Environmental Product Declaration

In accordance with ISO 14025 and EN 15804:2012+A2:2019/AC2021 for:

SINTAKOTE® Steel Pipeline System

from

Steel Mains Pty Ltd - Australia

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General information

Programme information

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CEN standard EN 15804+A2:2019/AC2021 serves as the Core Product Category Rules (PCR)
Product category rules (PCR): *Construction Products and Services, (PCR) 2019:14, v1.11.*
PCR review was conducted by: *The Technical Committee of the International EPD® System.* A full list of members available on *www.environdec.com for a list of members. The review panel may be contacted via info@environdec.com. Review chair: Claudia A. Peña, University of Concepción, Chile.*
Independent third-party verification of the declaration and data, according to ISO 14025:2006: ☐ EPD process certification ☒ EPD verification
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Procedure for follow-up of data during EPD validity involves third party verifier: ☒ Yes ☐ No

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EPDs within the same product category but from different programmes may not be comparable. EPDs of construction products may not be comparable if they do not comply with EN 15804. For further information about comparability, see EN 15804 and ISO 14025.

About Us

Company information

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Sintakote® Steel Pipeline System providing Solutions for Life™

Originating in 1878, Steel Mains is Australia's leading manufacturer and supplier of complete steel pipeline systems for the transportation of water and wastewater, offering a total solution approach to our customers.
Throughout Australia and the rest of the world, steel pipelines have long been used in water supply, particularly where high pressures, difficult laying conditions, security of supply, have required the strength, toughness, and security of steel.
Steel Mains and our forerunners have been at the forefront of providing solutions to the water industry for more than 140 years of pipeline manufacturing in Australia. Over that period steel pipeline design, manufacturing processes and technology have evolved into the **SINTAKOTE® Steel Pipeline System,** providing unique product solutions that will endure for a lifetime of water security for the communities they service.

Today, Steel Mains' products and services cover a range of industry needs both within Australia and globally, delivering quality, strength, durability and endurance.

Environmental Product Declaration for SINTAKOTE Steel Pipe

To demonstrate Steel Mains' commitment to sustainability and transparency, Steel Mains is pleased to publish this independently verified and registered Environmental Product Declaration (EDP) as part of our sustainability strategy moving forward.
This EPD focuses on Steel Mains' core product – **SINTAKOTE Mild Steel Cement Lined (MSCL) Pipe**, however, in this EPD it is commonly referred as *Sintakote Steel Pipe.*
Steel Mains' environmental commitment is to manufacture our SINTAKOTE Steel Pipe more sustainably. In addition to reducing, reusing and recycling materials where possible, Steel Mains is always investigating new ways in minimising the environmental footprint of its product.

Innovation & Technical Capabilities

Australian Manufacturing – Complete Solution Provider

The SINTAKOTE Steel Pipeline System is recognised in the Australian water industry for its highly evolved technical and physical characteristics for use in steel pipelines.

Steel Mains maintain world class manufacturing facilities and state of the art manufacturing capability. Over many years in operation Steel Mains has completed several major investments and upgrades to our Somerton and Kwinana[1] facilities over the decades. These investments ensure that our world class technology and production plants will continue to support Australia's water needs for many decades to come.
The decision to continuously invest has largely been due to the success of our SINTAKOTE fusion bonded polyethylene corrosion protection system and the unique configuration of our SINTAJOINT pipe rubber ring joint and its derivatives such as SINTALOCK welded rubber ring joint.

Steel Mains has over **70,000 tonnes of annual capacity** to support project owners and contractors across the country through three world-class pipe production mills well positioned in Somerton, VIC and Kwinana, WA. Steel Mains offers steel pipe products made from Australian manufactured Hot Rolled Steel custom-built to specific project requirements. For over a century, Steel Mains has provided product solutions to meet our customer needs.

[1]Kwinana facility is excluded from this EPD

Somerton, Victoria
40,000 tonnes p.a. capacity

Capability: 2 x spiral mill + production line; fittings fabrication
Pipe Diameter: 100-2,500 mm
Pipe Thickness: 4.5-25 mm
Pipe Length: 6.0 – 13.5 meters
Fittings: Fabrication, end forming, coating, and lining

Kwinana, Western Australia[1]
30,000 tonnes p.a. capacity

Capability: 1 x spiral mill + production line
Pipe Diameter: 500-1,400 mm
Pipe Thickness: 5-16 mm
Pipe Length: 11.7– 12.2 meters

Supporting the Move to a Circular Economy

A circular economy represents a shift from a linear economic model to a model that supports sustainable long-term growth. This is achieved by changing the way things are produced, consumed and extending the life of a product. As a result, the pressure on the environment is reduced due to minimum impact and waste. Furthermore, the supply and security of scarce commodities are improved due to the reduced need for resource-intensive activities to extract raw materials.

Steel Mains is committed to providing an Australian steel solution where 98% of our product content is locally sourced and locally made from Australian raw materials. In fact, the Australian supply chain of local raw materials extends through to transportation and finally in construction.

Steel, as the primary raw material, posesses high strength and unique benificial properties. When combined with superior corrosion protection, the strength of steel is retained indefinitely without compromising its quality. Steel Mains *Sintakote Steel Pipe,* has that unique combination that fully utilises the proven properties of steel over the pipeline life and steel can be used for other purposes at end of life. Steel Mains' pipeline product can be repaired, refurbished, recycled and reused thereby favouring a sustainable circular economy.

Strength Benefits of Steel

Steel offers high strength in proportion to wall thickness when compared to common materials. This allows the use of thin wall steel to achieve the desired operating pressure and installation parameters.
Steel provides high ring bending, shear resistance, beam strength and bidirectional strength as a result of wall thickness selection.
Soil compaction requirements are not as demanding as those for pipes of low ring stiffness.
The high beam strength of steel pipes also provides protection against poor pipe soil bedding and ground settlement.
In above ground installations steel pipe spans can be optimised to minimise piers and other supports.

Ductility for Performance in Extreme Conditions

Through its ductility, steel pipe is able to locally yield and plastically deform under extreme load while maintaining resistance to that load.
Stresses caused by unforeseen loads including impact, earth movement, washouts and extreme temperature changes can readily be accommodated. Service performance can thus be maintained in such conditions.

Boosting Capacity For The Future

In many instances it is necessary to increase the capacity of a water supply pipeline some years after installation. This may be as a result of unforeseen population growth or industrial expansion.
Steel pipelines designed on the basis of initial ring stiffness requirements often have capacity for a significant increase in pressure without reducing safety factors.

Reliability of Long-Term Performance

Because steel pipe retains its strength and stiffness characteristics, regardless of age, it can be relied upon to maintain its original performance over generations. Steel pipelines operating today, with over a century of service, are a real testimony to this capability.

Product

Sintakote Steel Pipe (UN CPC code: 41287)

Data contained within this EPD relates to Pipe Diameter size range of 114-2159 mm and Pipe Thickness of 4.8-16mm as detailed in Appendix 1, based on Somerton Manufacturing source data.

Product Characteristics

Steel Mains manufactures SINTAKOTE Mild Steel Cement Lined (MSCL) Medium Density Polyethylene (MDPE) coated pipe in accordance with AS 1579 utilising steel that is manufactured to AS/NZS 1594 – Hot-Rolled steel coil. Steel pipes are used for transporting aqueous media such as but not limited to potable and wastewater applications. Table 1 summarises the product/product components characteristics which ANZSIC code is 2122.

SINTAKOTE Corrosion Protection Coating

SINTAKOTE is a proprietary corrosion protection system which comprises a black medium density polyethylene which is fusion bonded directly to the steel pipe and fittings. The coating provides complete corrosion protection, as well as encompassing a unique rubber ring pipe jointing system.

Features of the coating include:

- Excellent adhesion
- High impact and load resistance
- Excellent chemical resistance
- High dielectric strength
- High electrical resistivity
- Low water absorption
- Resistance to soil stresses
- Service temperature range with temperatures from -40 to 70 °C having no detrimental effect on SINTAKOTE
- Ability to undergo cold bending in accordance with AS 2885 without damage to the coating

Table 1 - Product components characteristics

Product	SINTAKOTE Mild Steel Cement Mortar Lined (MSCL) (Medium Density Polyethylene) coated pipe
Product Name	Sintakote MSCL Pipe (commonly known as Sintakote Steel Pipe)
Manufacturing Standard	AS 1579
Pipe Diameter	114 - 2159 mm
Pipe Thickness	4.8 - 16 mm
Pipe Length	6.0 - 13.5 m
Pressure Rating	2.7 - 6.8 Mpa
Product Lifetime	Up to 200 Years
Steel	
Pipe Steel	Hot-Rolled steel coil manufactured in accordance with AS/NZS 1594 Standard
Minimum Yield Strength	250 MPa
Minimum Tensile Strength	350 Mpa
Coating	
SINTAKOTE	Medium Density Polyethylene manufactured to AS 4321 requirements
Thickness	1.6-2.3 mm
Density	940 kg/m^3
Service Temperature	- 40°C to +70°C
Lining	
Cement Mortar Lining	To AS 1281 requirements
Type	General Purpose (GP)
Thickness	9-19 mm

Manufacturing Process

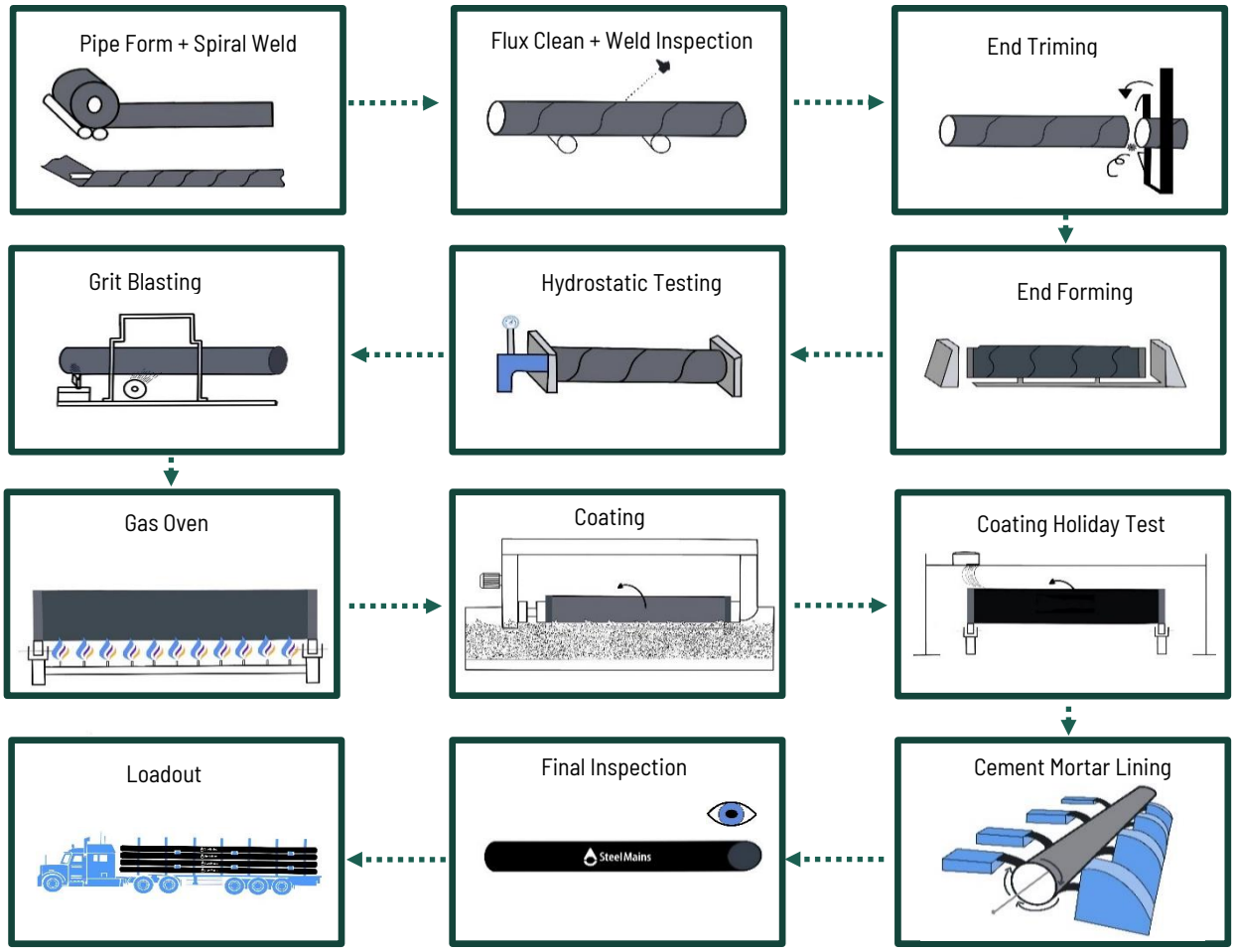


Figure 1| Manufacturing process of SINTAKOTE Steel pipes

Pipe Forming: Steel pipes are manufactured by spiral forming the pipe from steel coil. The spiral forming process uses hot rolled steel coil as a raw material. The steel is uncoiled, levelled and passed through a forming station that spirals the steel to the required outside diameter. The spiral seam is welded both internally and externally as part of the forming process. The pipe shell is then cut to the required length as it travels out of the forming and welding machine. All welding is carried out using the automatic submerged arc welding process.

Ends Preparation: Pipes have their ends prepared depending on the selected jointing systems.

Hydrotesting: Pipes for water supply pressure applications are hydrostatically tested to prove the steel and weld strength and to ensure that each pipe is watertight. The strength test is carried out at 90% of the steel minimum yield strength, to a maximum of 8.5 MPa, whilst the hydraulic leak test is carried out at the pipes rated pressure, which is equivalent to a stress of 72% of the steel minimum yield strength to a maximum of 6.8 MPa. Pipes for non-water supply / structural purposes are not hydrostatically tested unless requested at order placement.

SINTAKOTE Coating: SINTAKOTE is a medium density polyethylene which is applied to the pipe by a fusion bonding process. Polyethylene, supplied as a powder, is fusion bonded onto a blasted preheated steel pipe. This process provides a continuous and holiday free coating, with a smooth surface, ideal for above and below ground applications even in aggressive soils and when exposed to direct UV sunlight.

Cement Mortar Lining: Cement lining is applied in a centrifugal process by spinning the pipe at high speed and this results in a dense lining with a smooth surface. The lining is cured for a minimum of four days before the pipe is transported for installation. The dense lining produced offers good chemical resistance to potable water, saline and wastewater applications.

Product and Delivery

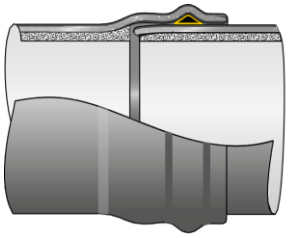
Packaging and transportation: There is no packaging required for Sintakote Steel pipes. Pipes are loaded on trucks in suitable and stable configurations utilizing reusable rubber lined bolsters, providing all controls and precautions in place to ensure safe and timely delivery of pipes.

Product Installation: Steel Mains has a number of common pipe jointing configurations, and selection is subject to geometrical and practical consideration.

Jointing Configurations:

Unrestrained

– Rubber ring joint, SINTAJOINT®

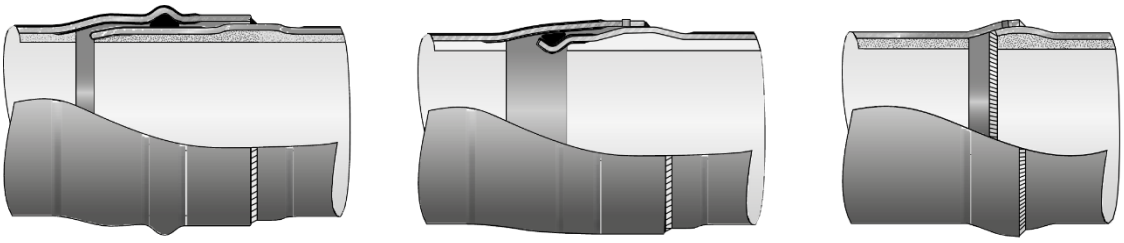


SINTAJOINT ®

Restrained

– Rubber ring joint with external fillet weld, SINTALOCK® (Type I &II)

– Ball and socket welded joint



SINTALOCK ® - Type I | SINTALOCK ® - Type II | Ball & Socket Joint

Figure 2 | Joint configuration for Steel Mains pipes

SINTAKOTE Steel Pipes Product Lifetime

The life cycle of SINTAKOTE Steel Pipe is dependent on the respective structural design, joint type, use, and maintenance. The use phase for steel pipe for water pipelines is not depicted as they involve maintenance free and generally durable products.

