A ‘Decision Framework for Assessing Options for the Disposal and Treatment of Contaminated Dredged Material’ in England and Wales

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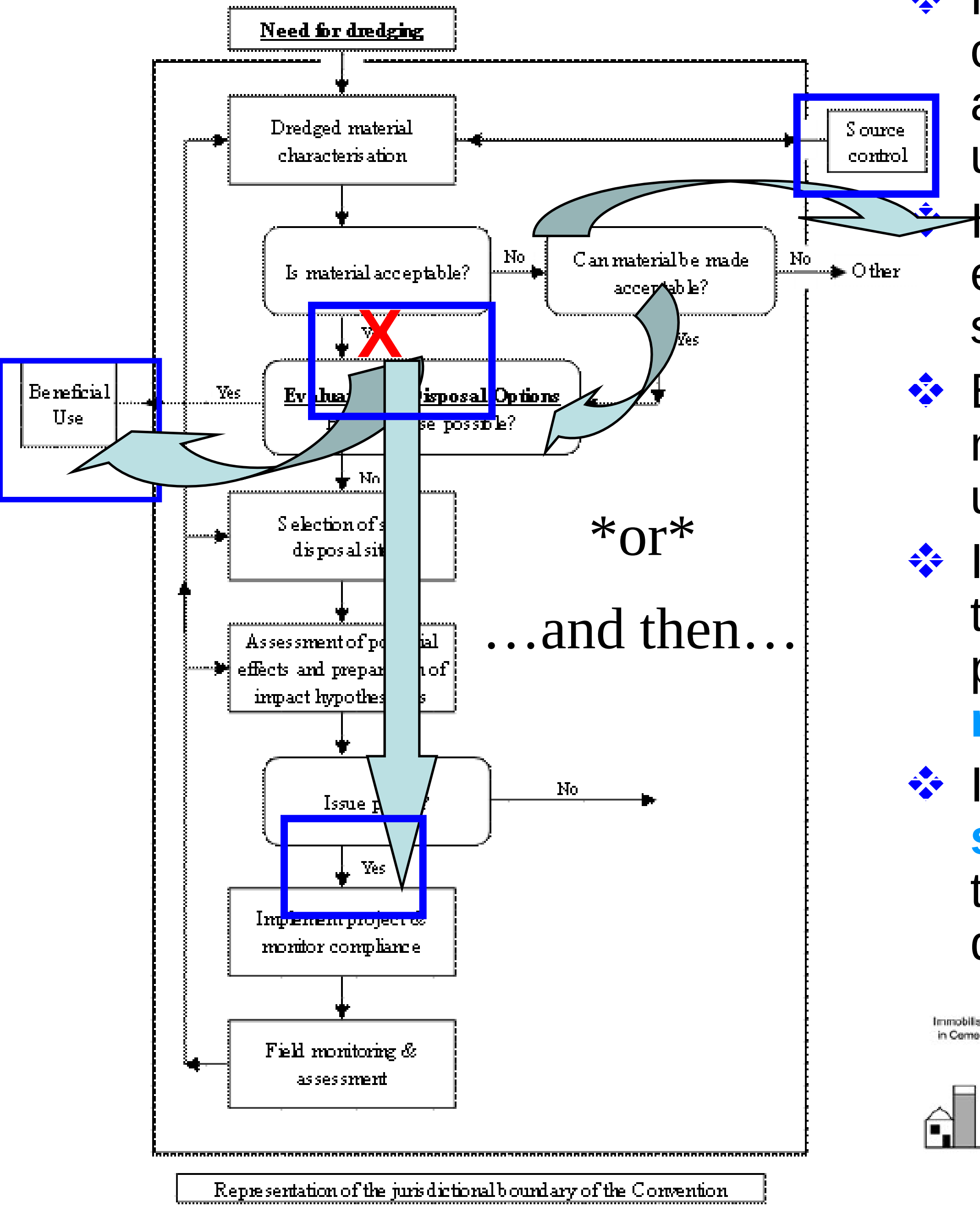
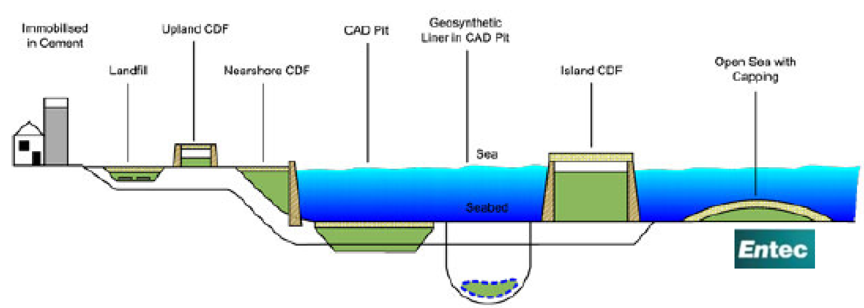
Overview

- The project objective was to provide guidance to the UK Marine Management Organisation (MMO) for a draft tiered framework for use by applicants who have to select management alternatives for contaminated dredged sediments
- This project covered the early tiers – the identification of reasonable management alternatives – and the associated sustainability assessment
- This presentation will introduce the ***draft*** guidance on the early tiers and the sustainability assessment



- Historically, DM has been considered a valuable resource, and as much as possible has been used beneficially
- If not useable, the goal is to cost-effectively and safely dispose at sea
- But, contaminants in sediments mean that not all sediments can be used or disposed of at sea
- In the short term, this means that there is a need to select and obtain permits for **alternative management approaches**
- In the longer term, **contaminant sources should be controlled** so that sediments can be re-used or disposed of without control



