

6.0. Evaluation and Analysis Tasks

This chapter provides an overview of the evaluation and analysis tasks conducted for each alternative carried forward from the Fatal Flaw Analysis. These tasks produced data and information used to identify the benefits and impacts of the No-Build Alternative and each proposed Build Alternative. The following provides a brief description of each task. Relevant graphics, technical memoranda, and technical reports associated with these tasks are referenced and summarized at the end of each task description.

6.1. ENGINEERING ANALYSIS

This section documents the assumptions and design criteria used to develop horizontal and vertical alignments for each of the build alternatives. The design criteria included identification of appropriate design guidelines, regulations, and criteria relative to horizontal geometry, vertical geometry, number of travel lanes, lane width, shoulder width, marine vessel clearances, and bicycle and pedestrian facilities (i.e. sidewalks and shoulders). Conceptual plans, profiles, and cross sections were developed as part of this task and were utilized to perform other relevant evaluation and analysis tasks. A key assumption in the engineering analysis was that any new bridge or bridges constructed would be required to last 100 years given proper maintenance and should provide the bridge structure the ability to accommodate the expected traffic and marine vessel growth in the region over the next 25 years.

Publications referenced in developing these criteria are AASHTO's "A Policy on Geometric Design of Highways and Streets", Maine DOT's "Highway Design Guide", and New Hampshire DOT's "Highway Design Manual". The following summarizes the criteria used for the Maine-New Hampshire Connections Study.

Design Options

Horizontal and vertical alignments developed were used to create option "footprints" used to quantify resource impacts and provide a basis for developing planning level cost estimates. Downstream alignments for Sarah Mildred Long Bridge Options were not investigated since accommodating the rail for the downstream alignment created more ROW impacts than the upstream alignment, as well as impacting the USCG identified 1000' turning basin immediately downstream of the Sarah Mildred Long Bridge.

Topographic Information

Aerial photos and Geographic Information System (GIS) data were used to develop horizontal and vertical alignments. The City of Portsmouth, NH provided GIS data including contours at one interval. For Kittery, ME, the Maine Office of GIS provided GIS files which included 20 foot contours.

Roadway Classification

Both NH DOT and MaineDOT classify the U.S. Route 1 Bypass as a Principle Arterial. U.S. Route 1 is a Principle Arterial in Maine and a Minor Arterial in New Hampshire. Neither was

identified as being part of the National Highway System (NHS). Route 103 in Kittery, Maine from the Portsmouth Naval Shipyard to U.S. Route 1 and U.S. Route 1 from Route 103 to the Kittery Rotary are on the Strategic Highway Network (StraHNet).

Speed

The Design Speed was assumed to be 35 mph for all alternatives.

Vertical Grade

The maximum vertical grade for highway alignments was assumed to be 6 percent. Maximum grade for pedestrians was 5 percent. Maximum vertical grade for rail alignments was assumed to be 1 percent.

Moveable Bridge Type

Three moveable bridge types were considered for the low and mid level bridges: lift, bascule, and swing. Because of the large horizontal clearances to be maintained, the lift bridge was assumed to be the most efficient using a through truss to maximize vertical clearances over the river.

Roadway and Rail Clearances

The roadway and rail clearances assumed for the bridge alternatives are noted below:

| | |
|---------|--------------------------------------|
| Roadway | 16'-6" (over arterial) |
| | 15'-6" (over collector & local road) |
| Rail | 22'-6" |

Bicycle/Pedestrian Widths

The bicycle/pedestrian widths assumed for the new bridge alternatives are noted below: (The rehabilitated bridge options may not be able to provide the minimum bicycle/pedestrian widths noted below.)

| | |
|------------|--|
| Bicycle | 5'-0" roadway shoulder minimum width (with guardrail or vertical curb) |
| Pedestrian | 5'-0" wide sidewalk (minimum width) |

Marine Vessel Clearances

The existing vertical and horizontal clearances for the bridges over the Piscataqua River were noted in Appendix 3. Maximum vertical and horizontal marine vessel clearances used in designing the replaced bridge alternatives are noted below:

| | |
|----------------------------|--|
| Memorial Bridge: | Horizontal – 260 feet (same as existing) |
| | Vertical – 150 feet (same as existing) |
| Sarah Mildred Long Bridge: | Horizontal – 270 feet ¹² |
| | Vertical – 135 feet (same as existing) |

¹² Horizontal width based upon current Panamax vessel dimensions (750' length, 108' beam, 135' air draft) with harbor pilot vessel on either side and current 30 +/--degree bridge skew to river channel.

Additional information regarding Engineering Analysis and associated findings can be found in the following documents included with this Study Report:

- *Appendix #3 – Navigational Needs of the Piscataqua River*
- *Appendix#53 – Engineering Design Criteria Memorandum*

6.2. MARINE NAVIGATION EVALUATION

This section summarizes the findings of the marine navigation evaluation performed for the Study, which included an identification of the existing horizontal and vertical clearances of the three bridges, and summary and evaluation of bridge lift data.

6.2.1 Existing Clearances and Frequency of Lifts

Table 6-1 provides the clearances for the three lower Piscataqua River bridges as identified on the National Oceanic and Atmospheric Administration (NOAA) Chart 13283, 20th Edition. The vertical clearance is the distance between mean high water and the underside of the bridge. The Memorial and Sarah Mildred Long Bridges have lift spans that provide additional vertical clearance when opened. The Sarah Mildred Long Bridge also provides a retractable span for the lower rail level that is not in the main ship channel but in shallower water close to the Kittery shore. The I-95 High Level Bridge is fixed providing a 135 foot vertical clearance.

**Table 6-1
Bridge Horizontal and Vertical Clearances**

| Bridge | | Horizontal | Vertical | |
|---------------------------|------------------|------------|----------------|---------|
| | | | Open | Closed |
| Memorial Bridge | | 260 feet | 150 feet | 19 feet |
| Sarah Mildred Long Bridge | Lift | 200 feet | 135 feet | 10 feet |
| | Retractable Span | 70 feet | 36 feet | 10 feet |
| I-95 High Level Bridge | | 440 feet | 135 feet fixed | |

Source: NOAA Chart 13283

Generally, the lift spans in the main channel are opened upon the vessel’s signal except for recreational and small commercial vessels which during certain time periods (May 15th – October 31st) must wait for a lift that occurs twice an hour or pass under with a vessel that is not required to wait.

6.2.2 Analysis of Bridge Lift Records

The New Hampshire Department of Transportation (NH DOT) has provided a copy of the log books for the lift spans of Sarah Mildred Long and Memorial Bridges. HNTB entered a portion of the 2008 records into a database to analyze data such as number of lifts by month, height of lifts, number of passing under vessels, and time span for the bridge lift.

Table 6-2 provides a breakdown of lifts for each bridge by month for 2008 based upon the log books for the Sarah Mildred Long and Memorial Bridges as provided by NH DOT. Lifts in

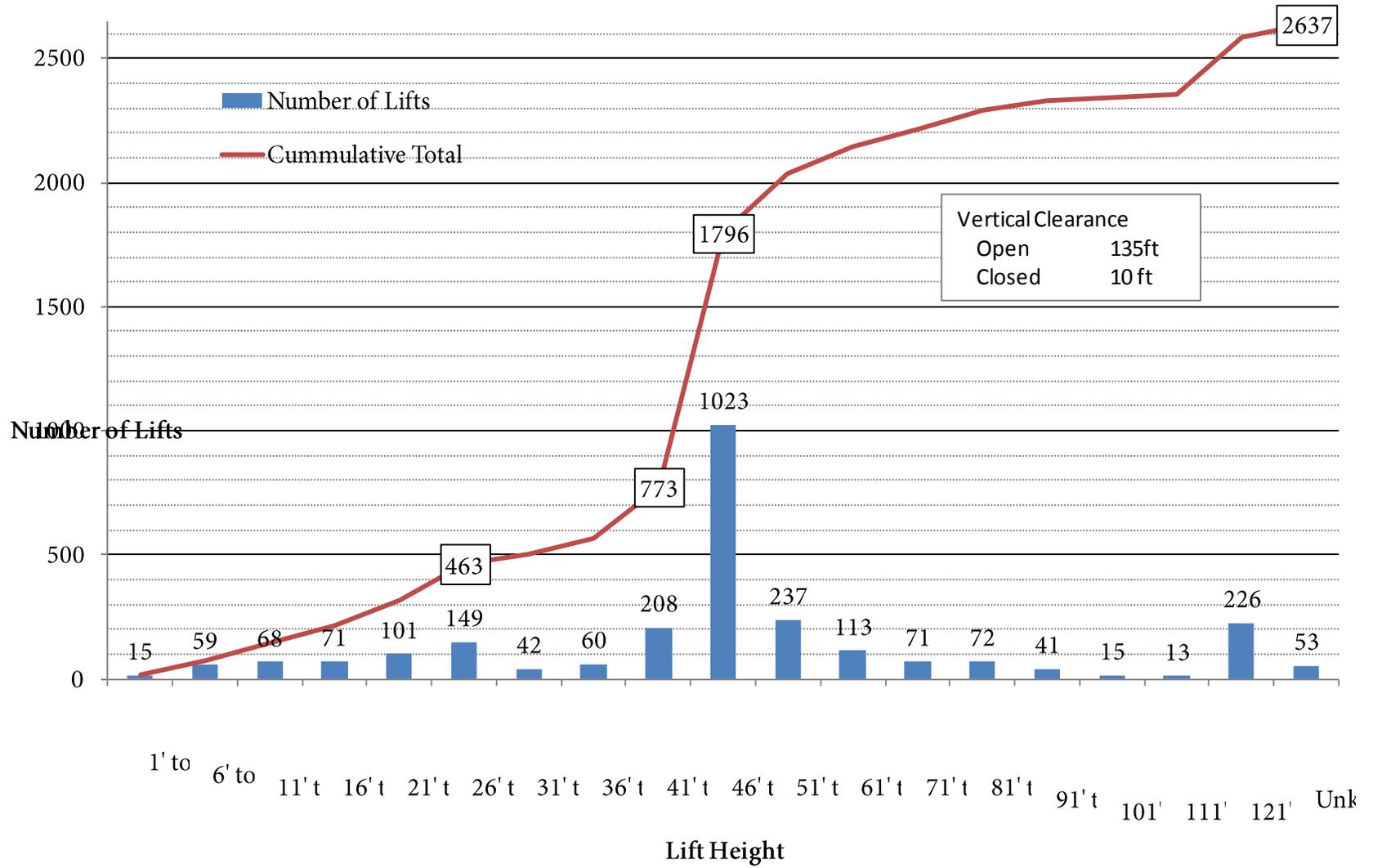
which a vessel did not pass underneath but had a purpose such as testing, maintenance, and training have been separated. Note that the total number of lifts for the Memorial Bridge is approximately 900 greater than for the Sarah Mildred Long Bridge. This is due to commercial vessels originating or stopping at either the Port of Portsmouth or day excursion vessels operating from docks in the City of Portsmouth located between these two bridges. In 2008, the retractable rail span was open all winter (typically closed) and this helped reduce the number of lifts and accounted for some of the 900 lift difference between the Memorial and Sarah Mildred Long Bridges.

**Table 6-2
Number of Lifts for 2008**

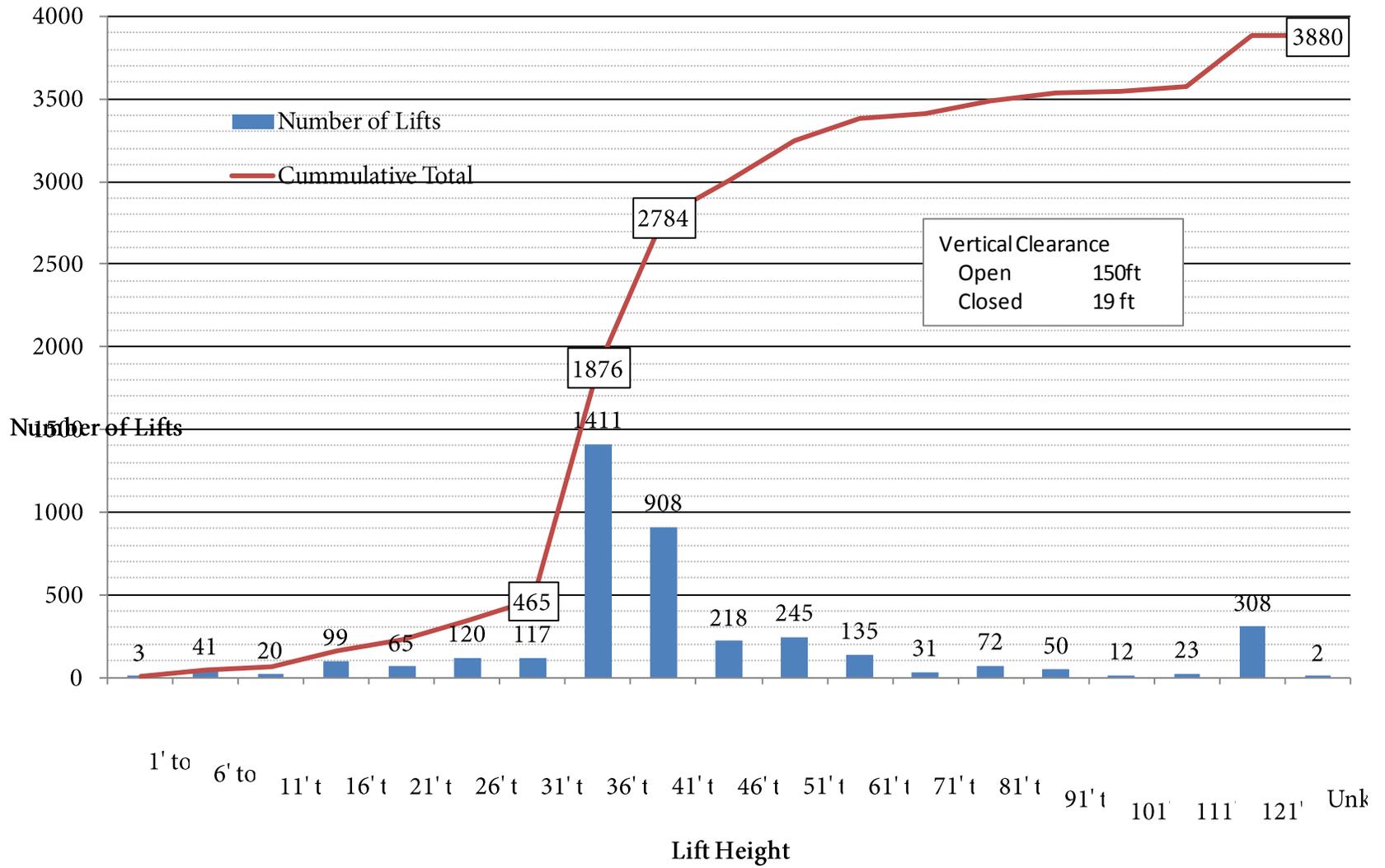
| Month | Sarah Mildred Long Bridge | | Memorial Bridge | |
|-----------------|-------------------------------|---|-------------------------------|---|
| | Lift for Vessel to Pass Under | Lift for Testing, Maintenance, Training, etc. | Lift for Vessel to Pass Under | Lift for Testing, Maintenance, Training, etc. |
| January | 239 | 3 | 271 | 7 |
| February | 189 | 15 | 216 | 16 |
| March | 182 | 51 | 189 | 15 |
| April | 231 | 29 | 179 | 46 |
| May | 258 | 29 | 297 | 9 |
| June | 232 | 79 | 451 | 23 |
| July | 274 | 52 | 525 | 5 |
| August | 248 | 46 | 488 | 3 |
| September | 226 | 70 | 427 | 3 |
| October | 196 | 82 | 357 | 3 |
| November | 137 | 17 | 246 | 4 |
| December | 225 | 68 | 234 | 9 |
| Subtotal | 2637 | 541 | 3880 | 143 |
| Total | 3178 | | 4023 | |

Figures 6-1 and 6-2 provide a summary of the lift height for both bridges. The lifts for testing, maintenance, and training have been excluded. These charts show the number of lifts for ranges of lift heights along with a cumulative total of the number of lifts. More than a third of the lifts for the Sarah Mildred Long Bridge are between 46 feet and 50 feet high. For the Memorial Bridge, more than a third of the lifts are between 36 feet and 40 feet high. This difference in range of heights can be attributed to the Memorial Bridge having a “closed” clearance nine feet higher than the Sarah Mildred Long Bridge.

Figure 6-1: Height of Lifts
Sarah Mildred Long Bridge



**Figure 6-2: Height of Lifts
Memorial Bridge**



The lift logs of the bridges provided the “Time Span Open” and “Time Span Closed” and the bridges take one to two minutes for the bridge to lift up or down depending on the height of the bridge lift. To calculate the length of the roadway closure, three minutes were added to the difference of “Time Span Open” and “Time Span Closed”. The average closure time for the roadways on the Sarah Mildred Long and Memorial Bridges are 9.5 and 8.9 minutes respectively. Most (79 percent for Sarah Mildred Long Bridge and 85 percent for Memorial Bridge) of the lifts closed the road for seven to ten minutes.

Additionally, bridge lift data was evaluated during traffic peak hour (3:45 to 4:45 PM) for the month of July 2008 for the Sarah Mildred Long and Memorial Bridges. This data was relevant to determine how much vehicular bridge capacity is affected during peak traffic times.

Additional information regarding the Marine Vessel Evaluation and associated findings can be found in the following documents included with this Study Report:

- **Appendix #3 – Navigational Needs of the Piscataqua River**
- **Appendix #45 – Bridge Capacity Analysis Summary Report**

6.3. CRASH EVALUATION

The section identifies locations within the Study Area where a higher number of crashes were reported. The data analyzed was provided by the Maine Department of Transportation: Traffic Engineering, Crash Records Section and the New Hampshire Department of Transportation. The three year crash analysis period was January 2005 to December 2007.

MaineDOT and NH DOT record all reported crashes in which there is property damage in excess of \$1000 or in which there has been personal injury. Crash reports received by MaineDOT are assigned to a corresponding node or element established as part of MaineDOT’s crash records system. The NH DOT organized data by recording crash locations as an intersection or a roadway link with exact location denoted by distance and direction from the nearest intersection.

In Maine, if a particular node or element meets certain criteria, then the MaineDOT classifies particular nodes or elements as a high-crash location (HCL). These criteria are:

- The link or node must have eight or more reported crashes over a three year period, and,
- The link or node must have a “critical rate factor” (CRF) over 1.00. (The critical rate factor relates the crash rate at a particular link or node to the statewide crash rate average for a similar type of facility).

Since CRF values are not calculated for locations in New Hampshire, comparable high crash locations (HCLs) between the two states could not be identified. As such, locations of high safety concern were based upon intersection or roadway sections with eight or more reported crashes over the three year crash analysis period identified.

Using these parameters, one (1) location in Kittery and eight (8) locations in Portsmouth were identified as locations for high safety concern. All nine locations are illustrated in Figure 6-3.

Figure 6-3
Locations of High Safety Concern



Remedial action was recommended for each location and summarized in *Appendix #2 – Crash Data Compilation and Summary* found in this Study Report.

6.4. ORIGIN AND DESTINATION ANALYSIS

This section summarizes the methodology and results of the origin and destination (O&D) surveys conducted for the study.

6.4.1: Vehicle Origin and Destination Survey

A vehicle O&D survey was conducted on the Memorial Bridge and the Sarah Mildred Long Bridge. The survey was performed on Tuesday, May 19, 2009, between the hours of 3:00 pm and 6:00 pm. Based on historic data provided by MaineDOT and NH DOT, this is the busiest period during the weekday for both bridges. Both northbound and southbound traffic was interviewed.

The purpose of the survey was threefold:

1. To understand key characteristics of the users of the two bridges;
2. To compare and contrast the types of trips served by each bridge; and,
3. To provide baseline data to be incorporated into the travel demand model developed for the study.

Approximately 380 surveys were required to be recorded at each bridge in order to achieve statistical validity⁹. A total of 640 vehicles were surveyed on the Memorial Bridge, while another 652 were surveyed on the Sarah Mildred Long Bridge. Table 6-3 provides a detailed summary of the survey sample.

Table 6-3
Interview Sample Summary

| <i>Bridge</i> | <i>Surveyed Vehicles</i> | <i>Total Vehicles</i> | <i>% Vehicles Surveyed</i> |
|-------------------------|--------------------------|-----------------------|----------------------------|
| Memorial - NB | 327 | 1,119 | 29.2% |
| Memorial - SB | 313 | 1,073 | 29.2% |
| Sarah Mildred Long - NB | 324 | 1,562 | 20.7% |
| Sarah Mildred Long - SB | 328 | 1,747 | 18.8% |
| Combined | 1,292 | 5,501 | 23.5% |

Survey data was entered and summarized into two categories — one summarizing the characteristics of the *vehicles* using each bridge, and the other summarizing the characteristics of the *trips* over each bridge. Results of the vehicle O&D survey for key characteristics are shown below.

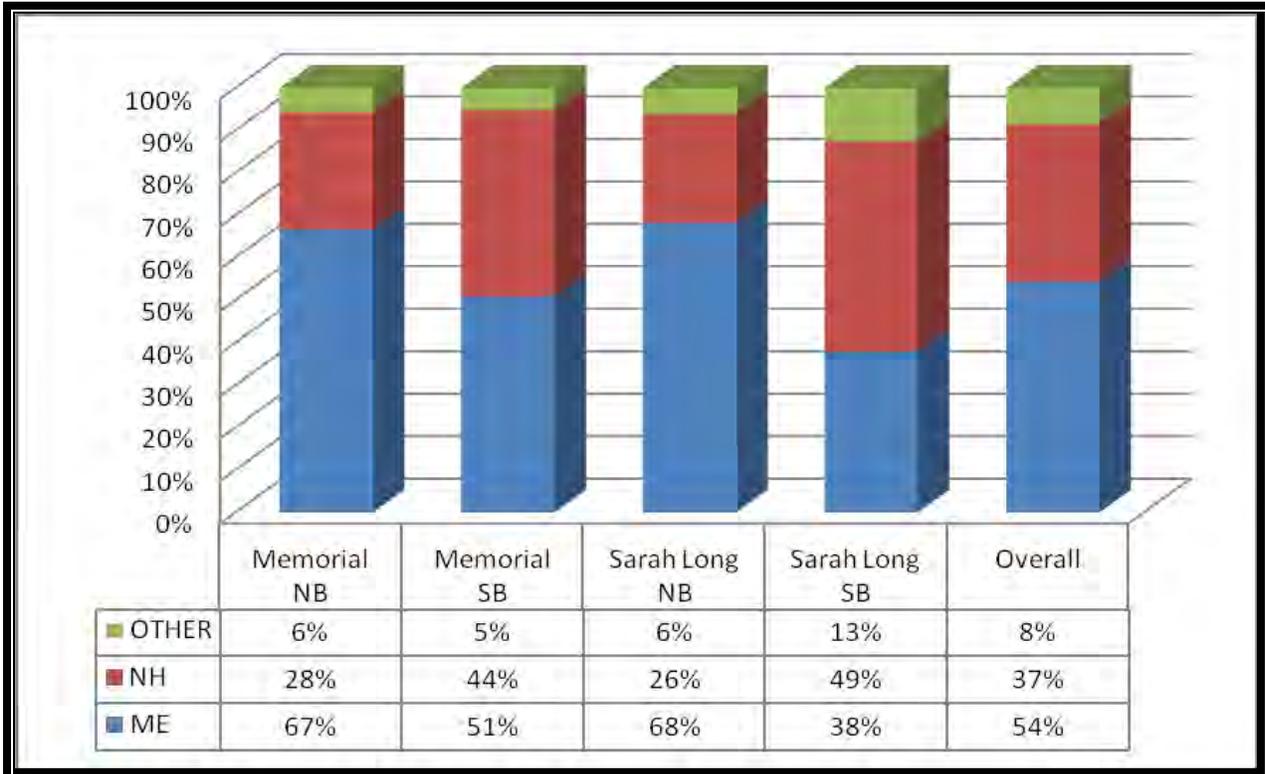
State of registration. Surveyors observed the license plate and noted the state in which the vehicle was registered. The state of registration was assigned to one of the following three categories:

- Maine,
- New Hampshire, and
- Other (For all vehicles registered outside of Maine and New Hampshire).

Figure 6-4 provides a summary of the responses.

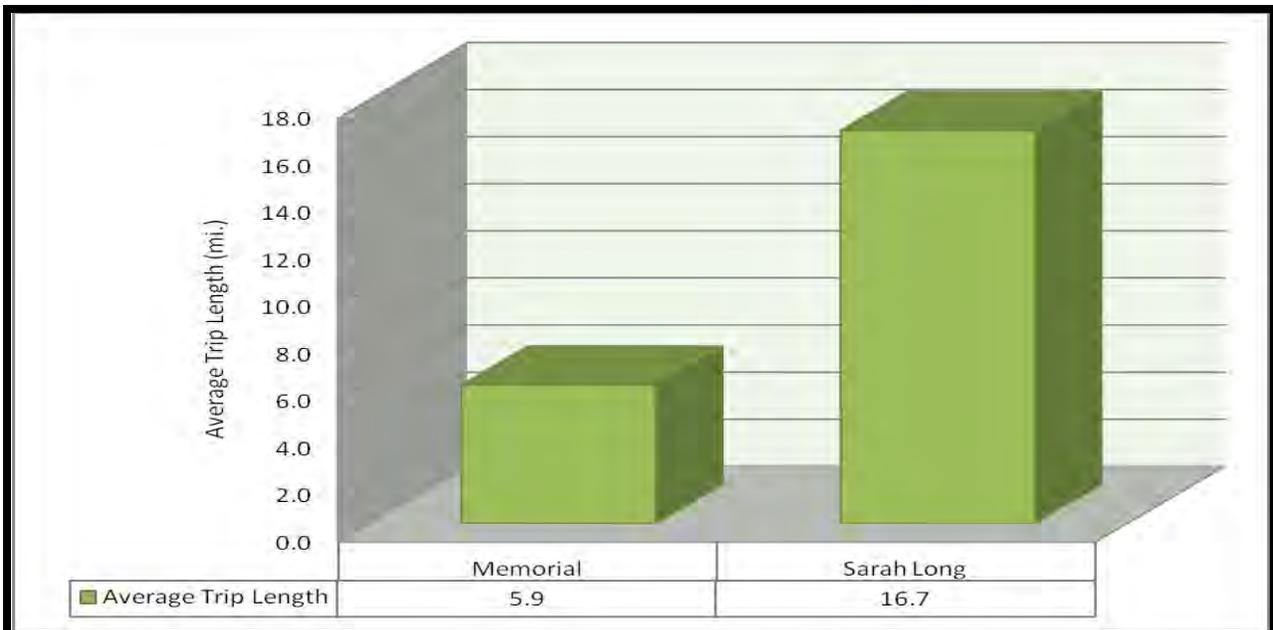
⁹ Approximately 380 surveys were needed to achieve a confidence level of 95 percent, with a confidence interval of ±5 percent.

Figure 6-4: State of Registration Summary



Trip Lengths. Trip lengths, from origin to destination, were calculated for each survey. The average trip length based on this data and the number of sampled surveys was then calculated. The results are shown in Figure 6-5.

