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Economics Analysis of Short-listed Pathways

CAP Meeting 10th April 2024

Agenda

- Introduction – Purpose & Overview
- Overview of Methodology & Metrics
- Overview of Key Assumptions
- Results by Management Unit
- Sensitivity Testing

Purpose

- The purpose of this analysis is to allow a relative ranking of the economic benefits of the adaptation pathways to be undertaken.
- The results of the analysis are to be used by CAP, in conjunction with the MCDA scoring and community feedback, to confirm their recommended preferred pathways for each Management Unit. There are no decisions expected today from CAP, these decisions will appear in their Recommendation Report.

Overview

- Applies the same principles of economic Real Options Analysis (ROA) as were applied in the Hawkes Bay Coastal Adaptation Economic Assessment (Infometrics, 2017).
- Develops the financial metrics identified in the Decision-Making Framework report (Jacobs, 2022), being "Cost + Loss" and "Value for Money" metrics as were used in the Hawkes Bay economic analysis, plus additional economic metrics of "Pathway Costs", "Damages Avoided" and "Benefit Cost Ratio".
- The calculation of the above economic metrics is based on the value of the built environment only (private properties and buildings, and selected Council infrastructure). It does not attempt to monetize or assess other values such as ecological, cultural, landscape or social values.
- The analysis makes no distinction of where the costs or losses from any of the adaptation pathways lie between private landowners or Council.
- Land-use planning measures are not included in the analysis, as actions to reduce risk are viewed as applying to all options

Methodology

Inputs:

- Top three pathways for each management unit (from MCDA scoring)
- Further definition and mapping of adaptation pathway options/actions
- Calculation of costs and losses for a baseline pathway (e.g. no additional interventions from current practice)
- Costing of options at each timeframe (implementation costs and ongoing maintenance/operational costs)
- Calculation of residual losses for each pathway (property and selected Council infrastructure only)

Economic Analysis

Outputs:

A series of economic metrics for each pathway:

- Pathway Cost
- Cost + Loss
- Value for Money
- Damage Avoided
- Cost Benefit ratio
- Number of properties still exposed in 2130

This presentation presents the draft results and outputs of this assessment, and a full report will be available soon.

A memorandum documenting the methodology, limitations and assumptions has been prepared and is available for the CAP.

Economic Metrics:

Pathway Total Cost ($)

- Is the total cost estimate covering both the implementation (e.g. design, consenting, construction) and operational/maintenance of all physical coastal hazard adaptation actions over the full 100-year time frame (discounted over time) for each pathway. For the baseline pathway, this is the cost of continuing the current level of expenditure over the next 100 years. Costs provided are high level and indicative. For physical interventions, they are based on a unit rate, not a specific design for the area.

Cost + Loss ($)

- Is the addition of the above costs with the monetary value of the losses
- 'Loss' is the residual loss calculation reflecting there may still be coastal erosion or inundation damages even with the implementation of the adaptation actions due to uncertainty in the climate science, the probability of larger than design storm events, and the pathways not necessarily being designed to completely protect all properties and infrastructure.

For interpreting the results, a lower 'Cost + Loss' value represents a more desirable adaptation pathway.

Value for Money (ratio of $"cost + Loss" to MCDA score)

- This metric compares the total "cost + loss" estimate for each pathway sequence against the total MCDA score for each pathway to provide the total cost of each MCDA point, hence a measurement of the "value for money" of the total pathway.

For interpreting the results, a lower 'Value for money' value represents a more desirable pathway.

Economic Metrics Continued:

Damages Avoided ($)

- This metric looks at the difference between the losses from a "baseline" which has no additional future adaptation actions or additional effort than the current management practices over the full 100-year time frame, and the adaptation pathway.

*For interpreting the results, **a higher 'damages avoided' represents a more desirable pathway.***

Number of Properties Still Exposed in 2130

- A non-economic metric as a way of displaying the effectiveness of the adaptation pathway to reduce the hazard risk, and provide context to the residual losses and the "Damages Avoided" metric. This metric is only in relation to property, not infrastructure or other values (social, ecological, cultural, landscape).

Cost Benefit Ratio (Total Damages avoided/ cost of invention)

- This metric is a traditional cost benefit analysis (CBA) metric that provides a ratio between the total discounted benefits and addition costs of the pathway actions above the cost of carrying on current practice.

*For interpreting the results, **a 'Cost Benefit Ratio' greater than 1 is a desirable pathway from an economic perspective,** as the benefits to the built environment outweigh the costs of implementing/maintaining the pathway.*

Other Key Assumptions

- The analysis is undertaken over 100 years from the implementation of the initial adaptation actions, which is set to 2030. The dollar values baseline is set to 2024.
- The Cost of status quo actions are as per estimates on past costs and rates outlined in the KCDC Long Term Plan 2021-2041 (LTP). Since the adaptation implementation starts in 2030 for the economic analysis, the costs associated with the proposed upgrade of the Raumati and Paekākāriki seawalls are not included in the short-term status quo costs as are expected to be implemented before 2030.
- Costs are indicative and high-level. They are based on a unit cost of that option, not a specific design to that area.
- Annual maintenance costs are associated with all physical adaptation actions. Where maintenance costs were not available from KCDC, 5-10% of implementation costs were used.
- Beach renourishment maintenance cost includes a 5 yearly top up to maintain design sand volumes over total epoch time period.

