MOBILITY

TRAVEL TIME

MO.1 Travel Time

What is this Specific Indicator?

This Specific Indicator examines travel time between various origins and destinations, by type of trip and mode.

If a Travel Demand Model is Present

In areas with a travel demand model, travel times will automatically be produced with input from the user on which infrastructure and programmatic actions are included within each bundle. In this case, minimal data collection or changes would need to be performed. In areas with a travel demand model:

- Travel time can be produced based on origin-destination data by zone and typically for a variety of modes such as SOV, HOV, freight, and transit. It can also be scaled to specific corridors for smaller applications.
- To separate commuter from non-commuter trips, travel time information can be classified by trip type (i.e., work-based trips) and models that typically provide freight trip information.

If a Travel Demand Model is not Present

In areas without a travel demand model, planning-level operational models would be used as follows:

- Travel time would rely on data from operational models (i.e., HERS and HCM planning-level methods) usually performed for smaller type roadway networks.
- Vehicle classification count data gathered specifically for a planning effort, or collected from nearby Automated Traffic Recorder locations could provide insights on the number of freight-related trips, while U.S. Census or household survey information may provide commuter vs. non-commuter trips for the area. Users could also develop estimates on trip type from applying assumptions from recent, nearby planning efforts assuming a sound method to develop assumptions was used.
- Depending on the scale of study, this can be done at the regional, sub-area, or corridor levels.

MOSAIC Value and Cost Informed Planning

MOBILITY

TRAVEL TIME

MO.2 Hours of Congestion

What is this Specific Indicator?

This Specific Indicator examines the hours of congestion aggregated for each bundle of action. Hours of congestion is a report only indicator. It may be used as the basis for but the reliability indicators, but is also deemed important to provide as a stand-alone statistic to policy makers. This is helpful to users in that it conveys not just how bad congestion is within one rush hour period, but how long the network remains congested. More and more, decision-makers are turning their attention away from trying to solve all congestion problems and towards lessening the duration of congested conditions.

How is data generated?

Similar to travel time, hours of congestion will be calculated within the travel demand model with input from the user on the infrastructure and other conditions within each bundle. Roadway characteristics (number of lanes, capacity, speed) and traffic volume data need to be collected and input as per a typical planning effort. Outputs relevant to this indicator are traffic volumes, travel times, and speeds. Mosaic provides a default threshold of free-flow speeds but users can adjust this depending on local conditions. Hours of congestion are determined by comparing peak hour roadway segment conditions to multi-hour roadway counts to compute hours of congestion above the thresholds determined in Mosaic or by the user. Guidance is provided in the *Oregon Highway Plan* (OHP) – *Mobility Standard Guidelines Report*. For areas without a travel demand model, the same calculation can be performed using traffic operational models.

MOBILITY

QUALITY OF SERVICE

MO.3 Reliability - Recurring Congestion

What is this Specific Indicator?

This Specific Indicator examines travel time reliability due to recurring congestion. Travel time reliability – the level of confidence to which travelers have in how long it will take them to reach their destination – is emerging as a powerful tool in identifying and resolving traffic-related problems.

How is data generated?

It is recommended that reliability be evaluated with qualitative scoring, unless the Mosaic user has quantitative information from another source to enter. 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 following reference: https://www.trb.org/StrategicHighwayResearchProgram2SHRP2/Blank2.aspx

MOBILITY

QUALITY OF SERVICE

MO.4 Reliability – Non-Recurring Congestion

What is this Specific Indicator?

This Specific Indicator examines travel time reliability due to non-recurring congestion, such as incidents (accidents and events) and seasonality (tourism). Weather-related events and construction and maintenance activities were not considered in this Specific Indicator. At this time weather-related events were considered to be difficult to predict. Future iterations of Mosaic could look to include non-recurring congestion due to construction and maintenance activities.

How is data generated?

It is recommended that this reliability 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 following reference: https://www.trb.org/StrategicHighwayResearchProgram2SHRP2/Blank2.aspx

MOBILITY

OUT-OF-POCKET COSTS

MO.5 User Costs

What is this Specific Indicator?

This Specific Indicator examines the user "out-of-pocket" costs associated with travel. The user costs included in this indicator are vehicle ownership, maintenance, parking, gas, and tolls/fares.

How is data generated?

User costs is a monetizable indicator and whenever possible should be calculated for economic valuation. In areas with a travel demand model, user costs will automatically be produced within Mosaic, with user input focused on which infrastructure and programmatic actions are included for each bundle within the model. In this case, minimal data collection or changes would need to be performed.

Mosaic does require user input in the Load Travel Data worksheet on the average user cost per vehicle or person mile by each mode of transportation (drive alone, drive with passenger, passenger, transit/drive, transit/walk, walk, bike, or truck). Default values are provided, but can be augmented or supplemented by the following sources:

- U.S. Census and National Household Travel Survey data is analyzed to understand vehicles per household across socioeconomic groups.
- Travel demand models typically provide cost information such as tolls/fare collection, parking costs, and vehicle miles traveled (VMT) that can produce fuel consumption estimates.
- Other user costs include vehicle maintenance, parking, gas, and tolls/fares. Gas and maintenance costs can be correlated to VMT or produced by the Highway Economic Requirements System.

This indicator takes the average user costs by mode supplied by the user and combines it with information input directly from the travel demand model on trip distance to provide a total user cost which is aggregated by timeframe and by bundle of action.

MOBILITY

TRAVEL CHARACTERISTICS

MO.6 Mode Split

What is this Specific Indicator?

This Specific Indicator examines mode split across a given transportation network by bundle of actions.

How is data generated?

Mode split is not able to be measured in dollars – mode split quantities are input into Mosaic and scored using how they are weighted in MODA. In areas with a travel demand model, mode split is an output that will automatically be populated with travel model data within Mosaic. User input is then focused on which infrastructure and programmatic actions are included for each bundle within the model. In this case, minimal data collection or changes would need to be performed.

In Mosaic, travel demand model data will automatically populate the number of trips by mode are associated with each bundle, by reporting timeframe. These are then compiled to produce a mode share statistic – the current Mosaic tool reports single-occupant vehicle mode share but this can be modified by the user.

If a travel demand model is not available, users can estimate mode split using traffic counts, vehicle miles traveled data, average vehicle occupancy data, transit ridership information, and mode split as reported in the U.S. Census.

MOBILITY

TRAVEL CHARACTERISTICS

MO.7 Vehicle Miles Traveled per Capita

What is this Specific Indicator?

This Specific Indicator examines *Vehicle Miles Traveled (VMT) per Capita*. VMT per capita is the number of miles driven, per person, per day. VMT per capita is a report only indicator. It is used as a basis for other indicators (environmental stewardship, air) but is also deemed important to provide as a stand-alone statistic to policy makers.

How is data generated?

In areas with a travel demand model, VMT per capita is an output that will automatically be populated within Mosaic, with user input focused on which infrastructure and programmatic actions are included for each bundle within the model. In this case, minimal data collection or changes would need to be performed.

In Mosaic, travel demand model data will automatically populate the VMT per capita associated with each bundle, by reporting timeframe. These come as direct imports of data from the travel demand model, which will report VMT in miles per day by mode and by trip purpose in the Travel Data Calcs worksheet.

Roadway and volume data may need to be collected to assist in this calculation. Travel demand models can produce VMT data based on trip lengths and the number of vehicles travelling within a defined area. These are then aggregated into a total VMT by trip purpose for all modes and divided by the population within the study area for the VMT per capita number.

Areas without a travel demand models would rely on different sources for the data, such as operational models (i.e., Highway Economic Requirements System [HERS] or *Highway Capacity Manual* [HCM] planning level methods). Population information can be gathered from the state’s Population Research Center at Portland State University or the U.S. Census.

MOBILITY

TRAVEL CHARACTERISTICS

MO7. Vehicle Miles Traveled per Capita

Additional resources

U.S. Department of Transportation, Bureau of Transportation Statistics. “U.S. Highway Vehicle Miles Traveled.” Available online at https://www.bts.gov/publications/

Streets Wiki. “Vehicle Miles Traveled.” Available online at

Highway Capacity Manual (HCM). Available online at http://hcm.trb.org/?qr=1

Highway Economic Requirements System (HERS). Available online at https://www.fhwa.dot.gov/asset/

ACCESSIBILITY

PROXIMITY

AC.1 Transportation Cost Index

What is the Specific Indicator?

This Specific Indicator examines the relative ease with which consumers can access a “market basket” of transportation destinations. 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 the Transportation Planning Performance Measures final report SPR 357 (October 2005). *Note that as of fall 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.* ODOT is conducting research in 2014 and 2015 to better enable use of this indicator in the future (research project SPR_760).

ACCESSIBILITY

PROXIMITY

AC.2 Population within *X* minutes between work and home

What is the Specific Indicator?

This Specific Indicator explores the percentage of the population that is able to travel between work and home within 45 minutes (or X-minutes). Users may at their discretion adjust this to focus on other types of trips, and may adjust the threshold level being measured by this indicator (for example, the percentage within 20 minutes, or 30 minutes, etc.)

How is data generated?

The “X-minute” threshold must be decided by the user first. To do this, identify if the area is urban or non-urban. If the area is urban, determine whether it is physically a large or small urban area. The “reasonable time” by geographic region can also be identified via literature review and/or specified by the user.

Travel demand models (travel demand models) measure future conditions at different geographical levels. Using survey data and travel demand models, the percentage of population that is able to travel between work and home within X minutes (with and without the plan) is then calculated.

- **State Level** - Oregon Statewide Integrated Model (SWIM) - This is the only model that identifies whether long-distance commute trips are work trips or not.
- **Metropolitan Planning Organization (MPO) Level** - Regional models differentiate trip purposes within the MPO, but do not differentiate long-distance external trips.

