Reservoir Design – an Executive Summary

AquaSafeSkills

Overview

- This presentation summarises the key aspects of an effective storage tank design. It can be used when reviewing design plans or developing a scope of works for a tender pack. For more detailed information on each section (including pictures/photos/explanations), refer to www.aquasafeskills.com.au > Technical > Documents > *Reservoir Design for the Next Generation V15*.

- **Section 1 – Location – Plan for future site needs**
- **What future development may occur?**
  - Will there be encroaching urban development?
  - Is there an avenue for waste disposal?
  - Will there be additional tanks?
    - Will there be a future need for pumping or chlorination?

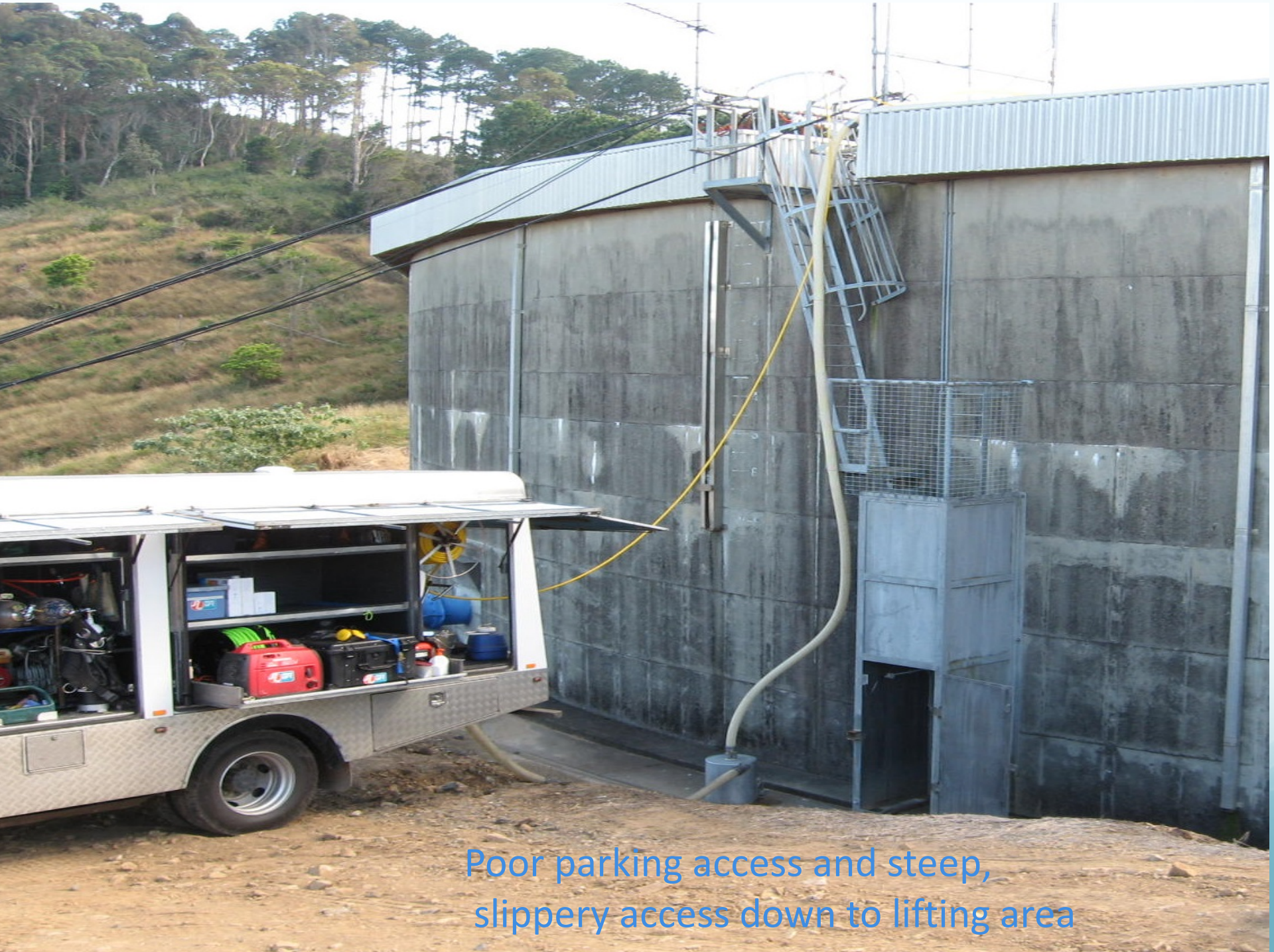
- **Does your access road accommodate for?**
  - Tankers for water delivery or waste water removal
  - Trucks for maintenance, repair or cleaning
  - Work vehicles for sampling, maintenance etc.
  - Is there a level parking section below the entry hatch/working area?


Transpacific

Good platform access

Poor platform access

Is there a level parking section below the entry hatch/working area?


Poor parking access and steep,
slippery access down to lifting area

- **Is the landscaping and site layout going to impact?**
  - Overgrown trees dropping material on the tank or damaging coatings
  - Root systems disrupting foundations or impacting pipes
  - Avoid steep slopes or provide stairs/walkways to access lifting areas up onto the tank
  - Limit access for scaffolding, cranes, digging or lifting equipment

Tree root structural damage

These healthy trees indicate seepage issues from under the tank floors or pipework


Poor all around access and side wall structural damage issues

- **Section 2 – Naming and Identification**
- **Does the naming convention?**
  - Clearly identify the reservoir location through suburb or area
  - Contain a water storage number (WS)

- **Are tank identifiers used?**
  - Is the tank ID clearly visible and durable?
  - Have clock face positioning numbers been stencilled inside and outside?
  - Are all penetrations (eg inlet, outlet, scour, monitoring etc) clearly marked?
  - Are all valve operating directions clearly marked?
  - Do the roof supports carry an ID number (eg, centre post is No.1, No.2 closest to the 6 o'clock position)

EFFECTIVE WATER STORAGE MAINTENANCE RUNS ON TIME!

THE CENTRE POST IS #1 AND FURTHER NUMBERS RADIATE OUTWARDS IN A CLOCKWISE DIRECTION WITH #2 BEING NEAREST TO THE 6 O'CLOCK POSITION.

A KEY PART OF ANY INSPECTION PROGRAMME IS ACCURATE IDENTIFICATION.

The Aqualift solution is to reference inspection positions using the numbers of a clockface.

These should be stenciled both inside and outside on circular tanks.

TOP NUMBERS ARE POSITIONED ABOVE THE HIGH WATER LINE

BOTTOM NUMBERS AT 500mm ABOVE FLOOR

THE OUTLET SCREEN IS MADE FROM HDPE - IT PROVIDES A SAFETY BARRIER FOR DIVERS AND PREVENTS FLOOR SEDIMENTS FROM ENTERING THE PIPEWORK.

THE DIRECTIONAL INLET NOZZLE IS MADE FROM HDPE MATERIAL AND IS FITTED WITH A STAINLESS STEEL "RAMTUBE" TO ENSURE EFFICIENT BLENDING OF THE STORED WATER.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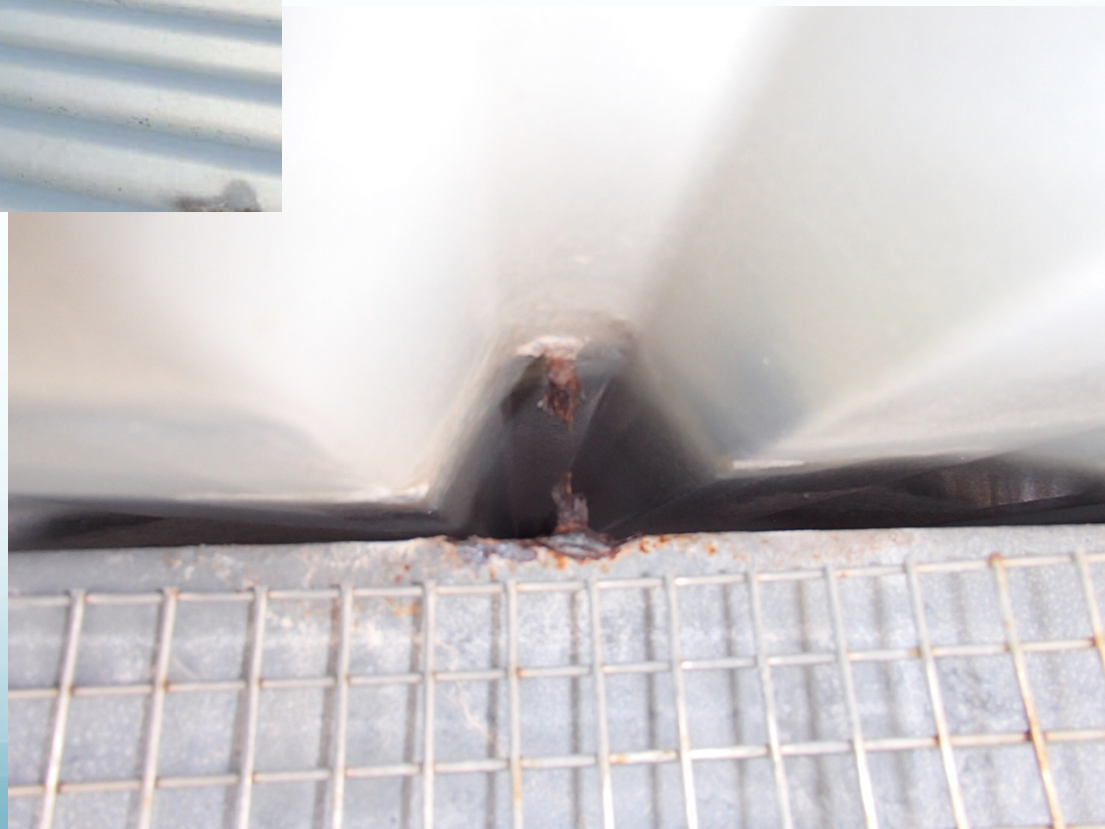
- **Section 3 – Roofing Systems**
- **Roof sheeting**
  - Are the fixing screws suitable for long term corrosion resistance?
  - Are ridge flashings minimised for effective sealing?
  - Are the roof sheets full length and only cut around the edges? (eg. avoid centre pitch design)
  - Are the edge fixings stronger to prevent wind damage?