Figure 6-5: Average Trip Length, by Bridge

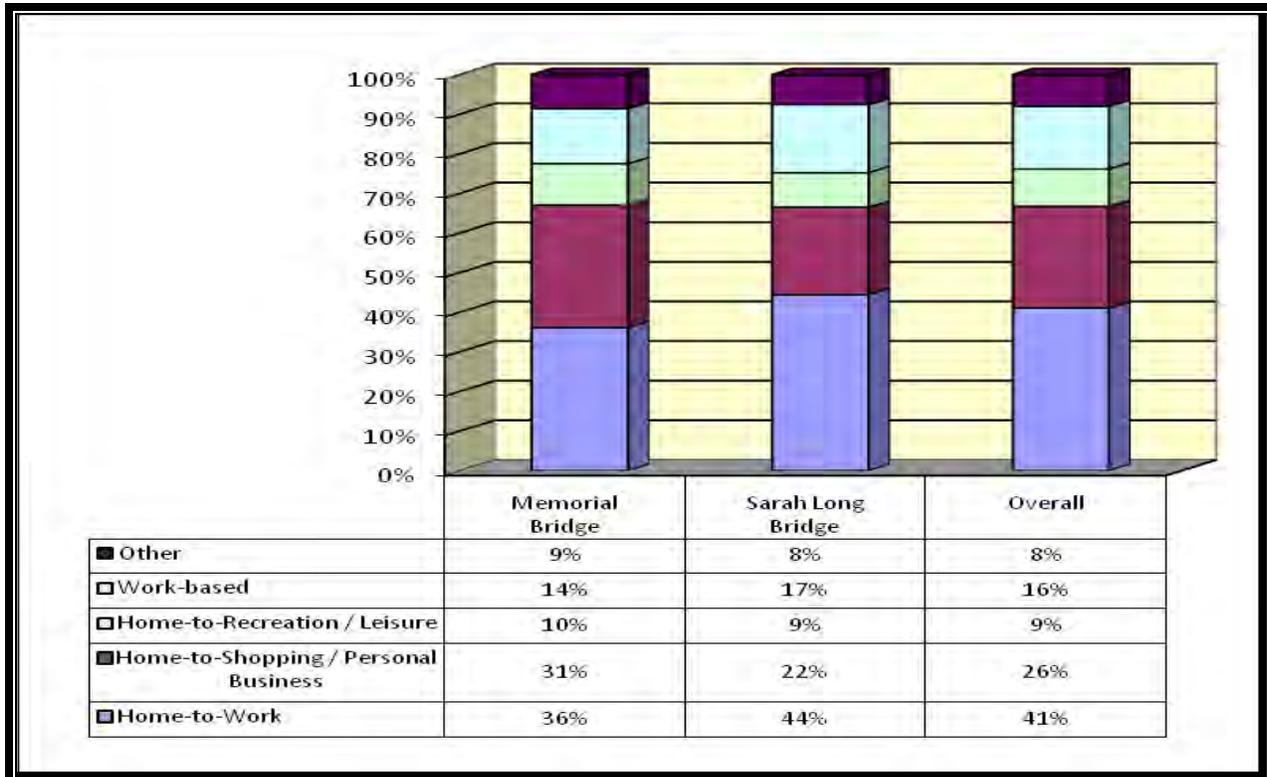


Trip Purpose. Each driver that participated in the survey was asked for the start point of the trip (the *origin*) and the end point of the trip (the *destination*). The driver was further asked to identify the “location type” of the origin and destination. Seven options were provided for the “location type” category: (1) home, (2) work, (3) store/shopping, (4) personal business, (5) recreation, (6) leisure, and (7) other. The location types for each trip’s origin and destination were then paired to generate a “trip purpose”. All trip purposes were subsequently placed into one of the following 5 categories:

- **Home-to-Work.** These are trips between home and work, in either direction.
- **Home-to-Shopping/Personal Business.** These are trips between a driver’s home and a place identified as either “shopping” or “personal business”.
- **Home-to-Leisure/Recreation.** These are trips between home and a place identified as either “leisure” or “recreation”.
- **Work-based.** These are all trips (other than “home-to-work” trips) that have “work” as either the origin or destination.
- **Other.** These encompass all types of trips not included in one of the 4 categories noted above. Examples would include “shopping-to-recreation” or “home-to-other”.

Figure 6-6 provides an overview of the trip purpose data provided by the survey respondents.

Figure 6-6
Trip Purpose by Bridge



All vehicle O&D data was used to help calibrate the travel demand model, which is described in greater detail in Section 6.5. Additional information regarding the vehicle Origin and Destination Analysis and associated findings can be found in the following document included with this Study Report:

- **Appendix #41 – Connections Origin-Destination Survey, Summary Report**

6.4.2: Bicycle and Pedestrian Origin and Destination Survey

A bicycle and pedestrian origin and destination (O&D) survey was conducted in July 2009 on the Memorial Bridge only. Similar to the vehicle O&D survey, the purpose of the survey was to gain a better understanding of the key characteristics of the bicycle and pedestrian users of the bridge and to support the calibration of the travel demand model.

The O&D survey was conducted on two days—Thursday, 16 July 2009, and Saturday, 18 July 2009. These days were chosen in order to observe any fluctuation in pedestrian and cyclist patterns between weekdays and weekends. Each survey was conducted from 11am to 2pm and from 3pm to 6pm. Interviewers requested pedestrians and cyclists to stop by word of mouth, as well as by holding signs that stated “Bicycle Survey, Please Stop”.

The survey was designed to gather the following seven pieces of information:

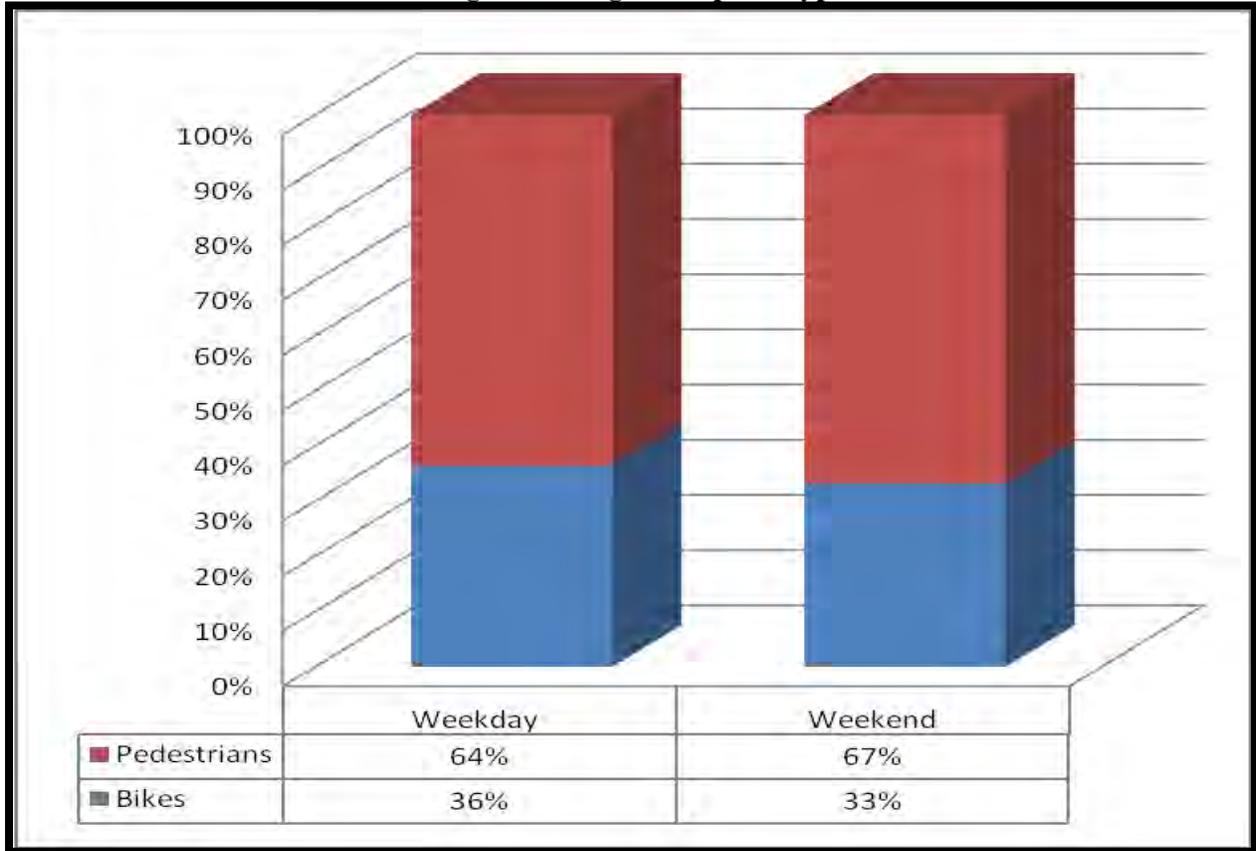
1. Direction of travel (NB vs. SB)
2. Transport type (pedestrian vs. bicycle)
3. State of permanent residence
4. Frequency of travel (both in terms of **days per week** and **months per year**)
5. Trip origin (location at which the current trip started)
6. Trip destination (location at which the current trip ends)
7. Trip purpose

Overall, a total of 242 bicyclists and pedestrians were interviewed—117 during the weekday survey, and 125 during the weekend survey. This represents a statistically valid sample size, yielding a confidence level of 95 percent with a confidence interval of ± 6 percent.

Survey data was entered and summarized into two categories—one summarizing the characteristics of the *users* on the bridge, and the other summarizing the characteristics of the *trips* over the bridge. Results of the bicycle and pedestrian O&D survey for key characteristics are shown below.

Transportation Type. As the surveyors approached participants, their method of transport was classified as either “pedestrian” or “bicycle”. Figure 6-7 summarizes the results of these classifications.

Figure 6-7
Bridge Crossing Transport Type

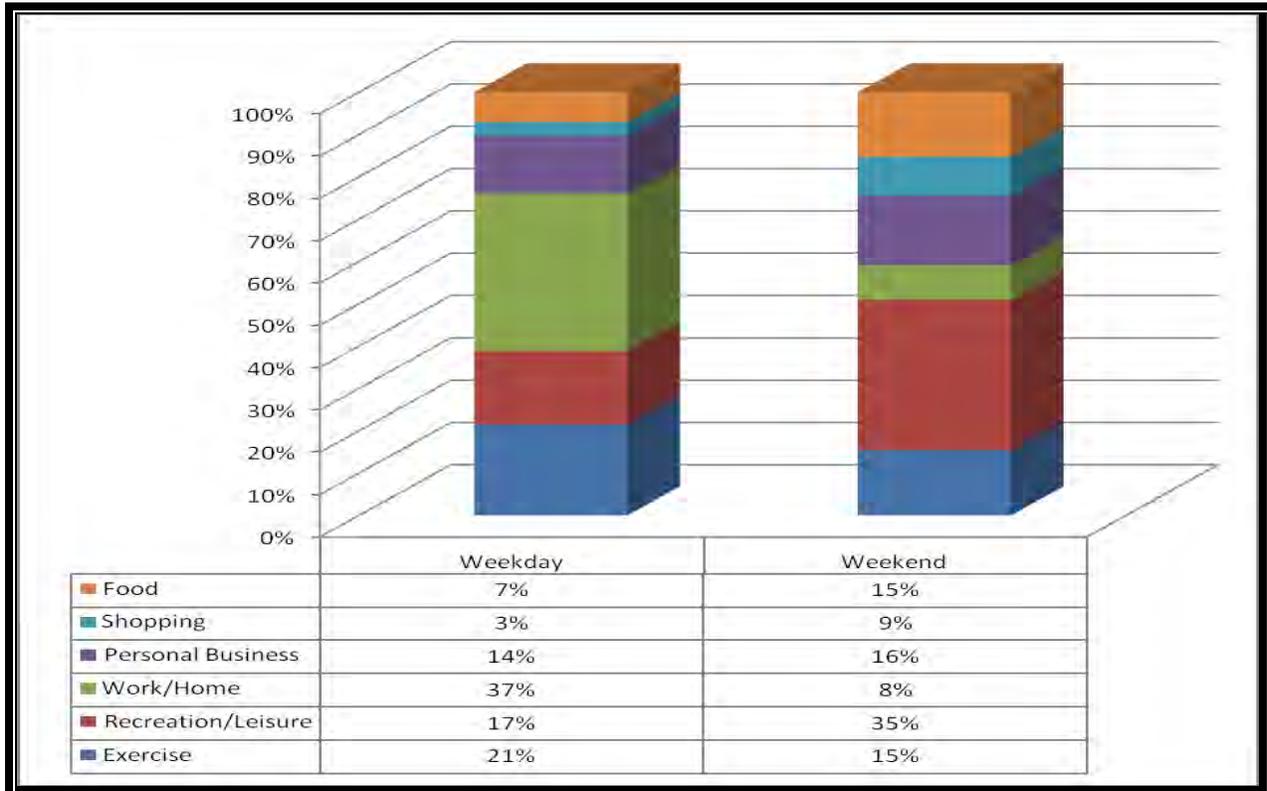


Trip Purpose. The identification of *trip purpose* is an important component of any origin–destination study. For the purpose of this pedestrian and bicycle origin–destination survey, participants were asked to categorize their trip purpose into one of the following six categories:

- **Exercise** – Pedestrians or cyclists utilizing the bridge for the purpose of exercise.
- **Recreation/Leisure** – Persons utilizing the bridge for the purpose of recreation or leisure, such as sightseeing.
- **Work/Home** – Persons crossing the bridge in order to go from home to work or from work to home.
- **Personal Business** – Persons conducting personal business such as visiting the bank or travelling to a doctor’s appointment by crossing the bridge.
- **Shopping** – Pedestrians or cyclists crossing the bridge in order to shop at a grocery store or mall.
- **Food** – Persons utilizing the river crossing for the purpose of visiting a restaurant.

The results are summarized in Figure 6-8.

**Figure 6-8
Trip Type Summary, Weekday vs. Weekend**



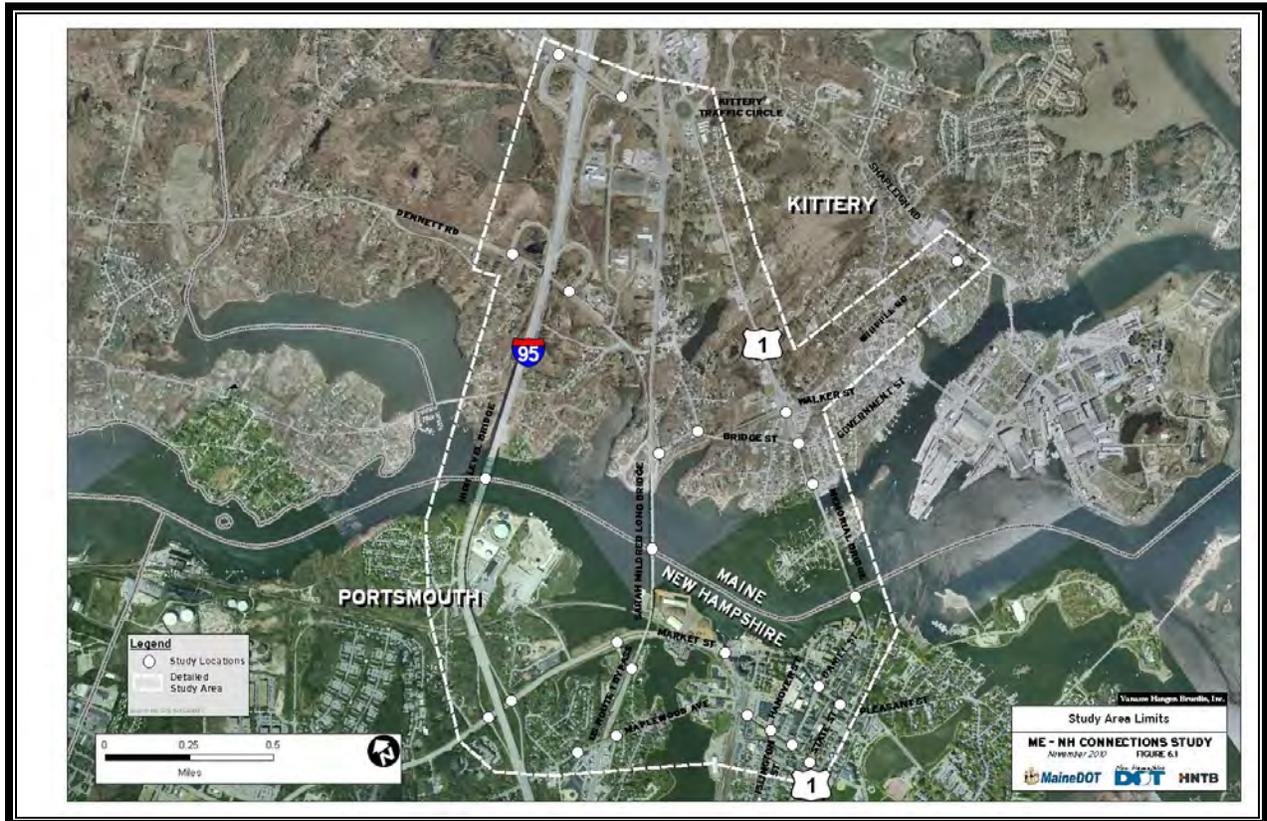
This O&D data was used to help calibrate the travel demand model for bicycle and pedestrian trips converted to vehicle trips. Additional information regarding the bicycle and pedestrian Origin and Destination Analysis and associated findings can be found in the following document included with this Study Report:

- **Appendix #42 – Connections Pedestrian and Bicycle Origin and Destination Survey, Summary Report**

6.5. TRAFFIC ANALYSIS

The methodologies and procedures used to perform the traffic analysis for the study are summarized in this section as well as the results of the evaluations. Traffic operations analyses are a multi-stepped process beginning with defining the Study Area and identifying the locations for detailed evaluation. The Study Area, determined during scope development, was generally limited to Interstate 95 (I-95), U.S. Route 1 and U.S. Route 1 Bypass in the Town of Kittery, Maine and the City of Portsmouth, New Hampshire. Figure 6-9 shows the Study Area limits for the detailed traffic operations analysis and identified the Study Area locations examined in depth.

**Figure 6-9
Traffic Study Area**



2009 Existing Traffic Volumes

The second step was developing the traffic volume networks. Traffic data (intersection turning movement counts and automatic traffic recorder data) was gathered in the spring of 2009 at numerous locations within the Study Area. The data was then balanced and seasonally adjusted to develop traffic volume networks for the Study Area. Existing 2009 traffic volume networks for the system-wide peak hour (weekday 3:45- 4:45PM) as well as the individual weekday morning and evening peak hours were established.

2035 Traffic Forecasts

A travel demand model was developed for the Study Area for the purpose of preparing vehicle traffic forecasts for the study. The model makes use of three existing models that cover portions of the model area (the Seacoast Regional Travel Demand Model, the New Hampshire Statewide Model, and the Maine Statewide Model). The model is based in TransCAD Transportation GIS Software. Traffic forecasts are for a summer weekday PM peak hour in the year 2035.

Traffic volumes and travel pattern information from several sources were used to calibrate the model to current conditions:

- Summer 2009 weekday PM peak hour volumes on the three bridges and at 23 intersections from counts conducted for the Maine-New Hampshire Connections Study and from other recent counts.
- Year 2009 origins and destinations of vehicle, pedestrian, and bicycle trips made on the Sarah Mildred Long and Memorial Bridges, based on intercept surveys conducted as part of the Maine-New Hampshire Connections Study (see Section 6.4).
- Town of residence information for current employees of PNSY.
- Year 2000 Census journey-to-work information.

Tables 6-4 and 6-5 identify current and future job, population and housing growth for Kittery and Portsmouth.

**Table 6-4
Population, Households & Employment Trends in Kittery, Maine 2000-2035**

| | 2000 | | 2007 | | 2008 | 2035 | | |
|--|--------------|--------------|--------------|--------------|--------------|---------------|--------------|---------------|
| | Population | Household | Population | Household | Employment | Population | Household | Employment |
| Kittery Portion of Study Area | 1,603 | 810 | 1,689 | 849 | 808 | 2,022 | 1,067 | 1,118 |
| Town of Kittery Total | 9,543 | 4,078 | 9,987 | 4,274 | 8,349 | 11,951 | 5,371 | 11,005 |

**Table 6-5
Population, Household & Employment Trends in Portsmouth, NH 2000-2035**

| | 2000 | | 2007 | | | 2035 | | |
|---|---------------|--------------|---------------|--------------|---------------|---------------|---------------|---------------|
| | Population | Households | Population | Households | Employment | Population | Households | Employment |
| Portsmouth Portion of Study Area | 5,214 | 2,903 | 5,391 | 2,929 | 10,447 | 5,671 | 3,181 | 13,800 |
| City of Portsmouth Total | 20,784 | 9,875 | 21,497 | 9,960 | 32,414 | 23,041 | 11,138 | 42,819 |

These population, household and employment forecasts were the basis for determining future travel demand within the Study Area. Based on these forecasts, traffic growth for each bridge in the Study Area was anticipated to increase as noted below:

- I-95 High Level Bridge: 0.9 percent per year
- Sarah Mildred Long Bridge: 0.7 percent per year
- Memorial Bridge: 0.8 percent per year

Four system-wide peak hour networks for 2035 were developed from travel demand models with the 2035 No Build condition assumed travel via the existing I-95 High Level Bridge and the existing (2-lane) Sarah Mildred Long Bridge with the Memorial Bridge being closed. The first

2035 Build condition (referred to herein as Alternative Build 1) allowed traffic to move as it does currently on all three bridges. The second 2035 Build condition (referred to as Alternative Build 2) allowed traffic on the existing I-95 High Level Bridge and on an expanded Sarah Mildred Long Bridge (2 lanes in each direction); this alternative assumed the Memorial Bridge is closed. The third 2035 Build condition (referred to as Alternative Build 3) allowed traffic on the existing I-95 High Level Bridge, on an expanded Sarah Mildred Long Bridge with 4 lanes, and on the Memorial Bridge with 2 lanes.

Existing (2009) and future No-Build (2035) bridge traffic volumes are summarized on Figures 6 through 10.

Capacity Analysis

In the final steps, the intersection locations were evaluated. The evaluation criteria used in the intersection analyses was based on methodology provided in the 2000 Highway Capacity Manual¹⁰ (HCM). Level of service (LOS) is a term used to denote the different operating conditions that occur on a given roadway facility under various traffic volume demands. LOS, defined in the HCM, are given letter designations ranging from LOS A (best) to LOS F (worst). For signalized intersections, the LOS designation was for the overall conditions at the intersection. Unsignalized intersection analyses, however, assumed that through traffic on the mainline was not affected by side street traffic and thus the LOS designations are for the turning movements, not the overall operations.

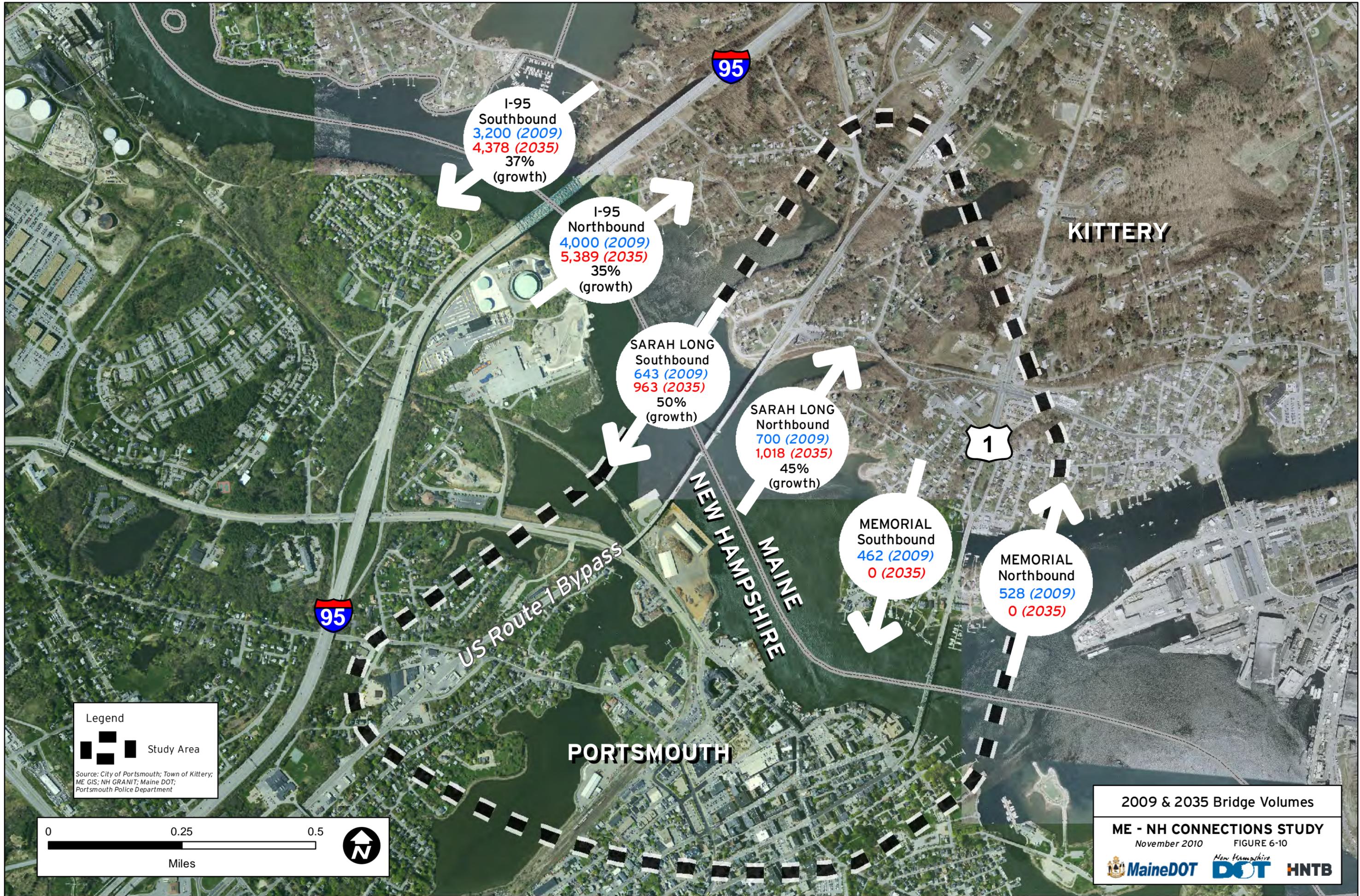
A volume to capacity (v/c) ratio was the primary tool used to analyze each of the three Study Area bridges. However, supplemental LOS analyses based on HCM criteria were also conducted for the I-95 High Level Bridge future operations. The methodologies and assumptions used to calculate the capacity for each of the three bridges can be found in the Piscataqua River Bridge Capacity Analyses Report (June 2010).

Signalized Intersection Capacity Analysis

The results of the signalized intersection capacity analyses are summarized in Table 6-6.

Existing Results: Under the 2009 weekday morning, weekday evening and system peak existing conditions some of the signalized intersections operate at LOS D or better. The maximum delay and v/c ratio experienced at any of the intersections was 40 seconds of delay per vehicle with a v/c ratio of 0.75 at the intersection of U.S. Route 1 at Maplewood Avenue in Portsmouth during the weekday evening peak period. It should be noted that the four traffic signals along Maplewood Avenue/Middle Street in Portsmouth operate within an existing coordinated signal system and the analyses at these intersections were performed using the existing (implemented in 2004) coordinated signal timings.

¹⁰ Highway Capacity Manual, Transportation Research Board, Washington, D.C., 2000.



No-Build Results: The 2035 No-Build condition was the benchmark from which the Build alternatives will be compared. Three signalized intersections were included in the 2035 analyses that were not included in the 2009 existing baseline conditions. Two of these are the Albacore Connector intersections with Market Street and U.S. Route 1 Bypass. The Albacore Connector was assumed to be a formalized connection between Market Street and the U.S. Route 1 Bypass and signalized at both ends by 2035. For analysis purposes, the existing signalized geometric condition was assumed to remain unchanged for the Market Street intersection. The new signalized intersection at the U.S. Route 1 Bypass was assumed to include the construction of a separate left-turn lane on the bypass under the 2035 No Build condition; the other approaches were assumed to consist of a single lane approach.

The third new signalized intersection included in the 2035 analysis is the intersection of Market Street and Russell Street. This unsignalized intersection currently meets peak hour signal volume warrants. Under the 2035 No Build condition, several hundred more vehicles are expected to divert to this location with the Memorial Bridge closed, further meeting signal warrant criteria. The intersection was assumed to be signalized with the existing geometric conditions. For analysis purposes, the intersection was assumed to be signalized for all 2035 No Build and Build alternatives.

As shown in Table 6-6, under the 2035 No Build conditions, most of the signalized intersections operate at LOS D or better. The exception was the intersection of the U.S. Route 1 Bypass at the Albacore Connector in Portsmouth, which was expected to operate at LOS F. It should be noted that while the intersections of Maplewood Avenue at Deer Street and Maplewood Avenue at U.S. Route 1 (Congress Street) in Portsmouth are operating at LOS D, they also operate at or near capacity with v/c ratios of 1.00 and 0.98 respectively.

Build Results: In response to the 2035 No-Build analysis results, it was determined that all of the Build alternatives would need to include signal improvements at the intersection of U.S. Route 1 Bypass at the Albacore Connector in Portsmouth and the junction of the U.S. Route 1 Bypass with Oak Terrace/Bridge Street in Kittery. The Build analyses at the intersection of U.S. Route 1 Bypass with the Albacore Connector included the construction of turn lanes on all intersection approaches. In Kittery, improvements assumed at the junction of the U.S. Route 1 Bypass with Oak Terrace/Bridge Street include signalizing the Oak Terrace and Bridge Street approaches to U.S. Route 1 Bypass, limiting access on Old Post Road to right-in/right-out access and signalizing the intersection of Cook Street/Bridge Street/Government Street to accommodate the rerouted Old Post Road traffic.

