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DETAILS

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WISE Software Users Guide

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The need for SHRP 2 was identified in TRB Special Report 260: Strategic Highway Research: Saving Lives, Reducing Congestion, Improving Quality of Life, published in 2001 and based on a study sponsored by Congress through the Transportation Equity Act for the 21st Century (TEA-21). SHRP 2, modeled after the first Strategic Highway Research Program, is a focused, time-constrained, management-driven program designed to complement existing highway research programs. SHRP 2 focuses on applied research in four areas: Safety, to prevent or reduce the severity of highway crashes by understanding driver behavior; Renewal, to address the aging infrastructure through rapid design and construction methods that cause minimal disruptions and produce lasting facilities; Reliability, to reduce congestion through incident reduction, management, response, and mitigation; and Capacity, to integrate mobility, economic, environmental, and community needs in the planning and designing of new transportation capacity.

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INTRODUCTION AND OVERVIEW

WHAT IS WISE?

The Work Zone Impact and Strategy Estimator (WISE) software can evaluate the impact of multiple projects that have been incorporated into the Transportation Improvement Program (TIP) and the network. The WISE tool is intended to be a decision support system to be used by planners and engineers to evaluate the impact of work zones and determine strategies to reduce these impacts. The software has been developed so that the level of effort in conducting analysis is minimal.

WISE is envisioned to be used by agencies to adhere to the Federal Highway Administration (FHWA) Work Zone Safety and Mobility Rule. For this reason, WISE has been developed based on the definitions and guidelines proposed in the rule (*see* box on next page).

WISE GUI (graphical user interface) is the link between the key WISE tools and metadata within the WISE software package. These key tools consist of the WISE Planning Module, WISE Operation Module, the WISE Analysis Engine, DynusT, and NEXTA. The WISE GUI links these tools using a WorkSpace concept. A single WorkSpace gathers the metadata necessary to define the network, multiple projects, variables, and scheduling data needed to successfully perform an evaluation of a given scenario in the Operation and Planning Modules.

PURPOSE AND APPLICATION

The WISE tool has been developed with consideration of how the program delivery process flows and how planners and engineers would need to use this tool. Because continual analysis is needed in this process, the WISE tool allows multiresolution modeling (Figure 1.1), in which data can be passed from macro- to meso-level models to

Key Provisions in Section 630.1010 of the Work Zone Rule

Significant Projects

- *Paragraph (a)* of this section defines a significant project as “one that, alone or in combination with other concurrent projects nearby is anticipated to cause sustained work zone impacts (as defined in Section 630.1004) that are greater than what is considered tolerable based on State policy and/or engineering judgment.”
- *Paragraph (b)* requires states to identify upcoming projects that are expected to be significant. It recommends that significant projects be identified as early as possible in the project delivery and development process and in cooperation with the FHWA. It also recommends that the state’s work zone policy provisions, the project’s characteristics, and the magnitude and extent of the anticipated work zone impacts be considered when determining whether or not a project is significant. Note: The purpose of identifying significant projects is to help develop and implement transportation management plans (TMPs) for projects based on their expected work zone impacts. This is addressed in Section 630.1012, Project-Level Procedures.
- *Paragraph (c)* further qualifies significant project designations by requiring all Interstate system projects within the boundaries of a designated transportation management area (TMA) that occupy a location for more than 3 days with either intermittent or continuous lane closures to be considered as significant projects.
- *Paragraph (d)* provides an exception clause for the above requirement in paragraph (c). For an Interstate system project or categories of Interstate system projects that are classified as significant through the application of the provisions in paragraph (c), but in the judgment of the state they do not cause sustained work zone impacts, the state may request an exception from the FHWA. Exceptions specifically apply to Sections 630.1012(b)(2) and 630.1012(b)(3) of the rule. Exceptions may be granted by the FHWA based on the state’s ability to show that the specific Interstate system project or categories of Interstate system projects do not have sustained work zone impacts.

work in a consistent manner with reasonable ease. The user must ensure data compatibility of these models at various levels. Therefore it is anticipated that a multiresolution approach with the ability to choose specific functionality and resolution will provide decision makers with a full range of strategic performance measures as they apply specific work zone strategies and alternatives to meet specific needs in the project delivery process.

WISE includes two main elements: the Planning Module and the Operation Module. The Planning Module lets the user evaluate the effectiveness of various travel demand and construction duration strategies for multiple projects through comparisons of two main criteria: construction cost and traveler delay cost (which is converted to monetary cost). Its primary output is a proposed sequencing of projects to minimize overall costs.

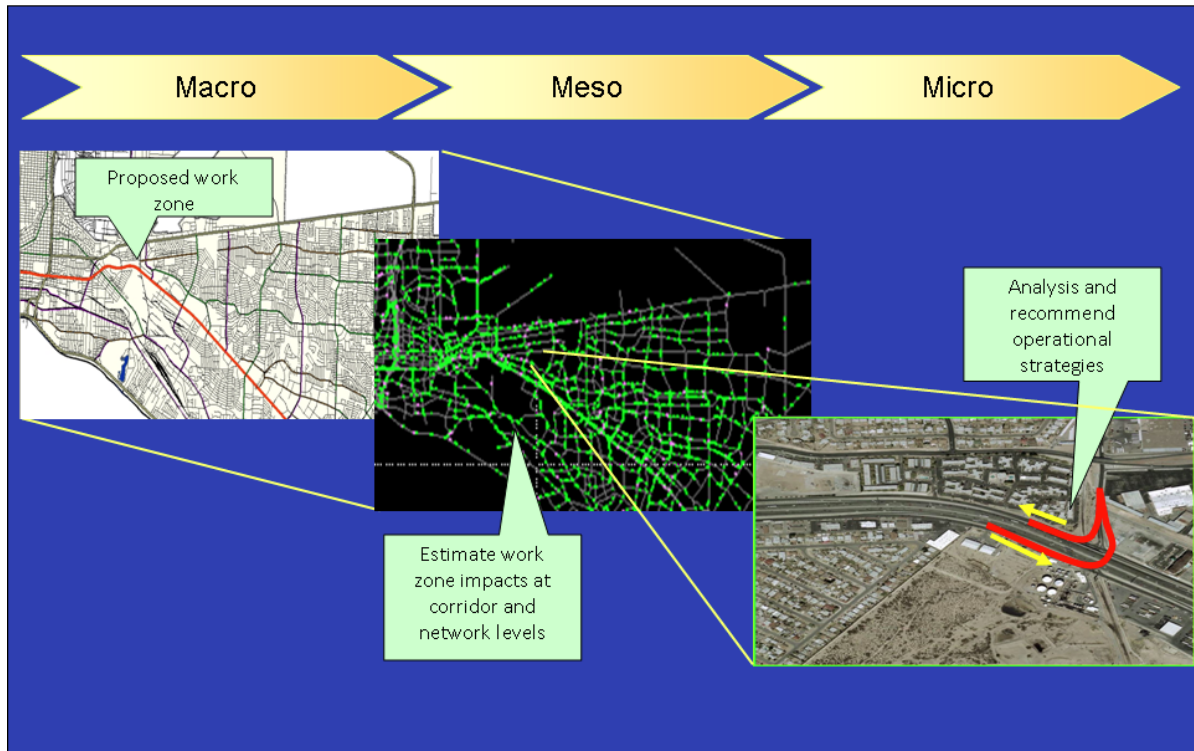


Figure 1.1. *Multiresolution modeling.*

The WISE tool can be used to address the following questions:

- What is a good scheduling of renewal projects?
- What strategies are cost-effective with mitigated user delays (congestion) for a program?
- Which traffic management plans work best in given conditions?
- What is the impact on traffic of the present program?

DynusT is the main functionality behind the Operation Module. The concept behind the Operation Module is to dive deeper into the granularity of the time-varying interactions occurring between traffic and the network during a work zone project. What a static model cannot capture—time-dependent congestion and diversion caused by congestion—a simulation model such as DynusT can. DynusT can still use the macroscopic network, yet provide in-depth information of a microscopic simulation model. The Operation Module requires the sensitivity of a simulation model that responds to congestion so that diversion response is reported in a robust and intuitive manner. The Operation Module attains a more accurate estimation of diversion because of the capacity reduction (i.e., work zone project, based on the network and simulation outcome). This diversion is reported back to the WISE system, and the user can choose whether to use this estimated diversion rate (i.e., feedback) in the Planning

Module. On the basis of this new diversion rate, the user can model whether this diversion changes the sequencing of projects. The “handshake” feature between the Planning Module and Operation Module enables the power of microsimulation in a macrosimulation model. Note that simulation models other than DynusT can be used to simulate the work zone(s); these refined diversion estimates can be manually input into the Planning Module. For example, the Model Validation and Pilot Studies used TransModeler software to estimate diversion. WISE performs traffic diversions in the sequencing algorithm in its Planning Module to analytically evaluate interdependency of work zone construction projects and the resultant traffic impact and delays networkwide, and it recommends a feasible sequence with a rule of minimum traffic delay over the studied seasons and period that the algorithm can find. Although the traffic diversion is an internal analysis module packaged with the sequencing algorithm, WISE has the functionality to execute traffic diversion under three different modes: WISE supplied, user supplied, and operation supplied. The handshake between the Operation Module and Planning Module enables the operation-supplied option.

LIMITATIONS

- The model’s data structure links well with DynusT but needs to be expanded to include other software.
- At the planning stage the model does not consider improvements in capacity and free flow speeds.
- Significant effort is needed to calibrate the mesoscopic model.
- Risks associated with construction are not considered.
- Explicit consideration of materials and workflow of the construction process are not modeled.

2

GETTING STARTED

SYSTEM REQUIREMENTS

General requirements follow:

- Windows-only application.
- x86-compatible processor.
- Microsoft Windows Server 2008 (32 bit), Windows Vista (32 bit), Windows 7 (32 bit).
- 512KB of RAM.

GUI-specific requirements follow:

- Operating system: Windows with .Net Framework.
- DynusT 3.1. The GUI only has .Net Framework requirements. The only processing requirements should be defined by the WISE Engine, NEXTA, or DynusT. The GUI will work with anything running the appropriate Windows .Net Framework.

INSTALLATION

The CD or online application includes a setup file named WISE V2_0_5 Installer.exe, which is the installer for the entire WISE software package, including DynusT and NEXTA. This installer verifies that the computer in which WISE is being installed meets minimum .NET Framework requirements. If at any time you are prompted with a .NET Framework error, please visit www.microsoft.com to download the latest .NET Framework installer for your operating system.

Follow these steps to complete the WISE software package installation:

1. Double-click on the WISE installation file WISE V2_0_5 Installer.exe.
2. The Installation Wizard will launch (Figure 2.1). Click Next.

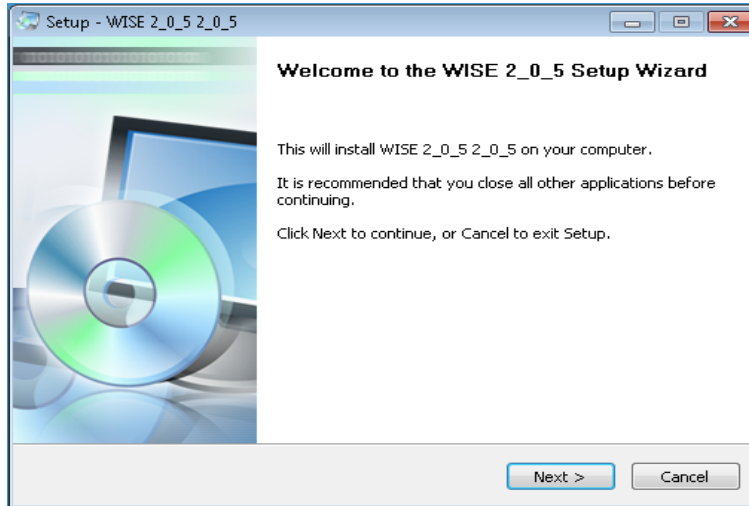


Figure 2.1. WISE installation Welcome screen.

3. Verify the directory of the installation (Figure 2.2). Click Next.

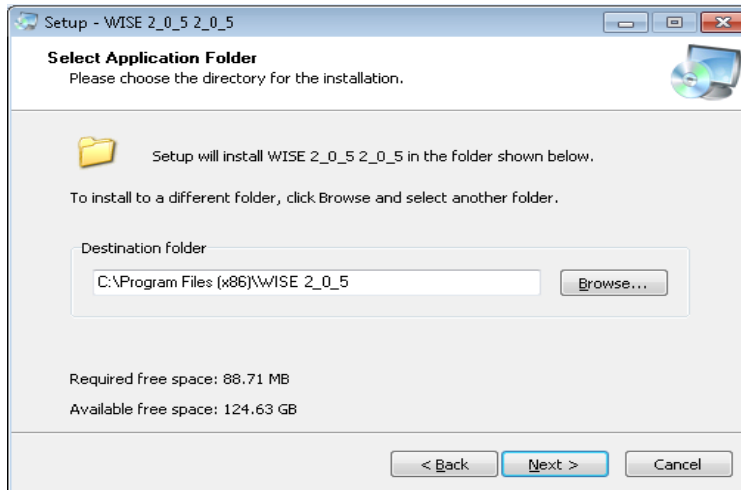


Figure 2.2. Directory for installation.

4. Verify the shortcut folder options (Figure 2.3). Click Next.

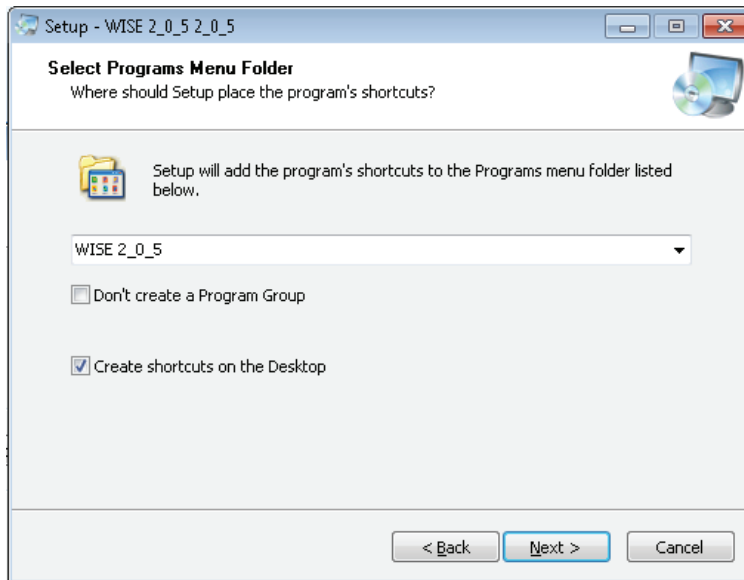


Figure 2.3. *Shortcut Folder options.*

5. Verify installation setup options (Figure 2.4). Click Install.

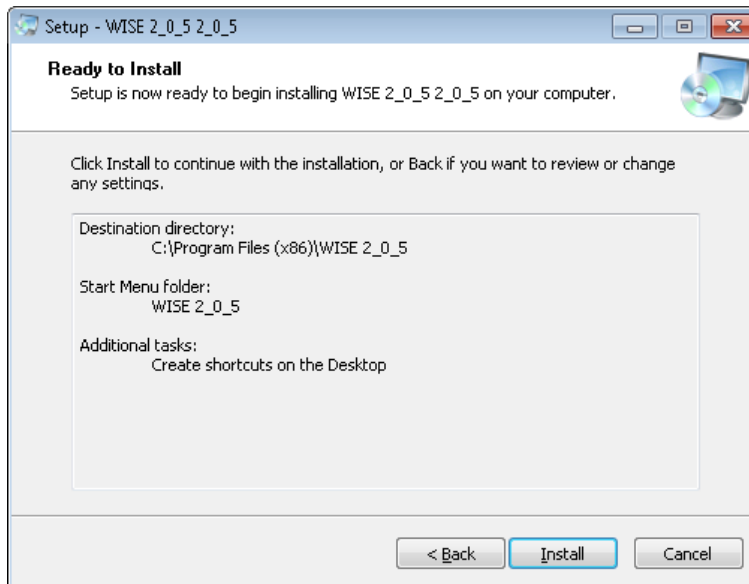


Figure 2.4. *Installation setup options.*

- After WISE installation progress bar screen completes, DynusT 3.1 installation is launched. If you are the administrator of the computer, click Yes on User Account Control prompt (Figure 2.5).

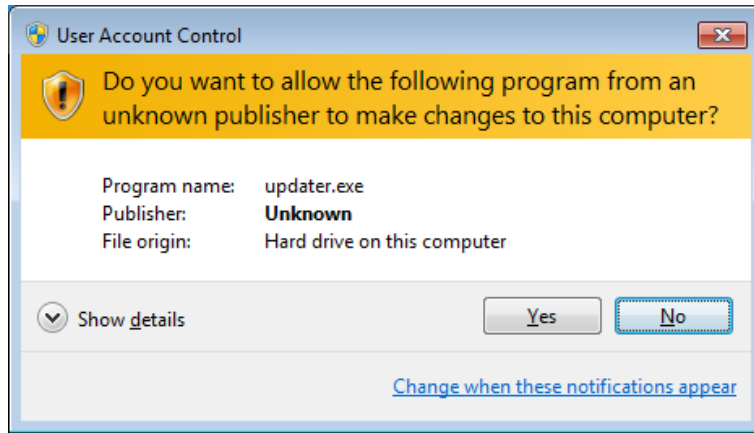


Figure 2.5. *User Account Control.*

- You will see the Welcome message from the installation. Click Next on the Welcome window.
- Enter the serial number 3979-3716-9135-2536 (Figure 2.6). Click Next.

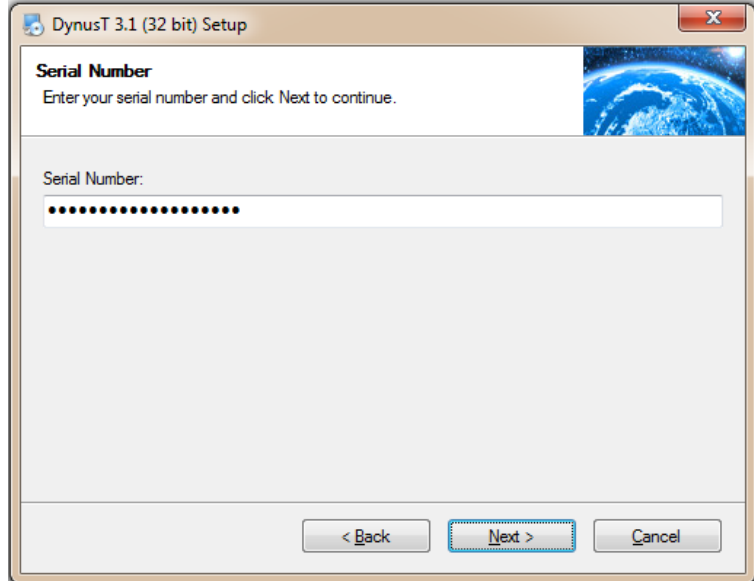


Figure 2.6. *Serial Number.*

- Click the “I agree to the terms of this license agreement” radio button on the License Agreement window (Figure 2.7).

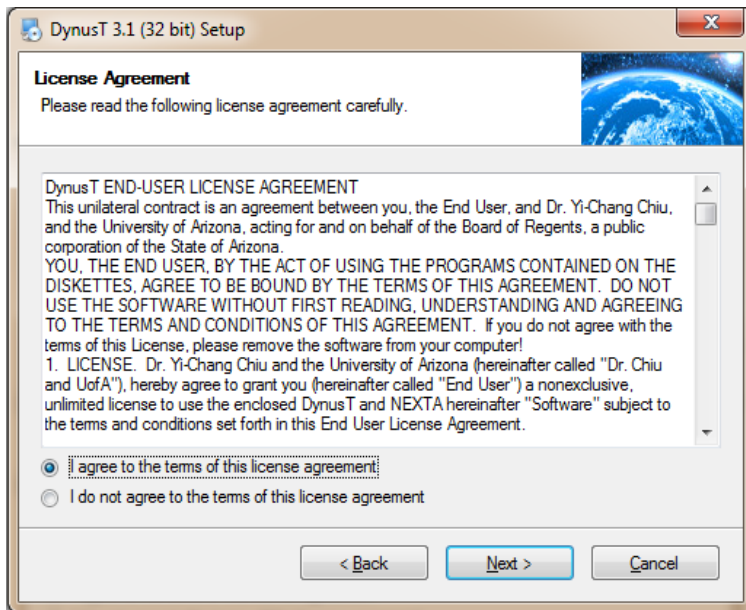


Figure 2.7. License Agreement.

- Enter the user name and company name in the User Information window (Figure 2.8). Click Next.

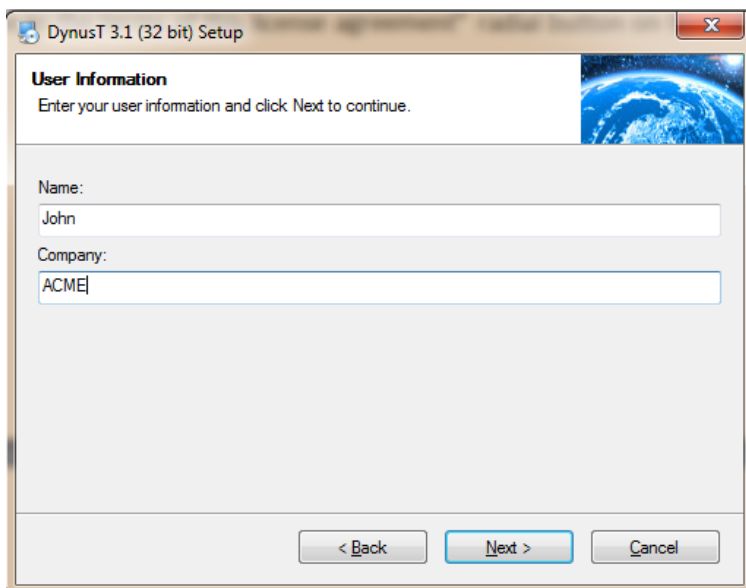


Figure 2.8. User Information.

