Report

Dudley Creek Flood Remediation

Downstream Options Multi Criteria Analysis (MCA)

Prepared for Christchurch City Council

Prepared by Beca Ltd (Beca) and Opus International Consultants Ltd (Opus)

10 June 2015

Revision History

Revision Nº	Prepared By	Description	Date
1	Stephanie Brown	Issued for information in advance of MCA criteria workshop (schedule for 30 April 2015)	22 April 2015
2	Stephanie Brown	Issued following MCA criteria workshop (30 April 2015) with draft criteria added	11 May 2015
3	Stephanie Brown	Criteria updated following review by MCA workshop participants	20 May 2015
4	Alex Jenkins	Updated to include Option C	10 June 2015
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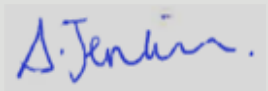
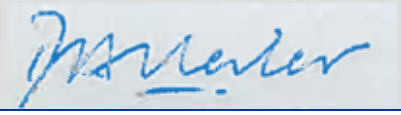
Document Acceptance

Action	Name	Signed	Date
Prepared by	Stephanie Brown and Alex Jenkins		10 June 2015
Reviewed by	David Heiler		10 June 2015
Approved by	David Heiler		10 June 2015
on behalf of	Beca Ltd and Opus International Consultants Ltd		

Executive Summary

To update following MCA criteria workshop and MCA scoping workshop

Contents

1 Introduction

Note this report when complete will form the MCA process and outcomes report that results in a recommended downstream option for the Project.

As of 10 June 2015 this report covers the process for undertaking the MCA and evaluation criteria developed following the workshop on 30 April 2015 and updated for comments by workshop participants.

1.1 Background

This report sets out the steps to run an assessment process in order to evaluate the shortlisted options for the downstream section of the Dudley Creek Flood Remediation project (Project).

As part of the project, the Council has resolved to undertake further analysis of three options for increasing the flow capacity of Dudley Creek downstream of Warden Street. These options are:

- Option A – Warden Street Bypass and Banks Avenue Channel Works
- Option B – Warden Street Bypass, Marian College, Richmond Park and Residential Red Zone Bypass
- Option C – Stapletons Road Channel Works, Petrie Street, Randall Street and Medway Street Piped Bypass.

The Project scope requires that the options are evaluated using a Multi Criteria Analysis (MCA) framework – a framework belonging to the Multi Criteria Decision Making (MCDM) group of frameworks. MCDM is the umbrella term for "the study of methods and procedures by which concerns about multiple conflicting criteria can be formally incorporated into the management planning process"[1]

1.2 Why use MCA?

MCA is suitable when an intuitive approach is not appropriate, for example because the decision-maker(s) feel the decision is too large and complex to handle intuitively, because it involves a number of conflicting objectives, or involves multiple stakeholders with diverse views. Often there is a desire for a formal procedure so that the decision making process can be made open and transparent, and is seen to be fair.

A MCA model is a software package in which alternatives and criteria are specified, data is entered and MCA method is undertaken to process the decision.

A key feature is its emphasis on the judgement of the decision making team, in establishing objectives and criteria, assessing relative importance weights and, to some extent, in judging the contribution of each option to each performance criteria.

MCA has many advantages as:

- it is open and explicit
- the choice of criteria that any decision making group may make are open to analysis and to change if they are felt to be inappropriate
- scores and weights, when used, are clear and are developed according to a process

[1] MCDC Society, 2006

- it can provide an important means of communication, within the decision maker and sometimes, later, between that body and the wider community
- it provides an audit trail.

However, it is important to remember MCA is a tool and that people make decisions. The MCA process assists people in making decisions. That assistance can take many different forms including: providing structure to discussions, documenting the process, separating matters of fact from matters of judgement, making value judgements unambiguous, creating shared understanding about the issues, generating a sense of common purpose and often, gaining agreement about the way forward.

