Integral Sustainability

Western Power Sustainability Assessment Peer Review

Eneabba to Moonyoonooka Transmission Line Corridor Selection

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Executive Summary

Western Power requested Integral Sustainability to conduct a peer review of the approach and methodologies applied in the Eneabba to Moonyoonooka Transmission Line Corridor selection process. The corridor selection process was undertaken by Western Power and SKM through a highly effective process in which sustainability assessment and stakeholder engagement were integrated with planning processes in a way that ensured not only the selection of the most sustainable transmission line corridor, but a high level of community trust in Western Power. Both organisations are to be commended for their efforts.

This peer review has two main dimensions:

- a technical review of the multi-criteria analysis (MCA) methodology used, including confidence analysis using an alternative MCA technique; and
- a review of the sustainability assessment approach taken in the context of international practice and Western Power's commitment to corporate sustainability.

While the MCA technique of additive weighting used for the analysis of the impact data was found to be inappropriate given the qualitative nature of much of the data gathered, additional MCA analyses conducted as part of the peer review confirmed option 10 as the best corridor option. However, it is suggested that the use of alternative MCA techniques such as concordance analysis would have been more appropriate and defensible.

Some further suggestions have been made as to how future sustainability assessment processes could perhaps be streamlined and improved particularly in relation to constraints analysis.

The overall process has been reviewed in light of international sustainability assessment practice for the purpose of highlighting the further opportunities available to Western Power as they begin to develop and implement a corporate sustainability strategy. It is suggested that sustainability assessment should ultimately be integrated with planning and decision-making at many levels across the organization, and that the benefits of sustainability assessment in terms of delivering sustainable outcomes is likely to be even greater at more strategic levels of decision-making.

1 Introduction

Western Power requested Integral Sustainability to conduct a peer review of the approach and methodologies applied in the Eneabba to Moonyoonooka Transmission Line Corridor selection process (subsequently referred to in this report as 'the corridor selection process'). The corridor selection process was undertaken by Western Power and SKM, and was conducted in six phases within a sustainability framework. Three main potential corridors were identified, and a total of 16 corridor options were assessed, all of them being derivations of the three main corridors. Extensive data on the potential sustainability impacts of the corridors was gathered through a highly consultative process that actively engaged community members and other stakeholders.

In phase 6 of the process, the information was analysed by SKM using a multi-criteria analysis (MCA) approach to rank the 16 corridors and identify the preferred route for the transmission line. Options 4 and 10 were both rated highly in the MCA process with Corridor 10 performing slightly better overall. On this basis, option 10 was identified as Western Power's preferred transmission line corridor.

There are several drivers underpinning the decision to have the corridor selection process peer reviewed. Firstly, this is the first time that Western Power has undertaken an entire corridor selection process using a sustainability assessment approach and therefore it is keen to learn from the experience and identify improvements for future such processes. This is particularly important since Western Power has recently committed to implement sustainability within its decision-making processes across the organization.

Secondly, given that options 4 and 10 ranked so closely in the MCA analysis, Western Power is seeking assurance that the process was sufficiently robust to permit confidence in the results and the selection of option 10 as the preferred corridor.

Accordingly, there were two main dimensions to the peer review undertaken by Integral Sustainability:

- a technical review of the MCA methodology used, including confidence analysis using an alternative MCA technique; and
- a review of the sustainability assessment approach taken in the context of international practice and Western Power's commitment to corporate sustainability.

This report presents the findings of the peer review conducted by Integral Sustainability. Section 2 reviews the sustainability assessment approach taken, highlighting alternative approaches that may be relevant to the further development of sustainability assessment practice within Western Power. Section 3 focuses in detail upon the technical aspects of the MCA methodology applied by SKM as the analytical component of the sustainability assessment, identifying its strengths and weaknesses and providing supplementary analyses for the purpose of evaluating the degree of confidence that can be placed in the results of the MCA. Section 4 draws the discussion together and makes some recommendations that Western Power may wish to consider in planning future sustainability assessments.

2 Sustainability Assessment Review

Sustainability assessment is a general term that encompasses a range of processes that broadly aim to integrate sustainability concepts into decision-making. Across the many different forms of sustainability assessment now being applied in a wide range of decision-making contexts around the world, a simple distinction can be drawn between 'external' sustainability assessments that may be conducted by regulators as part of a project approvals process, and 'internal' sustainability assessments conducted by proponents themselves as part of their business planning and decision-making processes (Pope, 2006).

The corridor selection process conducted by Western Power and SKM is an example of an internal sustainability assessment. It has been conducted voluntarily for the purpose of assuring a final decision that is compatible with the principles of sustainability, and Western Power is to be commended on adopting this proactive path. It is suggested that experience gained from this corridor selection process will prove invaluable in the further development of sustainability initiatives within Western Power, since internal sustainability assessment that guides key business planning and decision-making processes is an important and powerful component of a corporate sustainability strategy.

This section of the report seeks to facilitate learning from the corridor selection process by considering the approach taken in the context of international sustainability assessment practice. It firstly considers two conceptual aspects of sustainability assessment that have been shown to influence the nature of the process and ultimately its sustainability outcomes, the framing of the assessment and the operationalisation of the concept of sustainability (Morrison-Saunders and Therivel, 2006). As recognised by Western Power and SKM, stakeholder engagement is essential for effective sustainability assessment, and therefore the role of stakeholders in the overall corridor selection process is also briefly reviewed.

2.1 Framing the Sustainability Assessment

The question framing a sustainability assessment defines the role of the assessment and its relationship with the overall decision-making process (Morrison-Saunders and Therivel, 2006; Pope and Grace, 2006). The framing question in this case could be articulated as, "What is the most sustainable corridor for the transmission line?"[1]

This is an example of an open question, and is typical of a sustainability assessment conducted for the purpose of internal planning and the selection of a preferred option from a range of alternatives. In contrast, a closed question might ask, "Is Corridor 10 sustainable?" Closed questions are more appropriate for external sustainability assessments conducted by regulators for the purpose of determining whether or not a proposal should be approved[2].

[1] It is noted that SKM made the clear distinction between 'corridor selection' and the more detailed 'route selection' process, thus maintaining an appropriately strategic focus throughout the assessment process.