ACCESSIBILITY

PROXIMITY

AC2. Population within *X* minutes between work and home

- **Non-MPO, Rural, Smaller Urban Level** - Oregon Small Urban Model (OSUM) could be used. OSUM models do not have transit data in them nor do they differentiate for trip purpose.
    - When using ACS data for current conditions and travel demand models to forecast future conditions, there is no direct link between ACS and travel demand model data requiring a significant amount of data manipulation.

In general, the greater the number of households within the specified travel time, the more beneficial the bundle is.

Travel demand models will hold information about the origin TAZ and destination TAZ by trip purpose. Distances between these TAZs can be 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 by planning timeframes and by bundle.

The Specific Indicator is dependent on the size of the area under consideration. For example, while it is a meaningful measure for the Portland urban area, it might not be meaningful for a rural area where a large number of trips will require long distance travel. In such areas, this measure will not vary much, regardless of changes made per the transportation plan.

ACCESSIBILITY

EASE OF CONNECTIONS

AC.3 Location of Industrial Jobs in Relation to the Regional Freight Network

What is the Specific Indicator?

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 provides an indication of freight connectivity and accessibility.

How is data generated?

Data for this specific indicator come from a region's travel demand model and/or from a region's GIS network. The relevant information includes:

- Identifying the regional freight network (often classified as major or principal arterials, sometimes includes minor arterials as well)
- Jobs by labor classification at a parcel level or TAZ.

This information is required to use the specific indicator. If this information is not available, then the indicator cannot be estimated.

Users then must establish either a *travel time threshold* or a trip distance threshold. If establishing a travel time threshold, users must determine one or more specific parcels or TAZ centroids which will serve as key reference points. Travel model data is used to make this assessment.

If users instead choose a distance threshold, users will run a query in GIS to determine the total number of jobs within "x" distance of the network by period of analysis and by bundle.

Travel demand models at different geographical levels provide different information on both the number of jobs and the labor classification. These can be filtered for industrial and manufacturing jobs.

- Oregon Statewide Integrated Model (SWIM) at the state level
- Regional models at metropolitan planning organization (MPO) levels
- Oregon Small Urban Model (OSUM) for smaller non-MPO areas, including rural areas and smaller urban areas outside of metropolitan areas

ACCESSIBILITY

MODAL AVAILABILITY

AC.4 Population and employment within ¼ mile of a transit stop served by at least 30 vehicles per day

What is the Specific Indicator?

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.

How is data generated?

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.

AC.4 Population and employment within ¼ mile of a transit stop served by at least 30 vehicles per day

- Employment data can be obtained from the U.S. Census Local Employment Dynamics (LED) program at the Census Block level, which is a partnership between state labor market information agencies and the U.S. Census Bureau to develop new information about local labor market conditions.
- The Oregon Employment Department is another agency that publishes quarterly reports of employment. This data is very precise, but is confidential, and is generally available on request for planning agencies that have signed confidentially agreements.

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.

To forecast future conditions

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.

ACCESSIBILITY

MODAL AVAILABILITY

Ac.5 Amount of multi-use paths and bike boulevards

What is the Specific Indicator?

This Specific Indicator measures the total length of multi-use paths and bicycle boulevards in each bundle of action. These two facility types were highlighted in *Multi-User Perspectives on Separated, On-Street Bicycle Infrastructure* (*Transportation Research Record: Journal of the Transportation Research Board*, 2012) as providing a higher quality experience that attracts a greater number of bicyclists.

How is data generated?

This indicator determines the accessibility of the network of bicycle facilities (such as multi-use paths, bike lanes, and boulevards) as a measurement for the availability of bicycling as a modal option. Calculations would be performed as follows in GIS:

- Confirm that layers identifying the network of multi-use paths and bike boulevards exist for each bundle.
- Run a query in GIS to determine the total lane mileage of the multi-use path and bike boulevard system for each bundle, for each period of analysis.

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).

ACCESSIBILITY

MODAL AVAILABILITY

AC.6 Sidewalk Coverage

What is the Specific Indicator?

This Specific Indicator measures sidewalk coverage within the plan's study area, as an indicator of pedestrian modal availability. Sidewalks and other pedestrian facilities (e.g., multi-use paths) can be counted.

How is data generated?

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
Sidewalk Coverage = Sidewalk miles / roadway centerline miles

Sidewalk coverage may also be measured as the percentage of streets with sidewalks along both sides. A complete sidewalk system would provide sidewalks on both sides of every street (within a given area), and receive a value of 100 percent.

Future conditions would be assessed directly from project data, as specified in the plans or bundles (e.g., proposed location and mileage of new sidewalks).

Calculations would be performed as follows in GIS:

- Gather and organize layers identifying the sidewalks and paths in GIS.
- Run a query in GIS to determine length of pedestrian network by period of analysis and by bundle.

ECONOMIC
VITALITY

ECONOMIC IMPACTS OF SPENDING FOR CONSTRUCTION

EV.1 Number of Jobs Created or Retained by bundle

What is the Specific Indicator?

This Specific Indicator examines the number of jobs associated with a plan or bundle of actions, and associated income metrics. The number of jobs indicator is a report statistic. It is used as a basis for another indicator (changes in transportation costs by industry, EV2) but is also deemed important to provide as a stand-alone statistic to policy makers.

How is data generated?

The method described below has been developed specifically for assessing the short-run economic impacts of construction spending. The data collected for the *Funding the Transportation System / Finance* Category (*Capital Cost*s and *Lifecycle Costs* are the general indicators) provide cost information. Parameter values are used to estimate the direct, indirect, and induced effects of construction spending, which may be derived from the IMPLAN Input-Output modeling system commercialized by the Minnesota IMPLAN Group (MIG) (https://www.implan.com).

- Datasets for the State of Oregon are available at the county level through MIG. IMPLAN data for 2012 for all counties in the State of Oregon are included in Mosaic, in the Economic Data worksheet. IMPLAN datasets customized to a particular study area could be purchased and used by a specific planning effort.
- Data on hours of work by sector, from the Oregon Employment Department, may be used to convert the employment impacts estimated with IMPLAN to full-time equivalent (FTE) jobs.

An alternative source of information, provided as a sketch model in Mosaic, is a May 2009 memorandum prepared by the Council of Economic Advisers (CEA). The memorandum provides a simple rule for estimating the number of job-years "supported" by government spending. The memo argues that $92,000 of government spending supports one job-year (one person employed for one year), with 64% of the job-year estimate representing

EV1. Number of Jobs Associated with Plan or Bundle of Actions

direct and indirect effects, and 36% representing induced effects. A similar rule may be available, or estimated, for Oregon.

Using IMPLAN

Estimating the employment impacts of construction spending in IMPLAN would involve the following steps:

- Define the area within which the impacts will be estimated.
- Map the total capital costs into cost categories and groups of activities:
  - *Land Acquisition* –Primarily a transfer of assets. Apart from real estate/ financial/legal fees, there is typically no activity under this item
  - *Planning & Engineering* – Activities that occur before construction starts, including planning, preliminary engineering, environmental impact assessment, design, or permitting
  - *Construction* – Infrastructure construction as well as demolition, excavation, drainage, or landscaping
  - *Fixture, Furniture & Equipment* – Including road signs, rail signals, office furniture, and construction cranes
- Estimate the costs incurred *within* the study area. By definition, construction activities occur at the construction site, so no adjustment is needed. But architectural and engineering activities, for example, may occur outside the study area, and the associated cost estimates must be adjusted accordingly
  - Where exact information on cost categories and expected spending location is not available, historical cost data and factors may be used as approximations.
- Match construction activities with IMPLAN sectors. All activity groups identified above must be matched with sectors in IMPLAN (MIG provides a bridge between IMPLAN sectors and the North American Industry Classification System [NAICS]). Develop the impact model in IMPLAN and run the economic impact analysis. IMPLAN provides estimates for a number of output variables, including employment (number of full-time and part-time jobs, combined), business output (total value of sales, both intermediate and final), value added (business output minus intermediate consumption), labor income, and tax revenue.

ECONOMIC VITALITY

ECONOMIC IMPACTS OF SPENDING FOR CONSTRUCTION

EV1. Number of Jobs Associated with Plan or Bundle of Actions

The resulting direct, indirect, and induced employment impacts would then be exported out of IMPLAN, arrayed by industry, and pro-rated linearly in the Mosaic tool, for use in Mosaic. Mosaic allows for input of this information in the Economic Vitality worksheet.

Additional Resources

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.

European Commission, “Guide to Cost Benefit Analysis of Investment Projects,” July 2008

Boardman, Anthony E., David H. Greenberg, Aidan R. Vining, and David L. Weimer, *Cost Benefit Analysis: Concepts and Practice*, Third Edition, 2005, pp. 100-101

ECONOMIC VITALITY

ECONOMIC IMPACTS OF MORE EFFICIENT TRANSPORTATION SERVICES

EV.2 Changes in Transportation Costs by Industry

What is the Specific Indicator?

This Specific Indicator looks at the costs associated with transportation for each bundle of actions, as they vary by business type (industry) and for each planning timeframe.

How is data generated?

A number of data sources have been identified for estimating transportation cost savings by industry -- including savings to freight shippers/carriers and "on-the-clock" worker travel.

Freight cost savings

Freight cost savings can then be estimated by estimating how freight travel benefits (or disbenefits) are accrued to industry. The simple distribution of economic activity within the study area can be used to estimate the total change in freight costs to various industries.

Business cost savings

Estimating cost savings to business travel by industry first requires isolating the portion of total cost savings accruing to "on-the-clock" travel. Depending on the geographic location, travel demand models used in the estimation of *Mobility* measures may or may not have an adequate representation of this trip purpose. If they do, these can be used to identify cost savings to business travel. When they do not, the share of business travel to total travel should be obtained from household survey data and applied to the estimates of total cost savings produced with the transportation model. Employment data from the U.S. Census Bureau (Local Employment Dynamics) may then be used to distribute savings across industries.

