

NCDOT PROJECT-DELIVERY IMPROVEMENT RECOMMENDATIONS

July 4, 2007



Prepared for
THE NORTH CAROLINA GENERAL ASSEMBLY

Prepared by



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Executive Summary

In April 2007, the North Carolina General Assembly tasked PBS&J with the evaluation of policies and procedures implemented by the North Carolina Department of Transportation (NCDOT), specifically as they relate to the delivery of NCDOT projects. Three separate but related tasks were undertaken, each attempting to shed light on current NCDOT project-delivery methods and how they might be streamlined for greater cost-effectiveness and faster execution.

The purpose of this report is to provide a detailed overview of those activities and their ongoing status. The report's three main sections view the subject of NCDOT project delivery from unique perspectives: 1) addressing the current state of NCDOT project delivery with a substantial set of findings and recommendations; 2) analyzing NCDOT environmental policies and the influence they have on overall project delivery; and 3) a comprehensive set of 10 Value Engineering studies for projects in NCDOT's Transportation Improvement Program (TIP).

Three main sections of this document follow the **Executive Summary**, each pertaining to a different aspect of this overall project:

- The first section is **Status Update: NCDOT Project Delivery** and provides a snapshot overview of the current state of NCDOT project management and delivery, augmenting findings and recommendations from a 2004 report by Dye Management, as well as written responses from a November 2005 NCDOT report to the North Carolina General Assembly. This update is also based on extensive interviews with NCDOT senior managers and interested transportation industry leaders.
- The second section of the report focuses on an **NCDOT Environmental Process Review**, based upon interviews with NCDOT staff, resource agency staff, and industry representatives. This task involved an examination of the NEPA 404/Merger 01 process versus the Federal SAFETEA-LU Section 6002 process, and the impact of those processes upon project schedules and costs. This task also included an evaluation of related environmental policies, e.g. bridge buffer rules.
- The final and largest section of the report addresses **Value Engineering Study Recommendations** for selected TIP projects. Along with a recounting of the methodology used in the Value Engineering studies conducted in April and May

2007, the reader will find detailed descriptions of the 10 different TIP projects which formed the basis of the overall study effort. Selected alternatives and design suggestions that have been detailed in specific Value Engineering study reports also appear within this section of the report. After offering project-specific suggestions, the report concludes with supplemental information about different approaches being employed by the departments of transportation of other states with regard to engineering and design practices.

Section 1

Status Update: NCDOT Project Delivery

1.1 Introduction

PBS&J directed a 12-week study for the NC General Assembly generally focused on North Carolina Department of Transportation's (NCDOT's) Transportation Improvement Program (TIP) delivery processes. This update on project delivery builds upon a more extensive study conducted in 2004 by Dye Management and also upon written responses by NCDOT provided to the North Carolina General Assembly in Nov. 2005.

In particular, there were three distinct subtasks within the overall scope of this update. One first task consisted of 10 Value Engineering (VE) studies of specific projects in the DOT pipeline. A second task focused specifically on the DOT/Resource agency approaches to environmental reviews and permitting. The final task (and the one which is the focus of this section) is on the overall TIP management and project-delivery processes.

Understandably, some of the issues developed under the VE and environmental-process tasks will be incorporated within the final report in conjunction with this task. However, this discussion will focus specifically on the major project-delivery issues listed below which were first raised in the Dye Management report. (Note that the environmental process issues in the Dye report will, for the most part, be the subject of a separate discussion.)

General Issue Areas:

- Predictability, accountability, communications for project delivery
- Overall project-delivery process (specifically development/delivery TIP and use of alternative-delivery options)
- Causes of delay – consultant procurement/management
- Project-management principles/practice

PBS&J personnel conducted 10 interviews with senior NCDOT staff and former staff as well as individual and group sessions with transportation industry leaders and organizations. The interviews were conducted to encourage open and frank dialogue and followed the general issue areas outlined above. The interviews were not recorded and comments are not attributed by name or by the position held by those offering the comment.

As stated in the Overview section of the Dye Report, “NCDOT requires...top-down department-wide organizational and business improvement changes to increase accountability and provide for ‘end-to-end’ management oversight and control of project delivery.” The overriding conclusion of this update is that minimal progress has been made in regard to this challenge, and that significant further improvements are needed. For an organization as large (with approximately 14,000 employees) and complex (with responsibility for more than 78,000 miles of roadway, support for locally managed transit systems, a statewide rail program, ferry operations, and oversight of more than 70 general aviation airports) as NCDOT, change—and especially change management—is difficult. Such change requires nothing less than a significant and sustained commitment to creating a new culture at NCDOT. This culture must value project management and delivery at its core. Without that focus, the Department will never recapture the confidence of the taxpayers, the General Assembly, and the traveling public.

1.2 Findings

1.2.1 Predictability, Accountability, and Communications for Project Delivery

The following three recommendations were made in the Dye report:

- ***Recommendation 1.1:*** *Provide proactive and standardized delivery reports at the program and project level to policymakers, customers, and business partners.*
- ***Recommendation 1.2:*** *Revise the letting list process to improve accuracy and integrate with a multi-year delivery plan.*
- ***Recommendation 1.3:*** *Change the TIP structure to improve the ability to deliver projects as planned.*

Our update found that some progress in these areas had been achieved. However, the process of creating and monitoring the TIP needs to be overhauled.

Fundamentally, the TIP should be viewed as a planning and programming guide rather than a project- delivery tool or reporting mechanism. Measuring the TIP “success rate” and comparing projects in the TIP at the beginning of the year versus those that are actually delivered in that year, shows that NCDOT has only exceeded 80 percent once in

the last decade. In most years the success rate has hovered in the mid-50 to mid-60 percent levels. It hit an all-time low of 43 percent in 2004. These levels of “success” are not reflective of the effort expended by DOT staff and the consultant community to achieve results, nor do they reflect a standard to which any state-level transportation organization should aspire.

NCDOT has taken steps to refine and improve both a “12-month let list” and a “36-month let list.” These lists are intended to reflect monthly updates for those projects that are actually moving along in the TIP pipeline, and which can be reasonably expected to be let to construction within those time frames.

These lists could also be the basis for creating 1-year and 3-year “work plans” that would build better accountability and performance-tracking capability, as well as more realistic and achievable performance levels than the current TIP and its related “success” measures. Florida DOT, for example, invests heavily in creating such work plans as a means to direct work efforts, to evaluate performance on an individual and group basis, and to report outcomes to the public and its stakeholders (the Florida Legislature and Transportation Commission).

The 3-year work plan can become the “delivery TIP” envisioned in the Dye report (and discussed below). To pursue that approach it will be critical to screen carefully which projects are placed in the plan. Should the plan become like the current TIP (i.e., a composite of the wish lists of DOT Board members, legislators, MPOs and RPOs, community leaders, etc.) then it, too, will lose its relevance as a tool to measure outcomes in the transportation arena.

Projects further out in the planning horizon (or early in the planning/environmental review processes) could be grouped into broad categories of activity in the years beyond the third year of the TIP. This is consistent with the notion of a developmental TIP (discussed below).

Transparency is a critical element in 21st Century transportation planning and project delivery. It does little good (and potentially great harm) to carry precise estimates of future projects in the TIP as if there was a level of confidence in those estimates (and in those projects) that leaves no doubt as to their ultimate construction. In fact, as projects linger in the TIP without progress, they become a liability, as far as public perception of the process and the Department.

Such projects can also raise major concerns about whether the project is “in the TIP” to solve a transportation challenge or simply because it has a “patron” advocating for it. This is not to imply that legislators, Board members, and others should not advocate for projects within their jurisdictions. Rather, it is to assert that advocacy alone should not be sufficient to carry a project forward. In the end, transportation dollars should be used to solve transportation problems. The more one can “objectify” those decisions on the basis of explicit criteria and decision-making, the better will be the performance of the overall system of which one project is a part.

NCDOT has improved its cash-management practices in recent years, and should improve its project-management approaches (as discussed later in this report) in the coming years. As a result, the tools to create more predictability and reliability in project planning and delivery could produce extremely favorable results. Furthermore, it will be easy to communicate these results to any interested party. Finally, it should reassure legislative leaders and others that the department is using its resources wisely and in the public interest, as intended.

1.2.2 Overall Project-Delivery Process

The following three recommendations were made in the Dye report:

- ***Recommendation 2.1:*** Restructure the TIP so that it includes a development and a delivery component.
- ***Recommendation 2.2:*** In conjunction with the Highway Trust Fund Study committee work, amend statute so that it does not predefine the cross section of intrastate projects as four lanes.
- ***Recommendation 2.3:*** Evaluate alternative project-delivery options and pilot their use through the Turnpike Authority.

A delivery TIP, or project delivery work plan, has not been fully implemented by NCDOT although the “36-month let list” could be the basis for moving in that direction quickly. Although Dye suggested a 5 year horizon for such a TIP, our experience would recommend a shorter horizon (e.g., 3 years). In general, 3 years is adequate time to acquire right-of-way, design a facility, and develop reliable costs estimates, etc., in order to advance from a planning/permitting approval to a construction let date. Beyond that time frame, it is difficult to predict when a project might be let or whether the funds will be available to do so.

The delivery TIP, then, would be comprised of projects that have already moved substantially through the Planning and Environmental phases. These projects could be good candidates for an early Value Engineering (VE) effort, partly as a mechanism to fine-tune the cost estimate for the project. Better estimates at that point will help control “scope” changes and provide more predictability to the ultimate cost of the project and the TIP. A later, more comprehensive VE study could produce additional cost savings 1 to 2 years out from the let date.

With regard to the third recommendation (piloting alternative delivery options through the North Carolina Turnpike), there is certainly merit to that approach. In fact, the Triangle Expressway (in the RTP region) is proposed to be let as a series of design-build projects, and the Mid-Currituck Bridge is being pursued as a Public-Private Partnership (P3) effort. Neither project has advanced far enough to provide any significant insights yet. NCDOT has experienced mixed results with design-build as a way to reduce costs; the greatest benefits have been derived from faster completion of the projects than under traditional design-bid-build methods.

To get projects into and through the pre-construction phase of project development/delivery, neither NCDOT nor the NCTA to this point has considered seeking “turn-key” delivery by the consulting community. This approach has been successfully used in Florida, South Carolina, and other states to expedite the pre-construction process. However, this approach can only work well in an environment where clear performance standards have been set and clear accountability is enforced on both internal DOT and external consultant staff. Since NCDOT has neither established benchmarks nor budgets for pre-construction activities, the turn-key approach is premature at this point. With leadership to establish those standards and measures, such an approach would likely prove to be another useful tool for NCDOT in improving project delivery across the board.

The recommendation regarding the Highway Trust Fund has been implemented through legislation and the department will pursue those alternative cross-sections on the intrastate system as appropriate.

1.2.3 Addressing the Causes of Delay – Environmental Process

The following recommendation was made in the Dye report:

- ***Recommendation 3.1:*** *Stabilize and further strengthen the Merger 01 process by providing automatic issue escalation if work is not completed within specified timeframes.*

Most of the environmental-process recommendations are discussed at length in another section of this report. However, it is important to note the potential of this recommendation to improve delivery times and success rates *in the context of a project management culture.*

The “elevation” process envisioned in the various agreements among DOT and the resource agencies has rarely been used. This inaction is not surprising in the context of placing “consensus” or “concurrence” as a goal above efficient project delivery. As FHWA and NCDOT assert their leadership roles in defining “purpose and need” and “detailed study alternatives,” the need for elevation may increase and both agencies should be prepared to exercise their prerogative to get a timely decision.

Elevation alone will not significantly improve the project-delivery process. But elevation in the context of a project-management culture can be a powerful tool for improved decision-making and more efficient project delivery.

1.2.4 Addressing the Causes of Delay – Consultant Procurement and Management

The following three recommendations were made in the Dye report:

- ***Recommendation 4.1:*** *Simplify the consultant-procurement process.*
- ***Recommendation 4.2:*** *Establish a centralized procurement function to manage and administer all consultant contracts.*
- ***Recommendation 4.3:*** *Simplify consultant contract-approval processes.*

NCDOT has taken several steps to meet the intent of these recommendations. With regard to the third recommendation, the Board of Transportation has raised the threshold for approval of consultant contracts to \$250,000. This should have a positive benefit for quicker approval of smaller contracts.

Contract administration for pre-construction contracts and activities is in the process of being consolidated under the Project Development and Environmental Analysis (PDEA) unit. Over the longer run, this should reduce the time for negotiation of rates, etc. and

give the substantive specialists in PDEA more time to focus on the issues they know best. It should also assist in creating a comprehensive database with histories for project activities and consultants that will create one set of “facts” about which to negotiate terms and scopes of work more efficiently. It is too early in the transition to declare success, but the early signs are positive about this change in approach.

Related to these procurement issues, NCDOT has not established a good budgeting process for pre-construction activities and contracts. As a result, many projects have a “start-and-stop” character to them, which most likely increases the costs to DOT and also makes it difficult for consultants to plan their workloads and maintain the capacity to work efficiently and effectively on DOT projects.

Under the current system, it can take months after the “award” of a PDEA contract for an initial scope of work to be developed and for the detailed task orders under that scope to be negotiated. This approach is neither fair to the consultant community nor cost-effective for NCDOT. It would be advisable, especially on a pilot basis, for NCDOT to test alternative methodologies for engaging consultants to perform these tasks. Both Florida and South Carolina have experienced success with different approaches to this work effort, completing pre-construction activities sooner and at lower cost than North Carolina.

Other contracting methods (e.g., “lump sum/full delivery” or incentives for early completion) are worth testing to determine if they can reduce time (on average), or reduce the ultimate costs to DOT. More predictability with some sharing of risk with the private sector could produce large benefits.

1.2.5 Program and Project Management

The following 10 recommendations are drawn from the Dye report and since they all deal with aspects of “project management,” we have chosen to discuss them as a whole rather than separately:

Overall Program Management

- ***Recommendation 5.1:*** *Institute a Program-Delivery Management Committee to provide oversight, management control, and strategic direction for program management.*

- **Recommendation 5.2:** Establish measurable department-wide strategic objectives for program delivery, an annual business plan for improvements, and management accountabilities for accomplishing them.
- **Recommendation 5.3:** Establish a Program Office for project delivery.

Organizational Development to Strengthen the Application of Project-Management Principles and Practice

- **Recommendation 6.1:** Build on the recent organizational change establishing TIP Program Managers by making current PDEA and Preconstruction project-manager positions:
 - Dedicated positions solely to project management, responsible for scope, schedule, and budget management.
 - Separate project-management duties from technical-work tasks.
- **Recommendation 6.2:** Strengthen project-management practices by establishing standardized business rules, roles, and responsibilities for project delivery and then codify these in a project-delivery manual.
- **Recommendation 6.3:** Establish a project-management discipline-development program for NCDOT employees that recognizes project management as a professional discipline and provides employee development and training to strengthen the project-management discipline at NCDOT.
- **Recommendation 6.4:** For the most complex and/or highest priority projects, pilot a dedicated delivery team approach.

