Water
Infrastructure
Solutions

RESERVOIR RENOVATIONS – BEST CHANCE OR LOST CHANCE

This paper will highlight the key areas where old designs were deficient and it will also offer solutions to improve the safety of both operations personnel and the stored water.

RESERVOIR RENOVATIONS – BEST CHANCE OR LOST CHANCE

Many steel water storage tanks in NSW and Victoria were built in the mid 1980's, so have now been in service for 20 to 30 years.

A lot of the earlier generation concrete tanks were covered with roof structures at much the same time period to improve water quality.

Design requirements were more basic at that time, with personnel safety often the only major consideration.

Access ladders, entry hatch areas, roof drainage and ventilation systems have consequently failed to deliver the safety requirements to the stored water that consumers are expecting and are entitled to.

RESERVOIR RENOVATIONS – BEST CHANCE OR LOST CHANCE

Times have changed significantly and exposure to other industry requirements regarding storage systems such as food and beverages, have driven a ‘renaissance’ to upgrade our water tanks when scheduled maintenance falls due. This process can only be carried out effectively if all the issues involved are understood and a balance is achieved – a lot of money is often spent on one or two less important items, while missing out on the critical ones which are often inexpensive to fix. A successful outcome depends on a willingness to recognise errors already made, change original designs and formulate a more detailed scope of works for the intended renovation project.

PRIORITIES OUT OF BALANCE?

This new tank has an impressive external stairway system, but the entry hatch and platform areas remain unsealed against natural or deliberate contamination.

RESERVOIR RENOVATIONS – BEST CHANCE OR LOST CHANCE

Protective coatings are the single most important periodic maintenance required for steel tanks, so this is a good time to fix a lot of the other design issues that were implemented in the initial construction period. A lot of tanks have already been re-coated and everything else neglected, due to a poor understanding of the holistic requirements of water quality.

INTERNAL ACCESS LADDERS

Until the mid 1990’s, most tanks were emptied and drained for cleaning and inspection purposes. This entailed personnel climbing down into the tanks, often without the hind sight and benefit of confined space knowledge or training. Ladder materials were also limited then and galvanized steel was the preferred option, even though galvanizing had a limited protective life when immersed in water. Ladder and platform designs were based on the ability of personnel to climb them unassisted and rescue scenarios were often neglected or given low priorities.

INTERNAL ACCESS LADDERS

The AS 1657-1992 (fixed platforms, walkways, stairways and ladders) was used extensively, with little thought given to how it impacted on both confined space requirements (AS 2865- 2001 Safe Working in a Confined Space) or water quality.

Consequently we have tanks fitted with sloping ladders and platform structures that prevent effective rescue from within the confined space environment. These same ladders generally have stiles protruding from out of the tank that makes it impossible to seal the entry hatch areas against natural or deliberate contamination.

INTERNAL ACCESS LADDERS

The ladder takes up available hatch space and is caged, making a confined space rescue difficult. The stiles extend out through the hatch cover, which cannot be sealed.

INTERNAL ACCESS LADDERS

The ladder stiles extend out through the opening and the hatch cover is not sealed or secured

INTERNAL ACCESS LADDERS

Solution:
Use longer lasting, non polluting ladder materials such as FRP, and configure the designs to assist in a rescue scenario if required.
Vertical ladders are good for assisted climbing (using appropriate PPE) and they have benefits for rescue situations requiring several personnel at once to be lifted into or out of the tank.
But these ladders should not continue out through the entry hatch area – there are better methods of providing hand contact for the climber that do not jeopardise stored water quality.

INTERNAL ACCESS LADDERS

The original sloping steel ladder has been replaced with a vertical FRP unit, making more hatch space available for safe access or a rescue scenario. The hatch cover can now be sealed and secured against contamination.

ENTRY HATCHES

Entry hatches were mostly designed to keep out unauthorised personnel or larger vermin and rescue scenarios were not considered. The openings are often too small and the front edges of the hatch frame have been assessed as being a potential trip hazard to maintenance personnel - these raised edges were removed in most cases.

