Infrastructure Sustainability Council of Australia

IS Materials Calculator Guideline

Infrastructure Sustainability (IS) rating scheme

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INTRODUCTION

Introduction

This document explains the methodology behind the Mat-1 credit: Materials Life Cycle Impact Measurement and Reduction and the IS Material Calculator in the Materials Category of the Infrastructure Sustainability (IS) rating scheme, developed and administered by the Infrastructure Sustainability Council Australia (ISCA).

The IS Materials Calculator evaluates environmental impacts in relation to use of materials on infrastructure projects and assets. It should be used in conjunction with the Mat-1 credit in the Materials Category of the IS rating scheme.

Background

The global demand for resources is forecast to rise significantly this century. Increasing our resource efficiency (or 'eco-efficiency') is not only an environmental issue but will be vital to ensuring long-term economic prosperity for the global economy.

Infrastructure construction and operation has implications for materials selection and use. Infrastructure uses a large quantity, but relatively small number, of key materials but in a myriad of combinations and dimensions from different sources powered by different energy grids etc. In addition, there may be different implications for structural design of some infrastructure based on location and climate. For many infrastructure projects/assets the transport of the materials and hence their sourcing is highly significant. Equally there are often many opportunities to reuse materials locally would otherwise have been disposed to landfill.

Purpose

The primary purpose of these guidelines is to provide guidance for assessors who are preparing evidence and supporting documents as part of their self-assessment submission.

This document can also be used to:

- Provide guidance to other users of the IS Materials Calculator.
- Provide background information on the development of the IS Materials Calculator.
- Outline additional guidance to be used in conjunction with the existing guidance in the IS Technical Manual for the Mat-1 credit.

IS RATING SCHEME – MATERIALS

Materials category objective

The broad objective of the Materials category is to minimise the consumption of precious resources, optimise resource efficiency and reduce the environmental impacts of infrastructure through life cycle - cradle to cradle thinking. This approach encourages a move towards a world where natural resources are consumed no faster than the planet can replenish them and environmental pollution is released at a rate that is within the earth's carrying and rejuvenating capacity.

The credit for materials lifecycle measurement and reduction

The Mat-1 Credit: Materials Life Cycle Impact Measurement and Reduction uses a Materials calculator to assess the lifecycle impact of materials use on a project/asset. The user enters product quantities and transport distances and the calculator compares the impact of a project/asset's material use with a base case (reference case) for a range of materials. The aim of this credit is to reward the reduction of life cycle environmental impact of materials.

By completing the relevant sections of the calculator for a base case and then for the actual case, the reduction in environmental impact achieved (measured as IS EnviroPoints) determines the respective level achieved in the Mat-1 credit:

Level 1: Measurement of impact (but no reduction).
Level 1 to 3 on a sliding scale: A reduction in environmental impact of 0 to 30% achieves Level 1 to 3 on a sliding scale. Fractions of levels are allowed under the IS rating scheme Version 1.2 but not for earlier versions. See later in this guideline for details.

See the IS rating scheme Technical Manual 'Using Resources' section for more details on the base case approach.

The IS Materials Calculator provides a level playing field assessment tool for the embodied material impacts. The calculator can be used to inform design to use resources more efficiently and select lower impact materials and product options.

LIFE CYCLE ASSESSMENT – THE BASIS FOR THE IS MATERIALS CALCULATOR

Introduction

Life cycle assessment (LCA) is a methodology used to estimate the overall environmental impact of materials or products during their lifetime. LCA is the only method that assesses the environmental impacts of a product or activity (a system of products) over its entire life cycle that takes into account:

- Extraction and treatment of raw materials
- Product manufacturing
- Transport and distribution
- Construction processes
- Use-phase or Operation (maintenance and replacements are accounted for in the material calculator)
- End of life (not included in the material calculator)

LCA is used to measure the environmental impacts across a product's life cycle and to help avoid burden shifting between life cycle stages and/or types of environmental impacts. This means minimising impacts at one stage of the life cycle, or in a geographic region, or in a particular impact category, while helping to avoid increases elsewhere. For example, reducing the volume and impact of the initial construction materials, but with higher operational and maintenance impacts.

The main goals of LCA are to lessen the environmental impacts of products and services by guiding the decision-making process.

Australian construction products life cycle data sources

The IS Material Calculator includes calculated embodied environmental impact factors for the "cradle to manufacturer gate" for a wide range of typical construction materials. The transport component from the manufacturer's gate to the "project/asset (entry) gate" can vary significantly between project/assets, so the IS Material Calculator also includes the transport component for each material or product.

The IS Materials Calculator is based on the best available data from Australian life cycle inventory databases in the following order (hierarchy):

1. Australian National Life Cycle Inventory Database[1] (AusLCI), the national, publicly accessible database managed by the Australian LCA Society (ALCAS). Currently AusLCI contains a limited set of construction products.
2. The AusLCI "shadow database", a database managed by ALCAS to fill most of the gaps in the supply chain not covered by the AusLCI database. The shadow database is mostly based on European processes, and is consistent with AusLCI in scope and methodology. When new AusLCI processes become available, they replace the current shadow database process, thereby continually improving the overall quality of the LCI data.
3. WorldSteel LCI data - The AusLCI database does not yet contain LCI data of Australian steel products. The AusLCI shadow database contains limited data on steel production. In consultation with representatives from the Australian steel industry it was decided that the AusLCI shadow database steel LCI data do not provide the most appropriate and detailed representation of steel products used in Australia. To overcome this issue, WorldSteel LCI data were used to inform the environmental impacts of steel products in the IS Materials Calculator. It is expected that in the future Australian steel data will be incorporated into AusLCI and the IS Materials Calculator.

