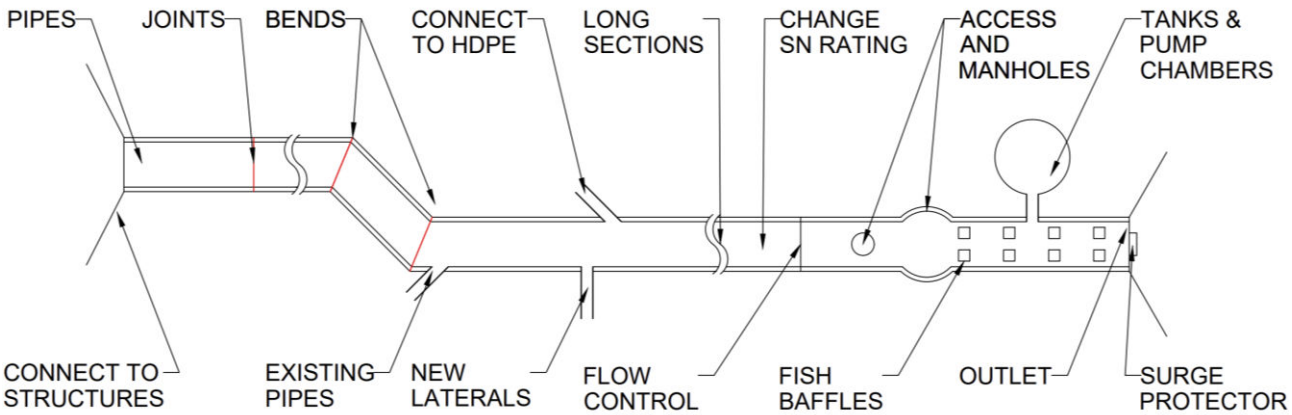
INFRAPIPE™

SUSTAINABLE SOLUTIONS FOR GENERATIONS TO FOLLOW

DESIGNING & SPECIFYING A NZ-MADE HDPE INFRAPIPE DN 450-3200 PIPELINE SN2-SN50+



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DESIGNING & SPECIFYING AN NZ-MADE HDPE INFRAPIPE DN 450-3200 PIPELINE SN2-SN50

Purpose

The Purpose of this document is to provide asset managers, consulting engineers and contractors with all the information they require to work with HDPE helical (spiral-wound) pipelines from INFRAPIPE from start to finish. It is a 10-minute read and is split into three parts for easy reference as well as a quick reference guide which points to the individual pipeline components:

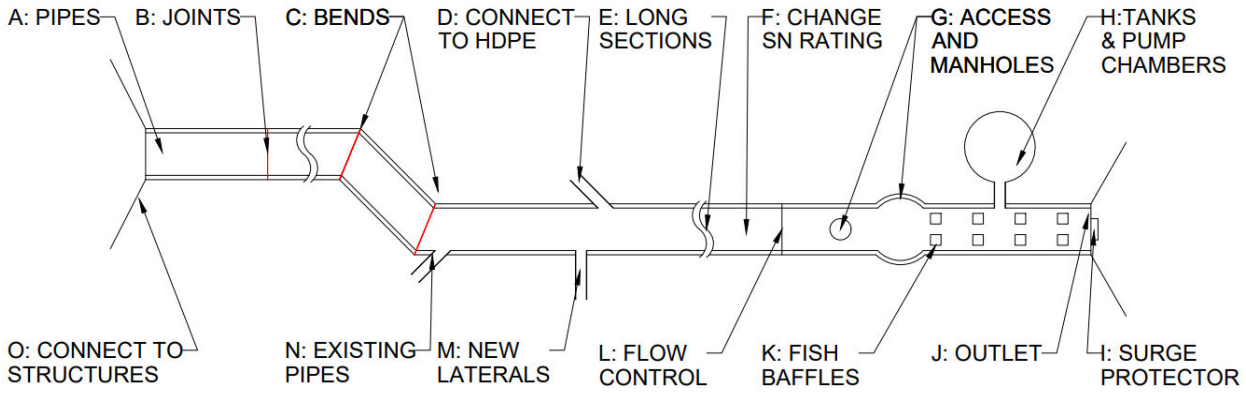
- QUICK REFERENCE INDEX
- PART ONE covers the scope of the pipeline:
  - The pipeline
  - Dimensions of the pipeline
  - Structures in the pipeline such as manholes
  - Connections
- PART TWO covers the design process
- PAR THREE has supporting information – TECHNICAL DATA & FAQs

HDPE helical pipes have a 100 year life and the following benefits:

- Lighter by a factor of 3 or more
- No maintenance
- Completely recyclable
- Very flexible design
- Short lead time
- Bends avoid the need for manholes
- Better value
- The best abrasion resistance
- Safer to work with
- Easy to modify
- Easy to install
- The best seismic resistance
- Made in New Zealand

QUICK REFERENCE

DRAWING TERMS AND INDEX



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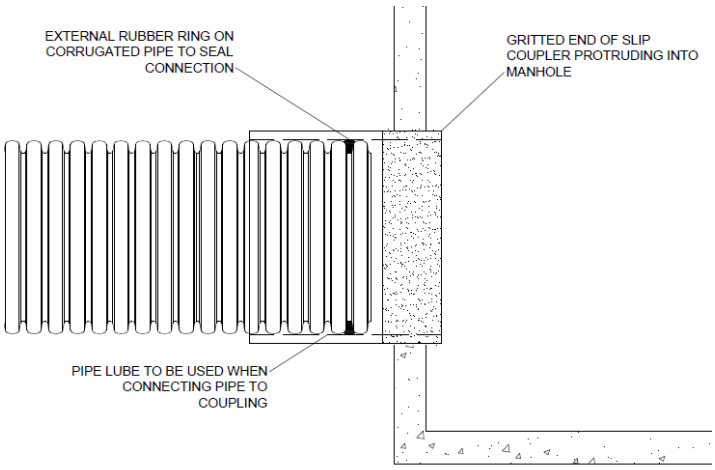
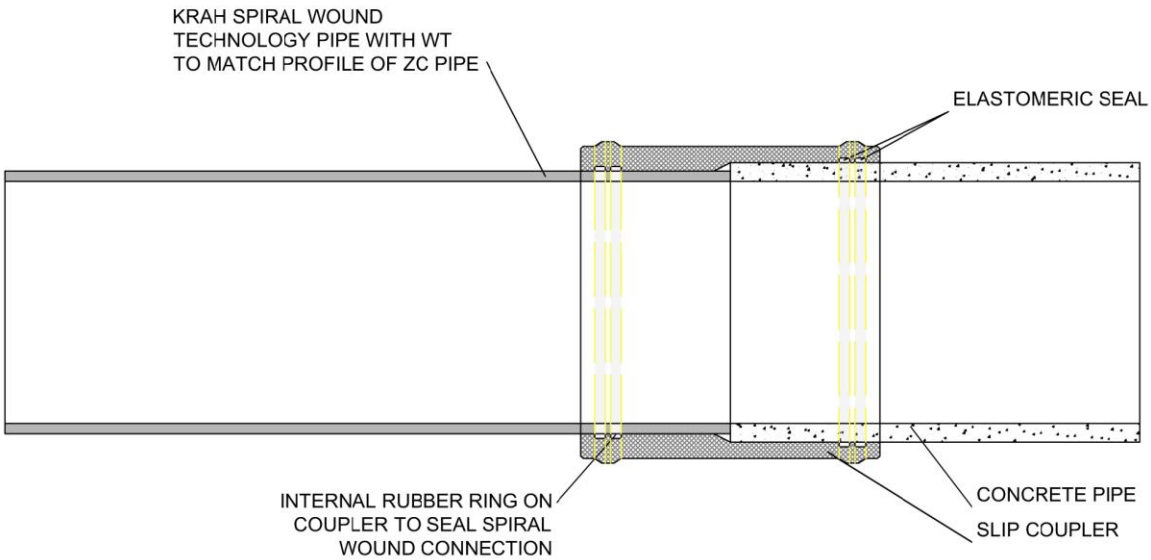
TRENCH DESIGN IS COVERED IN THE SUBSEQUENT INSTALLATION SECTION

CAN HDPE JOIN TO CONCRETE?

