INTEGRATING GEOSPATIAL TECHNOLOGIES INTO THE
PROPERTY MANAGEMENT PROCESS OF THE TRANSPORTATION
RIGHT-OF-WAY

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Thesis submitted to the Faculty of the Virginia Polytechnic Institute and State University in
partial fulfillment of the requirements for the degree of

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geographic information systems (GIS), unified modeling language (UML), enterprise architect

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Neelima Ghanta

ABSTRACT

Property Management, one functional area within Right-of-Way offices in state transportation agencies, is responsible for managing the property acquired for highway projects. These activities are data and document intensive and efficiency for performing them would be improved through the implementation of an information management system. Because of the geospatial nature of many of these activities, geographic information systems (GIS) would increase the effectiveness of this system. A literature review and survey were conducted to understand the current state of practice for the use of GIS and information management systems in Property Management. There is no identified comprehensive system that covers all Property Management activities. An initial step in developing a geospatially-enabled enterprise-level information management system, a logical model was developed. This included developing the business process diagram, business process models, and use case models based on the principles of systems engineering using the Computer Aided Software (CASE) Enterprise Architecture. Activities that would benefit from a geospatial component have been identified and included in the models. The developed models have been validated by working with PennDOT staff. The resulting model serves as a standard template for state transportation agencies and helps conceptualize the advantages of integration and interaction with other systems, and geospatial enablement prior to investment in an information management system.
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DEDICATIONS

I would like to thank my good friends, Nune and Sandeep who have always been there during my weakest times and whose company relieved me of the pain of being away from home. I would like to specially dedicate my work to my family who trusted me and gave me everything I wanted and my fiancé, Arun Shashank for his encouragement and love ever since I met him.
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CHAPTER 1: INTRODUCTION

1.1 PROBLEM STATEMENT

The right-of-way (ROW) division or office, which is a part of state transportation agencies, acquires and manages the land required for highway projects. Due to the data and document intensive nature of the work and the interdependency between ROW and other departments, it is often the bottleneck causing project delays and cost overruns. In an effort to improve the efficiency in project delivery, reduce delays, and improve service to the public, a major initiative for ROW offices is to manage the extensive information required to perform ROW activities electronically. Because of the strong geospatial nature of these activities, integrating geographic information systems (GIS) would add value to a ROW information system. Because ROW functional areas are strongly interdependent with each other and with other transportation activities, an enterprise level system that integrates these different activities is desired for optimal performance.

Traditional methods of collecting, storing, updating and disseminating ROW information is rigorous, time consuming, and often inefficient. Performance of different ROW activities can result in duplication of paper records or time loss due to locating necessary information. Duplicate data entry by different offices can result in inconsistency, missing data, and sometimes even data loss. These irregularities often result in undue delays and cost overruns. Maintaining and preserving this information on paper consumes space, is difficult to search, and is prone to damage and destruction.
Conversely, well-managed electronic data are more reliable, compact, reusable, consistent, and accessible. Properly managed and secure information management systems provide fast, convenient, and consistent access to multiple users, reducing the time and cost to access documents, eliminating data repetition and data-entry errors due to multiple formats, ultimately speeding up the entire ROW process which in turn reduces project costs. By using applications with centralized data management, data sharing between jurisdictions as well as with the public becomes possible.

To improve the efficiency of ROW activities, many states have automated the data entry, maintenance, storage, and display of information of some functional areas using various advanced technologies. A few states have incorporated enterprise-level information management system in their ROW offices. However, not many agencies have tapped the potential of GIS which are appropriate for many ROW functional areas due to the geospatial nature of these activities. GIS is a technology that manages, analyses, and disseminates geospatial information, making data more accessible to the decision maker. GIS decision making tools enhance data interpretation as well as data retrieval. Relationships, patterns, or trends are displayed through traditional charts, graphs, and spreadsheets as well as spatially using GIS (Hanson Professional Services Inc. 2005). The unique capability of GIS is that it allows location to be used to find, combine, view, display, and analyze information.

ROW activities include planning, engineering (design) of highways, property valuation, and acquisition, relocation, and management of both properties required for the highway projects and excess property. Each transportation project can be associated with large numbers of parcels,
whose status change with time, requiring the management of the corresponding ownership
details, property valuations, legal procedures, relocation options, and excess property disposition.
These activities are usually performed by different offices and in some cases, partially or fully by
contractors. ROW personnel also work with the public affected by the project. The overall
business process of a typical ROW office is shown in Figure 1-1.

This thesis focuses on Property Management function within ROW because, currently, this area
is under-represented in the use of information management and GIS (Hancock 2006). The other
functions are either already moving into geospatial environment or do not have a strong link to
GIS until they are incorporated into the enterprise.

The planning, engineering and mapping areas are strongly associated with ground data. GIS has
been used to identify environmentally sensitive areas in highway alignment in the planning
process (Marose and Gooch 2004, Federal Highway Administration 2004, Davey GIS services
planning activities like travel demand forecasting based on population trends, economic activity
and other factors, traffic assignment algorithms, current transportation system usage and
prediction of future additions to the system already incorporates information management and
GIS (GIS/Trans Limited 1999). Utility location, design and right-of-way plans, and outdoor
advertising activities are also beginning to migrate into a geospatially-enabled environment.
Most of the current applications use GPS to locate the facilities uniquely on the ground (Fraser
2000, Khunke 2001, Office of Real Estate Services 2004a, Office of Real Estate Services 2004b,
Figure 1-1. Business process diagram of ROW
Real-estate activities associated with property evaluation, acquisition and relocation are more transactional in nature than other ROW areas, which is why integration with GIS has not been as extensive as in other areas. Tasks follow a well-established and somewhat rigorous timeline and demand constant communication between the acquiring agency and the parcel owners and are document intensive. As these activities are not directly geospatial in nature, linking GIS has not been pursued as aggressively as for other areas.

1.2 RESEARCH GOALS AND OBJECTIVES

The goal of this research is to provide a prototypical framework for an enterprise-level geospatially-enabled information management system for Property Management activities within ROW offices of state transportation agencies. The objectives are to:

(1) Identify the current state of the practice in geospatially-enabled information management of Property Management in state Departments of Transportation (DOTs).

(2) Establish the business processes associated with ROW Property Management, and

(3) Develop the corresponding logical business process model.

1.3 RESEARCH APPROACH

The first step in this research was to study the current state of the practice in geospatially-enabled information management for Property Management in ROW offices of state DOTs. A literature review and survey were conducted to identify systems used in Property Management. Through the literature review, applications which were documented by the transportation agencies were identified. A survey was devised to obtain detailed information about the
Property Management systems that are currently in use by state transportation agencies. The survey has also helped to obtain more information about the systems that were identified in the literature. States which actively use GIS for Property Management activities were identified thorough a screening survey and were then sent a detailed survey to obtain information about how GIS has been implemented.

The next step of this research was to establish the business processes used in Property Management and to develop the corresponding business process diagram, showing the associated activities, sequence of information flow and activities, and association with and dependency on other departments and/or activities. This is the initial step to developing any effective information management system (Fletcher 1999).

Following the development of the process diagram, a business process model and a use case model for Property Management, two system design tools, were developed. The business process model provides a microscopic view of each activity within Property Management. The inputs (resources), actors, associated activities, dependent activities, output(s), goals, and responsibilities of each activity were identified. The use case model gives a bigger picture of Property Management showing all the activities and the corresponding actors. It also shows the relation between the processes, such as mandatory sequence, dependency between processes, and alternate sequence of processes to achieve a goal. Uniform Modeling Language (UML) was used to develop these models in “Enterprise Architect” (Sparx Systems Pty Ltd. 2004).
Finally, the *business process* and *use case models* were evaluated by working with Pennsylvania DOT’s ROW division personnel to ensure that the logical model effectively reflected their Property Management activities within their office.

### 1.4 Thesis Contributions

The literature and survey results show the current state of practice in information management of Property Management in state DOTs. Existing applications have different features, functionalities, hardware and software requirements, and user skills, providing various sets of benefits. Based on this, a *logical business model* for a prototypical information management system incorporating GIS for Property Management was developed.

The resulting contribution of this thesis is a template for an information management system for Property Management which realizes the following benefits:

- Provides a template for use by state DOTs to develop systems tailored to their needs
- Provides a tool for DOTs to see the possible outcomes through integration, interaction, and geospatial enablement before investing funds for a system to manage Property Management information
- Provides a structure to enable the integration of the Property Management information management system into an enterprise-level ROW information management system which would improve the project delivery process

The output of this research will assist DOTs with making decisions about funds investment and workforce allotment related to the development of a geospatially-enabled information
management system for Property Management activities. The results of this research are directed primarily to state transportation agencies.

1.5 REPORT STRUCTURE

Following the introduction in Chapter 1, Chapter 2 presents a review of relevant literature and evaluation of survey results to establish the background on which this research is based. Chapter 3 presents the methodology and development of the business process diagram, business process models, and use case models for Property Management while Chapter 4 describes the model validation performed with the assistance of Pennsylvania DOT (PennDOT) ROW staff. Finally, Chapter 5 presents conclusions and recommendations for further research.
CHAPTER 2: BACKGROUND

The purpose of Property Management is to administer and monitor acquired parcels and improvements prior to and after construction of a transportation project such that the public interest is served. This can include highway airspace which consists of the space above and below the highways as well as the on-ground space within right-of-way limits. Maintenance and monitoring of state-owned land is a continuous process which requires data and map preservation and continuous access to information.

Property Management includes activities which are transactional as well as geospatial in nature. Effective (electronic) information management is a basic step to improve the efficiency of any data intensive task. Geospatial enablement of the information management system adds value to the system by enabling visual spatial interpretation of data and links information using location as the common attribute. Finally, an enterprise-level system typically allows data sharing throughout the organization and across various departments.

The current state of practice of geospatially-enabled information management for Property Management in ROW offices is investigated through two methods, a review of the literature and a survey of state transportation agencies. Each focuses on current practices including technologies and applications used by states for property and asset information management for the ROW. The last section provides a brief review of the development of geospatially-enabled enterprise-level information management systems.
2.1 Literature Review

Based on a review of the literature, information systems that have a Property management component are categorized primarily as enterprise-level systems with or without GIS and activity-specific information systems (stand-alone) with GIS. Because of the large variation in the nature and time span of the different tasks in Property Management, existing information management systems are quite diverse in terms of size, technologies used, and tasks performed. It is evident from the literature that GIS for ROW is currently used primarily to display maps electronically, rather than as an analysis or decision-making tool by most state ROW agencies.

Examples of non-GIS enterprise systems include Right of Way and Utilities Management System (RUMS) of Virginia (AASTHO 2004) and Real Estate Management Information System (REMIS) of Michigan (Michigan Department of Transportation 2003), which have been used for information management across most ROW activities. For Property Management, RUMS handles maintenance and disposal of surplus properties and identification and management of property available for wetland replacement. REMIS includes excess property inventory maintenance, sale of improvements, and fixture disposal.

Highway Access Management System (HAMS) of Wisconsin is the only enterprise-level information management system identified where GIS has been used for decision making in addition to information management and display. Specifically, HAMS addresses highway access management of Property Management which is one of the post-construction activities (Mehta, 2006). Aeronautics Land Acquisition System (ALAS) of Illinois is an information management system covering most Property Management activities. ALAS is a geospatially-enabled web
application used to keep track of maintenance of the acquired property like clearance, and leasing / renting, prior to and during the construction phase (Hanson Professional Services Inc. 2005).

For activity-specific systems, New Jersey DOT has electronic maps that are accessible to personnel from all ROW departments, which is one of the basic uses of GIS (Ozbay 2004). In this case, information is stored and retrieved electronically. New Mexico DOT (NMDOT) has automated one task of Property Management using Non Right-of-Way Parcel and Improvement Inventory. Excess property maps are generated and made available to the public over the internet, which helps NMDOT keep track of parcel sales, abandonments, trades, leases, encroachments, and road exchanges with reduced record maintenance costs and response times (Federal Highway Administration 2004). California is planning to develop the Digital Land Record Information (DLRI) system, which will provide on-line access to land records information to various organizations as well as the public using GIS (Marose and Gooch 2004). This system will be a library of electronic land records that could be used by private and public agencies. Mississippi’s ROW division is designing a GIS system to develop a Parcel Tracking System that can be used to manage property clearance prior to construction (Petyon and Mississippi Department of Transportation 2002). All the identified Property Management systems have been summarized in Table 2-1.
Table 2-1. Summary of literature review

<table>
<thead>
<tr>
<th>Level of Automation</th>
<th>Name of the system</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Real Estate Management Information System (REMIS) (Michigan Department of Transportation 2003)</td>
<td>Michigan</td>
</tr>
<tr>
<td>Geospatially-enabled information management systems</td>
<td>New Jersey system (Ozbay 2004)</td>
<td>New Jersey</td>
</tr>
<tr>
<td></td>
<td>Non Right of way Parcel and Improvement Inventory (Federal Highway Administration 2004)</td>
<td>New Mexico</td>
</tr>
<tr>
<td></td>
<td>Digital Land Record Information (DLRI) (Marose and Gooch 2004)</td>
<td>California</td>
</tr>
<tr>
<td></td>
<td>Aeronautics Land Acquisition System (ALAS) (Hanson Professional Services Inc. 2005)</td>
<td>Illinois</td>
</tr>
<tr>
<td></td>
<td>Parcel Tracking system (Peyton and Mississippi Department of Transportation 2002)</td>
<td>Mississippi</td>
</tr>
<tr>
<td>Enterprise level geospatially-enabled information management systems</td>
<td>Highway Access Management System (HAMS) (Mehta, 2006)</td>
<td>Wisconsin</td>
</tr>
</tbody>
</table>

From this review, no information management system, with or without GIS, currently addresses all, or even most of, the activities that are performed by Property Management offices.

2.2 Survey of States

A screening survey was given to the participants of the 2005 American Association of State Highway and Transportation Officials (AASHTO)/Federal Highway Administration (FHWA) Right of Way and Utilities Subcommittee Conference in Austin, Texas, to identify states which actively use GIS to perform ROW activities. Thirty-five states and Puerto Rico responded. Respondents and states identified in the literature or referenced by already-participating states as using geospatial technologies were sent a detailed survey, provided in Appendix A, to obtain information about how GIS has been implemented in their ROW activities including Property Management. The survey was designed to obtain information about systems that are actually used in practice, development and maintenance details of the system, extent of geospatial nature
of the activities, benefits and/or returns on the investment for the system, variety and complexity of technical tools being used, and geospatial data requirements.

Of the 24 responses, 17 indicated general use of GIS while 11 indicated using an information management system for Property Management as summarized in Table 2-2. Nine of the eleven states indicated the use of GIS for Property Management.

**Table 2-2.** Survey results showing information management systems with GIS in Property Management

<table>
<thead>
<tr>
<th>State</th>
<th>GIS used</th>
<th>Stand alone*</th>
<th>Part of Comprehensive system (enterprise)</th>
<th>Name of the system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Property Management Parcel Inventory</td>
</tr>
<tr>
<td>California</td>
<td>Y</td>
<td>NI</td>
<td>NI</td>
<td>Excess Land Tracking GIS Website</td>
</tr>
<tr>
<td>Delaware</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Geo Media, Real Estate Management</td>
</tr>
<tr>
<td>Florida</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>RWMS</td>
</tr>
<tr>
<td>Georgia</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>T-Pro</td>
</tr>
<tr>
<td>Maryland</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Extraland</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Pictometry &amp; ArcView</td>
</tr>
<tr>
<td>Minnesota</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Traffic Sign Inventory</td>
</tr>
<tr>
<td>Mississippi</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Microsoft suite, Parcel Tracking software</td>
</tr>
<tr>
<td>New Mexico</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>ESRI ARCMAP 9</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>GRIP</td>
</tr>
</tbody>
</table>

* Independent systems which neither take input from other systems nor send output and/or information to other systems
NI – Not Indicated

Survey results show that the majority (9 out of 11) of states have geospatially-enabled stand-alone applications in ROW offices. Massachusetts and Delaware use an application where GIS is used to store and access electronic maps throughout the ROW division. Maryland and Arizona use a system with intelligent maps to carry out property maintenance, leasing, and disposal. These maps have information associated with their spatial location that could be used for
decision making. The Excess Land Tracking GIS Website of California enables Property Management staff to view zoomable maps of excess land locations, along with property status. Georgia has a non-GIS system, T-Pro which is used to manage parcel information. The geospatial component of the enterprise system GRIP in Oklahoma is being planned. It is used to manage post-construction activities within Property Management. The systems of Florida and Minnesota mostly manage information for Outdoor Advertising activities. These systems are summarized in Table 2-3.

