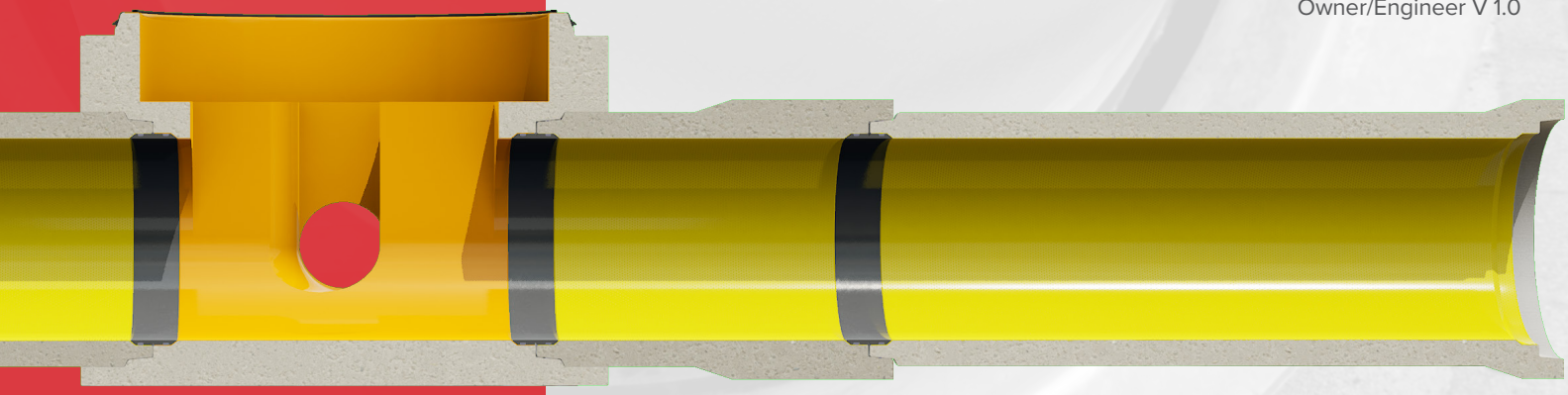
Geneva Pipe and Precast
A Northwest Pipe Company

Perfect Pipe: HDPE-Lined RCP

Technical Handbook

Owner/Engineer V 1.0



PERFECT

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KOMATSU

Geneva Pipe and Precast
A Northwest Pipe Company

Welcome to the Perfect Lined System

Perfect Pipe and Perfect Lined Manholes offer cutting-edge corrosion resistance for municipal sewer infrastructure. An integrated liner provides 100% coverage and creates a tight seal and a smooth laminar flow for long-lasting performance in sanitary sewer and wastewater environments.

Both Perfect Pipe and Perfect Lined Manhole Systems can be used in conjunction with almost any existing system and the innovative joint design enables connection without field welds in most sizes. This translates to rapid installation and long-term savings.

If you have any questions about the contents of this handbook or about the Perfect Pipe and Perfect Lined Manhole products please let us know. We're here to help!

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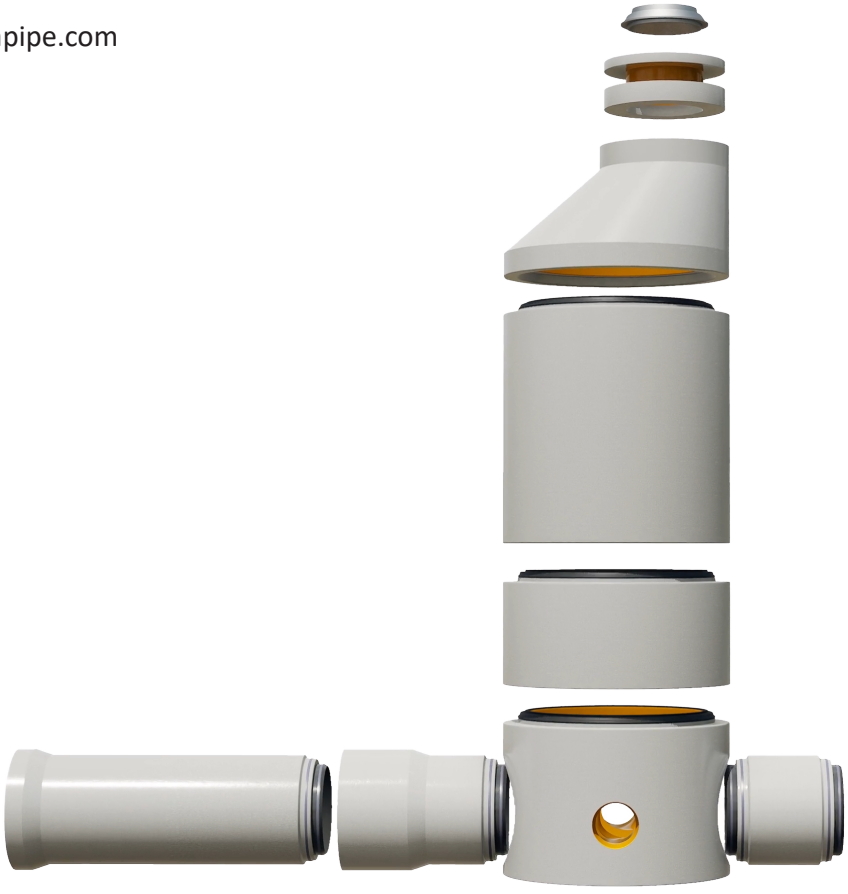

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PART 1
The Perfect Plant

Statement of Qualifications

We manufacture all of our concrete products in the controlled setting of our plants from locally sourced aggregates and cementitious materials with domestic steel. Our tight quality production and testing standards following ASTM and AASHTO specifications. Mastering the combination of mix design, computer-controlled batching, and the curing process, we add a bit of artistry to manufacture custom structures for your project.

We put quality as one of our highest priorities. We have been a UDOT Gold Quality Producer consecutively for 6 years (since 2013) and have been a National Precast Concrete Association (NPCA) Quality Certified plant ever since 2003 with outstanding scores on all quality reviews done by the third-party organization.

In-House Engineering

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Manufacturing Capabilities

PERFECT PIPE

- Ability to produce 24”-60” diameter Perfect Pipe with no-weld joints
- Ability to produce 72”-96” diameter HDPE -lined RCP

PERFECT LINED MANHOLE

- Ability to produce Perfect manholes in sizes 48”-96” diameter no-weld joints with eccentric or concentric cones or flat lids

CUSTOM LINED PRECAST STRUCTURES

- Ability to manufacture lined vaults, wet wells, and junction boxes

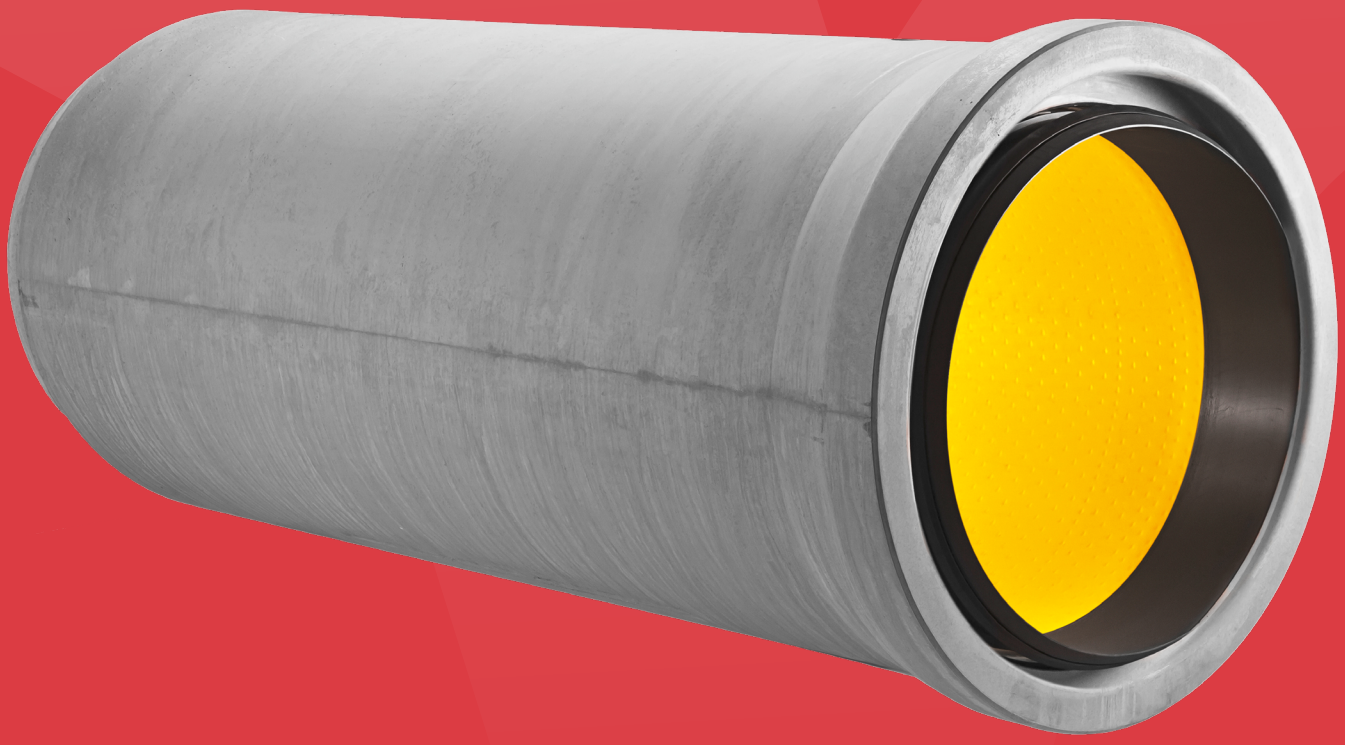
Production Equipment and Molds

Founded in 1964 the Austrian technology developer Schlusselbauer Technology has been a global supplier of innovative systems and plants for the production of precast concrete products for more than 50 years. Schlusselbauer is the developer of the Perfect Pipe HDPE-Lined Concrete Sanitary Pipe technology and production process, and produces the equipment and automation used to manufacture Perfect Pipe for Geneva Pipe and Precast.

The use of Self Consolidating Concrete (SCC) creates a product differentiated from conventionally manufactured precast concrete pipe in terms of strength (6,000 PSI), density and finish. Unlike drycast concrete pipe production, SCC is a highly flowable, non-segregating concrete with a slump flow of 20 to 30 inches that can spread into place, fill the formwork, encapsulate the reinforcement and stud-anchors of the HDPE-protective lining without introducing vibration.

The Schlusselbauer production molds are machined and assembled in Austria by experienced technicians. The tooling produced for Geneva Pipe and Precast is laser-cut with tolerances within + 0.036 inches and machined to the U.S. ASTM C-76 C-Wall standard. The production molds are designed and manufactured for a lifecycle of 100,000 pours.

PART 2
Perfect Pipe



Geneva Pipe and Precast
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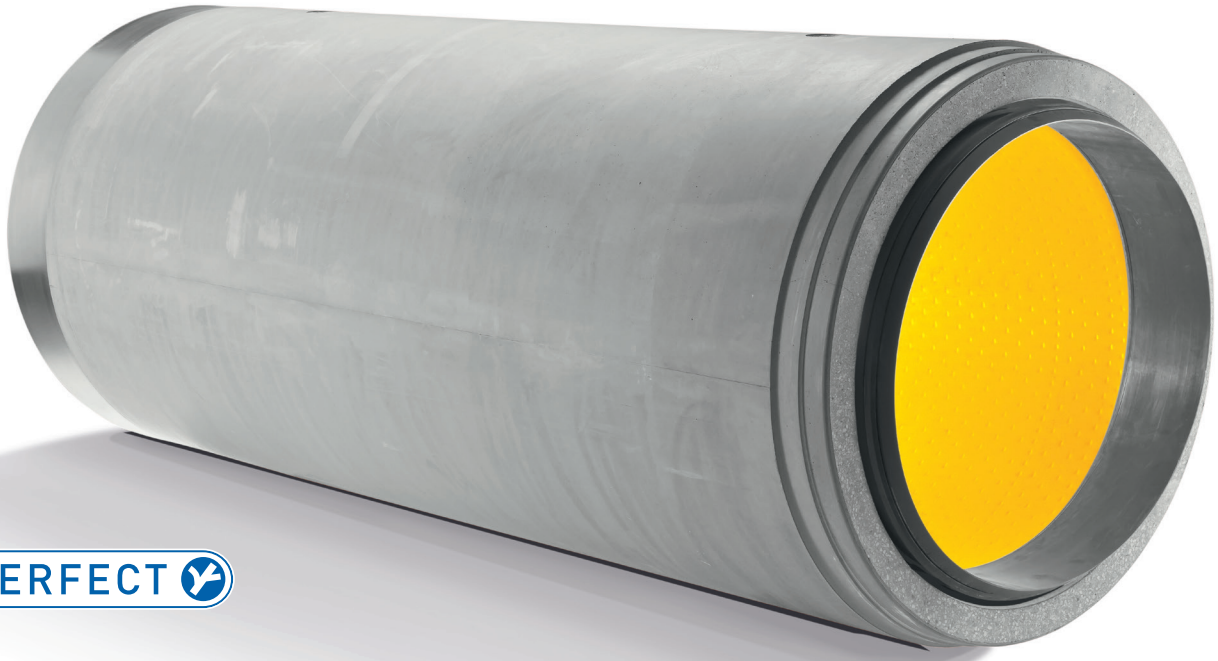
Perfect Pipe Product Guide

HDPE-Lined Reinforced Concrete Pipe



PERFECT

SANITARY SEWER APPLICATIONS

Direct Bury
Trenchless
High Loading
High Ground Water

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Section 2 Application

Section 3 Sizing and Availability

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Section 5 Materials, Components, and Manufacturing

Section 6 Testing and Quality Control

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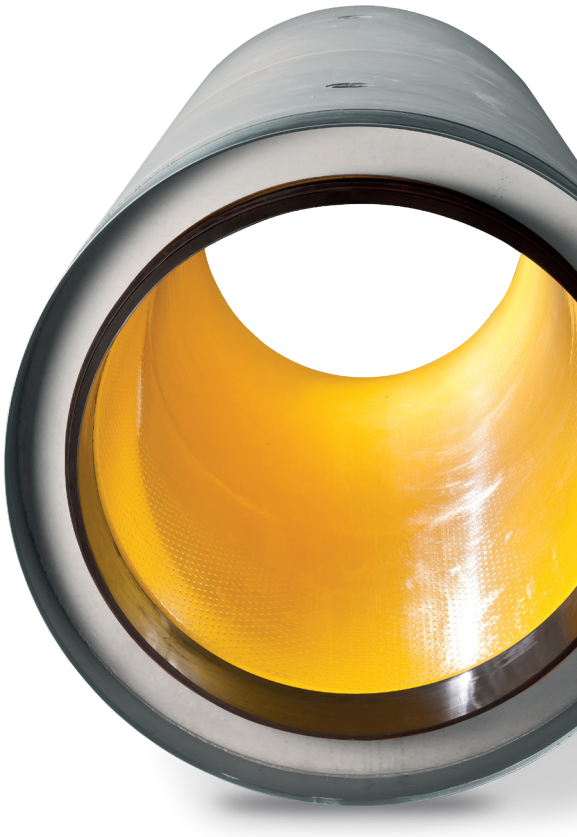


SECTION 1

Product Description

Perfect Pipe is a Reinforced Concrete Pipe (RCP) lined with a High-Density Polyethylene (HDPE) plastic lining that protects concrete from microbial induced corrosion in municipal wastewater systems. The pipe lay length is 9.84 feet (3 meters) and can be installed quicker than conventional 8-foot-length RCP. The pipe joints are connected by an internal joint coupler which eliminates the need for field welding. Small gaps on the outside of the internal joint coupler are fitted with two EPDM (ethylene propylene diene monomer) tilting edge gaskets which have been tested in excess of 35 psi external pressure. The smooth HDPE liner improves hydraulic flow, provides protection against system corrosion, and prevents sliming or build ups to reduce maintenance and operation costs.

