SIGMAH

SOCIAL + GREEN BENEFITS CALCULATOR

SOCIAL INFRASTRUCTURE AND GREEN MEASURES FOR AFFORDABLE HOUSING

User Guide (v.1.1) February 2025

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SIGMAH

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SIGMAH v.1.1 updates

SIGMAh is intended as an evolving product. From time to time we aim to provide additional functionality, update existing functionalities as new evidence becomes available, or updates due to general economic conditions. Version 1.1 updates are:

1. Updating and alignment of environmental benefits / disbenefits. The update relates to the size of negative effects (disbenefits) from removing existing green infrastructure. In version 1.1 these will now be larger / more negative.
2. Minor adjustment to WTP calculations. These only come into effect when lower quartile rents provided by SIGMAh are used. When market-based rents are used calculations remain unchanged.
3. Updating of consumer price index and rental price index based for financial years 2022/23 and 2023/24. Updating of price setting and cost-of-living calculation in social housing segment.
4. Updating of some labels and descriptions of summary graphs and summary benefits, including additional colour coding.
5. Further guidance on use of SIGMAh output in cost-benefit analysis. Guidance is related to the additional colour coding.

SIGMAH Calculator User Guide

1.0 Introduction

SIGMAH is the result of a series of research projects commissioned by the Community Housing Industry Association (CHIA). SIGMAH was produced at the Centre for Urban Transitions, Swinburne University of Technology.

The SIGMAH is intended to provide users with a tool to estimate the wider social and economic benefits (WSEB) that arise from delivering new social and affordable rental housing. The estimates produced by the SIGMAH can be used as inputs in social cost-benefit analysis (SCBA), but do not constitute a cost-benefit analysis.[1]

SIGMAH provides users with a tool to calculate three sides of wider social and economic benefits associated with social and affordable housing development and design:

1. Monetary and monetary equivalent estimates of benefits linked to the affordability status of dwelling tenancies.
2. Monetary estimates of the Greenhouse Gas (GHG) and environmental benefits linked to design features such as provision of green spaces and connectivity to transport options.
3. Monetary and CO_2 estimates of embodied carbon and energy performance of new dwellings.

There are currently two versions of SIGMAH with separate terms and conditions. These are SIGMAH and SIGMAH (NE). SIGMAH NE does not contain the Embodied Carbon interface. This user guide is intended for use with both versions. Section not applicable to the use of SIGMAH (NE) are identified by a (*).

1.1 SIGMAH INTERFACES

SIGMAH consists of two user interfaces.

Green+Social:	This is the main interface for calculation of affordability and environment linked wider social and economic benefits. In this interface users provide inputs on **Housing Development Details** (such as number of different properties, affordability status, housing of particular tenant groups, as well as energy rating of developments). In this interface users also add **Market Details** and **Environmental and Local Amenities**. This interface is general in use and requires little technical knowledge.
Embodied Carbon (*):	This interface is a stand-alone component. The Embodied Carbon interface is powered by the Environmental Performance in Construction (EPIC) database (Crawford et al 2019). EPIC is employed in this calculator under a Creative Commons license

[1] Advice or guidance is provided in a small number of cases on appropriate cost considerations that can be used in any cash flow or cost-benefit analysis.

2. INPUTTING USER VALUES

Cells in the interfaces are colour coded.

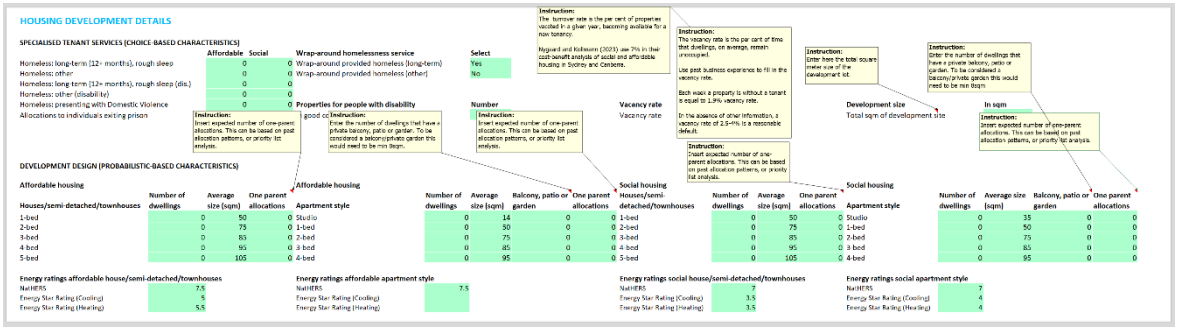
- Green cells: is where to input the information. Please note – only cells in green are modifiable in SIGMAH – all other cells are locked for editing. There is one exemption to this.
- Red cells: will appear, disappear or contain notifications and information depending on other settings in the calculator. Information can be entered in these, but is only used in the calculations if certain other combination of options are selected. When the relevant options are selected so the values are to be used in the calculation, these cells will turn green. This feature is further described under the Market Details instructions.

2.1 HOUSING DEVELOPMENT DETAILS

This part of the calculator is the main input for calculating wider social and economic benefits linked to the affordability status of housing developments. The benefits are related to the affordability status of properties and works on the assumption that households either meet the choice-based tenant characteristics, or that they are classified as low- to moderate-income (the two lowest income quintiles).

The below image shows Housing Development Details part in its entirety. For the illustrative purposes of the User Guide (v1.0) only, comment boxes are visible. In addition, drop-down selection menus also provide additional inputting instructions.

Figure 1: Housing Development Details overview



2.1.1 TENANT CHARACTERISTICS

Calculations of the WSEB in SIGMAH are either choice based or probabilistic. Choice based characteristics refer to expected tenants for whom particular characteristics can be pre-determined or planned by the housing provider. Probabilistic characteristics refers to the likelihood of a prospective tenant exhibiting a characteristic or circumstance. These cannot necessarily be planned for but are nevertheless known to occur for social and affordable housing tenants.

Choice based characteristics

Developers of new social and affordable housing may base their business case on commitments to housing people experiencing homelessness or domestic violence, people with disabilities or those exiting prisons. These characteristics of tenant allocation are choice based (for the housing provider).

The benefit values associated with these groups draws on targeted and specialised research, enabling direct linking of benefits to the choice of tenants. Specialised tenant services can be entered for both affordable and social housing allocations separately.

The choice-based characteristics are primarily related to homelessness or risk of homelessness. Classification of people into categories of homelessness is, however, not an exact science. Specialist Homelessness Services (SHS) data collection distinguishes between homelessness, risk of homelessness and other service needs. Given the varying complexity (and thus associated public sector cost implications) associated with people's ongoing and past experience of homelessness there is, when assessing social benefits, a further need to distinguish within the homelessness category itself.

SIGMAH therefore distinguishes between high-cost, complex and long-term forms of homelessness; other forms of homelessness; and homelessness where the person presents with domestic violence as the cause of seeking specialist homelessness services assistance. There have been a number of studies in Australia on the potential public sector cost offsets associated with providing secure housing for people experiencing complex and long-term homelessness.[2] These studies form the basis for setting references values for the difference homelessness categories.

Users are advised to enter values for the choice-based characteristics based on analysis of project business plans, analysis of own allocation practices or policy objectives. As a rule of thumb, people experiencing homelessness for more than 12 months, or rough sleeping, provide a proxy for complex and high-cost individuals in distinguishing between forms of homelessness. Appendix 1 to this User Guide provides summary statistics based on 10 years of SHS statistics, broken down by categories of homelessness as well as allocations to individuals existing prisons (classified as at-risk of homelessness).

A warning message is displayed if the number of specialised tenant allocations exceeds the total number of available dwellings, message adjusts according to whether it is available affordable, social or both that is exceeded. This does not stop the calculator from working but serves as a reminder to check allocation assumptions against dwelling characteristics to avoid over-inflating the WSEB benefits.

Figure 2: Complex-needs tenants warning

SPECIALISED TENANT SERVICES (CHOICE-BASED CHARACTERISTICS)	Affordable	Social
Homeless: long-term (12+ months), rough sleep	1	1
Homeless: other	0	0
Homeless: long-term (12+ months), rough sleep (dis.)	0	0
Homeless: other (disability)	0	0
Homeless: presenting with Domestic Violence	0	0
Allocations to individuals exiting prison	0	0
Note: number of specialised tenant allocations exceeds available number of dwellings in both affordable and social housing		

Importantly, providing accommodation to specialised tenant groups is also associated with additional costs. *If developing a business case, cash flow or cost-benefit analysis, these additional costs must be accounted for separately*. Suggestive cost values are provided in the instructions related to provision of wrap-around services for people experiencing homelessness. Research shows that the average benefits to individuals and society from housing people experiencing homelessness depend on whether or not they also receive support beyond being housed. The 'Wrap-around homelessness service' function in the calculator provides users with a choice of Yes and No. Calculations on WSEB adjust automatically to user's choice. The choice of providing additional wrap-around service to people experiencing homelessness also determines the turnover of this type of tenancy (a general turnover rate is specified separately, see below). Excluding wrap-around service inclusion from the calculation provide a measure of the positive externality of the housing availability itself.

