Vinidex
by aliaxis

Environmental Product Declaration

PVC Pressure Pipes


AUSTRALASIA EPD®
ENVIRONMENTAL PRODUCT DECLARATION

Environmental Product Declaration (EPD) in accordance with ISO 14025 and EN 15804
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Geographical area of application of this EPD: Australia
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EPD of Vinidex PVC pressure pipe products - in collaboration with the Plastics Industry Pipe Association of Australia (PIPA).

PIPA

Environmental Product Declaration

PVC Pressure Pipes

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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 to which pipe dimensions the installation results refer to.

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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

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 pressure pipe EPD results can also be used to represent PVC pressure 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.

Vinidex has 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.

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Table 1 - Product characteristics of PVC pressure pipes

Product Characteristics	
Product names/application	• PVC-U pressure pipe • Supermain® PVC-O pressure pipe • Hydro® PVC-M pressure pipe
Density	1420-1480 kg/m^3
Shore D hardness	80
Coefficient of linear thermal expansion	7 x 10^{-5}/˚C
Maximum working temperature	60˚C
Specific heat	1045 J/kg.K
Poisson's ratio	0.40
Tensile Strength	~50 MPa 90MPa (PVC-O in direction of orientation)
Flexural ring modulus	3000 – 3500 MPa (PVC-U, PVC-M) 4000 MPa (PVC-O)

Table 2 - Content Declaration

Material	PVC-U	Super-main® PVC-O	Hydro® PVC-M	CAS No.
Polyvinyl chloride resin (K67)	91%	93%	89%	9002-86-2
Calcium carbonate	4.6%	0.93%	0.89%	471-34-1
Calcium based stabiliser	2.7%	3.6%	2.7%	Confidential (nothing hazardous)
Titanium dioxide	1.4%	1.4%	1.3%	13463-67-7
Impact modifier			5.4%	63231-66-3 (predominantly)
Lubricants	<0.2%		<0.2%	8002-74-2 9002-88-4
Processing aid (PMMA)		0.56%		9011-14-7
Pigments	<0.3%	<0.3%	<0.3%	Various (nothing hazardous)
Total	100%	100%	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 fact that the pipes are left in the ground at end of life with negligible potential environmental impact, modules C1-C4 were deemed not relevant (of negligible impact). Due to the durability of PVC pressure pipes, and lack of planned or required maintenance throughout the service life, modules B1-B7 were also deemed not relevant.

