



INFRAPIPE™
SUSTAINABLE SOLUTIONS FOR GENERATIONS TO FOLLOW

INFRAPIPE MANUAL FOR INSPECTION, MAINTENANCE, MODIFICATION & REPAIR

This Manual covers the requirements for KRAH Profile pipe DN450-3200 and inline extruded CIVILPIPE DN225-DN1000. It does not cover third party-supplied products such as washdown systems, gaskets, lids, covers, surge protection, fish baffles, valves, couplers or dismantling joints. Contact INFRAPIPE for information on these products if required. For installation and testing see the relevant Installation & Test Plan (ITP).

RELEVANT DOCUMENTS, STANDARDS & PRIOR KNOWLEDGE

This Manual refers to AS/NZS2566, AS/NZS5065, AS/NZS4130 and AS/NZS5065. In addition, the following industry documents are of use:

Water NZ Gravity Pipe Inspection manual
Water NZ Pressurised Pipe Inspection manual
PIPE POP025 Water Jet Cleaning of Plastic Pipes

Users of this manual **should be familiar with the physical properties of Thermoplastics** and should have read the INFRAPIPE Materials Guide available here or from the INFRAPIPE website Downloads section.

RESOURCES

The INFRAPIPE Datasheet for Minor Equipment lists the typical equipment required for the support tasks associated with thermoplastic pipes: inspection, installation, modification, maintenance, repair and replacement.

Modification and Repair require appropriately trained personnel (RSP) for tasks which involve any form of welding of the PE or PP. INFRAPIPE classifies the required skills into the four types below and for each, the appropriate skill level

Skill	Standard	Advanced
Extrusion Welding	Able to weld simple repairs into pipes, such as a patch over damage	Able to weld complex modifications into pipes, such as new laterals
Collar Fusion Welding	Able to conduct welds on pipes up to 1350 in diameter for storm water	Able to conduct welds on all pipes for all uses
Butt Weld (medium – up to 1000mm)	Able to Butt Weld to the ISO21307 Standard	-
Butt Weld (large – 1001mm+)	Able to Butt Weld to the ISO21307 Standard	-

INFRAPIPE maintains a list of Recognised Support Professionals (RSPs) on its website at this location.
This list shows their regions covered and capabilities for repair, maintenance or modification.





INSPECTION

CONTENTS OF THE PIPE

This section relates to inspection of the pipe itself; inspection of the fluids and materials within the pipe is a user-defined activity. For cleaning, jetting etc. see the subsequent MAINTENANCE section. For general procedural guidance see:

Water NZ Gravity Pipe Inspection manual
Water NZ Pressurised Pipe Inspection manual

OVALITY

- AS/NZS2566 permits a long-term deflection of up to 7.5% in thermoplastic pipes.
- See the table below for the minimum Internal Diameter permissible for INFRAPIPE & CIVILPIPE sizes.
- Ovality can be assessed with a tape measure, or a proving tool of the appropriate diameter
- Accuracy of measurement +/- 2mm
- Measurement to be taken at the axial centre of the pipe

INFRAPIPE KRAH DN	Min ID mm		CIVILPIPE KRAH DN	Min ID mm
450	416		225	202
525	486		300	273
600	555		375	347
700	648		450	416
800	740		525	486
900	833		600	555
1000	925		800	740
1100	1018		1000	925
1200	1110			
1350	1249			
1500	1388			
1600	1480			
1800	1665			
2000	1850			
2300	2128			
2500	2313			
3200	2960			





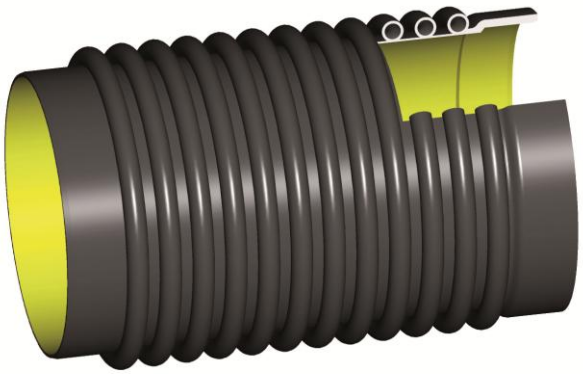
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COMPONENTS OF THE PIPE

A typical INFRAPIPE (DN450-3200) is a profile pipe as shown here, composed of an inner waterway wall which provides the bursting strength (PN), and layers of core tube wound around which provide the buckling strength (SN).

