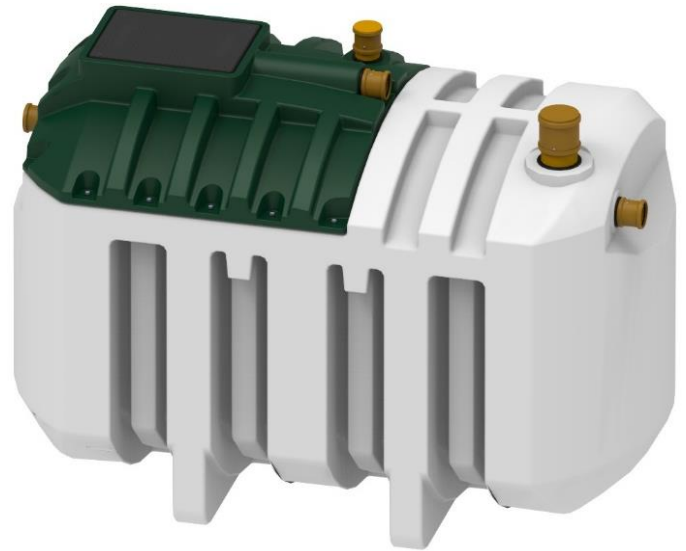


# Harlequin Continuous Aeration Plant

CAP 6, CAP 9 & CAP 12

## Installation and Operating Instructions



**INCLUDING NEW CAP 12 PRODUCT**  
RELEASE MARCH 2022

**Harlequin®** CE  
MANUFACTURING FOR TOMORROW

## Contents

| CONTENTS                                   | Page No. |
|--|----------|
| Harlequin CAP Key Data                     | 3        |
| General Information                        | 4        |
| Regulations and Guidelines                 | 5        |
| Installation Instructions                  | 6        |
| Operating Instructions                     | 12       |
| Warranty                                   | 13       |
| Maintenance                                | 14       |
| Installer Check-List                       | 15       |
| Fault Guide                                | 16       |
| Appendix 1: EN Certification               | 18       |
| Appendix 2: CAP 12 Installation Guidelines | 19       |
| Appendix 3: Service History                | 20       |

Harlequin CAP Key Data.

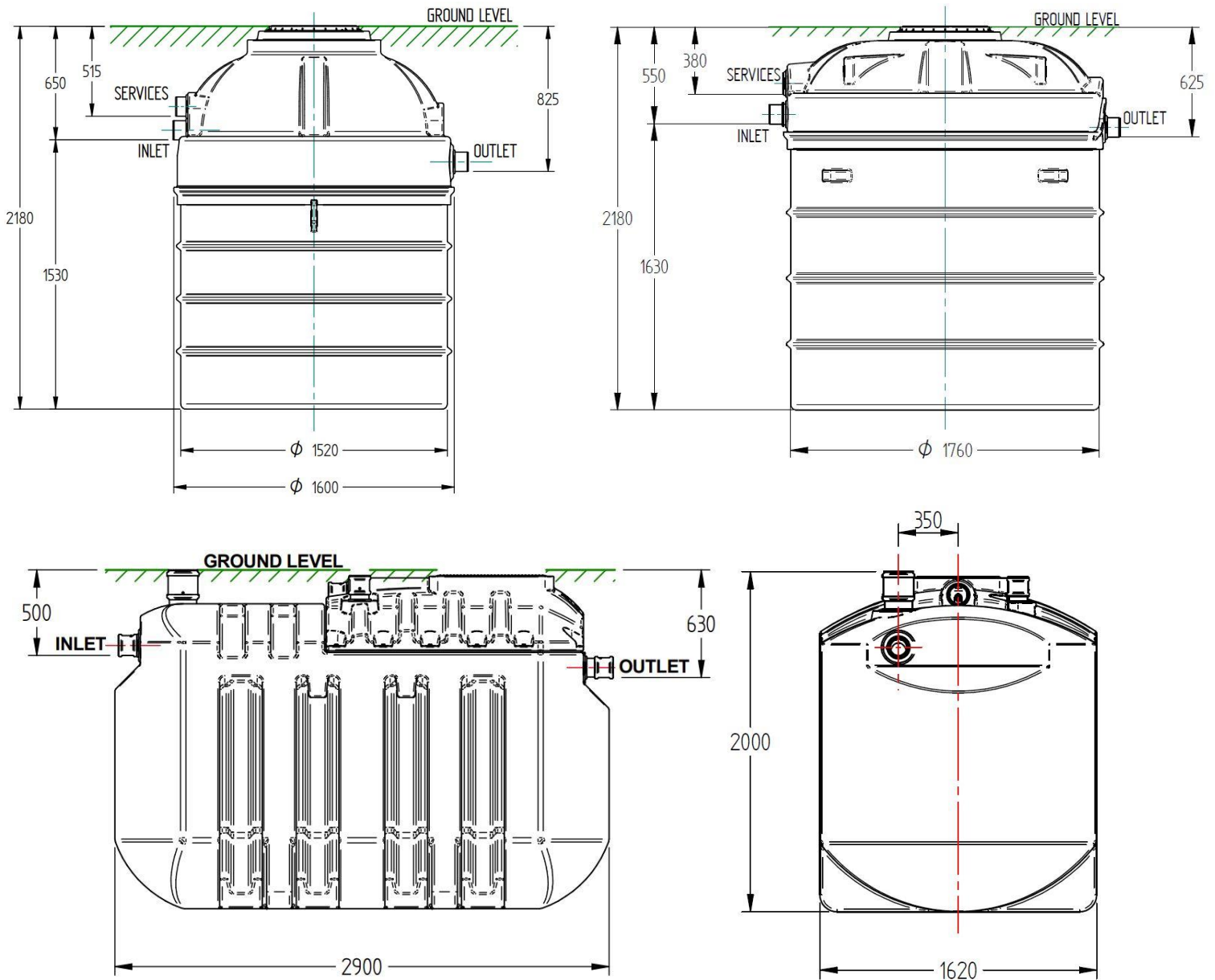


Figure 1: Harlequin CAP 6, CAP 9 & CAP 12 Key Dimensions (Gravity versions)

| Treatment efficiency<br>(nominal sequences –<br>same for both models) | Efficiency | Effluent  |
|---|------------|-----------|
| <b>COD</b>  | 92.6%      | 64.4 mg/l |
| <b>BOD<sub>5</sub></b>  | 96.2%      | 13.0 mg/l |
| <b>NH<sub>4</sub>-N</b>   | 71.9%      | 11.2 mg/l |
| <b>N<sub>TOT</sub></b>  | 58.2%      | 22.6 mg/l |
| <b>Phosphorus</b>   | 41.0%      | 4.3 mg/l  |
| <b>SS</b>   | 96.8%      | 12.3 mg/l |

|                                 | CAP 6                      | CAP 9                   | CAP 12                  |
|---------------------------------|----------------------------|-------------------------|-------------------------|
| Nominal organic daily load      | 0.34 kg/d                  | 0.51 kg/d               | 0.68 kg/d               |
| Nominal hydraulic daily load    | 0.9 m <sup>3</sup> /d      | 1.35 m <sup>3</sup> /d  | 1.8 m <sup>3</sup> /d   |
| Number of desludging            | Not more than once         |                         |                         |
| Electrical consumption          | 0.8 kWh/d                  | 1.1 kWh/d               | 2.5 kWh/d               |
| Max Dimensions                  | L 1660 W 1600 H 2180 mm    | L 1840 W 1760 H 2180 mm | L 2900 W 1620 H 2000 mm |
| Material                        | Polyethylene               |                         |                         |
| Watertightness                  | Pass                       |                         |                         |
| Structural behaviour (pit test) | Pass (also wet conditions) |                         |                         |
| Durability                      | Pass                       |                         |                         |
| Inhabitants Served              | 1-6                        | 7-9                     | 10-12                   |
| Desludging Intervals (months)   | 12                         | 12                      | 12                      |

Figure 2: Harlequin CAP 6, CAP 9 & CAP 12 Key Data

## General Information

### Introduction

It is strongly recommended that you read all sections of this manual before installing and operating your new Harlequin CAP Product. Some installation and operation requirements are specific to CAP products and it is important to familiarise yourself with these.

