Implementation of SHRP2 EconWorks Tools for Assessing the Wider Economic Benefits of Transportation

Final Report

Implementation Assistance Program (IAP)

Utah Department of Transportation
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Contents

1. Introduction

The Wasatch Front Central Corridor Study (WFCCS) is assessing solutions to address future capacity needs on the I-15 corridor through Salt Lake City, Utah. The study area is approximately 45-miles long and four-miles wide along I-15 from southern Davis County to northern Utah County. The majority of the state's population as well as car, transit and freight traffic are located within the study area. Utah's population is projected to double by 2050, which will profoundly increase travel along I-15. Significant growth along the I-15 corridor, which is geographically constrained, requires a new way of thinking and new types of solutions. With these challenges in mind, the WFCCS is focusing on innovative solutions that preserve the region's economic vitality, environmental sustainability, safety, and quality of life.

WFCCS is a collaborative effort involving the Utah Department of Transportation (UDOT), Utah Transit Authority (UTA), Wasatch Front Regional Council (WFRC), and Mountainland Association of Governments (MAG). All four agencies were part of the Management Team and were assisted by a study team. The four agencies, in collaboration with area stakeholders, recommend solutions that incorporate multiple modes of transportation and are compatible with emerging technologies through 2050. The solutions include improved connectivity between modes and a variety of choices and strategies for getting around. These solutions will be integrated into the WFRC and MAG 2019-2050 Regional Transportation Plans (RTPs), which are part of Utah's Unified Transportation Plan.[1]

During the project planning stages, three WFCCS scenarios were assessed based on their transportation demand management strategies:

- **Scenario 1** focuses on financial incentives to change travel behavior and patterns including improvements such as barrier-separated high occupancy vehicle (HOV) lanes.
- **Scenario 2** focuses on adding transit capacity and managing roadway capacity to maximize efficiency. This scenario also includes increasing transit service frequency.
- **Scenario 3** has the largest physical footprint of the three scenarios. It emphasizes providing new capacity by elevating sections of I-15 and developing mobility hubs.

The study team ran a travel demand model for all three build scenarios as well as current conditions and a "business as usual" future scenario (Scenario 0) to estimate the travel impacts.

Implementation Assistance Program (IAP)

The WFCCS included assessments of each scenario, which consisted of a benefit-cost analysis (BCA) and an economic impact analysis (EIA) during the planning and strategy stages of the project. In order to supplement the findings of the BCA and the EIA, UDOT assessed the same scenarios with the Second Strategic Highway Research Program (SHRP2) EconWorks economic analysis toolkit. The toolkit, which is known as the Wider Economic Benefits (W.E.B.) toolkit,

[1] www.wfccstudy.org

consists of tools that assess benefits not typically measured under traditional economic analyses. The toolkit also includes an accounting framework to aggregate results across the tools.

UDOT received SHRP2 Implementation Assistance Program (IAP) funding to demonstrate and document the use of the SHRP2 EconWorks W.E.B. tools. The intent of the IAP and scope of work developed by UDOT to test the tools is to:

- Create organizational awareness and understanding of EconWorks tools.
- Develop and provide professional capacity building resources for executives and practitioners on why, when, and how to use EconWorks tools in transportation planning and project development.
- Create opportunities to collaborate and share knowledge on the use of EconWorks tools.
- Promote development of new case studies, methods, tools and approaches for EconWorks tools.
- Guide long-term, national initiatives to support continued advancements and enhancements to EconWorks tools.

This report documents the use of the SHRP2 EconWorks tools during the planning and strategy stages of the WFCCS. The three EconWorks tools tested are the Reliability tool, Connectivity tool, and Buyer-Supplier Market Access tool. Section 2 presents documentation on how each UDOT utilized each tool. The documentation explains each tool's suitability and usefulness for assessing the WFCCS scenarios. The section also describes the preparation of inputs to test the tools as well as interpretation of tool outputs. Section 3 compares tool outputs to the BCA and EIA results estimated earlier in the WFCSS. Section 4 covers how UDOT used the tools in the decision-making process and Section 5 details how the tools relate to project goals and performance metrics established by the Management Team. Section 6 provides lessons learned from using the EconWorks tools. Section 7 suggests refinements to the EconWorks tools for future projects. Finally, Section 8 summarizes the effectiveness of the tools in describing economic impacts.

2. Documentation of Tool Use

Reliability Tool

The Reliability tool captures the impact of variable travel times on travelers. Given two routes of equal average travel times, but with differences in the reliability of those travel times, travelers are likely to choose the route with more reliable travel times. Traditional economic analysis accounts only for the value of time and does not place a value on the degree of predictability in trip duration.

The Reliability tool accounts for travel time reliability by considering the impacts of both recurring and non-recurring congestion on travel through the calculation of metrics including travel time index and hourly equivalent delay. At the start of the WFCCS, it was anticipated that the Reliability tool would be a suitable option for assessing the wider economic benefits of the proposed scenarios, as they were designed to alleviate roadway congestion and increase overall travel time reliability.

Suitability for a Range of Projects

The improvements proposed in the WFCCS scenarios vary by scenario, ranging from adding roadway and transit capacity to providing financial incentives to change travel behaviors. The Reliability tool is most appropriate for projects that add roadway capacity to existing corridors. The tool may underestimate the change in travel reliability for the scenarios that focus on enhancing transit availability, as users diverted to transit are considered in the No Build scenario, but not in the Build scenario. Presumably, transit offers greater travel time reliability than highway travel, but this is not measured in the tool.

Another limitation is the ability of the tool to handle barrier-separate HOV lanes. Some of the WFCCS scenarios provide HOV or priced lanes that draw traffic from general purpose lanes and convert general purpose lanes to managed lanes. Since these lanes have different capacities and operating characteristics from general purpose lanes, they should be evaluated separately, but the tool lacks the capability to support this analysis.

Usefulness for Consensus Building

The WFCCS Management Team identified travel time reliability as a project goal to be considered in the study evaluation. Ultimately, the results from the Reliability tool were not used in the evaluation because they were inconsistent with the standard BCA results (see Section 6). However, the study evaluation did use congestion measures and a travel time buffer index as they were included in a previous analysis.

