

## Foreword


Nagui M. Roupail, PhD  
ITRE Director

To ITRE staff, clients and friends,

It is my pleasure to submit the 2005 Institute for Transportation Research and Education (ITRE) Annual Activity Report. Once again, our staff, students and affiliated faculty have made 2005 yet another banner year of accomplishments. We continue to successfully carry out our stated mission and deliver quality research, education and technical services to the citizens of North Carolina and the Nation, while at the same time coping with sustained cuts in state appropriated funds for our operations year after year.

We have continued to grow in staff and expenditures following last year's trends. In 2005 we had 10 new hires and initiated a new program area on Commercial Vehicles and Safety and successfully recruited Dr. Ron Hughes from UNC-CH to lead it. Our in-house annual expenditures have increased by 26.5% over the previous year, which was a banner year itself. Our overall expenditures increased by an even higher rate of 37%. We are moving ahead toward our goal of enhancing ITRE's national visibility, evidenced by a substantial increase in project awards from federal sources such as Federal Highway Administration (FHWA), Environmental Protection Agency (EPA), National Institutes of Health (NIH), National Cooperative Highway Research Program (NCHRP) and Transit Cooperative Research Program (TCRP), and by involving our staff in national committee activities. Even more than last year, ITRE's students and staff will have a strong presence at the TRB 2006 Annual Meeting, with 13 papers accepted for presentation, a record number. Finally, we are proud to have provided record support for 34 graduate and undergraduate students this year, who were engaged in our research and technical assistance studies.

I want to thank each and every staff person at ITRE for their continued dedication and professionalism. On a personal note, I want to express my deep gratitude to Dr. John Fisher, Director of the Center for Transportation and the Environment (CTE), who retired this year after 13 years at the helm, and give a big welcome to Dr. E. Downey Brill, former Head of the Civil, Construction and Environmental Engineering (CCEE) Department here at North Carolina State University, who took over the CTE Directorship on November 1, 2005.



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Nagui M. Roupail, PhD  
ITRE Director

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## Annual Activity Report - 2005

### Institute for Transportation Research and Education (ITRE) North Carolina State University

This report summarizes ITRE's activities for the year 2005. The report first provides background information on the Institute's history, mission, goals and objectives. This is followed by an overview of the status of ITRE finances, personnel and technical activities conducted over the past year. Overall, despite the continuing decline in state support funds in the past few years, ITRE has been able to maintain and expand its programmatic activities.

#### Center Description

The Institute for Transportation Research and Education (ITRE) is an inter-institutional center of the University of North Carolina system. Chartered by the North Carolina General assembly in 1978, ITRE carries out research, training and technical support activities in the area of surface transportation for a host of national, state, and local clients to address the nation's critical transportation issues. ITRE is committed to leadership in the study of surface transportation issues through the fostering of analytical thinking, integrating technology in education and research, serving as a catalyst for problem solving, and cultivating professionals and students dedicated to excellence in transportation.

Currently, ITRE is organized into six program groups covering highway systems, commercial vehicles and safety, North Carolina local technical assistance, public transportation, pupil (school) transportation, and transportation and the environment. An updated high-level organizational chart is shown in **Exhibit I**.

#### Summary of ITRE Goals:

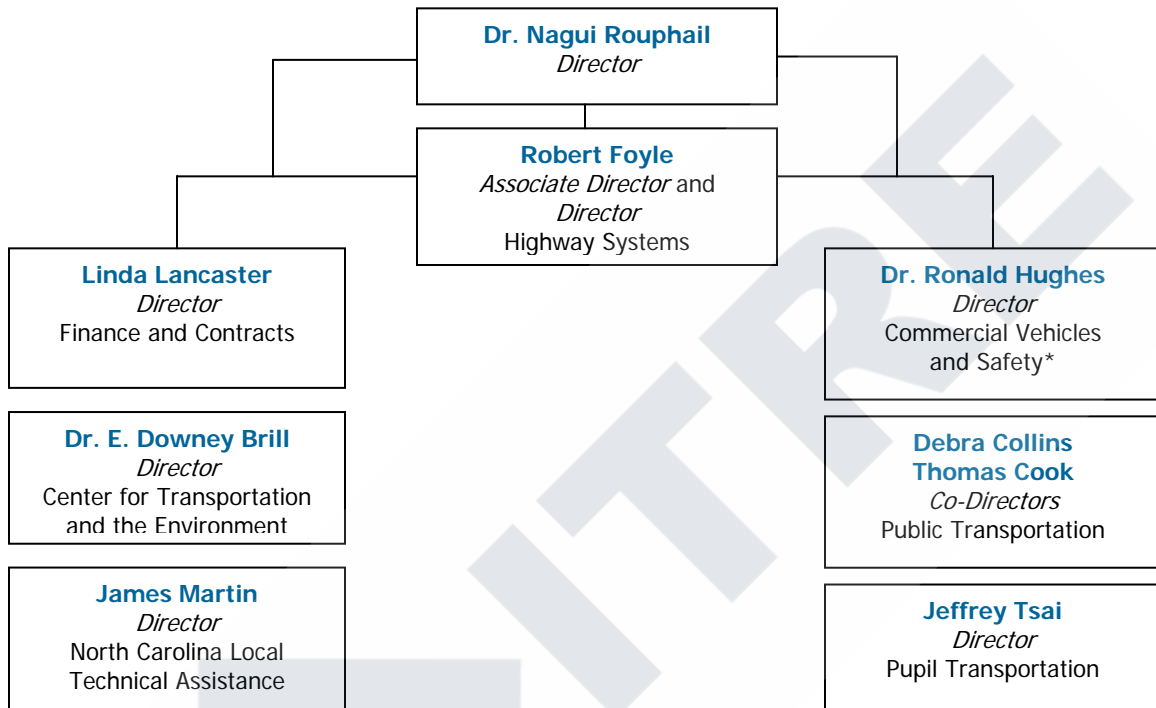
ITRE's 2002 strategic plan has set forth five major institute-wide goals:

1. Increase national visibility.
2. Conduct and disseminate research that impacts the transportation community.
3. Sustain and enhance educational opportunities to improve the knowledge and skills of transportation professionals.
4. Strengthen the relationship with, and gain recognition within the University System.
5. Provide superior technical assistance.

These goals are currently being achieved through various objectives, such as increasing national exposure through conference presentations, publishing research and outreach efforts, increased national project awards, continuing training efforts on a national, regional and state level, and promoting collaboration with the department of Civil Engineering faculty at North Carolina State University and the UNC System.

This report provides a glimpse of this year's activities and accomplishments in reaching these goals and objectives. More information about ITRE's programs and staff are available through ITRE's homepage: [www.itre.ncsu.edu](http://www.itre.ncsu.edu)

### Exhibit I- ITRE High-Level Organization Flow Chart By Primary Program Groups

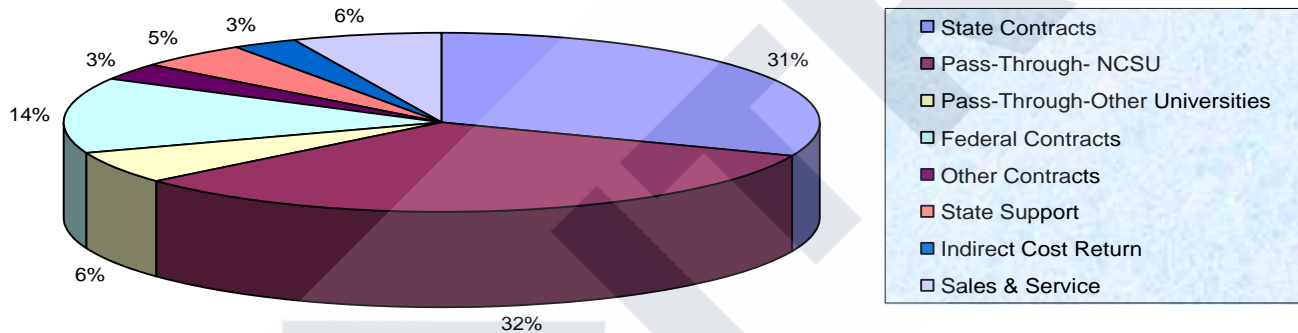


\*New Program Group

## Summary of ITRE's Finances

For the most recent Fiscal Year (04/05) in which complete figures are available, expenditures have been broken down by the funding source, as shown in **Exhibit II** below.