[2] This literature is reviewed in Nygaard (2019). For domestic violence see also Oberklaid and Alves (2022).

Figure 3: tenant characteristics

SPECIALISED TENANT SERVICES (CHOICE-BASED CHARACTERISTICS)

	Affordable	Social	Wrap-around homelessness service	Select
Homeless: long-term (12+ months), rough sleep	0	0	Wrap-around provided homeless (long-term)	Yes
Homeless: other	0	0	Wrap-around provided homeless (other)	No
Homeless: long-term (12+ months), rough sleep (dis.)	0	0		
Homeless: other (disability)	0	0		
Homeless: presenting with Domestic Violence	0	0	**Properties for people with disability**	**Number**
Allocations to individuals exiting prison	0	0	In good condition for people with disability	0

DEVELOPMENT DESIGN (PROBABILISTIC-BASED CHARACTERISTICS)

Affordable housing				Affordable housing		
Houses/semi-detached/townhouses	**Number of dwellings**	**Average size (sqm)**	**One parent allocations**	**Apartment style**	**Number of dwellings**	**Average size (sqm)**
1-bed	0	50	0	Studio	0	14
2-bed	0	75	0	1-bed	0	50
3-bed	0	85	0	2-bed	0	75
4-bed	0	95	0	3-bed	0	85
5-bed	0	105	0	4-bed	0	95

Energy ratings affordable house/semi-detached/townhouses		**Energy ratings affordable apartment style**	
NatHERS	7.5	NatHERS	7.5
Energy Star Rating (Cooling)	5	Energy Star Rating (Cooling)	
Energy Star Rating (Heating)	5.5	Energy Star Rating (Heating)	

Probabilistic characteristics

Many benefit values established in the literature is not related to specific (identifiable) characteristics of prospective tenants. For instance, mental health, educational attainment etc cannot a priori be determined. The calculator therefore computes WSEB based on probabilistic evidence. Additional details on how benefit impacts are calculated are provided in the Technical Appendix.

The probabilistic calculations are related to housing design characteristics. For instance number of bedrooms is related to number of children, which again provides the basis for linking research evidence on the impact of access to secure and affordable housing to number of beneficiaries. Users specify total number of dwellings (with different design characteristics) and whether or not these are expected to house one—parent households (the latter information is needed to estimate a total number of adults and children to be housed).

The calculation of WSEB greatly depends on who is housed in new properties. The majority of people (without specific identifiable characteristics) are not expected to derive a monetary or wellbeing effect, or reduce the cost to the public sector, as a function of moving into social and affordable housing *only*. In order to calculate the probabilistic-based WSEB users must specify:

- Type of dwellings that are provided:
  - houses and townhouses, or
  - apartment style dwellings
- Tenure basis:
  - Affordable, or
  - social housing
- Design characteristics:
  - number of bedrooms,
  - average size of each dwelling type,
  - whether apartment style dwellings have private balcony/garden space provided

Figure 3 illustrates this part of the calculator showing the affordable housing design characteristics. Social housing design characteristics (and instructions) are identical (not shown in Figure 3, but can be seen in Figure 4).

2.2.2 CONTEXTUAL DEVELOPMENT CHARACTERISTICS

Key contextual information relates to tenant 'Turnover rate', 'Vacancy rate' and 'Total sqm of the development site'.

The 'Turnover rate' is the per cent of dwellings, on average, vacated each year as a result of tenancies ending. The 'Turnover rate' plays an important role in determining WSEB. The majority of benefits are assumed to apply each year that a tenant remains in affordable housing. However, some benefits are one-off effects. For instance, benefit of improved educational attainment is modelled as a one-off benefit; similarly, Wellbeing Values are only applied in the first year of a tenant's tenure in social and affordable housing. The methodology behind Wellbeing Values assumes that people's expectations in subsequent years has adjusted to their new situation, making it the new norm (Fuijwara et al 2017). Wellbeing Values are therefore only attributed to new tenancies, which again is a function of the turnover rate. Turnover rates can be based on analysis of user's own tenancy records.

The 'Vacancy rate' is the per cent of time that dwellings, on average, remain unoccupied. The vacancy rate feeds into, for instance, the monetary benefits of rental discounts. Vacancy rates can be based on analysis of user's own tenancy records.

'Development size' (the size of the development in square meters) is required for calculation of various environmental related benefits.

Figure 4: contextual characteristics

Turnover rate	Per cent
Turnover rate	7%

Vacancy rate	Per cent
Vacancy rate	0%

Development size	In sqm
Total sqm of development site	-

Social housing Houses/semi-detached/townhouses	Number of dwellings	Average size (sqm)	One parent allocations
1-bed	0	50	0
2-bed	0	75	0
3-bed	0	85	0
4-bed	0	95	0
5-bed	0	105	0

Social housing Apartment style	Number of dwellings	Average size (sqm)	Balcony, patio or garden	One parent allocations
Studio	0	35	0	0
1-bed	0	50	0	0
2-bed	0	75	0	0
3-bed	0	85	0	0
4-bed	0	95	0	0

Energy ratings social house/semi-detached/townhouses	
NatHERS	7
Energy Star Rating (Cooling)	3.5
Energy Star Rating (Heating)	3.5

Energy ratings social apartment style	
NatHERS	7
Energy Star Rating (Cooling)	4
Energy Star Rating (Heating)	4

2.2.3 Energy and thermal performance

The final 'Housing Development Details' inputs relate to energy and thermal performance. Many low- and moderate-income households (indeed many Australians) live in energy and thermally inefficient houses. The SIGMAH provides estimates of reductions in energy expenditure (for households) as well as reductions in Greenhouse Gas emissions for new dwellings – relative to a pre-determined, representative private rented sector dwelling. Users select from dropdown menus the expected energy rating (NatHERS) of the dwelling, as well as energy ratings of cooling and heating infrastructure. The difference in GHG emissions and energy cost between the selected energy and thermal performance of the development and representative Private Rental Sector (PRS) values provides an additional measure of the development's benefit.

Figure 5: energy and thermal performance

Note: the use of the energy and thermal performance benefits in cost-benefit analysis is complex. A societal net gain can only be claimed if new developments replace existing dwellings or if energy and thermal performance exceed minimum planning standards.

2.2 MARKET DETAILS

This part of the calculator is the main input for adjusting wider social and economic benefits to their locational context as well as a number of economic variables used for estimating disposable income benefits and economic circumstances.

2.2.1 RENTAL INFORMATION

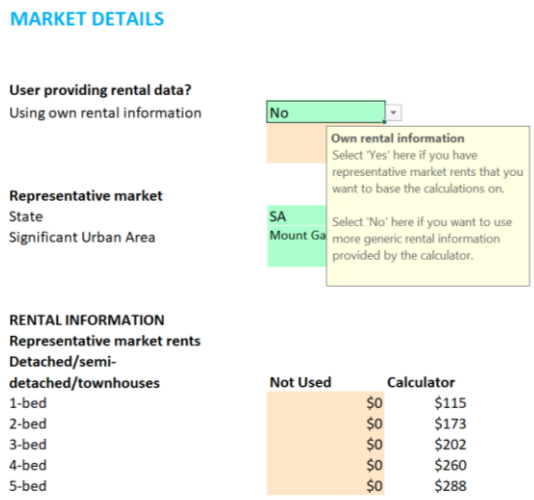
Information on rents is key to determining societal value as well as cost-of-living benefits to tenants. Filling in information relating to market rents consists of 3 steps.

Step 1 – providing own rental information or using calculator values (must be filled in)

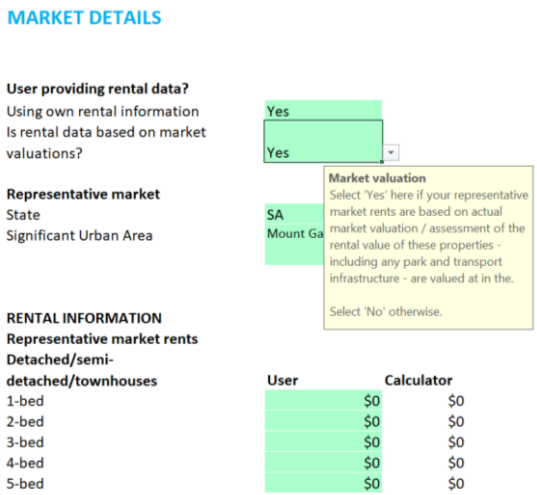
Two options are available to users. These are user-defined by selecting 'No' or 'Yes' from the drop-down menu under 'User providing rental data'. Figure 6 illustrates both options.

