Tunnelwell® Arch System Installation Instructions

1. General Notes

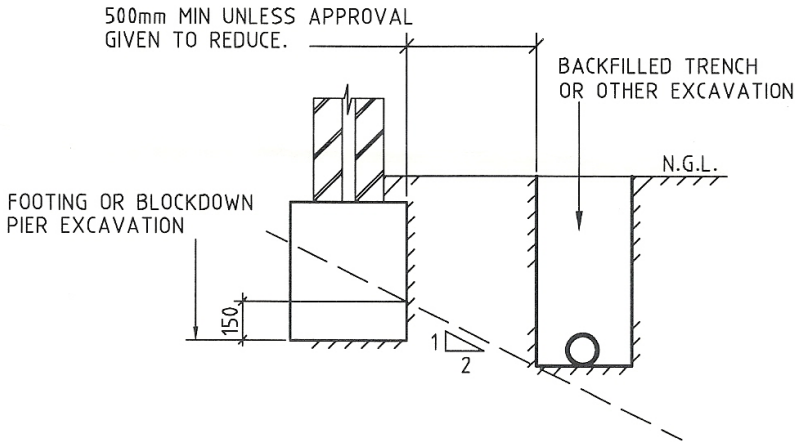
1.1 General

1.1.1 These instructions shall be read in conjunction with other consultants' drawings, specifications and written instructions provided by the engineer during the contract period.
1.1.2. If in doubt, ask – call 1300 4 TUNNEL. (1300 488 663)
1.1.3. Until all approvals from authorities are obtained, commencement of construction works shall not commence.
1.1.4. Unless varied by the project specification, all materials and workmanship shall be undertaken in accordance with the relevant Australian standards and the by-laws and ordinances of the relevant building authorities or authorities having jurisdiction over the works.
1.1.5. All dimensions indicated within these instructions shall be verified on site by the installation contractor.
1.1.6. Prior to commencing works on site, the contractor shall verify the position of all services in the area to ensure that the construction/installation does not interfere with any of those services.
1.1.7. During construction and transport to site, the arches shall be maintained in a stable condition with no part becoming overstressed or permanently deformed. After installation, the aches shall not be subjected to "construction loads" such as but not limited to, heavy lifting cranes or stabilizing foot pad ground induced loads, or other such loads which may cause damage to the arch systems. The arch areas should be quarantined or cordoned off during construction from any such movement or loads being applied until final finish surface areas are being completed for handover to the Client.
1.1.8. All storm water should be pre-treated with a catchment or gross pollutant trap system prior to entering the Tunnelwell® Arch Systems (TWAS).
1.1.9. The structural components detailed in these instructions have been designed for the following loads:

- In non-trafficable areas: Zero surcharge – compaction as required.
- For light trafficable loads such as cars and trucks up to 8-ton tare weights – compaction to 95% MDD.
- For heavy trafficable areas typically: W80, A160 and M1600 live loads as per AS5100.2-2017 – compaction to 98% MDD.

1.2 Subgrade

1..2.1 The load design of the Tunnelwell® Arch System (TWAS) is based on a subgrade which is of a naturally occurring cohesive soil material with a minimum allowable bearing capacity of 150 kPa for non-trafficable installations and 250 kPa for trafficable installations. For subgrades which consist of soils with cohesion, the subgrade material shall be compacted to 98% modified dry density± 2% from optimum moisture content. For subgrades which consist of soils without cohesion, the minimum requirement for the foundation material is that it shall pass 8 blows from a Perth Sand Penetrometer (PSP). Subgrades are to be approved by a suitably qualified geotechnical engineer shall be uniform in nature free from significant irregularities. It is noted that preparation of the subgrade shall consist of the removal of any topsoil, organic material, and the like with the naturally occurring subgrade material exposed prior to placing the TWAS over. The contractor shall be mindful of on-site drainage to ensure that ponding of water around the subgrade does not occur.
1.2.2. Between adjacent footings or excavations, the contractor shall not exceed a rise of 1 in a run of 2 in line of slope.
1.2.3. Unless approved in writing by the engineer, the limits of excavations near existing footings shall be in accordance with that indicated below.