Table 3 - System boundary and scope of assessment

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

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

LIFE CYCLE OF VINIDEX PVC PRESSURE PIPES

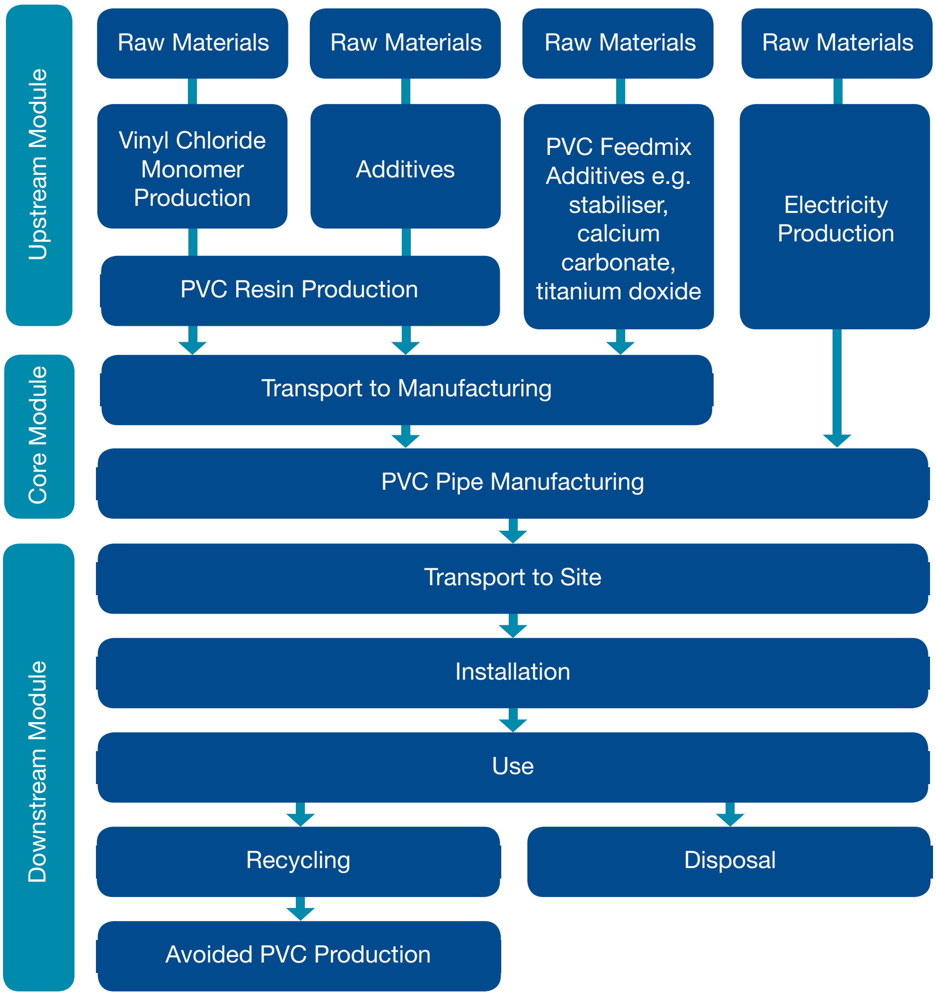


Figure 1 - Life cycle diagram of PVC pressure pipe production

VINIDEX PVC PRESSURE PIPE MANUFACTURING

Vinidex PVC pressure pipes are manufactured primarily from PVC resin along with additives, including: calcium carbonate, titanium dioxide, calcium based stabiliser, lubricants, processing aids and pigments. In the case of Hydro® PVC-M pipe, chlorinated polyethylene is also used as an impact modifier. The PVC resin is the main ingredient in all PVC pressure pipes, 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 in new pipe. The feed mix is heated and mixed prior to extrusion and then water cooled to form the pipe structure.

For Supermain® PVC-O pressure pipe, the extrusion process is followed by an additional expansion process which takes place under well defined and carefully controlled conditions of temperature and pressure. It is during the expansion that the molecular orientation, which imparts the high strength typical of PVC-O, occurs.

One end of the pipe is then re-heated after cutting and expanded to allow for pipe jointing. Finally, the lengths of pipe are palletised, packaged with a softwood timber frame, steel and PET strapping.

Vinidex PVC pressure pipe manufacturing sites are shown below in Figure 2. PVC-U pressure pipes are manufactured at all sites while Supermain® PVC-O pressure pipe is only manufactured in Sydney and Hydro® PVC-M pressure pipes are manufactured in Brisbane, Melbourne and Perth. The results shown in this EPD are representative of the weighted average production of PVC-U and PVC-M pipe products at respective manufacturing sites.

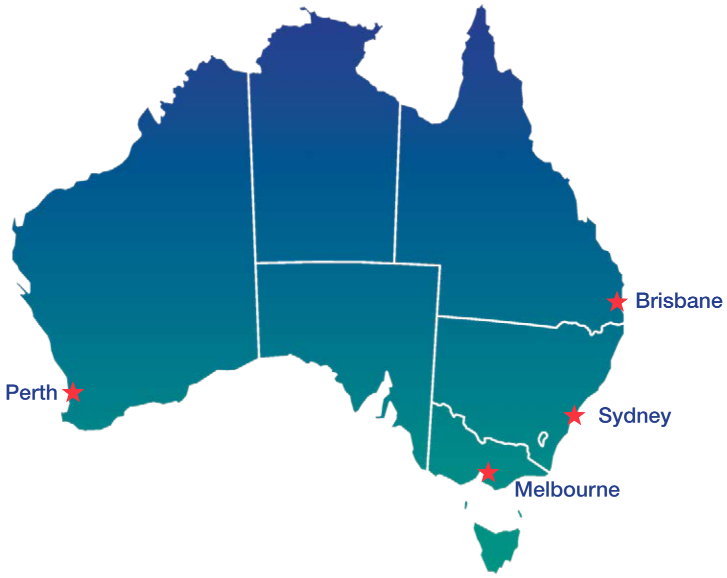


Figure 2 - Vinidex PVC pressure pipe manufacturing sites

DISTRIBUTION STAGE

Vinidex has standard PVC-U 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. The Supermain® PVC-O pressure pipe is only manufactured in Sydney and therefore requires significant distribution by road to other markets. The Hydro® PVC-M pipe is manufactured in Melbourne, Brisbane and Perth, with a significant amount of pipe delivered interstate to the NSW market.

