NCHRP

REPORT 695

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Guide for Implementing a Geospatially Enabled Enterprise-wide Information Management System for Transportation Agency Real Estate Offices

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Research sponsored by the American Association of State Highway and Transportation Officials
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TRANSPORTATION RESEARCH BOARD

WASHINGTON, D.C.
2011
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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

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NCHRP REPORT 695

Project 08-55A
ISSN 0077-5614
ISBN 978-0-309-21329-5
Library of Congress Control Number 2011930534

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

are available from:

Transportation Research Board
Business Office
500 Fifth Street, NW
Washington, DC 20001

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Printed in the United States of America

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FOREWORD

By Edward T. Harrigan
Staff Officer
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This report presents a guide for implementing a geospatially enabled enterprise-wide information management system for right-of-way offices and includes a logical model to assist with this implementation. The report will be of immediate interest to staff in state highway agencies responsible for the acquisition, management, and disposition of real estate for right-of-way.

Right-of-way (ROW) issues commonly cause project delay and increased costs. While many state departments of transportation (DOTs) use technology such as computer-aided drafting and design to draft ROW plans, the approved final plans are often manually recorded and filed on paper or Mylar. Posting and storing such data by hand is obsolete, inefficient, and unresponsive to the demands of modern project management, preventing multiple users from conveniently accessing real-time ROW information and resulting in undue delay and cost overruns. Moreover, paper and Mylar records are more vulnerable to damage or destruction by fire, flooding, or other catastrophic events.

Manually recorded ROW information includes agency ownership, appraisal information, acquisition status, and property management functions that are important for addressing real estate issues, utilities, environmental permitting and mitigation, access management, maintenance, and programming. Electronic management of this information improves the coordination and consistency of data, leading to reduced project delivery delays caused by ROW acquisition. In addition, the ability to retrieve these data electronically provides fast, convenient, and consistent access to all users, reducing the time and expense needed to ship documents, eliminating repetitive entries, minimizing data entry errors caused by multiple formats, and ultimately saving money for DOTs. Electronic management of real estate information can improve coordination with local jurisdictions and provide appropriate data to the public on DOT ownership of property.

The automation of ROW functions and development of data-integration models using existing technology, including geospatial applications (generally referred to as geographic information systems or GIS), are needed to enable multiple users to access the ROW information quickly and easily. The first step in this automation process was accomplished in NCHRP Project 8-55, "Integrating Geospatial Technologies into the Right-of-Way Data-Management Process," completed in 2006.[1] NCHRP Project 8-55 identified the data elements needed to support the automation of ROW functions into a fully operational system that integrates GIS technologies into the ROW process.

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[1] *NCHRP Research Results Digest 310: Integrating Geospatial Technologies into the Right-of-Way Data-Management Process*, Transportation Research Board of the National Academies, Washington, DC, December 2006.

The next step in the process of automating ROW functions was accomplished in NCHRP Project 8-55A, "Developing a Logical Model for a Geo-Spatial Right-Of-Way Land Management System" and is reported herein. The objectives of this research were to (1) develop an enterprise-level logical model for a prototypical GIS-enabled, ROW land management system for state DOTs and (2) demonstrate how the logical model could be linked with DOT enterprise systems now in use to assist with the model's implementation within the enterprise system. The project was carried out by the Virginia Polytechnic Institute and State University, Alexandria, Virginia.

The research led to the following key products: (1) a comprehensive annotated bibliography of literature about use of geospatial and innovative information systems to include enterprise-level systems used in state transportation agencies; (2) a logical model for a geospatially enabled enterprise-wide information management system for right-of-way offices developed using Sparx Systems Enterprise Architect and an accompanying implementation guide; (3) case studies demonstrating how the logical model might be integrated into the enterprise systems of several state DOTs; and (4) two executive summaries, the first of which is focused on the current state of the practice and is designed to answer "what's in it for me (my agency)?" while the second is focused on implementing an information system and answers "what does the ROW office need to ensure the implementation is successful?"

This report presents the guide for implementing the logical model; the accompanying CD-ROM presents the logical model and a guide for its use. The annotated bibliography and executive summaries are available on the *NCHRP Report 695* summary web page (www.trb.org/Main/Blurbs/165239.aspx). The project final report, which fully documents the research, may be downloaded from the NCHRP Project 8-55A web page (http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2326).

CONTENTS

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

SUMMARY

Guide for Implementing a Geospatially Enabled Enterprise-wide Information Management System for Transportation Agency Real Estate Offices

Effectively managing information in a state transportation agency is critical to the agency's ability to perform its mission of delivering safe, accessible, and sustainable transportation for people and goods while meeting performance goals under increasing resource constraints. Delivering projects on time and in budget is a high-priority performance goal that is both easily measured and highly visible. Fundamental to delivering projects is the ability to acquire real property within the required time frame. Acquiring property and relocating the affected people and businesses relies on knowing precisely and quickly the status of the different aspects of the acquisition and relocation process. Effectively managing the information required to perform these functions is at the heart of an enterprise-wide information management system for right-of-way offices. Geospatially enabling the system adds the "where" to managing this information. This visual capability greatly improves the information management system's communication of project status and information regarding the processes involved in the acquisition and management of real property.

Why Is an Information Management System Important?

A well-designed and implemented information management system can substantially improve management of resources, including personnel, money, information, and time. With the prevalence of networked communication and electronic data collection, analysis, visualization, and sharing, interoperable and immediate access to information is expected from both employees and the public. An integrated information system provides the ability to electronically store and access the large amount of documents, drawings, reports, and project-related information, which improves overall quality and reduces the potential for duplicated effort. The benefits of an information management system include the following:

- Improved on-time delivery of project real property
- Expedited project award
- Reduced staffing and/or improved staff efficiency
- Improved scheduling
- Improved access to information internally and by the public
- Improved customer service and public relations
- Improved documentation and reporting uniformity
- Reduced time to perform tasks

- Reduced redundancy in data entry and access
- Improved oversight capabilities
- Increased management flexibility
- Improved integration, use, and sharing of information

Including geospatial capabilities in the system enhances the ability to visualize, in a map, the status of parcels in a single project or across all active projects for any aspect of the acquisition or relocation process. As the system becomes mature, information from parcels on past projects becomes available for showing spatial trends and distributions of characteristics by region, land use (urban vs. rural), or other location-based analysis. Geospatial visualization can be used to show the following:

- Status of parcels in the acquisition/relocation process
- Purchase price of parcels
- Parcels by type of acquisition
- Parcels processed by a given agent
- Parcels with unique requirements
- Potential relocation properties

An important consideration is that without an enterprise-wide information management system, decision makers are limited in their ability to identify opportunities and challenges quickly and react appropriately in time to take advantage or counter potential impacts.

What Should an Information Management System Do?

The goal of a right-of-way information management system is maximizing quality to meet agency performance goals while optimizing resources. Specific objectives are defined by the agency when it begins the implementation process. If the information system is designed as a broad work environment, it should support the business needs and requirements of acquiring property and relocating people and businesses, including these activities:

- Standardizing input and output
- Standardizing reporting
- Seamlessly exchanging information with other agency systems
- Standardizing and streamlining business processes and rules with well-designed procedures and graphic user interfaces
- Providing local and/or centralized performance of business activities with local and/or centralized oversight

If the system is designed as an electronic ledger built on an agency-wide database, it should support the management of information required for operating the right-of-way, including the following activities:

- Standardizing input and output
- Standardizing reporting
- Seamlessly exchanging information with other agency systems

If or when the system is geospatially enabled, it should include the ability to visualize any information associated with a parcel, project, roadway, or other location-based feature to provide an intuitive and easily understood representation of that information for use in performing right-of-way activities, decision making, or resource allocation. With enhanced analysis tools, geospatial enablement can be used as a decision support tool to aid in evaluating and analyzing characteristics such as existence and mitigation of hazardous materials, early consideration of terrain complexities, potential relocation of utilities, and determination of suitability of excess property for sale or other uses.

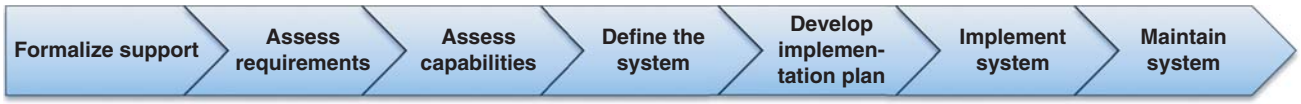


Figure 1. Implementation process for an information management system.

How Should an Information Management System Be Implemented?

Transportation agencies, in general, have defined procedures for implementing new technologies within the agency including both hardware and software. Understanding and working within this process is critical to the success of any new system. For systems that require a large commitment in time and funds, obtaining support from the upper management within the agency prior to initiating the formal process is also critical. Once these two factors have been addressed, the process to implement an information management system is well documented and follows standard procedures as shown in Figure 1.

Implementation is typically considered complete at the point when the system being implemented has transitioned to "business as usual" for its users.

This document provides a guide to implementing a geospatially enabled enterprise-wide information management system for right-of-way offices and can be used with or without the accompanying logical model.

Overview of the Guide

This guide and corresponding logical model provided on the attached CD were developed in response to the NCHRP Project 8-55 and as part of the continuation project 8-55A. NCHRP 8-55A recognized state transportation agencies' need for a rational method (1) to manage the large amount of information required to acquire real property and relocate affected people and businesses for transportation projects and (2) that would incorporate geospatial tools and analyses. The guide was written for the individual and steering group that will be shepherding the implementation process with step-by-step guidance through each of the first six procedures outlined in Figure 1. The appendices that are available on the *NCHRP Report 695* summary web page (www.trb.org/Main/Blurbs/165239.aspx) provide more detailed information on how to include or modify the logical model, should an agency decide to incorporate it into its design.

The basis for the guide and its use and the underlying precepts of the approach to the logical model are presented with reference to the NCHRP project, the Uniform Act, and the Federal Highway Administration's *Project Development Guide.* The implementation guide and logical model were designed with an emphasis on flexibility, given the unique nature of each state agency and the state laws that govern many of the activities undertaken by right-of-way offices as well as the varying cultures that prevail in both how business is performed and how technology is incorporated into that business.

Appendix A provides two executive summaries that can be used to support the initial marketing required to obtain upper level support for the information management system. The first summary focuses on the benefits of having a system, while the second highlights the necessary components to successfully implement a system.

CHAPTER I

Introduction

This guide provides a strategy for state transportation agencies to implement or expand a system to manage the large amount of information and documents involved in the information-intense business of acquiring and managing property and relocating the affected people and businesses, specifically incorporating geospatial capabilities. Because every transportation agency is unique in how it performs the activities necessary to acquire real property as well as how it implements technology, this document does not provide a detailed implementation plan but rather establishes a generalized process, with specific guidance where appropriate, on how agencies could proceed using the logical model for a geospatially enabled, right-of-way (ROW) information management system that was developed under NCHRP 8-55A. The remainder of this chapter provides the background about how this document and the corresponding logical model came about and some underlying concepts that will assist with the implementation process.

The Importance of a Right-of-Way Information Management System

The acquisition and management of real property is a significant component of the costs and scheduling associated with transportation projects. Because of the depth and breadth of these activities and their corresponding requirements, electronic management of the information is critical to effectively performing the business of offices that are responsible for the purchase of real property (referred to as right-of-way offices through the remainder of this guide) and allocating the necessary resources to meet agency and project objectives.

Electronic management of this information can improve the following:

- Coordination and consistency of data, leading to reduced project delivery delays resulting during right-of-way acquisition
- Access by appropriate users, reducing the time and expense needed to ship documents; eliminating repetitive data entry; minimizing data-entry errors caused by multiple formats; improving resource allocation and ultimately saving money and time for transportation agencies
- Coordination with local jurisdictions
- Availability of appropriate data to those affected by the process and the general public

While many state transportation agencies use technology such as computer-aided drafting and design (CADD) for preparing right-of-way plans, the final, approved, and as-built plans are often manually recorded and filed on paper or Mylar. Records of information and copies of documents associated with acquiring and managing property are kept in physical storage, which requires substantial space and time to retrieve. Posting and storing such data by hand is obsolete, inefficient, and unresponsive to the demands of modern project management, hindering multiple users from effectively accessing real-time right-of-way information and resulting in undue delay and

costs. Moreover, such hardcopy records are vulnerable to damage or destruction in the event of fire, flooding, or other catastrophic event.

