

JOINT TRANSPORTATION RESEARCH PROGRAM

INDIANA DEPARTMENT OF TRANSPORTATION
AND PURDUE UNIVERSITY



PROJECT MANAGEMENT TRAINING

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SPR-3115
Report Number: FHWA/IN/JTRP-2011/13
DOI: 10.5703/1288284314626

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RECOMMENDED CITATION

McCullouch, B., & Land, W. Project Management Training. Publication FHWA/IN/JTRP-2011/13. Joint Transportation Research Program, Indiana Department of Transportation and Purdue University, West Lafayette, Indiana, 2011.
DOI: 10.5703/1288284314626

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JOINT TRANSPORTATION RESEARCH PROGRAM

The Joint Transportation Research Program serves as a vehicle for INDOT collaboration with higher education institutions and industry in Indiana to facilitate innovation that results in continuous improvement in the planning, design, construction, operation, management and economic efficiency of the Indiana transportation infrastructure.
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TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. FHWA/IN/JTRP-2022/13	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle PROJECT MANAGEMENT TRAINING		5. Report Date 2011	
7. Author(s) Bob McCullough, Walter Land		6. Performing Organization Code 8. Performing Organization Report No. FHWA/IN/JTRP-2011/13	
9. Performing Organization Name and Address Joint Transportation Research Program 550 Stadium Mall Drive Purdue University West Lafayette, IN 47907-1284		10. Work Unit No.	
12. Sponsoring Agency Name and Address Indiana Department of Transportation State Office Building 100 North Senate Avenue Indianapolis, IN 46204		11. Contract or Grant No. SPR-3115	
15. Supplementary Notes Prepared in cooperation with the Indiana Department of Transportation and Federal Highway Administration.		13. Type of Report and Period Covered Final Report	
14. Sponsoring Agency Code			
16. Abstract <p>In 2005 the Indiana Department of Transportation (INDOT) went through a complete reorganization of its operations going from centralized to decentralized (District) management. This reorganization gave Districts autonomy to manage construction projects with one exception all added capacity projects are managed in the central office by the office of project management. Following in 2006 INDOT initiated a program named "Major Moves." This is a ten year major road building program that was funded partially through a \$4 billion lease of the Indiana Toll Road. Through Major Moves annual new construction will go from \$213 million in FY 2006 to \$1.2 billion in FY2009. These two factors caused INDOT to change their approach toward managing design and construction.</p> <p>This "new" approach toward projects requires an individual to manage projects with skills and functions that are not common at INDOT. Therefore the purpose of the project was to:</p> <ul style="list-style-type: none"> • Determine what skills were needed for INDOT project managers • Develop a training program to develop these needs • Deliver a training program <p>This report describes the training program established at INDOT and contains the resources available for project managers and training materials.</p>			
17. Key Words Project management, constructability, training, design, construction, scheduling		18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 10	22. Price

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EXECUTIVE SUMMARY

PROJECT MANAGEMENT TRAINING

Introduction

In 2005, the Indiana Department of Transportation (INDOT) went through a complete reorganization of its operations, going from centralized to decentralized (district) management. This reorganization gave districts autonomy to manage construction projects with one exception: All added capacity projects were to be managed in the Central Office by the project management team. Following this reorganization, in 2006, INDOT initiated a program called Major Moves. This is a ten-year major road building program that was funded partially through a \$4 billion lease of the Indiana Toll Road. Through Major Moves, annual new construction went from \$213 million in fiscal year 2006 to \$1.2 billion in fiscal year 2009. Due to the reorganization of operations and the initiation of Major Moves, INDOT changed their approach toward managing design and construction.

INDOT formed a project management section. This section started in the Central Office and has expanded to the six districts within the state. Each project is managed by a project manager (PM) from conception to completion. A PM is assigned to a project when a scope, schedule, and budget have been defined. One of the first decisions for the PM is to select either a consultant or an in-house design team. Typically, a PM in the central office has seven to eight projects that are corridor specific and not individual construction projects. The construction cost for these seven to eight projects total between \$500 million to \$1 billion. District PMs have a greater number of projects that are smaller and less complicated.

Individuals in the project management section required new skills that created a need for training. This project determined what skills were needed for project management, developed training materials and classes, and delivered the training.

Findings

One of the first steps was to define the training requirements for a PM.

