Guide to calculating a base case carbon footprint for land transport infrastructure projects: a case study

Scope creep and how this impacts a base case carbon footprint

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NZ TRANSPORT AGENCY
WAKA KOTAHI

Te Kāwanatanga o Aotearoa
New Zealand Government

More information

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1. Purpose

The purpose of this case study is to support NZ Transport Agency Waka Kotahi (NZTA) *Guide to calculating a base case carbon footprint for land transport infrastructure projects* (referred to as 'the Guidance' throughout this document). This case study aims to illustrate a scenario that a project might find themselves in whilst needing to calculate a base case carbon footprint (base case). It will use a worked example to illustrate how the base case calculations can be undertaken. This case study will outline recommended approaches for base case calculations when scope creep occurs during project delivery. It provides worked examples using 'Project A', based on the Guidance.

2. Background

NZTA has confirmed funding to proceed with Project A. The key features of Project A include:

- A new 16-kilometre highway, comprising of four lanes (two lanes in each direction).
- Two bridges, which span 400m and 200m respectively.
- Four grade-separated interchanges.
- A shared user pathway (SUP) spanning the length of the road, including a 20-metre bridge.
- A river with significance to local mana whenua.

Project A has completed the consent design[1] and is progressing towards 30% detailed design. The Project has received a cost estimate for the consent design, which included a breakdown of the material types and quantities.

User Tip: *To use the schedule of quantities within a cost estimate to calculate a base case, it would need to contain a sufficient breakdown of material types and quantities. This would need to be in alignment with the data entry cells within the PEET tool. If the schedule of quantities does not contain a sufficient amount of detail to input into the PEET tool, there are a number of options a project could take:*

1. *Rely on the second order of the PEET Tool to calculate the base case.*
2. *Extract material types and quantities from the design models.*
3. *Liaise with the cost estimator to produce a sufficient breakdown during the next phase of design.*

2.1. Scope creep

After completing the geotechnical investigations, Project A found the existing ground conditions were more unstable than previously thought. This increased the amount of ground improvements required, creating a design change that would increase the quantity of materials used for Project A. This change also results in the original base case being inaccurate, specifically it will be unfairly low as it does not account for the additional ground improvements. The artificially low base case means it will be hard to demonstrate any carbon reductions when undertaking the carbon footprint for the *Issue for Construction* design and the project will not be comparing 'apples with apples'. Consequently, some re-work for the base case is required and potentially the need to adopt an alternate approach.

User Tip: *Scope creep on infrastructure projects may occur on projects, particularly during detailed design. Technical issues may be identified and new solutions (beyond the existing scope), need to be developed.*

[1] Consent design reflects the design which has been approved through the resource consent process. The design indicates the alignment of the infrastructure and details such as bridges, intersections and where the design impacts sensitive environments.

3. Assessment

User Tip: *It is suggested that all Project's use the second order estimate within the PEET tool early in the design phase regardless of formal base case approach adopted. This will assist the Project team to understand what data is available and any gaps in data. This can help shape discussions with the Quantity Surveyor / Cost Estimator as Project's will understand what data they need. In addition, this can assist to identify any high-level carbon hotspots.*

As a result of the additional ground improvements, the material required to construct the project increased. This meant the cost estimate for the consent design did not provide an accurate representation of a 'business as usual' version of the actual design.

In this situation, the Sustainability Lead for Project A confirmed with the team that the consent design could no longer be used 'as is' for the base case for the following reasons:

- The base case and actual case would not be based on equivalent scope due to the additional ground improvements required.
- The actual case would likely have a disproportionately higher carbon footprint and/or carbon reductions achieved during design would not be evident.

Figure 1 was used to inform what base case approach was appropriate for Project A.

Section 4 of this case study document outlines two different worked examples for how Project A calculated their base case.

