Australian Government
Great Barrier Reef Marine Park Authority

Options Analysis Report

Executive Summary

Douglas Shoal Remediation Project

Great Barrier Reef Marine Park Authority

6 February 2020

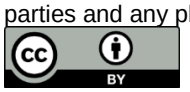
Level 25, 12 Creek Street
Brisbane. QLD. 4000

Advisian
Worley Group

advisian.com

Published by the Great Barrier Reef Marine Park Authority

ISBN 9780648721567



Disclaimer: This report was prepared by Advisian Pty Ltd for consideration by the Great Barrier Reef Marine Park Authority (the Authority) as part of the Douglas Shoal Environmental Remediation Project, and has been made available by the Authority on the understanding that users exercise their own skill and care with respect to its use. The contents do not represent Australian Government policy. Publication of this document does not indicate a commitment to a particular course of action. The Authority's requirements for the Remediation Works Procurement will be as stated in the approach to market documentation for that Procurement.

A catalogue record for this publication is available from the National Library of Australia

This publication should be cited as:

Advisian 2020, *Douglas Shoal remediation project: options analysis executive summary.* Prepared by Advisian Pty Ltd for the Great Barrier Reef Marine Park Authority, Townsville, Australia.

Comments and questions regarding this document are welcome and should be addressed to:

Great Barrier Reef Marine Park Authority
2–68 Flinders Street
PO Box 1379
Townsville QLD 4810, Australia

Phone: (07) 4750 0700
Fax: (07) 4772 6093
Email: info@gbrmpa.gov.au
www.gbrmpa.gov.au

1 Executive summary

Options analysis was undertaken to identify potentially feasible remediation options that are best aligned with the desired outcomes and objectives of the Douglas Shoal Remediation Project (the Project). This executive summary provides a synopsis of the options analysis process and its parameters. It describes identified remediation options and summarises results of their analysis, along with conclusions and considerations for Project progress. The options analysis process was undertaken in collaboration with the Great Barrier Reef Marine Park Authority (the Authority).

1.1 Background and context

The bulk carrier *Shen Neng 1* ran aground on Douglas Shoal in April 2010 and remained on the shoal for 10-days before being re-floated. During this grounding period, the vessel moved across the shoal resulting in damage to the shoal, plate damage to the vessel and paint loss (including antifouling paint (AFP)). Damage to the shoal included AFP contamination, creation of rubble, and flattening of the shoal, across approximately 42 hectares.

In late 2016, the Authority established the Project with funds from an out-of-court settlement for the grounding incident. The primary desired outcome of the Project is that remediation activities support natural recovery at Douglas Shoal. Subsidiary desired outcomes relate to the establishment of an effective Monitoring, Evaluation, Reporting and Improvement (MERI) framework; knowledge is recorded and shared to inform remediation efforts worldwide; and Traditional Owner values and opportunities are enhanced through the Project.

Advisian is providing planning and project management services to the Authority for the Project with a summary of the key stages of the services shown in Figure 1-1.

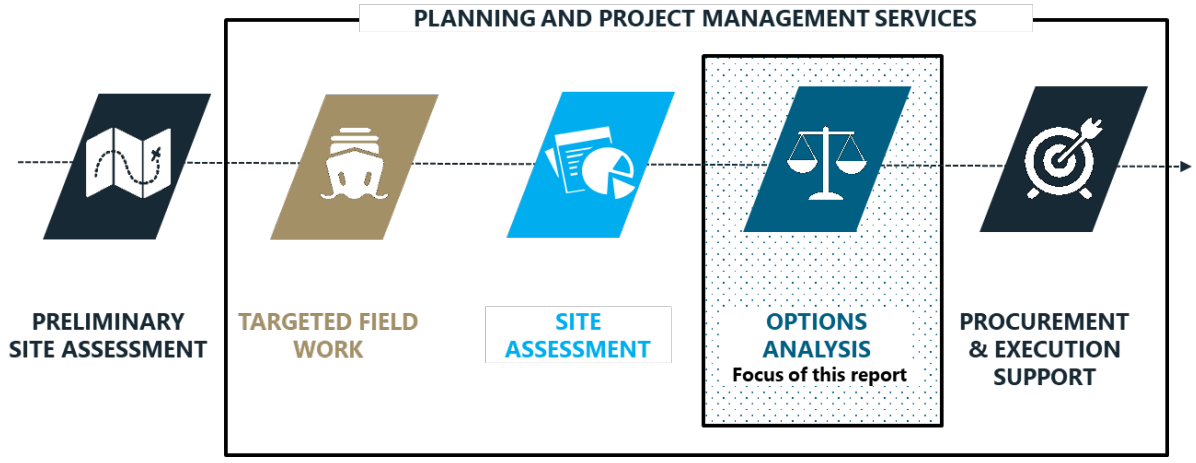


Figure 1-1 Key stages of Planning and Project Management services for the Douglas Shoal Remediation Project

The Site Assessment Report (Neale et al, 2019) identified remediation priorities and showed that almost ten years after the grounding incident contamination and physical damage remain as potential impediments to natural recovery, albeit their significance within the survey area may have diminished over time.

The report delineated areas of remediation priority (Figure 1-2) for contamination (Priority Area A) and the persistence of rubble (Priority Areas C, E and F). Addressing the contamination in Priority Area A and the persistence of rubble in Priority Areas C, E and F was the focus of the options analysis. Abrasive flattening and compaction damage were not considered to be of priority for remediation and therefore were not considered in the options analysis.