1.3 The Assessment Process

All option assessments require a clear documented process in order to understand how the decision was made. The key test of an option evaluation process is that other experts in the field should be able to repeat the process and come to the same decision.

The process is:

1. Establish the decision context – the purpose of the MCA, identify the decision maker(s) and other key players, design the assessment system
2. Identify the options to be assessed to achieve the objectives
3. Identify the criteria
4. Scoring – describe the consequences of the options, score the options on the criteria, check the consistency of the scores on each criteria
5. Weighing – assign weights and scores to each option to reflect their relative importance to the decision
6. Combine the weights and scores for an overall value
7. Examine the results
8. Sensitivity Analysis

2 Decision Context

The purpose of the MCA is to use it to evaluate the three shortlisted options for the downstream section of the Project.

The decision maker(s) are:

- Christchurch City Council

Other parties involved in the Project are:

- Stakeholders – CERA, Marian College, Ministry of Education (Shirley Boys High School), CCC Parks (Richmond Park), Ngai Tahu
- Directly affected parties – landowners whose property would be required
- Landowners adversely impacted by EQ related change to flood risk (those benefitting from the proposed works)
- Community affected by proposed works (but not directly affected by land acquisition)

The key players are anyone who can make a useful and significant contribution to the MCA. Key players are chosen to represent all the important perspectives on the subject of the analysis. The key players are:

- Engineering
- Ecology
- Landscape
- Consenting
- Property

3 Project Objectives

The objectives of the Project have been proposed by the project team and accepted by CCC following some refinements. The primary project objective is:

> *Return the Flockton Street area to pre-EQ levels of flood risk as measured by the number of consented residential floor levels that are modelled to flood in the 1 in 10 year and 1 in 50 year storm.*

In doing so the Project must achieve:

- Achieve the primary objective of returning flood risk to pre-EQ levels in the Flockton St area
- Meet the timelines imposed on the project. These are:
  - Commence construction by August 2015 for the agreed alignment for the "Upstream" portion
  - Make a recommendation on the preferred option for the" Downstream" portion by August 2015
  - Achieve the primary objective and substantially complete construction by August 2017
- Obtain Resource Management Act (RMA) and building consents to undertake the works
- Maintain compliance with RMA and building consents
- Secure property and access required for the project
- Work within a budget (currently set by CCC at $48M but to be confirmed)
- Solution to meet the requirements of the CCC Waterways, Wetlands and Drainage Guide

There are other what can be called 'nice to haves' that we would also like to do:

- Provide additional flood risk benefits over and above the primary objective
- Enhance CCC's and our own reputation with CCC, the public and stakeholders
- Improve amenity value along waterways
- Provide enhanced ecological habitats along waterways
- Develop solutions which consider the operation of the entire drainage network over the whole of its life

Setting objectives is important because the criteria used when comparing the options are closely linked to the objectives. In addition, if designation under the RMA is sought it is necessary to demonstrate that the option selected will meet the objectives of the project.

4 Options to be Assessed

The options to be assessed are:

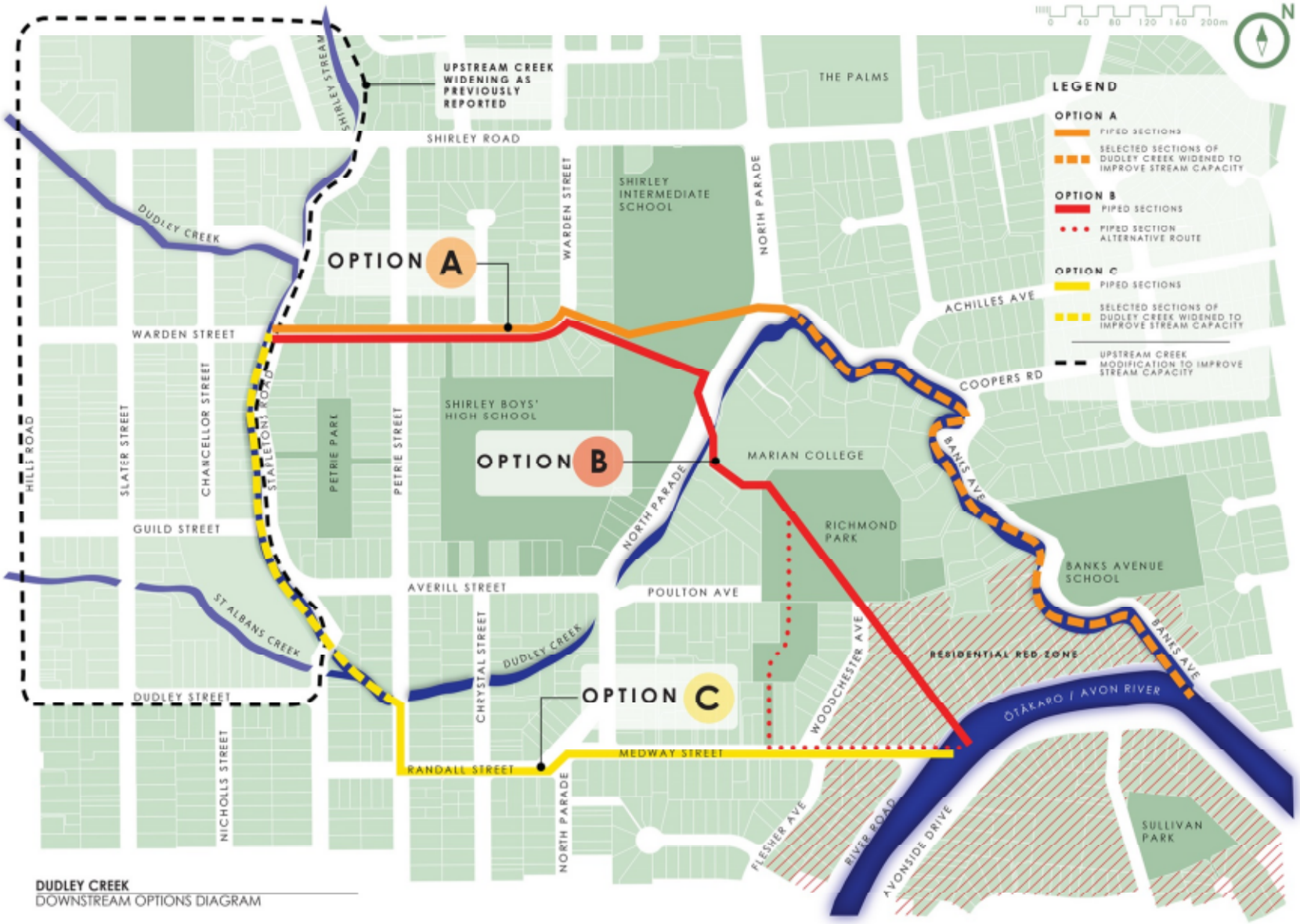
- Option A Corridor – Warden Street Bypass and Banks Avenue Channel Works
- Option B Corridor – Warden Street Bypass, Marian College, Richmond Park and Residential Red Zone Bypass
- Option C Corridor – Stapletons Road Channel Works, Petrie Street, Randall Street and Medway Street Piped Bypass

The above are corridor options. Within these options the following sub-options are currently being investigated to assess their viability:

- Option A sub-options:
  - Option A1 – Warden Street Gravity Bypass and widening of Dudley Creek along Banks Avenue
  - Option A2 – Warden Street Pumped Bypass and widening of Dudley Creek along Banks Avenue
  - Option A3 – Warden Street Pumped or Gravity Bypass and lift pump station at the Avon River end of Dudley Creek, with no channel widening along Banks Avenue
- Option B sub-options:
  - Option B1 – Gravity Bypass along Warden Street and through Marian College, Richmond Park and Residential Red Zone Bypass
  - Option B2 – Pumped Bypass along Warden Street and through Marian College, Richmond Park and Residential Red Zone Bypass
  - Option B3 – Gravity Bypass along Warden Street and through Marian College, Richmond Park and along Medway St to Avon River (bypassing RRZ)
  - Option B4 – Pumped Bypass along Warden Street and through Marian College, Richmond Park and along Medway St to Avon River (bypassing RRZ)
- Option C sub-options:
  - Option C1 – widening of Dudley Creek along Stapletons Road, Gravity Bypass along Petrie Street, Randall Street and Medway Street
  - Option C2 – widening of Dudley Creek along Stapletons Road, Pumped Bypass along Petrie Street, Randall Street and Medway Street

