Environmental Product Declaration

PVC Non-Pressure Pipes and Conduits used in Buildings

AUSTRALASIA EPD®
ENVIRONMENTAL PRODUCT DECLARATION

Environmental Product Declaration (EPD) in accordance with ISO 14025 and EN 15804
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EPD of Vinidex PVC-U non-pressure pipes and conduits - in collaboration with the Plastics Industry Pipe Association of Australia (PIPA).

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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. This version of the EPD has been updated to clarify the definition of "Indicator not assessed (INA)".

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CEN standard EN 15804 served as the core PCR	
PCR	Construction Products and Services, Version 2, 2015-03-03
PCR prepared by	**IVL Swedish Environmental Research Institute** Moderator: Martin Erlandsson, martin.erlandsson@ivl.se
Independent external verification of the declaration and data, according to ISO 14025:2010	☐ EPD process certification (Internal) ☑ EPD verification (External)
Accredited or approved by	The Australasian EPD® Programme

Vinidex Systems & Solutions

GREEN STAR EPD COMPLIANCE

✓ The EPD conforms with 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 Sustainable Product credit points under the GBCA's Green Star rating tools.

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

VINIDEX SYSTEMS AND SOLUTIONS

Vinidex Pty Limited (Vinidex) is Australia's leading manufacturer and supplier of quality PVC, PE and PP pipe systems and solutions for the transportation of fluid, data and energy with pipe systems ranging from 15 mm to 1000 mm.

Vinidex pipe and fittings systems are used in a broad range of applications including plumbing, water supply, sewerage and wastewater, stormwater and drainage, mining, industrial, rural, irrigation, electrical, telecommunications and gas.

We have nine manufacturing sites across Australia and a comprehensive nationwide network of warehousing and distribution facilities to enable efficient distribution of our own products and those of our national and international partners. Vinidex has extensive logistics experience with major projects and a proven track record for project delivery.

As part of the world wide Aliaxis Group of companies, Vinidex can provide products, access to international technologies and innovative solutions that are world class. The Aliaxis Group is a leading global manufacturer and distributor of plastics pipe systems, present in over 40 countries, with more than 100 commercial entities and employs over 15,000 people.

Vinidex is renowned for a commitment to technical advancement and product innovation. Our continuous evaluation programmes, examining new materials, processing technology and manufacturing equipment, ensure our continued position as a major participant in the pipe industry. Vinidex participates in Australian and International pipe associations as well as Australian and ISO standards committees.

At every level of Vinidex, you'll find a genuine commitment from our staff to exceed expectations and ensure that you are satisfied with the overall experience. We offer total solutions from design assistance, technical support, product supply, delivery logistics management and field support.

PRODUCT INFORMATION

PVC is the material of choice for non-pressure systems. It is used for plumbing, sewerage and drainage applications as well as for electrical and communications conduits. The material is ideally suited to these applications and is used in all types of buildings and infrastructure due to its ease of installation, light weight, non-conductive properties and long life. The material is very stable retaining its properties in the long term and does not corrode at all in wet conditions or environments commonly encountered that are aggressive towards metals or concrete. PVC pipes and conduits are used above ground, behind the wall, in fully exposed and buried installations.

Vinidex produces a complete range of PVC non-pressure pipe and conduit products conforming to relevant Australian Standards in sizes from 16 mm to 375 mm. Pipes have StandardsMark product certification and products intended for plumbing applications also have WaterMark certification permitting their use in plumbing applications in accordance with the Plumbing code.

Pipes and conduits are all produced from PVC-U although they are commonly referred to as being manufactured from PVC. PVC-U is PVC Unplasticised and contains no phthalates or other plasticisers. PVC-U is the technical description of the material used in specifications and Standards documentation. Specific product characteristics are shown in Table 1 and the content declaration in Table 2.

Table 1 - Product characteristics of PVC non-pressure pipe at 20 degrees C

Product Characteristics	
Product names/application	Polyvinylchloride (PVC) pipes covered in this EPD are: • PVC-U pipes for drain, waste and vent application • PVC-U conduits for electrical and communication applications • PVC-U pipes for stormwater and surface water applications See Table 12 to Table 15 for individual product codes.
UN CPC Code	36320 - Tubes, pipes and hoses, and fittings therefor, of plastics
Density	1420-1480 kg/m^3
Ultimate tensile strength	52 MPa
Compressive strength	66 MPa
Shore D hardness	80
Coefficient of linear thermal expansion	7 x 10^{-5}/˚C
Vicat softening temperature	80-84˚C
Elongation at yield	5.5%
Poisson's ratio	0.40
Ring bending modulus	3200 MPa

