# Accessibility IDT Team:
# Specific Indicator Data Sources and Estimation Methods

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## Introduction

The role of the Accessibility Indicator Development Team (IDT) is to develop the set of specific indicators for the Accessibility category of transportation system performance for the Oregon Least Cost Planning (LCP) project. This work includes developing a list of specific indicators and the estimation methods for evaluating them. This memorandum presents a refined list of specific indicators, documents the data that would be used, and lays out the steps involved in estimating the indicators for use in LCP.

This memo is the second for the Accessibility IDT. On November 18, 2011, the IDT submitted a memo that provided a draft list of specific indicators, and a brief overview of how the IDT would approach developing them. In response to this communication, the LCP core leadership team met throughout December to look across the nine categories of transportation system performance to ensure that the set of specific indicator was complete (addressing all key aspects of LCP), manageable, operational, and avoids duplication. The result of these discussions was a set of guidance back to the IDTs to reassess several indicators within their category, including questions about operationality and recommendations to eliminate specific indicators for reasons of duplication and manageability. This memo picks up from that set of guidance.

## Refined Specific Indicators

The Accessibility IDT met to discuss this proposed guidance in January 2012, and this section documents its progress in listing a refined set of specific indicators. Table 1 provides a list of refined specific indicators that responds to the core leadership team's guidance. This table is and will continue to be a work in progress and may be revised as the Accessibility IDT members work to further develop the specific indicators.

**Table 1: Refined Specific Indicators**

| General Indicator | Refined Specific Indicator(s) | Response to Comments from Leadership Team and Others |
|---|---|---|
| Proximity | • Transportation Accessibility Index<br>• Population within *X* minutes between work and home | Name of general indicator changed from "Land Use" to "Proximity" |
| Connectivity / Ease of Connections | • Location of industrial jobs in relation to the regional freight network | Added at the request of the SSC |
| Modal Availability | • Population and employment within ¼ mile of a transit stop served by at least 30 vehicles per day<br>• Amount of multi-use paths and bike boulevards<br>• Sidewalk coverage | Three specific indicators proposed because it was determined that no single indicator could cover all relevant modes |

For the **Proximity** general indicator, the Accessibility IDT selected the specific indicator "Cost to access a reference market basket of goods, services, and desired activities (Transportation Cost Index)" and removed the specific indicator "Percentage of population able to travel between work and home within 45 minutes."

The IDT went back and forth on which specific indicator to select, and only landed on the Transportation Accessibility Index after discussions with ODOT's Transportation Planning and Analysis Unit over the ability to measure this indicator without using the statewide integrated model. It was decided that the confirmed specific indicator would have a broader application and would cover more purposes.

The specific indicator "Percentage of population able to travel between work and home within 45 minutes" was subsequently reintroduced into the list, as members of the WG and Project Management Team felt that it was a good indicator of accessibility and quality of life. The definition of the indicator was modified slightly, so that users could specify the travel time threshold (*X* minutes, instead of 45 minutes).

For **Connectivity/Ease of Connection**, the specific indicator "Location of industrial jobs in relation to the regional freight network" was chosen.

The specific indicator "Percentage of O-D pairs that are connected by transit, biking, and pedestrian facilities" was removed from the list.

The specific indicator "Number of 4-way intersections per square mile" was removed from the list as well. Although this indicator is broadly used as a measure for connectivity in travel models, it might not be as useful for evaluation purposes with LCP at the planning level. One

reason is that usually this level of detail is not available at the planning level. Second, this indicator would only provide a measurement for the level of connectivity for auto users.

The specific indicator "Direct distances divided by actual travel distances between O-D pairs, by mode" was removed from the list because the concept of direct distance might be misleading. Natural or man-made barriers such as rivers or highways would not be accounted for when calculating the direct distance.

The specific indicator "Percentage of roadways without sidewalk" was replaced with "Sidewalk coverage" and moved to the **Modal Availability** general indicator.

Two other specific indicators were selected for Modal Availability: "Population and employment within ¼ mile of a transit stop served by at least 30 vehicles per day" and "Amount of multi-use paths and bike boulevards."

Overall, in the process of selecting specific indicators, one IDT member mentioned that given the differences that exist between the specific indicators in each of the general indicator categories and the limitations discussed above, it would be better to keep more than one specific indicator per general indicator in the tool and allow the user to select the indicator that would be most meaningful, given the application and data availability. The Project Management Team, however, felt that it was important to have a consistent set of indicators across all applications. In the end, all agreed that more than one specific indicator would be needed to cover the scope of the general indicators. Thus, there are now two specific indicators for Proximity, and three specific indicators for Modal Availability.

## Data Sources and Estimation Methods for Specific Indicator "*Transportation Cost Index*"

The following paragraphs were taken from "Transportation Planning Performance Measures" final report SPR 357 dated October 2005. IDT member Bud Reiff and TPAU staff member Brian Gregor co-wrote this paper. The estimation methods listed below come directly from this source.

The Transportation Accessibility Index is an accessibility measure that is analogous to the Consumer Price Index (CPI). The CPI measures the relative price for acquiring a reference market basket of goods and services. It may be used to compare living costs in different areas and changes over time. The Transportation Accessibility Index measures the relative cost of accessing a market basket of travel destinations. It may be used to compare accessibility by trip purpose, travel mode, income group, geographic area and time period. Travel demand models provide information that may be used to define the travel market basket and to calculate transportation costs.

The Transportation Accessibility Index is primarily intended to be a measure of accessibility and the effects of the transportation / land use system on the quality of life. It can also serve as an indicator of transportation / land use system compatibility and of balance. The primary purpose of the transportation system, from the standpoint of the individual household, is to provide affordable access to the goods, services, and daily activities that the household desires,

and which often play an important role in how household members perceive their quality of life. Like the CPI, which may be used to indicate relative change in the cost of the goods and services themselves, the Transportation Accessibility Index may be used to indicate changes in the costs to access goods and services. The Transportation Accessibility Index may be used to measure how transportation affordability varies across an urban area, how it changes over time, and how it is affected by various land use and transportation system alternatives.

Areas having excessively high Transportation Accessibility Indices in future year scenarios are indicative of problems with land use / transport system compatibility and balance. Extreme traffic congestion, combined with limited alternatives for accessing the "market basket" will result in reduced quality of life, with the household having to either endure higher costs or accept a more limited number of choices. Such situations might be addressed in a variety of ways, including land use changes, investment in alternative modes, transportation system management (TSM) measures, and additional roadway capacity, any of which could reduce the Transportation Accessibility Index. An overall regional Transportation Accessibility Index can be computed for each alternative solution to indicate relative effectiveness.

**Estimation Methods**

The Transportation Accessibility Index may be computed for different forms of travel demand models, but the specifications presented below are for use with the JEMnR model. The specifications could be readily adapted to other disaggregated discrete choice travel demand models.

**A. Define a market basket of travel destinations**

The goal of defining a market basket of travel opportunities is to identify a set of destinations that provide a good set of choices for meeting daily living needs. The process of identifying this market basket involves three steps:

1. Identify the categories of travel for which market baskets of travel destinations are to be defined;
2. Identify a market area that will serve as the reference for quantifying travel destinations; and
3. Calculate the number of travel destinations in the reference market area.

The travel categories are defined based on their definition in the model used for calculating the measure. For this study they include work, shopping, recreation and other non-school trips made from the home.

The second step involves identifying a market area that will serve as the reference for quantifying the market basket of travel destinations. The reference market area is a TAZ within the urban area and a set of zones located around the TAZ that represent a large number of destinations. The reference TAZ may be identified through the use of expert judgment or through a structured analytical process.

The final step is to identify the total quantity of market attractions located within the market area for each trip purpose. Disaggregated discrete choice models provide the information needed to measure the relative attractiveness of places in the urban area to different categories of households. The cumulative attractiveness of destinations within the reference market area may be measured using components of the destination choice model. This is the reference market basket.

**B. Calculate travel costs to access the market basket**

Once the travel destination market basket has been defined for each trip purpose, the average cost to access each market basket is calculated for each TAZ and income group in the model area. The information for calculating these costs comes from "access utilities" calculated for the JEMnR destination choice model. The access utilities measure the perceived "costs" of traveling between TAZs by trip purpose, income group and travel mode. The model-derived costs are converted into monetary units and are aggregated across travel modes and averaged across the market place for the TAZ.

Since the cost that is to be averaged varies by travel mode, it is necessary to combine the mode costs into one representative cost to be averaged across each TAZ market place.

The average cost to access the market basket from each TAZ is computed as a weighted average of the travel costs from that TAZ to each other TAZ in the market place containing the market basket of destinations for that TAZ. The weighting factor in calculating the average is the proportion of the market basket that is located within each TAZ in the market place. The market place for each TAZ is identified as the set of TAZs that contain the market basket of destinations and may be accessed at the lowest cost from the target TAZ.

**C. Compute Travel Cost Indices**

Transportation Accessibility Index values for each cost array are computed by dividing the values for each TAZ by the values for the reference TAZ. This produces TCI values by TAZ and income, by TAZ and trip purpose, and by TAZ for all incomes and purposes.

## Data Sources and Estimation Methodology for Indicator "*Population within X Minutes between Work and Home*"

### Data Sources

To measure current conditions:

- American Community Survey (ACS), Longitudinal Employer-Household Dynamics (LEHD) that combined the state administrative data on employers and employees with core Census Bureau censuses and surveys, and Oregon Household Activity Survey (OHAS) can be used to get information on existing travel patterns, in particular journey-to-work (JTW) data.
- Travel demand models at different geographical levels can be used: Oregon Statewide Integrated Model (SWIM) at the state level, regional models at MPO levels, Oregon State Urban Model (OSUM) for the smaller non-MPO areas, including rural areas and smaller urban areas outside of the metropolitan areas.

- OSUM models do not have transit data in them. Also, only SWIM identifies whether long-distance commute trips are work trips or not. MPO models differentiate trip purposes within the MPO, but do not differentiate long-distance external trips, and OSUM models do not differentiate for trip purpose. Using the state-wide model is the only way to get the longer distance trips. IDT members mentioned that ODOT and MPOs are aware of this shortcoming and are currently working on improving their models, but were not aware of the progress or any timeline.

To forecast future conditions:

- The travel demand models mentioned above could be used for forecasting future travel patterns.
- Note that in cases where ACS is used to measure current conditions and travel demand models to forecast future conditions, there is no direct link between ACS and travel demand models data and as a result there will be a significant amount of data manipulation required to make the measure work. One IDT member mentioned that LCOG provided model TAZ structure to CTTP so that the JTW data could be disaggregated to the LCOG TAZ level, but that this is not true for anywhere else.

To resolve definition issues:

- The "*X*-minute" threshold needs to be refined. This threshold would be dependent on whether the area under consideration is an urban or a non-urban area, and in case of the former, whether it is a large or small urban area. The reasonable time by geographical region could be identified via literature review and/or specified by the user.

### Estimation Methods

- Once the appropriate geography is selected (state, metropolitan area, county, etc), identify an acceptable time threshold based on geography. Using the survey data and travel demand models mentioned above, calculate the percentage of population that are able to travel between work and home within *X* minutes, with and without the plan.
- One limitation of this specific indicator is that it is very 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 that meaningful for a rural area, where this percentage is going to be high (e.g. 90%) and relatively constant. In such areas, this measure is not going to vary much, whatever we do with the transportation plan.
- This specific indicator is measured using travel demand models and thus, all the usual uncertainties that exist with using a travel demand model is also present here; namely uncertainties in travel demand models structure and input data such as population, land use, and employment forecasts. One possibility to address this uncertainty is to run different scenarios within the travel demand models and get an estimate of a range of values for the indicator. Also, if the noise in the estimate is more or less the same across alternatives, the risk associated with the uncertainty is small. But if the noise in the

estimate is pertinent to only one of the planning alternatives, then the risk would be higher since this would result in a biased evaluation.

## Data Sources and Estimation Methodology for Indicator "*Location of Industrial Jobs in Relation to the Regional Freight Network*"

### Data Sources

To measure current conditions:

- Travel demand models at different geographical levels: SWIM model at the state level, regional models at MPO levels, OSUM models for the smaller non-MPO areas, including rural areas and smaller urban areas outside of the metropolitan areas. Each of these models will have information on both the number of jobs and the labor classification. These can be filtered for industrial and manufacturing jobs.
- Modeling information can be supplemented with GIS data which can provide information on current land use and/or zoning. This can be used to check information from the demand model. In addition, GIS information will have a roadway layer which will designate the functional classification of the roadway, the capacity of the facility, and its ownership. Some geographies will also code the regional freight network directly into the GIS.

To forecast future conditions:

- Travel demand models forecast future land use in much the same manner as they do current land use. Coordinating with county population and employment forecasts and specific jurisdictions about how those forecasts are distributed, the models allocate jobs by labor classification into areas at a Traffic Analysis Zone scale.

### Estimation Method

- Once the appropriate geography is selected (state, metropolitan area, county, etc.), define what is considered "connected" for freight employment areas to reach the regional freight network. It is recommended that a **travel time threshold** be established, or an average speed or acceptable level of congestion.
- Import data from the model into the GIS or vice-versa (import data from the GIS into the model) so that assessments can be made between points (e.g., employment centers, freeway on-ramps).
- Assess whether the path, speed, and/or congestion is considered acceptable along the route between employment centers and the regional freight network.

## Data Sources and Estimation Method for Indicator "*Percentage of Population and Employment within a Quarter Mile of a Transit Stop Served by at Least 30 Vehicles per Day*"

### Data Sources

To measure current conditions:

- Population data can be obtained from Census block data or from parcel data that locate dwellings.
- Employment data can be obtained from Local Employment Dynamics (LED), 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. LED is publically available at the census block level but it requires certain confidentiality agreement. Oregon Employment Department is another source that publishes quarterly reports of employment. This data is very precise, but has issues with confidentiality. This data is available on request for planning agencies who have signed confidentially agreements.
- Data on transit stops and level of service can be obtained from transit agencies. The same data is provided in files meeting the "General Transit Feed Specification" (GTFS).

To forecast future conditions:

- For future conditions, we would know where the routes are, but not necessarily where the stops are going to be. So, we need to make some assumptions. For example, based on the new routes we could identify segments that are stop-eligible and segments that are not stop-eligible. For existing routes, we might assume that the stops stay in the same locations. Or we could make assumptions on where the new transit stops are going to be, based on assumptions on land use development and location of new employment and dwellings. We might not have accurate information on future employment and dwelling locations, but we might be able to get information on where the buildable land is. Or we could ask the travel agencies to provide us with their assumptions on transit stops and level of service for new routes.

To resolve definition issues:

- What is a "reasonable radius from transit stop"? The distance that people are willing to walk to and from a transit stop is typically between ¼ miles and ½ mile. People might be willing to walk further to get to an LRT stop than to a bus stop. This can be identified by literature review and from on-board surveys.
- What is an "acceptable transit service frequency"? For example, a maximum of 15-min headways during peak hours and 45-min headways during off-peak hours or a total of 30 services per day. This needs to be identified via literature review or via interviewing transit agencies.

### Estimation Method

- Distance to transit stop can be calculated through a spatial analysis of data on the locations of population and employment and data on the locations of transit stops.
- One uncertainty with this indicator is that the direct distance to a transit stop might be within the acceptable threshold, but the actual walking distance to get there might be much longer. For example, someone who is physically within ¼ mile from a transit stop might need to walk 2 miles to actually get to the stop, due to some natural or man-made barriers. Another uncertainty is related to assumptions on the location of the stops on new transit routes and their level of service.

## Data Sources and Estimation Method for Indicator "*Amount of Multi-Use Paths and Bike Boulevards*"

### Data Sources

- Potential data sources for current conditions include: the Oregon Bicycle and Pedestrian Plan; inventories of existing multi-use and bicycle facilities; bicycle and pedestrian LOS databases; and the street networks coded in travel demand models.
- Future conditions would be assessed directly from project data, as specified in the plans or bundles (e.g., additional mileage of multi-use paths and bike boulevards).

### Estimation Method

- The indicator would be estimated as the total mileage of multi-use paths and bike boulevards under various plans or bundles.
- Alternatively, the indicator could 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).
- The identification and selection of paths and boulevards within a given area, and the summation of mileage estimates, would be done within GIS.

## Data Sources and Estimation Method for Indicator "*Sidewalk Coverage*"

### Data Sources

- The availability of sidewalk coverage data may vary across geographies. Good data are found in many urban areas, but the indicator may be difficult to estimate accurately in rural Oregon. Sometimes, neighborhood organizations can be employed to gather this data for smaller cities.
- Potential data sources for current conditions include: the Oregon Bicycle and Pedestrian Plan; inventories of existing pedestrian facilities; bicycle and pedestrian LOS databases; and travel demand model street networks. As with the previous indicator, 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).

### Estimation Methods

- Sidewalk coverage may be defined in multiple ways. Thus, Portland Metro uses two related measures, estimated as follows:

*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.
- A related indicator is Average Sidewalk Width, estimated by considering all streets; including those with a sidewalk width equal to zero (a weighted average would be estimated, with sidewalk lengths used as weights).The indicator would be estimated within GIS.

## IDT Membership

The members of the Accessibility IDT are:

- Paul Thompson, Lane Council of Governments
- Rich Arnold, ODOT TPAU
- Bud Reiff, Portland Metro

An IDT conference call was held on January 18, 2012, to finalize the list of indicators and discuss estimation methodology and data sources. A second conference call was held on January 24, 2012, to further discuss estimation methodology and data sources.

Subsequent discussions were held between the Project Management Team and individual members of the IDT in March and April of 2012.

# Equity IDT Team:
# Specific Indicator Data Sources and Estimation Methods

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Date: April 09, 2012

## Introduction

The role of the Equity Indicator Development Team (IDT) is to develop the set of specific indicators for the Equity category of transportation system performance for the Oregon Least Cost Planning (LCP) project. This work includes developing a list of specific indicators and the estimation methods for evaluating them. This memorandum presents a refined list of specific indicators, documents the data that would be used, and lays out the steps involved in estimating the indicators for use in LCP.

This memo is the second for the Equity IDT. On November 18, 2011, the IDT submitted a memo that provided a draft list of specific indicators, and a brief overview of how the IDT would approach developing them. In response to this communication, the LCP core leadership team met throughout December to look across the nine categories of transportation system performance to ensure that the set of specific indicator was complete (addressing all key aspects of LCP), manageable, operational, and avoids duplication. The result of these discussions was a set of guidance back to the IDTs to reassess several indicators within their category, including questions about operationality and recommendations to eliminate specific indicators for reasons of duplication and manageability. This memo picks up from that set of guidance.

## Interpretation of the Term "Equity"

The Equity IDT adopted a relatively broad definition of equity. The team agreed that the Equity category should be looking at how the effects of a plan or bundle of actions are distributed across members of society.

The team discussed the framework laid out in a May 2011 presentation by UCLA Professor Brian Taylor. The presentation identifies three possible units of analysis (households or individuals;

population groups or interests; and geographic areas) and distinguishes between three types of equity relevant for transportation planning and decision-making:

- **Market equity** – where each household, group or jurisdiction receives transportation spending or benefits in proportion to their financial contribution (e.g., amount of taxes paid);

- **Opportunity equity** – where each household, group or jurisdiction receives an equal or proportionally equal share of total spending or benefits; and

- **Outcome equity** – where an attempt is made to equalize transportation services and capabilities (e.g., access to goods and services, mobility) across groups or jurisdictions.

The team felt that LCP should focus on Outcome and Opportunity equity, assessed across population groups.

The team discussed, at length, whether the distribution of benefits across geographic areas (with no reference to specific population groups) was a relevant equity concern for LCP. For example, should we consider indicators providing information on the distribution of effects across political jurisdiction boundaries? The team concluded that this was of secondary importance; and did not recommend any indicators for analysis strictly by geographic area.

The team also discussed the possibility of including **process-related indicators**; which would ask whether the needs of vulnerable population groups (as defined below) were identified and included in the transportation planning and decision-making process. The team recognizes the importance of process in achieving equity outcomes, but understands that LCP is best suited for the assessment of outcomes. Members of the team also felt that the degree of participation of vulnerable population groups may not vary significantly across plan alternatives/bundles of actions. The team concluded that this was an issue they would like to see documented in the LCP guidance, with recommendations on how to involve vulnerable groups early on in the planning process.

## Selection of Population Groups

The team decided to consider three population groups: **Income, Race/Ethnicity and Age**. The team also discussed Disabled and Language Barrier populations and decided not to include those at this time. The team agreed that the assessment of Disabled populations is important, but recognized that it would be difficult to include as one of the population groups due to data limitations (i.e., coarse level of detail in the Census or American Community Survey) and the need to prioritize indicators. The team also noted that there will be some overlap with disability and the other population groups proposed for assessment (Age and Income): they agreed that some nuances will be lost, but accepted the need for simplification (recognizing that at the plan level, a lot of details are generally lost). The group also recommended the consideration of disability for inclusion in future versions of the LCP tool if/when data availability and quality improves.

Where possible, benefits and costs should be distributed across, and reported for, all sub-groups (e.g., across all income quintiles or age groups) so that the benefits/impacts to different groups can be compared (e.g., the percentage of benefits accruing to low-income vs. high income groups). However, in presenting and weighting Equity results, the team felt that the focus should be on "vulnerable" groups. In other words, from an Equity perspective, plan alternatives/bundles of actions should be assessed primarily on the basis of their impacts on vulnerable groups, identified as:

- Low-income households;
- Racial and ethnic minorities; and
- Older adults and children.

The team further determined that the population groups of Race/Ethnicity and Income have higher priority than the population group of Age. They agreed that the income category would likely capture impacts to senior citizens on fixed incomes and/or low-income youth populations.

The team also agreed that Race/Ethnicity could be characterized as Minority vs. Non-Minority, rather than attempting to distribute each indicator across all known races in the study area.

## Refined Specific Indicators

The Equity IDT met to discuss this proposed guidance in January, February and March 2012, and this section documents its progress in developing a refined set of specific indicators. Table 1 provides a list of refined specific indicators that responds to the core leadership team's guidance. This table is and will continue to be a work in progress.

**Table 1: Refined Specific Indicators**

| General Indicator | Refined Specific Indicator(s) | Response to Leadership Team – Rationale, Thoughts, Concerns |
|---|---|---|
| Equity Analysis of Mobility Indicators | • Preferred: Distribution of transportation user benefits across population groups (age, race, and income)<br>• Alternate: Percent of all transportation user benefits in areas with high proportion of vulnerable population groups (e.g., low income areas, defined as areas where percent of households with income below Federal Poverty Level exceeds 1 standard deviation above mean) | • Transportation user benefits are changes in the mobility of users of the transportation system. They typically include changes in travel time, out-of-pocket costs (e.g., fuel consumption, tolls, fares), and reliability. Changes in travel costs (and travel volumes) are estimated relative to a "base case" or do-minimum scenario.<br>• User benefits may be reported as: total benefits over the period of analysis; average annual benefits; average annual benefits per household; or average benefits per trip.<br>• Estimation of preferred indicator would require assuming that the distribution of trips (and benefits) across population groups within a given area is the same as the distribution of the entire population living within the area.<br>• Both indicators would be based on current residential locations, for simplification. |
| Equity Analysis of Accessibility Indicators | • Preferred: Estimation of a Transportation Cost Index, in different geographic areas (e.g., urban vs. rural) and/or for different population groups (age, race, and income)<br>• Alternate: TBD (pending final revisions to the list of Accessibility indicators) | • The Equity team decided that none of the proposed Accessibility indicators cover all equity concerns and followed up with the Accessibility team to ask several questions.<br>• Options discussed include estimating the Percentage of population able to travel between work and home within 45 minutes, in different geographies (and indirectly for different groups); or percentage of population groups (by income, race, and age) with commuting time lower than 45 minutes, relative to entire population. The same would apply for the Percentage of population within a quarter mile of a transit stop served by at least X vehicles per day.<br>• If possible, the Equity team recommends the estimation of a Transportation Cost Index across different groups or geographies. The index measures relative changes in the generalized cost (including travel time and out-of-pocket costs) of accessing goods, services, and daily activities using various modes. The concept is analogous 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. |

| General Indicator | Refined Specific Indicator(s) | Response to Leadership Team – Rationale, Thoughts, Concerns |
|---|---|---|
| Equity Analysis of Environmental Stewardship Indicators | • Distribution of PM and PM Diesel emissions across population groups (age, race, and income), based on geographic distribution of emissions | • The geographic scale for analysis of this indicator remains to be determined (depends on data sources and availability).<br>• Another question is the area of impact of PM and PM Diesel emissions: How far from the source are the impacts appreciable?<br>  o For diesel PM, the general rule of thumb for transportation-related impacts is 500 m.<br>  o For PM2.5, the impacts would be broader since transportation is not the major source of those emissions. Essentially, it would be mixed with emissions from residential heating, backyard burning, etc. across a larger geographic area (larger than a census block, but smaller than a county). |
| Equity Analysis of Funding/Finance Indicators | • Preferred: Change in out-of-pocket transportation costs and housing costs measured across population groups (age, race, and income)<br>• Alternate: Change in out-of-pocket transportation costs (or subset of) measured across population groups (age, race, and income) | • The Equity team does not see measuring transportation revenues or costs across jurisdictional boundaries as a primary concern.<br>• The team discussed and concluded that the data was not available to measure the contribution of different population groups to the required revenues being proposed as part of a plan or action.<br>• In terms of the recommendation to measure changes in out-of-pocket costs, the team would like to include housing costs, to get a more complete picture of costs borne by households.<br>• Indicators may be reported as a change in costs, or as total costs as a percentage of household income. |
| Equity Analysis of Quality of Life Indicators | • Distribution of noise impacts across population groups (age, race, and income)<br>• Distribution of access to active modes across population groups (age, race, and income)<br>• Percentage change in traffic volumes passing through areas with a high proportion of vulnerable population groups (as a measure of community severance) | • The Equity team prefers to measure access to active modes rather than attempting to distribute changes in physical activity across population groups. This indicator could be moved under Accessibility, but likely fits best under Quality of Life, since that is really what it is trying to measure. More research is needed to define access to active modes.<br>• More research is needed to determine thresholds for noise impacts and severance impacts from changes in traffic volumes. The Equity team feels that both noise and severance are important to capture from an |

| General Indicator | Refined Specific Indicator(s) | Response to Leadership Team – Rationale, Thoughts, Concerns |
|---|---|---|
| | | equity perspective somewhere in the tool. |
| Equity Analysis of Land Use Indicators | • None at this time | • If the SWIM model can be used, there may be an ability to measure the distribution of changes in housing costs, which would be of interest to the Equity team (by itself, or in combination with out-of-pocket transportation costs as discussed under Equity Analysis of Funding/Finance Indicators). |
| Equity Analysis of Safety and Security Indicators | • Distribution of accident rates (fatalities and injuries) across population groups (age, race, and income)<br>• Distribution of access to emergency services (programs) and lifeline routes (facilities) across population groups (age, race, and income) | • The Equity team felt that two main areas were of interest from an equity perspective: Accidents/Injuries and Resiliency of the Network.<br>• If demographic data is not reported in conjunction with accident data, the team suggested considering a spatial overlay with areas with high concentrations of vulnerable populations<br>• The Equity team felt they need to know more about how the Safety & Security team is measuring "resiliency".<br>  o They stressed that we cannot assume that the vulnerable populations have access to cars/vehicles for evacuation purposes. The main purpose is to ensure that isolated populations without resources are not stranded in emergency situations.<br>• The team discussed Crime, but felt that the research on transportation system plan alternatives and crime outcomes was probably not conclusive enough to go further. The team also felt that crime is a lower priority than the other two indicators. |
| Equity Analysis of Economic Vitality Indicators | • Changes in the creation of long-term living wage jobs in areas with high concentrations of transportation disadvantaged populations.[1]<br>• Changes in access (travel time, reliability, modal availability, etc) to | • The Equity team agreed that, from an equity perspective, they are more concerned about long-term employment impacts, rather than the short-term effects of transportation spending.<br>• The team also discussed access to jobs vs. the creation of jobs and concluded that both are important from an equity perspective. The team agreed that access to jobs for low-income and minority populations is very important and |

[1] This indicator would focus on the distribution of jobs across different geographies and population groups. The efficiency gains associated with increasing the demand for labor (and employment) in areas of high structural unemployment would not be reported as an EQUITY outcome, but are considered for inclusion in the ECONOMIC VITALITY category.

| General Indicator | Refined Specific Indicator(s) | Response to Leadership Team – Rationale, Thoughts, Concerns |
|---|---|---|
| | employment across population groups. | merits a separate indicator under Economic Vitality (as it is not entirely captured under the Accessibility category).<br>• Definition of "living wage jobs" specific for OLCP:<br>o In Oregon, there is no official definition for a family wage: http://www.oregon.gov/PRISM/docs/family_and_living_wage_definitions.pdf?ga=t<br>o Business Oregon offers one definition for a family wage: the average pay per worker covered by the state's unemployment insurance system. This "average covered wage" is calculated down to the county level using data from the Oregon Employment Department.<br>o According to Wikipedia, living wage activists define living wage as the wage equivalent to the poverty line for a family of four http://en.wikipedia.org/wiki/Living_wage<br>o Further research will be needed to recommend a definition of "living wage job" for use in OLCP.<br>• The team defines transportation disadvantaged populations as low-income and/or minority populations.<br>• The team is unsure how to capture the potential negative (gentrification) impacts of revitalization: consider adding mitigation programs for gentrification in the OLCP program guide (value capture, rent control, etc)?<br>• The team is interested in looking at the impacts of DBE (MWBE) procurement requirements. However they are not sure it will be applicable at the plan level and request it be further researched. The team agreed there could be potential for innovative DBE contracting mechanisms to be included in the OLCP toolbox/program guide. The team agreed DBEs should focus on women and minority owned small-businesses. |

## Which indicators are the most important at addressing the objective(s) of the Equity category?

The team had initially determined that the four areas of greatest interest from an Equity perspective were Mobility, Accessibility, Environmental Stewardship, and Funding/Finance. However, as the discussion went along, other topics of interest emerged -- in particular with respect to Safety and Quality of Life. After identification and review of potential specific indicators in all categories, the following measures were determined to have the highest priority:

- **Access:** Estimation of a Transportation Cost Index, in different geographic areas (e.g., urban vs. rural) and/or for different population groups (age, race, and income);
- **Environmental:** Distribution of PM and PM Diesel emissions across population groups, based on the geographic distribution of emissions;
- **Quality of Life:** Distribution of access to active modes (transit, bike, and pedestrian) across population groups; and
- **Safety:** Distribution of accident rates (fatalities and injuries) across population groups.