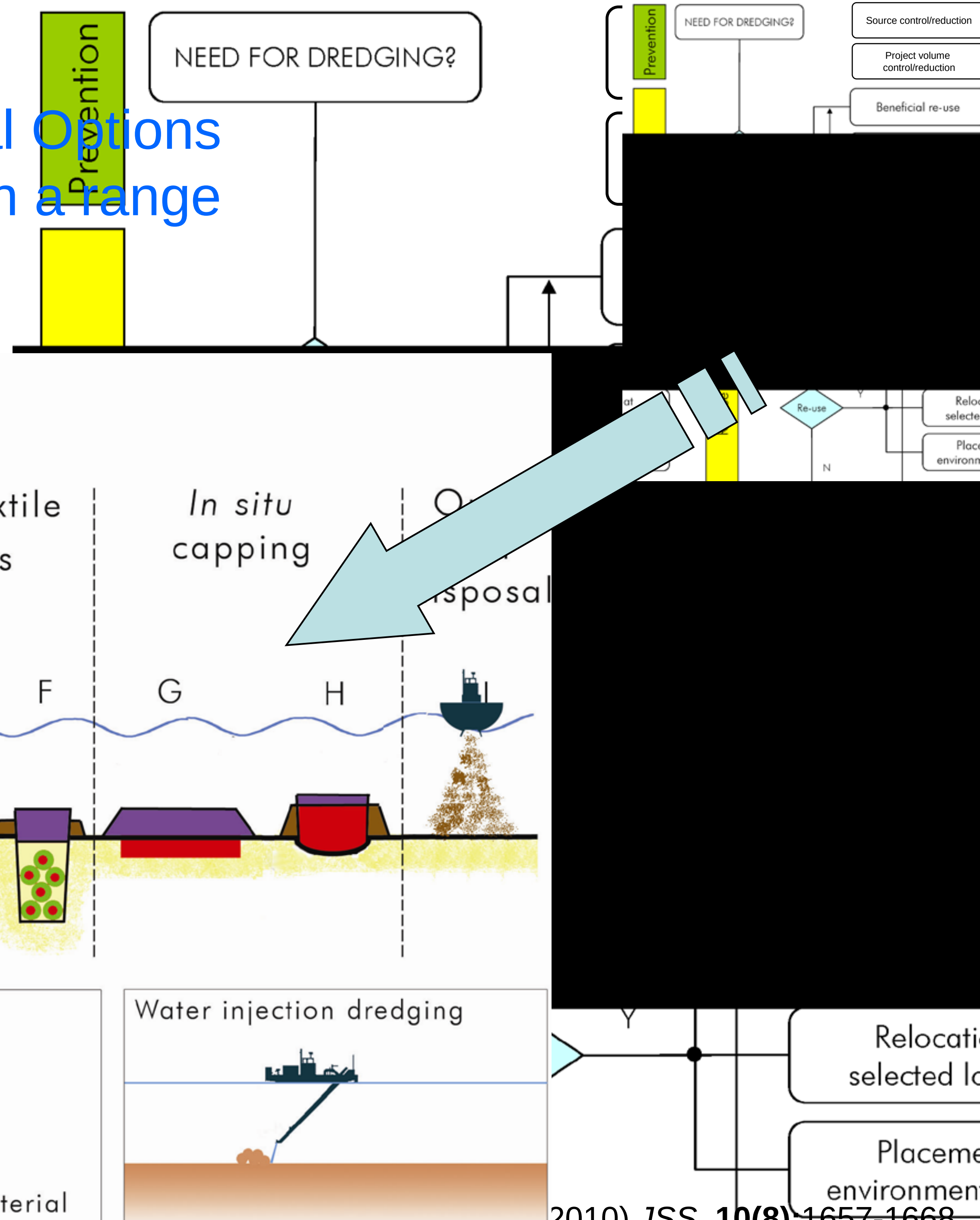
Addressing UK-specific priorities

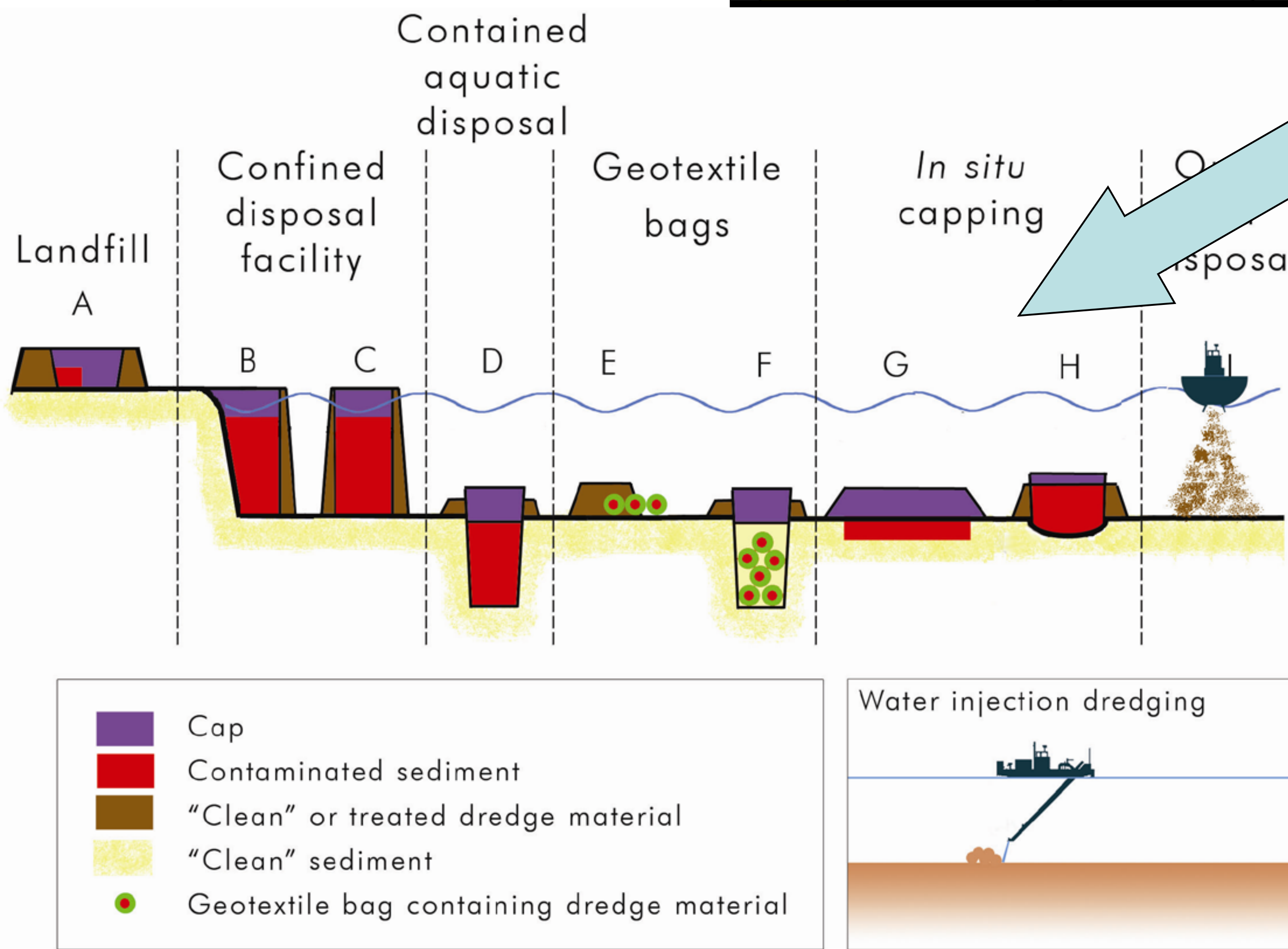
- The challenge is developing guidance and a framework which is technically correct, but focused on UK-specific decision drivers
- MMO requirements
  - Initial screen rules out “unreasonable options”
  - MCA approach ranks “effectiveness”
  - Separate ranking considers “effectiveness, cost and human health risk”
  - Later, detailed ranking of short-listed options
  - Monitoring strategies for selected option
- Criteria and indicators needed to be linked to these priorities

A range of Management Approaches (MAs) should be evaluated in a comparative assessment