EASILY WITH A FITTING LIKE THIS:



This Manhole 'starter' is a very effective, reliable and easy to fit means of joining HDPE pipes to concrete structures. For joining HDPE pipe to concrete pipes INFRAPIPE uses a slip coupler:



✓ **JOINING TO CONCRETE IS NOT A PROBLEM**

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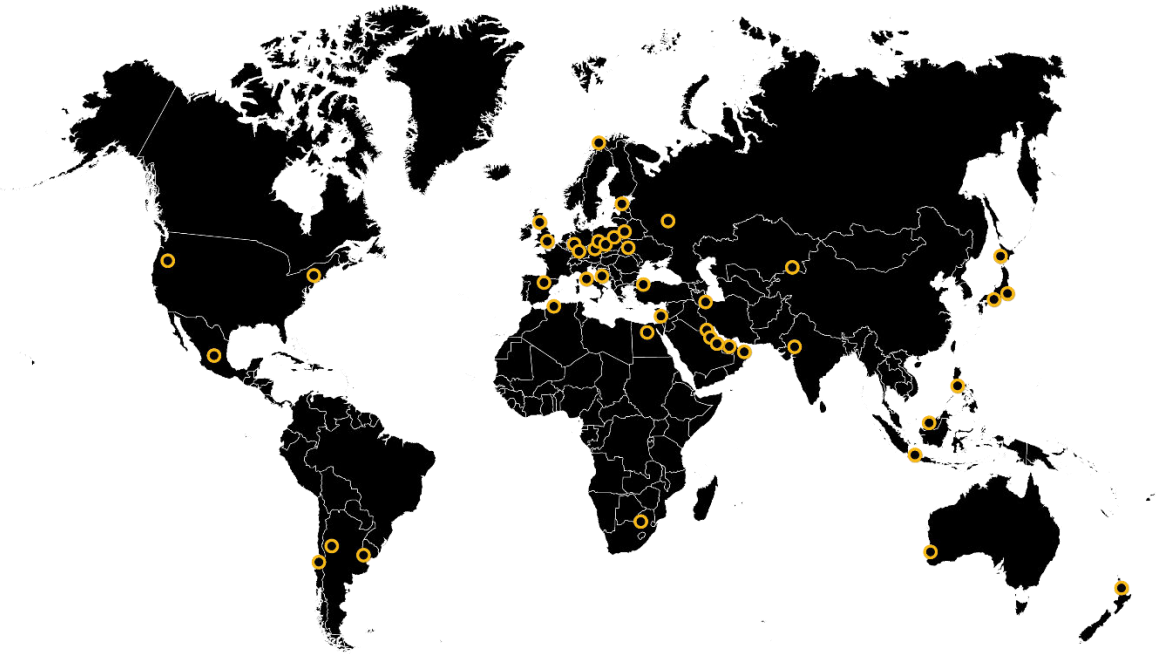
The first Krah machine began operation in 1968 and now the technology is used globally. In Europe, which has pioneered a significant proportion of innovation in civil engineering, HDPE is the preferred option for pipelines due to its low cost, flexibility and product life.



✓ INFRAPIPE uses proven European technology that is globally accepted

PIPELINE

Two terms define every section of pipe:

DN is the Nominal Diameter which for these pipes corresponds exactly to the ID - Internal Diameter – avoiding the possibility of confusion. The symbol ∅ can be used however it is less convenient in most software.

SN Rating is the Nominal Stiffness expressed as vertical load in N/m/m.
This can be provided to INFRAPIPE or our *Easypipe* software can be used to calculate the required SN Rating for any given section (see further detail below). SN Ratings are equal to one quarter the concrete class ie Class 4 equals SN16.

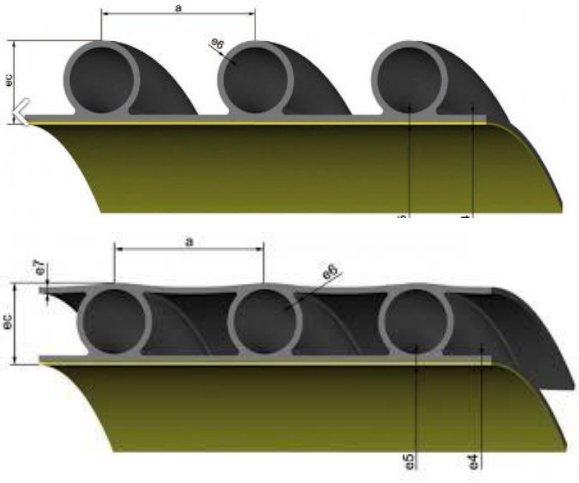
✓ INFRAPIPE calculate the required SN Rating for a pipe or sections of pipe

The pipe

HDPE helical wound pipe is created using a state of the art European Krah machine in East Tamaki which extrudes layers of resin and core tube on a rotating mandrel (from 450 to 3200mm diameter). It is the core tube which provides the exceptional strength (though solid wall pipe can also be manufactured if required).

The inner layer provides the smooth hydraulic efficiency and is the foundation on which the core tube is laid. The core tube provides the strength of the pipe through its axial resistance, being perpendicular to the pipe. The outer layer restrains the core tube, further increasing strength, and can add a layer of protection. The outer layer is only required in larger pipes, or for larger SN ratings or where the exterior needs to be smooth.

The profile defines the combination of core tube size and distance, number of core tube layers and number of outer layers. This provides the most economical pipe for the required SN rating after any OD or weight constraints. The pipe design software produces a certified output with all parameters (see Appendix 2)



PR Profile is the basic profile

CPR profile covers the core tubes

The mighty SN43 3200 shown below was manufactured with one inner layer, two very large core tube layers and then three outer layers to restrain the core tube.

Pipe dimensions

The table below shows the cross-sectional area of the pipe – and its equivalent in smaller pipes (shown by their ID). For use where burial is required, the cross-sectional area with 25% burial is also shown. Weight and OD are shown for the typical sizes for light duty and heavy duty applications; the OD is used for trench dimension calculations.

DN(ID)	Cross-sec area	Equivalent to 2 of ID	Equivalent to 3 of ID	25% burial Cross-sec area	SN4 OD	SN4 Weight	SN16 OD	SN16 Weight
450	158,963	300	250	127,869	528	78	542	90
525	216,366	375	300	174,045	603	91	621	141
600	282,600	375	300	227,323	678	103	720	175
700	384,650	450	375	309,412	792	142	842	212
800	502,400	525	450	404,131	892	187	962	263
900	635,850	600	525	511,478	1020	257	1096	329
1000	785,000	700	600	631,454	1120	284	1196	390
1100	949,850	700	600	764,059	1242	325	1332	428
1200	1,130,400	800	700	909,294	1222	325	1464	463
1350	1,430,663	900	700	1,150,825	1546	490	1596	735
1500	1,766,250	1000	800	1,420,772	1696	541	1776	889
1600	2,009,600	1100	900	1,616,522	1796	576	1878	943
1800	2,543,400	1200	1000	2,045,911	2032	703	2068	1609
2000	3,140,000	1350	1200	2,525,816	2232	978	2308	1878
2300	4,152,650	1600	1350	3,340,392	2572	1172	2634	2796
2500	4,906,250	1800	1500	3,946,588	2778	1454	2842	3395
3200	8,038,400	2000	1800	6,466,089	3500	2981	Ask	

Drawing Note	Example/Note
PIPE	"INFRAPIPE DN600 SN4"
SN RATING NOT KNOWN	*IF LEFT BLANK OR PIPE IS SPECIFIED AS* "SN TBC"

Joining the pipe

INFRAPIPE has an effective length of 5800mm (pipe length 6000mm)
Shorter lengths can be produced which means there is no waste and the asset owner is not charged for a length of pipe which then has to be cut and the offcut disposed of. Pipes can be joined in factory for a delivered length of 11.8m or longer.

Whilst joins are normally located at full pipe lengths (effective length is 5800mm) the presence of bends and structures can require them to be located at shorter lengths; Infrapipe will calculate this.

