First Semester Examination
2017/2018 Academic Session

January 2018

EAP315 – Wastewater Engineering
(Kejuruteraan Air Sisa)

Duration : 3 hours
(Masa : 3 jam)

Please check that this examination paper consists of TWELVE (12) pages of printed materials including appendix before you begin the examination.

[*Sila pastikan kertas peperiksaan ini mengandungi DUA BELAS (12) muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.*]

Instructions: This paper contains **FIVE (5)** questions. **PART A IS COMPULSORY**. Answer **THREE (3)** question in **PART B.** All question carry the same marks.

***[Arahan**: Kertas ini mengandungi **LIMA (5)** soalan. **BAHAGIAN A WAJIB DIJAWAB.** Jawab **TIGA (3)** soalan daripada **BAHAGIAN B**. Semua soalan membawa jumlah markah yang sama.]*

You may answer the questions either in Bahasa Malaysia or in English.

[*Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.*]

In the event of any discrepancies, the English version shall be used.

[*Sekiranya terdapat percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.*]

PART A: Answer ***All*** questions **(40 marks).**
BAHAGIAN A: *Jawab* ***SEMUA*** *soalan* ***(40 markah).***

1. (a). With the help of a sketch diagram in a house in Malaysia, define domestic wastewater sources and indicate differences in their sewer systems.

Dengan bantuan lakaran di sebuah rumah di Malaysia, definisikan sumber air sisa domestik dan tunjukkan perbezaan antara sistem pembetungannya.

[7 marks/*markah*]

(b). A wastewater from 100 houses flows into 10 m^3 big rectangular equalization tank before being pumped into the treatment plant. Calculate the retention time of this tank in hour at Dry Weather Flow (DWF). Take water consumption rate 225 L/capita.day.

Air sisa dari 100 rumah mengalir ke dalam tangki keseimbangan 10 m^3 sebelum dipam ke loji olahan. Kirakan masa tahanan tangki ini dalam jam pada Kadaralir Cuaca Kering (KCK). Ambil kadar penggunaan air 225 L/kapita.hari.

[6 marks/*markah*]

(c). A rectangular primary sedimentation tank is treating a wastewater from a housing scheme with the following design data:

Surface Loading Rate (SLR) 30 m^3/m^2.day
Length :30 m
Width:10 m

If the water consumption rate is 225 L/capita.day, determine the Population Equivalent (PE) of this wastewater at average flow.

Satu tangki enap primer mengolah air sisa dari satu skim perumahan berdasarkan data reka bentuk berikut:

Kadar Beban Permukaan (KBP) 30 m^3/m^2.hari
Panjang :30 m
Lebar :10 m

Sekiranya kadar penggunaan air adalah 225 L/kapita.hari, tentukan Penduduk Setara air sisa ini pada kadaralir purata.

[7 marks/*markah*]

(d). Sketch a typical process flow diagram for a conventional Activated Sludge Process (ASP).

Lakarkan rajah proses aliran tipikal Proses Enap Cemar Teraktif konvesional (ETK).

[5 marks/*markah*]

(e). Given the concentration of BOD_5 of a wastewater is 200 mg/L and the water usage is 200 L/capita.day. Determine the BOD_5 loading for this wastewater.

Diberi kepekatan BOD_5 air sisa ialah 200 mg/L dan penggunaan air ialah 200 L/capita.day. Tentukan beban BOD_5 untuk air sisa ini.

[5 marks/*markah*]

(f). Define the principal of the self-cleansing velocity in a sewer.

Takrifkan prinsip halaju swabersih dalam pembentung.

[5 marks/*markah*]

(g). Explain the differences between **TWO (2)** main required operating parameters of aerobic and anaerobic process.

*Terangkan perbezaan diantara **DUA (2)** keperluan parameter utama operasi untuk proses aerobik dan anaerobik.*

[5 marks/*markah*]

PART B: Answer **THREE (3)** questions.