## Issue of duplication or potential duplication between specific indicators either within the Equity category or with other categories

Due to the nature of the Equity category, there is no duplication issue with other categories. Under Equity, additional information on the effects of plan alternatives/ bundle of actions will be reported. Other categories look at the total impacts, benefits or costs of plan alternatives/ bundle of actions; the Equity indicators help assess how they are distributed.

There are a few duplication issues within the long list of Equity indicators presented in Table 1; for example:

- There is some overlap between the distribution of transportation user benefits across population groups and the estimation of a Transportation Cost Index for different groups or geographies.
- There is some overlap between changes in out-of-pocket costs (under FUNDING/FINANCE) and the distribution of transportation user benefits across population groups.

On the other hand, there is no duplication issue in the shorter, highest priority list of Equity indicators now recommended by the team for inclusion in the tool (Transportation Cost Index; PM and PM Diesel emissions; access to active modes; and distribution of accidents).

## Data Sources for Specific Indicators

To a large extent, estimation of the Equity indicators will rely on the data sources identified by the relevant IDTs.

In fact, the Equity team decided early on to use the indicators selected by the other teams as a starting point for their investigation of potential Equity indicators (where the other teams' indicators would simply be estimated across different groups and/or geographic units).

The additional data required for estimating the Equity measures would be sourced from the Census short form.

The American Community Survey (ACS) may be used for updates between decennial censuses -- as the surveys are done more frequently than on a decennial basis. The types of items typically associated with the Census short form (age, race and ethnicity, and income) are provided at a slightly higher geographic resolution (or at the same resolution but with very small sample sizes, making the data essentially useless). Roughly from largest to smaller, they include: state, county, metropolitan/micropolitan area, place, urban/rural, inside/outside metro and micro areas, school district, congressional district, public use micro data (PUMs) area, county subareas, and zip codes. Items such as the percent of people with disability and the language spoken at home are available at many of the same geographies, but are not available for county subareas or zip codes.

There are also good annual data coming from school districts, and ODOT is currently working with the state Environmental Justice Task Force regarding combining census and school district data.

## Approach to Estimating Specific Indicators

Equity indicators may be expressed as single-value indicators or distributional matrices. A distributional matrix separates the measure of interest (e.g., transportation user benefits, noise impacts, emissions of air pollutants) of different plans or bundles of actions (in column) by population group or region (in row). The table below is an example of a distributional matrix:

| | Plan #1 | | Plan #2 | | Plan #3 | |
|---|---|---|---|---|---|---|
| | $ Benefits | % Total | $ Benefits | % Total | $ Benefits | % Total |
| Group A | | | | | | |
| Group B | | | | | | |
| Group C | | | | | | |
| … | | | | | | |
| TOTAL | | | | | | |

Approaches to distributing effects by geographic area and by population group are described briefly below.

### Distribution of Effects by Geographic Area

- Derived from travel demand model data, 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. An alternative would be to consider where savings are projected to occur (e.g., based on project location).

- Estimation would involve summing-up benefits or effects across all destinations (origins) of trips originating (ending) in the area. This could be done within the travel demand model, or outside the model with output data organized in trip tables.

### Distribution of Effects by Population Group

- Derived from travel demand model data, supplemented with Census data as needed.
- There are three possible approaches:

1. **Distribution of Effects across all Population Groups based on Information in Travel Demand Models**: The travel demand model used in LCP may include a break-down of users by population group, in particular income. If this is the case, the distribution of user benefits and other effects (e.g., emissions, noise) may be estimated directly within the model, or from model output data.
2. **Distribution of Effects across all Population Groups based on Census Data on the Geographic Distribution of Households**: Benefits or other effects are first distributed by geography (e.g., TAZ); Census data on the distribution of households by group within each zone are used to distribute total benefits/effects within the zone across groups -- assuming that the distribution of benefits/effects is proportional to the distribution of households. This may be an over-simplification and where additional factors can be used to increase the accuracy of the distribution, they should be used.[2] Benefits or effects in each group are then summed-up across all zones within the study area.
3. **Estimation of Effects on Vulnerable Population Groups based on Census Data on the Geographic Distribution of Households**: Instead of deriving a distribution of benefits or effects across all population groups, we could focus on a single group (e.g., households below the Federal Poverty Level; defined at http://www.ocpp.org/poverty/, or a multiple of that level) and use the following method:
    - Benefits would be calculated for geographic areas where population in the target, vulnerable category as a percentage of total population exceeds *k* standard deviation(s) above the mean (*k* to be defined).
    - For each area, the share of vulnerable population in total population would be based on current residential locations, from the ACS.
    - The resulting indicators would then be something like: *Percent of all user benefits or effects occurring in "low-income" areas*
    - This is the method used by PSRC in Transportation 2040 (Appendix D Policy Analysis and Evaluation Criteria Report, February 2010).

## Reporting of Equity Indicators

[2] The team's concern, for example, is that just because 10% of the population in a geographic area is low-income doesn't mean that 10% of the benefits will be distributed to them accordingly (i.e., there may be other factors that intervene).

As mentioned above, the Equity indicators may be expressed -- and reported -- as distributional matrices or single values (e.g., Percent of all user benefits in "low-income" areas).

The use of maps, showing the geographic distribution of effects in relation to the location of different population groups, may also be helpful.

However, the team felt that a summary table similar to that used in the UK D*f*T's social and distributional impacts analysis would be preferable.

| | DISTRIBUTIONAL IMPACTS | | | | | SOCIAL IMPACTS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Income Groups (Income Domain) | | | | | User Groups | | | Social Groups | | | | | | |
| | Most Deprived ← → Least Deprived | | | | | | | | | | | | | | |
| | 0 – 20% | 20 – 40% | 40 – 60% | 60 – 80% | 80 - 100% | Pedes-trians | Cyclists | Motor-cyclists | Children and Young People | Young Men | Older People | Carers | Women | People with Disa-bilities | Black and Minority Ethnic |
| *Improve connectivity* and *Improve access to leisure* | ✓ | ✓✓ | ✓✓ | ✓✓ | ✓✓✓ | | | | | | | | | | |
| *Reduce exposure to noise* | XXX | ✓ | ✓✓✓ | ✓✓ | ✓✓✓ | | | | X | | | | | | |
| *Reduce air quality health costs* | ✓✓✓ | ✓✓✓ | ✓ | XXX | ✓ | | | | ✓✓ | | | | | | |
| *Reduce risk of death & injury* | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓✓ | | | | |
| *Reduce crime* | | | | | | | | | ✓✓ | | ✓ | | ✓✓ | | |
| *Reduce severance* | | | | | | | | | X | | XX | | | Xx | |
| *Improve accessibility* | | | | | | | | | ✓ | | ✓✓✓ | ✓ | ✓ | ✓✓✓ | |
| *Improve affordability* | XX | X | XX | ✓ | ✓✓ | | | | | | | | | | |

**Key to impacts:**

| | |
|---|---|
| ✓✓✓ | = Large Ben. |
| ✓✓ | = Mod. Ben. |
| ✓ | = Slight Ben. |
| X | = Slight Adv. |
| XX | = Mod. Adv. |
| XXX | = Large Adv. |

Source: DfT, *Detailed Guidance on Social and Distributional Impacts of Transport Interventions*, TAG Unit 3.17, IN DRAFT, January 2010, page 30

## Incorporation of Equity Indicators into MODA

This issue was discussed during the final meeting of the Equity team. An overview of the potential options reviewed is provided below, followed by the team's final recommendations.

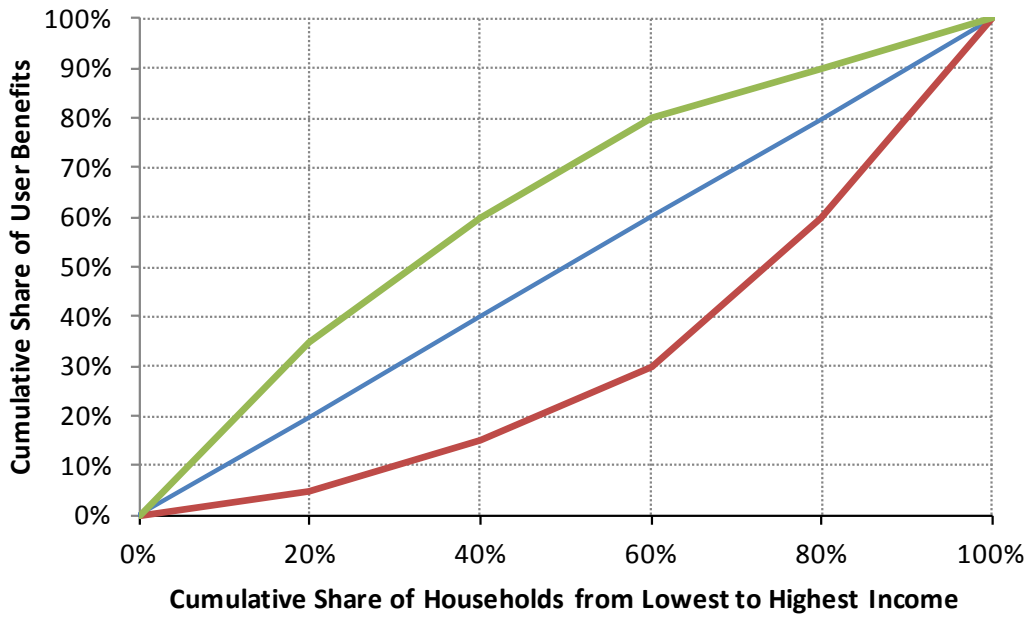
### Options Reviewed

Single value indicators (like the Percent of all user benefits in "low-income" or other target areas) could be added into MODA.

Multiple-value indicators (like the distribution of user benefits across income quintiles) could be synthesized into summary measures of dispersion (similar, in concept, to the GINI Coefficient), which could then be weighted into MODA. An example of a calculation of a dispersion measure is provided in the table and figure below. These are for illustration only.

| **Income Quintiles** | **Cumulative Share of Households from Lowest to Highest Income** | **Cumulative Share of Transportation User Benefits** | | |
|---|---|---|---|---|
| | | **Each Group Receives Equal Share of Benefits** *(diagonal)* | **Low-Income Receive Lower Share of Benefits** *(below diagonal)* | **Low-Income Receive Higher Share of Benefits** *(above diagonal)* |

| Income Quintiles | Cumulative Share of Households from Lowest to Highest Income | Cumulative Share of Transportation User Benefits | | |
|---|---|---|---|---|
| | | Each Group Receives Equal Share of Benefits *(diagonal)* | Low-Income Receive Lower Share of Benefits *(below diagonal)* | Low-Income Receive Higher Share of Benefits *(above diagonal)* |
| [$0 - $20,450[ | 20% | 20% | 5% | 35% |
| [$20,450 - $38,550[ | 40% | 40% | 15% | 60% |
| [$38,550 - $61,800[ | 60% | 60% | 30% | 80% |
| [$61,800 - $100,000[ | 80% | 80% | 60% | 90% |
| [$100,000 - …. [ | 100% | 100% | 100% | 100% |
| **COEFFICIENT** | | **0.00** | **-0.36** | **0.26** |




A third option would be to follow the UK D*f*T's approach and use a textual scale of impacts (from Largely Adverse to Largely Beneficial), develop a point system associated with the scale (e.g., Largely Adverse = - 5; Largely Beneficial = +5), and populate the scale across different target groups (e.g., low income, elderly, ethnic minorities).

The resulting "scores" could be included and weighted under MODA. The rating of different plans or bundles of actions could be based on the distributional matrices or single value indicators described in this document.

In addition, including Equity indicators into MODA would require defining a socially preferred set of equity outcomes, and defining weights that reflect these preferences. For example, do Oregonians want user benefits to be distributed equally across all income groups, or do they feel transportation policy should distribute more benefits to the poor and other vulnerable groups? Or do they feel that users should receive benefits in proportion to their contribution as taxpayers?

### Team Recommendations

The team agreed that they would like to roll-up the indicators into MODA so that jurisdictions need to weight equity and there is some transparency in how jurisdictions considered equity in the decision-making process. The team felt that simply reporting the Equity indicators, without including them in MODA, would make it easier for equity considerations to be left out of the final decision-making process.

On the issue of weighting Equity indicators in MODA (for example, should bundles of actions that focus more on outcome or opportunity equity be weighted more heavily in MODA?), the team recommended that OLCP users and communities be allowed to select their own weights. However, the team recommended including a discussion in the OLCP guidance document about what weighting the different kinds of Equity measures means; specifically the value of giving more weight to plans that distribute more benefits to vulnerable population groups (in terms of helping to correct historical inequalities).

## IDT Membership

The Equity IDT members met nine times by teleconference (Jan 20th, Feb 6th, Feb 9th, Feb 13th, Feb 21st, Feb 24th, Feb 29th, Mar 14th and Mar 21st) to discuss and refine the proposed specific indicators described in this memo. There were no changes in IDT membership during this time.

# Land Use IDT Team:
# Specific Indicator Data Sources and Estimation Methods

To: Kevin Murphy, CH2M HILL
Kate Lyman, CH2M HILL
Theresa Carr, CH2M HILL
Stéphane Gros, HDR

From: Sam Seskin, CH2MHILL

Date: *March 13, 2012*

## Introduction

The role of the Land Use Indicator Development Team (IDT) is to develop the set of specific indicators for the Land Use category of transportation system performance for the Oregon Least Cost Planning (LCP) project. This work includes developing a list of specific indicators and the estimation methods for evaluating them. This memorandum presents a refined list of specific indicators, documents the data that would be used, and lays out the steps involved in estimating the indicators for use in LCP.

This memo is the final for the Land Use IDT. On November 16, 2011, the IDT submitted a memo that provided a draft list of specific indicators, and a brief overview of how the IDT would approach developing them. In response to this communication, the LCP core leadership team met throughout December to look across the nine categories of transportation system performance to ensure that the set of specific indicators was complete (addressing all key aspects of LCP), manageable, operational, and avoids duplication. The result of these discussions was a set of guidance back to the IDTs to reassess several indicators within their category, including questions about operationality and recommendations to eliminate specific indicators for reasons of duplication and manageability. A second memo, dated February 2, 2012 picked up from that set of guidance. This final memo contains final recommendations which also address the induced land use effects of transportation plans and programmed investments.

## Refined Specific Indicators

Table 1 provides a list of refined specific indicators that responds to the core leadership team's guidance.

**Table 1: Refined Specific Indicators**

| General Indicator | Refined Specific Indicator(s) | Response to Leadership Team – Rationale, Thoughts, Concerns |
|---|---|---|
| *Amount and nature of land developed* | | *Removed General Indicator* |
| *Population and Employment* | *Population change and distribution*<br><br>*Employment change and distribution* | *Changed General Indicator by deleting reference to "density". Population and employment change provides insight into how future settlement patterns will change in response to implementation of the bundles of actions in a transportation plan. They do not by themselves indicate a positive or negative benefit and therefore are used for reporting purposes, neither monetized nor used in MODA. Would involve use of a land use forecasting model where available.* |
| *Land Value* | *Relative land value change from base year or no action. .* | *New measure added in part to replace Amount and Nature of Land Developed. Reported indicator, neither monetized nor used in MODA. Would involve use of a land use forecasting model where available.* |

- Population and employment changes or distributions are generally easy to understand, and easier to understand than measures of density. Reporting would be performed by maps displaying the change by geography, likely by traffic analysis zone (TAZ).Population and employment changes may affect other outcomes measured by other teams, such as the travel time indicator proposed by the Mobility Team. Thus we recommend them as a "report only" indicator.
- Land value may potentially be duplicative with travel time and costs, since land value changes are largely the capitalization of the future stream of travel benefits. This is mitigated by reporting land value changes and not including land value as a monetized or MODA indicator.

## Data Sources for Specific Indicators

### Population and Employment

Population and employment information is readily available as part of system planning processes in Oregon. Base year information can be obtained from either the Census Bureau or inputs to the travel demand model for both base and future year analysis. Because of the link to travel demand models the scale of population and employment numbers are at the TAZ level and are easily scalable and aggregated to other geographies of interest. The estimation method is described below.

### Land Value

Land value data exists frequently in GIS form by parcel, and it may be sorted or aggregated by land use type. However, the data for estimates of future land value would most likely rely upon the information within an integrated land use model (see below).

## Estimation Methods for Specific Indicators

### Population and Employment Density

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

> *Change in population for defined geography (TAZ) = future year population less base year population.*
>
> *Change in employment for defined geography (TAZ) = future year employment less base year employment.*

The values are mapped by the geography used in the calculation (TAZ) and shown either by year or in the form of a map showing change between base and future forecast year.

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 transport supply. The Oregon Statewide model (SWIM) does have the ability to estimate these variables, as does an integrated model available in the Portland region. These models have the ability to assess the transportation system effect on land value and would require the bundle of transportation system changes be analyzed in an iterative fashion over a set of forecast years. However, outside of the Portland region the State zone structure may be too coarse for sub state use. Further, the changes in many study areas may be too small to predict usefully with the statewide model. Therefore the indicator may, in most situations, be estimated by qualitative means such as expert panels. Mosaic's user Guide will furnish information on several techniques to inform this qualitative assessment.

### Land Value

Estimating changes in land value requires the use of SWIM 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 would be reported on a relative scale and measure the delta between a base year and forecast year or between two or more transport system scenarios/alternatives in a forecast year. The forecast year would match the analysis year used in the transport modeling. Suggested formula would be:

> *Change in Land Value for defined geography (TAZ) = future year land value(TAZ)/base year land value(TAZ).*

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

## IDT Membership

The Land Use IDT held a conference call to discuss the specific indicators and provide general direction to preparing the estimation methods. The composition of the Land Use IDT remains the same in January 2012 as it did in November 2011.

# Environmental Stewardship IDT Team: Specific Indicator Data Sources and Estimation Methods

To: Sam Seskin, CH2M HILL
Theresa Carr, CH2M HILL
Stephane Gros, HDR

From: Chris Behr, HDR
James Gregory, HDR

Date: 2/21/12

## Introduction

The role of the Environmental Stewardship Indicator Development Team (IDT) is to develop the set of specific indicators for the Environmental Stewardship category of transportation system performance for the Oregon Least Cost Planning (LCP) project. This work includes developing a list of specific indicators and the estimation methods for evaluating them. This memorandum presents a refined list of specific indicators, documents the data that would be used, and lays out the steps involved in estimating the indicators for use in LCP.

This memo is the second for the Environmental Stewardship IDT. On November 18, 2011 the IDT submitted a memo that provided a draft list of specific indicators, and a brief overview of how the IDT would approach developing them. In response to this communication, the LCP core leadership team met throughout December to look across the nine categories of transportation system performance to ensure that the set of specific indicator was complete (addressing all key aspects of LCP), manageable, operational, and avoids duplication. The result of these discussions was a set of guidance back to the IDTs to reassess several indicators within their category, including questions about operationality and recommendations to eliminate specific indicators for reasons of duplication and manageability. This memo picks up from that set of guidance.

## Refined Specific Indicators

The Environmental Stewardship IDT met to discuss this proposed guidance in January and February 2012, and this section documents its progress in listing a refined set of specific indicators. Table 1 provides a list of refined specific indicators that responds to the core leadership team's guidance. This table is and will continue to be a work in progress and may be revised as the Environmental Stewardship IDT members work to further develop the specific indicators.

**Table 1: Refined Specific Indicators**

| General Indicator | Refined Specific Indicator(s) | Response to Leadership Team – Rationale, Thoughts, Concerns |
|---|---|---|
| Air | • Criteria Air Contaminants (CAC)<br>• MSAT: Benzene<br>• Non-MSAT: Diesel PM<br>• Reporting only: Air Quality Non-Attainment Status | The leadership team thought these specific indicators were good and should be kept. Our IDT further clarified the selection of MSAT and Non-MSAT indicators, Benzene and Diesel PM, because they are representative of others in their respective categories. Lastly, an air quality nonattainment status should be a reported indicator because it may influence how the plan in LCP could impact regulatory guidelines, but not in a prescriptive process. |
| Energy | Lifecycle GHG emissions (capital, operations) | The leadership team suggested that we focus on GHG emissions from consumption, as originally proposed. Through further discussion, the indicator was modified to account for *lifecycle GHG emissions* – a "Well to Wheels" measure. |
| The indicators below are being merged into one specific indicator titled "resources at risk" which would be a composite index of the below factors | | |
| Ecological Resources | Potential Impacts to Threatened and Endangered (T&E) Species | Subsequent to the workshop, an indicator was developed to assess potential impacts to T&E species. These impacts are based on a geographic overlap of a plan and T&E species habitat area. The potential severity is captured by weighting endangered species habitat. |
| Water Resources | • Potential Impacts to Surface Waters<br>• Potential Impacts to Wetlands | Subsequent to the workshop, two indicators were developed on water resources: 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. |
| *Additional:* Hazardous Materials | Risk of Hazardous Material in Project Footprint | This additional indicator is intended to capture the risk of finding hazardous material within the plan footprint. The evaluation of the indicator would rely on local knowledge and any available land use studies. |
| *Additional:* Parks / Public Areas | Potential for Public Parks in Project Footprint | This additional indicator is intended to capture the risk of crossing a Local, State or National Park with special significance. This indicator would be based on the number of acres overlapped by the plan. |

- The general indicators of this category reflect different aspects of the environmental conditions and prioritizing among them has not been considered. Even within a general indicator a priority has not been discussed. For example, the *Air* general indicator includes

several specific indicators, all of which are included (and equally prioritized) because they all reflect potential impacts on human health. CACs differ from MSAT/Non-MSATs because evidence is available for monetizing CACs. MSAT/Non-MSATs would be measured in physical units relative to a State standard. MSATs/Non-MSATs are included because they are emerging health concerns and as such, can be included as a MODA indicator.

- This memo also discusses a series of indicators that are all associated with the location of a project's footprint. Assuming that the projects' locations are known, the impacts would be measured by the physical overlaps with: (a) threatened or endangered species habitat; (b) wetlands, of varying types; (c) surface waters; (d) sites with potentially hazardous materials; and (e) significant Local, State or National Parks. In general, because the types of impacts from the plan (or whether impacts would actually occur) would not be precisely known, these indicators serve only to provide planners with a greater awareness of potential complexities. In particular, it is recognized that any significant location overlaps could suggest higher mitigation costs may incurred. It is expected that some Plans may not have any impacts in these categories. They are included as potential indicators in case a Plan should account for these types of effects.
- Specific indicators are not directly overlapping with other categories. There could be a relationship between air quality measures and Quality of Life IDT but we have attempted to isolate the valuation of these impacts in our separate categories. It is important to note that the key drivers of the Environmental Stewardship indicators are the VMT by vehicle type and the location of the project, relative to local environmental resources (e.g. land, water and species impacts) and neighborhoods (e.g. air contamination in an environmental justice context).

## Air: Criteria Air Contaminants (CAC); Non-Attainment Status

### Data Sources for Specific Indicators

1. *What data exist today that addresses the specific indicator? What is the data source? Is it publicly available? What is the range of accuracy?*

   CACs refer to six pollutant compounds: nitrogen oxides (NOx), Sulfur dioxide (SO2), particulate matter (PM), Ozone, Carbon monoxide (CO), and Lead. An additional indicator, volatile organic compounds (VOCs), although not defined by USEPA as a CAC, will also be considered in this group because it is regulated and has 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. USEPA'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. This is a publicly available model that can be implemented by ODOT or ODEQ.

2. *Do data rely on a travel demand model? If so, what geographies have these data in their model?*

   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.

   An additional consideration for LCP is a further breakdown of passenger vehicles by a fleet mix forecast developed through Oregon's GreenSTEP model. The GreenSTEP 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 is a result from analyses of options for achieving carbon emission reduction goals by 2050.

   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 kwh of electricity produced and CAC emissions from power plants for recharging vehicle batteries. This data however is available from GreenSTEP and could be provided to LCP as a look-up table.

3. *What is the scale of the data source? Meaning, are the data different for different geographies within Oregon? How easy or difficult is it to modify this data source's application to different geographies?*

   MOVES is a national database and includes emissions differentiation at the State and County level. MOVES is a very flexible tool and ODOT or ODEQ analysts can readily produce the necessary data for use in LCP.

Emission rates in tons / VMT will be computed for each county by ODEQ. ODEQ and GreenSTEP developers would also coordinate on any associated updates to their forecasts of fleet mix, emissions rates, and other data tables.

4. *Does your source rely on any primary data collection? If so, is this typically conducted for a system-level planning effort?*

   No new primary data is required. The only primary data includes VMT which is produced from the travel demand models. Emissions rates are produced from MOVES. Other data tables (e.g. fleet mix forecast) would be obtained from the GreenSTEP model.

   An additional indicator that is recommended for reporting is a county's status with respect to non-attainment of air quality standards, especially for Ozone and PM2.5. These indicators are not proposed for weighting in MODA, but instead proposed for reporting because several counties are currently in, or risk facing, a non-attainment status. This indicator could enable users to consider long-range implications of transportation plans with respect to their air quality status.

5. *From your perspective, is Oregon on the verge of being able to take advantage of any groundbreaking or innovative research in the subject area of this indicator? What is the timeframe, and can anything be used this year (2012)?*

   CAC indicators of pollution are fairly standard in evaluations of transportation impacts. They are also frequently monetized impacts. Monetary value is based on human health and welfare effects. The data sources for monetary values in $/ton comes from recent USDOT TIGER application guidance that cites USEPA documents.

   What is potentially innovative is the introduction of the GreeenSTEP 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 LCP as an optional scenario to compare with the more conventional fleet emission rate forecast in MOVES.

### Estimation Methods for Specific Indicators

1. *State in simple terms (words or a simple formula) the basics of the model involved in developing each specific indicator. What are the relationships between the variables being used?*

   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. An average speed would be assumed in these forecasts. It is assumed that ODEQ would periodically produce these results from MOVES for each county in the State for use in the LCP tool. The units produced by MOVES would be converted to long or metric tons per VMT to be monetized.

2. *How are these steps different if the geography of LCP's use is changed (for example, if LCP was used at a county scale as opposed to a metropolitan region scale)*

   These steps would not be dramatically different if the geographical scale changes. 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 pro-rate the county-level emissions data in some way.

The CAC indicator PM can have environmental justice implications for emissions in urban areas. In such cases, it would be important to identify the areas with the highest densities of lower income residences, at say the census block, and quantify total emissions and associated costs in these areas.