Project-Management Information, Metrics, Standardized Methods, and Project-Management Tools

- **Recommendation 7.1:** Conduct an expedited organizational readiness assessment; then establish and implement a change-management plan for PMii.
- **Recommendation 7.2:** Design and implement a reporting system for program and project-management monitoring and control.
- **Recommendation 7.3:** Stabilize the use of PMii to support scheduling and establish a management-level reporting system before further adding to PMii or instituting other information-technology projects.

Overall, there are a few bright spots related to “project management,” but there has been limited progress in adopting a project-management culture and philosophy within the department.

The Project Management improvement initiative (PMii), an information-technology tool built over the past 4 years is now operational. (NCDOT has recently renamed this effort “Project Scheduling, Tracking, and Reporting System, or Project STARS,” but we have chosen to keep the original terminology for this discussion.) This technology makes project management possible, but does not ensure its use or success. The tool is only as good as the data and information that goes into it and only if it is used to track projects, identify problems, assist resolution of those problems, and identify an owner (or owners) of the project. Accountability for project delivery can then be benchmarked, measured, and assessed.

The PMii tool will also allow an Executive Reporting system so that NCDOT can pursue making high-level information regarding project status, program status, etc., available to both internal senior managers and external stakeholders (e.g., legislative leaders and the taxpayers of North Carolina). Many states have implemented such reporting systems, notably Florida and Virginia in the Southeast. The transparency created by providing this information in clear and concise style has enormous benefits in building public confidence and support, and in assuring that problem projects or programs are identified and resolved. And when these reports are made available on the Internet, it is possible to give everyone nearly “real-time” information at the same time.

Another area where improvement has occurred is in the management of PDEA projects on a regional basis. Three PDEA regional managers have been charged with managing roughly one-third of the state; maintaining close contact with Board members, DOT staff, and resource-agency contacts in their region; and ensuring that projects are moving, meetings are being held in a timely manner, and issues are getting resolved during the process. This approach, while not “cradle-to-grave” project management, nonetheless embraces a project-management philosophy that could yield broader results if adopted in other areas.

Another example where this approach was used was in the Moving Ahead! program that the legislature authorized and the department executed from 2003–2005. Although that program focused on smaller projects of regional (rather than statewide) import, the approach used to develop those projects and deliver them demonstrated a different method of project delivery that could hold important lessons for larger projects. That

method offered more direction and control by DOT regional staff, early identification of issues that could jeopardize or delay project delivery, and a focus on achieving immediate improvements in traffic flow, safety, or other variables. Moving Ahead! did not seek the ultimate 30-year solution when a 10-year improvement project would work in its stead. The way these projects were screened and reviewed could inform the process of preparing the “delivery TIP.”

Unfortunately, for most of the other recommendations offered herein, the Department’s response has been minimal or non-existent. A Program-Delivery Management Committee was established, but has not met on a regular basis since its formation. No office has been established for project-delivery oversight. Two Project Manager (PM) positions were created (for a brief time) in PDEA, but when the two incumbents secured other positions, these PM positions were never filled again.

Pre-construction activities are now managed by co-project managers but, in essence, it appears that this approach has limited impact—even though it is viewed positively by both internal and external stakeholders. It is too tentative in both breadth of activities covered and in its immersion within a broader culture focused on delivering entire projects, rather than documents or permits.

Our discussions with department leaders indicated receptivity to the “delivery team” approach and the PDEA efforts could certainly be the foundation for more aggressive use of that approach. “Piloting” these concepts on a few high-visibility, high-priority projects could assist the department in building rank-and-file support for a project-management culture.

1.3 Recommendations

1. Begin immediately to establish “Project Management” as the overall guiding philosophy for NCDOT. This can be started immediately by implementing several of the Dye Management recommendations, e.g. standardizing business rules and responsibilities, identifying and filling key PM positions, and establishing a small but strong Project Management Office.
2. Begin to use PMii both as a project-management tool and as a broader reporting mechanism. This can be achieved easily within the next 6 months, as a technological challenge, if there is a leadership focus and commitment to it.

3. Begin the new TIP cycle this summer, with the goal of having a measurable and realistic first- year work plan developed by May 2008, to be implemented for the second year of the TIP.
4. Develop and test alternative pre-construction scoping and contracting mechanisms to determine if significant time- or cost savings can be achieved through these new approaches.
5. Identify 10 pilot projects to test the “team delivery” concepts, using PM principles and methodologies.

Section 2

NCDOT Environmental Process Review

2.1 Introduction

A limited review and analysis of the North Carolina Department of Transportation's (NCDOT) environment-related policies and procedures as they relate to the delivery of the Transportation Improvement Program (TIP) was conducted in April 2007. This report summarizes the findings of that review and makes several recommendations regarding initiatives or changes that may reduce the pre-construction costs and/or schedules of transportation projects.

The scope of services consisted of two environmental tasks:

1. **TASK 1** – Review and analyze the current status of environment-related policies to develop alternative approaches that could produce cost savings without jeopardizing environmental standards.
2. **TASK 2** – Analyze the NEPA/404 Merger 01 process versus the Federal SAFETEA-LU Section 6002 process and the impact on costs and time in the delivery of the construction program.

The review and analysis for these two tasks consisted of two work efforts. The first involved a review of the following materials:

- The National Environmental Policy Act (NEPA)/404 Merger01 process (<http://www.ncdot.org/doh/preconstruct/pe/MERGER01/default.html>)
- NC Ecosystem Enhancement Program (www.nceep.net)
- Stream Mitigation Guidelines (Buffer Widths and Riparian Mitigation) (www.ncdot.org/doh/preconstruct/pe/NEU/NEUProcedures/)
- SAFETEA-LU and Environmental Streamlining (www.environment.fhwa.dot.gov)

The second effort consisted of a series of 10 interviews with staff members from the Federal Highway Administration (FHWA), NCDOT, U.S. Army Corps of Engineers (USACE), North Carolina Department of Environment and Natural Resources – Division of Water Quality (NCDWQ), and the U.S. Environmental Protection Agency (EPA).

These agencies are involved in the NEPA/404 Merger 01 process and/or permitting for TIP projects. In addition, interviews were conducted with several consultants who provide services related to NCDOT projects to these agencies.

Most of the discussion and information received from the interviews was anecdotal. However, memoranda, graphs, and other data were also obtained and will be referenced (as appropriate) in this review.

The findings from each of the two environmental tasks are described below. The report concludes with a **Recommendations** section.

2.2 Evaluated Environment-Related Policies and Procedures

The review of environmental policies and procedures (not including NEPA/404 Merger 01) to identify potential construction-cost savings focused on three topics:

- The North Carolina Ecosystem Enhancement Program (EEP)
- Stream Mitigation Guidelines (Riparian Restoration)
- NCDOT-Assisted Resource Agency Staffing

2.2.1 North Carolina Ecosystem Enhancement Program (EEP)

According to its stated purpose, the mission of the North Carolina Ecosystem Enhancement Program (EEP) is “to restore, enhance, preserve and protect the functions associated with wetlands, streams, and riparian areas, including but not limited to those necessary for the restoration, maintenance and protection of water quality and riparian habitats throughout North Carolina.” The program considers future road construction and development-related impacts along with environmental data to determine high-priority watershed sites across North Carolina for use as mitigation for impacts from future transportation projects and other economic-development projects.

NCDOT entered into an agreement in 2004 whereby NCDOT is responsible for providing EEP (no later than Feb. 1 of each year) with a certified report of all anticipated wetlands, buffer, and stream impacts by year, for 7 years into the future.

For anticipated wetland impacts, the units are acres of riverine, non-riverine, and coastal marsh. For buffers, the units are square feet, and for streams, the units are linear feet.

During each 12-month period, quarterly updates are required to be submitted (due on Feb. 1, May 1, Aug. 1, and Nov. 1, respectively). The estimates are prepared by NCDOT staff for all projects in the TIP, using geographic information systems (GIS), actual field surveys if available, and other data, depending upon the status of the project in the project-development process. Funds are provided by NCDOT on a quarterly basis for the cost of the projected mitigation, in anticipation that roadway construction impacts are mitigated—and monitored for success—prior to construction occurring.

All interviewees believed that the EEP process is a successful program that has resulted in the elimination of permitting delays that result from lack of wetland and stream mitigation or due to disputes between NCDOT and resource agencies regarding mitigation. There appeared to be consensus among the NCDOT staff interviewed (as well as unanimity among consultants interviewed), however, that impacts may be overestimated (subsequently resulting in potential over-payment). The reasons cited for the overestimations included the lack of accurate impact measures due to uncertainty about project footprint, bridge length, and roadway type 7 years prior to construction. The resource agencies require that mitigation measures be in place and monitored for success for 5 years before construction. In addition, many interviewees noted the varying accuracy of GIS data used to create initial impact estimates, which is dependent upon the age, geographic location, and field verification of the natural system data. In many cases, these impacts are never adjusted to reflect later project-development refinement. Finally, because of inattention to evaluating the original NCDOT assets transferred to EEP, there is a strong consensus that the ratios (of mitigated assets to impacts) have been consistently understated, i.e. ratios of 2 to 1 or higher have been required on assets that have been performing well and should more properly be valued at 1 to 1. This alone would reduce mitigation costs significantly.

2.2.2 Stream-Buffer Mitigation Guidelines

The project scope of services listed riparian buffers as a possible concern. This area is more accurately described as stream-mitigation guidelines, or more specifically, Buffer Widths and Riparian Restoration. In most cases, a protected buffer of a minimum of 50 feet on piedmont/coastal plain streams and 30 feet on mountain streams in designated watersheds is required at stream-mitigation sites. The requirement is currently implemented at NCDOT through a memorandum titled “Bridging of Riparian Buffer Zones” by NCDOT Deputy Secretary, Roger Sheats (dated June 5, 2002). This memorandum begins with the statement, “To the greatest extent possible, all highways on new construction that have stream crossings where a bridge structure is proposed shall

provide sufficient structure to avoid embankment or abutment encroachment into riparian zones 1 and 2 of the watercourse...The NCDOT shall consider such bridging as a requisite minimization of unavoidable impacts....”

It is a perception among several interviewees (including consultants) that the memorandum encourages greater bridge length than is required by regulations or environmental stewardship, and consequently creates greater bridge costs—both in initial construction and long-term maintenance—when NCDOT is bridging riparian buffer zones in designated watersheds. In fact, NCDOT calculated additional bridge-construction costs of \$4.2 million on recent projects (e.g., the Clayton and Knightdale bypasses) versus mitigation costs of less than \$200,000 where a mitigation strategy was pursued instead of the longer bridges. There are additional future bridge-maintenance costs, as well.

2.2.3 NCDOT Funding of Resource Agencies

NCDOT provides funds to several resource agencies in order to facilitate the NEPA/404 Merger 01 process, review of project documentation, and permitting of transportation projects. When questioned about the NEPA/404 Merger 01 process, all respondents stated that the funding assistance did result in more effective agency coordination, which results in more timely reviews and predictable permits. This funding supports more than 30 positions outside of NCDOT to facilitate these processes.

2.3 NEPA/404 Merger Process and SAFETEA-LU Section 6002

2.3.1 Background

NEPA/404 Merger Process

The NEPA/404 Merger 01 is a process intended to streamline the project development and permitting processes in North Carolina, as agreed to by the primary signatory agencies: U.S. Army Corps of Engineers (USACE); NC Department of Environment and Natural Resources (Division of Water Quality [DWQ] and Division of Coastal Management [DCM]); Federal Highway Administration (FHWA); and NCDOT. The Section 404/NEPA Merger process has been applied to surface transportation projects in the State of North Carolina since the original agreement integrating Section 404 permit requirements with the NEPA process was signed in May 1997. A modified agreement

was signed in May/June 2005 by the primary signatory agencies. It incorporated streamlining provisions of the Transportation Equity Act for the 21st Century (TEA-21) and other improvements and was titled “Merger 01.”

The Merger 01 process generally applies to new location projects and other projects requiring an individual Section 404 permit. Major milestones in the Merger 01 process are called concurrence points. “Concurrence” implies that each project team member and the agency that person represents agrees to decisions made at these defining points within the project-development process, and in doing so, pledges to abide by the decision made, unless a profound change of conditions arises later in the process. Concurrence is sequential and must be achieved in the proper order. There are seven concurrence points (CP) in the Merger 01 process. Signatures indicating concurrence with each point are required from the NCDOT, FHWA, U.S. Army Corps of Engineers, and the NC Division of Water Quality.

In recognition of the different types of projects, NCDOT has developed separate detailed processes for new location projects (Process I), widening projects (Process II), and bridge projects (Process III) within the overall Merger 01 process.

The FHWA and NCDOT are developing new Merger 01 training. This instruction will be intended for staff from FHWA, NCDOT, resource agencies, and consultants. A full roll-out of this new training pledge is expected in summer 2007.

SAFETEA-LU Section 6002

Section 6002 of SAFETEA-LU prescribes changes to existing FHWA and FTA procedures for implementing the National Environmental Policy Act of 1969 (NEPA) as amended, and for implementing the regulations of the Council on Environmental Quality (CEQ) regarding 40 CFR parts 1500 through 1508. Section 6002 states that, “These changes are the result of efforts to make the environmental-review process more efficient and timely, and to protect environmental and community resources. This should result in expedited approvals of urgently needed transportation improvements such as those identified by USDOT's congestion initiative. Section 6002 of SAFETEA-LU describes the roles of the project sponsor and the lead, participating, and cooperating agencies; sets new requirements for coordinating and scheduling agency reviews; broadens the authority for states to use Federal funds to ensure timely environmental reviews; and specifies a process for resolving interagency disagreements.” (Section 6002 can be reviewed in its entirety at www.fhwa.dot.gov/hep/section6002/intro.htm.)

2.3.2 Review

The analyses of the Merger 01 process and the comparison of the Merger 01 process with the FHWA requirements and regulations of SAFETEA-LU Environmental Review Process – Section 6002 (often referred to as “streamlining”) consisted of reviewing materials about Merger 01 on the NCDOT website, and examining Section 6002 on the FHWA website. The Merger 01 process was discussed thoroughly with all of the interviewees, and the Merger 01 process and the Section 6002 process were discussed with three representatives of FHWA. In addition, the authors are very familiar with the State of Florida’s Efficient Transportation Decision Making (ETDM) process. The State of Florida (utilizing the ETDM process) was the only state to be immediately granted a waiver by FHWA for compliance with SAFETEA-LU.