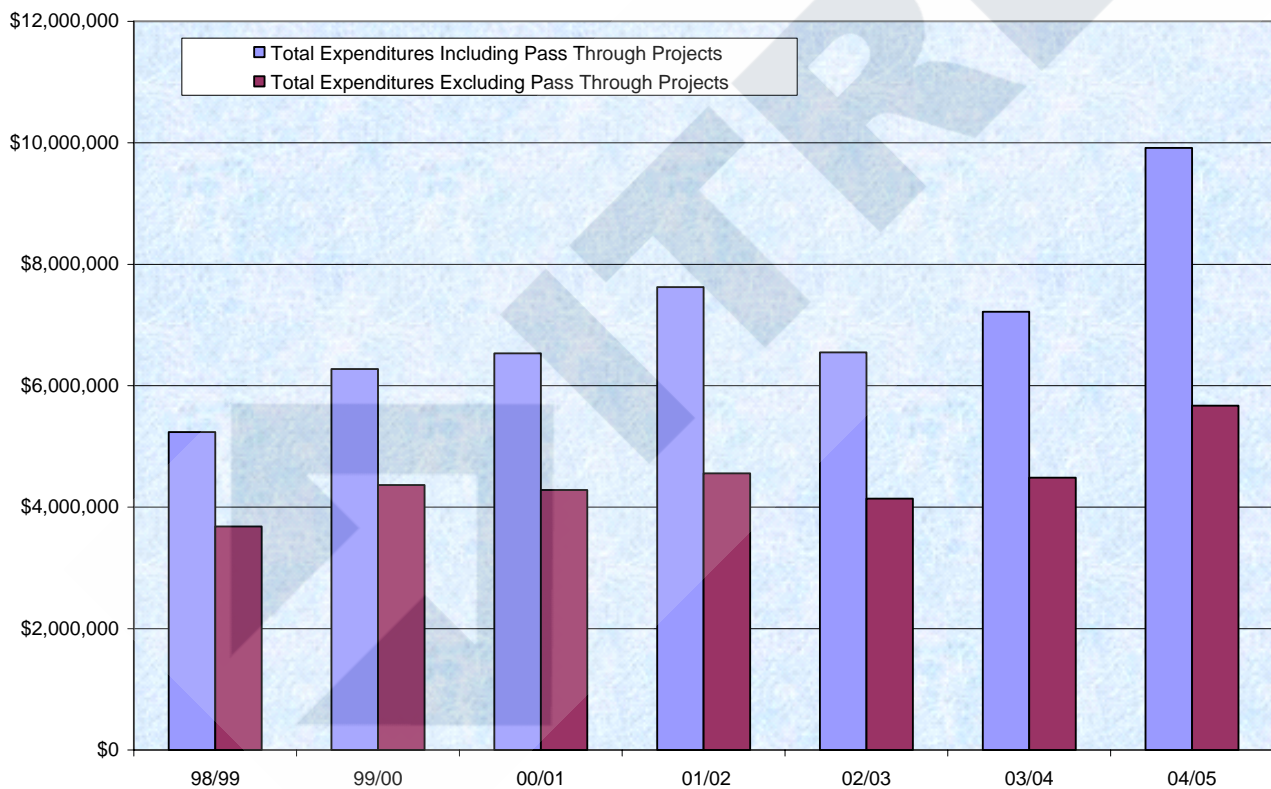
**Exhibit II- Expenditures by Source, FY 04/05**



Overall, about 5% of all expenditures came from *State Support* appropriations to ITRE related to administration, with additional operations support of 3% coming from *Indirect Cost Return*. These compare to 6 and 4% of all expenditures last year, indicating a continuing decline in flexible funds as a share of ITRE's operations. *State and Federal Contracts* total 45% of all activity, with state expenditures (31%) limited to those projects with North Carolina State Government agencies. *Sales and Service* activity (6%) is mostly from registration fees for workshops. *Pass-Through* projects to other departments at NCSU (32%) and other UNC universities (6%) are higher in volume from the previous year (32% combined). A listing of these projects is provided on page 15 of this document. *Other Contracts* (3%) include project activity primarily for municipalities and also include funding from other states.

**Exhibit III** tracks ITRE's annual expenditures over the past seven years. Following the trends observed in the last two years, our expenditures continue to be on an upward trend. In fact, ITRE passed many milestones this year: in-house expenditures exceeded \$5M for the first time in its history (\$5.6M); overall expenditures approached \$10M/year (\$9.915M) and double digit increases for both in-house and overall expenditures as compared to last year's figures.

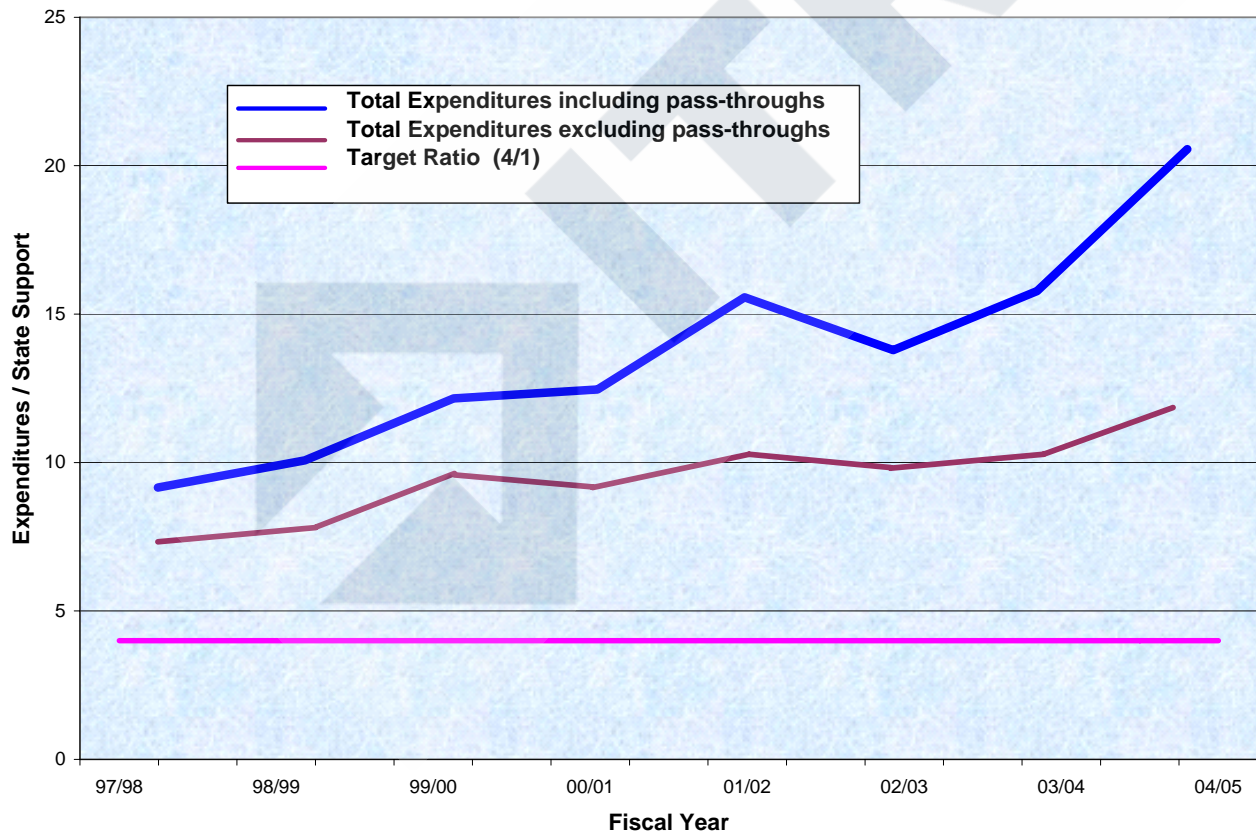
**Exhibit III - Tracked ITRE Expenditures in 7-year period**



