Cerclos

UDIA WA and Industry Partners

Land Development Infrastructure Life Cycle Assessment Study

Executive Summary

UDIA Urban Development Institute of Australia WESTERN AUSTRALIA

CEDAR WOODS DEVELOPING TOMORROW TODAY

DevelopmentWA

Introduction

This summary provides a concise overview of the scope, results, and key findings of the infrastructure Life Cycle Assessment (LCA) studies of 115 Hamilton Hill, Orion Industrial Park, and Bushmead land developments. LCA is the leading industry standard for measuring environmental impacts arising from the construction and operation of buildings and infrastructure, and for identifying optimum strategies for reducing those impacts.

The goal of this study is to profile and understand the environmental performance of the infrastructure works for the three land developments. The life cycle performance of the projects is compared to models representing business-as-usual practices and as such this is a comparative study.

A further goal of these studies is to develop a framework for assessing and reporting the life cycle environmental impacts of urban land developments.

The studies have been conducted in accordance with the International Standards 14040 and 14044, as well as the European Standard EN 15978.

Scope of the Study

Study Horizon

The modelled design life for the developments is 100 years which has been adopted for the LCA study period. Note that this does not mean that the developments are expected to be removed or demolished after 100 years; this timeframe has simply been selected as the study period horizon.

System Boundary

The system boundary, shown in Figure 1, includes impacts over the whole life cycle of the development, following the guidance given in EN15978.

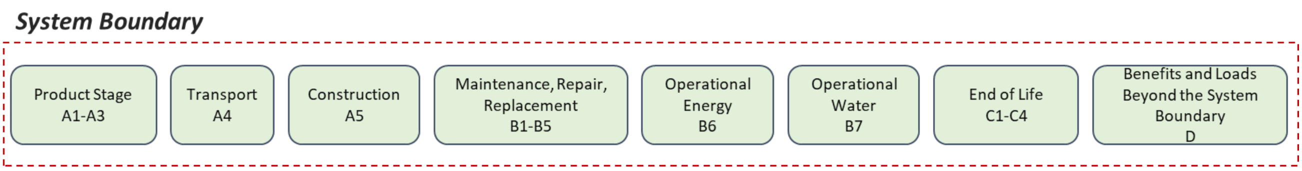

Figure 1: System Boundary Diagram

- **Product stage (A1-A3):** Includes Raw material Extraction, Transport, and Manufacturing.
- **Transport (A4):** Includes transportation of material and equipment to the site.
- **Construction (A5):** Includes impacts from the construction equipment and labour.
- **Recurring(B1-B5):** Includes Maintenance, Repair, and Replacement of roads, streetlights, etc.
- **Energy (B6):** Includes energy use during the use phase like lighting and irrigation.
- **End of Life (C1-C4):** Includes Demolition, transportation of waste, processing, and disposal.
- **Benefits and Loads Beyond the System Boundary (D):** Includes open and closed loop recycling, direct recycling, and operational energy exports.

Environmental Indicators

The study primarily focuses on the Global Warming Potential (GWP) impacts of the developments, which are measured as $kgCO_2eq$. However, six other environmental indicators are also included. The environmental indicators assessed in the studies are:

- Global Warming Potential (GWP),
- Ozone Depletion Potential (ODP),
- Acidification Potential for Soil & Water (AP),
- Eutrophication Potential (EP),
- Photochemical Ozone Creation Potential (POCP),
- Abiotic Depletion Potential – Elements (ADPE), and
- Abiotic Depletion Potential – Fossil Fuels (ADPF).

Overview of the Development Projects

Each of the projects is unique in various aspects. The 115 Hamilton Hill project is on the site of the former Hamilton Senior High School. The decommissioning of the high school afforded the project the opportunity to include significant amounts of reclaimed materials. This can be seen in the environmental strategy performance of this project with 6 of the 10 strategies involving reusing materials from the site.

