# ENVIRONMENTAL PRODUCT DECLARATION

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

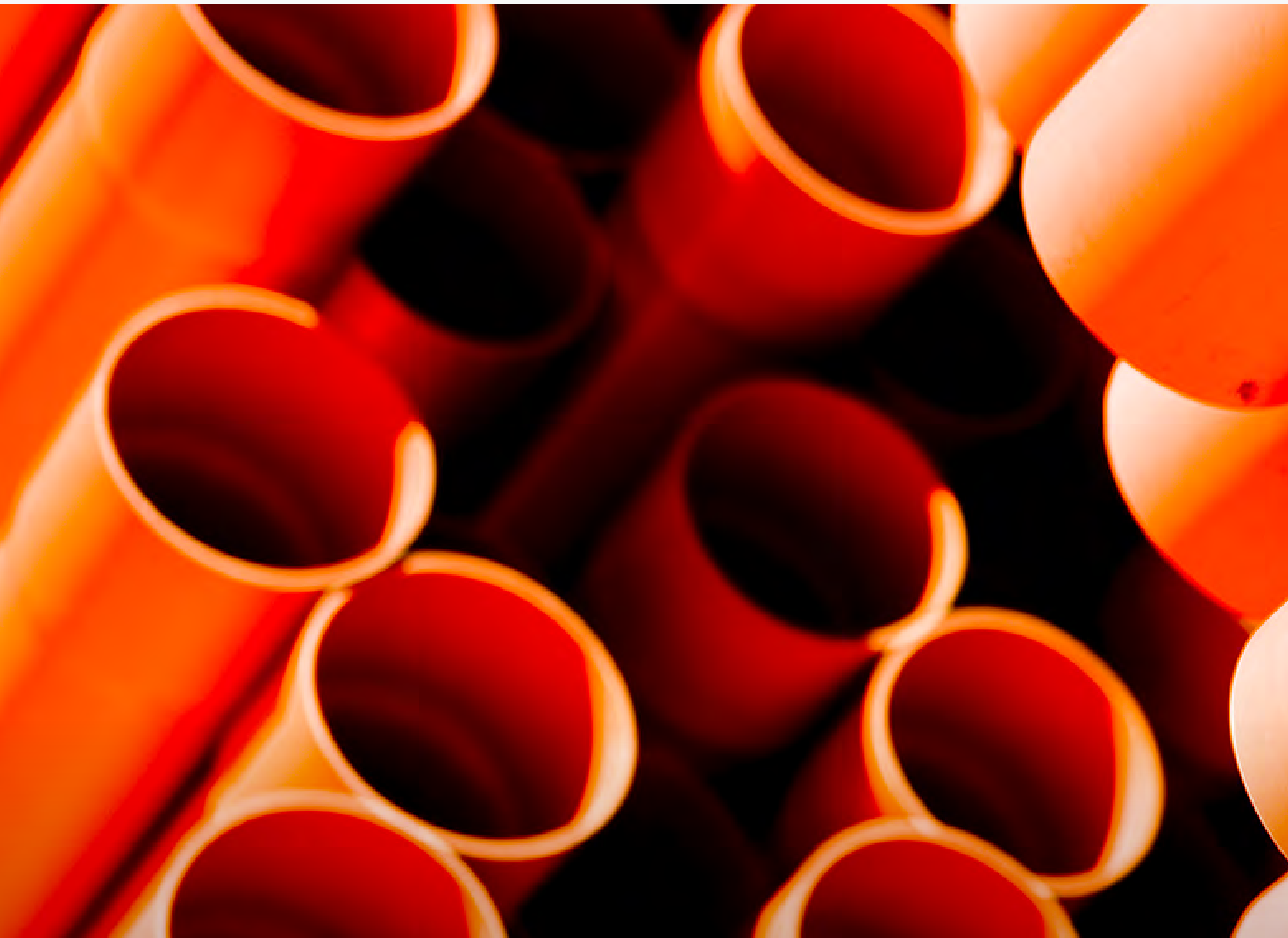
# PVC NON-PRESSURE PIPES

## FROM IPLEX PIPELINES AUSTRALIA PTY LIMITED

Programme: EPD Australasia, www.epd-australasia.com
Programme operator: EPD Australasia
EPD registration number: S-P-00713
Publication date: 2015-12-06
Valid until: 2027-11-23
Version 2.0: 2022-11-23
Geographic location: Australia
Reference year for data: 2020-2021
An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com

ECO PLATFORM EPD VERIFIED

AUSTRALASIA EPD® ENVIRONMENTAL PRODUCT DECLARATION



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# ENVIRONMENTAL PRODUCT DECLARATION

## PVC NON-PRESSURE PIPES

## 1.0 ENVIRONMENTAL PRODUCT DECLARATION DETAILS

An Environmental Product Declaration, or EPD, is a standardised and verified way of quantifying the environmental impacts of a product based on a consistent set of rules known as a PCR (Product Category Rules). Environmental product declarations within the same product category from different programmes may not be comparable. EPD 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.

This EPD has been updated to provide detailed information on the environmental impacts arising from the A5 module (installation module) to reflect the factors affecting installation are significantly influenced by pipeline designers, infrastructure agencies and installing contractors.

| | |
|---|---|
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| **ACCREDITED OR APPROVED BY:** | EPD Australasia |

**CEN STANDARD EN 15804 SERVES AS THE CORE PRODUCT CATEGORY RULES (PCR)**

| | |
|---|---|
| **PCR:** | Construction Products and Services, (PCR) 2019:14, v1.1 and UN CPC code(s) 36320 according to CPC v2.1, 2015. |
| **PCR PREPARED BY:** | The Technical Committee of the International EPD® System. A full list of members available on www.environdec.com. The review panel may be contacted via info@environdec.com. Review chair: Claudia A. Peña, University of Concepción, Chile |
| **EPD VERIFICATION (EXTERNAL):** | Independent third-party verification of the declaration and data, according to ISO 14025:2006 |
| **OTHER EPD'S FROM IPLEX:** | Iplex PVC Pressure Pipes EPD, Iplex PE Pipes EPD, Iplex BlackMAX® and SewerMAX® Polypropylene Pipes EPD |

The EPD owner has the sole ownership, liability, and responsibility for the EPD.

## 2.0 PRODUCT SUSTAINABILITY CREDIT POINTS

- ✓ EPD conforms to ISO 14025 and EN 15804.
- ✓ The EPD has been verified by an independent third party.
- ✓ The EPD has at least a cradle-to-gate scope.
- ✓ The EPD has product specific results.

This EPD may be used to obtain product sustainability credit points under the GBCA's Green Star rating tools and the Infrastructure Sustainability (IS) rating tools.

For the purpose of IS ratings, EPDs are Type III environmental declarations which provide valuable environmental impact data towards IS reward.

The PVC non-pressure pipe EPD results can also be used to represent PVC non-pressure pipe products in Whole of Building Life Cycle Assessments under Green Star rating tools. See the product details tables to convert the product results from kilogram of installed pipe to length of pipe for individual pipe products.

## 3.0 IPLEX PIPELINES AUSTRALIA

Iplex, one of Australasia's largest manufacturers and suppliers of plastic pipeline systems, is pleased to publish this Environment Product Declaration (EPD) for its Iplex and Key Plastics "KEYPLAS®" brands of non-pressure stormwater, DWV and electrical conduit products.

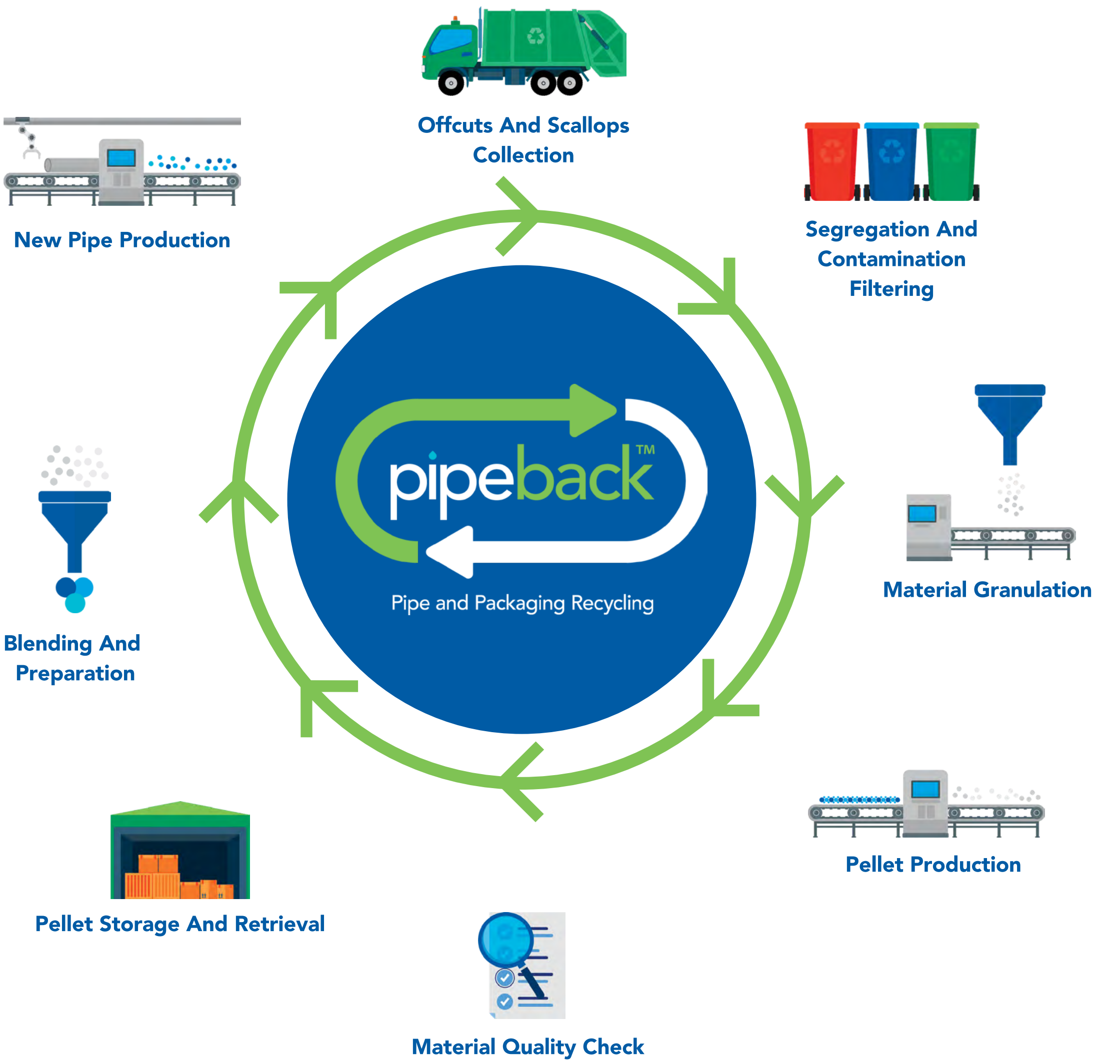
A wholly owned business unit of the ASX listed company Fletcher Building Limited, with operations nationally and in New Zealand. Iplex supplies pipe and conduit to applications including plumbing, irrigation, mining, industrial and chemical processes, electrical, gas, stormwater, sewer, raw, recycled and potable water.

