Bruce Rock Supermarket & Hardware: embodied carbon baseline (A1-A5) - ORA Case Study 2

ORA job 2020-0011. 52 & 52A Johnson St, Bruce Rock. As constructed 2022-23. Calculated October 2026 from IFC drawings, QS PTE 6.01 (Rawlinsons, 6 Apr 2022) and the refrigeration layout. Method and factors as the Narembeen case study (GBCA/thinkstep-anz A5 split, non-residential). Emission factors: NABERS National Emission Factors database v1.0 defaults (uncertainty adjusted) unless the product is known; see column S on the A1-A5 sheet.

Quantities from the structural (Fulcrum 21214) and architectural IFC drawings; steel from the AES fabricator material lists (Nov 2022). Remaining assumptions are marked Assumed on the A1-A5 sheet. Status: final for Case Study 2 (October 2026) and the SAP 2.0 G3 new-build baseline. Yellow cells on the A1-A5 sheet are assumed values.

Element group	A1-A3 kgCO2e	A4 kgCO2e	A5 kgCO2e	A1-A5 kgCO2e	% of total	kgCO2e/m2 GFA
Substructure	122,833	7,986	23,057	153,877	19.6%	124
Structure	290,626	15,250	54,555	360,430	45.9%	290
Roof	29,046	1,357	5,452	35,855	4.6%	29
External walls	25,551	3,254	4,796	33,601	4.3%	27
Glazing	27,715	577	5,202	33,494	4.3%	27
Internal walls	18,250	1,776	3,426	23,453	3.0%	19
Coolrooms	18,230	163	3,422	21,815	2.8%	18
Ceilings	3,894	604	731	5,228	0.7%	4
Finishes	7,956	728	1,493	10,177	1.3%	8
Services	83,415	7,661	15,658	106,734	13.6%	86
TOTAL BUILDING	**627,515**	**39,357**	**117,793**	**784,665**	**100.0%**	**630**
External works (yard asphalt, plant slabs), separate	4,313	1,170	810	6,293		5
Fitout: shelving, counters, desks (assumed masses), separate	50,144	3,898	9,413	63,455		51
Building + fitout (closer to Narembeen, which included furniture)				**848,119**		**681**

Check: equals A1-A5 sheet total	0
GFA (m2)	1,245.00
Upfront carbon A1-A5, building (kgCO2e/m2)	**630**
Total, building (tCO2e)	784.7
Structural steel, all types (tonnes)	48.9
Narembeen Admin Office refurbishment (A1-A5, 2026), reference only	209

Sensitivity: steel +/-10% (shop drawing lists are close to as-built)

Steel factor	A1-A5 kgCO2e/m2
90%	610
100%	630
110%	650

Not counted (see A1-A5 sheet): pallet racking, coolroom racking, refrigerated display cases and condensing units, promo bins and produce displays, gates, kerbs and landscaping. PV was Shire works, outside the contract. External works and the fitout (shelving, checkouts, help desk, desks, staff kitchen) are shown separately. Narembeen used product EPDs for some materials and netted timber carbon storage, so the two results are not like-for-like.

Remaining uncertainties (would refine, not overturn, the baseline)

1. Concrete delivery dockets (as-built m3 by grade); steel now from the AES fabricator lists
2. Spandek BMT (profile now known from the Finishes Schedule)
3. Perth distance (A4); concrete from WCS Concrete, Kellerberrin (~60 km)
4. Roof walkway length and weight; skirting length
5. Plant slab sizes and thickness; yard asphalt thickness
6. Slab concrete grade: S1.01 legend says 25 MPa, S1.02 table says 32 MPa (32 used)
7. Shelving: Lane Industries shelf and bay weights

SAP 2.0 goal G3 targets against this baseline

FY2027/28: -15% (kgCO2e/m2)	536
FY2028/29: -25% (kgCO2e/m2)	473
2030: -40%, in line with WorldGBC (kgCO2e/m2)	378
2050: net zero embodied carbon - reduce first, then certified offsets for the residual	

Carbon per use (see Case Study 2, "A smaller building")

Saving per 100 m2 not built (tCO2e)	63
Shire of Bruce Rock residents (ABS Census 2021)	979
tCO2e per Shire resident (indicative; catchment is wider)	0.80

Bruce Rock Supermarket & Hardware: upfront embodied carbon A1-A5 (as built, historical baseline). ORA job 2020-0011. Prepared October 2026. Quantities from architectural and structural IFC drawings; see Status column.