***This information is supplied as a best practise guide and it is the responsibility of the user/installer to verify that it is used appropriately for the ground and load conditions.***

***Installation of the equipment should only be undertaken by a qualified specialist who is covered with professional indemnity insurance.***

### End-user responsibilities

It is the end-user’s responsibility to ensure that their drainage and sewage treatment system complies with statutory requirements and does not cause pollution to the environment. Guidance can be found at Planning & Building Control departments as well as environmental agency offices regarding statutory obligations.

A professional consultant (architect/consulting engineer/drainage consultant) with experience in off-mains systems should be appointed to carry out a detailed site assessment evaluation and design of the groundworks.

***The plant must be installed, operated and maintained in accordance with the requirements of this document***

The Harlequin CAP is designed to provide full treatment of normal domestic wastewater to discharge direct to surface waters, removing the need for a drainage field (subject to a “Consent to discharge” license). The discharge from a treatment plant will require a Discharge Permit from the Environment Agency if the volume of discharge is greater than 5.0m<sup>3</sup>/day direct to watercourse or 2.0m<sup>3</sup>/day to drainage field, which must be obtained before installation.

In all cases, approval should initially be sought through the local authority Building Regulator. It may also be necessary to obtain the consent of:

- The Environment Agency (EA - England and Wales)
- The Scottish Environment Protection Agency (SEPA - Scotland)
- Environmental Protection Agency (EPA - Ireland)
- The Northern Ireland Environment Agency (NIEA)

### Health and Safety

The advice given in this document is provided with your safety in mind. This document should be retained for future reference and remain in the household should a new occupier take ownership. The following health and safety guidelines should always be strictly adhered to in relation to the operation and maintenance of any wastewater treatment plant. It is important that:

- ***All electrical work is carried out by a qualified electrician***
- ***All plumbing work is carried out by a qualified plumber or groundworks engineer***
- ***All maintenance activities include appropriate measures to safely isolate electrical and water sources.***

At all times, safe working practices should be observed and adopted to avoid accident and injury when working with the equipment.

- The site should preferably be fenced off to prevent unauthorised access, particularly for small children
- The air blower housing should always be kept closed when in operation
- The manhole covers should never be removed and left unattended, even during service visits
- The air blower housing contains electrics operating at 240v. All equipment must be isolated before any maintenance is carried out
- Misuse can lead to serious injury and damage to the plant

- Protective clothing and gloves should always be worn and careful attention paid to personal hygiene, especially if there is any potential contamination with sewage products
- Medical attention must be sought if a user is feeling unwell after coming into contact with wastewater products

Leaving the tank unattended during servicing should be strictly discouraged in accordance with the health and safety procedures.

**Warning: Wastewater treatment processes can produce hazardous gas concentrations even when vessels are fully drained. Never enter vessels without appropriate training and protective equipment.**

### Maintenance

It is important to note that it is the end user's responsibility to ensure that maintenance is performed on the system at the appropriate period. Maintenance will ensure good operation and avoid breakdown which could lead to environmental pollution. Environmental enforcement agencies responding to pollution will hold the owner of the system responsible for ensuring compliance with any consent parameters imposed on the site.

The Maintenance and Service requirements for the CAP product are listed on Page 13 of this document. The warranty for the product will be dependent on all the installation and servicing guidelines being followed.

**In the event of a warranty claim we will require information on the tanks servicing history**

### Regulations and Guidelines

The following documents provide guidance on the requirements of design and installation of wastewater treatment plants.

#### Publicly available guidance documentation

- Northern Ireland Environment Agency Water (Northern Ireland) Order 1999
- The Environmental Permitting (England and Wales) Regulations 2016
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011
- Building Control Regulations 2010, part H Drainage and Waste Disposal, 2015 edition
- British Water Flows and Loads – 4, Code of Practice

#### Relevant British design and testing standards

- EN 12566-3:2005+A2:2013
- BS 6297:2007+A1:2008

#### Tank sizes and construction

The Harlequin CAP is produced in three sizes, suitable for 6, 9 and 12 population equivalents - and is rotationally moulded in tough polyethylene which offers a very high level of impact resistance. It has been independently tested to ensure a robust construction and a long service life.

#### Tank design features

The CAP unit is provided with 2 moulded in lifting eyes or lifting slings on the side of the tank. These are not intended

for transportation of the units and are only to be used when the tank is empty. The lifting hook should be connected to the tank lifting eyes by separate slings of equal length. Ensure that the slinging angle does not exceed 60° at the hook to eliminate excessive compressive loads on the side of the unit. Secure pedestrian duty manhole covers are supplied as standard to comply with statutory regulations. The tanks have a flat base for stability during transportation and storage prior to installation.

#### Storage prior to installation

Tanks should be set on a smooth level base and securely tied or propped to prevent them from overturning and causing damage or injury.

#### Handling

The rotationally moulded polyethylene tanks should be handled by crane or other designated and suitably rated lifting equipment using the moulded lifting slots provided (only when empty). Please contact Harlequin if you require specific product drawings and dimensions of your product.

Harlequin Manufacturing Ltd can accept no responsibility for incorrect offloading or installation. The contractor is responsible for offloading all items of equipment with due regard to the following:

- DO NOT use chains or wire ropes.
- DO NOT lift the tank if it contains any water.
- DO NOT subject the tank to sharp impacts.
- DO check that all items delivered correspond with the delivery note.

When working in deep excavation, make sure that all necessary safety precautions are taken to ensure the stability of the excavation and provide safe working conditions for site personnel. The only time anyone needs to be working at the bottom of the excavation is when levelling the base and ensuring that the first backfill is correctly placed.

#### Plant siting

The discharge from a wastewater treatment plant should be sited a minimum of 10m from any watercourses or other buildings. The distance of the plant from properties may vary from area to area but attention should be paid to the invert on the tank, the subsequent drain gradient on the inlet pipework and the potential of superimposed loads. Local building control office advice should always be sought through planning permission, where required.

The direction of the prevailing wind should also be considered when assessing the plant location as odours may be present when the plant is being desludged or during maintenance. No odour should be present around the tank under normal operation providing the plant has been installed with the venting system (see 'ventilation' on page 8) and the plant has been correctly sized and installed.

For installation, consider the space required on site to allow an excavator to operate, for the removal of soil, delivery of concrete, gravel, etc. For maintenance, consider the access space required for a sludge emptying tanker. Maximum distance of 20m is needed to ensure hose length is sufficient.

Approval for the tank position should always be sought from the controlling authority at an early stage and planning signed off by the local authority building inspector prior to installation.

If using a drainage field, attention is drawn to the minimum recommended distances to other buildings and sources of water which may affect your plant location:

- Drainage Field from habitable dwelling = 15m
- Drainage Field from water course = 10m
- Drainage Field from well/drinking water source = 50m

### Drain gradients

Drain gradients from the dwelling to the treatment plant should be 1:40, although 1:80 can sometimes be permitted with approval of Building Control Officer. The gradient of pipes within a drainage field, if applicable, must be <1:200. The drain from the plant to the start of the drainage field should be in the range 1:40 to 1:80. These are only typical recommendations and must be approved by the Building Control Officer for specific sites.

### Ground and drain levels

Site plans should show existing and proposed ground levels and invert depths of the drain throughout its length. If the drain is too shallow, or if it passes under walls and foundations, it should be protected by concrete surrounds.

### Percolation tests and drainage fields, if applicable

A soil percolation test should be carried out over the proposed drainage field area where necessary. The calculations and drainage layout plan must be submitted to the Council Building Control dept along with the other drawings. The percolation tests should be carried out by a qualified specialist consultant who should be covered with professional indemnity insurance.

### Superimposed loads/protected areas

Harlequin does not recommend that superimposed loads, such as vehicles, be allowed within 3m of any part of the tank, ie not situated close to a driveway, roadway, or anywhere there is a risk of it being subjected to additional superimposed loads. The protected area should also be fenced off.

If vehicular or other superimposed loads are required to come within the protected area a qualified civil/structural engineer must be employed to design the installation. This design must prevent loads being transmitted onto the tank.

Harlequin Tanks may not cover the warranty for the tank body under superimposed load conditions; this responsibility must be covered by the civil/structural engineer. It is thus a requirement that the installation is signed off by this third-party engineer.

## Installation Instructions

Before any tank is installed, appropriate ground condition checks should be made to determine the soil constitution, position of the water table and any flood possibility in the area.

