SURFACE AND FOUL WATER DRAINAGE SCHEME

for

Mr and Mrs D NORRIS

CONVERSION OF EXISTING BUILDINGS TO RESIDENTIAL DWELLINGS

at

WRITTEN STONE FARM

WRITTEN STONE LANE, LONGRIDGE, PR3 2ZN

APRIL 2025

REFORD

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1. INTRODUCTION

1.1 This surface water and foul water drainage scheme has been produced on behalf of Mr and Mrs D Norris to discharge Conditions 27 and 28 of the planning approval from Ribble Valley Borough Council (Reference 3/2024/0622) for the conversions of existing buildings into residential dwellings at Written Stone Farm, Written Stone Lane, Longridge, PR3 2ZN. A location plan is included within Appendix A.

1.2 Condition 27 states the following:

The development shall not commence until details of a drainage scheme have been submitted. The detailed surface water sustainable drainage strategy shall be based upon the sustainable drainage and principles and requirements set out in the National Planning Policy Framework, Planning Practice Guidance and Defra Technical Standards for Sustainable Drainage Systems. No surface water shall be allowed to discharge to the public foul sewer(s), directly or indirectly.

The details of the drainage strategy to be submitted for approval should include, as a minimum:

- *Details of whether the site is greenfield or previously developed in terms of drainage*
- *Assessment of the hierarchy of drainage options*
- *Details of the contributing area*
- *Restricted discharge rate*
- *On-site surface water storage*
- *Allowances for climate change and urban creep*
- *Above ground, multifunctional SuDS components*
- *Arrangements for management and maintenance*

The sustainable drainage strategy shall be implemented in accordance with the approved details prior to first occupation of the dwelling hereby approved.

1.3 Condition 28 states the following:

The site shall be drained via separate systems for the disposal of foul and surface water.

1.4 This surface water and foul water drainage scheme is to discharge Conditions 27 and 28 of the planning approval. It describes the existing site conditions and proposed development. It assesses the potential impact of proposals on existing drainage and includes a proposed scheme for the provision of new drainage to serve the proposed development.

2. BASE INFORMATION

Existing site

2.1 The application site lies to the north of the B6243 Lower Road, approx. 2.7km to the northeast of Longridge. Around the site lie agricultural fields.

2.2 The site contains the traditional barn and outbuilding that are to be converted. Also within the site is a residential dwelling.

2.3 Access to the site is via Written Stone Lane accessed from the B6243 Lower Road.

2.4 The area of the site is 0.47ha, which includes the access to the site from the B6243 Lower Road.

Site geology

2.5 The online Soilscapes Viewer has identified the site lying in a region characterised by slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils with impeded drainage.

Understanding of existing drainage local to the site

2.6 United Utilities has confirmed that there are no public sewers local to the area.

2.7 The Cowley Brook crosses under the B6243 Lower Road approx. 1km to the east of the site. The Cowley Brook flows to the south to ultimately discharge into the River Ribble at Ribchester.

2.8 A watercourse in a stone culvert flows to the south through the site. The watercourse is part of the Cowley Brook catchment.

2.9 Drainage systems within the site deal with surface water runoff, foul drainage and dirty water from the farmyard hardstanding areas. Foul water is treated by a septic tank. The dirty water from the farmyard hardstanding areas is collected and discharged into an enclosed underground tank from where it is pumped out and disposed offsite.

Proposed development

2.10 The development is for the for proposed conversion of a barn to a two-storey, five bedroom dwelling; the demolition of an outbuilding and construction of a new double garage; construction of a new roof and conversion of a second outbuilding to form a single-storey incidental domestic hobby space; alterations to the existing vehicular access, the creation of domestic curtilage and landscaping; a new sewage treatment plant and diversion of a public footpath.

3. PROPOSED DRAINAGE SCHEME

3.1 The proposed drainage layout is included within Appendix B.

Surface water drainage

3.2 In accordance with the National Standards for Sustainable Drainage, the surface water drainage scheme should incorporate the use of Sustainable Drainage (SUDS) where possible. The approach promotes the use infiltration features in the first instance. If drainage cannot be achieved solely through infiltration due to site conditions or contamination risks, the preferred options are (in order of preference):

(i) a controlled discharge to a local waterbody or watercourse, or

(ii) a controlled discharge into the public sewer network (depending on availability and capacity).

3.3 The rate and volume of discharge should strive to provide betterment and be restricted to the pre-development values as far as practicable.

3.4 The online Soilscapes Viewer has identified the site lying in a region characterised by slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils with impeded drainage. Based upon the existing ground conditions, the use of soakaways to discharge of surface water back into the ground is not viable.

3.5 A watercourse in a stone culvert flows to the south through the site. The watercourse is part of the Cowley Brook catchment.

3.6 A drainage survey of the existing site drainage has been carried out and the existing surface water drainage system is not suitable for use for the proposed development. It is therefore intended that a new surface water drainage system will be installed within the site to collect surface water runoff from the roofs of the existing residential dwelling and converted buildings, and associated hardstanding areas and be controlled to the existing pre-development Greenfield runoff rate, Qbar, or 2.0 l/s whichever is the greater, allowing surface water runoff generated by all rainfall events up to the 100 year critical rain storm plus 50% on stored volumes to discharge into the

watercourse that flows to the south through the site. The additional 50% is to allow for climate change and has been included in the surface water volume.

3.7 To determine the restricted surface water discharge rate from the developed site, the pre-development Greenfield runoff rates have been calculated using the 'Causeway Flow' programme. The calculations are based upon the area of the site that is the extents of the barn conversion curtilage and this has been measured as 0.2ha. The existing pre-development Greenfield runoff rates have been calculated as below:

Pre-development discharge

Site Makeup	Brownfield
Brownfield Method	Greenfield
Greenfield Method	IH124
Positively Drained Area (ha)	0.200
SAAR (mm)	1196
Soil Index	5
SPR	0.53
Region	10
Betterment (%)	0
	Calc
QBar (l/s)	2.3

Return Period (years)	Growth Factor	Q (l/s)
1	0.87	2.0
30	1.70	4.0
100	2.08	4.9

3.8 As the existing pre-development Greenfield runoff rate, Qbar, has been calculated as 2.3 l/s, it is intended that new surface water drainage will therefore be constructed, appropriately sized to take surface water runoff from the proposed development and be attenuated to 2.3 l/s prior to a controlled discharge into the watercourse that flows to the south through the site.

