Mosaic User Guide

Prepared for

Oregon Department of Transportation

November 2014

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Contents

Step 1: Identify Bundles of Actions

Before applying Mosaic, planning agencies will have identified various "bundles" of transportation actions (including investments such as projects and programs) to be analyzed. Each bundle may represent a different approach to addressing the needs and opportunities identified for a study area.

Mosaic requires at least two bundles—a future "base case" and at least one alternative bundle. The base case may represent a "no build" or '"low build" future; the base case is intended as the point of comparison for alternative bundles. Mosaic compares alternative bundles with the base case. It is important to note that the base case must be fully analyzed across all indicators (in the same way that the alternative bundles must be analyzed).

Bundles may be created in variety of ways: assembled by agency staff, recommended by technical advisory groups, and/or agreed on by policymakers and stakeholders. Analysts can craft alternative bundles of transportation projects and programs in any way they choose. Some ideas include bundling the following:

- Different fiscal assumptions: more revenue, less cost, different revenue sources, fiscally constrained, fiscally unconstrained.

- Different scenarios, such as "cost of fuel increases" or "population density increases"

- Different goals, such as "reduce greenhouse gas emissions" or "improve public health outcomes"

- Different investment scenarios, including "increased investment in transit service" or "increase investment in Intelligent Transportation System technology"

- Different geographic emphasis, for example, with project or programs applied in specific corridors or neighborhoods

Users may also assemble bundles of actions within a complex corridor. Once bundles have been prepared, the next step is to enter information about them into the appropriate sections of the "Bundles Info" worksheet (see Step 4, Populating the Mosaic Tool, for further information). The "Bundles Info" worksheet contains a series of questions about assumptions used for the analysis.

These assumptions include the name of the bundle, location, base year for analysis, and period of the analysis (as well as any interim forecasting years). Users also report the year that dollar values were reported and discounted. The bundles themselves should comprise a package of individual supply-side (capital improvement) and demand-side (programmatic) ideas.

In the "Bundles Info" worksheet, users describe and list the projects in each bundle, and provide capital cost estimates and funding years for each project. Cost estimates are assumed to be an order-of-magnitude, unit-cost level of detail, prepared according to the Oregon Department of Transportation's (ODOT's) guidance on planning-level cost estimates. Similarly, costs for programs must be determined on a case-by-case basis and prepared according to national best practices. Some specific knowledge of funding expenditures is assumed to be available for short-term project concepts—those within a jurisdiction's capital improvements program—and that less is known about medium- to long-term project ideas.

Step 2: Establish the Mosaic Framework

To evaluate the effects of projects and programs, users must first understand the Mosaic Framework and key terms (see below). Mosaic has nine categories of transportation impacts and 40 specific indicators within these categories. These indicators, in turn, provide the basis for "scoring" various alternatives. Detailed information about the Mosaic categories and specific indicators can be found on the Mosaic website (https://www.oregon.gov/ODOT/Planning/Pages/Mosaic.aspx).

The Mosaic Framework

The Mosaic framework is based on the goals and policies of the Oregon Transportation Plan (OTP). The framework includes nine categories for transportation system performance, each with its own set of general and specific indicators, which are the backbone of Mosaic analysis. This goal and policy framework is comprehensive – the nine categories of performance include safety, economic performance, environmental benefits, and other categories of system performance that are typically evaluated during transportation planning efforts. By using Mosaic, an agency can help make its plan consistent with the goals and objectives of the OTP.

Definition of Key Terms

- **Categories of Transportation System Performance—**General topics or outcomes against which potential decisions will be evaluated. Performance measures and evaluation methods are proposed and developed under each category.

- **General Indicators—**Aspects of the categories of transportation system performance that will be evaluated, and for which a few workable measures or indicators can be defined. There are two to four general indicators defined for each category of transportation system performance.

- **Specific Indicators—**A measure of performance, described as clearly as possible in terms of scope and unit of measurement. There are one to three specific indicators for each general indicator.

Step 3: Weight Impacts with Stakeholders

Some Mosaic impacts are measured in dollars and some in other units of measure (time, area, etc.). All impacts measured in dollars can be compared easily and added to one another, but the values of indicators not measured in dollars are not so easily compared. For example, how does one compare the value of environmental resources to the value of sidewalks or the value of safe routes available in the event of an emergency?

Mosaic addresses questions like these through the use of Multi-Objective Decision Analysis (MODA), a process of structured decision making in which stakeholders assign weights to Mosaic's categories and indicators. This weight reflects stakeholders' assessment of the relative importance of one indicator as compared with another.

Weighting should be done by stakeholders. Stakeholders in Mosaic are those individuals who represent, as a group, a reasonable cross section of interests and perspectives. Typically these individuals are identified and participating in the planning activity before Mosaic is used in the planning process.

Prior to weighting, staff will have familiarized stakeholders with Mosaics categories and indicators of transportation impacts. As necessary, staff should furnish stakeholders with a list of indicator definitions. A version of this document is available on the Mosaic website (https://www.oregon.gov/ODOT/Planning/Pages/Mosaic.aspx) in the Library section.

Weighting should be done by stakeholders individually or in one or more groups that include people with different interests. Weighting will require one or more meetings, and it may occur at one or more times during the planning and decision making process. Staff should explain and facilitate the weighting activity.

Weighting provides these benefits:

- It is a proven approach for evaluating multiple criteria.

- It is particularly useful in facilitating insights and exploring, learning, and building consensus with stakeholders.

- The weighting process can be used to explore tradeoffs (as explained below).

- Results provide clear documentation for the reasons an alternative is selected.

- The weighting process builds a sense of stakeholder ownership in the results and outcomes.

What is a Weight?

A weight is a number assigned to a Mosaic category (or indicator). The number is an expression of its importance relative to other categories (or indicators).

The Process of Weighting

The weighting step in Weighting is best done with help or facilitation by an experienced individual. The formal process of assigning a weight is not difficult. However, to get the most value from weighting, stakeholders should identify a facilitator who has not only a working knowledge of Mosaic's categories and indicators (obtained from Step 2, above) but also is familiar with its use in supporting decision making. An experienced individual will take best advantage of opportunities for additional weighting steps, and to manage discussion of findings. This process is central to Mosaic's mission – to inform but not dictate decisions, and to help stakeholders get the most value from scarce transportation dollars. The use of weighting involves a number of options and tradeoffs. Below are some key examples.

- Weighting is done by stakeholders
- Stakeholders reach agreement on how to "spend" 100 points

- Economic Vitality
- Accessibility
- Funding/Finance
- Environmental Stewardship
- Quality of Life
- Mobility
- Equity
- Safety and Security
- Land Use

Stakeholders have 100 points to "spend" among indicators

QUALITY OF LIFE AND LIVABILITY

	FINAL WEIGHT	GENERAL INDICATORS
	15	Journey Ambiance
	30	Noise
	55	Physical Activity

When to Undertake Weighting

Stakeholders can weight indicators either before or after inputting data (or possibly both before and after) and get results from the Mosaic workbook.

Weighting before data has been entered in Step 4 affords stakeholders a chance to share their overall values with one another. This can be useful when a diverse group of citizens may not have had an opportunity to work together previously. When weighting before, it likely will be easier to weight categories first. This will afford ample opportunity for discussion without obligating stakeholders to understand the indicators fully at this early stage of the decision making process.

Regardless of whether weighting is done prior to entering data into Mosaic, stakeholders should (also) weight after Step 4, Populating the Tool. At that time, knowing how each bundle performed against each indicator affords stakeholders the chance to make more informed decisions. According to Multi Criteria Analysis: A Manual[1] many stakeholders at this time look both at the differences in the measured values for the bundles and at their own thoughts about how much they care about these differences. This allows users to add weight selectively to those categories and/or indicators that serve as the greatest differentiators among bundles, and reduce weights of those indicators whose measured values are essentially the same across bundles. Why weight an indicator that doesn't help differentiate one bundle from another? This approach proved very useful to stakeholders in the Mosaic Pilot conducted in 2013-2014.

The logic of waiting to weight categories or indicators until "endpoints" have been established for the indicators is evident from the following example.

Imagine you were buying a car. How much weight would you put, in advance, on price as a factor in your decision, versus color? Most people weight price as more important. Now consider the following facts (as illustrated in the

Figure below). One car has stripes. The other does not. The striped car costs $100 less than the one without stripes. Does the fact that the difference in price is very small change how much weight you give that indicator in your final decision?

Indicators First or Categories?

Stakeholders may weight either categories or indicators first. Weighting categories has two advantages. There are fewer of them, and all are easy to understand. Weighting indicators first has two advantages as well. Since all impacts in Mosaic are measured at the indicator (not the category) level, weighting indicators enables stakeholders to focus on the metrics that matter. Secondly, one can develop a composite score for categories from the indicator weights directly, since categories are sums of indicators. Weighting indicators precludes the need for a two-step process.

In either case, it is recommended that stakeholders review their weights after Step 4, in which the measured values of each indicator are calculated and presented. It is also recommended that stakeholders be given a round number of points, e.g. 100, to 'spend' and the final weights assigned – whether to categories, indicators, or both – add up to the total number given.

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[1] Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/7612/1132618.pdf (2009)

Weight All Indicators or Just Those That Are Not Monetized?

Mosaic is designed to monetize indicators whenever feasible, and the tool is set up to monetize all indicators for which the science of monetization is developed sufficiently. However stakeholders may choose to change the default settings and quantify or assess any indicator qualitatively if they prefer.

One of the reasons to monetize is to take advantage of the ability to add benefits together. When benefits all are measured in dollars they are combined very easily, and they are easily compared to costs. There is no need to weight them to enable a comparison.

Weighting is recommended only for those indicators that Mosaic does not monetize. There is a compelling logic to this. A MODA score for those indicators that cannot be valued monetarily affords an easy comparison with those benefits that can. It generates useful discussions and may lead to bundle refinements. If stakeholders find that they would prefer to weight an indicator that is identified in Mosaic for monetization, the user can change the measurement selection for that indicator to quantitative or qualitative and include it in weighting and MODA instead of monetization.

How to Get the Most Value from Weighting

Regardless of the order in which weights are developed, the timing, or the method, stakeholders should experiment with weights to see how they affect overall measures of relative value. For example, the weight given to the Accessibility category could be doubled, tripled, or eliminated to see whether that makes a difference in the relative value of one bundle or another. This exercise will be very useful in informing discussions and reaching decisions. The Mosaic tool has the capability to test changes to indicator weights in the "MODA Sensitivity" worksheet (see Step 4 of the User Guide for details).

Step 4: Populating the Mosaic Tool

Introduction

This section of the User Guide provides step-by-step instructions for entering information in the Mosaic workbook. Users of Mosaic are encouraged to first familiarize themselves with the tool through exploring the various worksheets; some users may want to go through it step-by-step with this User Guide at hand. This section of the User Guide is organized to follow the Mosaic workbook through its various worksheets or tabs.

A companion document to this User Guide, the *Mosaic Tool Documentation*, is available on the project website (https://www.oregon.gov/ODOT/Planning/Pages/Mosaic.aspx) in the Library section. This document provides detailed information about how the Mosaic tool calculates indicators, including the formulas and assumptions that underlie Mosaic indicator calculations. Detailed technical information is also provided on the sketch tools and other intermediate calculations, such as the intermediate calculations that are made with travel model data.

Additional information about each of the 40 Mosaic indicators is also found on the Mosaic website. Each indicator has an "indicator data sheet" available that provides information on the purpose and estimation of each Mosaic specific indicator.

Throughout Step 4, screenshots of the Mosaic tool are used to illustrate certain instructions. The screenshots show data entry and outputs from the Mosaic tool. It is important to note that the data used in the screenshots is purely for illustrative purposes and does not represent data from an actual application of Mosaic.

Key Terms

The following terms are used frequently in this section of the User Guide:

- **Aggregated travel data**: travel data loaded that was post-processed in a travel demand model or other algorithm to produce statistics used in various specific indicators. Users can enter either aggregated or disaggregated travel data in Mosaic.

- **Base Case:** the reference bundle which serves as the point of comparison for alternative bundles. The Base Case is usually a "no build" or "low build" alternative.

- **Benefit-Cost analysis (BCA)**: Systematic process for calculating and comparing benefits and costs of different bundles of projects, programs, and policies. BCA is used to monetize benefits and costs that can be expressed in dollars.

- **Bundles**: Groups of transportation actions and investments such as projects, policies, and programs that are evaluated in the Tool. Before analysis, each bundle is to be described, with capital cost estimates and funding years entered for each project.

- **Categories of Transportation System Performance:** General topic or outcome against which potential planning and project decisions will be evaluated. Mosaic includes nine Categories of transportation system performance, derived from Oregon Transportation Plan goals and policies.

- **Decision Maker:** Key audience of Mosaic, including agency management, political leaders and key stakeholders. During a planning process, decision makers (in addition to others) help determine the weights of categories and indicators of transportation system performance and evaluate Mosaic results.

- **Disaggregated travel data**: outputs from a travel demand model that include trip tables and travel time tables, organized by origin-destination pairs. Unlike aggregated travel data (see above), Mosaic processes disaggregated data used to measure certain specific indicators (mostly in the Mobility category). Users can enter either aggregated or disaggregated travel data in Mosaic.

- **Discount Rate**: Time-varying assumption that Mosaic uses to reduce the value of future dollar benefits or costs. The higher the discount rate, the less value is placed on future dollar benefits for each project.

- **Indicators (General):** Aspects of the categories of transportation system performance that will be evaluated, and for which a few measures or indicators are defined.

- **Indicators (Specific)**: An exact measure of performance, defined by a clear scope and a unit of measurement. Mosaic has 40 specific indicators.

- **Least Cost Planning:** As defined by the Oregon State Legislature in 2009's Jobs and Transportation Act, "least-cost planning means a process of comparing direct and indirect costs of demand and supply options to meet transportation goals, policies or both, where the intent of the process is to identify the most cost-effective mix of options."

- **MODA (Multi-Objective Decision Analysis)**: a process that evaluates and assigns value to different indicators that cannot be monetized. Stakeholders use a structured process to determine weights to categories and indicators that reflect their relative value. Quantitative or qualitative indicators may be used in MODA, which provides a basis for comparing monetized and non-monetized indicators.

- **Monetized**: Refers to measurement in dollars. Indicators that can be reliably and credibly measured in dollars are "monetized" in Mosaic. Monetization assumptions are based on research literature.

- **Net Present Value (NPV)**: Future discounted benefits minus costs. Net present value is used to compare monetized benefits to costs for each bundle.

- **Programs:** In Mosaic, "programs" refers to a suite of travel demand management programs that can be applied in bundles. These programs are designed to reduce vehicle travel demand. Users are provided guidance on the estimated range of effects for each program.

- **Report-only indicator:** these are indicators in Mosaic that are only provided as information to decision makers, but do not have a quantitative effect on the Mosaic analysis. "Report only" indicators are generally those that decision makers are accustomed to seeing during the transportation planning process (e.g., vehicle miles travelled per capita), the benefits of which are already represented in Mosaic benefit-cost calculations.

- **Sensitivity Testing**: in Mosaic, sensitivity testing is the process of testing how bundle values (in dollar or MODA terms) change if certain parameters are changed. For example, users can modify the value of time and see how the results for bundles change. This process allows users to understand how "sensitive" Mosaic outputs are to changes in key parameters, and thereby understand the possible impacts of uncertain measurements or assumptions on Mosaic outputs.

- **Sketch models:** sketch models or sketch planning tools are designed to provide order-of-magnitude estimates of some impacts of land use and transportation plans and projects. Several sketch models are included in Mosaic. These tools are simpler to use than complex modelling software. However, sketch models provide generalized results that must always be used and interpreted with caution.

- **Time-varying assumptions:** these assumptions include the *real discount rate*, the *value of time for personal and business travel*, and many other assumptions that influence Mosaic results. Users are provided guidance on the appropriate range of value for each assumption.

- **Weighting**: the process of assigning value to certain indicators in Mosaic. Through a structured process, stakeholders work in a group to assign weights for non-monetized indicators (excluding "report only" indicators).

Welcome

Worksheet Purpose

The "Welcome" worksheet (screenshot at right) is the title page for the Mosaic Tool, and it includes the version number and contact information for the tool and provides a link to the Mosaic website: https://www.oregon.gov/ODOT/Planning/Pages/Mosaic.aspx.

The **lock icon** signifies that the tool is locked for editing, so that only the cells where user input is permitted can be modified.

The **arrow icon** provides a hyperlink back to the "Content" worksheet.

www.oregonmosaic.org

MOSAIC
Value and Cost Informed Planning

VERSION 2.0

October 21, 2014

Fully Unlocked

| WELCOME | CONTENT | HELP | BUNDLES INFO | ADD PROGRAMS | CONTROL PANEL |

No user inputs are required on "Welcome" worksheet.

Content

Worksheet Purpose

The "Content" worksheet lists the contents for all worksheets in the Mosaic Tool. Users can read a description of what each worksheet does and click on a link that goes directly to that worksheet.

Different worksheets are grouped by the following colored tabs:

- Red (Welcome through Indicators) = Welcome and control

- Orange (Cost & Schedule through Weight Categories) = Assumptions and input data

- Dark Blue (Mobility through Equity) = Calculation of the value of specific indicators

- Brick Red (NPV Calculation through Output Sheets) = Aggregation and presentation of results (Outputs)

- Green (Economic Data through References) = Supporting data, models, and references

- Black (Travel Data Calculations through Lists & Lookup) = Intermediate calculations and workbook support

- Yellow (Review and Revisions through Diagnostics) = List of revisions made to the tool, sensitivity testing, and diagnostics

Throughout the Mosaic Tool, cells highlighted in light blue are intended for user input; white cells or cells in other colors are generally not intended for user input.

The arrow icon on worksheets throughout the Mosaic Tool provides a hyperlink back to Content.

No user inputs are required on the "Content" worksheet.

Help

Worksheet Purpose

The "Help" worksheet walks the user through the steps of populating the Mosaic Tool, from the initial identification of projects and bundles of actions to the final step of exporting results. Help serves as a navigation aid for users to walk step by step through the process.

Instructions and Relationships

Each task listed in the screenshot (right) is hyperlinked to the Mosaic worksheet where that function occurs in the tool. Users should start on this worksheet and work sequentially through the tool by clicking on the links provided for Steps 1a through Step 8d. For more information about how to enter data into and/or interpret each worksheet, users should consult the User Guide (https://www.oregon.gov/ODOT/Planning/Pages/Mosaic-User-Guide.aspx) page of instructions for that worksheet.

The "Help" worksheet also includes a color-coded key for the worksheet tabs, as illustrated below:

The "Help" worksheet also includes a color-coded key for font and cell backgrounds, as illustrated below:
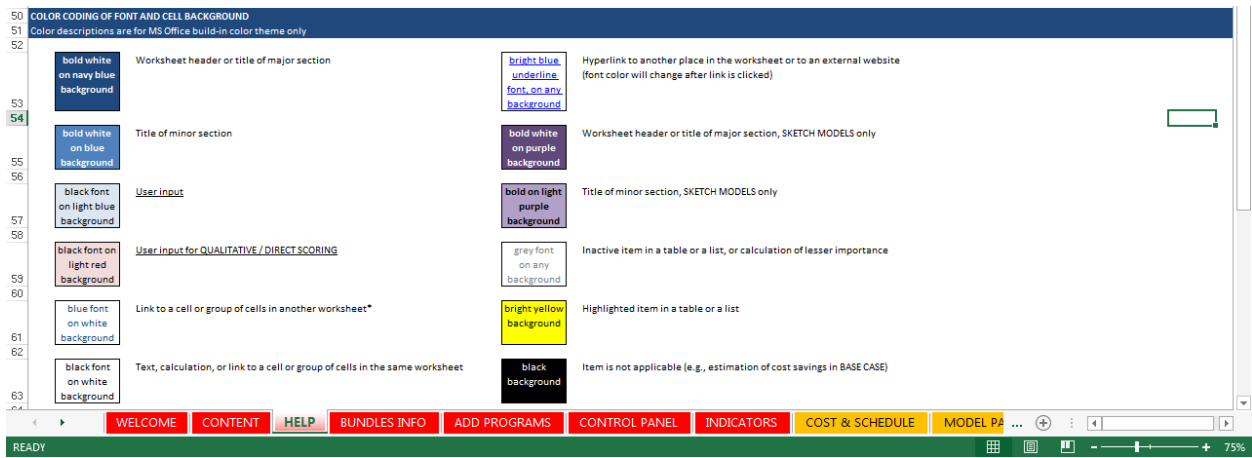
The email icon in the upper right corner of the "Help" worksheet allows users to easily email the Mosaic Tool to others.

All other worksheets in the Mosaic Tool provide a hyperlink back to the "Help" worksheet (screenshot at right). Clicking on the HELP button in the upper section of the worksheet allows the user to navigate efficiently throughout the tool by following other "Help" worksheet links.

Bundles Info

Worksheet Purpose

The "Bundles Info" worksheet is where users record information about the bundles of actions being evaluated in this Mosaic application, and where stakeholders can see a detailed description of what is being considered – and compared – by the tool.

Worksheet Considerations and Relationships

After completing the foundational work to build bundles for evaluation, the "Bundles Info" worksheet is where users enter general information about time frame and valuation assumptions, a summary description of each bundle, and a description of the projects and programs in each bundle, along with cost information and year(s) of expenditure. Throughout the Mosaic application, this worksheet serves as a reference comparing different bundles. Users will likely refer back to it frequently, especially as they evaluate Mosaic outputs or modify bundles.

Although most data in the "Bundles Info" worksheet do not directly populate other sheets, the base year identified in Cell C11 is pulled directly into the "Time-Varying Assumptions" worksheet (Cell G2) to serve as the basis of the calculations resulting from the annual application of time-varying assumptions (such as the discount rate) to Mosaic's monetized indicators.

Instructions

Note: throughout the Mosaic workbook, cells highlighted in light blue are intended for user input; white cells or cells in other colors are generally not intended for user input.

1. Enter the name of Mosaic application and the region in Cells C6 and C8.

2. Identify the period of analysis—Rows 10 through 16 will define the assumptions for the analysis. In Cells C11 and C12, the user will enter the base year and the first year of analysis, which is the year when the Mosaic process begins and the user collects information about existing conditions (the base year and the first year of analysis may be the same). The first year of analysis will be the same year of "current conditions" against which the base case and alternative bundles will be compared.

Next, the user enters the last year of analysis in Cell C13. To allow enough time for the Mosaic model to recognize the benefits of each bundle, users should extend the period of analysis 10 to 20 years beyond completion of the last capital improvement in the plan. Mosaic allows for a project period of up to 50 years.

Once the user has identified the base year and last year of analysis, Cell C14 reports the period of analysis in number of years. C15 displays the year that in which dollars are reported (2013 in the screenshot below), and C16 indicates the year to which costs will be discounted back. Both of these will be the same as the base year.

3. Enter travel demand forecast years—Rows 18 through 23 require the user to enter the travel demand forecast years for the Mosaic application. Users must enter the beginning point (current conditions) and at least one additional year in which the bundles will be evaluated. The additional year(s) of evaluation should be determined in consultation with the travel demand modeler for the jurisdiction. In Cell C23 the user should enter the first year for which benefits should be measured; typically this should be the year after the base year.

4. Enter summary information about bundles—in Rows 25 through 38, users enter the name and a summary description of each bundle in addition to the base case/"do minimum" option (an example is shown in the screenshot). The table allows for entry of up to ten bundles. *Note that the base case is a <u>future</u> base case – not current conditions.*

5. Enter information about projects in each bundle—In the **"Bundles Info"** worksheet, Rows 44 through 453 are where the user lists the projects that are included in the base case and each additional bundle (programs are entered on the "Add Programs" worksheet). Column D provides space for details and/or comments about the bundle. In Column E, users enter the period in which expenditures will be made on that project or program. This includes the years during which the project is built and the programs are developed – but it does not include the opening date or years of operation. Finally, Column F is where the estimated capital costs associated with each project or program are entered. See the screenshot below for examples. Detailed information about

programs in each bundles will be entered in the **"Add Programs"** worksheet (see next section of User Guide).

Project cost estimates are assumed to be at a unit cost level of detail, and should be prepared according to best practice guidance on planning-level cost estimates. Similarly, costs for programs must be estimated, using information contained in the Mosaic Program Guide, or other sources or local knowledge.

	A	B	C	D	E	F	G
1		INFORMATION ON BUNDLES AND PERIOD OF ANALYSIS					
2		VERSION 2.0					HELP
3		September 3, 2014					
4							
39							
40		**Select Programmatic Actions for Inclusion in Bundles**					
41		Add programmatic actions in the ADD PROGRAMS worksheet					
42		ATTENTION: Only those actions that are NOT represented in the travel data used in the tool should be added.					
43							
44		**Detailed Description of Bundles: List of Projects & Actions Considered**					
45							
46		**Base Case**	**2035 Low Build**	2010 existing network in the Portland Metro area plus projects that have been completed or are very			
47		**Projects & Actions Included**					
48		*INDEX*	*PROJECT OR ACTION NAME*	*COMMENTS* *(e.g., LOCATION, IMPACTS ON TRAFFIC)*	*PERIOD* *(YYYY-YYYY)*	*CAPITAL COSTS* *($million)**	
49		1					
50		2					
51		3					
52		4					
53		5					
54		6					
55		7					
56		8					
57		9					
58		10					
59		11					
60		12					
61		13					
62		14					
63		15					
64		16					
65		17					
66		18					
67		19					
68		20					
69		21					
70		22					
71		23					
72		24					
73		25					
74		26					
75		27					
76		28					
77		29					
78		30					
79		*For information only (entering or updating estimates here does not change any calculations in the workbook; use the COST & SCHEDULE worksheet to enter cost data)					

Add Programs

Worksheet Purpose

The "Add Programs" worksheet is where users select programmatic actions for inclusion in bundles. Note that users should add only those programs that are NOT already represented in the travel demand model data uploaded into the tool.

Worksheet Considerations and Relationships

The 20 programs described and included in the Mosaic Program Guide (https://www.oregon.gov/ODOT/Planning/Pages/Mosaic-Programs-Guide.aspx) are widely considered to be beneficial and are frequently implemented by jurisdictions as part of travel demand management efforts. The Mosaic Program Guide contains a summary of knowledge regarding the costs and benefits of these programs, with particular attention to impacts relating to Mosaic indicators. Users can choose to incorporate these programs into their bundles, as appropriate.

Application of and experiences with the programs vary widely. For 11 of the 20 programs detailed in the Program Guide, benefit and cost information is built into the Mosaic tool. (Groups 1 and 2, below). The other 9 programs (Groups 3 and 4, below) are widely considered beneficial, but there is not enough information yet to estimate their benefits and costs in the actual Mosaic tool.

Group 1: Both Benefit and Cost Values are Included in the Mosaic Tool

The programs in this group are built into the Mosaic tool on the Programs Worksheet. Benefits and costs are automatically calculated by the tool based on user input.

Group 2: Benefit Values are Included in the Mosaic Tool but Costs Must Be Entered Manually

The benefits of programs in this group are built into the Mosaic tool; however, cost information needs to be entered manually based on local estimates.

Group 3: Benefits and Costs are Best Estimated with Local Models

The Mosaic tool does not have these programs built into the tool, but the benefits and costs of the programs in this group may be estimated by local travel models. The resulting data is then uploaded into Mosaic as part of the travel model outputs.

Group 4: Programs are Beneficial but Not Included in the Mosaic Tool (Version 2.0)

A few programs are not capable of measurement within Mosaic at this time, but are included in the Programs Guide. For these, it is expected that cost/benefit information will become more available and more refined over time, enabling estimation of benefits and costs within the Mosaic tool. In the meantime, the Programs Guide includes programs like bike sharing, Safe Routes to School, and real-

time transit information systems – even though they cannot yet be measured by Mosaic – because they are believed to help advance outcomes consistent with the Mosaic categories.

The programs included in each group are provided below.

Nevertheless, based on published literature they are beneficial in achieving outcomes consistent with Mosaic categories. The programs included in each group are provided in Table 1 below.

Table 1. Program Incorporation into Mosaic				
Program Name	**Group 1**	**Group 2**	**Group 3**	**Group 4**
Parking Demand Management and Pricing		X		
Value Pricing			X	
Bike Sharing Program				X
Bike Parking Programs	X			
Safe Routes to School				X
Decrease or Eliminate Transit Fares		X		
Increase Transit Service	X			
Transit Priority Treatments			X	
Real-Time Transit Information Systems				X
Demand Responsive Transit Service				X
Carsharing	X			
Employer-Based TDM programs		X		
Trip Reduction Ordinances/Transportation Management Associations		X		
Individualized Marketing Programs	X			
Education and Outreach Campaigns		X		
Ridesharing	X			
Land Use Strategies		X		
Traffic Management Strategies			X	
High Occupancy Vehicle lanes			X	
Wayfinding and Signage				X

Instructions

The general instructions outlined below apply to entering information for each program in the "Add Programs" worksheet. For each program added, the summary tables in the "Control Panel" worksheet will be automatically updated to reflect the incorporation of the program into the bundles. Additionally, charts and graphs summarizing the benefits and costs of the programs incorporated into the tool, by bundle, are provided in the "Programs Calc" worksheet.

Following are general instructions for entering programs:

1. Is this program already represented in the travel demand model data uploaded into the tool? If yes, skip to the next program.

2. Mosaic provides per-vehicle miles traveled (VMT)-reduced cost estimates for some programs, but not all. Users can use Mosaic values or local values if available. If users do not have local cost estimates, and no costs are provided by Mosaic, skip to the next program. Otherwise, continue to the next step.

3. For each bundle, enter the implementation value on a scale of 0 to 1 in Column E, as described below:

   a. 0 = No Implementation
   b. Between 0 and 1 = Partial Implementation
   c. 1 = Full Implementation

4. For each bundle, enter the first year of program implementation in Column G.

5. For each bundle, enter the program duration in years in Column I.

6. For each bundle, enter the appropriate benefit value (percent change in regional VMT) in Column K. To help inform your decision, low and high ranges are presented in Columns M and N and additional guidance can be found in the Mosaic programs guide on the Mosaic website. If you are unsure, enter the midpoint value provided in Column L.

7. For each bundle, enter the total annual implementation costs (in millions) in base year dollars in Column R. Costs may be entered as the total annualized cost for the life of the program or as the "cost per VMT reduced;" for many (but not all) programs, the Mosaic Tool provides suggested costs per VMT. For those programs that do not, users can enter local cost estimates.

8. If the numbers for each bundle in Column R reflect the total annual implementation costs for the program, enter a "0" Column Q. If the costs are expressed in dollars per VMT eliminated, enter a 1 in Column Q.

Control Panel

Throughout Step 4, screenshots of the Mosaic tool are used to illustrate certain instructions. The screenshots show data entry and outputs from the Mosaic tool. It is important to note that the data used in the screenshots is purely for illustrative purposes and does not represent data from an actual application of Mosaic.

Worksheet Purpose

The "Control Panel" worksheet presents a summary of the key assumptions and results for each bundle of actions. It is primarily designed to allow users to compare the costs, benefits and nonmonetized impacts of all bundles at a glance.

Instructions

The "Control Panel" worksheet is only functional after the entire Mosaic Tool has been populated and initial outputs have been obtained.

Interpreting Worksheet Results

The "Control Panel" worksheet (screenshot below) is meant to be a summary of the Mosaic outputs, not to provide comprehensive cost/benefit analysis. For complete instructions on how to interpret the tool's results, see Step 5 of the User Guide, Interpreting the Results.

Sensitivity Testing

The first two charts on the "Control Panel worksheet display selected key assumptions used in the current application of Mosaic (see above), displayed in the "Baseline" columns (D and K). These parameters are imported from the "Model Parameters" worksheet while some require additional user input. The "Test" columns (E and L) allow users to enter variations on the parameters (see screenshot above). Users can then check the box in Cell E2 to conduct sensitivity testing with the "Test" parameters. The results display in the four charts below, starting in Row 17. Some terms warrant additional explanation:

- The **real discount rate** is the rate (net of inflation) which Mosaic uses to reduce the value of future dollar benefits or costs. The higher the rate, the less value Mosaic puts on future dollar benefits.

- The **social cost of carbon** is the dollar amount which corresponds to the cost of damages caused by carbon emissions.

- The **adjustment to capital costs from current estimates** and **adjustment to O&M costs from current estimates** allow users to apply an overall adjustment to the capital and O&M costs. For example, users could enter "1.50" in the "Test" column to test results with a factor of 1.5 applied to the capital and O&M costs.

- The "**elasticity of value of statistical life to w.r.t. (with respect to) real income**" is a statistic that expresses how the value of a human life ought to vary with respect to the income of the person who died. (e.g., how much more the life of a rich person is worth than a poorer one). If this assumption is of interest to stakeholders (for example, because incomes in the region are particularly high or low), they may prefer to vary the value of a statistical life directly since that is easier to understand.