The automation of right-of-way functions and data access and integration using information technology, including geospatial applications, are needed to enable transportation agencies to meet their performance objectives under increasing pressure to optimize resources and improve accessibility of right-of-way information.

Public Law 91-646 as Amended (Uniform Act)

Protection of individual rights and ensuring fair and equitable treatment of businesses related to the acquisition of personal property for federal or federally assisted projects is covered under Public Law 91-646, The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended. Commonly called the Uniform Act, this law is codified primarily in 23 CFR 710 and is divided into three major sections or titles:

- Title I contains the general provisions of the law and consists primarily of definitions.
- Title II, "Uniform Relocation Assistance," describes agency responsibilities to persons or businesses that are displaced.
- Title III, "Uniform Real Property Acquisition Policy," specifies agency requirements associated with obtaining real property.

This guide and the accompanying logical model have been developed based on the requirements of the Uniform Act as described in the Federal Highway Administration's *Project Development Guide.* (FHWA 2006)

NCHRP Project to Develop a Logical Model

In recognition of a desire to improve their ability to deliver land for transportation projects, state transportation agencies, through the NCHRP, established NCHRP Project 8-55, "Integrating Geospatial Technologies into the Right-of-Way Data-Management Process," which identified data elements necessary to support the automation of right-of-way functions as the first step in the development of a fully operational information management system. (Hancock 2006a,b)

That project was followed by NCHRP Project 8-55A, "Developing a Logical Model for a Geospatial Right-of-Way Land Management System," which included the objective of developing an enterprise-level logical model for a prototypical geospatially enabled, right-of-way information management system.

The research plan for NCHRP 8-55A included the following tasks:

1. **Literature Review:** (1) updated the literature review performed for NCHRP 8-55 with a literature search of key features and attributes of a logical model for a prototypical geospatially enabled, right-of-way management system for state transportation agencies and (2) reviewed other initiatives that relate to this project.
2. **Logical Model Outline:** prepared outlines of the logical model for the right-of-way business areas of appraisal, acquisition, relocation, and property management. These outlines consist primarily of process flow diagrams, business process models, and use case models as mapped to the business process models.
3. **Logical Model:** prepared the logical model for a prototypical enterprise-level, geospatially enabled information management system for state transportation agencies for the right-of-way business areas of appraisal, acquisition, relocation, and property management based on the outline from Task 2. This task provided (1) enterprise-wide standardization guidelines for data elements that cross multiple activities to ensure interoperability with other agency systems,

(2) guidelines for use by state transportation agencies to adapt the model to their specific requirements, (3) guidance on how such a system would integrate and interact with other agency systems, (4) information about how this system integrates into the project delivery process, and (5) guidance on how this system would support state transportation agency performance measures and goals.

This guidance consisted of refined use case models, domain models with sequence diagrams, collaboration diagrams, user interface models, class models (which capture data input and output), and component models. The guidance specified in this task was included in the implementation plan under Task 6.

4. **Test Plan:** prepared a test plan to test the validity, usefulness, and robustness of the logical models which were designed to determine (1) how features of the models integrate with existing geospatial systems and (2) how such a system might be implemented in states that do not presently use either geospatially enabled or right-of-way information management systems.
5. **Tests:** tested the logical models using three case studies. Based on the results of the case study analysis, the logical model was revised as necessary.
6. **Implementation Plan:** prepared generalized work plans for future implementation of the logical model in a state with (1) no enterprise-level, geospatially enabled right-of-way information management system, (2) an enterprise-level right-of-way information management system that is not geospatially enabled, and (3) a geospatially enabled system that has no or limited right-of-way components.

To assist states with finding the guidance enumerated in Task 3, Table 1 lists the specific guidance objectives and the locations where those objectives are addressed.

The resulting logical model, referred to as the *8-55A logical model* in the remainder of this guide, is available to state agencies as a possible structure for use in building their own information system and is provided on the attached CD in standard Uniform Modeling Language (UML) format using the software Enterprise Architect developed by Sparx Systems. (Sparx 2007)

Moving to a Geospatially Enabled Enterprise-wide Right-of-Way Information Management System

Information management systems exist in a continuum of structures and technologies from written records and file cabinets to individual desktop spreadsheets to Internet/intranet-based work environments that seamlessly integrate with agency databases and other systems and tools as represented in Figure 2. Understanding where your agency operates within this continuum will provide the necessary basis for establishing where to start.

Table 1. *8-55A Logical Model* Objectives

Objective	Description	Location*
1	Establish enterprise-wide standardization for data elements to ensure interoperability with other agency systems	Appendices C and D
2	Provide guidelines for use by state transportation agencies to adapt the model to their specific requirements	p. 28 and Appendix B
3	Provide guidance on how such a system would integrate and interact with other agency systems	Appendix B
4	Provide information about how this system integrates into the project delivery process	Figure 4 and Appendix B
5	Provide guidance on how this system would support state transportation agency in meeting performance measures and goals	p. 14

*Appendices are available on the accompanying CD-ROM and the *NCHRP Report 695* summary web page (www.trb.org/Main/Blurbs/165239.aspx).

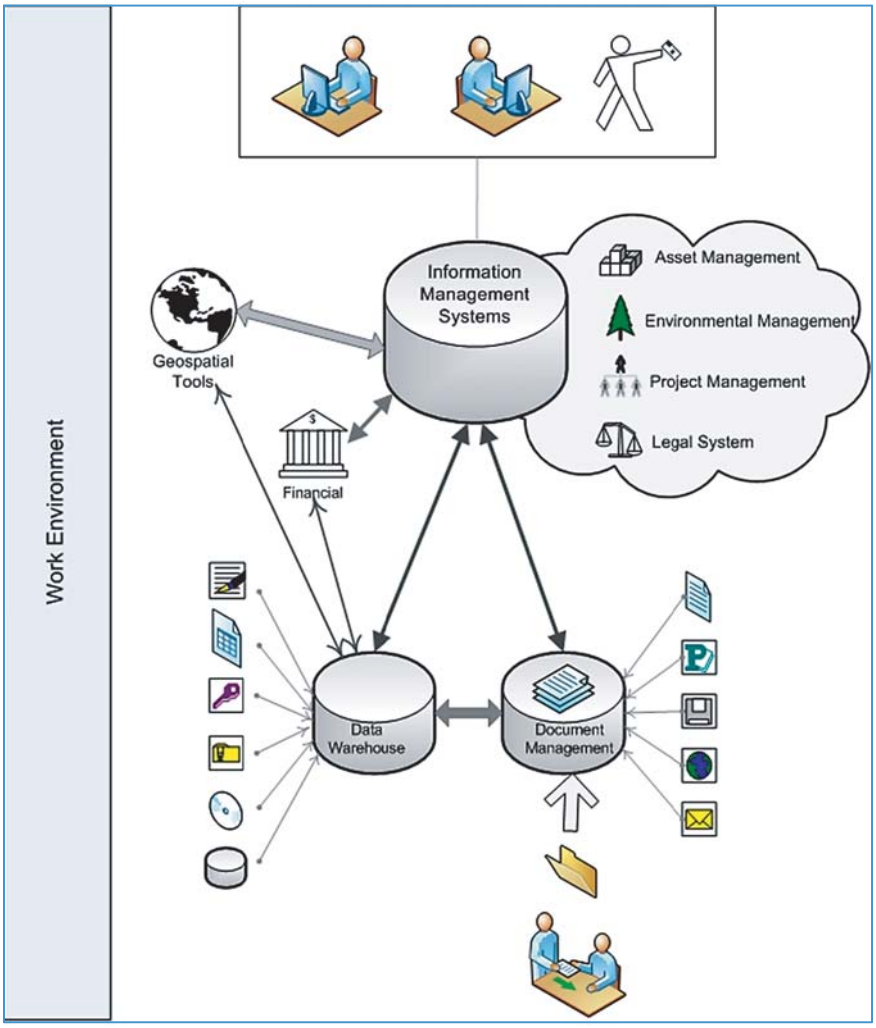


Figure 2. Enterprise work environment.

At the same time, every transportation agency performs the business of acquiring real property according to its state laws and policies and, for projects including federal funding, federal laws and policies. The corresponding procedures and activities have evolved according to the unique requirements and characteristics of each state. As a result, how a right-of-way office manages its information will determine how it will proceed with the implementation process.

Information Management Systems

Although right-of-way offices that do not use any type of digital information management are almost nonexistent, many still have aspects that are nondigital such as maintaining hardcopies of documents and drawings, having to physically go to the courthouse to research tax and property records, or sending hardcopy payment requests through the mail. Moving from these more traditional activities to digital information systems requires reeducating staff not only in the technologies but also in the culture of working digitally.

Many offices have developed localized information management tools and applications for a specific right-of-way activity. (Hancock 2006b) These activities range from maintaining spreadsheets to record and manage data about one or more activities to running macros in a geographic information system (GIS) that generate excess-property fact sheets for the public about purchase

opportunities. Migrating or reconfiguring these activities and data into an enterprise system may require linking them to the new system, reprogramming the application as part of the new system, or reentering legacy data into the new system.

Several right-of-way offices have implemented systems that are built on corporate-level database systems. These systems have been designed to improve data input, management, and access and have increased efficiency. Early systems were built on mainframe, centralized computers that were difficult to modify and generally did not have desktop access. Over time, these systems have been migrated to more modern enterprise systems, described in the next section, which provide substantial flexibility and improved user access.

As you approach implementing a new system or modifying an existing system, two fundamental approaches are commonly used for developing an enterprise-level information management system. The first approach follows on the previous paragraph and consists primarily of building data entry and management activities on an enterprise database system. This can be viewed as an electronic ledger system with various users entering their information into a series of linked data tables through user interfaces. This information is available to stakeholders and users, as specified within the system, either through graphic user interfaces (GUIs) or standard reporting capabilities that are part of the database system. This type of system is often designed using a detailed data architecture based on identifying attributes associated with right-of-way activities.

The second approach uses an electronic work environment that assists users in performing their activities and often includes business rules and decision support modules. It is typically developed independent of any database system while providing access to databases and interacting with other systems, and often it includes reengineered business processes to take advantage of available technologies. This type of system is usually designed from business flow diagrams that are then expanded to business process models and corresponding class models that are then used to build the data architecture. Either approach can be designed to include Internet/intranet access, geospatial enablement or linkage to a GIS system, and the ability to seamlessly exchange information with other systems.

The *8-55A logical model* is an example of the latter approach while the comprehensive list of attributes provided in NCHRP 8-55 is an example of a first step to the former approach. (Hancock 2006a,b)

Databases

The term "enterprise database system," as used in this guide, refers to a composite of (1) hardware—one or more servers, (2) a database software package—Oracle, Microsoft's SQL Server, IBM's Informix, or similar—that supports distributed computing and procedure development in standard .Net, Java or PL/SQL, and relational and object-oriented data management capabilities, and (3) agency data.

During the first push to centralize digital data management in the mid-twentieth century, many transportation agencies built databases in mainframe computer systems. These databases typically were not scalable and had limited access, reporting, and search capabilities. Although some were able to migrate to desktop access using front-end applications in a client-server relationship, they were very limited and prescriptive in what could be done. As agencies have upgraded to current enterprise database systems, they have moved data into the new structure using methods that vary from directly importing the old data to new database tables to redesigning the different datasets to take advantage of enhanced capabilities of the enterprise environment. This migration usually depends on available resources and other constraints at the time of initial implementation. When a redesign occurred, porting data from the old system to the new system

could be problematic and, in some cases, was not practical, requiring a break between the new and old data.

Even with the move to enterprise database systems, many datasets remain local to specific offices and personnel that are responsible for them. In part, this is the result of a need for data creators to maintain control of the data. It can also be a result of individual offices or personnel creating tools and datasets to make their work easier and not being aware that those tools and data may have broader uses or applicability. As technology has advanced, the ability to work in a distributed computing environment has enabled systems to access data from multiple sources and locations while allowing those data to remain under the control of the sourcing office. This is particularly important for data such as tax information, which is not sourced or managed by the transportation agency.

