$

PASS - Design velocity is greater than 0.750 m/s

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	66, High Street, Uxbridge				13446	
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	Drain: SW Basement Run-5				19	
Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date	
T	09/09/2016					

DESIGN OF A SURFACE WATER DRAIN

TEDDS calculation version 1.0.03



Drain design details

Design flow rate	$Q_{\text{design}} = 18.2 \times 10^{-3} \text{ m}^3/\text{s}$
Length of the drain	$L = 2.6 \text{ m}$
Fall along length of drain	$h = 0.0 \text{ m}$
Gradient of drain	$i = h / L = 0.012 \text{ (1 in 87)}$
Minimum flow velocity	$V_{\text{min}} = 0.750 \text{ m/s}$
Minimum pipe diameter	$D_{\text{min}} = 150 \text{ mm}$
Surface roughness	$k_s = 0.6 \text{ mm}$
Mean hydraulic depth factor	$m = 0.25$
Kinematic viscosity of fluid	$\nu = 1.31 \times 10^{-6} \text{ m}^2/\text{s}$

Using the Chezy equation

Constant	$c = 56$
Diameter of pipe required	$D = ((Q_{\text{design}}^2 \times 16) / (\pi^2 \times m \times c^2 \times i \times 1 \text{ m/s}^2))^{0.2} = 143 \text{ mm}$
Nearest pipe diameter	$D_{\text{chezy}} = 150 \text{ mm}$
Flow velocity using Chezy	$V_{\text{chezy}} = c \times \sqrt{(m \times D_{\text{chezy}} \times i \times 1 \text{ m/s}^2)} = 1.165 \text{ m/s}$

Using the Eschritt equation

Diameter of pipe required	$D = (Q_{\text{design}} \times 1000 \times \sqrt{(1 / i) / 0.00035 \text{ m}^3/\text{s}})^{0.382} \times 1 \text{ mm} = 148 \text{ mm}$
Nearest pipe diameter	$D_{\text{eschritt}} = 150 \text{ mm}$
Flow velocity using Eschritt	$V_{\text{eschritt}} = 26.738 \times (D_{\text{eschritt}} / 1 \text{ mm})^{0.62} \times 1 \text{ m/s} / (\sqrt{(1 / i) \times 60}) = 1.070 \text{ m/s}$

Using the Colebrook-White Equation for pipe running full and partially full

Design pipe diameter	$D_{\text{design}} = \max(D_{\text{chezy}}, D_{\text{eschritt}}, D_{\text{min}}) = 150 \text{ mm}$
Constant	$Z = \sqrt{(2 \times (g_{\text{acc}} / 1 \text{ m/s}^2) \times (D_{\text{design}} / 1000 \text{ mm}) \times i)} = 0.184$
Flow velocity	$V_{\text{full}} = -2 \times Z \times \log((k_s / (3.7 \times D_{\text{design}})) + ((2.51 \times \nu) / (D_{\text{design}} \times Z \times 1 \text{ m/s}))) \times 1 \text{ m/s}$ $V_{\text{full}} = 1.076 \text{ m/s}$
Flow rate running full	$Q_{\text{full}} = V_{\text{full}} \times \pi \times D_{\text{design}}^2 / 4 = 19.0 \times 10^{-3} \text{ m}^3/\text{s}$

PASS - Maximum flow rate is greater than design flow rate

From Hydraulics Research Tables 35 and 36

Depth as proportion of D	$x = 0.787$
Flow velocity at design flow rate	$V_{\text{design}} = 1.221 \text{ m/s}$

PASS - Design velocity is greater than 0.750 m/s

Designer	Job Title HIGH STREET, UXBRIDGE	Job No. 13446
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FOUR RUNS: (WORST CASE RUNS)

1st RUN TO CONSIDER IS.

FWMU - 7 - FWMU-8.

NO OF APARTMENTS

G	2	} 7 No.
1st	2	
2nd	2	
3rd	1	

$$\therefore \alpha = 0.5 \sqrt{(7 \times 6.3)} = \underline{\underline{3.3 L/5}}$$

LENGTH OF RUN = 14.5 m.