Users may vary any of the listed assumptions in Columns E and L to evaluate the effects on the benefits or score or a bundle. Results will appear in the tables and charts that follow.

In Rows 17 through 64, the table and the four charts that illustrate it (see screenshot below) provide a graphic illustration of cost and value comparisons for each bundle. The first two charts show how the bundles compare to one another with respect to each of the nine Mosaic Categories. In the screenshot, the chart on the left shows monetized benefits, and the one on the right displays the aggregate MODA scores of the respective bundles.
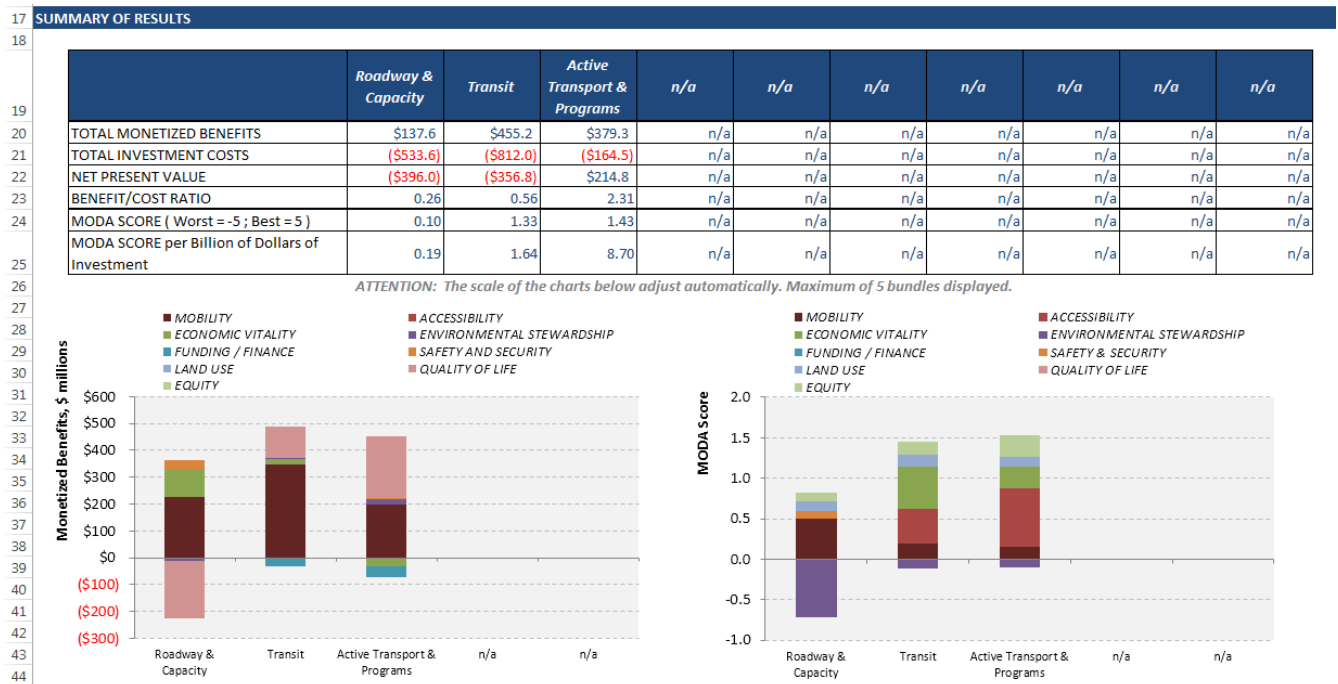
The next two charts in the screenshot below compare the respective MODA scores, Benefit/Cost ratio, and discounted investment cost of each bundle. In the chart below, the size of the bubbles is proportionate to the scale of the discounted investment for each bundle.
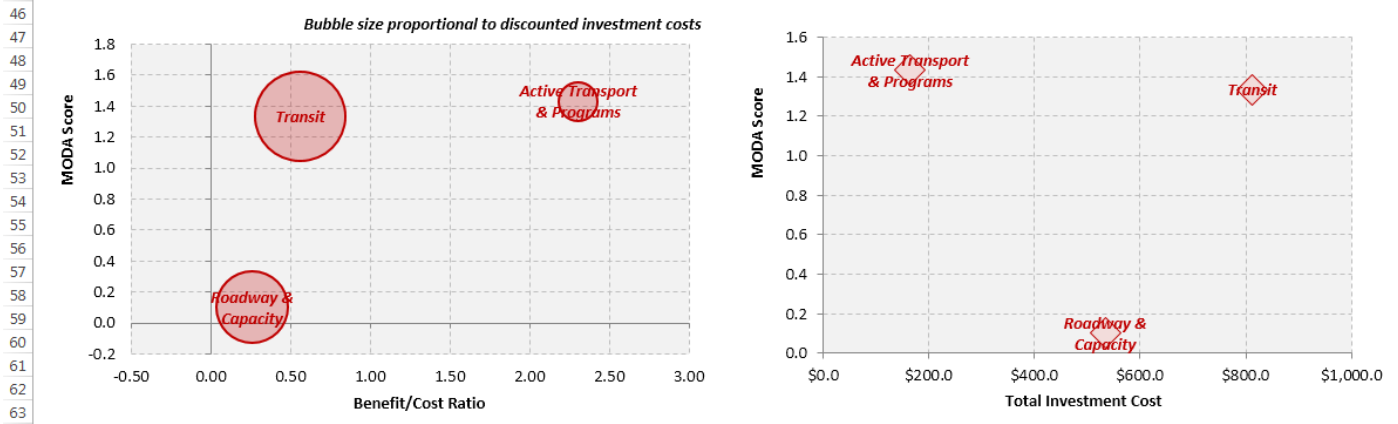
Next, the two tables that comprise the Value Comparison Dashboard in Rows 65 through 95 (see screenshot below) present the numeric data that underlies the charts above. The first shows how the bundles compare in relation to costs and the second describes how the bundles compare – and rank – in terms of net economic benefits[2] and overall nonmonetized MODA score.

	VALUE COMPARISON DASHBOARD			
65				
66				
67	HOW THE BUNDLES COMPARE IN RELATION TO COSTS (PRESENT-DISCOUNTED VALUE, MILLIONS OF BASE YEAR DOLLARS, RELATIVE TO THE BASE CASE)			
68				
69	BUNDLES	CAPITAL INVESTMENT	AVERAGE ANNUAL O&M OUTLAYS	TOTAL LIFE-TIME COSTS
70	Roadway & Capacity	$477.1	$1.7	$533.6
71	Transit	$437.6	$11.3	$812.0
72	Active Transport & Programs	$136.3	$0.6	$164.5
73	n/a	n/a	n/a	n/a
74	n/a	n/a	n/a	n/a
75	n/a	n/a	n/a	n/a
76	n/a	n/a	n/a	n/a
77	n/a	n/a	n/a	n/a
78	n/a	n/a	n/a	n/a
79	n/a	n/a	n/a	n/a
80				

Rows 96 through 130 (screenshot below) and 131 through 165 show stacked bar charts with the dollar value of all monetized specific indicators and MODA score for all specific indicators, respectively.

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[2] Net Present Value = the sum of future discounted benefits minus costs
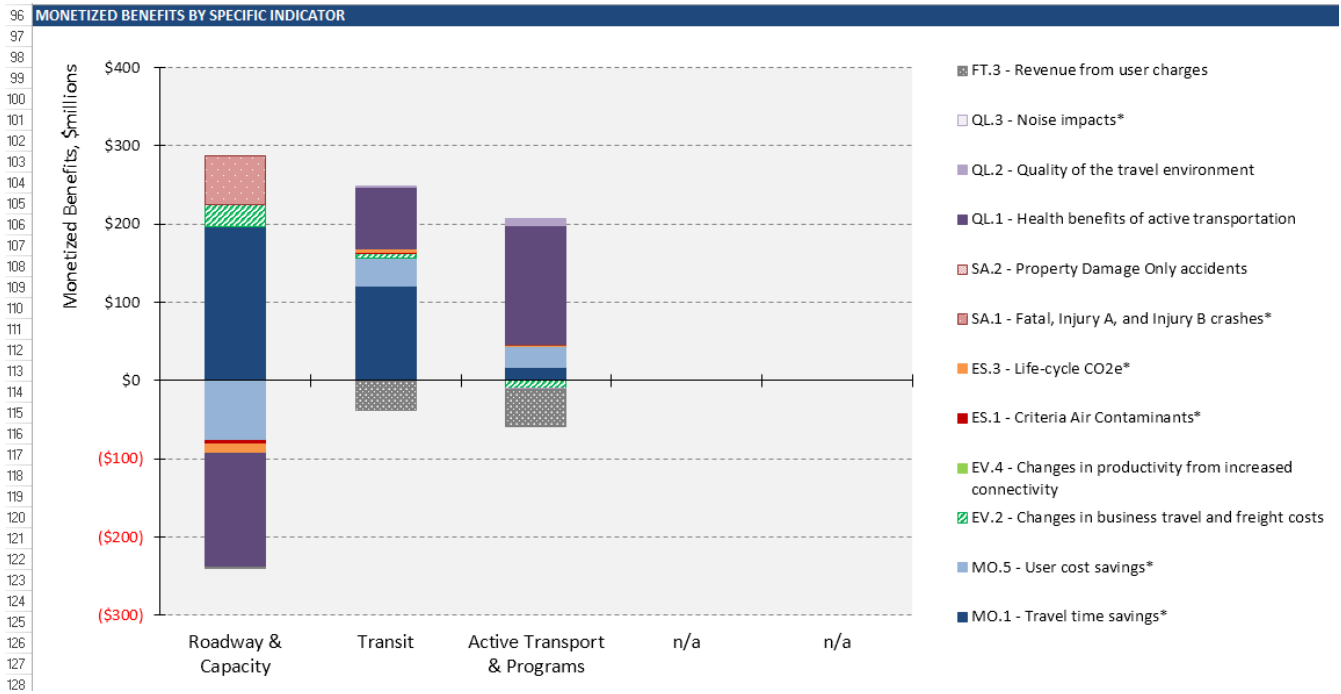
The final table on the "Control Panel" worksheet (Rows 166 through 216) lists the user-selected values for monetized indicators from Column E of the "Model Parameters" worksheet. If the selected value is within the range of Low – Most Likely – High, the cell containing that value is green. However, if the user has selected a value outside the recommended range, the cell containing that value highlights in red (see example screenshot below). This provides a visual reminder that selecting a value outside Mosaic's suggested range will require additional justification.

Indicators

Worksheet Purpose

The worksheet contains a list of all indicators that together comprise Mosaic. The worksheet is where users review how indicators are measured (either in dollars or other units) in the tool.

Worksheet Relationships

The "Indicators" worksheet sets the stage for the operation of the Mosaic Tool. Monetized indicators will be included in the monetized cost/benefit reported in the "Output" worksheet. The user has the option of including the monetized indicators in MODA scoring as well by selecting "TRUE" in Row 4 of this worksheet (for more information about this, see Step 3 of the User Guide, Weight MODA Indicators with Stakeholders). If the user chooses qualitative or quantitative scoring, it will be included in the MODA analysis.

The worksheet also contains a hyperlink for each indicator (Index, Column C) that takes the user to the worksheet containing the calculation of impacts, costs and benefits for that indicator.

Worksheet Considerations

The Mosaic framework is designed to monetize indicators whenever feasible. However, where an indicator is not capable of being reasonably and credibly monetized, the "Indicators" worksheet suggests one or more other means of measurement. Where indicators cannot be monetized, users should use quantitative rather than qualitative measurement, if possible. While both quantitative and qualitative indicators are evaluated in the MODA process, the use of quantitative measures (such as mode split percentages or percentage of street network that includes sidewalks) produces results that appear more objective and may be easier to explain.

There are four general reporting options available for indicators in Mosaic: monetized, quantitative scoring, qualitative scoring, and report only. Not every indicator may be reported in all four ways; for example several of the indicators, like MO.6 Mode Split, can only be presented as report only statistics. The following is a general description of the four methods of reporting indicator values:

- **Monetized**—The value of the indicators is expressed in US dollars. 13 of the 40 Mosaic indicators can be monetized. Users are generally advised to monetize all those indicators for which data are available. All of the monetized indicators may be alternately reported as quantitative scoring, qualitative scoring, or report only statistics. Monetized indicators are generally not weighted (see Step 3 of the User Guide).

- **Quantitative Scoring**—Where indicators cannot be monetized, users should use quantitative rather than qualitative measurement, if possible. While both quantitative and qualitative indicators are evaluated in the MODA process, the use of quantitative measures (such as mode split percentages

or percentage of street network that includes sidewalks) produces results that appear more objective and may be easier to explain.

The value of the quantitative indicators is expressed on a scale from -5 to +5. The base case is always represented by "0" such that the alternative bundles either perform better (up to +5) or worse (down to -5) in comparison to the base case. Quantitative data, like "tons of emissions" or "sidewalk coverage," is converted automatically by the Mosaic Tool to a scale from -5 to +5. Quantitative indicators are weighted and accounted for in the MODA scores for bundles. "Relative scoring" is always used, such that the worst performing bundle always receives a -5 and the best always a +5 relative to the base case.

- **Qualitative (or 'direct') Scoring**—The value of the indicator is expressed on a scale from -5 to +5. The base case is always represented by "0" such that the alternative bundles either perform better (up to +5) or worse (down to -5) in comparison to the base case. Users of Mosaic use professional judgment, available data, and other resources to score bundles on a scale from -5 to +5 in comparison to the base case. Users are advised to always use "local scoring" (relative to other bundles) such that that the highest and lowest performing bundles receive a +5 and -5, respectively. Users are advised of two key points:

  — **Scoring is completed by the Mosaic analyst and/or agency staff – it is not completed by stakeholders or policymakers.** Stakeholders and policymakers weight indicators, before and/or after they have been scored. Mosaic analysts should be careful to record their assumptions when generating scores for qualitative indicators and be prepared to provide explanations for scores if asked by stakeholders.

  — **Users must provide the "scale endpoints" along with the numeric scores in order to inform stakeholder weighting.** This is important so that stakeholders understand how "bad" or "good" a score of -5 or +5 really is. Consider the following example: a bundle performed worse than the base case because it decreased travel reliability on a single arterial road within an entire region. As the worst-performing bundle, it was consequently scored as -5 with respect to MO.3 Reliability-recurring congestion. The best-performing bundle improved reliability on this same stretch of road and was consequently scored +5. Stakeholders must be informed of the "endpoints" in order to weight this indicator – the low endpoint being "reliability decreases on one road" and the high endpoint being "an increase in reliability on the same road." The relative impact of these bundles on travel reliability (good and bad) is very small in terms of the regional transportation system. Therefore, stakeholders may not weight this indicator very highly, because the overall impact on reliability is so small for the bundles. However, without knowing the endpoints, stakeholders might only see the "-5" and "+5" scores, which may indicate – without any context – that the bundles had a much greater effect on reliability.

- **Report Only**—Some indicators in Mosaic are only reportable as "report only" statistics. This is usually because the indicator would be duplicative with other indicators if included in scoring. For example, the benefits associated with "VMT/Capita" are captured in other indicators (like "hours of

congestion," "travel time" and indicators in the Air Quality category), but VMT/Capita it is likely to have independent value to decision makers. Similarly, Hours of Congestion per Capita (MO.2) is contained within Travel Time (MO.1), but is also of interest to decision makers as a stand-alone figure. Any indicator in Mosaic may be reported as "report only" at the user's discretion.

Instructions

The user input on this worksheet occurs in Column E, "Use in Mosaic?" For each indicator, the worksheet presents a suggested method of measurement as the default in Column E.[3] Users are strongly encouraged to use the suggested value in Column E unless needed data are unavailable. If the user decides to change the suggested method of measurement, this is done by clicking on the box and selecting from the options in the pull-down menu that appears to the right of the box.

Should the user opt to use a measurement other than the recommendation, the linked worksheet in Column C is programmed to accept this change and estimate the indicator accordingly. However, as discussed above, users are encouraged to emphasize monetization and quantitative measurement whenever permitted by the Mosaic Tool.

For more information on how each indicator is estimated, users should consult the Indicator sheets on the Mosaic website (https://www.oregon.gov/ODOT/Planning/Pages/Mosaic-Categories.aspx)

Outputs

Monetized indicators will be included in the benefit/cost calculations of the Mosaic Tool. Quantitative and Qualitative indicators will be included in Mosaic's MODA ratings. Categorizing an indicator as "Report Only" means that indicator will not be weighted and thus will not be considered in Mosaic outputs.[4]

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[3] Default values in Column E are based on the work of the Mosaic Tool development consultants.

[4] For more information about cost/benefit, MODA and Report Only designations in Mosaic, see the "Comparison Process" heading in Home > About > Mosaic Framework under the "About" tab on the Mosaic website

Cost & Schedule

Worksheet Purpose

The "Cost & Schedule" worksheet is where users enter estimated life-cycle costs and revenues for each bundle. This information serves as the starting point for Mosaic's benefit/cost calculations.

Worksheet Considerations and Relationships

This worksheet records the total investment costs for each bundle. These include capital costs, annual operating and maintenance costs, and other annual incremental life-cycle costs. Users enter these estimates into the worksheet on an annual basis.[5]

The more refined the cost estimates for each bundle, the more useful the Mosaic Tool's outputs will be. Given that planning agencies are likely to have more annual cost data for projects that are closer in time (such as those included in a Capital Improvement Program) the tool requires annual estimates for near-term costs. Users should try to include as many cost components as possible, including construction, maintenance and operations, and right-of-way.

These cost and revenue estimates serve as the basis of multiple calculations on the "Economic Vitality" and "Funding & Finance" worksheets, as well at the "NPV Calc" worksheet, which compares monetized benefits to costs for each bundle.

Users may wish to acknowledge uncertainty regarding capital or operating costs by changing the values entered here and seeing the effects on specific indicators. Users can accomplish this through the "Control Panel" worksheet in Cells E12 and E13. Also see Step 6 in the User Guide for further discussion of sensitivity testing.

Instructions

Estimating Costs and Revenues

Before entering data on this worksheet, users must estimate the annual investment costs and revenues for each bundle. Cost estimates should be prepared according to best-practice guidance on planning-level cost estimates (See *https://web.aacei.org/* and *https://www.aspenational.org/*).

To develop cost estimates for each bundle, users must work with local planning and engineering staff to determine the cost (and construction time) of each individual project and/or program within the bundle. This will allow for sensitivity testing of the Mosaic outputs.

When estimating costs to enter into Mosaic, users must break the estimates down by category:

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[5] As noted in the instructions for the "Bundles Info" worksheet, the period of analysis will extend 10-20 years beyond completion of the last capital improvement in the plan.

1. Total Capital Costs (including design, engineering, permitting, right-of-way, and construction)

2. Annual Incremental Operating & Maintenance Cost

3. Other Annual Incremental Life Cycle Costs (i.e. major rehabilitation of a bridge or roadway, financial costs, and changes in operating and maintenance costs in other parts of the system)

Next, break down the total costs of each bundle annually by year of expenditure as shown in the screenshot below:

Estimated revenues will include fare revenue, tolling revenue, or other revenue streams (such as dedicated fees or taxes) that come from each bundle.

Entering Cost Data

Starting in Column G, enter the estimated annual investment costs for each bundle.[6] Once the cost information is entered into Columns F through BD (depending on the period of analysis), Mosaic will automatically sum the annualized investment costs to show several totals for each bundle:

- Total Capital Costs (Cells D11 through D22);
- Annual Incremental Operating & Maintenance Costs (Cells D24 through D35);
- Other Annual Incremental Life-Cycle Costs (Cells D37 through D48);
- Total Investment Costs (Cells D50 through D61).

---

[6] Column G pulls the base year from the "Bundles Info" worksheet, and Row 2 identifies each subsequent project year.

Column E (Rows 11 through 61) applies the discount rate[7] to the totals in Column D to give the Total Discounted cost for each.

Entering Revenue Data

In Rows 68 through 91, users enter the forecasted revenues for each bundle, allocated by time frame as described above.

Sensitivity Testing

Users can explore the sensitivity of bundle results with respect to cost in the Control Panel worksheet (see previous section).

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[7] Selected in Cell E11 of the "Model Parameters" worksheet

Model Parameters

Worksheet Purpose

The "Model Parameters" worksheet is the place where users can review and/or vary the value for many specific indicators. All affect the estimate of monetized benefits that informs the benefit-cost analysis.

Worksheet Considerations

The "Model Parameters" worksheet lists a large number of variables. For each variable, users can see a range of values – Low, Most Likely, or High (Columns F and G). The Most Likely and/or Low and High values were taken from a broad cross-section of peer-reviewed research. Column J cites the sources of these values.[8]

For each variable listed in Column C, the cell in Column E displays the "in use" value. Most Mosaic users will use the suggested default, as it has the highest likelihood of accurately representing the value for that variable. However, through stakeholder knowledge, informed discussion or further research there may be circumstances where the high or low end of the range will provide a more accurate measure of that variable. In every case the new value should fall within the stated range unless further credible research is used and appropriately sourced.

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[8] The Most Likely value is based on the existing guidance, and documented in Column J. When the guidance provides low and high values, they have been incorporated into Mosaic as well. When low and high values were not available in the literature, Mosaic assumes that "Low" = 80 percent of the Most Likely value, and "High" = 120 percent of the Most Likely value.

Details and links to research are provided in the "References" and "Supporting Data" worksheets.

GENERAL INDICATOR	VARIABLE NAME	UNITS	IN USE	DISTRIBUTION	ORIGINAL VALUES		ORIGINAL UNITS	SOURCES	ADJUSTMENT
MODEL PARAMETERS									
VERSION 2.0									
September 3, 2014	Report Monetized Indicators in Dollars of 2013								
GENERAL ASSUMPTIONS									
ALL	Annualization Factor	Days per year	300		300	300	days	User-Defined	n/a
ALL	Unit for Display of Benefits	n/a	$1,000,000		$1,000,000	$1,000,000		User-Defined	n/a
ALL	Minimum and Maximum Scores	n/a	-5.0	Minimum	-5.0	-5.0	n/a	User-Defined	n/a
			5.0	Maximum	5.0	5.0	n/a	User-Defined	n/a
ALL	Real Discount Rate, all Benefit and Cost Streams other than Carbon emissions	% per year	4.0%	Most Likely	4.0%	4.0%	% per year	Consultants Recommendation	n/a
				Low	3.0%	3.0%	% per year	OMB Circular A-4	n/a
				High	7.0%	7.0%	% per year	OMB Circular A-4	n/a
Air	Real Discount Rate, Carbon emissions only	% per year	3.0%	Most Likely	3.0%	3.0%	% per year	IWGSCC 2010	n/a
				Low	1.4%	1.4%	% per year	IWGSCC 2010	n/a
				High	5.0%	5.0%	% per year	IWGSCC 2010	n/a
Cost	Adjustment to Capital Costs from Current Estimates	factor	1.000		1.000	1.000	factor	User-Defined	n/a
Cost	Adjustment to O&M and other Life-Cycle Costs from Current Estimates	factor	1.000		1.000	1.000	factor	User-Defined	n/a
MOBILITY									
Travel time	Value of time for PERSONAL trips, LOCAL travel	$2013 per person hour	$12.7	Most Likely	$12.7	$11.9	$2010 per hour	US DOT 2011 (a)	1.068
				Low	$8.9	$8.3	$2010 per hour	US DOT 2011 (a)	1.068
				High	$15.3	$14.3	$2010 per hour	US DOT 2011 (a)	1.068
Travel time	Value of time for BUSINESS trips, LOCAL travel	$2013 per person hour	$25.0	Most Likely	$25.0	$23.4	$2010 per hour	US DOT 2011 (a)	1.068
				Low	$20.0	$18.7	$2010 per hour	US DOT 2011 (a)	1.068
				High	$30.0	$28.1	$2010 per hour	US DOT 2011 (a)	1.068
Travel time	Value of time for PERSONAL trips, INTERCITY travel, all Surface Modes except High Speed Rail	$2013 per person hour	$17.7	Most Likely	$17.7	$16.6	$2010 per hour	US DOT 2011 (a)	1.068
				Low	$15.3	$14.3	$2010 per hour	US DOT 2011 (a)	1.068
				High	$22.9	$21.4	$2010 per hour	US DOT 2011 (a)	1.068
Travel time	Value of time for BUSINESS trips, INTERCITY travel, all Surface Modes except High Speed Rail	$2013 per person hour	$25.0	Most Likely	$25.0	$23.4	$2010 per hour	US DOT 2011 (a)	1.068
				Low	$20.0	$18.7	$2010 per hour	US DOT 2011 (a)	1.068
				High	$30.0	$28.1	$2010 per hour	US DOT 2011 (a)	1.068
Travel time	Value of time for PERSONAL trips, INTERCITY travel, High Speed Rail and Air	$2013 per person hour	$33.9	Most Likely	$33.9	$31.7	$2010 per hour	US DOT 2011 (a)	1.068
				Low	$29.1	$27.2	$2010 per hour	US DOT 2011 (a)	1.068
				High	$43.5	$40.7	$2010 per hour	US DOT 2011 (a)	1.068

Tabs: HELP | BUNDLES INFO | ADD PROGRAMS | CONTROL PANEL | INDICATORS | COST & SCHEDULE | **MODEL PARAMETERS** | TIME-VARYIN...

READY — 75%

Worksheet Relationships and Outputs

The model parameters entered into this worksheet inform the calculations on all of the blue-tabbed worksheets that contain one or more monetized indicators. These include the Mobility, Economic Vitality, Environmental Stewardship, Funding &Finance, Safety & Security, and Quality of Life sheets.

The model values in Column F affect the scoring of each bundle and its ultimate benefit/cost value. This in turn impacts the tool output sheets and, ultimately, the Control Panel.

If users select a value on the "Model Parameters" worksheet that is outside the recommended/ expected range for any of the specific indicators, the cell containing that value (Rows 166 through 215, Column B on the "Control Panel" worksheet) will be will be flagged in red with a message stating that the value is outside the recommended range. In this way, any values selected for the "Model Parameters" worksheet that are outside the expected range will be visible to users as part of the tool outputs, and should be cited and documented.

The relationship between the "Model Parameters" worksheet and the "Control Panel" worksheet allows users to test a range of values for the monetized indicators, and see immediately how changing a value will affect Mosaic outputs.

Instructions

Cells A7, A27, A68, A117, and A138 on this worksheet list Category, while Columns B and C on this list General Indicator and Variable Name, respectively. Column D identifies the units in which the value of each variable will be reported.

Column E, "In Use," is the place where users enter the value to be used for each monetized indicator. In addition to being flagged on the "Control Panel" worksheet, values outside the expected range will cause the cell in Column E to highlight in red.

Columns H and I, "Original Values" and "Original Units" are the original values used in the literature cited in the "References" worksheet and/or the "Supporting Data" worksheet. These values have been adjusted to the current year or unit; the adjustment is noted in Column K.

The first several rows of the "Model Parameters" worksheet (Rows 7 through 26) provide important pieces of information about how benefit estimates are calculated and/or presented. Row 8 indicates that the Annualization Factor for all travel data is 300 days per year and Row 10 identifies $1,000,000 as the unit of display for benefits.

In Rows 15 through 17, users enter in Column E the Discount Rate to be used in this application of the Mosaic. The suggested rate of 3 percent through 7 percent is based on the federal government's recommended rate. Rows 19 through 21 allow the user to select the Real Discount Rate for carbon emissions and enter it in Column E.[9] Column J identifies the sources for these conclusions and recommendations. As with other parameters, users can select a discount other than the suggested one, but selecting a value outside the range identified in Columns F and G should be sourced and documented.

Rows 12 and 13 identify the minimum and maximum scores -5 to +5 for the scaling (normalization) of quantitative values of specific indicators.

In Rows 28 through 213, users accept or enter a value for each monetized variable in Column E as described above.

Finally, Column B of Rows 216 and 217 contain a "Restore Default Parameter Values" button. This allows users to easily restore the Column E values originally suggested by the Mosaic Tool.

Users can run comprehensive sensitivity testing from the "Sensitivity" worksheet (see details on this worksheet later in this step of the User Guide).

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[9] Economists and scientists have reasoned that the future impacts of carbon emissions likely are severe enough that they warrant being discounted less (i.e., valued more highly in current dollars) than other impacts.

Time-Varying Assumptions

Worksheet Purpose

The "Time-Varying Assumptions" worksheet shows the calculations resulting from the application of time-varying assumptions (such as the discount rate or change in real income) to various indicators on an annual basis. No user inputs are required on this worksheet.

Worksheet Relationships and Considerations

Many of the row headings in this worksheet represent the variables listed in Column C of the "Model Parameters" worksheet. Column E ("Value or Initial Value") and Column F ("Distribution") also pull the low, high, most likely, and "in use" values for each variable from the "Model Parameters" worksheet.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	TIME-VARYING ASSUMPTIONS						Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
2	VERSION 2.0						2010	2011	2012	2013	2014	2015	2016	2017	2018
3	September 3, 2014														
4					VALUE or										
5	VARIABLE NAME	CATEGORY	SOURCE	UNIT	INITIAL VALUE	DISTRIBUTION									
6															
7	Discount Factor	GENERAL	Calculated	n/a	4.0%	In Use	1.125	1.082	1.040	1.000	0.962	0.925	0.889	0.855	0.822
8					4.0%	Most Likely	1.125	1.082	1.040	1.000	0.962	0.925	0.889	0.855	0.822
9					3.0%	Low	1.093	1.061	1.030	1.000	0.971	0.943	0.915	0.888	0.863
10					7.0%	High	1.225	1.145	1.070	1.000	0.935	0.873	0.816	0.763	0.713
11															
12	Discount Factor, Carbon emissions only	ENVIRONMENT	Calculated	n/a	3.0%	In Use	1.093	1.061	1.030	1.000	0.971	0.943	0.915	0.888	0.863
13					3.0%	Most Likely	1.093	1.061	1.030	1.000	0.971	0.943	0.915	0.888	0.863
14					1.4%	Low	1.043	1.028	1.014	1.000	0.986	0.973	0.959	0.946	0.933
15					5.0%	High	1.158	1.103	1.050	1.000	0.952	0.907	0.864	0.823	0.784
16															
17	Future Expected Growth in Labor Productivity and	MOBILITY	Calculated	Index	1.6%	In Use	0.953	0.969	0.984	1.000	1.016	1.032	1.049	1.066	1.083
18	Real Income, Base Year = 1.000				1.6%	Most Likely	0.953	0.969	0.984	1.000	1.016	1.032	1.049	1.066	1.083
19					1.0%	Low	0.971	0.980	0.990	1.000	1.010	1.020	1.030	1.041	1.051
20					2.0%	High	0.942	0.961	0.980	1.000	1.020	1.040	1.061	1.082	1.104
21															
22	Value of time for PERSONAL trips, LOCAL travel	MOBILITY	Calculated	$2013 per person hour	$12.7	In Use	$12.1	$12.3	$12.5	$12.7	$12.9	$13.1	$13.3	$13.5	$13.8
23					$12.7	Most Likely	$12.1	$12.3	$12.5	$12.7	$12.9	$13.1	$13.3	$13.5	$13.8
24					$8.9	Low	$8.5	$8.6	$8.7	$8.9	$9.0	$9.2	$9.3	$9.4	$9.6
25					$15.3	High	$14.6	$14.8	$15.0	$15.3	$15.5	$15.8	$16.0	$16.3	$16.5
26															

From Column G rightward, the cells in this worksheet are where the time-varying assumptions are applied by year to each of the values listed in Column A.

The first three variables listed on the worksheet are stated as a percentage rate: Discount Factor (Row 7), Carbon Emissions Only Discount Factor (Row 12), and Future Expected Growth in Labor Productivity and Real Income (Row 17). These are the time-varying assumptions that are applied to the remaining variables listed in Column A. The values in Columns G through BD represent these calculations for years 1 through 50.

The "Time-Varying Assumptions" worksheet shows how the value chosen in Column E of the Model Parameters worksheet plays out over time. The calculations in this worksheet are built into Mosaic; no user modification takes place directly on this worksheet. The values change only when the discount rates or real income change assumptions are altered on the "Model Parameters" worksheet or the base year is changed on the "Bundles Info" worksheet.

Load Travel Data and Travel Data Calculations

Worksheet Purpose

The "Load Travel Data" and "Travel Data Calculations" worksheets provide the framework for using independently generated travel demand model information within Mosaic. Travel demand models are important to Mosaic.

Worksheet Considerations and Relationships

Although the Mosaic Tool has been developed so that it can work in areas that do not have a travel demand model, the availability of travel demand model data significantly improves the functionality of the tool. The underlying assumptions within the travel demand model that improve Mosaic functionality include the location, type, and number of jobs and households in a region.