Study team members (in consultation with FHWA and other PBS&J offices) were unable to identify any other states developing an independent streamlining process to address Section 6002. Several other states are in the process of revising their NEPA processes, in hopes of becoming compliant with Section 6002, but none have yet been approved by FHWA.

NCDOT staff is currently in the process of modifying the Merger 01 process to make it compliant with SAFETEA-LU Section 6002, and also has several other initiatives underway. NCDOT staff has determined that (while the Section 6002 process requirements regarding resource agency coordination are met or exceeded) it appears that a process for early public involvement (prior to Concurrence Point 1 – Purpose and Need for Project) is needed in order to address components of Section 6002. Section 6002 also encourages, but does not require, the development and publication of project schedules.

A particular emphasis of Section 6002 is reaffirming USDOT (FHWA in the case of road projects) as **the** lead agency for transportation projects. In addition, recipient agencies (e.g., NCDOT) can also be “joint lead agencies.” All other agencies (Federal, state, or local) are considered participating or cooperating agencies (the web page referenced on the preceding page explains these terms in detail). Of relevance to the review, Section 6002 gives clear authority to USDOT—and NCDOT as the joint lead agency—to define “purpose and need,” to determine alternatives to be considered in NEPA, and to determine the level of design required for the preferred alternatives. All of these authorities have become blurred or diffused under the Merger 01 process, as practiced in North Carolina during recent years.

Some elements of the Merger 01 process, such as the need for signed concurrence at various stages in the project development/NEPA process, are beyond what is required in the Section 6002 process. However, many interviewees believed that these elements of the Merger 01 process help guarantee an efficient permit application/issuance process with few or no delays occurring at that stage. Following the consensus-driven approach (in which signatures are not required at each step) described in Section 6002 may advance the early stages of the project faster since concurrence is not required and steps can overlap. However, it could lead to uncertainties in the permit application/issuance process if agency concerns voiced during the agency coordination process are not addressed. This trade-off between NEPA approval and the granting of permits is a critical aspect of comparing the Merger 01 process and Section 6002.

For example, a comparison of the Merger 01 process with the Florida Efficient Transportation Decision Making (ETDM) shows that the Merger 01 process provides a more predictable and shorter permitting process. However, several interviewees noted that while the Merger 01 process results in predictable permitting and less time spent in permit processing, it is likely that overall pre-construction project development and NEPA schedules have not been reduced—especially for projects at new locations. The Merger 01 process differs from ETDM in that it is not directly tied to local government and MPO long-range transportation planning and project identification. As a result, the Merger 01 process takes additional time to reach concurrence about Purpose and Need (CP 1) and requires more engineering detail and the detailed analyses of greater numbers of alternatives prior to CP 2 (Detailed Study Alternatives) and between CP 2 and CP 3 (Selection of Least Environmentally Damaging Alternative [LEDPA]/Preferred Alternative).

A higher level of engineering design and analyses of greater numbers of alternatives will result in higher planning costs for most projects, particularly lengthy new location projects. The level of engineering design used in Merger 01 differs from Florida DOT's ETDM process and the processes used by the DOTs of Pennsylvania, Texas, and Colorado. The Merger 01 process utilizes a higher level of engineering design earlier in the process and these additional design costs may produce no significant benefit if that alternative location is subsequently dropped later in the merger process.

The earlier Dye Management Report showed that North Carolina has a much greater number of Environmental Assessments (EA) than many other comparable states. The report recommended that NCDOT explore opportunities for reducing EAs in a manner similar to Florida's expanded CE process. A number of years ago, Florida entered into an agreement with the Federal Highway Administration (FHWA) to prepare an additional

type of Categorical Exclusion (CE) for specific types of roadway improvements, including the widening of roads when the projects meet certain criteria. The projects must exert no significant impacts on a checklist of potential impacts.

It should also be noted that the Merger 01 process and EEP both focus on water quality and wetland impacts and mitigation, while Section 7 of the Endangered Species Act (ESA) of 1973 as amended (and its role and review as part of NEPA) appear not to be specifically addressed in any of the proposed NCDOT initiatives.

Significant endangered-species issues have caused few project delays since the implementation of the Merger 01 process. However, as endangered-species coordination is not a required CP, a project could get stalled at or after CP 4a (Avoidance and Minimization) in the Merger 01 process until the issues are resolved through a Section 7 Consultation required before the completion of a Final Environmental Impact Statement (FEIS). One example of this occurring in North Carolina is the Monroe Bypass in Union County (TIP Project R-2559). The project was in the permitting process in the late 1990s/early 2000s when issues associated with the Carolina heelsplitter (an endangered freshwater mussel) delayed implementation of the project. This project has since been adopted by the NC Turnpike Authority as a candidate toll facility in combination with the Monroe Connector (TIP Project R-3329), and it is now being developed using the Section 6002 process, rather than Merger 01. This change in process will not expedite the resolution of the endangered species issue.

Several other actions beyond the development and revisions to the Merger 01 process have already resulted in schedule reduction and a predictable permitting schedule. These actions include:

- Better data management because of the data warehouse maintained by NCDOT Natural Environment Unit
- Increased NCDOT funding of resource agency positions
- Merger 01 process resource agency training in 2003 and 2004.

A discussion of other new NCDOT initiatives is included in the **Recommendations** section.

2.4 Recommendations

The recommendations provided herein address the Merger 01 process. NCDOT staff has also implemented several initiatives to decrease TIP pre-construction costs. The initiatives are at varying stages of discussion and development. Some of them are discussed below and others are part of the project delivery review, which is another focus of this study.

2.4.1 Processes

Merger 01 and Section 6002

NCDOT is currently planning to continue using Merger 01, making the changes needed to meet additional requirements in SAFETEA-LU Section 6002. As noted in this document, NCDOT prepared a submittal to FHWA that proposes, along with other minor changes, an addition of public (including agencies) meeting(s) prior to Merger 01 Concurrence Point 1, in order to meet SAFETEA-LU regulations in Section 6002. It appears that the proposed changes will result in NCDOT compliance with SAFETEA-LU. This method of compliance with SAFETEA-LU should continue to be pursued. However, NCDOT should reaffirm its lead-agency status in Merger 01 and seek agreement from cooperating agencies that acknowledges that lead role. Specifically, the definition of “purpose and need” and the definition of alternatives should remain within the lead agency purview and not be subject to lengthy reviews by participating agencies. Finally, the “elevation” process (which anticipates a series of steps to elevate a project or concurrence- point decision to higher levels in the agencies) should be used more frequently in order to resolve disagreements among participating agencies.

Other Potential Merger 01 Process Improvements

Endangered-species impacts are not explicitly included in the Merger 01 process, but have the potential to delay the pre-construction process and NEPA documentation. It is recommended that a process be developed to identify the potential and locate the presence of such species prior to Merger 01 Concurrence Point 2a. Colorado has been effective in its integration of conservation planning into their program, and in its programmatic mitigation for protected species. According to some interviewees, EEP was established to be able to accommodate a mitigation process of this type.

The Merger 01 process for road widenings (Process II) should be evaluated for streamlining opportunities. Road widenings typically start with a limited number of alternatives (e.g., widen symmetrically, to either side, or a combination of methods). Options to consider for streamlining could include combining or eliminating concurrence

points, postponing detailed designs or evaluations until only one or two alternatives remain, or exempting widening projects altogether for the merger process.

As part of the implementation of Section 6002, the FHWA encourages states to assume responsibility for Categorical Exclusions (CE). NCDOT is currently reviewing the CE process. The study team has recommended that the NCDOT develop a process (similar to Florida's) for the addition or expansion of CE evaluation and documentation for widening projects with no significant social or physical impacts, or significant controversy. The expanded CE process should either remove these projects from the Merger 01 process.

In addition to CE improvements, the level of engineering design utilized in the NEPA process for widenings and new location projects prior to the detailed study alternatives should be evaluated to determine if some types of projects could have a lesser level of design employed. The level of design should still achieve a certain level of confidence in the impact determinations adequate for early decision-making purposes.

Comments from interviewees suggest that in some instances, providing partial natural-resources data and survey results to other project-development team members before an entire environmental report is complete (i.e., by providing wetland and stream delineations prior to completion of the entire natural-resource technical memorandum) could improve efficiency. The natural resources technical memorandum addresses several types of natural-resource issues, including: water quality; wetlands; streams; protected species; and biotic communities. Some endangered plant species must be surveyed during specific times of the year, which can affect when a complete technical memorandum can be delivered. Providing partial data may need to be considered on a case-by-case basis, since delivery of partial data sooner may require multiple site visits and increase the costs and/or delivery time of the complete report.

GIS Improvements

NCDOT leadership is evaluating the existing NCDOT geographic information system (GIS) database. Enhancements to the existing GIS database are needed to improve the accuracy of data and to expand beyond the existing data layers. Detailed accurate natural-systems data is now being developed and collected in the NEU data warehouse. However, initial and periodic translation to GIS data layers would significantly improve the GIS database. In addition, existing land use and infrastructure layers also vary greatly in quality by location within the state.

While such a program may initially be costly, GIS improvements would assist in tying planning and project development closer together as required by SAFETEA-LU. If the GIS data development process and content receive the approval and/or support of NCDOT's partnering agencies, it might then be used in the early stages of the Merger 01 process to eliminate unreasonable alternatives. An accurate up-to-date GIS database could also decrease the time and effort spent at CP 1 and CP 2, respectively, in the Merger 01 process for new location projects.

If an improved GIS database is developed, the ETDM process in Florida suggests that the number of alternatives, level of engineering detail, and the timing of wetland jurisdictional determinations for alternatives carried to and through CP 3 (Selection of LEDPA/Preferred Alternative) could be reduced. If the number of alternatives and level of engineering detail are reduced at this stage of the Merger 01 process, cost and time could be saved and still meet the requirements of the NEPA process.

Tying Planning and Project Development Together

An initiative that ties planning and project development closer together has been developed by NCDOT staff, but not yet fully implemented. The overall purpose of this initiative, called the Integration of Planning and Project Development (Integration Process), is to develop an integrated planning process that provides a seamless connection between long-range planning and project development.

SAFETEA-LU and previous legislation have attempted to accomplish a continuous stronger tie between these two phases of pre-construction. The current Merger 01 process begins at the project development stage. The ETDM process in Florida begins the transportation improvements process at the Metropolitan Planning Organization (MPO) approval stage. The NCDOT integration initiative ties MPO approval to project development.

The new Integration Process should be SAFETEA-LU compliant, with a few minor adjustments. According to interviewees, the new Integration Process would place NCDOT well ahead of other states in this regard.

Several interviewees noted that roadway project priorities change over time. A project may go through one or several stages of development, or even through the entire pre-construction process, and then be "put on the shelf" as a different project is identified as a higher priority. Changes in how and when a project is completely funded would also eliminate projects coming and going in the pre-construction process. Full implementation

of the Integration Process may require changes to the current Board of Transportation and MPO roles and responsibilities. These issues are more fully addressed in the **Project Delivery** portion of this study.

Training and Resources

Several interviewees stated that the training of resource agency and NCDOT staff in the Merger 01 process in 2003 and 2004 resulted in a reduction of permitting time and helped foster relationships that have proven positive to agreement at the Merger 01 concurrence points. Periodic additional training about Merger 01 process changes and training for new staff is highly recommended. The FHWA and NCDOT will be implementing additional Merger 01 training for staff from FHWA, NCDOT, resource agencies, and consultants during summer 2007. The need for training regarding CP1 (Purpose and Need) was highlighted as one potential training area to focus on since this concurrence point was cited as one that can be difficult to achieve. Revising Merger 01 to more closely align with Section 6002 in this regard could have a similar effect. Meeting facilitation and agency roles, responsibilities, and authority are other areas where additional training is strongly recommended.

Most interviewees felt that the NCDOT funding of resources and NCDOT staff for the Merger 01 Process and permitting was adequate. However, it was noted that updated and new software needs sometimes were not addressed as quickly as necessary. Up-to-date computer equipment and software can help decrease review times, field work, and delineation timeframes.

2.4.2 Environmental Stewardship

Ecosystem Enhancement Program

As discussed previously, NCDOT is successful in meeting its water-quality environmental-stewardship goals through EEP, and the program has eliminated permitting delays resulting from lack of wetland and stream mitigation or disputes between NCDOT and resource agencies regarding mitigation. However, the development of an enhanced/expanded GIS database could reduce possible overestimates of impacts (and the subsequent potential for overpayment) as new projects are added to the TIP. Finally, the valuation of transferred assets and the validation of impacts through the project-development process provide additional areas for potential savings.

Buffer Widths and Riparian Mitigation

The NCDOT staff directive and decision (in many cases) to bridge the buffer area as well as the watercourse is beyond regulatory requirements and results in longer and more expensive bridges in locations where there may be no compelling environmental benefit. Elimination of NCDOT's Bridge Buffer memorandum is recommended. Such a change would reduce both initial construction and long-term maintenance costs, while preserving mitigation options to support environmental-stewardship goals.

Section 3

Value Engineering Study Recommendations

3.1 Introduction

In the most recent Long-Range Statewide Multimodal Transportation Plan completed by the North Carolina Department of Transportation (NCDOT) in Sept. 2004, it was estimated that NCDOT will need an additional \$65 billion above current funding levels over the next 25 years in order to meet the State's transportation needs. Due to this large funding shortfall, the North Carolina General Assembly contracted PBS&J to examine the impact on highway construction costs of the engineering design choices made by NCDOT, in order to determine whether different design choices would produce significant savings without compromising safety or project effectiveness.

As part of the contract with the General Assembly, PBS&J was tasked to perform Value Engineering (VE) studies for a selected sample of projects within NCDOT's Transportation Improvement Program (TIP), in order to yield insights on the design and cost practices of the NCDOT. Ten TIP projects were selected in collaboration with the General Assembly staff, with each project costing more than \$25 million and programmed for final design/project letting within 2 to 4 years. These 10 projects are representative of a cross-section of NCDOT TIP projects. They are located in unique traffic environments, geological provinces, and regionally interesting locations, ranging from the coastal areas of the Outer Banks to the mountainous terrain found in the western reaches of the state. As such, each project offers its own blend of project planning, design, and construction challenges.

During the conduct of the 10 VE studies, there were more than 141 creative ideas generated by the various teams. Of these, 52 alternatives were developed and documented, providing the potential for more than \$97.3 million in construction-cost savings. If national results in such matters were to govern the disposition of these alternatives, it could be expected that approximately \$5 million in actual construction-cost savings would be realized from this value engineering effort.

In addition, the VE teams documented more than 43 design suggestions. Design suggestions are brief written descriptions that the VE teams prepared in order to provide the State with insights about the projects when supportive data is minimal. These design suggestions have the potential to improve the end product and reduce construction costs.

