

Breakwater - South Australia (circa 1905)



The History Trust of South Australia

Port of Mackay (1938)



Cyclone damage to the harbour
breakwater at Mackay, 1938

Port of Mackay (2020)



Flickr (2020)

Port of Mackay after Cyclone Ului (2010)



ABC (2010)



28 August 2024

Upgrade, Reinstate, or Retreat? A Comparison of Breakwater Asset Management Strategies

Chris Leaman – National Maritime Team Lead
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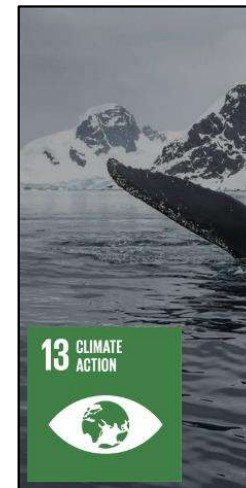
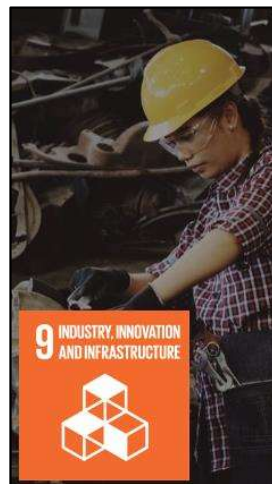


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- **High-level** assessment of maintenance strategies (what to do after damage)
- **Cast a wide net** to identify which strategies are feasible and worth further investigation
- Reporting to assist NQBP in developing a **business case** for alternative strategies



Port of Mackay - Overview



Port of Mackay – Breakwater parameters

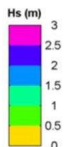
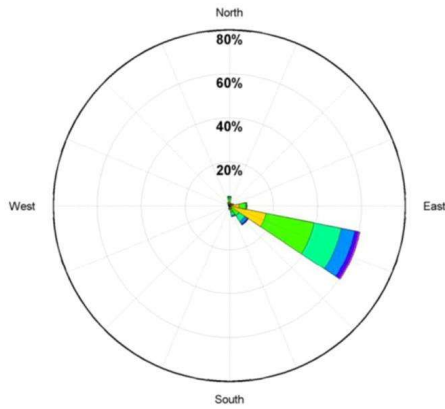


Structure	Length	Crest	M50	Slope
Northern Breakwater	900 m	9.6 to 10 mLAT	0.44 to 7.4 t	1:2
Southern Breakwater	1700 m	10.0 to 11.6 mLAT	1 t to 23 t	1:2 to 1:3
Middle Breakwater	700 m	9.7 mLAT	1.5 t	1:1.5 to 1:2
Western Revetment	1000 m	10.4 mLAT	0.4 to 2.6t	1:1.5 to 1:2

Port of Mackay – Representative cross-section



149°12'54"E 149°13'12"E 149°13'30"E 149°13'48"E 149°14'6"E 149°14'24"E



Metadata:
 Project: PD12
 Location: MackayWRB [149 54700, -21 03700]
 Data period: 13-Feb-2002 14:00:00 to 31-Jan-2018 23:30:00
 Data source: DES
 Data summary: All Records
 Number of Records: 227648