Product Features & Benefits

CONCRETE PIPE

- Strength
- Structure
- Durability
- Sustainability

HDPE LINER

- Chemical resistant
- Smooth surface for maximum hydraulics
- Prevents interior build-up for lower maintenance and operational costs

WATERTIGHT JOINT

- Factory installed joints minimize gasket installation errors
- Quick install time with no field welding
- Tested in excess of 35 psi

SECTION 2

Application

Perfect Pipe is intended for use as gravity pipe in sanitary sewer collection systems to prevent microbial induced concrete corrosion and improve hydraulics. While Perfect Pipe is a sustainable solution for all sanitary sewer collection systems, Perfect Pipe provides exceptional value in the following applications:

OPEN TRENCH INSTALLATION

The bell-spigot joint design of Perfect Pipe enables a simple installation process comparable to conventional RCP installation. The reinforced concrete provides an ideal structure allowing for minimized installation costs as compared to flexible pipe alternatives.

TRENCHLESS INSTALLATIONS

Available with a consistent outer diameter and a steel bell band, Perfect Pipe is the solution for sanitary sewer jacking or microtunneling installations. We manufacture Perfect Pipe using a wetcast, self-consolidating concrete (SCC) process to achieve high compressive strength and tight tolerances which support successful installation on the most challenging trenchless projects. A steel bell band provides additional concrete surface area to disperse the jacking forces.

HIGH LOADING CONDITIONS

Perfect Pipe can resist high loading conditions. Unmatched strength of reinforced concrete and versatility of concrete pipe design can meet almost any project needs, from shallow bury with concentrated loading condition to deep installations condition.

HIGH GROUNDWATER CONDITIONS

Perfect Pipe is an optimum solution when a sewer pipe must be installed below the groundwater table. Its design prevents groundwater infiltration and inflow which can result in higher costs of water treatment downstream. The internal joint coupler and tilting edge gaskets used in Perfect Pipe have been tested in excess **of 35 psi** external pressure or approximately **80 feet** of head. In addition, Perfect Pipe is excellent in resisting flotation forces due to its inherent self-weight of concrete. Perfect Pipe can be installed without using strap downs even if there is water in the trench.

ADDITIONAL BENEFITS

- Use in conjunction with any pipe system
- 100+ year design life
- Corrosion and abrasion resistant interior after decades of use
- No age-related decline in pressure
- Low maintenance
- Easy inspection with a bright view and clear joint location

SECTION 3

Sizing and Availability

Perfect Pipe is available through Geneva Pipe and Precast in nominal sizes ranging from 24" up to 60" diameter. See Table 1 for the full range of sizes available as well as details on design characteristics. Larger diameter lined pipe is available with field welded joints. Please contact your Geneva Pipe and Precast Sales Representative for more information on larger diameter lined pipe or for inquiries on Perfect Pipe sizing for trenchless applications. Perfect Pipe comes in 9.85' (3m) joint length.

Table 1: *Perfect Pipe Sizing Availability and Design Characteristics*

Nominal Pipe Size	*Inner Diameter*	*Total Flow Area*	*Achievable Curve Radius (based on standard lay length and allowable joint deflection*		
(inch)	*(mm)*	*(feet^2)*	*(°)*	*(inch/foot)*	*Radius (feet)*
24	(600)	3.04	1.20	0.24	470
30	(800)	5.41	0.90	0.18	626
36	(900)	6.84	0.80	0.16	705
42	(1100)	10.22	0.65	0.13	867
48	(1200)	12.17	0.60	0.12	940
60	(1500)	19.02	0.45	0.09	1075

SECTION 4

Design

DESIGN LIFE

Perfect Pipe is expected to have a design life that meets or exceeds 100 years under normal sanitary sewer conditions. Reinforced concrete pipe is a durable choice for long term value in stormwater applications. The Army Corps of Engineers recommends a design life of **70 to 100 years** for conventional precast reinforced concrete pipe. However many installations have exceeded 100 years in service life. Whether buried or exposed, RCP is immune to most elements; it won't burn, rust, tear, buckle, or deflect. Perfect Pipe goes beyond the long design life of a conventional RCP by lining the inside of the pipe with HDPE, providing full protection against corrosion in sewer applications.

SELECTION OF PIPE STRENGTH CLASS

RCP manufactured by Geneva Pipe and Precast meets the manufacturing requirements of American Society for Testing and Materials (ASTM) Specification C76. Perfect Pipe is available in standard **Class III**, **IV** and **V**, as well as special design to meet the highest load requirements.

To select the correct pipe class needed for your project, please refer to the LRFD Fill Height Tables developed by the American Concrete Pipe Association (ACPA). For assistance in specifying the correct pipe class needed for your project or for project requirements that result in a "Special Design" or fall outside of the limits provided in the LRFD Fill Height Tables, please contact a Geneva Pipe representative for support.

HYDRAULICS

One of the key benefits of Perfect Pipe is that it provides optimal flow characteristics when compared to conventional concrete pipe due to the smooth surface of the HDPE liner. The Manning's n value for HDPE is reported as low as **0.009**. It is common practice to consider larger values of Manning's n for long term conditions to account for sliming or build ups that occur over time or changes in pipe grade due to settlement or deflection of flexible HDPE pipe. However, the concrete structure surrounding the HDPE liner of Perfect Pipe eliminates any potential for pipe deflection which helps ensure that long term flow is not restricted. For hydraulic calculations, refer to Table 1.

MANHOLE CONNECTIONS

For a protected system, Geneva Pipe and Precast recommends that Perfect Pipe be paired with our Perfect Lined Manhole. Perfect Pipe is designed to be connected to manholes on the spigot end of the pipe utilizing the internal joint coupler. Geneva Pipe and Precast offers a Double Spigot Perfect Pipe for each manhole connection to allow for both sides of the manhole to have a spigot connection. Details of the Double Spigot Perfect Pipe can be seen in the Perfect Pipe Drawings at the end of this document. Perfect Pipe can also be connected to other types of manholes. Please contact a Geneva Pipe representative for details.

SERVICE LATERAL CONNECTIONS

Laterals are connected to Perfect Pipe by core drilling a hole through the reinforced concrete and HDPE liner and inserting a FABEKUN® Junction with a 6-inch (160 mm) or 8-inch (200 mm) integrated adjustable socket as shown in Figure 1. The FABEKUN® Junction is firmly anchored into the drilled hole in the concrete pipe and sealed to the liner by an O-ring that is compressed against the liner as the fitting is tightened. The three-dimensional seal adapts perfectly to the internal curvature of Perfect Pipe and the integrated adjustable socket allows the lateral pipe to swivel within a range of 0° to 13° to provide flexibility during installation and to accommodate different settlement behavior of the Perfect Pipe and the lateral pipe. The connector is typically installed by the manufacturer of Perfect Pipe, however field installation of the connector is also possible on existing pipe.

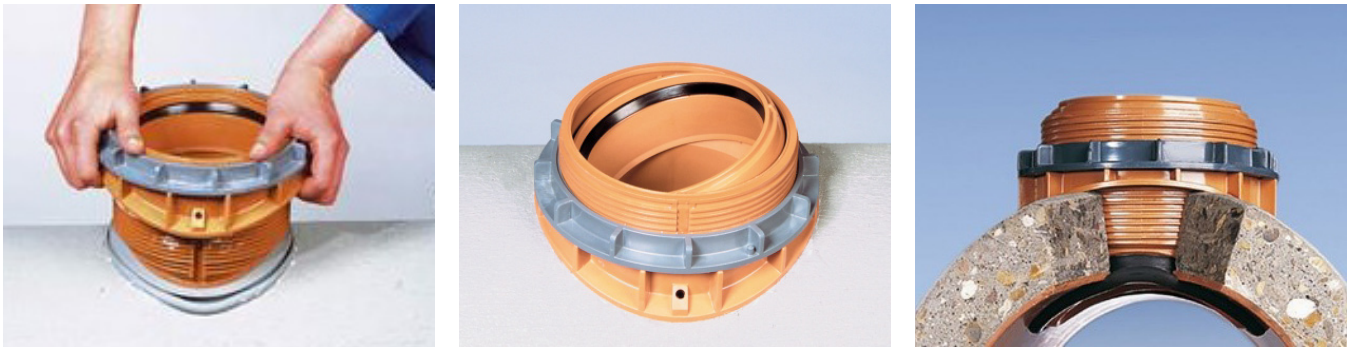


Figure 1: *FABEKUN® Junction Perfect Pipe Lateral Connection*

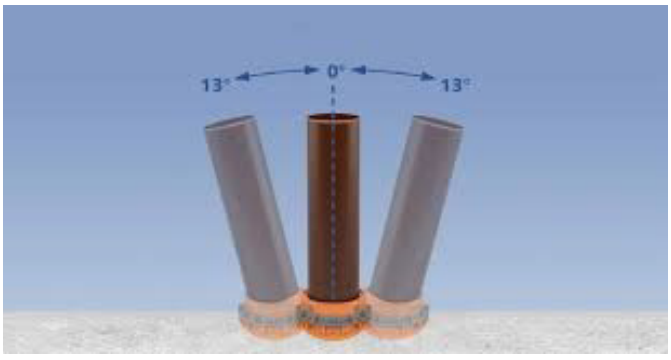


Figure 2: *Lateral 0° - 13° Swivel Range*

SECTION 5

Materials, Components, and Manufacturing

Perfect Pipe is a composite pipe made of RCP, HDPE liner and internal joint coupler. RCP is manufactured to ASTM C76. Each material and component used in Perfect Pipe, along with the manufacturing process used to fabricate the final pipe product, are described in this section.

MATERIALS & COMPONENTS

Reinforced Self-Consolidating Concrete

Reinforced Self-Consolidating Concrete (SCC) provides the structural component of Perfect Pipe. The highly flowable nature of SCC allows for the concrete to fill all voids between the anchors of the HDPE liner to enable a secure connection between the liner and the concrete. The minimum compressive strength is 4000 psi and can be increased for higher load demand.

HDPE Lining

The HDPE lining, with anchors on one side and a smooth finish on the other, is embedded into the concrete on the interior of the pipe to provide protection against microbial induced corrosion and to improve system hydraulics. The HDPE liner is yellow in color comes in a standard 1.65mm thickness. Thicknesses in 2mm and 2.5mm are also available. Please contact a Geneva Pipe representative with any questions.

Internal Joint Coupler

The internal joint coupler is installed into a preformed recess in the HDPE liner at the end of the pipe. The purpose of the coupler is to provide an even transition across each joint on the interior of the pipe to promote smooth, laminar flow. The connector also facilitates the gas and watertight seal necessary in a sanitary sewer environment by compressing the pipe gaskets against the HDPE liner.

Tilting Edge Gaskets

Two tilting edge gaskets are installed in raceways at each end of the connector. The gaskets are designed to have a double sealing edge to protect against both infiltration and exfiltration.

Load Transmission Ring

A load transmission ring is installed on the concrete spigot of each pipe to evenly distribute the pressures of the homing pipe and to prevent damage of the concrete joint. The load transmission ring is not intended for resisting hydrostatic pressures. All hydrostatic pressures are resisted by the EPDM tilting edge gaskets.

MANUFACTURING PROCESS

Perfect Pipe is manufactured at our state -of-the-art facility using latest technology in strict adherence to the industry standards and quality control.

We fabricate the liner at our facility, including cutting, welding, expanding and testing to fit RCP precisely. We factory install internal couplers with gaskets prior to shipping the pipes to the job site. This decreases the time needed for installation by the contractor and reduces the risk of improper gasket installation in the field.

SECTION 6

Testing and Quality Control

As an NPCA certified and UDOT Gold Class manufacturer, quality control is a main focus of Geneva Pipe and Precast. All products are manufactured in a controlled environment with every step of the process carefully measured and verified. The following inspections are carried out for each product manufactured by our team.

PRE-POUR INSPECTIONS

Prior to pouring the concrete into the form, our Quality Control team performs a variety of verifications to ensure the equipment, materials, and product components are correctly prepared and ready to be poured. Below are just some of the items that are checked before pouring the concrete into the form.

- **Equipment:** Production equipment is inspected to ensure adequate condition, dimensions, cleanliness, and proper setup.
- **Product Components:** Components such as lift inserts, spacers, or other embedded items are checked to verify proper type, quantity, and placement.
- **Reinforcement:** Wire size, type, placement, and spacing is inspected to ensure proper steel area and clear cover is provided per the manufacturing specification or product design.
- **Raw Materials:** The concrete mix is sampled and checked using a variety of tests including but not limited to slump flow, visual stability index (VSI), and air percentage. Concrete cylinders are also poured to test post-cure properties of the concrete such as 1-day, 7-day, and 28-day compressive strengths.

POST-POUR INSPECTIONS

Additional inspections of each product are carried out after the concrete has been poured, cured, and stripped from the form. Listed below are some of the items that are checked after the concrete product has cured.

