Incorporating Bicycle Level of Traffic Stress into MPO Performance Based Planning
FHWA Measuring Multimodal Connectivity Pilot Grant Program
Rockingham Planning Commission & Partnering for Performance New Hampshire

1. Description of the Proposed Effort

Project Goal & Overview

The goal of the proposed pilot project is to improve bicycle network planning for New Hampshire's Metropolitan Planning Organizations (MPOs) through: further development and refinement of a shared model for evaluating Bicycle Level of Traffic Stress (LTS); collection and compilation of supplemental road attribute data in five planning regions; development of one or more shared transportation system performance measures based on LTS; and incorporation of that measure/those measures in project development and project prioritization. To implement this scope of work the Rockingham Planning Commission and partner MPOs request $99,988 in Federal Highway Administration (FHWA) funding through the Measuring Multimodal Connectivity Pilot Grant Program.

The proposed project will involve New Hampshire's four MPOs, one rural regional planning commission and Plymouth State University (PSU) working collaboratively to refine a model for LTS analysis developed at PSU over the past two years; and use that model to develop consistent baseline LTS data across 92 municipalities. The PSU model is an adaptation of the Mineta Transportation Institute (MTI) Level of Traffic Stress model (Mekuria, Furth, and Nixon, 2012). The adaptation accounts for limited data available for much of the state on certain road attributes included in the original MTI model. The model has been used to date to develop LTS analyses for several cities (Manchester, Concord, Portsmouth) and a range of smaller communities. The MPOs will collect additional road attribute data including bicycle lanes, on-street parking and posted or prevailing speed for towns where those data have not been collected or compiled and incorporate them into the model to refine outputs.

Concurrently the five RPC/MPOs propose to develop and jointly adopt one or more LTS-based performance measures drawing on the *FHWA Guidebook for Measuring Multimodal Network Connectivity* (2018); and the experience of other MPOs and state DOTs around the country that have incorporated LTS into their project development and programming or are evaluating doing so. The updated model will then be used to run LTS network connectivity analyses for the five regions, with an emphasis on network quality and access to destinations – especially employment and educational opportunities. We anticipate network analyses will focus on key corridors and communities with concentrations of residential, commercial, educational and civic destinations in reasonable bicycling distance. The RPC/MPOs will incorporate the LTS network analyses into project development and programming decisions for their regional Metropolitan Transportation Plans as well as regional pedestrian/bicycle plans and corridor studies. Data will also be made available to member municipalities for municipal bicycle network planning and project development.

Background on Multi-MPO Collaboration on Performance Based Planning

The proposed project will pull together and build on two parallel planning processes underway in New Hampshire in the past three years. The first of these is a collaborative effort of the state's four

MPOs to begin implementing performance-based planning requirements set out in the Moving Ahead for Progress in the 21st Century Act (MAP-21). This collaborative process was initiated by the Strafford Regional Planning Commission and supported with grant funding from the FHWA Strategic Highway Research Program (SHRP2) Implementation Assistance Program.

The SHRP2 grant project featured participation by the four MPOs, one rural regional planning commission, the NHDOT Bureau of Planning and Community Assistance, NH Department of Environmental Services (NHDES), the Federal Transit Administration (FTA) and FHWA. The planning process included an extensive series of 25 stakeholder interviews and focus group meetings with over 80 individuals to identify perceived strengths of the existing transportation system, unmet needs, goals for system modernization and improvement, and ideas for measures to track improvement. The interviews and research by MPO staff led to an initial list of over 650 potential supplemental performance measures to supplement the seventeen core measures mandated by FHWA and four measures mandated by FTA.

This initial list was systematically vetted against a series of evaluation criteria addressing data availability, difficulty of new data collection, scalability to multiple geographies, consistency with MPO goals, relevance to stakeholder priorities, ease of comprehension, and other factors. This vetting process narrowed the list of potential supplemental measures to 24, for which draft methodologies were developed for data collection and measure calculation. Based on barriers encountered with data collection the short list was further narrowed to seven **supplemental shared performance measures** for which the MPOs have developed baseline conditions, historic trend data, draft targets and implementation strategies. These seven supplemental measures, addressing several aspects of transit access, transportation related Greenhouse Gas emissions, transit asset management and motorcycle fatalities, represent issues specific to New Hampshire and will be tracked jointly by the four MPOs.