Preparation of Inputs

The Reliability tool is user-friendly and requires minimal data that are generally available from traffic management systems. The basic data needs include annual average daily traffic (AADT), roadway capacity, and the number of lanes. While this information is readily available, the traffic information for the WFCCS was collected at cordon spot, a location along the highway, rather than for highway segments. Thus, some data manipulation was required to generate the required inputs for the six highway segments shown in Table 1. The cordon data for a spot in the middle of the segment was considered representative of the entire segment.

Table 1: Segments along the I-15 Corridor

Location	Segment From/To	MP Start	MP End	Distance
SR 92	2100 N to Bangerter	282.7	289.9	7.2
123rd South	Bangerter to 106th S.	289.9	293.7	3.8
78th South	106th S. to 5400 S.	293.7	300.4	6.7
33rd South	5400 S. to I-80 East	300.4	305	4.6
1300 S	I-80 East to I-215	305	313	8
US 89 - Farmington	I-215 to Shepard Ln	313	325.9	12.9

It was a relatively simple exercise to aggregate and prepare inputs for use in the Reliability tool. Due to the differences in highway operating characteristics, segments were separated into four roadway types as applicable: general purpose lanes, HOV lanes, elevated lanes, and collector-distributor lanes. Data were inputted for five scenarios – the base year, Scenario 0, and each of the three WFCCS build scenarios for 2050. These combinations required the Reliability tool to be run 195 times. Even more segment scenarios would be required if smaller segments had been defined along the corridor or if a multi-year analysis was conducted. Although the analysis was cumbersome, the ability to copy scenarios and make minor changes simplified data entry.

Dissemination and Interpretation of Outputs

To estimate the overall impact on reliability, the Reliability tool outputs for each segment and roadway type were aggregated for each WFCCS scenario. Unfortunately, the congestion metrics presented in the first section of the *Results* tab (including the travel time index) cannot be summed or aggregated across the individual tool runs. For example, the travel time index for two segments combined is not the sum or average of the travel time indices.

The study team used total equivalent delay by roadway type for each of the six segments (the outputs from the third section of the *Results* tab) to evaluate the differences in delay time across scenarios. The total equivalent delay includes recurring and non-recurring delay. The results (shown in Section 3) reflect the value of delay reductions and associated improved reliability for roadway users in each WFCCS scenario compared to Scenario 0.

Ease of Use and Understandability of Outputs

The Reliability tool is generally intuitive and easy to use and the outputs are fairly easy to understand. The concepts of total recurring and non-recurring vehicle delay and the value of the total congestion cost are very straightforward. However, it is not clear how the measures of recurring and non-recurring vehicle delay overlap with the average delays already measured in the travel demand model used for the corridor. Presumably, the travel demand model delays correspond with recurring delay, but the delay estimation methodologies in the tool are different.

The most confusing aspect of the Reliability tool outputs is how to interpret the congestion metrics when aggregating multiple segments along a corridor because most measures provided by the tool could not be added across the corridor. The study team added the total equivalent delay results for each segment to calculate the improvement for the corridor. The Reliability tool User Guide provides no guidance on how to combine other measures, such as the travel time index, to estimate an aggregate measure for the corridor.

Connectivity Tool

The Connectivity tool estimates the value of enhancing freight access connectivity to intermodal facilities in the study area. The tool includes a database of air, rail and marine facilities in the United States with key information on freight and passenger activity (e.g., unique origins and destinations, freight container values, etc.). The Connectivity tool was used to assess impacts to passenger and freight airports in the WFCCS scenarios.

Suitability for a Range of Projects

The WFCCS scenarios were designed to improve roadway conditions, potentially enhancing connectivity and access to intermodal facilities along the corridor. The study team identified four intermodal facilities using the database built into the Connectivity tool. The names, locations, and types of these facilities are summarized in Table 2.

Table 2: SHRP2 Connectivity Tool - Intermodal Facilities in WFCCS Study Area

Name	Location	Facility Type
Salt Lake City International Airport	Salt Lake City	Airport Freight / Passenger
Hill Air Force Base	Ogden	Airport Freight / Passenger
Provo Airport	Provo	Airport Freight / Passenger
Beck Street Truck/Rail Facility*	n/a	Rail Freight

**This facility has ceased operations*

The Connectivity tool database lists the Beck Street Truck/Rail Facility, but it has ceased operations. There are several other intermodal rail freight facilities located in the study area, but not listed in the tool. For example, Union Pacific operates an intermodal facility in Salt Lake City that moves 250,000 containers annually. Since the facility is not in the tool database, key inputs, such as unique origins and destinations served by the facility, are unavailable.

The use of the Connectivity tool was limited to examining connectivity impacts on the airport freight and passenger facilities listed in the tool. As shown in Table 2, there are three airports operating within the study area. Salt Lake City International Airport is the largest, with significant passenger traffic and freight activity. Hill Air Force Base is located approximately 30 miles north of Salt Lake City in Ogden, and Provo Airport is located about 50 miles south of Salt Lake City.

Usefulness for Consensus Building

The results from the Connectivity tool were not added to the BCA for several reasons. First, the tool could not assess all of the important intermodal facilities in the region. Second, connectivity benefits were calculated directly from outputs of the BCA, such as travel time savings for passenger and freight vehicles along the corridor. These benefits would be separate if they reflected delays at the intermodal facility or last-mile connectivity, but they appear to double-count benefits already captured in the BCA.

Third, the BCA conducted for WFCCS aggregates benefits over a 26-year analysis period. The Connectivity tool restricts analysis to a single year of benefits for up to three facilities at a time. The tool is best suited to compare the scenarios in a forecast year, but not aggregate benefits over a multi-year analysis period.

Preparation of Inputs

The Connectivity tool and the supplementary documentation provide clear written definitions of the necessary inputs. However, there are some bugs and project-specific issues that made the preparation of inputs challenging. On the *Intermodal Facility Inputs* tab, the dropdown menus for facility selection did not function properly. These had to be manually adjusted to perform the analysis. In addition, the “Clear Facility” button does not function properly and inputs had to be cleared manually. The tool requires unit lift capacity for rail freight facilities to be entered, but the value is not factored into any of the connectivity calculations.