INSTALLATION STAGE

The majority of this type of pipe is installed underground. The pipes are laid in an excavated trench. The trench width and depth varies with pipe size and will be specified by the infrastructure agency. For the size ranges nominated for this EPD, PIPA suggests an average trench width of around 400 mm would be appropriate and a trench depth of 900 - 1000 mm would be typical, noting that 97.5% of pipes sold are smaller than DN200 so would need smaller trenches, making this is very conservative estimate. The results in module A5 do not apply to larger pipe sizes than DN200. The energy required for trench excavation leads to significant impact during the installation of PVC pressure pipe.

Bedding and backfill materials vary in specification. In many cases no imported material is used but for many city based agencies sand bedding and gravel are used in the areas immediately below and at the sides of the pipe. It is estimated that imported backfill materials amount 0.3 m^3 of material per metre of pipeline. This material will need to be transported to site and given the predominance of this approach to city based installation it was estimated the typical transport distance is 30-50 km.

The joints for PVC pressure pipes of this type are almost exclusively all rubber sealed spigot and socket joints – there is no heat used, no thermal or chemical welding and no solvent used. Jointing is achieved by hand. The installer typically uses a bar and a block of wood to lever the end of the last pipe into the preceding pipe socket. Each joint (one every 6 m) requires a rubber seal. Wastage of pipe is minimal as short lengths are often required elsewhere and easily reused on subsequent sites or within the same site. PIPA estimates put wastage from unusable offcuts at less than 1%.

USE STAGE

Maintenance of the pipe systems is not required and not planned. The pipe systems are designed to last in excess of 100 years. The failure rate is also extremely low and is considered to be inconsequential (not relevant) in this EPD. PVC pressure pipe is the most reliable pipe system in Australia based on performance data from Australian water agencies. Post installation problems, if any, tend to be linked to 3rd party damage, such as when excavating for gas pipelines. There are no significant emissions from leaching of chemicals during the use stage for PVC pipes (European Commission, 2004).

END OF LIFE STAGE

PVC pressure pipes are generally installed underground and are assumed to remain underground at end of life. PVC pipes are inert and there is no incentive to dig them up to send for waste treatment.

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

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 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 pressure pipe 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.

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 leads to significant variance between the production impacts at Vinidex sites, however the purpose of this EPD is to represent the average Vinidex PVC pressure pipe products supplied to the Australian market. By including all manufacturing sites for PVC-U and PVC-M pressure pipe, this EPD is representative of the average production and is less susceptible to variation when production volumes vary. Supermain® PVC-O pressure pipe is currently only manufactured in NSW so there is no variation due to manufacturing location.

PVC PRESSURE PIPE ENVIRONMENTAL PERFORMANCE

The potential environmental impacts used in this EPD are explained in Table 5 and the results shown in Table 6, Table 9 and Table 12 (for PVC-U, Supermain® PVC-O and Hydro® PVC-M pressure pipes respectively). The use of energy and fresh water resources is shown in Table 7, Table 10 and Table 13. 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 possible that secondary material is used in the supply chain and therefore exists in the product life cycle. Table 8, Table 11 and Table 14 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-U PRESSURE PIPE ENVIRONMENTAL PERFORMANCE

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

	A1 & A2	A3	A4	A5
GWP (kgCO_2 eq)	2.83	0.669	8.76E-03	1.04
ODP (kgCFC11 eq)	4.84E-08	9.90E-10	2.84E-10	4.55E-08
AP (kgSO_2 eq)	8.52E-03	1.04E-03	2.17E-05	3.28E-03
EP (kgPO_4^{3-} eq)	2.04E-03	3.36E-04	5.42E-06	8.03E-04
POCP (kgC_2H_2 eq)	3.67E-04	4.85E-05	1.40E-06	1.66E-04
ADPE (kgSb eq)	4.10E-06	5.60E-07	1.98E-08	2.42E-06
ADPF (MJ)	16.7	7.08	0.138	13.48