While each of New Hampshire's MPOs/RPCs include goals and policies related to improving bicycle networks, to date no performance measures have been defined to spur and track implementation. Multiple measures for bicycle network safety and accessibility were evaluated as part of the SHRP2 research process, including miles of bicycle route, Highway Capacity Manual Bicycle Level of Service (BLOS), and Level of Traffic Stress (LTS), though the current lack of consistent data across MPO regions has been a barrier to defining a shared performance measure in this area.

Beyond development of the seven supplemental performance measures adopted to date, a major outcome of the SHRP2 planning effort has been the development of **Partnering for Performance NH** (PfPNH), an ongoing collaboration process among the four MPOs and periodically NHDOT. Regular monthly PfPNH meetings provide a forum for continued joint work to implement performance-based planning requirements and address other issues of shared concern. PfPNH will provide the collaborative multi-MPO forum for the work proposed here.

Bicycle Level of Traffic Stress & Adaptation to New Hampshire Context

While the SHRP2 process was underway, a related effort focused on active transportation performance measures was initiated by Plymouth State University (PSU), the Bike/Walk Alliance of New Hampshire, the NHDOT Bicycle & Pedestrian Transportation Advisory Committee (BPTAC) and two regional planning commissions. The goal of this effort has been to improve data on bicycle

network connectivity, usage and safety appropriate for New Hampshire, and ultimately to develop data that could drive project development and programming decisions. Over the past two years faculty and students at PSU have worked with two regional planning commissions to adapt the Bicycle Level of Traffic Stress (LTS) model developed at MTI to New Hampshire, and conduct LTS analyses for a range of urban and rural road networks. The key need for adaptation in the state is that road attribute data commonly collected in larger cities (presence of bike lanes, presence of on street parking, prevailing speed) are often not readily available for New Hampshire's rural and suburban roads, and even some urban streets.

Level of Traffic Stress is an alternative to the traditional Highway Capacity Manual Level of Service (LOS) measurement, which categorizes facilities largely based on capacity and traffic flow. While LOS analysis has been adapted to address people walking and bicycling (PLOS and BLOS), those methodologies treat all pedestrians and bicyclists as having the same skill level and sensitivity to automobile traffic. The LTS classification system characterizes traffic stress on a given road segment based on how comfortable bicycle riders of varying abilities would feel riding that segment. The traffic stress scale of one to four corresponds roughly to four categories of would-be transportation cyclists identified through survey work by Roger Geller and others for the City of Portland (Geller 2006; Dill and McNeil 2013).

Gellar's four groups included: 1) "Strong and Fearless" riders (~1% of the Portland population) who will travel by bicycle in virtually any conditions and on any roadway; 2) "Enthused and Confident" riders (~7% of the population) with advanced skills who will travel on most roadways but avoid high volume and speed conditions; 3) "Interested but Concerned" would-be riders (~59% of the population) who would ride if they see conditions on certain roadways as safe enough; and 4) "No Way No How" individuals (~33% of the population) who will not ride under any circumstance. While the percent of population in each group will vary somewhat by city or region, the basic groupings are transferable. They point to a large pool of would be cyclists - the "Interested But Concerned" - who could be induced to bicycle rather than drive for certain trip more frequently if roadways can be adapted to improve perceived safety. The LTS methodology drops the "No Way No How" group and essentially divides the "Interested and Concerned" category into groupings of children and adults, defining the following four levels of traffic stress shown in Figure 1.

Figure 1 – Level of Traffic Stress (LTS) Four Tier Classifications

LTS 1	• Low Stress • Suitable for all ages and abilities, including children
LTS 2	• Low Stress, with attention required • Indicates traffic stress that most adults will tolerate, including the "Interested by Concerned" rider
LTS 3	• More stressful than LTS 2 • Requires attention and suitable for adults with confidence to bicycle - the "Enthused and Confident" rider
LTS 4	• Most stressful • Suitable only for the most traffic tolerant – the "Strong and Fearless" rider

Adapted from Alta Planning & Design, Active Transportation Performance Measures, Tahoe Regional Planning Agency

Level of Traffic Stress analysis can be used to identify low stress networks that bicyclists particularly sensitive to traffic can feel comfortable riding, and also identify network gaps and aid in prioritizing projects which will have the greatest impact on network connectivity.