The Bushmead development is the only green field development of the three. And at 88ha, it is also the largest by a substantial margin. These two factors are likely contributors to Bushmead requiring more imported fill material than the other two sites.

The other unique aspects of the Bushmead development are that it includes 185ha of additional land that is being preserved as natural bushland; and that the developers are minimising newly landscaped areas. Although these strategies were not within the direct scope of this assessment, they are expected to provide significant benefit for biodiversity and could also save significant quantities of carbon.

Orion Industrial Park is the only industrial development assessed as part of this study. This means that the lots are significantly larger than the other developments resulting in significantly lower carbon emissions per m^2, but significantly higher carbon emissions per lot.

Results

Figures 2(a) & (b), 3(a) & (b), and 4(a) & (b) show key results of the studies: life cycle carbon impact by construction material and by life cycle stage.

115 Hamilton Hill (Development WA)

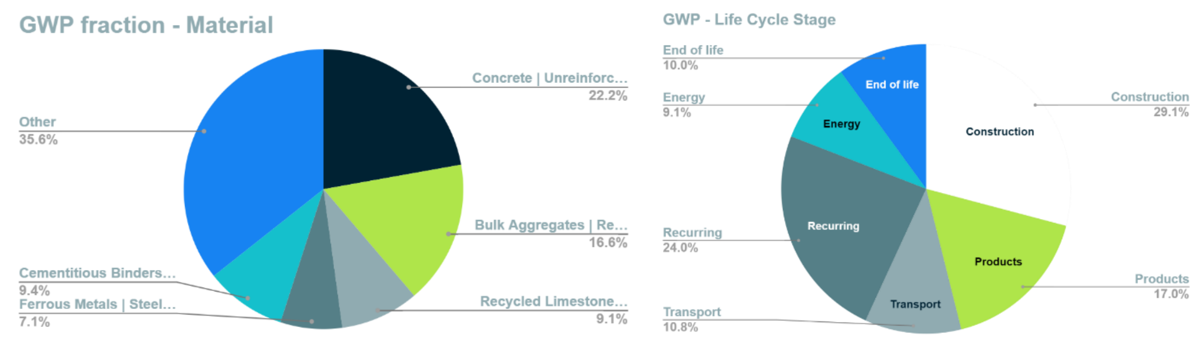

Figure 2: (a) Top 5 Materials by GWP impact ; (b) GWP impacts per life cycle stages

Bushmead Development (Cedar Woods)

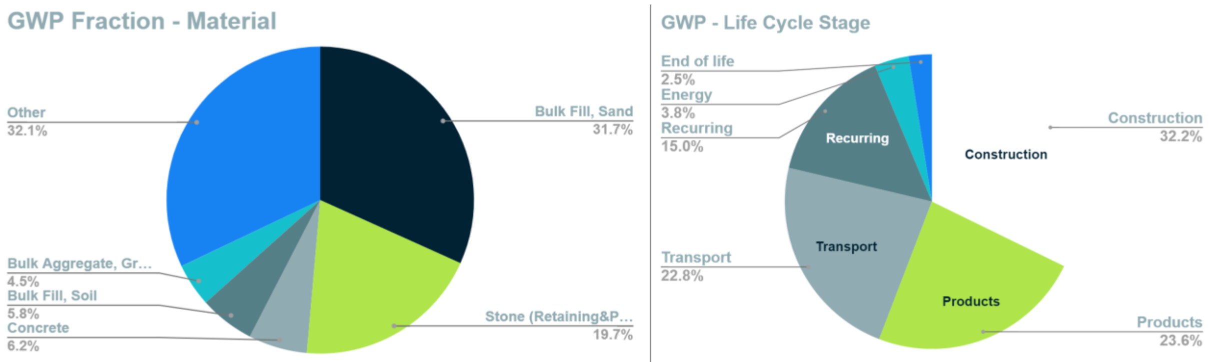

Figure 3: (a) Top 5 Materials by GWP impact ; (b) GWP impacts per life cycle stages

Orion Industrial Park (Development WA)