Other Key Assumptions

- The costs of implementing managed retreat actions are calculated from a 2.5x multiplier to the average private property values based on the retreat costing approach employed for the Hawkes Bay Coastal Strategy (Tonkin & Taylor, 2022). No identification on approaches for retreat have been undertaken as part of this assessment.
- The cost of set-back seawalls is based on the cost of more conventional vertical seawalls with additional cost of retreating the properties required to set-back the walls.
- Erosion losses include whole property value if any part of property is exposed, and all Council infrastructure above and below ground that is exposed.
- For flooding losses – the calculation of the Average Annual Damage to building is based on a simplified fragility curve from NIWA Riskscape platform, and only above ground infrastructure is included
- For Erosion losses – effectiveness of non-seawall actions to reduce erosion decreases with time due to shoreline responses to SLR and increased storm frequency.
  Enhanced Dune management assumed to reduce from 50% effectiveness in short term epoch to 10% in long-term epoch.
  Beach Renourishment and Dune Reconstruction reduce from 70% to 30% .

Economic Sensitivities - Discount Rate:

Sensitivity values:

- Core discount rate of 5% is applied on all future costs and losses to obtain present value figures. This is consistent with NZ government guidelines.
- Discount rates of 3% and 7% as lower and upper bounds are applied for sensitivity testing of the results to the discount rate.

Findings:

- The impact studies is on the 'Cost + Loss' and VFM rankings of the pathways
- A lower discount rate leads to a higher present value for costs + losses
- Since the MCDA scores stay the same, the higher the rate costs and losses are discounted at, the lower the VFM (Cost + Loss /MCDA score), making the results more desirable
- The relativity between the metrics scores for pathways within each Management Unit did not change, so a change in the discount rate does not cause any changes to the economic rankings of the pathways.

Economic Sensitivities – SLR Scenario SSP2-4.5

Method:

- Sensitivity testing was undertaken for the SSP2-4.5 scenario on a selected number of pathways to give an indication of differences in Cost + Loss, VFM and Damages Avoided metrics.
- Hazards were remapped for the lower SLR scenario. For the erosion hazard, this involved remapping projected future erosion informed by the assumed effectiveness of the options, and recalculating the residual impacts on infrastructure to inform losses.
- Costs were recalculated based on what was required within a pathway to mitigate the hazard in the lower SLR required (e.g. lower sediment supply volume for renourishment; reduced stopbank lengths).
- Sensitivity testing was undertaken for:
  - Unit 1B Pathway 3 (Enhance, Accommodate, Retreat)
  - Unit 9B Pathway 2 (Status Quo & Enhance, Enhance, Accommodate)
  - Unit 5A Pathway 1 (Enhance, Dune Reconstruction, Renourishment)
  - Unit 11A Pathway 1 (Status Quo & Enhance, Seawall, Re-establish the line with a protection structures)

Northern Adaptation Area

Economic Analysis of Pathways

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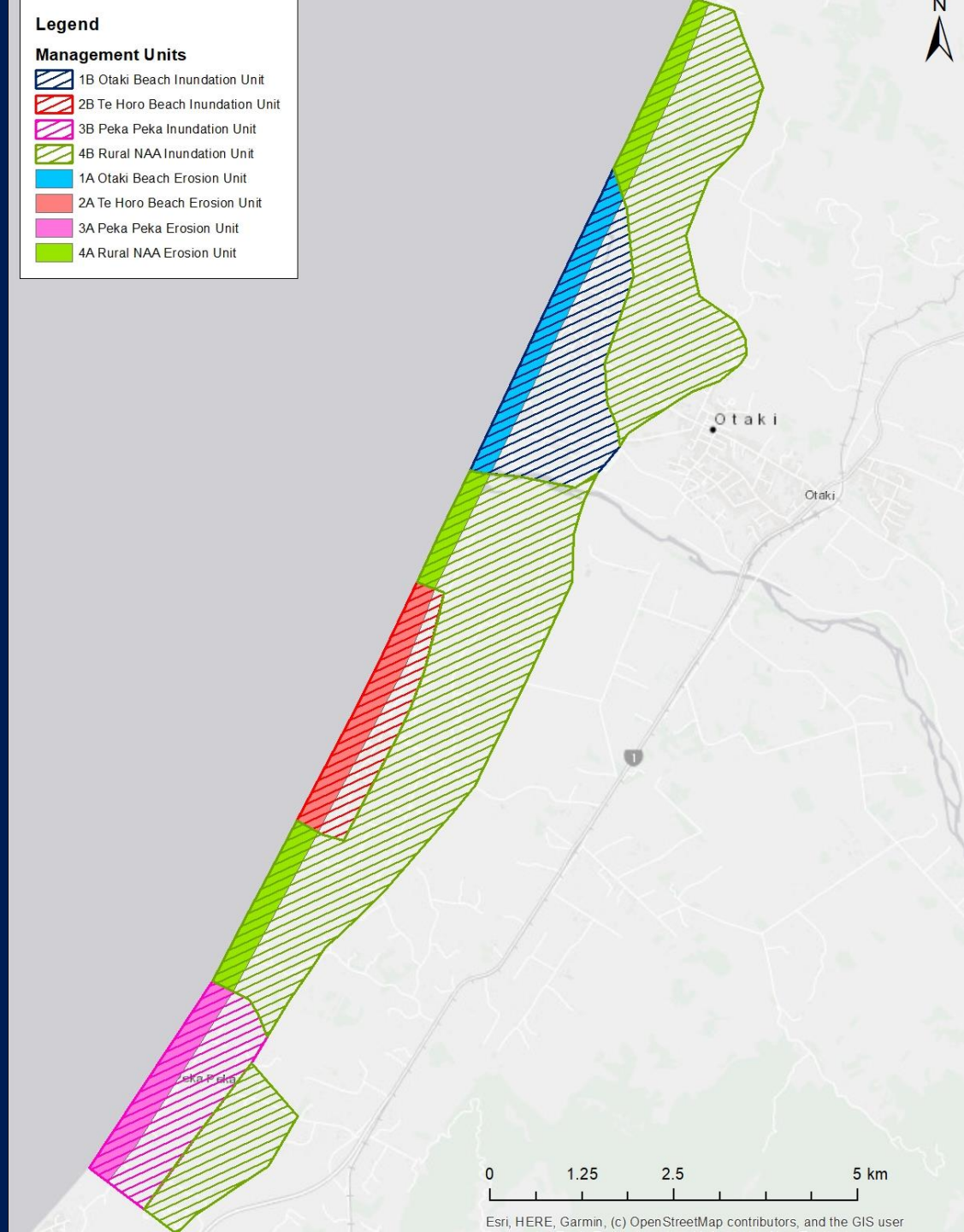