[2] Regulatory sustainability assessment is relatively uncommon and as yet has no legislative backing in any Australian jurisdiction. However, The Western Australian Government has conducted several trial processes, including the assessment of the location of the Gorgon gas development on Barrow Island, the South West Yarragadee Water Supply Development assessment and the Fremantle Outer Harbour strategic assessment.

Sustainability assessments framed by open questions have far more potential to influence decision-making and ultimately to deliver more sustainable outcomes than those framed by closed questions (Morrison-Saunders and Therivel, 2006; Pope and Grace, 2006), and therefore represent best practice for internal sustainability assessment processes conducted to support planning and decision-making processes. MCA techniques are ideal for structuring sustainability assessments framed by open questions and evaluating the available alternatives to identify a preferred option.

However, the question in this case, although open, was fairly low level in the context of the kinds of business planning decisions Western Power could be expected to make. For example, the higher level, strategic decisions culminating in the decision to build the 330kV transmission line from Eneabba to Moonyoonooka had already been made prior to the commencement of the sustainability assessment in this case. The opportunities to deliver sustainable outcomes are maximized by sustainability assessments that are framed by questions that are both open and strategic. It is therefore recommended that Western Power consider building upon experiences in this case to also undertake sustainability assessment as part of its higher-level strategic planning processes.

2.2 Operationalising Sustainability

If, as stated previously, sustainability assessment seeks to integrate sustainability into decision-making, then sustainability assessment requires the interpretation or operationalisation of the concepts of sustainability in a way that is meaningful to the decision at hand. This is always a challenge: like concepts such as hope and justice, sustainability is somewhat ‘fuzzy’ and elusive, and is thus open to broad interpretation (Government of Western Australia, 2003).

Operationalising sustainability for decision-making requires the identification of sustainability criteria (effectively equivalent to the corridor selection process sustainability aspects, each of which has a corresponding sustainability principle). These criteria should reflect both accepted high-level sustainability principles, such as those included in the Western Australian State Sustainability Strategy for example (Government of Western Australia, 2003) and the issues pertaining specifically to the proposal or decision at hand. It has been observed that reconciliation of the two is often difficult and linkages are not always evident (Gibson et al, 2005).

Despite these challenges and difficulties, the invocation of the overarching principles is an important reminder of the ‘bigger picture’ of sustainability beyond the decision at hand, and the essentially integrated nature of the concept. In practice, however, the sustainability criteria identified as being relevant to relatively low-level decisions such as this one quickly fall into separate environmental, social and economic (and in this case also technical) categories and thus sustainability assessments of this type may also be called ‘triple bottom line’ assessments (Pope et al, 2004).

It should be noted at this point that MCA techniques have their own specific requirements for the operationalisation of sustainability and the identification of sustainability criteria. These are discussed in Section 3 as part of the MCA review.

For each criterion identified, best practice sustainability assessment seeks to (Pope and Grace, 2006):

- minimise negative impacts;

- maximise positive outcomes; and
- ensure that relevant acceptability criteria are met.

These aspects are discussed in the context of the corridor selection process in the following sections.

2.2.1 The positive and the negative

Sustainability assessment is generally considered to be different from many other forms of impact assessment because it seeks to generate positive outcomes rather than simply minimizing negative impacts. This concept is embodied in the Western Australian sustainability principle of 'net benefit from development', particularly in relation to resource development projects (Government of Western Australia, 2003)[3].

Few opportunities to achieve positive impacts were identified, as evidenced by Table 33 of the SKM report, which shows most of the predicted environmental and social impacts to be negative. Some of the positive outcomes that are identified are somewhat questionable, for example capital cost savings and operational cost efficiencies. It may have been better to score negatively with more negative scores for options that were more expensive. The results are somewhat skewed by allocating these financial issues positive results. The issue of scoring is discussed further in Section 3 of this report.

The lack of positive outcomes was more reflective of the nature of the decision than any deficiency in the sustainability assessment process; as already mentioned, the opportunities for positive sustainability outcomes are generally limited for lower-level decisions such as the corridor selection process, and in such cases attention is typically focused on selecting the option with the least negative impacts. This is reflected in the sustainability principles themselves, many of which are phrased "Avoid/reduce/mitigate". In these situations, often the only opportunity to generate positive outcomes is through the provision of environmental offsets that not just counter-balance adverse impacts, but go further to provide a net environmental benefit (EPA, 2006). The opportunities to mitigate and offset negative impacts could have been evaluated in more detail in the sensitivity analysis, as discussed further in Section 3.

It is entirely appropriate that a decision at this level and of this nature should focus on minimizing negative impacts. The point to be made from a strategic perspective is that other decisions, particularly more strategic planning decisions, may provide Western Power with greater opportunities to deliver positive sustainability outcomes as well as minimizing negative impacts. For example, a long-term strategic plan might recognize the need to minimize energy wastage, but also to maximize the availability of renewable energy. The application of sustainability assessment to strategic planning would support Western Power in maximizing its corporate contribution to sustainability.

2.2.2 The acceptable and the unacceptable

The issue of trade-offs is central to any discussion of sustainability assessment where a large number of potentially competing issues are considered simultaneously. In

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[3] In this sense it is similar to objectives-led Strategic Environmental Assessment (SEA), which is common in many parts of the world, and particularly Europe. However, while SEA is by definition applied to strategic planning processes, sustainability assessment can also be applied to projects and lower-level decisions.

particular, the potential for environmental concerns to be traded off for economic gain is a common criticism of sustainability assessment (Morrison-Saunders and Fischer, 2006). While some trade-offs are almost inevitable in any decision, some trade-offs may be acceptable while others are not (Gibson et al, 2005). The clear definition of acceptability limits, which define the point at which a negative impact becomes unacceptable, is a means by which unacceptable trade-offs can be avoided, because it can therefore be argued that a final decision that does not violate any defined acceptability limits is acceptable, even though it may involve trade-offs.

Acceptability limits can thus be considered equivalent to inviolable constraints or 'fatal flaws', and their identification and consideration is often one of the most challenging aspects of a sustainability assessment process. The difficulties facing decision-makers include:

- determining whether or not a constraint actually is an acceptability limit or a fatal flaw; and
- deciding at which point in the process and exactly how acceptability limits should be considered in the assessment and decision-making process.