Geographic Information Systems

Every transportation agency makes use of some form of GIS and many agencies now maintain enterprise geospatial database systems. Use of GIS ranges from working directly with or using customized macros on GIS software such as Esri's ArcGIS, Bentley's Microstation, or Caliper's TransCAD to working with applications that are built on GIS platforms, web-based geospatial tools and applications, applications that include geospatial capabilities, or some combination of these. This use can be as simple as reviewing geospatial characteristics on Google Maps, which only requires Internet access and simple intuitive interactions, or as complex as comprehensive transportation planning or environmental impact analyses, which may require detailed understanding of GIS software and, in some cases, programming and system integration.

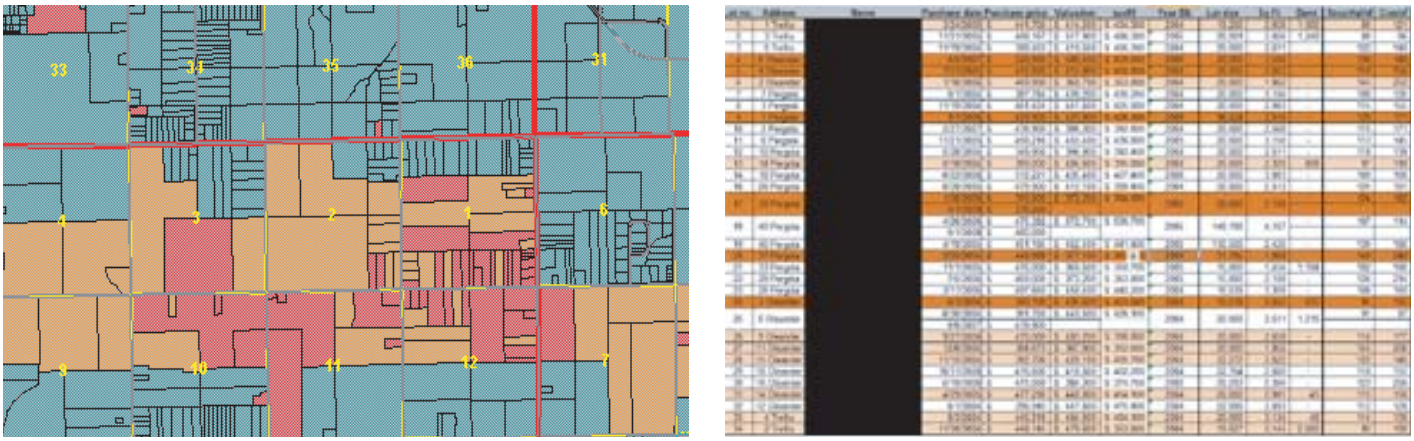
Many transportation agencies have implemented enterprise GISs that support distributed computing. This capability usually includes agency-established standards for data structure and metadata—the data about the data layer including accuracy, coverage, and much more. (For a full discussion of geospatial metadata, see http://www.fgdc.gov/metadata.) When this type of GIS capability is available, core geospatial datasets, such as boundaries and street centerlines, are maintained outside the right-of-way office and have attributes that have been established and populated for other agency missions. Because parcel boundaries and their corresponding information are typically not part of these other missions, a comprehensive statewide parcel dataset is not typically part of the enterprise geospatial data. This is probably the biggest challenge to incorporating GIS into the right-of-way information management system.

In agencies that do not yet have an enterprise GIS, a GIS office typically exists somewhere within the agency that supports one or more activity and may have geospatial layers that can be accessed or ported over for use by the right-of-way office. In this case, those layers may or may not have standardized structures and metadata. Additional work will probably be required to incorporate multiple layers of geospatial information that are not standardized. As with agencies that have enterprise systems, you will rarely find a parcel layer inside the agency.

Even if you do not initially plan to include geospatial capabilities in your right-of-way system, it is probably worth the effort to include the architecture for a parcel layer and the necessary attributes for incorporation at a later stage of development. Appendix B includes a section on how this can be done.

Implementing Geospatial Enablement

Using geospatial information to inform everything from specifying where traffic is backed up to identifying the best place to locate a new highway has moved from the back offices of GIS specialists to anyone who has access to a computing device. Because the public has ready



(a) map (b) table

Figure 3. Visual display of parcel information.

access to high-resolution imagery of their houses, they are coming to expect public agencies to have the same capabilities and more as part of their business. Adding GIS to your right-of-way activities provides additional benefits to your information management system, for example:

- Visualizing the status of parcels during the acquisition process. Maps are easier to understand and more intuitive than tables or lists as shown in Figure 3.
- Identifying special factors to consider such as hazardous waste sites, historic districts, etc., by overlaying different datasets.
- Visualizing the surrounding properties and features that could affect the take and valuation.
- Reviewing the proposed alignment and affected properties for possible savings or problems.

Because right-of-way offices are at varying stages in implementing an information management system and in using GIS, three specific scenarios were considered in NCHRP 8-55A for implementing a system:

1. An office does not have an information management system or wants to replace an existing one and include geospatial capabilities.
2. An office wants to geospatially enable an existing information management system.
3. An office does not have an information management system but has access to an agency enterprise GIS.

This guide considers each of these scenarios and provides information where appropriate to assist you in building or expanding your system. The *8-55A logical model* also supports all three of these scenarios and Appendix B explains how to use the model for the selected scenario.

How to Use This Implementation Guide

This guide provides a generalized process to implement a geospatially enabled information management system for state transportation right-of-way offices. Agencies can implement or enhance a system themselves or in partnership with the private sector. If desired, the *8-55A logical model* can be used as a basis for a system following the guide on how to use the model in Appendix B.

This implementation guide is organized to provide a rational process to help you achieve commitment, buy-in, and resources over time to achieve short- or long-range implementation

goals. Procedures are outlined that incorporate the unique characteristics of your agency, including the technical environment in which your agency operates and your agency's plans to accommodate technological change. Important considerations for using the guide include the following:

- Pay particular attention to getting started and achieving buy-in. This process includes generating awareness and support in upper levels of the agency, enlisting a champion, obtaining funding, establishing a task force, and deciding whether the agency will develop the system on its own or in partnership with others.
- Develop a clear understanding of the ultimate concept for the system. Different aspects to consider include defining the enterprise and identifying where in the process your agency is.
- Understand requirements for bringing a new system into your agency and work with your information technology (IT) office to meet these requirements while also meeting your needs and goals.
- Identify where your agency has evolved toward the ultimate concept, identify a path to develop and implement the desired concept, and set short-term and intermediate implementation goals.
- Carefully consider the information on system design, development, implementation, operations, and maintenance, including use of best practices for life cycle management of systems and software.
- Understand that content management is crucial to system success and that data and information must be properly managed over its life cycle.

The most important thing to keep in mind is that this process is not linear. Throughout and particularly at the beginning, you will reassess, redefine, and restructure. This is an important aspect of successfully implementing any system based on current technology since a technology's half-life is generally less than the time necessary to follow agency policies to implement that technology.

The process for implementing an information management system has been well defined in the literature for general business applications (Marks and Bell 2006, Harmon and Anderson 2003) and for different activities within transportation agencies (Booz and Baker 2003, Zhang et al. 2002).

Organization of the Implementation Guide

The remainder of the guide is organized according to the activities summarized in Table 2, which provides a summary of generally accepted steps. The order of these steps and substeps is not prescriptive and should be performed according to the culture of the agency. Where applicable, the guide explains how the *8-55A logical model* can be used or how it fits into the implementation process.

At the end of the guide are a list of references that were explicitly cited in the guide and the appendices, a list of acronyms and abbreviations, and a list of standard terminology from FHWA's *Project Development Guide* with some alternative terminology that was identified during NCHRP Project 8-55A. The following additional information is provided on the *NCHRP Report 695* summary web page (www.trb.org/Main/Blurbs/165239.aspx):

Appendix A: Two executive summaries designed to highlight why and how to implement a geospatially enabled information management system.
Appendix B: A guide on how to use the *8-55A logical model,* which includes a description of the model and guidance on how to use it as a starting point in your system development.
Appendix C: UML diagram documentation of the complete *8-55A logical model.*
Appendix D: *8-55A logical model* data model.
Appendix E: Annotated bibliography of documents that could be helpful.

Table 2. Summary of implementation process.

Activity	Steps	
Building Support: Chapter II	1	Recruit a champion
	2	Obtain leadership, stewardship, management support
	3	Appoint an initial working group
	4	Establish linkage to agency performance measures and goals
	5	Research related efforts (internal and external)
Assessing Your Requirements: Chapter III	1	Define your enterprise
	2	Identify needs
	3	Identify use cases
	4	Review business processes
	5	Evaluate best practices for incorporation
	6	Review legal and regulatory requirements
Assessing Your Capabilities: Chapter IV	1	Assess existing right-of-way systems
	2	Identify existing database structure(s)
	3	Identify existing geospatial capabilities (GIS tools)
	4	Identify related existing information systems
	5	Assess current policies for IT deployment
Defining the System: Chapter V	1	Define type of system
	2	Determine a starting point
	3	Define data structure
	4	Define geospatial capabilities
	5	Define document management
	6	Define reporting requirements
	7	Define links to other systems
Developing an Implementation Plan: Chapter VI	1	Identify phasing options
	2	Evaluate feasibility
	3	Develop timelines with milestones
Implementation: Chapter VII	1	Confirm/revise requirements
	2	Secure resources
	3	Develop detailed design
	4	Develop test plan
	5	Establish procedures for configuration management—Versioning
	6	Develop software
	7	Develop training plan
	8	Train users

CHAPTER II

Building Support

Implementing a multi-activity information management system is a complex and time-consuming proposition. Without appropriate support and leadership, it can be a potentially expensive exercise in futility and frustration. To avoid this experience and ensure that you achieve your goals, you should start the process by:

- Identifying the person or persons who can effectively market and promote the concept both inside and outside the agency
- Obtaining support and leadership from agency management
- Putting together a working group with representatives from the different stakeholders
- Demonstrating how the system can assist the agency with meeting its performance measures and goals
- Researching similar efforts to identify the state of the practice, lessons learned, and an understanding of anticipated costs, time, and resources.

Recruiting a Champion

Identifying the person who is enthusiastic about implementing a new and/or expanded information management system and who has the necessary influence to promote the idea to the level of management that writes the check is critical to this process. Without that support, the resources necessary to plan, design, build, and implement the system will not be realized. If at all possible, a second person should also be identified, because individuals with these characteristics are often promoted or leave the organization for more challenging opportunities. When agencies are asked for lessons learned from going through a system design and implementation process, having a champion is mentioned without exception.

Obtaining Leadership, Stewardship, and Management Support

Because of the complexities involved in developing an enterprise-level information management system, this effort must have leadership from someone who has the ability to allocate or obtain the necessary financial, technical, and staff resources. This person may or may not be the same as the champion. One of the important activities of this individual is to articulate the importance and value of the system to upper management, primarily those that allocate your budget, and other stakeholders across and outside the agency.

Support from management should extend over the time required to operationalize the system. If the total effort will take a substantial time commitment, phasing the implementation

and providing short-, medium-, and long-term milestones will help coordination with upper management.

Appointing the Working Group

Once you have the necessary support, you will want to establish a task force or working/steering group that includes representatives from the different stakeholders and future system users. The primary purpose of this group is to ensure that there is active and appropriate input and feedback as the process progresses. At a minimum, representatives from the following groups should be included:

- Right-of-way office leadership
- Regional real estate offices
- Each functional area in the right-of-way office (e.g., appraisal, acquisition, relocation, property management)
- Computer services, information technology unit, and GIS unit
- Project design and delivery

Depending on the extent of the enterprise (defined in Chapter III), additional representatives could be included, such as a member from mapping, planning, key environmental areas, or legal. As the process proceeds, you should revisit the makeup of the working group to ensure it continues to represent the necessary stakeholders and future users. If this system will be part of a larger agency initiative, you will need representation from this working group on the larger joint applications development (JAD) group.

Functions of the working group include directing and overseeing progress toward the development and implementation of the system. It establishes the anticipated level of effort, recommended approach, budget, schedule, and implementation strategy. It also defines whether the work is performed in-house, in cooperation with other organizations both internal and external, by contracting for services, or through a combination of the above.

