U.S. Department of Transportation
Volpe National Transportation Center (Volpe Center)
Macroeconomic Impacts of Highway Investment

STATEMENT OF WORK (SOW)

Background

The transportation system is facing new challenges to deliver and implement passenger and freight system improvements that meet the needs of accessibility, economic sustainability, air quality, livability and state of good repair. Transportation system enhancements are a means of maintaining or improving economic opportunities, output and productivity, and ultimately quality of life. There is a need to develop tools for understanding the economic impacts of alternative levels of transportation investments on the whole national economy. In support the Federal Highway Administration (FHWA) Office of Economic Investment Strategies (HPTS), the Volpe Center seeks the services of a contractor to perform macroeconomic modeling using its own model capable of analyzing the macroeconomic impacts from highway investments in the U.S.

Previous analyses conducted for these purposes have used USAGE-Hwy, a computable general equilibrium (CGE) model of the United States that has been modified to give distinct representation of transportation-related industries.[1] The topics of the previous analyses include comparisons of the macroeconomic impacts from:

- Differing levels of highway capital spending as discussed in FHWA's Conditions and Performance reports relating to 1) sustaining current spending; 2) maintaining current system performance; and 3) investing in all cost beneficial projects.
- Different funding methods: 1) bonds backed by increases in the gas tax; and 2) pay-as-you-go funding derived from an increase in the gas tax.
- Highway investment occurring during normal economic conditions v. recession conditions.

The Highway Economic Requirements System (HERS) model is used to estimate changes to highway system performance when provided with certain highway investment spending targets. The impacts from additional highway investment are provided in terms of: vehicle operating costs, travel times, maintenance costs, safety in terms of medical costs and fatalities, and fuel use.

The National Bridge Investment Analysis System (NBIAS) is an analytical tool developed by FHWA to predict future bridge conditions, estimate repair costs, and forecast long-term investment needs nationwide. NBIAS generates multi-year life cycle alternatives (up to 50 years) for over 600,000 bridges in the National Bridge Inventory (NBI). NBIAS evaluates the economic return on investments, such as user benefits gained from avoiding detours or resolving load postings.

[1] Dixon, P. B., Rimmer, M. T., & Waschik, R. (2017). Linking CGE and specialist models: Deriving the implications of highway policy using USAGE-Hwy. Economic Modelling, 66, 1–18. https://doi.org/10.1016/j.econmod.2017.04.022

Requirements

The following are requirements of the model used for this analysis.

1. The model must be founded upon core economic principles related to general equilibrium modeling:
   1.1. price and quantity demanded should be determined endogenously through market clearing forces that involve pricing to match supply and demand;
   1.2. multiple economic agents which seek to optimize their utility or profits should be represented in the markets; and
   1.3. the interactions between economic agents should generally be mediated through markets and prices.
2. The model must use an analysis period of at least 30 years.
3. The model used in the analysis must be able to realistically characterize macroeconomic impacts resulting from:
   3.1. Tax increases (impacts from changes in gas tax rates or introduction of VMT taxes);
   3.2. Changes in spending on highway and bridge construction;
   3.3. Changes in productivity for in-house and for-hire trucking sectors and business travel from changes in highway system performance in terms of vehicle operating costs (including fuel) and travel time;
   3.4. Changes to consumer welfare due to changes in highway system performance resulting from travel time savings, changes in vehicle operating costs (including fuel) and safety enhancements that reduce medical costs and fatalities;[2] and
   3.5. Changes in amounts of government borrowing.
4. The model used in the analysis must characterize the macroeconomic impacts in terms of:
   4.1. Output/Gross Domestic Product (GDP);
   4.2. Output at the individual industry level;
   4.3. Productivity;
   4.4. Employment levels;
   4.5. Wages;
   4.6. Welfare that includes non-medical related consumption, changes in travel time, and changes in fatalities valued according to USDOT guidance on value of statistical life; and
   4.7. Cost of borrowing for various financial instruments including government bonds.
5. The model must accurately capture cross-elasticities of demand between transportation modes: highway, air, water, and rail. Each of these industries must be represented separately in the model. The in-house components of each of these industries must also be represented.