A detailed technical study completed by Steel Mains confirms that Sintakote Steel pipe product lifetime of up to 200 years considering that external fusion bonded polyethylene coating (SINTAKOTE) is proven to provide superior external corrosion protection in almost all operating environments.

SINTAKOTE Steel Pipes are widely specified by the Australian Water Industry for use in critical potable and wastewater pipeline infrastructure in below and above ground applications (Pipeliner, 2022) (Danenbergsons, Kumar, & Tarlinton, 2022) (Pearce, 2017).

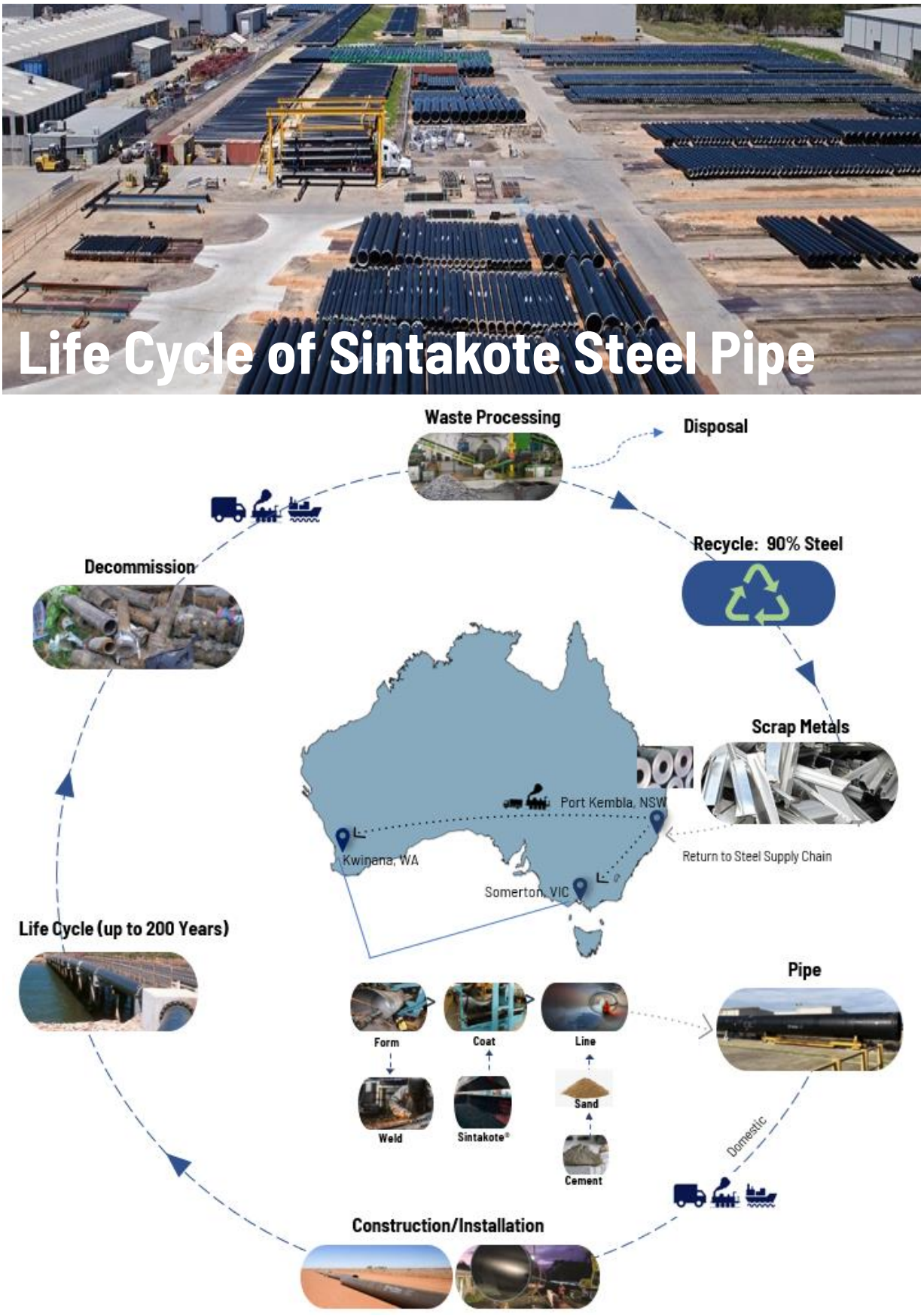


Figure 3 | Life Cycle of SINTAKOTE Steel pipes

LCA information

Declared unit	1 kg SINTAKOTE Steel Pipe
Geographical coverage	Victoria, Australia
LCA scope	Cradle to gate with module A4-A5, module C1-C4 and module D
Time representativeness	Foreground data on raw material requirements, manufacture, construction, use and end of life inputs and outputs was provided first-hand by Steel Mains for CY2020
Database (s) and LCA software used	The inventory data for the process are entered into the SimaPro (v9.3.0.3) LCA software program and linked to the pre-existing data for the upstream feedstocks and services selected in order of preference from: - For Australia, the Australian Life Cycle Inventory (AusLCI) v1.36 compiled by the Australian Life Cycle Assessment Society ((ALCAS), 2021) and the Australasian Unit Process LCI v2014.09. The AusLCI database at the time of this report was 1 year old, while the Australasian Unit Process LCI was 8 years old. - Other authoritative sources (e.g., Ecoinvent v3.8, (Moreno, 2021)), where necessary adapted for relevance to Australian conditions (energy sources, transport distances and modes and so on, and documented to show how the data is adapted for national relevance). At the time of reporting, the Ecoinvent v3.8 database was 1 year old.

Description of system boundaries

The scope of this LCA is Cradle to gate with module A4 and A5, module C1-C4 and module D. The following life cycle stages have not been declared, as they are deemed not applicable for SINTAKOTE pipes: Material emissions from usage (B1); Maintenance (B2); Repair (B3); Replacement (B4); Refurbishment (B5), Operational energy use (B6) and Operational water use (B7). The EPD is compliant with Product Category Rules – Construction Products (PCR 2019:14), EN 15804+A2 standard, ISO 14025 and General Programme Instructions (GPI) V3.01. The target audience for this EPD are businesses or customers who will be using Steel Mains' products. This study considers only one product (SINTAKOTE Steel Pipe) from one production site (Somerton, VIC). This EPD include SINTAKOTE steel pipes with a diameter range of 114-2159 mm, divided into 3 groups (Table 67). The LCA results presented are average for each group.

Table 2 | Life Cycle of building products: stage and modules included in this EPD

	Product stage			Construction process stage		Use stage							End of life stage				Resource recovery stage
	Raw material supply	Transport	Manufacturing	Transport	Construction installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
Module	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Modules declared	X	X	X	X	X	ND	ND	ND	ND	ND	ND	ND	X	X	X	X	X
Geography	USA/AU/CN	USA/AU/CN	AU	AU	AU	-	-	-	-	-	-	-	AU	AU	AU	AU	AU
Specific data used	>90%					-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	<10%					-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	Not applicable					-	-	-	-	-	-	-	-	-	-	-	-

ND = Not declared

The share of GWP-GHG indicator results in A1-A3 is reported in this study based on specific data used from BlueScope Steel EPD, which used more than 90% of product-specific LCI.

System diagram

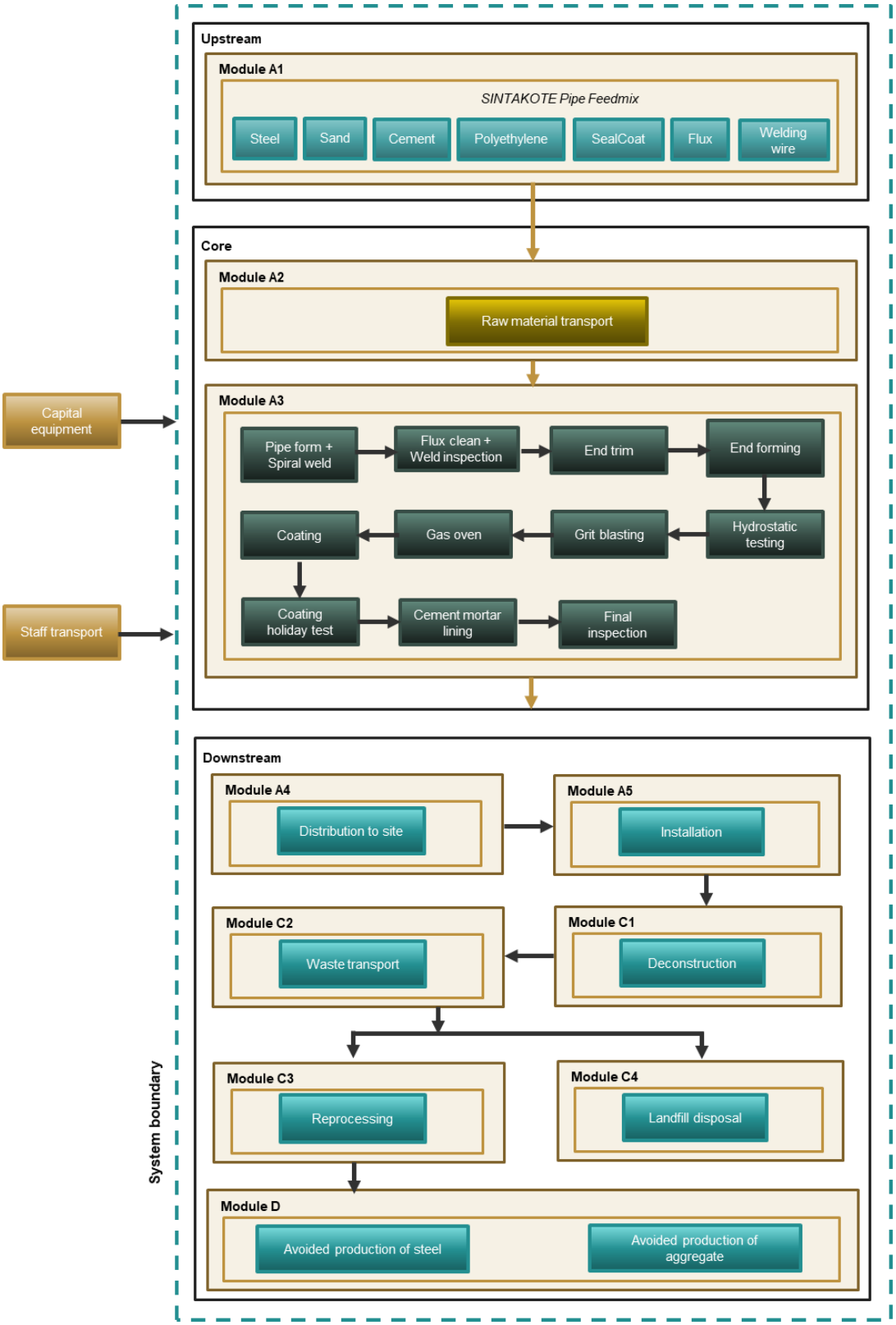


Figure 4 | System diagram

Product stage

Steel Mains use hot rolled steel produced by BlueScope Ltd. This steel contains 17.4% recycled material according to BlueScope EPD[1]. Flux as well as 4.0 mm and 3.2 mm welding wire are transported from overseas via ship to Australia. During manufacturing stage, a total of 0.043 kg waste was generated per kg SINTAKOTE Steel Pipe, which requires landfilling or recycling. These wastes include but not limited to aerosol cans, paint drums, oil filters, waste solvents, used oil, oily water, oily rags, scrap batteries, cardboard, SINTAKOTE dust, damaged timber pallets (wood), PPE, grinding discs, buffing discs, solid SINTAKOTE, old machinery, and other non-recyclable items. The distance from manufacturing site to landfill/recycling plant was assumed to be 50 km, which resulted 2.14 kg.km manufacturing waste transport for per kg SINTAKOTE Steel Pipe.

Distribution stage

All Steel Mains' products are transported by road from the manufacturing plant to customers' locations. Somerton, Victoria and Kwinana, WA are the manufacturing sites of Steel Mains. This EPD considers only the case of Somerton production site. The distance from Steel Mains' gate were calculated based on primary data from percentage of total products shipped to each state for per kg SINTAKOTE Steel Pipe.

Installation stage

Steel Mains SINTAKOTE Steel Pipes can be installed with two types of connections: Restrained (SINTALOCK) and Unrestrained (SINTAJOINT). In restrained connection, pipes are joined by one pass of external weld while in unrestrained installation, pipes are joined by slip-in process without welding the joints. The restrained and unrestrained pipe considered in this LCA and EPD considers Rubber ring joint with external fillet weld, SINTALOCK® and Rubber ring joint, SINTAJOINT®, respectively. The SINTAKOTE Steel Pipe with a dimension of 762 mm diameter X 6 mm steel thickness X 12 m has been chosen as the reference installation. The other sizes are expected to follow similar numbers with minor variations.

The weight of SINTAKOTE steel pipe is 184 kg/m for the selected pipe of dimension 762 mm diameter X 6 mm steel thickness X 12 m length. No material is scrapped throughout the installation process.

About 50% of SINTAKOTE Steel pipes require special filling material. A 1362x1410 mm trench is required for the selected pipe (762 mm diameter X 6 mm steel thickness X 12 m length). Approximately 8.34 kg of backfilling material (sand) is required for per kg pipe installation. A conservative transport distance of filling material is assumed as 25 km. The crane consumes 617.6 MJ of diesel used in one hour, grid electricity was used for welding, and pipes are installed underground (only underground installation is considered).

End of life stage

Three scenarios were assessed to ensure a comprehensive lifecycle analysis of the product:

1. Recycling of pipes and concrete at end-of-life (considers A1-A5, C1-C3 and D)[2]
2. Landfill disposal at end-of-life (A1-A5, C1, C2 and C4) and
3. Leaving the pipes as is at end-of-life (A1-A5)

Recycling and reuse of steel can provide significant economic benefits along with environmental benefits compared to steel production from raw materials. It is estimated that recycling of steel for reuse consumes 75% less energy than production of steel from raw materials (Planet Ark, 2022), which can add economic benefits to the overall pipe

[1]BlueScope (2020), Environmental Product Declaration – Steel – Hot Rolled Coil, version 2. EPD Australasia. https://epd-australasia.com/epd/steel-hot-rolled-coil/.

[2]Environmental impacts for C4 module are zero as there will be no landfilling for Scenario 1.

manufacturing process. According to recent studies, at least 90% of steel (Pickin, Randell, Trinh, & Grant, 2018) and 68% concrete (Goona, 2000) are recycled as detailed in the following section. These numbers are noteworthy as they avoid significant amount of virgin material production and justifies the cost of excavation of material as well as cost of transport to the recycling facility.

Three end of life scenarios are considered: 1) recycling of pipes; 2) landfill disposal and 3) leaving the pipes as is at EoL. While recycling is a preferred option, municipal landfill is also possible and should be done in accordance with relevant regulations (Trinius & Goerke, 2019). Underground infrastructure pipes are often left in the ground at the end of their service life particularly in the urban environment where multiple buildings are in close proximity and limited construction space is available. The excavation of pipes may lead to the ground pressures out of balance, resulting in both the movement of the ground and the infrastructure on the top or underneath it (Harrison, 2021). Therefore, leaving the pipe in-situ at EoL is also considered as a possible end of life scenario.

The life cycle of SINTAKOTE Steel Pipe is dependent on the respective structural design, use and maintenance. The use phase for steel pipe for water pipelines is not depicted as they involve maintenance free and generally durable products. An internal engineering study by the Steel Mains Technical Team confirms a product lifetime of up to 200 years for both buried and above ground pipe installations along with as both rubber ring and welded joints when used for potable water if the pipe is correctly installed and maintained, bearing in mind that external fusion bonded polyethylene coating (SINTAKOTE) is proven to provide superior external corrosion protection in almost all operating environments (Steel Mains, 2021). The scenarios included in this EPD are based on the most likely outcomes of the products at the end-of-life i.e., they will either be recycled, landfilled or kept as is. The excavator and crane are used to operate 0.02778 h and 0.20833 h, respectively for the deconstruction of 1 m pipe (Steel Mains, 2021). The distance from manufacturing site to landfill/ recycling plant is assumed to be 50 km.