Because working groups are not designed to provide day-to-day management, a project manager should be appointed and given the necessary resources to perform this activity. The functions of the project manager include the following:

- Managing required staff and resources
- Ensuring schedule adherence
- Managing risks
- Overseeing quality assurance
- Acting as technical contact for contractors and consultants
- Acting as point of contact for partners
- Providing day-to-day decision making
- Communicating with working group, upper management, and stakeholders

Linking to Agency Performance Measures and Goals

AASHTO's Standing Committee on Performance Management stated, "The country needs to establish national performance measures and refine existing state and local measures to begin a shift toward performance-based transportation policy." (AASHTO 2010) As this statement indicates, there is a strong push for tying policy to performance measures and requiring state agencies to be more accountable for and to those performance measures both at the national level and for agency goals and objectives. As such, funding will probably be tied in some way to

Table 3. Agency goals and measures.

Objective	Measure	Benefit from Having Right-of-Way System
On-time delivery	Percent meeting deadlines	The system maintains date stamps on all activities and can monitor critical dates as established in project setup.
On-budget delivery	Percent on-budget By project By parcel By type of payment	Financial records can be maintained on all specified categories of payments and expenditures.
Customer satisfaction	Qualitative, hard to measure Responses to queries	• Real-time accessibility by any authorized person to information associated with parcel, owner, person, or business being relocated • Real-time status information • Streamlined processing of payments
Other: Reduce excess property	Parcels sold	The system tracks excess parcels and can readily classify those suitable for resale.
Other: Social justice	Demographics of parcel owners	History of all parcels sold is available and could be mined for demographic characteristics.

showing how your system can improve performance measures and support agency goals. Therefore, it would be in your interest to obtain your agency's goals and measures and establish the appropriate linkages.

Of the broadly identified goals—safety, performance, preservation, operations, environment, project delivery, and economics—right-of-way activities fall squarely under project delivery. Table 3 provides some candidates for how the system would improve project delivery as well as other less widely used objectives. As you specify your reporting requirements, identify those that are important to your office and agency and add them to your system requirements.

On a more direct scale, your office may also have a series of performance measures that may be reported to the governor, the state transportation commission, oversight board, or other similar group, and the Federal Highway Administration. In addition to the measures listed in Table 3, these can include, but are not limited to, some measure of the following:

- Right-of-way certifications delivered
- Parcels under contract
- Parcels purchased
- Right-of-way projects closed and delivered within a specified time from construction contract acceptance
- Quality enhancement
- Skill development

These measures should be included as part of the system design and reporting with explicit linkages as performance measures.

Researching Related Efforts

At any given time, other operational units and offices across the agency may be expanding or replacing their information management and decision support tools or generating new or improved data. As you move into this process, it is incumbent on you to ensure that you are

aware of what is occurring to minimize duplication of effort, maximize leveraging these efforts, and ensure that, to the extent possible, your system can communicate with or is interoperable with these other activities, particularly available databases. In most agencies, proceeding with your system will require the approval of the IT department to ensure that this takes place. The sooner you discuss your concept with this office, the better chance you have of proceeding smoothly with minimal delays.

Technology changes rapidly and managing information using this changing technology also changes and expands capabilities. For example, the move from desktop computing to operating *in the cloud* has fundamentally changed how information is handled. (*In the cloud* or *cloud computing* is Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand from distributed sources.) Knowing the state of the practice will be important to the design of your system and, if you are contracting for services, in the request for quote. You may consider requesting a review or survey of comparable systems currently in use by other transportation agencies and/or state agencies. This survey can be performed either in-house or as part of a response to your request for services.

CHAPTER III

Assessing Your Requirements

You have established that you want an information management system and have initiated the process and garnered the appropriate support to move to the next step. In the requirements assessment, you define the scope and goals of the system including the following:

- The specific areas to include or "enterprise." The use of "enterprise" here should not be confused with an enterprise database system or GIS discussed earlier in this document. Here, "enterprise" refers to the extent of the operational areas that will be included in the system. When used with databases or GIS, "enterprise" refers to a system's ability to manage multiple datasets or instances of the database or GIS software over multiple machines and multiple users at the same time.
- The functions to be performed
- Data needed to support those functions
- Security issues including who will have access and what rights they will have
- What other systems will be part of the design and how these systems will interact with your system
- What anticipated technological advances to consider
- What legal and regulatory requirements must be addressed

This process is not linear and the assessment will continue to evolve as the process moves forward.

Partners and Defining the Enterprise

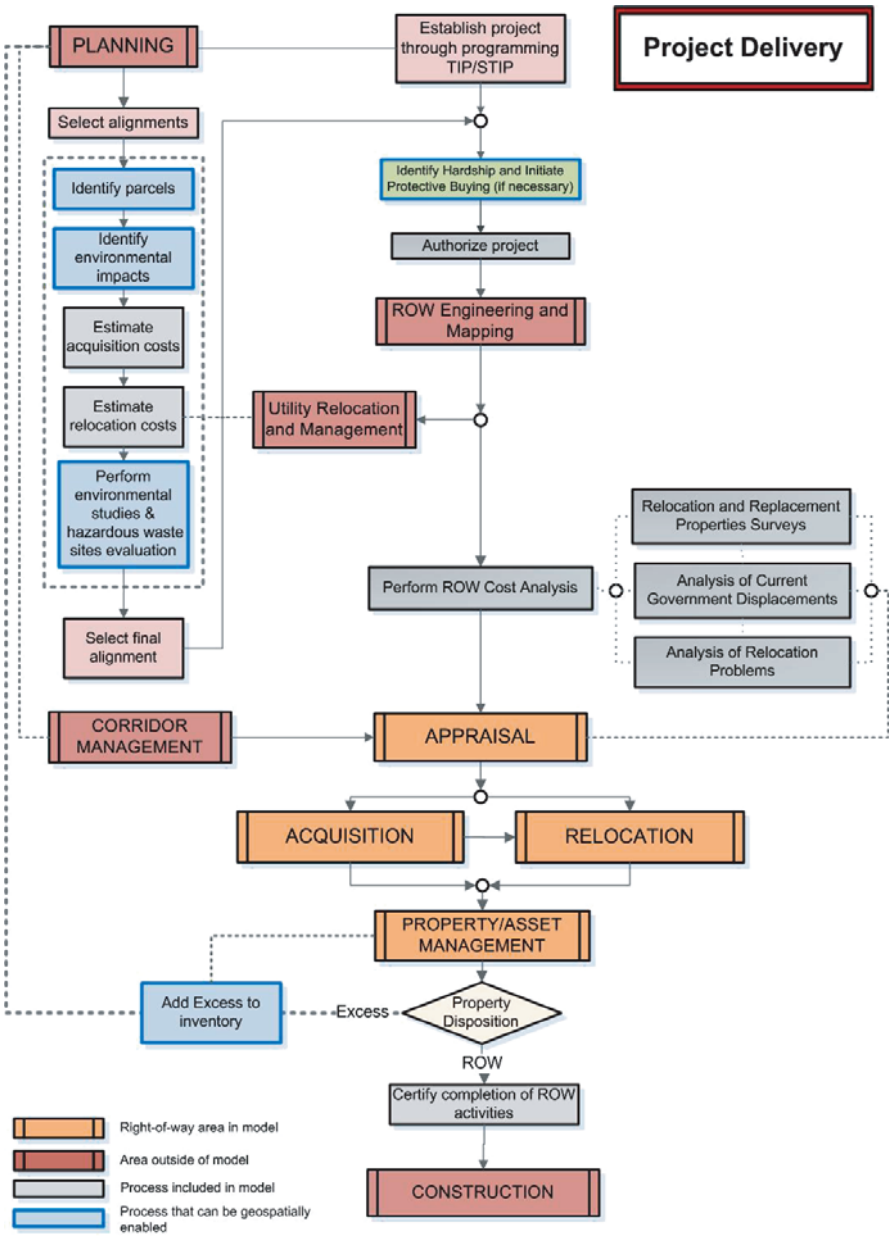
The first thing to decide is what functional areas to include in your system. A consideration for determining this is your span of control over resources and processes. Your authority to direct people, money, and equipment determines the boundary between internal and external strategies to system development. (Fletcher 1999) The essential distinction is that *internal* relationships are based on authority and power and *external* relationships are based on negotiation. Although this does not define the enterprise, it may be a determining factor when you consider the time and effort necessary to coordinate negotiations with external partners.

Table 4 summarizes functional areas that were included in the initial NCHRP 8-55 and 8-55A project statements. Based on results of the research performed in NCHRP 8-55, the focus for the *8-55A logical model* and this document was narrowed to the functional areas covered in the FHWA *Project Development Guide* but includes consideration for the other areas.

As indicated in Chapter I, right-of-way activities occur within the project delivery process. To help visualize the various aspects that come into play in the process along with the information in Table 4, a schematic of the project delivery process with the components that are included in the *8-55A logical model* is shown in Figure 4.

Table 4. Functional areas in right-of-way offices.

Operational Elements	Location in *8-55A Logical Model*	Reference to Project Development Guide
Planning	Overall	Chapter 5
ROW Project Management	Overall	Chapters 2, 3, 15
Engineering & Mapping	External Link	—
Property Appraisal	Appraisal Model	Chapters 6, 7, 8, 14
Property Acquisition	Acquisition Model	Chapters 9, 11, 14
Relocation Assistance	Relocation Model	Chapter 10
Property/Asset Management	Property Management Model	Chapter 12
Utility Relocation Management	External Link	—
Outdoor Advertising	External Link	—
Corridor Preservation	Overall	Chapter 6



Note: Many of the figures in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the web at www.trb.org/Main/Blurbs/165239.aspx) retains the color versions.

Figure 4. Right-of-way activities within project delivery.

Establishing Requirements

You will want to enumerate the requirements for your system before you start the design. These requirements encompass how you want the system to operate, what you want to accomplish with the system, who will have access, and what functions are essential to performing your business. If you will be contracting the system development, it is important to include this information in your request for bids.

Operational considerations include the following:

- Internet/intranet-based system or desktop client-server application
- Remote access and user management
- Public access
- Management of data input, use, and output
- Inclusion of business rules and decision support modules
- Geospatial tracking
- Geospatial decision support
- Document management

Examples of what you might want to accomplish could include the following:

- Streamlining your business activities
- Managing staff and contractors
- Improving your ability to balance workloads
- Near real-time monitoring of the status of different aspects of the process
- Automatic reporting to upper management and FHWA
- Improving your response to owners and persons being relocated
- Improving your auditing structure
- Improving data quality and reducing redundancy

Use Cases

To be embraced, the system must serve users for the activities that those users need to accomplish. Each of these different interactions with the system is referred to as a *use case.* In addition to ensuring that the system provides the necessary functionality, use cases are important in developing the interface design, or GUI, especially procedures for navigating around the system. Use cases are also important for testing the software to ensure that it performs the way the user expects it to.

Another purpose for use cases can be to set priorities for software development by focusing on use cases that would provide the greatest net value. Table 5 summarizes use cases that were identified as part of the *8-55A logical model.*

Business Processes

Requirements for the functionality of the system are initially captured when defining the business processes that are necessary to do the business of the right-of-way office. These requirements are then used to build the computer-based UML structure, which is then used to actually write code.

The business process diagrams for the *8-55A logical model* were extracted from the *Project Development Guide* (FHWA 2009) and are included in Appendix B. Appendix B explains how to use these diagrams to customize the model to your needs. Table 6 summarizes the high-level business process functions used in the *8-55A logical model.*

Table 5. Anticipated use cases.