These checks should be performed through test holes in the proposed area and checks with Building Control and the appropriate environmental regulator on any history of level alterations of the local water table. Once the site information has been gathered, the installation type can be selected as either 'Dry' or 'Wet' ground conditions. **If there is any doubt as to the summer/winter water table level, etc, a Wet site installation must be selected.** Failure to follow the guidance instructions during installation may render the warranty null and void.

### Modifying the tank invert depth

The standard CAP is designed to cater for drain invert depths of 650mm (CAP 6), 550mm (CAP 9) and 500mm (CAP 12). The invert depth cannot be reduced any further but standard Ø450mm (CAP 6 & CAP 9) or 450mm x 600mm (CAP 12) risers can be used to increase the invert depth where ground conditions are suitable.

In a standard gravity feed CAP, there should be no more than three of the risers used. In the pumped outlet version, we recommend no more than two to allow access to the submersible pump. If you wish to increase the invert beyond those maximum number of risers (up to a 2.0m maximum invert), we recommend the use of 1200mm concrete rings above the body of the tank to allow access to the manhole cover of the tank itself.

This should not be carried out unless the specific ground condition checks have been made and the installation appropriately modified. Installation for this situation **MUST** follow the Wet ground installation procedure unless a qualified structural engineer has specified the type of backfill.

***Failure to adhere to these design parameters may cause severe structural damage to the tank and will render any warranty null and void.***

**DRY GROUND CONDITIONS**

**WET GROUND CONDITIONS**

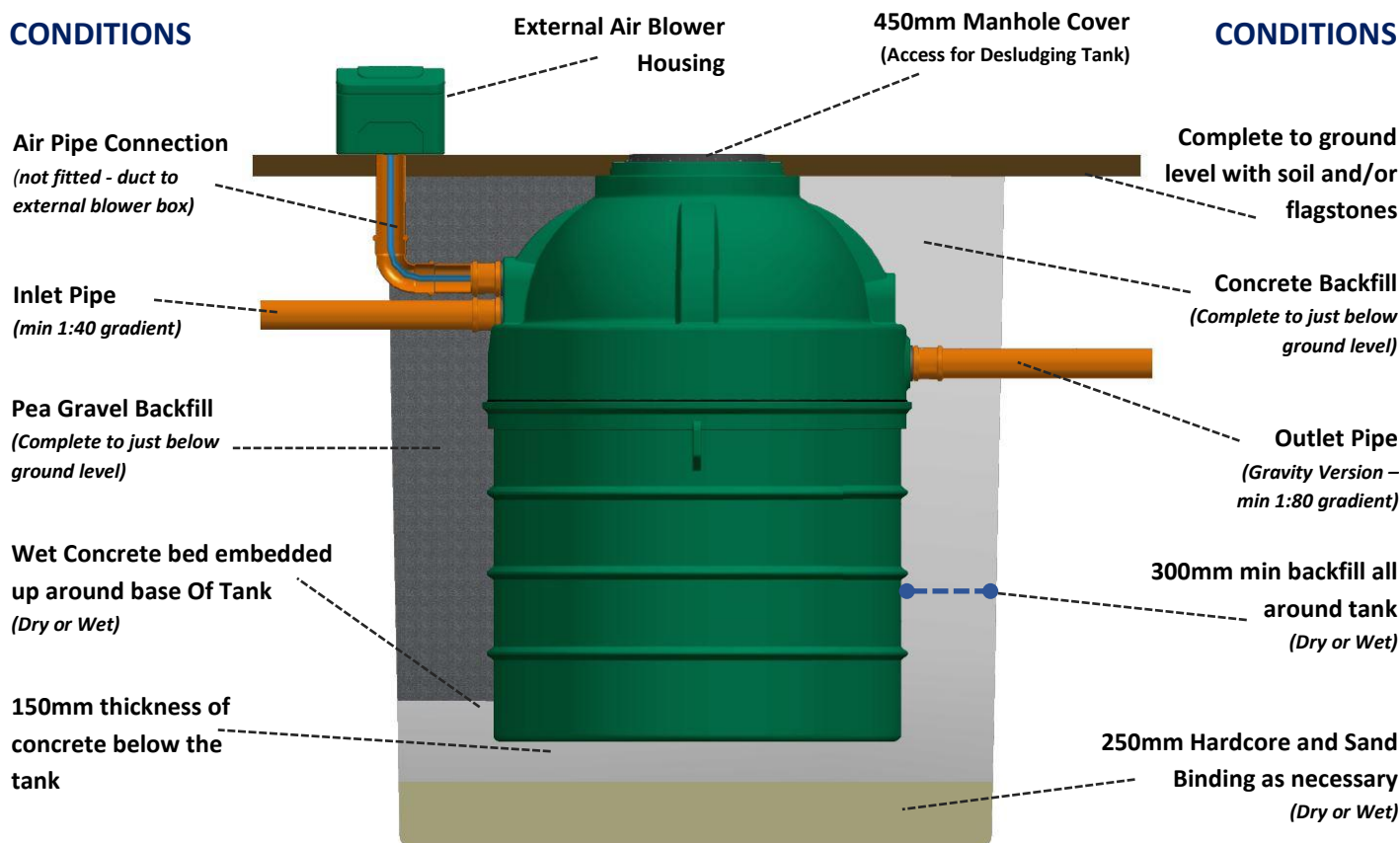


Figure 3: Typical Installation – Dry and Wet Ground Conditions (CAP 6 model Shown)

**‘Dry’ ground installation conditions**

A site is deemed as being dry when at no time does ground water rise above the base of the tank. This is a requirement throughout seasonal changes not just at the time of installation.

**NB:** If the complete surrounding soil structure is non-porous, eg, Clay or if the tank has been installed in bedrock etc, water will pool around the tank within the backfill. In this circumstance, **EITHER** a land drain must be installed to drain the installation to the base of the tank **OR** the wet installation procedure must be used. If the land drain is not sufficient to prevent water pooling around the tank the **WET** Installation procedure **MUST** be followed

**Dry installation procedure**

Excavation should allow for a minimum thickness of 300mm pea gravel all round and 150mm thickness of concrete below the tank(s). Where difficult ground conditions are encountered, ie, in unstable ground or shrinking clay, etc, an additional depth of 250mm should be excavated below the tank to allow for hardcore and sand blinding to provide a firm base for the concrete bed.

Place wet concrete (slump test 30mm, strength 25N/mm<sup>2</sup>) in base of the excavation to a depth of 150mm, grade and level to within 20mm. The concrete must extend a minimum of 300mm all around from the vertical sides of the tank(s). **This is vital to ensure a stable base to prevent settling of the tank(s) which could damage the pipe connections. Lower the**

**tank onto the dried concrete, taking care not to damage any external flanges or pipework and check it is true and level using a spirit level.** Ensure correct orientation of the inlet and outlet pipework. Check that the tank is level in all directions.

**For CAP 6 and CAP 9 models:** Fill each section of the tank starting with the media compartment and fill until the liquid level reaches 450mm. Next, place and consolidate additional concrete carefully around the base of the tank. This will ensure they are correctly supported once installed. **Note: Do NOT use a vibrating poker to compact the concrete.**

**For CAP 12 model:** Fill the tank(s) to approximately 600mm water depth once the tank has been lowered onto the concrete. It is critical that the Reactor/media Chamber of this model is filled first when installing this tank. This will prevent any buoyancy issues that WILL damage the tank. The Primary/Final settlement chambers may then be filled either through the inlet/outlet pipes or through the access/rodding points on the tank. Always maintain a higher liquid level in the reactor compared to the settlement chambers. Please refer to Appendix 2 for an illustrated guide on this.

**All Models:** Continue to fill the tank with water<sup>(1)</sup> whilst simultaneously backfilling around the tank with 12-15mm pea gravel, ensuring the level of water in the tank is maintained higher than the level of backfill (no greater than 200mm max). This will maintain equal pressure inside and outside the tank and will prevent any chance of movement during installation. When the tank is full of water to the inlet/outlet height, connect the inlet/outlet pipes to the tank (as labelled) and

continue to build up and around the tank with backfill to within 200mm of ground level (CAP 6 and CAP 9) or to around 100mm above the body of the tank (CAP 12).

### Pea gravel specification

Pea gravel or crushed aggregate of uniform particle size 12-15mm, free of sharp edges. Chemically inert, washed clean and free of contaminants.

### 'Wet' ground installation conditions

A site is deemed as wet when ground water can rise above the base of the tank. If in doubt of water table position, these Wet ground installation instructions must be followed.