- There is not one correct answer, just an attempt to quantify and balance risks, benefits and objectives
  - All options have risks and uncertainty
  - Option selection involves trade-offs; these, and their uncertainty, should be explicit
- Comparative approaches combine disparate lines of evidence and decision criteria into transparent frameworks

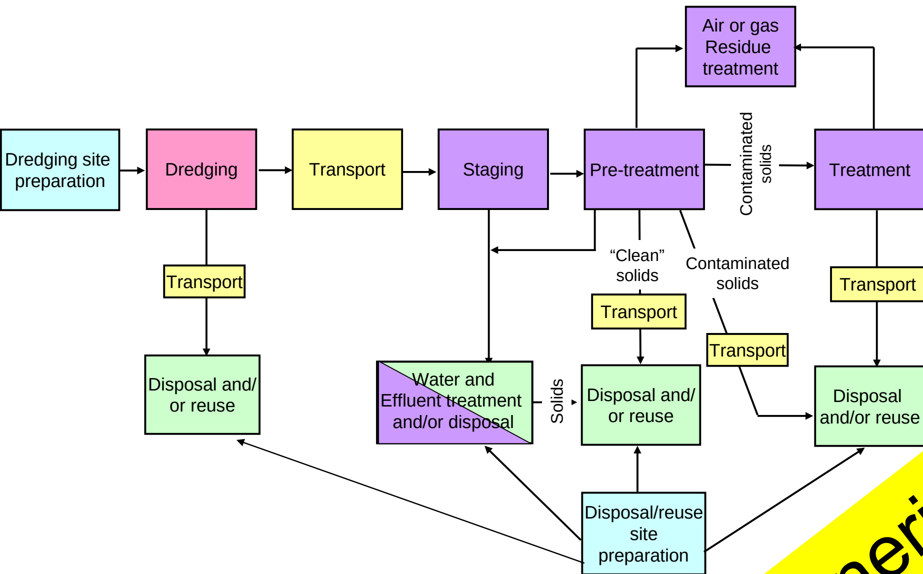
Containment and Disposal Options can be scored based upon a range of criteria…

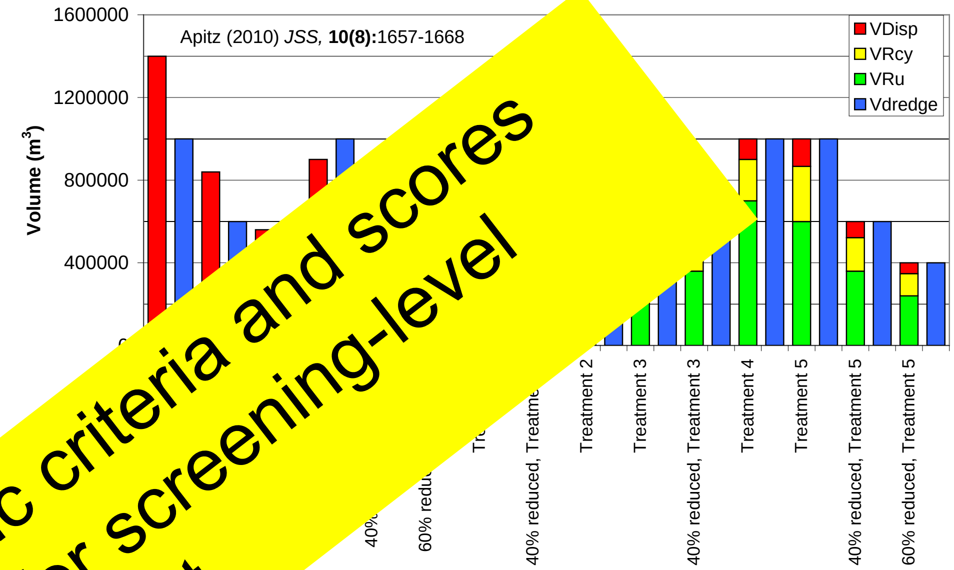




2010) *JSS*, **10(8)**:1657-1668

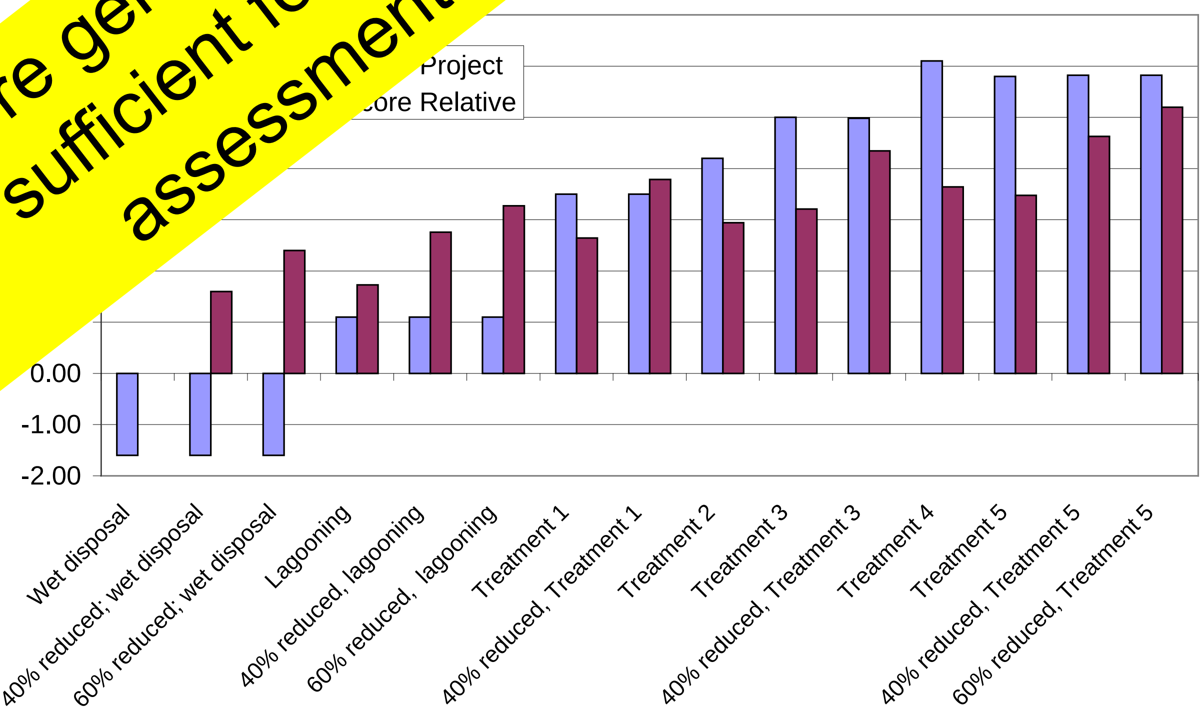
Scoring based upon specific project designs requires detailed assessment