11. Verify the directory for the installation listed in the Installation Folder window. Click Next (Figure 2.9).

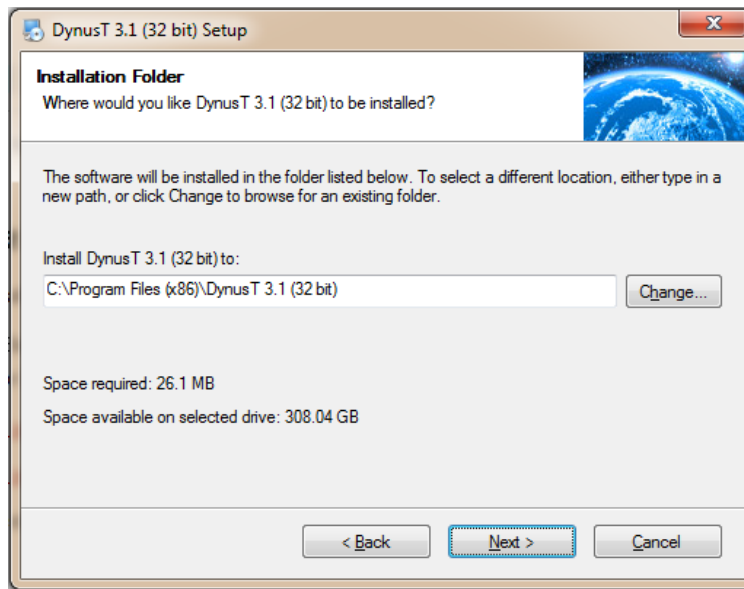


Figure 2.9. *Verify directory.*

12. Click Next on the Ready to Install window (Figure 2.10) to proceed to the actual installation.

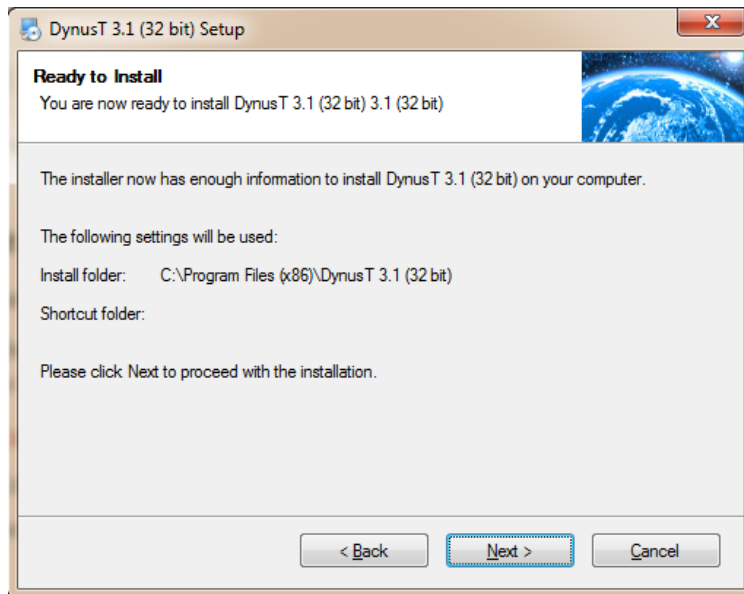


Figure 2.10. *Ready to Install.*

13. The installation will begin running. Three windows will open on the screen simultaneously.
 - a. The original installation window (Figure 2.11) will show the progress.

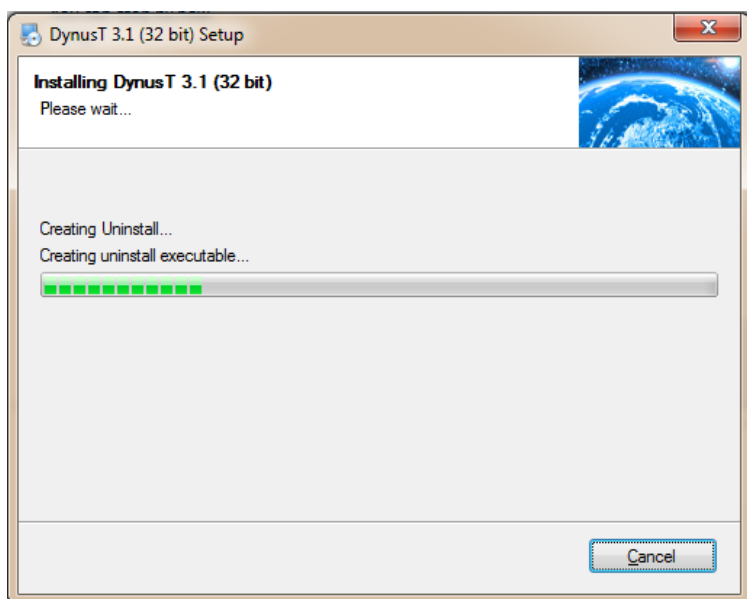


Figure 2.11. *Progress of installation.*

- b. The Microsoft Visual C++ Redistributable Package window will open (Figure 2.12). Click Yes, and the installation of this package will be complete.

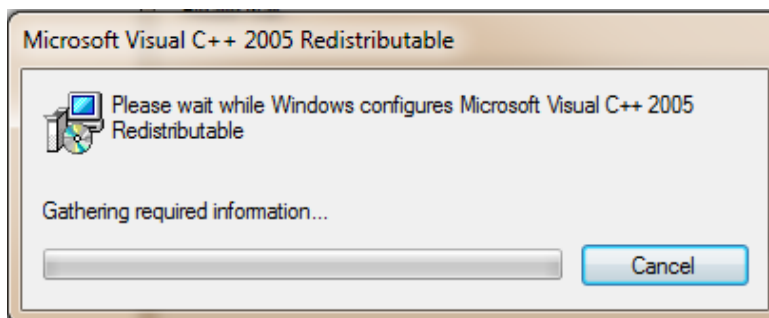
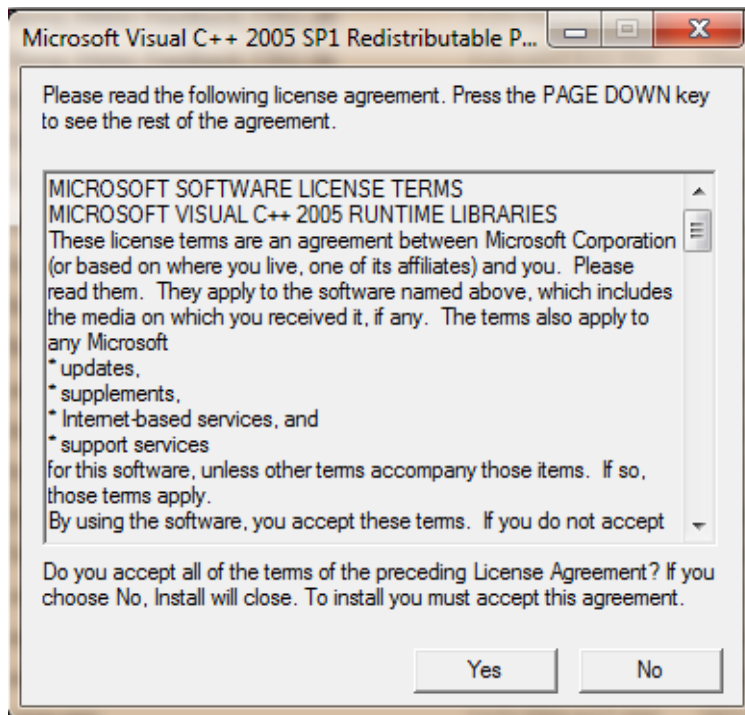


Figure 2.12. *Redistributable Package window.*

- c. The Setup window (Figure 2.13) will open simultaneously with the Microsoft Visual C++ Redistributable Package window.
 - i. Click Next.

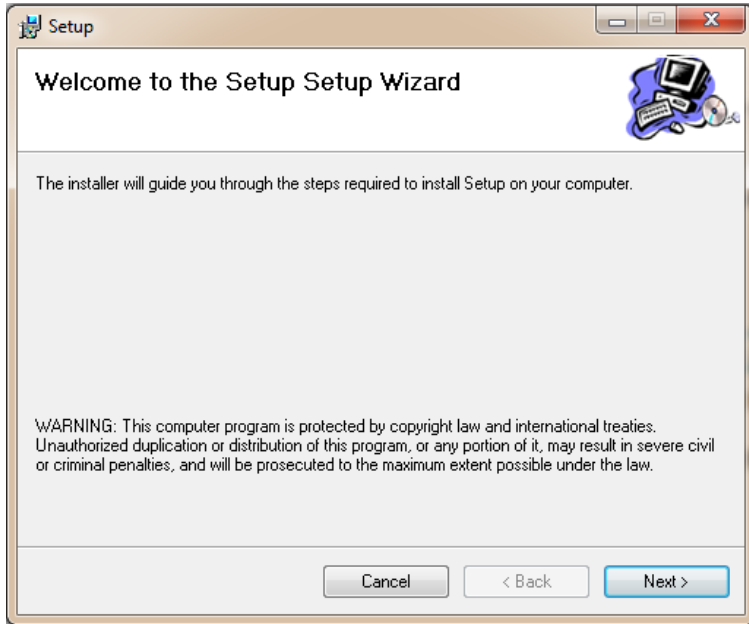


Figure 2.13. Setup window.

- ii. Verify the location of this installation (Figure 2.14). Click Next.

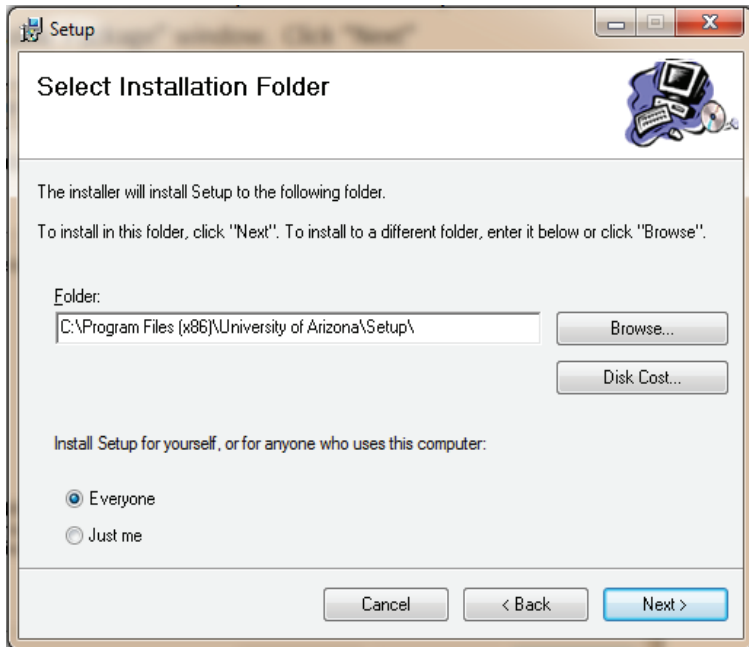


Figure 2.14. Verify location.

- iii. If you are the administrator of the computer, click Yes on User Account Control prompt (Figure 2.15).

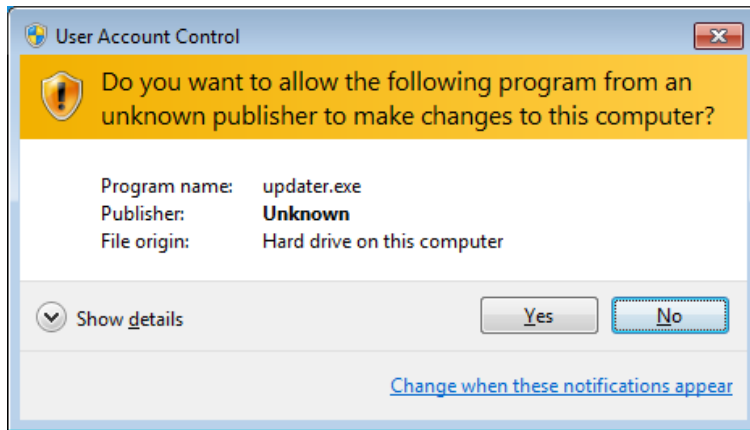


Figure 2.15. User Account Control for setup.

- iv. The Installing Setup window will display the installation progress (Figure 2.16).

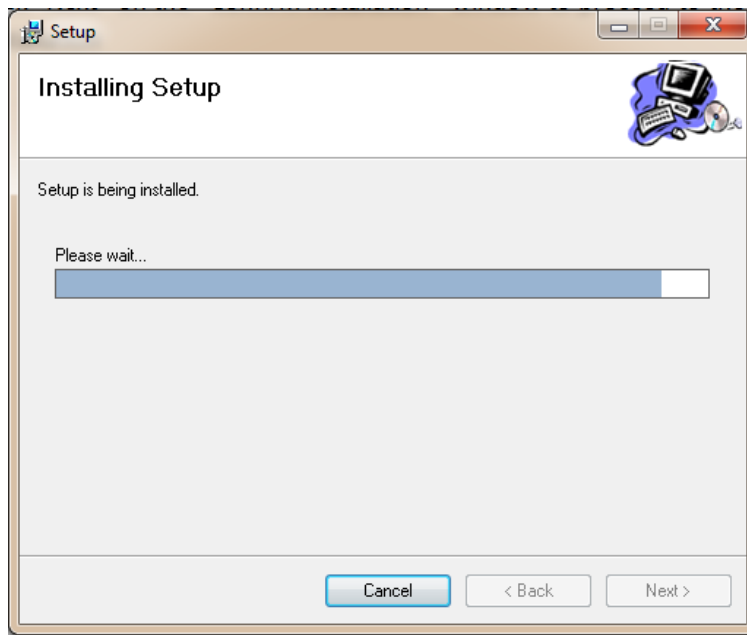


Figure 2.16. Setup installation progress.

- v. Click Close to complete the installation of Setup (Figure 2.17).

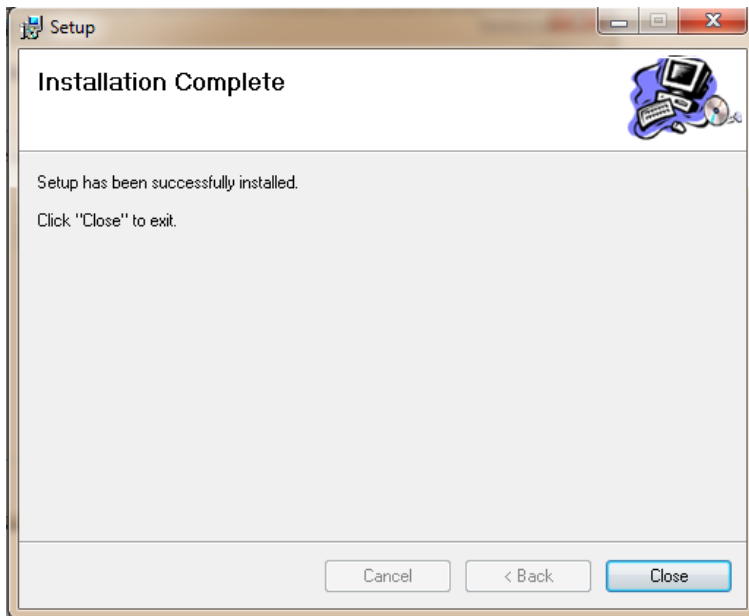


Figure 2.17. *Installation Complete.*

14. Once DynusT Setup installations are complete, click Finish on the original installation window to complete the installation (Figure 2.18).

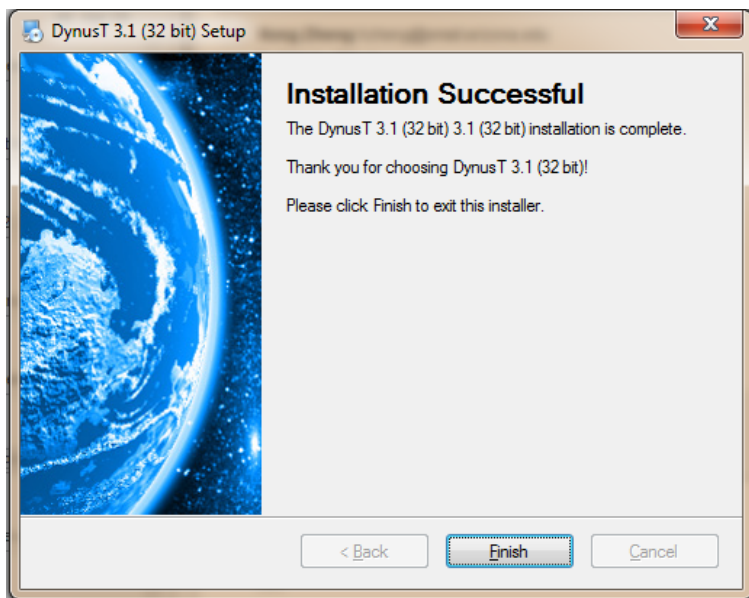


Figure 2.18. *Finish Installation.*

15. You will be returned to the WISE installation completion window. Click Finish, and WISE will be launched (Figure 2.19).

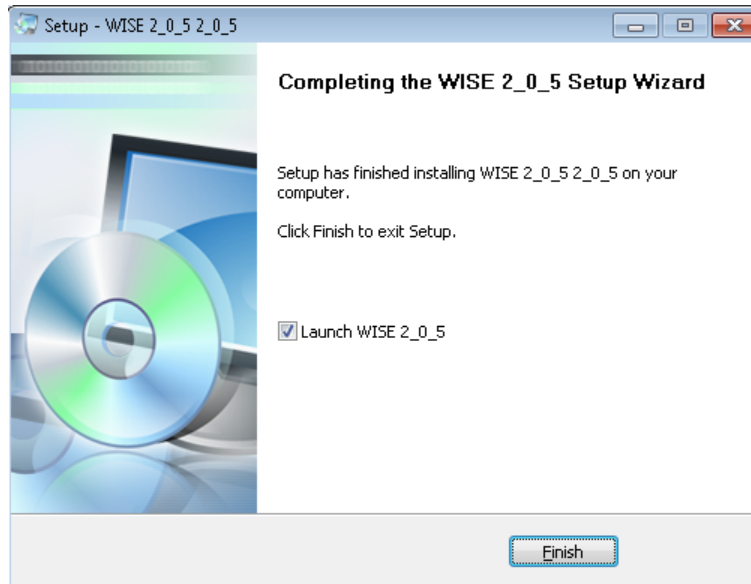


Figure 2.19. WISE is launched.

MINIMUM DATA REQUIREMENTS

- The user has the option of importing a predefined network, creating a new network, or modifying the current network. The network data set will have to be created in or converted to DynusT format. It must contain node, link, and zone information. More details can be found in this guide in the detailed Network Conversion section of Chapter 4, Planning Module Detail Elements, and in the network importing and creating sections of Chapter 3, Planning Module. The SHRP 2 R11 publication, *Work Zone Impact and Strategy Estimator (WISE) Software Validation and Pilot Tests*, documents WISE limitations and provides suggested strategies and programming scripts to convert an existing network into a network that can be used by WISE.
- All Planning Characteristic fields must be populated with valid values for the WISE Analysis Engine to run. The Planning Characteristics consist of the following:
 - The Season Factor for each month of the year (defaults to 1);
 - Start and End time of the entire program (MM/YYYY format);
 - Value of Time for the program (dollars per hour);
 - Demand Number of Hours for Day and Night; and
 - A Program Description.

- The user has the option of Importing an Existing Static Assignment or Importing Day and Night demand and running the WISE OBA (Origin-Based Algorithm for the Traffic Assignment Problem) Evaluator.
- Required project information includes the following:
 - Earliest start time;
 - Latest completion time;
 - Precedence constraints, if any;
 - Agency project cost; and
 - Mapping of each project to links in the network. See Creating Projects in Chapter 3, Planning Module.
- The Planning Module includes drop-down lists of demand-based and duration-based strategies that can be tested. At least one strategy must be selected, along with associated strategy attributes.

GUI TOOLS

The WISE software package is managed via a graphical user interface (GUI) (Figure 2.20). The four core topics are WorkSpaces, Planning Module, Operation Module, and Planning/Operation Hand-Off. These sections provide sufficient information to permit the user to navigate through the WISE software package utilizing all of the functions. Chapter 4 provides in-depth instructions for importing, converting, and/or creating a network and importing traffic information.

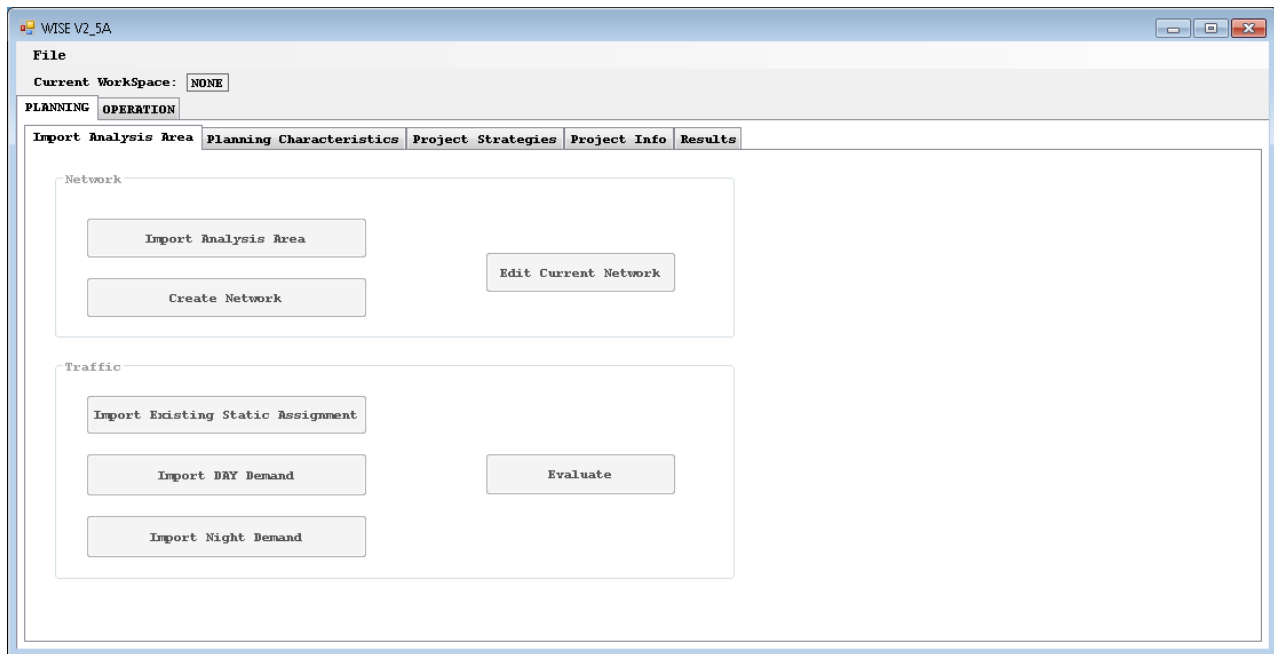


Figure 2.20. *Workspace screen.*

CREATE A WORKSPACE OR OPEN AN EXISTING WORKSPACE

Manage WorkSpaces

All use of the WISE software package must be completed within a defined WorkSpace. A WorkSpace is a directory that contains all of the data related to an instance of WISE needed for a complete analysis. When you launch WISE, you must either open an existing WorkSpace or create a new WorkSpace in order to begin using WISE. The WorkSpace that you choose or create will contain all of the data that are utilized in the Planning and Operation Modules. The current WorkSpace is at all times displayed across the top of the GUI Window next to Current WorkSpace. In the event that a WorkSpace is not yet selected, the Current WorkSpace will be displayed as None (Figure 2.21), and none of the planning or operation functions will be available to the user.