***The maximum permissible water table level is 1.5m (CAP 6 & CAP 9) and 1.7m (CAP 12) from the base of the tank(s). Failure to follow the guidance instructions during installation may render the warranty null and void.***

In poor soil conditions it is essential to make substantial provision for planking, strutting and temporary shuttering.

Adequate pumps should always be provided to keep the excavation free from ground water during the work. Provision should also be made for temporary covers and fencing around the excavation site to comply with statutory Health and Safety requirements.

### Wet installation procedure (continue from <sup>(1)</sup> above)

Continue to fill the tank with water and carefully place concrete around the tank building up the layers, ensuring that there are no voids remaining around the tank. Do not use a vibrating poker.

**For CAP 6 and 9 models:** Commence backfilling with concrete in 500mm lifts, and at the same time, fill each tank compartment with water starting with the media bay section, ensuring the level of water in the tank is maintained higher than the level of backfill (no greater than 200mm max). The concrete must be evenly distributed around the unit, ensuring pipework connections are not covered at this stage. The concrete must now be allowed to harden – approx 24hrs. This is to prevent an unbalanced buoyancy force from the wet concrete from lifting the tank from the excavation as the backfill is raised above the internal water level.

When the tank is full of water to the inlet/outlet height, connect the inlet/outlet pipes to the tank (as labelled) and continue placing the concrete, terminating at the shoulder of the unit (approx. 200mm from ground level). Finally, complete backfilling up to ground level with earth or reinforced ground slab as required.

**For CAP 12 model:** Excavations should allow for a minimum thickness of 300mm concrete all round and 150mm thickness of concrete below the tank. Where difficult ground conditions are encountered, ie, in unstable ground or shrinking clay, etc, an additional depth of 250mm should be excavated to allow for hardcore and sand blinding to provide a firm base for the concrete bed.

Place wet concrete (slump test 30mm, strength 25N/mm<sup>2</sup>) in base of the excavation to a depth of 150mm, grade and level to within 20mm. The concrete must extend a minimum of 300mm all around from the vertical sides of the tank(s). This is vital to ensure a stable base to prevent settling of the tank(s) which could damage the pipe connections. Lower the tank(s) onto the concrete and check it is true and level using a spirit level.

Fill the tank(s) to approximately 600mm water depth as mentioned above in the "dry" installation procedure. Next, place and consolidate additional concrete carefully under the lower radii of the tank(s). This will ensure they are correctly supported once installed. Do not use a vibrating poker.

Continue to fill the tank with water and carefully place concrete around the tank building up the layers, ensuring that there are no voids remaining around the tank. Do not use a vibrating poker. Ensure that the level of water inside the tank is maintained at a level approximately 400mm higher than that of the concrete backfill.

Fill the tank with water until it reaches the height of the outlet pipe and bring the concrete level up to within 400mm of this level. The concrete must now be allowed to harden – approx 24hrs. This is to prevent an unbalanced buoyancy force from the wet concrete from lifting the tank from the excavation as the backfill is raised above the internal water level.

Once the backfill concrete has hardened, connect the inlet/outlet pipes to the tank and continue to backfill with concrete, covering the top body of the tank by 100mm thick layer.

### Electrical power requirements

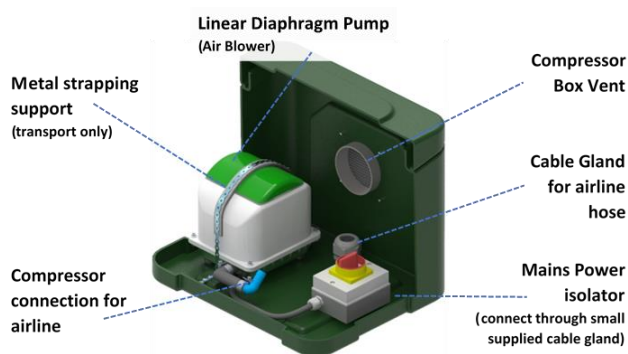
Power requirement is single phase 240V, through a 3-core steel wired armoured (SWA) cable. Refer to the Blower specification supplied with your unit for the specific power ratings to size the electrical cable but 1.5mm is usually adequate. The supply to the unit should be by means of a dedicated circuit with isolation and protection devices consistent with the requirements for fixed equipment and in accordance with the latest regulations. The electrical installation of this equipment must only be carried out by a fully qualified electrician.



### Inside the External Blower Housing

The standard external Blower Housing contains a linear diaphragm pump (air blower) pre-wired to a 20A Isolator (see Figure 4), 10m of airline hose and connection components for the airline and SWA power cable. The unit should be positioned close to the tank at ground level and this distance is limited by the length of airline provided. The perforated metal straps used for transport to hold the blower in place should be removed prior to use.

If the CAP is not to be installed upon delivery, we recommend storing the blower housing at ambient temperature until ready to commission. We also recommend shielding the blower box from direct sunlight when installed, as increased temperatures can reduce the lifespan of the diaphragms.



**Figure 4:** Inside the External Air Blower Housing

The mains power can be brought into the unit through the cable gland (supplied) with the drill location on the unit determined by the end user and then connected directly to the Isolator.

The incoming power supply to the tank must be installed with a separate earth leakage circuit breaker in the source building. Ensure the SWA cable is correctly installed, earthing the outer steel armouring at both ends.

### Connecting the airline to the tank

The supplied airline should be fed through the large cable gland at the bottom of the unit (Highlighted in Figure 4) and connected to the blue plastic elbow/hose-tail on the air blower using a jubilee clip that comes in the kit.

The other end of the airline should be cut to the correct length for your installation and brought into the tank through the service ducting above the tank inlet as shown in Figure 5. This should then be joined to the fixed pipework connected to the diffuser system as also highlighted in the same images. This pipework can be accessed through the main access manhole lid.

The flow regulator valve, which is connected to the diffuser pipework should be set to achieve an effluent return rate of a limited but consistent flow (**the desired setting will have the flow around 1.5l/min**). If the air in the sludge return is operating correctly you will be able to see the return flow through the 30mm hole at the top of the sludge return pipework. Under no circumstances should this valve be fully open or beyond a limited flow as this will detrimentally affect the efficiency of the performance of the plant.



**Figure 5:** Airline connections inside and outside the tank for CAP 6 and CAP 12 models

### Ventilation

It is important that a specific air venting point is provided by the installer to allow the system to freely vent and disperse gas. For these products, this should be achieved through the installation of a soil stack running to the top ridge of the dwelling(s), this must not terminate at eave height. The air from the system must be allowed to freely vent back the inlet pipe from the tank to this soil stack. The internal pipe work of the tanks allows ventilation from all chambers to the inlet pipe work. The soil stack can usually be installed through vertical extension of the dwelling's wastewater pipe where it leaves the building.

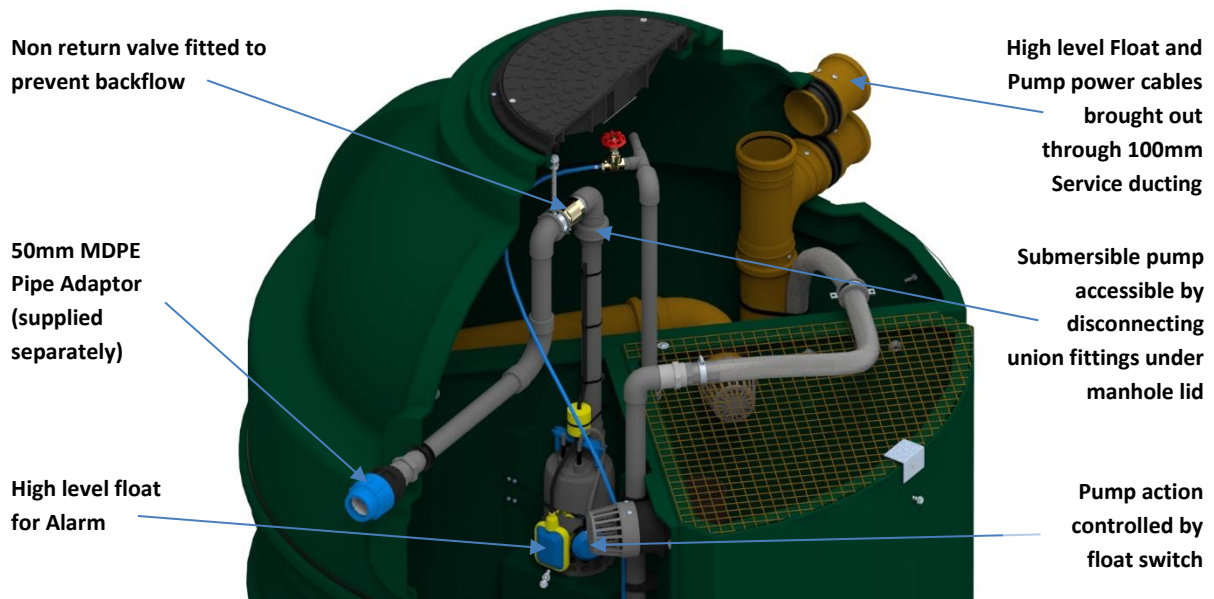
### Pumped Outlet Version (Optional)

Integrated pump outlets can be used where gravity drainage is not possible. The pump process operates through the submersible pump system situated in the Final Settlement Chamber, which is controlled with the use of a float switch. The float switch is set to turn on and off at predefined levels for pumping a specific volume of effluent out to a sample chamber or to discharge. This version of the product comes fitted with a 50mm MDPE Pipe Adaptor as an outlet connection on the tank as opposed to the standard 4" PVC pipe.