The above databases are developed following the ISO 14040:2006 and ISO 14044:2006 standards for LCA.

[1] See: http://alcas.asn.au/AusLCI/

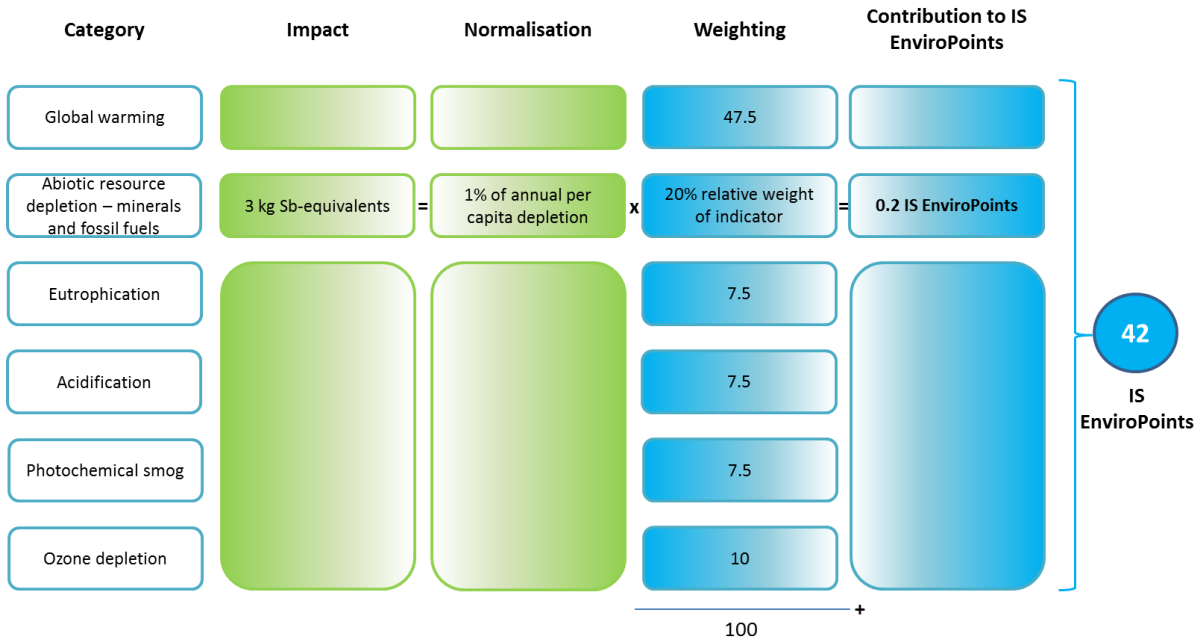
Life cycle environmental impacts assessment – IS EnviroPoints explained

For each stage of the life cycle, the agreed methodology for the environmental impact assessment (IS EnviroPoints) is based on a subset of the Building Product Life Cycle Inventory (BP LCI) impact assessment method. This approach converts the discrete environmental impacts of each product into a single indicator score (IS EnviroPoints) that enables comparison with other products. The subset of indicators that are reported are informed by the mandatory indicators currently required by the GBCA's Green Star LCA credit and are based on the EN 15804 and EN 15978 standards for 'Sustainability of construction works'.

The IS EnviroPoints impact assessment approach has four steps, as shown in Figure A.

1. **Classification**: Each of the compiled inputs and outputs are classified into the category of environmental impacts that they contribute to. See Appendix A for description of each impact category included.
2. **Impact characterisation**: All inputs and outputs are then measured for their potency, and the sum of contributing impacts is expressed in an appropriate unit (e.g. kg CO2e for global warming potential).
3. **Normalisation**: The category impacts are then normalised by expressing them as a percentage of the annual average Australian per capita impact (for that category). So, if a product takes 3 kg Sb-equivalents of resources to produce, and the average annual consumption of an Australian resident is 300 kg Sb-equivalents, then the normalised impact is 3/300 = 1%.
4. **Weighting**: Each category is weighted according to their relative value for the region where the end product is being used (i.e. Australia). The weightings are determined by an aggregation of particular Australian stakeholders' opinions[2] . The weighting values have been recalibrated to ensure the six categories add up to 100 IS EnviroPoints (see Figure A). The weighting values are displayed in Appendix A and in the IS Materials Calculator.