With these needs identified, a search was then conducted to determine the best and most efficient source for collecting and developing appropriate content for INDOT. Numerous sources were investigated, and it was discovered that the Washington State Department of Transportation (WSDOT) had developed similar training for their employees.

WSDOT was contacted and asked if INDOT could use these materials for an introductory course on project management. Permission was granted, and this content was used and customized for INDOT.

Three other courses were developed and delivered, and they are described in the Implementation section.

This training curriculum has improved the skill set of INDOT PMs, provided guidance in their role, and taught them how to properly manage projects.

Implementation

With an understanding of training requirements and the types of training resources available, INDOT decided to develop their own content. A training consultant worked with a committee comprised of INDOT and university personnel to develop the curriculum and content for the Project Management Process and Advance Project Management courses. The training curriculum developed was for Project Scheduling and the Project Management Process. These two courses were delivered by the consultant.

Another course, Advanced Project Management, was developed and delivered by another consultant with oversight and review from a project committee.

A third course, Advanced Construction CPM Scheduling, was developed and delivered in a similar manner.

A fourth course, Constructability Review and Change Order Process, was developed in 2010 and delivered at the Civil Engineering Professional Development Seminar at Purdue University.

This training content will be available through INDOT Employee Development. Training material is available at this website: <http://rebar.ecn.purdue.edu/INDOTpm/home.aspx>

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INTRODUCTION

In 2005, the Indiana Department of Transportation (INDOT) went through a complete reorganization of its operations going from centralized to decentralized (district) management. This reorganization gave districts autonomy to manage construction projects with the exception that all added capacity projects were to be managed in the Central Office by the office of project management. Following the reorganization, in 2006, INDOT initiated a program named Major Moves. This is a ten year major road building program that was funded partially through a \$4 billion lease of the Indiana Toll Road. Through Major Moves, annual new construction went from \$213 million in fiscal year 2006 to \$1.2 billion in fiscal year 2009. These two factors prompted INDOT to change their approach toward managing design and construction.

Previously, each project phase was individually managed. INDOT refers to the project phases before construction as *production*. Each production group (Environmental, Survey, Geotechnical, Design, Permitting, ROW, etc.) worked separately in a linear fashion, with one group working on the project and then passing it on to the next group. Passing through the various project phases in this manner resulted in a loss of continuity and lack of ownership. Another pressure incentive for improving project management was that of change orders. In 2004, cost overruns from change orders for scope changes, plan errors and omissions, changed conditions, and incentives resulted in a \$75 million cost to INDOT out of a total budget of \$775 million, which is almost 10%.

Due to the reorganization and Major Moves, INDOT formed a project management section. This section started in the central office and has expanded to the six districts within the state. Each project is managed by a project manager (PM) from conception to completion. A PM is assigned to a project when a scope, schedule, and budget have been defined. One of the first decisions for the PM is to select either a consultant or an in-house design team. Typically, a PM in the central office has seven to eight projects that are corridor specific and not individual construction projects. The construction cost for these seven to eight projects total between \$500 million to \$1 billion. District PMs, on the other hand, have a greater number of projects that are smaller and less complicated.

Figures 1 and 2 show the before and after approach toward project management at INDOT. Before (Figure 1), projects were managed by many functional managers and passed to the next phase upon phase completion. Now (Figure 2), projects are coordinated by one project manager who works with the various functional managers from project conception to completion.

After a project goes through the production phase, it enters the construction phase (letting, bidding, award, and contract execution). When a project goes to construction, the PM moves to a background position while the project engineer/supervisor becomes the chief figure on the project. All construction decisions are handled through the project engineer (PE). The PM is required to be in the field twice a month on each project. The reason for this is to provide the PM with an opportunity to learn what is working or not working

Before		
Phases	Management	Execution
Environmental ↓ Design ↓ Permitting ↓ Right of Way	Individual Functional Managers	In Serial Manner

Figure 1 INDOT Project Management process before 2005

After		
Phases	Management	Execution
Environmental ↓ Design ↓ Permitting ↓ Right of Way	(PM Coordinated) Functional Managers	In Parallel

Figure 2 INDOT current Project Management process

and apply these lessons to future projects, as well as answer any questions that are the result of design. Any design or scope changes that occur during construction are to be approved by the PM prior to issuing a change order. In the past, there was a trend of poor communications between the construction and the production phase. The PM provides this necessary communication.

To gain an understanding of the project management approach at INDOT, a description of a PM, the project development process (PDP), and the review program are provided below.