Category	User	Use Case Description
General	Program Manager	Person directing the ROW office
	Project Manager	Personnel managing specific ROW project
	Legal Counsel	Personnel in transportation agency legal department
	Title Researcher	Personnel researching and establishing clear title
	Internal Auditor	Transportation agency auditor
	ROW Accountant	Personnel responsible for ROW project expenses
	ROW Contract Manager	Personnel responsible for ROW project contracts
	Transportation Agency	State transportation agency
	FHWA Representative	FHWA ROW contact
Appraisal	Appraiser	Personnel performing parcel appraisal
	Appraisal Reviewer	Personnel reviewing parcel appraisal
	Specialty Appraiser	Personnel performing any specialty appraisals
	Owner	Property owner
Acquisition	Negotiator	Personnel negotiating sales price with property owner
	Agency Official	Official from agency that has authority to buy parcel
	Arbitrator	Official who has authority to arbitrate the parcel price
	Title Agent	Personnel who establishes clear title of the parcel
	Legal	ROW legal counsel
Relocation	Relocation Specialist	Personnel who assist persons and businesses requiring relocation
	Displaced Person	Person being relocated
	Displaced Business Owner	Owner of a business being relocated
Property Management	Property Manager	Personnel managing agency-owned property
	Appraiser	Personnel appraising agency-owned property for lease or sale
	Contract Manager	Personnel responsible for lease and maintenance contracts
	Contractors	Personnel or contractors responsible for maintaining state-owned properties
	Oversight Committee	Committee that approves state-owned parcel sales
	Tenant	Persons who lease state-owned property
	Public	General public who may have an interest in a project

Best Practices to Be Incorporated

If you perform a survey of related efforts and best practices, you will want to evaluate the results to decide what, if any, aspects to include in your effort. One approach to this is to list the components or functionality that you are interested in and rate them using the following:

0—Not applicable
1—Does not meet requirements
2—Partially meets requirements
3—Meets requirements
4—Exceeds requirements
5—Outstanding example

You would then evaluate the different components against the corresponding potential cost to determine which, if any, should be incorporated into your design.

Legal and Regulatory Requirements and Issues That Must Be Addressed

State agencies are required to follow legislative and regulatory mandates related to obtaining real property and relocating those affected. Because your business is built around these mandates, your office is aware of the unique requirements that you must meet. The *8-55A logical model* and

Table 6. Summary of high-level business process functions from the *Project Development Guide* by right-of-way business area.

Right-of-Way Area	Business Process Function
Project Development	Project establishment
	Initial planning
	Early acquisition
	Project authorization
	Project agreement
	Funds encumbered
	ROW mapping and engineering
	Utility relocation and management
	Staff identification
	Parcel identification & cost estimation
	Title document processing
	Identification of parcel type
Corridor Management	Corridor management
Appraisal	Parcel selection
	Initial review
	Appraiser assignment
	Contract appraiser
	Value donation
	Waiver
	Process
	Appraisal review
	Appraiser certificate
	Just compensation establishment
Acquisition	Pre-negotiation
	Negotiation
	Closing
Relocation	Relocation planning
	Services
	Assistance payments
Property Management	Pre-construction property management
	During construction property management
	Post-construction property management
	Rodent control
	Security inspection
	Hazardous materials
	Acquired property
	Construction
Project Closing	Update excess to inventory
	Review project plans
	Accumulate and store records
	Status report
	ROW certification
	State-defined processes
	Final claims
	Close accounting
	Re-open if necessary
	Encroachment cleaning
	Excess property disposition
	Construction

Appendix B indicate the readily identifiable areas as “state specific,” which are summarized below:

- Condemnation and everything associated with pursuing this process to obtain real property
- Mobile homes acquisition
- Protective buying

- Approved state-specific process for appraisal
- Approved state-specific process for acquiring property (not condemnation)
- Assessments
- Functional replacement of publicly owned facilities
- Inverse condemnation
- Highway access management
- Right-of-way leasing
- Leasing property outside of the right-of-way
- Airspace marketing
- Rules for disposing of excess property
- Mineral/water rights

The *8-55A logical model* does not develop these areas any further than to identify them as state specific.

As you build your model, you may want to explicitly identify these regulations and the corresponding activities in your design since these often relate directly to state and federal auditing and reporting requirements.

CHAPTER IV

Assessing Your Capabilities

As you define the activities associated with the new system, you need to understand the capabilities of your office and the capabilities available to you from broader agency resources and, possibly, from other state agencies. This assessment includes consideration of:

- Hardware and software: including desktop computing, servers, operating systems, and Internet/intranet connectivity
- Applications: including existing right-of-way support applications, database systems and management tools, document management systems, GISs, CADD, financial tracking applications, project management applications, and other information and/or decision support systems such as environmental and planning tools
- Data: including their availability, who maintains them, where they are maintained, policies associated with accessing and updating them, and available and required metadata
- Agency IT policies and procedures related to application development and management, data and metadata, hardware and software management, and updates

Because of the dynamic nature of technology and its implementation, this assessment should be revisited periodically through the implementation process; typically, this reassessment is one of the functions of the Working Group members. One thing to be aware of is the potential for project creep associated with new technologies.

Where you start in the implementation process depends on where your office and your agency currently are. Assessing existing capabilities encompasses several aspects of doing the business of acquiring real property, including the current level of use of information technology, available data, available information systems, and institutional culture.

Current Right-of-Way Applications

Within your office, you will want to identify what systems are already being used. These systems include any central office-wide applications, any external systems such as an electronic multiple listing service (MLS), and any task-specific tools such as spreadsheets with hyperlinks to useful websites, or reporting tools or templates.

You will want to include linkages in your new system to any applicable external systems, if practical. Any functionality that has proved useful in other tools and localized applications may be transferred to or implemented in the new system design, so knowing what exists is important.

You may want to expand an information management system that you already use that serves some or all of your activities. You will want to identify exactly what functions are already covered in the existing system so that you know what additional work you want to design based on your

requirements assessment. You will also need to understand the underlying data and system structure so you can effectively modify or build on it.

If you have a system that was developed before the technological changes that have occurred in distributed computing and enterprise database systems, you may want to evaluate the feasibility of migrating your system to the new environment. Service-oriented architectures, cloud computing, and distributed computing have changed the nature of how information-intense businesses operate and they provide much more flexibility and scalability in the design and implementation of complex information management systems.

Existing Database Structure

Probably the most important aspect of assessing your capabilities is knowing the database structure that is available within your transportation agency. This structure will typically provide the basis for your system, particularly for the electronic ledger-type system. It also provides the fundamental linkage to interoperability to other systems. You will want to identify existing databases that currently exist in the database system(s) that you want to include in the right-of-way system. This identification is generally done in conjunction with identifying other agency systems and datasets, including GIS. In most cases, these datasets will include metadata, or information about the data, which is necessary for your design. If a dataset does not include metadata, you will have to identify the owner of the data and obtain the necessary information.

Typically, the agency through the database system manager will have established policies for adding datasets to the system. You will need this information for the design and final implementation.

Existing Geospatial Capabilities

If you are building GIS visualization and analysis directly into your system, knowing what GIS software is available is less important than understanding the geospatial datasets, their content, and format. If you are going to integrate your system with an existing GIS, then you will need to know what that system is and what language and structure it uses to communicate.

Most of the large enterprise database systems now support geospatial data structures and many transportation agencies have migrated their geospatial data into these systems. Regardless of whether your agency has done so, you can include geospatial enablement in your system. However, if your agency does not maintain geospatial datasets on an accessible server, you will probably not be able to include this capability in your system until that structure is available because it may be impractical to generate all of the necessary datasets to support just your mission.

Other Information and/or Decision Support Systems

You interact with other offices in your agency when doing your business. Most commonly, you need data from them or need to provide them with data. You also want access to documents and, in some cases, you may want to review information in another system. Knowing what these systems are is important to your design so that the appropriate links are established to allow the necessary interaction. Areas that could have systems that need to be linked with your system include the following:

- Document management
- Financial

- Project management
- CADD
- Tax information
- Environment
- Planning
- Legal
- Asset management

Current Information Technology Policies

Transportation agencies have commonly established policies associated with the purchase, development, and implementation of new technology. These policies cover everything from whom you need to buy from to how you request proposals or bids to the procedures you must follow for implementing a new system. You should identify which policies you will need to follow as early in the process as possible since this can drive the timeline and allocation of resources.

CHAPTER V

Defining the System

It is important that you understand what you want from the system as you define it. Are you primarily looking for a tool to effectively manage the information associated with right-of-way activities or are you looking for a digital work environment that captures and supports business processes? Are you completely redesigning a system or enhancing an existing system, such as adding geospatial capabilities? Are you expanding another agency system to incorporate right-of-way activities? Do you want to incorporate decision support tools? Does your office work on local desktop computers or on agency servers through the Internet/intranet? These questions should be answered when you define your requirements.

Understanding these requirements in conjunction with how you want to meet them is the basis for actual design and development of the system. This chapter is designed to review different criteria and to provide guidance on how you can use the *8-55A logical model.*

Role of Workflow Management

How work is performed in your office will provide important input to the design of your system. Factors to consider include:

- Does your state centralize its right-of-way activities or are they delegated to the regions with the central office providing oversight?
- Are right-of-way activities performed by staff, contractors, or a combination of both?
- What functions are performed in each area of your office?
- How do you manage workloads?
- How do you handle approvals?
- Do you have internal performance measures that need to be tracked and reported?
- Who responds to owners or people being relocated when they call? Who responds to the public?

If you are considering a system that provides an electronic work environment, you will need to capture the business processes that are performed by each area in your office to ensure the same functionality is provided in the system. The *8-55A logical model* includes the business processes identified from FHWA's *Project Development Guide.*

Technical Architecture (Type of System)

The specific architecture of the system will be determined based on your requirements, capabilities, and the type of system that you want. Whether you want a user-friendly ledger-entry type interface to a comprehensive enterprise database or a customized front-end to a system built on service-oriented architecture will define how the design moves forward. Regardless, you will

want your system to be accessible, scalable, and reliable. Conceptually, the system will be composed of four logical components: user interface, application, data, and security.

User Interface

The user interface needs to be straightforward and understandable by each person for his/her own activities. Navigation between "pages" should be intuitive or easily learnable. Users should be able to get to the information they need easily in as few steps as possible.

Application

In the current technical environment, you will probably design the application to reside on a server that is then accessed remotely through the Internet/intranet. This structure typically consists of a web server, a development server, an application server, and the database server. You should work with your IT department to define the structure that best meets your needs.

The software residing on the web server manages connectivity and supports resource management—directly affecting system performance. This is extremely important for rapid access to the underlying databases and should be designed to accommodate the expected number of simultaneous database connections.

The application server hosts the actual application and executes user processes and requests from client software. If you are doing the development in-house, you will want a development server separate from the application server. This is where you make changes to the software and test it prior to launching it onto the application server. After you have implemented the system, the development server is used for adding upgrades and correcting problems.

Data

The database server houses the database software as well as the data. In a distributed environment, the data may reside on multiple computers or servers throughout the agency, which are then usually managed by the database software from the server for specific applications.

Security

Security is important at several levels of the enterprise architecture including the network, the application, and the data. Security should be carefully implemented to protect your investment while meeting accessibility needs.

Additional Considerations

When defining the characteristics of your system, several factors are important to consider. Compatibility and scalability issues include the following:

- Internet/intranet accessibility including speed and connection types
- Firewalls and security management
- Use of copyrighted and proprietary data/files
- Data sharing capabilities, such as XML
- Validation of data entry
- Workflow management
- Wireless support

- Accessibility standards compliance
- Use of non-proprietary/portable software code, such as Java or .Net, where possible.

Other factors you should consider in defining your system include the following:

- Every agency starts at a different point in the development process and approaches that process differently.
- Building a system using internal resources has different constraints and requirements than working with a consultant to build a system.
- Where your agency is with respect to the use of technology and willingness to embrace new approaches, hardware, and software will impact how you move forward.

Starting Point

Although not exhaustive, the following cases present some common starting points:

I. Your office does not have centralized information management capability and is developing a full geospatially enabled enterprise information management system or is totally replacing an existing system that is no longer responsive to current needs.
II. Your office wants to add geospatial capabilities to an existing enterprise information management system.
III. Your agency has an enterprise geospatial capability (a GIS warehouse, agency-wide geodatabase, or geospatial data service) and you want to incorporate it into your information management system. In this case, the term *enterprise* indicates the ability to access geospatial data through the Internet/intranet.

Case I

For the first case, you are starting, more or less, from scratch. This case gives you the most flexibility. Following the guidance provided in Appendix B, you can use all or part of the *8-55A logical model* as the backbone to build your system. If you are creating your own business processes, you have the ability to extract activities from the *model* with their corresponding components to incorporate in your process.

Case II

The second case is a common condition for states that have an information management system in place. The *8-55A logical model* provides a specific component that includes just the geospatial functionality, called "geospatial decision making activities" (GDMA). Although it is impractical to provide a step-by-step link from this model to an existing information management system, the structure clearly identifies the data necessary to support status tracking and activities that could benefit from geospatial analysis. These data elements and activities are connected back to the overall model in the *8-55A logical model* so that the source is identifiable for inclusion in your system design.