Critical information derived from a travel demand model includes the following:

- VMT per capita (Mobility category)

- Travel time (Mobility category, Economic Vitality category)

- Travel time reliability (Mobility category, Economic Vitality category)

- Hours of congestion (Mobility category, Economic Vitality category)

- User costs (Mobility category, Economic Vitality category)

- Mode split (Mobility category, Quality of Life category)

- Population and employment within ¼ mile of transit (Accessibility category)

- Transportation cost index (Accessibility category)[10]

Typically, planning processes use travel demand models to predict traffic conditions under "no build" and various build scenarios. To incorporate this process into Mosaic, an independent travel demand model is used to evaluate bundles of actions, including the following:

- Infrastructure projects, such as new roads or roadway expansion;

- Service improvements or changes such as increased transit service or increased or decreased speeds; and

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[10] Note that as of this writing, the Transportation Cost Index is not yet ready for use. Check on ODOT's project website for more information.

- Policy changes such as tolls or parking charges.

Information for all of these is coded into the travel demand model for each bundle. The model is run and outputs are provided that show trip volumes on the network, travel patterns, and mode split. This information is then input into the worksheets described below.

Instructions

Load Travel Data

Mosaic's "Load Travel Data" worksheet is designed to work within an existing planning process that uses a travel demand model. Two options for loading travel demand model information into the tool are available within the worksheet:

- Option 1: Load Disaggregated, or O-D (Origin Destination) Travel Data; and
- Option 2: Load Aggregated Travel Data (by Bundle & Mode)

Mosaic provides information on how alternative bundles of transportation projects and programs compare to some future "base case." The base case may be a future "no build" or "low build" bundle. A "current conditions" run of the travel model is also required in order for Mosaic to interpolate a stream of benefits from the future bundles, as shown in the figure. Current conditions travel data are generally needed for all monetized indicators. A list of indicators for which current conditions travel model data (highlighted in yellow) are generally needed is included in Table 2.
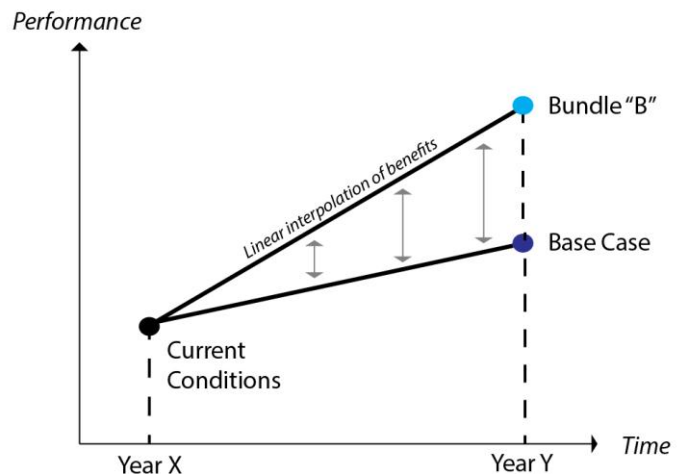
Table 2. Indicators for which current conditions data is generally needed		
Category	**Index**	**Specific Indicators**
Mobility	MO.1	Travel time
	MO.2	Hours of congestion
	MO.3	Reliability – Recurring congestion
	MO.4	Reliability – Nonrecurring congestion
	MO.5	User costs
	MO.6	Mode split
	MO.7	VMT per capita
Accessibility	AC.1	Transportation cost index
	AC.2	Population within X minutes between work and home
	AC.3	Location of industrial jobs in relation to the regional freight network
	AC.4	Population/emp within ¼ mile of a transit stop served by at least 30 vehicles per day
	AC.5	Amount of multiuse paths and bike boulevards
	AC.6	Sidewalk coverage
Economic Vitality	EV.1	Number of jobs created or retained by bundle, and associated income metrics
	EV.2	Changes in transportation costs by industry (business travel and freight)
	EV.3	Changes in employment by industry, and associated income metrics
	EV.4	Changes in productivity from increased connectivity
	EV.5	Changes in the total value of exports and imports
Environmental Stewardship	ES.1	Criteria air contaminants
	ES.2	Air toxics (Benzene and Diesel PM)
	ES.3	Life-cycle CO2e
	ES.4	Natural, built, and cultural resources at risk
Funding the Transportation System/Finance	FT.1	Capital costs
	FT.2	Other lifecycle costs
	FT.3	Total revenue
	FT.4	Share of lifecycle funds that are new or recycled
	FT.5	Net impact of program on state and local fiscal balance
Safety & Security	SA.1	Fatal, Injury A, and Injury B crashes
	SA.2	Property Damage Only (PDO) accidents
	SA.3	Emergency Management Systems (EMS) response times
	SA.4	Resiliency of the network
Land Use and Growth Management	LU.1	Population and employment change and distribution
	LU.2	Relative change in land value compared to base case or no action
Quality of Life and Livability	QL.1	Health benefits of active transportation
	QL.2	Quality of the travel environment
	QL.3	Noise impacts
Equity	EQ.1	Distribution of user benefits across population groups
	EQ.2	Distribution of PM and Diesel PM emissions across population groups
	EQ.3	Distribution of health benefits from active transportation across population groups
	EQ.4	Distribution of accident rates across population groups

Load O-D (Origin Destination) Travel Data

Users run the travel demand model for each bundle under consideration as they would in a typical planning process. They then load the trip and time tables into Mosaic using the navigation screen provided in this worksheet (see screenshot). All

relevant files are selected for each bundle, and then the user clicks the "load data" button to populate the "Travel Data Calc" worksheet within the Mosaic Tool.

The trip tables should be created as tab-delimited files, with the following information:

- Origin zone

- Destination zone

- Number of trips per day, during the peak period

  — By modeled year (current conditions and up to three forecast years)
  — By mode (for up to 8 modes)

- Number of daily trips off-peak

  — By forecast year
  — By mode

Similarly, the time tables should be created as tab-delimited files, with the following data:

- Origin zone

- Destination zone

- Distance between Origin and Destination, in miles

- Average trip time during the peak period, in minutes

  — By modeled year (current conditions and up to three forecast years)
  — By mode (for up to 8 modes)

- Average trip time off-peak, in minutes

    — By forecast year
    — By mode

- Free-flow (uncongested) travel time

An example trip table is provided in Table 3 below (see the Mosaic website for a more detailed version of this table). For most planning processes Option 1 (Load O-D travel data) will be adequate. However, in broader applications of Mosaic where the study area is either large or split into many zones, it will be more efficient to use the second option.

Table 3. Example Trip Table													
		PEAK						OFF-PEAK					
		2010			2035			2010			2035		
Origin	Destination	Mode 1	Mode 2	Mode 3	Mode 1	Mode 2	Mode 3	Mode 1	Mode 2	Mode 3	Mode 1	Mode 2	Mode 3
1	1	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
1	2	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
1	3	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
1	4	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
1	5	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
2	1	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
2	4	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
2	5	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
3	1	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
3	2	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
3	3	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
3	4	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
3	5	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
4	1	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
4	2	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
4	3	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
4	4	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
4	5	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
5	1	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
5	2	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
5	3	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
5	4	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592
5	5	1250	1000	1000	2160	1728	1728	1875	1500	1500	3240	2592	2592

Load Aggregated Travel Data

This option is best used in an area with a robust model or large area (1,000 traffic analysis zones [TAZs] or more). This option is comparable to Option 1, except that users run a script within their own travel demand model, and then load the results directly into the Mosaic Tool by clicking the "Load Aggregated Data" button shown in the screenshot below.

Note: Users select either the "Load O-D Travel Data" or the "Load Aggregated Travel Data" option, not both.

Travel Data Calculations

The travel demand data loaded into the tool through the "Load O-D Travel Data" or the "Load Aggregated Travel Data" option are displayed in the "Travel Data Calc" worksheet, and are used in that worksheet for further calculations. The data are organized by variable type (e.g., number of trips), bundle, mode (for up to eight modes), and modeled year. The screenshot below shows an example of intermediate calculations shown on the "Travel Data Calc" worksheet.

Worksheet Outputs

The "Load Travel Data" worksheet directly populate elements of the Mobility sheets, including the following:

- Number of person trips, per day
- Average travel time
- Average distance traveled
- Hours of congestion
- Travel time savings
- Travel time benefits
- VMT
- User cost savings

Travel demand model outputs also inform some MODA indicators within the "Accessibility" worksheet (including the Transportation Cost Index indicator[11] and the Location of Industrial Jobs in Relation to the Regional Transportation Network indicator), and help inform the development of monetized indicators within the "Quality of Life" worksheet (including the Reduced Incidence of Disease Due to Active Transportation indicator), and "Safety & Security" worksheet (Fatal and Injury Crashes indicator).

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[11] As noted previously, the Transportation Cost Index is not ready for use as of this writing.

Other Input Data

Worksheet Purpose

The "Other Input Data" worksheet is where users enter information about travel costs, population, expected population growth over time, and urban/rural population distribution. These data inform the calculations on several of the blue-tabbed indicator worksheets.

Instructions and Worksheet Relationships

Transportation Data and Assumptions (Row 7)

This section allows users to specific assumptions related to travel demand model data. User-specified settings include the following:

- **Definition of modes (Row 13)**—In this section, users specify which travel modes are represented in the travel data in Column C. Next, users need to specify how indicators MO.6, MO.2, and MO.7 are calculated. In Cells D and E, users specify how mode split (MO.6) will be calculated. In Column G, users specify which modes should be included in congestion estimation (generally auto and truck modes). In Column J, users specify which modes will be used to estimate VMT per capita. Finally, in Columns L through N, users specify which aspects of travel time – in vehicle, access, and waiting – are to be accounted for.

- **Distribution of trip purpose (Row 24)**—This section allows users to specify the distribution of trip purpose. This information may come from travel demand modelling staff or other resources. This distribution is important in estimating benefits for many indicators, e.g., estimating increases business or freight travel costs for Economic Vitality indicators.

- **Distribution of trip distance (Row 34)**—The user can specify what proportion of travel is local, intercity, etc. for both personal and business travel.

- **Number of person trips and average vehicle occupancy (Row 45)**—The user can specify persons per vehicle for each mode (for "walk" and "bike" modes, the number of persons should be 1.0). Users can change these occupancy settings based on available local data.

- **Bundle-specific travel data and assumptions, average cost per mile (Rows 64 through 122)**—This area allows users to establish the per-mile user costs associated with each transportation mode.

Demographic Data and Assumptions (Row 141)

Before entering data into this worksheet, users must coordinate with Oregon's population research center which maintains official population numbers and forecasts (https://www.pdx.edu/prc/. The following information will be needed about the project area:

- Population of the study area as of the base year
- Percent of the total population located in an urban area

- Average annual growth in population, including projections about future urban/rural split

Users then enter this information into the appropriate cells as shown in the screenshot above. The table headings will automatically populate with information from the "Bundles Info" worksheet, including the base year, selected travel demand forecast years, and the last year of analysis. Following are the steps for entering this information.

1. First, enter the base year population of the study area into Cell D146.

2. Next, enter the growth rate in Column H (Cells 146 through 156). The rate is copied into the cell in Column H for each bundle.

3. Then enter into Cell D160 the percentage of the total population living in an urban area.

4. Finally, users can enter the estimated percentage of population in an urban area for each of the travel demand forecast years and for the last year of analysis.[12] This information is entered into Columns E, F and G for each bundle. However, this information is not directly used in any calculations in Mosaic. This information is for reporting purposes only.

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[12] In addition to demographic data, users may need to work with their travel demand forecaster to get information about population growth by Transportation Analysis Zone (TAZ).

Weight Categories and Weight Indicators

WORKSHEET GROUP: ASSUMPTIONS AND INPUT DATA

Worksheet Purpose

The "Weight Indicators" and "Weight Categories" worksheets are where users enter the results of the stakeholder weighting process for MODA indicators. The scores resulting from the MODA process play a critical role in the Mosaic outputs as they provide a basis for comparing monetized and nonmonetized indicators.

Worksheet Considerations

After selecting which indicators will be evaluated by qualitative or quantitative measures on the Indicators worksheet, the Mosaic user must conduct a MODA weighting process as described in Step 3 of the Mosaic User Guide.

Instructions

As noted above, users must conduct a MODA weighting process, as follows, before these worksheets can be completed:

- If the MODA process was conducted in a "Categories first, then Indicators" (top-down) manner, the user enters the category scores first into the Weight Categories" worksheet.

- If the MODA process was conducted in a "Weight Indicators, then Categories" (bottom-up) manner, the user does will not enter anything into the "Weight Categories" worksheet, but goes directly to the "Weight Indicators" worksheet to enter the scores for each MODA indicator.

Weight Categories

On the "Weight Categories" worksheet, users enter the MODA weighting results if that process was completed by category first. (If the MODA process was conducted in an "Indicator-first" manner, then skip the "Weight Categories" worksheet and proceed directly to the "Weight Indicators" worksheet.)

Enter the weights for each category in the "User Defined" column (Column D). The user-defined weights should add up to a total of 100, as shown in the screenshot example below. The chart labelled "TOP DOWN" will only display if users are weighting categories first. These are the only user inputs required on this worksheet. The rest of the "Weight Categories" worksheet is a series of charts that allows the user to compare the results of the top-down (Categories first) with the bottom-up (Indicators, then Categories) weighting processes.

	A	B	C	D	E	F	G
1		SPECIFYING WEIGHTS AT THE CATEGORY LEVEL					
2		VERSION 2.0 with METRO Data & April 30 2014 Test Committee Weights					
3		November 26, 2014					
4							
5							
6			CATEGORIES	USER DEFINED TOP-DOWN (ENTER CATEGORY-LEVEL WEIGHTS IN CELLS BELOW)	USER DEFINED BOTTOM-UP (CALCULATED FROM INDICATOR-LEVEL WEIGHTS)	WEIGHTS PROPORTIONAL TO NUMBER OF INDICATORS IN MODA	EQUAL WEIGHTING
7	1	MOBILITY	10.0	10.0	11.8	11.1
8	2	ACCESSIBILITY	15.0	15.0	29.4	11.1
9	3	ECONOMIC VITALITY	20.0	20.0	5.9	11.1
10	4	ENVIRONMENTAL STEWARDSHIP	5.0	5.0	11.8	11.1
11	5	FUNDING / FINANCE	5.0	5.0	11.8	11.1
12	6	SAFETY & SECURITY	12.0	12.0	11.8	11.1
13	7	LAND USE & GROWTH MANAGEMENT	13.0	13.0	5.9	11.1
14	8	QUALITY OF LIFE		0.0	0.0	11.1
15	9	EQUITY	20.0	20.0	11.8	11.1
16		TOTAL POINTS	100.0	100.0	100.0	100.0

TOP-DOWN

- MOBILITY
- ACCESSIBILITY
- ECONOMIC VITALITY
- ENVIRONMENTAL STEWARDSHIP
- FUNDING / FINANCE
- SAFETY & SECURITY
- LAND USE & GROWTH MANAGEMENT
- QUALITY OF LIFE
- EQUITY
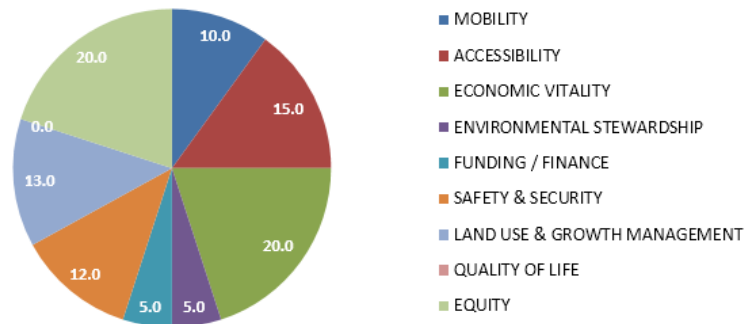
The category weights are automatically transferred to the "Weight Indicators" sheet to aid in entering the correct weight for specific indicators. With the "categories first" approach, users are required to enter the weights for each specific indicator on the "Weight Indicators" sheet. It is important to note that the total weight given to all specific indicators within a category must equal the weight given for that category. For example, in the screenshot below, the top-down category weight for the "Mobility" category is 15 points. The two specific indicators that are part of MODA – MO.3 and MO.4 – must have a combined total weight of exactly 15 points. In this example, MO.3 is given 8 points and MO.4 is given 7 for a total of 15.

CATEGORY	WEIGHT OF CATEGORY (TOP-DOWN)	WEIGHT OF CATEGORY (BOTTOM-UP)	GENERAL INDICATORS	INDEX	SPECIFIC INDICATORS	USE IN MOSAIC	WEIGHT OF INDICATOR (USER DEFINED)
MOBILITY	15.0	15.0	Travel Time	MO.1	Travel time	BCA	
				MO.2	Hours of congestion	REPORT	
			Quality of Service	MO.3	Reliability – Recurring congestion	MODA	8.0
				MO.4	Reliability – Non-recurring congestion	MODA	7.0
			Out of Pocket Costs	MO.5	User costs	BCA	
			Travel Characteristics	MO.6	Mode split	REPORT	
				MO.7	VMT per capita	REPORT	
ACCESSIBILITY	10.0	10.0	Proximity	AC.1	Transportation cost index	REPORT	
				AC.2	Population within X minutes between work and home	MODA	2.5
			Connectivity/Ease of Connections	AC.3	Location of industrial jobs in relation to the regional freight network	MODA	2.5
			Modal Availability	AC.4	Population and employment within ¼ mile of a transit stop served by at least 30 vehicles per day	MODA	3.0
				AC.5	Amount of multi-use paths and bike boulevards	MODA	1.0
				AC.6	Sidewalk coverage	MODA	1.0

Weight Indicators

The "Weight Indicators" worksheet is where users enter the values for individual indicators. This worksheet must be completed for all Mosaic applications, regardless of whether the MODA process weighted categories or indicators first.

Columns A and D list the Mosaic Categories and General Indicators, respectively. Columns E and F list specific indicators. Column G ("Use in Mosaic") pulls the chosen means of measurement for each of those indicators from the "Indicators" worksheet.

After running the MODA evaluation process described in Step 3, users enter the weights for each MODA indicator in Column I ("Weight of Indicator, User Defined"). The scores should add up to a total of 100 points. The total number of points will be noted in in Cells H2 and H3 at the top of the worksheet.

Columns B and C (see screenshot below) are where the allocation of points are displayed for each category, depending on whether the MODA scoring was done in a top-down (Category, then Indicator) or bottom-up (Indicator, then category) manner. Column B pulls the total weight for the Category from the "Weight Categories" worksheet, while Column C totals the user-defined indicator weights from Column H.

	B	C	D	E	F	G	H
1	S AT THE SPECIFIC INDICATOR LEVEL						
2	TRO Data & April 30 2014 Test Committee Weights						100.0 pts
3							
4							
5	WEIGHT OF CATEGORY (TOP-DOWN)	WEIGHT OF CATEGORY (BOTTOM-UP)	GENERAL INDICATORS	INDEX	SPECIFIC INDICATORS	USE IN MOSAIC	WEIGHT OF INDICATOR (USER DEFINED)
6	0.0	10.0	Travel Time	MO.1	Travel time	BCA	
7				MO.2	Hours of congestion	REPORT	
8			Quality of Service	MO.3	Reliability – Recurring congestion	MODA	6.0
9				MO.4	Reliability – Non-recurring congestion	MODA	4.0
10			Out of Pocket Costs	MO.5	User costs	BCA	
11			Travel Characteristics	MO.6	Mode split	REPORT	
12				MO.7	VMT per capita	REPORT	
13	0.0	15.0	Proximity	AC.1	Transportation cost index	REPORT	
14				AC.2	Population within X minutes between work and home	MODA	3.0
15			Connectivity/Ease of Connections	AC.3	Location of industrial jobs in relation to the regional freight network	MODA	4.0
16			Modal Availability	AC.4	Population and employment within ¼ mile of a transit stop served by at least 30 vehicles per day	MODA	6.0
17				AC.5	Amount of multi-use paths and bike boulevards	MODA	1.0
18				AC.6	Sidewalk coverage	MODA	1.0

Column J shows the lowest score assigned by users for the indicator listed in each row; Column L, the highest. Column K shows the value of the specific indicator corresponding to a score of 0 (when the minimum possible score is set to 0 in Cell E19 of the "Model Parameters" worksheet). Column M shows the value of the specific indicator associated with a score of 10 (when the maximum possible score is 10), respectively, for each indicator. These values are pulled from the blue calculation sheets. This information helps users determine which indicators have a significant enough impact to "move the needle" in evaluating bundles.

Column O is where the Mosaic Tool rescales MODA weights to 100 percent if the total number of points adds up to fewer or more than 100. (This would happen as a result of sensitivity testing, if the user recategorized an indicator from MODA to monetized or vice versa, thus changing the initial allocation of MODA points).

Column N is a yes/no toggle indicating whether that indicator is included in the MODA analysis, and Columns P through Z simply report the scores values (pulled from the blue calculations worksheets) for the different indicators.

Sensitivity Testing

After the initial Mosaic run has been completed and the results evaluated (see Steps 5 and 6 of the User Guide) the "Weight Indicators" worksheet is designed to accommodate sensitivity testing of the Mosaic outputs. Additional sensitivity testing can be accomplished in the "MODA Sensitivity" worksheet.

In some cases, as part of the sensitivity testing process, users may decide to shift the evaluation method for a specific indicator from MODA (qualitative or quantitative) to monetized scoring – or vice versa. This change would be entered on the "Indicators" worksheet. However, such a change gives rise to the need for reallocation of weighting points among the newly redefined set of MODA indicators.

On the "Weight Indicators" worksheet, Cells H2 and H3 at the top of the worksheet also reports the total number of points distributed. (As described above, the total number of MODA points in the initial Mosaic run will be 100).

At this point in the sensitivity testing process, the user has two choices:

- Accept the recalculated weighting percentages that the Mosaic Tool is programmed to generate automatically when the total number of points is less or greater than 100; or

- Reassign any "extra" points manually by changing the assigned weights of specific indicators in Column H.

In either case, users will need to explain the adjustments to stakeholders and decision makers as part of the sensitivity testing process.

Introduction: Indicators

The following sections detail user entry for the specific indicators within the nine Mosaic categories of impact. Some general instructions, applicable to all of these worksheets, are included below.

Throughout Step 4, screenshots of the Mosaic tool are used to illustrate certain instructions. The screenshots show data entry and outputs from the Mosaic tool. It is important to note that the data used in the screenshots is purely for illustrative purposes and does not represent data from an actual application of Mosaic.

Inputs

The years analyzed in all worksheets are established in the "Bundles Info" worksheet in Cells C11 through G11 (as shown in the screenshot of MO.1 Travel Time at right). These are user inputs and coincide with the analysis years available and/or established for the pertinent traffic analysis. For all indicators that are used in MODA or "report only", users must choose a year or value to use in MODA scoring. Users can choose any year of analysis or

an average of the years (this choice is made in Cell D32 in the screenshot above). The chosen year (or average) is then used to generate scores for MODA indicators.

Next, the "Indicators" worksheet is where users determine whether specific indicators will be monetized or whether they will be scored quantitatively, qualitatively, or reported. Decisions made in this "Indicators" worksheet will in turn tell the user which part of each of the category worksheets must be populated.

Those indicators that depend on travel data information (including most of the Mobility indicators, some of the Economic Vitality indicators, and others) from "Travel Data Calc" worksheets are automatically populated into the tool (depending on which reporting option the user chose for the indicator). Additionally, assumptions established in the Model Parameters, Economic Data, and Other "Inputs" worksheets are used to calculate the values found in many of the indicators.

If users determine in the "Indicators" worksheet that an indicator should be scored quantitatively or qualitatively, the weights allocated in the "Weight Category" or the "Weight Indicator" worksheets would inform the "In MODA" scoring section (various columns, depending on the specific indicator) of the relevant worksheet. Indicators that are "report only" do not impact Mosaic outputs.

For qualitative scoring of indicators, users would rate the anticipated performance of each bundle on a scale of -5 to +5. For example, a score of "-5" would indicate that the bundle does not help reduce nonrecurring delay, whereas a score of "+5" would indicate that the bundle does a tremendous job at reducing nonrecurring delay. Scores are then weighted according to how stakeholders have rated the indicator and/or the category (see "Weighting" worksheet). See the instructions for the "Indicators" worksheet for further details.

Mobility

Worksheet Purpose

The "Mobility" worksheet is the location where technical Mosaic users can locate all detailed data related to the seven Mobility-specific indicators. Although this worksheet interacts with several other sheets within Mosaic, and is largely auto-populated by a travel demand model, this location is the only one where micro-level data on each mobility indicator can be found. ***Users are cautioned to work closely with travel model staff to understand travel model outputs, their use in Mosaic, and the resulting outputs from the Mosaic Tool.***

Worksheet Considerations

Following are the seven specific indicators in the "Mobility" worksheet:

- MO1. Travel Time
- MO2. Hours of Congestion
- MO3. Reliability (Recurring)
- MO4. Reliability (Non-Recurring)
- MO5. User Costs
- MO6. Mode Split
- MO7. VMT per Capita

Three of the above—hours of congestion, mode split, and VMT per capita—are "Report Only" indicators. Both reliability indicators—MO.3 and MO.4—may be quantitatively or qualitatively evaluated. MO.1 Travel Time and MO.5 User Costs may be monetized.

Once users have loaded data from their travel demand model—or input travel information from other sources and described in the "Load Travel Data" worksheet—most of the cells in the "Mobility" worksheet are automatically populated. Information automatically populating Columns D through G provides Mobility findings by bundle for various report years (as established in the "Bundles Info" worksheet). Furthermore, if users have selected the monetized, scored quantitatively, or report only options these also are automatically populated for each indicator. For monetized reporting, this is done largely in Columns H and I, which are total monetized value and present value respectively. Quantitative reporting is done by analysis year (for example, 2012, 2020, 2030, etc.). The screenshot below shows an illustration of data from the travel demand model that is reported both in monetized and quantitative terms for the Travel Time indicator. Qualitative scoring is done by the user based on data provided by reporting year. This is described in the Tool Instructions section below.

	MO.1	TRAVEL TIME						
7								
8	1		Treatment in MOSAIC : Monetized					
9			Assigned Weight : 0.0%					
10								
11	PERSONAL TRAVEL TIME SAVING RELATIVE TO BASE CASE, HOURS PER DAY		2010	2035	n/a	n/a	TOTAL MONETIZED SAVINGS*	PRESENT VALUE OF SAVINGS**
12	Base Case	2035 Low Build	0	0	n/a	n/a	$0	$0
13	Bundle_1	Roadway & Capacity		5,950	n/a	n/a	$760	$422
14	Bundle_2	Transit		3,679	n/a	n/a	$470	$261
15	Bundle_3	Active Transport & Programs		469	n/a	n/a	$87	$48
16	Bundle_4	n/a		n/a	n/a	n/a	n/a	n/a
17	Bundle_5	n/a		n/a	n/a	n/a	n/a	n/a
18	Bundle_6	n/a		n/a	n/a	n/a	n/a	n/a
19	Bundle_7	n/a		n/a	n/a	n/a	n/a	n/a
20	Bundle_8	n/a		n/a	n/a	n/a	n/a	n/a
21	Bundle_9	n/a		n/a	n/a	n/a	n/a	n/a
22	Bundle_10	n/a		n/a	n/a	n/a	n/a	n/a

Instructions

If using a travel model, indicators MO.1, MO.2, MO.5, MO.6, and MO.7 are automatically populated from the "Travel Data Calc" worksheet. User input in the "Mobility" worksheet is therefore generally limited to two areas: (1) qualitative scoring (if users do not have access to a travel model, or prefer to score qualitatively) and (2) values used in MODA/reporting. Additional instructions for these indicator are as follows:

- **MO.2 Hours of Congestion:** this indicator is automatically populated, though users must choose which modes to include in the congestion analysis in the "Other Input Data" worksheet in cells G15 to G22. The number of hours of congestion are calculated based on all trips that have travel times different from "free flow" conditions; that is, all trips delayed in comparison to free flow conditions are included in the calculation of Hours of Congestion.

- **MO.3 and MO.4 (reliability indicators):** It is recommended that the two reliability indicators – MO.3 Recurring Congestion and MO.4 Non-Recurring Congestion – be evaluated with qualitative scoring, unless the Mosaic user has quantitative information from another source to enter. The reliability indicators are not monetized.

  A recently issued report from the Strategic Highway Research Program (SHRP2) offers an extensive overview of techniques to evaluate reliability quantitatively and qualitatively. Users may want to consult the publication *Incorporating Reliability Performance Measures into the Transportation Planning and Programming Processes.*[13]

The following section describes quantitative and qualitative scoring and choosing values used in MODA reporting:

- **Quantitative Scoring—**If users choose to score Mobility indicators quantitatively they have the ability to do so by selecting "Quantitative Scoring" in the "Indicators" worksheet, Column E. They are able to do this for all indicators *except* those that are report only. As described above, loading

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[13] Available from https://www.fhwa.dot.gov/goshrp2/ (March 2013)

travel data will automatically populate Columns D through G. With this method, the quantitative scores will be automatically calculated on a -5 to +5 scale. No further user input is needed.

- **Qualitative Scoring**—Users without access to a travel demand model may choose to score Mobility indicators qualitatively by selecting "Qualitative Scoring" in the "Indicators" worksheet, Column E. They are able to do this for all indicators *except* those two that are report only. Mosaic users should employ available data and professional judgment to determine qualitative scores for the mobility indicators. For example, if scoring MO.1 Travel Time qualitatively, Mosaic users may consider the number of projects in bundles that add travel lane capacity, increase transit service frequencies, or improve intersection function. These factors generally improve travel times; bundles with more of these projects may score higher as a result.

The following screenshot provides an example to help show how this scoring is done.

Accessibility

Worksheet Purpose

The "Accessibility" worksheet is where Mosaic users will go to input detailed data related to the six Accessibility-specific indicators. This location is the only one where specific data on each accessibility indicator can be found by bundle.

Worksheet Considerations

Following are the six specific indicators in the "Accessibility" worksheet:

- AC1. Transportation Accessibility Index

- AC2. Population within 45 Minutes between Home and Work

- AC3. Location of Industrial Jobs in Relation to the Regional Freight Network

- AC4. Population and Employment within ¼ Mile of a Transit Stop Served by at least 30 Transit Vehicles a Day

- AC5. Multiuse Paths and Bicycle Boulevards

- AC6. Sidewalk Coverage

All of the Accessibility indicators are either MODA (quantitative or qualitative scoring) or Report Only. The data used to populate these indicators either come from the land use assumptions and travel characteristics of a travel demand model, or from the agency's GIS. All analysis performed to populate this worksheet is done outside Mosaic. Therefore, user input in this worksheet is high. Guidance on how to populate the cells in this worksheet it provided in the Tool Instructions section below.

Instructions

User input is central to the "Accessibility" worksheet. What is provided in the tool is the framework for users to input information taken from outside sources. This selection will tell the user which part of the "Accessibility" worksheet they will enter information – Columns I through L for quantitative scoring or Column N for qualitative scoring. Instructions specific to each indicator are as follows:

- **AC1. Transportation Cost Index**—The Transportation Cost Index (TCI) looks at the relative changes in the generalized cost (including travel time and out-of-pocket costs) of accessing goods, services, and daily activities using various transportation modes. The concept is similar to the Consumer Price Index, where the generalized cost of a "basket" of trips (representing different modes, geographies, and trip purposes) is estimated under different planning options. The information is derived from travel demand model data and is aggregated from TAZ-level output. Benefits or effects allocated to a given area would include all benefits or effects attributable to trips starting

(or ending) in the area. More information on developing this specific indicator is found in ODOT's *Transportation Planning Performance Measures* final report SPR 357 (October 2005). *Note that as of August, 2014, the TCI is not yet ready for use. Users of Mosaic are advised to not use this indicator until such time that the TCI is available.* Check the TCI website for updates: http://www.oregon.gov/ODOT/Programs/ResearchDocuments/SPR760_TCIFinalReport.pdf

- **AC2. Population Within 45 (or X) Minutes between HOME and WORK**—This specific indicator measures the percentage of the population that is able to travel between work and home within 45 (or X) minutes. Users determine what length of time constitutes a "reasonable" distance between work and home in Cell C38 (see screenshot below). This is dependent on whether the area is urban or nonurban, whether the geography is large or small, and what is considered a "reasonable time."

Next, users determine the origin and the destination trip purposes – HOME and WORK are provided as default values but other trip purposes from a travel demand model can also be selected.

The other cells that are populated for this indicator are those in Rows 43 through 53, Columns D through G. This analysis is done outside Mosaic, largely via a travel demand model though GIS could be used as well. Travel demand models will hold information about the origin

TAZ and destination TAZ by trip purpose. Distances between these TAZs is established most commonly from TAZ centroid to TAZ centroid. Rough contours can then be established to determine the distance by which travelers can go within their established "reasonable time." Users then calculate the percentage of trips by origin TAZ that are within this contour and report out that percentage.