- **Concrete Strength:** The concrete cylinders mentioned in the pre-pour inspection section are tested for compressive strength at day 1, 7 and 28 after pouring to ensure concrete has gained sufficient strength prior to stripping, handling, and mobilization.
- **Visual Quality:** Each product is examined visually to ensure quality of finish and that any deficiencies are within specified acceptance criteria in relevant standards. If product does not meet specified acceptance criteria, it may be rejected. Cause for rejections could include cracks larger than 0.01”, spalling, segregation or excessive bug holes, exposed steel or other quality issues that may affect the long-term performance of the product. Minor defects that do not impair the use or life of the product may be repaired in a manner that meets the requirements of the owner or relevant specifications.
- **Geometry:** Products are measured to ensure that geometry is within the permissible variations of relevant standards. Go/No-Go gauges may be used to verify geometry. Products are always checked and confirmed against specified tolerance requirements.
- **Components and Appurtenances:** Product appurtenances such as lifting devices, plates, and inserts are checked to verify that they have been embedded into the concrete satisfactorily.

PERFECT PIPE TESTING

In addition to the Pre- and Post-Pour inspections mentioned above, which we carry out for all of our manufactured products, Perfect Pipe requires some additional quality control measures.

Three-Edge Bearing Test

The three-edge bearing (TEB) test is a destructive load test to determine the strength of a concrete pipe. In a TEB test, the pipe is loaded to the specified design strength D-load for that particular class of pipe to produce a 0.01-inch crack. The D-load for each pipe class can be seen in Table 2.

Table 2: *Reinforced Pipe Classes for 0.01-inch Crack per ASTM C76*

Pipe Class	Required Load (lbs./ft./ft.)
Class I	≤ 800
Class II	≤ 1000
Class III	≤ 1350
Class IV	≤ 2000
Class V	≤ 3000
Special Design	> 3000

Internal Hydrostatic Test

Each joint design manufactured by Geneva Pipe and Precast is verified through a hydrostatic test per ASTM C497 and ASTM C443 to ensure that the pipe meets the hydrostatic requirements stated in the specification for the installed pipe joint.

Spark Test

A spark test per ASTM D6365 is conducted on all factory made plastic welds in Perfect Pipe to ensure that the plastic HDPE is completely sealed. This test allows us to verify that the concrete portion of the pipe is completely protected by the plastic liner prior to shipping so that no corrosive gases can reach the concrete in an installed sewer condition.

THIRD-PARTY TESTING

In addition to the testing described above, Perfect Pipe has had a number of tests completed by third-party organizations over time. Below are some of the key third-party performance tests conducted.

External Hydrostatic Test

The Perfect Pipe joint has been tested for hydrostatic resistance to infiltration water pressure through an external joint test. As shown in Figure 3, two pipes were homed and strapped together. A small hole was drilled through the bell of the pipe to apply external water pressure on the EPDM tilting edge gaskets while a secondary gasket was used instead of the load distribution ring to ensure no outward water leakage through the pipe joint. Water pressure was applied and reached an ultimate capacity of 50 psi for 10 minutes and a working capacity of 36 psi for 20 hours.

Figure 3: *Infiltration Hydrostatic Test*

Chemical Resistance

The HDPE liner has been tested and passed for chemical resistance by various third party organizations. The liner samples were tested for weight change and other physical properties before and after exposure to chemical solutions and passed the performance requirements with excellent results.

Abrasion Resistance

The HDPE liner has superior abrasion resistance when compared to other pipe materials. The HDPE liner was tested for abrasion resistance following the Darmstadt test method in which the liner is placed in a 3-foot-long tipping channel with a sand-gravel-water mixture applied over top of the liner. Both ends of the tipping channel were alternately tilted over 22.5° lengthwise, in order to slide the gravel mixture over the liner. This movement was repeated for 200,000 cycles and the depth of abrasion on the liner was measured. The HDPE liner depth of abrasion had a mean and maximum measurement of 0.0087 and 0.014 inches, respectively.

Pullout Resistance

Following ASTM D7853, the HDPE liner anchored into the self-consolidating concrete was tested for hydraulic pullout resistance. A hole was drilled and water pressure was applied between the concrete and the liner until the liner detached from the concrete. Water pressure was held at 30 psi for 200 hours and then increased 5 psi of pressure every hour until failure. Figure 4 shows the apparatus used to conduct the test along with the quality of the concrete at failure.

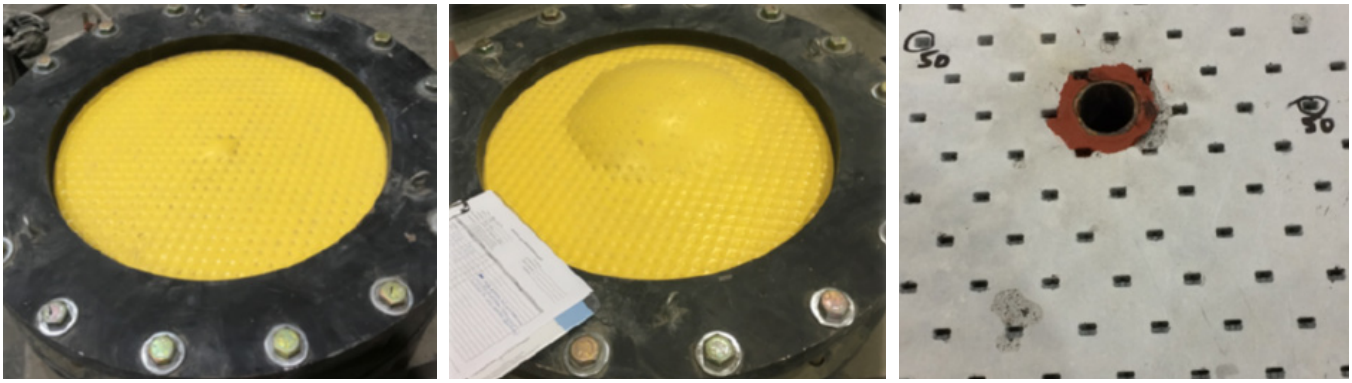


Figure 4: *Hydraulic Pullout Resistance of HDPE liner*

High-Pressure Jet Resistance

Perfect Pipe has also been tested for resistance of the cast in HDPE liner to a high pressure water jet for maintenance and line cleaning. Seven 12” nominal diameter pipes connected with the internal coupler and EPDM gaskets at a total length of 68 feet were tested. In this test, an eight-jet omni-directional nozzle emitted 74 gallons of water per minute at a pressure of 1500 – 1700 psi for 60 cleaning cycles of a consistent forward and backward movement through the entire pipe train. The pipe train was visually inspected with no detectable changes or damage after the test.

SECTION 7

Installation Recommendations

Mobilizing, handling, and installation of Perfect Pipe is similar to that of conventional RCP. Please refer to ASTM C1479 along with the Concrete Pipe and Box Culvert Installation manual created by ACPA for a complete guide and full details on proper installation of concrete pipe. Additional recommendations for the proper mobilization, handling, and installation of Perfect Pipe are provided below.

MOBILIZATION AND HANDLING

On-Site Handling

Perfect Pipe shall be handled with reasonable care. The contractor must take all necessary precautions to ensure the recommended handling methods outlined in this guide are followed. When moving pipe, avoid allowing the pipe to make contact with another pipe or other hard surfaces such as the trench box. All Perfect Pipe sections are equipped with two dog bone lifters. When moving or lifting the pipe, always use both lifters with a maximum sling angle not exceeding 60 degrees. Do not lift pipe from the pipe barrel. Recommended handling equipment includes crane or excavators. Transporting the pipe shall be done in a manner that prevents excessive impact or dynamic loads. When lifting or handling, making contact with the inside of the pipe is prohibited. Lifting with a front-end loader or forklift from the interior of the pipe will cause damage to the liner and may compromise the performance of the pipe. Do not drag pipe on the ground. Do not roll pipe over the ground.

Visual Inspection Upon Receiving the Pipe

Perfect Pipe undergoes a strict quality control process as specified in Testing and Quality Control section of this document. Pipe is delivered to the jobsite with a label to indicate product size, class, and manufacturing date. Contractor shall visually inspect the product for any potential deficiency listed below which can occur during handling and mobilization.

- Ensure coupler is not missing or damaged
- Ensure gasket is provided on the coupler and not damaged
- Check for any concrete damage such as chips, spalls, or cracks
- Check the liner to ensure there is no damage
- Ensure load transmission ring is provided on the spigot end of the pipe

Report any product damage or deficiencies to a Geneva Pipe and Precast representative and set product aside.

On-Site Storage

Perfect Pipe shall be stored in a location such that they are protected from traffic and construction equipment. Pipe shall be stored on a flat surface, preferably on a layer of aggregates. The pipe shall be wedged to avoid direct contact against adjacent pipe. Stacking pipe on the job site is not recommended. Contact a Geneva Pipe and Precast representative for information on UV exposure limits or to provide a stacking plan if required due to limited site area.

INSTALLING PERFECT PIPE

The installation of Perfect Pipe is very similar to the installation of standard RCP. Therefore, it is recommended to follow ASTM C1479 Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations along with ACPA's Concrete Pipe and Box Culvert Installation. Additional installation recommendations are provided in the following sections.

Pre-Installation

Contractor shall review all of the information in this Product Guide prior to the installation. For additional training or guidance in Perfect Pipe installation, please contact a Geneva Pipe and Precast representative. Project-specific product installation trainings can be provided upon request.

Preparation

Before final placement, contractor shall:

- Re-inspect the pipe in accordance with Receiving Visual Inspection recommendations above
- Ensure the Internal Joint Coupler and the inside of the bell and spigot are free of foreign objects such as dirt, soil, ice, snow, etc.
- Ensure the load transmission ring is resting in the recess of the pipe spigot
- Lubricate the exposed EPDM Tilting Edge Gasket, the full exterior of the coupler and inside of the spigot utilizing the product-specific lubricant provided

Installation

Perfect Pipe shall be lowered into position slowly. Contractor can home the pipe using one of the following methods:

- Assist with pry bar and piece of 2x4 wood. Place the piece of wood closer to the ground and flat against the bell of the pipe such that it makes contact with both sides of the pipe bell. Keeping the pipe suspended with the lifting sling, use pry bar leverage on the ground to transfer pressure to the pipe through the wood to push the pipe in.
- Use a lifting sling to pull the pipe. Connect the lifting pin near the joint that needs to homed and then pull in.

Do not use any other equipment such as bucket of the excavator to push the pipe in place. This will damage the joint.

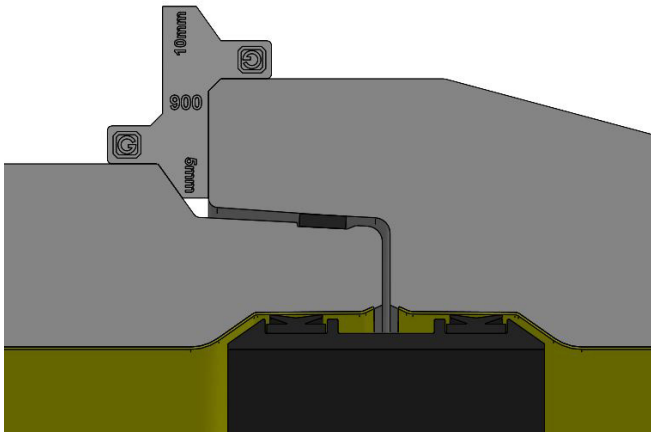


Figure 6: *Acceptable Joint Gap*

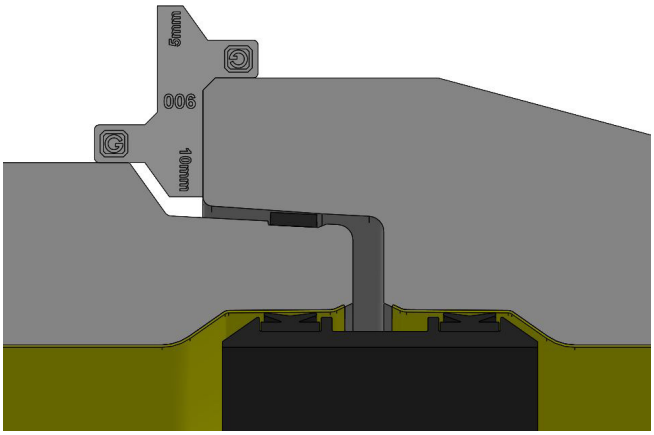


Figure 7: *Unacceptable Joint Gap*

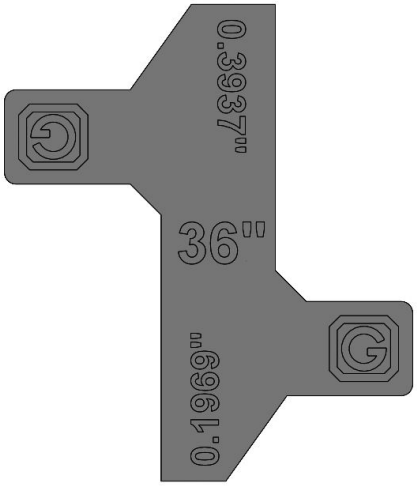


Figure 5: *Perfect Pipe Go-No Go Measurement Tool*

Joint Validation

After the pipe has been connected, the joint should be inspected to ensure that the pipes were homed properly. Unlike conventional RCP, the joint gap on the interior of the pipe cannot be inspected to ensure tolerances are met since the interior joint gap is covered by the internal joint coupler. Therefore, the joint must be measured for accuracy on the exterior of the pipe. Geneva Pipe and Precast will provide an exterior joint gap measurement tool specific for the pipe size being inspected. If a joint measurement tool was not provided, please contact your Geneva Pipe and Precast representative. Additional joint measurement tools can be provided upon request.

Perfect Pipe is designed to have a minimum joint gap of 0.197” (5 mm), and a maximum permissible joint gap of 0.394” (10 mm). This gap will allow a hydrostatic performance of 35 psi. A diagram of the joint measurement tool is provided in Figure 5. One side of the tool is sized to measure the minimum design joint gap and the other is to measure maximum permissible joint gap. Figures 6 and 7 show how the joint measurement tool is intended to be used and provides examples of an acceptable joint gap and an unacceptable joint gap, respectively.