Figure A: Illustration of the IS EnviroPoint Assessment

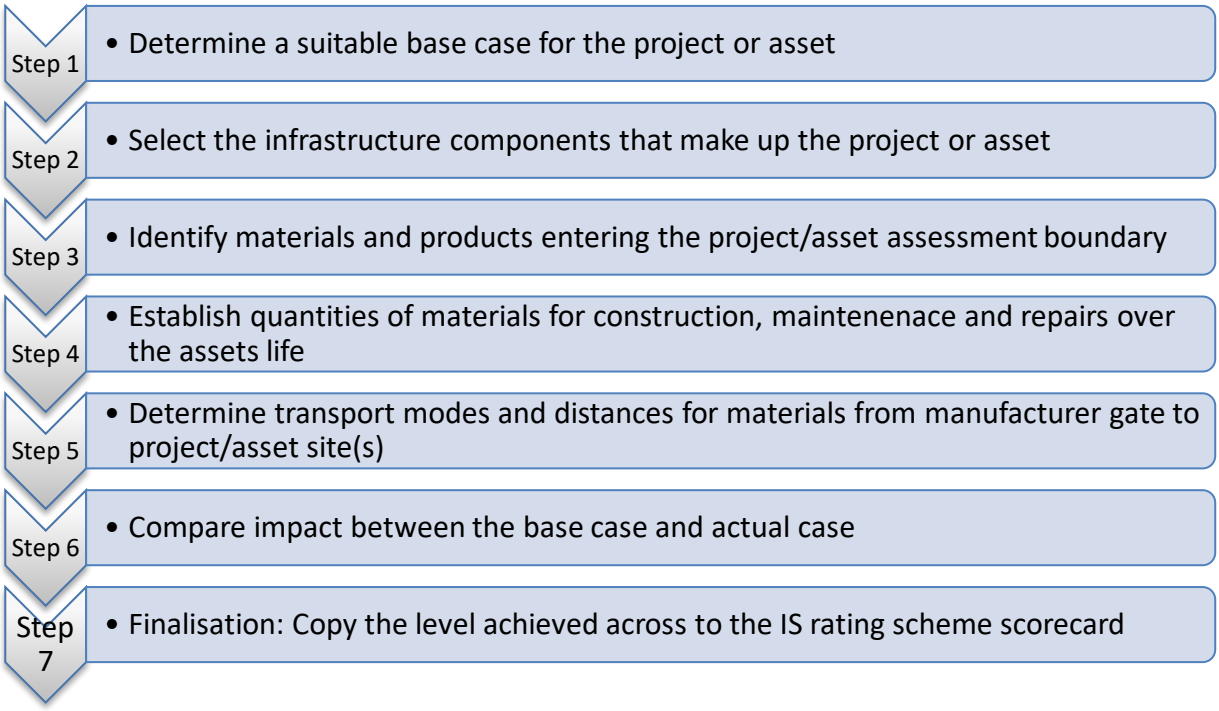


[2] Building Products Innovation Council (BPIC), 2010c, Weighting of Environmental Impacts in Australia, last viewed 01 February 2016, http://www.bpic.asn.au/lci/guidance-materials/weightings.

HOW TO USE THE MATERIALS CALCULATOR

The IS Material Calculator includes user instructions for calculating the IS EnviroPoints (and greenhouse gas emission) footprint of the base case and actual case. Figure B explains the overall approach.

Figure B: Steps for using the IS Materials Calculator for the base case and actual case



Step 1 Determine a suitable base case for the project or asset

For Design and As Built ratings, this is a suitable, early design accepted by key stakeholders as being representative of the original concept for the infrastructure development and using business-as-usual (BAU) technologies and assumptions. For Operation, the base case (or baseline) is typically based on a representative historical year(s). The base case must be verified early in the assessment process with ISCA. For more information on the Base Case (or Reference Design) approach, see the IS Technical Manual 'Using Resources' section.

Steps 2 to 5 need to be undertaken first for the base case and then for the actual case.

Step 2: Select the infrastructure components that make up the project or asset

On the Home worksheet, under the Base Case heading, select the infrastructure components that make up the project or asset. For simple projects/assets there is likely to be just one component, while for a more complex project/asset there may be a number of components that make up the project/asset. For example, a motorway project/asset may include the roadway itself, a tunnel, a cycle path and a bridge. For each infrastructure component, select the relevant sub-component and then fill in the quantities of this sub-component in the project/asset (measured in the units indicated). The quantities required will depend on the components selected. For example, for a roadway, the parameters are the length of road and the number of lanes.

Operations stage and infrastructure life

When selecting the infrastructure components as part of this step, consider the full lifecycle of the infrastructure including the operational stage out to the appropriate design life. The impact of materials and products selected during the operational stage is a key consideration for minimising environmental impact and must be entered into the materials

calculator. For example this may include but is not limited to:

- Repairs and replacement of materials (e.g. new or replacement asphalt or pavements)
- Use, maintenance and repairs of products (e.g. replacement fencing, drainage or footpaths)
- Purchase of raw materials (e.g. chemicals for water treatment, timber, landscaping)
- Transportation of above materials

As an example, the road operations stage can be significant to the infrastructure life cycle and the materials used during the operational stage need to be considered in the materials calculations. Relevant activities during the operation stage may include pavement rehabilitation and/or replacement, maintenance, landscaping works, sign replacements and barrier installations.

The impact for the operation of a road can be significant and as a result the selection of sustainable materials can provide significant savings in operational energy and maintenance requirements.

Step 3: Identify materials and products entering the project/asset assessment boundary

The Materials Details worksheets can be accessed by clicking on the 'Details' button within each component area or simply clicking on the relevant worksheet tab. For each infrastructure component, select those materials used on the project/asset. If a particular material type is not used then don't fill in that section. For each material type, select the specific material from the drop-down lists. Only materials/products entering the project boundary (and their transport) should be accounted for. For example, reused or recycled materials from within the project/asset boundary should not be included in the calculator (i.e. these are treated as 'bonus' materials by the calculator, thus encouraging internal reuse and recycling). Other project inputs (e.g. water, energy) and outputs (e.g. waste and emissions) are included in other IS rating scheme credits, and are thus accounted for elsewhere within the tool. For each infrastructure component selected, you will need to complete the detailed materials information for both the Base Case and the Actual Case.

Materials and products used for construction and operation of the infrastructure must be identified i.e. the whole infrastructure lifecycle must be addressed.

