JDP

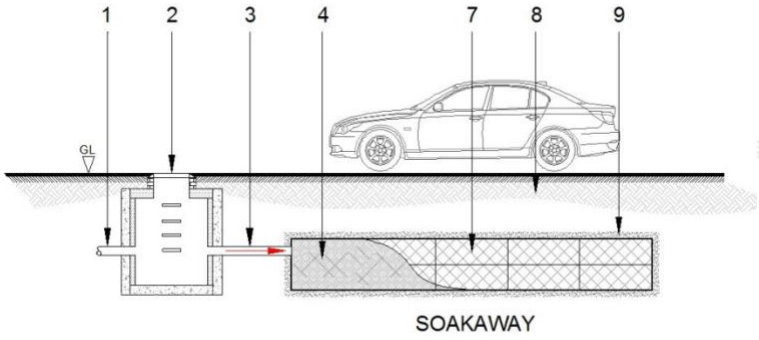
rainbox® 3S

TECHNICAL GUIDE

How the system works

Soakaway

Rainwater, which has been collected from impermeable surfaces, is directed to the crate structure via a silt trap chamber. As the crate structure fills, water begins to exfiltrate from the tank into the surrounding ground. The crate structure is surrounded with a permeable non-woven geotextile to prevent any ingress of silt to the crate structure.

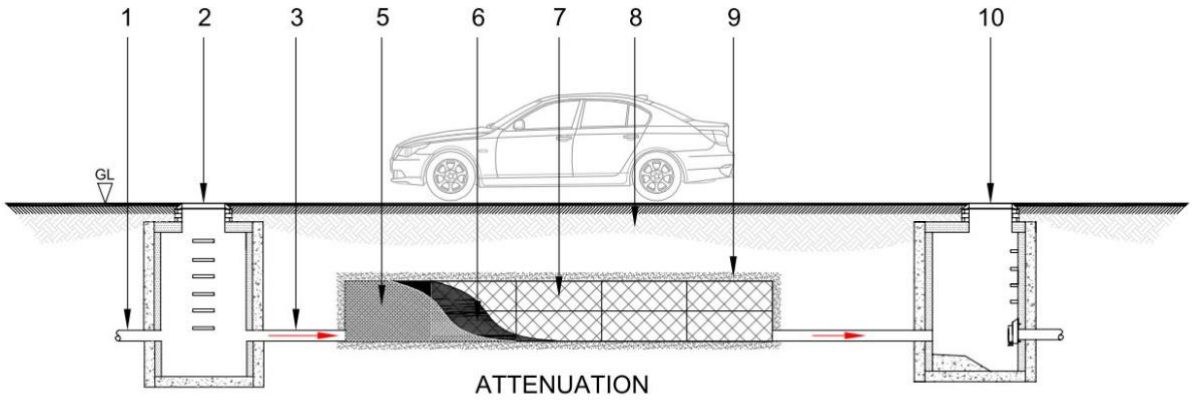


SOAKAWAY

1. Inlet to chamber
2. Silt trap chamber with minimum 300mm sump.
3. Inlet to soakaway/attenuation tank
4. 125g/m² Non-Woven Geotextile
5. 300g/m² Non Woven Geotextile Protection Fleece
6. 1.00mm Thick LLDPE Impermeable Geomembrane
7. Rainbox 3S Crate
8. Minimum cover as required
9. Layer of 100mm thick course sand
10. Outlet chamber fitted with a flow control device

Attenuation

Rainwater, which has been collected from impermeable surfaces, is directed to the crate structure via a silt trap chamber. A chamber downstream will contain a flow control device. When the inflow exceeds the allowable discharge rate the flow control device will serve to surcharge the crate structure with the excess storm water. The water is then discharged at the agreed rate to either a watercourse or existing sewer network. The crate structure is surrounded in an impermeable membrane to ensure it is watertight and protection fleece geotextile to prevent puncture of the membrane.