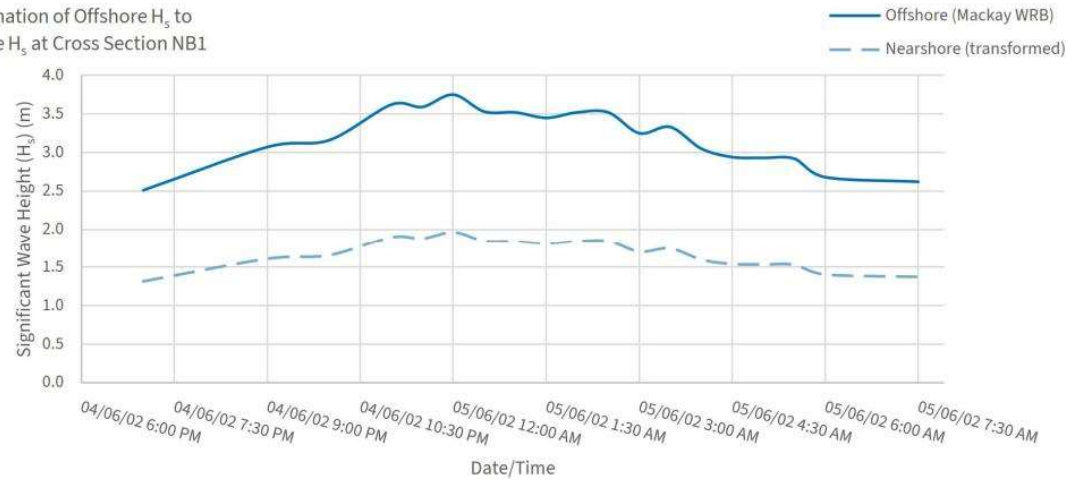


Synthetic Storms



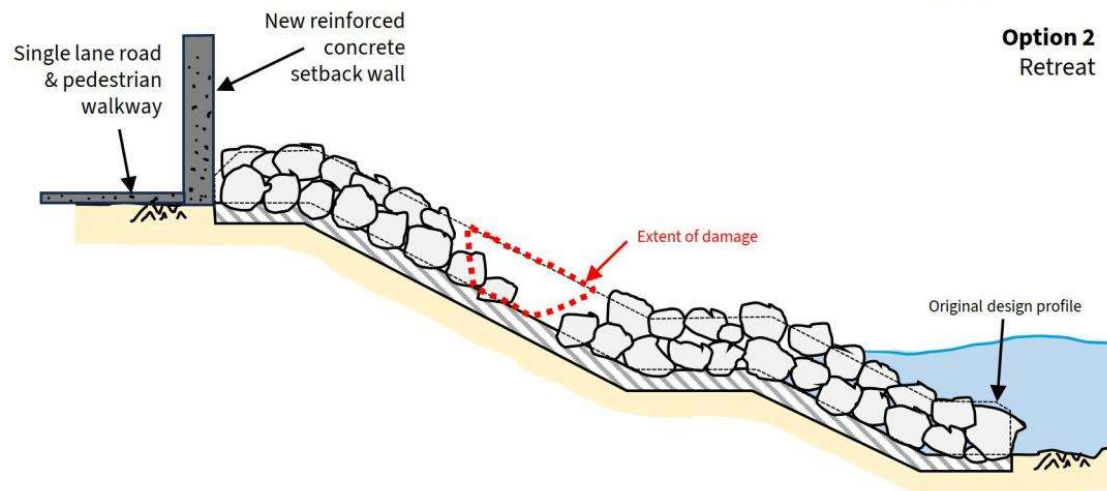
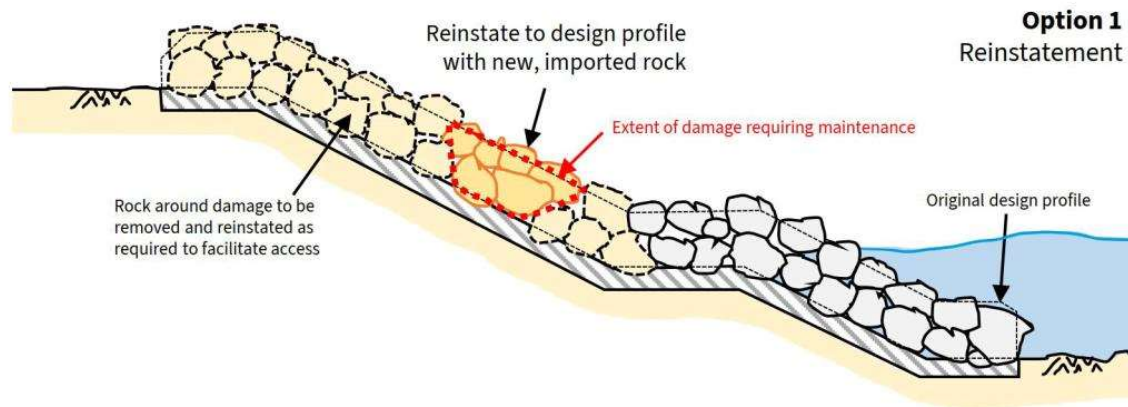
Storm ID	ARI	Date	Name
1	5	04/06/2002	
2	5	19/01/2002	
3	50	20/03/2010	TC Ului
4	10	30/01/2014	TC Dylan
5	20	28/03/2017	TC Debbie