Table 2 - Content Declaration

Material	Percentage Content	CAS No.
PVC resin	82%	9002-86-2
Filler	14%	471-34-1
Calcium based stabilizer	2.2%	Confidential (nothing hazardous)
Titanium white	0.83%	13463-67-7
Chlorinated polyethylene	0.39%	64754-90-1
Oxidised polyethylene wax	0.22%	9010-79-1
Polyethylene wax	0.19%	8002-74-2
Azodicarbonamide	0.11%	123-77-3
Pigments	<0.5%	Confidential (nothing hazardous)
Methyl methacrylate	<0.1%	80-62-6
Calcium Stearate	<0.1%	1592-23-0
Total	100%	

PRODUCT LIFE CYCLE OVERVIEW

The life cycle of a building product is divided into three process modules according to the General Program Instructions (GPI) of the Australasian EPD Programme (AEPDP, 2015) and four information modules according to ISO 21930 and EN 15804, and supplemented by an optional information module on potential loads and benefits beyond the building life cycle. Table 3 shows the system boundary and scope of the EPD. The scope of this EPD is "cradle to gate with options" as defined by EN 15804 - the specific system boundary is shown in Table 3. The intent of the EPD is to cover all modules of significant environmental impact over the full product life cycle. Due to the durability of PVC pressure pipes, and lack of planned or required maintenance throughout the service life, modules B1-B7 were deemed not relevant (of negligible impact).

Table 3 - System boundary and scope of assessment

Product Stage			Construction Stage		Use Stage							End of Life Stage				Benefits
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material supply	Transport	Manufacturing	Transport	Installation	Material emissions	Maintenance	Repair	Replacement	Refurbishment	Operational energy	Operational water	Deconstruction/Demolition	Transport	Waste processing	Disposal	Reuse/Recycling/ Recovery potential
X	X	X	X	X	NR	NR	NR	NR	NR	NR	NR	X	X	X	X	X

X = module included in EPD
NR = module not relevant (does not indicate zero impact result)