Corridors A, B (with RRZ bypass option) and C are presented on the following sketch.

The corridor options will be assessed through the MCA process. The decision to pump or gravitate flows along these corridors will not be determined through the MCA process as there is only a minor difference in effects between pumping and gravitating. The decision to pump or gravitate flows will be investigated with the support of the ECI contractor.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LEGEND
OPTION A
PIPED SECTIONS
SELECTED SECTIONS OF DUDLEY CREEK WIDENED TO IMPROVE STREAM CAPACITY
OPTION B
PIPED SECTIONS
PIPED SECTION ALTERNATIVE ROUTE
OPTION C
PIPED SECTIONS
SELECTED SECTIONS OF DUDLEY CREEK WIDENED TO IMPROVE STREAM CAPACITY
UPSTREAM CREEK MODIFICATION TO IMPROVE STREAM CAPACITY
UPSTREAM CREEK WIDENING AS PREVIOUSLY REPORTED
OPTION A
OPTION B
OPTION C
SHIRLEY ROAD
SHIRLEY STREAM
DUDLEY CREEK
WARDEN STREET
GUILD STREET
AVERILL STREET
DUDLEY STREET
RANDALL STREET
MEDWAY STREET
POULTON AVE
ACHILLES AVE
COOPERS RD
BANKS AVE
HILL ROAD
SLATER STREET
CHANCELLOR STREET
STAPLETON ROAD
PETRIE PARK
PETRIE STREET
WARDEN STREET
NORTH PARADE
CHRYSTAL STREET
NICHOLLS STREET
WOODCHESTER AVE
FLESHER AVE
RIVER ROAD
AVONSIDE DRIVE
ST ALBANS CREEK
THE PALMS
SHIRLEY INTERMEDIATE SCHOOL
SHIRLEY BOYS' HIGH SCHOOL
MARIAN COLLEGE
RICHMOND PARK
BANKS AVENUE SCHOOL
RESIDENTIAL RED ZONE
ŌTĀKARO / AVON RIVER
SULLIVAN PARK
DUDLEY CREEK
DOWNSTREAM OPTIONS DIAGRAM

5 Criteria

5.1 Background

The purpose of identifying criteria is to develop the means by which the options will be tested and compared. Each criterion must be measurable, that is, it must be possible to assess, at least in a qualitative sense, how well a particular option is expected to perform in relation to the criterion. This means, for each criteria, answering the question:

> "Is it possible in practice to measure or judge how well an option performs on these criteria?"

This is done by understanding what would distinguish between a 'good' choice and a 'bad' one.

5.1.1 Criteria requirements

Developing criteria requires consideration of:

- Do the criteria capture all the key aspects of the objectives that are the point of the MCA
- Over what timeframe are the criteria assessed
- It must be possible in practice to measure or judge how well an option performs on the criteria
- The ability to distinguish between a good choice and a bad one
- Independent criteria - can you assign preference scores for the options on one criterion without knowing what the options' preference scores are on any other criteria?
- Avoid using two or more criteria that essentially measure the same attribute as this would essentially amount to double counting
- Are there criteria which are unnecessary?
- and finally, have we included all the criteria necessary to compare the options' performance?

In essence developing criteria is asking "what do we care about" and being able to "describe the consequence (what does it look like)".

