

Appendix B – Supporting Data

An LCA-based cradle-to-site carbon quantification that details all the calculations and conversions used to arrive at the estimated CO₂ equivalent emissions from vinyl flooring manufacturing is provided below.

Yibin Cradle-to-Site Carbon Emission Values - Sheet Flooring ¹

Table 1. Yibin Cradle-to-Grave Carbon Emission Values (NOX EPD)

#	Code	Manufacturing Stage	Description	Value				Source Citation/Link	Included in Franke (2014)?	Included in Hong and Chen (2014) Paper?
				SI Value	SI Units	CO2e (kg) / m2	CO2e Units			
1	A1a	Raw Material Extraction	Primary Energy (Feedstock): Coal Mining	Not included in calculations	N/A	TBD	TBD		No	No
2	A1a	Raw Material Extraction	Primary Energy (Feedstock): Coal Mining	Not included in calculations	N/A	N/A	N/A		No	No
3	A1a	Raw Material Extraction	Mining of mercury	Not included in calculations	N/A	N/A	N/A		No	No
4	A1a; A1d	Raw Material Extraction	Brine Extraction	Included in #13 A1d Chlorine Production value	N/A	N/A	N/A	Hong, J., Chen, W., Wang, Y., Xu, C., & Xu, X. (2014). Life cycle assessment of caustic soda production: a case study in China. Journal of cleaner production, 66, 113-120.	No	Yes
5	A1a;A1d	Raw Material Extraction	PFAS/PTFE Manufacturing	0.000000037295	PFAS kg/m2 of PVC flooring	0.0000000000000045	kg CO2e / m2	https://onlinelibrary.wiley.com/doi/full/10.1002/ese3.441	No	No
6	A1a	Raw Material Extraction	Limestone Flour	2.945	kg CO2e / kg limestone	2.823	kg CO2e / m2	https://sciencedirect.com/article/10.1515/rtruet-2017-0011	No	No
7	A1a	Raw Material Extraction	Plasticizer (Bis(2-ethylhexyl) terephthalate)	802.388	kg CO2e / 390 kg	1.680	kg CO2e / m2	http://d-scholarship.pitt.edu/18	No	No

¹ The CO₂e kg/m² value for *Manufacturing of PVC into Tile* is calculated using A1a - A1e values and conversions/weights from the [Conversion/Weights](#) table.

					DEHP			234/1/LiYuan_ETD2013.pdf		
8	A1b	Raw Material Processing	Coking of Coal	Included in #15 A1e PVC Polymerization	N/A	N/A	N/A	N/A	Yes	No
9	A1b - new	Raw Material Processing	Mercury catalyst production	Not included in calculations	N/A	N/A	N/A	N/A	No	No
10	A1b	Raw Material Processing	Carbide Production	Included in #15 A1e PVC Polymerization	N/A	N/A	N/A	N/A	Yes	No
11	A1b	Raw Material Processing	Acetylene Preparation	Included in #15 A1e PVC Polymerization	N/A	N/A	N/A	N/A	Yes	No
12	A1c	Energy	Secondary Energy (Fuel): On Site Coal Fired Plant (100% Coal Emissions)	Included in #15 A1e PVC Polymerization	N/A	N/A	N/A	N/A	Yes	No
13	A1d	Chlorine Production	PTFE-based Production of Chlorine and Caustic Soda	1.590	ton CO2e / ton NaOH	1.757	kg CO2e / m2	https://www.researchgate.net/publication/260110281_Life_cycle_assessment_of_caustic_soda_production_A_case_study_in_China	Yes	Yes
14	A1d	Vinyl Chloride Monomer Production	Reaction of Petroleum Coke and Chlorine (Calcium Carbide) using mercury catalysts	Included in #15 A1e PVC Polymerization	N/A	N/A	N/A		Yes	No
15	A1e	PVC Polymerization	Polymerizing VCM	11.200	tonne CO2e / tonne PVC	17.932	kg CO2e / m2	https://www.ifeu.de/fileadmin/uploads/RECAST_URUMQI_Sub-project_3_Energy_efficiency_Final_report.pdf	Yes	No
16	A2	Raw Material Transportation	Brine Transportation	Included in #15 A1e PVC Polymerization	N/A	N/A	N/A	N/A	No	Yes
17	A2	Raw Material Transportation	Primary Energy (Feedstock): Coal Transportation	Included in #13 A1d Chlorine	N/A	N/A	N/A	N/A	No	Yes

				Production value						
18	A2	Raw Material Transportation	PFAS/PTFE Transportation	Included in #13 A1d Chlorine Production value	N/A	N/A	N/A	N/A	No	No
19	A2	Raw Material Transportation	Primary Energy (Feedstock): Coal Transportation	Included in #13 A1d Chlorine Production value	N/A	N/A	N/A	N/A	No	Yes
20	A3	Manufacturing	Energy of Manufacturing	950.000	btu/pound Tile	N/A	N/A	N/A	Yes	ounting for dif
21	A4	Transportation	Truck to Yibin	68.500	km truck	0.0174	kg CO2e / truck trip		No	No
22	A4	Transportation	Rail to Shanghai	1974.000	km rail	0.1233	kg CO2e / rail trip	Draft Logic and https://www.openrailwaymap.org/	No	No
23	A4	Transportation	Ocean Cargo Vessel to Norfolk, Virginia	19244.132	km ship	0.1123	kg CO2e / ship trip	https://sea-distances.org/	No	No
24	A4	Transportation	Norfolk Warehouse to Building Site	800.00	km truck	0.2038	kg CO2e / truck trip	https://www.scscertified.com/products/certified/SCS-EPD-06754-NOX-Corp_LVS_030921.pdf	No	No

Table 2: Hong (2014) - "Life Cycle Assessment of Caustic Soda Production: A Case Study in China"