Element / material	Number	Linear m	Area (m2)	Volume (m3)	Weight (kg)	A1-A3 ECF kgCO2e/unit	A1-A3 kgCO2e	A1-A3 kgCO2e per unit qty	A4 ECF kgCO2e/kg	A4 kgCO2e	A5a (2023) 17.24% of A1-A3	A5w (2023) 1.53% of A1-A3	Total A1-A5 kgCO2e	Status	Source / assumption	Element group	Emission factor source
SUBSTRUCTURE																	
Ground slab 125mm, 32 MPa			1,245.00	155.63	373,500.00	0.20	72,832.50	58.50	0.01	4,840.56	12,558.60	1,113.10	91,344.76	Measured	S1.01 legend: min. 125 thick slab on 0.2mm membrane, SL92 top. S1.02 concrete table: slabs on ground 32 MPa (legend says 25 MPa: 32 used, conservative). GFA 1,245 m2.	Substructure	NABERS NEF v1.0 default
ST1 load-bearing slab thickenings 500 x 250 (poured with slab)		60.30		7.54	18,090.00	0.20	3,527.55	58.50	0.01	234.45	608.26	53.91	4,424.17	Estimated	S3.01/S5.01: grid B (~41.7 m) and grid 4 A-B (~18.6 m). Full section counted (conservative).	Substructure	NABERS NEF v1.0 default
SF1 strip footings 550 x 300, 25 MPa		143.11		23.61	56,671.56	0.17	9,350.81	65.34	0.01	734.46	1,612.37	142.91	11,840.55	Measured	S1.01 footing schedule; S3.01 under perimeter panels, 2 x (41.675 + 29.88) m.	Substructure	NABERS NEF v1.0 default
Pad footings PF1-PF5, 25 MPa				11.95	28,675.80	0.17	4,731.51		0.01	371.64	815.86	72.31	5,991.32	Measured	S1.01/S3.01: PF1 1 x 2.0x2.0x1.5; PF2 2 x 1.5x1.5x0.8; PF3 11 x 0.55x0.55x0.3; PF4 9 x 0.5x0.5x0.45; PF5 1 x 0.75x0.75x0.6.	Substructure	NABERS NEF v1.0 default
Freezer room wear slab, 80mm topping 32 MPa (set-down 230mm)			24.01	1.92	4,609.44	0.20	898.84	37.44	0.01	59.74	154.99	13.74	1,127.30	Measured	AJ Baker refrigeration layout Rev C.03 For Construction (23/06/2023): freezer room 4,950 x 4,850, 80mm 32 MPa topping on F72 mesh.	Substructure	NABERS NEF v1.0 default
Slab mesh SL92 top (4.99 kg/m2 + 10% laps)			1,245.00		6,833.81	3.65	24,943.39	20.03	0.21	1,440.94	4,301.02	381.21	31,066.55	Measured	S1.01 legend. SL92 = 9mm bars at 200 each way.	Substructure	NABERS NEF v1.0 default
Footing reinforcement: SF1 5-L12TM, ST1 trench mesh, pad bars					1,384.75	3.65	5,054.33		0.21	291.98	871.53	77.25	6,295.08	Estimated	S1.01: SF1 5-L12TM (~4.7 kg/m +10%); ST1 3-L12TM assumed; PF1 N24/N20 @275, PF2 N20/N16 @300, PF3 N16 @250, PF4/5 SL81 (~470 kg total).	Substructure	NABERS NEF v1.0 default
Waterproof membrane 0.2mm polyethylene under slab			1,245.00		236.55	1.20	1,494.00	1.20	0.05	12.52	257.61	22.83	1,786.96	Measured	S1.01 legend. 1.2 kgCO2e/m2 for 200 micron HDPE film (EPiC 2024); mass 0.19 kg/m2.	Substructure	EPiC Database 2024
STRUCTURE																	
Tilt-up concrete panels 150mm, 40 MPa (18 panels P01-01 to P01-18)			547.73	82.16	197,176.80	0.23	45,745.02	83.52	0.01	2,555.41	7,887.87	699.12	56,887.42	Measured	AES precast shop drawings AES201109-PC Rev A (26/11/2022, for approval): sum of 18 panel sheets = 547.7 m2 net, 82.16 m3 (2,400 kg/m3). Panel sheets and S1.02 say 40 MPa; the AES GA sheet says 50 MPa (40 used; 50 MPa would add ~7 tCO2e). The IFC register DL-001 Rev 3 (12/1/2023) lists the panels at Rev 2 (P01-06 Rev 3); revised quantities not seen.	Structure	NABERS NEF v1.0 default
Panel reinforcement: SL82 central mesh + N16 bars (bar schedules)			547.73		2,896.90	3.65	10,573.67	19.30	0.21	610.82	1,823.23	161.60	13,169.32	Measured	AES reinforcement drawings P01-xx-2: N16 bars from bar bending schedules = 752 kg; SL82 central over 547.7 m2 (3.56 kg/m2 + 10% laps).	Structure	NABERS NEF v1.0 default
Structural steel, hot-rolled, incl. plates and fixings (fabricator list)					35,615.01	4.09	145,665.39		0.21	7,509.57	25,117.27	2,226.21	180,518.44	Measured	AES shop drawing Steel Material List ML-001 Rev B (Nov 2022), gross weight, less CC150 cold-formed. Galvanised factor used throughout (conservative: painted internal members would be ~2% lower).	Structure	NABERS NEF v1.0 default
Cold-formed galvanised purlins, girts, bridging, fascia channels (fabricator lists)					13,284.83	4.24	56,327.68		0.33	4,348.39	9,712.66	860.86	71,249.58	Measured	AES Coldform Material List ML-002, Bridging List ML-003 and CC150 channels from ML-001 (Nov 2022).	Structure	NABERS NEF v1.0 default
Roof walkways WW: 600mm aluminium (Saferight), mill finish		60.00			420.00	30.20	12,684.00	211.40	0.21	88.56	2,187.12	193.85	15,153.53	Assumed	Specification 07610 cl. 2.13 and Schedule WW. A2.20: walkways ~25 m + ~4 m to the plant platform and ~31 m along the PV array = ~60 m (scaled at 1:200). ASSUMED 7 kg/m including pedestals. NABERS aluminium extruded uncoated.	Structure	NABERS NEF v1.0 default
Mechanical plant deck and roof access platform, aluminium mill finish					650.00	30.20	19,630.00		0.21	137.06	3,384.83	300.01	23,451.89	Measured	Fabricator drawing SM 20356-FAB-PD-D1-01 (12/01/2023), submitted by Devlyn Australia as RFA-11: deck ~7.5 x 4.5 m with guardrails, tare 650 kg, aluminium mill finish. NABERS aluminium extruded uncoated 30.2 kgCO2e/kg. Replaces the earlier 400 kg steel allowance.	Structure	NABERS NEF v1.0 default
ROOF																	
