Amplified Work Plan (Research Approach)

Work Plan Logic: How Goals & Objectives will be Achieved

Background: *Evolution of the C11 Topic and Team*. Project C11 grew out of recommendations provided by the C03 team. Our team spent the better part of a year evaluating the original C03 concept and additional user needs, through discussions with local and state officials and a focus group of experienced experts as part of C03 Task 2, as well as meetings with the SHRP2 capacity oversight committee in which these issues were further discussed, culminating in recommendations of C03 Task 14.

Given the substantial "thought development" that went into the identification of priorities for additional work (a basis for Project C11), there is value to maintain continuity with Project C03 and its core firms. However, we have carefully reconstituted the staff involved to make use of individuals with the best technical skills to ensure a successful new C11 product. This can provide substantial benefit for the new project, particularly in terms of leveraging the prior C03 product and maximizing usefulness of new C11 products. to address. We have added additional technical expertise to address some of the remaining analytic needs of the proposed C11 work program, and have added new team members (Daniel Brod and Weris, Inc.) to address the unique complexities of statistical analysis that we envision for this project, And, we have rebalanced the efforts of the team to focus the attention of each contributor to those elements of the interactions with decision-points, performance measures and economic/land use interactions that supports the important extensions of modeling and applied research that we envision for this study. This approach will provide substantial benefit for the new project, particularly in terms of leveraging the prior C03 product and maximizing usefulness of new C11 products to address needs identified in the RFP, and those discussed in our response, below.

Motivation and Objective: *Practical Use*. An underlying theme that transcends the SHRP2 program is the development of practical and useful and "accessible" tools that can truly make a difference in transportation investment and planning. And in that context, there is a tension between economic impact modeling that can be so complex that nobody can be sure of its accuracy, and economic impact case studies that can be so simplistic that nobody can be sure of their applicability elsewhere. Originally, C03 was designed to provide a rich body of case studies to help inform the public and decision-makers, and also provide data for future research – and indeed the C03 product has fulfilled that promise. The web tool included in T-PICS has been a source of interest because of the way that it blends ease of use with a complex underlying set of quantitative and qualitative data derived from empirical analysis.

Yet one of the reactions to the case studies and web tools developed for T-PICS has been concern that they can be taken out of context or otherwise be misconstrued, as a project's proponents and opponents can choose to recognize only those cases that fit their needs, while even well-intentioned but naïve users could mistakenly draw conclusions that every project can be expected to achieve the average results achieved by similar projects elsewhere. The appropriate answer to this concern about mis-use of cases is not to require complex simulations or reliance solely on case studies, but rather, to develop useful tools that can bridge the gap between these options.

Core Concept for C11: *Three Classes of Decision-Support Needs*. The recommendations of our team for Project C03, which provided a basis for Project C11, were to create tools that can close the above-noted gap by fulfilling economic impacts assessment needs at various points in the collaborative decision-making process. To illustrate the concept, we group the key decision-

points (from SHRP2 Project C01) into three broad classes that may be applicable for all types of state and regional transportation agencies (including DOTs, MPOs and RPAs):

(1) Early stage planning (such as long-range transportation plans and area transportation needs studies) in which there is need for a *"broad brush scan"* of available options and the typical magnitude of economic impacts commonly associated with them, with basic information about the local context. The C03 product (case studies) addresses this need.

(2) Middle stage planning (such as development of project lists in programming processes and initial elements of corridor planning) in which further analysis is needed to establish the range of likely outcomes through *"sketch planning" procedures* that consider not only local context but also expected changes in traffic conditions. The C11 Project is intended to help extend the C03 product to address this need.

(3) Later stage planning (such as refinement of planning priorities, alternatives analysis or environmental studies for large projects) in which full and *detailed modeling and analysis* is conducted to refine estimates of expected impacts, given details of the project and forecasts of traffic and economic change. This can be provided through either (a) commercial transportation and economic analysis models, or (b) use of commercial consulting services (that provide customized versions of the same commercial model processes).

Essentially all commercial research and consulting firms already provide one or the other of these Class 3 solutions, while this project focuses on addressing an unmet need for Class 2. As these are complementary solutions designed to meet different needs, there should be no reason for either overlap or conflict between this study and the existence of other commercial models, tools and consultants.

In view of the three classes of decision support, the C11 product serves to fulfill three needs. First, it extends the usefulness of the C03 product and the ability of transportation analysts to better incorporate economic issues into mid-stage sketch planning applications. Second, it can extend the base of open source, public information and tools that researchers and consultants can use to provide more detailed analysis. Third, it can be structured to reinforce the overall integration, usefulness and accessibility of the TCAPP tools that are the core of the SHRP2 Capacity research program

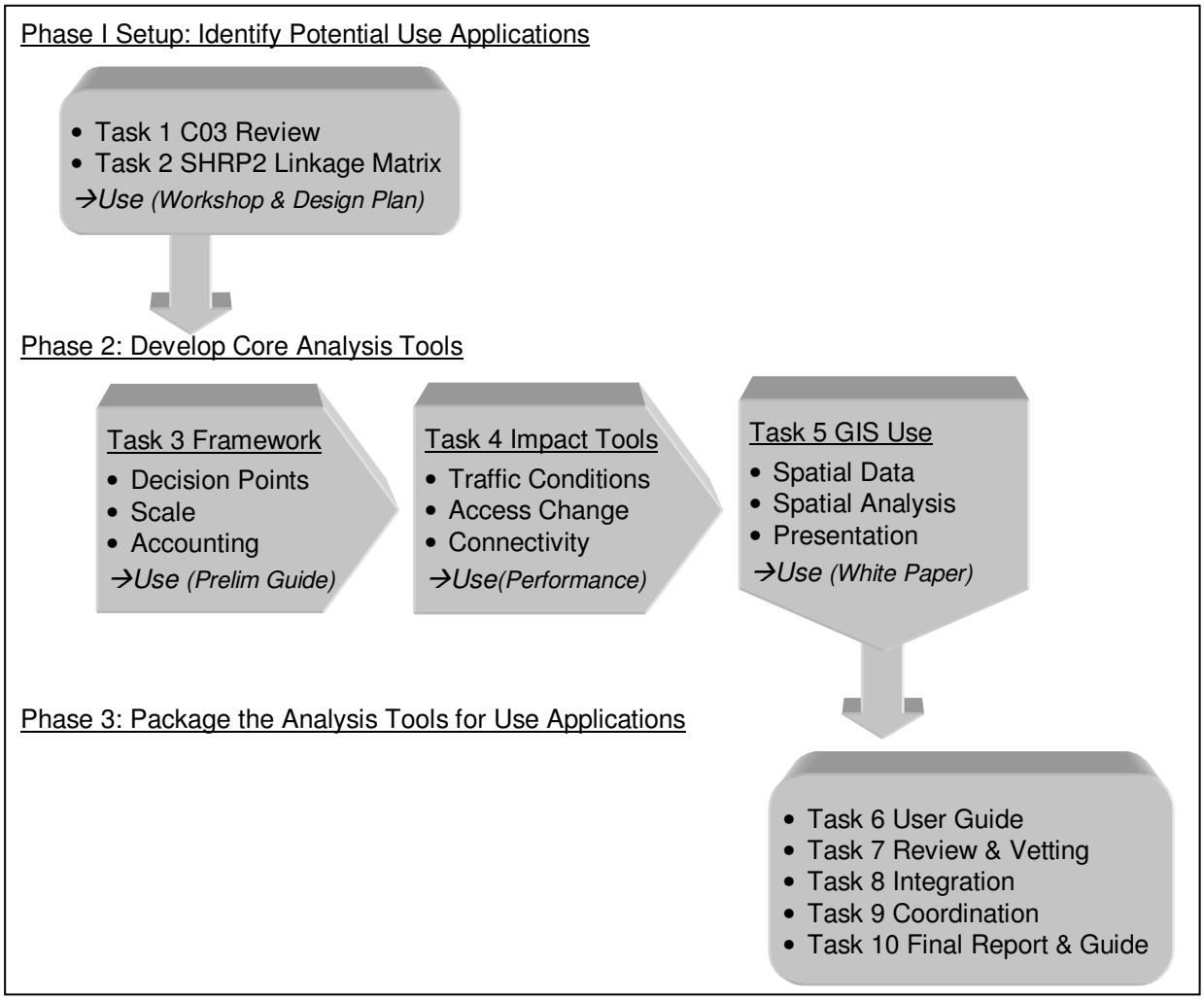
Approach: *An Integrated System*. This project is an opportunity to provide a *coherent and integrated* set of guidelines, impact accounting presentation formats, and accompanying tools. This is dramatically different from NCHRP and FHWA projects that have provided economic impact guides (e.g., NCHRP *Guidebook for Assessing Social & Economic Effects of Transportation Projects*, and FHWA *Guide to Quantifying the Economic Impacts of Federal Investments in Large-Scale Transportation Projects*) and "toolbox" products that catalogued available economic impact methods (e.g., FHWA *Toolkit for Regional Policy Analysis*). We know because members of our team were authors of these past products, and we understand the need to move forward rather than repeat old ideas and material. We also understand that the SHRP2 Capacity Program seeks to systematically improve planning processes, which is different from other sources of funding for research studies and experiments. Finally, we understand that it is imperative to design and introduce a new generation of web-based planning tools that reaches out to a new generation of planners and engineers that finds web-based tools more informative and useful in their professional practice than published guidebooks.