Benefits beyond the system boundary

The information in module D may contain technical information as well as LCA results from post-consumer recycling, i.e., environmental benefits or loads resulting from reusable products, recyclable materials and/or useful energy carriers leaving a product system e.g., as secondary materials or fuels. Avoided impacts from co-products from module A to C shall not be included in Module D. The benefits associated with recycling of pipes is only applicable for end-of-life Scenario 1 i.e., Recycling. The recycling process for steel pipes is modelled as shredding ore-melting of scrap steel in an electric arc furnace to produce low-alloyed steel post fragmentising. The benefit in this case is the avoided production of steel produced using iron ore in a blast furnace. The recycling process for concrete is modelled as crushing the concrete using a rock crusher to produce concrete gravel as only the crushed concrete aggregate can be recycled. The benefit in this case is the avoided production of gravels and steel produced using iron ore in blast furnace.

Cut-off rules

It is common practice in LCA/LCI protocols to propose exclusion limits for inputs and outputs that fall below a threshold% of the total, but with the exception that where the input/output has a "significant" impact it should be included. According to the PCR 2019:14, the Life Cycle Inventory data for a minimum of 95% of total inflows (mass and energy) per module to the upstream and core module shall be included, accounted as global warming potential (GWP) or energy consumption. In addition, if less than 100% of the inflows are accounted for, proxy data or extrapolation should be used to achieve 100% completeness. Data gaps in included stages in the downstream modules shall be reported in the EPD, including an evaluation of their significance. In accordance with the PCR 2019:14 v1.11, the following system boundaries are applied to manufacturing equipment and employees:

- Environmental impact from infrastructure, construction, production equipment, and tools that are not directly consumed in the production process are not accounted for in the LCI. Capital equipment and buildings typically account for less than a few percent of nearly all LCIs and this is usually smaller than the error in the inventory

data itself. For this project, it is assumed that capital equipment makes a negligible contribution to the impacts as per Frischknecht et al.[3] with no further investigation.

- Personnel-related impacts, such as transportation to and from work, are also not accounted for in the LCI. The impacts of employees are also excluded from inventory impacts on the basis that if they were not employed for this production or service function, they would be employed for another. It is very hard to decide what proportion of the impacts from their whole lives should count towards their employment. For this project, the impacts of employees are excluded.

- The transport of heavy equipment (e.g., excavators and cranes) to and from the installation site are excluded. Besides these exclusions, no energy or mass flows were excluded.
- Metal grit, accounts for 0.15% mass for the production of pipe, and the transport of metal grit for the pipe production was excluded.
- There was no pipe loss (cut-off) during installation.
- Pipe cutting during deconstruction was excluded from this study

Allocation

According to EN 15804 A2:2019, in a process step where more than one type of product is generated, it is necessary to allocate the environmental stressors (inputs and outputs) from the process to the different products (functional outputs) in order to get product-based inventory data instead of process-based data. An allocation problem also occurs for multi-input processes. The upstream data, violating the allocation principles requires to be clearly mentioned and justified. The processes which influence the product's environmental performance needs to be assigned to the respective module. In an allocation procedure, the sum of the allocated inputs and outputs to the products shall be equal to the unallocated inputs and outputs of the unit process, avoiding the double counting.
The following stepwise allocation principles shall be applied for multi-input/output allocations:

- The initial allocation step includes dividing up the system sub-processes and collecting the input and output data related to these sub-processes.

- The first (preferably) allocation procedure step for each sub-process is to partition the inputs and outputs of the system into their different products in a way that reflects the underlying physical relationships between them.
- The second (worst case) allocation procedure step is needed when physical relationship alone cannot be established or used as the basis for allocation. In this case, the remaining environmental inputs and outputs from a sub-process must be allocated between the products in a way that reflects other relationships between them, such as the economic value of the products.

Steel Mains' SINTAKOTE steel pipes assessed are manufactured in one plant located in Somerton, Melbourne, Australia. Mass and energy data have been sourced from the manufacturing plant by Steel Mains. This EPD includes SINTAKOTE steel pipes with a diameter range of 114-2159 mm, divided into 3 groups (Table 67). The quantities of materials required for producing Steel Mains' SINTAKOTE Steel pipe are specific to each group of products. Electricity, natural gas, LPG and water used as well as waste generated during the production of SINTAKOTE Steel pipes in the Somerton, VIC site in CY2020 are allocated to all pipes using mass allocation method.

Averages and Variability for GWP-GHG

This EPD include SINTAKOTE steel pipes with a diameter range of 114-2159 mm. The whole range of products are divided into 3 groups named as A, B and C (Table 67). The highest proportion of material used in the production of SINTAKOTE steel pipes per declared unit is steel. The variability for GWP-GHG of steel for groups A, B and C are within 4%, 6% and 0.1%, respectively.

[3]Frischknecht et. al., International Journal of Life Cycle Assessment, 12, 1-11, 2007

Background data

Generic and specific background data was sourced for raw materials in the upstream module, transportation, and end of life waste treatment. Specific data was adopted for steel to represent Steel Mains' SINTAKOTE Steel pipe product as accurately as possible. For Australia, the Australian Life Cycle Inventory (AusLCI) v1.36 compiled by the Australian Life Cycle Assessment Society (ALCAS, 2021) and the Australasian Unit Process LCI v2014.09. The AusLCI database at the time of this report was 1 years old, while the Australasian Unit Process LCI was 8 years old. Other authoritative sources (e.g., Ecoinvent v3.8 (Moreno, 2021), where necessary adapted for relevance to Australian conditions (energy sources, transport distances and modes and so on, and documented to show how the data is adapted for national relevance). At the time of reporting, the Ecoinvent v3.8 database was 1 years old. Global averages were used since the sourcing of these materials often changes from year to year. All background data used was less than 10 years old.

AusLCI dataset named as 'electricity, low voltage, Victoria/AU U' was used as the background for electricity. This dataset is from the latest version of AusLCI (v1.38, 2021). The electricity mix in this dataset accounts brown coal-based power, hydropower, wind power, photovoltaic power with contributions of 83.14, 6.51, 6.49 and 2.57%, respectively as well as minor contributions from biomass residue, biogass and natural gas based power generation systems.

Recycled content in products

The hot rolled steel used to produce Steel Mains' SINTAKOTE Steel pipes is sourced from BlueScope, which contains 17.4% recycled material according to the BlueScope EPD[4]. The recycled steel includes pre- and postconsumer recycled materials. Based on the guidelines from PCR 2019:14 and EN 15804 A2, the burden of impact from recycled materials has been excluded, but the impacts from processing of the recycled material have been allocated to Steel Mains. Essentially, secondary (recycled) materials bear only the impacts of the recycling processes.

Data quality and validation

The primary data used for the study (core module) is based on direct utility bills or feedstock quantities from Steel Mains' procurement records. Primary data was carefully reviewed in order to ensure completeness, accuracy and representativeness of the data supplied. The data was benchmarked against relevant benchmark data in Ecoinvent. Overall, the data was deemed to be of high quality for the core module. According to EN15804 A2, the data quality ranking is as follows: geographical representativeness – very good; technical representativeness – very good and time representativeness – very good.

Compliance with standards

The LCA and EPD have been developed to comply with:

- ISO 14040:2006 and ISO14044:2006+A1:2018 which describe the principles, framework, requirements and provides guidelines for life cycle assessment (LCA) (ISO 14040, 2006) (ISO 14044, 2006).
- ISO 14025:2006 Environmental labels and declarations – Type III environmental declarations -- Principles and procedures, which establishes the principles and specifies the procedures for developing Type III environmental declaration programmes and Type III environmental declarations (ISO 14025, 2006).
- ISO 14020:2000 Environmental labels and declarations — General principles, which describes the guiding principles for the development and use of environmental labels and declarations (ISO 14020, 2000).
- EN 15804+A2:2019: Sustainability of construction works – Environmental product declarations - Core rules for the product category of construction products- hereafter referred to as EN15804+A2 (BS EN 15804+A2, 2020).
- Product Category Rules (PCR) 2019:14, v1.1 – Construction products – hereafter referred to as PCR 2019:14 (PCR 2019:14, 2019).

[4]BlueScope (2020), Environmental Product Declaration – Steel – Hot Rolled Coil, version 2. EPD Australasia. https://epd-australasia.com/epd/steel-hot-rolled-coil/.

- General Programme Instructions (GPI) for the International EPD System V3.01 – containing instructions regarding methodology and the content that must be included in EPDs registered under the International EPD System (Environdec, 2019).
- Instructions of EPD Australasia V3.0 – a regional annex to the general programme instructions of the International EPD System.

Key assumptions and considerations

- Bluescope EPD was the source of LCIA data for steel.[4]
- All primary (foreground) data collected for this EPD was sourced from Steel Mains via a Request for Information spreadsheet. This data was collected for CY2020.
- A small portion of pipes are believed to be discarded or disposed into landfill after use. The assumption of 10% of pipes being disposed of in landfill is based on published literature.[5] The recycling rate has an impact on Module D - avoided production calculations.

Life cycle inventory

The proportion of steel in Steel Mains pipe varies with the diameter. In order to provide representative results for each pipe, the Steel Mains pipes, presented in this EPD, are divided into 3 groups: A,B and C (Table 67). Tables 3, 4 and 5 show material related data for per kg SINTAKOTE Steel Pipe in each group.

Table 3 - Materials used for manufacturing of SINTAKOTE Steel pipe: ***Product Group A***

Item	Mass (kg)	Post-consumer material (%)	Renewable material (%)
Steel	0.5395	17.4	0
Sand	0.2861	0	0
Cement-GP	0.1431	0	0
Polyethylene	0.0249	0	0
SealCoat Paint	0.0024	0	0
Flux	0.0026	0	0
Welding wire total	0.0014	0	0

Table 4 - Materials used for manufacturing of SINTAKOTE Steel pipe: ***Product Group B***

Item	Mass (kg)	Post-consumer material (%)	Renewable material (%)
Steel	0.6476	17.4	0
Sand	0.2669	0	0
Cement	0.1247	0	0
Polyethylene	0.0238	0	0
SealCoat Paint	0.0017	0	0
Flux	0.0045	0	0
Welding wire total	0.0025	0	0

[5]Pickin J et al., National Waste Report 2018, Prepared for the Department of the Environment and Energy; 2018, p. 31.

Table 5 - Materials used for manufacturing of SINTAKOTE Steel pipe: ***Product Group C***

Item	Mass (kg)	Post-consumer material (%)	Renewable material (%)
Steel	0.7232	17.4	0
Sand	0.1716	0	0
Cement-GP	0.0857	0	0
Polyethylene	0.0125	0	0
SealCoat Paint	0.0015	0	0
Flux	0.0035	0	0
Welding wire total	0.0018	0	0

None of the products contain one or more substances that are listed in the "Candidate List of Substances of Very High Concern for authorisation". According to the PCR 2019:14, if one or more substances of the "Candidate List of Substances of Very High Concern (SVHC) for authorisation" are present in a product and their total content exceeds 0.1% of the weight of the product, they need to be reported.

Environmental performance of SINTAKOTE Steel pipe

The estimated impact results are only relative statements which do not indicate the end points of the impact categories, exceeding threshold values, safety margins or risks. Most LCA tools have libraries of impact assessment methods that can completely automate the impact assessment. The following potential environmental impacts, use of resources and waste categories have been calculated in the SimaPro (v9.4) tool.

Table 6 - Life Cycle Impact, Resource and Waste Assessment Categories, Measurements and Methods

Impact Category	Abbreviation	Measurement Unit	Assessment Method and Implementation
Potential Environmental Impacts			
Global warming potential (fossil)	GWPF	kg CO_2 equivalents (GWP100)	Baseline model of 100 years of the IPCC based on IPCC 2013
Global warming potential (biogenic)	GWPB	kg CO_2 equivalents (GWP100)	Baseline model of 100 years of the IPCC based on IPCC 2013
Land use/ land transformation	GWPL	kg CO_2 equivalents (GWP100)	Baseline model of 100 years of the IPCC based on IPCC 2013
Total global warming potential	GWPT	kg CO_2 equivalents (GWP100)	Baseline model of 100 years of the IPCC based on IPCC 2013
Acidification potential	AP	mol H^+ eq.	Accumulated Exceedance, Seppälä et al. 2006, Posch et al., 2008
Eutrophication – aquatic freshwater	EP - freshwater	kg P equivalent	EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe[6]
Eutrophication – aquatic marine	EP - marine	kg N equivalent	EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe

Eutrophication – terrestrial	EP – terrestrial	mol N equivalent	Accumulated Exceedance, Seppälä et al. 2006, Posch et al.
Photochemical ozone creation potential	POCP	kg NMVOC equivalents	LOTOS-EUROS, Van Zelm et al., 2008, as applied in ReCiPe
Abiotic depletion potential (elements)*	ADPE	kg Sb equivalents	CML (v4.1)
Abiotic depletion potential (fossil fuels)*	ADPF	MJ net calorific value	CML (v4.1)
Ozone depletion potential	ODP	kg CFC 11 equivalents	Steady-state ODPs, WMO 2014
Water Depletion Potential*	WDP	m^3 equivalent deprived	Available WAter REmaining (AWARE) Boulay et al., 2016
Global warming potential, excluding biogenic uptake, emissions and storage	GWP-GHG	kg CO_2 equivalents (GWP100)	CML (v4.1)
Resource use			
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	PERE	MJ, net calorific value	ecoinvent version 3.6 and expanded by PRé Consultants[7]
Use of renewable primary energy resources used as raw materials	PERM	MJ, net calorific value	Manual for direct inputs[8]
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	PERT	MJ, net calorific value	ecoinvent version 3.6 and expanded by PRé Consultants
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	PENRE	MJ, net calorific value	Manual for direct inputs[9]
Use of non- renewable primary energy resources used as raw materials	PENRM	MJ, net calorific value	ecoinvent version 3.6 and expanded by PRé Consultants
Total use of non- renewable primary energy resources (primary energy and primary energy resources used as raw materials)	PENRT	MJ, net calorific value	ecoinvent version 3.6 and expanded by PRé Consultants[10]
Use of secondary material	SM	kg	Manual for direct inputs
Use of renewable secondary fuels	RSF	MJ, net calorific value	Manual for direct inputs
Use of non-renewable secondary fuels	NRSF	MJ, net calorific value	Manual for direct inputs
Use of net fresh water	FW	m^3	ReCiPe 2016
Waste categories			
Hazardous waste disposed	HWD	kg	EDIP 2003 (v1.05)
Non-hazardous waste disposed	NHWD	kg	EDIP 2003 (v1.05)[11]
Radioactive waste disposed/stored	RWD	kg	EDIP 2003 (v1.05)

[7] Method to calculate Cumulative Energy Demand (CED), based on the method published by Ecoinvent version 2.0 and expanded by PRé Consultants for raw materials available in the SimaPro database.
[8] Calculated based on the lower heating value of renewable raw materials.
[9] Calculated based on the lower heating value of non-renewable raw materials.
[10] Calculated as sum of *Non-renewable, fossil*, *Non-renewable, nuclear* and *Non-renewable, biomass*.
[11] Calculated as sum of *Bulk waste* and *Slags/ash*.

Additional environmental impact indicators			
Particulate matter	Potential incidence of disease due to PM emissions (PM)	Disease incidence	SETAC-UNEP, Fantke et al. 2016
Ionising radiation - human health**	Potential Human exposure efficiency relative to U235 (IRP)	kBq U-235 eq	Human Health Effect model
Eco-toxicity (freshwater)*	Potential Comparative Toxic Unit for ecosystems (ETP-fw)	CTUe	USEtox
Human toxicity potential - cancer effects*	Potential Comparative Toxic Unit for humans (HTP-c)	CTUh	USEtox
Human toxicity potential - non cancer effects*	Potential Comparative Toxic Unit for humans (HTP-nc)	CTUh	USEtox
Soil quality*	Potential soil quality index (SQP)	dimensionless	Soil quality index (LANCA®

**Disclaimer – The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.*
***Disclaimer – This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.*

Results for recycling at EoL scenario analysis

Refer to Appendix-1 for sizes' specifications of SINTAKOTE steel pipes. For the recycling scenario module C4 will have zero impact.