3. *What is the range of uncertainty involved in this specific indicator? How will you address this uncertainty? What are the risks associated with this uncertainty?*

   MOVES produces best estimates of emission rates for each pollutant. There are methods to assess the uncertainty in these rates through successive runs of MOVES but this would be time-consuming and would be unlikely to yield decision-critical information. Uncertainty in VMT may be sufficient to generate reasonable ranges in the uncertainties in total emissions (where total emissions = emissions per VMT * VMT).

4. *What is the range of uncertainty involved in the category when taken as a whole? What are some considerations around uncertainty when all the specific indicators in your category are aggregated, and assessed with the other categories? What should we be watching out for?*

   Uncertainty will primarily be a function of VMT, not the emissions rates from MOVES.

5. *Is this indicator suitable for monetization in a BCA context?*

   Yes. The costs of CAC emissions are frequently incorporated into BCA 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. Suitable values for monetization in Oregon could be derived from US DOT guidance that references an USEPA study called: *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)".[1]

| **Emission Type** | **$ / long ton ($2007)** | **$ / metric ton ($2007)** |
|---|---|---|
| Volatile Organic Compounds (VOCs) | $1,300 | $1,280 |
| Nitrogen oxides (NOx) | $5,300 | $5,217 |
| Particulate matter (PM) | $290,000 | $285,469 |
| Sulfur dioxide (SOx) | $31,000 | $30,516 |

[1] The report is found here: http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/CAFE_2012-2016_FRIA_04012010.pdf.

## Air: MSAT (Benzene) and Non-MSAT (Diesel PM)

### Data Sources for Specific Indicators

1. *What data exist today that addresses the specific indicator? What is the data source? Is it publicly available? What is the range of accuracy?*

   MSATs and Non-MSATs represent an emerging concern among air pollutants that have an adverse effect on humans – particularly as cancer causing chemicals. Emission levels are not regulated but State air toxic benchmarks have been established. In fact, 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.

   For LCP, two chemicals, benzene and diesel PM, have been selected to represent risks from other MSATs and Non-MSATs, respectively. Benzene and diesel PM are two of USEPA's six priority MSATs. The other four are acrolein, formaldehyde, 1,3-butadiene, and acetaldehyde. These six are subsumed within a much larger group of 188 air toxics identified in the Clean Air Act and a subset of 21 on which USEPA has issued regulations in Control of Emissions of Hazardous Air Pollutants from Mobile Sources (66 Final Rules (FR) 17235).

   Benzene is a known human carcinogen, and 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.

   Emission rates of benzene and diesel PM in tons / VMT (by vehicle type) are produced by the USEPA MOVES model. These emission rates would be combined with VMT by vehicle type from the travel demand model to produce total MSAT / Non-MSAT emissions. For each pollutant, the indicator is computed as a percentage increase or decrease in emissions from a plan alternative relative to State benchmarks.

2. *Do data rely on a travel demand model? If so, what geographies have these data in their model?*

   Total tons of benzene and diesel PM emissions 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. Also, as discussed in the CAC section, emissions for benzene and diesel PM would developed for passenger vehicle fleet mix forecasts that are consistent with GreenSTEP model. This includes county-level emissions estimates from electricity power plants.

3. *What is the scale of the data source? Meaning, are the data different for different geographies within Oregon? How easy or difficult is it to modify this data source's application to different geographies?*

   MOVES is a national database and includes emissions differentiation at the State and County level. MOVES is a very flexible tool and ODOT or ODEQ analysts can readily produce the necessary data. They will coordinate with GreenSTEP modelers for other data tables.

4. *Does your source rely on any primary data collection? If so, is this typically conducted for a system-level planning effort?*

   No new primary data is required. The only primary data includes VMT, which is produced from the travel demand models and used for a number of indicators in LCP. MSAT / Non-MSAT emissions rates are produced from MOVES. Other data would come from GreenSTEP.

5. *From your perspective, is Oregon on the verge of being able to take advantage of any groundbreaking or innovative research in the subject area of this indicator? What is the timeframe, and can anything be used this year (2012)?*

   Despite some uncertainties in directly tracing mobile sources of benzene and diesel PM with an increased incidence of cancer, the concerns about these pollutants are significant enough to be included in some NEPA processes. It would be innovative for Oregon to include these pollutants as part of a planning-level decision making process. Comments from the IDT team indicated that stakeholders are increasingly looking at MSATs and non-MSATs in NEPA processes. Accordingly, considering such impacts prior to NEPA can shed light on issues that could come up later.

### Estimation Methods for Specific Indicators

1. *State in simple terms (words or a simple formula) the basics of the model involved in developing each specific indicator. What are the relationships between the variables being used?*

   The calculation process for MSAT / Non-MSATs is similar to CACs in that MOVES produces forecasts of emission rates for benzene and diesel PM given a set of specific vehicles types, fuel types and county-level locations. An average vehicle speed would be assumed in these forecasts. The passenger vehicle fleet mix forecasts would be obtained from the GreenSTEP model. It is assumed that ODEQ would periodically produce these results from MOVES for each county in the State for use in the LCP tool.

   The final indicator would be physical measure of pollution that is computed from the change in total emissions for benzene and diesel PM relative to State benchmarks at the county level. The resulting ratios would indicate the degree to which the associated transportation plan contributes to benzene and diesel PM relative to the standard.

2. *How are these steps different if the geography of LCP's use is changed (for example, if LCP was used at a county scale as opposed to a metropolitan region scale)*

Analytical steps to produce total benzene and diesel PM emissions would not be dramatically different if the geographical scale changes. For study areas that are smaller or larger than a county level, the same weighted average procedure that is outline above for CAC emissions would apply to benzene and diesel PM.

Similar to the CAC PM indicator, diesel PM would also have environmental justice implications and be computed at a census block level.

3. *What is the range of uncertainty involved in this specific indicator? How will you address this uncertainty? What are the risks associated with this uncertainty?*

   MOVES produces the best available estimates of emission rates for each pollutant. As with CACs, the uncertainty in VMT would be used to generate reasonable ranges in the uncertainties in total emissions.

   It is recognized that the quantification of diesel PM in ambient air and the assessment of cancer risk has significant uncertainties. Exposure to diesel PM is presumed by both federal and state officials to result in excess cancer risk. Yet, researchers have not finalized how best represent the risk from diesel PM exposure. In addition, diesel PM emissions appear to be decreasing over time as older, dirtier vehicles are replaced with newer ones using cleaner fuels. The USEPA has not established a unit risk factor that indicates the severity of exposure to the pollutant but it is generally believed to be larger than other pollutants.

4. *What is the range of uncertainty involved in the category when taken as a whole? What are some considerations around uncertainty when all the specific indicators in your category are aggregated, and assessed with the other categories? What should we be watching out for?*

   Similar to CAC, uncertainty is a function of VMT not the emissions rates per VMT.

5. *Is this indicator suitable for monetization in a BCA context?*

   No. Monetization factors for MSAT and Non-MSAT pollutants are not sufficiently established in the economic literature. These indicators should remain as physical measures of impact relative to State benchmarks.

## Energy/Fuel: Lifecycle CO2

### Data Sources for Specific Indicators

1. *What data exist today that addresses the specific indicator? What is the data source? Is it publicly available? What is the range of accuracy?*

   Several chemical compounds associated with greenhouse gases, carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), are emitted from vehicles. While GHG emissions rates can be produced using MOVES, consistency with other Oregon initiatives is ensured by adopting the State's lifecycle GHG emission rates from fuel consumption and production. This measure is referred to as the *carbon intensity* of fuels. It is a "well-to-wheel" measure that includes emissions from refining and transporting fuels. The data on lifecycle emissions are Oregon-specific values that have been developed by ODEQ and ODOE. Data on lifecycle GHG emissions can be directly obtained from the GreenSTEP model.

2. *Do data rely on a travel demand model? If so, what geographies have these data in their model?*

   Yes. Total tons of emissions for lifecycle GHG are computed as a product of VMT by vehicle type (obtained from the travel demand model) and emissions rates in tons per VMT. GreenSTEP data would provide the lifecycle GHG emission rates per vehicle type (including passenger vehicle fleet mix forecasts).

3. *What is the scale of the data source? Meaning, are the data different for different geographies within Oregon? How easy or difficult is it to modify this data source's application to different geographies?*

   GreenSTEP data on lifecycle GHG emission rates per vehicle type and passenger vehicle fleet mix forecasts would be available at the county level. Since GHG impacts do not impact communities at a local level, a county-level analysis is sufficient.

4. *Does your source rely on any primary data collection? If so, is this typically conducted for a system-level planning effort?*

   No new primary data is required. The only primary data includes VMT, which is produced from the travel demand models. Lifecycle GHG emission rates would come from GreenSTEP.

5. *From your perspective, is Oregon on the verge of being able to take advantage of any groundbreaking or innovative research in the subject area of this indicator? What is the timeframe, and can anything be used this year (2012)?*

   Accounting for *lifecycle* GHG emissions would be an innovative departure from common practice (e.g. MOVES model results) that only includes emissions from fuel consumption. This indicator would be consistent with Oregon's carbon intensity reduction goal.

## Estimation Methods for Specific Indicators

1. *State in simple terms (words or a simple formula) the basics of the model involved in developing each specific indicator. What are the relationships between the variables being used?*

   Total GHG emissions from passenger vehicles would be computed at the county level using GreenSTEP data on 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 inline with the State's carbon intensity goals, would also come from GreenSTEP. Lifecycle GHG emission rates for trucks would also be obtained from GreenSTEP model. 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.

2. *How are these steps different if the geography of LCP's use is changed (for example, if LCP was used at a county scale as opposed to a metropolitan region scale)*

   A county-level analysis is sufficient because GHG impacts are felt at a much larger scale.

3. *What is the range of uncertainty involved in this specific indicator? How will you address this uncertainty? What are the risks associated with this uncertainty?>*

   A number of calculations in estimating lifecycle GHG emissions have uncertainty. Uncertainty is most readily captured through uncertainty in VMT. If ODOE and ODEQ can provide variability on the lifecycle GHG emissions factors, these could also be included.

4. *What is the range of uncertainty involved in the category when taken as a whole? What are some considerations around uncertainty when all the specific indicators in your category are aggregated, and assessed with the other categories? What should we be watching out for?*

   Uncertainty will be a function of VMT not the emissions rates per VMT.

5. *Is this indicator suitable for monetization in a BCA context?*

   Yes. 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 USDOT guidance that references an Interagency Working Group on Social Cost of Carbon document called Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 (February 2010).[2]

[2] *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)" http://www.epa.gov/oms/climate/regulations/scc-tsd.pdf

# Ecological Resources: Potential Impacts to Threatened and Endangered (T&E) Species

## Data Sources for Specific Indicators

1. *What data exist today that address the specific indicator? What is the data source? Is it publicly available? What is the range of accuracy?*

   This indicator determines if a project could cause impacts to threatened or endangered (T&E) species. The potential impacts would be assessed if the footprint of a plan alternative overlaps with known T&E habitat. It is assumed that the footprint could 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;
   - *NWR Critical Habitat Mapper:* shows mapped critical habitat for listed species[3]; and,
   - *Oregon Natural Heritage Information Center (ORHNIC):* provides information on the geographic location of records of threatened or endangered species. ORNHIC records are not mapped, but location information (township/range) is provided and can be integrated into a mapping or GIS environment.

   In all cases, data should be accessed by qualified ODOT staff.

2. *Do data rely on a travel demand model? If so, what geographies have these data in their model?*

   No. This indicator requires that plan alternatives have a geographical description.

3. *What is the scale of the data source? Meaning, are the data different for different geographies within Oregon? How easy or difficult is it to modify this data source's application to different geographies?*

   These data sources provide a consistent level of coverage and detail across the State.

4. *Does your source rely on any primary data collection? If so, is this typically conducted for a system-level planning effort?*

   No, the data sources use existing geographical data sets.

5. *From your perspective, is Oregon on the verge of being able to take advantage of any groundbreaking or innovative research in the subject area of this indicator? What is the timeframe, and can anything be used this year (2012)?*

   No, these data sets are used for a variety of purposes including NEPA assessments. In fact, because these data may be used for NEPA assessments, their use at a planning stage could provide continuity.

[3] Information sources: http://map.streamnet.org/website/bluesnetmapper/viewer.htm

## Estimation Methods for Specific Indicators

1. *State in simple terms (words or a simple formula) the basics of the model involved in developing each specific indicator. What are the relationships between the variables being used?*

   For this indicator, plan alternatives would be compared to data and/or maps to determine the amount of overlap (in acres) of identified habitat of T&E species potentially affected by the alternative. 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 proposed that acres with endangered species get multiplied by a factor of 2 whereas threatened species habitat acres are not weighted.

   The proposed indicator would be equal to the sum of all weighted T&E acres.

2. *How are these steps different if the geography of LCP's use is changed (for example, if LCP was used at a county scale as opposed to a metropolitan region scale)*

   They would not be affected because the analysis is developed from standardized geographical associations and produces a sum of impacts that is the same across any scale.

3. *What is the range of uncertainty involved in this specific indicator? How will you address this uncertainty? What are the risks associated with this uncertainty?>*

   Considerable uncertainty may exist in the geographic description of a plan and the potential impacts on T&E species. However for planning purposes, this uncertainty should not overly influence comparisons between alternatives.

4. *What is the range of uncertainty involved in the category when taken as a whole? What are some considerations around uncertainty when all the specific indicators in your category are aggregated, and assessed with the other categories? What should we be watching out for?*

   Natural resources indicators as a whole rely on broadly defined, mapped information. Their location within the area of a plan alternative indicates a level of attention and potential impact, but both the level of detail about a plan and the level of detail within each data set really only allow qualitative, comparative applications.

5. *Is this indicator suitable for monetization in a BCA context?*

   No. The level of information about potential project impacts, baseline resource conditions, and economic research cannot be easily generalized.

## Water: Potential Impacts to Surface Waters

### Data Sources for Specific Indicators

1. *What data exist today that address the specific indicator? What is the data source? Is it publicly available? What is the range of accuracy?*

   This indicator determines if a project could cause impacts to surface waters, generally perhaps through stormwater runoff or disrupted habitat. The potential impacts would be assessed if the project footprint crosses surface waters. It is assumed that the project footprint could 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; and
   - National Wetlands Inventory (NWI) maps [4].

   In all cases, data are publicly available and should be accessed by qualified ODOT staff.

2. *Do data rely on a travel demand model? If so, what geographies have these data in their model?*

   No. This indicator requires that plan alternatives have a geographical description.

3. *What is the scale of the data source? Meaning, are the data different for different geographies within Oregon? How easy or difficult is it to modify this data source's application to different geographies?*

   These data sources provide a consistent level of coverage and detail across the State.

4. *Does your source rely on any primary data collection? If so, is this typically conducted for a system-level planning effort?*

   No, the data sources use existing geographical data sets.

5. *From your perspective, is Oregon on the verge of being able to take advantage of any groundbreaking or innovative research in the subject area of this indicator? What is the timeframe, and can anything be used this year (2012)?*

   No, these data sets are used for a variety of purposes including NEPA assessments. In fact, because these data may be used for NEPA assessments, their initial use at a planning stage could provide greater continuity.

[4] Information sources: http://map.streamnet.org/website/bluesnetmapper/viewer.htm; http://www.fws.gov/wetlands/; http://www.oregon.gov/DSL/WETLAND/nwi.shtml

## Estimation Methods for Specific Indicators

1. *State in simple terms (words or a simple formula) the basics of the model involved in developing each specific indicator. What are the relationships between the variables being used?*

   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.

2. *How are these steps different if the geography of LCP's use is changed (for example, if LCP was used at a county scale as opposed to a metropolitan region scale)*

   They would not be affected because the analysis is developed from standardized geographical associations and produces a sum of impacts that is the same across any scale.

3. *What is the range of uncertainty involved in this specific indicator? How will you address this uncertainty? What are the risks associated with this uncertainty?*

   Considerable uncertainty may exist in the geographic description of a plan and the potential numbers of crossings. However for planning purposes, this uncertainty should not overly influence comparisons between alternatives.

4. *What is the range of uncertainty involved in the category when taken as a whole? What are some considerations around uncertainty when all the specific indicators in your category are aggregated, and assessed with the other categories? What should we be watching out for?*

   Natural resources indicators as a whole rely on broadly defined, mapped information. Their location within the area of a plan alternative indicates a level of attention and potential impact, but both the level of detail about a plan and the level of detail within each data set really only allow qualitative, comparative applications.

5. *Is this indicator suitable for monetization in a BCA context?*

   No. The level of information about potential project impacts, baseline resource conditions, and economic research cannot be easily generalized.

## Water: Potential Impacts to Wetlands

### Data Sources for Specific Indicators

1. *What data exist today that address the specific indicator? What is the data source? Is it publicly available? What is the range of accuracy?*

   This indicator determines if a project could cause impacts to wetlands, specifically. 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.

   Wetland locations across the State come from two primary sources: National Wetland Inventory (NWI) and Local Wetland Inventory (LWI).[5] NWI maps were created from aerial photograph interpretation, but LWI maps, which cover areas within designated urban growth boundaries, and supersede NWI within urban areas. These data are publicly available, much of it in a GIS format. The accuracy of the data is sufficient at a planning level as an indicator of the presence or absence of wetlands within a given area.

2. *Do data rely on a travel demand model? If so, what geographies have these data in their model?*

   No. This indicator requires that plan alternatives have a geographical description.

3. *What is the scale of the data source? Meaning, are the data different for different geographies within Oregon? How easy or difficult is it to modify this data source's application to different geographies?*

   NWI data is consistent statewide. LWI maps provide more refined data for urban areas.

4. *Does your source rely on any primary data collection? If so, is this typically conducted for a system-level planning effort?*

   No, the data sources use existing geographical data sets.

5. *From your perspective, is Oregon on the verge of being able to take advantage of any groundbreaking or innovative research in the subject area of this indicator? What is the timeframe, and can anything be used this year (2012)?*

   No, these data sets are used for a variety of purposes including NEPA assessments. In fact, because these data may be used for NEPA assessments, their initial use at a planning stage could provide greater continuity.

[5] Information sources: http://www.fws.gov/wetlands/; http://www.oregon.gov/DSL/WETLAND/lwi.shtml; http://www.oregon.gov/DSL/WETLAND/nwi.shtml

## Estimation Methods for Specific Indicators

1. *State in simple terms (words or a simple formula) the basics of the model involved in developing each specific indicator. What are the relationships between the variables being used?*

   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 other wetlands would not be weighted.

   The proposed indicator would be equal to the sum of all weighted wetland acres.

2. *How are these steps different if the geography of LCP's use is changed (for example, if LCP was used at a county scale as opposed to a metropolitan region scale)*

   They would not be affected because the analysis is developed from standardized geographical associations and produces a sum of impacts that is the same across any scale.

3. *What is the range of uncertainty involved in this specific indicator? How will you address this uncertainty? What are the risks associated with this uncertainty?*

   The uncertainty associated with the data for this indicatory 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. The 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.*" Still, these maps provide adequate information to indicate the resource and the likely implications for an alternative.

4. *What is the range of uncertainty involved in the category when taken as a whole? What are some considerations around uncertainty when all the specific indicators in your category are aggregated, and assessed with the other categories? What should we be watching out for?*

   Natural resources indicators as a whole rely on broadly defined, mapped information. Their location within the area of a plan alternative indicates a level of attention and potential impact, but both the level of detail about a plan and the level of detail within each data set really only allow qualitative, comparative applications.

5. *Is this indicator suitable for monetization in a BCA context?*

   Yes. Some research has been done to attempt monetization of potential project impacts, baseline resource conditions, and economic research though some uncertainty still remains.

## Hazardous Materials: Risk of Hazardous Material in Project Footprint

### Data Sources for Specific Indicators

1. *What data exist today that address the specific indicator? What is the data source? Is it publicly available? What is the range of accuracy?*

   Descriptive data that could be used in a planning context is available for this indicator. In fact, given a geographical description of the project, this indicator would serve only as a placeholder for local input to areas of suspected hazardous material sites. It is generally anticipated that this indicator would be significant for decisions only when the risk is high.

2. *Do data rely on a travel demand model? If so, what geographies have these data in their model?*

   No. This indicator requires that plan alternatives have a geographical description.

3. *What is the scale of the data source? Meaning, are the data different for different geographies within Oregon? How easy or difficult is it to modify this data source's application to different geographies?*

   A consolidated data source is not available for GIS-type comparisons. Instead, local knowledge would have to be included on a formalized basis.

4. *Does your source rely on any primary data collection? If so, is this typically conducted for a system-level planning effort?*

   Yes, information about the current or historical land uses within the geographical boundaries of the plan would be considered.

5. *From your perspective, is Oregon on the verge of being able to take advantage of any groundbreaking or innovative research in the subject area of this indicator? What is the timeframe, and can anything be used this year (2012)?*

   Not likely. This indicator relies heavily on local knowledge of land uses and may only be useful in certain cases.

### Estimation Methods for Specific Indicators

1. *State in simple terms (words or a simple formula) the basics of the model involved in developing each specific indicator. What are the relationships between the variables being used?*

   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 proposed that a severity score of 1 to 3 be applied to each instance where the risk of a hazardous materials site is high.

   The proposed indicator would be equal to the weighted sum of all potential hazardous sites.

2. *How are these steps different if the geography of LCP's use is changed (for example, if LCP was used at a county scale as opposed to a metropolitan region scale)*

This assessment depends on the geographical description of the project only and is not differentiated by scale.

3. *What is the range of uncertainty involved in this specific indicator? How will you address this uncertainty? What are the risks associated with this uncertainty?*

   This indicator is highly uncertain because of the reliance on local knowledge, and without site surveys. At a planning level, it is unclear how the uncertainty would be addressed. In all likelihood, the uncertainty would be accepted and users of the tool should take a risk averse perspective on site assessments.

4. *What is the range of uncertainty involved in the category when taken as a whole? What are some considerations around uncertainty when all the specific indicators in your category are aggregated, and assessed with the other categories? What should we be watching out for?*

   Natural resources indicators as a whole rely on broadly defined, mapped information. Their location within the area of a plan alternative indicates a level of attention and potential impact, but both the level of detail about a plan and the level of detail within each data set really only allow qualitative, comparative applications.

5. *Is this indicator suitable for monetization in a BCA context?*

   No. The level of information about potential project impacts, baseline resource conditions, and economic research cannot be easily generalized.

## Parks: Potential for Public Parks in Project Footprint

### Data Sources for Specific Indicators

1. *What data exist today that address the specific indicator? What is the data source? Is it publicly available? What is the range of accuracy?*

   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, which 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.

2. *Do data rely on a travel demand model? If so, what geographies have these data in their model?*

   No. This indicator requires that plan alternatives have a geographical description.

3. *What is the scale of the data source? Meaning, are the data different for different geographies within Oregon? How easy or difficult is it to modify this data source's application to different geographies?*

   Data may be available on the locations of Parks with general land use maps. These maps would have to be supplemented with local knowledge to know the significance of the Park and any ensuing complications arising from the plan.

4. *Does your source rely on any primary data collection? If so, is this typically conducted for a system-level planning effort?*

   Yes, information about the current or future Parks within the geographical boundaries of the plan would be considered.

5. *From your perspective, is Oregon on the verge of being able to take advantage of any groundbreaking or innovative research in the subject area of this indicator? What is the timeframe, and can anything be used this year (2012)?*

   Not likely. This indicator relies heavily on general maps and local knowledge of Parks.

### Estimation Methods for Specific Indicators

1. *State in simple terms (words or a simple formula) the basics of the model involved in developing each specific indicator. What are the relationships between the variables being used?*

   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 proposed that a severity score of 1 to 3 be applied to each instance where a Park may be impacted.

The proposed indicator would be equal to the weighted sum of all Parks impacted.

2. *How are these steps different if the geography of LCP's use is changed (for example, if LCP was used at a county scale as opposed to a metropolitan region scale)*

   This assessment depends on the geographical description of the project only and is not differentiated by scale.

3. *What is the range of uncertainty involved in this specific indicator? How will you address this uncertainty? What are the risks associated with this uncertainty?*

   This indicator is uncertain because of the reliance on local knowledge and general land use maps. This uncertainty would simply be accepted and users of the tool should take a risk averse perspective on assessing the status of potentially impacted Parks.

4. *What is the range of uncertainty involved in the category when taken as a whole? What are some considerations around uncertainty when all the specific indicators in your category are aggregated, and assessed with the other categories? What should we be watching out for?*

   Natural resources indicators as a whole rely on broadly defined, mapped information. Their location within the area of a plan alternative indicates a level of attention and potential impact, but both the level of detail about a plan and the level of detail within each data set really only allow qualitative, comparative applications.

5. *Is this indicator suitable for monetization in a BCA context?*

   No. The level of information about potential project impacts, baseline resource conditions, and economic research cannot be easily generalized.

## IDT Membership

IDT membership has not changed from the beginning of this process. Initially it was thought that a specialist in water resources from DEC would join the group and discuss water-based indicators. In the end it was decided that Susan White would be able to cover this topic.

Our team met has smaller groups via conference calls several times during the development of this memo. Several individual calls were held with Susan White (who covered all of the location-specific indicators). Her guidance on ecological resources, water resources, hazardous materials and Parks was developed in collaboration with resource specialists at HDR. Individual and group calls were held with Cory Ann Wind and Liz Hormann. A final coordinating call was held with Cory, Liz and Brian Gregor to ensure that our guidance for CAC, MSAT/Non-MSAT, and GHG were all consistent with other initiatives in Oregon and its GreenSTEP GHG planning tool.

# Safety and Security IDT Team: Specific Indicator Data Sources and Estimation Methods

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Date: February 20, 2012

## Introduction

The role of the Safety and Security Indicator Development Team (IDT) is to develop the set of specific indicators for the Safety and Security category of transportation system performance for the Oregon Least Cost Planning (LCP) project. This work includes developing a list of specific indicators and the estimation methods for evaluating them. This memorandum presents a refined list of specific indicators, documents the data that would be used, and lays out the steps involved in estimating the indicators for use in LCP.

This memo is the second for the Safety and Security IDT. On November 18, 2011 the IDT submitted a memo that provided a draft list of specific indicators, and a brief overview of how the IDT would approach developing them. In response to this communication, the LCP core leadership team met throughout December to look across the nine categories of transportation system performance to ensure that the set of specific indicator was complete (addressing all key aspects of LCP), manageable, operational, and avoids duplication. The result of these discussions was a set of guidance back to the IDTs to reassess several indicators within their category, including questions about operationality and recommendations to eliminate specific indicators for reasons of duplication and manageability. This memo picks up from that set of guidance.

## Refined Specific Indicators

The Safety and Security IDT met to discuss this proposed guidance in January and February 2012, and this section documents its progress in listing a refined set of specific indicators. Table 1 provides a list of refined specific indicators that responds to the core leadership team's guidance.

## Table 1: Refined Specific Indicators

| General Indicator | Refined Specific Indicator(s) | Response to Leadership Team – Rationale, Thoughts, Concerns |
|---|---|---|
| Safety Performance | *Crash performance (KAB crashes, crashes involving pedestrians, and crashes involving bicyclists).* | Initially there were three proposed specific indicators to account for Safety Performance: Fatal (K)/Incapacitating Injury (A) Crashes (KA crashes); Fatal (K), incapacitating (A) and non-incapacitating (B) crashes (KAB crashes); and SPIS/SPIS PUB (a measure calculated for all state routes). The SPIS/SPIS PUB accounts for historic crash frequency, crash severity and can be used for ranking).<br>In response to the request by the core team, the Safety and Security team has agreed to reduce this to one specific indicator that incorporates: the change in KAB crashes; crashes involving pedestrians; and crashes involving bicyclists.<br>This measure incorporates the following:<br>• Baseline KAB, pedestrian and bicyclist crash frequency: the existing safety performance of the system, measured in KAB crashes (i.e. crash history).<br>• Future anticipated KAB, pedestrian and bicyclist crash frequency: the future safety performance of the system (i.e. with implementation of the package of actions).<br>Rationale:<br>• The KAB measure focuses on the more severe crashes, accounting for tradeoffs that may occur between crash frequency and crash severity. It is common for projects or measures to improve safety would target severe crashes and at the same time increase PDO crashes. A measure only accounting for crash frequency and that includes PDO and Possible Injury Crashes (C crashes) would negatively impact a LCP score for projects when the score should reflect a positive safety benefit.<br>• The KAB measure is more stable over time because of the lower likelihood of underreporting in the higher severity crash grouping.<br>• The measure represents a larger pool of crashes to predict than KA crashes and KAB models are more statistically reliable than KA models.<br>• This specific indicator incorporates existing crash history.<br>• Pedestrian and bicyclist crashes involve vulnerable road users and a group that specifically requires consideration in terms of safety.<br>• Available safety tools do not allow for the prediction of transit and freight crashes as separate measures but rather include these crashes into the KAB crash measure listed under *Safety Performance* |

| General Indicator | Refined Specific Indicator(s) | Response to Leadership Team – Rationale, Thoughts, Concerns |
|---|---|---|
| EMS | *EMS Response Times* | The team originally proposed four separate specific indicators for *System Safety:* EMS; Ability to Enforce (whether infrastructure design supports the ability for police officers to monitor driver behavior); Speed Management; and Incident Management. Based on the need to reduce the overall number of indicators and support practical implementation of the tool. Recommendations from the Core Team resulted in the following updates:<br>• The *Ability to Enforce* and *Speed Management* indicators are removed from the list of indicators (to reduce the overall number of indicators).<br>• The *Incident Management* indicator is reallocated to the Mobility team to address as part of a mobility indicator on non-recurring congestion impacts (to prevent overlap between the two indicators).<br>• The *System Safety* general indicator is renamed to EMS.<br>• That EMS will only include one specific indicator: the change in EMS response times. |
| Security | *Resiliency of the Network: ability to maintain critical operations on the system* | The team originally proposed two separate specific indicators for *Security:*<br>• Crime/Perception of Security.<br>• Resiliency of the Network.<br>The *Crime/Perception of Security* indicator focused on crimes occurring at transit facilities ( including personal assault and property damage) and how people perceive their personal security in the area. The *Resiliency of the Network* indicator evaluates how the system operates during extreme incidents (i.e. extreme weather). Based on the need to reduce the overall number of indicators and support practical implementation of the tool, the Core Team recommended that only the *Resiliency of the Network* indicator be retained. This indicator places more emphasis on locations with repeat incidents, rather than those locations with potential for incidents and may incorporate emergency preparedness for special events and national security emergencies. |

### Indicator Priority

The *Safety Performance* and *EMS* indicators should have the highest priority in terms of addressing the objectives of the *Safety and Security* category.