	Value	Unit
Raw Data: from Hong and Chen (2014)	1.5900	ton CO2e / ton NaOH
Conversion: 1 ton Cl2 =	1.1280	ton NaOH
Chlorine + Caustic Soda + Brine converted to CO2e kg/kg product	1.7935	kg CO2e / kg Cl2
Conversion: VCM Acetylene - Chlorine ton to VCM ton	0.6000	ton Cl2 / ton VCM
Total CO2e CO2e kg/kg VCM	1.0761	kg CO2e / kg VCM
Conversion: VCM ton to PVC ton	1.0200	ton VCM / ton PVC
TOTAL CO2e kg/PVC kg	1.0976	kg CO2e / kg PVC
Product Weight	3.5500	kg / m2
Weight to floor	45.10%	%
TOTAL	1.7574	CO2e kg/m²

Table 3: Frank (2014) - Recast Urumqi Paper

	Value	Unit
Raw Data: Recast Urumqi	11.200	Mg CO2e per tonne of PVC
Convert to kg (it's the same ratio)	11.200	kg CO2e / kg PVC
Product Weight	3.550	kg / m2
Weight to floor	45.10%	
TOTAL	17.932	CO₂e kg/m²

Table 4: PFAS

	Value	Unit
Raw Data: PFAS kg / m2 of PVC flooring	0.000000373	PFAS kg/m2 of PVC flooring
Raw Data: PTFE (PFAS)	0.0121	CO2e kg/gram of PTFE
Converted value	0.0000121	kg CO2e / kg PTFE
TOTAL	0.000000000004513	CO₂e kg/m²

Table 5: Limestone Flour

	Value	Unit
Raw Data: Limestone	2.945	kg CO2e per kg of Limestone
Product Weight	3.55	kg/m2
Weight to Floor	27.00%	
TOTAL	2.823	CO₂e kg/m²

Table 6: Plasticizer (Di(2-ethylhexyl) terephthalate)

	Value	Unit
Raw Data: Plasticizer Di(2-ethylhexyl) terephthalate, DEHT	802.388	kg CO2e per 390 kg of DEHT
	390.000	
Converted	2.057	kg CO2e / kg DEPH
Product Weight	3.55	kg/m ²
Weight to Floor	23.00%	
TOTAL	1.680	CO₂e kg/m²

Table 7: Truck to Yibin

	Value	Unit
Raw Data: Truck to Yibin	68.500	km truck
HD Truck Combination Long Haul CIDI - LS Diesel	0.072	GHG-100 (kg/(MT km))
Product Percent of Ton	0.3550%	
TOTAL	0.017	CO₂e kg/m²

Table 8: Rail to Shanghai

	Value	Unit
Raw Data: Rail to Shanghai	1974	km rail
Freight Rails: Diesel	0.0175946154	GHG-100 (kg/(t km))
Product Percent of Ton	0.3550%	percent
TOTAL	0.123	CO₂e kg/m²

Table 9: Ocean Cargo Vessel to Norfolk, Virginia

	Value	Unit
Raw Data: Ocean Cargo Vessel to Norfolk, Virginia	19244.132	km ship
Asia to East Coast USA (East Coast)	89.857	grams CO2 per Twenty Foot Unit
Product Percent of TEU	0.0065%	percent
Conversion: 1 kg = 1000 g	1000	
TOTAL	0.112	CO₂e kg/Ship Trip

Table 10: Norfolk Warehouse to Building Site

	Value	Unit
Raw Data: Norfolk Warehouse to Building Site	800	km truck
HD Truck Combination Long Haul CIDI - LS Diesel	0.072	GHG-100 (kg/(MT km))
Product Percent of Ton	0.3550%	percent
TOTAL	0.204	CO₂e kg / Trip

1.1. Yibin Cradle-to-Site Carbon Emission Values - Tile Flooring

Table 11. Yibin Cradle-to-Site Carbon Emission Values (RFCI EPD)²

#	Code	Stage	Description	Value				Source Citation/Link	Included in Franke (2014)?	Included Hong and Chen (2014) Paper?
				SI Value	SI Units	CO2e (kg) / m ²	CO2e Units			
1	A1a	Raw Material Extraction	Primary Energy (Feedstock): Coal Mining	Not included in calculations	N/A	N/A	N/A		No	No
2	A1a	Raw Material Extraction	Primary Energy (Feedstock): Coal Mining	Not included in calculations	N/A	N/A	N/A		No	No
3	A1a	Raw Material Extraction	Mining of mercury	Not included in calculations	N/A	N/A	N/A		No	No
4	A1a; A1d	Raw Material Extraction	Brine Extraction	Included in #13 A1d Chlorine Production value	N/A	N/A	N/A	Hong, J., Chen, W., Wang, Y., Xu, C., & Xu, X. (2014). Life cycle assessment of caustic soda production: a case study in China. Journal of cleaner production, 66, 113-120.	No	Yes
5	A1a; A1d	Raw Material Extraction	PFAS/PTFE Manufacturing	0.0000121	kg CO2e / kg PTFE	0.000000000000451	kg CO2e / m ²	https://onlinelibrary.wiley.com/doi/full/10.1002/ese3.441	No	No
6	A1a	Raw Material Extraction	Limestone Flour	2.945	kg CO2e per kg of Limestone	9.212	kg CO2e / m ²	https://sciendo.com/article/10.1515/rtuect-2017-0011		