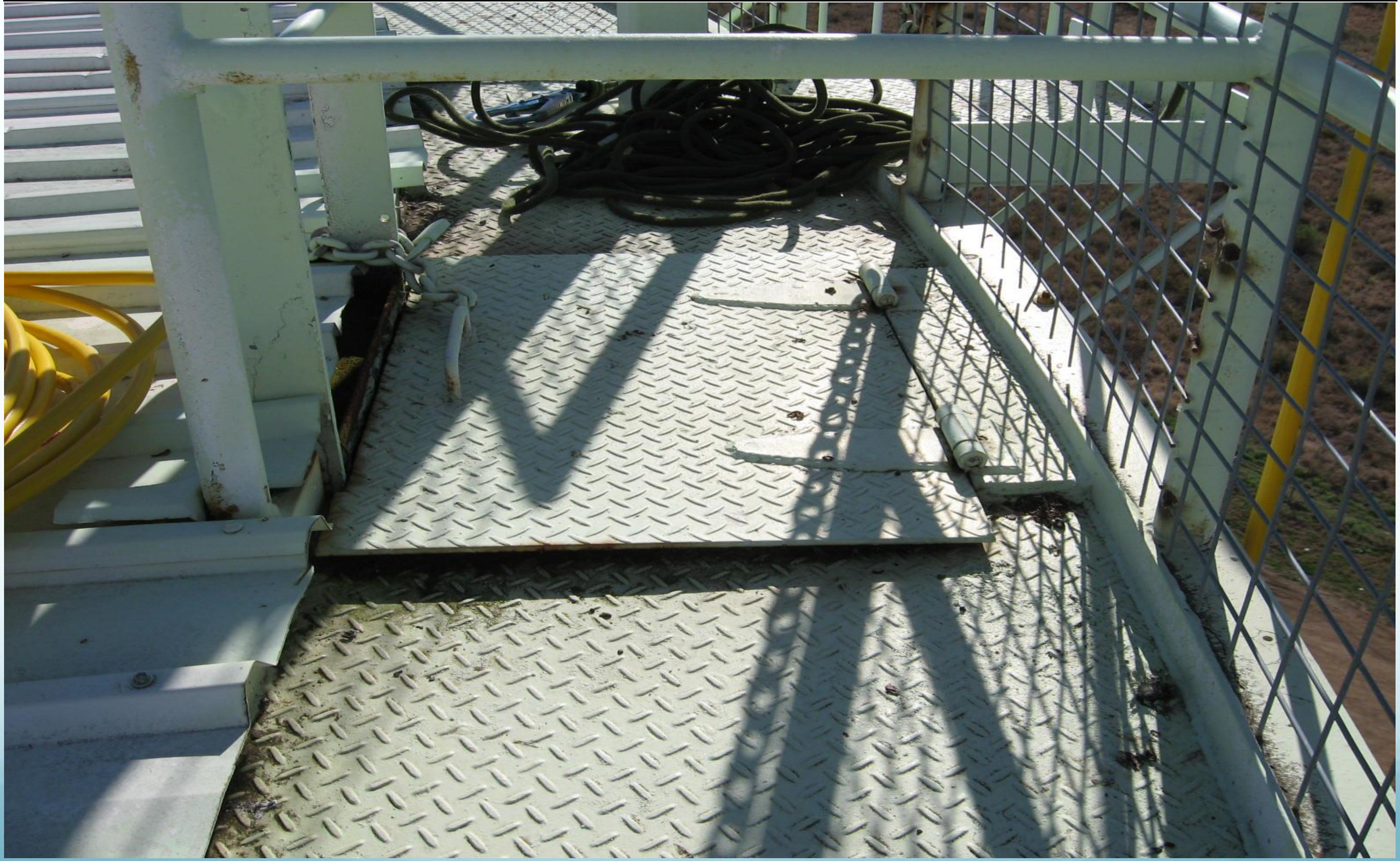
Hatch covers also had to accommodate the extended internal ladder stiles, so there was little chance of these original designs protecting the product stored within the tank.

ENTRY HATCHES

The front edge is missing from the hatch frame area and the hatch cover security has been compromised by trying to accommodate the protruding ladder stiles.

ENTRY HATCHES

The entry hatch is too small for safe confined space entry and there is no sealing capacity present to prevent natural or deliberate contamination from entering the tank.



ENTRY HATCHES

This entry hatch is too small for a confined space entry and it is poorly positioned on the platform. It should be parallel to and close to the wall area to allow for a more ergonomic placement of the ladder.

ENTRY HATCHES

Solution:
There are many aspects to safety and frequency should be an important factor in deciding which takes precedence. The risk of someone tripping once a year over a very obvious entry hatch frame, when stepping into the tank is minor when compared to natural pollutants entering our stored water 365 days of the year. The tank platform and roof areas are already full of trip hazards (if operators choose to walk around with their eyes closed), so why was the entry hatch in particular singled out for special attention?