Management Unit 1A – Otaki Beach Erosion

Management Unit: 1A - Otaki Beach Erosion														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of properties still exposed 2130
PW-0	Baseline							10.0	22.4						31
PW-5	Enhance	→	Enhance	→	Retreat	87	1	16.7	17.2	1	198	1	11.8	1	0
PW-4	Enhance	→	Renourishment	→	Retreat	74	2	17.5	18.1	2	245	2	11.8	1	0
PW-1	Enhance	→	Enhance	→	Renourishment	69	3	20.0	20.6	3	298	3	11.8	1	1

[1]Multi Criteria Decision Making Analysis score determined by the CAP
[2]Cost + Loss is equal to the cost estimate (operational and capital costs) for the full 100 year pathway + residual losses due to events that exceed a 1 in 100 year chance of occurrence.
[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Management Unit 1B – Otaki Inundation

Management Unit: 1B - Otaki Inundation														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of buildings still exposed 2130
PW-0	Baseline							6.9	46.1						547
PW-3	Enhance	→	Accommodate	→	Retreat	83	1	741.0	757.4	2	9125	2	22.8	3	21
PW-2	Enhance	→	Additional Hard Protection	→	Retreat	62	2=	761.4	777.7	3	12543	3	22.9	2	21
PW-1	Enhance	→	Accommodate	→	Additional Hard Protection	62	2=	75.0	91.1	1	1470	1	23.1	1	64

[1]Multi Criteria Decision Making Analysis score determined by the CAP
[2]Cost + Loss is equal to the cost estimate (operational and capital costs) for the full 100 year pathway + residual losses due to events that exceed a 1 in 100 year chance of occurrence.
[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Management Unit 2A – Te Horo Beach Erosion

Management Unit: 2A - Te Horo Beach Erosion														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of properties still exposed 2130
PW-0	Baseline							10.0	22.5						18
PW-5	Enhance	→	Enhance	→	Retreat	87	1	18.6	18.6	3	214	1	12.5	1	0
PW-4	Enhance	→	Renourishment	→	Retreat	74	2	16.7	16.7	1	226	2	12.5	1	0
PW-1	Enhance	→	Enhance	→	Renourishment	69	3	17.7	17.7	2	257	3	12.4	2	1

[1]Multi Criteria Decision Making Analysis score determined by the CAP
[2]Cost + Loss is equal to the cost estimate (operational and capital costs) for the full 100 year pathway + residual losses due to events that exceed a 1 in 100 year chance of occurrence.
[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Management Unit 2B – Te Horo Inundation

Management Unit: 2B Te Horo Beach Inundation														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of buildings still exposed 2130
PW-0	Baseline							6.9	9.2						43
PW-3	Enhance	→	Accommodate	→	Retreat	83	1	83.8	84.4	3	1017	2	1.69	3	4
PW-2	Enhance	→	Additional Hard Protection	→	Retreat	64	2	86.3	86.6	2	1353	3	2.0	1	4
PW-1	Enhance	→	Accommodate	→	Additional Hard Protection	64	2	20.4	21.0	1	328	1	1.73	2	8

[1]Multi Criteria Decision Making Analysis score determined by the CAP
[2]Cost + Loss is equal to the cost estimate (operational and capital costs) for the full 100 year pathway + residual losses due to events that exceed a 1 in 100 year chance of occurrence.
[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Management Unit 3A – Peka Peka Erosion

Management Unit: 3A – Peka Peka Erosion														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of properties still exposed 2130
PW-0	Baseline							10.0	13.1						34
PW-5	Enhance	→	Enhance	→	Retreat	87	1	73.6	73.6	3	846	2	3.0	1	0
PW-4	Enhance	→	Renourishment	→	Retreat	74	2	67.3	67.3	2	909	3	3.0	1	0
PW-1	Enhance	→	Enhance	→	Renourishment	69	3	19.2	20.1	1	291	1	2.2	3	15

[1]Multi Criteria Decision Making Analysis score determined by the CAP
[2]Cost + Loss is equal to the cost estimate (operational and capital costs) for the full 100 year pathway + residual losses due to events that exceed a 1 in 100 year chance of occurrence.
[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Management Unit 3B – Peka Peka Inundation

Management Unit: 3B – Peka Peka Inundation														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of buildings still exposed 2130
PW-0	Baseline							6.9	7.6						37
PW-3	Enhance	→	Accommodate	→	Retreat	85	1	90.4	90.5	3	1065	2	0.48	2	10
PW-2	Enhance	→	Additional Hard Protection	→	Retreat	66	2	84.7	84.9	2	1286	3	0.48	2	10
PW-1	Enhance	→	Accommodate	→	Additional Hard Protection	64	3	9.9	10.1	1	158	1	0.50	1	8

[1]Multi Criteria Decision Making Analysis score determined by the CAP
[2]Cost + Loss is equal to the cost estimate (operational and capital costs) for the full 100 year pathway + residual losses due to events that exceed a 1 in 100 year chance of occurrence.
[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Management Unit 4A – Northern Rural Erosion