5.2 Development of the Criteria

A workshop was held on 30th April 2015 to discuss potential criteria. The workshop was attended by:

- CCC - Project Managers, Surface Water Technical Consultants, Land Drainage Manager, CCC Land Drainage Unit Manager (in part) and Environment and Heritage Unit Manager (in part)
- Project Team - Consenting Lead, Design Lead - Upstream Section, Design Lead - Downstream Section, Team Leader, Landscape Lead, Ecology Lead.
- CERA – Horizontal Infrastructure team, Legal and Policy representatives.

5.2.1 Key areas to consider

The following list includes the outcomes that those at the workshop consider as key for the project.

The bottom lines

- Needs to meet primary objective, that is flood risk reduction in the Flockton St area
- Needs to have achieved the primary objective by August 2017

- Be acceptable to CERA from a process and issues considered point of view.

Hydraulic Performance

- Flood risk reduction benefits over and above primary objective (of flood risk reduction in the Flockton St area)

Cost

- Capital
- Capital renewals, operation and maintenance
- Whole of life cost

Long Term Sustainability

- Future proofed solution
- Resilience to damage in future natural hazard
- Ability to upgrade to convey higher flows (to provide increased level of service)
- Ability to adapt to climate change (coping with higher downstream water level or more intensive rainfall)

Operation

- Operability and maintainability
- Reliability/vulnerability during high flow event
- Health and safety risks during operation

Property, Consenting and Legal

- Risk of not meeting timetable due to consenting or property
- Risk of legal action – cost, reputation, delays
- Risk of delays due to reliance on CERA approval

Constructability

- Health and safety risks during construction (worker and public)
- Traffic and pedestrian impacts
- Noise and nuisance
- Disruption to public and services
- Risk of damage to other assets

Alignment with CCC's Wetland and Waterways Values (6 values, less drainage)

- Ecology
- Landscape
- Recreation
- Culture
- Heritage

Community

- Social cohesion
- Happy people

- Amenity effects
- The community is left with an asset

5.3 The Criteria Used

To ensure that the options were robustly assessed and relevant statutory requirements met, the MCA framework criteria factored in both cost, design and non-cost related outcomes. The non-cost outcomes essentially provide an assessment of the environmental, social and cultural 'effects' of the options, while the cost outcomes essentially focused on the economic component. Together, the non-cost, design and cost related outcomes provide a comprehensive assessment of the option.

Sub-criteria under each project outcome were developed to more clearly inform the assessment. The outcomes and sub-criteria are presented in full in the MCA scoring table (Table 5.1).

Flood Hazard Reduction

	Outcome	Criteria	Definition	Measurement
FLOOD REDUCTION	The degree to which the project provides mitigation of the flood risk	D1 – Vulnerability	Reliability of the option including any residual flood risk - design	The degree of robustness of the option and consequence of failure during a flood event
		D2 - Hydraulic performance / opportunity	Flood risk reduction over and above the primary objective of flood risk reduction in the Flockton St area	The number of properties that have improvements above the pre earthquake risk

Note that the project needs to meet the primary objective (flood risk reduction in the Flockton Street area). This means accepting that the options presented can meet the objective, otherwise they would not be assessed.

D1 is about how reliable the on-going 'operation' of the option is.

While there might be minor changes to the design options, it is to be assumed that no further optimisation would occur to the extent that it would change the outcomes

Cost

	Outcome	Criteria	Definition	Measurement
COST	The capital and ongoing costs of the project	C1 - Capital cost	Cost of design, consenting, property access/acquisition and construction	Construction cost estimate based on concept level design
		C2 - Whole of life cost	Whole of life costs including operation, maintenance and renewals	Whole of life cost estimate

The lowest cost option is to be seen as the preferred option under this criteria.