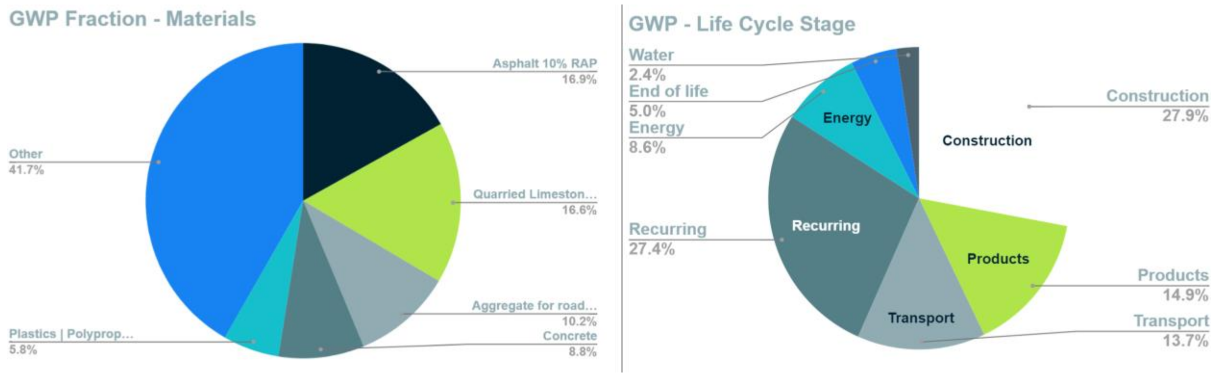

Figure 4: (a) Top Materials by GWP impact ; (b) GWP impacts per life cycle stages

Key Findings:

- **Construction (module A5)** is the largest contributor to life cycle impacts in all three studies, accounting for 29.12% of the overall carbon emissions for 115 Hamilton Hill, 32.2% for Bushmead, and 27.9% for Orion Industrial Park. This is the construction effort, i.e., the impact of the construction equipment itself.
- **Recurring Impacts (module B1-B5)** are the second largest contributing life cycle stage for two of the developments, accounting for 24% of impacts for 115 Hamilton Hill, and 27.4% for Orion Industrial Park. This included maintenance of landscaped areas, roads, paved areas, and services.
- **Products (module A1-A3)** are the second largest contributing life cycle stage for Bushmead, accounting for 23.6% of life cycle carbon impacts.
- For 115 Hamilton Hill the top material contributing to the carbon impact was **Concrete**, followed by **Recycled Concrete Aggregate**.
- For Bushmead the top material contributing to the carbon impact was **Bulk Fill (Sand)**, followed by **Stone (Retaining & Paving)**.
- For Orion Industrial Park the top material contributing to the carbon impact was **Asphalt (10% RAP)**, followed by **Limestone (Road Base & Retaining)**
- **Construction equipment**, such as loaders and dump trucks featured repeatedly in the top 10 individual items contributing to life cycle impacts for all three projects.
- **Operational energy of street lighting** was found to be a significant contributing individual item in all three projects.
- **Transport (module A4)** impacts were significant in all three projects, accounting for between 10%-23% of life cycle carbon.

Environmental Strategies Implemented in the Projects

Figures 5, 6, & 7 are waterfall charts of the carbon savings resulting from the environmental strategies included in the proposed design model of the three developments.

115 Hamilton Hill

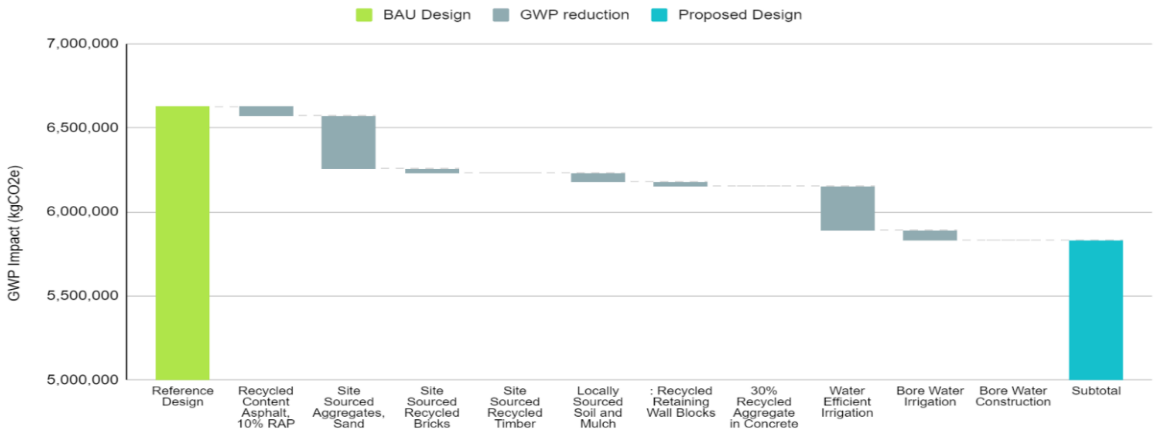

Figure 5: 115 Hamilton Hill development Carbon saving strategies

Bushmead Development (Cedar Woods)

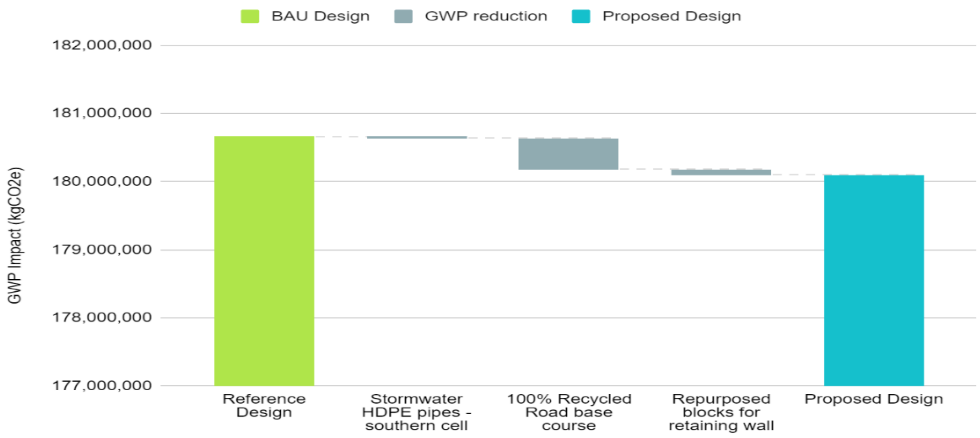

Figure 6: Bushmead Development Carbon Saving Strategies

Orion Industrial Park (Development WA)

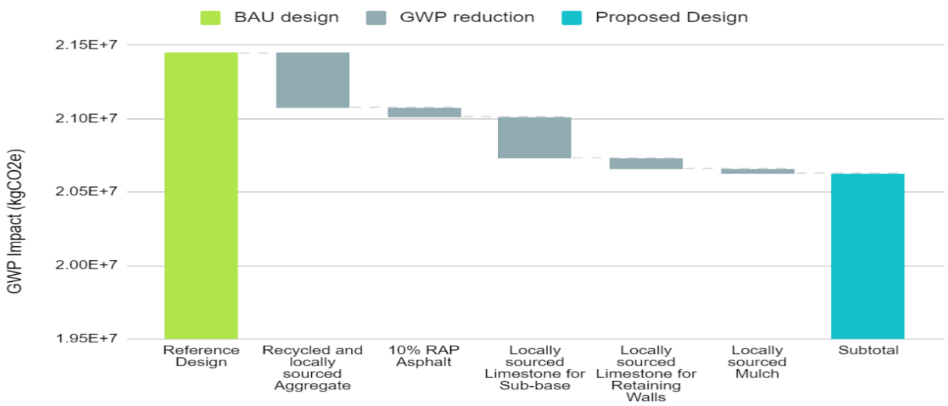

Figure 7: Orion Industrial Park Carbon saving strategies

Cerclos

Key Findings:

- The 10 strategies included in the proposed model for 115 Hamilton Hill reduced the life cycle carbon impact of the project by 12.1% compared to business as usual.
- **Site Sourced Aggregates, Sand** resulted in the highest savings for 115 Hamilton Hill, followed by **Water Efficient Irrigation**.
- The **100% Recycled Road Base Course** resulted in the highest saving for the Bushmead development.
- Carbon reduction from the strategies in the Bushmead development were not overly significant, however the out-of-scope strategies of retaining large areas of natural bushland, and minimising new landscaped areas are expected to have a substantial benefit for biodiversity.
- **Recycled and locally sourced Aggregate** resulted in the highest saving for Orion Industrial Park, followed by **Locally sourced Limestone for Sub-base**.
- The 5 strategies included in the proposed model for Orion Industrial Park reduced the life cycle carbon impact of the project by just under 4%.

Opportunities for Environmental Improvement

Based on the findings and results of the LCA studies, several opportunities for reducing life cycle emissions and improving environmental performance have been identified. These include:

Electric Equipment**:** Shifting from diesel-powered construction equipment to electric alternatives has the potential to significantly reduce life cycle emissions. It is recognised that electric construction equipment is not readily available in Australia at this time, and that there will be cost involved, however, it is expected that this transition will happen over coming years.

Electric Transport**:** With transport of material and equipment accounting for 10%-23% of impacts, electrification of freight transport has the potential to provide substantial benefits in terms of life cycle carbon emissions.

Solar Street Lighting**:** Switching to solar-powered streetlights is a relatively simple strategy using readily available, existing technology.

Minimize Imported Fill**:** Designing to minimise the use of imported fill materials in land development projects can help reduce carbon emissions associated with products and transportation.

Low-Impact Materials**:** Utilizing more sustainable alternative materials, such as low-carbon concrete and recycled asphalt pavement (RAP) will help lower the environmental impact of development projects.

Careful Consideration of Landscaped Areas**:** Designing landscaped areas to minimise maintenance, and reducing lawn areas, can substantially cut down ongoing impacts and water use.

Reduced Earth Movements on Site: To reduce the impact of construction equipment, designing to minimise on-site earth movement can be an effective measure to reduce life cycle emissions. This may be linked to minimising the quantity of imported fill, but could also be a further measure of carefully considering finished ground levels.

Cerclos

Next Steps

These findings emphasise the importance of considering the entire life cycle of a project and integrating sustainable practices into urban land developments.

***Encourage a Science-Based Approach*:** You can't improve what you don't measure. Encouraging developers to embed LCA into their process will help them to understand the full scope of environmental impacts, set realistic goals, track progress, demonstrate sustainable efforts, and manage risks.

***Foster Collaboration and Integration*:** Collaboration and knowledge sharing among governments, developers, builders, suppliers, consultants, academia, and communities will help to identify pragmatic solutions and best practices. A collective effort will foster innovative solutions and drive industry towards net-zero goals.

***Enhance Knowledge, Accuracy, and Standardisation*:** Promoting the development and implementation of standardised methodologies will ensure consistency and comparability across different assessments, enabling stakeholders to benchmark and measure their performance effectively.

***Extend Scope to the Entire Precinct*:** Broadening the focus beyond just development infrastructure to encompassing the entire precinct will facilitate a comprehensive understanding of interconnected factors and trade-off opportunities allowing for better decision-making.

***Facilitate Informed Decision-making*:** LCA enables design comparisons, measurement of environmental impacts and drives innovation in sustainable land developments. This data-driven approach enhances credibility, cost-effectiveness, and strategic planning.

***Training and Professional Development*:** Providing training programs, workshops, and conferences on development best practice guidelines will enhance the knowledge and skills of professionals involved in sustainable land development.