ECONOMIC VITALITY

ECONOMIC IMPACTS OF MORE EFFICIENT TRANSPORTATION SERVICES

EV.2 Changes in Transportation Costs by Industry

Other considerations

The Cost of Highway Limitations and Traffic Delay to Oregon's Economy (2007) identified the degree to which different industries depend on freight and passenger travel. This information may be used to comment on the effects of a plan, or supplement data used in the estimation. Data from the IMPLAN software will also help identify those industries relying most on transportation services; the IMPLAN Input-Output modeling system is commercialized by the Minnesota IMPLAN Group (MIG) (https://www.implan.com/) and is used widely to estimate economic impacts at a county or a state level.

Additional resources

Oregon Freight Plan, available online at https://www.oregon.gov/ODOT/Planning/Pages/Plans.aspx#OFP

The Cost of Highway Limitations and Traffic Delay to Oregon's Economy (2007), available online at https://www.portofportland.com/PDFPOP/Trade_Trans_Studies_CostHwy_Lmtns.pdf

ECONOMIC VITALITY

ECONOMIC IMPACTS OF MORE EFFICIENT TRANSPORTATION SERVICES

EV.3 Changes in Employment by Industry, and Associated Income Metrics

What is the Specific Indicator?

This Specific Indicator examines how employment numbers (broken down by industry and wage categories) are affected by bundles of actions. Changes in employment by industry is a report only indicator. It is used as a basis for another indicator (changes in transportation costs by industry, EV2) but is also deemed important to provide as a stand-alone statistic to policy makers. The services of an economist are recommended to help develop this specific indicator.

How is Data Generated?

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 software 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 Cost of Highway Limitations and Traffic Delay to Oregon’s Economy (2007) identified the degree to which different industries depend on freight and passenger travel. This information may be used to comment on the effects of a plan, or supplement data used in the estimation. Data from the

ECONOMIC VITALITY

ECONOMIC IMPACTS OF MORE EFFICIENT TRANSPORTATION SERVICES

EV.3 Changes in Employment by Industry and Wage Category

IMPLAN software will also help identify those industries relying most on transportation services; the IMPLAN Input-Output modeling system is commercialized by the Minnesota IMPLAN Group (MIG) (https://www.implan.com) and is used widely to estimate economic impacts at a county or a state level.

Analysis and input to develop EV3 comes from a sketch model imbedded in Mosaic, *Model for Estimating the Economic Impacts of Transportation Improvements*. Data needed to use this sketch model include:

1. Current employment by job category
2. Construction costs for bundle
3. Construction timelines by bundle
4. Expected revenues (total)
5. Congestion conditions

In addition, this indicator requires users to determine what is considered a “livable wage” in that specific geography. By comparing these jobs against a user-determined livable wage, the worksheet reports on how many livable wage jobs are created by the bundle. Users will have to reach consensus on the value of this input through discussion.

Additional resources

Oregon Freight Plan, available online at
https://www.oregon.gov/ODOT/Planning/Pages/Plans.aspx#OFP

The Cost of Highway Limitations and Traffic Delay to Oregon’s Economy (2007), available online at
https://www.portofportland.com/PDFPOP/Trade_Trans_Studies_CostHwy_Lmtns.pdf

ECONOMIC VITALITY

STRUCTURAL ECONOMIC EFFECTS

EV.4 Changes in Productivity from Increased Connectivity

What is the Specific Indicator?

This Specific Indicator examines the relationships of structural economic effects to productivity changes caused by enhanced transportation connections. It covers a number of distinct economic effects, including agglomeration economies, the economic impacts of increased competition, and labor supply effects. If estimated properly, these impacts can be added without risk of double-counting to the transportation user benefits estimated under the *Mobility* Category.

How is data generated?

Mosaic allows users to enter data directly into the tool for this indicator or to use one of two sketch models titled "*Model for Estimating Agglomeration Effects*" informs this indicator, but is only applicable for rail transit investments. If using the sketch model, data would be needed about infrastructure investments within each bundle, as well as the following:

- Total population of the study area
- Number of workers in the study area
- Total wages (gross, average)
- Gross domestic product (per capita, total)
- Size of study area
- Employment density
- Annual growth in travel costs
- Productivity elasticity
- Productivity growth

The sketch models take information above provided for the effort and uses it to calculate productivity effects from a change in connectivity.

Users may wish to take advantage of other tools that provide a broader picture of agglomeration benefits. See:

- UK Department for Transport, TAG UNIT A2.1, Wider Impacts, January 2014 at https://www.gov.uk/government/publications/webtag-tag-unit-a2-1-wider-impacts
- SHRP2 Project C11, Development of Tools for Assessing Wider Economic Benefits of Transportation at http://www.trb.org/Main/Blurbs/169524.aspx

Changes in Productivity from Increased Connectivity

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 use 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)

Mosaic provides a sketch model to inform the agglomeration elasticity coefficient estimates using findings from the economic literature. This helps the user identify productivity effects based on relevant factors such as study area size, density, and industry type.

Additional Resources

UK Department for Transport, *Transport, Wider Economic Benefits, and Impacts on GDP*, Discussion Paper, July 2005.

Melo, Patricia, et al., *A Meta-Analysis of Estimates of Urban Agglomeration Economies*, Regional Science and Urban Economics, 39, 2009, 332-342.

ECONOMIC VITALITY

STRUCTURAL ECONOMIC EFFECTS

EV.5 Changes in the Total Value of Exports and Imports

What is the Specific Indicator?

This Specific Indicator examines the structural economic effects due to the changes of import and export values. The changes in the total value of exports and import values indicator is a report statistic.

How is Data Generated?

The change in import and export values is largely automated within the Mosaic tool with information from the Economic Data worksheet and the Travel Data Calculations worksheet. Imports and exports values are taken from the North American Industry Classification System (NAICS) Total All Merchandise Exports from Oregon to World, Millions of Dollars and NAICS Total All Merchandise Imports to Oregon from World datasets, automatically part of Mosaic. User input is required as follows:

1. Determine annual growth to the study area economy
2. Report transportation costs as a proportion of total costs
3. Define elasticity with respect to transportation cost (low and high default values are provided within the tool as a guide)

ENVIRONMENTAL STEWARDSHIP

AIR

ES.1 Criteria Air Contaminants (CAC)

What is this Specific Indicator?

This Specific Indicator examines the criteria air contaminants associated with each bundle of actions. Criteria air contaminants (CACs) 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 considered in this group because it is regulated and is believed to have a similar effect on human health and welfare. CAC pollutants are emitted from vehicles and impair the health of people, especially the young and old.

Criterion Air Contaminants is a monetizable indicator and whenever possible should be calculated for economic valuation.

How is Data Generated?

Two models are required to generate data for this specific indicator: travel demand models, and the Environmental Protection Agency's (EPA's) Motor Vehicle Emission Simulator (MOVES) model. In addition, ODOT's Regional Strategic Planning Model (RSPM) provides information useful to this indicator and users may choose to coordinate with ODOT to see if using it is a possibility.

The use of travel demand models is merely for production of data for vehicle miles traveled (VMT) by bundle. This is being produced for the mobility category and users merely need to take that information and use it here. Other data needs include gathering emissions rates as produced from EPA's MOVES model. EPA's MOVES emission model is the best available source for determining the emission rates of CACs for different types of vehicles and speed of travel. MOVES is a national database and a flexible tool that supports emissions differentiation at the state and county level. This is a publicly available model that can be implemented by ODOT or DEQ. Coordination with ODOT or DEQ would be needed to ensure staff resources are available to support running the MOVES model.

MOVES produces forecasts of emission rates for each of the CAC pollutants given a set of specific vehicles types, fuel types, and county-level locations.

ES.1 Criteria Air Contaminants (CAC)

An average speed would be assumed in these forecasts. It is expected that the CAC emissions rates would be produced on a county level. If smaller or larger areas than the county level are desired, analysts may have to prorate the county-level emissions data in some fashion.

Total tons of emissions for each CAC pollutant are computed as a product of VMT by vehicle type (obtained from travel demand models) and emissions rates in tons per VMT (obtained from MOVES and using appropriate conversation rates). Data from the travel demand model on VMT per vehicle type would be aggregated into two general classes of vehicles: passenger vehicles (cars and trucks) and freight trucks.

Users would need to translate units produced by MOVES to long or metric tons per VMT in order for this indicator to be monetized. The costs of CAC emissions are frequently incorporated into benefit-cost analyses as a direct measure of the air pollution externality from motorized transportation. For example, when transportation projects achieve lower VMT compared to a baseline, the reduction in CAC emission costs are realized as a project benefit. Monetary values of CAC emissions are derived from research that has statistically related pollutant levels with human health and welfare effects. These have been incorporated directly into Mosaic – users merely need to report emissions volumes in long tons and these monetization calculations will be automatically applied within the tool.

Passenger vehicle breakdown

A further breakdown of passenger vehicles by a fleet mix forecast can be developed through RSPM. The RSPM model evaluates scenarios for achieving carbon reduction targets in the state and the proportion of advanced, fuel-efficient engines (i.e., hybrid-electric and electric) are an important determinant. The fleet mix forecast comes from analyses of options for achieving carbon emission reduction goals by 2050.

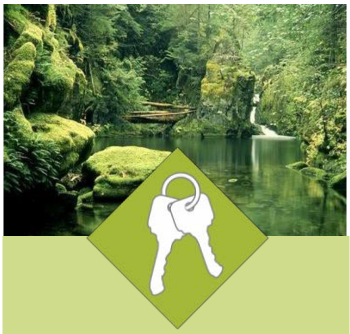
What is potentially innovative is the introduction of the RSPM model's passenger vehicle fleet mix forecasts that include fairly aggressive rates of adoption of hybrid-electric and electric vehicles. These forecasts could be potentially integrated in Mosaic as an optional scenario to compare with the more conventional fleet emission rate forecast in MOVES.

Using these projections of passenger vehicle fleet mix, VMT for each of type of passenger vehicle can be determined. Emission rates for each type of

vehicle would then be applied using results from MOVES. The analysis of emissions of fully electric vehicles however requires county level data on the kilowatt-hours of electricity produced and CAC emissions from power plants for recharging vehicle batteries.