Management Unit: 4A – Northern Rural Erosion														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of properties still exposed 2130
PW-0	Baseline							10.0	34.1						7
PW-1	Status Quo	→	Enhance	→	Enhance	72	1	20.0	24.2	1	336	1	19.8	1	2
PW-3	Status Quo	→	Enhance	→	Soft Engineering Protection	60	3	20.5	24.7	2	412	2	19.8	1	2
PW-2	Enhance	→	Enhance	→	Soft Engineering Protection	50	2	26.7	30.9	3	618	3	19.8	1	2

[1]Multi Criteria Decision Making Analysis score determined by the CAP
[2]Cost + Loss is equal to the cost estimate (operational and capital costs) for the full 100 year pathway + residual losses due to events that exceed a 1 in 100 year chance of occurrence.
[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Management Unit 4B – Northern Rural Inundation

Management Unit: 4B – Northern Rural Inundation														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of buildings still exposed 2130
PW-0	Baseline							6.9	7.5						14
PW-1	Status Quo	→	Enhance	→	Accommodate	69	1	8.7	9.2	1	131	1	0.2	2	3
PW-2	Accommodate	→	Accommodate	→	Retreat	64	2	40.0	40.2	2	628	2	0.3	1	3

[1]Multi Criteria Decision Making Analysis score determined by the CAP
[2]Cost + Loss is equal to the cost estimate (operational and capital costs) for the full 100 year pathway + residual losses due to events that exceed a 1 in 100 year chance of occurrence.
[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Central Adaptation Area

Economic Analysis of Pathways

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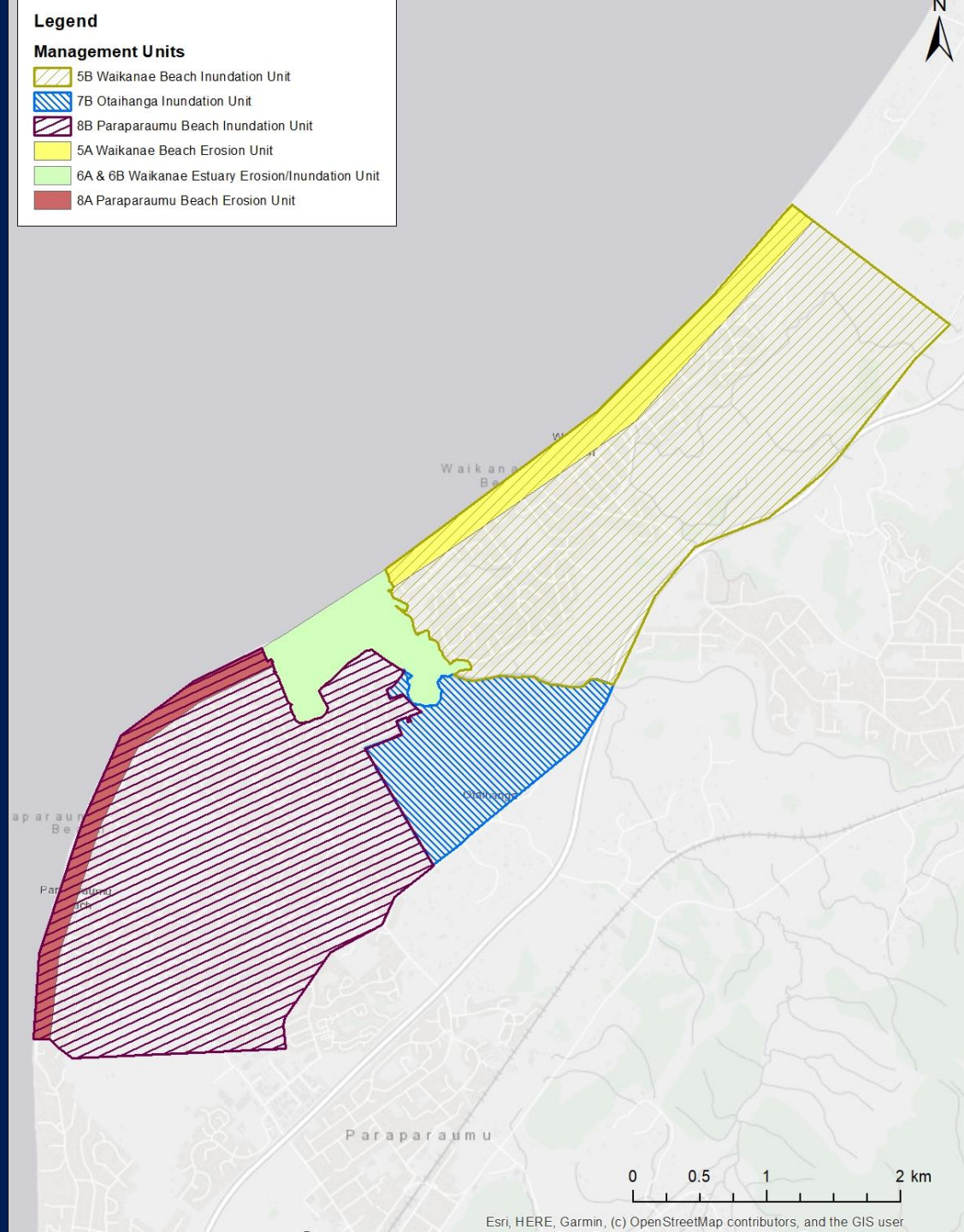