LIFE CYCLE OF VINIDEX PVC PIPES

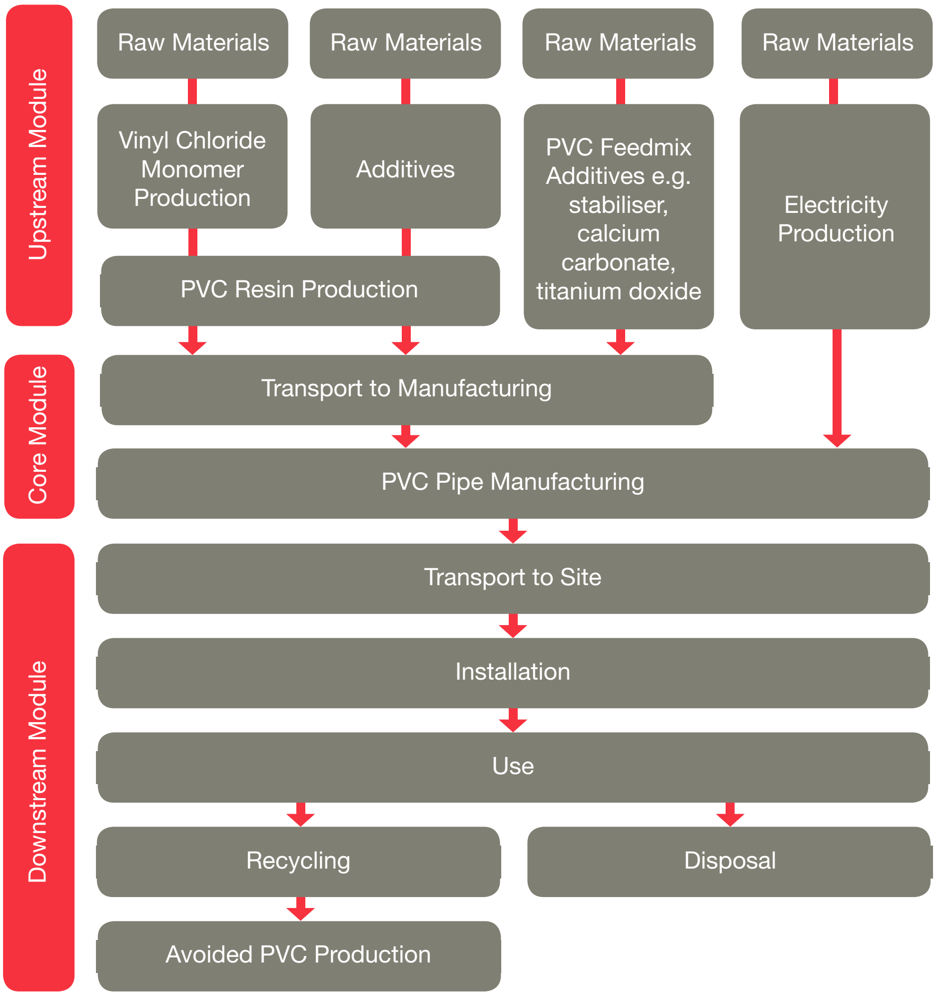

Figure 1 - Life cycle diagram of PVC pipe production

VINIDEX PVC PIPE MANUFACTURING

Vinidex non-pressure PVC pipes are manufactured primarily from PVC resin along with additives, including: calcium carbonate, titanium dioxide, calcium based stabiliser, lubricants and pigments. In the case of foam core PVC pipe, azodicarbonamide is also used as a blowing agent. The PVC resin is the main ingredient in the PVC pipe feed mix, and is manufactured in Australia primarily from imported vinyl chloride monomer. Internal PVC pipe scrap from production is fed back into the feed mix and utilised as the internal structure of foam core pipes also included in this EPD. The feed mix is heated and mixed prior to extrusion and then cooled with water to form the pipe structure. One end of the pipe is then re-heated after cutting and expanded to form a socket to allow for pipe jointing. Finally the lengths of pipe are palletised, packaged with a softwood timber frame, steel and PET strapping.

Vinidex PVC manufacturing sites for PVC non-pressure pipe are shown below in Figure 2.

The results shown in this EPD are representative of the weighted average PVC pipe production, incorporating PVC pipe of both solid wall and foam core construction.

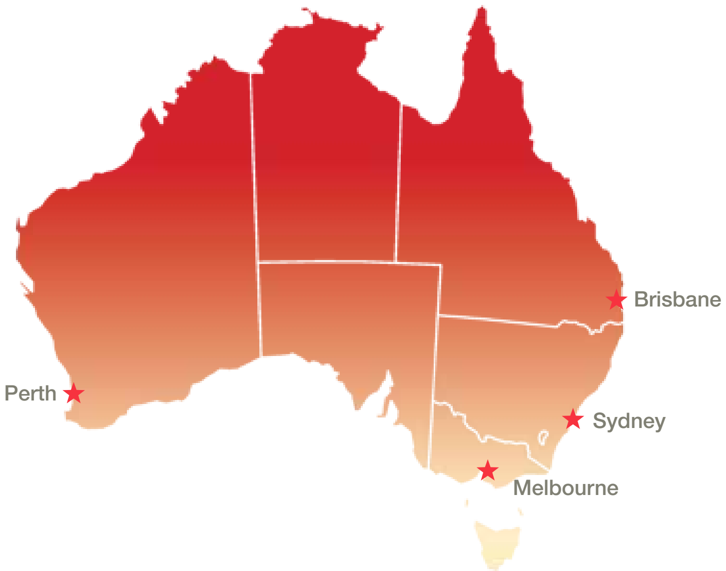

Figure 2 - Vinidex PVC non-pressure pipe manufacturing sites

DISTRIBUTION STAGE

Vinidex has PVC pipe manufacturing facilities in Australia's major markets, and the vast majority of pipe distribution is over short distances within Sydney, Melbourne, Brisbane and Perth metropolitan areas. While some pipe will be transported a long distance, either into rural areas or interstate to Adelaide, Hobart and Darwin, the weighted average distance to site is estimated to be between 50 and 70 km.

INSTALLATION STAGE

The majority of this type of pipe is installed inside buildings – in residential construction they are typically located in wall and floor cavities and for commercial and industrial applications often left exposed suspended from floor and ceiling surfaces as shown in the photographs below.

The pipes are carried by one person, cut by hand saw and positioned by hand – no machinery is used, it is all manual labour. The pipe systems are typically held in place by the penetration points at the walls or floor, or sometimes by brackets.

Jointing can be by rubber ring seals but the more common method in this group of pipe types would be to use solvent cement. The solvent softens the PVC and the close fit of the socket and spigot joint results in a chemical welding of the spigot to the socket. There is no heat required and minimal preparation based on having clean dry surfaces to apply solvent and then assemble the joint. Curing takes place quickly. Hold strength is reached in around 30 seconds and full cure achieved in less than 24 hours. No action or intervention of any kind is required to affect the curing process – simply waiting time before full service is recommended. There are tests performed at commissioning that confirm the installed system is leak free- typically low pressure air and vacuum testing. These tests and the installation requirements are regulated and specified in the National Plumbing Code of Australia which is now part of the National Construction Code administered by the Australian Building Codes Board.