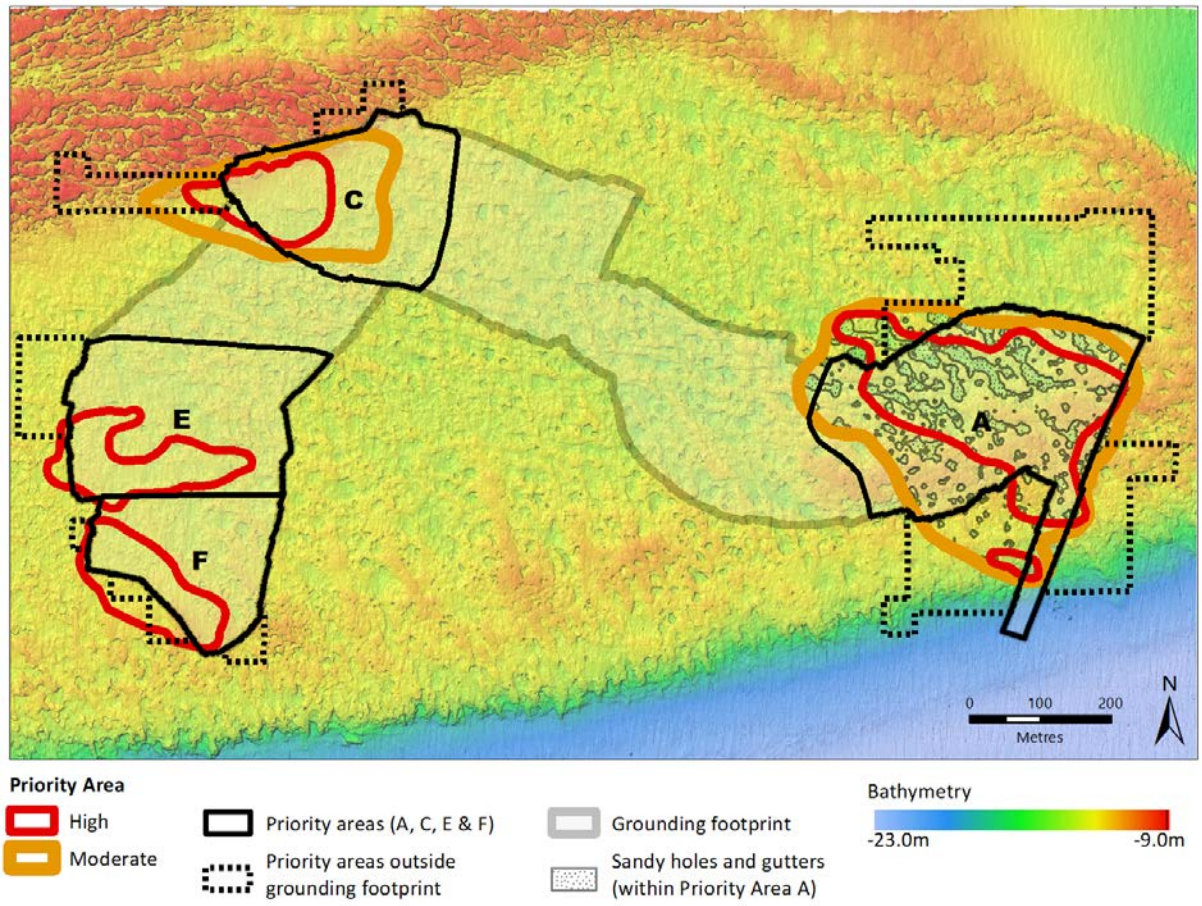


Figure 1-2 Priority remediation areas

1.2 Method

An objective of the options analysis was to narrow down the focus to potentially feasible remediation options. This analysis process is illustrated in Figure 1-3, with the key phases described below:

- Framing: This phase confirmed objectives, process, evaluation parameters, assumptions, boundaries, constraints and risks.

- Data collection and review: This phase focussed on the review of remediation literature, engagement with relevant stakeholders (including Traditional Owners), consideration of remediation tasks and constraints, and preliminary screening of remediation approaches.
- Options development: This phase defined themes, approaches, and representative options. For each representative option, high level cost and schedule estimates were developed and advantages, disadvantages, risks and opportunities identified.
- Options evaluation: This phase focussed on refinement of evaluation parameters, and evaluation of representative options via a Multi-Criteria Decision Analysis (MCDA). Sensitivity analysis was undertaken to support robust evaluation.

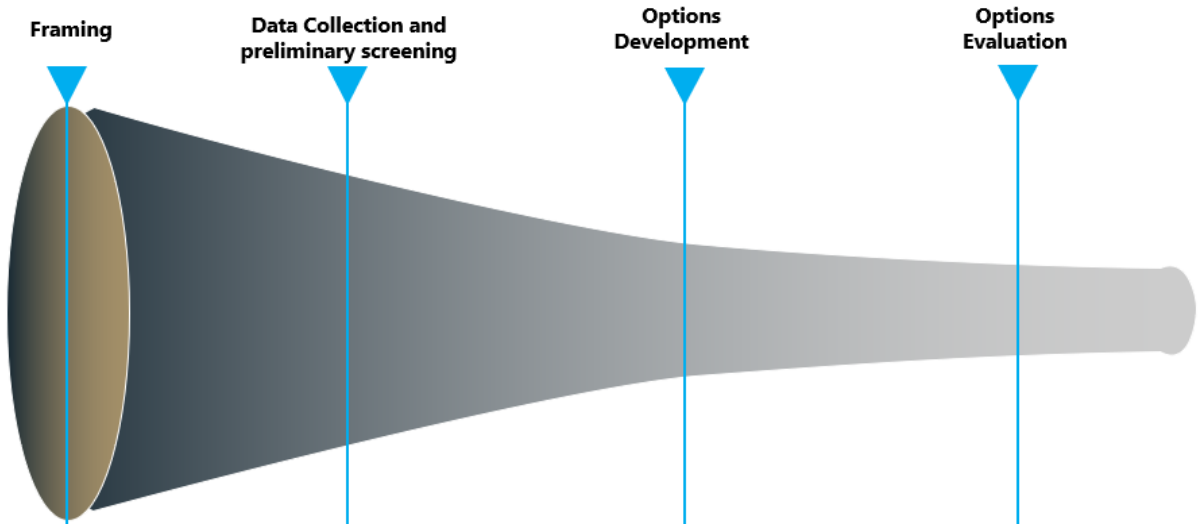


Figure 1-3 Options analysis process

1.3 Objectives and evaluation parameters

Expanding on the desired outcomes described above, the objectives for the Project were identified through the options analysis as:

- **Remediate the shoal to support natural recovery (Primary objective)**
- Realise the optimal contribution from Traditional Owners and outcomes for Traditional Owners and Indigenous groups
- Use the available funds in the most effective way, in acceptable timeframes considering value for money, public perception and ecosystem services
- Minimise harm to people and environment
- Learn from the Project to better respond to future incidents
- Meet community expectations
- Protect and enhance the Authority's reputation.

These objectives form the basis of the evaluation parameters (Table 1-1) against which options were assessed.

Table 1-1 Evaluation parameters

Parameter	Definition and notes
Cost	High level cost estimates associated with option implementation, with consideration of key factors (such as site conditions) that may affect cost.
Ability to enhance natural recovery onsite (within 10 years)	Options enhance the speed and extent of natural recovery for the site. Includes considerations such as natural growth, stability, diversity, protection of Traditional Owner culture values, and measurability of outcomes.
Enhance Traditional Owner economic outcomes	Options enhance participation and deliver positive economic outcome for Traditional Owners. Includes considerations such as employment and training.
Minimise environmental harm	Risk to the environment during implementation (short term impacts).
Minimise workplace health and safety risk	Risks to workforce and public health and safety during implementation (short term). Include considerations such as overall working time (particularly in-water), dangerous fauna, complexity of processes, and weather conditions.
Optimise opportunities for Australian and Queensland employment and businesses	Optimise opportunities for employment, capacity building and industry participation. Focussed on local or domestic (Australian) participation. *Note: Although initially identified as an evaluation parameter, through the options analysis it was determined that all options except 'Do nothing' may offer equivalent opportunities. As such this parameter did not differentiate the options apart from in relation to 'Do nothing', which offers less opportunity than all others.*
Community acceptance and social licence	Level of perceived community acceptance and social licence with respect to the options. Assumes the community has access to accurate information.
Proven technology	Technology maturity and usage. Focussed on the process and technology but not specific environmental outcomes.
Regulatory approvals and third-party agreements	Timeframe and resources required to obtain relevant permissions and agreements.
Schedule	Schedule associated with the likely campaign length, considering factors such as weather, site accessibility, material availability (excluding permitting).

1.4 Themes, approaches and representative options

In alignment with the Project objectives, the Project team agreed the focus of the options analysis was remediation rather than restoration. Remediation commonly refers to activity which addresses threatening processes that affect the environment, impeding natural recovery and/or subsequent rehabilitation or restoration. Restoration commonly refers to activity targeted at returning the area to its historical trajectory in terms of ecosystem function e.g. through enhancement, creation or re-creation of habitat. Remediation typically must happen before restoration activity can take place or natural recovery occur.

Options were focussed on addressing impediments to the natural recovery of the shoal (i.e. contamination or rubble), rather than on restoration of the shoal ecosystem. Dependent on the remediation option/s progressed and the requirements of those, the Authority may consider restoration activity in the future; however, restoration activity was not considered as part of the options analysis.

Two sets of remediation options were developed, the first to address the majority of the contamination in Priority Area A and the second to address the majority of the rubble in Priority Areas C, E and F using the areas and/or volumes as set out in the Site Assessment Report (Neale et al, 2019).

For each set of options, three common themes were identified for further development:

- Do nothing
- Non-removal of material
- Removal of material.

Alternate courses of action for each theme were identified as the 'approaches' set out in Table 1-2.

Table 1-2 Potential remediation approaches

Approach	Description
Monitored natural recovery	This is a 'do nothing' approach for comparative purposes. This approach assumes that no attempt is made to address the issues of contamination or rubble. Processes that may contribute to recovery include sediment burial, erosion or dispersion and contaminant degradation.
Enhanced monitored natural recovery	This is a minimal treatment approach that may include application of a thin-layer of capping material or amendment to enhance natural recovery processes. This option relies primarily on natural recovery but seeks to accelerate the recovery rate. This option is typically only considered feasible when natural recovery is likely to occur with minimal remediation effort.

Approach	Description
In-situ treatment	This approach involves mixing an additive with the sediment to reduce contaminant concentrations available in the water, or to plants and animals. Site characteristics influence choice of treatment material, application method and the effectiveness of the approach.
In-situ capping	This approach involves placing a layer of clean material (such as concrete) over the affected area to 'cap' and limit the movement of contaminants and/or rubble and reduce interaction of these with the environment. The cap may include use of geotextile or other material as additions to strengthen the cap and/or provide better habitat for plants and animals.
Removal	This process removes all or part of the contaminated sediment or rubble from the site by dredging (bulk or small-scale (e.g. through use of hand-held suction equipment)). Dredged sediment and water may be treated and disposed of on land or offshore dependent on regulatory requirements. Key differences between removal options may include dredging method and scale, along with sediment and water management.

At the finer scale of remediation option development many alternatives may be plausible (e.g. use of alternate equipment, material and processes). In recognition of this, the notion of 'representative options' was applied, and these were developed to provide a reasonable range of alternate concepts (within each remediation approach) and to address key differentiators between recognised remediation techniques for evaluation.

Representative options for remediation of contamination are summarised in Figure 1-4 with further description of each option provided in Table 1-3. Representative options for remediation of rubble are summarised in Figure 1-5 with further description of each option provided in Table 1-4.