These inherent challenges are recognised Section 4 of the SKM report, which makes a very useful distinction between significant constraints (analogous to acceptability limits) and management issues (analogous to negative impacts). Specifically, it is noted that some issues may have been identified as constraints too early in the process, whereas they were probably only management issues that could have been mitigated or even avoided at the route selection stage (SKM, 2007). This important point acknowledges that there are different levels of constraints along a continuum, and the difficulty of determining at which point 'unacceptability' is reached[4].

It is suggested that this self-observation by SKM is in fact one aspect of a certain lack of clarity about the way in which constraints have been considered in the process, particularly in relation to determining acceptability limits. While this is unlikely to have had any significant impacts on the sustainability assessment, and in fact has probably made the results more conservative, some comments are provided here that Western Power may wish to consider for future sustainability assessments.

The approach taken in the corridor selection process was to separate the constraints analysis from the impact analysis; that is, the constraints analysis was the basis upon which the possible corridors were identified, while the assessment of each corridor against the sustainability principles (criteria) provided the scores that were input into the MCA process from which the preferred corridor was selected. However, the relationship and linkages between the two sub-processes and the issues considered in each is not clearly defined; for example, 'aboriginal heritage and culture' is identified as a land use constraint issue (Table 23) and is also the subject of a sustainability principle in Table 27 ("Avoid/reduce/mitigate impacts on indigenous cultural heritage and encourage the rehabilitation/restoration of sites/areas where required"), whereas Native Title is not mentioned in the constraint analysis and only appears in the sustainability principle "Ensure that the transmission line does not unduly affect the cultural significance of areas subject to Native title claims". The principle "Minimise impacts on existing and potential

[4] As a minor point, it is suggested that for ease of reading and logical flow this discussion might be better placed later in the SKM report.

land use" effectively reiterates the purpose of the constraints analysis, while other sustainability principles already addressed in the constraints analysis related to impacts on buildings, visual amenity, and construction noise and vibration.

In the constraints analysis, stakeholders and the technical team were given a series of constraint issues and asked to firstly rate the importance of each, and then to define the distances at which an impact would be considered unacceptable, high, medium or low (Table 23). This analysis was then converted to a score (Table 24) and the cumulative weightings mapped using GIS (figures 14-18). Potential corridors were then selected to avoid areas with high cumulative weights. While the notion of unacceptability is clearly evident in this methodology, the use of cumulative weightings in this way does not guarantee that unacceptable impacts will always be avoided. For example, if an unacceptable impact has been identified in an area with respect to one constraint issue, but the impacts for all other constraint issues are low for the same area, then it could be determined from the cumulative weighting that the corridor could pass through this area, despite the unacceptable rating.

The result of this could be that the final corridor routes do indeed create unacceptable impacts or fatal flaws that must be considered again later in the decision-making process. This in itself is not a problem, and the MCA methodology is still valid under these circumstances, but it does indicate a certain degree of double-counting, which may also have contributed to the close results obtained in the MCA analysis, and perhaps also unnecessary complexity.

There are also some issues with the constraints identification process and particularly the allocation of acceptability distances for land uses. While this appears a very valid approach for land uses such as dwellings and other buildings, where impacts are somewhat subjective, it appears less justifiable for land uses such as the conservation estate, where it could be argued, for example, that impacts within a National Park are unacceptable while impacts outside it are acceptable and the issue of distance is less relevant. The use of acceptability distances to analyse constraints in this way means that in some cases the constraints analysis was a form of weighting, whereby participants indicated their high level of concern for certain issues by specifying long impact acceptability distances, whether or not this was meaningful. This point has been recognised by SKM.

An alternative approach to the constraints analysis would have categorically ruled out certain areas at this stage. In turn, this could mean that certain issues could be considered at the constraints stage and would not need to be considered again in the impact analysis. For example, if areas known to contain Threatened Ecological Communities were ruled out during the constraints analysis then there would have been no need to have the sustainability principle "Avoid/ reduce/ mitigate impacts on Threatened Ecological Communities" in the impact analysis since it would be known that all corridors already met this criterion.

Furthermore, the discussion on corridor optimization in Section 11 of the report highlights some issues that must now be considered at the final stage of the corridor and route selection process, for example areas where vegetation remaining represents less than 10% of pre-European levels and therefore further clearing would be unacceptable, which could have been identified as constraints much earlier in the process.

It is suggested that in future processes, acceptability limits should be defined as early as possible and unacceptable areas ruled out of consideration before options are identified, as far as possible. As already highlighted, it is recognised that it can be very difficult to categorically determine in advance what is acceptable and what isn't, as acceptability often depends upon circumstances. However, many acceptability limits are identified in legislation, and ultimately, as Western Power develops its corporate approach to sustainability, constraints may increasingly be identified from Western Power internal policies. The question that must be asked is, are there any things that Western Power would consider unacceptable? These would then be identified in the sustainability assessment as acceptability limits.

It is important to note that despite the issues discussed above, the constraints analysis was a very important part of the success of the overall process because it provided a means by which stakeholders could be actively and meaningfully engaged. The importance of this should not be underestimated.

2.3 Stakeholder Engagement

This process was considered an 'integrated sustainability assessment and comprehensive stakeholder engagement' process. The stakeholder engagement was one of the greatest strengths of the process; Western Power and SKM have recognised that local people are important sources of information and have harnessed this knowledge extremely effectively. The use of GIS technology to facilitate the stakeholder engagement was particularly effective.

As a result, one of the main benefits for Western Power is the increased trust that this sector of the community will have in Western Power and the avoidance of a potential negative and confrontational situation. Overall there was a sense of a truly collective decision-making process, as evidenced by the satisfaction questionnaires. This learning should be carried forward to more strategic levels of planning.

As Western Power begins to consider sustainability assessment as a framework for more strategic levels of decision-making, the potential of inclusive and deliberative processes to promote sustainability outcomes may be even greater.

2.4 Conclusions of Sustainability Assessment Review

Western Power and SKM have completed a very effective corridor selection process in which sustainability assessment was integrated with planning processes and stakeholder engagement in a way that ensures not only the selection of the most sustainable transmission line corridor, but a high level of community trust in Western Power. Both organizations are to be commended for their efforts.

Some suggestions have been made as to how future processes could perhaps be streamlined and improved, particularly in relation to constraints analysis. In particular it is recommended that:

- Acceptability limits be identified early in the process, as far as possible, enabling certain areas to be categorically ruled out of consideration;
- The relationship between constrains analysis and impact analysis be more clearly defined, recognising that some issues could be dealt with at the constraints stage and therefore be legitimately omitted from the impact analysis;

- An alternative to acceptability distances be considered for the assessment of some constraint issues.