The original MTI LTS model included the following inputs: number of traffic lanes in each direction, posted and prevailing speed, type and width of bicycle infrastructure, presence and width of on-street parking, frequency of bike lane blockage, presence and characteristics of turning lanes, and presence and characteristics of unsignalized crossings.

With limited intersection data and lack of consistent data on bicycle facilities and shoulder width in the NHDOT road layer, the MTI model has not been directly transferrable to New Hampshire. For many road segments the statewide GIS road layer only includes applicable data on traffic direction, number of lanes, AADT and in some cases posted speed. Beginning in 2016 Plymouth State University faculty and graduate students, working with planners in the Central and Southern New Hampshire RPC regions, secured a State Planning and Research grant from NHDOT to adapt the MTI model and collect additional road attribute data for case study areas using aerial photography, Google Street View and some field data collection.

The PSU model as developed to date includes three integrated versions based on the level of attribute data available for a given road segment. The model begins with Version 1 (fewest inputs – including direction and number of travel lanes, AADT, speed); proceeds to Version 2 if shoulder width data are available; and to Version 3 if data on bicycle facilities and on-street parking are available. The final LTS score for each segment is the score generated by the highest LTS model version run based on available attribute data. For example, if bicycle and parking lane data are only provided for 200 out of 1000 road segments, but shoulder width data are available for all 1000 segments, 200 segments would be scored with the Version 3 model results and the other 800 would be scored using the model Version 2 (Getts, 2017, Villamagna 2018). This multi-level model that adapts to varying levels of available data is similar in concept to that used by the Oregon Department of Transportation, which features a streamlined analysis for rural areas based on traffic volume, speed and shoulder width (ODOT Analysis Procedures Manual).

Figure 2: Screenshot of online GIS application showing initial LTS model output for Manchester, NH with respondents' flags commenting on model ratings and road hazards

To date the model has been used to develop baseline LTS data for the cities of Manchester and Concord, and approximately 25 smaller communities around New Hampshire. These model results have in turn been 'ground-truthed' by planning commission staff and PSU graduate researchers. The work scope proposed here also includes a series of public input forums (2 per region, 10 total) where community

members will be invited to review draft model outputs and provide feedback on the accuracy of stress ratings on road segments with which they are familiar. Another tool to be used for the proposed project is an ESRI ArcGIS webmap application that will allow for crowd-sourcing of model output evaluation. Using the ArcGIS webmap application adapted by PSU, any member of the public can view LTS scores for each road segment in their community and region, drop a pin on any street to provide their own LTS score, and comment to explain the score assigned. The goal of both the meeting-based and web-based public feedback is to better understand where and how the current LTS models may be over- or underestimating stress. The data gathered through this public feedback approach will be compared to the modeled results and analyzed to assess the number of road segments underscored or over-scored, and the roads most frequently reviewed. To further refine the model, the explanations submitted for scoring differences will be synthesized to evaluate whether the model is missing one or more key road-level attributes (e.g. road slope) or whether other factors are influencing perceived stress (e.g. adjacent land use or neighborhood).

The first and most time intensive task of the proposed project will be this work to collect additional needed road attribute data for the remaining communities in the five MPO/RPC regions, run the model for these communities and engage MPO staff and members of the public in ground truthing model outputs and iteratively refining the model. Subsequent tasks are described in Section 3.

2. Description of Dedicated Staffing/Resources.

Staffing

Should the proposed project be funded, the tasks described here will be undertaken by senior staff from New Hampshire's four MPOs; one of the state's five non-urban Regional Planning Commissions; and a faculty member and graduate research assistant at Plymouth State University who will manage the LTS model, incorporate new road attribute data, identify needed refinements and develop targeted network analyses. Partner planning agencies include Rockingham Planning Commission MPO (RPC), Nashua Regional Planning Commission MPO (NRPC), Southern NH Planning Commission MPO (SNHPC), Strafford MPO (SRPC), and Central NH Regional Planning Commission (CNHRPC). Rockingham Planning Commission MPO will serve as the lead agency, and will develop sub-agreements with NRPC, SNHPC, SRPC, CNHRPC and Plymouth State University.