The new product sought here should have *enhance the SHRP2 capacity effort* by following the progression of steps developed in C01, the performance measures developed in C02 and the project/setting taxonomies developed in C03. In fact, the central focus should be to build a suite

of tools that complements and enhances the value of those and other SHRP2 products. It is essentially impossible to achieve that goal if a consulting team merely divides topic assignments among different team members and produces a disparate collection of tools. We understand the need to now produce a suite of straightforward, clear and easy-to-use tools, through a logical sequence that is illustrated in Figure 1.

As shown in the figure, there are three key research products, provided by Tasks 3-5, which we label as the *core analysis tools.* These tools are all designed to extend use of T-PICS (C03) and the analysis beyond that product -- by leveraging external transportation and economic data sources that are in the public domain. The elements of these tasks all relate directly to specific aspects of T-PICS, as is explained in the Work Plan. The core analysis is preceded by a *preliminary phase* (Tasks 1-2) that defines the intended uses and applications of the analysis tools. And it is succeeded by a *final phase* (Tasks 6-10) that actually tests, refines and packages the analysis tools for practical use.

Figure 4-1 Logic Sequence for Improving Economic Analysis Tools for Transportation



Task 1: Review Project C03

Setup – Potential Uses
- Task 1 C03 Review

Objective: Ensure that the C11 product builds upon the structural design of Project C03 and addresses the core needs and issues that were identified in that earlier project.

Work: The EDRG Team conducted Project C03, developed its products and discussed them with the TCC (Technical Coordinating Committee), so our review of that project's deliverables will efficiently extract key issues affecting follow-up work under C11. Specifically, we recognize that an underlying element of all C03 products was the refinement of a structured classification of highway project and location/setting categories. All case studies were so classified, and the meta analysis was conducted with the aim of estimating how economic impacts varied among combination of these project and location categories. This structure must be maintained, for Project C11 to build upon the foundation of that earlier work, and to support the integrated planning process in TCAPP (C01) and the Visioning project being done for SHRP2 (C08).

A limitation of T-PICS case studies to date is that information is widely available for measuring post-project traffic volumes, but there is little pre/post data available on *changes* in highway system performance (such as travel time, cost, safety, connectivity and reliability). This was expected, given that the case studies involved projects constructed ten to twenty years ago (necessary in order to capture subsequent effects on economic development). Nevertheless, the issue must now be addressed in order to maximize value of the C11 products.

Thus, we will use this review to highlight a key issue for Project C11 – the need to identify sources or methods for developing further pre/post data for existing case studies (if possible) and for all future case studies and data collection (going forward from this time). The availability of some data on project-induced changes in pre/post transportation conditions will be critical for the development and use of Task 4 analysis tools, which seek to estimate how changes in traffic, access and connectivity affect the economy.

A second limitation of the T-PICS application to date is that not all projects cleanly fit into a single category of project type. Some individual highway projects may be part of a broader bundle or package of projects that includes inter-city corridors, local interchanges and connecting access roads. In some cases, the various elements of a project bundle are implemented in different phases, over time. In other cases, a highway may pass through a combination of urban and rural settings, spanning both economically distressed and non-distressed areas. C11 can help address such situations by providing an alternative way of decoupling the effects of complex and interrelated projects, by recasting them in terms of fundamental changes in access, reliability and connectivity factors that ultimately are the drivers of economic and land use impacts. These and other issues will be highlighted in the review of Project C03.

Product: A technical memo discussing structural classifications of case design, data inputs and output measures underlying Project C03, along with discussion of additional data needs that will define the design of Project C11's core analysis (in Tasks 3-4-5).

Task 2: Identify SHRP2 Linkages

Setup – Potential Uses
- Task 2 SHRP2 Linkage Matrix
→*Use (Workshop & Design Plan)*

Objective: Ensure that C11 addresses SHRP2 program goals, builds upon the foundation of earlier capacity projects, and complements other recent and ongoing SHRP2 projects spanning capacity, reliability and renewal topics.

Work: Members of our team have participated on teams for a wide range of SHRP2 projects – spanning Capacity (C01, C02, C03, C10), Reliability (L03 and L13) and Renewal (R06). We will leverage this information, and also conduct a full review of all relevant existing and anticipated SHRP2 projects, to identify complementary and overlapping topics and thus assess:

- how C11 products can be tailored to key decision points in the SHRP2 collaborative decision-making process that benefit from availability of economic impact tools for "middle stage" sketch planning (as defined earlier in this proposal);
- how C11 tools can be enhanced by drawing upon transportation performance and reliability measures and improved travel forecasting methods developed in other SHRP2 projects, and use them to generate better indicators of factors driving economic growth;
- how C11 output can be useful as an input to other SHRP2 projects, thus strengthening the overall research program; and
- opportunities to use C11 issues to inform the development of RFPs for future projects and identify potential research or implementation activities post-SHRP2.

Sub-Task 2A: Creating the Linkages matrix

In Task 2 the EDRG Team will review all final and interim research products from the Capacity, Reliability and Renewal programs to identify potential linkages or inter-relationships between these projects and C11. We will develop a Preliminary Inter-Relationships Matrix with an associated summary that briefly describes the type of linkage identified. This can be: (a) common input, output or intermediate analysis calculations, (b) sequential dependency in a decision-making process, or (c) common intended audiences. In addition, the team will review SHRP2 Research Plan problem statements for concurrently issued RFPs (e.g., the C15 RFP covering freight decision-making) and as yet unreleased RFPs to identify potential linkages to these future projects.

The EDRG Team will conduct a screening of all identified linkages to evaluate 1) the potential contribution to the overall goals of the Capacity, Reliability and/or Renewal programs if the linkage were explored in greater depth; and 2) the opportunity to strengthen the linkage during the remaining life of the SHRP2. The purpose of this screening will be to identify high value opportunities to strengthen the linkage of C11 and other research that should be evaluated in greater depth. High value opportunities are defined as linkages that make a direct contribution to the goals of one of the research programs **and** appear to be "doable" within the scope and budget of active or yet to be released research projects.

For each of the high value linkage opportunities identified, the EDRG Team will conduct further investigation. The team will work with principal investigators or key staff from related research projects to validate the C11 team's assessment of the type and value of the linkage and to develop a description of the approach, including any agreed to adjustments to the C11 or in-progress research work plans and the level of effort. This information will be shared with the TRB staff and the TCC (Technical Coordinating Committee). This could be done through one-on-one interviews or by convening a web conference of Principal Investigators.

For linkages that could make a significant contribution to the goals of the SHRP2 research programs but which cannot be completed during the remaining life of SHRP2, the EDRG Team will develop a short problem statement that describes the linkage opportunity, a general

approach to creating the linkage, the benefit to the SHRP2 program if it is done, and an general estimate of the level of effort required. This information will be presented so that it will be useful to teams developing future RFPs or post-SHRP implementation activities.

Sub-Task 2B: Integration with CO1 Decision Making Framework

The CO1 collaborative decision making framework (and the TCAPP website) and the CO3 case studies (and the T-PICS website) were two of the first projects authorized in the Capacity program. They were released to RFP in the same cycle and have run concurrently. As a result, although there is significant opportunity for integration of collaborative decision making and understanding the contribution of economic development to transportation capacity, the scopes of work for CO1 and CO3 scope of work did not create the linkages needed to create this integration. The integration of CO3 into TCAPPS, the web product from CO1, is currently minimal, providing simply a web-link to a small subset of CO3 case studies that included a discussion of collaborative decision making.

Task 2 provides an opportunity to begin to bridge this gap and bring a more robust understanding of the relationship of economic development impacts to the process of making capacity decisions in long range planning, corridor planning and NEPA/permitting. The EDRG Team includes the expertise of the fundamental research in both CO1 and CO3 to enhance this linkage cost effectively. To accomplish this goal we will convene a C11 team working group meeting, with appropriate invitations to other relevant, active Capacity project technical teams, such as those working on the C08 (Visioning) and C15 (Freight decision-making) projects. Attendees at this meeting will include the principal investigators and key staff from both teams. The purpose of this working group meeting will be to detail the integration of economic development impacts into the collaborative decision making framework. This includes:

- Identify of decision points in transportation decision making where economic development impacts should be discussed
- Policy questions related to economic development impacts that decision makers should consider at the identified key decision
- Role of formal decision making partners (state DOTs, MPOs, FHWA and resource agencies) in these discussions
- Information (data, analysis or related land use decisions) that are needed to inform these discussions
- Tools and technology supports that are currently available or will be added through the C11 research

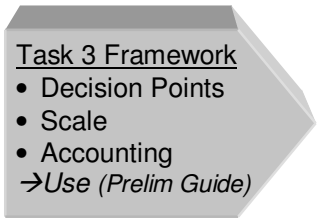
This process will enable the identification of additional factors affecting economic development impacts that can be integrated into the TCAPP web tool, enabling practitioners to both understand the relationship of economic development impacts to overall decision making, and provide them with specific guidance for enhancing their decision making to incorporate a more robust consideration of this important topic. It can also “lay the groundwork” for later making additional linkages with other SHRP2 projects addressing environmental and other externality factors.