3.9 The proposed surface water drainage for the development will take runoff from the roofs of the existing residential dwelling and converted buildings, and associated hardstanding areas.

3.10 The hardstanding areas adjacent to the development are to comprise permeable surfaces allowing surface water to percolate into the construction matrix where it will be stored prior to a controlled release into the watercourse that flows to the south through the site. It has been determined that in order to cater for the 100 year critical rain storm plus 50% added for climate change, the depth of the sub-base under the hardstanding areas comprising open graded crushed rock shall be a minimum thickness of 300mm.

3.11 A surface water drainage design has been carried out for the proposed development for all events up to the 100 year critical rain storm plus 50% for climate change on stored volumes. Attenuation is provided within underground storage tanks and within the construction matrix of the permeable paving. An allowance for urban creep has not been included as the area of the site that is the extents of the barn conversion curtilage comprises roofs and hardstanding areas, all of which have been included within the surface water drainage design. The surface water drainage design is included within Appendix C.

Foul water drainage

3.12 United Utilities has confirmed that there are no public sewers local to the area.

3.13 The proposal is for the conversions of existing buildings to residential dwellings. A drainage survey of the existing site drainage has been carried out and the existing foul water drainage system is suitable for use for the proposed development with the exception of the existing septic tank, which is to be replaced with a sewage treatment plant and the effluent discharged into the watercourse that flows to the south through the site.

3.14 A typical sewage treatment plant is the Marsh Ensign sewage treatment plant that has been sized for a population of twelve and is to be located within the underground tank that was previously used for storing the dirty water from the farmyard

hardstanding areas is prior to being pumped out and disposed offsite. Details of a typical sewage treatment plant can be found within Appendix D. The size of the plant is to be confirmed prior to ordering.

Sustainable Drainage Management and Maintenance Plan

3.15 The drainage within the developed site will remain private, being the responsibility of the owner(s) of the buildings.

3.16 The table below lists the various drainage features, along with the maintenance regime that should be followed.

BUILDING DRAINAGE	
Regular maintenance	**Frequency**
Visually inspect gutters to ensure they are kept clear of leaves, debris etc. Lift covers of drainage to inspect chambers for debris and build-up of silts. Manhole covers are securely in place.	Annually. No triggers other than maintenance to be taken on regular schedule.
Occasional tasks	**Frequency**
Remove leaves and debris from gutters. Remove debris from inspection chambers to ensure outlets are kept clear of debris to ensure adequate drainage.	As required. Indicator of problem / trigger for maintenance when surcharging or flooding of drains occurs or gutters and chambers full of debris and leaves etc.
Remedial work	**Frequency**
Should drains be heavily blocked or damaged contact a drainage maintenance company for unblocking / repair works.	As required. Indicator of problem / trigger for maintenance when drainage not functioning and unblocking pipes and chambers etc. not effective.
SEWAGE TREATMENT PLANT	
Regular maintenance	**Frequency**
Manhole covers are securely in place. Specialist operatives to lift covers and visually inspect sewage treatment plant to ensure it is clear of leaves, debris, silt, etc.	Annually or when notified.

Check drainage pipes are operating as expected.	
Specialist operatives to carry out maintenance of sewage treatment plant.	Annually or when notified.
Occasional tasks	**Frequency**
Specialist operatives to remove debris and silt from the sewage treatment plant to ensure outlets are kept clear of debris to ensure adequate drainage.	As required from regular maintenance inspection to trigger works.
Remedial work	**Frequency**
Specialist operatives are to advise of any repair works necessary to the sewage treatment plant. Drains heavily blocked or damaged to be jetted / repaired.	As required from regular maintenance inspection to trigger works or when equipment fails to work.
ATTENUATION STORAGE CRATES	
Regular maintenance	**Frequency**
Inspect and identify any areas that are not operating correctly. If required, take remedial action. Remove debris from the catchment surface (where it may cause risks to performance).	Monthly for 3 months, then annually. Monthly.
Occasional tasks	**Frequency**
Inspect / check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed. Survey inside of tank for sediment build-up and remove if necessary.	Annually Every 5 years or as required
Remedial work	**Frequency**
Repair / rehabilitate inlets, outlet, overflows and vents.	Every 5 years or as required

OPERATION AND MAINTENANCE REQUIREMENTS FOR PERMEABLE AREAS

Regular maintenance

Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment

Brushing and vacuuming (standard cosmetic sweep over whole surface)

Occasional maintenance

As required

Stabilise and mow contributing and adjacent areas

As required – once per year on less frequently used pavements

Removal of weeds or management using glyphospate applied directly into the weeds by an applicator rather than spraying

Remedial Actions

As required

Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the pervious area

As required

Remedial work to any depressions and rutting considered detrimental to the structural performance or a hazard to users

Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)

Rehabilitation of surface and upper substructure by remedial sweeping

Monitoring

Monthly for three months after installation

Initial inspection

Three-monthly, 48 hours after large storms in first six months

Inspect for evidence of poor operation and / or weed growth – if required, take remedial action

Annually

Inspect silt accumulation rates and establish appropriate brushing frequencies

Annually

Monitor inspection chambers

4. SUMMARY AND CONCLUSIONS

4.1 This surface water and foul water drainage scheme has been produced on behalf of Mr and Mrs D Norris to discharge Conditions 27 and 28 of the planning approval from Ribble Valley Borough Council (Reference 3/2024/0622) for the conversions of existing buildings into residential dwellings at Written Stone Farm, Written Stone Lane, Longridge, PR3 2ZN.