In addition to the physical improvements at the above locations, it was noted that signal timings and coordination have been optimized for the 2035 volumes. Signal operation improvements were also assumed at the intersection of U.S. Route 1 at Walker Street in Kittery where an existing signal deficiency is assumed to be fixed. The signal controller at Walker Street under

existing conditions also controls the operations at Government Street; these intersections are assumed to have their own traffic controllers in 2035 with appropriate signal timings.

Under the three Build alternatives, the signalized intersections operate at LOS D or better. No intersections were expected to operate at or near capacity under the Build 1 and Build 3 alternatives where the maximum projected v/c ratio is 0.92 under both alternatives. The Build 2 alternative shows the intersections of Maplewood Avenue at Deer Street and U.S. Route 1(Congress Street) at Maplewood Avenue in Portsmouth operating at LOS D with v/c ratios near capacity (0.98).

With the implementation of the proposed improvements discussed above for the U.S. Route 1 Bypass/Bridge Street area in Kittery, the signalized intersections of U.S. Route 1 Bypass with Oak Terrace and Bridge Street would operate at LOS C or better for the Build alternatives. Likewise, the proposed signalized intersection of Bridge Street/Government Street with Cook Street would operate at LOS C or better.

The results of the signalized intersection capacity analyses for the existing, no-build and build alternatives are summarized in Table 6-6.

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Table 6.6
Signalized Intersection Capacity Analyses Summary

| Location | 2009 AM Existing 2-MB, 2-SML | | | 2009 PM Existing 2-MB, 2-SML | | | 2009 Existing 2-MB, 2-SML | | | 2035 No Build 0-MB, 2-SML | | | 2035 Build 1 2-MB, 2-SML | | | 2035 Build 2 0-MB, 4-SML | | | 2035 Build 3 2-MB, 4-SML | | |
|--|---------------------------------|--------|------------------|---------------------------------|-------|-----|------------------------------|-------|-----|------------------------------|-------|-----|-----------------------------|-------|-----|-----------------------------|--------|------------------|-----------------------------|-------|-----|
| | v/c* | Delay+ | LOS [^] | v/c | Delay | LOS | v/c | Delay | LOS | v/c | Delay | LOS | v/c | Delay | LOS | v/c* | Delay+ | LOS [^] | v/c | Delay | LOS |
| U.S. Route 1 at Government Street | 0.29 | 21 | C | 0.36 | 16 | B | 0.37 | 16 | B | 0.27 | 17 | B | 0.42 | 17 | B | 0.28 | 28 | C | 0.41 | 17 | B |
| U.S. Route 1 at Walker Street | 0.35 | 20 | C | 0.7 | 25 | C | 0.78 | 28 | C | 0.67 | 28 | C | 0.81 | 32 | C | 0.75 | 23 | C | 0.79 | 31 | C |
| I-95 NB Ramps at Market Street | 0.49 | 21 | C | 0.73 | 26 | C | 0.67 | 25 | C | 0.85 | 41 | D | 0.78 | 24 | C | 0.81 | 25 | C | 0.78 | 32 | C |
| I-95 SB Ramps at Market Street | 0.44 | 18 | B | 0.65 | 23 | C | 0.6 | 22 | C | 0.86 | 33 | C | 0.74 | 25 | C | 0.75 | 26 | C | 0.7 | 27 | C |
| U.S. Route 1 (State Street) at Pleasant Street | 0.43 | 13 | B | 0.61 | 18 | B | 0.64 | 20 | C | 0.67 | 20 | B | 0.7 | 21 | C | 0.67 | 20 | B | 0.67 | 20 | B |
| U.S. Route 1 (State Street) at Middle Street | 0.4 | 15 | B | 0.66 | 30 | C | 0.53 | 24 | C | 0.79 | 33 | C | 0.66 | 23 | C | 0.8 | 31 | C | 0.65 | 23 | C |
| U.S. Route 1 (Congress Street) at Maplewood Avenue | 0.66 | 32 | C | 0.75 | 40 | D | 0.75 | 40 | D | 0.98 | 53 | D | 0.92 | 49 | D | 0.98 | 52 | D | 0.92 | 48 | D |
| Maplewood Avenue at Hanover Street | 0.24 | 11 | B | 0.36 | 15 | B | 0.4 | 15 | B | 0.59 | 17 | B | 0.47 | 16 | B | 0.58 | 17 | B | 0.48 | 16 | B |
| Maplewood Avenue at Deer Street | 0.49 | 33 | C | 0.6 | 37 | D | 0.63 | 35 | D | 1.00 | 49 | D | 0.79 | 32 | C | 0.98 | 45 | D | 0.81 | 32 | C |
| Market Street at Albacore Connector | Unanalyzed | | | Unanalyzed | | | Unanalyzed | | | 0.86 | 26 | C | 0.69 | 15 | B | 0.82 | 25 | C | 0.62 | 13 | B |
| U.S. Route 1 Bypass at Albacore Connector | Unanalyzed | | | Unanalyzed | | | Unanalyzed | | | 1.24 | 145 | F | 0.81 | 23 | C | 0.84 | 23 | C | 0.65 | 14 | B |
| Market Street at Russell Street | Unsignalized | | | Unsignalized | | | Unsignalized | | | 0.91 | 26 | C | 0.69 | 13 | B | 0.92 | 28 | C | 0.71 | 14 | B |
| U.S. Route 1 Bypass at Oak Terrace | Unsignalized | | | Unsignalized | | | Unsignalized | | | Unsignalized | | | 0.25 | 9 | A | 0.3 | 8 | A | 0.3 | 8 | A |
| U.S. Route 1 Bypass at Bridge Street | Unsignalized | | | Unsignalized | | | Unsignalized | | | Unsignalized | | | 0.8 | 34 | C | 0.72 | 29 | C | 0.59 | 23 | C |
| Cook Street at Bridge Street / Government Street | Unsignalized | | | Unsignalized | | | Unsignalized | | | Unsignalized | | | 0.65 | 16 | B | 0.88 | 29 | C | 0.81 | 26 | C |

* Volume to capacity ratio

+ Average delay expressed in seconds per vehicle.

[^] Intersection level of service.

Unsignalized Intersection Capacity Analysis

The unsignalized intersection capacity analysis results are summarized in Table 6-7. It should be noted that the intersection of U.S. Route 1 Bypass/Bridge Street at Old Post Road/Oak Terrace in Kittery has an unusual existing traffic control pattern; therefore, for analysis purposes, the northbound and southbound approaches were assumed to operate under stop control (as exists in the field), and the eastbound and westbound approaches were assumed to be free-flowing. As such the westbound approach operates with slightly longer delays than indicated by the results.

Existing Results: Many of the unsignalized intersections in the Study Area operate at good levels of service with moderate peak hour delays. However, several intersections experience some level of delay during the one or more of the existing peak hours. These include the intersections of U.S. Route 1 Bypass/Bridge Street at Old Post Road/Oak Terrace in Kittery, Whipple Road at Woodlawn Avenue /Shapleigh Road in Kittery, ME Route 236 at I-95 Exit 2 Northbound Ramps in Kittery, Maplewood at Cutts Street in Portsmouth (Southbound Ramps to Route 1 Bypass), and U.S. Route 1 at Market Street/Pleasant Street in Portsmouth. It is primarily the side street movements that operate at poor levels of service which is typical for unsignalized side streets and driveways during peak hours.

No-Build Results: Under the 2035 No-Build alternative, some of the unsignalized intersections in the Study Area are expected to operate at good levels of service with moderate delays. However, many intersections were expected to experience some level of delay during the system peak hour. In addition to the intersections identified under the existing conditions, the intersections of Cook Street at Government Street/Bridge Street in Kittery and Maplewood Avenue at Northbound ramps to U.S. Route 1 Bypass in Portsmouth have one or more movements operating at LOS E or LOS F. It is again primarily the side street movements that operate at poor levels of service with long delays.

Build Results: The 2035 Build alternatives do not noticeably change the operations at the majority of the unsignalized intersections from the No-Build alternative. Intersections with poor levels of service still typically operate at the same levels and intersections with acceptable levels of service maintain those levels. The intersection of U.S. Route 1 at Water Street in Kittery, while maintaining good levels of service under the three Build alternatives, shows a significant change in operations under the Build 1 and Build 3 alternatives. This operational change was a direct result of the Memorial Bridge operations with increased delay on the minor approaches when the bridge is open to vehicular traffic. Similarly, the intersection of U.S. Route 1 at Pleasant Street/Market Street in Portsmouth shows an increase in delay from 2035 No Build for movements on U.S. Route 1 during the Build 1 and Build 3 alternatives as a direct result of traffic utilizing the Memorial Bridge.

The locations of Cook Street at Government Street/Bridge Street and U.S. Route 1 Bypass/Bridge Street at Old Post Road/Oak Terrace in Kittery are the unsignalized locations

Table 6.7
Unsignalized Intersection Capacity Analyses Summary

| Location / Movement | 2009 AM Existing | | | 2009 PM Existing | | | 2009 Existing | | | 2035 No Build | | | 2035 Build 1 | | | 2035 Build 2 | | | 2035 Build 3 | | | Legend |
|--|------------------|--------|------|------------------|-------|-----|---------------|-------|-----|---------------|--------|------|--------------|-------|-----|--------------|-------|-----|--------------|-------|-----|--------|
| | 2-MB, 2-SML | | | 2-MB, 2-SML | | | 2-MB, 2-SML | | | 0-MB, 2-SML | | | 2-MB, 2-SML | | | 0-MB, 4-SML | | | 2-MB, 4-SML | | | |
| | Demand* | Delay+ | LOS^ | Demand | Delay | LOS | Demand | Delay | LOS | Demand* | Delay+ | LOS^ | Demand | Delay | LOS | Demand | Delay | LOS | Demand | Delay | LOS | |
| U.S. Route 1 at Water Street | 705 | 1 | A | 1,065 | 1 | A | 1,065 | 1 | A | 175 | 3 | A | 1,290 | 2 | A | 175 | 2 | A | 1,245 | 1 | A | |
| EB movements from Water Street | 15 | 14 | B | 15 | 14 | B | 15 | 12 | B | 5 | 9 | A | 15 | 13 | B | 5 | 9 | A | 15 | 13 | B | |
| WB movements from Water Street | 5 | 20 | C | 20 | 21 | C | 20 | 21 | C | 20 | 9 | A | 25 | 21 | C | 20 | 9 | A | 25 | 20 | C | |
| NB movements from U.S. Route 1 | 240 | 1 | A | 530 | 1 | A | 530 | 1 | A | 80 | - | - | 650 | 1 | A | 80 | - | - | 615 | 1 | A | |
| SB movements from U.S. Route 1 | 445 | 1 | A | 500 | 1 | A | 500 | 1 | A | 70 | 3 | A | 600 | 1 | A | 70 | 3 | A | 590 | 1 | A | |
| U.S. Route 1 Bypass at Bridge Street | 450 | 2 | A | 710 | 9 | A | 710 | 11 | A | 1,415 | ~ | F | 1,010 | 1 | A | 1,665 | 1 | A | 1,185 | 1 | A | |
| EB movements from U.S. Route 1 Bypass | 365 | 1 | A | 205 | 3 | A | 205 | 3 | A | 515 | 2 | A | 265 | - | - | 670 | - | - | 345 | - | - | |
| WB movements from Bridge Street | 55 | 6 | A | 445 | 8 | A | 445 | 9 | A | 815 | 17 | C | 690 | 1 | A | 910 | 1 | A | 770 | 1 | A | |
| NB movements from Oak Terrace | 20 | 12 | B | 40 | 24 | C | 40 | 38 | E | 60 | ~ | F | 40 | 10 | B | 50 | 15 | B | 40 | 11 | B | |
| SB movements from Old Post Road | 10 | 15 | C | 20 | 47 | E | 20 | 80 | F | 25 | 1480 | F | 15 | 13 | B | 35 | 18 | C | 30 | 14 | B | |
| Cook Street at Government Street / Bridge Street | 525 | 3 | A | 1,025 | 4 | A | 990 | 4 | A | 1,730 | 26 | D | | | | | | | | | | |
| EB movements from Bridge Street | 355 | 1 | A | 135 | 2 | A | 165 | 2 | A | 450 | 2 | A | Signalized | | | Signalized | | | Signalized | | | |
| SB movements from Cook Street | 110 | 14 | B | 150 | 23 | C | 165 | 27 | D | 195 | 237 | F | | | | | | | | | | |
| Whipple Road / Shapleigh Road at Woodlawn Avenue | 895 | 30 | B | 1,720 | 42 | F | 1,555 | 61 | E | 2,005 | ~ | F | 1,980 | ~ | F | 2,010 | ~ | F | 1,985 | ~ | F | |
| EB lefts from Whipple Road | 85 | 245 | F | 55 | 884 | F | 60 | 1,105 | F | 70 | ~ | F | 70 | ~ | F | 70 | ~ | F | 65 | ~ | F | |
| EB through/right from Whipple Road | 90 | 20 | C | 140 | 38 | E | 170 | 94 | F | 200 | 238 | F | 200 | 212 | F | 210 | 273 | F | 200 | 225 | F | |
| WB movements from Woodlawn Ave | 105 | 49 | E | 75 | 143 | F | 80 | 222 | F | 100 | ~ | F | 100 | ~ | F | 100 | ~ | F | 100 | ~ | F | |
| NB movements from Whipple Road | 275 | 5 | A | 1,205 | 3 | A | 980 | 4 | A | 1,250 | 5 | A | 1,230 | 5 | A | 1,250 | 5 | A | 1,240 | 5 | A | |
| SB movements from Shapleigh Road | 340 | 1 | A | 245 | 2 | A | 265 | 2 | A | 385 | 2 | A | 380 | 2 | A | 380 | 2 | A | 380 | 2 | A | |
| Dennett Street at I-95 Off Ramp | 395 | 4 | A | 585 | 6 | A | 580 | 6 | A | 905 | 17 | C | 725 | 7 | A | 695 | 7 | A | 570 | 6 | A | |
| WB movements from I-95 off ramp | 135 | 12 | B | 235 | 14 | B | 235 | 14 | B | 465 | 34 | D | 305 | 17 | C | 320 | 15 | C | 265 | 13 | B | |
| Dennett Street at I-95 On Ramp | 415 | 3 | A | 530 | 1 | A | 525 | 1 | A | 835 | 2 | A | 645 | 1 | A | 745 | 2 | A | 520 | 1 | A | |
| SB movements from Dennett Street | 250 | 5 | A | 125 | 4 | A | 115 | 4 | A | 205 | 6 | A | 145 | 4 | A | 205 | 6 | A | 145 | 4 | A | |
| U.S. Route 1 at Pleasant Street/Market Street | 820 | 14 | B | 1,225 | 46 | E | 1,020 | 30 | D | 1,145 | 33 | D | 1,240 | 59 | F | 1,145 | 33 | D | 1,220 | 54 | F | |
| WB movements from U.S. Route 1 | 385 | 17 | C | 445 | 37 | E | 535 | 45 | E | 545 | 51 | F | 640 | 100 | F | 545 | 51 | F | 625 | 89 | F | |
| NB movements from Pleasant Street | 155 | 10 | B | 165 | 12 | B | 185 | 12 | B | 230 | 12 | B | 240 | 13 | B | 235 | 13 | B | 235 | 12 | B | |
| SB movements from Market Street | 280 | 12 | B | 615 | 63 | F | 300 | 16 | C | 370 | 20 | C | 360 | 19 | C | 365 | 19 | C | 360 | 19 | C | |
| Market Street at Russell Street | 1,375 | 3 | A | 1,385 | 29 | A | 1,170 | 9 | A | | | | Signalized | | | Signalized | | | Signalized | | | |
| EB movements from Russell Street | 130 | 30 | D | 255 | 160 | F | 255 | 42 | E | | | | Signalized | | | Signalized | | | Signalized | | | |
| Maplewood Avenue at Cutts Street | 575 | 7 | A | 975 | 20 | B | 855 | 11 | B | 1,110 | 15 | B | 1,085 | 14 | B | 1,100 | 16 | C | 1,080 | 14 | B | |
| EB movements from Maplewood Avenue | 145 | 1 | A | 235 | 1 | A | 220 | - | - | 330 | - | - | 310 | - | - | 335 | - | - | 310 | - | - | |
| WB movements from Maplewood Avenue | 325 | 7 | A | 640 | 10 | A | 505 | 7 | A | 610 | 8 | A | 610 | 8 | A | 590 | 8 | A | 600 | 8 | A | |
| NB movements from Cutts Street | 70 | 14 | B | 80 | 144 | F | 110 | 37 | E | 150 | 71 | F | 145 | 64 | F | 155 | 78 | F | 150 | 60 | F | |
| SB movements from Cutts Street | 35 | 21 | C | 20 | 185 | F | 20 | 44 | E | 20 | 59 | F | 20 | 55 | F | 20 | 55 | F | 20 | 54 | F | |
| Maplewood Avenue at U.S. Route 1 Bypass NB | 650 | 3 | A | 1,095 | 3 | A | 935 | 3 | A | 1,340 | 5 | A | 1,290 | 4 | A | 1,325 | 4 | A | 1,275 | 4 | A | |
| WB movements from Maplewood Avenue | - | - | - | - | - | - | - | - | - | 685 | 3 | A | 685 | 3 | A | 665 | 3 | A | 680 | 3 | A | |
| NB lefts from NB Ramp | 20 | 12 | B | 45 | 22 | C | 35 | 17 | C | 45 | 38 | E | 45 | 34 | D | 40 | 36 | E | 40 | 33 | D | |
| NB rights from NB Ramp | 150 | 10 | B | 135 | 11 | B | 150 | 11 | B | 180 | 13 | B | 185 | 13 | B | 175 | 13 | B | 175 | 12 | B | |
| ME Route 236 at I-95 Exit 2 NB Ramps | 1,465 | 3 | A | 2,375 | 160 | E | 2,325 | 104 | E | 2,930 | 1,837 | F | 2,830 | 1,795 | F | 2,880 | 1,763 | F | 2,845 | 1,750 | F | |
| EB rights from Exit 2 NB Ramps | 110 | 13 | B | 220 | 13 | B | 185 | 12 | B | 300 | 16 | C | 225 | 14 | B | 190 | 14 | B | 205 | 14 | B | |
| WB lefts from I-95 NB / U.S. Route 1 SB | 135 | 15 | B | 150 | 30 | D | 135 | 36 | E | 165 | 93 | F | 170 | 98 | F | 170 | 95 | F | 170 | 97 | F | |
| WB rights from I-95 NB / U.S. Route 1 SB | 125 | 14 | B | 530 | 672 | F | 390 | 584 | F | 525 | ~ | F | 495 | ~ | F | 495 | ~ | F | 485 | ~ | F | |
| ME Route 236 at I-95 Exit 2 SB Ramps | 1,640 | 1 | A | 2,120 | 1 | A | 2,120 | 1 | A | 2,575 | 1 | A | 2,725 | 1 | A | 2,815 | 1 | A | 2,745 | 2 | A | |
| EB lefts from SB Off Ramp | 25 | 19 | C | 45 | 21 | C | 45 | 21 | C | 50 | 27 | D | 70 | 29 | D | 60 | 28 | D | 65 | 28 | D | |
| EB rights from SB Off Ramp | 155 | 12 | B | 165 | 11 | B | 165 | 11 | B | 200 | 12 | B | 200 | 12 | B | 275 | 13 | B | 240 | 13 | B | |

* Demand expressed in vehicles per hour.
+ Delay expressed in seconds per vehicle.
^ Level of service.
- Delay too large to calculate.
- No Data Available.

showing the greatest operational changes. As described in the signalized analysis section, U.S. Route 1 Bypass was proposed to be signalized at Oak Terrace and at Bridge Street in Kittery as is the intersection of Cook Street at Government Street/Bridge Street in Kittery. Old Post Road is assumed to be converted to a right-in/right-out access only at the Oak Terrace intersection in Kittery. The U.S. Route 1 Bypass/Bridge Street at Old Post Road/Oak Terrace intersection remains unsignalized and the rerouting of traffic from the restriction of Old Post Road allow this intersection to improve the minor legs' operations to LOS C or better in the Build 3 option.

Bridge Capacity Analysis

Capacity analyses were performed for the Sarah Mildred Long, Memorial, and I-95 High Level Bridges for the existing and future conditions. A key assumption in calculating bridge capacity is the number of bridge lifts during the peak hour. During the summer months, USCG regulations require the lift bridges to lift every half hour if there are vessels waiting to pass. Therefore, a worst-case of two lifts per hour was assumed for all Build and No-Build alternatives. In reality, analysis of the bridge lift records shows that the bridges rarely lift twice in one hour. The current average lift frequency is approximately once every two hours for the Sarah Mildred Long Bridge. Given this, alternative bridge lift frequencies of one lift or no lifts per hour were also analyzed for the No-Build and Build 1 alternatives. A no lift assumption would be more applicable to the Sarah Mildred Long Hybrid Bridge replacement option due to its increased vertical clearance over the water in the closed position.

Existing Results: The capacity analysis results for the bridges are summarized in Table 6-8. It should be noted that the existing bridge analyses assumed a worst case two-lifts per hour scenario for the two lift bridges.

The analysis results indicated that the bridges' critical approaches are operating at v/c ratios between 0.34 and 0.54 during the weekday morning peak hours, and at 0.85 during the weekday evening peak hours and between 0.69 and 0.82 during the system-wide peak hour. It should be noted that the v/c ratios during the weekday evening and the system-wide peak hour are approximately 0.85 on the critical approach, a level where operations appear to the average driver to be approaching capacity.

No-Build: Table 6-9 summarizes the analysis results for the 2035 No-Build alternative. This analysis was completed with river crossings at the I-95 High Level Bridge and the Sarah Mildred Long Bridge with the Sarah Mildred Long Bridge having two-lifts, one-lift and no lift alternatives. The Memorial Bridge is assumed to be closed. I-95 northbound will have a v/c ratio of 0.89 and a corresponding LOS D/E in the critical direction. More importantly, under this condition, the Sarah Mildred Long Bridge was projected to operate over capacity when there are two bridge lifts.

Under the 2035 No Build alternative with one and no bridge lifts, similar to the two-lift scenario, Sarah Mildred Long Bridge would continue to operate over capacity in the northbound direction.

I-95 High Level Bridge is anticipated to operate at LOS D in the northbound direction and LOS C in the southbound direction.

**Table 6-8
2009 Existing Bridge Capacity Analysis**

| Location | Weekday Morning Peak | | | Weekday Evening Peak | | |
|----------------------------------|----------------------|------------|--------|----------------------|----------|------|
| | Adj. Flow* | Capacity** | v/c*** | Adj. Flow | Capacity | v/c |
| <u>Memorial Bridge</u> | | | | | | |
| Northbound | 218 | 844 | 0.26 | 709 | 838 | 0.85 |
| Southbound | 288 | 844 | 0.34 | 494 | 838 | 0.59 |
| <u>Sarah Mildred Long Bridge</u> | | | | | | |
| Northbound | 419 | 956 | 0.44 | 848 | 1,033 | 0.82 |
| Southbound | 512 | 956 | 0.54 | 882 | 1,033 | 0.85 |
| | Hourly Flow**** | Capacity | v/c | Hourly Flow | Capacity | v/c |
| <u>I-95 High Level Bridge</u> | | | | | | |
| Northbound | 1,770 | 5,775 | 0.31 | 3,700 | 5,775 | 0.64 |
| Southbound | 2,870 | 5,775 | 0.50 | 3,130 | 5,775 | 0.54 |
| | System-wide Peak | | | | | |
| Location | Adj. Flow | Capacity | v/c | | | |
| <u>Memorial Bridge</u> | | | | | | |
| Northbound | 616 | 897 | 0.69 | | | |
| Southbound | 523 | 897 | 0.58 | | | |
| <u>Sarah Mildred Long Bridge</u> | | | | | | |
| Northbound | 864 | 1,056 | 0.82 | | | |
| Southbound | 796 | 1,066 | 0.75 | | | |
| | Hourly Flow | Capacity | v/c | | | |
| <u>I-95 High Level Bridge</u> | | | | | | |
| Northbound | 4,000 | 5,775 | 0.69 | | | |
| Southbound | 3,200 | 5,775 | 0.55 | | | |

* Adjusted (by peak hour factor (PHF)) traffic flow expressed in vehicles per hour.

** Capacity expressed in vehicles per hour.

*** Volume to capacity ratio.

**** Hourly flow is the unadjusted peak hour volume expressed in vehicles per hour.

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**TABLE 6-9
2035 BRIDGE CAPACITY ANALYSES – No Build**

| Location | | Two Lift Sarah Mildred Long (SML)* | | | One Lift SML** | | |
|--------------------|----|------------------------------------|-------|------|-----------------|-------|------|
| | | Volume | v/c | LOS | Volume | v/c | LOS |
| Interstate-95 | NB | 5,130 | 0.89 | D/E | 4,859 | 0.84 | D |
| | SB | 4,310 | 0.75 | D | 4,182 | 0.72 | C |
| | | <u>Adjusted</u> | | | <u>Adjusted</u> | | |
| Sarah Mildred Long | NB | 980 | 1,065 | 1.07 | 1,250 | 1,358 | 1.09 |
| | SB | 960 | 1,043 | 1.04 | 1,085 | 1,179 | 0.94 |
| Location | | No Lift SML*** | | | | | |
| | | Volume | v/c | LOS | | | |
| Interstate-95 | NB | 4,651 | 0.81 | D | | | |
| | SB | 4,057 | 0.70 | C | | | |
| | | <u>Adjusted</u> | | | | | |
| Sarah Mildred Long | NB | 1,458 | 1,585 | 0.96 | | | |
| | SB | 1,211 | 1,316 | 0.88 | | | |

^ Adjusted volumes calculated using a PHF of 0.92 for SML and PM Bridges.

* Volume to capacity (v/c) ratios calculated using the directional capacity determined for each bridge to be 5,775 vehicles per hour (vph) for I-95, and 1,000 vph for SML Bridge assuming two lifts during peak hour.

** Volume to capacity (v/c) ratios calculated using the directional capacity determined for each bridge to be 5,775 vph for I-95, and 1,250 vph for SML assuming one lift during peak hour.

*** Volume to capacity (v/c) ratios calculated using the directional capacity determined for each bridge to be 5,775 vph for I-95, and 1,650 vph for SML Bridge assuming no lift during peak hour

Build: Tables 6-10 and 6-11 summarize the results from the three 2035 Build alternatives. Build 1 assumed all three bridges in operation with two lanes on both the Sarah Mildred Long and the Memorial Bridges. The lift bridges were assumed to operate with two-lifts, one-lift, and no lifts per hour. Under this scenario, the v/c ratio on I-95 northbound decreased from 0.89 (under the No Build condition) to 0.81 with two bridge lifts. Meanwhile, the Memorial Bridge was projected to have a v/c ratio of 0.82 with the Sarah Mildred Long Bridge having a v/c ratio of 0.91. These results are worse than the existing conditions on all of the bridges.

Under Build 1 with one-lift per hour, similar operations to the two-lift scenario occur. Volume to capacity ratios declined slightly on I-95 High Level Bridge with each decrease in number of bridge lifts on the other bridges. Both the Sarah Mildred Long and Memorial Bridges also have v/c ratios projected to be lower with the decreasing number of bridge lifts.

**TABLE 6-10
2035 BRIDGE CAPACITY ANALYSES – Build 1**

| Bridge | | Two Lift SML & Two Lift Memorial Bridge (MB)* | | | One Lift SML & One Lift MB** | | |
|--------------------|----|---|-----------------|------------|------------------------------|-----------------|------------|
| | | <u>Volume</u> | <u>v/c</u> | <u>LOS</u> | <u>Volume</u> | <u>v/c</u> | <u>LOS</u> |
| Interstate-95 | NB | 4,690 | 0.81 | D | 4562 | 0.79 | D |
| | SB | 3,965 | 0.69 | C | 3887 | 0.67 | C |
| Sarah Mildred Long | | | <u>Adjusted</u> | | | <u>Adjusted</u> | |
| | | <u>Volume</u> | <u>Volume</u> | <u>v/c</u> | <u>Volume</u> | <u>Volume</u> | <u>v/c</u> |
| | NB | 840 | 913 | 0.91 | 991 | 1077 | 0.86 |
| | SB | 770 | 837 | 0.84 | 853 | 927 | 0.74 |
| Memorial | NB | 645 | 701 | 0.82 | 626 | 680 | 0.62 |
| | SB | 580 | 630 | 0.74 | 576 | 626 | 0.57 |
| Bridge | | No Lift SML & No Lift MB*** | | | | | |
| | | <u>Volume</u> | <u>v/c</u> | <u>LOS</u> | | | |
| Interstate-95 | NB | 4,443 | 0.77 | D | | | |
| | SB | 3,696 | 0.64 | C | | | |
| Sarah Mildred Long | | | <u>Adjusted</u> | | | | |
| | | <u>Volume</u> | <u>Volume</u> | <u>v/c</u> | | | |
| | NB | 1,091 | 1,186 | 0.72 | | | |
| | SB | 1,045 | 1,135 | 0.69 | | | |
| Memorial | NB | 644 | 700 | 0.52 | | | |
| | SB | 575 | 625 | 0.46 | | | |

^ Adjusted volumes calculated using a PHF of 0.92 for SML and PM Bridges.