If the user has chosen to score this indicator quantitatively, the cells in Columns I through L will automatically populate. If the user is scoring the indicator qualitatively, they will need to populate Column N on a rating of -5 to +5, using the numbers in Columns D through G to do so.

- **AC3. Location of Industrial Jobs in Relation to Regional Freight Network**—This specific indicator measures the number of industrial jobs located within a certain distance or travel time (determined by user) from the regional freight network. This analysis is done outside Mosaic and entered into Columns D through G as shown in the example below.

To conduct this analysis to determine the number of jobs within "x" minutes of the regional freight network, users would do the following:

— Identify specific parcels or TAZ centroids (e.g., a key intersection in an industrial district or a key industrial employment center) that would serve as reference points.

— Next, users would work with travel demand model staff to determine the number of jobs available within a certain travel time from that parcel or centroid.

Alternatively, users may estimate the number of industrial jobs within a certain spatial distance of the regional freight network, calculations would be performed as follows in GIS:

— Confirm that layers identifying the regional freight network (often classified as major or principal arterials, sometimes includes minor arterials as well), and jobs by labor classification

are available. Some areas will have this at a parcel level – this is preferred. However most areas will have this by TAZ (often part of the travel demand model's underlying land use assumptions).

— Define how distance between jobs and the regional freight network will be determined (e.g., by parcel, or by TAZ centroid).

— Run a query in GIS to determine number of jobs within x distance of the network by period of analysis and by bundle.

If the user has chosen to score this indicator quantitatively, the cells in Column L will automatically populate. If the user is scoring the indicator qualitatively, they will need to populate Column N on a rating of -5 to +5.

- **AC.4 Population & Employment Within ¼ Mile Of Transit Stop Served By At Least 30 Vehicles Per Day—**This specific indicator measures the number of households and jobs located within ¼ mile from a transit stop that is served by at least 30 vehicles per day. This indicates access to quality transit service. The distance to a transit stop is based on the distance that people are willing to walk to and from that transit stop. This distance may be modified by the user.

The acceptable transit service frequency is set at 30 vehicles per day, which is an assumed minimum service threshold for quality, reliable transit operations. The 30 vehicles per day is defined by the stop which could be served by multiple buses and/or multiple directions of service.

Distances to transit stops can be calculated through a spatial analysis of data on the location of population/employment and data on the locations of transit stops. This query can be done entirely within a GIS.

The direct distance to a transit stop compared to the actual walking distance may be different. The simplest method of analysis would be to create a buffer of ¼ mile from the location of the transit stop and consider all households and jobs within that buffer. This could be modified by the user to be a smaller buffer if the access to the transit stop is difficult due to natural or man-made barriers. Buffers should be made so that they cannot permeate barriers such as freeways or ridges where access is impossible. Furthermore network analysis within GIS could be performed so that the ¼ mile buffer is along streets, and not as the bird flies.

Data on transit stops and service frequency can be obtained from transit agencies. The same data is provided in files meeting the General Transit Feed Specification (GTFS). To measure current conditions:

— Gather population data from U.S. Census Block data or from parcel data that locates dwellings/residential units.

— Employment and population information may be available through an MPO's GIS files, or from the travel demand model's land use assumptions. If the latter this will be available at a Traffic Analysis Zone (TAZ) level.

— For future conditions, users may know the location of transit routes, but not necessarily the service frequency or the location of stops. Some assumptions may need to be made to allow forecasting. For example, for the baseline forecasting may be done assuming current transit service, or transit service including the transit agency's transportation improvement plan, but with future employment and population projections. It is assumed that the bundles of actions will include transit service and infrastructure investments.

- **AC5. Amount of Multiuse Paths and Bike Boulevards, in Miles—**This indicator determines the accessibility of the network of bicycle facilities (such as multiuse paths, bike lanes, and boulevards) as a measurement for the availability of bicycling as a modal option. The indicator can be estimated as the total mileage of multiuse paths and bike boulevards, under various plans or bundles. Alternatively, the indicator can be expressed as an index, with a value of 100 in the base case (i.e., the do minimum scenario against which all plans or bundles will be assessed). This analysis is done outside Mosaic and entered into Columns D through G as shown in the example below. Calculations would be performed as follows in GIS:

— Confirm that layers identifying the network of multiuse paths and bike boulevards for each bundle.

— Run a query in GIS to determine the total lane mileage of the multiuse path and bike boulevard system for each bundle, for each period of analysis.

If the user has chosen to score this indicator quantitatively, the cells in Column L will automatically populate. If the user is scoring the indicator qualitatively, they will need to populate Column N on a rating of -5 to +5, using the numbers in Columns D through G or with other data available.

- **AC6. Sidewalk Coverage—**This specific indicator measures the network of pedestrian facilities (such as sidewalks and paths) as an indicator of pedestrian modal availability. The availability of sidewalk coverage data may vary across geographies. Robust data are found in many urban areas, but the indicator may be difficult to estimate accurately in rural Oregon. On some occasions, neighborhood organizations can be employed to gather this data for smaller cities.

— Sidewalk coverage may be defined in multiple ways. Portland's Metro for example uses two related measurements estimated:

Sidewalk Density = Sidewalk miles / gross acre
  o   Sidewalk Coverage = Sidewalk miles / roadway centerline miles

— This analysis is done outside Mosaic and entered into Columns D through G as shown in the example below. Calculations would be performed as follows in GIS:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	ACCESSIBILITY CATEGORY														
2	ESTIMATION OF SPECIFIC INDICATORS														
3	VERSION 2.0 with METRO Data & April 30 2014 Test Committee Weights														
4	November 26, 2014														
5															
146	AC.6		SIDEWALK COVERAGE												
147	2		Treatment in MOSAIC : Quantitative Scoring												
148			Assigned Weight : 7.7%												
149															
150	SIDEWALK MILES / ROADWAY CENTERLINE MILES			2010	2035	n/a	n/a					QUANTITATIVE SCORING		DIRECT SCORING	
151	Base Case	2035 Low Build		0.42	0.44							0.0		n/a	
152	Bundle_1	Roadway & Capacity			0.44							0.0		n/a	
153	Bundle_2	Transit			0.44							0.0		n/a	
154	Bundle_3	Active Transport & Programs			0.57							5.0		n/a	
155	Bundle_4	n/a										n/a		n/a	
156	Bundle_5	n/a										n/a		n/a	
157	Bundle_6	n/a										n/a		n/a	
158	Bundle_7	n/a										n/a		n/a	
159	Bundle_8	n/a										n/a		n/a	
160	Bundle_9	n/a										n/a		n/a	
161	Bundle_10	n/a										n/a		n/a	
162															
163									Active Base Case						
164		Local minimum value			0.44				0.44						
165		Local maximum value			0.57										
166									Suggested Values						
167		Minimum value used in scoring		0.31	-5.0				0.31						
168		Maximum value used in scoring		0.57	5.0				0.57						
169															
170		Value used in MODA/REPORTED		2035											
171															

- Confirm that layers identifying the sidewalks, paths, and marked street crossings are available.

- Run a query in GIS to determine length of pedestrian network.

- Divide the total sidewalk mileage by the number of center lane road miles.

If the user has chosen to score this indicator quantitatively, the cells in Column L will automatically populate. If the user is scoring the indicator qualitatively, they will need to populate Column N on a scale of -5 to +5, using the numbers in Columns D through G.

Economic Vitality

Worksheet Purpose

The "Economic Vitality" worksheet is the location where Mosaic users can locate all detailed data related to the five Economic Vitality-specific indicators. This worksheet interacts with several other sheets within Mosaic, and is largely auto-populated by information entered in other sheets. This location is the one where micro-level data on each Economic Vitality indicator can be found.

Worksheet Considerations

Following are the five specific indicators in the "Economic Vitality" worksheet:

- EV1. Number of jobs associated with bundle, and associated income metrics
- EV2. Changes in transportation costs by industry (business travel and freight)
- EV3. Changes in employment by industry, and associated income metrics
- EV4. Changes in productivity from increased connectivity (agglomeration effects)
- EV5. Changes in the total value of exports and imports

Economic Vitality has more "Report Only" indicators than any other category – three of the above five indicators (EV1, EV3, and EV5) are Report Only. While these indicators are easily understood and are important to policy makers and citizens, the value associated with the number of jobs, the changes in employment, and the changes in the total value of imports and exports are all reported through other indicators.

The data used to populate these indicators come largely from one of three sources – running a travel demand model, running an input/output model, or using output from the Statewide Integrated Model (SWIM), if available. SWIM outputs for Mosaic purposes are not yet available as of fall, 2014; use of other sources for this data is recommended. Most of the cells within this worksheet are populated when cost and schedule information (see "Cost & Schedule" worksheet) is filled out for each bundle. Therefore, user input in this worksheet is low. Guidance on how and where a user can enter data in the worksheet is provided in the Tool Instructions section below.

Worksheet Relationships and Outputs

This worksheet interacts with others in the Mosaic Tool as follows:

Inputs

The following three sketch models provided in the "Sketch Models" worksheet inform the "Economic Vitality" worksheet:

- **Model for Estimating the Employment Effects of Construction Spending** (informs EV1, with models derived from IMPLAN data and runs for the State of Oregon and from the Council of Economic Advisors)

- **Model for Estimating the Economic Impacts of Transportation Improvements** (informs EV3, with models created for Mosaic to determine impacts on industry costs and on labor demand)

- Model for Estimating Agglomeration Effects (informs EV4)

The "Economic Data" worksheet specifically supports the "Economic Vitality" worksheet, and contains a large amount of information related to jobs created by labor category from construction by NAICS code and IMPLAN (Oregon dataset), data from the 2007 Oregon Economic Census, from the Bureau of Labor Statistics. These numbers are used in conjunction with bundle-specific data through "Travel Data Calc," "Cost & Schedule," or "Bundles Info" worksheets to populate cells in the "Economic Vitality" Worksheet.

Benefits monetized in the "Economic Vitality" worksheet are based on the reduction in travel time and changes in user costs associated with bundles of investments. These changes are quantified through the travel demand model outputs and calculated in the "Travel Data Calc" worksheet.

Instructions

For the two "report only" indicators (EV2 and EV4), users will have first selected through the "Indicators" worksheet whether the indicator would be monetized, quantitatively or qualitatively scored, or just reported as raw values. This selection will tell the user which part of the "Economic Vitality" worksheet they will enter information.

Also for each indicator users must enter the "Value used in MODA/Reported" listed in Columns D. These options are aligned with the periods of analysis that are selected in the "Bundles Info" worksheet. Users can select one of these values, or an average of the three.

Following are instructions specific to each indicator:

- **EV1. Number of Jobs Associated with Plan or Action**—Users are asked to enter information for two sections to create this indicator:

  — Whether to use the Council of Economic Advisors "Simple Rule" (see "Sketch Models" worksheet Rows 502 through 519) or IMPLAN
  (see "Economic Data" worksheet starting Row 7, "Sketch Models" worksheet Rows 490 to 501); and

  — The percent of total capital costs spent on land acquisition (Column F) and percent of capital costs spent outside the study area (Column G). Generally, 100 percent of the actual construction work will occur on site, but equipment (e.g., direct spending on transit vehicles) or professional services (e.g., pre-engineering) may be produced anywhere.

Users need to input this information directly from their cost estimate sheets. See screenshot below.

- **EV2. Changes in Transportation Costs by Industry**—Travel demand models at different levels of geography (e.g., state, metropolitan planning organization [MPO], and non-MPO) may be used to estimate total cost savings from reduced truck (freight) delay and business trip delay. Users should confirm that these modes and trip purposes are available in the travel model used.

  Rows 45 through 55 are automatically populated through information from two worksheets – Row 40's information comes from the "Economic Data" worksheet, TOTAL Value of Sales, Shipments, Receipts, Revenue, or Business Done and the change in transportation costs shown in rows 45 to 55 is estimated with information from the "Travel Data Calcs" worksheet. This data is provided as information only and not used in the calculation of scores for this indicator.

  Rows 61 through 71 are populated by aggregating business travel time savings, based on information from the "Travel Data Calcs" worksheet and the share of trips that is 'business travel,' which is determined by the user in Column F of the "Other Input Data" worksheet. The monetized benefits (or disbenefits) of changes in business travel time are shown in Columns H and I (if this indictor is monetized).

- **EV3. Changes in Employment by Industry**—Numbers for this section come from the "Sketch Model" worksheet, *"Model for Estimating the Economic Impacts of Transportation Improvements."* One user input on this indicator is analysis year (Cell D91). The second is the set of numbers in Columns D and E, Cells 101 through 111. These come from the Sketch Model worksheet, Cells K633 and K658. The third user input in this worksheet is Cell D143 – the identification of the living wage threshold. This breaks down permanent jobs created by each bundle into labor categories, and associating an average wage with that category. By comparing these jobs against a user-determined livable wage, the worksheet reports on how many livable wage jobs are created by the bundle. This information is not used directly in the calculation of any Mosaic indicators, but may be useful to decision-makers.

The data for changes in employment by industry is largely imbedded within the Mosaic tool, in the Economic Data worksheet. These include economic multipliers from IMPLAN that help identify the direct, indirect, and induced employment effects of construction spending. The Economic Data sheet specifically supports the Economic Vitality worksheet, and contains a large amount of information related to jobs created by labor category from construction by NAICS code and IMPLAN (Oregon dataset), data from the 2007 Oregon Economic Census, from the Bureau of Labor Statistics. These numbers are used in conjunction with bundle-specific data through "Travel Data Calc," "Cost and Schedule," or "Bundles Info" worksheets to populate cells in the Economic Vitality Worksheet.

The industry codes used in Business Oregon's strategic plan can be mapped into SWIM's industry classification -- if estimates of transportation benefits to key, "targeted" industries (e.g., clean technology, wood and forest products, and advanced manufacturing) can be produced.

ECONOMIC VITALITY CATEGORY
ESTIMATION OF SPECIFIC INDICATORS
VERSION 2.0
September 3, 2014

			11	21	22	23	31-33	42	44-45	48-49	51	52	53	54	55
Base Case	2035 Low Build	0.0													
Bundle_1	Roadway & Capacity	23.6	0.0	0.0	0.1	1.6	5.3	1.2	3.1	0.9	0.6	1.0	0.5	1.3	0.5
Bundle_2	Transit	-0.4	0.0	0.0	0.0	-0.1	0.4	-0.1	-0.1	0.0	0.0	0.0	0.0	-0.1	0.0
Bundle_3	Active Transport & Programs	-17.2	0.0	0.0	-0.1	-1.2	-3.1	-0.9	-2.4	-0.7	-0.5	-0.8	-0.4	-1.0	-0.4
Bundle_4	n/a	n/a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bundle_5	n/a	n/a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bundle_6	n/a	n/a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bundle_7	n/a	n/a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bundle_8	n/a	n/a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bundle_9	n/a	n/a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bundle_10	n/a	n/a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ANNUAL LABOR INCOME CREATED OR RETAINED IN MILLIONS OF CONSTANT BASE YEAR DOLLARS (RELATIVE TO BASE CASE)		TOTAL IN 2035	Agriculture & Forestry	Mining	Utilities	Construction	Manufacturing	Wholesale Trade	Retail Trade	Transportation and Warehousing	Information	Finance and Insurance	Real Estate and Rental and Leasing	Professional, Scientific, and Technical Services	Management of Companies and Enterprises
			11	21	22	23	31-33	42	44-45	48-49	51	52	53	54	55
Base Case	2035 Low Build	$0.0													
Bundle_1	Roadway & Capacity	$1.3	$0.0	$0.0	($0.0)	$0.1	$0.4	$0.1	$0.1	$0.0	$0.1	$0.0	$0.0	$0.1	$0.1
Bundle_2	Transit	($0.0)	$0.0	($0.0)	($0.0)	$0.0	$0.0	($0.0)	($0.0)	($0.0)	($0.0)	($0.0)	($0.0)	($0.1)	($0.0)
Bundle_3	Active Transport & Programs	($0.9)	$0.0	($0.0)	($0.0)	($0.1)	($0.2)	($0.1)	($0.1)	($0.0)	($0.0)	($0.0)	($0.0)	($0.1)	($0.0)
Bundle_4	n/a	n/a	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Bundle_5	n/a	n/a	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Bundle_6	n/a	n/a	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Bundle_7	n/a	n/a	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Bundle_8	n/a	n/a	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Bundle_9	n/a	n/a	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Bundle_10	n/a	n/a	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

Average Labor Income, in Base Year Dollars	$ 50,588	$ 31,198	$ 88,905	$ 134,161	$ 48,792	$ 69,643	$ 78,775	$ 32,117	$ 53,173	$ 91,628	$ 48,703	$ 68,631	$ 73,623	$ 113,255
What is Considered a Living Wage?	$ 40,000	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes

- **EV4. Changes in Productivity from Increased Connectivity**—This specific indicator examines the productivity changes caused by enhanced transportation connections ("agglomeration economies"). This is the second Economic Vitality indicator that can be monetized. It can also be scored quantitatively, qualitatively, or reported. The sketch model titled "Model for Estimating Agglomeration Effects" informs this indicator; note that this sketch model estimates benefits only related to rail transport improvements. Information from using the sketch model is input into the worksheet in Columns D through G. Agglomeration benefits are monetized automatically in Columns H and I. If users choose to score quantitatively, these are automatically populated in Columns I through L and if scored qualitatively users would need to create these scores manually in Column N.

External sketch models can be used to assess agglomeration benefits from a variety of transportation projects. There are several tools available as of this writing:

⎯ **Model from Transportation Research Board, Transit Cooperative Research Program (Row 669 of "Sketch Models").** This model requires inputs including regional population, number of workers, GDP per capita, and others. This model produces estimated agglomeration benefits for rail transit investments only, and does not capture other agglomeration benefits generated by other types of improvements.

⎯ **Method from UK Department of Transport, January 2014 (Row 731 of "Sketch Models").** See https://www.gov.uk/government/publications/webtag-tag-unit-a2-1-wider-impacts and https://www.gov.uk/guidance/transport-analysis-guidance-webtag

⎯ **Method from Transportation Research Board's Second Strategic Highway Research Program (SHRP2) (Row 738 of "Sketch models").** The final report can be accessed from https://www.trb.org/Main/Blurbs/169524.aspx. Tools for assessing wider economic benefits are available at http://www.tpics.us/tools/.

   o   Select the following tool and user guide: Effect Density, Buyer-Supplier Market Access Tool and Accessibility Analysis Tools Technical Documentation and User Guide, 2013.

   Alternately, users can input information directly into the model. This is not recommended unless the effort features an economic analysis that will focus specifically on the inputs below:

⎯ Estimate the impact of the plan or project on the effective density of employment in a given area, using output from a travel demand model

⎯ Estimate -- or using existing, peer-reviewed estimates of -- the elasticity of total productivity with respect to effective density

⎯ Calculate agglomeration effects using this formula:

   (Elasticity of total productivity with respect to the effective density of employment in the area) x (Change in the effective density of employment in the area due to the plan or project) x (Gross Domestic Product [GDP] in the area)

   Estimation of the impacts of transportation plans on the effective density of an area may be done using data on employment location from the Oregon Statewide Integrated Model (SWIM), if available, and changes in generalized travel costs, as estimated in travel demand models.

• **EV5. Changes in Total Value of Exports and Imports**—This report-only indicator provides the changes in total value of exports and imports to the state associated with each bundle of action. This is created automatically with a few user inputs shown in the screenshot below:

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	ECONOMIC VITALITY CATEGORY												
2	ESTIMATION OF SPECIFIC INDICATORS												
3	VERSION 2.0												
4	September 3, 2014												
5													

192	EV.5	CHANGE IN TOTAL VALUE OF EXPORTS AND IMPORTS										
193	4	Treatment in MOSAIC : Report Only										
194		Assigned Weight : 0.0%										

195													
196			Select Year of Analysis	2035									
197													
198	Value of Exports and Imports of Merchandise, millions of dollars												

199				2011			Annual Growth			2035			
200			Exports from Oregon to other Countries	$18,310			0.0%			$18,310			
201			Imports from other Countries to Oregon	$16,464			0.0%			$16,464			
202													
203	Transportation Costs as a Proportion of Total Costs, %												
204			Exports from Oregon to other Countries	10.0%									
205			Imports from other Countries to Oregon	10.0%									
206													
207	Elasticity w.r.t. International Transportation Cost Factor						Low	High					
208			Exports from Oregon to other Countries	-0.30			-3.00	-0.30	NERA Economic Consulting (2010), page 21				
209			Imports from other Countries to Oregon	-0.30			-3.00	-0.30	NERA Economic Consulting (2010), page 21				
210													

211													
212		CHANGE IN BALANCE OF TRADE IN MILLIONS OF CONSTANT BASE YEAR DOLLARS (RELATIVE TO BASE CASE)		Percent Change in Transport Costs		Percent Change in Value of EXPORTS	Total Value of EXPORTS ($ millions)	Change in Total Value of EXPORTS ($ millions)	Percent Change in Value of IMPORTS	Total Value of IMPORTS ($ millions)	Change in Total Value of IMPORTS ($ millions)		Change in BALANCE OF TRADE ($ millions)
213	Base Case	2035 Low Build					$18,310			$16,464			
214	Bundle_1	Roadway & Capacity		-0.118%		0.0%	$18,311	$0.6	0.0%	$16,465	$0.6		$0.07
215	Bundle_2	Transit		0.010%		0.0%	$18,310	($0.1)	0.0%	$16,464	($0.1)		($0.01)
216	Bundle_3	Active Transport & Programs		0.075%		0.0%	$18,310	($0.4)	0.0%	$16,464	($0.4)		($0.04)
217	Bundle_4	n/a		0.000%		0.0%	$18,310	$0.0	0.0%	$16,464	$0.0		n/a
218	Bundle_5	n/a		0.000%		0.0%	$18,310	$0.0	0.0%	$16,464	$0.0		n/a
219	Bundle_6	n/a		0.000%		0.0%	$18,310	$0.0	0.0%	$16,464	$0.0		n/a
220	Bundle_7	n/a		0.000%		0.0%	$18,310	$0.0	0.0%	$16,464	$0.0		n/a
221	Bundle_8	n/a		0.000%		0.0%	$18,310	$0.0	0.0%	$16,464	$0.0		n/a
222	Bundle_9	n/a		0.000%		0.0%	$18,310	$0.0	0.0%	$16,464	$0.0		n/a
223	Bundle_10	n/a		0.000%		0.0%	$18,310	$0.0	0.0%	$16,464	$0.0		n/a
224													

These inputs are then used in combination with travel demand model information to derive the effects of changes in travel time on imports and exports recorded as follows: (1) percent change in transportation costs (in percentage terms); (2) change in value of imports and exports due to the change in transportation costs; and (3) the change in the balance of trade (in $) due to the change in transportation costs.

Environmental Stewardship

Worksheet Purpose

The "Environmental Stewardship" worksheet is the location where Mosaic users can locate all detailed data related to the four Environmental Stewardship-specific indicators. This location is the only one where microlevel data on each Environmental Stewardship indicator are stored.

Worksheet Considerations

Following are the four specific indicators in the "Environmental Stewardship" worksheet:

- ES1. Criteria Air Contaminants
- ES2 Air toxics (benzene and diesel particulate matter)
- ES3. Life-Cycle CO2e
- ES4. Natural, Built, and Cultural Resources at Risk

Two of the four indicators (ES1 and ES3) can be monetized. Alternately, users could choose to score any of the indicators quantitatively, qualitatively, or as a report-only statistic.

The data used to populate these indicators come largely from running the EPA's MOVES model for emissions rates, from a travel demand model for VMT, running ODOT's Regional Strategic Planning Model (RSPM, formerly GreenSTEP) for fleet mix, and/or use of GIS data for ES4. This worksheet takes a moderate to high level of effort to complete due to the number of external models run for each bundle. Guidance on how to populate the worksheet is provided in the Tool Instructions section below.

Instructions

User input is extensive in the "Environmental Stewardship" worksheet. Running external models is needed for the "Environmental Stewardship" worksheet. VMT is produced from a travel demand model, and the passenger vehicle fleet mix forecasts would be obtained from RSPM, but other data needs include gathering emissions rates is produced from the EPA's MOVES emission model. This model is the best available source for determining the emission rates of Criteria Air Contaminants, and Mobile and Non-Mobile Air Toxics given a set of specific vehicles types, fuel types, speed, and county-level locations. MOVES is a publicly available, national database and includes emissions differentiation at the state and county level. The units produced by MOVES would be converted to long or metric tons per VMT to be monetized.

To start, users will select through the "Indicators" worksheet whether the indicator will be monetized, quantitatively or qualitatively scored, or just reported as raw values. This selection will tell the user which part of the "Environmental Stewardship" worksheet they will use to enter summary information.

Also for each indicator users must enter the "Value used in MODA/Reported" listed in Column D. These options are aligned with the periods of analysis that are selected in the "Bundles Info" worksheet. Users can select one of these values, or an average of the three.

Following are instructions specific to each indicator:

- **ES1. Criteria Air Contaminants**—Criterion air contaminants refer to six pollutant compounds: nitrogen oxides (NO_x), sulfur dioxide (SO_2), particulate matter (PM), ozone, carbon monoxide (CO), and lead. An additional indicator, volatile organic compounds (VOCs), although not defined by U.S. Environmental Protection Agency (EPA) as a CAC, is also considered in this group because it is regulated and has a similar effect on human health and welfare.

  Annual emission volumes, in thousands of long tons, is reported in Columns D through G for each of the six contaminants. As described above, the units produced by MOVES would be converted to long or metric tons per VMT before being entered into the tool. See below.

Columns I through K are automatically updated once Columns D through G are complete if this indicator is being monetized (see screenshot above). Once emissions volumes are entered for all criteria air contaminants (plus VOCs), cells that sum all numbers from the above will also be populated, as shown below.

| ALL CRITERIA AIR CONTAMINANTS COMBINED – STRAIGHT SUMMATION | | | | | | | | | DETERMINATION OF SCORES Based on Total Emission Volumes | | | | | |

ANNUAL EMISSION VOLUMES, IN THOUSANDS OF SHORT TONS		2010	2035	n/a	n/a	TOTAL VOLUMES	TOTAL COST SAVINGS*	PRESENT VALUE OF SAVINGS**	QUANTITATIVE SCORING		DIRECT SCORING		SCORES USED IN MODA
Base Case	2035 Low Build	62.943	34.828	n/a	n/a	1,447.5	$0.0	$0.0	0.0		n/a		n/a
Bundle_1	Roadway & Capacity		34.918	n/a	n/a	1,449.5	-$5.3	-$3.0	-5.0		n/a		n/a
Bundle_2	Transit		34.794	n/a	n/a	1,446.8	$1.9	$1.1	1.9		n/a		n/a
Bundle_3	Active Transport & Programs		34.822	n/a	n/a	1,447.4	$8.3	$4.4	0.3		n/a		n/a
Bundle_4	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a		n/a		n/a
Bundle_5	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a		n/a		n/a
Bundle_6	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a		n/a		n/a
Bundle_7	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a		n/a		n/a
Bundle_8	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a		n/a		n/a
Bundle_9	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a		n/a		n/a
Bundle_10	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a		n/a		n/a

*In millions of constant, base year dollars
**In millions of present-day, discounted dollars

		2010	2035		Active Base Case
Local minimum value			34.794		34.828
Local maximum value			34.918		
					Suggested Values
Minimum value used in scoring		34.918	-5.0		34.918
Maximum value used in scoring		34.738	5.0		34.738
Value used in MODA/REPORTED		2035			

If users choose not to monetize this indicator, cells to score them quantitatively will be automatically populated once the raw data are entered. If scoring qualitatively, users will need to score each bundle individually in Column O on a scale of -5 to +5 based on the raw data.

- **ES2. Air Toxics (benzene and diesel particulate matter)**—Mobile source air toxics (MSATs) and Non-MSATs represent an emerging concern among air pollutants that have an adverse effect on humans – particularly as cancer causing chemicals. Emission levels are not regulated, but state air toxic benchmarks have been established. Two pollutants, benzene and diesel particulate matter (PM), have been selected to represent risks from other MSATs and non-MSATs, respectively.

Similarly to ES1, the data to populate these two indicators come from the MOVES model. Users should enter quantitative data from MOVES into Columns D through G. This indicator is reported as a summation of emissions of the two pollutants – the summation is automatically produced in Row 180 through 190. If scoring qualitatively, users will need to score each bundle individually in Column O on a scale of -5 to +5 based on the raw data.

	A	B	C	D	E	F	G	H	I	J
1	ENVIRONMENTAL STEWARDSHIP CATEGORY									
2	ESTIMATION OF SPECIFIC INDICATORS									
3	VERSION 2.0 with METRO Data & April 30 2014 Test Committee Weights									HELP
4	November 26, 2014									

| ALL AIR TOXICS COMBINED – STRAIGHT SUMMATION | | | | | |

			2010	2035	n/a	n/a
Base Case	2035 Low Build		671.769	54.939	n/a	n/a
Bundle_1	Roadway & Capacity			54.961	n/a	n/a
Bundle_2	Transit			54.934	n/a	n/a
Bundle_3	Active Transport & Programs			54.937	n/a	n/a
Bundle_4	n/a			n/a	n/a	n/a
Bundle_5	n/a			n/a	n/a	n/a
Bundle_6	n/a			n/a	n/a	n/a
Bundle_7	n/a			n/a	n/a	n/a
Bundle_8	n/a			n/a	n/a	n/a
Bundle_9	n/a			n/a	n/a	n/a
Bundle_10	n/a			n/a	n/a	n/a

		2010	2035		Active Base Case
Local minimum value			54.934		54.939
Local maximum value			54.961		
					Suggested Values
Minimum value used in scoring		54.961	-5.0		54.961
Maximum value used in scoring		54.916	5.0		54.916
Value used in MODA/REPORTED		2035			

- **ES3. Life-Cycle CO2e**—Several greenhouse gases (GHG) including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are emitted from use of petroleum fuel in vehicles. This indicator assesses total "life cycle" greenhouse gas emissions associated with petroleum fuel use in transportation. This is a "well-to-wheel" measure that includes emissions from refining and transporting fuels, in addition to emissions from the use of fuel. This indicator is suitable for monetization in a BCA. The costs of GHG emissions are frequently incorporated into BCA analyses as a direct measure of the long-term impact of climate change and global warming. Reductions in GHG emissions are realized as a project benefit.

Data on lifecycle GHG emissions can be directly obtained from MOVES or RSPM. Total tons of emissions for lifecycle GHG are computed as a product of VMT by vehicle type (obtained from the travel demand model) and emissions rates in tons per VMT. RSPM provides the lifecycle GHG emission rates per vehicle type at the county level. Total GHG emissions from passenger vehicles are then computed using RSPM data for emissions rates per VMT for each type of vehicle.

ES.3 LIFE-CYCLE CO2E											
1 Treatment in MOSAIC: Monetized — Assigned Weight: 0.0%							DETERMINATION OF SCORES — Based on Emission Volumes				
ANNUAL EMISSION VOLUMES, IN MILLIONS OF METRIC TONS		2010	2035	n/a	n/a	TOTAL VOLUMES	TOTAL COST SAVINGS*	PRESENT VALUE OF SAVINGS**	QUANTITATIVE SCORING	DIRECT SCORING	SCORES USED IN MODA
Base Case	2035 Low Build	6.067	7.304			224.5	$0.0	$0.0	0.0	n/a	n/a
Bundle_1	Roadway & Capacity		7.318			224.7	-$15.5	-$8.9	-5.0	n/a	n/a
Bundle_2	Transit		7.299			224.4	$5.9	$3.4	1.9	n/a	n/a
Bundle_3	Active Transport & Programs		7.303			224.5	$22.2	$13.6	0.3	n/a	n/a
Bundle_4	n/a					n/a	n/a	n/a	n/a	n/a	n/a
Bundle_5	n/a					n/a	n/a	n/a	n/a	n/a	n/a
Bundle_6	n/a					n/a	n/a	n/a	n/a	n/a	n/a
Bundle_7	n/a					n/a	n/a	n/a	n/a	n/a	n/a
Bundle_8	n/a					n/a	n/a	n/a	n/a	n/a	n/a
Bundle_9	n/a					n/a	n/a	n/a	n/a	n/a	n/a
Bundle_10	n/a					n/a	n/a	n/a	n/a	n/a	n/a

*in millions of constant, base year dollars **in millions of present-day, discounted dollars

	2010	2035		
Local minimum value		7.299	Active Base Case	7.304
Local maximum value		7.318		
Minimum value used in scoring	7.318	-5.0	Suggested Values	7.318
Maximum value used in scoring	7.291	5.0		7.291
Value used in MODA/REPORTED	2035			

Users input annual emission volumes in millions of metric tons in Columns D through G. Columns I through K are automatically updated once Columns D through G are complete if this indicator is being monetized. If scoring quantitatively, users will need to score each bundle individually in Column O on a scale of -5 to +5.