With state resources increasingly coming under budget constraints and recent reductions, it is important that state-supported institutes and centers demonstrate that they are providing a good return on the state investment. One way to measure the return on that investment is by calculating the ratio of annual expenditures divided by state appropriated funds. Currently, the UNC Office of the President *desires a ratio of 4.0 or higher*. ITRE's figures over the last eight years are depicted in **Exhibit IV**.

**Exhibit IV** shows three lines. The top line represents the ratio of total annual expenditures divided by ITRE's state appropriation. Total expenditures include all pass-through research projects (internal to NCSU and external to other universities) and our portion of collected indirect costs distributed back to ITRE based on the previous year's expenditures. The lower line excludes all pass-through projects from annual expenditures when calculating the ratio, basically reflecting the value of in-house research activities. In both cases, the ratio is well above the indicated 4.0 minimum threshold and in the past year reaching a record 12.3:1 and 20:1 for in-house and all expenditures, respectively.

**Exhibit IV- Tracked ITRE Expenditures/State Appropriated Funds**



## Summary of Personnel Activities

In the year 2005, ITRE created eight new positions and hired a total of 11 staff members. A new program group was added, Commercial Vehicles and Safety, that houses one of the programs already established at ITRE. A new director was added for the new program group. **Exhibit V** outlines the personnel changes for 2005 by program group.

**Exhibit V - Personnel Activities in 2005**

| <b>Program Group</b>   | <b>New positions</b> | <b>New hires</b> | <b>New Program Area</b> |
|------------------------|----------------------|------------------|-------------------------|
| General Administration | 1                    | 3                | None                    |
| CTE                    | 4                    | 4                | None                    |
| Highway Systems        | 1                    | 1                | None                    |
| NC LTAP                | None                 | None             | None                    |
| CVS*                   | 1                    | 1                | 1                       |
| Public Transportation  | None                 | None             | None                    |
| Pupil Transportation   | 1                    | 2                | None                    |
| <b>Total</b>           | <b>8</b>             | <b>11</b>        | <b>1</b>                |

\*Commercial Vehicles and Safety



## 2005 Summary of Technical Activities

ITRE's Web site includes research and training directories that enable the user to search for specific ITRE activities. To explore our Web site for these activities go directly to each of these directory pages:

[www.itre.ncsu.edu/ITREmain/research\\_directory.html](http://www.itre.ncsu.edu/ITREmain/research_directory.html)

[www.itre.ncsu.edu/ITREmain/training\\_directory.html](http://www.itre.ncsu.edu/ITREmain/training_directory.html)

ITRE's active research and education activities at the national, state and local levels are listed below for the calendar year 2005.

## National Research and Development

Research efforts at ITRE are quite significant. There are 21 national-level projects listed below that were carried out by various program groups at the Institute.

### **A Video on Excellent Customer Service Resulting From Effective Taxicab Regulation**

Sponsor: Taxicab, Limousine and Paratransit Foundation (T.Cook)

### **Blind Pedestrians' Access to Complex Intersections**

Sponsor: Western Michigan University *Prime sponsor:* NIH (N. Roupail)

### **Center for Transportation and the Environment Continuing Operations**

Sponsor: NCDOT *Prime sponsor:* USDOT (J. Martin)

### **Community Impact Assessment Training**

Sponsor: NCDOT *Prime Sponsor:* FHWA (J. Martin)

### **Context Sensitive Solutions Graduate Course**

Sponsor: NCDOT *Prime sponsor:* FHWA (J. Martin)

### **Crossing Solutions for Roundabouts and Turn Lanes for Pedestrians with Vision Disabilities (NCHRP 3-78)**

Sponsor: National Cooperative Highway Research Program/NAS (R. Hughes and N. Roupail)

### **CTE Support Services for the Domestic Scan of Successful Wetland Mitigation Programs**

Sponsor: FHWA *Prime sponsor:* USDOT (K. McDermott)

### **Development of Standardized Urban/Suburban School Bus Driving Cycle**

Sponsor: Advanced Energy Corporation (J. Tsai)

### **Evaluation and Application of Pedestrian Modeling Capabilities Using Computer Simulation**

Sponsor: UNC-Chapel Hill *Prime sponsor:* National Eye Institute (N. Roupail)

### **FHWA CSS Activities**

Sponsor: NCDOT *Prime sponsor:* FHWA (J. Martin)

**FTA Teleconferences**

Sponsor: Federal Transit Administration (J. Martin)

**International Conference on Ecology and Transportation**

Sponsors: State of Washington DOT, EPA, FHWA (K. McDermott)

**In-Vehicle Energy and Emissions Information System**

Sponsor: National Science Foundation (N. Roupail)

**Local Technical Assistance Program (LTAP)**

Sponsor: NCDOT *Prime sponsor:* FHWA (J. Martin)

**Maintenance of the Ohio Transit Listserv**

Sponsor: RLS & Associates *Prime sponsor:* Ohio Department of Transportation (T. Cook)

**Multimodal Arterial Level of Service (NCHRP 3-70)**

Sponsor: Dowling and Associates *Prime sponsor:* NCHRP (N. Roupail)

**National Community Impact Assessment Course Delivery**

Sponsor: NCDOT *Prime sponsor:* FHWA (J. Martin)

**Ohio Technical Assistance Program**

Sponsor: RLS & Associates *Prime sponsor:* Ohio Department of Transportation (T. Cook)

**Regional Development, Population Trend and Technology Change Impacts on Future Air Pollution Emissions**

Sponsor: UNC-Chapel Hill *Prime sponsor:* Environmental Protection Agency (N. Roupail)

**Statewide Work Zone Safety Campaign for South Carolina Department of Transportation**

Sponsor: Fisher Communications Hill (T. Baughman)

**Workshop on Impacts of Global Climate Change on Hydraulics and Hydrology and Transportation**

Sponsor: USDOT (J. Martin)

## 2005 National Committee and Panel Participation by ITRE Personnel

### *Committees and Task Force Participation*

- FHWA Environmental Competency Building Advisory Committee (J. D'Ignazio)
- National Committee on Uniform Traffic Control Devices (T. Baughman)

#### TRB Committees

- Environmental Analysis in Transportation, ADC10 (J. Martin)
- "Friend of" Environmental Analysis in Transportation, ADC10 (T. Townsend)
- Highway Capacity and Quality of Service, AHB40 (R. Foyle)
- Paratransit, AP060 (T. Cook)
- Social and Economic Factors in Transportation, ADD20 (L. Lane)
- Traffic Law Enforcement, ANB40 (C. Cunningham)
- Transportation Planning Applications, ADB50 (L. Huntsinger)
- Transportation Safety Management, ANB10 (J. Tsai)
- Work Zone Traffic Control, Secretary, AHB55 (T. Baughman)

#### TRB Subcommittees

- Community Impact Assessment, ADD10(1) (L. Lane)
- Community Impact Assessment, ADD10(1) (T. Townsend)
- School Transportation, ANB10(6) (J. Tsai)
- Signalized Intersections, AHB40(3.1) (N. Rouphail)