### SUSTAINABILITY AT IPLEX

PVC pipe systems are engineered to meet some of the highest standards in the world. With over 80 years' manufacturing history, Iplex is an industry leader that strives to make a difference in sustainability and the manufacturing of environmentally friendly PVC pipe products.

PVC pipes manufactured by Iplex are made for long service life, and can have a service life longer than 100 years. The responsible use of resources is carefully management by Iplex reducing impacts associated with manufacturing, construction, extraction operations, including the distribution and use of pipe product.

A sustainable feature of Iplex PVC pipes is that they are made from thermoplastic material and are 100% recyclable. Iplex PVC pipes can be recycled back into the Iplex manufacturing process through its branded Pipeback™ Program. Pipeback™ offers a streamlined service for recycling PVC pipes post consumer use back into the manufacturing process, with collection depots in Queensland, South Australia, Victoria and New South Wales.




Iplex PVC pipes deliver essential services that sustain our communities. It is important to Iplex to extend its sustainability agenda beyond environmentalism to include economic and social aspects. Sustainable and safe practices are embedded deep in the Iplex culture and are driven by its corporate strategic priority *Sustainability at the Core* and cultural values *Protect, Be Bold, Customer Leading,* and *Better Together*. Iplex company personnel hold a wealth of expertise and experience and continue to work together with the general public, industry, stakeholders and regulatory bodies on sustainability agenda.

## TECHNICAL CAPABILITY

Iplex is a pioneer in pipe production and a foundation member of the Plastics Industry Pipes Association of Australia (PIPA). As part of Iplex's ongoing commitment to sustainability and the development of Australian and International Standards for plastics pipe and fittings, Iplex works collaboratively with the PIPA technical committees and Australian Pipelines and Gas Association working groups.

PVC pipe manufacturing plants are located close to major development regions in Brisbane, Sydney, and Melbourne and all products comply with the stringent requirements of Best Environmental Practice BEP PVC. Iplex manufactures a range of non-pressure PVC-U pipes and conduits to various AS/NZS Standards such as AS/NZS 1254 for Stormwater pipes, AS/NZS 1260 for Drain, Waste and Vent pipes, and AS/NZS 2053.2 for electrical and communications conduits.

In support of its extensive product range, Iplex employs professional engineers to assist pipe users and designers and publishes comprehensive engineering design guides that are freely available for download via its website: www.iplex.com.au.

The Iplex PocketENGINEER™ is a web portal where registered users can access design software to simplify hydraulic, structural and chemical resistance aspects of pipeline design. Visit www.pocketengineer.com.au.

For more information on Iplex's extensive range of pipeline products, visit www.iplex.com.au

## IPLEX PVC NON-PRESSURE PIPE PRODUCTS

The Australian Standards for PVC pipe (AS/NZS 1260 and 1254) have the Best Environmental Practice requirements developed by the Green Building Council of Australia (GBCA) embedded in them to facilitate and openly encourage responsible sourcing of raw materials, best practice manufacturing, fully independent third party certification compliance, simpler procurement and easier identification of compliant products. No other Australian or international product standards have taken this step.

## TABLE 1 – PRODUCT CHARACTERISTICS OF PVC-U PIPE AT 20°C

| PRODUCT CHARACTERISTICS | |
|---|---|
| PRODUCT NAMES/APPLICATION | Polyvinylchloride (PVC) pipes covered in this EPD are:<br>PVC-U Drainage, Waste and Ventilation (DWV) pipe<br>PVC-U Electrical conduit<br>PVC-U Stormwater pipe |
| UN CPC CODE | 36320 |
| DENSITY | 1530 kg/m³ |
| ULTIMATE TENSILE STRENGTH | 52 MPa |
| COMPRESSIVE STRENGTH | 66MPa |
| SHORE D HARDNESS | 85ASTM D2240 |
| COEFFICIENT OF LINEAR THERMAL EXPANSION | 7 x 10-5 / °C |
| VICAT SOFTENING TEMPERATURE | Approximately 80°C |
| ELONGATION AT YIELD | 5.5% |
| POISSON'S RATIO | 0.38 |
| RING BENDING MODULUS | 3 minute 3200 MPa and long term 1400 MPa |

## TABLE 2 – CONTENT DECLARATION

| ITEM | SOLID WALL PVC PIPE | | FOAM CORE PVC PIPE | |
|---|---|---|---|---|
| | MASS (KG) | PERCENTAGE (%) | MASS (KG) | PERCENTAGE (%) |
| PVC resin | 0.922 | 91.30% | 0.617 | 61.09% |
| Filler | 0.046 | 4.56% | 0.093 | 9.16% |
| Organic stabilizer | 0.026 | 2.56% | 0.019 | 1.83% |
| Titanium dioxide white (pigment) | 0.014 | 1.37% | 0.009 | 0.92% |
| Processing aid | 0.001 | 0.09% | - | 0.00% |
| Wax | 0.001 | 0.09% | - | 0.00% |
| Lubricant | - | 0.03% | - | 0.00% |
| PVC scrap pipe | - | 0.00% | 0.271 | 26.88% |
| Blowing agent | - | 0.00% | 0.001 | 0.12% |

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.

## PRODUCT LIFE CYCLE OVERVIEW

The scope of this LCA is cradle to gate with module A4, module C1-C4 and module D. The following life cycle stages have not been declared, as they are deemed not applicable for Iplex PVC non-pressure 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 Iplex's PVC non-pressure pipes. The EPD will provide the information on environmental impact data of Iplex's PVC non-pressure pipes to its customers. Both PVC solid wall and PVC foam core pipes are manufactured in Chipping Norton (NSW), Strathpine (QLD) and Reservoir (VIC) in Australia. Therefore, this is an average EPD of PVC solid wall and PVC foam core pipes from these production sites. The average was calculated as a weighted average of the different manufacturing sites where each type of product is being produced.

### TABLE 3 – SYSTEM BOUNDARY AND SCOPE OF ASSESSMENT

| | 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 | ND | ND | ND | ND | ND | ND | ND | ND | X | X | X | X | X |
| Geography | AU/ TW/ CH | AU/ TW/ CH | AU | AU | - | - | - | - | - | - | - | - | AU | AU | AU | AU | AU |
| Specific data used | ~98% | | | | | - | - | - | - | - | - | - | - | - | - | - | - |
| Variation – products | < ±10% | | | | | - | - | - | - | - | - | - | - | - | - | - | - |
| Variation – sites | < ±10% | | | | | - | - | - | - | - | - | - | - | - | - | - | - |