Roof edges unsecured by cheap, corroded roof screws



Good roof area. Continuous sheeting, no ridge caps or gutters

Poor roof area.
Cut sheets and multiple ridge caps

- Are edge ridges sealed effectively to prevent vermin or dust entry?
- Are the sheets oriented to prevent build-up of debris or water pooling behind roof fixtures?

Roof edges effectively sealed against vermin entry

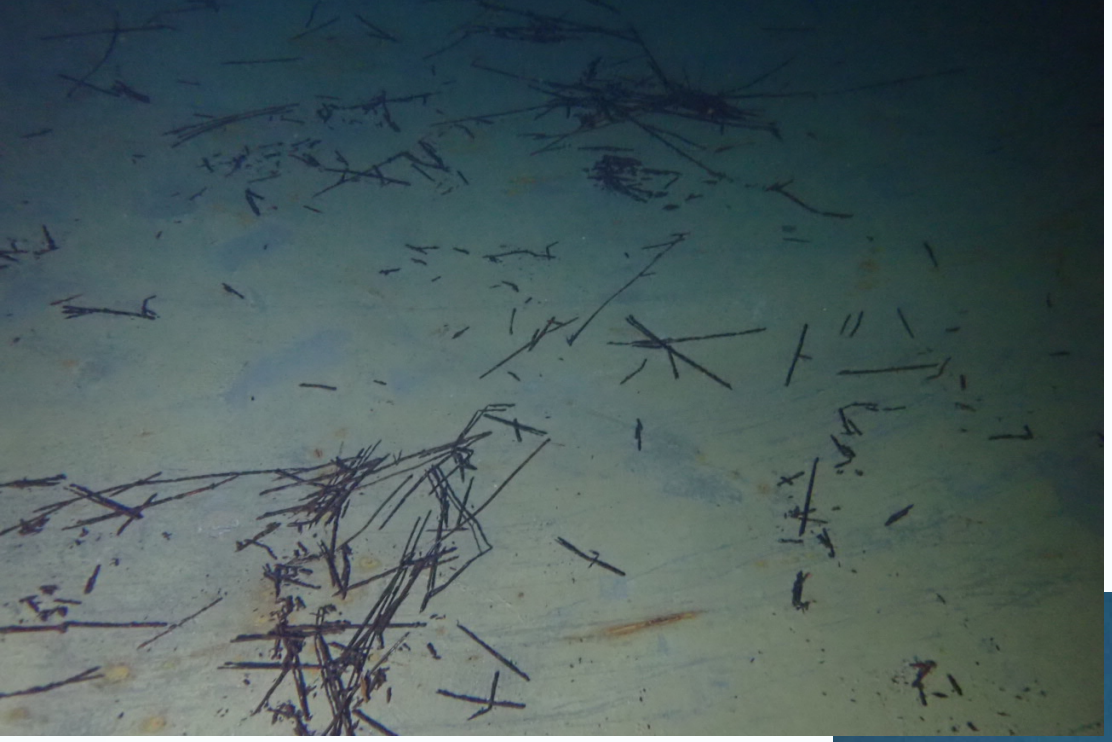
- **Roof gutters**
- Can roof gutters be eliminated to prevent future issues such as blockages, leak points, ongoing cleaning, damaged down pipes?

Roof edge gutters blocked by overhanging trees


No roof edge gutters
and level parking below
the platform area

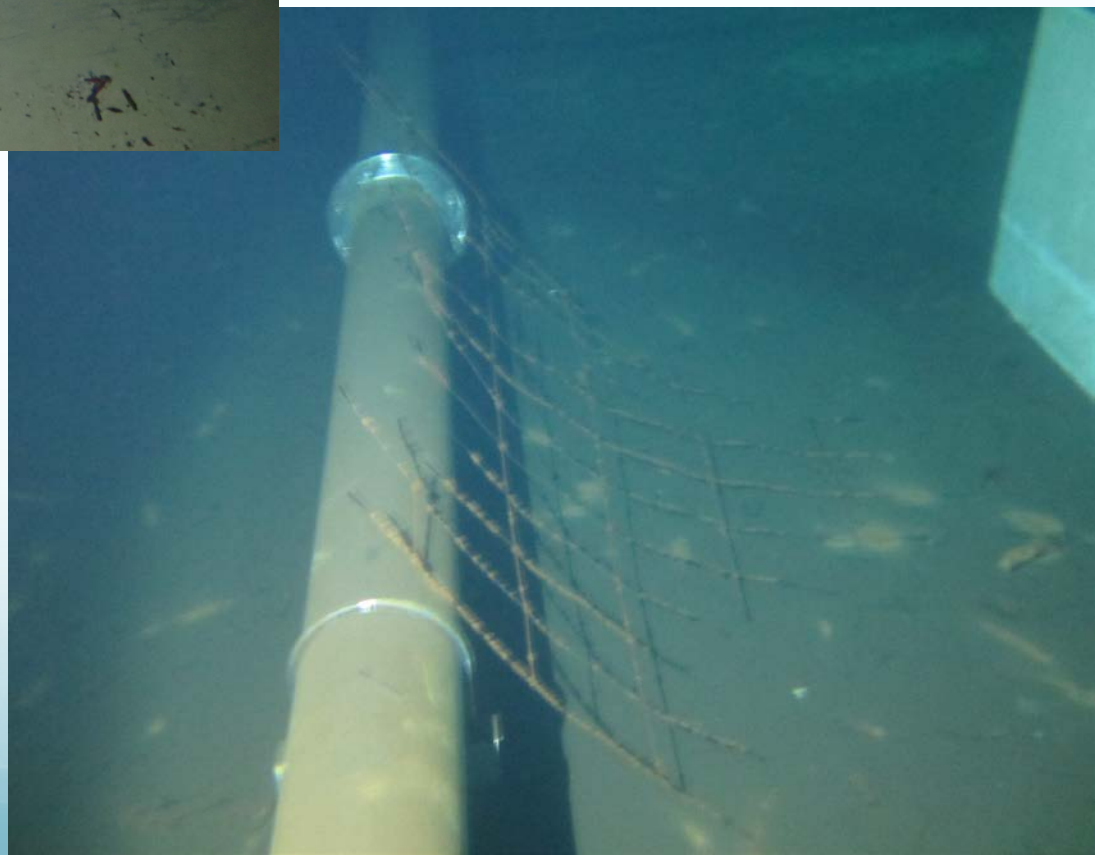
- **Roof Framing**
  - Are the materials suitable for use in moist, humid/severe conditions?
  - Are the fixings specified for longevity in severe conditions?
  - Has ‘under roof’ safety mesh been eliminated to avoid corrosion issues?
  - Do aluminium framing systems have fixings that will not loosen off due to flexing?

Aluminium roof framing fixing bolts
unsecured due to flexing movements



Roof safety mesh debris

Roof safety mesh debris making cleaning difficult



Roof safety mesh corroded and damaged sheeting

Corroded safety mesh roof sheet damage evidence

- **Ventilation**
  - Does the ventilation increase risk of contamination?
  - Are the inlet and exit vent points oriented away from contamination sources?
  - Do the inlet and exit vents encourage airflow?
  - Has a maintenance strategy been developed for turbine vents (ie. easy replacement, checking for internal corrosion)
  - Have fixed type vents been specified for high wind areas?