ATTENUATION

Crate Structure Volume

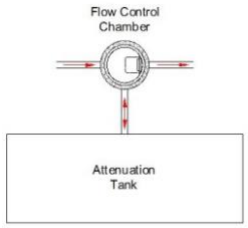
There are two major factors which determine the required volume within a crate structure based on attenuation or soakaway applications:

- Incoming flow rate: the amount of water collected from the impermeable areas of the development that is directed to the crate structure.
- Outward flow rate:

  Soakaway - infiltration into the ground (depends on the permeability of the ground and the surface area of the crate structure sides and base).

  Attenuation - discharge at a regulated flow rate (as agreed by the statutory authority) towards a water course or existing sewer network.

The storage volume required for soakaway or attenuation purposes is based on these two variables.

Offline System	**Online System**	
Attenuation	**Attenuation**	**Soakaway**
		
The inlet/outlet is connected to the same manhole/inspection chamber. The inlet pipe to the attenuation crate structure is above the normal dry weather flow level. The crate structure only fills up during periods of heavy rainfall.	The total volume of rainwater passes through the crate structure. The inlet(s)/outlet are located in different positions. The crate structure fills when the flow rate exceeds the agreed discharge rate.	All storm water flows into the crate structure and infiltrates into the surrounding ground as and when saturation allows until the crate structure is empty. The design of the crate structure is required to ensure a half empty time of 24 hours or less.

Interceptors/Silt Traps

The correct preliminary treatment must be used to ensure that all kinds of pollution are removed from the storm water before it enters the crate structure. This includes the removal of hydrocarbons, silt, debris and any other pollutant that may affect the performance of the crate structure.

The preliminary treatment of storm water is critical in terms of ensuring the system as a whole works effectively over the long term.

They are easy to maintain using traditional methods and resources associated with network maintenance.

If correctly maintained the right preliminary treatment will ensure the crate structure remains as efficient as possible.

The following are examples of preliminary treatment that may be used on storm water drainage systems.

Silt Traps

Silt traps can be formed in chambers/manholes using traditional materials such as concrete and brick. Alternatively, fabricated plastic chambers can be manufactured to create a sump with the required inlets and outlets pre-installed. It is good practice to install a silt trap immediately upstream of any crate structure. This helps to prevent any silt or debris from entering the crate structure which could cause damage or blockages.

Petrol Interceptors

Petrol interceptors come in the form of pre-fabricated packaged solutions. They can be either class 1 (for discharge to a water course or surface water sewer) or class 2 (for discharge to foul sewers). There are a number of different types of interceptors that are used in different circumstances. These are by-pass, full retention, forecourt and wash down/silt separators.

Filter Trench – Alternative Option

Filter trenches can be used to partially treat storm water run-off before it enters a crate structure. A filter drain will usually consist of a trench lined with impermeable membrane and filled with clean crushed stone. The storm water will flow in at the upstream end of the trench and naturally filter through the stone material before being collected at the downstream end by perforated pipework or similar. As the water filters through the stone in the trench any hydrocarbons present will be naturally removed.

Technical Characteristics

General Characteristics

Dimensions:	L 1200 x W 600 x D 420 mm
Gross Volume:	302 L
Storage Volume:	290 L
Void ratio:	96 %
Materials:	Polypropylene
Recyclable:	100 %
Approximate weight:	11.5 Kg

Crates are linked by clips:

Connection Options

- The RAINBOX® 3S comes with pre-formed cut-outs for connecting pipework up to 160mm OD.
- For sizes up to 400mm OD, specially made adaptor plates can be used.
- For larger diameter pipes a manifold system will need to be designed to facilitate connections to the crate structure.

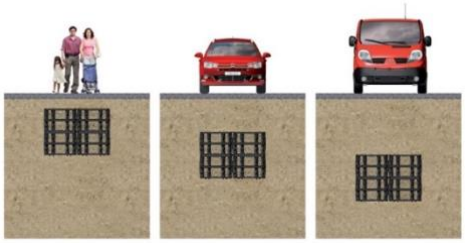
Optimal Strength

The strength of the RAINBOX® 3S is achieved through a combination of several parameters:

- **The alignment of the columns** ensures loads are transferred down through the entire crate structure as effectively as possible.
- **The design** around the edge of the RAINBOX® 3S ensures a perfect compromise between high levels of perforation and an even distribution of loads. Adjacent crates are connected by clips. This makes for a stronger overall crate structure and provides great durability, even under stress.