The Connectivity tool is better suited for analyzing spot improvements rather than corridor-wide improvements. On the *Improvement Inputs* tab, the tool is structured to analyze an improvement in a specific location. However, the WFCCS scenarios contain multiple project improvements along the entire I-15 corridor. The travel demand model outputs are provided for the entire study area, not just the sections that enhance access to intermodal facilities. Therefore, it is difficult to compute the number of trucks/cars around the intermodal facility, the hours saved per vehicle, and the distance of the improvement from the facility. To use the Connectivity tool for the WFCCS, the inputs for hours saved per vehicle were estimated using averages for the entire study area. The number of vehicles and the distance from improvements were calculated based on traffic data at several cordon locations.[2]

The Connectivity tool provides several default inputs for the value of freight and passenger vehicle-hour savings and the percentage of vehicles associated with an intermodal facility. The default value for the percentage of vehicles is computed based on a decay function incorporating the distance from the improvement. This function potentially overestimates the percentage of trucks associated with a particular facility due to the agglomeration of intermodal facilities in the study area. There are several intermodal facilities and distribution centers located in the study area. In addition, I-15 is a well-trafficked freight corridor. The distance function assumes over 60 percent of all trucks are associated with an intermodal freight facility located 10 miles away. Given the noted characteristics of the study area, this may be an overestimation. Unfortunately, no other data were available to estimate a more representative value.

Dissemination and Interpretation of Outputs

On the *Results* tab, the Connectivity Tool provides outputs, improvement impacts (e.g., travel time savings), and facility-specific information, such as activity, unique origins and destinations, and container values. The main output used in the EconWorks Accounting Framework is the weighted connectivity value. However, the Connectivity tool cannot calculate a weighted connectivity value for rail freight facilities. The tool documentation provides neither an explanation as to why this value cannot be calculated for rail freight facilities nor guidance on how to analyze a corridor that includes these facilities. Since the rail freight benefits could not be calculated, the analysis focused on the impact to air freight and air passenger facilities in the study area.

Ease of Use and Understandability of Outputs

The weighted connectivity index is the main output used to value connectivity and these results are presented in Section 3. However, the study team could not use the EconWorks Accounting Framework to monetize the scores for inclusion in the BCA. The Accounting Framework requires inputs for the No Build and Build scenarios, but it is not possible to calculate a No Build connectivity score other than zero because the number of hours saved is a required input. The Accounting Framework produces an error when zero is entered as the No Build value, so the connectivity benefits could not be monetized.

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[2] The cordon location for the Salt Lake City International airport is the intersection of I-15 and 1300 S. Hill Air Force Base is calculated using data from the intersection of I-15 and US 89 Farmington. Provo Airport is calculated using data from the intersection of I-15 and SR 92.

Buyer-Supplier Market Access

EconWorks provides two versions of the accessibility tool – the Buyer-Supplier Market Access tool and the Specialized Labor Market Access tool. The WFCCS analysis used the Buyer-Supplier Market Access tool because this tool is most suitable for projects that enhance access between consumer or producer markets (including enhancing access to places of employment or improving delivery access for commodities).

Of the two tools, the Specialized Labor Market Access tool is targeted to transportation links that serve important roles in work commuting. At first glance, this would be the appropriate tool to use as the study area is a key corridor for work commutes and access to jobs is a key metric for evaluation in this study. When utilizing the Specialized Labor Market Access tool, one must select a specific industry. While there are pockets of industry concentration, including a high-tech sector near Lehi, the overall industry distribution along this 45-mile corridor is not highly-specialized. The User Guide notes that the tool should be used only if the study area has specialized industry sectors.

The guidance for the Buyer-Supplier Market Access tool suggests that this tool would be suitable to utilize as the impedance matrix necessary to generate the effective density is based on employment by place of work. Thus, the study team decided that Buyer-Supplier tool was the most appropriate to represent overall accessibility.

Suitability for a Range of Projects

The Buyer-Supplier Market Access tool appears to be suitable for a wide range of transportation infrastructure improvements. Any investment that generates an improvement in freight movement or better transportation access for residents should be appropriate to analyze. The WFCCS provides a good opportunity to test the tool, as the various scenarios are focused on improving overall accessibility in the area as population increases constrain the existing resources.

Usefulness for Consensus Building

One of the key metrics in the WFCCS evaluation was access to employment within a 45-minute travel distance. However, the results from the Buyer-Supplier Market Access tool were not utilized as part of this evaluation. The effective density "score" provided as output from the tool was not an easily understood measure for general public consumption and evaluation. Thus, the WFCCS used an accessibility metric defined as the number of jobs accessible within a 45-minute travel time based on the travel demand model outputs. This is a more tangible and easily understood output than those provided by the EconWorks Buyer-Supplier Market Access tool.

Preparation of Inputs

The preparation of the inputs for the Buyer-Supplier Market Access tool was easily accomplished utilizing the travel demand model data for each scenario alternative. The tool limits the number of origin-destination (O-D) pairs that can be analyzed, so the travel demand data were aggregated into 15 large zones. Given the data available from the travel demand model, the Buyer-Supplier Market Access tool was run to assess effective density with no activity growth utilizing employment by place of work.

The study team encountered some difficulty in selecting the constant decay factor (α) and the productivity elasticity. The selection of α is critical to the outcomes generated by the model. The User Guide offers minimal guidance on how to select an appropriate parameter. The User Guide provides a wide range of potential productivity elasticities, ranging from 0.01 to 0.2, with no discussion on how to select a value from within this range.

Dissemination and Interpretation of Outputs

While it is relatively easy to gather outputs from the tool's *Output* tab, interpretation of these scores is more difficult. The raw Buyer-Supplier Market Access tool outputs are unintuitive. It is not clear how the "scores" for effective density and potential access are defined and what they represent. The Accounting Framework helps to monetize these scores and provide a measurement that can be explained.

Unfortunately, the results from the *productivity* section of the tool did not make sense. It was difficult to determine how the change in score matched the change in productivity and what this meant in relation to how travel demand patterns changed in each scenario. Overall, the results of the *productivity* section of the tool did not make sense relative to the BCA and EIA results. Some scores from the Buyer-Supplier Market Access Tool were extremely negative, while others were slightly positive. The BCA and EIA results showed less variability and none of the WFCSS scenarios should be expected to reduce access. The issue could be related to changes in transit service that were not considered by the Buyer-Supplier Market Access Tool. More information on the outputs generated can be found in Section 3.

Ease of Use and Understandability of Outputs

Entering inputs into the Buyer-Supplier Market Access tool is very straightforward. This is particularly true if one has access to travel demand model outputs, which can easily be converted into the O-D matrices used in the tool. This conversion is also easy if one has experience with Microsoft Excel.