The overall process has been reviewed in light of international sustainability assessment practice for the purpose of highlighting the further opportunities available to Western Power as they begin to develop and implement a corporate sustainability strategy. It is suggested that sustainability assessment should ultimately be integrated with planning and decision-making at many levels across the organization, and that the benefits of sustainability assessment in terms of delivering sustainable outcomes is likely to be even greater at more strategic levels of decision-making.

3 MCA Methodology Review

Multi-criteria analysis is a generic term that encompasses a variety of techniques used to choose the most desirable option from a range of options. It is particularly useful as a decision-aiding tool for sustainability, since it provides a framework within which a large amount of data across a wide range of dimensions can be managed and utilised in a structured way.

Some common terminology used in MCA techniques include:

1. **Options**: These are sometimes called 'alternatives'. In the MCA process often one of the options turns out to be better than the others. Sometimes, however, the outcome isn't so clear-cut. Usually the process eliminates the less desirable options but may only indicate that one or more other options are more acceptable than the others. MCA outcomes should be considered to inform the decision maker rather than to be the decision maker.
2. **Criteria**: In the corridor selection process these have been termed sustainability principles. Criteria are used to compare the options.
3. **Weights**: These indicate how important each of the criteria is relative to the other criteria. The higher the weight the more important the criterion.

The basic steps of any MCA process are (1) the identification of criteria (or sustainability principles in this case), (2) assessing and scoring the performance of each option against each criteria, (3) weighting the relative importance of the criteria, (4) analysing the scores and weights to generate an overall ranking of the options and (5) sensitivity analysis. There are many different ways in which each of these steps can be conducted, and it is very important that the most appropriate technique be selected for the decision at hand, particularly considering the type and quality of the available data.

Based on discussions with Western Power and SKM and a preliminary review of the project documentation, the MCA review conducted by Integral Sustainability has concentrated upon:

- Review of the appropriateness of the MCA techniques employed; and
- Assessment of the degree of confidence in the results, using alternative MCA techniques for comparative purposes.

These important issues are addressed in Sections 3.1 and 3.2, while other aspects of the MCA process are briefly discussed in Section 3.3.

3.1 *Review of MCA Technique Used*

There are dozens of MCA techniques in use that combine scores (principles) and the weight assigned to those scores in different ways, to generate the overall ranking of options. Not all of these techniques are necessarily new, for example cost-benefit analysis (CBA) is an MCA technique that compares options using the common basis of cost. More recently developed techniques include Evamix analysis and Concordance analysis, discussed further in section 3.1.5.

The technique applied in the corridor selection process was what is often referred to in MCA literature as the Additive Weight methodology. The Additive Weight methodology is the most intuitive and commonly used process to combine all the information in order to rank the options. Its relative simplicity and transparency are valuable characteristics that should not be downplayed, since it is important that the stakeholders understand how the information is processed and are comfortable with the process. The Additive Weight technique used and the limited range of scores were probably acceptable to the participants.

Although, as discussed below, additive weighting may not have been the most appropriate choice of technique or the one that delivered the ‘best’ outcome, it may at least have produced a good outcome that 'made sense' to the participants. The internal evidence of the document suggests that the public stakeholders were comfortable with the process.

However, for mathematical integrity, the additive weighting process has three important requirements:

1. the use of ratio-scaled scoring data;
2. the use of ratio-scaled weighting data; and
3. the use of a correct standardisation methodology for scoring data.

These three requirements are explained in the following sections and the corridor selection process is reviewed against them below.

3.1.1 The use of ratio-scaled scoring data

Ratio-scaled data is quantitative data, whereby a score of 2 is twice as good as a score of 1, and a score of 3 is 3 times as good as a score of 1. Qualitative data on the other hand doesn't inherently have this mathematical quality. Qualitative data may be scored with the numbers such as 1, 2 and 3, however these may represent qualities such as 'worst', 'mediocre' and 'best' or some other value such as 'red', 'blue' and 'green'. Hence with qualitative data the gap between assigned integers is rarely the same and therefore the scores cannot be added, subtracted, multiplied or divided. Hence qualitative data should not be used in the additive weight MCA technique.

In the corridor selection process some of the sustainability principles were essentially qualitative in nature, for example:

- “Minimise impacts on the landscape/local character of the area of interest”;
- “Ensure the transmission line can be accessed via the local road network”.

It is noted that it is often appropriate to use qualitative data when a large number of options is being considered, as it is not feasible or resource-effective to gather extensive quantitative data for every option. Furthermore, members of the community are often more comfortable with qualitative data. The issue therefore is not the qualitative data itself, but the way in which it has been used in this case.

The extent of the use of qualitative data is not explored in detail in this peer review as other evidence will be provided that suggests an alternative MCA methodology would be more appropriate.

3.1.2 The use of ratio-scaled weighting data

The SKM report suggests that weighting has been correctly handled in the corridor selection process and that workshop participants were clearly advised of the need for ratio-scaled weighting data, that is, for example, that a weight of say 8 is twice as important as a weight of 4 and a weight of 2 is only half as important as a weight of 4 etc. It is important to note for future reference that experience has shown a tendency amongst participants to 'order' the importance of the criteria and not truly weight the importance of the criteria using ratio-scale values. To counter this possibility a clear explanation of the process should always be presented.

It is also noted that the potential corridors were not presented to participants until after the weighting had been conducted, so that participants could not (consciously or sub-consciously) manipulate the weighting process according to personal corridor preferences.

Another potential issue is that the technical criteria were weighted by technical people. This is appropriate. On the other hand the social, environmental and economic criteria were weighted by public stakeholders. The additive weight methodology was then applied across all four perspectives. Given that there may have been inconsistencies between the comparative weighting values of these distinct groups, some sensitivity analysis of that potential differences in weights could have been undertaken. In section 3.2.2 this matter is taken up within the context of sensitivity analysis of an alternative MCA methodology.