Additional Resources

EPA study, *Corporate Average Fuel Economy for MY2012-MY2016 Passenger Cars and Light Trucks* (March 2010), page 403, Table VIII-8, "Economic Values for Benefits Computations (2007 Dollars)"



ENVIRONMENTAL STEWARDSHIP

ES.2 Air Toxics (Benzene and Diesel PM)

What is this Specific Indicator?

This Specific Indicator examines Mobile Source and Non-Mobile Source Air Toxics (MSATs and Non MSATs) associated with each bundle of actions. 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. Research is still attempting to precisely determine the consequences of air toxics from transportation facilities, but evidence suggests a clear correlation between proximity to highway traffic (especially trucks) and rail operations, and adverse impacts on people.

Benzene has been selected to represent risks from MSATs. Benzene is a known human carcinogen, and is one of the U.S. Environmental Protection Agency's (EPA's) six priority MSATs. The other five are diesel particulate matter, acrolein; formaldehyde; 1,3-butadiene; and acetaldehyde. These 6 are subsumed within a much larger group of 188 air toxics identified in the Clean Air Act and a subset of 21 for which EPA has issued regulations in *Control of Emissions of Hazardous Air Pollutants from Mobile Sources* (66 Final Rules (FR) 17235).

Diesel Particulate Matter (Diesel PM) has been selected to represent risks from non-MSATs. Diesel PM is one of the U.S. Environmental Protection Agency's (EPA's) six priority MSATs. The other five are benzene, acrolein; formaldehyde; 1,3-butadiene; and acetaldehyde. These 6 are subsumed within a much larger group of 188 air toxics identified in the Clean Air Act and a subset of 21 for which EPA has issued regulations in *Control of Emissions of Hazardous Air Pollutants from Mobile Sources* (66 Final Rules (FR) 17235).

Diesel PM is likely to be carcinogenic to humans by inhalation from environmental exposures. While the exact magnitude of the impacts of diesel PM are in some dispute, the overall impact is recognized to be significantly greater than for all other pollutants – even potentially as much as all other pollutants combined.

How is Data Generated?

The same weighted average procedure outlined for criterion air contaminants (CAC) emissions (EV1) would apply to benzene. Two models are required to generate data for this specific indicator: travel demand models, and the Environmental Protection Agency's (EPA's) Motor Vehicle Emission Simulator (MOVES) model. In addition, ODOT's Regional Strategic Planning Model provides information useful to this indicator and users may choose to coordinate with ODOT to see if using it is a possibility.

The use of travel demand models is merely for production of data for Vehicle miles traveled (VMT) by bundle. This is being produced for the mobility category and users merely need to take that information and use it here. Other data needs include gathering emissions rates as produced from EPA's MOVES model.

ENVIRONMENTAL STEWARDSHIP

GREENHOUSE GAS EMISSIONS (GHG)

ES.3 Lifecycle Carbon Dioxide Emissions (CO_2)

What is this Specific Indicator?

This Specific Indicator examines the Lifecycle Carbon Dioxide (CO_2) emissions associated with each bundle of actions. Several chemical compounds associated with greenhouse gases (GHG) - carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) - are emitted from vehicles. This Specific Indicator measures the total "life cycle" emissions associated with the use of motor vehicles, including emissions associated with the production and use of fuel. It is a "well-to-wheel" measure that includes emissions from refining and transporting fuels. The data on lifecycle emissions are Oregon-specific values developed by the Oregon Department of Environmental Quality (ODEQ) and Oregon Department of Energy (ODOE).

Lifecycle CO_2 emissions is a monetizable indicator and whenever possible should be calculated for economic valuation. 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. Monetized values of GHG emission reduction can differ widely depending on the analytical assumptions. Suitable values for monetization in Oregon could be derived from U.S. Department of Transportation (USDOT) guidance that references an Interagency Working Group on Social Cost of Carbon document, *Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866* (February 2010).

How is Data Generated?

While GHG emissions rates can be produced using the Motor Vehicle Emission Simulator (MOVES) similar to the process recommended for ES1 and ES2, consistency with other Oregon initiatives is can be improved by adopting the state's lifecycle GHG emission rates from fuel consumption and production. Useful data on lifecycle GHG emissions can be obtained using the Regional Strategic Planning Model (RSPM, formerly GreenSTEP). Users may choose to coordinate with ODOT to see if using RSPM is a possibility. Accounting for lifecycle GHG emissions would be an innovative departure from common practice (e.g., MOVES model results)

ENVIRONMENTAL STEWARDSHIP

GREENHOUSE GAS EMISSIONS (GHG)

ES.3 Lifecycle Carbon Dioxide Emissions (CO_2)

that only includes emissions from fuel consumption. This indicator can assist in measuring progress called for in Oregon's Clean Fuels Program.

Data is derived from travel demand model outputs. Total tons of emissions for lifecycle GHG are computed as a product of vehicle miles traveled (VMT) by vehicle type (obtained from the travel demand model) and emissions rates in tons per VMT. RSPM data would provide the lifecycle GHG emission rates per vehicle type (including passenger vehicle fleet mix forecasts). RSPM data on lifecycle GHG emission rates per vehicle type and passenger vehicle fleet mix forecasts would be available at the county level. Because GHG impacts do not impact communities at a local level, a county-level analysis would be sufficient.

Total GHG emissions from passenger vehicles would be computed at the county level using RSPM data for emissions rates per VMT for each type of vehicle.

- Emissions rates include GHG emissions from electricity used for charging electric vehicle batteries.
- Passenger vehicle fleet mix forecasts, which would be in line with the state's carbon intensity goals, would also come from RSPM.
- Lifecycle GHG emission rates for trucks would also be obtained from RSPM. These data would be combined with VMT to produce total lifecycle GHG emissions.

Forecasts of lifecycle GHG emissions would be produced for years 2020, 2035, and 2050; interim years would be interpolated. A county-level analysis is sufficient because GHG impacts are felt at a much larger scale. A number of calculations used to estimate lifecycle GHG emissions have uncertainty, which is most readily captured through uncertainty in VMT.

Additional Resources

Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 (February 2010), page 39, Table A-1 "Annual SCC Values 2010-2050 (in 2007 dollars)"
https://www.epa.gov/vehicles-and-engines

ENVIRONMENTAL STEWARDSHIP

RESOURCES AT RISK

ES.4 Natural, Built, and Cultural Resources at Risk

What is this Specific Indicator?

This Specific Indicator examines the natural, built, and cultural resources at risk associated with each bundle of action. It considers several factors to understand the "natural, built, and cultural resources at risk" including:

- Potential impacts to **threatened and endangered (T&E) species** are assessed based on the geographic overlap of a plan and T&E species habitat area. The potential severity is captured by weighting endangered species habitat.
- The potential impacts on **surface water and wetlands** are examined by gathering the acres of wetland potentially impacted and numbers of surface water crossings. The potential severity of impacts is captured by weights on more sensitive water bodies.
- The **risk of hazardous material** being located within the plan footprint is evaluated based on local knowledge and any available land use studies.
- The risk of crossing a **local, state, or national park** with special significance is captured by determining the number of park acres overlapped by the plan.

Natural resources indicators as a whole rely on broadly defined, mapped information. The level of detail about a plan and the level of detail within each data set allow for qualitative, comparative applications. This indicator is not suitable for monetization in a benefit-cost analysis (BCA) context. The level of information about potential project impacts, baseline resource conditions, and economic research cannot be easily generalized. The data sources listed below provide a consistent level of coverage and detail across the state.

How is Data Generated?

Threatened and Endangered (T&E) Species

This indicator determines if a project could cause impacts to T&E species by assessing if the footprint of an alternative overlaps with known T&E habitat,

determined by the amount of overlap. It is assumed that higher amounts of overlap could cause negative impacts to T&E species and incur more significant regulatory, engineering, and mitigation costs.

The severity of T&E impacts would be captured by weighting the acres of overlap with endangered species. It is recommended that acres with endangered species be multiplied by a factor of 2, whereas threatened species habitat acres are not weighted. The indicator would be equal to the sum of all weighted T&E acres. The footprint can be produced in a GIS format to facilitate the comparison. Data on T&E habitats are available in GIS maps in the following public resources:

- *StreamNet Interactive Mapper:* shows fish distribution of listed salmonids
- Northwest Regional Office of NOAA(National Oceanic and Atmospheric Administration) Fisheries *Critical Habitat Mapper:* shows mapped critical habitat for listed species[1]
- *Oregon Natural Heritage Information Center (ORHNIC):* provides information on the geographic location of records of T&E species. ORNHIC records are not mapped, but location information (township/range) is provided and can be integrated into a mapping or GIS environment.

Surface Waters

This indicator determines if a project could cause impacts to surface waters, generally through stormwater runoff or disrupted habitat. The potential impacts would be assessed if the project footprint crosses surface waters. This indicator requires that plan alternatives have a geographical description. The project footprint can be produced in a GIS form to facilitate analysis. Location data on surface waters are available in GIS maps in the following public resources:

- *StreamNet Interactive Mapper:* shows all streams and lakes including water bodies listed as "impaired" under Section 303(d) of the Clean Water Act ("303(d)-listed"), which are those that do not meet applicable water quality standards
- *National Wetlands Inventory (NWI) maps* [2]

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[1] Information sources: https://www.fisheries.noaa.gov/national/endangered-species-conservation/critical-habitat

ENVIRONMENTAL STEWARDSHIP

RESOURCES AT RISK

ES.4 Natural, Built, and Cultural Resources at Risk

Values for this indicator would be determined by overlaying plan alternatives on StreamNet (or NWI) maps to determine the numbers of crossings of surface waters. At higher numbers of overlaps, it is assumed that there would be a greater potential of negative impacts on these water bodies.