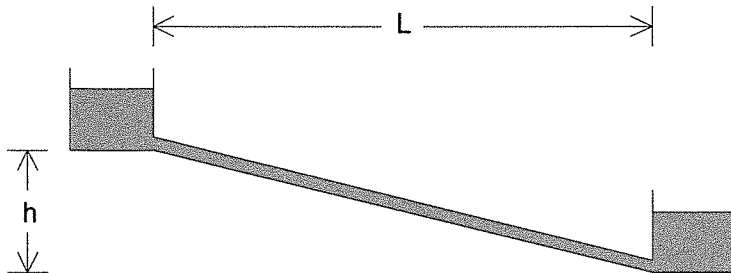
FALL = 210 mm

PIPE DIAMETER = 100 mm
(SEE ATTACHED)

Project 66, High Street, Uxbridge				Job no. 13446	
Calcs for Foul Drain: FWMH-7 to FWMH-8				Start page no./Revision 13	
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DESIGN OF A FOUL SEWER

TEDDS calculation version 1.0.03



Sewer design details

Design flow rate	$Q_{\text{design}} = 3.30 \times 10^{-3} \text{ m}^3/\text{s}$
Length of the sewer	$L = 14.5 \text{ m}$
Fall along length of sewer	$h = 0.2 \text{ m}$
Gradient of sewer	$i = h / L = 0.014 \text{ (1 in 69)}$
Minimum flow velocity	$V_{\text{min}} = 0.750 \text{ m/s}$
Minimum pipe diameter	$D_{\text{min}} = 100 \text{ mm}$
Surface roughness	$k_s = 1.5 \text{ mm}$
Mean hydraulic depth factor	$m = 0.25$
Kinematic viscosity of fluid	$\nu = 1.31 \times 10^{-6} \text{ m}^2/\text{s}$

Using the Chezy equation

Constant	$c = 56$
Diameter of pipe required	$D = ((Q_{\text{design}}^2 \times 16) / (\pi^2 \times m \times c^2 \times i \times 1 \text{ m/s}^2))^{0.2} = 69 \text{ mm}$
Nearest pipe diameter	$D_{\text{chezy}} = 100 \text{ mm}$
Flow velocity using Chezy	$V_{\text{chezy}} = c \times \sqrt{(m \times D_{\text{chezy}} \times i \times 1 \text{ m/s}^2)} = 1.066 \text{ m/s}$

Using the Eschritt equation

Diameter of pipe required	$D = (Q_{\text{design}} \times 1000 \times \sqrt{(1 / i) / 0.00035 \text{ m}^3/\text{s}})^{0.382} \times 1 \text{ mm} = 74 \text{ mm}$
Nearest pipe diameter	$D_{\text{eschritt}} = 100 \text{ mm}$
Flow velocity using Eschritt	$V_{\text{eschritt}} = 26.738 \times (D_{\text{eschritt}} / 1 \text{ mm})^{0.62} \times 1 \text{ m/s} / (\sqrt{(1 / i) \times 60}) = 0.932 \text{ m/s}$

Using the Colebrook-White Equation for pipe running full and partially full

Design pipe diameter	$D_{\text{design}} = \max(D_{\text{chezy}}, D_{\text{eschritt}}, D_{\text{min}}) = 100 \text{ mm}$
Constant	$Z = \sqrt{(2 \times (g_{\text{acc}} / 1 \text{ m/s}^2) \times (D_{\text{design}} / 1000 \text{ mm}) \times i)} = 0.169$
Flow velocity	$V_{\text{full}} = -2 \times Z \times \log((k_s / (3.7 \times D_{\text{design}})) + ((2.51 \times \nu) / (D_{\text{design}} \times Z \times 1 \text{ m/s}))) \times 1 \text{ m/s}$ $V_{\text{full}} = 0.799 \text{ m/s}$

Flow rate running full $Q_{\text{full}} = V_{\text{full}} \times \pi \times D_{\text{design}}^2 / 4 = 6.28 \times 10^{-3} \text{ m}^3/\text{s}$

PASS - Maximum flow rate is greater than design flow rate

From Hydraulics Research Tables 35 and 36

Depth as proportion of D	$x = 0.515$
Flow velocity at design flow rate	$V_{\text{design}} = 0.809 \text{ m/s}$

PASS - Design velocity is greater than 0.750 m/s

 consultancy engineering business environment	 TRAIN AND KEMP ENGINEERING BUSINESS SOLUTIONS 10 Kennington Park Place, London SE11 4AS Tel +44 (0) 20 7582 1276 E-Mail: mail@trainandkemp.co.uk Web: www.trainandkemp.co.uk	 FS 29858
Designer	Job Title HIGH STREET, UXBRIDGE	Job No. 13446
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NEXT CASE

FURROW - 9 TO FURROW - 10.