Management Unit 5A – Waikanae Beach Erosion

Management Unit: 5A – Waikanae Beach Erosion														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of properties still exposed 2130
PW-0	Baseline							10.0	40.3						27
PW-1	Enhance	→	Dune reconstruction	→	Renourishment	71	1	22.0	22.1	1	311	1	30.2	1	0
PW-6	Enhance & Dune Reconstruction	→	Retreat	→	Retreat	64	2	70.8	70.8	2	1106	2	30.2	1	0
PW-2	Enhance & Dune Reconstruction	→	Enhance & Renourishment	→	Seawall	60	3	71.2	71.2	3	1187	3	30.2	1	0

[1]Multi Criteria Decision Making Analysis score determined by the CAP
[2]Cost + Loss is equal to the cost estimate (operational and capital costs) for the full 100 year pathway + residual losses due to events that exceed a 1 in 100 year chance of occurrence.
[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Management Unit 5B – Waikanae Beach Inundation

Management Unit: 5B – Waikanae Beach Inundation														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of buildings still exposed 2130
PW-0	Baseline							6.9	17.5						524
PW-3	Enhance	→	Enhance	→	Accommodate	59	2	58.2	61.3	1	1040	1	7.5	1	68
PW-4	Enhance	→	Accommodate	→	Retreat	57	3	357.9	361.2	2	6336	2	7.3	3	68
PW-5	Enhance	→	Additional Hard Protection	→	Retreat	62	1	935.4	938.5	3	15137	3	7.5	1	68

[1]Multi Criteria Decision Making Analysis score determined by the CAP
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[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Management Unit 6AB – Waikanae Estuary

Management Unit: 6AB – Waikanae Estuary														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of properties still exposed 2130
PW-0	Baseline							10.0	10.0				NA	NA	0
PW-5	Enhance	→	Retreat	→	Retreat	86	1	11.6	11.6	1	134	1	NA	NA	0
PW-3	Enhance	→	Enhance	→	Bank Protection	78	2	14.4	14.4	3	184	2	NA	NA	0
PW-1	Status Quo	→	Enhance	→	Enhance	61	3	12.0	12.0	2	196	3	NA	NA	0

[1]Multi Criteria Decision Making Analysis score determined by the CAP
[2]Cost + Loss is equal to the cost estimate (operational and capital costs) for the full 100 year pathway + residual losses due to events that exceed a 1 in 100 year chance of occurrence.
[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Management Unit 7B – Otaihanga Inundation

Management Unit: 7B – Otaihanga Inundation														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of buildings still exposed 2130
PW-0	Baseline							6.9	14.6						83
PW-2	Enhance	→	Enhance	→	Accommodate	65	1	16.6	21.3	1	327	1	3.0	3	0
PW-4	Additional Hard Protection	→	Enhance	→	Retreat	56	2	181.6	182.5	3	3259	3	6.7	1	0
PW-5	Enhance	→	Additional Hard Protection	→	Additional Hard Protection	50	3	30.4	33.3	2	666	2	4.7	2	12

[1]Multi Criteria Decision Making Analysis score determined by the CAP
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[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Management Unit 8A – Paraparaumu Beach Erosion

Management Unit: 8A – Paraparaumu Beach Erosion														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of properties still exposed 2130
PW-0	Baseline							10.0	31.8						108
PW-1	Enhance	→	Dune Reconstruction	→	Renourishment	68	1	19.8	19.8	1	292	1	21.7	1	1
PW-6	Enhance & Dune Reconstruction	→	Retreat	→	Retreat	64	2	20.6	20.6	2	324	2	21.7	1	0
PW-2	Enhance & Dune Reconstruction	→	Enhance & Renourishment	→	Seawall	60	3	66.7	66.8	3	1113	3	21.7	1	1

[1]Multi Criteria Decision Making Analysis score determined by the CAP
[2]Cost + Loss is equal to the cost estimate (operational and capital costs) for the full 100 year pathway + residual losses due to events that exceed a 1 in 100 year chance of occurrence.
[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Management Unit 8B – Paraparaumu Inundation

Management Unit: 8B – Paraparaumu Inundation													
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of buildings still exposed 2130
PW-0	Baseline							6.9	15.7						484
PW-4	Enhance	→	Accommodate	→	Retreat	57	2	824.2	827.0	3	14509	2	6.0	1	84
PW-3	Enhance	→	Enhance	→	Accommodate	62	1	53.4	56.3	1	908	1	5.9	3	84
PW-5	Enhance	→	Additional Hard Protection	→	Retreat	56	3	824.0	826.7	2	14763	3	6.0	1	84

[1]Multi Criteria Decision Making Analysis score determined by the CAP
[2]Cost + Loss is equal to the cost estimate (operational and capital costs) for the full 100 year pathway + residual losses due to events that exceed a 1 in 100 year chance of occurrence.
[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Raumati Adaptation Area