Product: A memo providing the matrix of project linkages, workshop findings and implications for C11 project and product design. It will specifically cover:

- Identification of high value opportunities and strategy for linking C11 to other research in Capacity, Reliability and Renewal programs during remainder of SHRP2;

- Research or implementation problem statements for linking C11 to other SHRP2 research post-SHRP2; and
- Information to facilitate enhanced integration of economic development impacts into collaborative decision making (TCAPP).

Task 3: Accounting Framework



Objective: Develop an "accounting framework" for economic impact analysis that addresses information needs for transportation decision-making, and builds upon Project CO3 products. This will guide development of additional studies under Task 4 and provide a structure for their application.

Work: While the T-PICS system provides information on different types of economic impacts at different spatial scales and discusses their evolution over time, users are challenged to use that information correctly. There is always a risk that they may either "double count" or "under count" by inappropriate combining multiple measures. And there is also confusion regarding how to present findings on economic impacts and distinguish them from benefit-cost analysis results. Additional tools to be developed in subsequent tasks of this project will also need to be structured in a way that enhances economic impact assessment by filling gaps in (and thus fitting into) a consistent impact accounting system.

Thus, we will lay out an "accounting framework" – a format for relating the dimensions of data that are inputs in economic impact studies and output presentations of their findings. This framework, to be provided as a spreadsheet tool and recommended reporting format, will lay out the key elements of economic impact that are of interest for decision-making, and identify the impact measures that need to be assessed or predicted through econometric analysis in task 4. The resulting analysis measures will provide a basis for future enhancement of the T-PICS system, by enabling new and enhanced predictive tools to be developed in this project. In particular, it will help guide the work of Tasks 4-5 by establishing the parameters in which they must operate, and it will help guide development of the Task 6 User Guide by identifying relevant transportation and economic performance metrics to aid decision-making.

To address these desired uses, we plan to ensure that the framework will:

- build upon the *classification* of project types and settings underlying the T-PICS case studies. Categories may be expanded in the future, but there is little value in developing more categories as long as the number of available cases is limited.
- develop a *spatial scale dimension* that can distinguish small-scale impacts (e.g., highway interchange area) from medium scale impacts (e.g., local highway corridor) and large scale impacts (e.g., statewide or multi-state impact area). Experience to date has shown that different types of projects generate different forms of impact at different spatial scales (e.g., property values are most often highly localized, while job impacts often occur at a more regional scale). In addition, some projects generate shifts in location patterns that show up as major impacts at a local level but cancel out at a broader state level.
- develop a *temporal (time) dimension* that can distinguish short-term construction impacts, medium-term impacts on activity patterns, and longer term impacts on business investment and growth. A variety of studies and our own case studies have highlighted the fact that some of the more interesting job impacts may not occur for 5-10 years after a project, and that timing of those impacts varies by setting.

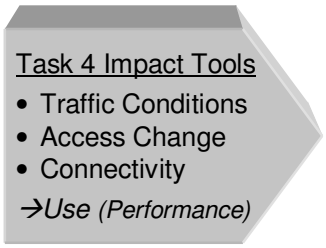
- cover the full range of applicable *transportation changes and external impacts* that affect economic impact outcomes. Thus, there must be some accounting of the full set of highway project factors (which include not only the average travel time and cost, but also highway impacts on reliability, accessibility, connectivity and environment) and distinctions between classes of affected parties whose reactions ultimately affect economic growth.
- provide a presentation basis to enhance *public understanding* and illuminate discussion of the relationship between transportation user impacts, broader economic impacts, and differences from benefit-cost analysis.

It should be noted that these spatial and temporal dimensions of the accounting framework can also distinguish elements of economic impact in broader economic studies, as discussed in the OECD "Workshop on Macro, Meso and Micro-economic Impacts of Transportation" and a subsequent article in the *Annals of Regional Sciences* (both involving members of our team). They further help to explain and display the "wider economic benefits" of transportation investments, consistent with the Eddington Study concept now being promoted in the UK. This work will be effectively accomplished by building up experience of the EDRG Team in addressing relationships between economic impact benefit-cost and financial accounting that EDRG has been addressing in workshops for OECD, TRB and FHWA, and reports for NCHRP and USDOT. Special attention will be given to steps needed to avoid both double-counting and mischaracterization of redistribution effects, as the spatial focus changes from local to broader area impacts.

Finally, the accounting framework will account for distributional equity factors and social /environmental factors that are hard to monetize. Members of our team (EDRG, ICF and CS) have authored guides and articles covering both of these issues, so we are well aware of their importance as valid considerations for decision-making. However, it is also important that the accounting framework clearly distinguish (and avoid confusion) between the four different perspectives involved in measurement of: (1) aggregate economic growth, (2) economic efficiency, (3) economic equity or distributional considerations, and (4) social factors that are not monetized.

Product: A memo on design of the accounting framework, a spreadsheet version of the accounting table, and a draft user guide on its application and interpretation.

Task 4: Analytic Tools



Objective: Develop a set of predictive impact analysis tools that can be used by state DOTs and MPOs and other researchers working for them. These tools should serve to: (a) enhance and extend the value of the T-PICS system to its users, and (b) enable "mid-stage" studies that can draw upon sketch planning methods to relate changes in transportation conditions to subsequent factors driving and enabling economic impact.

Work Plan Structure: We start by recognizing the key transportation factors that drive economic impact, according to business and economic development literatures. These factors, which are included in T-PICS case study design and reports, include the local setting (density and prior economic distress), travel cost elements (including travel distance and traffic speed), and other factors such as variability or reliability, labor market access, customer/ delivery market access, and intermodal connectivity. *The problem is that many of these factors that drive economic development are often not well measured or accounted for in standard transportation datasets.*

And when they are, agencies are not clear on how they can be applied to help explain past or predict future impacts on local and regional economies. So this task seeks to improve both (a) the data and measurement of key transportation factors that drive economic impact, and (b) the representation of behavioral relationships by which they lead to economic impact. We divide this new work into a series of four subtasks:

- Sub-Task 4A – Traffic Delay and Variability Conditions
- Sub-Task 4B – Market Access Conditions
- Sub-Task 4C – Intermodal Connectivity Conditions
- Sub-Task 4D – Suite of Tools Relating Highway Performance to Business Growth

While T-PICS case studies include some measure of each of these factors, they are not complete and usually exist only for post-project conditions. Of course, the only way to provide sketch planning estimates of the impact of changing these factors is by assessing the impact of variation and change in them. Thus, each subtask addresses:

Data: external sources that can be obtained and used to extend T-PICS case data, and represent transportation factors driving economic impact,
Methods: types of analysis that can be done, using Project C03 categories, to relate individual projects to changes in transportation conditions,
Measurement: ways to measure and portray project impacts on these transportation factors,
Tool & Use: spreadsheet products to portray effects of projects on transportation conditions, and relate them to resulting economic impacts.

Sub-Task 4A – Traffic Delay and Reliability Conditions

Data: We will assess availability and use of information sources on pre/post or time series (historic) traffic volumes (AADT) and performance (speed). We will focus on those that are freely obtainable for many or most highway segments around the US, and assess which of the different T-PICS project types can be covered by them (see right side box for listing of project types).

T-PICS Project Types
(separate by urban / rural)
- Limited Access Route
- Bypass Route
- Urban Beltway
- Limited Access Highway
- Route Widening (Lanes)
- New Bridge
- New Highway Interchange
- Access Connector Road
- Intermodal Freight Terminal
- Intermodal Pass. Terminal

This will cover a variety of data sources now available for both model inputs and evaluations of more recent past projects. For instance, NHPN datasets can provide volume and related information for the National Highway Planning Network for 1993 onward. The NHPN is being adapted to accommodate HPMS data, which also provides data of value for reliability measurement, on of the key elements in assessing the economic impact of highway investment on both passenger and commercial travel. In addition, most medium and large urban areas now have traffic management centers that collect continuous, volume and speed data on urban freeways. Data from seven of these areas were used in CS's L03 project and we have access to many more. From these data, congestion measures can be developed including several reliability measures, which requires a history of continuously-collected data. In recent years, the availability of vehicle probe data from private sources (e.g., Inrix, Navteq) has also grown substantially. These data provide congestion estimates on nearly all higher order highways, not just those where roadway imbedded counters or other permanent instrumentation exists. CS is currently using Inrix data on several projects and can assess its potential for future analysis. Some state DOTs are also now starting to purchase private vendor travel time data as a means of fueling their 511 traveler information systems, and these data may also be used for many other applications, including economic evaluations.

Methods: We will identify public methods or tools that can be used to assess how volume/capacity ratio changes can simultaneously affect speed and reliability (and which of the different project types and different settings can be covered). This will include methods developed by CS that cover both average delay functions developed for the HERS model and reliability functions developed for the SHRP2 L03 project. Both involve measuring performance from easily obtainable data sources. We can draw from a major finding of Project L03, that reliability as well as travel time are affected not only by strategies that target nonrecurring congestion but also by capacity expansion projects.