#### TRB Task Force

- Context Sensitive Design/Solutions, AFB50T (L. Lane)
- Ecology and Transportation, ADC30T (J. Martin)
- Environmental Justice in Transportation, ADD50T (L. Lane)
- Visualization in Transportation, ABJ95T (R. Hughes)

### *TRB Panel Participation*

- NCHRP Project 3-75, Analysis of Freeway Weaving Sections, (N. Rouphail)
- NCHRP Project 20-5, Synthesis of Highway Practice 36-04, "Visualization for Project Development" (R. Hughes)
- NCHRP Project 25-25, Quick Response Research for the Environment (J. D'Ignazio)
- TCRP Project A-28, Guidebook for Mitigating Fixed-Route Bus-and-Pedestrian Collisions (M. Meletiou)
- TCRP Project B-31, Benchmarking Productivity Performance of Demand Responsive Transit Services (T. Cook)
- TCRP Project J-7, Synthesis Topic SB-13, Transit Agency Participation in Medicaid Transportation Programs (D. Collins)
- NCHRP Project 25-22 on Technologies to Improve Consideration of Environmental Concerns in Transportation Decisions (J. Fisher)

### *Other National Group Participation*

- UNC Coastal Studies Institute Board of Directors (the Board membership is drawn from national audience even though it is part of UNC) (J. D'Ignazio)
- Hybrid Electric School Bus Advisory Group (J. Tsai)
- Scientific Review Board, Great Cities Initiative, UAB (N. Rouphail)
- Coordinator, Modelers Group, Next Generation Simulation (NGSIM), FHWA (N. Rouphail)

## State of North Carolina and Local Research and Development

Statewide projects in North Carolina were conducted mostly in conjunction with the NC Department of Transportation (NCDOT) and with local municipalities. This year was a particularly successful year for attracting sponsored research from state local agencies. These ongoing activities include 50+ different projects including pass-through projects to other universities.

### **2004 Update for North Carolina Alternative-Fueled or Low Emissions Bus Purchase Plan**

Sponsor: NCDOT (T. Cook)

### **An Evaluation of the Safety Effects of Speed Enforcement Cameras**

Sponsor: NCDOT-GHSP (J. Hummer, C. Cunningham)

### **Assessment of I-40 Hurricane Evacuation Plans**

Sponsor: UNC - Office of the President (GA) (N. Roupail)

### **Benchmarking for North Carolina Public Transportation Systems**

Sponsor: NCDOT (T. Cook and J. Lawrie)

### **Benefit-Cost Analysis Software for Transportation Planning**

Sponsor: NCDOT (R. Foyle)

### **Bicycle and Pedestrian Planning and Design Training for NCDOT**

Sponsor: NCDOT (T. Cook)

### **Bicycling Brochures for NC Counties**

Sponsor: NCDOT (T. Cook)

### **Context Sensitive Solutions Training for Construction, Operations and Maintenance**

Sponsor: NCDOT (J. Martin)

### **Context Sensitive Solutions Training for Planning and Pre-Construction Staff**

Sponsor: NCDOT (J. Martin)

### **Cross County Transit Study: Out-of-County Non-Medical Transportation Coordination**

Sponsor: NCDOT (T. Cook)

### **Determining Representative Sample Size for Maintenance Condition Assessment Data Collection**

Sponsor: NCDOT (R. Foyle)

### **Division Street and Driveway Access Handbook Training**

Sponsor: NCDOT (R. Foyle)

### **Economic Impact of North Carolina Airports**

Sponsor: NCDOT Division of Aviation (R. Foyle and S. Fain)

### **Ecosystem Enhancement Program (EEP)**

Sponsor: NCDENR (J. Martin)

**Effectiveness of Traveler Information Tools**

Sponsor: NCDOT (N. Rouphail and L. Huntsinger with NCSU (CCEE) and UNC-Chapel Hill (CRP))

**Environmental Enhancement Program**

Sponsor: NCDOT (J. Martin)

**Evaluation of Three-Point Restraint School Bus Seats in North Carolina**

Sponsor: NC Department of Public Instruction (J. Tsai)

**Facilitate North Carolina Department of Transportation Research Administration**

Sponsor: NCDOT (R. Foyle)

**I-40 Reversal Operational Traffic Analysis**

Sponsor: NCDOT (N. Rouphail working through College of Engineering, NCSU)

**I-95 Corridor Coalition Study: Feasibility Study for Wireless Inspections of Commercial Motor Vehicles (Phase I)**

Sponsor: NC Department of Crime Control & Public Safety (R. Hughes)

**Integrated Planning for School and Community\***

Sponsors: 16 Individual School Systems in NC and SC (J. Tsai)

\*These are 16 different projects conducted separately for each county/city school system

**Integrating Systems Planning and Project Development**

Sponsor: NCDOT (J. Martin)

**NCDOT Web Site Development Project**

Sponsor: NCDOT (T. Cook)

**North Carolina Department of Transportation Maintenance Technical Assistance**

Sponsor: NCDOT (T. Baughman)

**North Carolina Level of Service Program**

Sponsor: NCDOT (R. Foyle and N. Rouphail)

**North Carolina School Bus Safety Education Support**

Sponsor: NC Department of Public Instruction (J. Tsai)

**North Carolina Training and Technical Assistance Support for Child Transportation and Children with Special Needs**

Sponsor: NCDOT-GHSP (J. Tsai)

**Outer Banks Transportation Study**

Sponsor: NCDOT (T. Cook)

**Outreach Support Activities for Research Projects**

Sponsor: NCDOT (R. Foyle)

**Phase II Technical Support Services for the NCDOT Bicycle & Pedestrian Transportation**

Sponsor: NCDOT (T. Cook)

**Professional Enhancement Program**

Sponsor: NCDOT (T. Brown)

**Public Transportation Division Transit Operations Group/Urban Transit Assistance Program and Technology Implementation**

Sponsor: NCDOT (D. Collins)

**Rail Intern Program 2004-2005**

Sponsor: NCDOT (T. Cook)

**Regionalizing Public Transportation Services-Outreach & Planning Activities**

Sponsor: NCDOT (T. Cook)

**Research Support for Commercial Vehicle Enforcement**

Sponsor: NC Dept. of Crime Control & Public Safety/NCSHP (R. Hughes)

**Teach Fundamental Engineering Principles Program**

Sponsor: NCDOT (T. Falkie and T. Brown)

**Technical Assistance Services for the North Carolina Department of Transportation**

Sponsor: NCDOT (R. Foyle)

**Technical Assistance to the State Board of Education in the Support of the Transportation Information Management System (TIMS)**

Sponsor: NC Department of Public Instruction (J. Tsai)

**Technical Support Services for the NCDOT Bicycle & Pedestrian Transportation**

Sponsor: NCDOT (T. Cook)

**Technical Training Needs Research and Implementation Support**

Sponsor: NCDOT (R. Foyle)

**Traffic Signal Inspection Course Development and Presentation**

Sponsor: NCDOT (R. Foyle)

**Triangle Regional Model Service Bureau at ITRE**

Sponsor: NCDOT, TTA, DCHC MPO, CAMPO (L. Huntsinger)

## Active Pass-Through Projects to Other Universities

### **Analysis and Testing of a Bridge Deck Reinforced with GFRP Rebars**

Sponsor: NCDOT (UNCC, Gergely)

### **An Evaluation of Hemolymph Extraction as a Non-Lethal Sampling Method for Genetic Identification of Freshwater Mussel Species in Southeastern North Carolina**

Sponsor: NCDOT (UNC-W, Wilbur)