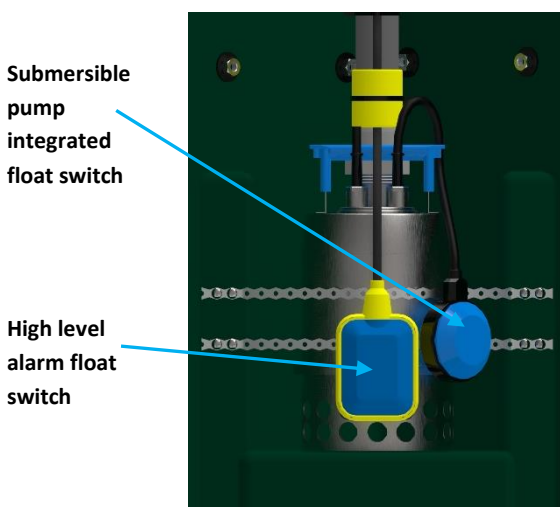
**Installation**

The pumped outlet version of the product should be installed physically by the same procedure as the standard tank. The cables for the high-level float and submersible pump should be brought out through the service ducting as shown in Figure 6 below to the external blower box. The high-level float is attached to the submersible pump and does not need to be disconnected. The submersible pump can be accessed in the final chamber through the removal of the manhole access lid and disconnecting the union fitting as also shown in Figure 6. Additionally in the CAP 12 model, the

mesh must also be removed to access the submersible pump through the 450mm x 600mm manhole lid. The external blower box for this version will contain several extra fittings as shown in Figure 8 below. The cable for the high-level float should be connected to the Overflow Alarm Control box and the power connection from the submersible pump should be connected to the junction box within the blower chamber. We recommend installing a separate power connection/isolation for the Overflow Alarm Control in the External Blower Box to ensure continued operation in the event of a pump power failure (see Figures 9 & 10 below for schematics of the connections).



**Figure 6:** Connections in Pumped Outlet version (CAP 6 Model Shown)



The Submersible pump in the final chamber of the tank operates by use of an integrated float switch. As the water level rises in the final chamber, the float will rise above the pump handle and activate the pump. The pump will then switch off when the water level drops again.

The high-level float is attached to the outlet PVC piping connected to the submersible pump. This switch activates the alarm in the blower box (Figs 8-10) and is designed to only be triggered when the water level rises towards the top of the inner chamber (failure of the pump). If the alarm activates while the pump is operating, the float has been installed too low on the pipework. Please check the operation of all floats when installing.

As with the gravity version of the system, we would recommend removing the submersible pump and (as well as the blower box) storing in dry conditions until the system is ready to be commissioned.

**Figure 7:** Pump and High-level Float Configurations in Pumped Outlet versions

## HARLEQUIN CAP INSTALLATION AND OPERATING INSTRUCTIONS

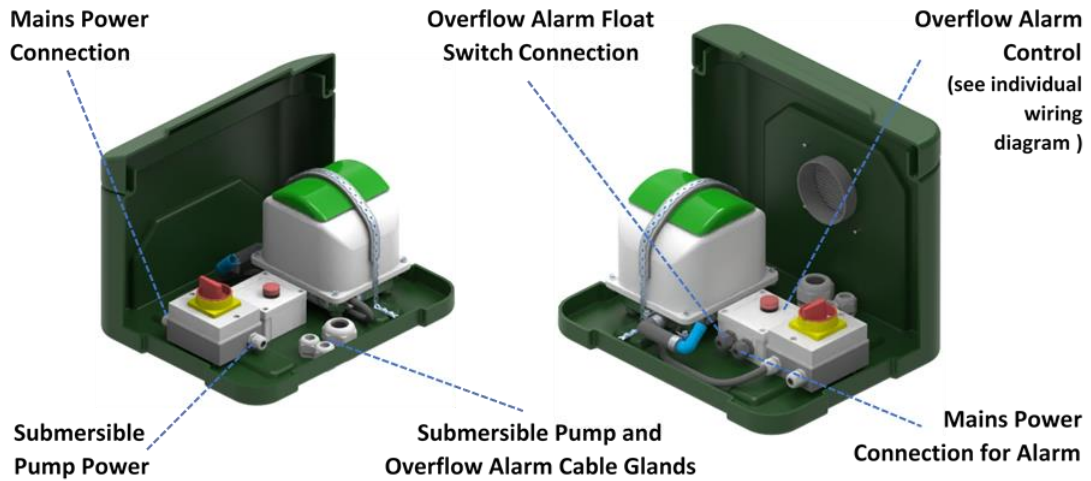


Figure 8: Inside the External Air Blower Housing (Pumped Outlet Version)

### WIRING DIAGRAM (PUMPED OUTLET VERSION)

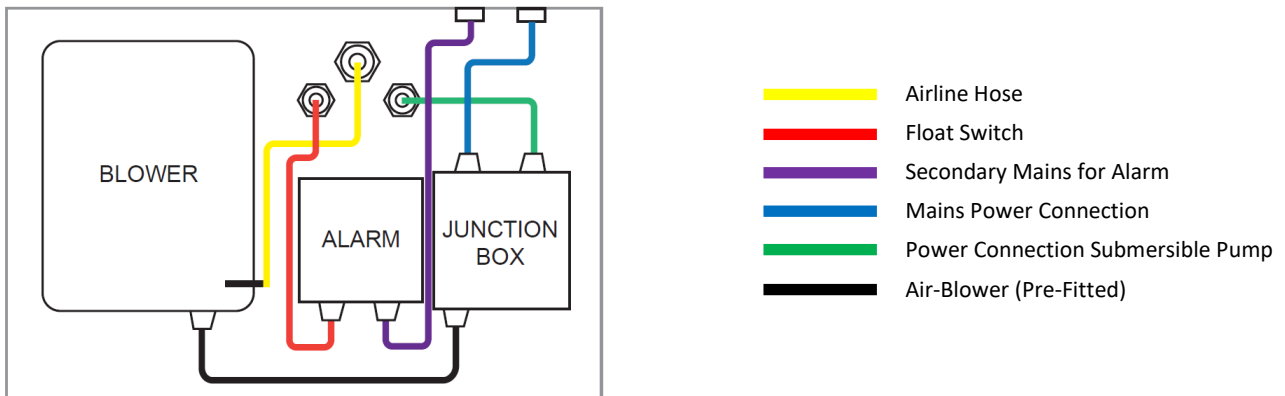


Figure 9: Connections inside External Air Blower Housing (Pumped Outlet Version)