* Volume to capacity (v/c) ratios calculated using the directional capacity determined for each bridge to be 5,775 vph for I-95, and 1,000 vph for SML Bridge and 850 vph for PM Bridge assuming two lifts during peak hour.

** Volume to capacity (v/c) ratios calculated using the directional capacity determined for each bridge to be 5,775 vph for I-95, and 1,250 vph for SML Bridge and 1,100 vph for PM Bridge assuming one lift during peak hour.

*** Volume to capacity (v/c) ratios calculated using the directional capacity determined for each bridge to be 5,775 vph for I-95, and 1,650 vph for SML Bridge and 1,350 vph for PM Bridge assuming no lift during peak hour.

Build 2 assumed traffic on the I-95 High Level Bridge and on the Sarah Mildred Long Bridge with four lanes. This river crossing combination was analyzed with two bridge lifts. The I-95 High Level Bridge would operate similarly to Build 1 with a critical v/c ratio of 0.81 and LOS D in the northbound direction. Under this alternative, volumes on the Sarah Mildred Long Bridge increased substantially compared to the 2035 No Build and Build 1 conditions with only two lanes on the bridge. However, with four lanes on the bridge the critical v/c ratio decreased to 0.79 which is lower than the 2009 existing condition.

TABLE 6-11
2035 BRIDGE CAPACITY ANALYSES - Build 2 & Build 3 with Two-Lifts

| Bridge | | Build 2 (MB-0, SML-4) | | | Build 3 (MB-2, SML-4) | | |
|--------------------|----|-----------------------|-----------------|------------|-----------------------|-----------------|------------|
| | | <u>Volume</u> | <u>v/c</u> | <u>LOS</u> | <u>Volume</u> | <u>v/c</u> | <u>LOS</u> |
| Interstate-95 | NB | 4,650 | 0.81 | D | 4,480 | 0.78 | D |
| | SB | 4,055 | 0.70 | C | 3,755 | 0.65 | C |
| Sarah Mildred Long | | | <u>Adjusted</u> | | | <u>Adjusted</u> | |
| | | <u>Volume</u> | <u>Volume</u> | <u>v/c</u> | <u>Volume</u> | <u>Volume</u> | <u>v/c</u> |
| | NB | 1,460 | 1,587 | 0.79 | 1,090 | 1,185 | 0.59 |
| | SB | 1,210 | 1,315 | 0.66 | 995 | 1,082 | 0.54 |
| Memorial | NB | 0 | 0 | - | 610 | 663 | 0.78 |
| | SB | 0 | 0 | - | 565 | 614 | 0.72 |

* Adjusted volumes calculated using a PHF of 0.92 for SML and PM Bridges.

** Volume to capacity (v/c) ratios calculated using the existing directional capacity previously determined for each bridge (5,775 vph for I-95, 1,000 vph for SML Bridge, and 850 vph for PM Bridge). SML four-lane alternative assumed to have a directional capacity of 2,000 vph.

Build 3 assumed that the Sarah Mildred Long Bridge would provide four lanes (either physically or under a hybrid option) and Memorial Bridge will provide two lanes over the Piscataqua River. Like Build 2, Build 3 was analyzed with only two bridge lifts. Under this condition, approximately 200 vph per direction are shifted from I-95 to the Sarah Mildred Long Bridge compared to the other build alternatives. This reduction in traffic reduced the critical northbound v/c ratio on I-95 High Level Bridge to 0.78. The v/c ratio for the Sarah Mildred Long Bridge is substantially reduced compared to the other build alternatives and is projected to be 0.59 under this scenario. The Memorial Bridge v/c ratio decreased slightly compared to the Build 1 from 0.82 to 0.78 for the critical northbound direction.

Summary of Traffic Analyses

Traffic analyses were conducted for the three Piscataqua River bridges between the Portsmouth, New Hampshire and the Kittery, Maine as well as selected Study Area intersections. These analyses included 2009 existing alternative, 2035 No Build alternative, and three 2035 Build alternatives.

Existing: Analyses for the 2009 existing traffic demands indicate that many of the Study Area intersections operate at acceptable levels of service. Although some of the unsignalized intersections experienced delays during the peak hour conditions, no substantial deficiencies or constraints were identified at either the signalized or unsignalized intersections. The capacity analyses of the Sarah Mildred Long Bridge and the Memorial Bridge indicated that both bridges

are at v/c ratios of 0.85 during some of the peak hours. To the average driver these bridges appear to be approaching capacity under the existing conditions. However, the I-95 High Level Bridge was not approaching capacity in 2009.

No-Build: Under the 2035 No-Build alternative, the Memorial Bridge would be closed leaving the Sarah Mildred Long Bridge and I-95 High Level Bridge to process all of the traffic over the Piscataqua River. The intersection of Market and Russell Streets in Portsmouth received a traffic signal. All of the other intersections selected for detailed traffic operation analysis maintained their existing geometry and operation control as was analyzed in the existing conditions. Volumes throughout the Study Area increased due to background growth while volumes on the bridges increased due to both background growth and the Memorial Bridge closure. The critical approach on the I-95 High Level Bridge would experience a v/c ratio of 0.89 with volumes approaching LOS E operations. Volume demands on the Sarah Mildred Long Bridge would exceed capacity with two-lifts, one-lift, and no lifts, resulting in v/c ratios of 1.07, 1.09, and 1.06 respectively on the critical approach. Three of the signalized intersections in Portsmouth would be operating at or over capacity (U.S. Route 1 at Maplewood Avenue, Maplewood Avenue at Deer Street and U.S. Route 1 Bypass at Albacore Connector). From this evaluation it can be concluded that the No Build condition would not accommodate the projected 2035 system peak hour traffic volumes.

Build 1: The Build 1 alternative assumed all three bridges are in operation with two lanes on both the Sarah Mildred Long and the Memorial Bridges. Build 1 assumed operational improvements at the signalized intersection of U.S. Route 1 at Government Street and U.S. Route 1 at Walker Street in Kittery with individual signal controllers assumed at each intersection. Additionally, Build 1 in Kittery assumed U.S. Route 1 Bypass is signalized at Oak Terrace and Bridge Street, Old Post Road was modified to allow right-in/right-out only traffic at the Bridge Street intersection and Cook Street at Bridge Street/Government Street is signalized. Lastly, in Portsmouth this alternative assumed improvements at the intersection of U.S. Route 1 Bypass and the Albacore Connector to provide separate turn lanes on all three approaches. With these improvements all of the signalized intersections operated at LOS D or better with a maximum v/c ratio of 0.92. The unsignalized intersections were expected to operate at approximately the same levels of service as under the 2035 No Build alternative with the exception of U.S. Route 1 Bypass/Bridge Street at Old Post Road/Oak Terrace in Kittery where the adjusted traffic patterns result in improved levels of service. Overall operations improve at eight intersections with the remaining intersections operating at approximately the same levels as under the No Build condition.

The I-95 High Level Bridge would operate with a critical v/c ratio of 0.81 at LOS D under Build 1 with two-lifts. The Sarah Mildred Long Bridge will operate with a critical northbound directional v/c ratio of 0.91 and the Memorial Bridge with a critical v/c ratio of 0.82 under the two-lift worse case condition. Motorists under the existing conditions would tend to feel that the Sarah Mildred Long Bridge operated near capacity with the v/c at 0.85 during the 2009 weekday

evening peak hour. Future year traffic operations on the bridges would be at approximately the same levels as the existing conditions under the Build 1 condition.

Build 2: The Build 2 alternative assumed traffic flow on the I-95 High Level Bridge and on the Sarah Mildred Long Bridge with four lanes (two lanes in each direction). The same signalized improvements as in Build 1 were assumed leading to all of the signalized intersection operating at LOS D or better. However, similar to the No-Build alternative, the intersections of U.S. Route 1 at Maplewood Avenue and Maplewood Avenue at Deer Street in Portsmouth both are expected to operate with a v/c ratio approaching 1.0. Signal timings at these intersections were optimized to provide efficient progression through the intersections with the least delay. The unsignalized Study Area intersections operated at the same or better levels of service than the 2035 No Build alternative. Operations improved at five intersections with the remaining locations operating at approximately the same levels as the No Build alternative.

The I-95 High Level Bridge would operate with a critical v/c ratio of 0.81 in the northbound direction at a LOS D. With four lanes on the Sarah Mildred Long Bridge the critical v/c ratio decreases to 0.79. Operations were similar on the bridges to levels under the Build 1 alternative; however additional reserve capacity was available.

Build 3: The Build 3 alternative assumed that the Sarah Mildred Long Bridge would provide four lanes and Memorial Bridge will provide two lanes over the Piscataqua River. The signalized improvements were the same as assumed in the other Build alternative leading to signalized operations of LOS D or better at all of the signalized intersections. No capacity issues were anticipated to occur at these intersections with the largest v/c ratio being 0.92 at the intersection of U.S. Route 1 at Maplewood Avenue in Portsmouth. The unsignalized intersections were anticipated to operate at the same or better levels of service than the 2035 No Build alternative. As in Build 1, intersection operations improved at eight intersections while remaining at approximate the same No Build levels at the other locations.

Under Build 3, approximately 200 vph per direction were shifted away from I-95 High Level Bridge over to the Sarah Mildred Long Bridge compared to the other build alternatives. This reduction in traffic reduced the critical northbound v/c ratio on I-95 to 0.78. The v/c ratio for the Sarah Mildred Long Bridge was projected to be 0.59 under this scenario. The v/c ratio for the Memorial Bridge was projected to be 0.78 for the critical northbound direction. There was available capacity on all three bridges for future growth beyond 2035.

Conclusion: In conclusion, the 2035 No-Build alternative would not accommodate the future traffic volume demands within the Study Area. However, all three Build alternatives considered, in conjunction with the additional improvements identified, were viable alternatives from a traffic operations perspective.

Additional information regarding Traffic Analysis tasks and associated findings are found in the following documents included with this Study Report:

- *Appendix #1 - Balanced Traffic and Seasonal Volume Adjustment.*
- *Appendix #5 - Seasonal Adjustment Factor Calculation.*
- *Appendix #6 - No Build Adjustments to Peak Hour Bridge Volumes.*
- *Appendix #14 - Existing Conditions Traffic Analysis.*
- *Appendix #15 - Memorial Bridge Closed Traffic Assessment.*
- *Appendix #19 - Closure of Bridges During Construction.*
- *Appendix #21 - Traffic Analysis Criteria.*
- *Appendix #23 - 2035 Traffic Operational Analysis.*
- *Appendix #26 – Baseline Growth and Summary.*
- *Appendix #28 – 2015 Construction Impacts.*
- *Appendix #29 – Traffic Forecasts Summary.*
- *Appendix #33 – Travel Demand Model Methodology.*
- *Appendix #45 - Bridge Capacity Analysis Summary Report.*

6.6. MULTIMODAL EVALUATION

This section summarizes the existing modes of transportation present within the Study Area, as well as the methodology and results of the multimodal evaluation conducted for the study.

6.6.1: Existing Modes

The first step in conducting the multimodal evaluation for this study was to define the services offered by each mode and identifying routes and facilities associated with each mode in the Study Area. A mode is a system for carrying transit passengers described by specific right-of-way, technology and operational features¹¹. The modes identified in the Study Area include bus, paratransit services, bicycle, pedestrian and organized van/car pools. Freight rail also exists in the Study Area. A high level summary of these modes is identified as follows:

Bus Services

The following bus services were identified in the Study Area.

- Local Services: The local bus services include the Cooperative Alliance for Seacoast Transportation (COAST) and Wildcat Transit. These are both fixed-route bus services. Currently no fixed-route bus service operates between Kittery and Portsmouth.
- Interstate Bus Transit: Two inter-state buses travel along the I-95 corridor: Greyhound, Inc. and C&J. They both provide Boston-bound travel.

Paratransit Services

The following paratransit services were identified in the Study Area

- York County Community Action Corporation (YCCAC);
- The Cooperative Alliance for Seacoast Transportation (COAST);
- Other special population services in Rockingham County;
- Various private taxi and shuttle services; and

¹¹ Source: American Public Transportation Association

- Portsmouth Naval Shipyard (PNSY) Employee Transit. While there is no formal shuttle service operated by PNSY, a number of private taxi and shuttle services operate to bring employees to and from work each day. These private taxi and shuttles companies include, but are not limited to:
 - Great Bay Limousine;
 - Seacoast Airport Service;
 - Coastal Transportation Services;
 - Southwick Airport Shuttle;
 - Luxury Limousine; and
 - Mermaid Transportation Company.

Additionally, there are a number of van/car pools that operate to take employees to and from work at the PNSY. Many of these use park and ride lots located throughout the region.

Van/Car Pooling Services

The following van/car pooling services were identified in the Study Area:

- GO MAINE. GO MAINE is an organization that provides services and information to commuters and other travelers who live, work, or travel in the State of Maine.

Bicycle and Pedestrian Services

The following is a summary of the existing bicycle and pedestrian accommodations in the Study Area.

Sarah Mildred Long Bridge

Bike and pedestrian use is currently prohibited on the Sarah Mildred Long Bridge since the bridge is located on the U.S. Route 1 Bypass, a limited access facility. Although bike and pedestrian use is prohibited, bicyclists and pedestrians use of the Bridge has been observed. People are less likely to use the bridge because of unfavorable conditions such as high motor vehicle volumes and speeds, lack of adequate striped shoulders, very narrow (3 foot) safety sidewalks, inadequate pedestrian railings, and frequent summertime bridge openings.

Memorial Bridge

The Memorial Bridge carries U.S. Route 1 between Portsmouth and Kittery across the Piscataqua River and the East Coast Greenway (ECG) identified as The NH Seacoast Greenway (NHSG) in New Hampshire and the Eastern Trail (ET) in Maine. It includes wooden plank sidewalks (approximately six to seven feet wide) on both sides and those sidewalks narrow to approximately 5.5 feet in the area of the raised superstructure and lift span. The sidewalks on the southern approach to the bridge consist of open metal grating.

The Memorial Bridge is the only bike/pedestrian connection between Portsmouth and Kittery. The shortest alternative bicycle route between Kittery and Portsmouth is approximately 24 miles in length, traveling through the communities of Portsmouth, Newington, Dover, Elliot and Kittery. Trips of this distance would likely discourage most cyclists from making local Kittery -

Portsmouth trips, and certainly all pedestrians would seek alternate transportation modes if the connection across the Memorial Bridge were to be lost.

Regional Connections:

The Memorial Bridge is situated on a major regional bike route, the East Coast Greenway. The ECG is a developing 3000 mile north-south urban trail project that passes through Kittery and Portsmouth as it extends from Calais, Maine to Key West, Florida. The section of the ECG within southern Maine is known as the Eastern Trail, and the section within New Hampshire is known as the New Hampshire Seacoast Greenway. These two routes are currently connected by the Memorial Bridge.

Freight Rail Services

This section includes a summary of the freight rail lines for the Sarah Mildred Long Bridge. These rail lines include the Portsmouth Branch and its connecting freight lines: Main Line West, Main Line East, and the Newington Branch.

Infrastructure

The Sarah Mildred Long Bridge is a double-deck truss bridge which spans the Piscataqua River between Portsmouth and Kittery. Completed in 1940, the bridge supports the U.S. Route 1 Bypass Highway on the upper level and a single track freight rail on the lower level. To accommodate various sizes of passing cargo ships and recreational watercraft and to minimize vehicular traffic disruption, the bridge has two lifting mechanisms. One of these mechanisms raises both the rail and highway and is used to accommodate large passing watercraft. For smaller watercraft, a retractable section of the rail allows the vehicular traffic not to be disrupted.

Freight Lines

The following is a summary of the freight rail lines in the Study Area.

Portsmouth Branch Freight Line

The freight rail line on the Sarah Mildred Long Bridge is one segment of a rail network owned by Boston and Maine Corporation (BM) and operated by Springfield Terminal Railway Company (STRY), a subsidiary of Pan Am Railways (formerly the Guilford Rail System). This rail segment is part of the Portsmouth Branch, an active 10-mile segment that extends from Newfields, New Hampshire through the Portsmouth Yard across the Piscataqua River through Kittery, Maine and to PNSY. Currently, this Portsmouth Branch is used solely to service PNSY.

The frequency of freight service provided on the Portsmouth Branch by STRY is as required. Two sidings, located in Portsmouth serve customers located along the rail line in addition to the Portsmouth Yard. Prior reports have classified the condition of the infrastructure along the Portsmouth branch as poor, though the track structure has been rated good to fair. Specifically, the surface condition of the track is good, and the drainage, ballast and tie conditions are fair. The track structure consists of 72, 75, 100 and 112 pound rail with wood ties.

Connecting Freight Lines

The Portsmouth Branch is connected to three other freight lines in Portsmouth, each owned by BM and operated by STRY. These lines include the Newington Branch, Main Line West, and Main Line East. These three lines are currently used exclusively for freight rail traffic, with the exception of the Main Line West, which shares a corridor with the Amtrak-operated Downeaster service for the Northern New England Passenger Rail Authority (NNEPRA) from Portland, Maine to Boston, Massachusetts.

Truck Services

Primary truck services to the region are through localized deliveries to both downtown Portsmouth and Kittery. No major truck distribution carriers were identified within the Study Area. Weight limit posting on the Memorial Bridge (ten tons for the past several years and three tons as of Nov. 20, 2009) bans all vehicles except for passenger cars and pick-up trucks from using that bridge. Heavier trucks servicing downtown Portsmouth and Kittery utilize either the Sarah Mildred Long Bridge (now posted at 10 tons in July, 2009) or the I-95 High Level Bridge. This includes deliveries to PNSY.

Layover/Storage Facilities

The only documented area for layover and storage is at the Port of Portsmouth. Specific facility capacity and turnover data was not obtained.

6.6.2: Potential Future Passenger Transportation Opportunities

This evaluation of transit and other passenger transportation opportunities considers how the bridge alternatives support or preclude future passenger transportation expansions.

Rail

The Pan Am Railway (PAR) Portsmouth Branch provides a railroad connection between Portsmouth, Kittery, PNSY, and the Main Line West in Newfields, New Hampshire. The Amtrak Downeaster operates along the Main Line West, with nearby stations in Exeter, Durham, and Dover, New Hampshire. Massachusetts Bay Transportation Authority (MBTA) commuter rail service operates along the Main Line West between Haverhill, Massachusetts and Boston. The Haverhill terminus for this service is slightly over 30 track miles from downtown Portsmouth. The MBTA also operates a commuter rail route over the former Eastern Route Main Line, which terminates in Newburyport, Massachusetts. The Newburyport terminus is approximately 20 miles from Portsmouth. While the Portsmouth Branch provides an active railroad connection to Portsmouth, the track along most of the Eastern Route Main Line has been removed.

To not preclude future expansion of MBTA commuter rail, it is worthwhile to consider possible expansion routes. Past planning studies have considered the possible extension of the MBTA Newburyport Line service from Newburyport to Portsmouth. This service could also potentially be extended to Kittery via the Sarah Mildred Long Bridge. The simplest terminus for this

service would be in Portsmouth, perhaps near the Portsmouth Yard. A central Portsmouth commuter rail station could be a logical location for a multi-modal transportation center with connections to both sides of the river.

The PAR Portsmouth Branch also provides a potential commuter or regional rail connection between Portsmouth/Kittery and Portland, Maine. This corridor could also potentially connect to the Town of Durham/University of New Hampshire and Dover. There are no plans to do this however.

Local Bus

No fixed-route public transit is currently offered in Kittery, to PNSY, or in nearby Maine communities. The Memorial and Sarah Mildred Long Bridges could connect future fixed-route service in Maine to Portsmouth. Because of its concentration of employment opportunities, PNSY would likely be the largest transit service generator with a bridge connection to Portsmouth. Local transit connecting to PNSY could also conceivably serve central Kittery and retail along Route 1, including the Kittery Outlets.

Transit-only or high-occupant vehicle (HOV) lanes are not foreseeable on either bridge. Transit-only lanes in the Market Square area of downtown Portsmouth should be evaluated as part of future transit service upgrades. Signal priority for transit and transit queue jumps at strategic locations should also be evaluated. These locations include downtown Portsmouth, approaches to both bridges, the Portsmouth Shipyard gateway, and central Kittery.

Regional Bus

U.S. Route 1 is a potential regional transit corridor between Portsmouth and southeastern Maine coastal communities. A limited stop corridor along U.S. Route 1 could follow either bridge to Portsmouth. Intercity motorcoach service would likely follow Interstate 95 to Portsmouth, as Greyhound service does today.

6.6.3: Evaluation of Transit Alternative

The section describes the feasibility and viability of a zero-fare, high frequency bus transit system between the downtowns of Portsmouth and Kittery by bicyclists and pedestrians currently using the Memorial Bridge. This evaluation included an estimate of the potential usage of the bus transit system, an estimate of resulting bicycle and pedestrian usage on the Sarah Mildred Long Bridge, and other observations. This bus transit system assessment assumes the Memorial Bridge is closed to all modes of traffic.

Definition of Proposed Bus Transit System

The proposed bus transit system route was assumed based on two objectives: 1) service or be in close proximity to the majority of the origins and destinations identified in the bicycle-pedestrian O&D survey, and 2) be time competitive with the existing origins and destinations factoring in the alternate travel time if bicycles and pedestrians switched to the Sarah Mildred Long Bridge. Figure 6-11 identifies the proposed bus transit system route and station stops.

Figure 6-11
Proposed Bus Transit System Route and Station Stops



In Figure 6-11, the proposed bus transit system services primarily the downtowns of Portsmouth and Kittery, and Badgers Island. The majority of the origins and destinations identified in the bicycle-pedestrian O&D survey also service these same areas. Five station stops were identified: 1) South end of existing Memorial Bridge on Daniel Street, 2) Portsmouth Downtown area (Market and Bow Street), 3) Kittery downtown (Government and Newmarch Street near entrance to PNSY), 4) U.S. Route 1 at Government and Walker Street (near Gourmet Alley and John Paul Jones Park), and 5) Badgers Island. The final route and stops could be modified if deemed appropriate to better serve Study Area needs.

Since time and convenience are key factors in bus transit system utilization, a convenient 10-minute headway was assumed. The one-way route distance is approximately 2.5 miles and the round trip travel time with stops and recovery was estimated to be 30 minutes. This would require three (3) buses to operate the service with a fourth bus assumed as a spare. Additionally, given the documented high demand of bicycles and pedestrians using the Memorial Bridge for all trip purposes, an 18-hour day (5 am – 11 pm), 365 day per year service was assumed. This length of day service is anticipated to cover the vast majority of all bicycle and pedestrian trips crossing the Memorial Bridge.

Results of Proposed Bus Transit System Analysis

The following section summarizes the estimated percent of existing bicycle and pedestrian trips that were calculated to shift to the proposed bus transit system. First, current trip times from trip lengths for bicycles and pedestrians were developed based on the weekday data available from the bicycle and pedestrian origin and destination survey. Understanding trip time was essential in determining which trip purposes might shift to bus transit vs. either eliminating the trip across

the river altogether or maintaining their current mode via the Sarah Mildred Long Bridge. Next, weekday bicycle-pedestrian origin and destination data was summarized to determine the percentage of each trip purpose, by trip mode (bicycle or pedestrian), that currently crosses the Memorial Bridge. Then, the likelihood that the various trip purposes would shift to the proposed bus transit system was estimated. These estimates were based on engineering judgment regarding trip purpose and origin or destination data. Finally, the total percentage of trips that would shift to the proposed bus transit system was determined by multiplying the estimated shift percentages by the number of bicycle and pedestrian trips by trip type. This yielded the estimated number of potential trips to shift which were then divided by the total number of trips.

Table 6-12 summarizes the estimated percent of bicycle and pedestrian trips to shift to the proposed bus transit system.

**Table 6-12
Estimated Percent of Bicycle and Pedestrian Trips to Shift to Transit**

| Purpose | Bicycle | Pedestrian | Total |
|--------------------|----------------|-------------------|--------------|
| Exercise | 0% | 0% | 0% |
| Food | 0% | 100% | 60% |
| Home | 100% | 100% | 100% |
| Personal Business | 0% | 100% | 69% |
| Recreation/Leisure | 42% | 33% | 38% |
| Shopping | 0% | 100% | 100% |
| Work | 33% | 100% | 74% |
| Totals | 26% | 67% | 52% |

From Table 6-12, 52 percent of the existing bicycle-pedestrian trips crossing the Memorial Bridge were estimated to shift to the proposed bus transit system. Bicycles accounted for 26 percent of these trips, while pedestrians comprised a greater percentage at 67 percent.

Additional information regarding Multimodal Evaluation tasks and associated findings can be found in the following documents included with this Study Report:

- *Appendix #4 – Multi Modal Existing Conditions.*
- *Appendix #16 – Pedestrian Bicycle Assessment with Memorial Closed.*
- *Appendix #25 - Multi Modal Evaluation.*
- *Appendix #32 - Transit Alternative Assessment.*
- *Appendix #42 - Connections Pedestrian and Bicycle Origin and Destination Survey, Summary Report.*

6.7. AIR QUALITY ANALYSIS

The section summarizes the potential future highway air quality impacts of the 2035 No Build Alternative (Memorial Bridge closed) and the 2035 Build Alternative conducted as part of this study. The air quality analysis assumes that both the Memorial Bridge and Sarah Mildred Long Bridge are open with two lanes. Based on a review of the 2035 traffic operational analysis

results, the two lane bridge options were selected for air quality analysis purposes since they provide a more conservative (congested) assessment of impacts for air quality conditions than four lane bridge options. Impacts associated with four lane bridge options would be less than determined herein for the two lane bridge options.

This assessment conducted a local (microscale) air quality analysis to demonstrate compliance with the National Ambient Air Quality Standards (NAAQS) by evaluating air quality impacts of 2035 No Build and Build conditions. The analysis also evaluated air quality impacts associated with the 2009 Existing Condition. The local or hotspot analysis evaluated carbon monoxide (CO) and particulate matter (PM). The air quality study assumes that if the 2035 Build Alternative that was selected for analysis purposes (the Alternative with the highest traffic demands and delays) meets the NAAQS, then all other alternatives would have lower concentrations and can be assumed to also meet the NAAQS. The Study Area is within the Ozone Maintenance area for Maine and New Hampshire.

Methodology

The microscale analysis evaluated air quality impacts associated with the project for the 2009 Existing Condition and 2035 No Build and 2035 Build Alternatives. The pollutants of concern included CO, PM₁₀ and PM_{2.5} concentrations at the most congested intersection, based upon traffic in the Study Area. The intersection selected for microscale air quality modeling was selected following the procedures outlined by the EPA guidelines¹². These procedures require that the intersections be ranked by their levels of service (LOS) and their total traffic volumes and that the air quality analysis model the highest ranked intersection. The intersection of Congress Street at Maplewood Street in Portsmouth was selected for the analysis because it was the most congested intersection in the Study Area. The air quality results calculated at this intersection represent the highest concentrations within the Study Area and it is expected that concentrations at other locations would be lower than this representative intersection.

Results

The results of the air quality analysis demonstrate that all of the pollutant (CO, PM_{2.5} and PM₁₀) concentrations for the 2009 Existing, and 2035 No-Build and Build Alternatives meet the NAAQS. The 1-hour and 8-hour CO values are well below the NAAQS standard of 35.0 ppm and 9 ppm respectively, and are consistent with the City of Portsmouth's designation as a CO Maintenance Area. Similarly, the values for 24-hour PM₁₀, 24-hour PM_{2.5} and annual PM_{2.5} are also well below the NAAQS standard of 150 ug/m³, 35 ug/m³ and 15 ug/m³ respectively.