3.1.3 The use of a correct standardization methodology for scoring data

To make the scores comparable between criteria (sustainability principles) requires a method of standardising the scores so that the best possible realistic outcome for each criterion has the same value as the best possible realistic outcome for another criterion. Likewise the worse possible realistic outcome for each criterion should have the same value as the worst possible realistic outcome for another criterion. Usually the range of standardized scores is between 0 (worst) to 1 (best), though any consistent range may be used. In the corridor selection process scores were standardised between -3 (worst) and +3 (best). This is an acceptable range.

Once the scores have been standardised they can be multiplied by their weights and these weighted standardized scores added across all criteria to give a final outcome, hence the term additive weighting (of the standardised scores). The higher the sum of the weighted standardised scores the better the option.

The corridor selection process was interesting in that it produced scores for the different criteria (sustainability principles) in a standardised format without first displaying the raw scores for each option within each criterion. It is more usual to produce a matrix (table) of original scores and then go through a more transparent standardization process to adjust the original scores into a comparable standardised range for all the criteria.

The process in this case was different but not inherently incorrect. The documentation clearly outlines the steps taken to adjust raw scores, such as distances developed using GIS methods, and to standardize them into 7 scoring bins, namely -3, -2, -1, 0, 1, 2 and 3. Given the uncertainty associated with some of the data the use of bins may be valuable. However one downside is the limited number of bins. Given the scores for many criteria were realistically limited to just four values, -3, -2, -1 and 0, it is immediately apparent that there is reduced scope for differentiating between the scores for the options, particularly those that are based on quantitative measurements. For example a score of 1.5 is not permitted. It is placed in the bin of either 1 or 2. A score of 2.5 likewise may be considered a 3 or a 2.

This rounding, especially of quantitative data, means a loss of precision and results in less opportunity to distinguish between options. On the other hand, given the inherent difficulty in handling qualitative data, the use of bins may help in some of the criteria. The loss of precision would to some degree correspond to the original lack of precision in scoring the qualitative data.

Furthermore, setting aside the issue of quantitative and qualitative scoring already discussed, there is an error in several of the criteria standardisation processes. As stated earlier, it is important in the standardization process to ensure that the worst realistic outcome and the best realistic outcome for each the criteria score the same values. In several of the criteria (principles) in the report the worst case is -3 and the best possible realistic outcome is 0, not +3. This is because these criteria measure impacts and positive scores of 1, 2 and 3 are not actually possible. While recognising that range of scores for some of the criteria in the standardization process is open to debate, that debate doesn't seem to be entertained in the report. This is a weakness in the report.

3.1.4 Conclusions of Review of MCA Technique Used

In summary there are several weaknesses in the Additive Weight technique used in the corridor selection process. While the weighting process appears to have been robust, the mixing of quantitative and qualitative criteria and the shortcomings of the standardisation methodology suggest that the MCA technique used may not have produced the 'best' outcome. The use of a limited range of standardised scores limited the scope for differentiation between options based on quantitative measurement, however it may have helped handle qualitative scores by automatically incorporating the lack of precision into the final outcome.

3.1.5 An Alternative Technique: Concordance Analysis

Concordance analysis is an appropriate alternative to additive weighting in this case, as it can handle a mixture of both qualitative and quantitative scores. Evamix requires the qualitative and the quantitative scores to be handled separately then recombined at the end, which isn't feasible given the time frame and the need to make informed decisions about each criterion.

One of the strengths of concordance analysis is that it doesn't use the mathematical operators of adding, subtracting, multiplying or dividing on the scores. Instead it just compares the scores between pairs of options for each of the criteria. Let us say we are comparing option 1 with other options. First, say, we compare it to option 2. If the score for option 1 in the first criterion is better than the score in option 2, option 1 is awarded the weight assigned to that criterion; if it is worse it isn't awarded the weight and instead that weight is allocated to option 2. The scores for the second criterion are then compared. Again the weight for that criterion is assigned to the option with the better score. (If the scores are the same, half the weight for that criterion is assigned to each of the options.) This is repeated for all the criteria. The awarded weights are added up for each option and divided by the sum of all the weights. The result is a number representing the percentage of the maximum possible. A good result is close to 1 (= 100%). A poor result is close to 0 (= 0%). This process is repeated until all options are compared to all the others.

The result is a concordance table as illustrated in Table 1. This table is the result of a concordance analysis on the final scores used corridor selection process (SKM, 2007). The table should be interpreted with the option named in the top row compared to the option named in the left most column. For example, the shaded cell with the value of 0.62 should be read as how option 10 compares to option 7. Option 10 received 62% of the weights in that comparison. It is therefore expected that Option 7 compared to option 10 should show 0.38 = 38%, which is does, as illustrated in the single cell with a double border.

Table 1: Concordance matrix of final scores

Options	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		0.47	0.48	0.54	0.54	0.48	0.46	0.52	0.55	0.59	0.46	0.51	0.50	0.47	0.50	0.52
2	0.53		0.49	0.58	0.56	0.52	0.47	0.54	0.55	0.59	0.48	0.51	0.52	0.49	0.53	0.55
3	0.52	0.51		0.58	0.55	0.52	0.48	0.54	0.57	0.61	0.49	0.53	0.54	0.50	0.56	0.57
4	0.46	0.42	0.42		0.50	0.44	0.42	0.48	0.49	0.54	0.44	0.45	0.48	0.44	0.46	0.47
5	0.46	0.44	0.45	0.50		0.44	0.42	0.48	0.53	0.57	0.48	0.47	0.50	0.49	0.48	0.48
6	0.52	0.48	0.48	0.56	0.56		0.46	0.54	0.57	0.59	0.50	0.51	0.53	0.50	0.52	0.53
7	0.54	0.53	0.52	0.58	0.58	0.54		0.58	0.59	0.62	0.53	0.55	0.58	0.54	0.58	0.60
8	0.48	0.46	0.46	0.52	0.52	0.46	0.42		0.53	0.57	0.48	0.45	0.50	0.48	0.50	0.50
9	0.45	0.45	0.43	0.51	0.47	0.43	0.41	0.47		0.54	0.47	0.42	0.46	0.47	0.49	0.48
10	0.41	0.41	0.39	0.46	0.43	0.41	0.38	0.43	0.46		0.42	0.42	0.44	0.43	0.44	0.44
11	0.54	0.52	0.51	0.56	0.52	0.50	0.47	0.52	0.53	0.58		0.48	0.52	0.51	0.54	0.53
12	0.49	0.49	0.47	0.55	0.53	0.49	0.45	0.55	0.58	0.58	0.52		0.54	0.53	0.53	0.53
13	0.50	0.48	0.46	0.52	0.50	0.47	0.42	0.50	0.54	0.56	0.48	0.46		0.49	0.49	0.48
14	0.53	0.51	0.50	0.56	0.51	0.50	0.46	0.52	0.53	0.57	0.49	0.47	0.51		0.54	0.52
15	0.50	0.47	0.44	0.54	0.52	0.48	0.42	0.50	0.51	0.56	0.46	0.47	0.51	0.46		0.52
16	0.48	0.45	0.43	0.53	0.52	0.47	0.40	0.50	0.52	0.56	0.47	0.47	0.52	0.48	0.48	
Sum	7.41	7.09	6.93	8.11	7.79	7.15	6.54	7.67	8.04	8.65	7.18	7.18	7.66	7.26	7.64	7.70
Min	0.41	0.41	0.39	0.46	0.43	0.41	0.38	0.43	0.46	0.54	0.42	0.42	0.44	0.43	0.44	0.44
Rank	9	14	15	2	4	13	16	6	3	1	12	11	7	10	8	5