Development and evaluation of options does not indicate that the option is acceptable to regulators, as the options are for comparative purposes only.

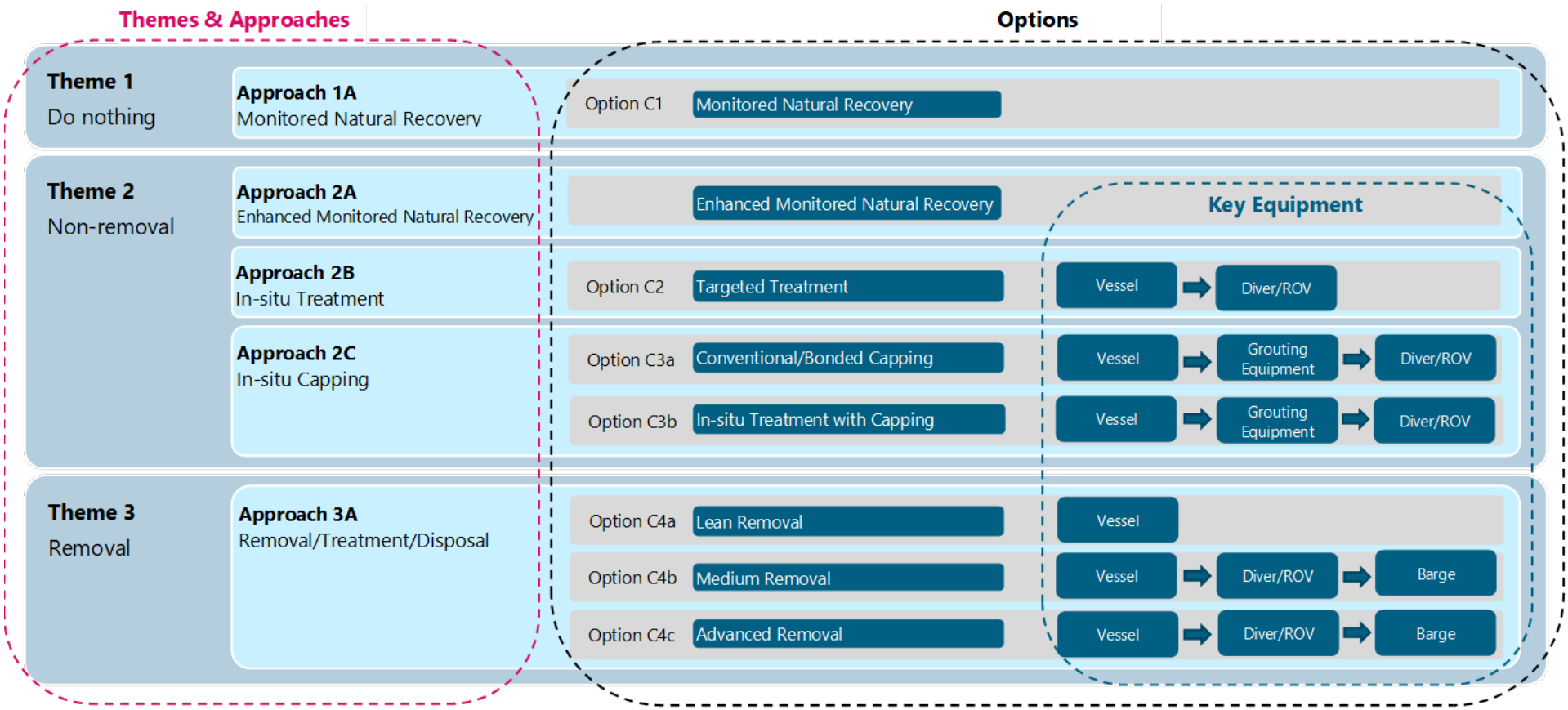


Figure 1-4 Remediation options for contamination

Table 1-3 Representative options for contamination (Area A)

Representative Option	Description and key assumptions
C1 Monitored natural recovery	No remediation activities undertaken. Option involves ongoing monitoring only, with no additional funds allocated to monitoring. It is assumed this monitoring program would be common to all remediation options.
Enhanced monitored natural recovery	Apply an amendment such as a thin layer of capping or in-situ treatment to accelerate the natural recovery processes. The amendment is of a much smaller scale or extent than for other non-removal options. This option predominantly relies on natural recovery with minimal interference. Given the high energy marine environment, minor amendment was considered highly unlikely to be effective. This option was excluded from further consideration.
C2 In-situ treatment	Divers used to pump and mix material (activated carbon) into areas of sediment across the total area of contamination (Priority Area A), addressing each sediment patch (e.g. holes and gutters) separately.
C3a Conventional / Bonded Capping	Divers used to cap areas of sediment across the total area of contamination (Priority Area A) using pumped grouting and placed scour protection, addressing each sediment patch (e.g. holes and gutters) separately.
C3b In-situ treatment with capping	In-situ treatment (Option C2) combined with conventional capping (Option C3a)
C4a Lean Removal	Trailer Suction Hopper Dredge (TSHD) vessel used to remove contaminated sediment and transport all dredged sediment and water (in TSHD hopper) from the site to a nearby port. Use existing wharf facilities and (new) pump out lines to pump the sediment and water from the TSHD to a (to be constructed) bunded onshore placement area. Dewatering from the placement area using physical processes and a diffuser at the water discharge point within the port. Trucking and disposal of dried sediment to landfill as contaminated material.
C4b Medium Removal	Diver assisted removal of contaminated material using small-scale dredge equipment. Screens applied to dewater the material and remove undissolved contaminants, with water discharged through diffuser at site. Transport dewatered sediment in bulk bags to a nearby port. Use existing wharf facilities to load material from the barge to truck and dispose of the material to landfill as contaminated material.
C4c Advanced Removal	Diver assisted removal of contaminated material using small-scale dredge equipment. Advanced water treatment to remove dissolved and undissolved contaminants, with water discharged through diffuser at site. Transport dewatered sediment in bulk bags to a nearby port along with residual process water. Use existing wharf facilities to load the material from the barge to truck and dispose of the material to landfill as contaminated material.

