CalEEMod

California Emissions Estimator Model

User Guide

Version 2022.1

Prepared for:
California Air Pollution Control Officers Association (CAPCOA)

Prepared by:
ICF
in collaboration with Sacramento Metropolitan Air Quality Management District, Fehr & Peers, STI, and Ramboll

Date:
April 2022

Acknowledgements

This program benefited from the hard work and creative insights of many people. The California Air Pollution Control Officers Association (CAPCOA) appreciates the efforts of all who contributed their time and energy to the project. In particular, CAPCOA thanks the following organizations and agencies.

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San Diego Association of Governments
San Diego Regional Climate Collaborative
San Joaquin Valley Air Pollution Control District
Santa Barbara County Air Pollution Control District
San Luis Obispo Air Pollution Control District
South Coast Air Quality Management District
The Climate Registry
University of California, Davis

Funding Partners

California Department of Transportation (via Senate Bill 1 Adaptation Planning Grants)

Bay Area Air Quality Management District

Sacramento Metropolitan Air Quality Management District

California Department of Public Health's Office of Health Equity, and Centers for Disease Control and Prevention (CDC) of the U.S. Department of Health and Human Services (HHS) as part of a financial assistance award totaling $147,000 with 100 percent funded by CDC/HHS. The contents

are those of the authors and do not necessarily represent the official views of, nor an endorsement, by CDC/HHS, or the U.S. Government.

Additional Recognition

CAPCOA would like to recognize the important contributions made to CalEEMod by the Institute of Transportation Engineers (ITE) for granting permission to CAPCOA to utilize its trip generation data. ITE's *Trip Generation Manual* can be obtained by visiting ITE's website: https://www.ite.org/technical-resources/topics/trip-and-parking-generation/.

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Version 2022.1

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1 Introduction

This User Guide to the California Emission Estimator Model (CalEEMod)® provides direction for appropriate use of the program and documents the detailed calculations and default assumptions. The purpose of CalEEMod is to provide a uniform platform for government agencies, land use planners, and environmental professionals to estimate ozone precursors, criteria pollutants, and greenhouse gases (GHG) (collectively referred to as "emissions") from land use development and linear projects in California. CalEEMod also integrates data from the Office of Environmental Health Hazard Assessment's (OEHHA) CalEnviroScreen® (CES) 4.0, the State of California's Cal-Adapt®, and the Public Health Alliance of Southern California's Healthy Places Index® (HPI) (November 2021) to identify potential climate risks and environmental burdens within the vicinity of a project. Measures to reduce emissions, climate risks, and environmental burdens are available for user selection and analysis.

1.1 Default Data and Assumptions

CalEEMod utilizes widely accepted methodologies for estimating emissions combined with default data that can be used when site-specific information is not available. Sources of these methodologies and default data include the United States Environmental Protection Agency's (USEPA) AP-42 emission factors, California Air Resources Board's (CARB) vehicle emission models, and studies commissioned by California agencies such as the California Energy Commission (CEC) and California Department of Resources Recycling and Recovery (CalRecycle). In addition, some local air districts provided customized values to support defaults and calculations for projects located in their jurisdictions. When no customized information was provided, and no regional differences were defined for local air districts, statewide default values are utilized. Because resource data and regulations are constantly changing, local agencies should be consulted to determine whether there are any circumstances when updated values should be used in place of the defaults currently incorporated into CalEEMod. A majority of CalEEMod's default data associated with locations and land use development project subtypes are derived from surveys of existing land uses. For any project that substantially deviates from the types and features included in the surveys, site-specific data that are supported by substantial evidence should be used, if available. Default data and quantification methodologies for construction emissions of linear projects are integrated from the Sacramento Metropolitan Air Quality Management District's Road Construction Emissions Model (RCEM), version 9.0.0 (last updated in 2018).

There are several opportunities for the user to change the defaults in the model; however, the user is required to provide justification for all changes made to the default settings (e.g., reference more appropriate data sources) in the Justification box before the user will be able to proceed to the next screen. Justifications are typically attached to content associated with a single screen rather than individual fields. The user should make every effort to ensure that correct data is entered, including the application of specific mitigation measures.

1.2 Purpose of Model

CalEEMod provides a simple and integrated platform to quantify construction and operations emissions, assess climate hazards and vulnerabilities, identify environmental burdens, and evaluate benefits of various emission reduction, climate risk reduction, and health and equity measures. Air pollution, climate change, and equity are not mutually exclusive—they are interrelated and, as such, demand integrated and comprehensive solutions. CalEEMod

incorporates data from CES, Cal-Adapt, and HPI to better support climate adaptation and equity considerations during project-level emissions review.

Specific to emissions, CalEEMod calculates construction and operations emissions from land use development projects and construction emissions from linear projects. The model quantifies maximum daily, average daily, average quarterly, and annual emissions, which can be used to support preparation of air quality and GHG analyses in California Environmental Quality Act (CEQA) documents, such as environmental impact reports (EIRs) and mitigated negative declarations (MNDs). In addition, air districts may rely on the model's emission estimates to show compliance with local agency rules. The emissions inventory modules also contain default values for estimating utility consumption (e.g., water, electricity, natural gas) that may be useful for preparing hydrology and energy analyses in other sections of a CEQA document.

CalEEMod displays data for extreme heat, extreme precipitation, wildfire, and sea level rise through an application programming interface (API) with Cal-Adapt. Based on the Cal-Adapt data and user inputs, the model provides a method to quantify and score the vulnerability of a project to projected climate change. CalEEMod presents environmental and health burdens relevant to a project area. These data are obtained from CES 4.0 and the HPI. CalEEMod also identifies if the project is in a Senate Bill (SB) 535–designated disadvantaged community, Assembly Bill (AB) 1550–designated low-income community, or AB 617–designated community.

The model provides the following primary functions.

- Calculates short-term construction emissions from land use development and linear projects associated with demolition, site preparation, grading, building construction, paving, and architectural coating from the following sources:
  - Exhaust emissions from off-road construction equipment.
  - Exhaust emissions from on-road mobile vehicles (workers, vendors, hauling, and onsite trucks).
  - Fugitive dust emissions from grading, bulldozing, truck loading, demolition, and on-road vehicles traveling along paved and unpaved roads.[1]
  - Evaporative volatile organic compound (VOC) emissions from architectural coating and paving activities.
  - Indirect GHG emissions from electricity consumption.
- Calculates operations emissions for land use development from the following sources:
  - Exhaust emissions from on-road mobile vehicles, hearths (e.g., stoves, fireplaces), off-road (e.g., forklifts, cranes) equipment, landscaping (e.g., mowers) equipment, and stationary sources (e.g., emergency generators, fire pumps, and process boilers).
  - Fugitive dust emissions associated with on-road mobile vehicle travel along roadways.
  - Evaporative VOC emissions from architectural coating activities, consumer products, parking lot degreasers, and fertilizers/pesticides.

[1] Fugitive dust from windblown sources, such as storage piles and inactive disturbed areas, as well as fugitive dust from off-road vehicle travel, are not quantified in CalEEMod, which is consistent with approaches taken in other comprehensive models.

  - Indirect GHG emissions from electricity and water consumption and direct GHG emissions from natural gas consumption.
  - Fugitive GHG emissions from decomposition of landfilled solid waste and avoided indirect GHG emissions from combusted biogas used for cogeneration.
  - Fugitive GHG emissions from refrigerants used in air conditioning and refrigeration equipment.
- Calculates changes in carbon and GHG emissions from the following vegetation changes:
  - Soil and aboveground and belowground biomass.
  - New tree plantings and/or removals.
- Displays projected extreme heat, precipitation, sea level rise, and wildfire risks to a project based on data from Cal-Adapt.
- Displays environmental and health indicator scores for a project based on data from CES 4.0 and HPI.
- Quantifies and scores the vulnerability of a project to projected climate change across eight hazards.
- Identifies priority climate hazards of most concern to a project and location.
- Provides a database of measures to reduce emissions, climate risks, and environmental burdens. Many of the measures described in the California Air Pollution Control Officers Association's (CAPCOA) *Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity: Designed for Local Governments, Communities, and Project Developers* (Handbook)[2] have been incorporated into CalEEMod.
- Identifies climate risk reduction measures applicable to a project based on the project scale, land use type(s), and location.
- Identifies measures to address the environmental and health burdens of the project site based on the CES 4.0 indicator scores and the project scale and land use type(s).

1.3 Structure of the Model

CalEEMod is structured into five main components, as shown in the left-hand side bar navigation panel of the tool. Clicking on the **Home** button will automatically return the user to the **Home** component's corresponding screen. The **Map, Inputs, Results,** and **Report** components include one or more modules, submodules, or screens, which will appear in an expanded side bar navigation panel when the user clicks on any of the activated component buttons. The project name is displayed at the top of the expanded panel for easy reference. The user may collapse the expanded panel by clicking the arrow to the right of the project name.

Figure 1 illustrates the structure of CalEEMod and hierarchy among the components, modules, submodules, and screens (see Chapter 4, *Detailed Program Components, Modules, Submodules, and Screens*). Certain aspects of the model require information from preceding screens, and, therefore, the intention of the model is that the user progresses through each screen in the order presented.

[2] Available: https://www.caleemod.com/handbook/index.html.

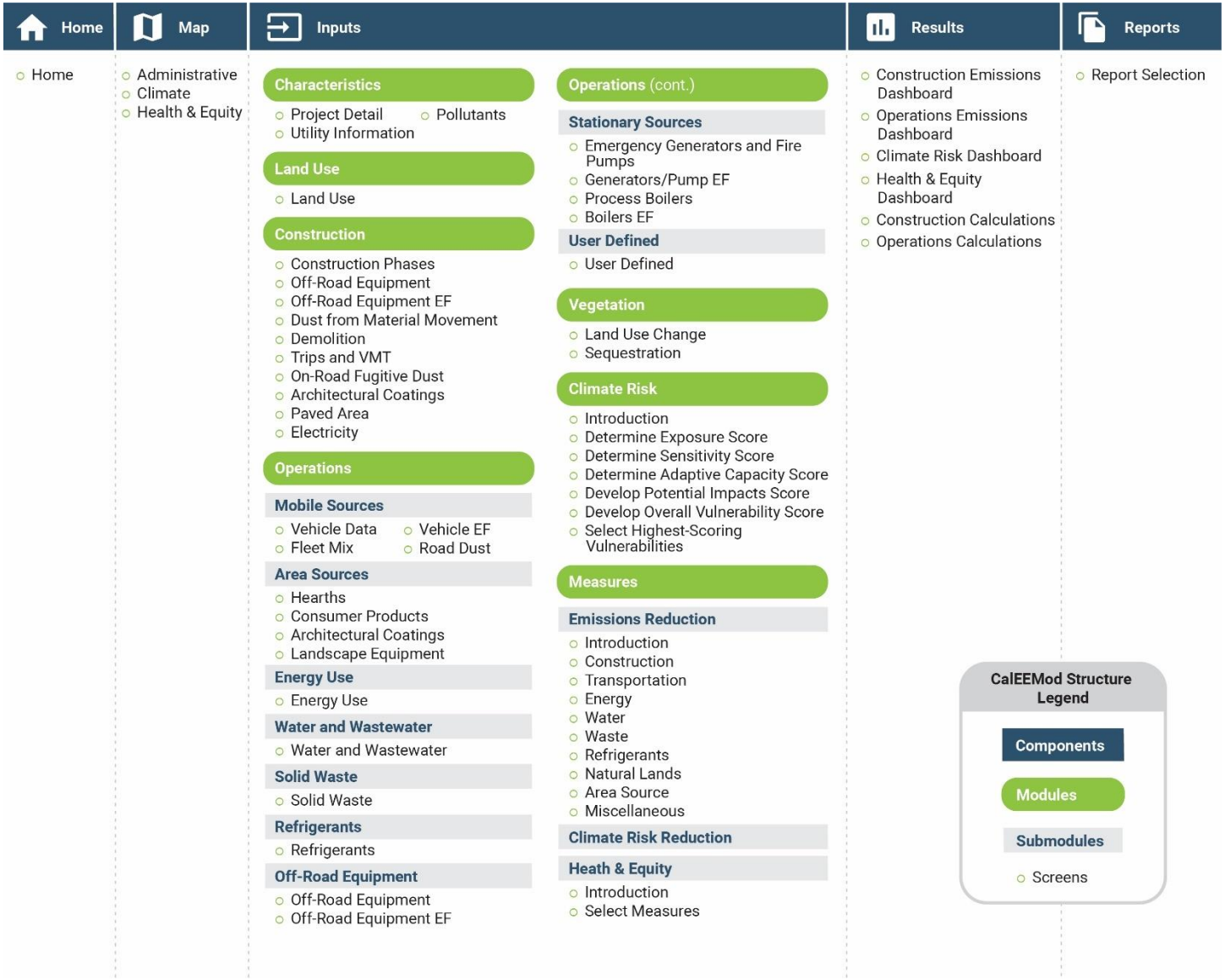

Figure 1. Structure of CalEEMod

2 Accessing CalEEMod

CalEEMod is available at https://www.caleemod.com/. CalEEMod is now accessed directly through a browser and requires an internet connection. This web-based version of CalEEMod does not require downloading or installation. A user can save, manage, and share multiple projects that will be retained in the browser cache. The user is encouraged to export projects that they wish to retain long term. Saved projects can be uploaded to CalEEMod, as discussed further in Section 3.2, *Creating and Uploading a Project*. Cached projects will be erased when the browser cache is cleared.

3 Using CalEEMod

3.1 Key Features

CalEEMod comprises a series of screens within modules and submodules, each designed with an individual purpose to define features of a project (e.g., construction schedule and equipment, operational activity). Projects may include new land use developments, new or expanded roadways, linear infrastructure improvements, or various plan-level developments, such as master, specific, and general plans (see Section 3.3, *Defining a Project*, for more information on the two scales at which projects can be defined in CalEEMod). Efficiencies were built into the model to prepopulate defaults when possible based on simple user entries. For example, a user defines a project location in the **Map** component, which will automatically propagate location-based information such as air district, utilities, windspeed, and precipitation. The user has control over which defaults are overridden with more accurate, project-specific information, and how changes to those values affect other, linked inputs in the model. As noted in Section 1.3, *Structure of the Model*, the user must work through each screen in the order they are presented. The user will, however, be able to return to screens that have already been completed.

The following are key features of CalEEMod, some of which are further described in this Guide. Screenshots are provided for easy reference.

1. *Top Bar*: Current or past model runs can be accessed and managed using the “My Projects” menu (three horizontal bars) in the upper right-hand corner. Once selected (checked), projects can be downloaded or deleted (see Figure 2). Additionally, new projects can be created or uploaded directly from this window.
2. *Side Navigation Bar*: This resource contains the five core model components—**Home**, **Map**, **Inputs**, **Results**, and **Report** (see Figure 3). Initially, the user will be required to enter project information sequentially to activate certain components of the model. Once a screen is complete, a check mark will appear to the left of the screen name in the Side Navigation Bar. Users can return to previously completed screens as they work through the model. Once a model run is complete, the user can also use the Side Navigation Bar to move between any of the components. The “Back” and “Next” browser buttons operate in a similar manner.

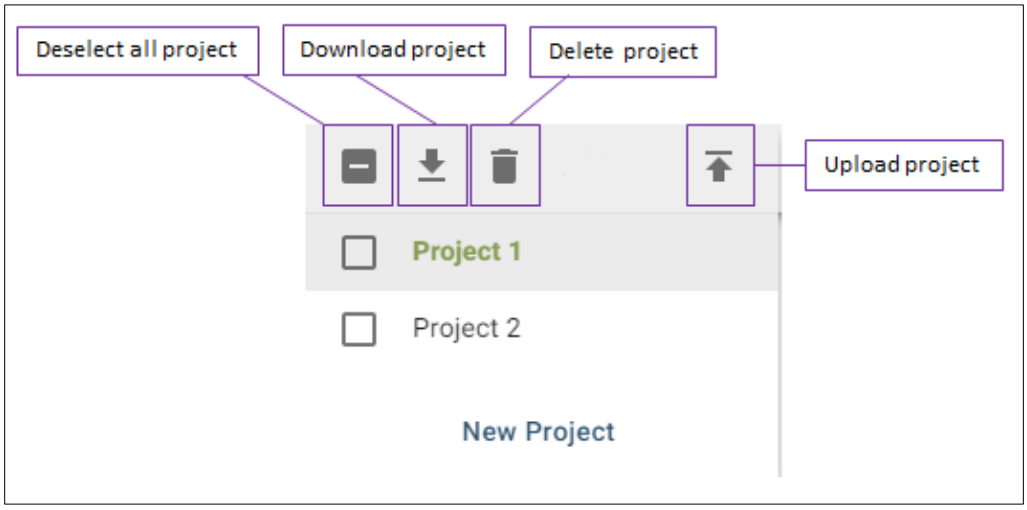

Figure 2. Select, Download, Delete, and Upload Projects

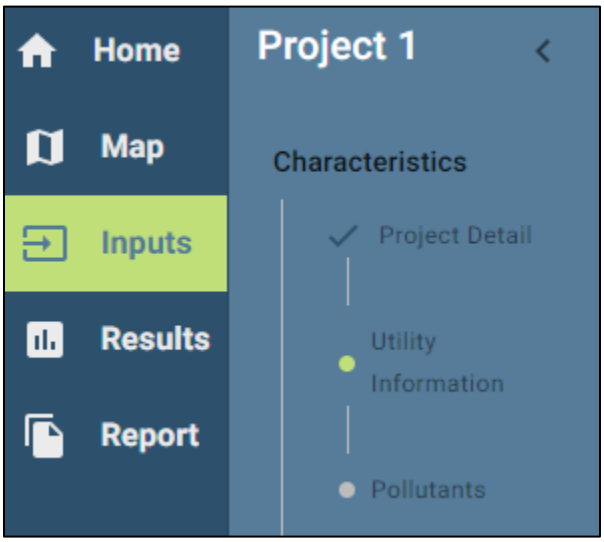

Figure 3. Side Navigation Bar

3. *Automatic Saving*: The user is not required to save projects as the user progresses through the model because projects are automatically cached during the process. This means that if there is an internet outage or the computer unexpectedly powers down, the project will still be available. Automatically saved projects can be accessed in the “My Projects” menu in the upper right of the screen. The browser cache can be cleared, so once completed, projects should be downloaded and saved in a secure location for future use.

4. *Automatic Updates to Default Values*: CalEEMod is a complex information model that requires the user to input a certain level of project detail. Some inputs have later dependencies that are assumed, such as trip lengths based on Traffic Analysis Zone (TAZ). The user then can override these assumptions as they move through the model. Because the model was built for flexibility so that a user is not “locked in” once they make an entry, they do have the ability to move back and make changes. These changes can then have implications on their dependencies, which may or may not have already had an override. Because a user may

have different interests in how these dependencies are handled, the model was built with three update options that can be set in the **Project Detail** screen. Be advised that a change made to the automatic update input will set how defaults and overrides are tracked moving forward but not retroactively (see Section 4.3.1.1, *Project Detail Screen*).

5. *Required vs. Recommended Inputs*: While defaults are available for most inputs, CalEEMod requires a certain amount of user-provided information. CalEEMod denotes required user inputs with red underline and text (see Section 4.3.2.1, *Land Use Screen*). The user must supply this information for the model to function properly. CalEEMod also identifies recommended user inputs with blue underline and text. Providing values for recommended inputs is not required for the model to output results but doing so will improve the accuracy of the analysis. For example, as discussed further in Section 4.3.2.1, *Land Use Screen*, defining the special landscape area will provide for a more accurate quantification of operational outdoor water.
6. *Pencil Edit and Delete Row*: CalEEMod uses a combination of dropdown menus and direct cell inputs to obtain primary information from the user. In certain instances, when defaults are automatically loaded based on prior user inputs, the cells cannot be directly overridden. The user must click the pencil icon to the right of the data to modify defaults (Figure 4). When the pencil icon is clicked, an override splash screen will appear for user input (Figure 5). The pencil edit function was deliberately programmed to avoid unintentional edits to default cells. The pencil edit function is often provided at the row level, with the splash screen covering multiple related inputs. Be sure to click the check mark to save all edits and close the pencil edit widget. The user may delete an entire row by clicking the trash can icon located on the right-hand side of the screen (Figure 4).

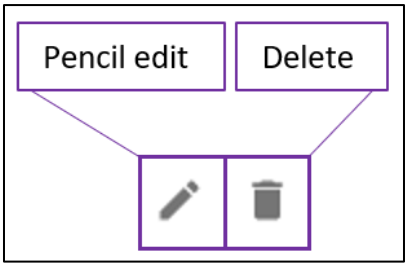

Figure 4. Pencil Edit and Delete Functions

7. *"i" Messages*: CalEEMod contains many features and inputs that may not be obvious to the user. For this reason, "i" messages were added throughout the model, when possible, to provide additional content and instruction. These can be viewed by hovering over the "i" icons found next to many entry fields (Figure 5).

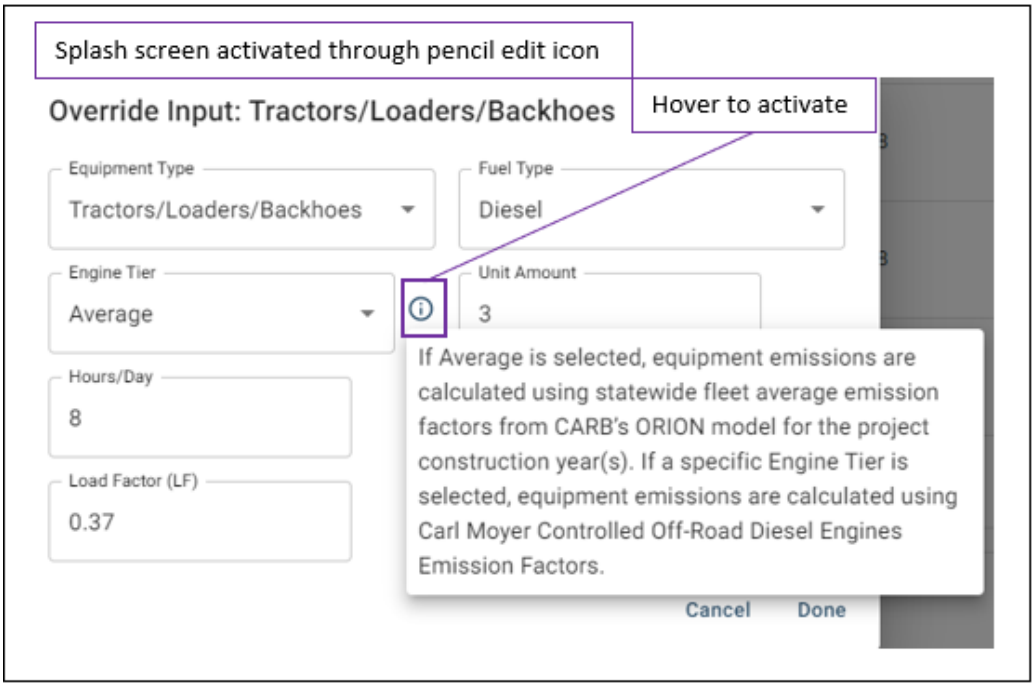

Figure 5. Splash Screens and Informational ("i") Messages

8. *Tabular View and Data List View*: Many entry screens contain the option to view tables in two different modes, depending on user preference. Some users may prefer to work through a large table, whereas others may prefer to think about one element at a time. Where available, the user can switch between tabular data and list view by clicking the icons in the upper right-hand corner of the screen (Figure 6). Note that some toggles and additional features are only available in the tabular data view mode.

Figure 6. Tabular and List View Options

3.2 Creating and Uploading a Project

The user can create a new project or upload an existing project on the **Home** screen. The user should select "New Project" to create a new project or select "Upload Project" to open a project that was previously created and saved as a .json file (see Figure 2). Note that projects previously created are automatically saved in the user's browser cache and can be accessed by clicking the "My Projects" menu in the upper right-hand corner of the screen (see Section 3.1, *Key Features*). Once the user clears their browser cache, previous projects will no longer be available in the "My Projects" menu and the user must upload the .json file to access prior model runs.

Clicking New Project will load the **Start a New Project** splash screen where the user can start defining a project.

3.3 Defining a Project

It is recommended that the user begin defining their project on the **Start a New Project** splash screen (Figure 7). At a minimum, this screen requires the user to name the project and define the applicable land use scale before moving forward. The user is encouraged to answer the optional question to define the land use types and subtypes for their project.

The land use scale defines the geographic extent of the project and influences the applicability of various measures. The user should select from one of the following land use scales.

- Project/Site: Projects that occur at the scale of a parcel, business, or individual development smaller than a neighborhood.
- Plan/Community: Projects that occur at the scale of a neighborhood (e.g., specific plan, general plan, climate action plan), corridor, or entire municipality (e.g., city- or county-level).

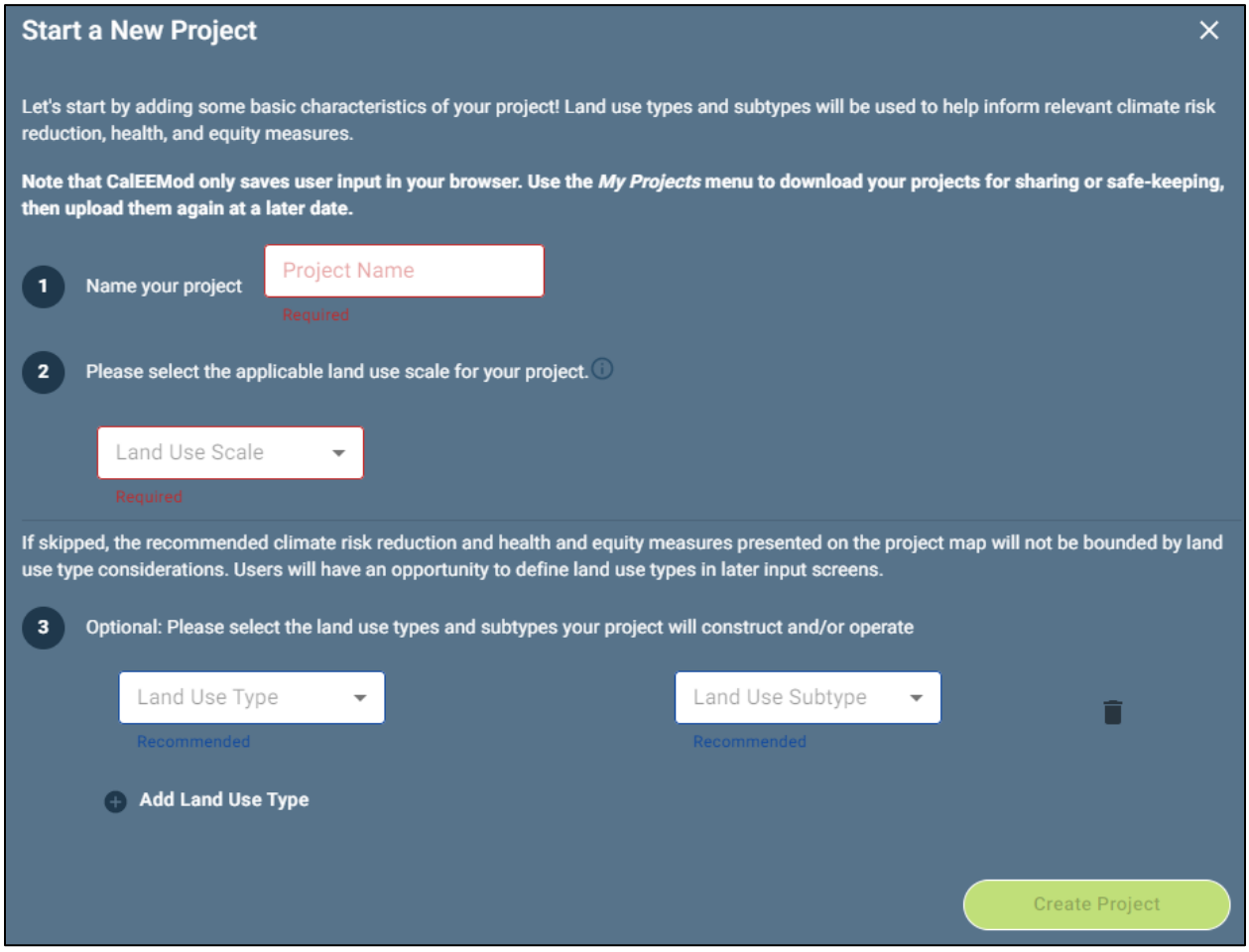

Figure 7. Start New Project Splash Screen

The land use type and land use subtype menus allow the user to identify the land use(s) that will occur at the project site. The user may select from any of the following eight primary land use types: Commercial, Educational, Industrial, Linear, Parking, Recreational, Residential, and Retail. Each of these land use types includes several more detailed land use subtypes (e.g., Single

Family Housing). The 79 different land use subtypes for development projects were chosen for inclusion in CalEEMod because each has an established trip rate, which is critical for mobile source calculations, as discussed further below in Section 4.3.4.1, *Mobile Sources Submodule*. The four land use subtypes for linear projects were directly incorporated in CalEEMod from the RCEM. The user will have an opportunity to further define the selected land use types and subtypes in **Land Use** screen (see Section 4.3.2, *Land Use Module*). Refer to Table 1 in Section 4.3.2.1.2, *Land Use Subtype*, for a complete description of all land use types and subtypes included in CalEEMod.

If the land use types and subtypes are not defined on the **Start a New Project** splash screen, the available and relevant measures analyses in the **Map** component will not be able to identify measures that are applicable to the project based on climate hazard and existing health and environmental burden analysis.

3.4 Defining the Project Location

The project location is critical to ensuring accurate emissions quantification and representation of climate risks and environmental burdens. Specifically, the location determines the electric utility emissions factor, building energy zones, trip lengths and generation rates, and other critical variables. It is also used to identify the applicable grid cell and census tract to enable spatial analysis of projected climate risks and environmental burdens from Cal-Adapt and CES 4.0 and the HPI, respectively. The user can define the project location using any of the following options.

- Pin the location by clicking directly on the map. Use the zoom-in feature to place the pin with greatest accuracy.
- Type the project address in the input box.
- Type the project latitude/longitude coordinates in the input box.

It is recommended for linear projects and larger development projects, including plan-level analyses (e.g., specific plans, general plans), that the user identify the center point of their project area to define the project location. Please note that many of the model parameters are defined at the census tract resolution or smaller (e.g., TAZ). Therefore, modeled results may not be reflective or inclusive of larger project areas, particularly predicted climate risks and environmental burdens.

After the project location is entered, contextual spatial information will be returned in the **Map** component (see Section 4.2, *Map Component*). If the user would like to adjust the project location, they should click the “Change Location” button at the top of the left-hand navigation bar. Changing the project location will reset dependent default values.

3.5 Altering Default Data

CalEEMod was designed with default assumptions supported by substantial evidence to the extent available at the time of programming. The functionality and content of CalEEMod is based on fully adopted methods and data. However, CalEEMod was also designed to allow the user to change the defaults to reflect site- or project-specific information, when available, provided that the information is supported by substantial evidence. When a default is overridden, an “i" message will appear below the input on most screens, indicating that the field has been changed.[3] Overrides to defaults can be reverted to the original value by clicking the “reset” button (see Figure

[3] When a default is changed on the **Land Use** screen, a return arrow instead of an “i” message will appear to the right of the input. Clicking the arrow will revert the field back to the original value.

8). If the user chooses to modify any defaults, an explanation will be required in the Justification box. Modifications to defaults and the explanations are noted in the output report. Comments are important because they show the user's justification for the modifications, which allows reviewers the ability to determine whether the modifications are appropriate and sufficiently justified. Be sure to click "Save Justification" to record all remarks made in the Justification box.

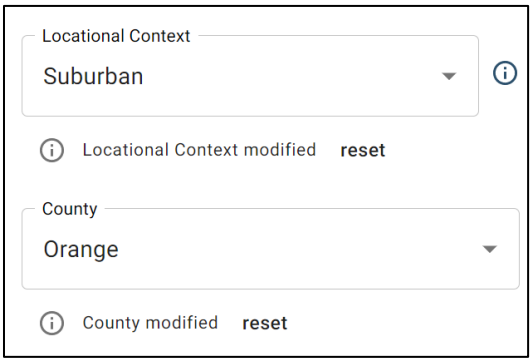

Figure 8. Change to Defaults Notification

3.6 Selecting Measures

CalEEMod includes 138 emission reduction measures, 99 climate risk reduction measures, and 50 health and equity measures. Emission reduction measures are categorized as either "Quantified" or "Qualitative or Supporting Measures." CalEEMod includes analytics to estimate emission reductions and some co-benefits achieved by quantified measures. Emissions benefits of qualitative or supporting measures are not currently quantified by CalEEMod. Methods for quantifying these measures have not yet been developed, are not fully supported by available research, or require specific details that are difficult to address under a methodology with general applicability. Although not quantitatively evaluated, qualitative or supporting measures may achieve emissions reductions and co-benefits on their own or may enhance the ability of quantified measures to attain expanded reductions and co-benefits. User-selected qualitative or supporting measures are noted in the output report.

Most of the measures are from CAPCOA's Handbook, with CalEEMod directly incorporating (with some deviations) the quantification methods, assumptions, and defaults, as appropriate. As noted in the Handbook, the list of available measures reflects a wide range of strategies that are frequently used to reduce GHG emissions, bolster communities against expected climate impacts, and enhance community health and equity. This does not mean that other measures should not be considered or may not be effective or quantifiable. CAPCOA encourages the user to be bold and creative as they approach mitigation and measure selection. If measures are not available as options in CalEEMod, the user can alter program inputs that would be affected to account for mitigation measures that may be less common. This will require creating separate CalEEMod files to properly account for unmitigated and mitigated scenarios (see Section 4.3.7, *Measures Module*).

3.7 Using the Dashboards

The dashboards are an interactive tool that allows the user to quickly view key emissions, climate, and health and equity results for their project. There are two dashboards for emissions reporting: construction results and operations results. There is one dashboard for climate risks and one

dashboard for health and equity. The dashboards allow the user to customize and filter the presentation of results using a combination of tables, graphs, and icons. The user may also view selected measures, as available. The user must complete all required inputs in the **Emissions** and **Climate Risk** modules for the dashboards to function. Once all inputs are satisfied, the dashboards are automatically updated based on real-time user changes to the model (see Section 4.4, *Results Component*).

3.8 Running Reports

The **Report** component allows the user to select the type of report desired for the project (i.e., detailed, summary, quarterly, custom). A preview of the reports can be viewed on screen and then saved as a Microsoft Excel (.xls), comma-separated value (.csv), or Adobe Acrobat (.pdf) file. The .pdf file meets accessibility requirements as expressed under AB 434 (see Section 4.5, *Reports Component*).

4 Detailed Program Components, Modules, Submodules, and Screens

As displayed in Figure 1, CalEEMod is organized in a hierarchy of structural elements, consisting of components, modules, submodules, and screens. This section summarizes each of the structural elements, explains how to navigate the corresponding user interface, and explains key terms and concepts that appear in the interface. For more detailed information on certain subjects mentioned in this chapter, the user should refer to the following appendices.

- **Appendix A, *Glossary*:** Definitions of all terms.
- **Appendix B, *Acronym List*:** List of acronyms.
- **Appendix C, *Emission Calculation Details for CalEEMod*:** Emissions and activity quantification methods and sources. This appendix also describes potential limitations that the user should consider in their CalEEMod applications with respect to mobile source emissions modeling.
- **Appendix D*, Technical Source Documentation for Emissions Calculations*:** Additional technical emissions quantification methods and sources.
- **Appendix E, *Support Documentation for Climate Change Analyses*:** Vulnerability assessment methodology and technical information on climate risk reduction measures.
- **Appendix F, *Support Documentation for Health and Equity Association Scoring*:** Specific scoring criteria for health and equity measures and instructions for completing the **Health and Equity Evaluation Scorecard**.
- **Appendix G, *Default Data Tables*:** Tabular data queried by CalEEMod to return available defaults in the user interface and calculate emissions.
- **Appendix H, *Comparison to CalEEMod Version 2020.4.0:*** Compares key functions and features between CalEEMod Version 2022.1 and the prior version of CalEEMod (Version 2020.4.0).

4.1 Home Component

4.1.1 Home Screen

The **Home** screen is the landing page for the model and is where the user can create a new project or upload an existing project (see Figure 2). The **Home** screen includes links to this Guide and prior desktop versions of CalEEMod. The user can also access training videos for the model.

4.2 Map Component

The **Map** component displays geospatial information relevant to the emissions, climate risk, and health and equity analyses. To access the **Map** component, the user must first define the project location (see Section 0, *Defining the Project Location*). Once the project location is defined, the user is advanced to the **Administrative** map screen, which is the first of three map screens. The user can navigate among the three screens using the "Back" and "Next" buttons located at the bottom of the left-hand navigation bar, or by clicking the screen name listed in the horizontal bar located above the map interface. Where geospatial layers are available on each screen, the user can display these layers by clicking the open circle located to the right of the layer name presented in the left-hand navigation bar.

4.2.1 Administrative Map Screen

The **Administrative** map screen displays geospatial information relevant to the quantification of construction and operations emissions. The screen displays layers for the county, city, and TAZ in which the project is located. In addition to these layers, the **Administrative** map screen identifies the applicable locational context, air basin, air district, gas utility, and electric utility for the project location. These data are presented in the left-hand navigation bar. Geospatial layers for these data are not currently available. The user may adjust any of the default administrative model inputs determined by the project location on the **Project Detail** screen (see Section 4.3.1.1, *Project Detail Screen*).

The locational context refers to the level of development for the census tract. The locational context is used to determine the applicability of emission reduction measures in the transportation sector. The three locational contexts identified in CalEEMod are suburban, urban, and rural. A "NA" value will be returned for the locational context if the project census tract is identified as "preserve land" or if the project census tract is not mapped in the locational context geospatial domain. If the locational context is reported as "NA" or the user would like to modify the default, they should contact the local land use planning agency (e.g., city), transportation agency (e.g., metropolitan planning organization), or air district for the region where the project is located for additional guidance.

4.2.2 Climate Map Screen

The **Climate** map screen displays climate risks relevant to the project area. Geospatial layers for four climate hazards are available—extreme heat, precipitation, sea level rise, and wildfire (refer to Appendix E, *Support Documentation for Climate Change Analyses*). If the climate hazard is applicable to the project location, its map layer will display the midcentury (2040–2059 average) risk for the grid cell in which the project is located.

In addition to displaying climate risks applicable to the project location, the **Climate** map screen identifies the climate risk reduction measures most applicable to the project type and location.

This function is only available when the land use subtype(s) are defined in the **Start a New Project** splash screen (Figure 7). Click the "Select Available Measures" button on the bottom of the left-hand navigation bar to view the list of measures on the **Climate Measures** splash screen. CalEEMod identifies applicable measures based on the relevant climate hazards, project scale, and project land use subtype(s). Checking a measure on the **Climate Measures** splash screen will automatically preselect the measure in the **Climate Risk Reduction** submodule. Additional information on the measure applicability analysis is presented in Appendix E, *Support Documentation for Climate Change Analyses*.

4.2.3 Heath & Equity Map Screen

The **Health & Equity** map screen displays environmental and health burdens relevant to the project census tract. Data are obtained from CES 4.0 and the HPI (refer to Appendix F, *Support Documentation for Health and Equity Association Scoring*). The user can view geospatial layers for the overall CES 4.0 score and HPI composite score. Click the "See individual CES 4.0 scores" button presented in the left-hand navigation bar to view the **CES 4.0 Indicator Scores** splash screen**,** which shows the individual indicator scores for the project census tract that make up the overall CES 4.0 score. Similarly, click the "See individual HPI scores" button to view the **HPI Indicator Scores** splash screen**,** which shows the scores for the project census tract that make up the HPI composite score.

In addition to CES 4.0 and HPI layers, the **Health & Equity** map screen identifies if the project location is in a disadvantaged community, low-income community, or Community Air Protection Program community. (Definitions for these three community areas are provided in Appendix A, *Glossary*.) The "Yes" or "No" response is presented in the left-hand navigation bar. Geospatial layers for these data are not currently available in CalEEMod.

The **Health & Equity** map screen also identifies the five most relevant emissions reduction, climate risk, and health and equity measures that address the environmental and health burdens of the project site. This function is only available if the land use subtype(s) are defined by the user in the **Start a New Project** splash screen (Figure 7). Click "Relevant Measures" to view the list of measures on the **Relevant Measures** splash screen. CalEEMod selects the top five measures with the strongest associations to the existing health and equity conditions in each census tract. The splash screen also identifies the remaining additional applicable measures. Checking a measure on the splash screen will automatically preselect the measure in the **Climate Risk Reduction** submodule and **Health & Equity Measures** submodule. Refer to the measure applicability and association analysis in Appendix F, *Support Documentation for Health and Equity Association Scoring*, for additional information.

4.3 Inputs Component

The **Inputs** component is the largest component in CalEEMod, requiring the user to input various required project data and review available defaults to determine if they can be changed to reflect site- or project-specific information, if available, provided that the information is supported by substantial evidence (see Section 3.5, *Altering Default Data*). The screens are grouped together in the **Characteristics, Land Use, Construction, Operations** (includes submodules), **Vegetation, Climate Risk, and Measures** (includes submodules) modules.

4.3.1 Characteristics Module

The **Characteristics** module is comprised of three screens—**Project Detail**, **Utility Information**, and **Pollutants**. Inputs to the **Characteristics** module will trigger numerous project-appropriate default data to populate on subsequent screens.

4.3.1.1 Project Detail Screen

The **Project Detail** screen displays the project name and key locational information from the **Administrative** map screen, including the county, locational context, and TAZ. The user may override any of these locational defaults. If a map-intersect for the project location is not available and geospatial information does not load from the **Map** component, users will be required to input the information on this screen. The required inputs will be denoted with red underline and text (see Section 3.1, *Key Features*). If applicable and desired, the user may identify the lead agency for the project on this screen.

Based on the project location, CalEEMod generates default inputs for the windspeed, precipitation frequency, and CEC electricity demand forecast zone (EDFZ). The user should carefully review these defaults to confirm their applicability to the project. The user can override all defaults with project-specific data, where available and appropriate.

- *Windspeed (m/s)*: Windspeed, in meters per second (m/s), influences the intensity of emission factors related to fugitive dust generated during project construction. CalEEMod includes average annual windspeeds based on hourly data from 1996 to 2006 for various monitoring stations throughout California from the Western Regional Climate Center (2021). CalEEMod selects the nearest monitoring station to the project location and reports the associated windspeed as the default for the model run.
- *Precipitation Frequency (days)*: Precipitation frequency influences the intensity of emission factors related to fugitive dust generated during project construction and from vehicles travelling on paved and unpaved roads during construction and operation. Precipitation frequency represents the average annual days with precipitation greater than 0.1 inch based on data from 2015 to 2019 for various monitoring stations throughout California (NOAA 2021). CalEEMod selects the nearest monitoring station to the project location and reports the associated number of “wet days” as the default for the model run.
- *CEC Electricity Demand Forecast Zone*: The CEC has designated major electricity planning areas across the state for use in their geospatial energy analyses. The planning areas are further divided into 28 EDFZs. The EDFZ influences default calculations for building energy consumption and the effectiveness of emission reduction measures in the energy sector. Note that the EDFZs are different from the building climate zones that were developed by CEC for the Title 24 Standards. The EDFZs are identified in CalEEMod instead of the building climate zones because the default building energy consumption estimates are based on consumption datasets organized by EDFZ (see Section 4.3.4.3, *Energy Use Screen)*. The user may confirm the default EDFZ by reviewing Figure D-1 in Appendix D5, *Analysis of Building Energy Use Data*. An interactive version of the figure is also available from the CEC (2021a).[4]

CalEEMod will automatically quantify emissions for construction and project operations. The user may deselect either if they are not applicable to the project, or both if they are only interested in climate or health and equity elements of the model. The appropriate selection may be made by

[4] Available: https://cecgis-caenergy.opendata.arcgis.com/datasets/CAEnergy::california-electricity-demand-forecast-zones/about.

clicking the dropdown menu under the "Quantify emissions for" data field, or by clicking directly on Construction or Operations. Use the green toggle to completely skip the emissions model (i.e., you do not want to quantify either construction or operations emissions). Deselecting construction or operations (or both) will deactivate the corresponding module(s) within CalEEMod and then preclude the analysis from the results and reports. Depending on user selection, certain inputs on the **Project Detail** screen may also be deactivated.

If applicable, the user should identify the start date of construction and operational year for their project. The start date for construction triggers a rolling calendar that begins with the construction start date, followed by various construction phases that will be populated with default date ranges in the **Construction Phases** screen (see Section 4.3.3.1, *Construction Phases Screen*). The operational year is typically the first year following construction when the project is fully operational. CalEEMod relies on the initial operational year to apply the appropriate emission factors in all operational module calculations. CalEEMod can accommodate construction and operational years from 2010 through 2050. This wide range of dates allows the user to analyze a project for a year that occurs in the past or further into the future. It is important to note that the selection of years is limited to minimize the file size associated with the vehicle emission factors associated with each operational year. For a project that consists of multiple operational phases with emissions-generating activities expected to change across years, the user is recommended to run the model multiple times for the various input parameters for each operational year.

The "Analysis Level for Defaults" input on this screen has significant influence on default values on subsequent screens. This input defines the geographic extent of many defaults, including on-road vehicle emission factors, solid waste disposal rates, percent of vehicle travel on unpaved/paved roads, days of landscaping equipment use, VOC content of architectural coatings, and hearth usage. CalEEMod defaults to the "County" analysis level, which provides the most locationally-specific data. The user may override this default and select air basin, air district, or statewide, in which case default inputs would be derived based on aggregated data over the larger geography. If uncertain about what region to choose for the analysis level, the user should consult their lead agency.

The "Automatic Updates to Default Values**"** input on this screen is another important feature that has significant influence on default values on subsequent screens. Depending on the user selection from the dropdown menu, the model will change its response when a user updates an input that is linked to another input. For example, default building energy consumption (see Section 4.3.4.3, *Energy Use Screen*) is determined, in part, based on the land use subtype (see Section 4.3.2.1, *Land Use Screen*). Consider a scenario where a user inputs their land use subtype as "Single Family Housing" on the **Land Use** screen, navigates to the **Energy Use** screen to override the default electricity consumption values with project-specific information, and then returns to the **Land Use** screen to update the land use subtype to "Apartments High Rise." If the user then navigates back to the **Energy Use** screen, the electricity consumption values may or may not be updated for the "Apartments High Rise" land use subtype, depending on the user's original selection for the "Automatic Updates to Default Values" input. There are three update options.

- *Always*: Automatically updates linked inputs based on real-time user input. In the above example, the user-overridden electricity consumption would be updated to default values based on the new "Apartments High Rise" land use subtype.
- *Never*: Freezes automatic downloading of programmed defaults for all inputs. In the above example, the user-overridden electricity consumption would be retained. In fact, when the user first navigates to the **Energy Use** screen to override the default electricity consumption for the

"Single Family Housing" land use subtype, there would have been no default consumption value for them to override.

- *If not overridden*: Freezes automatic downloading of only those linked inputs the user has overridden. In the above example, the user-overridden electricity consumption would be retained. However, if the user had retained the default natural gas use values on the **Energy Use** screen associated with the "Single Family Housing" land use subtype and then returned to the screen after updating the land use subtype to "Apartments High Rise," the previous default natural gas use would be updated to new default values based on the new "Apartments High Rise" land use subtype.

4.3.1.2 Utility Information Screen

The **Utility Information** screen displays the electric utility and gas utility for the project location. The user should confirm the utilities before moving forward. The user may select a different utility from the dropdown menu. If the project utility is not included in the dropdown menu, the user may select "User Defined."

CalEEMod includes carbon intensities for several electric utilities throughout California (California Utilities 2021). If carbon intensities for the selected utility are not available, CalEEMod will default to the statewide average carbon intensity (USEPA 2021). Electricity emissions can be quantified using the latest year with reported carbon intensity data, which is 2019. Alternatively, the user may elect to use forecasted future year carbon intensities that reflect utility-specific planning considerations, including future integration of renewables. It is important to note that the forecasted factors are not exclusive to just renewable integration; they reflect many other considerations made by the utility in projecting future supplies and generation. For this reason, forecasted factors may not always decline relative to the prior year.

If "Forecasted Factors" is toggled on, CalEEMod will use the forecasted carbon intensities applicable to the operational year. Forecasted electricity emission factors are only available for a subset of utilities and years. No future year emission factors are available for the statewide default. Where future year data are not available for a utility or year, toggling the "Forecasted Factors" button will not yield any changes to the emission factors shown on the screen. A similar toggle is provided in the **Electricity** screen for construction electricity consumption (see Section 4.3.3.10, *Electricity Screen*). It is recommended that the user consult their local electricity provider for updated emission factors available at the time of their analysis before proceeding with the defaults.

The selected natural gas utility is provided for informational purposes only and does not influence the carbon intensity of natural gas combustion. Emission factors for natural gas combustion are from the USEPA (1998a) AP-42 and the CARB (2020a).

4.3.1.3 Pollutants Screen

CalEEMod quantifies criteria pollutants and GHGs. The model automatically selects all criteria pollutants and GHGs in the **Pollutants** screen for quantification. The user should uncheck any pollutants they do not want quantified before moving forward. Unchecked pollutants will be excluded from the dashboards and the reports.

The **Pollutants** screen also allows the user to insert analysis thresholds for each pollutant. Thresholds can be input in terms of pounds per day, short tons per quarter, short tons per year, and metric tons (MT) per year, depending on the timescale and pollutant. Identification of

thresholds is optional. The user input thresholds will appear in the dashboards and reports to be compared with the project emissions, as applicable.

4.3.1.3.1 Criteria Pollutants

Criteria pollutants are a group of six common air pollutants for which the federal and state governments have set national ambient air quality standards (NAAQS) and California ambient air quality standards (CAAQS), respectively. The standards are set to protect public health and welfare and the environment. The federal criteria pollutants are ozone (O_3), carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and particulate matter (PM), which consists of particulates 10 microns in diameter or less (PM10) and 2.5 microns in diameter or less (PM2.5). Definitions of these pollutants are provided in Appendix A, *Glossary*.

CalEEMod quantifies all criteria pollutants except Pb, O_3, and NO_2. Pb is associated with some industrial sources and processes. Specific details to support broad quantification of these emissions are not currently available for CalEEMod. O_3 is not directly emitted into the atmosphere. Rather, it is naturally formed through photochemical reactions between reactive organic gases (ROG) and nitrogen oxides (NO_X) (O_3 precursors). CalEEMod quantifies both ROG[5] and NOx emissions, with NOx encompassing NO_2. CalEEMod also quantifies total organic gases (TOG), of which ROG is a subset. Separate emission estimates are provided for fugitive PM10 and PM2.5 and exhaust PM10 and PM2.5.

4.3.1.3.2 Greenhouse Gases

The principle anthropogenic (human-made) GHGs contributing to global warming are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated compounds, including sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). The most common GHGs emitted by land use developments and linear construction projects, which are quantified by CalEEMod, are CO_2, CH_4, and N_2O.[6] CalEEMod also quantifies common refrigerant GHGs (abbreviated to "R" in the model) used in air conditioning and refrigeration equipment, some of which are HFCs. Definitions of these pollutants are provided in Appendix A, *Glossary*.

Methods have been set forth to describe emissions of GHGs in terms of a single gas to simplify reporting and analysis. The most accepted method to compare GHG emissions is the global warming potential (GWP) methodology defined in Intergovernmental Panel on Climate Change (IPCC) reference documents. IPCC defines the GWP of various GHG emissions on a normalized scale that recasts all GHG emissions in terms of carbon dioxide equivalent (CO_2e), which compares the gas in question to that of the same mass of CO_2 (CO_2 has a global warming potential of 1 by definition). CalEEMod uses GWPs for CO_2, CH_4, and N_2O from IPCC's (2007) *Fourth Assessment Report*, consistent with statewide GHG emissions reporting protocol. GWPs for refrigerants are from the IPCC (2007), CARB (2020b), and World Meteorological Organization (2018).

[5] CalEEMod uses the term VOC when referring to emissions from the application of architectural coatings, consistent with local regulations. VOCs are organic compounds that can evaporate into an organic gas. VOC can be either reactive or non-reactive. Over the years, non-reactive VOCs have been exempted from regulation. Both VOC and ROG are precursors to ozone, so they are summed in the CalEEMod output under the header ROG.

[6] PFCs may be generated by certain industrial and manufacturing processes but are not currently quantified by CalEEMod. Likewise, CalEEMod does not quantify SF_6, which is a human-made chemical commonly used as an electrical insulating fluid for power distribution equipment.

4.3.2 Land Use Module

4.3.2.1 Land Use Screen

The **Land Use** module includes the **Land Use** screen where the user can identify the land use(s) that will be built on the project site. The land use types and subtypes, unit, size, lot acreage, building square feet, landscape area, special landscape area, and population fields determine the default variables that are used in the quantification of construction and operations emissions. In addition, depending on the project land use type, additional data fields will appear on this screen. Recreational land use types have an input for the recreational building area and Linear land use types have an input for the predominant soil type.

When the user arrives on the **Land Use** screen, the land use types and subtypes that the user previously defined in the **Start a New Project** splash screen will automatically be prepopulated. The user can identify additional land use types by clicking the “Add Land Use Type” button. Finally, if desired, the user may enter a description of each land use subtype in the “description” column, which may be helpful to easily tell apart two entries of the same land use subtype. This description will be included in the CalEEMod output. Figure 9 presents the layout of the **Land Use** screen with some example land use subtypes selected, highlighting the required, recommended, and nonapplicable data fields.

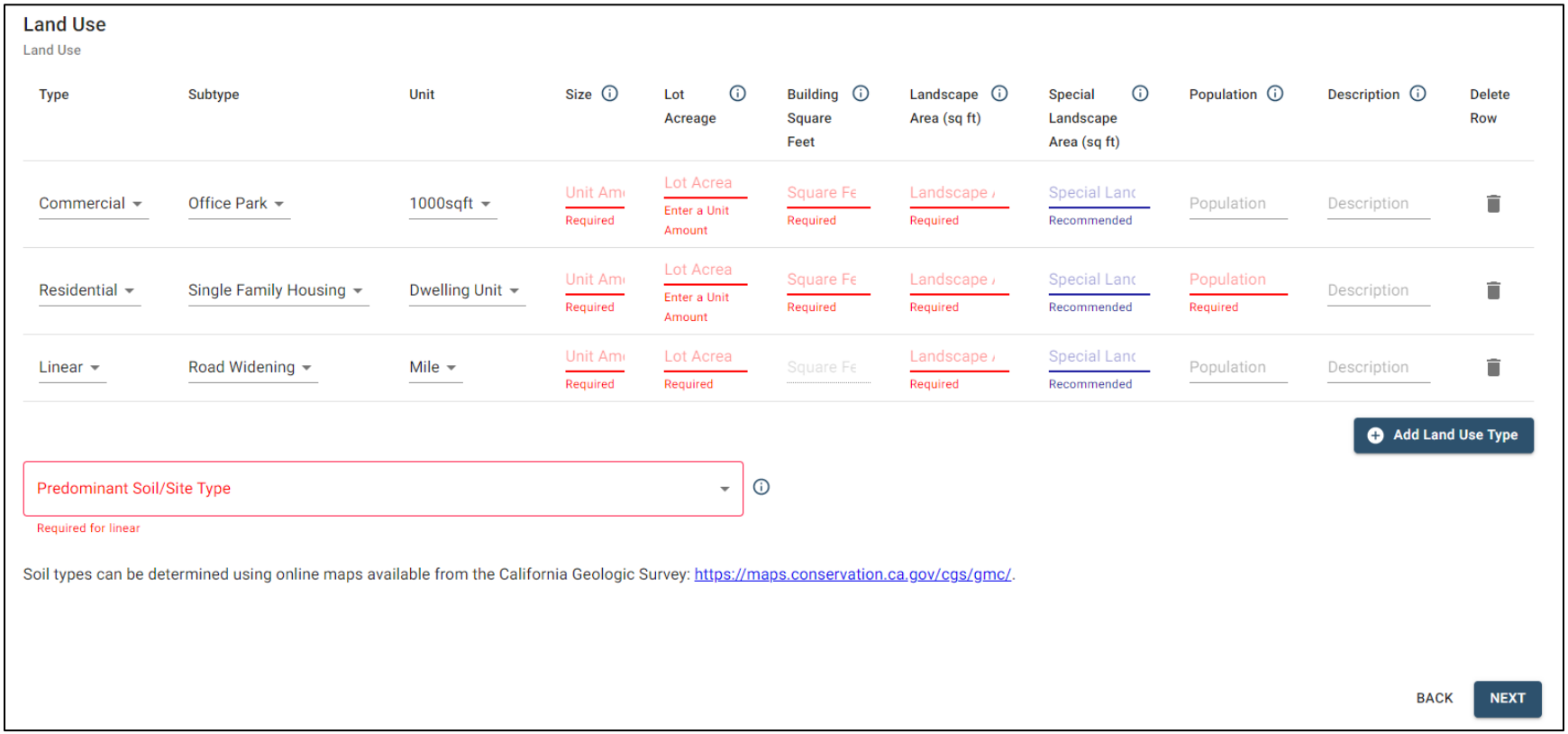

Figure 9. Land Use Screen

4.3.2.1.1 Land Use Type

The land use "type" column allows the user to select any of the following primary land use types from a dropdown list.

- Commercial
- Educational
- Industrial
- Linear
- Parking
- Recreational
- Residential
- Retail

As discussed in Section 4.3.2.1.2, *Land Use Subtype*, these land use types are further subdivided into 79 land use subtypes that are primarily based on land use classifications from the Institute of Transportation Engineers (ITE). CalEEMod also contains Linear land use subtypes, as defined by the Sacramento Metropolitan Air Quality Management District's RCEM.

4.3.2.1.2 Land Use Subtype

The land use "subtype" column allows the user to select from 79 land use subtypes. Subtypes for non-linear (i.e., land use or vertical) land uses are based primarily on the land use definitions from the ITE's (2017a) *Trip Generation Manual, 10th Edition*, which are used to inform default trip generation rates for operational mobile sources.[7] In some cases, similar generalized land uses or surrogate data were mapped to some of the non-linear land use subtypes to generate the default data needed for various screens. The four land use subtypes for linear projects were directly incorporated in CalEEMod from the RCEM. The user also has the option to select a "user defined" land use subtype; however, there are no default data (including size) available on the **Land Use** screen for user defined land use subtypes. The user will need to manually enter all information to support emissions quantification.

Descriptions of the CalEEMod land use subtypes are provided in Table 1. The table identifies the corresponding ITE land use code, where applicable.

[7] The default trip generation rates included in CalEEMod are a subset of a larger compilation of data that can be obtained from ITE (https://www.ite.org/technical-resources/topics/trip-and-parking-generation/).

Table 1. CalEEMod Land Use Subtypes

Land Use Subtype	Description	ITE Land Use Code
COMMERCIAL		
Bank (With Drive-Through)	Drive-in banks provide banking facilities for motorists who conduct financial transactions from their vehicles; many also serve patrons who walk into the building.	912
General Office Building	A general office building houses multiple tenants where affairs of businesses, commercial or industrial organizations, or professional persons or firms are conducted. If information is known about individual buildings, it is suggested that this land use be used instead of the more generic office park.	710
Government (Civic Center)	A group of government buildings that are interconnected by pedestrian walkways.	733
Government Office Building	This is an individual building containing either the entire function or simply one agency of a city, county, state, federal, or other governmental unit.	730
Hospital	A hospital is any institution where medical or surgical care and overnight accommodations are provided to non-ambulatory and ambulatory patients. However, it does not refer to medical clinics or nursing homes.	610
Medical Office Building	This is a facility that provides diagnoses and outpatient care on a routine basis but is unable to provide prolonged in-house medical and surgical care. One or more private physicians or dentists generally operate this type of facility.	720
Office Park	Office parks are usually suburban subdivisions or planned unit developments containing general office buildings and support services, such as banks, restaurants and service stations, arranged in a park-or campus-like atmosphere. This should be used if details on individual buildings are not available.	750
Pharmacy/Drugstore W/O Drive Thru	These are retail facilities that primarily sell prescription and non-prescription drugs. These facilities may also sell cosmetics, toiletries, medications, stationery, personal care products, limited food products and general merchandise. The drug stores in this category do not contain drive-through windows.	880
Pharmacy/Drugstore with Drive Thru	These are retail facilities that primarily sell prescription and non-prescription drugs. These facilities may also sell cosmetics, toiletries, medications, stationery, personal care products, limited food products and general merchandise. The drug stores in this category contain drive-through windows.	881

Land Use Subtype	Description	ITE Land Use Code
Research & Development	R&D centers are facilities devoted almost exclusively to R&D activities. The range of specific types of businesses contained in this land use category varies significantly. R&D centers may contain offices and light fabrication areas.	760
User Defined Commercial	User defined Commercial land use subtype.	—
EDUCATIONAL		
Day-Care Center	A day care center is a facility where care for preschool age children is provided, normally during the daytime hours. Day care facilities generally include classrooms, offices, eating areas and playgrounds.	565
Elementary School	Elementary schools typically serve students attending kindergarten through the fifth or sixth grade. They are usually centrally located in residential communities to facilitate student access and have no student drivers.	520
High School	High schools serve students who have completed middle or junior high school.	530
Junior College (2Yr)	This land use includes 2-year junior, community, or technical colleges.	540
Junior High School	Junior high (or middle) schools serve students who have completed elementary school and have not yet entered high school.	522
Library	A library is a facility that consists of shelved books; reading rooms or areas; and sometimes meeting rooms.	590
Place of Worship	A place of worship is a building in which public worship (religious) services are held (e.g., church, synagogue, mosque, etc.). A place of worship is comprised of an assembly hall or sanctuary; it may also house meeting rooms, classrooms and occasionally dining catering or party facilities.	560
University/College (4Yr)	This land use includes 4-year universities or colleges that may or may not offer graduate programs.	550
User Defined Educational	User defined Educational land use subtype.	—
INDUSTRIAL		
General Heavy Industry	Heavy industrial facilities usually have a high number of employees per industrial plant and are generally limited to the manufacturing of large items.	140

Land Use Subtype	Description	ITE Land Use Code
General Light Industry	Light industrial facilities are free-standing facilities devoted to a single use. The facilities have an emphasis on activities other than manufacturing and typically have minimal office space. Typical light industrial activities include printing, material testing and assembly of data processing equipment. This land use subtype must be less than 50,000 square feet. [a]	110
Industrial Park	Industrial parks contain several industrial or related facilities. They are characterized by a mix of manufacturing, service and warehouse facilities with a wide variation in the proportion of each type of use from one location to another. Many industrial parks contain highly diversified facilities.	130
Manufacturing	Manufacturing facilities are areas where the primary activity is the conversion of raw materials or parts into finished products. It generally also has office, warehouse, and R&D functions at the site.	140
Refrigerated Warehouse-No Rail	This is a warehouse that has refrigeration but no rail spur.	157
Refrigerated Warehouse-Rail	This is a warehouse that has refrigeration and a rail spur.	157
Unrefrigerated Warehouse-No Rail	This is a warehouse that does not have refrigeration and no rail spur.	150
Unrefrigerated Warehouse-Rail	This is a warehouse that does not have refrigeration but has a rail spur.	150
User Defined Industrial	User defined Industrial land use subtype.	—
LINEAR		
Bridge/Overpass Construction	Construction or modification of a bridge or overpass.	—
Road Construction	Construction of new roadway.	—
Road Widening	Widening of an existing roadway.	—
User Defined Linear	User defined Linear land use subtype.	—
PARKING		
Enclosed Parking Structure	This is an enclosed parking structure that may be above or below ground. It is not covered in asphalt. This land use will require lighting and ventilation and will have more than one floor with no elevator.	—
Enclosed Parking with Elevator	This is an enclosed parking structure that may be above or below ground. It is not covered in asphalt. This land use will require lighting and ventilation and will have more than one floor with an elevator.	—

Land Use Subtype	Description	ITE Land Use Code
Other Asphalt Surfaces	This is an asphalt area not used as a parking lot (e.g., long driveway, basketball court, etc.)	—
Other Non-Asphalt Surfaces	This is a non-asphalt area (e.g., equipment foundation, loading dock area, etc.).	—
Parking Lot	This is a typical single surface parking lot typically covered with asphalt. This land use will require lighting.	—
Unenclosed Parking Structure	This is an unenclosed parking structure that may be above or below ground. It is not covered in asphalt. This land use will require lighting but not ventilation. It will have more than one floor with no elevator.	—
Unenclosed Parking with Elevator	This is an unenclosed parking structure that may be above or below ground. It is not covered in asphalt. This land use will require lighting but not ventilation. It will have more than one floor with an elevator.	—
User Defined Parking	User defined Parking land use subtype.	—
RECREATIONAL		
Arena	Arenas are large indoor structures in which spectator events are held. These events vary from professional ice hockey and basketball to non-sporting events such as concerts, shows, or religious services. Arenas generally have large parking facilities, except when located in or around the downtown of a large city.	460
City Park	City parks are owned and operated by a city.	411
Fast Food Restaurant W/O Drive Thru	This land use includes fast-food restaurants without drive-through windows. Patrons generally order at a cash register and pay before they eat.	933
Fast Food Restaurant with Drive Thru	This category includes fast-food restaurants with drive-through windows.	934
Golf Course	Golf courses include 9-, 18-, 27- and 36-hole courses. Some sites may also have driving ranges and clubhouses with a pro shop, restaurant, lounge and banquet facilities.	430
Health Club	These are privately-owned facilities that primarily focus on individual fitness or training. Typically, they provide exercise classes; weightlifting, fitness and gymnastics equipment; spas; locker rooms; and small restaurants or snack bars.	492
High Turnover (Sit Down Restaurant)	This land use consists of sit-down, full-service eating establishments with turnover rates of approximately one hour or less. This type of restaurant is usually moderately priced and frequently belongs to a restaurant chain.	932

Land Use Subtype	Description	ITE Land Use Code
Hotel	Hotels are places of lodging that provide sleeping accommodations and supporting facilities such as restaurants; cocktail lounges; meeting and banquet rooms or convention facilities; limited recreational facilities and other retail and service shops.	310
Motel	Motels are places of lodging that provide sleeping accommodations and often a restaurant. Motels generally offer free onsite parking and provide little or no meeting space and few supporting facilities.	320
Movie Theater (No Matinee)	Movie theaters consist of audience seating, single or multiple screens and auditoriums, a lobby and a refreshment stand. Movie theaters without matinees show movies on weekday evenings and weekends only; there are no weekday daytime showings.	444
Quality Restaurant	This land use consists of high quality, full-service eating establishments with typical turnover rates of at least one hour or longer. Quality restaurants generally do not serve breakfast, some do not serve lunch; all serve dinner. This type of restaurant usually requires reservations and is generally not part of a chain. Patrons commonly wait to be seated, are served by a waiter, order from menus and pay for meals after they eat.	931
Racquet Club	These are privately-owned facilities that primarily cater to racquet sports.	491
Recreational Swimming Pool	This is a typical recreational swimming pool that may be associated with community centers, parks, swim clubs, etc.	495
User Defined Recreational	User defined Recreational land use subtype.	—
RESIDENTIAL		
Apartments High Rise	High-rise apartments are units located in rental buildings that have more than 10 levels and most likely have one or more elevators.	222
Apartments Low Rise	Low-rise apartments are units located in rental buildings that have 1–2 levels.	220
Apartments Mid Rise	Mid-rise apartments in rental buildings that have 3–10 levels.	221
Condo/Townhouse	These are ownership units that have at least one other owned unit within the same building structure.	220
Condo/Townhouse High Rise	These are ownership units that have 3 or more levels.	221

Land Use Subtype	Description	ITE Land Use Code
Congregate Care (Assisted Living)	These facilities are independent living developments that provide centralized amenities such as dining, housekeeping, transportation and organized social/recreational activities. Limited medical services may or may not be provided.	254
Mobile Home Park	Mobile home parks consist of manufactured homes that are sited and installed on permanent foundations and typically have community facilities such as recreation rooms, swimming pools and laundry facilities.	240
Retirement Community	These communities provide multiple elements of senior adult living. Housing options may include various combinations of senior adult housing, congregate care, assisted living, and skilled nursing care aimed at allowing the residents to live in one community as their medical needs change.	255
Single Family Housing	All single-family detached homes on individual lots typical of a suburban subdivision	210
User Defined Residential	User defined Residential land use subtype.	—
RETAIL		
Automobile Care Center	An automobile care center houses numerous businesses that provide automobile-related services, such as repair and servicing; stereo installation; and seat cover upholstering.	942
Convenience Market (24 Hour)	These markets sell convenience foods, newspapers, magazines and often beer and wine. They do not sell or dispense motor vehicle fuels (i.e., gasoline and diesel).	851
Convenience Market with Gas Pumps	These markets sell or dispense motor vehicle fuels (e.g., gasoline and diesel), convenience foods, newspapers, magazines and often beer and wine. This includes convenience markets with motor vehicle fueling dispensers where the primary business is the selling of convenience items, not the fueling of motor vehicles.	853
Discount Club	A discount club is a discount store or warehouse where shoppers pay a membership fee to take advantage of discounted prices on a wide variety of items such as food, clothing, tires and appliances. Many items are sold in large quantities or in bulk.	857
Electronic Superstore	These are free-standing facilities that specialize in the sale of electronic merchandise.	863
Free-Standing Discount Store	Discount stores offer centralized cashiering and sell products that are advertised at discount prices. These stores offer a variety of customer services and maintain long store hours seven days a week.	815

Land Use Subtype	Description	ITE Land Use Code
Free-Standing Discount Superstore	The discount superstore is similar to the free-standing discount stores with the addition that they also contain a full-service grocery department under the same roof that shares entrances and exits with the discount store area.	813
Gasoline/Service Station	This land use includes service stations where the primary business is the fueling of motor vehicles. They may also have ancillary facilities for servicing and repairing motor vehicles.	944
Hardware/Paint Store	These stores sell hardware and paint supplies and are generally free-standing buildings.	816
Home Improvement Superstore	These are free-standing facilities that specialize in the sale of home improvement merchandise.	862
Regional Shopping Center	A shopping center is an integrated group of commercial establishments that is planned, developed, owned and managed as a unit. A shopping center's composition is related to its market area in terms of size, location and type of store.	820
Strip Mall	Small strip shopping centers contain a variety of retail shops and specialize in quality apparel, hard goods and services such as real estate offices, dance studios, florists and small restaurants.	826
Supermarket	Supermarkets are free-standing retail stores selling a complete assortment of food: food preparation and wrapping materials; and household, cleaning items. Supermarkets may also contain the following products and services: ATMs, automobile supplies, bakeries, books and magazines, dry cleaning, floral arrangements, greeting cards, limited-service banks, photo centers, pharmacies and video rental areas.	850
User Defined Retail	User defined Retail land use subtype.	—

[a] For a project with a lot size greater than 50,000 square feet, the user will need to select a different land use type such as general heavy industry, industrial park, or manufacturing.
ATM = automatic teller machine; ITE = Institute of Transportation Engineers; R & D = research & development.

4.3.2.1.2.1 Accounting for Parking Area

For all land use subtypes except single-family housing, the user should designate parking areas as a separate “parking” land use type (e.g., enclosed parking structure). No separate parking land use for a driveway or garage needs to be identified for the single-family housing subtype because parking is already included in the default lot acreage. Figure 10 shows how CalEEMod treats parking area based on the footprint and lot acreage for a single-family housing land use subtype compared to all other land use subtypes. As depicted, the lot acreage of a single-family housing land use includes both the parking and building footprint. For all other land uses, the lot acreage is the same as the building footprint, so parking needs to be entered as a separate land use.

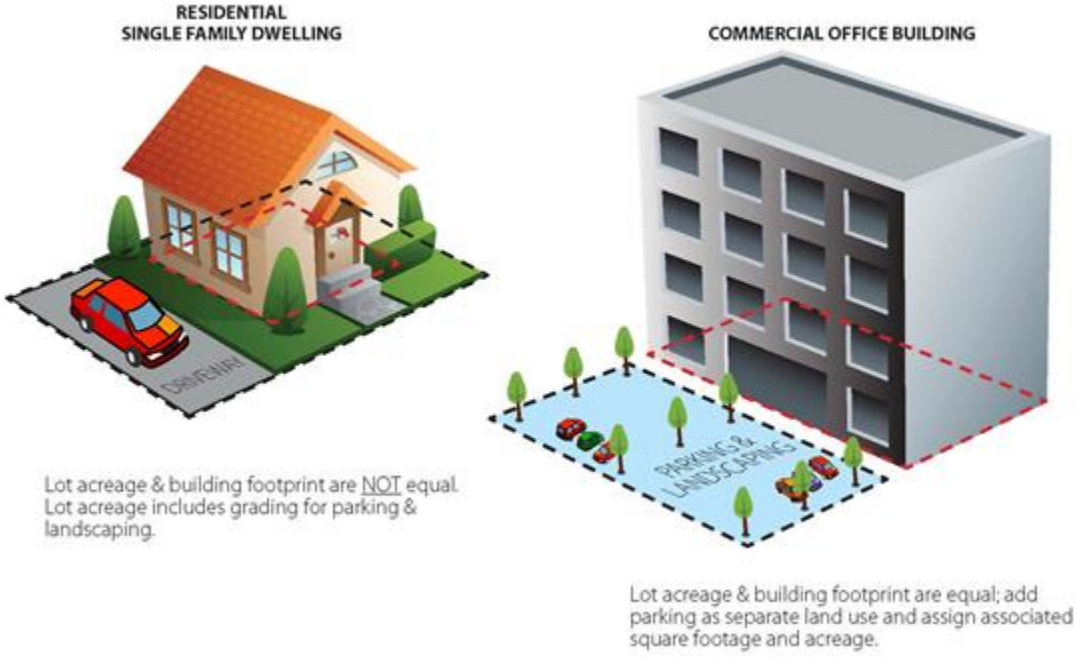

Figure 10. CalEEMod Default Parking Area and Lot Acreage

For the Parking land use type, the land use subtypes are grouped into two primary options: parking lot or parking structure (e.g., garage). There are four types of parking structures: (1) enclosed, (2) enclosed with an elevator, (3) unenclosed; and (4) unenclosed with an elevator. The reason for these specific descriptions is so that the model properly accounts for energy impacts associated with ventilation and elevator operations (see Appendix D6, *Assessment of Energy Emissions Associated with Parking Lots and Structures*).

4.3.2.1.2.2 User-Defined Land Use Subtypes

The user may select "user defined" to characterize project land use subtypes that are not included in CalEEMod or accurately represented by the available default land use subtypes. If a "user defined" land use subtype is selected, the user will need to manually provide inputs to all data fields on the **Land Use** screen. Emissions will not be calculated for the "user defined" land use subtype if the required data fields are left blank. Also, inputs on other screens linked to the user defined unit and size (e.g., electricity and natural gas consumption) will default to 0 and require manual inputs. An alternative approach to entering a "user defined" land use subtype would be to choose a land use subtype that most closely fits the project and allow the model to prepopulate the data fields with the defaults. Then, the user can go back through the model and modify the defaults with any known specific project information and enter the required Justification to explain why the defaults are modified.

4.3.2.1.3 Unit and Size

After selecting the land use subtype, the default value for the "Unit" will be prepopulated if there is only one option available (e.g., the only unit for the "Single Family Housing" land use subtype is Dwelling Unit [DU]). If the land use subtype has more than one potential unit (e.g., a "Golf

Course" land use subtype's size can be defined by the number of acres or number of holes), the user must select the unit from the dropdown menu.

Next, the user must input the corresponding "Size." For example, a Residential land use type could be 5 DUs, a Linear land use type could be 5 miles, a Hospital land use subtype could be 200 beds, an Industrial Park land use subtype could be thirty 1,000 square feet (which equates to 30,000 square feet, which is calculated in the "Building Square Feet" data field), etc. For most land use types, the combination of unit and size may prepopulate the default values for the "Lot Acreage," "Building Square Feet," and "Population" data fields on this screen. It is important to note that the square footage, which is used for calculating emissions from sources such as architectural coatings and energy use, relates to the total building square footage and not the building footprint or lot acreage.

4.3.2.1.4 Lot Acreage

The lot acreage of the proposed development is used to estimate housing density and assign construction default data (e.g., grading, site preparation). For most land use types, CalEEMod generates defaults for the lot acreage based on user inputs for the land use subtype, unit, and size. If actual lot acreage data is available, the user should override the default value. For Linear land use types, there is no default lot acreage based on the unit and size (e.g., project site length in miles). This is because no default project site width is assumed for Linear land use types, which is needed to calculate the area.

CalEEMod limits the total lot acreage for all land use subtypes combined in one model run to less than or equal to 10,000 acres.

Table 2 contains default housing density data per Residential land use in terms of DUs per acre. By using these data, CalEEMod estimates the number of acres for Residential land use subtypes. For example, if the user enters 10 DUs in the Apartments Low Rise land use subtype, then the lot acreage would be 0.63 acre (10 DU divided by 16 DUs/acre).

Table 2. Default Housing Density [a]

Land Use Subtype	Density (Dwelling Units/Acre)
Single Family Housing	3
Apartments Low Rise	16
Apartments Mid Rise	38
Apartments High Rise	62
Condo/Townhouse	16
Condo/Townhouse High Rise	64
Mobile Home Park	8
Retirement Community	5
Congregate Care (Assisted Living)	16

[a] Based on the density assumed in Institute of Transportation Engineers *Trip Generation 8th Edition*.

The user should adjust the default lot acreages if the project is a *mixed-use, multi-story building*. There is no mixed-use land use subtype available in CalEEMod, and the user will need to input two or more land use subtypes (e.g., Apartments High Rise and Strip Mall) to capture all uses.

For these projects, the default lot acreage value for the Residential land use subtype should be retained and the lot acreage values for all non-residential land use subtypes should be zeroed out. If the mixed-use, multi-story building includes only non-residential land uses, whichever land use subtype has the highest default lot acreage value should be retained and the acreage values for all other land use subtypes should be zeroed out. Figure 11 provides an example of a mixed-use project and instructions for applying the appropriate square footage and acreage.

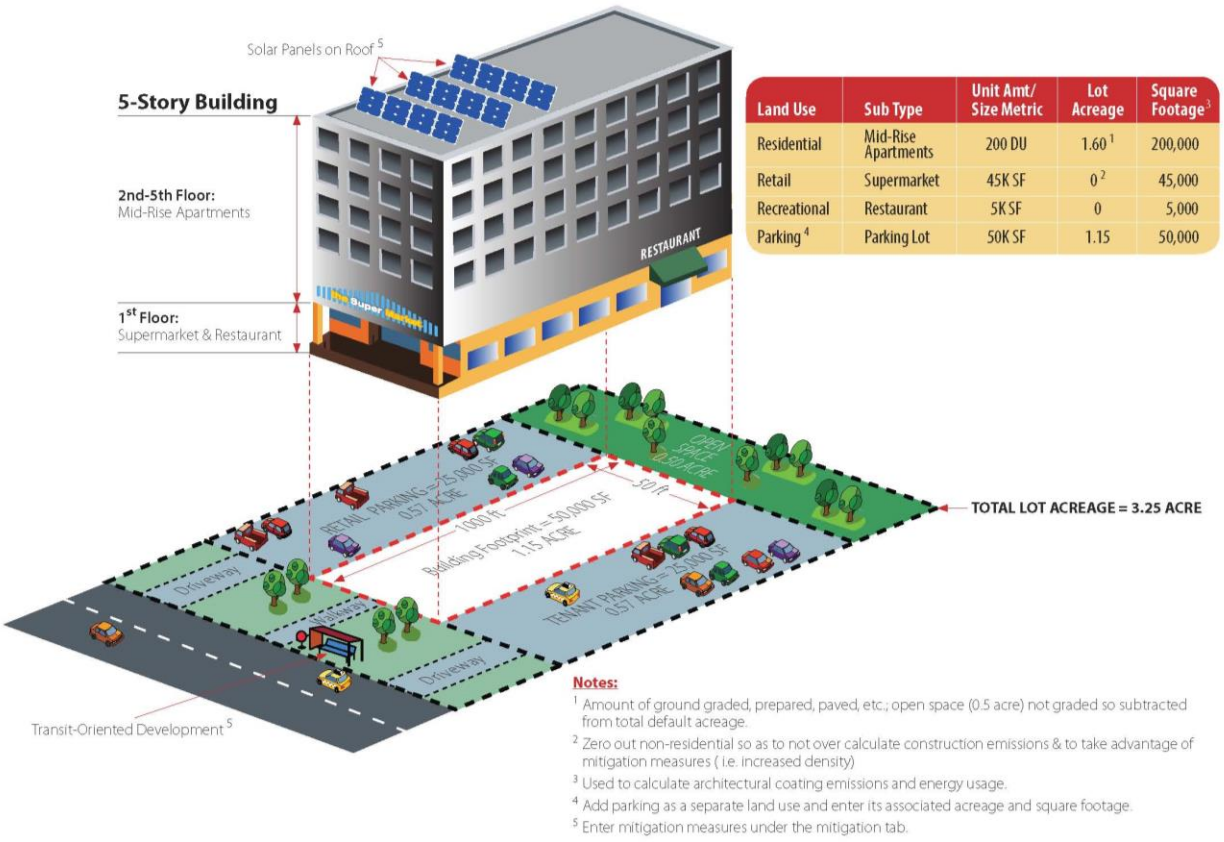

Figure 11. Example of Mixed-Use Project in CalEEMod

4.3.2.1.5 Building Square Feet

CalEEMod generates default inputs for residential building square footage using the average area of a DU for each Residential land use subtype, based on the 2019 Residential Appliance Saturation Survey (CEC 2020). For non-residential land use types where the unit selected is a measure of area (e.g., 1,000 square feet, acre), the building square footage is the product of the unit and size. For example, an industrial park with an input of 30 for size and 1,000 square feet for unit equates to a building square footage of 30,000 square feet. For non-residential land use types where the unit selected is not the area (e.g., number of beds, employees, students), the building square footage is calculated based on land use-specific conversion factors (e.g., square feet per employee) derived from Table B1 of the U.S. Energy Information Administration's Commercial Building Energy Consumption Survey (2016) and land use statistics from the South Coast Air Basin (See Appendix D, *Technical Source Documentation for Emissions Calculations*). No building square footage is assumed for Parking land use subtypes with no structure (e.g.,

Parking Lot land use subtype) and the city park and golf course land use subtypes. Accordingly, the building square footage for these land use subtypes is locked at 0 and cannot be overridden.

The building square feet data field is not applicable to Linear land use types used for roadway projects. Accordingly, the building square footage is locked at 0 and cannot be overridden.

4.3.2.1.6 Landscape Area and Special Landscape Area

Landscape area and special landscape area (see Appendix A, *Glossary*) are defined per the Model Water Efficient Landscape Ordinance (MWELO). Note that landscape area should include water features and all planting and turf areas in a landscape design plan, including special landscape area. Defaults for the landscape area are only available for the single-family housing land use subtype. The user must provide the landscaping area for all other land use subtypes. Leaving the input for landscaping area blank will exclude quantification of outdoor water consumption and associated emissions.

CalEEMod assumes 0 special landscape area as a default for all land use subtypes except city park, golf course, elementary school, high school, junior college (2 yr.), junior high school, and university/college (4 yr.). For these uses, the default special landscape area is equal to the user input for landscape area (i.e., the model assumes 100 percent of the landscape area is classified as special landscape area). Unlike the landscaping area data field, leaving the input for special landscape area blank will not prohibit the model from calculating outdoor water consumption emissions. However, defining the special landscape area (if any) is recommended, as it will provide for a more accurate quantification of operational outdoor water use given the different water use rates for special landscape area and landscape area.

4.3.2.1.7 Population

For Residential land use types, the population field will be prepopulated with a default estimate based on the number of DUs, using a conversion factor of residents per DU. The conversion factor is based on statewide residential data for the year 2020 derived from the California Department of Finance (2020). If the actual population is known, the user should override the default value. The population is used to determine the Residential land use subtypes' default solid waste generation rate.

For all non-Residential land use types, CalEEMod assumes 0 population. Because the population is not used to determine the non-Residential land use subtypes' default solid waste generation rate, or any other data field, the user can retain the default value of 0 without modeling repercussions.

4.3.2.1.8 Recreational Building Area

If the user selects a City Park, Recreational Swimming Pool, and/or Golf Course land use subtype, a column will appear that will prompt the user to enter the square footage of only the buildings associated with these land uses (e.g., restrooms/changing rooms, pro-shop). The user must input site-specific building square footage data because there are no default values for building footprints for these land use types. By excluding the entire lot size for these three land use types, and instead only using the square footage of the buildings, the calculations for consumer product use (see Section 4.3.4.2.2, *Consumer Products Screen*) will provide a more accurate representation of how and where these materials are used and avoid incorrectly attributing consumer products use and architectural coatings to greenspaces and pool water.

4.3.2.1.9 Predominant Soil/Site Type

This data field will only appear on the screen if the user selects a Linear land use type. The predominant soil/site type is a required user input that affects the construction schedule phasing durations. The user can select one of three options from the dropdown menu. The California Geological Survey provides an online geologic map that helps determine the appropriate option.[8]

4.3.3 Construction Module

The **Construction** module includes 10 screens that cover the different types of sources that contribute to construction emissions. To move from one screen to another, the user can use the "Next" and "Back" buttons or click on any of screen names in the left-hand menu.

4.3.3.1 Construction Phases Screen

The **Construction Phases** screen is where the user can enter the type of each construction phase and the date range for each phase. CalEEMod generates default construction phases and schedule inputs based on user inputs in the **Land Use** screen. For non-Linear land use types, construction surveys performed by the South Coast Air Quality Management District (South Coast AQMD) are used to define the default phases and durations based on the total project acreage (see Appendix D, *Technical Source Documentation for Emissions Calculations*). For Linear land use types, the "Linear Land Use Type Construction Workdays" data field will appear on the screen. This field represents the total number of workdays for all construction phases of all Linear land use types. This data field requires a user input. Combined with the user selection of the predominant soil/site type on the **Land Use** screen, these inputs determine the default construction phase durations (Ramboll 2016).

CalEEMod automatically populates the "Phase Name" and "Phase Type" columns. The default phase types differ for non-Linear and Linear land use types. Definitions of the default phase types are provided in Table 3. If Linear and non-Linear land use types are identified on the **Land Use** screen, the default assumptions will be generated for all phase types. Depending on the project being modeled, not all phases may be necessary, so the user may need to delete phases that are not applicable to the project. For example, not all projects require demolition. In addition, the user may need to add multiple phases of similar types for large projects with staged build out scenarios. The inclusion of specific construction phases will define the types of calculations and default assumptions that occur in subsequent screens.

[8] Available: https://maps.conservation.ca.gov/cgs/gmc/.

Table 3. CalEEMod Default Construction Phases [a]

Phase Type	Description
NON-LINEAR LAND USE TYPES (VERTICAL CONSTRUCTION)	
Demolition	Involves removing buildings or structures.
Site Preparation	Involves clearing vegetation (grubbing and tree/stump removal) and removing stones and other unwanted material or debris prior to grading.
Grading	Involves the cut and fill of land to ensure that the proper base and slope is created for the foundation.
Building Construction	Involves the construction of the foundation, structures, and buildings.
Paving	Involves the laying of concrete or asphalt such as in parking lots, roads, driveways, or sidewalks.
Architectural Coating	Involves the application of coatings to both the interior and exterior of buildings or structures, the painting of parking lot or parking garage striping, associated signage and curbs, and the painting of the walls or other components such as stair railings inside parking structures.
LINEAR LAND USE TYPES (LINEAR CONSTRUCTION)	
Linear, Grubbing & Land Clearing	Involves clearing vegetation (grubbing and tree/stump removal) and removing stones and other unwanted material or debris prior to grading for linear projects.
Linear, Grading & Excavation	Involves the cut and fill of land to ensure that the proper base and slope is created for the linear project.
Linear, Drainage, Utilities & Sub-Grade	Involves installation of drainage features, utilities, and any associated sub-grading.
Linear, Paving	Involves the laying of concrete or asphalt.

[a] In additional to these default phases, CalEEMod includes a trenching phase. While trenching is a phase option, there are currently no defaults for this phase. If a project includes trenching, the user must enter site-specific inputs on all screens, where relevant.

The start and end dates are automatically populated with a default construction schedule starting with the demolition phase, with subsequent phases starting the day after the previous phase's end date. The default "Start Date" for the demolition phase is the "Start of Construction" date defined on the **Project Detail** screen. The same is true for Linear land use type projects, with the exception that the first phase type is "Linear, Grubbing & Land Clearing." Because CARB's emission factors vary from year to year, when the user inserts the start and end dates for each construction phase, the model will select the correct emission factors for the year when each piece of off-road equipment will be utilized.

The user can select from a dropdown box the number of days per week that construction will occur. CalEEMod automatically defaults to 5 days per week. Five days per week assumes that construction will occur from Monday through Friday. Selections of less than 5 days per week assume construction occurs anytime between Monday and Friday. Six days per week assumes that construction will occur Monday through Saturday. The selected number of days per week influences the calculation of total workdays.

The "Total Work Days" field indicates the number of working days that it will take to complete a particular construction phase. The "Start Date," "End Date," and "Days/Week" columns are

dynamically linked. When the “Enable Auto-Scheduler” toggle located at the top of the screen is toggled on, changes to any one of these columns will trigger automatic adjustments among the fields.

If desired, the user may enter a description of each construction phase in the “Phase Description” column.

4.3.3.2 Off-Road Equipment Screen

The **Off-Road Equipment** screen allows the user to select the type and quantity of off-road equipment needed for each construction phase and to define the daily usage schedule. CalEEMod generates default equipment assumptions based on user inputs in the **Land Use** and **Construction Phases** screens. CalEEMod will populate the default equipment list for all construction phases. For each equipment type, CalEEMod will generate defaults for the fuel type, engine tier, number of equipment operating per day, daily operational hours per equipment, and the equipment horsepower and load factor. For non-Linear land use types, the South Coast AQMD construction survey is used to inform the default equipment lists (including number of required equipment and daily operating hours), which are based on total project acreage as calculated from the lot acreage(s) entered on the **Land Use** screen for the land use type(s) (see Appendix D, *Technical Source Documentation for Emissions Calculations*). The default construction equipment is determined to be the most appropriate for the size and types surveyed. Some data in the South Coast AQMD survey was extrapolated to create default values for project sizes that were not in the survey. For Linear land use types, a survey of 11 road construction projects (Tetra Tech 2013) is used to inform the default number and type of equipment per phase, which are based on the land use subtype and maximum area disturbed per day. The maximum area disturbed per day is calculated as the lot acreage divided by the number of workdays in the linear grading phase.

Because the majority of off-road equipment used for construction projects is diesel fueled, CalEEMod assumes all equipment in the default list is diesel-powered. The exception is electric signal boards associated with Linear land use types, which are assumed to be powered by grid electricity. Likewise, CalEEMod defaults to using calendar year average equipment emission factors as opposed to tier-specific rates (e.g., Tier 1). Using the pencil button to the right of each entry of an equipment type, the user may override any defaults for “Fuel Type” and “Engine Tier” if project-specific information is available. Available fuel options are diesel, gasoline, compressed natural gas, and electric. Available engine tier options are Tier 1, Tier 2, Tier 3, Tier 4 interim, Tier 4 final, and statewide average for the calendar year.

Defaults for the equipment “Horsepower” and “Load Factor” fields are automatically populated with the default average values from CARB’s OFFROAD2007 and OFFROAD2011.

If the project requires the use of off-road equipment that is not specifically listed in the dropdown list, the user can select from three generalized equipment categories to add customized equipment to the analysis: (1) Other Construction Equipment, (2) Other General Industrial Equipment, and (3) Other Material Handling Equipment. In addition, the user may choose to select a surrogate equipment type that has a similar horsepower rating and load factor. To include water trucks and cement trucks in the analysis, the user needs to first determine if these trucks are off-road or on-road vehicles. If they are only driven off-road, then the user can select the Off-Highway Trucks category in the Off-Road Equipment column. If the trucks are driven on-road, the user can account for the on-road emissions by entering this information as additional vendor trips on the **Trips and VMT** screen (see Section 4.3.3.6, *Trips and VMT Screen*).

4.3.3.3 Off-Road Equipment Emission Factors Screen

The **Off-Road Equipment Emission Factors** screen provides the equipment-specific emission factors for user review and confirmation. Only those pollutants associated with off-road construction equipment are shown in the screen. Calendar year average emission factors for diesel, gasoline, and compressed natural gas off-road equipment are derived from CARB's OFFROAD2017-ORION v1.0.1. Tier-specific emission factors for diesel equipment are obtained from CARB's (2017a) Carl Moyer Program Guidelines. Default emission factors for electric equipment show as 0 because emissions are quantified in the **Electricity** screen using utility specific emission factors (see Section 4.3.3.10, *Electricity Screen*). If the user inputs an equipment horsepower that falls outside the maximum horsepower range for an equipment type programmed in the model, a red warning message will appear, and CalEEMod will apply emission factors from the maximum-programmed horsepower range to the equipment.

4.3.3.4 Dust from Material Movement Screen

The **Dust from Material Movement** screen calculates, by default, the following fugitive dust emissions associated with the site preparation and grading phases for non-Linear land use types and all phases except paving for Linear land use types.[9]

1. Dozers moving dirt.
2. Graders or scrapers leveling the land.
3. Loading or unloading dirt into haul trucks.

These methods have been adapted from USEPA's (1998b, 2006a) AP-42 method for Western Coal Mining. Once the user enters the amount of material imported and exported to the site, CalEEMod will estimate the number of hauling trips associated with material transport activities and prepopulate it as a default on the **Trips and VMT** screen (refer to Appendix D, *Technical Source Documentation for Emissions Calculations,* for suggested material movement quantities by project land use type and size). The user may define the material transport size metric in terms of short ton of debris or cubic yards. The user may also select whether the import/export of material is phased (e.g., the same truck that arrives with material departs with another load of material to export in one round trip or two one-way trips). The calculations for non-phased material import/export trips assume that one truck arrives empty and departs full and a different truck arrives full for a total of two round trips (or four one-way trips). Thus, phasing of material import and export trips reduces the number of haul trips. Emissions from on-road truck travel are included in the **Trips and VMT** screen (see Section 4.3.3.6, *Trips and VMT Screen*).

For land use development projects, the total acres graded column represents the cumulative distance traversed on the property by the grading equipment, assuming a blade width of 12 feet. To properly grade a piece of land, multiple passes with grading equipment may be required. So even though the lot size is a fixed number of acres, the total acres graded could be an order of magnitude higher than the footprint of the lot. The default area is calculated based on the equipment list (including number of equipment), the number of days needed to complete the default phases listed on this screen (e.g., grading), and the maximum number of acres a given piece of equipment can traverse in an 8-hour workday. For Linear land use types, the total acres graded is equal to the user input for lot acreage in the **Land Use** screen.

[9] While certain construction phases appear on this screen by default, the user can model dust emissions from material movement under any phase in the construction schedule by clicking "Add Phase." The user must define the total acres graded for all non-default phases.

If applicable, the user may select the "Water Exposed Area" toggle to account for dust control as part of the project design. Default PM emission reduction efficacies are available for watering exposed surfaces at frequencies of two or three times per 8-hour workday (Countess Environmental 2006:Table 3-7). If the user selects a frequency of "Other" from the dropdown menu, the PM reduction defaults to 0 and requires a user input.[10] If the "Water Exposed Area" toggle is selected, the reduction efficacies will be applied to the calculation of unmitigated fugitive dust. If any dust control strategies are selected on this screen, the user will not be able to select them in the **Measures** module as this would be double counting. Only select dust control strategies on this screen if they are part of the project design. If the project will implement dust control as mitigation, select the measures in the **Measures** module**.**

4.3.3.5 Demolition Screen

The **Demolition** screen calculates, by default, fugitive dust emissions from building demolition for non-Linear land use types. The user must define the amount of demolished material that is expected to be generated during one or more construction phases. The user can select the size metric to define the amount of demolished material in terms of short ton of debris or building square footage. The calculation of fugitive dust emissions during demolition is derived from the methodology described in the report prepared for the USEPA by Midwest Research Institute (MRI) (1988).

Like the calculation for dust from material movement, the user may select the "Water Demolished Area" toggle to account for dust control as part of the project design. Default **PM emission** reduction efficacies are available for watering during demolition at a frequency of two times per 8-hour workday (Countess Environmental 2006:Table 3-7). If the user selects a frequency of "Other" from the dropdown menu, the PM reduction defaults to 0 and requires a user input. Only select dust control on this screen if the strategy is part of the project design. If the project will implement dust control as mitigation, select the measure in the **Measures** module.

4.3.3.6 Trips and VMT Screen

The **Trips and VMT** screen calculates exhaust and mechanical (i.e., tirewear and brakewear) emissions from trips and vehicle miles traveled (VMT) of construction workers, vendors, haul trucks, and onsite haul trucks. Depending on the user inputs for several data fields across the **Characteristics** module, **Land Use** module, and prior screens in the **Construction** module, for certain trip types and phases, the number of trips, trip length, and vehicle class for worker, vendor, and hauling trips will be prepopulated with default values.

CalEEMod quantifies the default number of construction worker one-way trips per day by multiplying 2.5 times the number of pieces of equipment for all phases (except building construction and architectural coating). For the building construction phase, the number of workers is derived from a study conducted by the Sacramento Metropolitan Air Quality Management District that determined the number of workers needed for various types of land uses and corresponding project size. This study and its analysis are included in Appendix D, *Technical Source Documentation for Emissions Calculations*. For the architectural coating phase, the number of worker trips is approximately 20 percent of the number of worker trips needed during the building construction phase.

For Linear land use types, defaults for the number of one-way vendor trips per day are available for all construction phases. The vendor trip rate accounts for water trucks but no other types of

[10] Local air districts may have suggestions for reduction efficacies in their CEQA guidelines.

vendors (e.g., cement trucks). If the Linear land use construction requires other types of vendor trips, the user will need to add those trips to the defaults quantified for water trucks. For non-Linear land use types, the default number of vendor trips is only available for the building construction phase. The trip rates are derived from the Sacramento Metropolitan Air Quality Management District construction survey (see Appendix D, *Technical Source Documentation for Emissions Calculations*). The survey defines vendor trips as those made by cement and water trucks. If the building construction phase requires other types of vendor trips, the user will need to add those trips to the defaults quantified for cement and water trucks. The user must also provide vendor trips rates for all other land use development phases requiring this type of vehicle trip. Appendix D includes suggested vendor trip rates for construction phases where defaults are not currently programmed.

The default values for hauling trips are based on the amount of material that is demolished (as defined in the **Demolition** screen) or imported or exported (as defined in the **Dust from Material Movement** screen), assuming that a truck can haul 20 short tons (or 16 cubic yards) of material per load. If one load of material is delivered, CalEEMod assumes that one haul truck importing material will also have a return trip with an empty truck (e.g., two one-way trips). Similarly, a haul truck needed to export material is assumed to have an arrival trip in an empty truck and a loaded departure truck (e.g., two one-way trips). Thus, each trip to import and export material is considered as two separate round trips (or four one-way trips). However, if the "Material Import/Export Phased?" box is checked in the **Dust from Material Movement** screen, the same haul truck that imported the material will be assumed to be the same haul truck that exports material resulting in one round trip (or two one-way trips). There are no trip rate defaults for onsite trucks. The user must enter site-specific assumptions when a project includes onsite truck trips. Refer to Appendix D, *Technical Source Documentation for Emissions Calculations*, for suggested onsite trip rates and lengths.

The user can select the type of vehicle mix for each of the four construction trip types (e.g., worker). The construction vehicle mix class descriptors are defined in Appendix A, *Glossary*.

Default trip length estimates for workers and vendors are based on the 2015 California Statewide Travel Demand Model (CSTDM) and regional travel demand models from local metropolitan planning organizations (MPO) or Regional Transportation Planning Agencies (RTPA), where available. If MPO/RTPA data are available for the project location, the user may select either data source by clicking the appropriate toggle. The hauling trip length default is set at 20 miles. There are no trip length defaults for onsite trucks.

4.3.3.7 On-Road Fugitive Dust Screen

The **On-Road Fugitive Dust** screen defines the variables that will be used to determine fugitive dust emissions from on-road vehicles driving over paved and unpaved roads during construction. CalEEMod automatically prepopulates the roadway and vehicle characteristic fields based on USEPA's AP-42 (2006b, 2011). The default percentage of VMT on paved roadways is available by air basin, air district, county, and statewide and will therefore prepopulate based on the user-selected analysis level defined on the **Project Detail** screen. All onsite trucks trips are assumed to occur within the project construction boundary and, therefore, exclusively on unpaved roads.

If applicable, the user may select the "Control Strategy" toggle to account for dust control as part of the project design. Default PM reduction efficacies are provided for a range of control strategies (Countess Environmental 2006:Tables 3-7, 6-6, and 5-5). If the "Control Strategy" toggle is selected, the reduction efficacies will be applied to the calculation of unmitigated fugitive dust. Only select dust control on this screen if the strategies are part of the project design. If the project

will implement dust control as mitigation, the user should select the measure(s) in the **Measures** module.

4.3.3.8 Architectural Coatings Screen

The **Architectural Coatings** screen calculates VOC emissions from painting the interior/exterior of residential and non-residential buildings. The screen also calculates VOC emissions from parking lot painting or striping for Linear land use types. The user may override any of the default surface areas estimated. In addition, each of these surface types has a different emission factor indicating the VOC content of the paint in grams per liter (g/L). The emissions associated with parking structures are included in the non-residential interior/exterior square footage, whereas the emissions associated with parking lot striping are accounted for in a separate parking category.

4.3.3.9 Paved Area Screen

The **Paved Area** screen calculates VOC emissions from asphalt paving. CalEEMod provides default inputs for area paved for the single-family housing land use subtype and all Linear and Parking land use subtypes. CalEEMod assumes 0 paved area for all other land use types. The user should override this value if their project includes additional paving. Because evaporative VOC emissions are only generated by asphalt paving, the user should also specify the percentage of area paved with asphalt as opposed to another material (e.g., concrete). The default asphalt percentage is 100 percent for all Linear and Parking land use subtypes (except for Non-Asphalted Surfaces) and 0 percent for all other land use types.

4.3.3.10 Electricity Screen

The **Electricity** screen calculates GHG emissions from the consumption of electricity during construction. This screen includes the linked input for the electric utility from the **Utility Information** screen. And, similar to operational electricity inputs (discussed in Section 4.3.1.2, *Utility Information Screen*), the GHG emission factors (electricity) toggle allows the user to choose between emission factors from the latest year with reported data (2019) or the forecasted future year carbon intensities applicable to each construction year, reflective of implementation of SB 100.

If the user selected electric-powered off-road equipment in the **Off-Road Equipment** screen, CalEEMod prepopulates the Electricity input with the associated annual electricity consumption in this screen. If a project includes non-equipment sources of electricity consumption, the user should sum the additional electricity with the default equipment-based electricity. CalEEMod does not estimate electricity consumption for any source other than user defined electric-powered equipment (e.g., mobile offices, electric haul trucks).

4.3.4 Operations Module

The **Operations** module includes four submodules and 19 screens that cover the various types of sources that contribute to operations emissions. Please note that CalEEMod only quantifies operational mobile, area, energy, water, wastewater, and water emissions for non-Linear land use types (e.g., Commercial, Residential). If a linear project includes operational sources with these emission types, the user may quantify the emissions outside of CalEEMod and insert them in the **User Defined** screen. Alternatively, the user may consider selecting a non-Linear land use type on the **Land Use** screen to characterize the non-linear operational component of a Linear land use type project.

4.3.4.1 Mobile Sources Submodule

The **Mobile Sources** submodule consists of four screens to gather the information necessary to estimate emissions from trips and VMT from on-road vehicles associated with the project land use types.

4.3.4.1.1 Vehicle Data Screen

This screen includes several data fields related to vehicles trips and VMT. The number of trips affect the calculation of starting exhaust and evaporative emissions. The VMT affects the calculation of running exhaust, brake wear, tire wear, and fugitive dust from paved and unpaved roads.

The user can define the project vehicle trip and VMT data in one of two ways. If the user clicks "Generate Default Trips and VMT" on this screen, CalEEMod prepopulates default vehicle trip and VMT inputs based on various user inputs on the **Land Use** screen. The user may override any of the default trip and VMT inputs. Alternatively, if the user would like to manually define project-specific trip and VMT inputs from a traffic study or other source, they should click "Enter VMT and Trips Manually." If after making their selection the user would like to change methodologies, they should click the "Generate Default VMT and Trips Instead / Enter VMT and Trips Manually Instead" button located near the top left side of the screen.

If the "Enter Trips and VMT Manually" button is clicked, this screen provides data fields for the user to input daily trips and VMT for weekdays, Saturday, and Sunday, as well as annual trips and VMT. The user is required to, at minimum, input vehicle data at either the daily timescale or annual timescale. If only daily traffic data are available, annual trips and VMT will be upscaled assuming 365 days of vehicle activity per year. Likewise, if only annual traffic data are available, daily trips and VMT will be averaged over 365 days per year. However, it is recommended the user input vehicle data at both timescales.

If the "Generate Default Trips and VMT" button is clicked, this screen displays the default trip rates, trip lengths, trip purpose, and trip type percentages for each land use subtype of the project.

Default vehicle trip rates are based primarily on ITE's (2017a) *Trip Generation Manual, 10th Edition*. They are expressed in terms of the size metric (thousand square feet or DU) defined on the **Land Use** screen and are listed for weekday, Saturday, and Sunday.

Depending on what the user selects on the "CSTDM / MPO/RTPA" toggle, default vehicle trip lengths for primary trips will be populated using data from the 2015 CSTDM or local MPO/RTPA, where available. Diverted trips represent the typical diversion from a freeway to adjacent highway commercial uses for urban/suburban areas and are assumed to take a slightly different path than a primary trip. Diverted trips are assumed to be 2 miles per trip. Pass-by trips are assumed to be 0.1 mile per trip, and are a result of no diversion from the primary route.

For each land use subtype, there are nine data fields for the trip link type percentages, grouped into three sets (weekday, Saturday, and Sunday) of three data fields organized by trip link type: primary, diverted, and pass-by. The default percentages are based on data from ITE's (2017b) *Trip Generation Handbook, 3rd Edition*. The sum of the inputs for each set must equal 100 (i.e., weekday primary plus weekday diverted plus weekday pass-by is 100 percent).

For each land use subtype, there are six data fields for the trip type percentages, grouped into two sets (residential and non-residential). The three residential trip types are defined in one of three ways: home-work (H-W), home-shop (H-S), and home-other (H-O). Non-residential trip

types also defined in one of three ways: H-W, work-other (W-O), and other-other (O-O). See Appendix A, *Glossary*, for definitions of the trip types. The default percentage of each trip by type is based on either the 2015 CSTDM or local MPO/ RTPA, where available, as selected by the user. The sum of the inputs for each set must equal 100 (i.e., residential H-W plus residential H-S plus residential H-O is 100 percent).

4.3.4.1.2 Fleet Mix Screen

The **Fleet Mix** screen displays for the operational analysis year each land use subtype's vehicle fleet mix by season (Annual, Winter, and Summer). The fleet mix is comprised of the 13 vehicle types from EMFAC2021 using the EMFAC2007 vehicle category classifications. The user can hover their cursor over the "i" icon located to the right of the data field name to view the full vehicle type name.

The default fleet mix is derived from EMFAC2021 v1.0.1 based on the user input to the "Analysis Level for Defaults" data field on the **Project Detail** screen. For example, if the user selects County as the analysis scale, and the project is in Sacramento County, the default fleet mix will reflect the operational year fleet mix-average for Sacramento County. If the user selects Air Basin as the analysis scale, the default fleet mix will reflect the operational year fleet mix-average for the Sacramento Valley Air Basin. The default fleet mix is not sensitive to the land use subtype (i.e., the same defaults are generated for all land use subtypes in the project run). Input fields are provided by land use subtype to provide flexibility if the user would like to override defaults and supply land use subtype specific information.

4.3.4.1.3 Vehicle Emission Factors Screen

The **Vehicle Emission Factors** screen contains the detailed vehicle emission factors for the operational analysis year by EMFAC2007 vehicle type. There are separate tabs for annual, summer, and winter emission factors. Only those pollutants associated with on-road vehicles are shown on the screen. All vehicle emission factors, except those for HFCs, are based on EMFAC2021 v1.0.1 (CARB 2021a). HFC emission factors are based on a combination of EMFAC2021 v1.0.1 vehicle data and information provided by CARB (2017b). Emission factors are dependent on the user input to the "Analysis Level for Defaults" data field on the **Project Detail** screen, similar to the fleet mix.

Default emission factors were generated from the most recent version of EMFAC available at the time of model development, which was EMFAC2021 (v1.0.1) released in April 2021. This rule accounts for the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule, which was repealed in December 2021.[11] As new versions of EMFAC are released and/or as new regulations change expected future year emission factors, it is recommended that the user consider overriding the default data on this screen with the latest emission factor model data.

4.3.4.1.4 Road Dust Screen

The **Road Dust** screen displays data fields used to calculate fugitive emissions from paved and unpaved roads based on USEPA's AP-42 methodology (2006b, 2011). The default percentage of VMT on paved roadways is available by air basin, air district, county, and statewide and will

[11] The SAFE rule was finalized in 2020 and changed the national fuel economy standards for light duty vehicles from 46.7 miles per gallon (mpg) to 40.4 mpg in future years. However, on April 22, 2021, the National Highway Traffic and Safety Administration (NHTSA) issued a notice of proposed rulemaking to repeal the rule. The repeal was finalized on December 21, 2021. NHTSA is in process of adopting more stringent corporate average fuel economy (CAFE) standards for model year 2024–2026 vehicles.

therefore prepopulate based on user input to the “Analysis Level for Defaults” data field on the **Project Detail** screen.

The default values for the data fields related to unpaved road dust (i.e., material silt content, material moisture content, and mean vehicle speed) are statewide averages except for projects in the San Luis Obispo region. For projects in the San Luis Obispo Air Pollution Control District (SLOAPCD), the model defaults to parameters provided by the air district. The user can override the statewide and SLOAPCD defaults if data specific to the project location is known. Local jurisdictions can also provide guidance on defaults that properly reflect known regional road dust parameters.

If the user turns on the toggle button located at the top of the screen, the unpaved road dust emission factors from CARB’s statewide emission inventory (CARB 2004, 2009; MRI 2005) will be used to calculate paved road dust instead of the data fields from the USEPA AP-42 paved road dust quantification method. CARB emission factors are recommended for projects in the Sacramento Metropolitan Air Quality Management District.

4.3.4.2 Area Sources Submodule

The **Area Sources** submodule consists of four screens that gather the information necessary to estimate emissions from hearths, consumer products, architectural coatings, and landscaping equipment. Each of these emission sources is represented on an individual screen, as discussed below. Please note that natural gas emissions are associated with both hearths, shown within the **Area Sources** submodule, and building energy, shown on the **Energy Use** screen (see Section 4.3.4.3, *Energy Use Screen*) that appears after this submodule.

4.3.4.2.1 Hearths Screen

This screen allows the user to enter the number and types of wood stoves and fireplaces as well as the usage of these devices. Wood stoves are separate from fireplaces since a home may have both and these devices may have different use patterns. For each type of device, the number of devices entered represents the total number of devices installed in all DUs for a particular land use subtype. Default numbers of hearths and stoves by Residential land use subtypes are available for most locations based on data provided by local air districts. The defaults reflect current air district rules regarding hearths and wood stoves in new residences. Commercial land uses are assumed by default to have no hearths or wood stoves. However, the user may manually input hearth and stove data for any non-Residential land use types included in their model run.

4.3.4.2.2 Consumer Products Screen

The data fields on this screen are used to calculate the VOC emissions from various consumer products. Consumer products are various solvents used in non-industrial applications that emit VOCs during use. These typically include cleaning supplies, kitchen aerosols, cosmetics, and toiletries. CalEEMod also quantifies VOC emissions from pesticides/fertilizers used at City Parks and Golf Courses and from parking surface degreasers. Note that CalEEMod assumes that there will be no VOC emissions from the actual pool surface area for the Recreational Swimming Pool land use subtype because the chemicals used for pool maintenance are not considered to be VOCs. Details of how the consumer product VOC emission factors were determined can be found in Appendix D3, *Consumer Products Use*, and Appendix D4, *Degreaser, Fertilizer/Pesticides Use Analysis*.

4.3.4.2.3 Architectural Coatings Screen

This screen provides data fields for the reapplication rate, VOC coating content, and coated area for each building surface type and parking surface. The reapplication rate is the percentage of the total surface area that is repainted each year. A default of 10 percent is used, meaning that 10 percent of the surface area is repainted each year (i.e., all surface areas are repainted once every 10 years). The annual emissions are divided by 365 days per year to determine average daily emissions. This is based on assumptions used by South Coast AQMD in their district rules regarding architectural coatings. Some districts provided details on their coating regulations that phase-in over time, which have been incorporated to the extent feasible, given the general classifications of paint (interior or exterior for residential and non-residential plus parking surfaces). Coating VOC contents from state regulations are used for air districts that did not provide specific architectural coating information. The user should consult their local air district for suggested values that may be lower than the state regulations.

4.3.4.2.4 Landscape Equipment Screen

CalEEMod can generate landscaping emissions based on statewide average equipment emission intensities for the number of snow and summer days for the project location. The user should click "Generate Default" to enable this function. Alternatively, the user can manually define a landscaping equipment inventory by clicking "Enter Manually."

If the "Generate Default" button is clicked, the screen will display data fields for the number of snow days and summer days applicable to the project location, which are assumed to represent the number of equipment operational days per year. The number of days is applied to a statewide average weighted landscape equipment emission factor derived from CARB's Small Off-Road Engines Model v1.1 (SORE2020) (CARB 2020c).

If the "Enter Manually" box is checked, the screen will display blank data fields for the user to define for each land use type the number of pieces of equipment, fuel type, and hours of operation per day and per year for each selected equipment type. Defaults from SORE2020 are available for equipment HP and load factor.

4.3.4.3 Energy Use Screen

The **Energy Use** screen is used to gather the information necessary to estimate the emissions associated with building electricity and natural gas usage (non-hearth). Electricity use is in units of kilowatt hours (kWh) per year for each land use subtype. Natural gas use is in units of a thousand British Thermal Units (KBTU) per year for each land use subtype.

Title 24 of the California Code of Regulations, known as the California Building Standards Code or Title 24, contains energy conservation standards applicable to all new or altered residential and non-residential buildings throughout California. Within CalEEMod, building electricity and natural gas use is divided into two categories: (1) end uses subject to Title 24 standards, and (2) end uses not subject to Title 24 standards. The distinction is required to enable accurate calculation of several energy sector reduction measures.

CalEEMod generates default electricity and natural gas consumption based on the EDFZ input on the **Project Detail** screen and the land use subtypes and building square feet input on the **Land Use** screen. The user can override these defaults and input total annual electricity and natural gas consumption by project land use subtype or disaggregated Title 24 and non-Title 24 electricity and natural gas consumption. If the user changes any of the consumption values, the recalculate button to the right of all inputs must be selected to process the change (Figure 12).

The recalculate function will ensure total consumption equals the sum of Title 24 and non-Title 24 consumption. Note that the recalculate energy use button is only available in the tabular data view mode.

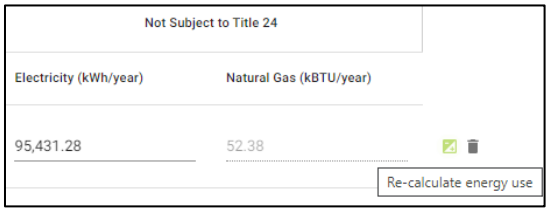

Figure 12. Recalculate Building Energy Use Button

Default electricity and natural gas consumption is based on 2019 consumption estimates using the CEC's (2020, 2021b) 2018–2030 Uncalibrated Commercial Sector Forecast and 2019 Residential Appliance Saturation Survey (see Appendix D, *Technical Source Documentation for Emissions Calculations*). If project-specific energy estimates are available, it is recommended the user manually input the total annual electricity and natural gas consumption, especially for projects with operational years far into the future.

4.3.4.4 Water and Wastewater Screen

The **Water and Wastewater** screen determines the GHG emissions associated with supplying and treating water and wastewater used and generated by the project land uses. This screen is used to enter the amount of water in gallons used indoors and outdoors for each land use subtype. Default consumption estimates are automatically generated for all land use subtypes. Outdoor water consumption defaults are calculated using the Maximum Applied Water Allowance (MAWA) method established under the California Department of Water Resources' (DWR) 2015 MWELO (California Code of Regulations [C.C.R.], Title 23, Division 2, Chapter 2.7). Indoor water consumption defaults are based on studies published by the Water Research Foundation (2016), Pacific Institute (Gleick et al. 2003), and American Water Works Association (Dziegielewski et al. 2000). The quantity of indoor water is used to estimate the amount of wastewater.

The **Water and Wastewater** screen also shows the electricity intensity factors for various phases of providing water: supply, treatment, distribution, and wastewater treatment. Supply means bringing the water from its primary source such as the ground, river, or snowpack to the treatment plant. Distribution means bringing the water from the treatment plant to the end users. The electricity intensity factors vary depending on the hydrologic region where the project is located. GHG emissions are calculated from this screen by multiplying the electricity intensity factors by the utility GHG emissions intensity factors input on the **Utility Information** screen. The default electricity intensity factors are based on a study published by The Pacific Institute (Sziniai et al. 2021). Since the electricity intensity of water supply can vary greatly based on location, the user should override these values if they have more specific information regarding their specific water supply and treatment.

Wastewater may also result in direct emissions of GHGs. These depend on the type of wastewater treatment system (i.e., septic, aerobic, or lagoon) used. Therefore, the wastewater treatment type percentages are displayed as data fields on the screen. The sum of the inputs for the wastewater treatment type must equal 100 (i.e., septic plus aerobic plus facultative lagoon is 100 percent).

In addition, the model calculates GHG emissions if wastewater solids are digested either through an anaerobic digester or with co-generation from combustion of digester gas. Each wastewater solid treatment type has associated GHG emission factors. Some of these emissions may be classified as biogenic. Note that not all the biogenic emissions from wastewater treatment are accounted for in CalEEMod because there are not adequate emissions factors at this time.

4.3.4.5 Solid Waste Screen

The **Solid Waste** screen determines the GHG emissions at landfills associated with disposal of solid waste generated for each project land use subtype. To estimate GHG emissions from solid waste disposed by a land use subtype annually, the total amount of CO_2 and CH_4 that would be generated through decomposition over the span of 20 to 30 years is calculated (USEPA 2016a:1-2). This is based on CARB's (2010) methods for quantifying GHG emissions from solid waste using the degradable organic content of waste. Waste disposal rates by land use subtype are primarily based on CalRecycle (n.d.) data. The amount of CH_4 emitted depends on characteristics of the landfill, and therefore the default percentage of CH_4 emitted is based on the types of landfills assumed by CARB in their GHG emissions inventories. Portions of these emissions are biogenic.

The defaults for the gas capture (e.g., no capture, flaring, energy recovery) are statewide averages except for Santa Barbara APCD, which has a 100 percent landfill capture gas flare. The sum of the inputs for the "No Gas Capture" and "Capture Gas Flare" must equal 100 percent. The user should override the defaults if the gas capture at the landfill to be used by the project is known. Local jurisdictions can also provide guidance on default values that properly reflect known regional solid waste gas capture.

4.3.4.6 Refrigerants Screen

The **Refrigerants** screen is used to gather the information necessary to estimate the fugitive GHG emissions associated with building air conditioning (A/C) and refrigeration equipment. Different types of refrigeration equipment are used by different types of land uses. For example, an office may use various types of A/C equipment, while a supermarket may use both A/C equipment and refrigeration equipment. All equipment that uses refrigerants has a charge size (i.e., quantity of refrigerant the equipment contains), operational and service refrigerant leak rates (from regular operation and routine servicing), and number of times serviced per lifetime. Each refrigerant has a GWP that is specific to that refrigerant. CalEEMod automatically generates a default A/C and refrigeration equipment inventory for each project land use subtype based on industry data from the USEPA (2016b). CalEEMod quantifies refrigerant emissions from leaks during regular operation and routine servicing over the equipment lifetime and then derives average annual emissions from the lifetime estimate. Note that CalEEMod does not quantify emissions from the disposal of refrigeration and A/C equipment at the end of its lifetime.

4.3.4.7 Off-Road Equipment Submodule

4.3.4.7.1 Off-Road Equipment Screen

The **Off-Road Equipment** screen allows the user to identify any off-road equipment (e.g., forklifts, cranes, loaders, generator sets, pumps, pressure washers) used during operational activities at the project site. Because such equipment cannot be assumed for a particular land use project, the user must provide these inputs for CalEEMod to calculate the associated emissions. Once the user identifies an equipment type, all other data fields are prepopulated with default values, except for the amount of equipment per day. The model assumes default operation activity of 8 hours per day and 260 days per year. Similar to off-road equipment used for construction activities

(see Section 4.3.3.2, *Off-Road Equipment Screen*), the default equipment "Horsepower" and "Load Factor" data are prepopulated based on the operational year and equipment type based on the default average values from CARB's OFFROAD2007 and OFFROAD2011. The model assumes diesel fuel and calendar year average emissions rates, but a dropdown menu is provided to allow the user to select fuel and engine tier type, if known.

4.3.4.7.2 Off-Road Equipment Emission Factors Screen

The information in Section 4.3.3.3, *Off-Road Equipment Emission Factors Screen*, listed for off-road equipment used for construction activities applies the same to this screen, except that for this screen, the operational year is used to determine the default emission factors instead of the construction year(s).

4.3.4.8 Stationary Sources Submodule

The **Stationary Sources** submodule consists of four screens to gather the information necessary to estimate emissions from emergency generators and fire pumps and process boilers. Each of these screens is discussed below. Consult with the local air district to determine if permitted stationary sources should be included in the project analysis using CalEEMod.

4.3.4.8.1 Emergency Generators and Fire Pumps Screen

This screen allows the user to define emergency generators and fire pumps and associated operating information. This type of equipment operates only for maintenance and testing, or during emergency situations, such as power failures. To calculate emissions, the user must enter the equipment type, fuel type, engine rating (in horsepower), the anticipated maximum daily usage, and the anticipated maximum annual usage. The user may change the default load factor.

4.3.4.8.2 Generators/Fire Pumps Emission Factors Screen

This screen displays the default emission factors for the emergency generators and/or fire pumps identified by the user on the **Emergency Generators and Fire Pumps** screen. Only those pollutants associated with emergency generators and fire pumps are shown in the screen.

4.3.4.8.3 Process Boilers Screen

This screen allows the user to define process boilers and associated operating information. Do not use this option for boilers providing space heating or building hot water, as these uses are already included in building energy use (see Section 4.3.4.3, *Energy Use Screen*). To calculate process boiler emissions, the user must input the number of boilers, fuel type, boiler rating (in million BTU/hr) and maximum anticipated daily and annual heat inputs.

4.3.4.8.4 Boilers Emission Factors Screen

This screen displays the default emission factors for the user-identified process boilers. Only those pollutants associated with process boilers are shown in the screen.

4.3.4.9 User Defined Screen

The **User Defined** screen allows the user to input emissions estimates for any project source not captured by prior screens. Emissions for this source would include any other miscellaneous sources that typically require permits to operate issued by an air district. Emissions may be manually entered, either by transferring values from the permits to operate, or by calculating

emissions outside of CalEEMod. Any emissions entered in the screen will be transferred to the appropriate reports.

4.3.5 Vegetation Module

The **Vegetation** module includes two screens to estimate GHG emissions (or removals) from land use change and changes in sequestration from tree planting (or removal). Each of these screens is discussed below.

4.3.5.1 Land Use Change Screen

The **Land Use Change** screen estimates changes in CO_2 associated with both soil and aboveground and belowground biomass resulting from project-induced changes in land use and cover types.

To calculate soil carbon accumulation, the user must select from the dropdown menu the project's "Vegetation Land Use Type" and the "Vegetation Soil Type." The soil type for the project area can be obtained from UC Davis' SoilWeb online geospatial tool.[12] Based on these inputs, the default annual CO_2 accumulation per acre rate is prepopulated using resources published by CARB (2020d). CalEEMod uses the accumulation rates to calculate the net change in total CO_2 based on the user's inputs for the "Initial Acres" and "Final Acres" data fields.

To calculate above and belowground biomass carbon accumulation, the user must select from the dropdown menu the project's "Cover Type." Based on this input, the default annual CO_2 accumulation per acre rate is prepopulated using resources published by CARB (2021b). The net change in total CO_2 is calculated based on the user's inputs for the "Initial Acres" and "Final Acres" data fields.

Users can override the CO_2 accumulation default for specific vegetation land use types or cover types. Alternatively, users can select "Other" from the dropdown to manually define their vegetation land use or cover type and the associated CO_2 accumulation rate.

4.3.5.2 Sequestration Screen

The **Sequestration** screen directs the user to the U.S. Forest Service (USFS) (2021) i-Tree Planting tool.[13] The i-Tree Planting tool quantifies increased carbon sequestration from urban tree planting using species-based biomass equations that account for user defined site-specific variables and tree growth rates. The tool also quantifies GHG reductions from energy savings (e.g., kWh), if applicable. The user should directly copy the outputs from the i-Tree Planting Calculator to the applicable fields in the **Sequestration** screen. The user is also required to input the project "Operations Lifetime" in number of years.

4.3.6 Climate Risk Module

The **Climate Risk** module helps the user calculate the risks of their project to eight different climate-related hazards. To determine climate risks, the user will develop an overall vulnerability score, which consists of combining three elements: project exposure, sensitivity, and adaptive capacity (these concepts are defined in Appendix A, *Glossary)*. From there, the user can select the highest scoring vulnerabilities to identify appropriate climate risk reduction measures.

[12] Available: https://casoilresource.lawr.ucdavis.edu/gmap/.
[13] Available: https://planting.itreetools.org/.

The method for scoring climate risks is largely based on the guidance presented in Chapter 4, *Assessing Climate Exposures and Measures to Reduce Vulnerabilities*, of CAPCOA's Handbook. The user is encouraged to review this chapter before completing the **Climate Risk** module. As noted in the Handbook, the scoring analysis provided by CalEEMod should not replace a full climate vulnerability assessment performed using the State's *Adaptation Planning Guide* (APG) or other resources. Moreover, the scores alone should not be used to define or communicate the climate risks for a project. A climate vulnerability score of 5, for example, does not mean that a project will face certain climate catastrophe. Similarly, a score of 1 does not mean that a project will not face any climate hazards. The purpose of the scoring method is to aid the user in prioritizing the most significant climate risks so that they can select appropriate risk reduction measures for their project. If the user is seeking a more thorough or tailored analysis, then they should refer to the APG, the Resilient-CA website,[14] or other resources provided in the Handbook.

4.3.6.1 Introduction Screen

The **Introduction** screen offers a high-level outline of the process the user will go through to assess climate hazards and develop a vulnerability score. CalEEMod analyzes the eight climate hazards shown in Figure 13.

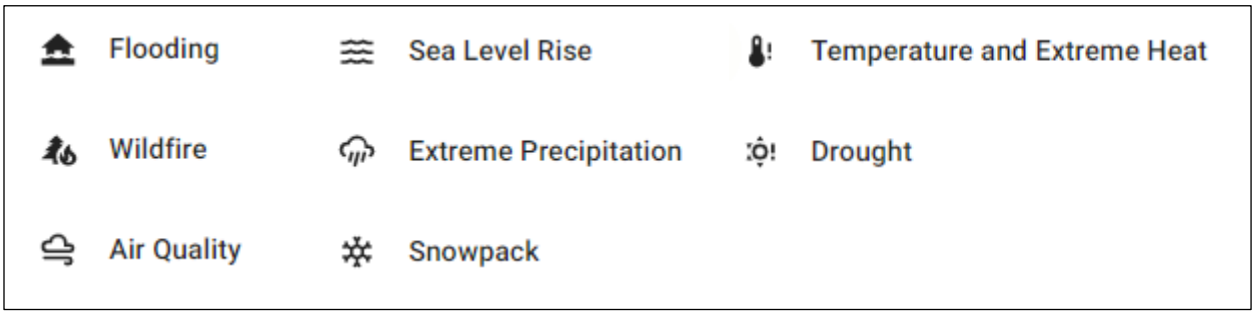

Figure 13. Climate Hazards

Based on the project's location, the screen presents climate hazards most applicable to the user's project based on anticipated climate change. For example, projects that lie along the coast would be exposed to sea level rise and, therefore, the sea level rise hazard would be automatically selected. The user can click on additional hazards to include them in the exposure analysis or uncheck hazards if they are not applicable to the project. Unchecking a hazard will preclude it from further analysis in the module. If the user is unsure whether a hazard is applicable, it is best to include the hazard and have later steps in the module determine the hazard's importance.

4.3.6.2 Determine Exposure Score Screen

This screen guides the user through scoring their project's exposure to each selected climate hazard. The hazards are scored on a scale of 1 to 5, with 1 being the least exposed (i.e., "low") and 5 being the most exposed (i.e., "high"). The module calculates an initial exposure score for the four Cal-Adapt hazards (sea level rise, temperature and extreme heat, extreme precipitation, and wildfire). Depending on the hazard, the user can adjust this initial exposure score by answering guiding questions. For the remaining four hazards (flooding, drought, snowpack, and air quality), the user will answer guiding questions to determine an exposure score.

[14] Available: https://resilientca.org/.

For all hazards, the user also has the option to manually refine the calculated exposure score by adjusting the slider. The user may make this adjustment if there are unique reasons that the module cannot capture why the calculated exposure score is not appropriate for the project.

When answering questions or manually refining the calculated exposure score, note that this screen determines the *exposure* of the project to the climate hazard. Project components related to sensitivity (the extent to which a project would be adversely affected by exposure to a hazard) and adaptive capacity (the ability to manage and reduce vulnerabilities from projected hazards) are considered in later screens. Thus, it is important for the user to focus only on exposure when going through this screen.

4.3.6.3 Determine Sensitivity Score Screen

This screen guides the user through scoring the sensitivity of their project to each selected climate hazard on a 1-3-5 scale (with 1 being the least sensitive and 5 being the most sensitive). The user will answer a series of questions to help determine the sensitivity score of their project to each hazard. Once again, the user has the option to manually refine the calculated sensitivity score by adjusting the slider. The user may make this adjustment if there are unique reasons that the module cannot capture why the calculated sensitivity score is not appropriate for the project.

4.3.6.4 Determine Adaptive Capacity Score Screen

This screen guides the user through scoring the adaptive capacity of their project to each selected climate hazard on a 1-3-5 scale (with 1 having “low” adaptive capacity and 5 having “high” adaptive capacity). The user will answer a series of questions to help determine the adaptive capacity score of their project to each hazard. Once again, the user has the option to manually refine the calculated adaptive capacity score by adjusting the slider. The user may make this adjustment if there are unique reasons that the module cannot capture why the calculated adaptive capacity score is not appropriate for the project.

4.3.6.5 Determine Potential Impact Score Screen

This screen presents the potential impact scores for each selected climate hazard. The potential impact score is the average of the exposure and sensitivity scores and is an intermediary step before the final calculation of overall vulnerability. Like prior screens, scores are given on a scale of 1 to 5, with 1 being the least impacted and 5 being the most impacted. Hazards that were not selected for analysis on the **Introduction** screen are excluded from this screen. The user does not make any changes here but can use this screen as reference to see how their past answers have influenced the potential impacts scores. If the user wants to change the potential impacts scores, they may return to the exposure and sensitivity screens to do so.

4.3.6.6 Determine Overall Vulnerability Score Screen

The screen combines the potential impacts score with the adaptive capacity score to form an overall vulnerability score for each climate hazard on a scale of 1 to 5. Hazards that were not selected for analysis on the **Introduction** screen are excluded from this screen. The user does not make any changes here but can use this screen as reference to see how their past answers have influenced the overall vulnerability scores. If the user wants to change the overall vulnerability scores, they may return to the exposure, sensitivity, and adaptive capacity screens to do so.

4.3.6.7 Select Highest-Scoring Vulnerabilities Screen

This screen shows overall vulnerability scores for all climate hazards and preselects those that have a vulnerability score of 3 or above. This helps the user focus on selecting risk reduction measures for the most relevant climate hazards to their projects. The user can click on additional hazards to include in risk reduction measure selection or uncheck preselected hazards based on their risk tolerance and/or other considerations (e.g., policy objectives). Hazards that were not selected for analysis on the **Introduction** screen are excluded from this screen.

4.3.7 Measures Module

The **Measures** module consists of three submodules covering emissions reduction, climate risk reduction, and health and equity. There are 287 measures across the three submodules for user review and consideration. Most of the measures are from CAPCOA's Handbook, with CalEEMod directly incorporating quantification methods, assumptions, and defaults, as appropriate. The following sections discuss specific details unique to each submodule. Consistent among all three submodules is the presentation of measure co-benefits. Co-benefits are additional benefits that will be achieved by the measure beyond the primary measure function (e.g., climate risk reduction). The co-benefit categories considered in CalEEMod include the following.

- **Improved air quality**. Criteria pollutant reductions (considered a co-benefit to a measure that targets GHG emissions reductions).
- **Energy and fuel savings**. Electricity, natural gas, refrigerant, propane, gasoline, or diesel reductions.
- **VMT reductions**. Reductions in vehicle miles traveled.
- **Water conservation**. Water use reductions.
- **Enhanced pedestrian or traffic safety**. Reduced collisions; pedestrian/bicyclist safety.
- **Improved public health**. Toxic air contaminant reductions (including exposure); increased physical activity; improved public safety; improved social determinants of health.
- **Improved ecosystem health**. Improved biological diversity and soil and water quality.
- **Enhanced energy security**. Systemwide load reduction; local energy generation; levelling out peaks.
- **Enhanced food security**. Stability of food systems; improved household access to food.
- **Social equity**. Address existing social inequities (e.g., housing/anti-displacement, community engagement, availability of disposable income).

CalEEMod assigns co-benefits to measures that are likely to result from measure implementation; however, it should be noted that the achievement of co-benefits is not guaranteed because many co-benefits are dependent on how the measure is implemented. Use the "Filter Measures" button to view measures that achieve desired co-benefits. Note that CalEEMod only includes analytics to quantify improved air quality, energy and fuel savings, VMT reductions, and water conservation from select emission reduction measures (see Appendix C, *Emission Calculation Details for CalEEMod*). All other co-benefits, and co-benefits from climate risk reduction and health and equity measures, are not currently quantified by CalEEMod, but will be noted in the output report, as applicable.

Any measures selected by the user on the **Climate Risk** or **Health and Equity** map screens will appear as preselected within the corresponding measure screen(s) for climate risk reduction and health and equity. Preselected measures will be italicized in the emission reduction screens. Another consistent presentation item among the three submodules and measure screens is the highlighting of the relevant measures from the **Health and Equity** map screen. The five most relevant measures for addressing environmental and health burdens of the project site are identified with an asterisk (*). These measures are further explained in the **Relevant Measures** splash screen on the **Health and Equity** map screen (see Section 4.2.3, *Health & Equity Map Screen*).

4.3.7.1 Emissions Reduction Submodule

The **Emissions Reduction** submodule consists of 10 screens that cover the different types of sources that contribute to construction and operations emissions. Within each screen, measures are categorized as either “quantified” or “qualitative or supporting measures.” CalEEMod includes analytics to quantify emission reductions achieved by quantified measures. Emissions benefits of supporting or qualitative measures are not currently quantified by CalEEMod. User-selected supporting or qualitative measures are noted in the output report.

The user should click the checkboxes to select the measures that will be implemented by the project. The notepad icon to the right of the measure title links to the measure factsheet or measure description. Measure factsheets from the Handbook are available for most quantified measures and some qualitative or supporting measures. If a measure factsheet is not available, a narrative description of the measure is provided. Once a measure is selected, additional user input may be requested to enable quantification. Where available, default values are provided in the data fields. The user should review these defaults and confirm their applicability to the project analysis. All default values can be overridden with project-specific information, where available and appropriate.

Emissions reductions achieved by several measures may be quantified by equally applying the reduction efficacy to all land use subtypes in the model run, or through targeted application to specific land use subtypes. For example, the user may elect to install green roofs on all project land use subtypes by selecting “All Land Use Subtypes” under Measure E-5, *Install Green Roofs in Place of Dark Roofs*. Alternatively, the user may select “By Land Use Subtype” to identify a subset of project land use subtypes that will install green roofs (see Figure 14).

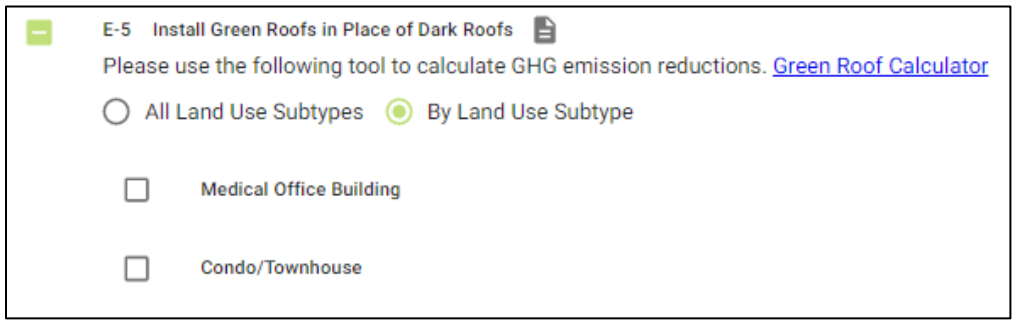

Figure 14. Applying Emission Reduction Measures by Land Use Subtype

Note that the user may be prevented from selecting specific measures based on prior inputs. For example, some measures are mutually exclusive. That is, selection of one measure precludes implementation of another. For example, the user cannot implement Measure T-5, *Implement Commute Trip Reduction Program (Voluntary)*, and Measure T-6, *Implement Commute Trip Reduction Program (Mandatory implementation and Monitoring).* Implementation of other measures may depend on selection of a prerequisite measure or action. For example, the user cannot implement Measure C-8, *Use Renewable Diesel*, unless they either also selected Measure C-5, *Use Advanced Engine Tiers*, or identified tier specific equipment in the **Off-Road Equipment** screen. Finally, some measures may be deactivated if the user have already selected the control strategy in prior screens. For example, the user cannot implement Measure C-9, *Dust Suppressants*, if the control is enabled on the **On-Road Fugitive Dust** screen. The checkboxes for measures that are not applicable to a project or cannot be quantified are shown in gray and cannot be selected (as discussed further in Appendix C, *Emission Calculation Details for CalEEMod*). Hover over the checkboxes for information on why the measure is not available, as illustrated in Figure 15.

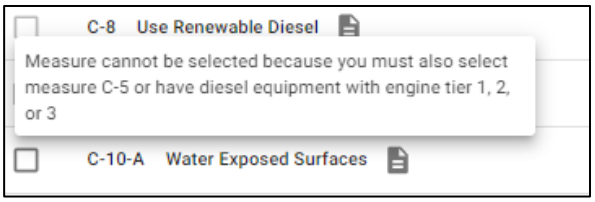

Figure 15. Nonapplicable Measure C-8 Messaging

Measures that were preselected on the **Climate** and **Health and Equity** map screens are *italicized*. The measures are not automatically checked because quantification of several measures depends on prerequisite user inputs in the **Construction** or **Operations** modules and/or user selection of other emission reduction measures. Accordingly, the necessary details underpinning quantification of some measures are not known until after the user has advanced beyond the **Map** component. The italics are provided as a reminder of user preference at the beginning of the analysis. The user will need to manually check all measures that can be implemented by the project.

4.3.7.2 Climate Risk Reduction Submodule

The **Select Climate Measures** screen provides 99 measures for the user to select from to reduce their vulnerability. Some measures may address multiple climate hazards. For example, Measure MH-4, *Strengthen Building Structures*, can bolster a project's resilience to extreme precipitation, flooding, and wildfire. The climate hazards addressed by each measure are shown using the icons identified in Section 4.3.6.1, *Introduction Screen*. Measures that address priority hazards identified in the **Select Highest-Scoring Vulnerabilities** screen within the **Climate Risk** submodule are shown first in the list of available measures. The icons for priority hazards are also shown in larger font.

Each measure could have one or more of the following risk reduction benefits.

- **Reduces exposure:** Reduces the presence of project elements in areas that are subject to climate hazards.
- **Reduces sensitivity:** Reduces the level to which a project element would be affected by exposure to a changing climate.
- **Increases adaptive capacity:** Increases the ability of a project element to moderate harm or exploit risk reduction opportunities.

The user should select the measures that will be implemented by the project. The caret icon to the left of the measure number can be clicked to show the measure description. Measures that were preselected on the **Climate** and **Health and Equity** map screens will be automatically checked. Measures not applicable to the project based on the user identified land use type(s) and project scale are shown in gray. While the model has identified these measures as not applicable to the project based on prior inputs, users may still select these measures. This differs from nonapplicable emissions measures, which cannot be selected by the user (as discussed further in Appendix C, *Emission Calculation Details for CalEEMod*).

For each measure selected, the user should review the three risk reduction benefit columns (reduces exposure, reduces sensitivity, increases adaptive capacity). Some measures may not accomplish any of the three functions, while other measures may accomplish a mix or all three. Measures that do not achieve the risk reduction benefit are given a score of 0, which cannot be modified by the user. For those measures that achieve a risk reduction benefit, CalEEMod identifies a range of potential reduction depending on implementation (e.g., 2 to 4). The user should select the appropriate reduction benefit score for the project using the dropdown menu. Hover over the "information" buttons for guiding questions to consider when scoring each benefit.

The user can select as many climate risk reduction measures as they wish. Measures are not additive, and a user's exposure, sensitivity, and adaptive capacity score will not go below 0 or surpass 5. The selection of multiple measures will help provide the user more options to reduce their climate risk. The actual benefit of these measures will depend on how the project implements the chosen risk reduction measures.

4.3.7.3 Health & Equity Measures Submodule

The **Health & Equity** submodule presents two screens with the 50 available health and equity measures for user consideration and selection. The health and equity measures seek to promote health equity, progress toward racial equity, and inclusion of and solidarity with marginalized, underrepresented, and vulnerable communities. The measures are identified as either process measures or outcome measures. Process measures focus on facilitating greater community participation and decision-making in the process of land use planning, and outcome measures focus on enhancing the project features and operational practices that advance equitable outcomes.

There are 16 process measures organized into three categories: Community-Centered Development, Inclusive Engagement, and Accountability. There are 34 outcome measures organized into six categories: Construction Equity, Public Health and Air Quality, Inclusive Economics and Prosperity, Inclusive Communities, Anti-Displacement and Housing, and Climate Resilience.

4.3.7.3.1 Introduction Screen

The user may elect to identify health and equity measures that will be implemented by the project, or complete the **Health and Equity Evaluation Scorecard**. The **Health and Equity Evaluation Scorecard** provides a simple process to evaluate how well a project has adopted specific measures and practices to deliver greater health, equity, and other benefits to support the existing community. The scorecard includes all measures except those in the Anti-Displacement and Housing and Climate Resilience categories. These measures are excluded from the scorecard due to the spectrum of implementation strategies and requirements that defy simple scoring. The user can select if they would like to complete the **Health and Equity Evaluation Scorecard** by making the appropriate selection on this screen.

4.3.7.3.2 Select Measures Screen

The user who elects not to complete the **Health and Equity Evaluation Scorecard** should select the measures that will be implemented by the project. Measures that were preselected on the **Climate** and **Health and Equity** map screens will be automatically checked. Measures not applicable to the project based on the user identified land use type(s) and project scale are shown in gray. While the model has identified these measures as not applicable to the project based on prior inputs, users may still select these measures by clicking the pencil edit icon. This differs from nonapplicable emissions measures, which cannot be selected by the user (as discussed further in Appendix C, *Emission Calculation Details for CalEEMod*).

Users completing the **Health and Equity Evaluation Scorecard** must identify scores using the dropdown menus for all 40 measures. The user will be restricted from advancing forward until scores are identified for all measures. Users can select "N/A" for measures that are not applicable to the project. Most measures follow a 1 to 5 scoring range, with higher point values corresponding to increasing levels of action. Some measures adopt a modified scoring scheme within this range (e.g., 1-3-5 or a 3-4-5), again with higher point values corresponding to greater levels of action. A 0 should be given to measures that are applicable to a project but not included or implemented in a manner that is accepted by community members. Appendix F, *Support Documentation for Health and Equity Association Scoring*, provides more specific scoring criteria for each measure. The user should consult Appendix F when completing the **Health and Equity Evaluation Scorecard**. Scoring criteria can also be viewed by clicking the caret to the left of the measure number.

Note measures that were preselected on the **Climate** and **Health and Equity** map screens are given a starting score of 0. The user should adjust this score to appropriately reflect measure implementation for the project, if necessary. Measures not applicable to the project based on the user identified land use type(s) and project scale are highlighted gray with a score of "N/A." Users may add custom health and equity measures to the scorecard if additional strategies will be implemented by the project. Click the plus sign to the right of the category title to add a custom measure under that category. Users will need to provide a measure title and measure description and identify the entity sponsoring the additional measure. Custom measures can be scored within a range of 0 to 5.

4.4 Results Component

The **Results** component includes four dashboards that display key results for the model run and two emissions calculation screens. There are two dashboards for emissions results: construction and operations. Results for climate risk are displayed on a separate dashboard, as are results for health and equity. All four dashboards present summary information using a combination of charts, icons, and tables. The two calculation screens present a series of emissions results tables by source The user must complete all required inputs in the **Emissions** and **Climate Risk** modules for the dashboards and results screens to function. Once all inputs are satisfied, the dashboards and results screens are automatically updated based on real-time user changes to the model.

4.4.1 Construction Emissions Dashboard

The construction emissions dashboard displays construction emissions results. Figures 16a and 16b illustrate the primary components of the dashboard. The left-hand sidebar panel should be

used to adjust the dashboard content. The results are displayed to the right of the panel based on user selections to the following parameters.

- Construction Year: Use the drop-down menu to select the construction year for the results.
- Pollutant Type: The pollutant type determines the emissions that are displayed in the pollutant cards. Selecting "Criteria Pollutant" will display result cards for TOG, ROG, NOx, CO, SO_2, PM10, and PM2.5. Selecting "Greenhouse Gas" will display result cards for CO_2, CH_4, N_2O, R, and CO_2e. Note that regardless of the pollutant type selected, result cards will only be generated for pollutants selected for quantification on the **Pollutants** screen.
- Calculation Type: The calculation type controls how emissions are displayed in the pollutant cards. Maximum daily emissions can be quantified and displayed using summer or winter emission factors (for emission sources with seasonally variable emission factor data). Winter emissions occur between October and March, and summer emissions occur between April and September. Select "Daily – Summer (Max)" or "Daily – Winter (Max)." If either of these calculation types are selected, the pollutant cards will display the highest (i.e., maximum) daily emissions quantified for the season and construction year. Users may also view daily results based on an average annual calculation by choosing "Daily (Average)." Annual emissions can be generated by selecting "Annual."
- Condition: The condition controls whether unmitigated or mitigated emissions results are displayed in the temporal bar chart and construction category pie chart. Unmitigated results do not account for reductions achieved by user-selected measures. Mitigated results include quantified emissions reduction. The mitigated condition can only be selected if construction measures have been selected in the **Measures** module.
- Pollutant to Spotlight: The pollutant to spotlight controls the pollutant shown in the temporal bar chart and category pie chart. Results shown for the top three user-selected measures and remaining measures are also specific to the selected pollutant. Only those pollutants selected for quantification on the **Pollutants** screen will be available to select. If a pollutant was selected on the **Pollutants** screen, but no emissions would be generated for the selected construction year, the radio button for that pollutant will be locked. Because there are no emissions, the pollutant cannot be displayed in the temporal bar chart and category pie chart.

The pollutant cards at the top of the dashboard summarize the emissions results based on user selections for the construction year, pollutant type (criteria pollutants or GHGs), and calculation type. If the project run includes mitigation, both unmitigated and mitigated emissions will be displayed. The card shows the numeric emission(s) result. The horizontal bar depicts the relative magnitude of the emissions. The cards also display pollutant thresholds if they were entered by the user on the **Pollutants** screen. The horizontal magnitude bar will display red if emissions exceed the threshold and green if emissions do not exceed the threshold. This is also illustrated by the position of the vertical threshold bar relative to the emissions magnitude. The horizontal magnitude bar will display gray if there is no applicable threshold.

The temporal bar chart displays emissions results by construction phase and day based on user selections for the construction year, pollutant type, calculation type, condition, and pollutant to spotlight. The chart can only be generated for "Daily – Summer (Max) (lb/day)" and "Daily – Winter (Max) (lb/day)" calculation types. Use the slider to adjust the presentation scale for the x-axis (schedule). The chart defaults to the widest presentation option with the slider buttons on either end of the viewing pane. Moving the sliders closer together will adjust the presentation to as refined as a single day. Users may also select or deselect individual phases by clicking their

colored box in the legend below the chart. Hovering over the chart will display the daily emissions contributions for each applicable construction phase.

The construction category pie chart displays the contribution of average daily emissions by source based on user selections for the construction year, pollutant type, condition, and pollutant to spotlight. Hover over the pie chart to see the source contribution in terms of percent of total emissions and mass emissions (average pounds per day). Users may also select or deselect individual sources by clicking their colored box in the legend to the right of the chart.

The selected measures box identifies the three user-selected construction measures that achieve the greatest reduction (in terms of total mass) over the entire duration of the construction period for the spotlighted pollutant. Fewer measures may be shown if the user selected fewer than three measures in the **Measures** module. The box to the right displays the total number of selected measures that reduce the selected pollutant and identifies if any additional measures are available and may be selected to achieve further reductions. Users can click the “Additional Strategies” button to return to the **Measures** module and revise measure selections, if desired.

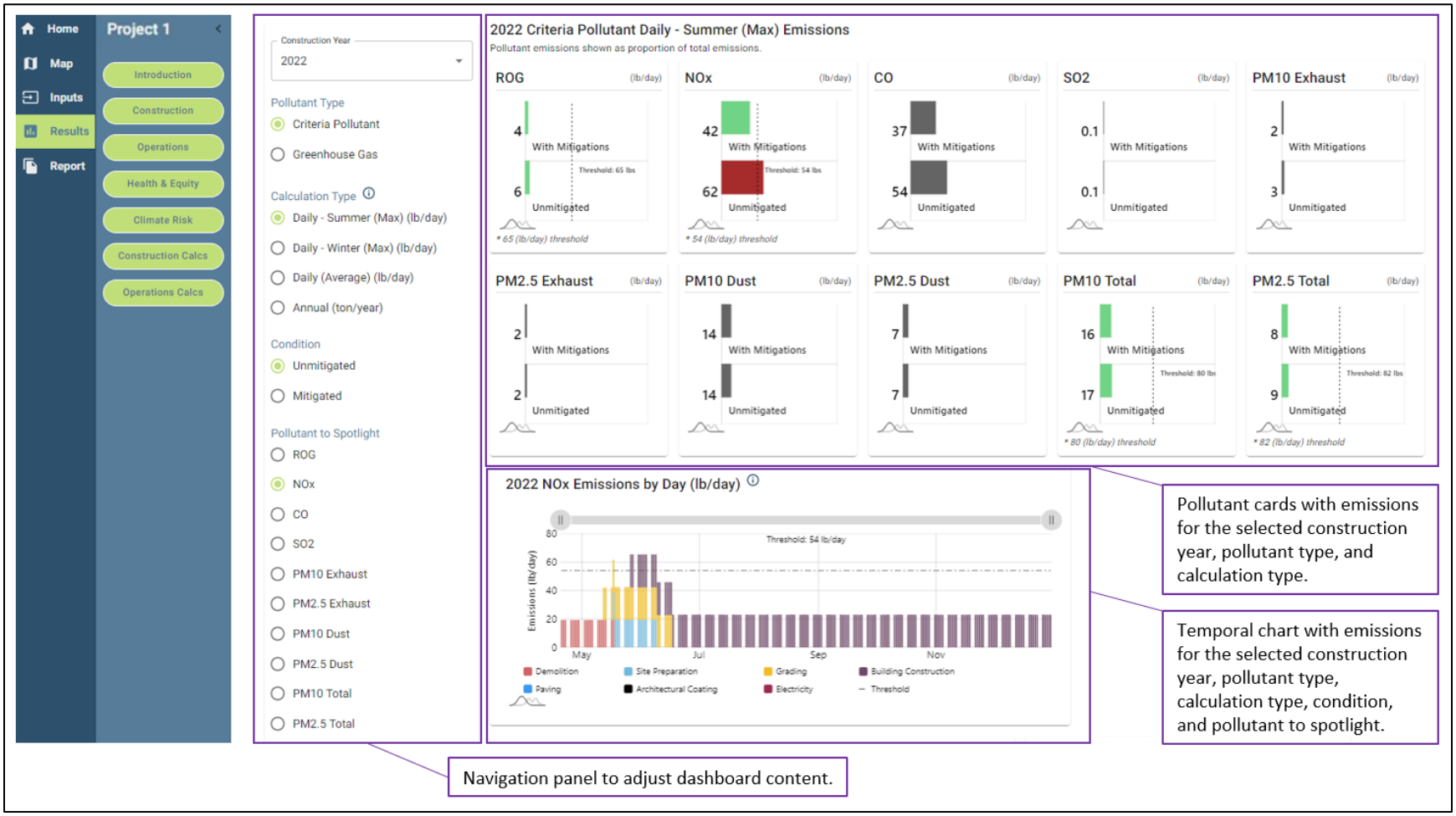

Figure 16a. Construction Emissions Dashboard

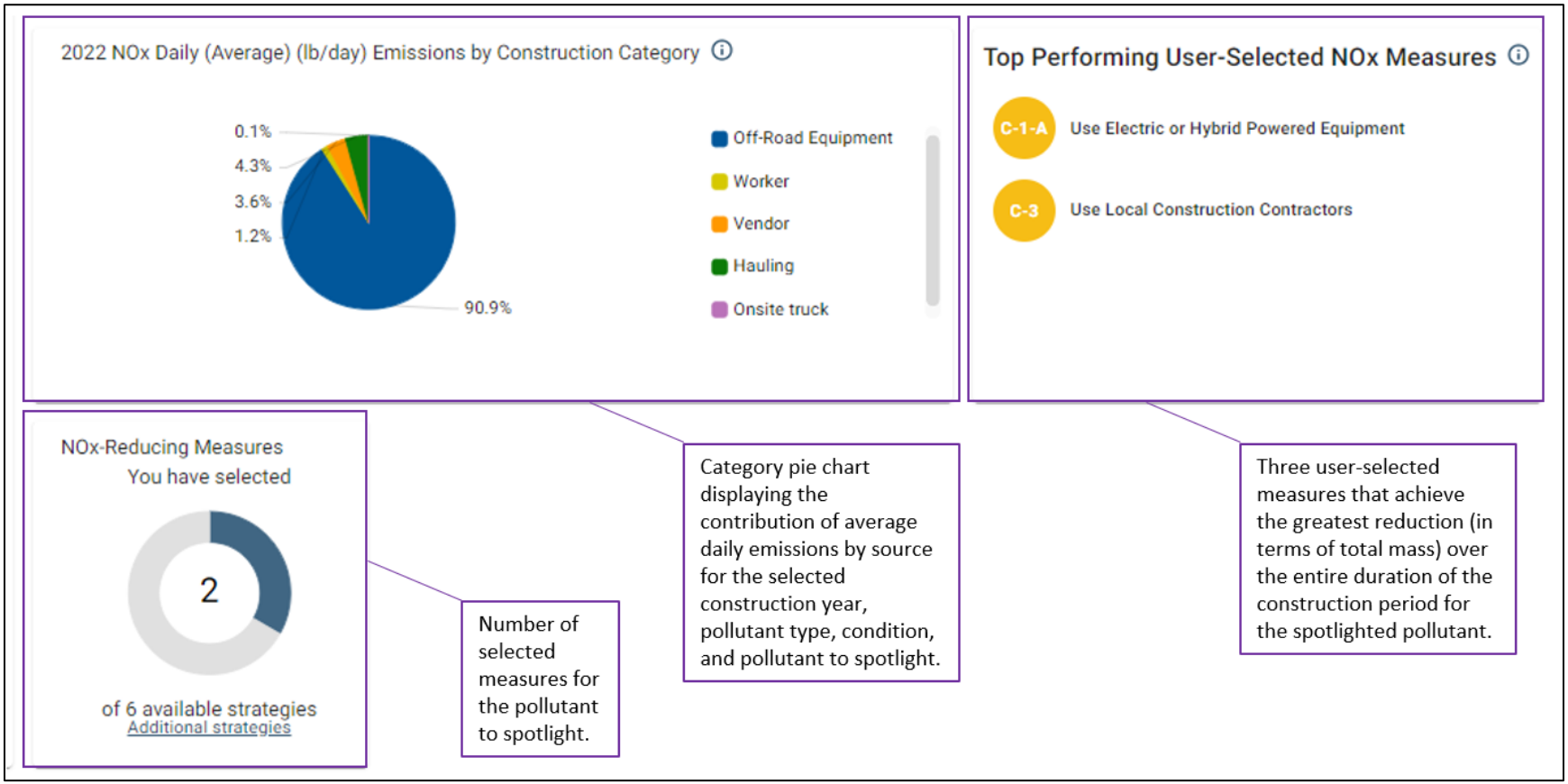

Figure 16b. Construction Emissions Dashboard

4.4.2 Operations Emissions Dashboard

The operations emissions dashboard displays operations emissions results for the operational year defined on the **Project Detail** screen. Figures 17a and 17b illustrate the primary components of the dashboard. The left-hand sidebar panel should be used to adjust the dashboard content. The results are displayed to the right of the panel based on user selections for the pollutant type, calculation type, condition, and pollutant to spotlight. These parameters are the same as described above in Section 4.4.1, *Construction Emissions Dashboard*.

The pollutant cards at the top of the dashboard summarize the emissions results based on user selections for the pollutant type and calculation type. The category pie chart displays the contribution of average daily emissions by source based on user selections for the pollutant type, condition, and pollutant to spotlight. The display of emissions and functionality of the pollutant cards and pie chart are the same as described above for the construction emissions dashboard.

The selected measures box identifies the three user-selected operations measures that achieve the greatest reduction (in terms of total mass) for the spotlighted pollutant. The top-three ranking does not consider how combining multiple measures could potentially reduce the effectiveness of an individual measure. In other words, the efficacy of each measure is analyzed in isolation for the measure ranking exercise on the dashboard. As noted in Section 7.1, *Emissions Reduction Submodule*, in Appendix C, *Emission Calculation Details for CalEEMod*, damping effects of measures are accounted for in the quantification of daily and annual mitigated emissions.

The selected measures box functions similarly to the measure box on the construction emissions dashboard (refer to Section 4.4.1, *Construction Emissions Dashboard*).

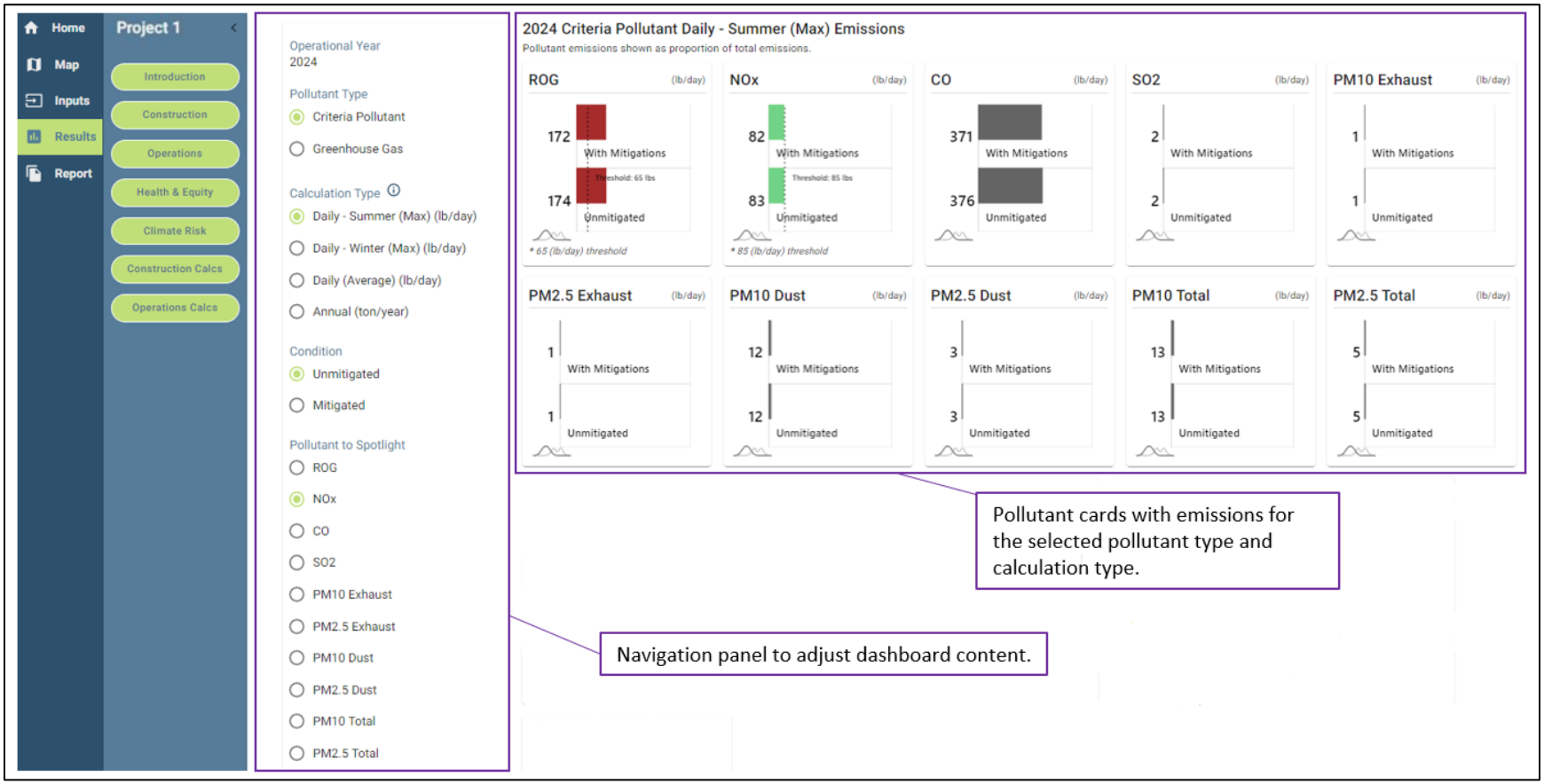

Figure 17a. Operations Emissions Dashboard

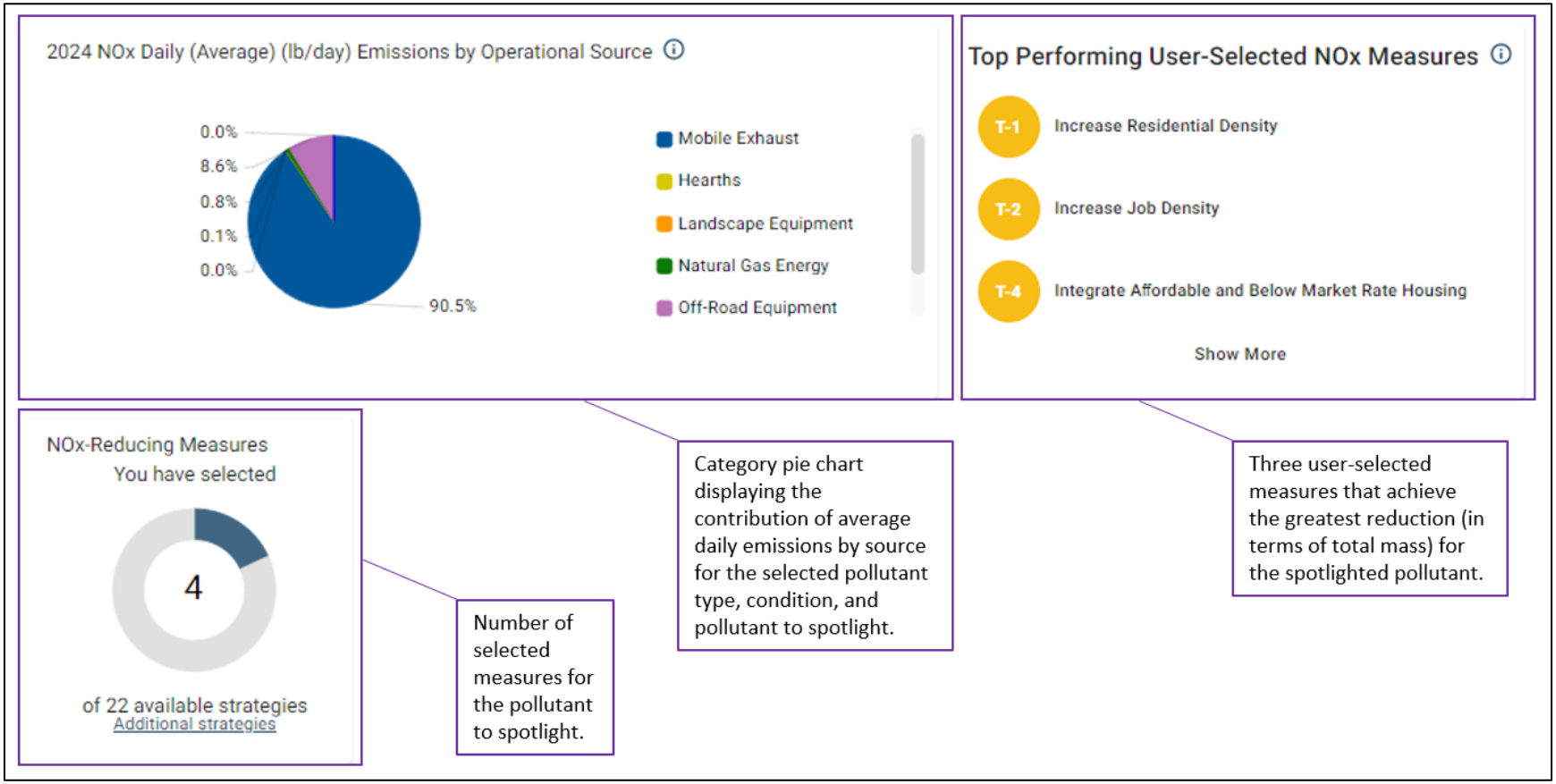

Figure 17b. Operations Emissions Dashboard

4.4.3 Climate Risk Dashboard

The climate risk dashboard displays results from the climate risk analysis. Figures 18a and 18b illustrate the primary components of the dashboard. Use the radio buttons in the left-hand sidebar to select the climate risk to display. Only those risks analyzed in the **Climate Risk** module (i.e., checked on the **Introduction** screen) can be viewed. The hazard icon (see Figure 13) and risk analysis results are presented to the right of the panel. Scores for exposure, sensitivity, adaptive capacity, and initial vulnerability are provided. An adjusted vulnerability score that accounts for measure benefits will also be displayed if climate risk reduction measures were selected in the **Measures** module. Refer to Appendix E, *Support Documentation for Climate Change Analyses*, for information on how CalEEMod calculates measure effects on the vulnerability score. All climate risk scores displayed on the dashboard are color-coded according to the matrix presented on the **Develop Overall Vulnerability Score** screen and in Figure E-1 in Appendix E.

The selected measures box identifies the three user-selected measures that achieve the greatest improvement in the vulnerability score. The box to the right of the top-three analysis displays the total number of measures selected by the user that address the climate risk and identifies if any additional measures are available to achieve further protection. These boxes function similarly to the measure boxes on the construction and operations emissions dashboards. Co-benefits that may be achieved by the selected measures are displayed below the measure boxes.

4.4.4 Health & Equity Dashboard

The health & equity dashboard displays the overall CES and HPI scores relevant to the project census tract and, if completed, the **Health and Equity Evaluation Scorecard**. Figures 19a and 19b illustrate the primary components of the dashboard. The overall CES and HPI scores are color-coded according to the color gradient displayed for these layers on the **Health & Equity** map screen. The two measure boxes function similarly to measure boxes on all other dashboards. As discussed in Appendix F, *Support Documentation for Health and Equity Association Scoring*, all measures are scored based on their potential to address specific health and equity indicators. These scores are multiplied by the indicator values from CES, yielding a single efficacy score for each applicable measure. The top-three measures box presents the three user-selected measures that achieve the highest score. The display of measure co-benefits is the same as shown on the climate risk dashboard.

If users have elected to complete the **Health and Equity Evaluation Scorecard** (see Section 4.3.7.3, *Health & Equity Measures Submodule*), the evaluation report will be presented at the bottom of the dashboard. The report presents the number of scored measures implemented by the project and total points earned by category. The maximum points possible is shown for each category, as well as the weighted category scores based on the maximum total points possible. Weighted categorical scores are also shown in a spider chart to facilitate analysis of a project's strong and weak points. Based on the overall weighted score, the dashboard presents the equity award tier for the project run. Refer to Appendix F, *Support Documentation for Health and Equity Association Scoring*, for additional information on the how CalEEMod generates the scorecard results.

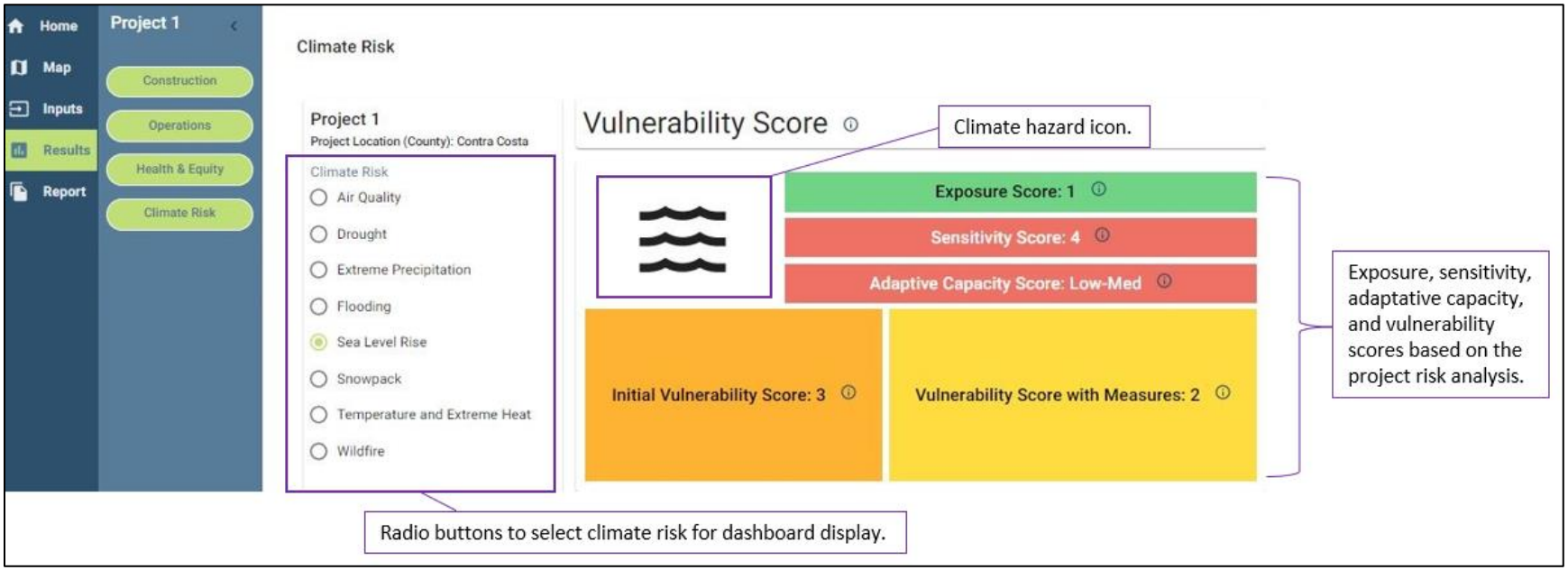

Figure 18a. Climate Risk Dashboard

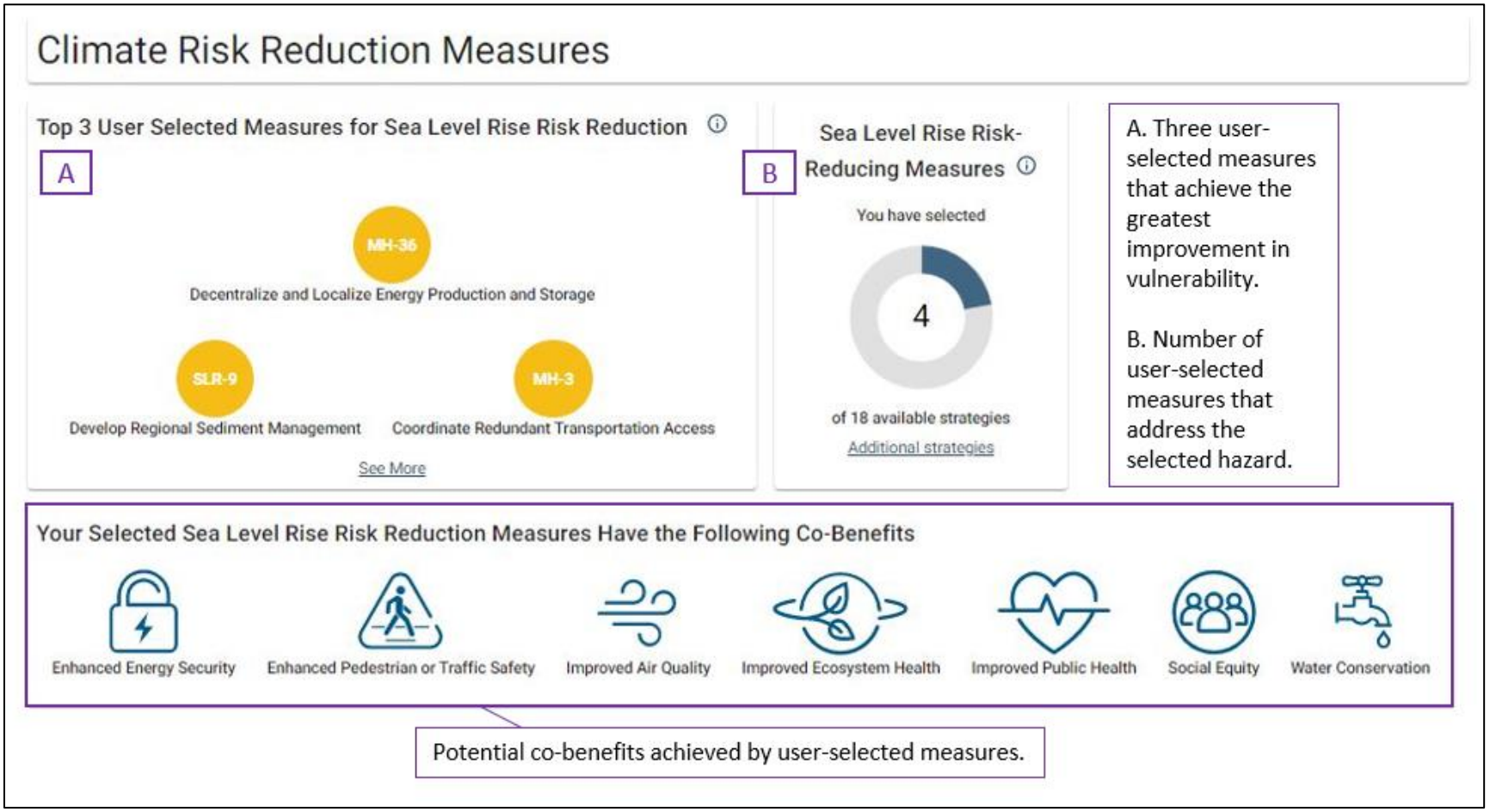

Figure 18b. Climate Risk Dashboard

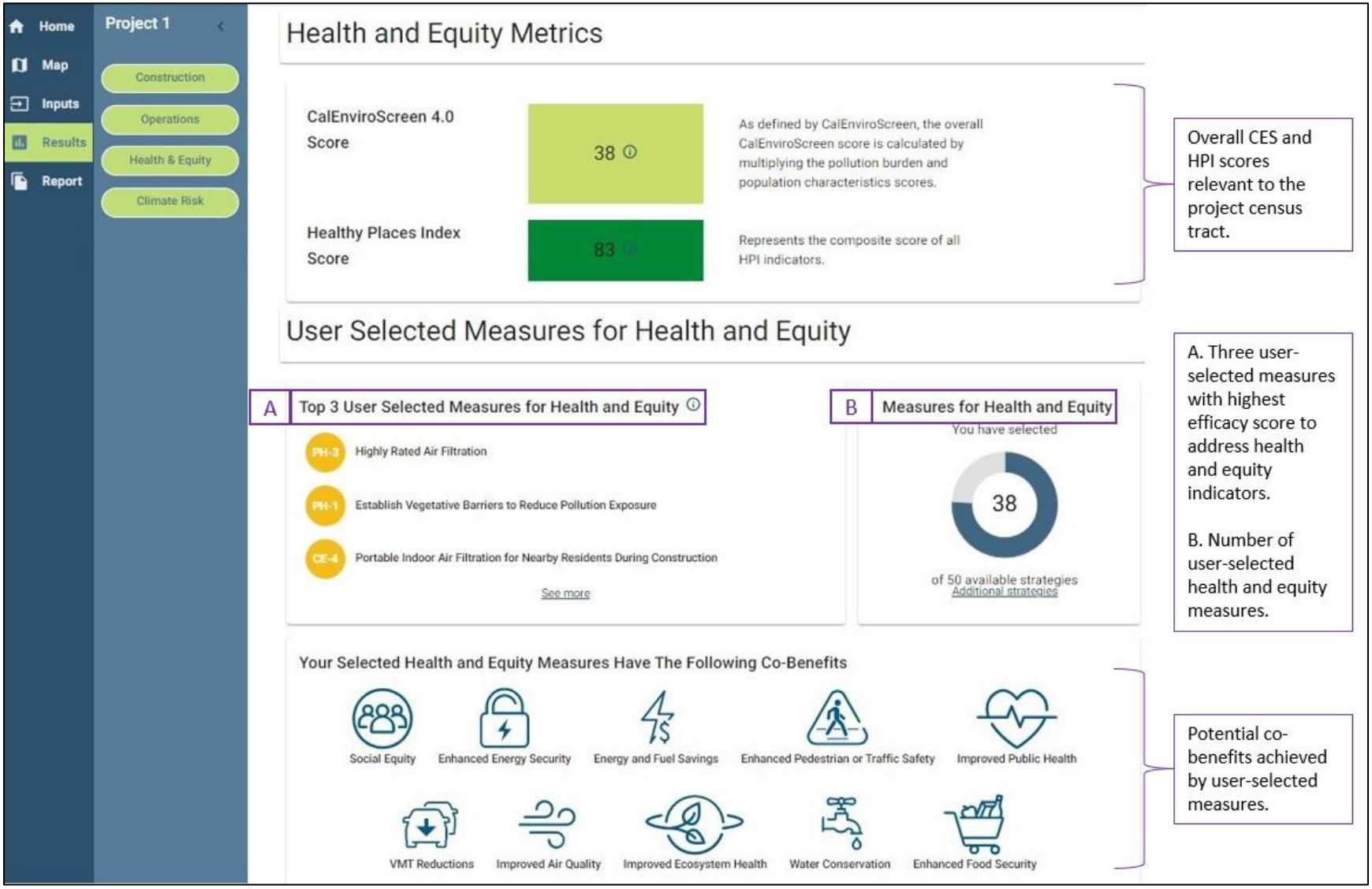

Figure 19a. Health & Equity Dashboard

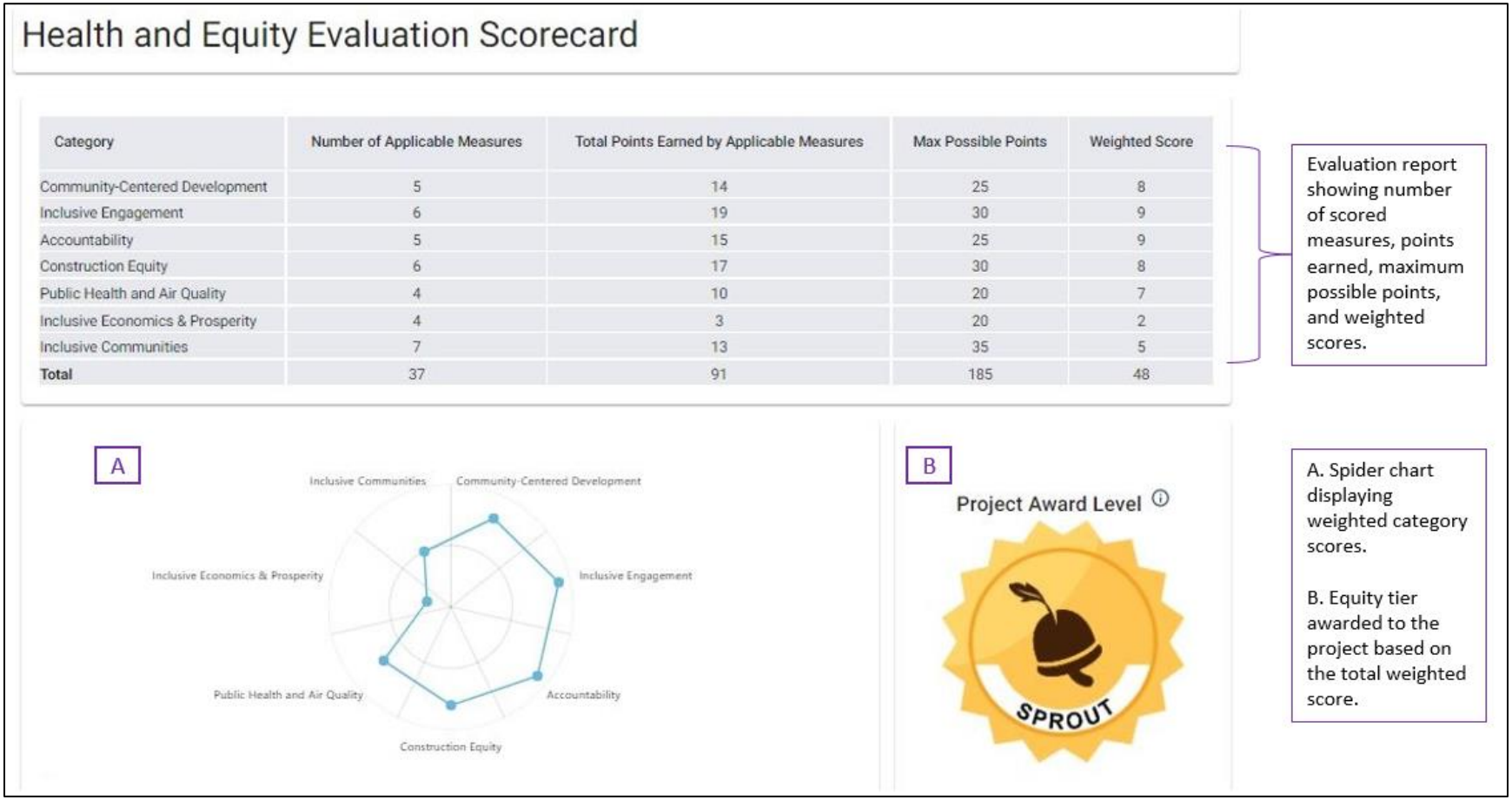

Figure 19b. Health & Equity Dashboard

4.4.5 Construction Calculations

This screen displays total construction emissions from all sources and then individually by source (i.e., off-road equipment, dust from material movement, demolition, mobile exhaust, on-road fugitive dust, architectural coatings, paving, and electricity consumption). Where applicable, the source tables present emissions by process. For example, emissions from vehicle trips and VMT are presented separately within the mobile exhaust table. Users can view the equations and variables underpinning the results by clicking directly on any calculated emissions value in the tables. This will display a splash screen with the unformatted, raw calculation details (see Figure 20). Users can click the toggles at the top of the screen to display unmitigated or mitigated emissions for the daily or annual condition. Daily emissions can be presented for the winter or summer season. While the emissions displayed in the **Construction Calcs** screen can also be viewed in the construction emissions dashboard and **Reports** component, the screen enhances transparency by specifically identifying the equations and variables used by CalEEMod to quantify construction emissions by source and process.

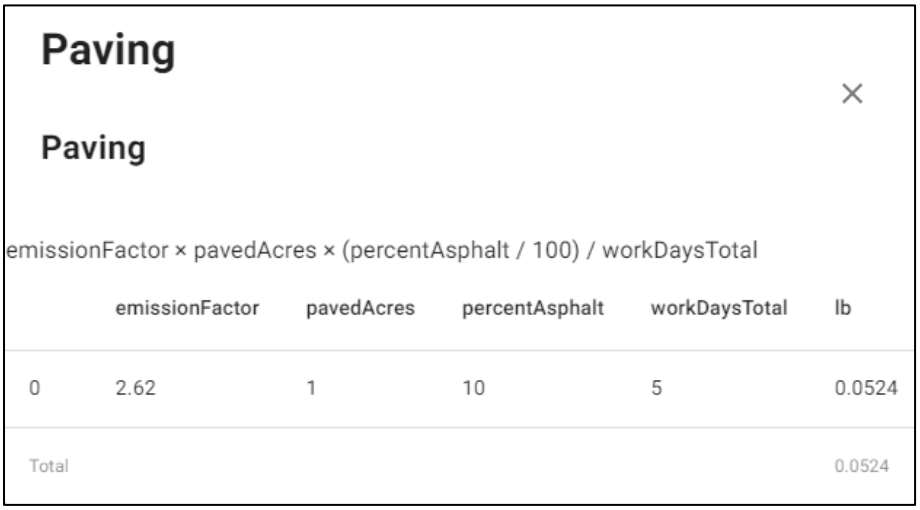

Figure 20. Calculation Splash Screen for Daily ROG from Paving

4.4.6 Operations Calculations

This screen displays total operations emissions from all sources and then individually by source (i.e., mobile exhaust, on-road fugitive dust, hearts, consumer products, architectural coatings, landscape equipment, energy consumption, water and wastewater, solid waste, refrigerants, off-road equipment, emergency generators and fire pumps, process boilers, user-defined, land use change, and sequestration). The functionality of this screen is the same as described above for the construction calculations screen.

4.5 Reports Component

4.5.1 Report Selection Screen

The **Reports** module is where the user can select the desired output for the model run. The available reports include summary, detailed, quarterly, and custom. The summary and quarterly

reports present high-level construction and operations results, consistent with the level of detail displayed on the construction and operations emissions dashboard screens. The summary and quarterly reports do not include any outputs related to climate risk or health and equity. The detailed report presents more comprehensive emissions data, with results displayed for individual emission sources (e.g., hearths, consumer products). The detailed report also includes quantified co-benefits (e.g., water consumption), activity data (e.g., VMT), changes to data field defaults, user input justification remarks, and results for the climate risk and health and equity analyses. If measures are selected by the user, both the summary and detailed reports will display unmitigated and mitigated results, as applicable. The custom report allows the user to identify sections to include/exclude from the report.

For the summary and detailed reports, daily emissions are quantified using both summer and winter emission factors (for emission sources with seasonally variable emissions factor data). As discussed further in Appendix C, *Emission Calculation Details for CalEEMod*, maximum daily construction emissions for the winter and summer seasons are presented separately. The calculation of maximum (i.e., highest) emissions during each season considers the start and end dates of individual construction phases. Only emissions generated by those construction phases that occur between October and March are included in the calculation of winter maximum emissions. Likewise, only those emissions generated by those construction phases that occur between April and September are included in the calculation of summer maximum emissions. The consideration of seasonality in the presentation of summer and winter outputs is new to version 2022.1 and can result in considerable differences in maximum daily summer and winter results. Annual emissions are quantified using average annual emission factors, as applicable. Note that, for all emissions results, negative values indicate an emissions decrease, or benefit.

CalEEMod will display a preview of the selected report on the screen. From this report preview, the user can print the report or save the report as a Microsoft Excel (.xls), comma-separated value (.csv), or Adobe Acrobat (.pdf) file. It is important to note that the data presented in the Excel file has already been calculated and the calculated results are placed in the grids as text. For this reason, the user cannot change an emission value presented in an Excel file and expect the report to calculate a revised value. These values, however, can be copied to a new Excel spreadsheet for any further desired calculations with the data. Also, the Adobe Acrobat file meets AB 434 accessibility requirements. Certain formatting considerations (e.g., use of dashes, non-merged cells) were made to achieve compliance.

5 References

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