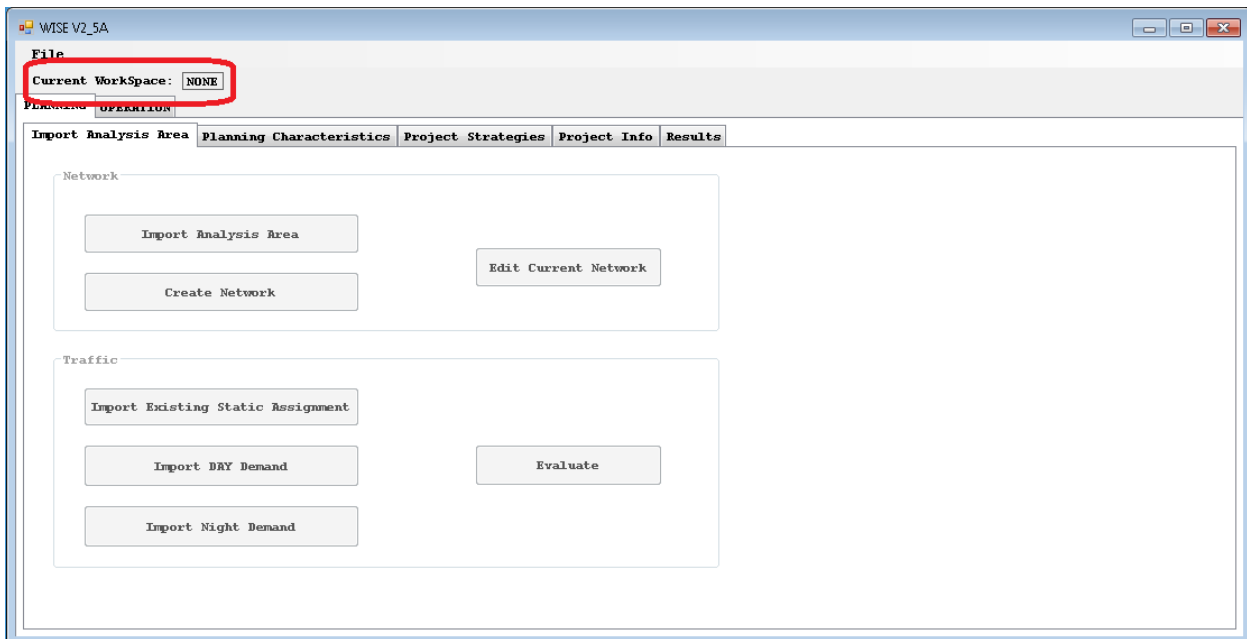


Figure 2.21. *WorkSpace example.*

Create a New WorkSpace

To create a new WorkSpace, select File → Create New WorkSpace (Figure 2.22). After the browser window appears on the screen, navigate to where the WorkSpace is to be saved and provide a directory name for the WorkSpace. Then click OK. Once the WorkSpace has been successfully generated, WISE will create a notification: “The Following WorkSpace Has Been Created:” <WorkSpace Name>.

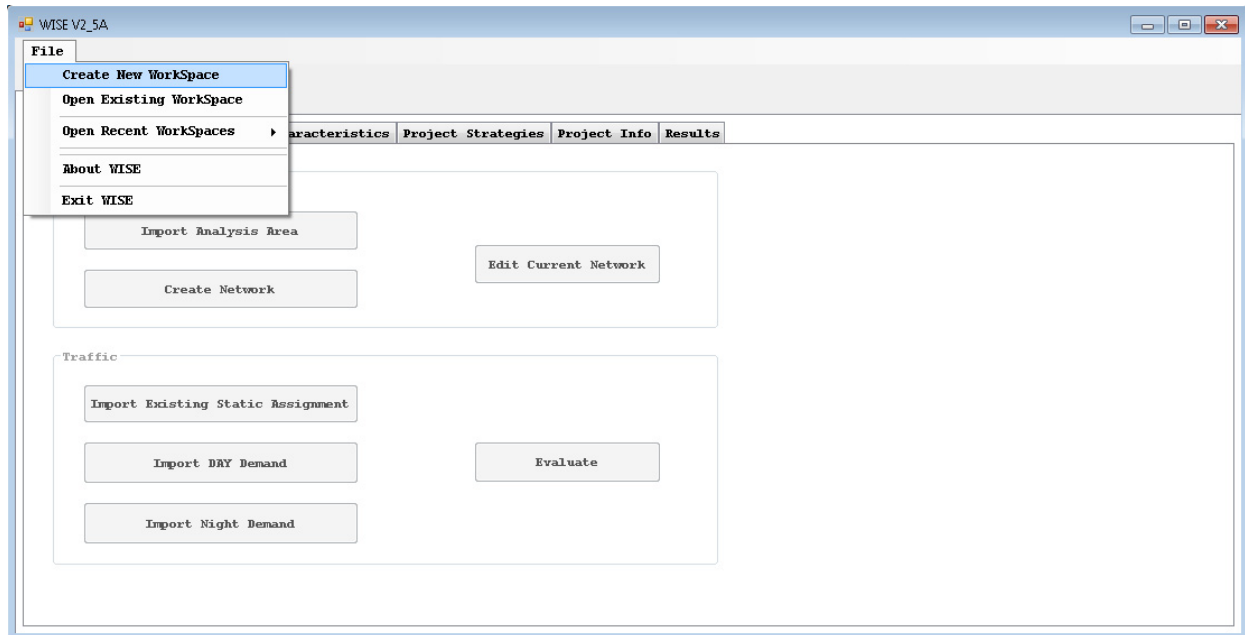


Figure 2.22. WorkSpace drop-down menu.

Open an Existing Workspace

To open an existing Workspace, select either File → Open Existing Workspace or File → Open Recent WorkSpaces. Recent WorkSpaces contains the last four WorkSpaces (Figure 2.23) that were accessed. The Open Existing Workspace function will display a browser window from which the user must navigate to the Workspace to be opened. Select the Workspace and click OK. If the selected folder is not a valid WISE Workspace, an error will be displayed, and no Workspace will be opened.

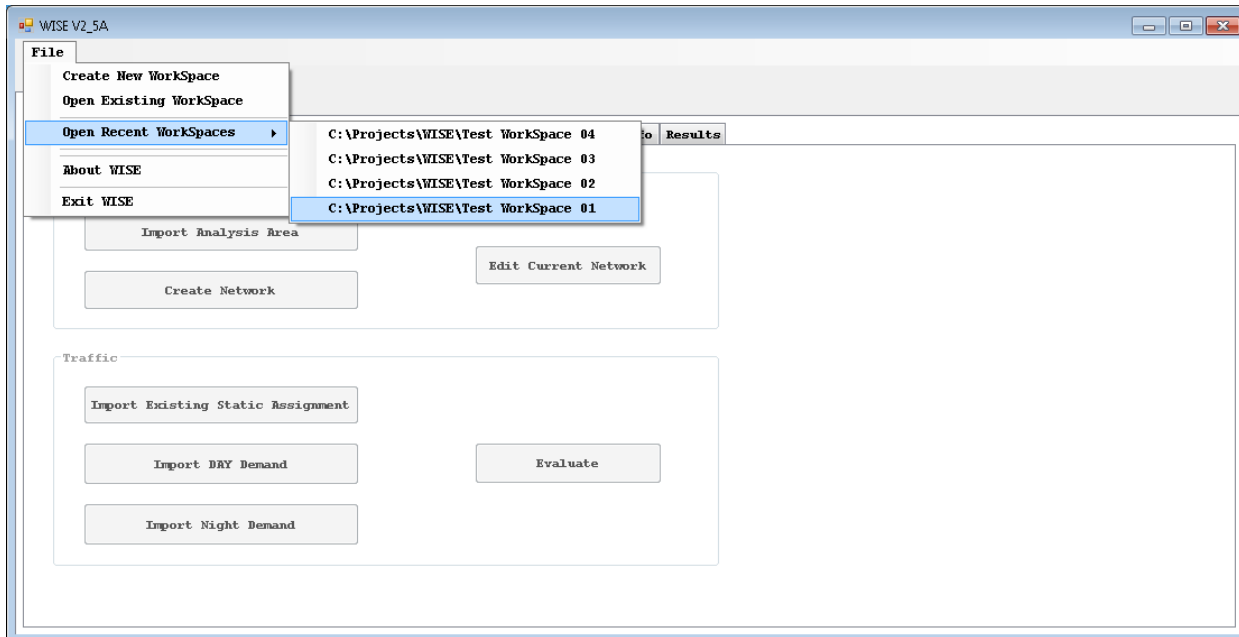


Figure 2.23. *Open Recent Workspace drop-down menu.*

SAVE AND CLOSE A WORKSPACE

To save the current Workspace, select File → Save Workspace. WISE will run an initial validation of the Workspace and provide a list of errors, if applicable, and an option to save anyway via Yes or No. If you select Yes, then the Workspace will be saved containing all of the errors identified and will be available for you to continue updating or return to at a later time. If you select No, you will return to the current Workspace without losing any data.

To close a Workspace, select File → Close Workspace. WISE will prompt you to save the Workspace before closing via Yes or No. If you select Yes, then WISE will run the same validation as performed during the Save function above and prompt you if you would like to Save with errors if errors are found. If errors are found and you select No, then WISE will not close and you will return to the active Workspace, allowing you to fix errors or Close without Saving.

WORKSPACE FOLDER STRUCTURE AND IMPORTANT FILES

WorkSpaces have a specific file structure that WISE relies upon to operate. This file structure consists of a primary WorkSpace folder, which is the main folder you save as your WorkSpace name during creation. All subfolders and data related to a WorkSpace are stored within the primary WorkSpace Folder.

The primary WorkSpace folder contains up to four documents along with two subfolders, Planning and Operation. All of the documents and subfolders are created or populated by the WISE GUI. Manual manipulation of these folders or documents is not necessary during typical use of WISE.

The four documents that can be found in the primary WorkSpace folder are listed below with their origin (either WISE User Interface or Network Import File):

- LinkMatrix.csv (WISE);
- SavedLinkMatrix.csv (WISE);
- WISE_Version.txt (WISE); and
- WorkZone.date (Network).

The two LinkMatrix files are used to store WorkSpace data related to the Network Links and the interface between the Planning and Operation Modules.

The Planning subfolder is the main folder, which will contain all of the network data, error logs, and files necessary to run NEXTA and DynusT with the associated WISE WorkSpace. The Planning folder should contain only one Network File (file with .dws extension). Some files are duplicated in the Planning subfolder and the Primary WorkSpace folder; this is normal behavior for WISE. The Planning subfolder will also have three subfolders of its own, which contain the WISE Analysis Engines. These folders are Demand, Main_schedule, and OBA. All of the folders are generated at the creation of a new WISE WorkSpace and may take a little time to be created.