Table 2-3. Summary of survey results showing systems used for Property Management (Hancock 2006)

<table>
<thead>
<tr>
<th>Level of Automation</th>
<th>Name of the system</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geospatially-enabled information management systems</td>
<td>Property Mgmt. Parcel Inventory</td>
<td>Arizona</td>
</tr>
<tr>
<td></td>
<td>Excess Land Tracking GIS Website</td>
<td>California</td>
</tr>
<tr>
<td></td>
<td>Geo Media, Real Estate Management</td>
<td>Delaware</td>
</tr>
<tr>
<td></td>
<td>Extraland</td>
<td>Maryland</td>
</tr>
<tr>
<td></td>
<td>Pictometry &amp; ArcView</td>
<td>Massachusetts</td>
</tr>
<tr>
<td></td>
<td>Traffic Sign Inventory</td>
<td>Minnesota</td>
</tr>
<tr>
<td></td>
<td>ESRI ARCMAP 9</td>
<td>New Mexico</td>
</tr>
<tr>
<td>Enterprise level geospatially-enabled information management system</td>
<td>GRIP (in planning stage)</td>
<td>Oklahoma</td>
</tr>
<tr>
<td>Enterprise level information management system</td>
<td>RWMS</td>
<td>Florida</td>
</tr>
<tr>
<td></td>
<td>Microsoft suite, Parcel Tracking software</td>
<td>Mississippi</td>
</tr>
<tr>
<td></td>
<td>T-Pro</td>
<td>Georgia</td>
</tr>
</tbody>
</table>

Table 2-4 summarizes the system utility, implementation status, and future plans of each state for information management of Property Management. The majority of these systems are used by ROW/Utility personnel or other transportation staff of the DOTs. In general, the applications that were implemented recently are being used occasionally, whereas older systems have become an integral part of Property Management and are being used regularly. The survey shows that the
majority of the states are looking forward to developing their systems further to integrate with enterprise-level systems.

Table 2-4. System utility, implementation status and future plans of each state

<table>
<thead>
<tr>
<th>State</th>
<th>Name of the system</th>
<th>How often used</th>
<th>ROW/Utilities</th>
<th>Other Transportation staff</th>
<th>Consultants</th>
<th>Public</th>
<th>Other</th>
<th>How long</th>
<th>Stage of Implementation</th>
<th>Who uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>Property Mgmt. Parcel Inventory</td>
<td>Occasionally</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>California</td>
<td>Excess Land Tracking GIS Website</td>
<td>Regularly</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Delaware</td>
<td>Geo Media, Real Estate Management</td>
<td>Occasionally</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Florida</td>
<td>RWMS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NI</td>
<td></td>
</tr>
<tr>
<td>Georgia</td>
<td>T-Pro</td>
<td>Regularly</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Maryland</td>
<td>Extralnd</td>
<td>Regularly</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>Pictometry &amp; ArcView</td>
<td>Regularly</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Minnesota</td>
<td>Traffic Sign Inventory</td>
<td>Regularly</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Mississippi</td>
<td>Microsoft suite, Parcel Tracking software</td>
<td>Occasionally</td>
<td>NI</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>New Mexico</td>
<td>ESRI ARC MAP 9</td>
<td>Regularly</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>GRIP</td>
<td>Regularly</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

NI - Not Indicated

Table 2-5 summarizes how the systems were developed and are maintained by DOTs. Most of the systems have been purchased from consultants. General maintenance and technical assistance is mostly provided by the information technology staff of the corresponding DOTs. Systems in
Maryland and New Mexico that are simple and small do not have any documentation. Larger systems have at least one method of documentation.

Table 2-5. System development and maintenance aspects

<table>
<thead>
<tr>
<th>State</th>
<th>Name of the system</th>
<th>Purchased from consultant</th>
<th>Purchased from vendor</th>
<th>Who developed</th>
<th>Who maintains</th>
<th>Technical assistance</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>Property Mgmt. Parcel Inventory</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>California</td>
<td>Excess Land Tracking GIS Website</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Delaware</td>
<td>Geo Media, Real Estate Management</td>
<td>NI</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Florida</td>
<td>RWMS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Georgia</td>
<td>T-Pro</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Maryland</td>
<td>Extraland</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>Pictometry &amp; ArcView</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Minnesota</td>
<td>Traffic Sign Inventory</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Mississippi</td>
<td>Microsoft suite, Parcel Tracking software</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>New Mexico</td>
<td>ESRI ARCMAP 9</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>GRIP</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

NI - Not Indicated

Table 2-6 summarizes the additional technologies used and the agency benefits of an information management system. In addition to GIS, imagery is being used in many systems to augment geospatial data. Data warehousing helps to maintain a time-variant, integrated and non-volatile
database for analysis and decision making and is a feature observed in some systems. Web interface, Global Positioning System (GPS), and data integration are also additional features used by a few states in Property Management systems. These applications have largely reduced personnel time, improved coordination and decision making. According to the survey responses, cost reduction is not documented or tracked, often because GIS systems have high start-up costs which show return on the investment only in the long term.

Table 2-6. Additional system features and benefits to the DOTs

<table>
<thead>
<tr>
<th>State</th>
<th>Name of the system</th>
<th>Advanced technologies in addition to GIS</th>
<th>Benefits to your agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>Property Mgmt. Parcel Inventory</td>
<td>Y N N N Y Y N N</td>
<td>Reduced personnel time</td>
</tr>
<tr>
<td>California</td>
<td>Excess Land Tracking GIS Website</td>
<td>N N Y Y Y Y N</td>
<td>Reduced project delivery time</td>
</tr>
<tr>
<td>Delaware</td>
<td>Geo Media, Real Estate Management</td>
<td>N N N Y Y N N</td>
<td>Reduced costs</td>
</tr>
<tr>
<td>Florida</td>
<td>RWMS</td>
<td></td>
<td>Improved coordination between activities</td>
</tr>
<tr>
<td>Georgia</td>
<td>T-Pro</td>
<td>N N Y N Y Y N</td>
<td>Improved streamlining</td>
</tr>
<tr>
<td>Maryland</td>
<td>Extraland</td>
<td>N N N N N N Y</td>
<td>Improved decision making</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>Pictometry &amp; ArcView</td>
<td>Y N Y N N N</td>
<td>Improved quality of work</td>
</tr>
<tr>
<td>Minnesota</td>
<td>Traffic Sign Inventory</td>
<td>Y Y N N N N</td>
<td>Improved volume of work</td>
</tr>
<tr>
<td>Mississippi</td>
<td>Microsoft suite, Parcel Tracking software</td>
<td>Y Y Y Y Y N</td>
<td>Improved communications</td>
</tr>
<tr>
<td>New Mexico</td>
<td>ESRI ARCMAP 9</td>
<td>N N Y Y Y N</td>
<td>Other</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>GRIP</td>
<td>N N Y Y N N</td>
<td>Other</td>
</tr>
</tbody>
</table>

NI - Not Indicated

Table 2-7 summarizes the data layers used in the geospatial component of the systems. As shown, the parcel layer with core cadastral, geospatial and ROW specific information, and road
centerlines are the most common layers used in Property Management systems. Aerial imagery is often used for display purposes.

Table 2-7. GIS data layers used in each system

<table>
<thead>
<tr>
<th>State</th>
<th>Name of the system</th>
<th>Data Layers in the System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>Property Mgmt. Parcel Inventory</td>
<td>Y Y N N N N Y Y Y Y</td>
</tr>
<tr>
<td>California</td>
<td>Excess Land Tracking GIS Website</td>
<td>Y Y N N N N N Y N N</td>
</tr>
<tr>
<td>Delaware</td>
<td>Geo Media, Real Estate Management</td>
<td>Y N Y N N Y N Y N Y</td>
</tr>
<tr>
<td>Florida</td>
<td>RWMS</td>
<td></td>
</tr>
<tr>
<td>Georgia</td>
<td>T-Pro</td>
<td>N N N N N N N N N</td>
</tr>
<tr>
<td>Maryland</td>
<td>Extraland</td>
<td>Y Y Y N N N N N N</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>Pictometry &amp; ArcView</td>
<td>N N N N N N N N Y N</td>
</tr>
<tr>
<td>Minnesota</td>
<td>Traffic Sign Inventory</td>
<td>N N Y N N N N N Y</td>
</tr>
<tr>
<td>Mississippi</td>
<td>Microsoft suite, Parcel Tracking software</td>
<td>Y Y Y Y N N N Y Y N</td>
</tr>
<tr>
<td>New Mexico</td>
<td>ESRI ARCMAP 9</td>
<td>Y Y Y Y N N Y N N N</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>GRIP</td>
<td>N N Y N N Y N Y N N</td>
</tr>
</tbody>
</table>

NI - Not Indicated

From the literature review and survey results, it has been identified that most of Property Management systems with GIS carry out only limited activities within Property Management, and are standalone. On the other hand, Property Management is highly associated with other ROW functional areas like appraisal, acquisition and relocation, and non-ROW areas like construction. Although many states have strategic plans to develop an enterprise-level geospatially-enabled right-of-way systems, none are currently used in practice.
Larger systems like ALAS, GRIP, HAMS, RUMS, REMIS enable data sharing with other ROW departments, whereas, individual applications such as those used by New Mexico, New Jersey, Maryland, Arizona, Massachusetts, and Delaware provide limited interaction for ROW as a whole. Although there are systems serving multiple ROW areas, none of them actually cover all the activities within Property Management. Some maintenance activities like inventory management, rodent control, sale of improvements, airspace marketing and development within Property Management have not been addressed in any identified system. Lack of a geospatial component in systems like RUMS, REALMS, and REMIS potentially reduces their effectiveness since they do not provide visualization of the information. Accessing the information using the desired location on a map is more intuitive than searching an ID or name or address. Viewing the parcel status on a thematic map is easier to assimilate and more informative than looking at a table of textual facts.

From the surveys, barriers to developing a geospatially-enabled ROW information management system include high software development costs, lack of knowledge about benefits of information management systems, lack of domain experts within organizations, absence of proper data maintenance, lack of coordination, inadequate networking capabilities, fear of new technology, and lack of willingness by the organization to change.

It is evident from the literature and surveys that current geospatially-enabled information management systems for Property Management in ROW offices are mostly standalone applications that use GIS to display maps electronically, rather than as an analysis or decision-making tool. Of the systems identified, ALAS is a standalone ROW-level enterprise system
covering many of the Property Management activities, while HAMS is the only enterprise level geospatially-enabled ROW information management system, which handles only a minimal portion of Property Management activities.

In brief, no currently used geospatially-enabled enterprise level system was identified that covers all Property Management tasks. Although surveys reveal that many DOTs are interested in extending their systems by adding new modules, and/or integrating other systems, there is still a need for a comprehensive application covering the activities of Property Management which includes GIS and enterprise-level data integration.

2.3 GEOSPATIALLY-ENABLED ENTERPRISE INFORMATION MANAGEMENT SYSTEMS

Enterprise GIS is a coordinated effort taken across various organizations to build a common, standard, and more precise geospatial infrastructure that is accessible across jurisdictional and organizational boundaries. The enterprise enables uniform access to the data for all users. Geospatial data are made available to users either through user specific views, individually customized applications, and/ or through communication to enterprise-level systems (Oppmann 1999).

Enterprise systems assure both horizontal and vertical integration of data across organizations. Data sharing between the same department in various locations is horizontal integration. Data interoperability between different departments at various levels of an organization is vertical
integration. In both the cases, each organizational unit has consistent data without having to perform data maintenance functions (Oppmann 1999).

Barriers to implementing geospatially-enabled information management systems are as follows:

- States have not identified information as a resource that needs to be developed and maintained. Lack of knowledge about the benefits of information management systems and the associated cost generally does not encourage organizations in this direction.
- Lack of domain (information technology) expertise in higher officials who have decision making powers. As a result, there is no driving force.
- Lack of consistent, accurate and up-to-date data has been difficult, particularly if there is no strong centralized IT capability.
- Lack of coordination and communication between various participating agencies has caused the enterprise approach to fail.
- In the past, fast, reliable, redundant, and secure networking capabilities required for information management systems were considered resource intensive.
- Fear of new technology has been difficult to overcome. In addition, procedures such as lack of support for training were established which made the change to new methods difficult.
Enterprise GIS is likely to be used in the future due to several emerging technological and organizational trends that are as follows (Oppmann 1999):

- Rapidly evolving technology in terms of hardware, software and networking is increasing the expectations of the public on the organizations in terms of flexibility, efficiency and timeliness.
- Development of technologies requiring lesser user expertise and with graphical user interfaces is a boost to the GIS users to integrate geospatial component into applications.
- Increasing availability and knowledge of GIS to the end users due to rapid computerization in the society and the commercialization of GIS.
- Increasing demand on core GIS resources which can not be managed easily by individual departments within an organization unless, coordinated efforts are put together to build a federated system.

Steps in building an enterprise system are:

- Building flow diagrams that shows information and work flow within as well as between the organizations.
- Developing an enterprise-level information (logical) model which includes data sources, sinks, and work and/or information flow within the organization as well as the ones crossing the enterprise boundary (Fletcher 1999).
- Construction of domain models (high level business objects), sequence diagrams, collaboration diagrams, and user interface models (Sparx Systems Pty Ltd. 2004).
- Creating class models that specify the exact objects in the system, their data and attributes, and their behavior or operations (Sparx Systems Pty Ltd. 2004).
• Building component models which define the discrete packages and components that would become deployable chunks of software (Sparx Systems Pty Ltd. 2004) or defining system boundaries by grouping closely linked processes and data together (Fletcher 1999).

This research is focused on creating the backbone for a geospatially enabled information management system and follows the first two steps outlined above.
CHAPTER 3: METHODOLOGY

Development of an enterprise-level geospatially-enabled ROW information management system requires enumerating the business processes of the functional areas that are to be included. This is followed by development of an information management system with or without a geospatial component that may or may not be integrated with other departments in an enterprise environment to enable automatic data import and export, based on the needs and budget of the organization.

As discussed earlier, this research focused on Property Management activities within state transportation agency ROW offices. In transportation projects, there is usually an interim period between the acquisition of land and construction of the transportation facility after the property is purchased. Acquired land and any accompanying improvements are valuable resources which must be protected and often can be productive during this interim period. Even after construction is completed, the right of way needs to be monitored to ensure safe and effective functioning of the highway facility, and the excess property needs to be disposed to protect the investments of the public. The administration of acquired land and improvements is called Property Management and is sub-categorized as pre-construction, construction, and post-construction.

Pre-construction activities mainly are managing the property before the construction actually begins. The parcel requirement for the project is determined soon after it is acquired or after the relocation of the property owners. Next improvements on the parcel are disposed through sale, owner retention, or demolition. In the case of projects that commence months or years after
acquisition, property is rented temporarily. During this period, as the property must be maintained in decent, safe, and sanitary (DSS) condition, maintenance agreements are signed either with the tenant or contractor. This is followed by property clearance or demolition prior to construction.

If the time gap between acquisition and highway construction is short, during-construction activities begin without renting and maintenance tasks. For the construction, land is graded which is often contracted or may be part of construction. Security inspections of the acquired property and rodent control are carried out routinely during pre-construction and during-construction phases of Property Management.

Post-construction activities include identifying excess property and disposing of it in the most profitable manner or tracking and managing property that is not sold or part of the transportation right of way. Right-of-Way maintenance includes safety of the highway by preventing encroachments, protecting access control, and monitoring and marketing of highway airspace after the construction is complete.