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 PVC-U pipe

	A1 & A2	A3	A4	A5
PERE (MJ)	1.74	0.253	7.50E-04	0.362
PERM (MJ)	0	0	0	0
PERT (MJ)	1.74	0.253	7.50E-04	0.362
PENRE (MJ)	64.0	7.11	0.139	13.8
PENRM (MJ)	0	0	0	0
PENRT (MJ)	64.0	7.11	0.139	13.8
SM (kg)	INA	INA	INA	INA
RSF (MJ)	INA	INA	INA	INA
NRSF (MJ)	INA	INA	INA	INA
FW (m^3)	0.692	0.059	2.48E-03	0.869

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 PVC-U pipe

	A1 & A2	A3	A4	A5
HWD (kg)	0.0103	1.05E-06	9.29E-08	1.36E-05
NHWD (kg)	0.153	0.0652	8.90E-04	0.254
RWD (kg)	3.56E-06	1.49E-08	2.26E-09	4.40E-07

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

SUPERMAIN® PVC-O PRESSURE PIPE ENVIRONMENTAL PERFORMANCE

Table 9 - Potential environmental impacts per 1 kg of installed PVC-O pipe

	A1 & A2	A3	A4	A5
GWP (kgCO_2 eq)	2.76	0.756	0.104	0.104
ODP (kgCFC11 eq)	3.56E-08	1.16E-09	3.37E-09	4.55E-08
AP (kgSO_2 eq)	8.37E-03	1.12E-03	2.57E-04	3.28E-03
EP (kgPO_4^{3-} eq)	1.97E-03	3.73E-04	6.44E-05	8.03E-04
POCP (kgC_2H_2 eq)	3.07E-04	5.01E-05	1.67E-05	1.66E-04
ADPE (kgSb eq)	3.81E-06	5.94E-07	2.35E-07	2.42E-06
ADPF (MJ)	14.3	7.68	1.64	13.5

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 - Use of resources per 1 kg of installed PVC-O pipe

	A1 & A2	A3	A4	A5
PERE (MJ)	1.76	0.251	8.91E-03	0.362
PERM (MJ)	0	0	0	0
PERT (MJ)	1.76	0.251	8.91E-03	0.362
PENRE (MJ)	62.7	7.71	1.65	13.8
PENRM (MJ)	0	0	0	0
PENRT (MJ)	62.7	7.71	1.65	13.8
SM (kg)	INA	INA	INA	INA
RSF (MJ)	INA	INA	INA	INA
NRSF (MJ)	INA	INA	INA	INA
FW (m^3)	0.651	0.0535	0.0294	0.869

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 11 - Generation of waste per 1 kg of installed PVC-O pipe

	A1 & A2	A3	A4	A5
HWD (kg)	0.0106	1.00E-06	1.10E-06	1.36E-05
NHWD (kg)	0.145	0.0906	0.0105	0.254
RWD (kg)	3.70E-06	1.40E-08	2.67E-08	4.40E-07

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

HYDRO® PVC-M PRESSURE PIPE ENVIRONMENTAL PERFORMANCE

Table 12 - Potential environmental impacts per 1 kg of installed PVC-M pipe

	A1 & A2	A3	A4	A5
GWP (kgCO_2 eq)	2.87	0.601	0.0337	1.04
ODP (kgCFC11 eq)	5.21E-08	9.39E-10	1.05E-09	4.55E-08
AP (kgSO_2 eq)	8.71E-03	1.05E-03	8.18E-05	3.28E-03
EP (kgPO_4^{3-} eq)	2.08E-03	3.32E-04	2.07E-05	8.03E-04
POCP (kgC_2H_2 eq)	3.74E-04	5.06E-05	5.34E-06	1.66E-04
ADPE (kgSb eq)	4.27E-06	5.16E-07	7.34E-08	2.42E-06
ADPF (MJ)	19.7	6.50	0.531	13.5

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 13 - Use of resources per 1 kg of installed PVC-M pipe