ENTRY HATCHES

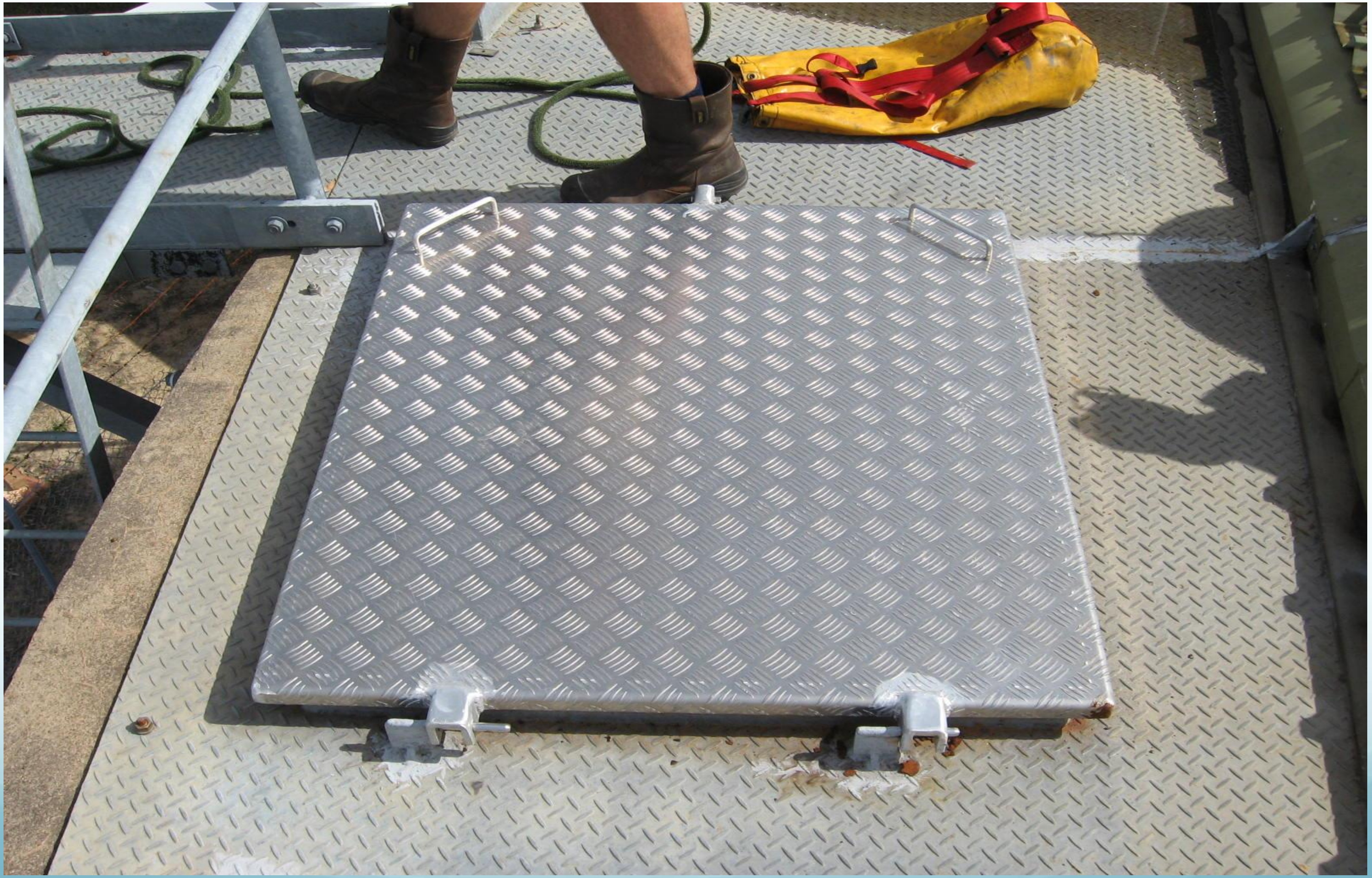
Entry hatches need to be enlarged to at least 900mm by 900mm and fully sealed and secured - that includes the frame sealed onto the surrounding platform areas, the covers overlapped around the edges of the frame and having nothing protruding through them. Storm water and debris ponding needs to be eliminated from the immediate area to maintain a clean working environment when entering or exiting the tank.

ENTRY HATCHES

A simple and inexpensive hatch upgrade – the ladder stiles have been trimmed off, the front edge has been sealed and the sliding hatch replaced with a hinged, overlapping type cover that increases security and prevents contamination entry.

ENTRY HATCHES

A simple and inexpensive upgrade – the hatch cover is now secure and sealed.



PLATFORM AREAS

Platform areas need to be enlarged and sloped to encourage effective drainage, there needs to be adequate clearance to allow debris to be removed easily. Larger, uncluttered work areas assist in improving ergonomics and rescue systems need to be incorporated to assist confined space entry and exiting of the tank.

Guard rails need to be put in place to prevent personnel from falling off the immediate platform or roof area, but not to limit access to the safer areas of the roof, where regular maintenance needs to be carried out.

PLATFORM AREAS

This tank is also used as a 'Broadcasting facility' – the platform area is littered with aerials and there are safety concerns for personnel with the associated EMF hazards.

PLATFORM AREAS

This platform requires guard rails on the LHS and the entry hatch area is unsealed. The adjacent roof sheets are ponded with debris and cannot drain away effectively .

PLATFORM AREAS

The working space is too small, the entry hatch is unsealed and the whole area is covered in bird faeces and debris. The adjacent trig tower is encouraging birds to roost in this particular area.

PLATFORM AREAS

The working area is overcrowded with control boxes and other accessories, that could have been located further away to make room around the immediate access area.

PLATFORM AREAS

Personnel are 'fenced into' a small working section and have to continually climb over the rails to access the roof area - more guard rails are required on either side of the roof.