The *Data Entry* tab for the Buyer-Supplier Market Access tool has two paths for data entry –one for ten or fewer zones and one for more than ten zones. When using ten or fewer zones, a form pops up directing the user to manually enter data one at a time. Since the WFCCS analysis used a network with more than ten zones, data entry was simplified. The study team could copy a pre-formatted matrix into the relevant input tab. This process would have been tedious if there were fewer zones due to the need for manual data entry.

As noted above, the outputs were not very easy to understand and the graph included in the *Output* tab was difficult to interpret. The "scores" were not intuitive without context and need to be converted into a dollar value using the Accounting Framework.

3. Tool Outputs and Comparisons to Other Economic Models

The primary economic analysis tools used to assess WFCCS scenarios were BCA and EIA. The results from these tools were used to compare performance metrics relating to project goals for the corridor. The

BCA summarizes several project benefits, including travel time savings, vehicle operating cost savings, emissions cost savings, and safety benefits. Total project benefits and costs were aggregated over an analysis period and benefit-cost ratios were used to compare the cost effectiveness of the scenarios. The study team conducted the EIA using benefits from the BCA and project spending as inputs into a REMI PI+ model. REMI PI+ is a widely applied regional economic analysis model that evaluates the effects of public investments and policies at the regional level. The model incorporates a general equilibrium framework with an input-output approach. A full description of the model is available on REMI's website at http://www.remi.com/products/pi. The economic impacts include initial construction spending and long-term productivity gains from increased transportation efficiency.

The EconWorks tools are intended to estimate wider economic benefits – meaning those not traditionally included in BCA. To test the applicability of adding these results to the BCA, the relative magnitude of impacts was compared to results for a standard BCA calculated for each WFCCS scenario. In addition, the results were compared to outputs from the Buyer-Supplier Market Access tool.

However, there were complications in integrating the results from the EconWorks tools with the BCA and EIA. The EconWorks tools can provide outputs for a single year only. For the IAP assessment, the tools were used to compare conditions across the WFCCS in the final year of the analysis period (2050). However, the BCA and EIA estimate benefits over the entire analysis period (2025-2050). This makes it difficult to incorporate the benefits from the EconWorks tools into the BCA and EIA. Additional assumptions are needed to estimate benefits during intermediate years to calculate benefits over the period of analysis.

While the EconWorks guidance discusses adding the wider economic benefits to standard BCA, it is unclear how to incorporate these benefits into EIA (if at all). Some benefits from the EconWorks tools are calculated as functions of Gross Regional Product (GRP). Since the WFCCS considered changes in GRP as a measure of economic impact, it seems reasonable that these wider economic benefits might reflect GRP impacts as well. However, it is unclear whether the outputs of the EconWorks tools should be added to REMI model output, replace these outputs, or be used as inputs to the REMI model. The outputs from the tools were compared to the relevant analyses conducted as part of this evaluation in an effort to gauge the order of magnitude of the outcomes.

The rest of this section presents the results from the BCA and EIA conducted for WFCCS, then compares results calculated using the EconWorks tools. The BCA and EIA results are presented over a multiple-year period of analysis, while the comparisons are shown for only the year 2050. This is due to the limitations of the tools in creating time-series data.

The BCA considered project benefits beginning in 2025 and ending in 2050. The BCA results over the period of analysis are presented in Table 3. Scenario 1 has the highest benefit-cost ratio, but Scenario 2 generates higher total benefits. Scenario 3 has a negative net present value over the period of analysis. Table 4 presents the benefits generated in each WFCCS scenario. Travel time savings make up the majority of benefits in Scenario 2 and 3. Safety benefits are highest in Scenario 1.

Table 3: WFCCS BCA Results by Scenario, Discounted at 4 Percent ($ millions)

Results Summary	Scenario 1	Scenario 2	Scenario 3
Lifecycle Benefits	$3,194.2	$8,864.1	$1,156.6
Lifecycle Costs	$910.2	$2,969.5	$3,326.5
B/C Ratio	**3.51**	**2.99**	**0.35**

Table 4: WFCCS Benefits by Scenario, Discounted at 4 Percent ($ millions)

Results Summary	Scenario 1	Scenario 2	Scenario 3
Travel Time Savings	$1,268.6	$6,054.9	$1,219.7
Vehicle Operating Costs	$921.4	$2,453.8	($75.0)
Safety	$940.7	$247.0	$10.6
Emissions	$63.5	$108.3	$1.3
Total Benefits	**$3,194.2**	**$8,864.1**	**$1,156.6**

The EIA includes the effects of construction spending and gains to transportation efficiency over the period of analysis. The economic impacts to Davis, Salt Lake, and Utah counties were calculated separately and then aggregated in Table 5. Impacts due to construction spending are highest in Scenario 3 and impacts due to transportation efficiency are highest in Scenario 1. Overall, Scenario 2 had the highest economic impact in terms of GRP.

Table 5: WFCCS EIA Results by Scenario ($ millions)

Results Summary	Scenario 1	Scenario 2	Scenario 3
Construction Spending (GRP)	$3012	$9,320	$10,984
Transportation Efficiency (GRP)	$2,821	$5,416	$
Total Economic Impact (GRP)	**$5,833**	**$14,736**	**$11,832**

Reliability Tool

The results of the Reliability tool for each scenario were compared to the travel time savings from the BCA. Since the Reliability tool outputs are available for only one year, the results for a single year (2050) were used to compare the order of magnitude across the three scenarios. Ideally, the outputs from the Reliability tool could be easily attained as a time-series and compared to the BCA. The results of the single year comparison are shown in Table 6.

Table 6: Comparison of Benefit-Cost Travel Time Savings and Reliability Tool Outputs for 2050, $

Results Summary	Scenario 1	Scenario 2	Scenario 3
Travel Time Savings (BCA)	$92,613,037	$385,677,707	$77,671,026
Total Equivalent Delay Savings (Reliability Tool)	*$3,016,779*	*$960,879*	*-$427,166*

Comparing the outputs from the two models shows a great difference in the order of magnitude of the results and the overall performance across scenarios. First, the scale of the benefits is drastically different. This makes sense because the BCA considers travel time savings from the entire travel demand model network, while the Reliability Tool results reflect only changes on I-15. Second, the relative rankings of the scenarios are different. Since the travel time savings are evaluating a measure similar to recurrent delay portion of the equivalent delay savings, the relative order of the scenarios should be similar. Given the very small margin of added benefit in any given year and the tediousness of inputting all of the information to generate a time-series, the added value of utilizing the Reliability Tool appears to be minimal.