Roof sheeting, Lysaght Spandek Colorbond (Shale Grey)			1,270.00		6,223.00	3.24	20,156.30	15.87	0.15	926.73	3,475.58	308.05	24,866.65	Estimated	Materials and Finishes Schedule IFC (7/11/2022): RS Lysaght Spandek. A2.20: lower roof 720, upper 475 (13 deg), yard 75 m2. BMT not stated: 4.9 kg/m2 assumed; 3.239 kgCO2e/kg from Colorbond EPD (18.3 kgCO2e/m2 at 5.65 kg/m2).	Roof	BlueScope Colorbond EPD (as Narembeen)
Awning roof sheeting, Colorbond			131.28		643.27	3.24	2,083.56	15.87	0.15	95.80	359.27	31.84	2,570.47	Estimated	East awning ~3 x 29.6 m, south ~14.16 x 3 m.	Roof	BlueScope Colorbond EPD (as Narembeen)
Flashings, cappings, gutters 0.55 BMT flat (allowance)			150.00		672.00	15.10	2,265.00	15.10	0.15	100.07	390.56	34.62	2,790.25	Assumed	150 m2 flat sheet allowance; 15.1 kgCO2e/m2 Colorbond EPD as Narembeen.	Roof	BlueScope Colorbond EPD (as Narembeen)
Roof insulation RS.I: AirCell Insulbreak 70 + AirCell Insuliner (foil-faced air-cell)			1,195.00		717.00	3.80	4,541.00	3.80	0.33	234.69	783.01	69.40	5,628.10	Estimated	Specification 07610 cl. 2.4: AirCell 3-in-1 reflective sarking, top layer Insulbreak 70, bottom layer Insuliner. RS.I to lower and upper roofs (1,195 m2); yard roof and awnings uninsulated (schedule). Site photos show foil-faced blanket. Factor: EPiC 2024 aluminium foil insulation 1.9 kgCO2e/m2 per layer x 2 (proxy). Mass 0.6 kg/m2 assumed for A4.	Roof	EPiC Database 2024 (proxy)
Rooftop PV array														Excluded	Not installed under the building contract: PV is Shire works (Tuan, Oct 2026). QS had a $65k provisional sum.	Roof	
EXTERNAL WALLS																	
W.C1 lining: 76mm steel stud to tilt-up		1,643.10	547.70		1,293.78	4.24	5,485.63	3.34	0.33	423.48	945.89	83.84	6,938.84	Estimated	A9.20 W.C1. 3 lm/m2, 1.27 lm/kg as Narembeen.	External walls	NABERS NEF v1.0 default
W.C1 lining: 13mm plasterboard			547.70		4,655.45	0.47	2,202.03	4.02	0.05	246.37	379.70	33.65	2,861.75	Estimated	A9.20 W.C1.	External walls	NABERS NEF v1.0 default
W.C1 insulation in stud cavity (glass wool)			547.70		1,330.91	0.96	1,277.67	2.33	0.33	435.63	220.31	19.53	1,953.15	Assumed	A9.20 "insulated concrete panel"; product not stated.	External walls	As Narembeen (product EPD/earlier factor)
Tilt-up paint: external (incl. mural) and internal			547.70		205.39	0.89	488.55	0.89	0.33	67.23	84.24	7.47	647.48	Estimated	0.5 + 0.392 kgCO2e/m2 as Narembeen.	External walls	As Narembeen (product EPD/earlier factor)
W.E1 textured concrete facade panel 10mm (FC.1, Cemintel Barestone)			43.00		709.50	1.39	986.21	22.94	0.33	232.23	170.05	15.07	1,403.56	Estimated	Schedule: Cemintel Barestone External Facade (or similar). A9.20 W.E1, ~43 m2 from A3.00. Fibre cement default per kg x 16.5 kg/m2.	External walls	NABERS NEF v1.0 default
W.E2/W.E3 Express panel 9mm (FC.2, Cemintel Express Panel Wall)			100.00		1,490.00	1.39	2,071.10	20.71	0.33	487.71	357.12	31.65	2,947.58	Estimated	Schedule: Cemintel Express Panel Wall. A9.20, ~100 m2 from A3.00. Fibre cement default per kg x 14.9 kg/m2.	External walls	NABERS NEF v1.0 default
W.E1/W.E2 steel top hats and battens		1,166.40			1,267.83	4.24	5,375.58	4.61	0.33	414.98	926.92	82.16	6,799.64	Estimated	A9.20: W.E1 2 layers, W.E2/E3 4 layers at 2.4 lm/m2; 0.92 lm/kg.	External walls	NABERS NEF v1.0 default
W.E1 90mm steel stud		129.00	43.00		101.57	4.24	430.68	3.34	0.33	33.25	74.26	6.58	544.77	Estimated	A9.20 W.E1 (W.E2/E3 framed off the facade frames).	External walls	NABERS NEF v1.0 default
W.E1/W.E2 13mm plasterboard lining			103.00		875.50	0.47	414.11	4.02	0.05	46.33	71.41	6.33	538.18	Estimated	Omitted in bulkheads and parapet rear; 43 + 60 m2.	External walls	NABERS NEF v1.0 default
Facade external paint			143.00		28.60	0.50	71.50	0.50	0.33	9.36	12.33	1.09	94.28	Estimated	143 m2.	External walls	As Narembeen (product EPD/earlier factor)
W.FR1 fire resistant wall: Express panel 9mm both faces			100.00		1,490.00	1.39	2,071.10	20.71	0.33	487.71	357.12	31.65	2,947.58	Estimated	A9.20 W.FR1 ~50 m2 x 2 faces.	External walls	NABERS NEF v1.0 default
W.FR1: 13mm MR Fycheck x 4 layers			200.00		2,060.00	0.47	974.38	4.87	0.05	109.02	168.01	14.89	1,266.30	Estimated	A9.20 W.FR1. Plasterboard default per kg x 10.3 kg/m2.	External walls	NABERS NEF v1.0 default
W.FR1: 92mm stud and top hats		390.00			307.09	4.24	1,302.05	3.34	0.33	100.52	224.51	19.90	1,646.98	Estimated	A9.20 W.FR1.	External walls	NABERS NEF v1.0 default
Spandek cladding W.E4, W.F1, W.F2			60.00		294.00	3.24	952.27	15.87	0.15	43.78	164.20	14.55	1,174.80	Estimated	A3.00 west RS above RD.01 ~29 m2, gables/parapets ~31 m2. 4.9 kg/m2 assumed.	External walls	BlueScope Colorbond EPD (as Narembeen)
Spandek walls: top hats		288.00			313.04	4.24	1,327.30	4.61	0.33	102.47	228.87	20.29	1,678.92	Estimated	A9.20 W.E4 / A9.21 W.F1.	External walls	NABERS NEF v1.0 default
Spandek walls: 13mm plasterboard			30.00		255.00	0.47	120.62	4.02	0.05	13.49	20.80	1.84	156.75	Estimated		External walls	NABERS NEF v1.0 default
GLAZING AND EXTERNAL DOORS																	