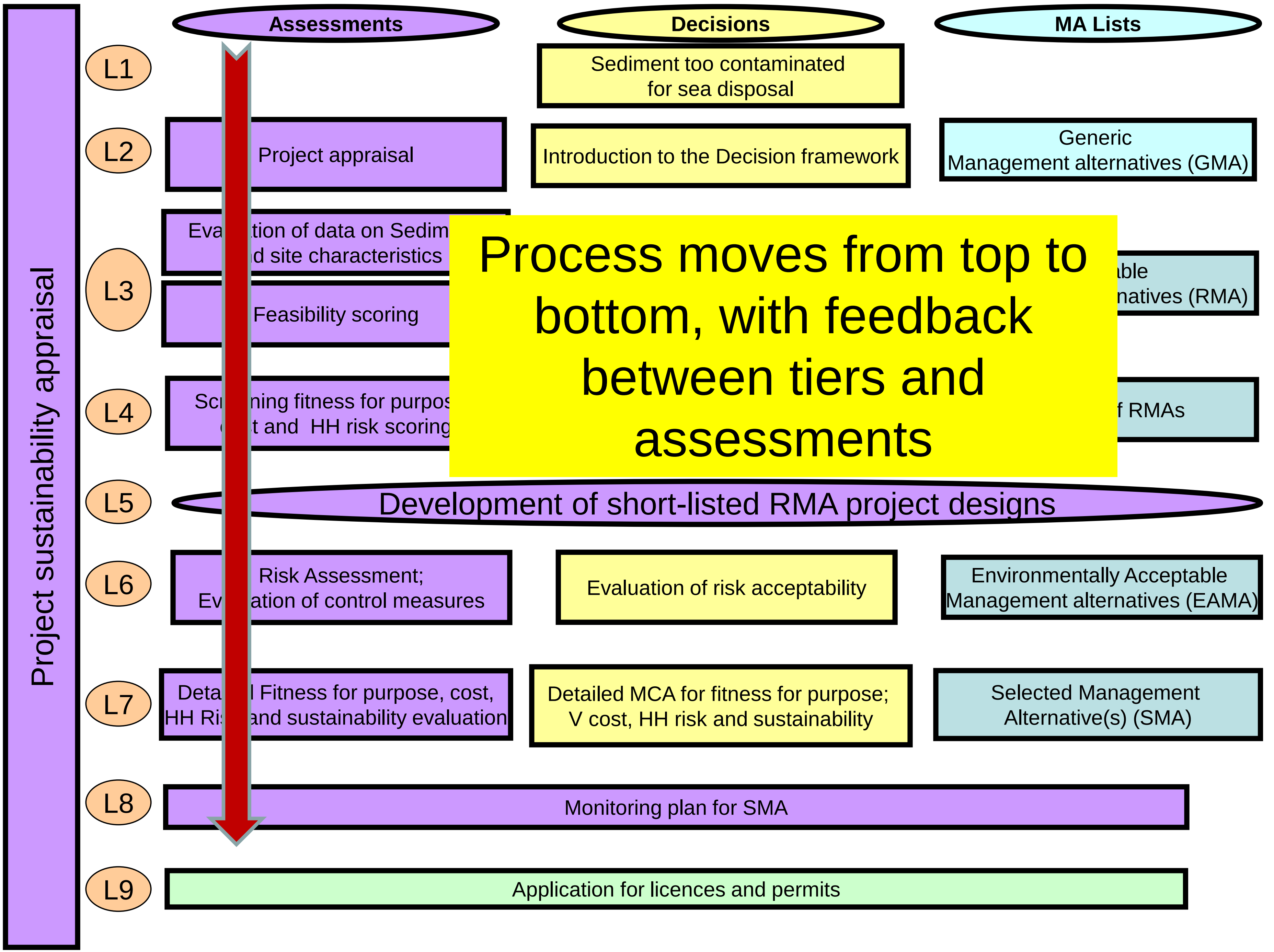


$F_{PP(scenario)} = (V_{dredge} - V_{disp}) / V_{dredge}$

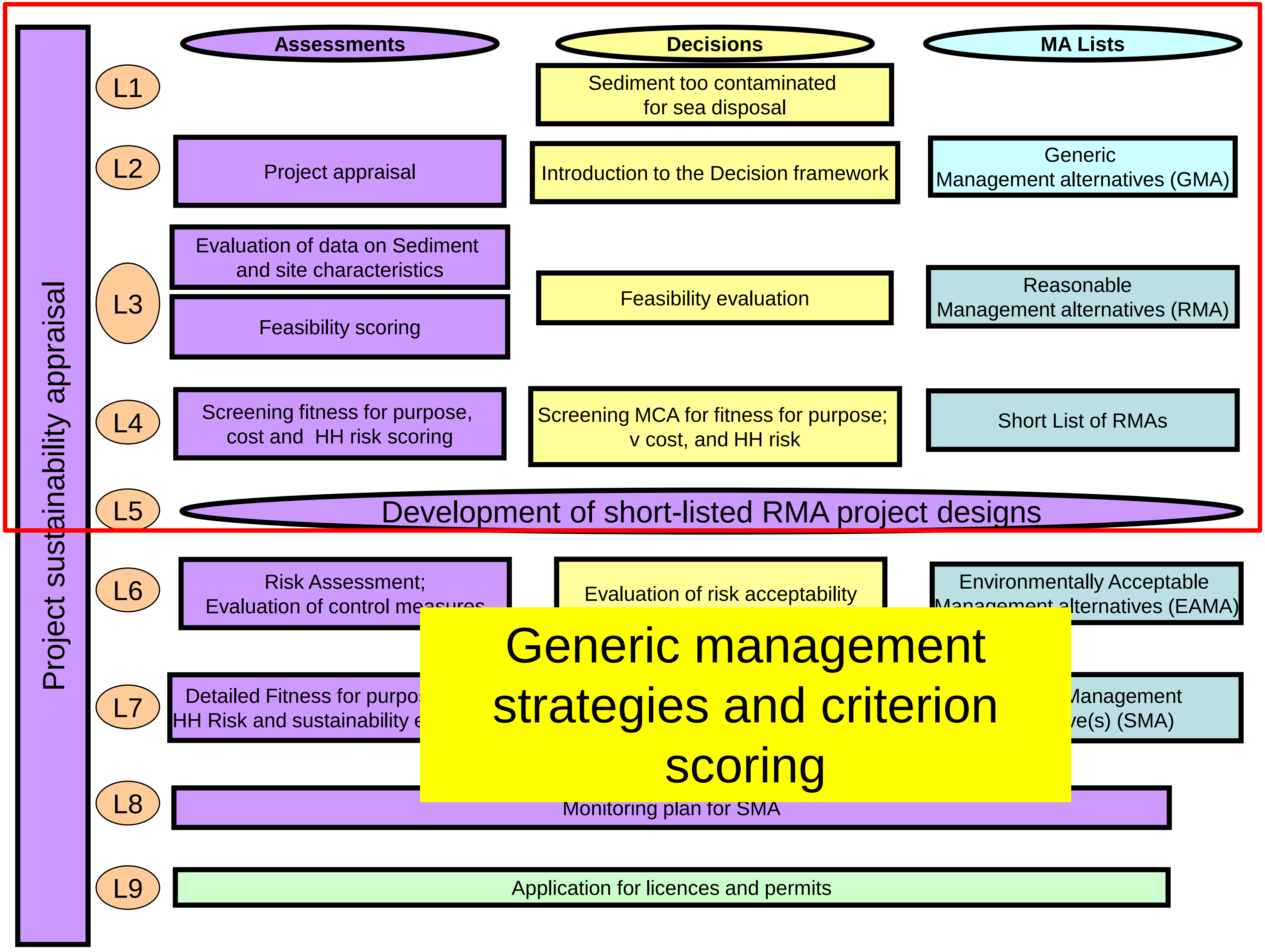
$F_{PP(relative)} = (V_{total(max)} - V_{total(scenario)}) / V_{to}$