Economic Analysis of Pathways

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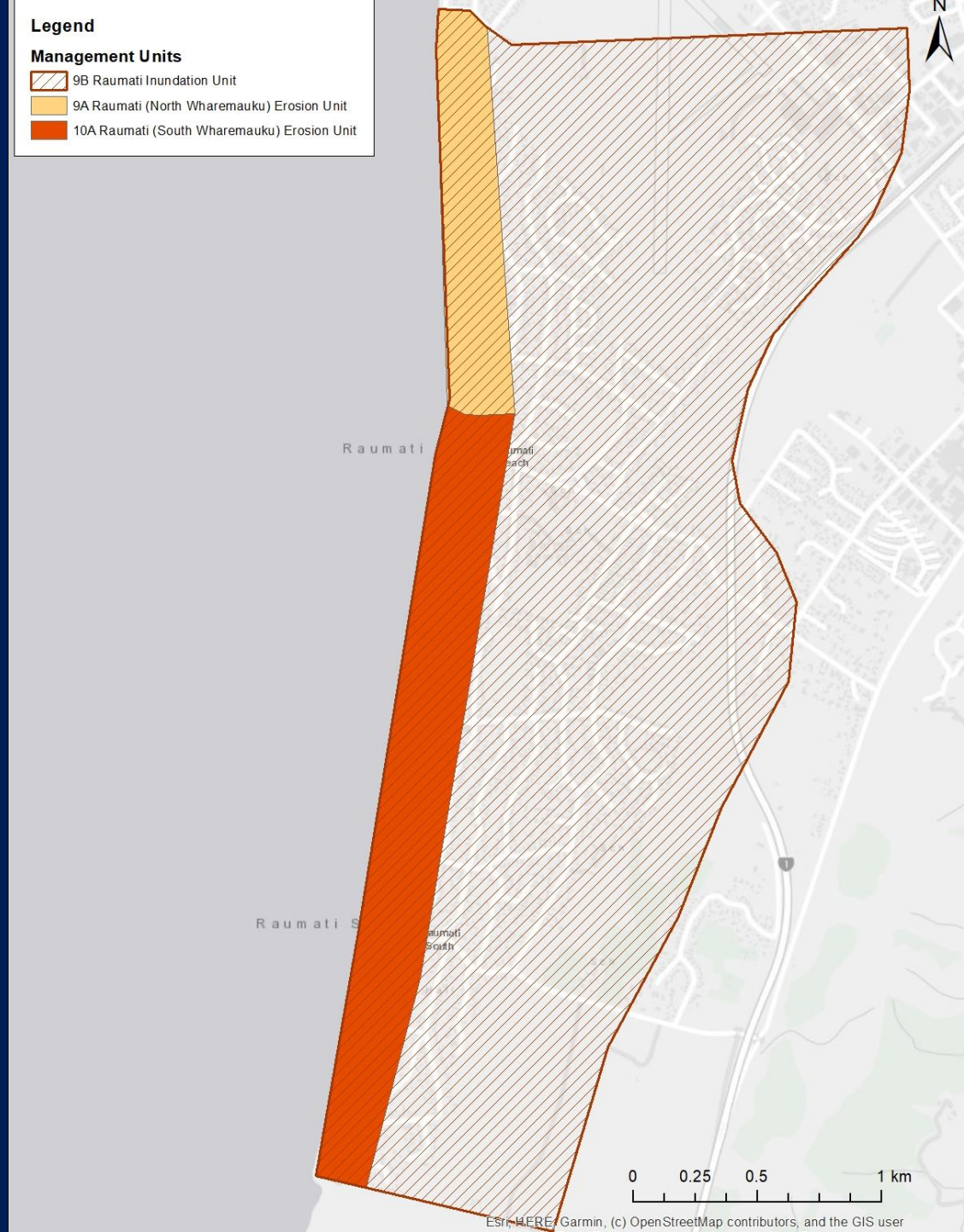

Management Unit 9A - Raumati (North of Wharemauku Stream) Erosion

Management Unit: 9A – Raumati (North of Wharemauku Stream) Erosion														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of properties still exposed 2130
PW-0	Baseline							18.0	188.7						204
PW-4	Enhance	→	Re-establish the line with a setback seawall and dune reconstruction	→	Renourishment	53	1	269.6	337.6	2	6371	2	102.7	2	4
PW-2	Enhance	→	Seawall	→	Re-establish the line with protection structure	52	2	272.4	339.5	3	6529	3	103.6	1	14
PW-6	Seawall	→	Re-establish the line with protection structure	→	Enhance Seawall	52	2	254.5	325.5	1	6260	1	99.7	3	14

[1]Multi Criteria Decision Making Analysis score determined by the CAP
[2]Cost + Loss is equal to the cost estimate (operational and capital costs) for the full 100 year pathway + residual losses due to events that exceed a 1 in 100 year chance of occurrence.
[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Management Unit 10A - Raumati (South of Wharemauku Stream) Erosion

Management Unit: 10A – Raumati (South of Wharemauku Stream) Erosion														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of properties still exposed 2130
PW-0	Baseline							8.4	377.4						548
PW-5	Status Quo & Enhance	→	Re-establish the line with a setback seawall and dune reconstruction	→	Renourishment	53	2	437.8	579.4	3	10933	2	227.4	2	7
PW-2	Status Quo & Enhance	→	Enhance seawall	→	Re-establish the line with a setback seawall and dune reconstruction	57	1	422.4	561.5	1	9850	1	229.9	1	7
PW-4	Status Quo & Enhance	→	Re-establish the line with a setback seawall	→	Enhance Seawall	52	3	431.8	574.4	2	11046	3	226.4	3	7

[1]Multi Criteria Decision Making Analysis score determined by the CAP
[2]Cost + Loss is equal to the cost estimate (operational and capital costs) for the full 100 year pathway + residual losses due to events that exceed a 1 in 100 year chance of occurrence.
[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Management Unit 9B – Raumati Inundation

Management Unit: 9B – Raumati Inundation														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of buildings still exposed 2130
PW-0	Baseline							6.9	8.0						106
PW-1	Status Quo & Enhance	→	Enhance	→	Additional Hard Protection	54	2	19.7	20.1	3	373	3	0.6	1=	34
PW-3	Status Quo & Enhance	→	Additional Hard Protection	→	Enhance	51	3	7.7	8.4	1	165	1	0.3	3	48
PW-2	Status Quo & Enhance	→	Enhance	→	Accommodate	55	1	16.2	16.6	2	302	2	0.6	1=	29

[1]Multi Criteria Decision Making Analysis score determined by the CAP
[2]Cost + Loss is equal to the cost estimate (operational and capital costs) for the full 100 year pathway + residual losses due to events that exceed a 1 in 100 year chance of occurrence.
[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Paekākāriki Adaptation Area