- **ES4. Resources at Risk**—This indicator examines several factors to understand the "natural, built, and cultural resources at risk" including: (a) potential impacts to threatened and endangered (T&E) species; (b) potential impacts on surface water and wetlands; (c) potential risk of hazardous material being located within the plan footprint; and (d) the potential risk of crossing a local, state, or national park with special significance. This indicator is not suitable for monetization in a BCA context.

		NATURAL, BUILT, AND CULTURAL RESOURCES AT RISK									
229	ES.4										
230	3	Treatment in MOSAIC : Qualitative Scoring						DETERMINATION OF SCORES			
231		Assigned Weight : 6.6%						Based on Index Values			
232											
233	SEVERITY INDEX		2010	2035	n/a	n/a		QUANTITATIVE SCORING	DIRECT SCORING	SCORES USED IN MODA	
234	Base Case	2035 Low Build						n/a	0.0	0.0	
235	Bundle_1	Roadway & Capacity						n/a	-5.0	-5.0	
236	Bundle_2	Transit						n/a	-3.0	-3.0	
237	Bundle_3	Active Transport & Programs						n/a	-2.0	-2.0	
238	Bundle_4	n/a						n/a	n/a	n/a	
239	Bundle_5	n/a						n/a	n/a	n/a	
240	Bundle_6	n/a						n/a	n/a	n/a	
241	Bundle_7	n/a						n/a	n/a	n/a	
242	Bundle_8	n/a						n/a	n/a	n/a	
243	Bundle_9	n/a						n/a	n/a	n/a	
244	Bundle_10	n/a						n/a	n/a	n/a	
245											
246					Active Base Case						
247		Local minimum value		0.000	0.000						
248		Local maximum value		0.000							
249					Suggested Values						
250		Minimum value used in scoring	0.000	-5.0	0.000						
251		Maximum value used in scoring	0.000	5.0	0.000						
252											
253		Value used in MODA/REPORTED	2035								
254											

Users populate Columns D through G through composing a score for resources impacted by each bundle. Resource impacts can be calculated in a number of ways. Users can assess the number of critical resources impacted by each bundle by mapping the bundle projects and critical resources. Users can then enter the number of critical resources that might be affected, or create an index based on the number of resources affected (e.g., with the base case or "do minimum" scenario set at 100), resulting in a quantitative score. Users can also qualitatively score the bundles from -5 to +5 based on available data if they so choose (see screenshot above).

Funding & Finance

Worksheet Purpose

The "Funding & Finance" worksheet is the location where users can find relevant cost and revenue information critical to the BCA calculations, summarized succinctly and organized by bundle.

Worksheet Considerations

Following are the five specific indicators in the "Funding & Finance" worksheet:

- FT1. Capital Costs
- FT2. Other Lifecycle Costs
- FT3. Total Operating Revenue
- FT4. Share of Lifecycle Costs that are "New" or "Recycled"
- FT5. Net Impact of Programs on State or Local Fiscal Balance

Of the above indicators, two (FT1 and FT2) must be monetized, as they serve as the denominator in the cost-benefit analysis. FT3 can be monetized, but users can also select to score that indicator quantitatively or qualitatively, or report it as a statistic. FT4 can be scored quantitatively or qualitatively or reported, and FT5 can be qualitatively scored or reported.

Indicator FT3 is only relevant for those bundles which contain dedicated user fees or charges, such as toll facilities, transit fares, or other such fees. If a bundle does not contain such facilities, this indicator need not be evaluated. FT4 and FT5 are only relevant under unusual circumstances as described in the Instructions below.

Much of the information in this worksheet is automatically populated by inputs from the "Cost & Schedule" worksheet (see below). Minimal direct user input is required in this worksheet.

Instructions

User input is minimal in the "Funding & Finance" worksheet. No user input is recommended at all for FT1 and FT2 as these are purely monetized indicators with data transposed directly from the "Cost & Schedule" worksheet. Data entered by bundle and by year in the "Cost & Schedule" are broken out and transposed in the Funding & Finance worksheet into Capital and Lifecycle Costs (FT1 and FT2 respectively), and Operating Revenues (FT3). Data are reported in Columns D and E for FT1 and FT2, and D through G for FT3.

If the user selects to monetize FT3, to score that quantitatively, or to use it as a report statistic, no user input is required for that indicator either, as data are also transposed directly from the "Cost & Schedule" worksheet. If however the user determines that FT3 should be scored qualitatively they will populate Column K on a scale of -5 to +5 based on raw data in Columns D through G.

Following are instructions specific to indicators FT4 and FT5:

- **FT4. Share of Lifecycle Costs that are "New" or "Recycled"**—This specific indicator examines the amount of financial contributions (e.g., capital costs raised directly by a private owner/operator of a toll road or a transit service) from the private sector, "new" funds generated by local public agencies (i.e., taxes, fees, charge or levies which are not present today), and/or "recycled funds" (e.g., financial contributions from local or regional governments that come from some sort of revolving loan fund). Users obtain this information from communications with the relevant agencies involved with the planning effort. This analysis is done outside Mosaic. When completed, users enter a percentage number (between 0 and 100 percent) in Columns D through G. If scoring quantitatively, Column I will automatically populate. Alternately if the user is scoring this indicator qualitatively they will use the data reported in Columns D through G to populate Column K on a scale of -5 to +5.

- **FT5. Net Impact of Programs on State or Local Fiscal Balance**—FT5 is only relevant under unusual financial circumstances (e.g., when the revenues for the bundle may affect the funding agency's credit rating, or when expenditures are affected by "compression" under Oregon Measure 5; see https://www.oregon.gov/DOR/programs/property/Pages/default.aspx). Users are only able to score this indicator

qualitatively. The screenshot to the left shows both where user input is required (Column E) and guidance for how to score bundles.

Qualitative scores are based on the order of magnitude percentage impact of a bundle on state or local fiscal balance. These can be reported as adverse, neutral, and beneficial. Due to the complexity of this qualitative assessment, Mosaic users are advised to seek suitably qualified expertise.

Safety & Security

Worksheet Purpose

The "Safety & Security" worksheet is the location where technical Mosaic users can locate all detailed data related to the three Safety & Security-specific indicators.

Worksheet Considerations

Following are the three specific indicators in the "Safety & Security" worksheet:

- SA1. Fatal, Injury A and Injury B Crashes
- SA2. Property Damage Only (PDO) accidents
- SA3. Emergency Management Systems Response Times
- SA4. Resiliency of the Network

Of these four indicators, SA1 and SA2 can be monetized. Alternately, users could choose to score any of the indicators quantitatively, qualitatively or as a report-only statistic.

This worksheet takes a moderate to high level of effort to complete due to the separate analyses run for each indicator, for each bundle. A planning-level safety sketch tool is needed to estimate SA1 and SA2. Several such tools exist – a separate safety tool[14] is provided with Mosaic to aid in estimating this indicator. Other external tools exist, including several other models based on Highway Safety Manual methodology. Data to inform SA3 would be developed from travel model data or by making a qualitative assessment. Data to inform SA4 come from GIS and travel model data. Guidance on how to populate the worksheet is provided in the Tool Instructions section below.

Assumptions established in the "Model Parameters" worksheet are used to calculate the values found in the "Safety & Security" worksheet, largely in Columns J and K where indicator data are monetized (total value = Column J and net present value = Column K). These monetized values depend on the "Time-Varying Assumptions" worksheet which takes the assumptions established in the "Model Parameters" and applies the discount rate to establish yearly values across the time horizon of the planning process. It is only those annualized values that are recorded in Columns J and K.

These are three separate processes involving three separate analysis tools, described briefly below:

- **SA1, Fatal, Injury A, and Injury B Crashes** and **SA2, Property Damage Only (PDO) Crashes,** require the use of the Mosaic safety modelling tool. A basic highway safety spreadsheet tool is available on the Mosaic website that can provide data for entry into Mosaic. This tool provides "before and after" crash rate estimates for different types of roadway facilities. Results from the safety tool can

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[14] The safety tool, available on the project website (https://www.oregon.gov/ODOT/Planning/Pages/Mosaic.aspx), provides crash statistics related to motor vehicle incidents and is useful for evaluating primarily roadway projects. It is not suitable for estimating the safety effects of transit safety improvements, or bicycle and pedestrian-specific safety improvement projects.

be entered directly into the Mosaic Tool for SA1 and SA2. *See Table 4, Instructions for Using he Mosaic Safety Tool, below for detailed information about the Mosaic Safety Tool.* Users can also use their own sources to generate the inputs needed for this indicator.

- **SA3, Emergency Management Systems Response Times**, the anticipated change in travel times on major routes to hospitals and trauma centers (using the travel demand model) would offer a quantifiable measure to assess the likely anticipated change in EMS response times for a bundle of projects. This indicator can also be assessed qualitatively.

- GIS is used to calculate **SA4, Resilience of the Network.** See the "Instructions" section below for details.

Instructions

User input is extensive in the "Safety & Security" worksheet. Findings from a safety modelling tool, travel demand model data, and GIS are required to complete this worksheet. Following are instructions specific to each indicator:

- **SA1, Fatal, Injury A, and Injury B Crashes, and SA2 Property Damage Only (PDO) Crashes—** Users will estimate the predicted fatal, injury A, and injury B crashes and PDO crashes on an annual basis. These data are then entered in Columns D through G for each bundle. Information is entered just for the years of the planning horizon. These are entered by class in separate rows of the tool; below is a screenshot that shows sample entries for fatal crashes in Rows 14 through 17. Separate rows are established for users to enter crash information for Injury A and Injury B crashes. Users will similarly enter the number of PDO crashes for SA2. *If using the Mosaic safety tool to estimate crash statistics, then see Table 4, Instructions for Using the Mosaic Safety Tool, for use at the end of this section.*

The Mosaic Tool internally aggregates these annual data to a total number of fatal crashes, injury A crashes, and injury B crashes, and for SA.2, the total number of PDO crashes. The tool then

automatically monetizes these data in Columns J and K through applying the assumptions documented in the "Model Parameters" worksheet, as adjusted in the "Time-Varying Assumptions" worksheet.

If users choose not to monetize this indicator, cells to score them quantitatively will be automatically populated once the raw data are entered. If scoring qualitatively, users will need to score each bundle individually in Column O on a scale of -5 to +5 based on the raw data.

- **SA3, Emergency Management Systems (EMS) Response Times**—Users will estimate the emergency response times outside Mosaic using travel model data and enter this information in Columns D through G for each bundle. This indicator can be estimated quantitatively by assessing the change in EMS response times on key routes to area hospitals, by assessing how travel times change from fire stations or other EMS facilities, or by other methods. Information is entered just for the years of the planning horizon.

— Users can identify emergency facilities (police and fire stations, hospitals, trauma centers, etc.) and use a travel demand model and/or GIS software to estimate how much area around the station is accessible within a defined time frame; e.g., users may choose 5 minutes as a threshold response time around EMS response facilities and estimate how large an area is encompassed within 5 minutes of EMS facilities for each bundle. Those bundles that perform best would result in the largest area reachable within 5 minutes from EMS facilities.

— Alternatively, users can estimate the changes in key routes to emergency facilities (hospitals, trauma centers) and estimate the change in travel times on the corridor with a travel demand model. The anticipated change in travel times on major routes to hospitals and trauma centers would offer a quantifiable measure to assess the likely anticipated change in EMS response times for a bundle of projects.

Mosaic has been coded to convert this information into quantitative scores once the raw data are entered. If scoring qualitatively, users will need to score each bundle individually in Column O on a scale of -5 to +5 based on the raw data.

- **SA4, Resiliency of the Network**—Users will estimate the impacts of bundles to the emergency lifeline routes outside Mosaic using the process outlined in the previous section. They will then score each bundle individually in Column O on a scale of -5 to +5 based on suggestions for determining a qualitative score (see below). This indicator can be estimated using the following method:

  — First, confirm that several GIS layers exist in the planning area: (1) a listing of lifeline routes; (2) location of hospitals and medical emergency centers in relation to these lifeline routes; current condition of lifeline routes; and (3) assessment of what damage would occur with a natural or manmade disaster.

  — For each bundle, users would then identify which lifeline routes were improved to function better during an emergency referenced in (3) above. Those bundles that provide greater improvements to lifeline routes would score higher.

	SA.4	RESILIENCY OF THE NETWORK			
152					
153	3	Treatment in MOSAIC : Qualitative Scoring			
154		Assigned Weight : 5.4%			

	RESILIENCY OF THE NETWORK		DIRECT SCORING	SCORES USED IN MODA	COMMENTS / DESCRIPTION
157	Base Case	2035 Low Build	0.0	0.0	
158	Bundle_1	Roadway & Capacity	1.0	1.0	
159	Bundle_2	Transit	0.0	0.0	
160	Bundle_3	Active Transport & Programs	0.0	0.0	
161	Bundle_4	n/a	n/a	n/a	
162	Bundle_5	n/a	n/a	n/a	
163	Bundle_6	n/a	n/a	n/a	
164	Bundle_7	n/a	n/a	n/a	
165	Bundle_8	n/a	n/a	n/a	
166	Bundle_9	n/a	n/a	n/a	
167	Bundle_10	n/a	n/a	n/a	

169	Value used in MODA/REPORTED	2035	*This cell is not used in the workbook and is only for documentation.*

SUGGESTIONS FOR DETERMINING A QUALITATIVE SCORE FOR THIS INDICATOR:

EXPECTED IMPACT OF BUNDLE	SCORE
Large Adverse	-5
	-4
Moderate Adverse	-3
	-2
Slight Adverse	-1
Neutral	0
Slight Beneficial	1
Moderate Beneficial	2
	3
Large Beneficial	4
	5

Bundles with an adverse impact on the emergency lifeline routes would be given a low score relative to the base case and each other, whereas bundles which benefit routes identified as emergency lifelines would receive a higher score.

Table 4. Instructions for Using the Mosaic Safety Tool

The Mosaic Safety Tool is a separate Microsoft Excel-based tool available on the [Mosaic website](#). Developed in 2014, this tool applies Highway Safety Manual (HSM) concepts to demonstrate the quantitative safety effects of converting one facility type to another (in terms an increase or decrease in crashes). The tool is capable of evaluating a suite of common road system improvement types.

The Mosaic Safety Tool provides a framework for evaluating the effects of specific roadway improvements - like roadway geometry, street lighting, etc. – on specific transportation facilities. The tool provides a snapshot of how a particular transportation facility performs with respect to crashes both before and after improvements are made.

Using input on traffic volumes and speeds as well as existing geometric conditions, the tool predicts crash frequency and distributions of collision types by severity. Users can also apply different crash modification factors (CMFs) to produce their effects on crash rates. Users enter road and intersection modifications *separately* in the tool. Total crashes for the length of the corridor are produced by adding roadway segment predicted crashes and intersection predicted crashes. Users should ensure that future scenario predictions include crashes for both roadway segments and intersections if examining improvement projects with intersections. If, for example, the number of lanes was increased on a road segment with an intersection, analysis would need to be completed for both the road segment and the intersection.

Mosaic Safety Tool outputs consist of before and after annual crash rate tables that can be used to generate the inputs for indicators SA1 and SA2 in the larger Mosaic Tool.

The Mosaic Safety Tool consists of several spreadsheets in an Excel 2010 workbook:

- **Background—**Contains basic information about use of the tool.

- **Instructions –** These instructions are also provided in the workbook.

- **Road_Widen_Project_Urban—**This tab allows users to examine the safety effects of road widening projects on urban roads.

  - 2-lane Undivided Urban Arterial to 3-lane Undivided Urban Arterial with two-way left turn lane
  - 2-Lane Undivided Urban Arterial to 4-lane Undivided Urban Arterial
  - 2-Lane Undivided Urban Arterial to 4-lane Undivided Urban Arterial with two-way left turn lane
  - 2-Lane Undivided Urban Arterial to 4-lane Divided Urban Arterial
  - 3-Lane Undivided Urban Arterial with two-way left turn lane to 5-Lane Urban Arterial with two-way left turn lane
  - 3-Lane Undivided Urban Arterial with two-way left turn lane to 4-Lane Undivided Urban Arterial
  - 4-Lane Undivided Urban Arterial to 4-Lane Divided Urban Arterial

- ***Road_Widen_Project_Rural—***This tab allows users to examine the safety effects of road widening projects on rural roads.

  - 2-Lane Undivided Rural to 4-Lane Divided Rural Highway
  - 2-Lane Undivided Rural to 4-Lane Undivided Rural Highway

- **Intx_Project_Rural_Urban—**This tab allows users to examine the safety effects of intersection improvement projects.

  - Add Left Turn Lane at signal (4SG – urban/Suburban)
  - Add Right Turn Lane at signal (4SG – urban/Suburban)
  - Improve skewness angle (4ST – rural)
  - Convert stop-control to signalized
  - Convert high-speed intersection to roundabout (less than 45 mph)
  - Convert low-speed intersection to roundabout (more than 45 mph)

- **Other_Project—**This tab allows users to examine the safety effects of the following projects:

  - Traffic Calming (speed management) (Urban/Suburban)
  - Install bicycle boulevard
  - Horizontal Curve Delineation (Rural)
  - Add auxiliary lane (rural 4-lane divided highway)

Table 4. Instructions for Using the Mosaic Safety Tool

— Pave unpaved shoulder (rural divided highway)

- **Function_Rural_Widen, Function_Intx, Function_Intx, and Function_Other**—These tabs contains HSM functions pertaining to projects. No user input is needed on these tabs.

- **HSM_Default_Table**—This tab contains HSM look up values for crash modification factors and other values. This tab is only for user reference – no user input *is* needed.

Use input is limited to the 3rd through 6th spreadsheets above, where before and after crash statistics inputs and outputs are located. Users can change any of the values in the "value" column (Column C for current year, Column H for future year) in these tabs. Those values highlighted in green generally come from the HSM; users can modify these values based on local conditions. Cells highlighted in blue are intended for user input and modification. Users are encouraged to enter as much data as available in the blue cells for each crash scenario (daily traffic volumes, speeds, number of driveways on a segment, etc.) While all data are not necessary, completing as many data inputs as possible will improve the accuracy of the results. Users should evaluate one project at a time, rather than by bundle.

Enter both the current year conditions and the future year conditions. For example, in the Road_Widen_Project_Urban tab, "2-lane Undivided Urban Arterial" to "3-lane Undivided Urban Arterial with two-way left turn lane," (Row 1), users enter values in Column C for the "before" (or current year) condition and enter values in to Column H for the "future" (or improved) condition. Crash statistics are then produced for both the current conditions (Row 133, Columns A through D) and future conditions (Row 133, Columns G through J).

Once all projects have been evaluated, the total base year and future year crash rates can be entered into the Mosaic Tool. Note that the safety tool produces a combined statistic called "fatal-injury" crashes. The Mosaic Tool requires users to enter Injury A, Injury B, and Fatal crashes separately (each has different monetization assumptions). The combined "fatal-injury" crash statistic can be broken down into the fatal and injury crashes by finding crash statistics specific to the city or county Mosaic is being applied. Users would multiply the combined fatal-injury crash statistic produced by the tool by the proportion of crashes that are fatal in the study area to produce the estimated number of fatal crashes; the same method would be used to produce the number of injury crashes. ODOT provides crash statistics on their website: https://www.oregon.gov/ODOT/Data/Pages/Crash.aspx

Land Use

Worksheet Purpose

The "Land Use" worksheet is the location where users can find summarized information relevant to report statistics for the Land Use indicators or to score them under MODA. These are organized by bundle.

Worksheet Considerations

Following are the two specific indicators in the "Land Use" worksheet:

- LU1. Population and Employment Change and Distribution
- LU2. Relative Land Value Change Compared to Base Case

The important consequences of land use changes expressed in the two indicators are taken into account in other Mosaic categories and indicators (e.g., Mobility, Accessibility, Environmental Stewardship, Quality of Life and elsewhere). In addition, the land use data serve as a basis for weighting the Land Use category in MODA, or as "report only" data points of interest to policy and decision-makers. This is described in more detail below. The information in this worksheet is produced outside Mosaic and entered into the tool.

Instructions

User input is minimal in the "Land Use" worksheet and all analysis work is done outside Mosaic. Following are instructions specific to indicators LU1 and LU2:

- **LU1. Population and Employment Change and Distribution**—This indicator is intended for users to qualitatively score how a bundle effects future land use. Data are generated by running a regional land-use model or from professional judgment based on factors that affect land use change based on transportation investment, or from other methods or tools. This indicator may be displayed as a series of maps for each bundle showing future population and employment distributions; bundles that result in population and employment distributions that are in line with or in support of future land use plans would receive higher scores. Those bundles that result in undesirable population and employment distributions would receive lower scores.

  Users who do not have access to a land use model should consult Land Use Impacts of Transportation, A Guidebook (https://pubsindex.trb.org/view.aspx?id=498620) for techniques to estimate the land use impacts of their bundles. When completed, all results are entered into the worksheet, Column E.

  Alternatively, this indicator can be qualitatively scored on the basis of whether or not the expected impact on land use of each bundle is consistent with local, regional, and/or state land use policies

and goals (higher score), or whether the bundle is not consistent with these policies and goals (lower score).

- **LU2. Relative Land Value Change Compared to Base Case**—This specific indicator looks at the connection between transportation changes and changes to land values, as compared to prices if no transportation changes were made in that area. This indicator is only available as "report only" as it may be duplicative with monetized benefits expressed in mobility indicators assessing travel time savings and user costs. Land value data exists frequently in GIS by parcel, and it may be sorted or aggregated by land use type. However, estimates of future land value should come from an integrated land use model. Change in land value is reported on a relative scale and measures the data between a base year and forecast year or between two or more transport system scenarios/alternatives in a forecast year. Results are entered into the worksheet by analysis year, Columns D through G.

  Similar to LU1, users can score this indicator qualitatively by populating Column M on a scale of -5 to +5. In this case, higher land values equate to higher scores whereas land value decreases equate to lower scores. Users also have the option of scoring this indicator quantitatively. The coding has been done within Mosaic to make this quantitative scoring automatic once the raw data have been entered in Columns D through G.

Quality of Life

Worksheet Purpose

The "Quality of Life" worksheet is the location where technical Mosaic users can locate detailed data related to the three Quality of Life-specific indicators.

Worksheet Considerations

Following are the four specific indicators in the "Quality of Life" worksheet:

- QL1. Health Benefits of Active Transportation
- QL2. Quality of the Travel Environment
- QL3. Noise Impacts

All three of the above indicators can be monetized. Alternately, users could choose to score them quantitatively or qualitatively, or indicate that their raw findings be used as a report-only statistic. All of these indicators are measured in terms of the change relative to the base case.

The data used to populate these indicators come largely from work done by the user in the "Sketch Models" worksheet. Sketch models are provided for each of the three indicators, and some indicators require population of multiple sketch models to receive results. This worksheet takes a moderate to high level of effort to complete due to the separate analyses run for each indicator, for each bundle. A brief description of each sketch model is provided in the section below and instructions on how to populate them is described in the Sketch Tools section.

Instructions

User input is extensive in the "Quality of Life" worksheet. Findings from the "Sketch Models" worksheet are required to complete this worksheet. Following are instructions specific to each indicator:

- **QL1. Health Benefits of Active Transportation**—Users toggle back and forth between Rows 10 through 161 of the "Quality of Life" worksheet and Rows 7 through 341 of the "Sketch Models" worksheet to populate this indicator. The first sketch models in Rows 10 and Rows 55 of the sketch models worksheet provide estimates for the number of additional cyclists associated with a bundle of improvements and a model for the estimated number of aggregate walk trips made per day. These models can be employed if users do not have a travel model that produces data for cycling and walking modes. Users are required to enter various data, such as the mileage of bicycle and pedestrian facilities, population density, population growth, percent of commuters, and percent of commuting by walking and cycling. See the "sketch models" section of this User Guide for more information.

Users enter the number of "bicycle users" and "daily walkers" in Rows 15 through 25, Columns D through G and I through L in the "Quality of Life" worksheet. Users are also required to enter the average distance travelled per cyclists and walker per day in Columns H and M respectively.

Once the number of daily "bicycle users" and "daily walkers" is entered into the "Quality of Life" worksheet, users will enter the number of statistical lives saved due to bicycling and walking in Rows 33 through 43. Users can use the sketch model in Rows 114 through 173 to estimate this number (total statistical lives saved are generated in Rows 162 through 172, Columns M through O in the "Sketch Model" worksheet) and then enter the values manually in the "Quality of Life" worksheet. Reduction in disease incidence is automatically populated in Rows 47 through 135 of the "Quality of Life" worksheet from the sketch planning model for estimating the health effects of increased physical activity (in Row 175 of the "Sketch Models" worksheet.)

The Mosaic Tool has been coded to automatically monetize these data in Columns J and K through applying the assumptions of the value of statistical life saved as documented in the "Model Parameters" worksheet and as adjusted in the "Time-Varying Assumptions" worksheet.

If users choose not to monetize this indicator, cells to score them quantitatively will be automatically populated once the raw data are entered. If scoring qualitatively, users will need to score each bundle individually in Column O on a scale of -5 to +5 based on the raw data.

	NUMBER OF CASES OF CARDIOVASCULAR DISEASES AVOIDED (RELATIVE TO BASE CASE)		2010	2035	n/a	n/a		TOTAL NUMBER OF CASES AVOIDED	MONETARY VALUE OF AVOIDED CASES*	PRESENT VALUE OF AVOIDED CASES**
79										
80	Base Case	2035 Low Build	0.000	0.000				0.00	$0.0	$0.0
81	Bundle_1	Roadway & Capacity		-0.574				-13.57	-$0.7	-$0.4
82	Bundle_2	Transit		-0.067				-1.58	-$0.1	$0.0
83	Bundle_3	Active Transport & Programs		0.559				13.21	$0.7	$0.4
84	Bundle_4	n/a						n/a	n/a	n/a
85	Bundle_5	n/a						n/a	n/a	n/a
86	Bundle_6	n/a						n/a	n/a	n/a
87	Bundle_7	n/a						n/a	n/a	n/a
88	Bundle_8	n/a						n/a	n/a	n/a
89	Bundle_9	n/a						n/a	n/a	n/a
90	Bundle_10	n/a						n/a	n/a	n/a
91										

Note*: It is important to note that QL.1 (in the "Quality of Life" worksheet) requires entry in Columns D through G and J through L of the change in the number of regular *cyclists* and *walkers* – not the change in the number of cycling or pedestrian *trips*. It is therefore important for the user to transform the number of *trips* for both modes to the number of "*users*." These can be estimated by utilizing local data on the average number of walking or cycling trips taken per person per day, or by referring to national household travel survey data to transform the number of "trips" to the number of "users."

If using the sketch models to estimate demand, the sketch model for cyclists (Row 10 of the "Sketch Models" worksheet) produces the number of cyclists, and no data transformation is needed. However, the sketch model for walking (Row 55 of the "Sketch Models" worksheet) produces the number of estimated pedestrian *trips* per day, requiring the user to transform these to the number of *walkers*. Again, local data or national household travel survey data can be used to

transform the number of trips to number of walkers (based on the average number of trips taken per pedestrian per day. The user would divide the number of pedestrian trips by the average number of pedestrian trips per day to yield the number of "daily walkers.")

Special note on the model for estimating demand for walking (Row 55, "Sketch Models" worksheet): this model, unlike the cycling model in Row 10, is not sensitive to the supply of walking facilities; the sketch model produces a baseline estimate of the number of walkers based on national household travel survey data and population. Users are advised to estimate the change in the number of walkers for different bundles using other methods, i.e., methods that estimate change in the number of walkers or walk trips based on improved facilities or changes in land use associated with a particular bundle. Some resources for estimating these changes are provided below:

— Evaluating Active Transport Benefits and Costs (2014, Victoria Transport Policy Institute). Pages 11 and 12 detail effects on pedestrian demand from various improvements. http://www.vtpi.org/nmt-tdm.pdf

— Using Built Environment Characteristics to Predict Walking for Exercise (2008, Lovasi, et. al.) http://www.ij-healthgeographics.com/content/7/1/10

- **QL2. Quality of the Travel Environment—**Users will populate this indicator directly. Note that the number of walkers and cyclists benefiting from improvements is calculated using the method outlined for QL.1 above. User inputs are split into pedestrian and bicycling environments. Elements valued in the pedestrian environment include street lighting, curb level, pavement evenness, and directional signage. Elements valued in the bicycling environment include segregated cycle track, segregated cycle lane, non-segregated cycle lane, wider lane, secured parking facilities, and changing and shower facilities. Users start by populating the number of pedestrians impacted (number of regular walkers) and the miles of improvement by pedestrian element (see example in screenshot below).

Users input similar information for features of the bicycling environment.

The Mosaic Tool has been coded to automatically monetize these data in Columns P and Q. If users choose not to monetize this indicator, cells to score them quantitatively will be automatically populated once the raw data are entered. If scoring qualitatively, users will need to score each bundle individually in Column N on a scale of -5 to +5 based on the raw data.

Like QL.1 above, it is important to note that this indicator requires entry of the number of *users* affected, not number of *trips*. See the note under QL1 for instructions.

- **QL3. Noise Impacts**—The indicator values the impact of increased (or decreased) noise on households. There are two monetization methods that users can employ to evaluate this indicator. This indicator may also be evaluated quantitatively, by estimating the number of households affected by traffic noise, or the indicator may be measured qualitatively.

  — **Monetization: Method 1**—Users enter information directly into the "Sketch Models" worksheet, Rows 377 through 486. The information required is an approximation of the number of households experiencing various decibel noise change when compared to the base case for each bundle, organized by decibel ranges and by planning year. Users are not necessarily required to run a noise model to conduct this analysis – it is set up to catch the number of residences located within a certain distance of the projects that comprise a bundle. This can be approximated in GIS from creating a buffer from the centerline of each project in the bundle, and running a query in GIS to count the number of residences within that buffer. This number entered into the sketch model is *the net difference* in number of residences from the Base Case that is entered.

  The sketch model then monetizes the changes in noise levels by household and aggregates this to the bundle level. These outputs are used to populate the "Quality of Life" worksheet, Rows 404 through 414, by numbers of households impacted, monetized effects during the planning horizon year, and total monetized effects over time. If users choose not to monetize this indicator, cells to score them quantitatively will be automatically populated once the raw data are entered. *Because of the cost and time required to use this method, it is best applied if improvements are only being made to relatively few facilities or on a complex corridor. Users would be required to infer future noise levels from existing conditions.*

  — **Monetization: Method 2**—Users can calculate the per-VMT external costs of noise and enter the total costs directly in the tool in Columns F and G. Per-VMT estimates for noise can be found in Rows 297 and 363 in the "Supporting Data" worksheet. The table starting in Row 297 provides per-VMT noise cost estimates by vehicle type and roadway type. If using this method, users would create a spreadsheet and sort VMT by both the type of facility and transportation mode to yield a total a total noise cost associated with the bundle. The values in Row 363 are only vehicle-based, and not sorted by vehicle type. If using these values, users would multiply the VMT generated in each bundle by the external noise cost for each mode to yield a total cost

for each bundle. Note that users may want to use both method to establish a range of possible values for this indicator.

		HOUSEHOLDS IMPACTED		MONETIZED EFFECTS*			TOTAL			QUANTI. SCORING		DIRECT SCORING		SCORES USED IN MODA
		2020	2035	2020	2035		CONSTANT DOLLARS*	IN PRESENT VALUE**						
Base Case	2035 Low Build	0	0	$0.00	$0.00					0.0		n/a		n/a
Bundle_1	Roadway & Capacity	0	0	($0.02)	($0.02)		($0.52)	($0.30)		0.0		n/a		n/a
Bundle_2	Transit	0	0	$0.01	$0.01		$0.16	$0.09		0.0		n/a		n/a
Bundle_3	Active Transport & Programs	0	0	($0.02)	($0.02)		($0.65)	($0.37)		0.0		n/a		n/a
Bundle_4	n/a						n/a	n/a		n/a		n/a		n/a
Bundle_5	n/a						n/a	n/a		n/a		n/a		n/a
Bundle_6	n/a						n/a	n/a		n/a		n/a		n/a
Bundle_7	n/a						n/a	n/a		n/a		n/a		n/a
Bundle_8	n/a						n/a	n/a		n/a		n/a		n/a
Bundle_9	n/a						n/a	n/a		n/a		n/a		n/a
Bundle_10	n/a						n/a	n/a		n/a		n/a		n/a

QL.3   NOISE IMPACTS
1   Treatment in MOSAIC : Monetized
     Assigned Weight : 0.0%

DETERMINATION OF SCORES
Based on Number of Households Impacted

Noise Data Available for: Forecast Year 1   2020
                              Forecast Year 2   2035

Use resources in the SKETCH MODELS worksheet to update the tables below

*In millions of constant, base year dollars
**In millions of present-day, discounted dollars

			Active Base Case
Local minimum value		0.0	0.0
Local maximum value		0.0	

			Suggested Values
Minimum value used in scoring	0.0	-5.0	0.0
Maximum value used in scoring	0.0	5.0	0.0

Value used in MODA/REPORTED	2035

Equity

Worksheet Purpose

The "Equity" worksheet is the location where technical Mosaic users input detailed data related to the equity analysis.