The following table summarizes the overall results of the VE studies conducted.

Value Engineering Study Results

Number of TIP projects studied	10
Total estimated cost of the 10 TIP projects	\$662 million
Total cost-savings potential generated from VE studies	\$97.3 million
Estimated actual cost savings realized from VE studies (based on average national results)	\$40.2 million (It is believed that alternative AP-11 can be expected to yield virtually the full amount of the calculated \$35.2 million in cost savings)
Cost to perform VE studies	\$215,000
Creative ideas generated	141
Cost-saving alternatives developed	52
Design suggestions documented	43

Projecting the potential cost savings from an aggressive VE effort at NCDOT is imprecise at best. However, assuming cost savings in the range of 6 percent to 15 percent (as indicated in the table above), it is possible that NCDOT could “create” additional resources of **\$100 million or more per year** using VE methodologies. While these additional dollars would not close the funding gap, it would be an important component of meeting critical transportation needs across the state.

The results of the VE studies for the 10 TIP projects indicated the following general areas of focus regarding potential cost savings:

- **Cost Awareness** – Cost estimates for several of the TIP projects studied were out-of-date or based on a minimal amount of supportive information. Cost estimates developed for the TIP should be based on as much detail about the projects as possible, in order to provide meaningful estimates that the NCDOT can use to effectively allocate funds.
- **Construction-Cost Knowledge** – Most TIP projects that were studied implemented traditional construction methods and materials that have been used in the past. While these design choices may work well, being more aware of the costs associated with such design choices will allow NCDOT to consider more cost-effective options that are currently available.
- **Right-of-Way** – Like construction- and materials costs, the cost of right-of-way acquisition should be considered in conjunction with development of the roadway design. Several TIP projects that were studied contained opportunities to modify the roadway alignment in order to reduce right-of-way acquisition and its

associated costs. For example, one project demonstrated the potential to save \$8.2 million in right-of-way costs by changing the side of the road on which widening occurs.

- **Median Width and Type** – There are two primary issues related to the choice of median width and type: right-of-way cost and safety. Typically, we find that the fifth lane (with opposing turns in the median) is commonly used in urban areas, largely because that usage facilitates access to retail properties and minimizes right-of-way costs. Hence, there is often considerable financial pressure to reduce median width. However, safety must also play a key role in the determination of median configuration. For example, it is not desirable to have traffic on Hwy 64 using a 12-foot-wide median lane for passing at high speeds. The opposing left-turn lane in such situations (or “dead man’s lane”) can prove dangerous during poor travel conditions. These safety concerns apply across the board to rural design settings, and argue against the use of a fifth lane in design considerations.
- **Context-Sensitive Design** – Considering context-sensitive design in projects can provide cost-saving design options. For example, the design for a TIP project studied included an asphalt nature trail. However, a trail made of natural material (e.g., gravel, dirt, recycled rubber mulch, wood chips, pine straw, etc.) would be more context sensitive as well as more cost effective.

Overall, it was concluded that the planning and design personnel working for the State, (either as employees or as consultants to the State) practice their design methods in a fashion similar to their counterparts in other states. Participants in the project-design teams maintain high standards for their work and the end products that result from their efforts. They consider a variety of elements throughout the life of the project, including: safety; environmental concerns; local interest-group demands; traffic projections; and recognized design standards. However, there is always room for improvement in the area of project delivery and this report provides conclusions and recommendations to help address this issue. These conclusions and recommendations are based on practices of other state departments of transportation, as well as the VE studies performed on the 10 representative TIP projects from across the state.

3.2 Background

PBS&J was tasked to perform Value Engineering (VE) studies for 10 representative TIP projects with the objective of identifying cost-reducing alternatives to design approaches

in current use. The following section describes the basic methodology used in the VE study process.

3.2.1 Methodology

The VE study approach was founded as part of the standardized job plan fostered by SAVE International, the recognized authority on the practice of value engineering. Use of the job plan guides the search for high-cost areas within projects and includes procedures for developing alternative solutions for consideration.

Each of the studies was facilitated by a Certified Value Specialist (CVS) that has extensive value-engineering experience with numerous departments of transportation from around the country. As a result, the 10 studies are in full compliance with the guidelines for the Federal Highway Administration's (FHWA) Value Management objectives for state VE programs.

3.2.2 Purpose of Report

The purpose of this report is to summarize the findings of 10 VE studies, particularly with regard to questions surrounding timeliness and the cost-effectiveness of project-delivery methods. In addition, lessons learned from the VE studies should provide insights into NCDOT practices, as compared to what other states are doing to enhance their transportation-project delivery methods. This report identifies the VE study results and, from those results, draws conclusions and presents recommendations for strengthening project-delivery methods. In addition, this report provides some practical recommendations for enhancing the VE program at the NCDOT. These recommendations are based on the best practices of different Value Engineering programs successfully functioning at other state departments of transportation.

3.3 Value Engineering Studies – Project Information

Value Engineering studies were performed for a selection of 10 TIP projects located across North Carolina. The 10 projects selected for VE study presented a variety of planning, design, and construction challenges for the VE teams to consider.

3.3.1 Project Descriptions

Brief descriptions of the 10 projects that were evaluated through the VE study process are provided below. A detailed summary for each study—including project description and study results—is provided in **Appendix A**.

- **R-2545** – Widen US 64 from east of Columbia to east of the Alligator River; Tyrrell and Dare Counties (Estimated Cost: \$255 million).
- **R-3403** – Widen US 17 in Bridgeton from Mills Street to SR 143 (Antioch Road) to NC 43; Craven County (Estimated Cost: \$41.2 million).
- **R-3825-A** – Widen NC 42 from US 70 at Clayton to 0.26 mile east of SR 1902 (Glen Laurel Road); Johnston County (Estimated Cost: \$27.1 million).
- **I-4744** – Widen I-40 from Wade Avenue to I-440/US 1/US 64; Wake County (Estimated Cost: \$61 million).
- **R-2303A** – Widen and new location segments along NC 24 from west of SR 1006 (Maxwell Road/Clinton Road) to SR 1853 (John Nunnery Road); Cumberland County (Estimated Cost: \$47.7 million).
- **U-3326B** – Widen US 29 Business (Freeway Drive) from SR 2686 (Richardson Drive) to NC 14; Rockingham County (Estimated Cost: \$56.9 million).
- **U-3600** – Widen US 220 Business (North Fayetteville Street) from SR 2261 (Old Liberty Road) to US 220 at US 311; Randolph County (Estimated Cost: \$30.9 million).
- **R-3833** – Widen SR 1100 (Brawley School Road) from SR 1177 (Chuckwood Road) to US 21; Mooresville, Iredell County (Estimated Cost: \$80.7 million).
- **R-2813B** – Widen NC 146 (Long Shoals Road) from West of SR 3501 (Clayton Road) to east of I-26; Buncombe County (Estimated Cost: \$25.1 million).
- **R-4430** – Widen SR 1783 (Upward Road) from US 176, crossing over I-26, and ending at SR 1006 (Howard Gap Road); Henderson County (Estimated Cost: \$36.5 million).

3.3.2 Project-Specific Recommendations

The following are key recommendations for each of the 10 TIP projects that the VE team participants have suggested for consideration when examining NCDOT project-delivery methods. Additional detail about each cost-saving alternative and design suggestion created for these projects as part of the VE study effort can be found in the VE reports created for each project, which are submitted separately from this document.

- **R-2545: US 64 EAST OF COLUMBIA TO EAST OF THE ALLIGATOR RIVER; TYRRELL AND DARE COUNTIES**

TIP Project R-2545 is planned to widen US 64 to a four-lane divided facility. To avoid future flooding, the roadway is planned to be elevated by as much as 6 feet, requiring significant earthwork and shoring during construction. The project includes replacement of the existing 2.9-mile Lindsey C. Warren Bridge, which crosses the Alligator River.

Alternative BI-5 – This alternative offsets the new bridge on an alignment that is distant enough from the swing arc of the existing Center Pivot Bridge to avoid staging for the construction of the new bridge. This offers the potential to save approximately \$28 million in construction costs. It is early enough in the design process to accomplish this and to realize a significant portion of the projected cost savings.

Alternative AP-11 – This alternative reduces the median width to 12 feet. There would be a 4-foot monolithic raised concrete median with 4-foot inside shoulders. Since the drainage would be handled by sheet flow rather than by a contained storm-pipe system, the drainage boxes can be eliminated and the profile grade lowered by approximately 5 feet. This dramatically reduces the amount of earth fill required and greatly reduces the impact on the adjacent lands (which are very sensitive environmentally). The construction-cost savings for this alternative would equal approximately \$35 million. This alternative has been discussed with Mr. Art McMillan, State Highway Design Engineer, and it appears that there is a good prospect for this alternative to be accepted.

- **R-3403: US 17 IN BRIDGETON FROM MILLS STREET TO SR 143 (ANTIOCH ROAD) TO NC 43; CRAVEN COUNTY**

The purpose of this project is to alleviate vehicular congestion and improve the level of service along US 17. By upgrading the level of service, the highway's safety also will be enhanced. An improved US 17 in Craven County will also allow better mobilization whenever hurricane evacuations are ordered in nearby

coastal regions. This project is an important part of a regional transportation need to improve traffic flow in the US 17 corridor that accesses the Cherry Point Marine Base and the coast.

Alternative No. 1 – The original design calls for the widening of US 17 to occur on the eastern side of the current alignment, and then switch over to the western side of the alignment. The alignment on the western side involves costly land acquisition. It is suggested in this alternative that the widening be performed more on the eastern side of the alignment, in order to avoid some of the more expensive real estate. This has the potential of reducing the overall cost of the project by \$220,000.

Alternative No. 2 – Similar to the preceding alternative, this alternative proposes that new lanes be constructed at Little Swift Creek, reducing the cost of right-of-way acquisition by approximately \$46,000.

Alternative No. 4 – The original design calls for the use of a 30-foot median width from Station 42+00 to Station 72+00. The alternative design would make use of a median barrier with 6-foot inside shoulders, and reduce the median width to 14 feet. This offers the opportunity to reduce the construction costs by \$143,000. Through the use of median barriers, the amount of right-of-way acquisition required is significantly reduced.

Alternative No. 5 – The existing lanes appear to be 11 feet wide. The crash rates for the project area indicate a better-than-state-average safety record. Hence, it may be a consideration to continue using the 11-foot width. Widening the facility to four 11-foot lanes (with 2-foot-inside and 4-foot-outside paved shoulders) provides an alternative typical section that is 28 feet wide in each direction. If this is found to be reasonable under guidance for context-sensitive design, the potential cost savings would be slightly more than \$1 million.

Alternative No. 7 – Based on the cost estimates for Section B, the original design calls for the construction of two bridges, each being 38 feet wide and 1,228 feet long. The alternative uses one single bridge in lieu of two bridges. This can be accomplished by providing a bridge that is 65 feet wide. This design change will require some minor adjustments to taper the roadway to meet the reduced bridge width. The potential cost savings is approximately \$1.4 million.

Design Suggestions – There were two design suggestions that offer the possibility of construction-cost savings, although these savings were not calculated, due to the limited amount of design information available. These design suggestions included reducing the bridge span, and reducing or eliminating the turning bays in areas without curb and gutter.

- **R-3825-A: NC 42 FROM US 70 AT CLAYTON TO 0.26 MILE EAST OF SR 1902 (GLEN LAUREL ROAD); JOHNSTON COUNTY**

The purpose of this project is to symmetrically widen NC 42 from US 70 to SR 2022 (Old NC 42). From Old NC 42 to SR 2008 (Fox Ridge Road), the proposed new lanes will be constructed on the north side of existing NC 42. NC 42 will be widened symmetrically from Bennett Place to Buffalo Road (SR 1003). Bridge No. 75 (carrying NC 42 over the Neuse River) will be replaced with a new structure. It should be noted that conducting a VE study about this project was very difficult, since there was very little project information, including the fact that there was no construction-cost estimate.

Alternative No. 4 – This alternative reduces the median width from 17.5 feet to a 10-foot median with a median barrier. Even with the additional cost for the median barrier and associated changes, the overall cost for the project was projected to be reduced by \$309,000. Additional benefits include the potential to reduce right-of-way takings and reduce the environmental footprint of the project.

Alternative No. 6 – This alternative reuses part of the existing pavement, in order to reduce construction costs by \$48,000.

Design Suggestions – There were two key design suggestions: 1) improve local access to residents and businesses; and 2) modify side slopes to reduce the environmental footprint and to reduce right-of-way takings.

- **I-4744: I-40 FROM WADE AVENUE TO I-440/US 1/US 64; WAKE COUNTY**

Since the project was at such a limited state of development, very little information was available for use in the VE study. The VE team was provided with a roll of two drawings that showed the alignment of future improvements to existing facilities from the I-40 split to I-440. The drawings consisted of aerial photography with some property lines drawn on them. There was no labeling of existing roadway infrastructure, i.e., no drainage indicated, no typical sections listed, and no grades or elevations labeled. Discussions with the project manager at NCDOT indicated that there was currently no official estimate for the project, except to say that the current “placeholder” figure is \$60 million for the roadway work and \$1 million for the right-of-way.

The current plan appears to be to add one lane eastbound and one lane westbound (in the now depressed grassed median), to bring the total number of lanes up to six. There are plans in the future to add an additional lane in each direction to bring the total up to eight lanes serving the east- and westbound traffic needs.

The project manager noted that when the seventh and eighth lanes are added, the project will likely be extended back to Harrison Avenue and involve some additional bridge work. As a courtesy, the VE team was supplied with an unofficial estimate from a third party, which indicates that the six-lane work would cost \$28.7 million and the eight-lane work would cost \$31 million. This estimate is at odds with the earlier unofficial estimate of \$60 million that was cited by the NCDOT project manager.

Since the data available for this project was rather limited, the observations that can be made about construction-cost impact (by way of value engineering), must be limited to design suggestions concerning the “usual suspects” in projects of this nature. Specific cost-saving alternatives could not be developed.

- On the six-lane improvement “courtesy estimate,” it was noted that there are nearly \$4 million in bridge widenings. This probably represents the biggest opportunity for cost avoidance. Consideration should be given to modifying the abutment treatments to avoid the costs, particularly on the six-lane widening effort.
 - Shoulder paving and the attendant widths should be reviewed for adequacy and kept to a minimum.
 - Consideration should be given to incorporating the existing shoulders into the eventual pavement build-out.
 - It seems likely that the six-lane build out can be accomplished within the existing right-of-way.
-
- **R-2303A: NC 24 FROM WEST OF SR 1006 (MAXWELL ROAD/CLINTON ROAD) TO SR 1853 (JOHN NUNNERY ROAD); CUMBERLAND COUNTY**
The proposed action involves a combination of widening, new location segments, and other improvements to the existing NC 24 roadway from 2.8 miles east of I-95 to I-40 to create a four-lane divided facility. There will be bypasses and/or other alternate routings around Stedman, Autryville, and Roseboro. The highway will follow a portion of the Faircloth Freeway, in order to bypass Clinton. To the east of Clinton, the route will be on new location. Widening portions will have partial control of access, while new location segments will have limited control of access.
Alternative AP-4 – This alternative uses a new alignment (north of the existing alignment), in order to reduce the cost of right-of-way takings. The alternative alignment segment could have the effect of eliminating the relocations of four residences and nine businesses. The expected cost savings would be approximately

\$8.2 million. This is early in the project development, so the alternative routing might prove to be a viable consideration.