Figure 6: Market Details overview

Panel A



Panel B



A. If selecting No: At the time of developing a proposal users may not have access to representative market rents.
B. If selecting Yes: A new data entry question will appear. This asks whether the rental information is based on actual market valuations / assessments of what the proposed dwellings would be rented at *in the private rental market*. The choices here are 'Yes' and 'No'.
    i. If selecting Yes: You should select *yes* if the market valuation / assessments are based on the dwelling characteristics as well as any additional design features such as access to parks,

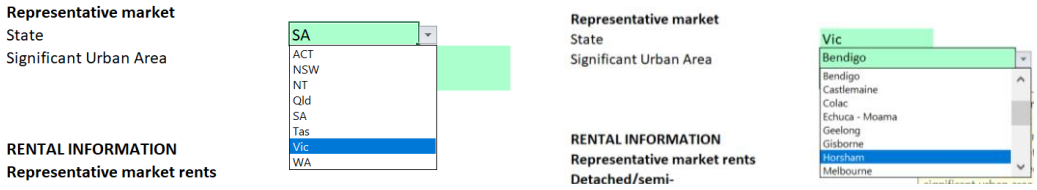
public or active transport. The calculator contains several willingness to pay (WTP) estimates for a range of amenities (parks, public transport). These will become inactive to minimise any double counting of benefits.

ii. If selecting No: You should select *no* if rental information does not reflect dwellings with similar design features such as access to parks, public or active transport. For instance, a user may have more up to date lower-quartile rental information, or more place specific lower-quartile rental information than is contained in SIGMAh. This will activate the willingness to pay data in the calculator.

Step 2 – selecting representative market context (must be filled in)

The calculator provided market rents differentiate capital cities and rest of state. SIGMAH contains market information sourced from (REIA 2022 and Fair Trading NSW 2022) that can be used as indicative rents. These market rents represent lower quartile rents for dwellings of different sizes. In order to identify the market context, users provide information on 'State' and 'Significant Urban Area' (SUA) within each state, using the two drop down menus shown in Figure 7.

Figure 7: Representative market context



Note: The representative market context should be filled in irrespective of whether users provide own rental information or not. A number of values – in addition to rental values – in the SIGMAH are dependent on location of new housing developments. For instance, social cost of air quality is a function of local population density.

Step 3 – inputting representative market rents (only if option A is 'Yes')

Having answered 'Yes' under Step 1, (all cells should now be green as per Panel B, Figure 6) representative lower-quartile rents (Option B.ii above) or market rents (Option B.i above) should be entered by number of bedrooms and for houses and apartment style properties separately. Enter representative market values, in the green cells in the 'User' column. When choosing to enter own rental values, the values that appear in the 'Calculator' column will equal the user inputted values.

Figure 8: User provided representative market rents

RENTAL INFORMATION
Representative market rents

Detached/semi-detached/townhouses	User	Calculator	Apartment style flats	User	Calculator
1-bed	$420	$420	Studio	$325	$325
2-bed	$510	$510	1-bed	$370	$370
3-bed	$650	$650	2-bed	$460	$460
4-bed	$700	$700	3-bed	$600	$600
5-bed	$850	$850	4-bed	$750	$750

2.2.2 Additional market details

Four additional pieces of market information are required. These are illustrated in Figure 9.

Figure 9: Additional market details

Time value of money	
Discount rate	5%
Consumer price inflation	2.5%
First year of operation	
Base year of calculation	2023
Affordability rent discount	
% of market rent	74.99%

When reporting on the wider social and economic benefits associated with current and future benefits it is common practice to express the value of future benefits relative to their monetary equivalents today. For instance, in cost-benefit analysis this is a critical step in the assessment of projects. From an investment appraisal perspective, expressing future cost and benefits in terms of today's value of money is an important step in assessing the value of today's decisions over time.

This is the choice of 'discount rate' under the 'Time value of money'. Choice of discount rates are highly influential when determining costs and benefits and net present value of benefits (NPV). Current guidance in Australia suggests that 7% should be used as the central discount rate for any social cost-benefit analysis, and 3% and 10% for sensitivity analysis (**COA 2006)**. In NSW the guidance is 5% for social cost-benefit analysis, and 3% and 7% for sensitivity analysis (**NSW Treasury 2023)**.

Users can specify their preferred discount rate, but it is advised to follow common practice in the state of operation. The discount rate used in calculation is adjusted based on the assumed price inflation assumptions provided by users under 'Consumer price inflation'. Cost-benefit analysis should be conducted without adjusting for inflation separately, as inflation relates to the time value of money. All NPV calculations in the calculator thus automatically adjust the calculation-discount rate, when information is added on both 'Discount rate' and 'Consumer price inflation'.

To complete the determination of prices in the calculator, users select the expected 'First year of operation'. This enables prices to be adjusted for starting year. Note – this also affects the NPV calculations which, in all cases, will be calculated in the value of the first year of operation too.

Finally, users can set the 'Affordability rental discount' relative to market rent. This value is used in calculating purchasing power and societal benefits associated with improvement in affordability.

2.3 ENVIRONMENTAL AND LOCAL AMENITY DETAILS

This part of the calculator is the main input for benefits relating development design features such as: provision of green space and local transportation amenities. Unlike the benefit values derived with inputs in section 2.1, the benefits derived in this section are not related to the affordability status of properties. This part of the calculator can in principle be used for any type of housing development.

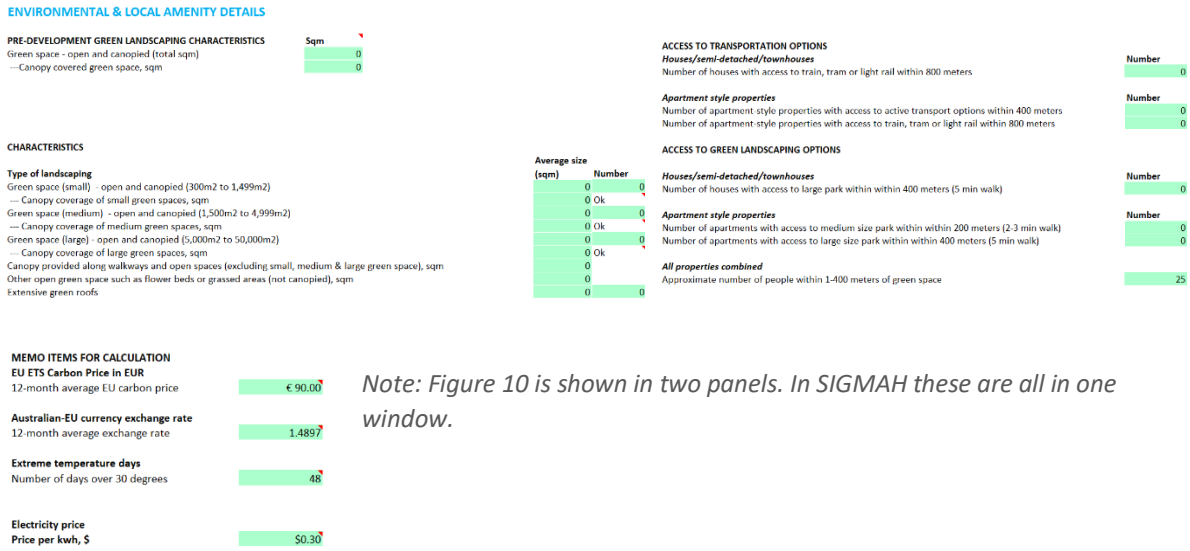
The values entered in this part calculate and monetises benefits based on:

- Interim Framework for Valuing Green Infrastructure and Public Spaces (NSW DPE 2022)
- Benefits Estimation Tool – Valuing the benefits and blue-green infrastructure (CIRIA 2019)
- Green Space Valuation Survey Low-Income Housing (Lagarde et al 2022)

If using this part of the calculator for housing that is not social or affordable (below market rent) and where tenants are not low income, all other benefit calculations then all WSEB summary outputs should be ignored. Figure 10 gives an overview of the Environmental & Local Amenities interface.

There are five components to this interface.