Measurement: We will develop an approach, to be utilized in the spreadsheet tool, to handle delays that occur over only some parts of the day and which are masked by the commonly available AADT figures. This will include sketch planning distributions for travel time by time of day (applicable for rural roads and intercity highways … beyond just urban freeways), and delay factors for rural areas associated with queuing behind slow-moving vehicles in areas where passing is difficult due to limitations associated with road geometrics (even though V/C ratios appear to indicate only mid-level congestion). We will again seek to leverage existing tools and incorporate their findings into new tools and applications for this project. So even though the data inputs are simple, the HERS delay functions are based on a model that built up delay from individual hours of the day and use a series of temporal demand distributions based on analysis of continuous field data. Likewise, the SHRP2 L03 relationships were developed for peak hour, peak period, mid-day and 24-hour time periods. CS is currently updating these distributions for signalized highways for NCHRP Project 3-97 ("Traffic Signal Analysis with Varying Demands and Capacities") and for freeways for the I-95 Performance Measures Project. The SHRP 2 L03 dataset can also be used to develop hour or sub-hour intervals.

The proposed econometric work will include regression analysis that relates measures of economic growth and change (as dependent variables) to alternative indicators of volume/capacity ratio, delay, reliability and changes in those indicators (which are the explanatory or independent variables). Exploratory analysis will be conducted to examine the applicability of alternative measures of both the dependent and independent (explanatory) variables. Both the availability of data measures and their explanatory power (including confidence intervals) will be assessed, and will be a basis for recommendations regarding their use in project assessment tools.

Tool & Use: Based on the preceding analysis, we will develop a spreadsheet-type of analysis tool that can be used to estimate or represent the *traffic delay and reliability/variability* element of highway performance improvement for specific types of projects, and provide this tool in an update of T-PICS. We will also prepare instructions (as an part of the User Guide) on how the tool can be used to represent intermediate factors that also affect economic growth and development. The tool will be specifically designed so that highway delay and reliability performance measures can be used for different types of projects in different areas, to represent the impacts of both completed and proposed highway improvements. This will enable their effects to be related to economic impact outcomes under sub-task 4e. For instance, it will distinguish the different ways that travel time variability affecting commuters, freight shippers and logistics companies, each of which has a different type of economic impact.

Sub-Task 4B –Market Access Conditions

Data: We will assess availability and use of spatial detail data on population, employment and other origins and destinations that can be used to calculate pre/post changes in market accessibility due to highway improvements.

T-PICS Access Types
- Labor Market
- Shopping Market
- Same Day Delivery Market
- Recreation/Other Market

This will focus on data to measure labor commute, shopping/business and truck delivery markets, and changes in them that may occur when transportation projects change access along particular corridors. ***It will be conducted in conjunction with the Task 5 analysis of geographic information systems*** because we expect the market access measures to employ spatially geo-coded datasets representing the location of residences and businesses, and travel times between those distances.

Once upon a long time ago (back in the twentieth century), it was necessary to employ large and detailed analysis of transportation analysis zones (TAZs) in network models, to represent labor market and truck delivery markets. But as GIS systems have become commonplace across all 50 states, and the road network and travel times have become encoded in common GPS navigation systems, it now becomes possible for anyone to map travel time isochrones from any population center, and measure the population or employment within them. This kind of spatial data, contained in GIS systems covering all states (or by using providers such as ESRI GIS or OpenSource GIS), also makes it possible to represent a topography of labor market or truck delivery market access from any given point. This data was, in fact, already used to populate the T-PICS case studies with measures of local labor market size. We will develop a description of the available datasets and more importantly, the availability and limitations of data for tracking impacts of past projects and forecasting impacts of proposed projects.

Methods: We will identify publicly-available methods that can be used to assess how changes in highway travel time along various corridors can lead to changes in the scale of labor markets, delivery markets and customer access markets. Optimal measurements combine spatial analysis of origin and destination points, O-D travel patterns and highway network performance data. We will review the range of available approaches, including:

- Simplified sketch planning approaches, using maps and spreadsheets, which are described in detail in a chapter on accessibility measurement in NCHRP Report 456 (Weisbrod and Forkenbrock, 2001)

- Detailed traffic network modeling approaches, which define generalized accessibility as the denominator of the trip distribution equation in travel demand models. (For a given zone i, that is value is expressed as the sum over all zones j of the product of the attractions in all other zones j and the friction factor to travel from a given zone i to all other zones j)

- Intermediate measures of the form now used in T-PICS, which use an arbitrary cutoff defining a travel time “commute shed” or “delivery shed,” and then apply a GIS spatial database to calculate the magnitude of workforce or business activity occurring within that “shed.”

- More sophisticated composite measures which utilize GIS to map the pattern of population and employment density, and overlay market attraction contours (distribution patterns) to generate a weighted score of market access (and changes in it caused by transport projects).

Measurement: We will develop an approach, to be utilized in the spreadsheet tool, to estimate the magnitude of labor and delivery areas and the effects of transportation capacity projects on the scale of those areas. There are several approaches to be investigated. Sketch planning and commute shed measures (as well as the access measures shown in T-PICS) use an arbitrary cutoff (such as 45 minute one-way travel time for commuting, and 2.5 hours one-way time for same day delivery). That can make them susceptible to measurement errors and discontinuities

related to the choice of a specific origin point. In other words, a small change in the point of measurement can change the entire market measurement, depending on whether a major population or employment center is located just barely inside or outside of the cutoff travel time.

TTI brings extensive experience with GIS applications and will explore use of more sophisticated density contours in GIS and other spatial analysis systems. This will enable more realistic and accurate calculation of project impacts on market areas, because the measure will not be skewed by either small changes in the starting point for measurement, or by discontinuities in the density of activity that occur with use of arbitrary market area boundaries. However, care will have to be taken in how this kind of application is developed and provided in the updated T-PICS, as greater user resources are necessary to apply this alternative approach. Finally, in addition to population and employment, it is also possible to estimate trip productions and attractions so that the number of affected trips, and not just population and employment totals, can be calculated.

With any of these alternative measurement approaches, we will be able to measure the "effective density" or magnitude of worker or business delivery opportunities for any particular location, and thus the effect of transportation capacity changes on opportunities. Differences in effective market size can then be statistically related to differences in the composition of economic activity attracted to an area. This is the concept underlying the notion of "agglomeration economies" that can be generated by a transportation improvement. New economic geography provides the theoretical guidance on implications of effective market scale on productivity and business growth. This benefit would over and above benefits effects of travel cost alone. Our approach builds on this concept (already operationalized in the UK by Graham et al, 2007, and in work for the ARC by Comings, Weisbrod and Lynch, 2007).

The proposed econometric work will include regression analysis that relates measures of economic growth and change (as dependent variables) to alternative indicators of market scale, density and changes in those indicators (which are the explanatory or independent variables). Exploratory analysis will be conducted to examine the applicability of alternative measures of both the dependent and independent (explanatory) variables. Both the availability of data measures and their explanatory power (including confidence intervals) will be assessed, and will be a basis for recommendations regarding their use in project assessment tools.

Tool & Use: Based on the preceding analysis, will provide a spreadsheet-type tool that can be used to estimate or represent the *market access* element of highway performance improvement for specific types of projects. We will also prepare instructions (as an part of the User Guide) on how the tool can be used to represent intermediate factors that drive economic growth and development. The tool will be specifically designed so that market access measures can be applied for different types of projects in different areas, and represent the impacts of both completed and proposed highway improvements. This will enable access outcomes to be related to economic impact outcomes under sub-task 4e. For instance, it will distinguish access effects for commuters and for delivery trucks, each of which has a different type of economic impact.

SubTask 4C – Intermodal Connectivity Conditions

Data: We will explore potential sources of information on pre/post changes in access from highways (or from population centers via highways) to intermodal rail, air and marine terminals. The data sources may build upon the USDOT database of intermodal facilities, additional data from the Army Corps of Engineers (ACE),

T-PICS Connectivity
- Hwy to Intermodal Freight
- Hwy to Passenger Rail
- Hwy to Air Terminal
- Hwy to Marine Terminal
- Hwy to Intl. Gateway

Intermodal Association of North America (IANA), geospatial coding systems and available sources of travel time as discussed under Subtask 4a. We will also summarize availability of indicators of intermodal facility activity, in terms of passenger and freight volumes, frequency of service and breadth of locations served. The data sources and methods for characterizing intermodal terminal activity and access will vary by mode.

Methods: We will identify the three dimensions of intermodal connectivity: (a) access time to intermodal interchange terminals, (b) service frequency for intermodal interchange at those terminals, and (c) scale of services offered, including volume and number of destinations served. These dimensions can be viewed separately or put into composite measures through tools such as simple spreadsheet-based "gravity models" -- that rate attraction by service frequency and scale, and then decay that attraction as access time from it increases. There are spreadsheet tools that provide these measures. The mix of business activity at various locations has been statistically related to differences in intermodal connectivity.

Measurement. We will develop an approach, to be utilized in the spreadsheet tool, to estimate the level of intermodal connectivity and the potential effects of transportation capacity projects on that connectivity. The economic impacts of improvements to intermodal connectivity will then be related to changes in traffic conditions (recurrent delay, reliability) and the nature of activity at the intermodal terminal. The methods for characterizing intermodal terminal activity and access will vary by mode.

- *Rail Intermodal Terminals* – The Intermodal Association of North America (IANA) maintains the most accurate directory of rail intermodal terminals, including location and lift capacity. BTS, FRA, and Oak Ridge National Laboratory also maintain information on rail intermodal terminals. However, none of the sources provides information on the level of activity at rail intermodal terminals. Railroads often consider this proprietary information. As a proxy, we will consider railroad traffic density. This measurement will build on the role of ICF as a leader in railroad network analysis, having led a variety of studies for the Federal Railroad Administration and individual railroads to analyze rail safety and energy issues as well as studies using data from Oak Ridge National Laboratory's Railroad Network model.