PLATFORM AREAS

A platform upgrade with poor outcomes – personnel are ‘fenced into’ a small working area and the roof sheets are not sealed where the platform module was cut in.

PLATFORM AREAS

A close up of the platform to roof sheet sealing and a lack of understanding regarding the upgrade process and what it was supposed to achieve.

PLATFORM AREAS

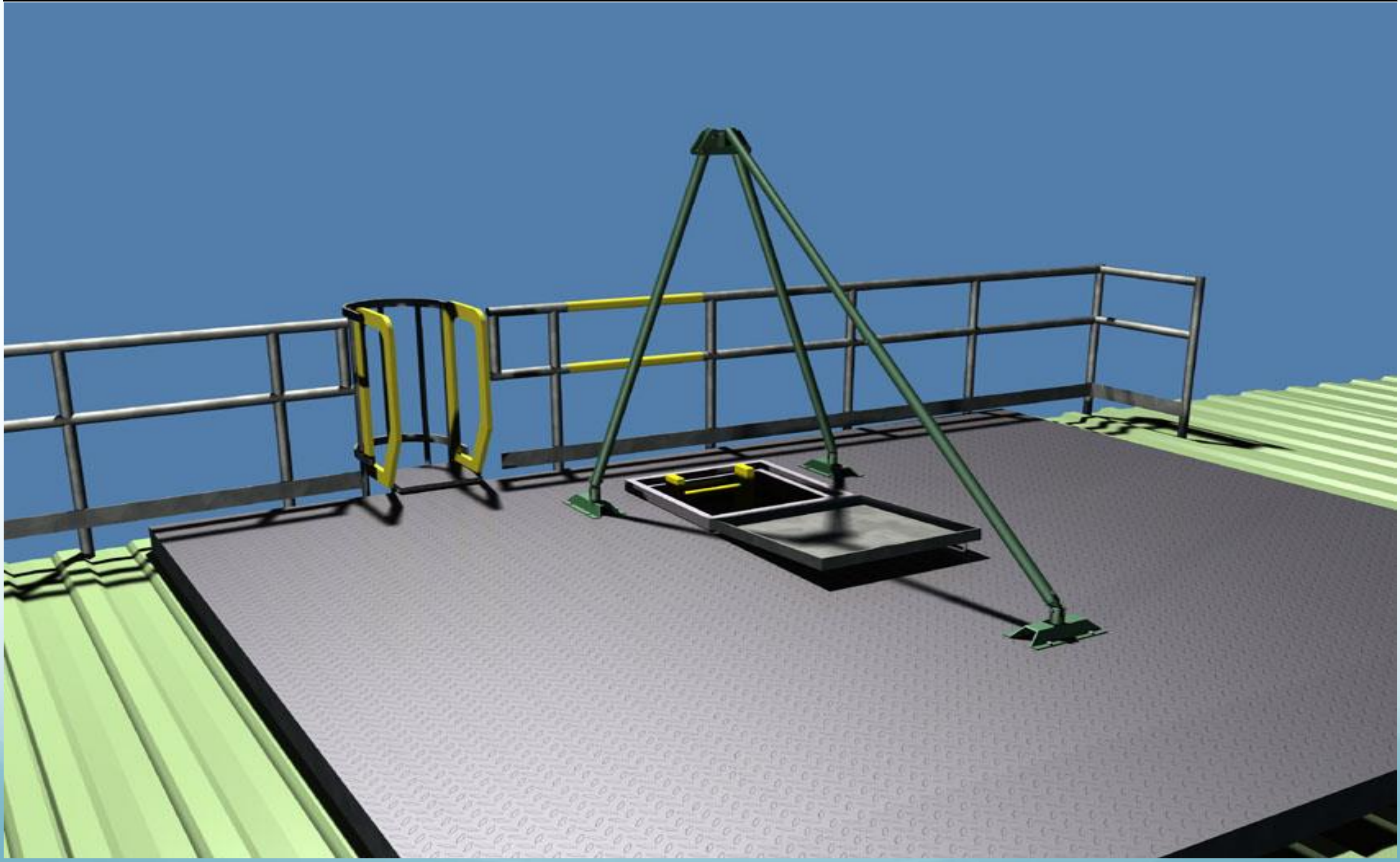
Another close up of the new platform area and how the roof now drains directly into the tank. Good design would have overcome these issues and made the project worthwhile.

PLATFORM AREAS

A new roof and platform, however a roof vent was placed right in the middle of the working area – this DOES count as a trip hazard!

PLATFORM AREAS

This is a concept design for a good platform area – open plan, plenty of working space and a rescue system in place to suit confined space requirements.



PLATFORM AREAS

This new platform layout is a big improvement – it has a good slope for effective drainage and a rescue system is in place.

PLATFORM AREAS

A simple 'open plan' upgrade on a small tank – adequate guard rails around the sealed hatch area and FRP mesh protecting the adjacent roof sheets.

