Introduction:
The 2002 Guide for Design of New and Rehabilitated Pavement Structures (The Guide) is a uniform and comprehensive set of procedures for the design of new and rehabilitated flexible, rigid, and composite pavements. The Guide is based on mechanistic-empirical principles where it assumes that pavement can be modeled as a multi-layered elastic structure. This is quite a leap compared to the original AASHO Road Test, which was completely empirical (i.e. based on performance equations for the test location in Ottawa, Illinois). The Guide provides a number of new approaches for characterizing materials to be used in 21st century pavements. The mechanistic characterization of paving materials allows for the application of the principles of engineering mechanics, namely stress and strain, to the pavement analysis. Being able to input different material characteristics in the design model will allow the engineer to predict the performance of the pavement. Another improvement offered by The Guide is the use of traffic input based on the number of axles by type and weight, while eliminating the use of ESAL’s. The Guide also considers of the effects of temperature and moisture on a project basis using site-specific environmental factors, by implementing the FHWA’s Integrated Climate Model (ICM). Additionally, The Guide offers a system of hierarchical inputs permitting the engineer to devote efforts consistent with importance of the project under consideration. Currently The Guide is under development through the NCHRP 1-37A with target date for completion in early 2004.
It is very challenging to come up with a VDOT preparation plan of implementation, while the actual research is not yet complete, nor that The Guide is approved by AASHTO. Nevertheless, portions of the research can be used to enhance the current 1993 AASHTO Guide for Design of Pavement Structures, while the completed and calibrated 2002 Guide will be a total replacement to the 1993 guide.

**Objective:**

**Preparation Plan Tasks:**
The plan will be accomplished in two phases through the execution of the following tasks:

**Phase I**
Immediate utilization of applicable portions of The Guide, (as soon as The Guide is approved by AASHTO, anticipated by June 2005), to enhance the current 1993 Guide:

- **Task 1:** Traffic data, Meeting the Traffic Monitoring Guide (TMG) requirements and using load spectra from Weigh In Motion (WIM) to obtain axle loading, then converting it to ESAL will provide more reliable traffic input. Traffic data will be based on 6 WIM sites, Two from VDOT and four from Department of Motor Vehicles (DMV). The level of the traffic input data is dependent on the availability the WIM equipment in the area of the project. The cost of that phase is $1,000,000, which includes installation costs, personnel costs, and operating and maintenance costs. Personnel managing the WIM program need to be on board before this task can be accomplished. The anticipated date is June 2005.
- **Task 2:**
  - 2.1: Subgrade resilient modulus, as input rather than using CBR correlated formulas. Equipment is operational, planned seminar on selecting resilient modulus design input value/s is being considered by the Pavement Design and Evaluation section, and the Soils section. Testing soil samples from new
construction projects as part of the validation and calibration can start immediately to enhance the pavement performance evaluation.

- **2.2: Concrete Elastic Modulus**, Use of the database generated from the actual testing of VDOT mixes. This is a level II input which is an improvement to using default values.

- **2.3 Concrete Modulus of Rupture**, Use of the database in similar fashion to Elastic Modulus, with additional correlation to concrete Compressive Strength. This provides an advantage for new construction quality, and acceptance.

**Phase II**

It involves a full utilization of the completed 2002 Guide. This phase is dependent on the completion of the NCHRP and AASHTO approval of the Guide. Essentially Phase II will focus on the determination of the inputs, the use of the software, and applicability of the methods, Validation, calibration factors, and default values to Virginia’s conditions and materials.

**Task 3 : Traffic Data:**

- Using level I data for rehabilitation project, where the WIM installations are on the project site (planning for 12 sites), while level II & III are used for new alignment design, based on the project priority.

- Cost of installation, operation, and maintenance for 12 WIM sites, is three million dollars.

- It requires three full-time positions to operate/manage the WIM system. The three positions are provided by the Traffic Management, Richmond District, and the Materials Division at one position each.

- The WIM program will require five years for completion, anticipated 2008.

- Steps are under way to get the personnel allocation, and sell the Operations staff on the WIM program.

**Task 4: Materials Characterization:**

- **Task 4.1: Soils Data**, level I for rehabilitation projects, and to establish data base for new alignment (during construction), while level II is used for new alignment design.
• The soils Resilient Modulus testing facility is operational.
• There is no need for additional resources.
• **Task 4.2: Aggregate Data.** Both aggregates type I, Number 21 A, and 21B will be characterized for their Resilient Modulus. Two options are under consideration, one is to modify VDOT’s soils resilient modulus equipment to run the test, while the other is to farm out the testing to a private laboratory (ICAR is the first choice). This is a one time characterization to be used with all three levels of design. Anticipated completion time is Dec 2004.

• **Task 4.3: Asphalt Concrete Data,** all VDOT mixes will be tested for the Complex Modulus ($E^*$) and catalogued to meet level II and III for new construction. Asphalt mixes are also tested for new construction to establish database, and assist in predicting the asphalt performance, as part of the validation and calibration.

• Most of the equipment has been upgraded, with exception of the strain sensors, which is due in two months.

• The recommended procedures for asphalt testing have been provided to the Asphalt committee chairman.

• Testing is planned to start in the spring of 2004, and completion by June 2005.