BAHAGIAN B: *Jawab* ***TIGA (3)*** *soalan.*

2. (a). Prove that settling velocity for a rectangular sedimentation tank is influenced by width and length of the tank.

Buktikan bahawa halaju enapan tangki enap segiempat tepat dipengaruhi oleh lebar dan panjang tangki.

[7 marks/*markah*]

(b). A rectangular primary sedimentation tank is designed based on the following data:
Housing 100 unit
Weir Loading Rate (WLR) 200 m^3/m.day
Length: Width, 3:1
Width: Depth, 1:1
Water consumption rate 225 L/capita.day

Satu tangki enap primer segiempat tepat direka bentuk berdasarkan data berikut:
Kediaman 100 unit
Kadar Empang Limpah (MLR) 200 m^3/m.hari
Panjang: Lebar, 3:1
Lebar : Dalam, 1:1
Kadar penggunaan air 225 L/kapita.hari

Determine at Q peak:

Tentukan pada Q puncak:

(i). Surface Loading Rate (SLR).

Kadar Beban Permukaan (KBP)

[7 marks/*markah*]

(ii). Horizontal velocity in mm/s

Halaju horizontal dalam mm/s

[6 marks/*markah*]

3. (a). Sketch and define the term 'return activated sludge, Q_R'. Explain its difference in application against an aerated lagoon system.

Lakar dan definisikan 'enap cemar kembali, Q_R'. Terangkan perbezaan aplikasinya berbanding sistem lagun terudara.

[5 marks/*markah*]

(b). Calculate the oxygen requirement in kg/day for an aeration tank of an activated sludge process with the following design data:

BOD_5 : 250 mg/L (65% has been degraded on day 5)
Q2 : 2,000 m^3/day
y : 0.5 mg/mg
k_d : 0.065/day
θ_c : 8 days

Kirakan keperluan oksigen dalam kg/hari untuk satu tangki pengudaraan proses enap cemar teraktif dengan data reka bentuk berikut:

BOD_5 : 250 mg/L (65% telah terurai pada hari ke 5)
Q2 : 2,000 m^3/hari
y : 0.5 mg/mg
k_d : 0.065/hari
θc : 8 hari

[8 marks/*markah*]

(c). An aeration tank in a conventional activated sludge process is having the following design data:
Volume : 1,000 m^3
Organic load : 1,300 kg/day
MLVSS : 2,000 mg/L
MLSS : 35% is inert

Calculate the Food to Microorganism (F: M) ratio of this plant.

Satu tangki pengudaraan proses enap cemar teraktif mempunyai data reka bentuk seperti berikut:
Isipadu : 1,000 m^3
Beban Organik : 1,300 kg/hari
MLVSS : 2,000 mg/L
MLSS : 35% daripadanya lengai

Kirakan nisbah makanan ke mikroorganisma (F: M) loji ini.

[7 marks/*markah*]

4. (a). Describe the important factors that need to be considered before combining non-toxic industrial wastewater and domestic wastewater in one treatment system.

Terangkan faktor-faktor penting yang perlu dipertimbangkan sebelum menggabungkan air sisa industri bukan toksik dan air sisa domestik dalam satu sistem rawatan.

[10 marks/*markah*]

(b). If the maximum allowable flow velocity is 2.5 m/s and Manning wastewater coefficient, n = 0.013, design, the pipe size and slope to carry a flow of 0.16 m^3/s.

Jika halaju aliran maksimum yang dibenarkan adalah 2.5 m/s dan pekali kekasaran Manning, n = 0.013, reka bentukkan, saiz dan cerun paip untuk membawa aliran air sisa 0.16 m^3/s.

[10 marks/*markah*]

5. (a). Explain the relationship between COD influent, SOUR and F/M ratio profile as shown in **Figure 1**.