Element / material	Number	Linear m	Area (m2)	Volume (m3)	Weight (kg)	A1-A3 ECF kgCO2e/unit	A1-A3 kgCO2e	A1-A3 kgCO2e per unit qty	A4 ECF kgCO2e/kg	A4 kgCO2e	A5a (2023) 17.24% of A1-A3	A5w (2023) 1.53% of A1-A3	Total A1-A5 kgCO2e	Status	Source / assumption	Element group	Emission factor source
External windows, glass: 6mm EnergyTech toughened (G1)			69.75		1,046.21	2.38	2,489.97	35.70	0.21	220.60	429.35	38.05	3,177.97	Measured	LGA-WA window shop drawings LGA-046 Rev B (16/02/2023, Devlyn RFA-13): W01 2 x 4.77 x 1.5; W02 2 x 3.42 x 1.5; W09 2 x 4.41 x 1.5; HW.01 6 off 5.8 x 0.78; W03 0.9 x 1.2 and 2.66 x 1.2; W04 0.9 x 0.59. 15 kg/m2.	Glazing	NABERS NEF v1.0 default
External window frames: Capral 419 Flushline / 400 Narrowline, powder coated		203.24			406.48	32.00	13,007.36	64.00	0.21	85.71	2,242.88	198.79	15,534.74	Estimated	Frame length = perimeters + mullions from LGA-046 Rev B (~203 m). Section masses not on the shop drawings: 2 kg/m assumed (Capral catalogue weights would confirm).	Glazing	NABERS NEF v1.0 default
D01 store entry: 6mm toughened (G1) and spandrel (G2) glass			9.86		147.83	2.38	351.82	35.70	0.21	31.17	60.67	5.38	449.04	Measured	LGA-046 Rev B: D01 3.65 x 2.7 m, Capral 419 frame with Capral 225 sliding doors, Rubek auto operator.	Glazing	NABERS NEF v1.0 default
D01 aluminium frame and sliding door sashes		24.45			48.90	32.00	1,564.80	64.00	0.21	10.31	269.82	23.91	1,868.85	Estimated	Perimeter + verticals + transom (~24.5 m); 2 kg/m assumed.	Glazing	NABERS NEF v1.0 default
Internal glazing IW.01, IW.02 (6mm toughened, mirror film)			6.14		92.16	2.38	219.34	35.70	0.21	19.43	37.82	3.35	279.95	Measured	LGA-046 Rev B: IW.01 3.72 x 1.2, IW.02 1.4 x 1.2.	Glazing	NABERS NEF v1.0 default
Internal glazing aluminium frames (Capral 419)		16.24			32.48	32.00	1,039.36	64.00	0.21	6.85	179.22	15.88	1,241.31	Estimated	Perimeters + mullion; 2 kg/m.	Glazing	NABERS NEF v1.0 default
Aluminium door frames: Capral 400 Narrowline to D02 x2, ID.01 x5, ID.02 x1		42.28			84.56	32.00	2,705.92	64.00	0.21	17.83	466.59	41.35	3,231.69	Estimated	LGA-046 Rev B door schedule (~42 m of frame); 2 kg/m assumed.	Glazing	NABERS NEF v1.0 default
Roller doors RD.01 x3 (4.0 x 3.4) and RD.02 (4.0 x 1.8)			48.00		1,243.20	132.00	6,336.00	132.00	0.15	185.14	1,092.52	96.83	7,710.50	Measured	A9.02 sizes; A2.00 counts. NABERS roller door default per m2 (25.9 kg/m2).	Glazing	NABERS NEF v1.0 default
INTERNAL WALLS																	
W.I1 plasterboard wall: 92 x 0.75 BMT studs at 450		846.00	282.00		908.38	4.24	3,851.51	4.55	0.33	297.33	664.12	58.86	4,871.82	Estimated	A9.20 W.I1 ~282 m2 (A2.02). Stud mass scaled by BMT from 0.55.	Internal walls	NABERS NEF v1.0 default
W.I2 thick wall: 2 rows 92 x 1.15 BMT at 300		844.56	105.57		1,390.47	4.24	5,895.60	6.98	0.33	455.13	1,016.59	90.10	7,457.41	Estimated	A9.20 W.I2, grid B ~20.7 x 5.1 m.	Internal walls	NABERS NEF v1.0 default
W.I3 lightweight wall: 2 x 64 x 1.15 BMT back-to-back at 300		280.00	35.00		320.69	4.24	1,359.71	4.86	0.33	104.97	234.46	20.78	1,719.92	Estimated	A9.20 W.I3 ~35 m2.	Internal walls	NABERS NEF v1.0 default
W.IF fire wall 120/120/120: 76 stud		66.00	22.00		51.97	4.24	220.35	3.34	0.33	17.01	37.99	3.37	278.72	Estimated	A9.21 W.IF ~22 m2.	Internal walls	NABERS NEF v1.0 default
W.BH internal bulkhead walls: 92 stud		120.00	40.00		94.49	4.24	400.63	3.34	0.33	30.93	69.08	6.12	506.76	Assumed	A9.21 W.BH. 40 m2 allowance.	Internal walls	NABERS NEF v1.0 default
Internal plasterboard 13mm (W.I1, W.I2, W.I3 both faces; W.BH one face)			885.14		7,523.69	0.47	3,558.71	4.02	0.05	398.15	613.63	54.39	4,624.88	Estimated		Internal walls	NABERS NEF v1.0 default
Fire-resistant plasterboard 13mm x 2 each side (W.IF)			88.00		906.40	0.47	428.73	4.87	0.05	47.97	73.93	6.55	557.17	Estimated		Internal walls	NABERS NEF v1.0 default
W.WA wet area walls: HMR plasterboard both faces			60.00		510.00	0.47	241.23	4.02	0.05	26.99	41.60	3.69	313.50	Assumed	~30 m2 wall.	Internal walls	NABERS NEF v1.0 default
Internal paint, 2 coats			1,003.14		175.55	0.39	393.23	0.39	0.33	57.46	67.81	6.01	524.51	Estimated		Internal walls	As Narembeen (product EPD/earlier factor)
W.BT MDF groove boards to walls and ceiling/bulkhead (18mm assumed)			80.00	1.44	1,039.68	1,320.00	1,900.80	23.76	0.33	340.31	327.76	29.05	2,597.92	Estimated	A9.21 W.BT, changed from composite timber battens to MDF groove boards during construction (Tuan, Oct 2026). ~80 m2 (site photos show the groove boards on the bulkheads and soffits over the checkouts and produce). NABERS MDF 1,320 kgCO2e/m3, 722 kg/m3. Biogenic storage (1,290 kgCO2e/m3) not netted; NABERS reports it separately.	Internal walls	NABERS NEF v1.0 default
COOLROOMS																	