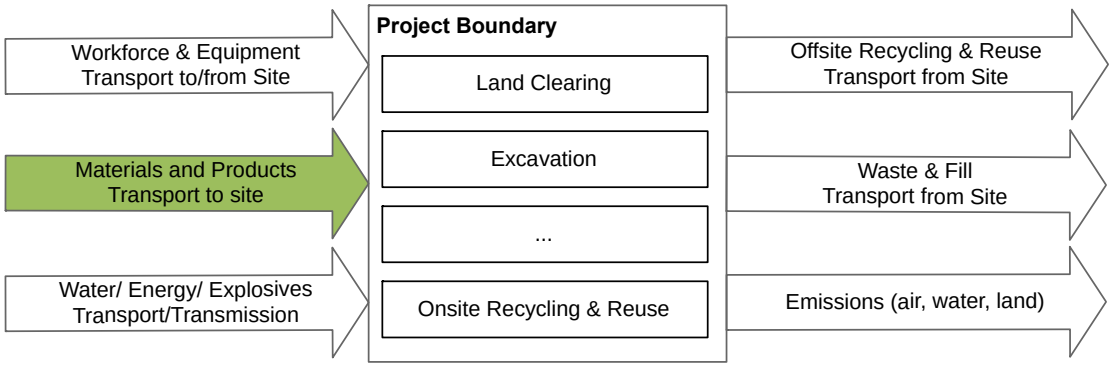
New approach to Concrete

Version 1.2 of the calculator provides a new and improved approach for concretes. The new approach was developed to recognise there could be significant variation in cement content of concrete, even when the strength grade and percentage supplementary cementitious materials (SCMs) are similar. A further improvement is that the number of concrete product variations that are covered by the calculator is virtually endless. As a result, the accuracy of the concrete section is significantly improved.

Ready mixed concrete and precast concrete are entered separately. For ready mixed and for precast concrete the user can choose to select default concrete mix designs based on strength grade and SCM content, or to enter custom concrete mix designs. The latter option allows project teams to investigate concrete compositions with suppliers and optimise their concrete selection. It also provides a clear pathway for concrete suppliers to lower their products' environmental impacts through innovation.

Note: the concrete section is currently only suited for Portland cement based concrete products. Geopolymer products use an activator that is currently not covered by this section of the calculator. However, Geopolymer concrete pipes are included in the piping section. If you would like geopolymer concrete (or any other materials) to be added in future versions of the calculator, see Q8 in the Q&A.

Figure C: Steps for using the IS Materials Calculator for the base case and actual case



Step 4: Establish quantities of materials for construction, maintenance and repairs over the infrastructure life

Enter the quantities of each material used. Quantities may be sourced from bill of materials and estimator or quantity surveyor calculations. If necessary convert the quantities to the units used in the Material calculator (typically mass but other common units are provided for several materials). Standard densities for conversion between volume and mass or vice versa are included in the calculator.

Step 5: Determine transport modes and distances for materials from manufacturer gate to project/asset site(s)

The calculator has programmed typical embodied impacts for materials and products up to the manufacturer's gate. In order to account for the environmental impact of transport from the manufacturer gate (e.g. production site or quarry) to project/asset site, the user needs to establish and include the transport modes and the transport distances (km) to get the materials to site. Note that the user must enter the one way distance – the factors in the calculator already include return trips and suitable assumptions about back-loading.

For most projects/assets the user needs to make reasonable assumptions for transport distances and modes. The environmental impact from transport is typically most significant for high volume/mass materials such as concrete, aggregates, sand and fill. It is therefore most important to note differences between the base case and actual case for these products and materials.

The calculator supports one or two transport modes per material.

See the calculator (LCI worksheet) for more information on the environmental impacts of various transport modes.

Step 6: Compare impact between the base case and actual case

If you wish to copy the Base Case data to the Actual Case data then click on the 'Copy to Actual' button (repeat this step for each component). This can be a good starting point for investigating suitable design changes.

As the materials details are completed, the environmental impact expressed in terms of IS EnviroPoints (and GHG emissions) is calculated. Once all Materials Details are completed, press the "Home" button (or select the Home tab) to return to the Home worksheet and compare the Base Case and Actual Case results. The calculator quantifies the difference between the environmental impact of the Base and Actual Case and determines the level achieved for the Mat-1 credit (shown in the top right hand corner of the Home worksheet).

Just measuring the environmental impact achieves Level 1 in the Mat-1 credit, while a reduction in environmental impact (IS EnviroPoints), compared to a base case, of 0 to 30% achieves Level 1 to 3 on a sliding scale. Fractions of levels are allowed under the IS rating scheme Version 1.2 but not for earlier versions (see Figure D). For example, a 10% reduction would achieve Level 1 + (10% / 30%) x (3 – 1) = Level 1.67. This sliding scale

approach provides encouragement to pursue every reduction opportunity possible. Reductions beyond 30% may be awarded innovation points.

The calculator can be used as a design tool at this point by adjusting the materials and quantities in the Actual project/asset and observing the difference this makes to the overall environmental impact. Note that the level achieved is determined only from the IS EnviroPoints (which includes GHG emissions as one of the six impact categories). The GHG emissions are shown separately in the calculator simply because this information may be useful to the project/asset. The difference between the base and actual case footprints should be explained in the credit summary form by describing the key changes and their impacts in terms of reductions or increases in materials environmental impacts. It is recommended that this be supported by using a waterfall chart or similar (see example in Appendix B).