The following files, which can be found in the Planning subfolder, are listed with their origin as either WISE or Network files (*indicates that the file must be present in all network analysis areas to import a network successfully):

- ~~~.dws* (Network);
- DynusT.exe (Network);
- NEXTA.exe (Network);
- NEXTA_Config.xml (Network);
- bg_demand_adjust.dat* (Network);
- bitmap.dat* (Network);
- bus.dat* (Network);
- control.dat* (Network);
- demand.dat* (Network);
- demand_HOV.dat* (Network);

- demand_superzone.dat* (Network);
- demand_truck.dat* (Network);
- destination.dat* (Network);
- epoch.dat* (Network);
- GradeLengthPCE.dat* (Network);
- incident.dat* (Network);
- leftcap.dat* (Network);
- linkname.dat* (Network);
- linkxy.dat* (Network);
- movement.dat* (Network);
- network.dat* (Network);
- node.csv* (Network);
- node_error.log* (Network);
- origin.dat* (Network);
- output_option.dat* (Network);
- parameter.dat* (Network);
- pathxyz.bat (WISE);
- pricing.dat* (Network);
- Project.html (WISE) (a document generated by WISE containing all of the Work-Spaces' Project Characteristics);
- ramp.dat* (Network);
- scenario.dat* (Network);
- sensor.dat* (Network);
- StopCap2Way.dat* (Network);
- StopCap4Way.dat* (Network);
- subarea.dat* (Network);
- super_space_split.dat* (Network);
- super_time_split.dat* (Network);
- superdemand.dat* (Network);
- superzone.dat* (Network);
- system.dat* (Network);
- toll.dat* (Network);
- TrafficFlowModel.dat* (Network);
- version.dat* (Network);

- vms.dat* (Network);
- WorkZone.dat* (Network);
- xy.dat* (Network);
- YieldCap.dat* (Network);
- zone.dat* (Network); and
- zone_mapping.dat* (Network).

Additional error log files may be generated during WISE normal operation. At the time that an error log is necessary, the WISE User Interface will notify the user where the log file can be found.

3

PLANNING MODULE

IMPORTING, CREATING, AND MODIFYING A NETWORK

All WorkSpaces must contain one valid network, which contains all projects. All networks that are imported must be imported in the NEXTA Format (see Chapter 4 for instructions on generating a NEXTA Network). The user has the option of importing a predefined network, creating a new network, or modifying the current network. All of these options are available under Planning → Import Analysis Area → Network (Figure 3.1).

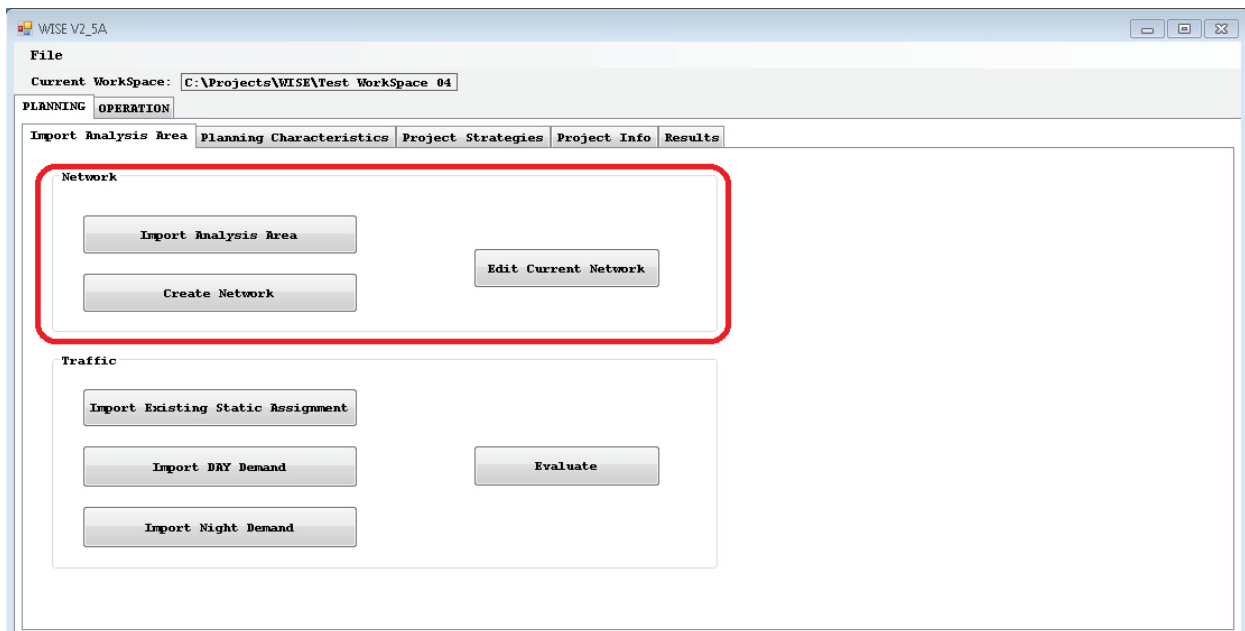


Figure 3.1. *Import Analysis Area tab: Network.*

Importing an Existing Network

To import an existing network, select Import Analysis Area, and a browser window will appear. Navigate to the folder containing the network and click OK. If you already have a network defined in a WorkSpace, then this action will *erase* the current network in its entirety, which *will not* be reversed if you exit WISE without saving changes. See Chapter 4 for instructions on converting an existing network for use in WISE.

Creating a New Network

To create a new network, select Create Network, and NEXTA will launch. See Chapter 4 for instructions on creating a NEXTA Network. Once you have created the network, save it in the Planning folder of the WorkSpace and close NEXTA. Note: If you already have a network defined in a WorkSpace, then this action will *erase* the current network in its entirety. This erasure *will not* be reversed if you exit WISE without saving changes.

Modifying Current Network

To modify the existing network, select Edit Current Network, and NEXTA will launch with the current network open for editing. See the first sections of Chapter 4 for additional NEXTA instructions. Once you have modified the network, save the network and close NEXTA.

IMPORTING TRAFFIC

WISE provides the option of importing an existing static assignment or importing day and night demand and running the WISE OBA Evaluator. All of these options are available through Planning → Import Analysis Area → Traffic (Figure 3.2). All of the Import buttons (Import Existing Static Assignment, Import Day Demand, and Import Night Demand) open a browser window, and you must navigate to, highlight, and select OK for the file that you choose to import. The Evaluate button will run the OBA analysis as described previously. See Chapter 4 for greater detail on importing traffic data.

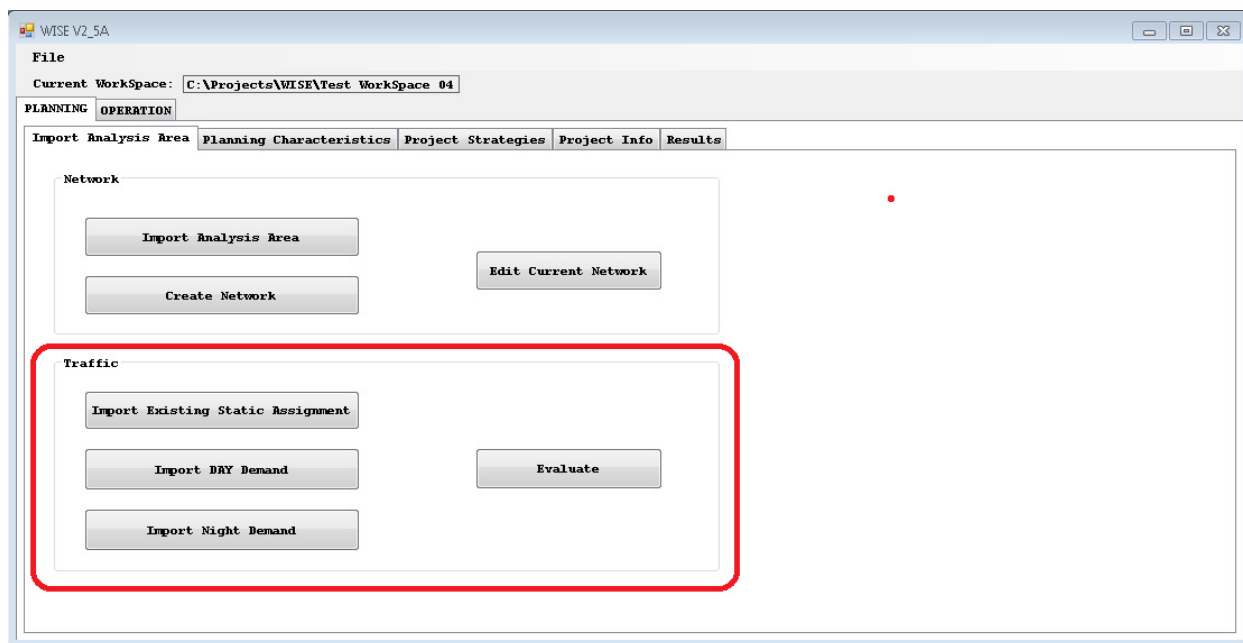


Figure 3.2. *Import Analysis Area tab: Traffic.*

EXECUTING STATIC ASSIGNMENT IN WISE

WISE has the capability to execute its own static assignment algorithm if the user does not have static assignment results. (See the subsection called Preparing Input File in the Importing Traffic Information section of Chapter 4 in this users guide).

WISE implements an OBA called Algorithm B (1). To run the static assignment algorithm, the network and the demand that are imported from Importing Traffic Information in Chapter 4 must be in place. Figure 3.2 shows the buttons used to run the algorithm. At least Import Day Demand or Import Night Demand must be imported before running the algorithm. The Evaluate button will run the algorithm.

Once the algorithm is completed, the Static_Import.csv file will be produced in the same format as explained in Preparing Input File in Chapter 4.

DEFINING PLANNING CHARACTERISTICS

Planning Characteristics for the entire program under evaluation are defined under Planning → Planning Characteristics as shown in Figure 3.3. All Planning Characteristic fields must be populated with valid values for the WISE Analysis Engine to run. The Planning Characteristics consist of the Seasonal Factor for each month of the year (defaults to 1), Start and End time of the entire program (MM/YYYY format), Value of Time for the program (dollars per hour), Demand Number of Hours for Day and Night, and a Program Description. To enter the Planning Characteristics values, select the text box associated with each and enter the value. Once you have entered all Planning Characteristics, you can validate all fields on the Planning Characteristics tab by

clicking Validate Planning Characteristics at the bottom of the tab. If there are any invalid values, then the text box for all invalid values will be highlighted red. Please see Chapter 8, Data Limits, for details on valid values for each Planning Characteristic.

Figure 3.3. *Planning Characteristics tab.*

WORK ZONE CONSTRUCTION STRATEGIES

Assigning Project Strategies

Each Workspace must contain at least one strategy to be assigned to projects within the Workspace. Project Strategies are created from the Planning → Project Strategies tab shown in Figure 3.4. Strategies are either Demand-Based or Duration-Based. You can enter strategies individually or import and export all strategies. Please see Chapter 8, Data Limits, for details on valid values for each Project Strategy.

WISE allows users to evaluate a wide range of strategies. These strategies can be broadly classified as demand based or duration based. All strategies help either to reduce demand close to the work zone or to reduce the duration of the work zone (Table 3.1). For example, some strategies relate to the following issues:

1. *Daytime and nighttime.* Because night demand is usually much lower than day demand, undertaking work zones at night might have very little impact on traffic and thus save considerable user cost in comparison with undertaking work zones during the day. However, scheduling work zones at night usually costs more real dollars from the agency's budget. Planners and policy makers must address the tradeoff between the magnitude of user cost and that of agency cost. See item 5 for a discussion of how WISE can address this issue.

2. *Seasonal impact.* Another common factor in the cost induced by work zone scheduling is the seasonal factor. It is well known that traffic demand varies by season and by month. Particularly in tourism areas, for example, demand during nonpeak periods is much lower than during the peak tourism periods. Conducting work zone implementation during reduced demand periods saves user cost. The WISE tool allows you to put constraints on the months of the year during which renewal cannot take place, for example, by excluding the winter months that tend to bring heavy snowfall.
3. *Demand reduction factor.* Before work zone implementation, agencies usually carry out large-scale public involvement campaigns. These may reduce local demand near the projects, for example, non-work-based discretionary trips such as shopping trips or recreation. This local demand reduction is measured by the demand reduction factors.
4. *Traffic diversion impact.* With the presence of a work zone in the network, traffic usually diverges through a day-to-day learning process and continues toward a new equilibrium. This diversion effect involves a new traffic assignment computation in the work zone scheduling framework. Users can adopt the default WISE calculation for diversion, enter a value based on local knowledge or experience, or run the WISE Operation Module or any local, calibrated microscopic simulation model to develop a microscopic simulation value for diversion.
5. *Putting weight on user cost with respect to monetary cost of the project.* WISE uses a general cost that combines both agency and user costs to measure whether a project is cost-effective. Agency cost refers to the monetary expenses related to work zone project constructions; its unit is the dollar. User cost refers to the user travel time; its unit is the vehicle-minute.

WISE utilizes a user-specified parameter, Value of Time (VOT), to convert vehicle-minutes of users' travel time to monetary dollars. The VOT unit is dollar per vehicle-minute. Agencies may estimate the relationship between the road user's cost and monetary dollars in various ways and thus have various values for VOT; accordingly, the modeler should specify VOT carefully. The general recommended value of VOT ranges from one-third to one-half of the average hourly wage rate in the specified work zone construction area. However, an agency usually assigns different weights to monetary dollars and user costs derived from VOT. For example, the agency cost might be considered equivalent to the user cost by a factor of 2, meaning every 2 dollars of the user cost that is converted by VOT merits 1 monetary dollar. In this instance a modeler should adjust the VOT by half, so that WISE computes the general cost as the sum of monetary dollars spent in construction plus converted and weighted monetary dollars "paid" by users.

6. *Fast construction techniques.* Fast construction techniques significantly reduce the duration of construction but come at increased cost.

TABLE 3.1. CLASSIFICATION OF STRATEGIES

	Demand-Based Strategies	Duration-Based Strategies
Operational	Dynamic message signs Daytime/nighttime work Signal optimization	Programming/design/materials Improving parallel roads Scheduling around critical events Daytime/nighttime work
Planning	Public information Improving parallel roads	Total vs. partial closures Incentive/disincentive contracting Short-duration closures Project sequencing Construction techniques Daytime/nighttime work

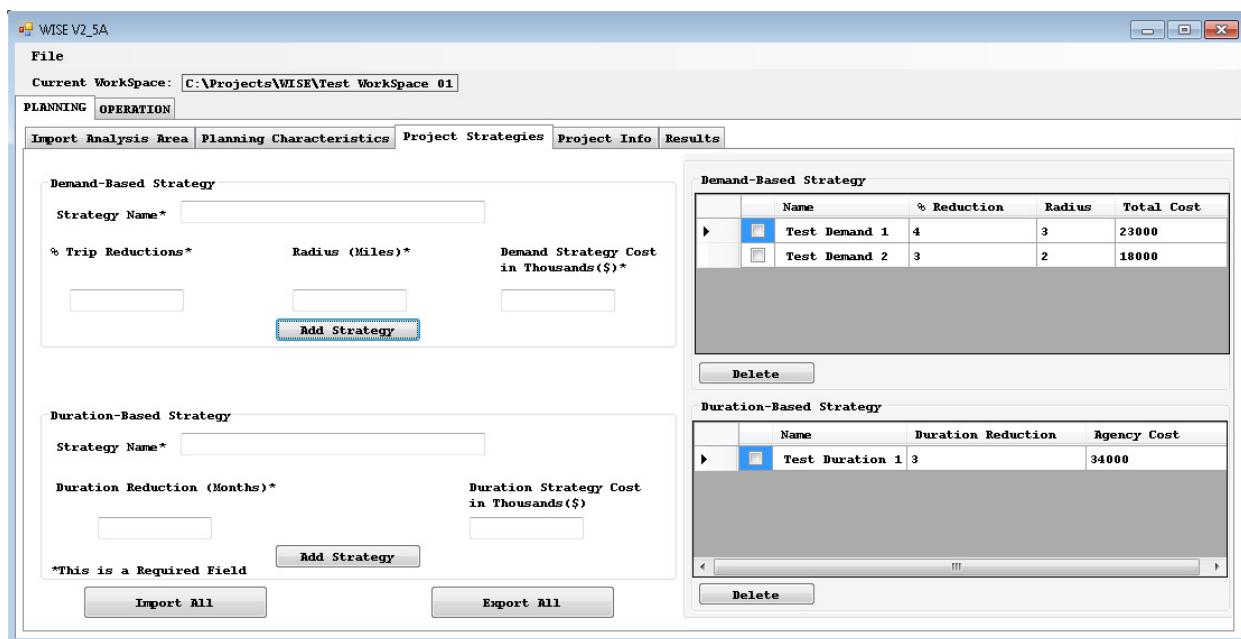


Figure 3.4. Project Strategies tab.

Creating Demand-Based Strategies

To create a Demand-Based Strategy, in the Demand-Based Strategy box on the Project Strategies tab, enter the Strategy Name, % Trip Reductions, Radius (in miles), and Demand Strategy Cost (in thousands of dollars). Then click Add Strategy in the Demand-Based Strategy box. Each Demand-Based Strategy must have a unique name. If you duplicate a name, then WISE will ask if you would like to write over the existing strategy. You can use this function to modify existing strategies by entering the exact name.

If an invalid value is entered, then WISE will generate a warning and highlight the incorrect field in red without saving the strategy to the list of strategies.

Once you have added a strategy, it will be displayed in the Demand-Based Strategy list to the right of the GUI, as illustrated by Test Demand 1 and Test Demand 2 in Figure 3.4.

Creating Duration-Based Strategies

To create a Duration-Based Strategy, in the Duration-Based Strategy box on the Project Strategies tab, enter the Strategy Name, Duration Reductions (Months), and Demand Strategy Cost (in thousands of dollars). Then click Add Strategy in the Duration-Based Strategy box. Each Duration-Based Strategy must have a unique name. If you duplicate a name, then WISE will ask if you would like to write over the existing strategy. You can use this function to modify existing strategies by entering the exact name.

If an invalid value is entered, then WISE will generate a warning and highlight the incorrect field in red without saving the strategy to the list of strategies.

Once you have added a strategy, it will be displayed in the Duration-Based Strategy list to the right of the GUI, as illustrated by “Test Duration 1” in Figure 3.4.

Deleting Strategies

To delete one or more strategies of a given type (i.e., demand based or duration based), select the check box next to each strategy in the list of current strategies to the right of the GUI on the Project Strategies tab. Then click Delete at the bottom of the appropriate strategy listing (Figure 3.5).

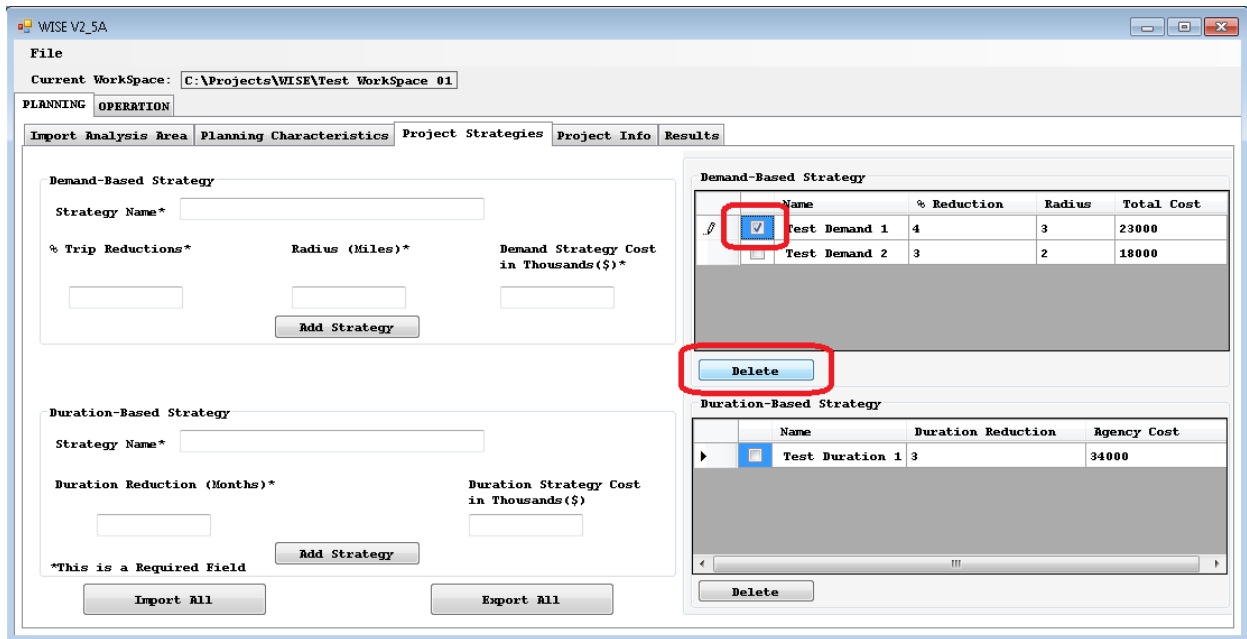


Figure 3.5. Delete a strategy.

Importing and Exporting Strategies

WISE GUI allows you to import and export strategies. The process imports or exports all Demand-Based and Duration-Based strategies at once. When you import strategies, you delete all strategies that were previously in the WorkSpace. To import or export, click Import or Export at the bottom of the Planning Strategies tab. A browser window will open. Either navigate to the strategies that you would like to import or navigate to a folder and then name the file whatever you would like to call the strategies you are exporting. You can import strategies only from WISE-generated strategy files.

USING PROJECT INFORMATION

Creating Projects

All WISE WorkSpaces must have multiple projects to perform an analysis. To create a project, you must define a network with valid links and at least one strategy. All projects are managed from the Planning → Project Info tab (Figure 3.6). If you modify a link or strategy after you have used it within a project, please see the next section on Viewing or Modifying Projects to update the strategy or links as needed.

You can always identify how many projects have already been defined within a given WorkSpace by viewing the Project Counter at the Planning → Project Info tab (Figure 3.6). In Figure 3.6, the Project Counter is “0”; and the current project is a “New” project of the “0” projects currently defined.

The screenshot shows the WISE V2_5A software interface. The window title is "WISE V2_5A". The "File" menu is open, showing "Current Workspace: C:\Projects\WISE\Test Workspace 01". The "OPERATION" tab is selected. The "Project Info" sub-tab is active. The main area shows "Project : New of 0". Below this are fields for "Project Name*", "Scheduling Details" (Earliest Start*, Latest End*), "Total Contract Duration (Months)*", "Project Precedence", "Total Project Construction Cost in Millions (\$)", "Project Strategies" (Demand-Based, Duration-Based), "Project Link", "Capacity", "Speed", "Number of Lanes", "Diversion" (User Supplied, Operation Supplied), and "Validate Project" and "Save/Add Project" buttons. On the right, the "All Projects" table is empty with columns "#", "Name", "Link", and "Precedence". Below the table are "Delete Project" and "Go To Project" buttons.