- *Passenger Rail Terminals* – Roadway improvements to intercity and commercial rail stations can reduce travel time and create economic benefits. BTS maintains the Intermodal Passenger Connectivity Database, which can be used to characterize the availability of connections among various scheduled public transportation modes at each facility. At present, this database covers only intercity rail stations, airline airports, and ferry terminals, although the addition of commuter rail stations is expected soon. The measurement will build upon ICF analysis of passenger rail activity and access in a variety of studies for FRA and for various intercity, high-speed intercity, regional rail networks, and commuter lines.

- *Air Terminals* – Because air transport typically involves much shorter travel time than other intercity modes, improvements in ground access to air terminals can have a significant effect on total door-to-door travel time for both passengers and freight. Public information on passenger and air cargo activity by airport is readily available from the U.S. DOT datasets. Airport connectivity can be assessed from plane schedule information. However, it will be important to consider not just direct flights to and from a given airport but also the degree to which direct flights provide access to major passenger and cargo airport hubs. This measurement will build upon the experience of ICF's SH&E division, which maintains airline financial traffic and fare data from the US DOT, as well as other industry sources for airline schedules, traffic, fleet and financial data. It could also incorporate findings from the Market Information Data Tapes (MIDT) database, a tool for identifying an airport's air service area.

- *Marine Terminals* – Detailed public information on current and historic activity at marine ports is available from the U.S. Army Corp of Engineer (ACE) (including freight tonnage and vessel calls). Trade value at ports is available from the American Association of Port Authorities, commercial sources, and (for international trade) customs data. In addition to freight tonnage and value information, the economic impact of roadway connectivity improvements will also depend on the dominant commodities and transport modes at a port. For example, improving roadway access to a container terminal will likely have greater impact than improving access to a liquid bulk terminal, which typically involves landside transport by pipeline and rail. This measurement will build on ACE entrances and clearances data can be used to determine the origins and destinations of ships for each US port, and thus the degree of connectivity to other seaports worldwide. It will utilize ICF experience with ACE and other port data sets, including a recent national port emission inventory that required analysis of vessel calls (by vessel type) and cargo (by commodity) for more than 80 individual ports.

- *International Gateways* – Because of customs and security regulations, there is robust public data on activity levels at international gateways. For Canadian and Mexican gateways, BTS maintains current and historic data on vehicle and train crossings by Port of Entry (POE). The BTS TransBorder Freight Data provides both freight value and tonnage by mode and POE. Air and marine international gateways can be characterized using the Marine and Air Terminal data sources described above. This measurement can build upon datasets covering international surface trade and transportation, and ICF studies of Mexican and Canadian border crossing activity for the Bureau of Customs and Boarder Protection.

- BTS National Transportation Atlas Database of Multimodal Facilities (NTAD) – This is a multi-modal database and is available from years 1998 through 2009. Its content has expanded over the years. The 2008 and 2009 versions includes various mutli-modal transportation facilities (airports, rail stations, ports, bridges, weigh stations, etc.), freight networks, National Highway Planning Network (proposed future highways), rail networks, waterways, air quality non-attainment areas, and various political boundaries. (NTAD) 2008.

  The proposed econometric work will include regression analysis that relates measures of economic growth and change (as dependent variables) to alternative indicators of highway access time to intermodal (rail, air and marine) terminals, changes in those access times, (which together comprise explanatory or independent variables). Exploratory analysis will be conducted to examine the applicability of alternative measures of both the dependent and independent (explanatory) variables. Both the availability of data measures and their explanatory power (including confidence intervals) will be assessed, and will be a basis for recommendations regarding their use in project assessment

Tool and Use: Based on the preceding analysis, will develop a spreadsheet-type tool that can be used to estimate or represent the intermodal connectivity element of highway performance improvement for specific types of projects. We will also prepare instructions (as part of the User Guide) on how the tool can be used to represent intermediate connectivity factors that also affect economic growth and development.

The tool will be specifically designed so that intermodal connectivity measures can be applied for different types of projects in different areas, and represent the impacts of both completed and proposed highway improvements. This will enable connectivity changes to be related to economic impact outcomes under sub-task 4e.

Sub-Task 4D –Predictive Tools Relating Highway Performance to Economic Outcomes

A critical aspect of our proposal for Task 4 is that we shift the focus of analysis from *traditional transportation impact measures* (i.e., travel time, cost and safety) to *intermediate factors* that actually matter to individual business operators and thus actually "drive" economic development processes (i.e., market access, connectivity, and delay/reliability). We then relate *economic development impact outcomes* (reflecting rates of growth and location of economic activities) to those drivers. The suite of predictive tools is designed to provide a transparent sequence of intermediate measures of these driver factors and final economic growth outcomes. It will be designed to be applicable for all of the different types of projects represented in T-PICS.

Data: Information from sub-tasks 4a – 4c will provide information for measurement of delay, reliability, access and connectivity conditions (aka, "drivers of economic impact"), and the effects of highway-related projects on those conditions. That information will serve several purposes: (1) it will enhance existing T-PICS case studies through pre/post measures of project impacts on these factors driving economic impact, (2) it will allow future case studies to be more complete by providing the enhanced measures, and (3) it will provide data outside of the T-PICS cases, which can also be used to relate these transportation factors to economic impact outcomes.

Measures: The suite of tools will be developed to enable statistical analysis of relationships between traditional transportation impact, factors, the intermediate "drivers" and actual economic outcomes. The analysis will make use of both the T-PICS dataset and a national GIS-based dataset of all counties in the continental US to be assembled by EDRG and TTI. These two datasets will provide measures of both spatial variation and temporal changes in the location and growth of employment and business activity at county or local levels. They will provide a basis for multivariate spatial regressions to assess the relative role of these factors, and their interactions, in generating economic impacts at local and regional levels.

These regressions will update but follow the form of past research studies that have already established relationships of access, reliability and connectivity to regional economic growth, including regressions by Weisbrod and Treyz ("Productivity and Accessibility, " BTS Journal of Transportation & Statistics, 1998), EDR Group (intermodal connectivity and market access effects on sources of economic growth, Appalachian Regional Commission, 2008), and agglomeration economies in the UK (Graham, OECD, 2007) . Our ability to build on the models used in past research will help to ensure practical and useful results.

Use and Tool: The results of the statistical exercise will serve multiple purposes. The main purpose is to provide a solid and defensible basis for new spreadsheet-type predictive tools that will be useful for state and regional transportation agencies (including DOTs, MPOs and RPAs). The tools will show: (a) how effects of individual projects can be portrayed in terms of before-and-after changes in key factors driving economic impact, and (b) how changes in those factors can be used to assess the magnitude of likely economic impacts. The tools will also enable (c) improvement in aggregate regional and statewide performance metrics and (d) an upgrading of the current "meta-analysis" associated with the T-PICS case data.

The suite of tools will be presented to users in the form of a spreadsheet workbook that can be accessed or downloaded from the T-PICS web site. It will enable enhanced analysis of the T-PICS data, and those results will be used to upgrade the predictive capability of the statistically-based "meta analysis" engine that is already functioning within T-PICS. The system design will also allow for separate analysis for those wishing to conduct their own sketch planning processes. To maximize flexibility, it will be downloadable from the web site to user computers, for use by with Excel or any other spreadsheet program that can read its universal format.

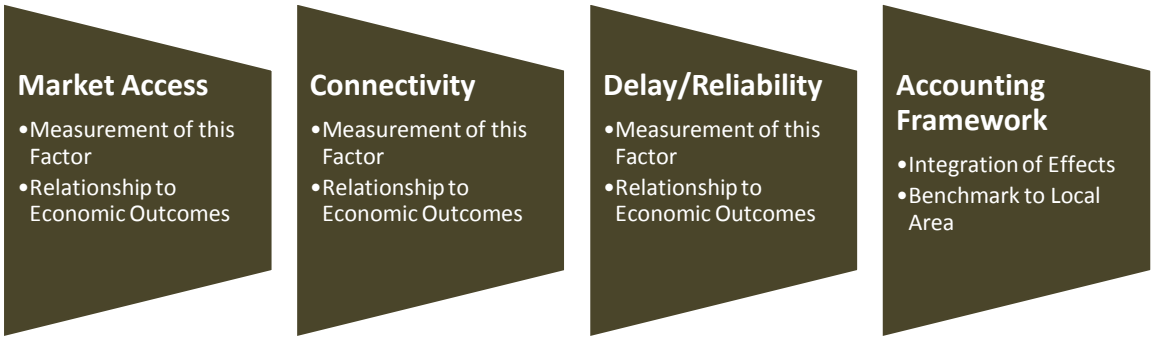
The workbook will consist of separate modules covering: (1) market access, (2) connectivity and (3) delay/reliability. Each module will consist of two parts:

- Part A which takes information about project impacts on transportation conditions, and develops composite measures of changes in "driver" factors, and

- Part B which shows how changes in those driver factors affect the likely magnitude of economic impact for the relevant type of project.