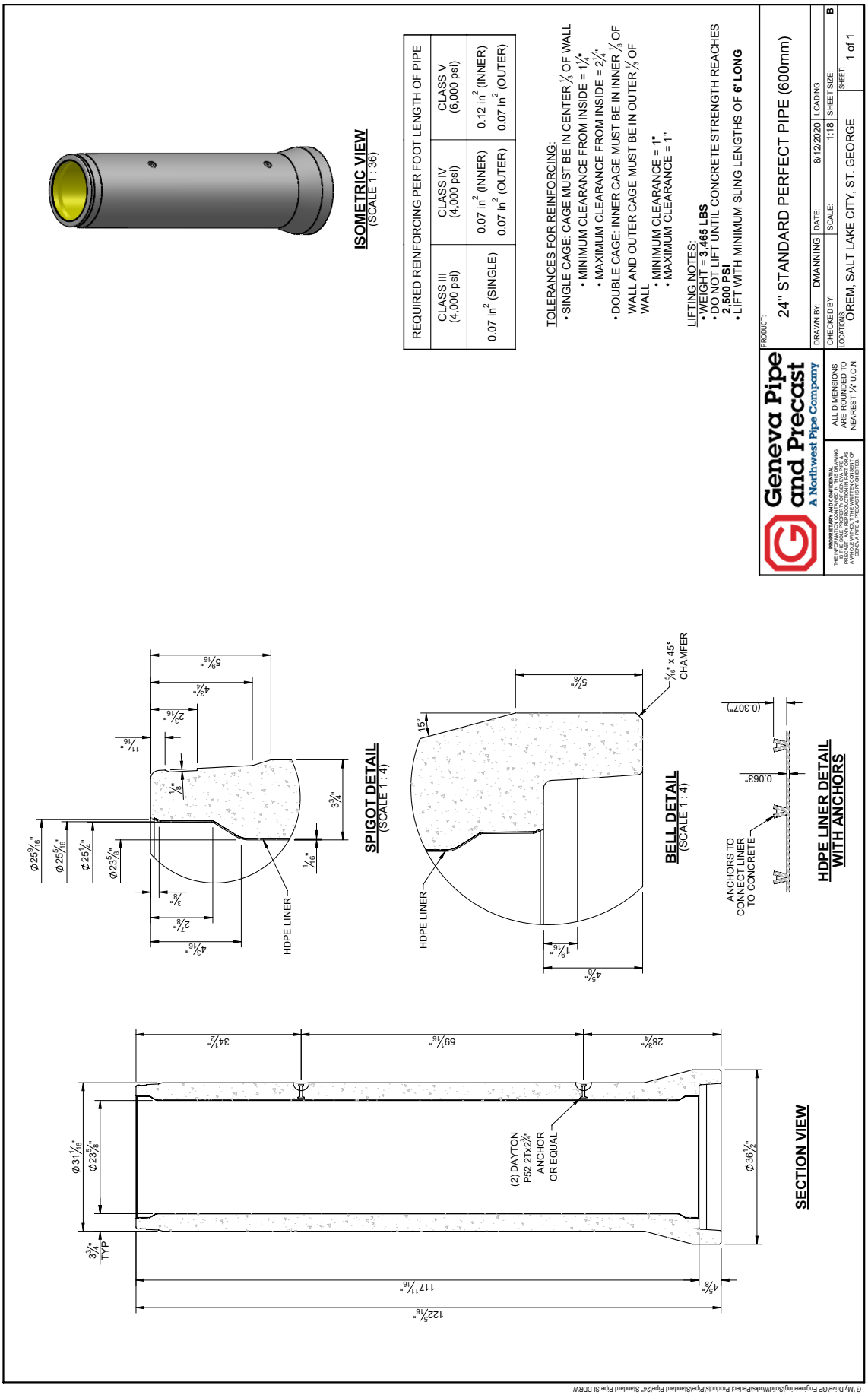
NOTES

SECTION 8

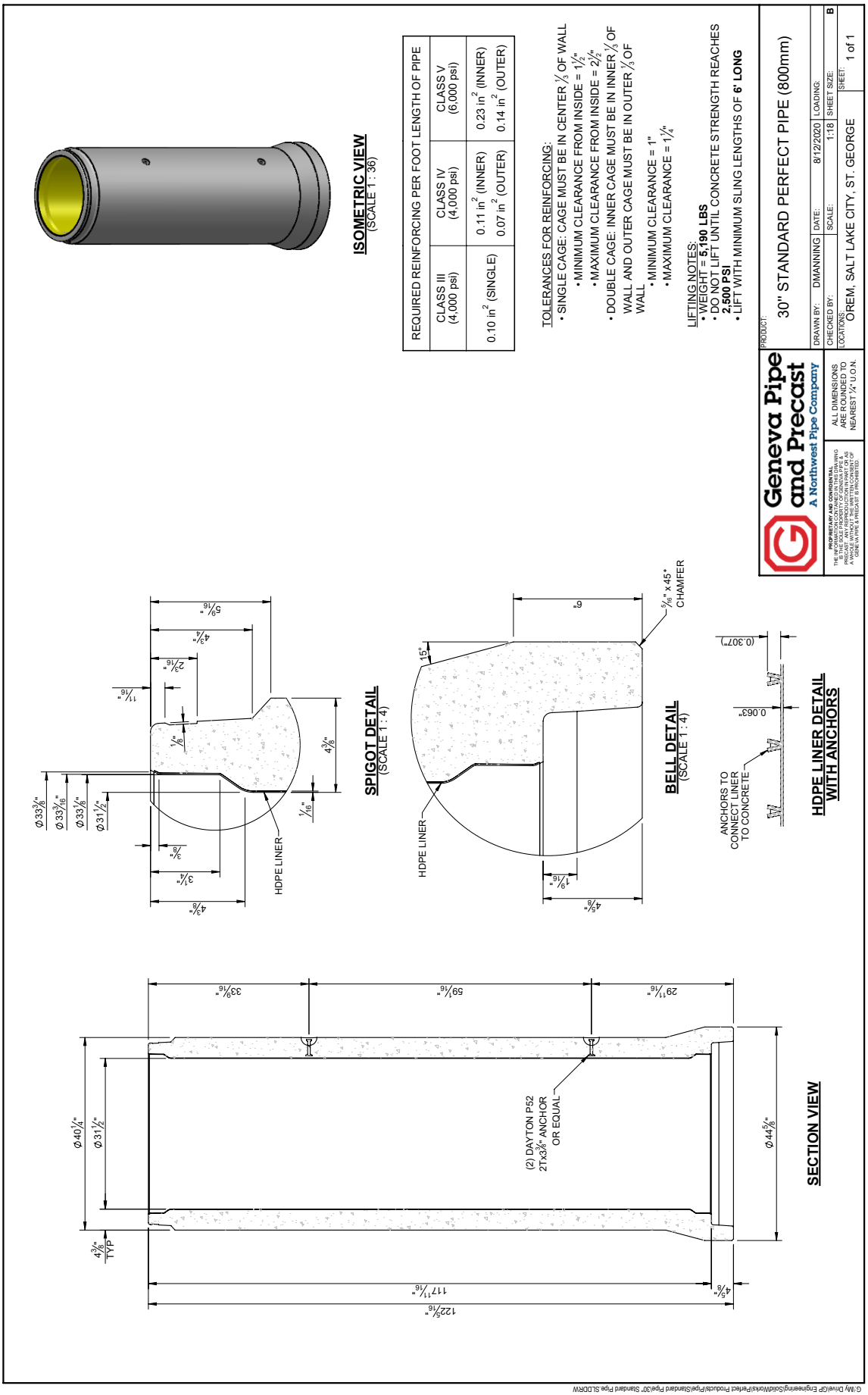
Product Drawings

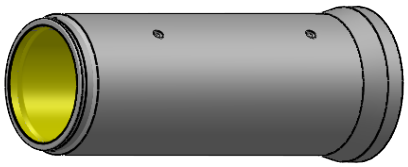
On the following pages are 10 sheets of technical drawings, including:

- 24” Standard Perfect Pipe (600mm)
- 30” Standard Perfect Pipe (800 mm)
- 36” Standard Perfect Pipe (900mm)
- 48” Standard Perfect Pipe (1200mm)
- Microtunneling Lined Pipe (1200mm)
- Overview of Perfect Pipe System
- Standard Perfect Pipe Isometric & Cross Section View
- Short Perfect Pipe Isometric & Cross Section View
- Double Spigot Perfect Pipe Isometric & Cross Section View
- HDPE Liner & Joint Detail



G:\My Drive\GP Engineering\SolidWorks\Perfect Products\PipeStandard Pipe\24" Standard Pipe SLDDRW


ISOMETRIC VIEW
(SCALE 1 : 36)
REQUIRED REINFORCING PER FOOT LENGTH OF PIPE
CLASS III (4,000 psi)
CLASS IV (4,000 psi)
CLASS V (6,000 psi)
0.10 in² (SINGLE)
0.11 in² (INNER)
0.07 in² (OUTER)
0.23 in² (INNER)
0.14 in² (OUTER)
TOLERANCES FOR REINFORCING:
• SINGLE CAGE: CAGE MUST BE IN CENTER 1/3 OF WALL
• MINIMUM CLEARANCE FROM INSIDE = 1½"
• MAXIMUM CLEARANCE FROM INSIDE = 2½"
• DOUBLE CAGE: INNER CAGE MUST BE IN INNER ½ OF WALL AND OUTER CAGE MUST BE IN OUTER 1/3 OF WALL
• MINIMUM CLEARANCE = 1"
• MAXIMUM CLEARANCE = 1¼"
LIFTING NOTES:
• WEIGHT = 5,190 LBS
• DO NOT LIFT UNTIL CONCRETE STRENGTH REACHES 2,500 PSI
• LIFT WITH MINIMUM SLING LENGTHS OF 6' LONG
PRODUCT:
30" STANDARD PERFECT PIPE (800mm)
Geneva Pipe and Precast
A Northwest Pipe Company
DRAWN BY: DMANNING
DATE: 8/12/2020
LOADING:
CHECKED BY:
SCALE: 1:18
SHEET SIZE: B
LOCATIONS: OREM, SALT LAKE CITY, ST. GEORGE
SHEET: 1 of 1
ALL DIMENSIONS ARE ROUNDED TO NEAREST 1/4" U.O.N.
SPIGOT DETAIL
(SCALE 1 : 4)
HDPE LINER
BELL DETAIL
(SCALE 1 : 4)
HDPE LINER
HDPE LINER DETAIL WITH ANCHORS
ANCHORS TO CONNECT LINER TO CONCRETE
SECTION VIEW
(2) DAYTON P52 2TX3⅜" ANCHOR OR EQUAL
G:\My Drive\GP Engineering\SolidWorks\Perfect Products\Pipe\Standard Pipe\30" Standard Pipe.SLDDRW



ISOMETRIC VIEW
(SCALE 1 : 36)

REQUIRED REINFORCING PER FOOT LENGTH OF PIPE		
CLASS III (4,000 psi)	CLASS IV (4,000 psi)	CLASS V (6,000 psi)
0.20 in^2 (SINGLE) - or - 0.08 in^2 (INNER) 0.07 in^2 (OUTER)	0.14 in^2 (INNER) 0.09 in^2 (OUTER)	0.27 in^2 (INNER) 0.16 in^2 (OUTER)

TOLERANCES FOR REINFORCING:
- SINGLE CAGE: CAGE MUST BE IN CENTER ⅓ OF WALL
  - MINIMUM CLEARANCE FROM INSIDE = 1½"
  - MAXIMUM CLEARANCE FROM INSIDE = 2¼"
- DOUBLE CAGE: INNER CAGE MUST BE IN INNER ⅓ OF WALL AND OUTER CAGE MUST BE IN OUTER ⅓ OF WALL
  - MINIMUM CLEARANCE = 1"
  - MAXIMUM CLEARANCE = 1¼"

LIFTING NOTES:
- WEIGHT = **6,205 LBS**
- DO NOT LIFT UNTIL CONCRETE STRENGTH REACHES **2,500 PSI**
- LIFT WITH MINIMUM SLING LENGTHS OF **6' LONG**

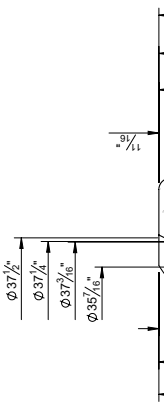
Geneva Pipe and Precast
A Northwest Pipe Company

PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF GENEVA PIPE & PRECAST. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF GENEVA PIPE & PRECAST IS PROHIBITED.

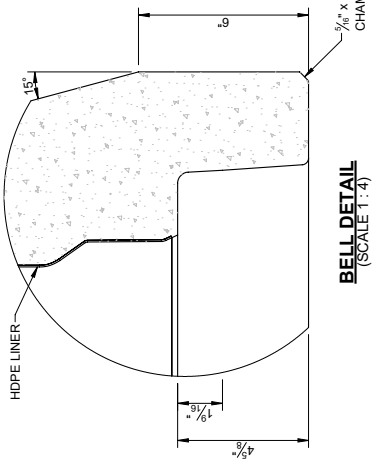
ALL DIMENSIONS ARE REFERENCED TO NEAREST ½" U.O.N.