[2] One possible approach is that used by the USAGE-HwyF model, which includes as an industry "private road transportation" which is modelled as using inputs of cars, household car repairs, and fuel. Its output is sold to the "Vacation transport" and "Commuter transport" industries. These sales are accompanied by an artificial sales tax that covers the cost of driver time. See Peter B. Dixon, Maureen T. Rimmer, Robert Waschik, Linking CGE and specialist models: Deriving the implications of highway policy using USAGE-Hwy, Economic Modelling, Volume 66, 2017, Pages 1-18, ISSN 0264-9993, https://doi.org/10.1016/j.econmod.2017.04.022. (https://www.sciencedirect.com/science/article/pii/S0264999317305965)

6. The model must use the most current data available to characterize the US economy as of **2024**, including the most recent version of the detailed input-output tables from the Bureau of Economic Analysis and the most recent version of the Transportation Satellite Accounts.

The research products that will be produced using the model meeting the above requirements are described below.

Government Furnished Information (GFI)

HERS and NBIAS Model Outputs

The Volpe Center will provide the contractor with a spreadsheet of HERS and NBIAS model outputs for all analytical scenarios relative to this analysis. The information from HERS and NBIAS will be presented for each year for 30 years.

Key HERS output categories and the methods HERS uses to monetize the corresponding impacts are described below. Note that HERS covers just 85 percent of vehicle-miles travelled in the United States, so the HERS outputs must be adjusted to national level accordingly before being included in the macroeconomic model:[3]

- **Travel time cost savings** are monetized using estimates of the values of time which are based on prevailing wage rates and time costs for goods being held in inventory on trucks. The Volpe Center will provide travel time benefits measured in person-hours and dollars. After receiving the HERS model results, the Volpe Center will factor these time savings benefits to show how these benefits are divided between passenger vehicles and trucks and urban and rural system performance.

- **Vehicle Operating Costs Savings** represent the changes in fuel use and other variable costs that would result from improving the conditions of the highway for existing users. The Volpe Center will provide estimates of the fuel savings measured in gallons, along with assumed values for fuel prices and taxes, and estimates of monetized impacts on total vehicle operating costs. These costs are estimated using engineering relationships between pavement condition and geometry and vehicle operating costs. This category of benefits will be factored to show how these benefits are divided between passenger vehicles and trucks and urban and rural system performance.

- **Incremental travel expenditures** represent expenditures for fuel and auto service for VMT above baseline levels (or reductions in expenditures for VMT below baseline levels). The Volpe Center will provide estimates of vehicle operating costs for incremental travel, along with incremental fuel use in gallons. This category of benefits will be factored to show how these

[3] NBIAS outputs are still in development but will be similar.

benefits are divided between passenger vehicles and trucks and urban and rural system performance.

- **Safety cost savings** is the value of injuries and fatalities avoided from projects that improve safety. This value is based on estimated willingness to pay (WTP) to avoid injuries and fatalities that in turn is based on DOT value of statistical life. This WTP includes avoided medical costs and property damage costs and lost wages from lost working time due to injuries. The Volpe Center will provide an estimate of changes in fatalities and total safety-related costs.

- **Highway maintenance costs savings** are savings to the agencies responsible for maintaining highways. Rebuilt highways experience reduced maintenance costs. The Volpe Center will provide an estimate of changes in expenditures on highway maintenance.

- **Emissions reductions.** Reducing fuel burned also reduces emissions. The benefits of emissions reductions are estimated by willingness to pay to avoid respiratory illness associated with air quality problems resulting from vehicle emissions. The Volpe Center will provide estimates of the monetized impact of vehicle emissions.

Tasks

The contractor shall: (1) develop or expand its current macroeconomic model to meet the requirements listed above; and (2) conduct and report on new model simulations addressing high-priority research questions to be identified by the Volpe Center, with a focus on examining the impacts of high-priority highway investment scenarios involving factors such as alternative investment timing and investment levels.