The higher the sum the better the outcome. The maximum possible outcome would be 1 for each comparison, or a total of 15, because each option is compared to 15 other options. In this case option 10 is the best outcome as it is ranked number 1 with 8.65/15 = 58% of potential weights. Option 4 is the next best outcome. The third best outcome is option 9.

All MCA techniques have some weaknesses. While concordance analysis is very useful for analysing both quantitative and qualitative analysis, or a mixture of both, it doesn't allocate weights based on the absolute value of the score, just the comparative value of the score. Within a particular criterion, even if both scores in a pair wise comparison are poor, the weight is rewarded to the option that is better, even if only marginally better.

To help minimise this weakness a dominance matrix may be used. To form the dominance matrix each of the scores in the concordance analysis is compared to a threshold value. If it is higher than the threshold it is given a value of 1. If it is lower than the threshold it is given a value of 0. The results are summed to give the dominance value. The higher the dominance value the better the option. An example of a dominance matrix is given in Table 2; it is based on the concordance results in Table 1.

Table 2: Dominance matrix based on the Table 1 using a highest threshold possible so that one option dominates all others.

Threshold of 0.542 (the highest minimum in the second last row of the concordance analysis)

Options	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		0	0	1	0	0	0	0	1	1	0	0	0	0	0	0
2	0		0	1	1	0	0	0	1	1	0	0	0	0	0	1
3	0	0		1	1	0	0	1	1	1	0	0	0	0	1	1
4	0	0	0		0	0	0	0	0	1	0	0	0	0	0	0
5	0	0	0	0		0	0	0	0	1	0	0	0	0	0	0
6	0	0	0	1	1		0	0	1	1	0	0	0	0	0	0
7	1	0	0	1	1	1		1	1	1	0	1	1	0	1	1
8	0	0	0	0	0	0	0		0	1	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0		1	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0
11	0	0	0	1	0	0	0	0	0	1		0	0	0	1	0
12	0	0	0	1	0	0	0	1	1	1	0		0	0	0	0
13	0	0	0	0	0	0	0	0	0	1	0	0		0	0	0
14	0	0	0	1	0	0	0	0	0	1	0	0	0		0	0
15	0	0	0	0	0	0	0	0	0	1	0	0	0	0		0
16	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
Dominance	1	0	0	8	4	1	0	3	6	15	0	1	1	0	3	3
Rank	8	12	12	2	4	8	12	5	3	1	12	8	8	12	5	5

The ranking of the options in this dominance matrix (Table 2) are the same as the ranking of the sums in the concordance matrix (Table 1) for the top five options. After that the ranks change marginally. Often the two approaches produce similar results but not always. Using both methods is a form of sensitivity analysis.

3.2 Confidence Analysis

In this peer review further analysis of the scores developed in the corridor selection process has been undertaken to evaluate the degree of confidence that Western Power may place in the outcomes of the corridor selection process. The confidence analysis was undertaken in two phases:

1. **Refinement of Additive Weight Analysis:** It was considered desirable to check the calculations undertaken in the report as well as consider the outcome of using better standardisation techniques to counter some of the weakness in the standardization methodology actually used.
2. **Analysis by Alternative Technique - Concordance Analysis:** Given the earlier conclusion that the Additive Weight technique was not the best technique to use with a mixture of quantitative and qualitative scores, concordance analyses were undertaken on the scores. Concordance analysis was also used in a variety of ways to check the sensitivity of the outcomes.

The results of both these sets of analyses are displayed in Table 3. To distinguish between the various analyses the codes in the left hand column of the table will be used in the discussion that follows. In these codes AW stands for Additive Weight and C stands for Concordance.

Table 3: Summary of further MCA analysis of the SKM scores.

	Options:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Additive Weight Analysis																	
AW1	Standard Additive Weight using -3 to +3 scores	8	14	11	2	6	10	16	3	5	1	15	13	9	12	7	4
AW2	4 added to original scores (same as SKM method)	8	14	11	2	6	10	16	3	5	1	15	13	9	12	7	4
AW3	Ditto, but expressed as % of ideal	39.7	38.7	38.9	41.7	40.8	39.2	38.3	41.0	40.9	42.2	38.7	38.8	39.6	38.8	40.5	41.0
AW4	Ignore principles with same scores across all options	8	14	11	2	6	10	16	3	5	1	15	13	9	12	7	4
AW5	Add Wt using more realistic standardisation	10	14	15	2	6	13	16	4	3	1	11	12	7	9	8	5
AW6	Add Wt using max and min scores for standardization	9	12	15	2	7	10	16	4	5	1	13	14	8	11	6	3
Concordance Analysis																	
C1	Standard Concordance	8	12	12	2	4	8	12	5	3	1	12	8	8	12	5	5
C2	Ignore principles with equal scores for all options	8	12	12	2	4	8	12	5	3	1	12	8	8	12	5	5
C3	Equivalent number of principles in each perspective	7	7	11	2	4	10	13	7	2	1	13	13	11	13	5	5
C4	Equal perspective wts after separ-ate perspective concord rank	13	15	11	5	3	14	12	8	5	1	5	15	1	3	10	9
C5	Equal perspective wts after separ-ate perspective concord sum	11	13	15	5	3	12	16	9	3	1	5	13	1	5	9	8
C6	Technical perspective wts doubled	12	12	12	6	4	12	12	8	3	1	11	4	2	8	8	7