Figure 10: Environmental and local amenity calculation overview



ENVIRONMENTAL & LOCAL AMENITY DETAILS

PRE-DEVELOPMENT GREEN LANDSCAPING CHARACTERISTICS	Sqm
Green space - open and canopied (total sqm)	0
--- Canopy covered green space, sqm	0

CHARACTERISTICS	Average size (sqm)	Number	
Type of landscaping			
Green space (small) - open and canopied (300m2 to 1,499m2)	0	0	
--- Canopy coverage of small green spaces, sqm	0		Ok
Green space (medium) - open and canopied (1,500m2 to 4,999m2)	0	0	
--- Canopy coverage of medium green spaces, sqm	0		Ok
Green space (large) - open and canopied (5,000m2 to 50,000m2)	0	0	
--- Canopy coverage of large green spaces, sqm	0		Ok
Canopy provided along walkways and open spaces (excluding small, medium & large green space), sqm	0		
Other open green space such as flower beds or grassed areas (not canopied), sqm	0		
Extensive green roofs	0	0	

ACCESS TO TRANSPORTATION OPTIONS	Number
Houses/semi-detached/townhouses	
Number of houses with access to train, tram or light rail within 800 meters	0
Apartment style properties	
Number of apartment style properties with access to active transport options within 400 meters	0
Number of apartment style properties with access to train, tram or light rail within 800 meters	0

ACCESS TO GREEN LANDSCAPING OPTIONS	Number
Houses/semi-detached/townhouses	
Number of houses with access to large park within within 400 meters (5 min walk)	0
Apartment style properties	
Number of apartments with access to medium size park within within 200 meters (2-3 min walk)	0
Number of apartments with access to large size park within within 400 meters (5 min walk)	0
All properties combined	
Approximate number of people within 1-400 meters of green space	25

MEMO ITEMS FOR CALCULATION	
EU ETS Carbon Price in EUR	
12-month average EU carbon price	€ 90.00
Australian-EU currency exchange rate	
12-month average exchange rate	1.4897
Extreme temperature days	
Number of days over 30 degrees	48
Electricity price	
Price per kwh, $	$0.30

Note: Figure 10 is shown in two panels. In SIGMAH these are all in one window.

2.3.1 PRE-DEVELOPMENT GREEN LANDSCAPE CHARACTERISTICS

All environmental benefits (greenhouse gas and air quality) are calculated relative to what existed prior to new or redevelopment. That is, if an area contained a 300 sqm green open space prior to development, and also has a 300sqm green open space after development, then the additional value created is zero.

Users enter two pre-development values in square meters: the total amount of green space and the amount of canopy covered green open space. If an area has 200 sqm of green open space and 100 sqm of tree canopy covered space, then 300 sqm (green space) and 100 sqm (canopy covered green space) should be entered as the pre-development characteristics.

2.3.2 POST-DEVELOPMENT GREEN LANDSCAPE CHARACTERISTICS

Post-development characteristics can be entered in some detail. The calculator allows users to specify green space by sizes and design characteristics.

Some developments may have multiple areas of green development and of varying sizes. Users should enter the average size of small, medium and large green spaces, and the number of these.

After specifying combined (open and canopied areas) of different sizes the total canopied area of small, medium and large green spaces should be entered separately.

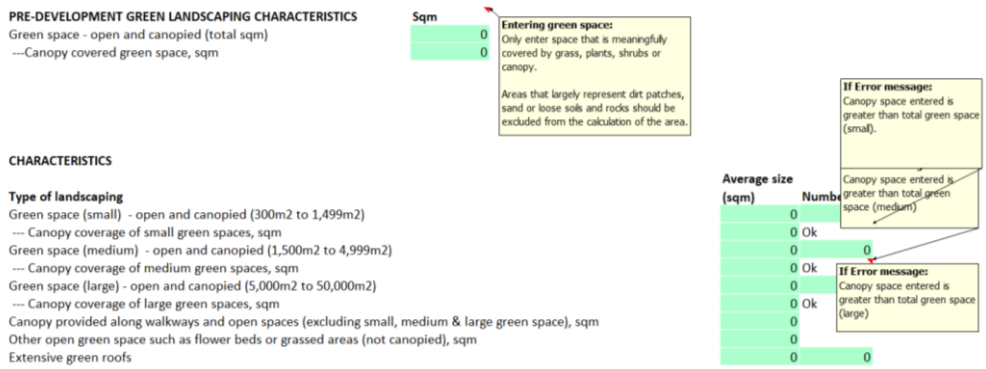
Box 1: Size definitions

- Small: 300-1,499 sqm
- Medium: 1,500-4,999 sqm
- Large: 5,000-50,000 sqm

For reference, a Tennis court is 260 sqm and Melbourne Cricket Ground is 20,000 sqm.

Figure 11 provides an illustration: If there are two small green spaces as part of a development, each ca 500 sqm in size, and each of these areas have 100 sqm of canopied spaces, then enter 500 as the average size of green space (small) and 200 as canopy coverage. The calculator produces an error message (saying: "Error") if canopied space exceeds total small green spaces. If the canopied area is less than/same size as the total (in this case 2x500 sqm) green space (small), then the message 'Ok' is produced.

Figure 11: Entering green space information



In addition to small, medium and large green space characteristics, users can enter size related information for – in each case this should only be information that is not also covered by entry of small, medium and large green spaces:

- Additional canopy coverage, such as along walkways, cycle lanes or trees that are not part of dedicated green areas.
- Other open green space, such as flower beds or grassed areas (not canopied).
- Extensive green roofs, such as roof-top gardens or vegetated roofs. For green roofs it is also necessary to enter the number of such roofs. Note only green roofs including a mix of canopied, bush and low-rise vegetation should be considered. Green roofs entirely composed of grass should not be counted.

The specifying of green and landscaping characteristics is linked to reduction in GHG emissions via carbon sequestration and health benefits air quality improvement (PM2.5 reduction).

The benefit values for green design are based on NSW DPE (2022) guidance. Typically research on green benefits is conducted on mature green spaces. Thus, GHG sequestration rates vary as trees grow and then reach maturity. This process will depend on the type of trees that are planted. Following DPE (2022) SIGMAH employs four growth phases when calculating GHG benefits.

Similarly, cooling effects (reduction in temperature and energy expenditure) from canopy is typically based on established or mature trees. SIGMAH assumes that post-development trees (additional trees) are young and therefore do not deliver the full cooling effect for some time. The same four growth phases as in DEP (2022) are employed in calculating cooling effects, with the trees in the first 5 years of establishment only providing a 25% benefit, increasing to 50% in the next five years, 75% in the following 10 years before full benefit after 20 years.

Green open space should reflect areas that also contain vegetation reaching at least 20-30 cm. Cropped lawns, while generating benefits through evapotranspiration do not generate the same cooling benefits as areas with longer grass and shrubs. SIGMAH will thus likely overestimate the health and GHG benefits arising from cooling if the entered green space is simply a manicured green lawn. In this case estimates with and without the green space should be provided for comparison.

2.3.3 ACCESS TO TRANSPORTATION AMENITIES

In this part users specify the number of properties within 400 meters (4-5 minute walk) and 800 meters (8-10 minute walk) distances to train, trams and light rail options; or 400 meters (4-5 minute walk) to active transport options (dedicated walking or cycling path connecting place of residence with shopping, leisure and work opportunities). The benefits associated with these design features are based on Willingness-to-Pay estimates undertaken by Simetrica-Jacobs for this calculator (Lagarde et al 2022).

Box 2: Willingness to Pay (WTP)

The WTP measures used in this calculator are based on choice experiments conducted with current owners and renters across Australia. The values represent the additional price low-income tenants were prepared to pay in rent if a number of design features were added to their current housing circumstance. Since the calculator also derives an adjusted rental discount benefit (for social and affordable rents, relative to private market rents) there is a risk of double counting these benefits. The WTP values (as existence value) are therefore only operational when 'Using own rental information' and 'Is rental data based on market valuation' are set to 'No'.

WTP estimates were derived using a series of choice experiments referenced against tenants current proximity to local amenities and the provision of additional local amenities.

Two types of transport amenities are available in the calculator (Figure 12):

- Train, tram or light rail within 800 meters
- Active transport within 400 meters. Active transport options are dedicated walking/cycling lanes between tenant homes and places of work, leisure and/or shopping.

Figure 12: Transport amenities by dwelling type

ACCESS TO TRANSPORTATION OPTIONS	
Houses/semi-detached/townhouses	**Number**
Number of houses with access to train, tram or light rail within 800 meters	0
Apartment style properties	**Number**
Number of apartment-style properties with access to active transport options within 400 meters	0
Number of apartment-style properties with access to train, tram or light rail within 800 meters	0

Willingness-to-Pay is estimated separately for tenants living in lower density developments such as houses, semi-detached and town houses, and higher density developments such as apartment blocks. The research undertaken for this calculator found that WTP differed by type of property. Therefore the options that can be specified differ for houses and apartment style developments.

Users should enter the number of dwellings (of each category) falling within the specified catchment areas of the different transport options. Only add all properties if it is the case that all the dwellings detailed in Section 2.1 (Housing Development Details) are situated within the catchment areas.