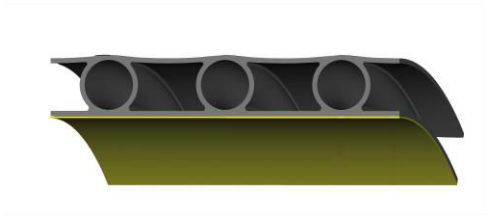
The core tube is wound continuously round the pipe in a spiral (helical) manner.

Some larger, stronger pipes may have 2 or more layers of this core tube.



A twinwall CIVILPIPE (DN225-1000) by comparison is composed of an inner waterway wall and then individual corrugation ribs as shown in the drawing below right.

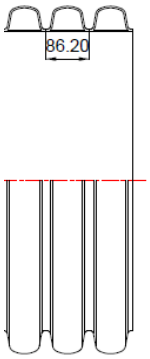
Other variants of the INFRAPIPE can contain the coretube layer(s) with one or more layers of HDPE as shown below left. This can provide added strength, or make welding easier for tanks, manholes and access chambers



A CPR pipe with outer layer



A solid wall pipe



The ribs of a CIVILPIPE

INFRAPIPE can also be found in solid wall pipes (or sections thereof) as shown above which have no core tube and are one solid continuous layer of resin. In the example to the right the main line in profile pipe then has an added outer layer for the section where the riser is welded in, and the riser itself is made from solid wall pipe.



EXTERNAL DAMAGE

INFRAPIPE Pipes can and do recover all of their shape after deformation. If a pipe has been crushed by an excessive load, the pipe should be allowed to recover – with no load – for 24 hours prior to taking measurements and assessing the health of the pipe. This is not the same for pipes like Euroflo ID1000+ which are SRP (steel reinforced) and do not recover from deformation.

Physical damage to the [externally] exposed ends will not affect the integrity of the pipe provided it covers an area with an axial length of 300mm long or less. This damage only needs to be assessed from its impact on the hydraulic efficiency of the pipe and its potential for attracting debris in stormwater installations.

Physical damage to the exposed exterior of the pipe can be repaired as shown here.





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INTERNAL DAMAGE

Physical damage to the waterway of the pipe should be measured and photographed for Repair.

Damage to the components of a socket/spigot join should be assessed for deformity, in particular:

- Is the socket still aligned around the circumference (consistent dimensions between socket and spigot)?
- Is the spigot separated from the socket radially in any location (ie there is a gap between the OD of the spigot and the ID of the socket)?
- Is the spigot physically missing in any way?

If none of the above have occurred then the joint should be functioning normally and repairs can be scheduled in the normal course of business. The socket and spigot are twice as strong as the remainder of the pipe and hence can accommodate minor damage.

If the above have occurred then the joint may be impaired and photographs and measurements should be forwarded to INFRAPIPE or an RSP.

LONGITUDINAL (AXIAL) DISPLACEMENT

Displacement is only possible with ring-jointed CIVILPIPE or gasket jointed KRAH INFRAPIPE when pipes have not been secured or restrained and excessive forces may have been applied, causing pipes to be moved away from each other and the socket/spigot joint compromised.

Take measurements from the affected socket/spigots and contact INFRAPIPE for an assessment of the effectiveness of the joint. If pipes cannot be mechanically re-joined then the addition of material with extrusion welding will restore a smooth waterway and the full integrity of the join.