C7	Technical perspective wts halved	8	9	11	2	4	11	14	4	3	1	11	14	9	14	7	4
C8	Social perspective wts doubled	8	9	9	2	4	11	14	7	3	1	14	11	11	14	4	4
C9	Social perspective wts halved	10	14	14	3	5	10	14	7	2	1	10	7	4	10	7	6
C10	Environ perspective wts doubled	9	14	15	5	4	11	15	6	3	1	7	11	2	7	11	9
C11	Environ perspective wts halved	8	9	9	2	5	13	13	7	3	1	13	9	9	13	5	4
C12	Economic perspective wts doubled	8	8	11	2	4	8	13	6	3	1	13	13	12	13	6	5
C13	Economic perspective wts halved	12	12	12	5	3	12	12	7	2	1	10	7	3	10	7	6
Concordance Analysis on perspectives and sensitivity on their ranks																	
C14	Technical perspectives alone	14	14	8	10	6	14	8	10	6	3	5	3	1	2	10	10
C15	Social perspectives alone	8	11	4	1	8	11	4	7	10	6	14	11	16	14	2	2
C16	Environment perspectives alone	8	12	15	8	4	8	15	4	7	4	1	12	2	2	12	8
C17	Economic perspectives alone	4	4	4	1	4	4	12	4	1	1	15	13	13	15	4	4
C18	Sum	34	41	31	20	22	37	39	25	24	14	35	39	32	33	28	24
C19	Rank of sum	11	16	8	2	3	13	14	6	4	1	12	14	9	10	7	4

Table 4: The results of the SKM analysis of the data (taken from page 192 of the SKM report).

Options:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
% of Ideal	39.7	38.7	38.9	41.7	40.8	39.2	38.3	41.0	40.9	42.2	38.7	38.8	39.6	38.8	40.5	41.0

3.2.1 Refinement of Additive Weighting Process

The first point to make in rows AW1, AW2 and AW3 (Table 3) is that the peer review mathematics using a standard additive weight technique based on the SKM standardised scores produced exactly the same results as the SKM team. (In this peer review a rank of 1 is the best.). This confirms both that the SKM mathematics and the peer review mathematics in using the additive weight technique are consistent. It isn't saying that the MCA methodology used is the best, but it is saying that when the numbers are calculated using the same technique the same results are obtained. A comparison of row AW3 with Table 4 demonstrates that the "% of Ideal" are the exactly the same.

Row AW4: It is common, but not necessary, to remove criteria that score the same across all the options. Obviously this will not affect the ranking outcomes. Applying an Additive Weight analysis after removing these criteria resulted in exactly the same ranking. The "% of Ideal" changed very slightly; for example for option 10 it increased from 42.2% to 42.7%. This isn't a very significant matter, but it was considered worth checking. The results of other changes of the "% of Ideal" are not included as they were also found to be minor.

Row AW5: The importance of using a correct standardisation methodology was discussed earlier. In this analysis each of the criteria was re-examined. A more realistic range of the raw scores was chosen (the scores were not changed), in many cases limited to -3 to 0 as scores of 1, 2 or 3 were considered unrealistic. A new standardised matrix was developed and the additive weight analysis processed. The outcome indicates that there was some change in the rankings; however options 10 and 4 were still the strongest. This analysis shouldn't be considered definitive as the acceptable range for the scores wasn't debated with SKM or Western Power. It is likely that there would be some differences in interpretation of the potential range of realistic scores for some of the criteria. This approach can be considered a form of sensitivity analysis.

Row AW6: Often in additive weighting analysis the worst actual score for a criterion is standardized to 0 and the best actual score is standardized to 1. The results of adopting this approach are reflected in the outcomes, which can be considered another form of sensitivity analysis with options 10 and 4 coming out best. Option 16 improves to rank 3. Overall, however, there are few changes.

3.2.2 Further Concordance Analysis

In the subsequent rows in Table 3 concordance analysis was used. Given the weaknesses of the additive weighting technique, these concordance analysis results are significant as they handle the analysis differently. Concordance analysis in these circumstances is probably more robust than the additive weighting approach. It must be remembered that the raw scores in concordance analysis don't have to be standardised as the scores are compared and the weights assigned to the better option.

In row C1 the outcomes of a standard concordance analysis of the raw scores are shown. They are the same as the ranks shown in the worked example of concordance analysis illustrated in Tables 1 and 2. Option 10 is the best, followed by option 4.

Row C2: When criteria with the same scores across all options are removed this was the result. As expected it is the same outcome as C1.

In rows C3 to C19 a set of sensitivity analyses are carried out.

Row C3: Given that there were a different number of criteria within the four perspectives and therefore a potential for skewed results, the weights for each criterion within the perspectives were adjusted. As there were 9 technical perspectives, 10 social, 10 environmental and 3 economic the following adjustment factors were applied before the concordance analysis was processed:

The weights for the technical criteria were multiplied by 10/9.
The weights for the social criteria were multiplied by 10/10 (that is they were not adjusted).
The weights for the environmental criteria were multiplied by 10/10 (i.e. not adjusted).
The weights for the economic criteria were multiplied by 10/3.

The consequence of taking this approach is to create the effect of using an equal number of criteria in each perspective. Interestingly the outcome only showed a minor change in the ranking of the options even though the economic weights increased by 333%.

Row C4: In this case a concordance analysis was undertaken on the criteria within each perspective. The dominance rankings for each of these perspectives were, in turn, analysed using the concordance technique. A weight of 1 was applied to each perspective. This is the equivalent of saying that were 4 categories analysed, namely the technical, the social, the environmental and the economic. Sub-criteria were used to determine the scores for these categories. Then a concordance analysis was carried out on the 4 categories under the assumption that each one was important as the other. There is no way that we can test what weights the stakeholders would have given to these 4 categories as the question was never asked. Compared to other outcomes there was a significant change in the outcome rankings, yet option 10 remained the best.

Row C5: The results here are the outcome of the same process undertaken in the previous row except that the concordance sums, not the dominance rankings, were used in the subsequent concordance analysis. There are only minor changes compared to row C4, however option 10 came out the best.