No OF APARTMENTS

G	4	} 15 No.
1st	4	
2nd	4	
3RD.	3	

$$Q = 0.5 \sqrt{(15 \times 6.3)} = \underline{\underline{4.8 L/S}}$$

LENGTH OF RUN = 7.1M

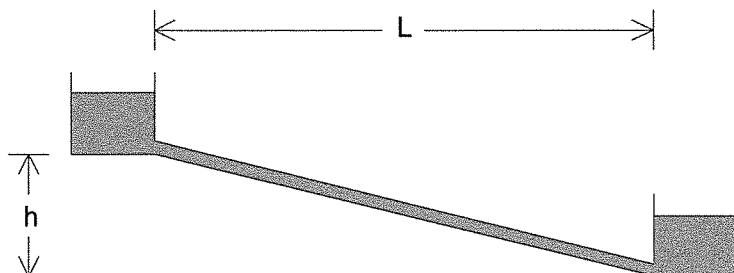
FALL = 100mm.

PIPE DIAMETER = 100mm.
(SEE ATTACHED)

Project 66, High Street, Uxbridge				Job no. 13446	
Calcs for Foul Drain: FWMH-9 to FWMH-10				Start page no./Revision 25	
Calcs by T	Calcs date 10/09/2016	Checked by	Checked date	Approved by	Approved date

DESIGN OF A FOUL SEWER

TEDDS calculation version 1.0.03



Sewer design details

Design flow rate	$Q_{\text{design}} = 4.80 \times 10^{-3} \text{ m}^3/\text{s}$
Length of the sewer	$L = 7.1 \text{ m}$
Fall along length of sewer	$h = 0.1 \text{ m}$
Gradient of sewer	$i = h / L = 0.014 \text{ (1 in 71)}$
Minimum flow velocity	$V_{\text{min}} = 0.750 \text{ m/s}$
Minimum pipe diameter	$D_{\text{min}} = 100 \text{ mm}$
Surface roughness	$k_s = 1.5 \text{ mm}$
Mean hydraulic depth factor	$m = 0.25$
Kinematic viscosity of fluid	$\nu = 1.31 \times 10^{-6} \text{ m}^2/\text{s}$

Using the Chezy equation

Constant	$c = 56$
Diameter of pipe required	$D = ((Q_{\text{design}}^2 \times 16) / (\pi^2 \times m \times c^2 \times i \times 1 \text{ m/s}^2))^{0.2} = 81 \text{ mm}$
Nearest pipe diameter	$D_{\text{chezy}} = 100 \text{ mm}$
Flow velocity using Chezy	$V_{\text{chezy}} = c \times \sqrt{(m \times D_{\text{chezy}} \times i \times 1 \text{ m/s}^2)} = 1.051 \text{ m/s}$

Using the Eschritt equation

Diameter of pipe required	$D = (Q_{\text{design}} \times 1000 \times \sqrt{(1 / i) / 0.00035 \text{ m}^3/\text{s}})^{0.382} \times 1 \text{ mm} = 86 \text{ mm}$
Nearest pipe diameter	$D_{\text{eschritt}} = 100 \text{ mm}$
Flow velocity using Eschritt	$V_{\text{eschritt}} = 26.738 \times (D_{\text{eschritt}} / 1 \text{ mm})^{0.62} \times 1 \text{ m/s} / (\sqrt{(1 / i) \times 60}) = 0.919 \text{ m/s}$

Using the Colebrook-White Equation for pipe running full and partially full

Design pipe diameter	$D_{\text{design}} = \max(D_{\text{chezy}}, D_{\text{eschritt}}, D_{\text{min}}) = 100 \text{ mm}$
Constant	$Z = \sqrt{(2 \times (g_{\text{acc}} / 1 \text{ m/s}^2) \times (D_{\text{design}} / 1000 \text{ mm}) \times i)} = 0.166$
Flow velocity	$V_{\text{full}} = -2 \times Z \times \log((k_s / (3.7 \times D_{\text{design}})) + ((2.51 \times \nu) / (D_{\text{design}} \times Z \times 1 \text{ m/s}))) \times 1 \text{ m/s}$ $V_{\text{full}} = 0.788 \text{ m/s}$
Flow rate running full	$Q_{\text{full}} = V_{\text{full}} \times \pi \times D_{\text{design}}^2 / 4 = 6.19 \times 10^{-3} \text{ m}^3/\text{s}$

PASS - Maximum flow rate is greater than design flow rate

From Hydraulics Research Tables 35 and 36

Depth as proportion of D	$x = 0.663$
Flow velocity at design flow rate	$V_{\text{design}} = 0.869 \text{ m/s}$

PASS - Design velocity is greater than 0.750 m/s

Designer

Job Title

HIGH STREET, UXBRIDGE

Job No.