² The value for #5 - PFAS/PTFE Manufacturing kg CO2e / kg PTFE is a LCA value

7	A1a	Raw Material Extraction	Plasticizer (Bis(2-ethylhexyl) terephthalate)	802.388	kg CO2e per 390 kg of DEHP	1.098	kg CO2e / m2	http://d-scholarship.pitt.edu/18234/1/LiYuan_ETD2013.pdf		
8	A1b	Raw Material Processing	Coking of Coal	Included in #15 Ae PVC Polymerization	N/A	N/A	N/A		Yes	No
9	A1b - new	Raw Material Processing	Mercury catalyst production	Not included in calculations	N/A	N/A	N/A		No	No
10	A1b	Raw Material Processing	Carbide Production	Included in #15 Ae PVC Polymerization	N/A	N/A	N/A		Yes	No
11	A1b	Raw Material Processing	Acetylene Preparation	Included in #15 Ae PVC Polymerization	N/A	N/A	N/A		Yes	No
12	A1c	Energy	Secondary Energy (Fuel): On Site Coal Fired Plant (100% Coal Emissions)	Included in #15 Ae PVC Polymerization	N/A	N/A	N/A		Yes	No
13	A1d	Chlorine Production	PTFE-based Production of Chlorine and Caustic Soda	1.590	ton CO2e / ton NaOH	2.132	kg CO2e / m2	https://www.researchgate.net/publication/260110281_Life_cycle_assessment_of_caustic_soda_production_A_case_study_in_China	Yes	Yes
14	A1d	Vinyl Chloride Monomer Production	Reaction of Petroleum Coke and Chlorine (Calcium Carbide) using mercury catalysts	Included in #15 Ae PVC Polymerization	N/A	N/A	N/A		Yes	No
15	A1e	PVC Polymerization	Polymerizing VCM	11.200	tonne CO2e / tonne PVC	21.751	kg CO2e / m2	https://www.ifeu.de/fileadmin/uploads/RECA_ST_URUMQI_Sub-project_3_Energy_efficiency_Final_report.pdf	Yes	No
16	A2	Raw Material Transportation	Brine Transportation	Included in #15 Ae PVC Polymerization	N/A	N/A	N/A		No	Yes
17	A2	Raw Material	Primary Energy (Feedstock):	Included in #13 A1d Chlorine	N/A	N/A	N/A		No	Yes

		Transportation	Coal Transportation	Production value						
18	A2	Raw Material Transportation	PFAS/PTFE Transportation	Included in #13 A1d Chlorine Production value	N/A	N/A	N/A		No	No
19	A2	Raw Material Transportation	Primary Energy (Feedstock): Coal Transportation	Included in #13 A1d Chlorine Production value	N/A	N/A	N/A		No	Yes
20	A3	Manufacturing	Energy of Manufacturing	950.000	btu/pound Tile	N/A	N/A		Yes	Yes (each accounting for different stages)
21	A4	Transportation	Truck to Yibin	68.500	km truck	0.017	kg CO2e / truck trip		No	No
22	A4	Transportation	Rail to Shanghai	1974.000	km rail	0.123	kg CO2e / rail trip	Draft Logic and https://www.openrailwaymap.org/	No	No
23	A4	Transportation	Ocean Cargo Vessel to Norfolk, Virginia	19244.132	km ship	0.112	kg CO2e / ship trip	https://sea-distances.org/	No	No
24	A4	Transportation	Norfolk Warehouse to Building Site	800.000	km truck	0.204	kg CO2e / truck trip	https://www.scs-certified.com/products/cert_pdfs/SCS-EPD-06754_NOX-Corp_LVS_030921.pdf	No	No

Table 12: Hong (2014) - "Life Cycle Assessment of Caustic Soda Production: A Case Study in China"

	Value	Unit
Raw Data: from Hong and Chen (2014)	1.590	ton CO2e / ton NaOH
Conversion: 1 ton Cl2 =	1.128	ton NaOH
Chlorine + Caustic Soda + Brine converted to CO2e kg/kg product	1.794	kg CO2e / kg Cl2
Conversion: VCM Acetylene - Chlorine ton to VCM ton	0.600	ton Cl2 / ton VCM
Total CO2e CO2e kg/kg VCM	1.076	kg CO2e / kg VCM
Conversion: VCM ton to PVC ton	1.020	ton VCM / ton PVC
TOTAL CO2e kg/PVC kg	1.098	kg CO2e / kg PVC
Product Weight	5.930	kg / m2
Weight to floor	32.75%	%
TOTAL	2.132	CO2e kg/m²

Table 13: Frank (2014) - Recast Urumqi Paper

	Value	Unit
Raw Data: Recast Urumqi	11.20	Mg CO2e per tonne of PVC
Convert to kg (it's the same ratio)	11.20	kg CO2e / kg PVC
Product Weight	5.930	kg / m2
Weight to floor	32.75%	
TOTAL	21.752	CO2e kg/m²

Table 14: PFAS

	Value	Unit
Raw Data: PFAS kg / m2 of PVC flooring	0.0000000373	PFAS kg/m2 of PVC flooring
Raw Data: PTFE (PFAS)	0.012	CO2e kg/gram of PTFE
Converted value	0.0000121	kg CO2e / kg PTFE
TOTAL	0.000000000000451	CO₂e kg/m²

Table 15: Limestone Flour

	Value	Unit
Raw Data: Limestone	2.95	kg CO2e per kg of Limestone
Product Weight	5.930	kg/m2
Weight to Floor	52.75%	
TOTAL	9.212	CO₂e kg/m²

Table 16: Plasticizer (Di(2-ethylhexyl) terephthalate)

	Value	Unit
Raw Data: Plasticizer Di(2-ethylhexyl) terephthalate, DEHT	802.388	kg CO2e per 390 kg of DEHT
	390	
Converted	2.057	kg CO2e / kg DEPH
Product Weight	5.930	kg/m2
Weight to Floor	9.00%	
TOTAL	1.098	CO₂e kg/m²

Table 17: Truck to Yibin

	Value	Unit
Raw Data: Truck to Yibin	68.50	km truck
HD Truck Combination Long Haul CIDI - LS Diesel	0.072	GHG-100 (kg/(MT km))
Product Percent of Ton	0.3550%	
TOTAL	0.017	CO₂e kg/m²