Alternative AP-5 – The initial design indicates that the project will require significant borrow. By lowering the profile grade, the earthwork might be better balanced and the costs of construction reduced by as much as \$1.3 million.

- **U-3326B: US 29 BUSINESS (FREEWAY DRIVE) FROM SR 2686 (RICHARDSON DRIVE) TO NC 14; ROCKINGHAM COUNTY**

The NCDOT proposes to improve US 29 Business (Freeway Drive) by widening the current two-lane facility to a multi-lane facility. The total length of the project is approximately 6.7 miles. The purpose of this project is to increase the traffic-carrying capacity and level of service for US 29 Business (Freeway Drive). It is anticipated that the facility's current capacity will be exceeded by 18,000 vehicles in the 2025 design year.

Alternatives EW-1, EW-3 and EW-4 – These alternatives reduce the clearance height between the bottom of three new bridges and the surface of the roadway pavement below. The cost savings attached to exercising these options would be approximately \$125,000. Not figured into these savings could be a considerable amount of added savings, due to a reduction in right-of-way acquisition. It was not possible to calculate these savings at the time of the VE study, due to a lack of developed detail at this stage of design.

Alternative AP-4 – This alternative reduces the multi-use path width from 10 feet to 8 feet. This path runs for approximately 10,000 feet along the southern edge of the project. This slight reduction in width should not interfere with its function but could save approximately \$25,000. Again, there could be some additional, substantial cost savings involved in reducing the amount of right-of-way that is to be acquired.

Alternative XS-4 – This alternative reduces the amount of fencing by half for an approximate construction-cost savings of \$73,500.

Bridge Alternatives BI-1, BR-2 and BR-5 – These alternatives reduce the cost of the bridges by shortening one bridge, re-using one bridge, and reducing the width of another bridge. The expected cost savings for these three alternatives is \$400,000. Again, there could be additional right-of-way cost savings for these three alternatives.

Design Suggestion EW-6 – This design suggestion calls for increasing cut to reduce borrow. In addition, DS – EW7 calls for the reduction of the fill height at outer road -Y20B-, which currently has a designed fill of approximately 50 feet. Obviously, if this fill height is reduced, there could be a significant savings in the

amount of borrow required to construct the fill, a likely right-of-way cost savings, and the ability to construct the class of pipe or culvert at this location in a less expensive manner.

It cannot be overstated that right-of-way represents a great source of potential cost savings. With the limited detail available at the time of the VE workshop, it was not possible to clearly identify the specifics of most of these potential cost savings. Judging by the ability of the designers to affect the placement of the property-taking lines in the final design, the expected cost-savings potential could be between \$1 million and \$3 million. This should be a strong focus as the project goes forward.

- **U-3600: US 220 BUSINESS (NORTH FAYETTEVILLE STREET), SR 2261 (OLD LIBERTY ROAD) TO US 220 AT US 311; RANDOLPH COUNTY**

The proposed project begins at SR 2261 (Old Liberty Road) and ends at US 220, covering a distance of 5.2 miles. The project includes a four-lane divided cross section, with a 23-foot-wide raised median to separate opposing traffic streams. The bridge over Haskett's Creek will be replaced with a wider bridge to accommodate the multi-lane facility. Outside travel lanes are planned to be 14 feet wide in order to accommodate bicycle traffic.

Alternative AP-1 – This alternative leaves Beasley Street in place and adjusts the mainline to tie into Beasley. This would provide for almost \$46,000 in construction-cost savings.

Alternative AP-3 – As a design suggestion, the team recommends investigation of a five-lane section at the southern end of the project. This design change would reduce impacts on business relocations, reducing right-of-way costs, and eliminating multiple u-turns. There was insufficient information available to identify specific cost savings and safety concerns would also need to be evaluated before recommending adoption of this design suggestion.

Alternative AP-4 – The current design calls for widening the outside lane in each direction by 2 feet to provide more room for bicycles. This is an ambiguous way in which to provide for bicycle traffic. It might be best to avoid seeming to formalize a bike lane (and reduce the construction costs by \$540,000) by not adding the 2 extra feet.

Alternative RW-3 – This alternative demonstrates the possibility of adjusting the alignment from Caudle Road to Claude Holden Road, in order to reduce the right-of-way impact—thereby reducing the land costs by \$135,000.

- **R-3833: SR 1100 (BRAWLEY SCHOOL ROAD) WIDENING FROM SR 1177 (CHUCKWOOD ROAD) TO US 21; MOORESVILLE, IREDELL COUNTY**

This project will widen SR 1100 to a four-lane divided facility and the intersection of SR 1196 (Gibbs Road) and Brawley School Road will be relocated to the west of its current location and tie into Brawley School Road, directly across from Rolling Hills Road. A single-point urban interchange (SPUI) is included where Brawley School Road crosses I-77, and a bridge will be constructed where the relocated Gibbs Road crosses an unnamed tributary. The total project length is 5.9 miles.

Alternative AP-1 – This alternative points out the cost-savings potential associated with moving the bicycle lane out of the roadway and making it a part of a shared-use pedestrian/bicycle path. This makes it possible to use much less expensive paving and generates potential cost savings of approximately \$2.8 million in initial construction costs.

Alternative AP-2 – This alternative reduces the costs of construction by \$2.7 million, by eliminating the sidewalk on one side of the roadway.

Alternative AP-7 – This alternative explores another option if it is decided to provide for bicycles in the travelway. The new approach would be to use the 14-foot-wide outer lane and mark it with “sharrows,” a new traffic-lane marking that indicates that the lane is intended to be shared by motorists and bicyclists. The cost savings for this approach is approximately \$3.2 million.

- **R-2813B: WIDEN NC 146 (LONG SHOALS ROAD) FROM WEST OF SR 3501 (CLAYTON ROAD) TO EAST OF I-26; BUNCOMBE COUNTY**

This project will widen NC 146 (Long Shoals Road) to a multi-lane facility from NC191 (Brevard Road) to US 25 (Hendersonville Road). The total project length is approximately 3.5 miles. The recommended typical cross section is a five-lane, curb, and gutter section. The project proposes to construct a segment of NC146 on new location from NC 191 to just east of Clayton Road (SR 3501). This includes replacing Bridge No. 53 (Long Shoals Bridge) over the French Broad River and Bridges No. 113 and 114, which carry I-26 over NC 146. The cost estimate provided in the TIP was \$32.5 million. However, the project was recently let at a cost of approximately \$52 million.

Alternative AP-1 – This alternative addresses an isolated instance in which the roadway extends beyond the necessary width, and reduces the width by 2 feet, which reduces the construction costs by almost \$51,000.

Alternative BR-1 – The bridge typical section indicates a width of 14 feet for two of the lanes on the bridge. The width is reduced to a more standard 12 feet for these two lanes and reduces the cost of the bridge by \$180,700.

Alternative BR-2 – The bridge over the French Broad River is to be shortened by approximately 100 feet. This is to be achieved through the use of MSE wall abutments. The resulting construction-cost reduction is \$542,685. (It should be noted that the need exists to check to make sure that MSE walls work well with the location so close to the river's edge.)

Alternative BR-4 – This alternative reduces the median shoulder widths from 12 feet to 6 feet on the bridge typical section. This reduces the cost of the bridge by almost \$410,000.

- **R-4430: WIDEN SR 1783 (UPWARD ROAD) FROM US 176, CROSSING OVER I-26 AND ENDING AT SR 1006 (HOWARD GAP ROAD); HENDERSON COUNTY**

This project will widen SR 1783 (Upward Road) to a multi-lane facility. TIP Project R-4430 begins at US 176, crosses over I-26, and ends at SR 1006 (Howard Gap Road). The project length is approximately 2.7 miles.

Alternative AP-5 – This alternative reduces the turning-lane width from 12 feet to 10 feet. The posted speed limit in this area is 45 mph. With the necessity to slow for a turning movement, consideration might be given to this lane-width reduction, which resulted in almost \$743,000 in construction-cost savings.

Alternative BI-2 – The original design calls for a structural steel bridge at this location. Alternative BI-2 suggests the use of a pre-stressed concrete (PSC) bridge. The resulting cost savings would exceed \$521,000.

Alternative BI-3 – The original design calls for the construction of a detour bridge to help maintain traffic during construction. The alternative demonstrates the potential benefits of using staged construction on the existing bridge in lieu of building the detour bridge. The result could generate almost \$1.4 million in construction-cost savings.

3.4 Recommendations

A recent report from the Federal Highway Administration's Inspector General cited a substandard implementation rate for VE alternatives reported for North Carolina. Based on the results of the VE studies performed and FHWA's report, some general conclusions regarding NCDOT's VE practices can be noted:

- There is a wealth of opportunities for VE practitioners to identify cost savings, if practitioners are permitted access to NCDOT projects and are supplied with full project documentation.
- The project data supplied for the 10 NCDOT TIP projects ranged from acceptable to inadequate. The recommendations of this report highlight what data is suggested to be provided in a well-integrated VE program.
- The results to be realized from Value Engineering are very much dependent on the following conditions:
 - Support from the highest levels of management.
 - The presence of a champion for VE within the ranks of NCDOT.
 - Follow-through in making sure that projects whose estimates exceed \$25 million are indeed “VE’ed” and that the implementation-meeting notes are thoroughly reviewed by management, in order to make sure that sound alternatives are not being dismissed for shallow reasons.
 - Implementation meetings should be conducted in a formal manner and decisions about alternatives should be based on a positive approach. This approach would be epitomized by deciding not to dismiss an idea until practitioners have had an opportunity to explore the suggestion and determine if it can be modified and made to work in a manner that improves the project and/or increases the return on construction dollars spent.

What was learned during the conduct of the VE studies also included the identification of a wealth of opportunities for realizing returns by exploring the following areas of Value Engineering inquiry. These are outlined in the following section.

3.4.1 Recommendations Based on Value Engineering Studies

As part of the VE study process, one of the key questions encountered concerned whether the planning and design teams are routinely erring by choosing the more costly choices recommended by the references that govern their practice. Generally, designers do tend to stick to design formulas that have worked in the past, and it is easy to fall into a routine when designing projects. Although such a routine may work well and provide a solid design for a project, it can lead to instances of capital outlays that might be avoided by considering different design options. However, no consistent bias to “over-design” projects was found in this VE review.

This section provides recommendations about NCDOT's practices and procedures based on the results of the VE studies performed for each of the 10 TIP projects. The results of the VE studies indicated the following general areas of focus in relation to potential cost savings.

Cost Awareness

Cost estimates for several TIP projects studies were out-of-date or based on minimal amounts of support information. The following are specific examples:

- **I-4744:** It was noted that the expected cost would be approximately \$60 million. However, there was no formal estimate available to support this figure. In addition, the description of work was rather vague as to content, timing, and potential effect on the eventual cost outcome. On the same project, there was \$1 million set aside for right-of-way, as a “placeholder” figure to cover this cost. However, there was no information to support this number.
- **R-2813B:** The VE team was not supplied with a construction-cost estimate. There was an older TIP figure, as mentioned in the VE report. This was a cost summary that noted that the project was expected to cost \$32 million. It is understood that this design/build project has recently been let to construction. At that time, it was expected to cost approximately \$42 million, but the project actually cost approximately \$10 million more. This means that the pre-bid cost predictions were low by 25 percent. This signals an important shortfall in maintaining a grasp on the marketplace and current costs.
- **R-4430:** The construction-cost estimate that was supplied to the VE team for project R-4430 was dated Feb. 2007, meaning it is reasonably current. This estimate concluded that the expected construction cost would be \$27.4 million. The estimate appeared to be fairly detailed, yet contained some very high mark-ups, including those for “Miscellaneous” and “Mobilization for Structural and Utilities” (10 percent), as well as a similar mark-up for Roadway (25 percent). This estimate did not include the cost of environmental compliance, the protection of cultural assets, or the cost of right-of-way. This seems to be fairly standard practice in keeping the construction estimate separate from the “soft costs” of the projects. This is a concern because an interested party will likely find total project costs hard to discern.

Recommendations. Cost estimates should be based on as much detail about the projects as possible, in order to provide meaningful estimates that the NCDOT can use to help it effectively allocate funds. The following specific recommendations address the issue of cost awareness.

- Even the earliest attempt at estimating the eventual cost of a project should contain more detail to replace the current 35-percent contingency-type mark-up factors.
- From the very beginning of a project's life, the right-of-way and environmental staff members should be consulted and the best information available should be inserted into the estimate. The resulting estimate should provide a useful, comprehensive view of the expected total actual cost of the finished project.
- It is recommended that the cycle that governs design development be accompanied by a similar cycle that governs the development of the attendant construction-cost estimate for each project. As more is known about each project, the more detailed the cost estimate should be. The goal should be that in its final stages, the construction estimate would fall within 5 percent of the final successful bid. What likely happened in the R-2813B cost overrun is that the latest estimate was not supported by a market analysis and/or a final pre-bid perspective on the most current cost of key materials. It has been speculated that in recent months, contractors have not been "hungry" and will bid-up to make it worthwhile to pursue new projects. It has also been found that the Design/Build approach may not be serving its original purposes, due to the flush market conditions. Constructors are passing along the risks associated with high and unknown material costs by significantly increasing their bids to cover such factors. Because of this practice, the NCDOT may need to consider doing what other states and federal agencies are doing, i.e., rejecting absurdly high bids in order to "discipline" the marketplace. Withholding contracts can have a cooling effect on the race to raise bids. On Design/Build projects, consideration should be given to rejecting bids and going back to Design/Bid/Build practices until the current wave of project-cost problems has passed. This will likely result in a project delay, but could actually reduce the final project costs.
- Finally, the construction-cost estimate should be a dynamic document that is maintained (as needed) to provide the clearest possible picture of eventual cost impact. This means giving a "time value of money" perspective on the eventual cost of the project. Since projects have a way of slipping up and down the time line, the estimate should be the first tool considered when significant project time swings occur.