Design & Installation Guidance

Vertical loading to the crate structure is determined by the cumulative loads associated with the backfill and any loads linked to operations (vehicular loads (live loads) or permanent structures (dead loads)). Horizontal loading, is determined by the pressure exerted by the earth.



The resulting information determines the minimum and maximum cover depth and the maximum excavation depth. Table 1 shows the parameters for the different applications.

Table 1 (For Guidance Only*)	**Load (GVW)**		
	Pedestrians	**Small Vehicles ≤ 3T**	**Vehicles ≤ 12T****
Coverage in m (based on backfill φ' 30° and density 20kN/m²)			
Min.	0.30	0.50	1.20
Max.	2.50	2.20	2.00
Max Excavation Depth in m			
with backfill φ' 20°	2.90	2.90	2.90
with backfill φ' 25°	3.80	3.80	3.50
with backfill φ' 30°	4.00	4.00	4.00

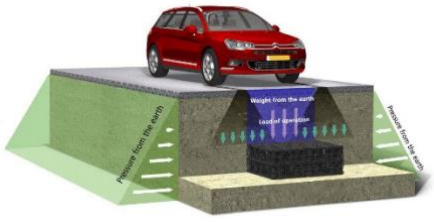
* The installer of the RAINBOX 3S system should ensure that a structural design check in line with CIRIA C680 has been carried out prior to work commencing.
** Use by heavier vehicles may be permissible depending on site conditions. Please contact JDP Technical Support for more information.
φ angle of internal friction

Adjacent to buildings the minimum horizontal distance to the crate structure should be 1.5 times the depth to invert. For a soakaway, this distance must be a minimum of 5m as per Building Regulations 2010 Approved Document H (unless a specific study makes it possible to recommend a shorter distance).

Each individual project can be assessed by the JDP Technical Support Department to help create the most cost-effective solution for our client.

Load Resistance

Given the very significant loading to which the RAINBOX® 3S crate will be exposed following installation, it has been designed to cope perfectly with these extreme mechanical demands. The image below provides an overview of the forces to which the crates will be subjected.



These loads can be grouped into two categories:

- **Permanent**: weight and lateral pressure from the earth and any permanent loads associated with storage facilities
- **Temporary**: weight and lateral pressure from mobile loads and loads associated with materials stored during work on site

These are transferred through the ground towards the buried crate structure.

Dimensional Parameters

Calculations for the pressure generated by the earth and the water table.

The forces present in the ground must be considered in both a vertical and horizontal direction. The vertical pressure corresponds to the sum of the various forces acting in this direction. The horizontal pressure corresponds to a fraction of the vertical forces, depending on the quality of the earth (angle of internal friction).

$$Fh \text{ (horizontal forces} = \lambda a \times Fv \text{ (vertical forces), where } \lambda a = \frac{1 - \sin \varphi}{1 + \sin \varphi}$$

Angle of Internal Friction		
Ground Type	**φ**	**λa**
Fine, dry sand	10 to 20°	0.490 to 0.704
Fine, moist sand	15 to 25°	0.406 to 0.589
Medium, slightly moist gravel	30 to 40°	0.217 to 0.333
Moist topsoil	30 to 45°	0.172 to 0.333
High compact earth	40 to 50°	0.132 to 0.217
Pebbles, shingle	40 to 50°	0.132 to 0.217
Dry marls	30 to 45°	0.172 to 0.333
Dry clays	30 to 50°	0.132 to 0.333
Moist clays	0 to 20°	0.490 to 1.000
Soft sandstone and miscellaneous rocks	50 to 90°	0.000 to 0.132

*These values are for information only and should be validated via shear testing on site.

**Calculations where the water table is involved (for retention) must factor in at 100% the pressure exerted by the water table in both a vertical and horizontal direction.