13-446

Date

SEPT 16

Section

DRAINAGE

Pages No.

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FWMM-1 = 1st BASEMENT:

No. of APARTMENTS.

(1)

GRD	6	}	31 No.
1st	6		
2nd	6		
3rd	5		
4th	2		
5th	2		
6th	2		
7th	2		

$$Q = 0.5 \sqrt{(31 \times 6.3)}$$

$$= \underline{\underline{6.94/5.}}$$

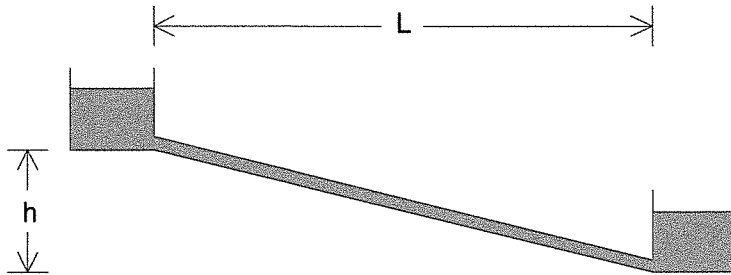
LENGTH OF RUN = 9.6m (FROM BASEMENT WALL).

FAU = 125mm.

Project 66, High Street, Uxbridge				Job no. 13446	
Calcs for Foul Drain: FWMH-10 to Basement				Start page no./Revision 27	
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DESIGN OF A FOUL SEWER

TEDDS calculation version 1.0.03



Sewer design details

Design flow rate	$Q_{\text{design}} = 6.90 \times 10^{-3} \text{ m}^3/\text{s}$
Length of the sewer	$L = 9.6 \text{ m}$
Fall along length of sewer	$h = 125.0 \text{ m}$
Gradient of sewer	$i = h / L = 13.021 \text{ (1 in 0)}$
Minimum flow velocity	$V_{\text{min}} = 0.750 \text{ m/s}$
Minimum pipe diameter	$D_{\text{min}} = 150 \text{ mm}$
Surface roughness	$k_s = 1.5 \text{ mm}$
Mean hydraulic depth factor	$m = 0.25$
Kinematic viscosity of fluid	$\nu = 1.31 \times 10^{-6} \text{ m}^2/\text{s}$

Using the Chezy equation

Constant	$c = 56$
Diameter of pipe required	$D = ((Q_{\text{design}}^2 \times 16) / (\pi^2 \times m \times c^2 \times i \times 1 \text{ m/s}^2))^{0.2} = 24 \text{ mm}$
Nearest pipe diameter	$D_{\text{chezy}} = 150 \text{ mm}$
Flow velocity using Chezy	$V_{\text{chezy}} = c \times \sqrt{(m \times D_{\text{chezy}} \times i \times 1 \text{ m/s}^2)} = 39.131 \text{ m/s}$

Using the Eschritt equation

Diameter of pipe required	$D = (Q_{\text{design}} \times 1000 \times \sqrt{(1 / i) / 0.00035 \text{ m}^3/\text{s}})^{0.382} \times 1 \text{ mm} = 27 \text{ mm}$
Nearest pipe diameter	$D_{\text{eschritt}} = 150 \text{ mm}$
Flow velocity using Eschritt	$V_{\text{eschritt}} = 26.738 \times (D_{\text{eschritt}} / 1 \text{ mm})^{0.62} \times 1 \text{ m/s} / (\sqrt{(1 / i)} \times 60) = 35.931 \text{ m/s}$

Using the Colebrook-White Equation for pipe running full and partially full

Design pipe diameter	$D_{\text{design}} = \max(D_{\text{chezy}}, D_{\text{eschritt}}, D_{\text{min}}) = 150 \text{ mm}$
Constant	$Z = \sqrt{(2 \times (g_{\text{acc}} / 1 \text{ m/s}^2) \times (D_{\text{design}} / 1000 \text{ mm}) \times i)} = 6.189$
Flow velocity	$V_{\text{full}} = -2 \times Z \times \log((k_s / (3.7 \times D_{\text{design}})) + ((2.51 \times \nu) / (D_{\text{design}} \times Z \times 1 \text{ m/s}))) \times 1 \text{ m/s}$ $V_{\text{full}} = 31.784 \text{ m/s}$
Flow rate running full	$Q_{\text{full}} = V_{\text{full}} \times \pi \times D_{\text{design}}^2 / 4 = 562. \times 10^{-3} \text{ m}^3/\text{s}$

PASS - Maximum flow rate is greater than design flow rate

From Hydraulics Research Tables 35 and 36

Depth as proportion of D	$x = 0.078$
Flow velocity at design flow rate	$V_{\text{design}} = 10.730 \text{ m/s}$

PASS - Design velocity is greater than 0.750 m/s

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BASEMENT (RUN ~ 2)

No of APARTMENTS.

