



DRAINAGE SYSTEM AND SEWERAGE CALCULATION REPORT

**PROJECT FOR BUILDING A DATA CENTER
CYRUS ONE-MAD01**

Revision 03 – 30/06/2023



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1. INTRODUCTION

The purpose of this project is the construction of a new data center located in 2 Nevero St, Valdelacasa, Alcobendas (Madrid), 28108, Spain. The complex is comprised of two buildings, one used as data center and other used as Front of House (FoH), connected by the goods-lift hall; a gantry, where all pods for LV, Batteries, IDF, etc. are located; a yard, where generators are located; a substation (not within the scope of this project); and the yards and driveways surrounding the buildings/gantry.

The complex will be built in three phases:

Phase 1. The construction of the core and shell of both buildings, the gantry to L1 level, and building's surrounding areas and the installation of all required MEP equipment for the operation of a Data Hall of 9 MW IT Capacity with a double 10 MW supply.

Phase 2. The installation of all required MEP equipment for the operation of additional IT power until the full use of the temporary double 10 MW supply

Phase 3. The installation of all required MEP equipment for the operation the full Data Center (18 MW of IT power)

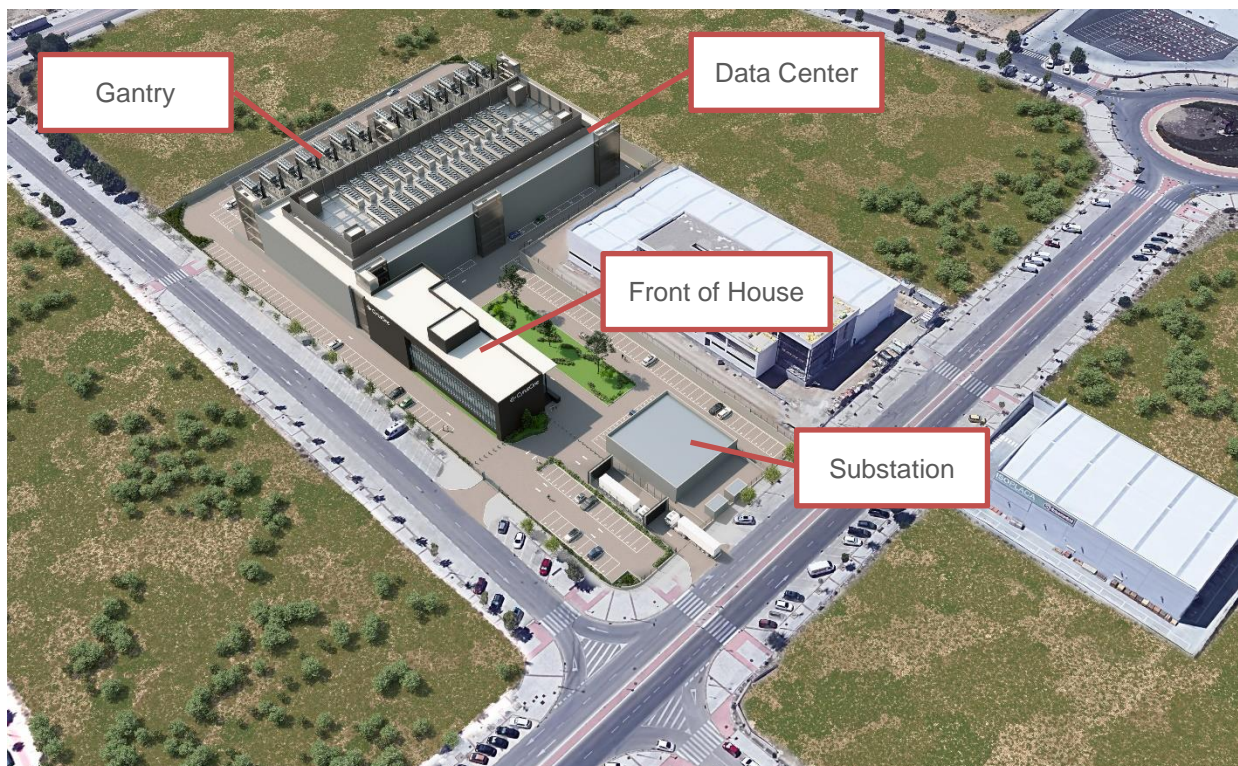


Figure 1 Data Center Zones.

1.1. SCOPE OF THIS REPORT

This report contains the design calculations for the technical design (Riba 4) of the **Sewerage and Drainage Systems** of project phase 1. The sewerage and drainage systems as described in this report comprises the infrastructure that conveys runoff, condensates and foul water.

1.2. DEFINITIONS AND ABBREVIATIONS

The following definitions are used within this report:

Term	Description
GC1	General Contractor 1 responsible for Civil, Structure and Architecture Works
GC2	General Contractor 2 responsible for Mechanical and Electrical Works
Quark	Architectural, Mechanical and Electrical Engineering Design Consultants
The Project	Project for building the MAD01 Data Center for CyrusOne
VA	Mechanical and Electrical Engineering Design Consultants

Table 1 Definitions

The following abbreviations are used within this report:

Abbreviation	Description
BMS	Building Management System
C1	Cyrus One
CE	European Conformity (Marking)
CRAC	Computer/Critical Room Air-Conditioning (Unit)
CRAH	Computer/Critical Room Air-Handling (Unit)
CSA	Civil, Structure and Architecture

Abbreviation	Description
CTE	Spanish Building Regulation (Código Técnico de la Edificación)
DH	Data Hall
DoC	Declaration of Conformity
EN	European Standard
ESP	External Static Pressure
FM	Facility Management or Facility Manager
FoH	Front of House
IP	Internet Protocol
IP	Ingress Protection (Code), according to standard IEC 60529
ISO	Standard from International Organization for Standardization
LL	Landlord
L/min	Liters per minute
M&E	Mechanical and Electrical
PE	Polyethylene
PLC	Programmable Logic Controller
SUDS	Sustainable Urban Drainage System
TCP	Transmission Control Protocol
VA	Venables Associates
UNE	Spanish Standard (Una Norma Española)

Table 2 Abbreviations

2. DESIGN CRITERIA

2.1. CODES, STANDARDS AND GUIDELINES

Please refer to section 2.1 from the Sewerage and Drainage System Description Report (document CYR-MAD01-TD-QUA-XX-XX-RP-M-RAIN-0001).

2.2. FUNCTIONAL AND PERFORMANCE CRITERIA

The design described in this report has been prepared in accordance with the known requirements from CyrusOne regarding sewerage and drainage systems.

3. DESIGN CRITERIA

3.1. DESIGN INPUTS

The following design inputs have been received from CyrusOne and VA:

- In CRAHs corridor in front of each CRAH unit, a floor gully shall be installed.
- In DH, four floor gullies shall be installed per DH lateral side.
- A driptray shall be installed under suspended drains in L1 DH (with a leak detector at the driptray).
- To install a duct so an inflatable pipe plug could be installed in the future to isolate pipes during a fuel leak.

Additionally, the Municipality requires installing a rainwater harvesting tank and a rainwater attenuation tank in compliance with the Alcobenda's Building Bylaw.

4. RUNOFF DRAINAGE CALCULATION

The calculation of the runoff flow rates to be drained has been done by using the following formula (from standard EN 12056-3):

$$Q = r \times C \times A$$

where:

- Q is the rate of flow of water, in L/s
- r is the rainfall intensity, in L/(s·m²)]
- A is the effective area, in m²
- C is a runoff coefficient (taken as 1,0 unless national and local regulations and practice state otherwise), dimensionless.

4.1. RAINFALL INTENSITY

The Spain source of rainfall is available in Building Code (CTE), Requirement DB HS 5. The following map shows rainfall intensity, r, for no given return period.

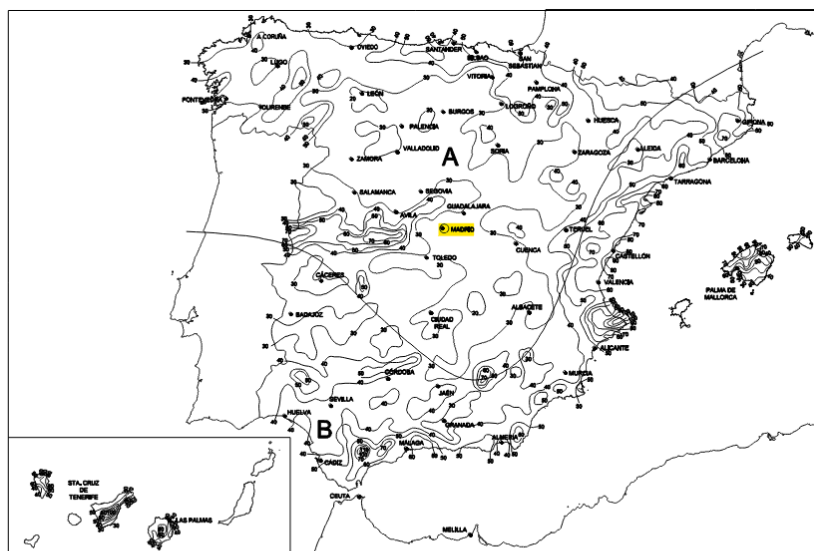


Figura B.1 Mapa de isoyetas y zonas pluviométricas

		Tabla B.1 Intensidad Pluviométrica i (mm/h)											
Isoyeta		10	20	30	40	50	60	70	80	90	100	110	120
Zona A		30	65	90	125	155	180	210	240	275	300	330	365
Zona B		30	50	70	90	110	135	150	170	195	220	240	265

Figure 2 Isohyet map of Spain.