Transformation of Offshore H_s to Nearshore H_s at Cross Section NB1

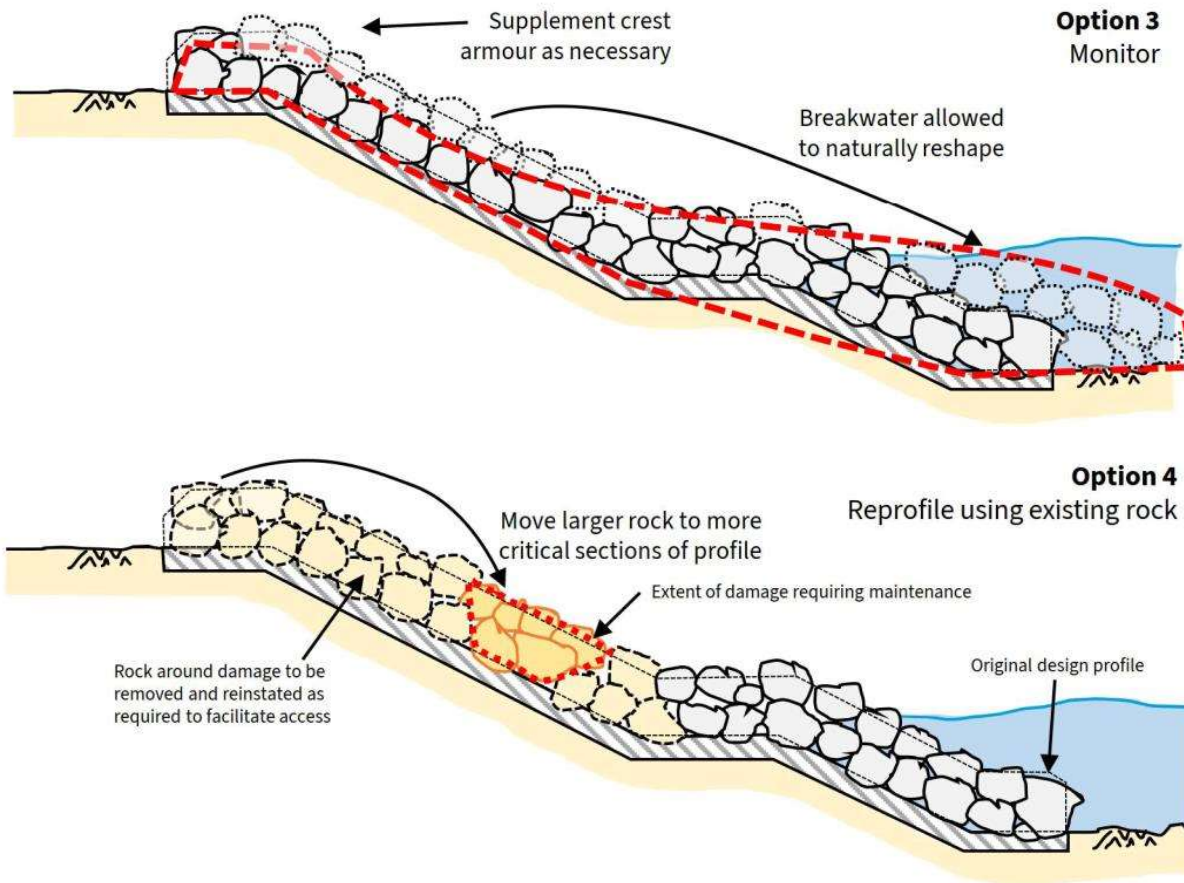


- **Option 1:** Reinstatement (base case)
- **Option 2:** Retreat
- **Option 3:** Monitor
- **Option 4:** Reprofile using existing rock
- **Option 5:** Partial progressive overlay upgrade
- **Option 6:** Full replacement of armour layer