Case III

The third case can be considered from two perspectives. One perspective is similar to the first case in that you are designing your system and linking to the agency geospatial system. As with the first case, you will work closely with the manager of the GIS data to provide the appropriate connections from the data to your functionality. The second perspective is from

your right-of-way office that is using a GIS and wants to build right-of-way business functionality behind the geospatial interface. With this case, you can use the *8-55A logical model* for activities that are not associated with GIS or are just passing status attributes directly to an existing GIS to build functionality. For geospatial activities, you can use the *model* as a reference to program additional functions into the GIS interface as desired.

Data Structure

Transportation agencies have extensive data and most have migrated to one or more enterprise database systems such as Oracle, Microsoft SQL Server, IBM DB2, or IBM Informix to manage these data. When you identify your capabilities, which system to use is probably already determined by your agency, or possibly, your state.

As part of the design phase, you will create a data architecture for your system. The architecture should include descriptions of the following:

- Data in storage
- Data in motion
- Data stores
- Data groups
- Data items
- Mappings of those data artifacts to applications, locations

Appendix D provides the initial data architecture that evolved from the *8-55A logical model* development.

Geospatial Capabilities

Geospatial capabilities have become available in a multitude of different areas within transportation agencies. Historically, GIS has been prevalent in planning offices as represented by where the GIS office often exists in an agency's organization chart. With the rapid changes in technology from desktop to cloud applications and from localized to centralized or distributed data management, GIS has become more accessible to personnel and functions across every aspect of transportation including right-of-way activities.

Given the ready availability of on-line spatial visualization tools such as Google Maps and Earth and Microsoft Globe, you already have access to some capabilities. If your agency has a license with one of these providers, you can provide functionality that interfaces with these tools to display your geospatial information on top of their underlying imagery and layers. You should note that these tools do not support more advanced geospatial analyses.

If you have access to a GIS such as Esri's ArcGIS, Bentley's Microstation, or Caliper's TransCAD, you will be able to include GIS in your system. However, the one geographic feature that can limit a geospatial system's usefulness—the availability of a statewide parcel, or cadastral dataset—can be a difficult obstacle to overcome. Some options that you might consider are outlined in the following paragraphs.

State GIS Office

You can partner with your state GIS office to build your state cadastre layer. This process will probably be time consuming and potentially expensive unless other agencies are also supporting the effort.

Taxing and Other Agencies

You can consider partnering with your state's taxing agencies or other jurisdictional entities if they have a geospatial parcel layer. This option can be challenging for several reasons including the number of agencies involved, difficulty in identifying who has geospatial layers, and the need to work out mutually acceptable agreements.

Point Locations

If you have access to a comprehensive list of properties that include a set of coordinates or other readily geo-locatable information representing their locations, you can use this to create a point layer within your GIS and then use the points in place of boundaries for many geospatial activities.

Your Own Parcel Layer

It is usually impractical for a state transportation agency to create and maintain a statewide parcel layer. Although less than ideal, you can work with your engineering and mapping group to extract parcels from the right-of-way maps for new projects and add those parcels to a parcel layer that you have created as part of your system on a project-by-project basis. Applications exist that can convert CADD drawings to GIS or, in some cases, interact directly between the two systems. You will need to add the associated information about owner and other attributes that you specify in the design. Using this method limits the dataset to only those parcels that are part of a transportation project; so again, your functionality will be limited. This approach may not meet the standards set by the Federal Geospatial Data Committee for a cadastral layer of the National Spatial Data Infrastructure, so it should be used with care for other purposes.

Document Management

Document management should not be confused with reporting. A document management system is a computer system used to track and store electronic documents and/or images of hardcopy documents. Reporting systems are used to generate readable reports from various data sources. In many cases, these reports will be stored in the document management system, but these two systems are distinct.

Most right-of-way activities include a multitude of documents to meet legal, auditing, or business needs and requirements. These documents may come from other agencies or offices, such as titles, tax records, or right-of-way design drawings, or they may be generated by business activities in the right-of-way office, such as a certificate of appraisal or a written offer to an owner.

As with databases, many transportation agencies have implemented an enterprise document management system which should be leveraged. If such a system is not available, including a system in the design is worth consideration given the benefits of near-instant desktop access by any approved stakeholder; the ability to search for documents using key words, names, dates, or other attributes beyond project and parcel numbers; reducing the possibility of misfiling or not re-filing a document; freeing up physical storage space; and, with appropriate backup procedures, eliminating the possibility of loss due to fire or flood, etc.

Remember that the document management system contains only those documents that have been entered into it. Your agency may or may not have invested in adding historical documents (documents from before the implementation) to the system. Any documents prior to that time will still be in hardcopy and you will want a way to reference their location if those documents are necessary to your business.

Reporting

Although reporting may seem a minimal design consideration, it has the potential to be one of the items most responsible for project creep. You will want to define the critical documents and reports that are necessary for your business activities and ensure these are included in the technical design. You will also want to create a running collection of desired reports that you identify during the implementation process and after the system is in place.

The *8-55A logical model* does not explicitly address reporting although it does include required documents as identified in the FHWA *Project Development Guide.*

CHAPTER VI

Developing an Implementation Plan

If you have the resources and commitment to implement your system in a single phase, you can skip the next section. Often, however, you are constrained by resources or having to coordinate with other efforts necessary to support right-of-way activities, such as development of the necessary geospatial layers, i.e., statewide parcel layers.

Depending on the reason for phasing your implementation, you will need to determine the appropriate functionality to assign to each phase. If you are coordinating with another effort, you should structure your phases such that one phase consists of the coordinating functions while the other(s) consist of functions that are mostly independent. If you are constrained by resources, you will probably want to group functions by enterprise-wide functionality—data management, document management, geospatial enablement, expanded reporting—rather than by functional area—appraisal, acquisition, etc.

Phasing Options

Because of the interconnectedness of information in right-of-way offices, an information management system should cover all the functions of the office when it is implemented. However, there are some strategies for this implementation that allow you to phase in some aspects, such as adding geospatial capabilities or electronic document management, after the system is in place. Similarly, modules or tools that improve how certain aspects are performed, such as a contract management module for lease agreements, can be added later.

When you perform your capabilities assessment, you will identify what your agency already has and the environment that exists for local versus centralized and distributed systems. Based on this assessment, you will decide which of the following strategies to follow:

- Local information management system—This system would consist of a database and the front-end software on a desktop computer or server on a local area network (LAN) that supports staff activities including data access and entry, document generation, and reporting. This configuration would potentially require coordinating the data from different locations. However, given the current state of technology, this strategy would probably be used only if the agency does not yet have an enterprise database system that is accessible throughout the agency.
- Centralized information management system—This system would consist of an enterprise database system and either an Internet-based front end or locally installed front end that accesses the database through the Internet/intranet. This configuration is probably the most common for systems that have been implemented over the past decade or are under design.
- Distributed information management system—This system would consist of one or more distributed enterprise database systems, an Internet-based front end, and access to other

applications and systems both inside and outside the agency through desktop, notebook, handheld, or other mobile computing devices. If interagency agreements are in place to allow it, your system could seamlessly access tax records directly from the source or business data for relocation planning, etc.

To include geospatial enablement, you also have several strategies:

- You include it in the initial design and implementation—The geospatial functionality is included in the use case and business process models and the data are included in the data architecture. The geospatial capability can be built into the system or linked to an external GIS software package.
- You have an existing information management system and you want to add geospatial enablement—The *8-55A logical model* includes specific locations in the model where data are obtained from or entered in the system as well as activities that could be geospatially enabled. You would identify these areas in your system and expand the capability to provide the necessary functionality.
- You have access to an enterprise GIS and want to incorporate it into your information management system—As with the previous strategy, the *8-55A logical model* provides specific data locations where data are obtained from or entered in a system. Linkages to the GIS would be included in the system design.

Two possible options for adding a GIS are porting the appropriate information to an existing GIS package or programming geospatial capabilities within the information management system. The first approach would establish a method of passing information between the system and GIS software. If staff members are familiar with GIS, they could then use it as desired. If they are not, you could include a macro to perform the desired GIS functionality in the GIS software. The GIS can be launched from within the information management system or as a separate application. The second approach is to build the GIS functions in the system either by using the GIS software application programming interface (API), which allows you to use the functionality of the software but in the system interface without the overhead of the complete GIS package, or by programming the geospatial capabilities directly in the system. It should be noted that there are GIS software packages that are designed to support land management and can be modified to meet the information management needs of your office.

Feasibility

You will need to determine the feasibility of implementing the various components of your system. If you determine that implementation of a component is not feasible for some reason, you will need to find a strategy to overcome the difficulty or barrier or pursue a redesign that does not require that component. The following types of feasibility should be considered:

- Managerial
- Organizational
- Staffing and other resources
- Technical
- Financial

Implementation Timeline and Milestones

Once you have decided whether you will need to phase your implementation, you will want to develop a schedule that shows each phase and the major milestone that will be achieved in the short, mid, and long term. Using a Gantt chart or other project management software to lay out

the major implementation activities within the schedule will help you and the developers stay on track. This schedule will also help to control project creep once development has started because not only does creep affect the cost but also deadlines. Activities should include the following:

- Implementation of major layers or modules of the system
- Actions to secure resources for implementation including funding, staff, consultants, hardware, and software
- Actions associated with software development, testing, and implementation
- Training

CHAPTER VII

Implementation

Implementation should follow accepted software development techniques using software development life cycle methodology and is assumed to begin with the actual software development. Steps of the implementation process include the following:

- Establishment of the detailed design
- Prototype development
- Incremental refinement
- Testing and documentation
- Training
- Establishment of a maintenance and support plan

Requirements

As you initiate each phase, you should review the requirements for that phase to ensure that they still support your goals and objectives and meet the needs of your office. If necessary, you will need to revise these requirements.

Resources

Once you have reviewed your design and are ready to move to development, you will need to secure the necessary resources. You should have received a commitment for the development, implementation, and maintenance of the system before initiating the process, but now is the time to formalize the agreement and funding. The following resources need to be established:

1. You will need to secure funding.
2. You will need to obtain staff or hire the development contractor. If you are developing the system in-house, you may need to hire staff either in your office or in cooperation with the IT department. If you are contracting the work out, you will need to write the request for services, evaluate proposals, select the contractor, and award the contract. This contractor may or may not be the same one that you contracted to support your earlier planning activities. You may want to dedicate a staff member to working with the contractor during the implementation process.
3. If you are developing the system in-house, you will need to coordinate with the IT department to establish the necessary development environment including computers, communications, and the necessary development software.
4. Regardless of whether you develop the system in-house or with a contractor, you will need to work with the IT department to establish accepted development protocols particularly for integrating with existing database systems and other information systems and for creating your final data architecture and metadata.

Detailed Design

Before starting the software coding, you will establish the detailed design. Designers will review and confirm requirements with the agency project manager and work group and encapsulate them through the following:

- Conventions for graphical user interfaces
- Input screens
- Output screens and standard reports
- Navigation procedures
- Database design
- Geospatial functionality
- Interfaces to other systems

The basis for the last three items are included in the *8-55A logical model* but actual requirements associated with the systems that exist in your agency need to be specified and incorporated in the design.

Test Plan

You will need a test plan to evaluate the system as it is operationalized. In addition to the standard alpha and beta testing of the phase being implemented, you can also include testing at milestones that were identified when you defined the system. The following types of tests can be included:

- Unit testing for testing components that are being built
- Integration testing for testing how components work together
- System testing to ensure that the system meets business needs
- Acceptance testing to evaluate user satisfaction
- Scenario testing to ensure that the system meets user needs

Most development environment software includes the ability to build these tests into the development process. It may be worth the time and resources to include time for staff to work with developers during the later testing, but prior to the alpha testing of the system as a whole.

In the test plan, you will want to establish a method to document successful and unsuccessful tests and to capture comments during the process. Project creep can rapidly absorb allocated resources if you do not carefully control the evaluation of what was included in the design versus what "would be nice to have." For contracted development, the contractor is responsible, at its expense, to ensure the system meets design specifications. Anything that is outside the design specifications is usually performed at additional cost.

Procedures for Configuration Management—Versioning

If you are developing the system in-house, you will need to have procedures for tracking versions and updates to the software. Most development environment software includes versioning and the ability to "check out" and "check in" code. When multiple developers are working on the project, you should make sure you have the enterprise version of the development software so that changes can be synchronized.