Specifically for Madrid, rainfall intensity is determined as follow:


ESTIMATION OF RAINFALL INTENSITY					
Project:	Cyrus One MAD01				
Code:	21516	Revisión:	01		
Design by:	TCA	Supervised by:	JMA	Date:	Nov-21
				Approved by:	FGA
Estimation according to HS 5 section of Basic Document HS Salubridad from the Spanish Building Code (CTE)					
Town:	Madrid				
Zone:	A				
Isohyet:	30				
Rainfall intensity, r (mm/(h·m²)):	90				
Safety factor, C_s (%):	20.0%				
Design rainfall intensity, r (mm/(h·m²)):	110				

Table 3 Estimation of rainfall intensity.

4.2. RUNOFF COEFFICIENT, C

The rate of flow of rainwater to be drained away from all areas under steady state conditions are calculated according to standard EN 12056-3. The design run-off coefficient is 1.0.

4.3. QUANTITY OF RAINWATER RUNOFF PER AREA

The flow rates of rainwater runoff to be drain per collecting area are shown in the following table.


RAINWATER RUNOFF CALCULATIONS			
Project:	Cyrus One MAD01		
Code:	21516	Revisión:	01
Date:	Nov-21	Design by:	TCA
Supervised by:	JMA	Approved by:	FGA
Design rainfall intensity, r (L/(s·m²)):		0.031	
Summary			
Level	Area m²	Flowrate L/s	
L1	12,560.4	381.43	
R1	5,818.8	180.53	
R2	78.6	2.45	
R3	92.0	2.86	
Total	18,549.8	567.27	

Table 4 Rainwater runoff flow rate per collecting area. Summary

Ref.	Description	Level	Area, A m ²	Composition of the collecting area	Runoff coefficient, C	Flowrate, Q L/s
OF.R3.001	Office. R3 Level. Collecting Area 001	R3	92.0	Roof	1.0	2.86
OF.R2.001	Office. R2 Level. Collecting Area 001	R2	27.5	Roof	1.0	0.86
OF.R2.002	Office. R2 Level. Collecting Area 002	R2	51.1	Roof	1.0	1.59
DC.R1.001	DC. R1 Level. Collecting Area 001	R1	97.0	Roof	1.0	3.01
DC.R1.002	DC. R1 Level. Collecting Area 002	R1	205.6	Roof	1.0	6.38
DC.R1.003	DC. R1 Level. Collecting Area 003	R1	243.4	Roof	1.0	7.55
DC.R1.004	DC. R1 Level. Collecting Area 004	R1	243.4	Roof	1.0	7.55
DC.R1.005	DC. R1 Level. Collecting Area 005	R1	243.4	Roof	1.0	7.55
DC.R1.006	DC. R1 Level. Collecting Area 006	R1	243.4	Roof	1.0	7.55
DC.R1.007	DC. R1 Level. Collecting Area 007	R1	243.4	Roof	1.0	7.55
DC.R1.008	DC. R1 Level. Collecting Area 008	R1	206.9	Roof	1.0	6.42
DC.R1.009	DC. R1 Level. Collecting Area 009	R1	98.6	Roof	1.0	3.06
DC.R1.010	DC. R1 Level. Collecting Area 010	R1	255.2	Roof	1.0	7.91
DC.R1.011	DC. R1 Level. Collecting Area 011	R1	255.2	Roof	1.0	7.91
DC.R1.012	DC. R1 Level. Collecting Area 012	R1	96.5	Roof	1.0	3.00
DC.R1.013	DC. R1 Level. Collecting Area 013	R1	205.3	Roof	1.0	6.37
DC.R1.014	DC. R1 Level. Collecting Area 014	R1	241.8	Roof	1.0	7.50
DC.R1.015	DC. R1 Level. Collecting Area 015	R1	241.8	Roof	1.0	7.50
DC.R1.016	DC. R1 Level. Collecting Area 016	R1	241.8	Roof	1.0	7.50
DC.R1.017	DC. R1 Level. Collecting Area 017	R1	241.8	Roof	1.0	7.50
DC.R1.018	DC. R1 Level. Collecting Area 018	R1	241.8	Roof	1.0	7.50
DC.R1.019	DC. R1 Level. Collecting Area 019	R1	204.0	Roof	1.0	6.33
DC.R1.020	DC. R1 Level. Collecting Area 020	R1	94.5	Roof	1.0	2.93
DC.R1.021	DC. R1 Level. Collecting Area 021	R1	255.0	Roof	1.0	7.91
DC.R1.022	DC. R1 Level. Collecting Area 022	R1	255.0	Roof	1.0	7.91
OF.R1.001	Office. R1 Level. Collecting Area 001	R1	221.4	Roof	1.0	6.87
OF.R1.002	Office. R1 Level. Collecting Area 002	R1	158.1	Roof	1.0	4.91
OF.R1.003	Office. R1 Level. Collecting Area 003	R1	38.8	Roof	1.0	1.21
OF.R1.004	Office. R1 Level. Collecting Area 004	R1	146.9	Roof	1.0	4.56
OF.R1.005	Office. R1 Level. Collecting Area 005	R1	146.9	Roof	1.0	4.56
OF.R1.006	Office. R1 Level. Collecting Area 006	R1	143.3	Roof	1.0	4.45
OF.R1.007	Office. R1 Level. Collecting Area 007	R1	150.8	Roof	1.0	4.68
OF.R1.008	Office. R1 Level. Collecting Area 008	R1	157.9	Roof	1.0	4.90
URL1.001	Plot. L1 Level. Collecting Area 001	L1	216.1	Concrete pavement	1.0	6.70
URL1.002	Plot. L1 Level. Collecting Area 002	L1	250.3	Concrete pavement	1.0	7.77
URL1.003	Plot. L1 Level. Collecting Area 003	L1	323.9	Concrete pavement	1.0	10.05
URL1.004	Plot. L1 Level. Collecting Area 004	L1	273.0	Concrete pavement	1.0	8.47
URL1.005	Plot. L1 Level. Collecting Area 005	L1	141.1	Concrete pavement	1.0	4.38
URL1.006	Plot. L1 Level. Collecting Area 006	L1	273.0	Concrete pavement	1.0	8.47
URL1.007	Plot. L1 Level. Collecting Area 007	L1	1,866.2	Concrete pavement	1.0	57.86
URL1.008	Plot. L1 Level. Collecting Area 008	L1	1,702.1	Concrete pavement	1.0	52.77
URL1.009	Plot. L1 Level. Collecting Area 009	L1	206.0	Concrete pavement	1.0	6.39
URL1.010	Plot. L1 Level. Collecting Area 010	L1	191.6	Concrete pavement	1.0	5.94
URL1.011	Plot. L1 Level. Collecting Area 011	L1	80.8	Concrete pavement	1.0	2.51
URL1.012	Plot. L1 Level. Collecting Area 012	L1	126.7	Concrete pavement	1.0	3.93
URL1.013	Plot. L1 Level. Collecting Area 013	L1	251.0	Concrete pavement	1.0	7.79
URL1.014	Plot. L1 Level. Collecting Area 014	L1	251.7	Concrete pavement	1.0	7.81
URL1.015	Plot. L1 Level. Collecting Area 015	L1	221.3	Concrete pavement	1.0	6.87
URL1.016	Plot. L1 Level. Collecting Area 016	L1	238.3	Concrete pavement	1.0	7.39
URL1.017	Plot. L1 Level. Collecting Area 017	L1	217.4	Concrete pavement	1.0	6.74
URL1.018	Plot. L1 Level. Collecting Area 018	L1	20.3	Parks & gardens	0.4	0.26
URL1.019	Plot. L1 Level. Collecting Area 019	L1	269.7	Concrete pavement	1.0	8.37
URL1.020	Plot. L1 Level. Collecting Area 020	L1	20.0	Parks & gardens	0.4	0.25
URL1.021	Plot. L1 Level. Collecting Area 021	L1	291.4	Concrete pavement	1.0	9.04
URL1.022	Plot. L1 Level. Collecting Area 022	L1	264.1	Concrete pavement	1.0	8.19
URL1.023	Plot. L1 Level. Collecting Area 023	L1	20.8	Parks & gardens	0.4	0.26
URL1.024	Plot. L1 Level. Collecting Area 024	L1	187.7	Concrete pavement	1.0	5.82
URL1.025	Plot. L1 Level. Collecting Area 025	L1	187.7	Concrete pavement	1.0	5.82
URL1.026	Plot. L1 Level. Collecting Area 026	L1	201.9	Concrete pavement	1.0	6.26
URL1.027	Plot. L1 Level. Collecting Area 027	L1	68.1	Parks & gardens	0.4	0.85
URL1.028	Plot. L1 Level. Collecting Area 028	L1	245.3	Concrete pavement	1.0	7.61
URL1.029	Plot. L1 Level. Collecting Area 029	L1	161.6	Concrete pavement	1.0	5.02
URL1.030	Plot. L1 Level. Collecting Area 030	L1	131.8	Concrete pavement	1.0	4.09
URL1.031	Plot. L1 Level. Collecting Area 031	L1	40.6	Parks & gardens	0.4	0.51
URL1.032	Plot. L1 Level. Collecting Area 032	L1	266.1	Concrete pavement	1.0	8.26
URL1.033	Plot. L1 Level. Collecting Area 033	L1	214.9	Parks & gardens	0.4	2.67
URL1.034	Plot. L1 Level. Collecting Area 034	L1	122.9	Concrete pavement	1.0	3.82
URL1.035	Plot. L1 Level. Collecting Area 035	L1	196.3	Concrete pavement	1.0	6.09
URL1.036	Plot. L1 Level. Collecting Area 036	L1	196.3	Concrete pavement	1.0	6.09
URL1.037	Plot. L1 Level. Collecting Area 037	L1	329.2	Concrete pavement	1.0	10.21
URL1.038	Plot. L1 Level. Collecting Area 038	L1	263.1	Concrete pavement	1.0	8.16
URL1.039	Plot. L1 Level. Collecting Area 039	L1	263.1	Concrete pavement	1.0	8.16
URL1.040	Plot. L1 Level. Collecting Area 040	L1	251.5	Concrete pavement	1.0	7.80
URL1.041	Plot. L1 Level. Collecting Area 041	L1	19.9	Parks & gardens	0.4	0.25
URL1.042	Plot. L1 Level. Collecting Area 042	L1	323.8	Concrete pavement	1.0	10.04
URL1.043	Plot. L1 Level. Collecting Area 043	L1	323.8	Concrete pavement	1.0	10.04
URL1.044	Plot. L1 Level. Collecting Area 044	L1	34.4	Parks & gardens	0.4	0.43
SEL1.001	Substation Plot. Collecting Area 001	L1	813.5	Concrete pavement	1.0	25.22