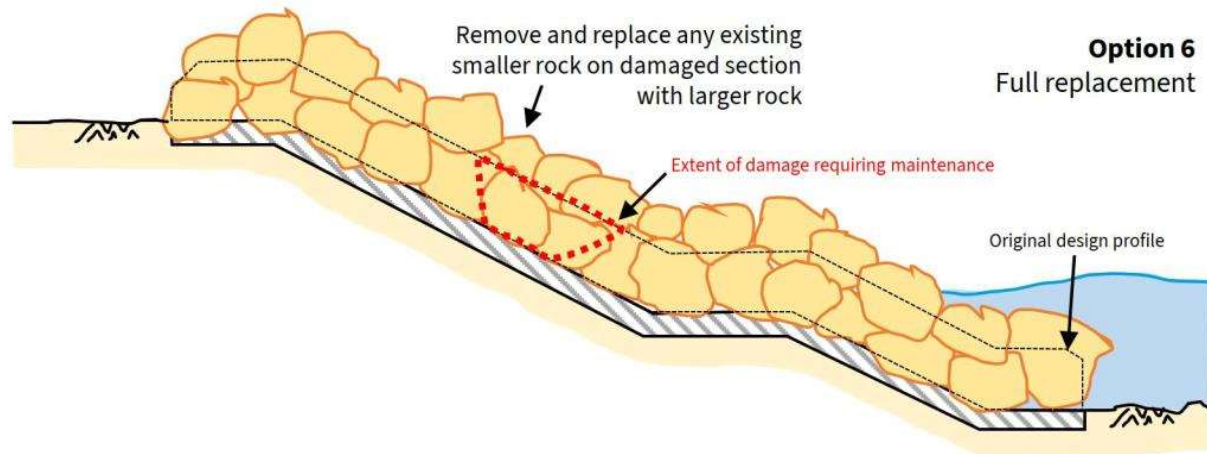
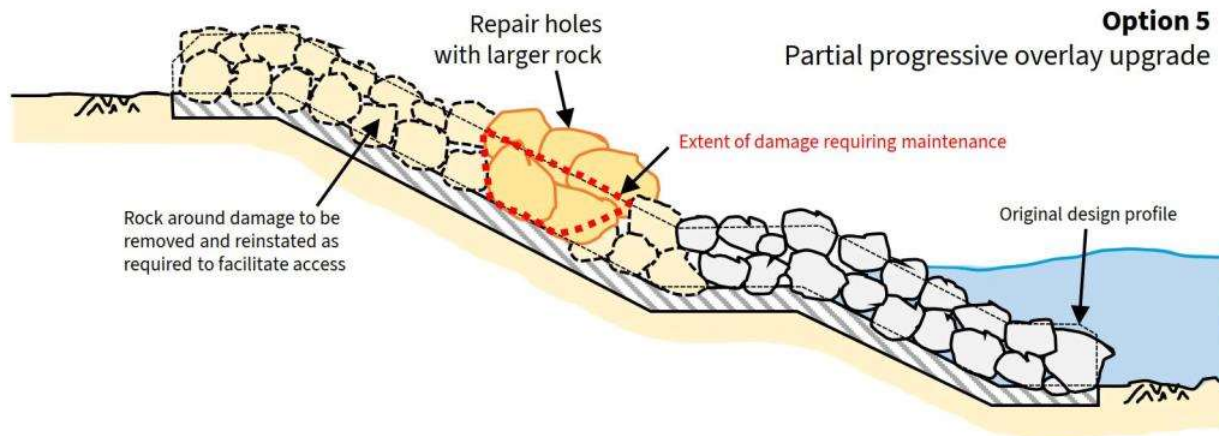
Maintenance Options – Reinstatement & Retreat