Coolroom insulated panels 75mm EPS (produce, dairy): walls, ceilings, panel doors			135.00		1,566.00	67.20	9,072.00	67.20	0.05	82.87	1,564.30	138.65	10,857.82	Estimated	AJ Baker refrigeration layout Rev C.03 shows 75mm EPS; the Finishes Schedule (IP.2/IP.3) says 100mm Bondor EPS-FR. Either way NABERS insulated panel <=100mm applies. Two rooms ~20 m2, 2.8 m high, ~135 m2.	Coolrooms	NABERS NEF v1.0 default
Freezer insulated panels 150mm EPS: walls, ceiling, floor			102.90		1,522.85	89.00	9,157.66	89.00	0.05	80.59	1,579.07	139.96	10,957.27	Measured	AJ Baker layout Rev C.03: freezer 4,950 x 4,850 x 2.8 m external, 150mm EPS: walls 54.9, ceiling 24.0, floor 24.0 m2. NABERS insulated panel >100mm.	Coolrooms	NABERS NEF v1.0 default
CEILINGS AND SOFFITS																	
Plasterboard ceilings 13mm			56.00		476.00	0.47	225.15	4.02	0.05	25.19	38.82	3.44	292.60	Estimated	A2.30 RCP ~56 m2.	Ceilings	NABERS NEF v1.0 default
Ceiling suspension system		168.00	56.00		182.61	4.24	774.26	4.61	0.33	59.77	133.51	11.83	979.37	Estimated	3 lm/m2, 0.92 lm/kg.	Ceilings	NABERS NEF v1.0 default
Ceiling paint			56.00		9.80	0.39	21.95	0.39	0.33	3.21	3.79	0.34	29.28	Estimated		Ceilings	As Narembeen (product EPD/earlier factor)
Soffit lining SL: Cemintel Express Panel 9mm to east awning			89.00		1,326.10	1.39	1,843.28	20.71	0.33	434.06	317.84	28.17	2,623.35	Estimated	Schedule SL: FC sheeting 1200 x 3000 x 9mm with 10mm negative detail. ~89 m2; fibre cement default per kg x 14.9 kg/m2.	Ceilings	NABERS NEF v1.0 default
Soffit battens		213.60			232.17	4.24	984.42	4.61	0.33	76.00	169.74	15.04	1,245.20	Estimated	2.4 lm/m2.	Ceilings	NABERS NEF v1.0 default
Soffit paint (external)			89.00		17.80	0.50	44.50	0.50	0.33	5.83	7.67	0.68	58.68	Estimated		Ceilings	As Narembeen (product EPD/earlier factor)
DOORS AND FINISHES																	
40mm solid core timber door leaves: D02 x2, ID.01 x5, ID.02 x2 leaves, ID.05	10		19.50		1,209.00	111.00	2,164.50		0.33	395.73	373.23	33.08	2,966.54	Measured	LGA-046 Rev B door schedule (leaves by others) + A2.00 for ID.05; ID.04 is a pressed-metal fire door (not counted). NABERS door default per m2: 10 leaves x ~1.95 m2.	Finishes	NABERS NEF v1.0 default
Door paint			40.00		7.00	0.39	15.68	0.39	0.33	2.29	2.70	0.24	20.91	Estimated	12 doors x 2 faces x 2 m2.	Finishes	As Narembeen (product EPD/earlier factor)
Stainless steel trolley bay handrail (Moddex TR30, 48.3 OD)		24.30			96.23	5.99	576.41	23.72	0.33	31.50	99.39	8.81	716.10	Estimated	Moddex DI drawing 15303 (2/3/2023), approved TN 2/3/2023 (Devlyn RFA-15). Two rails on posts: ~8.4 m run x 2 rails + ~7 posts x 1.05 m = ~24 m of 48.3 x 3.2 pipe at 3.6 kg/m, +10% fittings.	Finishes	NABERS NEF v1.0 default
Aluminium skirting SK: Gyprock Plano BF600, 60mm, white powdercoat		300.00			90.00	32.00	2,880.00	9.60	0.33	29.46	496.60	44.02	3,450.08	Assumed	Schedule SK. ASSUMED ~300 m of skirting to plasterboard-lined walls at 0.3 kg/m. NABERS aluminium extruded powder coated.	Finishes	NABERS NEF v1.0 default
Vinyl flooring VF.1: Armstrong Medintone homogeneous sheet vinyl			40.00		464.00	37.80	1,512.00	37.80	0.21	97.84	260.72	23.11	1,893.66	Estimated	Schedule VF.1. Office, staff, comms ~40 m2.	Finishes	NABERS NEF v1.0 default
Floor tiles 8mm			15.00		270.00	0.98	265.68	17.71	0.21	56.93	45.81	4.06	372.48	Estimated	UAT and cleaner ~15 m2.	Finishes	As Narembeen (product EPD/earlier factor)
Wall tiles 10mm (W.WA)			30.00		540.00	0.98	531.36	17.71	0.21	113.86	91.62	8.12	744.97	Assumed	~30 m2 allowance.	Finishes	As Narembeen (product EPD/earlier factor)
Waterproofing to wet areas			45.00		22.50	0.46	10.35	0.23			1.78	0.16	12.29	Estimated	~45 m2.	Finishes	As Narembeen (product EPD/earlier factor)
Concrete floor sealer / polish to trading floor														Excluded	Product not identified; minor.	Finishes	
BUILDING SERVICES																	
Building services MEP: NABERS rate, office/commercial low rise <7,500 m2			1,245.00		23,406.00	67.00	83,415.00	67.00	0.33	7,661.25	14,383.36	1,274.83	106,734.44	Assumed	NABERS Rules s.9.6: services by rate per m2, no item take-off. No retail rate in NEF v1.0; office low rise (67 kgCO2e/m2, 18.8 kg/m2) chosen over warehouse with HVAC (57.4). Refrigeration plant and refrigerant are excluded (equipment; leakage is B1).	Services	NABERS NEF v1.0 default
EXTERNAL WORKS (reported separately, not in the building total)																	
Plant slabs in rear yard: GEN SB, BGEN, FCN, BP (150mm assumed, 32 MPa)			20.70	3.11	7,452.00	0.20	1,453.14	70.20	0.01	96.58	250.57	22.21	1,822.49	Estimated	Tuan, Oct 2026: only concrete in the yard is under the plant marked on A2.12. Scaled from A2.12: GEN SB ~1.0 x 7.7, BGEN surround ~5.6, FCN condensers ~6.0, BP baler ~1.4 m2. Thickness and grade not on S-drawings.	External works	NABERS NEF v1.0 default