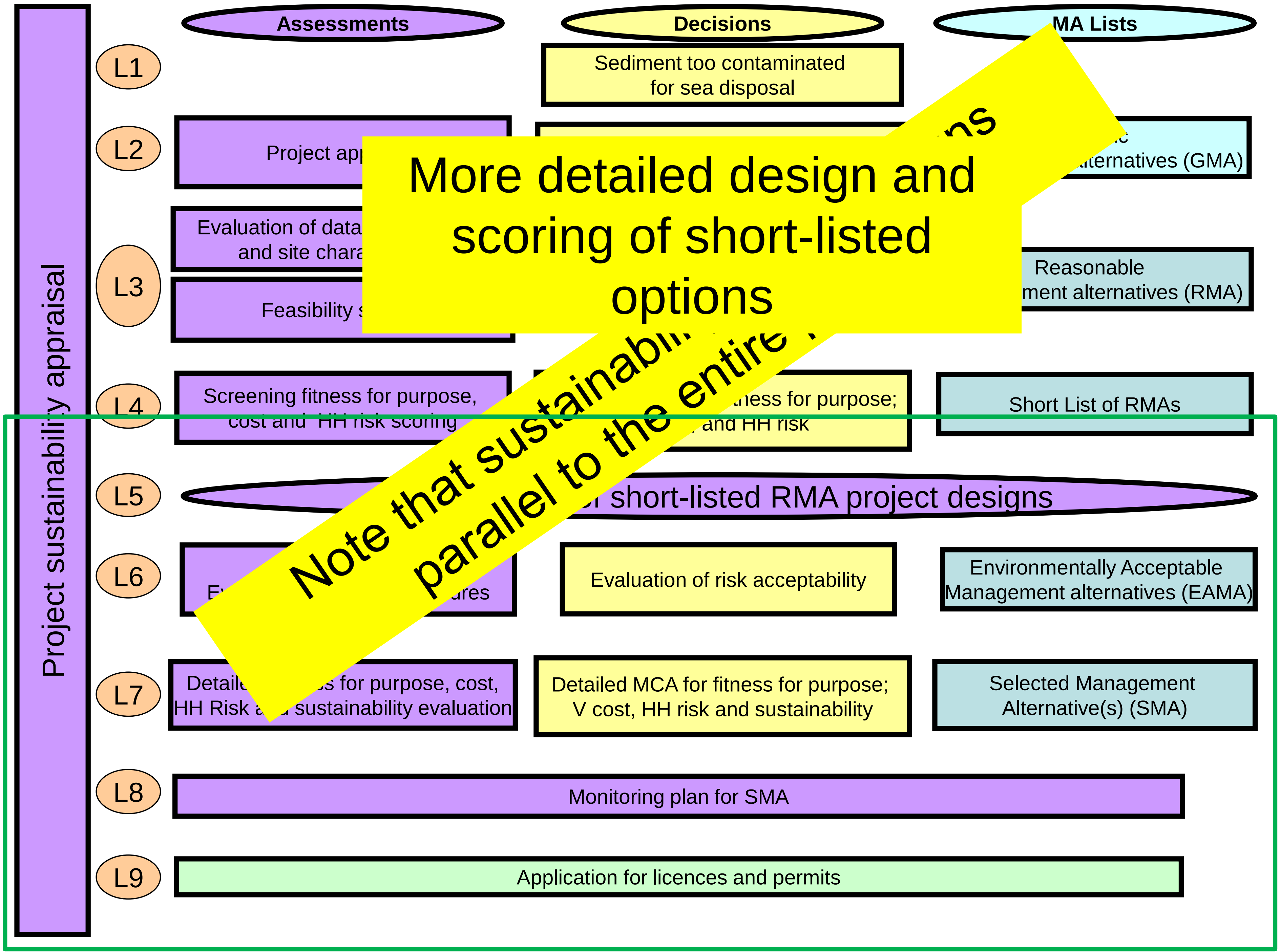


In practice, more generic criteria and scores should be sufficient for screening-level assessment.



Assessments
Decisions
MA Lists
L1
L2
L3
L4
L5
L6
L7
L8
L9
Project sustainability appraisal
Sediment too contaminated for sea disposal
Project appraisal
Introduction to the Decision framework
Generic Management alternatives (GMA)
Feasibility scoring
natives (RMA)
f RMAs
Process moves from top to bottom, with feedback between tiers and assessments
Development of short-listed RMA project designs
Risk Assessment;
Evaluation of risk acceptability
Environmentally Acceptable Management alternatives (EAMA)
Detailed MCA for fitness for purpose; V cost, HH risk and sustainability
Selected Management Alternative(s) (SMA)
Monitoring plan for SMA
Application for licences and permits


Assessments
Decisions
MA Lists
Project sustainability appraisal
L1
Sediment too contaminated for sea disposal
L2
Project appraisal
Introduction to the Decision framework
Generic Management alternatives (GMA)
L3
Evaluation of data on Sediment and site characteristics
Feasibility scoring
Feasibility evaluation
Reasonable Management alternatives (RMA)
L4
Screening fitness for purpose, cost and HH risk scoring
Screening MCA for fitness for purpose; v cost, and HH risk
Short List of RMAs
L5
Development of short-listed RMA project designs
L6
Risk Assessment; Evaluation of control measures
Evaluation of risk acceptability
Environmentally Acceptable Management alternatives (EAMA)
L7
L8
Monitoring plan for SMA
L9
Application for licences and permits
Generic management strategies and criterion scoring


Project sustainability appraisal
Assessments
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MA Lists
L1
L2
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L4
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L6
L7
L8
L9
Sediment too contaminated
for sea disposal
More detailed design and
scoring of short-listed
options
Reasonable
Screening fitness for purpose,
Short List of RMAs
Evaluation of risk acceptability
Environmentally Acceptable
Management alternatives (EAMA)
Detailed MCA for fitness for purpose;
V cost, HH risk and sustainability
Selected Management
Alternative(s) (SMA)
Monitoring plan for SMA
Application for licences and permits

A coherent set of criteria are*:

- Exhaustive
  - Allow a clear delineation between options
- Cohesive
  - Options that rank higher on one criterion should be preferred
- Clear
  - Linked to decisions, in scientific terms and in the minds of decision makers
- **Not** redundant – avoiding bias and double-counting
- Relevant
  - Meaningful to the actual decision process

*Burgman M. Risks and Decisions for Conservation and Environmental Management. Cambridge University Press, 2005.