PRODUCT: 36" STANDARD PERFECT PIPE (900mm)

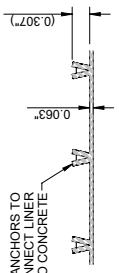
DRAWN BY:	DMANNING	DATE:	8/12/2020	LOADING:	HS20
CHECKED BY:		SCALE:	1:18	SHEET SIZE:	B
LOCATIONS:	OREM, SALT LAKE CITY, ST. GEORGE			SHEET:	1 of 1



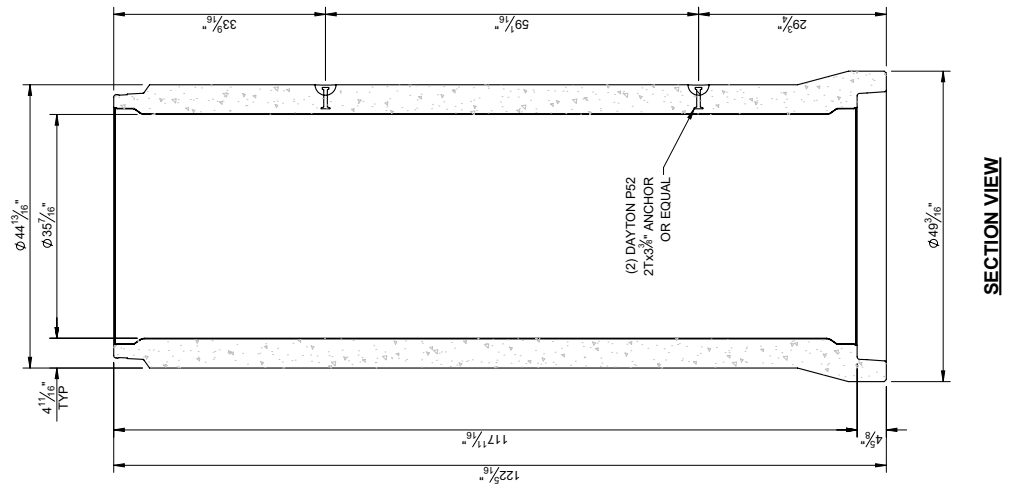
SPIGOT DETAIL
(SCALE 1 : 4)



BELL DETAIL
(SCALE 1 : 4)

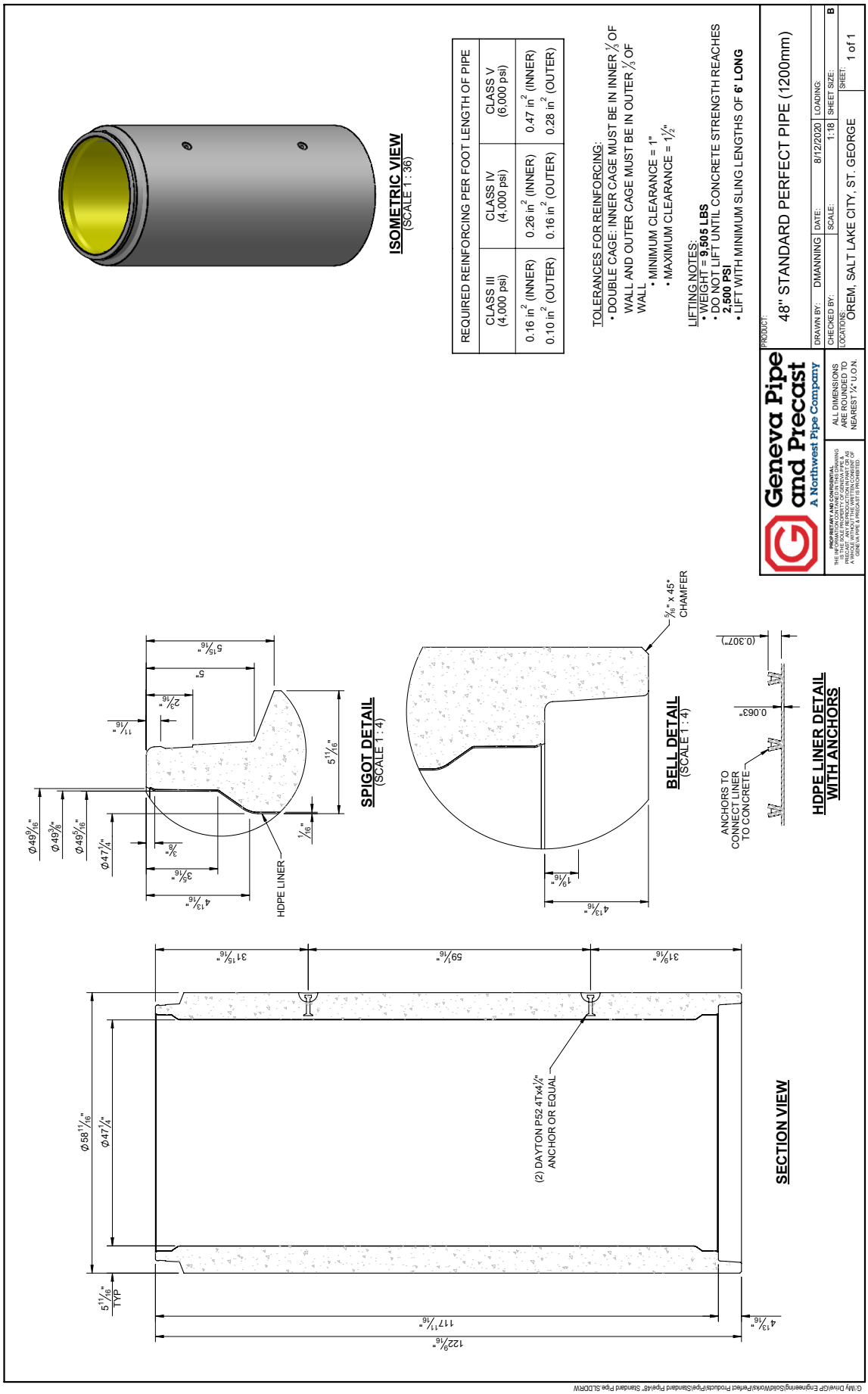


HDPE LINER DETAIL WITH ANCHORS

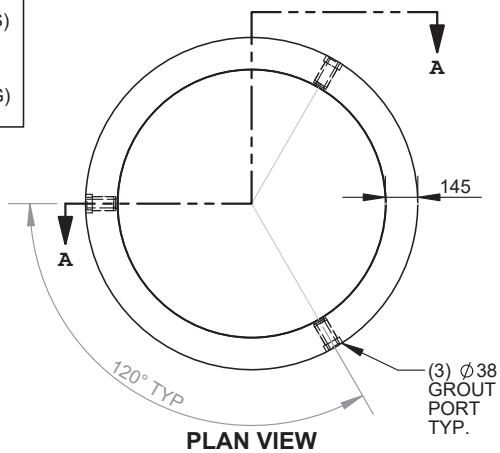


SECTION VIEW

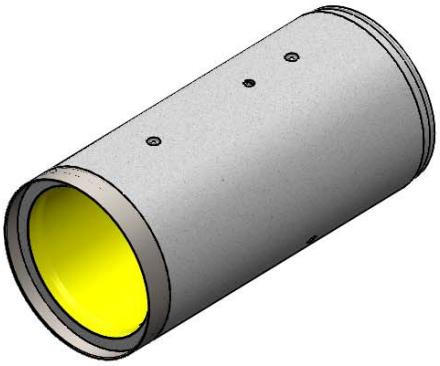
G:\My Drive\GP Engineering\SolidWorks\Perfect Products\Pipe\Standard Pipe\36" Standard Pipe.SLDDRW


ISOMETRIC VIEW
(SCALE 1 : 36)
REQUIRED REINFORCING PER FOOT LENGTH OF PIPE
CLASS III (4,000 psi)
CLASS IV (4,000 psi)
CLASS V (6,000 psi)
0.16 in² (INNER)
0.10 in² (OUTER)
0.26 in² (INNER)
0.16 in² (OUTER)
0.47 in² (INNER)
0.28 in² (OUTER)
TOLERANCES FOR REINFORCING:
• DOUBLE CAGE: INNER CAGE MUST BE IN INNER ½ OF WALL AND OUTER CAGE MUST BE IN OUTER ½ OF WALL
• MINIMUM CLEARANCE = 1"
• MAXIMUM CLEARANCE = 1½"
LIFTING NOTES:
• WEIGHT = 9,505 LBS
• DO NOT LIFT UNTIL CONCRETE STRENGTH REACHES 2,500 PSI
• LIFT WITH MINIMUM SLING LENGTHS OF 6' LONG
PROJECT:
48" STANDARD PERFECT PIPE (1200mm)
Geneva Pipe and Precast
A Northwest Pipe Company
DRAWN BY: DMANNING
DATE: 8/12/2020
LOADING:
CHECKED BY:
SCALE: 1:18
SHEET SIZE: B
LOCATIONS:
OREM, SALT LAKE CITY, ST. GEORGE
SHEET: 1 of 1
ALL DIMENSIONS ARE ROUNDED TO NEAREST 1/4" U.O.N.
SPIGOT DETAIL
(SCALE 1 : 4)
HDPE LINER
BELL DETAIL
(SCALE 1 : 4)
5/16" x 45° CHAMFER
HDPE LINER DETAIL WITH ANCHORS
ANCHORS TO CONNECT LINER TO CONCRETE
SECTION VIEW
(2) DAYTON P52 4Tx4½" ANCHOR OR EQUAL
G:\My Drive\GF Engineering\SolidWorks\Precast Products\Pipe\Standard Pipe\48" Standard Pipe.SLDDRW

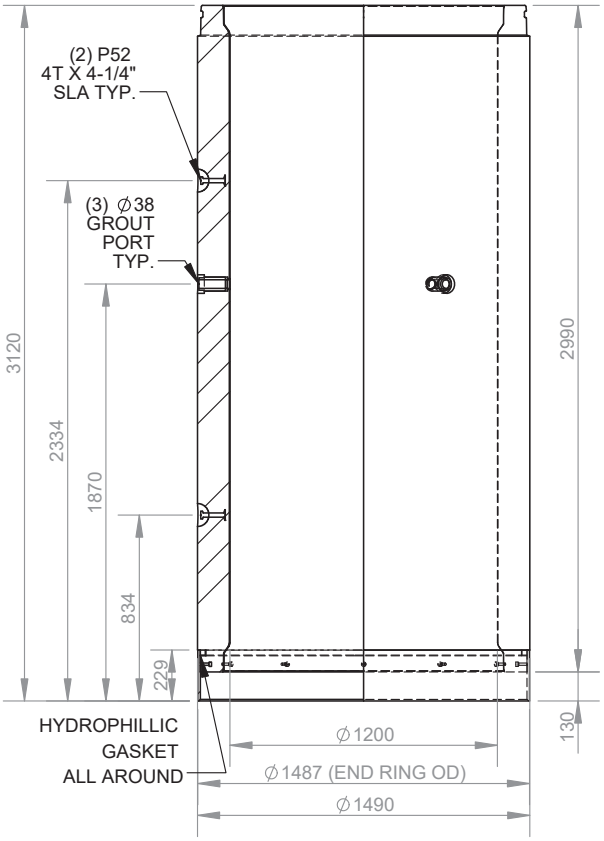
STENCIL
CCP-OAKVILLE CSA A257.2 1200 X (CLASS) L = 3m LINED TYPE HSe (DATE OF MFG) 4530 KG



PLAN VIEW



ISOMETIC (BELL) VIEW AS INSTALLED



ELEVATION VIEW (SECTION A)

MATERIAL LIST		
DESCRIPTION	**QTY**	**TYPE**
P52 4T X 4-1/4" SLA	2	E
1.6mm THK X 2980mm WIDE LINER	3.77 m	E
∅38 GROUT PORT WITH PLUG (OPTIONAL)	3	E
∅1487 (OD) X 11 THK STEEL END RING BLACK COAT - WITH GROUT PORT ORANGE COAT - WITHOUT GROUT PORT	1	E
HYDROPHILLIC GASKET SIKA HYDROTITE CJ-0725-3K OR APPROVED EQ.	4.67m	E

TECHNICAL PERFORMANCE DATA		
MATERIALS	CONCRETE STRENGTH (f_c')	50 MPa
	REINFORCING STEEL (f_y)	485 MPa
THREE EDGE BEARING TEST	DESIGN LOAD	500 kN
	ULTIMATE LOAD	625 kN
	BASED ON 140-D CAGE DESIGN. OTHER CLASS IS AVALIABLE UPON REQUEST	
PERMISSIBLE JACKING LOAD	CONCENTRIC	10600 kN
	ECCENTRIC	6600 kN
	CALCULATED BASED ON 50MPa AND FULL CONTACT AREA	
JOINT HYDROSTATIC TEST	INFILTRATION	250 kPa
	EXFILTRATION	250 kPa
	BASED ON STRAIGHT ALIGNMENT FULL-SCALE TEST RESULT ON PE COUPLER AND DEFAULT GASKETS.	

ALL DIMENSIONS ARE IN mm
DRAWINGS ARE NOT TO SCALE
EXPOSURE CLASS = N AS PER CSA A23.1
CDW TO ASTM A1064
Fy = 485MPa (Deformed) 450MPa (Smooth)
STEEL TO CSA G40.20 GRADE 300W
CLASS TO BE EVALUATED BASED ON 3EB TEST
STEEL DESIGN NOT SHOWN
CONCRETE MIX = WC

MIN. CONC STRENGTH 50 MPa
CLEAR COVER = 25 mm MIN
TOLERANCES TO CSA A257.2
STRIP CONC. STRENGTH 20 MPa
AIR ENTRAINMENT 5 % TO 8 %
REF TO "PMLJ" FOR JOINT DETAIL

REV.	DESCRIPTION	ENG.	DATE
2	HYDROPHI. GASKET, COLOR CODE RING	SW	
1	INITIAL RELEASE	SW	
0	REVIEW	SW	

GENEVA PIPE AND PRECAST STANDARD DRAWING

STD. | DOC ID

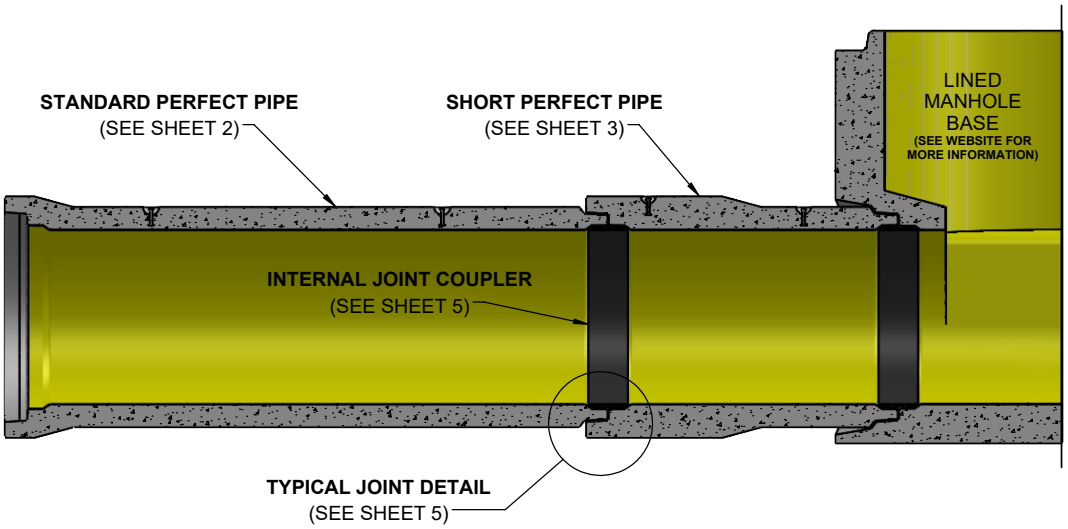
TITLE

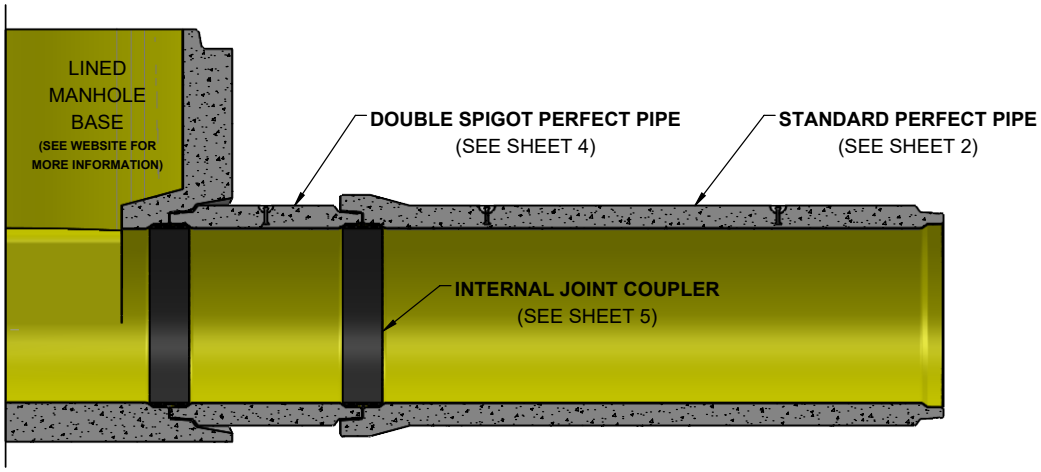
MICRO-TUNNELLING LINED PIPE
1200 mm DIAMETER
3.0m LAY LENGTH

DRAWN BY	CHECKED BY	DATE	FILE	PAGE
				1 OF 1

GENEVA PIPE AND PRECAST

1-817-201-2900 www.nwpipe.com



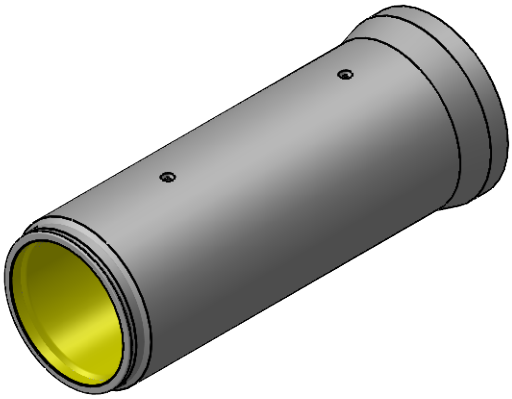


SHORT PERFECT PIPE:
- USED FOR MINOR PIPELINE LENGTH ADJUSTMENTS.