Figure 3.6. Project Info tab.

To create a new project, navigate to the Planning → Project Info tab and type in the appropriate values for the following fields: Project Name, Earliest Start Time and Latest End Time (MM/YYYY format), Total Duration of Project (in months), and Project Precedence. Also select Day and/or Night and fill in the appropriate Total Project Construction Cost in millions of dollars. (You can fill in a cost for Day or Night only if you click the appropriate boxes.) You must select at least one strategy from the Project Strategies pull-down menus (one Demand- or Duration-Based Strategy or one of each). You must also select a Project Link from the pull-down menu (selecting a Project Link will automatically populate the Capacity, Speed, and Number of Lanes fields). If the Project Strategies or Project Link pull-down menus do not have any valid options, then you have not generated any strategies, you have not imported a valid network, or all of your Project Links have already been assigned (each link can be assigned to only one project).

Before adding the new project, you must also select a Diversion. If you would like the WISE Diversion Engine to generate the Diversion automatically in the Planning Module, select User-Supplied and leave the value at “0.” The Planning Module uses static assignment. You also have the option of supplying a Diversion other than “0,” based on experience and judgment or on separate studies. If you desire additional accuracy for estimating potential traffic diversion due to construction delays, you can request or perform a microsimulation on your own model, and manually input the results to the Planning Module. If you desire additional accuracy and the convenience of the built-in “handshake” between the Operational and Planning Modules, you can apply the DynusT model as part of the Operation function, develop diversion estimates in the Operation Module, and rerun the Planning Module. Applying diversion estimates from the Operation Module is an explicit choice in the Planning Module. See the section Performing Diversion in this chapter for further information on the Operation-Supplied Diversion. The Operation Module-supplied Diversion will not be available for new projects until the Operation Module is run; until then the Operation Supplied box will indicate “null.”

Once all project information is complete, click Save/Add Project to add the project to the All Projects list on the right-hand side of the Project Info tab. WISE will then validate all fields and highlight invalid fields in red. In addition, the GUI will return the Active Project screen to a New Project screen, and the Project Counter will display New of Total so that new projects can be added.

At any time during the generation or modification of a project, you can click Validate Project, and WISE will highlight all fields that have errors or display an “error free” message.

Please see Chapter 8, Data Limits, for details on valid values for each field within the Project Info tab.

Viewing or Modifying Projects

To either view or modify an existing project you must select the check box next to the project of interest in the All Projects list on the Project Info tab and click Go To Project at the bottom of the list (Figure 3.7). This action will populate the Project screen to the left of the Project Info tab with the selected project. The Project Counter will now display Project x of $total$. You can now modify all project fields as when you created the project. When you click Save/Add Project, WISE will perform the same validation and operation as in creating a new project and will update the project in the All Projects list. This modification will also return the Active Project screen back to New of Total so new projects can be added.

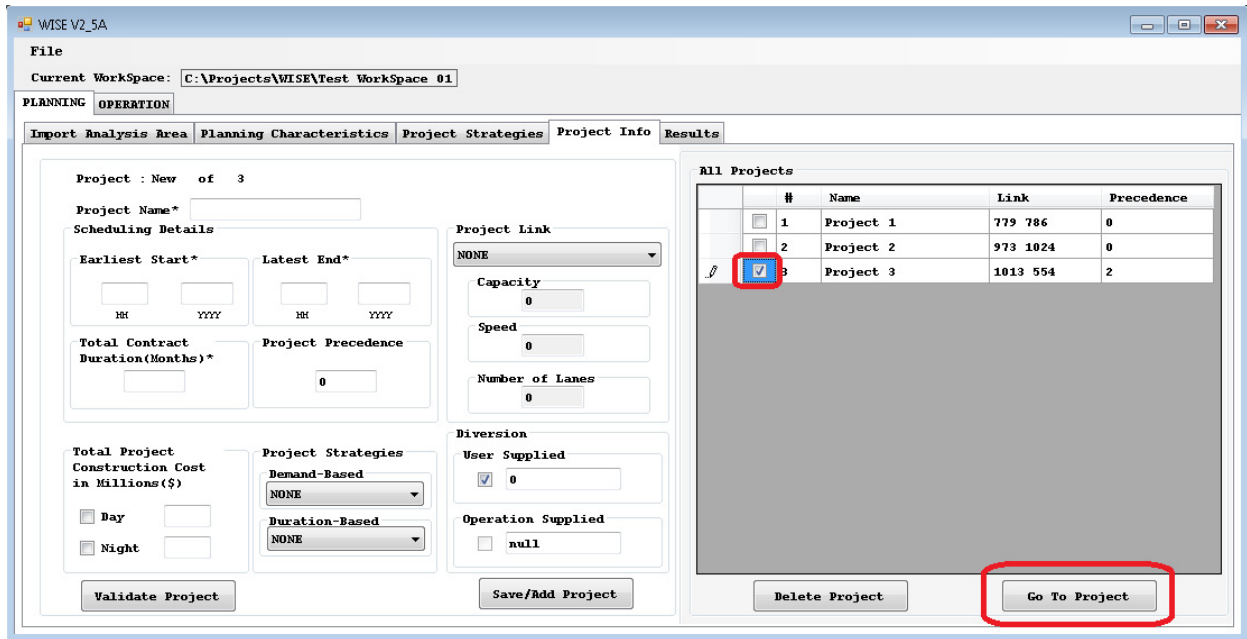


Figure 3.7. Project Info tab: View or modify a project.

Deleting Projects

To delete a project from the WorkSpace, select the check box next to the project or projects in the All Projects List that you would like to delete, then select the Delete Project button from the bottom of the list (Figure 3.8). After prompting you to ensure that you would like to delete the specified projects, WISE will delete them. Once a project is deleted, it will no longer appear on the All Projects list.

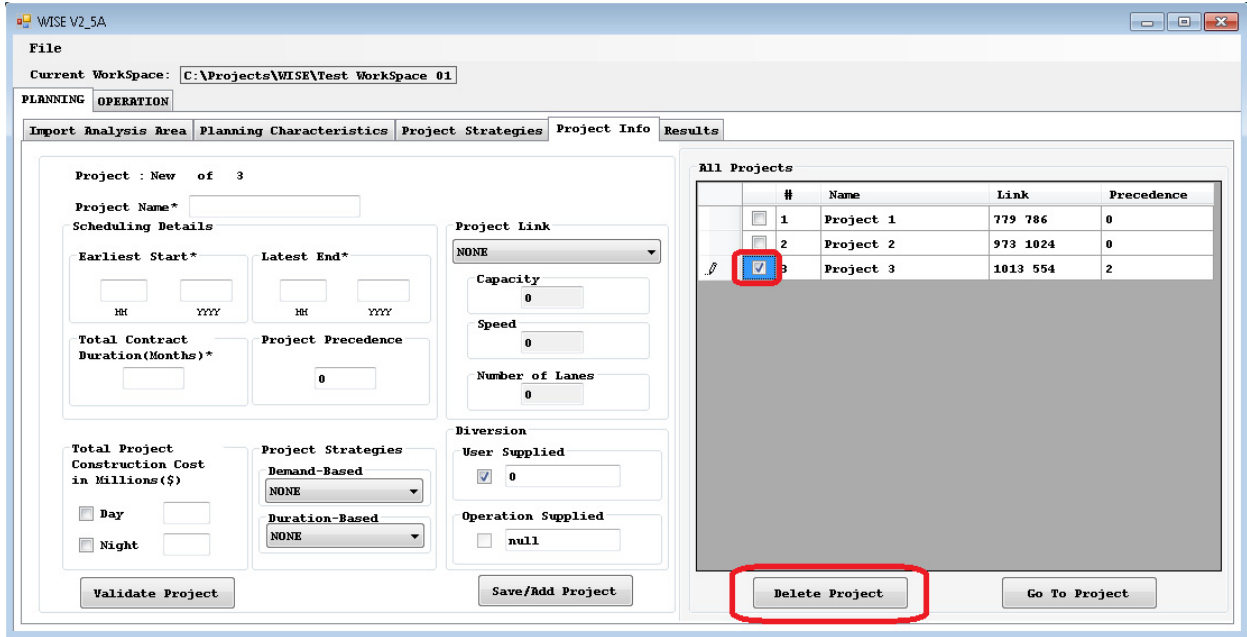


Figure 3.8. Project Information tab: Delete Project.

RUNNING THE PLANNING MODULE WISE ANALYSIS ENGINE

Once all necessary inputs are entered into the Planning Module of the current WorkSpace, the user can run the WISE Analysis Engine. To do so, the entire WorkSpace must complete a successful WorkSpace Validation and Save. The WorkSpace Validation and WISE Analysis Engine are run from the Planning → Results tab (Figure 3.9).

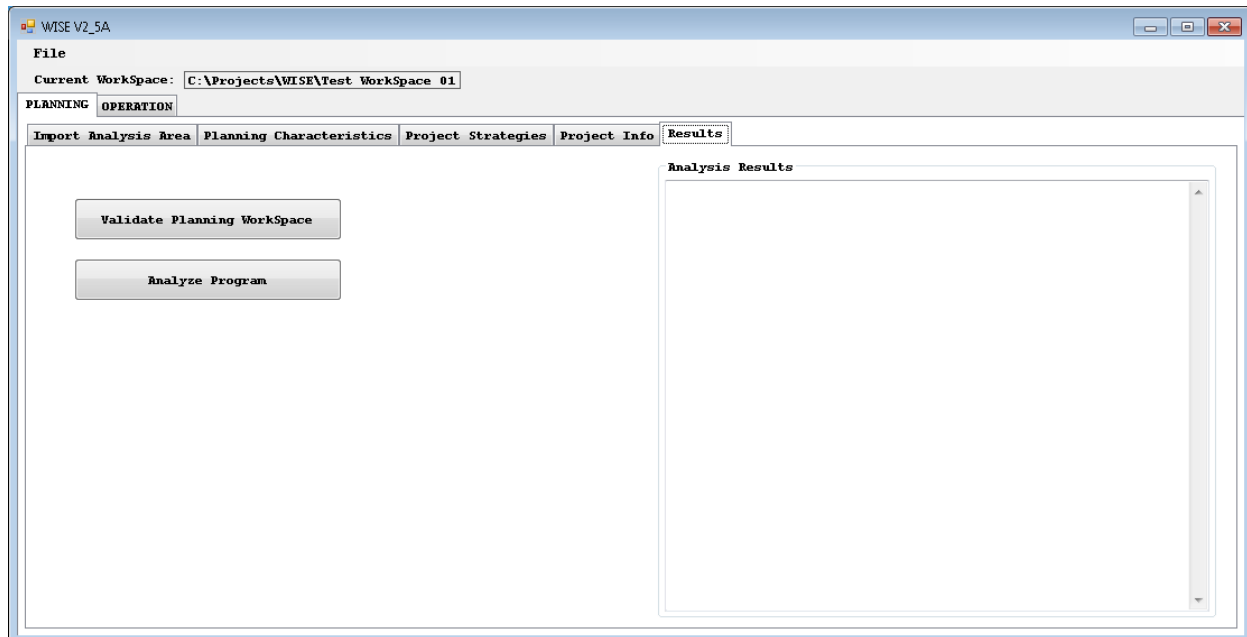


Figure 3.9. *Planning Results tab.*

Validating WorkSpace

To validate the entire WorkSpace, you must select Planning → Results → Validate Planning WorkSpace. This function will validate the entire WorkSpace and generate a log of any errors it detects. WISE will display the location of any error log in a pop-up window. Validation of the Planning WorkSpace prompts the user to save the current WorkSpace and validates as follows:

- Checks for valid network.
- Ensures that the link (including Speed/Capacity/Number of Lanes) and strategies have not been modified since they were applied to a project.
- Validates the following, regarding schedules and dates:
 - All projects fit within the duration of the program;
 - Each project precedence is feasible (Note: projects can coincide); and
 - All Duration-Based Strategies applied to projects have feasible Duration Reduction for Project Duration.

Generating Results

Once the WorkSpace is ready for analysis of the Planning Module, the user can run the WISE Analysis Engine. To do so, select the Planning → Results → Analyze Program button (Figure 3.9). The program will first validate the planning network and then, if all validations are clear, run the WISE Analysis Engine. A command window will show that the Analysis Engine is running. At completion, the Analysis Results Box will populate the Planning → Results tab in the Analysis Results box (see Figure 3.9). See Display and Interpretation of Results later in this chapter for more information on the analysis results.

PERFORMING DIVERSION

WISE performs traffic diversions in the sequencing algorithm in the Planning Module to analyze interdependency of work zone construction projects and the resultant traffic impact and delays networkwide, and it recommends a feasible sequence with a rule of minimum traffic delay over the studied seasons and period. Although the traffic diversion is an internal analysis module packaged within the sequencing algorithm, WISE can execute traffic diversion under three different modes: WISE-supplied, user-supplied, and operation-supplied. Technical details of traffic diversion analysis in WISE are discussed in Optimization of Project Sequence.

WISE-Supplied Mode

WISE-supplied mode is the default setting. If the user or operation model does not supply traffic diversion information, then WISE executes the default mode automatically. WISE analyzes traffic diversions through an internal logic, which finds a set of alternatives to the route through the work zone construction link. If WISE's analysis indicates that the work zone construction link involves congestion, then WISE diverts a portion of traffic on the work zone construction link to the set of alternative routes if doing so would lead to less delay. The internal logic seeks an equilibrium state between the work zone link route and its alternative routes. Analytically, the WISE-supplied diversion module achieves equal travel time between both (sets of) routes.

To enable the WISE-supplied traffic diversion rate, in the Diversion box on the Planning → Project Info tab, keep the User Supplied box checked and enter the number "0" in the field (Figure 3.10).

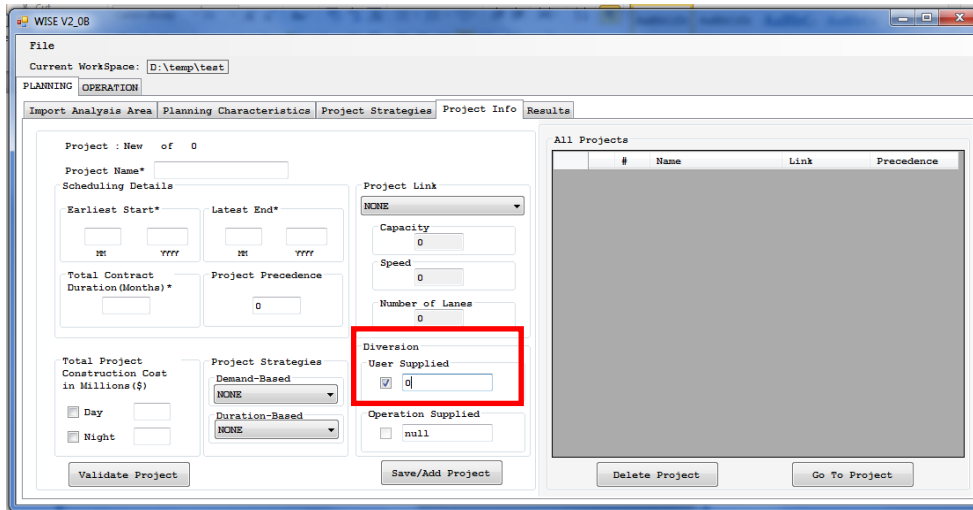


Figure 3.10. Define WISE-supplied traffic diversion rate.

User-Supplied Mode

WISE provides an interface that allows users to provide a traffic diversion rate, if it is known by those who are familiar with local traffic performance or is obtained by additional traffic studies outside of WISE (including the use of separate microsimulation models, as described in the R11 pilot test report). To execute the user-supplied mode, in the Diversion box on the Planning → Project Info tab, select User Supplied and enter a positive number (at least 1 and no more than 100) in the field (Figure 3.11). For example, the number 15 shown in Figure 3.11 means that 15% of the traffic on the work zone construction link is to be diverted to the set of alternative routes.

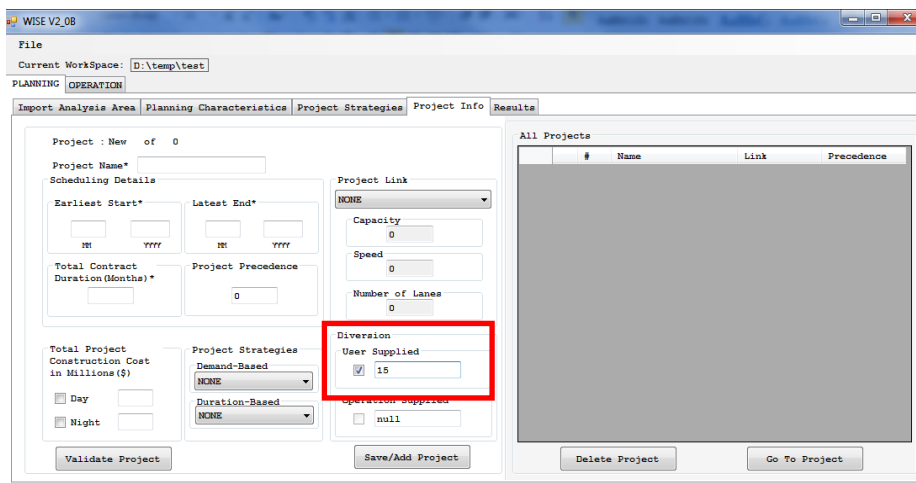


Figure 3.11. Define user-supplied traffic diversion rate.

Given the user-supplied traffic diversion rate, WISE finds a set of alternatives to the route through the construction link, as in the default mode, and it diverts the user-supplied portion of traffic from the work zone construction link to the alternative routes regardless of the computed travel time.

Operation-Supplied Mode

The operation-supplied diversion rate provides an interface to feed the traffic diversion data analyzed in the Operation Module back to the Planning Module (Figure 3.12), illustrating the “handshake” between the two modules. To enable this operation-supplied mode, the user must first run the Operation Module. If the Operation Module has not produced analysis data, then the operation-supplied check box on the Planning → Project Info tab is gray and not checkable.

After the Operation Module has been run, and with the traffic data produced by WISE, the check box becomes activated. When the check box is selected, WISE identifies the simulation data set, reads the produced outputs internally, and automatically displays the diversion rate in the field.

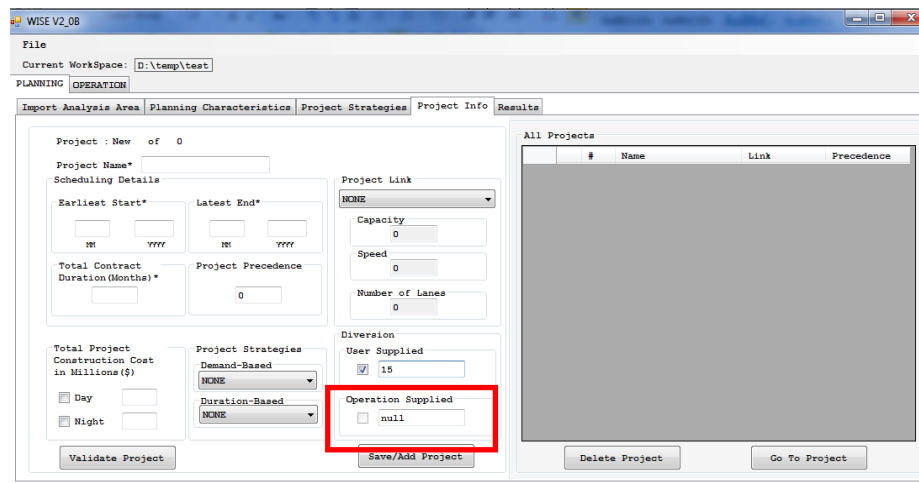


Figure 3.12. Define operation-supplied traffic diversion rate.

USING PROJECT INFORMATION TOOLS

Running the Algorithm

Validate Planning Workspace

Upon completion of project setup and directly before executing the Algorithm program, you can click Planning → Results → Validate Planning WorkSpace button to ensure that the input numbers are valid. This step provides an additional safeguard to ensure that the numbers of project setup are feasible within a reasonable domain supported by WISE. Invalid numbers and inputs are identified in a warning message. The program cannot run until all invalid inputs that the validation procedure identified have been cleared.

Analyze Program

The Planning → Results → Analyze Program button executes the sequencing algorithm in WISE, to analyze traffic delays in the network with the project setup. The algorithm evaluates interdependency of construction projects as well as the resultant traffic delays under a set of logically generated feasible schedules, and it recommends the best schedule plan with the lowest generalized cost.

Display and Interpretation of Results

When the analyzing program is completed, the sequence results are automatically displayed in the Analysis Results box on the right-hand side of program window (Figure 3.13).

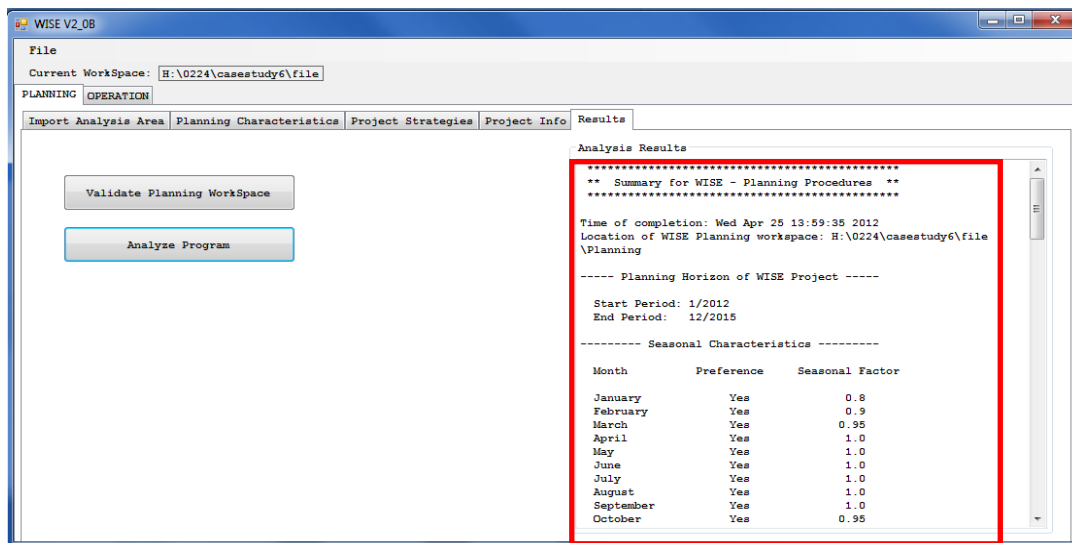


Figure 3.13. Display analysis results.

The first part of the WISE output summarizes the basic inputs of the analyzed scenario. It displays the overall planning horizon, month-specific seasonal factors, and number of projects specified by inputs.

The second part of the output displays the recommended sequence of each project, as well as its associated traffic variables, in an order of construction modes following daytime construction, nighttime construction, and both.

Figure 3.14 illustrates how the project sequence results are displayed. It shows a quick summary of the project setup, including the project ID, link where the project resides, capacity reduction rate, original posted speed limit, new posted speed limit during construction, and agency cost involved for implementation.

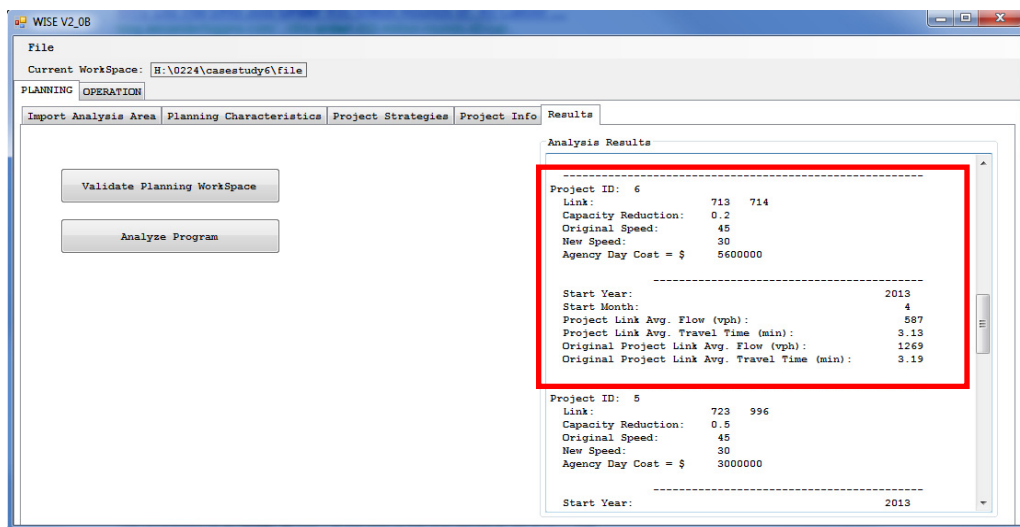


Figure 3.14. Display project sequence and its associated traffic variables.

The recommended project sequence follows. It displays the year and month that are recommended for the start of construction. The completion time is not displayed, but the user can compute it from the starting construction time and project duration (taking into account any Duration-Based Strategy). The output also includes the average flow, in units of vehicles per hour, and average travel time, in units of minutes, on the work zone construction link. Those numbers are averaged by work zone construction period. For example, if a work zone project lasts for 3 months, then the displayed flow and travel times are averaged over 3 months. To facilitate a comparison, the output also displays the original flow and travel time before construction, which are annual average numbers. Usually the user will see a reduced flow with increased travel time. Reduced flow implies WISE analysis traffic diversion for the analyzed work zone project. Two factors lead to an increased travel time: the drop of capacity and the reduced posted speed limit during construction.

Optimization of Project Sequence

WISE selects the best schedule plan based on the generalized cost, which contains both user cost and agency cost. User cost is also known as traffic delays, measured by vehicle hours prolonged for all travelers in the network arising from the work zone constructions. Traffic delay is converted to user cost by multiplying value of time.

Agency cost represents the monetary dollars spent out-of-pocket to implement the evaluated construction plan. Agency cost is specified by users when defining demand-based and duration-based construction strategies. See the Work Zone Construction Strategies section earlier in Chapter 3.

Given the user cost derived from traffic delay and the agency cost, WISE evaluates the generalized cost summarized for the entire analysis period. Logically, WISE generates a number of schedule scenarios and eventually selects the one with the lowest whole-period generalized cost among all schedule plans evaluated.

The main task of the sequencing algorithm is to evaluate traffic delay for use in computing user costs. Traffic delay varies from month to month because of geometric features of the network (e.g., links are partially closed for construction in a specific month), travel demand varies month to month, and delays are scenario-specific depending on the individual construction schedule plan. In this regard, WISE evaluates traffic delay for each month and then summarizes the overall delay for the entire analysis period.