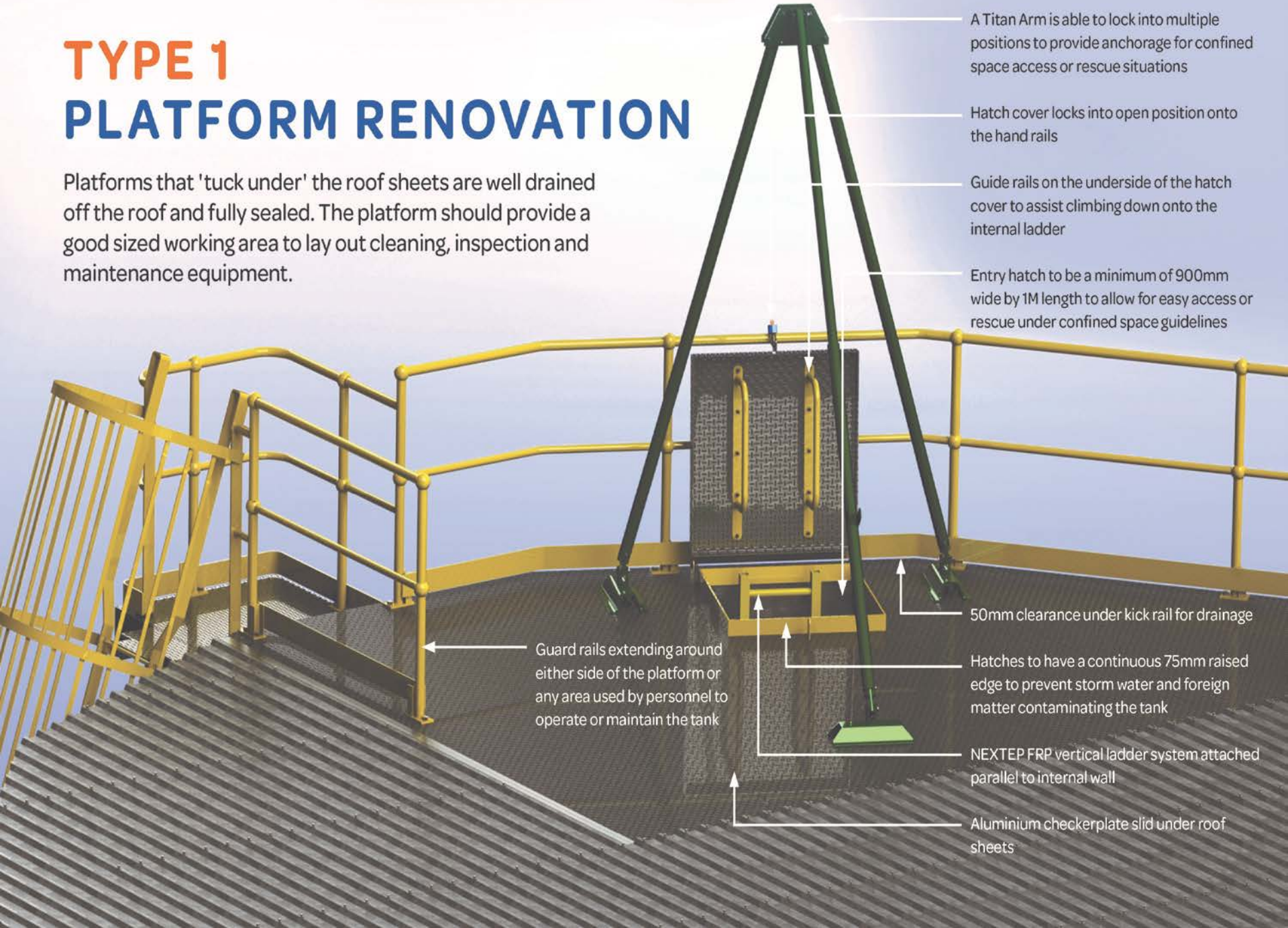
Secure side wall,
fine vent mesh

Fixed roof vents for
high wind areas

- **Section 4 – Access Systems**
- **Platforms**
  - Does the platform area “fall” away to the outside edge to prevent ponding?
  - Has drainage into the tank been eliminated?
  - Has expanded mesh been used on top of the adjacent roof sheets to prevent impact damage?
  - Is the available working area adequate for maintenance tasks and rescue situations?

TYPE 1
PLATFORM RENOVATION

Platforms that 'tuck under' the roof sheets are well drained off the roof and fully sealed. The platform should provide a good sized working area to lay out cleaning, inspection and maintenance equipment.

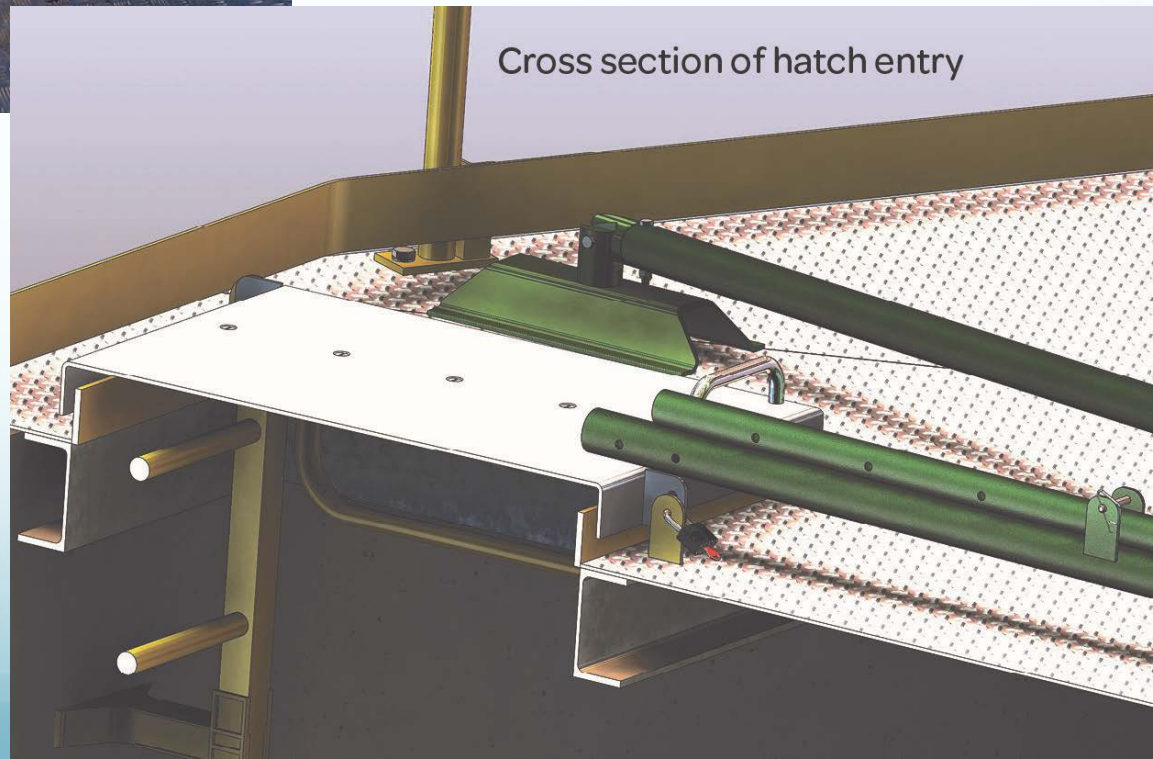


- **Guard Rails**
  - Do they extend at least 6m either side of the access platform?
  - Do kick rails have adequate drainage and debris removal clearance?
  - Are hinged gates latched to prevent accidental opening?
  - Are stanchions or handrails fitted to assist descending the internal ladder?

- **Entry Hatches**
  - Is the hatch a minimum of 900mm x 900mm to allow for easy diver access or robotic equipment?
  - Do they have a continuous raised edge frame to prevent ingress?