Construction-Cost Knowledge

Most of the 10 TIP projects studied implemented traditional construction methods and materials that have been used in the past. While these design choices may work well, becoming more aware of the costs associated with such design choices will allow

NCDOT to consider more cost-effective options that are currently available. Below are specific examples:

- **R-2545:** This project could realize savings by the consideration of two items related to construction cost: shifting a bridge alignment to avoid staging of new bridge construction, and reducing the median width from 12 feet to 4 feet.
- **R-3403:** Reducing construction costs on this project is possible by reducing the median width on a portion of this project from 30 feet to 14 feet, or using one bridge instead of two.
- **R-3825A:** Reducing median width is possible on this project, in order to save on construction costs.
- **U-3326B:** Savings in construction costs can be realized by simply reducing a multi-use path width and fencing on this project.
- **R-4430:** The use of a concrete bridge instead of a steel bridge (or using staged construction of the bridge, instead of a detour bridge) can result in construction-cost savings.

Recommendations. Consideration of the costs of materials and construction when making design choices can exert a favorable impact on cost savings. Even a seemingly small adjustment in design can create a substantial savings in cost. The following recommendation should be considered:

- An environment needs to be established in which the design team is encouraged to use improved construction-cost knowledge as the basis for its design choices. This implies that using what has been implemented in the past may not always be the best choice and that there may be new technologies (routinely employed in the open marketplace) that the State is not considering. A simple example is the possibility of using keystone-type retaining walls in lieu of heavy, standard concrete gravity retaining walls. These walls have the benefit of being attractive, easily constructed, and approximately half as expensive as gravity walls.

Right-of-Way

Like the costs of construction and materials, the cost of right-of-way acquisition should be considered in conjunction with development of the roadway design. Below are specific examples in which design changes could result in a reduction in right-of-way acquisition and cost.

- **R-3403:** Two alternatives developed for this project resulted in reduction of right-of-way costs, with only small shifts to the roadway alignment.
- **R-2303A:** Using a new alignment on this project could substantially reduce right-of-way costs by approximately \$8.2 million.

Recommendation. As noted previously, the right-of-way professional should be consulted early and often in order to help maintain an accurate construction-cost estimate. In addition, this professional should be included in the design team to help build a design-team awareness of the impact of its design choices on the eventual cost outcomes for the projects. Too often designers make their design decisions and the right-of-way professional proceeds to acquire the land necessary to accommodate that design.

Due to the fact that the TIP program addresses traffic needs where congestion has become a real problem, it is not unexpected that the preparation for construction involves the acquisition of properties that have experienced recent and significant value increases. With high-value lands and structures at stake, the planning for these costs must be strategically sound and the effort continuous, from initial concept to the eventual ribbon-cutting ceremony.

Median Width and Type

Two primary issues dominate the issue of median width and type: right-of-way cost and safety. Typically, we find that the fifth lane (with opposing turns in the median) is commonly used in urban areas, largely because that usage facilitates access to retail properties and minimizes right-of-way costs. If one were to build a 44-foot-wide divided median in an area such as Durant Road (Raleigh, N.C.), it is likely that the cost for the right-of-way just to build the median would range from \$100 to \$200 per lineal foot. This is based on a right-of-way cost of \$100,000 to \$200,000 per acre. Hence, there is often considerable financial pressure to reduce median width. However, that same economic pressure doesn't always come into play, especially in non-urban areas:

- **R-2545:** In a rural setting, such as Hwy 64 near the Alligator River, property values are considerably less than in urban areas and are probably worth approximately \$6,000 per acre. This would result in a median cost of \$0.138/square foot, or \$6.06 per lineal foot for the 44-foot-wide median right-of-way cost. Because of the relatively low costs involved, designers can consider using slightly more room for medians without creating considerable associated costs. However, it should be noted that such cost savings are often offset by the cost of the earth needed to construct such a median.

Recommendation. Although cost savings are of course a key factor for consideration during the design process, safety must be given paramount importance. For example, in the R-2545 design situation noted above, it would not prove desirable to have traffic on Hwy 64 using a 12-foot-wide median lane for passing at high speeds. The use of

opposing left-turn lanes (or “dead man’s lane”) can often prove hazardous during inclement-weather situations. This applies to rural design settings across the board. Instead of implementing such a configuration, a better design choice would involve the use of a somewhat narrow median supplemented with the periodic placement of slow-traffic lanes added on the right side of moving traffic, in order to facilitate through-traffic movement around slower-moving traffic.

Context-Sensitive Design

Considering context-sensitive design in projects can provide cost-saving design options. Some examples found in the TIP projects studied follow:

- **R-3403:** Designing 11-foot lanes for this project may be acceptable due to the fact that this road currently has 11-foot lanes and an accident rate that is better than the state average. Providing 11-foot lanes in this instance would provide substantial cost savings.
- **R-3833:** Moving a bicycle lane off the roadway and making it part of a bike/pedestrian path for this project is not only safer, but also provides considerable construction-cost savings. This project could also use natural materials for the construction of the bike/pedestrian path, in lieu of the asphalt included in the current design.

Recommendation. Awareness of context-sensitive design and how it can positively affect project costs is important. Being cognizant of context-sensitive design choices that are available for a project (and their potential cost savings) can result in a more appropriate design for the setting, as well as reduced construction costs.

3.4.2 Value Engineering Program Recommendations

As part of this study, value engineering procedures and practices from other states were reviewed to see how they might be used in NCDOT’s Value Engineering program to enhance the effectiveness of value engineering and its application to projects.

The following recommendations were developed through a review of practices of the departments of transportation from various states, and from the experience of the PBS&J team, in order to enhance the VE program efforts at the NCDOT.

Project Delivery

The project-delivery process is not typically thought of as the subject of a VE workshop. However, the Value Engineering Job Plan is a problem-solving tool that has been

successfully applied to studying and streamlining the project delivery system for DOTs and military construction projects. An excellent example is the study that was conducted for the Maryland State Highway Administration (MdSHA). During this workshop, it was determined that MdSHA had more than 192 steps within its project-delivery system. These steps resulted in an average project delivery time of approximately 12 years. By brainstorming and evaluating the various steps of the delivery system, it was found that several years could be taken off the delivery time while dramatically reducing costly management-team changes.

Life-Cycle Costing

In most instances, it has been observed that the various state departments of transportation tend to emphasize the initial cost of building projects. When life-cycle costs are documented as part of design solutions or as results of a VE study, little attention is generally paid to these issues. Highway construction funds are hard to come by, but states and municipalities also are finding it more difficult to provide the staff, equipment, and materials necessary to maintain their transportation infrastructure. Accordingly, design decisions and VE studies need to employ the best methods of life-cycle costing to better inform decision makers about the long-term impact of designs.

Cost-Based Decision Making

Designers are called on to make decisions at various stages of project delivery, each decision moving inexorably toward the final configuration that will govern the cost of the end project. During most of the timeframe in which the most critical decisions are made, the construction-cost estimate still carries large contingencies in order to cover unknowns. This means that the designer's decisions are mostly made on the basis of the range of recommended choices used in standard practices and policies, not on the basis of the likely impact on final costs. This method of practice needs to be tempered with up-to-date, dynamically loaded cost information. In other words, the designers need to see the net cost effect of their design choices as they make their design decisions. In order for this to happen, designers need to either have input ready from their cost-estimating staff, or they need to be well informed about the relative cost of methods and materials that result from design decisions. It is recommended that the cycle that governs design development be accompanied by a similar cycle that governs construction-cost estimate development. The objective would be to have at hand a continually updated, current construction-cost estimate. This objective would be applicable to both NCDOT in-house project delivery team and consultant-team practice.

Design Choices Affecting Construction

It is generally accepted that the design and planning team members rarely have an adequate knowledge of construction methods used in the field. Accordingly, it is an excellent practice for the Value Engineering team to include an expert that has extensive highway construction and pavement-maintenance experience. This approach has proven invaluable on the VE team work that has been performed at the Georgia DOT. In that jurisdiction, the construction team member has served to “keep the team honest”—meaning that this person has been able to evaluate suggested alternatives in a manner that focuses on what really will work well in the field. NCDOT has used this methodology on a few projects in recent years, but it could do more.

3.4.3 Additional Information

A discussion of various Value Engineering guidance, practices, and principles employed by other agencies (including FHWA and other state departments of transportation) is included in **Appendix B**.

A list of items to consider in the Value Engineering process is provided in **Appendix C**.

APPENDIX A

Value Engineering Study Summaries

A.1 R-2545: US 64 Improvements East of Columbia to East of the Alligator River (Tyrrell and Dare Counties)

Project Description

The US 64 Improvements project (North Carolina DOT TIP R-2545) is planned to widen US 64 from east of Columbia to east of the Alligator River. In accordance with the Strategic Highway Corridor initiative, US 64 is to be classified as an Expressway, a 4-lane divided facility with a design speed of 60 mph. Two median options are being considered: a 23-foot elevated median, and a 46-foot depressed median. To avoid future flooding, the roadway is planned to be elevated by as much as 6 feet, requiring significant earthwork and shoring during construction. The project includes replacement of the existing 2.9-mile Lindsey C. Warren Bridge that crosses the Alligator River.

There are significant environmental considerations throughout the project area, including wetlands, canals, endangered species, game lands, and the Alligator River National Wildlife Refuge. Right-of-way will be required to widen the facility; as many as 30 to 35 residences will be affected, and some businesses could also be impacted.

The current estimate for the cost of construction ranges from \$208 million to \$255 million, depending upon the median width and type selected.

Study Results

The Value Engineering team developed eight alternatives and eight design suggestions. The results are grouped according to the following headings:

Value Improvements for the Project. Alternative AP-7 analyzes the option of switching from a 46-foot depressed median to a 30-foot depressed median. It was seen as the narrowest configuration that would work well, in light of the fact that the roadway must be raised by 6 feet in order to handle future flooding events. The cost savings attached to exercising this option would exceed \$3.1 million.

AP-11 is one of the best alternatives under consideration. It calls for using a 12-foot raised median that drains from the centerline to the edge of the pavement. This makes it possible to avoid the very expensive 6 feet of earth fill that was necessary as a result of the drainage structure clearance for depressed median drainage. The resulting cost savings are in excess of \$35 million, which do not include right-of-way cost savings that would result from the use of this narrower, alternative median.

Related to AP-7 is Alternative EW-6, which calls for the use of a center berm that would serve two purposes: 1) provide a separation temporarily while the new lanes are constructed (raised 6 feet above the existing roadbed); and 2) serve as the permanent separation between the eastbound and westbound traffic. At the same time, the median would be changed from a 46-foot-wide depressed median to an 18-foot-wide bermed median. The construction of the berm would be accomplished using HESCO Bastions or an approved equivalent method. The resulting cost savings would total approximately \$750,000.

Bridge Alternative BI-5 provides for shifting the alignment of the bridge to minimize construction staging costs. This is expected to reduce the construction cost by \$28 million. Another bridge alternative suggests the methods for reducing the number of bridge piers, resulting in potential cost savings of approximately \$4 million (See BI-4).

Design Suggestions. There are design suggestions that offer the potential for expediting work, reducing construction costs, and weighing alternative design considerations. They are generally intended to provide useful guidance to the project-delivery team. The design suggestions are generally less detailed, due to the early nature of the design of this project.

Contingency Suggestions. It is always a consideration for projects of this dollar magnitude that budget constraints may affect the delivery and configuration of the end project. As a result, the VE team has provided some suggested courses of action that might be employed in the event that funding become a problem in the delivery of the

project. These should be considered more as cost reductions rather than value engineering recommendations per se.

These considerations include the full spectrum of options, from deferring the widening of the roadways, simply replacing the bridge (AP-3), constructing one eastbound and two westbound lanes, deferring the work on the least-traveled segment (US 64 eastbound from SR 1229 to the Alligator River; see Alternative AP-4). Another possibility is to pursue right-of-way acquisition and grading for the full, four-lane build-out, but build only the two westbound lanes and one eastbound lane.

Each of the alternatives in this classification has very large dollar savings associated with them. However, again, these are intended to be employed only should funding issues pose problems for the completion of the work.

A.2 R-3403: US 17 in Bridgeton from Mills Street to SR 143 (Antioch Road) to NC 43; Craven County

Project Description

The purpose of this project is to alleviate vehicular congestion and improve the level of service along US 17. By upgrading the level of service, the highway's safety will also enhanced. Also, an improved US 17 in Craven County will allow better mobilization whenever hurricane evacuations are ordered in nearby coastal regions.

The 1992 New Bern-Bridgeton-Trent Woods-River Bend Urban Thoroughfare Plan classifies US 17 as an Urban Major Thoroughfare from Mills Street in Bridgeton to approximately 1.5 miles (2.4 kilometers) north of SR 1433 (Antioch Road). From this point northward, the highway is classified a Rural Major Collector. The "US" designation indicates that the route is on the National Highway System. This project is an important

part of a regional transportation need to improve traffic flow in the US 17 corridor that accesses the Cherry Point Marine Base and the coast.

The current estimated construction cost is \$41,200,000.

Study Results

During the Speculation phase, the VE Team identified eight alternative ideas that appeared to offer potential for reducing the construction cost, improving the end product, and/or reducing the difficulty and time of project construction. After the Evaluation phase was completed, five alternative ideas and two design suggestions remained for further consideration.

Value Improvements for the Project. There was nearly \$1.4 million embodied in three value-engineering alternatives that are seen as adding value or improving the return on the construction investment. These alternatives serve to reduce the cost of paving and or reduce the cost of right-of-way.

Design Suggestions. There were two design suggestions that also could serve to reduce the costs of construction. These were not described in detail due to the limited amount of documentation available for this project.

Contingency Suggestions. Alternative No. 7 proposes building just one bridge instead of two. This is an excellent example of a contingency alternative, since it would likely not be an exercised alternative, if construction funding was adequate.

Project Documentation

Project documentation included: the hearing maps; a brief plan set; the purpose and need statement; some traffic data; and preliminary pavement design. The construction-cost estimate was commensurate with the level of project-plan development (preliminary).

A.3 R-3825-A: NC 42 from US 70 at Clayton to 0.26 Miles East of SR 1902 (Glen Laurel Road); Johnston County

Project Description

The purpose of this project is to symmetrically widen NC 42 from US 70 to SR 2022 (Old NC 42). From Old NC 42 to SR 2008 (Fox Ridge Road), the proposed new lanes will be constructed on the north side of existing NC 42. NC 42 will be widened symmetrically from Bennett Place to Buffalo Road (SR 1003). Bridge No. 75 (carrying NC 42 over the Neuse River) will be replaced with a new structure. These proposed improvements are designed to minimize impacts to streams, wetlands, and adjoining properties.

The current estimated construction cost is \$27,124,500. The derivation of this estimate was not available to the VE team. The VE team, therefore, performed an independent estimate of probable costs to develop the “estimated savings” for the alternative designs.