Results for restrained installation – declared unit per kg SINTAKOTE Steel pipe

Product Group A

Table 7 | Environmental impacts for restrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-fossil	kg CO_2 eq.	1.71E+00	8.77E-02	6.80E-02	6.25E-02	5.29E-03	1.88E-01	0.00E+00	-5.96E-01
GWP-biogenic	kg CO_2 eq.	1.94E-02	1.14E-05	1.58E-05	2.05E-06	6.90E-07	4.05E-04	0.00E+00	5.78E-03
GWP-luluc	kg CO_2 eq.	7.93E-05	6.61E-07	1.52E-06	8.36E-10	3.99E-08	5.24E-08	0.00E+00	4.53E-04
GWP-total	kg CO_2 eq.	1.73E+00	8.77E-02	6.80E-02	6.25E-02	5.29E-03	1.88E-01	0.00E+00	-5.89E-01
ODP	kg CFC 11 eq.	1.79E-08	1.42E-08	6.75E-10	8.86E-12	8.54E-10	1.55E-09	0.00E+00	-1.28E-08
AP	mol H^+ eq.	6.59E-03	5.41E-04	5.97E-04	5.55E-04	3.27E-05	1.17E-03	0.00E+00	-1.80E-03
EP-freshwater	kg P eq.	2.56E-05	2.83E-06	7.16E-07	4.52E-08	1.71E-07	5.81E-06	0.00E+00	-2.64E-04
EP-marine	kg N eq.	1.46E-03	1.18E-04	2.56E-04	2.48E-04	7.13E-06	1.66E-04	0.00E+00	-3.82E-04
EP-terrestrial	mol N eq.	1.63E-02	1.32E-03	2.80E-03	2.71E-03	7.95E-05	1.78E-03	0.00E+00	-4.71E-03
POCP	kg NMVOC eq.	4.95E-03	4.56E-04	6.74E-04	6.51E-04	2.75E-05	4.88E-04	0.00E+00	-1.73E-03
ADP-minerals & metals	kg Sb eq.	9.99E-07	2.76E-07	3.77E-08	1.37E-09	1.66E-08	1.87E-07	0.00E+00	1.15E-06
ADP-fossil	MJ	1.70E+01	1.22E+00	1.17E-01	2.23E-02	7.34E-02	1.21E+00	0.00E+00	-3.94E+00
WDP	m^3	2.40E+00	7.48E-01	1.41E-01	3.12E-02	4.51E-02	4.53E+00	0.00E+00	-3.09E-01

Table 8 | Resource use for restrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	2.13E-01	1.25E-02	3.91E-03	5.25E-04	7.53E-04	7.89E-02	0.00E+00	1.30E-01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.13E-01	1.25E-02	3.91E-03	5.25E-04	7.53E-04	7.89E-02	0.00E+00	1.30E-01
PENRE	MJ	1.71E+01	1.29E+00	1.23E-01	2.24E-02	7.76E-02	1.22E+00	0.00E+00	-4.07E+00
PENRM	MJ.	3.63E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.72E+01	1.29E+00	1.23E-01	2.24E-02	7.76E-02	1.22E+00	0.00E+00	-4.07E+00
SM	kg	1.13E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	1.69E-03	1.87E-04	2.18E-05	4.15E-06	1.13E-05	5.60E-05	0.00E+00	-2.80E-03

Table 9 | Waste production for restrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Hazardous waste disposed	kg	2.14E-02	1.53E-06	1.02E-07	6.11E-09	9.24E-08	3.78E-07	0.00E+00	-7.59E-05
Non-hazardous waste disposed	kg	3.47E-02	1.24E-02	8.28E-04	8.44E-05	7.46E-04	3.30E-02	0.00E+00	1.74E-02
Radioactive waste disposed	kg	1.57E-05	7.03E-09	2.35E-07	6.82E-11	4.24E-10	5.26E-09	0.00E+00	3.99E-06

Table 10 | Output flows for restrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	4.44E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.77E-01	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 11 | Additional environmental impact indicators for restrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-GHG	kg CO_2 eq.	1.66E+00	8.62E-02	6.66E-02	6.13E-02	5.20E-03	1.85E-01	0.00E+00	-5.50E-01
Particulate matter	disease incidence	7.54E-08	7.01E-09	3.40E-09	1.58E-09	4.23E-10	8.91E-09	0.00E+00	-2.06E-08
Ionising radiation - human health	kBq U-235 eq	6.36E-03	5.10E-05	1.98E-04	4.72E-07	3.08E-06	3.66E-05	0.00E+00	2.77E-02
Eco-toxicity (freshwater)	CTUe	4.15E+00	6.75E-01	1.54E+00	1.47E+00	4.07E-02	6.12E-01	0.00E+00	-1.80E+01
Human toxicity potential - cancer effects	CTUh	1.89E-10	2.49E-11	1.38E-10	1.06E-11	1.50E-12	4.04E-11	0.00E+00	4.83E-09
Human toxicity potential - non cancer effects	CTUh	2.90E-08	9.14E-10	1.57E-09	8.09E-10	5.51E-11	5.79E-10	0.00E+00	1.30E-07
Soil quality	dimensionless	1.39E+00	2.93E-01	2.44E-02	3.71E-03	1.77E-02	4.12E-01	0.00E+00	-9.67E-01

Product Group B

Table 12 | Environmental impacts forrestrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-fossil	kg CO_2 eq.	1.96E+00	8.77E-02	6.80E-02	6.25E-02	5.29E-03	1.88E-01	0.00E+00	-5.96E-01
GWP-biogenic	kg CO_2 eq.	2.03E-02	1.14E-05	1.58E-05	2.05E-06	6.90E-07	4.05E-04	0.00E+00	5.78E-03
GWP-luluc	kg CO_2 eq.	8.05E-05	6.61E-07	1.52E-06	8.36E-10	3.99E-08	5.24E-08	0.00E+00	4.53E-04
GWP-total	kg CO_2 eq.	1.97E+00	8.77E-02	6.80E-02	6.25E-02	5.29E-03	1.88E-01	0.00E+00	-5.89E-01
ODP	kg CFC 11 eq.	1.75E-08	1.42E-08	6.75E-10	8.86E-12	8.54E-10	1.55E-09	0.00E+00	-1.28E-08
AP	mol H^+ eq.	7.42E-03	5.41E-04	5.97E-04	5.55E-04	3.27E-05	1.17E-03	0.00E+00	-1.80E-03
EP-freshwater	kg P eq.	2.48E-05	2.83E-06	7.16E-07	4.52E-08	1.71E-07	5.81E-06	0.00E+00	-2.64E-04
EP-marine	kg N eq.	1.63E-03	1.18E-04	2.56E-04	2.48E-04	7.13E-06	1.66E-04	0.00E+00	-3.82E-04
EP-terrestrial	mol N eq.	1.83E-02	1.32E-03	2.80E-03	2.71E-03	7.95E-05	1.78E-03	0.00E+00	-4.71E-03
POCP	kg NMVOC eq.	5.56E-03	4.56E-04	6.74E-04	6.51E-04	2.75E-05	4.88E-04	0.00E+00	-1.73E-03
ADP-minerals & metals	kg Sb eq.	9.41E-07	2.76E-07	3.77E-08	1.37E-09	1.66E-08	1.87E-07	0.00E+00	1.15E-06
ADP-fossil	MJ	1.94E+01	1.22E+00	1.17E-01	2.23E-02	7.34E-02	1.21E+00	0.00E+00	-3.94E+00
WDP	m^3	2.82E+00	7.48E-01	1.41E-01	3.12E-02	4.51E-02	4.53E+00	0.00E+00	-3.09E-01

Table 13 | Resource use for restrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	2.59E-01	1.25E-02	3.91E-03	5.25E-04	7.53E-04	7.89E-02	0.00E+00	1.30E-01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.59E-01	1.25E-02	3.91E-03	5.25E-04	7.53E-04	7.89E-02	0.00E+00	1.30E-01
PENRE	MJ	1.95E+01	1.29E+00	1.23E-01	2.24E-02	7.76E-02	1.22E+00	0.00E+00	-4.07E+00
PENRM	MJ.	3.38E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.95E+01	1.29E+00	1.23E-01	2.24E-02	7.76E-02	1.22E+00	0.00E+00	-4.07E+00
SM	kg	1.36E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	2.14E-03	1.87E-04	2.18E-05	4.15E-06	1.13E-05	5.60E-05	0.00E+00	-2.80E-03

Table 14 | Waste production for restrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Hazardous waste disposed	kg	2.14E-02	1.53E-06	1.02E-07	6.11E-09	9.24E-08	3.78E-07	0.00E+00	-7.59E-05
Non-hazardous waste disposed	kg	3.58E-02	1.24E-02	8.28E-04	8.44E-05	7.46E-04	3.30E-02	0.00E+00	1.74E-02
Radioactive waste disposed	kg	1.80E-05	7.03E-09	2.35E-07	6.82E-11	4.24E-10	5.26E-09	0.00E+00	3.99E-06

Table 15 | Output floes for restrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	4.44E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.49E-01	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 16 | Additional environmental impacts for restrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-GHG	kg CO_2 eq.	1.90E+00	8.62E-02	6.66E-02	6.13E-02	5.20E-03	1.85E-01	0.00E+00	-5.50E-01
Particulate matter	disease incidence	8.66E-08	7.01E-09	3.40E-09	1.58E-09	4.23E-10	8.91E-09	0.00E+00	-2.06E-08
Ionising radiation - human health	kBq U-235 eq	7.15E-03	5.10E-05	1.98E-04	4.72E-07	3.08E-06	3.66E-05	0.00E+00	2.77E-02
Eco-toxicity (freshwater)	CTUe	4.15E+00	6.75E-01	1.54E+00	1.47E+00	4.07E-02	6.12E-01	0.00E+00	-1.80E+01
Human toxicity potential - cancer effects	CTUh	2.14E-10	2.49E-11	1.38E-10	1.06E-11	1.50E-12	4.04E-11	0.00E+00	4.83E-09
Human toxicity potential - non cancer effects	CTUh	3.46E-08	9.14E-10	1.57E-09	8.09E-10	5.51E-11	5.79E-10	0.00E+00	1.30E-07
Soil quality	dimensionless	1.40E+00	2.93E-01	2.44E-02	3.71E-03	1.77E-02	4.12E-01	0.00E+00	-9.67E-01

Product Group C

Table 17 | Environmental impacts for restrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-fossil	kg CO_2 eq.	2.07E+00	8.77E-02	6.80E-02	6.25E-02	5.29E-03	1.88E-01	0.00E+00	-5.96E-01
GWP-biogenic	kg CO_2 eq.	1.90E-02	1.14E-05	1.58E-05	2.05E-06	6.90E-07	4.05E-04	0.00E+00	5.78E-03
GWP-luluc	kg CO_2 eq.	7.53E-05	6.61E-07	1.52E-06	8.36E-10	3.99E-08	5.24E-08	0.00E+00	4.53E-04
GWP-total	kg CO_2 eq.	2.08E+00	8.77E-02	6.80E-02	6.25E-02	5.29E-03	1.88E-01	0.00E+00	-5.89E-01
ODP	kg CFC 11 eq.	1.50E-08	1.42E-08	6.75E-10	8.86E-12	8.54E-10	1.55E-09	0.00E+00	-1.28E-08
AP	mol H^+ eq.	7.72E-03	5.41E-04	5.97E-04	5.55E-04	3.27E-05	1.17E-03	0.00E+00	-1.80E-03
EP-freshwater	kg P eq.	1.95E-05	2.83E-06	7.16E-07	4.52E-08	1.71E-07	5.81E-06	0.00E+00	-2.64E-04
EP-marine	kg N eq.	1.69E-03	1.18E-04	2.56E-04	2.48E-04	7.13E-06	1.66E-04	0.00E+00	-3.82E-04
EP-terrestrial	mol N eq.	1.90E-02	1.32E-03	2.80E-03	2.71E-03	7.95E-05	1.78E-03	0.00E+00	-4.71E-03
POCP	kg NMVOC eq.	5.80E-03	4.56E-04	6.74E-04	6.51E-04	2.75E-05	4.88E-04	0.00E+00	-1.73E-03
ADP-minerals & metals	kg Sb eq.	7.83E-07	2.76E-07	3.77E-08	1.37E-09	1.66E-08	1.87E-07	0.00E+00	1.15E-06
ADP-fossil	MJ	1.99E+01	1.22E+00	1.17E-01	2.23E-02	7.34E-02	1.21E+00	0.00E+00	-3.94E+00
WDP	m^3	2.13E+00	7.48E-01	1.41E-01	3.12E-02	4.51E-02	4.53E+00	0.00E+00	-3.09E-01

Table 18 | Resource use for restrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	2.66E-01	1.25E-02	3.91E-03	5.25E-04	7.53E-04	7.89E-02	0.00E+00	1.30E-01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.66E-01	1.25E-02	3.91E-03	5.25E-04	7.53E-04	7.89E-02	0.00E+00	1.30E-01
PENRE	MJ	2.00E+01	1.29E+00	1.23E-01	2.24E-02	7.76E-02	1.22E+00	0.00E+00	-4.07E+00
PENRM	MJ.	2.18E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.00E+01	1.29E+00	1.23E-01	2.24E-02	7.76E-02	1.22E+00	0.00E+00	-4.07E+00
SM	kg	1.52E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	2.09E-03	1.87E-04	2.18E-05	4.15E-06	1.13E-05	5.60E-05	0.00E+00	-2.80E-03

Table 19 | Waste production for restrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Hazardous waste disposed	kg	2.14E-02	1.53E-06	1.02E-07	6.11E-09	9.24E-08	3.78E-07	0.00E+00	-7.59E-05
Non-hazardous waste disposed	kg	3.34E-02	1.24E-02	8.28E-04	8.44E-05	7.46E-04	3.30E-02	0.00E+00	1.74E-02
Radioactive waste disposed	kg	1.91E-05	7.03E-09	2.35E-07	6.82E-11	4.24E-10	5.26E-09	0.00E+00	3.99E-06

Table 20 | Output flows for restrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	4.44E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.26E-01	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 21 | Additional environmental impact indicators for restrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-GHG	kg CO_2 eq.	2.01E+00	8.62E-02	6.66E-02	6.13E-02	5.20E-03	1.85E-01	0.00E+00	-5.50E-01
Particulate matter	disease incidence	9.24E-08	7.01E-09	3.40E-09	1.58E-09	4.23E-10	8.91E-09	0.00E+00	-2.06E-08
Ionising radiation - human health	kBq U-235 eq	6.22E-03	5.10E-05	1.98E-04	4.72E-07	3.08E-06	3.66E-05	0.00E+00	2.77E-02
Eco-toxicity (freshwater)	CTUe	3.71E+00	6.75E-01	1.54E+00	1.47E+00	4.07E-02	6.12E-01	0.00E+00	-1.80E+01
Human toxicity potential - cancer effects	CTUh	2.07E-10	2.49E-11	1.38E-10	1.06E-11	1.50E-12	4.04E-11	0.00E+00	4.83E-09
Human toxicity potential - non cancer effects	CTUh	3.78E-08	9.14E-10	1.57E-09	8.09E-10	5.51E-11	5.79E-10	0.00E+00	1.30E-07
Soil quality	dimensionless	1.30E+00	2.93E-01	2.44E-02	3.71E-03	1.77E-02	4.12E-01	0.00E+00	-9.67E-01

Results for unrestrained installation – declared unit per kg SINTAKOTE Steel Pipe

Product Group A

Table 22 | Environmental impacts for unrestrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-fossil	kg CO_2 eq.	1.71E+00	8.77E-02	2.08E-03	6.25E-02	5.29E-03	1.87E-01	0.00E+00	-5.96E-01
GWP-biogenic	kg CO_2 eq.	1.94E-02	1.14E-05	6.82E-08	2.05E-06	6.90E-07	4.04E-04	0.00E+00	5.78E-03
GWP-luluc	kg CO_2 eq.	7.93E-05	6.61E-07	2.78E-11	8.36E-10	3.99E-08	5.23E-08	0.00E+00	4.53E-04
GWP-total	kg CO_2 eq.	1.73E+00	8.77E-02	2.08E-03	6.25E-02	5.29E-03	1.87E-01	0.00E+00	-5.89E-01
ODP	kg CFC 11 eq.	1.78E-08	1.42E-08	2.94E-13	8.86E-12	8.54E-10	1.55E-09	0.00E+00	-1.28E-08
AP	mol H^+ eq.	6.59E-03	5.41E-04	2.00E-05	5.55E-04	3.27E-05	1.16E-03	0.00E+00	-1.80E-03
EP-freshwater	kg P eq.	2.56E-05	2.83E-06	1.50E-09	4.52E-08	1.71E-07	5.79E-06	0.00E+00	-2.64E-04
EP-marine	kg N eq.	1.46E-03	1.18E-04	9.09E-06	2.48E-04	7.13E-06	1.65E-04	0.00E+00	-3.82E-04
EP-terrestrial	mol N eq.	1.63E-02	1.32E-03	9.93E-05	2.71E-03	7.95E-05	1.78E-03	0.00E+00	-4.71E-03
POCP	kg NMVOC eq.	4.95E-03	4.56E-04	2.42E-05	6.51E-04	2.75E-05	4.87E-04	0.00E+00	-1.73E-03
ADP-minerals & metals	kg Sb eq.	9.99E-07	2.76E-07	4.54E-11	1.37E-09	1.66E-08	1.86E-07	0.00E+00	1.15E-06
ADP-fossil	MJ	1.70E+01	1.22E+00	7.41E-04	2.23E-02	7.34E-02	1.20E+00	0.00E+00	-3.94E+00
WDP	m^3	2.20E+00	7.48E-01	1.04E-03	3.12E-02	4.51E-02	4.51E+00	0.00E+00	-3.09E-01