Hatch cover locks onto guard rails. Vertical handrails allow easy access down onto the ladder

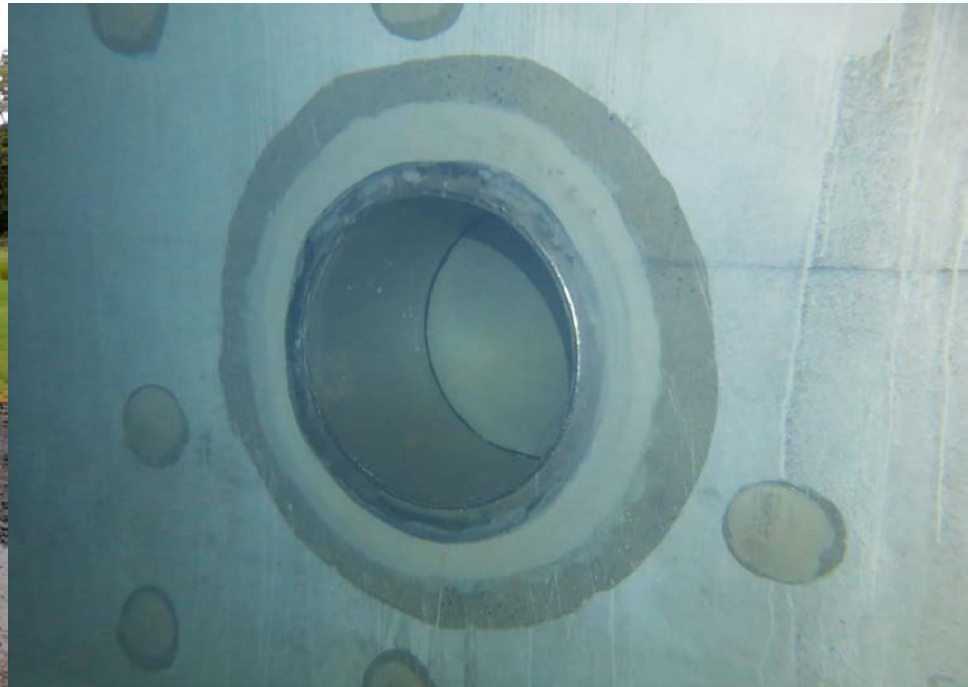
Vertical locking tabs allow padlock to lay flat and not fill with rain water



- Are they completely sealed with no internal projections (eg stanchions)?
- Are they lockable when closed?
- Are they securable when open?
- Are they heavy duty to withstand climatic and vandalism events?
- Are they light enough for a single person lift?

- **Access Hatches**

  - For tanks over 30m diameter, does it have a second hatch @ 180 degrees to the entry hatch?
  - Is there a sidewall hatch for empty tank, confined space access (min 900mm x 900mm)?



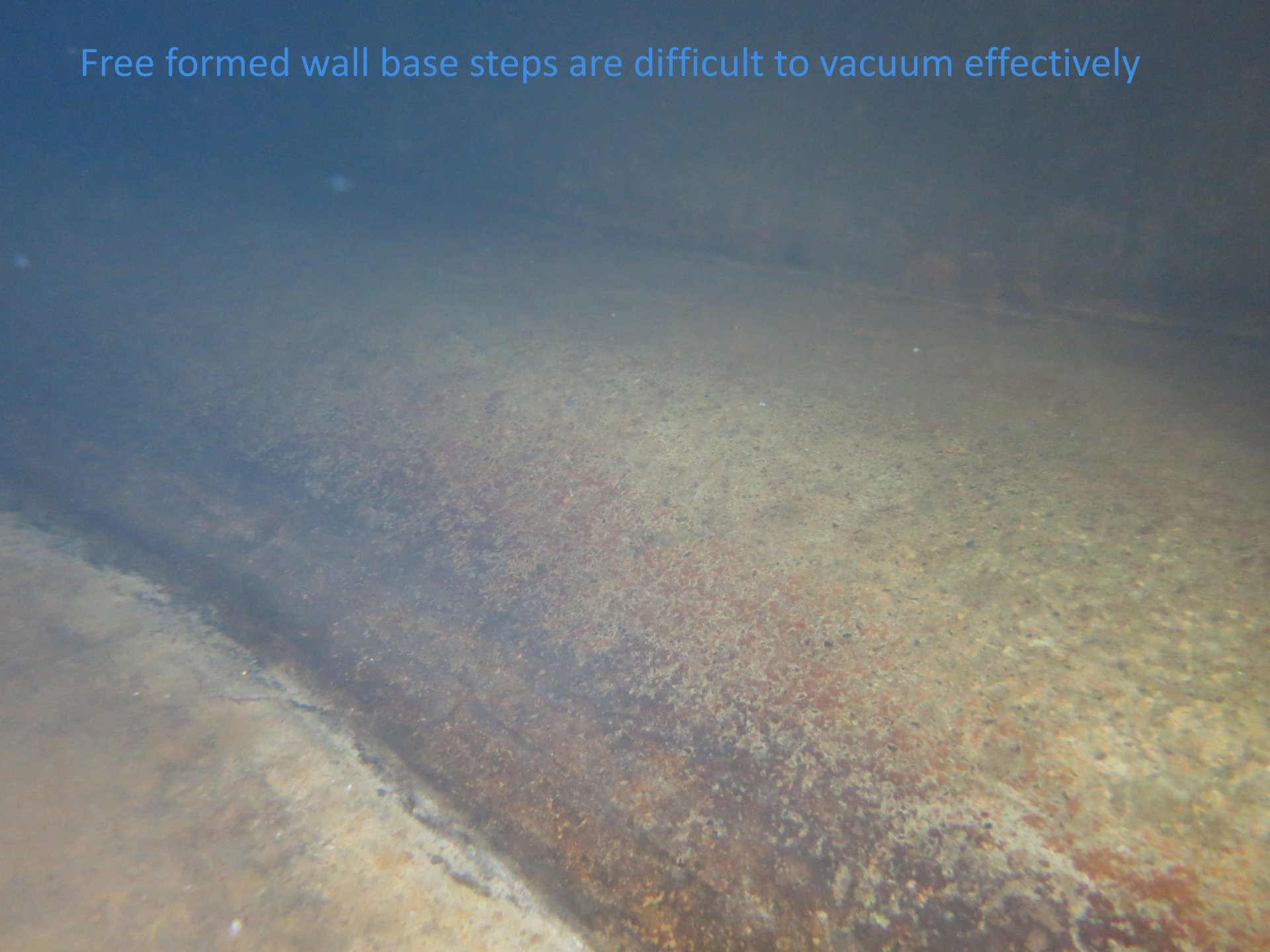
- **Rescue Systems**
  - Can the davit be folded away (to prevent birds roosting)?
  - Can the rescue equipment be rigged without the need for a step ladder?
  - Can it sustain sideways loading for complex rescue situations?

Folded down when not in use

Luffed backwards for easy rigging

- **Section 5 – Internal Design Features**
- **General**
  - Are there sediment entrapment areas (eg, steps around walls or post bases, low penetrations which can't be cleaned under)
  - Do horizontal surfaces (eg. platform landings) have perforated surfaces to prevent sediment build up?

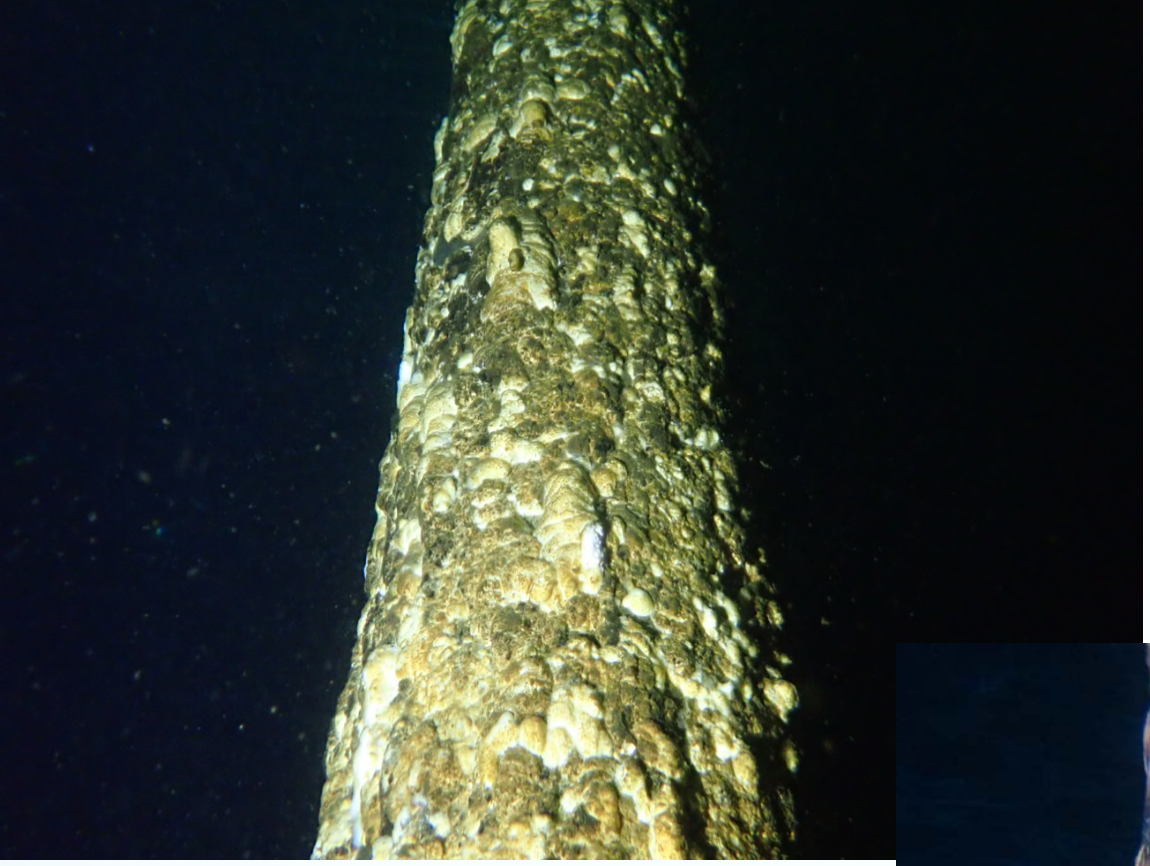
Free formed wall base steps are difficult to vacuum effectively



- **Materials**

  - Are all materials (including fixings) cathodically compatible?
  - Do all metals have a protective coating for immersion?
  - Have all stainless-steel items been passivated to prevent localised corrosion?
  - Have aluminium items undergone acid washing to remove carbon particles?