According to the BCA, Scenario 2 provides the greatest amount of travel time savings. This scenario invests heavily in transportation demand management strategies, roadway pricing and management, and transit system upgrades to alleviate roadway congestion. A goal of the Scenario 2 strategy is to increase “seat utilization” by increasing vehicle occupancy and reducing the total number of vehicles. These demand management strategies should greatly improve travel time reliability for highway users. This is not reflected by the order of magnitude of the results from the Reliability Tool, which indicates a recurrent and non-recurrent delay savings of less than $1 million compared to $3 million for Scenario 1. The relatively modest reliability improvement for Scenario 2 may reflect an inability of the Reliability Tool to take demand management strategies into consideration.

The Reliability tool results show that Scenario 1 provides the greatest reduction in equivalent delay. This scenario adds a small amount of roadway capacity, while providing financial incentives to change travel behaviors. The increase in reliability according to the tool is likely a function of the increased roadway capacity and speeds.

Scenario 3 focuses on adding capacity for all modes and developing centers of activity. It includes a large capacity improvement along I-15 by adding an elevated section with additional lanes. While the BCA results suggest that this scenario provides the smallest travel time savings of the WFCCS scenarios, it still improves travel times relative to Scenario 0. In contrast, the Reliability tool results suggest that the scenario will reduce travel time reliability relative to the Scenario 0. This seems unlikely given the large capacity improvements envisioned for the corridor in Scenario 3.

The Reliability tool does not account for changes in vehicle occupancy or shifts in peak directional travel. This may result in skewed outputs relative to the conditions utilized in the travel demand model that generated the inputs for the BCA. Additionally, the strategy to focus on higher occupancy vehicles in Scenario 2 is not accounted for in the Reliability Tool, likely understating the monetary benefits in terms of dollars per vehicle hour.

Connectivity Tool

The Connectivity tool calculates outputs for freight and passenger vehicles separately. The main output is the weighted connectivity value, which is a product of the connectivity raw value and the time savings of vehicles associated with the facility. Table 7 shows the key inputs available in the Connectivity tool for each facility in the WFCCS study area.

Table 7: EconWorks Intermodal Facility Input Data

Output	Salt Lake City International Airport	Hill Air Force Base	Provo Airport
Freight			
Activity (tons per year)	180,905	137	0
Unique Origins/Destinations	182	5	21
Facility Connectivity Raw Value	15.5	0.0	0.0
Passenger			
Activity (passengers per year)	20,299,906	434	2,276
Unique Origins/Destinations	177	4	22
Facility Connectivity Raw Value	35.9	0.0	0.0

Table 8 summarizes the results calculated using the Connectivity Tool. These results reflect impacts for a single year (2050) in each WFCCS scenario. The outputs include the value of the time savings for vehicles associated with each intermodal facility and the weighted connectivity index. As explained in previous sections, the weighted connectivity index could not be monetized using the Accounting Framework.

Table 8: EconWorks Connectivity Tool Results, by WFCCS Scenario (2050)

Output	Scenario 1	Scenario 2	Scenario 3
Salt Lake City International Airport			
Value of Time Savings for Facility (freight)	$1,709,919	$6,841,717	$1,008,508
Weighted Connectivity Value (freight)	*26,510,832*	*106,074,965*	*15,636,053*
Value of Time Savings for Facility (passenger)	$1,386,884	$4,392,541	$1,329,237
Weighted Connectivity Value (passenger)	*49,831,914*	*157,827,666*	*47,760,604*
Hill Air Force Base			
Value of Time Savings for Facility (freight)	$483,084	$1,712,262	$277,714
Weighted Connectivity Value (freight)	*155.8*	*552.3*	*89.6*
Value of Time Savings for Facility (passenger)	$481,799	$1,974,472	$441,936
Weighted Connectivity Value (passenger)	*8.4*	*34.3*	*7.7*
Provo Airport			
Value of Time Savings for Facility (freight)	$585,820	$2,151,659	$349,378
Weighted Connectivity Value (freight)	*0.0*	*0.0*	*0.0*
Value of Time Savings for Facility (passenger)	$602,853	$1,996,697	$561,737
Weighted Connectivity Value (passenger)	*301.9*	*999.8*	*281.3*

Scenario 2 has the most significant impact on enhancing intermodal connectivity. This is consistent with the BCA results, since Scenario 2 also had highest travel time savings benefits. Overall, the facility with the highest benefits is the Salt Lake City International Airport. There is significantly more freight and passenger activity at this facility compared to others in the study area. The majority of benefits for Hill Air Force Base come from freight, while the connectivity benefits for Provo airport come primarily from airport passengers.

Buyer-Supplier Market Access Tool

The Buyer-Supplier Market Access tool measures the benefit of increased effective density. Two sets of outputs are provided by the tool – an effective density score and a dollar value for total productivity. The effective density score can be converted to a dollar value based on increased market access. This is calculated using the GRP and a productivity elasticity factor within the Accounting Framework. Table 9 shows the effective density score, productivity from the tool, the value as provided by the Accounting Framework, and the results of the REMI model for 2050.

Table 9: Buyer-Supplier Market Access Tool and REMI Model Outputs for 2050

Tool	Results Summary	Scenario 1	Scenario 2	Scenario 3
Buyer-Supplier Market Access Tool	*Effective Density Score*	*884,241*	*832,436*	*884,030*
	Productivity ($M)	*$6.7*	*-$1,332.3*	*$4.8*
	Value from Accounting Framework	*$1.3*	*-$258.8*	*$0.2*
REMI	Transportation Efficiency (GDP - $M)	$258.5.	$551.9	$85.5

As was noted earlier in this section, it is unclear whether the accessibility benefits should be added to the EIA or compared with results from the EIA. The Buyer-Supplier Market Access tool results vary greatly from the REMI model results. According to the REMI analysis, Scenario 2 generates the highest economic impact from transportation efficiency improvements in 2050, followed by Scenario 1 and Scenario 3. The Buyer-Supplier Market Access tool shows Scenario 1 having the greatest benefits and Scenario 2 having strongly negative benefits.