Rockingham Planning Commission (MPO)
David Walker, Transportation Program Manager
Scott Bogle, Senior Transportation Planner
Christian Matthews, Transportation GIS Analyst

Nashua Regional Planning Commission (MPO)
Greg Lantos, Principal Transportation Planner
Matt Waitkins, Senior Transportation Planner
Ryan Friedman, Senior GIS Planner

Central New Hampshire Planning Commission
Michael Tardiff, Executive Director
Craig Tufts, Principal Planner/GIS Planner

Strafford Regional Planning Commission (MPO)
Colin Lentz, Senior Transportation Planner
Marcia Moreno-Báez, Principal GIS Planner
Rachel Dewey, Data Analyst

Southern NH Planning Commission (MPO)
Nate Miller, Deputy Executive Director
Adam Hlasny, Senior Transportation Planner
Alan Yu, Principal Transportation Planner

Plymouth State University
Amy Villamagna, Abbott Professor of Environmental Studies
Raegan Young, Research Assistant

Resources

A total of $99,988 is requested from the Federal Highway Administration (FHWA) administration, comprising 80 percent of the total project budget. The required 20 percent non-federal matching funding, totaling $24,997, will be provided through a combination of cash and in-kind sources. The four MPOs and CNHRPC will provide $15,838 in cash match from local dues. Plymouth State University will provide $3,406 in in-kind staff time representing 40 hours of state funded salary for Professor Villamagna; and an additional $5,753 in volunteer time will be generated by members of the public participating in ground truthing LTS model results. The total proposed project budget including Federal share and match is $124,985. These amounts are broken out by project task in the following section, and in the attached budget table.

3. Draft Work Plan.

The following work tasks roughly follow the Connectivity Analysis Process outlined in the *FHWA Guidebook for Measuring Multimodal Network Connectivity (2018).* This process includes: 1) identifying the planning context (in this case project identification and prioritization for MPO Metropolitan Transportation Plans, bicycle and pedestrian plans and corridor studies); 2) defining the analysis method (in this case LTS using the PSU model), 3) assembling necessary data; 4) computing metrics; 5) packaging results; and 6) using results to inform MPO and municipal decision-making.

Task 0 – Project Administration

As the notice of funding availability stipulates that grant awards will pass through state departments of transportation, hours are built into the proposed budget for monthly reporting and billing, and periodic check-in with a New Hampshire Department of Transportation (NHDOT) grant manager. A start date of January 1, 2019 is assumed based on the typical timeline for an NHDOT contract to be approved by New Hampshire's Governor and Council, which must approve all state contracts over $25,000. If funded the MPOs will work with NHDOT and their respective Executive Councilors to expedite the contract approval process and minimize delays in project start. Also included under this task is time for sub-agreement development with partner agencies.

Budget: $3,020 Total, including $2,416 proposed FHWA share
Timeframe: December 2018 – September 2019

Task 1 – Regional Data Collection & LTS Model Refinement

This task includes the bulk of data collection and consequent MPO/RPC staff and PSU graduate researcher hours for the project. Key subtasks include:

- Run the current 3-level LTS model for the five participating MPO and RPC regions spanning 92 municipalities.
- Identify portions of network for which only Level I data currently exist and develop and quality check Version 2 and Version 3 data (e.g. shoulder width, on-street parking, marked bicycle lanes, posted and/or prevailing speed, etc.) to the extent possible and refine model.
- Engage the public in model output evaluation through a series of ten public workshops (two per planning region) and use of the ArcGIS online webmap tool.
- Synthesize input and refine model accordingly with attention to variations in output between the three model versions. Considerations will include: 1) does the basic Version 1 model underestimate or overestimate LTS score; 2) is the relationship (over- vs. underestimation) consistent throughout regions or does a spatial pattern exist; and 3) if the relationship is consistent, is there a single added attribute that influences the discrepancy and can data for that attribute be collected and maintained consistently and cost effectively across regions?