The contractor shall: (a) review the output from HERS and NBIAS (to be provided by Volpe as GFI) and identify any concerns regarding anomalous data to the Volpe Center; (b) incorporate the model refinements to meet the requirements listed above; (c) run sets of scenarios using the refined model based on the finalized set of output from HERS; (d) provide a summary of the model input files and model summary output files; and (e) provide a written report describing important features of how the scenarios were modeled, including the effects of the model refinements and industry level impacts. The written report shall contain analysis and explanation suitable to be included in a policy briefing for a non-technical audience, but with sufficient technical detail to persuade the reader of credibility of the methodology and results.

There is no travel required for this work; the contractor may complete this work through regular videoconference meetings with the Volpe Center without meeting in person.

This SOW also includes “option line items” (Tasks 6, 7, 8, and 9).

The following tasks are designed to structure a series of communications between the Volpe Center and the contractor to ensure that the final work product meets the Government’s needs. The contractor

shall communicate as often as necessary with the Volpe Center to obtain the information needed to complete the project.

The deliverables shall include detailed outputs from the model, including all items listed in item #4 of the model requirements. Results for individual industries of interest shall also be provided, analyzed and discussed by the contractor in the policy briefing(s). Additionally, the technical report shall document assumptions for policy shocks, such as levels and timing of highway investment, and its socioeconomic impacts over time.

Task 1: Project Management (CLIN 00100, funded)

Within two weeks of award, the contractor shall participate in a kickoff meeting with the Volpe Center and its FHWA sponsor. The meeting, to be held via videoconference, will focus on discussion of the specifics of the model and any necessary refinements. During this meeting, the contractor shall present its initial plan for how it will complete the model refinements and new model runs.

In addition, the contractor will provide monthly progress reporting due on the 15th of each month in PDF format.

The contractor shall provide: attendance at kickoff meeting, presentation of initial plans on how to complete the model refinements and monthly progress reporting.

Task 2: Update macroeconomic model to 2024 (CLIN 00200, funded)

The contractor, with input from the Volpe Center, shall determine the best way to modify its model to meet the requirements listed above, including *updating the data underlying the model to the most recent available to represent U.S. economy as of 2024*. The contractor shall implement the modifications and produce a technical memo describing the revised model, including the original model features, data, relationships, assumptions, etc. and the model refinements implemented under this task. The memo shall contain information, examples, sensitivity analysis or case studies demonstrating how the model meets the requirements listed above. The memo shall document the impacts of certain model updates in output variables, compared with the original model.

Within two weeks of delivery of the technical memo, the contractor shall participate in a meeting with the Volpe Center and its FHWA sponsor to discuss the contents of the technical memo. The meeting will be held via teleconference.

The contractor shall provide: technical memo describing the updated version of the macro model.

Task 3: Conduct Analysis using Updated Model for 2024 and HERS-derived shocks (CLIN 00300, funded)

The contractor shall conduct a series of runs using the model refinements developed under Task 2. The policy runs (approximately three in number) represent shocks to the US economy derived from the HERS model. The runs will be discussed relative to a baseline run representing conditions in 2024. The results

shall relate to a single policy issue and shall be discussed collectively in a single report. The report will include: (a) a summary of the model inputs, including HERS model outputs; (b) a discussion of key assumptions used to model the baseline economic conditions, including unemployment rate, interest rates, etc.; (c) a thorough discussion of the model results including intuitive explanations for those results; and (d) industry-level model results.

The new model runs will incorporate parameters (i.e., HERS model outputs) from HERS runs. The Volpe Center will provide the contractor with the relevant HERS model outputs for each scenario.

The contractor shall communicate regularly with the Volpe Center to ensure that the baseline assumptions in the macroeconomic runs are consistent with the HERS baseline scenarios for all model runs. The paramount areas to ensure consistency include levels of highway investment and productivity growth associated with road transportation activity. If consistency cannot be achieved, the reasons for the lack of consistency should be discussed in the report described below.

For the model runs under this task, the default specification of macroeconomic model should be conducted under an assumption of no sensitivity of labor supply to travel time savings.

In addition to the report, the contractor shall provide a summary file of key model outputs (e.g., effects on GDP, productivity, employment, wages, consumption, tax revenues, and net government debt over time) by year in Microsoft Excel for Volpe and FHWA use (e.g., preparation of outreach materials, subsequent economic analysis).