• **Task 4.4: Concrete and Stabilized Materials Data,** Current VDOT concrete mixes will be characterized for elastic Modulus, modulus of Rupture, Compressive Strength, and Thermal Coefficient of Expansion for use as level II. Additionally, mixes from new projects will be tested to enhance the database and predict concrete pavement performance, as part of the validation, and calibration process. Stabilized Materials, including Cement Treated Aggregate (CTA), Soil Cement,
and Lime Stabilized Soils will be tested for Elastic Modulus. Samples obtained from newly constructed pavements will be used for testing. The obtained data is used for calibration, and establishing both correlation and default values.

- The testing facility is operational.
- No additional resources are needed.
- Database for concrete and stabilized materials to be completed by June 2005.

- **Task 5: Calibration and Validation:**
- The challenge is to determine the validity of the design method and default values to Virginia conditions and materials. Calibration is the process of making adjustments to the theoretical models to compensate for model simplification and limitations in simulating actual pavement behavior and distress development, while validation is to determine whether the model provides a reasonable prediction of actual performance, and if the desired accuracy or correspondence exists between predicted and monitored performance.
- **Task 5.1:** The current plan is to utilize the LTPP site in Danville, and the Smart Road in Blacksburg, in addition to the matching sites in the LTPP at large (i.e. Southeastern sites due to similar climate) to cross check the various levels of actual field distresses with the program predicted distresses. This effort should lead to either using the default values from the Guide or obtaining calibration factors.
- **Task 5.2:** Software Applicability just started through the participation of VDOT’s Pavement Design Program Manager as a panel member of AASHTO’s efforts to develop a new generation of Mechanistic-Empirical Design Software known as DARWinM. Finalized time line to accomplish this task still under development. It could be estimated that this effort to be completed before AASHTO would ask the DOTs to vote on the adoption of the Guide. Anticipated time is Dec 2005

**Task 5.3:** Data Management Work is in the preliminary stages of developing the scope for the re-write of Materials Database System. Some of the major objectives that have been identified are:
• The development of a web based system which will allow both VDOT and Contractors to input test results.
• Improved online sample tracking so that customers know the status of the testing.
• Information collected should include all data required by AMRL.
• Expand the data sources to include field testing.
• Where appropriate include GIS data.

The data is currently stored in SQL Server and we will continue to use SQL Server for storing the data. Data export will probably include comma-delimited formats and XML which is quickly becoming the de facto standard for data distribution.

This approach is very suitable for The Guide, where it ties data from the districts, and it is accessible to all committees working on the Guide.

• The Computer Technology section is charged with data management for The Guide. This is planned as internal effort, and it would take 1.5 MEL to complete, within three years time frame (June 2006).
• As present, the target time frame needed to complete the calibration and validation is 2011. It also requires two engineering positions (one senior and one entry level) to dedicate full time in conducting the verification.

• Task 6: Training

VDOT personnel have been exposed to pavement design using mechanistic approach through several NHI courses since 1989. Although that actual practice of the design procedure was not exercised, still it would provide a minimum knowledge of the methodology.

Task 6.1: The assistant State Materials Engineer (Technical) and the Pavement Design Program Manager are planning on attending the NCHRP 1-37A training anticipated to be held by September 2004. This is a five day program involving representatives from the State DOTs, and FHWA. Interaction and exchange of experiences regarding the Guide is very essential. It also provides a face to face discussion with the research team.

Task 6.2: This task is devoted to training central office and field personnel. The training will be conducted by members of the Training committee. The training of the central office personnel would be conducted first. A three day training during March 2006 is planned. Training of field personnel (essentially at the
Districts) is planned for June 2006. This is to allow for the central office personnel to gain additional expertise with the software, where they become resources to field personnel. Two districts at the time would be trained on the use of the software. It is envisioned that pavement design using both the 1993 Guide and the 2002 Guide will be performed during the time of calibration (2006-2011). This approach will provide continuous gain of expertise in using the Guide, and comparing results between the 1993 Guide and 2002 Guide.

- **Impact on VDOT Standards and Specification**

  Level I design requires site-specific input data, but since our plans are prepared at least two years in advance, it is necessary to have close cooperation between the designer, and the contract preparation team. As an example, the Performance Prediction Model is based on the initial IRI (as built), which means that the contract has to require such initial IRI value. This may require changing the way we do business now, where the contractor is given incentive/disincentive to comply with the current rideability specs, where we may end up with initial IRI value that is different from the design value. Performance specs seem to lend itself to the goal for implementing the Guide. As an example Cement Treated Aggregate (CTA) currently has prescriptive specifications i.e., use 4% cement by weight with Type I, size 21A aggregate. This method would not be adequate for the Guide. The GRAC is preparing a research statement titled “Evaluation of the Strength of Cement Treated Aggregate for Pavement Bases”. This research is to be conducted by the University of Virginia. The research would characterize the CTA in terms of its Young’s Modulus, and the Unconfined Compressive Strength, which are input parameters for the Guide, and easy to specify as performance specs.

- **This plan is based on the most recent available information. Several milestones in this plan are based on anticipated time for completion of the NCHRP 1-37A work,**
and the research panel review. The next milestone is when The Guide is completed, and the state DOTs training is done. This will provide the opportunity to ask more details questions to the Research Team, and interact with other states to benefit from their approach, and in turn making adjustment to VDOT plan.