The results also show that projected concentrations at the study receptor locations are similar under the future 2035 No-Build and Build Alternatives. The projected PM concentrations are virtually the same between the No-Build and Build Alternatives. The 2035 Build Alternative CO concentrations are generally slightly less than the 2035 No Build Alternative.

¹²*Guidelines for Modeling Carbon Monoxide from Roadway Intersection*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Technical Support Division; Research Triangle Park, NC; EPA-454/R-92-005; November 1992.

Additional information regarding Air Quality analysis and associated findings can be found in the following document included with this Study Report:

- *Appendix #24 - Future Air Quality Analysis.*

6.8. NOISE ANALYSIS

The section provides a summary of the highway traffic noise analysis performed for this study. This includes noise background, noise criteria, noise monitoring methodology, existing condition sound levels.

Background

Sound (noise) is described in terms of loudness, frequency, and duration. Loudness is the sound pressure level measured on a logarithmic scale in units of decibels (dB). For community noise impact assessment, sound level frequency characteristics are based upon human hearing, using an A-weighted (dBA) frequency filter. The A-weighted filter is used because it approximates the way humans hear sound. The most common way to account for the time varying nature of sound (duration) is through the equivalent sound level measurement, referred to as L_{eq} . The L_{eq} averages the background sound levels with short term transient sound levels and provides a uniform method for comparing sound levels that vary over time. The time period used for highway noise analysis is typically one hour. The peak hour L_{eq} represents the noisiest hour of the day or night and usually occurs during the peak periods of automobile and truck traffic. FHWA guidelines and criteria require the use of the one hour L_{eq} for assessing highway traffic noise impacts on different land uses.

The following general relationships exist between hourly highway traffic noise levels and human perception:

- A 1 or 2 dBA increase/decrease is not perceptible to the average person;
- A 3 dBA increase/decrease is a doubling/halving of acoustic energy, but is just barely perceptible to the human ear; and
- A 10 dBA increase/decrease is a tenfold increase/decrease in acoustic energy, but is perceived as a doubling/halving in loudness to the average person.

Noise Abatement Criteria

Highway traffic noise can adversely affect common human activities, such as communication. FHWA has established Noise Abatement Criteria (NAC) to help protect the public health and welfare from excessive highway traffic noise. Recognizing that different areas are sensitive to noise in different ways, the NAC varies according to land use. The FHWA NAC is described in Table 6-13. MaineDOT and NH DOT endorse the FHWA procedures and consider highway traffic noise impacts to occur when existing or future sound levels approach (within 1 dBA), are at, or exceed the NAC.

Table 6-13
Noise Abatement Criteria (NAC) One-Hour, A-Weighted Sound Levels (dBA)

| Activity Category | L_{eq}(h)* | Description of Activity Category |
|--------------------------|---------------------------|--|
| A | 57 (Exterior) | Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purposes. |
| B | 67 (Exterior) | Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals. |
| C | 72 (Exterior) | Developed lands, properties, or activities not included in Categories A or B above. |
| D | -- | Undeveloped lands |
| E | 52 (Interior) | Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums. |

* L_{eq}(h) is an energy-averaged, one-hour, A-weighted sound level in decibels (dBA).

Source: 23 CFR Part 772 from the Code of Federal Regulations (CFR) - *Procedures for Abatement of Highway Traffic Noise and Construction Noise.*

Methodology

This highway traffic noise analysis evaluated the traffic data in the Study Area to determine the time period that the highest sound levels are expected to occur. Traffic data was reviewed to identify the peak traffic hours of the day. This review of the traffic data revealed that the highest traffic volumes occurred during the weekday evening peak hours. It is important to note that the various intersections throughout the Study Area peak at different times during the weekday evening peak period. As such, the individual intersection peak hour volumes were used in the noise evaluation.

A noise monitoring program was conducted to establish existing peak hour sound levels at eight noise monitoring locations within the Study Area. All noise monitoring data was conducted using a type one noise monitor (Larson Davis – Model 824) in conformance with the FHWA noise monitoring guidelines¹³. These sound level values were used to calibrate the noise model and to help establish existing conditions. All existing and future sound levels were calculated using the FHWA’s approved highway noise model, the Traffic Noise Model (TNM) 2.5¹⁴. The TNM input data includes peak hour traffic volumes, vehicle mix, vehicle speeds, and roadway and receptor geometry. The future sound level predictions are based on the weekday evening peak hour traffic data. The noise analysis calculated the sound levels at each receptor location and compared the results to the existing conditions and the FHWA noise impact criteria.

¹³ *Measurement of Highway Related Noise*, US Department of Transportation, Federal Highway Administration FHWA-PD-96-046, May 1996.

¹⁴ Federal Highway Administration’s Traffic Noise Model (FHWA TNM) Version 2.5, February 2004.

Existing Conditions

The Study Area was evaluated to identify receptor locations that have outdoor activities and would be sensitive to highway traffic noise, such as residential receptors located within 500 feet from the edge of the major Study Area roadways of U.S. Route 1 Bypass and U.S. Route 1. The Study Area was split into eight sections, four in Kittery and four in Portsmouth.

Sound level data was collected on Wednesday, April 8, 2009 at eight locations within the Study Area during the evening peak hour period. The dominant noise sources observed included general traffic and truck traffic on major Study Area roadways, predominantly I-95, U.S. Route 1 Bypass, and U.S. Route 1. The measured noise levels are presented in Table 6-14.

**Table 6-14
Noise Monitoring Data**

| Monitoring Location | Measured Sound Level (dBA) |
|--|-----------------------------------|
| <u>Kittery, ME</u> | |
| M1-Oak Terrace - western cul-de-sac | 55 |
| M2-Bridge Street / Oak Terrace – at Condos | 62 |
| M3-Commercial Street – half way between Government Street & Water Street | 50 |
| M4-Badgers Island West - east end of cul-de-sac | 53 |
| <u>Portsmouth, NH</u> | |
| M5-Albacore Park - northwest corner of parking lot | 56 |
| M6-Northwest Street - between #136 and #76 | 61 |
| M7-High Street - southwest corner of High Street & Hilton Connector | 53 |
| M8-Court Street - 100 feet south of Atkinson Street | 60 |

The results of the noise monitoring indicated that the sound levels in the Study Area range from approximately 50 to 62 dBA. All of these sound levels are below the NAC for residential land uses of 66 dBA, i.e. are not within 1 dBA of Activity Category B (67 dBA) as defined in Table 6-13. The existing sound level data were used to calibrate the TNM to accurately predict highway traffic sound levels throughout the Study Area.

Existing and Future Sound Levels (Modeled)

The TNM was used to calculate the existing and future sound levels at all the receptor locations in the Study Area based upon roadway geometry, traffic volumes, and vehicle speeds. Table 6-15 summarizes the 2009 Existing, 2035 No Build, and 2035 Build modeled sound levels.

Table 6-15
Modeled Sound Levels

| No. | Monitoring Location | 2009 Existing (dBA) | 2035 No Build (dBA) | Delta 2035 No Build to 2009 (dBA) | 2035 Build (dBA) | Delta 2035 Build to 2009 (dBA) |
|--------|-----------------------------|---------------------|---------------------|-----------------------------------|------------------|--------------------------------|
| | <u>Kittery, ME</u> | | | | | |
| R1(M) | Oak Terrace | 56.8 | 58.0 | 1.2 | 57.9 | 1.1 |
| R2(M) | Bridge Street / Oak Terrace | 59.3 | 60.5 | 1.2 | 60.4 | 1.1 |
| R3(M) | Commercial Street | 51.6 | 50.0 | -1.6 | 52.4 | 0.8 |
| R4(M) | Badgers Island (west) | 54.2 | 55.8 | 1.6 | 54.9 | 0.7 |
| R5 | Juniper Point/Prince Avenue | 50.6 | 51.9 | 1.3 | 51.8 | 1.2 |
| R6 | Main Street / E Street | 51.6 | 52.3 | 0.7 | 52.5 | 0.9 |
| R7 | Love Lane | 55.4 | 56.0 | 0.6 | 56.7 | 1.3 |
| | <u>Portsmouth, NH</u> | | | | | |
| R8(M) | Albacore Park | 58.3 | 59.6 | 1.3 | 59.5 | 1.2 |
| R9(M) | Northwest Street | 60.6 | 61.9 | 1.3 | 61.9 | 1.3 |
| R10(M) | High Street | 54.0 | 55.0 | 1.0 | 54.7 | 0.7 |
| R11(M) | Court Street | 57.7 | 57.7 | 0.0 | 57.7 | 0.0 |
| R12 | Mill Pond Way | 57.5 | 58.0 | 0.5 | 58.0 | 0.5 |
| R13 | Prescott Park | 46.1 | 46.0 | -0.1 | 46.7 | 0.6 |
| | | | | | | |

Source: TNM by VHB.

2035 No Build: U.S. Route 1 Memorial Bridge closed.

2035 Build: U.S. Route 1 Memorial Bridge reopens with two travel lanes.

The modeled 2009 Existing sound levels ranged from 46.1 to 60.6 dBA. The 2009 Existing condition was compared to two future conditions: the 2035 No Build Alternative (Memorial Bridge closed) and the 2035 Build Alternatives (Memorial Bridge and Sarah Mildred Long Bridge open with the two lane option). Traffic volumes and roadway geometrics were adjusted to reflect the future year conditions.

Conclusions

Study Area modeled sound levels were determined to range from 46.1 to 60.6 dBA in the 2009 Existing condition and from 46.0 to 61.9 dBA in the 2035 No-Build condition and from 46.7 to 61.9 dBA in the 2035 Build Alternatives conditions. All of the 2035 No-Build and Build Alternative project sound levels resulted in nominal increases in sound over the existing conditions (which are not expected to be perceptible to the average person) and are below the NAC for residential areas. As such, the sensitive noise receptors within the Study Area are not expected to be impacted by highway traffic noise associated the alternatives being considered in this study. Therefore, no highway noise mitigation was determined to be required at this time.

Additional information regarding Noise analysis and associated findings can be found in the following documents included with this Study Report:

- *Appendix #12 – Existing Conditions Noise.*
- *Appendix #22 - Future Noise Conditions.*

6.9. NATURAL RESOURCE IMPACT EVALUATION

The natural resource impact evaluation assessed the impact to natural resources for each alternative. The natural resources analyzed included:

- River water quality impacts;
- Natural areas, terrestrial and aquatic habitat;
- Threatened and endangered species;
- Special aquatic sites including wetlands; and
- Floodplains/floodways.

Existing natural resources in the Study Area are illustrated on the following figures: Figures 6-12 (Special Aquatic Sites); 6-13 (Surface Waters and Groundwater Features); 6-14 (Natural Communities); 6-15 (FEMA Special Flood Hazard Areas); and, 6-16 (Geology).

SPECIAL AQUATIC SITES EVALUATION

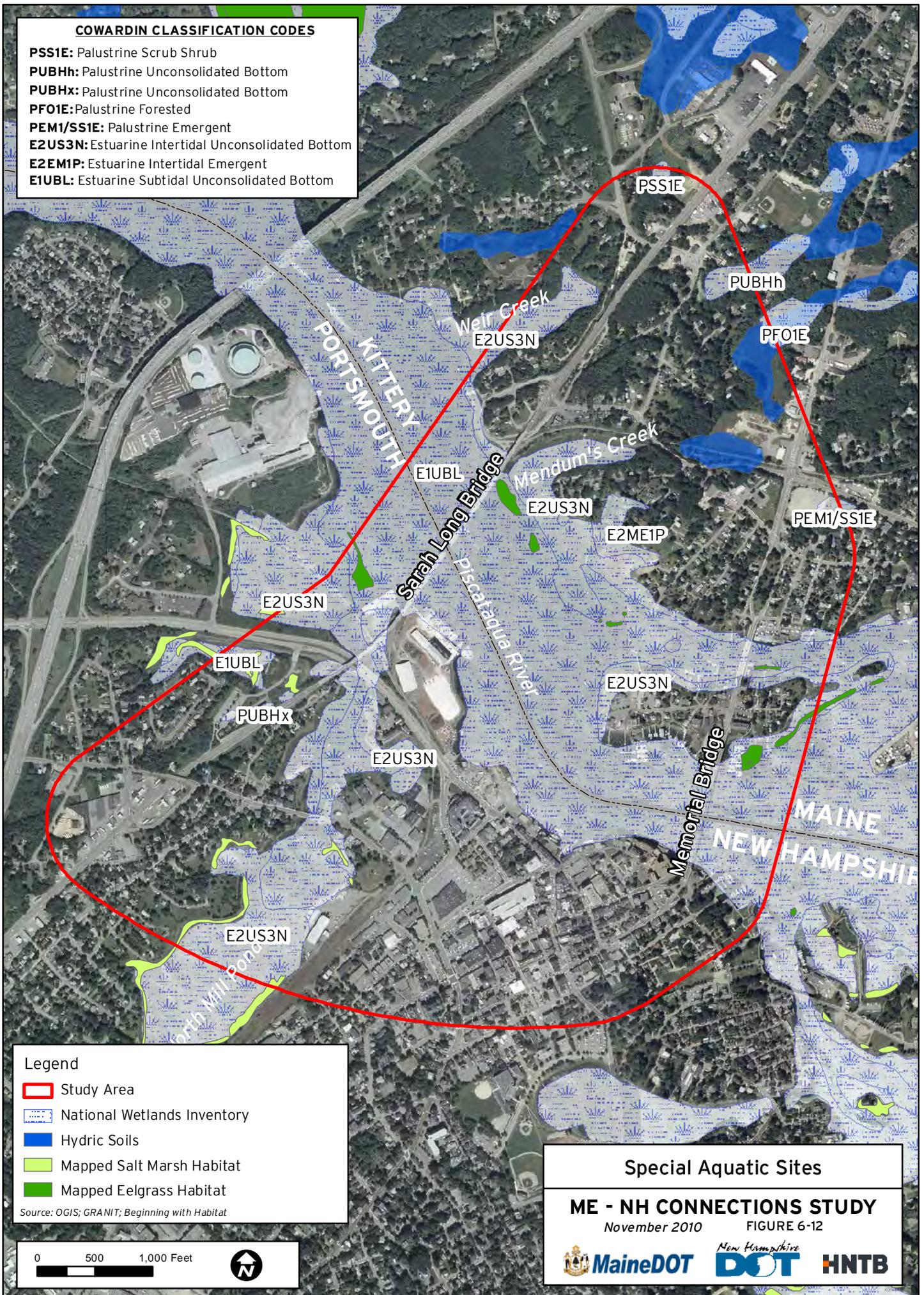
Special aquatic sites were mapped using GIS data layers available from New Hampshire Geographically Referenced Analysis and Information Transfer System (NH GRANIT) and the Maine Office of Geographic Information Systems (MEGIS) as well as information from the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) web soil survey. United States Geological Survey (USGS) Quad maps were reviewed, and a windshield survey was conducted. The municipal offices in both Kittery and Portsmouth were also consulted regarding wetland resources. As shown on Figure 6-12, Special Aquatic Sites, the Memorial Bridge and Sarah Mildred Long Bridge cross the Piscataqua River, a near-coastal estuarine system. As shown on Figure 6-14, salt marches are mapped at several locations within the Study Area, with one near the Sarah Mildred Long Bridge approach in Portsmouth.

An area of mapped eelgrass habitat is located east (downstream) of the Memorial Bridge on the Maine shore of the Piscataqua River. Two other mapped eelgrass areas are located in the vicinity of the Sarah Mildred Long Bridge: one area east (downstream) of this bridge on the Maine shore and one area west (upstream) of this bridge on the New Hampshire shore. Other special aquatic sites, such as National Wetland Inventory (NWI) wetlands and mapped saltmarsh habitat exist within the Study Area. Hydric soils are present in the Study Area, but not in close proximity to any of the remaining alternatives.

In order to determine preliminary impacts, the GIS map data were layered over aerial photos and the conceptual designs. In addition to estimating potential permanent impacts, temporary impacts to the Piscataqua River as related to the number of new bridge piers to be placed in the river or existing bridge piers to be removed from the river were also identified for each

COWARDIN CLASSIFICATION CODES

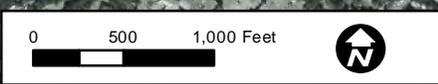
- PSS1E:** Palustrine Scrub Shrub
- PUBHh:** Palustrine Unconsolidated Bottom
- PUBHx:** Palustrine Unconsolidated Bottom
- PFO1E:** Palustrine Forested
- PEM1/SS1E:** Palustrine Emergent
- E2US3N:** Estuarine Intertidal Unconsolidated Bottom
- E2EM1P:** Estuarine Intertidal Emergent
- E1UBL:** Estuarine Subtidal Unconsolidated Bottom



Legend

- Study Area
- National Wetlands Inventory
- Hydric Soils
- Mapped Salt Marsh Habitat
- Mapped Eelgrass Habitat

Source: OGIS; GRANIT; Beginning with Habitat



Special Aquatic Sites

ME - NH CONNECTIONS STUDY

November 2010 FIGURE 6-12

alternative. The potential wetland impacts are broken down by Cowardin Classification Codes.

THREATENED AND ENDANGERED SPECIES EVALUATION

The threatened and endangered species evaluation documented known occurrences of threatened and endangered species and significant wildlife habitat based on GIS data layers available from NH GRANIT and MEGIS, maps and publications from the Maine Department of Conservation, New Hampshire Fish and Wildlife, New Hampshire Natural Heritage Bureau, Maine Department of Inland Fisheries and Wildlife, and Maine Wildlife and Natural Areas Program. U.S. Fish and Wildlife Service (USFWS) Maine and New Hampshire field offices were contacted and both noted that there are no federally listed species in the Study Area, but the Maine division noted that the New England Cottontail, a candidate species, does occur within the Study Area. The New Hampshire field office listed the following potential species: eastern cougar, gray wolf and puritan tiger beetle have been listed as extirpated in New Hampshire. Gray wolf is not known to be present in New Hampshire, however populations from Canada may occur and there is no federally designated critical habitat in the State of New Hampshire.

The National Marine Fisheries Service (NMFS) guide to Essential Fish Habitat (EFH) designation identified EFH in and surrounding the Study Area for the following species: Atlantic salmon, Atlantic cod, haddock, Pollock, whiting, red hake, white hake, winter flounder, yellowtail flounder, windowpane flounder, American plaice, Atlantic halibut, Atlantic sea scallop, Atlantic sea herring, bluefish, Atlantic mackerel and bluefin tuna. However, further communication and coordination with the NMFS Protected Resources Division indicated that there are no species listed or designated critical habitat under the jurisdiction of NMFS that are known to occur in the Study Area. In addition, the Protected Resources Division commented that there is no designated critical habitat or essential fish habitat for Atlantic salmon in the Piscataqua River. The New Hampshire state list of threatened and endangered species provided by New Hampshire Fish and Game lists several threatened and endangered species that may be present in the Study Area: Blanding's turtle and shortnose sturgeon are listed as endangered. Communications with NMFS indicate there have been no recorded incidents of shortnose sturgeon spawning or migrating into or within the Piscataqua River, nor has foraging, overwintering or resting habitat been documented in the Piscataqua River. Per the Wednesday, October 6, 2010 Federal Register, Volume 75, No. 193, NMFS has proposed that Atlantic Sturgeon be listed as a threatened species in the Gulf of Maine, including the Piscataqua River. Bald eagle and peregrine falcon are listed as threatened in New Hampshire. Other species that are listed as threatened and have the potential to be found in the Study Area are bridle shiner and spotted turtle.

SURFACE WATERS AND GROUNDWATER EVALUATION

This evaluation documented existing surface water, groundwater and drinking water resources within the Study Area. Resource data was collected from MEGIS and NH GRANIT. No aquifers or public drinking water wells are located in the Study Area. As shown on Figure 6-13,

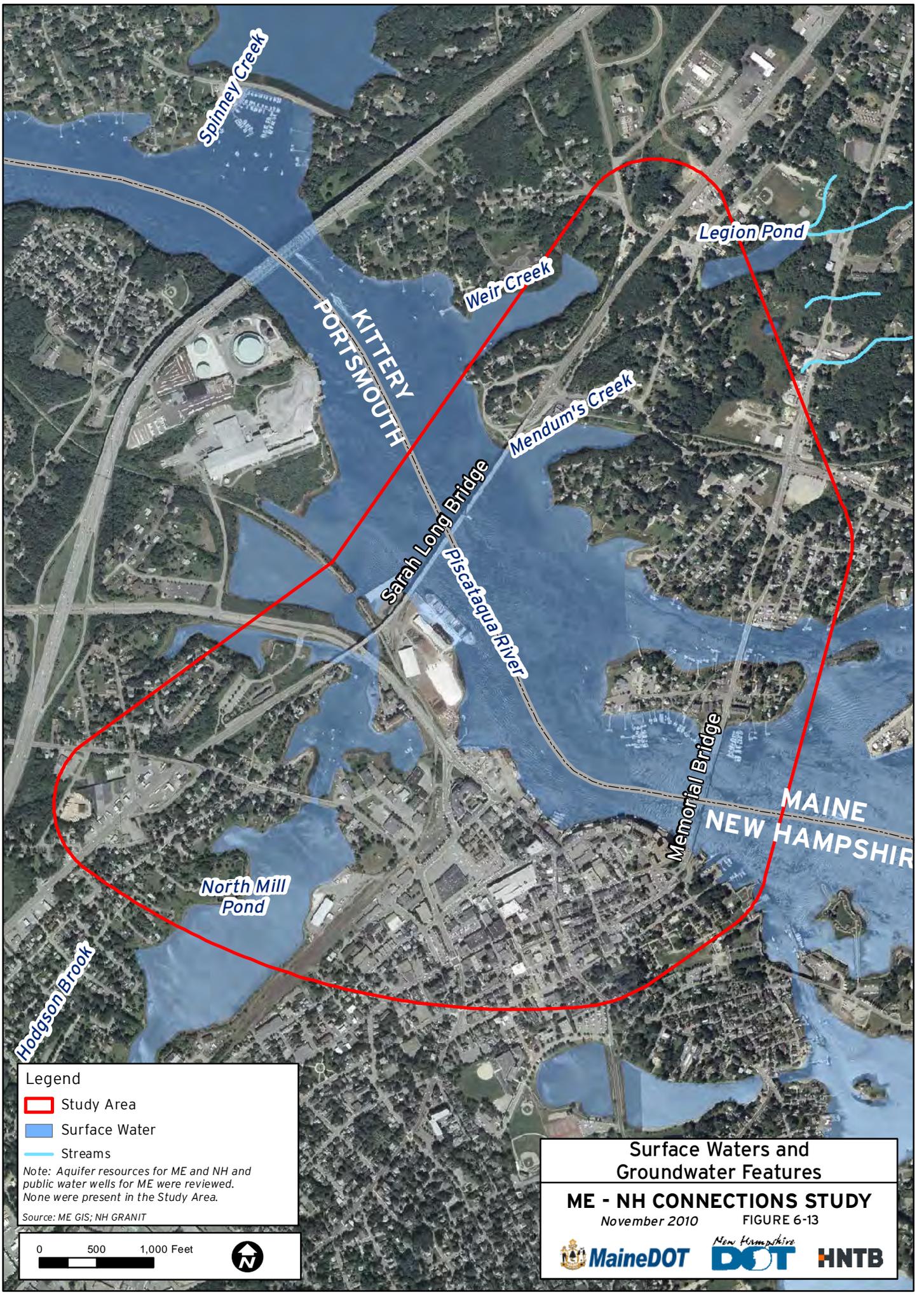
surface waters in the vicinity of the Memorial Bridge and the Sarah Mildred Long Bridge include the Piscataqua River; Mendum's Creek, Legion Pond, and Weir Creek in Kittery; and, North Mill Pond in Portsmouth. The Piscataqua River, which defines the boundary between Portsmouth and Kittery, is an estuarine river in the Study Area. The Study Area is approximately three miles upstream from the ocean outlet at Portsmouth Harbor. North Mill Pond is located within the Study Area on the north side of Portsmouth and is considered a Great Pond and is given additional protection in the State of New Hampshire as a public waterbody and is subject to the provisions of the Comprehensive Shoreland Protection Act (NH RSA 483-B). It is a 58.9 acre salt water pond that is fed by the tidal waters of the Piscataqua River and by the freshwater flow of Hodgson Brook. In Kittery there are several small ponds in the north of the Study Area. Legion Pond, located on the northeast edge of the Study Area, is a 4.5 acre pond that is surrounded by residential development. There are two smaller ponds to the east of Legion Pond as well as tributaries that connect the ponds. Two tributaries drain into Legion Pond and one drains Legion Pond to the Piscataqua River. At the Piscataqua River in Kittery there are two inlets, Mendum's Creek and Weir Creek.

NATURAL AREAS, TERRESTRIAL, AND AQUATIC HABITAT EVALUATION

This evaluation described existing natural areas, terrestrial habitats and aquatic habitats within the Study Area. Sources of information, including the New Hampshire Wildlife Action Plan (2006) and the Beginning with Habitat program in Maine were used to identify the natural communities within the Study Area. Data layers from NH GRANIT and MEGIS were also reviewed. The Beginning with Habitat program, a part of the Maine Department of Inland Fisheries and Wildlife, compiles habitat information from multiple sources to create one source of information about habitat of statewide and national importance. The Study Area includes mostly developed lands. Several tidal waterfowl and wading bird habitats exist within the Study Area including an area along the Portsmouth shore adjacent to the Sarah Mildred Long Bridge and an area along the Kittery shore of the Piscataqua River at both the Memorial and Sarah Mildred Long Bridge locations. This latter area is also designated softshell clam habitat. An inland waterfowl and wading bird habitat is located to the north of the Study Area in Kittery.

The Piscataqua River is listed as an anadromous and catadromous fish run. The area surrounding the Piscataqua River is mapped as riparian habitat, and has a 250-foot wide shoreland protection zone surrounding it. The Piscataqua River is mapped as a high value habitat for priority trust species according to the USFWS. Priority trust species are species that regularly occur in the Gulf of Maine and meet one of the following criteria: are federally endangered, threatened or candidate species, are migratory birds, sea-run fish or marine fish that show significant and persistent declining population, have been identified by multiple states in the Gulf of Maine watershed as threatened or endangered, or are identified as a species of concern by U.S. Shorebirds Conservation Plan, Colonial Waterbird Plan or Partners in Flight.

Vernal pool data from MEGIS and NH GRANIT indicate no vernal pools in the Study Area.



Legend

- Study Area
- Surface Water
- Streams

Note: Aquifer resources for ME and NH and public water wells for ME were reviewed. None were present in the Study Area.