4.2 Based upon the existing ground conditions, the use of soakaways to discharge of surface water back into the ground is not viable.

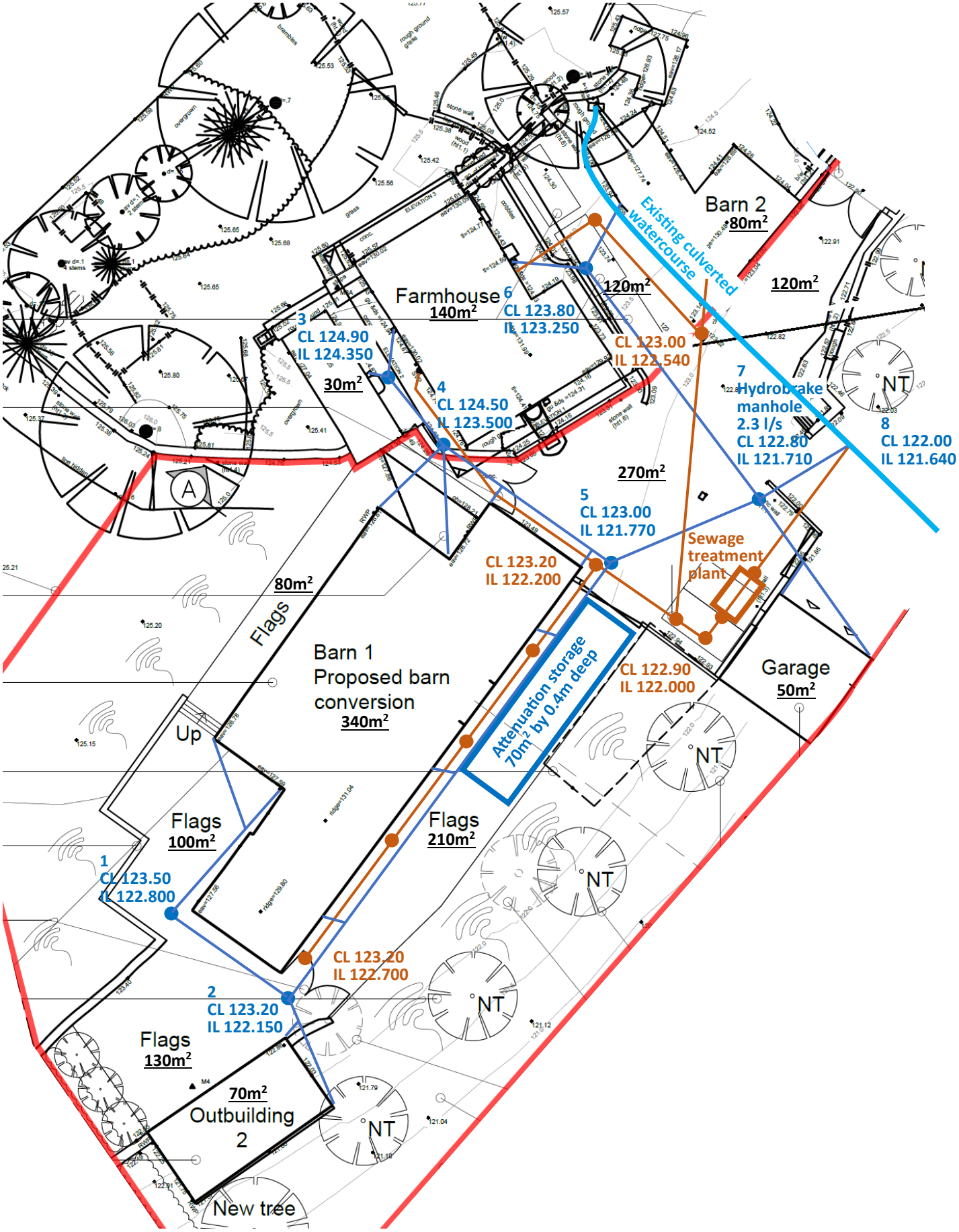
4.3 Surface water runoff will be restricted to 2.3 l/s allowing surface water runoff generated by all rainfall events up to the 100 year critical rain storm plus 50% on stored volumes to discharge into the watercourse that flows to the south through the site.

4.4 Foul water is to be treated by a new sewage treatment plant, from which the effluent is to be discharge into the watercourse that flows to the south through the site.

APPENDIX A

LOCATION PLAN

APPENDIX B



PROPOSED DRAINAGE LAYOUT

APPENDIX C

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	2	Maximum Rainfall (mm/hr)	75.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	18.900	Minimum Backdrop Height (m)	2.000
Ratio-R	0.280	Preferred Cover Depth (m)	0.450
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Depth (m)
area 1	0.010	5.00	123.500	1	0.500
1	0.011	5.00	123.500	600	0.700
area 2	0.034	5.00	123.200	1	0.700
2	0.019	5.00	123.200	600	1.050
3	0.010	5.00	124.900	600	0.550
area 4	0.008	5.00	124.500	1	0.500
4	0.011	5.00	124.500	600	1.000
area 5	0.027	5.00	123.000	1	0.500
5	0.005	5.00	123.000	600	1.230
area 6	0.024	5.00	123.800	1	0.500
6	0.015	5.00	123.800	600	0.550
7			122.800	1500	1.090
8			122.000	1200	0.360