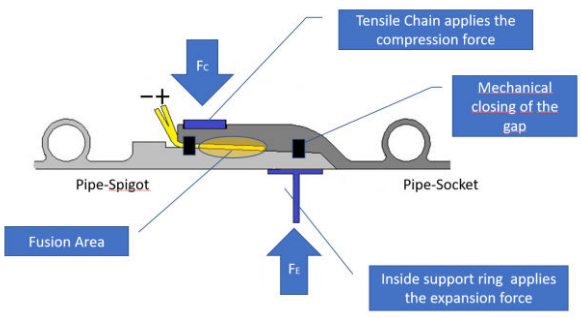
✓ INFRAPIPE will calculate the location of joins and length of pipes

There are two types of joins used for INFRAPIPE; **Double Rubber Ring Joint (RRJ)** is the standard join which is conducted by contractor staff onsite. Each join takes approximately ten-twenty minutes in good conditions (dependant on pipe size).

Electro Fusion (EF) Welds are performed onsite by INFRAPIPE specialist personnel or by contractor personnel who have been trained by INFRAPIPE. This is a far more advanced technology than smaller EF couplers used on small PE lines. EF welds take approximately one hour each, depending on pipe size, during which time the next pipe can be laid in the trench ready for insertion joining.

The wire installed

The process



In progress

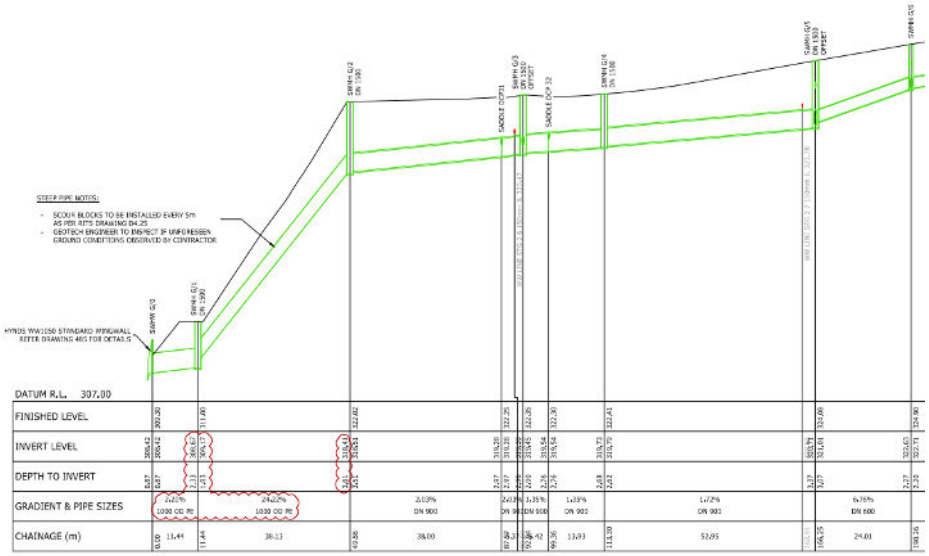
EF welds are essential with significant grades or where the pipe is pressurized and are preferred by some asset owners for all waste applications as there is no possibility of infiltration.

Drawing Note	Example/Note
TYPE OF JOINS	"INFRAPIPE DN600 SN4 (EF WELD)" *OR* "INFRAPIPE DN600 SN4 (RRJ)"
LOCATION OF JOINS	LOCATION OF JOINS NEED NOT BE SHOWN

The nature of joins can be annotated once for the entire pipeline or shown in sections with the nature of the join being added in brackets after the pipe detail The location of joins need not be shown.

Tanks are also typically joined in situ once sections exceed road haulage length limits (18m+ depending on diameter). For more information on tanks from 10-1000m3+ read the sister document of this one, "Infratank Information for Professionals"

The gradient at this project in Wharenui Rise required EF joins because of the 22% fall. Once welded nearby, it then took 2 minutes 47 seconds for three diggers to lay the entire 51m section. See this video of the installation



✓ INFRAPIPE handles very steep gradients using EF welds

Bends – horizontally, vertically or both

The flexibility of HDPE is such that any angle can be created at any location – see this rather extreme example below:

Bends are created in sections of up to 22.5 degrees so the most economical design would use combinations of that amount - however the cost of a bend is not great being roughly equal to an additional metre of pipe per section of the bend.

The standard radius of a bend is the DN of the pipe, this is the minimum that can be achieved but greater radii are possible.

The exact angles and locations of bends need not be confirmed until the pipe is manufactured (there are no moulds to design and create) so projects can be designed and quoted on a plan and then modified until the last minute with site survey or evolved construction outcomes.

Drawing Note	Example/Note
BENDS	*HORIZONTAL ANGLES OF BENDS ARE HELPFUL* *VERTICAL ANGLES WILL BE CALCULATED FROM LONG SECTIONS* *RADIUS TO BE SHOWN ONLY IF DIFFERENT FROM STANDARD*

No specific annotation is necessary for bends on a drawing but providing the approximate angle can be helpful.

✓ Bends can be made in any angle and often reduce overall cost

Connecting the pipe to other pipes in the proposed works

This section covers connections to other pipes laid as part of the proposed works.
See further below in CONNECTIONS for more detail on connecting to existing pipes, laterals or pipes made of other materials.

HDPE Pipes can be joined in any way in any place.

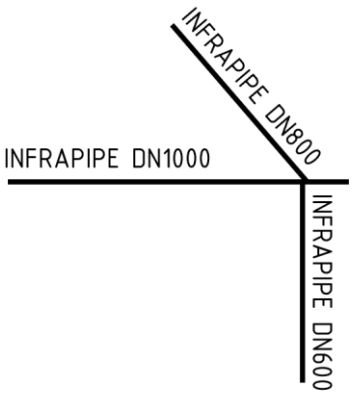
Smaller pipes can have any Invert level in relation to the pipe the flow is joining, provided that for non-pressure applications there is sufficient grade for the direction of flow.

Any angle of connection can be fabricated. For connections arriving at an unsuitable angle to the direction of flow, a further bend can be incorporated into the fitting as shown below.

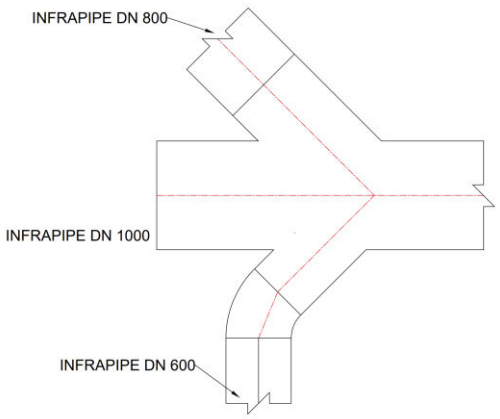
✓ INFRAPIPE will design the fitting to achieve the connection

It is also possible to manufacture solutions for the unusual event of the flow being split – to multiple outfalls, to avoid obstacles or reduce overall height.

Simply draw the connection which suits the site as shown and INFRAPIPE will design the fitting and calculate the adjacent pipe lengths for connections.



The drawing will show this



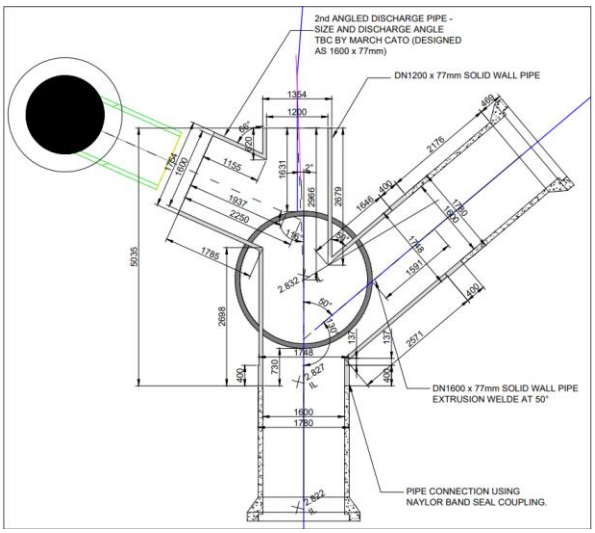
and INFRAPIPE will create and cost this

When the number of inbound connections at one point are too great for a single fitting (typically more than one connection per side), there are two alternatives:

- Firstly INFRAPIPE can use bends to move one of the connections (typically down stream) which can then be an addition to the first fitting or achieved as a second independent one.
- Or INFRAPIPE can connect the inbound connections prior to their connection to the main flow.
- Lastly use a chamber, not for access, but to receive the flows because its larger diameter can accept more smaller connections. See the mighty example below being manufactured for Auckland airport.