	A1 & A2	A3	A4	A5
PERE (MJ)	1.73	0.209	2.85E-03	0.362
PERM (MJ)	0	0	0	0
PERT (MJ)	1.73	0.209	2.85E-03	0.362
PENRE (MJ)	66.1	6.56	0.534	13.8
PENRM (MJ)	0	0	0	0
PENRT (MJ)	66.1	6.56	0.534	13.8
SM (kg)	INA	INA	INA	INA
RSF (MJ)	INA	INA	INA	INA
NRSF (MJ)	INA	INA	INA	INA
FW (m^3)	0.698	0.0767	9.27E-03	0.869

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 14 - Generation of waste per 1 kg of installed PVC-M pipe

	A1 & A2	A3	A4	A5
HWD (kg)	0.0101	9.87E-07	3.44E-07	1.36E-05
NHWD (kg)	0.158	0.0496	3.30E-03	0.254
RWD (kg)	3.51E-06	1.41E-08	8.36E-09	4.40E-07

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 and the installation of pipes in ground – comparatively little impact is caused by the PVC pressure 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. From installation it is diesel consumed during the operation of excavator which is responsible for significant impact.

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 has 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

Due to PVC pressure pipes being installed in the ground, it is economically unfeasible to excavate at end of life for the purpose of recycling. However, PVC pressure pipe excavated for other reasons (e.g. new construction) 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. 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.

The following key properties of Vinidex PVC pipe aid recyclability:

- 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.

- There are no dioxins emissions from recycling of PVC pressure pipes.

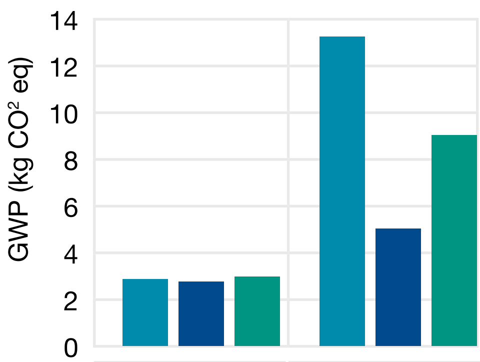
- Vinidex PVC pressure pipe contains no heavy metal additives – so no lead and no cadmium. Australian Standards for PVC pipe specifically exclude such additives and are the only national PVC pipe product standards to do so worldwide.

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

PRODUCT SPECIFICATIONS

The following tables (Table 15 - Table 22) can be used to calculate the environmental results for specific Vinidex PVC pressure pipe products. The tables give the mass for a standard 6 m length of pipe. For product codes for other pipe colours and lengths see www.vinidex.com.au.

The tables can also be used to compare different types of PVC pressure pipes. The declared unit in this study is 1 kg of pipe. However, the environmental benefits of material efficient pipes can be more clearly seen when comparing a given length of pipe. The figure below shows the Global Warming Potential results for 1 kg and 1 m length of Vinidex Series 2, DN100, PN 16 PVC-U, PVC-O and PVC-M.



	1 kg of pipe	1 m of pipe
Vinyl Iron® PVC-U	2.83	13.21
Supermain® PVC-O	2.76	5.06
Hydro® PVC-M	2.86	9.06

Figure 3 - Comparison of DN100, PN 16 S2 PVC pressure pipes

Table 15 - Product specifications for PVC-U Series 1 pipe (Solvent cement joint)

Product Description	Pressure Class PN	Vinidex Code	Colour	Mass of pipe (kg/6m length)
15mm Pressure Pipe	18	13510	White	0.9
20mm Pressure Pipe	12 18	13520 13550	White	1.0 1.4
25mm Pressure Pipe	9 12 18	13560 13570 13590	White	1.3 1.6 2.2
32mm Pressure Pipe	9 12 18	13600 13610 13640	White	2.0 2.6 3.6
40mm Pressure Pipe	6 9 12 18	13650 13660 13680 13700	White	1.9 2.6 3.3 4.7
50mm Pressure Pipe	6 9 12 18	13710 13720 13740 13760	White	2.7 4.0 5.1 7.4
65mm Pressure Pipe	6 9 12 18	14500 14510 14520 14530	White	4.3 6.3 8.1 10.6
80mm Pressure Pipe	6 9 12 18	14550 14560 14570 14590	White	6.1 8.7 11.2 16.2
100mm Pressure Pipe	4.5 6 9 12 18	14600 14610 14620 14630 14650	White	7.6 9.8 14.4 18.7 26.6
125mm Pressure Pipe	4.5 6 9 12	14660 14670 14680 14690	White	11.4 14.8 21.6 2.9
150mm Pressure Pipe	6 9 12 18	14720 14730 14740 14760	White	19.3 28.3 36.8 52.2