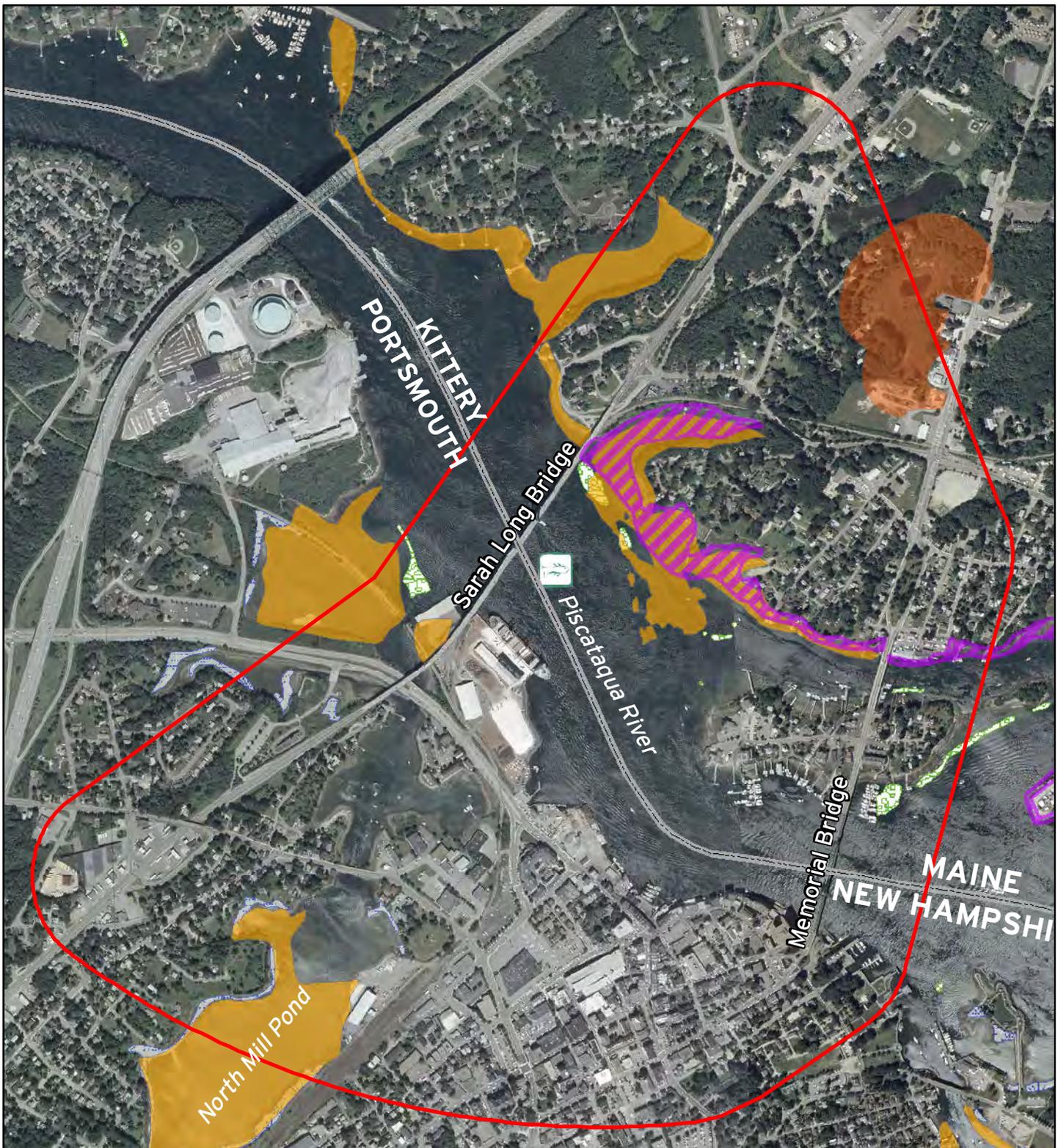
Source: ME GIS; NH GRANIT



Surface Waters and Groundwater Features

ME - NH CONNECTIONS STUDY

November 2010 FIGURE 6-13



Legend

- ▭ Study Area
- ▭ Softshell Clams
- ▭ Inland Waterfowl and Wading Bird Habitat
- ▭ Mapped Eelgrass Habitat
- ▭ NH Mapped Salt Marsh
- ▭ Tidal Waterfowl and Wading Bird Habitat
- ▭ Anadromous/Catadromous Fish Run

Source: ME GIS; NH GRANIT; Beginning with Habitat



Natural Communities

ME - NH CONNECTIONS STUDY

November 2010 FIGURE 6-14

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA) – SPECIAL FLOOD HAZARD AREA EVALUATION

This analysis evaluated documented floodplain and flood hazard areas from the FEMA map service center and FEMA Geographic Information System data layers available from NH GRANIT and MEGIS. FEMA definitions for flood zones found within the Study Area are as follows:

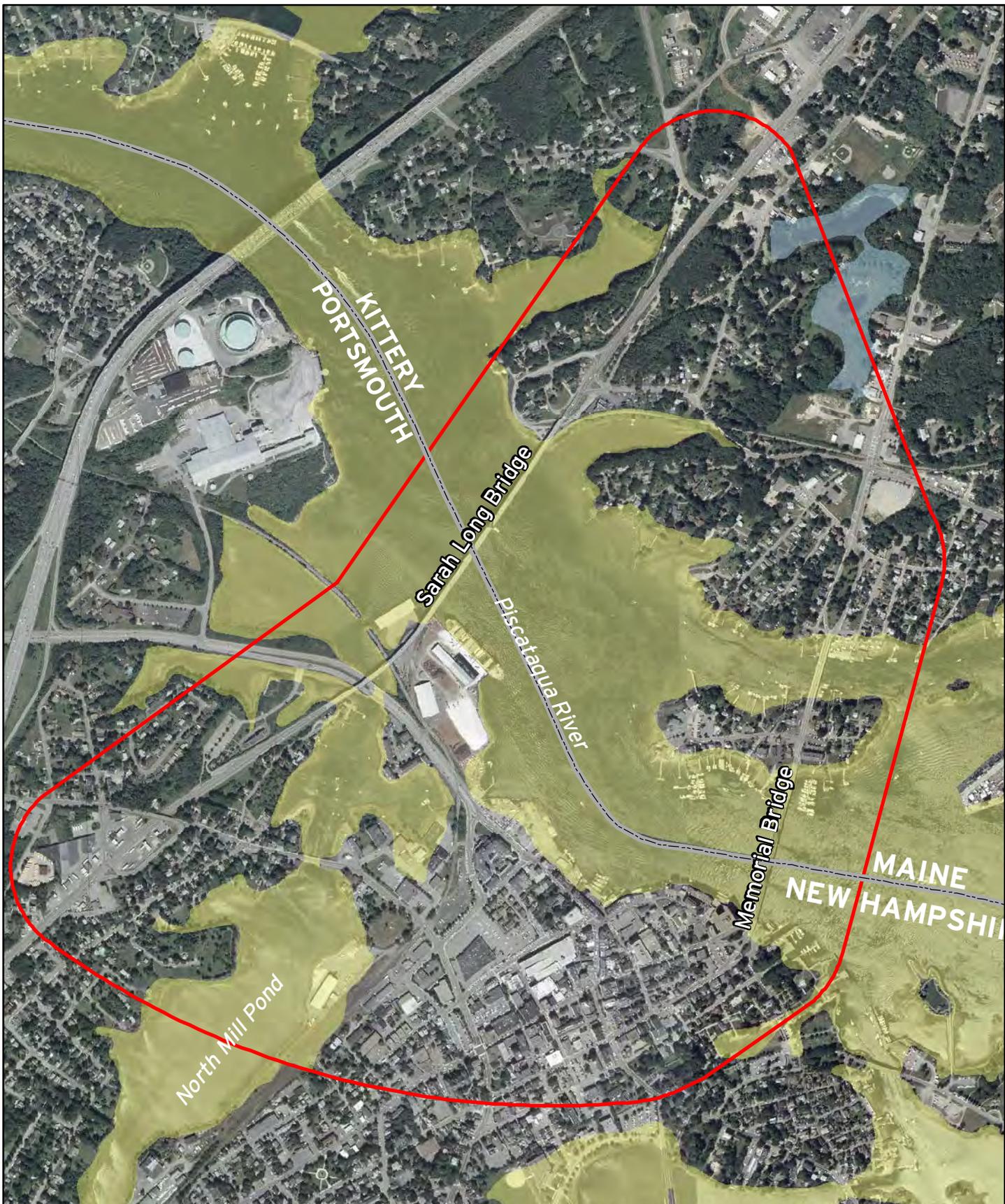
- Zone A – Special Flood Hazard Area inundated by the 100 year flood, determined by approximate method. No base flood elevation or flood hazard factors determined.
- Zone A2 – This is a numbered A Zone. Special Flood Hazard Area inundated by the 100 year flood, determined by detailed method. Base flood elevations shown and zones subdivided by flood hazard factors.
- Zone AE – Special Flood Hazard Area inundated by the 100 year flood, determined by detailed method. Base flood elevations shown and zones subdivided by flood hazard factors. AE Zones are now used on new format Flood Insurance Rate Maps (FIRMs) instead of numbered A Zones.

As shown on Figure 6-15, the Piscataqua River special flood hazard area includes the river and extends inland on both the Portsmouth and Kittery shorelines. In Portsmouth, the special flood hazard area is Zone AE with a base flood elevation of 9 feet as referenced to the National Geodetic Vertical Datum (NGVD) of 1929. The Zone AE area generally follows the shoreline except for two areas. The area extends past the shoreline of the Piscataqua River on the west side of the Study Area where the floodplain extends to include all of North Mill Pond and its shoreline. On the south side of the Study Area the Zone AE area extends away from the shoreline towards Washington Street near the Strawberry Banke Historic District.

In the Study Area in Kittery, there are two special flood hazard areas; a Zone A2 area surrounding the Piscataqua River and a Zone A area further north. The Zone A2 area has a base flood elevation of 9 feet as referenced to NGVD 1929 and generally follows the shoreline of the Piscataqua River. The Zone A2 area extends into a small inlet to the east of Route 1 that stops at Government Street. The Zone A area is in the northern part of the Study Area. The Zone A area includes Legion Pond and another small pond. It also includes several small unnamed tributaries that drain the area.

PHYSICAL GEOGRAPHY, SOILS, AND GEOLOGY EVALUATION

The evaluation documented information regarding the physical geography, soils and geology of the Study Area. Sources of information include the Web Soil Survey and Geographic Information Systems and soil layers available from the USDA and NRCS. Geological information from the New Hampshire and Maine Geological Surveys was also collected to document the bedrock, surficial geology and other geological features within the Study Area, as shown on Figure 6-16. In Portsmouth ground elevation ranges from approximately 10 feet at the



Legend

- Study Area
- Special Flood Hazard Areas
- Zones A2 and AE
- Zone A

0 500 1,000 Feet



FEMA Special Flood Hazard Areas

ME - NH CONNECTIONS STUDY

November 2010

FIGURE 6-15



shoreline of the Piscataqua River and along the shores of North Mill Pond to 50 feet in the southwest corner of the Study Area. In Kittery, ground elevation ranges from 10 feet at the shoreline of the Piscataqua River to a high point of 60 feet just east of Interstate 95. Although there is some topographical relief in the Study Area, the topography is generally flat and representative of a low coastal area.

In Portsmouth, soils are mostly described as Urban land or Urban land-Canton complex. Urban land is an area where most of the surface is covered by urban structures. The Urban land-Canton complex is a gravelly fine sandy loam. There are also small areas of Chatfield-Hollis-Canton complex. This is a fine sandy loam to gravelly fine sandy loam.

In Kittery, soils are mostly described as Urban land and Lyman fine sandy loam. Urban land is an area where most of the surface is covered by urban structures. The Study Area also has some small areas of Biddeford Mucky Peat. The majority of soils in the Study Area are well drained to somewhat excessively well drained. There are small areas of Biddeford Mucky Peat in York County that are very poorly drained. Lyman fine sandy loam is a somewhat excessively drained soil. York County also contains some inclusions within the Lyman fine sandy loam that are well drained and somewhat excessively drained Hermon soils, moderately well drained Scio and Skerry soils, and somewhat poorly drained and poorly drained Brayton soils.

In Rockingham County there are no prime farmland soils within the evaluation and analysis Study Area. In York County the Lyman fine sandy loam with 3 to 8 percent slopes is considered a farmland soil of statewide importance. This type of farmland soil is protected by the Farmland Protection Policy Act (FPPA), which seeks to minimize the extent to which Federal programs contribute to the unnecessary and irreversible conversion of farmland to non-agricultural uses, even when active agricultural activities are not currently on-going.

Additional information regarding natural resource impact evaluation and associated findings can be found in the following documents included with this Study Report.

- *Appendix #34 – Special Aquatic Sites Impact Memo*
- *Appendix #35 – Endangered Species Impact Memo*
- *Appendix #37 – Surface Water Resource Impact Tech Memo*
- *Appendix #38 – Habitat Resource Impact Tech Memo*
- *Appendix #39 - FEMA Resource Impact Tech Memo*
- *Appendix #40 - Physical Geography, Soils and Geology*

6.10. PHYSICAL RESOURCE IMPACT EVALUATION

The physical resource impact evaluation measured the impact of each Build Alternative and included:

- Impacts to neighborhoods;
- Impacts to community resources (publicly owned property);
- Impacts to commercial properties; and

- Impacts to residential properties.

This evaluation documented the potential physical resource impacts of the alternatives that remained after the fatal flaw analysis. Property data for Portsmouth was collected from the Portsmouth Assessor's Department, Portsmouth Department of Public Works, and the Portsmouth Planning Department and is up to date as of September 2009.

Property data for Kittery was collected from the Kittery Assessor's Department and the Kittery Planning Department and is up to date as of April 2009. This property data was collected in GIS and Microsoft Excel format and was overlaid with the conceptual design alternatives to determine areas of impact. An area of impact was defined as an area where the edge of slope line (also known as "limit of disturbance") falls outside of the existing road right-of-way. The GIS property lines that were used are for planning purposes only and all potential impacts are approximate.

Figures 6-17 and 6-18 identify the community facilities within the Study Area.

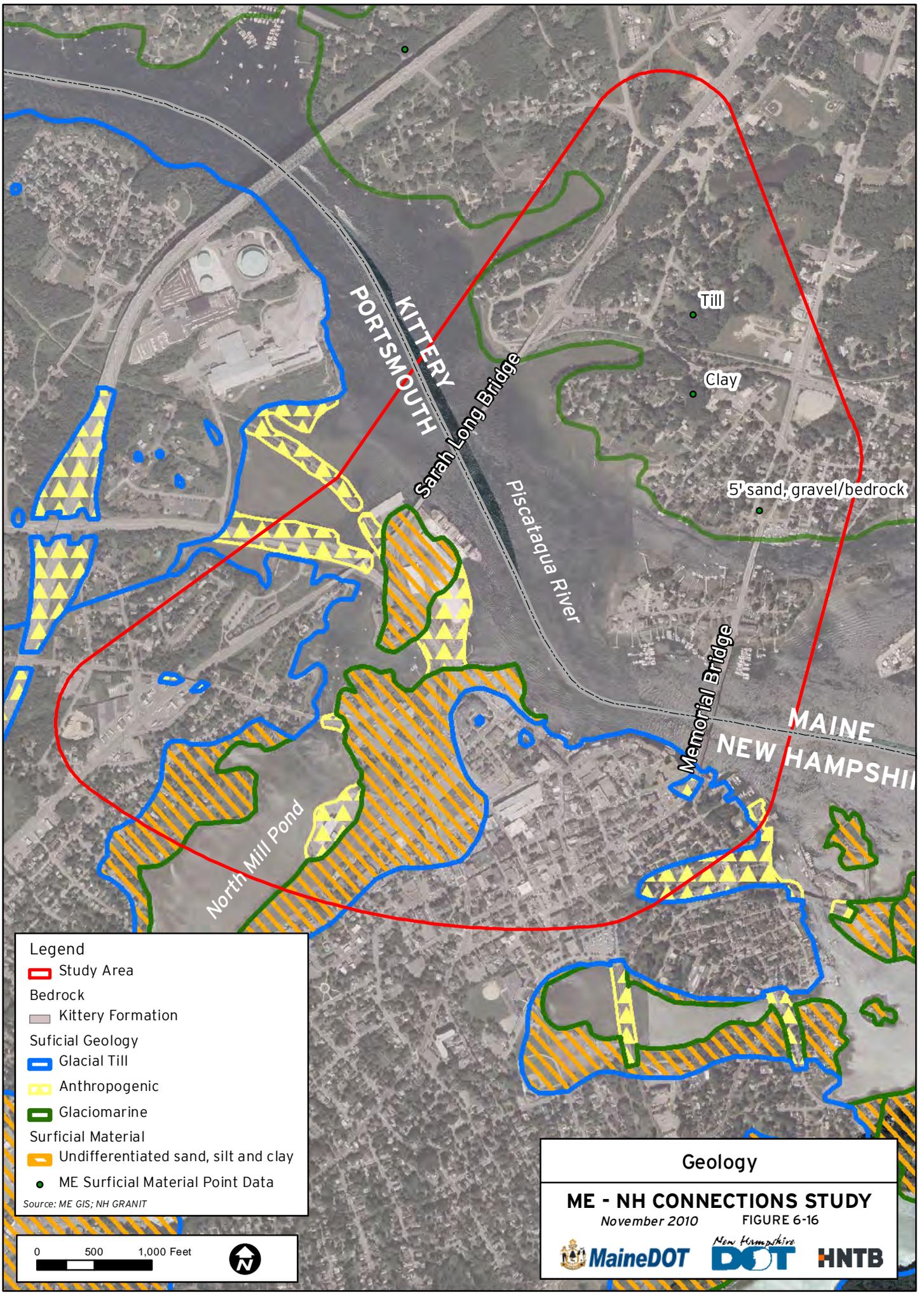
Additional information regarding Physical Resource Impact evaluation and associated findings can be found in the following document included with this Study Report:

- ***Tech Memo #36 - Property Resource Impact Tech Memo.***

6.11. LAND USE IMPACT EVALUATION

The land use impact evaluation assessed each alternative's impact to existing zoning and activity centers in both communities within the Study Area. This included evaluation of existing land use maps, zoning maps, comprehensive plans, and current and planned activity centers. This analysis also evaluated existing socio-economic conditions and provided future housing, population, and job growth forecasts for the Study Area in the Year 2035.

Background data and trends on population, households and employment were collected from the City of Portsmouth Master Plan, 2000, Town of Kittery Comprehensive Plan, 1999 as well as in consultation with the Planners from each community. In addition, U.S. Census 1990 and 2000 data was collected at the block level and aggregated to the Traffic Analysis Zones (TAZ) level in the Study Area. To estimate current 2007/2008 base conditions for population and households, each community's share of the American Community Survey (ACS) estimates at the County Level were applied. Employment estimates were obtained from the State of Maine Department of Labor for Kittery and from the New Hampshire Department of Labor for Portsmouth. The employment estimates were then allocated proportionally to each TAZ based on the community's share of employment and in consultation with the community planners and PNSY to validate and adjust findings based on local knowledge. In 2007, Kittery's population was estimated at 9,987 and projected to increase by 1,964 to 11,951 in 2035 and the population of Portsmouth in 2007, estimated at 21,497 and is projected to increase by 1,544 to 23,041 in 2035.



Legend

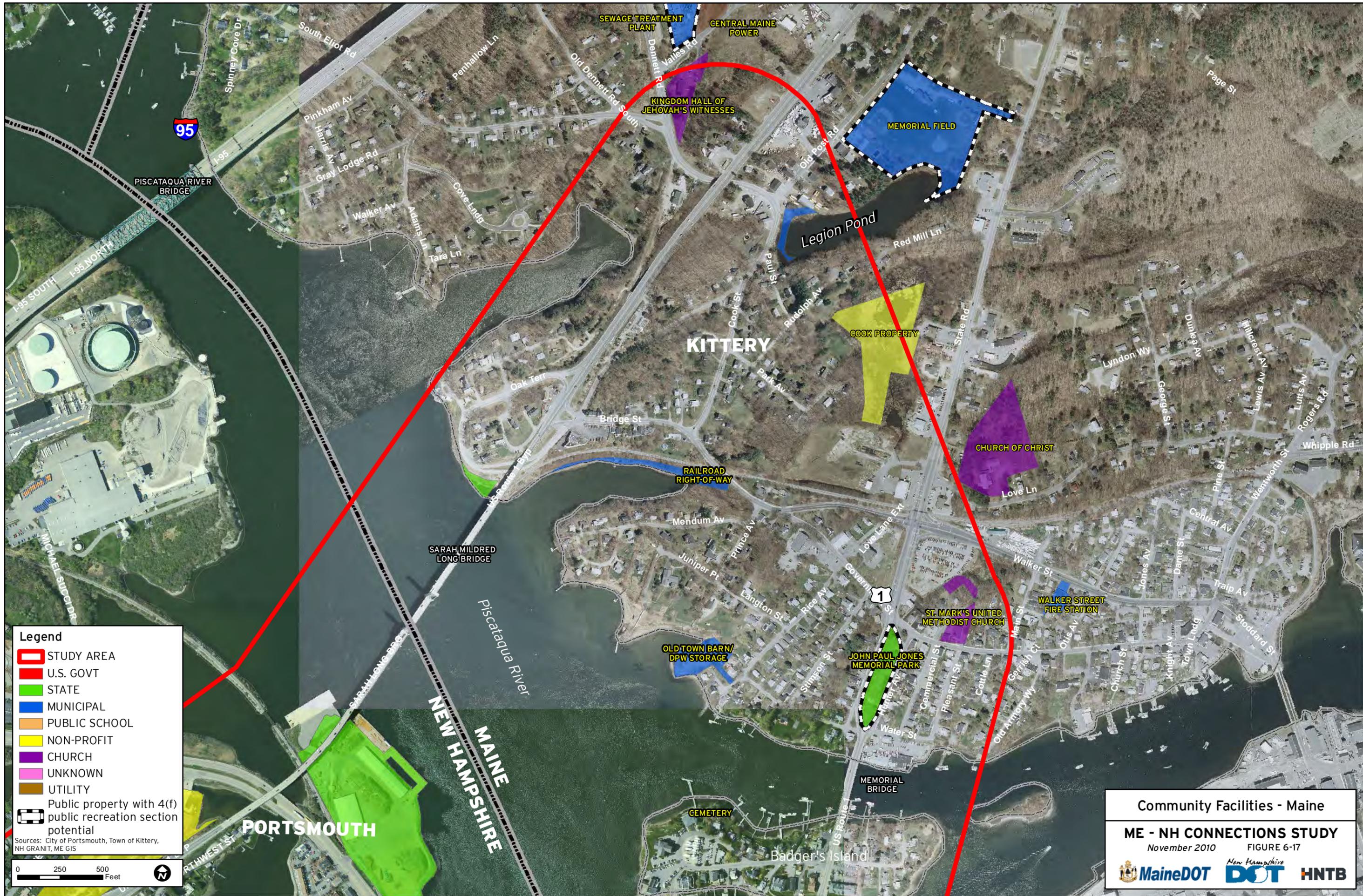
- Study Area
- Bedrock
- Kittery Formation
- Surficial Geology
- Glacial Till
- Anthropogenic
- Glaciomarine
- Surficial Material
- Undifferentiated sand, silt and clay
- ME Surficial Material Point Data

Source: ME GIS; NH GRANIT



Geology

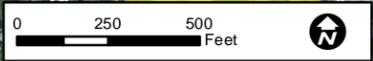
ME - NH CONNECTIONS STUDY
 November 2010 FIGURE 6-16



Legend

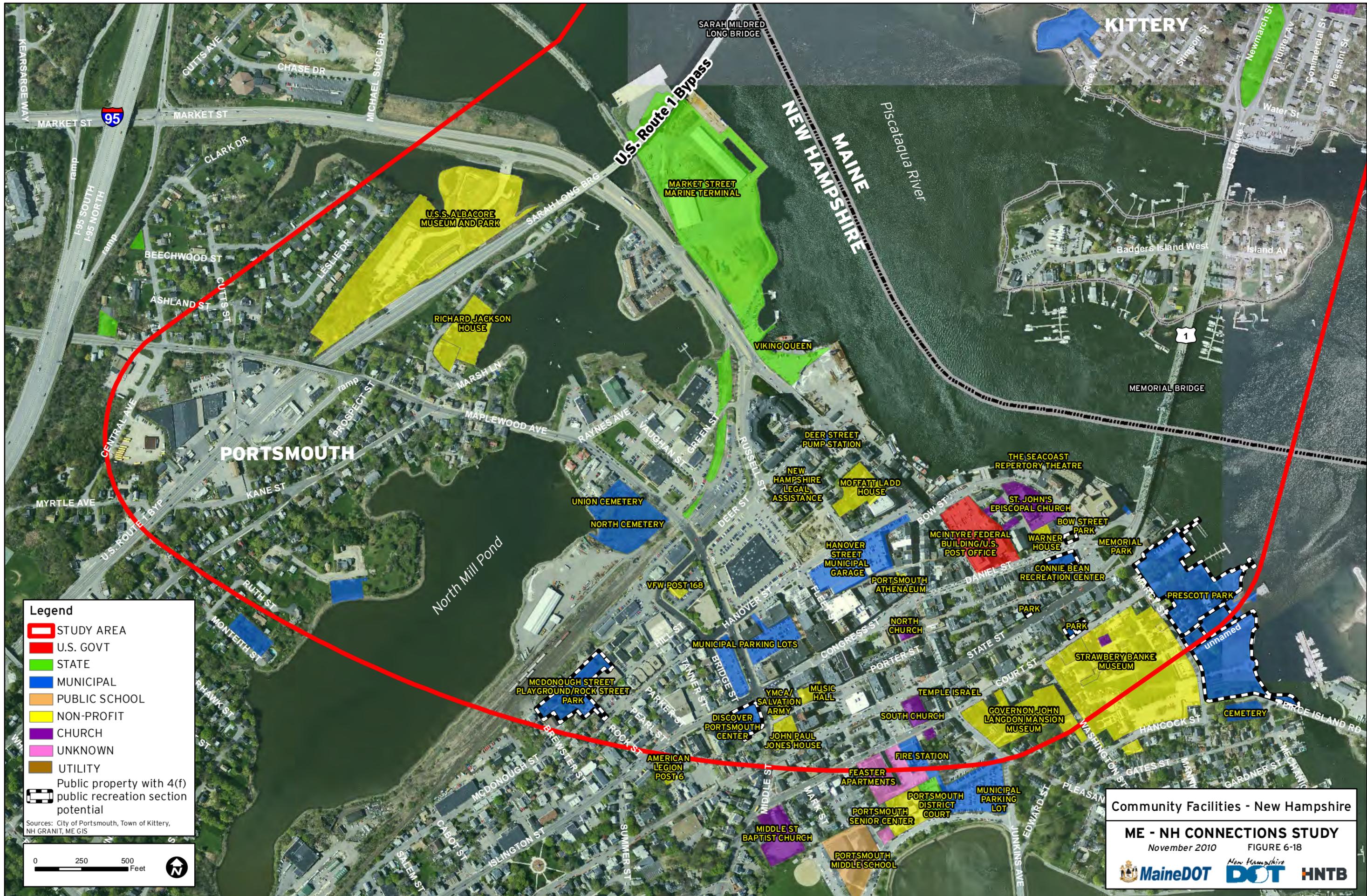
- STUDY AREA
- U.S. GOVT
- STATE
- MUNICIPAL
- PUBLIC SCHOOL
- NON-PROFIT
- CHURCH
- UNKNOWN
- UTILITY
- Public property with 4(f) public recreation section potential

Sources: City of Portsmouth, Town of Kittery, NH GRANIT, ME GIS



Community Facilities - Maine

ME - NH CONNECTIONS STUDY
November 2010 FIGURE 6-17



Legend

- STUDY AREA
- U.S. GOV'T
- STATE
- MUNICIPAL
- PUBLIC SCHOOL
- NON-PROFIT
- CHURCH
- UNKNOWN
- UTILITY
- Public property with 4(f) public recreation section potential

Sources: City of Portsmouth, Town of Kittery, NH GRANIT, ME GIS



Community Facilities - New Hampshire

ME - NH CONNECTIONS STUDY
November 2010 FIGURE 6-18

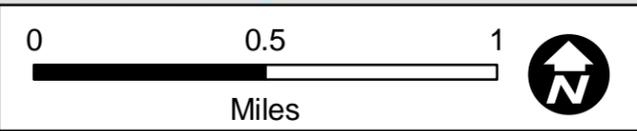
Household size for both communities is similar with Kittery averaging 2.29 persons per household for 2000-2007 and Portsmouth averaging 2.04 persons per household in 2000 and 2.13 in 2007. Most employment within the Study Area of Kittery is located on Badgers Island, around Memorial Bridge and along the U.S. Route 1 corridor. Employment within the Study Area of Portsmouth is concentrated along the waterfront between the Sarah Mildred Long and Memorial Bridges, in the historic downtown district and about ½ mile south of the Sarah Mildred Long Bridge in the area served by medical facilities.

The land use of the portion of the Study Area in Kittery is predominately residential adjacent to both the Sarah Mildred Long and Memorial Bridges. Commercial land use in Kittery is focused primarily along U.S. Route 1 and the U.S. Route 1 Bypass approximately ½ mile north of each bridge. Kittery's zoning within the Study Area has a residential focus. Commercial zones in Kittery are located adjacent to the Outlet Malls in the vicinity of the Sarah Mildred Long Bridge and there also is an allowance of low density mixed use development in the vicinity of the Memorial Bridge. The portion of the Study Area located in Portsmouth includes a high degree of dense commercial and residential land uses concentrated along the waterfront and adjacent to the Memorial Bridge. Similar to Kittery, Portsmouth's Study Area zoning is primarily residential along the U.S. Route 1 Bypass. Commercial and mixed use development in Portsmouth is provided in the central business district and in the vicinity of the Memorial Bridge. Areas designated for future commercial growth and investment in the Kittery Study Area are approximately ½ mile north of the Sarah Mildred Long and Memorial Bridges toward the Outlet Mall area. Future residential growth in Kittery is designated on both sides of the Memorial Bridge approaches in the waterfront area. In the Portsmouth Study Area, the focus of commercial growth and investment is directed in the Central Business District and an area along the U.S. Route 1 Bypass ½ mile south of the Sarah Mildred Long Bridge, supporting current land use and zoning practices. Residential areas in Portsmouth are concentrated on the east side of the Sarah Mildred Long Bridge and the east side of the Memorial Bridge and reflect Portsmouth's plans to support current land use patterns. The land use pattern in each municipality reflects a focus and higher density of mixed residential and commercial uses and activity centered around the Memorial Bridge Connection.