INDOT PROJECT MANAGER

An INDOT PM is responsible for the project from conception to completion. The PM leads each step in the project management process and must possess a thorough understanding of this process. Specifically:

- Coordinates development of projects from time of programming through construction.
- Coordinates with designers, utilities, R/W, railroads, local authorities, etc.
- Plans and attends various meetings during project development.
- Develops or assists in development of project budget and schedule.

TABLE 1
Project Categories and Responsibilities

Project Classification	Number of steps	Example Project	Typical Project Management Responsibility
Maintenance	4	Crack Sealing	Districts
Minor	11	Repave/spot improvement	Districts or Central Office
Major	12	New, Interstate	Central Office

TABLE 2
Project Classifications and Processes

Project Classification	Minor	Major
Maintenance		
Step 1. Project Compilation (Data management and inspections)	Step 1. Professional services (Contracts and agreements)	Step 1. Professional services (Contracts and agreements)
Step 2. Project Identification	Step 2. Conduct Research and Technical Studies	Step 2. Conduct Research and Technical Studies
Step 3. Prioritization of selected projects	Step 3. Identify and evaluate conceptual solutions	Step 3. Identify and evaluate conceptual solutions
Step 4. Separate projects into project categories for submittal	Step 4. Develop reasonable alternatives	Step 4. Develop reasonable alternatives
	Step 5. Identify preferred alternatives	Step 5. Identify preferred alternatives
	Step 6. Stage 1 — Develop preferred alternative	Step 6. Stage 1 — Develop preferred alternative
	Step 7. Stage 2 — Advanced preferred alternative	Step 7. Stage 2 — Advanced preferred alternative
	Step 8. Environmental approach	Step 8. Environmental approach
	Step 9. Prepare final ROW plans	Step 9. Prepare final ROW plans
	Step 10. Begin Land acquisition	Step 10. Begin Land acquisition
	Step 11. Stage 3 — Complete preferred alternative	Step 11. Stage 3 — Complete preferred alternative
	Step 12. Prepare Final Tracings package	Step 12. Prepare Final Tracings package

- Monitors project schedule and budget throughout life of project, including construction.
- Reviews and recommends solutions to project issues (design, utilities, R/W, etc.).
- Coordinates work of various groups to produce completed contract packages, including planning, production, contracts, and construction.
- Provides project updates to various divisions and offices as needed, including the executive staff.
- Provides assistance to construction post-letting in interpretation of intent of project.
- Reviews requests for changes to design or scope of contracts and makes recommendations to appropriate construction personnel.
- Communicates directly with all personnel associated with the project to understand and coordinate work to achieve desired results for INDOT.
- Attends partnering meetings.

One objective of the PDP is to provide the PM a roadmap to how a project should be managed. This plan is based on project type. Depending on project size, complexity, and environmental impact, INDOT uses three categories for projects and each one has a different PDP. The three types are: major projects, minor projects, and maintenance projects. Table 1 illustrates the different categories, the steps in their process, and their management responsibilities. For the project classifications, the processes are shown in Table 2.

PDP

The PDP can be viewed as a tool or flowchart that can help effectively manage the scope, budget, schedule, and quality of projects. Tools and techniques alone are not sufficient without effective project management knowledge and skills. The PDP is the recognized process. The PDP includes several tools for the PM and these include a Gantt chart(developed in

Primavera), constructability reviews, consultant evaluation, and a web site. A PDP Manual was developed in 2007 and is included in Appendix A.

The website (<http://rebar.ecn.purdue.edu/INDOTPM>) is a resource center for INDOT's project managers. It contains resources, forms, and training program information. The resources include: a communication plan, change management plan, transition and closure plan, a quality assurance and quality control plan, and a PDP Gantt chart for each project category type. Forms are available for constructability reviews and consultant evaluations.

Gantt charts and the Primavera software enable PMs to monitor project development, allowing early identification of potential problems and facilitating the timely delivery of the project. Every project will have a Primavera schedule and the PM will use the template schedule to create a project-specific schedule. Each schedule has built-in activities at specific points in the PDP. Monitoring these specific activities will help the PM update the schedule as needed. Having a schedule for project development provides the ability to focus on items that can deliver the project quicker. Gantt charts identify:

- Each step and its associated tasks
- Duration of the time necessary to accomplish each task
- Predecessor and successor tasks

Gantt charts for the major and minor projects are found in Appendices B and C respectively.