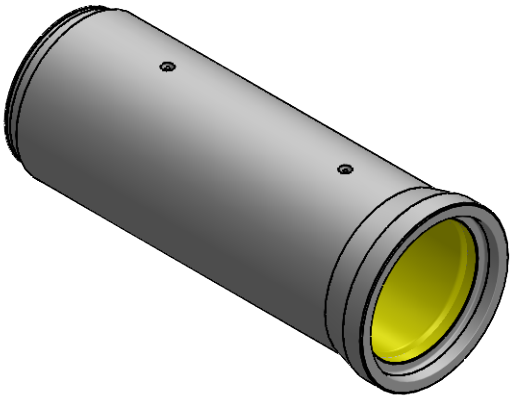
DOUBLE SPIGOT PERFECT PIPE:
- USED TO CONNECT TO MANHOLES. ONLY SPIGOT END OF PIPE CAN CONNECT TO MANHOLES.

INTERNAL JOINT COUPLER:
- USED IN EACH JOINT CONNECTION TO PROVIDE RESISTANCE TO INFILTRATION AND EXFILTRATION.

Geneva Pipe and Precast A Northwest Pipe Company	PRODUCT:	PERFECT PIPE SYSTEM			
	DRAWN BY:	DMANNING	DATE: 8/26/2021	LOADING:	PER PROJECT
	CONTACT:	(801) 225-2416 or info@genevapipe.com	WEBSITE: www.genevapipe.com	SHEET:	1

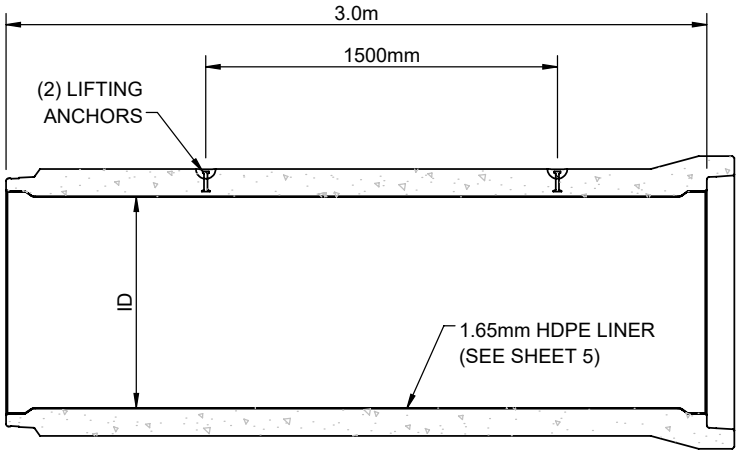


ISOMETRIC VIEW
(SPIGOT END)



ISOMETRIC VIEW
(BELL END)

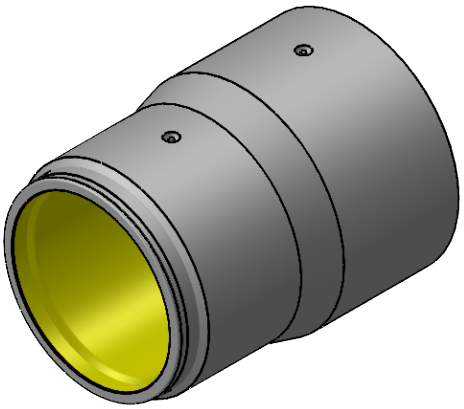
NOMINAL SIZE (inch)	ID (mm)
12"	300
15"	400
21"	500
24"	600
27"	700
30"	800
36"	900
40"	1,000
42"	1,100
48"	1,200
52"	1,300
56"	1,400
60"	1,500



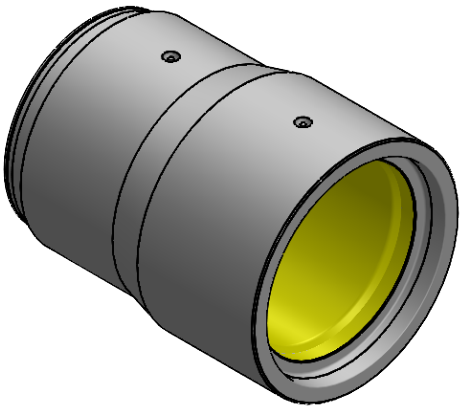
SECTION VIEW

Geneva Pipe and Precast
A Northwest Pipe Company

PRODUCT:	STANDARD PERFECT PIPE				
DRAWN BY:	DMANNING	DATE:	8/26/2021	LOADING:	PER PROJECT
CONTACT:	(801) 225-2416 or info@genevapipe.com	WEBSITE:	www.genevapipe.com	SHEET:	2

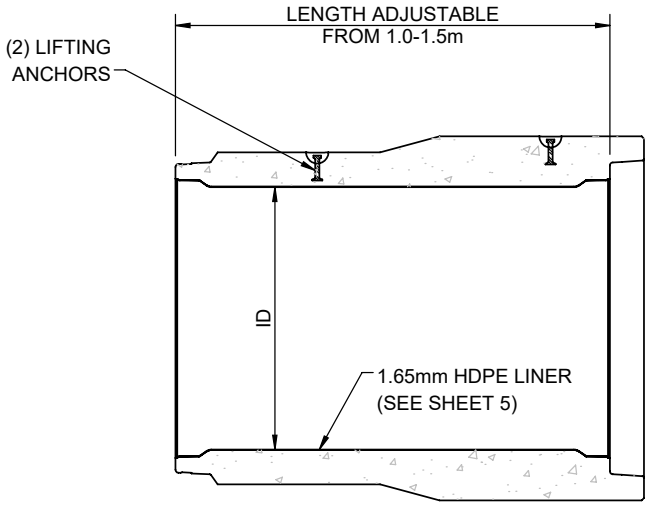


ISOMETRIC VIEW
(SPIGOT END)



ISOMETRIC VIEW
(BELL END)

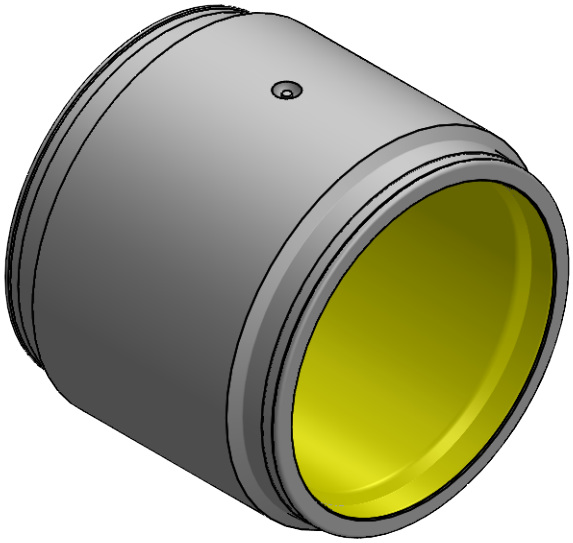
NOMINAL SIZE (inch)	ID (mm)
12"	300
15"	400
21"	500
24"	600
27"	700
30"	800
36"	900
40"	1,000
42"	1,100
48"	1,200
52"	1,300
56"	1,400
60"	1,500



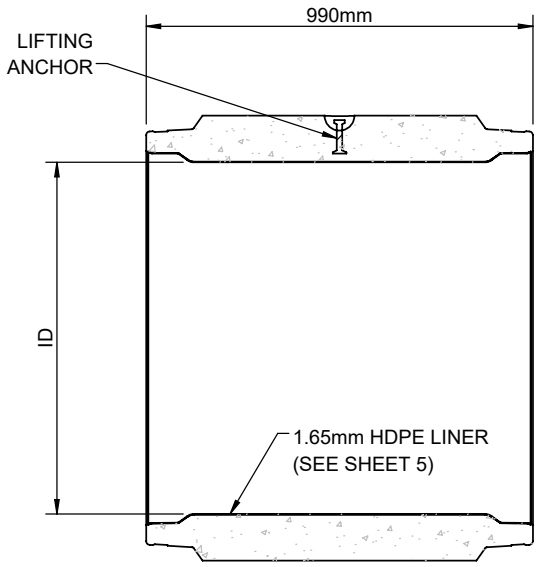
SECTION VIEW

Geneva Pipe and Precast
A Northwest Pipe Company

PRODUCT:	SHORT PERFECT PIPE				
DRAWN BY:	DMANNING	DATE:	8/26/2021	LOADING:	PER PROJECT
CONTACT:	(801) 225-2416 or info@genevapipe.com	WEBSITE:	www.genevapipe.com	SHEET:	3



ISOMETRIC VIEW



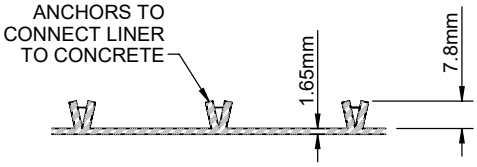
SECTION VIEW

NOMINAL SIZE (inch)	ID (mm)
12"	300
15"	400
21"	500
24"	600
27"	700
30"	800
36"	900
40"	1,000
42"	1,100
48"	1,200
52"	1,300
56"	1,400
60"	1,500

Geneva Pipe and Precast
A Northwest Pipe Company

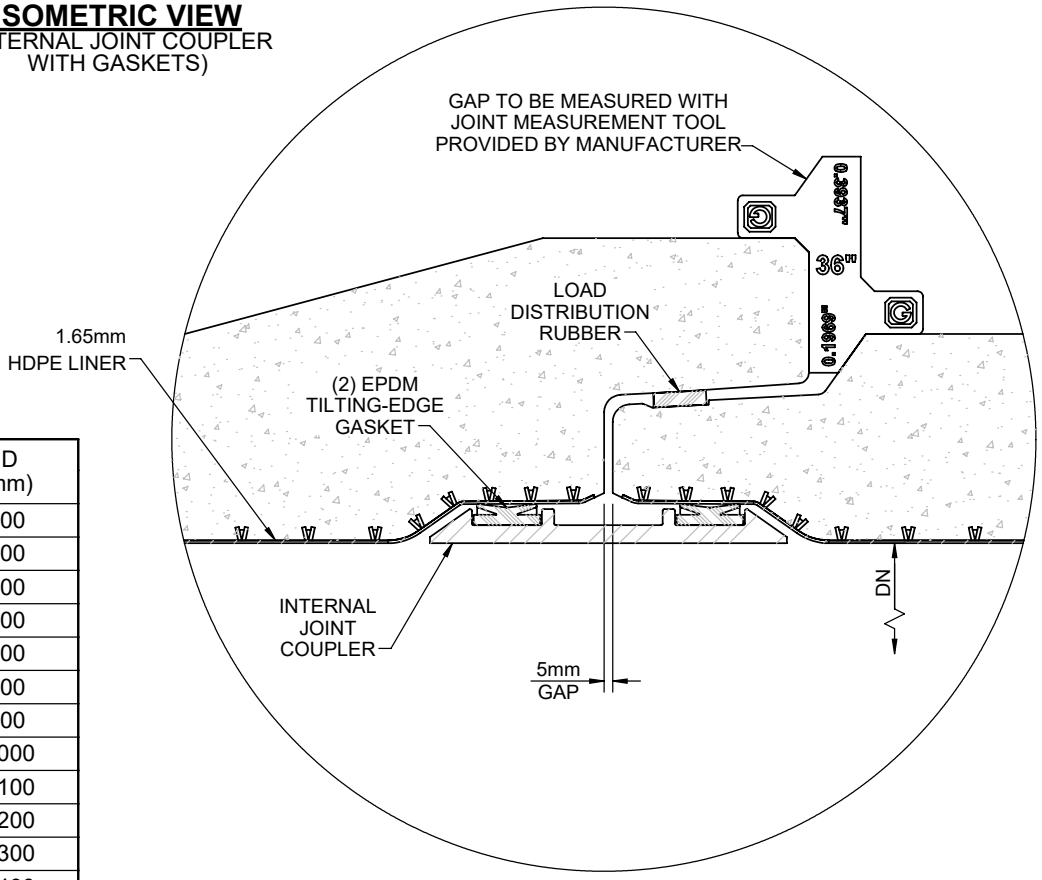
PRODUCT:	DOUBLE SPIGOT PERFECT PIPE				
DRAWN BY:	DMANNING	DATE:	8/26/2021	LOADING:	PER PROJECT
CONTACT:	(801) 225-2416 or info@genevapipe.com	WEBSITE:	www.genevapipe.com	SHEET:	4

ISOMETRIC VIEW
(INTERNAL JOINT COUPLER WITH GASKETS)



HDPE LINER DETAIL WITH ANCHORS

NOMINAL SIZE (inch)	ID (mm)
12"	300
15"	400
21"	500
24"	600
27"	700
30"	800
36"	900
40"	1,000
42"	1,100
48"	1,200
52"	1,300
56"	1,400
60"	1,500



JOINT DETAIL

Geneva Pipe and Precast
A Northwest Pipe Company

PRODUCT:	PERFECT PIPE JOINT				
DRAWN BY:	DMANNING	DATE:	8/26/2021	LOADING:	PER PROJECT
CONTACT:	(801) 225-2416 or info@genevapipe.com	WEBSITE:	www.genevapipe.com	SHEET:	5

SECTION 9

Perfect Pipe System Specification for Gravity Sewer and Culvert Pipe *(Revised 7/29/21)*

Part 1 - General

1.01 SCOPE OF WORK

This specification covers materials, installation, and testing requirements for gravity sanitary sewers using Perfect Pipe.