- **Posts**
  - Are aluminium posts cathodically insulated from floor fixings and roof framings?
  - Post materials should be either concrete or epoxy coated steel, NOT galvanised steel or aluminium
  - Are the number of posts minimised to assist with water circulation and reduce sediment trapping points?
  - Are post bases squared off to allow for easy cleaning?



Aluminium posts corrode if they are not insulated from top and bottom connections. They act as an anode to the steel reinforcing in the concrete walls

Galvanised steel posts corrode when the galvanising material acts as an anode to the steel it is covering


Stainless Steel fixings not
insulated from
aluminium post base

Post base difficult to clean with foundations above the floor area

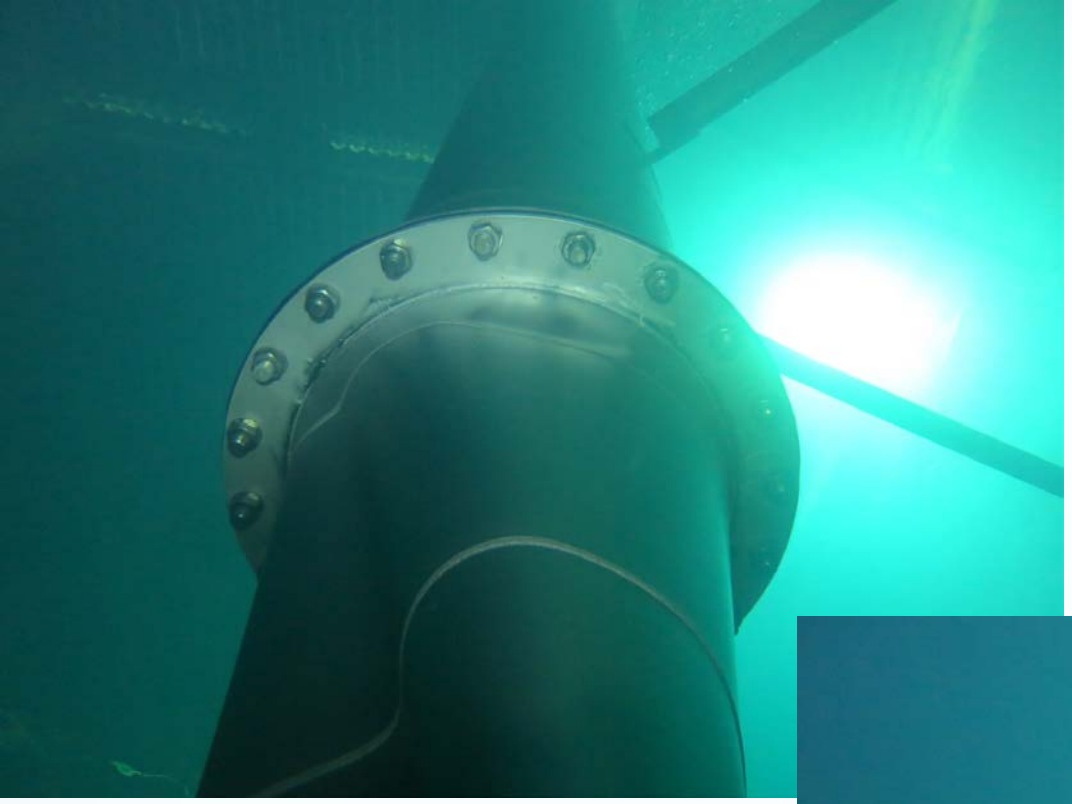
A simple post base with foundations below the floor area


Too many posts. Larger
rafter sections would have
allowed for fewer supports

- **Pipe Work**
  - Has pipe work within the tank been minimised (eg, only flanged penetrations protruding into the tank)?
  - Are all penetrations (except the scour) flanged to allow for future fitting of nozzles, screen and flow meters?
  - Is the overflow system external to the tank and is the end screened off to prevent vermin entry?
  - Can GRP or HDPE be used for overflow risers and supports to avoid corrosion?

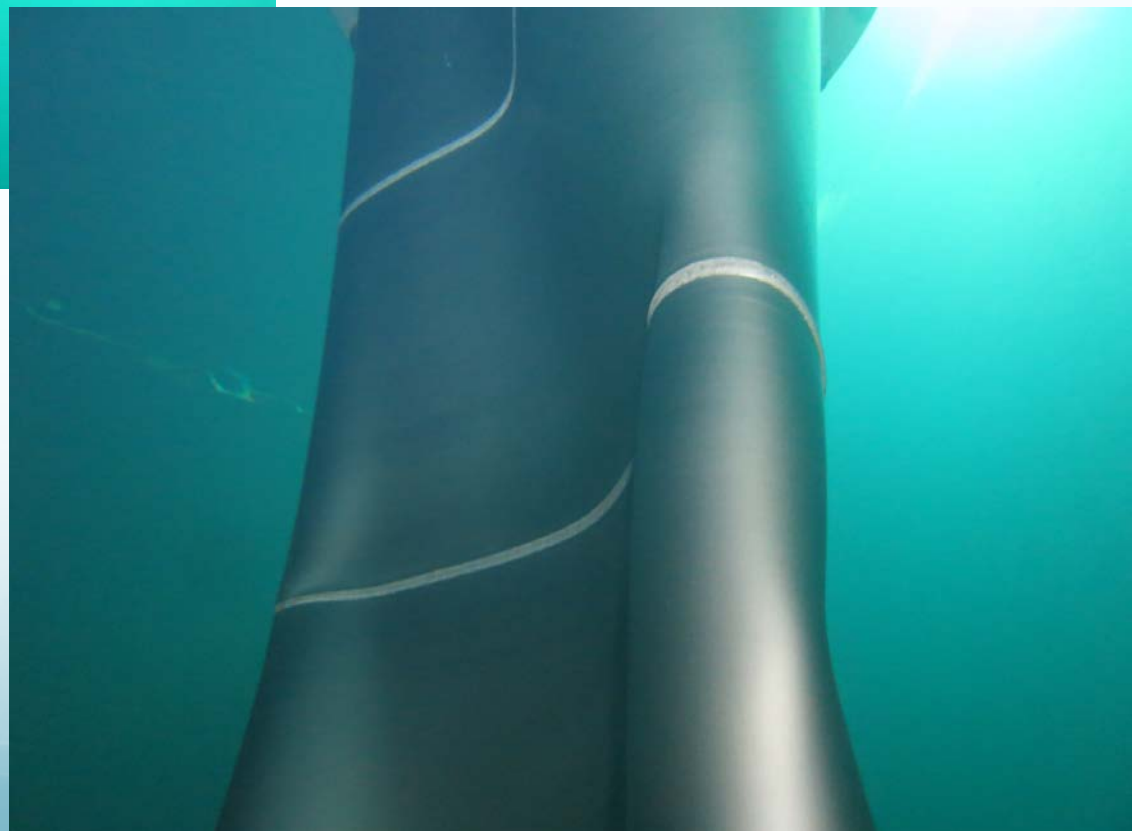
The overflow is a simple hole in the wall connected to external pipework, draining into a screened pit