Every project must have a documented public involvement plan (PIP). The PM is responsible for developing and implementing the PIP. The PIP outlines the strategy and responsibilities for informing and involving the project stakeholders through all the PDP stages. The PIP will start at the kickoff meeting and evolve through the project. Appendix D contains a copy of the PIP Manual.

REVIEWS

Consultant evaluations and constructability reviews are performed at various stages of the project, as shown on the PDP. Constructability reviews are done at seven stages, see Table 3 for the type and timing of the constructability review and consultant evaluations.

TABLE 3
Required Constructability and Consultant Reviews

Constructability Review	Consultant Evaluation
1. Preliminary Field Check	Consultant Evaluation 1
2. Detailed Design Plan	Consultant Evaluation 2
3. Final Field Check	Consultant Evaluation 3
4. Final Plan & Document Review	PDP step 6 — Preliminary Field Check
5. Pre-construction	PDP Step 7 — Intermediate Field Check
6. Mid-contract review	PDP Step 11 — Final Field Check
7. Post construction	Project Management

These reviews and evaluations are checklists. The PM meets with the area engineer who is responsible for these reviews. This is a significant communication improvement between design and production over the previous project management approach. After each constructability review a consultant evaluation will be done by the area engineer. There are also seven consultant evaluations. These scores are used in the future selection of design consultants.

TRAINING PROGRAM

Training was essential in establishing the new PM system at INDOT. The needs for training were:

- To deliver projects on-time and at cost.
- Accountable to customers to deliver while practicing open, honest, and proactive project information sharing.
- Explain the "Cradle to Grave" concept in PM.
- Reorganization changed the process and decentralized PM.
- New positions were created which provides new career opportunities.

One of the first steps in creating a training program is to define the curriculum and then determine what PM training exists and could be used. Training courses offered by the National Highway Institute (NHI) and developed by a national consulting firm were evaluated for content, cost, and delivery method. Information on these courses are shown below:

- Value Engineering Workshop – 5 days, \$650/participant, class size: 20 to 30
- Managing Highway Contract Claims: Analysis and Avoidance — 2.5 days, \$335/participant, class size: 20 to 30.
- Use of Critical Path Method(CPM) for Estimating, Scheduling and Timely Completion — 2 days, \$270/participant.
- Alternative Contracting — 2 days, \$270/participant.
- Managing High Technology Projects in Transportation — 2 days, \$270/participant.
- Design and Operation of Work Zone Traffic Control — 1 day, \$200/participant.
- Construction Zone Safety Inspection — 1 day, \$200/participant.

Another source is with consulting firms who specialize in this area of training. One firm is Fales Management or FMI. Fales has training on the following topics, the number of training hours is in parentheses.

Human patterns Profile and Personal Performance Feedback (2 hours)

- Identify personal strengths and weaknesses identified by your peers.
- Adjust your working behavior for improved performance.
- Understand how to best lead your project team and identify how to improve your management skills.

Time Management (2 hours)

- Evaluate how you manage your time during the day/week.
- Identify ways that you use time effectively and ineffectively.
- Identify specific ways you can improve your time management, productivity, and personal effectiveness.

Project Planning (2 hours)

- Develop a complete project delivery plan including work breakdown structure, schedule, project budget, and QC/QA plans.
- Organize a project team.
- Communicate effectively to all project stakeholders.
- Identify and plan for risks and contingencies in the project delivery process.
- Document and communicate the plan to appropriate parties.

Project Start-up (2 hours)

- Identify and share key project issues, strategies, methods, and milestones.
- Plan and manage an effective meeting.
- Initiate effective communication with the project team.
- Create and maintain a cooperative team environment.
- Use submittals/RFIs to provide concise communication to other project stakeholders.

Change Order Management (2 hours)

- Identify and evaluate all changes.
- Identify cost and schedule implications of changes.

Project Tracking and Control (2 hours)

- Accurately assess project percentage completion using put-in-place and yet to complete methods.
- Identify appropriate control actions in response to known status of project scope, schedule and budget.
- Identify causes of project variance.
- Identify and document lessons-learned.

Evaluating this option led to a conclusion that the subject matter was not entirely appropriate and the cost high. For these reasons the direction of creating the content and delivering was chosen.