Permissible limits for displacement are 30mm for INFRAPIPE and CIVILPIPE for storm water.
Further displacement should be prevented by the use of bolts, screws or other mechanical fixtures, or by extrusion welding.

HORIZONTAL DEFLECTION

Pipes may be deflected temporarily by a radius equal to 25 times their ID and permanently, 50 times the ID, ie for a DN 1000 the permissible short-term deflection has a radius of 25m and long-term 50m.

Deflections greater than this, irrespective of the level of impairment of joints, can reduce the life of the pipe by inducing creep in the material and should be reported for risk assessment.

VERTICAL DEFLECTION

As per Horizontal Deflection above but with the added requirement to consider any shear forces acting on unsupported pipes.
Refer to INFRAPIPE with the new soil loads and drawings of the unsupported area.

TEMPERATURE

If dimensional measurements are conducted, the ambient temperature should be recorded. HDPE can expand/contract by up to 2mm per metre per degree Celsius if above or below 20 degrees Celsius. In the event of abnormal values being recorded, the surface temperature of the pipe should also be recorded.





INFRAPIPE CORE TUBE

The core tube which is wound continuously around the pipe is made of PP and encased in PE. It can be repaired by:

- Removing the PE, welding the PP and then replacing the PE sheath
- The supply of a replacement section of core tube
- The supply of a replacement section of pipe
- The supply of ribs to weld in place of the core tube as in page 12
- Pumping flowable fill into the core tube

Minor penetrations in the core tube will have no effect on the pipe, and if these permit the ingress of water this too has no consequences (core tubes are often filled to reduce buoyancy). Damage to core tube over a section less than 150mm long will not affect the performance of the pipe, provided the waterway is still protected.

CIVILPIPE CORRUGATED RIBS

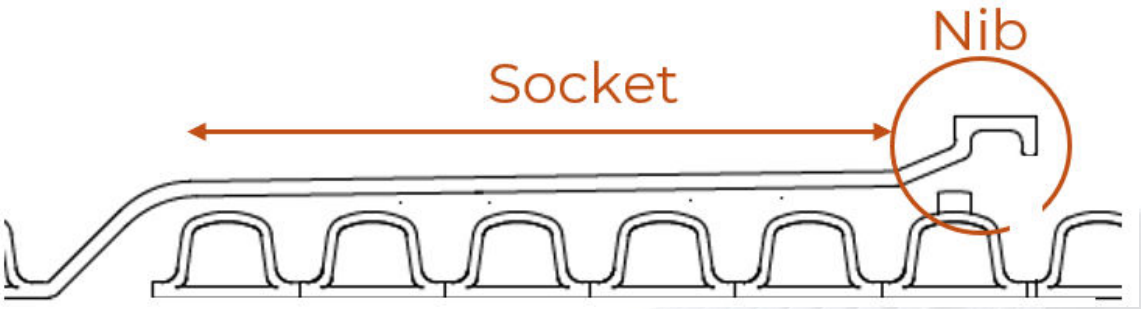
Damage to ribs over a section less than 150mm long will not affect the performance of the pipe, provided the waterway is still protected.

CIVILPIPE PROTECTIVE NIB PREVENTS SOCKET DAMAGE

CIVILPIPE is a next generation twinwall product. The most important advancement is the development of a **protective Nib for the socket** to prevent damage during transit or installation. Additionally, the socket is flared before the nib by 3mm (225) to 5mm (450) to make insertion easier. As per the diagram and picture below, after the full length of the socket, the ID and OD of the pipe increase again before terminating in a rigid box section type design.

This U section plays no part in the sealing process – the rubber ring sits between the ribs 1 & 2 or 2 & 3.

When inspecting CIVILPIPE, damage or compression to the Nib is acceptable as its purpose is purely to protect the socket. Only deformity to the socket section itself (below) is of concern.