Maintenance Options – Monitor & Reprofile



Maintenance Options – Overlay & Replacement



Shortlisted Options



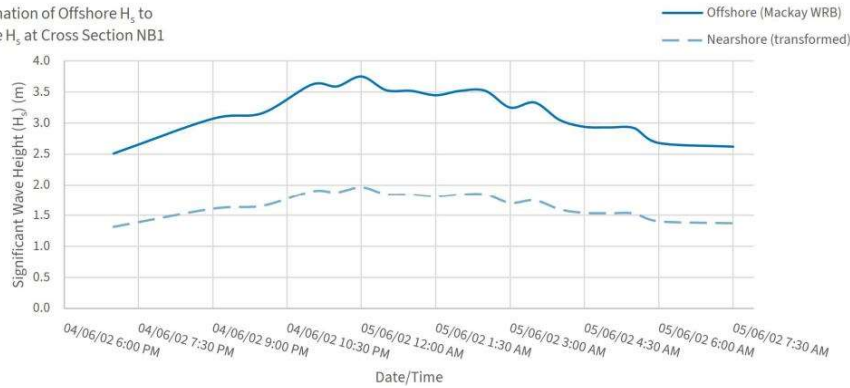
Section	Nominated options
Northern Breakwater (Profile 1 & 2)	<ul style="list-style-type: none">• Option 3 – Monitor• Option 6 – Full replacement
Northern Breakwater (Profile 3)	<ul style="list-style-type: none">• Option 6 – Full replacement
Southern Breakwater (Profile 1 & 2)	<ul style="list-style-type: none">• Option 3 – Monitor• Option 5 – Partial progressive upgrade• Option 6 – Full replacement
Southern Breakwater (Profile 3)	<ul style="list-style-type: none">• Option 6 – Full replacement
Western Revetment (Profile 1)	<ul style="list-style-type: none">• Option 5 – Partial progressive upgrade• Option 6 – Full replacement
Middle Breakwater (Profile 1)	<ul style="list-style-type: none">• Option 5 – Partial progressive upgrade• Option 6 – Full replacement

BREAKWAT Analysis



Storm ID	ARI	Date	Name
1	5	04/06/2002	
2	5	19/01/2002	
3	50	20/03/2010	TC Ului
4	10	30/01/2014	TC Dylan
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Transformation of Offshore H_s to Nearshore H_s at Cross Section NB1



Neural Network 001

Structure type	1. Rubble mound structure, 1.1 Conventional breakwater
Response factor	1. Hydraulic response, 1.3 Overtopping
Formula	Neural network
Output parameter	(q) Mean overtopping rate
INPUT	
(Hm0) Spectral significant wave height	TABLE
(Tm-1.0) Spectral wave period	4.000 (s)
(h) Water depth	5.00 (m)
(RC) Crest freeboard	1.00 (m)
(Ac) Armour crest freeboard of the structure	0.500 (m)