Economic Analysis of Pathways

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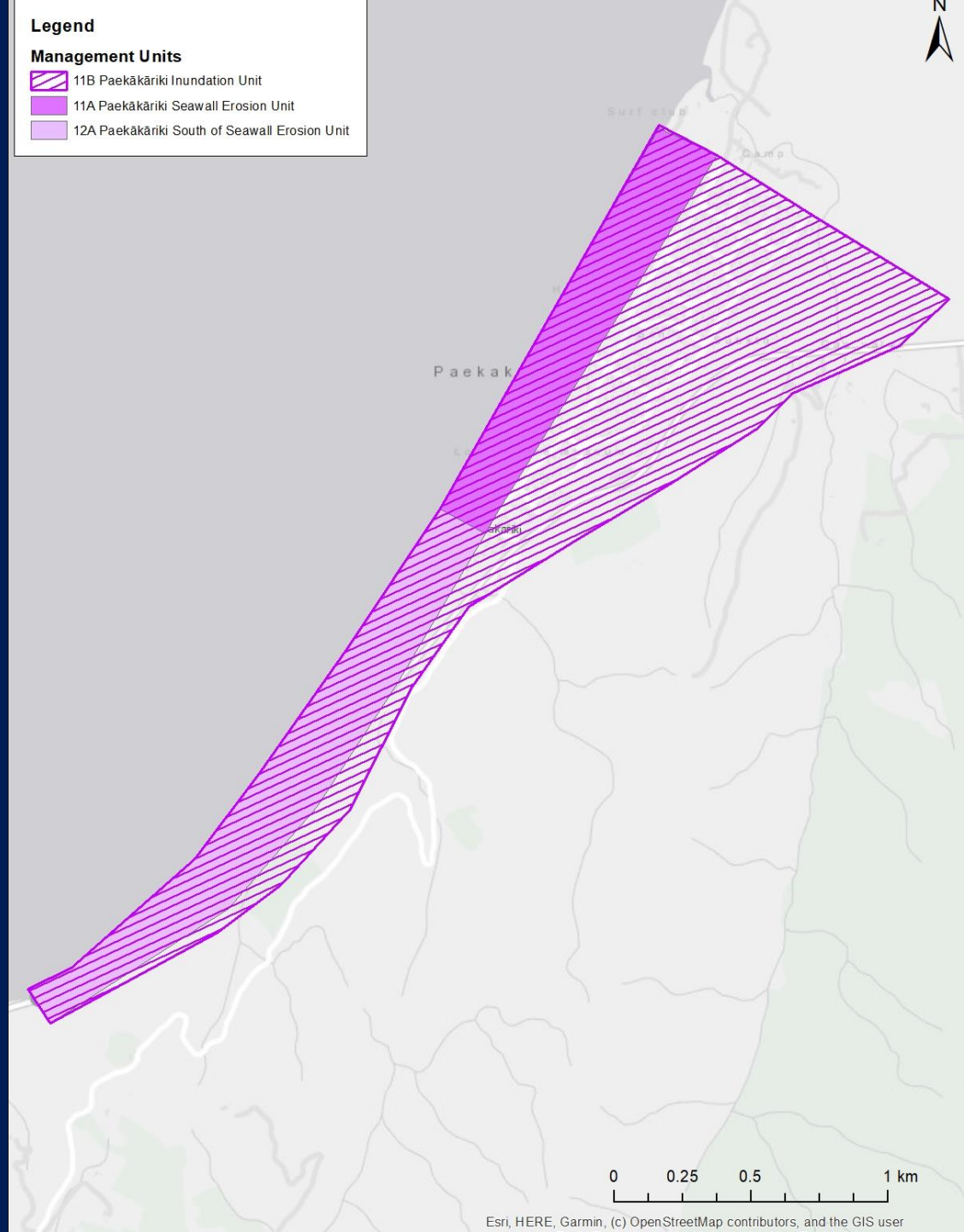

Management Unit 11A - Paekākāriki Seawall Erosion

Management Unit: 11A Paekākāriki Seawall Erosion														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of properties still exposed 2130
PW-0	Baseline							8.4	53.0						151
PW-1	Status Quo & Enhance	→	Seawall	→	Re-establish the line with protection structure	63	1	200.1	206.4	1	3276	1	38.3	2	30
PW-4	Status Quo & Enhance	→	Re-establish the line with protection structure & Dune reconstruction	→	Beach renourishment	58	3	269.9	275.3	3	4746	3	39.2	1	1
PW-3	Status Quo & Enhance	→	Re-establish the line with protection structure	→	Enhance protection structure	63	1	194.3	208.1	2	3302	2	30.9	3	30

[1]Multi Criteria Decision Making Analysis score determined by the CAP
[2]Cost + Loss is equal to the cost estimate (operational and capital costs) for the full 100 year pathway + residual losses due to events that exceed a 1 in 100 year chance of occurrence.
[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Management Unit 12A - Paekākāriki (South of seawall) Erosion

Management Unit: 12A – Paekākāriki (South of seawall) Erosion														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4] ($m)	Damages avoided ranking	Number of properties still exposed 2130
PW-0	Baseline							8.4	97.1						59
PW-4	Enhance Package	→	Re-establish the line with protection structure & dune reconstruction	→	Beach renourishment	61	2	133.9	167.9	1	2753	2	54.1	3	1
PW-3	Enhance Package	→	Re-establish the line with protection structure	→	Enhance Seawall	63	1	135.1	168.9	2	2681	1	54.3	2	0
PW-2	Enhance Package	→	Seawall	→	Re-establish the line with protection structure	54	3	143.7	177.5	3	3286	3	54.4	1	0