GND 8
 1st 8
 2nd 8
 3rd 7
 4th 4
 5th 4
 6th 4
 7th 4

47 No.

$$Q = 0.5 \sqrt{(47 \times 6.3)} \\ = \underline{\underline{8.6 L/S}}$$

LENGTH OF RUN = 4.9m

FALL = 55mm.

15mm

(RUN ~ 3)

$$Q = 0.5 \sqrt{(47 \times 6.3)} \\ = \underline{\underline{8.6 L/S}}$$

LENGTH OF RUN = 5.6m.

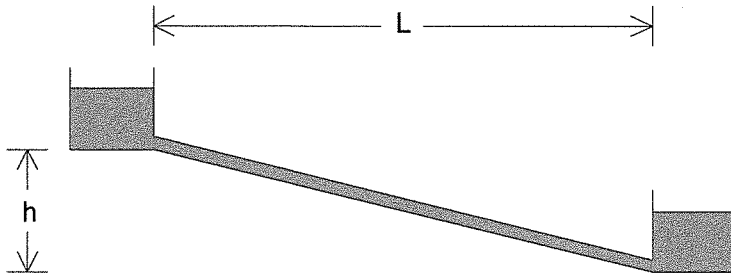
FALL = 72mm.

15mm

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DESIGN OF A FOUL SEWER

TEDDS calculation version 1.0.03



Sewer design details

Design flow rate	$Q_{\text{design}} = 8.60 \times 10^{-3} \text{ m}^3/\text{s}$
Length of the sewer	$L = 4.9 \text{ m}$
Fall along length of sewer	$h = 0.1 \text{ m}$
Gradient of sewer	$i = h / L = 0.011 \text{ (1 in 89)}$
Minimum flow velocity	$V_{\text{min}} = 0.750 \text{ m/s}$
Minimum pipe diameter	$D_{\text{min}} = 150 \text{ mm}$
Surface roughness	$k_s = 1.5 \text{ mm}$
Mean hydraulic depth factor	$m = 0.25$
Kinematic viscosity of fluid	$\nu = 1.31 \times 10^{-6} \text{ m}^2/\text{s}$

Using the Chezy equation

Constant	$c = 56$
Diameter of pipe required	$D = ((Q_{\text{design}}^2 \times 16) / (\pi^2 \times m \times c^2 \times i \times 1 \text{ m/s}^2))^{0.2} = 106 \text{ mm}$
Nearest pipe diameter	$D_{\text{chezy}} = 150 \text{ mm}$
Flow velocity using Chezy	$V_{\text{chezy}} = c \times \sqrt{(m \times D_{\text{chezy}} \times i \times 1 \text{ m/s}^2)} = 1.149 \text{ m/s}$

Using the Eschritt equation

Diameter of pipe required	$D = (Q_{\text{design}} \times 1000 \times \sqrt{(1 / i) / 0.00035 \text{ m}^3/\text{s}})^{0.382} \times 1 \text{ mm} = 112 \text{ mm}$
Nearest pipe diameter	$D_{\text{eschritt}} = 150 \text{ mm}$
Flow velocity using Eschritt	$V_{\text{eschritt}} = 26.738 \times (D_{\text{eschritt}} / 1 \text{ mm})^{0.62} \times 1 \text{ m/s} / (\sqrt{(1 / i) \times 60}) = 1.055 \text{ m/s}$

Using the Colebrook-White Equation for pipe running full and partially full

Design pipe diameter	$D_{\text{design}} = \max(D_{\text{chezy}}, D_{\text{eschritt}}, D_{\text{min}}) = 150 \text{ mm}$
Constant	$Z = \sqrt{(2 \times (g_{\text{acc}} / 1 \text{ m/s}^2) \times (D_{\text{design}} / 1000 \text{ mm}) \times i)} = 0.182$
Flow velocity	$V_{\text{full}} = -2 \times Z \times \log((k_s / (3.7 \times D_{\text{design}})) + ((2.51 \times \nu) / (D_{\text{design}} \times Z \times 1 \text{ m/s}))) \times 1 \text{ m/s}$ $V_{\text{full}} = 0.926 \text{ m/s}$
Flow rate running full	$Q_{\text{full}} = V_{\text{full}} \times \pi \times D_{\text{design}}^2 / 4 = 16.4 \times 10^{-3} \text{ m}^3/\text{s}$