Table 18: Rail to Shanghai

	Value	Unit
Raw Data: Rail to Shanghai	1974	km rail
Freight Rails: Diesel	0.018	GHG-100 (kg/(t km))
Product Percent of Ton	0.3550%	percent
TOTAL	0.123	CO₂e kg/m²

Table 19: Ocean Cargo Vessel to Norfolk, Virginia

	Value	Unit
Raw Data: Ocean Cargo Vessel to Norfolk, Virginia	19244.132	km ship
Asia to East Coast USA (East Coast)	89.857	grams CO ₂ per Twenty Foot Unit
Product Percent of TEU	0.0065%	percent
Conversion: 1 kg = 1000 g	1000	
TOTAL	0.112	CO₂e kg/Ship Trip

Table 20: Norfolk Warehouse to Building Site

	Value	Unit
Raw Data: Norfolk Warehouse to Building Site	800	km truck
HD Truck Combination Long Haul CIDI - LS Diesel	0.072	GHG-100 (kg/(MT km))
Product Percent of Ton	0.3550%	percent
TOTAL	0.204	CO₂e kg / Trip

1.2. Occidental Cradle-to-Site Carbon Emission Value - Sheet Flooring³⁴

Table 21: Occidental Cradle-to-Grave Carbon Emission Value (NOX EPD)

#	Code	Stage	Description	Value				Source Citation/Link
				SI Value	SI Units	CO2e (kg) / m ²	Units	
1	A1a	Raw Material Extraction	Natural gas liquids extraction, distribution, and processing (to power plant and cracker)	Included in #11 A1d VCM Production value	N/A	N/A	N/A	N/A
2	A1a; A1d	Raw Material Extraction	Brine Extraction	Not included	N/A	N/A	N/A	N/A
3	A1a;A1d	Raw Material Extraction	Asbestos Extraction	0.0000371	kg CO2e / g asbestos	0.00000142	kg CO2e / m ²	https://www.mdpi.com/2071-1050/13/6/3565/pdf
4	A1a	Raw Material Extraction	Limestone Flour	2.945	kg CO2e per kg of Limestone	2.823	kg CO2e / m ²	Kittipongvises, S. (2017). Assessment of Environmental Impacts of Limestone Quarrying Operations in Thailand. Environmental & Climate Technologies, 20(1).
5	A1a	Raw Material Extraction	Plasticizer Bis(2-ethylhexyl) terephthalate)	802.388	kg CO2e per 390 kg of DEHP	1.680	kg CO2e / m ²	Li, Y. (2013). Life Cycle Assessment to Di-2-Ethylhexyl Phthalate (DEHP), Applications and Potential Alternatives (Doctoral dissertation.

³ The CO₂e kg/m² value for *Manufacturing of PVC into Tile* is calculated using A1a - A1e values and conversions/weights from the [Conversion/Weights](#) table.

⁴ The value for #3 - Asbestos Extraction kg CO₂e / kg PTFE is a LCA value

								University of Pittsburgh
6	A1b	Raw Material Processing	Ethane to Ethylene: cracking	Included in #11 A1d VCM Production value	N/A	N/A	N/A	N/A
7	A1c	Plant Emissions/Energy Usage U.S.	Plant Emissions from Production and Natural Gas Plant	Included in #11 A1d VCM Production value	N/A	N/A	N/A	N/A
8	A1c	Energy Usage (Colombia)	On Site Grid Emissions for Colombia	Included in #12 A1e PVC Polymerization	N/A	N/A	N/A	N/A
9	A1c	Energy Usage (U.S.)	Lancaster, Pennsylvania Electricity Grid Emissions	Included in #19 A3 Manufacturing PVC into Tile	N/A	N/A	N/A	N/A
10	A1d	Chlorine Production	Asbestos-based production of chlorine and caustic soda	Included in #11 A1d VCM Production value	kg CO2e / g asbestos	N/A	N/A	https://www.mdpi.com/2071-1050/13/6/3565/pdf
11	A1d	VCM Production	Reaction of ethylene and chlorine to produce ethylene dichloride. EDC Cracker to produce VCM.	2.071	CO2e tonne per VCM output	3.383	kg CO2e / m2	https://ghgdata.epa.gov/ghgp/service/facilityDetail/2020?id=1001705&ds=E&et=&popup=true https://www.eia.gov/opendata/gb.php?category=5897&sdid=ELEC.PLANT.CONNS_EG_BTU.55313-ALL-ALLA https://onlinelibrary.wiley.com/doi/full/10.1002/es.e3.956 https://archive.epa.gov/region6/6pd/air/pd-r/ghg/web/pdf/oxychem-ethylene-revised-app0314.pdf https://www.icis.com/subscriber/icb/chemicalpro

								file?commodityId=10197 &regionId=10011#
12	A1e	PVC Polymerization	Polymerizing VCM at Mexichem Plant in Colombia	1860.000	btu / lb PVC	0.404	kg CO2e / m2	Gaines, L. L., & Shen, S. Y. (1980). Energy and materials flows in the production of olefins and their derivatives (No. ANL/CNSV-9). Argonne National Lab., IL (USA).
13	A2	Raw Material Transportation	Brine Transportation	Not included	N/A	N/A	N/A	N/A
14	A2	Raw Material Transportation	Asbestos Transportation	1509.000	km truck	0.384	kg CO2e / truck trip	https://www.openrailwaymap.org/
15	A2	Raw Material Transportation	Asbestos Transportation	8674.768	km ship	0.054	kg CO2e / ship trip	Google Maps
16	A2	Transportation	Ship from Ingleside, Texas to Cartagena, Colombia	3033.000	km ship	0.019	kg CO2e / ocean freight trip	https://sea-distances.org/
17	A2	Transportation	Ship from Cartagena, Colombia to Pedricktown, New Jersey	3353.000	km ship	0.021	kg CO2e / ship trip	https://sea-distances.org/
18	A2	Transportation	Truck to Lancaster, Pennsylvania for floor manufacturing	103.000	km truck	0.026	kg CO2e / truck trip	Google Maps
19	A3	Manufacturing	Manufacturing PVC into Tile	950.000	btu / lb PVC	0.583	kg CO2e / m2	Freeman, W. (2005). Generic Vinyl Composition Tile.
20	A4	Transportation	Lancaster, Pennsylvania to Building Site	800.000	km truck	0.204	kg CO2e / truck trip	NOX Corporation. (2018). Environmental Product Declaration: Luxury Vinyl Sheet Flooring.