The overflow outlet is fitted
with a vermin proof, hinged cover

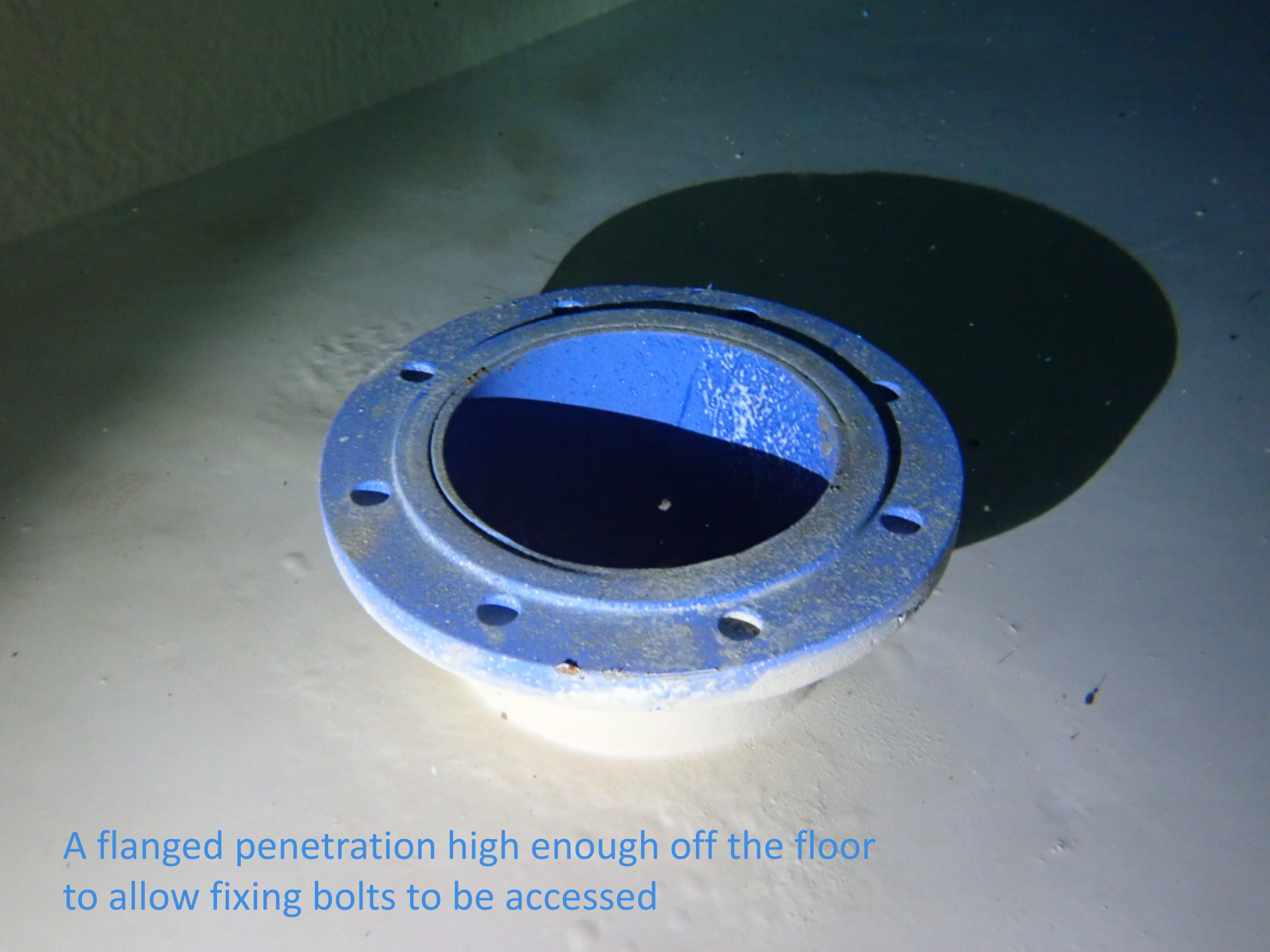


A thin-walled SS overflow riser that would have saved money during the construction phase

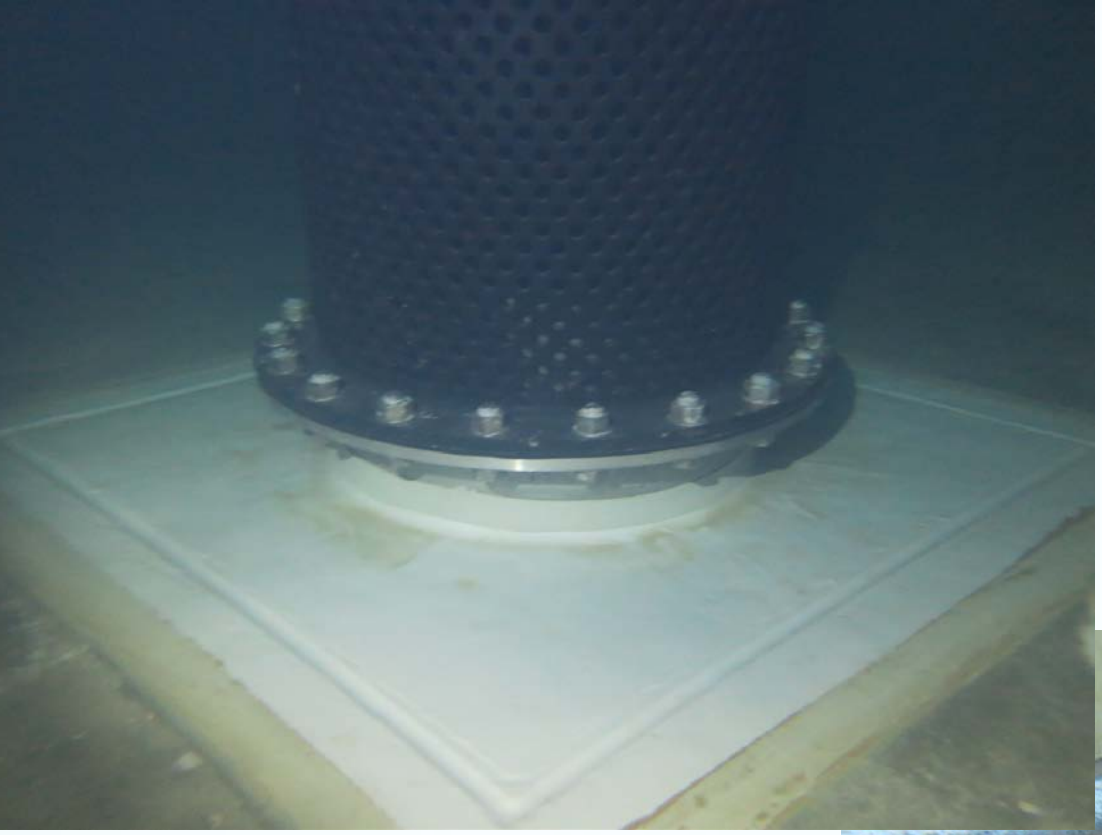
What happens under pressure to thin-walled overflow risers. This collapse occurred during the first filling process



- **Outlets & Screens**
  - Are outlets at least 150mm above the floor to prevent sediment ingress?
  - Does the outlet have a flange?
  - Have concrete plinths been eliminated to prevent adjacent sediment build up?
  - Are close fitting, protective screens installed on outlets to prevent internal sediment build up, which cannot be effectively cleaned away?
  - Is the screen material cathodically compatible?



A flanged penetration high enough off the floor
to allow fixing bolts to be accessed



A flanged and sealed outlet base with an HDPE safety screen fitted

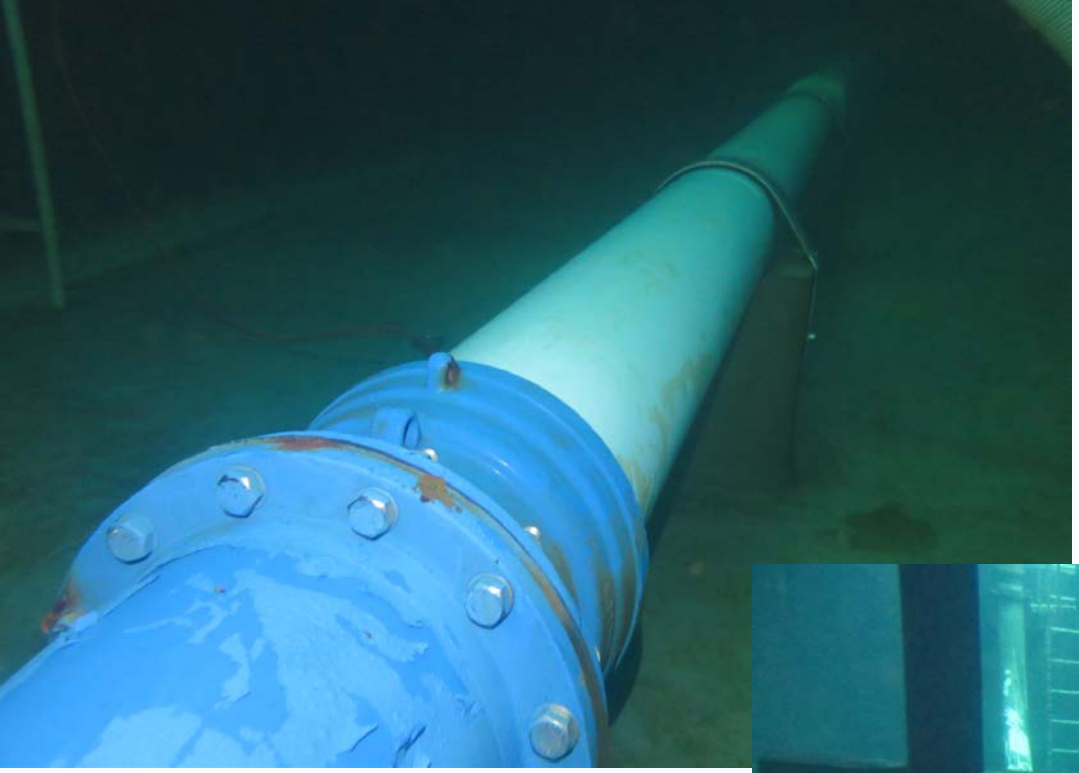
An outlet surrounded by a concrete plinth which collects sediments