Within two weeks of delivery of the draft report, the contractor shall participate in a video conference with the Volpe Center and its FHWA sponsor to discuss the report. The contractor shall update the report based on feedback from the Volpe Center.

The Volpe Center will provide: list of primary impacts to include in the report, HERS model data describing scenarios for runs, and feedback on the draft report.

The contractor shall provide: presentation of model results during project meeting, draft and final reports, and model output results by year in a spreadsheet file.

Task 4. Review Summary of Analysis Drafted by USDOT (CLIN 0400, funded)

USDOT anticipates including a summary of the macroeconomic impacts of different highway spending levels in the next Conditions and Performance report to Congress with base year 2024. If the optional Tasks 5, 6, and 7 are exercised by the Volpe Center, the summary will also relate to different bridge spending levels. This task requires the contractor to review the summary of the results drafted by Volpe staff and respond to comments from various reviewers of the Conditions and Performance report as it goes through the review process at USDOT.

The Volpe Center will provide: a summary of the analysis for inclusion in the Conditions and Performance report.

The contractor shall provide: corrections and clarifications to the summary and responses to comments from reviewers as the report is reviewed prior to publication.

Task 5. Review and refine methodology for incorporating NBIAS-derived shocks into USAGE-Hwy (CLIN 00500, option)

Volpe staff will develop a preliminary method for translating NBIAS-derived investment levels in Bridge preservation projects into quantified benefits measures. The same benefit categories listed for HERS above will be used for this NBIAS-derived investment levels. Under this task, the contractor will review the Volpe method and suggest revisions or refinements to the method.

The Volpe Center will provide: a description of the methodology and quantitative examples of the method.

The contractor will provide: comments related to suggested refinements to the method and participation in a video meeting to discuss the method and suggestions.

Task 6. Conduct Analysis using Updated Model for 2024 and NBIAS-derived shocks (CLIN 00600, option)

The work under this task is the same as is described for Task 3, but for NBIAS-derived shocks related to up to 3 different bridge investment levels (compared to a baseline scenario).

The Volpe Center will provide: list of primary impacts to include in the report, NBIAS model data describing scenarios for runs, and feedback on the draft report.

The contractor shall provide: presentation of model results during project meeting, draft and final reports, and model output results by year in a Microsoft Excel file.

Task 7. Conduct Analysis using Updated Model for 2024 with HERS-derived shocks and NBIAS-derived shocks (CLIN 00700, option)

The work under this task is the same as is described for Task 3, but for 3 scenarios that combine HERS-derived shocks and NBIAS-derived (compared to a baseline scenario). The scenarios will be the same as those analyzed under Task 3 and Task 6 but combined to reflect the highway and bridge investments occurring in combination, instead of in isolation. That is, the investment levels will be the sum of the highway investment levels derived from HERS and analyzed under Task 3 and bridge preservation investment levels derived from NBIAS and analyzed under Task 6. Similarly, the benefits will represent the combination of HERS-derived benefit impacts and NBIAS-derived benefit impacts

The Volpe Center will provide: list of primary impacts to include in the report, HERS/NBIAS model data describing scenarios for runs, and feedback on the draft report.

The contractor shall provide: presentation of model results during project meeting, draft and final reports, and model output results by year in a Microsoft Excel file.

Task 8. Participation in Modeling Workshop with Stakeholders (CLINS 0800, option)

The contractor will participate in a workshop with stakeholders to gather feedback and recommendations for how to improve the model. Attendees will include Volpe staff, FHWA staff, staff from other agencies within the U.S. Department of Transportation, academics, and practitioners. The contractor's participation will include:

- Attendance at the workshop via video conference such as Zoom or Google Meet.
- Providing a presentation explaining the model, how it is run, key assumptions, and examples of how it has been used in past projects.
- Answering questions from other attendees regarding the model.
- Summarizing recommendations from attendees and providing USDOT with an assessment of the feasibility and utility of the recommendations.

The contractor will provide: attendance and presentation at a seminar schedule for a date and time that is mutually agreed to by Volpe and the contractor, attendance at premeeting with Volpe to discuss content, attendance at dry run meeting to test technology, assessment of recommendations from attendees.