The contractor shall undertake investigatory localised excavations near existing footings to ascertain their depth prior to excavating adjacent to them. It is noted that excavating to a depth below that indicated above shall not be undertaken without the written approval from the engineer.

1.2.4. Where installations are required **under main roads**, it is recommended to lay a support base material often referred to as a Dense Gravel Base Footing (DGB Footing), 300mm wide x 150mm thick of 8-20mm sieve size fine crushed rock (maximum aggregate 20mm) material compacted to 98% standard maximum dry density at optimum moisture content ±2% in compacted layers not exceeding 200mm located centrally under each toe of each side of the arches.

1.2.5 A geotechnical report for the site from a suitably qualified geotechnical engineer is necessary to establish soil classification and subgrade conditions prior to the design of a Tunnelwell® Arch System (TWAS). A TWAS will suit most site conditions and soil types. However special provisioning may be required depending on the geotechnical conditions. Engineering advice will be required if it is the geotechnical engineers' opinion that geotechnical conditions on site do not comply with that noted in 1.2.1.

In circumstances where the base/bottom of the Tunnelwell® arch trench has rock in the base, the TWAS requires an additional excavation of 600mm below the underside of the arch with 600mm of compacted base course extending to 300mm beyond the side walls of the arch.

Pictures showing base layer compaction testing.

Pictures showing base layer levelling and boning of trench.

2. Trench installation and pegging arches into place

Once the TWAS excavation has been prepared and meets the criteria set out in Section 1 General Notes as well as any other relevant design criteria depending on geotechnical conditions, level the compacted subgrade area as necessary and begin to lift in arch sections - starting at one end with the female lip at the end point.

Setting the arches:

Setting the width of each arch size is important! The arches may vary slightly in width from packing and transport to site. The 1m3 arch must be set at 1740mm wide (toe to toe) and pinned accordingly. Should the 1740mm measurement vary by ±20mm and the arches are fitting together well, proceed with the installation. Any variation >±20mm, the arches need to be set back to 1740mm toe to toe prior to laying commencing/continuing.

Screeding:

Pictures showing screeding.

Pictures showing screeding.

Installation of arches:

The next section of arch will then be placed over the male end lip at the other end. It is the installer's sole responsibility to ensure the arches seal properly. Failure to comply with this note shall void any warranty claim.
Repeat this process until the required lengths of arch have been installed. The installation of the arch units shall be in a straight line or as directed by any relevant design drawings. After all the arch units have been placed, the recommended sequence of installation thereafter is as follows:

- Place first section as above at correct invert level but allow room for end cap to fit over the end of the first section placement with 600mm clear space for backfill and compaction all around the arches for the entire length of arches being installed. It is recommended but not essential to not install end caps until the TWAS is completed to allow an internal visual inspection of the arches being installed to ensure that all sections are connected correctly, and male and female lips are locking up correctly. This recommendation is entirely up to the installer who must assess the best way to optimise the installation and backfill methodology. Longer runs (>50m) do not suit holding back and not fitting end caps.
- Dispersion mats (Gabion): the dispersion mats must be installed and placed directly below the arch sections where an inlet pipe is to be connected to the TWAS.
- As each arch section is installed, insert steel pins to hold the arch in place as you proceed along the trench; check the 1740mm measurement every 4 arches installed to ensure width consistency. These are driven in by using a hammer or pneumatic hammer once the steel pin has been placed firmly through the pre-set holes in the toe of each arch section. Then drive the pins to refusal. Make sure each arch section is fitted properly to the last section prior to setting the steel pins in place.
- Note: Tunnelwell® has the purpose made pin/peg drivers available for purchase at $60.00 each + GST which fit most electric/battery SDS chuck hammer drills.

Picture showing laying.

Picture showing laying.

Picture showing laying.

Picture showing pinning.