*Terangkan hubungan antara influen COD, SOUR dan nisbah F/M profil berpandukan **Rajah 1.***

[6 marks/*markah*]

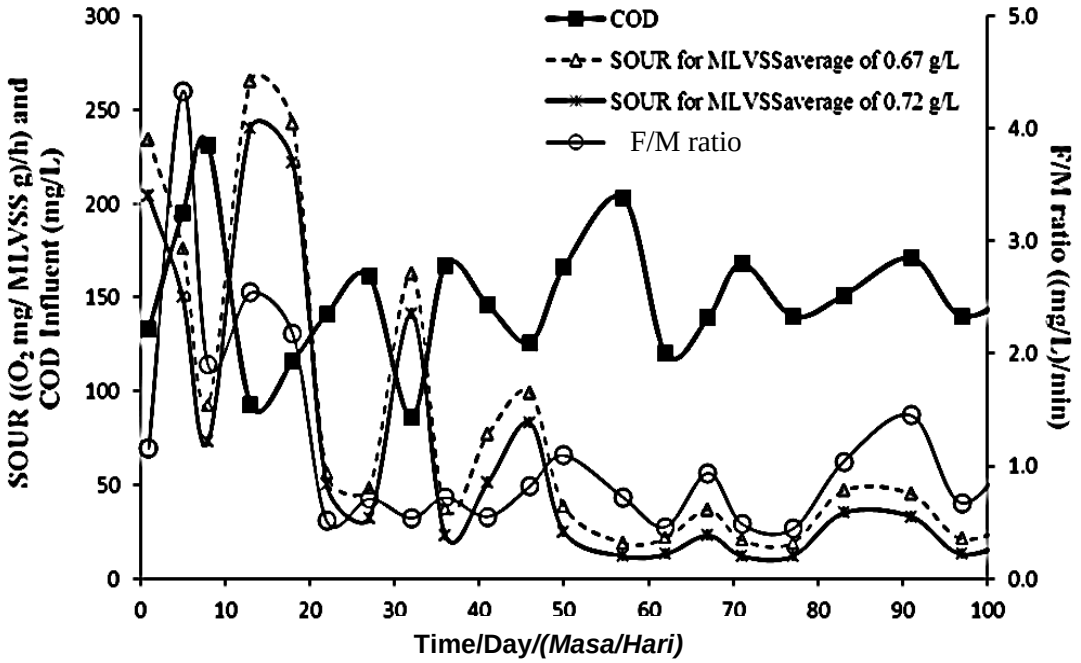

Figure 1:Profile of COD influent, F:M ratio and SOUR at different concentration of MLVSS.

Rajah 1: Profil influen COD, nisbah F:M dan SOUR pada kepekatan MLVSS berbeza

(b). A sample of sewage is diluted by a factor of 4:100 using seeded dilution water. The initial DO of the diluted sample was 7.15 mg/L and the final DO after 5 days was 3.40 mg/L. The corresponding initial and final DO of the seeded dilution water was 7.55 mg/L and 7.45 mg/L, respectively. Calculate the BOD_5 of the wastewater sample.

Sampel air sisa dilarutkan pada faktor 4:100 menggunakan air pencairan. DO awal dalam sampel yang dicairkan ialah 7.15 mg/L dan DO terakhir selepas 5 hari adalah 3.40 mg/L. DO awal dan akhir bagi air pencairan pilihan ialah masing-masing 7.55 mg/L dan 7.45 mg/L. Kirakan BOD_5 sampel air sisa.

[4 marks/*markah*]

(c). One of the sustainable methods for final disposal of treated sludge is through land application. Describe the land application technique and discuss the advantageous of applying treated sludge onto land.

Salah satu kaedah mampan bagi pelupusan enap cemar terawat adalah melalui pengaplikasian tanah. Terangkan teknik pengaplikasian tanah dan bincangkan kelebihan mengaplikasikan enap cemar yang dirawat ke atas tanah.