These differences may be due to the nature of the impedance matrix, which includes transit improvements and thus reduces overall effective density. If this measure is used to generate productivity gains within the Buyer-Supplier Market Access tool, negative benefits are not entirely surprising. In Scenario 2, the increased transit scenario, travel times for transit users will be longer than for highway users, indicating a decrease in accessibility. Under this scenario, users will choose different points of O-D pairs than in scenarios that are less transit-focused, changing the overall effective density score, and thus the outputs from the tool.

The negative Buyer-Supplier Market Access tool results for Scenario 2 were also different from the positive results of a WFCCS analysis of access to employment within a 45-minute commute time. Scenario 2 provides access to an estimated 1,308 thousand jobs by automobile and 420 thousand jobs by transit for the average community of concern, compared to 1,132 thousand jobs by automobile and 329 thousand by transit in Scenario 0.

4. Decision-Making with the Tools

At the project onset, the intention was to utilize the EconWorks tools to supplement findings from the BCA and EIA. However, there was confusion on how to incorporate EconWorks benefits into the BCA and EIA. The inputs required for the Reliability and Connectivity tools are reliant on the outputs calculated in the BCA. While the wider economic benefits are additive to the BCA, it is unclear whether they are additive or should be considered separately from the benefits in the EIA. The documentation for the EconWorks tools does not provide guidance on how the results should be incorporated

In addition, the outputs from the Reliability and Buyer-Supplier Market Access tools were inconsistent with the results of the BCA and EIA. The research team reviewed the data poor reliability equation incorporated into the reliability tool and found the Reliability benefits are very small compared to the magnitude of the travel time savings calculated in the BCA and the relative ranking of projects are counter-intuitive. The formula simplifies such that reliability benefits (as a percent of the travel time benefits) are a monotonically increasing function of the demand-capacity ratio. As a percent of travel time benefits, the reliability benefits very quickly approach 30 percent. Based on this outcome, the team expected the tool to predict reliability benefits in the same direction and ranking as the mobility benefits even though they would not necessarily behave in the same direction or ranking in the real world. Additionally, the accessibility benefits estimated in the Buyer-Supplier Market Access tool differed from accessibility changes estimated using other techniques.

As a result, the wider economic benefits calculated using the EconWorks tools were not incorporated in the BCA and EIA. The study team opted to use more traditional measures for assessing the achievement of project goals by the WFCCS scenarios as described in Section 5.

5. Tool Use for Project Development

The WFCCS Management Team created a set of goals against which to measure all scenarios:

- Improve safety;
- Increase person throughput in the corridor;
- Improve travel time reliability for trips using the corridor;
- Increase regional accessibility to jobs and education, particularly for economically disadvantaged populations;
- Improve air quality;
- Improve economic outcomes while considering both benefits and costs;
- Reduce direct household transportation costs; and
- Improve mode balance.

The study team used various performance metrics to assess and compare the scenarios and their achievement of the project goals. The findings from the EconWorks tools were intended to supplement several of these performance metrics. However, the study team opted to use more traditional evaluation metrics for assessing these project goals.

The Reliability tool measured the effectiveness of each scenario on the improvement in travel time reliability for trips using the corridor. The other performance measures for assessing travel time reliability include comparing peak hour commute times and the buffer index across scenarios. The Buyer-Supplier Market Access tool was used to assess the increase in regional accessibility to jobs and education. Other performance metrics to assess this goal includes comparing the number of jobs accessible within 45-minute trip. In addition, the EIA provides overall impacts to GRP[3], personal income, and the number of jobs in the study area.

6. Lessons Learned from Process

Results Compared to BCA & EIA in Magnitude and Relative Ranking

As shown in Table 10, the results from the traditional economic analysis differ greatly from the results shown by the EconWorks tools.

Table 10: Outputs Comparison for 2050

Measure	Results Summary	Scenario 1	Scenario 2	Scenario 3
Reliability	Travel Time Savings (BCA)	$92,613,037	$385,677,707	$77,671,026
	Total Equivalent Delay Savings (Reliability Tool)	*$3,016,779*	*$960,879*	*-$427,166*
Buyer-Supplier Market Access	*Effective Density Score (Accessibility Tool)*	*883,990*	*884,241*	*884,030*
	Productivity ($M) (Accessibility Tool)	*$6.7*	*-$1,332.3*	*$4.8*
	Value from Accounting Framework	*$1.3*	*-$258.8*	*$0.2*
	Transportation Efficiency (GDP) ($M) - REMI	$258.5	$551.9	$85.5

As was noted previously, results could not be attained from the Connectivity tool for direct comparison with other models. The Reliability and Buyer-Supplier Market Access tools produced outputs that were inconsistent in ranking and magnitude compared to the results from the BCA, EIA, and the other WFCCS criteria. For example, the Reliability tool indicates that Scenario 2 generates the lowest benefits, while the BCA showed the highest benefits for this scenario. The difference in relative ordering is concerning as Scenario 2 is designed to remove vehicles from the roadway, thus reducing delay and increasing reliability. Additionally, the EIA found that Scenario 2 had the most significant economic impact, while the Buyer-Supplier Market Access tool shows a negative impact on accessibility in this scenario.

The Buyer-Supplier Market Access tool estimates the productivity benefit as the change in productivity multiplied by an elasticity and the GRP. This is the change in GRP associated with improvements in productivity due to increased accessibility. The “transportation efficiency” benefit estimated in REMI is the change in GRP due to transportation cost savings. These are different concepts, but it is useful to see: a) how much GRP changes due to productivity versus cost savings (magnitude question), and b) whether the directional change in GRP is the same for both (direction question). The Utah research team expected the directionality to be the same because a project that lowers transportation costs also increases accessibility. An issue that arises with Scenario 2 is that it shows a large, negative change in productivity, while the travel

[3] REMI refers to GRP as GDP

time savings and transportation efficiency show the project is beneficial. This suggests a potential problem in the way productivity is calculated. The intent is not to suggest that productivity and transportation efficiency are the same, but rather to use one to apply a reasonableness test to the other.

The discrepancies between models may also be explained by complexity of the WFCCS study area and the limited capabilities of the tools in handling non-highway improvements. The WFCCS scenarios focus on a large number of improvements over a 45-mile corridor, including pricing management and transit strategies that are designed to influence travel and development patterns. The EconWorks tools are not well suited to handle the level of complexity and nuance associated with the diversity of project improvements.