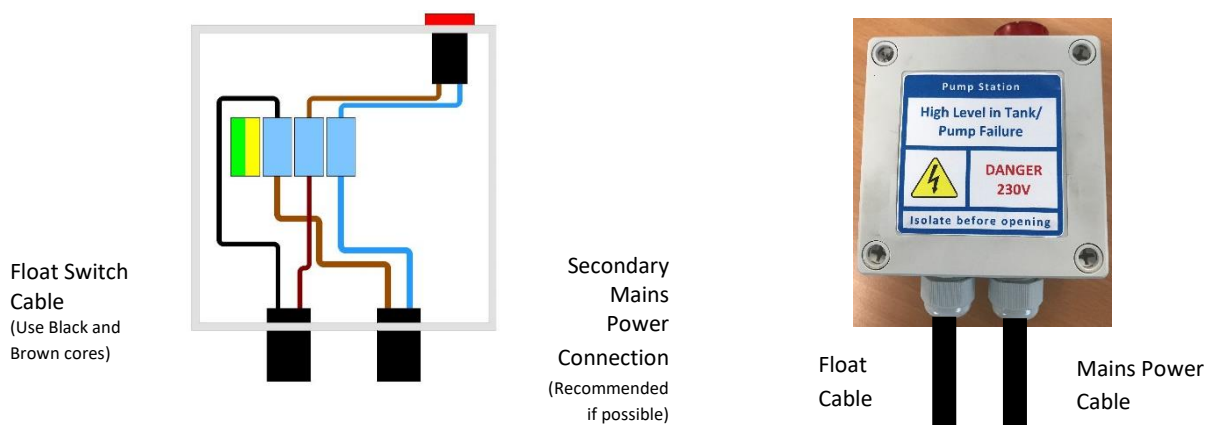


Figure 10: Wiring Connections inside Alarm box (Pumped Outlet Version)

## Operating Instructions

### Process description

The CAP Sewage treatment plant is specifically designed to treat domestic sewage and other biodegradable waste in a simple and compact system:

- A Moving Bed Biofilm Reactor (MBBR) biological system that maximises bacterial growth without the potential for clogging in the system
- The bacteria receive a continuous air supply and are mixed and aerated by the high-volume fine bubble diffuser.
- There are no mechanical moving parts or electrical components within the tank (excluding Pumped Outlet versions). All functions are operated by air power generated by a linear diaphragm pump (air blower) housed in the external box. This allows safe and easy maintenance

Wastewater enters the first of three chambers, the Primary, where settlement takes place with the heaviest solids sinking and the floating matter rising. These solids are retained and stored in this chamber where anaerobic bacteria, ie, bacteria which do not utilise oxygen, break down the organic matter.

The clarified water is transferred to the aeration chamber where it is mixed with freely moving plastic media elements. The media elements support large bacterial populations over their surfaces which are mixed with the water in the chamber.

Through contact with the bacteria, the organic and nutrient constituents of the water are removed. The chamber is continuously aerated by a fine bubble diffuser which provides the oxygen to nourish the bacteria. The air blower which drives the bubble diffuser is easily accessed for maintenance in the external housing. The treated water finally flows through into a smaller final settlement chamber where any sloughed off bacteria or escaping solids are collected.

There is also recirculation pipework (sludge return) connecting the bottom of the final settlement chamber back to the primary settlement chamber. The recirculation flow comes from an airline installed within that pipework. This airline is connected to the main air supply by means of a control tap which ensures the correct balance of flow between the recirculation pipe and the diffuser. This pipework allows the system to recirculate the effluent to prevent stagnation, especially in times of low influent loading.

The final effluent will either flow by gravity through the 4" Water Pipe outlet or will be pumped out through the 50mm MDPE connection by a submersible pump (Optional Pumped Outlet version). From here the completely treated water flows to the outlet where it is discharged back into the environment either directly to a water course or through an underground drainage field.

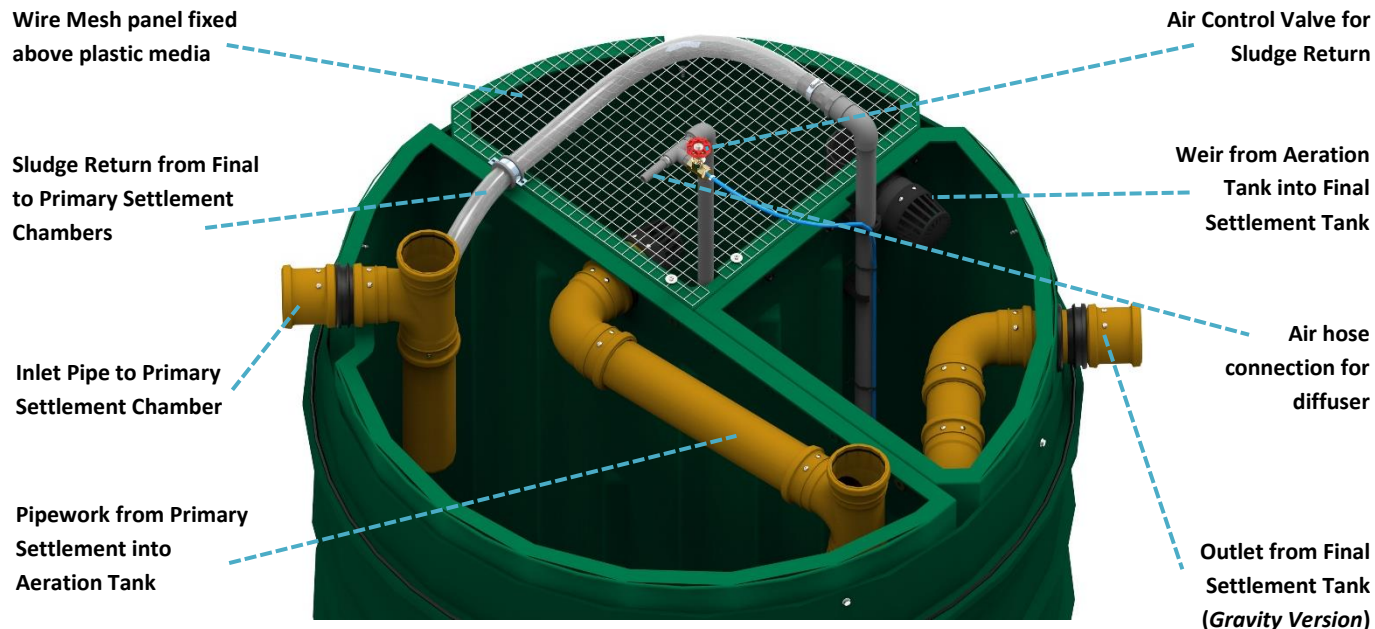


Figure 11: Harlequin CAP Internal Process Description (CAP 6 Gravity model shown)

### Components inside the tank

There are no electro/mechanical moving parts within the standard plant, making the system very reliable and simple to maintain.

The air bubble diffuser in the reactor vessel can be removed by removing the mesh covering the reactor and unclipping the fixed solid pipe and extracting through the main access lid. Rodding access is also provided on all pipework as per normal Building Control guidelines for underground drainage.

### Air blower

The air supply is provided by a linear diaphragm type air blower and is used across all Harlequin Wastewater Systems. This style of air blower is proven to be very energy efficient, cool running with a low noise output. This is kept within the external Blower Housing as described above and shown in Figures 4 & 8.

### Plant Start Up

1. Fill the plant with clean water until there is a discharge from the outlet.
2. Check all the airline connections are connected per the installation instructions on Page 8 to ensure air tightness
3. Check the blower ventilation is unobstructed.
4. Turn on the main power supply to the blower unit.
5. Turn the isolator switch inside the External blower housing to the on position. This will start the blower running.
6. It will take a minute or so for the pressure to build up in the system depending on the distance of the blower from the treatment plant.
7. Check that bubbles are breaking the surface in the filter media section of the treatment plant.
8. The flow regulator tap on the airlift recycle should be set to achieve an effluent return rate of not quite a constant flow. This may need adjustment due to temperature conditions or distance of blower from the treatment plant. NOTE: It will take about a minute between adjustments for a change in flowrate. The desired setting is where the flow only just 'spitting' back. Under no circumstances must this tap be fully open or the flow constant, as this will detrimentally affect the process performance of the treatment plant.
9. If a discharge pump is fitted in the final settlement area, check for operation.
10. Fit the manhole cover and lock if necessary.

The CAP tank is now in an operational state. However, the treatment process relies on the growth of microorganisms on the filter media. The time taken for these naturally occurring organisms to develop is dependent on temperature and may take up to six weeks in winter.

Until the biomass is fully developed, the treatment process will be incomplete. During this time do not allow any strong cleaning agents or bleaches to enter the system.

### Plant Shut Down

Temporary absence of flow to the plant will not be detrimental as the air lift will continue to recycle sewage within the system. However, if the flow of sewage to the plant will be interrupted for more than a month, the following procedure should be completed:

1. Desludge the primary and final settlement tank compartments in accordance with the instructions below.
2. Refill the plant with clean water.
3. Fit the manhole cover and lock if necessary.
4. Stop the blower by turning the isolator switch to off.
5. Switch off the power supply to the blower enclosure.