- ✓ **Nib prevents damage**
- ✓ Makes installation easier
- ✓ The taper allows for a very secure seal
- ✓ Longer socket makes life easier







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QUICK DEFECT IDENTIFICATION PROCESS

For installed gravity pipes. For pipes prior to installation, please consult the relevant Handling & Installation Guide from INFRAPIPE Downloads section.

PREPARATIONS

Staff conducting defect identification may require the following:

- Pipe details and dimensions from Asset Register or site drawings
- Measuring equipment
- Water jet cleaning equipment in accordance with PIPA POP205 *Water Jet Cleaning of Plastic Pipes*
- Photographic equipment
- Straight edge

INTERNAL EXAMINATION

Measure to confirm ID matches permissible deflection (7.5% of design ID)

Note, measure and report the following:

- Gouges, cracks or other point damage greater than 1mm deep or 1mm wide
- Isolated dents or bulges which deviate from the surface level by more than 2mm (0.05% of diameter?)
- Penetrations through the pipe
- Separation or damage at socket/spigot joins
- Deflection in any plane
- Radial bulges or wrinkles in the waterway (from compression)

EXTERNAL EXAMINATION (INCLUDING THE ENDS)

Note, measure and report the following:

- Penetrations through the waterway of the pipe
- Complete fracture of a core tube or corrugation (penetration of a core tube or corrugation is not a defect unless it compromises the waterway)
- For CPR pipes – with an outerlayer – penetrations of the outer layer must be investigated, contact INFRAPIPE
- Distortion, disruption or dislocation of joints (if visible)
- Cracks, fractures or other damage greater than 100mm in length and 5mm in width at the Inlet or Outlet
- Deformation of the ends of the pipe

FOR PRESSURE PIPE

- Follow the requirements from AS/NZS2033:2024 and AS/NZS4130:2018





MAINTENANCE

THERMOPLASTICS NEED NO MAINTENANCE

Thermoplastic pipes need no maintenance. They have either been damaged and need repair or they have not. There is no physical decay of the product to monitor.

WATER JET CLEANING

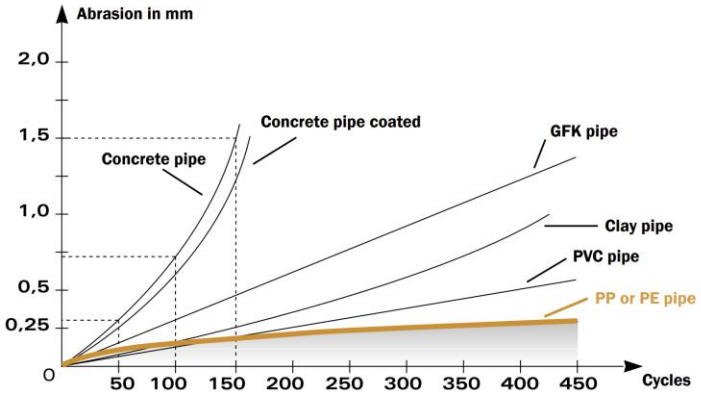
Conduct the internal cleaning of the pipe in accordance with PIPE POP025 Water Jet Cleaning of Plastic Pipes.
Unlike concrete and GRP, thermoplastic pipes do not degrade or abrade as a result of water jet cleaning conducted correctly. HDPE/PP have the greatest abrasion resistance as per the Darmstadt test below.

MATERIAL LIFE – PRODUCT LIFE

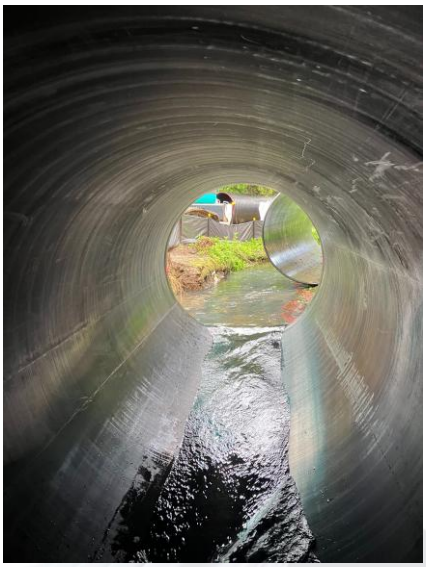
The latest meta study by TEPPFA confirmed that the expected life of HDPE pipes is well in excess of 100 years. This is in addition to the 2006 research conducted on pipes exhumed after 50 years in the ground which confirmed their service life will exceed 100 years, or the study conducted in 2014 which investigated a wide variety of pipes to confirm their service life was 100 years plus.