Inclusion of EconWorks Tool Results

The results from the EconWorks tools were not included in the evaluation process for the WFCCS. While travel time reliability and job accessibility are identified as project goals, the outputs from the Reliability or Buyer-Supplier Market Access tools were not reported as performance metrics for evaluating these goals. The level of confidence in the results from the EconWorks tools was lower than the traditional planning measures, such as buffer time indices, travel time savings, and access to employment.

The primary driver of the discrepancies is the diversity of project improvements considered in each of the scenarios. It appears that the tools are most suitable for projects that focus on traditional roadway capacity expansion rather than a mix of alternatives. The results for the transit-heavy scenario (Scenario 2) indicate a decrease in accessibility despite the investment. This is likely because transit travel times are longer than roadway travel times. Scenarios 1 and 2 also added high-occupancy vehicle lanes and tolling. The ability of the Reliability tool to handle these varied lane-types and demand systems is not readily apparent.

Difficulties Using EconWorks Tools

On the surface, the tools were easy to use, with simple data entry processes and clear instructions. However, a few issues arose during the testing process and the study team using the tools frequently questioned whether or not they were using the tools correctly.

Reliability Tool

When using the Reliability tool, there was confusion on how to assess HOV lanes or tolled facilities. These are key components of the traffic management strategy for the WFCCS scenarios. It is unclear how willingness to pay and vehicle occupancy parameters are accounted for within the tool. The corridor includes several segments with different numbers of lanes in each direction. It is unclear how the Reliability tool factors these variations with the hourly AADT distribution based on two-way capacity.

Another difficulty was aggregating multiple segment scenarios. In the analysis, total delay time and cost were summed over multiple segments, but travel time index could not be aggregated. The single-year analysis period for the Reliability tool is also limiting. Estimating reliability for each year would be too time consuming and unrealistic for WFCCS. Alternatively, benefits could be linearly interpolated between a base year and future year. But this is not an ideal solution because the reliability benefits are non-linear functions of the input variables.

Connectivity Tool
There were two difficulties with the Connectivity tool – one general and one due to the nature of the projects being evaluated. First, the results are not meaningful without the ability to utilize the Accounting Framework. The Reliability and Buyer-Supplier Market Access tools require outputs for No Build and Build scenarios. In contrast, the Connectivity tool prompts the user enter the incremental difference between scenarios. This does not provide adequate outputs for the Accounting Framework, which requires separate No Build and Build values. Second, it was difficult to utilize the Connectivity tool for the WFCCS as the study analyzed an entire program of improvements rather than individual segments. This made it difficult to isolate the changes and specific areas where connectivity improvements might occur.

Buyer-Supplier Market Access Tool
As noted in Section 5, the greatest difficulty with the Buyer-Supplier Market Access tool was determining the parameters for the constant decay factor (α) and for the productivity elasticity. These parameters drive the overall model outputs. They are not well defined and cannot be changed with any level of certainty to improve the overall results.

7. Recommendations for Tool Refinement

The study team developed several recommendations for refinement as a result of testing the EconWorks tools. These recommendations are listed by tool in the following sections.

Reliability Tool

Strengths
- Easy to use
- Readily available inputs
- Simple to understand outputs

Weaknesses
- Unable to assess multiple years
- Inability to add volumes
- Reliance on directionality of travel and built-in traffic patterns
- Handling of mulit-modal projects, toll roads and HOV lanes

Suggested Refinements
While the Reliability Tool is suitable for simple projects, the study team has suggested several refinements after testing the tools for a scenario-based study. The primary suggestion involves refining the tools capabilities in terms of analysis. For the WFCCS, the study team had to enter 195 different segments to assess the reliability along the corridor for five project scenarios. This provides one year of results. As is standard, the BCA is conducted over a lifecycle rather than for a single year. If the Reliability tool is intended to be utilized as an add-on to traditional BCA, it would be ideal to provide capabilities to generate benefits for multiple years without requiring the user to enter data manually for every segment in each year of an analysis period.

Similarly, it would be helpful to have a method for users to enter multiple segments. As the tool is currently constructed, the user has to name and save each scenario in a pop-up window without the ability to view input values. It would be helpful to preserve the majority of inputs by copying scenarios and making minor changes without re-entering every parameter. However, inputs could be further improved by the ability to copy a table of inputs into the model rather than manually entering information for 195 scenarios.

The remaining recommendations and suggestions are theoretical questions that arose when analyzing the WFCCS scenarios. The results were questionable for scenarios that include HOV lanes or managed toll lanes. More guidance is needed on whether these types of projects should be analyzed using the tool and whether any adjustments are needed to account for capacity variation, congested speeds, or user willingness to pay on these lane types.

A second question arose regarding how to handle variations in shares of truck traffic throughout the day. Often, the percent of truck traffic is different in peak periods compared to the daily average. It is not clear if this is already considered in the Reliability tool or if changes need to be made to the parameters. Given that the number of trucks impacts the overall traffic flow, it would be helpful to have a better understanding of how the truck shares vary throughout the day and allow for variation in this parameter throughout the day.

Another concern is the heavy reliance on directionality of peak period travel. This was particularly problematic for the 45-mile WFCCS study area, which has multiple nodes so the direction of peak travel changes along the corridor. At the northern end near Farmington Station, the AM Peak is in the southbound direction. For the middle of the corridor, the AM Peak is primarily northbound. There is also a technology hub near the Lehi Station, which attracts commuters so flows are more evenly divided by direction in this section. Additionally, each WFCCS scenario will result in different development patterns and centers of activity, which are not easily accounted for in the analysis.

Finally, sometimes when a scenario is copied, the text in the form indicates “Scenario copied” and other times it indicates “Scenarop [sic] copied, do NOT forget to save” or “Scenarop [sic] not saved.”

Connectivity Tool

Strengths

- Uses well-defined and easy-to-interpret inputs and outputs
- Identifies intermodal facilities in study area
- Compares connectivity of intermodal facilities

Weaknesses

- Analyzes only than one year at a time
- Cannot evaluate more than three facilities at a time
- Unable to monetize weighted connectivity score

Suggested Refinements

The Connectivity tool is helpful in identifying intermodal facilities operating in the project study area. The tool inputs and outputs are well-defined and easy to interpret for the user. However, there are several refinements needed before the tool can be used effectively for assessing projects.