First, the activity flow of Property Management is represented through a business process diagram described in section 3.1. This is used to develop a Logical Model which includes business process models and use case models for Property Management for a prototypical geospatially-enabled, ROW Property Management information system. For each type of model, terminology and symbols of that model type are explained. This is followed by a detailed
discussion of an example process or use case. The complete models are provided in appendix B
and C respectively.

3.1 BUSINESS PROCESS DIAGRAM

The initial step in effectively designing an information management system is developing a

diagram of the activities involved in the business, known as a business process diagram. A

business process produces specific outputs from defined inputs and resources. The process
diagram shows the various interactions within the organization to produce the desired output. A

process can thus be defined as a specific ordering of work activities across time and place, with a

beginning, an end, and clearly defined inputs and outputs (Sparx Systems Pty Ltd. 2004).

The FHWA real estate, project development and acquisition guides and right-of-way guides were

used to establish the general sequence of tasks within Property Management and were the

primary inputs for building the process diagram (FHWA 2006a, FHWA 2006b). These

guidelines outline the required activities within Property Management when federal funds are

used in the highway project. States typically perform these tasks for projects that do not include

federal funds, as well.

The diagram, shown in Figure 3-1, gives a general framework of Property Management activities

which individually are often more complicated. The work involved in each activity or functional

area of ROW depends on laws and policies at the state level, nature of the taxing authority,

physical characteristics of the state, etc. In addition to this, any of the activities shown in Figure

3-1 might or might not be a part of Property Management ROW activities for any given state. Air
space management can be part of Outdoor Advertising which is often a separate office either within or outside ROW. Similarly, ROW inventory management (signs, shared ROW leases) is often considered to be a part of asset management, not Property Management. The activities of Property Management are characterized in a flowchart in Figure 3-1.
Figure 3-1. Business process diagram of Property Management
3.2 **Logical Model**

After defining the scope and activities of Property Management using a business process diagram, the next step was to develop a *logical model* which is an essential part of software development. It allows the software developer to capture the overall structure and procedures that comprise the work done by the organization or department (Spewak 1993). In the following discussion, the bold terms are the technical terms used by Enterprise Architect, the italicized terms are the titles of various elements (processes, actors, events, use cases, classes) in the developed models, and the geospatial component and potential ways of using the geospatial technology for an activity have been presented in blue box with links to related activities. In the discussion of the business process model and use case model examples, a number in parenthesis after the italicized terms is used to help the reader easily locate the element in the figure of the model.

The logical model defines the sequence of information flow, system bottlenecks and interactions where processed information is awaited from related departments, inputs and outputs of each functional area, and the resources required. External information and user inputs come from the larger enterprise(s) and, often, the output is a feedback to the larger enterprise itself. A *logical model* helps to effectively define the input and output data, provides a template to customize systems according to the specific requirements of each agency, enables users to understand the bigger picture involving interaction and integration with all involved divisions, and represents the system’s role in meeting agency goals. This, in turn, helps contain costs by enabling long-term planning and effective use of labor.
The logical model of Property Management has been represented in two forms, as a business process model and as a use case model. The business process model helps to describe the intricate details of the system by representing all activities and sub-activities of that system along with its associated elements like inputs, outputs, goals, and actors. By connecting design elements (such as use cases) back to the business process model, a fully traceable model can be constructed extending from the broad process outlines to the functional requirements and eventually to the software itself. The use case model gives an overall idea of the Property Management system and its integration and interaction with other ROW systems along with the parties responsible or associated with the business processes within the system. Though there are various models to represent a business process diagram, business process model and use case model have been chosen because together these models enable the reader to understand the process without missing any details required for development of a preliminary application. The models have been described in detail in the following sections with examples.

The two components of the logical model were developed using the Computer Aided Software Engineering (CASE) tool Enterprise Architect by Sparx Systems (Sparx Systems Pty Ltd. 2004). The tool is based on the uniform modeling language (UML) which is flexible, extendable, and comprehensive, yet generic enough to be applied to any software system. Using Enterprise Architect, individual activities were built and then linked to represent the Property Management.
3.2.1 Business Process Model

The business process model describes both the behavior of and the information flows within an organization or system. It is a representation of each business process (activity) within a system, in this case, Property Management. The inputs (resources), actors, output(s), goals, and the responsibilities of each activity are captured. The activities are linked based on the business process diagram in Figure 3-1. A business process model, in addition to being a crucial step in designing a software system, enables the developer to clearly identify the scope of the proposed system and the part of the system that is not a part of the automation or that remains a manual process (Sparx Systems Pty Ltd. 2004).

3.2.1.1 Components of the Business Process Model

The concepts associated with business process modeling necessary to understand a business process model have been described in this section.

- **Resource**: A resource is an input to a business process, and, unlike information, is typically consumed during the processing. For example, at the end of highway construction, geospatial layers of parcels acquired and proposed right-of-way are used up to create layers of the actual non-right-of-way property. At the end of the construction, the initial parcel boundaries will not exist anymore.

- **Information**: Business processes use information to tailor or complete their activities. Information, unlike resources, is not consumed in the process - rather it is used as part of the transformation process. Information may come from external sources, customers, internal organizational units, or may be the product of other processes. For example,
during the excess property sale, the appraisal data of a parcel is viewed by the Property Management personnel to determine the worth of the property and the actual boundaries of the parcel. Using these data, the property is advertised for sale. The source of the information could be an actor, an object or an event. In this example, the information source is the object of “parcel” and the “parcel feature” from the geospatial layer of parcels.

- **Output**: A business process will typically produce one or more outputs of value to the business, which either feed into or trigger subsequent internal activities or other external systems. An output may be a physical object, such as an updated record or invoice, a transformation of raw resources into a new arrangement, such as grading of the land for the ROW, or an overall business result, such as disposing of excess property.

- **Goal**: The goal is the reason the organization does the work. It defines the benefits this process has for the organization as a whole and how this process satisfies business needs.

3.2.1.2 **KEY TO THE BUSINESS PROCESS MODEL**

The components of a business process model discussed in the previous section and the connectivity between them is represented using the symbols shown in Table 3-1.
Table 3-1. Key to Business Process Model

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Class</strong></td>
<td>Defines the abstract characteristics of a thing, including the thing's characteristics (its attributes or properties) and the things it can do (its behaviors or methods or features). For example, the class “ROW inventory” would consist of attributes of the ROW, for example width, length, capacity, location of utility lines, etc. Methods of a class are the activities associated with the class, for example update and delete records. Collectively, the properties and methods defined by a class are called members. An Object is a particular instance of a class. For example, a section of four lane highway for a project, where the highway is an object and number of lanes and width of the Right of way are attributes.</td>
</tr>
<tr>
<td><strong>Receive event</strong></td>
<td>Indicates that an event occurs in the system due to some external or internal stimulus. Typically this will invoke further activities and processing. For example, the process, owner retention of improvements in Pre-construction Property Management, is triggered by an event, Justification. The Property Management personnel need to approve that there is another lot available to move the improvements and that the owner retention reduces the project costs when compared to demolition or clearance of the improvements from the site.</td>
</tr>
<tr>
<td><strong>Send event</strong></td>
<td>Models the generation of a stimulus in the system and the passing of that stimulus to other elements within the system or external to the system. In the excess property sale, after the construction of the highway, retention of the property may be desired to selling it, due to various reasons. In which case, the parcel object that is going to be retained by the ROW is updated to the database through a send event called, retain.</td>
</tr>
</tbody>
</table>
| **Actor** | Person, machine, other systems, current system or sub-system that triggers events or processes. Actors in Property Management –  
FHWA personnel | Person  
Property Management Personnel | Person  
Appraiser | Person  
Relocator | Person  
Appraisal | Other system  
Acquisition | Other system  
Relocation | Other system  
Property Management | Property Management system |
### Table 3-1. Key to Business Process Model (cont.)

<table>
<thead>
<tr>
<th>Process</th>
<th>Composite Process</th>
<th>Collaboration</th>
<th>Decision</th>
<th>Supply Link</th>
<th>Input Link</th>
<th>Output Link</th>
<th>Control flow Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>An activity element comprising a set of well established tasks which expresses the concept of a business process. Typically a process involves inputs, outputs, work flows, goals and connections with other processes. Example of a Process is, Parcel Requirement Status in Pre-Construction Property Management. It involves tasks like viewing the location of parcels and proposed Right of way, and determining the extent to which the parcels might be used in the project. Business processes that involve sub-processes are composite processes. Such processes are depicted by an additional infinity symbol on the right. For example, the composite process Improvement Disposal consists of alternative processes defining ways of disposal like owner retention, sale, and demolition which each involve events, inputs, processes, outputs, and actors.</td>
<td></td>
<td>Defines a set of cooperating roles and their connectors. These are used to collectively illustrate a specific functionality. For example, property owners who have temporarily rented a parcel until the construction actually begins are to be relocated. Relocation settlement involves rent that the owner might owe and the relocation assistance that ROW owes to the owner. At this point, Property Management works in association with the Relocation department of ROW.</td>
<td>Indicates a point of conditional progression. It is a point where subsequent activities vary based on the choice made. For example, in Excess Property Sale, if federal funds are involved in the project, value of excess property is a point of decision whether to advertise the property for sale or retain the property.</td>
<td>Indicates that the information or object linked to the process is viewed in the processing phase without alteration and / or exhaustion. In the model, the link connecting the Property Management personnel and the event, Justification is an information link. The link shows the approval from the Property Management personnel.</td>
<td>Indicates that the attached object or resource is consumed in the processing procedure. The link connecting geospatial layers to the process where the parcel’s extent of usefulness in the project is determined. In this case, the information about the parcel requirement would be updated back into the database.</td>
<td>Link to object ‘Output’. The links connecting most of the processes in the model to the parcel database are output links. Attributes of the parcels are updated to the database after every process, prior to construction.</td>
<td>Link from another process that represents the sequence of activities and the direction of work flow. It generally connects two business processes. Links between consecutive processes like Pre-construction and During construction Property Management.</td>
</tr>
</tbody>
</table>
### Table 3-1. Key to Business Process Model (cont.)

<table>
<thead>
<tr>
<th>Association Link</th>
<th>Indicates that processes attached by this link work together on some activities to achieve the goals of the organization. An association link is used to connect the <em>Pre-construction Property Management</em> and <em>Relocation</em>. These departments work together on relocation of and financial settlement to the owner.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal Link</td>
<td>A link to object ‘Goal’.</td>
</tr>
</tbody>
</table>

#### 3.2.1.3 Example of Business Process Model

One of the activities, Owner Retention of Improvements is described in detail to illustrate the structure of the **business process model** of Property Management. This discussion moves from the overall model to the specific activity, Owner Retention of Improvements of pre-construction Property Management. In the example, the bold terms are the technical terms, the italicized terms are the titles of various elements (processes, actors, events, use cases, classes), and the geospatial component of an activity has been shown in blue box.

The overall analysis diagram of Property Management is shown in Figure 3-2. An analysis diagram is used to capture high level business processes and initial models of system behavior and elements. It is simpler than many other system models and captures essential business characteristics. It provides an overview of where the proposed software system being considered will fit into the organizational structure and daily activities. The main components or sub-tasks of the system are listed in Table 3-2.
Figure 3-2. Analysis Diagram of Property Management

Table 3-2. Major elements of Property Management and associated Non-Property Management elements shown in Figure 3-2 and Figure 3-3

<table>
<thead>
<tr>
<th>Number in the Model</th>
<th>Name in the Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Acquisition</td>
</tr>
<tr>
<td>(2)</td>
<td>Relocation</td>
</tr>
<tr>
<td>(3)</td>
<td>Pre-construction Property Management</td>
</tr>
<tr>
<td>(4)</td>
<td>During construction Property Management</td>
</tr>
<tr>
<td>(5)</td>
<td>Construction</td>
</tr>
<tr>
<td>(6)</td>
<td>Post-construction Property Management</td>
</tr>
<tr>
<td>(7)</td>
<td>Rodent Control</td>
</tr>
<tr>
<td>(8)</td>
<td>Security Inspection</td>
</tr>
<tr>
<td>(9)</td>
<td>Parcel Inventory</td>
</tr>
<tr>
<td>(10)</td>
<td>Right-of-Way Inventory</td>
</tr>
</tbody>
</table>

Figure 3-3 shows the business process model of the Property Management analysis diagram shown in Figure 3-2. Some of the processes like Pre-construction Property Management (3), During construction Property Management (4), and Post-construction Property Management (6) may or may not be separate sub-departments in Property Management. This representation is used to logically represent Property Management activities in an uncomplicated manner such that all the business processes are covered. In Figure 3-3, Rodent Control (7) is linked via control...
**flow links** to *Pre-construction Property Management* (3), and *During construction Property Management* (4) as *Rodent Control* (7) begins after property acquisition and terminates after the *Construction* (5).

**Figure 3-3. Business Process Model of Overall Property Management**

*Security Inspection* (8) is conducted periodically before and after the construction as soon as some property is acquired by the ROW. As a result, in Figure 3-3, *Security Inspection* (8) has **control flow links** to all three stages of Property Management, *Pre-construction Property Management* (3), *During construction Property Management* (4), and *Post-construction Property Management* (5). Due to the ongoing nature of these processes, *Rodent Control* (7) and *Security Inspection* (8) are continuous processes.
The databases involved are, *Parcel Inventory (9)* and *Right-of-Way Inventory (10)*. Because this is a model for an enterprise-level GIS system, geospatial data of parcels, and roads are modeled as being accessible from the GIS office throughout the process. Data related to each parcel object is updated to the database which is shown by an **object flow link** to *Pre-construction Property Management (3)*, and *Post-construction Property Management (6)*. The Right-of-Way database is created and updated after the completion of the highway construction which is represented by an **object flow link** to *During construction Property Management (4)*, and *Post-construction Property Management (6)*.

Non-Property Management elements *Acquisition (1)* and *Relocation (2)*, and/or Non-Right-of-Way element, *Construction (5)* in Figure 3-3, show the association and interaction of Property Management with other departments. Parcel acquisition is followed either by *Relocation* or Property Management based on the time gap between *Acquisition (1)* and *Construction (5)*. If the time gap is several months or years between *Acquisition (1)* and *Construction (5)*, property is rented on a temporary basis. In that case, relocation of the owners is carried out by Property Management personnel with the help of *Relocation (2)* personnel before *Construction (5)* as a part of *Pre-construction Property Management (3)*. *Relocation (2)* is represented using **association** symbol indicated during *Pre-construction Property Management (3)* through an **association link**.

*Acquisition (1), Pre-construction Property Management (3), During construction Property Management (4), Construction (5) and Post-construction Property Management (6)* are linked by
control flow links to indicate the direction of work flow. All the composite processes described in Table 3-2 are linked to their sub-systems.

In this example, the first composite process, Pre-construction Property Management is shown in Figure 3-4. The sub-tasks of are listed in Table 3-3.

Table 3-3. Major elements of Pre-construction Property Management shown in Figure 3-4

<table>
<thead>
<tr>
<th>Number in the Model</th>
<th>Name in the Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Geospatial Data</td>
</tr>
<tr>
<td>(2)</td>
<td>Parcel Inventory</td>
</tr>
<tr>
<td>(3)</td>
<td>Requirement Type</td>
</tr>
<tr>
<td>(4)</td>
<td>Property Disposition</td>
</tr>
<tr>
<td>(5)</td>
<td>Improvement Disposal</td>
</tr>
<tr>
<td>(6)</td>
<td>Rental</td>
</tr>
</tbody>
</table>

After the property is acquired by the ROW, determination of the extent of requirement of the parcel or parcel Requirement Type (3) for the construction like substantially excess, substantially ROW, etc, becomes the first step in Pre-construction Property Management. The usefulness of an acquired parcel for highway project is determined in the process Requirement Type (3) and updated to the Property Management records, as processes like, Improvement Disposition (5), Grading of right of way, and Excess Property Disposal need this information. To determine the usefulness of the parcels, location of the parcels and the proposed highway need to be analyzed using Geospatial Layers of Parcels and Right-of-Way (1). Analysis tools in GIS can be used to calculate the area of the parcel that is going to be a part of the right-of-way by overlaying layers of Parcel Boundaries and proposed Right-of-Way. The parcel requirement of each parcel object
in the project is then updated to the Property Management Parcel Database (2) through an object link.