Wastage of pipe is minimal as short lengths are often required elsewhere and easily reused on subsequent sites or within the same site. A very rough estimate puts wastage from unusable offcuts at less than 2%.

USE STAGE

Maintenance of the pipe systems is not required and not planned. These systems are designed with this in mind as access to these systems in a finished building is often limited given their location in floor slabs or behind finished walls and ceilings. The pipe systems are designed to outlast the building with a life expectancy in excess of 100 years. The failure rate is also extremely low and is considered to be inconsequential (not relevant) in this EPD. Post installation problems, if any, tend to be linked to 3rd party damage such as inadvertently drilling through pipes behind ceiling and wall finishes. There are no significant emissions from leaching of chemicals during the use stage for PVC pipes (European Commission, 2004). In the case that pipe is damaged, repair is simple using either a mechanical clamp or cutting out a small section (typically only 100 mm in the case of a drilled hole or misdirected fastener type of incident) and replacing with a new section of pipe or simply a repair sleeve fitting – accessing the pipe to effect the work will generally be the most challenging aspect of a repair.

END OF LIFE STAGE

PVC plastics pipe systems are readily recyclable and are currently recycled in all capital cities in Australia. Practically all pre-consumer pipe waste is recycled at manufacturing locations and post-consumer pipe waste recycling is on the rise. Due to the fact that plastic pipes have a very long service life, most plastic pipe that has been installed in Australia is still in its first lifetime.

Plastic pipe therefore represents a very small proportion of waste going to landfill – a fact confirmed by an audit of construction and demolition waste in NSW from 2011 (DSEWPC, 2011). PVC pipe can be recycled 6-7 times without significant reduction in pipe material quality requirements. Assuming a pipe lifetime of 100 years, the PVC material in PVC pipes may have a lifetime in excess of 600 years.

Due to a lack of national data on PVC pipe recycling, recycling rates were calculated by using best estimates for PVC pipe waste generation and recycling in NSW. Based on estimates by the former Department of Environment and Climate Change (DECC) and subsequent discussions with PIPA, it was estimated that there is approximately 1,300 tonnes of PVC pipe entering the waste stream each year in NSW. The current amount of PVC pipe recycled in NSW is approximately 350 tonnes, giving a recycling rate of 26.9%. This recycled PVC material is used in an innovative product range where the recyclate is used to manufacture new pipe with the same life and performance expectations as pipe made solely from virgin material. It is good to know that even when that long service life has been achieved that it can be recycled again back into pipe with exactly the same performance and life expectancy as the original pipe. So not only does plastic pipe connect Australia, it is also very much in the loop as far as recycling is concerned.

LIFE CYCLE ASSESSMENT METHODOLOGY

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

Table 4 - Details of LCA Study

Declared unit	1 kg of installed pipe
Geographical coverage	Australia
LCA scope	Cradle to gate with options
Reference service life	100 years - While the design life of the PVC pipe is in excess of 100 years, the duration of the pipe use in buildings will be less for buildings with a shorter lifetime.

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.

LCA is the compilation of the inputs, outputs and environmental impacts of a product system throughout its life cycle. It is a technique that enables industries to identify the resource flows and environmental impacts (such as greenhouse gas emissions, water and energy use) associated with the provision of products and services.

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

Life cycle data has been sourced from material quantity data and production process data from:

- Vinidex reporting systems and staff
- Vinidex feed mix suppliers

Core manufacturing data was collected directly from Vinidex manufacturing sites. Electricity consumption was allocated to pipe via mass of pipe produced.

BACKGROUND DATA

Generic background data was sourced for raw materials in the upstream module, transportation and end of life waste treatment. Background data was adapted to represent Vinidex PVC non-pressure pipe and conduit product as accurately as possible. Australian inputs were primarily modelled with the AusLCI database (AusLCI, 2009) and the Australasian Unit Process LCI (Life Cycle Strategies, 2015) and the ecoinvent v3 database where suitable Australian data was not available. Materials sourced from outside Australia were modelled based on global averages using the ecoinvent v3 database. 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.

CUT OFF CRITERIA

Environmental impacts relating to personnel, infrastructure, and production equipment not directly consumed in the process are excluded from the system boundary as per the PCR (IEPDS, 2015), section 6.6. All other reported data were incorporated and modelled using the best available life cycle inventory data, except for the ingredient *Calcium Stearate - 61G*, which was excluded due to lack of suitable background data. The excluded ingredient makes up less than 0.1% of the total feed mix mass.

ALLOCATION

Allocation was carried out in accordance with the PCR (IEPDS, 2015), section 6.7. No allocation between co-products in the core module as there were no co-products created during manufacturing.