Table 23 | Resource use for unrestrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	2.13E-01	1.25E-02	1.74E-05	5.25E-04	7.53E-04	7.86E-02	0.00E+00	1.30E-01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.13E-01	1.25E-02	1.74E-05	5.25E-04	7.53E-04	7.86E-02	0.00E+00	1.30E-01
PENRE	MJ	1.71E+01	1.29E+00	7.44E-04	2.24E-02	7.76E-02	1.22E+00	0.00E+00	-4.07E+00
PENRM	MJ.	3.63E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.72E+01	1.29E+00	7.44E-04	2.24E-02	7.76E-02	1.22E+00	0.00E+00	-4.07E+00
SM	kg	1.13E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	1.69E-03	1.87E-04	1.38E-07	4.15E-06	1.13E-05	5.59E-05	0.00E+00	-2.80E-03

Table 24 | Waste production for unrestrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Hazardous waste disposed	kg	2.14E-02	1.53E-06	2.03E-10	6.11E-09	9.24E-08	3.76E-07	0.00E+00	-7.59E-05
Non-hazardous waste disposed	kg	3.47E-02	1.24E-02	2.80E-06	8.44E-05	7.46E-04	3.29E-02	0.00E+00	1.74E-02
Radioactive waste disposed	kg	1.57E-05	7.03E-09	2.26E-12	6.82E-11	4.24E-10	5.24E-09	0.00E+00	3.99E-06

Table 25 | Output flows for unrestrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	4.44E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.77E-01	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 26 | Additional environmental indicators for unrestrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-GHG	kg CO_2 eq.	1.66E+00	8.62E-02	2.04E-03	6.13E-02	5.20E-03	1.84E-01	0.00E+00	-5.50E-01
Particulate matter	disease incidence	7.54E-08	7.01E-09	1.26E-10	1.58E-09	4.23E-10	8.88E-09	0.00E+00	-2.06E-08
Ionising radiation - human health	kBq U-235 eq	6.36E-03	5.10E-05	1.57E-08	4.72E-07	3.08E-06	3.65E-05	0.00E+00	2.77E-02
Eco-toxicity (freshwater)	CTUe	4.15E+00	6.75E-01	4.89E-02	1.47E+00	4.07E-02	6.10E-01	0.00E+00	-1.80E+01
Human toxicity potential - cancer effects	CTUh	1.89E-10	2.49E-11	3.54E-13	1.06E-11	1.50E-12	4.03E-11	0.00E+00	4.83E-09
Human toxicity potential - non cancer effects	CTUh	2.90E-08	9.14E-10	2.77E-11	8.09E-10	5.51E-11	5.77E-10	0.00E+00	1.30E-07
Soil quality	dimensionless	1.39E+00	2.93E-01	1.23E-04	3.71E-03	1.77E-02	4.10E-01	0.00E+00	-9.67E-01

Product Group B

Table 27 | Environmental impacts for unrestrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-fossil	kg CO_2 eq.	1.96E+00	8.77E-02	2.08E-03	6.25E-02	5.29E-03	1.87E-01	0.00E+00	-5.96E-01
GWP-biogenic	kg CO_2 eq.	2.03E-02	1.14E-05	6.82E-08	2.05E-06	6.90E-07	4.04E-04	0.00E+00	5.78E-03
GWP-luluc	kg CO_2 eq.	8.05E-05	6.61E-07	2.78E-11	8.36E-10	3.99E-08	5.23E-08	0.00E+00	4.53E-04
GWP-total	kg CO_2 eq.	1.97E+00	8.77E-02	2.08E-03	6.25E-02	5.29E-03	1.87E-01	0.00E+00	-5.89E-01
ODP	kg CFC 11 eq.	1.75E-08	1.42E-08	2.94E-13	8.86E-12	8.54E-10	1.55E-09	0.00E+00	-1.28E-08
AP	mol H^+ eq.	7.42E-03	5.41E-04	2.00E-05	5.55E-04	3.27E-05	1.16E-03	0.00E+00	-1.80E-03
EP-freshwater	kg P eq.	2.48E-05	2.83E-06	1.50E-09	4.52E-08	1.71E-07	5.79E-06	0.00E+00	-2.64E-04
EP-marine	kg N eq.	1.63E-03	1.18E-04	9.09E-06	2.48E-04	7.13E-06	1.65E-04	0.00E+00	-3.82E-04
EP-terrestrial	mol N eq.	1.83E-02	1.32E-03	9.93E-05	2.71E-03	7.95E-05	1.78E-03	0.00E+00	-4.71E-03
POCP	kg NMVOC eq.	5.56E-03	4.56E-04	2.42E-05	6.51E-04	2.75E-05	4.87E-04	0.00E+00	-1.73E-03
ADP-minerals & metals	kg Sb eq.	9.41E-07	2.76E-07	4.54E-11	1.37E-09	1.66E-08	1.86E-07	0.00E+00	1.15E-06
ADP-fossil	MJ	1.94E+01	1.22E+00	7.41E-04	2.23E-02	7.34E-02	1.20E+00	0.00E+00	-3.94E+00
WDP	m^3	2.82E+00	7.48E-01	1.04E-03	3.12E-02	4.51E-02	4.51E+00	0.00E+00	-3.09E-01

Table 28 |Resource use for unrestrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	2.59E-01	1.25E-02	1.74E-05	5.25E-04	7.53E-04	7.86E-02	0.00E+00	1.30E-01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.59E-01	1.25E-02	1.74E-05	5.25E-04	7.53E-04	7.86E-02	0.00E+00	1.30E-01
PENRE	MJ	1.95E+01	1.29E+00	7.44E-04	2.24E-02	7.76E-02	1.22E+00	0.00E+00	-4.07E+00
PENRM	MJ.	3.38E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.95E+01	1.29E+00	7.44E-04	2.24E-02	7.76E-02	1.22E+00	0.00E+00	-4.07E+00
SM	kg	1.36E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	2.14E-03	1.87E-04	1.38E-07	4.15E-06	1.13E-05	5.59E-05	0.00E+00	-2.80E-03

Table 29 | Waste production for unrestrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Hazardous waste disposed	kg	2.14E-02	1.53E-06	2.03E-10	6.11E-09	9.24E-08	3.76E-07	0.00E+00	-7.59E-05
Non-hazardous waste disposed	kg	3.58E-02	1.24E-02	2.80E-06	8.44E-05	7.46E-04	3.29E-02	0.00E+00	1.74E-02
Radioactive waste disposed	kg	1.80E-05	7.03E-09	2.26E-12	6.82E-11	4.24E-10	5.24E-09	0.00E+00	3.99E-06

Table 30 | Output flows for unrestrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	4.44E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.49E-01	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 31 |Additional environmental impact indicators for unrestrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-GHG	kg CO_2 eq.	1.90E+00	8.62E-02	2.04E-03	6.13E-02	5.20E-03	1.84E-01	0.00E+00	-5.50E-01
Particulate matter	disease incidence	8.66E-08	7.01E-09	1.26E-10	1.58E-09	4.23E-10	8.88E-09	0.00E+00	-2.06E-08
Ionising radiation - human health	kBq U-235 eq	7.15E-03	5.10E-05	1.57E-08	4.72E-07	3.08E-06	3.65E-05	0.00E+00	2.77E-02
Eco-toxicity (freshwater)	CTUe	4.15E+00	6.75E-01	4.89E-02	1.47E+00	4.07E-02	6.10E-01	0.00E+00	-1.80E+01
Human toxicity potential - cancer effects	CTUh	2.14E-10	2.49E-11	3.54E-13	1.06E-11	1.50E-12	4.03E-11	0.00E+00	4.83E-09
Human toxicity potential - non cancer effects	CTUh	3.46E-08	9.14E-10	2.77E-11	8.09E-10	5.51E-11	5.77E-10	0.00E+00	1.30E-07
Soil quality	dimensionless	1.40E+00	2.93E-01	1.23E-04	3.71E-03	1.77E-02	4.10E-01	0.00E+00	-9.67E-01

Product Group C

Table 32 | Environmental impacts for unrestrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-fossil	kg CO_2 eq.	2.07E+00	8.77E-02	2.08E-03	6.25E-02	5.29E-03	1.87E-01	0.00E+00	-5.96E-01
GWP-biogenic	kg CO_2 eq.	1.90E-02	1.14E-05	6.82E-08	2.05E-06	6.90E-07	4.04E-04	0.00E+00	5.78E-03
GWP-luluc	kg CO_2 eq.	7.53E-05	6.61E-07	2.78E-11	8.36E-10	3.99E-08	5.23E-08	0.00E+00	4.53E-04
GWP-total	kg CO_2 eq.	2.08E+00	8.77E-02	2.08E-03	6.25E-02	5.29E-03	1.87E-01	0.00E+00	-5.89E-01
ODP	kg CFC 11 eq.	1.50E-08	1.42E-08	2.94E-13	8.86E-12	8.54E-10	1.55E-09	0.00E+00	-1.28E-08
AP	mol H^+ eq.	7.72E-03	5.41E-04	2.00E-05	5.55E-04	3.27E-05	1.16E-03	0.00E+00	-1.80E-03
EP-freshwater	kg P eq.	1.95E-05	2.83E-06	1.50E-09	4.52E-08	1.71E-07	5.79E-06	0.00E+00	-2.64E-04
EP-marine	kg N eq.	1.69E-03	1.18E-04	9.09E-06	2.48E-04	7.13E-06	1.65E-04	0.00E+00	-3.82E-04
EP-terrestrial	mol N eq.	1.90E-02	1.32E-03	9.93E-05	2.71E-03	7.95E-05	1.78E-03	0.00E+00	-4.71E-03
POCP	kg NMVOC eq.	5.80E-03	4.56E-04	2.42E-05	6.51E-04	2.75E-05	4.87E-04	0.00E+00	-1.73E-03
ADP-minerals & metals	kg Sb eq.	7.83E-07	2.76E-07	4.54E-11	1.37E-09	1.66E-08	1.86E-07	0.00E+00	1.15E-06
ADP-fossil	MJ	1.99E+01	1.22E+00	7.41E-04	2.23E-02	7.34E-02	1.20E+00	0.00E+00	-3.94E+00
WDP	m^3	2.13E+00	7.48E-01	1.04E-03	3.12E-02	4.51E-02	4.51E+00	0.00E+00	-3.09E-01

Table 33 | Resource use for unrestrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	2.66E-01	1.25E-02	1.74E-05	5.25E-04	7.53E-04	7.86E-02	0.00E+00	1.30E-01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.66E-01	1.25E-02	1.74E-05	5.25E-04	7.53E-04	7.86E-02	0.00E+00	1.30E-01
PENRE	MJ	2.00E+01	1.29E+00	7.44E-04	2.24E-02	7.76E-02	1.22E+00	0.00E+00	-4.07E+00
PENRM	MJ.	2.18E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.00E+01	1.29E+00	7.44E-04	2.24E-02	7.76E-02	1.22E+00	0.00E+00	-4.07E+00
SM	kg	1.52E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	2.09E-03	1.87E-04	1.38E-07	4.15E-06	1.13E-05	5.59E-05	0.00E+00	-2.80E-03

Table 34 | Waste production for unrestrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Hazardous waste disposed	kg	2.14E-02	1.53E-06	2.03E-10	6.11E-09	9.24E-08	3.76E-07	0.00E+00	-7.59E-05
Non-hazardous waste disposed	kg	3.34E-02	1.24E-02	2.80E-06	8.44E-05	7.46E-04	3.29E-02	0.00E+00	1.74E-02
Radioactive waste disposed	kg	1.91E-05	7.03E-09	2.26E-12	6.82E-11	4.24E-10	5.24E-09	0.00E+00	3.99E-06

Table 35 | Output flows for unrestrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	4.44E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.26E-01	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 36 | Additional environmental impact indicators for unrestrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-GHG	kg CO_2 eq.	2.01E+00	8.62E-02	2.04E-03	6.13E-02	5.20E-03	1.84E-01	0.00E+00	-5.50E-01
Particulate matter	disease incidence	9.24E-08	7.01E-09	1.26E-10	1.58E-09	4.23E-10	8.88E-09	0.00E+00	-2.06E-08
Ionising radiation - human health	kBq U-235 eq	6.22E-03	5.10E-05	1.57E-08	4.72E-07	3.08E-06	3.65E-05	0.00E+00	2.77E-02
Eco-toxicity (freshwater)	CTUe	3.71E+00	6.75E-01	4.89E-02	1.47E+00	4.07E-02	6.10E-01	0.00E+00	-1.80E+01
Human toxicity potential - cancer effects	CTUh	2.07E-10	2.49E-11	3.54E-13	1.06E-11	1.50E-12	4.03E-11	0.00E+00	4.83E-09
Human toxicity potential - non cancer effects	CTUh	3.78E-08	9.14E-10	2.77E-11	8.09E-10	5.51E-11	5.77E-10	0.00E+00	1.30E-07
Soil quality	dimensionless	1.30E+00	2.93E-01	1.23E-04	3.71E-03	1.77E-02	4.10E-01	0.00E+00	-9.67E-01

Results for landfilling at EoL scenario analysis

Refer to Appendix-1 for sizes' specifications of SINTAKOTE steel pipes. For the landfilling scenario, modules C3 and D will have zero impact.