Budget: $70,757 Total, including $56,605 proposed FHWA share
Timeframe: January–April 2019

Task 2 – Performance Measure Definition

This task will begin with a review of other statewide, regional and municipal planning agencies that have adopted or are evaluating performance measures based on LTS. Known examples at time of submittal include the Oregon Department of Transportation and CalTrans. The five RPC/MPOs will then work through the Partnering for Performance NH forum to define preferred LTS-based performance metric(s) that correspond to goals and policies established in their respective Metropolitan Transportation Plans and regional Long Range Transportation Plans. Of the five core components of multimodal network connectivity described in the *FHWA Guidebook for Measuring Multimodal Network Connectivity* (Network Completeness, Network Density, Route Directness, Access To Destinations And Network Quality), we anticipate selected measures will focus on Access to Destinations (what key destinations can be reached via a low stress network), and Network Quality (how does the network support users of varying levels of experience and comfort with bicycling) (FHWA 2018).

Budget: $5,832 Total, including $4,665 proposed FHWA share
Timeframe: January-April 2019

Task 3 – Network Analysis by Region and Target Community

Once the LTS model has been refined with additional needed road segment attribute data, and desired performance measures have been identified, this task focuses on the network analyses

needed to track the designated measures. This work is anticipated to include the RPC/MPOs working with PSU to refine the model to include major trip generators by community (schools, downtowns, employment centers, parks/playgrounds, residential areas); and then running analyses to calculate connectivity for selected trip pairs, including residential to K-12 schools and community colleges, residential to employment centers, and residential to key destinations such as grocery stores, libraries and community centers. There is also interest among the MPOs in assessing LTS in relation to census blocks with high minority or low-income populations. Choice of analyses for this task and visualizations for Task 4 will draw on case studies from the *FHWA Guidebook for Measuring Multimodal Network Connectivity* (2018).

Budget: $9,562 Total, including $7,650 proposed FHWA share
Timeframe: May-June 2019

Task 4 – Package Results

Through the PfPNH collaboration the participating RPC/MPOs and PSU will identify a standard set of visualizations and analysis outputs needed in each region to inform project development and prioritization. Examples envisioned currently include network connectivity analysis maps for each region and key communities, and identification of priority road segments where bicycle facility improvements can have the greatest impact on network connectivity. For example, prioritizing projects that will create low stress access to schools, community colleges and employment centers for the highest percent of residential development within an established bicycling distance.

Budget: $8,700 Total, including $6,960 proposed FHWA share
Timeframe: June-July 2019

Task 5 – Performance Measure Implementation

All five participating RPC/MPOs are committed to integrating the analyses and performance metrics developed here into project identification for regional pedestrian/bicycle plan and corridor studies, as well as project development and prioritization for their respective Metropolitan Transportation Plans or Regional Long Range Transportation Plans. Currently all of New Hampshire's MPOs use an agreed upon set of 12 criteria for project evaluation for MPO/LRTP inclusion, though with variations in weight defined at the regional level. Modification of these criteria to account for LTS is an anticipated outcome. Each regional planning agency will also make analyses available to member municipalities to shape local project identification for municipal bicycle and pedestrian plans, and subsequent municipal project development.

Budget: $12,324 Total, including $9,859 proposed FHWA share
Timeframe: August-September 2019

Task 6 – Report Development

The collaborating RPC/MPOs, with Rockingham Planning Commission as lead, will document how the MPOs operationalized Level of Traffic Stress as a measure of network connectivity into their respective performance based planning processes in a final report consistent with the content and

format requirements set out in the notice of funding availability and the F*HWA Guidelines for Preparing Technical Reports*.