ABRASION RESISTANCE – PRODUCT LIFE (DARMSTADT TEST)

HDPE has the optimum abrasion resistance of any pipe material as proven in numerous tests:



Abrasion curve of various pipe materials according to the Darmstadt procedure.



NB The above diagram is taken from a European paper, GFK is GRP/FRP.

The Darmstadt procedure, which has been the standard for abrasion testing since the 1960s, simulates the abrasion and resulting wear of liners and pipes that would occur in actual operating conditions by tilting a pipe section containing a mix of sand, gravel and water through 22.5 degrees above and below the horizontal for at least 100,000 cycles. The results for PP or PE pipe show a much greater resistance to abrasion and hence operating life is significantly longer.

The specimen comprises a 1metre length of DN300 pipe that is tilted to and fro in a controlled slow rocking motion at a frequency of 0.18 HZ; this corresponds to 21.6 stress cycles per minute – defined as the movement of the abrasive material in one direction.
The frequency ensures that the abrasion material travels the complete length of the test specimen. The abrasive material is a quartz sand and gravel in a water slurry containing approximately 46% by volume abrasive material in grain sizes 0-30mm. The abrasive material is changed every 100,000 stress cycles (approx. 77 hours).





MODIFICATION

ANGLE CUT THE ENDS

For installations where the lie of the land requires the line of the pipe to be at an angle to the inlet flow (or outlet), the end can be angle cut (as per the example to the right) which, if it will be exposed, can be sealed with PE sheet if required.



ADD LATERALS

Laterals can be added easily either with proprietary products such as the Fernco Storm Saddle or Quikseal, or using the HAS system or a fitting from BauConnect as shown below:



A PA Saddle



A HAS connection



A Bauconnect lateral junction

ADD RISER

It is possible to add risers to pipes in situ. After a hole is made of the appropriate diameter, the solid wall pipe manufactured for the purpose must be lowered into the penetration and secured mechanically (ideally it will be supplied over-length and holes can be drilled into the top to suspend it). The riser is then cut flush internally and It is then welded in place inside and out. Theoretically this could be accomplished with low flows remaining in the pipe but it is quicker to seal the pipe off.

ADD INSPECTION OR RODDING PORTS

For smaller penetrations the process is the same as a lateral or if a specific angle is required then a penetration can be welded in place if the pipe is large enough to permit manual entry.

ADD DROPPERS

Adding a dropper which extends the flow from the outlet and/or alters its direction is easily achieved using shearbands. If the joint cannot be supported then a welded solution is required.



A shearband being used to connect tide gates

ADD OR MODIFY FISH PASSAGE AIDS

As PE will accept screws, fish passage baffles or other mechanisms can be retrospectively added or modified. Screw holes should not be left vacant and if a fitting is removed, the screw should be reapplied to protect the integrity of the pipe.

EXTEND THE LINE

Should a pipeline need to be extended (for a road widening for instance) this can be achieved using shearbands for CIVILPIPE, slip couplers or welded solutions for INFRAPIPE KRAH or clamps/seals for both types of pipe.





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CUT THE LINE – JOIN

If a larger line needs to be cut to introduce a new connection, the new fitting would include slip couplers or other mechanisms to rejoin the line. Typically this new fitting would include a riser for access.