Study Results

During the Speculation phase, the VE team identified 11 alternative ideas that appeared to hold potential for reducing the construction cost, improving the end product, and/or reducing the difficulty and time of project construction. After the Evaluation phase was completed, six alternative ideas and four design suggestions remained for further consideration.

Value Improvements for the Project. There were two key alternatives that provide for reduced right-of-way acquisition cost and, in one instance, help to reduce the environmental impact. Alternative No. 3 indicates a savings of \$309,100 by reducing the median width. Alternative No. 8 proposes to use the existing roadway as the fifth lane and reports a cost savings of \$418,000.

Design Suggestions. There were two design suggestions. One provides a U-turn opportunity to improve traffic operations, while the other suggests fine-tuning the side slopes for the road in order to minimize right-of way takings and help avoid environmentally sensitive areas.

Contingency Suggestions. There was one contingency alternative, Alternative No. 6, which provides for using a fifth lane instead of a median. The cost of that decision indicates a net savings of approximately \$48,400.

Project Documentation

Project documentation for this workshop was very limited. The VE team had to develop its own estimate of probable cost. The plans did not cover the project in thorough detail.

A.4 I-4744: I-40 from Wade Avenue to I440/US 64; Wake County

Project Report Notes

Since the project was at such a limited state of development, the information contained in this minimal report summary is being provided as the Value Engineering report for this work effort. The VE team was provided with a roll of two drawings that contained only the existing facilities. In effect, these two drawings covered the alignment of future improvements from the I-40 split to I-440. The drawings looked like the initial result of aerial photography renderings with some property lines drawn on them. There was no labeling of existing roadway infrastructure, i.e., no drainage indicated, no typical sections, and no grades or elevations labeled. Discussions with the project manager at NCDOT indicated that there was no official estimate for the project, except to say that the current “placeholder” figure is \$60 million for the roadway work and \$1 million for the right-of-way.

Project Description

The TIP number for this project is I-4744. It is officially known as SR 1728 (Wade Avenue Milepost 289) to I-440/US 1 – 64 (Milepost 293) – Add Lanes. The current plan appears to propose adding one lane eastbound and one lane westbound (in the now depressed grassed median), to bring the total number of lanes to six. There are plans in the future to add an additional lane in each direction, which would bring the total up to eight lanes serving the eastbound and westbound traffic needs. The project manager noted that when lanes Nos. 7 and 8 are added, the project will likely be extended back to Harrison and involve some additional bridge work. As a courtesy, the VE team was supplied with an unofficial estimate that indicates that the six-lane work will cost \$28.7 million and the eight-lane work will cost \$31 million. However, this is at odds with the earlier estimate cited in the **Project Report Notes** section above.

Study Results

Since the data available for this project was rather limited, the observations that can be made about construction-cost impact (by way of value engineering) must be limited to design suggestions concerning the “usual suspects” in projects of this type:

Value Improvements for the Project. The VE team provided the following observations specific to this project:

- On the six-lane improvement “courtesy estimate,” it was noted that there are nearly \$4 million in bridge widenings. This probably represents the biggest opportunity for cost avoidance. Consideration should be given to modifying the abutment treatments to avoid the costs, particularly on the six-lane widening effort.
- Shoulder paving and the attendant widths should be reviewed for adequacy and kept to a minimum.
- Consideration should be given to incorporating existing shoulders into the eventual pavement build-out.
- It seems likely that the six-lane build-out can be done within the existing right-of-way.

Project Documentation

As previously noted, the documentation for this project was very limited.

A.5 R-2303-A: NC 24 from West of SR 1006 (Maxwell Road/Clinton Road) to SR 1853 (John Nunnery Road); Cumberland County

Project Description

The proposed action involves a combination of widening, adding new location segments, and making other improvements to the existing NC 24 roadway located from 2.8 miles east of I-95 to I-40, in order to create a four-lane divided facility. Based on the need to avoid disruption to development within the area towns, there will be bypasses and/or other alternate routings around Stedman, Autryville, and Roseboro. The highway will follow a portion of the Faircloth Freeway in order to bypass Clinton. To the east of Clinton, the route will be on new location. Widening portions will have partial control of access, while new location segments will have limited control of access. Most intersections will be at grade.

The project is divided into segments for planning and construction purposes. Some portions of the project include only one alternative, while in other areas there are several alternate routings. The result is a total of 6 alternatives, some of which represent areas in which more than one routing option exists.

Project costs (related to both construction and right-of-way) for upgrading the entire 40-mile segment of NC 24 are estimated to be in the range of \$334 million to \$357 million, depending upon the preferred alternative that is ultimately selected.

Based on documentation provided to the VE team, this VE study was focused on Segments A-1, A-2, A-3, and A-4, which together constitute a total of 6.5 miles. The current construction-cost estimate for these segments is \$33,550,000. Right-of-way costs for the “best fit” alternative are estimated at \$14,115,000.

Study Results

Value Improvements for the Project. While project materials indicate that several alternatives are under consideration, one that the VE team looked at was documented in Alternative AP-4. This alternative provides for moving road segment A-2 to a new location. By doing so, this alternative greatly reduces the number of residential- and business takings and appears to offer a chance to reduce the total cost by as much as \$8 million.

Alternative AP-5 provides for lowering the alignment’s vertical profile in order to reduce the earthwork aspects of the project. This would reduce the construction cost by approximately \$1.3 million.

Design Suggestions. The four key design suggestions address various traffic-operation conditions that might be improved through exercising the suggested courses of action. Involved in these design suggestions are turn-out radii, channelized left turns, channelized right turns, and dual U-turn lanes.

Project Documentation

The documentation included: hearing meeting maps; cost estimates for the various alternatives; traffic-operation analyses; and other data at a level consistent with the current early planning stage.

A.6 U-3326-B: US 29 Business (Freeway Drive) from SR 2686 (Richardson Drive) to NC 14; Rockingham County

Project Description

The North Carolina Department of Transportation (NCDOT) proposes to improve US 29 Business (Freeway Drive) by widening the current two-lane facility to a multi-lane facility, from SR 2670 (South Scales Street) to NC 14 in Reidsville. The project is divided into two sections for funding purposes: U-3326A and U-3326B. U-3326A begins at SR 2670 (South Scales Street), ends at US 158 (Richardson Drive), and is located within the Water Supply Watershed of Reidsville Lake and Troublesome Creek. U-3326B begins at US 158 (Richardson Drive) and ends at NC 14. Although Section B is eligible for intrastate funds and Section A is ineligible, both sections will be let to contract simultaneously. The total length of the project is approximately 6.7 miles.

The purpose of this project is to increase the traffic-carrying capacity and level of service for US 29 Business (Freeway Drive). The need is based on the current facility operating near capacity. It is anticipated that the facility's current capacity will be exceeded by 18,000 vehicles in the 2025 design year.

The proposed improvements to US 29 Business (Freeway Drive) are state and federally funded and are identified as Project Numbers U-3326A and U-3326B in the 2006–2012 NCDOT *Transportation Improvement Program (TIP)*. Right-of-way acquisition and construction for U-3326A and U-3326B are scheduled in federal fiscal years 2007 and 2009, respectively.

Roadway Length. The total length of the project is 6.7 miles, consisting of 2.0 miles in U-3326A and 4.7 miles in U-3326B.

The current estimate for the cost of construction is \$42.7 million. Right-of-way is expected to cost approximately \$13 million more and the cost for handling utilities is expected to cost around \$1.2 million.

Study Results

Value Improvements for the Project. There were eight alternatives and six design suggestions proposed by the VE team, including several key ideas that provided for reducing the cost associated with the bridges on the project. Three of these ideas (EW-1, EW-3, and EW-4) related to reducing the clear height for three bridges. It appeared that these bridges were being placed with excessive clearance. However, the drawings are conceptual in nature and it is difficult to know with certainty that the excess clearance will yield the indicated savings. Nonetheless, if the excess clearance is as indicated, there would be approximately \$100,000 in construction-cost savings achieved through lowering these bridges.

Another bridge-based alternative (BR-5) calls for the widening of one of the bridges on a side road. The traffic on this bridge is projected to be very low and does not seem to justify bridge widening. The cost savings associated with this alternative is approximately \$253,000.

Bridge alternative BR-1 calls for shortening a proposed bridge. This would appear to be a readily addressed change and would reduce construction costs by almost \$150,000.

Moving the guardrail up to the face of the vertical curb (as documented in alternative AP-3) would reduce the berm width and lower the construction cost by nearly \$286,000.

Design Suggestions. The design suggestions address ways to reduce the construction costs. They are offered as design suggestions, since there was a limited amount of information to use had they been developed as alternatives. These suggestions (such as Design Suggestion EW-7, below) appear to contain real opportunities for cost savings and should be explored further as the design matures:

EW-7 – Reduce earthwork at outer road -Y20B-. This design suggestion is based on the fact that it appears that moving the outer road a short distance in an area where there is a very deep fill could reduce the fill height and cost associated with a great deal of borrow.

From the typical sections, it appears that some side streets have pavement designs that are commensurate with mainline pavement. It is suggested in AP-2 that these pavement sections be reduced in order to reduce the construction cost.

Contingency Suggestions. There was only one alternative in this category. BR-2 is proposed as a design suggestion and provides for re-using the existing bridge. This would be accomplished by jacking the existing bridge to a new, higher seat on new abutments. Details do not yet permit full evaluation of this alternative.

Project Documentation

The documentation for this project was very acceptable for the project-development level. Traffic-operations data, cost estimate, and plan content were very useful in developing the alternatives.

A.7 U-3600: US 220 Business (North Fayetteville Street), SR 2261 (Old Liberty Road) to US 220 at US 311; Randolph County

Project Description

The proposed project begins at SR 2261 (Old Liberty Road) and ends at US 220, covering a distance of 5.2 miles. The purpose of the project is to improve existing and future safety and the level of service by widening the roadway. The project includes a four-lane divided cross section, with a 23-foot-wide raised median to separate opposing traffic streams. The bridge over Haskett's Creek will be replaced with a wider bridge to

accommodate the multi-lane facility. Outside travel lanes are planned to be 14 feet wide in order to accommodate bicycle traffic that may wish to use the roadway. The project is divided into two sections (A and B) for funding and scheduling reasons.

The project is located in a mixed suburban-to-rural area. Four stream crossings and seven signalized intersections are within the project limits. The right-of-way required to widen US 220 Business will result in approximately 9 residential and 15 business relocations.

Project costs (including those related to both construction and right-of-way) are currently estimated at \$30,918,000.

Study Results

Value Improvements for the Project. The VE team identified four alternatives and six design suggestions. Alternative AP-4 indicates the cost of a decision to provide the extra width of full-depth pavement to accommodate bicycle lanes. This cost is identified as \$540,692. It is suggested that consideration be given to eliminating these bicycle accommodations. A lower-cost possibility might involve providing an improved, multi-purpose bike/pedestrian trail in order to meet this need while keeping costs down. AP-5 provides an insight into a higher-cost approach that would serve the purpose of getting the bicycles out of the flow of traffic, but at a modest cost increase of approximately \$79,000.

Design Suggestions. The developed alternatives include six design suggestions. They address minimizing right-of-way takings, improving traffic operations, and reducing environmental concerns. The design suggestions include:

- **AP-2** – Suggests the use of a variable median width in order to limit the amount of right-of-way that must be taken.
- **AP-3** – Suggests consideration of five-lane section at southern end of project.
- **AP-6** – Reconfigures the intersection of Morningstar Road and Wesleyan Road in order to improve the flow of traffic within the area. This would also provide enough storage for vehicles to stop at the railroad tracks and not block US 220 Business.

- **AP-7** – Provides opportunities to improve on the poor sight distance and poor operational characteristics associated with the railroad and Wesleyan Road.
- **BI-2** – This design suggestion proposes the use of a bottomless culvert (similar to a ConSpan type structure) in order to maintain a natural channel for Haskett’s Creek to pass underneath the new roadway construction. This should assist in reducing the environmental concerns for the project.

Project Documentation

The project documentation included a construction-cost estimate, traffic data, and an environmental assessment. The colored public-hearing maps were most useful in terms of generating the project VE findings. It is obvious from looking over these maps that the most fruitful future objective (for cost-control purposes) will involve containing the right-of-way needs of this project.

A.8 R-3833: SR 1100 (Brawley School Road) Widening from SR 1177 (Chuckwood Road) to US 21; Mooresville, Iredell County

Project Description

The North Carolina Department of Transportation (NCDOT) proposes to widen SR 1100 to a four-lane divided facility. Additionally, the intersection of SR 1196 (Gibbs Road) and Brawley School Road will be relocated to the west of its current location and tie into Brawley School Road directly across from Rolling Hills Road. A single-point urban interchange (SPUI) is included where Brawley School Road crosses I-77, and a bridge will be constructed where the relocated Gibbs Road crosses an unnamed tributary. The total project length is 5.9 miles. The project is located in Mooresville, in Iredell County.

The current estimate for the cost of construction totals \$80,676,000, which includes \$37,800,000 for construction and \$42,876,000 for right-of-way acquisition.

Study Results

Value Improvements for the Project. The VE team identified four alternatives and three design suggestions. This project contains a significant expense related to accommodating bicycle and pedestrian traffic. These accommodations also necessitate a strong right-of-way requirement. As a result, the VE team focused on these issues. Alternative AP-1 calls for moving the bike path from the roadway and enlarging the nearby walkway to accommodate both bicycles and pedestrians. Doing this could generate a cost savings of approximately \$2.8 million. AP-7 calls for reducing the lane width on the outside lane from 16 feet to 14 feet and marking the pavement with “sharrows,” an innovative pavement marking that clearly indicates to motorists and bicyclists that the pavement is to be shared by the two groups. This could reduce the cost of construction by nearly \$3.2 million.

Design Suggestions. There were three design suggestions under consideration. One of them calls for having unused right-of-way revert back to owners at the end of construction. Another suggests that construction be expedited by letting a contract for utility relocations well in advance of the proposed overall project.

Contingency Suggestions. The Value Engineering effort noted one alternative in this category (i.e., the elimination of sidewalk on one side of the road). This alternative (AP-2) would reduce the cost of construction by approximately \$2.7 million. This option could be well worth considering if funding is a problem.

Project Documentation

The documentation for this project included a set of plans, cost estimate, environmental assessment, request for right-of-way cost estimate, and some traffic data. This was adequate for this level of value engineering.

A.9 R-2813-B: Widen NC 146 (Long Shoals Road) from West of SR 3501 (Clayton Road) to East of I-26; Buncombe County

Project Description

The North Carolina Department of Transportation (NCDOT) proposes to widen NC 146 (Long Shoals Road) to a multi-lane facility from NC191 (Brevard Road) to US 25 (Hendersonville Road) in Buncombe County. The project is divided into three sections: 1) Section A, from NC 191 to just east of the French Broad River; 2) Section B, from just east of the French Broad River to east I-26 Interchange; and 3) Section C, from just east of the I-26 Interchange to US 25. The total project length is approximately 3.5 miles. The length of Section A is approximately 1.6 miles, Section B is 0.12 mile, and Section C is 1.8 miles. The recommended typical cross section is a five-lane, 68-foot face-to-face of curbs and gutter section. The project proposed to construct a segment of NC146 on new location from NC 191 to just east of Clayton Road (SR 3501). This includes replacing Bridge No. 53 (Long Shoals Bridge) over the French Broad River and Bridges Nos. 113 and 114 (which carries I-26 over NC 146).

The project was included in the 2000–2006 North Carolina Transportation Improvement Program (TIP). The estimated project cost in the TIP was \$32,505,000, which included \$6,002,000 for right-of-way, \$12,637,000 for construction, \$1,470,000 spent in previous years, and \$12,395,000 post-year (beyond the year 2006) right-of-way and construction costs. A recent estimated project cost was \$25,055,000, which included \$21,800,000 for construction and \$3,255,000 for right-of-way. Section A is scheduled for right-of-way acquisition in federal fiscal year (FFY) 2007 and construction in FFY 2008. Section B was scheduled for right-of-way acquisition in FFY 2004 and construction let in FFY 2005 and Section C was scheduled for right-of-way acquisition in FFY 2001 and construction let in FFY 2002. The project was recently let for a cost of \$52 million.

Study Results

Value Improvements for the Project. The VE team identified six alternatives and six design suggestions. Among them, Alternative BR-1 calls for the reduction of two of the

bridge lanes from 14 feet in width to 12 feet in width. This represents a slight change from normal design practice, but could reduce the cost of the bridge by \$180,700.

Alternative BR-3 calls for the reduction of the length of the bridge over the French Broad River by using MSE abutment walls. This could potentially reduce the cost of construction by almost \$543,000.

Alternative BR-4 would reduce the median shoulder widths on Bridge Typical Section No. 2 from 12 feet to 6 feet. This would offer potential cost savings of almost \$410,000.

Design Suggestions. Design Suggestion MI-2 encourages the use of a concrete median in lieu of the planned turf median. This could provide the benefit of reducing the long-term maintenance cost while avoiding the possibility of a traffic hazard resulting from the planting of trees within the turf median.

Contingency Suggestions. None.

Project Documentation

The State provided a set of preliminary plans, soil borings, traffic information, revised RFP for BAFO, earthwork summaries, and a preliminary design map.

A.10 R-4430: Widen SR 1783 (Upward Road) from US 176, Crossing over I-26 and Ending at SR 1006 (Howard Gap Road); Henderson County

Project Description

The North Carolina Department of Transportation (NCDOT) and the Federal Highway Administration (FHWA) propose to widen SR 1783 (Upward Road) to a multi-lane facility. Transportation Improvement Program (TIP) Project R-4430 begins at US 176,

crosses over I-26, and ends at SR 1006 (Howard Gap Road). This Henderson County project covers a distance of approximately 2.7 miles.

The proposed project is listed in the 2006–2012 TIP. The current cost estimate, dated Feb. 12, 2007, lists the construction cost at \$27,400,000. The 2005 report (Finding of No Significant Impact) listed the right-of-way cost as being approximately \$8.3 million with \$840,000 for mitigation.

Study Results

Value Improvements for the Project. The VE team identified nine alternatives and four design suggestions. While a deviation from normal design practice, alternative AP-5 could save approximately \$742,000 by reducing the turning lanes from 12 feet to 10 feet in width.

Bridge alternative BI-2 calls for the use of a pre-stressed concrete (PSC) bridge in lieu of the structural steel bridge. This design change is expected to reduce the construction cost by \$521,000.

Design Suggestions. Design Suggestion AP-6 serves as a reminder that it would be good to revisit the pavement design to see if the cost considerations have changed due to the recent spike in energy costs. The key consideration noted in this case is the possibility of using soil stabilization to improve the subgrade material and, hopefully, reduce the reliance on more expensive materials (such as graded aggregate base course and asphalt components) in the typical section.

Contingency Suggestions. Alternative AP-3 calls for the elimination of several median cross-over locations and the corresponding turn lanes and U-turn bulbs. As noted in the narrative, “it would seem that four locations for these U-turn bulbs is excessive, given the project’s short 2.7 mile length, in addition to having six signalized intersections within the project limits.” This reduction in construction scope could save approximately \$382,000.

Project Documentation

The VE team utilized the supplied project materials noted below during the conduct of its work in the VE Study effort:

- North Carolina Department of Transportation
 - Figures 1 and 2 (total of three sheets)
 - Memorandum – Cost Verification (dated Feb. 12, 2007)
 - Preliminary Estimate (Feb. 12, 2007)
 - Memorandum – Geotechnical Report – Design and Construction Recommendations (Dec. 1, 2005)
 - Memorandum – Preliminary Pavement Design (June 28, 2005)
 - Scoping Meeting Minutes (Feb. 11, 2007)
 - Internal “Natural Resources Steering Committee” Meeting Summary (Feb. 12, 2007)

This project’s concepts and issues were outlined in the following documents, which were provided by NCDOT:

- Finding of No Significant Impact (Oct. 2005)
- Administrative Action – Environmental Assessment Report (March 2004)
- Plan Set – Prepared by Kimley-Horn and Associates, Inc. (printed in Dec. 2006)
- Preliminary Plan Wall Version – total of three sheets

APPENDIX B

Observations from Other Jurisdictional Practices

The following are some of the unique practices being employed in various settings around the country:

Federal Highway Administration (FHWA)

In a recent message to the staff at FHWA, the Executive Director went on record to emphasize the need to support a new openness to innovative design measures. This message was imparted primarily in response to the pressing need to deliver more projects to meet traffic demands while (at the same time) seeing the funds available for such projects dwindling. The most highly regarded solution offered was seen as reviewing current design practices for signs of dogged attachment to outdated and more costly design solutions.

As noted above, FHWA leadership has made it known that it believes that planning and design managers need to challenge each other and their teams to think in terms of innovative measures that can reduce construction costs—in order to make it possible to get more done with the limited resources available. The Inspector General of the FHWA has also noted in a recent audit of VE efforts by individual states that North Carolina has not performed well in meeting VE program goals.

Recent FHWA guidance reflects the following principles:

- Planning and design decisions need to be cost-based.
- To be “cost-based” implies that planners and designers must be trained in the skills of construction-cost estimation, life-cycle costing, and be provided with an awareness of the manner in which materials choices are made.
- Some key innovative practices fostered by FHWA:
 - Context-sensitive solutions
 - Informed deviations from standard practices
 - Incorporation of roundabouts to minimize signalization costs and enhance traffic flows. (**Note:** It should be referenced that life-cycle cost savings can equal as much as four times the initial cost of signalizing an

intersection in which roundabouts can be employed. As a guideline, Georgia's policy on the use of roundabouts is that they will only be used in situations where there is one lane of traffic due to safety concerns associated with two-lane roundabouts.)

- Transportation Asset Management (TAM) – The FHWA and AASHTO promote this decision-making process. The focus is on system performance, rather than on money spent and the number of miles of roadway improved. It helps to confirm resource allocations prior to making firm commitments. This methodology provides the tools and the structure necessary to:
 - Set goals
 - Identify priorities
 - Measure results
 - Demonstrate performance
 - Increase customer satisfaction

The benefits of this decision-making process can include:

- Strategic thinking that considers long-term consequences of investments (and can help take the subjective aspects of project selection out of the mix);
- Businesslike, performance-driven, customer-oriented process that focuses on the return on an investment (ROI);
- The use of new analytical tools and new ways of applying old tools, in order to better integrate data and support decision making.

Missouri State Department of Transportation

The Missouri DOT employs a concept called “Practical Design” as part of its VE program. This approach allows for the construction of just what is necessary to address the transportation need. The Missouri DOT expects to save more than \$400 million over the next 5 years by encouraging the challenge of design standards, fitting solutions to settings, and through the revisiting of projects already slated for construction (in order to

re-think the application of costly criteria to the design of projects). As Mr. Allen of the Department has stated, “Practical Design, like Value Engineering, strives to build the right project at the right time, achieving delivery of the project scope—no more and no less.”

Ohio Department of Transportation

The Ohio Department of Transportation (ODOT) has developed and implemented a Project Development Process (PDP) that includes regular communication among technical disciplines, results in quality plans, and minimizes cost overruns during right-of-way acquisition and project construction. Depending on project size, complexity, and/or potential impact to the environment, ODOT transportation projects are categorized as Minimal, Minor, or Major. The PDP consists of a certain number of steps depending upon the project category, with the most complex projects requiring up to 14 steps. This PDP is a reflection of the suggested program followed by FHWA. It has streamlined and changed the sequencing of the normal process by:

- Encouraging communications among disciplines;
- Requiring documentation of the reasoning behind project-related decisions;
- Eliminating duplicated efforts among disciplines;
- Providing for early identification of potential “red flag” issues; and
- Ensuring that work products are completed as early in the process as possible

One of the most essential components of the PDP is a uniform Work Breakdown Structure (WBS) for each of the three project categories. This takes much of the guesswork out of the sequencing of events, from concept to completion. The more important topics covered in the WBS include the following:

- Definition of study area
- Public involvement plan
- Initiation and completion of design-level mapping
- Analysis of existing and future conditions
- Environmental programming
- Red flag summary
- Design activities

- Cost-estimate milestones
- Value Engineering workshop
- All design reviews and suggested durations of reviews

The PDP has resulted in a much more cost-effective delivery of the projects involved in the process. It has become a trusted source of project consensus and has eliminated numerous costly steps in the project-delivery system.

Virginia

Besides running a nationally recognized Value Engineering program for the Commonwealth's transportation projects, the Virginia Department of Transportation has started employing an on-line dashboard to provide project status reports on a need-to-know basis. This dashboard display permits authorized parties to "drill down" into the available database that supports the dashboard, and find key information vital to maintaining control of individual projects. As discussed elsewhere in this report, NCDOT's Project Management Improvement Initiative (PMii) will provide similar capabilities, but it has been slow in reaching operational capability.

Alaska, Arizona, Iowa, Kentucky, Maine, Michigan, Minnesota, Montana, North Carolina, New York, Utah, Vermont, Washington

The Colorado DOT took a poll of various DOTs around the country, concerning their stance on Value Engineering Change Proposals during construction (VECPs). In general, it was found that few states had any opposition to the practice of accepting VECPs for general construction. It was notable that the states named above were willing (under certain conditions) to accept VECPs related to the pavement design. Pavement design is one of those topics that come up on every VE study for roadways. In general, there is a "hands-off" attitude prevalent in the handling of such matters. It is typically announced that the pavement design has been selected by DOT specialists (without any discourse allowed about the quality of that decision), and that the chosen pavement design is not subject to further debate. Also, rarely is a VE team equipped with a team member who is knowledgeable in the area of pavement design. However, since so many states are open

to VECs on the subject, and since so much of the eventual cost of roadway projects is based on pavement design, it is recommended that the processes involved in pavement design be reviewed. The State of Florida DOT formed what is called the Florida Center for Pavement Excellence (FCPE), a cross-functional team with representatives from different areas, including: construction; asphalt materials; concrete materials; geotechnical materials; pavement evaluation; pavement management; and pavement design. This team provides the sounding board for new, optimal pavement designs and helps to assure that the latest thinking is being incorporated into the development of economical pavement alternatives.

APPENDIX C

Value Engineering Potential

Project leaders routinely entertain a large number of potential Value Engineering creative ideas, or items that should be weighed and measured for how well they are employed in the final design. The following is a partial list of “targets of opportunity” for Value Engineering:

Drainage	<ul style="list-style-type: none"> • Pipe-size optimization • Improved inlet design to reduce pipe size • Material selection • Headwall necessity/type • Outlet treatment
Right-of-Way	<ul style="list-style-type: none"> • Acquisition process • Easements vs. permanent • Minimization of takes <ul style="list-style-type: none"> ○ Relationship to horizontal geometrics ○ Placement of ramps at interchanges (distance of separation determines takes) ○ Avoidance of high-profile properties
Environmental	<ul style="list-style-type: none"> • Permitting • Minimization of wetlands • Specimen trees • Tree replacement • Erosion and sedimentation-control measures
Cultural Resources	<ul style="list-style-type: none"> • Historic sites • Historic “viewsheds”
Horizontal Geometrics	<ul style="list-style-type: none"> • Optimization/impact on right-of-way
Vertical Geometrics	<ul style="list-style-type: none"> • Optimization/impact on earthwork
Accommodation of Utilities	<ul style="list-style-type: none"> • Impact on construction schedule • Coordination difficulties • Impact on right-of-way
Signalization	<ul style="list-style-type: none"> • Use span-wire signal installation versus mast arms • Use video vehicle detection versus loops • Standardize mast arm
ITS	<ul style="list-style-type: none"> • Consolidate various ITS devices onto one structure • Use overhead FO cable versus underground • Use wireless communication versus FO cable
Roadside “Furniture”	<ul style="list-style-type: none"> • Signage/markings • Guardrails

	<ul style="list-style-type: none"> • Median barriers • Sound-attenuation walls • Fencing/controlled access • Retaining walls • Sidewalks • Lighting
Typical Sections	<ul style="list-style-type: none"> • Lane and shoulder widths • Bicycle and pedestrian facilities • Side slopes versus right-of-way takings • Placement of guardrails
Pavement Design	<ul style="list-style-type: none"> • Adequacy • Maintainability and life-cycle cost
Structures – Bridges/Culverts/Animal Crossings/Bike and pedestrian Tunnels – LCC Based Choices	<ul style="list-style-type: none"> • Walkways on bridges • Bikeways on bridges • Raised median on bridges • ConSpan-type structure in lieu of large box culvert • MSE vs. paved slope protection
Design Costs	<ul style="list-style-type: none"> • Flow of project reviews • Minimization of number of persons involved in in-house design/permit reviews
Construction-Cost Topics	<ul style="list-style-type: none"> • Contract methods (DBB/DB/DBO) • Contract general conditions • Mobilization • Cost of owning risk • Mobilization cost • Project close-out (disputes, settlements, LDs, demobilization) • Construction phasing • Construction staging (eliminating unknowns) • Mobilizing utility companies • Excellent planning figures, routinely updated • Earned-value reporting
Construction Contract Administration	<ul style="list-style-type: none"> • Conduct of daily affairs • Documentation of activities • Avoidance of claims • Use of the construction schedule to avoid construction pitfalls
Other Uses for the Roadway (May Affect Geometrics)	<ul style="list-style-type: none"> • Evacuation routes • Fiber-optic utility backbone • Special events • Mass transit corridors