Notes

1. The installer of a RAINBOX® 3S system should ensure that the correct design procedures have been followed and structural performance has been calculated in line with the method and safety factors stated in CIRIA C680, Structural Design of Modular Geocellular Drainage Tanks. This should be carried out before any construction work on the system begins.
2. Table 1 shows guidelines to the crate depths only. Each system should be designed to the specific parameters relating to that site in line with Note 1. It may be possible that the tank can be used with less backfill or to greater depths depending on site conditions.
3. JDP reserve the right to change this document at any time without prior notification. All descriptions, dimensions and illustrations in this

For more information on the design of a RAINBOX® 3S system please contact JDP Technical Support.

Ground Conditions

The characteristics of the ground are of critical importance when thinking about the dimensions for a soakaway crate structure. With this in mind, it is advisable to conduct the following studies in advance:

- Geotechnical study
- Presence of water (height)
- Permeability testing
- Condition of earth (pollution)

The scope of the investigation conducted in this area will depend on the scale of the project (surface area and volume of the crate structure), as well as taking local factors into account. It is worth remembering that the ground can sometimes vary greatly in terms of its composition, with variations in infiltration capacity across the same site.

The actual infiltration capacity of the ground should be measured via tests on site. This should be done to the guidelines outlined in BRE Digest 365 Soakaway Design which will then allow the results to be calculated into an infiltration rate for the site. Using this infiltration rate and the expected flow of storm water it is possible to calculate what size the crate structure will need to be. This is done on individual job basis and can be completed by JDP Technical Support.

The table below gives an example of typical soil infiltration rates for different types of ground. These can be used in initial calculations but for final designs the exact infiltration rate should be calculated using the method outlined above.

Average permeability based on nature of ground (for guidance only)

Ground Type	Sand											
	Coarse with sand	Coarse	Medium					Fine				
In m/day	500	20.0	10.0	9.0	8.0	7.0	6.0	5.0	4.0	3.0	2.0	1.0
In mm/hour	20833.3	833.3	416.7	375.0	333.3	291.7	250.0	208.3	166.7	125.0	83.3	41.7
In m/s	$5.8.10^{-03}$	$2.3.10^{-04}$	$1.2.10^{-04}$	$1.0.10^{-04}$	$9.3.10^{-05}$	$8.1.10^{-05}$	$6.9.10^{-05}$	$5.8.10^{-05}$	$4.6.10^{-05}$	$3.5.10^{-05}$	$2.3.10^{-05}$	$1.2.10^{-05}$

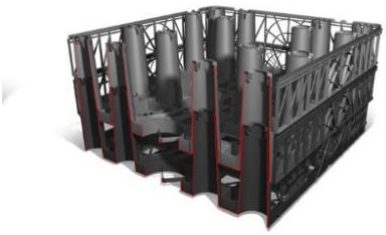
Ground Type	Sand						Other materials					
	Very Fine			Fine, chalky			Peat	Chalk	Clay loom	Silt clay	Clay + fine sand	Clay
In m/day	0.9	0.7	0.5	0.264	0.240	0.144	0.053	0.050	0.036	0.013	0.010	0.002
In mm/hour	37.5	29.2	21	11	10	6	2.2	2.1	1.5	0.54	0.41	0.09
In m/s	$1.0.10^{-05}$	$8.1.10^{-06}$	$5.8.10^{-06}$	$3.1.10^{-06}$	$2.8.10^{-06}$	$1.7.10^{-06}$	$6.1.10^{-07}$	$5.8.10^{-07}$	$4.2.10^{-07}$	$1.5.10^{-07}$	$1.1.10^{-07}$	$2.5.10^{-08}$

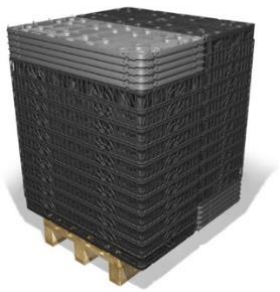
Reduced Environmental Impact

The RAINBOX® 3S is designed to be packed and stacked with the elements interlinked together.

This reduces the carbon footprint by 50% from a transport perspective, by reducing the vehicle requirements by half.

Similarly, stock takes up less storage space on site.