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	area 1	1	1.000	0.600	123.000	122.999	0.001	1000.0	50	5.11	54.8
1.001	1	2	10.000	0.600	122.800	122.275	0.525	19.0	100	5.21	54.4
2.000	area 2	2	1.000	0.600	122.500	122.499	0.001	1000.0	50	5.11	54.8
1.002	2	5	38.000	0.600	122.150	121.770	0.380	100.0	225	5.69	52.6
3.000	3	4	7.000	0.600	124.350	123.500	0.850	8.2	100	5.04	55.1
4.000	area 4	4	1.000	0.600	124.000	123.999	0.001	1000.0	50	5.11	54.8
3.001	4	5	14.000	0.600	123.500	121.895	1.605	8.7	100	5.20	54.4
5.000	area 5	5	1.000	0.600	122.500	122.499	0.001	1000.0	50	5.11	54.8
1.003	5	7	10.000	0.600	121.770	121.710	0.060	166.7	225	5.86	52.0
6.000	area 6	6	1.000	0.600	123.300	123.299	0.001	1000.0	50	5.11	54.8
6.001	6	7	19.000	0.600	123.250	121.825	1.425	13.3	100	5.26	54.2
1.004	7	8	7.000	0.600	121.710	121.640	0.070	100.0	100	6.01	51.5

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)
1.000	0.145	0.3	1.5	0.450	0.451	0.010	0.0
1.001	1.777	14.0	3.1	0.600	0.825	0.021	0.0
2.000	0.145	0.3	5.0	0.650	0.651	0.034	0.0
1.002	1.307	52.0	10.5	0.825	1.005	0.074	0.0
3.000	2.710	21.3	1.5	0.450	0.900	0.010	0.0
4.000	0.145	0.3	1.2	0.450	0.451	0.008	0.0
3.001	2.633	20.7	4.3	0.900	1.005	0.029	0.0
5.000	0.145	0.3	4.0	0.450	0.451	0.027	0.0
1.003	1.010	40.1	19.0	1.005	0.865	0.135	0.0
6.000	0.145	0.3	3.6	0.450	0.451	0.024	0.0
6.001	2.127	16.7	5.7	0.450	0.875	0.039	0.0
1.004	0.769	6.0	24.3	0.990	0.260	0.174	0.0

Manhole Schedule

Node	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
area 1	123.500	0.500	1	0	1.000	123.000	50
1	123.500	0.700	600	1	1.000	122.999	50
				0	1.001	122.800	100
area 2	123.200	0.700	1	0	2.000	122.500	50
2	123.200	1.050	600	1	2.000	122.499	50
				2	1.001	122.275	100
				0	1.002	122.150	225
3	124.900	0.550	600	0	3.000	124.350	100
area 4	124.500	0.500	1	0	4.000	124.000	50
4	124.500	1.000	600	1	4.000	123.999	50
				2	3.000	123.500	100
				0	3.001	123.500	100
area 5	123.000	0.500	1	0	5.000	122.500	50

Manhole Schedule

Node	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
5	123.000	1.230	600	1	5.000	122.499	50
				2	3.001	121.895	100
				3	1.002	121.770	225
				0	1.003	121.770	225
area 6	123.800	0.500	1				
				0	6.000	123.300	50
6	123.800	0.550	600	1	6.000	123.299	50
				0	6.001	123.250	100
7	122.800	1.090	1500	1	6.001	121.825	100
				2	1.003	121.710	225
				0	1.004	121.710	100
8	122.000	0.360	1200	1	1.004	121.640	100

Simulation Settings

Rainfall Methodology	FSR	Summer CV	0.750	Drain Down Time (mins)	240
FSR Region	England and Wales	Winter CV	0.840	Additional Storage (m^3/ha)	20.0
M5-60 (mm)	18.900	Analysis Speed	Normal	Check Discharge Rate(s)	x
Ratio-R	0.280	Skip Steady State	x	Check Discharge Volume	x

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0	100	0	0	0
30	0	0	0	100	50	0	0

Node 7 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	121.710	Product Number	CTL-SHE-0071-2300-1090-2300
Design Depth (m)	1.090	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.3	Min Node Diameter (mm)	1200

Node area 1 Online Orifice Control

Flap Valve	x	Invert Level (m)	123.000	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Diameter (m)	0.010		

Node area 2 Online Orifice Control

Flap Valve	x	Invert Level (m)	122.500	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Diameter (m)	0.010		

Node area 4 Online Orifice Control

Flap Valve	x	Invert Level (m)	124.000	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Diameter (m)	0.010		

Node area 5 Online Orifice Control

Flap Valve	x	Invert Level (m)	122.500	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Diameter (m)	0.010		

Node area 6 Online Orifice Control

Flap Valve	x	Invert Level (m)	123.300	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Diameter (m)	0.010		

Node 5 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	121.770
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	236

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	70.0	0.0	0.400	70.0	0.0	0.401	0.0	0.0

Node area 1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	123.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.32	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)
0.000	100.0	0.0

Node area 2 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	122.500
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.32	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)
0.000	320.0	0.0

Node area 4 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	124.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.32	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)
0.000	80.0	0.0

Node area 5 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	122.500
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.32	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)
0.000	270.0	0.0

Node area 6 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	123.300
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.32	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)
0.000	240.0	0.0