A fourth module will address interactions and double counting, and account for local economic conditions to display ratings of a project's overall impact, in terms of where it will fall (at the high end, middle or low end) of the range of expected outcomes predicted by T-PICS. A final and optional aspect of the spreadsheet system will be presentation of the accounting framework developed in Task 3. This accounting system will have to be manually filled in, based on a variety of additional cost, schedule and local finance data that is beyond the scope of this project.

Figure 4-2. The Four Modules



The four modules, along with the Task 3 accounting table, will be designed as a suite of tools that can be used within T-PICS or for stand-alone use by staff of state and regional transportation agencies. However, it must be recognized that some agencies will face challenges acquiring and applying needed data, due to limited staff capacity, resources and/or expertise. It is also clear that not all agencies will have the ability or desire to initiate the effort required to conduct this form of additional economic impact analysis. In the face of this challenges and issues, the project team will provide a discussion of tradeoffs involved in trying maximize ease-of-application, usefulness, accuracy and resource requirements. The most appropriate course of action will then be recommended, with the dual goal of providing a product that can be useful to a significant number of agencies, while also minimizing the likelihood of mis-use and mis-interpretation that comes from oversimplification.

To ensure usefulness, the suite of tools will be designed to require only data that is easily collected or assembled by those conducting a sketch planning study, or which can be acquired from data sources that are either public or very widely used and commonly used by state DOTs and MPOs. This will not preclude product from also being used in conjunction with travel models, land use models, economic models or commercial consultant studies, but those additional uses will not be part of its standard use.

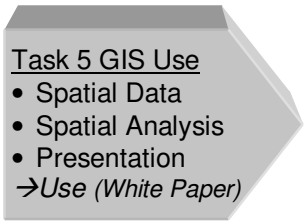
To further ensure integrity of the product, the formulas will be protected from misuse, but the product will be freely available and usable to all, via web inks established by the National

Academies. The National Academies will also be given a non-exclusive license for all object code and final products.

Product for Task 4: There will be three products:

1) Suite of tools developed in this task and designed to be imbedded in T-PICS
2) Memo, discussing outcomes of subtasks A-D, specifically distinguishing situations where these tools can be used to extend usefulness of T-PICS or apply for more refined mid-range planning processes.
3) User Guide section covering data sources, analysis methods, the suite of tools and their applications for addressing different forms of highway project decision-making that occur at various decision points in the planning process.

Task 5: Geographic Information Systems



Objective: Identify and assess ways to utilize GIS (geographic information systems) and geo-spatial tools to improve and leverage the Task 4 tools.

Work: While the T-PICS system provides information on different types of economic impacts, it does not currently include any form of spatial analysis or presentation beyond the use of Google Maps to portray case study location and highway setting. The addition of GIS systems can provide three potential benefits:

- *Enhanced presentation of project* setting - by making it possible to portray a project's location relative to population and employment market centers, as well as highway network and intermodal facility connections.

- *Enhanced visualization of project impact* – by showing the scale of the areas affected by changes in labor market or delivery market areas, or changes in access to intermodal connections.

- *Enhanced analysis of spatial impacts* – by leveraging the spatial database analysis strengths of GIS to develop layered or multi-dimensional calculations of access and connectivity *gradients*; i.e., the slope by which project impacts taper off with increases in travel time and distance from the project site and the potential for more advanced, quantitative spatial analysis using approaches such as spatial autocorrelation to assess factor interactions. In fact, our approach for analysis of market access (sub-task 4b) explicitly integrates GIS in this way.

Data Systems: GIS systems are now common among state and regional transportation agencies and planning agencies across the country. Public information, geo-coded with spatial information, includes boundary files, employment data, population data, intermodal terminal data and some transportation networks. The HPMS (highway performance monitoring system) data will also be available in GIS format starting this coming year.

There are many options for GIS frameworks, including widely used commercial systems such as ESRI products (ArcInfo, ArcView and ESRI/GIS) and TransCAD, as well as numerous open source GIS systems. (An interested party can check out opensourcegis.org which lists several (20+) open source and free GIS tools and software that can be used for the development of an integrated GIS component to TPICS.) Some larger MPOs also use TELUS (a publicly-available information management and impact system with integrated GIS, developed by NJIT). The

selection of specific GIS software can be left to individual agencies, as the availability of public or commonly acquired spatial datasets is the primary factor enabling innovative and new applications of GIS for SHRP2 studies. Uses of GIS in analytic support through T-PICS will be presented in ways that users of either proprietary or open source software can access key concepts and apply the principles supported through the web tool.

Applications: As TTI's team has been actively showcasing the use of GIS tools through both commercial and open source systems, we propose that each should be used to illustrate the ways that GIS systems can be applied to both (a) spatial analysis and (b) visualization applications. Both sources share the common attribute(s) in that they can enhance the communication of project level or program level assessments of transportation performance or impacts, as well as benefits of broader network level connectivity improvements.

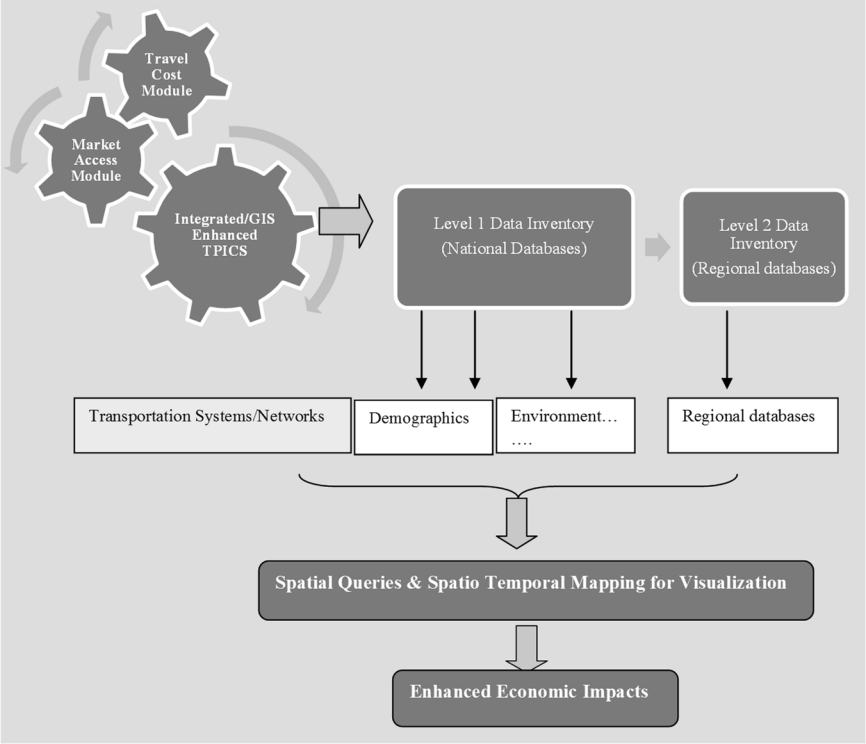
First, spatial analysis will be illustrated by use of market access impact measurement methods in Subtask 4B, which will be extended from access time and density gradient measures to also include "spatial adjacency" indicators that reflect additional impacts that transportation access improvements can have for adjacent areas. Spatial impact analysis has already been integrated with economic models in a number of cases around the country, where economic and land use modeling techniques have been tied together. The future for expansion of this integration will also be addressed.

Second, use of GIS for visualization will be reviewed in terms of applications to date that range from query options (to locate planned roadway improvements), to buffering options around planned roadways/improvements (to allow for improved visualization of project immediate areas and surrounding areas). These applications will be illustrated using information drawn from cases in the current set of T-PICS data and supplemental information for these cases developed using the methods and research results obtained in Task 4. Practical application of GIS methods will be described via the process illustrated in the following chart. Additional analysis and discussion of emerging trends in GIS-based spatial and economic analysis will focus on potentials for broader integration of geospatial and economic impact tools in the future, as suggested by the current research being conducted in the US and in Europe.

Product: A White Paper on GIS and geospatial data integration for analysis and visualization of economic impacts and wider economic benefits. We also propose a "proof of concept" through application of GIS to market access measurement issues in sub-task 4b and to apply this via examples to selected cases in the T-PICS database. These latter examples will be selected to illustrate key combinations of project type, setting and socio-demographic characteristics most illustrative of the visualization and economic impacts that the proposed GIS applications are designed to support.

The product will be accompanied by a discussion of how these tools can be used in various ways by state and regional transportation agencies that may differ in terms of their current levels of staff expertise, capacity and resources time. This discussion will recognize that some agencies are already sophisticated users of GIS, others are not but will eventually become adopters of GIS technology, and yet others may continue to lack the size or budget scale to ever take on some kinds of GIS-based traffic and economic analysis. However, even this latter class of agencies may be able to leverage the capabilities of other parties to make use of GIS applications.

Example of GIS in an Enhanced and Integrated T-PICS System
(Visualization and Query Components)



Task 6: Draft User Guide

Task 6 User Guide
- Accounting Framework
- Analytic Tools
- Applications

Objective: Develop a draft user guide that documents results from Tasks 1-5, including both the new "accounting framework" and "suite of tools" designed to improve economic impact analysis.

Work: The Project Team, including lead members from each of the organizations (EDRG, ICF, CS, TTI and Weris), will work together as a team to produce a clear and comprehensive user guide. It will be separated into two parts: (1) *technical instructions* on the mechanics of using the work products, and (2) *application guidance*, regarding when and how these tools should be used.