The cost includes:

- Capital cost:
  - All costs to design, consent, construct

  - cost and probability of discrete risks
  - cost of implementing the required mitigation for each option. *So if an option requires removal of a lot of established trees, but allows for mitigation in terms of replacement planting and enhancement, the mitigation cost is included in the capital cost criteria*
  - cost of property acquisition/easements - Including cost of property acquisition (total and partial) means the number of actual properties is not directly captured rather it is the total cost of purchase that is the measure. Impacts on property during construction and social impacts are considered in the environmental section.
- Capital renewal, maintenance and operation costs that are a component of the whole of life cost:
  - Cost to operate
  - Maintenance requirements – this captures the ability to maintain as this comes at a cost
  - Capital renewals (e.g. replacement of pumps and electrics at say 15 years)
  - having implemented health and safety requirements.

If there are other aspects of property acquisition that are not necessarily financially compensated for then these are captured elsewhere – e.g. social impacts, disruption during construction.

There is an indirect cost of ongoing flooding to properties if there is a delay in delivering the project due to legal challenge and extended land access negotiations. This will be reported separately from the capital cost of the scheme as it is not a direct cost to CCC. The cost and risk of this will be evaluated under the timeframe risk criteria (R2).

Environment

	Outcome	Criteria	Definition	Measurement
ENVIRONMENT	The project integrates well with the environment and any adverse effects on the ecology, landscape, recreation, heritage and culture are minimised	E1- Ecology - instream	The impact on the self-sustaining process and inter-relationships among plants, animals and insects	The degree of the adverse impact (instream and riparian) with the required mitigation in place
		E2 – Ecology: terrestrial	The impact on the self-sustaining process and inter-relationships among plants, animals and insects	The degree of the adverse impact with the required mitigation in place
		E3 - Landscape	The impact on the special character of sites and places, their aesthetic qualities and their meaning to the community	The degree of the adverse impact with the required mitigation in place
		E4 - Recreation	The impact on the active and passive recreation, play and the structures that support these activities	The degree of the adverse impact with the required mitigation in place
		E5 - Heritage	The impact on sites and activities of historical and natural significance	The degree of the adverse impact with the required mitigation in place
		E6 - Culture	The impact on Ngai Tahu and the community's perception of a resource and its values, indicated by community involvement in management, celebration of past events and	The degree of the adverse impact with the required mitigation in place

	Outcome	Criteria	Definition	Measurement
			planning for the future	
	The health and wellbeing of the community has been considered	E7 – Community impact (social)	The option provides for peoples wellbeing and sense of community	Qualitative assessment of impact – quality of life, community cohesion, health & wellbeing. This will be measured through consultation feedback
	Temporary effects from construction are managed	E7 - Construction	Effects of constructing the option including the natural environment, traffic, pedestrians, noise, disruption to public and services, health and safety risks, damage to other assets, access to private property.	The degree of adverse effect from construction activities

* E1 – 5 recognises the CCC's 6 Values (minus drainage). These values are expressed in the Waterways, Wetlands and Drainage Guide: Part A Visions.

It is the degree of the adverse effect even with appropriate mitigation in place (ie. we can't do something that has totally unacceptable effects) that is being assessed. The timeframe over which the impact is assessed will vary for each of the criteria. When the option assessment is undertaken the timeframe used for each criteria will need to be documented.

Consideration of the criteria excludes cost to implement mitigation and cost of property acquisition.

Long Term Sustainability

	Outcome	Criteria	Definition	Measurement
LONG TERM SUSTAINBILITY	The project is considered sustainable in the long term	S1 - Long term sustainability	Ability to future proof the solution whether that be for climate change, increased levels of service or resilience to damage in a future natural hazard	Qualitative assessment of the ability of the option to be future proofed

While a short term solution might met the current flooding issue it could preclude future opportunities or even the means to address future adverse effects (eg. climate change). This is not about the cost of enabling a future proofed solution, or the cost to fix something if a future natural hazard was to occur, but the ability to come along at a later date and provide additional benefit. By long term we mean 50+ years based on the life of the asset.