Table 16 - Product specifications for Polydex® PVC-U Series 1 pipe (Rubber ring joint)

Product Description	Pressure Class PN	Vinidex Code	Colour	Mass of pipe (kg/6m length)
50mm Polydex	9 12	16010 16020	White	4.1 5.1
80mm Polydex	6 9 12	16100 16110 16120	White	6.1 8.7 11.4
100mm Polydex	6 9 12	16150 16160 16170	White	9.8 14.5 18.7
125mm Polydex	9 12	16210 16220	White	21.9 28.3
150mm Polydex	4.5 6 9 12	16250 16260 16270 16280	White	15 19.2 28.7 37.3
200mm Polydex	4.5 6 9 12	16320 16330 16340 16350	White	26.6 35.0 51.6 67.7
225mm Polydex	4.5 6 9 12	16380 16390 16400 16410	White	33.3 44.2 62.7 83.4
250mm Polydex	4.5 6 9 12	16440 16450 16460 16470	White	41.6 55.4 80.9 103.7
300mm Polydex	4.5 6 9 12	16500 16510 16520 16530	White	53.5 69.9 102.3 132.2
375mm Polydex	4.5 6	16540 16550	White	86.2 113.1
450mm Polydex	6	16570	White	182.2

Table 17 - Product specifications for Vinyl Iron® PVC-U Series 2 pipe

Product Description	Pressure Class PN	Vinidex Code	Colour	Mass of pipe (kg/6m length)
100mm Vinyl Iron	12 16 18 20	17260 17270 17280 17290	Blue	21 28 30 33
150mm Vinyl Iron	12 16 18 20	17300 17310 17320 17330	Blue	45 58 65 71
200mm Vinyl Iron	12 16	17340 17342	Blue	72 93
225mm Vinyl Iron	12	17390	Blue	89
250mm Vinyl Iron	12 16	17350 17354	Blue	108 141
300mm Vinyl Iron	12 16	17360 17364	Blue	158 205
375mm Vinyl Iron	12 16	17379 17382	Blue	242 314

Table 18 - Supermain® PVC-O International Series pipe (Rubber ring joint)

Product Description	Pressure Class PN	Material	Vinidex Code	Nominal Bore	Mass of pipe (kg/ 6m length)
160iso Supermain	10	PVC-O 355	17535	150mm	16
225iso Supermain	10	PVC-O 355	17534	200mm	32
250iso Supermain	10	PVC-O 355	17533	225mm	39
280iso Supermain	10	PVC-O 355	17532	250mm	50
315iso Supermain	10	PVC-O 355	17531	300mm	63
160iso Supermain	12.5	PVC-O 450	17528	150mm	16
225iso Supermain	12.5	PVC-O 450	17529	200mm	32
250iso Supermain	12.5	PVC-O 450	17530	225mm	39
280iso Supermain	12.5	PVC-O 450	17527	250mm	50
315iso Supermain	12.5	PVC-O 450	17526	300mm	63

Table 19 - Supermain® PVC-O Series 2 pipe

Product Description	Pressure Class PN	Material	Vinidex Code	Colour	Mass of pipe (kg/ 6m length)
100mm Supermain S2	12.5	PVC-O 400	17220	Blue	10.4
150mm Supermain S2	12.5	PVC-O 400	17225	Blue	22.2
200mm Supermain S2	12.5	PVC-O 400	17230	Blue	37.7
225mm Supermain S2	12.5	PVC-O 400	17240	Blue	47.4
250mm Supermain S2	12.5	PVC-O 400	17450	Blue	57.4
300mm Supermain S2	12.5	PVC-O 400	17460	Blue	84.4
100mm Supermain S2	16	PVC-O 500	17221	Blue	11.0
100mm Supermain S2	16	PVC-O 450	17491*	Blue	11.7
150mm Supermain S2	16	PVC-O 500	17226	Blue	23.1
150mm Supermain S2	16	PVC-O 450	17492*	Blue	24.6
200mm Supermain S2	16	PVC-O 500	17231	Blue	39.7
225mm Supermain S2	16	PVC-O 500	17241	Blue	49.5
250mm Supermain S2	16	PVC-O 500	17455	Blue	59.7
300mm Supermain S2	16	PVC-O 500	17464	Blue	88.2
200mm Supermain S2	20	PVC-O 500	17493+	Blue	46.7
225mm Supermain S2	20	PVC-O 500	17494+	Blue	58.8
250mm Supermain S2	20	PVC-O 500	17456+	Blue	74.7

* indicates SN10 stiffness, + indicates SN11 stiffness.