![Figure 3-4. Business Process Model of Pre-Construction Property Management](image)

After the usefulness of a parcel is determined, Property Management personnel make either Improvement Disposition (5) and/or Renting (6) of the property. Improvement Disposition (5) and Renting (6) are composite processes that involve sub-tasks. Process Renting (6) is temporary leasing of the property so that the available resources are used efficiently to reduce the overall project costs. In this example, the first composite process, Improvement Disposition (5) is explained further.
The composite process, *Improvement Disposition* consists of three alternatives; owner retention of the improvements, sale, and demolition of the improvements as shown in Figure 3-5. The representation used in the model is provided in Table 3-4.

**Table 3-4.** Major elements of Improvement Disposition shown in Figure 3-5

<table>
<thead>
<tr>
<th>Number in the Model</th>
<th>Name in the Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) PM personnel</td>
<td>(2) Justification</td>
</tr>
<tr>
<td>(3) Owner Retention</td>
<td>(4) Sale</td>
</tr>
<tr>
<td>(5) Clearance/ Demolition</td>
<td>(6) Geospatial Data</td>
</tr>
<tr>
<td>(7) Parcel Inventory</td>
<td>(8) Contract</td>
</tr>
</tbody>
</table>

**Figure 3-5.** Business Process Model of Improvement Disposition
For **Owner Retention (3)** of improvements, approval of the concerned **Property Management personnel (1)** is required stating the availability of lots or space near the current parcel to move the improvements. The **Property Management personnel (1)** is the **actor** who justifies whether **Owner Retention (3)** of improvements result in lower project costs or not. The event, **Justification (2)** is mandatory for **Owner Retention (3)** to occur irrespective of the involvement of federal funds. The approval is shown using an **information flow link** from actor to the event, **Justification (2)**. The **Owner Retention (3)** process consists of the actual sale to the owner and a performance bond from the owner, stating that the improvement removal costs would be paid by the owner, if he/ she fail to move the improvements.

Improvement **Sale (4)** involves advertising of the improvements, actual sale and a performance bond from the purchaser. The improvements are **Demolished or Cleared (5)** either if the improvements are permanent structures that cannot be sold or if improvements remained unsold through **Owner Retention (3)** or **Sale (4)**. GIS could be used to show display various aspects like type of demolition showing if it is handled by the ROW or separately contracted or contracted as a part of **Construction** contract, level of **Clearance (5)** required based how built out the area is, and status of **Clearance (5)** of various parcels.

The **Geospatial Data (6)** and other parcel details like list of improvements, and date of relocation are required for **Improvement Disposition**. The kind of disposal and the associated information about each parcel **object** is updated into the **Parcel Database (7)** via an **object flow link** shown in Figure 3-5.
Improvement disposal could be contacted by the Property Management personnel (1) in which case all the improvement disposal processes are performed by a contractor. The major tasks of Contract (8) process are to track the bids, and manage the terms of contract.

Appendix B provides the complete validated business process model.

3.2.2 USE CASE MODEL

The use case model gives a broader overall picture of the Property Management system, describing the proposed functionality including business processes (activities), association and dependency between the processes, and the corresponding actors. Generally, each use case model consists of a set of activities and actors using the system which logically belong to a group. It is a collection of related and alternative scenarios that flow towards a common goal. For example, the Property Management system consists of three use case models representing the pre-construction, during construction, and post-construction activities. The first use case model consists of various activities that have a common goal, to prepare the right of way for highway construction such that the available resources are used efficiently.

3.2.2.1 KEY TO THE USE CASE MODEL

The components of a use case model are actors and use cases which are defined in Table 3-5. The symbols used to represent these components and the connectivity between them are shown in Table 3-5.
**Table 3-5. Key to Use Case Model**

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Represents a discrete unit of interaction between an actor (human or machine) and the system. A use case is a single unit of meaningful work. For example in Pre-construction use case model, owner retention of improvements is a use case. A use case may 'include', 'extend', 'precede', 'depend' on another use case.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actor</td>
<td>Person, machine, another systems, current system, sub-system that triggers events or processes. An actor might be used to perform a business process (use case) or invoke a use case or just be associated with a use case. Actors in Property Management –</td>
</tr>
<tr>
<td></td>
<td>FHWA personnel Person</td>
</tr>
<tr>
<td></td>
<td>Property Management Personnel Person</td>
</tr>
<tr>
<td></td>
<td>Appraiser Person</td>
</tr>
<tr>
<td></td>
<td>Relocator Person</td>
</tr>
<tr>
<td></td>
<td>Appraisal Other system</td>
</tr>
<tr>
<td></td>
<td>Acquisition Other system</td>
</tr>
<tr>
<td></td>
<td>Relocation Other system</td>
</tr>
<tr>
<td></td>
<td>Property Management Property Management system</td>
</tr>
<tr>
<td>Collaboration</td>
<td>Defines a set of cooperating roles and their connectors. These are used to collectively illustrate a specific functionality. See Table 3-1 for an example.</td>
</tr>
<tr>
<td>Extend Link</td>
<td>Used to denote alternative flow (scenario) in this system. Extend connection is also used to indicate that one use case (optionally) extends the behavior of another. In this model, during the Pre-construction Property Management, some activities like structure maintenance, rodent control and ROW clearance are either contacted or performed by Property Management department.</td>
</tr>
<tr>
<td>Association</td>
<td>Association is the general relationship type between elements. All the Property Management activities have an association link with the Property Management personnel.</td>
</tr>
<tr>
<td>Precede link</td>
<td>Used to show some mandatory sequence of use cases. For example, owner retention of improvement needs an approval from Property Management personnel. So, justification is an event that precedes owner retention of improvements.</td>
</tr>
<tr>
<td>Invoke Link</td>
<td>Used to show the cases where use case is triggered only by the presence of a specific element. In this case, involvement of FHWA invokes certain use cases which are not carried out otherwise.</td>
</tr>
<tr>
<td>Dependency Link</td>
<td>Used to show dependency of one use case over another use case or actor for the completion of task. For example, rental rates, and leasing and maintenance use cases are mutually dependent on each other in the Pre-construction use case model.</td>
</tr>
</tbody>
</table>
3.2.2.2 Example of Use Case Model

This section explains the use case model of one of the major functional areas of Property Management, *Pre-construction Property Management*. A collection of related and alternative scenarios that flow towards a common goal is represented as a single **package** or **use case model**. The **package diagram** of Property Management is shown in Figure 3-6. The representation used in the **package diagram** is provided in Table 3-6.

**Table 3-6.** Major elements of Package Diagram of Property Management shown in Figure 3-6

<table>
<thead>
<tr>
<th>Number in the Package Diagram</th>
<th>Name in the Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Pre-Construction Property Management</td>
</tr>
<tr>
<td>(2)</td>
<td>During Construction Property Management</td>
</tr>
<tr>
<td>(3)</td>
<td>Post-Construction Property Management</td>
</tr>
</tbody>
</table>

**Figure 3-6.** Package Diagram of Property Management
**Package diagrams** are used to reflect the organization of packages and their elements, and provide a visualization of their corresponding namespaces. The connectors between **packages**, Pre-Construction, During Construction, and Post-Construction Property Management reveal the direction of work flow, and illustrate the snapshot of the Property Management system at a macro level. The **package**, Pre-Construction Property Management, is linked with the **package**, During Construction Property Management with a **precedes link** from Table 3-5, which means that processes in the second package occur after the processes in the first package.

The **use case model** of Pre-Construction Property Management has been shown in Figure 3-7 and the representation used in the use case model is provided in Table 3-7.

**Table 3-7.** Use cases and actors of Pre-Construction Property Management shown in Figure 3-7

<table>
<thead>
<tr>
<th>Number in the Model</th>
<th>Name in the Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Parcel Requirement Type</td>
</tr>
<tr>
<td>(2)</td>
<td>Rodent Control</td>
</tr>
<tr>
<td>(3)</td>
<td>Contract</td>
</tr>
<tr>
<td>(4)</td>
<td>Clearance/ Demolition</td>
</tr>
<tr>
<td>(5)</td>
<td>Relocation/ Settlement</td>
</tr>
<tr>
<td>(6)</td>
<td>Relocator</td>
</tr>
<tr>
<td>(7)</td>
<td>Security Inspection</td>
</tr>
<tr>
<td>(8)</td>
<td>Property Management Personnel</td>
</tr>
<tr>
<td>(9)</td>
<td>Maintenance</td>
</tr>
<tr>
<td>(10)</td>
<td>Rental</td>
</tr>
<tr>
<td>(11)</td>
<td>Appraiser</td>
</tr>
<tr>
<td>(12)</td>
<td>Improvement Sale</td>
</tr>
<tr>
<td>(13)</td>
<td>Appraisal System</td>
</tr>
<tr>
<td>(14)</td>
<td>Justification</td>
</tr>
<tr>
<td>(15)</td>
<td>Improvement Owner Retention</td>
</tr>
</tbody>
</table>
Figure 3-7. Use Case Model of Pre-Construction Property Management
The **actor**, *Property Management Personnel (8)*, is associated with all of the tasks of *Pre-Construction Property Management* including making *Parcel Requirement (1)* updates, *Improvement Sale (12)* and/or *Owner Retention (15)*, *Renting (10)* of the property, *Security Inspection (7)*. *Improvement maintenance (9)*, *Rodent Control (2)*, and *Demolition (4)* of structures and *Clearance (4)* of improvements are either *Contracted (4)* or directly handled by the *Property Management Personnel (8)*. This alternative way of performing these activities is represented in the use case model by connecting *Contract (3)* use case with *Improvement maintenance (9)*, *Rodent Control (2)*, and *Demolition/Clearance (4)* use cases via **extend link** from Table 3-5. All the other use cases which are associated only with the *Property Management Personnel (8)* are connected using **association links**.

As discussed in the business process model of *Improvement Disposal, Justification (14)* from *Property Management Personnel (8)* is necessary for *Owner Retention (15)* of improvements. This logic has been shown by a **precede link** between use cases *Justification (14)* and *Improvement Owner Retention (15)*.

Some activities require assistance of non-Property Management personnel in addition to Property Management personnel, such as *Relocation Settlement*, *Rental (10)* process, and *Improvement Sale (12)*. For *Relocation Settlement* of an owner who has temporarily rented the place after the *Acquisition*, association between *Property Management Personnel (8)* and the **actor**, *Relocator (6)* is essential. An *Appraisal Database (13)* is accessed to obtain the list of improvements on each parcel for *Improvement Sale (12)*. As a result, in addition to *Property Management Personnel (8)*, *Appraisal System (13)* is also an **actor** associated with this **use case**.
The dependency links in back and forth direction between Rental (10) and Maintenance (9) processes shows mutual dependency between both activities. The rental rates, and free occupancy period of a tenant is influenced by his/her ability to maintain the structure and the fair market price obtained from an Appraiser (11).

A complete presentation of the validated use case models of Property Management is provided in Appendix C.

Business process models and use case models that were developed based on the business process diagram of Property Management have been presented in this chapter. These have been validated with the help of Pennsylvania DOT (PennDOT) which is presented in the next chapter.
CHAPTER 4: MODEL VALIDATION

To ensure that the logical model that was developed for this research effectively represents the business process for Property Management in a state transportation agency, it was validated with the help of Pennsylvania DOT (PennDOT). A brief preview of PennDOT is provided followed by a description of the process that was used to validate the model. Details of the validation are then presented along with modifications to the model based on the validation. The logical model is modified based on this evaluation.

4.1 BACKGROUND

The PennDOT is responsible for more than 41,000 miles of roadway which is approximately 35% of the total. PennDOT is divided into eleven districts including 67 counties. The central office is located in Harrisburg. The Utility and Right of Way Section (URWS) is responsible for carrying out ROW tasks including acquisition, relocation, and Property Management, in compliance with federal and state policies and procedures for highway and bridge projects.

PennDOT has a recognized history of performing continuous quality management of its business processes. URWS was part of the reengineering initiative in 1995 which redesigned and streamlined right of way activities within the department. In 2001, the section decided to replace the main-frame REMIS system which had become obsolete and costly to maintain. The Bureau of Information Systems (BIS) and URWS started the replacement process in 2003. At the beginning of 2004, the Information Technology Request was approved and the formal process of defining the new ROW application was started. In 2004, PennDOT contracted with Bentley
Systems to implement their Right of Way Office software over a 10-month period (Hancock 2006).

PennDOT has been through development of software applications twice, once for REMIS and again for ROW application and URWS personnel have actively participated in both. The ROW personnel are quite familiar with the software development process. PennDOT has also been part of the initial study for National Cooperative Highway Research Program (NCHRP) project 8-55, Integrating Geospatial Technologies into Right-of-Way Data-Management Process which provided the basis for this research. In addition, PennDOT is within driving distance allowing for a face-to-face meeting as a part of validation process.

4.2 Validation Process

A sequence of steps has been followed to validate the logical model. Initially, the PennDOT’s right-of-way manual (PennDOT 2006) was compared to the FHWA guides (FHWA 2006a, FHWA 2006b) on right-of-way to identify procedures in Property Management which vary from or expand on the FHWA guidelines. Activities with different levels of emphasis, additional tasks, and state specific behavior were identified in this step. Next, a meeting was arranged with the Property Management personnel of PennDOT to discuss the validity of the logical model. The changes suggested by the PennDOT personnel were documented and the business process diagram was updated. The business process models and use case models provided in Appendices B and C include these modifications.
4.2.1 **Comparison between FHWA ROW Guide and PennDOT ROW Manual**

Prior to meeting the PennDOT staff to validate the Property Management model, the operating procedures stated in the FHWA real estate guides based on the Uniform Act (Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 amended by Public Law 91-646, Public Law 100-17, Public Law 102-240, Public Law 105-117) are compared to the operating procedures of PennDOT from their ROW manual. The documents are similar since PennDOT’s manual was based on FHWA guides, the Uniform Act, and state policies and procedures.

Although FHWA guides discussed all activities of Property Management, this discussion was more generic. Details like the exact manner of operation, data requirements for forms and notices, bidding options, and composition of decision making committees are not specified in FHWA guides. PenDOT’s manual covered all the activities except access management, highway maintenance, and airspace management since these activities are either performed by another office or are not used at all. FHWA guides are more comprehensive in terms of the flow of work and sequence of activities within Property Management, whereas PennDOT’s manual provides more details about each activity within Property Management.

The key differences that were identified include the sale of excess property and the approval required for disposing of property. Federal documents indicate that state projects that are partly or fully funded by the federal funds need to strictly follow the Uniform Act (Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 amended by Public Law 91-646, Public Law 100-17, Public Law 102-240, Public Law 105-117). In excess property sale after
highway construction, federal guidelines indicate that the disposal (sale) of property valued less than a certain threshold, often $1000 is not required since processing costs exceed the value of the property. PennDOT is required to advertise and sell property irrespective of its value. In this case, state laws and procedures overrode the federal guidance. During the justification process for excess property disposition which is an approval from maintenance, safety, design, planning, right-of-way, environment, access management, and traffic operations personnel, that a sale would not hamper the safety and efficiency of the any of the above sectors, only decisions about interstate facilities with federal funds involve FHWA staff in the decision making process.

4.2.2 MEETING

The main components of the meeting included a presentation covering the concepts and keys to the logical model and a walk-through of the model using Enterprise Architect to show the business process and use case models.

After a brief introduction of the research, the business process diagram of ROW activities shown in Figure 1-1 was presented to the URWS personnel to ensure that the overall information and work flow, and the functional areas linked to Property Management, have been represented correctly.

Next, the URWS personnel were interviewed about their activities within Property Management, any requirements for specialization of the personnel, sub-divisions within the office of Property Management, if any, and the role of FHWA guidelines in Property Management in PennDOT.
The business process diagram for Property Management, Figure 3-1, was presented and discussed, to ensure that the activities represented how PennDOT operates.