The functionality of the Connectivity tool needs to be improved. For the WFCCS, the study team had to manually alter dropdown menus for facility selection on *Intermodal Facility Inputs* tab. In addition, the “Clear Facility” button did not function properly and the inputs needed to be manually cleared. The unit lift capacity required for rail freight facilities is not linked to the calculations on the *Results* tab even though this would conceptually be an important consideration.

The weighted connectivity value computed by the tool cannot be monetized using the EconWorks Accounting Framework. While the Accounting Framework requires a weighted connectivity value for the No Build and Build scenarios, the Connectivity tool calculates an incremental value for the Build scenario. A value of zero cannot be entered for the No Build scenario in the Accounting Framework. It is unclear from the tool documentation whether the weighted connectivity value is additive across facilities. If not, the impacts for each facility need to be assessed separately in the Accounting Framework.

The database built into the tool does not contain a complete set of intermodal facilities operating in the WFCCS study area, omitting Union Pacific's rail freight facility in Salt Lake City. This facility would experience significant benefits from enhanced connectivity, but information on it is not contained in the Connectivity tool. The tool documentation provides sources, but does not provide guidance on updating facility-specific input data.

The Connectivity tool can calculate outputs for most types of intermodal facilities, but the documentation does not explain why a weighted connectivity value cannot be calculated for rail freight facilities. The WFCCS study area contains several rail freight facilities, but the Connectivity Tool is limited in assessing their benefits.

Overall, the Connectivity tool does not add much value to the standard economic benefits estimated in the BCA. The tool repurposes the travel time savings in the project area for the freight and passenger vehicle close to intermodal facilities. The outputs reflect improvements to roadway travel times near intermodal facilities rather than changes in intermodal capacity or last-mile connections that might result in increased activity.

Buyer-Supplier Market Access Tool

Suggested Refinements

When the outputs from a travel demand model are available, it is very easy to enter information into the Buyer-Supplier Market Access tool. The suggested refinements primarily involve clarifications and minor adjustments to address some of the weaknesses.

Strengths

- Easy to use with travel demand outputs

Weaknesses

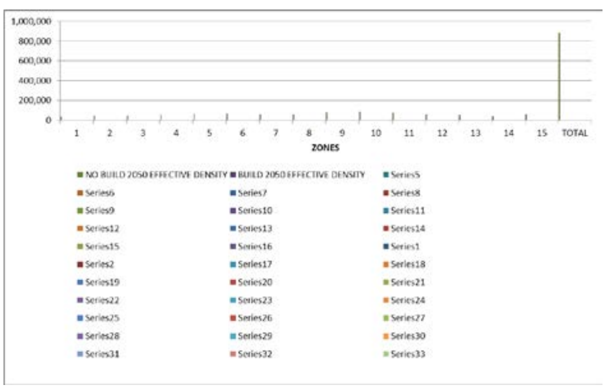
- Accepts limited number of O-D pairs
- Parameter selection (decay constant and elasticity) affects results and little guidence provided
- Provides Outputs difficult to interpret
- Effective density score may not capture mulit-modal improvement if travel demand model data is used.

The number of O-D pairs that can be handled by the tool limits the usefulness of the outputs. The travel demand model used in the WFCCS provided "medium" and "large" aggregations, which have 32 and 15 O-D pairs, respectively. Since the limit on the number of zones in the model is 30, the "large" aggregation of 15 zones had to be for this analysis. Using the finer "medium" aggregation would have been preferred, but the tool could not handle 32 O-D pairs. Based on the size of the study area and the improvements, it is unclear how the number and size of zones would impact the overall accessibility results. It is recommended that the number of zones be expanded if possible.

The User Guide should have clarifications with regards to the selection of the constant decay factor (α) and the productivity elasticity, and whether to calculate effective density or potential access. While each of these subjects is addressed briefly in the guidance, the amount of information and the implications of choosing different values are not clearly explained. This makes it difficult to determine whether or not the outputs are reasonable and should be utilized for evaluation.

As shown in Figure 1, the chart provided in the *Output* tab is not helpful. The notation indicates that the chart shows the effective density scores before and after project improvements. The chart is dominated by 33 blank series and skewed by the inclusion of a "total" bar which changes the scale. It is recommended that the chart be revisited and updated to exclude extraneous information.

Figure 1: Example of Output in Buyer-Supplier Market Access Tool



8. Effectiveness in Describing Economic Impacts

Based on the results of the testing, the study team found that the EconWorks tools did not effectively describe economic impacts compared to the standard BCA and EIA. All three tools were tested, but no results were attained from the Connectivity tool due to the inability to monetize the outputs utilizing the Accounting Framework. The Reliability tool outputs were compared to the travel time savings from the BCA and the Buyer-Supplier Market Access tool outputs were compared to the EIA. Both of these comparisons found stark differences between the EconWorks outputs and the traditional methods.

With regards to the Reliability tool, the comparison to travel time savings is not a direct relationship, but the study team expected to see similar ranking outcomes since the benefit is related due to congestion reduction, which should lead to increased travel reliability. This was not the case. The Reliability tool indicated that the scenario with the greatest amount of travel time savings according to the BCA did not perform well in terms of increased reliability. The discrepancy in relative ranking between traditional travel time measures and the reliability measures is counterintuitive and casts doubt on how to interpret the tool results.

For the Buyer-Supplier Market Access tool, the results differed from the findings of the EIA. While the theory behind the tool is logical, the results are much different than those calculated using a REMI model. In the single year that was available for assessment, the magnitude of the REMI outputs was significantly higher than the outputs from the Buyer-Supplier Market Access tool. There were also strikingly different results on Scenario 2. The EIA identified this scenario as having the largest increase in productivity, while with the Buyer-Supplier Market Access tool showed reduced accessibility with the improvements. This may be due to the increased emphasis on transit service rather than highway improvements.

It is possible that the complexity and nuance of the proposed improvements in the WFCCS scenarios were beyond the capability of the EconWorks tools. The scenarios include transit improvements, travel demand management, and land-use changes. The EconWorks tools appear to be more suited to analyzing projects with simple highway enhancements or spot improvements rather than multi-modal strategies or corridor-wide investments.