Figure 6-19 (Activity Centers – ME), Figure 6-20 (Activity Centers – NH), and Figure 6-21 (Lane Use/Zoning) provide a graphical overview of existing land use features for the Study Area.

Additional information regarding Land Use Impact evaluation and associated findings can be found in the following documents included with this Study Report:

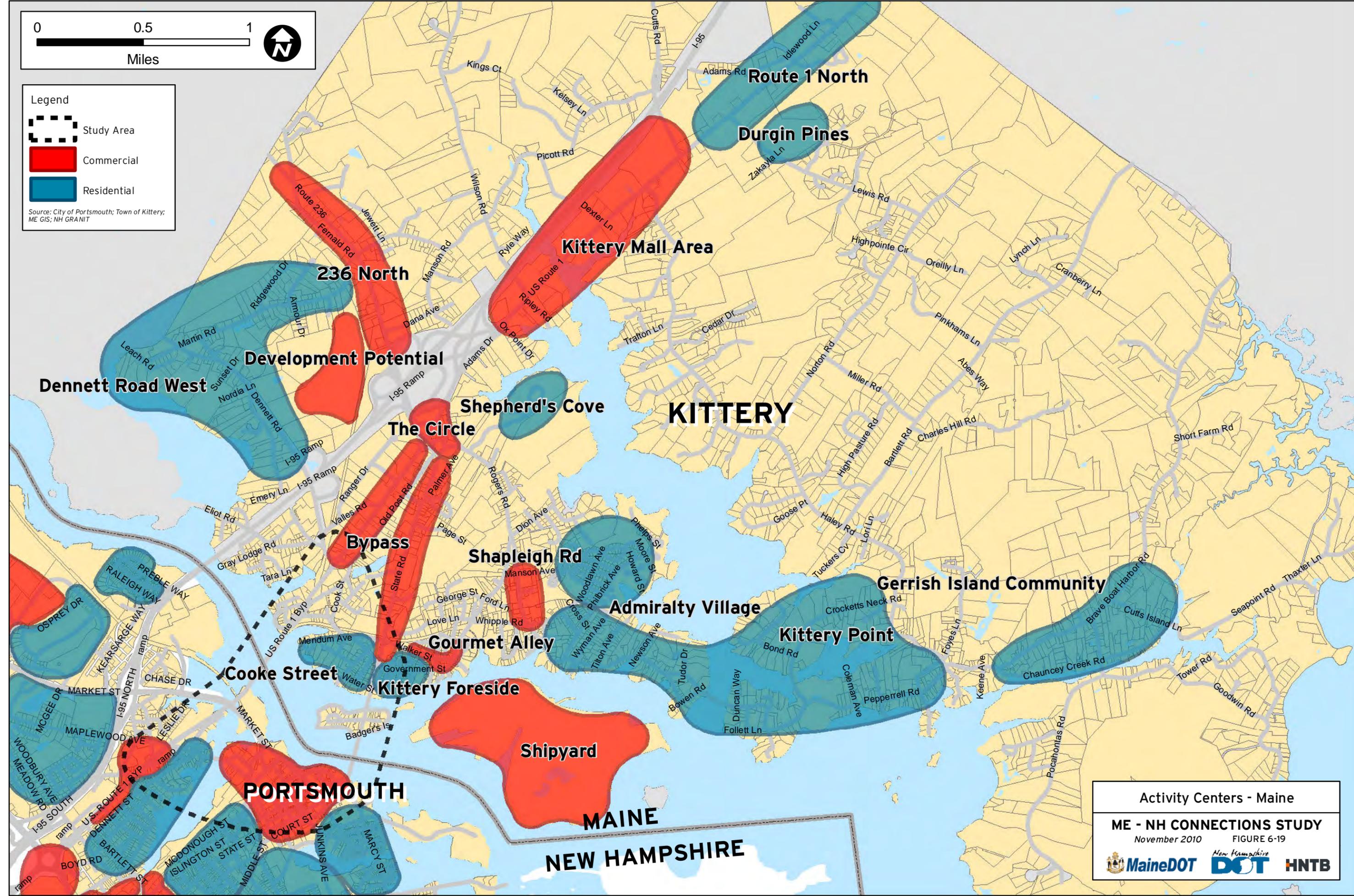
- *Appendix #8 – Socio Economic Conditions and Future Projections.*
- *Appendix #9 - Land Use Base Conditions.*



Legend

- Study Area
- Commercial
- Residential

Source: City of Portsmouth; Town of Kittery, ME GIS; NH GRANIT



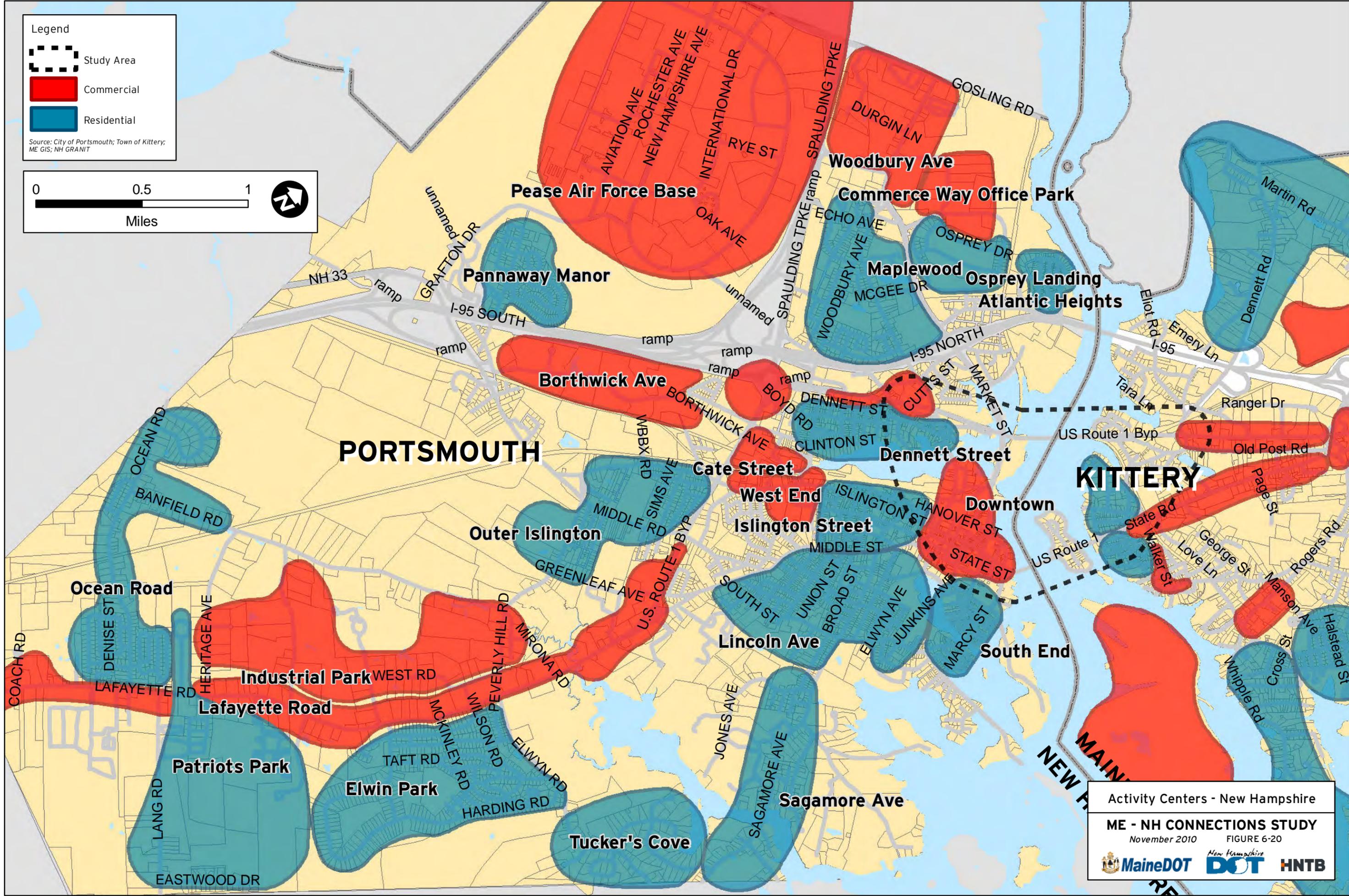
Activity Centers - Maine
ME - NH CONNECTIONS STUDY
 November 2010 FIGURE 6-19

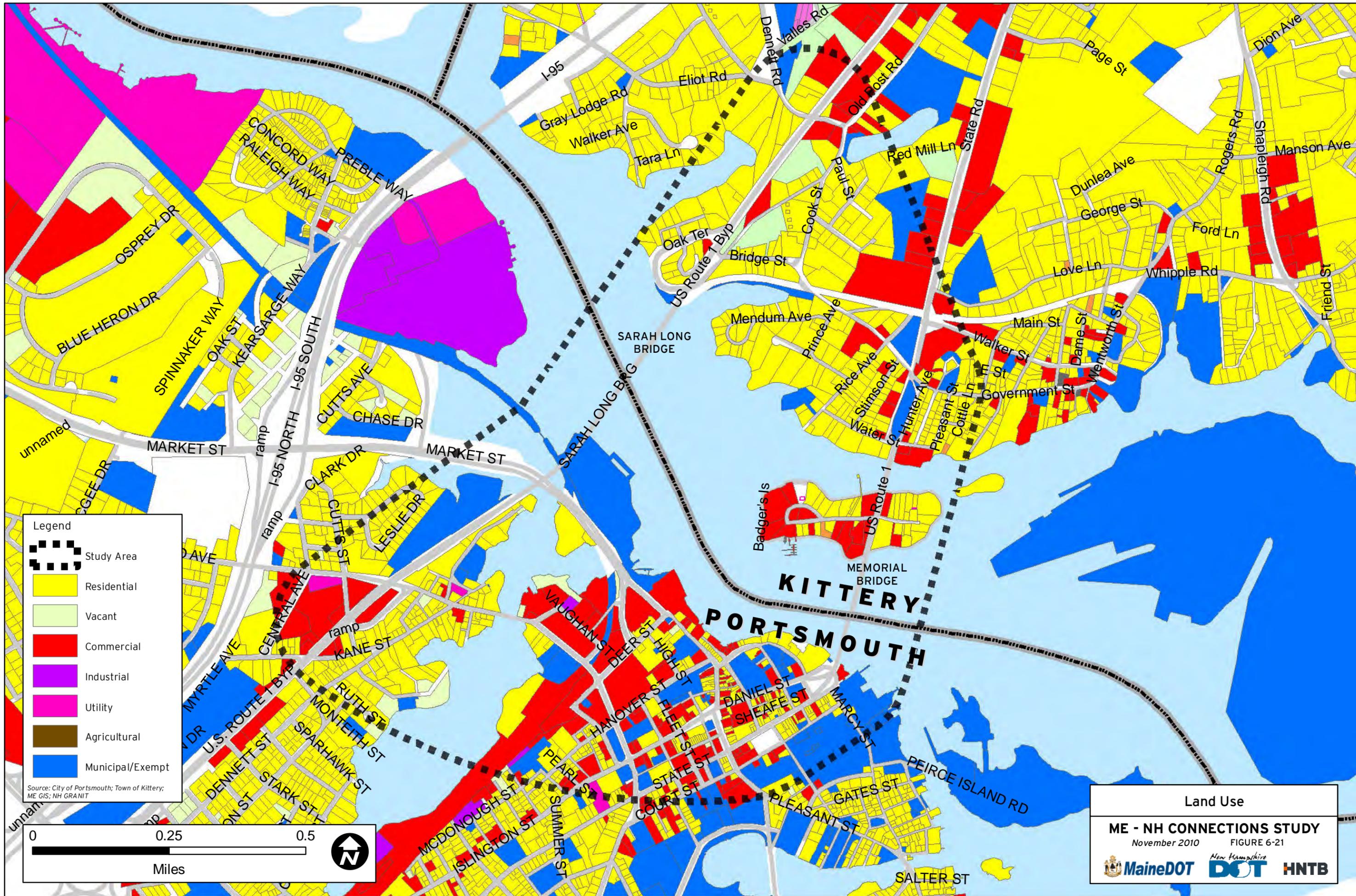
Legend

-  Study Area
-  Commercial
-  Residential

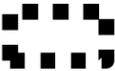
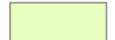
Source: City of Portsmouth; Town of Kittery;
ME GIS; NH GRANIT

0 0.5 1
Miles

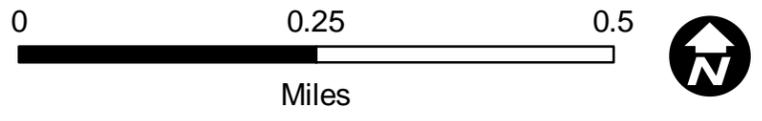





Legend

-  Study Area
-  Residential
-  Vacant
-  Commercial
-  Industrial
-  Utility
-  Agricultural
-  Municipal/Exempt

Source: City of Portsmouth; Town of Kittery; ME GIS; NH GRANIT



Land Use

ME - NH CONNECTIONS STUDY
November 2010 FIGURE 6-21





6.12. HISTORIC IMPACT EVALUATION

The preliminary Historic Impact evaluation assessed the level of effect to all historic properties listed or eligible for listing on the National Register of Historic Places in the area of potential effect, in accordance with Section 106 of the National Historic Preservation Act. The historic impact evaluation also identified each alternative's ability to satisfy the provisions of Section 4(f) of the Department of Transportation Act of 1966.

The evaluation summarized information developed in New Hampshire, augmented with new research on the Maine side of the Piscataqua River. File searches were conducted at the two State Historic Preservation Offices, which are the New Hampshire Division of Historical Resources (NH DHR) and the Maine Historic Preservation Commission (MHPC), to identify all previous survey in the Connections Study Area. National Register listed and eligible properties and historic districts were identified on base maps and in the Report data base. All previously documented areas and individual properties in the Study Area in Portsmouth and Kittery determined to be National Register eligible are shown on base maps and listed below.

1. U.S.S. Albacore {National Historic Landmark (NHL)}, Portsmouth
2. Richard Jackson House (NHL), Portsmouth
3. Moffatt-Ladd House (NHL), Portsmouth
4. MacPheadris-Warner House (NHL), Portsmouth
5. John Paul Jones House (NHL), Portsmouth
6. Governor John Langdon House (NHL), Portsmouth
7. George Rogers House {Listed on the National Register (NR Listed), Portsmouth
8. North Cemetery (NR Listed), Portsmouth
9. The Hill (NR Listed), Portsmouth
10. St. John's Church (NR Listed), Portsmouth
11. Portsmouth Athenaeum (NR Listed), Portsmouth
12. New Hampshire Bank (NR Listed), Portsmouth
13. Old Portsmouth Public Library (NR Listed), Portsmouth
14. Rockingham Hotel (NR Listed), Portsmouth
15. South Church (NR Listed), Portsmouth
16. John Paul Jones Memorial Park (NR Listed), Kittery
17. Strawberry Banke Historic District (NR Listed), Portsmouth

18. Cole's Gulf Station {Eligible for Listing on the National Register (NR Eligible), Portsmouth
19. Cutts Mansion (NR Eligible), Portsmouth
20. Memorial Bridge (NR Eligible), Portsmouth and Kittery
21. Sarah Mildred Long Bridge (NR Eligible), Portsmouth and Kittery
22. U.S. Route 1 Bypass Historic District (NR Eligible), Portsmouth
23. Christian Shore Historic District (NR Eligible), Portsmouth
24. Creek Neighborhood Historic District (NR Eligible), Portsmouth
25. Eastern Railroad Historic District (NR Eligible), Portsmouth
26. Memorial Bridge Historic District (NR Eligible), Portsmouth
27. U.S. Route 1 Bypass – Maine (NR Eligible), Kittery
28. Portsmouth Naval Shipyard Rail Spur (NR Eligible), Kittery
29. Warren's Lobster House Sign (NR Eligible), Kittery
30. #6 Water Street, Kittery (NR Eligible), Kittery
31. #14 Stimson Street, Kittery (NR Eligible), Kittery

Figures 6-22 and 6-23 show the location of existing historic resources for Kittery, Maine and Portsmouth, New Hampshire respectively for the Study Area.

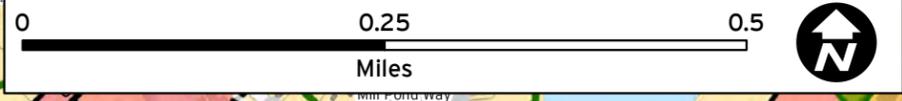
Additional information regarding historic resources can be found in the following document included with this Study Report:

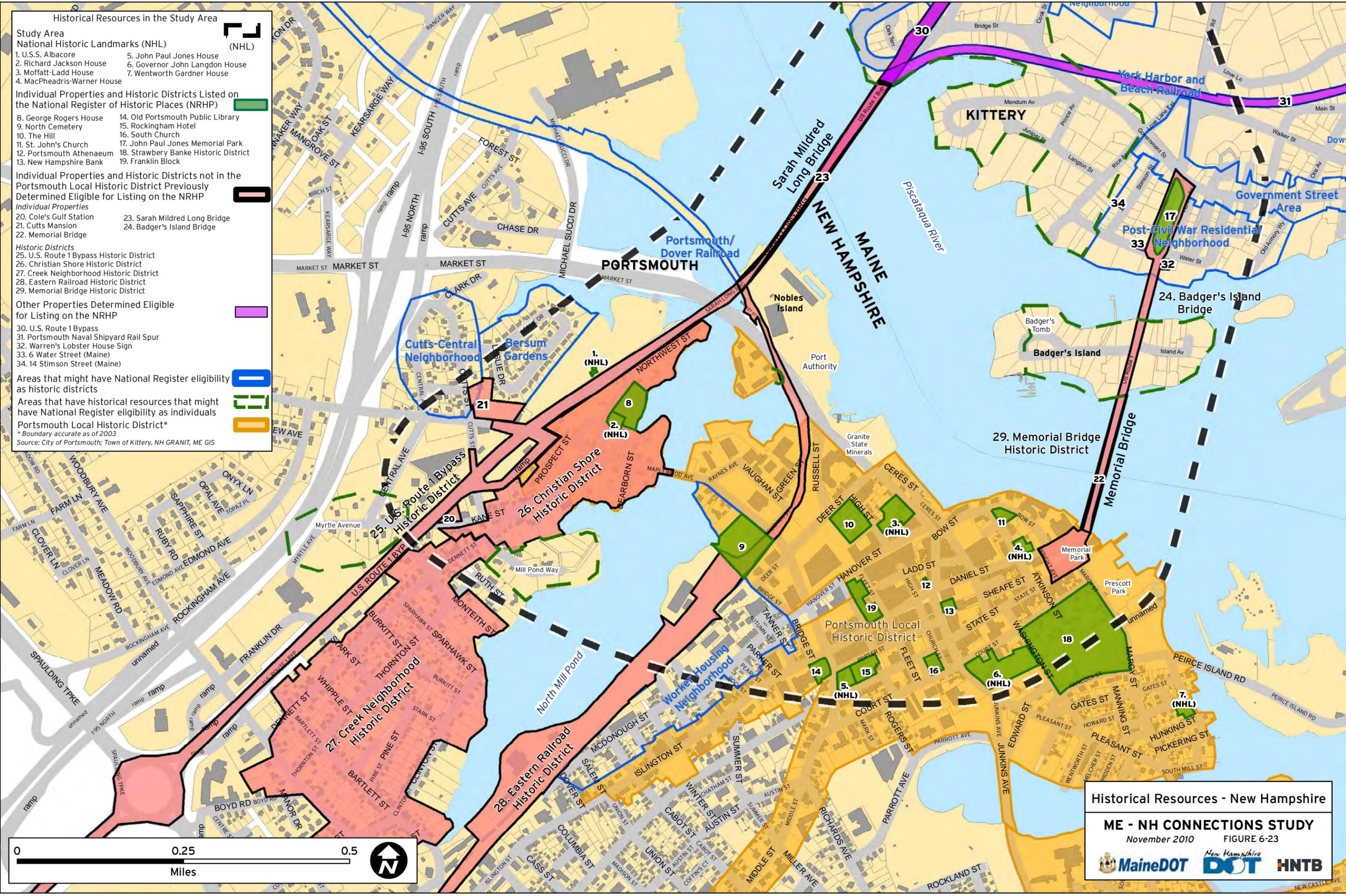
- ***Appendix #54 – Summary Report on Historic Resources.***

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Historical Resources in the Study Area

- Study Area**
- National Historic Landmarks (NHL)** (NHL)
- | | |
|-----------------------------|--------------------------------|
| 1. U.S.S. Albacore | 5. John Paul Jones House |
| 2. Richard Jackson House | 6. Governor John Langdon House |
| 3. Moffatt-Ladd House | 7. Wentworth Gardner House |
| 4. MacPheadris-Warner House | |
- Individual Properties and Historic Districts Listed on the National Register of Historic Places (NRHP)**
- | | |
|--------------------------|--|
| 8. George Rogers House | 14. Old Portsmouth Public Library |
| 9. North Cemetery | 15. Rockingham Hotel |
| 10. The Hill | 16. South Church |
| 11. St. John's Church | 17. John Paul Jones Memorial Park |
| 12. Portsmouth Athenaeum | 18. Strawberry Banke Historic District |
| 13. New Hampshire Bank | 19. Franklin Block |
- Individual Properties and Historic Districts not in the Portsmouth Local Historic District Previously Determined Eligible for Listing on the NRHP**
- Individual Properties*
- | | |
|-------------------------|-------------------------------|
| 20. Cole's Gulf Station | 23. Sarah Mildred Long Bridge |
| 21. Cutts Mansion | 24. Badger's Island Bridge |
| 22. Memorial Bridge | |
- Historic Districts*
- | |
|---|
| 25. U.S. Route 1 Bypass Historic District |
| 26. Christian Shore Historic District |
| 27. Creek Neighborhood Historic District |
| 28. Eastern Railroad Historic District |
| 29. Memorial Bridge Historic District |
- Other Properties Determined Eligible for Listing on the NRHP**
- | |
|---|
| 30. U.S. Route 1 Bypass |
| 31. Portsmouth Naval Shipyard Rail Spur |
| 32. Warren's Lobster House Sign |
| 33. 6 Water Street (Maine) |
| 34. 14 Stimson Street (Maine) |
- Areas that might have National Register eligibility as historic districts**
- Areas that have historical resources that might have National Register eligibility as individuals**
- Portsmouth Local Historic District***
- * Boundary accurate as of 2003
- Source: City of Portsmouth; Town of Kittery, NH GRANIT, ME GIS





- Historical Resources in the Study Area**
- Study Area**
- National Historic Landmarks (NHL)** (NHL)
1. U.S.S. Albacore
 2. Richard Jackson House
 3. Moffatt-Ladd House
 4. MacPheadris-Warner House
 5. John Paul Jones House
 6. Governor John Langdon House
 7. Wentworth Gardner House
- Individual Properties and Historic Districts Listed on the National Register of Historic Places (NRHP)**
8. George Rogers House
 9. North Cemetery
 10. The Hill
 11. St. John's Church
 12. Portsmouth Athenaeum
 13. New Hampshire Bank
 14. Old Portsmouth Public Library
 15. Rockingham Hotel
 16. South Church
 17. John Paul Jones Memorial Park
 18. Strawbery Banke Historic District
 19. Franklin Block
- Individual Properties and Historic Districts not in the Portsmouth Local Historic District Previously Determined Eligible for Listing on the NRHP**
- Individual Properties**
20. Cole's Gulf Station
 21. Cutts Mansion
 22. Memorial Bridge
 23. Sarah Mildred Long Bridge
 24. Badger's Island Bridge
- Historic Districts**
25. U.S. Route 1 Bypass Historic District
 26. Christian Shore Historic District
 27. Creek Neighborhood Historic District
 28. Eastern Railroad Historic District
 29. Memorial Bridge Historic District
- Other Properties Determined Eligible for Listing on the NRHP**
30. U.S. Route 1 Bypass
 31. Portsmouth Naval Shipyard Rail Spur
 32. Warren's Lobster House Sign
 33. 6 Water Street (Maine)
 34. 14 Stimson Street (Maine)
- Areas that might have National Register eligibility as historic districts**
- Areas that have historical resources that might have National Register eligibility as individuals**
- Portsmouth Local Historic District***
- * Boundary accurate as of 2003
- Source: City of Portsmouth; Town of Kittery, NH GRANIT, ME GIS



Historical Resources - New Hampshire

ME - NH CONNECTIONS STUDY

November 2010 FIGURE 6-23

6.13. ARCHEOLOGICAL IMPACT EVALUATION

The potential for impact to archaeological resources was evaluated by assessing areas for archaeological sensitivity. Phase O/IA studies were performed. Archeological resource impact analysis was focused along the section of U.S. Route 1 adjacent to the Memorial Bridge and sections of the U.S. Route 1 Bypass adjacent to the Sarah Mildred Long Bridge only.

This assessment included review of site files, technical reports, maps, photographs and secondary resources to determine archaeologically sensitive areas ranked "high," "moderate," and "low" within the Area of Potential Effect (APE). The work included an inspection of the APE to confirm sensitive areas identified during the background research review. The APE extended approximately 1,000 to 2,500 feet inland from the Piscataqua River and 200 feet from the highway centerlines on either side of the two bridges.

Figures 6-24 thru 6-28 provide a graphical overview of the archaeological sensitivity along the U.S. Route 1 Bypass and U.S. Route 1 within the Study Area.

Additional information regarding Archeological Impact evaluation and associated findings can be found in the following document included with this Study Report:

- *Appendix #55 – Summary Report on Archeological Sensitivity Assessment.*

6.14. PRELIMINARY LEVEL COST ANALYSIS

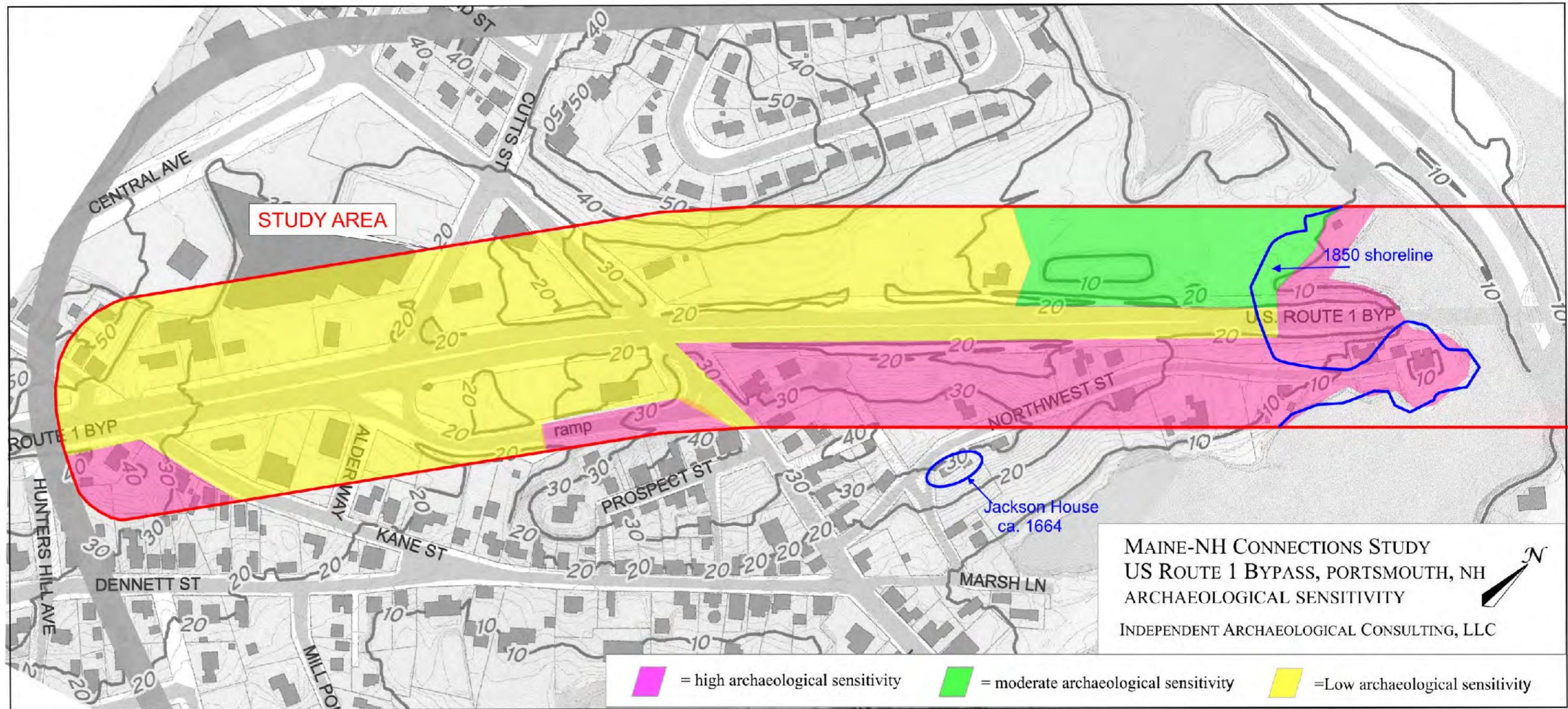
This section summarizes the preliminary level cost analysis conducted as part of this study. The planning level costs developed as part of the preliminary level cost analysis were not based on engineering plans or designs for the alternatives concepts, but rather are based on a compilation of assumptions, unit costs from other projects, percentage factors and best estimates of what the work may cost. No alternatives were dismissed based on the planning level costs developed. Actual costs may vary from these planning level costs once design engineering is completed. A range of costs was developed for each alternative.