Results for 1 year Critical Storm Duration. Lowest mass balance: 99.93%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
1440 minute winter	area 1	990	123.059	0.059	0.1	1.8976	0.0000	SURCHARGED
15 minute winter	1	10	122.821	0.021	1.3	0.0125	0.0000	OK
1440 minute winter	area 2	1350	122.592	0.092	0.3	9.5536	0.0000	SURCHARGED
15 minute winter	2	10	122.195	0.045	3.5	0.0287	0.0000	OK
15 minute winter	3	10	124.366	0.016	1.2	0.0104	0.0000	OK
1440 minute winter	area 4	930	124.055	0.055	0.1	1.4361	0.0000	SURCHARGED
15 minute winter	4	10	123.524	0.024	2.5	0.0120	0.0000	OK
960 minute winter	area 5	915	122.579	0.079	0.4	6.9189	0.0000	SURCHARGED
120 minute winter	5	82	121.821	0.051	2.7	3.4315	0.0000	OK
960 minute winter	area 6	885	123.377	0.077	0.3	5.9830	0.0000	SURCHARGED
15 minute winter	6	10	123.272	0.022	1.8	0.0186	0.0000	OK
60 minute winter	7	46	121.822	0.112	2.2	0.1979	0.0000	SURCHARGED
15 minute summer	8	1	121.640	0.000	1.8	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
1440 minute winter	area 1	Orifice	1	0.0				
15 minute winter	1	1.001	2	1.3	1.095	0.092	0.0117	
1440 minute winter	area 2	Orifice	2	0.1				
15 minute winter	2	1.002	5	3.5	1.083	0.068	0.1440	
15 minute winter	3	3.000	4	1.2	1.071	0.056	0.0078	
1440 minute winter	area 4	Orifice	4	0.0				
15 minute winter	4	3.001	5	2.5	1.749	0.119	0.0197	
960 minute winter	area 5	Orifice	5	0.1				
120 minute winter	5	1.003	7	2.0	0.192	0.049	0.1320	
960 minute winter	area 6	Orifice	6	0.1				
15 minute winter	6	6.001	7	1.8	1.375	0.107	0.0246	
60 minute winter	7	Hydro-Brake®	8	1.9				8.8

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.93%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
720 minute winter	area 1	675	123.126	0.126	0.3	4.0931	0.0000	SURCHARGED
15 minute winter	1	10	122.834	0.034	3.2	0.0201	0.0000	OK
1440 minute winter	area 2	1410	122.672	0.172	0.7	17.8114	0.0000	SURCHARGED
15 minute winter	2	10	122.216	0.066	8.7	0.0423	0.0000	OK
15 minute winter	3	10	124.375	0.025	2.9	0.0161	0.0000	OK
600 minute winter	area 4	540	124.121	0.121	0.3	3.1258	0.0000	SURCHARGED
15 minute winter	4	10	123.538	0.038	6.1	0.0193	0.0000	OK
1440 minute winter	area 5	1410	122.660	0.159	0.5	13.9519	0.0000	SURCHARGED
120 minute winter	5	94	121.941	0.171	6.3	11.4322	0.0000	OK
1440 minute winter	area 6	1380	123.459	0.159	0.5	12.3279	0.0000	SURCHARGED
15 minute winter	6	10	123.285	0.035	4.3	0.0293	0.0000	OK
120 minute winter	7	94	121.941	0.231	2.6	0.4080	0.0000	SURCHARGED
15 minute summer	8	1	121.640	0.000	2.1	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
720 minute winter	area 1	Orifice	1	0.1				
15 minute winter	1	1.001	2	3.2	1.408	0.228	0.0226	
1440 minute winter	area 2	Orifice	2	0.1				
15 minute winter	2	1.002	5	8.8	1.218	0.169	0.4099	
15 minute winter	3	3.000	4	2.9	1.358	0.135	0.0150	
600 minute winter	area 4	Orifice	4	0.1				
15 minute winter	4	3.001	5	6.0	2.240	0.292	0.0378	
1440 minute winter	area 5	Orifice	5	0.1				
120 minute winter	5	1.003	7	2.0	0.189	0.051	0.3607	
1440 minute winter	area 6	Orifice	6	0.1				
15 minute winter	6	6.001	7	4.3	1.756	0.256	0.0464	
120 minute winter	7	Hydro-Brake®	8	2.2				26.8

Results for 100 year Critical Storm Duration. Lowest mass balance: 99.93%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute winter	area 1	900	123.162	0.162	0.3	5.2601	0.0000	SURCHARGED
15 minute winter	1	10	122.839	0.039	4.1	0.0231	0.0000	OK
1440 minute winter	area 2	1410	122.719	0.219	0.8	22.6531	0.0000	SURCHARGED
15 minute winter	2	10	122.223	0.073	11.2	0.0473	0.0000	OK
15 minute winter	3	10	124.378	0.028	3.7	0.0183	0.0000	OK
600 minute winter	area 4	570	124.157	0.157	0.4	4.0783	0.0000	SURCHARGED
15 minute winter	4	10	123.544	0.044	7.8	0.0222	0.0000	OK
960 minute winter	area 5	945	122.699	0.199	0.9	17.4381	0.0000	SURCHARGED
180 minute winter	5	140	122.023	0.253	6.3	16.9026	0.0000	SURCHARGED
1440 minute winter	area 6	1410	123.496	0.196	0.6	15.2546	0.0000	SURCHARGED
15 minute winter	6	10	123.291	0.041	5.6	0.0338	0.0000	OK
180 minute winter	7	140	122.023	0.313	2.6	0.5524	0.0000	SURCHARGED
15 minute summer	8	1	121.640	0.000	2.1	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
960 minute winter	area 1	Orifice	1	0.1				
15 minute winter	1	1.001	2	4.1	1.505	0.293	0.0272	
1440 minute winter	area 2	Orifice	2	0.1				
15 minute winter	2	1.002	5	11.3	1.255	0.218	0.5568	
15 minute winter	3	3.000	4	3.7	1.444	0.173	0.0180	
600 minute winter	area 4	Orifice	4	0.1				
15 minute winter	4	3.001	5	7.8	2.389	0.375	0.0454	
960 minute winter	area 5	Orifice	5	0.1				
180 minute winter	5	1.003	7	2.1	0.189	0.052	0.3977	
1440 minute winter	area 6	Orifice	6	0.1				
15 minute winter	6	6.001	7	5.6	1.883	0.334	0.0745	
180 minute winter	7	Hydro-Brake®	8	2.2				40.0