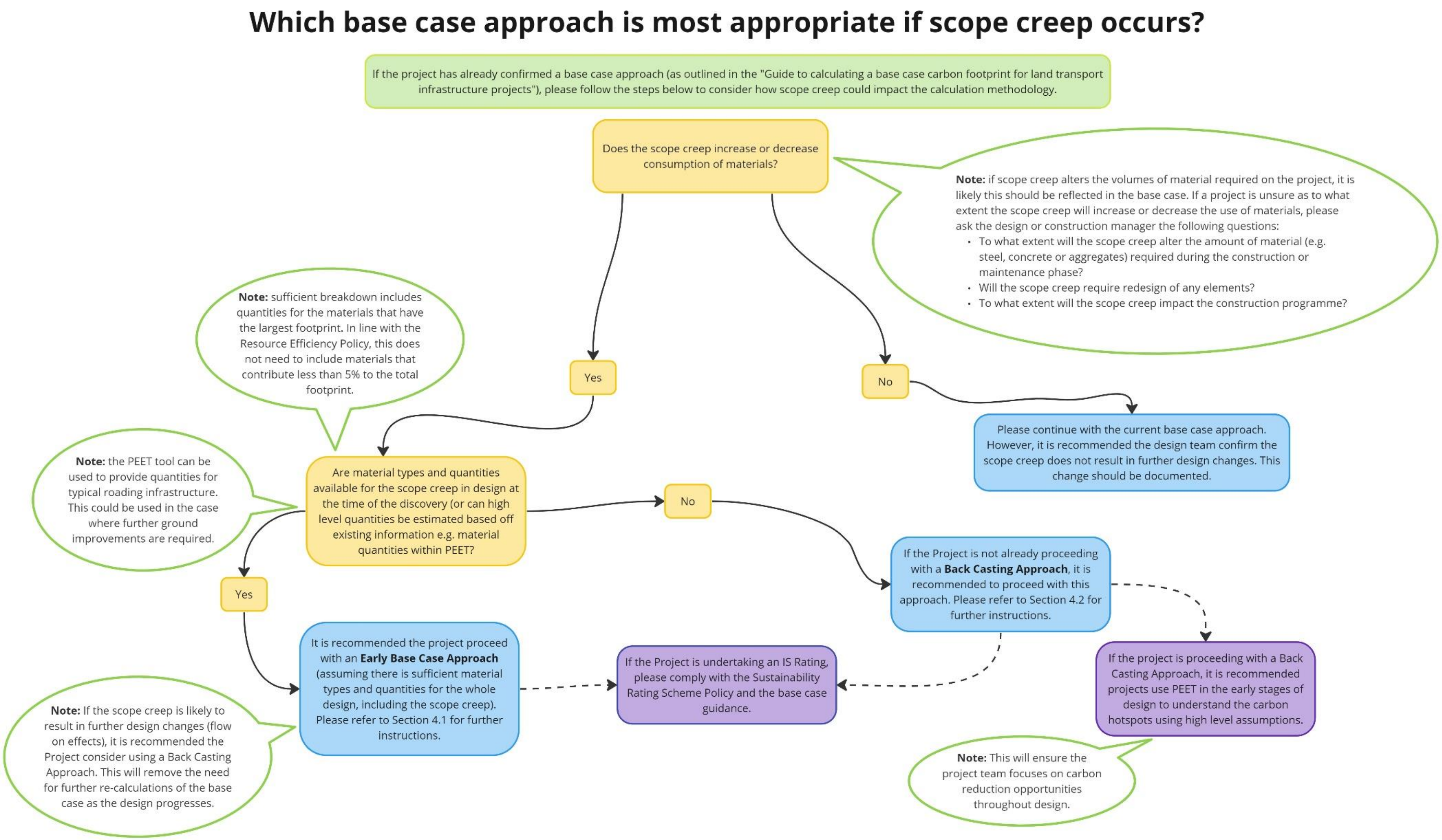


Figure 1 Approach for calculating a base case when scope creep occurs

4. Next Steps

Section 4.1 and 4.2 outlines the two pathways for how Project A could calculate their base case footprint using an early base case and back casting approach respectively. Please note the numbers in this example are purely indicative.