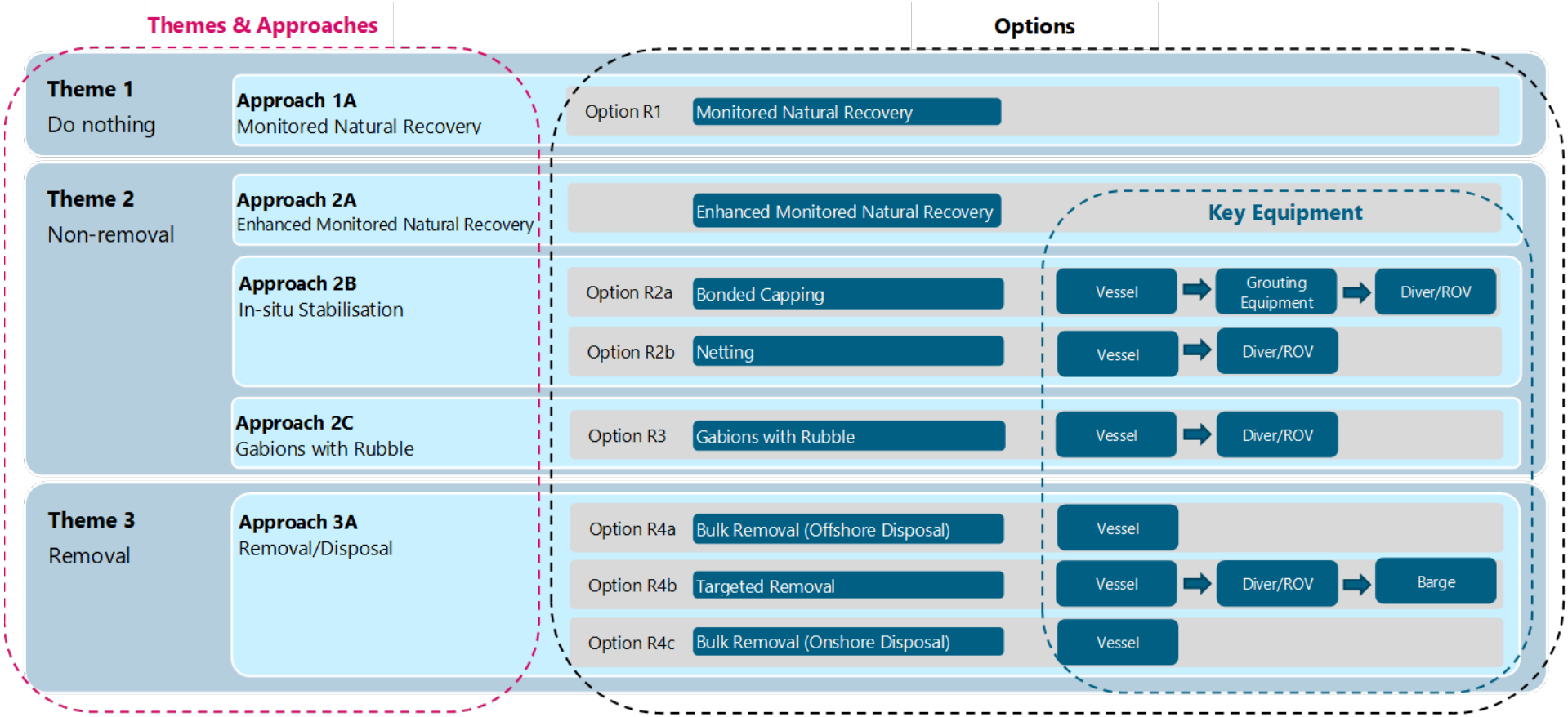


Figure 1-5 Remediation options for rubble

Table 1-4 Representative options for rubble (Areas C, E and F)

Representative Option	Description and key assumptions
R1 Monitored natural recovery	No remediation activities undertaken. Option involves ongoing monitoring only, with no additional funds allocated to monitoring. It is assumed this monitoring program would be common to all remediation options.
Enhanced monitored natural recovery	Apply an amendment such as a thin layer of capping to accelerate the natural recovery processes. The amendment is of a much smaller scale or extent than for other non-removal options. This option predominantly relies on natural recovery with minimal interference. Given the high energy marine environment, minor amendment was considered highly unlikely to be effective. This option was excluded from further consideration.
R2a Bonded Capping	Divers used to cap areas of rubble using pumped grouting and placed scour protection, addressing each sediment patch (e.g. holes and gutters) separately.
R2b Netting	Divers used to place and secure netting (e.g. geofabric) across areas of loose rubble.
R3 Gabions with rubble	Design and place gabion structure on the seafloor to restrict movement of rubble and potentially support subsequent habitat restoration. Divers used to pump a portion of rubble (~30%) into gabion structures underwater to restrict movement of the remaining rubble.
R4a Bulk Removal with Offshore Disposal	TSHD used to remove rubble by dredging (with hopper overflow) and transport of rubble (in TSHD hopper) to a nearby location (<10km from the site) and then placed on the seabed.
R4b Targeted Removal	Diver assisted removal of rubble using small-scale dredge equipment. Screens applied to dewater the material and remove suspended sediment with water then discharged through diffuser at site. Transport dewatered sediment in bulk bags to a nearby port. Use existing wharf facilities to directly load the material from the barge to truck and dispose of the material to landfill as clean fill.
R4c Bulk Removal with Onshore Disposal	TSHD used to remove rubble by dredging (with hopper overflow) and transport of rubble (in TSHD hopper) from the site to a nearby port. Use existing wharf facilities and (new) pump out lines to a (to be constructed) bunded onshore placement area. Dewatering from the placement area using physical processes and a diffuser at the water discharge point in the port. Truck and dispose of dried material to landfill as clean fill.