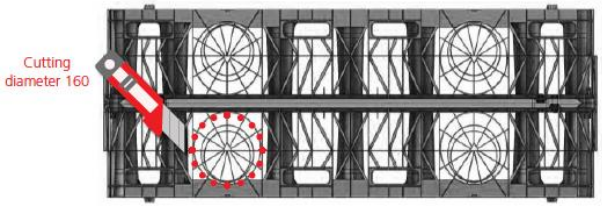


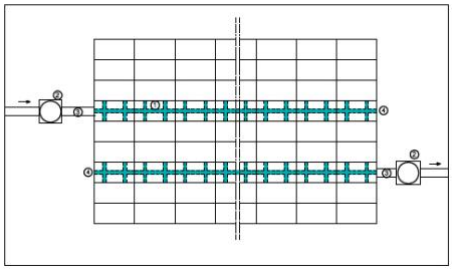


Ease of Inspection & Cleaning

Once the cut-outs provided on the lateral walls of the RAINBOX® 3S crates have been removed, access to the inspection channels can be achieved from the upstream silt trap or downstream inspection chamber/manhole.

Example





The design of the RAINBOX® 3S crate makes it possible to pass a camera through for inspection purposes.

The crate structure is normally inspected on the bottom layer of RAINBOX® 3S crates as this is where any possible silt build up will occur. On deeper crate structures inspection channels can be created at a higher level.

The RAINBOX® 3S crate has been tested and is able to withstand a water jet with a pressure setting of 120 bar.

Note: This functionality in no way diminishes the importance of upstream preliminary treatment measures in terms of facilitating collection of floating or suspended elements and thereby preventing any clogging of the crate structure.

Microdrainage Design Calculations

The JDP Technical Support team are able to calculate the required size of soakaway and attenuation crate structures using Microdrainage software. Microdrainage is the industry standard software for use in drainage design and can be used to assist in planning applications or applications to discharge to an existing water course or sewer.

A soakaway or attenuation crate structure is designed for the normal levels of rainfall likely to occur over a given period. It is also possible to factor in climate change over the course of the return period.

To produce accurate and detailed calculations in Microdrainage the correct information on the following parameters should be provided:

Location
Where is the site geographically?

Return Period & Climate Change
What return period should the crate structure be designed to cope with and what factor of climate change will be included in the design?

Impermeable Surfaces
What area of impermeable surface is going to drain towards the crate structure?

Soil Infiltration Rate (Soakaway Only)
What is the soil infiltration rate at the proposed site of the soakaway system? Does this allow for a soakaway to be installed based on the parameters outlined in BRE Digest 365 Soakaway Design?

Approved Discharge Rate (Attenuation Only)
What is the approved maximum discharge rate from the attenuation system? Is this to be discharged via gravity or a pumped system?

Levels
What are the proposed invert and cover levels for the crate structure? This will allow JDP Technical Support to design the crate structure to be as economical and efficient as possible.

Installation Advice

Earthworks – formation level

The excavation will be done according to current best practice relating to open cut earthworks.

The set-up is as follows:

- For soakaway: horizontal formation level
- For attenuation: sloping formation level between 0.5% and 1%, linear crate structures may require some partitioning.

Flatness tolerance:

- Generally, 0.1% of the crate structure's length in a range between 2cm and 5 cm

Installation bed

This is a 100mm bed of filler materials (sand, gravel or any other material satisfying the criteria for soil) adjusted as per the parameters for the formation level (outlined above). Sharp objects, large stones or other foreign objects should be removed.

Delivery, handling & storage

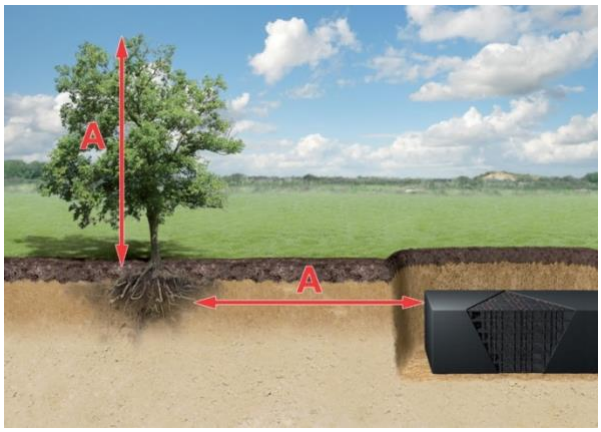
The RAINBOX® 3S crates are packed on pallets.