For a specific month, traffic delay is measured in a manner that considers the traffic diversion effect. It is assumed that some travelers will respond to the construction event and choose their own alternate route to minimize their own delay. The traffic diversion effect indicates the need to measure the interdependency of work zone projects. If a work zone project involves a route that is an alternative to a route in another work zone project, then the algorithm can measure a worse delay when construction is concurrent rather than sequential. As a general rule, interdependent projects are usually not recommended for construction in overlapping time windows because such a situation increases traffic delay.

Delay caused by work zone construction networkwide is measured by a k -shortest path (KSP) algorithm that appropriately captures travelers' diversion. The KSP algorithm in WISE is a revised version of the ranking algorithm based on the work of Martins (2). As a general rule, it finds the shortest path by considering paths one by one between a set of diversion points and merging points. More specifically, WISE identifies a set of upstream nodes r of a work zone project as diversion points, specifies a set of downstream nodes s as merging points, and then solves k shortest paths between sets r and s . A set of paths among KSPs that leads to a shorter travel time than the one through a construction link is specified as a set of alternative routes for traffic diversion. Traffic diversion shifts flow from the longer route (in time) to the shorter route, so that travel times along two routes are identical after flow shifting, indicating an equilibrium state.

A set of feasible schedules is generated by a large-scale neighborhood search heuristic. A feasible schedule, or plan, means that the schedules identified for each project satisfy the earliest starting time and latest completion time, the duration is within the domain that users specify, and the precedence constraints, if any, are valid. The heuristic starts from a feasible schedule plan, computes month-specific traffic delay, and obtains the overall generalized cost for the entire analysis period. Based on the current plan and evaluation result, WISE generates another plan that may lead to an improvement and performs the same evaluation again. In each iteration, the heuristic usually identifies a better plan. The analysis procedure continues until the program cannot identify further improvement within a certain number of iterations.

REFERENCES

1. Dial, R. A Path-Based User-Equilibrium Traffic Assignment Algorithm That Obviates Path Storage and Enumeration. *Transportation Research Part B: Methodological*, Vol. 40, No. 10, 2006, pp. 917–936.
2. Martins, E. D. V. An Algorithm for Ranking Paths in Acyclic Networks. *OR Spektrum*, Vol. 5, No. 2, 1983, pp. 87–90.
3. *Transportation Research Circular E-C153: Dynamic Traffic Assignment—A Primer*. Transportation Research Board of the National Academies, Washington, D.C., 2011. <http://www.trb.org/publications/blurbs/165620.aspx>.

4

PLANNING MODULE DETAIL ELEMENTS

GETTING A DATA SET INTO WISE: CONVERTING A DATA SET INTO NEXTA FORMAT

Network Conversion

DynusT adopts the approach of a flexible and robust interface, using an Excel template file—with existing GIS-based demand forecasting and network planning software packages. This arrangement provides the appropriate stages of importing an existing network (i.e., links, nodes, and zones) to a DynusT data set. An Excel template is included in the software package, in the directory in which the software is installed (file name: GIS_Network.xls). The typical path to this folder is C:\Program Files \DynusT 3.1 (32 bit).

Because DynusT is a simulation-based model, typically the centroids and centroid connectors from a static network are not used but are replaced by a more detailed (block face level) zonal system with connectors. For the purposes of DynusT in WISE, removal of that information is optional. However, it can be done either in the existing planning software from which the importing network originates, or by carefully modifying these items in the Excel conversion template. An overall explanation of the centroid methodology can be found in the DynusT Online User's Manual (1).

The general procedure for network conversion is as follows.

1. Export network-related tabular information regarding nodes, links, and zones from the original network-modeling software. Most software packages can export this information either as an Excel file or as a comma-delimited file (*.csv).
2. Copy the node, link, and zone information to the appropriate worksheet in the Excel template file.

3. Import the Excel template file to NEXTA to convert the network to DynusT format.

Note: The pilot test report documents a user’s experience with downloading, importing, and troubleshooting complex freeway networks into compatible NEXTA and DynusT formats. Users may find useful suggestions and “work-arounds” in that document.

The following describes the necessary information to copy into the Excel template file.

NODE Worksheet

The NODE worksheet contains columns for ID, Longitude, Latitude, TAZ, and

	A	B	C	D	E	F
1	ID	Longitude	Latitude	TAZ	CTRL_TYPE	
2	1	-87365273	30543771	6	1	
3	2	-87358147	30533184	0	1	
4	3	-87367790	30522933	0	5	
5	4	-87361143	30518285	9	5	
6	5	-87354698	30513770	0	5	
7	6	-87362726	30504954	0	5	
8	7	-87366043	30501253	0	1	
9	8	-87348680	30494723	0	1	
10	9	-87345104	30503474	0	5	
11	10	-87319293	30481690	0	1	
12	11	-87306365	30467481	16	1	
13	12	-87404965	30511595	1	1	
14	13	-87382957	30506474	0	1	
15	14	-87376318	30513453	0	5	

CTRL_TYPE (Figure 4.1).

Figure 4.1. NODE worksheet.

The node IDs are listed in the ID column, and they should be consistent with their association with the network links. That is, the node IDs used to describe links in the “Link” section should be consistent here. (Basically the input file has two sections, a node section and a link section. A link is defined as traveling from Node A to Node B. The node IDs in the node section must match up with the nodes used to define the links.) The Longitude and Latitude columns contain the *x* and *y* coordinates of each node. Any coordinate plane format is accepted because NEXTA will convert it to its own coordinate system. The TAZ column indicates each node’s association with a TAZ, that is, the node is within the geographical boundary of the TAZ. If for any reason a node does not have a TAZ, you may enter a “0.” The CTRL_TYPE column refers to the type of traffic control designated to that node. Table 4.1 lists traffic control types and describes each control type’s identification record. It is suggested that the user set up default-actuated signal control. More information can be found in the DynusT Wiki Online User’s Manual (2).

TABLE 4.1. TRAFFIC CONTROL TYPES FOR NODES

Type	Description
1	No control
2	Yield sign
3	Four-way stop sign
4	Pretimed signal control
5	Actuated signal control
6	Two-way stop sign

LINK Worksheet

This worksheet contains the following columns (Figure 4.2). Note that users may fill in the columns denoted by an asterisk (*) at their discretion; WISE will apply default settings to any fields in those columns that are not filled.

- ID;
- Length;
- Dir;
- TYPE;
- LANES;
- TAZ;
- From_ID;
- To_ID;
- GRADE*;
- NAME*;
- LEFTTURNBAY*;
- LIMIT*;
- ADJSPEED*;
- SATURATION_FLOW_RATE*;
- MAX_SERVICE_RATE*;
- RIGHTTURNBAY*.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
	ID	Length	Dir	TYPE	LANES	TAZ	From_ID	To_ID	GRADE	NAME	LEFTTURNBAY	LIMIT	ADJSPEED	SATURATION_FLOW_RATE	MAX_SERVICE_RATE	RIGHTTURNBAY
1	1	7187.96	1	1	3	1	12	13								
2	2	7186.85	1	1	6	0	13	12								
3	3	1047.65	1	5	3	3	19	14								
4	4	982.30	1	5	3	3	14	19								
5	5	3260.60	1	5	3	4	18	3								
6	6	3247.39	1	5	3	0	3	18								
7	7	4470.95	1	1	6	0	1	2								
8	8	4475.50	1	1	6	6	2	1								
9	9	1576.57	1	5	3	2	16	13								
10	10	1579.08	1	5	2	0	13	16								
11	11	3309.95	1	5	3	0	13	14								
12	12	3301.76	1	5	5	0	14	13								
13	13	4375.57	1	5	3	0	14	3								
14	14	4385.64	1	5	3	0	3	14								
15	14	4385.64	1	5	3	0	3	14								

Figure 4.2. LINK worksheet.

Although not always used in DynusT, the ID column is a reference that is necessary for the user. The Length column contains the length of each link in feet. The Dir column should contain a 0, 1, or -1 value. All links in DynusT are directional, and DynusT will convert links that are bidirectional into two separate links in opposing directions. (WISE will accept only two-way links, so if a WISE network is sent to DynusT, DynusT will convert it to one-way pairs. But it will not go the other way. That is, if a network exists in DynusT as one-way pairs, it must be manually converted to two-way links for use in WISE.)

The Type column refers to the link’s functional class or functional type. Table 4.2 describes each link type’s identification record. The user must aggregate link classes from the planning network to these classes used in DynusT. Additional classes cannot be made or recognized in DynusT.

TABLE 4.2. LINK FUNCTIONAL CLASSES

Type	Description
1	Freeway
2	Freeway segment with detector (for ramp metering)
3	On-ramp
4	Off-ramp
5	Arterial
6	HOT
7	Highway
8	HOV
9	Freeway HOT
10	Freeway HOV

The Lanes column represents the number of lanes in each directional link. As stated earlier, all links in DynusT are directional links. Because many planning tools represent links by one link that is marked as bidirectional, the user must be diligent when creating a bidirectional link from one link listed. NEXTA may generate a warning message during the eventual import of the Excel template file (see the Importing Completed Data Sets section). The TAZ column indicates each link’s association with a TAZ, that is, the link is within the geographical boundary of the TAZ. If for any reason a link does not have a TAZ, you may enter a “0.” The From_ID and To_ID columns are the start node and end node of a link. As mentioned in the NODE Worksheet section earlier in this chapter, these node IDs should be listed in the NODE worksheet.

You may fill in the remaining columns, denoted by an asterisk (*) in the list, at your discretion; WISE will apply default settings to any fields in those columns that are not filled. The Grade column contains the percentage highway grade of the link. The Name column designates the name of the link. The LeftTurnBay column contains the number of left turn bays downstream of the link. The Limit column is the speed limit of the link mph. The AdjSpeed column is a speed adjustment factor applied to

the speed limit. The Saturation_Flow_Rate column contains each link’s saturation flow rate; this value is used for arterial links because this rate is measured at intersections. DynusT uses this value for all arterial links, and the remaining link types will not use this value. The Max_Service_Rate column contains each link’s maximum service flow rate. The RightTurnBay column contains the number of right turn bays.

ZONE Worksheet

This worksheet contains columns for ZONENO and TAZ (Figure 4.3)

	A	B	C	D	E
1	ZONENO	TAZ			
2		1	1		
3		2	2		
4		3	3		
5		4	4		
6		5	5		
7		6	6		
8		7	7		
9		8	8		
10		9	9		
11		10	10		
12		11	11		
13		12	12		
14		13	13		
15		14	14		

Figure 4.3. ZONE worksheet.

Entries to the ZONENO column must be in increasing, consecutive order starting from “1.” The TAZ column should be filled with the actual TAZ IDs from the user’s planning travel demand or similar traffic model. In a typical planning model, the TAZ number designation could be a sequence with skipped numbers not necessarily starting from a TAZ ID of 1; however, DynusT requires the zone numbers to start from 1 and be consecutive. This worksheet maintains the mapping between the DynusT zone number and the actual TAZ numbers from the user’s planning model.

SIGNAL Worksheet

This worksheet contains columns for MaxGreen, MinGreen, and Amber (Figure 4.4).

	A	B	C	D
1	MaxGreen	MinGreen	Amber	
2		45	5	4
3				
4				
5				
6				
7				
8				

Figure 4.4. SIGNAL worksheet.

As noted in the NODE Worksheet section earlier in this chapter, default traffic control can be placed on nodes. Because of the great possibility that the network is in a large, regional area, the network might be too large and the effort too time consuming for manual placement of signals at every intersection. It may be more realistic to indicate “default” traffic signals applied to the whole network from the start. This worksheet allows the user to quickly assign a default-actuated signal control. After the conversion process, the user may manually change signal timings if desired. The default signal type can only be actuated (i.e., not “pre-timed” or “none”).

Importing Completed Data Sets

Once the Excel template file is prepared, the user can import the file by navigating to File → Import Files → Import GIS Data Set → Import Network Table (Figure 4.5). NEXTA must have a new, blank project open. To open such a project, click File → New.

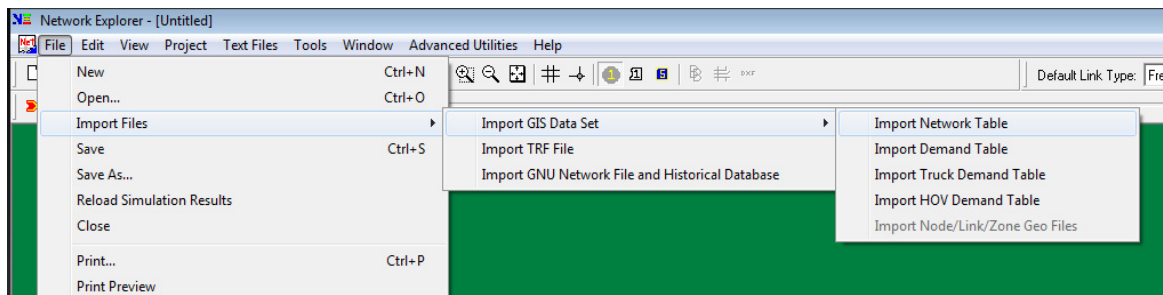


Figure 4.5. *Importing the Excel template file.*

As indicated earlier regarding the number of lanes and bidirectional links, during the import and conversion of the Excel template file, NEXTA will ask the following question as a warning: “Is the number of lanes on a two-way link for one direction only?” (Figure 4.6).

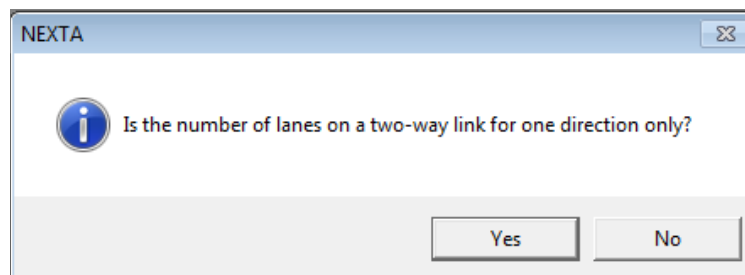


Figure 4.6. *NEXTA link direction warning.*

This question refers to links in the spreadsheet that are labeled with $Dir = 0$ and asks whether the number of lanes for such a link is for one direction or the link is split evenly to be bidirectional. In other words, answering Yes imports the links as a 1, which is one-directional, and answering No imports the links as a 0, which is bidirectional.

Once the import is complete, the user can see the network produced on NEXTA. To complete the conversion process, simply save the network by going to File → Save, create a new folder to contain all input files, and name the project file.

For more information regarding the conversion process and other information regarding DynusT and NEXTA, see the DynusT Wiki Online User's Manual (3).

CREATING A NETWORK FROM SCRATCH

To create a network from scratch, click Create Network under the Planning → Import Analysis Area tab (Figure 4.7). This will open the NEXTA interface.

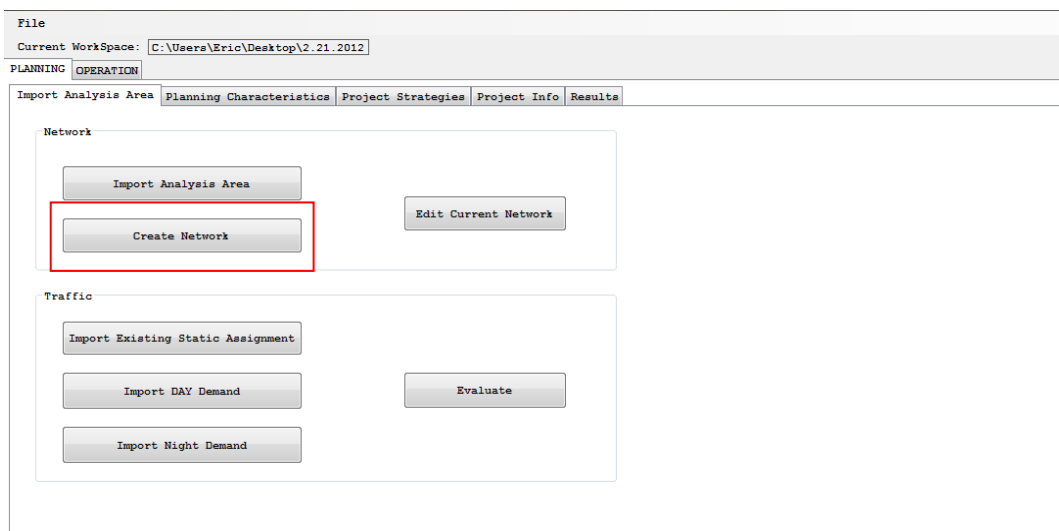


Figure 4.7. Create Network button.

Once NEXTA is open, a new, blank NEXTA project should already be opened. If it is not, then click File → New in NEXTA. This will create a blank project. You can create new nodes, links, and zones using the network creation tools, as demonstrated in Figures 4.8 and 4.9. For more information, see the DynusT Wiki Online User's Manual (4).

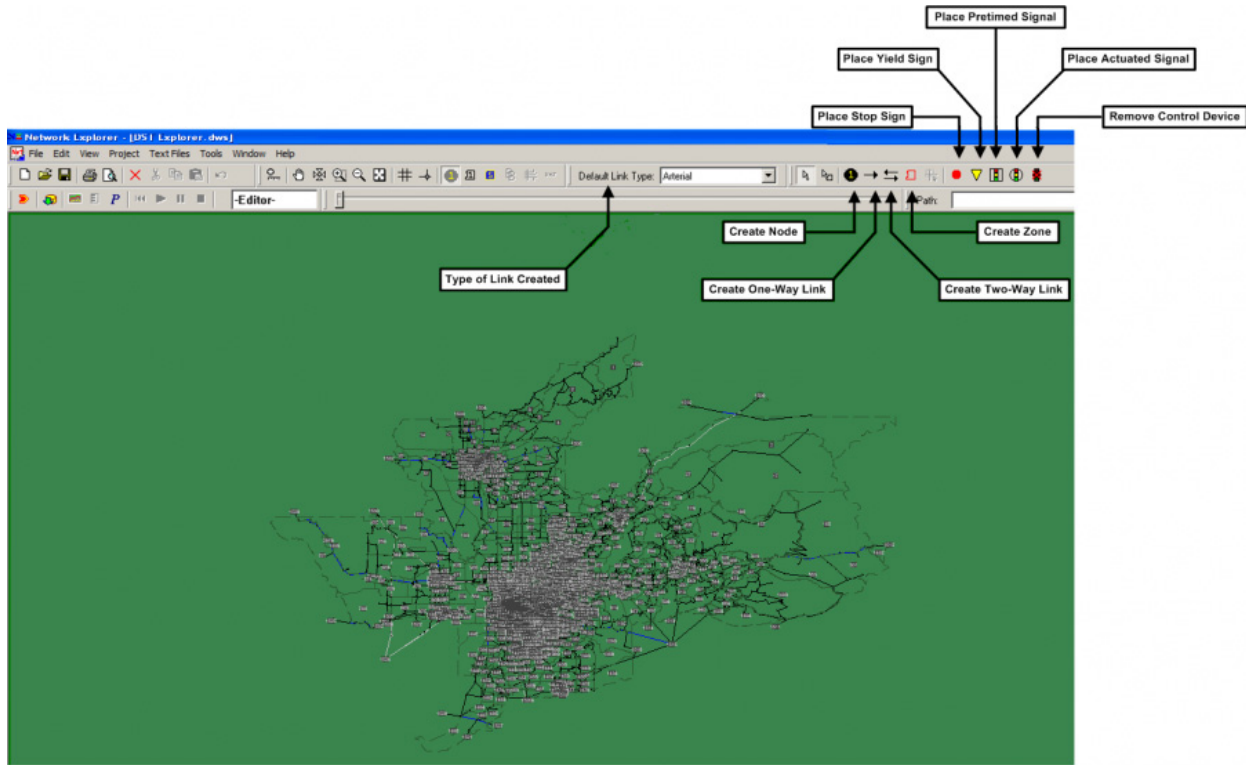


Figure 4.8. Create new nodes, links, and zones in NEXTA.

Source: DynusT Online User's Manual (4).

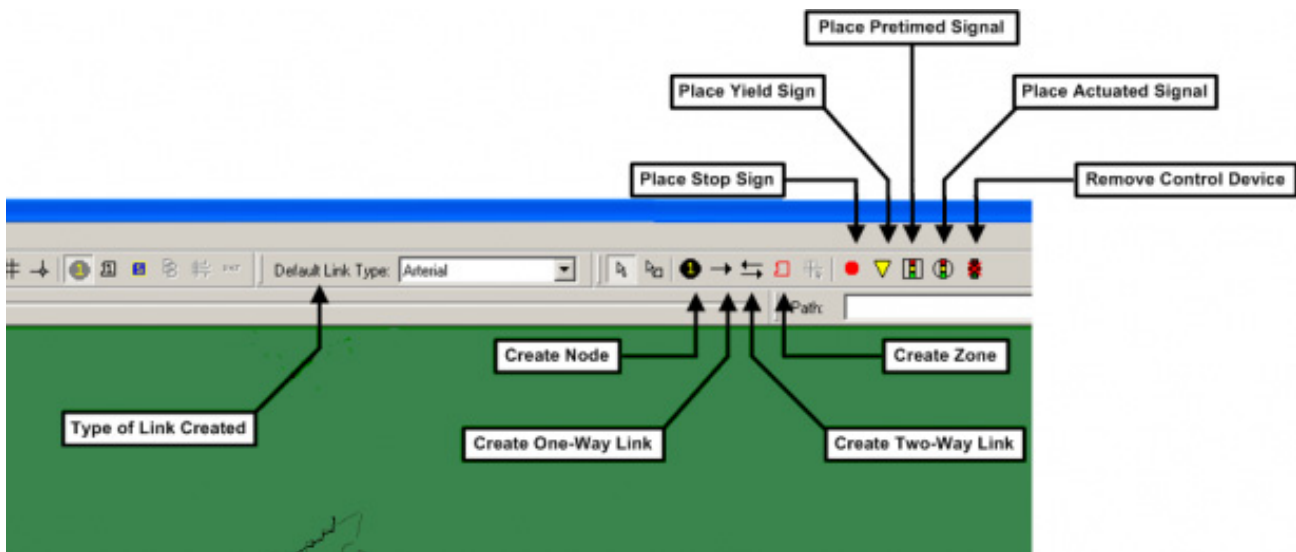