Step 7: Finalisation: Copy the level achieved across to the IS rating scheme scorecard

Copy the level achieved across to the IS rating scheme scorecard. Save a copy of the Materials Calculator and a printed copy of the Home worksheet (signed by a suitable project representative as being an accurate and representative record) for use as evidence with the rating submission. Provide suitable calculations and materials tracking data as background also.

Figure D: Benchmarks for Different IS rating scheme Versions

Benchmark Requirement	Version 1.1	Version 1.2
Level 1	Measurement of impact (but no reduction)	
Level 2	A reduction of between 15% - 30%	A reduction of 0 to 30% achieves Level 1 to 3 on a sliding scale. Fractions of levels are allowed.
Level 3	A reduction of > 30%	

QUESTIONS AND ANSWERS

This section includes some typical questions and answers regarding the IS Material Calculator. Questions not answered in this section can be directed to ISCA at: info@isca.org.au

Q1: Do we have to use the IS Material Calculator to determine the level achieved in Mat-1?

A1: The IS rating scheme allows for use of equivalent LCA techniques upon agreement with ISCA (through submission of a Credit Interpretation Request). This may be specifically suitable for projects/assets where manufacturer specific LCA information is available through independent and verified sources e.g. Environmental Product Declarations.

Q2: Our project uses materials with higher/lower impacts than what is used in the IS Material Calculator. Can and should we use manufacturer specific LCA impact factors if available?

A2: The IS Material Calculator is built around (Australian) average environmental impact profiles, primarily based on data from the Australian Life Cycle Inventory (AusLCI) database and its shadow database. The project/asset can seek credit under Mat-2 for specific products with environmental certifications, or use an equivalent LCA technique (in agreement with ISCA) where manufacturer specific information is available for the majority of materials and products used for the project/asset.

Q3: Why doesn't the calculator differentiate between where and how my product is produced?

A3: The current version of the IS Material Calculator includes generic Australian construction product life cycle data. The aim with the IS Materials Calculator is to provide a level playing field assessment tool of the embodied material impacts. The IS Materials Calculator can be used to inform design and decision making to use resources more efficiently and select lower impact materials and product selections. Users can define the additional transport associated with the source of a material or product including when this is from overseas.

It is anticipated that the IS Material Calculator will be further developed to incorporate other materials, including overseas products, in future updates to the tool.

The project can seek credits under Mat-2 for specific products with environmental certifications, or use equivalent LCA techniques (in agreement with ISCA) where manufacturer specific information is available for lower impact products.

Q4: What should I do if I use up all of the slots within one material type e.g. steel for a project/asset component?

A4: Use a new project/asset component (select the same component and sub-component types) and then enter the relevant data in the relevant base case and actual tabs.

Q5: How should materials recycled within the project/asset be handled by the calculator? What about materials from outside the project/asset being reused on the project/asset?

A5: Materials recycled or reused within the project should not be included as a material input if processing occurs on-site (see step 3 under the section How to Use the IS Materials Calculator above), as these materials are unlikely to contribute any significant environmental burden. However, should you wish to include the volume of materials recycled or reused within the project so that this information is captured in the calculator, then we recommend selecting "general fill" in the Aggregates section, as this material comes free of burden. In the comment box you can then clarify that these are materials that are recycled or reused within the project boundaries.

Reused materials, sourced outside of the project/asset but not requiring additional processing, shouldn't be included in the material calculator either, as these are also considered burden-free. However, transport of these materials generally should be accounted for. Similar to materials recycled or reused on-site, you should also select "general fill" in the Aggregates section for externally sourced reused materials. This will then allow you to add transport of the reused material to site. In the comment box you can clarify that this data entry refers to materials that are reused from outside the project boundaries and provide relevant details. The calculator includes some common recycled materials (sourced from outside the project/asset). For example, there is an option for recycled crushed concrete/masonry under the category Aggregates, allowing for the additional processing to produce crushed concrete/masonry. Transport to site should be included for these materials.

ISCA intends to make improvements to the handling of recycled and reused materials in future versions of the Calculator.

Q6: Can I get embodied/embedded energy information out of the calculator?

A6: The IS Materials Calculator accounts for non-renewable energy resource depletion as one of the components of the IS EnviroPoint factor. Embodied energy is not reported specifically, rather the IS EnviroPoint method captures the broader environmental implications of energy use, such as global warming, photochemical smog, acidification, eutrophication and resource depletion, all likely to relate to embodied energy (especially for combustion of fossil fuels).

Q7: What is the difference between 'IS EnviroPoints' and 'EcoPoints' which were used in previous versions of the calculator?

A7: 'EcoPoints', used in the previous versions of the calculator, were calculated from a combination of 14 environmental indicators. The IS EnviroPoints cover only six environmental indicators. Although ISCA supports an inclusive approach that covers a broad range of indicators, stakeholders have questioned the pertinence and completeness of (Australian) LCI data to support all 14 indicators. The subsequent review led to two major changes in version 1.2 of the calculator:

1. The LCI data that support the IS Materials Calculator are now sourced from AusLCI, Australia's national LCI database. These data meet strict guidelines for completeness and transparency and provide a more consistent set of data across the calculator.
2. The number of indicators that make up the single score result (renamed to IS EnviroPoints) was reduced to six in order to:

Reduce the high uncertainty inherent in some of the more exotic indicators
Better align the calculator with other initiatives, such as GBCA's Green Star rating tools and key international standards (EN 15804 and EN 15978) for 'Sustainability of construction works'
Better align the impact assessment method with the limitations of LCI databases.

Q8: Can I get new materials added to the calculator and if so, what is the process?