ND = Not declared

AU = Australia

TW = Taiwan

CH = China

## LIFE CYCLE DIAGRAM OF PVC NON-PRESSURE PIPE PRODUCTION

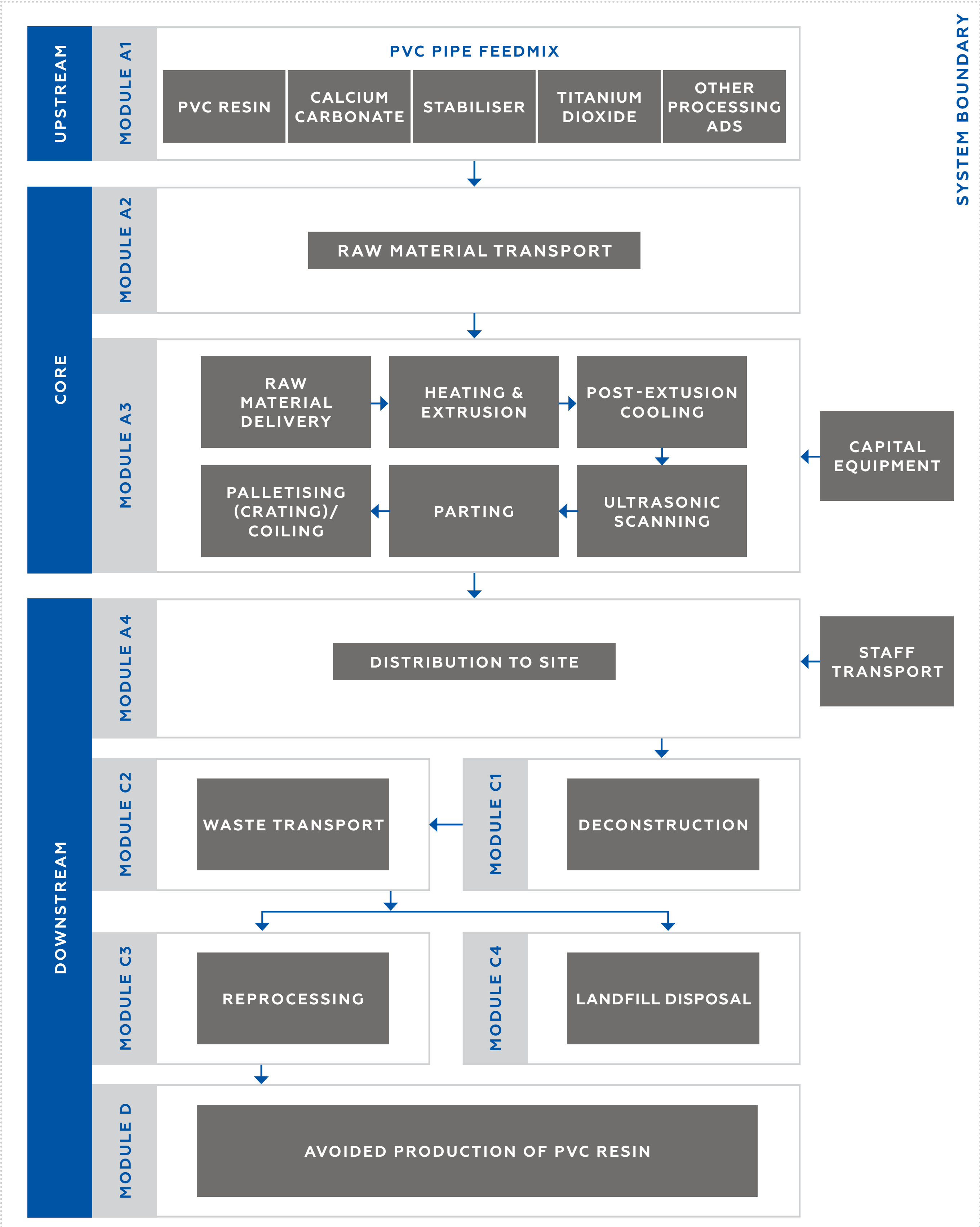



FIGURE 1 - IPLEX PVC NON-PRESSURE PIPE EPD SYSTEM BOUNDARY

## IPLEX PVC NON-PRESSURE PIPE MANUFACTURING

Non-pressure PVC pipes are manufactured primarily from PVC resin along with additives, including: calcium carbonate, titanium dioxide, organic stabiliser, lubricants and pigments. In the case of foam core PVC pipe, azodicarbonamide is also used as a blowing agent. Internal PVC pipe scrap is fed back into the feed mix and utilised as the internal structure of foam core pipes also included in this EPD. All internal scrap is reprocessed within Iplex manufacturing facilities. Therefore, the use of internal scrap in the foam core pipe carries the same burden as the original material processing. In this case, the PVC scrap was modelled exactly similar way as PVC solid wall pipes was modelled. Both PVC solid wall and PVC foam core pipes are manufactured in Chipping Norton (NSW), Strathpine (QLD) and Reservoir (VIC) in Australia. Since it is assumed that 1% of pipe is wasted during the installation process, 1.01 kg of pipe is produced for each kg of pipe installed. The total feedmix was calculated based on the weighted average of the feedmix of all production sites. Transport distances to site for key feedmix ingredients were calculated using Google Maps (road transport) and the weighted average transport to each site was calculated. In the case of solid wall pipes, transport distance of wax and lubricant was excluded as their contribution is less than 1%. For similar reason, transport distance of blowing agent was excluded in the case of foam core pipes.

The electricity, LPG and water manufacturing inputs were all allocated based on 1.01 kg of pipe produced from solid wall and foam core PVC lines. The manufacturing inventory of each Iplex site was modelled related to 1.01kg

production volume (equivalent to 1 kg installed pipe), taking into account a specific electricity grid mix for each state. This was then modelled for total manufacturing taking into account 1.01 kg production and corresponding manufacturing inputs at each site. For example, Iplex has 3 solid wall PVC pipe manufacturing sites, consequently total production of 3.03 kg (3x1.01) (equivalent to 3 kg installed pipe) is considered in the model. For LPG, an energy density of 26.5 MJ/L was assumed for modelling. Packaging requirements for both solid wall and foam core PVC pipes were calculated using the packaging analysis data, provided by Iplex staff. Both solid wall and foam core pipes are packaged with a softwood timber frame and PET strapping. The waste material of a specific site was distributed to each of the pipe types based on their production share in that site.

## DISTRIBUTION STAGE

The majority of PVC non-pressure pipes deliveries are within metropolitan areas where manufacturing sites are located. Iplex has a manufacturing site within 300 km of every major market except for Western Australia and South Australia. The weighted average distance from manufacturing to installation site is estimated to be 50-70 km by Iplex. For this study a distribution distance of 60 km was assumed.

## INSTALLATION STAGE

The environmental impacts and other indicators related to the installation stage of PVC non-pressure pipes and other flexible pipes is highly dependent on the specific details relating to a particular pipeline's design. Variables include pipe diameter(s), length of the pipeline, installation technique, terrain, geology, environmental conditions, specified fill and embedment materials and the resultant installation techniques employed by the installing contractor. Given the significant number of variables involved, attempts to define an 'average' or 'typical' pipeline installation for the purpose of calculating environmental and resource impacts will be highly inaccurate. Moreover, it would be potentially misleading for the resultant numbers to be applied across the wide range of non-pressure PVC pipe diameters and applications and for these numbers to be used for comparative purposes. Consequently, the A5 Installation module will not be covered other than to outline the installation process and highlight those factors that influence the environmental impacts.

PVC non-pressure pipes are typically available in 3 – 6m straight lengths and are installed above ground, either on the inside or outside of buildings and can also be buried below ground. Applications include drain, waste and vent (DWV) plumbing, stormwater plumbing, electrical and communications conduits.

Iplex PVC non-pressure pipe and conduit of nominal diameter 90 mm and below are predominantly installed above ground, either on inside or outside of buildings – in residential construction they are typically located in wall and floor cavities. In the case of commercial, industrial, and high-rise residential installations pipe diameters up to nominal diameter 150mm are also used and are typically suspended from floor and ceiling surfaces. Pipes are light enough to be carried by person, cut by handsaw, and positioned into place by hand. Installation requirements for plumbing applications are defined by the various parts of AS/NZS 3500 Plumbing and Drainage standards and volume three of the National Construction Code.

Iplex PVC pipe diameters 100 mm and larger are predominantly buried, with DN100 and 150 mm pipes typically being used to connect building services to larger diameter PVC sewer or stormwater drainage infrastructure provided by water and council agencies. This scenario also applies in the case of PVC conduits used to house and protect electrical and communications cables.

Buried installations use typical open trench methods. The main factors which contribute to the impacts of installation for open trench buried 'flexible' pipes apply across a range of pipe materials. The AS/NZS 2566.2 Standard covers trench excavation and design, definition of fill and embedment zones and their respective compaction requirements and field testing of the installed pipeline. Installation design is also dependent on other design factors such location, construction and traffic loadings and minimum design requirements specified by infrastructure agencies such as Water Authorities. In all cases the diameter of the installed pipe significantly influences installation design which in turn directly influences environmental impacts associated with buried pipeline construction. LCA modelling of open trench installations shows that trench excavation, and provision and transport imported embedment materials account for the majority (90%) of environmental impacts. In many cases, the specifier and constructor can influence these factors and consequently the overall environmental impact of pipe installation.

A more detailed summary of the construction factors influencing environmental impacts for open trench installations are outlined below:

### TRENCH EXCAVATION

Trench excavation, in particular diesel consumption by trenching excavators, governs most of the environmental and resource burden for the installation phase and is strongly correlated to the size of the trench and the type and configuration of excavator used. Additionally, there are various factors that affect efficiency of the excavator and speed of the excavation. Factors such as excavator bucket volume, bucket fill rate, cycle time, swing angle, type of excavated ground, as well as site environment and weather conditions, all influence the performance of the excavator. Equipment choice and operational efficiency is under the control of the trenching contractor.

### FILL / EMBEDMENT

Type of fill / embedment materials are nominated by the pipeline designer, infrastructure owner or installer, and depend on the pipe application. LCA modelling shows that the use of screened and quarried virgin aggregate material (gravel) results in a higher environmental impact than other materials such as natural sand, recycled glass sand, crusher dust and concrete recycled into aggregate. The impact of different embedment materials in terms of Global Warming Potential (GWP) is shown in Figure 2.