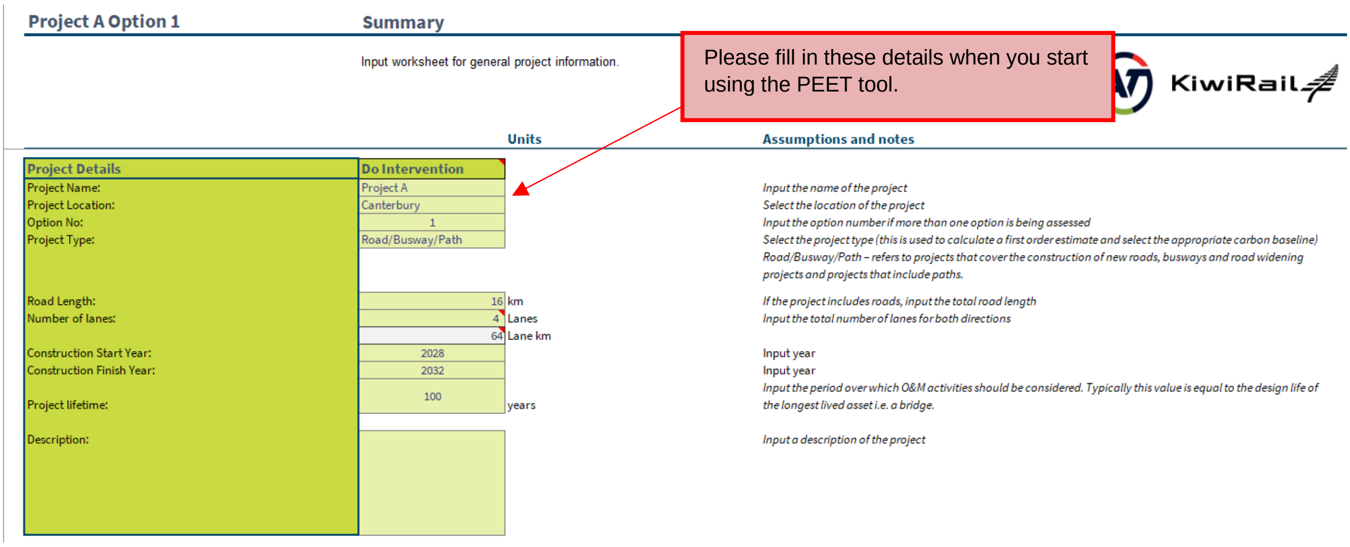
> **User Tip:** Section 3.4.1 and 3.4.2 from the *Guide to calculating a base case carbon footprint for land transport infrastructure projects* should be used to supplement the instructions detailed below.

4.1. Early base case approach

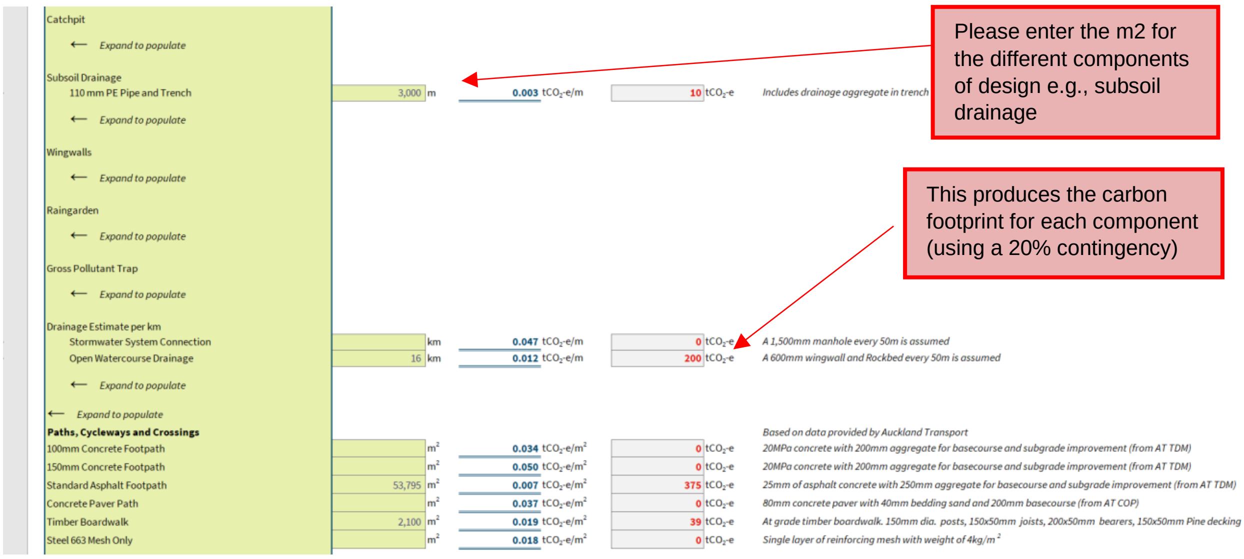
In this worked example, Figure 1 identified an early base case approach as most appropriate for Project A.

The following steps describe how Project A calculated their base case, using an early base case approach.