1.5 Analysis

The evaluation parameters were used to analyse the representative options. Each representative option was scored against the evaluation parameters and scores tallied across parameters for that option. Several scenarios were used for analysis including to test sensitivity:

- Scores for each parameter were weighted based on Authority input regarding the relative importance of that parameter (base case analysis)
- Scores for each parameter were weighted based on Authority input regarding the relative importance of that parameter with exclusion of the score for the cost parameter
- Scores for each parameter were equivalently weighted so parameters were of equal importance
- Scores for each parameter were equivalently weighted so parameters were of equal importance with exclusion of the score for the cost parameter.

1.5.1 Contamination

A summary of the tallied scores under each scenario for the contamination representative remediation options, along with their ranking is provided in Table 1-5. More positive scores show better alignment, while more negative scores show poorer alignment with Project objectives. Figure 1-6 shows score components for the base case analysis (Authority input weighted score including cost).

Table 1-5 Contamination representative options analysis summary

	Authority input Weighted Score incl. cost (Rank)	Authority input Weighted Score excl. cost (Rank)	Equivalently Weighted Score incl. cost (Rank)	Equivalently Weighted Score excl. cost (Rank)
Option C1: Do Nothing	-0.41 (5)	-0.43 (5)	-0.60 (6)	-0.67 (7)
Option C2: In-situ Treatment	-0.91 (7)	-0.92 (7)	-0.70 (7)	-0.56 (6)
Option C3a: Conventional / Bonded Capping	-0.27 (4)	-0.21 (4)	0 (4)	0.22 (4)
Option C3b: In-situ Treatment with Capping	-0.69 (6)	-0.67 (6)	-0.50 (5)	-0.33 (5)
Option C4a: Removal – Lean	0.54 (1)	0.65 (1)	0.60 (=1)	0.78 (=1)
Option C4b: Removal – Medium	0.38 (2)	0.46 (2)	0.60 (=1)	0.78 (=1)
Option C4c: Removal - Advanced	0.31 (3)	0.44 (3)	0.50 (3)	0.78 (=1)

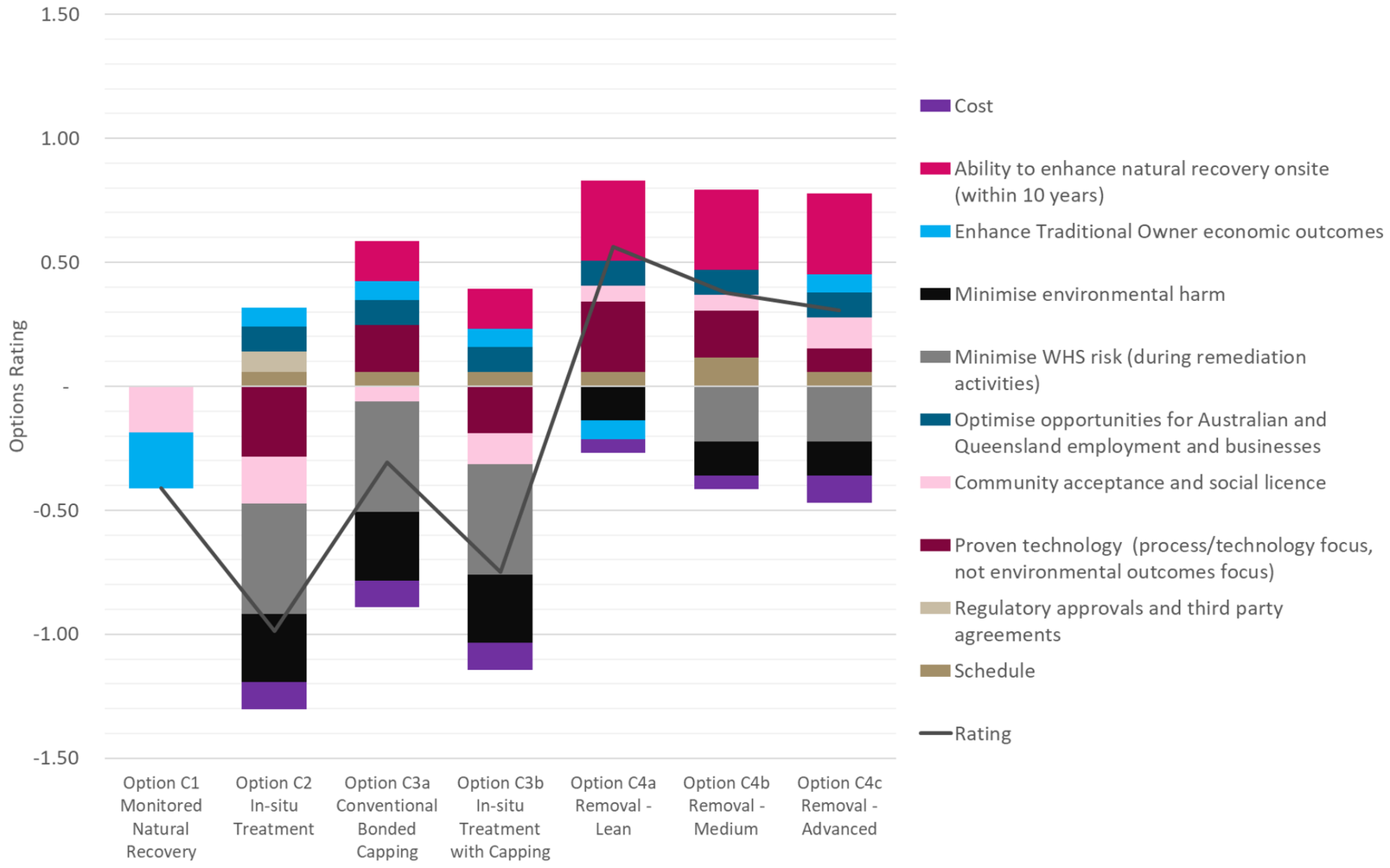


Figure 1-6 Contamination options analysis using base case (Authority input weighted score including cost)