VARIATION

The background LCA report tested the variation in results between manufacturing locations. The manufacturing location led to significant variance between the production impacts at Vinidex sites, however the purpose of this EPD is to represent the average Vinidex PVC pipe product supplied to the Australian market. By including all four manufacturing sites all in different states, this EPD is representative of the average production and is less susceptible to variation when production volumes vary.

PVC NON-PRESSURE PIPE AND CONDUIT ENVIRONMENTAL PERFORMANCE

The potential environmental impacts used in this EPD are explained in Table 5 and the results for Vinidex PVC non-pressure pipe and conduit are shown in Table 6. The use of energy and fresh water resources is shown in Table 7. The use of secondary material and secondary material used as energy resources is listed as ‘INA’ (indicator not assessed). Although Vinidex do not directly use secondary material, it is unknown whether secondary material is used in the supply chain and therefore exists in the product life cycle. Table 8 shows the generation of waste throughout the product life cycle.

Table 5 - Environmental indicators used in the EPD

Environmental Indicator	Unit	Description
Global Warming Potential [a]	kg carbon dioxide equivalents	Increase in the Earth's average temperature, mostly through the release of greenhouse gases. A common outcome of this is an increase in natural disasters and sea level rise.
Ozone Depletion Potential [b]	kg CFC-11 equivalents	The decline in ozone in the Earth's stratosphere. The depletion of the ozone layer increases the amount of UVB that reaches the Earth's surface. UVB is generally accepted to be a contributing factor to skin cancer, cataracts and decreased crop yields.
Acidification Potential [c]	kg sulphur dioxide equivalents	A process whereby pollutants are converted into acidic substances which degrade the natural environment. Common outcomes of this are acidified lakes and rivers, toxic metal leaching, forest damage and destruction of buildings.
Eutrophication Potential [c]	kg phosphate equivalents	An increase in the levels of nutrients released to the environment. A common outcome of this is high biological productivity that can lead to oxygen depletion, as well as significant impacts on water quality, affecting all forms of aquatic and plant life.
Photochemical Ozone Creation Potential [c]	kg ethylene equivalents	Ozone in the troposphere is a constituent of smog that is caused by a reaction between sunlight, nitrogen oxide and volatile organic compounds (VOCs). This is a known cause for respiratory health problems and damage to vegetation.
Abiotic Depletion Potential – Elements / minerals [c]	kg antimony equivalents	The extraction of non-living and non-renewable elements and minerals. These resources are essential in our everyday lives and many are currently being extracted at an unsustainable rate.
Abiotic Depletion Potential – Fossil Fuels [c]	MJ net calorific value	The extraction of non-living and non-renewable fossil fuels. These resources are essential in our everyday lives and many are currently being extracted at an unsustainable rate.







Life cycle impact assessment methods used: a - CML (v4.1) – based on IPCC AR4 (GWP 100); b - CML (v4.1) – based on WMO 1999; c - CML (v4.1)

PVC NON-PRESSURE PIPE ENVIRONMENTAL PERFORMANCE

Table 6 - Potential environmental impacts per 1 kg of installed pipe

	A1 & A2	A3	A4	A5	C1	C2	C3	C4
GWP (kgCO_2 eq)	2.85	0.758	8.85E-03	6.03E-03	5.18E-05	0.0198	0.0578	0.0146
ODP (kgCFC11 eq)	7.51E-08	1.18E-09	2.87E-10	2.96E-11	1.28E-14	2.10E-09	2.95E-10	1.23E-09
AP (kgSO_2 eq)	7.72E-03	1.26E-03	2.19E-05	9.77E-06	3.28E-07	7.66E-05	9.15E-05	5.96E-05
EP (kgPO_4^{3-} eq)	1.83E-03	4.07E-04	5.47E-06	2.94E-06	6.82E-08	1.94E-05	2.87E-05	1.50E-05
POCP (kgC_2H_2 eq)	4.91E-04	4.54E-05	1.42E-06	4.28E-07	1.16E-08	4.92E-06	3.36E-06	3.67E-06
ADPE (kgSb eq)	3.61E-06	6.60E-07	2.00E-08	6.38E-09	1.19E-12	1.02E-07	5.73E-08	6.00E-08
ADPF (MJ)	22.9	8.46	0.140	0.0787	7.85E-04	0.289	0.691	0.212

GWP = Global Warming Potential, **ODP** = Ozone Depletion Potential, **AP** = Acidification Potential, **EP** = Eutrophication Potential, **POCP** = Photochemical Oxidant Formation Potential, **ADPE** = Abiotic Resource Depletion Potential – Elements, **ADPF** = Abiotic Resource Depletion Potential – Fossil Fuel