Risk

	Outcome	Criteria	Definition	Measurement
RISK	Risks have been managed to the extent practical	R1 - Legal Risk	The extent to which there is risk around legal action	The degree of unmanageable risk
		R2 - Timeframes	Not meeting timeframes due to consenting or property access agreements	The degree of unmanageable risk

	Outcome	Criteria	Definition	Measurement
		R3 – Red Zone land	Red Zone land - ability to acquire or access and use the land	The degree of risk around access to Red Zone land – purchase or easements and ongoing use

No project can be completely risk free but risks can be managed. This is about the degree of risk with each option, i.e. the extent to which there is risk around delays, legal action and CERA approval. It includes risk around residual flood risk. The risks around timing (ie. delivery of the project) are captured here.

6 Scoring

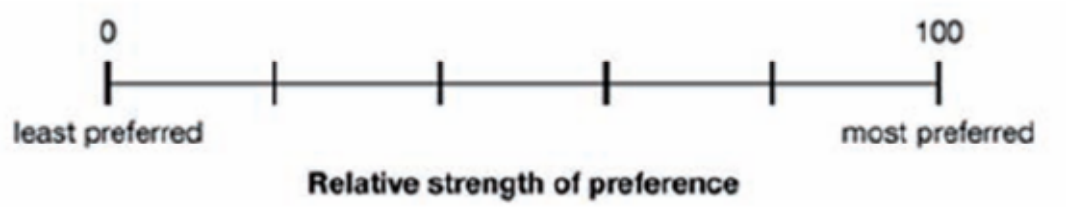
6.1 Background

MCA techniques commonly apply numerical analysis in two stages:

- Scoring
- Weighting

The expected consequences of each option are assigned a numerical score on a strength of preference scale for each option for each criterion.

In this way more preferred options score higher on the scale, and less preferred options score lower. Typically scales extend from 0 to 100, where 0 represents a real or hypothetical least preferred option (worst outcome), and 100 is associated with a real or hypothetical most preferred option (best outcome). All options considered would then fall between 0 and 100.



Once the end points are established for each criterion, there are three ways in which scores may be established for the options.

1. Value: to translate a measure of achievement on the criterion concerned into a value score on the 0 – 100 scale. The value functions are normally linear however, in some cases it may be appropriate to use a non-linear scale eg. noise levels are measured on a decibel scale is that non-linear

2. Direct rating: when a commonly agreed scale of measurement for the criteria in question does not exist, or where it is not possible for undertake the measures (eg. time or resources). Uses the judgement of an expert simply to associate a number in the 0–100 range with the value of each option on that criteria

3. Series of pairwise assessments expressing a judgement of the performance of each option relative to each of the others

Each of the three methods outlined above can also be used to establish the relative weights to be given to criteria.

6.2 Approach to Scoring

The way in which the criteria are scored will be determined once the criteria are confirmed. This will ensure that the way in which the criteria are assessed is using the end points

6.3 Outcomes of Scoring Process

This section will cover the outcomes of the scoring process – scheduled for 14 July 2015

7 Weighing

MCA decision preferences are expressed through criteria weights. In doing so the importance of each criteria relative to other criteria is expressed.

Weighing assigns weights for each of the criterion to reflect their relative importance to the decision. The process of deriving weights is fundamental to the effectiveness of a MCA.

Weighing techniques include[2]:

- Pairwise comparison –statements made of preference between pairs of criteria
- Swing weights –think about the attractiveness of the swing from worst to best on each criteria
- Ordinal ranking –rank criteria in order of importance
- Fixed point scoring –distribute a set number of points amongst the criteria
- Rating – assigning a score of importance to each criteria

Weighing to be done in a workshop – scheduled for 14 July 2015

7.1 Weightings Used

This section will document the outcomes of the weighting exercise

8 Sensitivity Analysis

Uncertainty is inherent in the MCA process because the decisions makers preferences, expressed as weights, are subjective values. Sensitivity analysis explores the robustness of the result(s) and how sensitive they are in changes to the model. It systematically varies the weights and/or data to see how they affect the results. If a minor variation in one criteria significantly influences the result, that parameter should be subject to further scrutiny.

9 Recommendation

This section will document any agreement on the way forward or make recommendations

[2] Harding reference