Worksheet Considerations

Following are the four specific indicators in the "Equity" worksheet:

- EQ1. Distribution of User Benefits Across Population Groups
- EQ2. Distribution of Diesel and PM Emissions Among Population Groups
- EQ3. Distribution of Health Benefits from Active Transportation Across Population Groups
- EQ4. Distribution of Accident Rates Across Population Groups

Each of these four specific indicators can be scored qualitatively under MODA or presented as a "report only" statistic. These four indicators draw from data produced for other indicators in Mosaic. Each equity indicator requires the user to apply geographic and demographic analysis to these data.

The data used to populate these indicators come largely from the other Mosaic categories, specifically accessibility, environmental stewardship, quality of life, and safety and security. However, some additional GIS mapping analysis is required for equity: (1) the identification of different population group categories, (2) the spatial mapping of these groups over the Mosaic planning area, and (3) the spatial mapping of each factor (e.g., accident rates, air pollution, user benefits, health benefits).

Demographic categories could include urban/rural, race and ethnicity, and income; however additional categories such as age, presence of a disability, language spoken at home, and others could be considered in this analysis if desired. These indicators also include the option to note how benefits or impacts are distributed between urban and rural areas.

Instructions

User input is central to the "Equity" worksheet. Each of the Equity indicators are qualitatively scored or reported. The general guidance used for scoring each indicator is illustrated on the next page. Information entered into Column D (and in the instance of EQ3, Column E as well) come from the other relevant category sheets. Following are four other relevant category worksheets:

- **Accessibility (informs EQ1)**—Travel time savings and user cost savings for personal travel are transposed directly into the "Equity" worksheet, and serve as the starting point for the EQ1 analysis. Users can also choose to use Transportation Cost Index data from indicator AC.1 if available. *Due to time and data constraints during Mosaic development, the project team was unable to test a method for this indicator. Users are advised to not use this indicator or consult with technical staff on appropriate estimation methods.*

- **Environmental Stewardship (informs EQ2)**—Annual particulate matters emissions are transposed directly into the "Equity" worksheet, and serve as the starting point for the EQ2 analysis.

- **Quality of Life (informs EQ3)**—The Additional Miles of Travel by Bicycle and Walking data are transposed directly into the "Equity" worksheet, serving as the starting point for the EQ3 analysis.

- **Safety & Security (informs EQ4)**—The changes in distribution of accident rates serve as the starting point for the EQ4 analysis.

Users can either score bundles on a score from -5 to +5 if using quantitative assessment or from a score "a lot worse" to "a lot better" if scoring qualitatively (see screenshot below). Both scales represent that adverse effects are given lower scores and beneficial effects are given higher scores. Users are strongly advised to consult their technical staff on the most appropriate method of estimating all Equity indicators; qualitative evaluation may be the most appropriate method in many cases depending on the quality of data available.

	EQUITY CATEGORY
2	ESTIMATION OF SPECIFIC INDICATORS
3	VERSION 2.0
4	September 3, 2014

SUGGESTIONS FOR DETERMINING A QUALITATIVE SCORE FOR EQUITY INDICATORS:

CODE	EXPECTED IMPACT RELATIVE TO OTHER GROUP(S)	SCORE
Wrs_Lg	A Lot Worse	-5
		-4
Wrs_Md	Moderately Worse	-3
		-2
Wrs_Sl	Slightly Worse	-1
Equal	Equal	0
Btt_Sl	Slightly Better	1
Btt_Md	Moderately Better	2
		3
Btt_Lg	A Lot Better	4
		5

Following are instructions specific to each indicator:

- **EQ1. Distribution of User Benefits Population Groups**— The following method was not tested during development of the Mosaic tool due to time and data limitations. Users are therefore advised to not use this indicator at this time. However, users should discuss this indicator and method with technical staff to evaluate possible options for measuring this indicator.

    Travel time savings and user cost savings are automatically populated from the "Mobility" worksheet in Column D from Rows 30 through 40. With GIS or other sources, users then perform geospatial analysis to determine the distribution of user cost savings and travel time savings across geographies and populations —urban/rural areas, areas with a high percentage of low household income, and areas with a high proportion of racial and ethnical minorities. These categories can be adjusted based on what is of direct interest to policy makers.

QUANTITATIVE ASSESSMENT

USER BENEFITS (TRAVEL TIME SAVINGS AND USER COST SAVINGS FOR PERSONAL TRAVEL)		PRESENT VALUE OF USER BENEFITS*	IN URBAN / RURAL AREAS		IN AREAS WITH LOW / HIGH MEDIAN HOUSEHOLD INCOME**		IN AREAS WITH LOW / HIGH PROPORTION OF RACIAL & ETHNIC MINORITIES***	
			URBAN	RURAL	LOW INCOME	HIGH INCOME	LOW SHARE	HIGH SHARE
Base Case	2035 Low Build	$0.0						
Bundle_1	Roadway & Capacity	$228.0						
Bundle_2	Transit	$348.5						
Bundle_3	Active Transport & Programs	$199.4						
Bundle_4	n/a	n/a						
Bundle_5	n/a	n/a						
Bundle_6	n/a	n/a						
Bundle_7	n/a	n/a						
Bundle_8	n/a	n/a						
Bundle_9	n/a	n/a						
Bundle_10	n/a	n/a						

*In millions of present-day, discounted dollars
** Median household income within TAZ greater/lower than Average +/- 1 Standard Deviation
*** Proportion within TAZ greater/lower than Average +/- 1 Standard Deviation

Users then use this information to provide a score to each bundle for each of the categories considered. As seen below, this example scores each bundle against the equitable distribution of effects to rural areas (Column H), for low vs. high income areas (Columns J and K), and to areas with a low and high percentage of racial and ethnic minorities (Columns M and N). Column P is the overall assessment of each bundle's equitable distribution of effects based on the scores in Columns H through N.

EQUITY CATEGORY
ESTIMATION OF SPECIFIC INDICATORS
VERSION 2.0
September 3, 2014

HELP

Assigned Weight : 0.0%

QUANTITATIVE ASSESSMENT

USER BENEFITS (TRAVEL TIME SAVINGS AND USER COST SAVINGS FOR PERSONAL TRAVEL)		PRESENT VALUE OF USER BENEFITS*	IN URBAN / RURAL AREAS		IN AREAS WITH LOW / HIGH MEDIAN HOUSEHOLD INCOME**		IN AREAS WITH LOW / HIGH PROPORTION OF RACIAL & ETHNIC MINORITIES***	
			URBAN	RURAL	LOW INCOME	HIGH INCOME	LOW SHARE	HIGH SHARE
Base Case	2035 Low Build	$0.0						
Bundle_1	Roadway & Capacity	$228.0						
Bundle_2	Transit	$348.5						
Bundle_3	Active Transport & Programs	$199.4						
Bundle_4	n/a	n/a						
Bundle_5	n/a	n/a						
Bundle_6	n/a	n/a						
Bundle_7	n/a	n/a						
Bundle_8	n/a	n/a						
Bundle_9	n/a	n/a						
Bundle_10	n/a	n/a						

*In millions of present-day, discounted dollars
** Median household income within TAZ greater/lower than Average +/- 1 Standard Deviation
*** Proportion within TAZ greater/lower than Average +/- 1 Standard Deviation

QUALITATIVE ASSESSMENT RELATIVE TO OTHER GROUPS

USER BENEFITS EQUITY SCORING		RURAL	LOW INCOME	HIGH INCOME	LOW SHARE	HIGH SHARE	DIRECT SCORING	USED IN MODA
Base Case	2035 Low Build	Equal	Equal	Equal	Equal	Equal	0.0	n/a
Bundle_1	Roadway & Capacity	Equal	Equal	Equal	Equal	Equal	0.0	n/a
Bundle_2	Transit	Equal	Equal	Equal	Equal	Equal	0.0	n/a
Bundle_3	Active Transport & Programs	Equal	Equal	Equal	Equal	Equal	0.0	n/a
Bundle_4	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Bundle_5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Bundle_6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Bundle_7	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Bundle_8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Bundle_9	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Bundle_10	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

- **EQ2. Distribution of PM 2.5 Across Population Groups**—This indicator evaluates the distribution of air pollution across population groups and geographies. Particulate matter emissions are produced by EPA's MOVES model as part of the analysis for the Environmental Stewardship indicators. To estimate this indicator, users can make a qualitative assessment of the amount of PM emissions occurring within low-income versus high income communities and/or minority versus non-minority communities. This can be accomplished by first mapping low income and minority populations, then overlaying estimates of PM emissions produced by TAZ or other geography (users perform this spatial analysis for each bundle separately). This requires running the MOVES model to

produce emissions at the TAZ or equivalent level to be able to view the geographic distribution of emissions. Bundles are rated on the "a lot worse" to "a lot better" qualitative scale.

- **EQ3. Distribution of Health Benefits from Active Transportation Across Population Groups**—The instructions to populate EQ3 are similar to the process to populate EQ2, as described above. Quantitative analysis may be performed, showing the difference in the percent share of cycling and walking trips occurring in different geographies and populations (note that this requires a robust travel model and link-level pedestrian and cycling data so that cycling and walking trips can be readily visualized). This analysis can be accomplished by first mapping low income and minority populations, then mapping link-level cycling and walking trips and overlaying the two to calculate what percentage of these trips occur in low income or minority areas. This analysis is conducted for each bundle separately.

  Alternatively, users may elect a qualitative assessment. In this case, users map all planned active transportation *facilities* and overlay this with the low income and/or minority populations. From these, the user would make a qualitative assessment of where planned facilities will occur and which population groups are most likely to benefit. It is assumed that more people will walk and bike where facilities are constructed. Bundles are rated on the "a lot worse" to "a lot better" qualitative scale.

- **EQ4. Distribution of Accident Rates across Population Groups**—The instructions to populate EQ4 are similar to the process for the other equity indicators. This indicator is evaluated qualitatively, based on the spatial distribution of accident rates from the "Safety & Security" worksheet. Users first map all projects *for which safety benefits were assessed* (some projects may not have been assessed for their benefit to transportation safety and the user may wish to exclude these from analysis). Next, the change (positive or negative) in accident rates on those facilities is mapped. The user then makes a qualitative assessment based on where accident rates are distributed with relation to low income or minority populations (or other groups of concern). Bundles are rated on the "a lot worse" to "a lot better" qualitative scale.

  Rows 160 through 212 of the "Equity" worksheet allow for a summary comparison of the qualitative scores of each Equity indicator, as shown below.

	A	B	C	D	E	F	G	H	I	J
1	EQUITY CATEGORY									
2	ESTIMATION OF SPECIFIC INDICATORS									
3	VERSION 2.0									
4	December 5, 2014									
5										

L59										
L60	SUMMARY OF EQUITY IMPACTS									
L61										
L62										

	RELATIVE TO OVERALL IMPACTS, ON ENTIRE POPULATION	GEOGRAPHIC AREAS		HOUSEHOLD INCOME		RACIAL & ETHNIC MINORITIES		OVERALL EQUITY SCORE
L63		URBAN	RURAL	LOW INCOME	HIGH INCOME	LOW SHARE	HIGH SHARE	
L64								
L65	**DISTRIBUTION OF USER BENEFITS**							
L66	Base Case n/a			n/a	n/a	n/a	n/a	n/a
L67	Bundle_1 n/a			n/a	n/a	n/a	n/a	n/a
L68	Bundle_2 n/a			n/a	n/a	n/a	n/a	n/a
L69	Bundle_3 n/a			n/a	n/a	n/a	n/a	n/a
L70	Bundle_4 n/a			n/a	n/a	n/a	n/a	n/a
L71	Bundle_5 n/a			n/a	n/a	n/a	n/a	n/a
L72	Bundle_6 n/a			n/a	n/a	n/a	n/a	n/a
L73	Bundle_7 n/a			n/a	n/a	n/a	n/a	n/a
L74	Bundle_8 n/a			n/a	n/a	n/a	n/a	n/a
L75	Bundle_9 n/a			n/a	n/a	n/a	n/a	n/a
L76	Bundle_10 n/a			n/a	n/a	n/a	n/a	n/a

Net Present Value Calculations

Output Charts

Output Tables

Output Sheets

These four worksheets display the outputs of a Mosaic application. Detailed descriptions of each worksheet can be found in Step 5: Interpret the Results.

Economic Data

Worksheet Purpose

This worksheet describes several key sources of data used to create the Mosaic Tool, including economic multipliers imported from the IMPLAN economic impact modeling system.[15] These multipliers inform the calculations for several of the specific indicators in the Economic Vitality and Equity categories.

Worksheet Considerations and Relationships

No user inputs are required on this worksheet. However, cells shaded in light blue contain data imported from IMPLAN that should be replaced by data from a new IMPLAN run every 1 to 2 years.

The globe symbol at the top of the worksheet allows the user to navigate quickly and easily between the "Economic Data" worksheet and the "Economic Vitality" worksheet.

The first table on this worksheet (Rows 7 through 453) lists the economic impacts of every $1 million spent on IMPLAN Sector 36, "Construction of Other New Nonresidential Structures." This is the sector that includes most transportation construction. Sector 36 (Row 47) is highlighted in this worksheet.

As illustrated in the screenshot below, each row in the table lists an industry affected by transportation construction spending. Columns C through F show employment impacts measured in jobs, Columns G through J show the value added impacts (the dollar value of additional goods and services purchased) of each $1 million spent on transportation construction, and Columns K through N show the labor income impacts (the dollar value of wages paid). Column O lists the average income for each industry, and Column P identifies whether that industry provides low-income (identified by "1") or livable wage (identified by "0") jobs.

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[15] Created by MIG, Inc., the IMPLAN system (https://implan.com/) generates detailed social accounting matrices and multiplier models of local economies. IMPLAN is used by states, universities, and the federal government to help understand the potential fiscal impacts of program investments and policy decisions.

ECONOMIC DATA INCLUDING MULTIPLIERS FROM IMPLAN AND EMPLOYMENT DATA
VERSION 2.0
September 3, 2014

ECONOMIC MULTIPLIERS FROM IMPLAN
The table below shows the impacts of $1,000,000 of Industry Sales in Sector 36 (Construction of other new nonresidential structures), in dollars of 2011

IMPLAN CODE	INDUSTRY	EMPLOYMENT IMPACTS				VALUE ADDED IMPACTS				LABOR INCOME IMPACTS				AVERAGE INCOME	LOW INCOME?
		DIRECT	INDIRECT	INDUCED	TOTAL	DIRECT	INDIRECT	INDUCED	TOTAL	DIRECT	INDIRECT	INDUCED	TOTAL		
1	Oilseed farming	0.0	0.0	0.0	0.0	$0	$38	$463	$502	$0	$25	$299	$324	$36,795	0
2	Grain farming	0.0	0.0	0.0	0.0	$0	$90	$872	$962	$0	$54	$518	$571	$20,974	1
3	Vegetable and melon farming	0.0	0.0	0.0	0.0	$0	$2	$480	$482	$0	$2	$455	$457	$88,095	0
4	Fruit farming	0.0	0.0	0.0	0.0	$0	$6	$439	$445	$0	$6	$413	$419	$82,229	0
5	Tree nut farming	0.0	0.0	0.0	0.0	$0	$1	$14	$14	$0	$1	$11	$12	$49,882	0
6	Greenhouse, nursery, and floriculture production	0.0	0.0	0.0	0.0	$0	$55	$463	$518	$0	$54	$448	$501	$64,523	0
7	Tobacco farming	0.0	0.0	0.0	0.0	$0	$0	$2	$3	$0	$0	$2	$2	$7,231	1
8	Cotton farming	0.0	0.0	0.0	0.0	$0	$5	$26	$31	$0	$2	$14	$16	$31,864	0
9	Sugarcane and sugar beet farming	0.0	0.0	0.0	0.0	$0	$3	$49	$52	$0	$2	$29	$31	$11,252	1
10	All other crop farming	0.0	0.0	0.0	0.0	$0	$531	$311	$841	$0	$432	$253	$685	$45,513	0
11	Cattle ranching and farming	0.0	0.0	0.0	0.0	$0	$8	$342	$350	$0	$3	$134	$137	$8,507	1
12	Dairy cattle and milk production	0.0	0.0	0.0	0.0	$0	$7	$308	$315	$0	$2	$86	$88	$8,720	1
13	Poultry and egg production	0.0	0.0	0.0	0.0	$0	$6	$311	$317	$0	$5	$258	$263	$60,476	0
14	Animal production, except cattle and poultry and eggs	0.0	0.0	0.0	0.0	$0	$19	$429	$448	$0	$7	$165	$173	$9,133	1
15	Forest nurseries, forest products, and timber tracts	0.0	0.0	0.0	0.0	$0	$308	$68	$376	$0	$98	$22	$120	$55,202	0
16	Logging	0.0	0.0	0.0	0.0	$0	$641	$127	$768	$0	$577	$114	$691	$44,836	0
17	Fishing	0.0	0.0	0.0	0.0	$0	$1	$13	$14	$0	$1	$9	$9	$24,843	0
18	Hunting and trapping	0.0	0.0	0.0	0.0	$0	$0	$60	$60	$0	$0	$14	$14	$10,377	1
19	Support activities for agriculture and forestry	0.0	0.0	0.0	0.0	$0	$308	$565	$873	$0	$356	$653	$1,010	$28,615	0
20	Oil and gas extraction	0.0	0.0	0.0	0.0	$0	$9,238	$4,527	$13,765	$0	$4,011	$1,966	$5,977	$120,814	0
21	Coal mining	0.0	0.0	0.0	0.0	$0	$497	$584	$1,082	$0	$255	$300	$556	$84,376	0
22	Iron ore mining	0.0	0.0	0.0	0.0	$0	$143	$21	$164	$0	$42	$6	$49	$80,841	0
23	Copper, nickel, lead, and zinc mining	0.0	0.0	0.0	0.0	$0	$180	$116	$295	$0	$44	$29	$73	$84,045	0
24	Gold, silver, and other metal ore mining	0.0	0.0	0.0	0.0	$0	$309	$146	$456	$0	$62	$30	$92	$91,422	0
25	Stone mining and quarrying	0.0	0.0	0.0	0.0	$0	$3,311	$127	$3,439	$0	$1,416	$55	$1,471	$54,401	0
26	Sand, gravel, clay, and ceramic and refractory minerals mining and quarrying	0.0	0.0	0.0	0.0	$0	$924	$60	$985	$0	$628	$41	$669	$56,153	0
27	Other nonmetallic mineral mining and quarrying	0.0	0.0	0.0	0.0	$0	$270	$58	$327	$0	$101	$22	$122	$73,833	0
28	Drilling oil and gas wells	0.0	0.0	0.0	0.0	$0	$0	$0	$0	$0	$0	$0	$0	n/a	0
29	Support activities for oil and gas operations	0.0	0.0	0.0	0.0	$0	$1,296	$621	$1,917	$0	$1,220	$585	$1,804	$81,430	0
30	Support activities for other mining	0.0	0.0	0.0	0.0	$0	$233	$45	$279	$0	$118	$23	$141	$73,875	0
31	Electric power generation, transmission, and distribution	0.0	0.0	0.0	0.0	$0	$5,749	$9,258	$15,007	$0	$1,663	$2,679	$4,342	$138,782	0

Tabs: NPV CALC | OUTPUT CHARTS | OUTPUT TABLES | OUTPUT SHEETS | **ECONOMIC DATA** | SKETCH MODELS | SUPPORTING DATA | REFER …

The second table on the worksheet (Rows 458 through 483) contains the same information about the economic impact of each $1 million spent on IMPLAN sector 36, except that it has been aggregated into larger sectors. To achieve the aggregated information, this table sums the impacts of industries in multiple NAICS (North American Industry Classification) codes. As shown in the screenshot below, industries are aggregated in this table according their two-digit NAICS codes. This allows for a higher-level look at the economic impacts data. Data for the Construction sector are highlighted in yellow.

ECONOMIC DATA INCLUDING MULTIPLIERS FROM IMPLAN AND EMPLOYMENT DATA
VERSION 2.0
September 3, 2014

Lower 5% | $24,809

Summary of Impacts by 2-Digit 2007 NAICS Code (North American Industry Classification System)

2007 NAICS CODE	INDUSTRY	EMPLOYMENT IMPACTS				VALUE ADDED IMPACTS				LABOR INCOME IMPACTS				AVERAGE INCOME
		DIRECT	INDIRECT	INDUCED	TOTAL	DIRECT	INDIRECT	INDUCED	TOTAL	DIRECT	INDIRECT	INDUCED	TOTAL	
11	Agriculture, Forestry, Fishing and Hunting	0.0	0.0	0.1	0.2	$0	$2,030	$5,341	$7,371	$0	$1,626	$3,898	$5,524	$31,198
21	Mining	0.0	0.1	0.0	0.1	$0	$16,402	$6,307	$22,708	$0	$7,899	$3,055	$10,954	$88,905
22	Utilities	0.0	0.0	0.0	0.0	$0	$8,143	$12,456	$20,598	$0	$2,245	$3,534	$5,780	$134,161
23	Construction	7.8	0.0	0.1	7.9	$430,294	$1,855	$3,818	$435,968	$378,732	$1,567	$3,153	$383,452	$48,792
31-33	Manufacturing	0.0	0.7	0.3	1.0	$0	$91,308	$47,000	$138,307	$0	$48,314	$23,610	$71,924	$69,643
42	Wholesale Trade	0.0	0.2	0.2	0.4	$0	$29,180	$29,452	$58,632	$0	$16,952	$17,110	$34,061	$78,775
44-45	Retail Trade	0.0	0.2	1.1	1.3	$0	$11,672	$55,453	$67,124	$0	$7,429	$34,023	$41,451	$32,117
48-49	Transportation and Warehousing	0.0	0.2	0.2	0.4	$0	$16,337	$14,501	$30,838	$0	$12,197	$10,526	$22,724	$53,173
51	Information	0.0	0.1	0.1	0.2	$0	$15,593	$23,830	$39,423	$0	$7,456	$12,267	$19,724	$91,628
52	Finance and Insurance	0.0	0.2	0.8	1.1	$0	$31,222	$164,469	$195,691	$0	$11,170	$41,063	$52,232	$48,703
53	Real Estate and Rental and Leasing	0.0	0.1	0.0	0.1	$0	$14,051	$6,407	$20,458	$0	$4,746	$1,817	$6,563	$68,631
54	Professional, Scientific, and Technical Services	0.0	0.9	0.3	1.3	$0	$80,241	$32,557	$112,798	$0	$68,276	$23,765	$92,041	$73,623
55	Management of Companies and Enterprises	0.0	0.1	0.1	0.1	$0	$8,680	$8,914	$17,594	$0	$7,125	$7,318	$14,443	$113,255
56	Administrative and Support and Waste Management and Remediation Services	0.0	0.4	0.4	0.8	$0	$16,352	$15,882	$32,233	$0	$13,042	$12,473	$25,515	$33,813
61	Education Services	0.0	0.0	0.2	0.2	$0	$93	$8,572	$8,665	$0	$83	$7,871	$7,953	$36,785
62	Health Care and Social Assistance	0.0	0.0	1.1	1.1	$0	$2	$66,437	$66,439	$0	$1	$61,433	$61,434	$53,873
71	Arts, Entertainment, and Recreation	0.0	0.0	0.2	0.2	$0	$1,443	$8,368	$9,812	$0	$1,193	$5,837	$7,030	$28,875
72	Accommodation and Food Services	0.0	0.1	0.7	0.8	$0	$4,662	$23,388	$28,050	$0	$3,035	$16,019	$19,054	$24,238
81	Other Services (except Public Administration)	0.0	0.2	0.6	0.8	$0	$13,108	$20,774	$33,881	$0	$10,861	$19,064	$29,925	$37,135
92	Public Administration	0.0	0.0	0.1	0.1	$0	$2,379	$5,426	$7,805	$0	$2,832	$7,133	$9,965	$78,064
	TOTAL	7.8	3.7	6.7	18.2	$430,294	$364,751	$559,352	$1,354,397	$378,732	$228,048	$314,969	$921,749	$50,588

Source: Minnesota Implan Group (MIG)

The job and income figures in these tables populate several of the specific indicator tables in the "Economic Vitality" worksheet.

The third table on this worksheet (Rows 485 through 498) summarizes the economic impact of each $1 million spent on IMPLAN sector 36 according to the impact on industries that typically contain a higher number of low-income jobs.

The Notes table (Rows 500 through 536) contains a list of the activities included in IMPLAN sector 36 (transportation activities are highlighted in green), a link to IMPLAN, and a list of other IMPLAN sectors relevant for transportation investments.

The last section of this worksheet details additional data sources:

- 2007 Census employment data from the State of Oregon

- 2011 County-level employment and wage data for the State of Oregon from the Bureau of Labor Statistics;

- Assumptions regarding industry revenue growth, employment growth and employee benefits; and

- 2007 Freight flows and trade data from FHWA.

Supporting Data and Calculations

Worksheet Purpose

This worksheet provides assumptions, data sources and calculation methodology used to develop measures for many of the Mosaic parameters, including:

- Value of time (Rows 7 through 118)
- Value of preventing injuries (Row 119 through 159)
- Property damage costs (Rows 160 through 194)
- Freight inventory costs (Rows 195 through 205)
- Valuation of travel time reliability (Rows 206 through 257)
- Monetization of vehicle operating costs (Rows 258 through 293)
- Evidence on the marginal external costs of highway projects (Rows 294 through 370)
- Costs of air pollution (Rows 371 through 406)
- Future fuel costs (Rows 407 through 482)
- Price indices, employment cost index and exchange rates (Rows 483 through 522)
- Weight and length conversion factors (Rows 523 through 537)
- Alternative Value of Time Estimates for Oregon (Rows 538 through 586)

For parameters that require user input into sketch models, see the "Sketch Models" worksheet.

Sketch Models

Worksheet Purpose

The "Sketch Models" worksheet includes a number of "sketch-planning" tools to assist users in the estimation of some specific indicators. The principal source(s) for each model is cited in the worksheet, and below. The Mosaic Tool Documentation (available on the project website ww.oregonmosaic.org) provides additional guidance on the sketch tools.

The tools in this worksheet are designed to monetize as many impacts as possible. Users retain the ability to opt for quantification only using the outputs of these sketch models, or for using a qualitative approach. The latter two approaches are available through use of MODA.

It is important to note that sketch tools, by their nature, provide generalized results and must always be employed with caution. Professional judgment is required in the use of these sketch tools – sketch tool outputs must be analyzed critically to ensure the results reflect what might be expected for a given community. Some sketch tools may be most appropriate for communities or regions of a certain size. Users should research the source for these sketch models (which is provided here in the User Guide and in the Mosaic tool itself) to determine if they are appropriate for the particular geography under study.

Sketch-Planning Models for Estimating Changes in Physical Activity (Rows 7 through 54)

1. **Model from the UK Department for Transport, TAG Unit 3.14.1, August 2012**

This model uses the following input variables:

*   Total roadway mileage within the study area, in the Base Case and for each bundle;

*   Mileage of facilities for bicycle use (bicycle lanes or traffic free route), in the Base Case and for each bundle;

*   An elasticity of demand with respect to the proportion of roadway mileage for bicycle use; and

*   The number of bicycle users in the Base Case.

The sole output of the model is the number of bicycle users in the Build Scenario (i.e., under each bundle). It is derived by calculating the percentage change in the proportion of roadway mileage for bicycle use, and augmenting the number of bicycle users with the elasticity coefficient. A snapshot of the model is provided below.

	BASE CASE	BUILD	CHANGE
Total roadway mileage within study area	500.0	600.0	
Mileage of facilities for bicycle use (bicycle lanes or traffic free route)	5.0	20.0	
Proportion of facilities for bicycle use	1.0%	3.3%	233.3%
Elasticity of demand with respect to proportion of facility for bicycle use	0.05		
Number of bicycle trips per day	2,000	2,124	124.1

Source: UK Department for Transport, Transport Analysis Guidance (TAG) Unit 3.14.1, Guidance on the Appraisal of Walking and Cycling Schemes, August 2012, page 13
http://www.dft.gov.uk/webtag/documents/expert/unit3.14.php

2. Model from the Transportation Research Board, National Cooperative Highway Research Program (NCHRP), Guidelines for Analysis of Investments in Bicycle Facilities (2006)

This sketch-planning model estimates the additional number of bicycle users resulting from investment in a new bike facility. It uses the following input variables:

- Population density within the study area, in persons per square mile;

- Average annual population growth in the study area, in percent;

- Additional length of bike facility brought about by the plan or project, in miles;

- Percentage of adult residents;

- Percentage of commuters in adult population;

- Current bicycle commute share, in percent of total commuting trips; and

- Percentage of children who ride a bicycle on any given day.

The tool also uses a set of biking likelihood multipliers, provided in the NCHRP guidelines, to estimate the likely increase in the number of cyclists from the population residing in three buffer areas around the new bike facility (1/4 mile, 1/2 mile and 1 mile). All input variables (in light blue shaded cells) and intermediate output variables are shown in the screenshot below.

								BASE CASE			BUILD		
							2010	**2035**	**2035**	**2035**	**2035**	**2035**	**2035**
1	SKETCH-PLANNING MODELS												
2	VERSION 2.0												
3	September 3, 2014												
22	*MODEL from Transportation Research Board, National Cooperative Highway Research Program – CYCLING*												
23	*Guidelines for Analysis of Investments in Bicycle Facilities (2006)*												
27	Population Density in the Study Area per square mile						3,579	4,014	4,014	4,014			
28	Average Annual Population Growth within Study Area					0.5%							
29	ADDITIONAL Bicycle Facility Length, in miles					35.0							
30	Buffer Area within 1/4 mile of a Bike Facility					17.7							
31	Buffer Area within 1/2 mile of a Bike Facility					35.8							
32	Buffer Area within 1 mile of a Bike Facility					73.1							
33	Population Living Within 1/4 mile of a Bike Facility						63,335	71,035	71,035	71,035			
34	Population Living Within 1/4-1/2 mile of a Bike Facility						64,741	72,612	72,612	72,612			
35	Population Living Within 1/2-1 mile of a Bike Facility						133,698	149,952	149,952	149,952			
36	Percentage of Adult Residents					74.3%							
37	Percentage of Commuters in Adult Population					63.9%							
38	Current Bicycle Commute Share					0.1%							
39	Percentage of Children who Ride a Bike on a Given Day					1.0%							
40	Daily Existing Bicycle Commuters						62	70	70	70			
41	Total Adult Bicycling Rate (NCHRP Formula)					0.3%							
42	Total Daily Existing Adult Cyclists						895	1,003	1,003	1,003			
43	Total Daily Existing Child Cyclists						673	755	755	755			
44	Biking Likelihood Multiplier (within 1/4 mile)					2.93							
45	Biking Likelihood Multiplier (within 1/2 mile)					2.11							
46	Biking Likelihood Multiplier (within 1 mile)*					0.00							*Not statistically significant
47	Total New Induced Adult Cyclists										1,235	1,235	1,235
48	Total New Induced Child Cyclists										929	929	929
49	Total New Bicycle Commuters										86	86	86
50	**Total Number of Cyclists**						1,567	1,758	1,758	1,758	3,922	3,922	3,922
52	**Additional Number of Cyclists**										2,164	2,164	2,164

3. Model based on trip length for WALKING

This sketch planning tool provides an estimate for the number of baseline pedestrian trips generated in a study area. It uses the following input variables:

- Total area population

- Number of daily trips per person (from National Household Travel Survey or local data if available)

- Percent of all trips less than ½ mile (from National Household Travel Survey or local data if available)

- Percent of trips less than ½ mile that are walk trips (from National Household Travel Survey or local data if available)

This sketch tool provides a baseline number of pedestrian trips. Users of Mosaic can use these data to estimate the number of additional pedestrians associated with a bundle of actions (see *Evaluating Active Transport Benefits and Costs*, 2014, Victoria Transport Policy Institute. Pages 11 and 12 detail effects on pedestrian demand from various improvements http://www.vtpi.org/nmt-tdm.pdf)

Special note on the model for estimating demand for walking (Row 55, "Sketch Models" worksheet): this model, unlike the cycling model in Row 10, is not sensitive to the supply of walking facilities; the sketch model produces a baseline estimate of the number of walkers based on national household travel survey data and population. Because the quality of life indicators measure the difference between alternative bundles and the base case, users are advised to estimate the change in the number of walkers for different bundles using other methods, i.e., methods that estimate change in the number of walkers or walk trips based on improved facilities or changes in land use associated with a particular bundle. Some resources for estimating these changes are provided below:

- Evaluating Active Transport Benefits and Costs (2014, Victoria Transport Policy Institute). Pages 11 and 12 detail effects on pedestrian demand from various improvements. http://www.vtpi.org/nmt-tdm.pdf

- Using Built Environment Characteristics to Predict Walking for Exercise (2008, Lovasi, et. al.) https://ij-healthgeographics.biomedcentral.com/articles/10.1186/1476-072X-7-10

Sketch-Planning Model for Estimating the Health Effects of Increased Physical Activity, Statistical Lives Saved (Rows 73 through 174)

1. Mortality Rates for Oregon

This simple sketch tool calculates an average mortality rate for adults age 25 through 64. The tool is set up for Oregon state data, but users may enter more specific local, regional, or different state data. The average mortality rate for ages 25 through 64 produced in Column J is integral to the outputs in the sketch model discussed in #3 below.