Neural Network 001 - (q) Mean overtopping rate

Hm0 (m)	q (l/s/m)
0.5000	0.01201
0.5909	0.03437
0.6818	0.09127
0.7727	0.2205

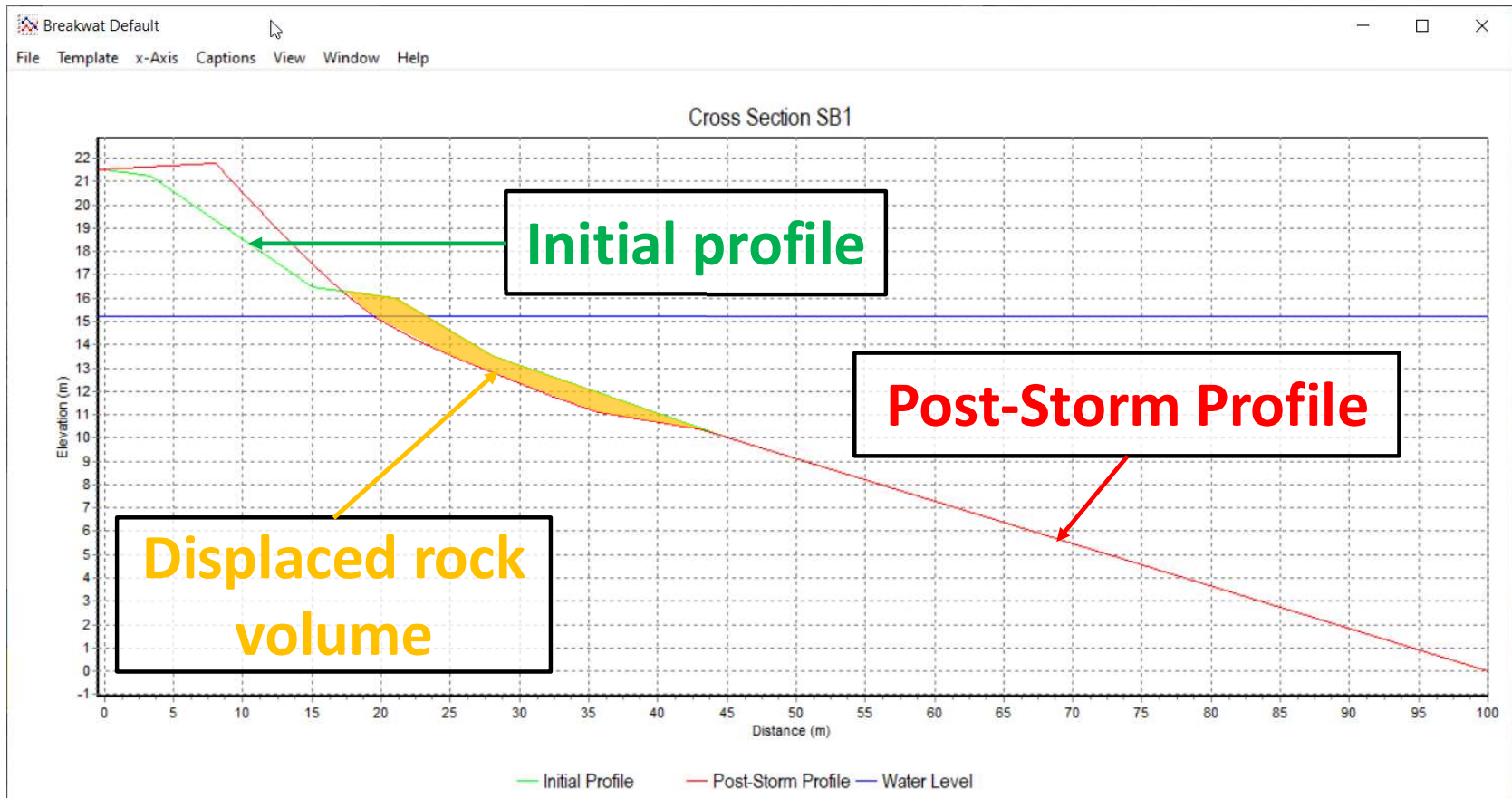
Neural Network 001 - (Hm0) Spectral significant wave height