Task 9. Additional Model Runs (CLINs 00900 – 02400, option)

If exercised, these sixteen (16) option line items require the contractor to perform additional model runs relating variations in scenarios related to previously explored policy scenarios. These can be thought of as sensitivity analyses or minor corrections to the policies explored in the central analysis under Task 3, Task 6, or Task 7. For each of these option line items for modeling runs that are exercised, the Volpe Center will provide the specifics of the additional scenario to be modeled and the contractor shall perform the modeling and provide a short memo describing how the scenario was modeled, the results of the analysis, explanations of those results and industry level impacts as well as a spreadsheet containing the numeric results in tabular suitable for creating graphical exhibits. The short memo describing the specification and results of each model run must be suitable for being inserted into the larger report describing the relevant analysis delivered under Task 3, Task 6, or Task 7. For Task 9, each scenario will relate to one model run compared to a baseline model run.

The Volpe Center will provide: specifics of scenario(s) to be modeled and associated HERS or NBIAS model data.

The contractor shall provide: short memo describing specification and results of the scenario and excel spreadsheets containing the numeric results.

SOW Deliverables and Timeline

The timeline for deliverables is provided in the table below. All work under this project, including funded CLINs and any options that are funded, will conclude by October 30, 2027. All reports and document deliverables shall be submitted to the Volpe Center Technical Point of Contact via email.

Holiday Deadline Extensions. If any performance date or deadline falls within a Holiday Window (as defined below), the time for performance shall automatically be extended as follows:

Winter Holiday Extension: If the deadline falls between December 18th and January 2nd, inclusive (the "Winter Holiday Window"), the deadline shall be extended by two weeks.

CLIN	Task	Deliverable	Due Date
00100 (funded)	1	Kick-off meeting, including initial research plan	Within 2 weeks of award
	1	Progress reporting	Monthly through 30 October 2027
00200 (funded)	2	Technical memo describing model refinements	Within 2 months of award
	2	Meeting to discuss model updates	Within 1 week of providing Task 2 memo, NLT 31 December 2026
00300 (funded)	3	Draft report and summary output files	Within 6 weeks of receiving specification of Task 3 scenarios from Volpe or finishing Task 2 , whichever is later, NLT 31 August 2027
	3	Meeting to discuss model results	Within 1 week of providing draft Task 3 report, NLT 31 August 2027
	3	Final report	Within 2 weeks of receiving comments on draft from Volpe, NLT 31 August 2027
00400 (funded)	4	Review of summary drafted by Volpe staff	Within 2 weeks of receiving summary, NLT 31 August 2027
	4	Responses to reviewer comments	Within 1 week of receiving comment (as needed)
00500 (option)	5	Comments	Within 2 weeks of receiving description of methodology, NLT 30 October 2027
00600 (option)	6	Draft report and summary output files	Within 6 weeks of receiving specification of Task 3 scenarios from Volpe or finishing Task 2 , whichever is later, NLT 30 October 2027
	6	Meeting to discuss model results	Within 1 week of providing draft Task 3 report, NLT 30 October 2027

CLIN	Task	Deliverable	Due Date
	6	Final report	Within 2 weeks of receiving comments on draft from Volpe, NLT 30 October 2027
00700 (option)	7	Draft report and summary output files	Within 6 weeks of receiving specification of Task 3 scenarios from Volpe or finishing Task 2 , whichever is later, NLT 30 October 2027
	7	Meeting to discuss model results	Within 1 week of providing draft Task 3 report, NLT 30 October 2027
	7	Final report	Within 2 weeks of receiving comments on draft from Volpe, NLT 30 October 2027
00800 (option)	8	Summary of feasibility and utility of recommendations from workshop attendees	Within 2 weeks of workshop, NLT 30 October 2027
00900-02400 (option)	9	Specification of additional scenario and report on results of additional scenario	Within 2 weeks of option exercise through 30 October 2027

Acceptance Criteria

To be accepted, deliverables shall be emailed to the project technical point of contact (POC), Catherine Taylor, at Catherine.Taylor@dot.gov. The deliverables will be reviewed by the Government for compliance with the SOW, timeliness, and format. The technical POC will acknowledge acceptance of each deliverable by email.