A8: Suppliers (or manufacturers) of infrastructure materials and products can have their environmental information incorporated into AusLCI[3] , which would make it eligible for inclusion into future updates to the IS Materials Calculator. Where possible, data should be provided at industry level as the IS Materials Calculator predominantly covers industry average material profiles. In version 1.2 of the Calculator this process was undertaken to add LCI data for asphalt products and geopolymer concrete pipes. Key industry stakeholders submitted relevant data to ALCAS, who then assured the data meet AusLCI requirements.

[3] The procedures for adding data to AusLCI are published here: http://alcas.asn.au/AusLCI/index.php/Publications

Q9: Can I enter both default and custom concrete data?

A9: No, for the calculations to work correctly you should select an option to enter either default or custom concrete data across both Base and Actual Case data. Only the option that is selected will contribute to the calculation of the environmental impacts. For example, when you enter custom concrete compositions and then click on the “Use default mix designs” button, the custom data you entered are hidden and will not contribute to the total environmental impact.

Note that the data are not removed, so you can always go back to your previous data entry (by clicking “Define custom mix designs”) and continue from where you left. In that case the default options are hidden and excluded from the calculations.

If you have access to details for some concrete mixes but not for others, then you should use the “Define custom mix designs” option. Use the “Default concrete compositions” tab to inform the mix designs for which you don’t have specific details.

The IS EnviroPoints used in the calculator represent a single score created from six environmental impact categories as per Figure E.

Please ensure that you are working with the latest release of the IS Materials Calculator. The calculator will be updated when required to incorporate improvements and to account for innovation and new data on infrastructure product/material. The release date of the calculator is shown on the "Home" worksheet. Registered projects/assets are permitted to use the release which was current at the date of registration, or later releases. Earlier releases must not be used.

To check for the latest release of an IS Materials Calculator, please visit the ISCA website www.isca.org.au. Details of changes made to each release of an IS Materials Calculator can be viewed in the "Changelog" worksheet.

Figure E: IS EnviroPoints categories

Indicator	Description	Relative Weight IS EnviroPoints
Global warming	The increase in the Earth’s average temperature. A common outcome of this is an increase in natural disasters and sea level rise.	47.5%
Abiotic resource depletion	The extraction of non-living and non-renewable natural resources. These resources, such as fossil fuels and minerals, are an essential resource in our everyday lives and most of them are currently being extracted at an unsustainable rate.	20.0%
Acidification	A process whereby pollutants are converted into acidic substances, which degrade the natural environment. Common outcomes of this are acidic lakes and rivers, toxic metal leaching, forest damage and accelerated corrosion of metals, concrete structures and limestone.	7.5%
Eutrophication	An increase in the levels of nutrients in the environment. A common outcome of this is high biological productivity that can lead to oxygen depletion, as well as significant impacts on water quality, affecting all forms of aquatic and plant life.	7.5%
Photochemical smog	A type of air pollution that is caused by a reaction between sunlight, nitrogen oxide and volatile organic compounds (VOCs). This is a known cause for respiratory health problems and damage to vegetation and smog.	7.5%
Ozone depletion	The decline in the total volume of ozone in the Earth’s stratosphere. The depletion of the ozone layer increases the amount of UVB that reaches the Earth’s surface. UVB is generally accepted to be a contributing factor to skin cancer, cataracts and a decrease in crops and plankton yield.	10.0%

The indicators that are reported are aligned with the mandatory indicators currently required by the GBCA's Green Star LCA credit, which are based on the EN 15804 and EN 15978 standards for 'Sustainability of construction works'. However, it is important to note that the IS Materials Calculator applies the environmental impact assessment methodology for each indicator as defined in the Building Product Life Cycle Inventory (BP LCI) impact assessment method. The underlying impact assessment models are not always identical to the ones used by Green Star and the European standards. For example, in the latter, abiotic resource depletion is split into fossil fuel depletion (expressed in MJ) and minerals depletion (expressed in Sb-equivalents). Fossil fuel depletion and minerals depletion are aggregated (both expressed in Sb-equivalents) in the IS Materials Calculator method. Whilst this is a relatively minor technical difference, it makes the results from the two methods incompatible.

WHITSUNDAY SEWAGE TREATMENT PLANT UPGRADE

Downer[4] was awarded Australia's first IS Design rating (and later an As Built rating, both at an 'Excellent' level), for its design and construction of two sewage treatment plants (STPs) in North Queensland for Whitsunday Regional Council. The project consisted of upgrades to two sewage treatment plants – at Proserpine and Cannonvale in North Queensland – to serve growing communities and meet the most stringent effluent discharge requirements to protect the Great Barrier Reef. The project achieved a significant reduction (34%) in environmental impact (as measured in IS EnviroPoints) compared to the base case which would correspond to a level 3 achievement in the Mat-1 credit.

The base case would have generated 4,396 tonnes of CO2-e for materials. In comparison, Downer's actual design generated 2,908 tonnes of CO2-e for materials. This represents a 34% reduction in embodied GHG emissions.