Table 7 - Use of resources per 1 kg of installed pipe

	A1 & A2	A3	A4	A5	C1	C2	C3	C4
PERE (MJ)	1.66	0.200	7.58E-04	2.44E-03	4.51E-07	3.86E-03	0.0244	2.56E-03
PERM (MJ)	0	0	0	0	0	0	0	0
PERT (MJ)	1.66	0.200	7.58E-04	2.44E-03	4.51E-07	3.86E-03	0.0244	2.56E-03
PENRE (MJ)	65.8	8.52	0.140	0.0803	7.85E-04	0.304	0.695	0.221
PENRM (MJ)	0	0	0	0	0	0	0	0
PENRT (MJ)	65.8	8.52	0.140	0.0803	7.85E-04	0.304	0.695	0.221
SM (kg)	INA	INA	INA	INA	INA	INA	INA	INA
RSF (MJ)	INA	INA	INA	INA	INA	INA	INA	INA
NRSF (MJ)	INA	INA	INA	INA	INA	INA	INA	INA
FW (m^3)	0.699	0.0930	2.50E-03	3.60E-03	6.62E-07	0.0103	0.0349	6.42E-03

PERE = Use of renewable primary energy excluding raw materials, **PERM** = Use of renewable primary energy resources used as raw materials, **PERT** = Total use of renewable primary energy resources, **PENRE** = Use of non-renewable primary energy excluding raw materials, **PENRM** = Use of non-renewable primary energy resources used as raw materials, **PENRT** = Total use of non-renewable primary energy resources, **SM** = Use of secondary material, **RSF** = Use of renewable secondary fuels, **NRSF** = Use of non-renewable secondary fuels, **FW** = Use of net fresh water, **INA** = Indicator not accessed due to a limitation of the LCA tools and databases used to calculate the required resource flows. INA does not imply zero impact

Table 8 - Generation of waste per 1 kg of installed pipe

	A1 & A2	A3	A4	A5	C1	C2	C3	C4
HWD (kg)	9.37E-03	1.22E-06	9.38E-08	1.42E-08	6.10E-12	3.93E-07	1.37E-07	2.31E-07
NHWD (kg)	0.122	0.0506	8.99E-04	5.65E-03	7.31E-08	2.17E-03	0.0747	0.696
RWD (kg)	1.91E-06	1.73E-08	2.28E-09	1.15E-09	1.31E-13	8.48E-09	3.47E-09	4.99E-09

HWD = Hazardous waste disposed, **NHWD** = Non-hazardous waste disposed, **RWD** = Radioactive waste disposed

INTERPRETATION OF LCA RESULTS

The majority of environmental impact lies within the raw material supplied to Vinidex manufacturing sites – comparatively little impact is caused by the PVC pipe manufacturing at Vinidex sites. From the feed mix ingredients, PVC resin is responsible for the majority of all environmental impacts and use of resources, although additives were still found to have a significant impact.

SENSITIVITY ANALYSIS

AVERAGE PRODUCTION OF PVC PIPE AND CONDUIT

The results shown in this EPD are representative of average PVC pipe production, incorporating pipe of both solid wall and foam core construction. The raw materials used in the feed mix of these products is largely similar, except that a blowing agent is also used in the feed mix of foam core pipe. A sensitivity analysis was performed to assess the difference in impact between the solid wall and foam core pipe products. The results varied by less than 10% in all environmental impact categories apart from ozone depletion potential (27% higher for foam core pipe) and photochemical oxidation (26% higher for solid wall pipe).

END OF LIFE RECYCLING RATE

The assumption for end of life recycling rate was tested using low and high rates based on estimation ranges for PVC pipe in construction and demolition waste stream and current PVC pipe recycling rates. The amount of PVC pipe entering the waste stream is difficult to calculate due to low volumes and only recent targeted separation and collection. Estimates were made from PIPA PVC pipe recycling data and PVC waste data estimated by PIPA in collaboration with the former Department of Environment and Climate Change. A case study into PVC pipe recycling was published by the Department of Sustainability, Environment, Water, Pollution and Communities (DSEWPC, 2012). Using extremes of both PVC pipe waste and recycling rates gave a low recycling rate of 15.4% and a high of 61.5%. Both of these rates were tested and found to lead to a 6.8% increase and 14.8% decrease in global warming potential respectively – however this is only when including the potential benefits of recycling (Module D). When looking at only modules A1-C4, the environmental indicators did not vary considerably.