Approaches for tiered scoring of management strategies – fitness for purpose (feasibility and effectiveness criteria)

	Criteria (broad)	Sub-Criteria/ indicators	Approach - low tier Generally based upon generic approaches	Approach - high tier - based upon detailed project plans
Feasibility	Technical feasibility	Is MA appropriate for contaminants?	Guidance documents, checklists, tables	Feasibility study, bench tests (for some approaches)
		Is MA appropriate for sediments?	Guidance documents, checklists, tables, case studies	Feasibility study, bench tests (for some approaches)
		Is MA ap	Hydrodynamics, water depth, weather, habitat and	d surveys
		Is M		tier
		Is M		proposals
	Availability of sites	Disposal/use site availability	Estimates from DM volume; water content; access; site availability; time	More detailed assessment based on specific processes
		Conflict with other disposal/use site uses	Can be affected by a range of potential conflicts including environmental windows	More detailed assessment based on specific processes
		Staging/storage/treatment area site availability	Process-specific; depends on handling steps and rates; time and footprint	More detailed assessment based on specific processes
		Conflict with other staging/storage/treatment site uses	Requires knowledge of site, access issues, etc	More detailed assessment based on specific processes; stakeholder inputs
	Compliance with government regulations and standards in the short and long terms	Do sediments meet criteria for site u	For disposal or beneficial re-use, comparison of sediment contaminant levels with disposal and/or	More detailed assessment based on tor inputs
Effectiveness at reducing ecological risk	Effectiveness at reducing risk over the long term	Number/severity/likelihood of long-term exposure pathways (ecological)	Generic, qualitative assessment	More detailed assessment based on specific processes
		Lifespan of risk reduction	Generic, qualitative assessment	More detailed assessment based on specific processes
		mode of risk reduction	destruction, removal, transfer, immobilisation, control?	destruction, removal, transfer, immobilisation, control?
	Effectiveness at reducing risk over the short term	Number/severity/likelihood of short-term exposure pathways (ecological)	Generic, qualitative assessment	More detailed assessment based on specific processes
		Time to reduction	Generic, qualitative assessment	More detailed assessment based on specific processes

Stoppers – a failure of feasibility criteria eliminates MA

These criteria address efficacy

Example fitness for purpose scores – dot colour is score; box colour is uncertainty

	Fitness for purpose or Overall Effectiveness														
	Feasibility										**Effectiveness at reducing risk**				
	Technical feasibility					Availability of sites				Compliance with government regulations and standards in the short and long terms	Effectiveness at reducing risk over the long term			Effectiveness at reducing risk over the short term	
options	Is MA appropriate for contaminants?	Is MA appropriate for sediments?	Is MA appropriate for site?	Is MA mature?	Is MA available?	Disposal/use site availability	Conflict with other disposal/use site uses	Staging/storage/treatment area site availability	Conflict with other staging/storage/treatment site uses	Do sediments meet citeria for site use?	Number/extent of long-term exposure pathways (ecological)	Lifespan of risk reduction	mode of risk reduction	Number/extent of short-term exposure pathways (ecological)	Time to reduction
	FT1	FT2	FT3	FT4	FT5	FA1	FA2	FA3	FA4	FR1	EL1	EL2	EL3	ES1	ES2
1				------	------	------	------	------	--------	--------	--------	--------	--------	--------	--------
2															
3								------	--------	--------	--------	--------	--------	--------	--------
4											--------	--------	--------	--------	--------
5															
6															
7															

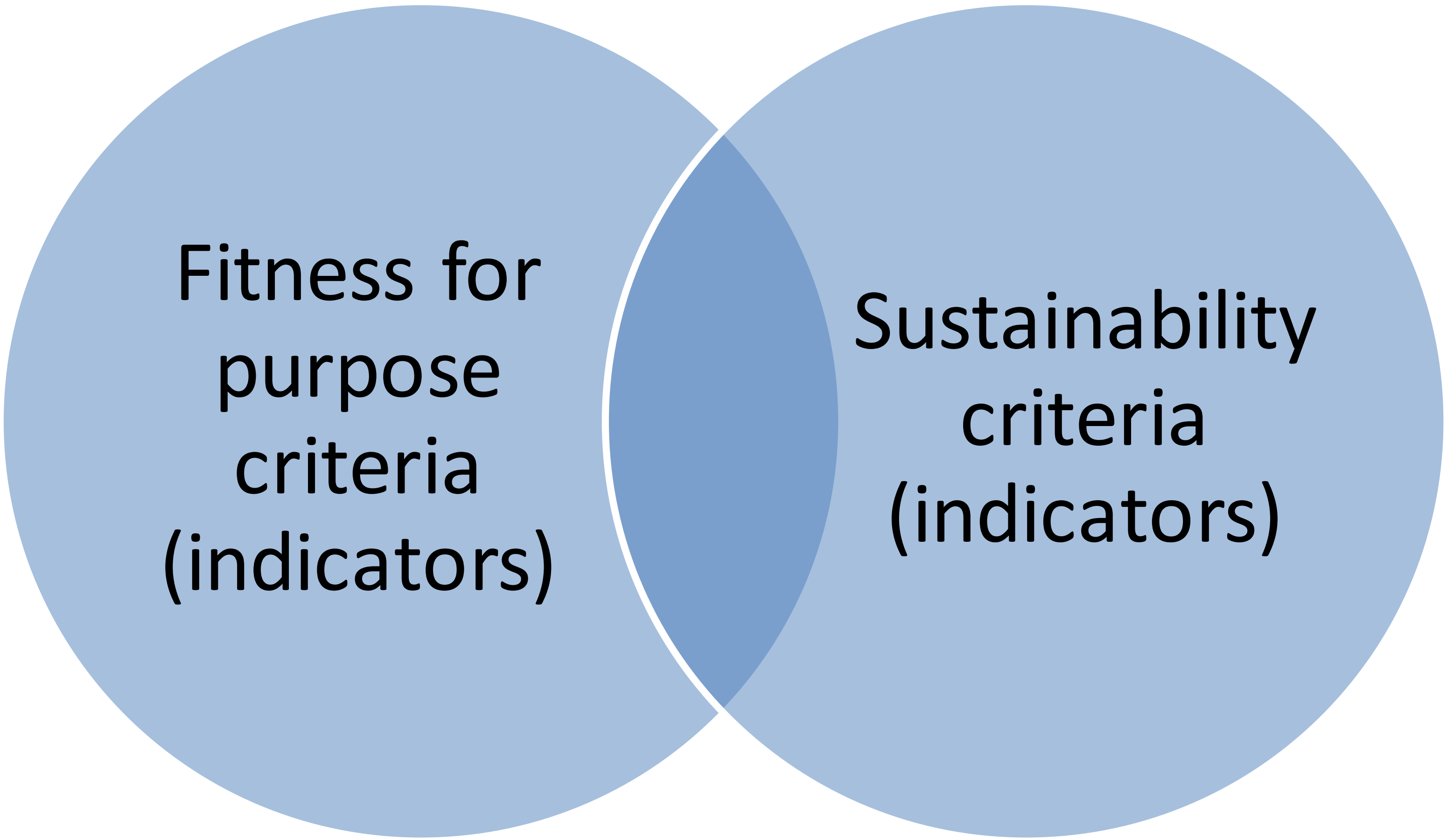
from C Vivian, R Edwards, S E Apitz and P Bardos (2011) *Guidance for the Decision Framework for Assessing Options for the Disposal and Treatment of Contaminated Dredged Material*, Cefas contract report ME5403 Module 18 Centre for Environment, 31 March 2011, Fisheries & Aquaculture Science, Lowestoft, UK.