### **Concrete Diffusion Coefficients and Existing Chloride Exposure in NC**

Sponsor: NCDOT (UNC-C, Gergely)

### **Development of an Earth Pressure Model for Design of Retaining Structures in Piedmont Soils**

Sponsor: NCDOT (UNCC, Anderson)

### **Ecological Assessment of a Wetlands Mitigation Bank – Phase III, Assessment of Restoration**

Sponsor: NCDOT (UNC-Asheville, Moorhead)

### **Economic Impact of Traffic Incidents on North Carolina's Interstate Facilities**

Sponsor: NCDOT (UNC-CH, Khattak)

### **Evaluation and Implementation of BMPs for NCDOT's Highway and Industrial Facilities**

Sponsor: NCDOT (UNCC, Wu)

### **Evaluation of Design and Construction of HPC Deck Girder Bridge in Stanley County, North Carolina**

Sponsor: NCDOT (UNCC, Gergely)

### **Evaluation of Manufactured Stormwater Best Management Practices**

Sponsor: NCDOT (UNCC, Allan)

### **Feasibility of Using Compressive Strength Test Results for Acceptance Testing of Concrete Pavements**

Sponsor: NCDOT (NCA&T, Rojeski)

### **Interstate 40 Value Pricing Assessment**

Sponsor: NCDOT (NCA&T, Benjamin)

### **Signal Replacement with an Interchange**

Sponsor: NCDOT (UNCC, Kane)

### **The Connection Between Land Use and Transportation in Land Use Plans**

Sponsor: NCDOT (UNC-CH, Rodriguez and Gudschalk)

### **Transportation and Cost Impacts of School Locations and School Travel**

Sponsor: NCDOT (UNCC, Kane)

## TRB Presentations

Fourteen presentations will be made at the January 2006 meeting of the Transportation Research Board (TRB). Many of the papers will also be considered for publication in an upcoming *Transportation Research Record*.

### **Community Impact Assessment Practice: Where we've been, Where we are, Where we're going (06-1072)**

*TRB, Washington, D.C., 2006*

Teresa Townsend, ITRE, North Carolina State University  
Leigh B. Lane, ITRE, North Carolina State University  
Ann Hartell, ITRE, North Carolina State University

### **Creating and Operating a Walking School Bus Program (06-0721)**

*TRB, Washington, D.C., 2006*

Jeff Tsai, ITRE, North Carolina State University  
Katie Caggia, Wake County Public Schools  
Diane Ward, University of North Carolina

### **Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities, NCHRP 3-78 Update (P06-0203)**

*TRB, Washington, D.C., 2006*

Ron Hughes, ITRE, North Carolina State University

### **Effect of Roundabout Operations on Pollutant Emissions (06-1343)**

*TRB, Washington, D.C., 2006*

Margarida C. Coelho, Technical University of Lisbon  
Tiago L. Farias, Technical University of Lisbon  
Nagui M. Rouphail, ITRE, North Carolina State University

### **Exploratory Analysis of Crossing Difficulties for Blind and Sighted Pedestrians at Channelized Turn-Lanes (06-0425)**

*TRB, Washington, D.C., 2006*

Bastian Jonathan Schroeder, ITRE, North Carolina State University  
Nagui M. Rouphail, ITRE, North Carolina State University  
Robert S. Wall, Western Michigan University

### **Failure Detection and Diagnosis in Micro-Simulation Traffic Models (06-0530)**

*TRB, Washington, D.C., 2006*

Baohong Wan, Martin/Alexiou/Bryson, PLLC  
Nagui M. Rouphail, ITRE, North Carolina State University  
Jerome Sacks, National Institute of Statistical Sciences

### **Improving Prediction of Annual Average Daily Traffic for Non-Freeway Facilities by Applying Spatial Statistical Method (06-0669)**

*TRB, Washington, D.C., 2006*

JinKi Eom, ITRE, North Carolina State University  
Man Sik Park, North Carolina State University  
Tae-Young Heo, North Carolina State University  
Leta F. Huntsinger, ITRE, North Carolina State University



**Incorporating the Effects of Traffic Signal Progression Into the Proposed Incremental Queue Accumulation (IQA) Method (06-0107)**

*TRB, Washington, D.C., 2006*

Dennis W. Strong, Strong Concepts

Nagui M. Rouphail, ITRE, North Carolina State University

**Integrating Planning and NEPA: Linking Transportation and Land Use Planning to Indirect and Cumulative Impacts (06-2096)**

*TRB, Washington, D.C., 2006*

Janet D'Ignazio, ITRE, North Carolina State University

Julie Hunkins, North Carolina Department of Transportation

**New Calculation Method for Existing and Extended HCM Delay Estimation Procedures (06-0106)**

*TRB, Washington, D.C., 2006*

Dennis W. Strong, Strong Concepts

Nagui M. Rouphail, ITRE, North Carolina State University

Ken Courage, University of Florida

**Reasonable Speed Limits on Suburban Multilane Highways with Curbs (06-2464)**

*TRB, Washington, D.C., 2006*

Jongdae Baek, North Carolina State University

Joseph E. Hummer, North Carolina State University

Billy M. Williams, North Carolina State University

Christopher M. Cunningham, ITRE, North Carolina State University

**School Bus Occupant Protection (06-1925)**

*TRB, Washington, D.C., 2006*

Derek Graham, North Carolina Department of Public Instruction

Jeff Tsai, ITRE, North Carolina State University

**Sensitivity Analysis of Highway Capacity Manual Input Variables and LOS Analysis Tool for Four Facility Types in North Carolina (06-1314)**

*TRB, Washington, D.C., 2006*

Shannon J. Fain, ITRE, North Carolina State University

Robert S. Foyle, ITRE, North Carolina State University

**Speed and Facility-Specific Emission Estimates for On-Road Light Duty Vehicles (06-1096)**

*TRB, Washington, D.C., 2006*

H. Christopher Frey, North Carolina State University

Nagui M. Rouphail, ITRE, North Carolina State University

Haibo Zhai, North Carolina State University

## Published Refereed Journal Papers

Coelho, M., T. Farias and N. Rouphail (2005), "A Methodology for Modeling and Measuring Traffic and Emission Performance of Speed Control Traffic Signals", *Journal of Atmospheric Environment*, 39, 2367-2376, Elsevier.

Coelho, M., T. Farias and N. Rouphail, (2005), "Impact of Speed Control Traffic Signals on Pollutant Emissions", *Transportation Research D*, 323-340, Elsevier.

D'Ignazio, Janet, and Julie Hunkins, (2005), "Context Sensitive Solutions in the Planning Process: North Carolina's Experience", *Journal of the Transportation Research Board*, #1904, 75-83, TRB, Washington, D.C.

Lee, J., N. Rouphail, J. Hummer, (2005), "Lane Utilization Prediction Models for Lane-Drop Intersections", *Journal of the Transportation Research Board*, #1912, 47-56, TRB, Washington, D.C.

Paulo, R., J. Lin, N. Rouphail and J. Sacks, (2005), "Calibrating and Validating Deterministic Traffic Models: Application to the HCM Control Delay at Signalized Intersections", *Journal of the Transportation Record*, #1920, 95-105, TRB, Washington, D.C.

Rouphail, N.M., R. Hughes and K. Chae, (2005), "Exploratory Simulation of Pedestrian Crossings at Roundabouts", *ASCE Journal of Transportation Engineering*, Volume 131, Issue 3, 211-218.

Townsend, Teresa, Leigh Lane, and James Martin, (2005), "Context Sensitive Solutions: Training Experience", *Journal of the Transportation Research Board*, #1904, 67-74, TRB, Washington, D.C.

## Other Published Papers

Do, Ann H., J. Hummer, J.L. Toole, and N. Rouphail, (2005), "Making Trails", *Public Roads*, Vol. 69, No. 1, FHWA, Washington, D.C., 12-17.