ADDITIONAL ENVIRONMENTAL INFORMATION

Vinidex recognises the importance of incorporating environmental sustainability into our business strategies. Environmental issues are now the subject of greater community awareness. Vinidex have long been mindful of these issues, demonstrated by our achievements in minimising waste, post-industrial and post-consumer recycling, minimising energy use on production as well as minimising embodied energy in our products.

In 2002, the Vinyl Council of Australia launched a voluntary product stewardship initiative to recognise and address all environmental issues facing the Australian PVC industry. Vinidex has been a signatory to the Product Stewardship Program since its foundation. Recently, Vinidex was awarded the PVC Stewardship Excellence Award for 2014-15. This award certifies that Vinidex met 100% of the Australian PVC industry's Product Stewardship commitments in 2014.

BEST ENVIRONMENTAL PRACTICE PVC

In 2010 the GBCA reviewed its Green Star rating tool and under a new approach, the use of Vinidex 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), Vinidex was subjected to an extensive audit process by independent third party certifier, ApprovalMark. On Monday 20th February 2012, Vinidex was issued with BEP PVC Certificate of Compliance No. 570.

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, 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 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. Vinidex PVC pipe is manufactured using a simple material composition. There are no other plastic or rubber materials used. There are no fibres or other composite materials, coatings or linings. There are no phthalates or other plasticisers used. Hence when pipes are recycled there are no complex separation processes and the recycled pipe material can generally be used directly in the production of new pipe products to maximise end-of-life opportunities.

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.

Specific PVC recycling locations are available in Sydney, Melbourne and Brisbane and PVC-U pipe can be recycled at general plastic recycling stations throughout Australia.

MODULE D – RECYCLABILITY POTENTIALS

Recycled PVC materials are generally produced from mixed colour PVC, resulting in a brownish colour which is not suitable for all applications. This is due to PVC pipes being colour-coded for particular applications: water pipes are blue, electrical conduits are orange and stormwater pipes are white. There are also some limitations to repurposing of recycled PVC e.g. EN-ISO 1452 does not permit any recycled PVC be used for water pipes. The brownish colour of recycled material makes it most appropriate for multi-layer pipes (e.g. foam core or triple layer pipes), where the inside and outside are made from a virgin material and the middle layer (approximately half the pipe mass) can be made from up to 100% recyclate. Multi-layer pipes can also facilitate the recycling of materials that contain some level of contamination or heavy metals where they can be enclosed in the inner layer. Multi-layer pipes are more rigid and are normally used for 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, 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).

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PVC can be recycled up to six or 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). Small amount of contaminants can be adjusted for by varying additives in the feed mix such as lubricants and processing aids.

The following tables represent the potential benefit from end of life recycling through offsetting the production of virgin PVC.

Table 9 - Potential environmental impact recycling, net flow 0.147kg/kg (average solid and foam core)

	D - Recyclability potentials	Impact reduction (%)
GWP ($kgCO_2$ eq)	-0.500	-18%
ODP (kgCFC11 eq)	-5.65E-10	-0.8%
AP ($kgSO_2$ eq)	-1.13E-03	-15%
EP ($kgPO_4^{3-}$ eq)	-3.07E-04	-17%
POCP (kgC_2H_2 eq)	-2.48E-05	-5.1%
ADPE (kgSb eq)	-5.62E-07	-16%
ADPF (MJ)	-1.54	-6.7%

GWP = Global Warming Potential, **ODP** = Ozone Depletion Potential, **AP** = Acidification Potential, **EP** = Eutrophication Potential, **POCP** = Photochemical Oxidant Formation Potential, **ADPE** = Abiotic Resource Depletion Potential – Elements, **ADPF** = Abiotic Resource Depletion Potential – Fossil Fuel

Table 10 - Potential benefits in resource use from recycling, net flow 0.147kg/kg (average solid and foam core)

	D - Recyclability potentials	Resource use reduction (%)
PERE (MJ)	-0.374	-23%
PERM (MJ)	0	0
PERT (MJ)	-0.374	-23%
PENRE (MJ)	-12.0	-18%
PENRM (MJ)	0	0
PENRT (MJ)	-12.0	-18%
SM (kg)	INA	INA
RSF (MJ)	INA	INA
NRSF (MJ)	INA	INA
FW (m^3)	-0.0683	-10%

PERE = Use of renewable primary energy excluding raw materials, **PERM** = Use of renewable primary energy resources used as raw materials, **PERT** = Total use of renewable primary energy resources, **PENRE** = Use of non-renewable primary energy excluding raw materials, **PENRM** = Use of non-renewable primary energy resources used as raw materials, **PENRT** = Total use of non-renewable primary energy resources, **SM** = Use of secondary material, **RSF** = Use of renewable secondary fuels, **NRSF** = Use of non-renewable secondary fuels, **FW** = Use of net fresh water, **INA** = Indicator not assessed