CUT THE LINE – EXPAND



It is possible (but rare) that a change in gradient and the addition of extra flows upstream require a larger pipe for a section of an existing pipeline. In this case a slip coupler shear band or other connection such as the Bauconnect fitting can be used

MOVE THE LINE

In situations where it would be beneficial to move some of the line (typically but not exclusively horizontally), this can be done in accordance with the permissible limits for deflection. In this case, contractors should:

- Ensure new bedding correct
- Protect the pipe where being pulled/pushed – use half-pipe or webbing
- Consider thrust or anchor blocks to maintain the shape

STRUCTURES – ADD HDPE MANHOLES



If a manhole is required (typically to add an additional connection) a customized HDPE Manhole can be produced to suit the exact nature of the connection. Additionally, manholes can be manufactured with the pipe and benching offset or tangential which can make installation easier.

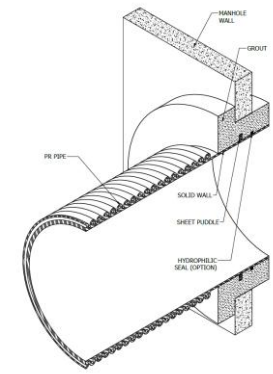
The new connection will have a standard socket and is laid upstream from the manhole, the connections for the existing line will be slip couplers, shear bands or seals/clamps.

Note INFRAPIPE can manufacture 'split' slip couplers which are welded in situ if the existing profile does not permit a movable slip coupler.

ADD CONECTION

INFRAPIPE can manufacture connections which do not require a manhole typically a large "Y" form, with or without a riser for access. This is added to the line in the same way as an HDPE manhole (as above).

STRUCTURES – ADD CONCRETE MANHOLES OR OTHER CONNECTIONS



If an INFRAPIPE pipe must be combined with a concrete structure – head wall, sump, manhole or mixing box, typically the pipe is fitted in situ with a puddle flange which provides the basis of longitudinal mechanical resistance or other gripping mechanism prior to the concrete being poured to provide a corbel (see right).

TEMPERATURE

HDPE can expand/contract by up to 2mm per metre per degree Celsius if above or below 20 degrees Celsius. Modification should not be conducted when different components are at different temperatures as this can induce thermal stress in the finished solution.





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USING INFRAPIPE TO REPAIR OTHER PIPELINES

INFRAPIPE KRAH is widely used to repair other pipes because of their light weight, customisable configuration and fast manufacturing time.

When the storms of 2022 washed away Nelson's primary water supply, INFRAPIPE was able to supply replacement pipe within a week and its light weight enabled the use of a light structure to bridge the gap over the landslip and restore drinking water to the city (see pic below)



In the Japanese sinkhole of 2016, the repair was completed within a week using KRAH pipes (below left)





In the Philippines where frequent seismic activity destroys the supply to the hundreds of small hydro-electric schemes, KRAH pipes are flown in and used to repair the existing steel pipes with flanged connections (above right)

Contact INFRAPIPE for the best connection option for fast repairs to pipelines made from legacy materials





REPAIR

HDPE responds to thermal resetting, ie an area of the pipe can be reheated and then reshaped or refitted. This malleability, plus the homogenous nature and high strength of extrusion welding make repairs quick, simple and very effective.

For watermain applications consult PROMAINS for live repair equipment and fittings repair advice

END-DAMAGE

For end-damage to pipes that are not yet installed (or are due to be joined to another pipe) contact INFRAPIPE to confirm if the pipes are still viable (see above for damage to CIVILPIPE sockets)

PENETRATIONS

Small penetrations of the waterway can be repaired with extrusion welding, using patches if necessary.

CRUSHING OR BUCKLING DAMAGE

This requires a site measure and investigation of the excess loadcase causes. INFRAPIPE is specified with a Safety Factor of 2.5 – giving a Probability of Failure of 1:100,000 and then manufactured with a further 25% Safety Factor in manufacturing.