### GLOBAL WARMING POTENTIAL (KG $CO_2$ EQ) PER $M^3$ OF EMBEDMENT MATERIAL

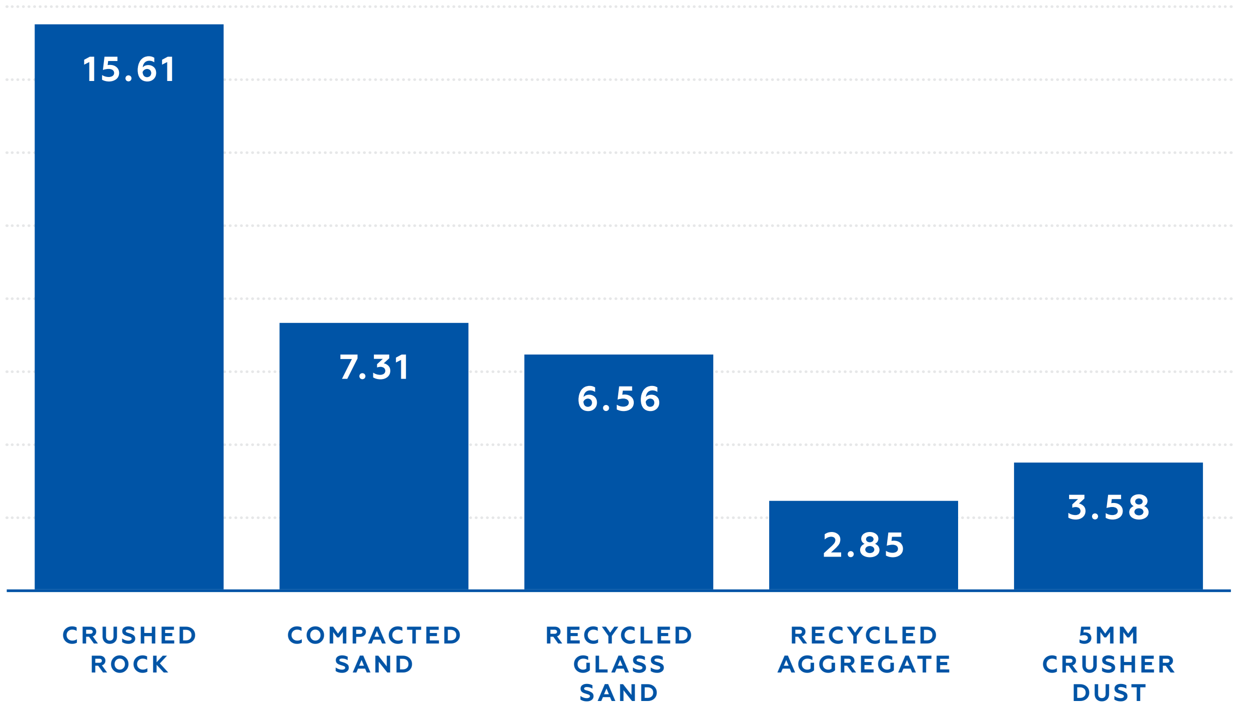



FIGURE 2 - GWP PER M3 OF EMBEDMENT MATERIAL FOR NON-PRESSURE PIPES

- Transportation of fill materials that are required to be imported to site, and of excavated material from the site that cannot be used in the embedment zone will impact carbon footprint and energy consumed.
- The use of equipment for backfilling and compaction will also contribute to the total environmental impact. In terms of backfilling, this can be achieved either by using machinery or may be done manually. Compaction of embedment material can be achieved using powered portable compacting machines such as surface plate vibrators or by manual means using hand tampers in some circumstances. Where single size aggregate is used the required compaction may be achieved during material dumping.

### PIPE LIFTING EQUIPMENT

In many cases PVC non-pressure pipes are light enough to be lifted into the trench by hand. However, this will be dependent upon trench depth. Larger diameter pipes, greater than DN150 will require mechanical lifting equipment, in many cases an excavator is used.

### PIPE JOINTING

PVC non-pressure pipes are commonly joined by either of the following methods:

- Solvent weld jointing (SWJ) - pipe or fitting socket and spigot ends are joined by initial application of a primer to the jointing surfaces, followed by application of solvent cement and subsequent insertion of the spigot end into the socket. The solvent softens the PVC and the close fit of the socket and spigot joint results in chemical welding of the spigot to the socket. This method of jointing is predominantly used for DWV and Stormwater pipe diameters 100mm and below and for all diameters of electrical and communications conduit.
- Rubber ring jointing (RRJ) – in this case an elastomeric seal ring installed in the ring groove of the pipe socket provides a seal with the inserted pipe spigot. Rubber ring jointed systems are typically for DWV PVC pipes larger than DN150, especially those used in water and council agency sewer infrastructure.

### PACKAGING MATERIALS AND WASTE

Packaging materials include timbers and strapping used to protect the pipe during transport. In many cases, these may be reused or recycled rather than disposed of to landfill. Wastage of pipe is minimal and is estimated that unusable offcuts account for less than 1%. Waste pipe offcuts which cannot be reused can be recycled.

## USE STAGE

Pipe systems are made to meet at least a 50 year design life and often exceed 100 years before any major rehabilitation is required. This long life expectancy allows them to be safely embedded into building structures or buried underground with limited access. Failure rates are extremely low and considered inconsequential in this EPD.

## END OF LIFE

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-A4, C1-C3 and D)[1]
2. Landfill disposal at end-of-life (A1-A4, C1, C2 and C4)[2] and
3. Leaving the pipes as is at end-of-life (A1-A4)

Recycling of pipes in the deconstruction and demolition phase can be challenging and complex. In particular, when pipes are encapsulated with other materials to keep them in place such as concrete, spoil or metal brackets. Technically, clean offcuts can be recycled back into new pipe products. Iplex provides PVC recycling centers across Australia in locations close to major service regions including Brisbane, Sydney, Melbourne and Adelaide. In addition to these sites specifically recycling PVC pipe there are general plastics recyclers in all capital cities. The Plastics and Chemicals Industries Association (PCIA) conducts annual studies on the levels of plastics recovery and recycling. The 2009 National Plastics Recycling Survey study highlighted that "little plastic material is recovered from the C&D sector" but acknowledges that there is growing activities around recycling of used plastics from the industry (Hyder Consulting, 2009).

According to the study of construction and demolition waste in Australia, conducted in NSW by the then Department of Environment and Climate Change (DECC), 13,000 tonnes of the total C&D wastes consisted of plastic materials of all types. PIPA estimated approximately 650 – 1,950 tonnes of PVC pipe in the NSW C&D waste stream annually. A 2011 case study on PVC pipe recycling by DSEWPC estimated that 300-400 tonnes of PVC was being recycled annually in Sydney and Melbourne (DSEWPC, 2012; Heathcote, 2015). This gives a range of EOL recycling rate of 15.4 – 61.5% for PVC pipe. The middle of this range gives 26.9% recycling rate for PVC pipe.

Diesel fuel consumption for deconstruction of PVC pipes have been calculated based on the gravitational potential energy required to lift 1 kg of pipe 10 m above ground, assuming 15% diesel energy conversion into effective work. A distance to waste treatment/disposal of 50 km was assumed and transport via rigid truck.

## BENEFITS BEYOND THE SYSTEM BOUNDARY

Rigid PVC has a high recyclability and can be mechanically recycled back into a pipe product performing the same structural function as one made only from virgin material. However, as recycled rigid PVC materials can be of varying colours they often do not meet the colour requirements of the respective pipe application Standards or customer specifications for example, electrical conduits are required to be orange, drain waste and vent pipe are required to be light grey and stormwater pipes are white. Therefore, PVC recycled material not meeting the respective colour requirements is most appropriately used back into the core (middle) layer of sandwich construction pipes. Sandwich construction pipes consist of an inside and outside made from virgin PVC material and the core (middle) layer that can incorporate up to 100% recycled PVC material depending upon material properties. Sandwich construction pipes are normally restricted to non-pressure applications, such as electrical conduit pipe (DSEWPC, 2011). Due to the long life of rigid PVC products and low volume in waste streams, there is also no current limitation for the amount of recycled PVC that can be utilised. According to a 2011 European study by PVC4Pipes, up to 50% recycled PVC can be used in foam core pipes and a level of only 25% would consume more recycled rigid PVC than is currently available on the market (Fumire & Tan, 2012). PVC can be recycled six to seven times with almost no inherent quality degradation. Assuming a pipe product life of 100 years means that PVC material could potentially have a lifespan in excess of 600 years (DSEWPC, Waste and Recycling in Australia 2011, 2012). A small amount of contaminant can be adjusted for by varying additives in the feedmix such as lubricants and processing aids.

[1] 26.9% product is considered to be recycled and this amount is considered in C3 calculation.
[2] 73.1% product is considered to be landfilled and this amount is considered in C4 calculation.

Recycled PVC is very close to matching the "functional equivalence" of virgin PVC pipe feedmix, whereby each tonne of PVC pipe reprocessed (taking into account processing losses) will likely avoid production of the equal mass of virgin PVC pipe feedmix (Fumire & Tan, 2012). However, considering the inability of recycled PVC to perform the exact same function as virgin PVC pipe feedmix, a value-correction factor of 90% was used. This study also assumes that 15% of PVC is lost during processing.