PASS - Maximum flow rate is greater than design flow rate

From Hydraulics Research Tables 35 and 36

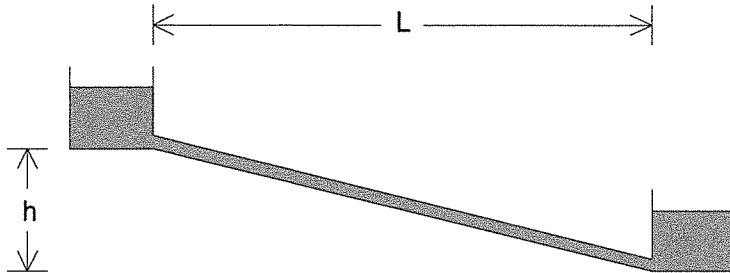
Depth as proportion of D	$x = 0.515$
Flow velocity at design flow rate	$V_{\text{design}} = 0.937 \text{ m/s}$

PASS - Design velocity is greater than 0.750 m/s

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DESIGN OF A FOUL SEWER

TEDDS calculation version 1.0.03



Sewer design details

Design flow rate	$Q_{\text{design}} = 8.60 \times 10^{-3} \text{ m}^3/\text{s}$
Length of the sewer	$L = 5.6 \text{ m}$
Fall along length of sewer	$h = 0.1 \text{ m}$
Gradient of sewer	$i = h / L = 0.013 \text{ (1 in 78)}$
Minimum flow velocity	$V_{\text{min}} = 0.750 \text{ m/s}$
Minimum pipe diameter	$D_{\text{min}} = 150 \text{ mm}$
Surface roughness	$k_s = 1.5 \text{ mm}$
Mean hydraulic depth factor	$m = 0.25$
Kinematic viscosity of fluid	$\nu = 1.31 \times 10^{-6} \text{ m}^2/\text{s}$

Using the Chezy equation

Constant	$c = 56$
Diameter of pipe required	$D = ((Q_{\text{design}}^2 \times 16) / (\pi^2 \times m \times c^2 \times i \times 1 \text{ m/s}^2))^{0.2} = 104 \text{ mm}$
Nearest pipe diameter	$D_{\text{chezy}} = 150 \text{ mm}$
Flow velocity using Chezy	$V_{\text{chezy}} = c \times \sqrt{(m \times D_{\text{chezy}} \times i \times 1 \text{ m/s}^2)} = 1.230 \text{ m/s}$

Using the Eschritt equation

Diameter of pipe required	$D = (Q_{\text{design}} \times 1000 \times \sqrt{(1 / i) / 0.00035 \text{ m}^3/\text{s}})^{0.382} \times 1 \text{ mm} = 109 \text{ mm}$
Nearest pipe diameter	$D_{\text{eschritt}} = 150 \text{ mm}$
Flow velocity using Eschritt	$V_{\text{eschritt}} = 26.738 \times (D_{\text{eschritt}} / 1 \text{ mm})^{0.62} \times 1 \text{ m/s} / (\sqrt{(1 / i) \times 60}) = 1.129 \text{ m/s}$

Using the Colebrook-White Equation for pipe running full and partially full

Design pipe diameter	$D_{\text{design}} = \max(D_{\text{chezy}}, D_{\text{eschritt}}, D_{\text{min}}) = 150 \text{ mm}$
Constant	$Z = \sqrt{(2 \times (g_{\text{acc}} / 1 \text{ m/s}^2) \times (D_{\text{design}} / 1000 \text{ mm}) \times i)} = 0.194$
Flow velocity	$V_{\text{full}} = -2 \times Z \times \log((k_s / (3.7 \times D_{\text{design}})) + ((2.51 \times \nu) / (D_{\text{design}} \times Z \times 1 \text{ m/s}))) \times 1 \text{ m/s}$ $V_{\text{full}} = 0.992 \text{ m/s}$
Flow rate running full	$Q_{\text{full}} = V_{\text{full}} \times \pi \times D_{\text{design}}^2 / 4 = 17.5 \times 10^{-3} \text{ m}^3/\text{s}$

PASS - Maximum flow rate is greater than design flow rate

From Hydraulics Research Tables 35 and 36

Depth as proportion of D	$x = 0.494$
Flow velocity at design flow rate	$V_{\text{design}} = 0.987 \text{ m/s}$