Element / material	Number	Linear m	Area (m2)	Volume (m3)	Weight (kg)	A1-A3 ECF kgCO2e/unit	A1-A3 kgCO2e	A1-A3 kgCO2e per unit qty	A4 ECF kgCO2e/kg	A4 kgCO2e	A5a (2023) 17.24% of A1-A3	A5w (2023) 1.53% of A1-A3	Total A1-A5 kgCO2e	Status	Source / assumption	Element group	Emission factor source
Asphalt rear yard, 40mm asphaltic concrete (thickness assumed)			211.30	8.45	20,284.44	0.14	2,860.11	13.54	0.05	1,073.45	493.17	43.71	4,470.44	Estimated	A2.12 yard 29.935 x 7.75 m less plant slabs. Base course not counted. NABERS Rules Table 7.3 includes hardstands for retail.	External works	NABERS NEF v1.0 default
Footpath: existing brick pavers lifted and reused														Measured	Tuan, Oct 2026. Reused material: zero A1-A3 (NABERS Rules s.7: reused materials carry transport only, negligible here).	External works	
FITOUT: SHELVING, COUNTERS AND DESKS (reported separately, not in the building total)																	
Shelving: Qshelf flat metal and wire shelves (powder coated steel)	1235				6,175.00	4.51	27,849.25		0.33	2,021.20	4,802.08	425.62	35,098.15	Assumed	Lane Industries quote 4/01/2023; flat metal shelves and plywood trims confirmed by Tuan (Oct 2026). Shelves counted from the quote (base + 3/4/6 per bay face): SH.B 30 faces x4, SH.GF 110 x5, SH.DS 18 x7, ends 19 x5, SH.OD 12 x7, SH.ON 6 x7, SH.L 9 x4, SH.HS 19 x7, SH.HD 7 x7 = 1,235 shelves. ASSUMED 5 kg per shelf.	Fitout	NABERS NEF v1.0 default
Shelving: Qshelf uprights, back panels, base brackets and kick plates (steel)	230				4,600.00	4.51	20,746.00		0.33	1,505.67	3,577.26	317.06	26,145.99	Assumed	230 bay faces from the Lane quote. Site photos (Tuan, Oct 2026) show full-height perforated steel back panels on every bay. ASSUMED 20 kg of steel per bay face: back panel ~0.9 x 1.8 m x 0.8 mm (~10 kg) + share of uprights, base plinth and brackets (~10 kg). Lane Industries bay weights would replace both steel lines.	Fitout	NABERS NEF v1.0 default
Shelving: clearcoat birch plywood kick fronts, top capping, portal features			15.50	0.28	142.01	968.00	270.07		0.33	46.48	46.57	4.13	367.25	Assumed	Lane quote: birch ply to 19 ends and 4 portal ends (250 deep, 1800 high). ASSUMED ~15.5 m2 of 18mm ply. NABERS plywood 968 kgCO2e/m3, 509 kg/m3; storage not netted.	Fitout	NABERS NEF v1.0 default
Checkouts x2 and hardware help desk counter: melamine particleboard carcasses			48.40	0.87	619.42	880.00	766.66		0.33	202.75	132.20	11.72	1,113.32	Assumed	Tuan, Oct 2026: particleboard is used in the checkout counters and the help desk counter next to the office. Lane quote: 2 mirrored Abacus checkouts 2,880 x 1,125 x 900 (FN.S); hardware POS/help desk F.HW custom (size not given). ASSUMED ~16.7 m2 of 18mm board per checkout (top, base, ends, front, back, partitions) and ~15 m2 for the help desk. NABERS particleboard 880 kgCO2e/m3, 711 kg/m3.	Fitout	NABERS NEF v1.0 default
Checkout and help desk tops: hex ply phenolic resin			8.48	0.15	77.69	968.00	147.76		0.33	25.43	25.48	2.26	200.92	Assumed	Lane quote: Hex ply phenolic resin tops. ASSUMED 2 x 3.24 m2 (checkouts) + ~2 m2 (help desk), 18mm. NABERS plywood 968 kgCO2e/m3.	Fitout	NABERS NEF v1.0 default
Office desks: melamine particleboard	2		8.00	0.14	102.38	880.00	126.72		0.33	33.51	21.85	1.94	184.02	Assumed	Tuan, Oct 2026: office desks are particleboard. Number and sizes not documented: ASSUMED 2 desks x ~4 m2 of 18mm board (top, modesty panel, ends). NABERS particleboard 880 kgCO2e/m3.	Fitout	NABERS NEF v1.0 default
Staff room kitchen cabinetwork: melamine particleboard (A6.20)			15.00	0.27	191.97	880.00	237.60		0.33	62.84	40.97	3.63	345.04	Estimated	Tuan, Oct 2026: staff room cabinetwork is particleboard. A6.20: 2,100 run; base cabinets ~1,575 x 870 x 600 with drawers and sink cupboard, overheads 2,100 x 600 x ~330, laminate benchtop 2,100 x 600. Carcasses, doors, drawers ~12.5 m2 + benchtop at double thickness ~2.5 m2 = ~15 m2 of 18mm board.	Fitout	NABERS NEF v1.0 default
NOT COUNTED																	
Pallet racking (BOH and hardware), galvanised steel														Excluded	Lane quote: 4 runs (2,743 and 3,810 mm bays, 2,438 uprights). Mass not given.	Fitout-x	
Coolroom racking, aluminium and plastic (19 bays + corners)														Excluded	Lane quote: 5 starter + 14 add-on bays, 610 x 2000 high. Aluminium is carbon-intensive (30+ kgCO2e/kg): worth getting the weight if fitout is reported.	Fitout-x	
Refrigerated display cases and condensing units (AJ Baker / Bonnet Neve)														Excluded	Equipment, outside A1-A5 building scope. Bonnet Neve quote QD22-0073E (29/04/2022): dairy Rock Eco L20 5 x 3.75 m (R134a), freezer Crystal L20 2 x 3.905 m (R404a); plug-in cases R290. Refrigerant charge and leakage are use stage (B1): relevant to operational carbon, not this baseline.	Fitout-x	
Tobacco unit, promo bins x17, produce bins x8, produce islands x2, flower displays x2														Excluded	Lane quote items, MDF / birch ply / melamine (site photos show birch ply bins and islands with metal edge trims, on castors); dimensions given but not taken off.	Fitout-x	
Gates, kerbs, landscaping														Excluded	Minor external works.	Fitout-x	
TOTAL kgCO2e (building, excl. external works and shelving)							**627,514.55**			**39,356.57**	**108,203.16**	**9,590.31**	**784,664.59**				
kgCO2e per m2 GFA							**504.03**			**31.61**	**86.91**	**7.70**	**630.25**				
GFA (m2), enclosed, from A2.00			1,245.00														
Total tCO2e													784.66				