3. Sealing arch joints with the foam strip

Each arch must have the foam strip (supplied 2560x35x25) fitted between the joints as per drawings after the arches have been installed prior to any backfilling commencing. The arches must be clean and free from sand over toe piece as shown in picture above. The foam strip simply pushes into the joint gap by hand with the 25mm wide section being the width and the 35mm section being the height. Push foam in firmly covering the whole joint/arch section – a fly screen spline roller or similar tool helps. This can be done after each section is installed but it is more efficient to do all arches once laying has been completed. If there is overhang at the base due to any stretching this can be trimmed with a Stanley knife if required. Once this has been done, backfill can commence. Make sure backfilling does not dislodge any foam strips during the process.

4. Backfilling and Compaction to the top of the arches

NOTE: The use of tamping rammer compactors ("Jumping Jacks") is strictly prohibited for backfill compaction over TWAS arch units.

Appropriate backfilling and compaction are critical elements for the successful installation of the TWAS. Given that the TWAS does not use gravel, crushed rock, or reconstituted concrete over to the arches, the methodology of the compaction is pivotal for a TWAS to meet the AS5100.2-2017, Australian Bridge Code Design.

The backfill material must be a free draining and granular backfill, have a dry density greater than 18kg/m3 and less than 20kg/m3 and have an angle of internal friction between 30-34 degrees.
The backfill material shall be compacted in 300mm maximum depth compacted layers. Compaction must be to 98% Modified Dry Density (MDD) ±2% from optimum moisture content or 8 blows to the foot/300mm for a PSP. (Refer note 1.1.9) Each compacted layer of backfill must be installed evenly on each side of the TWAS prior to going to the next compacted backfill layer. The maximum differential in compacted backfill level on either side of the arch shall not exceed 150mm. Repeat the backfill material compaction process until the crest of the arches is reached. When compacting the sides of the arches immediately adjacent the arch side, keep the compactor 100mm away from the arch walls so the plate does not make contact with the arches.

DO NOT install backfill using a front-end loader or backhoe bucket directly over the top of the arches.

Picture showing correct backfill method – DO NOT backfill over top of arches until top level is reached.

Pictures showing backfilling.

Picture showing backfilling.