2.3.4 ACCESS TO GREEN AND LANDSCAPING AMENITIES

In addition to the carbon sequestration and air quality benefits, urban greening also provides personal recreational and personal benefits and contribute to reducing urban heat island effects. These benefits are dependent on proximity to green space and number of people affected. *Note: green space and landscaping potentially also provides benefits to people not directly living in new developments (the developments specified in Section 2.1). In the SIGMAH there is no attempt to capture these benefits extended benefits.*

Personal benefits are captured in SIGMAH through either market valuation of rental prices or WTP estimates (see Box 2). Cooling and health benefits are captured through proximity to green space. As per access to transport amenities, WTP values are based on primary research for SIGMAH and reflects the estimated WTP of low income households in Australia for these local amenities. The estimates WTP differed for tenants in houses and apartment style developments.

Access to green and landscaping amenities is specified in terms of proximity and size of green space (Figure 13):

- Number of houses within 400 meters of a large park
- Number of apartments within 200 meters of a medium sized park
- Number of apartments within 400 meters of a large park.

Note: number of apartments within 200 and 400 meters of parks should be treated as separate categories. That is, a dwelling that is within 400 meters of a large park should not also be classified as being within 200 meters of a medium park.

In addition to specifying dwellings within specific catchment areas, users should identify the approximate number of people within these catchment areas. *Note: people within the catchment area should only include approximate number of people in the dwellings that form part of the proposed development.*

Figure 13: Green space amenity by dwelling type

ACCESS TO GREEN LANDSCAPING OPTIONS	
Houses/semi-detached/townhouses	**Number**
Number of houses with access to large park within within 400 meters (5 min walk)	0
Apartment style properties	**Number**
Number of apartments with access to medium size park within within 200 meters (2-3 min walk)	0
Number of apartments with access to large size park within within 400 meters (5 min walk)	0
All properties combined	
Approximate number of people within 1-400 meters of green space	0

2.3.5 Monetising green benefits

The final component requires users to source a number of input values from publicly available sources. These are economic and weather-related variables that change over time.

Figure 14: Economic and weather variables for monetising green benefits

MEMO ITEMS FOR CALCULATION	
EU ETS Carbon Price in EUR	
12-month average EU carbon price	€ 90.00
Australian-EU currency exchange rate	
12-month average exchange rate	1.4897
Extreme temperature days	
Number of days over 30 degrees	48
Electricity price	
Price per kwh, $	$0.30

In order to monetise the benefit generated by carbon sequestration a value needs to be placed on CO_2. The GSBC calculation of carbon sequestration benefits follow NSW guidance on valuing carbon (NSW DPE 2022, NSW Treasury 2023). The European Union's Emissions Trading Scheme (ETS) carbon price can be obtained from a number of sources. The 12-month average preceding the estimation should be used in calculations. The carbon prices are then scaled automatically using a 2.25 per cent WTP-based scaler (NSW Treasury 2023). The ETS price needs to be converted to Australian dollars using prevailing exchange rates. Links to data sources are provided in Box 3.

Box 3: Key links for accessing economic and weather data:

ETS carbon price: https://ember-climate.org/data/data-tools/carbon-price-viewer/

Historical exchange rate information: https://www.oanda.com/fx-for-business/historical-rates

Bureau of Meteorology: http://www.bom.gov.au/climate/data/index.shtml

Electricity prices: https://www.finder.com.au/average-cost-of-electricity

Urban greening and landscaping reduce the effect of urban heat islands and heat waves. The *Interim Framework for Valuing Green Infrastructure and Public Spaces* (NSW DPE 2022) recommends using number of days exceeding 30 degrees Celsius as a proxy for measuring the times that green spaces will produce a measurable heat-related benefit.

Box 4 provides information on how to navigate the Bureau of Meteorology website to obtain this information for specific locations in Australia.

Box 4: Obtaining days exceeding 30 degrees

1. Use the map to select location.
2. Select 'Daily maximum temperature' from I would like.
3. Map will produce a small call-out box: click on 'Daily max. temperature' link.
4. Select from 'Show in table': Days above 30 degrees.

Finally, users should specify a representative electricity price in cents for SIGMAH to estimate cost of living benefits associated with energy efficiency and thermal standards of construction (note these are specified as part of the Housing Development Details).

2.4 SIGMAH OUTPUTS RELATED TO HOUSING DEVELOPMENT, ENVIRONMENTAL AND LOCAL AMENITY INPUTS

SIGMAH provides users with two kinds of outputs – numeric and graphic summaries.

Numeric summaries

These provide summary lines of monetised benefits accruing to the public and private sectors of the economy. For instance, public sector benefits include avoided public expenditure on health-related services that are attributable to security of affordable tenure or GHG emissions reductions; private sector benefits include *net* societal benefits arising from rental discounts or wellbeing associated with security of tenure or access to green space.

Numeric summaries are given for average annual benefits per dwelling, average annual benefits over a 40-year horizon, the total benefits accrued over 40 years, and for each of 40 years. Figure 17 shows an excerpt.

Figure 17: excerpt of numeric summary output

MONETISED BENEFITS HOUSING DEVELOPMENT INPUTS		Average per dwell, per annum (40)	Average per annum (40)	Total over 40 years	Yr 1	Yr 2	Yr 3
Total public benefit ($)	Public	$ 247	$ 7,401	$ 296,051	$ 4,392	$ 4,502	$
Total private benefit ($)	Private	$ 1,556	$ 46,682	$ 1,867,260	$ 27,703	$ 28,396	$
Total private benefit, WTP + wellbeing($)	Private	$ 1,889	$ 56,684	$ 2,267,364	$ 98,541	$ 33,478	$
Total housing development benefits ($)	**Combined**	**$ 2,136**	**$ 64,085**	**$ 2,563,415**	**$ 102,933**	**$ 37,980**	**$**
NPV Total public benefit ($)	Public	$ 48	$ 1,428	$ 57,128			
NPV Total private benefit ($)	Private	$ 300	$ 9,008	$ 360,322			
NPV Total private benefit, WTP + wellbeing ($)	Private	$ 404	$ 12,122	$ 484,884			
NPV Total housing development benefits ($)	**Combined**	**$ 452**	**$ 13,550**	**$ 542,012**			

Note: numbers are entirely illustrative (include 2.5% inflation).

In Figure 17 total public, private and combined private and wellbeing benefits are illustrated. The illustration is based on a 15 affordable rental and 15 social rental housing development, no specialised tenant services included.

The right-hand side of the figure shows the summaries for average per dwelling, per annum; the average benefit per annum; and the total benefits. Benefits are aggregated separately for public and private benefits and combined. Public benefits are those that reduce public sector expenditure. Private benefits are those that accrue to the tenant. Private benefits are presented with and without the inclusion of monetised Wellbeing Values and Willingness-to-Pay estimates (WTP included depending on how rental values are recorded in the Green+Social Interface). Visible also is the annual breakdown for Year 1 to Year 3. In the calculator itself annual breakdowns are available for years 1-40.

In the illustration the 30 (15 affordable and 15 social rental dwellings) generate a combined social benefit of $2,136 per annum, per dwelling; $64,085 per annum combined; and, $2,563,415 for the 40-year assessment period as a whole. In the absence of specialised tenant services, most of the combined benefit is a private sector (household and private economy) benefit, with a relatively small share of public sector (e.g. avoided expenditure) benefit.

Figure 17 also illustrate the net present value (NPV) calculations associated with these benefits. Again, NPV calculations is provided for public, private and combined private and wellbeing, as well as three categories combined.

Figure 18 shows the full overview of numeric summaries related to the Housing Development, Environmental and Local Amenity inputs.

Figure 18: overview all numeric summaries

MONETISED BENEFITS HOUSING DEVELOPMENT INPUTS		
Total public benefit ($)	Public	
Total private benefit ($)	Private	
Total private benefit, WTP + wellbeing($)	Private	
Total housing development benefits ($)	**Combined**	
NPV Total public benefit ($)	Public	
NPV Total private benefit ($)	Private	
NPV Total private benefit, WTP + wellbeing ($)	Private	
NPV Total housing development benefits ($)	**Combined**	
MONETISED BENEFITS ENVIRONMENTAL AND LOCAL AMENITIES INPUTS		
Green infrastructure GHG sequestration & health from canopy cover		
GHG sequestration (CO2) benefit (tons)	Public	
GHG sequestration social value ($)	Public	
Clean air benefit from green infrastructure ($)	Public	
Green infrastructure and urban cooling		
GHG reduction from green infrastructure cooling (CO2 tons)	Public	
GHG reduction from green infrastructure cooling ($)	Public	
Health benefit from green infrastructure cooling ($)	Public	
Combined CO2 abatement and health from canopy cover and urban cooling		
GHG reduction from green infrastructure cooling and sequestration (CO2 tons)	Public	
GHG reduction from green infrastructure cooling and sequestration ($)	Public	
Health and clean air benefits ($)	Public	
Total environmental and local amenity inputs ($)		
NET PRESENT VALUE canopy cover & GHG sequestration		
NPV GHG sequestration ($)	Public	
NET PRESENT VALUE GHG sequestration, cooling and health		
NPV GHG reduction from green infrastructure cooling and sequestration ($)	Public	
NPV Urban cooling health benefit ($)	Public	
NPV Clean air benefit ($)	Public	
NPV Total environmental and energy benefit ($)	**Public**	
Combined housing development, environmental and local amenity inputs ($)	**Combined**	
NPV combined housing development, envionrmental and local amenity inputs (	**Combined**	
COMBINED COST OF LIVING RELIEF, NOMINAL ($)		
Combined energy expenditure reduction ($)	Private	
Nominal rental reduction ($)	Private	
Combined cost of living relief, nominal ($)	**Private**	
NPV Energy expenditure ($)	Private	
NPV Combined cost of living relief, nominal ($)	**Privte**	

Numeric summaries provide monetised values ($). The exemption to this is CO_2 that also is captured in weight (tons).