INFRAPIPE will design the fitting to optimize hydraulic efficiency and minimize pipe length and therefore cost

Drawing Note	Example/Note
CONNECTIONS	*NO NOTE REQUIRED*



✓ INFRAPIPE uses fittings and connections to avoid expensive manholes

Longer sections of pipe – potential economy

Infrapipe also operates a corrugating HDPE pipe machine capable of manufacturing SN8 or SN16 in DNs 1000, 800, 600, 525, 450 and below. This pipe is quicker to manufacture but has none of the design flexibility that the spiral-wound Krah product has – it cannot be welded into complex structures, or made in different thicknesses (SN ratings) or used with EF welding. It can be integrated into manholes using a corbel or manhole connector.

However, for straight runs alone, this product is more economical to manufacture and no slower to install and it has been designed so that it can be seamlessly integrated into the Krah product having an identical ID. It is available in SN8 and SN16 versions.

This does not affect the design but offers the contractor economic alternatives

Drawing Note	Example/Note
NIL	*INFRAPIPE WILL OFFER THIS ECONOMY TO THE CONTRACTOR AND THE ASSET MANAGER*

Change SN Rating

All other products come in a set range of strengths and therefore design engineers are accustomed to selecting the required SN rating (or class for concrete) from a range of available products.

The Krah system can produce the stiffness rating required (or slightly greater) for each length of pipe which can save over 27% in product cost

The Krah manufacturing system already includes an allowance for manufacturing tolerances but it may be appropriate for the designer to also introduce a safety factor for the following reasons:

- Actual soil conditions encountered
- As built differences in cover height

INFRAPIPE recommends 10%

✓ INFRAPIPE saves money by making each pipe only as strong as needed

Note that up to the day of manufacture INFRAPIPE can modify the SN rating of the pipe for any individual 6m section if the actual soil conditions or cover heights differ from what is quoted.

How should the design engineer approach this?

1. Supply the Geotech report and the longitudinal sections to Infrapipe who will use the *Easypipe* software to recommend SN ratings.

OR

2. Specify an SN rating for sections of the pipe on the drawing.

Drawing Note	Example
THIS SECTION SN RATING	"THIS SECTION INFRAPIPE DN800 SN8"

For this stopbank in the Waikato, the SN rating was only increased for the pipes laid directly under the stopbank, significantly reducing cost to the asset owner.

STRUCTURES IN THE PIPE

Manholes & access chambers

Traditionally there are three reasons for providing a manhole/access chamber to a pipeline. Using HDPE presents more economical options for almost every requirement:

A person needs to be able to enter the pipe or see down the pipe:

- ✓ Either a manhole or a tangential access is required, dependant upon the diameter of the pipe.

The pipe needs to be connected or change direction:

- ✓ Manholes are no longer necessary; bends or connections are cheaper and quicker to make and install and they have better hydraulic performance.

Access is required for CCTV or other remotely operated equipment:

- ✓ Manholes are no longer necessary; an access hatch or tangential access will suffice as an inspection chamber and have better hydraulic performance.

There are further economies and efficiencies with the HDPE product because all options can be supplied integrated into the pipe. The product is delivered with the socket and spigot to lay like a normal pipe but includes the access structure in the pipe section.

A person needs to be able to enter the pipe or see down the pipe:

1. For pipelines that are 1000mm in diameter and below, the recommended option is to add a 1100 diameter manhole.

2. For pipelines of 1100mm diameter to 1800mm, the access is integrated into the pipeline by adding a cylinder of 1000mm diameter sufficient for an inspector to stand and then a 600mm riser above this.

3. For pipelines of 2000mm and more, tangential access is the preferred option. A cylinder of 1000mm diameter is offset at the side of the pipe

Note that any access can be offset as required to avoid placing access points in roads or other locations which present a difficulty or ongoing cost for the asset manager. This can enable a more efficient or effective routing of the whole pipe.

Access is required for remote sensing equipment only:

A 600mm diameter riser is added to the pipe centrally (or tangentially if requested). Any diameter from 450+ could be used (450,525,600,700,800,900,1000+).



✓ Access is integrated into the pipeline in the most efficient way

Pipe Diameter	Drawing Note	Example
450-3200	FOR REMOTE ACCESS (CCTV ETC)	"INFRAPIPE ACCESS POINT"
450-1000	FOR PERSON ACCESS	"INFRAPIPE INTEGRATED MANHOLE"
1100-1800		"INFRAPIPE INTEGRATED ACCESS"
2000-3200		"INFRAPIPE TANGENTIAL ACCESS"

Note that all person access options can be provided in any diameter from 600 mm upwards if 1000mm diameter is not required for the tasks anticipated.

The drawings should provide approximate cover depth so that INFRAPIPE can then determine riser size. Infrapipe will then calculate the required SN ratings of the access method and design it (including buoyancy protection). This is then supplied as a complete system.

- ✓ On request, risers can be supplied so they can be cut to size on site
- ✓ Covers, lids and loadrings are addressed by INFRAPIPE
- ✓ Buoyancy is calculated by INFRAPIPE and if needed buoyancy protection design and estimates will be included in the design and quotes.

Tanks, pump stations & wetwells

Tanks can be integrated into a pipeline either on the line or parallel to it in order to provide detention capacity. This can include some form of permanent flow control or pumping as required.

Simply provide:

- Volume required
- Inlet location and diameter
- Outlet location and diameter
- Overflow location and diameter if required
- Flow control or pumping if required
- Access locations if required

And INFRAPIPE will propose the solution.

For more information on tanks from 10-1000m3+ read the sister document of this one, "Infratank Information for Professionals" or contact sales@infrapipe.co.nz

Drawing Note	Example/Note
SHOW TANK VOLUME AND LOCATION	"INFRATANK 100M3"

Pump stations and wetwells can be provided integrated into the pipeline or offset as required. Cess pits and sumps can be easily connected.

Drawing Note	Example/Note
PUMP STATION SHOW L/SEC, MIN VOLUME	"PUMP STATION 50L/S"

For tanks, pump stations & wetwells, INFRAPIPE will calculate the buoyancy risk and design the proposed solution.

Outlet surge protection

Infrapipe is compatible with outlet surge protection.

Inlets and outlets

- ✓ For inlets or outlets which require an unique structure, these can be welded into any shape in HDPE – whatever height, width, apron dimensions, outfall scour protection or combination of pipes is required.
- ✓ INFRAPIPE can provide scruffy domes or create diffusers if needed
- ✓ Inlets, outlets or diffusers can all be sunk and the flexibility of a plastic pipe allows the pipeline to follow gentle contours on the seabed if required.

Integrated fish baffles - and an outfall about to take its final plunge in the Red Sea:

Environmental protection – fish baffles etc

Infrapipe is compatible with all recognized systems of environmental protection/assistance. Fish baffles are welded into the pipe in the factory and pipes can be prepared for the installation of fish ladders on site.

Flow control

Infrapipe is compatible with all recognized systems of flow control and can be fitted with the following:

- ✓ Scour blocks
- ✓ Low flow chambers
- ✓ Baffles

These are installed in the factory.

Drawing Note	Example
DETAIL THE FUNCTION REQUIRED	"FISH BAFFLES"

CONNECTIONS

Drawing Note	Example
FOR ANY CONNECTION	"INFRAPIPE CONNECTION"

INFRAPIPE will then design and quote the required connection.