The severity of potential impacts is captured by weighting water bodies which are 303(d)-listed. Crossings of these water bodies would be weighted by a factor of 2 and all other water bodies would be counted as 1. The proposed indicator would be equal to the sum of all weighted water body crossings.

Wetlands

This indicator determines whether a project could cause impacts to wetlands. The potential impacts would be assessed if the project footprint eliminates or damages wetlands. It is assumed that the project footprint could be produced in a GIS form to facilitate analysis. This indicator requires that plan alternatives have a geographical description.

- Wetland locations across the state come from two primary sources: NWI and Local Wetland Inventory (LWI).[3] NWI maps were created from aerial photograph interpretation, but LWI maps, which cover areas within designated urban growth boundaries, supersede NWI within urban areas.

Values for this indicator would be developed by overlaying maps of plan alternatives on LWI or NWI maps and determining the acreage of overlap of identified wetlands. It is assumed that higher acres of overlap indicate a higher potential negative impact on wetlands.

The potential severity of impacts would be developed by weights on more significant wetland types. For example, estuarine and forested wetlands and locally significant wetlands (as indicated by LWI) are often higher value resources. In these cases, the acreage would be weighted by a factor of 2; all

[2] Information sources: https://www.fws.gov/wetlands/data/mapper.html; https://www.fws.gov/wetlands/; https://www.oregon.gov/dsl/WW/Pages/WWFAQ.aspx

[3] Information sources: https://www.fws.gov/wetlands/; https://www.oregon.gov/dsl/WW/Pages/WWFAQ.aspx

ES.4 Natural, Built, and Cultural Resources at Risk

other wetlands would not be weighted. The indicator would be equal to the sum of all weighted wetland acres.

The uncertainty associated with the data for this indicator should not be an issue. NWI and LWI maps provide useful information on the likely presence of wetlands at a regional (e.g., citywide, countywide) scale. They do not provide accurate information on the precise location and extent of wetlands, nor do they conclusively indicate whether wetlands are present or absent. Oregon Department of State Lands' website states: "Information shown on the Local Wetland Inventory maps is for planning purposes only, as wetland information is subject to change. There may be unmapped wetland and waters subject to regulation and all wetlands and water boundary mapping is approximate." Nevertheless, these maps provide adequate information to indicate the resource and the likely implications for an alternative.

Hazardous Material

This indicator serves only as a placeholder for local input to areas of suspected hazardous material sites. It would be significant for decisions only when the risk is high. This indicator requires that plan alternatives have a geographical description.

Due to the reliance on local knowledge, and without site surveys, this indicator is highly uncertain and users of the tool should take a risk-adverse perspective on site assessments. A consolidated data source is not available for GIS-type comparisons. Instead, local knowledge would have to be included on a formalized basis. Primary data collection would include consideration of information about the current or historical land uses within the geographical boundaries of the plan.

This indicator could only be evaluated by studying the geographic description and map of the plan to determine where and in what degree of severity might the risk of unknown hazardous materials be highest. It is recommended that a severity score of 1 to 3 be applied to each instance where the risk of a hazardous materials site is high. The indicator would be equal to the weighted sum of all potential hazardous sites. This assessment depends on the geographical description of the project only and is not differentiated by scale.

ENVIRONMENTAL STEWARDSHIP

RESOURCES AT RISK

ES.4 Natural, Built, and Cultural Resources at Risk

Public Parks

General GIS data is available for this indicator to identify locations of local, state and national parks. In addition to the community and natural resources that parks present, other programs, namely Section 6(f) of the *Land and Water Conservation Fund Act* and Section 4(f) of the *US Department of Transportation Act*, both convey protections on public park land. It is generally anticipated that only in cases when a plan could have a significant impact on a park would this indicator be relevant. This indicator relies heavily on general maps and local knowledge of parks.

This indicator could only be evaluated by studying the geographic description and map of the plan to determine where and in what degree of severity a current or future park might be impacted. It is recommended that a severity score of 1 to 3 be applied to each instance where a park may be impacted. The indicator would be equal to the weighted sum of all parks impacted.

FUNDING/
FINANCE

CAPITAL COSTS

FT.1 Capital Costs

What is this Specific Indicator?

This Specific Indicator looks at capital costs associated with each bundle of actions. Capital Costs is a monetized indicator. It is one of only two indicators within Mosaic where monetization is the only option available to users. This indicator must be calculated for economic valuation as it contributes to the denominator in the cost-benefit analysis.

How is data generated?

Cost estimation is reported in specialized engineering documents generated for specific “bundle” components. For planning-level efforts capital cost factors can be calculated based on unit costs, using available information from the following prioritization of data sources: (i) internal historical data, (ii) external historical data, and (iii) comparables.

Each “bundle” will consist of a project list or a list of components containing, at a minimum: location, transportation mode, proposed improvements, length of each improvement, and construction schedule. Mosaic users should use experience and examples from peers to develop planning level cost estimates. Other guidance is available for developing unit costs for infrastructure projects through the Association of General Contractors (AGC) and from your regional ODOT office. Guidance on costing programmatic actions is available in the Programs Guide and within the Mosaic tool itself.

Total capital cost for each “bundle” must be estimated on a yearly basis. There are differing levels of accuracy for capital costs. The more advanced the “bundle” component, the higher the accuracy and the breakdown into different cost types (e.g., engineering and design). The amount of contingency provided for each bundle element will account for the level of engineering data available for the cost estimate.

Users enter capital costs in Mosaic’s “Cost and Schedule” worksheet by bundle and by year. No other data entry is required for this specific indicator within the “Funding and Finance” worksheet – data are input directly from the “Cost and Schedule” worksheet.

FUNDING/ FINANCE

LIFECYCLE COSTS

FT.2 Other Lifecycle Costs

What is this Specific Indicator?

This Specific Indicator explores the lifecycle costs associated with each bundle of actions. Lifecycle Costs is a monetized indicator. It is one of only two indicators within Mosaic where monetization is the only option available to users. This indicator must be calculated for economic valuation as it contributes to the denominator in the cost-benefit analysis. Subject matter expertise is highly recommended in estimating this specific indicator.

How is Data Generated?

Users enter lifecycle costs in Mosaic's "Cost and Schedule" worksheet by bundle and by year. No other data entry is required for this specific indicator within the "Funding and Finance" worksheet – data are input directly from the "Cost and Schedule" worksheet.

Total lifecycle costs are determined using the following equation:

> *Total Lifecycle Costs = Total Capital Cost + O&M Cost + Financial Costs (including borrowing costs for fiscal funds) + Other Costs.*[1]

- Where:
  - Total capital costs are estimated as described in the *Capital Costs* Specific Indicator.
  - Operations and maintenance (O&M) costs are estimated by applying high-level cost factors to the improvements included in each bundle and their corresponding operating standards.[2] O&M cost factors vary by transportation mode, type of infrastructure, and location, and may not have a homogeneous unit for their application (e.g., some may be

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[1] Examples of "other costs" include O&M cost reductions in other parts of the system as a result of the construction of a "bundle."

[2] Currently, the majority of operating standards for improvements are not defined. However, work is being done in the area of "Sustainability in Project Delivery" to address this issue.

FT.2 Other Lifecycle Costs

applied on a per-mile basis while others are applied on a per-user basis).

- Financial costs are estimated based on yearly funding shortfalls for each bundle using projected cash-flow calculations (i.e., Yearly Available Funds to Finance bundle, excluding borrowing + Yearly Operating Revenues – Total Yearly Costs). The cost of borrowing fiscal funds to cover the yearly cash shortfalls is determined as if it was incurred at the beginning of the construction period using the appropriate credit market rate.

- High-level capital cost (indicator FT1) plus operations and maintenance (O&M) factors are used in combination with specific characteristics of “bundle” components to determine the capital and O&M components of each bundle’s total lifecycle costs.
  - Financial costs are estimated using cash-flow calculations for each “bundle” and cost of borrowing funds.
  - The “other costs” sub-category will consist of experts’ opinions.
- O&M cost factors can be calculated based on available information using the following prioritization of data sources: (i) internal historical data, (ii) external historical data, and (iii) comparables.
- Financial information such as yearly cash flows and cost of borrowing could be requested from ODOT. Subject matter experts will be responsible for estimating the “other costs” sub-category.
  - Historical records for O&M costs exist for highway projects within ODOT. For other modes, information can be requested from the relevant agencies or comparables from the literature and other public databases (such as the National Transit Database) can be used to estimate the appropriate factors.
  - Cash-flow calculations for each bundle could be performed by ODOT. Please NOTE: Coordination with ODOT would be needed to determine availability of staff to perform calculations. Moreover, borrowing cost estimates could be used to estimate the financial costs of borrowing funds for different bundles.
- Capital cost factors may aggregate over project types but normally discriminate according to geography. Cash flow estimations for smaller-than-state geographies may not be performed by ODOT, but should be replicable by the appropriate authority. Borrowing cost, however, may

FT.2 Other Lifecycle Costs

not be replicable at a sub-state geography depending on the specific borrowing capacity of the corresponding authority. Estimations by subject matter experts are component-specific and therefore scalable.

- All types of costs should be estimated on a yearly basis during the entire planning horizon and then discounted using the appropriate discount factor to obtain their present value.
- The procedure to estimate financial costs may not apply to bundles comprising geographic areas smaller than the state due to potential differences in borrowing costs or lack of borrowing capacity.
- O&M cost factors may not coincide with the description of improvements in individual bundle components. Therefore, cost factors for similar improvements may need to be used.

FUNDING/ FINANCE

OPERATING REVENUES

FT.3 Total Revenues

What is this Specific Indicator?

This Specific Indicator examines the total amount of operating revenue forecasted for each bundle of actions. However, operating revenues should be contrasted against the cost of the bundle to obtain a more realistic picture of the revenue-generating power of different bundles.

Total revenues is a monetizable indicator and whenever possible should be calculated for economic valuation, unless reliable revenue estimates are not available (in which case, qualitative assessment of the revenue-generating potential of a bundle may be appropriate).

