Appendix 1: Methodology

This study uses straightforward analysis methods to estimate the amount of commuter delay that might be saved by the TIP and Long Range Plans. This amount is them compared with the amount of delay that is likely to be added to the region through increased traffic and increased congestion. The comparison then leads to the development of specific recommendations for each region. A summary of the steps is as follows:

1. **Review plans.** Information from the short-range (Transportation Improvement Program) and Long-Range Transportation Plan for each urbanized area was reviewed to identify all projects likely to have an impact on congestion. This assessment identified about 333 projects on the TIP and about 985 projects on long-range plans. These projects were then carefully described and located on maps of the regions.

2. **Literature review** The literature and state and local reports on congestion in North Carolina was briefly reviewed, to determine the impact and weight now being placed on congestion. The literature review consisted primarily of the long range plans, congestion management plans, and TIPs for each urban region, plus other major federal and state documents dealing with congestion.

3. **Locate projects impacting congestion**. Reviewing each region, we located the TIP and LRP projects relative to the project maps identified above. Projects with TIP identifiers were generally located using TIP maps or end-point descriptions; projects on the long-range plans were located with the help of LRP maps and with other information such as reserved right-of-way. In cases where projects cross count lines or regional boundaries, length and costs were split proportional to the portions within each county or within the MPO urbanized area boundary. Once located, the map sections were merged with the spreadsheet data to permit graphical display of information.

4. **Estimate current and future congestion indices for metro areas**. Using 1995 and 2003 reported data from each region, future-year (2030) congestion indices for each region were estimated based on region size, traffic density and growth rates. For most regions of the state, this was about a doubling of delay, corresponding to a 50-70 percent increase in regional VMT.

5. **Regional commuting data** (travel by mode) were gathered from the 2000 Census. This data consists of modal splits, travel times, auto ownership and number of commuters for each region.

6. **Estimate current and future 'delay'.** Regional 'delay' was estimated by using the congestion estimates and the estimates of total commuters to estimate each region's total daily commuting time and the portion in 'delay' as opposed to 'free flow' time, that is what the travel times would be without the presence of other vehicles.

7. **Estimate TIP and LRP impacts.** Estimates of the effect of additional projects (those on the TIP and the long range plan) on delay reduction were then made. This was computed as follows:
   - For each project, determine the number of lanes added and the project length, from the TIP or the LRP documentation. Verify the length with TransCAD.
   - For each project, estimate the average traffic load by facility type and region. This was done not by using traffic assignment, but rather by computing average traffic volumes by functional class/region for 1995 and 2003, and then projecting them to 2030. The assumed traffic volumes for each region/functional class are shown in Table A.1. These traffic volumes are approximations for numerous sections of roads within each urban region but are based on current volumes and growth rates.

Table A.1: Average 2030 Traffic Volumes by Region and Functional Class

City Code	Name	Interstates	Other Freeway/ Expressway	Other Urban Principal Arterials and Major/ Minor Arterials	Collectors, Local Streets and others	Total/ Average
	FC Code	**1**	**2**	**3**	**4**	**5**
3	Charlotte	150000	75649	43110	8000	11006
14	Raleigh	140000	51416	31282	7000	8312
6	Fayetteville	49150	48724	36136	5000	7762
5	Durham	87277	60533	27799	6000	7777
17	Winston-Salem	88523	65332	22607	5000	6934
9	Greensboro	105753	41024	28007	5000	7123
16	Wilmington	40133	54944	39512	5000	7749
7	Gastonia	130611	55265	20692	6000	7581
4	Concord	122988	NA	30486	6000	7208
1	Asheville	79559	52579	31404	5000	9210
12	High Point	57065	24392	20794	5000	5536
13	Jacksonville	NA	45000	26568	5000	5202
11	Hickory	65923	55751	19520	5000	7271
2	Burlington	125803	45000	18750	5000	7890
10	Greenville	NA	45000	17988	5000	3456
8	Goldsboro	NA	45001	23273	5000	5581
15	Rocky Mount	70000	42012	18361	5000	4829

This Table operates as follows. For a future Interstate in Charlotte, the 2030 traffic volume would be assumed to be 150,000 ADT. For a collector in Jacksonville, the average 2030 traffic volume would be assumed to be 5,000 ADT.