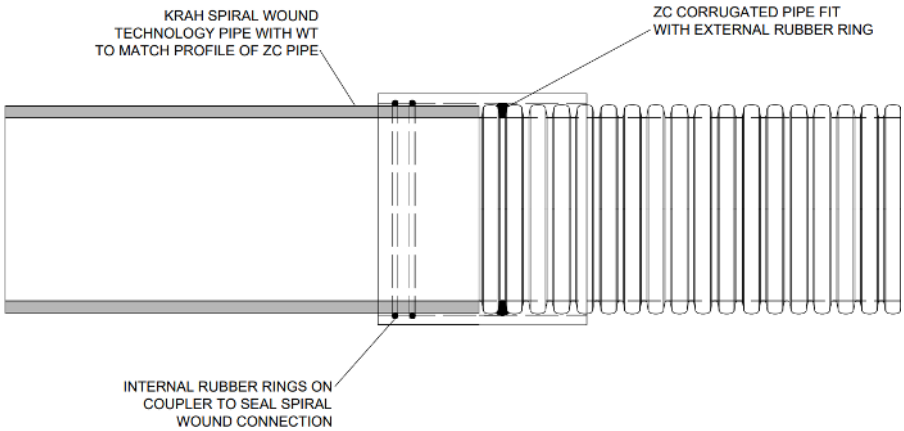
Connecting to laterals of other materials

Connections to PVC or other plastic laterals can be achieved with fittings provided by Fernco or by using the HAS system:

Connecting to other pipes

Connecting to other pipes is easily accomplished with slip couplers or shear bands

An INFRAPIPE slip coupler between two pipes



Differences in diameter can be addressed easily with integrated reducers.

An alternative to the slip coupler, particularly in a repair situation, is the highly effective Hermetica seal in sizes 300-4000mm. It is seen here in the repair to the primary potable water line to Nelson which was destroyed by a large washout after the rains of Sep 22. To provide the pipe took a week, the seal two weeks and the bridge six weeks and then supply was permanently restored across a steep hillside.

The Hermetica seal

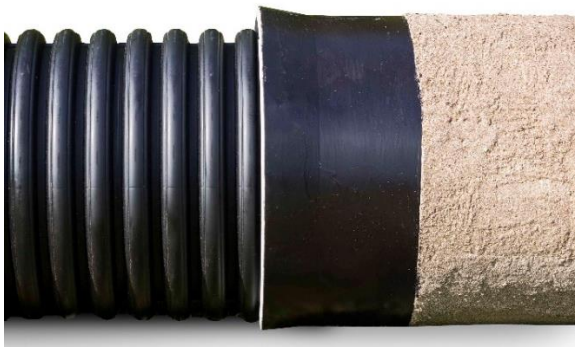
A shear band

✓ INFRAPIPE can join any pipe to any pipe

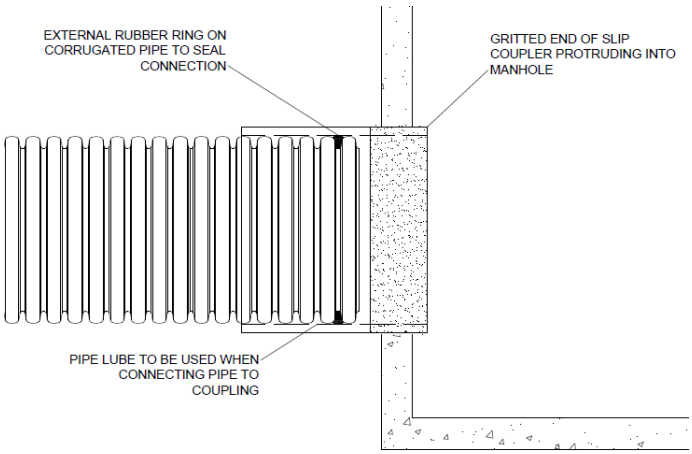
Connecting to other structures

INFRAPIPE can be easily connected to other structures such as wingwalls, filtration devices such as Stormwater 360 products, waste tanks such as ECOFLOW or existing concrete manholes. This can be achieved in the following ways:

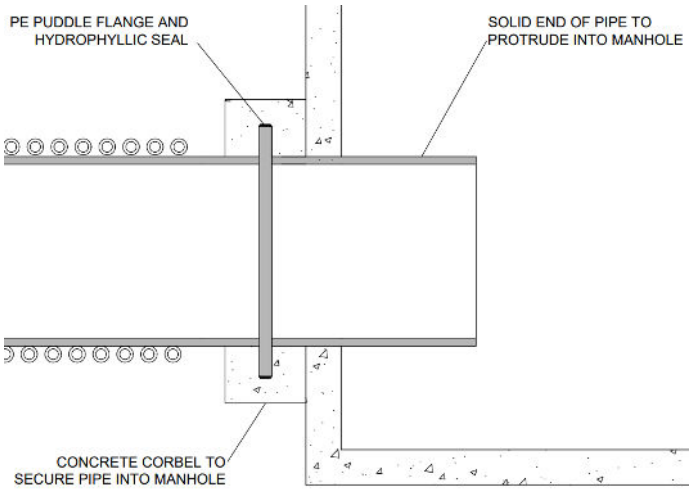
1. Using a standard manhole connector for smaller diameters
2. Using a custom-made fitting such as a slip coupler
3. Creating a concrete/epoxy mortar corbel around the join
4. Using a puddle flange and/or hydrophillic seal in conjunction with a concrete/epoxy mortar corbel



1- A standard manhole connector



2 – A slip coupler



3 & 4 – A puddle flange & a concrete corbel

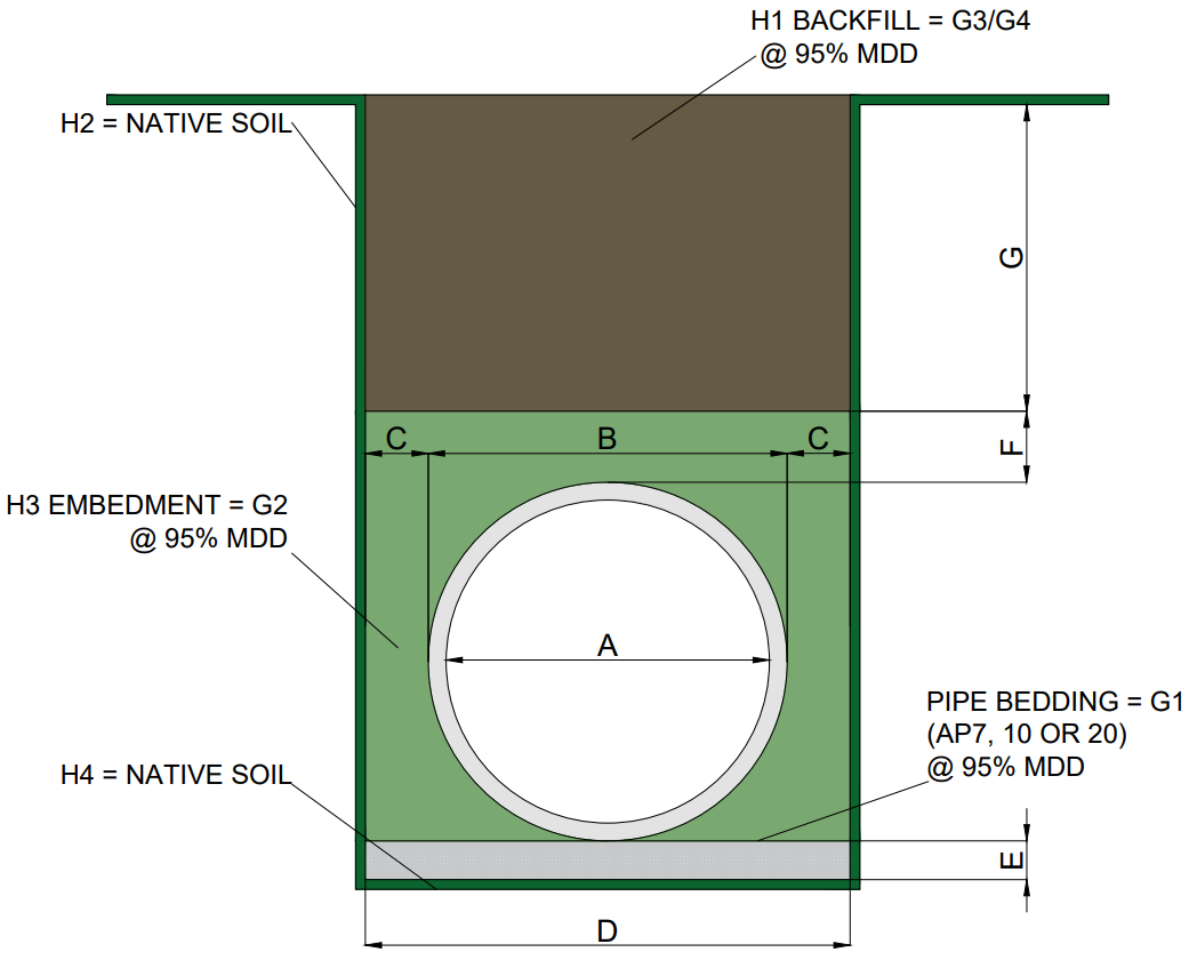
✓ INFRAPIPE can join any pipe to any concrete structure

DESIGN PARTICULARS – THE TRENCH & BUOYANCY

Trench & cover

For most applications the pipe is located under the ground. Aboveground use is possible – contact INFRAPIPE for more details. For a flexible pipeline there are two components:

The trench includes the material above, below and to the sides of the pipe so that it has sufficient support.
The cover height up to a given maximum for a pipe SN rating is the amount of material above the pipe because of the site or the loading requirements.