### Specific Indicator Overlap

During the identification process of indicators, the Safety and Security team identified *Incident Management* as a component of Safety and Security. This represents an overlap with Mobility. The Mobility team has generated a specific indicator to quantify the travel time impacts of non-reoccurring congestion. The Safety and Security team recognizes that the longer a crash remains on the system, the likelihood of a second and subsequent crash increases. As such, the Safety and Security team is coordinating with Mobility to ensure no duplication exists for the development of a non-reoccurring congestion specific indicator that would incorporate the impact of increased travel time and increased crash risk.

## Data Sources for Specific Indicators

### Safety Performance: Crash Performance

Data inputs for PlanSafe software: historic crash data, travel demand data, and socio demographic data. The historic crash data is captured in the Oregon crash database and maintained by Crash Analysis & Reporting Unit in the Transportation Data Section of the Oregon Department of Transportation. The information is not publicly available but can be requested as part of a project or by agency partners. The Department and the Traffic Records Coordinating Committee (TRCC) of the state identify and implement efforts that continue to improve the reliability and accuracy of crash data. Low severity crashes are likely to be underreported and are therefore not included in the indicator estimation. The travel demand data are developed and generated for long-range transportation plans by state or regional transportation agencies. The information is not publicly available but can be requested as part of a project or by agency partners. The indicator uses output from a regional travel demand model (GIS layer) and estimates crash performance by TAZ or census Block Group. The scale of data sources does not differ between geographies within Oregon and the indicator can be determined for any of the geographies. The socio demographic data are captured in US Census or collected by a state or regional agency as part of the socio-demographic data inputs for the travel demand model(s) in the region. US Census data are publicly available and socio-demographic data for travel demand models can be requested from the agency. No primary data collection is required solely for the development of this indicator. The data inputs are commonly already in use for system planning and safety planning at the state and regional level. Oregon will be taking advantage of groundbreaking or innovative research in the subject area of this indicator? The PlanSafe software was recently updated and the updated software will be released this summer. The updated software can be used this year.

### EMS: Change in EMS Response Times

The State of Oregon is implementing NEMSIS 3.0. Emergency response times are captured in this database. Through an assessment of this database, the Oregon Health Authority and the EMS program in the Transportation Safety Division of ODOT can identify response times in different zip codes or geographies (likely cities and counties). The information is not publicly available but can be requested as part of a project or by agency partners. Using this information, major routes to hospitals and trauma centers from these geographies can be identified. The anticipated change in travel times on major routes to hospitals and trauma

centers (using the travel demand model) would offer a quantifiable measure to assess the likely anticipated change in EMS response times for a bundle of projects. There is ongoing research in the estimation of EMS response times that this project may benefit from – the Safety and Security Team is monitoring progress with these projects to determine the relative success of ideas currently being tested and whether Oregon would be able to use these results or products this year. This indicator would require additional effort.

### Resiliency of the Network

Data that specifically quantifies the resiliency of the network are not readily available. The development of this indicator will rely on input from the Oregon Health Authority; the EMS program in the Transportation Safety Division of ODOT; and law enforcement agencies in the region. The Safety and Security team is currently investigating innovative approaches to develop a consistent and independent quantitative measure for this indicator. The team is also monitoring ongoing research in the topic area.

## Estimation Methods for Specific Indicators

### Safety Performance: Crash Performance

The safety performance indicator will be developed using output from the PlanSafe software originally developed as part of NCHRP 8-44(02) (recently updated). The software uses negative binomial (count data models) to predict future anticipated safety performance given the current system (system flows, socio-demographics and crash history) and future anticipated travel demand and socio-demographics. The steps will remain the same across geographies. The planning level models, as with any predictive model, provide anticipated average outcomes using input that only incorporates part of what may indicate change in safety performance over time. The models were validated spatially and the software tool self-selects the model that best fits the historic data. While uncertainty is part of any model output, PlanSafe provides the best possible prediction of future performance given the limited information available for long-range transportation planning scenarios. The research underlying PlanSafe recommends the use of Block Groups as units rather than Traffic Analysis Zones based on the Modifyable Areal Unit Problem and thus analysis by Block Group is recommended with a transformation of results to TAZs as a final step. The crashes can be converted into monetary estimates using the crash cost estimates in use by the State of Oregon.

### EMS: EMS Response Times

The impact of the bundle of projects on EMS response times would be a quantitative assessment based on the anticipated change in estimated travel times on major routes serving hospital and trauma centers. It will rely on output from the travel demand model and thus have the same level of uncertainty than that associated with the travel demand models used by the particular agency. This measure is a surrogate measure and would not represent actual response time: the indicator is intended to only capture differences in travel times on relevant major routes. There is currently no method in use to convert the results into monetary estimates that would meet the requirements of this project. The team is continuing their investigation of a monetary estimation for this indicator.

### Resiliency of the Network

Currently the Resiliency of the Network indicator is a qualitative measure that would be determined using input from the Oregon Health Authority; the EMS program in the Transportation Safety Division of ODOT; and law enforcement agencies in the region. Concerns regarding consistent application of this indicator across alternatives and the qualitative nature of the indicator remain. There is currently no method in use to convert the results into monetary estimates that would meet the requirements of this project. The team is continuing their investigation of a monetary estimation for this indicator.

## IDT Membership

There were no changes in IDT membership. The Agency IDT is composed of the following members:

- Dorothy Upton/ODOT
- Tim Burks/ODOT
- Kelly Karpi/ODOT
- Nick Fortey/FHWA.

### IDT Interaction

The IDT (Agency and Consultants) met first in for a chartering meeting on November 7th, 2011. Since then, there have been two conference calls arranged between the Agency and Consultant IDT members. The first conference call took place after receiving feedback from the Core Team on the specific indicators developed at the chartering meeting. The IDT discussed the feedback and provided recommendations on modifications to the specific indicators list. The second conference call took place in early February to discuss how to quantitatively or qualitatively measure safety using the agreed upon specific indicators.

At the November 2011 meeting the IDT agreed that the use of PlanSafe to estimate the anticipated impact of a bundle of projects on the safety performance of the system would be ideal. However, given that such analyses are not currently performed as part of agency planning activities, the IDT proceeded with the discussion and development of alternative approaches to assess the impact on safety performance. The IDT agreed that no suitable alternative exist to a PlanSafe analysis: the alternative approaches would rely on qualitative assessments, would require detailed information about the infrastructure changes of different projects that would not be available at the planning level and that would require extensive effort to develop. The team also voiced concerns regarding consistent application of the indicators across alternative bundles of projects and the fact that these measures cannot be readily converted into monetary values. The team thanks the IDT for their commitment and participation.

# Quality of Life and Livability IDT Team: Specific Indicator Data Sources and Estimation Methods

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## Introduction

The role of the Quality of Life and Livability Indicator Development Team (IDT) is to develop the set of specific indicators for the Quality of Life and Livability category of transportation system performance for the Oregon Least Cost Planning (LCP) project. This work includes developing a list of specific indicators and the estimation methods for evaluating them. This memorandum presents the team's progress to date on developing a refined list of specific indicators, documenting the data that would be used, and laying out the steps involved in estimating the indicators for use in LCP.

This memo is the second for the Quality of Life and Livability IDT. On November 18, 2011, the IDT submitted a memo that provided a draft list of specific indicators, and a brief overview of how the IDT would approach developing them. In response to this communication, the LCP core leadership team met throughout December to look across the nine categories of transportation system performance to ensure that the set of specific indicators was complete (addressing all key aspects of LCP), manageable, operational, and avoids duplication. The result of these discussions was a set of guidance back to the IDTs to reassess several indicators within their category, including questions about operationality and recommendations to eliminate specific indicators for reasons of duplication and manageability. This memo picks up from that set of guidance.

## Refined Specific Indicators

The Quality of Life and Livability IDT met to discuss this proposed guidance six times (Jan 10th, Jan 18th, Jan 27 th, Jan 30th, Feb 2nd, and Feb 14th) and this section documents its progress in listing a refined set of specific indicators. Table 1 provides a list of refined specific indicators that responds to the core leadership team's guidance. This table is and will continue to be a work in progress and may be revised as the Quality of Life and Livability IDT members work to further develop the specific indicators.

**Table 1: Refined Specific Indicators**

| General Indicator | Refined Specific Indicator(s) | Response to Leadership Team – Rationale, Thoughts, Concerns |
|---|---|---|
| | *Monetary value of statistical lives saved per year due to cycling and walking* | The IDT has made great progress connecting travel model outcomes to changes in physical activity, resulting health outcomes (mortality), and monetizing these impacts. The team is continuing to investigate the connection between the travel model outputs and the needed physical activity inputs. An additional call is being scheduled between IDT members and Alex (modeler at ODOT) to discuss. One key question is whether the travel model can produce outcomes (change in # of miles walked, biked, and changes in the amount of time spent in these activities) by age and sex to correspond to the population subgroups with differing incidences of mortality. |
| *Physical Activity* | *Monetary values of reductions in the population incidences (translated to number of cases) of:*<br>– *Breast Cancer*<br>– *Colon Cancer*<br>– *Cardiovascular Disease (CVD)*<br>– *Dementia*<br>– *Depression*<br>– *Diabetes* | The IDT is making tremendous progress in this area. Disease specific relative risks with confidence intervals were obtained from the ITHIM meta-analysis. A Compendium of Activities and Corresponding Metabolic Activity report will relate the outputs from the ITHIM to minutes of physical activity. However, this must be compared to a baseline/existing conditions of current morbidity and disease rates ( from Vital Statistics, the Oregon State Cancer Registry, and Behavioral Risk Factor Surveillance System). The team is working on determining the demographic categories available from the travel model outputs (the risk reductions vary by certain demographic characteristics) so that the potential to develop the baseline conditions and risk reductions for key diseases can be determined. |
| *Journey Ambiance* | *Monetary value of transportation features aimed at* | The QoL IDT assumes that the level of service (including viewscape, comfort, stress) for users of other modes will be captured by other teams. |

| General Indicator | Refined Specific Indicator(s) | Response to Leadership Team – Rationale, Thoughts, Concerns |
|---|---|---|
| | *pedestrian and bicycle users journey ambiance* | |
| *Community Resources* | *Qualitative rating of impacts (positive or negative) to community resources* | This indicator covers community resource displacements and positive or negative impacts to the surrounding environments of community resources. The team recommends a qualitative scale (positive, negative, mixed, indeterminate) for assessing plan-level impacts to community resources, similar to the approach used by NATA. The team does not recommend monetizing this indicator at this time. |
| *Noise* | *Monetary value of predicted noise levels (both absolute and changes in levels) at residential sites within 10 to 300 meters of a roadway* | • Assess changes in noise levels (decibels) by type of receptor and apply the monetary estimates developed in NATA for increments in decibels at residential receptors. Develop rules of thumb for adjusting these estimates to other receptor types.<br>• For certain applications, ODOT is required to assess noise impacts and to consider mitigation. To accomplish this, ODOT developed the Noise Manual, July 2011 and it was approved by the FHWA.<br>• In the event that ODOT is not required or chooses not to follow those procedures, a less rigorous, but still valuable method is recommended for LCP. This method essentially develops noise contours. The model inputs include pavement type, analysis years, traffic volumes and speeds and, acoustical barriers. The noise contours can be calculated using a spreadsheet software program or calculated from look-up tables. Model outputs will include the changes in noise levels in decibels. |

**Priority**

The Physical Activity general indicator has two recommended classes of specific indicators. The monetary value of statistical lives saved per year (mortality) and multiple morbidity indicators, measured in terms of the changes in the number of cases of specific diseases and the avoided costs of treatment and/or lost productivity. These mortality and morbidity health outcomes are considered by the IDT to be of the highest priority as they are quantifiable, most can be monetized with a reasonable degree of empirical evidence, and they are likely to vary across transportation schemes. The list of diseases with population incidences shown to be related to the level of physical activity includes:

- Breast Cancer
- Colon Cancer
- Cardiovascular Disease (CVD)
- Dementia
- Depression
- Diabetes

The team requires feedback from ODOT on the outputs from the transportation demand models by demographic group. Otherwise the team is prepared to finalize recommendations for monetizing each of these health outcomes as noted in the present draft.

In terms of priority for all of the other general indicator categories, in early discussions, the IDT considered the Journey Ambiance category to be the highest priority. The IDT has not revisited this question with the benefit of the team's research.

### Duplication and/or Gaps

Potential for duplication between the QoL and other IDTs and the potential for gaps, where it appears that indicators may not be addressed by any of the IDTs are described below:

- Environmental Stewardship Team: While none of the QoL IDT's specific indicators are currently anticipated to overlap with those of the other IDTs, general indicator categories have been passed back and forth between the teams and care should be taken by the PMT to ensure confusion has not occurred. Currently, the QoL IDT is charged with developing the Community Resource specific indicators and the Environmental Stewardship IDT is charged with developing (human) Exposure to Pollutants. Parklands by their nature fall into both camps – so these areas may be double counted or excluded altogether. Some other cultural historical resources (e.g., battle grounds, Oregon Trail) could also fall into both categories. Basically, any functioning ecosystem that is also used by people is a potential grey area.
- Mobility Team and/or Land Use Team. The Journey Ambiance indicator developed for Quality of Life focuses primarily on active modes. It was assumed that the Mobility and/or Landuse Teams were capturing aspects of journey ambience (views, comfort, stress) for the passive mode users. If this is not the case, then the QoL IDT is recommending that these teams include such specific indicators in their work.

## Data Sources for Specific Indicators

### Physical Activity: Monetary value of statistical lives saved per year due to cycling and walking

Data availability on the monetary value of statistical life is good and confidence limits may be available. The QoL IDT recommends using the same monetary value of a statistical life saved as ODOT uses for preventing fatal accidents and for reducing air emissions as well as any other transportation-related fatalities. The empirical evidence linking physical activity to all causes of mortality is strong and confidence limits are available. Baseline incidences of mortality rates in

Oregon are available by sex and age group (see Table 1). The weak link in the chain may be the reliability and accuracy of the measures of changes in physical activity levels due to transportation schemes. This is a question for discussion with ODOT as it relates to the outputs from the transportation demand model.

The data from the transportation demand modeling are available for MPOs (spell out), only. Corresponding data are not available for all other areas. This means that this indicator will only be quantifiable for MPOs. The QoL IDT is requesting additional coordination with the ODOT travel demand modelers about the scale (level of aggregation by sex and age grouping) of the transportation model outputs. We understand that an ODOT meeting across multiple teams was scheduled for late February to discuss the multiple demands on the transportation demand model. We have not received feedback from the meeting. The mortality and morbidity impacts will be more precise if they can be developed for certain sub-populations based upon age and sex. As stated above the mortality and morbidity estimates will only be feasible for those geographic regions for which the state has travel demand modeling capability. No corresponding estimates will be available for regions outside of the MPOs. The sources do rely upon primary data gathering to support estimating the travel demand models. This data is typically collected for system level planning for the MPOs.

**Table 1. Mortality Rates from Oregon Vital Statistics (2009)[1]**

| Sex | Age group | Mortality rate per 100,000 (all causes) |
|---|---|---|
| Men | 25-44 | 155.8 |
| Men | 45-64 | 750 |
| Men | 65+ | 4,789.50 |
| Women | 25-44 | 81.6 |
| Women | 45-64 | 464.2 |
| Women | 65+ | 4,515.10 |

It is our understanding that the state is moving toward activity-based models that produce predictions scalable to the individual – rather than simply aggregate proportions for the population or population subgroups. This will increase the accuracy of the analysis of health effects. We are unaware of the planned geographic extent of the forthcoming models (i.e., whether they will include geographic regions beyond the MPOs). These activity-based models will not be available in 2012.

The following list of data sources and references includes references that are directly applicable to the quantification of the mortality indicator as well as supporting literature. In addition there is some overlap with morbidity indicators.

[1] http://public.health.oregon.gov/BirthDeathCertificates/VitalStatistics/annualreports/09V2/Documents/chapter6/table601.pdf

**Data Sources and References:**

- Travel Model Outputs
- Source for ODOT Policy on monetary value of statistical lives saved
- *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
- Oregon Vital Statistics: http://public.health.oregon.gov/BirthDeathCertificates/VitalStatistics/annualreports/09V2/Documents/chapter6/table601.pdf
- USEPA 2011, *The Benefits and Costs of the Clean Air Act 1990 to 2020*. Final Report USEPA Office of Air and Radiation. March 2011.
- *Walking and Biking to School Physical Activity and Health Outcomes*, Research Brief, May 2009, Active Living Research.
- *Making the Link from Transportation to Physical Activity and Obesity*, Research Brief, Summer 2009, Active Living Research.
- Wadud, Zia, and Ian Waltz, *A Comparison of Air Quality Related Mortality Impacts of Different Transportation Modes in the US*, TRB 2011 Annual Meeting
- Urban Design 4 Health. Inc. (2010). *The Hidden Health Costs of Transportation*. American Public Health Association.
- 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.
- 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.
- David Ragland – SafeTREC, UC Berkeley, *Transportation and Health: Policy Interventions for Safer, Healthier People and Communities*, http://www.prevent.org/Additional-Pages/Transportation-and-Health.aspx
- Darren E.R. Warburton, Crystal Whitney Nicol, Shannon S.D. Bredin, *Health benefits of physical activity: the evidence*, CMAJ, March 14, 2006, 174(6) | 801
- Appendix to Warburton DER, Nicol CW, Bredin SSD, *Health benefits of physical activity: the evidence, CMAJ* 2006;174(6):801-9.
- Guenther Samitz,1 Matthias Egger2,3 and Marcel Zwahlen3, *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

### Physical Activity: Monetary value of reductions in the population incidences of morbidity

Like the mortality impacts, the morbidity impacts are linked to outputs from the travel demand models that quantify changes in the number of minutes or the distance traveled using active modes (walking and biking). To the extent that these estimates can be provided for subgroups of the population (by age and sex), the accuracy of the resultant health impacts will improve. Data from a meta-analysis showing the relative risk reductions due to changes in physical activity has been provided to the team by researchers involved in developing the Integrated

Transportation and Health Impacts Model (ITHIM). We have requested the corresponding confidence bounds. These risk reductions are quantified in MET units, as shown in Table 2, which are converted to their time and distance equivalents using the Compendium of Activities and Corresponding Metabolic Activity report to correspond to model outputs from the transportation demand modeling (see Table 3). *MET (Metabolic Equivalent)* is defined as the ratio of the work metabolic rate to the resting metabolic rate. One MET is defined as 1 kcal/kg/hour and is roughly equivalent to the energy cost of sitting quietly.[2]

**Table 2. Morbidity Risk Reductions in Metabolic Equivalents from Integrated Transport & Health Impacts Model (ITHIM), Version Nov. 1, 2011, James Woodcock**

| Diagnostic Category | Subgroup | RR per 1 MET/week | Lower bound, 95% CI* | Upper bound, 95% CI |
|---|---|---|---|---|
| Breast cancer | | 0.973 | 0.961 | 0.986 |
| Colon cancer | M | 0.961 | 0.930 | 0.993 |
| | F | 0.973 | 0.951 | 0.996 |
| CVD | | 0.938 | 0.918 | 0.962 |
| Dementia | | 0.943 | 0.913 | 0.973 |
| Diabetes | | 0.943 | 0.913 | 0.971 |
| All-cause mortality Woodcock all physical activity | | 0.891 | 0.860 | 0.915 |
| All-cause mortality Woodcock walking alone | | 0.954 | 0.922 | 0.984 |

**Table 3. Conversion Table for Translating METs to Levels of Physical Activity Associated with Active Transportation [3]**

| | Time | Distance traveled | Metabolic equivalent (MET) (kcal/kg/hour) |
|---|---|---|---|
| Walking, 2.8 to 3.2 mph, level, moderate pace, firm surface | 1 hour | 3 miles | 3.5 |

[2] http://prevention.sph.sc.edu/tools/compendium.htm

[3] Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett Jr DR, Tudor-Locke C, Greer JL, Vezina J, Whitt- Glover MC, Leon AS. 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

| | Time | Distance traveled | Metabolic equivalent (MET) (kcal/kg/hour) |
|---|---|---|---|
| Walking, 3.5 mph, level, brisk, firm surface, walking for exercise | 1 hour | 3.5 miles | 4.3 |
| Biking, 12-13.9 mph, leisure, moderate effort | 1 hour | 12-13.9 miles | 8.0 |

Census data, data from the Centers for Disease Control and Prevention, and Oregon Vital Statistics are available for establishing baseline conditions and for combining with the risk reduction coefficients to estimate the changes in the number of cases, by disease. Relevant data are from the Behavioral Risk Factor Surveillance System (BRFSS). Oregon administers its own BRFSS for county- and state-level estimates of physical activity and disease burden. Pending discussions with ODOT on the model outputs from the transportation demand models, the QOL IDT will use these data sources to complete the appropriate version of Table 4 on the baseline incidences of various diseases by age and sex, below. Table 4 can be completed to correspond to the same or similar demographic groups for which estimates of changes in physical activity will be available from the travel demand model.

**Table 4. Baseline Disease Incidence Rates Template Table**

| Sex | Age group | Breast Cancer | Colon cancer | CVD | Dementia | Depression | Diabetes |
|---|---|---|---|---|---|---|---|
| Cost per case | | | | | | | |
| Men | 25-44 | | | | | | |
| Men | 45-64 | | | | | | |
| Men | 65+ | | | | | | |
| Women | 25-44 | 130.3 per 100,000 per year | | | | | |
| Women | 45-64 | 130.3 per 100,000 per year | | | | | |
| Women | 65+ | 130.3 per 100,000 per year | | | | | |

- Oregon breast cancer incidence data show 130.3 cases per 100,000 per year[4].
- The Alzheimer's Association estimates that 76,000 Oregonians age 65+ have Alzheimer's. Alzheimer's is the most common form of dementia, accounting for 60-80 percent of cases[5]. Assuming Alzheimer's accounts for 70 percent of dementia cases in Oregon this gives (76,000 * 1.429 = 108,500) Oregonians age 65+ with dementia in 2010. Since dementia is much more common among older adults, we do not recommend estimating effects for the population younger than 65.
- The CDC estimates the prevalence of current depression among Oregon adults was 7.1 percent in 2006-2008[6]. The same report includes estimates of national depression prevalence by age and sex.

Monetary estimates of the avoided health care costs are available for most of the diseases, and may be available for the others (see Table 5). These estimates provide an underestimate of the total economic value of avoiding morbidity cases as they do not include lost work days or pain and suffering. The range in accuracy varies by disease and is generally less accurate and less comprehensive than the mortality benefits. Note that the costs for some types of illness are reported an a lifetime case bases; whereas others are reported on an annual basis.

**Table 5. Cost of Illness Estimates**

| Disease | Direct costs per case | References |
|---|---|---|
| Colorectal cancer | LIFETIME COSTS: $155,348 in direct costs (2009 dollars) based on the experience of Oregon patients diagnosed in 1996 and followed through the end of 2009. (This estimate applied pro-rated estimates from EPA "Cost of Illness Handbook" for initial treatment phase ($27,768 per 3 months), maintenance cost ($8,295 per year), and terminal treatment ($30,563 per last 6 months) to cases diagnosed in Oregon in 1996. For deceased patients: survival months were calculated as difference in months between date of diagnosis and date of death. For patients alive 12/31/2009, survival months were | The Environmental Protection Agency (1996). The Cost of Illness Handbook. Continuously updated until 2010. Available online at:<br>http://www.epa.gov/oppt/coi/index.html |

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

5 http://www.alz.org/downloads/Facts_Figures_2011.pdf

6 http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5938a2.htm?s_cid=mm5938a2_e%0D%0A
http://www.cdc.gov/Features/dsDepression/Revised_Table_Estimates_for_Depression_MMWR_Erratum_Feb%202011.pdf

| Disease | Direct costs per case | References |
|---|---|---|
| | calculated as difference in months between date of diagnosis and date of death.) | |
| Diabetes | ANNUAL COSTS: $6,650 per case in direct costs, (in 2009 dollars) which includes the proportion of costs attributable to diabetes. $2,900 in indirect costs per case. Estimate was derived by dividing the ADA state total estimate by the number of Oregonians with diabetes (based on 2008 PSU population estimates and 2008 BRFSS). | ADA Diabetes Cost Calculator for Oregon<br><br>American Diabetes Association. "Economic costs of diabetes in the U.S. in 2007". Diabetes Care. 2008 Mar;31(3):596-615. Available online at:<br><br>http://care.diabetesjournals.org/content/31/3/596.full.pdf+html |
| All Cardio-vascular | | No distributions available. The COI point estimates (lost earnings plus direct medical costs) are based onICD-9 code level information (e.g., average hospital care costs and average length of hospital stay) reported in Agency for Healthcare Research and Quality, 2000 (www.ahrq.gov). No adjustments are made to cost of illness values for income growth.<br><br>Source: USEPA.2011. The Benefits and Costs of the Clean Air Act 1990 to 2020. Final Report USEPA Office of Air and Radiation. March 2011. |
| (ages 65+) | $27,319 | |
| All Cardio-vascular | | |
| (ages 20–64) | $29,364 | |
| Breast Cancer | $50,000 per case per lifetime. | Campbell's review found studies with a range of estimated lifetime costs from $20,000 to $100,000[7], with most of the studies of direct treatment costs centered around $30-35,000. The Campbell review did not inflation-adjust the estimates for comparison, unfortunately, and the studies are from the 1980s and 1990s. Adjusting for inflation (using the medical CPI), would more than double the cost estimates from most of the studies cited. Also, as Campbell noted, most lifetime |

[7] Campbell JD, Ramsey SD (2009). The Costs of Treating Breast Cancer in the US. Pharmacoeconomics 27(3) 199-209.

| Disease | Direct costs per case | References |
|---|---|---|
| | | cost estimates were likely an underestimate for today's lifetime cost of treating breast cancer because of changes in practice patterns and improved survival. |
| Dementia | $218,700 per case per lifetime | Alzheimer's Disease International published country-specific annual per capita costs for dementia. For the U.S. annual costs were the sum of direct medical ($8,403 , social care costs ($22,233, and informal care ($17,968)[8]. The average survival time for a person diagnosed with dementia is 4.5 years.[9]. This gives $218,700 per case. |
| Depression | $3,309 per case per year. | Greenberg estimates annual direct treatment costs at $3,309 (2000 dollars) per patient[10]. |

The reliance upon the travel demand model is similar to the mortality indicator, as is the scale of the data source. Empirical work related to the linkages between physical activity and the incidences of various diseases is on-going by WHO and others and this should increase the reliability of those estimates. However, we are not anticipating major breakthroughs in 2012. The following list of additional data sources and citations includes references that are directly applicable to the quantification of the morbidity indicators as well as supporting literature. In addition there is some overlap with mortality indicator.