Perfect Pipe (24" to 60") is a patented composite pipe system comprised of reinforced concrete pipe with cast-in HDPE liner, an internal coupler, and dual EPDM gaskets.

This specification is applicable to pipes installed in open trench and pipes installed with trenchless methods.

1.02 REFERENCE SPECIFICATIONS

Except as otherwise indicated, all reinforced concrete pipe shall conform to the applicable requirements of the following specifications, latest edition.

ASTM C33 Specification for Concrete Aggregates

ASTM C76 Standard Specifications for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

ASTM C150 Standard Specifications for Portland Cement

ASTM C443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gasket

ASTM C497 Standard Methods of Testing Concrete Pipe, Manhole Sections or Tile

ASTM C618 Specification for Coal Fly Ash and Raw or Calcined Natural Possolan for Use as a Mineral Admixture in Portland Cement Concrete

ASTM C655 Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe

ASTM C1131 Standard Practice for Least Cost (Life Cycle) Analysis of Concrete Culvert, Storm Sewer, and Sanitary Sewer Systems

ASTM C1479 Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe using Standard Installations

ASTM D6365 Standard Practice For Nondestructive Testing Of Geo-membrane Seams Using The Spark Test

ASTM D7853 Standard Test Method for Hydraulic Pullout Resistance of a Geo-membrane with Locking Extensions Embedded in Concrete

1.03 SUBMITTAL DATA

A. Material safety data sheets (MSDS).

B. Submit drawings detailing pipe dimensions, wall thickness, and joints.

C. Submit test reports on all shop testing required herein and applicable standards referenced in Sec 1.02 of this specification.

D. Submit test reports on physical properties of EPDM used in gaskets.

E. Submit mill test certificates identifying chemical and physical properties of each lot of reinforcing steel delivered.

F. Submit concrete mix designs including compliance of ASTM C150 and cement type.

G. Submit HDPE certificates with physical and mechanical properties.

H. For trenchless/jacking pipe, submit jacking load design strength.

I. Submit installation details.

1.04 INSPECTION

A. All pipe furnished under this specification is subject to inspection in the Manufacturer's plant by the Owner's Representative.

B. Perfect Pipe System shall be inspected and tested as required by the Engineer or a designated 3rd party firm that has been approved by the owner. The Engineer will be provided copies of all test reports.

1.05 QUALITY ASSURANCE

A. The producer shall be NPCA Quality Certified.

B. Factory Performed Thermoplastic Welding: All fabrication and welding must be done by AGRU Certified welders/fabricators in accordance with the published directives and QA/QC procedures of the liner manufacturer. When the welding is completed and spark tested per ASTM D6365, the finished concrete product will be protected by a homogeneous monolithic Thermoplastic Liner System that will provide excellent resistance to microbial attack, abrasion, and chemicals normally found in municipal sanitary sewer environments.

1.06 CAUSES FOR PIPE REJECTION

Pipe can be rejected for any of the following reasons:

A. Exposure of any wires and positioning spacers or chairs used to hold the reinforcement cage in position or steel reinforcement in any surface of the pipe.

B. Bubble voids (bug-holes) on the interior and exterior surfaces of the pipe exceeding 1/2 inch in depth unless packed with mortar or other approved material.

C. Any chipped or broken joint that may affect intended joint performance as determined by the Manufacturer's Engineer.

D. Any of the following cracks:

1. A crack having a width of 0.01 inch or more throughout a continuous length of 1 foot or more.
2. Any crack extending through the wall of the pipe and having a length in excess of the wall thickness.

1.07 GUARANTEE

The pipe liner Manufacturer shall warrant that the materials furnished are to be free from manufacturing defects in materials and workmanship for a period of 1 year from date of shipment.

Part 2 - Products

2.01 SANITARY SEWER PIPE

A. Acceptable Manufacturers:

1. Geneva Pipe and Precast, A Northwest Pipe Company
2. Approved Equal as determined by Engineer.

B. Reinforced concrete pipe shall be manufactured per ASTM C76.

C. To evaluate that the desired service life will be obtained if alternate piping materials are specified, a Least Cost Analysis of all piping material will be required. The analysis shall follow the procedure as described in ASTM C1131. For analysis purposes, service lifes of 100 years for HDPE lined RCP, 50 years for High Density Polyethylene and 50 years for Glass Fiber Reinforced Thermosetting Resin pipe shall be used.

D. General requirements for all RCP: All RCP shall be designed and manufactured with minimum wall C design.

E. Provide grouting holes for micro-tunneling Perfect Pipe.

2.02 BASIS OF DESIGN

A. Bell and spigot reinforced concrete sewer pipe shall be manufactured from self-consolidating concrete (SCC) with a minimum compressive strength of 6,000 PSI conforming to material and performance standards of ASTM C76.

B. Cement for the pipe shall conform to ASTM C150.

C. For pipe installed below the water table, calculations shall be performed by Design Engineer and submitted to check for possible flotation.

2.04 JOINTS

A. Elastomeric gasket material shall be produced from EPDM rubber and designed to have a double sealing edge. The Double-Tilting Edge gasket shall comply with applicable testing required by ASTM F477.

B. Connector shall be manufactured from Polypropylene Black (PP-B) resin in DN250 – 600mm and Glass Fiber Reinforced Polypropylene Black (PP-GF) resin in DN700 – 1500mm.

C. Joints shall be capable of meeting the requirements of ASTM C443.

D. Joint for Perfect Pipe in Trenchless application:

1. The outside of the joint shall be reinforced with a steel bell band and an “O” ring gasket, as deemed necessary by the Manufacturer.
2. Packers: the contact surfaces of all pipe joints that transmit the axial (longitudinal) jacking forces shall be separated by a packing (cushion) made of:
   a. Plywood
   b. Particle board; or
   c. Other low-modulus (compression resistant) materials.

2.05 PRODUCT MARKING

Plainly mark each length of pipe with the date of manufacture, class of the pipe, pipe diameter and manufacturer’s name.

2.06 ACCEPTING TESTING & REPAIRS

The following tests shall be required:

A. Hydrostatic: The pipe barrel and pipe joint shall be subjected to an internal hydrostatic pressure per ASTM C443.

B. Load Bearing Test: One Three-Edge-Bearing Test in accordance with ASTM C497 for the load to produce the 0.01 inch crack and the ultimate load. All Three-Edge-Bearing tests shall be run on pipe manufactured without liners.

C. Concrete Strength: The compressive strength shall be determined according to ASTM C76 or C655.

D. Pipe and liner is allowed to be repaired if made necessary because of occasional imperfections in manufacture or damage during handling. A repair procedure shall be submitted to the Engineer for approval prior to any repairs being made. All repaired pipe or liner will be inspected and considered acceptable if, in the opinion of the Engineer, the repairs are sound, properly finished and cured and conform to the requirements of the specifications.

Part 3 - Installation

3.01 PIPE LAYING

A. Pipe shall be installed in accordance with ASTM C1479, the Concrete Pipe and Box Culvert Installation manual created by ACPA, and Section 7 of the Perfect Pipe Product Guide on “Installation Recommendations”.

B. Preparation of bedding and backfill shall be as specified on the drawings and per the requirements of the references listed in 3.01A, above.

C. Pipe shall be protected from lateral displacement by pipe embedment material installed as provided in the Drawings. Under no circumstances shall concrete pipe be laid in water and no pipe shall be laid in unsuitable weather or trench conditions. Pipe shall be laid with bell ends facing the direction of laying except when making closures.

D. Pipe shall be laid to line and grade as shown on the plans.

3.02 CONNECTION TO PRECAST STRUCTURES

A. When the standard connection cannot be made at a structure, the transition procedure and the connection shall be submitted to the Engineer for approval.

3.03 REPAIR OF IMPERFECTIONS

A. Repairs shall be compatible with the methods of making pipe. All repair methods will be submitted to the Engineer for approval.

SECTION 10

North America Installations

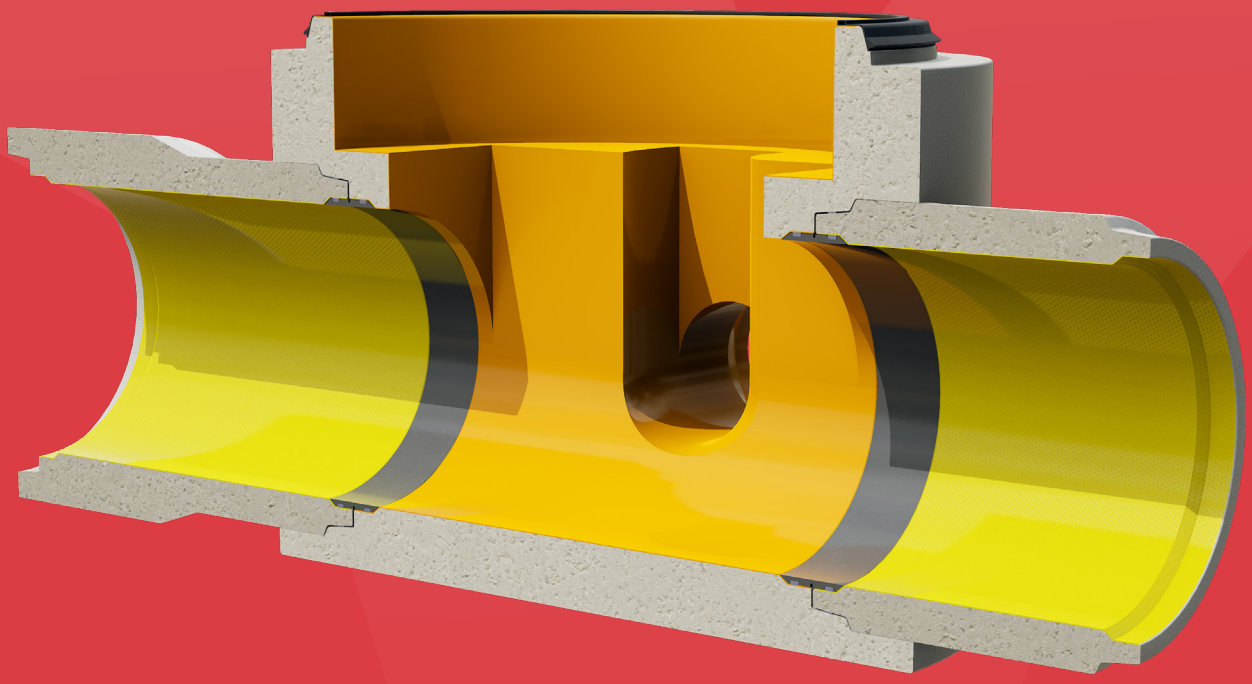
Table 3: *HDPE-Lined RCP Installations in North America Project Summary*

Location	Year Installed	Dia. (in)	Length (ft)	Trenchless/ Open-Cut	Precaster	Owner	Project Name
Tuscon, AZ	2017	15	380	Open-Cut	Jensen Precast	Pima County Regional Wastewater Reclamation District	Black Wash Augmentation Project
Toronto, ON	2017	24	675	Open-Cut	Con Cast	Town of Brampton	Scottish Heather Installation Brampton Peel Region
Ottawa, ON	2017	48	136	Open-Cut	Con Cast	City of Ottawa, ON	Katimavik Rd - Kanata West PS
Toronto, ON	2018	48	2,625	Open-Cut	Con Cast	Town of Richmond Hill, ON	West Gomley - External Sanitary Sewer
Toronto, ON	2018	36	3,938	Trenchless	Con Cast	Town of Richmond Hill, ON	Leslie St. - Town of Richmond Hill
Ottawa, ON	2018	48	6,536	Open-Cut	Con Cast	City of Ottawa, ON	North Kanata Trunk Sewer Phase 2
Kansas City, MO	2019	36	400	Open-Cut	American Concrete Products	City of Smithville, MO	Smithville Wastewater Treatment Facility
Omaha, NE	2019	48	700	Open-Cut	American Concrete Products	City of Omaha	CSO Fontenelle Lake James/Paxton Basin
Omaha, NE	2019	30	700	Open-Cut	American Concrete Products	City of Omaha	CSO Fontanelle Lake James/Paxton Basin
Omaha, NE	2020	42	1,100	Open-Cut	American Concrete Products	City of Omaha	Riverview Lift Station
Washington, IA	2020	24	384	Open-Cut	American Concrete Products	City of Washington	N. 4th Avenue Improvements
Fairfield, IA	2020	24	380	Open-Cut	American Concrete Products	City of Fairfield	Step 2 Sanitary Sewer Improvements
Omaha, NE	2020	60	710	Open-Cut	American Concrete Products	City of Omaha	Saddlecreek Retention
Toronto, ON	2020	24	748	Open-Cut	Con Cast	Town of Brampton	Scottish Heather Installation Phase 4- Brampton Peel Region
Toronto, ON	2020	24	1,214	Open-Cut	Con Cast	West Gwillimbury, ON	Bond Head North Sub. in West Gwillimbury
Kitchener, ON	2020	42	2,726	Trenchless	Con Cast	Kitchener, ON	Middle Strasburg Sanitary Trunk Sewer

North America Installations (continued):

Location	Year Installed	Dia. (in)	Length (ft)	Trenchless/ Open-Cut	Precaster	Owner	Project Name
Iowa City, IA	2021	30	1,100	Open-Cut	American Concrete Products	City of Iowa City	Scott Blvd. Trunk Sanitary Sewer Extension
Iowa City, IA	2021	24	3,496	Open-Cut	American Concrete Products	City of Iowa City	Scott Blvd. Trunk Sanitary Sewer Extension
Omaha, NE	2021	60	650	Open-Cut	American Concrete Products	City of Omaha	OPW54003 NFM Dodge St. & 77th Street
Calgary, AB	2021	36	2,362	Open-Cut	Con Cast	City of Calgary, AB	Glacier Ridge West Basin Sanitary Trunk Sewer
Vaughan, ON	2021	24	1,880	Open-Cut	Con Cast	City of Vaughan, ON	Jane Street Sanitary Sewer
Vaughan, ON	2021	32	1,615	Open-Cut	Con Cast	City of Vaughan, ON	Jane Street Sanitary Sewer
Kaysville, UT	2022	24	1,900	Open-Cut	Geneva Pipe and Precast	Central Davis Sewer District	950 N. Sewer Trunkline
Kaysville, UT	2022	32	1,500	Open-Cut	Geneva Pipe and Precast	Central Davis Sewer District	950 N. Sewer Trunkline
Logan, UT	2022	42	95	Trenchless	Geneva Pipe and Precast	City of Logan	1800 N. Sewer 600 West

APPENDIX
Material Data Sheets



Thermoplastic Lining

General

For precast concrete pipes in sewer applications it is an essential requirement to protect the inside surface. The protection of the inside surface is necessary to ensure water proofing, good flow characteristics and high chemical resistance.
Past experience has shown that unprotected concrete surfaces as well as chemical based linings such as coatings, sprayed linings are not providing the life duration which is required for such investment intensive life lines for cities and industrial installations.
Lining with thermoplastic material which is based on mechanical bonding in the concrete substrate is providing much superior properties for such applications. This report will discuss the main benefits of such linings and various methods of construction.