There are two design process options at this stage:

- The design for the location dictates the trench design and cover
- The required trench and cover dictate the design

Where the design dictates the trench and cover, the design should be provided to INFRAPIPE who will determine the SN rating of the pipe required.

However if the design can be modified (or based around the optimum trench and cover) then INFRAPIPE can advise on the most economical choice.

INFRAPIPE design schedules can then include pre-calculations on trench depths, widths, cover height and backfill volumes.

✓ INFRAPIPE calculates the trench dimensions for the soil and load

BACKFILL MATERIAL CLASSIFICATION TABLE:

GRANULAR BACKFILL			COHESIVE BACKFILL
G1	G2	G3	G4
• Graded Crushed Rock • River Gravel and Beach • Gravel	• Valley Sand • Drift & Basin Sand • Dune Sand • Beach Sand	• Weathered Gravel • Clayey Gravel • Loamy Sand • Liquid Sand • Alluvial Clay	• Clay • Loess • Loam • Alluvial Marl

Buoyancy

Plastic pipelines can become buoyant in situations with a high water table. INFRAPIPE will calculate the buoyancy prevention requirements for a location (and sub locations) and specify the volume of concrete needed to avoid buoyancy, if any plus the securing mechanisms. This could be provided in multiple forms:

- Concrete collars placed over the pipe
- Ballast blocks placed beside the pipe and secured over the pipe
- A slab poured on site to which the pipe or structures are secured

✓ INFRAPIPE will calculate buoyancy requirements

The most substantial anti-buoyancy anchors are for seabed applications

Drawing Note	Example
BUOYANCY	"ANCHOR SYSTEM BY INFRAPIPE"

DESIGN PROCESS

Hydraulic performance

Initially it is recommended that hydraulic requirements are calculated without allowances for manholes or other structural impediments to flow.

Early Supplier Involvement (ESI) can then determine the minimum structures, connections and bends. INFRAPIPE will return a schedule (DRS) showing how they would achieve each connection (see example below) and then allowance can be made for the impact on hydraulic performance.

Design Schedule

INFRAPIPE will propose a solution through a design Schedule. This defines the components, ensures that changes are tracked and that the solution is clearly understood by all parties. An example is shown below:

Design Return Schedule (DRS)

Project: Date: Drawings Version:

								kg	kg	mm	mm	mm	m3	
Section	Sub Section	QTY	DN	SN	Length	Chainage	Component	Max weight	Anti-Buoyancy	Trench Width	Trench Depth	Cover Height	Backfill	Notes
	1 A	3	1800	12	5.8	17.4	PIPE							
	1 A	1	1800	12	2.6	2.6	SHORT							
	1 A	1	1800	12	0.8	0.8	SLIP COUPLER							TO EXISTING CONCRETE PIPE
SECTION TOTAL						20.8								

Note the blue components are used during Early Supplier Involvement; normally once the process moves to estimation the columns in grey are also calculated.

Supply drawing notes and tech detail

Engineers estimate

INFRAPIPE can provide an engineers estimate which would include:

- Approximate product costs
- Approximate freight costs
- Product weights for craneage costs
- Approximate welding onsite costs (if required)
- Approximate buoyancy prevention requirements
- Excavation and backfill volumes for the trench itself for costing.

Contractors quote

In order to provide a comprehensive quote, INFRAPIPE will require:

1. Geotechnical and water table data
2. Site drawings and any relevant hydraulic design data
3. Any constraints on delivery or laying (as this may affect the most economical freight choices)
4. Details of connections required to existing pipes or structures
5. Details of connections to inlets or outlets
6. Long sections or other data to establish riser heights
7. Long sections or other data to establish cover heights and loads
8. Access requirements
9. Additional modifications:
    i. Fish baffles and environmental protections
    ii. Flow control requirements
    iii. Surge protection requirements
    iv. Any other requirements

The quote from INFRAPIPE will then include

A. Product costs
B. Delivery costs (and methodology)
C. Onsite welding costs (if required)
D. Final product weights
E. A list of the products which will be sourced by the contractor if not INFRAPIPE – concrete anchors and straps, lids, loadrings, covers and other materials which may be best sourced locally.

Once a quote is accepted INFRAPIPE will then provide:

F. Shop drawings for fabrications – bends, connections, access points & manholes
G. Pipeline lay plan
H. A list of any outstanding design inputs (site survey requirements etc.)

Final cost

Site surveys can cause changes in cost as a result of the following:

- Changes to depth can affect risers and structures
- Changes to angle may affect beds and connections
- Changes to cover height may affect SN rating of pipes
- Changes to distances may affect the chainage (total distance)
- Changes to gradients may affect chainage and bends

In addition, the following may occur which may not automatically lead to an increase in cost:

- Changes found in the invert levels and nature of existing connections
- Changes in the angles of the pipeline which do not change the number of bend sections

Note that pipe length costs do not change in a linear fashion; a 4m pipe does not cost 80% of the cost of a 5m pipe due to manufacturing costs (machine loading, mandrel warm up and machining the ends) and freight costs. Lay rates per metre should be agreed with input from INFRAPIPE.

Site care of the product

INFRAPIPE has detailed instructions for site care of the product which can be found in the following document:

Handling, Transportation & Storage – Krah Pipes

A flat laydown area is required that is sufficient for the amount of product required by each stage of the construction plan. Product can be stacked 2 high so for pipes less than DN2000 the area of the laydown area alone can be calculated as

$$1.4 * DN * L / 12$$

Where L is the length of the section to be stored and laid.
Manholes, bends, fittings, pipes DN2000+ or any other product will require an area 10 * DN as a rule of thumb.

HOW TO SAVE COST IN PIPELINE DESIGN

There are some locations such as marine/coastal environments or ones with constrained access or elevated seismic/geotechnical risk where HDPE is the automatic choice. For other locations, the design engineer can optimize the design for their client in the following ways by using helical HDPE:

PIPELINE PRODUCT COST

- Exact strength required = less pipe cost
- Lighter product = less pipe freight cost
- Exact length required = less pipe cost
- Shortest distance (using bends) = less pipe cost
- No additional support needed for higher loads = less pipe cost
- Using reducers = no manhole costs or less pipe cost
- Connect laterals directly = no manhole cost
- Inspection access = no manhole cost
- Bends for change of direction = no manhole cost
- Bends for steep grades = no manhole cost

PIPELINE INSTALLATION COST

- Less joins = less installation cost
- Factory joins (12m lengths) = less installation costs
- Lighter product = less installation cost
- Lighter product = less OSH risk
- Less manholes = less installation cost
- Prefabricated manholes = less installation cost

PIPELINE LIFETIME COST

- No maintenance = no cost
- No corrosion = no cost
- Less abrasion = longer life
- Less seismic risk = less cost
- Easy to repair = less cost
- No infiltration with EF welds = no cost

SOLID WALL ALTERNATIVES

The KRAH Technology can also create solid wall pipe which can be much more economical than traditional inline extrusion (which has large setup costs) for shorter runs of larger diameters, or more extreme wall thicknesses. Whilst the table below shows the most common SDRs (Standard Dimension Ratios – which dictate the wall thickness for a given pressure rating), INFRAPIPE can achieve any SDR.