Washington DOT (WSDOT) had developed and delivered PM training. WSDOT was contacted and they offered to share their curriculum and content. A description of their project management training program can be found at <http://www.wsdot.wa.gov/Projects/ProjectMgmt/Training.htm>. After reviewing these sources it was determined that training would have three components:

- Project Scheduling
- Project Management Process
- Advance Project Management

Another activity was to determine what the training needs are for the various personnel (or job positions) involved in the PM process. Table 4 summarizes this information.

Project Scheduling

1. Introduction to Project Scheduling
2. Introduction to Project Scheduling — On time project delivery
3. Introduction to Project Scheduling — A simple project network
4. Schedule logic and diagrams
5. Schedule diagrams
6. Schedule basics and calculations
7. Managing project schedules

Project Management Process

1. Introduction
2. Initiate and Align
3. Plan the Work
4. Endorse the Plan
5. Work the Plan
6. Transition and Closure

This training was developed with a training consultant and an internal INDOT committee consisting of INDOT employees, design consultants and Purdue University. The course material developed and delivered around the state is in Appendix E.

Advance Project Management

This training focuses on managing scope, budget, and schedule, and with some coverage of value engineering. Outcomes will be that participants will be able to identify the difference between scope creep and schedule recovery and develop scope contingencies. Also, plan and estimate percent complete for schedule and budget management and devise contingencies during project delivery.

This training was developed with an outside consultant and was delivered one time and stopped. The reason it was discontinued was the training received poor reviews due to content as nonrelevant.

The training materials are in Appendix F.

Advanced Construction CPM Scheduling

This course includes the following

- Claim analysis strategies.
- How to use CPM scheduling analysis to evaluate and substantiate time extension requests and ways to avoid claims resulting from job schedule change.

TABLE 4
Project Management Training Requirements

Training Need	Level	Target Positions or Classifications	Est. Number	Schedule
Project Mgmt. Basics	Introductory — Overview of management principles: scope, schedule, budget, risk mgmt.	• CO Div. of CM (3 EXBB, 7 HE1)	• 10	Initial/Semi-annual refresher
		• DCE & AE (6 EXBB, 30 HE1)	• 36	
		• Selected PE/S (40 CE3, 20 EAS3)	• 60	
CPM Scheduling I	Introduction — Basic CPM concepts; reading CPMs, spec req's, etc.	• CO Div. of CM (3 EXBB, 7 HE1)	• 10	Initial/Semi-annual refresher
		• DCE & AE (6 EXBB, 30 HE1)	• 36	
		• Selected PE/S (40 CE3, 20 EAS3)	• 60	
CPM Scheduling II	Advanced — calculating CPM, comparing to baseline, resource allocation, specific software applications	• CO Div. of CM (FE) (2 HE1)	• 2	Initial/New promotions/ Update as Specs & software evolve
		• Dist AE (20 HE1)	• 20	
		• Selected PE (20 CE3)	• 20	
Claims Mgmt. I	Introduction — Claims avoidance & handling; legal concepts of specs	• CO Div. of CM (3 EXBB, 7 HE1)	• 10	Initial/New hires
		• DCE & AE (6 EXBB, 30 HE1)	• 36	
		• All PE/S (all CE5-3, all EAS3)	• 305	
Claims Mgmt. II	Advanced — Risk mgmt., handling court appearances, writing specs, etc.	• CO Div. of CM (1 EXBB, 2 HE1)	• 3	Initial/New promotions/ Update as training evolves
		• DCE + Selected AE (6 EXBB, 12 HE1)	• 18	
		• All AE (30 HE1)	• 30	
Construction Mgmt.	Specific INDOT training on contract field administration procedures	• All PE/S (all CE5-3, all EAS3)	• 305	Initial/Regular refresher
		• All AE (30 HE1)	• 30	
		• All PE/S (all CE5-3, all EAS3)	• 305	
Construction Traffic Mgmt. Plans	Review & application of MOT schemes; adapting plans in field; TMPs; INDOT policies, etc.	• All AE (30 HE1)	• 30	Initial/Regular refresher
		• All PE/S (all CE5-3, all EAS3)	• 305	
		• All AE (30 HE1)	• 30	
Contract Document Reviews	How to review plans & specs at various stages of contract development	• All PE/S (all CE5-3, all EAS3)	• 305	Initial/Regular refresher
		• All AE (30 HE1)	• 30	
		• All PE/S (all CE5-3, all EAS3)	• 305	
Value Engineering	Advanced workshop to meet FHWA requirements	• Select group from CO and Districts (2 EXBB, 18 HE1)	• 20	Initial/New members

CO- construction operations, CM — construction management, DCE — district construction engineer, AE — area engineer, PE — project engineer, FE — field engineer. With an understanding of training requirements and the types of training resources available, INDOT decided to develop their own content. WSDOT's training material was consulted and used as a reference. INDOT then hired a training consultant who worked with a committee comprised of INDOT and university personnel to develop the curriculum and content for the Project Management Process and Advance Project Management courses. The training curriculum developed is shown below.