Table 22: VCM Occidental

Production Inputs	Value	Units	Notes
Raw Data: OxyChem Ingleside CO2e reported releases (2020)	1,895,249.00	CO2e metric tonnes	Reported by OxyChem Ingleside in 2020
POWER PLANT INPUT (METHANE)			
Raw Data: Power plant electric fuel consumption (2020)	26,012,731.00	MMBtu	
2020 Power plant natural gas consumption	408,133.63	U.S. tons	U.S. tons methane consumed in power plant (34.59 lb per MMBtu)
2020 Power plant natural gas consumption	370,252.70	metric tonnes	methane consumed in power plant
2020 methane leakage from extraction and distribution	13,876.54		2.6% from extraction and 0.8% from distribution per Howarth
2020 CO2E from methane leakage during extraction	346,913.58	CO2e	(using 25 GWP) - note: 25-year rate is 84 GWP, so this is an underestimate. 25GWP is EPA standard reporting practice however
CRACKER INPUT (ETHANE GAS LIQUID)			
Cracker Capacity (tons per year)	600,000.00	metric tonnes ethylene per year	
NGL throughput - 2019 CO2E from methane leakage during extraction (2.6% of capacity tonnage * 25 GWP)	15,600.00	metric tonnes per year	Assumes 100% efficient consumption of throughput; conservative.
TOTAL CO2e 2020 from Methane leakage for inputs	362,513.58	CO2e	
Total Emissions from Ingleside Chemical Plant and related NGL inputs	2,257,762.58	CO2e metric tonnes	

Ingleside VCM capacity	1,090,000.00	metric tons in 2018	
CO2e per VCM output	2.071341818	CO2e tonne per VCM output	
Conversion: ton VCM / ton PVC	1.020	ton VCM / ton PVC	
Conversion: ton CO2e / ton PVC	2.113	ton CO2e / ton PVC	
Conversion: kg CO2e / kg PVC	2.113	kg CO2e / kg PVC	
Product Weight	3.550	kg / m2	
Weight to floor	45.10%		
TOTAL	3.383	kg CO2e / m2	

Table 23: Asbestos

	Value	Units
VCM PtE	0.580	ton Cl2 / ton VCM
PVC Polymerization	1.020	ton VCM / ton PVC
Asbestos use / chlorine	0.0000404	kg asbestos / kg Cl2
Occidental Asbestos in PVC	0.0000239	kg asbestos / kg PVC
Conversion: 1 kg =	1000	g
Conversion: g asbestos / kg PVC	0.024	g asbestos / kg PVC
Raw Data	0.0000371	kg CO2e / g asbestos
Total emissions from asbestos	0.000000886	kg CO2e / kg PVC
Product Weight	3.55	kg / m2
Weight to floor	45.10%	
TOTAL	0.00000142	CO₂e kg/m²

Table 24: Polymerizing VCM at Mexichem Plant in Colombia

	Value	Units
Raw Data: PVC Polymerization	1860.000	btu / lb PVC
Conversion: 1 lb =	0.454	kg
Conversion: 1 btu =	0.000293	kWh
Total kWh / kg PVC	1.202	kWh / kg PVC
Raw Data: On Site Grid Emissions for Colombia	209.919	g CO ₂ e / kWh
Conversion: 1 kg =	1000	
Total kg CO₂e / kWh Colombia grid	0.201	kg CO₂e / kWh Colombia grid
Total Emissions from PVC Polymerization	0.252	kg CO₂e / kg PVC
Product Weight	3.550	kg / m ²
Weight to floor	45.10%	
TOTAL	0.404	CO₂e kg/m²

Table 25: Manufacturing PVC into Tile

	Value	Units
Raw Data: Manufacturing PVC into Tile	950	btu / lb
Conversion: 1lb =	0.454	kg
Conversion: 1 btu =	0.0003	kWh
Total	0.614	kWh / kg tile
Raw Data: Emissions Pennsylvania Manufacturing from eGrid	592,930.302	MT / million MWh
Conversion: 1 tonne =	1000	kg
Conversion: 1 million MWh =	1,000,000,000	kWh
Conversion: kg CO2e / kWh Pennsylvania Grid	0.593	kg CO2e / kWh Pennsylvania Grid
Total	0.364	kg CO2e / kg tile
Product Weight	3.55	kg / m2
Weight to floor	45.10%	
TOTAL	0.583	CO₂e kg/m²

Table 26: Limestone Flour

	Value	Units
Raw Data: Limestone	2.945	kg CO2e / kg limestone
Product Weight	3.55	kg / m2
Weight to Floor	27.00%	
Total	2.823	CO₂e kg/m²

Table 27: Plasticizer Di(2-ethylhexyl) terephthalate

	Value	Units
Raw Data: Plasticizer Di(2-ethylhexyl) terephthalate, DEHT	802.388	kg CO2e / 390 kg DEHT
kg	390	
Total	2.058	kg CO2e / kg DEHP
Product Weight	3.55	kg / m2
Weight to Floor	23.00%	
TOTAL	1.680	CO₂e kg/m²

Table 28: Transportation: Lancaster, Pennsylvania to Building Site

	Value	Units
Raw Data: Transportation: Lancaster, Pennsylvania to Building Site	3033	km ship
Product Percent of TEU	0.0065%	
North America to South America (East Coast)	96.286	g CO2 / twenty foot unit
Conversion: 1 kg =	1000	g
Total	0.0190	kg CO2e / ocean freight trip