## 4.0 LIFE CYCLE ASSESSMENT METHODOLOGY

This section includes the main details of the Life Cycle Assessment (LCA) study as well as assumptions and methods of the assessment. A summary of the life cycle assessment parameters is given in Table 4.

### TABLE 4 – LCA INFORMATION

| | |
|---|---|
| DECLARED UNIT | 1 kg pipe |
| GEOGRAPHICAL COVERAGE | Australia |
| LCA SCOPE | Cradle to gate with module A4, 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 Iplex for financial year 2020-2021. |
| 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:<br>– For Australia, the Australian Life Cycle Inventory (AusLCI) v1.36 compiled by the Australian Life Cycle Assessment Society ((ALCAS), Australian Life Cycle Inventory (AusLCI) – v1.36, 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.<br>– 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. |

Life cycle assessment (LCA) requires a compilation of the inputs, outputs and environmental impacts of a product system throughout its life cycle. LCA can enable businesses to identify resource flows, waste generation and environmental impacts (such as climate change) associated with the provision of products and services.

Life cycle thinking is a core concept in sustainable consumption and production for policy and business. Upstream and downstream consequences of decisions must be taken into account to help avoid the shifting of burdens from one type of environmental impact to another, from one political region to another, or from one stage to another in a product's life cycle from the cradle to the grave.

According to EN 15804, EPDs of construction products may not be comparable if they do not comply with this standard, and EPDs might not be comparable, particularly if different functional units are used.

## CORE DATA COLLECTION

- All primary (foreground) data collected for this EPD was sourced from Iplex via a Request for Information spreadsheet. This data was collected for the financial year 2020-2021.
- A small portion of pipes (1%) become wastage during installation as unusable offcuts.
- For this study, 2.7% of solid wall pipes and 2.4% of foam core pipes are assumed to be recycled. The main impact of varying recycling rate is avoided production in Module D.

## BACKGROUND DATA

Generic background data was sourced for raw materials in the upstream module and transportation. Background data was adapted to represent Iplex PVC non-pressure pipe as accurately as possible. For Australia, the Australian Life Cycle Inventory (AusLCI) v1.36 compiled by the Australian Life Cycle Assessment Society ((ALCAS), Australian Life Cycle Inventory (AusLCI) – v1.36, 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. Other sources with sensitivity analysis reported to show the significance of this data for the results and conclusions drawn.

## DATA QUALITY AND VALIDATION

The primary data used for the study (core module) is based on direct utility bills or feedstock quantities from the Iplex's procurement records. Primary data was carefully reviewed in order to ensure completeness, accuracy and representativeness of the data supplied. Contribution analysis was used to focus on the key pieces of data contributing to the environmental impact categories. 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, PCR 2019:14 Product Category Rules- Construc Products Version 1.11, 2019).
- 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.

## CUT-OFF RULES

It is common practice in LCA/LCI protocols to propose exclusion limits for inputs and outputs that fall below a threshold percentage of the total, 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. 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.
- In the case of solid wall pipes, transport distance of wax and lubricant was excluded as their contribution is less than 1%. For similar reason, transport distance of blowing agent was excluded in the case of foam core pipes.

Besides these exclusions, no energy or mass flows were excluded.

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

## 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. 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.

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.

There are no co-products from the production of Iplex PVC non-pressure pipe and therefore allocation issues were avoided. There is no double counting of the impact from any manufacturing or other associated processes.

PVC non-pressure pipe is manufactured in Chipping Norton (NSW), Strathpine (QLD) and Reservoir (VIC) in Australia. Mass and energy data have been sourced from the manufacturing plant by Iplex. The quantities of materials and electricity required for producing Iplex PVC non-pressure pipe are calculated on basis of the amount (tonnes) of pipe manufactured on a particular site in financial year 2020-2021 and the associated electricity consumption for that particular product line. This data is also recorded as part of the standard quality assurance purpose.

The allocation approach for the background LCA databases utilised in this report is also compliant with the PCR. More specifically, the burden of primary production of materials is always allocated to the primary user of a material, while secondary (recycled) materials bear only the impacts of the recycling processes. There is no use of secondary materials and fuels.


PREMIUM BEP PVC 225 PVC-U
PIPE

# 5.0 IPLEX PVC NON - PRESSURE PIPE ENVIRONMENTAL PERFORMANCE

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 (v9.1.1.1) tool.

### TABLE 5 – 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 $PO_4^{3-}$ equivalents | CML (v4.1) |
| **Eutrophication – aquatic freshwater** | EP - freshwater | kg P equivalent | EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe[4] |
| **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 |

| IMPACT CATEGORY | ABBREVIATION | MEASUREMENT UNIT | ASSESSMENT METHOD AND IMPLEMENTATION |
|---|---|---|---|
| **RESOURCE USE** | | | |
| **Global warming potential, excluding biogenic uptake, emissions and storage** | GWP-GHG | kg $CO_2$ equivalents (GWP100) | CML (v4.1) |
| **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[5] |
| **Use of renewable primary energy resources used as raw materials** | PERM | MJ, net calorific value | Manual for direct inputs[6] |
| **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[7] |
| **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[8] |
| **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)[9] |
| **Radioactive waste disposed/stored** | RWD | kg | EDIP 2003 (v1.05) |
| **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 version 2 |
| **Human toxicity potential - cancer effects*** | Potential Comparative Toxic Unit for humans (HTP-c) | CTUh | USEtox version 2 |
| **Human toxicity potential - non cancer effects*** | Potential Comparative Toxic Unit for humans (HTP-nc) | CTUh | USEtox version 2 |
| **Soil quality*** | Potential soil quality index (SQP) | dimensionless | Soil quality index (LANCA®) |

[4] EN 15804:2012+A2:2019 specifies that the unit for the indicator for Eutrophication aquatic freshwater shall be kg PO4 eq, although the reference given ("EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe") uses the unit kg P eq. This is likely a typographical error in EN 15804, which is expected to be corrected in a future revision. Until this has been corrected, results for Eutrophication aquatic freshwater shall be given in both kg PO4 eq and kg P eq. in the EPD.

[5] 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.

[6] Calculated based on the lower heating value of renewable raw materials.

[7] Calculated based on the lower heating value of non-renewable raw materials.

[8] Calculated as sum of Non-renewable, fossil, Non-renewable, nuclear and Non-renewable, biomass.

[9] Calculated as sum of Bulk waste and Slags/ash.

## RESULTS FOR PVC SOLID WALL PIPE

### TABLE 6 – ENVIRONMENTAL IMPACTS FOR PVC SOLID WALL PIPE

| INDICATOR | UNIT | A1-A3 | A4 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|
| GWP-F | kg $CO_2$ eq. | 3.38 | 0.01 | 5.22E-05 | 0.02 | 0.06 | 2.82E-03 | -0.38 |
| GWP - B | kg $CO_2$ eq. | -0.01 | 8.40E-07 | 1.77E-09 | 1.63E-06 | 1.01E-04 | 6.48E-06 | -7.54E-03 |
| GWP - Luluc | kg $CO_2$ eq. | 2.27E-03 | 5.43E-08 | 7.20E-13 | 1.82E-07 | 2.75E-08 | 0.00 | -5.31E-04 |
| GWP - T | kg $CO_2$ eq. | 3.37 | 0.01 | 5.22E-05 | 0.02 | 0.06 | 2.82E-03 | -0.39 |
| ODP | kg CFC 11 eq. | 1.06E-06 | 5.14E-10 | 7.63E-15 | 2.57E-09 | 3.03E-10 | 3.57E-15 | -5.95E-08 |
| AP | mol H+ eq. | 0.02 | 7.35E-05 | 4.62E-07 | 1.55E-04 | 3.96E-04 | 2.34E-05 | -5.46E-03 |
| EP - F | kg $PO_4^{3-}$ eq. | 3.41E-03 | 7.57E-06 | 6.79E-08 | 1.79E-05 | 2.83E-05 | 3.09E-06 | -1.33E-04 |
| EP - F | kg P eq. | 6.82E-04 | 2.99E-07 | 3.89E-11 | 8.07E-07 | 1.66E-06 | 9.89E-11 | -1.52E-06 |
| EP - M | kg N eq. | 3.53E-03 | 1.84E-05 | 2.01E-07 | 4.09E-05 | 6.30E-05 | 9.15E-06 | -2.82E-04 |
| EP - T | mol N eq. | 0.04 | 2.04E-04 | 2.19E-06 | 4.48E-04 | 6.83E-04 | 9.99E-05 | -2.82E-03 |
| POCP | kg NMVOC eq. | 9.69E-03 | 6.60E-05 | 5.72E-07 | 1.43E-04 | 1.90E-04 | 2.65E-05 | -1.20E-03 |
| ADP | kg Sb eq. | 3.54E-05 | 2.97E-08 | 1.18E-12 | 1.01E-07 | 5.73E-08 | 5.59E-12 | -3.30E-08 |
| ADP - F | MJ | 5.73 | 0.05 | 1.92E-05 | 0.25 | 0.28 | 2.90E-03 | -10.06 |
| WDP | $m^3$ | 9.15 | 0.08 | 2.69E-05 | 0.23 | 1.49 | 4.80E-05 | -12.24 |