For interpretation of this figure:

- Positive weighted scores for each parameter show above the zero line and negative weighted scores show below the zero line.
- For each parameter the broadness of the band represents its contribution to the overall score (positive or negative) with a broader band indicating a greater contribution and a narrower band indicating a lesser contribution.
- The rating line represents the tallied score for each option (positive or negative scores for each parameter) to achieve a final score.
- A highly positive score indicates better alignment with Project desired outcomes and objectives while a highly negative score indicates poorer alignment with Project desired outcomes and objectives.

As shown in Table 1-5, each of the removal options scored higher than any of the non-removal options or the do-nothing option under all analysis. Each of the removal options also had lower estimated cost and shorter estimated campaign duration than the non-removal options.

Of the non-removal options, Option C3a (Conventional capping) consistently scored the highest; however, this option is considered unlikely to be economical for full scale remediation and has a relatively high estimated cost compared to removal options C4a and C4b. The remaining non-removal options were considered likely to be ineffective for remediation of contamination at the shoal.

1.5.2 Rubble

A summary of the tallied scores under each scenario for the rubble representative remediation options, along with their ranking is provided in Table 1-6. More positive scores show better alignment, while more negative scores show poorer alignment with project objectives. Figure 1-7 shows score components for the base case analysis (Authority input weighted score including cost).

Table 1-6 Rubble representative options analysis summary

	Authority input Weighted Score incl. cost (Rank)	Authority input Weighted Score excl. cost (Rank)	Equivalently Weighted Score incl. cost (Rank)	Equivalently Weighted Score excl. cost (Rank)
Option R1: Do Nothing	-0.41 (5)	-0.43 (5)	-0.60 (5)	-0.67 (6)
Option R2a: Bonded Capping	-0.90 (6)	-0.85 (6)	-0.70 (6)	-0.44 (5)
Option R2b: Netting	-1.23 (7)	-1.22 (7)	-1.10 (7)	-0.89 (7)
Option R3: Gabions with rubble	-0.07 (4)	-0.06 (4)	0.20 (3)	0.33 (3)
Option R4a: Bulk Removal (Offshore)	0.18 (3)	0.27 (3)	0.10 (4)	0.22 (4)
Option R4b: Targeted Removal	0.20 (2)	0.32 (2)	0.40 (2)	0.67 (2)
Option R4c: Bulk Removal (Onshore)	0.68 (1)	0.81 (1)	0.70 (1)	0.89 (1)

As shown in Table 1-6, each of the removal options scored higher than any of the non-removal options or the do-nothing option under all analysis scenarios, except for Option R3 (Gabions with rubble) which outperformed Option R4a (Bulk removal with offshore disposal) under equivalently weighted scenarios. In addition, each of the removal options has lower estimated costs and shorter estimated campaign duration than the non-removal options, except for Option R3 (Gabions with rubble) which is estimated to be of shorter duration and lower cost than R4b (Targeted removal).