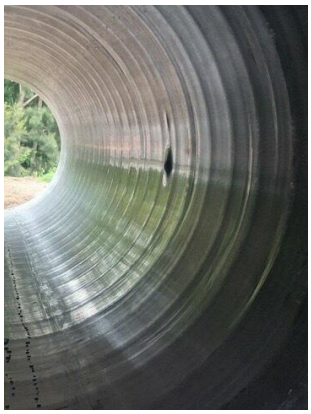
It is therefore more likely that the loadcase or installation is the cause than pipe failure, and this needs to be addressed prior to replacement.

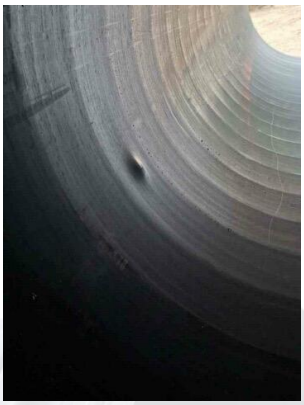
GOUGES, CRACKS AND FRACTURES

Minor penetrations of the waterway can be repaired with extrusion welding, using patches if necessary

DENTS

Minor dents or bulges can be repaired with heat and/or extrusion welding; larger ones will require sectional replacement. These examples here are easily repaired with heat alone.





SECTIONAL REPLACEMENT

More extensive damage will require the section of pipe to be cut out and replaced. This is a relatively simple process, firstly isolating the damaged section using HDPE Sheet patches, cutting out the section and replacing with new pipe using extrusion welding and patches/ couplers to tie-in the sections. It is important that the replacement section is of suitable diameter and SN rating to maintain the integrity of the pipeline. See example below.





EXTRUSION WELDED REPAIR EXAMPLE

STEP 1: DETERMINING THE SIZE OF THE DAMAGE

It is important to expose as much of the damaged pipe as possible so ensure that excavation is done extremely carefully and where possible use hand tools. To determine the size of the damage by taking measurements and photographs that can be sent to the INFRAPIPE™ appointed Project Manager. They will quickly determine the appropriate methodology for repairing the damage.

STEP 2: STARTING THE REPAIR

For the damage shown to the left, a HDPE patch repair is the most appropriate repair methodology as the damage is easily accessible. The damaged area will need to be removed and then the area where welding will take place is to be cleaned with isopropyl alcohol and lint free rags. As a watertight weld is required it is important to remove any potential contaminants from the weld zone. Once the hole is cut a final measurement of the patch will be taken. It is important prior to welding that the inside layers of the HDPE pipe are bevelled with a router or a hand scraper to minimise the potentially for any debris to get caught on it in the pipeline.

STEP 3: EXTRUSION WELDING THE PATCH

To carry out extrusion welding repairs on site there needs to be a constant power source, no moisture in the weld zone and the work is to be carried out by a competent extrusion welder from the list of RSPs or an INFRAPIPE™ employee. The patch is made from HDPE sheet which can be heated to form the diameter or can be fabricated prior with cuts and welds to have the same radius as the pipe that requires repairing

STEP 4: ADDING THE STIFFENING RIBS

Once the patch is fitted in place and all welding has been completed it is time to add the stiffening ribs to ensure the patch piece exceeds the required pipe strength. The stiffening ribs are also made from HDPE and are extrusion welded onto the exterior of the patch. After the welds have cooled the pipe can be backfilled in accordance with AS/NZS 2566.2:2002 – Buried flexible pipelines Part 2: Installation.

If a test process is required for a certificate of conformity, the repair can then be tested with a spark tester.

If the pipe is a solid wall or twin wall structure pipe the repair is still the same, but a pipe section of a similar strength can be manufactured and used as opposed to HDPE sheet.

MYTHBUSTERS

There are a number of legacy technologies that have seen the rest of the world change and fear being supplanted by HDPE. As a result, there are some myths floating around which need to be addressed:

Fat adhesion

- There is no evidence that fat or waste adheres to HDPE, nor can any information be found on the issue globally. None of the proofs or studies of the Hazen-Williams nor Darcy-Weisbach equations have identified this as an issue. This has been investigated and the results can be read here in this study on the effects of fat accumulation in HDPE pipes in NZ.