**Data Sources and References:**

- Travel Model Outputs
- The Environmental Protection Agency (1996). *The Cost of Illness Handbook*. Continuously updated until 2010. Available online at: http://www.epa.gov/oppt/coi/index.html
- ADA Diabetes Cost Calculator for Oregon http://www.diabetesarchive.net/advocacy-and-legalresources/cost-of-diabetes-results.jsp?state=Oregon&district=0&DistName=Oregon+%28Entire+State%29

[8] Xie J, Brayne CB, Matthews FE (2008). Survival times in people with dementia: analysis from population based cohort study with 14 year follow-up. BMJ 336, 258-262.

[9] Xie J, Brayne CB, Matthews FE (2008). Survival times in people with dementia: analysis from population based cohort study with 14 year follow-up. BMJ 336, 258-262.

[10] Greenberg PE et al. (2003). Table 5 from The Economic Burden of Depression in the United States: How Did It Change Between 1990 and 2000? Journal of Clinical Psychiatry 64(12), 1465-75.

- American Diabetes Association. *Economic costs of diabetes in the U.S. in 2007*. Diabetes Care. 2008 Mar; 31(3):596-615. Available online at: http://care.diabetesjournals.org/content/31/3/596.full.pdf+html
- USEPA.2011, *The Benefits and Costs of the Clean Air Act 1990 to 2020*, Final Report USEPA Office of Air and Radiation. March 2011.
- http://www.huffingtonpost.com/robert-leahy-phd/the-cost-of-depression_b_770805.html - includes a good list of references
- http://www.dementia2010.org/ (Estimates each case costs £27,647 per year)
- George Van Houtven, Matthew Rousu, Jui-Chen Yang, Charles Pringle, Wanda Wagstaff, and Jason DePlatchett, *Valuation of Morbidity Losses: Meta-Analysis of Willingness-to-Pay and Health Status Measures,* RTI Health, Social, and Economics Research Research Triangle Park, NC 27709 Contract Number 223-01-2466 RTI Project Number 08184.002, March, 2003.
- PWC. *A walking Strategy for New South Wales: Assessing the Economic Benefits of Walking*. Prepared for PCAL and DECCW, February 2011
- Elliot Fishman, Ian Ker, Jan Garrad and Todd Litman (2011), *Cost and Health Benefits of Active Transport in Queensland: Research and Review*, prepared by CATALYST for Health Promotion Queensland (www.education.qld.gov.au/health/research/index.html; www.sensibletransport.org.au/sites/sensibletransport.org.au/files/u5/Executive%20Summary%2010.09.11%20V2.pdf).
- Jane Powell, Anja Dalton, Christian Brand and David Ogilvie (2010), *The Role Of Walking And Cycling In Advancing Healthy And Sustainable Urban Areas*, Built Environment, Vol. 36, No. 4, Dec. pp. 504-518; summary at: www.atypon-link.com/ALEX/doi/abs/10.2148/benv.36.4.385.
- ECU (2004), *Physical Inactivity Cost Calculator* (www.ecu.edu/picostcalc), College of Health & Human Performance, East Carolina University (www.ecu.edu).
- ICLEI (2007), *Active Transportation Quantification Tool*, Cities for Climate Protection, International Council for Local Environmental Initiatives (http://att.ccp.iclei.org); at http://att.ccp.iclei.org/more/about.
- WHO (2008), *Health Economic Assessment Tool for Cycling* (HEAT for Cycling), World Health Organization Region Office Europe (www.euro.who.int).
- Sonja Kahlmeier, Francesca Racioppi, Nick Cavill, Harry Rutter, and Pekka Oja (2010), *Health in All Policies in Practice: Guidance and Tools to Quantifying the Health Effects of Cycling and Walking*, Journal of Physical Activity and Health, Vol. 7, Supplement 1, pp. S120-S125.
- Graeme Lindsay, Alistair Woodward and Alex Macmillan (2008), *Effects On Health And The Environment Of Increasing The Proportion Of Short Urban Trips Made By Bicycle Instead Of Motor Vehicle*, School of Population Health, University of Auckland (www.fmhs.auckland.ac.nz).
- NZTA (2010), *Economic Evaluation Manual*, Volumes 1 and 2, New Zealand Transport Agency (www.nzta.govt.nz); at www.nzta.govt.nz/resources/economic-evaluation-manual/volume-1/index.html and www.nzta.govt.nz/resources/economic-evaluation-manual/volume-2/docs/eem2-july-2010.pdf.

- Jessica Y. Guo and Sasanka Gandavarapu (2010), *An Economic Evaluation Of Health-Promotive Built Environment Changes*, Preventive Medicine, Vol. 50, Supplement 1, January 2010, pp. S44-S49; at www.activelivingresearch.org/resourcesearch/journalspecialissues.
- Marlon G. Boarnet, Michael Greenwald and Tracy E. McMillan (2008), *Walking, Urban Design, and Health: Toward a Cost-Benefit Analysis Framework*, Journal of Planning Education and Research, Vol. 27, No. 3, pp. 341-358; at http://jpe.sagepub.com/cgi/content/abstract/27/3/341.
- Robert J. Stokes, John MacDonald and Greg Ridgeway (2008), *Estimating The Effects Of Light Rail Transit On Health Care Costs*, Health & Place, Volume 14, Issue 1, March, pp. 45-58.
- Hyangun Sung, Jihyung Park and Hyeja Kim (2009), *A Study on the Impact of the Green Transport Mode on Public Health Improvement*, KOTI World-Brief, Vol. 1, No. 1, Korea Transport Institute (www.koti.re.kr), May, pp. 6-8; http://english.koti.re.kr/upload/eng_publication_regular/world-brief01.pdf.
- Andrew Dannenberg and Richard Jackson. 2001. *Making Healthy Places*, 2011 Island Press http://erb.kingdomnow.org/review-making-healthy-places-dannenberg-et-al-vol-4-21/
- CDC Transportation Policy Recommendations http://www.cdc.gov/transportation/docs/FINAL%20CDC%20Transportation%20Recommendations-4-28-2010.pdf
- San Diego CPPW project http://www.sdcounty.ca.gov/hhsa/programs/phs/chronic_disease_health_disparities/CPPW.html; http://www.sdcounty.ca.gov/hhsa/programs/phs/documents/CPPW-HealthImpact.pdf
- Woodcock J, et al. Public health benefits of strategies to reduce greenhouse-gas emissions: Urban land transport. Lancet. Dec 5; 374: 1930-43.
- Maizlish, N., J. Woodcock, S. Co, B. Ostro B, C. Fanai, and D. Fairley. 2011. *Health Co-Benefits and Transportation-Related Reductions in Greenhouse Gas Emissions in the Bay Area,* ITHIM_Technical_Report11-21-11.pdf. Definitons of health outcome measures from: http://www.who.int/healthinfo/global_burden_disease/metrics_daly/en/
- Campbell JD, Ramsey SD (2009). The Costs of Treating Breast Cancer in the US. Pharmacoeconomics 27(3) 199-209. http://www.alz.co.uk/research/files/WorldAlzheimerReport2010.pdf
- Xie J, Brayne CB, Matthews FE (2008). Survival times in people with dementia: analysis from population based cohort study with 14 year follow-up. BMJ 336, 258-262.
- 2011 Alzheimer's Disease Facts and Figures: http://www.alz.org/downloads/Facts_Figures_2011.pdf


### Journey Ambiance

Journey ambience is addressed as it relates to evaluating walking and biking transportation schemes. By and large, these indicators would be quantities that are components of the transportation schemes and then monetized using literature values. These data do not rely upon a travel demand model. 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 bikability. Table 6 shows the list of factors and estimates of monetary values to be considered for inclusion in assessing the journey ambience of the pedestrian environment. This table was developed by HDR using the UK Department of Transport assumptions. It is recommended that the £ be converted to $ for use in OLCP and that these be viewed as placeholders until it can be verified that the estimates are generally applicable to Oregon residents and/or such values become available from other sources.

**Table 6. Values of different aspects of the pedestrian environment used in the evaluation of the London Strategic Walk Network**

| Walking schemes | | |
|---|---|---|
| Street lighting | 3.4p/km | Heuman (2005) |
| Crowding | 1.7p/km | Heuman (2005) |
| Kerb level | 2.4p/km | Heuman (2005) |
| Information panels | 0.8p/km | Heuman (2005) |
| Pavement evenness | 0.8p/km | Heuman (2005) |
| Directional signage | 0.5p/km | Heuman (2005) |
| Benches | 0.5p/km | Heuman (2005) |

The specific indicator identified for capturing journey ambience for cyclists is miles of segregated tract. The monetary value depends upon whether the bikeway is on-road or off-road and if off-road, whether or not it has a separate track or just a bike lane. The IDT has identified a potential equation for estimating the monetary values of pedestrian and bicyclist journey ambiance (see Estimation section). However, data sources and availability for the inputs are not yet fully developed.

**Data Sources and References:**

- Washington State Department of Transportation, Montlake Triangle Project, Tiger Discretionary Grants Program, Economic Analysis Supplementary Documentation, October 26, 2011.
- UK Department of Transport, Transport Analysis Guidance (TAG) Unit 3.14, Guidance on the monetizing of Journey Ambiance, January, 2010. http://www.dft.gov.uk/webtag/documents/expert/unit3.14.php

### Community Resources

The team recommends using the following definition for community resources, taken from NATA and modified for OLCP. Community resources include:

- Buildings or structures (individually or in association) of architectural, historic, or community significance. Examples include historic buildings or bridges, community centers, museums, etc.
- Community spaces that provide recreational opportunities and places for people to gather, such as parks, open space, public squares, etc.

- Sites with historic or archeological significance (e.g. monuments, battlefields, cemeteries, etc).
- Other locally significant community resources not included above (included to allow jurisdictions to add resources based on local values and preference).

The IDT recommends qualitative specific indicators based upon the nature and extent of the impacts to these resources (see section on Estimation Methods for Community Resources). The data for these specific indicators is not dependent upon the travel demand models but would rely upon GIS data showing transportation routes as overlays on layers showing the various types of community resources. These data may need to be reviewed by persons with expertise in cultural/historical and other community resources to make a determination on impacts (positive and negative) as well as the significant of the impacts.

**Data Sources and References:**

- Department for Transport. 2003. The Heritage of Historic Resources Sub-Objective TAG Unit 3.3.9 Transport Analysis Guidance (TAG). June 2003. www.webtag.org.uk. While data are not readily available for all of these resources, it is recommended that OLCP start first with data available statewide from the State Historic Preservation Office and Statewide Geospatial Data Clearinghouse, and then use locally available data, as available.
- State Historic Preservation Office (historic and archeological resources); Oregon Historic Sites Database http://heritagedata.prd.state.or.us/historic/
- Statewide Geospatial Data Clearinghouse & Spatial Data Library (state parks) http://gis.oregon.gov/DAS/EISPD/GEO/alphalist.shtml
- Local GIS data layers: While data availability will vary by jurisdiction, it is recommended that where available, GIS layers for schools, community centers, churches, local parks and open space, museums, recreational resources, landmarks, cemeteries, or other locally significant community resources (that are not captured by the statewide data) be included in the analysis.

## Noise

The QOL team recommends assessing changes in noise levels (decibels) by type of receptor and applying the monetary estimates developed in NATA for increments in decibels above baseline conditions. Data on baseline and projected future 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). “Noise contour” means the decibel levels associated with a given distance from the center line of the relevant alignment. Data on the following parameters that affect noise levels are needed in a screening level analysis using the FHWA look-up tables or equivalent software:

- Specify Traffic volumes and speeds:
    - Number of vehicles and speeds by five vehicle types (automobiles, medium trucks, heavy trucks, buses, and motorcycles) at speeds of 0 to 130 kilometers per hour (km/h) in 10 km/h increments;

- Specify whether the sound level propagation will be over acoustically hard or soft terrain;
- Specify whether or not there will be a single wall barrier. If so:
    - Provide the height (i.e. between 2 and 10 m), and
    - Provide the distance (i.e., either 10 or 30 m from the centerline of the roadway); and
- Consult look-up tables or use software to obtain model outputs at distances from 10 to 300 m in 10 m increments from the centerline of the roadway.

This model is user friendly and does not require a noise expert. That is in contrast to the TNM used for federally compliant noise impact analyses. The model can be run anywhere in the state that can provide the model inputs. This approach does not rely upon developing noise maps. The noise study is usually prepared after the traffic data are developed. This approach assumes that the noise source is along a straight line. Go out from the center line in increments of fifty feet (or 10 meters). 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 this seems reasonable with current GIS technology. The output from the spreadsheet model gives the decibel levels associated with the specified traffic volumes and speeds as one gets increasingly further from the center line of the alignment. The noise predictions may tend to over-predict the noise consequences.

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. An excellent description of noise impacts by type of receptor can be found in the Oregon DOT Noise Manual (2011). Residential areas and parks, where people may spend substantial time outdoors have lower noise thresholds than businesses. For some buildings (e.g., recording studios, historical building with poor noise buffering capacity) inside noise levels are important. 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.

**Data Sources and References:**

- 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. http://www.fhwa.dot.gov/policy/hcas/final/five.htm
- Delucchi also provides estimates for buses: http://www.its.ucdavis.edu/publications/1996/UCD-ITS-RR-96-03(14)_rev1.pdf (Table 14-9)
- Some estimates for rail transit can be found at: http://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).

- Mark Delucchi, 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.

## Estimation Methods for Specific Indicators

### Physical Activity:
### Monetary value of lives saved per year due to cycling and walking

The general form for the equation for reduced mortality is below:

$$\begin{aligned}&Fewer\ [deaths]\\&= (Population\ numbers\ by\ sex\ and\ age\ category)\\&\times (Observed\ [mortality]\ rates\ for\ sex\ and\ age\ categories)\\&\times [1 - (increase\ in\ physical\ activity\ due\ to\ intervention)\\&\times (\%\ reduction\ in\ [mortality]\ risk\ per\ unit\ increase\ in\ physical\ activity)]\end{aligned}$$

The number of avoided mortalities per year would be multiplied by the value of a statistical life. We recommend using the value of statistical life from the ODOT policy, for consistency with valuing lives saved from safety measures, reducing air emissions, and all other pathways to reducing mortality impacts.

Each step of the process from estimating the changes in physical activity to monetizing the value of statistical lives saved has multiple uncertainties, only some of which would be captured in confidence intervals assuming that one has confidence intervals. The uncertainties can compound each other. How do we evaluate these chains of uncertainties?

As a program, we likely need to give some thought to identifying a process for defining key uncertainties that simultaneously underlie many of the indicators across the general indicator categories. Other criteria for identifying key uncertainties includes: significant impact on the value of the indicator, and important differentiators among alternative transportation schemes.

### Physical Activity:
### Monetary value of reductions in the population incidences of obesity and/or morbidity

The general form for the equation for reduced morbidity is the same as for mortality and is described below:

$$\begin{aligned}&Fewer\ [disease\ cases]\\&= (Population\ numbers\ by\ sex\ and\ age\ category)\\&\times (Observed\ [morbidity]\ rates\ for\ sex\ and\ age\ categories)\\&\times [1 - (increase\ in\ physical\ activity\ due\ to\ intervention)\\&\times (\%\ reduction\ in\ [morbidity]\ risk\ per\ unit\ increase\ in\ physical\ activity)]\end{aligned}$$

To monetize morbidity, the economic benefit measure of interest is the individual's willingness to pay (WTP) to reduce the risk of experiencing an illness. This measure consists of four components (Freeman, 2003).

- Averting cost (to reduce the risk of illness);
- Mitigating costs for treatments such as medical care and medication;
- Indirect costs such as lost time from paid work, maintaining a home, and pursuing leisure activities; and
- Less easily measured but equally real costs of discomfort, anxiety, pain, and suffering.

Methods used to estimate WTP vary in the extent to which they capture these components. Some studies directly estimate willingness to pay to avoid risk of illness using stated preference surveys. These studies are costly and difficult to implement. Other studies estimate only cost of illness and thus only capture mitigating and indirect costs, omitting averting expenditures and lost utility associated with pain and suffering. However, these estimates are less costly to obtain and easier to defend. For these reasons, it is important to identify what factors are included in the monetary values that are found in the empirical literature.

### Journey Ambiance

As applied, the methodology follows this 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

As applied, the methodology follows this 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

An HDR report provides the following flowchart outlining the Methodology to Monetize Journey Ambiance Benefits[11]:

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

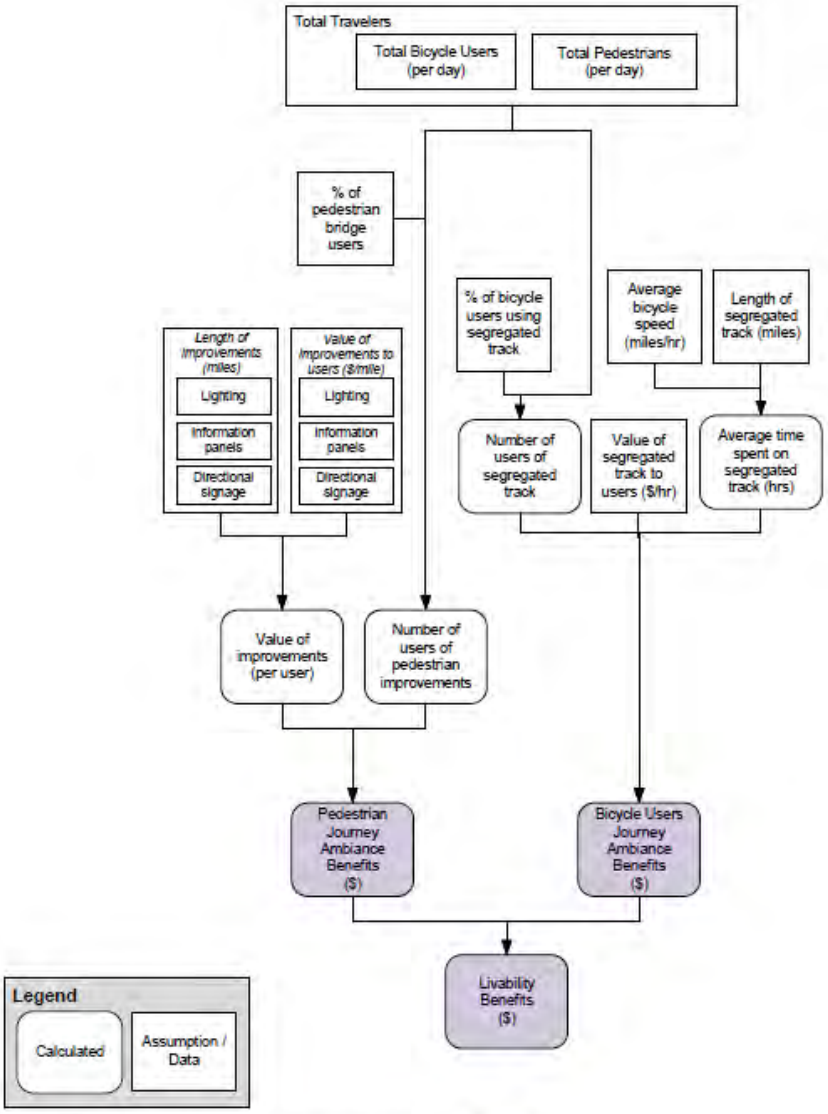


**Figure 7. Methodology to Monetize Journey Ambiance Benefits**

## Community Resources

The team recommends comparing transportation system plan alternatives using a qualitative scale to assess the overall impacts (net positive or negative) to community resources within the study area (derived from NATA and adapted for OLCP) using the following steps:

1. Map the GIS layers that show community resources using the definition provided in the data resources section, and according to data availability.
2. For each community resource in the study area, rate impacts on a scale of 1 to 5 for each transportation system plan alternative, where 1 is strongly negative, 2 is weakly negative, 3 is neutral, 4 is weakly positive, 5 is strongly positive. ODOT may consider asking representatives from other agencies to review the ratings. The same individuals should rate all schemes due to the subjective nature of the ratings.

3. Develop a composite rating for each transportation system plan alternative, based upon the results from #2. For example the composite qualitative rating may be positive, negative, mixed, indeterminate, or inconsequential according to the definitions below, derived from NATA and adapted for OLCP.

    - **Positive** – where the alternative contributes to the protection or enhancement of the community resources; this could apply either where the net probable outcome is clearly beneficial, or where mixed positive and negative impacts could apply but the positive substantially outweighs the negative.
    - **Negative** – where the alternative is detrimental to the protection of the community resources; this could apply either where the net probable outcome is clearly detrimental, or where mixed negative and positive impacts could apply but the negative substantially outweighs the positive.
    - **Mixed** – where the alternative has a combination of impacts on the community resources, but data resolution does not yet allow a conclusion on the balance between them or their magnitude.
    - **Indeterminate** – where the data level does not allow any secure conclusions about potential positive or negative impacts to be reached.
    - **Inconsequential** - the plan alternative will have minimal and insignificant impacts on the community resources.

The team recommends using Table 1 Heritage of Historic Resources – Definitions of Overall Assessment Scores from NATA for additional guidance on what constitutes positive or negative impacts (included as an attachment to this report).

The team also recommends retaining the information on number of resources in the study area; and the share assigned to each score, as well as the score assigned to each resource. Besides providing back-up documentation, this would provide a starting point for any more detailed assessment at a later date, should that be deemed necessary or desirable.

### Noise

ODOT is required to conduct noise impact analyses for projects that apply under 23 CFR 772. To comply with the federal requirements, ODOT has developed the Noise Manual, July 2011. This document details the methods and data requirements for developing predictions of baseline noise levels and future noise levels for each transportation system alternative under consideration. The model inputs include:

- pavement type,
- analysis years,
- traffic volumes,
- traffic speeds,
- number of lanes,
- acoustical barriers, and
- acceptable uses of traffic noise contours.

Noise predictions are developed using the latest version of the FHWA Traffic Noise Model (TNM) (currently version 2.5) or other models found acceptable to FHWA as noted in the FHWA Noise Standard. Model outputs will include the changes in noise levels in decibels. This is a data intensive process and it relies upon sophisticated analysis to predict the future baseline with project conditions. As such, it is not anticipated that ODOT will choose to apply similar methods to evaluate noise impacts to their planning decisions that are not subject to 23 CFR 772.

For LCP applications where ODOT has the flexibility to choose a less rigorous approach, we recommend the use of noise contours as a screening method for determining the approximate noise conditions for an area. The use of this method 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. The use of noise contours can give a good indication of the potential for noise impacts, and can do so at a reasonable cost. The use of contours however, is 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.

Sets of noise contours have been developed and the results are reported in a series of look-up tables, which are also available in software form (USDOT, 2004). The FHWA no longer maintains the software, but ODOT has a copy. The objective of the look-up tables is to provide a reference of pre-calculated Transportation Noise Model (TNM) results for simple highway geometries. "Simple highway geometries entail sound levels propagated from an infinitely-long, straight roadway over flat ground to receivers at user-selected offset distances. All receivers are set at a height of 1.5 m above the ground. Specifically, the tables contain results for the following parameters:

- Five vehicle types (automobiles, medium trucks, heavy trucks, buses, and motorcycles) at speeds of 0 to 130 kilometers per hour (km/h) in 10 km/h increments;
- Sound level propagation over acoustically hard or soft terrain;
- A single wall barrier (if desired) at a height of between 2 and 10 m, and located at a distance of either 10 or 30 m from the centerline of the roadway; and
- Receivers at distances from 10 to 300 m in 10 m increments from the centerline of the roadway." (pp 1-2).

The model would need to be run for baseline condition (without the proposed action) and the conditions with the alternative proposed actions. This is because both the noise level and the size of the change in the noise level matter. The outputs from the look-up tables will be in decibels. As a separate step, these decibel levels are compared to the threshold levels developed by ODOT for the different classes of receptors. (See the table below copied from the ODOT Noise Manual, Table 1, p.11).

**Table 7. Federal Highway Administration Noise Abatement Criteria—Oregon Department of Transportation Noise Abatement Approach Criteria Hourly A-Weighted Sound Level Decibels (dBA)**

| Activity Category | Activity Criteria[a] Leq (h) | | Evaluation Location | Land Use Activity Description |
|---|---|---|---|---|
| | FHWA NAC[b] | ODOT NAAC[c] | | |
| A | 57 | 55 | Exterior | Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where preserving those qualities is essential if the area is to continue to serve its intended purpose. |
| B[e] | 67 | 65 | Exterior | Residential |
| C[e] | 67 | 65 | Exterior | Active sports areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings |
| D | 52 | 50 | Interior | Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios |
| E[e] | 72 | 70 | Exterior | Hotels, motels, offices, restaurants/bars, and other developed lands, properties, or activities not included in A–D or F |
| F | — | — | — | Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing |
| G | — | — | — | Undeveloped lands that are not permitted |

[a] The Leq(h) Activity Criteria values are for impact determination only and are not design standards for noise abatement measures.
[b] Federal Highway Administration noise abatement criteria
[c] Oregon Department of Transportation noise abatement approach criteria
[e] Includes undeveloped lands permitted for this activity category

For residential receptors, apply monetary values from NATA as per Table 8 after adjusting pounds to dollars and after adjusting 2002 dollars to current dollars. For receptors other than residences, (i.e., business/commercial establishments; community services, historical/cultural/ parks and open spaces where people congregate) the number of impacted receptors by type may need to be noted.

Table 2 below (From WebTAG Unit 3.3 2 Noise Subobjective, Table 2 (p.10), Department for Transport, April 2011) shows the annual value of the impact of a 1dB change in exposure to noise at noise levels from 45 to 81 dB LAeq, 18 hr. These are the standard appraisal values based on the UK average household income, for general use. They are also the values applied in the TAG Noise Spreadsheet. They are expressed at 2002 prices and values and are assumed to

grow in line with real GDP per household. They should be used with a positive sign to value the benefit of noise reductions and with a negative sign to value the disbenefit of noise increases.

**Table 8. Monetary Value of Changes in Noise Level (per household, 2002 prices)**

| $L_{Aeq,\ 18hr}$ dB(A) | | £ per household per dB change |
|---|---|---|
| Low | High | |
| | <45 | 0.0 |
| 45 | 46 | 8.4 |
| 46 | 47 | 11.1 |
| 47 | 48 | 13.7 |
| 48 | 49 | 16.3 |
| 49 | 50 | 19.0 |
| 50 | 51 | 21.6 |
| 51 | 52 | 24.2 |
| 52 | 53 | 26.9 |
| 53 | 54 | 29.5 |
| 54 | 55 | 32.1 |
| 55 | 56 | 34.8 |
| 56 | 57 | 37.4 |
| 57 | 58 | 40.0 |
| 58 | 59 | 42.7 |
| 59 | 60 | 45.3 |
| 60 | 61 | 48.0 |
| 61 | 62 | 50.6 |
| 62 | 63 | 53.2 |
| 63 | 64 | 55.9 |
| 64 | 65 | 58.5 |
| 65 | 66 | 61.1 |
| 66 | 67 | 63.8 |
| 67 | 68 | 66.4 |
| 68 | 69 | 69.0 |
| 69 | 70 | 71.7 |
| 70 | 71 | 74.3 |
| 71 | 72 | 76.9 |
| 72 | 73 | 79.6 |
| 73 | 74 | 82.2 |
| 74 | 75 | 84.9 |
| 75 | 76 | 87.5 |
| 76 | 77 | 90.1 |
| 77 | 78 | 92.8 |
| 78 | 79 | 95.4 |
| 79 | 80 | 98.0 |
| 80 | 81 | 98.0 |

## IDT Membership

No changes in IDT membership has occurred since submission of the QoL IDT Methodology memo. However, the team has been regularly consulting with outside participants, including:

- Daniel S Morris, Oregon Health Authority
- Alex Bettinardi, ODOT Transportation Planning and Analysis Unit

- Carol Newvine, ODOT

The QoL IDT is grateful to those listed above for their ongoing assistance and insights.

In preparation of this memo, the QoL IDT members compared research and findings during six conference calls throughout January and February. Mariah and Mary Jo worked to compile the recommendations in this memo. The QoL IDT reviewed the draft memo simultaneously with the PMT's review. The team has compiled review comments and other edits received in February and incorporated them into the present document.