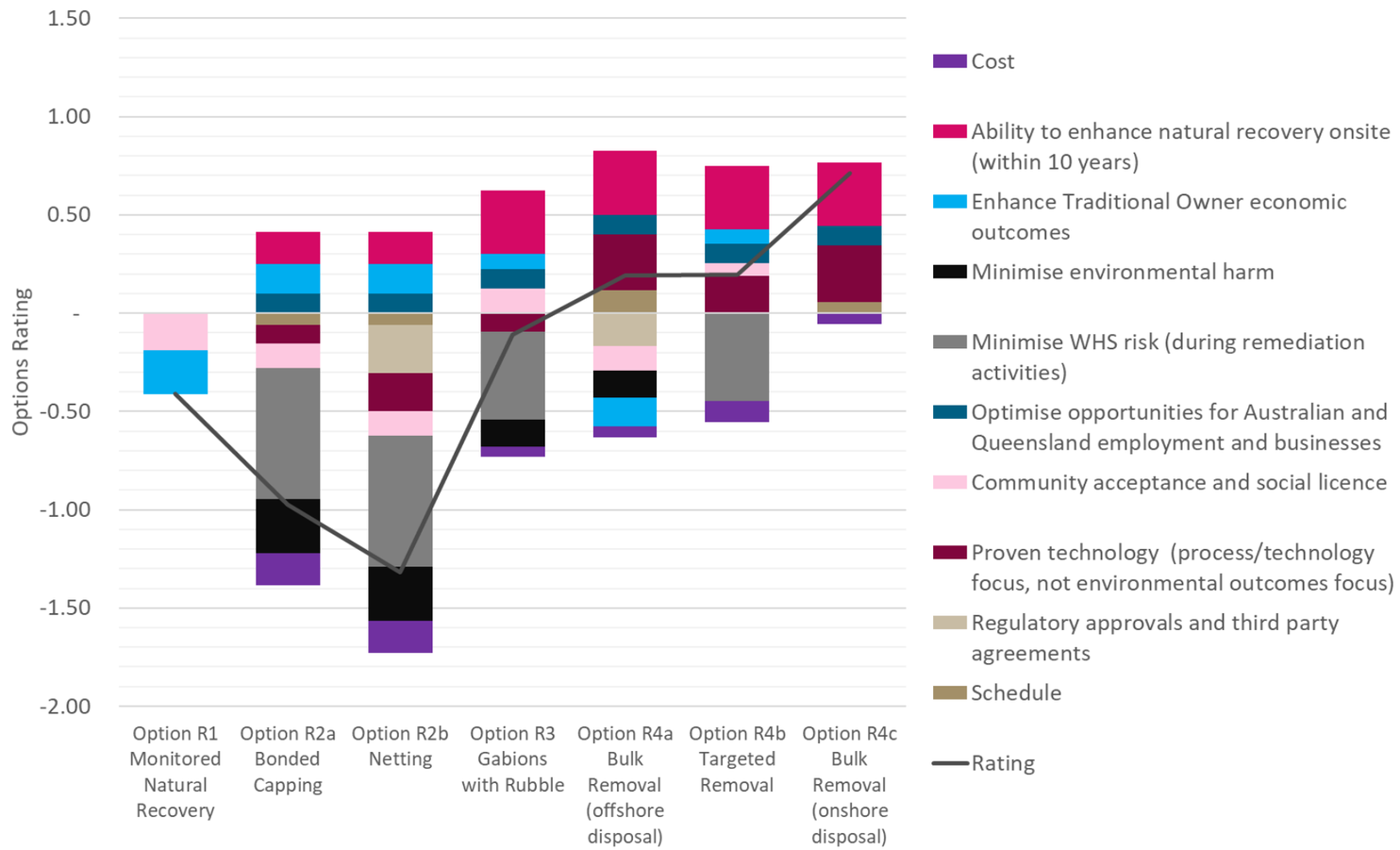


Figure 1-7 Rubble options analysis weighted results

For interpretation of this figure:

- Positive weighted scores for each parameter show above the zero line and negative weighted scores show below the zero line.
- For each parameter the broadness of the band represents its contribution to the overall score (positive or negative) with a broader band indicating a greater contribution and a narrower band indicating a lesser contribution.
- The rating line represents the tallied score for each option (positive or negative scores for each parameter) to achieve a final score.
- A highly positive score indicates better alignment with Project desired outcomes and objectives while a highly negative score indicates poorer alignment with Project desired outcomes and objectives.

Non-removal options, Option R2a (Bonded capping) and Option R2b (Netting), both mostly ranked lower than the do-nothing option, mainly due to their high costs, extended campaign duration, limited proven application and high potential for workplace health and safety risk.

1.6 Conclusions and considerations for progress

Based on the results of the options analysis, the representative options were categorised as:

- Potentially feasible for full-scale remediation at Douglas Shoal: Options in this category warrant further consideration
- Unlikely to be feasible for full-scale remediation at Douglas Shoal: Options in this category only warrant further consideration for small-scale trials if significant value is likely be accrued through learnings for other future remediation, noting that this reflects a secondary desired outcome to full-scale remediation
- Not feasible for use at Douglas Shoal: Options in this category do not warrant further consideration.

Table 1-7 sets out the categorisation of the representative remediation options based on the options analysis.

Table 1-7 Categorisation of representative remediation options

Category	Contamination*	Rubble*
Potentially feasible for full-scale remediation at Douglas Shoal	C4a Removal – Lean C4b Removal – Medium C4c Removal - Advanced	R3 Gabions with rubble R4a Bulk Removal with Offshore Disposal R4b Targeted Removal R4c Bulk Removal with Onshore Disposal
Unlikely to be feasible for full-scale remediation at Douglas Shoal	C1 'Do Nothing' C3a Conventional Capping	R1 'Do Nothing' R2a Bonded Capping
Not feasible for use at Douglas Shoal	Enhanced Monitored Natural Recovery C2 In-situ treatment C3b In-situ treatment with capping	Enhanced Monitored Natural Recovery R2b Netting

*Note that ordering is numerical within each category and is not based on rankings.

The representative options most closely aligned with the Authority's objectives to address most of the contamination and/or rubble at Douglas Shoal are:

- Option C4a (Lean Removal) to address contamination in Priority Area A
- Option R4c (Bulk Removal with Onshore Disposal) to address rubble in Priority Areas C, E and F.

A number of other important considerations relevant to progress of the Project were identified through the options analysis:

- Significant potential exists for cost and schedule synergies to be achieved for the Project should the remediation method for contamination and rubble be compatible e.g. through use of the same equipment to reduce mobilisation and demobilisation timeframe and costs.
- Variation in remediation area features is likely to affect remediation method efficiency e.g. challenging areas for bulk removal to fully address in an efficient manner may include small pockets of material (such as in the southerly part of Priority Area A) and shallower areas of the shoal (such as the High Relief Terrace area adjacent the northern part of Priority Area C).
- Reduction of significant uncertainty with respect to the representative remediation options may be addressed through the Authority confirming a position and/or undertaking further investigations with respect to the following matters
  - Environmental restrictions for water disposal in the Marine Park and/or in port areas
  - Access to suitable land for management of removed material
  - Bulk dredge availability
  - Environmental restrictions (location and quality) on disposal of removed material.
- For efficient address of the Project's learning-related objective there is likely to be value in the Authority confirming a position and/or undertaking further investigations with respect to:
  - The merits and/or feasibility of undertaking small-scale trials of some remediation methods (in addition to full-scale remediation of the shoal) for future learnings, considering the unique features of Douglas Shoal including remoteness and exposure to prevailing wind and sea conditions
  - Restoration techniques that may be applied in conjunction with (or after) the remediation activities, while considering the unique features of Douglas Shoal.

As the Project is at concept stage, many assumptions were made during the options development, including some common to all options and others unique to each option. It is recognised that changes to key assumptions may affect the outcomes of the options analysis. As the Project advances uncertainty associated with these assumptions is anticipated to reduce and the alignment of the progressed option/s with Project objectives should be reviewed.