1. Project A confirmed they would use the PEET tool as the base case calculation tool. The Sustainability Advisor set up the PEET tool summary tab as described in the instructions 'READ ME' tab.



2. The Sustainability Lead derived information for the consent design (prior to the scope creep occurring) and input these into the second order estimate within the PEET tool.



3. The Design Team received the ground investigation results and identified that the ground conditions were more unstable than previously thought. This required the design to have additional ground improvements to stabilise the land, creating 'scope creep' (as opposed to scope change). This increased the materials required and therefore impacted the base case quantities.

User Tip: *Involve the sustainability lead (or equivalent) in design discussions regarding the scope creep to ensure the updated design is delivered in a low carbon and sustainable manner.*

4. The Sustainability Lead spoke with the Design Manager to gather information required to input the additional ground improvement materials into the second order estimate of the PEET tool. By using the second order estimate, Project A was able to continue with the early base case approach.

User Tip: *If the scope creep is likely to progress through design stages under a different programme and/or further refinements of the scope are expected, it is recommended the project use a back casting approach to reduce any future or iterative re-calculations.*

5. The Sustainability Lead entered the additional ground improvements data into the second order of a new PEET spreadsheet.
6. The PEET tool produced the total tCO_2e associated the additional ground improvements.
7. The Sustainability Lead was then able to add the tCO_2e for the scope creep and consented design base case together to understand Project A's updated base case.
8. The Sustainability Lead continued to track sustainability initiatives associated with carbon reduction throughout the project life cycle. They calculated the associated 'business as usual' design using the third order estimate (e.g., the schedule of quantities) in the PEET tool. Material quantities were entered into separate versions of the PEET tool to ensure each initiative was tracked appropriately. Please refer to the 'sustainability initiative' case study for further information on why a 'business-as-usual' design is required and appropriate calculation methods.

User Tip: *The material types and quantities associated with 'business-as-usual design' should be added to the third order in the PEET Tool. This will produce the total carbon footprint (tCO2-e) for each business-as-usual design.*

9. Project A's IFC design was completed.
10. The cost estimate for IFC was completed and this was provided to the Sustainability Lead.
11. The Sustainability Lead derived material types and quantities from the IFC schedule of quantities and input these into the third order estimate within the PEET tool.

User Tip: *If a project used the second order estimate for the base case and the third order for the actual case, please make sure you are comparing a design on a like-for-like basis. Project's may be required to re-baseline (e.g., update the base case calculation) using the third order estimate (as opposed to the second order) to ensure you are comparing elements on a like-for-like basis).*

12. Project A compared their base case to the actual case to confirm the carbon reductions achieved for the Project.

13. The Sustainability Lead followed the reporting requirements within the resource efficiency guideline and reported the base case to NZTA.

General Tips:

The second order estimate is useful when a project does not have a full breakdown of material types and quantities. However, this also means the base case will not be as accurate. This may require re-baselining in some circumstances.

If the Design Lead provides material types and quantities for certain design elements, they could be inputted into the third order estimate (while still relying on the second order estimate for other elements), to produce a more accurate carbon footprint. However, if both the second and third order are used in one calculation, only the highest order estimate will be reported in the 'results' tab. If this is the case, it is recommended the total calculation is completed in a separate spreadsheet.

The emissions calculations for standard design elements in the second order estimate include a contingency of 20% to provide an estimate appropriate for the initial stage of project assessment.

Don't wait until completion to undertake the calculations for sustainability initiatives – if left too late, the ability for the design team to provide support with quantifying the savings could be lost.

Based on the current functionality of PEET, it will be easier for projects to track initiatives in a separate version of the PEET tool.

For the reporting requirements, please refer to the NZTA specifications: P48 Resource Efficiency Specification and P49 Sustainability rating scheme application during tender and delivery of capital works project.

4.2. Back casting approach

The Sustainability Lead spoke with the Design Manager to understand if material types and quantities for the additional ground improvements could be readily provided by the design team and/or through the models prior to completion of 30% detailed design for the project.

The Design Manager confirmed as the additional ground improvements were still being confirmed by the design team, the models did not currently contain sufficient material quantities to calculate the base case.

Following the process outlined in Figure 1 for this worked example, a back casting approach was identified as the most appropriate method for Project A.