If the system is being developed by a contractor, you will want to establish a method for tracking the versions that are released to you for evaluation or after fixes are made.

Another aspect to be aware of as you develop your system is the versions of the other agency-wide systems that your system interacts with including the following:

- Operating systems
- Web-based browsers or Internet connection software
- Runtime framework software
- Database management systems
- Geospatial software or tools

Major upgrades or version rollouts can substantially affect your system functionality and design.

Software Development

Once you have defined your test procedures and versioning, you will start actual development. Development will consist of the following steps:

1. Develop the prototype. Prototype is the term for the system while it is being developed and before it has been officially accepted.
2. Prepare documentation. Documentation should start when development starts and should be updated throughout the development process. You should specify the type of documentation you require such as the user manual, a programmer manual, a data dictionary, on-line help, etc. and when it should be submitted such as with each milestone and test phase. Documentation is a part of the process that is often allowed to slide, which then results in limited usefulness if and when the software is completed.
3. Test prototype. Ideally, you want each potential user, or at least a representative of each use case, to test the system. Realistically, you will probably assign a small number of staff members from your office to perform the initial alpha test. It is important to document the results of the test based on the test plan to identify discrepancies between its performance and the design specifications as well as any problems or bugs.
4. Refine prototype. The prototype and documentation need to be revised to address the issues identified during alpha testing. As noted earlier, it is important to distinguish what is part of the original design that needs adjusting to meet the specifications and what is new or modified functionality.
5. Retest prototype. This is the beta test and is usually close to the deployable system. If possible, this testing should be as close to "live" as possible to make sure that it is performing as expected.
6. Implement system. Once you have officially accepted the system, you will roll it out to the right-of-way office staff. You may want to consider a phased implementation with one region going live followed by the remainder of the state or you can roll it out all at once.

Training Plan

As the system is getting ready for testing, you should prepare a training plan. This is separate from the regular training that will be necessary for new hires, although you can potentially use any material generated as part of the training process. You will need to consider the following aspects as you put together your plan.

- Where will the training take place? Will you have one or more short courses at a central facility, will you visit the regions and/or local offices, or will you offer synchronous on-line training?
- Will you offer training sessions for each type of user or will you train staff in the overall system?
- Will you train trainers, training a selected number of staff members who then train the members in their area?

- Will you train with live data and active projects?
- What resources will you provide to staff: users guides, step-by-step guides, on-line tutorials, full-time help staff?

If you phase implementation across the state, you will want to phase the training as well and possibly revise it based on input from the early sessions.

Information to include in the training should cover the following:

- Security requirements, how to set up an account, how to reset passwords, etc.
- How to maneuver through the system
- How to search for information
- User screens including how to get to them
- Data being entered and any rules or restrictions associated with those data
- How to generate reports
- How to use the geospatial tools
- How to use document management tools
- Who to contact when users have questions or problems

Training

Providing adequate training is one of the most often mentioned lessons learned from system implementation reports and presentations. You are asking your staff to do something that they are not familiar with and in many cases to change the way they have done things for several years. It is very important that you provide them with the necessary training so that they are comfortable with the new system. Although you may be tempted to be sparing with the number and length of training sessions, you will probably regret it in the long run.

Communication is also critical to the training process. Listening to your staff will assist in making sure that the training is effective. Once you have delivered a training session, solicit feedback and follow up with any problems or concerns that came up during the session.

References

AASHTO Standing Committee on Performance Management, "The World of Transportation Performance Measurement at Your Fingertips" web page, http://www.transportation.org/?siteid=97, accessed June 29, 2010.

"AASHTO Turbo Relocation Win," BEM Systems, Inc. http://www.bemsys.com/index.php?option=com_content&view=article&id=45:aashto-turbo-relocation-win&catid=20:recent-news&Itemid=27, accessed August 6, 2009.

Ambler, S. W. (2004). *The Object Primer 3rd Edition: Agile Model Driven Development with UML 2.* New York: Cambridge University Press.

Booz Allen Hamilton and Michael Baker, Jr. Inc. (2003). *NCHRP Report 481: Environmental Information Management and Decision Support System—Implementation Handbook.* Transportation Research Board, Washington, D.C.

Brice, Tim (2006). "Logical vs. Physical Design: Do You Know the Difference?" M. Bryce & Associates (MBA). Florida. http://it.toolbox.com/blogs/irm-blog/logical-vs-physical-design-do-you-know-the-difference-9011

Federal Highway Administration (2006). *Project Development Guide (PDG).* http://www.fhwa.dot.gov/realestate/pdg.htm, accessed on August 15, 2007.

Federal Highway Administration (2007). "Evaluation of State Condemnation Process." http://www.fhwa.dot.gov/realestate/cndmst.htm, accessed October 10, 2010.

Federal Highway Administration (2009). *Real Estate Acquisition Guide for Local Public Agencies.* http://www.fhwa.dot.gov, accessed on August 15, 2007.

Fletcher, D. (1999). "The Interoperable Enterprise," *Enterprise GIS,* Urban and Regional Information Systems Association (URISA), Park Ridge, Illinois.

Ghanta, N. (2007), "Integrating Geospatial Technologies into the Property Management Process of the Transportation Right-of-Way." Master's thesis, Virginia Polytechnic Institute and State University, Falls Church, Virginia.

Hancock, Kathleen L. (2006a). *NCHRP Research Results Digest 310: Integrating Geospatial Technologies into the Right-of-Way Data-Management Process.* Transportation Research Board, Washington, D.C. http://www.trb.org/Main/Public/Blurbs/158500.aspx

Hancock, Kathleen L. (2006b). *NCHRP Web-Only Document 95: Integrating Geospatial Technologies into the Right-of-Way Data-Management Process: Appendixes A through F.* Transportation Research Board, Washington, D.C. http://www.trb.org/Main/Public/Blurbs/158501.aspx

Harmon, John and Steven Anderson (2003). *The Design and Implementation of Geographic Information Systems, Edition 1,* Wiley & Sons, Inc. Hoboken, New Jersey.

Marks, Eric and Michael Bell (2006). *Service-Oriented Architecture: A Planning and Implementation Guide for Business and Technology,* Wiley & Sons, Inc, Hoboken, New Jersey.

Ozbay, Kaan and Nebahat Noyan (2003). "Evaluation and Development of MIS Interface," Report FHWA-NJ-2003-002, Rutgers, New Jersey.

Nicewarner, N. (2004). "Why Have Conceptual, Logical, and Physical Data Modeling?" *PowerBuilder Developers Journal,* SYS-CON Media, Inc. http://pbdj.sys-con.com/node/106944

Saka, Anthony A. (2004). *Geographic Information System Implementation of State Department of Transportation Right-of-Way Programs.* Office of Real Estate Services. Federal Highway Administration, Washington, D.C. DTFH61-03-H-00121. http://www.fhwa.dot.gov/realestate/rowsurvjuly04.htm

Sparx Systems Pty Ltd. (2007). *Enterprise Architect—UML CASE Tool—Desktop, Professional and Corporate Editions, Version 7.0* [Software]. Available from http://www.sparxsystems.com.au/products/ea/index.html

Zhang, Zhanmin, X. Zhang, W.R. Hudson, and M. McNerney (2002). *GIS Implementation Plan for PMIS.* Research report for Texas Department of Transportation, Austin, TX.

Acronyms and Abbreviations

AASHTO—American Association of State Highway and Transportation Officials
API—Application programming interface
CADD—computer-aided drafting and design
CASE—computer-assisted software engineering
CRS—coordinate referencing system
DOT—department of transportation
DSS—decision support system
DSS—"decent, safe, and sanitary" for replacement dwellings
GIS—geographic information system
GIS-T—GIS transportation applications
GPS—global positioning system
GUI—graphical user interface
HTML—hypertext markup language
HTTP—hypertext transport protocol
ISO—International Organization for Standardization
IT—information technology
ITS—intelligent transportation systems
JAD—joint application development
LAN—local area network
LRS—linear referencing system
MPO—metropolitan planning organization
NCHRP—National Cooperative Highway Research Program
O&M—operations and maintenance
OLAP—online analytical processing
RDBMS—relational database management system
ROW—right-of-way
SDK—software development kit
SGML—standard generalized markup language
SOA—service oriented architecture
SQL—structured query language
STIP—State Transportation Improvement Program
TCP/IP—transmission control protocol/internet protocol
TIP—Transportation Improvement Program
UML—uniform modeling language
XML—extensible markup language

Terminology

Standard Terminology from Uniform Act

appraisal: A written statement independently and impartially prepared by a qualified appraiser setting forth an opinion of defined value of an adequately described property as of a specific date, supported by the presentation and analysis of relevant market information.

appraisal waiver: Method of establishing property value if the agency determines that an appraisal is unnecessary because the valuation problem is uncomplicated and the fair market value is estimated below an established threshold.

business: Any lawful activity, excepting a farm operation, conducted primarily

1. for the purchase, sale, lease and rental of personal and real property, and for the manufacture, processing, or marketing of products, commodities, or any other personal property;
2. for the sale of services to the public;
3. by a nonprofit organization.

comparable replacement dwelling: Any dwelling that is

1. decent, safe, and sanitary;
2. adequate in size to accommodate the occupants;
3. within the financial means of the displaced person;
4. functionally equivalent;
5. in an area not subject to unreasonable adverse environmental conditions; and
6. in a location generally not less desirable than the location of the displaced person's dwelling with respect to public utilities, facilities, services, and the displaced person's place of employment.

corridor preservation: See protective buying.

detailed appraisal: An appraisal format for all valuations that require in-depth analysis and presentation of relevant market information.

displacing agency: Any Federal agency carrying out a program or project, and any State, State agency, or person carrying out a program or project with Federal financial assistance, which causes a person to be a displaced person.

displaced person: Any person who moves from real property, or moves his personal property from real property

1. as a direct result of a written notice of intent to acquire or the acquisition of such real property in whole or in part for a program or project undertaken by a Federal agency or with Federal financial assistance; or
2. on which such person is a residential tenant or conducts a small business, a farm operation, or a business defined in paragraph (7)(D), as a direct result of rehabilitation, demolition,

or such other displacing activity as the lead agency may prescribe, under a program or project undertaken by a Federal agency or with Federal financial assistance in any case in which the head of the displacing agency determines that such displacement is permanent.

farm operation: Any activity conducted solely or primarily for the production of one or more agricultural products or commodities, including timber, for sale or home use, and customarily producing such products or commodities in sufficient quantity to be capable of contributing materially to the operator's support.

Federal agency: Any department, agency, or instrumentality in the executive branch of the Government, any wholly owned Government corporation, the Architect of the Capitol, the Federal Reserve banks and branches thereof, and any person who has the authority to acquire property by eminent domain under Federal law.

Federal financial assistance: Means a grant, loan, or contribution provided by the United States, except any Federal guarantee or insurance, any interest reduction payment to an individual in connection with the purchase and occupancy of a residence by that individual, and any annual payment or capital loan to the District of Columbia.

lead agency: The United States Department of Transportation.

low value appraisal: An appraisal technique used for appraisal waivers for uncomplicated and low value acquisitions.

minimum payment: Policy to offer a minimum acquisition amount for nominal acquisitions.

minimum standards appraisal: An appraisal format that is consistent with established and commonly accepted practice for acquisitions which, by virtue of their low value and simplicity, do not require the in-depth analysis and presentation necessary in a detailed appraisal.

Also referred to as memorandum appraisal.

mortgage: Such classes of liens as are commonly given to secure advances on, or the unpaid purchase price of, real property, under the laws of the State in which the real property is located, together with the credit instruments, if any, secured thereby.

person: Any individual, partnership, corporation, or association.

protective buying: Purchasing a limited number of parcels within the line of a proposed transportation corridor prior to location approval to preclude development from occurring which may limit the choice of highway alternatives.

short form appraisal: Example of a minimum standards appraisal that includes descriptions of the property and acquisition, an analysis of the comparable sales used, photographs of the property, and an analysis of the value conclusions.