Lawrie, Jud, (2005), "Strategic Planning and Management in Transit Agencies", *TCRP Synthesis 59*, TRB, Washington, D.C.

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## Conference Exhibits and Participation in 2005

### Center for Transportation and Environment

- Deer-Vehicle Crash Reduction Symposium, Madison, WI
- FHWA CSS National Conference, Minneapolis, MN
- International Association of Impact Assessment Annual Meeting, Boston, MA
- International Conference on Ecology and Transportation, San Diego, CA (Co-Sponsor and Lead Organizer)
- ITE National Meeting, Las Vegas, NV
- Mid-West Regional CSS Conference, Minneapolis, MN
- NCSITE Annual Meeting, Raleigh, NC
- Transportation Research Board Annual Meeting, Washington, D.C.

### NC LTAP

- 2005 NC Street Maintenance Engineers Conference, Wilmington, NC
- 2005 NC Transportation Forum, Charlotte, NC
- LTAP Region 4 Annual Meeting, Lexington, KY
- NC APWA Annual Chapter Meeting, New Bern, NC
- Southeastern Local Roads Conference, Savannah, GA

### Pupil Transportation Group

- National Association for Pupil Transportation Annual Conference, Austin, TX
- National Association of State Directors of Pupil Transportation Services Annual Conference, Austin, TX
- North Carolina Pupil Transportation Conference, Asheville, NC
- North Carolina School Bus Driver ROADeo, Raleigh, NC
- North Carolina School Bus Safety Conference, Raleigh, NC
- Transportation Research Board Annual Meeting, Washington, D.C.
- Wake County GIS Exhibition, Raleigh, NC

### Highways

- Training 2005 Conference and Expo, New Orleans, LA
- Transportation Research Board Annual Meeting, Washington, D.C.
- TRB Committee AHB40, Highway Capacity and Quality of Service Mid-Year Meeting, Las Vegas, NV
- TRB National Roundabouts Conference, Vail, CO
- TRB Workshop on Traffic Modeling, Sedona, AZ

### Triangle Regional Service Bureau

- Transportation Planning Applications Conference, Portland, OR
- Transportation Research Board Annual Meeting, Washington, D.C.

### Public Transportation Group

- NCDOT/PTD Community Transportation Conference, Charlotte, NC
- North Carolina Public Transportation Association Conference, Wilmington, NC
- Transportation Research Board Annual Meeting, Washington, D.C.

### Commercial Vehicles and Safety

- Future Truck and Bus Safety Research Directions Conference, Washington, D.C.
- I-95 Corridor Coalition, Saratoga Springs, NY
- ITE Conference, Rocky Mount, NC
- North Carolina GIS Conference, Winston-Salem, NC
- Transportation Research Board Annual Meeting, Washington, D.C.

## Summary of Education/Training and Outreach

ITRE's combined training activities educated more than 11,500 individuals in 2005. Some of the education opportunities included Work Zone Safety, offering 205 workshops; the Center for Transportation and the Environment's (CTE) National Teleconference Series and Context Sensitive Solutions Design classes; the Local Technical Assistance Program, offering 59 workshops to local government employees; and training classes through the Public Transportation Group, Pupil Transportation Group, and Municipal Technical Services Program. The Public Transportation Group conducts approximately 104 courses at ITRE including classes off-site. The Highway Systems Group provides training on Maintenance Technical Assistance, Professional Enhancement and Fundamentals of Engineering Principles program. These programs have always had a good track record and operate close to capacity. The Transportation Founders Fund offered two well-attended seminars by nationally recognized speakers in 2005. Training areas are depicted in Exhibit VI.

**Exhibit VI - Summary of Training Activities in 2005**

| Program Area                                | Training/Workshops in 2005                   | Instruction Hours per Session | Sessions Offered | Total Hours | Attendees |
|---|--|-------------------------------|------------------|-------------|-----------|
| <b>ITRE</b>                                 | Transportation Founders Fund Speaker Series  |                               |                  |             |           |
|   | <i>Mr. Dennis Rash (4/19/2005)</i>           | 1                             | 1                | 2           | 60        |
|   | <i>Dr. Essam Radwan (10/03/2005)</i>         | 1                             | 1                | 2           | 55        |
| <b>CTE</b>                                  | Context Sensitive Solutions                  | 24                            | 16               | 384         | 476       |
|   | Teleconference Series                        | 3                             | 5                | 15          | 1,750+    |
| <b>Highway Systems</b>                      | Asphalt Pavement Maintenance                 | 7                             | 12               | 84          | 232       |
|   | Drainage                                     | 7                             | 17               | 119         | 343       |
|   | FEP Program for NCDOT Employees              | 25.2                          | 39               | 982.8       | 429       |
|   | Fundamentals of Engineering (FE) Review      | 140                           | 1                | 140         | 21        |
|   | FE Review – Night                            | 66                            | 2                | 132         | 56        |
|   | Flagger Training                             | 4                             | 36               | 144         | 578       |
|   | Flagging - Instructor                        | 12                            | 10               | 120         | 128       |
|   | Guardrail Design, Installation & Maintenance | 7                             | 12               | 84          | 146       |
|   | Highway Engineering Concepts (HEC)           | 119                           | 3                | 357         | 90        |
|   | Maintenance Condition Survey                 | 0                             | 0                | 0           | 0         |
|   | Professional Engineering (PE) Review         | 112                           | 1                | 112         | 42        |
|   | PE Review – Night                            | 57                            | 3                | 171         | 122       |
|   | Signal Capacity Analysis                     | 8                             | 1                | 8           | 42        |
|   | Traffic Control Certification                | 21                            | 6                | 126         | 166       |
|   | Traffic Signal Inspection Workshops          | 6                             | 5                | 30          | 130       |
|   | Traffic Signal Systems                       |                               |                  |             |           |
|   | <i>Day 1 – Traffic Signal Fundamentals</i>   | 6                             | 2                | 12          | 46        |
|   | <i>Day 2 – Signal Systems Fundamentals</i>   | 6                             | 2                | 12          | 46        |
|   | Work Zone Safety – Basic                     | 6                             | 67               | 402         | 1,673     |
|   | Work Zone Safety – Basic, Instructor         | 28                            | 2                | 56          | 30        |
|   | Work Zone Safety – Intermediate              | 7                             | 35               | 245         | 878       |
|   | Work Zone Safety – Advanced                  | 7                             | 23               | 161         | 470       |
|   | Work Zone Traffic Control Supervisor         | 21                            | 15               | 315         | 343       |
| Local Roads Conference                      | 1  | 1                             | 1                | 50          |           |
| <b>Municipal Technical Services Program</b> | Introduction to ArcGIS                       | 24                            | 5                | 120         | 23        |
|   | Introduction to ArcGIS (NCDOT)               | 24                            | 4                | 96          | 32        |
|   | Intermediate ArcGIS                          | 16                            | 3                | 48          | 10        |
|   | Integrating GIS/GPS                          | 16                            | 1                | 16          | 3         |
|   | Customized GIS Training                      | 12                            | 3                | 36          | 10        |

| Program Area                                    | Training/Workshops in 2005   | Instruction Hours per Session | Sessions Offered | Total Hours  | Attendees     |
|---|--|-------------------------------|------------------|--------------|---------------|
| <b>NC LTAP</b>                                  | Advanced Trenching "Competent Person" Refresher                      | 4                             | 1                | 4            | 10            |
|   | Advanced Work Zone Safety  | 7                             | 3                | 21           | 58            |
|   | Asphalt Pavement Maintenance   | 6                             | 2                | 12           | 92            |
|   | Asphalt Roller Operator Training                                     | 6                             | 1                | 6            | 18            |
|   | Backhoe Operator Training  | 6                             | 2                | 12           | 27            |
|   | Basic Drainage/Roadway Drainage Maintenance                          | 7                             | 1                | 7            | 26            |
|   | Basic Work Zone Safety   | 7                             | 5                | 45           | 134           |
|   | Communicating with the Public and Media                              | 16                            | 1                | 16           | 15            |
|   | Concrete: What, When and How   | 7                             | 2                | 14           | 50            |
|   | Confined Space Entry/Lockout/Tagout                                  | 7                             | 1                | 7            | 18            |
|   | Excavation Safety  | 6                             | 1                | 6            | 14            |
|   | Flagger Training   | 4                             | 4                | 12           | 85            |
|   | Flagging Instructor Training   | 10                            | 1                | 10           | 15            |
|   | Geotextiles in Soil Structures & Pavements                           | 7                             | 1                | 7            | 46            |
|   | Guardrail Design, Installation & Maintenance                         | 7                             | 1                | 7            | 3             |
|   | Intermediate Work Zone Safety  | 7                             | 4                | 21           | 101           |
|   | Introduction to Americans With Disabilities Act                      | 4                             | 2                | 8            | 39            |
|   | Loader Operator Training   | 7                             | 1                | 7            | 2             |
|   | Maintenance & Repair of Utility Cuts                                 | 4                             | 3                | 12           | 99            |
|   | Management and Supervisory Skills <i>for Experienced Supervisors</i> | 7                             | 1                | 7            | 23            |
|   | Management and Supervisory Skills <i>for First Time Managers</i>     | 7                             | 2                | 14           | 52            |
|   | Motorgrader Operator Training  | 6                             | 1                | 6            | 8             |
|   | OSHA 10-Hour Safety Training   | 10                            | 1                | 10           | 18            |
|   | Plan Reading for Field Personnel                                     | 6                             | 1                | 6            | 16            |
|   | Risk Management & Tort Liability                                     | 6                             | 1                | 46           | 40            |
|   | Roadside Landscaping for North Carolina                              | 6                             | 1                | 6            | 18            |
|   | Snow & Ice Control   | 7                             | 3                | 18           | 299           |
|   | Soils Fundamentals   | 6                             | 2                | 12           | 76            |
|   | Stormwater Hydrology and Design                                      | 7                             | 2                | 14           | 35            |
|   | Traffic Calming  | 4                             | 1                | 4            | 13            |
| Trenching "Competent Person"                    | 7  | 4                             | 28               | 60           |               |
| Writing Skills for Transportation Professionals | 6  | 2                             | 12               | 54           |               |
| <b>Public Transportation</b>                    | Americans with Disabilities  | 30                            | 3                | 90           | 118           |
|   | Developing RFP   | 1.5                           | 1                | 1.5          | 45            |
|   | Route Match Activities: <i>User Groups</i>                           | 1.5                           | 7                | 10.5         | 92            |
|   | <i>Specialized Training</i>  | 5                             | 1                | 5            | 7             |
|   | <i>Implementation Trainings</i>                                      | 42                            | 3                | 126          | 32            |
|   | <i>Vendor Demonstrations</i>   | 10                            | 2                | 20           | 14            |
|   | Technology and Planning  | 7                             | 1                | 7            | 50            |
|   | Transit Operations Planning  | 4                             | 1                | 4            | 23            |
|   | Transportation Leadership Development Program                        | 120                           | 2                | 240          | 16            |
|   | TriP_Maker Advanced  | 6                             | 28               | 168          | 93            |
|   | TriP_Maker   | 6                             | 28               | 168          | 90            |
|   | TriP User Group  | 2                             | 2                | 4            | 56            |
|   | Safe Routes to School  | 8                             | 6                | 48           | 150           |
|   | <i>Facilitator Training</i>  | 8                             | 5                | 40           | 25            |
|   | Bicycle Planning and Design  | 6.5                           | 4                | 26           | 153           |
| Pedestrian Planning and Design                  | 6.5  | 10                            | 65               | 137          |               |
| <b>Pupil Transportation</b>                     | Boundaries   | 6                             | 5                | 30           | 45            |
|   | EduLog.NT  | 12                            | 7                | 84           | 63            |
|   | EMU/System Admin   | 6                             | 7                | 42           | 51            |
|   | Maris  | 12                            | 6                | 72           | 51            |
|   | Plotting   | 6                             | 5                | 42           | 44            |
|   | Reporting  | 6                             | 3                | 18           | 19            |
|   | Special Needs Transportation   | 6                             | 4                | 24           | 90            |
|   | Special Training   | 6                             | 7                | 42           | 18            |
| <b>Totals</b>                                   |  | <b>1,332</b>                  | <b>541</b>       | <b>6,327</b> | <b>11,526</b> |

## Marketing/Public Relations Outreach in 2005

Press releases/advisories/stories communicated to media:

- Total news releases sent including 1 media advisory: 49 (49% increase)
- Press releases concerning research studies or activities at ITRE have resulted in a variety of media interest including top television news programs, newspapers, online news periodicals, radio programs, Web sites, transportation magazines, and even Web logs.
- 82 news stories or articles were published citing ITRE, ITRE research, or an ITRE program/staff member. Not all reports correctly reported the facts, but ITRE was cited. More articles are likely to have been published citing ITRE that were not found or tracked. (82% increase)
- 27 News stories resulted directly from press releases sent from our office (80% increase)
- 5 articles were written and published citing ITRE's research, 4 by current staff members and one by a graduated doctoral student. One article also created interest for news in the *Wall Street Journal*. 7 journal papers of staff members were also published.

In 2005, ITRE was cited in the following 45 media outlets and publications:

|  |                                      |
|--|--------------------------------------|
| ABC 11   | Salisbury Post                       |
| Asheboro Courier-Tribune                             | School Transportation News           |
| Asheville Citizen-Times                              | Southern Pines Pilot                 |
| Bladen Journal                                       | thenewspaper.com                     |
| Brunswick Beacon                                     | The Bulletin                         |
| Charlotte Observer                                   | The Courier-Times                    |
| Cincinnati Inquirer (OH)                             | The Daily Tarheel                    |
| City of Raleigh Web site                             | The Graham Star                      |
| Daily Advance (Jacksonville)                         | The Herald (SC)                      |
| Durham Herald-Sun                                    | The News & Observer                  |
| Greensboro News-Record                               | The Pilot (Pinehurst area)           |
| Greenville Daily Reflector                           | The Virginian-Pilot (VA)             |
| Hendersonville Times-News                            | Tribune-Chronicle (OH)               |
| Jacksonville Daily News                              | TRB News Board                       |
| McTrans Moving Technology Newsletter                 | TR News (Nat'l)                      |
| Myrtle Beach Sun News (SC)                           | UNC-TV                               |
| National Campaign to Stop Red Light Running Web site | Union County Public Schools Web site |
| NCSU Civil Engineering News                          | Wall Street Journal                  |
| NCSU College of Engineering News                     | Waynesville Smoky Mountain News      |
| News 14 Carolina                                     | Wilson Daily Times                   |
| Public Roads Magazine                                | Winston-Salem Journal                |
| Outer Banks Sentinel                                 | WRAL-TV                              |
|  | WSPA News Channel 7 (SC)             |

## Student Support

ITRE projects have supported a large number of students from various disciplines and universities over the past five years. The table below summarizes our track record on student support, indicating a surge in graduate student involvement at ITRE.

| Year         | Undergraduate | Graduate  | Total      |
|--------------|---------------|-----------|------------|
| 1997-98      | 6             | 7         | 13         |
| 1998-99      | 4             | 2         | 6          |
| 1999-00      | 10            | 4         | 14         |
| 2000-01      | 21            | 10        | 31         |
| 2001-02      | 14            | 9         | 23         |
| 2002-03      | 11            | 15        | 26         |
| 2003-04      | 11            | 19        | 30         |
| 2004-05      | 11            | 23        | 34         |
| <b>Total</b> | <b>88</b>     | <b>89</b> | <b>177</b> |

| Undergraduate 2005                     | Graduate 2005                 |                                |
|--|-------------------------------|--------------------------------|
| Emily Bone                             | Daniel Carter                 | Jae Joon Lee, <i>Ph.D</i>      |
| Ryan Hough                             | Kosok Chae, <i>Ph.D</i>       | Jiong Lin                      |
| Bryan Hough                            | Margarida Coelho, <i>Ph.D</i> | Jonathan Lewis                 |
| April Schmiege-Fosmore                 | Barden Culbreth               | Jason Lundberg                 |
| Martin Holland                         | Jin Ki Eom, <i>Ph.D</i>       | Liza Runey                     |
| Dylan Liverman                         | Daniel Findley                | Bastian Schroeder, <i>Ph.D</i> |
| Lauren Moellers                        | Zhai Haibo, <i>Ph.D</i>       | Jeremy Scott                   |
| Stephen Reuschle                       | Yang Han, <i>Ph.D</i>         | Christina Settle               |
| Sravya Suryadevara                     | Ann Hartell                   | Anna Leos-Urbel                |
| Christopher Vaughan                    | Saeed Abul Hosseini           | Jyuang Yang                    |
| Corey Vernier                          | Hyejung Hu, <i>Ph.D</i>       | Emily Zechman, <i>Ph.D</i>     |
| <b>High School Students not listed</b> | Daniel Keilson                |                                |

As seen above, the past three fiscal years show a significant increase in the students we are supporting through our projects. This is a result of ITRE making a conscious effort to involve students in our activities. Many of the students are seeking careers in transportation, and we are glad to provide an environment where transportation research and education is seen as a rewarding career. We are also delighted to report that three Ph. D. students who were partially or fully supported through ITRE have successfully completed the doctorate program. These include: Kosok Chae, Jae Joon Lee and Margarida Coelho (Technical University of Lisbon).

ITRE is also hosting and providing partial support for a Post-Doctoral Fellow position, another first. **Dr. Xuesong Zhou** from the University of Maryland is involved in research projects related to Transportation and Environment and Advanced Travelers Information Tools. He has also assisted in proposal writing and was guest lecturer for a graduate course.

Students have come from the following 8 degree programs:

- Civil Engineering
- Computer Science
- English
- Environmental Science
- Geography
- Mathematics
- Political Science
- Urban Planning

## Appendix – Summary of Program Groups

### *Center for Transportation and the Environment*

As a U.S. Department of Transportation university transportation center of excellence, the Center for Transportation and the Environment (CTE) conducts research, education, and technology transfer activities that seek to mitigate the impacts of surface transportation on the environment. CTE's mission is national in scope, although CTE co-sponsors activities and makes its services available at the local, state, and regional levels as well. CTE has provided over a decade of service to transportation and environmental professionals and has played a pivotal role in developing the next generation of professionals who will be charged with meeting future mobility needs in an environmentally sound manner. The federal transportation bill, recently signed into law by President George W. Bush, includes funding for CTE. The new bill, which finances the nation's surface transportation programs, provides \$500,000 per year to CTE for fiscal years 2006 through 2009.

### *Highway Systems Group*

The Highway Systems Group developed out of the early research and development efforts in the 1980's on projects for the Division of Highways of NCDOT. Today's efforts expand upon that base of knowledge to include focus areas such as: Highway Safety, Transportation Policy, Traffic Operations, Work Zone Safety, Maintenance Operations, Professional Development Training, and Professional Engineering Review.

- *Triangle Regional Model Service Bureau*

The purpose of the Triangle Regional Model Service Bureau is to provide transportation modeling expertise to the Capital Area Metropolitan Planning Organization, the Durham-Chapel Hill-Carrboro Metropolitan Planning Organization, the Triangle Transit Authority, and NCDOT to support each agency's needs in meeting the requirements in Section 134, Title 23, U.S. Code, NC General Statutes 136-66, and the 1990 Clean Air Act. This work includes, but is not limited to: (1) design and development multimodal travel demand models; and (2) integration of GIS technologies into supply side forecasting, demand side forecasting, and transportation plan development.

### *Commercial Vehicles and Safety Group*

The Commercial Vehicles and Safety Group provides data analysis and program evaluation support to the Motor Carrier Safety Assistance Program (MCSHP) of the NC State Highway Patrol as well as conducts collaborative research and development with and for government, industry, and professional/domain specific organizations. It is the parent ITRE group for Geographic Information Systems (GIS) work done through the Municipal Technical Services Program. This group also provides specialized expertise in the areas of 3D/4D visualization as well as research on the performance needs of visually impaired pedestrians.

- *Municipal Technical Services Program*

The Municipal Technical Services Program (MTSP) at ITRE is comprised of technical staff members that provide a wide range of technical services to state and local governments throughout the Mid-Atlantic region.

### *NC Local Technical Assistance Program*

The Federal Highway Administration established the North Carolina Local Technical Assistance Program in 1982. The NC LTAP center plays a leading role in helping state and local government agencies assess and apply new transportation technologies through a broad spectrum of highway research, training and transportation planning activities. North Carolina's LTAP Program offers four primary types of assistance: Training Workshops, Technical Materials, Technical Information Services, and Quarterly Newsletters.



### *Public Transportation Group*

The Public Transportation Group is responsible for research, training, and technical assistance in the area of public transportation. Activities focus on the following transportation modes: urban fixed-route and paratransit, rural demand-responsive transit, passenger rail, bicycle and pedestrian, taxicab and livery. This group pursues practical applications that can have immediate benefits to increasing efficiencies in transit operations and positively impact service and transportation choices for the passenger.

- *Bicycle and Pedestrian Program*

The Bicycle and Pedestrian Program has the distinction of long-standing working partnerships with NCDOT's Division of Bicycle and Pedestrian Transportation, one of the oldest comprehensive bike programs in the country. This partnership works closely together on research and technical assistance projects.

### *Pupil Transportation Group*

The mission of the Pupil Transportation Group is to apply transportation engineering principles and technology to the operation and management of multi-modal school transportation in order to provide for safe and efficient transportation of school children. The key to the success of the pupil transportation group is its partnership with local education agencies, state agencies, universities, national associations, and private industries. The very first Perley A. Thomas Award was given to the group for achievement and innovation in the field of school bus transportation at the 2005 North Carolina Hall of Fame Induction Ceremony.

- *OR/Ed. Lab Program*

The Operations Research/Education Laboratory (OR/Ed. lab) has developed a system of Integrated Planning for School and Community (IPSAC), which fully integrates community and regional data, 10-year economic and demographic forecasts, demographic and land use studies, digitized pupil and school location files, and mathematical optimization algorithms. The lab uses the modern tools of management science helping educators and public administrators to make decisions wisely, to evaluate policy alternatives thoroughly, and to allocate resources efficiently.

2005 sponsors for IPSAC research include the following school 16 systems: Asheboro City, Bladen County, Brunswick County, Chapel Hill/Carrboro, Chatham County, Granville County, Johnston County, Moore County, Nash-Rocky Mount, Onslow County, Randolph County, Rock Hill South Carolina School District #3, Pitt County, Stokes County, Union County, and Wake County.

- *Transportation Information Management Systems Program (TIMS)*

The TIMS Program provides support and consulting for the Computer Assisted Routing Program used in every secondary school system in North Carolina. The Transportation Information Management System is a joint project activity among the North Carolina Department of Public Instruction, Institute for Transportation Research and Education, and the Urban Institute at UNCC.