This was followed by a discussion about how PennDOT’s Property Management activities would benefit from the incorporation of a geospatial component.

A brief introduction to business process models and use case models was given followed by an explanation of their key concepts and components. Finally, using Enterprise Architect, a detailed walkthrough of the Property Management models was performed. The discussion followed the sequence of diagrams shown in Appendices B and C. As the walkthrough progressed, relevant comments and feedback were recorded and are presented in results. The models were then modified to reflect this feedback.

4.3 RESULTS

Based on the review of PennDOT’s manual and discussions with PennDOT staff, several modifications were made to the business process diagram and logical model. A slight change in the overall business process diagram was suggested to show that, the Utility Management and Property Management areas of ROW work jointly on activities like relocation of the utilities in the right of way as shown in Figure 4-1.

PennDOT defined the general processes of Property Management as leasing of the acquired property and right of way; clearance of the parcels, safety and rodent control prior to construction and excess property sale and ROW management after the construction.
Figure 4-1. Validated business process diagram of ROW
The URWS personnel felt that the business process diagram of ROW functional area, Property Management is very close to their actual workflow. Most of the changes suggested by PennDOT were applicable to any state and a few were specific just to Pennsylvania. The modified business process diagram is presented Figure 4-2.

In response to the incorporation of GIS into their process, they would include functionality for evaluating excess property for disposal and determination of parcel justification. Dale L. Perry, Chief of Administration and Property Management Unit, indicated that geospatial data layers for parcels, road centerlines, land use type, soil type, and vegetation cover would be necessary to provide this functionality.

From the business process model PennDOT personnel indicated that, in addition to Security Inspection and Rodent Control, mitigation of Hazardous Materials is also a continuous process that is conducted frequently after property acquisition and prior to construction. Figure B-2 shows the updated business process model of Property Management.

For Pre-Construction Property Management process shown in Figure 3-3, the tasks that were previously considered to be invoked only when federal funds were involved, like parcel Requirement Type determination and Justification prior to Owner Retention Improvements are required even for the projects without federal funds. Thus, the decision box showing federal funds involvement has been removed. For property disposal, another category of disposal, Personal Property Disposal, was added.
Figure 4-2. Updated business process diagram of Property Management for PennDOT
In the composite process, *Improvement Disposal*, state-specific use of the acquired improvements includes using the property by other public agencies such as fire departments for training. Although PennDOT disposes of improvements through one of the three traditional methods, *Owner Retention, Sale* or *Demolition*, URWS personnel suggested including the state specific option in the standard template which is shown in the business process diagram of Property Management in Figure 4-2. In the business process model, the state-specific use of improvements would be recorded in the form of an attribute to the parcel as a part of the process *Demolition and Clearance*. In addition, *Demolition and Clearance* of improvements could be performed either by Property Management, an individual contractor, or a contractor as a part of the construction contract. These changes in the functions have been explained in the discussion for *Demolition and Clearance* in Appendix B.

For excess property, properties of all sizes are sold, even if the processing costs exceed the sale value of the property, according to the PennDOT manual. The updated model is presented in Figure B-9. The federal government’s approval for sale decisions is required only for interstate facilities. A box showing involvement of state-specific laws has been included in the business process diagram. The decision about land use type of excess property to be sold involves the actor, *ROW disposition committee* instead of *Property Management personnel*. Decisions about *ROW Disposal* also involve the actor, *ROW disposition committee* instead of *Property Management personnel*. *ROW Disposal* is considered only if it benefits the ROW. Land use type of sold *excess* property and disposed ROW is updated in the database and are added as additional functions to the *ROW disposition* process.
Finally, the use case models of *Pre-Construction Property Management*, *During Construction Property Management*, and *Post-Construction Property Management* were updated to reflect the changes discussed earlier. A summary of the changes is tabulated in Table 4-1.

<table>
<thead>
<tr>
<th>Change suggested</th>
<th>Type of modification</th>
<th>Modified element</th>
<th>Location in the report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Link between Property Management and Utility division</td>
<td>General</td>
<td>Business process diagram of ROW</td>
<td>Figure 4-1</td>
</tr>
<tr>
<td>Mitigation of Hazardous Materials</td>
<td>General</td>
<td>Business process diagram</td>
<td>Figure 4-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Business process model</td>
<td>Figure B-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use case model</td>
<td>Figure C-2, C-3</td>
</tr>
<tr>
<td>Removal of Federal Funds decision box</td>
<td>General</td>
<td>Business process diagram</td>
<td>Figure 4-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Business process model</td>
<td>Figure B-3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use case model</td>
<td>Figure C-2</td>
</tr>
<tr>
<td>Addition of Personal Property Disposition</td>
<td>General</td>
<td>Business process diagram</td>
<td>Figure 4-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Business process model</td>
<td>Figure B-3, B-6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use case model</td>
<td>Figure C-2</td>
</tr>
<tr>
<td>Demolition/ Clearance</td>
<td>General</td>
<td>Business process diagram</td>
<td>Figure 4-2</td>
</tr>
<tr>
<td>Excess property sale justification</td>
<td>General</td>
<td>Business process model</td>
<td>Figure B-9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use case model</td>
<td>Figure C-4</td>
</tr>
<tr>
<td>ROW disposal justification</td>
<td>General</td>
<td>Business process model</td>
<td>Figure B-10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use case model</td>
<td>Figure C-4</td>
</tr>
<tr>
<td>Improvements disposition</td>
<td>State-specific</td>
<td>Business process diagram</td>
<td>Figure 4-2</td>
</tr>
<tr>
<td>Excess property sale</td>
<td>State-specific</td>
<td>Business process diagram</td>
<td>Figure 4-2</td>
</tr>
</tbody>
</table>

This chapter presented the validation process which consists of comparison between the FHWA ROW guides and PennDOT ROW manual, and the meeting with PennDOT's URWS personnel to demonstrate and record their suggestions. The logical models developed in this research using FHWA guides have been modified based on input from PennDOT personnel.


CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

Conclusions from this research are presented, followed by a discussion of recommendations about the future work.

5.1 CONCLUSIONS

• Although several Property Management information systems have been identified through the literature review and survey, none of them is comprehensive. No geospatially-enabled information management system currently exists that covers all, or even a majority of the activities in Property Management.

• The efficiency of Property Management activities could be enhanced by managing information within a geospatially-enabled enterprise-level information management system.

• A business process diagram, business process models, and use case models have been developed for Property Management which are essential steps in developing an information management system.

The resulting significance of this thesis is a template for an information management system for Property Management. The standard template provides a more effective start point for state agencies who can then tailor the structure of the information system to suite their unique needs. Business process diagram and use case models provide the interaction between Property Management activities with other ROW functional areas as well as the integration of a Property Management into the overall ROW enterprise system. The business process models show partial
geospatial enablement of appropriate activities within Property Management. These models help DOT personnel identify returns from investing funds in an enterprise-level geospatially enabled information system that supports integration with other ROW departments. This research documents how the state transportation agencies could improve project delivery through the use of enterprise systems. During the validation of the models, PennDOT staff indicated that the model is a move in the right direction.

Gary C. Fawver, Chief of Utilities and Right-of-Way section, said that “Logical models like this would have been very helpful in our Right-of-Way application development, and could have saved time and money”.

Dale L. Perry, Chief of Administration and Property Management Unit, commented that “This model covers the work done in our Property Management office accurately. It provides a good starting point to DOTs when developing information management systems”.

5.2 RECOMMENDATIONS

Future research would include development of business process models for other ROW functional areas such as appraisal or relocation, followed by the logical models for an enterprise-level information management system. This is the horizontal expansion of the research, which comprises similar work on other related areas.

Vertical expansion of the research or the next level of development would be to construct the domain model (high level business objects), sequence diagrams, collaboration diagrams, and user
interface models. Using the inputs and outputs of the business process models and the details of
the use case, the next step defines the fine details about the interaction within each task and
between various tasks, as well as develops the interface a user will use to execute use case
scenarios. The user interface model and the sequence diagrams from the domain model, combine
to create the class models which specify the exact objects in the system, their data and attributes,
and their behaviors or operations. From the class models, component models are built to define
the discrete packages and components that would become deployable chunks of software.
REFERENCES


APPENDIX A

PRELIMINARY SURVEY FORM


1. Does your State ROW/Utilities agency use GIS?        STATE NAME: __________________________
   □ Yes       □ No

2. If No, are you planning to incorporate GIS in the future?
   □ No       □ Yes (in short term, 0-5 yrs)       □ Yes (in long term > 5 yrs)  
   (if you answered No to Question 1, please skip to Question 6)

3. Which ROW Functional Area(s) use GIS? (check all that apply)
   □ Planning & Environmental Assessment
   □ ROW Plans and Maps
   □ Property Appraisal
   □ Appraisal Review
   □ Property Acquisition
   □ Condemnation
   □ Relocation Assistance
   □ Property/Asset Management
   □ Titles
   □ Certification/Procedure
   □ Surveys/ROW Engineering
   □ Utility Relocation/Management
   □ Outdoor Advertising Control
   □ Corridor Preservation
   □ Other__________________________

4. How often is GIS used for ROW/Utilities applications in your agency?
   □ Not at all
   □ Rarely
   □ Occasionally
   □ Regularly
   □ Frequently

5. Who uses GIS? (check all that apply)
   □ ROW/Utilities Staff
   □ Public
   □ Other Transportation Staff: Dept(s)__________________________
   □ Contractors (utility providers, etc)
   □ Other__________________________

6. What other technologies does your agency use? (check all that apply)
   □ Data Warehouse
   □ GPS
   □ Data Integration/Standards
   □ Real-Time Data Collection
   □ Web Interface
   □ Imagery
   □ Other______________

7. Please provide contact information:
   Name: ______________________ Phone: ___________ Email: ______________________
   Agency name & address: ______________________________________________________

   Thank you for your time in completing this survey.

   For further information please contact:
   Dr. Kathleen Hancock, 703-518-2718, hancockk@vax.wvu.edu or Dr. Nicholas Koncz, 703-518-2717,
   koncz@vt.edu

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**DETAILED SURVEY FORM**


Person completing survey:
Name: ______________________________________________________
Phone: ______________________________________________________
Email: ______________________________________________________
Agency name & address: _______________________________________

Person to contact for questions: □ Same as above
Name: ______________________________________________________
Phone: ______________________________________________________
Email: ______________________________________________________
Agency name & address: _______________________________________

Which ROW functional areas use a system that includes GIS or computer mapping? *Check all that apply*

*For this survey, “system” is any computer-based program, data management tool, decision support system, document tracking tool, etc that your agency uses to perform its activities.*

<table>
<thead>
<tr>
<th>Functional Area</th>
<th>Uses GIS</th>
<th>If stand alone program</th>
<th>If part of a more comprehensive system</th>
<th>Name of System (how you refer to the system)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning &amp; Environmental Assessment</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Surveys/ ROW Engineering</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>ROW Plans and Maps</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Property Appraisal</td>
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</tr>
<tr>
<td>Appraisal Review</td>
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</tr>
<tr>
<td>Property Acquisition</td>
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<tr>
<td>Condemnation</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Title Management</td>
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<td></td>
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</tr>
<tr>
<td>Relocation Assistance</td>
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<td></td>
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<tr>
<td>Certifications/ Procedure Review</td>
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<td></td>
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<tr>
<td>Property / Asset Management</td>
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<tr>
<td>Utility Relocation / Management</td>
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</tr>
<tr>
<td>Outdoor Advertising Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corridor Preservation</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other ________________</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Please complete Questions 1 through 16 for each system checked above. Make additional copies of these pages as necessary.

SYSTEM NAME (Functional Area) ____________________________________________

1. Briefly describe how GIS is used in this system.
________________________________________________________________________
________________________________________________________________________

2. How often is this system used in your agency?
   ___Rarely
   ___Occasionally
   ___Regularly

3. Who uses this system? Check all that apply
   ___ROW/Utilities Staff
   ___Other Transportation Agency Staff: specify _____________________________
   ___Consultants
   ___Contractors: Utilities, etc
   ___Public
   ___Other: specify ____________________________

4. How long has your agency been using this system?
   ___0 to 12 months
   ___More than one (1) year
   ___More than five (5) years

5. What is the current stage of system implementation of this system?
   ___Fully implemented, no additional work planned
   ___Implemented, additional functionality planned
   ___Implemented, links to other applications planned
   ___Implemented, integration with a larger system planned
   ___Currently in use but still being developed

6. How was this system developed?
   ___Existing system purchased from a vender/consultant without customization:
   Name of vender/consultant ____________________________________________
   ___Existing system purchased from a vender/consultant, customized by vender:
   Name of vender/consultant ____________________________________________
   ___Existing system purchased from a vender/consultant, customized in house:
   Name of vender/consultant ____________________________________________
   ___Developed specifically for your agency by consultants
   ___Developed specifically for your agency by in-house staff
   ___Other: Specify ________________________________________________

7. Who is responsible for maintaining this system?
   ___ROW staff
   ___Transportation department/agency IT (information technology) staff
   ___Consultants
   ___Other: specify ________________________________________________
8. Who is responsible for providing technical assistance for this system?
   ___ ROW staff
   ___ IT (information technology) staff
   ___ Vendor
   ___ Consultants
   ___ Other: specify________________________________________________

9. Do you have documentation for this system? Check all that apply
   ___ Yes, manual(s):
     ___ Users Manual
     ___ System Manual
   ___ Yes, online “help”
   ___ Yes, our own “cheat sheets”
   ___ No

10. What advanced technologies does this system use (in addition to GIS)? Check all that apply
    ___ GPS
    ___ Wireless/mobile data input
    ___ Web interface
    ___ Imagery
    ___ Data warehouse
    ___ Data integration
    ___ Other: specify________________________________________________

11. What geospatial (GIS) data layers does this system use? Check all that apply

<table>
<thead>
<tr>
<th>Data Layer</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>___ Parcel boundaries/Tax data</td>
<td>___ Parcel ownership data</td>
</tr>
<tr>
<td>___ Parcel ownership data</td>
<td>___ Road centerlines or polygons</td>
</tr>
<tr>
<td>___ Demographic data</td>
<td>___ MLS data</td>
</tr>
<tr>
<td>___ Hazardous materials sites</td>
<td>___ Special Areas (ie wetlands, historic districts)</td>
</tr>
<tr>
<td>___ Building footprints</td>
<td>___ Aerial imagery</td>
</tr>
<tr>
<td>___ Asset location (utilities, etc)</td>
<td>___ Other: specify</td>
</tr>
</tbody>
</table>

The “Source” should be who provides your agency with this data layer. If it is accessible through a data warehouse or the internet, indicate the agency who manages the source data. Please be as specific as possible.

12. How has this system benefited operations in your agency? Check all that apply
    ___ Reduced personnel time
    ___ Reduced project delivery time
    ___ Reduced costs
    ___ Improved coordination between activities
    ___ Improved streamlining
    ___ Improved decision making
    ___ Improved quality of work
13. Provide any additional comments about benefits that your agency has recognized since implementation of this system.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

14. What were the major barriers (internal and external), if any, that your agency experienced during planning and implementing this system?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

15. List any disadvantages that your agency experiences in using this system?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

16. If you could “re-do” this system and/or it’s implementation, what would you differently?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

Thank you for your time in completing this survey.

For further information please contact:
Dr. Kathleen Hancock, 703-518-2718, hancockk@vt.edu
or Dr. Nicholas Koncz, 703-518-2717, Koncz@vt.edu

Please return the completed survey to:
Virginia Tech Center for Geospatial Information Technology
1101 King St. Suite 610
Alexandria, VA 22314
# APPENDIX B – BUSINESS PROCESS MODEL OF PROPERTY MANAGEMENT

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Model Details

The business process model describes both the behavior of and the information flows within an organization or system. The inputs (resources), actors, output(s), goals, and the responsibilities of each activity are captured. This document provides a complete overview of all element details.