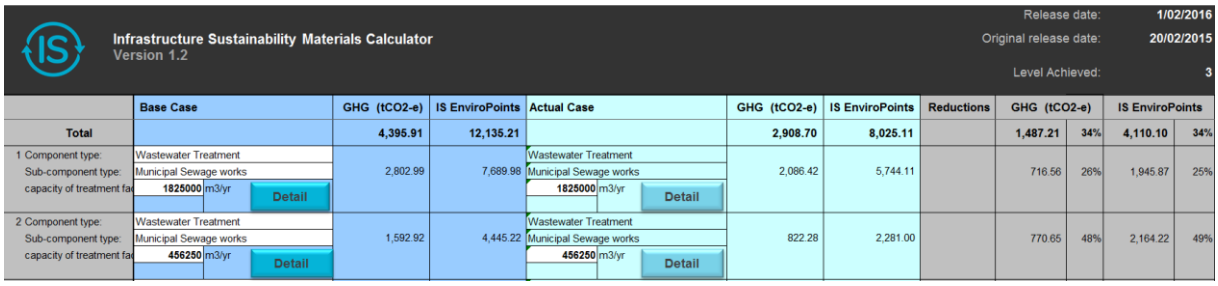
Key initiatives included:

- **Avoid:** The key initiative to reduce embodied impact was to substitute the client-specified oxidation ditch process elements (large concrete structures) with a membrane bioreactor at Cannonvale and a sequential bioreactor at Proserpine. This resulted in reductions in materials use as follows:
    - 999 less tonnes of concrete,
    - 1,181 less tonnes of metals (steel and aluminium),
- **Switch:** It was decided to use 'green' concrete supplied from the batch plant next to Cannonvale STP to avoid up to 125km haulage for other alternative materials.
- In addition, neither the base case (nor common practice) in this sector includes the use of 'green' concrete mixes with a flyash content greater than 25% for 40 MPa concrete. The 40 MPa concrete used on the project was a 30% flyash blend provided by Hanson – further reducing embodied carbon and utilising a 'waste' material.
- **Re-use:** All materials excavated at both sites, including topsoil, subsoil and rock, were beneficially re-used on site. This included crushing and re-using rock on-site to avoid the need to import crushed rock and generate the additional emissions associated with transport.
- Topsoil, subsoil, rock and tree waste (mulch) were beneficially reused – avoiding importation or disposal. Topsoil was stockpiled for future re-application prior to revegetation; subsoil and rock were used for batters and mulch was used in temporary landscaping and erosion control.
- Material transport distances and modes were calculated based on the location of the supplier (using a road distance calculator) and industry knowledge about the most appropriate / commonly used transport methods for the particular material (taking into account the size / load of items / products). Transportation from the supplier was believed to be the most impactful mode along the supply chain.

Note that this project applied and was certified using version 1.1 of the IS Materials Calculator but this case study information has been updated using version 1.2 of the calculator.

[4] Formerly Tenix

Figure F: Snapshot of the Material Calculator 'Home' page for the Whitsunday Sewage Treatment Plant Upgrade



Infrastructure Sustainability Materials Calculator
Version 1.2

Release date: 1/02/2016
Original release date: 20/02/2015
Level Achieved: 3

	Base Case		GHG (tCO2-e)	IS EnviroPoints	Actual Case		GHG (tCO2-e)	IS EnviroPoints	Reductions	GHG (tCO2-e)		IS EnviroPoints	
Total			4,395.91	12,135.21			2,908.70	8,025.11		1,487.21	34%	4,110.10	34%
1 Component type:	Wastewater Treatment		2,802.99	7,689.98	Wastewater Treatment		2,086.42	5,744.11		716.56	26%	1,945.87	25%
Sub-component type:	Municipal Sewage works				Municipal Sewage works								
capacity of treatment fa	1825000	m3/yr Detail			1825000	m3/yr Detail							
2 Component type:	Wastewater Treatment		1,592.92	4,445.22	Wastewater Treatment		822.28	2,281.00		770.65	48%	2,164.22	49%
Sub-component type:	Municipal Sewage works				Municipal Sewage works								
capacity of treatment fa	456250	m3/yr Detail			456250	m3/yr Detail							

Figure G: Waterfall chart comparing actual case to base case for Whitsunday Sewage Treatment Plan Upgrade