### Warranty

It is ultimately the customer/house owners' responsibility to ensure that their drainage and sewage treatment system complies with all statutory requirements.

Harlequin Manufacturing cannot guarantee the quality of effluent produced as we cannot control what enters the plant. The warranty policy covers the plant only and does not cover or guarantee an effluent quality. Drainage fields, drains and the emptying of primary tanks remain the responsibility of the treatment plant owner.

The plant will have a 2 year extended warranty (if the product is registered with Harlequin) that is valid from the date of sale – this warranty covers the body of the tanks and ancillary equipment (excluding consumables), where a replacement will be delivered to site. This is subject to the tank being installed correctly according to the instructions listed in this guide and the servicing requirements being met.

The warranty does not cover anything before or after the tank i.e. soak away, drainage, venting and it does not cover damage done to the plant by any other product within the system.

### **In the event of a warranty claim we will require information on the tanks servicing history**

If a Harlequin Wastewater Treatment Plant arrives on site damaged, it is to be reported by the end user / installer at the time of delivery/installation.

It is the installer's responsibility to check the plant internally for damage. It is also the installer's responsibility for the electrical supply, safety, connection, suitability and testing non-interference with other electrical systems as well as the ducting, hoses, venting and sealing.

The plant is not designed to have any non-biological waste going into the tank and is not suitable for any waste out with the plants design parameters. If a fault develops with the tank due to unsuitable waste entering the system this is not covered by the warranty agreement.

To ensure that the plant continues to operate efficiently, your attention is drawn to the following points:

DO NOT exceed the maximum design loading of the plant.

DO NOT allow surface water to enter the system.

DO NOT allow high volume discharges such as from swimming pools or Jacuzzis to enter the system.

DO NOT allow large quantities of non-biological waste/chemicals such as water softeners, disinfectants, strong acids or alkalis, oil and grease, pesticides or photographic chemicals to enter the system.

DO NOT use chemical or biological emulsifiers in grease traps.

DO NOT allow fats, oil or grease from catering applications to enter the system.

### Maintenance Schedule:

#### Desludging:

As with any packaged treatment plant, it is extremely important that the CAP is desludged and serviced at the prescribed intervals so that the maximum working life of the components is achieved, and that effluent quality does not deteriorate.

It is a requirement of the product warranty that desludging is performed at the required intervals. Proof of desludging, in the form of invoices clearly showing the desludging date, may be required. Failure to carry out regular desludging may affect your Harlequin product warranty. Failure to desludge the system at the appropriate time may cause excessive solids to build up. This could result in solids washout which can pollute water courses or block drainage fields. Details of the desludging procedure can be found in the Maintenance Schedule.

1: To access the sections of the tank for desludging, the main manhole lid will need to be removed from the tank (see Figure 3 & 5 for images). This lid is held in by 2 screws.

2: Check the primary settlement tank with a probe, the top floating crust blanket should not exceed 200mm thick, arrange desludge if required

3: Desludge the primary and final settlement tanks every 12 months\*. This should be done by an experienced local waste disposal company.

4: The tanker suction hose should be carefully lowered into the primary and final chambers ensuring all settled sludge is removed.

5: It is important **NOT** to desludge the aeration chamber which contains the active bacteria affixed to the media. This will stop your system operating correctly

6: Once desludging is complete the plant should be refilled immediately with water (waste or clean) to re-balance internal and external pressures on the plant.

This can be done by using a hosepipe or by running several taps in the household(s).

*\* We recommend that these CAP systems be desludged at least once a year or more often if necessary. The desludging interval may be extended on sites where lower solid concentrations exist (ie a plant is not meeting its full utilisation) but the sludge level should not rise above 700mm before desludging. Contact Harlequin Manufacturing for further information.*

#### General Checks:

- Check the operation of the blower. If the blower has failed for any reason other than a mains power failure the warning beacon will be flashing.
- Check the operation of the diffusers (bubbles rising in the Biological zone).
- Check the recycle flow into the inlet zone. Look at the liquor being returned, it should run clear by the end of its cycle.
- Check the inlet and outlet stilling zones are clear of debris. (Remove any obstructions).
- Check the blower ventilation is un-obstructed.
- Check the biomass growth on the filter media. The biomass should be a light brown colour, not white or grey. The odour in the plant should be 'earthy'. There should not be a noticeable 'rotten eggs' smell.
- Check the final effluent. If this is cloudy or contains many suspended particles, then the final settlement tank is likely to require desludging.

**Filters:** It is a recommendation that the air blower filter be checked/cleaned/replaced (if necessary) every 3 months, particularly on sites which are prone to dusty conditions. Service kits and instructions for the checking/replacement of a filter are available on request. The warranty on the blower is subject to the filter quality being maintained.

**Diaphragms:** The working life of the diaphragm depends on the operating conditions and the work environment but for optimal operation and both parts need to be replaced every 12 months. The warranty on the blower unit is subject to the diaphragm being maintained. Diaphragms kits and instructions are available on request.

**Valve Boxes:** It is recommended by the manufacturer that these covers are replaced every three years to maintain optimum performance.

#### 24-monthly intervals

A full service on the plant should be performed. The service should ensure that all aspects of the system are functioning correctly.

Particular areas of detail include:

- Checking all chambers for damage
- Checking the full air system including the air blower and diffusers
- Checking lid seals and air blower chamber
- Checking ventilation system
- Checking electrical connections at the plant.

**FINAL INSTALLATION CHECK LIST**

- Tank Installed correct distance from property
- Tank installed on a flat concrete base
- Tank backfilled with pea-gravel in “dry” ground conditions
- Tank backfilled with concrete in “wet” ground conditions
- Air hose cut to length and connected to blower box and tank connections securely
- Electrical installation completed and Air blower running
- Check Diffuser is in correct position with air bubbles passing up through media evenly
- Effluent return is operating at minimum consistent level with no air bubbles in final chamber
- Customer has been advised on desludging and servicing of tank
- Customer has been given copy of Installation and Servicing Guide

**CAP 12 Specific:**

- Reactor/Media Chamber filled with water before Primary Chamber

**Pumped Outlet Version:**

- Secondary power supply for High level alarm (recommended)
- Ensure Submersible pump starts operating as float rises above pump
- Ensure Pump turns off as liquid level lowers below top of pump
- Ensure high level alarm operates if water level rises towards top of chamber

GENERAL FAULT-FINDING GUIDE

| Symptom  | Cause   | Action (all work must be performed by a specialized company)                       |
|--|---|--|
| Strong smell                                   | Blocked or damaged air diffuser                                     | Remove the diffuser; clean or replace if necessary                                 |
|  | Blocked or damaged air hose   | Change the damaged hose, unblock it if necessary                                   |
|  | Kinks/bends in the air hose   | Change damaged air hose  |
|  | Air escaping from joints  | Check connections and tighten them if necessary                                    |
|  | The joints of the pipes are damaged                                 | Check and replace the seals if necessary   |
|  | The air diffuser is no longer at the bottom of the tank             | Re-Install the diffuser at the bottom of the tank, replace the weight if necessary |
|  | High sludge level   | Arrange a desludging of the tank   |
|  | The diaphragm of the blower is damaged                              | Replace the diaphragm  |
| Poor quality effluent                          | The air diffuser is clogged or torn                                 | Remove the diffuser; clean or replace if necessary                                 |
|  | Blocked or damaged air hose   | Change the damaged hose, unblock it if necessary                                   |
|  | Kinks/bends in the air hose   | Change damaged air hose  |
|  | Air escaping from joints  | Check connections and tighten them if necessary                                    |
|  | There is an organic overload because of the use of garbage grinders | Compost biological wastes  |
|  | High sludge level   | Arrange a desludging of the tank   |
|  | There is no power supply  | Check power  |
|  | The diaphragm of the blower is damaged                              | Replace the diaphragm  |
| Treated water contains large amounts of solids | High sludge level   | Arrange a desludging of the tank   |
|  | Excessive use of the washing machine                                | Minimise continuous use of equipment that will dispose to the tank                 |
| Fat build up within the tank                   | Excessive use of the washing machine                                | Minimise continuous use of equipment that will dispose to the tank                 |
|  | Excessive fatty components coming to tank through waste streams     | Separate fatty waste streams and minimise amounts going to tank                    |