### TABLE 7 – RESOURCE USE FOR PVC SOLID WALL PIPE

| INDICATOR | UNIT | A1-A3 | A4 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|
| PERE | MJ | 2.53 | 1.00E-03 | 4.52E-07 | 3.54E-03 | 0.02 | 3.15E-04 | -0.06 |
| PERM | MJ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PERT | MJ | 2.53 | 1.00E-03 | 4.52E-07 | 3.54E-03 | 0.02 | 3.15E-04 | -0.06 |
| PENRE | MJ | 61.10 | 0.05 | 1.93E-05 | 0.26 | 0.28 | 2.90E-03 | -10.90 |
| PENRM | MJ. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PENRT | MJ | 61.10 | 0.05 | 1.93E-05 | 0.26 | 0.28 | 2.90E-03 | -10.90 |
| SM | kg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| RSF | MJ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NRSF | MJ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FW | $m^3$ | 0.02 | 1.89E-05 | 3.57E-09 | 4.34E-05 | 7.99E-04 | 6.76E-07 | -4.81E-04 |

### TABLE 8 – WASTE PRODUCTION FOR PVC SOLID WALL PIPE

| INDICATOR | UNIT | A1-A3 | A4 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|
| Hazardous waste disposed | kg | 3.29E-05 | 1.36E-07 | 5.26E-12 | 3.83E-07 | 1.30E-07 | 3.47E-13 | -5.36E-07 |
| Non-hazardous waste disposed | kg | 0.35 | 1.34E-03 | 7.27E-08 | 2.18E-03 | 0.07 | 0.69 | -0.02 |
| Radioactive waste disposed | kg | 6.14E-05 | 6.33E-10 | 5.88E-14 | 1.51E-09 | 1.35E-09 | 0.00 | -3.46E-09 |

## RESULTS FOR PVC SOLID WALL PIPE

### TABLE 9 – OUTPUT FLOWS FOR PVC SOLID WALL PIPE

| INDICATOR | UNIT | A1-A3 | A4 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|
| Components for re-use | kg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Material for recycling | kg | 0.00 | 0.00 | 0.00 | 0.00 | 6.09 | 0.00 | 0.00 |
| Materials for energy recovery | kg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Exported energy, electricity | MJ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Exported energy, thermal | MJ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

### TABLE 10 – ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS FOR PVC SOLID WALL PIPE

| INDICATOR | UNIT | A1-A3 | A4 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|
| GWP-GHG | kg $CO_2$ eq. | 3.26 | 0.01 | 5.15E-05 | 0.02 | 0.06 | 2.78E-03 | -0.35 |
| Particulate matter | disease incidence | 1.35E-07 | 1.10E-09 | 1.31E-12 | 1.14E-09 | 3.35E-09 | 8.63E-11 | -3.20E-08 |
| Ionising radiation - human health | kBq U-235 eq | 0.16 | 4.43E-06 | 4.07E-10 | 1.08E-05 | 9.39E-06 | 0.00 | -2.55E-05 |
| Eco-toxicity (freshwater) | CTUe | 51.60 | 0.28 | 1.27E-03 | 0.15 | 0.36 | 0.05 | -9.86 |
| Human toxicity potential - cancer effects | CTUh | 1.73E-09 | 4.44E-12 | 1.03E-14 | 6.62E-12 | 1.36E-11 | 5.12E-13 | -9.24E-11 |
| Human toxicity potential - non cancer effects | CTUh | 4.50E-08 | 2.27E-10 | 6.98E-13 | 2.14E-10 | 2.87E-10 | 3.74E-11 | -8.52E-09 |
| Soil quality | dimensionless | 3.18E+03 | 0.02 | 3.20E-06 | 0.11 | 0.13 | 6.42E-04 | -0.27 |

## RESULTS FOR PVC FOAM CORE PIPE

### TABLE 11 – ENVIRONMENTAL IMPACTS FOR PVC FOAM CORE PIPE

| INDICATOR | UNIT | A1-A3 | A4 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|
| GWP-F | kg $CO_2$ eq. | 3.20 | 0.02 | 5.22E-05 | 0.02 | 0.06 | 2.82E-03 | -0.25 |
| GWP - B | kg $CO_2$ eq. | -0.02 | 1.48E-06 | 1.77E-09 | 1.63E-06 | 1.01E-04 | 6.48E-06 | -4.99E-03 |
| GWP - Luluc | kg $CO_2$ eq. | 2.10E-03 | 9.58E-08 | 7.20E-13 | 1.82E-07 | 2.75E-08 | 0.00 | -3.51E-04 |
| GWP - T | kg $CO_2$ eq. | 3.19 | 0.02 | 5.22E-05 | 0.02 | 0.06 | 2.82E-03 | -0.26 |
| ODP | kg CFC 11 eq. | 1.03E-06 | 9.07E-10 | 7.63E-15 | 2.57E-09 | 3.03E-10 | 3.57E-15 | -3.94E-08 |
| AP | mol H+ eq. | 0.02 | 1.30E-04 | 4.62E-07 | 1.55E-04 | 3.96E-04 | 2.34E-05 | -3.61E-03 |
| EP - F | kg $PO_4^{3-}$ eq. | 3.24E-03 | 1.34E-05 | 6.79E-08 | 1.79E-05 | 2.83E-05 | 3.09E-06 | -8.77E-05 |
| EP - F | kg P eq. | 6.43E-04 | 5.27E-07 | 3.89E-11 | 8.07E-07 | 1.66E-06 | 9.89E-11 | -1.01E-06 |
| EP - M | kg N eq. | 3.38E-03 | 3.25E-05 | 2.01E-07 | 4.09E-05 | 6.30E-05 | 9.15E-06 | -1.86E-04 |
| EP - T | mol N eq. | 0.03 | 3.60E-04 | 2.19E-06 | 4.48E-04 | 6.83E-04 | 9.99E-05 | -1.87E-03 |
| POCP | kg NMVOC eq. | 9.25E-03 | 1.17E-04 | 5.72E-07 | 1.43E-04 | 1.90E-04 | 2.65E-05 | -7.93E-04 |
| ADP | kg Sb eq. | 3.34E-05 | 5.24E-08 | 1.18E-12 | 1.01E-07 | 5.73E-08 | 5.59E-12 | -2.18E-08 |
| ADP - F | MJ | 53.00 | 0.09 | 1.92E-05 | 0.25 | 0.28 | 2.90E-03 | -6.66 |
| WDP | $m^3$ | 12.30 | 0.14 | 2.69E-05 | 0.23 | 1.49 | 4.80E-05 | -8.10 |

### TABLE 12 – RESOURCE USE FOR PVC FOAM CORE PIPE

| INDICATOR | UNIT | A1-A3 | A4 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|
| PERE | MJ | 2.43 | 1.77E-03 | 4.52E-07 | 3.54E-03 | 0.02 | 3.15E-04 | -0.04 |
| PERM | MJ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PERT | MJ | 2.43E | 1.77E-03 | 4.52E-07 | 3.54E-03 | 0.02 | 3.15E-04 | -0.04 |
| PENRE | MJ | 56.60 | 0.09 | 1.93E-05 | 0.26 | 0.28 | 2.90E-03 | -7.19 |
| PENRM | MJ. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PENRT | MJ | 56.60 | 0.09 | 1.93E-05 | 0.26 | 0.28 | 2.90E-03 | -7.19E |
| SM | kg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| RSF | MJ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NRSF | MJ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FW | $m^3$ | 0.02 | 3.33E-05 | 3.57E-09 | 4.34E-05 | 7.99E-04 | 6.76E-07 | -3.19E-04 |

### TABLE 13 – WASTE PRODUCTION FOR PVC FOAM CORE PIPE

| INDICATOR | UNIT | A1-A3 | A4 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|
| Hazardous waste disposed | kg | 3.12E-05 | 2.40E-07 | 5.26E-12 | 3.83E-07 | 1.30E-07 | 3.47E-13 | -3.55E-07 |
| Non-hazardous waste disposed | kg | 0.33 | 2.36E-03 | 7.27E-08 | 2.18E-03 | 0.08 | 0.69 | -0.01 |
| Radioactive waste disposed | kg | 5.78E-05 | 1.12E-09 | 5.88E-14 | 1.51E-09 | 1.35E-09 | 0.00 | -2.29E-09 |

## RESULTS FOR PVC FOAM CORE PIPE (CONT'D)

### TABLE 14 - OUTPUT FLOWS FOR FOAM CORE PIPE

| INDICATOR | UNIT | A1-A3 | A4 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|
| Components for re-use | kg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Material for recycling | kg | 0.00 | 0.00 | 0.00 | 0.00 | 6.09 | 0.00 | 0.00 |
| Materials for energy recovery | kg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Exported energy, electricity | MJ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Exported energy, thermal | MJ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

### TABLE 15 - ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS FOR PVC FOAM CORE PIPE

| INDICATOR | UNIT | A1-A3 | A4 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|
| GWP-GHG | kg $CO_2$ eq. | 3.09 | 0.02 | 5.15E-05 | 0.02 | 0.06 | 2.78E-03 | -0.02 |
| Particulate matter | disease incidence | 1.31E-07 | 1.95E-09 | 1.31E-12 | 1.14E-09 | 3.35E-09 | 8.63E-11 | -2.11E-08 |
| Ionising radiation - human health | kBq U-235 eq | 0.15 | 7.81E-06 | 4.07E-10 | 1.08E-05 | 9.39E-06 | 0.00 | -1.69E-05 |
| Eco-toxicity (freshwater) | CTUe | 48.90 | 0.49 | 1.27E-03 | 0.15 | 0.36 | 0.05 | -6.53 |
| Human toxicity potential - cancer effects | CTUh | 1.63E-09 | 7.83E-12 | 1.03E-14 | 6.62E-12 | 1.36E-11 | 5.12E-13 | -6.12E-11 |
| Human toxicity potential - non cancer effects | CTUh | 4.26E-08 | 4.00E-10 | 6.98E-13 | 2.14E-10 | 2.87E-10 | 3.74E-11 | -5.63E-09 |
| Soil quality | dimensionless | 2.99E+03 | 0.03 | 3.20E-06 | 0.11 | 0.13 | 6.42E-04 | -0.18 |