# Attachment 1 to QOL Draft Report

## Table A-1 Heritage of Historic Resources – Guidance for Assigning Assessment Scores for Impacts to Cultural/Historical/Community Resources[12]

**Large beneficial (positive) effect**

The plan alternative would:

- provide potential, through removal, relocation or substantial mitigation of very damaging or discordant existing impacts (direct or indirect) on the heritage, for very significant or extensive
- restoration or enhancement of characteristic features or their setting
- make a major contribution to government policies for the protection or enhancement of the heritage
- remove or successfully mitigate existing visual intrusion, such that the integrity, understanding and sense of place of a highly valued area, a group of sites or features of national or regional
- significance is re-established

**Moderate beneficial (positive) effect**

The proposals would:

- provide potential, through removal, relocation or mitigation of damaging or discordant existing impacts on the heritage, for significant restoration of characteristic features or their setting
- contribute to Regional or Local policies for the protection or enhancement of the heritage
- enhance existing historic landscape/townscape character through beneficial landscaping/mitigation and good design

**Slight beneficial (positive) effect**

The proposals:

- are not in conflict with national, regional or local policies for the protection of the heritage.
- restore or enhance the form, scale, pattern or sense of place of the heritage resource through good design and mitigation
- remove or mitigate visual intrusion (or other indirect impacts) into the context of locally or regionally significant heritage features, such that appreciation and understanding of them is improved

**Neutral effect**

The proposals:

[12] Department for Transport. 2003. The Heritage of Historic Resources Sub-Objective TAG Unit 3.3.9 Transport Analysis Guidance (TAG), p.9, June 2003. http://www.dft.gov.uk/webtag/documents/expert/pdf/unit3.3.9.pdf

- are not in conflict with, and do not contr bute to policies for the protection or enhancement of the heritage
- maintain existing historic character in a landscape/townscape
- have no appreciable impacts, either positive or negative, on any known or potential heritage assets
- are a combination of slight positive and negative impacts, on locally significant aspects of the heritage
- do not result in severance or loss of integrity, context or understanding within a Historic landscape

**Slight adverse (negative) effect**
The proposals would:
- be in conflict with local policies for the protection of the local character of the heritage
- have a detrimental impact on the context of regionally or locally significant assets, such that their integrity is compromised and appreciation and understanding of them is diminished
- damage locally significant heritage features for which adequate mitigation can be specified
- not fit well with the form, scale, pattern and character of a historic landscape/townscape/area

**Moderate adverse (negative) effect**
The proposals would:
- be out of scale with, or at odds with the scale, pattern or form of the heritage resource
- be intrusive in the setting (context), and will adversely affect the appreciation and understanding of the characteristic heritage resource
- be in conflict with local or regional policies for the protection of the heritage
- be damaging to nationally significant heritage assets, resulting in loss of features such that their integrity is compromised, but not destroyed, and adequate mitigation has been specified
- be a major direct impact on regionally or locally significant heritage, resulting in loss of features such that their integrity is substantially compromised, but adequate mitigation can be specified

**Large adverse (negative) effect**
The proposals would:
- have a major direct impact on nationally significant heritage assets such that they are lost or their integrity is severely damaged
- have a moderate direct impact on or compromise the wider setting of multiple nationally or regionally significant heritage assets, such that the cumulative impact would seriously compromise
- the integrity of a related group or historic landscape/townscape
- have a major direct impact on regional heritage assets, such that their integrity is lost and no adequate mitigation can be specified

- be highly intrusive and would seriously damage the setting of the heritage resource, such that its context is seriously compromised and can no longer be appreciated or understood
- be in serious conflict with government policy for the protection of the heritage, as set out in PPG 15 and PPG 16
- be strongly at variance with the form, scale and pattern of a historic landscape/townscape

# Mobility IDT Team:
# Specific Indicator Data Sources and Estimation Methods

To: Sam Seskin, CH2M HILL
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From: Lidwien Rahman/ODOT
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Date: February 29, 2012

## Introduction

The role of the Mobility Indicator Development Team (IDT) is to develop the set of specific indicators for the Mobility category of transportation system performance for the Oregon Least Cost Planning (LCP) project. This work includes developing a list of specific indicators and the estimation methods for evaluating them. This memorandum presents a more refined list of specific indicators, begins to identify the data and methods that could be used, and begins to lay out the steps involved in estimating the indicators for use in LCP.

This memo is the second for the Mobility IDT. On November 18th, 2011, the IDT submitted a memo that provided a draft list of specific indicators, and a brief overview of how the IDT would approach developing them. In response to this communication, the LCP core leadership team met throughout December to look across the nine categories of transportation system performance defined for the LCP project to ensure that the set of specific indicators was complete (addressing all key aspects of LCP), manageable, operational, and avoids duplication. The result of these discussions was a set of guidance back to the IDTs to reassess several indicators within their category, including questions about operationality and recommendations to eliminate specific indicators for reasons of duplication and manageability. This memo picks up from that set of guidance.

## Refined Specific Indicators

The Mobility IDT met to discuss this proposed guidance in January and February 2012, and this section documents its progress in listing a refined set of specific indicators. Table 1 provides a list of refined specific indicators that responds to the core leadership team's guidance. This table is, and will continue to be, a work in progress and may be revised as the Mobility IDT members work to further develop the specific indicators.

**Table 1: Refined Specific Indicators**

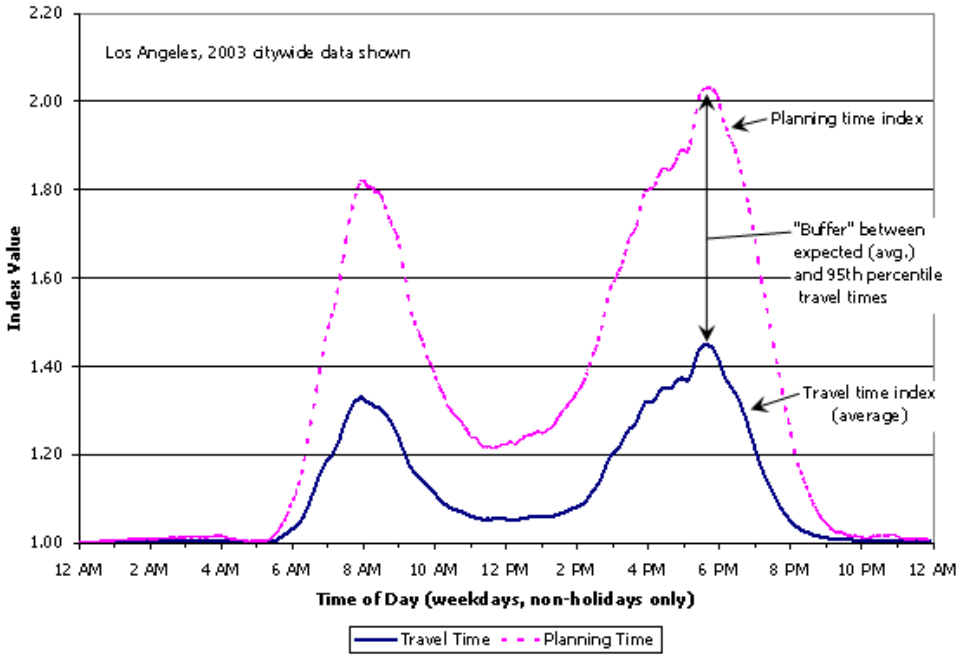
| General Indicator | Refined Specific Indicator(s) | Response to Leadership Team – Rationale, Thoughts, Concerns |
|---|---|---|
| *Travel Time* | *Travel Time (with Travel Time Index)* | • Travel time should be calculated for economic valuation along with Travel Time Index (TTI). TTI normalizes trips of different routes and lengths and provides the basis for developing reliability.<br>• Travel time should consider small incremental changes that consider ITS/operational strategies. Although we recommend giving guidance that small travel time improvements could just be reported.<br>• Costs, where feasible, should be developed by mode (i.e. SOV, HOV, transit, and freight). These modes typically have different costs associated with them.<br>• Suggest reporting freight and commuter-related trips travel times under Economic Vitality rather than Mobility.<br>• May not need to produce travel time for non-motorized modes such as pedestrians and bicyclists due to quality of travel time data and other LCP indicators are more important to these modes. |
| | *Hours of Congestion* | • Integrates existing traffic data with future travel demand/operational models.<br>• Uses demand to capacity ratio (D/C) as an input. Could also consider using ADT/C since this measure has already been established through previous HERS modeling. |
| *Quality of Service* | *Reliability – Recurring* | • Develop a buffer time index (BTI) to calculate the travel time reliability during peak periods. Buffer time represents how much additional time a person needs to ensure a reliable on-time trip. This would also create a congestion premium.<br>• Existing data can be used to correlate TTI and BTI that will assist in calculating future reliability. The TTI and BTI relationship has been performed in previous HERS modeling (Exhibit 2).<br>• May be able to be developed for non-urban (and non-model). |
| | *Reliability – Non-Recurring* | • Consider how non-recurring events, such as incidents (accidents and events) and seasonality (tourism), relate to roadway performance and understand their effect on |

| General Indicator | Refined Specific Indicator(s) | Response to Leadership Team – Rationale, Thoughts, Concerns |
|---|---|---|
| | | a system's reliability.<br>• Weather and construction were discussed, but in the context of evaluating long-range studies are not considered to be outcomes of the plan or controllable, unlike crashes and investment decisions to better respond to incidents and events.<br>• Depending on the data available, may not be able to develop this indicator outside of urban areas. |
| *Out of Pocket Costs* | *User Costs* | • Possibly relocate indicator. |
| *Trips* | *Mode Share* | • Report share for auto, carpool, transit, bike, and walk. |
| | *Vehicle Miles Travelled (VMT) per capita* | • Coordinate with Green House Gas (GHG) calculation. |

- Folks were very interested in travel time, reliability, mode share and VMT as indicators. Reliability is becoming more prevalent in the industry and used in the planning process. The team was intrigued about how to incorporate reliability into the decision-making process. A thought from the group was to create a buffer index that could quantify the reliability of a system or roadway. An example from FHWA is shown in Exhibit 1.
- There was a consensus that out of pocket costs needs to be comprehensive and if labeled within the Mobility category does it accomplish that? Thoughts on what it needs to cover are vehicle ownership costs including maintenance, parking, gas, tolls/fares etc. The team felt that many of these are not mobility related but very important to capture.
- The team felt that the HCM 2010 multi-modal LOS's (auto/pedestrian/bike/transit) indicator should be reported. It provides a different perspective than what is covered under accessibility. LOS addresses the perception, comfort and operations of the facility/system separately for motor vehicle drivers and passengers, pedestrians, transit riders, and bicyclists.

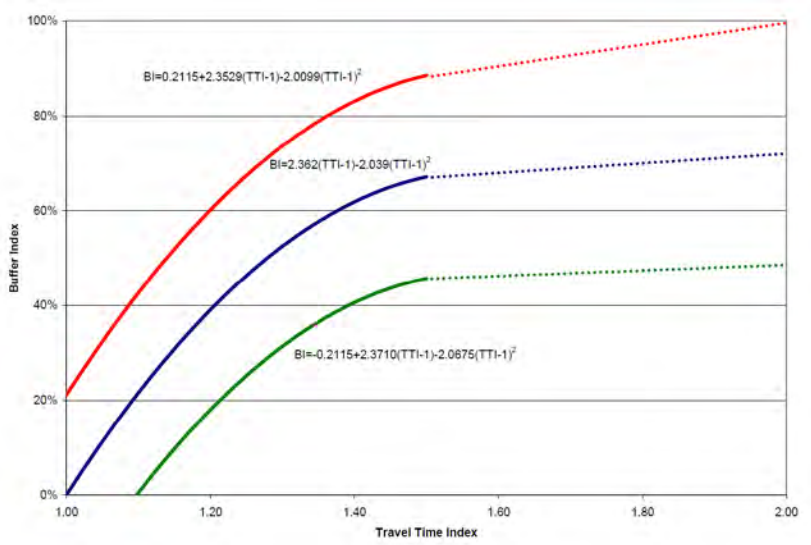
  It was agreed though that MMLOS seems to be more appropriate to corridor studies/plans and smaller-scale TSPs and not necessarily larger-scaled TSP's/regional analysis unless its effort is reduced or simplified (i.e. specific corridors or subareas).

## Exhibit 1 – Travel Time Reliability – Planning Time Index (PTI)




Source: http://www.ops.fhwa.dot.gov/publications/tt_reliability/TTR_Report.htm

## Exhibit 2 – Example: Travel Time Index and Buffer Index Relationship




Source: ODOT Operations Performance Measures Final Report, 2004

## Data Sources for Specific Indicators

For most of the mobility indicators, the values could be calculated by travel demand models, traffic operational analysis or traffic-related and survey/census data. In some cases, post-processing of model data/results may be necessary. In Oregon, travel demand models are available in numerous areas, including the possible use of the statewide travel demand model. Exhibit 2 produces a map of the areas were a model exists.

**Exhibit 2 – Oregon Travel Demand Models**

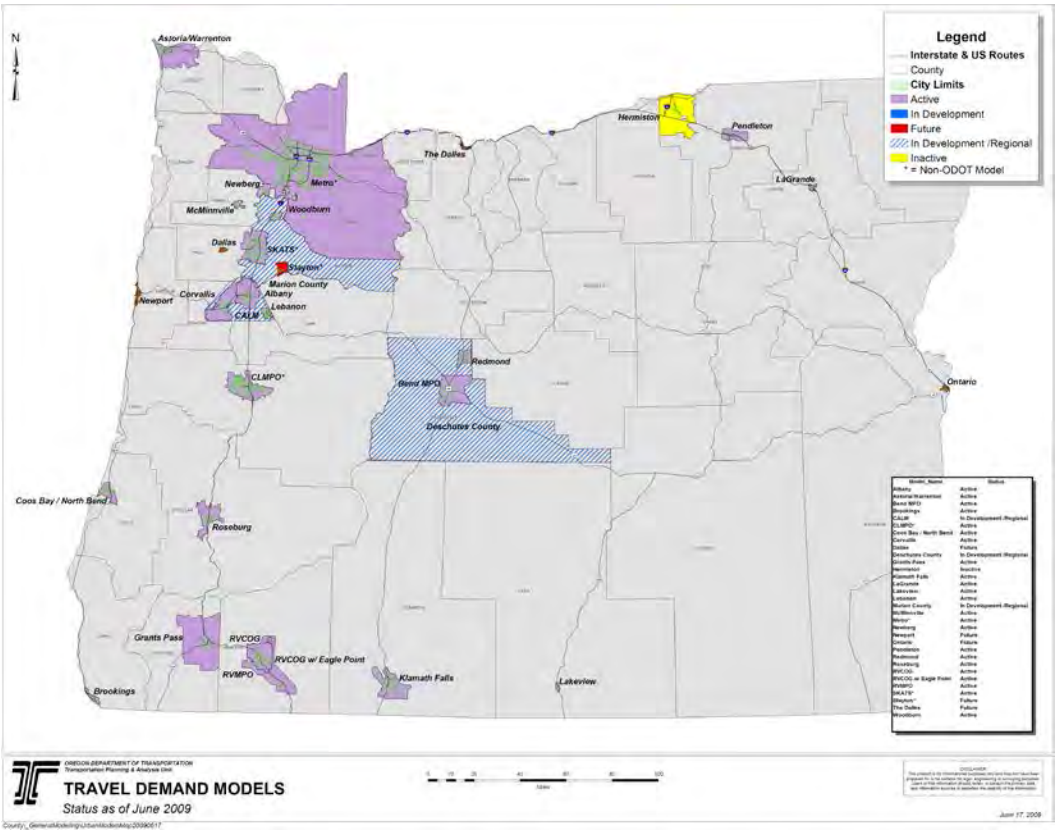



**Table 2: Specific Indicator - Data Sources**

| Specific Indicators | Data Sources |
|---|---|
| *Travel Time* | • In areas with a travel demand model, they typically produce travel times by mode, therefore minimal data collection or changes would generally need to be performed.<br>• In areas without a TDM, the agency would need to rely on different sources such as planning-level operational models (i.e. HERS or planning-level HCM methods). Roadway and volume data need to be collected to assist in the calculation. |
| *Hours of Congestion* | • Similar to travel time, hours of congestion can be calculated from either travel demand models or planning-level operational models. Roadway and volume data need to be collected to assist in the calculation. |

| Specific Indicators | Data Sources |
|---|---|
| *Reliability – Recurring* | • Data from the *Travel Time* indicator would be used in addition to existing multi-hour traffic data collected over a period of time. It would be preferred that data used to create the TTI and BTI relationship would be for over a year to incorporate seasonality.<br>• This could be achieved through the PORTAL system in Metro, possibly ATR sites for spot locations, 3rd party contracts (such as with INRIX) |
| *Reliability – Non-Recurring* | • Similar data sources as *Reliability – Recurring* indicator data sources with additional information on incident/events to understand their effect on roadways.<br>• Existing roadway and traffic data would need to be collected to quantify the effect of with and without incident/events on various types of roadway (for example effect incidents have in congestion vs. non-congestion conditions and on arterials versus highways). |
| *User Costs* | • Census and household data to understand vehicles per household classified by socio-economic information.<br>• Travel demand models typically provide cost information such as tolls/fare collection, parking costs and VMT that can produce fuel consumption. |
| *Mode Share* | • Mode share could be calculated from travel demand models. If a travel demand model is not available, traffic operational models could be used to estimate mode share. In addition to the data needed for VMT, average vehicle occupancy data and transit ridership information would need to be collected. |
| *VMT per Capita* | • VMT could be calculated from either travel demand models or traffic operational models. Roadway and volume data may need to be collected to assist in the calculation. Population information would come from the State's Population Center at Portland State University. |

## Estimation Methods for Specific Indicators

Many of the Mobility indicators are produced from readily-available travel demand models. Where models are not available and other software/tools are required, it was agreed that planning level applications need to be considered to economize the effort. Further development and testing will be needed in order to apply several of the indicators. Some of the implementation details need to be worked through during the LCP testing phase.

**Table 3: Specific Indicator - Estimation Methods**

| Specific Indicators | Estimation Methods |
|---|---|
| *Travel Time* | In areas with a travel demand model:<br>• Travel time can be produced based on origin-destination (O-D) data by zones 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.<br>• To separate commuter vs. non-commuter trips, travel time information can be classified by trip type (i.e. work-based trips) and models typically provide freight trip information.<br>In areas without a travel demand model:<br>• Would need to rely on different sources such as operational models (i.e. HERS and HCM planning level methods). These are usually performed for smaller-type roadway networks. To economize could use HCM – arterial analysis to produce roadway travel times.<br>• Vehicle classification count data could provide freight-related trips. Census or household survey information may provide commuter vs. non-commuter trips for area. Could also estimate based on information from similar areas or use information from the nearest area with a travel demand model.<br>• Depending on scale of study, this can be done at regional, sub-areas, or roadway levels. |
| *Hours of Congestion* | • In areas with a travel demand model, compare peak hour roadway segment demand to capacity ratio to existing multi-hour roadway counts to compute hours of congestion above the applicable mobility standard guidelines tables provided in the OHP – Mobility Standard Guidelines Report.<br>• For areas without a travel demand model, can perform the same calculation using traffic operational models.<br>• Depending on scale of study, this can be done across screenlines and roadway segments. |
| *Reliability – Recurring* | • Buffer time index (BTI) will produce additional travel time necessary to ensure on-time reliability. Reliability can be based on correlating existing TTI and BTI relationships to future travel times produced from a travel demand model or other source.<br>• Depending on the agency plan, roadway characteristics and TTI's will change, therefore the relationship between TTI and BTI will adjust and change reliability.<br>• Depending on scale of study, this can be done at regional, sub-areas, or roadway levels. |
| *Reliability – Non-Recurring* | • The travel times and indices developed for *Recurring Reliability* would provide the basis for developing *Non-Recurring Reliability*. |

| Specific Indicators | Estimation Methods |
|---|---|
| | • Existing data with and without incidents would be used to adjust those travel times and indices and develop non-recurring reliability information. Data would need to be developed for different roadway types and performance levels to understand an incidents effect in different situations.<br>• A component of the estimation method would be to correlate roadway performance levels to likelihood of incidents.<br>• Research on how ITS/incident management strategies adjust an incidents effect on travel could be incorporated to understand their benefits. |
| *User Costs* | • Summary of user costs that includes vehicle ownership, maintenance, parking, gas, tolls/fares. Gas and maintenance costs can be correlated to VMT or produced by HERS. |
| *Mode Share* | • Mode share information would be derived from a travel demand model or by other sources such as HERS. |
| *VMT per Capita* | • Travel demand model can produce VMT based on trip lengths and number of vehicles travelling within a defined area of zones.<br>• In areas without a travel demand model would need to rely on different sources such as operational models (i.e. HERS or HCM planning level methods).<br>• Depending on scale of study, this can be done at regional, sub-areas, or roadway levels. |

## IDT Membership

There have been no changes to the group's membership since last year's workshop. The group is fully-engaged and provides thoughtful comments during our conference calls. When necessary, additional information is provided via email for review and documentation purposes.

# Economic Vitality IDT Team: Specific Indicator Data Sources and Estimation Methods

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Date: February 21, 2012 (REVISED DRAFT)

## Introduction

The role of the *Economic Vitality* Indicator Development Team (IDT) is to develop the set of specific indicators for the *Economic Vitality* category of transportation system performance for the Oregon Least Cost Planning (LCP) project. This work includes developing a list of specific indicators and the estimation methods for evaluating them. This memorandum presents a refined list of specific indicators, documents the data that would be used, and lays out the steps involved in estimating the indicators for use in LCP.

This memo is the second for the *Economic Vitality* IDT. On November 18th 2011, the IDT submitted a memo that provided a draft list of specific indicators, and a brief overview of how the IDT would approach developing them. In response to this communication, the LCP core leadership team met throughout December to look across the nine categories of transportation system performance to ensure that the set of specific indicator was complete (addressing all key aspects of LCP), manageable, operational, and avoids duplication. The result of these discussions was a set of guidance back to the IDTs to reassess several indicators within their category, including questions about operationality and recommendations to eliminate specific indicators for reasons of duplication and manageability. This memo picks up from that set of guidance.

## Refined Specific Indicators

The *Economic Vitality* IDT met to discuss this proposed guidance in January 2012, and this section documents its progress in listing a refined set of specific indicators. Table 1 provides a list of refined specific indicators that responds to the core leadership team's guidance. This table is and will continue to be a work in progress and may be revised as the *Economic Vitality* IDT members work to further develop the specific indicators.

**Table 1: Refined Specific Indicators**

| General Indicator | Refined Specific Indicator(s) | Type | Response to Leadership Team – Rationale, Thoughts, Concerns |
|---|---|---|---|
| Economic Impacts of Spending for Construction | Number of jobs associated with the plan or bundle of actions (expressed in FTE jobs and job-years) | Quantitative Report Only | ▪ Name of general indicator changed to reflect focus on short-term, construction impacts<br>▪ Selection of single specific indicator (employment)<br>▪ Other measures of economic activity (e.g., GRP/GSP, income, tax revenue) may be derived as well, for information<br>▪ Use of rule-of-thumb relationship (e.g., $ per new job) OR parameter estimates from IMPLAN to quantify employment impacts<br>▪ Recommend inclusion of indicator as "Report Only" instead of MODA<br>▪ Use of "shadow pricing" in BCA when plan/project hires unemployed labor |
| Economic Impacts of more Efficient Transportation Services | Changes in generalized travel cost by industry (freight and on-the-clock worker travel) | Monetized | ▪ First proposed measure to be included in BCA (MONEY) under this category, instead of MOBILITY<br>▪ Estimation of effects on real economy (second measure) will require use of "predictive" economic impact model<br>▪ Preferred solution (use of SWIM look-up tables) will not be available for beta version of LCP tool |
| | Changes in state or regional employment by industry, and associated income metrics | Quantitative Report Only | |
| Structural Economic Effects of Transportation System Improvements | Changes in productivity from increased accessibility (agglomeration effects) | Monetized BCA | ▪ Selection of one specific indicator (agglomeration)<br>▪ Other effects (on competition, labor supply) to be considered in future versions of LCP tool<br>▪ Proposed indicator could be monetized and added to user benefits in BCA<br>▪ Some effects, however, may be captured in "Changes in state/ regional employment and associated income metrics" estimated from SWIM |
| Local Economic Development & Revitalization Effects | N/A | Report Only | ▪ Specific indicator(s) to be developed through coordination with EQUITY team<br>▪ Likely focus on Economically Distressed Areas |

## Which indicators are the most important at addressing the objective(s) of the Economic Vitality category?

- Indicators under the Economic Vitality category should address the following questions "*Does the plan or action contribute to the economic prosperity of Oregon (i.e., growth in employment, productivity or other high value economic activity)?*"
- The two most important indicators identified by the team are related to employment effects: Number of jobs associated with the plan or bundle of action (due to construction spending); and Changes in state/regional employment resulting from improved transportation services.
- The IDT recommends that neither measure be included in LCP through BCA or MODA, but simply be reported for information:
    - Labor used in construction should be considered a cost in LCP, and LCP users should avoid placing a value on to it.
    - The employment effects of improved transportation services would be, in large part, already counted as direct business transportation cost savings.
- The team also recognized that a number of additional measures could be derived with the economic impact models used in the estimation of employment effects. These may include: changes in output (value of sales), value added (GRP/GSP), or labor income by industry, as well as changes in state and local tax revenue.
- For the general indicator "Structural Economic Effects of Transportation System Improvements", the team recommends focusing on agglomeration effects; as they are generally considered the most significant of the "wider" economic impacts, and a number of practical approaches have been proposed for their estimation in the literature.

## Issue of duplication or potential duplication between specific indicators either within the Economic Vitality category or with other categories

- ***With other categories***: to a large extent, the economic impacts of more efficient transportation services are the re-expression of transportation user benefits estimated in other categories (e.g., MOBILITY, ACCESSIBILITY, SAFETY). Theoretical economists have shown that if the economy is highly efficient (if it operates under the assumptions of "perfect competition"), the sum of changes in final economic outcomes (e.g., value added, income) will be identical to the sum of transportation user benefits. This is only true – even in theory – if user benefits and economic outcomes are measured for the same geographic area, and over the same period of time. In practice, however, economies are not perfectly competitive, and user benefits and changes in economic outcomes are often estimated for different geographies. But a significant degree of overlap is likely to remain between indicators in the MOBILITY category and economic measures defined for the general indicator "Economic Impacts of more Efficient Transportation Services".

- ***Within the category***: the structural economic effects of transportation system improvements (aka wider economic impacts) may be accounted for in models used in the estimation of other economic effects, such as SWIM. Thus, the proposed specific indicator "Changes in state/ regional employment by industry" is likely to reflect both the "direct" economic impacts associated with travel time savings, reliability improvements and out-of-pocket cost savings (captured in the MOBILITY category) and other structural effects resulting from firms' and households' location decisions and improvements in system connectivity.
- Duplication issues may be mitigated by adopting one of the following two approaches:
    1. Derive transportation user benefits using a standard approach in terms of travel time savings, reliability improvements, and out-of-pocket cost savings in the MOBILITY category; and estimate "wider economic impacts", which by definition are those economic effects that are not accounted for in traditional measures of user benefits. Other indicators may be estimated as well in the ECONOMIC VITALITY category, but they would not be added to transportation user benefits (neither in BCA nor MODA); or
    2. Estimate the total economic impacts of the proposed plans or bundles of actions (i.e., the final economic outcomes) and use these estimates instead of MOBILITY measures in the overall tally of benefits. Changes in travel time, reliability, fuel consumption, etc. may still be quantified in MOBILITY, but the estimation of total monetized benefits would be based on ECONOMIC VITALITY indicators.
- The team feels that Approach #1, which is the most common in economic appraisals of transportation projects, would be preferable – in large part due to the difficulty of implementing Approach #2 in a satisfactory manner. Another reason is that some effects traditionally captured in MOBILITY have limited or no relation to the real economy (e.g., time savings for social and recreational travel), but should still be included in LCP (BCA).

## Data Sources & Estimation Methods for the Specific Indicator proposed under Economic Impacts of Spending for Construction

The team reviewed a number of possible estimating approaches:

1. Semi-quantitative assessment of employment impacts using an ordinal scale (as proposed by the PMT);
2. Application of a rule-of-thumb, in the spirit of the US DOT Guidance on Economic Impact Analysis for TIGER Grant Applications (e.g., use of Council of Economic Advisers' estimate of one job-year for every $92,000 of government spending);
3. Use of parameter estimates (e.g., Economic Multipliers) derived from IMPLAN for the State of Oregon as a whole, or regions and counties within the State, and built into the LCP tool;
4. Requiring that LCP users run IMPLAN (or another I/O model) and only input the outcomes of the analysis into the LCP tool; and

5. Requiring that LCP users run the Statewide Integrated Model.

The team recommended exploring Option #2 (application of a simple rule) and Option #3 (use of parameters from IMPLAN). Both options will be further investigated, and may eventually be built into the LCP tool.