They should be unloaded with a forklift truck or manually if unpacked.

They should be stored on a flat and clean surface.

For longer storage periods (several months), it is advisable to store them away from direct sunlight.

Root Ingress Prevention
Where there are trees, plants or other vegetation near to the crate structure, a root barrier geotextile must be utilised. This should be done when the crate structure is at a distance less than or equal to the height of the vegetation when mature.



Geotextile & Impermeable Membrane Surround
The kind of geotextile and/or membrane surround used will depend on the application of the crate structure.

For soakaway purposes the crate structure should be surrounded in a non-woven geotextile to allow the storm to infiltrate the surrounding ground and prevent the ingress of silts etc.

For attenuation purposes the crate structure should be surrounded in an impermeable membrane and a non-woven geotextile protection fleece.

Characteristics of the geotextile/membrane materials to be used:

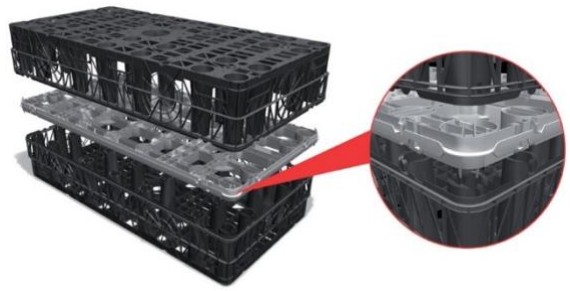
- For **soakaway** purposes, the geotextile must be of a non-woven type and should have a mass of at least 100 g/m².

- For **attenuation** purposes, the impermeable membrane must be at least 1.0mm thick and have the joints either welded (best practice) or taped to the manufacturer's specifications. The protection fleece should have a mass of at least 300 g/m².

Assembly

Constructing the RAINBOX® 3S crates

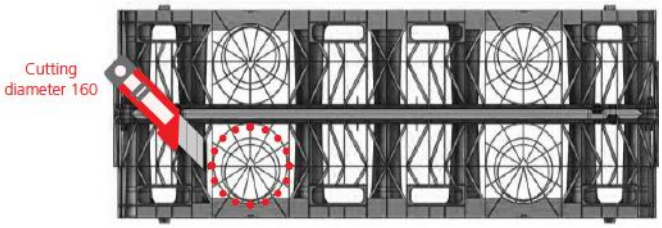
The RAINBOX® 3S crates consist of two half-boxes and a centre plate which are assembled prior to their installation in the required location.



Preparation of inspection channels

The RAINBOX® 3S crate walls used to create the inspection channels must always be cut before installation.

Ensure that all cut outs in side wall of crates are removed to create an inspection channel through the crate structure.



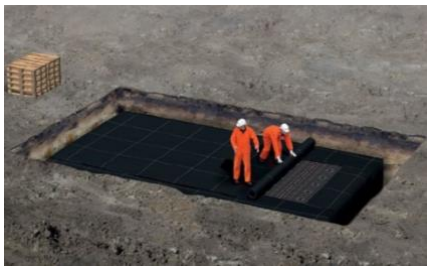
Installation of RAINBOX® 3S crates

Install the RAINBOX® 3S crates into the excavated area, making sure the crate structure size matches that of the design and allowing for any necessary inspection channels.

Assemble the crate structure using the clips, at a ratio of two clips per contact side. Use the single clips for the internal and upper sides of the crate structure. Use the double clips for the intermediary levels within the crate structure.

Build the crate structure up layer by layer until the correct depth has been achieved.

Once all the crates have been installed, wrap the top of the crate structure with the geotextile and/or membrane.



Connections

Connections can be made on any of the four sides of the RAINBOX® 3S crate.