Picture showing balancing pipes

Sealed

Un-sealed awaiting mastic

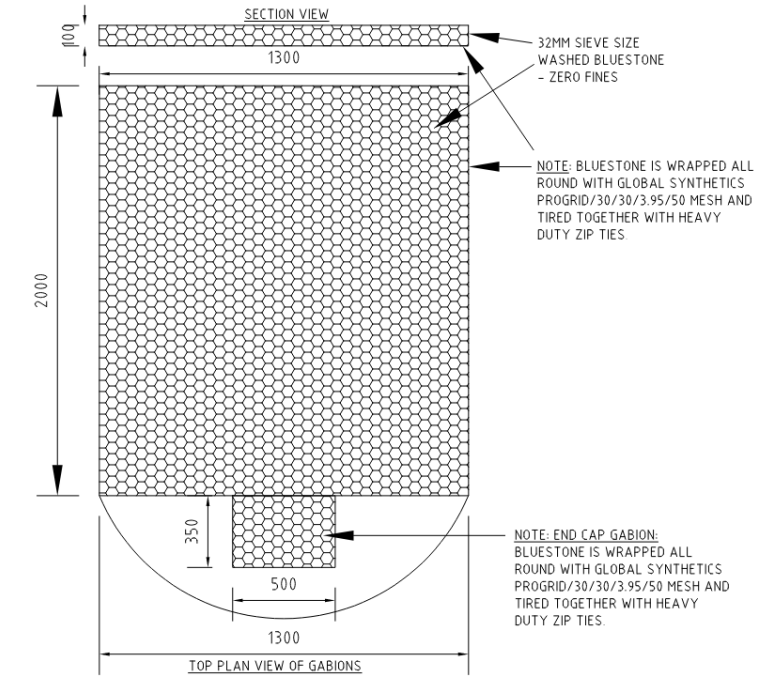
Pictures showing balancing pipes

5. Fitting Balancing Pipes

Balancing pipes are only required where more than one Tunnelwell® Arch Systems are manifolded together or where the design engineer wants to balance overflow/excessive water flows between multiple arch systems. The balancing pipe size is 100mm diameter UPVC size and must fit into the top of the arch chambers either side by not less than 100mm before being sealed. The number of balancing pipes required is at the discretion of the design engineer.
Note: The balancing pipe inlet may also be used as the air relief connection point if the required pipe cover is not available for a top arch connection point such as the minimum cover of 600mm.

6. Fitting Gabions

Note: Before fitting end caps and where no access manhole(s) has been provided in the design, place the stormwater dispersion mats (gabions) inside the arch chambers where stormwater connections are made at end cap locations. Where a pipe may be connected to the top entry points if required by the design engineer a gabion is considered unnecessary, but the end entry points need to have ≥32mm sieve size crushed rock spread for the length and width of that arch section and must be not less than 100mm thick across the soil base. The gabion must be a minimum length of 2000mm or greater depending on the design of water velocities. This applies to both overt and invert connection pipe selections by the design engineer. For invert level pipe entry connections, the gabion must be cut into the soil base, so the inlet pipe is flush with the top of the gabion. For overt level pipe entry connections, the gabion may sit on top of the soil base area.



NOTE: CONTRACTORS MAY CONNECT INDIVIDUAL GABION'S TOGETHER OR MAKE ONE LARGE GABION TO SUIT DESIGN FLOWS AS SPECIFIED. MINIMUM GABION FOR 1M³ ARCH IS 2 LINEAL METRES PLUS END CAP GABION. ADDITIONAL LENGTHS ARE RECOMMENDED BY MANUFACTURER TO REDUCE GOUGING FROM STORMWATER INFLOW VELOCITIES. REFER TO DESIGN ENGINEERS DRAWINGS FOR ADDITIONAL LENGTHS.

DETAIL OF TUNNELWELL GABIONS FOR 1M³ ARCH SIZE - NTS

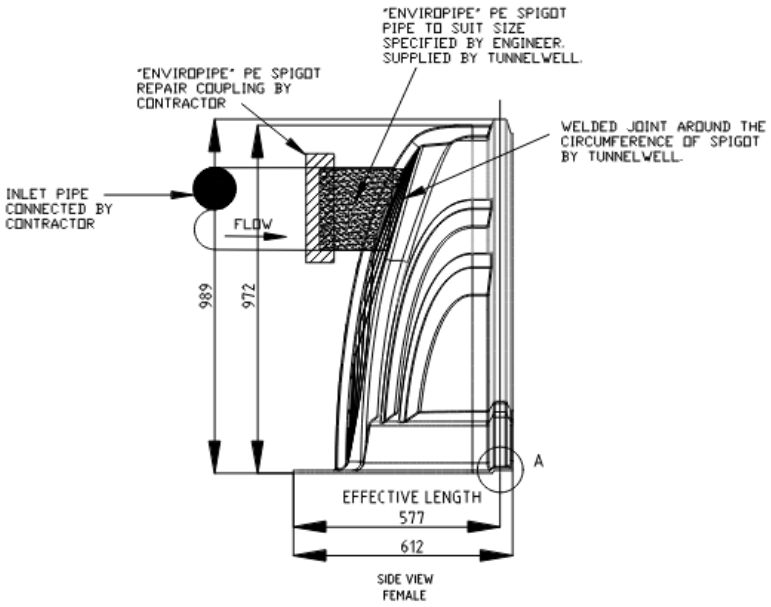
7. Fitting end caps to arches

At this stage make stormwater connections to end caps. This depends on whether the design engineer has designed entry pipes to be at overt of arches or invert of arches.