Hm0 (m)	q (l/s/m)
1	0.5000
2	0.5909
3	0.6818

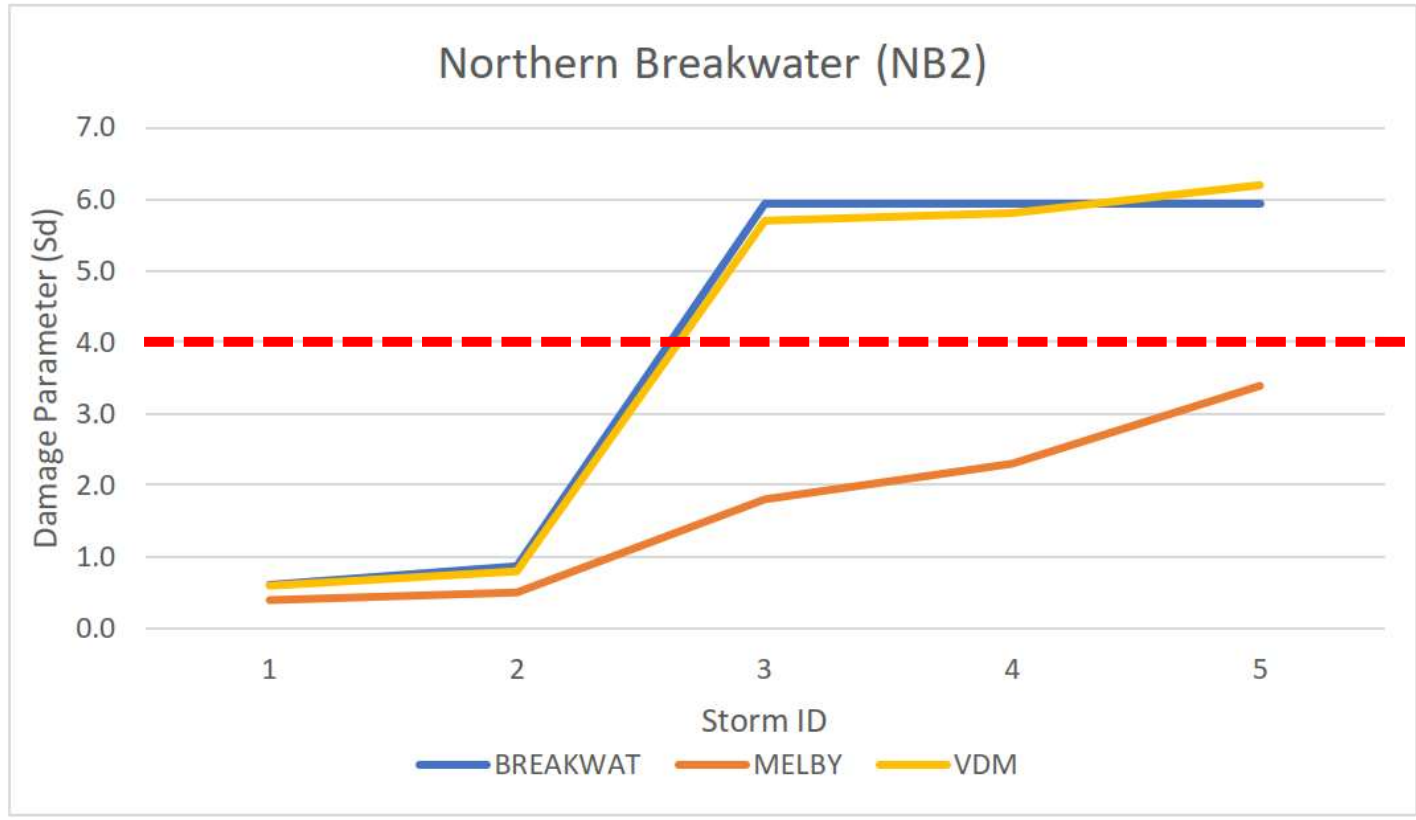
Other parameters shown in the interface:

- (hb) Water depth on the berm: 0 (m)
- (tan(αB)) Slope of the berm: 0 (-)
- (B) Width of the toe of the structure: 2.00 (m)
- (ht) depth of toe below swl: 4.50 (m)
- (γf) Roughness reduction factor (seaward): 0.700 (-)
- (γvw) Crown wall reduction factor: (-)
- (P) Excavation probability: (-)