2. Model from the World Health Organization, Quantifying the Health Effects of Cycling and Walking (2007)

This sketch-planning model estimates the number of statistical lives saved resulting from increased cycling. It is based on the results of an empirical study conducted in Copenhagen, Denmark. The results of that study are "scaled" using data or assumptions on the average distance traveled per year per new cyclist.

The following input values are needed to populate the tool:

- Number of additional bicycle users, aged 25 through 64;
- Mean distance traveled per day, in miles; and
- Average number of days traveled per year.

Baseline mortality rates by age group are also used in the calculations. They were obtained from Oregon Vital Statistics (2010) and are included within the tool.

MODEL from World Health Organization
Quantifying the Health Effects of Cycling and Walking (2007)

		2020	2030	2040
Calculate mean distance traveled per year				
Mean distance traveled, miles		2.5		
Proportion of users who make return trip, %		90%		
Average days traveled per year, days		117		
Mean distance traveled per year per cyclist, miles		556		
Calculate relative risk for study area				
Mean distance traveled per year per cyclist in Copenhagen study, miles		1,007		
Relative risk (Copenhagen) *		72%		
Risk reduction (Copenhagen)		28%		
Risk reduction (Study area)		15%		

* The relative risk of an active cyclist of all-cause mortality is 72% relative to the prevalence of mortality in the population as a whole.

Calculate reduced mortality benefit				
Proportion of population aged 25-64 who die **each year** from all causes		0.00366		
Extra cyclists aged 25-64 encouraged by project/bundle relative to Base Case		620	685	757
Expected deaths in this population		2.3	2.5	2.8
Lives saved in year t		0.4	0.4	0.4

Assumes common definition of "Adult"

Mortality Rates from Oregon Vital Statistics (2010)

Sex	Age Group	Mortality rate per 100,000 (all causes)	Number of Deaths	Implied Population Size		Average Mortality Rate for Ages 25-64	0.00366
Men	15-24	79.2	202	255,051			
	25-44	155.8	775	497,433			
	45-64	750.0	3,692	492,267			
	65+	4,789.5	11,043	230,567			
Women	15-24	33.8	68	201,183			
	25-44	81.6	391	479,167			
	45-64	464.2	2,450	527,790			
	65+	4,515.1	12,958	286,993			
OVERALL Age 15+			31,579	2,970,449	(Census Estimate = 3,051,544)		
OVERALL Age 25-64			7,308	1,996,656	(Census Estimate = 2,035,386)		
Source:	http://public.health.oregon.gov/BirthDeathCertificates/VitalStatistics						

		Mortality rate per 100,000 (all causes)	Number of Deaths	Implied Population Size		Average Mortality Rate for Ages 25-64	0.00366
SKETCH-PLANNING MODELS							
VERSION 2.0							
September 3, 2014							

MORTALITY RATES FOR OREGON
Oregon Vital Statistics (2010)

Sex	Age Group	Mortality rate per 100,000 (all causes)	Number of Deaths	Implied Population Size		Average Mortality Rate for Ages 25-64	0.00366
Men	15-24	79.2	202	255,051			
	25-44	155.8	775	497,433			
	45-64	750.0	3,692	492,267			
	65+	4,789.5	11,043	230,567			
Women	15-24	33.8	68	201,183			
	25-44	81.6	391	479,167			
	45-64	464.2	2,450	527,790			
	65+	4,515.1	12,958	286,993			
OVERALL Age 15+			31,579	2,970,449	(Census Estimate = 3,051,544)		
OVERALL Age 25-64			7,308	1,996,656	(Census Estimate = 2,035,386)		
Source:	http://public.health.oregon.gov/BirthDeathCertificates/VitalStatistics						

MODEL from the World Health Organization – CYCLING
Quantifying the Health Effects of Cycling and Walking (2007)

	2035
Calculate mean distance traveled per year	
Mean distance traveled, miles per one-way trip	2.5
Proportion of users who make return trip, %	90%
Average days traveled per year, days	117
Mean distance traveled per year per cyclist, miles	556
Calculate relative risk for study area	
Mean distance traveled per year per cyclist in Copenhagen study, miles	1,007
Relative risk (Copenhagen) *	72%
Risk reduction (Copenhagen)	28%
Risk reduction (Study area)	15%

* The relative risk of an active cyclist of all-cause mortality is 72% relative to the prevalence of mortality in the population as a whole.

Calculate reduced mortality benefit - ILLUSTRATION	
Proportion of population aged 25-64 who die **each year** from all causes	0.00366
Extra cyclists aged 25-64 encouraged by project/bundle relative to Base Case	1,000
Expected deaths per year in this population	3.7
Lives saved in year *t*	0.6

MODEL derived from 2014 WHO/Europe Health Economic Assessment Tool – CYCLING AND WALKING
http://www.heatwalkingcycling.org

Go to QUALITY OF LIFE

3. Model derived from 2014 WHO/Europe Health Economic Assessment Tool for estimating mortality reduction associated with Cycling and Walking

This tool provides an estimate for the mortality reduction benefit associated with cycling and walking. Rows 114 through 142 provide "dose-response" curves that inform outputs in the second part of the sketch tool. Users are advised to use the default values, but may change if better local data are available for any parameter.

In the second part of the tool, from Rows 143 through 174, the number of statistical lives saved is calculated. The sketch tool automatically transposes the number of bicycle users, number of regular walkers, and number of miles traveled on average for each from user inputs on the "Quality of Life" worksheet. Users need to enter the percentage of the population age 25 through 64 in Column F. Users should also enter study area-specific information in the Mortality Rates section from Rows 76 through 91 (see 1. Mortality Rates for Oregon above).The tool then automatically calculates the number of annual statistical lives saved in Columns I through K, with a summary in Columns M through O. These numbers can then be entered into the appropriate place in the "Quality of Life" worksheet.

Sketch-Planning Model for Estimating the Health Effects of Increased Physical Activity, Reduced Incidence of Diseases (Rows 175 through 341)

1. Model based on Integrated Transport & Health Impacts Modeling Tool (ITHIM), Version November 1, 2011

This sketch-planning model estimates reductions in the incidence of six diseases as a result of increased physical activity (biking or walking). If using default values in this tool, user input is minimal. The tool calculates the reduced incidence of disease for each for each disease in which incidence data are available based on the number of additional cyclists and walkers entered in the "quality of life" spreadsheet.

It uses three sets of input variables, shown in the screenshot below:

- Baseline disease incidence rates, in cases per 100,000 per year (the user can find these data from various state resources. For Oregon data, see https://public.health.oregon.gov/DiseasesConditions/ChronicDisease/DataReports/Pages/AdultDat a.aspx);

- Conversion factors for translating levels of physical activity associated with biking or walking into Metabolic Equivalents; and

- Morbidity risk reduction factors per Metabolic Equivalent per week.

MODEL based on Integrated Transport & Health Impacts Modeling Tool (ITHIM)
Version November 1, 2011

Baseline Disease Incidence Rates Template Table, per 100,000 per year

	Incidence Rate	
Breast Cancer	130.3	
Colon Cancer	100.0	Missing data
Cardiovascular Disease (CVD)	100.0	Missing data
Dementia	100.0	Missing data
Depression	7,100.0	
Diabetes	100.0	Missing data

Sources: http://statecancerprofiles.cancer.gov/cgi-bin/quickprofiles/profile.pl?41&055

Conversion Table for Translating Levels of Physical Activity Associated with Active Transportation into METs

		Time	Distance Traveled (miles)	MET (kcal/kg/hour)	MET per mile	Use in Calculations
	Walking, 2.8 to 3.2 mph, level, moderate pace, firm surface	1 hour	3.0	3.50	1.167	In Use
	Walking, 3.5 mph, level, brisk, firm surface, walking for exercise	1 hour	3.5	4.30	1.229	Not in Use
	Biking, 12-13.9 mph, leisure, moderate effort	1 hour	13.0	8.00	0.618	In Use

Source: Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett Jr DR, Tudor-Locke C, Greer JL, Vezina J, Whitt- Glover MC, Leon AS
https://sites.google.com/site/compendiumofphysicalactivities/compendia'

Morbidity Risk Reductions per Metabolic Equivalent

Diagnostic Category	Sub Group	RR per 1 MET / week		Diagnostic Category	RR per 1 MET / week	
Breast Cancer	all	0.97320		Breast Cancer	0.97320	
Colon Cancer	m	0.96065		Colon Cancer	0.96677	Approximated with simple average
	f	0.97288		Cardiovascular Disease (CVD)	0.93832	
Cardiovascular Disease (CVD)	all	0.93832		Dementia	0.96563	
Dementia	all	0.96563		Depression	0.96693	Approximated with simple average
Depression	>29	0.95590		Diabetes	0.94278	
	15-29	0.97795				
Diabetes	all	0.94278				

Source: Integrated Transport & Health Impacts Modelling Tool (ITHIM), Version Nov. 1, 2011, James Woodcock

The Mosaic Tool combines the above information with estimates of increased physical activity through the following formulas:

- TOT MET = MET per Mile x Average Distance Traveled per Day x Number of Days per Week
- RR = TOT MET x Risk Reduction per MET
- Number of Cases Avoided = Number of Cyclists or Regular Walkers x Incidence Rate x Risk RR

Sketch-Planning Model for Estimating Journey Ambience Benefits (Rows 342 through 373)

1. **Model from the UK Department for Transport, TAG Unit 3.14, January 2010**

This sketch-planning model estimates the journey ambience benefits brought about by selected improvements to the pedestrian and bicycle user environments. It uses estimates of willingness-to-pay reported in the economic literature and summarized in the UK Department for Transport's online Transport Appraisal Guidance (see screenshot below).

The values shown in the above tables are combined, in the "Quality of Life" worksheet, with estimates of miles of improvements and number of pedestrians and bicycle users impacted daily, (under the Base Case and under each bundle), to arrive at total monetized benefits.

Sketch-Planning Model for the Monetary Valuation of Noise Impacts (Rows 374 through 486)

1. **Model from the UK Department for Transport, TAG Unit 3.3.2, August 2012**

This sketch-planning model allows users of Mosaic to monetize changes in noise levels. Evidence on the monetary value of changes in exposure to noise (in British Pounds per household per year) were obtained from UK DfT's Transport Analysis Guidance, converted to current U.S. Dollars and arrayed in 3dB bands, as shown in the screenshot below.

Data on the number of households experiencing changes in noise levels relative to the Base Case must be entered into the tool (in the two matrices located in Rows 377 through 484) *for each bundle*, to derive estimates of monetized noise impacts. These data must be developed by the user outside of the Mosaic framework, using available noise estimation models.

SKETCH-PLANNING MODELS
VERSION 2.0
September 3, 2014

Cost estimates grow in real terms over time, with real GDP per capita

Dollars per Household per Year	<45	45-47.9	48-50.9	51-53.9	54-56.9	57-59.9	60-62.9	63-65.9	66-68.9	69-71.9	72-74.9	75-77.9	78-
Base Year	$0	$30	$97	$147	$198	$235	$300	$351	$402	$452	$503	$554	$
Forecast Year 1	$0	$33	$108	$165	$221	$263	$335	$392	$449	$506	$562	$619	
Forecast Year 2	$0	$39	$126	$193	$260	$308	$393	$459	$526	$592	$659	$726	

2020 FROM \ TO	<45	45-47.9	48-50.9	51-53.9	54-56.9	57-59.9	60-62.9	63-65.9	66-68.9	69-71.9	72-74.9	75-77.9	78-80.9
<45	$0	-$33	-$141	-$306	-$527	-$790	-$1,125	-$1,517	-$1,966	-$2,471	-$3,034	-$3,653	-$4
45-47.9	$33	$0	-$108	-$273	-$494	-$757	-$1,092	-$1,484	-$1,932	-$2,438	-$3,000	-$3,620	-$4
48-50.9	$141	$108	$0	-$165	-$386	-$649	-$984	-$1,376	-$1,825	-$2,330	-$2,892	-$3,512	-$4
51-53.9	$306	$273	$165	$0	-$221	-$484	-$819	-$1,211	-$1,660	-$2,165	-$2,728	-$3,347	-$4
54-56.9	$527	$494	$386	$221	$0	-$263	-$598	-$990	-$1,438	-$1,944	-$2,506	-$3,126	-$3
57-59.9	$790	$757	$649	$484	$263	$0	-$335	-$727	-$1,176	-$1,681	-$2,244	-$2,863	-$3
60-62.9	$1,125	$1,092	$984	$819	$598	$335	$0	-$392	-$841	-$1,346	-$1,909	-$2,528	-$3
63-65.9	$1,517	$1,484	$1,376	$1,211	$990	$727	$392	$0	-$449	-$954	-$1,517	-$2,136	-$2
66-68.9	$1,966	$1,932	$1,825	$1,660	$1,438	$1,176	$841	$449	$0	-$506	-$1,068	-$1,687	-$2
69-71.9	$2,471	$2,438	$2,330	$2,165	$1,944	$1,681	$1,346	$954	$506	$0	-$562	-$1,182	-$1
72-74.9	$3,034	$3,000	$2,892	$2,728	$2,506	$2,244	$1,909	$1,517	$1,068	$562	$0	-$619	-$1
75-77.9	$3,653	$3,620	$3,512	$3,347	$3,126	$2,863	$2,528	$2,136	$1,687	$1,182	$619	$0	-$
78-80.9	$4,329	$4,296	$4,188	$4,023	$3,802	$3,539	$3,204	$2,812	$2,363	$1,858	$1,295	$676	$
81+	$5,033	$5,000	$4,892	$4,727	$4,506	$4,243	$3,908	$3,516	$3,067	$2,562	$2,000	$1,380	$

2035 FROM \ TO	<45	45-47.9	48-50.9	51-53.9	54-56.9	57-59.9	60-62.9	63-65.9	66-68.9	69-71.9	72-74.9	75-77.9	78-80.9
<45	$0	-$39	-$166	-$359	-$618	-$926	-$1,319	-$1,778	-$2,304	-$2,897	-$3,556	-$4,281	-$5
45-47.9	$39	$0	-$126	-$319	-$579	-$887	-$1,280	-$1,739	-$2,265	-$2,857	-$3,516	-$4,242	-$5
48-50.9	$166	$126	$0	-$193	-$453	-$760	-$1,153	-$1,612	-$2,138	-$2,731	-$3,390	-$4,116	-$4
51-53.9	$359	$319	$193	$0	-$260	-$567	-$960	-$1,419	-$1,945	-$2,538	-$3,197	-$3,923	-$4
54-56.9	$618	$579	$453	$260	$0	-$308	-$701	-$1,160	-$1,686	-$2,278	-$2,937	-$3,663	-$4
57-59.9	$926	$887	$760	$567	$308	$0	-$393	-$852	-$1,378	-$1,971	-$2,630	-$3,356	-$4
60-62.9	$1,319	$1,280	$1,153	$960	$701	$393	$0	-$459	-$985	-$1,578	-$2,237	-$2,963	-$3
63-65.9	$1,778	$1,739	$1,612	$1,419	$1,160	$852	$459	$0	-$526	-$1,118	-$1,777	-$2,503	-$3
66-68.9	$2,304	$2,265	$2,138	$1,945	$1,686	$1,378	$985	$526	$0	-$592	-$1,251	-$1,977	-$2
69-71.9	$2,897	$2,857	$2,731	$2,538	$2,278	$1,971	$1,578	$1,118	$592	$0	-$659	-$1,385	-$2
72-74.9	$3,556	$3,516	$3,390	$3,197	$2,937	$2,630	$2,237	$1,777	$1,251	$659	$0	-$726	-$1
75-77.9	$4,281	$4,242	$4,116	$3,923	$3,663	$3,356	$2,963	$2,503	$1,977	$1,385	$726	$0	-$
78-80.9	$5,074	$5,035	$4,908	$4,715	$4,456	$4,148	$3,755	$3,296	$2,770	$2,177	$1,518	$792	$
81+	$5,899	$5,860	$5,733	$5,540	$5,281	$4,973	$4,580	$4,121	$3,595	$3,002	$2,343	$1,618	$

Results for the bundles are displayed in Row 484.

Sketch-Planning Model for Estimating the Employment Effects of Construction Spending (Rows 487 through 519)

The Mosaic Tool includes two sketch-planning models for estimating the short-term employment effects associated with construction spending:

- A model derived from IMPLAN data and runs for the State of Oregon; and

- A model based on the Council of Economic Advisers' Estimates of Job Creation from the American Recovery and Reinvestment Act of 2009, dated May 2009.

Both models can be used directly from the "Economic Vitality" worksheet, and users of Mosaic do not have to add or edit anything in the "Sketch Models" worksheet.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	SKETCH-PLANNING MODELS													
2	VERSION 2.0													
3	September 3, 2014													
4														
5														
486														
487	SKETCH-PLANNING MODEL FOR ESTIMATING THE EMPLOYMENT EFFECTS OF CONSTRUCTION SPENDING													
488														
489												Go to ECONOMIC VITALITY		
490		MODEL derived from IMPLAN data and runs for the State of Oregon												
491		See ECONOMIC DATA worksheet												
492														
493			$1,000,000	of Industry Sales in Sector 36 (Construction of other new nonresidential structures), in dollars of 2011										
494														
495		Generates	18.2	Total jobs		$1,354,397	in Value Added		$921,749	in Labor Income			$50,588	in Labor Income per Worker
496														
497		Direct	7.8			$430,294			$378,732				$48,779	
498		Indirect	3.7			$364,751			$228,048				$61,387	
499		Induced	6.7			$559,352			$314,969				$46,721	
500														
501														
502		MODEL from Council of Economic Advisers												
503		Estimates of Job Creation from the American Recovery and Reinvestment Act of 2009, May 2009												
504												Estimates Implied in IMPLAN Data		
505		Simple Rule for Estimating Job-Years "Created" by Government Spending:										included in ECONOMIC DATA worksheet		
506			$92,000	of government spending creates 1 job-year (i.e., 1 person employed for 1 year or 2 persons employed for 6 months)								$54,883		
507			64%	of the job-years represent direct and indirect effects								63%		
508			36%	of the job-years are induced effects								37%		
509														
510		Source:	Executive Office of the President, Council of Economic Advisers, "Estimates of Job Creation from the American Recovery and Reinvestment Act of 2009," Washington, D.C., May 11, 2009											
511			http://www.whitehouse.gov/administration/eop/cea/Estimate-of-Job-Creation											
512														
513		Example of Calculation:												
514			$10.0	total spending in year t, in millions of dollars										
515			109	total job-years associated with the bundle or project								182		
516			70	job-years "created" directly or indirectly								115		
517			39	job-years "created" as a result of induced household spending								67		
518														

Sketch-Planning Models for Estimating the Economic Impacts of Transportation Improvements (Rows 520 through 665)

1. Models based on HDR Decision Economics' Study of the Economic Costs of Congestion Study, for the Partnership for New York City, HDR (2008)

These models estimate the economic impacts of changes in the performance of the transportation system using travel data from the Mobility category and a large number of simplifying assumptions. They are suited to estimating the effects of a plan aimed specifically at improving traffic flows within a congested area. They should not be used for other purposes.

The first model estimates the impacts of a plan or project on logistics costs in four industries: Construction, Manufacturing (shown in the screenshot below), Retail Trade, and Wholesale Trade. The model also estimates the potential employment effects of these changes in costs, but only in the Manufacturing industry.

					Sources
577 **Manufacturing**					
578 *Assumptions*					**Sources**
579 Logistics costs as percentage of sales, %	5.0%	5.0%	5.0%		Meta-analysis in FHWA Freight Benefit-Cost Analysis Study
580 Elasticity of logistics costs with respect to transit time	0.27	0.27	0.27		Meta-analysis in FHWA Freight Benefit-Cost Analysis Study (95% confidence interval
581 Transit through area as percentage of total transit time, %	25%	25%	25%		Reasoned assumption
582 Baseline industry revenues, $ millions	$13,782	$23,727	$23,727		2007 Economic Census and 2010 BLS employment data
583 Elasticity of industry revenues with respect to costs	7.0	7.0	7.0		NCHRP report 463, Table 5.3, manufacturing industries
584 Industry mark-up, %	15%	15%	15%		Reasoned assumption
585 Industry employment, number of jobs	33,739	46,815	46,815		2007 Economic Census and 2010 BLS employment data
586 Average employment-to-output ratio, jobs per $1 million of output	2.4	2.0	2.0		Calculated
587					
588 *Impact Calculation*					
589 Percent reduction in average speed, %	0.0%	21.5%	21.5%		
590 Increase in logistics costs due to congestion, %	0.0%	1.4%	1.5%		
591 Increase in logistics & industry costs due to congestion, $ millions per year	$0.0	$17.2	$17.3	-$0.1	
592 Baseline industry costs, $ millions	$11,715	$20,168	$20,168		
593 Overall increase in industry costs, %	0.00%	0.09%	0.09%		
594 Reduction in industry revenues due to congestion, $ millions per year	$0.0	$141.6	$142.1	-$0.5	
595 Reduction in industry employment due to congestion, number of jobs	0	279	280	-1	
596					
597 **Wholesale Trade**					
598 *Assumptions*					**Sources**
599 Logistics costs as percentage of sales, %	5.0%	5.0%	5.0%		Meta-analysis in FHWA Freight Benefit-Cost Analysis Study
600 Elasticity of logistics costs with respect to transit time	0.27	0.27	0.27		Meta-analysis in FHWA Freight Benefit-Cost Analysis Study (95% confidence interval
601 Transit through area as percentage of total transit time, %	25.0%	25.0%	25.0%		Reasoned assumption
602 Baseline industry revenues, $ millions	$22,518	$38,765	$38,765		2007 Economic Census and 2010 BLS employment data
603					
604 *Impact Calculation*					
605 Percent reduction in average speed, %	0.0%	21.5%	21.5%		
606 Increase in logistics costs due to congestion, %	0.0%	1.4%	1.5%		
607 Increase in logistics & industry costs due to congestion, $ millions per year	$0.0	$28.1	$28.2	-$0.1	
608					

Economic impact estimates are derived from changes in average vehicle speed (in the Base Case and under each bundle) calculated elsewhere in the Mosaic Tool, and in Row 530 of the "Sketch Models" worksheet:

The second model estimates the impacts of a plan or project on commuting costs, and the potential secondary effects on employee compensation and the demand for labor. It uses estimates of commuting delay costs derived in the Mobility category (and shown in Row 638 of the "Sketch Models" worksheet), along with a number of assumptions derived the economic literature (including an estimate of the elasticity of labor demand with respect to total labor cost). Users must enter values for Rows 641 through 651 using sources shown in Column L. This sketch models include some default values that may be used by the Mosaic user, but all should be checked for appropriateness.

		BASE CASE		OPTION *k*	OPTION *k* IMPACT	
635	**MODEL from HDR Decision Economics - IMPACTS ON LABOR DEMAND**					
636	*Based on: Economic Costs of Congestion Study, for the Partnership for New York City, HDR (2008)*					
637						
638						
639		2013	2035	2035	2035	
640	**Assumptions**					**Sources**
641	Commuting delay costs relative to free flow conditions, $ per year per employee	$374.1	$629.1	$633.5		Derived from MOBILITY worksheet
642	Additional vehicle operating costs relative to free flow conditions, $ per year per employee	$0.0	$0.0	$0.0		Derived from MOBILITY worksheet
643						
644	Proportion of excess commuting cost absorbed by employers, % of total	50%	50%	50%		NCHRP Report 463
645	Average annual salary, $ per year	$48,688	$60,408	$60,408		Based on BLS data
646	Total labor cost including benefits and supplementary labor income, $ per year	$63,294	$78,530	$78,530		Based on BLS data and analysis
647	Elasticity of labor demand with respect to total labor cost	1.00	1.00	1.00		Based on HDR's Costs of Congestion Study and reasoned assumptions
648	Employment, number of jobs	443,342	615,165	615,165		BLS county data for 2010
649	Percent of employees commuting to work, % of total employment	95.0%	95.0%	95.0%		Based on Census data
650	Number of employees commuting to work	421,175	584,407	584,407		Calculated
651	Average employment-to-output ratio, jobs per $1 million of output	4.3	4.3	4.3		Based on 2007 Economic Census for Oregon
652						
653	**Calculations**					
654	Average excess commuting cost per employee, $ per year	$374	$629	$633		
655	Increase in average annual compensation needed to offset commuting costs, $ per year	$187	$315	$317		
656	Increase in labor costs due to congestion, %	0.3%	0.4%	0.4%		
657	Reduction in labor demand due to congestion, %	0.3%	0.4%	0.4%		
658	Reduction in employment due to excess commuting costs, number of jobs	1,252	2,360	2,376	-16.6	
659	Reduction in the value of regional business activity, $ millions of revenue	$290	$547	$551	-$4	
660						
661	Total reduction in employment due to excess congestion, jobs	1,252	2,639	2,657	-17	
662	Reduction in the value of regional business activity, $ millions	$290	$689	$693	-$4	
663	Percent of total employment in study area	0.3%	0.4%	0.4%	0.0%	

Sketch-Planning Model for Estimating Agglomeration Effects—*For Investments in Rail Transit Only (*Rows 666 through 748)

1. **Model from the Transportation Research Board, Transit Cooperative Research Program (TCRP), Methodology for Determining the Economic Development Impacts of Transit Projects (2012)**

This sketch-planning model may be used to develop a range of potential agglomeration benefits associated with investment in rail transit in the Portland-Vancouver metropolitan area; users may modify the input parameters in Rows 677 through 686 if using Mosaic in a different metropolitan area. Agglomeration benefits are those benefits that result from companies and people being near one another. These benefits can be monetized by estimating the value of increased productivity (i.e., through the more efficient exchange of materials or information).

Note that the users may use other external tools to estimate broader agglomeration benefits – see tools described in Rows 731 through 748.

The model uses the following bundle-specific input data (to be provided by Mosaic users):

- New proposed track mileage, miles;
- New proposed train revenue miles per year; and
- New proposed rail seat capacity, in seats.

669	**MODEL from Transportation Research Board, Transit Cooperative Research Program - *FOR INVESTMENTS IN RAIL TRANSIT ONLY***		
670	*Methodology for Determining the Economic Development Impacts of Transit Projects (2012)*		
671			
672	New proposed track mileage, miles	2.2	*A measure of the route path over a rail facility without regard to the number of rail tracks existing in the right-of-way*
673	New proposed train revenue miles per year	18,247.6	*The number of additional miles traveled by new or existing trains while in revenue service*
674	New proposed rail seat capacity, seats	47.1	*The number of physical seats installed on any newly acquired vehicles*
675			
676	**DATA for Portland-Vancouver-Beaverton, OR-WA**		
677	Population	2,203,745	
678	Workers	1,388,060	
679	Wage, average payroll in dollars	$43,022	
680	Gross payroll, millions of dollars	$59,718	
681	GDP per capita	$45,935	
682	Gross GDP, millions of dollars	$101,230	
683	Base track miles	48.4	4.6%
684	Central city employment density	2,596	
685	Square miles of urbanized area (UZA)	526	
686	Square miles of metropolitan area (MSA)	6,684	
687			

It also uses a number of parameter values and formulas developed as part of the TCRP project, to develop low, medium and high estimates of productivity effects expressed in terms of GDP per capita or average wage, summarize in Rows 679 through 682 of the "Sketch Models" worksheet.

SUMMARY OF PRODUCTIVITY EFFECTS, ANNUAL IN MILLIONS OF DOLLARS						
	AVG. WAGE	TOTAL WAGE	GDP / CAPITA	GDP	COMBINED	
Minimum	$13.1	$18.2	$23.5	$51.9	$18.2	
Maximum	$741.7	$1,029.6	$1,195.9	$2,635.5	$2,635.5	
Median	$555.4	$770.9	$891.9	$1,965.6	$903.7	<< Use this estimate as a measure of annual benefits, in Portland Metropolitan Area only

Sketch Planning Tool for Estimating Inventory Costs (Row 749)

1. **Model from FHWA Highway Economic Requirements System, 2005 (Row 749)**

This sketch tool allows the user, if they desire, to estimate the per-hour inventory cost associated with business (freight) travel time. Users can edit the commodities, perishability, distribution of freight, and average value per ton in Rows 770 through 775. The output from this tool is a per-truck-hour inventory cost that can be added to the value of time for truck drivers in the "Model Parameters" worksheet (Row 52).

References

Worksheet Purpose

The "References" worksheet lists all sources for the parameters included in the Model Parameters worksheet (referenced in Column J, *Sources*). References are listed alphabetically along with links to websites, research papers, and other documentation used in the tool development. No user inputs are required on this worksheet.

Travel Data Calculations

Worksheet Purpose

This worksheet provides detailed travel information that is imported automatically from the "Load Travel Data" worksheet or entered manually, and is used in the "Mobility" and "Economic Vitality" worksheets. It is comprised of the following three sections:

- Travel Data, Loaded or Entered Manually (Rows 10 through 177)
- Intermediate Calculations (Row 178 through 344)
- Estimation of Annual Data Series (Rows 361 through 632)

This worksheet is populated automatically when uploading travel data, or data could be entered manually if desired. The final section of this worksheet – Estimation of Annual Data Series – monetizes travel information using assumptions established in the "Model Parameters" worksheet. Changes in data in this worksheet would result from adjustments made in either the "Model Parameters" or the "Load Travel Data" worksheets.

No user input is required for this worksheet. This worksheet provides intermediate data and calculations that are used in other places within the workbook. It is a useful worksheet to examine if Mosaic outputs in Mobility or Economic Vitality do not seem accurate.

Program Calculations

WORKSHEET GROUP: INTERMEDIATE CALCULATIONS AND WORKBOOK SUPPORT

Worksheet Purpose

The "Program Calculations" worksheet calculates the cumulative impact of the implemented programmatic actions on VMT. It should be noted that the external costs associated with increased use of other modes (e.g., emissions from transit vehicles) are NOT accounted for. Default values are included in this worksheet, however users are able to select and modify some of the values, if desired. Mosaic automatically carries the output from this worksheet into appropriate Output sheets, Tables, charts and Calculations.

Section Overview and Instructions

- **Summary of Impacts and Cost Estimates by Bundle from the "Add Programs" Worksheet:** This section provides charts and graphs summarizing the benefits and costs of the programs incorporated into the tool, by bundle. No user inputs are required.

- **Include Monetized Impacts of Selected Programs in MOSAIC Results:** This section provides users with the option to select the variables included in the monetized impacts of VMT reduction. The default setting is to include the variables listed in Cells C43 through C51. Users have the option to include or exclude each variable by entering either a 0 (exclude) or a 1 (include) in Column D. Mosaic recommends that all be included.

- **Monetization of Changes in Vehicle Miles Traveled:** This section shows the calculations and assumptions used to monetize the benefits of VMT reduction for autos and trucks for each variable. If desired, users can adjust the default values (Column E), which are set at the midpoint of the range of estimate. Some reasons for making adjustments are shown in Column J. Users can also adjust the values in Column E for purposes of sensitivity testing.

- **Direct Transportation Impacts of Selected Programmatic Actions:** This section provides information on the impact of the programs on total VMT in the study area, by bundle. Because the Mosaic Tool assumes that all program impacts are independent and additive, this section provides the opportunity to cap the percent VMT reduction in any bundle. The default value in the Mosaic Tool in Cells D89 through D99 is 5 percent. Users can change this value. Mosaic recommends it as a reasonable upper value for system planning purposes.

- **Impacts of Selected Programmatic Actions on Specific Indicators, Relative to Base Case:** This section provides summary tables showing the monetized impacts, by bundle, of the implemented programs on the VMT reduction indicators. If desired, users can change the percent distribution between autos and trucks. The default setting is 100 percent autos, based on the assumption that the majority of VMT reduction effects from the programs are likely to come from autos. Additionally, default values for persons per car and tonnes per truckload are provided in Cells G171

and G172. These values help to inform the Lifecycle CO_{2e} calculation as a result of reduced VMT and can also be updated by the user with more specific local values, if available.

- **Total Investment or Implementation Cost of Selected Programmatic Actions, Relative to Base Case:** This section provides summary tables showing the discounted and non-discounted costs, by bundle, of the included programs.

- **Efficiency of Selected Programmatic Actions:** This section provides a summary table of the net present value and benefit cost ratios of the included programs, by bundle.