Cost Criteria

	Criteria (broad)	Sub-Criteria/ Indicator	Approach - low tier Generally based upon generic approaches	Approach - high tier - based upon detailed project plans
Costs	Monetary cost (i.e. would the measure be disproportionately costly to implement) including any long-term monitoring and maintenance requirements as well as potential remediation if required	Capital cost	Generic, qualitative assessment	More detailed assessment based on specific processes
		OM cost	Generic, qualitative assessment	More detailed assessment based on specific processes
		Monitoring cost	Generic, qualitative assessment	More detailed assessment based on specific processes
		Maintenance cost	Generic, qualitative assessment	More detailed assessment based on specific processes
		Liability measures	Generic, qualitative assessment	More detailed assessment based on specific processes
		Failure cost	Generic, qualitative assessment	More detailed assessment based on specific processes

- Costs can be very project-specific so can only be roughly scored in early tiers.
- Care should be taken that all cost elements are considered, as monitoring, maintenance and liability costs may overwhelm initial project costs

Criteria in decision making encompasses fitness for purpose (will a dredged material management option adequately fulfill the *technical* requirements for it) and sustainability criteria. These overlap but are not exactly the same, and may be best managed as separate decision elements



Framework for CDM Management Sustainability Assessment

Start

Yes

Is the wider project design set?

No

TASK: Set dredging requirements as part of a wider development project (**Stage A)**

or

Progress but record
The reason for the
decision to progress

No

MILESTONE: Establish a sustainable dredging strategy to embed within the project design: dredged materials known

Sustainable?

Yes

Progress

MILESTONE:
Dredged materials
management specification

TASK: Select most Sustainable dredged material management option to deliver project objectives (**Stage B)**

Challenge project design

MILESTONE: Complete
MA Appraisal

Based on:

SuRF
SUSTAINABLE REMEDIATION FORUM UK

Progress but record
The reason for the
decision to progress

or

No

Sustainable?

Yes

Progress

Sustainability Assessment Indicators - Environmental

ELEMENT	CATEGORY	ISSUES THAT INDICATORS MIGHT NEED TO BE CONSIDERED
Environmental 1	**Impacts on air**	Emissions that may affect climate change or air quality, such as greenhouse gases (e.g. CO2, CH4, N2O), NOX, SOX, particulates (especially PM5 and PM10), O3, VOCs, ozone-depleting substances, etc. *(Note: Does not include any odorous effects, bioaerosols, allergens or dust, as these are included in 'Social 3: Impacts on neighbourhoods or regions'.)*
Environmental 2	**Impacts on sediment, soil, porewater and ground conditions**	Changes in physical, chemical, biological sediment or soil condition that affects the functions or services provided by sediments and soils. May include sediment/soil quality (chemistry), water filtration and purification processes, contaminant attenuation, sediment/soil structure and/or organic matter content or quality; soil/sediment, coastal and/or wetland erosion and stability, geotechnical properties, compaction and other damage to structure affecting stability, drainage, or provision of another ecosystem good or service. Impacts on geological SSSIs and geoparks.
Environmental 3	**Impacts on groundwater and surface waters**	Release of contaminants (including nutrients), dissolved organic carbon or silt/particulates, affecting suitability of water for potable or other uses, water body status (under WFD) and other legislative water quality objectives, biological function (aquatic ecosystems) and chemical function, mobilisation of dissolved substances. Effects of water abstraction included, such as lowering river levels or water tables or potential acidification. *(Note: Does not include any water abstraction use or disposal issues, as this is covered in 'Environmental 5: Use of natural resources and generation of wastes'.)*
Environmental 4	**Impacts on ecology**	Direct consequences for flora, fauna and food chains, especially protected species, biodiversity and impacts on SSSIs. Introduction of alien species. Significant changes in ecological community structure or function. Loss of habitat. Impacts of light, noise and vibration on ecology. Use of decontamination equipment or disposal sites or operations that affect fauna (e.g. affecting bird or bat flight, or animal migration, etc; environmental windows). Impacts on fish or marine mammals. *(Note: Does not include effects on soil and aquatic ecosystems, which are covered in 'Environmental 2: Impacts on soil and ground conditions' and 'Environmental 3: Impacts on water', whilst impacts of light, noise and vibration on humans are covered in 'Social 3: Impacts on neighbourhoods and regions'.)*
Environmental 5	**Use of natural resources and generation of wastes**	Consequences for land and water resources, use of primary resources and substitution of primary resources within the project or external to it, including raw and recycled aggregates. Use of energy/fuels taking into account their type/origin and the possibility of generating renewable energy by the project. Handling of materials on-site, off-site and waste disposal resources. Water abstraction, use and disposal.
Environmental 6	**Intrusiveness**	Impacts on flooding or increase risk of flooding, coastal erosion; alteration of landforms that affect environment, (e.g. a "natural" view). *(Note: Does not include effects on built environment and protection of archaeological resources, which are covered in 'Social 3: Impacts on neighbourhoods or regions', whilst affects on ecology are covered in 'Environmental 4: Impacts on ecology'.)*

Sustainability Assessment Indicators - Social

Social 2	**Ethical and equity considerations**	How are social justice and/or equality addressed? Is the spirit of the 'polluter pays principle' upheld with regard to the distribution of impacts and benefits? Are the effects of works disproportionate to, or more beneficial towards, particular groups? What is the duration of remedial works and are there issues of intergenerational equity (e.g. avoidable transfer of contamination impacts to future generations)? Are the businesses involved operating ethically (e.g. open procurement processes)? Does the treatment approach raise any ethical concerns for stakeholders (e.g. use of genetically modified organisms)?
Social 3	**Impacts on neighbourhoods or regions**	Impacts to local community, including dust, light, noise, odour and vibrations during works and associated with traffic, including both working-day and night-time / weekend operations. Effect of antisocial use of site, and its impact of other regeneration activities. Impacts on the built environment, architectural conservation, conservation of archaeological resources. Effect of the project on local culture and vitality. *(Note: Does not include effects or perceptions of a "natural" view, which is covered in 'Environment 6: Intrusiveness'.)*
Social 4	**Community involvement and satisfaction**	Impacts of works on public access to services (all sectors – commercial, residential, educational, leisure, amenity). Inclusivity and engagement in decision making-process. Transparency and involvement of local community, directly or through representative bodies
Social 5	**Compliance with policy objectives and strategies**	Compliance of the works with policies, regulatory standards and good practice as set out nationally, by local authority, at the request of community and/or in line with industry working practices and expectations. Do sediments to be disposed of or beneficially used meet regulatory criteria for endpoint?
Social 6	**Uncertainty and evidence**	How has sustainability assessment been carried out and what has it considered? Quality of investigations, assessments (including sustainability) and plans, and their ability to cope with variation. Accuracy of record taking and storage. Requirements for validation/verification.