The user guide will not, nor should it, be a perfunctory assembly of products from prior tasks. Specifically:

- ***The application guidance*** part will actually be presented first, since it sets the stage and provides users with information regarding when it is most appropriate to use these tools. It will build on a distillation of the planning and decision-making processes, and identify needs for information on economic and land use impacts at different stages in those processes. It must build upon the outcomes of Tasks 1-2, Project C01/C07 and TCAPP, and factors discussed in the SHRP2 integration task (which are described in more detail in Task 7, which follows). This guidance will specifically distinguish:

  - The planning context – elements of the collaborative decision process, and key decision points at which sketch planning techniques are appropriate to assess economic impacts of transportation proposals (based on findings from Tasks 1-2);

- The impact and benefit accounting process – types of impacts and benefits, when they should be assessed to best inform discussion and decision-making, and how they should be defined in an accounting framework to avoid double-counting and under-counting of benefits (based on findings from Task 3);

- Economic Impact Processes – paths by which highway capacity changes can affect the economy, the "intermediate factors" that drive economic impacts, and how the new tools can be most effectively used to measure intermediate and final economic outcomes (based on findings from Tasks 4-5).

- Presentation and Visualization Support – how the results can be most effectively presented to inform decision-making with logical explanations and transparent calculations, and using visual representations that convey "visual information" and ways of conveying explanations of the spatial context of economic impact data.

➢ ***The technical instructions*** will build largely upon interim memos produced as part of Task 3 (memo on accounting framework) and Task 4 (suite of tools). An important additional element will be discussion of how to collect or assembled information from existing sources to construct a reasonable representation of differences between project (build) and alternative (no-build) scenarios. This will include protocols for data assembly to facilitate pre/post-comparison in future case studies, and protocols for data collection to facilitate predictive applications in future planning and alternatives analyses that build on similar research already conducted in development of cases for the T-PICS database.

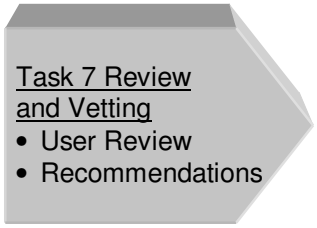
The technical instructions will also be oriented to provide guidance for a range of different kinds of agencies and levels of expertise, including (a) those that are already sophisticated technology users, (b) those that may are on a path towards greater staff technical capacity, and (c) those that are resource constrained.

The instructions will also discuss ways to best ensure *completeness* – a particularly critical matter that we have found plagues and distorts many impact studies. Incompleteness occurs most egregiously when a project is proposed or built to address problems that are not revealed by standard data on daily averages for traffic volume, speed and accidents. This can include access constraints, peak conditions, vulnerability to non-recurring congestion or limited intermodal connectivity. The accounting framework and suite of tools have been very consciously defined to explicitly enable measurement of these additional factors, which are often of critical importance for economic development. Yet we have also found that many transportation planning agencies still lack the capability to document and assess changes in these factors. The instructions will be designed to help them address that need.

Our team will design the user guide to be realistic and applied, following a "how to" approach in which we walk users through the different contexts of: (1) early stage planning (such as long-range transportation plans and area transportation needs studies), (2) middle stage planning (such as development of project lists in programming processes and initial elements of corridor planning) and (3) later stage planning (such as refinement of planning priorities, alternatives analysis or environmental studies for large projects). The guide will explain *when* it is appropriate to apply the various techniques, *how* the products of this project can be best used, and the steps involved in using them appropriately. It will be designed to link directly with analysis that supports decision-making through the KDPs in the TCAPP system (with placeholders as necessary in the draft version), and will cross-reference linkages to process issues that will be further discussed in the Task 8 work product.

Product: A draft user guide that presents findings of Tasks 1-5, by identifying ways in which accounting framework and predictive tools can be most effectiveness used to inform planning processes and decisions. (Following completion of Tasks 7-9, the user guide will be revised to produce a final version.)

Task 7: Review and Vetting



Objective: Provide for a review and vetting process for the user guide, using a group of practitioners to obtain feedback and recommendations regarding its content and usefulness.

Work: The review and vetting process is clearly intended to focus on practical use of the guidebook, including its completeness and effectiveness in accomplishing the stated goals of improving the application of economic impact measurement and accounting for highway projects. This is equivalent to a product "*beta test,*" for it asks early adopters to try it out in and then provide feedback regarding their reactions and suggestions for improvement.

Review Topics. The topics to be reviewed, and areas for improvements, can include: (a) clarity of writing, (b) completeness of coverage, (c) practicality of steps, (d) level of effort required for users, (e) understandability of results, and (f) usefulness of outcomes.

While the review focuses on the user guide, it necessarily covers use of the accounting framework and tools, so it is likely that the reviews will also provide recommendations regarding the layout, labeling and overall format of forms and reports provided by the tools. Responding to those comments will not require massive new work, but it could call for some tweaking of the tools themselves.

Review Process. In the end, a successful review process can lead to revised tools and revised guide and that will succeed because it has been fully vetted by practitioners, who can vouch for their usefulness. However, extreme care must be taken to ensure a quality review and vetting process, and that depends in large part on the selection of parties who conduct the review.

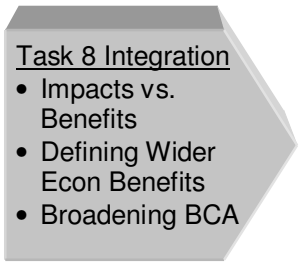
In designing the review process, our team had internal discussions of the pros and cons of pre-selecting and designating a review panel comprised of academic and practitioner experts. We reached a consensus that at this juncture – that it is most appropriate for the review to focus on practitioners, and specifically those that represent the full range of likely users. We found that those agencies most interested in paid participation SHRP2 research review had a "self-selection bias" – they were the agencies whose staffs already understood economic impacts and had already been studying and measuring them. This is not the most appropriate or useful group to review the products.

Accordingly, the project team will identify and assemble a small group of typical user be assembled to "exercise" the tools, user guide, and documentation (to perform a limited beta test) and thus vet the products. Our approach is to identify this group by reaching out to state and regional planners through groups such as AASHTO, AMPO, NADO and TRB, and finds those who are: (a) most interested in learning more about economic impact assessment, (b) do not yet do much work in this area, but (c) are interested in learning more and trying out the sketch planning tools and guide. We found interest among the national organizations in supporting this approach, and we identified a web conference format as an appropriate way to assemble reviewers from around the US for discussion of this topic. Our current plan is to invite staff from

up to ten agencies, representing both state and local/regional levels, to review the guide and accompanying tools. We will ensure that at least six of them will then follow through to complete reading of the guide, testing it, and vetting its usefulness.

Product: A memo that compiles review and vetting process results, and discusses modifications to be made to the final format for tools and the final user guide.

Task 8: Integration



Objective: This task applies results of Tasks 1-7 to further show how they can be integrated into broader elements of benefit/cost analysis and decision-making processes. It is designed to: [1] Explain the difference between economic impact analysis (EIA) and benefit/cost analysis (BCA), and provide guidance as to how EIA results can inform BCA measurement by incorporating wider economic benefits without double-counting; and [2] Demonstrate how economic impacts should be considered at key decision points as laid out in TCAPP (Project C01).

Work: The work consists of analysis and writing that will ultimately appear as part of the final research report and updated user guide. It is comprised of two distinct parts:

Sub-Task 8A. Economic impact analysis and benefit/cost analysis

Comparing Methodologies. It is natural and appropriate that the C11 products be explained in terms of how they do and do not fit into economic impact analysis (EIA) and benefit/cost assessment (BCA). While this project focuses on EIA, it has substantial implications for BCA because it seeks to formalize many of the transportation-related productivity factors that drive economic development and also legitimately represent societal benefits. Thus, an outcome of this project will be insight and recommendations that may affect the use of both techniques.

The EDRG Team is uniquely well positioned to accomplish this work. For the last decade, Glen Weisbrod has written about differences between EIA and BCA in a variety of publications. This includes the NCHRP 456 guide to social and economic impacts (coauthored with Forkenbrock), USDOT freight guide, ACRP review of aviation BCA, NCHRP study of "hard to quantify economic and environmental impacts" and articles in *Transportation Research Record*, *Annals of Regional Science* and *Evaluation & Program Planning*. He has also spoken widely on this topic for USDOT, an OECD panel and agencies in the UK, Netherlands, and Australia.

Accounting for Wider Benefits. The Task 3 accounting framework will have distinguished between factors affecting only EIA, only BCA and those that overlap to affect both. We will leverage that material to highlight the key transportation-related factors of productivity – which include agglomeration (effective density) economies, logistics (connectivity and just-in-time scheduling) economies, and production scale economies. These productivity factors are key drivers of economic development, as they affect business investment decisions. They are also the primary basis for "wider economic benefits" that can be incorporated into BCA.

The existence of these wider economic benefits is not new, as there is a literature on externality benefits of public investment, including business productivity, going back at least fifty years. Recognition in transportation BCA is also not new, as both productivity and incremental macroeconomic benefits were recognized in the FAA's BCA guidance published eleven years

ago, and in the ASCE/Caltrans BCA web guide that goes back five years, as well as the 2006 USDOT Guide to Quantifying Benefits of Freight Investments. Yet while the concepts are not new, the T-PICS case studies do serve to explicitly highlight market access and connectivity measures in both the database tables and text. Thus, our discussion of these issues will serve to explicitly define and distinguish the elements of business productivity, show how they relate to SHRP2 research, show how they are included in the C03/C11 products, and show how that information can be included in BCA calculations.