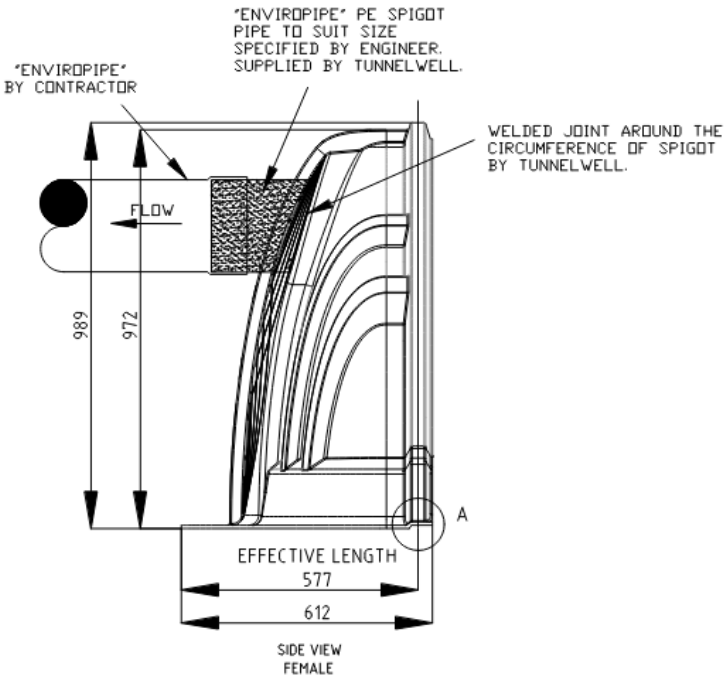
Note: Connection of UPVC and PE pipes: There is a glue that will join the UPVC to the PE end caps together, but it is very expensive.

To overcome this issue Tunnelwell® will make up connections to end caps to meet project design as shown below. These end caps will have PE corrugated pipes of nominated sizes by the project engineer butt-welded by Tunnelwell® onto the ends of the end caps at the designated design invert/overt levels. Clients can order end caps with pipe sizes of >100mm with Enviropipes PE100 pipes butt welded into the end caps to ensure a perfect seal with no sand ingress later after backfilling due to settlement or earth movements breaking mastic seals on larger systems. It is a Tunnelwell® mandatory requirement to have the spigots welded in on any commercial installation – Tunnelwell® will include these costs when quoting such large systems. If a Contractor is using UPVC pipes where PE spigots have been welded onto the end caps, they must supply a slip coupling to connect to PE spigot and switch back to UPVC pipework. The slip couplings are available from Reece Civil or Galvins Plumbing Supplies, but only come in 100mm and 150mm sizes. Alternatively, the switch can be done by connecting the UPVC pipe to a GPT or deceleration chamber and then connecting from that chamber to the Tunnelwell® Arch System using PE corrugated pipes using a PE socket.

Note: Enviropipes make a repair coupling for their corrugated PE100 pipe sizes from 225mm - 750mm diameter which is a rubber ring seal both ends. This is the recommended fitting for pipe joins by Tunnelwell® and is available via Reece Civil. Part # CRC225 (225 is pipe dia) for inlet connections. For outlet connections the normal practice is to connect using the socket end of the pipe and continue laying after that connection.



DETAIL OF 1M3 END CAP - INLET SPIGOT CONNECTION (NTS)



DETAIL OF 1M3 END CAP - OUTLET SPIGOT CONNECTION (NTS)

After end cap connections are completed continue to backfill to the top of the arches.

8. Final Backfilling and Compaction above the top of the arches

Once the compacted backfill on either side of the arches has reached the top of the arches and associated pipework has been installed and connected, continue compacted backfill as previously specified over the entire width of the arches. When backfilling the first 300mm maximum deep lift of compacted backfill over the top of the arches, lower the vibration intensity of the compactor when going directly over the crests of the arches as the compactor will tend to "bounce" slightly. The location of compaction testing shall be limited to that shown in the table below:

Tunnelwell® Arch Systems (TWAS) Compaction Regime	
Cover over the arch	**Test Point - Offset from Centreline**
Minimum cover – 600mm	600mm
600mm to 900mm	Varies linearly from 600mm to zero.
≥ 900mm to 2500mm	Zero

Recommended backfill height over the top of the arches is 750mm for any traffic application.