Figure 18 distinguishes between green, blue and yellow summaries.

- Green summaries are calculated on the assumption that any impacts are additional to what *society* otherwise would experience. Green summaries can thus be used as an input to cost-benefit analysis.
- Blue summaries are also calculated on the assumption that any impacts are additional to what *society* would otherwise experience. The societal impact is, however, proxied by the impact on residents in the development. The extent to which this proxy accurately captures total societal impacts is a function of development designs. For instance, if urban cooling and health effects also positively or negatively impact people outside the development, then SIGMAH values are only partial. Blue values should be used in cost-benefit analysis with caution.
- Yellow summaries cannot be used in cost-benefit analysis. While these do constitute a very real benefit to tenants (or related to tenants), the values themselves also constitute a loss to someone (e.g. forgone rental income); or a comparison of energy consumption (including CO2 emissions) in a counterfactual private rental situation. In the latter case any energy consumption is nevertheless

additional to what *society* experienced prior to the housing development.[3] In the green summaries these positive and negative effects are adjusted for, but not in the yellow summaries. Instead, the yellow summaries provide an indication of how tenants/residents stand to benefit.

Graphic summary

Graphic summaries visualise key outputs. In Figure 18 the $2,563,415 combined (over 40 years) benefit from the earlier 30 dwelling illustration is shown (Panel 1, Figure 18). Graphs are also provided on a per annum, per dwelling, and per annum basis, as well as NPV (not shown in Figure 18). Panel 2 (Figure 18) shows the social value associated with reduced GHG emissions resulting from the proposed development having a NatHERS rating exceeding the NatHERS rating typically found in private sector rental. CO_2 reduction is shown in Panel 3. Panel 4 shows the monetary benefit (tenants) resulting from improved energy efficiency (lower heating/cooling bills) and reduced rent. As noted above – these values are not classified as societal benefits, although they are of course benefits to the individual tenant.

Note: dollar values will be either nominal (if inflation is greater than zero) or real (if inflation is set to zero).

Figure 18: Excerpt of graphical summary output

Note: Panel 1: Housing and tenure benefits; Panel 2 Environmental and local amenity benefits; Panel 3 Energy and GHG sequestration abatement; Panel 4 Cost of living relief; Panel 5 Combined monetised benefits.
All numbers are illustrative and do not reflect any actual development.

[3] A societal gain would only emerge if the new housing developments resulted in the removal less energy efficient dwellings. In this case though care needs to be taken in the interpretation of the monetised benefits from the housing development which assumes that additional housing is developed and that people previously not having access to affordable and appropriate housing *now do*.

2.4.1 WHAT DO THE GRAPHS SHOW?

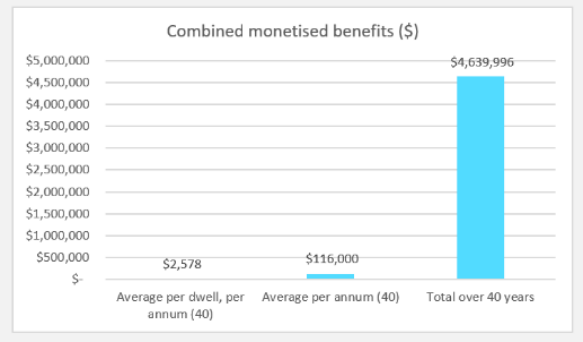


Table 1 below provides an overview of what is measured and contained in each of the bar charts above (Panel 1-5). For Panel 1 and Panel 2 the output is provided over the entire calculation period (40 years). These are the illustration in figure 18. Panel 1 and Panel 2 are also provided on an annual basis (not shown above), annual benefit per dwelling (not shown above), and for the entire calculation period (40 years) (not shown above), but on a discounted basis (net present value, NPV, basis). The nominal or real values summarise benefits without adjusting for the time value of money, risk or alternative uses of resources. The NPV is a function of the discount rate that is inputted in the Market Details interface.

Table 1: SIGMAH summary outputs and their meanings

Summary output category	Bar chart label	What is its meaning or content
Housing and tenure benefits (Societal benefit)	**Total public benefits**	Monetary estimate of public sector cost offsets. For instance, reduction in health expenditure or police/criminal justice expenditure. Cost offsets measure the expenditure that tenants in the housing development would likely have incurred, but that – because of secure and affordable housing – no longer are expected to take place. This represents saving to the public sector. The Technical Appendix provides an overview of specific variables and values.
	Total private benefit	Monetary estimate of the benefit that society over all experiences. For instance, rental reductions relative to market rents provide a small overall net benefit to society in the form of increased consumption. This is a societal (private sector) gain. Improved education attainment or reduction in stress related expenditure similarly are additional benefits to the individual (private sector). The Technical Appendix provides an overview of specific variables and values.
	Total private benefit, WTP + wellbeing	In addition to monetary benefits, people also experience subjective wellbeing (SWB) effects arising from non-tangible or non-market outcomes. These are measured using Wellbeing Values and/or Willingness-to-Pay. For instance, security of tenure or the absence of stress can generate wellbeing effects that are not measured by any monetary expense that either individual, society or the public sector directly experiences. Wellbeing Valuation is a method for providing a monetary equivalent value to such benefits, recognising that societal gain is a combination of monetary benefits as well as additional wellbeing benefits. The WV approach estimates the impact of the service or outcome and the impact of income on people's SWB and uses these estimates to calculate the exact amount of money that would produce the equivalent impact on SWB as the service or outcome in question. The Technical Appendix provides an overview of specific Wellbeing Values provided by the Australian Social Value Bank for SIGMAH. SIGMAH also includes WTP measures for certain design features. When included (depending on how rental values are recorded

		on the Green+Social Interface) these are included in the wellbeing summary.
	Total housing development benefit	This measure combines the 'Total public benefits' and the 'Total private benefit + wellbeing' into a single measure.
Environmental and local amenity benefits (Societal benefit)	**GHG reduction from green infrastructure cooling and sequestration**	This output provides a summary measure of the reduction in CO2 emissions associated with lower energy consumption resulting from green infrastructure provided cooling effects, and the sequestration of CO2 from additional trees. Sequestration in relative to the rate of sequestration experienced prior to the development and thus additional sequestration. The social value of this CO2 abatement is function of the amount (tons) of CO2 abatement and the prevailing EU ETS price. The Technical Appendix provides an overview of how energy and GHG sequestration benefits are calculated.
	Health benefit from green infrastructure cooling	Trees, vegetated areas and grass provide cooling effects by producing shade, evapotranspiration and reduced reflection of sunlight. Cooling of urban environments reduces heat-induced mortality and is an important component of developing future and climate proof(er) urban environments. The Technical Appendix provides an overview of how cooling benefits are calculated.
	Clean air benefit from green infrastructure	Canopy and extensive green roofing contribute to the removal fine particular matter (PM10 and PM2.5) from the air. Particular matter causes damage to heart and lungs (PM10) and can enter deep into the lungs and blood stream (PM2.5). SIGMAH includes estimated health benefits from canopy cover (DPE 2022) as well as extensive green roofing. Health benefits associated with green roofing is based on CIRIA (2019). The Technical Appendix provides an overview of how clean air benefits are calculated.
	Total environmental and local amenity input	This is a summary measure of the green infrastructure benefits = 'Energy and GHG sequestration abatement social value' + 'Health benefit from green infrastructure cooling' + 'Clean air benefits from green infrastructure'.
Energy and GHG sequestration abatements (tons) (Societal benefit)	**GHG reduction from green infrastructure cooling (CO2 tons)**	The values reported in the 'Environmental and local amenity benefits' graphical output is the monetary value of any benefits. The energy and GHG sequestration abatement (tons) graph shows the physical value of CO2 reduction associated with lower energy consumption and sequestration of CO2 from green infrastructure. Summary output is provided by: i. Per dwelling and per year; ii. Per year (development as a whole) iii. Entire assessment period, 40 years (development as a whole)
Cost of living relief (Individual benefit)	**Cost of living relief**	SIGMAH is concerned with making better economic cases for investment in social and affordable housing. Consequently the focus is on estimating societal gains. However, access to social and affordable housing also represent a gain to the individual resident. The 'Cost of living relief' measure captures the full reduction in rental payment (the societal gain is a function of the propensity to consume out of income and thus a much smaller amount than the full rental reduction value), as well as reduction in energy expenditure relative to living in an

		average private rental property. This measure captures an important distributional impact of providing social and affordable housing, but should not be equated with the societal gain. *Cost of living relief is measured relative to what the equivalent cost (based on market rents) would be for the affected tenants if properties were let as private rental.*
Combined monetised benefits (Societal benefit)	**Combined monetised benefits**	This is a summary measure of 'Total Housing Development benefits' and 'Total environmental and local amenity input'. Summary output is provided by: i. Per dwelling and per year; ii. Per year (development as a whole) iii. Entire assessment period, 40 years (development as a whole)