## INFORMATION ON BIOGENIC CARBON CONTENT

### TABLE 16 – BIOGENIC CARBON CONTENT FOR 1 KG OF PVC NON-PRESURE PIPE

| BIOGENIC CARBON CONTENT | UNIT | QUANTITY |
|---|---|---|
| Biogenic carbon content in product | kg C | 0.00E+00 |
| Biogenic carbon content in packaging | kg C | 6.23E-03 |

Note: 1 kg biogenic carbon is equivalent to 44/12kg $CO_2$.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## INTERPRETATION OF RESULTS RECYCLING AT EOL SCENARIO ANALYSIS

### POTENTIAL ENVIRONMENTAL IMPACTS

The product stage (A1-A3) is the primary contributor to GWPT and water depletion impacts in the modules A1-A4 and C1- C3,. 97.3% of GWPT arises from the product stage or A1-A3 modules.

The product stage (A1-A3) contributes to  96-99.7% of all other environmental impact categories except WDP.

WDP impacts from A1-A3 modules account 83.5%.

In case of GWPT impacts, PVC resin is the highest contributor of A1-A3 GWPT impacts (68.2%) followed by titanium dioxide white (3.4%).

- The major WDP impacts originates from product stage (A1-3), accounting for 83.5% of total WDP impacts followed by waste processing (C3) with a WDP contribution of 13.6%.
- Contribution from distribution (A4) and waste transport (C2) to ODP are 4.6% and 22.8%, respectively. Deconstruction (C1) and waste disposal (C4) have negligible contribution (nearly zero).
- The avoided production of PVC resin in module D provide potential benefits. In the case of GWPT impacts, the benefit is 11.3% of lifecycle GWPT.

### RESOURCE USE

- The major resource use impacts in the modules A1-A4 and C1- C3 originate from the product stages (A1-A3), ranging between 95.9-99%.

PVC resin has the highest renewable resources, accounting for 72.3% of total lifecycle renewable utilisation. The second largest renewable resources user is the processing aid, accounting 1.3% of the total lifecycle renewable resources.

PVC resin is the largest non-renewable resource user accounting for 85.7% of total lifecycle non-renewable resource utilisation. This is followed by wax those accounts 2.9% of total lifecycle non-renewable resources.

The highest contributor to total lifecycle Fresh Water use is from PVC resin, accounting for 88.5%. This is followed by the processing aid which uses 1.8% Fresh Water of whole lifecycle.

- There is no use of renewable secondary fuels.
- The renewable resource use impact is 4% of total renewable and non-renewable resource use impacts.
- The recycling of pipe in module D provides negligible positive impacts in fresh water (FW) use with a lifecycle saving of 2.3%.

### WASTE AND OUTPUT FLOWS

- About 100% of all waste generated in the modules A1-A4 and C1-C3 is non-hazardous.

The product stage (A1-A3) contributes to 81.6% of all non-hazardous waste generated. PVC resin is highest contributor to non-hazardous waste, accounting about 68.2%.

The recycling of pipe in module D assists in avoiding 4.8% non-hazardous waste.

## INTERPRETATION OF RESULTS FOR PVC FOAM CORE PIPE RECYCLING AT EOL SCENARIO ANALYSIS

### POTENTIAL ENVIRONMENTAL IMPACTS

- The product stage (i.e., A1-A3) is the primary contributor to GWPT and water depletion impacts in the modules A1-A4 and C1- C3,. 96.9% of GWPT arises from the product stage or A1-A3 modules.

The product stage (A1-A3) contributes to 95.4-99.6% of all other environmental impact categories except WDP. WDP impacts from A1-A3 modules account 86.8%.

In case of GWPT impacts, PVC resin is the highest contributor of A1-A3 GWPT impacts (48.2%) followed by PVC scrap (21.8%).

- The major WDP impacts originates from product stage (A1-3), accounting for 86.8% of total WDP impacts followed by waste processing (C3) with a WDP contribution of 10.6%.
- In any impact category except WDP, contributions from distribution (A4), waste transport (C2) and waste processing (C3) are negligible (less than 1%). While deconstruction (C1) has a nearly zero contribution.
- The avoided production of PVC resin in module D provide potential benefits. In the case of GWPT impacts, the benefit is 7.8% of lifecycle GWPT.

### RESOURCE USE

- The major resource use impacts in the modules A1-A4 and C1- C3 originate from the product stages (A1-A3), ranging between 96.3-98.9%.

PVC resin has the highest renewable resources accounting 50.4% of total lifecycle renewable utilisation. The second largest renewable resources user is the PVC scrap, accounting 21.3% of the total lifecycle renewable resources.

PVC resin is the largest non-renewable resource user accounting for 61.9% of total lifecycle non-renewable resource utilisation. This is followed by PVC scrap that accounts for 27.5% of total lifecycle non-renewable resources.

The highest contributor to lifecycle Fresh Water use is from PVC resin, accounting for 52.5%. This is followed by PVC scrap which uses 22.2% Fresh Water of whole lifecycle.

- There is no use of renewable secondary fuels.
- The renewable resource use impact is 4.1% of total renewable and non-renewable resource use impacts.
- The recycling of pipe in module D provides negligible positive impacts in fresh water (FW) use with a lifecycle saving of 1.4%.

### WASTE AND OUTPUT FLOWS

- 100% of all waste generated in the modules A1-A5 and C1-C3 is non-hazardous.

The product stage (A1-A3) contributes to 80.7% of all non-hazardous waste generated. PVC resin is highest contributor to non-hazardous waste, accounting about 47.2% followed by PVC scrap with 19.5% of contribution.

The recycling of pipe in module D assists in avoiding 3.3% non-hazardous waste.

### LANDFILLING AT EOL SCENARIO ANALYSIS

All results except those for modules C3, C4 and D are same for the landfilling and recycling scenario. For the landfilling scenario module C3 and D will have zero impact, whereas the module C4 will be considered in this case.

### LEAVING THE PIPES AS IS AT EOL SCENARIO ANALYSIS

All results except those for modules C1-C4, and D are same for this scenario and recycling. Impacts for C1-C4 and D will be zero in this case.

# 6.0 ADDITIONAL ENVIRONMENTAL INFORMATION

The plastic products are highly inert and are used predominantly in outdoor applications. They do not release any dangerous substances to indoor air, soil, or water.

## BEST ENVIRONMENTAL PRACTICE PVC

In 2010 the GBCA reviewed its Green Star rating tool and under a new approach, the use of Iplex PVC pressure and non-pressure pipe, conduit and fittings can assist buildings to qualify for up to two positive credit points where pipe and fittings can be shown to comply with the GBCA "Best Practice Guidelines for PVC in the Built Environment".

As a means of demonstrating Best Environmental Practice PVC (BEP PVC), Iplex was subjected to an extensive audit process by independent third party certifier, Approval Mark. On 9th February 2022, Iplex was issued with BEP PVC Certificate of Compliance No. 037.

## HEALTH RISK ASSESSMENT

The GBCA's Literature Review and Best Practice Guidelines for the Life Cycle of PVC Building Products (GBCA, 2010) provides an overview of health and environmental concerns that have been voiced by stakeholders relating to PVC production and end of life product management. Regarding concerns about additives, Iplex PVC pipe material is itself unplasticised PVC, and hence does not contain plasticiers – phthalates. Australian Standards for PVC pipe, as the only national PVC pipe product standards to do so worldwide, specifically exclude heavy metal (e.g. lead and cadmium) additives (PIPA, 2014). Furthermore, the Adaptation of the USGBC TSAC Report for Relevance to Australian DWV Pipe (BRANZ, 2008) found that for typical pipe products "No single material shows up as the best across all the human health and environmental impact categories, nor the worst". The GBCA further found that the level of dioxins emitted due to best practice production of PVC and its constituents is much less than that from other sources. Therefore, there is insufficient rationale for discrimination against PVC building products on the basis of dioxin emissions (GBCA, 2010).

## GUIDANCE FOR PVC PIPE RECYCLING

PVC pipe has a high recyclability and can be mechanically recycled back into a non-pressure pipe product performing the same structural function as one made only from virgin material. Due to the long life of rigid PVC products and low volume in waste streams, there is also no current limitation for the amount of recycled PVC that can be utilised.

Iplex Pipeback™ Program offers a streamlined service for recycling post consumer PVC pipes back into the manufacturing process with collection depots in North Queensland, Queensland, South Australia, Victoria and New South Wales.

Iplex recycling facilities will accept clean and unused pipe offcuts and fittings. For more information and to arrange a convenient drop-off time (by appointment only) please complete the 'contact us' form on the Iplex website. Once Iplex has received your request a recycling team member will be in touch.

# 7.0 PRODUCT SPECIFICATIONS

The following tables can be used to calculate the environmental results for specific Iplex pipe products. The unit weight and length of pipe give the total mass of pipe for each product code.