Figure 4.9. Create new nodes, links, and zones in NEXTA (close-up of screen).

Source: DynusT Online User's Manual (4).

It is best to save the NEXTA project before engaging in network creation and editing. You must save the network in the location of the WISE WorkSpace, specifically in “*WISE WorkSpace folder*\Planning,” where “*WISE WorkSpace folder*” is the location and folder name of the WISE WorkSpace. Saving the network in this location is important. If the network is not in the correct folder, then WISE will experience and show an error (Figure 4.10).

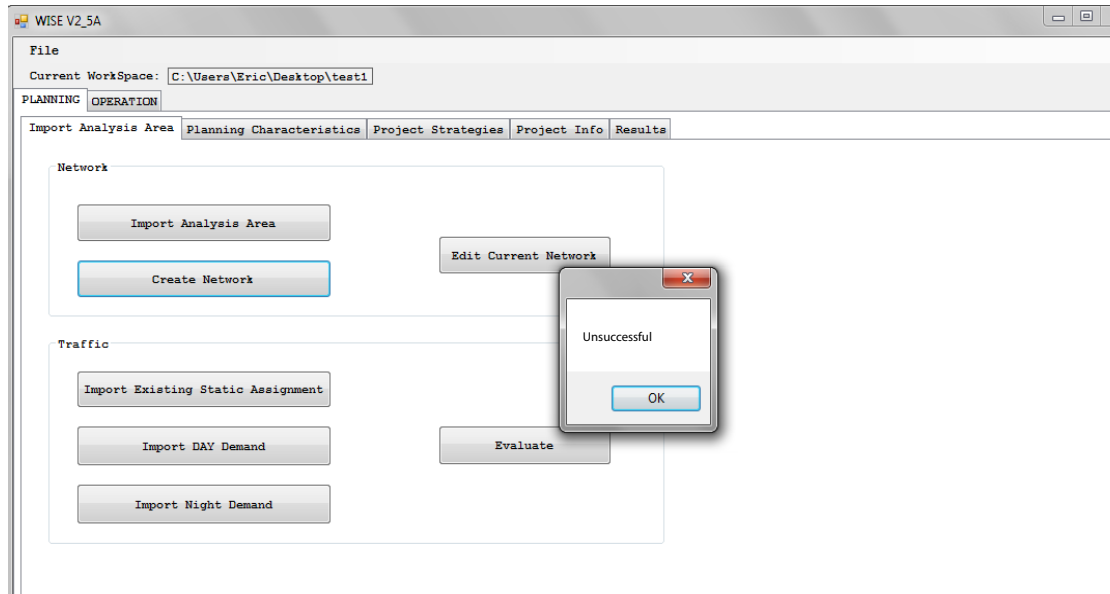


Figure 4.10. WISE reports error in creating network from scratch.

Once you have created the desired network, close the NEXTA window, and WISE will then recognize the network. To ensure that the network is correctly saved and recognized by WISE, click Edit Current Network (Figure 4.11).

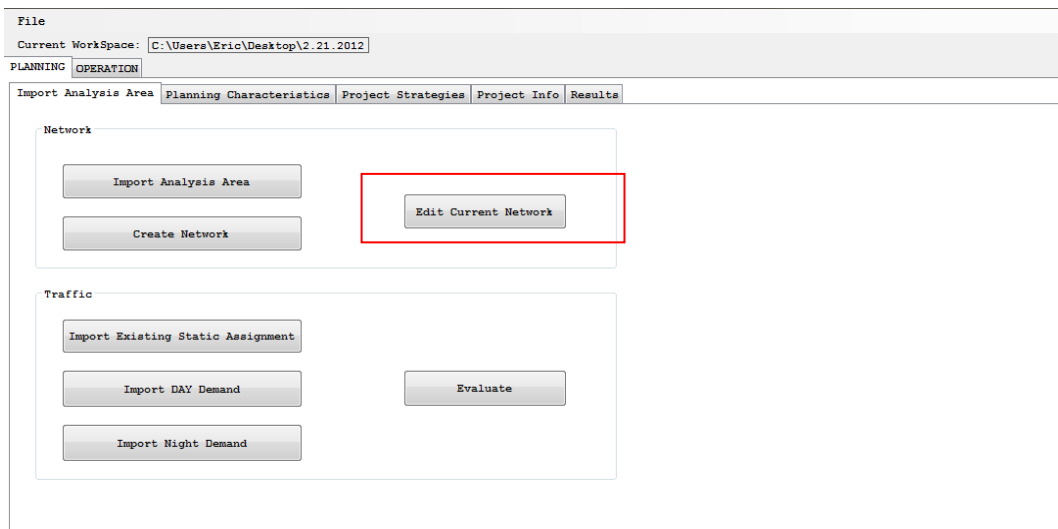


Figure 4.11. Edit Current Network button.

IMPORTING TRAFFIC INFORMATION

The Planning Module can use existing traffic information available from an external source or separate traffic study. For example, users have the option to perform traffic assignment analysis through an external traffic software package (e.g., TransCAD or CUBE) and then import the results as existing traffic information into WISE. The information that WISE uses is the link travel time and link flows from assignment.

WISE supports imported traffic information for up to two different time periods, to recognize demand variance during the time of day. By default, WISE recognizes one peak demand as “day demand” and the other nonpeak demand as “night demand” (Figure 4.12). The user has the option to import two demand periods of interest in analyzing delay for either day or night or both, and the user may also define how many hours the two respective demand periods represent. WISE analyzes and estimates hourly traffic delay caused by the representative demand and then multiplies by the number of hours to obtain the daily traffic delay (i.e., user cost) that will be utilized in the sequencing algorithm. For example, if the user anticipates that major daytime traffic delay will occur during the morning peak of 6:00–9:00 a.m., then he or she can import a demand averaged from the period 6:00–9:00 a.m. as a day demand and define the number of hours associated with this demand as 3 h. WISE analyzes and estimates hourly delay and then multiplies by 3 to obtain daytime delay resulting from the representative demand. To import existing traffic information, follow the steps described in the next sections.

The screenshot shows the 'Import Analysis Area' dialog box in the WISE V2.08 software. The 'Demand Number of Hours' section is highlighted with a red box. The 'Day Number of Hours' is set to 3.5 and the 'Night Number of Hours' is set to 3.5. Other fields include 'Start Time of Program' (1 2012), 'End Time of Program' (12 2015), and 'Value of Time(Dollars/Hour)' (25). The 'Seasonal Information' section shows seasonal preference factors for each month. The 'Program Description' field is currently empty and set to 'NONE'. A 'Validate Planning Characteristics' button is located at the bottom right of the dialog box.

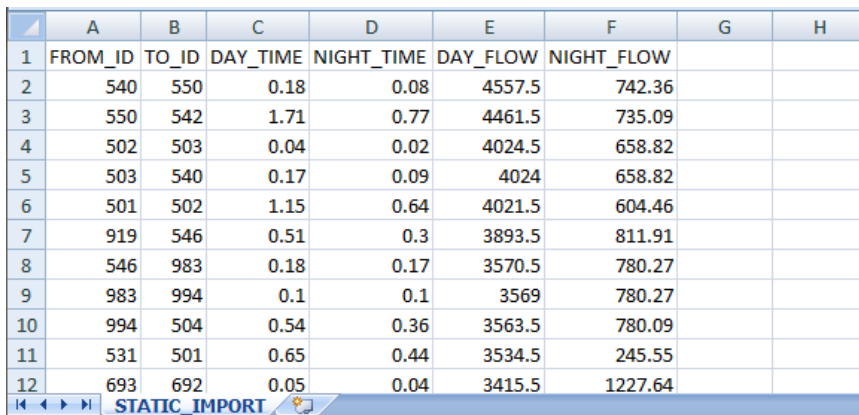
SEASONAL PREFERENCE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SEASONAL FACTOR	0.8	0.9	0.95	1	1	1	1	1	1	0.95	0.9	0.85

Figure 4.12. Define number of hours of representative demand.

Preparing Input File

A comma-delimited file (*.csv) titled `Static_Import.csv` must be prepared for the WISE software to import. The file contains columns for the following information. Figure 4.13 shows the format that is required to populate this information.

- FROM_ID;
- TO_ID;
- DAY_TIME;
- NIGHT_TIME;
- DAY_FLOW; and
- NIGHT_FLOW.



	A	B	C	D	E	F	G	H
1	FROM_ID	TO_ID	DAY_TIME	NIGHT_TIME	DAY_FLOW	NIGHT_FLOW		
2	540	550	0.18	0.08	4557.5	742.36		
3	550	542	1.71	0.77	4461.5	735.09		
4	502	503	0.04	0.02	4024.5	658.82		
5	503	540	0.17	0.09	4024	658.82		
6	501	502	1.15	0.64	4021.5	604.46		
7	919	546	0.51	0.3	3893.5	811.91		
8	546	983	0.18	0.17	3570.5	780.27		
9	983	994	0.1	0.1	3569	780.27		
10	994	504	0.54	0.36	3563.5	780.09		
11	531	501	0.65	0.44	3534.5	245.55		
12	693	692	0.05	0.04	3415.5	1227.64		

Figure 4.13. `STATIC_IMPORT.csv` file opened in Excel.

The FROM_ID and TO_ID are the start and end node IDs, respectively, of all existing links in the network. Every link must be represented in this file. The DAY_TIME and NIGHT_TIME columns refer to the link travel time in minutes. The DAY_FLOW and NIGHT_FLOW columns refer to the assigned flow rate in vehicles per hour (vph). If the WISE tool is being used for only daytime or only nighttime, enter “0” in the appropriate cells for whichever time period is not being used.

Importing Origin–Destination Trip Demand

Importing origin–destination (OD) trip demand involves importing OD trip tables that represent the daytime period and nighttime period being modeled in WISE. The demand information should correspond to the zonal count of the imported network. The demand serves as the input for the static assignment if the user is running the static assignment function in WISE (i.e., Import Existing Static Assignment is not being used).

Preparing OD Trip Demand File

The general procedure to prepare the OD trip tables in the format that WISE requires for conversion follows.

1. Export from the user's planning software the demand (OD) data to a comma-delimited (*.csv) text file (Figure 4.14).
2. Save the file as a *.txt file. For daytime demand, save the file as day.txt. For nighttime demand, save the file as night.txt.

Line	Origin-Destination	Value
1	1,1	69.76
2	1,2	405.89
3	1,3	64.15
4	1,4	31.91
5	1,5	39.07
6	1,6	30.01
7	1,7	25.44
8	1,8	2.14
9	1,9	42.97
10	1,10	13.97
11	1,11	10.70

Figure 4.14. Three-column format of OD trip table.

Importing Demand Data

Once the demand text files have been prepared, click Import DAY Demand (or Import Night Demand), as shown in Figure 4.15, and a file browser will open. Choose the location of the day.txt file (Figure 4.16). The function will then convert the demand information to the format required by the WISE software.

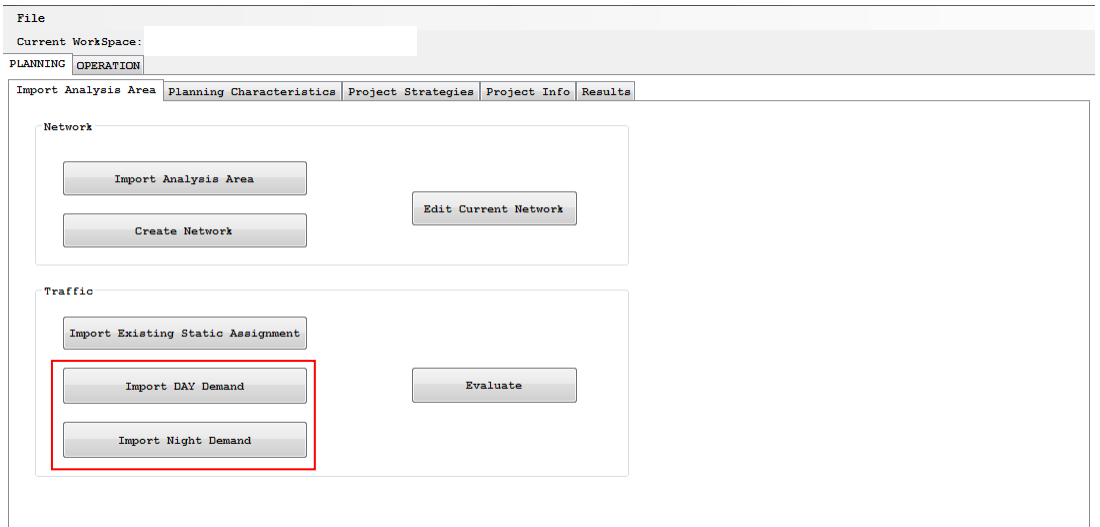


Figure 4.15. Import demand data.

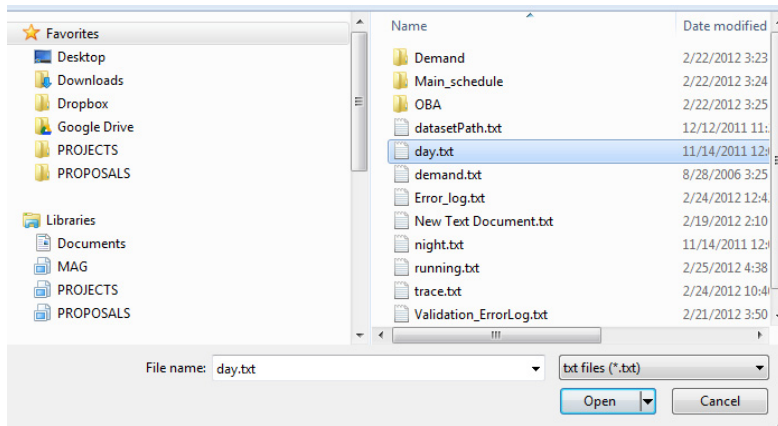


Figure 4.16. Select the demand text file.

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1. DynusT Wiki Online User's Manual. Getting Started: Generation Links and Destination Nodes. http://dynust.net/wikibin/doku.php?id=start:getting_started#generation_links_and_destination_nodes.
2. DynusT Wiki Online User's Manual. Getting Started: Generation Links and Destination Nodes—Default Control Signals. http://dynust.net/wikibin/doku.php?id=start:getting_started#default_control_signals.
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4. DynusT Wiki Online User's Manual. Getting Started: Network Basics. http://dynust.net/wikibin/doku.php?id=start:getting_started#network_basics.

5

OPERATION MODULE

HAND-OFF FROM PLANNING TO OPERATION (INTERCONNECTION)

Traffic diversion resulting from work zone congestion is an important input to the WISE model. The WISE default diversion, based on static assignment, is not optimal. Users can manually input their own estimates of diversion, as explained previously. Users also can choose to simulate work zones in their network models and manually input the diversion factors into the WISE model. (This is the alternative that was implemented for the Phase 4 operational tests for validation and pilot test sites.) Alternatively, users can create and implement the DynusT networks and models, as described below; this option allows for direct transfer of diversion factors between the Operation and Planning modules of WISE.

DynusT

DynusT is a software package for dynamic traffic simulation and assignment (DTA) that can support engineers and planners in addressing emerging transportation planning and operations issues. With DynusT, engineers and planners can estimate the evolution of systemwide traffic flow dynamics patterns that result from individual drivers' seeking the best routes to their destinations and responding to changing network demand, supply, or control conditions.

DynusT was not developed to replace travel demand models or microscopic simulation approaches; instead, by integrating with these models, it is aimed at supporting application areas in which realistic traffic dynamic representation is needed for a large-scale regional or corridor network. These application areas include assessing the impacts of alternate traffic operations and control strategies and evaluating strategies for work zone, incident, and special event management. Engineers or planners can also use the software to assess the impacts of intelligent transportation system technologies,

such as dynamic message signs, ramp meters, and in-vehicle guidance systems, on the transportation network. In addition, DynusT can both evaluate congestion-pricing schemes for toll roads and produce traffic operations data for air quality analyses.

DynusT consists of iterative interactions between its two main modules: traffic simulation and traffic assignment. Vehicles are created and loaded into the network based on their respective origins and follow a specific route based on their intended destinations. The large-scale simulation of networkwide traffic is accomplished through the mesoscopic simulation approach that omits inter-vehicle car-following details while maintaining realistic macroscopic traffic properties (e.g., speed, density, and flow). After simulation, necessary measures of effectiveness (MoEs) are fed into the traffic assignment module. It consists of two algorithmic components: a time-dependent shortest-path (TDSP) algorithm and time-dependent traffic assignment. The TDSP algorithm determines the time-dependent shortest path for each departure time, and the traffic assignment component assigns a portion of the vehicles departing at the same time between the same OD pair to the time-dependent least-travel time path, following the “route swapping” type of traffic assignment procedure.

DynusT in WISE

DynusT provides the main functionality for the Operation Module. The module’s function is to dive deeper into the time-varying interactions occurring between traffic and the network during a work zone project. What a static model cannot capture—time-dependent congestion and diversion caused by congestion—a simulation model such as DynusT can. DynusT can still use the macroscopic network yet provide in-depth information of a microscopic simulation model.

The Operation Module requires the sensitivity of a simulation model that responds to congestion so that diversion response is reported in a robust and intuitive manner. The Operation Module attains a more accurate estimation of diversion due to the capacity reduction (i.e., work zone project, based on the network and simulation outcome). In WISE, this diversion is reported back to the WISE system, and the user can choose whether to use this estimated diversion rate (i.e., feedback) in the Planning Module. Based on this new diversion rate, the user can model whether this diversion changes the sequencing of projects.

Dynamic Traffic Assignment

DTA models have become a viable modeling option. They supplement existing travel forecasting models and microscopic traffic simulation models. Travel forecasting models represent the static regional travel analysis capability, whereas microscopic traffic simulation models are superior for dynamic corridor-level travel analysis. DTA models fill in the gap by enabling dynamic traffic to be modeled at a range of scales from the corridor level to the regional level with expanded and unique functional capabilities enabled by the DTA methodology.

The objective of static traffic assignment is to determine network traffic flows and conditions resulting from demand or supply interactions via route choices from travelers. Route choice behavior is based on the assumption that all travelers intend to travel from their origin to their destination in the shortest time. When every traveler

succeeds in finding such a route, every used route has the minimum time or cost between its origin and destination; moreover, for each OD pair, every route used has the same travel time. This condition is known as user optimal or user equilibrium. DTA has a similar objective but with a representation of time variations in traffic flows and conditions, thus attempting to reflect the reality of traffic networks.

Dynamic network analysis models seek to provide another, more detailed means to represent the interaction among travel choices, traffic flows, and time and cost measures in a temporally coherent manner (e.g., to further improve the existing time-of-day static assignment approach). More specifically, DTA models aim to describe such time-varying network and demand interaction using a behaviorally sound approach. The DTA model analysis results can be used to evaluate many more meaningful measures related to individual travel time and cost as well as systemwide network measures for regional planning purposes.

To learn more about DTA, see *Dynamic Traffic Assignment—A Primer (1)*.

RUNNING A WISE PROJECT IN OPERATIONS (DynusT)

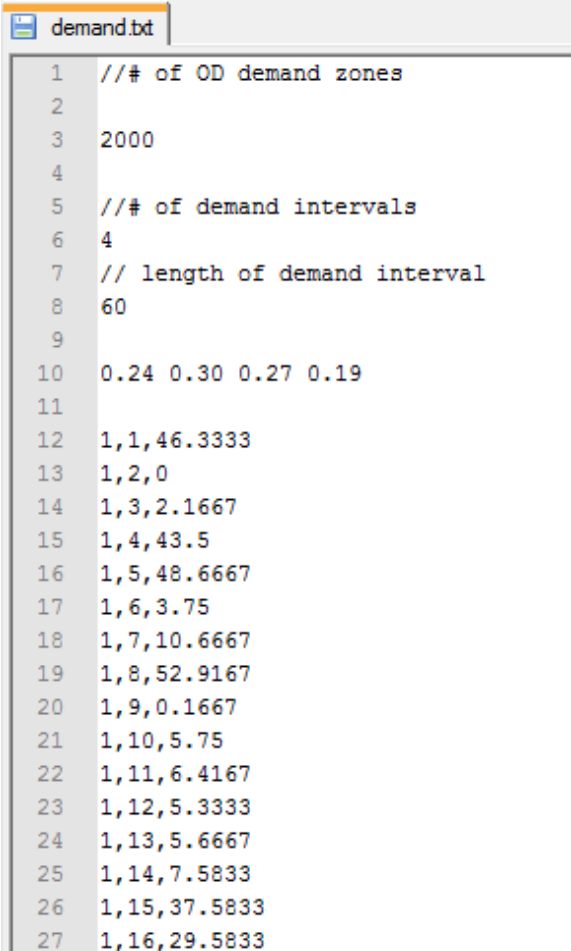
Importing Time-Dependent Demand

Because the Operation Module is aimed at examining the time-varying congestion interactions, the user has the option to input time-dependent demand to represent changes in service demand over time, especially for the peak periods of congestion. DynusT uses OD trip demand as the input for vehicle generation for simulation. With NEXTA, the modeler can create time-dependent demand for a peak period of interest. The demand being imported is a single demand matrix being divided into several demand periods.

The general procedure for time-dependent demand conversion follows:

1. Export from the planning software the demand (OD) data to a comma-delimited (*.csv) text file.
2. Go to the installation directory of DynusT. The typical path to this folder is C:\Program Files \DynusT 3.1 (32 bit).
3. Copy the demand.txt file to another working location. This is the file that will be edited and imported to create the demand for DynusT.
4. Open the demand.txt file. It should look similar to the file shown in Figure 5.1.
5. Replace the information in this text file. The fields are explained in the following steps.
 - a. Line 3: Number of zones in the network;
 - b. Line 6: Number of demand periods that will be created from this import file;
 - c. Line 8: The uniform time duration of the demand periods being imported; and
 - d. Line 10: The percentage of demand to each demand period from the single demand table being imported.
6. Copy the exported demand data from step 1 and paste the data starting at line 12.
7. Save the demand.txt file.

8. Open NEXTA and open the existing network project to which the demand will be imported.
9. In NEXTA go to File → Import Files → Import GIS Data Set → Import Demand Table (Figure 5.2).