Table 29: Transportation: Cartagena, Colombia to Pedricktown, New Jersey

	Value	Units
Raw Data: Transportation: Cartagena, Colombia to Pedricktown, New Jersey	3353	km ship
Product Percent of TEU	0.0065%	
North America to South America (East Coast)	96.286	g CO2 / twenty foot unit
Conversion: 1 kg = g	1000	g
Total	0.021	kg CO2e / ship trip

Table 30: Truck to Lancaster, Pennsylvania for floor manufacturing

	Value	Units
Raw Data: Truck to Lancaster, Pennsylvania for floor manufacturing	103	km truck
HD Truck Combination Long Haul CIDI - LS Diesel	0.072	GHG-100 (kg/(MT km))
Product Percent of Metric Ton	0.355%	
Total	0.0262	kg CO2e / truck trip

Table 31: Transportation: Lancaster, Pennsylvania to Building Site

	Value	Units
Raw Data: Lancaster, Pennsylvania to Building Site	800	km truck
HD Truck Combination Long Haul CIDI - LS Diesel	0.072	GHG-100 (kg/(MT km))
Product Percent of Metric Ton	0.355%	
Total	0.2038	kg CO2e / truck trip

1.3. Occidental Cradle-to-Site Carbon Emission Value - Tile Flooring⁵⁶

Table 32: Occidental Cradle-to-Site Carbon Emission Value (RFCI EPD)

#	Code	Stage	Description	Value				Source Citation/Link
				SI Value	SI Units	CO ₂ e (kg) / m ²	Units	
1	A1a	Raw Material Extraction	Natural gas liquids extraction, distribution, and processing (to power plant and cracker)	Included in #11 A1d VCM Production value	N/A	N/A	N/A	N/A
2	A1a; A1d	Raw Material Extraction	Brine Extraction	Not included	N/A	N/A	N/A	N/A
3	A1a;A1d	Raw Material Extraction	Asbestos Extraction	0.0000371	kg CO ₂ e / g asbestos	0.0000017 2	kg CO ₂ e / m ²	https://www.mdpi.com/2071-1050/13/6/3565/pdf
4	A1a	Raw Material Extraction	Limestone Flour	2.945	kg CO ₂ e / kg limestone	9.212	kg CO ₂ e / m ²	Kittipongvises, S. (2017). Assessment of Environmental Impacts of Limestone Quarrying Operations in Thailand. Environmental & Climate Technologies, 20(1).
5	A1a	Raw Material Extraction	Plasticizer Bis(2-ethylhexyl) terephthalate)	802.388	kg CO ₂ e / 390 kg DEHP	1.098	kg CO ₂ e / m ²	Li, Y. (2013). Life Cycle Assessment to Di-2-Ethylhexyl Phthalate (DEHP). Applications and Potential Alternatives

⁵ The CO₂e kg/m² value for *Manufacturing of PVC into Tile* is calculated using A1a - A1e values and conversions/weights from the [Conversion/Weights](#) table.

⁶ The value for #3 - Asbestos Extraction kg CO₂e / kg PTFE is a LCA value

								(Doctoral dissertation, University of Pittsburgh).
6	A1b	Raw Material Processing	Ethane to Ethylene: cracking	Included in #11 A1d VCM Production value	N/A	N/A	N/A	N/A
7	A1c	Plant Emissions/Energy Usage U.S.	Plant Emissions from Production and Natural Gas Plant	Included in #11 A1d VCM Production value	N/A	N/A	N/A	N/A
8	A1c	Energy Usage (Colombia)	On Site Grid Emissions for Colombia	Included in #12 A1e PVC Polymerization	N/A	N/A	N/A	N/A
9	A1c	Energy Usage (U.S.)	Lancaster, Pennsylvania Electricity Grid Emissions	Included in #19 A3 Manufacturing PVC into Tile	N/A	N/A	N/A	N/A
10	A1d	Chlorine Production	Asbestos-based production of chlorine and caustic soda	Included in #11 A1d VCM Production value	kg CO2e / g asbestos	N/A	kg CO2e / m2	https://www.mdpi.com/2071-1050/13/6/3565/pdf
11	A1d	VCM Production	Reaction of ethylene and chlorine to produce ethylene dichloride. EDC Cracker to produce VCM.	2.071	CO2e tonne per VCM tonne output	4.103	kg CO2e / m2	" https://ghgdata.epa.gov/ghgp/service/facilityDetail/2020?id=1001705&ds=E&et=&popup=true https://www.eia.gov/opendata/qb.php?category=5897&sdid=ELEC.PLANT.CONNS_EG_BTU.55313-ALL-ALL.A https://onlinelibrary.wiley.com/doi/full/10.1002/ese3.956 https://archive.epa.gov/region6/6pd/air/pdr/ghg/web/pdf/oxychem-ethylene-revised-app0314.pdf https://www.icis.com/su

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12	A1e	PVC Polymerization	Polymerizing VCM at Mexichem Plant in Colombia	1860.000	btu / lb PVC	0.490	kg CO2e / m2	Gaines, L. L., & Shen, S. Y. (1980). Energy and materials flows in the production of olefins and their derivatives (No. ANL/CNSV-9). Argonne National Lab., IL (USA).
13	A2	Raw Material Transportation	Brine Transportation	Not included	N/A	N/A	N/A	N/A
14	A2	Raw Material Transportation	Asbestos Transportation	1509.000	km truck	0.384	kg CO2e / truck trip	https://www.openrailwaymap.org/
15	A2	Raw Material Transportation	Asbestos Transportation	8674.768	km ship	0.054	kg CO2e / ship trip	Google Maps
16	A2	Transportation	Ship from Ingleside, Texas to Cartagena, Colombia	3033.000	km ship	0.019	kg CO2e / ocean freight trip	https://sea-distances.org/
17	A2	Transportation	Ship from Cartagena, Colombia to Pedricktown, New Jersey	3353.000	km ship	0.021	kg CO2e / ship trip	https://sea-distances.org/
18	A2	Transportation	Truck to Lancaster, Pennsylvania for floor manufacturing	103.000	km truck	0.026	kg CO2e / truck trip	Google Maps
19	A3	Manufacturing	Manufacturing PVC into Tile	950.000	btu / lb PVC	0.707	kg CO2e / m2	Freeman, W. (2005). Generic Vinyl Composition Tile.
20	A4	Transportation	Lancaster, Pennsylvania to Building Site	800.000	km truck	0.204	kg CO2e / truck trip	NOX Corporation. (2018). Environmental Product Declaration: Luxury Vinyl Sheet Flooring.