If you want SDR 17		Then try INFRAPIPE		Or choose next size	If you want SDR 13.6		Then try INFRAPIPE		Or choose next size	If you want SDR 11		Then try INFRAPIPE		Or choose next size
DN	ID	ID	OD	ID	DN	ID	ID	OD	ID	DN	ID	ID	OD	ID
560	494	525	595		560	478	525	613		560	458	450	550	525
630	556	525	595	600	630	537	525	613	600	630	515	525	641	
710	626	600	680	700	710	606	600	702		710	581	600	732	
800	706	700	806	800	800	682	700	820		800	655	700	854	

MAINTENANCE, MODIFICATION & REPAIR

INFRAPIPE requires no maintenance. Being chemically inert, homogenous and resilient, there are no requirements to inspect or repair or maintain the product.

Should the product need modification or repair, any suitably qualified PE extrusion welder can weld the product. INFRAPIPE can advise on the most efficient way of modifying or repairing the product and can if necessary arrange for this.

PRODUCT TECHNICAL DETAILS

STANDARDS

INFRAPIPE is accredited to ISO 9001:2015 and the pipe is certified to ISO Type 5 5065:2005, these certificates can be provided on request or found on the INFRAPIPE website

TOLERANCES

Due to the nature of the product shrinkage of the material can affect the ID of the pipe by 2-3mm (ie a maximum of 0.5%). Pipes can vary by +/- 50mm unless this affects the laying plan and the final length is adjusted to ensure the exact chainage.

PRODUCT LIFE

The latest meta study by TEPPFA (see INFRAPIPE website) confirmed that the expected life of HDPE pipes is well in excess of 100 years.

TESTING

INFRAPIPE operates a test laboratory and tests pipe as required by AS/NZS 5065:2005 in accordance with AS/NZS1462.

Testing measures the deflection using constant speed load cells:

RECYCLABILITY

The product is entirely recyclable. All production waste is reprocessed and re-used. The standards do not permit the use of other recycled material in the manufacture of product for civil engineering applications however INFRAPIPE makes extensive use of recycled material in its rural and forestry applications.

SEISMIC PROPERTIES

Due to its high flexibility the product is significantly more resilient than the more rigid alternatives. See Appendix One for a survey of KRAH pipes after the Japanese earthquake of 2011, and for more information on seismic testing see this article:

https://www.krah.net/de/news/latest-news/299-extensive-earthquake-dynamic-fitness-test

CHEMICAL RESISTANCE

HDPE (high density polyethylene) and PP (polypropylene) have excellent chemical resistance. A chart showing all the minimal reactivity potential of these materials to a wide range of common chemicals is found on the INFRAPIPE website

ROUGHNESS COEFFICIENT

AS2200 “Design charts for water supply and sewerage” give a range of values of the Colebrook-White Coefficient for polymers of 0.003 to 0.0015 and for concrete of 0.03 to 0.6.

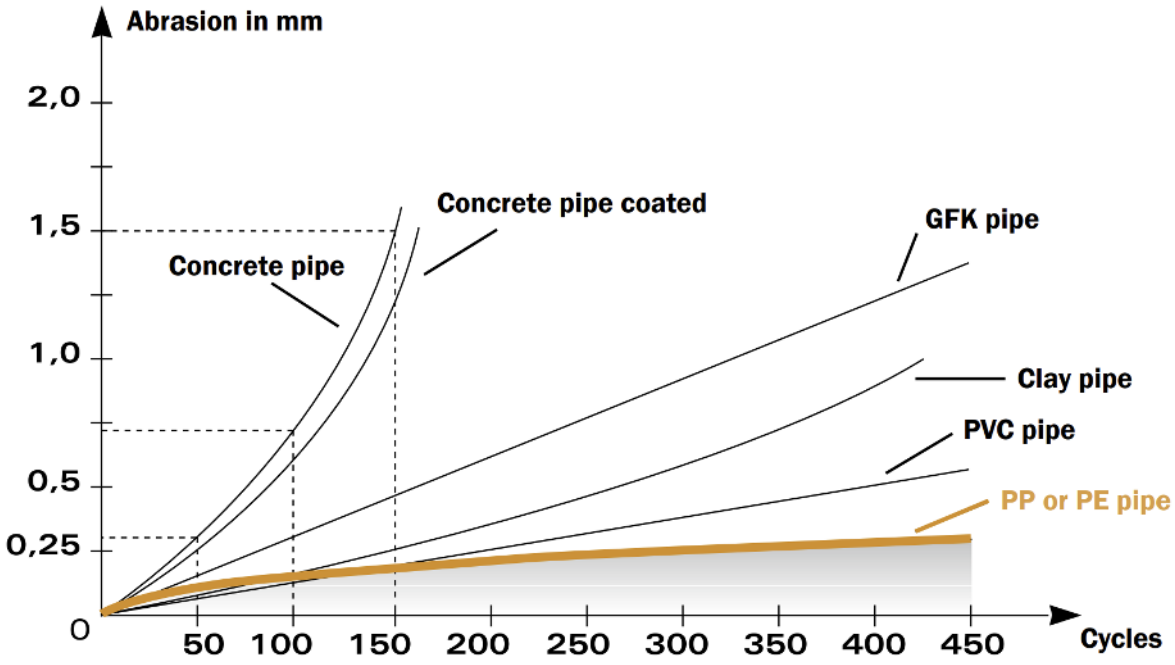
PERFORMANCE

HDPE is extremely smooth and the hydraulic performance using these pipes and fittings can be calculated as follows:

https://www.krah.net/en/news/latest-news/276-hydraulic-calculation-of-pe-pressure-pipes

ABRASION RESISTANCE

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.

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 greater resistance to abrasion and hence operating life.

✓ A DN600 PE pipe will abrade in 13,500 kcycles, for concrete - 5,600 kcycles

CRACK RESISTANCE

Materials compliant to AS/NZS 4131 when applied through the helical extrusion process are deemed by AS/NZS 5065:2005 to have sufficient Environmental stress cracking resistance in clause 2.1.7 of the standard.

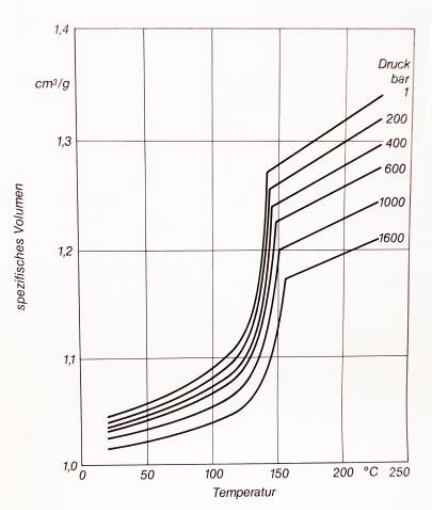
PRESSURE

INFRAPIPE is suitable for use in low pressure applications up to 3 bar with EF welds, depending on the wall thickness of the pipe.

THE EFFECTIVENESS OF ELECTROFUSION (EF) WELDING

The EF welding system for the Krah technology joins the two pipes seamlessly by melting them, together. Using the significant thermal expansion of polyethylene, the volume of which rises from 1.06 cm3/gram to 1.35 cm3/gram above 130 degrees Centigrade, and providing a compression force either side of the heated area, creates a completely homogenous joint as shown below (the wire ends show where the heat was applied); it would be accurate to say there is no longer a joint.

The thermal expansion of HDPE and a section of the pipe after EF welding



For more detail see here

UV RESISTANCE

HDPE is sufficiently UV resistant for a typical installation period. However significant delays can require protection from direct sunlight to prevent the pipe temporarily losing ovality which can increase installation time.

ENVIRONMENTAL CONSTRAINTS

These pipes are used successfully in the icy wastes of Norway and the scorching sands of the Persian Gulf. They are ideal for acidic soils, marine or coastal applications and all other harsh environments.

CERTIFICATES OF CONFORMITY AND PRODUCER STATEMENTS

Producer Statements and Certificates of Conformity can be issued by INFRAPIPE on request. Overall testing is in accordance with ISO 5065:2005 and raw material used is tested for Melt Mass-Flow Rate (MFR) in accordance with ISO 1133-1:2022 *Plastics – Determination of the melt mass-flow rate and melt volume-flow rate of thermoplastics*. All resins used are certified to AS/NZS 4131:2010 and batch certificates are retained.