Ref: Table 7 (page 33), 'Embodied Carbon & Embodied Energy in Australia's Buildings', GBCA and thinkstep-anz for DISER (2021). Linear interpolation between 2019 and 2050 values, kgCO2e/m2 shares.

							Construction year (input)	
		2019	Proportion to A1-3	2050	Proportion to A1-3	Slope (m)	2023	Proportion to A1-3
Non-residential	A1-A3	7.35	1	9.44	1	0.067419355	7.6196774194	100.00%
	A4	0.13	0.01768707482993	0.21	0.02224576271186	0.002580645	0.1403225806	1.84%
	A5a	1.47	0.2	0.26	0.02754237288136	-0.03903226	1.3138709677	17.24%
	A5w	0.11	0.01496598639456	0.16	0.01694915254237	0.001612903	0.1164516129	1.53%
	C2	0.03	0.00408163265306	0.05	0.00529661016949	0.000645161	0.0325806452	0.43%
	C3-C4	0.04	0.00544217687075	0.06	0.00635593220339	0.000645161	0.0425806452	0.56%

Bruce Rock construction 2022-23 (IFC Aug 2022, last architectural revision Aug 2023). 2023 used; change H3 to test.

A4 Default Transport Emission

Project location:	Bruce Rock	
Distance from Perth (km)	245	ASSUMED: approx. road distance Perth to Bruce Rock via Great Eastern Hwy; confirm
Concrete plant distance (km)	60	WCS Concrete Pty Ltd, Kellerberrin batch plant (supplier per Tuan, Oct 2026). ~60 km by road via the Granite Way (Wheatbelt Tourism trail length); confirm

	Distance 1 km	Emission 1 kgCO2e/tkm	Distance 2 km	Emission 2 kgCO2e/tkm	A4 EF kgCO2e/kg
Local supply 16t truck (concrete)	60	0.216			0.012960
Perth supply 16t truck	245	0.216			0.052920
Eastern States product (truck) + Perth leg	4000	0.0686			0.327320
Eastern States product (rail) + Perth leg	4000	0.024			0.148920
Overseas product (Shanghai) + Perth leg	190	0.0686	9000	0.0161	0.210854

Same transport assumptions and emission factors as the Narembeen case study (2024), with Bruce Rock distances.

Drawing take-off (for comparison only; the fabricator lists below are used). From Fulcrum Structural Engineering drawings 21214 S1.01-S5.04 Rev 0 (IFC 10/8/22). Lengths scaled from 1:100 plans and 1:50 elevations (drawings say do not scale: treat as estimate). Section masses are nominal catalogue values (hollow sections calculated from dimensions), approx. +/-5%.