LCP users may choose to run IMPLAN, SWIM or other economic impact models to derive more accurate estimates of employment effects, but this analysis would not be required.

The team agreed that it would be difficult, with the tools at hand, to estimate the net number of jobs created (Statewide, or in a region or county), and to separate jobs creation from jobs retention. Thus, the proposed specific indicator was defined as "*Number of jobs created or retained.*"

The team agreed that the specific indicator should only be reported in LCP: it should not be included in either BCA or MODA.

Finally, the team recommended using a "shadow wage" to estimate project costs in BCA when the plan (or bundle of actions) hires unemployed labor.

***Identification of Data Sources***

The cost information to be used in the estimation of economic impacts would be based on data collected for the FUNDING THE TRANSPORTATION SYSTEM / FINANCE category (Capital Costs and Lifecycle Costs general indicators).

Additional information may be required to break-down cost data into adequate cost categories (see Overview of Estimation Methods, below). The exact source of this information will be determined through coordination with the FUNDING THE TRANSPORTATION SYSTEM / FINANCE IDT.

Parameter values to estimate the direct, indirect and induced effects of construction spending may be derived from the IMPLAN (IMpact analysis for PLANning) Input-Output modeling system commercialized by the Minnesota IMPLAN Group (http://www.implan.com).

Datasets for the State of Oregon are available at the county level through MIG. The IDT will check whether the IMPLAN datasets purchased by TPAU (and possibly others within ODOT) may be used in applying the LCP methodology described below.

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 is a May 2009 memorandum prepared by the Council of Economic Advisers.[1] The memorandum provides a simple rule for estimating the number of job-years "created" by government spending. It argues that $92,000 of government spending creates one job-year (one person employed for one year); with 64% of the job-year estimate representing direct and indirect effects, and 36% representing induced effects

[1] 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

(http://www.whitehouse.gov/administration/eop/cea/Estimate-of-Job-Creation). A similar rule may be available, or estimated, for Oregon.

***Overview of Estimation Methods***

The method described below has been developed specifically for assessing the short-run economic impacts of construction spending. A similar approach could be applied in the estimation of employment impacts from incremental maintenance and operations spending, although uncertainty in the estimates would be considerably greater.

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

1. Definition of the area within which the impacts will be estimated.

2. Mapping of total capital costs into cost categories and groups of activities. These may include:

- *Land Acquisition* – This is primarily a transfer of assets and apart from real estate/financial/legal fees, there is typically no activity associated with this cost item;
- *Planning & Engineering* – Activities that occur before construction starts, including various professional services such as planning, preliminary engineering, design work, environmental impact assessment, or permitting;
- *Construction* – In addition to the construction of the structure itself, this category includes activities like demolition, excavation, drainage or landscaping; and
- *Fixture, Furniture & Equipment* – These items are not integral to the structure even though they are often part of the construction costs; they include road signs, rail signals, office furniture, and construction cranes.

3. Estimation of 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.

4. Where exact information on cost categories and expected spending location is not available for the plans or bundles of actions being assessed, historical cost data and factors may be used as approximations.

5. Matching of activities with IMPLAN sectors. All activity groups identified above must be matched with sectors in IMPLAN (MIG provides a bridge between IMPLAN sectors and NAICS).

6. Development of the impact model in IMPLAN, and impact analysis runs. 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, intermediate and final), value added (business output minus intermediate consumption), labor income, and tax revenue.

The estimation method outlined above may be used to develop a set of parameter values, structured as look-up tables for incorporation into the LCP tool. Development and use of these tables would involve running an IMPLAN impact analysis with a given level of expenditures (say $100 million) across a number of activities and sectors representing a "typical" transportation plan or project. The resulting direct, indirect and induced employment impacts would then be exported out of IMPLAN, arrayed by industry, and pro-rated linearly in the LCP tool, for LCP applications.

Look-up tables could be developed for different geographies (e.g., State, group of counties, individual counties) and different project types (e.g., highway construction, rail transit, bus transit).

The team also discussed developing adjustment factors to account for potential disruptions to economic activity during construction. The approach to estimating these factors has not been outlined yet.

***Use of Shadow Wages in the Estimation of Plan/Project Costs***

With high and persistent unemployment, the market wages used in the estimation of plan or project costs are likely to *exceed* the opportunity cost of labor (i.e., the true cost of the plan to society).[2] In other words, because some of the workers employed through the plan would be unemployed otherwise – or engaged in a lower-productivity occupation – the opportunity cost of their labor is less than what they receive in wages.

This provides a rational for adjusting the labor cost estimates used in BCA.

An approach to this adjustment consists of using the "shadow price" of labor, in lieu of market wages. In practice, however, estimating an exact "shadow wage" is very difficult. And various approximations have been proposed in the literature.

For example, the European Commission[3] suggests using the following formula, in situations of strong involuntary unemployment:

$$SWR = W.(1-u)$$

Where: *SWR* is the shadow wage
*W* is the market wage
*u* is the regional or national rate of unemployment[4]

Boardman et al. (2006) identify five possible measures, but all require that the number of workers who would be otherwise unemployed be estimated.[5]

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[2] This is due to minimum wage legislations and other labor market rigidities, which prevent wages from adjusting to a market-clearing level.

[3] European Commission, "Guide to Cost Benefit Analysis of Investment Projects", July 2008 http://ec.europa.eu/regional_policy/sources/docgener/guides/cost/guide2008_en.pdf

[4] The effects of taxation are ignored in this formula, for simplification

[5] 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

In situations where labor cost estimates are not available through the FUNDING THE TRANSPORTATION SYSTEM / FINANCE category, a percent factor (labor cost as a percentage of total capital or life-cycle costs) derived from data on comparable plans or bundles of actions may be used.

Note also that use of shadow pricing in LCP would require making assumptions about the business cycle (and unemployment) in the long term. This may not be advisable in all LCP applications.

***Team's Answers to PMT Questions***

| PMT Questions | Team's Answer |
|---|---|
| What data exist today that address the specific indicator? What is the data source? Is it publicly available? What is the range of accuracy? | ▪ Data on construction spending derived from measures developed for the FUNDING THE TRANSPORTATION SYSTEM / FINANCE category.<br>▪ Use of MIG's IMPLAN data sets and modeling system, supplemented with data from Oregon Employment Department.<br>▪ IMPLAN datasets are available for a fee, but purchase costs may be shared with other research efforts.<br>▪ Data and assumptions in IMPLAN are widely considered to be quite accurate, but they are static (e.g., there is no price adjustment); this can limit accuracy somewhat.<br>▪ The IMPLAN data used in estimation will be based on current economic conditions and industry structure, yet they may be applied to assess the impacts of construction spending occurring many years for now (in a 30-year plan). This again will reduce the accuracy of our estimates. |
| Do data rely on a travel demand model? If so, what geographies have these data in their model? | ▪ No. The proposed methods do not rely on travel demand data. |
| What is the scale of the data source? Meaning, are the data different for different geographies within Oregon? How easy or difficult is it to modify this data source's application to different geographies? | ▪ IMPLAN datasets are consistent in structure across all geographies.<br>▪ Employment effects could be estimated at the county level, for groups of counties (regions) or statewide.<br>▪ County-level analyses would be more costly, and look-up tables may be developed for broader geographies instead. |
| Does your source rely on any primary data collection? If so, is this typically conducted for a system-level planning effort? | ▪ No. |
| From your perspective, is Oregon on the verge of being able to take advantage of any groundbreaking or innovative research in the subject area of this indicator? What is the timeframe, and can anything be used this year (2012)? | ▪ TPAU might develop look-up tables based on SWIM scenario runs to simulate the impacts of construction spending -- in addition to assessing the effects of transportation system improvements.<br>▪ This would allow considering a broader range of effects and would lead to more accurate economic impact estimates.<br>▪ These tables would not be ready in 2012. |
| State in simple terms (words or a simple formula) the basics of the model involved in developing each specific indicator. What are the relationships between the variables being used? | ▪ Through data on inter-industry purchases and sales (Input-Output tables), and a number of simplifying assumptions, the IMPLAN model estimates the direct and "knock-on" (indirect and induced) effects of construction spending within different sectors of the economy.<br>▪ Reported estimates are "gross" impacts, which may include transfers from other sectors of the economy.<br>▪ The proposed methods will not allow estimating the number of net new jobs created. |

| PMT Questions | Team's Answer |
|---|---|
| How are these steps different if the geography of LCP's use is changed (for example, if LCP was used at a county scale as opposed to a metropolitan region scale) | ▪ The data sets and assumption values may be different, not the methodology. |
| What is the range of uncertainty involved in this specific indicator? How will you address this uncertainty? | ▪ The accuracy of the indicator will depend, in large part, on the accuracy of the cost estimates (and their composition) used in the estimation of direct spending.<br>▪ The use of IMPLAN (or similar I/O models), look-up tables or rules-of-thumb will introduce additional error<br>▪ This uncertainty can be addressed through sensitivity analysis. |

## Estimation Methods & Data Sources for the Specific Indicators proposed under Economic Impacts of more Efficient Transportation Services

The team has identified two specific indicators for this general indicator.

The first "Transportation Cost Savings by Industry (goods movement and business travel)" could be estimated with information produced by the MOBILITY team, combined with industry data from SWIM.

The team discussed a number of approaches to estimating the second proposed specific indicator (Changes in State or Regional Employment by Industry), including:

1. Running the TREDIS model (or similar off-the-shelves tool) and using the outcomes of the analysis as inputs to the LCP tool, for reporting purposes;
2. Running SWIM and using the outcomes of the analysis as inputs to the LCP tool, for reporting purposes; or
3. Using look-up tables based on SWIM scenario runs to estimate the indicator -- within the LCP tool.

The team felt that Option #3 was the most promising, for a number of reasons (including operationality and cost considerations).

This option was outlined by Becky Knudson in an e-mail to the PMT dated January 11, 2012. The email indicates that TPAU is currently preparing a work plan for developing the look-up tables. The IDT will review the work plan when it is ready, and update their proposed estimation methods accordingly.

As a result, the following sections describe data sources and methods for the first measure only, "Changes in generalized travel costs by industry (freight and on-the-clock worker travel)".

### *Identification of Data Sources*

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:

- Travel demand models at different levels of geography (e.g., state, MPO, non-MPO) may be used to estimate total cost savings (including travel time savings, reliability benefits, and out-of-pocket cost savings as defined in the MOBILITY category) and distribute them across different areas based on where savings occur, where trips originate, or where they end.
- Information on trip purposes embedded in travel demand models (e.g., Non-Home-Based Work for "on-the-clock" travel) may be supplemented with data from other models or sources used in planning applications.
- Data on business (production) locations may be obtained from SWIM, at a level on the order of Traffic Analysis Zones, over the entire state.
- Data on freight flows by industry and geographic area (e.g., Oregon Area Commissions on Transportation, selected freight corridors, or Traffic Analysis Zones) may be obtained from SWIM, from databases developed for the Oregon Freight Plan, or through the ongoing Freight Bottlenecks Study.

***Overview of Estimation Methods***

Estimating cost savings to freight flows by industry may involve one of the following three methods:

1. For travel demand analyses involving the use of SWIM, the model will likely produce benefit estimates broken down by industry, or could be re-programmed to do so.
2. In applications that do not involve the use of SWIM, a possible approach would be to use origin/destination data from the travel demand model used in the estimation of MOBILITY measures, and combine those data with information on business locations embedded in SWIM. Savings could be allocated to businesses and industries based on the origin and/or destination of freight flows.
3. An ongoing Freight Bottlenecks study by TPAU will help identify industries that depend on key corridors within the State, as well as the commodities being shipped through the corridors. Information produced as part of this study may be used to distribute travel cost savings across industries, although the exact approach to doing so has not been outlined.

Estimating cost savings to business travel by industry will require, first, isolating the portion of total cost savings accruing to "on-the-clock" travel. Travel demand models used in the estimation of MOBILITY measures may or may not have an adequate representation of this trip purpose. When they don't, the share of business travel in total travel (possibly derived from survey data) may be applied to the estimates of total cost savings produced with the transportation model. Information on business locations from SWIM or employment data from the U.S. Census Bureau (Local Employment Dynamics) may then be used to distribute savings across industries.

Other elements to consider in the estimation:

- The industry codes used in Business Oregon's strategic plan can be mapped into SWIM's industry classification -- if we are to produce estimates of transportation benefits to key,

"targeted" industries (e.g., clean technology, wood & forest products, advanced manufacturing, etc.).

- A 2007 study on the Cost of Highway Limitations and Traffic Delay to Oregon's Economy 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 IMPLAN will also help identify those industries relying most on transportation services.

***Team's Answers to PMT Questions***

| PMT Questions | Team's Answer |
|---|---|
| What data exist today that address the specific indicator? What is the data source? Is it publicly available? What is the range of accuracy? | ▪ Output from travel demand models used in the estimation of MOBILITY measures.<br>▪ Data on business locations from SWIM, supplemented possibly with data on employment location from US Census Bureau (LED).<br>▪ Data on freight flows from Oregon Freight Plan and associated databases (e.g., Oregon Commodity Flow Forecast).<br>▪ All the above data are publicly available.<br>▪ The accuracy of traditional travel demand models is generally considered to be poor. |
| Do data rely on a travel demand model? If so, what geographies have these data in their model? | ▪ Yes.<br>▪ The data needed for the estimation are typically available in trip tables, with origins and destinations defined at the TAZ level. |
| What is the scale of the data source? Meaning, are the data different for different geographies within Oregon? How easy or difficult is it to modify this data source's application to different geographies? | ▪ The scale of the data from the transportation model will depend on the application (State, Regional, non-MPO models).<br>▪ Employment and business location data are both available at a level compatible with travel demand model output.<br>▪ Long-haul freight flow data only available for major corridors or OD pairs. |
| Does your source rely on any primary data collection? If so, is this typically conducted for a system-level planning effort? | ▪ No. |
| From your perspective, is Oregon on the verge of being able to take advantage of any groundbreaking or innovative research in the subject area of this indicator? What is the timeframe, and can anything be used this year (2012)? | ▪ Yes.<br>▪ TPAU's proposal to develop look-up tables for use in the estimation of economic impacts resulting from transportation system improvements. Cannot be used in 2012.<br>▪ TPAU's Freight Bottlenecks study. Some emerging findings might be used in 2012. |
| State in simple terms (words or a simple formula) the basics of the model involved in developing each specific indicator. What are the relationships between the variables being used? | ▪ Estimates of travel cost savings will be disaggregated by trip purpose and industry using the geographic information embedded in travel demand models, and data on business and/or employment location, in SWIM and other databases. |
| How are these steps different if the geography of LCP's use is changed (for example, if LCP was used at a county scale as opposed to a metropolitan region scale) | ▪ The steps would be the same. The data sources and level of detail may vary across applications. |
| What is the range of uncertainty involved in this specific indicator? How will you address this uncertainty? | ▪ The accuracy of the indicator will depend, in large part, on the accuracy of the travel demand models. Mapping of travel cost savings to industries will add to that uncertainty, in particular when used in forecasting. |

| PMT Questions | Team's Answer |
|---|---|
| | ▪ This uncertainty may be addressed through scenario testing and sensitivity analysis and by providing a lot of caveats when presenting/describing the results. |

## Estimation Methods & Data Sources for the Specific Indicators proposed under Structural Economic Effects of Transportation System Improvements

The third general indicator of the ECONOMIC VITALITY category covers a number of distinct economic effects, including agglomeration economies, the economic impacts of increased competition, and labor supply effects.

If estimated properly, they can be added to the transportation user benefits estimated under MOBILITY, without risk of double-counting. In the economic literature they are referred to as "Wider Economic Impacts" (where wider really means "not accounted for elsewhere"; and impacts is used in lieu of benefits, to convey the idea that they can be positive or negative).

Following recommendations by the PMT, the team decided to focus its attention on a single indicator: Changes in productivity from increased accessibility, or agglomeration effects.

Prevailing methods for estimating agglomeration effects consist of quantifying changes in output – for a firm or an industry – resulting from a change in the proximity of that firm or industry to other firms, customers and employees, *holding everything else constant*.

The change in output due to the change in proximity (i.e., the elasticity of productivity with respect to agglomeration) is usually estimated using econometric techniques and cross-sectional data, where each cross-section is an industry.[6]

The literature suggests using "*effective density*" as an indicator of proximity.

The effective density of employment reflects the degree of accessibility to a firm or industry from a neighboring area, by weighting the number of workers living in the neighboring area by a measure of the transportation costs between the two locations. Effective density can be estimated using the following formula: [7]

$$D_{t,i} = \sum_k E_{t,k} \cdot T_{t,i,k}^{\alpha}$$

Where:

$D_{t,i}$ = effective density of employment of area *i* in year *t*

$E_{t,k}$ = work-place based employment in area *k* in year *t*

$T_{t,i,k}$ = generalized cost of travel between areas *i* and *k* in year *t*

[6] The use of micro data (i.e., data on individual firms, tracked over time as a panel) is a better option; but it is much more costly and not always possible to implement – due to privacy concerns.

[7] Adapted from: UK Department for Transport, *Transport, Wider Economic Benefits, and Impacts on GDP*, Discussion Paper, July 2005

$\alpha$ = parameter

***Overview of Estimation Methods***

The estimation would involve the following three steps:[8]

1. Estimating the impact of the plan or project on the effective density of employment in a given area, using output from a travel demand model;
2. Estimating -- or using existing, peer-reviewed estimates of -- the elasticity of total productivity with respect to effective density; and
3. Calculating agglomeration effects as: (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 (GDP in the area)

The resulting estimate would be expressed in monetary terms, and would be additive to the transportation user benefits calculated elsewhere (under MOBILITY).

Additional considerations and research items identified by the team:

1. What types of economic effects are represented in SWIM? Does SWIM simulate the effects of agglomeration on firms' costs? Are economies of scale accounted for in SWIM's implicit production functions?
2. Would agglomeration effects be additive to transportation user benefits estimated with SWIM, as opposed to with a traditional four-step travel demand model?
3. SWIM is undergoing a number of improvements, including replacement of the Economic-Demographic (ED) component with an economic scenario generator tool, and the use of PECAS to simulate the location decisions of firms and households. Would these improvements (and the use of PECAS in particular) change our answers to Questions 1 and 2 above?

The literature also raises a number of methodological issues:

- There is no consensus on the duration of agglomeration impacts, their estimation over time or the existence of a "maturation process" (i.e., "ramp-up" period).
- It is not clear how the magnitude of agglomeration effects vary with distance, and whether that relationship is linear (as assumed in most agglomeration studies) or not.

***Identification of Data Sources***

Estimation of the impacts of transportation plans on the effective density of an area may be done using data on employment location from SWIM and changes in generalized travel costs, as estimated in SWIM or other travel demand models.

[8] All steps would be "hard-wired" in the LCP tool, eventually.

A significant amount of research has been done to estimate the elasticity of productivity with respect to effective density; but empirical results vary greatly across studies. Melo et al. (2009) reviewed a large sample of studies of agglomeration effects. They reported elasticity estimates ranging from -0.088 to +0.194. They also found significant differences in magnitude over time and across industries.[9]

This suggests that using existing elasticity estimates published in the economic literature may be problematic.

An alternative approach may be to limit the definition of the specific indicator to "Effective Density of Employment", for inclusion in MODA or in the REPORT ONLY category.

***Team's Answers to PMT Questions***

| PMT Questions | Team's Answer |
|---|---|
| What data exist today that address the specific indicator? What is the data source? Is it publicly available? What is the range of accuracy? | ▪ Output from travel demand models used in the estimation of MOBILITY measures.<br>▪ Data on business locations from SWIM, supplemented possibly with data on employment location from US Census Bureau (LED).<br>▪ Elasticity coefficients from the economic literature.<br>▪ All the above data are publicly available.<br>▪ The accuracy of traditional travel demand models is generally considered to be poor.<br>▪ There are considerable concerns regarding the accuracy of available elasticity estimates, and agglomeration economies in general. |
| Do data rely on a travel demand model? If so, what geographies have these data in their model? | ▪ Yes.<br>▪ The data needed for the estimation are typically available in trip tables, with origins and destinations defined at the TAZ level. |
| What is the scale of the data source? Meaning, are the data different for different geographies within Oregon? How easy or difficult is it to modify this data source's application to different geographies? | ▪ The scale of the data from the transportation model will depend on the application (State, Regional, non-MPO models).<br>▪ Employment data are available at a level compatible with travel demand model output. |
| Does your source rely on any primary data collection? If so, is this typically conducted for a system-level planning effort? | ▪ No. |
| From your perspective, is Oregon on the verge of being able to take advantage of any groundbreaking or innovative research in the subject area of this indicator? What is the timeframe, and can anything be used this year (2012)? | ▪ Not clear at this stage.<br>▪ TPAU look-up tables described earlier in this memo may capture some agglomeration effects. |
| State in simple terms (words or a simple formula) the basics of the model involved in developing each specific indicator. What are the relationships between the variables being used? | ▪ The method can be summarized as follows: Agglomeration effects = (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 (GDP in the area)<br>▪ Due to difficulties associated with elasticity measurement, the specific indicator may be reduced to "Changes in the Effective |

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

| PMT Questions | Team's Answer |
|---|---|
| | Density of Employment". |
| How are these steps different if the geography of LCP's use is changed (for example, if LCP was used at a county scale as opposed to a metropolitan region scale) | ▪ The steps would be the same. The data sources and level of detail may vary across applications. |
| What is the range of uncertainty involved in this specific indicator? How will you address this uncertainty? | ▪ The accuracy of the indicator will depend on the accuracy of the travel demand models. Use of available evidence on the elasticity of productivity with respect to agglomeration would considerably add to that uncertainty.<br>▪ This uncertainty may be addressed through scenario testing and sensitivity analysis a. Alternatively, the indicator may be redefined to the simpler "Effective Density" concept. |

## Assessment of Uncertainty for the Economic Vitality Category as a Whole

***What is the range of uncertainty involved in the category when taken as a whole? What are some considerations around uncertainty when all the specific indicators in your category are aggregated, and assessed with the other categories? What should we be watching out for?***

The range of uncertainty involved in the ECONOMIC VITALITY category is much larger than in many other categories. This is true for the value of the proposed indicators under any planning option, and for the magnitude of the changes in the proposed indicators across planning options.

The extra uncertainty is due in large part to the nature of the category itself, where an attempt is being made to predict how the economy may respond to increased spending or improved travel conditions.

This response is complex , and the uncertainty associated with predicting it will, in most cases, compound the uncertainty associated with quantifying the direct effects of a plan or bundle of actions (estimated in the MOBILITY or FUNDING THE TRANSPORTATION SYSTEM categories).

## IDT Membership

The composition of the IDT has not changed. The members are:

- Lisa Ansell, Oregon Business Development Department
- Carolyn Eagan, Oregon Department of Employment
- Becky Knudson, ODOT, Transportation Planning Analysis Unit
- Denise Whitney-Dahlke, ODOT, Long Range Planning Unit

Dave Kavanaugh, Chief Economist at ODOT, provided comments by e-mail on the estimation of economic impacts of construction spending.

## Communication between Team Members

- January 26, 2012: e-mail to IDT with minutes from January 11 conference call and subsequent communications

- January 26, 2012: e-mail from Dave Kavanaugh on the estimation of FTE
- January 20, 2012: e-mail from Dave Kavanaugh on the estimation of economic impacts of construction spending
- January 13, 2012: e-mail from Becky Knudson on areas of SWIM improvements
- January 11, 2012: e-mail from Becky Knudson on the development of SWIM lookup tables
- January 11, 2012: conference call with Becky Knudson and Denise Whitney-Dahlke (Lisa Ansell and Carolyn Eagan unable to attend)

## List of Documents provided by Team Members

- Abraham, John E. and J.D. Hunt, *Random utility location/production/exchange choice, the additive logit model, and spatial choice micro-simulations*, Working Paper, TRB 2007
- Batten, Carl, *Replacing ED*, Draft Memorandum for Discussion Only, January 11, 2011
- Business Oregon, *Job Creation & Retention Policy*, effective January 1, 2012
- Business Oregon, *Key Performance Measures (KPM) Methodology Overview*, October 14, 2011
- Moeckel Rolf and Rick Donnelly, *Draft Specification for an Economic Scenario Generator (ECOS) for Oregon*, Parsons Brinckerhoff, Inc., January 29, 2010
- Oregon Business Council and Portland Business Alliance, *The Cost of Highway Limitations and Traffic Delay to Oregon's Economy*, prepared by the Economic Development Research Group, March 20, 2007
- ODOT, *Oregon Freight Plan*, prepared by Cambridge Systematics and the Freight Mobility Unit, Adopted June 15 2011
- ODOT, *Oregon Statewide Integrated Model (SWIM2), Model Description*, Draft Report version 2.5, prepared by Parsons Brinckerhoff, HBA Specto and EcoNorthwest, November 2010
- ODOT Freight Mobility Unit, *Oregon Freight Plan Modeling Analysis Technical Memo*, prepared by the ODOT Transportation Planning Analysis Unit, August 2010
- ODOT, *Economic and Transportation Modeling and Analysis of Bridge Options*, Technical Report, prepared by ODOT Transportation Planning Analysis Unit, Parsons Brinckerhoff Quade & Douglas, MW Consulting and HBA Specto, June 2004
- ODOT Transportation Planning Analysis Unit, *Analysis Tools*, memorandum, December 12, 2008
- ODOT Transportation Planning Analysis Unit, *Statewide Congestion Overview for Oregon*, January 2004

# Funding the Transportation System/Finance IDT Team: Specific Indicator Data Sources and Estimation Methods

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## Introduction

The role of the Funding the Transportation System/Finance Indicator Development Team (IDT) is to develop the set of specific indicators for the Funding the Transportation System/Finance category of transportation system performance for the Oregon Least Cost Planning (LCP) project. This work includes developing a list of specific indicators and the estimation methods for evaluating them. This memorandum presents a refined list of specific indicators, documents the data that would be used, and lays out the steps involved in estimating the indicators for use in LCP.

This memo is the second for the Funding the Transportation System/Finance IDT. On November 18, 2011 the IDT submitted a memo that provided a draft list of specific indicators, and a brief overview of how the IDT would approach developing them. In response to this communication, the LCP core leadership team met throughout December to look across the nine categories of transportation system performance to ensure that the set of specific indicator was complete (addressing all key aspects of LCP), manageable, operational, and avoids duplication. The result of these discussions was a set of guidance back to the IDTs to reassess several indicators within their category, including questions about operationality and recommendations to eliminate specific indicators for reasons of duplication and manageability. This memo picks up from that set of guidance.

## Refined Specific Indicators

The Funding the Transportation System/Finance IDT met to discuss this proposed guidance in January 2012, and this section documents its progress in listing a refined set of specific indicators. Table 1 provides a list of refined specific indicators that responds to the core leadership team's guidance. This table is and will continue to be a work in progress and may be revised as the Funding the Transportation System/Finance IDT members work to further develop the specific indicators.

**Table 1: Refined Specific Indicators**

| General Indicator | Refined Specific Indicator(s) | Response to Leadership Team – Rationale, Thoughts, Concerns |
|---|---|---|
| Capital Costs | Total Capital Costs | Team recognizes that, even though per-mile and other per-unit-based cost factors are the most appropriate way to estimate program costs at the planning level, they are broad in nature and therefore are subject to inaccuracies. Whenever possible, team recommends users of LCP process to cite the source (e.g., guidance or specific document) from which the per-unit cost estimates were calculated or taken. |
| Lifecycle Costs | Total Lifecycle Costs | Clear conceptual guidelines and methodologies should be written for every cost sub-category to avoid double-counting in the estimation of lifecycle costs. Total lifecycle costs include financial cost component, which is not traditionally part of CBA accounting. |
| Operating Revenues | Total Revenues | Team would like to emphasize that the total amount of operating revenue may not be the best indicator to reflect the importance of revenues. 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." |
| Leveraging Funds from Private Sector and Other State / Federal Agencies | Percentage of lifecycle funds that are "new" and "recycled" | Team would like to emphasize that "new" funds are preferred over "recycled" funds since they represent additional money that will be spent in transportation projects. |
| Net Impact on State Fiscal Balance and Debt | Net fiscal impact of program | Team would like to emphasize that some of the specific indicators chosen for deletion (i.e., "Percentage of State Debt Capacity Remaining After Borrowing to Cover Capital Costs" and "Impact of Program on State's Balance Sheet") were meant to capture any State factors that could jeopardize the completion of a "bundle." As such, the team proposes to include an additional specific indicator on "Risk of State Factors Jeopardizing the Program." The specific indicator can be added using a 1 to 5 scale (where 1 is "low risk" and 5 is "high risk") and a detailed characterization of the risk levels can be |

| General Indicator | Refined Specific Indicator(s) | Response to Leadership Team – Rationale, Thoughts, Concerns |
|---|---|---|
| | | developed (as guidance) based on the types of risk and their potential outcome (preliminary list of potential risk factors and their outcomes included in Appendix). It is suggested that this specific indicator be included as part of the MODA aggregation process. |

From the specific indicators listed above, special emphasis should be placed on "Total Lifecycle Costs," "Percentage of lifecycle funds that are 'new' (or private) and 'recycled'" and "Net fiscal impact of program." The first specific indicator provides an estimate of the total cost of implementing a "bundle" and should be compared to the benefits generated by it. The second indicator captures the "bundle's" potential to diversify its sources of funding beyond the state and regional realm. Finally, the third indicator communicates the actual cost society will pay for a specific "bundle."