PLATFORM AREAS

Another simple renovation – extra guard rails, a new overlapping hatch cover and the adjacent roof sheets protected to increase the available working area.

PLATFORM AREAS

A new enlarged and fully sealed entry hatch, additional guard rails and an 'open plan' working area – note the telemetry control box located in a sensible position.

ROOF AND PLATFORM DRAINAGE

Any drainage system that is not obvious and external to the tank has a potential to fail. The platform areas were forgotten when it came to drainage issues – a little water draining back into the tank was probably looked upon as being a bonus during dry times! Roof and walkway drainage systems can often overflow and deposit waste materials directly into the stored water because of the way they have been configured. This can be through poor alignment of the internal drain with the overflow bell mouth or under estimated volumes of water collected on the roof area during peak rain periods.

Box type gutters can fail through blockage or corrosion and contamination will occur with no-one the wiser.

ROOF AND PLATFORM DRAINAGE

The roof area has not been maintained and the internal gutters are totally blocked with bird faeces and debris – this contamination drains back into the tank during rain events.

ROOF AND PLATFORM DRAINAGE

The roof sheets are fastened directly onto the hatch frame and have no means of draining water and debris away from this area - the ponded water leaks into the tank.

ROOF AND PLATFORM DRAINAGE

A significant hole has been cut into the platform area to service a sensor unit – all this accumulated material is finding its way into the tank.

ROOF AND PLATFORM DRAINAGE

These roof drains appear to be OK – until you look underneath the platform area!

ROOF AND PLATFORM DRAINAGE

A piece of 90mm storm water pipe is simply pushed inside a 150mm drain point – and expected to prevent excess water and contamination from entering the tank!

ROOF AND PLATFORM DRAINAGE

Another example of a roof drain which is not connected into anything – this was very simple to fix once it was identified.

ROOF AND PLATFORM DRAINAGE

This drain point is only slightly better – at least some duct tape has been used to try and create a seal between the pipes!

ROOF AND PLATFORM DRAINAGE

This box gutter has corroded away and is now draining all of the roof directly into the tank

ROOF AND PLATFORM DRAINAGE

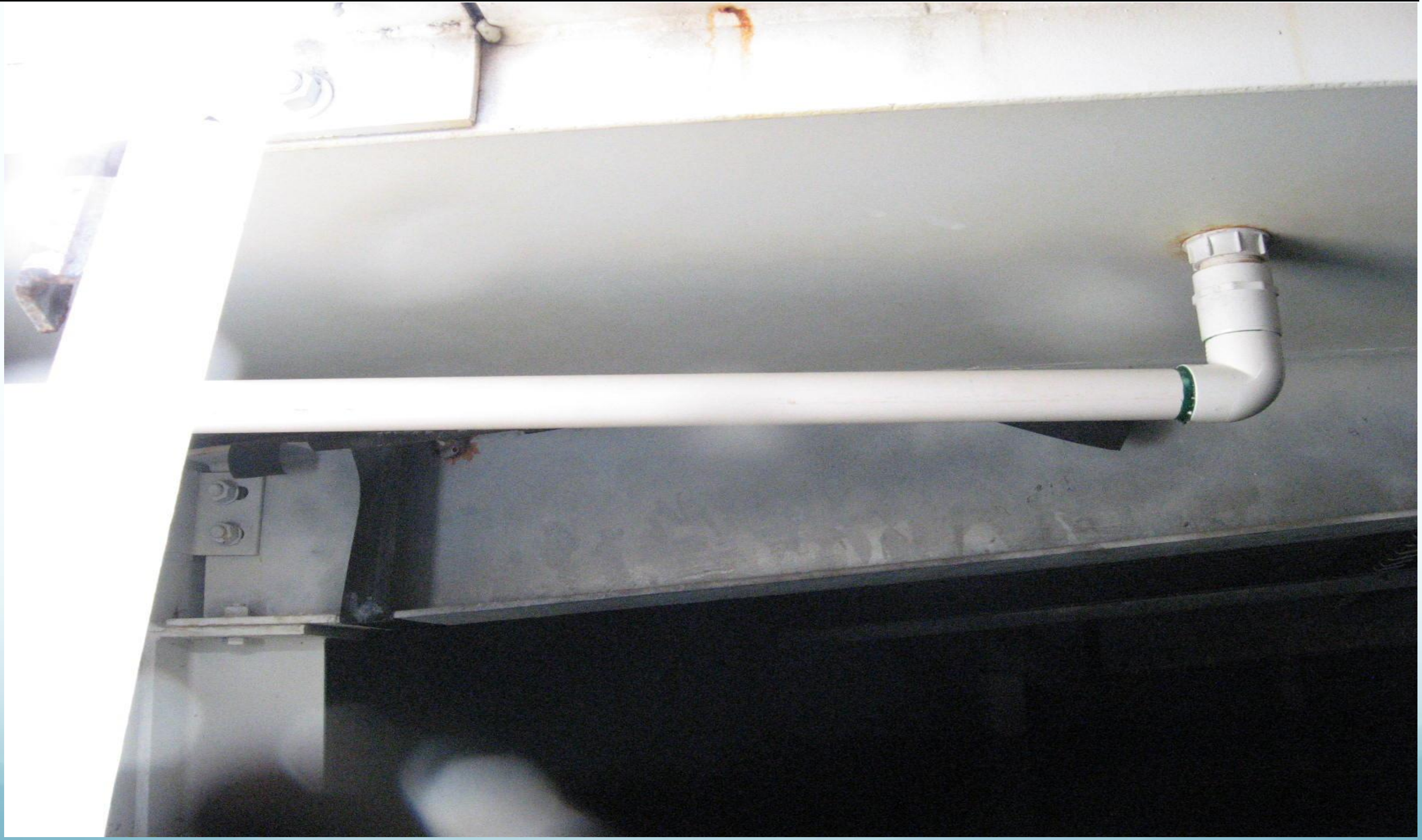
Solution:
Change roof designs to avoid internal gutter systems and enlarge and re-align existing drainage points to cater for peak storm activity.
Install drainage points in ponded platform areas that exit out through the adjacent wall area.
Carry out regular monitoring during heavy rain periods to ensure contamination isn’t occurring within the tank (an unpleasant and wet activity but necessary to avoid failures).