How is Data Generated?

User input is entered in Mosaic's "Cost and Schedule" worksheet by bundle and by year. No other data entry is required for this specific indicator within the "Funding and Finance" worksheet – data are taken directly from the "Cost and Schedule" worksheet.

Guidance on developing revenues for bundles involving user fees or charges, is included as follows:

> *Total revenues = "incidental revenues" (e.g., leasing of right-of- way [ROW]) + farebox revenues + increases in tax revenues resulting from the bundle (as long as the additional tax revenue can be attributed entirely to the bundle)*

- Total revenues must be differentiated from funding contributions made throughout the lifecycle of the program by the promoters of the bundles. For example, scheduled contributions/investments by state and local agencies or the private sector used to pay for lifecycle costs should not be included in the estimation of Total Revenues.
- Total gross revenue generated by the bundle is estimated on a yearly basis; revenues of future years are discounted using the appropriate discount rate, which results in present value estimations.
- Farebox revenues and increases in tax revenues, are standard methodologies (i.e., based in demand parameters and elasticities) that must be used in the estimation of revenues.
- In the case of incidental revenues, high-level revenue factors may be used in combination with bundle characteristics to estimate this amount.

FUNDING/ FINANCE

OPERATING REVENUES

FT3. Total Revenues

Preliminary financial studies are used to generate total revenue as relevant for specific bundle components (e.g., individual projects and programs). Revenue factors and characteristics for bundle components may also be used to generate total revenues (for "incidental revenues" only). Please note that many projects and programs will not generate revenues; this indicator is limited to those with user fees, fares, or tolls. Preliminary financial studies offer the highest accuracy because they are performed for the specific bundle component. If these studies do not exist, historical data from state and comparables from literature may be used.

For farebox revenues, the ownership of the specific project or program must determine the source of data. Likely sources would include historic data from that agency, from other agencies of similar size, and from the National Transit Database (NTD).

For tax-revenue increases associated with each bundle, the corresponding agency at the appropriate geographic level will need to provide the estimated amount (if the bundle generates an increase in state taxes, ODOT will provide this estimation).

FUNDING/
FINANCE

LEVERAGING FUNDS FROM PRIVATE SECTOR AND OTHER AGENCIES

FT.4 Share of Lifecycle Funds that are "New" or "Recycled"

What is this Specific Indicator?

This Specific Indicator examines the amount of various financial contributions. For example, 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).

How is Data Generated?

Users obtain data for this indicator from communications with the relevant agencies involved with the planning effort. When completed, users enter a percentage number (between 0 and 100 percent) of financial contributions contributed directly from the private sector, from new local agency funds, and/or recycled funds. Data is generated at the local level and, therefore, calculation of this indicator is easily scalable to any geographic level within Oregon.

Total funds required by each "bundle of actions" (denominator in indicator's equation) correspond to costs estimated in the *Other Lifecycle Costs* Specific Indicator. There are two main sources to identify leveraged funds:

- **Communications and negotiations for state-allocated federal funds with ACTs** - Communications are submitted to, or negotiations are held with, the Oregon Transportation Commission (OTC) and require the applicant to disclose information on funding sources, amounts, and investment schedules. Funding sources in these communications and negotiations include the private sector as well as "local counterparts." Total lifecycle costs will be estimated in the *Other Lifecycle Costs* Specific Indicator.
- **Applications (used in a broad sense) for statewide competitive funding programs.**

FUNDING/
FINANCE

LEVERAGING FUNDS FROM PRIVATE SECTOR AND OTHER AGENCIES

FT4. Share of Lifecycle Funds that are "New" or "Recycled"

To determine the share of lifecycle funds that are new or recycled for each bundle, the following equation is used:

*Percentage = [(New + Recycled funds) / Total bundle funds] * 100*

- New funds are equivalent to the funds committed[1] by private investors to each bundle or by fresh funds generated by local public agencies within their jurisdictions (i.e., are not a result of a transfer of funds from a state or federal agency), as reported in the appropriate documentation.
- Recycled funds are equivalent to the funds committed by other local, state, or federal agencies to each bundle not considered new (according to the definition established), as reported in the appropriate documentation.
- "Total bundle funds" are the funds required to complete a bundle and, therefore, are equivalent to the amount estimated in the *Other Lifecycle Funds* Specific Indicator.
- In all cases, funds are reported in their present value (i.e., discounted at the appropriate discount rate based on the schedule of investment).

[1] "Committed funds" refers to raised funds regardless of their schedule of investment.

FUNDING/
FINANCE

NET IMPACT OF PROGRAM ON STATE AND LOCAL FISCAL BALANCE

FT.5 Net Impact of Program on State and Local Fiscal Balance

What is this Specific Indicator?

This Specific Indicator examines the potential effects of implementing bundle projects and programs on agency finances – that is, how the bundle may impact an agency's credit rating or bonding capability due to changes in fiscal balance (fiscal surplus or deficit). It is up to the individual Mosaic user group to decide whether to use or not use this indicator.

How is Data Generated?

This indicator can only be scored qualitatively. Users are provided suggestions on how to score each bundle on a scale from "largely adverse" (greater than -3% change in fiscal balance) to "largely beneficial" (greater than +3% change in fiscal balance).

SAFETY
& SECURITY

SYSTEM SAFETY

SA.1 Fatal, Injury A, and Injury B Crashes

What is this Specific Indicator?

This Specific Indicator examines the change in costs related to injuries and loss of life that results from transportation incidents. Transportation decision making can influence costs related to the loss of life by designing transportation plans, projects, and actions that result in increased safety for all modes and users.

How is data generated?

Data for this indicator is generated using the Mosaic safety modelling tool (separate spreadsheet tool). Users would estimate the number of fatal, “Injury A” (disabling injury), and “Injury B” (evident injury) crashes that are expected to occur with each bundle of projects and programs. The “value” of the estimated change, positive or negative, in the number of fatalities and injuries associated with each bundle (as compared to the base case) is automatically monetized in Mosaic.

A spreadsheet tool is available on the Mosaic website to aid in estimating this indicator. This tool that can be used to estimate the difference in crash rates associated with a bundle of actions. It provides crash estimates for a variety of facility types.

SAFETY
& SECURITY

SYSTEM SAFETY

SA.2 Property Damage Only Crashes

What is this Specific Indicator?

This Specific Indicator examines the change in property damage only crashes associated with a bundle of transportation projects and programs. Property damage only (PDO) crashes represent a large proportion of all crashes and in turn represent a significant impact on local economies.

How is data generated?

As with SA.1, the data for SA.2 is generated by employing the Mosaic safety modelling tool (separate spreadsheet tool). Once PDO crash rates are generated, the Mosaic tool automatically monetizes the change in PDO crashes for each bundle based on an average cost per PDO crash.

SAFETY
& SECURITY

SYSTEM
SECURITY

SA.3 Emergency Management Systems

What is this Specific Indicator?

This Specific Indicator examines the change in Emergency Management Systems (EMS) response times by bundle of action. This measure does not represent actual response time; rather, the Specific Indicator is intended to capture differences in emergency vehicle travel times on relevant major routes.

How is data generated?

The impact of the bundle of projects on EMS response times results in a quantitative or qualitative assessment based on the anticipated change in estimated travel times on major routes serving hospital and trauma centers. Output from the travel demand model is used to develop this information. There is currently no method in use to convert the results into monetary estimates that would meet the requirements of this project; therefore this indicator is not recommended for monetization.

Users can approach this indicator in a number of ways.

- 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.

SAFETY
& SECURITY

SYSTEM SECURITY

SA.4 Resiliency of the Network

What is this Specific Indicator?

The *Resiliency of the Network* Specific Indicator evaluates how the transportation system operates during extreme incidents (e.g., extreme weather), focusing on the ability for the greatest population numbers to safely reach medical centers in the event of an emergency.

How is Data Generated?

Ideally, this indicator relies on information coded into a GIS about the quality of the transportation network and its ability to withstand a natural or terrorist event. However, additional data could be obtained from the Oregon Health Authority, the Emergency Management System (EMS) program in the Transportation Safety Division of ODOT, and law enforcement agencies in the region.

GIS is used to calculate resilience of the network. This is done first by confirming that several 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 event of a given size. For each bundle, users would then identify which lifeline routes were improved to survive the natural event referenced under (3) above. This finding would then be entered into the Mosaic tool.

There is currently no method in use to convert the results into monetary estimates that would meet the requirements of this project.

LAND USE

POPULATION AND EMPLOYMENT DENSITY

LU.1 Population and Employment Change and Distribution

What is this Specific Indicator?

This Specific Indicator examines the change in population and employment (total numbers, distribution) with a plan or bundle of actions. This indicator provides insight into how future land use patterns will change in response to the implementation of the bundles of actions in a transportation plan. It is evaluated qualitatively, in terms of whether the future population and employment distribution supports or does not support existing land use plans, or presented as a "report only" statistic.

How is Data Generated?

Population and employment information is readily available as part of system planning processes in Oregon. Base year and future year land use information can be found at a Traffic Analysis Zone level within a travel demand model.

Most transportation models used in Oregon do not have feedback loops in the modeling system that shifts where population or employment locate given a change in transportation supply. The Oregon Statewide Integrated Model (SWIM) can estimate these variables at certain scales, as can other integrated land use models available for certain geographies in Oregon (e.g. MetroScope in the Portland region). These models can assess the transportation system effect on land value and require the bundle of transportation system changes be analyzed in an iterative fashion over a set of forecast years. This indicator may, in most situations, be estimated by qualitative means such as expert panels.

The population and employment distribution or changes can be expressed as follows:

- Changes in distribution of population and employment can be shown through using an integrated land use model as described above, or through a literature review and/or peer review panel to estimate the specific land use effects of a bundle of actions. Depending on the model used, the future change in distribution of population and employment can be compared to the existing plans. This provides a qualitative basis for comparing bundles to each other. Those bundles that are anticipated to result in "undesirable" distribution of employment and population would receive lower

LU.1 Population and Employment Change and Distribution

scores, while those resulting in favorable distribution would receive higher scores.