Rows C6 to C13: These are sensitivity tests based on significantly increasing the weights between perspectives. For each perspective, in turn, the weights were doubled then halved whilst retaining the weights for the other perspectives. The variations in the technical weights was considered the most important to test because the criteria within that perspective were weighted by technical people whereas all the other criteria were weighted by the public stakeholders. There may have been some inherent differences in the weighting process between the groups. In all cases option 10 was the most robust. Options 9 consistent ranked well. Option 4 ranked second several times but was more variable than option 9. Thus the use of different groups to weight the criteria in the different perspectives didn't appear to have a significant impact on the overall outcome. Moreover option 10 was found to be robust over a wide range of weightings.

Rows C14 to C19: This is another form of sensitivity analysis. Each of the perspectives was analysed separately. The rankings over the four perspectives were then added. The outcome assumes that the perspectives all have equal weights. Again options 10 and 4 held up well.

3.2.3 Conclusion of Confidence Analysis

Although the additive weight method used in the corridor selection process contained methodological weaknesses, it produced a result that was consistent with a more robust use of the additive weight techniques and of the use of an alternative technique, concordance analysis.

This confirms that option 10 is the best option within the context of the process undertaken to involve technical persons as well as the public stakeholders. The use of numerous sensitivity approaches always resulted in option10 being the best ranked option when all the perspectives were taken into account.

Given the weaknesses, why did the Additive Weight methoodology used in the report produce similar results to the revised Additive Weight methodology suggested in this review and why did these in term compare so favourably with the Concordance analysis? The answer to this wasn't analysed in detail, however a quick review of the original scores for option 10 reveals that:

- the sum of all the scores was better than the some of all the scores for all the other options (without any weighting being considered)
- of the 32 principles it had the highest score in 15, a mid range score in 4, the lowest score in 6 and the same score for the remaining 5.

These two factors in themselves don't mean that the option 10 would always come out best but it does suggest that, depending on the weights used, it was always likely to come out towards the top no matter what MCA methodology was used. The various approaches and sensitivity analysis undertaken above confirmed this to be the case.

3.3 Other comments on MCA process

Some further reflections on sustainability principles (criteria) and sensitivity analysis are warranted.

3.3.1 Sustainability principles/criteria

The need for overarching sustainability principles to be operationalised for a specific decision-making context was discussed in Section 2.2 of this report. Some issues associated with the selection of sustainability criteria have also been discussed in the discussion of acceptability limits and constraints in Section 2.2.2. In this section, the sustainability principles/criteria used in the corridor selection process are reviewed against the principle of good MCA.

In the identification of appropriate sustainability principles for the corridor selection process, consideration was given to the availability of data to enable assessment of performance against the principles, and to the need for principles that would allow comparison of the corridor options, that is, principles against which the options could be distinguished (SKM 2007, p157).

In addition, suites of criteria suitable for application within MCA processes should have certain characteristics. Ideally, they should be (Annandale and Lantzke 2000):

- Complete, meaning that there should be no additional basis other than the defined criteria for distinguishing between options;
- Operational, that is able to be practically applied;
- Decomposable, meaning that each criterion should be able to be analysed independently of all others;
- Non-redundant, meaning that criteria should not overlap and therefore result in ‘double accounting’;
- Minimal, that is the smallest number of criteria possible while still embodying the previous characteristics.

There was a certain degree of overlap and redundancy in the sustainability principles. For example, Threatened Ecological Communities could be grouped with Declared Rare Flora and significant vegetation communities under a general title of “flora”. There is some overlap between the technical principle relating to delivery of the project within the required deadlines and environmental issues, since it is assumed that the project timeframes will be largely dictated by the environmental approvals process.

3.3.2 Sensitivity analysis

The quality of data used in MCA for the various criteria are rarely the same. Some are prone to being less accurate than others. Likewise in MCA some techniques are more useful and appropriate than others. A good MCA process will incorporate sensitivity analysis of both the data and the methodologies used.

The corridor selection process thoughtfully explored uncertainties within the data set by various means including aspect removal and perspective removal. On the other hand the report does not explore sensitivity by using another or other MCA techniques, or by using alternative weightings, a point noted by SKM in Section 4.6.2 of their report (SKM, 2007). Sensitivity analysis could have helped to assess potential mitigation and enhancement strategies and to further refine options.

Other forms of review and assurance were conducted outside the MCA analysis, all of which added to the robustness of the overall process. These included the level of confidence analysis, the qualitative comparison of corridor options 4 and 10, and the preliminary route inspection.

4 Conclusions

Western Power and SKM are to be commended on the corridor selection process. A sustainability assessment framework was utilised to assess and compare 16 potential transmission line corridors from Eneabba to Moonyoonooka in a highly consultative process.

The most significant finding of this peer review is that the MCA technique of additive weighting used for the analysis of the impact data was inappropriate given the qualitative nature of much of the data gathered. Other issues were identified with the way in which the scores were standardised. These problems could have been overcome by the use of an alternative technique, such as concordance analysis, which does not require ratio-scaled scoring data and is thus more suitable for more qualitative assessment processes. However, it is recognised that the additive weighting technique does have the advantage of being transparent and easily understood, which may have contributed significantly to the acceptance of the process by the community and other stakeholders.

Very significantly for Western Power, alternative MCA analyses conducted as part of the peer review process demonstrated that despite the limitations of the analytical technique used, option 10 was clearly confirmed as being the best option.

Some further suggestions have been made as to how future sustainability assessment processes could perhaps be streamlined and improved, particularly in relation to constraints analysis. It is recommended that:

- Acceptability limits be identified early in the process, as far as possible, enabling certain areas to be categorically ruled out of consideration;
- The relationship between constrains analysis and impact analysis be more clearly defined, recognising that some issues could be dealt with at the constraints stage and therefore be legitimately omitted from the impact analysis;
- An alternative to acceptability distances be considered for the assessment of some constraint issues.

The overall process has been reviewed in light of international sustainability assessment practice for the purpose of highlighting the further opportunities available to Western Power as they begin to develop and implement a corporate sustainability strategy. It is suggested that sustainability assessment should ultimately be integrated with planning and decision-making at many levels across the organization, and that the benefits of sustainability assessment in terms of delivering sustainable outcomes is likely to be even greater at more strategic levels of decision-making.

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Integral Sustainability
20th July 2007

5 References

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