[1]Multi Criteria Decision Making Analysis score determined by the CAP
[2]Cost + Loss is equal to the cost estimate (operational and capital costs) for the full 100 year pathway + residual losses due to events that exceed a 1 in 100 year chance of occurrence.
[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Management Unit 11B - Paekākāriki Inundation

Management Unit: 11B – Paekākāriki Inundation														
Pathway	Short term	→	Medium term	→	Long term	MCDA[1] Score	MCDA Ranking	Pathway total PV cost ($m)	Cost + Loss[2] ($m)	Cost + Loss Ranking	VFM[3] ($ '000/point)	VFM Ranking	Damages avoided[4]	Damages avoided ranking	Number of buildings still exposed 2130
PW-0	Baseline							6.9	7.0						5
PW-2	Status Quo & Enhance	→	Enhance Package	→	Accommodate Package	59	1	7.9	7.9	1	134	1	21,458	1	2
PW-1	Status Quo & Enhance	→	Enhance Package	→	Additional Hard Protection	51	2	10.3	10.3	2	202	2	10,425	3	4
PW-3	Status Quo & Enhance	→	Additional Hard Protection	→	Enhance New Inundation Protection	46	3	10.3	10.4	3	225	3	14,267	2	3

[1]Multi Criteria Decision Making Analysis score determined by the CAP
[2]Cost + Loss is equal to the cost estimate (operational and capital costs) for the full 100 year pathway + residual losses due to events that exceed a 1 in 100 year chance of occurrence.
[3]Value for Money – How much it costs to 'purchase' each MCDA point based on the MCDA score and total cost estimate (operational and capital) of each 100 year pathway
[4]Damages avoided - The difference between the losses from a baseline pathway of no additional future adaptation actions or effort from the current management practices over the full 100 year time frame and adaptation pathway.

Scenario Tests
- SLR Scenario (SSP2-4.5)

Economic Sensitivities – SLR Scenario SSP2-4.5

Findings:

- **For inundation pathways (1B PW3 and 9B PW2):**
  - The costs + loss metric is more favourable in the lower SLR scenario due to the smaller number of buildings requiring retreat, and hence the lower cost.
  - The damages avoided metric is higher in the SSP5-8.5 scenario; but only due to the more potential damages in a status quo pathway under the higher SLR scenario.
  - As a result of the lower costs associated with the long term accommodate options within these pathways for the SSP2-4.5 scenario; the VFM metric is more favourable with less SLR.
- **For erosion pathways (5A PW1 and 11A PW1):**
  - For the erosion pathway with enhancement/soft engineering options **(5A Pathway 1),** the economic metrics are within the same order of magnitude for both SLR scenarios.
  - For the erosion pathway with a hard engineering/retreat approach **(11A Pathway 1),** the cost + loss metric is lower for the SSP2-4.5 scenario. This is a result of the lower potential losses (e.g. property) in this scenario compared to the higher SLR scenario
  - The VFM metric is similar across both SLR scenarios because the cost to implement the option is assumed to be similar across both scenarios (e.g. still requires retreat of properties within setback to re-establish the line).
  - As expected, the damages avoided metric is higher for the SSP5-8.5 scenario, as the damages in the baseline scenario are higher.

Additional Metrics
- Benefit Cost Ratio (BCR)

Results Summary

Management Unit	PW	BCR	BCR Ranking
1A	PW-0		
	PW-5	2.16	1
	PW-4	1.86	2
	PW-1	1.34	3
1B	PW-0		
	PW-3	0.03	2
	PW-2	0.03	3
	PW-1	0.34	1
2A	PW-0		
	PW-5	1.45	3
	PW-4	1.87	1
	PW-1	1.62	2
2B	PW-0		
	PW-3	0.02	3
	PW-2	0.02	1
	PW-1	0.13	2
3A	PW-0		
	PW-5	0.05	3
	PW-4	0.05	3
	PW-1	0.24	1
3B	PW-0		
	PW-3	0.01	3
	PW-2	0.01	3
	PW-1	0.17	1
4A	PW-0		
	PW-1	1.99	1
	PW-3	1.89	2
	PW-2	1.19	3
4B	PW-0		
	PW-1	0.12	1
	PW-2	0.01	2

Results Summary

Management Unit	PW	BCR	BCR Ranking
5A	PW-0		
	PW-1	2.52	1
	PW-6	0.50	3
	PW-2	0.49	2
5B	PW-0		
	PW-3	0.15	1
	PW-4	0.02	2
	PW-5	0.01	3
6AB	PW-0		
	PW-5	NA	NA
	PW-3	NA	NA
	PW-1	NA	NA
7B	PW-0		
	PW-2	0.31	1
	PW-4	0.04	3
	PW-5	0.20	2
8A	PW-0		
	PW-1	2.22	1
	PW-6	2.06	2
	PW-2	0.38	3
8B	PW-0		
	PW-4	0.01	3
	PW-3	0.13	1
	PW-5	0.01	3

Results Summary

Management Unit	PW	BCR	BCR Ranking
9A	PW-0		
	PW-4	0.41	3
	PW-2	0.41	3
	PW-6	0.42	1
9B	PW-0		
	PW-1	0.04	3
	PW-3	0.40	1
	PW-2	0.07	2
10A	PW-0		
	PW-5	0.53	3
	PW-2	0.56	1
	PW-4	0.53	3

Results Summary

Management Unit	PW	BCR	BCR Ranking
11A	PW-0		
	PW-1	0.20	1
	PW-4	0.15	3
	PW-3	0.17	2
11B	PW-0		
	PW-2	0.02	1
	PW-1	0.00	3
	PW-3	0.00	3
12A	PW-0		
	PW-4	0.43	1
	PW-3	0.43	1
	PW-2	0.40	3

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