- The expected distribution of population and employment can alternatively be presented as a “report only” statistic. Maps of anticipated future land use could be created and presented to decision makers.

LAND USE

LAND VALUE

LU.2 Relative Land Value Change Compared to Base Case or No Action

What is this Specific Indicator?

This Specific Indicator examines the change in land values associated with a plan or bundle of actions, as compared to the base case. This Specific Indicator looks at the connection between transportation changes and changes to the land price, as compared to prices if no transportation changes are in that area. Land value may potentially be duplicative with the *Travel Time* and *Costs* Specific Indicators because land value changes are largely the capitalization of the future stream of travel benefits. Therefore, land value changes are a report statistic only, deemed important to provide as a stand-alone statistic to policy makers.

How is Data Generated?

Land value data exists frequently in GIS form by parcel, and it may be sorted or aggregated by land use type. However, estimates of future land value would come from an integrated land use model.

Estimating changes in land value requires using outputs from the Oregon Statewide Integrated Model (SWIM) (if available) or a regional model that has incorporated land values in an integrated manner between the land use and transport system components of its regional modeling process. 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. The forecast year matches the analysis year used in the transport modeling. The formula is:

> *Change in land value for defined geography (Traffic Analysis Zone [TAZ]) = future year land value (TAZ)/base year land value (TAZ).*

The result is a percent change from base year to future year or from base case to action scenario. The results are reported through mapping at the geography used in the analysis. The geographies can be aggregated and analyzed at different levels by aggregating raw land value results to the desired geography.

QUALITY OF LIFE

PHYSICAL ACTIVITY

QL.1 Health Benefits of Active Transportation

What is this Specific Indicator?

This Specific Indicator examines the health benefits from active transportation. Travel choices are connected to changes in physical activity, resulting in health outcomes. Morbidity and mortality are the two health outcomes explored in this indicator, as affected by the changes in the number of miles walked and biked (active transportation), or changes in the amount of time spent participating in these activities. Lives saved and disease reduced due to active transportation is a monetizable indicator and whenever possible should be calculated for economic valuation.

How is Data Generated?

The Mosaic tool provides a series of sketch models to estimate the morbidity and mortality reduction effects of cycling and walking. It is important to note that in order to estimate this indicator, Mosaic users must have travel data on cycling and walking. At a minimum, users should have a (1) baseline estimate of the number of cycling and walking trips taken per day, (2) ability to estimate the *future* number of cycling and walking trips taken per day based on changes in population and/or additional facilities, and (3) ability to estimate the number of miles walked and biked per day (or per trip, extrapolated to a per day amount). Much of this information may be produced by more robust travel demand models. Users should consult their travel model staff to understand what data the model can produce. However, there are several sketch models in Mosaic (see the User's Guide) available to help in estimating bicycle and walking trips within a region. The user must look to other sources, though, to determine how the number of walking and cycling trips in a region might change due to increased population or construction of additional facilities.

Once data and the number of cycling and walking trips, users enter data into other sketch models to produce both morbidity and mortality reduction (or increase) statistics, which are then automatically monetized by Mosaic.

The following sections provide some details about how the morbidity and mortality components of this indicator or calculated. See the User's Guide for detailed information on how to estimate these indicators.

QUALITY OF LIFE

PHYSICAL ACTIVITY

QL.1 Health Benefits of Active Transportation

Mortality

The mortality rates by sex and age group included in Mosaic are available through the State of Oregon's Public Health Department. Using the sketch tool, the number of avoided deaths per year (i.e. change in mortality risk) would be multiplied by the value of a statistical life. ODOT guidelines for measuring the value of statistical life are used for consistency with valuing lives saved from safety measures, reducing air emissions, and all other pathways to reducing mortality impacts. Travel demand model data is only available for Metropolitan Planning Organizations (MPOs). Corresponding data is not available for all areas outside of MPO boundaries.

Morbidity

Disease specific relative risks, with confidence intervals, were obtained from the Integrated Transport and Health Impact Modeling Tool (ITHIM) meta-analysis. A *Compendium of Activities and Corresponding Metabolic Activity* relates the outputs from the ITHIM to minutes of physical activity. Data can then be compared to a baseline/existing conditions of current morbidity and disease rates (from the statewide Center for Health Statistics, the Oregon State Cancer Registry, and the Behavioral Risk Factor Surveillance System).

The demographic categories available from the travel model outputs should be determined to evaluate the potential for developing the baseline conditions and risk reductions for key diseases. Risk reductions vary by certain demographic characteristics.

Additional Resources

2011 Compendium of Physical Activities: a second update of codes and MET values. Medicine and Science in Sports and Exercise, 2011;43(8):1575-1581. Available for download at https://sites.google.com/site/compendiumofphysicalactivities/compendia

Gill, D. L., Chang, Y.-K., Murphy, K. M., Speed, K. M., Hammond, C. C., Rodriguez, E. A., et al. (2010). *Quality of Life Assessment for Physical Activity and Health Promotion*. Applied Research Quality Life Journal, 15-19.

QUALITY OF LIFE

PHYSICAL ACTIVITY

QL.1 Health Benefits of Active Transportation

Genter J. A., Donovan S., Petrenas, B., and Badland, H. 2008. *Valuing the health benefits of active transport modes.* NZ Transport Agency research report 359. 72 pp

Guenther Samitz, Matthias Egger and Marcel Zwahlen. *Domains of physical activity and all-cause mortality: systematic review and dose–response meta-analysis of cohort studies*, International Journal of Epidemiology 2011;40:1382–1400 doi:10.1093/ije/dyr112

Oregon Vital Statistics: https://www.oregon.gov/oha/ph/birthdeathcertificates/pages/index.aspx

Ragland, David – SafeTREC, UC Berkeley, *Transportation and Health: Policy Interventions for Safer, Healthier People and Communities*, http://www.prevent.org/Additional-Pages/Transportation-and-Health.aspx

U.S. Department of Transportation (DOT). March 18, 2009. "Treatment of the Economic Value of a Statistical Life in Departmental Analysis – 2009 Annual Revision," Memorandum to Modal Administrators

QUALITY OF LIFE

JOURNEY AMBIANCE

QL.2 Quality of the Travel Environment

What is this Specific Indicator?

This Specific Indicator examines the quality of the travel environment, organized by bundle of transportation actions. Quality of the travel environment is a monetizable indicator and whenever possible should be calculated for economic valuation.

How is data generated?

The Mosaic tool provides a sketch tool that streamlines the development of this specific indicator. This is: *Model for Estimating Journey Ambience Benefits* (derived from the UK Department for Transport)

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. Users input similar information for features of the bicycling environment.

By and large, walking and biking indicators are typical components of the transportation plans. The data requirements are similar across different geographies and would be assembled as part of a typical system-level planning effort that is intended to address system walkability and bikeability.

The general formula for pedestrians:

Length of Improvements X Value of Improvements to Users ($/mile) = Value of Improvements (per user)
Value of Improvements (per user) X Number of Users of Improvements = Pedestrian Journey Ambiance Benefits

QUALITY
OF LIFE

JOURNEY AMBIANCE

QL3. Quality of the Travel Environment

Journey ambience for cyclists is measured in miles of dedicated infrastructure. The monetary value depends upon whether the bikeway is "on-road" or "off-road." If on road, monetary values depend on whether the bikeway has a separate track or just a bike lane.

The general formula for bicyclists:

> *Average Bicycle Speed X Length of Facility =*
> *Average Time Spent on Facility (hours)*
> *Average Time Spent on Facility (hours) X Number of Users of Facility X Value of Facility ($/hour) =*
> *Bicycle Journey Ambiance Benefits*

Additional Resources

Washington State Department of Transportation, Montlake Triangle Project, Tiger Discretionary Grants Program, Economic Analysis Supplementary Documentation, October 26, 2011, pg 22. https://www.wsdot.wa.gov/NR/rdonlyres/E2D55DF9-A6A8-4F72-A2BC-A42914DBAEE1/0/BCA.pdf

UK Department of Transport, Transport Analysis Guidance (TAG) Unit 3.14, Guidance on the monetizing of Journey Ambiance, January, 2010.

QUALITY OF LIFE

NOISE

QL.3 Noise Impacts

What is this Specific Indicator?

This Specific Indicator examines the noise impacts of each bundle of actions. Changes in noise levels (decibels) are evaluated in decibel increments to determine the levels of impact. Residential areas and parks, where people may spend substantial time outdoors, have lower noise thresholds than businesses. Noise impacts is a monetizable indicator and whenever possible should be calculated for economic valuation.

How is Data Generated?

The Mosaic tool provides a sketch model that streamlines the estimation of this specific indicator. This is: *Model for Estimating the Monetary Valuation of Noise Impacts* (UK Department for Transport). Changes in noise levels (decibels) are assessed by type of receptor and applied to the monetary estimates developed in National-Scale Air Toxics Assessment (NATA) for increments in decibels above baseline conditions. An excellent description of noise impacts by type of receptor can be found in the Oregon Department of Transportation (ODOT) *Noise Manual* (July 2011).

The monetary values associated with the noise impacts depends upon the type of receptor, the baseline noise levels, and the size of the increment to decibel levels. GIS data showing the number of receptors by type and by noise contour (i.e., distance from the center line of the alignment) are needed. As an alternative to the sketch model, users can apply a cost per VMT generated (based on USDOT methodology) to generate an estimate of the monetized value of noise impacts.

The information required to complete the sketch model 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 required to run a noise model to conduct this analysis – it is set up to catch the number of residences that are 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 is not the one entered into the sketch model, however – it is the net difference in number of residences

QUALITY OF LIFE

NOISE

QL.3 Noise Effects

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. This information is then automatically populated into the Quality of Life worksheet, by numbers of households impacted.

