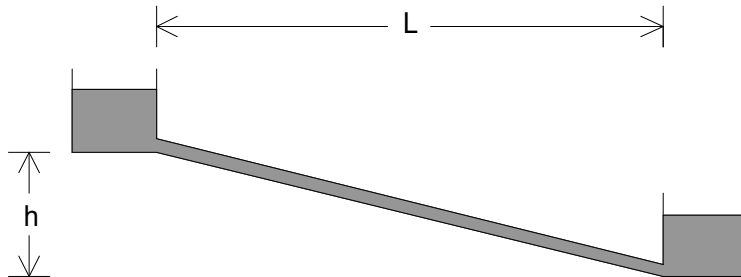


Project 325 Deansgate, Manchester				Job no. 22244	
Calcs for Foul Water Run 1 - 225 mm				Start page no./Revision 1	
Calcs by AC	Calcs date 11/10/2023	Checked by AO	Checked date	Approved by	Approved date

DESIGN OF A FOUL SEWER

TEDDS calculation version 1.0.04



Design pipe flow limited to 0.75 times full depth

Sewer design details

Design flow rate	$Q_{\text{design}} = 34.6 \times 10^{-3} \text{ m}^3/\text{s}$
Length of the sewer	$L = 19.0 \text{ m}$
Fall along length of sewer	$h = 0.237 \text{ m}$
Gradient of sewer	$i = h / L = 0.012 \text{ (1 in 80)}$

(Library item Sewer design details)

Minimum flow velocity	$V_{\text{min}} = 0.750 \text{ m/s}$
Minimum pipe diameter	$D_{\text{min}} = 225 \text{ mm}$
Surface roughness	$k_s = 1.5 \text{ mm}$
Mean hydraulic depth factor	$m = 0.30$
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	$D = ((Q_{\text{design}}^2 \times 16) / (\pi^2 \times m \times c^2 \times i \times 1 \text{ m/s}^2))^{0.2} = 175 \text{ mm}$
Nearest pipe diameter	$D_{\text{chezy}} = 225 \text{ mm}$
Flow velocity using Chezy	$V_{\text{chezy}} = c \times \sqrt{(m \times D_{\text{chezy}} \times i \times 1 \text{ m/s}^2)} = 1.625 \text{ m/s}$

Using the Eschitt equation

Diameter of pipe required	$D = (Q_{\text{design}} \times 1000 \times \sqrt{(1 / i) / 0.00035 \text{ m}^3/\text{s}})^{0.382} \times 1 \text{ mm} = 187 \text{ mm}$
Nearest pipe diameter	$D_{\text{eschitt}} = 225 \text{ mm}$
Flow velocity using Eschitt	$V_{\text{eschitt}} = 26.738 \times (D_{\text{eschitt}} / 1 \text{ mm})^{0.62} \times 1 \text{ m/s} / (\sqrt{(1 / i) \times 60}) = 1.430 \text{ m/s}$

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

Design pipe diameter	$D_{\text{design}} = \max(D_{\text{chezy}}, D_{\text{eschitt}}, D_{\text{min}}) = 225 \text{ mm}$
Constant	$Z = \sqrt{(2 \times (g_{\text{acc}} / 1 \text{ m/s}^2) \times (D_{\text{design}} / 1000 \text{ mm}) \times i)} = 0.235$
Flow velocity	$V_{\text{full}} = -2 \times Z \times \log((k_s / (3.7 \times D_{\text{design}})) + ((2.51 \times \nu) / (D_{\text{design}} \times Z \times 1 \text{ m/s}))) \times 1 \text{ m/s}$ $V_{\text{full}} = 1.281 \text{ m/s}$
Flow rate running full	$Q_{\text{full}} = V_{\text{full}} \times \pi \times D_{\text{design}}^2 / 4 = 50.9 \times 10^{-3} \text{ m}^3/\text{s}$

PASS - Maximum flow rate is greater than design flow rate

From Hydraulics Research Tables 35 and 36

Depth as proportion of D	$x = 0.605$
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PASS - Design pipe flow less than 0.75 times full depth

Flow velocity at design flow rate	$V_{\text{design}} = 1.375 \text{ m/s}$
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PASS - Design velocity is greater than 0.750 m/s