```

1 //# of OD demand zones
2
3 2000
4
5 //# of demand intervals
6 4
7 // length of demand interval
8 60
9
10 0.24 0.30 0.27 0.19
11
12 1,1,46.3333
13 1,2,0
14 1,3,2.1667
15 1,4,43.5
16 1,5,48.6667
17 1,6,3.75
18 1,7,10.6667
19 1,8,52.9167
20 1,9,0.1667
21 1,10,5.75
22 1,11,6.4167
23 1,12,5.3333
24 1,13,5.6667
25 1,14,7.5833
26 1,15,37.5833
27 1,16,29.5833

```

Figure 5.1. Text file of importing time-dependent demand.

Figure 5.1 explains the fields more completely. The “2000” indicates the number of zones in the network and should be changed to reflect the correct number of zones in the WISE network at the time of use. The user must provide this number as input since the program does not have any way of distinguishing a zone from a node. The “4” indicates the number of demand matrices that this importing demand data is going to represent (e.g., if a demand matrix from the planning tool represents a 24-hour time period and this table is being divided 24 times, then there will be 24 demand intervals). The “60” represents the length of time (in minutes) that each demand interval represents. Line 10 provides the percentage of demand that each demand interval will have from the total demand data. For example, the first OD pair is from zone 1 to zone 1,

and the demand for this pair over the 4 h (four demand intervals at 60 min per interval) is 46.3333. The demand for each 1-h interval will then be 11.12, 13.90, 12.1, and 8.80, based on the percentages provided in line 10.

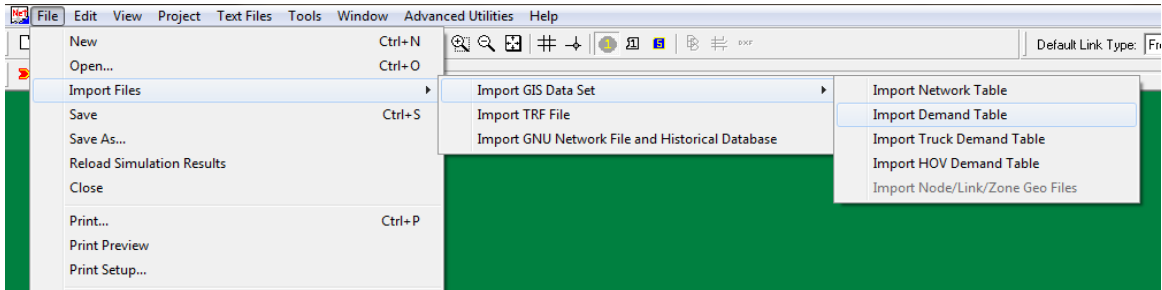


Figure 5.2. *Importing time-dependent demand text file.*

OPERATIONS TRAFFIC DIVERSION

The Operation Module can only be utilized once the Planning Module has been set up with projects and a valid network. The Operation Module is used to calculate a diversion for each project to be used in the WISE Analysis Engine as specified in the Project Information for each project. Once the Planning WorkSpace is set up, the Operation tab will populate with a list of all projects in the WorkSpace (Figure 5.3). The user must run a base scenario for all projects and an individual project scenario for each project for which the user would like the Operation Module to provide Diversion calculations.

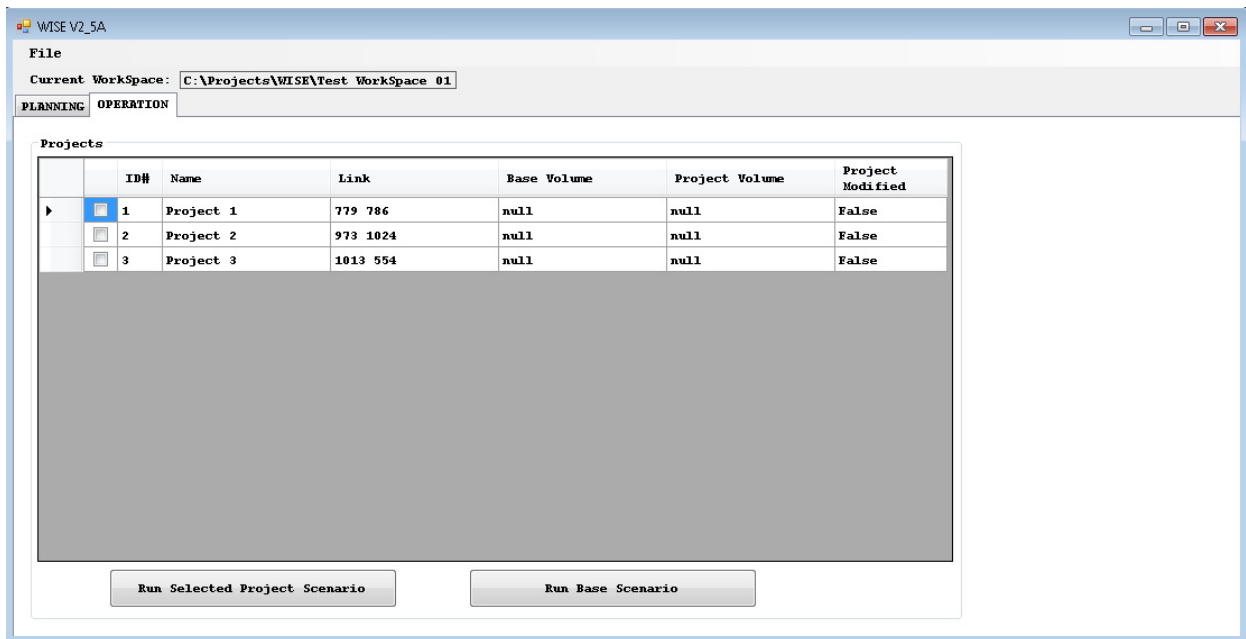


Figure 5.3. *Operation Module's list of all projects in WorkSpace.*

Base Scenario

To run the base scenario for all projects, click Operation tab → Run Base Scenario (Figure 5.4). The Operation Module will perform a validation check of the Planning Module and only run if the WorkSpace passes Planning WorkSpace Validation. If the Planning WorkSpace Validation is clear, the WISE GUI will launch NEXTA for the base scenario. You must then launch DynusT to perform an analysis. Once DynusT has completed the analysis of the base scenario, close NEXTA/DynusT, and, if the analysis was successful, the WISE Operation module will then populate the Base Volume column with the Base Volume value generated by the DynusT analysis of each project (Figure 5.4). WISE will display an error if the DynusT run was unsuccessful.

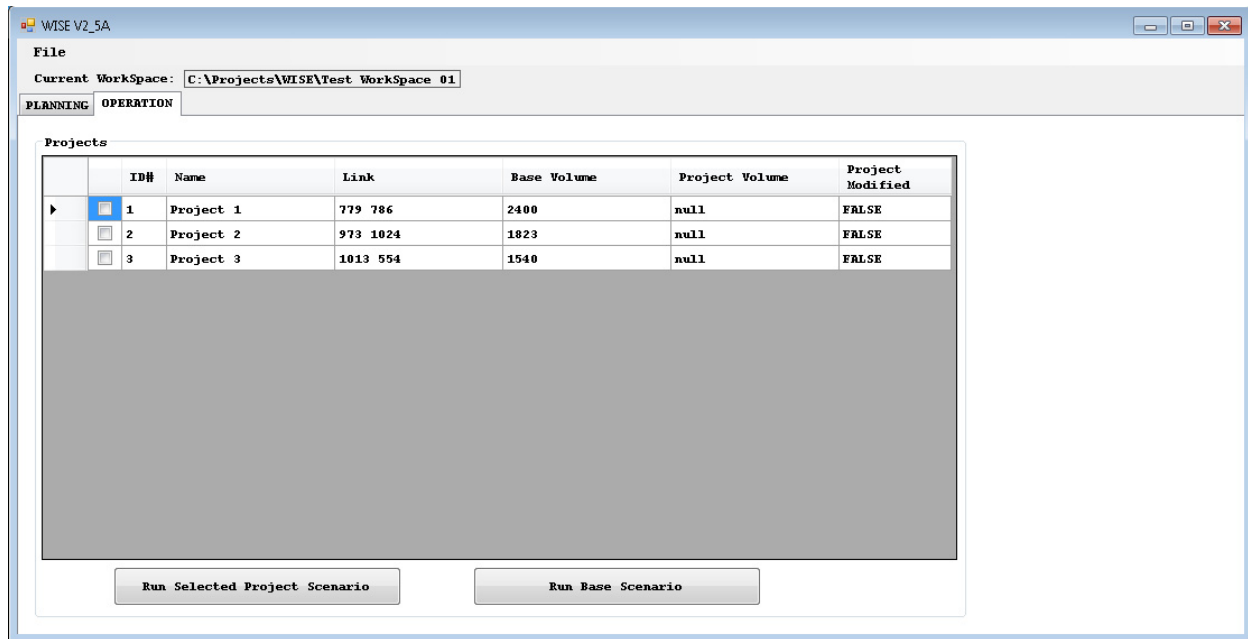


Figure 5.4. Operation Module: Project Volume population.

Individual Scenario

To run the individual scenario for a project, from the Operation tab's Projects list, select the check box next to the desired project and then select Run Selected Project Scenario (Figure 5.5).

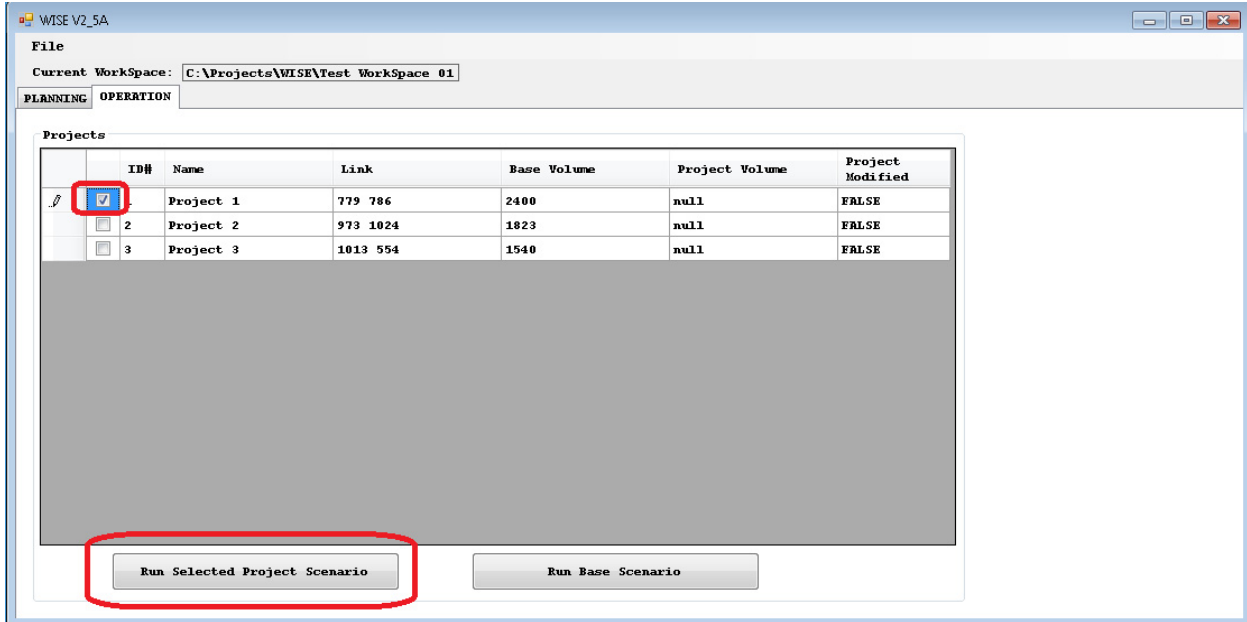


Figure 5.5. Operation Module: Run Selected Project Scenario.

The Operation Module will perform a validation of the Planning Module and only run if the WorkSpace passes Planning WorkSpace Validation. If the Planning WorkSpace Validation is clear, the WISE GUI will launch NEXTA for the specific Project Scenario. The user must then launch DynusT to perform an analysis. Once DynusT has completed the analysis of the project scenario, close NEXTA/DynusT, and if the analysis was successful, the WISE Operation Tab will now populate the Project Volume column with the Volume from the DynusT analysis of the specific project scenario, as seen for Project 1 in Figure 5.6. WISE will display an error if the DynusT run was unsuccessful. (Note: WISE does not provide information on why a DynusT run might be unsuccessful. DynusT is supported by the University of Arizona, and as such users should contact the University of Arizona for support.)

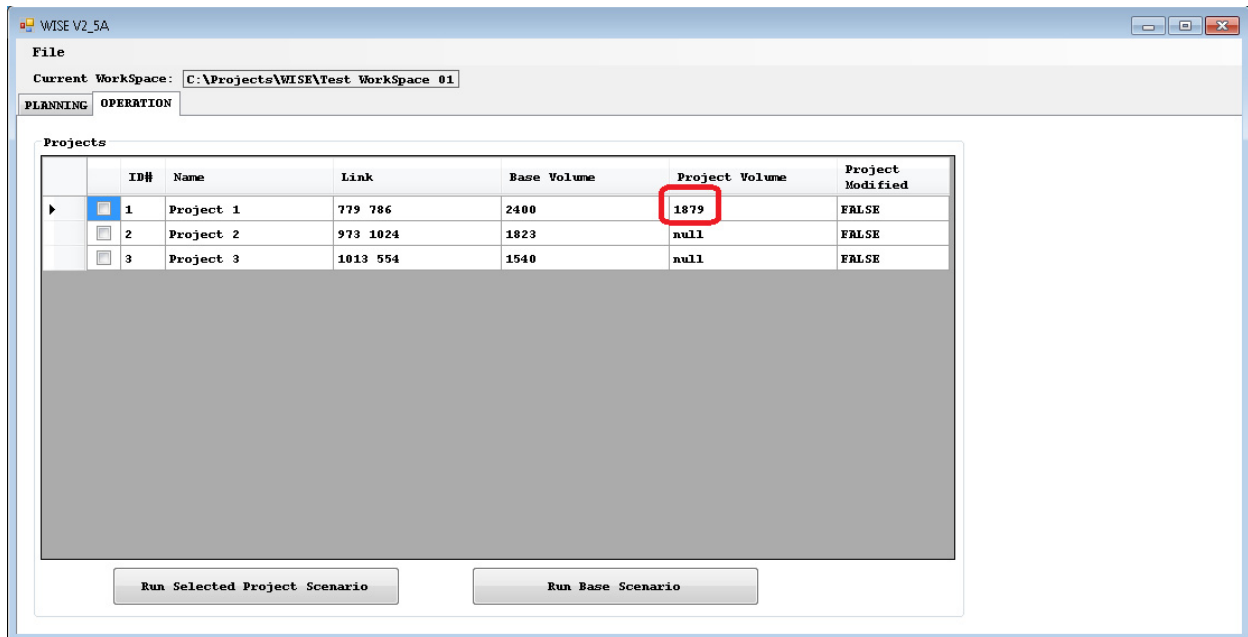


Figure 5.6. Operation Module: Project Volumes.

Modifications to Projects after Operation Scenario Runs

If a project is modified within the Planning Module, then the project and base scenarios may need to be run again to collect the correct volumes for the new Project scenario. You can identify whether a project has been modified since collection of the Base and Project volumes by viewing the Project Modified column on the Operation tab's Projects list (Figure 5.7). An entry of FALSE in that column means that no changes have been made to the project or any of its associated attributes since the volumes were last collected. An entry of True in the column (Figure 5.7, Project 1) means that the project or attributes associated with it have been modified since the volumes were last collected, and the user may want to rerun the base and/or project scenarios.

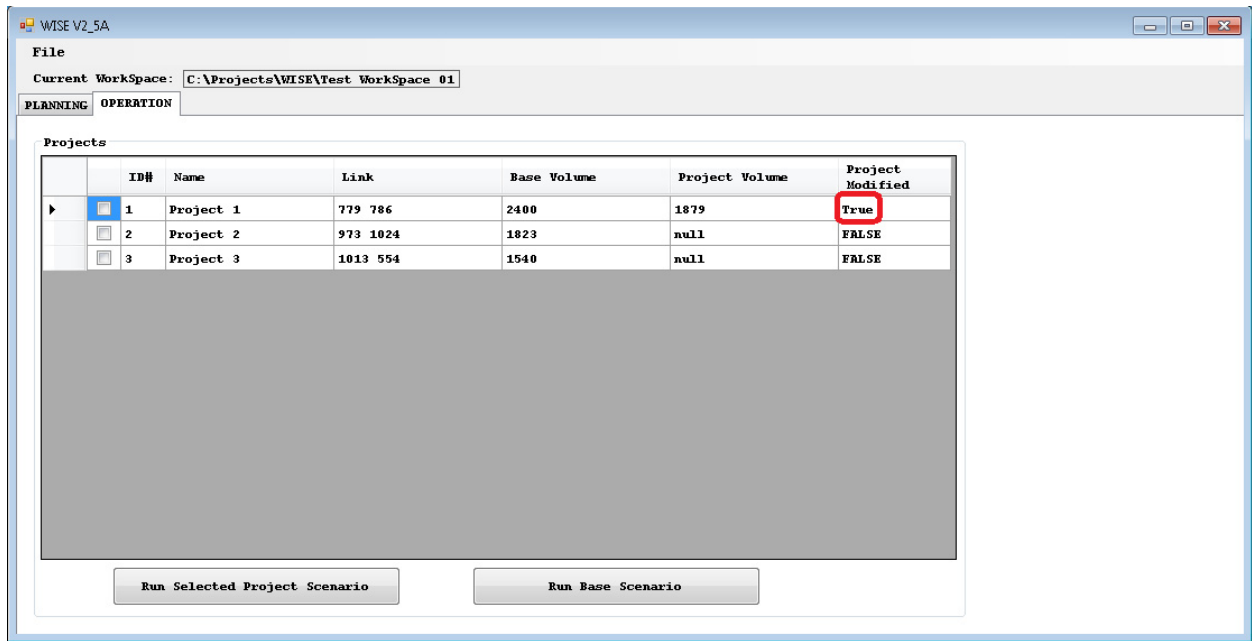


Figure 5.7. Operation Module: internal checks.

REFERENCE

1. Chiu, Y.-C., J. Bottom, M. Mahut, A. Paz, R. Balakrishna, T. Waller, and J. Hicks. *Transportation Research Circular E-C153: Dynamic Traffic Assignment—A Primer*, Transportation Research Board of the National Academies, Washington, D.C., 2011. www.trb.org/DataInformationTechnology/Blurbs/165620.aspx.

6

HAND-OFF FROM OPERATION BACK TO PLANNING

Once a given project has collected the data for the Base and Project scenarios, you can use the operation-supplied diversion in the Project Info tab in the Planning Module (see Creating Projects in Chapter 3). Thus, to modify a project, the user can now go back and select Operation-Supplied Diversion. The operation-supplied diversion is available *only* if the Operation Module produced a valid diversion (see Chapter 8, Data Limits, for details on valid diversion values). Otherwise the operation-supplied diversion will remain “null” in the Project Info tab. Once the Operation Module has a valid diversion, the user may choose to go back to the WISE Planning Module’s Analysis Engine and rerun the analysis with the new diversion.

7

ACRONYMS AND GLOSSARY

CLASSIFICATION OF SOFTWARE FUNCTIONALITIES**Transportation Modeling Categories**

analytical or deterministic. Analytical and deterministic tools are usually based on the procedures found in the *Highway Capacity Manual*. The resulting factors—capacity, density, level of service (LOS), delay, queue—from these tools are based on empirical equations derived from field data and small-scale experiments. This type of tool is able to analyze small-scale effects but is not practical for large-scale, network applications.

DynusT. This dynamic traffic assignment simulation model was released under a GNU General Public License as a precondition for award of SHRP 2 Project C10B, Partnership to Develop an Integrated, Advanced Travel Demand Model with Fine-Grained, Time-Sensitive Networks: Sacramento-Area Application. (A GNU General Public License is a free software license. DTALite and DynusT were released under this license for use in SHRP 2 Projects C05 and C10B) A dynamic traffic assignment model is a computerized analysis package that tracks the movements of individual vehicles in a model street network and quantifies the performance of the network by summing the results of individual vehicle movements. DynusT is being enhanced and mated with SACSIM, which is an activity-based traffic model released in an open-source format by the Sacramento Area Council of Governments. This model will be enhanced and mated with DynusT in the SHRP 2 C10B project. DynusT is also the platform for the WISE Operation Module.

GUI. Graphical user interface.

simulation, macroscopic. Macroscopic simulation models use the fundamental traffic qualities of speed, volume, and density on a sectional basis (i.e., network links). This means that tracking individual cars in a macroscopic model is impossible. They require less detailed network link data to operate than do microscopic models, but they do not offer as much detail.

simulation, mesoscopic. Mesoscopic simulation models provide middle ground between the macro- and microscopic approaches. Mesoscopic models typically are able to track individual vehicles, but they also rely on speed, volume, and density relationships to determine the movement of these vehicles.

simulation, microscopic. Microscopic simulation models are capable of tracking individual vehicles on a second-by-second basis to capture the ways that these vehicles interact with each other. This means that these models employ car-following and lane-changing algorithms to determine individual vehicle behaviors.

tool suite. A tool suite is a computer software package that combines two or three of the simulation types described above. In this way, a user is able to easily model a network with different fidelities when necessary. Examples include VISSIM with VISUM and TransCAD with TransModeler.

traffic signal optimization. Traffic signal optimization software packages are tools used to develop signal-timing plans at both isolated locations and synchronized corridors or grids. These tools also require basic information such as traffic counts for intersections.

travel demand model. Travel demand models are mathematical models that are used to determine the travel patterns based on demand. Originally, these types of models were developed to determine the impact of infrastructure improvements. They forecast specific outputs, such as mode choice, destination choice, and route choice.

GEOGRAPHIC SCALE

The geographic scale of a work zone becomes important when attempting to model potential traffic impacts. A variety of software packages exists across a broad spectrum for modeling different sizes of networks. Software on the lower end of the spectrum, such as Highway Capacity Software (HCS), describes traffic with simple in/out patterns and is a good match for isolated work zones. Other types of software that are capable of modeling entire regional road systems would be a good fit for network (grid) and regional work zones where detours may need to be analyzed.

The geographic scale of a work zone is a consideration of both the size and impact of any potential road work. The types of work zone geographic scales fall into four main categories: isolated, corridor (pipe), network (grid), and regional.

corridor (pipe). A corridor work zone (or pipe work zone) is any road work that occurs along a major highway segment. An example of this type of work zone would be an interstate widening or repaving project. This type of work zone is slightly larger in size and has the potential to cause more traffic disruption on the regional level.

isolated. An isolated work zone can be thought of as a single point within a much larger network. Examples of isolated work zones can include rural lane closures or re-designed intersections. This type of work zone is small in size and should have minimal impact on traffic over the regional network.

network (grid). A network work zone (or grid work zone) is any project that involves construction on connected, interdependent roads with multiple access points. This type of construction may also require one or more viable alternate routes. Examples include interstate reconstruction, full roadway closures, and work zones in urban centers. This type of work zone is large in size and will disrupt traffic patterns on a large scale. However, the impact is usually restricted to an urban area.

regional. A regional work zone is similar to a network work zone in that it involves construction taking place on connected and interdependent routes and may require detours. The difference between the two is the size of the traffic impacts. Regional work zones will cause regional-level traffic impacts. This could possibly mean disrupting several urban areas or several towns in a region.

FUNCTIONALITY

Software tools are used to make decisions regarding planning, operations, construction management, and logistics. Based on each field's purpose, the functionality ranges from cost-benefit analysis to traffic impacts and delay to efficient material transport and management.

construction management. Construction management involves the overall planning, coordination, determination of resource requirements, and implementation of the project. Determination of time-of-day for construction, project design and optimal construction scheduling, and traffic impact analysis are considered as part of the analysis for estimating the impact of management strategies.

logistics. Logistics involves determining efficient practices to transport materials and optimal scheduling to reduce operational and storage costs. The work zone logistics would involve, for example, the duration of the closure of lanes and determining construction techniques and how the workers will put up the cones.

operations. Operations involve analysis of current management and safety of traffic and other users. Operations typically involve planning and maintaining signs, signals, pavement markings, and lighting. The management of ITS and safety initiatives to

improve driver behavior are considered. Determination of traffic measurements such as delay, speed, occupancy, levels of service, queue lengths, and others are used to evaluate the behavior and functionality of traffic operations and management.

planning. Planning involves making long-term decisions and goals. The involvement of all users of the system is normally considered as part of the process as improvement strategies are evaluated to improve the overall functionality of the system. Forecasting future demand growth, employment, and land use are normally considered, as well as estimating impacts of proposed future improvements.

USERS AND PROPRIETARY ISSUES

Users such as engineers and transportation planners are intended to incorporate software packages that were evaluated for various functionalities identified in the previous section.

engineers. Use by engineers typically involves studying traffic impacts from an operational aspect as well as the planning process of project-specific construction and operational management strategies. Project design and coordination are topics considered with the engineers interested in actual implementation of such strategies.

planners. Use by planners typically involves the advanced long-term planning of strategies for a road network depicting various projects to improve systemwide functionality. Demand forecasting, employment, and land use strategies are topics of interest for such planners, as well as system effects and air quality issues based on traffic and population growth.

proprietary. Proprietary software is defined as software that is licensed under exclusive legal right of the developer and/or owner. The user is given the right to use the software under license agreements and is restricted from tampering with and modifying such software.

Other software may be termed as open source or freeware, meaning the use and licensing are more liberal in the use of, the study of, and changes and improvements of software made by users. Freeware focuses more on the free use of software, and open source is focused on the community use and development of software to benefit the overall software community.

DATA INPUTS

cost of various strategies. Different construction strategies have different implications on life-cycle costs. Use of fast construction material and techniques can result in reduction in the period of time work zones are implemented but may require higher regular maintenance costs during the life cycle of the project. These costs and benefits need to be evaluated at a life-cycle level.

pavement. As identified in the interviews in Phase 1, for most departments of transportation (DOTs) and metropolitan planning organizations (MPOs), pavement management systems play a critical role in determining projects and project sequencing. Therefore, it is critical to determine the software tools that need pavement inputs and how they are used.

production rate for various strategies. Several construction strategies identified during the interviews have different production rates depending on the materials being used, the construction technique, weather, and night versus day. Such factors have a significant effect on the duration of the work zone.

traffic. Traffic data include volume counts, speeds, travel time, and density and are used to calibrate and validate simulation models.

MEASURES OF EFFECTIVENESS

agency cost. For the WISE Software Program, agency cost is the project-related cost to construct each of the renewal projects listed in the analysis. The construction cost includes all expenditures necessary for the design, construction, and maintenance of traffic costs incurred during construction. Agency cost does not include the delay cost incurred by the driving public. If a project is delayed, the agency cost includes the increase in the project cost due to postponing the construction of the project.

environmental impact. The environmental impact is directly related to the amount of emissions vehicles make during their trips. This measure is especially relevant when a large amount of congestion is present.

road user cost. This figurative cost is ascribed to all road users who face delay and congestion. It represents the negative impact of such road conditions and the road user's preference to avoid such costs.

safety surrogate. Any data set that can act as a surrogate to safety. For example, speed variance, number of lane changes, and conflicting points.

traffic conditions. Traffic conditions represent a broad data set used by traffic engineers and planners to assess the traffic conditions (such as speed, delays, accelerations, lane changing) on any particular roadway.

queue length and delay. Queue lengths and delays are used as a measure of effectiveness to evaluate the type and level of impact a work zone will have.

RESOURCE REQUIREMENTS

animation or presentation. When applied to software, the term often means its ability to make animations or presentations. This is very important for traffic simulation, not only to present results but also to locate trouble spots in the network.

availability of source code or algorithm. Open-source software is any computer program that allows fellow developers to see the actual code that makes up the software. This visibility makes it easier for developers in similar areas to calibrate. Open-source software is usually free or donation-based.

computational speed. The computational speed of software is a measure of the amount of time it takes to execute all of the required steps from start to finish. Most steps can be performed in a matter of minutes, but steps in more complicated systems can take several hours.

cost. The cost of software is the price that the developer and/or publisher asks the user to pay for the product. This is the opposite of nonproprietary software, which is available for free or by donation.

effort in application. The amount of effort required to transfer an existing network or data set into a newer system.

Excel based. Excel-based software uses Microsoft Excel as a “window” into which the software is entered. This means that the software is merely an extension of Excel rather than a unique software package.

level of effort for training. A measure of a software package’s ease of use. Easy software can be understood after only a few demonstrations, but more complicated software may require several days of training. As a general rule, open-source software is usually more complex and less user-friendly than commercially developed software.

memory. The amount of memory a given program will take up is a measure of the size (in bytes) of the program and its files.

transferability of data to other packages. The ability of data to be exchanged across multiple packages is important in order to coordinate output between packages. This is usually facilitated by either file conversion or reliance on a universal file format.

DYNAMIC DEMAND CHANGES

departure time choice. Departure time choice is usually a facet of the mode choice a traveler must make. For instance, a traveler using a passenger car may depart at any time, while a traveler using bus transit must wait until the next bus arrives in order to depart.

destination change. A destination change occurs when a traveler diverts to a destination other than the one originally intended when the trip began.

induced or foregone demand. Induced demand (latent demand) is a phenomenon that occurs when traffic volumes increase when facility LOS and/or capacities increase. Foregone demand is the opposite effect, when facilities with low LOS and/or capacities experience lower volumes because of travelers’ hesitancy to use such facilities.

mode shift. Any shift in mode that a traveler makes in order to complete a trip. This action could be part of an overall trip plan or could result from dissatisfaction with the current mode.

route diversion, en route. A diversion that occurs when travelers decide to alter their route during the trip. This diversion might be because of any of a number of factors, including Intelligent Transportation System (ITS) signs warning of impending congestion, radio announcements, word-of-mouth, or approaching traffic congestion perceived first-hand.

route diversion, pretrip. A type of diversion that occurs when a traveler decides to alter his or her route before the trip begins.



DATA LIMITS

TABLE 8.1. “PROJECT INFORMATION” CONSTRAINTS

Field	GUI Value	Comment
Work zone speed	$5 \leq x \leq$ the original speed limit; integer	The work zone speed limit cannot be zero or cannot be faster than original speed limit.
User-supplied diversion rate	If user-defined diverge is TRUE, then $1 \leq x \leq 100$; integer. If user-defined diverge is FALSE, then $x = 0$	If the route divergence uses user-defined rate, then $1 \leq x \leq 100$; integer. If the route divergence computes diverge rate internally, then $x = 0$.
Day cost	Integer and nonnegative	
Night cost	Integer and nonnegative	Agency cost should be realistic.
Capacity/lane reduction	$x \geq 0.01$; float	Percentage of capacity reduction due to work zone construction. Should be greater or equal to 0.01.
Duration	Integer; $1 \leq x \leq$ (latest end time – earliest start time);	Note the caution below about duration-based strategies. Such strategies must not result in zero or negative duration.
Duration-based strategy*	If one project i was applied by a duration-based strategy k , then the duration of project $i \geq$ duration-based strategy + 1	Duration-based strategy cannot reduce the project duration to zero or negative.
Link	Single use	Each project is unique link.

*The reduction amount of the duration strategy specified in “Project Information” must be less than the project duration. Each strategy and duration reduction is applied on a project-by-project basis.

TABLE 8.2. “STRATEGY INFORMATION” CONSTRAINTS

Field	GUI Value	Comment
Demand-reduction rate	$1 \leq x \leq 5$; integer	Demand-based strategy cannot reduce demand more than 5%.
Demand-based radius	$1 \leq x \leq 5$; integer	Demand-based strategy is only effective to reduce demand within a radius of 1 and 5 miles around the construction link.
Demand-based cost	Integer, nonnegative	Agency cost.
Duration reduction*	Integer $x \geq 1$	
Duration-based cost	Integer, nonnegative	Agency cost.

*Reduction means a reduction in construction duration time when the strategy is applied to a project. Each duration strategy is applied to a project on a case-by-case basis.

TABLE 8.3. “PLANNING CHARACTERISTICS” CONSTRAINTS

Field	GUI Value	Comment
Value of time	$\$5 < x < \300 ; float	Between \$5 and \$300.
Start time year	2010; integer	Cannot be less than the year 2010.
End time year	2030; integer	Cannot exceed the year 2030.
Day number of hours	$1 \leq x \leq 12$; float	Between 1 and 12 hours of day.
Night number of hours	$1 \leq x \leq 12$; float	Between 1 and 12 hours of night.
Seasonal factors	$0.5 \leq x \leq 1.5$; float	Stay within reasonable range.
Number of projects	$1 \leq x \leq 20$; integer	The engine cannot exceed more than 20 projects.

If any errors related to these data limitation fields are made, the user will be prompted by the engine, which will indicate that an error has been made and that an error file called “error_log.txt” was produced.

9

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RELATED SHRP 2 RESEARCH

Project Management Strategies for Complex Projects (R10)

Analytical Procedures for Determining the Impacts of Reliability Mitigation Strategies (L03)

Evaluating Alternative Operations Strategies to Improve Travel Time Reliability (L11)

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