- Based on traffic volumes, the savings in travel time through each section is then calculated based on the increase in speed and section length. The following table shows the assumptions for increases in speed for various types of work:

Table A.2: Changes in Speed from Work Types

Project Type	Project Type Code	Work Type Code	Capacity per lane, Before	Capacity per lane. After	Speed, Before	Speed, After
New freeway 4+L	2	1	2400	2400	40	60
New freeway --->8L	20	1	2400	2400	45	65
New freeway --->6L	30	1	2400	2400	40	60
New 4L arterial	9	2	1400	1400	45	55
New 2L arterial	10	2	1200	1200	30	45
Widen Urban art 4L--->6L	17	2	1400	1400	35	50
New 3L arterial	25	2	1400	1400	25	50
New 5L arterial	26	2	1400	1400	30	40
Add Single lane	1	3	1400	1400	30	45
Widen Urban art 2L--->4L	6	3	1400	1400	20	40
New Exit on Freeway	8	3	2400	2400	50	60
Ramp Connection	16	3	1000	1200	40	45
New Interchange	18	3	2000	2000	35	55
Widen urban art 2L ---> 5L	27	3	1400	1400	30	40
Widen urban art 4L ---> 7L	29	3	1400	1400	30	60
Widen Urban art 3L--->5L	31	3	1400	1400	30	50
Widen 2L ---> 6L	33	3	1400	1400	25	50
Widen Freeway 6L---->8L	3	4	2400	2400	40	60
Widen Freeway 4L---->6L	4	4	2400	2400	40	60
Widen Freeway 4L---->8L	5	4	2400	2400	30	60
Widen Freeway 8L --->10L	24	4	2400	2400	50	60
Widen Rural art 2L--->4L	7	6	1600	1600	45	60
Widen Rural art 4L--->6L	19	6	1600	1600	45	60
Significant intersect. upgrade	11	7	1400	1400	30	50
Roundabout	15	7	1400	1600	15	35
Interchange Upgrade	23	7	2000	2000	35	55
Road Realignment	32	7	1400	1400	50	55
Signal group optimization	12	8	1400	1400	20	40
HOT/HOV	13	9	2400	2400	45	65
New bridge	14	10	1400	1400	35	45
Widen Bridge	28	10	1400	1400	35	45
6L UA --->6L Freeway	21	11	1400	2400	40	65
4L UA --->4L Freeway	22	11	1400	2400	35	60

Minor Impr without widening	34	12	1100	1400	35	45
Lane red and traffic calming	35	13	1400	1000	45	35

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For instance, for an urban arterial widening (PTC 6), the table reads that the overall average speed would increase from 20 to 40 mph.

- From this information, the daily savings in travel time through the section can be calculated as:

  DVHT Saved = AADT *0.2 *(L/SpeedB - L/SpeedA)

  The 0.2 here is the adjustment from ADT to peak hour traffic, since off peak traffic would typically not be affected. AM and PM peak hour traffic is about 20% of daily ADT.

  For example, if an urban widening of a section 0.85 miles long is predicted to carry 28,000 ADT, then the daily savings in travel time is:

  DVHT Saved = 28000 * 0.2 * (0.85/20 – 0.85/40)
  = 5600 * (0.02125)
  = 119 hours/day

  In this example, the average peak-hour driver would save 0.02125 hours (about 1.2 minutes) through the section driving at 40 rather than 20 mph, so all 5,600 peak period drivers would save about 119 hours of travel time per day.

  The annual savings in delay time would be just this number times 250, the average number of work days in a year:

  AnVHT Saved = DVHT Saved * 250
  = 119 * 250
  = 29750 hours

  Taking this example further, if the project cost $ 5M, then the cost per delay hour saved, over 20 years would be:

  Cost/Delay Hour Saved = 5,000,000/(29750*20) = $8.40.

  For several project types, this procedure was modified slightly:

  i. For intersection and roundabout work, short sections of road about 0.1 miles long were assumed.
  ii. For exits and ramps, ADT affected was assumed to be 0.1 times mainline ADT. Typical traffic volumes for freeways have about 10% using a given exit; and average trip lengths about 10 miles long.

iii. For new facilities, 'before' speeds were assumed to be what traffic would encounter if the new facility were not in place, i.e. congested arterials.

8. **Quantify impacts on economy.** The impact of congestion on travel time cost and operating costs were then made. Based on this, an estimate the impact of congestion on the region's economy was made.

9. **Recommendations.** For each region, we then estimated what additional steps, beyond the TIP and Long Range Plan, need to be taken to reduce congestion.