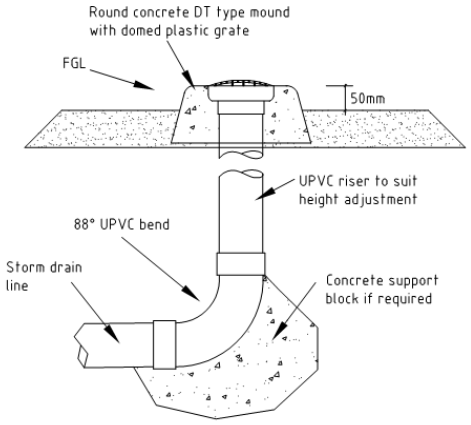
9. Compaction Testing Certificates

Compaction test certificates shall be made available for every installation of the TWAS if requested. These certificates shall incorporate the tests for every compacted layer and indicate locations of test points recorded against a simple block diagram and all tests should be independently or third party witnessed. These certificates shall be incorporated into the Project installation and operating/maintenance manuals for future reference for the Client. The frequency of compaction testing shall be at 3 metre intervals along each side of the TWAS per layer of compaction. Should a warranty claim be made, and the installer is unable to produce independently witnessed compaction certificates, the warranty claim may be rejected.

10. Air relief provisions

All sealed stormwater chambers should be designed to allow air to expel from within the chamber to prevent any backpressure on the upstream discharge pipe systems connecting to the stormwater chamber (TWAS). If access arch chambers are not designed into a TWAS, then vents should be incorporated using the pre-set holes in the top of each arch section to connect onto that opening provision and extend a 150mm pipe to the surface and provide a vented connection to the TWAS – refer to diagram 1and 2 below. The number of vents should be established by the design engineer. If no engineer is engaged for the design, provide at least 1 x 150mm air relief vent to each 30m3 of storage capacity provided or 1 x 225mm air relief vent to each 50m3 of storage capacity provided.

DIAGRAM 1 – shows a vent which has been offset from the top of the arch. Otherwise refer to Diagram 2 but add vented grate.



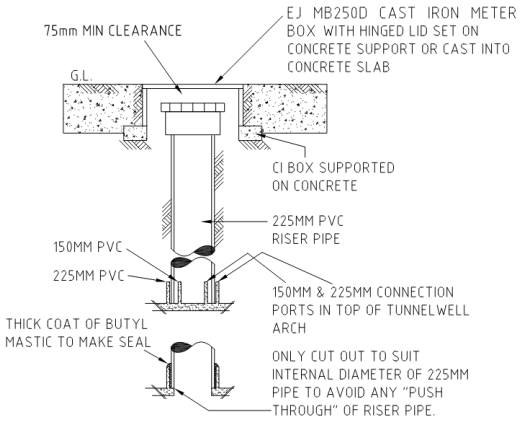
Detail of Tunnelwell Air Relief Grate in Concrete Mound (nts)

Note: UPVC pipe manufacturer's installation and cover requirements are to be adhered to.

11. Inspection or Cleaning Access

All sealed stormwater chambers should be designed to allow for inspection/monitoring and or cleaning provisions. If access arch chambers are not designed into a TWAS, then inspection access should be incorporated using the pre-set holes in the top of each arch section to connect to that opening provision and extend a 225mm pipe to the surface and provide an inspection point to the TWAS – refer to diagram 2 below. The number of inspection points should be established by the design engineer. If no engineer is engaged for the design, provide at least 1 x 225mm inspection point to each arch system or one for each 30 chambers as a minimum requirement.