Sub-Task 8B. Use of economic impact Information at Key Decision Points

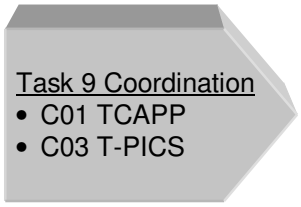
The Task 1-2 reviews of linkages to other studies will have identified ways in which this project can either (a) directly inform decision-making, or (b) indirectly assist decision-making by complementing other studies and measures of performance impact. We will distill that information to provide a summary table showing explicitly how C03 case study data and C11 enhanced predictive capabilities can serve to inform different types of decisions required at various stages in the planning process.

This table will distinguish key decision points from TCAPP and identify the associated economic assessment needs, spanning: (a) early stage planning -- such as long-range transportation plans and area transportation needs studies), (b) middle stage planning -- such as development of project lists in programming processes and initial elements of corridor planning, and (c) later stage planning -- such as alternatives analysis, project selection processes or environmental studies for large projects. This effort will build upon work that members of our team have done as lead consultants for SHRP2 projects C01, C02, C03 and C07. Recent experience has also shown that some aspects of analysis and visualization will be important in supporting "Visioning Processes" as developed in ***SHRP2 Project C08***. Moreover, on-going research on integrating freight decision-making into the TCAPP process in ***SHRP2 Project C15*** may be sufficiently advanced such that tools being developed in this project – especially those related to commercial market access, factor productivity and reliability effects can be effectively cross-referenced.

We will then specify updates to be made to the TCAPP decision guide and T-PICS web tool (and implemented in Task 9) to incorporate this information about key decision points. The updates will include: (1) new cross-references within TCAPP to relevant forms of economic analysis that can be used at various decision points, (2) added material in the T-PICS user manual that references ways in which the economic analysis can be used in decision-making, (3) added reference to the new C11 products within TCAPP, and (4) access to the new C11 products (or links to access them) added directly within T-PICS.

Product: A memo on Task 8 results, including both (a) added discussion material to be included in the final User Guide, concerning the definition of productivity and wider economic benefits, and their use within EIA and BCA applications, and (b) description of new material to be added to TCAPP and T-PICS, and new description of tools to be added in the Final Research Report.

Task 9: Coordination



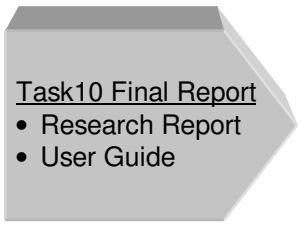
Objective: Coordinate with the project C01/C07 and C03 contractors, and with other SHRP2 research that may be sufficiently advanced to consider (such as C08 and C15), and to link the results of this new C11 project to TCAPP and T-PICS, T-VIZ (C08) and also add links to government and other relevant web sites.

Work: The Project Team will implement all changes called for in Task 8, including additions and updates to both TCAPP and T-PICS. This will include: (1) within TCAPP – added references to use of economic analysis and the C11 tools at various decision points, and (2) within T-PICS, access to the new C11 products and coverage of them in the user manual. In addition, we will submit information to managers of *www.data.com* and other relevant public web sites information so that they can add announcements and links to T-PICS and Project C11 products (at their discretion).

Since our project team includes both ICF and EDRG -- the contractors that developed and now host TCAPP and T-PICS -- this process will be vastly streamlined in terms of cost, time and effort. Most importantly, there will be no significant issues of cross-contractor expenses or coordination required.

Product: Updates made to both TCAPP and T-PICS to include discussion and links to tools developed in Project C11.

Task 10: Final Research Report and User Guide



Objective: Prepare and submit: (1) a final User Guide and (2) a final Research Report.

Work: The final version of the User Guide will be based on the Task 6 draft User Guide, with modifications called for by the Task 7 review process findings, the Task 8 integration analysis findings and the Task 9 coordination activities. Special care will be taken to assure that relevant and appropriate linkages to TCAPP decisions processes, including those that are currently being considered for modification relative to freight project decision-making in C15, and that are emerging in the visualization project (C08) are included.

The final Research Report will be a companion document that consolidates all relevant project results that are not in the User Guide. It will be compiled by assembling all written products developed for Tasks 1-5 and 7-9 that are not already incorporated in the User Guide. Those materials will be edited to produce a coherent and useful final report that also serves as documentation of Project C11 and its activities. For purposes of completeness, it will also include an outline of the separate User Guide and T-PICS web site modifications.

Product: The modified User Guide and Final Research Report will be submitted for review by the ETG (Expert Task Group), SHRP2 staff and by others (in accordance with National Academies report review procedures), after which it will be revised as necessary and submitted in final form. (Note: It is understood that the ETG will be available for use as a sounding board throughout the project, but their ultimate responsibility is to merely assure the quality of the final products of this project.)

4.3 Anticipated Research Results

Innovations. Results of this research project are expected to yield a series of innovations that will help to advance the state of research and improve highway investment decision-making. They will be in the form of:

- *An accounting framework tool* that transportation planning agencies can use to sort out economic impact analysis, benefit/cost analysis, fiscal and financial analysis results. It will be provided as part of the broader suite of tools, but it will be presented in the form of a downloadable spreadsheet workbook that can be used independently of any other tools. This can dramatically help planners sort out the differences, and thus become more responsive to decision-makers as well as more accurate in clarifying public discussions about highway investment.
- *Enhancement to T-PICS,* accomplished by incorporating results of statistical analysis tools that will extend the "meta analysis" predictive engine (used in the My Project Tools" part of T-PICS) to better assess the likely impacts of proposed projects. This will be accomplished by allowing additional information about expected changes in transportation conditions to be used to refine the expected range of a project's impact on the economy.
- *A suite of measurement and impact tools* that can be used by transportation planners, either with T-PICS or as part of an independent sketch planning process, to provide insight into the expected or potential form of economic impacts. The suite will work by translating proposed project effects on travel conditions into intermediate factors affecting business productivity, which in turn will be applied to gauge the nature of expected impacts on the economy of affected areas. This suite, by addressing intermediate factors (such as reliability, market access and intermodal connectivity), will provide a more transparent and logical estimation and presentation of expected economic impacts. This will help inform public discussion and decision-making.
- *A User Guide* that is written specifically for applied transportation planning analysts, which explains when and how the accounting tool and suite of predictive tools should be used, and how their results should be interpreted. This will be critical to ensure appropriate use of the tools, and minimize likelihood of results being taken out of context.

4.4 Applicability of Results to SHRP2 Objectives

4.4A Results to Advance SHRP2 Objectives

SHRP2, through its capacity program, seeks *transportation planning that better integrates community, economic and environmental considerations into new highway capacity*. This proposed work plan is tailored to address that goal in four ways:

- First, it provides an accounting framework that sorts out various money and non-money impacts on the economy, and it links them to different treatments in benefit/cost analysis (covering community, environmental and economic impacts).
- Second, it explores (and provides a white paper on) emerging applications of geographic information systems (GIS), as a way to provide spatial analysis and visualization applications for both economic and environmental impact factors.

- Third, it explores (and provides tools for) measurement of community effects on access, job markets and other factors that affect economic development as well as community quality of life.
- Finally, it provides a user guide that lays out a logical sequence of effects to explain how highway capacity changes can lead to economic growth, by means of various intermediate community and spatial impacts.

4.4B Results to Integrate with Overall Capacity Research Plan

The C11 products can enhance the *SHRP2 capacity effort* by following the progression of decision steps developed in C01/C07, the performance measures developed in C02 and the project/setting taxonomies developed in C03. In addition, the C11 work plan is designed to also incorporate SHRP2 *reliability* measures and datasets being addressed in L03, L11 and L14.

Members of our project team have worked on most of these projects. This relationship will greatly facilitate the matrix of SHRP2 project linkages as part of Task 2, and the coordination with other projects as part of Tasks 8 and 9. There are particularly strong linkages to Project C01/C07 and Project C03, which are explained below.

Integration with Project C03 (T-PICS). The products of Project C11 are designed to extend the value of the T-PICS product developed as part of Project C03. Specifically, the accounting framework, suite of tools and user guide to be developed in Project C11 are all designed to extend the usefulness of T-PICS by enabling its users to utilize additional information on changes in travel conditions to better predict impacts of proposed projects. As noted in the RFP, the C11 tools are also designed to work independently and fill a gap, by operate at a sketch planning level that is more sophisticated that the existing T-PICS (case study-based web tool) but far less demanding than more complex transportation, economic and land use simulation modeling systems.

Integrating with Project C01/C07 (TCAPP). The product of Project CO1, TCAPP, is a user-friendly presentation of the collaborative decision making framework. The user guide and tool products of Project C11 are designed to leverage the TCAPP tool by explicitly tying their uses to specific points in the collaborative decision-making process. Thus, the C11 user guide will explicitly distinguish the different types of economic impact information needed for early stage planning (such as long-range transportation plans and area transportation needs studies), middle stage planning (such as development of project lists in programming processes and initial elements of corridor planning) and later stage planning (such as refinement of planning priorities, alternatives analysis or environmental studies for large projects). Through this linkage, the C11 product will increase the usefulness of TCAPP.