ROOF AND PLATFORM DRAINAGE

This platform has a reverse fall and water was ponding around the entry hatch area – a simple drain point was cut in at the lowest point and then plumbed out through the adjacent side wall area

ROOF AND PLATFORM DRAINAGE

The under side area of the platform – this simple plumbing job was carried out using ‘off the shelf fittings’ while standing on the internal ladder



VENTILATION SYSTEMS

Effective and well designed ventilation is required to protect roof framing from premature corrosion. It can also remove condensate material that collects under the roof sheets and which drops back into the water and affects taste and odour in the stored water. In some cases too much or poorly positioned ventilation areas can cause more contamination issues than they solve – there has to be a balance depending on the surrounding environment. Tanks surrounded by overhanging trees will be subject to excess leaf debris which can enter the tank through the vents. Also tanks in very dusty or industrial areas will need to have ventilation limited or re-positioned to avoid additional contamination from occurring.

VENTILATION SYSTEMS

This tank is surrounded by high trees and leaf debris is gathering on the upper wall support ledge and blowing or washing into the tank. The base section needs to be sealed off and fine mesh vents be cut into the side panels at regular intervals.

VENTILATION SYSTEMS

This ventilation is poorly designed – the mesh is too coarse and not sealed along the lower edge, where contamination and debris is collecting and entering the tank.

VENTILATION SYSTEMS

Solution:
Design ventilation systems to suit the local environment.
Windy areas should not have turbine vents fitted as these will wear out quickly through over use – fixed vents are preferred.
Mesh panels should be positioned away from prevailing wind areas to avoid excessive wind born contamination.
The materials used should be corrosion proof and be fine enough to keep out insects and leaf type debris.

VENTILATION SYSTEMS

Use ventilation mesh that will not corrode or allow small contamination particles to enter the tank

INTERNAL FITTINGS AND PIPE WORK

Removing or replacing any fitting that adversely affects water quality is important. Materials such as AC overflow risers, ductile iron pipes, galvanized metal items and any un-coated penetrations all need to be attended to during the renovation process. Fittings placed inside steel tanks are commonly coated with the same materials used on the wall and floor, but some items such as ladders and support brackets have been galvanized and these have deteriorated at a far quicker rate than the wall and floor areas. Concrete tanks generally have uncoated fittings, as no one considered protective coatings due to the concrete being relatively stable from a corrosion perspective. The unprotected items however corrode and continue to pollute the water on a continual basis.

INTERNAL FITTINGS AND PIPE WORK

This AC overflow riser pipe has begun to delaminate and the particles are mixing in with the stored water.