Results for restrained installation – declared unit per kg SINTAKOTE Steel pipe

Product Group A

Table 37 | Environmental impacts for restrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-fossil	kg CO_2 eq.	1.71E+00	8.77E-02	6.80E-02	6.25E-02	5.29E-03	0.00E+00	5.52E-03	0.00E+00
GWP-biogenic	kg CO_2 eq.	1.94E-02	1.14E-05	1.58E-05	2.05E-06	6.90E-07	0.00E+00	6.87E-06	0.00E+00
GWP-luluc	kg CO_2 eq.	7.93E-05	6.61E-07	1.52E-06	8.36E-10	3.99E-08	0.00E+00	1.84E-08	0.00E+00
GWP-total	kg CO_2 eq.	1.73E+00	8.77E-02	6.80E-02	6.25E-02	5.29E-03	0.00E+00	5.53E-03	0.00E+00
ODP	kg CFC 11 eq.	1.79E-08	1.42E-08	6.75E-10	8.86E-12	8.54E-10	0.00E+00	9.82E-10	0.00E+00
AP	mol H^+ eq.	6.59E-03	5.41E-04	5.97E-04	5.55E-04	3.27E-05	0.00E+00	3.68E-05	0.00E+00
EP-freshwater	kg P eq.	2.56E-05	2.83E-06	7.16E-07	4.52E-08	1.71E-07	0.00E+00	5.93E-08	0.00E+00
EP-marine	kg N eq.	1.46E-03	1.18E-04	2.56E-04	2.48E-04	7.13E-06	0.00E+00	1.25E-05	0.00E+00
EP-terrestrial	mol N eq.	1.63E-02	1.32E-03	2.80E-03	2.71E-03	7.95E-05	0.00E+00	1.37E-04	0.00E+00
POCP	kg NMVOC eq.	4.95E-03	4.56E-04	6.74E-04	6.51E-04	2.75E-05	0.00E+00	4.01E-05	0.00E+00
ADP-minerals & metals	kg Sb eq.	9.99E-07	2.76E-07	3.77E-08	1.37E-09	1.66E-08	0.00E+00	4.34E-09	0.00E+00
ADP-fossil	MJ	1.70E+01	1.22E+00	1.17E-01	2.23E-02	7.34E-02	0.00E+00	7.09E-02	0.00E+00
WDP	m^3	2.40E+00	7.48E-01	1.41E-01	3.12E-02	4.51E-02	0.00E+00	2.57E-02	0.00E+00

Table 38 | Resource use for restrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	2.13E-01	1.25E-02	3.91E-03	5.25E-04	7.53E-04	0.00E+00	6.85E-04	0.00E+00
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.13E-01	1.25E-02	3.91E-03	5.25E-04	7.53E-04	0.00E+00	6.85E-04	0.00E+00
PENRE	MJ	1.71E+01	1.29E+00	1.23E-01	2.24E-02	7.76E-02	0.00E+00	7.48E-02	0.00E+00
PENRM	MJ.	3.63E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.72E+01	1.29E+00	1.23E-01	2.24E-02	7.76E-02	0.00E+00	7.48E-02	0.00E+00
SM	kg	1.13E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	1.69E-03	1.87E-04	2.18E-05	4.15E-06	1.13E-05	0.00E+00	3.96E-05	0.00E+00

Table 39 | Waste production for restrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Hazardous waste disposed	kg	2.14E-02	1.53E-06	1.02E-07	6.11E-09	9.24E-08	0.00E+00	3.00E-08	0.00E+00
Non-hazardous waste disposed	kg	3.47E-02	1.24E-02	8.28E-04	8.44E-05	7.46E-04	0.00E+00	1.06E+00	0.00E+00
Radioactive waste disposed	kg	1.57E-05	7.03E-09	2.35E-07	6.82E-11	4.24E-10	0.00E+00	1.75E-10	0.00E+00

Table 40 | Output flows for restrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	4.44E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 41 | Additional environmental impact indicators for restrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-GHG	kg CO_2 eq.	1.66E+00	8.62E-02	6.66E-02	6.13E-02	5.20E-03	0.00E+00	5.39E-03	0.00E+00
Particulate matter	disease incidence	7.54E-08	7.01E-09	3.40E-09	1.58E-09	4.23E-10	0.00E+00	1.97E-10	0.00E+00
Ionising radiation - human health	kBq U-235 eq	6.36E-03	5.10E-05	1.98E-04	4.72E-07	3.08E-06	0.00E+00	1.31E-06	0.00E+00
Eco-toxicity (freshwater)	CTUe	4.15E+00	6.75E-01	1.54E+00	1.47E+00	4.07E-02	0.00E+00	5.11E-01	0.00E+00
Human toxicity potential - cancer effects	CTUh	1.89E-10	2.49E-11	1.38E-10	1.06E-11	1.50E-12	0.00E+00	1.06E-12	0.00E+00
Human toxicity potential - non cancer effects	CTUh	2.90E-08	9.14E-10	1.57E-09	8.09E-10	5.51E-11	0.00E+00	5.78E-11	0.00E+00
Soil quality	dimensionless	1.39E+00	2.93E-01	2.44E-02	3.71E-03	1.77E-02	0.00E+00	1.31E-01	0.00E+00

Product Group B

Table 42 | Environmental impacts for restrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-fossil	kg CO_2 eq.	1.96E+00	8.77E-02	6.80E-02	6.25E-02	5.29E-03	0.00E+00	5.52E-03	0.00E+00
GWP-biogenic	kg CO_2 eq.	2.03E-02	1.14E-05	1.58E-05	2.05E-06	6.90E-07	0.00E+00	6.87E-06	0.00E+00
GWP-luluc	kg CO_2 eq.	8.05E-05	6.61E-07	1.52E-06	8.36E-10	3.99E-08	0.00E+00	1.84E-08	0.00E+00
GWP-total	kg CO_2 eq.	1.97E+00	8.77E-02	6.80E-02	6.25E-02	5.29E-03	0.00E+00	5.53E-03	0.00E+00
ODP	kg CFC 11 eq.	1.75E-08	1.42E-08	6.75E-10	8.86E-12	8.54E-10	0.00E+00	9.82E-10	0.00E+00
AP	mol H^+ eq.	7.42E-03	5.41E-04	5.97E-04	5.55E-04	3.27E-05	0.00E+00	3.68E-05	0.00E+00
EP-freshwater	kg P eq.	2.48E-05	2.83E-06	7.16E-07	4.52E-08	1.71E-07	0.00E+00	5.93E-08	0.00E+00
EP-marine	kg N eq.	1.63E-03	1.18E-04	2.56E-04	2.48E-04	7.13E-06	0.00E+00	1.25E-05	0.00E+00
EP-terrestrial	mol N eq.	1.83E-02	1.32E-03	2.80E-03	2.71E-03	7.95E-05	0.00E+00	1.37E-04	0.00E+00
POCP	kg NMVOC eq.	5.56E-03	4.56E-04	6.74E-04	6.51E-04	2.75E-05	0.00E+00	4.01E-05	0.00E+00
ADP-minerals & metals	kg Sb eq.	9.41E-07	2.76E-07	3.77E-08	1.37E-09	1.66E-08	0.00E+00	4.34E-09	0.00E+00
ADP-fossil	MJ	1.94E+01	1.22E+00	1.17E-01	2.23E-02	7.34E-02	0.00E+00	7.09E-02	0.00E+00
WDP	m^3	2.82E+00	7.48E-01	1.41E-01	3.12E-02	4.51E-02	0.00E+00	2.57E-02	0.00E+00

Table 43 | Resource use for restrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	2.59E-01	1.25E-02	3.91E-03	5.25E-04	7.53E-04	0.00E+00	6.85E-04	0.00E+00
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.59E-01	1.25E-02	3.91E-03	5.25E-04	7.53E-04	0.00E+00	6.85E-04	0.00E+00
PENRE	MJ	1.95E+01	1.29E+00	1.23E-01	2.24E-02	7.76E-02	0.00E+00	7.48E-02	0.00E+00
PENRM	MJ.	3.38E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.95E+01	1.29E+00	1.23E-01	2.24E-02	7.76E-02	0.00E+00	7.48E-02	0.00E+00
SM	kg	1.36E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	2.14E-03	1.87E-04	2.18E-05	4.15E-06	1.13E-05	0.00E+00	3.96E-05	0.00E+00

Table 44 | Waste production for restrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Hazardous waste disposed	kg	2.14E-02	1.53E-06	1.02E-07	6.11E-09	9.24E-08	0.00E+00	3.00E-08	0.00E+00
Non-hazardous waste disposed	kg	3.58E-02	1.24E-02	8.28E-04	8.44E-05	7.46E-04	0.00E+00	1.06E+00	0.00E+00
Radioactive waste disposed	kg	1.80E-05	7.03E-09	2.35E-07	6.82E-11	4.24E-10	0.00E+00	1.75E-10	0.00E+00

Table 45 | Output flows for restrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	4.44E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 46 | Additional environmental impacts indicators for restrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-GHG	kg CO_2 eq.	1.90E+00	8.62E-02	6.66E-02	6.13E-02	5.20E-03	0.00E+00	5.39E-03	0.00E+00
Particulate matter	disease incidence	8.66E-08	7.01E-09	3.40E-09	1.58E-09	4.23E-10	0.00E+00	1.97E-10	0.00E+00
Ionising radiation - human health	kBq U-235 eq	7.15E-03	5.10E-05	1.98E-04	4.72E-07	3.08E-06	0.00E+00	1.31E-06	0.00E+00
Eco-toxicity (freshwater)	CTUe	4.15E+00	6.75E-01	1.54E+00	1.47E+00	4.07E-02	0.00E+00	5.11E-01	0.00E+00
Human toxicity potential - cancer effects	CTUh	2.14E-10	2.49E-11	1.38E-10	1.06E-11	1.50E-12	0.00E+00	1.06E-12	0.00E+00
Human toxicity potential - non cancer effects	CTUh	3.46E-08	9.14E-10	1.57E-09	8.09E-10	5.51E-11	0.00E+00	5.78E-11	0.00E+00
Soil quality	dimensionless	1.40E+00	2.93E-01	2.44E-02	3.71E-03	1.77E-02	0.00E+00	1.31E-01	0.00E+00

Product Group C

Table 47 | Environmental impacts for restrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-fossil	kg CO_2 eq.	2.07E+00	8.77E-02	6.80E-02	6.25E-02	5.29E-03	0.00E+00	5.52E-03	0.00E+00
GWP-biogenic	kg CO_2 eq.	1.90E-02	1.14E-05	1.58E-05	2.05E-06	6.90E-07	0.00E+00	6.87E-06	0.00E+00
GWP-luluc	kg CO_2 eq.	7.53E-05	6.61E-07	1.52E-06	8.36E-10	3.99E-08	0.00E+00	1.84E-08	0.00E+00
GWP-total	kg CO_2 eq.	2.08E+00	8.77E-02	6.80E-02	6.25E-02	5.29E-03	0.00E+00	5.53E-03	0.00E+00
ODP	kg CFC 11 eq.	1.50E-08	1.42E-08	6.75E-10	8.86E-12	8.54E-10	0.00E+00	9.82E-10	0.00E+00
AP	mol H^+ eq.	7.72E-03	5.41E-04	5.97E-04	5.55E-04	3.27E-05	0.00E+00	3.68E-05	0.00E+00
EP-freshwater	kg P eq.	1.95E-05	2.83E-06	7.16E-07	4.52E-08	1.71E-07	0.00E+00	5.93E-08	0.00E+00
EP-marine	kg N eq.	1.69E-03	1.18E-04	2.56E-04	2.48E-04	7.13E-06	0.00E+00	1.25E-05	0.00E+00
EP-terrestrial	mol N eq.	1.90E-02	1.32E-03	2.80E-03	2.71E-03	7.95E-05	0.00E+00	1.37E-04	0.00E+00
POCP	kg NMVOC eq.	5.80E-03	4.56E-04	6.74E-04	6.51E-04	2.75E-05	0.00E+00	4.01E-05	0.00E+00
ADP-minerals & metals	kg Sb eq.	7.83E-07	2.76E-07	3.77E-08	1.37E-09	1.66E-08	0.00E+00	4.34E-09	0.00E+00
ADP-fossil	MJ	1.99E+01	1.22E+00	1.17E-01	2.23E-02	7.34E-02	0.00E+00	7.09E-02	0.00E+00
WDP	m^3	2.32E+00	7.48E-01	1.41E-01	3.12E-02	4.51E-02	0.00E+00	2.57E-02	0.00E+00

Table 48 | Resource use for restrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	2.66E-01	1.25E-02	3.91E-03	5.25E-04	7.53E-04	0.00E+00	6.85E-04	0.00E+00
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.66E-01	1.25E-02	3.91E-03	5.25E-04	7.53E-04	0.00E+00	6.85E-04	0.00E+00
PENRE	MJ	2.00E+01	1.29E+00	1.23E-01	2.24E-02	7.76E-02	0.00E+00	7.48E-02	0.00E+00
PENRM	MJ.	2.18E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.00E+01	1.29E+00	1.23E-01	2.24E-02	7.76E-02	0.00E+00	7.48E-02	0.00E+00
SM	kg	1.52E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	2.09E-03	1.87E-04	2.18E-05	4.15E-06	1.13E-05	0.00E+00	3.96E-05	0.00E+00

Table 49 | Waste production for restrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Hazardous waste disposed	kg	2.14E-02	1.53E-06	1.02E-07	6.11E-09	9.24E-08	0.00E+00	3.00E-08	0.00E+00
Non-hazardous waste disposed	kg	3.34E-02	1.24E-02	8.28E-04	8.44E-05	7.46E-04	0.00E+00	1.06E+00	0.00E+00
Radioactive waste disposed	kg	1.91E-05	7.03E-09	2.35E-07	6.82E-11	4.24E-10	0.00E+00	1.75E-10	0.00E+00

Table 50 | Output flows for restrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	4.44E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 51 | Additional environmental impact indicators for restrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-GHG	kg CO_2 eq.	2.01E+00	8.62E-02	6.66E-02	6.13E-02	5.20E-03	0.00E+00	5.39E-03	0.00E+00
Particulate matter	disease incidence	9.24E-08	7.01E-09	3.40E-09	1.58E-09	4.23E-10	0.00E+00	1.97E-10	0.00E+00
Ionising radiation - human health	kBq U-235 eq	6.22E-03	5.10E-05	1.98E-04	4.72E-07	3.08E-06	0.00E+00	1.31E-06	0.00E+00
Eco-toxicity (freshwater)	CTUe	3.71E+00	6.75E-01	1.54E+00	1.47E+00	4.07E-02	0.00E+00	5.11E-01	0.00E+00
Human toxicity potential - cancer effects	CTUh	2.07E-10	2.49E-11	1.38E-10	1.06E-11	1.50E-12	0.00E+00	1.06E-12	0.00E+00
Human toxicity potential - non cancer effects	CTUh	3.78E-08	9.14E-10	1.57E-09	8.09E-10	5.51E-11	0.00E+00	5.78E-11	0.00E+00
Soil quality	dimensionless	1.30E+00	2.93E-01	2.44E-02	3.71E-03	1.77E-02	0.00E+00	1.31E-01	0.00E+00

Results for unrestrained installation – declared unit per kg SINTAKOTE Steel Pipe

Product Group A

Table 52 | Environmental impacts for unrestrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-fossil	kg CO_2 eq.	1.71E+00	8.77E-02	2.08E-03	6.25E-02	5.29E-03	0.00E+00	5.51E-03	0.00E+00
GWP-biogenic	kg CO_2 eq.	1.94E-02	1.14E-05	6.82E-08	2.05E-06	6.90E-07	0.00E+00	6.86E-06	0.00E+00
GWP-luluc	kg CO_2 eq.	7.93E-05	6.61E-07	2.78E-11	8.36E-10	3.99E-08	0.00E+00	1.84E-08	0.00E+00
GWP-total	kg CO_2 eq.	1.73E+00	8.77E-02	2.08E-03	6.25E-02	5.29E-03	0.00E+00	5.51E-03	0.00E+00
ODP	kg CFC 11 eq.	1.78E-08	1.42E-08	2.94E-13	8.86E-12	8.54E-10	0.00E+00	9.80E-10	0.00E+00
AP	mol H^+ eq.	6.59E-03	5.41E-04	2.00E-05	5.55E-04	3.27E-05	0.00E+00	3.67E-05	0.00E+00
EP-freshwater	kg P eq.	2.56E-05	2.83E-06	1.50E-09	4.52E-08	1.71E-07	0.00E+00	5.92E-08	0.00E+00
EP-marine	kg N eq.	1.46E-03	1.18E-04	9.09E-06	2.48E-04	7.13E-06	0.00E+00	1.24E-05	0.00E+00
EP-terrestrial	mol N eq.	1.63E-02	1.32E-03	9.93E-05	2.71E-03	7.95E-05	0.00E+00	1.36E-04	0.00E+00
POCP	kg NMVOC eq.	4.95E-03	4.56E-04	2.42E-05	6.51E-04	2.75E-05	0.00E+00	4.00E-05	0.00E+00
ADP-minerals & metals	kg Sb eq.	9.99E-07	2.76E-07	4.54E-11	1.37E-09	1.66E-08	0.00E+00	4.33E-09	0.00E+00
ADP-fossil	MJ	1.70E+01	1.22E+00	7.41E-04	2.23E-02	7.34E-02	0.00E+00	7.07E-02	0.00E+00
WDP	m^3	2.20E+00	7.48E-01	1.04E-03	3.12E-02	4.51E-02	0.00E+00	2.57E-02	0.00E+00

Table 53 | Resource use for unrestrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	2.13E-01	1.25E-02	1.74E-05	5.25E-04	7.53E-04	0.00E+00	6.83E-04	0.00E+00
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.13E-01	1.25E-02	1.74E-05	5.25E-04	7.53E-04	0.00E+00	6.83E-04	0.00E+00
PENRE	MJ	1.71E+01	1.29E+00	7.44E-04	2.24E-02	7.76E-02	0.00E+00	7.46E-02	0.00E+00
PENRM	MJ.	3.63E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.72E+01	1.29E+00	7.44E-04	2.24E-02	7.76E-02	0.00E+00	7.46E-02	0.00E+00
SM	kg	1.13E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	1.69E-03	1.87E-04	1.38E-07	4.15E-06	1.13E-05	0.00E+00	3.95E-05	0.00E+00