Budget: $7,077 Total, including $5,662 proposed FHWA share
Timeframe: July-September 2019

Task 7 – Peer Sharing

At the conclusion of the pilot project, members of the MPO collaborative will participate in at least two FHWA organized peer exchanges among other transportation agencies to share the project approach, challenges encountered and solutions adopted, and project outcomes. Within New Hampshire and New England, we anticipate presenting project outcomes at one or more regional conferences, potentially including the Northern New England Chapter of the American Planning Association (NNECAPA) conference, the New Hampshire Planning Association (NHPA) conference, and/or the New England Bike/Walk Summit.

Budget: $4,585 Total, including $3,668 proposed FHWA share
Timeframe: October 2019-November 2019

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	PROPOSED EXPENSES						PROPOSES SOURCES OF FUNDING				
Task/Subtask	RPC Direct Staff Cost	RPC Indirect @ 1.2765	PSU Contract	MPO/RPC Contracts	In-Kind Hours Value	Total Budget Incl In-Kind	Proposed FHWA Share	MPO Cash Match	PSU In-Kind Match	Public In-Kind Match	Total Proposed Match
Task 0 - Project Administration	**$ 1,327**	**$ 1,694**	**$ -**	$ -	$ -	$ 3,020	$ 2,416	$ 604	$ -	$ -	$ 604
0.1 Administration, billing and NHDOT communication											
Task 1 - Model Refinement	$ 4,452	$ 5,683	$ 11,802	$ 41,023	$ 7,797	$ 70,757	$ 56,605	$ 6,355	$ 2,044	$ 5,753	$ 14,151
1.1 Run current PSU LTS model for 5 MPO/RPC regions											
1.2 Develop add'l attribute data where not available											
1.3 Public engagement through forums and ArcGIS app											
1.4 Synthesize input and refine model											
Task 2 - Performance Measure Definition	$ 398	$ 508	$ 1,210	$ 3,715	$ -	$ 5,832	$ 4,665	$ 1,166	$ -	$ -	$ 1,166
2.1 Research LTS-based measures used by other MPOs											
2.2 Work through PPNH to define LTS-based metric											
Task 3 - Network Analysis by Region and Target Community	$ 332	$ 423	$ 5,030	$ 3,096	$ 681	$ 9,562	$ 7,650	$ 1,231	$ 681	$ -	$ 1,912
3.1 Refine model to include major trip generators											
3.2 Run and review connectivity analysis											
Task 4 - Package Results	$ 597	$ 762	$ 1,768	$ 5,573	$ -	$ 8,700	$ 6,960	$ 1,740	$ -	$ -	$ 1,740
4.1 Create network visualizations and analysis summaries											
Task 5 - Performance Measure Implementation	$ 1,061	$ 1,355	$ -	$ 9,907	$ -	$ 12,324	$ 9,859	$ 2,465	$ -	$ -	$ 2,465
5.1 Incorp LTS measure(s) in core MPO planning processes											
Task 6 - Report Development	$ 1,327	$ 1,694	$ 1,239	$ 2,477	$ 341	$ 7,077	$ 5,662	$ 1,075	$ 341	$ -	$ 1,415
6.1 Develop pilot project final report											
Task 7 - Peer Sharing	$ 531	$ 677	$ 1,797	$ 1,238	$ 341	$ 4,585	$ 3,668	$ 576	$ 341	$ -	$ 917
7.1 Pilot grantee peer sharing and other dissemination											
Personnel Cost Subtotals	**$ 10,025**	**$ 12,797**	**$ 22,847**	**$ 67,029**	**$ 9,159**	**$ 121,857**	**$ 97,486**	**$ 15,212**	**$ 3,406**	**$ 5,753**	**$ 24,371**
Non Personnel Costs (meeting travel)						$ 3,128	$ 2,503	$ 626	$ -	$ -	$ 626
Total Project Cost						**$ 124,985**	**$ 99,988**	**$ 15,838**	**$ 3,406**	**$ 5,753**	**$ 24,997**

Notes:
Proposed RPC MPO time is budgeted at $33.17/hour for senior staff and $15.00/hour for intern plus 127.65% IDC
Other RPC/MPOs time is budgeted at $34/hour plus 127.65% IDC for a total of $77.40/hour
Plymouth State University time is budgeted at $51.58/hour for Faculty and $16.00/hour for Graduate Researcher plus 8.4% fringe plus 56.7% PSU IDC