Table 11 - Potential reduction in waste generation by recycling, net flow 0.147kg/kg (average solid and foam core)

	D - Recyclability potentials	Resource use reduction (%)
HWD (kg)	-2.31E-03	-25%
NHWD (kg)	-0.0136	-11%
RWD (kg)	-3.75E-09	-0.20%

HWD = Hazardous waste disposed, **NHWD** = Non-hazardous waste disposed, **RWD** = Radioactive waste disposed

PRODUCT SPECIFICATIONS

The following tables (Table 12 to Table 15) can be used to calculate the environmental results for specific Vinidex PVC non-pressure pipe and conduit products. The tables give the mass for a representative range of standard lengths of pipe. For product codes for other Vinidex pipes and lengths see www.vinidex.com.au.

Table 12 - DWV pipe product details

Product Description	Product Code	Class	Effective Length (m)	Mass per pipe length (kg/length)
40mm DWV Pipe	20230		6	2.5
50mm DWV Pipe	20260		6	3.5
65mm DWV Pipe	20280		6	5.3
80mm DWV Pipe	20310		6	6.9
100mm DWV Pipe SCJ SN6	1900	SN6	6	9.5
100mm DWV Pipe SCJ SN10	18005	SN10	6	11.2
150mm DWV Pipe SCJ SN4	19070	SN4	6	18.6
150mm DWV Pipe SCJ SN8	19111	SN8	6	23.6
225mm DWV Pipe SCJ SN4	19140	SN4	6	42.7
225mm DWV Pipe SCJ SN8	19180	SN8	6	53.6
225mm DWV Pipe RRJ SN4	19650	SN4	3	22.8
225mm DWV Pipe RRJ SN8	19680	SN8	3	29.3
300mm DWV Pipe SCJ SN4	19210	SN4	6	70.9
300mm DWV Pipe SCJ SN8	19250	SN8	6	88.2
300mm DWV Pipe RRJ SN4	19710	SN8	3	36.6
300mm DWV Pipe RRJ SN8	19730	SN8	3	45.6

Table 13 - Stormwater pipe product details

Product Description	Product Code	Effective Length (m)	Mass per pipe length (kg/length)
90mm Stormwater Pipe	20510	6	4.7
100mm Stormwater Pipe	20520	6	7.5
150mm Stormwater Pipe	20530	6	14.4
225mm Stormwater Pipe	20540	6	33.7
300mm Stormwater Pipe	20550	6	56.9
375mm Stormwater Pipe	20580	6	86.4

Table 14 - Electrical conduit product details

Product Description	Product Code	Class	Effective Length (m)	Mass per pipe length (kg/length)
20mm Electrical Conduit	10700	HD	4	0.77
25mm Electrical Conduit	10720	HD	4	1.1
32mm Electrical Conduit	10740	HD	4	1.5
40mm Electrical Conduit	10760	HD	4	2.2
50mm Electrical Conduit	10780	HD	4	3.1
63mm Electrical Conduit	10800	HD	4	4.8
80mm Electrical Conduit	10820	HD	4	10.9
100mm Electrical Conduit	10840	HD	4	13.6
125mm Electrical Conduit	10860	HD	4	19.6
150mm Electrical Conduit	10880	HD	4	27
200mm Electrical Conduit	21070	HD	4	46.5
250mm Electrical Conduit	21072	HD	4	74.9
20mm Electrical Conduit	10020	MD	4	0.63
25mm Electrical Conduit	10040	MD	4	0.81
32mm Electrical Conduit	10060	MD	4	1.26
40mm Electrical Conduit	10080	MD	4	1.76
50mm Electrical Conduit	10100	MD	4	2.6
150mm Electrical Conduit	21058	MD	4	13.1
200mm Electrical Conduit	11340	MD	6	54.9
80mm Electrical Conduit	11040	LD	6	6.5
100mm Electrical Conduit	11100	LD	6	10.5
125mm Electrical Conduit	11200	LD	6	16.0
150mm Electrical Conduit	11320	LD	6	20.7
200mm Electrical Conduit	11330	LD	6	37.9

Table 15 - Communications conduit product details

Product Description	Product Code	Effective Length (m)	Mass per pipe length (kg/length)
20mm Communication Conduit	11640	4	0.6
25mm Communication Conduit	11650	4	0.8
32mm Communication Conduit	11660	4	1.2
50mm Communication Conduit	11680	4	2.8
80mm Communication Conduit	11690	6	9.1
100mm Communication Con-duit	11695	6	15.3

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