DIAGRAM 2



DETAIL OF TUNNELWELL ACCESS POINT FOR INSPECTION AND CLEAN OUT (NTS)

12. Confined Space Legislation and AS 2865 – 1195

Entering a TWAS via an access arch section is dangerous and confined space regulations should be followed. The installer should procure third party confined space signs and fix them inside each cover and grate to warn personnel entering the chambers of that danger. Only qualified and certified holders of confined space certificates should enter the TWAS. All required documentation and certified personnel should be on site when an entry is performed.

13. Pre-Treatment of Stormwater prior to entering arches

If design requires pre-treatment of incoming stormwater discharges, the installer should seek advice from a pre-treatment specialist provider. Tunnelwell® does not make or supply pre-treatment systems.

14. Deceleration of Stormwater prior to entering arches

Flow rates for horizontal stormwater discharges into the Tunnelwell® Arch System end caps should be ≤1.00ms^{-1} for all pipe sizes.

These criteria may involve the installation of a deceleration chamber(s) depending on the inflow rates of the designed system catchment(s). Apparatus such as concrete liners* sized for appropriate catchment inflow with suitable lids or concrete liners* with baffles installed are an acceptable method for velocity reduction of inflow stormwater.

- Denotes that concrete liners need to be adequately vented to allow for air relief to prevent any backpressure on the upstream catchment systems.

Flow rates for vertical stormwater discharges into Tunnelwell® Arch System arch crest inlets (pre-set at 150mm or 225mm NB) should be:

- ≤1.00ms^{-1} for 100mm pipes
- ≤1.00ms^{-1} for 150mm pipes
- ≤1.00ms^{-1} for 225mm pipes

NOTE: All inflow discharges into Tunnelwell® Arch Systems must occur over a correctly sized "stormwater dispersion mat" (gabion) length taking into consideration the discharge velocity rate for the distance that stormwater will travel before settling on the base of the arch system to avoid any scouring of the base material upon which the arches are laid.

Siphonic discharges are not permitted directly into Tunnelwell® arches whatsoever. They must be decelerated through a chamber first to ≤1.00ms^{-1}.

15. Maintenance issues

Maintenance on TWAS is very low.

- Inspect chambers annually for any compression from wheels loads and if found notify Tunnelwell® immediately so an engineer can come to site and check for any unknown issues.
- Rake over bottom of chambers to turn over soils and remove hydrocarbons impregnated in the sand from roadways and carparks caused by brake pads and leaking oil from vehicles.
- Check stormwater dispersion mat (Gabions) locations and any other stormwater entry points (tops of arches) for any gouging and or degradation from constant water inflows.

- Clear any debris that may have entered the chamber from infill flows of stormwater should no pre-treatment system have been installed prior to the TWAS.

16. Construction load warning

Until final design intent and interpretation of the intended installation, the installed TWAS shall not be subjected to "construction loads" during the construction period. The TWAS areas should be cordoned off to all traffic during construction. The TWAS shall never be subjected to "construction loads" such as but not limited to cranes > 10 tonne aggregate loadings, crane stabilisers, front end loaders laden with heavy loads, turning of heavy equipment over the installed TWAS, water tankers and the like until final finishes have been completed. After completion of hardstand areas or roads, all loads must comply with or be within the limits of the structural certificate issued by Tunnelwell®.

THE IMPORTANCE OF INSTALLATION PROCEDURES

Tunnelwell® has a continuing commitment to excellence. But no matter how well manufactured a product is, incorrect installation can jeopardize this. Installing units on uneven ground is a recent issue we have had - the product is not faulty, it's the install that's subpar.

Every project we dispatch has the installation requirements and supporting documents sent to the successful tenderer prior to the project going to construction. These documents cover everything from the design criteria and installation requirements. Maintenance and cleaning procedures are also included in these documents so the user is also aware of what is required, and all documentation should be handed to the Client on project completion as part of the operating and servicing manuals.
The importance of correctly following our installation processes and procedures should not be underestimated - it's easy to blame the product but if the installation is below standard to start with, complications down the track will be an issue. If there is anything not clear when installing our product, please email us at sales@Tunnelwell.com or call us, on 1300 488 663, we are here to help and at the end of the day want the best result for the customer.

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