The Funding the Transportation System/Finance IDT identified four topics that require attention by the project's core team:

- IDT assumed that reduction of costs on other parts of the system as a result of the completion of a "bundle" are included in the estimation of the Total Lifecycle Cost indicator. The validity of this assumption requires confirmation by the core team to avoid double-counting issues with similar benefit captured somewhere else in the LCP framework.
- Estimation of total lifecycle costs includes a financial cost component related to the interest payment resulting from the public sector borrowing funds to finance a "bundle." This component is not part of a traditional (i.e., economic) CBA estimation since the interest costs are implicitly taken into account by means of the discount rate[1]. Therefore, caution should be exercise when deciding the aggregation procedure used for this specific indicator (CBA vs. MODA).
- Estimation of farebox revenues, a component of the operating revenues specific indicator, should be contrasted with other specific indicators estimated under the mobility category (especially travel time savings) to ensure no double counting exists and to guarantee the correct magnitude of the impacts estimated under each specific indicator.
- Some of the inputs used in the construction of the indicators under the Funding the Transportation System/Finance category can be combined with those of a traditional CBA to create a Financial CBA metric. Both measures (i.e., the economic and the financial CBA) provide a different type of feasibility test that may be relevant for decision-makers and therefore there may be a need to use both in the LCP framework. Whereas economic CBA

[1] The financial component of the total lifecycle costs, along with the total operating revenues, can be used to estimate a financial CBA. However, the procedure and goals of a financial CBA bear little resemblance to those of a traditional CBA (see discussion on "topics that require attention by core team" for a proposed way to introduce financial CBA considerations in the LCP framework).

focuses on determining the feasibility of a "bundle" from the social perspective through the generation of social benefits above social costs, the financial CBA assesses the financial viability of that same "bundle" using financial-returns metrics that reflect the "bundle's" attractiveness from a financial standpoint. As a result of this distinction, "bundles" that generate a large amount of social benefits and are socially feasible may exhibit a lack of financial viability due to cash-flow concerns. Similarly, "bundles" that are financially viable may not generate enough social benefits to be considered socially desirable. Inclusion of the financial CBA metric does not imply that a new stand-alone aggregation procedure needs to be created in the LCP framework. The financial CBA metric could be included as part of the MODA classification, where the weights associated to this metric would represent the importance to decision makers of the financial viability criterion[2].

## Data Sources and Estimation Methods for Specific Indicators

The characteristics of the data sources and estimation methods that were identified for each one of the specific indicators in this category are described in the following tables.

[2] Specific and detailed guidance would have to be developed to describe the methodology for estimating the "Financial CBA."

**General Indicator:** Capital Costs.
**Specific Indicator:** Total Capital Costs.

| DATA SOURCES | |
|---|---|
| **Characteristic** | **Description & Comments** |
| Type of input used in estimation | Preferred: cost estimation by team of engineers.<br>Alternative: capital cost factors & characteristics for "bundle" components (e.g., projects or programs) |
| Potential data sources | Cost estimation is reported in specialized engineering documents generated for specific "bundle" components, including preliminary design studies. Capital 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. |
| Availability of data | Cost estimation by engineering team may be available if "bundle" component is sufficiently developed. However, due to the nature of the LCP exercise, in the majority of cases these studies will not be available. Historical records of construction expenditures for certain modes (specifically roads) exist within ODOT. For other modes, information can be requested from the relevant agencies[3] or comparables can be used from the literature and other publicly available databases such as the National Transit Database (NTD). Prospective documents – created by scoping teams – can be used to determine characteristics of "bundle" components (i.e., individual projects or programs) such as length, location, type of improvement and construction schedule and may even include cost estimates. |
| Accuracy of data | Different levels of accuracy for engineering studies. The more advanced the "bundle" component, the higher the accuracy and the breakdown into different cost types (e.g., engineering and design). In the case of capital cost factors, some inaccuracies may arise in their estimation due to aggregation of available information over project types and locations. Additionally, the introduction of contingencies may reduce the accuracy of the estimates. However, factor-based estimates are considered acceptable for planning purposes. |
| Scale of data sources | Engineering studies provide estimates that are specific to the "bundle" components considered. Capital cost factors may aggregate over project types but normally discriminate according to geography (see Appendix for example of capital costs factors). This is generally acceptable for planning purposes. |

[3] Draft list of agencies included as Appendix to this document.

| ESTIMATION METHOD | |
|---|---|
| **Characteristic** | **Description & Comments** |
| Description of method | Preferred: aggregation of costs of individual "bundle" components reported in engineering studies (if available).<br>Alternative: high-level capital cost factors will be used in combination with specific characteristics of each "bundle" components to determine the "bundle's" total capital costs. Capital cost factors vary by transportation mode, type of infrastructure, length and location of the improvement (rural/urban).<br>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. Independently of the method used, total capital cost for each "bundle" will be estimated on a yearly basis and costs in future years will be discounted using the appropriate discount rate to obtain the present value of total capital costs. |
| Scale of methodology | Both methodologies take into account differences in project types and geographies since they are based on cost estimations for individual "bundle" components. |
| Uncertainties & risks | Engineering studies are typically unavailable at the planning stage. Cost factors may not coincide with description of improvements in individual "bundle" components and therefore cost factors for similar improvements may need to be used. |
| Range of uncertainty | If engineering studies are not available, cost-factor method can be employed. Despite a potential lack of exact correspondence between available cost factors and characteristics of individual "bundle" components, cost estimation using factors for similar characteristics is acceptable in planning exercises. |

**General Indicator:** Lifecycle Costs.
**Specific Indicator:** Total Lifecycle Costs.

| DATA SOURCES | |
|---|---|
| **Characteristic** | **Description & Comments** |
| Type of input used in estimation | High-level capital cost and O&M factors will be used in combination with specific characteristics of each "bundle" components to determine the capital and O&M components of the "bundle's" total lifecycle costs. Financial costs will be estimated using cash-flow calculations for each "bundle" and cost of borrowing funds. The "other costs" sub-category will consist of expert's opinions. |
| Potential data sources | Capital and 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 can be obtained from ODOT. Subject matter experts will be responsible for estimating the "other costs" sub-category. |
| Availability of data | Historical records for capital and O&M costs exist for highway projects within ODOT. For other modes, information can be requested from the relevant agencies[4] 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" are performed by ODOT. Moreover, this agency has estimates of borrowing costs that can be used to estimate the financial costs of borrowing funds for different "bundles." ODOT staff or external consultants can act as subject matter experts. |
| Accuracy of data | In the case of capital and O&M cost factors, some inaccuracies may arise in their estimation due to aggregation of available information over project types and locations. Cash flow estimations can also be inaccurate due to the uncertainty in the deployment of committed funds, with the inaccuracy growing with time. Subject matter experts may provide relatively accurate estimations due to their experience. |
| Scale of data sources | 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 not be replicable at a smaller-than-state geography depending on the specific borrowing capacity of the corresponding authority. Estimations by subject matter expert estimations are component-specific and therefore scalable. |

[4] See Appendix for a list of agencies.

| ESTIMATION METHOD | |
|---|---|
| **Characteristic** | **Description & Comments** |
| Description of method | Total Lifecycle Costs = Total Capital Cost + O&M Cost + Financial Costs (including borrowing costs for fiscal funds) + Other Costs[5]. All types of costs should be estimated on a yearly basis during the entire planning horizon (determined by the overall LCP process) and then discounted using the appropriate discount factor to obtain their present value.<br>Total capital costs will be estimated as described in the specific indicator. O&M costs will be estimated applying high-level cost factors to the improvements included in each "bundle" and their corresponding operating standards[6]. O&M cost factors vary by transportation mode, type of infrastructure and location and may not have a homogeneous unit for its application (e.g., some may be applied on a per-mile basis while others on a per-user basis). Further research is needed to determine the units in which each factor will be applied. Financial costs will be estimated based on yearly funding "gaps" 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 "gaps" will be determined as if it was incurred at the beginning of the construction period using the appropriate credit market rate. Whenever possible, other costs will be calculated using subject matter expert opinions. |
| Scale of methodology | 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. |
| Uncertainties & risks | Capital and/or O&M cost factors may not coincide with description of improvements in individual "bundle" components and therefore cost factors for similar improvements may need to be used. Additionally, some geographic areas where "bundles" are considered may not have borrowing capacity and therefore estimation of financial cost may be impossible. In other cases, the geographic area may have a different borrowing cost for funds compared to the cost to the State of Oregon. This borrowing cost may be subject to different degrees of uncertainty. |
| Range of uncertainty | Uncertainty in cost factors can be moderate but is acceptable in planning exercises. Uncertainty about the borrowing capacity and/or borrowing differential is expected to increase as the geographic area becomes smaller. |

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

[6] 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.

**General Indicator:** Operating Revenues.
**Specific Indicator:** Total Revenues.

| DATA SOURCES | |
|---|---|
| **Characteristic** | **Description & Comments** |
| Type of input used in estimation | Preferred: preliminary financial studies for specific "bundle" component.<br>Alternative: revenue factors & characteristics for "bundle" components (for "incidental revenues" only) |
| Potential data sources | The order of preference for data is the following: (i) preliminary financial studies; (ii) historical data from Oregon recorded by ODOT or another government agency; (iii) historical data from Oregon recorded by private sector operator; (iv) comparables from the literature or public databases. |
| Availability of data | For "incidental revenues" in highways, historical data to estimate revenue factors may be available at ODOT but needs to be properly organized for its use. Alternatively, comparables from the literature can be used to estimate the appropriate factors. For other modes, information can be requested from relevant agencies or private operators[7].<br>For farebox revenues the ownership of the "bundle" will determine the source of data. For example, for private-sector promoted "bundles," projections used in preliminary financial studies are usually available and can be requested by ODOT. For "bundles" promoted by the government, the agency promoting the "bundle" must provide the estimates. In government-promoted "bundles" the availability of preliminary studies may be limited.<br>For tax-revenue increases associated to each "bundle," the corresponding agency at the appropriate geographic level will have to provide the estimated amount[8]. The availability of preliminary studies may be limited. |
| Accuracy of data | Preliminary financial studies offer the highest accuracy since they are performed for the specific "bundle" component. Historical data from the state may be subject to aggregation inaccuracies (i.e., revenue factors calculated using this process may not correspond exactly to improvements featured in "bundle" components analyzed). Comparables from literature potentially present the highest inaccuracy due to differences in location, behavior by users, etc. |
| Scale of data sources | Preliminary financial studies are tailor-made and therefore scalable to any geography. Historical data from state and comparables from literature may be scalable to different geographies, though it varies by transportation mode (potentially less scalable for transit components and more scalable for highways). |

[7] See Appendix for a list of potential external agencies.
[8] If the "bundle" generates an increase in state taxes, ODOT will provide this estimation.

| ESTIMATION METHOD | |
|---|---|
| **Characteristic** | **Description & Comments** |
| Description of method | Total revenues = "incidental revenues" (e.g., leasing of 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")[9].<br>Total gross revenue generated by "bundle" will be estimated on a yearly basis; revenues of future years will be discounted using the appropriate discount rate, resulting in present value estimations[10].<br>In the cases of farebox revenues and additional marginal tax revenues, standard methodologies (i.e., based in demand parameters and elasticities) must be used in the estimation of revenues[11]. In the case of "incidental revenues," high-level revenue factors may be used in combination with "bundle" characteristics to estimate this amount[12]. |
| Scale of methodology | Both methodologies (preliminary financial studies and revenue factors) can be scalable to any geographic level since they depend on individual characteristics of "bundle" components for their implementation. |
| Uncertainties & risks | Preliminary financial studies may not always be available, especially during the planning phase of "bundle" components. Therefore, in many occasions this indicator may be equal to zero or, alternatively, may not be able to convey all the revenue-generating potential of a "bundle." Alternatively, if revenue factors are used to estimate "incidental revenues," these factors may not coincide with the specific characteristics of individual "bundle" components and therefore factors for similar components may need to be used. |
| Range of uncertainty | If preliminary financial studies are available, the level of uncertainty is acceptable for a planning exercise. However, if they are not available, revenue potential will be consistently underestimated, causing "bundles" to appear less attractive than they potentially are. |

[9] 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.

[10] For consistency, if the definition of total lifecycle costs used in this document (i.e., including financial costs) is to be used as part of the CBA aggregation process, then the operating costs indicator should also be included in the CBA classification. This could imply reclassifying some specific indicators in the mobility category to avoid double counting (for example, between farebox revenues and travel time savings).

[11] In both cases, the corresponding agency at the appropriate geographic level will have to provide the methodology used in the preliminary financial studies.

[12] Appropriate units (e.g., per-mile or per-user) must be used in this estimation. Further research is needed to determine the appropriate units for different types of incidental revenues and project types.

**General Indicator:** Leveraging Funds from Private Sector and Other State / Federal Agencies.
**Specific Indicator:** Percentage of lifecycle funds that are "new" and "recycled."

| DATA SOURCES | |
|---|---|
| **Characteristic** | **Description & Comments** |
| Type of input used in estimation | Amount of financial contributions to "bundle" from private sector and "fresh" funds generated by local public agencies ("new" funds) and financial contributions from local or regional governments ("recycled") as reported in the appropriate documents. Total funds required by "bundle" (denominator in indicator's equation) correspond to total lifecycle costs estimated in appropriate specific indicator. In response to SSC comments, the team will in this indicator measure financial rate of return on investment (ROI). |
| Potential data sources | Two main sources to identify leveraged funds: (i) communications and negotiations for state-allocated Federal funds with Area Commissions of Transportation; (ii) applications (used in a broad sense) for statewide competitive funding programs. Additionally, ODOT has a P3 unit to promote and regulate public-private partnerships. As these arrangements become more common, the P3 unit can turn into a source of information for private funds invested. |
| Availability of data | Communications are submitted to or negotiations are held with Oregon's Transportation Commission 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." Amount of total lifecycle costs will be estimated in corresponding specific indicator. |
| Accuracy of data | Communications sent to and negotiations held with ODOT contain preliminary information but require a certain level of commitment by the applicant to honor the obligations. Therefore, the accuracy of the data is adequate for a planning exercise. |
| Scale of data sources | Data is generated at the local level (specific geography depends on the specific Area Commission of Transportation) and therefore calculation of this indicator is easily scalable to any geographic level within Oregon. |

| ESTIMATION METHOD | |
|---|---|
| **Characteristic** | **Description & Comments** |
| Description of method | Percentage = [ ("New" + "Recycled" funds) / Total "bundle" funds ] * 100<br>"New" funds will be equivalent to the funds committed[13] 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) reported in the appropriate documentation. "Recycled" funds will be equivalent to the funds committed by other local, state or Federal agencies to each "bundle" that are not considered "new" (according to the definition established above), 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 "total lifecycle costs" specific indicator.<br>In all cases funds will be reported in their present value (i.e., discounted at the appropriate discount rate based on their schedule of investment). |
| Scale of methodology | The methodology can be scaled to any geographic level since the components of the formula are also scalable. |
| Uncertainties & risks | Main uncertainties are those expressed in the estimation of "total lifecycle costs" specific indicator since it corresponds to the total "bundle" funds used as denominator in the equation. Also, there is a risk of potentially having to evaluate a "bundle" that was not discussed with Oregon's Transportation Commission using the mechanism explained in the "data sources" section. In this case, estimates of "new" and "recycled" funds will have to be provided by the appropriate agency to estimate this indicator. |
| Range of uncertainty | The uncertainty associated to the estimation of total "bundle" funds is adequate for planning purposes. Uncertainty related to the evaluation of "bundles" that did not follow the procedure established in the "data sources" section may be high, depending on the definition of "funds committed" used by the agency reporting this amount. |

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

**General Indicator:** Net Impact on State Fiscal Balance and Debt.
**Specific Indicator:** Net fiscal impact of program[14].

| DATA SOURCES | |
|---|---|
| **Characteristic** | **Description & Comments** |
| Type of input used in estimation | For "total revenues" and "total lifecycle costs" components of the formula, amounts estimated in the specific indicators. For "new" funds, corresponding amount estimated as part of the "percentage of lifecycle funds that are 'new' (or private) and 'recycled'" specific indicator. |
| Potential data sources | For each component of the formula, those listed in the corresponding specific indicators. |
| Availability of data | Amounts of "new" (or private) funds, total revenues and total lifecycle costs along with their schedules of realization/investment will be obtained from the sources listed for each corresponding specific indicator. However, as it was explained in each specific indicator, some of those sources may not be available. Specific examples include farebox revenue studies (portion of total revenues component of formula), borrowing costs (portion of total lifecycle costs component of formula) and additional tax revenues (portion of total lifecycle costs component of formula). |
| Accuracy of data | Different formula components have different accuracy levels. In particular, the least accuracy can stem from the amount of total revenue due to a potential lack of preliminary financial studies to estimate it. Another potential uncertainty is the financial cost portion of the total lifecycle cost component of the formula, since for smaller-than-state geographies this amount may not be available. |
| Scale of data sources | With the exception of borrowing costs, all data is potentially scalable at the less-than-state geography. |

[14] By construction, this specific indicator captures the amount of federal, state and local funds (including borrowing) needed to cover the lifecycle costs of a "bundle." However, in itself does not provide an assessment on the feasibility of realizing each one of them (in particular borrowing).

| ESTIMATION METHOD | |
|---|---|
| **Characteristic** | **Description & Comments** |
| Description of method | Fiscal Impact = "New" Funds + Total Revenues – Total Lifecycle Costs. Measured as the "gap" between total funds available from non-public sources (i.e., "new" funds and operating revenues) and total lifecycle costs associated to each "bundle."<br>"Gap" will be reported in its present value (i.e., discounted at the appropriate discount rate) following the schedule of its components. |
| Scale of methodology | Most components of the formula can be scalable and their results are adequate for planning purposes. However, the financial costs portion of the total lifecycle cost component of the formula may not be scalable to some geography levels. |
| Uncertainties & risks | The uncertainty for this specific indicator is a combination of the individual uncertainties of the specific indicators associated to the formula components. Therefore, an important uncertainty is the availability of borrowing capacity and borrowing costs for less-than-state geographic levels. Additionally, there is a risk that total revenues may be equal to zero or may not be able to convey all the revenue-generating potential of a "bundle" due to a lack of preliminary financial studies. Finally, there is a risk of having to evaluate "bundles" that did not apply to Oregon's Transportation Commission and therefore may contain a different definition of "new" funds. |
| Range of uncertainty | Again, the range of uncertainty is a combination of the individual ranges of the specific indicators associated to the formula components. The uncertainty can be relatively high if data sources for borrowing costs and revenues are not available. |

## IDT Membership

There were no changes to the Funding the Transportation System/Finance IDT membership during this stage. The work presented in this document was the result of two conference calls (held on January 5 and 12, 2012) and a series of e-mail exchanges where different versions of the document were reviewed by the members of the Funding the Transportation System/Finance IDT.

# Appendix

## 1. Example of Cost Factors for Different Project Types

## ESTIMATED COSTS PER MILE

(REVISED JULY 2011)

THIS SHEET IS INTENDED TO AID PLANNERS IN OBTAINING A ROUGH ESTIMATE FOR PROJECTS IN EARLY PLANNING PHASES. THE FIGURES ARE AVERAGES FOR THE PAST 2 YEARS AND SHOULD BE ADJUSTED IF YOUR JOB IS OUTSIDE THE ORDINARY SCHEME OF WORK. CALL AMY KING AT 2525 FOR ASSISTANCE.

NOTE: CHECK THE LABEL ON THE FIGURE YOU ARE USING. SOME ARE "PER LANE MILE."

**NEW ROADS** (TURNKEY PROJECTS ON NEW LOCATION WITH "AVERAGE" DRAINAGE WITHOUT BRIDGE QUANTITIES) PER MILE

| ROAD TYPE | URBAN AREAS | RURAL-MOUNTAINS | RURAL-OTHER |
|---|---|---|---|
| 6 LANE FREEWAY | $ 10,850,000 | N/A | N/A |
| 4 LANE FREEWAY | $ 8,800,000 | $ 10,400,000 | $ 6,750,000 |
| 4 LANE WITH PAINTED MEDIAN | N/A | $ 5,675,000 | $ 4,725,000 |
| 4 LANE UNDIVIDED | $ 5,525,000 | N/A | N/A |
| 4 LANE DIVIDED | $ 5,675,000 | $ 6,400,000 | $ 4,725,000 |
| 4 LANE ARTERIAL* | N/A | N/A | $ 10,375,000 |
| 2 LANE ARTERIAL | $ 3,175,000 | $ 2,975,000 | $ 2,750,000 |
| 2 LANE COLLECTOR | $ 2,100,000 | $ 1,900,000 | $ 1,700,000 |

* IN A FLOODPLAIN WITH BORROW DITCHES

**BRIDGES AND BOX CULVERTS** (DOES NOT INCLUDE APPROACH ROADS. USE SQ. FT. OF FINAL STRUCTURE.)

| | | |
|---|---|---|
| NEW BRIDGE | $ 106 | PER SQ. FT. DECK AREA |
| WIDEN EXISTING BRIDGE | $ 69 | PER SQ. FT. DECK AREA (OLD DECK REMOVED & REPLACED) |
| REPLACE EXIST. DECK | $ 63 | PER SQ. FT. DECK AREA (NO NEW SUBSTRUCTURE) |
| REMOVAL OF BRIDGE | $ 14 | PER SQ. FT. DECK AREA |
| BOX CULVERT | $ 63 | PER SQ. FT. BOX TOP AREA |
| DETOUR BRIDGES | $ 65 | PER SQ. FT. (MORE IN SEISMIC AREAS) |

**WIDENING EXISTING ROADWAY**

| | URBAN | RURAL |
|---|---|---|
| 2 LANES TO 3 LANES (PASSING LANES-RURAL) | $ 3,450,000 PER MILE | $ 1,850,000 PER MILE |
| 2 LANES TO 4 LANES | $ 4,450,000 PER MILE | $ 3,175,000 PER MILE |
| 2 LANES TO 4 LANES DIVIDED* | N/A PER MILE | $ 3,875,000 PER MILE |
| 2 LANES TO 5 LANES | $ 4,725,000 PER MILE | $ 3,375,000 PER MILE |
| 2 LANES TO 5 LANES** | N/A PER MILE | $ 8,075,000 PER MILE |
| 3 LANES TO 5 LANES | $ 4,675,000 PER MILE | N/A |
| 4 LANES TO 5 LANES | $ 3,150,000 PER MILE | N/A |
| 3R WIDENING (2 LANES) | $ 1,500,000 PER MILE | $ 1,050,000 PER MILE |

* 4 LANE DIVIDED HWY. USING EXISTING LANES AS TWO OF THE LANES ** IN A FLOODPLAIN WITH BORROW DITCHES EXISTING

**RECONSTRUCTION** (NEW DRAINAGE, BASE, SURFACING, MINOR WIDENING)

| | | |
|---|---|---|
| NON-FREEWAY | $ 1,500,000 PER LANE MILE | $ 1,250,000 PER LANE MILE |
| FREEWAY (BOND ISSUE JOBS) | $ 1,425,000 PER LANE MILE (INCLUDES NEW SUPERSTRUCTURES ON BRIDGES) | |
| | $ 700,000 PER LANE MILE (RUBBLIZE & OVERLAY OR COLD MILL & OVERLAY- NO BRIDGES | |

**FREEWAY PATCHING & REHABILITATION** (FULL DEPTH PATCHING, MINOR DRAINAGE & BASE REPAIRS, SHOULDER REPAIR, CLEAN & FILL JOINTS, ETC.)

$ 895,000 PER LANE MILE

**OVERLAYS** (11 - 12 FOOT LANES, AVERAGE ACHM DEPTH = 2")

| | PG 64-22 | PG 70-22 & PG 76-22 |
|---|---|---|
| PERFORMANCE GRADE ACHM | $ 83,500 PER LANE MILE | $ 91,000 PER LANE MILE |
| | SINGLE | DOUBLE |
| ASPHALT SURFACE TREATMENT | $ 13,500 PER LANE MILE | $ 16,000 PER LANE MILE |

**PHASE WORK BREAKOUTS** (USE WHEN PROJECTS WILL BE DONE IN PHASES OR PARTS OF A PROJECT ARE COMPLETE AND ADDITIONAL WORK IS BEING PROGRAMMED: PAVE GRAVEL ROAD, PLACE BASE & SURFACING, ETC.)

**GRADING AND DRAINAGE** (NO STRUCTURES, BASE OR SURFACING - NEW LOCATIONS)

| | MOUNTAINOUS AREAS | OTHER AREAS |
|---|---|---|
| FREEWAY & PRIMARY | $ 1,425,000 PER LANE MILE | $ 1,025,000 PER LANE MILE |
| OTHER ROADS | $ 950,000 PER LANE MILE | $ 815,000 PER LANE MILE |

**SURFACING** (INCLUDES BASE & SHOULDERS ON NEW LOCATION. INCLUDES BASE PREPARATION, DRAINAGE & MINOR WIDENING ON EXISTING GRAVEL ROADS)

| | PG 64-22 | PG 70-22 & PG 76-22 |
|---|---|---|
| FREEWAY & PRIMARY | $ 615,000 PER LANE MILE | $ 880,000 PER LANE MILE |
| | PG 64-22 | DOUBLE A.S.T. |
| OTHER ROADS | $ 570,000 PER LANE MILE | $ 450,000 PER LANE MILE |

**INTERCHANGES** (TRUMPET OR DIAMOND LAYOUT)

| | |
|---|---|
| ADDED TO EXISTING | $ 9,450,000 EACH |
| NEW ROUTE | $ 5,850,000 EACH |

**SIGNALS**

| | |
|---|---|
| $ 130,000 | PER INTERSECTION |

**SIGNALS WITH IMPROVEMENTS**

| | |
|---|---|
| $ 475,000 | WITH ADDITIONAL CAPACITY |
| $ 260,000 | WITH NO ADDITIONAL CAPACITY |

**CABLE BARRIER PROJECTS** - $235,000 PER MILE ($45) PER FT.

## 2. List of External data sources

External Agencies from which historical data on costs and revenues for non-highway projects can be obtained include:

**Mode: Transit**

- Tri-Met
- Lane Transit
- Salem-Keizer Transit
- Rogue Valley Transit
- Bend Area Transit
- Corvallis Transit

**Mode: Rail**

- Union Pacific
- Burlington Northern
- Portland & Western
- Albany & Eastern
- Oregon Pacific

### 3. Preliminary list of "State Risk Factors"

The following risks have been identified (preliminarily) by the Funding the Transportation System/Finance IDT to be capable of potentially jeopardizing the successful completion of a "bundle."

| Risk | Potential Outcome | Threat to "Bundle" Completion if Risk is Realized |
|---|---|---|
| Debt ceiling for state | "Bundles" requiring debt levels above the ceiling will not be able to access this funding source in its entirety, reducing the financial feasibility of the "bundle."<br><br>NOTE: There is a legislative ceiling and a market ceiling. This risk applies to both. | High |
| Impact on state cash flow | "Bundles" that require large amounts of cash from the state may create cash flow problems, jeopardizing the financial viability of the "bundle." | High |
| Political risk | In the most common example, lack of community approval for a "bundle" may delay its construction indefinitely. This, in turn, | High |

| | | |
|---|---|---|
| | results in sponsors losing money that was already invested in the project. | |
| Long-term outstanding commitments by state to regions or counties | These types of obligations arise when the state commits to invest a pre-determined amount on infrastructure only after a regional or local authority has met certain conditions (usually in the form of completing some infrastructure or meeting certain investment targets).<br><br>These commitments are legally binding and the state must honor them, requiring funds to do it. The higher the number of outstanding commitments there are, the lower the amount of funds that may be potentially available to finance "bundles." | High |