### TABLE 17 - PRODUCT SPECIFICATIONS FOR PVC SOLID WALL PIPE PRODUCTS

| APPLICATION | PRODUCT CODE | DN NOMINAL SIZE (MM) | STIFFNESS/ PRESSURE RATING | LENGTH (M) | MINIMUM MEAN OUTSIDE DIAMETER (MM) | MASS (KG/M) |
|---|---|---|---|---|---|---|
| CONDUIT | CNBN20445 | 20MM | NA | 4.5M | 26.6 | 0.19 |
| CONDUIT | CTC50445 | 50MM | NA | 4.5M | 60.2 | 0.90 |
| CONDUIT | CTCO20 | 20MM | NA | 4.5M | 26.6 | 0.20 |
| CONDUIT | CTCR50 | 50MM | NA | 4.5M | 60.1 | 0.75 |
| DWV | DPSH40 | 40MM | NA | 6.0M | 42.8 | 0.42 |
| DWV | DPSH50 | 50MM | NA | 6.0M | 55.7 | 0.59 |
| DWV | DPSH65 | 65MM | NA | 6.0M | 68.7 | 0.88 |
| DWV | DPSH80 | 80MM | NA | 6.0M | 82.3 | 1.19 |
| DWV | DPSHOYS100 | 100MM | SN6 | 6.0M | 110.2 | 1.18 |
| DWV | DPSHOYS50 | 50MM | NA | 6.0M | 55.7 | 0.62 |
| CONDUIT | P600506WHT | 50MM | HD | 6.0M | 49.7 | 0.75 |
| CONDUITS | P9002006 | 200MM | NA | 6.0M | 225 | 4.58 |
| CONDUITS | P900204 | 20MM | NA | 4.0M | 19.7 | 0.16 |
| CONDUITS | P900254 | 25MM | NA | 4.0M | 24.7 | 0.20 |
| CONDUITS | P900324 | 32MM | NA | 4.0M | 31.7 | 0.32 |
| CONDUITS | P900326 | 32MM | NA | 6.0M | 31.7 | 0.32 |
| CONDUIT | P900504 | 50MM | NA | 4.0M | 49.7 | 0.66 |
| STORMWATER | WPSO150 | 150MM | HD | 6.0M | 160 | 2.13 |
| STORMWATER | WPSO150SL | 150MM | NA | 6.0M | 160 | 2.43 |
| STORMWATER | WPSO225 | 225MM | HD | 6.0M | 250 | 5.58 |
| STORMWATER | WPSO300 | 300MM | HD | 6.0M | 315 | 8.83 |
| STORMWATER | WPSO375 | 375MM | HD | 6.0M | 400 | 14.37 |
| STORMWATER | WPSO75 | 75MM | HD | 6.0M | 75 | 0.58 |
| STORMWATER | WPSO90 | 90MM | HD | 6.0M | 90 | 0.73 |
| STORMWATER | WPSO90SL | 90MM | NA | 6.0M | 90 | 0.79 |

## TABLE 18 - PRODUCT SPECIFICATIONS OF PVC FOAM CORE PIPE PRODUCTS

| APPLICATION | PRODUCT CODE | DN NOMINAL SIZE (MM) | STIFFNESS / PRESSURE RATING | LENGTH (M) | MINIMUM MEAN OUTSIDE DIAMETER (MM) | MASS (KG/M) |
|---|---|---|---|---|---|---|
| DWV | DSEH375 | 375MM | SN8 | 3.0M | 400 | 46.84 |
| DWV | DSEHS100 | 100MM | SN10 | 6.0M | 110 | 1.85 |
| DWV | DSME100 | 100MM | SN10 | 6.0M | 110.2 | 1.40 |
| DWV | DSME150 | 150MM | SN8 | 6.0M | 160 | 3.33 |
| DWV | DSME225 | 225MM | SN8 | 6.0M | 250 | 8.62 |
| DWV | DSME300 | 300MM | SN8 | 6.0M | 315 | 13.93 |
| DWV | DSMH100 | 100MM | SN6 | 6.0M | 110.2 | 1.18 |
| DWV | DSMH150 | 150MM | SN4 | 6.0M | 160 | 2.45 |
| DWV | DSMH225 | 225MM | SN4 | 6.0M | 250 | 6.85 |
| DWV | DSMH300 | 300MM | SN4 | 6.0M | 315 | 10.92 |
| CONDUIT | P600804WHT | 80MM | HD | 4.0M | 88.7 | 1.40 |
| CONDUIT | P900806 | 80MM | BLANK | 6.0M | 88.7 | 1.12 |
| CONDUIT | P900100445 | 100MM | BLANK | 4.5M | 114.1 | 1.82 |
| CONDUIT | P9001006 | 100MM | BLANK | 6.0M | 114.1 | 1.73 |
| CONDUIT | P6001004 | 100MM | HD | 4.0M | 114.1 | 2.20 |
| CONDUIT | P6001004WHT | 100MM | HD | 4.0M | 114.1 | 2.25 |
| CONDUIT | P6001006 | 100MM | HD | 6.0M | 114.1 | 2.02 |
| CONDUIT | P6001006WHT | 100MM | HD | 6.0M | 114.1 | 2.28 |
| CONDUIT | P6001504 | 150MM | HD | 4.0M | 160 | 4.05 |
| CONDUIT | P6001504WHT | 150MM | HD | 4.0M | 160 | 4.38 |
| CONDUIT | P6001504WHT | 150 | N/A | 4.0 | 160 | 4.38 |

# 8.0 REFERENCES

(ALCAS), A. L. (2021). Australian Life Cycle Inventory (AusLCI) – v1.36.

Australian/New Zealand Standard. (2005). AS/NZS 5065:2005 Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications.

AWE, D. o. (2020). 2018-19 Australian plastics recycling survey - national report.

BS EN 15804+A2. (2020). BS EN 15804:2012+A2:2019 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products.

BRANZ. (2008). TUDY REPORT Adaptation of the USGBC TSAC Report for Relevance to Australian DWV Pipe. Retrieved August 9, 2015, from http://www.edgeenvironment.com.au/docs/Branz%20report%20- %20 Adaptation%20of%20USBGC%20TSAC.pdf

DSEWPC. (2011). Construction and demolition waste guide. Canberra: Department of Sustainability, Environment, Water, Pollution and Communities (DSEWPC). Retrieved from http://www.environment.gov.au/system/files/resources/b0ac5ce4-4253-4d2b-b001-0becf84b52b8/files/case-studies.pdf

DSEWPC. (2012). Waste and Recycling in Australia 2011. Sydney: Department of Sustainability, Environment, Water, Pollution and Communities (DSEWPC). Retrieved from http://www.environment.gov.au/system/files/resources/b4841c02-229b-4ff4-8b3b-ef9dd7601d34/files/waste-recycling2011.pdf

Environdec. (2019). General Programme Instructions for the International EPD® System, version 3.01.

European Commission. (2004). Life Cycle Assessment of PVC and principle competing materials. Retrieved from http://ec.europa.eu/enterprise/sectors/chemicals/files/sustdev/pvcfinal_ report_lca_en.pdf

Frischknecht, R. (2007). The Environmental Relevance of Capital Goods in Life Cycle Assessments of Products and Services. Int. J LCA.

Fumire, J., & Tan, S. R. (2012). HOW MUCH RECYCLED PVC IN PVC PIPES? PVC4Pipes.

GBCA. (2010). Literature Review and Best Practice Guidelines for the Life Cycle of PVC Building Products. Retrieved August 9, 2015, from http://www.gbca.org.au/uploads/156/2716/Literature%20Review%20and%20Best%20 Practice% 20Guidelines%20for%20 the%20Life%20Cycle%20of%20PVC%20Building%20Products.pdf Retrieved from http://www.pvc4pipes.com/

General Programme Instructions of the International EPD® System. Version 4.0. https:// www.datocms-assets.com/37502/1617181375-general-programme-instructions-v-4.pdf

Heathcote, M. (2015, July 17). Personal correspondence. Plastics Industry Pipe Association (PIPA).

Hyder Consulting. (2009). 2009 National Plastics Recycling Survey. Plastic and Chemicals Industry Association (PCIA).

Iplex. (2015). Iplex Pipelines. Retrieved from DWV Pipe and Fittings: Field Testing: http://www.iplex.com.au/iplex.php?page=lib&lib=8&sec=56&chap=105

ISO 14020. (2000). ISO 14020:2000, Environmental labels and declarations — General principles. Geneva: International Organization for Standardization.

ISO 14025. (2006). ISO 14025:2006 - Environmental labels and declarations - Type III environmental declarations - Principles and procedures. Geneva: International Organization for Standardization (ISO).

ISO 14040. (2006). ISO 14040:2006. Environmental management – Life cycle assessment – Principles and framework. Geneva: International Organization for Standardization.

ISO 14044. (2006). ISO 14044:2006. Environmental management – Life cycle assessment – Requirements and guidelines. Geneva: International Organization for Standardization.

Moreno, R. F. (2021). Documentation of changes implemented in the ecoinvent database v3.8 (2021.09.21)

PCR 2019:14. (2019). PCR 2019:14 Product Category Rules- Construc Products Version 1.11.

PIPA. (2014). Sustainability. Retrieved August 7, 2015, from http://www.pipa.com.au/sustainability

Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., & & Weidema, B. (2019). The ecoinvent database version 3.6.

WoodSolutions. (2017). EPD Softwood Timber.

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