Installation Instructions are in accordance with AS/NZS 2566.1:1998 *Buried Flexible Pipelines: Structural design* and AS/NZS 2566.2:2002 *Buried flexible pipelines – Installation*. Manufacture of the product is designed to DIN16961, EN13476, ASTM F894 and ISO 9969.

MAINTENANCE & MODIFICATION

The pipe will need no maintenance at all.

Modification can easily be achieved by a competent HDPE welder. INFRAPIPE can provide third-party fittings for adding smaller laterals, a section can be modified in situ using the HAS equipment, or a section removed, modified and replaced using Hermetic seals or shear bands as above.

REFERENCE DOCUMENTS

Read Infrapipe Guide to Maintaining Your Warranty
Read Infrapipe guide to Delivery and Handling the Product (Krah)
Read Infrapipe guide to Inspection on Delivery

There are many more documents (such as guides to large underground tanks) available here in INFRAPIPEs online library

FAQs

These are some of the questions most commonly asked about INFRAPIPE

How do we know the pipe will last one hundred years?

Products of this kind have been in use in Germany since 1956 and continuously tested since then without any loss of function detected:

https://plasticker.de/Plastics_News_2921_Basell_50_years_of_continuous_testing_of_pipes_made_from_Hostalen_HDPE_grades_completed?begriff=hosta&div=n

What is the leadtime?

There is no mould to prepare, no lengthy machine set-up, no extensive tooling change nor curing after manufacture – a pipe can be ordered one day and installed the next. Larger projects will require co-ordination with INFRAPIPE for capacity constraints. To repair Nelson's water supplies after the rains of September 2022, product was made the next day.

What is Infrapipe's production capacity?

INFRAPIPE can make significant volumes of pipes each working day, so dependant upon the SN ratings, maximum capacity ranges from 108 lineal metres per week of DN3200 pipe to approx. 180 lineal metres per week of DN2300m pipe to 720 lineal metres of DN600.

How do Infrapipes handle seismic events?

HDPE pipes have high flexibility allowing them to absorb seismic energy without breaking or cracking. The ductile nature of PE allows the pipe to deform without breaking, allowing them to stretch and elongate rather than fracture. Fusion welding is used to join the pipes together to create a bond as strong as, if not stronger than the pipe itself ensuring the joints do not break or leak during a seismic event. See this survey of pipes after the Japanese earthquake of 2011

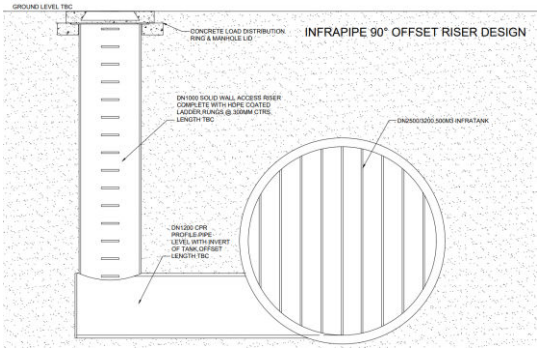
What happens if the pipe is damaged?

It is not easy to damage HDPE but should this occur (before, during or after installation), Infrapipe's site services team can repair with welding onsite.

If the pipe is damaged in subsequent years, any qualified HDPE welder can repair the pipe quickly and easily with welding being dry and usable within 45 minutes of completion. HDPE is homogeneous (ie it has no need of a protective gelcoat or paint) so damage is easy to deal with and has no impact on longevity.

What is an offset access?

The flexible construction of an Infrapipe allows for an inspection access which is offset from the pipe or tank itself, allowing pipes or tanks to be placed under roads or in other locations where frequent access to a central riser for inspection is expensive, inefficient or unsafe.



What maintenance is required

Infrapipes require no maintenance on the body of the pipe or tank. Ever. There is no rotting, rusting or corroding. HDPE is completely unaffected by any NZ soil.

Can the tank be recycled?

Infrapipes are completely recyclable. All production waste is recycled into culvert.

What is the carbon footprint

Whilst each application varies (due to location and design), HDPE generally has an environmental cost of 1.92 CE/kg and when it is then recycled this drops to 0.23 CE/kg.

ABOUT INFRAPIPE

Infrapipe is an independent NZ-owned business with factories in Auckland and Palmerston North. It was established to offer New Zealand the latest pipe technologies which are now standard in the rest of the world.

sales@infrapipe.co.nz www.infrapipe.co.nz

APPENDICES

1. A survey of Krah pipes after the Japanese earthquake of 2011
2. An example of static analysis and design
3. Some interesting examples

Appendix 1 – survey of pipes after the 2011 Japanese earthquake

Place	Date of Investigation	Diameter (mm)	Length (m)	Soil embankment (m)	Ratio of deflection (%)	Appearance
Hiranai town Aomori Pref.	3rd June 2011	1200	68.0	11.0	4.1 %	no damage
Rokkasho village Aomori Pref.	2nd June 2011	1800	140.0	27.5	4.4 %	no damage
Miyako city Iwate Pref.	26th May 2011	2400	5.0	1.0	0.2 %	no damage
Kamaishi city Iwate Pref.	25th May 2011	1800	80.0	9.8	3.9 %	no damage
Kamimasuzawa Iwate Pref.	25th May 2011	1000	75.0	12.0	3.0 %	no damage
Sumida town Iwate Pref.	23rd May 2011	2000	85.0	17.3	1.8 %	no damage
Sumida town Iwate Pref.	23rd May 2011	1100	105.0	10.8	3.0 %	no damage
Rikuzen Takata city Iwate Pref.	24th May 2011	1200	64.6	10.8	3.9 %	no damage
Rikuzen Takata city Iwate Pref.	24th May 2011	1500	65.0	8.0	1.7 %	no damage
Rikuzen Takata city Iwate Pref.	24th May 2011	1000	80.0	15.8	4.2 %	no damage
Rikuzen Takata city Iwate Pref.	28th May 2011	1000	84.8	16.3	3.9 %	no damage
Rikuzen Takata city Iwate Pref.	28th May 2011	1000	74.6	13.5	3.9 %	no damage
Rikuzen Takata city Iwate Pref.	28th May 2011	1000	35.3	6.2	2.5 %	no damage
Rikuzen Takata city Iwate Pref.	30th May 2011	1000	70.0	13.0	4.3 %	no damage
Rikuzen Takata city Iwate Pref.	30th May 2011	1000	66.0	11.4	3.0 %	no damage
Rikuzen Takata city Iwate Pref.	30th May 2011	1000	78.0	13.0	3.9 %	no damage
Rikuzen Takata city Iwate Pref.	31st May 2011	1000	67.8	10.3	1.0 %	no damage
Rikuzen Takata city Iwate Pref.	31st May 2011	1000	58.1	9.3	3.0 %	no damage
Tome city Miyagi Pref.	1st June2011	900	82.0	16.0	3.6 %	no damage
Osaki city Miyagi Pref.	1st June 2011	1200	60.0	10.0	3.3 %	no damage
Fukushima city Fukushima Pref.	27th May 2011	1800	159.0	27.0	0.6 %	no damage

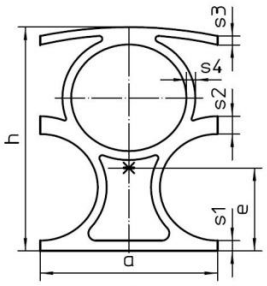
Appendix 2 examples of static analysis and design

Profile sheet

Internal standard

KRAH™ www.krah.net

profile no. COP 125-1095.7



Dimension			statical data		
Length (L)	500.00	[mm]	Ix	197,225,707.00	[mm^4]
Waterway (s1)	40.00	[mm]	Moment of inertia (I)	1,095,698.37	[mm^4/mm]
Waterway (s2)	-	[mm]	Distance of inertia (e)	120.84	[mm]
Waterway (s3)	15.00	[mm]	Section modulus inside (Wi)	9,067.35	[mm³/mm]
Thickness (s4)	10.00	[mm]	Section modulus outside (Wa)	6,389.66	[mm³/mm]
Profile height (h)	292.32	[mm]	equivalent solid wall (evw)	236.02	[mm]
Profile width (a)	180.00	[mm]	Profile area radial (ap)	102.12	[mm²/mm]
Coretube diameter (sd)	125.00	[mm]	Profile area axial (ap2)	55.00	[mm²/mm]

Appendix 3 Some interesting examples