Table 54 | Waste production for unrestrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Hazardous waste disposed	kg	2.14E-02	1.53E-06	2.03E-10	6.11E-09	9.24E-08	0.00E+00	3.00E-08	0.00E+00
Non-hazardous waste disposed	kg	3.47E-02	1.24E-02	2.80E-06	8.44E-05	7.46E-04	0.00E+00	1.05E+00	0.00E+00
Radioactive waste disposed	kg	1.57E-05	7.03E-09	2.26E-12	6.82E-11	4.24E-10	0.00E+00	1.74E-10	0.00E+00

Table 55 | Output flows for unrestrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	4.44E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 56 | Additional environmental impact indicators for unrestrained product group A pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-GHG	kg CO_2 eq.	1.66E+00	8.62E-02	2.04E-03	6.13E-02	5.20E-03	0.00E+00	5.38E-03	0.00E+00
Particulate matter	disease incidence	7.54E-08	7.01E-09	1.26E-10	1.58E-09	4.23E-10	0.00E+00	1.96E-10	0.00E+00
Ionising radiation - human health	kBq U-235 eq	6.36E-03	5.10E-05	1.57E-08	4.72E-07	3.08E-06	0.00E+00	1.30E-06	0.00E+00
Eco-toxicity (freshwater)	CTUe	4.15E+00	6.75E-01	4.89E-02	1.47E+00	4.07E-02	0.00E+00	5.10E-01	0.00E+00
Human toxicity potential - cancer effects	CTUh	1.89E-10	2.49E-11	3.54E-13	1.06E-11	1.50E-12	0.00E+00	1.06E-12	0.00E+00
Human toxicity potential - non cancer effects	CTUh	2.90E-08	9.14E-10	2.77E-11	8.09E-10	5.51E-11	0.00E+00	5.77E-11	0.00E+00
Soil quality	dimensionless	1.39E+00	2.93E-01	1.23E-04	3.71E-03	1.77E-02	0.00E+00	1.30E-01	0.00E+00

Product Group B

Table 57 | Environmental impacts for unrestrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-fossil	kg CO_2 eq.	1.96E+00	8.77E-02	2.08E-03	6.25E-02	5.29E-03	0.00E+00	5.51E-03	0.00E+00
GWP-biogenic	kg CO_2 eq.	2.03E-02	1.14E-05	6.82E-08	2.05E-06	6.90E-07	0.00E+00	6.86E-06	0.00E+00
GWP-luluc	kg CO_2 eq.	8.05E-05	6.61E-07	2.78E-11	8.36E-10	3.99E-08	0.00E+00	1.84E-08	0.00E+00
GWP-total	kg CO_2 eq.	1.97E+00	8.77E-02	2.08E-03	6.25E-02	5.29E-03	0.00E+00	5.51E-03	0.00E+00
ODP	kg CFC 11 eq.	1.75E-08	1.42E-08	2.94E-13	8.86E-12	8.54E-10	0.00E+00	9.80E-10	0.00E+00
AP	mol H^+ eq.	7.42E-03	5.41E-04	2.00E-05	5.55E-04	3.27E-05	0.00E+00	3.67E-05	0.00E+00
EP-freshwater	kg P eq.	2.48E-05	2.83E-06	1.50E-09	4.52E-08	1.71E-07	0.00E+00	5.92E-08	0.00E+00
EP-marine	kg N eq.	1.63E-03	1.18E-04	9.09E-06	2.48E-04	7.13E-06	0.00E+00	1.24E-05	0.00E+00
EP-terrestrial	mol N eq.	1.83E-02	1.32E-03	9.93E-05	2.71E-03	7.95E-05	0.00E+00	1.36E-04	0.00E+00
POCP	kg NMVOC eq.	5.56E-03	4.56E-04	2.42E-05	6.51E-04	2.75E-05	0.00E+00	4.00E-05	0.00E+00
ADP-minerals&metals	kg Sb eq.	9.41E-07	2.76E-07	4.54E-11	1.37E-09	1.66E-08	0.00E+00	4.33E-09	0.00E+00
ADP-fossil	MJ	1.94E+01	1.22E+00	7.41E-04	2.23E-02	7.34E-02	0.00E+00	7.07E-02	0.00E+00
WDP	m^3	2.82E+00	7.48E-01	1.04E-03	3.12E-02	4.51E-02	0.00E+00	2.57E-02	0.00E+00

Table 58 | Resource use for unrestrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	2.59E-01	1.25E-02	1.74E-05	5.25E-04	7.53E-04	0.00E+00	6.83E-04	0.00E+00
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.59E-01	1.25E-02	1.74E-05	5.25E-04	7.53E-04	0.00E+00	6.83E-04	0.00E+00
PENRE	MJ	1.95E+01	1.29E+00	7.44E-04	2.24E-02	7.76E-02	0.00E+00	7.46E-02	0.00E+00
PENRM	MJ.	3.38E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.95E+01	1.29E+00	7.44E-04	2.24E-02	7.76E-02	0.00E+00	7.46E-02	0.00E+00
SM	kg	1.36E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	2.14E-03	1.87E-04	1.38E-07	4.15E-06	1.13E-05	0.00E+00	3.95E-05	0.00E+00

Table 59 | Waste production for unrestrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Hazardous waste disposed	kg	2.14E-02	1.53E-06	2.03E-10	6.11E-09	9.24E-08	0.00E+00	3.00E-08	0.00E+00
Non-hazardous waste disposed	kg	3.58E-02	1.24E-02	2.80E-06	8.44E-05	7.46E-04	0.00E+00	1.05E+00	0.00E+00
Radioactive waste disposed	kg	1.80E-05	7.03E-09	2.26E-12	6.82E-11	4.24E-10	0.00E+00	1.74E-10	0.00E+00

Table 60 | Output flows for unrestrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	4.44E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 61 | Additional environmental impact indicators for unrestrained product group B pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-GHG	kg CO_2 eq.	1.90E+00	8.62E-02	2.04E-03	6.13E-02	5.20E-03	0.00E+00	5.38E-03	0.00E+00
Particulate matter	disease incidence	8.66E-08	7.01E-09	1.26E-10	1.58E-09	4.23E-10	0.00E+00	1.96E-10	0.00E+00
Ionising radiation - human health	kBq U-235 eq	7.15E-03	5.10E-05	1.57E-08	4.72E-07	3.08E-06	0.00E+00	1.30E-06	0.00E+00
Eco-toxicity (freshwater)	CTUe	4.15E+00	6.75E-01	4.89E-02	1.47E+00	4.07E-02	0.00E+00	5.10E-01	0.00E+00
Human toxicity potential - cancer effects	CTUh	2.14E-10	2.49E-11	3.54E-13	1.06E-11	1.50E-12	0.00E+00	1.06E-12	0.00E+00
Human toxicity potential - non cancer effects	CTUh	3.46E-08	9.14E-10	2.77E-11	8.09E-10	5.51E-11	0.00E+00	5.77E-11	0.00E+00
Soil quality	dimensionless	1.40E+00	2.93E-01	1.23E-04	3.71E-03	1.77E-02	0.00E+00	1.30E-01	0.00E+00

Product Group C

Table 62 | Environmental impacts for unrestrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-fossil	kg CO_2 eq.	2.07E+00	8.77E-02	2.08E-03	6.25E-02	5.29E-03	0.00E+00	5.51E-03	0.00E+00
GWP-biogenic	kg CO_2 eq.	1.90E-02	1.14E-05	6.82E-08	2.05E-06	6.90E-07	0.00E+00	6.86E-06	0.00E+00
GWP-luluc	kg CO_2 eq.	7.53E-05	6.61E-07	2.78E-11	8.36E-10	3.99E-08	0.00E+00	1.84E-08	0.00E+00
GWP-total	kg CO_2 eq.	2.08E+00	8.77E-02	2.08E-03	6.25E-02	5.29E-03	0.00E+00	5.51E-03	0.00E+00
ODP	kg CFC 11 eq.	1.50E-08	1.42E-08	2.94E-13	8.86E-12	8.54E-10	0.00E+00	9.80E-10	0.00E+00
AP	mol H^+ eq.	7.72E-03	5.41E-04	2.00E-05	5.55E-04	3.27E-05	0.00E+00	3.67E-05	0.00E+00
EP-freshwater	kg P eq.	1.95E-05	2.83E-06	1.50E-09	4.52E-08	1.71E-07	0.00E+00	5.92E-08	0.00E+00
EP-marine	kg N eq.	1.69E-03	1.18E-04	9.09E-06	2.48E-04	7.13E-06	0.00E+00	1.24E-05	0.00E+00
EP-terrestrial	mol N eq.	1.90E-02	1.32E-03	9.93E-05	2.71E-03	7.95E-05	0.00E+00	1.36E-04	0.00E+00
POCP	kg NMVOC eq.	5.80E-03	4.56E-04	2.42E-05	6.51E-04	2.75E-05	0.00E+00	4.00E-05	0.00E+00
ADP-minerals&metals	kg Sb eq.	7.83E-07	2.76E-07	4.54E-11	1.37E-09	1.66E-08	0.00E+00	4.33E-09	0.00E+00
ADP-fossil	MJ	1.99E+01	1.22E+00	7.41E-04	2.23E-02	7.34E-02	0.00E+00	7.07E-02	0.00E+00
WDP	m^3	2.13E+00	7.48E-01	1.04E-03	3.12E-02	4.51E-02	0.00E+00	2.57E-02	0.00E+00

Table 63 | Resource use for unrestrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	2.66E-01	1.25E-02	1.74E-05	5.25E-04	7.53E-04	0.00E+00	6.83E-04	0.00E+00
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.66E-01	1.25E-02	1.74E-05	5.25E-04	7.53E-04	0.00E+00	6.83E-04	0.00E+00
PENRE	MJ	2.00E+01	1.29E+00	7.44E-04	2.24E-02	7.76E-02	0.00E+00	7.46E-02	0.00E+00
PENRM	MJ.	2.18E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.00E+01	1.29E+00	7.44E-04	2.24E-02	7.76E-02	0.00E+00	7.46E-02	0.00E+00
SM	kg	1.52E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	2.09E-03	1.87E-04	1.38E-07	4.15E-06	1.13E-05	0.00E+00	3.95E-05	0.00E+00

Table 64 | Waste production for unrestrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Hazardous waste disposed	kg	2.14E-02	1.53E-06	2.03E-10	6.11E-09	9.24E-08	0.00E+00	3.00E-08	0.00E+00
Non-hazardous waste disposed	kg	3.34E-02	1.24E-02	2.80E-06	8.44E-05	7.46E-04	0.00E+00	1.05E+00	0.00E+00
Radioactive waste disposed	kg	1.91E-05	7.03E-09	2.26E-12	6.82E-11	4.24E-10	0.00E+00	1.74E-10	0.00E+00

Table 65 | Output flows for unrestrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	4.44E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 66 | Additional environmental impact indicators for unrestrained product group C pipes installation

Indicator	Unit	A1-3	A4	A5	C1	C2	C3	C4	D
GWP-GHG	kg CO_2 eq.	2.01E+00	8.62E-02	2.04E-03	6.13E-02	5.20E-03	0.00E+00	5.38E-03	0.00E+00
Particulate matter	disease incidence	9.24E-08	7.01E-09	1.26E-10	1.58E-09	4.23E-10	0.00E+00	1.96E-10	0.00E+00
Ionising radiation - human health	kBq U-235 eq	6.22E-03	5.10E-05	1.57E-08	4.72E-07	3.08E-06	0.00E+00	1.30E-06	0.00E+00
Eco-toxicity (freshwater)	CTUe	3.71E+00	6.75E-01	4.89E-02	1.47E+00	4.07E-02	0.00E+00	5.10E-01	0.00E+00
Human toxicity potential - cancer effects	CTUh	2.07E-10	2.49E-11	3.54E-13	1.06E-11	1.50E-12	0.00E+00	1.06E-12	0.00E+00
Human toxicity potential - non cancer effects	CTUh	3.78E-08	9.14E-10	2.77E-11	8.09E-10	5.51E-11	0.00E+00	5.77E-11	0.00E+00
Soil quality	dimensionless	1.30E+00	2.93E-01	1.23E-04	3.71E-03	1.77E-02	0.00E+00	1.30E-01	0.00E+00

Results for leaving the pipes as is at EoL scenario analysis

Refer to Appendix-1 for sizes' specifications of SINTAKOTE steel pipes. For the leaving the pipes as is at EoL scenario, modules C1-C4 and D will have zero impact for restrained and unrestrained installation. Results are not separately presented here as they can be extracted from the other two EoL scenarios.

Interpretation of results for restrained installation

Interpretation of results were performed using recycling at EoI scenario. This is for simplicity as well as recycling at EoL is the most desired EoL scenario.

Product group A

Potential environmental impacts

- The product stage (i.e., A1-A3) is the primary contributor to GWP - total impacts in the modules A1-A5 and C1-C3, except Water depletion potential (WDP). About 80.6% of GWP - total arises from the product stage or A1-A3 modules.
    - The product stage (A1-A3) contributes to 30.4-86.5% of all other environmental impact categories except WDP.
    - WDP impacts from A1-A3 modules account 30.4%.
    - Steel is the highest contributor of A1-A3 GWP - total impacts (76.4%) followed by cement (10.8%).
- The major WDP impacts originates from waste processing (C3), accounting 57.4% of total WDP impacts.
- Environmental impacts from deconstruction (C1) are less than 11.1% in any category whereas that are less than 2.5% for waste transport (C2).
- Installation (A5) accounts less than 11.1% impact in any environmental impact category.
- Distribution (A4) accounts for 4.1% of GWP – total impacts. However, the impacts from this module in ODP, AP, EP-freshwater, EP-marine and EP-terrestrial are higher and range between 4.8 and 42.9%.
- The avoided production of steel and concrete in module D provide potential positive impacts in GWP – total, AP, EP – M, EP – T, ADP – F and WDP. In the case of GWP – total impacts, the benefit is 27.9% of GWP – total. The benefit in WDP category is only 3.9% of WDP impacts and that in ODP category is 37.4% of ODP impacts.
- The GWP – total impacts reduce by 21.01% for recycling end-of-life products instead of landfilling.

Resource use

- The major resource use impacts in the modules A1-A5 and C1- C3 originate from the product stages (A1-A3), ranging between 68.3-100%.
    - Product stage (A1-A3) utilises the highest renewable resources accounting 86.2% of total renewable utilisation. The second largest renewable resources user is the C3, accounting 25.9% of the total renewable resources.
    - Steel is the largest non-renewable resource user within module A1-A3, accounting 73% of total value, utilised by module A1-A3. This is followed by manufacturing electricity and cement (accounts for 4.4 and 3.4% of total non-renewable resources in A1-A3).
    - Steel contributes to 73.5% of total renewable and non-renewable resource use impacts in module A1-A3. This is followed by manufacturing electricity (4.3%) and cement (3.5%).

- The highest contributor to Fresh Water use is steel, accounting for 63.1% of the impacts in module A1-A3.

- There is no use of renewable secondary fuels.
- The renewable resource use impact is 1.89% of total renewable and non-renewable resource use impacts.
- The recycling of steel and concrete in module D provides positive impacts equivalent to 20.6% of the total non- renewable primary energy resources (PENRT) use.

Waste and Output flows

- About 78.9% of all waste generated in the modules A1-A5 and C1-C3 is non-hazardous
    - The product stage (A1-A3) contributes to 42.3% of all non-hazardous waste generated. This is followed by waste processing (C3), accounting about 41.2%.
    - The avoided production of steel and concrete in module D provides a positive impact equivalent to 79% of total non-hazardous waste.

Product group B

Potential environmental impacts

- The product stage (i.e., A1-A3) is the primary contributor to GWP - total impacts in the modules A1-A5 and C1-C3, except Water depletion potential (WDP). About 82.6% of GWP - total arises from the product stage or A1-A3 modules.
    - The product stage (A1-A3) contributes to 33.9-87.97% of all other environmental impact categories except WDP.
    - WDP impacts from A1-A3 modules account 33.9%.
    - Steel is the highest contributor of A1-A3 GWP - total impacts (80.2%) followed by cement (5.73%).
- The major WDP impacts originates from waste processing (C3), accounting 54.5% of total WDP impacts.
- Environmental impacts from deconstruction (C1) are less than 10.3% in any category whereas that are less than 2.5% for waste transport (C2).
- Installation (A5) accounts less than 10.6% impact in any environmental impact category.
- Distribution (A4) accounts for 3.7% of GWP – total impacts. However, the impacts from this module in ODP, AP, EP-freshwater, EP-marine and EP-terrestrial are higher and range between 4.8 and 41.5%.
- The avoided production of steel and concrete in module D provide potential positive impacts in GWP – total, AP, EP – M, EP – T, ADP – F and WDP. In the case of GWP – total impacts, the benefit is 24.9% of GWP – total. The benefit in WDP category is only 3.7% of WDP impacts and that in ODP category is 37.7% of ODP impacts.
- The GWP – total impacts reduce by 18.7% for recycling end-of-life products instead of landfilling.