2.5 EMBODIED CARBON CALCULATIONS (*)

This part of SIGMAH makes use of the Environmental Performance in Construction (EPiC) database (http://epicdatabase.com.au).[4] EPiC is an open-access Life Cycle Inventory of the environmental flows of construction materials. Environmental flows are embodied energy, embodied water and embodied greenhouse gas emissions. EPiC is subject to a Creative Commons license: CC BY-NC-ND 4.0 that allows users to copy and redistribute the material in any format or medium provided its use is appropriately attributed (see footnote 2), for non-commercial uses (not primarily intended for commercial advantage or monetary compensation, and, is not used to create derivate products (remixed, transformed or built upon). Full license details are available here: https://creativecommons.org/licenses/by-nc-nd/4.0.

The embodied carbon calculations are done in a separate interface, the Embodied Carbon Interface. Unlike the use of the Green+Social Interface, the embodied carbon calculations require specialist knowledge. For instance, using SIGMAH to estimate the embodied carbon of new developments requires knowledge of how much and what type of building material will be used in construction.

The embodied carbon calculations functionality within SIGMAH is therefore intended as a basis for documenting the embodied carbon of proposed housing developments, rather than a tool for designing low-carbon housing developments, comparing different development options or detailed life-cycle assessment of developments.[5] The latter two tasks require highly specialist knowledge as well as software.[6]

By documenting the embodied carbon of new developments SIGMAH allows users to:

1. Compare the embodied carbon footprint and social cost of a development to environmental benefits provided by provision of other design solutions, e.g. carbon sequestration provided by parks and landscaping.
2. Detail the carbon balance (CO_2e) of new developments over a 40 year period.[7]
3. Detail years to (potential) carbon and GHG emissions neutrality.

2.5.1 BUILDING MATERIAL CATEGORIES (*)

The EPiC database provides material coefficients (water, energy and CO_2e values) for some 280 construction materials across 8 material categories:

- Concrete and plaster products
- Glass
- Insulation
- Metals
- Plastics
- Sand, stone and ceramics
- Timber products
- Miscellaneous category

[4] Crawford, R.H., Stephan, A. and Prideaux, F. (2019) Environmental Performance in Construction (EPiC) Database, The University of Melbourne, Melbourne.
[5] Lifecycle Assessment typically considers construction inputs in additional detail (e.g. more product classes) and would incorporate replacement of material over the lifetime of a development. For instance, if some building materials are replaced every 5 or 10 years, then this input would similarly be counted multiple times throughout the lifecycle assessment.
[6] The EPiC website provides resources and links to open-access software for users that seek these additional functionalities.
[7] To calculate GHG emissions and social costs a range of GHG emissions are converted into their equivalent impact as Carbon Dioxide (CO_2). These converted values are expressed as Carbon Dioxide Equivalents (CO_2e).

Each materials category contains a number of types of materials within that category, which again contain specific materials/products. This is illustrated in Table 2.

Table 2: Illustration of building material categorisation

Category	Type	Material/product
Concrete and plaster products	Blocks	Concrete block
		Concrete block - 390 × 190 × 90 mm
		Concrete block - 390 × 190 × 140 mm
		Concrete block - 390 × 190 × 190 mm
	Cement	Cement mortar
		Portland cement

2.5.2 Inputting data for embodied carbon calculations

Material components used in construction are entered using three units of measurement: kilos (kg), area/square meters (m^2) or numbers (no). Figure 15 provides an illustration.

Drop-down menus appear on each stipulated green line. There are as many lines as there are material/product types in each category. Upon selection of material/product type the required unit of measurement is specified in the blue cells. In the illustration this is number (no) for Concrete block 390x190x140mm and kilos (kg) for Concrete block. In the lower half of Figure 15, FC weatherboard 300x7.5mm is entered in square meters (m^2). Once the unit of measurement is specified (red cells) the amount of material inputs is specified in the green cells (under Input).

Figure 15: specifying amounts of material used in construction

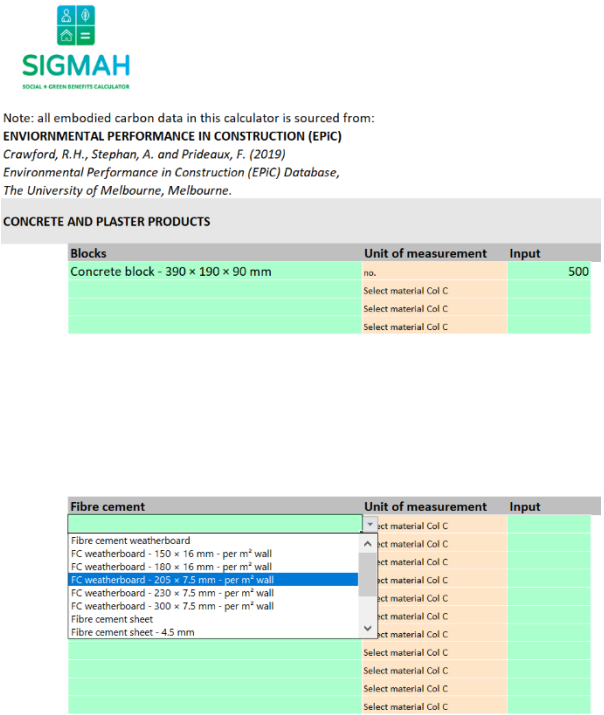
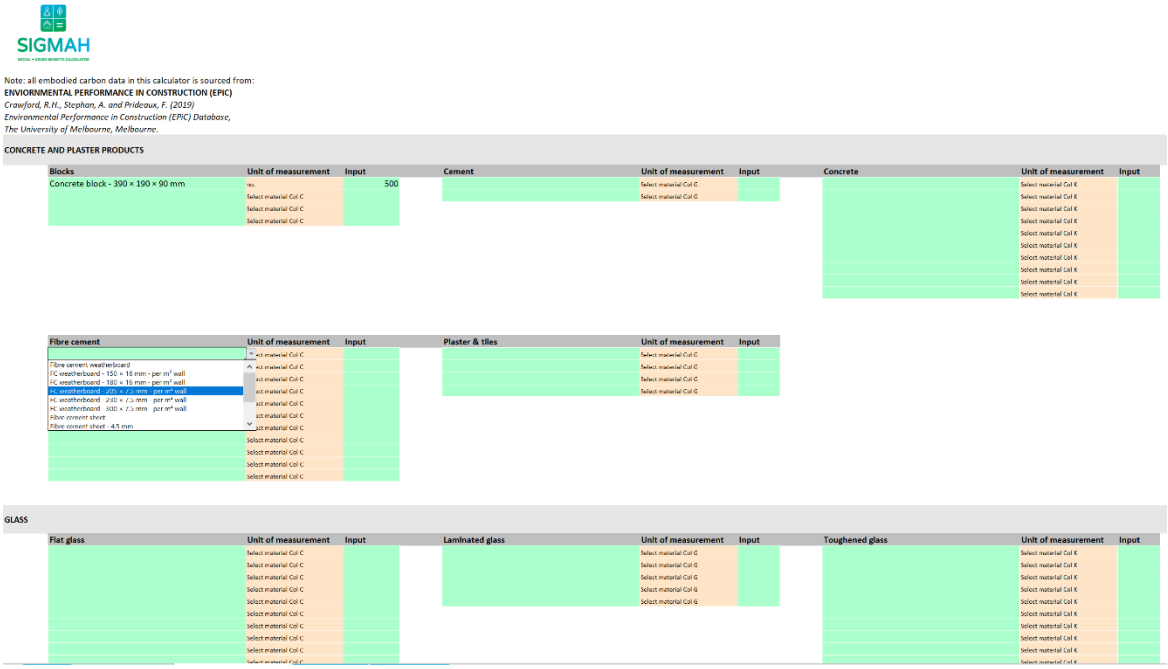


Figure 15 shows two types of materials within the Concrete and plaster product category. A fuller overview of this category, as well as the Glass and Insulation categories is provided in Figure 16.

Figure 16: Embodied carbon interface – three categories



2.6 ILLUSTRATION OF OUTPUT BASED ON EMBODIED CARBON INTERFACE INPUTS (*)

The Embodied Carbon Interface provides the functionality of estimating the embodied carbon, water and energy contained in new housing developments. Figure 19 and Figure 20 illustrates the output generated by SIGMAH. This illustration is based on the inclusion of 1,000 sqm of green space of which 200sqm is canopied, doubling the size of relative to what existed before development.

Figure 19: Illustrative SIGMAH embodied environmental flow values

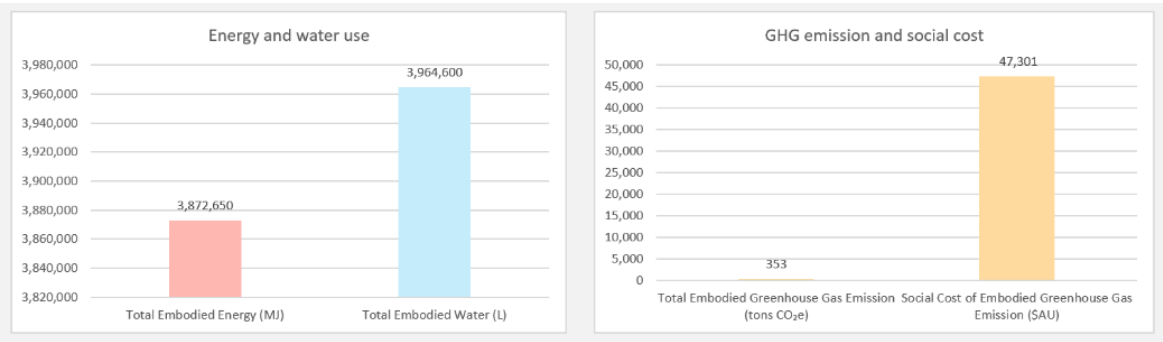


Figure 19 shows the combined (of the three material inputs in Figure 17) embodied energy, embodied water and embodied GHG emissions.

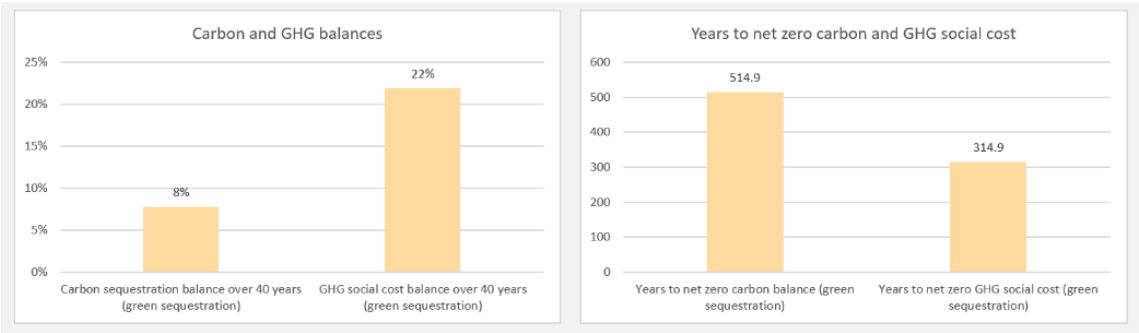
Figure 20 shows the carbon balances of this illustration. The left hand panel shows how much of carbon sequestration has taken place over a 40 year period and expresses this as a per cent of the embodied CO_2e (Figure 19, right panel). Similarly, it expresses the social cost associated with the CO_2e used in the illustration as a per cent of the social value generated by the provision of green space. In the illustration the park provided has absorbed the equivalent of 62% of the embodied carbon represented by the building materials, and 73%

of the social cost. The absorption of social cost exceeds the real carbon balance (rate of sequestration) as the value placed on climate mitigation is expected to increase over time (NSW Treasury 2023).

The right hand panel shows how many years are required for the provided green space to sequester the same amount of CO_2e embodied in construction. The output is also expressed in terms of social cost. Based on the illustration numbers it would take 514.9 years for the development to be net zero. Because the value of future carbon reductions increases relative to today (NSW Treasury 2023) the number of years (314.9) it takes for the social cost to be neutral is less than the real carbon balance.

Note: the carbon sequestration and GHG social cost balance in Figure 20 are only based on the sequestration of carbon as a result of the provision of green infrastructure. This does not include the abatement of carbon associated with lower energy consumption. Thus the measures show how much carbon is produced by the construction of housing development, and how much of this will be absorbed by the provision of green infrastructure.

Figure 20: Illustrative carbon balances



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Appendix 1

Table A1 provides a breakdown of Specialist Homelessness Services data. The data summarises 10 years (2011/12-2021/22) of SHS service provision, specifically a breakdown of people presenting to a homelessness service provider and receiving long-term accommodation support. Long-term accommodation support is defined as housing for at least 3 months and with the expectation of ongoing tenure. There is a large number of people presenting to homelessness services that are not provided with long-term accommodation support. The statistics in Table A1 therefore are indicative of the resource constraint that characterises access to secure social and affordable housing in Australia, and the characteristics of those that are allocated long-term accommodation support.

Cross-tabulation of the Homelessness (Homeless, At risk, Other) with Domestic violence (DV) assistance provided (Yes, No) and Long-term accommodation provision (Yes, No) was used to create the three Homelessness categories used in SIGMAH: Homelessness (not presenting to SHS as DV), At risk of homelessness (not presenting to SHS as DV) and Homelessness (presenting to SHS as DV). These are the three categories in **bold**. Notably, homelessness pathways are complex. The qualification 'presenting to SHS' as either DV or not, does not fully capture the role of DV in the causes of homelessness. Many people presenting to SHS for assistance may have experiences of DV in their personal experience, without it constituting the recorded, or directly preceding, cause of seeking assistance.

Cross tabulating Homelessness (Homeless, At risk, Other) with Dwelling type in the SHS statistics, was done to distinguish between Long-term (12 months+) rough sleeping forms of homelessness, and Other forms of homelessness; and in the At risk of homelessness category, those existing prisons. The rationale for the two subcategories of Homelessness is set out in main text of the User Guide. To identify number of people experiencing long-term homelessness in the SHS data the following dwelling proxies were used: Tent, Improvised dwelling, No dwelling/in the open, Emergency accommodation, Hotel/B&B/motel (typically placed by an SHS provider). Remaining dwelling forms were used to identify Other homelessness (including temporary).

From a SIGMAH data entry perspective Table A1 can be used to give a general understanding, or profile, of the choice-based characteristics where users are not relying on own data or knowledge. The breakdown is particularly applicable to social housing allocations, although for a number of CHOs they may also be applicable to affordable housing allocations.

In NSW Table A1 could be taken to say that out of a 100 people receiving long-term accommodation support when presenting to specialist homelessness services 34 would be classified as homeless – of these some 14-15 would be classified as Long-term homeless, 19-20 would be classified as other homeless. Some 39 would be classified as At risk of homelessness. These would not enter in the Choice-based characteristics part of SIGMAH, apart from 2-3 individuals exiting a correctional facility. A further 9 would similarly also not be entered in the Choice-based characteristics part of SIGMAH.

Table A1: Presenting to SHS and receiving long-term accommodation support (3mnts+ with expectation of ongoing accommodation)

	NSW	VIC	QLD	WA	SA	TAS	ACT	NT
Homelessness (not presenting to SHS as DV)	**0.34**	**0.36**	**0.48**	**0.42**	**0.37**	**0.48**	**0.39**	**0.27**
…Long-term (12 mnts+), rough sleep	…0.43	…0.31	…0.41	…0.42	…0.27	…0.29	…0.29	…0.41
…Other homelessness (temporary)	…0.57	…0.69	…0.59	…0.58	…0.73	…0.71	…0.71	…0.59
At risk of homelessness (not presenting to SHS as DV)	**0.39**	**0.36**	**0.33**	**0.35**	**0.35**	**0.43**	**0.39**	**0.40**
…At risk correctional facility	…0.07	…0.03	0.04	…0.07	…0.03	…0.04	…0.04	…0.08
Homelessness (presenting to SHS as DV)	**0.19**	**0.20**	**0.13**	**0.17**	**0.20**	**0.05**	**0.10**	**0.24**
Other	**0.09**	**0.09**	**0.06**	**0.07**	**0.09**	**0.04**	**0.12**	**0.08**

Source: AIHW (https://www.aihw.gov.au/reports/homelessness-services/specialist-homelessness-services-annual-report/data)