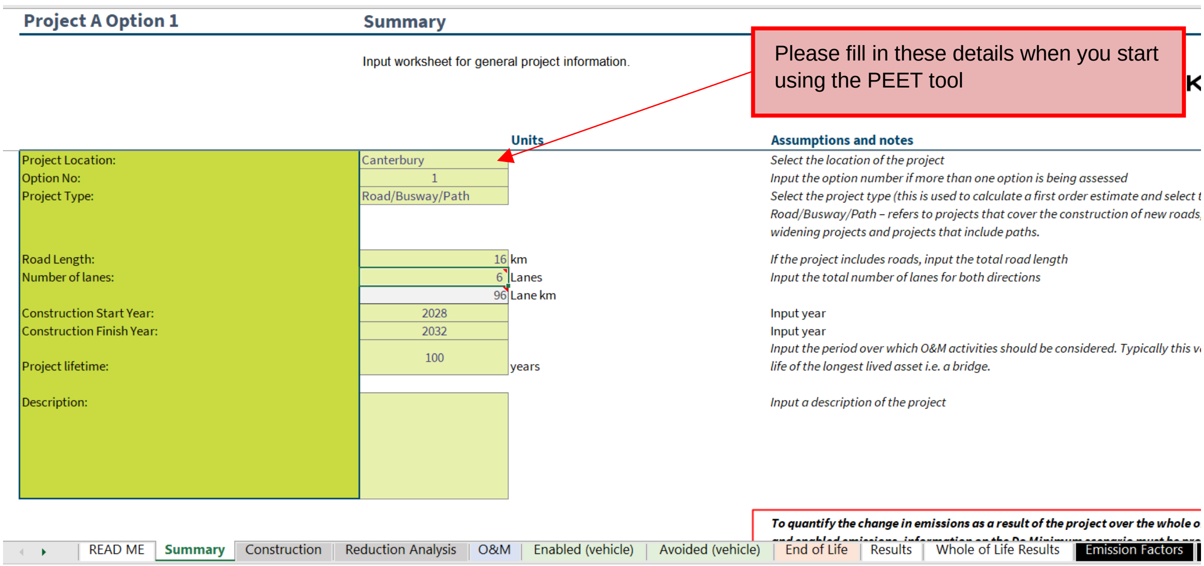
The following steps describe how Project A calculated their base case, using the back casting approach.

> **User Tip:** *The back casting approach is most appropriate if the scope creep is likely to progress through design stages under a different programme and/or further refinements of the scope are expected. This approach will remove the need for further iterative re-calculations of the base case as the design progresses.*

1. The Design Team received the ground investigation results and identified that the ground conditions were more unstable than previously thought. This required the design to have additional ground improvements to stabilise the land, creating 'scope creep' (as opposed to scope change). This increased the materials required and therefore impacted the base case quantities.
2. Detailed design (including the additional ground improvements) continued to progress.

> **User Tip:** *Involve the sustainability lead (or equivalent) in design discussions to ensure the updated design (including the scope creep for this case study) is delivered in a low carbon and sustainable manner.*

3. The Design Team worked to understand all the design implications as a result of the additional ground improvements, including if it would result in increased earthworks and/or changes to road geometry.
4. Project A confirmed they would use the PEET tool as the base case calculation tool. The Sustainability Advisor set up the PEET tool summary tab as described in the instructions 'READ ME' tab.



5. The Sustainability Lead continued to track and calculate sustainability initiatives associated with carbon reduction throughout the project life cycle using the third order estimate in the PEET tool. Material quantities for a ‘business-as-usual’ design were quantified and entered into separate versions of the PEET tool to ensure each initiative was tracked appropriately. Please refer to the ‘sustainability initiative’ case study for further information on why a ‘business-as-usual’ design is required and appropriate calculation methods.

> **User Tip:** *The material types and quantities associated with ‘business-as-usual design’ should be added to the third order in the PEET tool. This will produce the total carbon footprint (tCO2-e) for each business-as-usual design. Please refer to the ‘sustainability initiative’ case study for further information.*