BREAKWAT Results



Results – Damage parameter



Sd > 4 triggers repairs

Results – Tonnes of rock



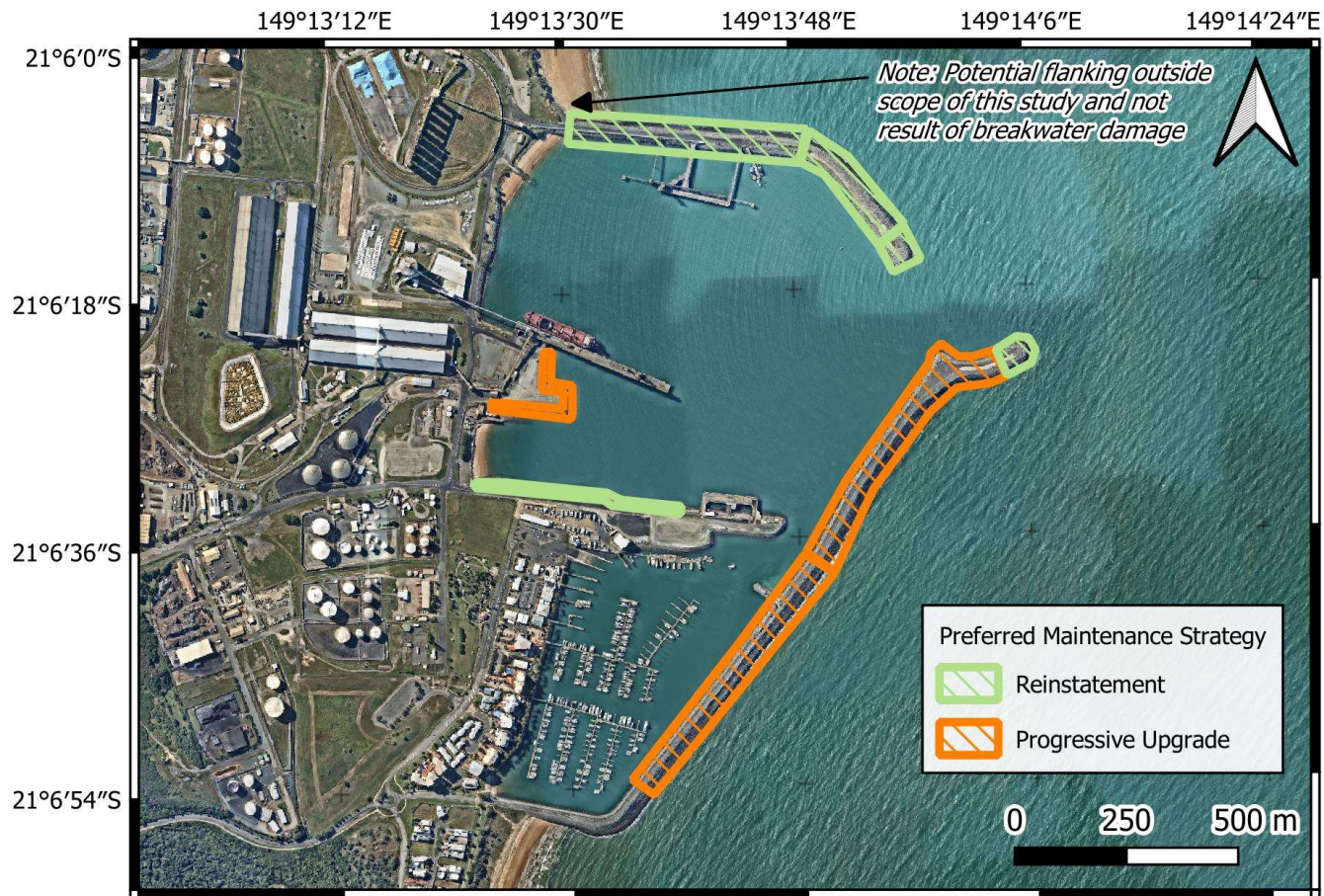
Structure	Section	Reinstate	Monitor	Partial upgrade	Full upgrade
Northern breakwater	1	2,300	Stable	-	44,000
	2	1,600	Stable	-	13,800
	3 (Roundhead)	1,500	-	-	0
Southern breakwater	1	49,200	Instable	8,300	53,950
	2	29,200	Instable	8,600	53,950
	3 (Roundhead)	0	-	-	0
Middle breakwater	1	0	-	0	0
Western revetment	2	2,400	-	1,500	30,300

Results – \$ per m


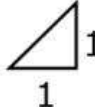




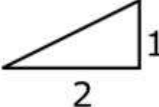

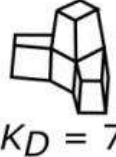



Structure	Section	Reinstate	Monitor	Partial upgrade	Full upgrade
Northern breakwater	1	\$294	-	-	\$6,778
	2	\$493	-	-	\$4,251
	3 (Roundhead)	\$462	-	-	-
Southern breakwater	1	\$4,797	-	\$1,251	\$5,114
	2	\$2,658	-	\$1,063	\$5,114
	3 (Roundhead)	\$0	-	-	\$0
Middle breakwater	1	\$0	-	-	-
Western revetment	2	\$482	-	\$370	\$7,468

Recommendations



Cox, R.J., Howe, D., Modra, B., 2019. Upgrading Breakwaters in Response to Sea Level Rise: Practical Insights from Physical Modelling:

	H wave height	θ seaward slope	M armour mass	K_D stability coefficient	ρ, Δ armour density
Less stable					
More stable					

Questions?



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PIANC 2024, Sydney Australia
28 August 2024

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