This outlet is flush to the floor.
Note the sediments being drawn in

The outlet is flush with the floor and the screen prevents effective cleaning from occurring

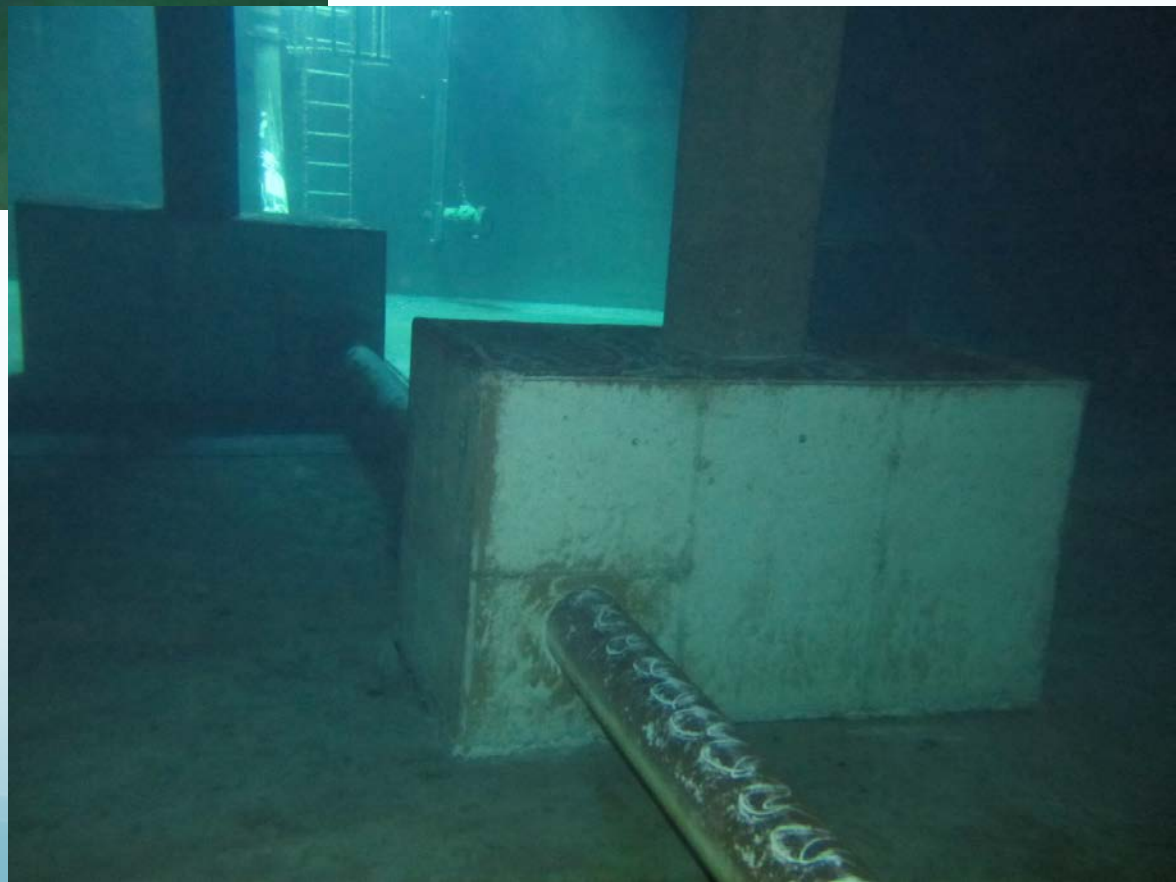
- **Inlets**
  - Does the inlet provide water circulation to eliminate stale areas, promote efficient disinfectant distribution but avoid disturbing floor sediment?
  - Is excessive circumferential water movement avoided?
  - Is there an additional ‘blank’ inlet (or outlet) for future installations?

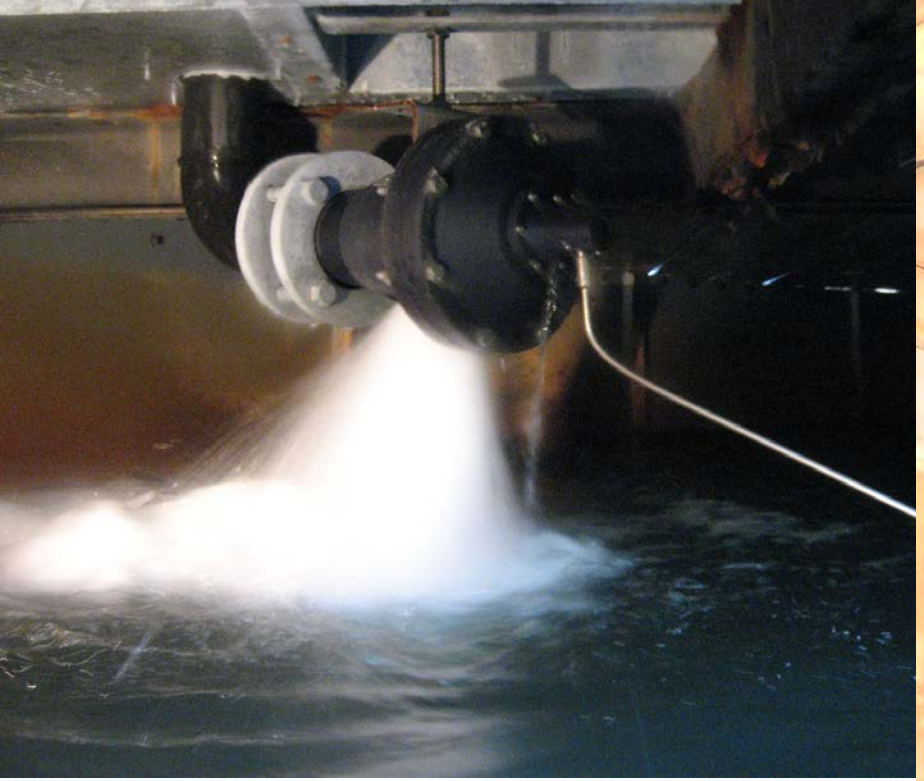
A spare penetration that could be either an inlet or outlet



Inlet pipework running across the floor to separate from the outlet. An HDPE inlet nozzle would provide effective mixing plus separation

How does a cleaning robot handle these floor conditions?





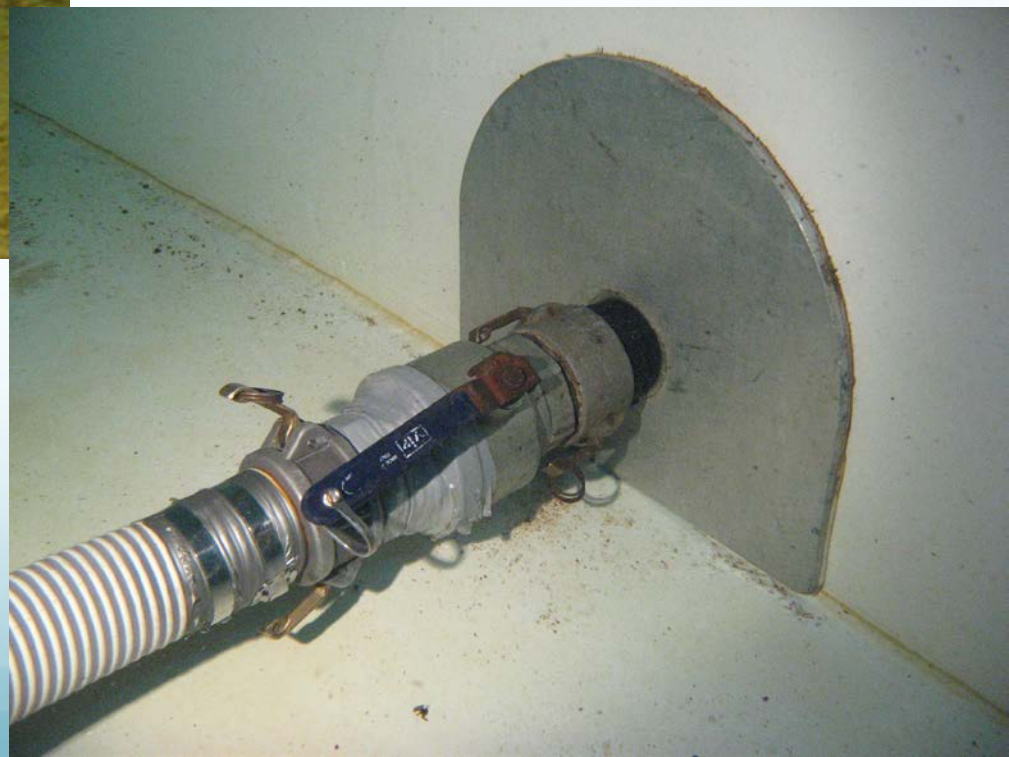
Top fill inlets can cause sediment disturbance when water levels are accidently low. The aeration also reduces disinfection levels within the new incoming water