[10 marks/*markah*]

APPENDIX / *LAMPIRAN*

Peak Factor = $4.7\ p^{-0.11}$ (p in thousand)
Faktor Puncak = $4.7\ p^{-0.11}$ (p dalam ribu)

Retention time =Volume/discharge
Masa tahanan = Isipadu /kadaralir

Population Equivalent = $\frac{\text{Organic load from premises}}{\text{Organic load from 1 person}}$
Penduduk Setara = $\frac{\textit{Beban Organik Premis}}{\textit{Beban Organik 1 orang}}$

Manning: $Q=(1/n)\ (A)\ (R)^{2/3}\ (s)^{1/2}$
Manning

$V=(1/n)\ (R)^{2/3}\ (s)^{1/2}$

$R=A/P$

Width of screen = $\frac{\text{(width of blade + opening)}}{\text{opening}}$ $\frac{\text{(Discharge)}}{\text{(velocity) (depth of wastewater)}}$
Lebar saring = $\frac{\textit{(Lebar bilah + saiz bukaan)}}{\textit{Saiz bukaan}}$ $\frac{\textit{(Kadaralir)}}{\textit{(Halaju) (Kedalaman air sisa)}}$

Pumping cycle = $\frac{\text{Actual volume}}{\text{Dry Weather Flow}} + \frac{\text{Actual volume}}{\text{(Pumping rate-Dry Weather Flow)}}$
Sela pengepaman = $\frac{\textit{Isipadu sebenar}}{\textit{Kadaralir Cuaca Kering}} + \frac{\textit{Isipadu sebenar}}{\textit{(Kadar pam-Kadaralir Cuaca Kering)}}$

Surface Overflow Rate = $\frac{\text{Discharge}}{\text{Surface Area}}$
Kadar Beban Permukaan = $\frac{\textit{Kadaralir}}{\textit{Luas Permukaan}}$

Solids Loading Rate = $\frac{\text{(Discharge) (Mixed Liquor)}}{\text{Surface Area}}$
Kadar Beban Pepejal = $\frac{\textit{(Kadaralir) (Likur Tercampur)}}{\textit{Luas Permukaan}}$

Weir Loading Rate = $\frac{\text{Discharge}}{\text{Length of weir}}$
Kadar Beban Empang Limpah = $\frac{\textit{Kadaralir}}{\textit{Panjang Empang Limpah}}$

Volume of pyramid = (1/3) (base area) (height)
Isipadu Piramid = *(1/3) (luas dasar) (tinggi)*

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Organic Load =(Discharge) (BOD)
Beban Organik =*(Kadaralir) (BOD)*

Area of primary sedimentation tank = $\frac{\text{(Discharge + Returned discharge) (Mixed liquor)}}{\text{Flux}}$

Keluasan Tangki enap primer = $\frac{\textit{(Kadaralir + Kadaralir Pusing Balik) (Likur Tercampur)}}{\textit{Fluks}}$

Solids flux = $\frac{\text{Settling velocity}}{\text{(1/Solids concentration) - (1/Concentration of settled solids)}}$

Fluks Pepejal = $\frac{\textit{Halaju enapan}}{\textit{(1/Kepekatan Pepejal) - (1/Kepekatan Pepejal Terenap)}}$

BOD kinetics $BOD_t=Lo(1-10^{-k1t})$
Kinetik BOD

$k_T=k_{20}(1.047)^{(T-20)}$

$L_T=L_{20}[1+0.02(T-20)]$

Thomas: $(t/BOD)^{1/3} = (kL_o)^{-1/3} + (k^{2/3}/6L_o^{1/3})\ t$
Thomas

Volumetric Organic Loading = $\frac{\text{(Discharge) (BOD)}}{\text{Volume}}$

Beban Organik Isipadu = $\frac{\textit{(Kadaralir) (BOD)}}{\textit{Isipadu}}$

Food: Microorganism = $\frac{\text{(Discharge) (BOD)}}{\text{(Volume) (Mixed liquor)}}$

Makanan: Microorganism = $\frac{\textit{(Kadaralir) (BOD)}}{\textit{(Isipadu) (Likur Tercampur)}}$

Aerial Organic Loading = $\frac{\text{(Discharge) (BOD)}}{\text{Surface area}}$

Beban Organik Kawasan = $\frac{\textit{(Kadaralir) (BOD)}}{\textit{Luas Permukaan}}$

Oxygen requirement = $\frac{Q \times BOD_5}{BOD_5/BOD_L} - 1.42\ Px$
Keperluan Oksigen

Growth of mixed liquor = $\frac{y}{1+kd\theta c}$(Discharge)(BOD)

Pertambahan Likur Tercampur = $\frac{y}{1+kd\theta c}$*(Kadaralir)(BOD)*

Ratio of returned sludge $R=\frac{\text{Returned discharge}}{\text{Discharge}}$

Nisbah enap cemar kembali $R=\frac{\textit{Kadaralir kembali}}{\textit{Kadaralir}}$

$X_a=X_R(R/1+R)$

Oxygen requirement = aLr + bSa
Keperluan oxigen
a = BOD removal coefficient
= Pekali penyingkiran BOD
Lr = BOD removed
= BOD tersingkir
b = endogenous sludge coefficient
= pekali endagenous enap cemar
Sa = Mass of mixed liquor
=Jisim Likur Tercampur

Oxygen supply rate = $\frac{\text{Oksigen required}}{\text{BOD removed}}$

Kadar Bekalan Oksigen = $\frac{\textit{Oksigen Diperlu}}{\textit{BOD tersingkir}}$

Sludge age = $1/\theta=yu-k_d$
Umur enap cemar

$\theta_c = \frac{V.MLSS}{Q_w.SS}$

Sludge Volume Index (SVI) = (Setted MLSSin 30 minutes)/MLSS
Indeks Isipadu Enap cemar (SVI) = (Isipadu MLSS mengenap dalam 30 minit)/MLSS

Tangki Septik, C=225P
Septic tank

Design of oxidation pond:
Reka bentuk kolam pengoksidaan:

$L_e/L_i = 1/(1+k_1t)$
$A = Q/Dk_1\ [L_i/L_e-1]$

$k_T = 0.30\ (1.085)^{T-20}$

Organic Loading = L_iQ/A
Beban Organik = L_iQ/A

Maximum Organic Loading = $7.5\ (1.054)^T$
Beban Organik Maksimum = $7.5\ (1.054)^T$

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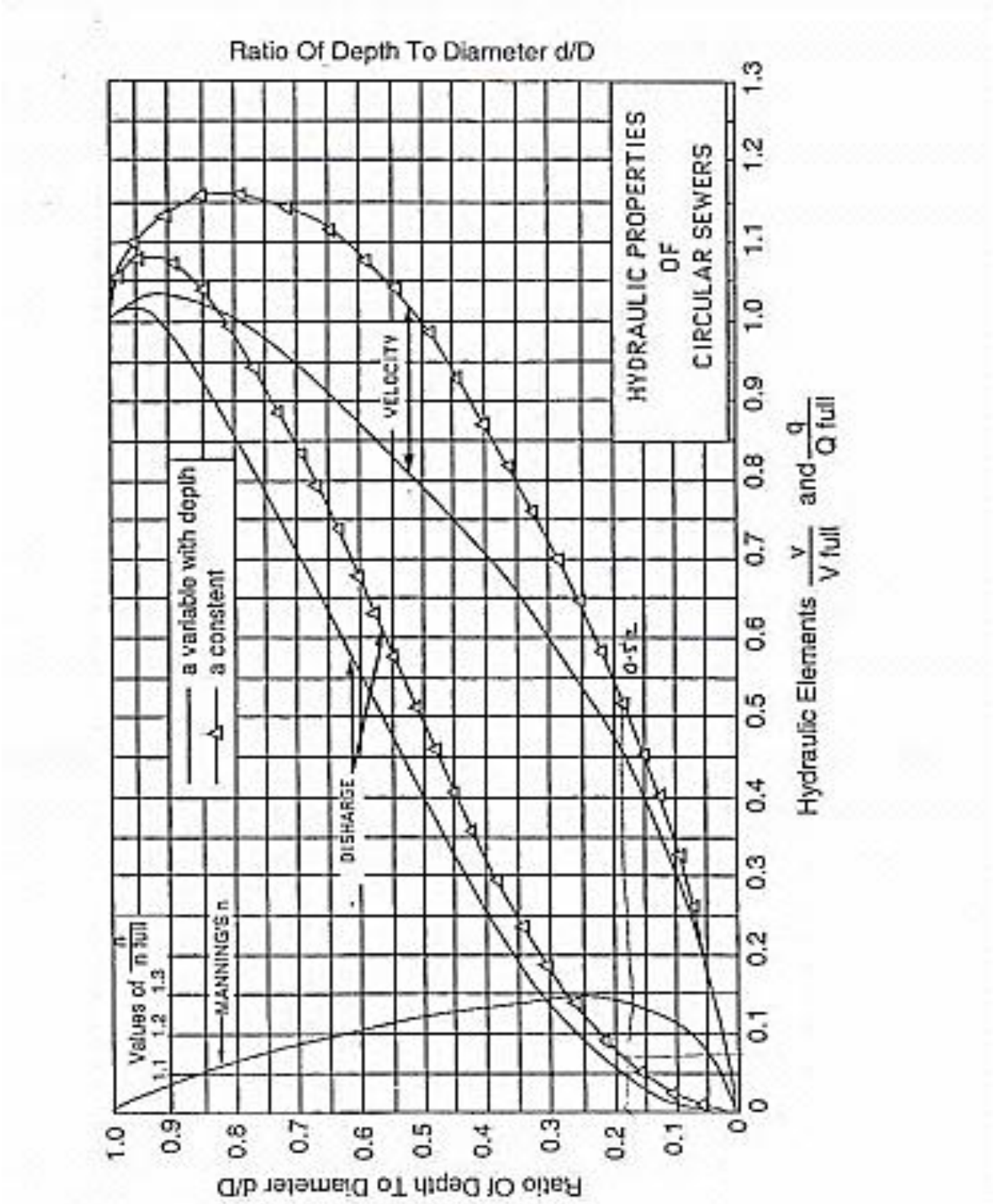
Table B.1 Recommended Population Equivalent Factors

Type of Premise/Establishment	Population Equivalent (recommended)
Residential	5 per house
Commercial (includes offices, shopping complex, entertainment/ recreational centres, restaurants, cafeteria, theaters)	3 per 100 m^2 gross area
Schools/Educational Institutions: – Day schools/institutions – Fully residential – Partial residential	 0.2 per student 1 per student 0.2 per student for non residential student and 1 per student for residential student
Hospitals	4 per bed
Hotels (with dining and laundry facilities)	4 per room
Factories (excluding process water)	0.3 per staff
Market (wet type)	3 per stall
Petrol Kiosks/Service Stations	18 per service bay
Bus Terminal	4 per bus bay
Taxi Terminal	4 per taxi bay
Mosque	0.5 per person
Church/Temple	0.2 per person
Stadium	0.2 per person
Swimming Pool/Sports Complex	0.5 per person
Public Toilet	16 per wc
Type of Premise/Establishment	Population Equivalent (recommended)
Airport	0.2 per passenger 0.3 per employee
Laundry	10 per machine
Prison	1 per person
Golf Course	20 per hole


Ratio Of Depth To Diameter d/D
HYDRAULIC PROPERTIES OF CIRCULAR SEWERS
VELOCITY
DISCHARGE
a variable with depth
a constant
MANNING'S n
Values of n/n full
1.1 1.2 1.3
Hydraulic Elements v/V full and q/Q full
Ratio Of Depth To Diameter d/D
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3
1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1 0

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