Table 20 - Hydro® PVC-M Series 1 pipe (Solvent cement joint)

Product Description	Pressure Class PN	Vinidex Code	Mass of pipe (kg/6m length)
100mm Hydro PVC-M	9 12	17040 17050	9 12
150mm Hydro PVC-M	9 12	17085 17095	19 24
200mm Hydro PVC-M	9 12	17115 17125	37 49

Table 21 - Hydro® PVC-M Series 1 pipe (Rubber ring joint)

Product Description	Pressure Class PN	Vinidex Code	Mass of pipe (kg/6m length)
100mm Hydro S1 PVC-M	9 12	17035 17045	9 12
150mm Hydro S1 PVC-M	9 12	17080 17090	19 24
200mm Hydro S1 PVC-M	6 9 12	17100 17110 17120	31 36 47
225mm Hydro S1 PVC-M	9 12	17135 17140	46 58
250mm Hydro S1 PVC-M	6 9 12	17145 17150 17155	50 56 76
300mm Hydro S1 PVC-M	6 9 12	17160 17165 17170	62 69 96
375mm Hydro S1 PVC-M	6 9 12	17175 17180 17174	99 115 150
450mm Hydro S1 PVC-M	6 9 12	17171 17172 17173	155 188 247
500mm Hydro S1 PVC-M	6 9 12	17415 17416 17417	201 236 297
575mm Hydro S1 PVC-M	6 9 12	17418 17419 17420	245 296 388

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Table 21 - Hydro® PVC-M Series 2 pipe (Rubber ring joint)

Product Description	Pressure Class PN	Vinidex Code	Colour	Mass of pipe (kg/6m length)
100mm Hydro S2 PVC-M	12 16 18 20	17181 17182 17183 17184	Blue	14 19 21 22
150mm Hydro S2 PVC-M	12 16 18 20	17185 17186 17187 17188	Blue	30 39 43 48
200mm Hydro S2 PVC-M	12 16	17189 17190	Blue	52 66
225mm Hydro S2 PVC-M	16	17194	Blue	83
250mm Hydro S2 PVC-M	12 16	17197 17198	Blue	79 103
300mm Hydro S2 PVC-M	12 16	17201 17202	Blue	113 145
375mm Hydro S2 PVC-M	9 12 16	17206 17207 17208	Blue	139 173 222
450mm Hydro S2 PVC-M	6 9 12 16	17411 17412 17413 17414	Blue	161 190 249 326

REFERENCES

AEPDP. (2015). General Programme Instructions for the Australasian EPD Programme, Version 1.0, 2015-02-02.

BRANZ. (2008). *STUDY 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-%20Adaptation%20of%20USBGC%20TSAC.pdf

CEN. (2013). EN 15804:2012 Sustainability of construction works.

Environmental Product Declarations. Core rules for the product category of construction products. Brussels: Centre of European Standardization (CEN).

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

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%20Practice%20Guidelines%20for%20the%20Life%20Cycle%20of%20PVC%20Building%20Products.pdf

IEPDS. (2015). PCR 2012:01, *Construction products and Construction services*, Version 2.0, 2015-03-03. Stockholm: International EPD® System.

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

ISO. (2006). ISO 14040:2006 - Environmental management - life cycle assessment - principles and procedures. Geneva: International Organization for Standardization (ISO).

ISO. (2006). ISO 14044:2006 - Environmental management - life cycle assessment - requirements and guidelines. Geneva: International Organization for Standardization (ISO).

Life Cycle Strategies. (2015). *Australasian LCI Database.* Retrieved from Life Cycle Strategies: http://www.lifecycles.com.au/#!australasian-database/cbm5

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

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