Mark	Member	Section	kg/m	No.	Length each (m)	Total length (m)	Mass (kg)	Finish / type	Source and notes
TR10	Lower roof trusses: top and bottom chords + end verticals	250 PFC	35.5	5	39.2	196.0	6,958.0	Painted HR	S3.02 TR10 at grids 2-6, span A-B ~18.85 m; S4.01 750 deep
TR10	Lower roof trusses: diagonals	75x75x4 SHS	8.6	5	24.0	120.0	1,032.0	Painted HR	S4.01 ~22 diagonals x ~1.1 m
TR1/TR2	Grid B trusses: top and bottom chords	200x100x8 RHS	34.4	2	41.5	83.0	2,855.2	Painted HR	S4.02, two trusses 7-4 and 4-1, 2.21 m deep
TR1/TR2	Grid B trusses: vertical chords	89x89x5 SHS	12.7	2	17.7	35.4	449.1	Painted HR	S4.02 ~8 internal verticals each
TR1/TR2	Grid B trusses: diagonals	89x89x3.5 SHS	9.1	2	35.2	70.4	640.6	Painted HR	S4.02 ~11 diagonals each
TR1/TR2	Grid B trusses: end verticals and clerestory posts	200 PFC	22.9	2	8.7	17.3	396.6	Painted HR	S4.02
TR1/TR2	Clerestory top beam (laid flat)	200 PFC	22.9	2	20.8	41.5	950.4	Painted HR	S4.02
C1	Column at B/4	200x200x9 SHS	52.3	1	7.3	7.3	381.8	Painted HR	S3.01/S4.01; height scaled
C2	Columns at B/7 and B/1	200UC59	59.5	2	7.3	14.6	868.7	Painted HR	S3.01
C3	Perimeter / facade / yard columns	100x100x6 SHS	17.0	11	5.0	55.0	935.0	Galvanised HR	S3.01 11 no. (PF3 pads); average height 5.0 m
C4	Awning columns	89x89x4 SHS	10.4	9	3.5	31.5	327.6	Galvanised HR	S3.01 9 no. (PF4 pads); member schedule says 90x4 SHS
C5	Facade columns	100x100x8 SHS	21.8	2	5.8	11.6	252.9	Galvanised HR	S4.03 east elevation
C6	Yard column	100x100x5 SHS	14.4	1	3.5	3.5	50.4	Galvanised HR	S3.01 (PF5)
RB1	Yard roof beams	250UB31	31.4	3	8.2	24.6	772.4	Painted HR	S3.02
B2	Yard edge beam	150 PFC	17.7	1	9.2	9.2	162.8	Painted HR	S3.02
RB2	Upper roof rafters	310UB46	46.2	7	11.2	78.4	3,622.1	Painted HR	S3.03 at grids 1-7, B-C on slope
RB4	Canopy roof beams	150UB14	14.0	1	26.0	26.0	364.0	Galvanised HR	S3.02 east and south awnings
S1	Roof struts	139.7x5 CHS	16.6	13	6.9	89.7	1,489.0	Painted HR	S3.02/S3.03
RBR	Roof bracing	90x90x6 EA	8.2	1	293.0	293.0	2,408.5	Painted HR	S3.02/S3.03 X-bracing, ~37 diagonals
WP1	Wall plates to panels	150 PFC	17.7	1	93.0	93.0	1,646.1	Painted HR	S3.02/S3.03 grids A, C and 7
SA1	Shelf angle	100x100x10 EA	14.2	1	18.9	18.9	267.7	Painted HR	S3.02 grid 1
Facade frame	East and south facade frames: top and bottom chords	200 PFC	22.9	9	8.5	76.5	1,751.9	Galvanised HR	S4.03: 7 east + 2 south bays
Facade frame	Facade frames: end verticals	100 PFC	8.3	9	6.1	54.9	457.3	Galvanised HR	S4.03
Facade frame	Facade frames: diagonals and centre post	75 SHS / 75x5 EA	7.0	9	10.5	94.1	658.4	Galvanised HR	S4.03 (mix of 75x4 SHS, 75x3 SHS, 75x5 EA; average 7 kg/m)
FR1	Infill frames above roller doors	125 PFC	11.9	3	19.0	57.0	678.3	Galvanised HR	S4.05 3 no.; S5.03 ~3.95 x 2.4 m welded frame
FR1	Infill frame bracing	75x4 EA	4.5	3	9.2	27.6	124.2	Galvanised HR	S5.03
WBR	Wall rod bracing	16 dia rod	1.6	1	64.0	64.0	101.1	Galvanised HR	Allowance
P3	Lower roof purlins @1100	C25019	6.3	1	821.7	821.7	5,168.5	Cold-formed galv	S3.02, 18 rows x 41.5 m, +10% laps
P4	Purlins under mechanical plant @400	C25024	7.9	1	124.0	124.0	982.1	Cold-formed galv	S3.02 extra rows in plant zone
P1	Yard roof purlins	Z15012	2.7	1	74.0	74.0	201.3	Cold-formed galv	S3.02
P2	Upper roof purlins @1100/900	Z20015	4.2	1	547.8	547.8	2,322.7	Cold-formed galv	S3.03, 12 rows
P5	Canopy purlins @1000	C20024	6.7	1	162.0	162.0	1,078.9	Cold-formed galv	S3.02 east and south awnings
G1	Girts @1000 max	C10015	2.3	1	418.0	418.0	969.8	Cold-formed galv	Facade, south frame, roller door heads, clerestory, parapets; estimated
FT1	Fascia trusses (150 stud frame, welded)	150 stud	8.0	1	38.6	38.6	308.8	Cold-formed galv	S4.03; 8 kg per m of fascia assumed

Totals (kg)

Hot-rolled, painted	24,901
Hot-rolled, galvanised	5,701
Cold-formed, galvanised	11,032
Connections, base plates, cast-in plates, cleats, bolts: +5% of hot-rolled (as Narembeen)	1,530
TOTAL STEEL (kg)	**43,164**
kg steel per m2 GFA	34.7

Cross-check: QS PTE 6.01 structural steel trade $807,000 implies ~$/t The implied rate is high for 2022 regional WA, so the QS trade may include items not shown on the S-drawings, or the take-off is light. Fabricator shop tonnage would settle it.	$18,696

FABRICATOR SHOP DRAWING MATERIAL LISTS (USED IN THE CALCULATION)

AES project AES201109, PO 0023, 28-29 Nov 2022: Steel Material List ML-001 Rev B, Coldform Material List ML-002 Rev A, Bridging List ML-003 Rev A, Drawing List DL-001 Rev A. Gross weights, including plates, cleats and cast-in items.

ML-001 Steel material list: all hot-rolled sections, plates, flats, studs (total)	36,562
less CC150-2.3 cold-formed channels in ML-001 (fascia frames), moved to cold-formed	-947
Hot-rolled steel incl. plates and fixings	**35,615**
ML-002 Coldform material list: purlins, girts, tie rods	11,594
ML-003 Bridging list	744
CC150-2.3 cold-formed channels from ML-001	947
Cold-formed steel	**13,285**
TOTAL STEEL, fabricator lists (kg)	**48,900**
kg per m2 GFA	**39.3**
Drawing take-off above, for comparison (kg)	**43,164**
QS PTE 6.01 structural steel $807,000 per tonne of fabricated steel	**$16,503**

The drawing take-off was about 12% below the fabricator lists (mainly plates, cleats and flybraces). Fabricator lists used.