- It appears that when HDPE pipes first became available, they were used to reinstate burst or buckled clay or other broken sewer lines and when this was not always successful, this was attributed to the material, not the mechanical impediments which may have rendered some of these operations unachievable.

Microplastics

- There is no evidence that microplastics emanate from HDPE more than an FRP tank and its epoxy layers or from the PVC pipes that initially handle the waste, in fact as the Darmstadt data below shows, less abrasion must mean less free particles. Cementitious particles (which are more frequent due to the much higher abrasion levels) are equally as harmful due to their very high alkalinity.
- The amount of surface area exposed by piping in NZ pales into insignificance compared to the polyester clothjng that is worn and washed every day, or the PVC food wrapping that is cut or torn to access its contents, all of which are going down the same pipes.
- It was confirmed in 2024 that HDPE has no effect on the reproductive function (for instance) where PVC is responsible for falling sperm counts etc. because “PVC contains chemicals that cause endocrine disruption”
- Latest research has proven that there is no correlation between microplastics in a pipe and the material of the pipe (ie the pipe is not responsible).

Biological adhesion

- ✓ The evidence shows that HDPE is the most resistant to the adhesion of biofilms, which enable microbial accumulation and invasion. For more details see https://www.mepmiddleeast.com/news/borouge-krah-misr-bahr-al-baqr
- ✓ There is no comparison to be made between thermoplastics and concrete for biofilm XX, the porosity of concrete makes it a haven for microbes. This study shows that PE outperforms PVC as well.

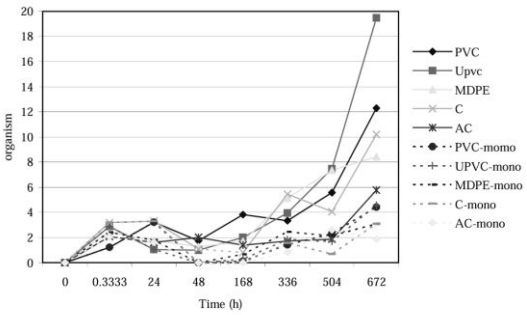


Figure 2
Mean counts of coliform bacteria (cfu·cm⁻²) by time and pipe materials within chlorine (0 h - 672 h) and combined chlorine-monochloramine (24 h - 672 h) treated water systems

Buoyancy

In some situations (larger pipes, less cover, high ground water and low density fill above) then tanks and closed pipes (ie not culverts) can become buoyant and exert a lifting force on the soil above. This is only likely in situations with larger pipes, less dense soil, less cover and high ground water levels. For more detail please see the Pipe and Trench Design Manual.



Ovality/circularity

Pipes that are left in the harsh sun for a couple of seasons can deform. This is easily prevented by

- Using proper dunnage in the correct location
- Storing pipes with their alignment marks at the 3 o’clock or 9 o’clock position.
- Only storing pipes one high

In the extreme event that the above is insufficient, INFRAPIPE has braces which can be used to ensure the circular shape of each socket and spigot prior to laying.





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Fire

Concrete deteriorates at these temperatures and could need structural replacement as spalling – which commences above temperatures of 200C – weakens the concrete permanently.



HDPE drainage pipes and fittings do not self-sustain in fires, the practical amount of flammable material and the volume of airflow needed to reach the consistent temperatures required is too great for the vast majority of applications. A material that will stay in place (not drain away) is typically not intense enough and the quantity needed then blocks the very airflow it requires. This has been tested overseas (to the satisfaction of the appropriate authorities), as these photos from tests by the Bahrain government Ministry of Works show:

UV

Under AS/NZS5065, INFRAPIPE standard HDPE comes with sufficient carbon black additive in the resin to ensure a 50 year resilience to NZ's worst UV levels. However, asset managers in sunnier locations seeking extra reassurance can request a further uplift in carbon black levels.



CONTACT OUR TEAM

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