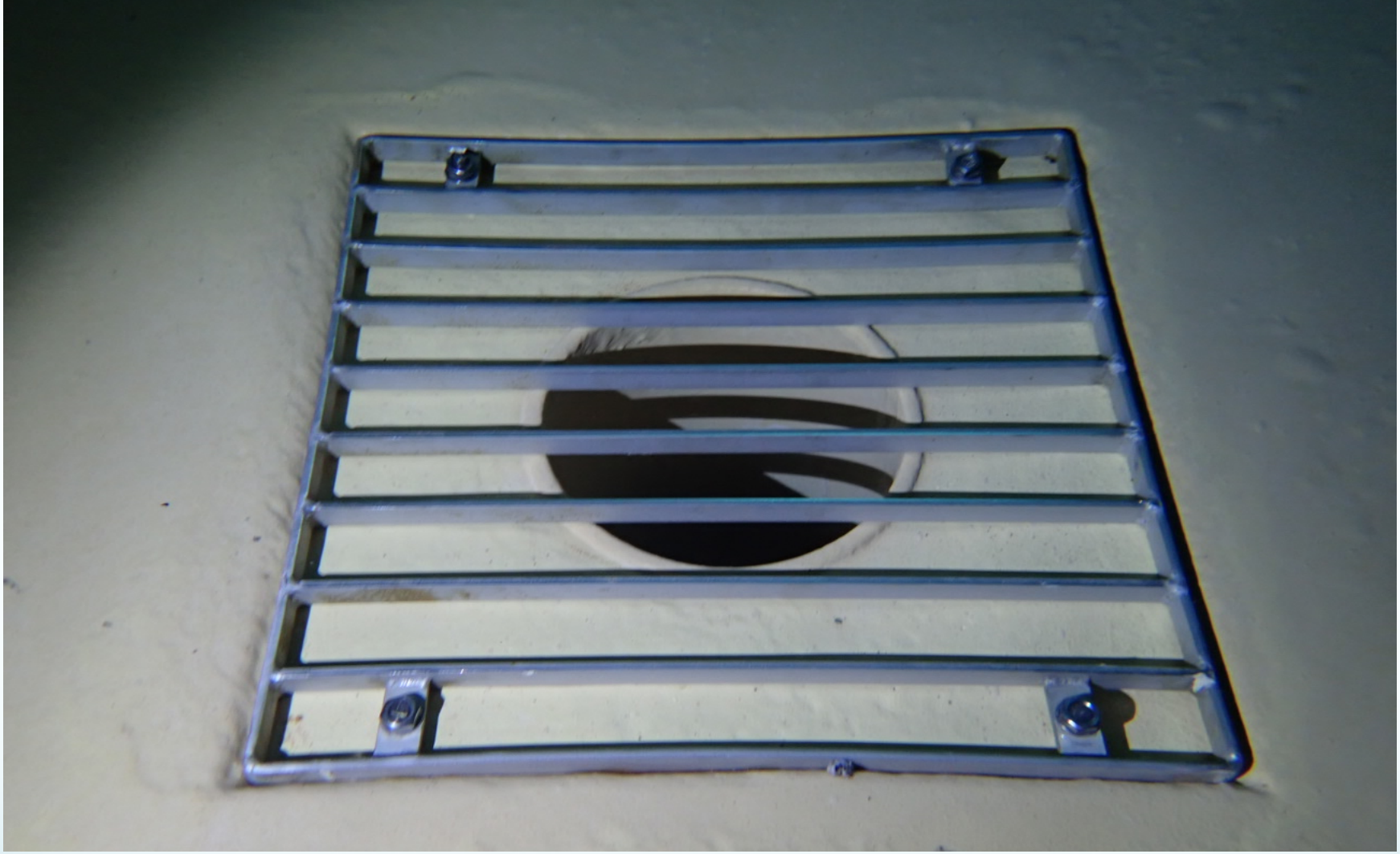

Sediment disturbance is an issue when water levels
are low, leading to contamination issues downstream

- **Scour System**
  - Is the scour penetration a minimum of 150-200mm in diameter and level with the floor to enable a vacuum suction plate to be fitted?
  - Is the scour point located near the entry hatch for quick and easy cleaning set-up?
  - Have scour trenches been avoided if diver or robotic cleaning is to be used?
  - Do the through-wall scour points have a hose or tanker fill coupling?

Floor mounted scour with no safety screen fitted, allows a scour plug to be fitted

A side wall scour mounted at floor level allows a scour plate to be fitted





A screened scour. How do you fit a scour plate for diver cleaning?

An additional scour fitted close to tanker access. It can also provide an emergency water supply.

The internal scour penetration that can have a plug fitted

Scour on the LHS 200mm off the floor. How do you completely drain the tank for recoating the floor?

Scour on the RHS, 150mm off the floor. This is a new tank, so who was the designer and builder?

- Are external scour exit points within the client property to prevent disputes with local residents?
- Is an in-ground sump connected to the scour outlet which can be pumped out?

- **Sediment Disposal**

- Is there a sewer point nearby which can be used for sediment disposal?
- Can a levee bank or small holding dam be incorporated to allow turbid waste to settle out?

A coarse sand coffer dam allows waste water to filter out cleanly and sediments to remain behind

A permanent onsite coffer dam

The scour and overflow are connected into this onsite coffer dam

- **Section 6 – Environment**
- Has the surrounding environment been considered when deciding the type of storage tank to be designed and constructed?
- There are four basic environments to be considered – Coastal, Forestry, Rural and Industrial.
- Coastal environments have higher salt/chloride factors that will affect the construction materials used in roofing and upper wall areas.
- Forestry environments are prone to fires and serious heat impacts.
- Rural environments have considerable WQ impacts on the stored water – dust and wind-borne contaminants caused by farming practices…burning off, ploughing, harvesting, feed lots etc
- Industrial areas often have wind-born pollution contaminants from manufacturing of a wide range of materials.

Galvanised roofing structures prematurely corroding due to coastal salt contacts

Tanks situated next to an Abattoir, where dry weather conditions cause contaminated dust from animal activity to enter into the water

Inground tanks have dust and grass clippings debris issues when mowing is carried out

Inground tanks should not have side wall vent mesh fitted due to vermin and vegetation entry issues

Dust and vegetation evidence on top of the post

Vegetation contamination evidence at various levels on the waterline area

A severe bushfire burned right up to and around the compound area

Roof tree branch debris from the bushfire

- **Section 7 – Security**
- Does the surrounding area have a history of vandalism?
- Are security fences suitable for the likely risks to be encountered?
- Are security fences built on well cleared areas, which are not likely to encroach again in the future?
- Are access systems onto the tank upper areas well secured?
- Can vandals find ways to by-pass the external access systems?

Light-weight security fencing is easily rammed and damaged, allowing vandal access

Secure ‘prison type’ fencing is more secure against vandal attacks

How can the fence security be checked and maintained effectively?

An overgrown tree is easy to climb up and over and then the vandalism can begin

All the ladder compound security is wasted when it can be easily by-pasted by a 66-year-old ‘vandal’

Electrical boxes create easy foot holds if mounted too close to the ladder compound

Mesh is easy to cut through with a battery powered Angle grinder

This solid panelling is more difficult to cut through and offers no easy foot holds. Maintenance items can also be stored safely away from ‘prying eyes’

- For more detailed information on each section (including pictures/photos/explanations), refer to www.aquasafeskills.com.au > Technical > Documents > *Reservoir Design for the Next Generation V15*.