Table 33: VCM Occidental

	Value	Units	Notes
Raw Data: OxyChem Ingleside CO2e reported releases (2020)	1,895,249.00	CO2e metric tonnes	Reported by OxyChem Ingleside in 2020
POWER PLANT INPUT (METHANE)			
Raw Data: Power plant electric fuel consumption (2020)	26,012,731.00	MMBtu	
2020 Power plant natural gas consumption	408,133.63	U.S. tons	U.S. tons methane consumed in power plant (34.59 lb per MMBtu)
2020 Power plant natural gas consumption	370,252.70	metric tonnes	methane consumed in power plant
2020 methane leakage from extraction and distribution	13,876.54		2.6% from extraction and 0.8% from distribution per Howarth
2020 CO2E from methane leakage during extraction	346,913.58	CO2e	(using 25 GWP) - note: 25-year rate is 84 GWP, so this is an underestimate. 25GWP is EPA standard reporting practice however
CRACKER INPUT (ETHANE GAS LIQUID)			
Cracker Capacity (tons per year)	600,000.00	metric tonnes ethylene per year	
NGL throughput - 2019 CO2E from methane leakage during extraction (2.6% of capacity tonnage * 25 GWP)	15,600.00	metric tonnes per year	Assumes 100% efficient consumption of throughput; conservative.
TOTAL CO2e 2020 from Methane leakage for inputs	362,513.58	CO2e	
Total Emissions from Ingleside Chemical Plant and related NGL inputs	2,257,762.58	CO2e metric tonnes	

Ingleside VCM capacity	1,090,000.00	metric tons in 2018	
CO2e per VCM output	2.071341818	CO2e tonne per VCM output	
Conversion: ton VCM / ton PVC	1.020	ton VCM / ton PVC	
Conversion: ton CO2e / ton PVC	2.113	ton CO2e / ton PVC	
Conversion: kg CO2e / kg PVC	2.113	kg CO2e / kg PVC	
Product Weight	5.93	kg / m2	
Weight to floor	32.75%		
TOTAL	4.103	kg CO2e / m2	

Table 34: Asbestos

	Value	Units
VCM PtE	0.580	ton Cl2 / ton VCM
PVC Polymerization	1.020	ton VCM / ton PVC
Asbestos use / chlorine	0.0000404	kg asbestos / kg Cl2
Occidental Asbestos in PVC	0.0000239	kg asbestos / kg PVC
Conversion: 1 kg =	1000	g
Conversion: g asbestos / kg PVC	0.024	g asbestos / kg PVC
Raw Data	0.0000371	kg CO2e / g asbestos
Total emissions from asbestos	0.000000886	kg CO2e / kg PVC
Product Weight	5.93	kg / m2
Weight to floor	32.75%	
TOTAL	0.00000172	CO₂e kg/m²

Table 35: Polymerizing VCM at Mexichem Plant in Colombia

	Value	Units
Raw Data: PVC Polymerization	1860	btu / lb PVC
Conversion: 1 lb =	0.454	kg
Conversion: 1 btu =	0.0003	kWh
Total kWh / kg PVC	1.202	kWh / kg PVC
Raw Data: On Site Grid Emissions for Colombia	209.919	g CO ₂ e / kWh
Conversion: 1 kg =	1000	
Total kg CO₂e / kWh Colombia grid	0.210	kg CO₂e / kWh Colombia grid
Total Emissions from PVC Polymerization	0.252	kg CO₂e / kg PVC
Product Weight	5.93	kg / m ²
Weight to floor	32.75%	
TOTAL	0.490	CO₂e kg/m²

Table 36: Manufacturing PVC into Tile

	Value	Units
Raw Data: Manufacturing PVC into Tile	950	btu / lb
Conversion: 1lb =	0.454	kg
Conversion: 1 btu =	0.0003	kWh
Total	0.6138	kWh / kg tile
Raw Data: Emissions Pennsylvania Manufacturing from eGrid	592,930.302	MT / million MWh
Conversion: 1 tonne =	1000	kg
Conversion: 1 million MWh =	1,000,000,000	kWh
Conversion: kg CO2e / kWh Pennsylvania Grid	0.593	kg CO2e / kWh Pennsylvania Grid
Total	0.364	kg CO2e / kg tile
Product Weight	5.93	kg / m ²
Weight to floor	32.75%	
TOTAL	0.707	CO₂e kg/m²

Table 37: Limestone Flour

	Value	Units
Raw Data: Limestone	2.9450	kg CO2e / kg limestone
Product Weight	5.93	kg / m ²
Weight to Floor	52.75%	
Total	9.212	CO₂e kg/m²

Table 38: Plasticizer Di(2-ethylhexyl) terephthalate

	Value	Units
Raw Data: Plasticizer Di(2-ethylhexyl) terephthalate, DEHT	802.388	kg CO2e / 390 kg DEHT
kg	390	
Total	2.0574	kg CO2e / kg DEHP
Product Weight	5.93	kg / m2
Weight to Floor	9.00%	
TOTAL	1.098	CO₂e kg/m²