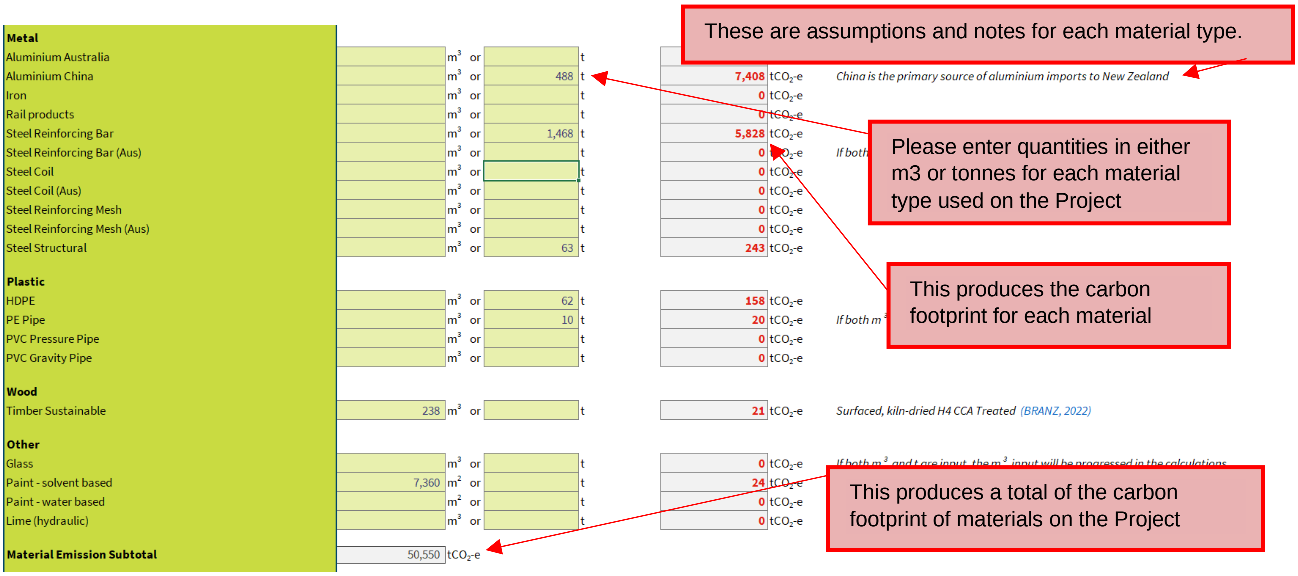
6. The Sustainability Lead engaged with the external Cost Estimator to outline the material types and quantities required to calculate the base case. This included outlining the types of materials within the PEET tool and the volumes required as outlined below. This ensured that when Project A received the revised schedule of quantities, the information could be more easily transferred into the PEET tool.

> **User Tip:** *Engage with your Cost Estimator (within your organisation or an external company) to ensure the schedule of quantities associated with the cost estimate contain a breakdown of materials and units to calculate the base case in line with the data entry cells for PEET. Line items within the schedule of quantities often comprise of one component e.g., “bus shelter” and “road bridge”, without breaking down all the separate materials. The units are also often in m^2 or per unit e.g., 5 x 3m piles. This can make it difficult for the Sustainability Team to calculate the carbon footprint.*

7. Project A’s ‘Issued for Construction’ (IFC) design was completed.
8. The schedule of quantities for IFC was completed and this was provided to the Sustainability Lead.

> **User Tip:** *Discuss any timeframe requirements for your base case with your Cost Estimator prior to IFC, as this can take a month (or longer) to be received. If you are completing an Infrastructure Sustainability Rating, receiving the schedule of quantities associated with the cost estimate may be time critical for your ISC submission.*

9. The Sustainability Lead derived material types and quantities from the IFC schedule of quantities and input these into the third order estimate within the PEET tool.



10. Using separate versions of the PEET tool, the Sustainability Lead replaced the carbon reduction initiative (from Step 5) with a business-as-usual design and added this to the actual footprint to calculate the project’s base case. This produced Project A’s base case and actual footprint.

11. The Sustainability Lead followed the reporting requirements within the resource efficiency guideline and reported the base case to NZTA.

General Tips

Based on the current functionality of PEET, it will be easier for projects to track initiatives in a separate version of the PEET tool.

To calculate the total footprint, it is recommended you use a blank spreadsheet where you can add all the totals from each PEET tool.

Don't wait until completion to undertake the 'sustainability initiatives' calculations – if left too late, the ability for the design team to provide support with quantifying the savings could be lost.

Project A chose to use the PEET tool because it was not undertaking an IS Rating and it was more efficient to use an existing tool (as opposed to creating a bespoke spreadsheet).

For the reporting requirements, please refer to the NZTA specifications: P48 Resource Efficiency Specification and P49 Sustainability rating scheme application during tender and delivery of capital works project.