The business process model of each business process is shown, followed by the details of the comprising elements. In this document, the elements of a diagram are discussed in the order of the work flow shown in Figure 3-1. For each element, element type, description of the tasks carried out within the element or by the element, and links with other elements in the business process diagram are presented. The types of elements shown in this report are package diagram (refer 3.2.2.2), object, activity, collaboration, decision node, event, and actor (refer Table B-1). The composite processes in a business process are discussed further at the page specified later in the report.

COMPONENTS OF BUSINESS PROCESS MODEL

The concepts associated with business process modeling necessary to understand a business process model have been described in this section.

- **Resource**: A resource is an input to a business process, and, unlike information, is typically consumed during the processing. For example, in the excess property sale, the appraisal data, and taxpayer information of a parcel is used up or appended to update information about the date of sale, and the amount obtained through the sale.

- **Information**: Business processes use information to tailor or complete their activities. Information, unlike resources, is not consumed in the process — rather it is used as part of the transformation process. Information may come from external sources, customers, internal organizational units or may be the product of other processes. For example, during the excess property sale, the appraisal data of a parcel is viewed by the Property Management personnel to determine the worth of the property and the actual boundaries of the parcel. Using these data, the property is advertised for sale. The source of the information could be an actor, an object or an event. In this example, the information source is the object of parcel and the parcel feature from the geospatial layer of parcels.

- **Output**: A business process will typically produce one or more outputs of value to the business, which either feed into or trigger subsequent internal activities or other external systems. An output may be a physical object (such as an updated record or invoice), a transformation of raw resources into a new arrangement (grading of the land for the ROW) or an overall business result such as disposing of excess property.

- **Goal**: The goal is the reason the organization does the work. It defines the benefits this process has for the organization as a whole and how this process satisfies business needs.
KEY TO BUSINESS PROCESS MODEL
The components of a business process model discussed in the previous section and the connectivity between them is represented using the symbols shown in Table B-1.

Table B-1. Key to Business Process Model

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>Defines the abstract characteristics of a thing, including the thing’s characteristics (its attributes or properties) and the things it can do (its behaviors or methods or features). For example, the class “ROW inventory” would consist of attributes of the ROW, for example width, length, capacity, location of utility lines, etc. Methods of a class are the activities associated with the class, for example update and delete records. Collectively, the properties and methods defined by a class are called members. An Object is a particular instance of a class. For example, a section of four lane highway for a project, where the highway is an object and number of lanes and width of the Right of way are attributes.</td>
</tr>
<tr>
<td>Receive event</td>
<td>Indicates that an event occurs in the system due to some external or internal stimulus. Typically this will invoke further activities and processing. For example, the process, owner retention of improvements in Pre-construction Property Management, is triggered by an event, Justification. The Property Management personnel need to approve that there is another lot available to move the improvements and that the owner retention reduces the project costs when compared to demolition or clearance of the improvements from the site.</td>
</tr>
<tr>
<td>Send event</td>
<td>Models the generation of a stimulus in the system and the passing of that stimulus to other elements within the system or external to the system. In the excess property sale, after the construction of the highway, retention of the property is better than selling it, due to various reasons. In which case, the parcel object that is going to be retained by the ROW is updated to the database through a send event, retain.</td>
</tr>
<tr>
<td>Actor</td>
<td>Person, machine, other systems, current system or sub-system that triggers events or processes. Actors in Property Management – FHWA personnel Property Management Personnel Appraiser Relocator Appraisal Acquisition Relocation Property Management</td>
</tr>
</tbody>
</table>

74
Table B-1. Key to Business Process Model (cont.)

<table>
<thead>
<tr>
<th>Process</th>
<th>Composite Process</th>
<th>Collaboration</th>
<th>Decision</th>
<th>Supply Link</th>
<th>Input Link</th>
<th>Output Link</th>
<th>Control Flow Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>An activity element comprising a set of well established tasks which expresses the concept of a business process. Typically a process involves inputs, outputs, work flows, goals and connections with other processes. Example of a Process is, Parcel Requirement Status in Pre-Construction Property Management. It involves tasks like viewing the location of parcels and proposed Right of way, and determining the extent to which the parcels might be used in the project. Business processes that involve sub-processes are composite processes. Such processes are depicted by an additional infinity symbol on the right. For example, the composite process Improvement Disposal consists of alternative processes defining ways of disposal like owner retention, sale, and demolition which each involve events, inputs, processes, outputs, and actors.</td>
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</tr>
<tr>
<td>Defines a set of cooperating roles and their connectors. These are used to collectively illustrate a specific functionality. For example, property owners who have temporarily rented a parcel until the construction actually begins are to be relocated. Relocation settlement involves rent that the owner might owe and the relocation assistance that ROW owes to the owner. At this point, Property Management works in association with the Relocation department of ROW.</td>
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<td></td>
</tr>
<tr>
<td>Indicates a point of conditional progression. It is a point where subsequent activities vary based on the choice made. For example, in Excess Property Sale, if federal funds are involved in the project, value of excess property is a point of decision whether to advertise the property for sale or retain the property.</td>
<td></td>
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</tr>
<tr>
<td>Indicates that the information or object linked to the process is viewed in the processing phase without alteration and / or exhaustion. In the model, the link connecting the Property Management personnel and the event, Justification is an information link. The link shows the approval from the Property Management personnel.</td>
<td></td>
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</tr>
<tr>
<td>Indicates that the attached object or resource is consumed in the processing procedure. The link connecting geospatial layers to the process where the parcel’s extent of usefulness in the project is determined. In this case, the information about the parcel requirement would be updated back into the database.</td>
<td></td>
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</tr>
<tr>
<td>Link to object ‘Output’. The links connecting most of the processes in the model to the parcel database are output links. Attributes of the parcels are updated to the database after every process, prior to construction.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Link from another process that represents the sequence of activities and the direction of work flow. It generally connects two business processes. Links between consecutive processes like Pre-construction and During construction Property Management.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table B-1. Key to Business Process Model (cont.)

<table>
<thead>
<tr>
<th>Association Link</th>
<th>Indicates that processes attached by this link work together on some activities to achieve the goals of the organization. An association link is used to connect the Pre-construction Property Management and Relocation. These departments work together on relocation of and financial settlement to the owner.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal Link</td>
<td>A link to object “Goal”.</td>
</tr>
</tbody>
</table>

**Business Process Model** – *(Analysis diagram)*

An Analysis diagram is used to capture high level business processes and early models of system behavior and elements. It is less formal than some other diagrams, but provides a good means of capturing the essential business characteristics and needs. The associated business workflow diagram is shown in Figure 3-1.

![Analysis Business Process Model](image)

**Figure B-1.** Analysis diagram of Property Management

**Business Workflow - Property Management**

*Type: Package «system»*

The Workflow package documents business processes, drawing on stakeholders, structures and objects defined in the Context and Object packages showing how these work together to provide fundamental business activities.

**Overall Logical Diagram - Property Management** – *(Logical diagram)*

This diagram represents Property Management functional area as a single system. The main components or sub-tasks of the system are Pre-Construction, During Construction and Post-Construction Property Management, Rodent Control, Security Inspection and mitigation of
Hazardous Materials which are continuous processes, and the databases involved, Parcel Inventory and Right-of-Way Inventory.

Figure B-2. Overall logical model of Property Management

**Inventory - Parcel Appraisal, Acquisition, Relocation, Property Management**
*Type: Object*

Ideally, all the ROW information of the parcels like appraisal, acquisition, relocation and Property Management are centrally stored in an enterprise-level system. This information could be accessed by authorized personnel of all ROW functional areas. In this case, Pre-Construction and Post-Construction sub-systems need access to this central data base.

**Connections**

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<td><strong>Object Flow</strong></td>
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<td><strong>Inventory - Parcel Appraisal, Acquisition, Relocation, Property Management</strong></td>
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<td><strong>Object Flow</strong></td>
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<td><strong>Post- Construction PROPERTY MANAGEMENT</strong></td>
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</tbody>
</table>

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**ROW Inventory**

Type: **Object**

Once the highway construction is completed, parcels no longer exist. The property becomes Right of way with specific attributes. This data base is accessed by all Post-Construction Property and some Non-Property Management activities of ROW.

### Connections

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<tr>
<td><strong>Object Flow</strong> Source -&gt; Destination</td>
<td>Public Post- Construction PROPERTY MANAGEMENT</td>
<td>Public ROW Inventory</td>
</tr>
</tbody>
</table>

**ACQUISITION**

Type: **Activity**

Property Management generally follows acquisition or relocation process. Once the parcels are acquired from their respective owners, they become the property of the state which needs to be safeguarded and maintained efficiently.

### Connections

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<td>Public Pre-Construction PROPERTY MANAGEMENT</td>
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</tbody>
</table>

**Pre-Construction PROPERTY MANAGEMENT**

Type: **Activity**

Pre-Construction PROPERTY MANAGEMENT consists of activities between property acquisition and construction. In the model, composite process, Pre-Construction PROPERTY MANAGEMENT can be clicked to view the sub-processes involved. See page 82 for Business Process of Pre-Construction Property Management.

### Connections

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<td>Public Pre-Construction PROPERTY</td>
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</table>
PROPERTY MANAGEMENT - During Construction

Type: Activity

PROPERTY MANAGEMENT – During Construction consists of activities that are carried out very close to the construction period or during the construction. In the model, composite process, PROPERTY MANAGEMENT - During Construction can be clicked to view the sub-processes involved. See page 98 for Business Process of Property Management - During Construction.

Connections

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</table>
CONSTRUCTION
Type: Activity

Highway construction is a non-ROW process. Optional Property Management activities like grading and improvement clearance could be a part of the construction contract.

CONNECTIONS
Type: Activity

Post-Construction PROPERTY MANAGEMENT
Type: Activity

Post-Construction PROPERTY MANAGEMENT consists of activities after the construction is completed. It mainly consists of managing excess property and right of way. In the model,
composite process, Post-Construction PROPERTY MANAGEMENT can be clicked to view the sub-processes involved. See page 100 for Business Process of Post-Construction Property Management.

**Connections**

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**Hazardous Materials**

Type: Activity

Mitigation of Hazardous Materials in the acquired property is one of the continuous processes after acquisition and before construction.

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<td>Public Hazardous Materials</td>
<td>Public PROPERTY MANAGEMENT - During Construction</td>
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Rodent Control
Type: Activity

Preliminary Inspection, Contract, Inter-Agency agreement are various ways in which Rodent Control is conducted. Rodent Control is a continuous process in Property Management till the start of project construction.

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Security Inspection
Type: Activity

The security of the improvements is one of the major concerns of the ROW department. Frequent inspections are conducted to avoid vandalism, theft, etc.

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<td>Public PROPERTY MANAGEMENT - During Construction</td>
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</table>

RELOCATION
Type: Collaboration

Relocation of the parcel owners and eligible tenants takes place either after acquisition in case of short time gap between the acquisition and project construction. If the time gap is couple of
months or years, relocation of the owners might take place just before the beginning of the construction as a part of Pre-Construction Property Management.

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<td>Public RELOCATION</td>
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</table>
Requirement Type

Type: **Activity**

Requirement type of a parcel like substantially excess, substantially ROW etc has to be determined prior to any Property Management activities on the parcels.

**Connections**

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<td><strong>Object Flow</strong></td>
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<tr>
<td><strong>ControlFlow</strong></td>
<td>Public Requirement Type</td>
<td>Public Property Disposition</td>
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</tbody>
</table>
Property Disposition

Type: DecisionNode

There are two sub-tasks of Property Management prior to the construction, the disposal of the improvements and personal property on the parcel and/or renting the property in case of longer gap between property acquisition and construction. This decision is based on the time gap between acquisition and actual construction.

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<td>Public Property Disposition</td>
<td>Public Improvement Disposition</td>
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<tr>
<td>ControlFlow Source -&gt; Destination</td>
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<td>Public Personal Property</td>
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<tr>
<td>ControlFlow Source -&gt; Destination</td>
<td>Public Requirement Type</td>
<td>Public Property Disposition</td>
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</tbody>
</table>

Improvement Disposition

Type: Activity

The improvements on the acquired parcels such as structures, vehicle, etc have to be cleared as a part of pre-construction tasks. In the model, Improvement Disposition can be clicked to view the sub-processes in this process. See page 85 for Business Process of Improvement Disposition.

Connections

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<tbody>
<tr>
<td>ControlFlow Source -&gt; Destination</td>
<td>Public Property Disposition</td>
<td>Public Improvement Disposition</td>
</tr>
</tbody>
</table>

Rental

Type: Activity

The acquired property is rented on a temporary basis if the time gap between the actual construction and property acquisition is a few months or years to avoid vandalism and to use the resources more efficiently. In the model, Rental process can be clicked to view the sub-processes in this process. See page 90 for Business Process of Renting.

Connections

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<tr>
<td>ControlFlow Source -&gt; Destination</td>
<td>Public Property Disposition</td>
<td>Public Rental</td>
</tr>
</tbody>
</table>
Personal Property

*Type:* **Activity**

The personal items left by the property owners after their relocation have to be cleared by the Property Management division. In the model, Personal Property can be clicked to view the subprocesses in this process. See page 94 for Business Process of Personal Property Disposition.

**Connections**

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<tbody>
<tr>
<td>ControlFlow</td>
<td>Public Property Disposition</td>
<td>Public Personal Property</td>
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</table>

Geospatial Layers - Parcels, Right-of-Way

*Type:* **Object**

The geospatial data along with other parcel details is a resource used to perform Property Management tasks.

**Connections**

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<tr>
<td>Object Flow</td>
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Inventory - Parcel Property Management

*Type:* **Object**

Ideally, all the ROW information of the parcels like appraisal, acquisition, relocation and Property Management are to be centrally stored for an enterprise-level system. After the processes have been completed for each (object) parcel, the information is updated to the Property Management records of the parcel.

**Connections**

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</table>
Improvement Disposition

PM personnel
Type: Actor

The staff of Property Management in ROW division of a DOT.

Connections

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<tr>
<td>Source -&gt; Destination</td>
<td>PM personnel</td>
<td>Justification</td>
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</table>

Justification
Type: Event

The approval of the concerned Property Management personnel is required stating the availability of lots to move the improvements to a different lot and that this would result in lower project costs.
### Owner Retention

**Type:** Activity

This activity involves the actual sale to the owner and a Performance bond from the owner so that the improvement removal costs are paid incase the owner fails to move the improvements after the sale.

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<td>Public Justification</td>
<td>Public Owner Retention</td>
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</table>

### Sale

**Type:** Activity

Involves advertising of the improvements, sale and a performance bond from the purchaser so that the improvement removal costs are paid incase of failure to move the improvements after the sale.

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</table>
Clearance/ Demolition

Type: Activity

Permanent structures that cannot be sold and other improvements that remain unsold are cleared from the site through demolition. This activity could be carried out by the Property Management personnel or a contractor chosen by the Property Management division or the construction contractor.

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**Contract**

Type: Activity

The improvement disposal might be contracted. In that case, the Property Management personnel manage the contract alone.

**Connections**

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<tr>
<td></td>
<td>Contract</td>
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</tr>
</tbody>
</table>
Geospatial Layers - Parcels, Roads, Right-of-Way

Type: **Object**

The geospatial data (layers) along with other parcel details is a resource used to perform Property Management tasks.

**Connections**

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
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<td>Public Inventory - Parcel Appraisal, Relocation, Property Management</td>
<td>Public Geospatial Layers - Parcels, Roads, Right-of-Way</td>
</tr>
</tbody>
</table>

Inventory - Parcel Appraisal, Relocation, Property Management

Type: **Object**

Ideally, all the ROW information of the parcels like appraisal, acquisition, relocation and Property Management are to be centrally stored for an enterprise-level system. This information could be accessed by authorized personnel of all ROW functional areas. In this case, appraisal data of improvements, relocation information are needed to dispose the improvements.

After the processes have been completed for each (object) parcel, the information is updated to the Property Management records of the parcel.