Results for 100 year +50% CC Critical Storm Duration. Lowest mass balance: 99.93%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
1440 minute winter	area 1	1020	123.250	0.250	0.4	8.0958	0.0000	FLOOD RISK
15 minute winter	1	10	122.849	0.049	6.1	0.0291	0.0000	OK
1440 minute winter	area 2	1410	122.839	0.339	1.2	35.0425	0.0000	SURCHARGED
180 minute winter	2	152	122.769	0.619	5.0	0.3992	0.0000	SURCHARGED
15 minute winter	3	10	124.385	0.035	5.6	0.0227	0.0000	OK
960 minute winter	area 4	915	124.232	0.232	0.4	6.0006	0.0000	FLOOD RISK
15 minute winter	4	10	123.556	0.056	11.7	0.0284	0.0000	OK
1440 minute winter	area 5	1380	122.820	0.320	1.0	28.0019	0.0000	FLOOD RISK
180 minute winter	5	148	122.769	0.999	9.4	26.9968	0.0000	FLOOD RISK
1440 minute winter	area 6	1350	123.615	0.315	0.9	24.4564	0.0000	FLOOD RISK
15 minute winter	6	10	123.302	0.052	8.4	0.0428	0.0000	OK
180 minute winter	7	148	122.769	1.059	3.6	1.8709	0.0000	FLOOD RISK
15 minute summer	8	1	121.640	0.000	2.2	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
1440 minute winter	area 1	Orifice	1	0.1				
15 minute winter	1	1.001	2	6.1	1.662	0.436	0.0366	
1440 minute winter	area 2	Orifice	2	0.1				
180 minute winter	2	1.002	5	5.0	0.718	0.097	1.5113	
15 minute winter	3	3.000	4	5.6	1.601	0.262	0.0245	
960 minute winter	area 4	Orifice	4	0.1				
15 minute winter	4	3.001	5	11.6	2.633	0.563	0.0619	
1440 minute winter	area 5	Orifice	5	0.1				
180 minute winter	5	1.003	7	2.7	0.173	0.067	0.3977	
1440 minute winter	area 6	Orifice	6	0.1				
15 minute winter	6	6.001	7	8.4	2.050	0.504	0.1059	
180 minute winter	7	Hydro-Brake®	8	2.3				50.4

APPENDIX D

Ensign®
Sewage treatment plants
Intensive biological processing for off-mains wastewater

Overview

The Marsh Ensign is widely regarded as one of the most efficient, reliable and economical sewage treatment plants on the market.

The standard Ensign has been adapted to improve reliability and the Ensign:Ultra now brings unique enhancements to further improve noise level, treatment efficiency and final effluent quality.

Class leading performance
Tested and approved to BSEN12566-3/A1:2009 all Ensign units provide treatment well within national consent requirements. Published test results of 11.5:19.2:8.4mg/ltr (BOD:suspended solids:ammonia), with influent concentrations on test higher than those chosen by most competitor plants, effectively equates to 97% pollutant removal.

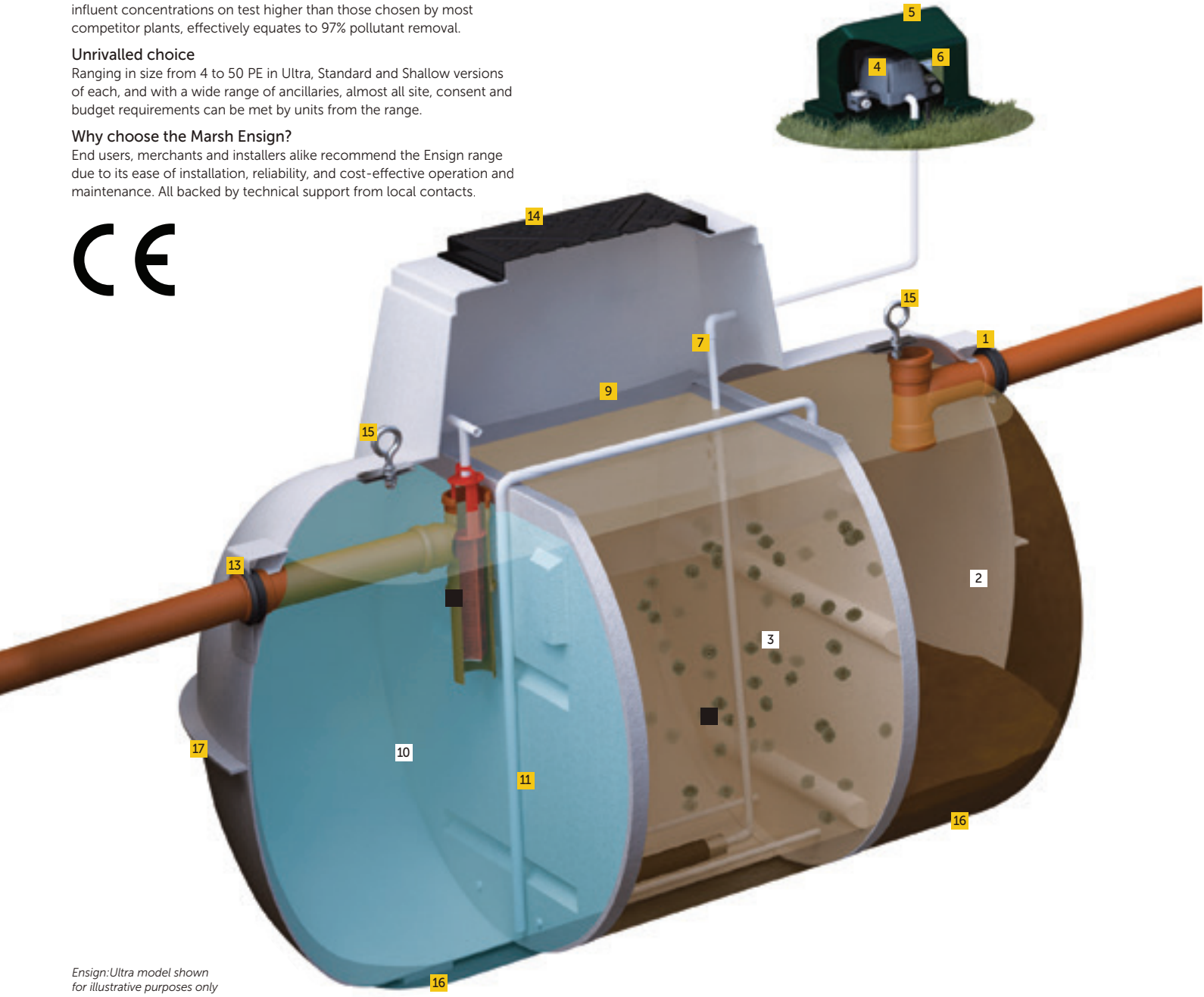
Unrivalled choice
Ranging in size from 4 to 50 PE in Ultra, Standard and Shallow versions of each, and with a wide range of ancillaries, almost all site, consent and budget requirements can be met by units from the range.

Why choose the Marsh Ensign?
End users, merchants and installers alike recommend the Ensign range due to its ease of installation, reliability, and cost-effective operation and maintenance. All backed by technical support from local contacts.

CE

Operating principle

In addition to anaerobic digestion taking place in the primary settlement chamber [2] the Ensign:Ultra unit allows the clarified water to pass into a second 'aeration' chamber [3] where it is treated to remove the dissolved constituents. Here aerobic bacteria, supported by diffused air and mobile media, ensures full treatment is achieved before the treated effluent and 'sloughed off' bacteria flows to a final settlement chamber [10]. The final effluent is then discharged to the drainage field or watercourse via a Polylok filter.



Ensign:Ultra model shown for illustrative purposes only

Benefits

1 **Inlet with 'Forsheda seal'**
Forsheda seal provides flexibility in the joint for easier installation.
Optional risers to increase invert depth are available.

2 **Primary settlement chamber**

3 **Aeration chamber**

4 **Advanced compressor with alarm (Ensign:Ultra units only)**
Near silent compressor ensures minimal running, maintenance and servicing costs. Integral alarm detects low pressure in air line. (Regular Low-energy compressor on Ensign:Standard models).

5 **Compressor housing - internal or external options available**
The compressor can be housed internally or externally with no difference in cost.
External recommended to increase compressor life, and supplied as standard on 4PE, shallow and pumped outlet versions.

6 **RCD/Electrical connection (Ensign:Ultra units only)**
The RCD box provides easier installation and proveds a higher degree of safety. (Regular plug/socket connection on Ensign:Standard models).

7 **PVC pressure pipe/diffuser(s)**
Provides a protective conduit for the air diffuser line. Can be easily removed for maintenance and cleaning.

8 **Bio-media**
High specification bio-media (310m^3 per m^2) and membrane diffusers ensure even circulation to eliminate 'dead spots'. The bio-media is contained by a stainless steel securing mesh to ensure no migration during handling or potential flooding.

9 **Stainless steel mesh**
Retains media in aeration chamber during transportation and handling, and in the event of flooding.

10 **Final settlement chamber**

11 **32mm sludge return**
Larger diameter sludge return prevents the possibility of blockages and improves system circulation. Provides higher effluent quality whilst balancing flow over a 24 hour period or periods of intermittent use.

12 **Unique Polylok tertiary filter (Ensign:Ultra units only)**
The Polylok tertiary filter reduces suspended solids and BOD by a further 40% helping to extend drainage field life.

13 **Outlet with 'Forsheda seal'**
Forsheda seal provides flexibility in the joint for easier installation.
Optional pumped outlets are available.

14 **Impermeable lid**
Heavy duty lid/frame improves strength and durability whilst blending into the surrounding environment. (Regular lid on Ensign:Standard models).

15 **Integral lifting eyes**
For safe and secure on-site handling.

16 **Stabilising feet**
Stabilising feet prevents the tank from rolling and allows safe and steady transportation and installation.

17 **Unique 'keying-in' lip**
Assists anchoring into granular or concrete surrounds.

Whisspurr
Acoustic Vibration Reduction (AVR) unit
Suitable for all types of diaphragm compressors.
See page 14.

Guidance notes

Package Sewage Treatment Plant's (or PSTP's) are often a suitable option where groundwater in the surrounding environment is vulnerable, drainage field percolation values are restrictive, or direct discharge to a water course or surface water sewer is the prefered discharge method.

- *PSTP's should be sized using the latest version of British Water Flows & Loads which provides detailed information on sewage production figures and sizing calculations*
- *Regulatory authorities for the control of pollution in the UK normally require treatment plants conforming to BSEN12566:3 to be demonstrated as capable of producing a minimum effluent discharge quality of 20:30:20 (Biochemical Oxygen Demand;Suspended Solids: Ammoniacal Nitrogen in mg/ltr), although in certain areas more stringent site-specific qualities may be required*
- *No surface water should enter the system as this can reduce the system's capacity and cause solids to be flushed out which may prematurely block drainage field or cause pollution*
- *As with septic tanks sludge should be removed annually or in line with manufacturers instructions*

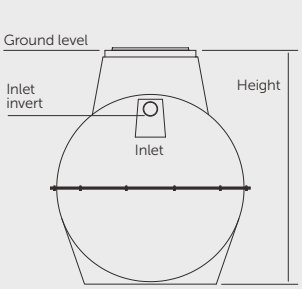
Many domestic sewage treatment plants offered by "internet resellers" claim to hold EN12566-3 compliance. This does not necessarily mean compliance with the UK National Forward, May 2007.

These plants may have been tested in their country of origin but not tested to the same criteria as Marsh Industries, where we strictly adhere to the UK National Forward. Contact contracts@marshindustries.co.uk for more information.

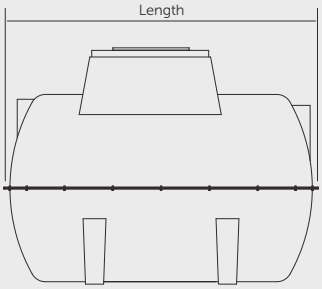
> The Marsh Ensign is widely regarded as one of the most efficient, reliable and economical sewage treatment plants on the market

Specifications

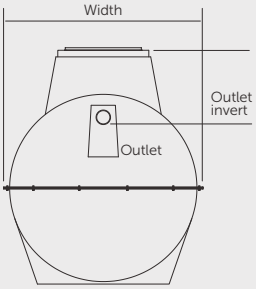
Ensign:Ultra and Ensign:Standard



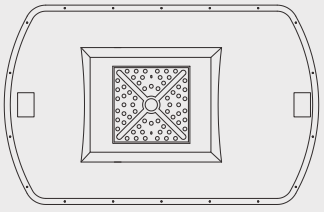
View on inlet end



Typical side elevation



View on outlet end


Typical plan view

Ensign:Ultra and Ensign:Standard

Model	Length	Width	Height	Inlet		Outlet	
(Pop)	+/-50mm	+/-50mm	+/-50mm	Invert	Ø	Invert	Ø
4	1600	1332	1575	540	110	600	110
6	2602	1650	1935	550	110	625	110
8	2602	1650	1935	550	110	625	110
10	2602	1650	1935	550	110	625	110
12	2860	1912	2139	550	110	625	110
16	2860	1912	2284	720	110	800	110
20	3650	1912	2284	720	160	800	160
25	3650	1912	2284	770	160	850	160
30	4200	1912	2284	770	160	850	160
35	4200	1912	2284	770	160	850	160
40	5200	1912	2284	770	160	850	160
45	5200	1912	2284	770	160	850	160
50	5200	1912	2284	770	160	850	160

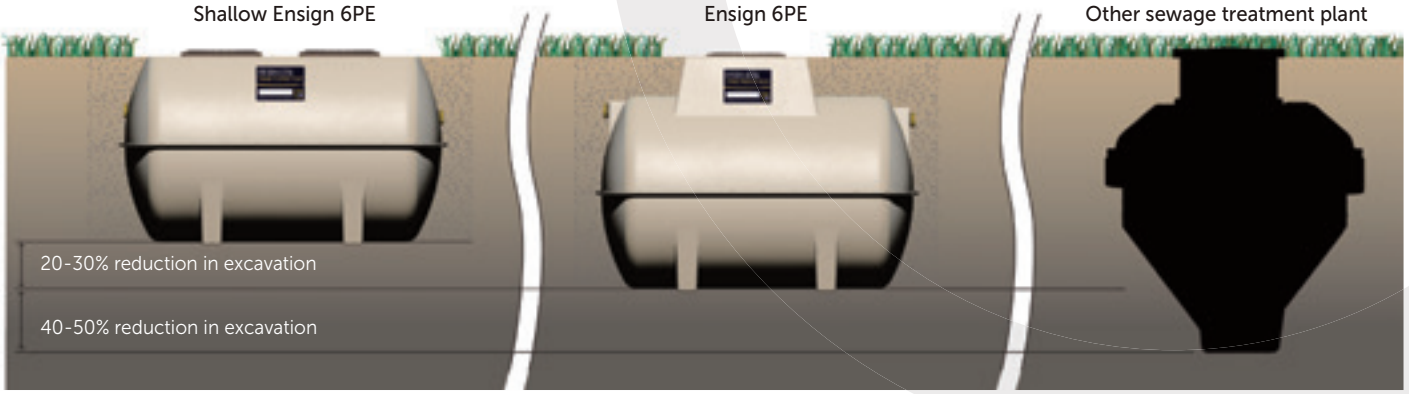
Notes:

> *Larger population sewage treatment plants may be supplied as multiple tank configurations.*
> *For precise tank sizes and configurations, please contact Marsh Industries*
> *All dimensions in mm*

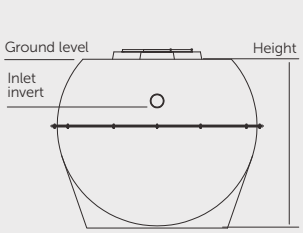
Shallow units

Common sewage treatment plants on the market often exceed 2.3m high. Marsh Industries offer a range of shallow plants from 4-35PE that are only 1.6m in height, meaning installation is not only possible*, but easier and safer too.

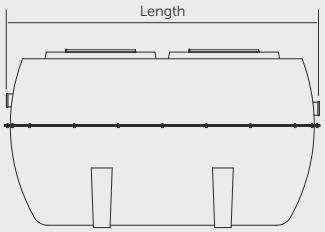
**Shallow Ensign's are often favoured when hard rock site conditions mean deeper alternatives, involving costly and time-consuming excavation.*



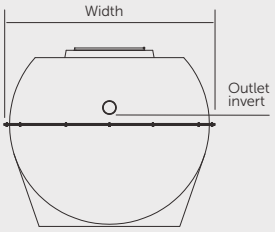
Shallow Ensign:Ultra and Shallow Ensign:Standard



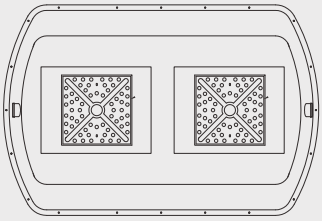
View on inlet end



Typical side elevation



View on outlet end


Typical plan view

Shallow Ensign:Ultra and Shallow Ensign:Standard

Model	Length	Width	Height	Inlet		Outlet	
(Pop)	+/-50mm	+/-50mm	+/-50mm	Invert	Ø	Invert	Ø
6	2860	1912	1600	500	110	575	110
8	2860	1912	1600	500	110	575	110
10	2860	1912	1600	500	110	575	110
12	2860	1912	1600	500	110	575	110
16	3400	1912	1600	500	110	575	110
20	4200	1912	1600	500	160	575	160
25	4200	1912	1600	500	160	575	160
30	5200	1912	1600	500	160	575	160
35	5200	1912	1600	500	160	575	160

Notes:
> *Larger population sewage treatment plants may be supplied as multiple tank configurations.*
> *For precise tank sizes and configurations, please contact Marsh Industries*
> *All dimensions in mm*