The noise study is usually prepared after the traffic data are developed, and is conducted in fifty feet (or ten meter) increments from the common centerline of a highway. This approach assumes that the noise source is along a straight line. This suggests that the proposed transportation system changes would need to be divided into a series of linear segments that approximate the actual alignment, but is reasonable with current GIS technology.

The use of noise contours can give a good indication of the potential for noise impacts, and can do so at a reasonable cost. Some considerations when looking at a “noise contour”:

- Refers to the decibel levels associated with a given distance from the center line of the relevant alignment.
- Assumes a location that has total exposure to the roadway, is flat and level, and has no additional acoustic screening such as hills, embankments, or dense vegetation. All distances shown are from the common centerline of the highway.
- Is user friendly and does not require a noise expert, in contrast to the TNM. The model can be run anywhere in the state that can provide the model inputs and does not rely upon developing noise maps.
- Not as accurate as an individual site study, which considers the effects of additional shielding or other natural factors that may affect the noise levels at a specific location.

Data on baseline and projected future traffic conditions, with and without the transportation program, are required to develop “noise contours” for the transportation noise model look-up tables or software version (recommended).

QL.3 Noise Effects

Additional Resources

Oregon Department of Transportation. 2011. Noise Manual. July, 2011.

U.S. DOT Federal Highway Administration. 2004. FHWA TRAFFIC NOISE MODEL® VERSION 2.5 LOOK-UP TABLES USER'S GUIDE. FHWA-HEP-05-008 Final Report DOT-VNTSC-FHWA-0406, Prepared by Federal Highway Administration Research and Special Programs Administration, John A. Volpe Acoustics Facility, Cambridge, MA 02142-1093, December 2004.

Table V-22 of the FHWA Cost Allocation Study provides noise cost estimates for five vehicle types, including autos and buses. Available online at https://www.fhwa.dot.gov/policy/otps/costallocation.cfm

Rail transit estimates for can be found at: https://www.vtpi.org/tca/tca0511.pdf (with references to studies in Europe)

The Noise Sub-objective, TAG Unit 3.3.2, April 2011, UK Department for Transport, Transport Analysis Guidance (TAG).

Delucchi, Mark, Don McCubbin. "External Costs of Transport in the U.S., Forthcoming in Handbook of Transport Economics," ed. by A. de Palma, R. Lindsey, E. Quinet, and R. Vickerman, Edward Elgar Publishing Ltd. (2010), Institute of Transportation Studies, University of California, Davis.

Delucchi also provides estimates for buses (Table 14-9): http://www.glmri.org/downloads/lngMisc/External%20Costs%20of%20Transport%20in%20the%20US-Delucci%20&%20McCubbin-%20I.pdf

EQ.1 Distribution of User Benefits Across Population Groups

What is this Specific Indicator?

This Specific Indicator examines the distribution of *user benefits* (travel time savings and user cost savings) across geographic areas and/or by population group. Alternatively, users could evaluate the Transportation Cost Index (TCI) across population groups and geographies. *As of fall 2014, the TCI is not available for use.* ODOT is conducting research in 2014 and 2015 to better enable use of TCI in the future (research project SPR_760). See the discussion of indicator AC.1 for more information.

How is Data Generated?

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.

Information from the Mobility worksheet is automatically populated in the Mosaic tool. Additional data required for the equity analysis will come from an agency's GIS, from a travel demand model (limited), from school districts, or directly from the U.S. Census. The Decennial Census or American Community Survey (ACS) may be used as well. In order to assess the geographic distribution of travel time benefits, users may need maps of project locations in order to make a qualitative assessment of the effects.

Equity analyses could vary depending on what specific agencies wish to explore, however additional GIS mapping analysis is expected to cover (1) the identification of different population group categories and (2) the spatial GIS mapping of these groups over the Mosaic planning area. The following information would be gathered:

Population Groups

- Race and ethnicity
- Median household income
- Percent of households below the poverty line
- Language spoken at home

Geographic Groups

- City boundary
- County boundary

EQUITY

EQ1. Transportation Accessibility Index by Geographic Area and Population Groups

- Urban/rural
- Zip code
- Neighborhood boundary

Additional categories such as age, presence of a disability, language spoken at home, and others could be considered in this analysis if desired.

Users input the distribution of benefits associated with each bundle, and then use this information to provide a score to each bundle for each of the categories considered. Users can estimate this indicator quantitatively by entering the share of benefits accruing to high income/low income areas, etc. Users may also make a qualitative assessment of the information available.

EQUITY

ENVIRONMENTAL STEWARDSHIP

EQ.2 Distribution of PM 2.5 Emissions across Population Groups

What is this Specific Indicator?

This Specific Indicator examines the distribution of Particulate Matter (PM) emissions by geographic area and by population group. This indicator is developed within Mosaic's Environmental Stewardship worksheet, and explores the presence of PM 2.5 emissions in the study area.

How is Data Generated?

This Specific Indicator looks at the way that PM emissions are dispersed within different population groups across a geographic area. Generally, the area of impact of PM emissions from the source are slightly over ¼ mile.

As referenced above, data generated for PM emissions will be developed under the environmental stewardship worksheet. Additional data required for the equity analysis will come from an agency's GIS, from a travel demand model (limited), from school districts, or directly from the U.S. Census. The Decennial Census or American Community Survey (ACS) may be used as well.

Equity analyses could vary depending on what specific agencies wish to explore, however additional GIS mapping analysis is expected to cover (1) the identification of different population group categories and (2) the spatial GIS mapping of these groups over the Mosaic planning area. The following information would be gathered:

Population Groups

- Race and ethnicity
- Median household income

EQUITY

ENVIRONMENTAL STEWARDSHIP

EQ2. PM Diesel Emissions Distribution by Geography and Population Groups

- Percent of households below the poverty line
- Language spoken at home

Geographic Groups

- City boundary
- County boundary
- Zip code
- Neighborhood boundary

Additional categories such as age, presence of a disability, language spoken at home, and others could be considered in this analysis if desired.

The distribution of PM emissions is automatically imported from the Environmental Stewardship worksheet, and serve as the starting point for the EQ2 analysis. Users then compare the PM emissions findings across two equity indices:

1. Geographic equity
2. Social equity

Users input the distribution of benefits associated with each bundle, and then use this information to provide a score to each bundle for each of the categories considered. Users may also score this indicator qualitatively.

EQUITY

QUALITY OF LIFE

EQ.3 Distribution of health benefits from active transportation across population groups

What is this Specific Indicator?

This Specific Indicator examines the distribution of reduced morbidity and mortality by geographic area and by population group. The starting point for this analysis comes from indicator QL1, Health Benefits Due to Active Transportation, and explores the effects of active transportation (such as walking, biking) on incidence of diseases and death. See the discussion of indicator QL1 for more information.

This equity measures *access to* active modes, rather than the use of active modes across population groups.

How is Data Generated?

As referenced above, data generated for QL1 will inform this indicator. The number of additional daily miles walked or biked for each bundle is automatically imported into the EQ3 worksheet. Additional data required for the equity analysis will come from an agency's GIS, from a travel demand model (limited), from school districts, or directly from the U.S. Census. The Decennial Census or American Community Survey (ACS) may be used as well.

Equity analyses could vary depending on what specific agencies wish to explore, however additional GIS mapping analysis is expected to cover (1) the identification of different population group categories and (2) the spatial GIS mapping of these groups over the Mosaic planning area. The following information would be gathered:

Population Groups

- Race and ethnicity
- Median household income

EQUITY

QUALITY OF LIFE

EQ3. Reduced Incidence of Disease due to Active Transportation by Geography and Population Groups

- Percent of households below the poverty line
- Language spoken at home

Geographic Groups

- City boundary
- County boundary
- Urban/rural
- Zip code
- Neighborhood boundary

Additional categories such as age, presence of a disability, language spoken at home, and others could be considered in this analysis if desired.

Users input the distribution of benefits associated with each bundle, and then use this information to provide a score to each bundle for each of the categories considered. Users may score this indicator qualitatively as well.

EQUITY

SAFETY

EQ.4 Distribution of Accident Rates across Population Groups

What is this Specific Indicator?

This Specific Indicator examines the distribution of fatal and injury crash values by geographic area and by population group. The fatal and injury crashes indicator is developed within Mosaic's Safety and Security worksheet, and explores the forecasted effects of a bundle of actions on serious crash incidents by geography. See the discussion of indicator SA1 for more information on the Fatal and Injury Crash indicator.

How is Data Generated?

As referenced above, fatal and Injury crash data will be developed under the safety and security worksheet. Additional data required for the equity analysis will come from an agency's GIS, from a travel demand model (limited), from school districts, or directly from the U.S. Census. The Decennial Census or American Community Survey (ACS) may be used as well.

When examining accidents/injury rates across population groups from an equity perspective, it is important to consider vulnerable populations. For this Specific Indicator, collecting demographic information along with accident data will be important. However, if this data is not available, creating a spatial overlay of areas with high concentrations of vulnerable populations (low-income, minority, elderly, children, and people with disabilities) is another way to correlate the data.

Equity analyses could vary depending on what specific agencies wish to explore, however additional GIS mapping analysis is expected to cover (1) the identification of different population group categories and (2) the spatial GIS mapping of these groups over the Mosaic planning area. The following information would be gathered:

Population Groups

- Race and ethnicity

EQUITY

SAFETY

EQ4. Fatalities and Injuries by Geography and Population Groups

- Median household income
- Percent of households below the poverty line
- Language spoken at home

Geographic Groups

- City boundary
- County boundary
- Urban/rural
- Zip code
- Neighborhood boundary

Additional categories such as age, presence of a disability, language spoken at home, and others could be considered in this analysis if desired.

This indicator may only be evaluated qualitatively, due to the exceeding difficulty of quantifying the spatial distribution of collisions. Users then compare these findings across three equity indices:

1. Urban vs. rural
2. Geographic equity
3. Social equity

Users input the distribution of benefits associated with each bundle, and then use this information to provide a score to each bundle for each of the categories considered.