Table 5 Rainwater runoff flow rate per collecting area.

Collecting areas are shown on drawing CYR-MAD01-TD-QUA-00-L1-DR-M-RAIN-1001.

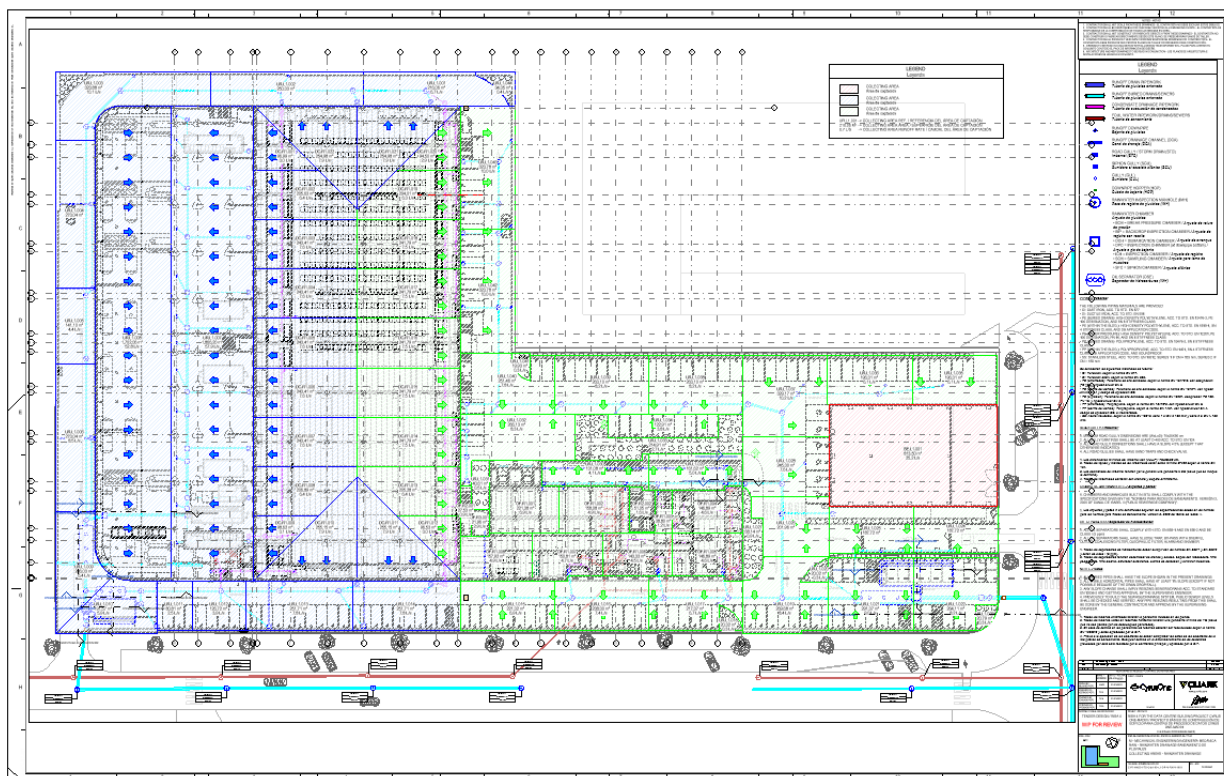


Figure 3 Drawing CYR-MAD01-TD-QUA-00-L1-DR-M-RAIN-1001.

4.4. SIZING OF GUTTERS AND DRAINAGE CHANNELS

Manning formula has been used for sizing gutters and drainage channels:

$$v(h) = \frac{1}{n} \times \left(\frac{A_m(h)}{P_m(h)} \right)^{2/3} \times i^{1/2}$$

$$Q(h) = \frac{1}{n} \times \frac{A_m(h)^{5/3}}{P_m(h)^{2/3}} \times i^{1/2}$$

where:

- $A_m(y)$ is the cross-sectional area of flow, in m^2
- $P_m(y)$ is the wetter perimeter, in m
- n is the Gauckler–Manning coefficient, dimensionless, and taken as 0.013
- i is the slope of the hydraulic grade line, in m/m.
- $V(h)$ is the cross-sectional average velocity, in m/s.



DIMENSIONADO DE LA RED DE EVACUACIÓN DE AGUAS																	
Proyecto:		Cyrus One MAD01															
Código:		21516		Fecha:		Revisión:		01									
Diseñado por:		TCA		Supervisado por:		Aprobado por:											
Cálculos																	
Tipo de sistema		Mixto, Fecales, Pluviales															
Método de cálculo		Caudales Dimensionado tuberías															
Pluviales		EN 12056-3 Manning, Prandtl-Colebrook...															
Fecales		CTE DB HSS															
Colector		Suspendido		70.0%		Llenado		Diámetro mínimo		Pendiente		Material - Norma				Característica	
		Enterrado		70.0%				90		2.0%		PP-EN 1451				Insonorizado	
				30.0%				160		1.6%		PE-EN 13476-3					
Bajante				30.0%				89		N/A		SS-UNE 19049-1				Insonorizado	
Tramo																	
Nodo inicial		Nodo final		Longitud (m)	Ref.	Elemento			Caudales		Unidades de descarga		Colectores / Bajantes		Tubo		
Nº Nodo	Cota (m)	Nº Nodo	Cota (m)			Tipo	Dimensiones (mm)	Elemento, Qo (L/s)	Acumulado, Q (L/s)	Elemento (DU)	Acumulado (DU)	Tipo	Pendiente (%)	Diámetro (mm)	Material - Norma		
R3001	706.72	R2001	702.00	4.72	HOP.01	Cazoleta		1.43	1.43			Bajante		89			
R3002	706.72	R2003	702.00	4.72	SDR.01	Cazoleta		0.66	0.66			Bajante		89			
R3003	706.72	R2004	702.00	4.72	SDR.01	Cazoleta		0.66	0.66			Bajante		89			
R3004	706.72	R2005	702.00	4.72	SDR.01	Cazoleta		0.66	0.66			Bajante		89			
R3005	706.72	R2006	702.00	4.72	SDR.01	Cazoleta		0.66	0.66			Bajante		89			
R2001	702.00	R1001	698.52	3.48	HOP.01	Cazoleta		1.43	2.86			Bajante		89			
R2002	702.00	R1002	698.52	3.48	HOP.01	Cazoleta		1.59	1.59			Bajante		89			
R2003	702.00	R2004	702.00	0.00					0.66			Colector suspendido	2.00%	90			
R2004	702.00	R2005	702.00	0.00					1.32			Colector suspendido	2.00%	90			
R2005	702.00	R1DC1	698.52	3.48					1.98			Colector suspendido	2.00%	90			
R2006	702.00	R1007	698.52	3.48					0.66			Colector suspendido	2.00%	90			
R2007	702.00	R1008	698.52	3.48					0.00			Colector suspendido	2.00%	90			
R2008	702.00	R1DC2	698.52	3.48					0.00			Colector suspendido	2.00%	90			
R1001	698.52	R1X	698.52	0.00					2.86			Colector suspendido	2.00%	90			
R1002	698.52	R1X	698.52	0.00					1.59			Colector suspendido	2.00%	90			
R1003	698.52	L0041	684.30	14.22	DCA01	Canal		4.48	4.48			Bajante	0.30%	89	PP-EN 1451		
R1004	698.52	L0038	684.30	14.22	DCA01	Canal		4.48	4.48			Bajante	0.30%	89	PP-EN 1451		
R1005	698.52	L0037	684.30	14.22	DCA02	Canal		8.75	8.75			Bajante	0.30%	90	PP-EN 1451		
R1006	698.52	L0036	684.30	14.22	DCA02	Canal		8.75	8.75			Bajante	0.30%	90	PP-EN 1451		
R1007	698.52	L0035	684.30	14.22	DCA02	Canal		8.75	9.41			Bajante	0.30%	90	PP-EN 1451		
R1008	698.52	L0045	684.30	14.22	DCA03	Canal		6.20	6.20			Bajante	0.30%	90	PP-EN 1451		
R1009	698.52	L0048	684.30	14.22	DCA03	Canal		6.20	6.20			Bajante	0.30%	89	PP-EN 1451		
R1010	698.52	L0051	684.30	14.22	DCA03	Canal		6.20	6.20			Bajante	0.30%	89	PP-EN 1451		
R1011	698.52	L0054	684.30	14.22	DCA03	Canal		6.20	6.20			Bajante	0.30%	89	PP-EN 1451		
R1012	698.52	R1015	698.52	0.00	DCA04			4.56	4.56			Colector suspendido	2.00%	90			
R1013	698.52	R1016	698.52	0.00	DCA04			4.56	4.56			Colector suspendido	2.00%	90			
R1014	698.52	L0035	684.30	14.22	DCA04			4.56	4.56			Colector suspendido	2.00%	90			
R1015	698.52	L0Y1	684.30	14.22					4.56			Bajante		90	PP-EN 1451		
R1016	698.52	L0Y3	684.30	14.22					4.56			Bajante		90	PP-EN 1451		
R1017	698.52	L0001	684.30	14.22	DCA07	Canal		6.24	6.24			Bajante	0.30%	89			
R1018	698.52	L0004	684.30	14.22	DCA07	Canal		6.24	6.24			Bajante	0.30%	108			
R1019	698.52	L0006	684.30	14.22	DCA07	Canal		6.24	6.24			Bajante	0.30%	108			
R1020	698.52	L0009	684.30	14.22	DCA07	Canal		6.24	6.24			Bajante	0.30%	108			
R1021	698.52	L0011	684.30	14.22	DCA07	Canal		6.24	6.24			Bajante	0.30%	108			
R1022	698.52	L0014	684.30	14.22	DCA07	Canal		6.24	6.24			Bajante	0.30%	108			
R1023	698.52	L0015	684.30	14.22	DCA07	Canal		6.24	6.24			Bajante	0.30%	108			
R1024	698.52	L0016	684.30	14.22	DCA07	Canal		6.24	6.24			Bajante	0.30%	108			
R1025	698.52	L0017	684.30	14.22	DCA07	Canal		6.24	6.24			Bajante	0.30%	108			
R1026	698.52	L0130	684.30	14.22	DCA06	Canal		5.27	5.27			Bajante	0.30%	108			
R1027	698.52	L0132	684.30	14.22	DCA06	Canal		5.27	5.27			Bajante	0.30%	108			
R1028	698.52	L0134	684.30	14.22	DCA06	Canal		5.27	5.27			Bajante	0.30%	108			
R1029	698.52	L0094	684.30	14.22	DCA05	Canal		6.29	6.29			Bajante	0.30%	108			
R1030	698.52	L0097	684.30	14.22	DCA05	Canal		6.29	6.29			Bajante	0.30%	108			
R1031	698.52	L0100	684.30	14.22	DCA05	Canal		6.29	6.29			Bajante	0.30%	108			
R1032	698.52	L0103	684.30	14.22	DCA05	Canal		6.29	6.29			Bajante	0.30%	108			
R1033	698.52	L0106	684.30	14.22	DCA05	Canal		6.29	6.29			Bajante	0.30%	108			
R1034	698.52	L0111	684.30	14.22	DCA05	Canal		6.29	6.29			Bajante	0.30%	108			
R1035	698.52	L0115	684.30	14.22	DCA05	Canal		6.29	6.29			Bajante	0.30%	108			
R1036	698.52	L0119	684.30	14.22	DCA05	Canal		6.29	6.29			Bajante	0.30%	108			
R1037	698.52	L0124	684.30	14.22	DCA05	Canal		6.29	6.29			Bajante	0.30%	108			
R1038	698.52	L0072	684.30	14.22	DCA08	Canal		5.27	5.27			Bajante	0.30%	108			
R1039	698.52	L0075	684.30	14.22	DCA08	Canal		5.27	5.27			Bajante	0.30%	108			
R1040	698.52	L0077	684.30	14.22	DCA08	Canal		5.27	5.27			Bajante	0.30%	108			
L0001	684.30	L0003	684.19	6.98	ICH.03	Arqueta pie de bajante			6.24			Colector enterrado	1.60%	160			
L0002	684.30	L0003	684.07	4.51	STD.01	Imbomal		6.69	6.69			Colector enterrado	5.00%	160			
L0003	684.07	L0005	683.92	9.64	IMH.01	Pozo de registro			12.93			Colector enterrado	1.60%	160			
L0004	684.30	L0005	684.19	6.98	ICH.03	Arqueta pie de bajante			6.24			Colector enterrado	1.60%	160			
L0005	683.92	L0008	683.82	6.48	IMH.01	Pozo de registro			19.17			Colector enterrado	1.60%	200			
L0006	684.30	L0008	684.19	6.98	ICH.03	Arqueta pie de bajante			6.24			Colector enterrado	1.60%	160			
L0007	684.30	L0008	684.17	2.70	STD.01	Imbomal		6.69	6.69			Colector enterrado	5.00%	160			
L0008	683.82	L0010	683.71	6.48	IMH.01	Pozo de registro			32.10			Colector enterrado	1.60%	250			
L0009	684.30	L0010	684.19	6.98	ICH.03	Arqueta pie de bajante			6.24			Colector enterrado	1.60%	160			
L0010	683.71	L0013	683.56	9.64	IMH.01	Pozo de registro			38.33			Colector enterrado	1.60%	250			
L0011	684.30	L0013	684.19	6.98	ICH.03	Arqueta pie de bajante			6.24			Colector enterrado	1.60%	160			
L0012	684.30	L0013	684.19	2.18	STD.01	Imbomal		6.69	6.69			Colector enterrado	5.00%	160			
L0013	683.56	L0019	683.22	21.04	IMH.01	Pozo de registro			51.26			Colector enterrado	1.60%	315			
L0014	684.30	L0015	684.21	5.77	ICH.03	Arqueta pie de bajante			6.24			Colector enterrado	1.60%	160			
L0015	684.21	L0016	684.12	5.77	ICH.03	Arqueta pie de bajante			12.47			Colector enterrado	1.60%	160			
L0016	684.12	L0017	684.02	5.77	ICH.03	Arqueta pie de bajante			18.71			Colector enterrado	1.60%	200			
L0017	684.02	L0019	683.92	6.17	ICH.03	Arqueta pie de bajante			24.95			Colector enterrado	1.60%	250			

Table 7 Pipe sizing (1). Rainwater

DIMENSIONADO DE LA RED DE EVACUACIÓN DE AGUAS																
Proyecto:		Cyrus One MAD01														
Código:		21516		Fecha:		Revisión:		01								
Diseñado por:		TCA		Supervisado por:		Aprobado por:										
Tramo										Colectores / Bajantes		Tubo				
Nodo inicial		Nodo final		Longitud (m)	Ref.	Elemento			Caudales		Unidades de descarga		Tipo	Manning (tabulado)		Material - Norma
Nº Nodo	Cota (m)	Nº Nodo	Cota (m)			Tipo	Dimensiones (mm)	Elemento, Qo (L/s)	Acumulado, Q (L/s)	Elemento (DU)	Acumulado (DU)	Pendiente (%)		Diámetro (mm)		
L0018	684.30	L0019	684.30	0.00	STD.01	Imbomal		7.93	7.93			Colector enterrado	5.00%	160		
L0019	683.22	L0021	683.22	0.00	IMH.01	Pozo de registro			84.14			Colector enterrado	1.60%	400		
L0020	684.30	L0021	684.30	0.00	STD.01	Imbomal		7.93	7.93			Colector enterrado	5.00%	160		
L0021	683.22	L0023	683.22	0.00	IMH.01	Pozo de registro			92.06			Colector enterrado	1.60%	400		
L0022	684.30	L0023	684.30	0.00	STD.01	Imbomal		7.93	7.93			Colector enterrado	5.00%	160		
L0023	683.22	L0025	683.22	0.00	IMH.01	Pozo de registro			99.99			Colector enterrado	1.60%	400		
L0024	684.30	L0025	684.30	0.00	STD.01	Imbomal		7.93	7.93			Colector enterrado	5.00%	160		
L0025	683.22	L0027	683.22	0.00	IMH.01	Pozo de registro			107.91			Colector enterrado	1.60%	400		
L0026	684.30	L0027	684.30	0.00	STD.01	Imbomal		7.93	7.93			Colector enterrado	5.00%	160		
L0027	683.22	L0033	683.22	0.00	IMH.01	Pozo de registro			115.84			Colector enterrado	1.60%	400		
L0028	684.30	L0030	684.30	0.00	STD.01	Imbomal		6.10	6.10			Colector enterrado	5.00%	160		
L0029	684.30	L0030	684.30	0.00	STD.01	Imbomal		6.10	6.10			Colector enterrado	5.00%	160		
L0030	684.30	L0032	684.30	0.00	IMH.01	Pozo de registro			12.20			Colector enterrado	1.60%	160		
L0031	684.30	L0032	684.30	0.00	STD.01	Imbomal		10.20	10.20			Colector enterrado	5.00%	160		
L0032	684.30	L0033	684.30	0.00	IMH.01	Pozo de registro			22.40			Colector enterrado	1.60%	200		
L0033	683.22	L0042	683.22	0.00	IMH.01	Pozo de registro			138.24			Colector enterrado	1.60%	400		
L0034	684.30	L0042	684.30	0.00	STD.01	Imbomal		7.61	7.61			Colector enterrado	5.00%	160		
L0035	684.30	L0036	684.30	0.00	ICH.03	Arqueta pie de bajante			13.97			Colector enterrado	1.60%	200		
L0036	684.30	L0037	684.30	0.00	ICH.03	Arqueta pie de bajante			22.72			Colector enterrado	1.60%	200		
L0037	684.30	L0038	684.30	0.00	ICH.03	Arqueta pie de bajante			31.47			Colector enterrado	1.60%	250		
L0038	684.30	L0040	684.30	0.00	ICH.03	Arqueta pie de bajante			35.94			Colector enterrado	1.60%	250		
L0039	684.30	L0040	684.30	0.00	DCA.09	Canal		9.11	9.11			Colector enterrado	1.60%	160		
L0040	684.30	L0041	684.30	0.00	BPC.01	Arqueta con resalto			35.94			Colector enterrado	1.60%	250		
L0041	684.30	L0042	684.30	0.00	ICH.03	Arqueta pie de bajante			40.42			Colector enterrado	1.60%	250		
L0042	683.22	L0044	683.22	0.00	IMH.01	Pozo de registro			186.27			Colector enterrado	1.60%	500		
L0043	684.30	L0044	684.30	0.00	IMH.01	Pozo de registro		25.22	25.22			Colector enterrado	1.60%	250		
L0044	683.22	L0058	683.22	0.00	IMH.01	Pozo de registro			211.49			Colector enterrado	1.60%	500		
L0045	684.30	L0047	684.30	0.00	ICH.03	Arqueta pie de bajante			6.20			Colector enterrado	1.60%	160		
L0046	684.30	L0047	684.30	0.00	STD.01	Imbomal		5.32	5.32			Colector enterrado	5.00%	160		
L0047	684.30	L0050	684.30	0.00	IMH.01	Pozo de registro			11.51			Colector enterrado	1.60%	160		
L0048	684.30	L0050	684.30	0.00	ICH.03	Arqueta pie de bajante			6.20			Colector enterrado	1.60%	160		
L0049	684.30	L0050	684.30	0.00	STD.01	Imbomal		5.32	5.32			Colector enterrado	5.00%	160		
L0050	684.30	L0053	684.30	0.00	IMH.01	Pozo de registro			23.02			Colector enterrado	1.60%	200		
L0051	684.30	L0053	684.30	0.00	ICH.03	Arqueta pie de bajante			6.20			Colector enterrado	1.60%	160		
L0052	684.30	L0053	684.30	0.00	STD.01	Imbomal		5.32	5.32			Colector enterrado	5.00%	160		
L0053	684.30	L0056	684.30	0.00	IMH.01	Pozo de registro			34.54			Colector enterrado	1.60%	250		
L0054	684.30	L0056	684.30	0.00	ICH.03	Arqueta pie de bajante			6.20			Colector enterrado	1.60%	160		
L0055	684.30	L0056	684.30	0.00	STD.01	Imbomal		5.32	5.32			Colector enterrado	5.00%	160		
L0056	684.30	L0058	684.30	0.00	IMH.01	Pozo de registro			46.05			Colector enterrado	1.60%	315		
L0057	684.30	L0058	684.30	0.00	STD.01	Imbomal		4.74	4.74			Colector enterrado	5.00%	160		
L0058	683.22	L0065	683.22	0.00	IMH.01	Pozo de registro			262.27			Colector enterrado	1.60%	500		
L0059	684.30	L0065	684.30	0.00	STD.01	Imbomal		4.74	4.74			Colector enterrado	5.00%	160		
L0060	684.30	L0061	684.30	0.00	STD.01	Imbomal		5.82	5.82			Colector enterrado	1.00%	160		
L0061	684.30	L0062	684.30	0.00	STD.01	Imbomal		5.82	11.64			Colector enterrado	5.00%	160		
L0062	684.30	L0065	684.30	0.00	IMH.01	Pozo de registro			11.64			Colector enterrado	1.60%	160		
L0063	684.30	L0064	684.30	0.00	STD.01	Imbomal		8.75	8.75			Colector enterrado	5.00%	160		
L0064	684.30	L0065	684.30	0.00	STD.01	Imbomal		8.75	17.49			Colector enterrado	5.00%	160		
L0065	683.22	L0066	683.22	0.00	IMH.01	Pozo de registro			296.13			Colector enterrado	1.60%	630		
L0066	683.22	L0067	683.22	0.00	OSE.01	Separador de hidrocarburos			296.13			Colector enterrado	1.60%	630		
L0067	683.22	L0068	683.22	0.00	SWT.01	Tanque de tormentas			296.13			Colector enterrado	1.60%	630		
L0068	683.22	L0069	683.22	0.00	SCH.01	Arqueta para toma de muestras			296.13			Colector enterrado	1.60%	630		
L0069	683.22	L0070	683.22	0.00	DCH.01	Arqueta de arranque			296.13			Colector enterrado	1.60%	630		
L0070	683.22	L0071	683.22	0.00	IMH.01	Pozo de registro			296.13			Colector enterrado	1.60%	630		
L0071	683.22	L0P_123	683.22	0.00	IMH.01	Pozo de registro			296.13			Colector enterrado	1.60%	630		
L0072	684.30	L0074	684.30	0.00	ICH.03	Arqueta pie de bajante			5.27			Colector enterrado	1.60%	160		
L0073	684.30	L0074	684.30	0.00	STD.01	Imbomal		6.70	6.70			Colector enterrado	5.00%	160		
L0074	684.30	L0076	684.30	0.00	IMH.01	Pozo de registro			11.97			Colector enterrado	1.60%	160		
L0075	684.30	L0076	684.30	0.00	ICH.03	Arqueta pie de bajante			5.27			Colector enterrado	1.60%	160		
L0076	684.30	L0079	684.30	0.00	IMH.01	Pozo de registro			17.25			Colector enterrado	1.60%	200		
L0077	684.30	L0079	684.30	0.00	ICH.03	Arqueta pie de bajante			5.27			Colector enterrado	1.60%	160		
L0078	684.30	L0079	684.30	0.00	STD.01	Imbomal		7.77	7.77			Colector enterrado	5.00%	160		
L0079	684.30	L0081	684.30	0.00	IMH.01	Pozo de registro			30.29			Colector enterrado	1.60%	250		
L0080	684.30	L0081	684.30	0.00	STD.01	Imbomal		5.03	5.03			Colector enterrado	5.00%	160		
L0081	684.30	L0083	684.30	0.00	IMH.01	Pozo de registro			35.32			Colector enterrado	1.60%	250		
L0082	684.30	L0083	684.30	0.00	STD.01	Imbomal		5.03	5.03			Colector enterrado	5.00%	160		
L0083	684.30	L0086	684.30	0.00	IMH.01	Pozo de registro			40.34			Colector enterrado	1.60%	250		
L0084	684.30	L0085	684.30	0.00	DCA.10	Canal		4.24	4.24			Colector enterrado	7.90%	160		
L0085	684.30	L0086	684.30	0.00	DCA.11	Canal		8.62	12.85			Colector enterrado	0.30%	250		
L0086	684.30	L0087	684.30	0.00	IMH.01	Pozo de registro			53.19			Colector enterrado	1.60%	315		
L0087	684.30	L0128	684.30	0.00	IMH.01	Pozo de registro			53.19			Colector enterrado	1.60%	315		
L0088	684.30	L0089	684.30	0.00	DCA.12	Canal		4.24	4.24			Colector enterrado	0.30%	160		
L0089	684.30	L0128	684.30	0.00	DCA.12	Canal		4.24	8.47			Colector enterrado	0.30%	200		
L0090	684.30			0.00	IMH.01	Pozo de registro			0.00			Colector enterrado	1.60%	160		
L0091	684.30	L0092	684.30	0.00	STD.01	Imbomal		9.22	9.22			Colector enterrado	5.00%	160		
L0092	684.30	L0095	684.30	0.00	ICH.03	Arqueta de registro			9.22			Colector enterrado	1.60%	160		
L0093	684.30	L0095	684.30	0.00	STD.01	Imbomal		9.22	9.22			Colector enterrado	5.00%	160		
L0094	684.30	L0095	684.30	0.00	ICH.03	Arqueta pie de bajante			6.29			Colector enterrado	1.60%	160		
L0095	684.30	L0098	684.30	0.00	ICH.04	Arqueta de registro			24.73			Colector enterrado	1.60%	250		
L0096	684.30	L0098	684.30	0.00	STD.01	Imbomal		9.22	9.22			Colector enterrado	5.00%	160		
L0097	684.30	L0098	684.30	0.00	ICH.03	Arqueta pie de bajante			6.29			Colector enterrado	1.60%	160		
L0098	684.30	L0101	684.30	0.00	ICH.04	Arqueta de registro			40.24							


DIMENSIONADO DE LA RED DE EVACUACIÓN DE AGUAS															
Proyecto:		Cyrus One MAD01													
Código:		21516		Fecha:		Revisión:		01							
Diseñado por:		TCA		Supervisado por:		Aprobado por:									
Tramo										Colectores / Bajantes		Tubo			
Nodo inicial		Nodo final		Longitud	Ref.	Elemento		Caudales		Unidades de descarga		Tipo	Manning (tabulado)		Material - Norma
Nº Nodo	Cota	Nº Nodo	Cota					Elemento, Qo	Acumulado, Q	Elemento	Acumulado		Pendiente	Díámetro	
L0100	684.30	L0101	684.30	0.00	ICH.03	Arqueta pie de bajante		6.29				Colector enterrado	1.60%	160	
L0101	684.30	L0104	684.30	0.00	ICH.05	Arqueta de registro		55.75				Colector enterrado	1.60%	315	
L0102	684.30	L0104	684.30	0.00	STD.01	Imbomal		9.22	9.22			Colector enterrado	5.00%	160	
L0103	684.30	L0104	684.30	0.00	ICH.03	Arqueta pie de bajante		6.29				Colector enterrado	1.60%	160	
L0104	684.30	L0107	684.30	0.00	ICH.05	Arqueta de registro		71.26				Colector enterrado	1.60%	315	
L0105	684.30	L0107	684.30	0.00	STD.01	Imbomal		9.22	9.22			Colector enterrado	5.00%	160	
L0106	684.30	L0107	684.30	0.00	ICH.03	Arqueta pie de bajante		6.29				Colector enterrado	1.60%	160	
L0107	684.30	L0109	684.30	0.00	ICH.07	Arqueta de registro		86.77				Colector enterrado	1.60%	400	
L0108	684.30	L0109	684.30	0.00	STD.01	Imbomal		9.22	9.22			Colector enterrado	5.00%	160	
L0109	684.30	L0112	684.30	0.00	ICH.07	Arqueta de registro		95.99				Colector enterrado	1.60%	400	
L0110	684.30	L0112	684.30	0.00	STD.01	Imbomal		9.22	9.22			Colector enterrado	5.00%	160	
L0111	684.30	L0112	684.30	0.00	ICH.03	Arqueta pie de bajante		6.29				Colector enterrado	1.60%	160	
L0112	684.30	L0114	684.30	0.00	ICH.07	Arqueta de registro		111.50				Colector enterrado	1.60%	400	
L0113	684.30	L0114	684.30	0.00	STD.01	Imbomal		9.22	9.22			Colector enterrado	5.00%	160	
L0114	684.30	L0116	684.30	0.00	ICH.07	Arqueta de registro		120.72				Colector enterrado	1.60%	400	
L0115	684.30	L0116	684.30	0.00	ICH.03	Arqueta pie de bajante		6.29				Colector enterrado	1.60%	160	
L0116	684.30	L0118	684.30	0.00	ICH.07	Arqueta de registro		127.01				Colector enterrado	1.60%	400	
L0117	684.30	L0118	684.30	0.00	STD.01	Imbomal		9.22	9.22			Colector enterrado	5.00%	160	
L0118	684.30	L0120	684.30	0.00	ICH.07	Arqueta de registro		136.23				Colector enterrado	1.60%	400	
L0119	684.30	L0120	684.30	0.00	ICH.03	Arqueta pie de bajante		6.29				Colector enterrado	1.60%	160	
L0120	684.30	L0122	684.30	0.00	ICH.07	Arqueta de registro		142.52				Colector enterrado	1.60%	400	
L0121	684.30	L0122	684.30	0.00	STD.01	Imbomal		9.22	9.22			Colector enterrado	5.00%	160	
L0122	684.30	L0126	684.30	0.00	ICH.09	Arqueta de registro		151.74				Colector enterrado	1.60%	500	
L0123	684.30	L0125	684.30	0.00	STD.01	Imbomal		9.22	9.22			Colector enterrado	5.00%	160	
L0124	684.30	L0125	684.30	0.00	ICH.03	Arqueta pie de bajante		6.29				Colector enterrado	1.60%	160	
L0125	684.30	L0126	684.30	0.00	ICH.07	Arqueta de registro		15.51				Colector enterrado	1.60%	200	
L0126	684.30	L0127	684.30	0.00	ICH.09	Arqueta de registro		167.25				Colector enterrado	1.60%	500	
L0127	684.30	L0128	684.30	0.00	BPC.02	Arqueta con resalto		167.25				Colector enterrado	1.60%	500	
L0128	684.30	L0129	684.30	0.00	IMH.01	Pozo de registro		228.91				Colector enterrado	1.60%	500	
L0129	684.30	L0145	684.30	0.00	OSE.02	Separador de hidrocarburos		228.91				Colector enterrado	1.60%	500	
L0130	684.30	L0133	684.30	0.00	ICH.03	Arqueta pie de bajante		5.27				Colector enterrado	1.60%	160	
L0131	684.30	L0133	684.30	0.00	DCA.13	Canal		7.81	7.81			Colector enterrado	0.30%	200	
L0132	684.30	L0133	684.30	0.00	ICH.03	Arqueta pie de bajante		5.27				Colector enterrado	1.60%	160	
L0133	684.30	L0135	684.30	0.00	IMH.01	Pozo de registro		18.36				Colector enterrado	10.70%	200	
L0134	684.30	L0135	684.30	0.00	ICH.03	Arqueta pie de bajante		5.27				Colector enterrado	1.60%	160	
L0135	684.30	L0139	684.30	0.00	IMH.01	Pozo de registro		23.63				Colector enterrado	7.00%	200	
L0136	684.30	L0138	684.30	0.00	DCA.13	Canal		7.79	7.79			Colector enterrado	0.30%	200	
L0137	684.30	L0138	684.30	0.00	STD.01	Imbomal		3.93	3.93			Colector enterrado	5.00%	160	
L0138	684.30	L0139	684.30	0.00	ICH.03	Arqueta de registro		11.72				Colector enterrado	1.60%	200	
L0139	684.30	L0143	684.30	0.00	IMH.01	Pozo de registro		35.35				Colector enterrado	1.60%	250	
L0140	684.30	L0142	684.30	0.00	STD.01	Imbomal		12.33	12.33			Colector enterrado	5.00%	160	
L0141	684.30	L0142	684.30	0.00	DCA.14	Canal		2.51	2.51			Colector enterrado	0.30%	160	
L0142	684.30	L0143	684.30	0.00	IMH.01	Pozo de registro		14.84				Colector enterrado	1.60%	200	
L0143	684.30	L0144	684.30	0.00	IMH.01	Pozo de registro		50.19				Colector enterrado	1.60%	315	
L0144	684.30	L0145	684.30	0.00	OSE.03	Separador de hidrocarburos		50.19				Colector enterrado	1.60%	315	
L0145	684.30	L0146	684.30	0.00	IMH.01	Pozo de registro		279.10				Colector enterrado	1.75%	500	
L0146	684.30	L0147	684.30	0.00	SWT.02	Tanque de tormentas		279.10				Colector enterrado	1.75%	500	
L0147	684.30	L0148	684.30	0.00	SCH.02	Arqueta para toma de muestras		279.10				Colector enterrado	1.75%	500	
L0148	684.30	L0149	684.30	0.00	DCH.01	Arqueta de arranque		279.10				Colector enterrado	1.75%	500	
L0149	684.30	L0P. 94	684.30	0.00	P.44NM-94	Pozo de registro		279.10				Colector enterrado	1.75%	500	

Table 9 Pipe Sizing (3). Rainwater

4.6. OIL SEPARATOR SIZING

All rainwater shall pass through an oil separator as required for BREEAM.

Oil separator is sizing according to standard EN 858-2 Separator systems for light liquids (e.g. oil and petrol) - Part 2: Selection of nominal size, installation, operation and maintenance.

According to standard EN 858-2, the size of the separator shall be calculated from the following formula:

$$NS = (Q_r + f_x \times Q_s) \times f_d$$

where:

- NS is the nominal size of the separator;
- Q_r is the maximum flow rate of rainwater, in L/s;
- Q_s is the maximum flow rate of wastewater, in L/s;
- f_d is the density factor for the relevant light liquid;
- f_x is the impediment factor depending on the nature of the discharge.

The following table shows light liquid separator sizes:

LIGHT LIQUID SEPARATOR SIZING					
Project:	CyrusOne	Revision:	01	Date:	Dec-21
Code:	21530	Supervised by:	JMA	Approved by:	SAL
Design by:	TCA				
0					
Reference	OSE.001	OSE.002	OSE.003		
Zone	Green Zone	Blue Zone A	Blue Zone B		
Discharge type, acc. to section 4.1 from EN 858-2	b	b	b		
Light liquid type acc. to table A.1 from EN 858-2	Diesel fuel, diesel oil	Diesel fuel, diesel oil	Diesel fuel, diesel oil		
Density of the light liquid acc. to table A.1 from EN 858-2	0.85	0.85	0.85		
Density of the light liquid acc. to other sources	0.85	0.85	0.85		
Density factor, f _x , acc. to table A.1 from EN 858-2	1.0	1.0	1.0		
Density factor, f _d , acc. to table 3 from EN 858-2	1.0	1.0	1.0		
CONFIGURATION OF SEPARATOR SYSTEM ACC. TO TABLE B.2 FROM EN 858-2					
Sludge trap	Si	Si	Si		
Separator Class	I	I	I		
By-pass	Si	Si	Si		
Sampling shaft	Si	Si	Si		
Configuration	I	I	I		
CALCULATION OF SEPARATOR NOMINAL SIZE, NS					
Maximum flow rate of rainwater	Q _r	287.74	235.73	43.80	
Maximum flow rate of wastewater	Q _s	0.00	0.00	0.00	
Impediment factor acc. to T table 2 from EN 858-2	f _x	Not relevant as Q _s = 0 (only rainwater)	Not relevant as Q _s = 0 (only rainwater)	Not relevant as Q _s = 0 (only rainwater)	
Most unfavourable density factor	f _d	1.0	1.0	1.0	
Theoretical nominal size calculated from formula (1) from EN 858-2	NS	287.74	235.73	43.80	
Nominal size acc. to section 5 from EN 858-1	NS	300	300	50	

Table 10 Light liquid separator sizing.

4.7. RAINWATER HARVESTING TANK AND STORMWATER ATTENUATION TANK

The Municipality requires to have a sustainable urban drainage system (SUDS) consisting of a rainwater harvesting tank and a stormwater attenuation tank.

Both tanks shall be sized according to bylaw procedure. These procedures do not consider a n-year return period between rainfall events, irrigation needs, a specific percent reduction in offsite flow rates,

compliance with a specific standard (EN 16941-1, DIN 1989-1, etc.), etc. as design criteria for any of the tanks. The design is based on a very simple equations or relationships.

4.7.1. STORMWATER ATTENUATION TANK SIZING

According to local bylaw, the capacity, V , of the stormwater attenuation tank shall be 1.3 m^3 each 100 m^2 of total plot area, S :

$$V = 1.3 \times \frac{S}{100} = 1.3 \times \frac{18,849.0 \text{ m}^2}{100 \text{ m}^2} = 244.7 \text{ m}^3$$

The **effective capacity, 244.7 m^3** , shall be distributed into the stormwater attenuation tank and the rainwater harvesting tank. 75.0% of total capacity, 183.5 m^3 , shall be stored in the stormwater attenuation tank and the (25.0%) remaining capacity, 61.2 m^3 , in the rainwater harvesting tank. Then **total effective capacity of stormwater attenuation tank is 183.5 m^3** .

4.7.2. RAINWATER HARVESTING TANK

According to local bylaw the rainwater harvesting tank shall be sized according to the following formula:

$$V = \frac{C}{50} + \frac{J}{250}$$

where:

- V is the effective capacity of the rainwater harvesting tank, in m^3 .
- C is total runoff catchment areas at building roof level, in m^2 , and equal to $5,182.9 \text{ m}^2$.
- J is green areas, in m^2 , and equal to $3,769.8 \text{ m}^2$

The effective capacity of the rainwater harvesting tank, V , shall be 118.7 m^3 . Nonetheless, as mentioned in section 4.7.1, 61.2 m^3 shall be added to rainwater harvesting tank to detained excess rainwater, therefore, **total effective capacity of rainwater harvesting tank is 179.9 m^3** .

4.7.3. RAINWATER PUMP SIZING

Due to both tanks are not sized and designed based on the “rational method”, pump flow rate is not designed to meet a specific requirement.

The pumped flow rate, Q , is 60 L/s (

The following formula has been used to calculate pump ESP:

$$ESP = (1 + f_s) \times (H + \Delta P_p + \Delta P_{vf})$$

where:

- f_s is a safety factor, dimensionless, and equal to 25%
- H is pressure head, in kPa.
- ΔP_p is pressure drop in pipes, in kPa.
- ΔP_{vf} is pressure drop in valves and fittings, in kPa. To calculate fluid head loss through fittings and valves the following formula has been used:

$$\Delta p = K \times \rho \times \left(\frac{v^2}{2} \right)$$

where:

- o K is a geometric and size dependent loss coefficient, dimensionless. K values for different fittings and valves have been obtain from manufacturer's published "K" factor for the fitting or valve.
- o v is fluid average velocity, in m/s.
- o ρ is water density at 20.0°C, in kg/m³, and equal to 998.0 kg/m³.

PRESSURE HEAD

Pressure head, H , in kPa, is calculate by using the following equation:

$$H = \frac{\rho \times g \times \Delta h}{1,000}$$

where:

- Δh is the change in height, in, and equal to 6.5 m.
- ρ is water density at 20.0°C, in kg/m³, and equal to 998.0 kg/m³.
- g is the acceleration of gravity, in m/s², and equal to 9.807 m/s².

Then **H is 63,62 kPa.**

PRESSURE DROP IN PIPES

The Darcy-Weisbach equation has been used to calculate pressure drop caused by fluid friction in pipes, ΔP_p :

$$\Delta P_p = f \times \left(\frac{L}{D} \right) \times \left(\frac{\rho \times V^2}{2} \right)$$

where:

- L is the length of pipe, in m, and equal to 11.5 m.

- V is the average velocity, in m/s, and equal to 5.1 m/s.
- D is the internal diameter of pipe, in m, and equal to 0.122 m (122.3 mm – OD 160 HDPE pipe acc.to standard EN 12201-2).
- f is the friction factor, dimensionless. To calculate the friction, factor the Colebrook-White formula has been used:

$$\frac{1}{\sqrt[2]{f}} = 1.74 - 2 \times \log \left(\frac{2 \times \varepsilon}{D} + \frac{18.7}{Re \times \sqrt[2]{f}} \right)$$

where:

- o ε is the absolute roughness of pipe wall, m, and equal to 0.0000060 m (for plastic pipes).
- o Re is the Reynolds number, dimensionless. To calculate Reynolds number, the following formula has been used:

$$Re = \frac{D \times V \times \rho}{\mu}$$

where:

- μ is the dynamic viscosity of fluid, in Pa·s, and equal to 0.001139 Pa·s.
- ρ is water density at 20.0°C, in kg/m³, and equal to 998.0 kg/m³.

Reynolds number value is 547,588.

Friction factor, f, value is 0.0136.

Pressure drop in pipes, ΔP_p , is 36.3 kPa (1,447.3 Pa/m).

PRESSURE DROP IN VALVES AND FITTINGS

To calculate fluid head loss through fittings and valves, ΔP_{vf} , the following formula has been used:

$$\Delta p_{vf} = K \times \rho \times \left(\frac{v^2}{2} \right)$$

where:

- K is a geometric and size dependent loss coefficient, dimensionless. K values for different fittings and valves have been obtain from manufacturer's published "K" factor for the fitting or valve.
- v is fluid average velocity, in m/s.
- ρ is water density at 20.0°C, in kg/m³, and equal to 998.0 kg/m³.

Pressure drop for each valve and fitting, ΔP_{vf} , is shown in the following table:

Valve / Fitting	K-value	ΔP_{vf} (Pa)	No. of...	ΔP_{vf} (Pa)
45° Elbow	0.27	3,504	1	3,504
90° Elbow	0.60	7,787	5	38,937
Gate valve	0.11	1,428	1	1,428
Check valve	1.90	24,660	1	24,660
Intake	1.00	12,979	1	12,979

Table 11 Pressure drops in valves and fittings.

Total pressure drop in valves and fittings, ΔP_{vf} , is 81,51 kPa.

Pump ESP is 226.79 kPa.

RAINWATER PUMP CHARACTERISTICS

Rainwater pump shall have the minimum following characteristics:

- Minimum flow rate: 60.0 L/s (216.0 m³/h)
- ESP: 227 kPa (2.3 bar)

5. FOUL WATER DRAINAGE

Foul water gravity drainage system has been sized according to Requirement DB HS 5 Drainage from Spanish Building Regulation (CTE). The DB HS5 from CTE uses the Hunter Method for sizing foul water drainage systems.

5.1. DISCHARGE UNITS AND DRAW-OFF POINT DISCHARGE PIPE SIZES

Branch discharge pipe sizes of sanitary appliance are sized based on the following data:

- Type of sanitary appliance
- Use type of plumbing fixtures (either private or public)
- Discharge units (UD)

Discharge units, UD, and branch discharge pipe sizes given in the following table shall be used:

Draw-off point / Water fitting	UD	Discharge Pipe (mm)
Washbasin, handbasin	2.0	40
Bidet	3.0	40
Shower head	3.0	50
Bath	4.0	50
WC-cistern	5.0	100
WC-Flush valve	10.0	100
Pedestal urinal	4.0	50
Stall urinal	2.0	40
Battery of urinal	3.5	50
Domestic kitchen sink	6.0	50
Non-domestic kitchen sink	2.0	40
Washing sink	3.0	40
Sink	8.0	100
Drinking Fountain Faucet	0.5	25
Siphon drain	3.0	50
Dishwasher	6.0	50
Washing machine	6.0	50

Table 12 Table 4.1 from DB HS5 of CTE. Discharge units and discharge pipe per draw-off point.

In addition, in case either a sanitary appliance or draw-off point is not included in the table 4.1 the following discharge units and discharge pipe sizes shall be used:

Discharge Pipe (mm)	UD
32	1

Discharge Pipe (mm)	UD
40	2
50	3
60	4
80	5
100	6

Table 13 Table 4.2 from DB HS5 of CTE. Alternative DUs and discharge pipe sizes.

5.2. PIPE SIZING

5.2.1. DISCHARGE STACKS SIZES

Discharge stacks are sized based on the following data:

- No. of building floors (less or equal than 3 floors) served by the stack
- Discharge units (UD) per stack

Maximum UD per discharge stacks size (pipe diameter in mm), and maximum UD per drain discharging into the stack shall be according to table 4.4 from DB HS5 of CTE (see table below):

UD	Discharge Pipe (mm)
10	50
19	63
27	75
135	90
360	110
540	125
1,208	160
2,200	200
3,800	250
6,000	315

Table 14 Extract from Table 4.4 of DB HS5 of CTE. Discharge stack sizes.

5.2.2. DRAINS SIZES

Drain shall be sized based on the following data:

- No. of building floors (less or equal than 3 floors) served by the stack
- Discharge units (UD) per drain

Discharge branches shall be sized according to the following table:

Discharge Pipe (mm)	UD		
	1.0%	2.0%	4.0%
32	-	1	1
40	-	2	3
50	-	6	8
63	-	11	14
75	-	21	28
90	47	60	75
110	123	151	181
125	180	234	280
160	438	582	800
200	1,600	1,920	2,300
250	2,900	3,500	4,200
315	5,710	6,920	8,290
350	8,300	10,000	12,000

Table 15 Table 4.5 from DB HS5 of CTE. Drain sizes.

5.2.3. SUMMARY

The following table summarizes pipe sizing:

CALCULATION OF SANITARY PIPEWORK SYSTEM AND FOUL DRAINAGE SYSTEM																	
Project:		CyrusOne		TCA		Code:		21530									
Design by:		JMA		Revision:		00											
Approved by:		FGA		Date:		Jan-22											
Design standard:		CTE DB HSS															
System:		Publico		Number of floors:		2											
		Minimum diameter		Slope		Pipe Material - Standard											
Branch discharge. Hung				2.0%		PP - EN 1451 - Insonorizada											
Branch discharge. Buried				2.0%		PP - EN 1451											
Secondary drain				2.0%		PP - EN 1451 - Insonorizada											
Drain		110		2.0%		PP - EN 1852											
Underground drain		160		2.0%		PP - EN 1852											
Stack		90		N/A		PP - EN 1451 - Insonorizada											
Node		Levels		Floor	Appliance			Sanitary Pipework & Foul Drainage Network						Pipe		Type	Size (mm)
initial	final	initial	final		Type	DU	Diameter (mm)	Discharge outlet	DU	Section type	Length (m)	Slope (%)	Diameter (mm)	DN/OD (mm)			
L1001	L1003	6.65	6.60	L1	Shower	3.0	40	Vertical	3.0	Branch Discharge. Hung	2.41	2.0%	40	40			
L1002	L1003	6.65	6.61	L1	Wash basin	2.0	32	Vertical	2.0	Branch Discharge. Hung	1.90	2.0%	32	32			
L1003	L1005	6.60	6.60	L1					5.0	Secondary Drain	0.28	2.0%	50	50			
L1004	L1005	6.65	6.61	L1	WC with cistern	5.0	100	Vertical	5.0	Branch Discharge. Hung	1.88	2.0%	100	110			
L1005	L1012	6.60	6.56	L1					10.0	Secondary Drain	1.63	2.0%	100	110			
L1006	L1008	6.65	6.59	L1	Shower	3.0	40	Vertical	3.0	Branch Discharge. Hung	2.89	2.0%	40	40			
L1007	L1007	6.65	6.61	L1	Wash basin	2.0	32	Vertical	2.0	Branch Discharge. Hung	1.83	2.0%	32	32			
L1008	L1010	6.59	6.57	L1					3.0	Secondary Drain	1.07	2.0%	50	50			
L1009	L1010	6.65	6.58	L1	WC with cistern	5.0	100	Vertical	5.0	Branch Discharge. Hung	3.55	2.0%	100	110			
L1010	L1012	6.57	6.54	L1					8.0	Secondary Drain	1.36	2.0%	100	110			
L1011	L1012	6.65	6.61	L1	Slop hopper	8.0	100		8.0	Drain	2.22	2.0%	50	50			
L1012	L0020	6.54	0.74	L1					26.0	Stack		--	100	110			
L0001	L0003	0.74	0.70	L0	WC with cistern	5.0	100	Vertical	5.0	Branch Discharge. Buried	2.06	2.0%	100	110			
L0002	L0003	0.74	0.70	L0	WC with cistern	5.0	100	Vertical	5.0	Branch Discharge. Buried	1.76	2.0%	100	110			
L0003	L0006	0.70	0.61	L0					10.0	Underground drain	4.66	2.0%	100	110	Arqueta sifonica	500 x 500	
L0004	L0006	0.74	0.70	L0	WC with cistern	5.0	100	Vertical	5.0	Branch Discharge. Buried	2.06	2.0%	100	110			
L0005	L0006	0.74	0.70	L0	WC with cistern	5.0	100	Vertical	5.0	Branch Discharge. Buried	1.76	2.0%	100	110			
L0006	L0019	0.61	0.56	L0					20.0	Underground drain	2.17	2.0%	100	110	Arqueta sifonica	500 x 500	
L0007	L0010	0.74	0.71	L0	Wash basin	2.0	32	Vertical	2.0	Branch Discharge. Buried	1.53	2.0%	32	32			
L0008	L0010	0.74	0.72	L0	Wash basin	2.0	32	Vertical	2.0	Branch Discharge. Buried	1.03	2.0%	32	32			
L0009	L0010	0.74	0.73	L0	Wash basin	2.0	32	Vertical	2.0	Branch Discharge. Buried	0.52	2.0%	32	32			
L0010	L0013	0.71	0.67	L0					6.0	Underground drain	1.83	2.0%	50	50			
L0011	L0013	0.74	0.70	L0	WC with cistern	5.0	100	Vertical	5.0	Branch Discharge. Buried	1.90	2.0%	100	110			
L0012	L0013	0.74	0.71	L0	WC with cistern	5.0	100	Vertical	5.0	Branch Discharge. Buried	1.31	2.0%	100	110			
L0013	L0019	0.67	0.62	L0					16.0	Underground drain	2.73	2.0%	100	110	Arqueta sifonica	500 x 500	
L0014	L0016	0.74	0.74	L0	Wash basin	2.0	32	Vertical	2.0	Branch Discharge. Buried	0.01	2.0%	32	32			
L0015	L0016	0.74	0.74	L0	Wash basin	2.0	32	Vertical	2.0	Branch Discharge. Buried	0.01	2.0%	32	32			
L0016	L0019	0.74	0.73	L0					4.0	Underground drain	0.72	2.0%	50	50			
L0017	L0019	0.74	0.73	L0	Wash basin	2.0	32	Vertical	2.0	Branch Discharge. Buried	0.58	2.0%	32	32			
L0018	L0019	0.74	0.73	L0	Slop hopper	8.0	100	Vertical	8.0	Branch Discharge. Buried	0.74	2.0%	100	110			
L0019	L0020	0.56	0.47	L0					50.0	Underground drain	4.77	2.0%	100	110	Arqueta sifonica	500 x 500	
L0020	L0027	0.47	0.36	L0					76.0	Underground drain	5.55	2.0%	100	110	Arqueta sifonica	500 x 500	
L0021	L0023	0.74	0.71	L0	WC with cistern	5.0	100	Vertical	5.0	Branch Discharge. Buried	1.34	2.0%	100	110			
L0022	L0023	0.74	0.73	L0	Wash basin	2.0	32	Vertical	2.0	Branch Discharge. Buried	0.70	2.0%	32	32			
L0023	L0027	0.71	0.33	L0					7.0	Underground drain	18.96	2.0%	100	110	Arqueta sifonica	500 x 500	
L0024	L0026	0.74	0.73	L0	WC with cistern	5.0	100	Vertical	5.0	Branch Discharge. Buried	0.67	2.0%	100	110			
L0025	L0026	0.74	0.73	L0	Wash basin	2.0	32	Vertical	2.0	Branch Discharge. Buried	0.40	2.0%	32	32			
L0026	L0027	0.73	0.46	L0					7.0	Underground drain	13.37	2.0%	100	110	Arqueta sifonica	500 x 500	
L0027	UR001	0.33	-0.88	L0					90.0	Underground drain	1.20	2.0%	100	110	Arqueta sifonica	500 x 500	
UR001	UR002	-0.88	-1.42	UR					90.0	Underground drain	27.12	2.0%	100	110	Arqueta sifonica	500 x 500	
UR002	UR003	-1.42	-1.79	UR					90.0	Underground drain	18.50	2.0%	100	110	Pozo de registro circular	1200	
UR003	4-019	-1.79	#N/A	UR					90.0	Underground drain	6.69	2.0%	100	110	Arqueta de arranque	500 x 500	

Table 16 Foul Water Pipe Sizing