Table 39: Transportation: Lancaster, Pennsylvania to Building Site

	Value	Units
Raw Data: Transportation: Lancaster, Pennsylvania to Building Site	3033	km ship
Product Percent of TEU	0.0065%	
North America to South America (East Coast)	96.2857	g CO2 / twenty foot unit
Conversion: 1 kg =	1000	g
Total	0.019	kg CO2e / ocean freight trip

Table 40: Transportation: Cartagena, Colombia to Pedricktown, New Jersey

	Value	Units
Raw Data: Transportation: Cartagena, Colombia to Pedricktown, New Jersey	3353	km ship
Product Percent of TEU	0.0065%	
North America to South America (East Coast)	96.286	g CO2 / twenty foot unit
Conversion: 1 kg = g	1000	g
Total	0.021	kg CO2e / ship trip

Table 41: Truck to Lancaster, Pennsylvania for floor manufacturing

	Value	Units
Raw Data: Truck to Lancaster, Pennsylvania for floor manufacturing	103	km truck
HD Truck Combination Long Haul CIDI - LS Diesel	0.072	GHG-100 (kg/(MT km))
Product Percent of Metric Ton	0.355%	
Total	0.026	kg CO2e / truck trip

Table 42: Transportation: Lancaster, Pennsylvania to Building Site

	Value	Units
Raw Data: Lancaster, Pennsylvania to Building Site	800	km truck
HD Truck Combination Long Haul CIDI - LS Diesel	0.072	GHG-100 (kg/(MT km))
Product Percent of Metric Ton	0.355%	
Total	0.204	kg CO2e / truck trip

1.4. Cradle-to-Grave Carbon Emissions from EPDs

Table 43: Cradle-to-Grave Carbon Emissions - NOX EPD

Code	Stage	Value	Units	Source Citation/Link
A5	Installation	0.0114	CO ₂ e kg/m ²	NOX Corporation. (2018). Environmental Product Declaration: Luxury Vinyl Sheet Flooring.
B1	Use	N/A	N/A	Not included in EPD.
B2	Maintenance	9.59	CO ₂ e kg/m ²	NOX Corporation. (2018). Environmental Product Declaration: Luxury Vinyl Sheet Flooring.
B3	Repair	N/A	N/A	Not included in EPD.
B4	Replacement	15.5	CO ₂ e kg/m ²	NOX Corporation. (2018). Environmental Product Declaration: Luxury Vinyl Sheet Flooring.
B5	Refurbishment	N/A	N/A	Not included in EPD.
B6	Building Operational Energy Use during product use	N/A	N/A	Not included in EPD.
B7	Building Operational Water Use during product use	N/A	N/A	Not included in EPD.
C1	Destruction	N/A	N/A	Not included in EPD.
C2	Transportation	0.145	CO ₂ e kg/m ²	NOX Corporation. (2018). Environmental Product Declaration: Luxury Vinyl Sheet Flooring.
C3	Waste Processing	N/A	N/A	Not included in EPD.
C4	Disposal	1.34	CO ₂ e kg/m ²	NOX Corporation. (2018). Environmental Product Declaration: Luxury Vinyl Sheet Flooring.

Table 44: Cradle-to-Grave Carbon Emissions - RFCI EPD

Code	Stage	Value	Units	Source Citation/Link
A5	Installation	1.17	CO ₂ e kg/m ²	https://www.armstrongflooring.com/pdbupimages-flr/219176.pdf
B1	Use	N/A	N/A	Not included in EPD.
B2	Maintenance	6.1	CO ₂ e kg/m ²	https://www.armstrongflooring.com/pdbupimages-flr/219176.pdf
B3	Repair	N/A	N/A	Not included in EPD.
B4	Replacement	21.5	CO ₂ e kg/m ²	https://www.armstrongflooring.com/pdbupimages-flr/219176.pdf
B5	Refurbishment	N/A	N/A	Not included in EPD.
B6	Building Operational Energy Use during product use	N/A	N/A	Not included in EPD.
B7	Building Operational Water Use during product use	N/A	N/A	Not included in EPD.
C1	Destruction	N/A	N/A	Not included in EPD.
C2	Transportation	0.067	CO ₂ e kg/m ²	https://www.armstrongflooring.com/pdbupimages-flr/219176.pdf
C3	Waste Processing	N/A	N/A	Not included in EPD.
C4	Disposal	0.266	CO ₂ e kg/m ²	https://www.armstrongflooring.com/pdbupimages-flr/219176.pdf

1.5. Conversions/Weights⁷

Table 45: Conversions/Weights

Description	Value	Units	Source
VCM Acetylene	0.60	Chlorine ton to VCM ton	Nguyen, NL et al. (2002). PVC based on Carbon. (Provided via personal communiques with Bernd Franke).
VCM Acetylene	0.42	Acetylene ton to VCM ton	Nguyen, NL et al. (2002). PVC based on Carbon. (Provided via personal communiques with Bernd Franke).
VCM Ethane to Ethylene	0.58	Chlorine ton to VCM ton	Gaines, L. L., & Shen, S. Y. (1980). Energy and materials flows in the production of olefins and their derivatives (No. ANL/CNSV-9). Argonne National Lab., IL (USA).
PVC Polymerization	1.02	VCM ton to PVC ton	Gaines, L. L., & Shen, S. Y. (1980). Energy and materials flows in the production of olefins and their derivatives (No. ANL/CNSV-9). Argonne National Lab., IL (USA).
Chlorine Conversion	1.128	ton NaOh to 1 ton Chlorine	Garcia-Herrero, I., Margallo, M., Onandía, R., Aldaco, R., & Irabien, A. (2017). Life Cycle Assessment model for the chlor-alkali process: A comprehensive review of resources and available technologies. Sustainable Production and Consumption, 12, 44-58.

⁷ Ton refers to “metric ton”.