## HARLEQUIN CAP INSTALLATION AND OPERATING INSTRUCTIONS

|   |  |   |
|---|--|---|
|   | The air diffuser is clogged or torn      | Remove the diffuser; clean or replace if necessary  |
|   | Blocked or damaged air hose              | Change the damaged hose, unblock it if necessary  |
|   | Kinks/bends in the air hose              | Change damaged air hose   |
|   | Air escaping from joints                 | Check connections and tighten them if necessary   |
| High water level (above the pipes)                            | Blockage in the pipes                    | Clean all pipes (Inlet, outlet and inside the tank where possible)  |
| Air Blower warning  | Issue with the Air blower                | Check the power supply, the diaphragm and air filter. Replace/repair if necessary   |
| There is no recirculation flow from the final settlement tank | Issue with the Air blower                | As above  |
|   | Recirculation pipework is blocked        | Use a wooden pole to agitate any sludge which has settled around the bottom of the recirculation pipework in the final settlement tank. If there is a substantial level of sludge, then arrange a service |
|   | No air getting to the recirculation line | Check that the air control valve has been opened to a suitable level so that a limited constant flow of liquid is achieved  |
|   | The air control jet is blocked           | Remove and clean the jet. In cleaning the jet ensure the orifice is not enlarged.   |
|   | Air bubbles in Final Settlement tank     | Check that the blue air hose is connected correctly to the fitting on the PVC pipe in the final settlement chamber.   |
| Higher Noise Levels   | Issue with the Air blower                | Ensure that the perforated metal straps holding the unit down within the external blower housing have been removed  |

Appendix 1: EN Certification



## Certificate

386.01C01

**Harlequin Manufacturing Ltd**  
21 Clarehill Road, Moira, County Armagh, Northern Ireland, BT67 0PB, UK

**EN 12566-3, Annex B**  
Small wastewater treatment systems for up to 50 PT

**Small wastewater treatment system CAP**  
Moving bed biofilm reactor (MBBR) in one polyethylene tank

Test report PIA2021-386B24

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**Evaluation of the nominal sequences of the 38-week testing**

|                                       |                             |
|---------------------------------------|-----------------------------|
| Nominal organic daily load (influent) | 0.32 kg BOD <sub>5</sub> /d |
| Nominal hydraulic daily load          | 0.9 m <sup>3</sup> /d       |
| Material                              | Polyethylene                |

|                      |                     |          |           |
|----------------------|---------------------|----------|-----------|
| Treatment efficiency | Efficiency          | Effluent |           |
|                      | COD                 | 92.6 %   | 64 mg/l   |
|                      | BOD <sub>5</sub>    | 96.2 %   | 13 mg/l   |
|                      | TN <sub>b</sub> *   | 58.2 %   | 22.6 mg/l |
|                      | NH <sub>4</sub> -N* | 71.9 %   | 11.2 mg/l |
|                      | P <sub>tot</sub>    | 41.0 %   | 4.3 mg/l  |
|                      | SS                  | 96.8 %   | 12 mg/l   |

**Evaluation of the complete 38-week testing**

|                        |           |
|------------------------|-----------|
| Electrical consumption | 0.8 kWh/d |
| Number of desludging   | 1         |

\* determined for temperatures  $\geq 12^{\circ}$  C in the bioreactor.

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Tested by:

**PIA – Prüfinstitut für Abwassertechnik GmbH**  
(PIA GmbH)  
Hergenrather Weg 30  
52074 Aachen, Germany

This document replaces neither the declaration of performance nor the CE marking.

  
Notified Body  
No.: 1739

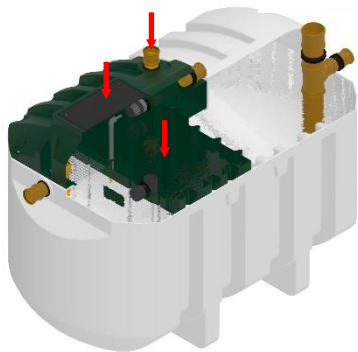
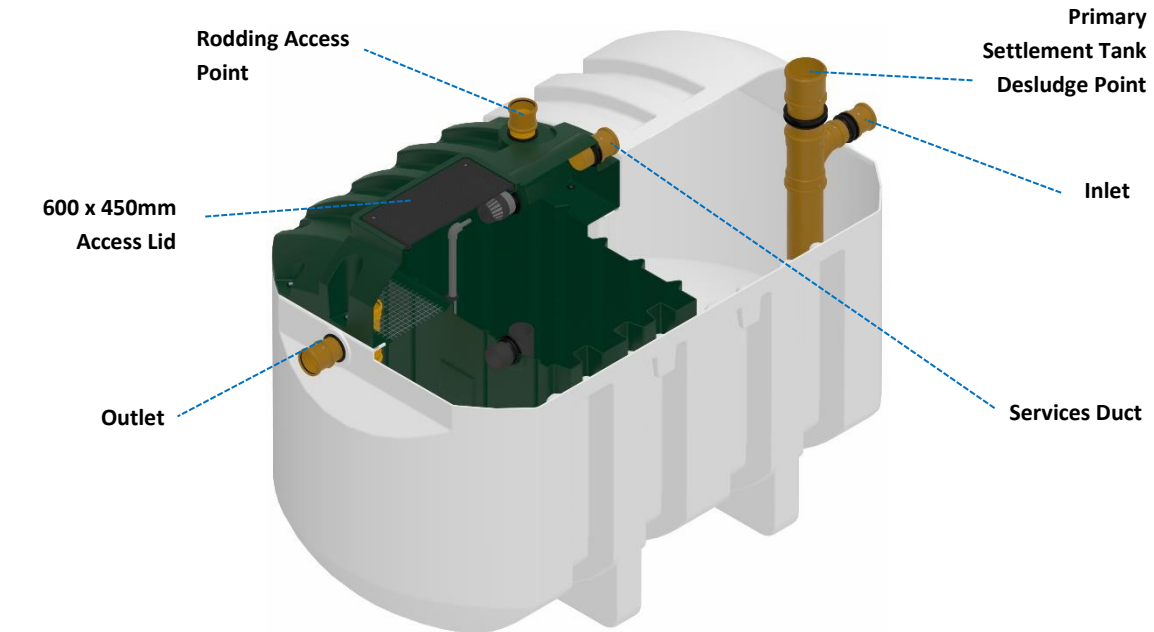


  
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Akreditierungsstelle  
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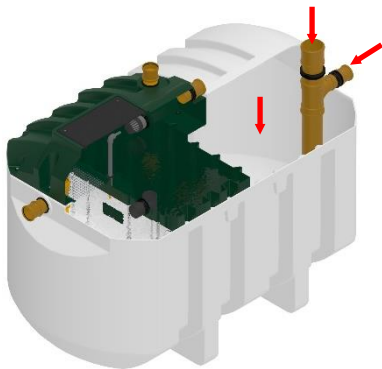
  
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Martina Wermter
September 2021

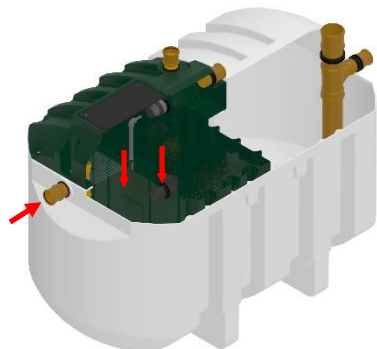
Appendix 2: CAP 12 Installation Guidelines



- Once tank has been lowered onto concrete base, fill the reactor chamber first through the 450mm x 600mm manway access lid or through the Rodding Access Point for that Chamber. This **MUST** be carried out first to prevent damage to the tank



- When Reactor/media chamber is filling, you can start to fill the Primary and Final Settlement chambers. You can fill the Primary chamber though the primary Desludge Point or the Tank Inlet point. Always ensure the liquid level in the Reactor is higher than the other chambers



- You can fill the Final Settlement Chamber though the main 450\*600mm manhole access lid or through the Tank Outlet. The tank will be full when the liquid level reaches the outlet pipe.

**HARLEQUIN CAP INSTALLATION AND OPERATING INSTRUCTIONS**

**Appendix 3: Service History**

| <b>Service Date</b> | <b>Maintenance Details</b><br>(Service/call out/de-sludge) | <b>Signature</b><br>(with Company name) |
|---------------------|--|---|
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