INTERNAL FITTINGS AND PIPE WORK

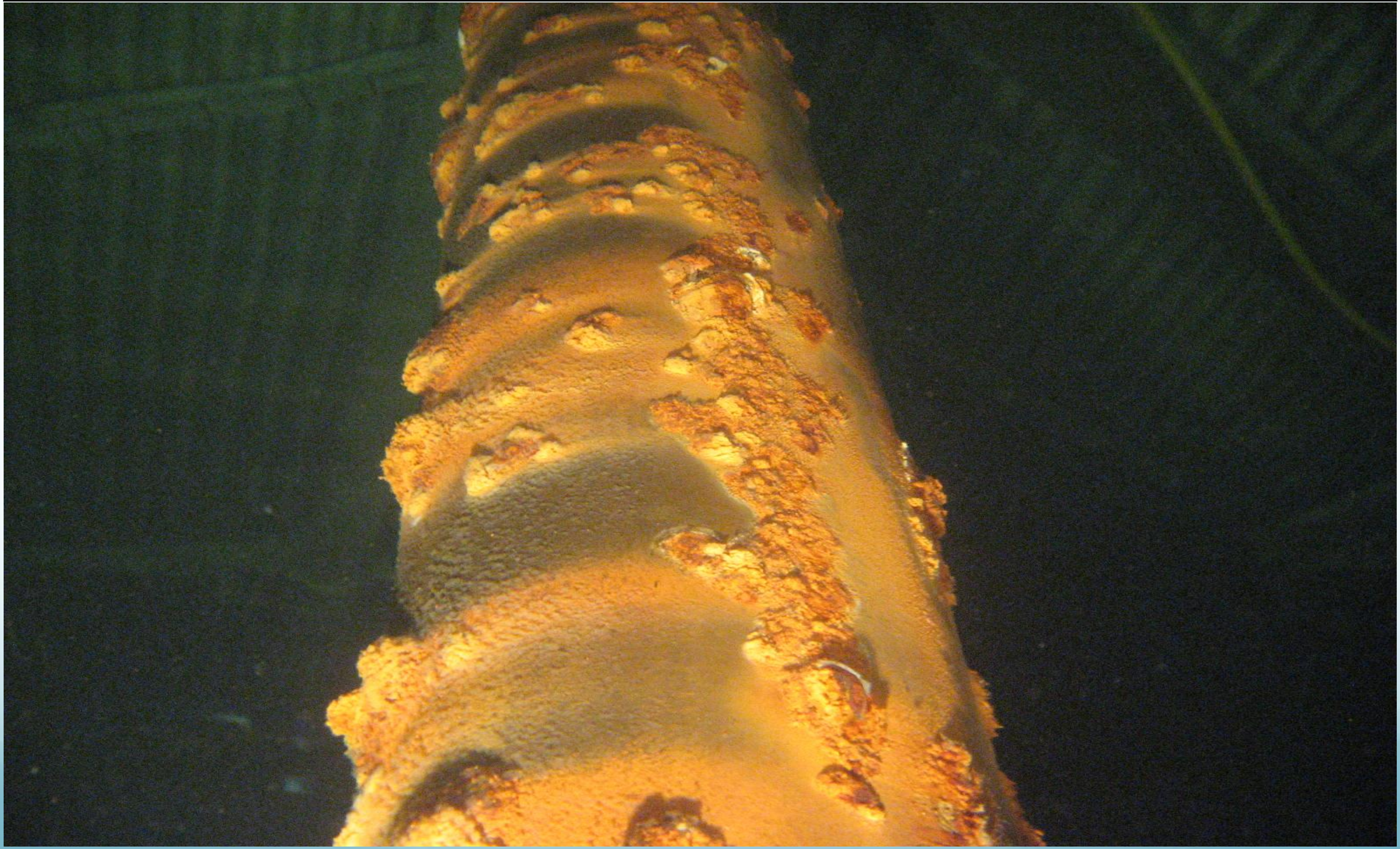
Remove any old and obsolete pipe work when tanks are being renovated.

INTERNAL FITTINGS AND PIPE WORK

The support brackets on this overflow riser pipe are galvanized and beginning to corrode, while the epoxy coated areas are still OK.