PASS - Design velocity is greater than 0.750 m/s

 consultancy engineering business environment	 TRAIN AND KEMP ENGINEERING BUSINESS SOLUTIONS 10 Kennington Park Place, London SE11 4AS Tel +44 (0) 20 7582 1276 E-Mail: mail@trainandkemp.co.uk Web: www.trainandkemp.co.uk	 FS 29858
Designer	Job Title HIGH STREET, UXBRIDGE	Job No. 13446
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BASEMENT RUN - 1

No OF APARTMENTS

= 65 No.

$$Q = 0.5 \sqrt{(65 \times 6.3)} = \underline{\underline{10.1 \text{ L/S}}}$$

LENGTH = 9.8M

FAU = 104mm

150mm 

BASEMENT RUN - 5. & 6 (COMBINED)

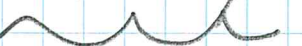
No OF APARTMENTS =

= 90 No.

$$Q = 0.5 \sqrt{(90 \times 6.3)} = \underline{\underline{11.9 \text{ L/S}}}$$

LENGTH = 9.8M

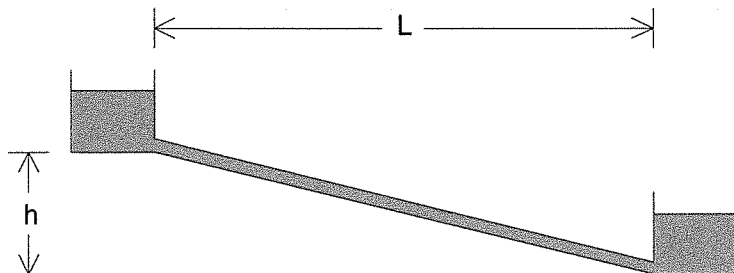
FAU = 127mm.

150mm 

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DESIGN OF A FOUL SEWER

TEDDS calculation version 1.0.03



Sewer design details

Design flow rate	$Q_{\text{design}} = 10.0 \times 10^{-3} \text{ m}^3/\text{s}$
Length of the sewer	$L = 8.0 \text{ m}$
Fall along length of sewer	$h = 0.1 \text{ m}$
Gradient of sewer	$i = h / L = 0.013 \text{ (1 in 77)}$
Minimum flow velocity	$V_{\text{min}} = 0.750 \text{ m/s}$
Minimum pipe diameter	$D_{\text{min}} = 150 \text{ mm}$
Surface roughness	$k_s = 1.5 \text{ mm}$
Mean hydraulic depth factor	$m = 0.25$
Kinematic viscosity of fluid	$\nu = 1.31 \times 10^{-6} \text{ m}^2/\text{s}$

Using the Chezy equation

Constant	$c = 56$
Diameter of pipe required	$D = ((Q_{\text{design}}^2 \times 16) / (\pi^2 \times m \times c^2 \times i \times 1 \text{ m/s}^2))^{0.2} = 110 \text{ mm}$
Nearest pipe diameter	$D_{\text{chezy}} = 150 \text{ mm}$
Flow velocity using Chezy	$V_{\text{chezy}} = c \times \sqrt{(m \times D_{\text{chezy}} \times i \times 1 \text{ m/s}^2)} = 1.236 \text{ m/s}$

Using the Eschritt equation

Diameter of pipe required	$D = (Q_{\text{design}} \times 1000 \times \sqrt{(1 / i) / 0.00035 \text{ m}^3/\text{s}})^{0.382} \times 1 \text{ mm} = 115 \text{ mm}$
Nearest pipe diameter	$D_{\text{eschritt}} = 150 \text{ mm}$
Flow velocity using Eschritt	$V_{\text{eschritt}} = 26.738 \times (D_{\text{eschritt}} / 1 \text{ mm})^{0.62} \times 1 \text{ m/s} / (\sqrt{(1 / i) \times 60}) = 1.135 \text{ m/s}$

Using the Colebrook-White Equation for pipe running full and partially full

Design pipe diameter	$D_{\text{design}} = \max(D_{\text{chezy}}, D_{\text{eschritt}}, D_{\text{min}}) = 150 \text{ mm}$
Constant	$Z = \sqrt{(2 \times (g_{\text{acc}} / 1 \text{ m/s}^2) \times (D_{\text{design}} / 1000 \text{ mm}) \times i)} = 0.196$
Flow velocity	$V_{\text{full}} = -2 \times Z \times \log((k_s / (3.7 \times D_{\text{design}})) + ((2.51 \times \nu) / (D_{\text{design}} \times Z \times 1 \text{ m/s}))) \times 1 \text{ m/s}$ $V_{\text{full}} = 0.998 \text{ m/s}$
Flow rate running full	$Q_{\text{full}} = V_{\text{full}} \times \pi \times D_{\text{design}}^2 / 4 = 17.6 \times 10^{-3} \text{ m}^3/\text{s}$