110mm and 160mm pipework can be connected to the crates directly using the preformed cut out recesses provided.

For pipework from 225mm to 400mm, a specially manufactured adaptor plate can be used. This can be attached directly to the side of the crate and the geotextile and/or membrane will be installed to surround the adaptor plate.

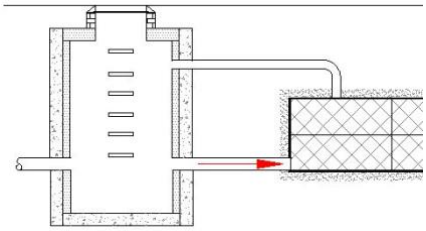
If the diameter of the pipework is greater than 400mm, the connections can be facilitated using a manifold system from the adjacent manhole. This allows what would be a larger diameter connection to be split into a number of smaller diameter connections.

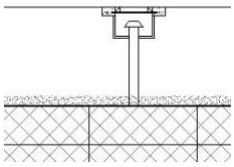
For soakaway purposes it may be necessary to manifold the inlet on pipe diameters that are smaller than 300mm. This should be done if the risk of erosion of the formation level is deemed great enough. Due to the crate structure being surrounded in geotextile only any high flows of storm water could result in damage to the formation layer beneath the crate structure.

Ventilation

The crate structure must have vents to maintain a balance between internal and external pressure levels.

These are positioned by means of special shafts or preferably towards upstream/downstream inspection chambers or manholes, with these being ventilated.



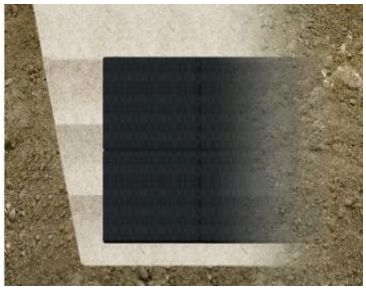


Backfilling

Backfilling must be performed in accordance with good practice and the choice of materials. A protective layer of sand, at least 100 mm thick, must be applied across the whole of the structure.

Lateral backfill: this must be built up in 150mm layers to form a homogeneous peripheral mass to prevent the crate structure from becoming displaced.

It is then a question of the type of backfill to use - either topsoil or as per car park or access road design.



This will depend on where the crate structure is situated. As the successive layers of backfill are being deposited, it is important to ensure a minimum coverage of 500mm has been applied before performing any heavy compacting when under a car park or access road or when deeper than 500mm in a non-trafficked area.

Movement of construction machinery

You may use a range of different construction machinery to backfill the crate structure. It is not suitable to run compactors, whether vibrating or not, directly over the elements of the crate structure because of the dynamic extra loads applied to the crate structure.

Below is a list of the covering levels required for various pieces of machinery based on backfill with an angle of internal friction $\varphi \geq 45°$.

Coverage (in m)	Compacting machinery properties
Min. 0.1	Hand-operated compactor, vibrating plate **Total weight**: around 700 kg **Dimensions**: 0.9 x 0.7 m
Min. 0.2	Light compactor **Total weight**: around 2.5 t **Dimensions**: 1.2 x 3.2 m
Min. 0.5	Articulated compactor, backhoe **Total weight**: around 12 t **Dimensions**: 5.9 x 2.3 m
Min. 0.8	Lorries ≤ 30 tonnes

Maintenance

The interceptors/silt traps will ensure that the crate structure lasts, which is why it is important that they are maintained and cleaned on a regular basis:

- Cleaning of preliminary treatment devices
- Replacement of filters
- Clearance of silt build up
- Clearing of mud
- Sweeping of roadways
- Regular inspection of devices

Similarly, an inspection using camera equipment following particular events (periods of exceptional rainfall, work carried out close to the crate structure, etc.) is advisable in order to check the crate structure is still sound and working properly.

For any more information on the RAINBOX® 3S please contact JDP Technical Support.

Contact JDP

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By continuing to invest in extensive stock levels to ensure local availability of our product range, and combining expertly trained staff, our own specially designed vehicle fleet, a dedicated in-house Technical Support team and a growing nationwide network of branches, JDP is always close to the project and ready to serve.