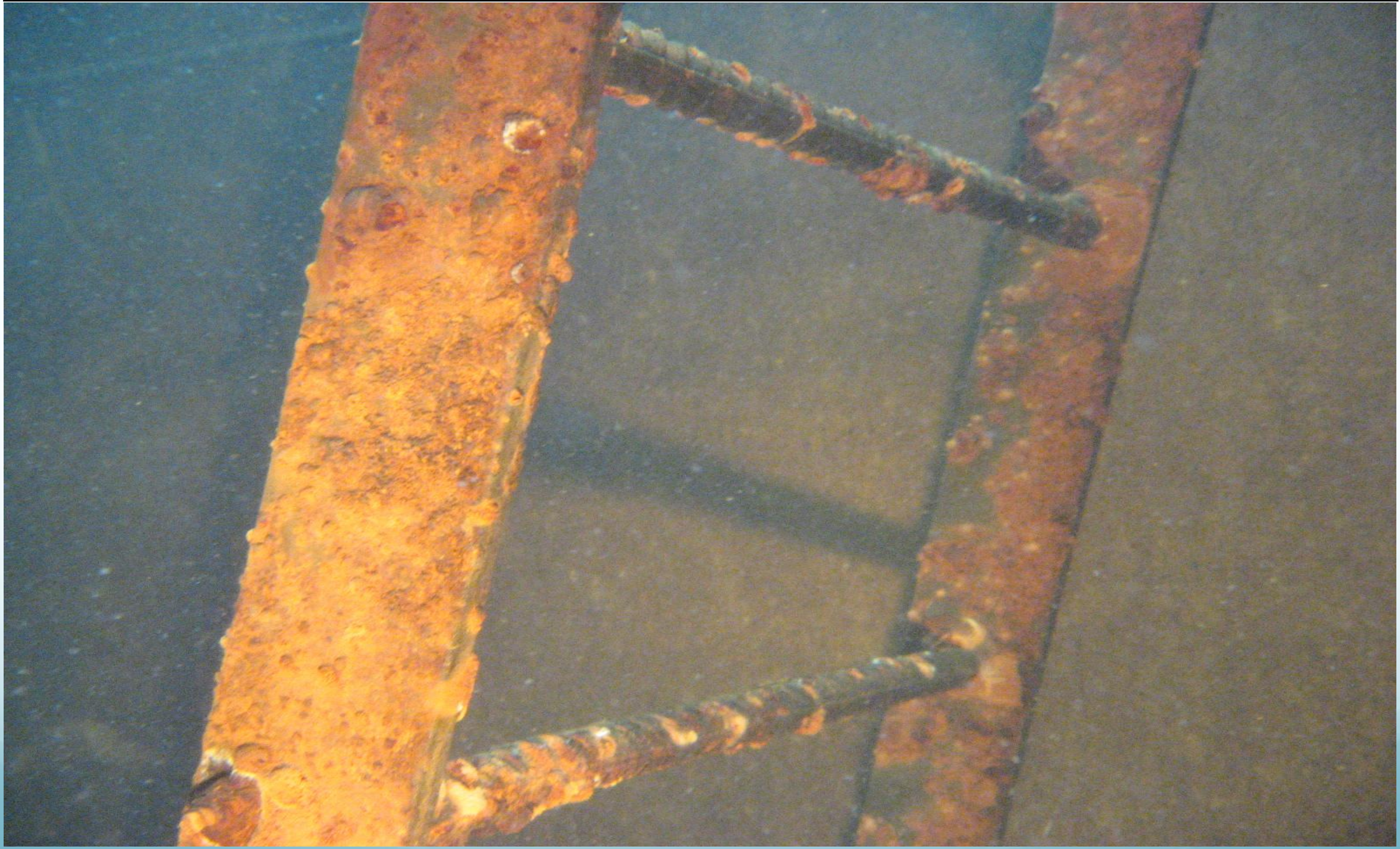
INTERNAL FITTINGS AND PIPE WORK

This roof support post was galvanized instead of being epoxy coated like the wall and floor areas of the tank.



INTERNAL FITTINGS AND PIPE WORK

Ladders and fittings were also often galvanized whilst the epoxy coated wall and floor areas are still in good condition.



INTERNAL FITTINGS AND PIPE WORK

Solution:
Replace corroded or structurally deteriorated items with materials that are cathodically compatible and suitable for immersion in potable water.
Plan for the long term requirements - weld mounting stubs and flanges onto inlet and outlet penetrations so that the fitting of nozzles and safety screens can be carried out.
Fit additional pipe penetrations through the walls of steel tanks to cater for future connections to the distribution system – we often see additional outlets connected to scour penetrations and this results in poor quality water being delivered downstream. Once a tank has been re-coated it is too late to begin welding on brackets and other fittings, without compromising the new renovation.

INTERNAL FITTINGS AND PIPE WORK

Simplify pipe work systems so that effective water blending takes place and sediment disturbances are minimised as water passes in and out of the tank. A ‘passive tank’ merely stores a given amount of water – a ‘working tank’ avoids contamination issues and maintains good water quality for the consumers.

Top filling inlets should be avoided, as they cause significant turbulence down to the floor area if water levels are low. It is better to move water upwards into a tank, so that the water column is moved in a uniform pattern without sediment disturbance. Fit directional nozzles to wall and floor inlets to avoid disturbing any sediments present and to also blend the stored water and keep it fresh.

INTERNAL FITTINGS AND PIPE WORK

Two way nozzles will improve the functionality of common inlet outlet penetrations and reduce short circuiting of the new and older water entering and leaving the tank.
Well designed safety screens should be fitted to outlets to avoid diver entanglement. Screens should be sized closely to the penetrations to avoid sediments from accumulating internally around the pipe work – this material would be difficult to clean away without removing the screen each time. If screens are too large, they become passive and sediments collect on the surfaces, only to be drawn into the distribution system during high flow periods. Screens should also have a solid raised edge around the base area to keep out any adjacent floor sediments.

INTERNAL FITTINGS AND PIPE WORK

Directional inlet nozzles made from non corroding HDPE – these units will enhance the inlet pipe work and improve the stored water quality. The SS Ram tubes provide a safety barrier for divers and also reduce any back pressure issues to the inlet pumps.

INTERNAL FITTINGS AND PIPE WORK

Outlet safety screens made from HDPE prevent sediment accumulation from entering the pipe work – they should fit the penetration closely to avoid internal sediment entrapment which is difficult to remove during normal cleaning operations.

Water
Infrastructure
Solutions