Advantages of Thermoplastic Lining

Thermoplastic lining based on already widely used material such as **High density polyethylene (PEHD)** is applied to the concrete substrate during the construction of the system. This provides major advantages over other lining systems.

- Immediate implementation of the lining material ensuring better bonding capabilities and faster construction cycles (coatings can only be applied after concrete is completely dry and clean which will increase construction time)
- Mechanical anchoring by means of anchor studs which are applied on the thermoplastic liner during manufacturing provides high bonding strength between the lining material and the concrete (high pull out strength and ground water pressure resistance)

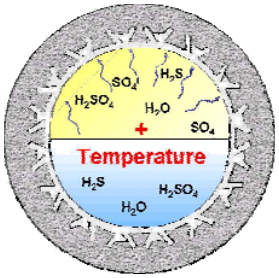
Thermoplastic lining provides further major advantages for such kind of applications such as:

- **Full leak tightness**

The material has excellent mechanical properties including high elongation behaviour. These properties provide in the application the benefit that cracks of the concrete structure will not create a leak of the lining material.Cracks of the concrete substrate will be bridged.The picture shows destructive tests performed on CPL lined concrete pipes where thisbehaviour of the lining material is demonstrated.

- **Very good chemical resistance**

Unprotected concrete structures are heavily deteriorated by chemical attack resulting in many cases that the structures are collapsing or heavily leaking. Similar behaviour is also happening on coated concrete structures whereby the lifetime is slightly higher than for unlined systems. Especially in regions where environment temperatures are consistently higher than 25 °C chemical resistance of concrete structures play a significant factor for the life time of the system.



Thermoplastic materials such as PEHD are chemically resistant against diluted solutions of salts,acids and alkalis if these are not strong oxidizing agents. Good resistance is also given against many solvents, such as alcohols, esters and ketones. This ensures that thermoplastic systems are not deteriorated by any chemical attack of long periods and will therefore play a significant factor for the long life duration of sewer systems.

- **Very good abrasion resistance**

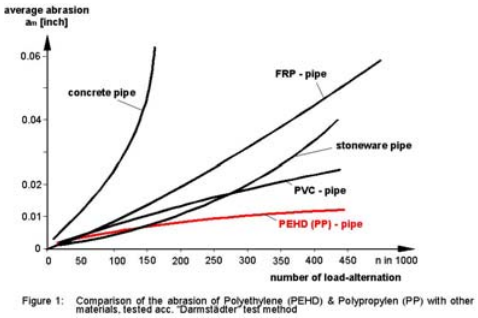


Figure 1: Comparison of the abrasion of Polyethylene (PEHD) & Polypropylen (PP) with other materials, tested acc. "Darmstädter" test method

Unlined concrete surfaces do not have very good resistance against abrasion. In operation this will create pretty fast deterioration of the installed system. Reduced flow capabilities, build up of sediments in the tunnel have been detected in many occasions. Abrasion tests have verified that various material types do provide very different properties. As the best materials, thermoplastic materials such as PEHD have by far the highest abrasion resistance.

- **very good resistance against root growth**

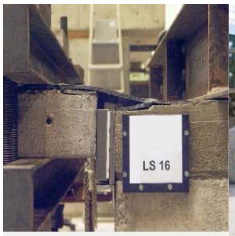
Unlined or uncoated surfaces do not provide resistance against penetration of roots.
Especially joint sections showing such problems. The growth of roots into piping system will cause reduction of the static condition of the installed underground system and is causing significant reduction of flow capability. Cracks which are leading to leaking require significant efforts in maintenance, causing high operation cause downtime periods in operation.

- **Good surface smoothness**

Quelle: MPA Karlsruhe

Plastic lining provides the further bid advantage of very smooth surface characteristic.
The above given properties and benefit of plastic ensure also that the surface properties remain consistent for the service life
A further advantage is that cleaning of the system does not require a lot of effort and is possible up to 120bar.

- **Settlements**



Quelle: MPA Karlsruhe

For pipelines settlements must be considered in weak soil conditions which can cause cracks or joint problems. Thermoplastic liners can take settlements by its high elongation properties.

Long-term analyses based on actual testing also identified that PEHD lined surfaces are suitable to withstand life durations more than 100 years.

The SURE GRIP CPL System meets the requirements of national and international standards. National approvals are qualifying this system for the application for precast pipes for the transport and storage of drinking and waste water.

Österreichisches Normungsinstitut
Austrian Standards Institute

DS Dichtungstechnik GmbH informs

Recommendations for storage of seals

As far as possible, the following points should be noted for the storage of loose gaskets (DIN EN 681-1, appendix D):

- The storage temperature should be below 25°C.
- The seals should be protected against light, especially against strong sunlight and artificial light with a high ultraviolet content.
- The seals should not be stored in a room that contains equipment that can produce ozone, such as mercury arc lamps or appliances with electric high voltage which can cause sparks or silent electrical discharges.
- The seals should be stored relaxed without tension, pressure or other deformations. They should not be hung on any part of the seal.
- The seals should be kept clean all the time.

In principle, the DS sealing material made of styrene-butadiene rubber (SBR) and ethylene-propylene-diene rubber (EPDM) is adequately weather- and aging-resistant for outdoor storage for up to **2 years**.
For example, rubber matrices are added to the rubber matrix, which migrate to the profile surface after vulcanization and provide protection against ozone and UV radiation as well as heat radiation as a surface film.
Like a depot effect they provide for a repair of injured surface films.
For seals installed in the pipe, it exists a sufficient amount of protection against weathering and aging.

Loose seals should be mounted just before delivery to the site.
Weather and high tensile stress in the sealing-ring endanger especially the joint of the both ends of the sealing-ring.

Recommendations:

1. **Storage of the loose gaskets before installation is weather-protected in accordance with DIN EN 681-1 (see above)**
2. **Mount the loose seal rings just before delivery to the site**

Aging resistance before installation

If the storage recommendations described above will be observed, our seals in the non-installed state keep their full operability up to **5 years** from their production date.

Lifetime of elastomer seals

- An aging of elastomeric seals is accelerated by the action of UV radiation and ozone. Once a seal has been installed, these factors are excluded.
- Our seals are tested according to the aging tests of DIN EN 681-1.
- In the installed state, the pressure forces will be relaxed.
  This relaxation is taken into account by the minimum grouting of 25%.
- Seals taken from us, which were installed 45 years ago, fulfilled the physical values of DIN 4060.
- In the case of appropriate treatment and standard mounting on the site, we assume a lifetime of our seals from 80 to 100 years.

DS Dichtungstechnik GmbH, Nottuln, 26.01.2015

PERFECT PIPE

PERFECT Connector DN250 – 600

- **PERFECT Connector**
  injected molded
  plug-in-connection

- **PP-B black**

Technical properties for PPB material for PERFECT Connector as per DIBT Approval Z-42.5-552.

	Property	Standard	Unit	PP-B
MECHANICAL PROPERTIES	Density	DIN EN ISO 1183-1	g/cm³	0,911 – 0,922
	Melt Flow Rate (230°C / 5 kg)	DIN EN ISO 1133	g/10 min	1,20 – 1,70
	Tensile Strength	DIN EN ISO 527-1	MPa	≥ 28
	Tensile Strain at Break	DIN EN ISO 527-1	%	≥ 26
	Flexural Modulus	DIN EN ISO 178	MPa	≥ 1.440
	Flexural Strength	DIN EN ISO 178	MPa	≥ 41
	Charpy Impact Strength (23°C)	DIN EN ISO 179-1	kJ/m²	≥ 120

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PERFECT PIPE

PERFECT Connector DN700 – 1500

- **PERFECT Connector**
  injected molded
  plug-in-connection

- **PP-GF black**

Technical properties for PPB material for PERFECT Connector as per DIBT Approval Z-42.5-552.

	Property	Standard	Unit	PP-GF
MECHANICAL PROPERTIES	Density	DIN EN ISO 1183-1	g/cm³	1,215 – 1,285
	Melt Flow Rate (MFR 230°C / 2,16 kg)	DIN EN ISO 1133	g/10 min	3,0 – 6,0
	Oxidation Induction Time (OIT bei 210°C)	DIN EN ISO 11357-6	min	> 40
	Tensile Strength	DIN EN ISO 527-1	MPa	≥ 95
	Tensile Strain at Break	DIN EN ISO 527-1	%	≥ 2
	Flexural Modulus	DIN EN ISO 178	MPa	≥ 6.500
	Flexural Strength	DIN EN ISO 178	MPa	≥ 138
	Charpy Impact Strength (23°C)	DIN EN ISO 179-1	kJ/m²	≥ 35

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ecoTECHNIC TECHNOLOGY THAT SEPARATES

PERFECT PIPE

Material Datasheet - Load Transmission Ring DN250 - 1500

- **Polymer:** NBR
- **Quality designation:** 70-N-03 E
- **Colour:** black

Tested Characteristic	Testing Method	Unit	NBR
Hardness	DIN 53505	Shore A	71
Density	DIN 53479	g/cm³	1,23
Tensile strength	DIN 53504	N/mm²	11,6
Elongation at break	DIN 53504	%	309
Compression Set 70°C 24 H at 25% deformation	DIN ISO 815	%	31
Ozon resistance 50 PPHM, 23°C, 72 H, 20% elongation	DIN 53509	-	No cracks

Temperature resistance (short-term)	from -40°C	to	+100°C
Permanent Temperature resistance	from -30°C	to	+90°C

Oil resistant

The material data is based on laboratory tests and should not be construed as a specification. The properties measured on finished products can be different to the material data based on laboratory test. The standardized sampling of specimens from finished products is not always possible.

Subject to errors and modifications.

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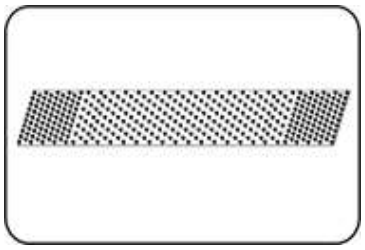
ecoTECHNIC TECHNOLOGY THAT SEPARATES

HDPE Perfect Liner
Concrete Protective Liner

The Plastics Experts.

- **Perfect Liner**
  - Stud type: 7.8 mm
  - Extruded



- **Hot gas extrusion welding**
- **HDPE yellow (~RAL 1018)**
- **Type code 21.559**

Property	Standard	Unit	Product
Specific density at 23 °C	ISO 1183	g/cm^3	0.94 - 0.96
Melt flow rate MFR 190/5	ISO 1133	g/10min	1.6 - 2.0
Tensile stress at yield	ISO 527	MPa	≥ 12
Elongation at yield	ISO 527	%	≥ 8
Elongation at break	ISO 527	%	≥ 400
Modus of elasticity	ISO 527	MPa	≥ 620
Pull-out resistance at 23°C Tensile test 5 mm/min (short term)	In accordance to DIN ISO 4624	N/Stud kN/m²	≥ 500* 854
Anchor stud arrangement	-	Studs/m²	~1709 central section ~2324 edge section
Backpressure resistance at 23 °C	DIBt-test methode	1,5 bar/ 1000h	fulfilled
Max. Working temperature	-	°C	60**
Linear coefficient of thermal expansion	DIN 53752	$K^{-1} \times 10^{-4}$	1.8***
Flammability	UL 94 DIN 4102 EN 13501	-	94-HB B2 Class E
UV stabilized	-	-	3 years Central Europe 15 monthSouth-western Asia
Colour	-	-	Yellow (~RAL 1018)

18.11.2020_003

*… Pull-out test were carried out with self-compacting concrete and a 1.65 mm Perfect Liner
**… Depending on media/ consultation with AGRU
***… guide value

The data in this table are approximate values and based upon results of the internal inspection, data of raw material suppliers as well as tests in the course of approval procedures and external inspections. The results can differ slightly from the indicated mean values in longitudinal and transverse direction and due to different nominal thicknesses and raw materials. In any case requirements relating to a special project (tender documents) have to be agreed with AGRU. Independent of the indicated test standards, internal tests and data on test certificates are generally carried out in accordance with the appropriate test procedures according to OENORM (Austrian Standard) resp. DIN (German Standard) or EN ISO. AGRU assumes no liability in connection with the use of this data. The specifications on these sheets are subject to change without notice.

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Firmenbuchnummer: 171838 d
Firmenbuchgericht: LG Steyr

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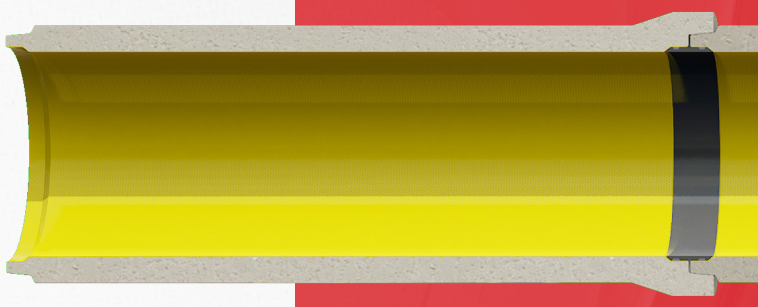

Geneva Pipe and Precast
A Northwest Pipe Company

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