PASS - Maximum flow rate is greater than design flow rate

From Hydraulics Research Tables 35 and 36

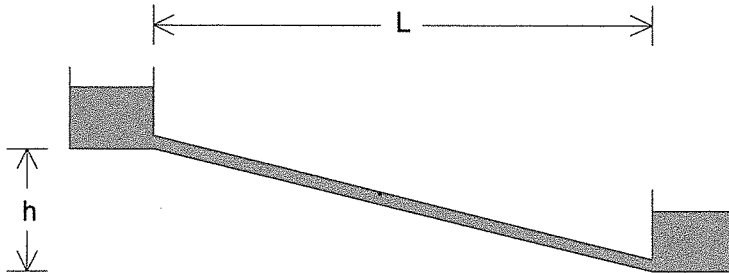
Depth as proportion of D	$x = 0.540$
Flow velocity at design flow rate	$V_{\text{design}} = 1.028 \text{ m/s}$

PASS - Design velocity is greater than 0.750 m/s

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DESIGN OF A FOUL SEWER

TEDDS calculation version 1.0.03



Sewer design details

Design flow rate	$Q_{\text{design}} = 11.9 \times 10^{-3} \text{ m}^3/\text{s}$
Length of the sewer	$L = 9.8 \text{ m}$
Fall along length of sewer	$h = 0.1 \text{ m}$
Gradient of sewer	$i = h / L = 0.013 \text{ (1 in 77)}$
Minimum flow velocity	$V_{\text{min}} = 0.750 \text{ m/s}$
Minimum pipe diameter	$D_{\text{min}} = 150 \text{ mm}$
Surface roughness	$k_s = 1.5 \text{ mm}$
Mean hydraulic depth factor	$m = 0.25$
Kinematic viscosity of fluid	$\nu = 1.31 \times 10^{-6} \text{ m}^2/\text{s}$

Using the Chezy equation

Constant	$c = 56$
Diameter of pipe required	$D = ((Q_{\text{design}}^2 \times 16) / (\pi^2 \times m \times c^2 \times i \times 1 \text{ m/s}^2))^{0.2} = 118 \text{ mm}$
Nearest pipe diameter	$D_{\text{chezy}} = 150 \text{ mm}$
Flow velocity using Chezy	$V_{\text{chezy}} = c \times \sqrt{(m \times D_{\text{chezy}} \times i \times 1 \text{ m/s}^2)} = 1.235 \text{ m/s}$

Using the Eschritt equation

Diameter of pipe required	$D = (Q_{\text{design}} \times 1000 \times \sqrt{(1 / i) / 0.00035 \text{ m}^3/\text{s}})^{0.382} \times 1 \text{ mm} = 123 \text{ mm}$
Nearest pipe diameter	$D_{\text{eschritt}} = 150 \text{ mm}$
Flow velocity using Eschritt	$V_{\text{eschritt}} = 26.738 \times (D_{\text{eschritt}} / 1 \text{ mm})^{0.62} \times 1 \text{ m/s} / (\sqrt{(1 / i) \times 60}) = 1.134 \text{ m/s}$

Using the Colebrook-White Equation for pipe running full and partially full

Design pipe diameter	$D_{\text{design}} = \max(D_{\text{chezy}}, D_{\text{eschritt}}, D_{\text{min}}) = 150 \text{ mm}$
Constant	$Z = \sqrt{(2 \times (g_{\text{acc}} / 1 \text{ m/s}^2) \times (D_{\text{design}} / 1000 \text{ mm}) \times i)} = 0.195$
Flow velocity	$V_{\text{full}} = -2 \times Z \times \log((k_s / (3.7 \times D_{\text{design}})) + ((2.51 \times \nu) / (D_{\text{design}} \times Z \times 1 \text{ m/s}))) \times 1 \text{ m/s}$ $V_{\text{full}} = 0.996 \text{ m/s}$
Flow rate running full	$Q_{\text{full}} = V_{\text{full}} \times \pi \times D_{\text{design}}^2 / 4 = 17.6 \times 10^{-3} \text{ m}^3/\text{s}$

PASS - Maximum flow rate is greater than design flow rate

From Hydraulics Research Tables 35 and 36

Depth as proportion of D	$x = 0.603$
Flow velocity at design flow rate	$V_{\text{design}} = 1.068 \text{ m/s}$

PASS - Design velocity is greater than 0.750 m/s