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<tr>
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<td><strong>Inventory - Parcel Appraisal, Relocation, Property Management</strong></td>
<td><strong>Geospatial Layers - Parcels, Roads, Right-of-Way</strong></td>
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</tbody>
</table>
Rental

Figure B-5. Business process model of Rental

Appraiser
Type: Actor

Rental rates need to be established based on the market price for which an appraiser is approached.

<table>
<thead>
<tr>
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<tbody>
<tr>
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</tr>
<tr>
<td>Source -&gt; Destination</td>
<td>Appraiser</td>
<td>Rental Rates</td>
</tr>
</tbody>
</table>

Rental Rates
Type: Activity

Establishing rental rates involves market price consideration, maintenance capabilities of the interested party. Free occupancy period is determined based on occupant type like short term owner, short term non-owner, long term tenant etc.
PM personnel

Type: Actor

The staff of Property Management in ROW division of a DOT.

Tenant Selection

Type: Event

Tenant selection is made based on credit check, financial statement, employer and previous landlord references. It is even influenced by the maintenance capabilities of the tenant.
Lease and Maintenance Agreements

*Type:* **Activity**

Lease and Maintenance agreements are made on factors like personal liability insurance, type of structure, age of structure, length of lease, and ability of tenant to provide maintenance. The payment method and location are also established at this point.

**Connections**

<table>
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</tr>
</thead>
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<tr>
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<td>Public Inventory - Parcel Property Management</td>
</tr>
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</tr>
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<tr>
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<td>Source -&gt; Destination</td>
<td>Public Lease and Maintenance Agreements</td>
</tr>
<tr>
<td></td>
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<td>Public Rental Rates</td>
</tr>
<tr>
<td><strong>ControlFlow</strong></td>
<td>Source -&gt; Destination</td>
<td>Public Rental Rates</td>
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<td><strong>ControlFlow</strong></td>
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<td>Public Tenant Selection</td>
</tr>
<tr>
<td></td>
<td>Public</td>
<td>Public Lease and Maintenance Agreements</td>
</tr>
</tbody>
</table>

Relocation

*Type:* **Collaboration**

Relocation of the parcel owners and eligible tenants takes place after acquisition in case of short, time gap between the acquisition and project construction. If the time gap is couple of months or years, relocation of the owners might take place just before the beginning of the construction as a part of Pre-Construction Management.

**Connections**

<table>
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<tr>
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<th>Source</th>
<th>Destination</th>
</tr>
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<tbody>
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</tr>
<tr>
<td></td>
<td>Public</td>
<td>Public Relocation</td>
</tr>
</tbody>
</table>
Inventory - Parcel Property Management

*Type:*  **Object**

The geospatial data (layers) along with other parcel details is a resource used to perform Property Management tasks.

**Connections**

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
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<tbody>
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<td><strong>Object Flow</strong> Source -&gt; Destination</td>
<td>Public Lease and Maintenance Agreements</td>
<td>Public Inventory - Parcel Property Management</td>
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<tr>
<td><strong>Object Flow</strong> Source -&gt; Destination</td>
<td>Public Rental Rates</td>
<td>Public Inventory - Parcel Property Management</td>
</tr>
</tbody>
</table>
PM personnel
Type: **Actor**

The staff of Property Management in ROW division of a DOT.

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
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<tbody>
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</tr>
<tr>
<td></td>
<td>PM personnel</td>
<td>Justification</td>
</tr>
</tbody>
</table>

Justification
Type: **Event**

The Property Management staff has to justify the retention of any personal property by explaining the need to the department and also by showing that retention would be reduce project costs than sale or clearance.
### Retention

**Type:** Activity

Personal property of the occupants of the acquired property is retained by the ROW division if there is a need for that particular item and if retention is less costlier than sale or clearance.

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
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</thead>
<tbody>
<tr>
<td><strong>Object Flow</strong></td>
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<td>Public Retention</td>
</tr>
<tr>
<td><strong>ControlFlow</strong></td>
<td>Public Justification</td>
<td>Public Retention</td>
</tr>
<tr>
<td><strong>Object Flow</strong></td>
<td>Public Retention</td>
<td>Public Inventory - Parcel Appraisal, Relocation, Property Management</td>
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</tbody>
</table>

### Sale

**Type:** Activity

Involves advertising the list of items, and sale.

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
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<tbody>
<tr>
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<tr>
<td><strong>Object Flow</strong></td>
<td>Public Inventory - Parcel Appraisal, Relocation, Property Management</td>
<td>Public Sale</td>
</tr>
<tr>
<td><strong>Object Flow</strong></td>
<td>Public Sale</td>
<td>Public Inventory - Parcel Appraisal, Relocation, Property Management</td>
</tr>
</tbody>
</table>
Clearance

Type: **Activity**

Personal property that could not be sold or retained is cleared from the site.

**Connections**

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
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</thead>
<tbody>
<tr>
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<td>Public Inventory - Parcel Appraisal, Relocation, Property Management</td>
</tr>
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<td><strong>Object Flow</strong> Source -&gt; Destination</td>
<td>Public Inventory - Parcel Appraisal, Relocation, Property Management</td>
<td>Public Clearance</td>
</tr>
<tr>
<td><strong>ControlFlow</strong> Source -&gt; Destination</td>
<td>Public Contract</td>
<td>Public Clearance</td>
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</tbody>
</table>

Inventory - Parcel Appraisal, Relocation, Property Management

Type: **Object**

Ideally, all the ROW information of the parcels like appraisal, acquisition, relocation and Property Management are to be centrally stored for an enterprise-level system. This information could be accessed by authorized personnel of all ROW functional areas.

In this case, appraisal data of improvements, relocation information are needed to dispose the improvements.

After the processes have been completed for each (object) parcel, the information is updated to the PM records of the parcel.

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<td><strong>Object Flow</strong> Source -&gt; Destination</td>
<td>Public Inventory - Parcel Appraisal, Relocation, Property Management</td>
<td>Public Sale</td>
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<tr>
<td><strong>Object Flow</strong> Source -&gt; Destination</td>
<td>Public Inventory - Parcel Appraisal, Relocation, Property Management</td>
<td>Public Retention</td>
</tr>
</tbody>
</table>
Contract

Type: **Activity**

Personal property disposal might be contracted. In that case, the Property Management personnel manage the contract alone.

**Connections**

<table>
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<th>Connector</th>
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<th>Destination</th>
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<tr>
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<td><strong>ControlFlow</strong> Source -&gt; Destination</td>
<td>Public Contract</td>
<td>Public Clearance</td>
</tr>
</tbody>
</table>
Contract

*Type: Activity*

In majority of the projects, grading of the right of way is contracted either as a part of the construction contract or differently. If the contract is not a part of construction contract, it is managed by the Property Management personnel.

**Connections**

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<th>Source</th>
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<tbody>
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</tr>
<tr>
<td>Source -&gt; Destination</td>
<td>Contract</td>
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</table>

Grading

*Type: Activity*

Land is graded or leveled prior to the construction. This task is often considered as a part of construction or contracted. Improvement clearance could also be a part of construction for large projects.

**Connections**

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<tr>
<td>Source -&gt; Destination</td>
<td>Grading</td>
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### Geospatial Layers - Right-of-Way, Topology

**Type:**   **Object**

The geospatial data (layers) along with other ROW details is a resource used to perform Property Management tasks.

**Connections**

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<td><strong>Object Flow</strong></td>
<td>Source -&gt; Destination</td>
<td>Public ROW Inventory</td>
</tr>
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</table>

### ROW Inventory

**Type:**  **Object**

After the highway construction is completed, parcels no longer exist. The property becomes Right of way with specific attributes. This data base is accessed by all Post-Construction Property and Non-Property Management activities of ROW.

**Connections**

<table>
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<tr>
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<tbody>
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<tr>
<td><strong>Object Flow</strong></td>
<td>Source -&gt; Destination</td>
<td>Public ROW Inventory</td>
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</table>
Property Type

*Type:* **DecisionNode**

After the construction is complete, the property owned by the DOT would either be Right of way or excess.

*Connections*

<table>
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<td><strong>Source -&gt; Destination</strong></td>
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Excess

*Type:* **Activity**

Excess property is disposed in by either selling or retaining. In the model, the process, excess can be clicked to view the sub-processes. See page 102 for Business Process of Excess.

*Connections*

<table>
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<td><strong>Source -&gt; Destination</strong></td>
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</table>
Property Disposal

*Type:* *DecisionNode*

Property which comes under right of way is managed or disposed if it is no longer needed.

**Connections**

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<td>Public Property Disposal</td>
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</table>

ROW Management

*Type:* *Activity*

Right of way leasing, air space marketing and sale, and right of way maintenance are major ROW management tasks. In this model, this process has not been shown further as many state ROW divisions do not consider this to be a part of Property Management.

**Connections**

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ROW Disposal

*Type:* *Activity*

Some times, right of way is disposed after the construction. See page 106 for Business Process of ROW Disposal.

**Connections**

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</table>
Excess

Geospatial enablement
Right-of-way, parcel, vegetation, soil type and land use layers are overlaid to analyze highway safety, traffic demand and supply, environment and economy to justify property disposal and zoning type. Value of the property could also be calculated.

Figure B-9. Business process model of Excess property disposal

Justification
Type: 

Property sale has to be justified by both Disposition committee and FHWA personnel if,
- the facility is an interstate
- and federal funds are involved
Else, only disposition committee’s approval is required.

Connections

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<thead>
<tr>
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</table>
FHWA personnel
_Type: Actor_

Staff of federal highway administration who justify the excess property sale along with the Disposition committee.

**Connections**

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
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<tr>
<td>Source -&gt; Destination</td>
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<td>Justification</td>
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</table>

Disposition Committee
_Type: Actor_

It is a group of decision makers who approve the excess property sale. The number of people comprising the committee is dependent on the value of the property.

**Connections**

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<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
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</thead>
<tbody>
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<td>Public</td>
</tr>
<tr>
<td>Source -&gt; Destination</td>
<td>Disposition Committee</td>
<td>Justification</td>
</tr>
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</table>

Property Sale
_Type: Activity_

The excess property is advertised and sold after being approved by Disposition committee.

**Connections**

<table>
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<tr>
<th>Connector</th>
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<th>Destination</th>
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<tbody>
<tr>
<td><strong>Object Flow</strong>_ Source -&gt; Destination</td>
<td>Public Property Sale</td>
<td>Public ROW inventory</td>
</tr>
<tr>
<td></td>
<td>Public Geospatial layers - Parcels, Right-of-Way, Road centerlines</td>
<td>Public Property Sale</td>
</tr>
<tr>
<td><strong>Association</strong>_ Unspecified</td>
<td>Public Appraisal</td>
<td>Public Property Sale</td>
</tr>
<tr>
<td><strong>Information Flow</strong>_ Source -&gt; Destination</td>
<td>Public Appraisal</td>
<td>Public Property Sale</td>
</tr>
<tr>
<td><strong>ControlFlow</strong>_ Source -&gt; Destination</td>
<td>Public Justification</td>
<td>Public Property Sale</td>
</tr>
</tbody>
</table>
Retain

Type: Event

Properties are retained:
1. Though it is no longer required for the highway project but, no federal funds are involved
2. Disposal of the property is not justified or if the property is considered necessary to be retained by FHWA or disposition committee

Connections

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object Flow Source -&gt; Destination</td>
<td>Public Justification</td>
<td>Public Retain</td>
</tr>
<tr>
<td>Object Flow Source -&gt; Destination</td>
<td>Public Geospatial layers - Parcels, Right-of-Way, Road centerlines</td>
<td>Public Retain</td>
</tr>
<tr>
<td>Object Flow Source -&gt; Destination</td>
<td>Public Retain</td>
<td>Public ROW inventory</td>
</tr>
</tbody>
</table>

Geospatial layers - Parcels, Right-of-Way, Road centerlines

Type: Object

The geospatial data (layers) along with other ROW details is a resource used to perform Property Management tasks.

Connections

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object Flow Source -&gt; Destination</td>
<td>Public Geospatial layers - Parcels, Right-of-Way, Road centerlines</td>
<td>Public Property Sale</td>
</tr>
<tr>
<td>Object Flow Source -&gt; Destination</td>
<td>Public Geospatial layers - Parcels, Right-of-Way, Road centerlines</td>
<td>Public Retain</td>
</tr>
<tr>
<td>Object Flow Source -&gt; Destination</td>
<td>Public ROW inventory</td>
<td>Public Geospatial layers - Parcels, Right-of-Way, Road centerlines</td>
</tr>
</tbody>
</table>
ROW inventory

*Type: Object*

Once the highway construction is completed, parcels no longer exist. The property becomes Right of way with specific attributes. This data base is accessed by all Post-Construction Property and Non-Property Management activities of ROW.

**Connections**

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Object Flow</strong></td>
<td>Public</td>
<td>Geospatial layers - Parcels, Right-of-Way, Road centerlines</td>
</tr>
<tr>
<td>Source -&gt; Destination</td>
<td>ROW inventory</td>
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</tr>
<tr>
<td><strong>Object Flow</strong></td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td>Source -&gt; Destination</td>
<td>Retain</td>
<td>ROW inventory</td>
</tr>
<tr>
<td><strong>Object Flow</strong></td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td>Source -&gt; Destination</td>
<td>Property Sale</td>
<td>ROW inventory</td>
</tr>
</tbody>
</table>
**ROW Disposal**

In case of federal funds involvement, impact on highway safety, traffic, environment, economy (tax) due to proposed ROW disposal have to be analyzed to approve the access disposal. Property sale has to be justified by both Disposition committee and FHWA personnel if,
- The facility is an interstate
- And federal funds are involved

Otherwise, only disposition committee’s approval is required.

**Connections**

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Flow Approval Source -&gt; Destination</td>
<td>Public Disposition Committee</td>
<td>Public Justification</td>
</tr>
<tr>
<td>ControlFlow Source -&gt; Destination</td>
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<td>Public Access Disposal</td>
</tr>
<tr>
<td>ControlFlow Source -&gt; Destination</td>
<td>Public Justification</td>
<td>Public ROW Leasing</td>
</tr>
<tr>
<td>ControlFlow Source -&gt; Destination</td>
<td>Public Justification</td>
<td>Public Relinquishment</td>
</tr>
</tbody>
</table>
FHWA personnel
*Type:* **Actor**

Staff of federal highway administration who justify the excess property sale along with the Disposition committee.

**Connections**

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Flow Approval Source -&gt; Destination</td>
<td>Public FHWA personnel</td>
<td>Public Justification</td>
</tr>
</tbody>
</table>

Disposition Committee
*Type:* **Actor**

It is a group of decision makers who approve the excess property sale. The number of people comprising the committee is dependent on the value of the property.

**Connections**

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Flow Approval Source -&gt; Destination</td>
<td>Public Disposition Committee</td>
<td>Public Justification</td>
</tr>
</tbody>
</table>

Relinquishment
*Type:* **Activity**

Giving the rights on ROW to other public agency.

**Connections**

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>ControlFlow Source -&gt; Destination</td>
<td>Public Justification</td>
<td>Public Relinquishment</td>
</tr>
</tbody>
</table>

ROW Leasing
*Type:* **Activity**

Leasing to private organizations.

**Connections**

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<thead>
<tr>
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<th>Source</th>
<th>Destination</th>
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</thead>
<tbody>
<tr>
<td>ControlFlow Source -&gt; Destination</td>
<td>Public Justification</td>
<td>Public ROW Leasing</td>
</tr>
</tbody>
</table>
Access Disposal

Type: **Activity**

Adding another access point to the highway.

**Connections**

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
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<td>Public</td>
</tr>
<tr>
<td>Source -&gt; Destination</td>
<td>Justification</td>
<td>Access Disposal</td>
</tr>
</tbody>
</table>
APPENDIX C – USE CASE MODEL OF PROPERTY MANAGEMENT

Table of Contents

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Key to Use Case Model ...................................................................................................................... 112
Use Case Model ............................................................................................................................... 113
  Pre-Construction Property Management ........................................................................... 114
  During Construction Property Management ............................................................................. 122
  Post- Construction Property Management .................................................................................. 126
The **use case model** gives a bigger picture of the Property Management system describing the proposed functionality of the system including business processes (activities), association and dependency between the processes, and the corresponding actors.

**Key to Use Case Model**
The components of a **use case model** are actors and **use cases**. The symbols used to represent these components and the connectivity between them is represented using the symbols shown in Table C-1.

<table>
<thead>
<tr>
<th>Table C-1. Key to Use Case Model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Use Case</strong></td>
</tr>
<tr>
<td><strong>Actor</strong></td>
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<tr>
<td><strong>Collaboration</strong></td>
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<tr>
<td><strong>Extend Link</strong></td>
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<tr>
<td><strong>Association</strong></td>
</tr>
<tr>
<td><strong>Precede link</strong></td>
</tr>
</tbody>
</table>
Table C-1. Key to Use Case Model (cont.)

<table>
<thead>
<tr>
<th>Invoke Link</th>
<th>Used to show the cases where use case is triggered only by the presence of a specific element. In this case, involvement of FHWA invokes certain use cases which are not carried out otherwise.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependency Link</td>
<td>Used to show dependency of one use case over another use case or actor for the completion of task. For example, rental rates, and leasing and maintenance use cases are mutually dependent on each other in the Pre-construction use case model.</td>
</tr>
</tbody>
</table>

**Use Case Models - (Package diagram)**

*Package diagrams* are used to reflect the organization of packages and their elements. The nesting connector between Pre-Construction and Post-Construction Property Management reflects what the package contents reveal. The linked Use Cases are shown in pages 112, 120, and 124.

**Figure C-1. Package diagram of Property Management**
Figure C-2. Use case model of Pre-Construction Property Management
Appraisal system
Type: Actor

List of the improvements is obtained from the information system of appraisal department.

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Public</td>
</tr>
<tr>
<td>Source -&gt; Destination</td>
<td>Improvement Sale</td>
<td>Appraisal system</td>
</tr>
</tbody>
</table>

Appraiser
Type: Actor

An appraiser of appraisal department estimates the rental rates based on the market value.

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>UseCaseLink</td>
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<td>Public</td>
</tr>
<tr>
<td>Source -&gt; Destination</td>
<td>Rental</td>
<td>Appraiser</td>
</tr>
</tbody>
</table>

PM personnel
Type: Actor

The staff of Property Management in ROW division of a DOT.

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td>Unspecified</td>
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<td>Contract</td>
</tr>
<tr>
<td>Association</td>
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<tr>
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<td>PM personnel</td>
<td>HazMat Mitigation</td>
</tr>
<tr>
<td>Association</td>
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<td>Public</td>
</tr>
<tr>
<td>Unspecified</td>
<td>PM personnel</td>
<td>Relocation/ Settlement</td>
</tr>
<tr>
<td>Association</td>
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</tr>
<tr>
<td>Unspecified</td>
<td>PM personnel</td>
<td>RELOCATION/ Settlement</td>
</tr>
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<tr>
<td>Unspecified</td>
<td>PM personnel</td>
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<td>Association</td>
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<td>Public</td>
</tr>
<tr>
<td>Unspecified</td>
<td>PM personnel</td>
<td>Clearance/ Demolition</td>
</tr>
<tr>
<td>Association</td>
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<td>Public</td>
</tr>
<tr>
<td>Unspecified</td>
<td>PM personnel</td>
<td>Rodent Control</td>
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<tr>
<td>Association</td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td>Unspecified</td>
<td>PM personnel</td>
<td>Parcel Requirement Type</td>
</tr>
</tbody>
</table>
Relocator
Type: Actor

Property Management personnel work with the relocation personnel to relocate the owners who rented the property after acquisition.

Connections

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Public PM personnel</td>
<td>Public Improvements and Personal Property Sale</td>
</tr>
<tr>
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<td>Public PM personnel</td>
<td>Public Improvement Owner Retention</td>
</tr>
<tr>
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<td>Public PM personnel</td>
<td>Public Justification</td>
</tr>
<tr>
<td>Association Unspecified</td>
<td>Public PM personnel</td>
<td>Public Security Inspection</td>
</tr>
<tr>
<td>Association Unspecified</td>
<td>Public PM personnel</td>
<td>Public Personal Property Clearance</td>
</tr>
</tbody>
</table>

ACQUISITION
Type: UseCase

Only after the property is acquired, property is managed by the Property Management division.

Connections

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependency Source -&gt; Destination</td>
<td>Public ACQUISITION</td>
<td>Public Parcel Requirement Type</td>
</tr>
</tbody>
</table>

Parcel Requirement Type
Type: UseCase

Requirement type of a parcel like substantially excess, substantially ROW etc has to be determined prior to any Property Management activities on the parcels.
Connections

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Source -&gt; Destination</td>
<td>Public ACQUISITION -&gt; Public Parcel Requirement Type</td>
</tr>
<tr>
<td>Association</td>
<td>Unspecified</td>
<td>Public PM personnel -&gt; Public Parcel Requirement Type</td>
</tr>
</tbody>
</table>

**Contract**

_Type: UseCase_

The improvement disposal, personal property disposal, security inspection, rodent control, renting and maintenance and hazardous materials mitigation might be contracted. In that case, the Property Management personnel manage the contract alone.

Connections

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Source -&gt; Destination</td>
<td>Public Contract -&gt; Public HazMat Mitigation</td>
</tr>
<tr>
<td>Extend</td>
<td>Source -&gt; Destination</td>
<td>Public Contract -&gt; Public Clearance/ Demolition</td>
</tr>
<tr>
<td>Extend</td>
<td>Source -&gt; Destination</td>
<td>Public Contract -&gt; Public Security Inspection</td>
</tr>
<tr>
<td>Extend</td>
<td>Source -&gt; Destination</td>
<td>Public Contract -&gt; Public Rodent Control</td>
</tr>
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<td>Public PM personnel -&gt; Public Contract</td>
</tr>
<tr>
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<td>Source -&gt; Destination</td>
<td>Public Contract -&gt; Public Maintenance</td>
</tr>
<tr>
<td>Extend</td>
<td>Source -&gt; Destination</td>
<td>Public Contract -&gt; Public Rental</td>
</tr>
</tbody>
</table>

**HazMat Mitigation**

_Type: UseCase_

Mitigation of Hazardous Materials in the acquired property is one of the continuous processes after acquisition and before construction.

Connections

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
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</thead>
<tbody>
<tr>
<td>Extend</td>
<td>Source -&gt; Destination</td>
<td>Public Contract -&gt; Public HazMat Mitigation</td>
</tr>
<tr>
<td>Association</td>
<td>Unspecified</td>
<td>Public PM personnel -&gt; Public HazMat Mitigation</td>
</tr>
</tbody>
</table>
**Rodent Control**

*Type: UseCase*

Preliminary Inspection, Contract, Inter-Agency agreement are various ways in which Rodent Control is conducted. Rodent Control is a continuous process in Property Management till the start of project construction.

**Connections**

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>Extend Source -&gt; Destination</td>
<td>Public Contract</td>
<td>Public Rodent Control</td>
</tr>
</tbody>
</table>

**Clearance/ Demolition**

*Type: UseCase*

Permanent structures that cannot be sold and other improvements that remain unsold are cleared from the site through demolition. This activity could be carried out by the Property Management personnel or a contractor chosen by the Property Management division or the construction contractor.

**Connections**

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
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<tbody>
<tr>
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<td>Public Clearance/ Demolition</td>
</tr>
<tr>
<td>Extend Source -&gt; Destination</td>
<td>Public Contract</td>
<td>Public Clearance/ Demolition</td>
</tr>
</tbody>
</table>

**RELOCATION/ Settlement**

*Type: UseCase*

Relocation of the parcel owners and eligible tenants takes place after acquisition in case of short, time gap between the acquisition and project construction. If the time gap is couple of months or years, relocation of the owners might take place just before the beginning of the construction as a part of Pre-Construction Management.

**Connections**

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
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</tr>
<tr>
<td>Association Unspecified</td>
<td>Public PM personnel</td>
<td>Public RELOCATION/ Settlement</td>
</tr>
</tbody>
</table>
**Maintenance**

*Type:* **UseCase**

Lease and Maintenance agreements are made on factors like personal liability insurance, type of structure, age of structure, length of lease, and ability of tenant to provide maintenance. The payment method and location are also established at this point.

**Connections**

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
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<tbody>
<tr>
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<tr>
<td><strong>Too</strong></td>
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<td><strong>Maintenance</strong></td>
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<td><strong>Dependency</strong></td>
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<td><strong>Extend</strong></td>
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<td><strong>Public</strong></td>
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<td></td>
<td><strong>Contract</strong></td>
<td><strong>Maintenance</strong></td>
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</tbody>
</table>

**Rental**

*Type:* **UseCase**

Establishing rental rates involves market price consideration, maintenance capabilities of the interested party. Free occupancy period is determined based on occupant type like short term owner, short term non-owner, long term tenant etc.

**Connections**

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<tr>
<th>Connector</th>
<th>Source</th>
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<tbody>
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</tr>
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<td><strong>Source -&gt; Destination</strong></td>
<td><strong>Public</strong></td>
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</tr>
<tr>
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<td><strong>Source -&gt; Destination</strong></td>
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<td><strong>Public</strong></td>
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<tr>
<td></td>
<td><strong>PM personnel</strong></td>
<td><strong>Rental</strong></td>
</tr>
</tbody>
</table>

**Improvements and Personal Property Sale**

*Type:* **UseCase**

Improvement sale involves advertising of the improvements, sale and a performance bond from the purchaser so that the improvement removal costs are paid incase of failure to move the improvements after the sale.
### Connections

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
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</thead>
<tbody>
<tr>
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<td>Source -&gt; Destination</td>
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</tr>
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</tr>
<tr>
<td>Association</td>
<td>Unspecified</td>
<td>Public Improvements and Personal Property Sale</td>
</tr>
</tbody>
</table>

### Justification

*Type: UseCase*

The approval of the concerned Property Management personnel is required stating the availability of lots to move the improvements to a different lot and that this would result in lower project costs.

In the case of personal property, Property Management staff has to justify the retention of any personal property by explaining the need to the department and also by showing that retention would be reduce project costs than sale or clearance.

### Improvement Owner Retention

*Type: UseCase*

This activity involves the actual sale to the owner and a Performance bond from the owner so that the improvement removal costs are paid incase the owner fails to move the improvements after the sale.
**Personal Property Retention**

*Type:* UseCase

Personal property of the occupants of the acquired property is retained by the ROW division if there is a need for that particular item and if retention is less costly than sale or clearance.

**Connections**

<table>
<thead>
<tr>
<th>Connector</th>
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</tr>
<tr>
<td>Source -&gt; Destination</td>
<td>Justification</td>
<td>Personal Property Retention</td>
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</table>

**Security Inspection**

*Type:* UseCase

The security of the improvements is one of the major concerns of the ROW department. Frequent inspections are conducted to avoid vandalism, theft, etc.

**Connections**

<table>
<thead>
<tr>
<th>Connector</th>
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<th>Destination</th>
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<tbody>
<tr>
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<tr>
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<td>Security Inspection</td>
</tr>
</tbody>
</table>
During Construction Property Management
Type: Package

Figure C-3. Use case model of During Construction Property Management

PM personnel
Type: Actor
The staff of Property Management in ROW division of a DOT.

Connections

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
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</table>
| Association Unspecified | Public
PM personnel | Public
Security Inspection |
| Association Unspecified | Public
PM personnel | Public
Rodent Control |
| Association | Public
PM personnel | Public |

122
Property Management personnel work with the relocation personnel to relocate the owners who rented the property after acquisition.

**Connections**

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
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</thead>
<tbody>
<tr>
<td>Association</td>
<td>Public PM personnel</td>
<td>Public Settlement and Relocation</td>
</tr>
</tbody>
</table>

**contract**

Type: **UseCase**

The security inspection, rodent control, renting, hazardous materials mitigation, and grading of ROW might be contracted. In that case, the Property Management personnel manage the contract alone.

**Connections**

<table>
<thead>
<tr>
<th>Connector</th>
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<tbody>
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<td>Public HazMat Mitigation</td>
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<td>Extend Source -&gt; Destination</td>
<td>Public Contract</td>
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</tr>
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</tr>
<tr>
<td>Association Unspecified</td>
<td>Public PM personnel</td>
<td>Public Contract</td>
</tr>
</tbody>
</table>

**Grading**

Type: **UseCase**

Land is graded or leveled prior to the construction. This task is often considered as a part of construction or contracted. Improvement clearance could also be a part of construction for large projects.
<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
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</thead>
<tbody>
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</tr>
<tr>
<td>Association</td>
<td>Public PM personnel</td>
<td>Public Grading</td>
</tr>
</tbody>
</table>

**HazMat Mitigation**

*Type: UseCase*

Mitigation of Hazardous Materials in the acquired property is one of the continuous processes after acquisition and before construction.

<table>
<thead>
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</tr>
<tr>
<td>Association</td>
<td>Public PM personnel</td>
<td>Public HazMat Mitigation</td>
</tr>
</tbody>
</table>

**Rodent Control**

*Type: UseCase*

Preliminary Inspection, Contract, Inter-Agency agreement are various ways in which Rodent Control is conducted. Rodent Control is a continuous process in Property Management till the start of project construction.

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
<th>Destination</th>
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</tr>
<tr>
<td>Extend</td>
<td>Public Contract</td>
<td>Public Rodent Control</td>
</tr>
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</table>

**Security Inspection**

*Type: UseCase*

The security of the improvements is one of the major concerns of the ROW department. Frequent inspections are conducted to avoid vandalism, theft, etc.
Relocation of the parcel owners and eligible tenants takes place after acquisition in case of short, time gap between the acquisition and project construction. If the time gap is couple of months or years, relocation of the owners might take place just before the beginning of the construction as a part of Pre-Construction Management.

### Settlement and Relocation

**Type:** Collaboration

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</table>
Post- Construction Property Management

Type: Package

Post- Construction Property Management

Figure C-4. Use case model of Post-Construction Property Management
Appraisal System
Type: Actor

List of the improvements is obtained from the information system of appraisal department.

Connections

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</tr>
<tr>
<td>UseCaseLink</td>
<td>Source -&gt; Destination</td>
<td>Public Appraisal System</td>
</tr>
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</table>

FHWA
Type: Actor

Staff of federal highway administration who justify the excess property sale along with the Disposition committee.

Connections

<table>
<thead>
<tr>
<th>Connector</th>
<th>Source</th>
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PM personnel
Type: Actor

The staff of Property Management in ROW division of a DOT.

Connections

<table>
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<tr>
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</tbody>
</table>

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### Justification

**Type:** UseCase

Property sale has to be justified by both Disposition committee and FHWA personnel if,
- the facility is an interstate
- and federal funds are involved
Otherwise, only disposition committee’s approval is required.

### Connections

<table>
<thead>
<tr>
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| Public ROW leasing |
| **Dependency**
Source -> Destination | Public Justice
| Public Access disposal |
| **Dependency**
Source -> Destination | Public Justice
| Public ROW relinquishment |
| **Dependency**
Source -> Destination | Public Justice
| Public Excess Property Sale |
| **Association**
Unspecified | Public
| PM personnel |
| Public Justice |
| **Dependency**
Source -> Destination | Public
| FHWA |
| Public Justice |

### Excess Property Sale

**Type:** UseCase

The excess property is advertised and sold after being approved by Disposition committee.

### Connections

<table>
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| PM personnel |
| Public Excess Property Sale |
| **UseCaseLink**
Source -> Destination | Public
| Excess Property Sale |
| Public Appraisal System |
**ROW relinquishment**
*Type: UseCase*

Giving the rights on ROW to other public agency.

**Connections**

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<tbody>
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**ROW leasing**
*Type: UseCase*

Leasing to private organizations.

**Connections**

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**Access disposal**
*Type: UseCase*

Adding another access point to the highway.

**Connections**

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**Access Management**
*Type: UseCase*

Involves access change justification considering various factors.

**Connections**
### Airspace Management

**Type:** UseCase

Includes highway airspace marketing, development, and management.

**Connections**

<table>
<thead>
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