Lists & Lookup

WORKSHEET GROUP: INTERMEDIATE CALCULATIONS AND WORKBOOK SUPPORT

Worksheet Purpose

The "Lists & Lookup" worksheet is the place where the set of values to be included in drop-down menus is defined for all of the worksheets in the Mosaic Tool. The worksheet was created for programmers. It is not intended to be utilized as part of running a Mosaic analysis.

Review and Revisions

Worksheet Purpose

This worksheet is available for users to keep track of any changes made to the Mosaic code or background workings of the tool. The worksheet is not intended to be utilized as part of running a Mosaic analysis.

Flowchart

Worksheet Purpose

This worksheet provides a flowchart that describes the flow of data and user inputs through Mosaic. No user input is required on this worksheet.

Sensitivity and MODA Sensitivity

WORKSHEET GROUP: REVISIONS, SENSITIVITY TESTING, AND DIAGNOSTICS

Worksheet Purpose

These two worksheets provide a quick way to assess the sensitivity of the monetized value of bundles to various parameters in the Mosaic workbook.

Instructions

Sensitivity

This worksheet allows the user to see the magnitude of effect of all Mosaic parameters (e.g., discount rate, value of time, social cost of ozone, etc.) on the benefit-cost ratio and Net Present Value (NPV) for each bundle. Users enter the "percent change in parameter values" in Cell B6. The default setting is +100 percent (i.e., doubling of the parameter value), but users can change to any value to see how changes in different parameters affect the benefit-cost ratio and NPV. Parameters are changes one-at-a-time, meaning that the results show the effect on the total bundle value *for that indicator in isolation*. Results are displayed in Rows 11 through 60, Columns A through K and M through W. Columns A through K show the percent change in the benefit-cost ratio for each bundle based on the user-entered percent change in the parameter. Columns M through W show the absolute change in NPV in millions of dollars. Colors denote the direction and magnitude of change – red indicates negative changes in value, green indicates positive changes in value, and the darker the color, the greater the magnitude of change.

	SENSITIVITY ANALYSIS ON MODEL PARAMETERS										
1	VERSION 2.0										
2	September 3, 2014										
3											
4											
5											
6	Percent Change in Parameter Values = 100%		Run Sensitivity								
7											
8											
9	**Percent Change in B/C Ratio**										
10	from Variations in:	BUNDLE_1	BUNDLE_2	BUNDLE_3	BUNDLE_4	BUNDLE_5	BUNDLE_6	BUNDLE_7	BUNDLE_8	BUNDLE_9	BUNDLE_10
11	Real Discount Rate, all Benefit and Cost Streams other than Carbon emissions	-7.59%	-16.03%	-22.94%							
12	Real Discount Rate, Carbon emissions only	2.50%	-0.29%	-1.29%							
13	Adjustment to Capital Costs from Current Estimates	-47.20%	-35.02%	-45.30%							
14	Adjustment to O&M and other Life-Cycle Costs from Current Estimates	-9.58%	-31.56%	-11.38%							
15	Value of time for PERSONAL trips, LOCAL travel	305.66%	57.30%	8.77%							
16	Value of time for BUSINESS trips, LOCAL travel	45.01%	2.14%	-3.30%							
17	Value of time for PERSONAL trips, INTERCITY travel, all Surface Modes except High Speed Rail	0.00%	0.00%	0.00%							
18	Value of time for BUSINESS trips, INTERCITY travel, all Surface Modes except High Speed Rail	0.00%	0.00%	0.00%							
19	Value of time for PERSONAL trips, INTERCITY travel, High Speed Rail and Air	0.00%	0.00%	0.00%							
20	Value of time for BUSINESS trips, INTERCITY travel, High Speed Rail and Air	0.00%	0.00%	0.00%							
21	Value of time for TRUCK drivers	43.65%	2.47%	-4.38%							
22	Future Expected Growth in Labor Productivity and Real Income per Capita	166.56%	25.38%	1.08%							
23	Vehicle Operating Costs per Mile, Autos	-157.59%	-3.12%	17.59%							
24	Vehicle Operating Costs per Mile, Trucks	0.00%	0.00%	0.00%							
25	Social Cost of Carbon Monoxide (CO)	-0.39%	0.05%	0.01%							
26	Social Cost of Volatile Organic Compounds (VOC)	-0.02%	0.00%	0.00%							

MODA Sensitivity

This worksheet allows the user to see the magnitude of effect of a change in weight for each MODA indicator (all those indicators that are evaluated qualitatively or quantitatively). Users enter the desired "change in indicator weight (points)" in cell B6. For example, if a user wanted to see the effects of increasing weights by 1.5 times, the user would enter "1.5" in cell B6. Users can change to any value to see how changes in the weight of an indicator affects how each bundle performs with respect to that indicator. Results are displayed in rows 9 through 20, columns A through K. Columns A through K show the change in the MODA value for each indicator based on the user-entered change in indicator weights. Note that this process shows the results of increasing indicator weights for each indicator *independent* of the other indicators (that is, as if all other weights were held constant).

Colors denote the direction and magnitude of change – red indicates negative changes in value, green indicates positive changes in value. The darker the color, the greater the magnitude of change.

Diagnostics

This worksheet provides additional charts displaying bundle performance over time for various Specific Indicators and other data points. No user input is needed in this worksheet. Users can use the charts in this worksheet to understand how benefits are distributed through time.

Step 5: Interpret the Results

Note: screenshots of the Mosaic tool are used to illustrate certain instructions. The screenshots show data entry and outputs from the Mosaic tool. It is important to note that the data used in the screenshots is purely for illustrative purposes and does not represent data from an actual application of Mosaic.

When all required data are entered into Mosaic, the tool produces a set of outputs enabling the user to compare the costs and benefits (both monetized and non-monetized) of each bundle. The Mosaic outputs are presented in several different formats designed to help the user understand the tradeoffs among bundles.

The outputs of a Mosaic application are reported in four sheets with brick-red colored tabs: **Output Sheets**, **Output Charts**, **Output Tables**, and **Net Present Value (NPV) Calculation**. As they begin to analyze Mosaic application results, users should consult the "Output Sheets" and "Output Charts" worksheets first. These present a higher-level view of the results by type of indicator (Output Sheets) and graphically (Output Charts). The other two worksheets (Output Tables and Net Present Value Calculation) offer a more detailed view of the raw output data from the Mosaic application.

The worksheets discussed below include all Mosaic results. Users are advised to also prepare documentation of the key assumptions that underlie the estimation of certain indicators. This information may be especially important for those indicators that are scored qualitatively. Other assumptions in the Time Varying Assumptions worksheet, such as the discount rate or cost of time, may also be useful for decision making. Users are advised to provide the information found in the "Control Panel" worksheets and the series of four output sheets discussed below (the four worksheets discussed below are formatted for printing).

Output Sheets Worksheet

If a detailed listing of outputs is desired, users should consult this worksheet first as they begin to analyze Mosaic results. Otherwise, users can consult the "Output Charts" worksheet for graphic depictions. The "Output Sheets" worksheet provides output for each of the Mosaic categories in three different tables entitled: Benefit-Cost Analysis, MODA, and Report Only.

Table 1: Benefit-Cost Analysis

Rows 6 through 66 of this worksheet display benefit-cost analysis information for each bundle. Column A displays the icon for each category. Column B lists the reference number of each monetized indicator within the category, and Column C contains the name of that indicator. Starting at Column E, each column lists the dollar value of the benefits associated with the indicators. The benefit-cost analysis figures are expressed present value (e.g., 2012) dollars, in millions. Rows 62 through 66 present the total monetized benefits, total monetized costs, net present value of the investment, and the benefit-cost ratio for each bundle.

Table 2: Multi-Objective Decision Analysis

Rows 69 through 133 show the measured value of each non-monetized (quantitative or qualitative) indicator. The values in the cells in Rows 73 through 131 come from the "Output Tables" worksheet.

As in Table 1, Column A displays the category icons and Columns B and C list the reference number and name of each. Column D shows the weight of each MODA indicator in relation to the other indicators. Category weights are totaled and shown in Column D at the bottom row of each category. Starting with Column E, the table shows the measured value of each indicator in each bundle.

The values shown in Row 134, starting with Column E, are the aggregate MODA scores for each bundle. These express the score of each bundle relative to others, given the weights assigned to categories by stakeholders. (Users can change weights as explained previously; doing so will change the scores shown in this row.)

Table 3: Report Only

Rows 135 through 197 display the valued associated with the indicators categorized as "report only" in the Mosaic application. As explained in the user guide for the "Indicators" worksheet, the report only category is used only when an indicator is accounted for elsewhere in the Mosaic analysis, but contains information in which decision makers are likely to be particularly interested. Report only indicators are not weighted, nor are they included in either the benefit- cost or MODA analysis reported in the tables above.

Table 4: Main Estimating Assumptions

Rows 202 through 245 detail the key estimating assumptions used in the Mosaic application:

- "Bundles Being Assessed" (Rows 206 through 220) pulls the name and description of each bundle from the detailed description tables on the "Bundles Info" worksheet.

- "General Assumptions" (Rows 221 through 227) pulls information from the "Bundles Info" worksheet about the base year, first year of analysis, last year of analysis, and period of analysis.

- "Monetization" (Rows 228 through 245) pulls a variety of estimating assumptions from the "Bundles Info" worksheet and the "Model Parameters" worksheet.

- "Scoring and MODA" (Rows 247 through 259) lists the weight given by the MODA evaluation to each category, as reported on the "Weight Categories" worksheet.

Output Charts Worksheet

The "Output Charts" worksheet provides information similar to that presented in the "Output Sheets" worksheet, but in graphic form. The first six charts show a variety of information about the bundles, but require no user inputs.

- The first two bar charts (Rows 6 through 27) show the benefit/cost ratio for each bundle (Rows C through L) and the aggregate MODA scores for each bundle (Rows N through X). This enables the

user to compare bundles at a high level and to understand the overall role that each category of benefit played in the total MODA score.

- The third chart (Rows 29 through 50, Columns C through L) arrays the aggregate MODA scores against total investment cost for each bundle. This enables the user to compare the value of a bundle (as expressed in stakeholder terms) to the investment cost required to "buy" that set of valued benefits.

- The fourth chart (Rows 29 through 50, Columns N through W) shows the aggregate MODA score and the benefit-cost ratio for each bundle. The bubble size for each bundle is proportional to the discounted investment cost for that bundle. This enables the user to compare, simultaneously, the value of a bundle measured in dollars against the value expressed in the terms important to stakeholders, while at the same time noting the bundle's investment cost.

- The fifth and sixth charts (Rows 53 through 73) show, respectively, the growth in VMT per capita over time and the incremental transportation investment spending for each bundle. (These data may be useful, but are not essential to interpreting results.)

- The two charts in Rows 76 through 99 show the monetized benefits of each bundle by category, and the contribution of each category to the bundles MODA score. Users can click on the pull- down menu in Cell 79D to see results in these two charts for each selected bundle.

- Rows 107 through 140 show the value of monetized indicators within the nine Mosaic categories. This chart shows the monetary "contribution" of each specific indicator to the total monetized value of each category.

- Rows 141 through 173 similarly show the weighted MODA scores within the nine Mosaic categories. This chart shows the MODA "contribution" of each specific indicator to the total MODA score for each category.

- Rows 175 through 216 contain a "radar chart" that graphically displays the monetized benefits of each bundle by specific indicator.

Output Tables Worksheet

The "Output Tables" worksheet contains the raw data used to create the "Output Sheets" and "Output Charts" worksheets. Users may consult these sheets to get a more detailed breakdown of the costs and benefits of each bundle by indicator.

- The first table on the worksheet is titled "Most Likely Outcomes." This refers to the fact that some of the data in this table are the result of stakeholders or staff picking values for certain variables (e.g., cost estimates, income growth rates, and others in the "Model Parameters" worksheet) from a range of possible values offered there.

- This table presents output data for all specific indicators, including intermediary outputs. For example, with MO.1 Travel Time Savings, the indicator is reported as "travel time savings in millions

of dollars" (Row 9). This table also provides "travel time savings, hours per day" (Row 11) which is intermediary data used to estimate the monetized value.

- The second table in the worksheet (Row 95) displays the most likely outcomes associated with benefit-cost analysis.

- The third table in the worksheet (Row 119) displays the most likely outcomes associated with MODA analysis.

- The "Consequences Table" starting in Row 135 allows the user to quickly see how a bundle performs compares to the other bundles. This table contains all outputs for all the specific indicators. Users can click on the column associated with each bundle and the spreadsheet will automatically update to show how each of the other bundles performs with respect to the selected bundle. The table displays cells as red and green; red means that the other bundle(s) performed worse than the selected bundle and green means that the other bundle(s) performed better than the selected bundle. Where bundle perform the same, the cell is left white. An example with the "roadway and capacity" bundle selected is shown below.

	Category of Transportation System Performance	Index	Specific Indicator	Units	Base Case	Roadway & Capacity	Transit	Active Transport & Programs
136	CONSEQUENCES TABLE							
139	MOBILITY							
140		MO.1	Travel time saving	hours per day	0	5,950	3,679	469
141		MO.2	Hours of congestion	hours per day	149,150	147,831	148,973	150,064
142		MO.3	Reliability – Recurring congestion	score	0.0	0.0	0.0	1.0
143		MO.4	Reliability – Non-recurring congestion	score	0.0	0.0	0.0	0.0
144		MO.5	User costs	$ per trip	$1.812	$1.817	$1.809	$1.811
145		MO.6	Mode split	% drive alone	47.58%	47.59%	47.51%	47.54%
146		MO.7	VMT per capita	miles	20.93	22.88	22.80	22.78
147	ACCESSIBILITY							
148		AC.1	Transportation cost index	index	0	0	0	0
149		AC.2	Population within X minutes between work and home	percent	85.0%	85.0%	85.0%	85.0%
150		AC.3	Location of industrial jobs in relation to the regional freight network	jobs	37,735	37,735	37,735	37,735
151		AC.4	Population and employment within ¼ mile of a transit stop	percent	63.0%	63.0%	69.0%	63.0%
152		AC.5	Amount of multi-use paths and bike boulevards	miles	7.50	7.50	7.50	20.60
153		AC.6	Sidewalk coverage	ratio	0.44	0.44	0.44	0.57
154	ECONOMIC VITALITY							
155		EV.1	Number of jobs created or retained by bundle	jobs	0	8,185	6,203	1,831
156		EV.2	Business transportation cost savings by industry	PV$million	$0.0	$98.6	$19.6	($32.0)
157		EV.3	Changes in employment by industry	jobs	0.0	23.6	(0.4)	(17.2)
158		EV.4	Changes in productivity from increased connectivity	score	0.0	0.0	5.0	2.5
159		EV.5	Changes in the total value of exports and imports	PV$million	$0.0	$0.1	($0.0)	($0.0)
160	ENVIRONMENTAL STEWARDSHIP							
161		ES.1	Criteria air contaminants (full period)	short tons	1,447.5	1,449.5	1,446.8	1,447.4
162		ES.2	Air toxics (Benzene and Diesel PM)	short tons	54.9	55.0	54.9	54.9
163		ES.3	Life-cycle CO2e	metric tons	224.5	224.7	224.4	224.5
164		ES.4	Natural, built, and cultural resources at risk	score	0.0	-5.0	-3.0	-2.0

Net Present Value (NPV) Calculation Worksheet

After consulting the "Output Sheets" and "Output Charts" worksheets, users may consult the "NPV Calc" worksheet if they desire a more detailed understanding of the data that comprise the benefit-cost ratio produced by a Mosaic application. The purpose of the worksheet is to enable the user to see all monetized benefits displayed by year (Columns F through Z), by bundle (Columns B through D) and by category of benefit (Rows 59 through 168).

The worksheet breaks down the benefit-cost analysis according to: 1) the estimated internal rate of return over the life of each bundle; and 2) the net present value of each bundle broken down annually.

In addition, the worksheet breaks down the net present value calculation to reveal total benefits and total investment cost, and it lists the monetized value of each category over time for all of the bundles.

Benefit-Cost Ratio (Rows 11 through 21)

This table shows the benefit-cost ratio (total present value of monetized benefits divided by total present value of monetized costs) for each of the bundles evaluated in Mosaic. This information allows users to evaluate each bundle based on its benefit-cost ratio. The table also enables users to compare the benefit-cost ratio of various bundles to one another.

Two benefit-cost ratios are presented: the first option is calculated with all incremental benefits divided by all incremental costs (this is the traditional way benefit-cost ratios are calculated). The second option provides a benefit-cost ratio calculated with incremental benefits divided by *net agency costs*. This second option shows the benefit-cost ratio with only those costs incurred by the agency; costs borne by other agencies – state or federal government funds, for example – are not included on the cost side. This option can be helpful in showing the "leveraged" benefits associated with a bundle of actions.

Net Present Value (Rows 23 through 33)

The net present value table shows for each bundle the value of the benefits minus the costs expressed in current (base year)[16] dollars. Values are expressed in millions of dollars. Columns F through Z estimate the NPV (benefits minus costs in current $) for each year of the project life. Given the nature of most types of transportation benefits, an analysis of annual value or return is not likely to be useful or informative unless some change is programmed into a bundle (e.g., change in tolls, taxes, borrowing costs, or other costs or revenues) in a particular year.

Total Benefits (Row 35) and Total Investment Costs (Row 47)

These tables show the present value of benefits and costs associated with bundles.

Summary of Monetized Benefits by Category (Rows 59 through 167)

This section shows the monetized benefits by Mosaic category for each bundle. Rows 72 through 179 show the benefits of the bundles, both total and yearly estimates, in each of the nine Mosaic categories. For each category, Column D shows the total monetized benefits of each bundle. When a category contains no monetized indicators (accessibility, land use, and equity), the amount in Column D is "zero." Columns F through Z break down the benefits into yearly estimates. Categories that contain no monetized benefits are marked by red column headings.

Estimation of Net Agency Costs (Row 169)

This table shows an estimate of the total investment costs borne by the agency. This excludes investment costs borne by others (e.g., through federal grants) and costs funded by user fees or other revenue sources.

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[16] The base year is identified on the "Bundles Info" worksheet (Cell C11). It is the first year of analysis for the bundles.

Step 6: Use the Results to Make Decisions

Mosaic is not a tool to be run in one afternoon. Rather, it is designed to be used frequently during Oregon's existing transportation planning process to evaluate possible actions to achieve the community's vision. Transportation planning traditionally involves the use of evaluation criteria. What's different about using Mosaic? First, Mosaic offers planners, stakeholders, and policy makers two distinct ways to do this within one tool. One is benefit-cost analysis (BCA). The other is multi-objective decision analysis (MODA). Both are proven, valuable tools, but neither has been used frequently in transportation planning and decision making. More importantly, Mosaic offers them together for the first time. This enriches and informs the decision-making process in a way not previously possible.

Three key metrics in BCA will be most useful. All three are found under the "Control Panel" worksheet of the workbook. The first is a benefit-cost ratio. For each bundle, this expresses the dollar value of benefits generated for each dollar spent. Mosaic incorporates state-of-the-art knowledge about a broad range of environmental, economic, and social benefits. It is designed to represent, as fully and fairly as possible, the dollar value of benefits and costs of transportation projects, programs, and system operations in terms and with costs that are calibrated and relevant to Oregon and Oregonians.

The second is the measure of net present value (NPV). This expresses the dollar benefits (after subtracting costs) of each bundle. This is especially useful if the bundles have different costs and decision makers want to know which bundle generates the most benefits overall.

The third is internal rate of return (IRR). This measures, in a percentage, the return on the investment (cost) of a bundle. The better the return, the more attractive the bundle is when compared to others.

While these metrics are informative, they rarely answer all of the questions a decision maker has. Decision makers will want to know the reasons behind these findings, and the Mosaic Tool and process are designed to facilitate this analysis. Also, decision makers may not be comfortable looking solely at dollar costs and benefits; for this reason, Mosaic offers the MODA process as a complement to BCA.

The weighted MODA score for each bundle is the key metric. It represents the value of each bundle based on the weight decision makers give to each of Mosaic's nine categories of benefits and the indicators that define them. As with BCA, this metric rarely answers all the questions that decision makers have. To answer these questions and take full advantage of Mosaic's ability to support and inform decision making – whether using BCA, MODA, or both – users should follow the steps below.

- As suggested above, **begin by looking at the key metric(s)**. They will convey the overall value of each and every bundle.

- If several bundles are close in value (or if the logic for selecting a bundle for implementation is not obvious for any reason), **examine the charts under the Control Panel and Output Charts tabs**. These display the contribution of each category of benefits to the total value or benefits associated with any particular bundle. One chart shows this in dollars, the other in terms of the MODA score. Note whether (or how much) these vary. For example, one bundle may contribute substantially

more to economic vitality, safety, or accessibility than others. While Mosaic does not enable an easy examination of the *reasons* for these differences (the tool does not display individual projects or program data), stakeholders may look at the Bundles Info worksheet, review the listed projects and programs in each bundle, and discuss how or whether they explain the bundle's overall monetary value or score. (We will explore an alternative to this in a subsequent step, below).

- **Compare the bundles' rank and score in BCA to the MODA scores**. This information is found most conveniently under the "Control Panel" worksheet as well, in the chart that displays bundles with circles. When a bundle's monetized value (relative to others) differs significantly from its relative MODA score, decision makers should understand why. How did they weight each category of benefits? How does this compare to the value of that category of benefits expressed in dollars? Answering these types of questions will generate valuable insights that will inform decision making.

- **Next, look at the net benefits generated by each bundle** (net present value) in Row 115. A bundle may generate benefits (NPV), but how much benefit is enough to warrant investment? Can it be compared to returns on other public capital expenditures? How does it compare? While transportation analysts rarely address this question, Mosaic sets the stage for such discussions.

- **Conduct sensitivity tests by varying the parameter values** in the in the "Sensitivity" worksheet. Mosaic parameter values are assumptions that affect the performance (i.e., monetized benefits) of bundles. While based on empirical data, some are subject to a wide variation in observed value. Some key examples are shown on the top of the "Control Panel" worksheet. Others are found on the "Time-Varying Assumptions" worksheet. Another key example is the cost of projects that users enter in the "Bundles Info" worksheet. A key Mosaic principle is to acknowledge uncertainty. Varying the assumptions in the tabs identified above, and observing their effect, is the principal way to anticipate the effects of uncertainty on the value (benefits) of bundles, individually and in relation to one another.

- For the same reason, users should **test the effects of changing the MODA weights** given to categories and indicators. This can be accomplished in the "MODA Sensitivity" worksheet. The weights are a subjective measure of importance. Discussing how or whether to vary these weights generates many insights, both into the opinions and values held by stakeholders and into the extent to which changing the MODA weights affect the relative ranking of the bundles themselves.

- **Consider whether to create new bundles and/or modify existing ones**. Changing the mix or number of projects and programs may increase their attractiveness (value in dollars or in MODA) to stakeholders. Stakeholders take this step after completing Steps 3-6 above, at which time they will be better informed about the value (and risk) in the individual projects and programs that have been proposed initially. Changing the bundles will necessitate a re-estimation of travel impacts by re-running the travel model with the new bundles, as well as re-estimation of several of the tools in the Sketch Planning tab. Users should take this step thoughtfully, and only after addressing all necessary options and issues in Steps 3 through 6 because this step involves substantial staff effort.

With the added benefits resulting from completing sensitivity testing, decision makers frequently have sufficient information to make more informed decisions. Mosaic's principal value can be found in this

moment. Whether used in a transportation system plan (TSP), a regional transportation plan (RTP), or a large-scale corridor plan, users should review the key Mosaic metrics (identified at the beginning of this section) and confirm that the resulting bundle has sufficient value to merit implementation.

It should be noted, however, that Mosaic **outputs cannot in themselves dictate a decision**. Rather, the information offers stakeholders a transparent assessment of value, benefits and costs to help inform decisions about whether to proceed with a set of investments.

Recommendations for Users

As you consider or begin working with Mosaic, here are some recommendations and information to keep in mind. Some of these points are covered in more detail elsewhere in the User Guide, but are worth mentioning again, in order to enhance your successful application of Mosaic.

It is important to note that Mosaic may not be appropriate for all transportation planning processes. Mosaic is not currently set up to evaluate individual projects and is not appropriate for project prioritization. Additionally, Mosaic does not dictate decisions or provide conclusive answers regarding the value of transportation investments; instead it provides information to consider and helping to illuminate tradeoffs and expected or unexpected impacts. Mosaic may also be inappropriate if choices are limited in scale (i.e., only a few projects are evaluated) or insufficient resources are available to use Mosaic.

In rural areas, Mosaic may be beneficial if planning efforts are complex or controversial. However, if a community is only reviewing a limited number of possible investments or project impacts can be readily identified, Mosaic may not provide value to the process.

Use of Mosaic is all about transparency and helping stakeholders and decision-makers understand tradeoffs. It is therefore essential to have stakeholders involved at every step of the planning process: during goal setting, engagement in the MODA process, consideration of inputs, and discussion of outputs/results.

Required Skills

The following skills, already present in the training and experience of Oregon's planning professionals, are necessary for the application of Mosaic:

- A broad understanding of travel behavior and how it responds to changes in networks, policies, and programs
- For those places where travel models exist, the ability to use existing models to generate travel forecasts
- Familiarity with geographic information system software and with the data layers available in the study area
- The ability to estimate planning-level costs of transportation improvements
- Familiarity with socioeconomic data (e.g., population, household, employment) commonly used in transportation planning
- Familiarity with the terminology of travel behavior, spatial data, and economic analysis
- Experience in using Microsoft Excel-based analytic tools
- Above all, a desire to increase the value we receive from transportation investments

With these skills, a planning professional is able to understand the intent and content of Mosaic. Nevertheless, to embark on a first-time use of Mosaic, planners will likely need assistance with the details of using the tool and managing the Mosaic process. First-time Mosaic users will need access to

other professionals who can offer technical assistance, answer questions, and support the work of populating the workbook with data, as well as coaching the first-time user in how to use the information for decision-making.

Key Issues

Study Area Definition

Typically, this issue is moot; system plans are defined by jurisdictional boundaries, for example. However for special studies such as corridors, the study area definition should be large enough to capture the vast majority of affected travel behavior, but not so large that differences are difficult to measure. At a minimum this means the area needs to be larger than the facility itself; how much larger should be determined by regional expert knowledge. Mosaic is not for project level analysis.

Bundles

Bundles will be uniquely tailored to the study area; bundles represent planning scenarios to evaluate. Many users will be developing multimodal investment strategies. Some may wish to vary the level of investment across bundles. Some may choose to build bundles with different geographic emphases. Some may use Mosaic in a visioning process in which land use and modal investment strategies are key variables. Others may choose to emphasize roadway pricing strategies. Still others may use Mosaic for decisions about a complex travel corridor in which there are multiple segments at issue, and multiple treatments available for each. This is an incomplete list of possibilities. Mosaic can accommodate any of the above. Data limitations or stakeholder preferences may affect the methods used to measures the indicators; but in all cases, the tool itself should not be a limitation. Ultimately, however, Mosaic does not direct actual choices. Decision makers will remain responsible for weighing and evaluating bundles, with community input.

There are a variety of considerations when forming bundles, such as resources available (staff time and modelling capabilities, for example adjustments to bundles may require re-modeling the results), the number of bundles, and the budget and time available for analysis. When creating the bundles themselves, it is important to be clear in the purpose or intent of the bundle, e.g., ask: why did we create this bundle? Bundles should be created with intention, and not represent arbitrary collections of projects and programs.

Trip Capture

Every study area not only contains trips that have origins and/or destination inside it, but also through trips. Planners need to determine whether through travel is substantial enough to be included in the analysis and/or to be affected by programs or investments being studied.

Travel Model Availability

The Portland region has developed several enhancements to its models not otherwise available in Oregon, such as the ability to forecast bicycle and pedestrian travel and freight (commercial vehicle) movement. Other regions may not have equivalent tools available, nor will all places have a transit mode choice model at their disposal. The Mosaic tool includes several sketch tools for estimating non-motorized demand. Mosaic's use does not require a travel model, though without a travel model,

more indicators will need to be evaluated in MODA with quantitative or qualitative measures rather than with BCA.

Aggregate vs. Disaggregate Travel Data

Mosaic offers analysts two options for importing travel data into the tool. The modeler either can export trip and travel time data by bundle, mode, origin/destination pair and time of day (disaggregated), or intermediate results estimated within the travel demand model and loaded directly into Mosaic (aggregated). Consult with your travel modeling staff about which of these is best for your application.

Use of Sketch Models

The consultant team recommends using the models included in the Mosaic tool. If the sketch models are employed, it is appropriate to acknowledge the uncertainty associated with their statistical estimation techniques.

Evaluation of Programmatic Actions

The Programs Guide is a core component of Mosaic and vital to achieving the intent behind Mosaic to fairly evaluate many different kinds of transportation investments. The guide includes costs and ranges of estimates for the effectiveness of these programs on a number of key indicators. Specific sources for these conclusions are included. However, the literature is not extensive on many of the programs (many are studies of one or two locations). Professional judgment is required to identify appropriate inputs to Mosaic. Users of the guide will want to take care in applying these estimates to their geography by noting the extent to which the places studied resemble their own. Users should select an estimate that best suits their local conditions from those available and described in the Programs Guide where appropriate.

The Programs Guide includes this explicit direction. If used, the estimates of impacts should be expressed as a range, to incorporate the effects of uncertainty.

Travel Model Data

Travel model data is integral to Mosaic, especially the Mobility indicators. It is important to note that Mosaic outputs are therefore dependent on the assumptions and outputs from travel models. Mosaic users are advised to work closely with modelling staff to ensure that travel model assumptions are agreed upon and documented. In addition, the Mosaic tool often displays *averages* with respect to intermediate calculations and indicator estimation (e.g., average cost per trip). Because these averages take into account thousands or millions of trips from a travel demand model, the difference between bundles on an average basis may be very small. However, the difference for some individual trips – which Mosaic is not equipped to display easily, but could be extracted from the raw travel model data itself – may be much larger (e.g., user costs for many trips may stay the same across bundles, while some trips may experience large increases or decreases, depending on the location of bundle projects).

Inputs and Outputs

The professional judgment of qualified staff is key to successful use of Mosaic. Staff members need to be clear in the decisions they make (e.g., what discount rate to use) so that the impacts of these decisions can be understood. Communication with travel model staff, for instance, is very important to ensure that the assumptions used in travel modelling are clear and reasonable.

If outputs or results from Mosaic are surprising, users are advised to examine key inputs (like travel model data) and revisit how indicators were scored (especially for qualitative indicators which require a high degree of staff judgment). Users can consult the Mosaic Tool Documentation for detailed answers about how a particular indicator is estimated. The robust sensitivity testing capabilities of the Mosaic tool and allow users to test other possible factors that may result in surprising Mosaic outputs. Weights can be analyzed to determine if they are causing an outsize influence on certain indicators (which would spur further discussion with stakeholders on the weighting exercise results). In the same vein, sensitivity testing can be conducted on the model parameters, like the value of time or discount rate, to determine if Mosaic results are particularly sensitive to some parameters. The Mosaic "Control Panel" worksheet shows users whether the value of a parameter is within recommended range or outside it, adding a further level of information to consider.

Context

Mosaic results provide information about *sources of value*. The results need to be accompanied by a complete list of indicators and how they are measured, in addition to information about key model parameters that may be valuable for the discussion, like the value of time, cost of carbon dioxide emissions, or the discount rate. Results must also be considered in the context of the goals and values that stakeholders identified at the beginning of the planning process. Finally, technical support from planners experienced in decision making processes will help place Mosaic outputs in context.

Major lessons from the 2013-2014 Mosaic Test

The table below contains some additional findings and tips to consider once the decision has been made to use Mosaic.

Test Committee: Some Lessons Learned

MODA and Weighting

Stakeholder values are an important element of weighting and should be made explicit at the beginning of a planning process (before initiating use of Mosaic).

MODA weighting should take place after enough data have been developed to define indicator "endpoint" values. Once Mosaic outputs are available later in the process, stakeholders should review weights and adjust them as a group in light of previously articulated values and preferences.

Skilled facilitation of the weighting process is essential.

Indicators

Users need a clear understanding of each indicator and how it is measured. There is a document available on the Mosaic website which contains this information.

Decision Making

Graphical display is essential to understanding tool outputs and bundle comparisons. The tool contains templates; you may identify other ways that meet your needs.

The reasons behind the measured values must be clearly explained to stakeholders. This requires an understanding of local conditions and the characteristics and composition of your bundles, combined with good professional judgment.

The comparison of monetized results to non-monetized results (one of Mosaic's distinguishing features) helps users gain a deeper understanding of "value." Plan on spending sufficient time exploring what this comparison shows, and identifying the reasons behind it.

Some results may be surprising and may challenge stakeholders' prior assumptions or preferences. Allow for discussion of these results. Provide examples of input data or assumptions that may contribute to surprising results, also explore how indicators or transportation impacts may interact, also contributing to surprises.