Sustainability Assessment Indicators - Economic

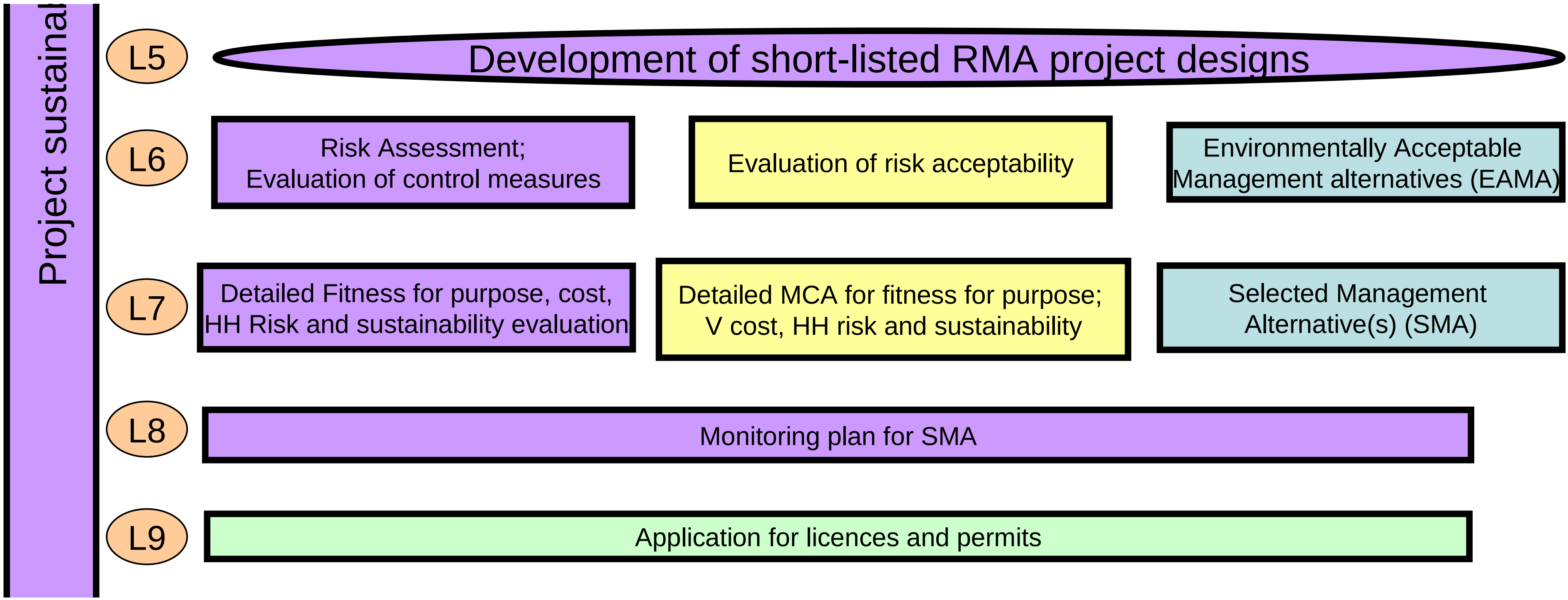
Economic 1	**Direct economic costs and benefits**	Direct financial costs and benefits of remediation, disposal option or beneficial re-use for organisation, consequences of capital and operation costs, and sensitivity to alteration (e.g. uplift in site value to facilitate future development, minimisation of risk or threat of legal action)
Economic 2	**Indirect economic costs and benefits**	Long term or indirect impacts and benefits, such as financing debt, allocation of financial resources internally, changes in site/local land/property values, and fines and punitive damages (e.g. following legal action, so includes solicitor and technical costs during defence). Consequences of an area's economic performance. Tax implications. Financial consequences of impact on corporate reputation. (*excluding factors considered under induced economic benefit)*
Economic 3	**Employment and employment capital**	Job creation, employment levels (short and long term), skill levels before and after, opportunities for education and training, innovation and new skills
Economic 4	**Induced economic benefit**	Creating opportunities for inward investment, use of funding schemes, ability to affect other projects in the area / by client to enhance economic value
Economic 5	**Life span and project risks**	Duration of the risk management (remediation) benefit, e.g. fixed in time for a containment system); factors that might impact the chances of success of the remediation works and issues that may affect works, including community, contractual, environmental, procurement and technological risks. ELD liability implications?
Economic 6	**Project flexibility**	Ability of project to respond to changing circumstances, including discovery of additional contamination, different sediment materials, or timescales. Robustness of solution to climate change effects. Robustness of solution to altering economic circumstances. Requirements for ongoing institutional controls. Ability to respond to changing regulation or its implementation

Example of Assessment Outcome at end of Level 4 – MAs 5-7 would be short-listed for further assessment

Option	Feasibility	Effectiveness	Cost and Benefits	Human health	Sustainability	Short-listed
1	M		M	M	M	No
2	H	M	M	M	M	No
3	H		M	M	M	No
4	H		M	M	M	No
5	H	H	H	H	M	Yes
6	H	H	H	H	M	Yes
7	H	H	M	M	M	Yes

Colours are scores; letters are level of certainty

Higher tiers of assessment require detailed project designs



- Project designs are developed for short-listed RMAs so that project-specific costs and risks can be evaluated
- These are subjected to more quantitative MCA
- Selected Management Alternative (SMA) informs monitoring plan and applications

Conclusions

- A tiered approach with uncertainty assessment seeks to minimise unnecessary assessments
- Examination of all criteria seeks to avoid premature elimination of sustainable options
- Early tiers can use generic scoring tables, but site- or project-specific information can be applied where available
- In many cases, early scoring will be rapid, using expert knowledge
  - The process can then document decision basis and ensure that all parameters have been considered

- For more information:
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  - Paul Bardos (paul@r3environmental.co.uk)
  - Sabine E. Apitz (drsea@cvrl.org)
  - Draft tiered framework at: http://archive.defra.gov.uk/corporate/consult/ports-marinas/summary-responses.pdf
- This project was funded by the UK Department for Environment, Food and Rural Affairs
- Approach presented is still draft and under consideration