LIFE-CYCLE COST ANALYSIS

The life-cycle cost analysis (LCCA) was an evaluation technique used to compare and evaluate the economical feasibility of the design alternatives over an assumed service life-cycle. For the purpose of this LCCA, the assumed service life-cycle was 100 years for all alternatives.

Cost categories comprising Life Cycle cost included:

- Capital Cost– Planning level cost associated with building the asset and putting it into initial service. Capital cost included all bridge, highway, rail and right-of-way costs associated with each alternative, but did not include any mitigation costs (e.g., wetlands, historic, etc.).
- Operation and Maintenance Cost – Planning level costs over a 100-year period associated with periodic capital reinvestment needs and the day to day operation and maintenance of movable bridge lift spans (excluding power and incidental costs). Operation and Maintenance cost included all costs accrued after initial service associated with

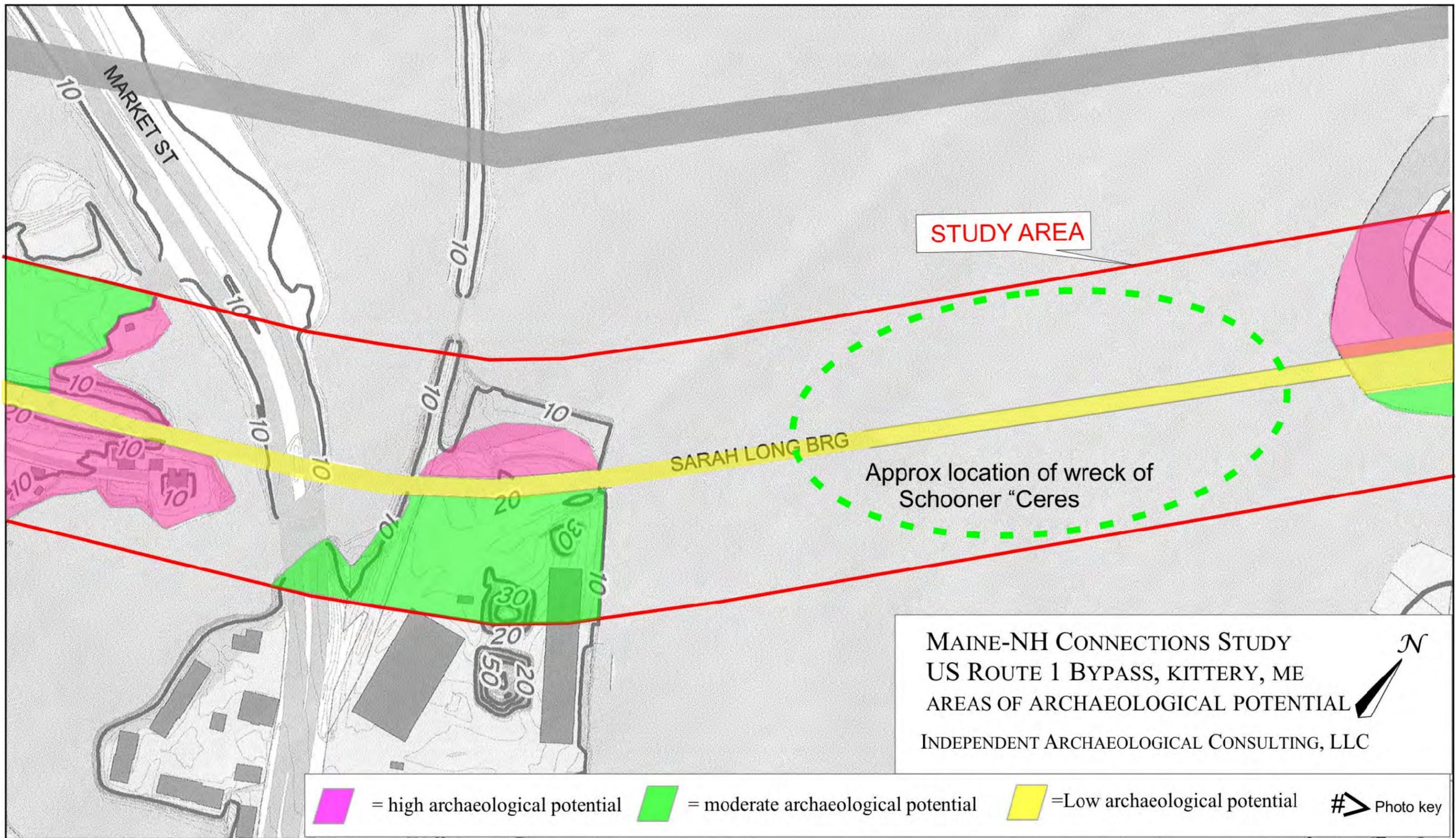


Areas of Archaeological Potential

ME - NH CONNECTIONS STUDY

November 2010 FIGURE 6-24





Areas of Archaeological Potential

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 November 2010 FIGURE 6-25





STUDY AREA

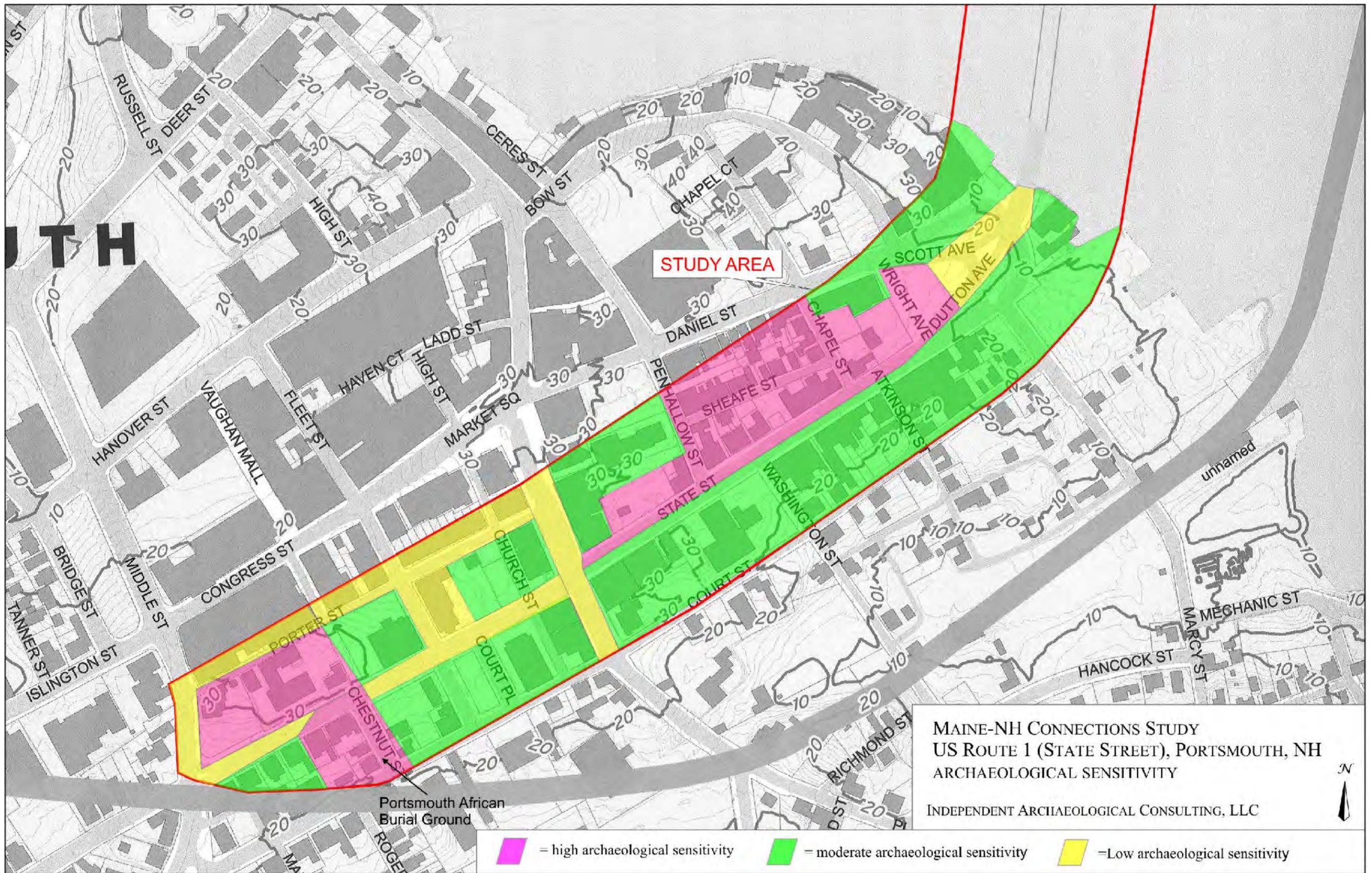
MAINE-NH CONNECTIONS STUDY
 US ROUTE 1 BYPASS, KITTERY, ME
 AREAS OF ARCHAEOLOGICAL POTENTIAL
 INDEPENDENT ARCHAEOLOGICAL CONSULTING, LLC



- = high archaeological potential
- = moderate archaeological potential
- = Low archaeological potential

Areas of Archaeological Potential

ME - NH CONNECTIONS STUDY
 November 2010 FIGURE 6-26



Areas of Archaeological Potential

ME - NH CONNECTIONS STUDY

November 2010 FIGURE 6-27





Areas of Archaeological Potential

ME - NH CONNECTIONS STUDY

November 2010 FIGURE 6-28



preventive activities intended to extend, preserve, improve, or restore the life of the asset as well as labor costs to operate the facility over the life of the asset.

Table 6-16 provides a summary of the Life Cycle costs for each alternative.

Table 6-16
Summary of Life-Cycle Costs by Alternative (Costs in Millions of Dollars)

| Alternative | Range of Capital Costs | Range of Operation and Maintenance Costs | Range of Life Cycle Costs |
|-------------|------------------------|--|---------------------------|
| No-Build | \$18-\$22 | \$126-\$154 | \$144-\$176 |
| 4 | \$166-\$204 | \$121-\$149 | \$287-\$353 |
| 5a | \$229-\$281 | \$94-\$116 | \$323-\$397 |
| 5b | \$265-\$325 | \$103-\$127 | \$368-\$452 |
| 6a | \$233-\$287 | \$94-\$116 | \$327-\$403 |
| 6b | \$265-\$325 | \$103-\$127 | \$368-\$452 |
| 7 | \$238-\$292 | \$103-\$127 | \$341-\$419 |
| 8 | \$238-\$292 | \$103-\$127 | \$341-\$419 |
| 9 | \$251-\$309 | \$94-\$116 | \$345-\$425 |
| 10 | \$224-\$276 | \$94-\$116 | \$318-\$392 |
| 11 | \$197-243 | \$89-\$111 | \$287-\$353 |

BENEFIT-COST ANALYSIS

A benefit-cost analysis was used in this study for determining the benefits and the costs of the various alternatives. The process involved comparing the present worth cost of the total expected design year benefits of one or more actions against their respective total expected 100 year life-cycle costs in order to assess relative economic feasibility. Benefits and costs were adjusted for the time value of money, so that all flows of benefits and flows of project costs over time (which tend to occur at different points in time) were expressed on a common basis in terms of their present value.”

For this study, the transportation benefits for each build alternative were derived by calculating the cost savings from three areas: (1) reduced VHT, (2) reduced VMT, and (3) reduced system delays versus the No-Build Alternative. The analysis did not consider delays caused by bridge openings. This additional analysis will be conducted during the Sarah Mildred Long Bridge

environmental documentation phase and will likely change the benefit-cost ratios. The estimated cost of each build alternative included all capital, and operation and maintenance costs.

Vehicle Hours Traveled – The design year (Year 2035) VHT costs were determined by converting the peak hour VHT to an annual value using the *Peak-Hour Mobility Benefit Multiplier Table*, developed by the MaineDOT Bureau of Transportation Systems Planning. The annual VHTs were then multiplied by a weighted average time value of \$13.40 per hour to calculate the “Total VHT Cost”. The \$13.40 per hour assumes 5.2 percent heavy truck traffic at a rate of \$39.00 per hour and 94.8 percent passenger car traffic at a rate of \$12.00 per hour. Note that the 5.2 percent truck traffic and 94.8 percent passenger car traffic were derived using automatic traffic recording (ATR) class count data for the two lower-level crossings. VHT benefits were calculated as the difference between the No-Build Alternative and each of the build alternatives. As noted above, the analysis did not consider delays caused by bridge openings. This additional analysis will be conducted during the Sarah Mildred Long Bridge environmental documentation phase.

Vehicle Miles Traveled – The design year (Year 2035) VMT costs were determined by converting from the peak hour VMT to an annual value using the *Peak-Hour Mobility Benefit Multiplier Table* developed by the MaineDOT Bureau of Transportation Systems Planning. Vehicle operating costs were assumed to be \$0.15 per VMT and safety costs were assumed to be \$0.10 per VMT for a total cost of \$0.25 per VMT. This value of \$0.25 per VMT was multiplied by the VMTs developed using the regional model to obtain the “Total VMT Costs”. VMT benefits were calculated as the difference between the No-Build Alternative and each of the build alternatives. As noted above, the analysis did not consider delays caused by bridge openings. This additional analysis will be conducted during the Sarah Mildred Long Bridge environmental documentation phase.

System Delays – The design year (Year 2035) system delays were generated using Synchro model total delay outputs. The design year system delay costs were determined by converting from the peak hour system delays to an annual value using the *Peak-Hour Mobility Benefit Multiplier Table* developed by the MaineDOT Bureau of Transportation Systems Planning. The annual system delays were then multiplied by the weighted average time value of \$13.40 per hour to calculate the “Total System Delay Cost”. Note that the \$13.40 per hour was developed using the same assumptions as described in the VHT section above. System delay benefits were calculated as the difference between the No-Build Alternative and each of the build alternatives. The total design year benefits were calculated as the sum of the present worth values of the VHT, VMT, and System Delay benefits.

Capital, and Operation and Maintenance (O&M) Costs – Planning level Capital, and O&M costs for the assumed 100 year life-cycle were obtained from the LCCA. These planning level costs represent the net present value of future costs for each build alternative over an assumed

100 year life-cycle. The net present value of the planning level life-cycle costs for each build alternative was then used to calculate an annualized Capital, and O&M costs.

Table 6-17 summarized the results of the benefit-cost analysis.

**Table 6-17
Summary of Benefit-Cost Ratios by Alternative**

| Alternative | Annualized Total Costs | Total Design Year Benefits | Benefit:Cost Ratio |
|-------------|------------------------|----------------------------|--------------------|
| No-Build | \$ 7,078,145 | \$ - | |
| 4 | \$ 12,585,554 | \$ 8,933,292 | 1.62 |
| 5a | \$ 14,422,158 | \$ 8,933,292 | 1.22 |
| 5b | \$ 16,386,783 | \$ 9,489,706 | 1.02 |
| 6a | \$ 14,633,951 | \$ 8,933,292 | 1.18 |
| 6b | \$ 16,375,439 | \$ 9,489,706 | 1.02 |
| 7 | \$ 15,213,595 | \$ 6,282,577 | 0.77 |
| 8 | \$ 15,202,251 | \$ 6,282,577 | 0.77 |
| 9 | \$ 15,271,659 | \$ 9,426,308 | 1.15 |
| 10 | \$ 14,098,471 | \$ 6,433,493 | 0.92 |
| 11 | \$ 13,094,186 | \$ 6,433,493 | 1.07 |

Additional information regarding Cost Analysis and associated findings can be found in the following documents included with this Study Report:

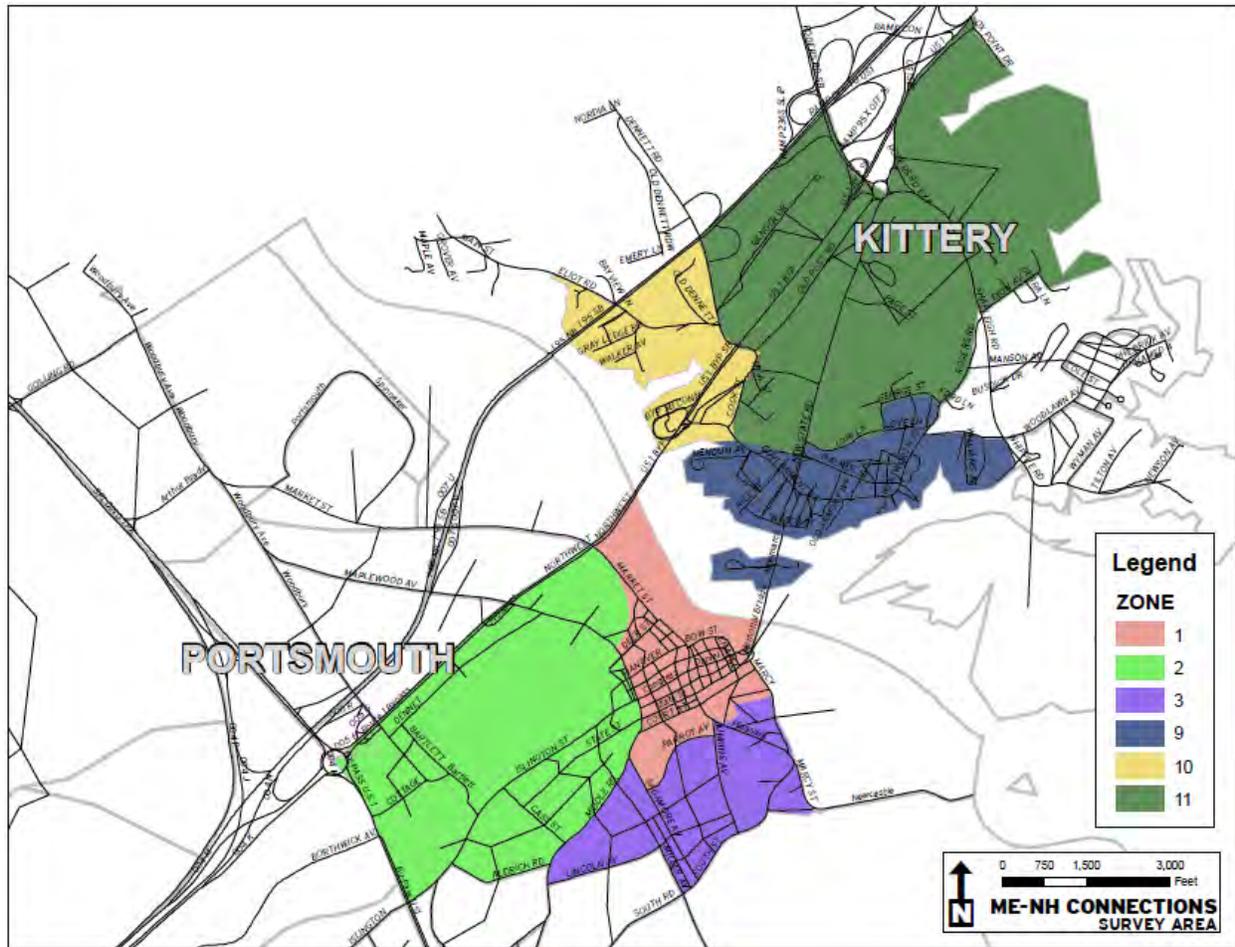
- *Appendix #18 – Benefit Cost Methodology.*
- *Appendix #30 - Life Cycle Cost Analysis (LCCA).*

6.15. BUSINESS IMPACT ASSESSMENT

This section summarizes the business impact assessment conducted as part of this study.

Two independent surveys were conducted during March 2010: an exit survey of customers and a survey of business owners. Figure 6-29 identifies the survey area and corresponding zones relative to the Business Impact assessment.

Figure 6-29: Survey Area Map with Zones



Exit Survey: This survey questioned customers as they were leaving a sample of businesses in order to get a snapshot of business trade areas and the extent to which customers are originating from or headed to the opposite side of the Piscataqua River via the Memorial Bridge. Interviewers were stationed for selected two to three hour periods at a total of 15 businesses from Thursday, March 18, through Saturday, March 20, 2010. During these periods they randomly intercepted customers as they were leaving the business and administered a brief questionnaire. A cross-section of businesses with customer traffic was selected with the assistance of local chambers of commerce and Stakeholder Committee members. These included convenience and destination retailers, restaurants, and personal service businesses.

Seven of the businesses were located in Downtown Portsmouth (Zone 1 on Figure 6-29). Eight of the businesses were located in Kittery in Zones 9, 10, and 11 on the attached map, including six centered on or near U.S. Route 1 in the pathway of the Memorial Bridge and two located on the U.S. Route 1 Bypass in the pathway of the Sarah Mildred Long Bridge.

Six percent of the interviews were conducted between 7 and 9 a.m. over the three days; 25 percent between 9 a.m. and 1 p.m.; 53 percent between 1 and 6 p.m.; and 6 percent between 6 and 8 p.m.

The survey intercepted and completed interviews with 1,505 customers. While these are statistically representative only of the businesses in which the interviews were conducted, the number and distribution of interviews yield results that provide good insight to trade areas and the use of Memorial Bridge by customers of businesses with walk-in traffic.

Business Survey: This survey was a mail-out to 330 businesses of all types located in the pathways to and from the Memorial and Sarah Mildred Long Bridges, within Zones 1-4 in Portsmouth and Zones 9-11 in Kittery, as shown on Figure 6-29. The surveys were mailed with stamped, self-addressed return envelopes on March 11, 2010, with a deadline of March 25, 2010 to return them. Of the 330 mailings, 247 were in Portsmouth and 83 were in Kittery. Forty of the mailings were returned as undeliverable, reducing the sample to 290. Of these, a total of 96 returned completed questionnaires, a rate of 33 percent, which would be well within the range of what would be expected in a mail-out survey.

This survey sought information from the businesses about the places of origination of their customers, reliance of their customers on the three bridges between Kittery and Portsmouth, how a temporary closing of the Memorial Bridge to vehicles in fall 2009 affected sales, share of customers who arrive at the business on foot or by bicycle, and their perceptions of the likelihood that customers would find alternative routes to their businesses if the Memorial Bridge were closed to vehicles in the future.

Because returns from mail-out surveys are not random, the results are not applicable to statistical tests of significance and cannot reliably be extrapolated to all businesses in the Study Area. However, they provide important impressions and, as long as appropriate caution is exercised, contribute to an understanding of potential impacts.

Summary of Key Findings

The Exit Survey of more than 1,500 customers patronizing a cross-section of 15 businesses in Portsmouth and Kittery provides an indication of the percentage of customers that would be “at risk” for these types of businesses (retailers, restaurants, and personal service establishments) if the Memorial Bridge were closed to vehicles. By “at risk” we mean that these customers would need to find an alternative route to the businesses. Considering the shares of customers who said they had crossed the bridge immediately before arriving at the business and considering the

modes of transportation (auto, walking, bicycling), a gross estimate of such ~~at~~ “at risk” customers would be:

- Portsmouth Downtown Zone 1: 15 percent to 20 percent
- Kittery Zones 9 and 11: 35 percent to 40 percent
- Kittery Zone 10: 10 percent to 15 percent

Not all of these customers would be lost, because some would find acceptable alternative routes. Based on responses in the Business Survey, it would not be unreasonable to assume that approximately half of the customers would find alternative routes. This would imply an impact on these types of walk-in businesses (retailers, restaurants, and personal service establishments) of:

- Portsmouth Downtown Zone 1: 7 percent to 10 percent
- Kittery Zones 9 and 11: 17 percent to 20 percent
- Kittery Zone 10: 5 percent to 8 percent

The overall impact to all businesses in the surveyed area would be somewhat less than this because some businesses in the area do not rely on walk-in traffic and would be less affected by a closure to vehicles (though some respondents in the business survey noted that their employees, if not their customers, would be affected).

Another benchmark from the business survey was the comparison of Oct-Nov 2009 sales versus the average of Oct-Nov sales for the three previous years. The median response was 10 percent to 14 percent decline. Considering a possible background change due to recession of a six percent decline, this suggests a median decline in the four percent to eight percent range due to the six week closure of the bridge to vehicles. The background changes may have been more severe for recession-sensitive businesses included in the survey, such as building contractors; and for businesses that rely on pass-by traffic immediately en route to or from the Memorial Bridge.

These different ways of examining the possible overall impact on customers and sales of closing the Memorial Bridge to vehicles reach fairly consistent results within a range of eight percent to 17 percent depending on location – *for businesses that rely on customer traffic*. These are, of course, synthesized results for the area as a whole. Individual businesses would be affected differently: businesses that are convenience-oriented, that rely primarily on pass-by traffic, and that are immediately en route to the Memorial Bridge may be impacted more (i.e., up to or more than a 17 percent impact); businesses that are destination-oriented, that rely primarily on traffic coming to the business for a specific reason, and that draw from an area that would not be as dependent on the Memorial Bridge may be impacted less (i.e., eight percent or less). But an

eight percent to 17 percent impact on customers/sales for businesses with customer traffic in the area studied would be a reasonable conclusion based on the available information.¹⁵

Regional Economic Effect

This analysis assessed the region-wide economic impacts of each alternative. The “region” for purpose of this study would be the Primary Market Area for Zones 1, 9, 10, and 11 (Figure 6-29), as indicated by the Exit Survey. A shopping area’s Primary Market Area typically accounts for 60 to 70 percent of the area’s sales. In this case, it comprises the 16 municipalities that account for approximately two-thirds of the traffic captured in the Exit Survey. These extend from York, ME in the north to Hampton Falls, NH in the south, and west to Dover, NH and So. Berwick, ME. They are partly within the Portsmouth, NH-ME Metro area, partly within the Rochester-Dover, NH-ME Metro area, and partly just outside of these two metro areas.

If a decision were made that led to an average loss of eight percent to 17 percent of sales or customers for businesses that rely on customer traffic in a particular part of the region, would this reverberate to a region-wide loss of this economic activity? In our judgment this would be unlikely.

There would be a region-wide loss only if (1) it caused regional and visitor demand for the affected goods and services to decline, or (2) there were not substitute locations or businesses within the region to take up the slack. As to the first possibility, there is no evidence to suggest that overall regional and visitor demand for the affected goods and services would decline. As to the second possibility, there are a number of commercial centers in Portsmouth and Kittery that are and/or could be alternative locations unconstrained by the status of the Memorial Bridge for the types of affected businesses in the impacted area. There undoubtedly are competing areas elsewhere within the region as well.

Additional information regarding Business Impact Assessment and associated findings can be found in the following document included with this Study Report:

- *Appendix #44 – Customer and Business Survey Results Reliance on Memorial Bridge to Access Businesses Proximate to Bridge in Portsmouth and Kittery.*

6.16. ENVIRONMENTAL CLEARANCES ASSESSMENT

The environmental clearances assessment evaluated and documented each alternatives’ ability to obtain the necessary Coast Guard permit or permits as well as satisfying the procedural requirements of the NEPA process. This assessment is based upon discussions with relevant state and federal agencies throughout the Study Process and Study Team opinion of permit requirements. No separate documents were prepared for this assessment.

¹⁵ This estimate is based in part on the perception of businesses participating in the survey as to the likelihood that their customers continued to come to their establishments during the fall 2009 bridge closure. For perspective, the additional travel time to the affected zones from a variety of points in the area via the Sarah Long Bridge ranges from a half-minute to about five minutes.