- Actions to take in the event of project delay or interruption and strategies to resolve delay.

The training was delivered through a consultant using in-class instruction at various locations around the state.

Constructability Review and Change Order Process

This training was developed in 2010 and was delivered first at the Civil Engineering Professional Seminar held on November 4 at Purdue University. A copy of the Constructability Guide Book and training materials are in Appendices G and H.

The timeline for the PM training courses is the following.

Summer 2006 — Identify training needs and review available training materials. Select WSDOT Project Management Training materials.

August 2006 – Hire Stu Walesh as moderator to develop training materials for Project Management Basic course.

Sept. 06 – Jan. 07 – Developed training materials.

March 07 – Hire training consultant – Trauner to deliver the Project Management Basic Course referred to as the Project Management Process Course.

April 07 – Pilot course delivered

Summer 07 – Present PM Basic course around the state.

November 08 – Deliver Advanced PM course one time and then cancelled.

09 – Develop Constructability Review program and materials.

10 – Deliver Constructability Review training at the Civil Engineering Professional Development Seminar in November held at Purdue University.

CONCLUSION

The last couple years at INDOT has brought on significant changes in the way construction projects are managed. One is the formalizing of project development processes; this removes uncertainty and minimizes errors and omissions. Another is that performing activities in parallel can significantly reduce time on a

project. Two phases that have long development times, design and environmental, can be started and performed partially at the same time. Previously the environmental document did not include final design considerations. So when the environmental document is completed the design requirements are included. Another is utility coordination and wet land permitting. This coordination can start earlier in the project. For example, INDOT contacts utilities early in the plan development process so that the designer can work with utilities to reduce if not eliminate utility conflicts. At the same time the designer is developing plans, a wet land investigation can occur. Also, ROW activities can be started in the environmental phase because significant design information is available. ROW engineering can be completed with abstracting completed and start appraising and buying when the environmental document is signed. Previously design was started when the environmental document was signed. This saves significant time and more accurate information is available since the various phases are working together. Performing the tasks in parallel requires one PM to coordinate.

Previously at INDOT, very few people knew the whole picture when developing their piece of the project. Environmental footprints were evaluated without a complete understanding of the final design impacts such as vertical alignments, drainage features or maintenance of traffic solutions. Constructability was not even thought of during the environmental development phase. This gave cause for frequent environmental revisions that resulted in project delays. The other possibility was locking into solutions very early on. As better solutions were found later in design, it would be too late to make environmental document revisions without significant impacts on the schedule.

With the PM as the project “owner”, strong consideration is given to all decisions and how they may impact the project budget and schedule. Previously,

since there was not a single owner, scope creep was rampant. PM now frequently have to say “no” when asked to make additions to the project scope during development and construction. Since a PM is involved during construction and makes frequent site visits to ensure that the project is problem free as possible as it is built. In the past, the project was considered “delivered” the day tracings were submitted. Anything after that point was a construction division issue to deal with. The designers only heard about the project if there were major problems. Smaller issues were just dealt with. No learning resulted from this process.

The constructability reviews are improving the design product as well as the product coming out of the production phase. The lessons learned on each project are archived for retrieval and use on future similar projects. This will impact the quality of the design which will be reflected in less change orders and lower claims.

A formal training program has helped to solidify the the understanding of who and what project managers do. It has communicated the process and procedures in a standardized manner to bring consistency and thereby minimize misunderstandings to the project management process.

Another change for the PM is gaining an understanding of the function of the whole agency and how all of the parts function together from planning to budgeting to construction and maintenance. PM’s also have to take a much more active role in representing the agency to the local agencies and public. INDOT’s PM’s truly possess ownership and pride in their work as they see their projects completed.

APPENDICES A – H

Note: Since the start of this project in 2007, INDOT has undergone organizational and functional changes. These have caused some of the documents in the Appendices to become outdated, particularly the PDP Manual and the GANTT charts in Appendices B and C.