Resource use

- The major resource use impacts in the modules A1-A5 and C1- C3 originate from the product stages (A1-A3), ranging between 72.5-100%.
    - Product stage (A1-A3) utilises the highest renewable resources accounting 72.5% of total renewable utilisation. The second largest renewable resources user is the C3, accounting 22.5% of the total renewable resources.
    - Steel is the largest non-renewable resource user within module A1-A3, accounting 77.3% of total value, utilised by module A1-A3. This is followed by manufacturing electricity (accounts 3.9% of

total non-renewable resources in A1-A3) and cement (2.6% of total non-renewable resources in A1-A3).

- Steel contributes to 77.5% of total renewable and non-renewable resource use impacts in module A1-A3. This is followed by manufacturing electricity (3.8%) and cement (2.7%).

  The highest contributor to Fresh Water use is steel, accounting for 59.8% of the impacts in module A1-A3.

- There is no use of renewable secondary fuels.
- The renewable resource use impact is 1.89% of total renewable and non-renewable resource use impacts.
- The recycling of steel and concrete in module D provides positive impacts equivalent to 18.4% of the total non- renewable primary energy resources (PENRT) use.

Waste and Output flows

- About 79.3% of all waste generated in the modules A1-A5 and C1-C3 is non-hazardous
  - The product stage (A1-A3) contributes to 42.7% of all non-hazardous waste generated. This is followed by waste processing (C3), accounting about 40.2%.

Product group C

Potential environmental impacts

- The product stage (i.e., A1-A3) is the primary contributor to GWP - total impacts in the modules A1-A5 and C1-C3, except Water depletion potential (WDP). About 83.4% of GWP - total arises from the product stage or A1-A3 modules.
  - The product stage (A1-A3) contributes to 29.7-88.28% of all other environmental impact categories except WDP.
  - WDP impacts from A1-A3 modules account 29.7%.
  - Steel is the highest contributor of A1-A3 GWP - total impacts (85.4%) followed by cement (3.71%).
- The major WDP impacts originates from waste processing (C3), accounting 57.9% of total WDP impacts.
- Environmental impacts from deconstruction (C1) are less than 10% in any category whereas that are less than 2.7% for waste transport (C2).
- Installation (A5) accounts less than 10.4% impact in any environmental impact category.
- Distribution (A4) accounts for 3.5% of GWP – total impacts. However, the impacts from this module in ODP, AP, EP-freshwater, EP-marine and EP-terrestrial are higher and range between 4.8 and 44.5%.
- The avoided production of steel and concrete in module D provide potential positive impacts in GWP – total, AP, EP – M, EP – T, ADP – F and WDP. In the case of GWP – total impacts, the benefit is 23.8% of GWP – total. The benefit in WDP category is only 4% of WDP impacts and that in ODP category is 40.4% of ODP impacts.
- The GWP – total impacts reduce by 17.7% for recycling end-of-life products instead of landfilling.

Resource use

- The major resource use impacts in the modules A1-A5 and C1- C3 originate from the product stages (A1-A3), ranging between 77.3-100%.

- Product stage (A1-A3) utilises the highest renewable resources accounting 73.1% of total renewable utilisation. The second largest renewable resources user is the C3, accounting 22% of the total renewable resources.
- Steel contributes to 86.5% of total renewable and non-renewable resource use impacts in module A1-A3, followed by manufacturing electricity (3.8%)

  The highest contributor to Fresh Water use is steel, accounting for 66.8% of the impacts in module A1-A3.

- There is no use of renewable secondary fuels.
- The renewable resource use impact is 1.88% of total renewable and non-renewable resource use impacts.
- The recycling of steel and concrete in module D provides positive impacts equivalent to 18% of the total non-renewable primary energy resources (PENRT).

Waste and Output flows

- About 78.9% of all waste generated in the modules A1-A5 and C1-C3 is non-hazardous
  - The product stage (A1-A3) contributes to 41.2% of all non-hazardous waste generated. This is followed by waste processing (C3), accounting about 41.3%.

Interpretation of results for unrestrained installation

Recycling at EoL scenario analysis

Product group A

Potential environmental impacts

- The product stage (i.e., A1-A3) is the primary contributor to GWP - total impacts in the modules A1-A5 and C1-C3, except Water depletion potential (WDP). About 83.2% of GWP - total arises from the product stage or A1-A3 modules.
  - The product stage (A1-A3) contributes to 29.2-87% of all other environmental impact categories except WDP.
  - WDP impacts from A1-A3 modules account 29.2%.
  - Steel is the highest contributor of A1-A3 GWP - total impacts (76.5%).
- The major WDP impacts originates from waste processing (C3), accounting 59.8% of total WDP impacts.
- Environmental impacts from deconstruction (C1) are less than 12.5% in any category whereas that are less than 2.5% for waste transport (C2).
- Installation (A5) accounts less than 0.6% impact in any environmental impact category.
- Distribution (A4) accounts for 4.3% of GWP – total impacts. However, the impacts from this module in ODP, AP, EP-freshwater, EP-marine and EP-terrestrial are higher and range between 5.2 and 42.1%.
- The avoided production of steel and concrete in module D provide potential positive impacts in GWP – total, AP, EP – M, EP – T, ADP – F and WDP. In the case of GWP – total impacts, the benefit is 28.8% of GWP – total. The benefit in WDP category is only 4.1% of WDP impacts and that in ODP category is 38.2% of ODP impacts.
- The GWP – total impacts reduce by 21.8% for recycling end-of-life products instead of landfilling.

Resource use

- The major resource use impacts in the modules A1-A5 and C1- C3 originate from the product stages (A1-A3), ranging between 77.3-100%.
    - Product stage (A1-A3) utilises the highest renewable resources accounting 69.3% of total renewable utilisation. The second largest renewable resources user is the C3, accounting 26.2% of the total renewable resources.
    - Steel is the largest non-renewable resource user within module A1-A3, accounting 95.8% of total value, utilised by module A1-A3.
    - Steel contributes to 73.3% of total renewable and non-renewable resource use impacts in module A1-A3
- There is no use of renewable secondary fuels.
- The renewable resource use impact is 1.51% of total renewable and non-renewable resource use impacts.
- The recycling of steel and concrete in module D provides positive impacts equivalent to 20.7% of the total non- renewable primary energy resources (PENRT) use.

Waste and Output flows

- About 78.9% of all waste generated in the modules A1-A5 and C1-C3 is non-hazardous
    - The product stage (A1-A3) contributes to 42.3% of all non-hazardous waste generated. This is followed by waste processing (C3), accounting about 41.2%.

Product group B

Potential environmental impacts

- The product stage (i.e., A1-A3) is the primary contributor to GWP - total impacts in the modules A1-A5 and C1-C3, except Water depletion potential (WDP). About 82.8% of GWP - total arises from the product stage or A1-A3 modules.
    - The product stage (A1-A3) contributes to 22.6-85.6% of all other environmental impact categories except WDP.
    - WDP impacts from A1-A3 modules account 34.5%.
    - Steel is the highest contributor of A1-A3 GWP - total impacts (81.29%) followed by cement (5.73%).
- The major WDP impacts originates from waste processing (C3), accounting 55.3% of total WDP impacts.
- Environmental impacts from deconstruction (C1) are less than 11.5% in any category whereas that are less than 2.6% for waste transport (C2).
- Installation (A5) accounts less than 0.4% impact in any environmental impact category.
- Distribution (A4) accounts for 3.8% of GWP – total impacts. However, the impacts from this module in ODP, AP, EP-freshwater, EP-marine and EP-terrestrial are higher and range between 5.5 and 42.4%.
- The avoided production of steel and concrete in module D provide potential positive impacts in GWP – total, AP, EP – M, EP – T, ADP – F and WDP. In the case of GWP – total impacts, the benefit is 25.7% of GWP – total. The benefit in WDP category is only 3.8% of WDP impacts and that in ODP category is 38.5% of ODP impacts.
- The GWP – total impacts reduce by 19.3% for recycling end-of-life products instead of landfilling.

Resource use

- The major resource use impacts in the modules A1-A5 and C1- C3 originate from the product stages (A1-A3), ranging between 73.4-100%.
    - Product stage (A1-A3) utilises the highest renewable resources accounting 73.4% of total renewable utilisation. The second largest renewable resources user is the C3, accounting 22.7% of the total renewable resources.
- There is no use of renewable secondary fuels.
- The renewable resource use impact is 1.55% of total renewable and non-renewable resource use impacts.
- The recycling of steel and concrete in module D provides positive impacts equivalent to 18.5% of the total non- renewable primary energy resources (PENRT).

Waste and Output flows

- About 79.1% of all waste generated in the modules A1-A5 and C1-C3 is non-hazardous
    - The product stage (A1-A3) contributes to 43.2% of all non-hazardous waste generated. This is followed by waste processing (C3), accounting about 40.6%.

Product group C

Potential environmental impacts

- The product stage (i.e., A1-A3) is the primary contributor to GWP - total impacts in the modules A1-A5 and C1-C3, except Water depletion potential (WDP). About 85.7% of GWP - total arises from the product stage or A1-A3 modules.
    - The product stage (A1-A3) contributes to 28.5-88.6% of all other environmental impact categories except WDP.
    - WDP impacts from A1-A3 modules account 28.5%.
- The major WDP impacts originates from waste processing (C3), accounting 60.4% of total WDP impacts.
- Environmental impacts from deconstruction (C1) are less than 11.2% in any category whereas that are less than 2.7% for waste transport (C2).
- Installation (A5) accounts less than 0.4% impact in any environmental impact category.
- Distribution (A4) accounts for 3.6% of GWP – total impacts. However, the impacts from this module in ODP, AP, EP-freshwater, EP-marine and EP-terrestrial are higher and range between 5.2 and 45.5%.
- The avoided production of steel and concrete in module D provide potential positive impacts in GWP – total, AP, EP – M, EP – T, ADP – F and WDP. In the case of GWP – total impacts, the benefit is 24.4% of GWP – total. The benefit in WDP category is only 4.1% of WDP impacts and that in ODP category is 41.3% of ODP impacts.
- The GWP – total impacts reduce by 18.3% for recycling end-of-life products instead of landfilling.

Resource use

- The major resource use impacts in the modules A1-A5 and C1- C3 originate from the product stages (A1-A3), ranging between 77.3-100%.
    - Product stage (A1-A3) utilises the highest renewable resources accounting 74% of total renewable utilisation. The second largest renewable resources user is the C3, accounting 22.1% of the total renewable resources.

- There is no use of renewable secondary fuels.
- The renewable resource use impact is 1.55% of total renewable and non-renewable resource use impacts.
- The recycling of steel and concrete in module D provides positive impacts equivalent to 18% of the total non-renewable primary energy resources (PENRT) use.

Waste and Output flows

- About 78.7% of all waste generated in the modules A1-A5 and C1-C3 is non-hazardous
    - The product stage (A1-A3) contributes to 41.6% of all non-hazardous waste generated. This is followed by waste processing (C3), accounting about 41.7%.

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Appendix

SINTAKOTE Steel Pipe Specifications

Table 67 | Pipe specifications and product groups

Outside Diameter	Wall Thickness	Rated Pressure (Welded)	Rated Pressure (Rubber Ring Joint)	Sintakote	CML	Bore ID CML	Product Weight (Empty Pipe)	Ring Bending Stiffness	Steel Grade	Product weight (CML)	Product weight (SK)	Product Group
		P_R	P_R	t_s	T			S_D	MPa			
mm	mm	MPa	MPa	mm	mm	mm	kg/m	N/m/m		Kg/m	Kg/m	
114	4.8	6.8	-*	1.6	9	86	19.9	2,453,272	300	6	1	B
168	5.0	6.8	-*	1.6	9	140	31	818,055	300	10	1	B
219	5.0	6.8	-*	1.6	9	191	41.0	361,496	300	14	1	B
273	5.0	6.8	-*	1.6	9	245	51.6	184,052	300	17	1	B
324	5.0	6.7	4.2	1.8	12	290	68.4	126,646	300	27	2	A
324	6.0	6.8	4.2	1.8	12	288	76	200,219	300	27	2	B
406	5.0	5.3	4.2	1.8	12	372	86.4	63,757	300	35	2	A
502	5.0	4.3	4.2	1.8	12	468	107.4	33,488	300	43	3	A
502	6.0	5.2	4.2	1.8	12	466	119.4	52,764	300	43	3	B
559	5.0	3.9	3.9	2.0	12	525	120.3	24,179	300	49	3	A
559	6.0	4.6	4.2	2.0	12	523	133.6	38,072	300	48	3	B
610	5.0	3.5	3.5	2.0	12	576	131.5	18,565	300	53	4	A
610	6.0	4.2	4.2	2.0	12	574	146.1	29,220	300	53	4	B
660	5.0	3.3	3.3	2.0	12	626	142.5	14,630	300	58	4	A
660	6.0	3.9	3.9	2.0	12	624	158.3	23,017	300	58	4	B
660	8.0	5.2	4.2	2.0	12	620	189.8	48,463	300	57	4	B
762	5.0	2.8	2.8	2.0	12	728	164.9	9,477	300	67	4	A
762	6.0	3.4	3.4	2.0	12	726	183.2	14,901	300	67	4	B
762	8.0	4.5	4.2	2.0	12	722	219.7	31,336	300	67	4	B
813	6.0	3.2	3.2	2.3	16	769	219.7	14,408	300	95	6	A
813	8.0	4.3	4.2	2.3	16	765	258.7	29,256	300	94	6	B
914	6.0	2.8	2.8	2.3	16	870	247.6	10,115	300	107	6	A
914	8.0	3.8	3.8	2.3	16	866	291.5	20,522	300	107	6	B
1016	8.0	3.4	3.4	2.3	16	968	324.6	14,901	300	119	7	B
1016	10.0	4.3	4.2	2.3	16	964	373.4	26,447	300	118	7	B
1125	8.0	3.1	2.8	2.3	16	1077	360	10,951	300	132	8	B
1125	10.0	3.8	3.7	2.3	16	1073	414.1	19,424	300	132	8	B
1219	8.0	2.8	2.8	2.3	16	1171	390.6	8,594	300	143	8	B
1219	10.0	3.5	3.5	2.3	16	1167	449.3	15,236	300	143	8	B
1422	10.0	3	3	2.3	19	1370	556.2	10,326	300	198	10	B
1422	12.0	3.6	3.6	2.3	19	1366	624.7	16,526	300	198	10	B
1626	12.0	3.2	3.2	2.3	19	1570	715.7	11,019	300	227	11	B
1626	16.0	3.5	3.2	2.3	19	1562	872.2	23,707	250	226	11	C
1750	12.0	2.5	2.9	2.3	19	1688	771.1	8,824	300	245	12	B
1750	16.0	3.3	-*	2.3	19	1680	939.8	18,976	250	244	12	C
1829	12.0	3	2.8	2.3	19	1767	806.3	7,723	300	256	12	B
1829	16.0	2.9	-*	2.3	19	1759	982.8	16,602	250	255	12	C
1981	12.0	2.7	-*	2.3	19	1919	860.7	6,069	300	278	13	B
1981	16.0	3.6	-*	2.3	19	1911	1065.6	13,039	250	277	13	C
2159	16.0	3.3	-*	2.3	31	2065	1350.8	12,213	250	491	15	B

Notes:

1) In order to compare Pipe Diameters with Other Materials it is important to compare Bore Internal Diameters, Ring Bending Stiffness and Pressure Ratings.
2) -* means not available in this Diameter or steel wall thickness as Sintajoint Rubber Ring Joint Pipe.
3) Other diameters, wall thicknesses, steel grades and rated pressures are also available.
4) Pipe categories equate to steel content of completed pipe: A) 50-59%, B) 60-69%, C) 70%-75%

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Environmental Product Declaration

Sintakote® Steel Pipeline System

In accordance with ISO 14025 and EN 15804:2012+A2:2019/AC2021

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