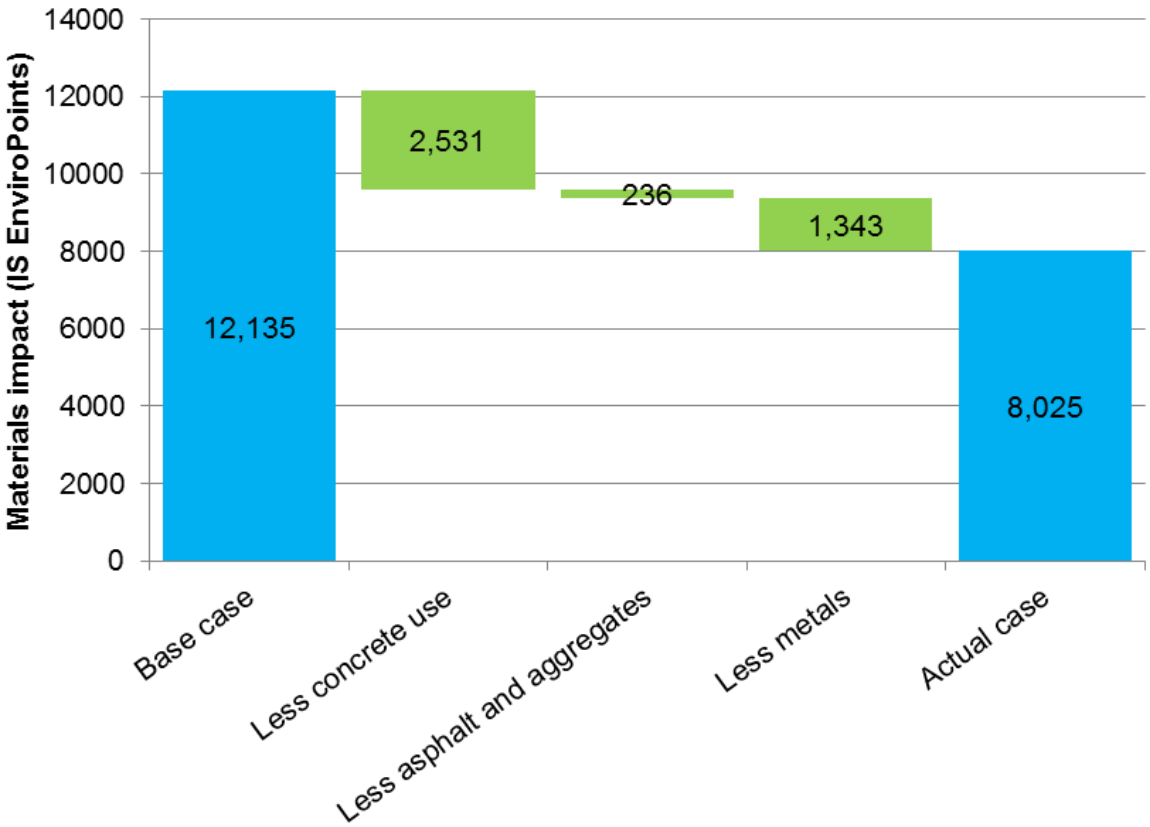


Figure H: Base case (left) and Actual case (right) Materials Calculator data entry for the Cannonvale STP Upgrade

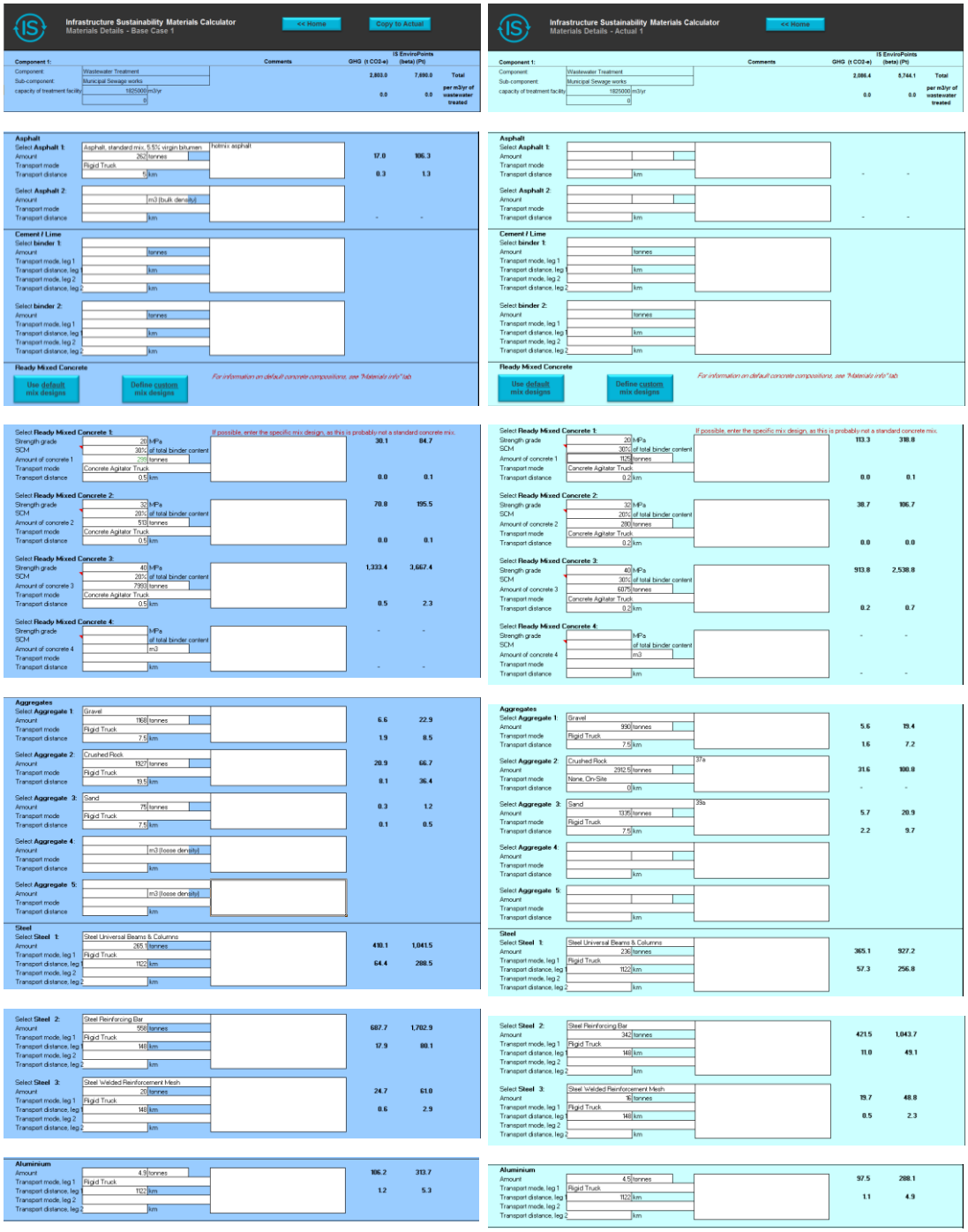


Figure I: Base case (left) and Actual case (right) Materials Calculator data entry for the Proserpine STP upgrade