State: Any of the several States of the United States, the District of Columbia, the Commonwealth of Puerto Rico, any territory or possession of the United States, the Trust Territory of the Pacific Islands, and any political subdivision thereof.

state agency: Any department, agency, or instrumentality of a State or of a political subdivision of a State, any department, agency, or instrumentality of 2 or more States or of 2 or more political subdivisions of a State or States, and any person who has the authority to acquire property by eminent domain under State law.

value finding appraisal: Example of a minimum standards appraisal for uncomplicated acquisitions of only land or land and minor improvements and includes comparable sales data, photographs of the property and a brief analysis of the value conclusion.

Additional or Alternative Terminology

The terminology presented in this section was identified during the course of NCHRP Project 8-55A. Where possible, a source is included in parenthesis. However, this does not indicate that the official definition of the term comes from that source, just that it was identified from that source. Terms in italics were identified as alternative terminology for more uniformly accepted terms.

30-day notice: This is a notice that may be given to a person who will be required to move a residence, business, or personal property as a result of an agency's project. It informs the person that he or she must move the residence, business, or personal property 30 days from the date of the notice. (FHWA 2009)

access control: Power of Government to restrict/control a property owner's right to create entrances and exits on a public road. (FHWA 2009)

acquisition: The process of obtaining right-of-way necessary to construct or support a project. (FHWA 2009)

actual moving expenses: The costs that are paid to disconnect, move, and reinstall personal property. These costs are usually associated with the move of a business. A complete list of costs eligible for Federal reimbursement can be found in 49 CFR 24.301 and 303. (FHWA 2009)

actual direct loss of tangible personal property: Businesses and farms that move as a result of having their real estate acquired sometimes elect not to move some of their personal property. They may be eligible to receive a payment for this personal property. See 49 CFR 24.301(g)(14) for a complete explanation of how an Actual Direct Loss of Tangible Personal Property payment is calculated. (FHWA 2009)

administrative settlement: Payment amount offered by a state transportation agency to encourage the owner to agree to settle. (FHWA 2007)

after appraisal: Part of the appraisal of a property from which only a portion of that property is acquired for the planned project. This type of acquisition is often referred to as a "partial acquisition." That portion that is valued "after" the acquisition is sometimes referred to as the "remainder" or "remaining parcel." The after value takes into account the effects of the partial acquisition and any effects (negative or positive) that it may have on the value of the remainder. (FHWA 2009)

alternate dispute resolution (ADR): A range of different forums and processes that can be used to resolve a dispute. Two forms of ADR include administrative settlements and mediation. (FHWA 2009)

approved appraisal: An appraisal must be approved by an agency official before it can be used as the basis for offering an estimate of just compensation. (FHWA 2009)

before appraisal: Part of the appraisal of an affected property that estimates the value of the property as it is before the acquisition. Law and regulations typically require that this estimate of value cannot include any increase or decrease in the value of the property that results from the planned or anticipated project. (FHWA 2009)

condemnation: The legal process of acquiring private property for public use or purpose through the state's power of eminent domain. Condemnation is usually not used until all attempts to reach a mutually satisfactory agreement through negotiations have failed. (Virginia DOT)

cost of substitute personal property (relocation assistance): In some instances a business or farm owner who has to move his or her personal property may decide to replace some items of

personal property instead of moving them. The property owner may receive some reimbursement for replacing these items of personal property at the site to which he or she moves. An explanation of how to calculate the reimbursement a property owner is eligible to receive can be found at 49 CFR 24.301(g)(16). (FHWA 2009)

cost (appraisal approach): Cost, income capitalization, and sales comparison are the three approaches an appraiser can use to estimate the value of a property. The cost approach estimates the value of a property by adding the value of the land plus estimated cost to construct/replace the improvement and then subtracting the estimated amount of depreciation from the current structure. (FHWA 2009)

damages: In some instances, the acquisition, planned use, or construction may cause a loss in value of remaining property (damages may also extend to adjoining properties in which the property owner has an interest). Normally, the value of the damage is based on a before and after appraisal or on the cost to cure. An owner is entitled to payment of damages and receives this payment as a part of the payment of just compensation. (FHWA 2009)

disconnect costs: When a business or farm owner has to move personal property, he may be eligible to receive reimbursement for the cost to disconnect, dismantle, and remove his personal property. See 49 CFR 24.301(g)(3) for a list of federally reimbursable disconnect costs. (FHWA 2009)

DSS survey: Survey of physical condition of a replacement dwelling and its effect on the health and safety of the occupants. (FHWA 2009)

easement: An easement is the right of one person to use all or part of the property of another person for some specific purpose. Easements can be permanent or temporary. The term may be used to describe either the right itself or the document conferring the right. (Virginia DOT)

eminent domain: The right to take private property for public use. In the United States, just compensation must be paid for private property. (Virginia DOT)

encroachments: A situation that usually occurs when items such as a house, sign or well are discovered to be on agency property (right-of-way, etc.) illegally or without permission. (FHWA 2009)

fair market value: The price which a willing buyer will pay a willing seller for a piece of real estate. The exact definition of fair market value depends on where (the jurisdiction) the property being bought or sold is located, on state/local case law and on other state/local legal issues. (FHWA 2009)

federally assisted project: A federally assisted project is one which receives Federal reimbursement or payment of some project expenses such as planning, construction, right-of-way acquisition, and property management. (FHWA 2009)

(fixed residential moving cost) schedule: This schedule is used to calculate the amount of reimbursement that displaced persons may be eligible to receive if they decide to move their own personal property. A copy can be found at http://www.fhwa.dot.gov/realestate/index.htm in the section Relocation Assistance. (FHWA 2009)

functionally equivalent: Term used to describe how the replacement dwelling offered to a displaced person is to compare to the displacement dwelling in regard to performing the same function, and providing the same utility. (FHWA 2009)

highest and best use: The legal use or development/redevelopment of a property that makes it most valuable to a buyer or the market. (FHWA 2009)

housing of last resort: Justification for additional or alternative assistance when a program or project cannot proceed on a timely basis because comparable replacement dwellings are not available. (FHWA 2009)

Also referred to as last resort housing.

incentive payment: payments that are over and above the just compensation offer or computed relocation benefits. (FHWA 2006)

incidental expenses (settlement expenses): Reimbursement for some settlement expenses that a residential property owner may receive after he or she buys a dwelling to replace the acquired property. A complete list of eligible expenses can be found at 49 CFR 24.401(e)(1-9). (FHWA 2009)

increased mortgage interest costs: This is a payment that a residential property owner may be eligible to receive to offset the increased cost of getting a mortgage on a replacement dwelling. An explanation of how to determine if a property owner is eligible to receive this reimbursement and how to calculate the payment can be found at 49 CFR 24.401(d). (FHWA 2009)

initiation of negotiations: The date an agency makes the first personal contact with the owner of real property, or his/her representative, to provide a written offer to purchase the property being acquired. (Virginia DOT)

interest: A right, title, or legal share in something. People who share in the ownership of real property have an interest in the property. (Virginia DOT)

just compensation: The payment to a property owner to acquire property for a federally funded or federally assisted project. The payment includes the value of the real estate acquired and any damages caused to the remainder of the property by the acquisition and/or construction. (FHWA 2009)

last resort housing: Same as housing of last resort

lease: An agreement between a landlord, a property owner or property manager, and a tenant. (FHWA 2009)

loss of tangible personal property: Same as alternate actual payment [California DOT (Caltrans)]

memorandum appraisal: See minimum standards appraisal. (Caltrans)

minimum payment method: See waiver valuation. (Caltrans)

minimum qualifications of appraisers: The criteria that an agency uses to determine which appraisers or review appraisers are qualified based on experience, state licenses, or state certifications to perform specific appraisal and review assignments. Additional information on minimum qualifications of appraisers can be found at 49 CFR 24.103(d), Qualifications of appraisers and review appraisers. (FHWA 2009)

mobile home: The term mobile home includes manufactured homes and recreational vehicles used as residences [See 49 CFR 24.2(a)(17)]. (FHWA 2009)

negotiation: The primary method for acquiring property. It involves explaining items such as details of construction, offer of just compensation, and what just compensation is. The negotiation process involves listening to the property owner and determining the best way (negotiated settlement/administrative settlement) to reach an agreement for the sale of property. (FHWA 2009)

NEPA (National Environmental Policy Act of 1969): NEPA applies to all Federal agencies and most of the activities they manage, regulate, or fund that affect the environment. It requires all agencies to disclose and consider the environmental implications of their proposed actions. Information on NEPA and Federal aid project requirements can be found in the regulations at 23 CFR 771. (FHWA 2009)

nonprofit organization: A public or private entity that has established its nonprofit status under applicable Federal or state law. (Virginia DOT)

parcel diary: See waiver valuation. (Caltrans)

personal property: In general, refers to property that can be moved and is not permanently attached to, or a part of, the real estate. (FHWA 2009)

personalty: Refers to items that are determined to be personal property. (FHWA 2009)

realty: Refers to items that are determined to be real property. (FHWA 2009)

reestablishment expenses: A business, farm, or nonprofit organization may be eligible to receive reimbursement for some of its expenses related to relocating and re-establishing when it is required to move for a federally aided project. A list of expenses that are reimbursable can be found at 49 CFR 24.304. (FHWA 2009)

regulatory (Federal aid program): This refers to the regulations that tell how the Federal aid highway program is administered. The primary regulations for right-of-way real property acquisition, relocation, appraisal, property management, junkyard control, outdoor advertising, and property management are 23 CFR 710, 750, 751 and 49 CFR 24. (FHWA 2009)

relocation assistance program (RAP): Structured program to ensure that persons displaced as a result of a state highway project are treated fairly, consistently, and equitably. (Caltrans)

relocation impact document: See relocation survey. (Caltrans)

relocation planning: A process for federally aided projects and programs that involve identifying and considering the potential impact created by displacing residences, farms, businesses, and nonprofit organizations and planning methods to minimize that impact. Information on relocation planning requirements can be found at 49 CFR 24.205. (FHWA 2009)

relocation survey: The preparation of an inventory of characteristics and needs of individuals, families, businesses and non-profit organizations, and farms to be relocated including (1) a survey of the real estate market to determine if an adequate supply of comparable replacement housing and suitable replacement locations for businesses and farms will be available to meet the needs of the displaced persons in a timely manner, (2) an analysis of the problems anticipated in the relocation of the occupants including any special relocation advisory services that may be necessary, and (3) proposed solutions for resolving anticipated problems. (FHWA 2009)

replacement housing valuation: Same as DSS survey.

small business: A business having not more than an established number of employees working at a site that is the location of economic activity and that will be acquired for a program or project or is displaced by a program or project. (Virginia DOT)

statutory (Federal aid program): This refers to the laws passed by Congress that govern real estate acquisition activities for Federal and federally assisted programs and projects. The primary statute governing Federal and federally assisted real estate acquisition activities is the Uniform Act. (FHWA 2009)

stipulated (legal) settlement: In instances in which condemnation proceedings have begun, parties can still negotiate, and in some instances, can agree to a settlement before their case is heard. To conclude the negotiation, the parties present the judge or presiding authority their agreement to settle, which is called a stipulated settlement. (FHWA 2009)

uneconomic remnant: A segment of real property in which the owner is left with an interest after the partial acquisition of the owner's property, and which has been determined has little or no value or utility to the owner. (FHWA 2009)

utility relocation: The adjustment of a utility facility required by the program or project undertaken by the displacing agency. It includes removing and reinstalling the facility, including necessary temporary facilities; acquiring necessary right-of-way on a new location; moving,

rearranging, or changing the type of existing facilities; and taking any necessary safety and protective measures. (FHWA 2009)

waiver valuation: The valuation process used and the product produced when the agency determines that an appraisal is not required, pursuant to 49 CFR 24.102(c)(2) appraisal waiver provisions. (FHWA 2009)

Also referred to as minimum payment method; parcel diary (Caltrans)

APPENDICES

The appendices are not published herein but are provided on the *NCHRP Report* 695 summary web page (www.trb.org/Main/Blurbs/165239.aspx). The titles of the appendices are as follows:

Appendix A: Executive Summaries

Appendix B: Guide on How to Use the *8-55A Logical Model*

Appendix C: NCHRP *8-55A Logical Model* UML Diagrams

Appendix D: *8-55A Logical Model* Data Architecture & Class Model

Appendix E: Annotated Bibliography

Appendices B, C, and D are also available on the accompanying CD-ROM.

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation