CONSTRUCTABILITY GUIDE BOOK

CONSTRUCTABILITY REVIEW PROCESS

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CONSTRUCTABILITY REVIEW PROCESS

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CONSTRUCTABILITY REVIEW PROCESS

INTRODUCTION

First, at this time, these Constructability Reviews are to be conducted only on the Major New projects.

Next, this manual is called "Constructability Guide Book". And it is, but it is more. It covers some of the common goals and shared responsibilities for delivering the project.

Everyone on a project has a function or role and a responsibility assigned to that role or function. The team is that group of individuals that perform the work required for the project and project delivery. Early and constant communication is essential among all parties. The team leaders are the project manager and the construction manager. Their success depends on their mutual coordination and communication.

This past year, the constructability reviews were least successful for two reasons. First, the reviews were conducted before the right of way and utilities concerns were addressed. To correct this error, we have moved the reviews forward in the Project Development Process.

Second, the constructability reviews overall were conducted with a minimum of effort. Reasons given were "too much work, not enough time". In our present work environment, that may be true. Everyone has a lot of work. Some more than others. But the problems will not go away and will need to be corrected at some point. We can and will make a difference the earlier in the process we can do this. The same mistakes seem to be made over and over and we need your knowledge and input before we pay the premium on change orders and or claims.

Thorough constructability reviews during the design development will reduce the issues encountered during construction and reduce change orders. Furthermore, it will also reduce the overall workload on the construction staff.

You can make a difference!

So let us begin.....

CONSTRUCTABILITY REVIEW PROCESS

BACKGROUND

Constructability for highway projects is as old as the engineering, design and construction process. It is nothing new. INDOT, over the years, has practiced elements of a constructability program but did not give it a name. Plans were submitted to District Construction for review and conducted field checks to get construction feedback. The concept was valid but its execution was destined for failure for several reasons. First, participation by District personnel was sporadic. Next, after the preliminary field check, there was no review until plans were 90% complete at the final field check. Review at this stage usually meant there would be delay of the project until the corrections could be made. If not corrected, change orders would be submitted for any errors and omissions or changes in scope by Construction. It was not successful.

Change orders in 1991 seemed manageable at 3½% of the construction budget. Three years later when change orders rose to 5%, INDOT moved to stem the tide. We introduced the Construction Evaluation and Contract Documents process to focus on the problem. At the same time, contractors were brought in to conduct constructability reviews.

For years we had continued to discuss the possibility of constructible plans and the costs of resolving problems in the field. The problem was getting designers and construction engineers to work effectively together. Something had to be done. The situation had become untenable. The percentage of change orders had risen to 11% of the construction budget. Efforts, so far, had failed. The overall culture needed change.

Was there any way that we could meld their efforts? Could it be taught? No way!

Highway construction is an experienced-based industry. Construction is not taught. Construction is learned. It is learned by experiencing a wide diversity of construction elements in different situations under various conditions and requirements. If this experience and knowledge was coupled with Design's knowledge, whether it is geometric, geotechnical, hydraulic or the like, it could produce a more efficient and constructible project.

Then it happened in 1997, when INDOT began a Design-Build program, and when construction managers worked effectively integrating design and construction efforts. The result was their change orders totaled only 2-2½% of the Construction budget for the fifteen "design – build" or "fast track" projects. The success of this Special Projects Section's process was the keystone in the development of INDOT's Project Management process.

Today, effective project management by Construction has reduced INDOT's change orders to 5% of the construction budget.

CONSTRUCTABILITY REVIEW PROCESS

CURRENT PRACTICES

Project Management is INDOT's process to deliver projects. The Project Management Plan can be viewed as a "road map" which can effectively manage the scope, budget, schedule and quality of projects. It consists of two phases, pre-construction and construction.

Together, the Project Manager and the Area Engineer (hereafter referred to as Construction Manager) as team leaders, facilitate this road map to a successful completion.

Pre-Construction: With the support of the Construction Manager, the Project Mangers plans, coordinates, and develops construction projects from planning to the contract letting.

Construction: With the support of the Project Manger, the Construction Manager plans, coordinates, and supervises construction projects from the contract letting to its completion.

RESPONSIBILITIES AND ACCOUNTABILITY

The project manager and the construction manager have respective project management responsibilities and accountability. Their joint oversight of the designer's efforts to deliver a successful project to contract requires mutual coordination and communication.

- The Project Manager schedules the Constructability Reviews during project development. He/she will coordinate with the Construction Manager in sufficient time to ensure their participation. The Project Manager sends all plans and necessary documents to Construction Manager.
- The Project Manager will schedule the Field Checks and the Constructability/Utility Conference.
- After the letting, the Construction Manager will schedule the Pre-Construction Conference, and will coordinate with the Project Manager to ensure their participation. Major Moves Project Managers and Designers are required to attend Pre-Construction Conferences.
- When the Construction Manager determines the schedule of the project construction meetings (weekly, monthly) he/she will notify the Project Manager. Major Moves Project Managers are required to attend these meetings and to visit projects each month.
- Both Project and Construction Managers will each coordinate any event with the other to accommodate the required participation.

CONSTRUCTABILITY REVIEW PROCESS

RESPONSIBILITIES AND ACCOUNTABILITY cont'd

Scope

- The Project Manager defines and maintains the scope with the designer. At each Constructability stage, the Project Manager reviews the project purpose, need and scope with the Construction Manager.
- The Construction Manager, during project construction, maintains the scope by clarifying and defining any change with the Project Manager.

Schedule

- The Project Manager defines the project schedule from project start to the contract letting.
- Schedule considerations, during development, are made and defined by both the Project Manager and Construction Manager. Their effort defines the "time set" by the Construction Manager.
- The Construction schedule is the responsibility of the Construction Manager.

Budget

- The Project Manager is responsible for the project's budget and defines the project budget for development and construction. He/she coordinates and oversees funding for both periods.
- The Construction Manager is responsible to maintain the construction budget. Copies of all construction change orders and tracking documents will be transmitted to the Project Manager in a timely manner.
- The Project Manager will determine if any change has impacted the budget. With consultation of the Construction Manager he/she will determine if restitution is warranted for any errors and omissions, constructability and the like.
- The Project Manager will coordinate the funding required by changes.

CONSTRUCTABILITY REVIEW PROCESS

CONSTRUCTABILITY GOAL

The Indiana Department of Transportation has endorsed constructability reviews to improve the total quality of our construction bid package. The narrow focus on just fixing problems has changed to the broader focus of preventing problems. The Department will ensure the use of construction knowledge and experience in planning and design to achieve the project objectives. While early involvement of construction personnel is most important, multi-disciplinary teamwork is needed from the beginning. There are few constructability concepts that are single discipline activities.

A multi-disciplinary team will support the partnering and team building concept and will improve constructability results. The team creation allows the functional offices to know of each other's involvement and provides some of the cross-training and formal communication needed throughout the process.

The Environmental offices are a critical team member needed at the project's early stages. Often, design changes are late as a result of environmental procedures, issues, and permits that were not considered early enough. The team goal to jointly solve problems with Project Management is critical for maximizing project delivery.

Similarly, early partnering with Real Estate and Utilities can improve the project development and delivery process.

It is important for the Project Manager to build and strengthen relationships with the Functional Managers. As project development becomes more demanding and deals with increasingly complex issues, the partnering process should be used to bring the multiple stakeholders into the process.

External partnering should also be considered with some of the agencies, i.e., IDEM, DNR, USCE. Partnering with external resource and local agencies would allow the critical and complex permitting process to proceed more smoothly.

Additionally, closer partnering with INDOT consultants will avoid any major communication problems. Better coordination can be achieved when they meet with the multi-disciplinary teams responsible for the project during review sessions.

Team building and Partnering are not new concepts to the Department and have been employed successfully in the construction area. Constructability is another area in which success is dependent on these concepts.

CONSTRUCTABILITY REVIEW PROCESS

REVIEW PROJECT SELECTION

INDOT has several types of major, intermediate, and minor projects for reviews. Typical categories may include major highway construction, major interchange construction, bridge construction, bridge rehabilitation, resurfacing and the like in a three-level process.

Constructability Review Level 1 includes Pre-Construction reviews at Stage 1, Stage 2, and Stage 3 Final Plan Review, Mid-Contract Review and Post Construction Review for these types of projects:

- Major, larger, complex roadway improvements (including new construction, widening, or realignment projects with significant staging, and traffic handling requirements).
- Major, complex bridge replacement including post-tensioned, cable-stayed, movable, extensive and complex rehabilitations.
- Major, complex interchange construction or modification.
- Major, large preservation projects that include widening and major structure replacement.

Constructability Review Level 2 includes Stage 1 and Stage 3 plan development, Mid-Contract Review and Post Construction Review for these types of projects:

- Major, less complex roadway projects (including widening projects with minimal staging/traffic handling.
- Major, less complex structure or interchange projects.
- Most preservation projects, including minor widening, drainage or safety improvements.
- All less complex bridge projects

Constructability Review Level 3 includes a Stage 3 plan development review and Post Construction Review for simple projects:

- Preventive maintenance overlay projects
- All others

CONSTRUCTABILITY REVIEW PROCESS

CHECKLISTS

INDOT uses checklists of items that have historically caused constructability problems, project delays and cost overruns. The checklists serve as a means for reviewers to focus on the areas and issues of concerns.

- Eliminate construction requirements that are impossible or impractical to build.
- Maximize constructability, recognizing the availability and suitability of materials and the standards of practice of the construction resources.
- Verify accurate depictions of site conditions with regard to access, utilities, right of way, soils, and general configuration.
- Ensure the maintenance of traffic is appropriate to the project site conditions and constraints.
- Determine appropriate construction durations and milestones. Analyze schedule and any special conditions and restrictions.
- Verify requirements for QA/QC during construction.
- Clearly define procedures for scheduling outages and the reasonableness of utility relocation efforts.
- Determine requirements for Department-provided services, and utility connections.
- Make certain that designs can be constructed using methods, materials, and equipment common to the construction industry.
- Pay attention to the requirements of the public including adjacent land use functions, existing transit patrons, and persons with disabilities.
- Make sure coordination is included with all affected parties.
- Make certain adequate provisions are provided for access, staging, and storage of waste and supplies; parking for worker and construction vehicles; and mitigation of environmental impacts during construction.

CONSTRUCTABILITY REVIEW PROCESS

REVIEW AND EVALUATION PROCESS

Review Stages 1, 2, and 3 Final Plan Completion

- The Construction Manager (Area Engineer and/or Project Engineer/Supervisor) and the Project Manager conduct the reviews.
- Reviews for pre-construction period will be conducted during design at Stages 1,2, and 3 plan developments. These reviews will be scheduled by the Project Manager.
- The Project Manager will confer with the Construction Manager to establish time and place. The Project Manager then in a timely manner sends hard copy plans and any documents needed for review.
- Upon completion of each review, the Construction Manager will contact the Project Manager to analyze the review results. They will discuss with the Designer all corrections to be made before the next review.
- The Project Manager will promptly relay these findings to the Consultant (Engineer of Record) to be analyzed and to address any questions of the reviewers.
- After receiving confirmation of the review by the Engineer of Record, the Construction Manager and Project Manager shall evaluate the Consultant and forward any results with recommendations to the proper authorities.

Review Stages: Mid-Contract and Post Construction

- During construction, reviews will be made at Mid-Contract of construction and at Post-Construction. The Construction Manager will schedule these reviews.
- Construction and Project Managers will evaluate Consultant's performance.

CONSTRUCTABILITY REVIEW PROCESS

FREQUENCY OF REVIEWS

Survey of Project Managers, District Construction and Area Engineers identified certain recurring constructability issues. These issues impact costs, schedule and quality.

- Utilities
- Right of Way
- Drainage
- Permits
- Traffic Control

To address these critical issues, it has been necessary for project-level paradigm shifts.

- The project constructability process shall include planning, design, construction and maintenance
- Use of constructability review tools
- Use a team approach
- Develop plans, specifications, and contract documents for constructability
- Provide feedback to Design on construction performance of design

This requires re-engineering of the Project Development Process to adapt the Constructability Review process for timely application within the context of the PDP.

CONSTRUCTABILITY REVIEW PROCESS

COORDINATION/COMMUNICATION

Coordination. There should be continued coordination and clear communication to produce the constructible project.

During Pre-Construction, the Project Manager will coordinate each phase. When scheduling these, the Project Manager will first coordinate with the Construction Manager to insure his/her schedule is clear.

Communication. At Development stage, the Project Manager is the official communicator, speaking for the Department.

- While the Utility Coordinator/Designer coordinates efforts with the utilities, it is essential that the Project Manager to make contact with the utilities to better involve them in their efforts.

- Personal contact with team members strengthens working relationships. There should be a face to face meeting with everyone during the project development.

- Personal contact is best in person or at least by phone. The contacts can be verified by E-Mail.

- Team members will inform the Project Manager of their project progress. Communication to the Designer and to Construction or others will be through the Project Manager.

During Construction, the Construction Manager is the Department spokesman to coordinate and communicate.

- The Construction Manager shall communicate with designers and other team members through the Project Manager. This communication may be simultaneous but necessary for the Project Manager's involvement.

CONSTRUCTABILITY REVIEW PROCESS

PRE-CONSTRUCTION

Stage 1 Constructability Review

Stage 1 review on four criteria:

- Plans
- Site Investigation
- Utilities & Right of Way
- General Considerations

Stage 1. Plans for the Stage 1 submission are 25% complete. In this phase, the Environmental Document is developed and critical issues of field survey, existing utilities, existing right-of-way, project limits, structure hydraulics, structure sizing and type selection, typical sections, horizontal alignments, and vertical alignments are identified and discussed in detail. Concerns are noted and an analysis made to determine if project goals and objectives are still being met.

Stage 1 Documents

- Stage 1 Plans
- Environmental Summary (Draft Document)
- Description of all permits needed
- Firm line/grade/geometric layout
- Abbreviated Engineer's Assessment
- Design Exception
- Mainline Culvert Hydraulics Report
- Bridge Hydraulics Report
- Bridge Structure Economic Analysis
- Cost Estimate
- Commitment Report

CONSTRUCTABILITY REVIEW PROCESS

Stage 1

Commonly Missed Items to Check

- The designer should have some indication of what permits will be needed for the contract at 25% plans. If this includes the geometric layout then impacts should be determined. The designer should compile a list of permits which may be pertinent at this time. (USACE, RGP, NWP, etc) Although the designer cannot apply at this point due to the limited amount of details, all permits should be discussed and listed so that additional permits can be added or other permits can be omitted in the future.
- The existing right of way (if applicable) should be shown at this point. INDOT should verify that the right of way shown on the 25% plans is actually owned by INDOT. If not, and this does happen, there will be time to remedy this during the new right of way procurement.
- Verify the structure of the existing road way, do cores of the existing pavement and shoulder need to be taken? If so, at what locations should cores be taken? The existing pavement may affect MOT, pavement removal, etc.

UTILITY COORDINATION FLOW CHART – INDOT PROJECT

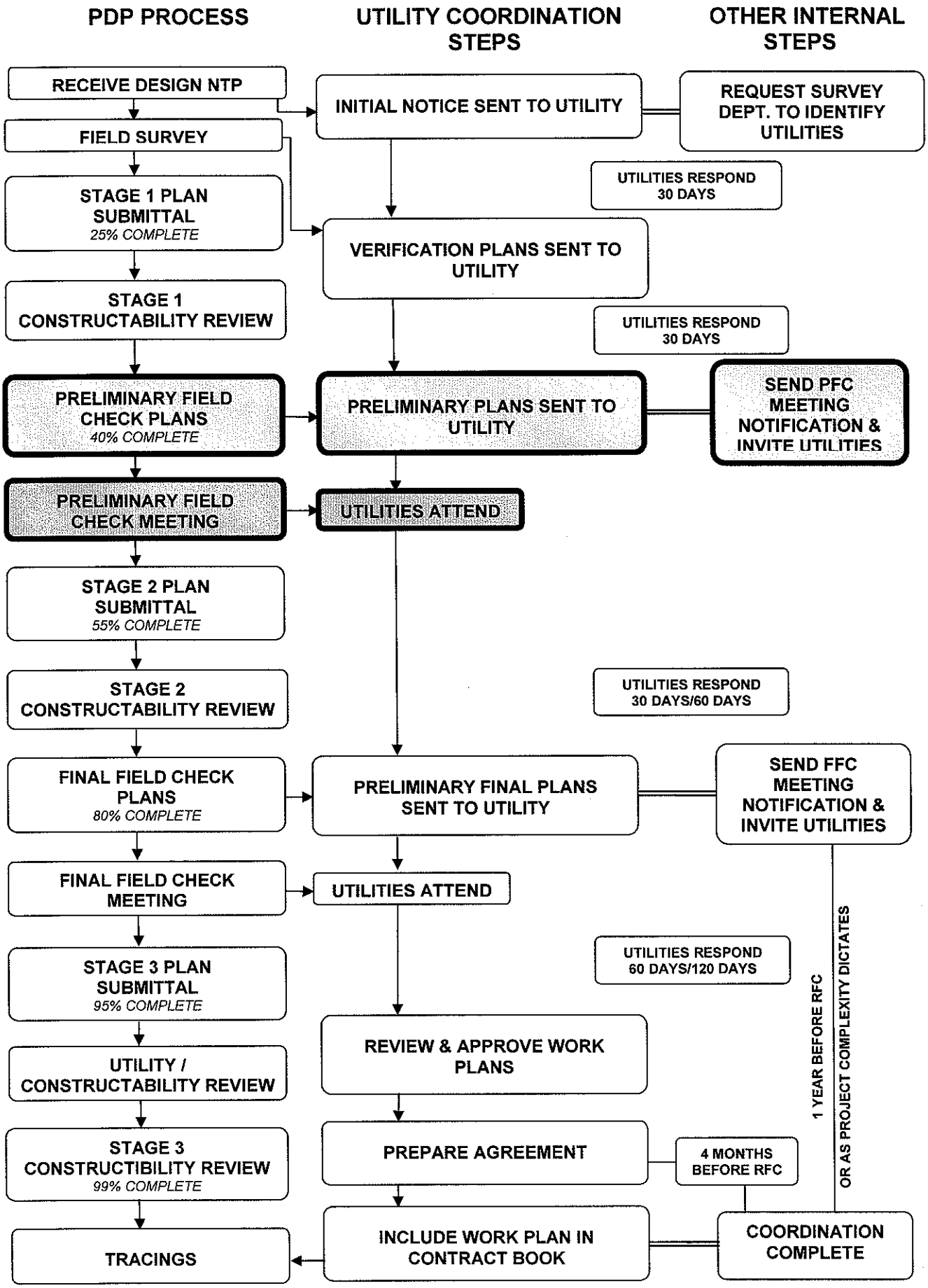

Figure U-1

CONSTRUCTABILITY REVIEW PROCESS

Preliminary Field Check

Preliminary Field Check is that step where the project team has the first opportunity to coordinate their efforts and examine plans and documents.

It is also the first time for the team and the utilities to coordinate efforts for relocation (See Figure U-1, opposite page). It is appropriate for the Field Check to be conducted in two steps. Step 1 would allow efforts to be focused on utility concerns. Starting here and continuing throughout the project development, the Project Manager and Construction Manager with the Designer, Utility Coordinator and the Utilities must enter discussions that utility impacts can be minimized and relocations can be completed sooner.

The Project Manager will have contacted each utility and sent Preliminary Field Check plans with the Utility Checklist. Each utility is asked to complete it during their review. (See Appendix 2)

It is in everyone's best interest to design around utilities to the maximum extent possible. It will reduce costs and project delays due to utility relocations.

The plans for the Preliminary Field Check are 40% complete. The object of these plans is to have enough design information on the plans for the utility companies to be able to determine what major impacts the project will cause to their existing utility faculties.

Step 1, Preliminary Field Check

Offices involved:

- Project Management
- Construction Management
- Design
- Utilities

Items to review:

- How many utilities are involved with the project? Check for utilities not identified on the plans.
- Are utilities knowledgeable about the road design? Is R/W conducive to utility relocation?
- Preliminary R/W layout. Sufficient R/W for utilities?
- If project is "limited access R/W", will utilities stay in R/W?
- Will SUE be utilized?
- What will be the clearing requirements for the project and/or utility relocation?

CONSTRUCTABILITY REVIEW PROCESS

PRELIMINARY FIELD CHECK cont'd

Step 2, Preliminary Field Check

In Step 2 of the Field Check, the team will review environmental requirements, any right of way issues, drainage, and any MOT concerns

Offices involved:

- Project Management
- Construction
- Design
- Traffic - District
- Environmental
- Geotechnical
- Real Estate
- Maintenance

Items to review:

- What is the life expectancy of the project? Is all of the work necessary to complete the intended purpose?
- Check on the budget.
- What is the construction schedule? Is it an early-season project or mid-season project?
- Is R/W outside the clear zone?
- What are the expected permits required and their impact to the schedule?
- What are the expected environmental restrictions and their impact to the schedule?
- Conceptual Traffic Maintenance Plan and phasing? Any detour should be driven.
- Compare costs/feasibility of staged construction and detour.
- Check for drives not identified on plans.
- Intersection layout?
- Conceptual storm sewer layout.
- Drainage outlets meet phasing shown?
- Property relocations?
- Check for new developments and conditions not noted on the plans.
- Verify that the construction limits are reasonable. (allows enough work space)
- Landscaping and erosion control items reasonable?
- Safety concerns addressed?
- Maintenance concerns addressed?
- Any other special concerns, material, local festivals, etc.?
- Review Commitment Report

CONSTRUCTABILITY REVIEW PROCESS

PRELIMINARY FIELD CHECK cont'd

Commonly Missed Items to Check

- Keep any existing Highway Lighting operating as long as practical during utility relocation and construction. May be practical to use temporary electrical service.
- Access/maintenance of existing drives for residents and businesses should be discussed.
- The final grades and widths of the proposed drives for residents and businesses should be discussed. The designer should try to make the existing drives either at the existing grades or less. This may show a cause for additional temporary right of way.
- Are there any existing survey monuments – such as Section Corners – that need to be maintained?
- Are there any existing castings such as survey monuments, manholes, inlets, valves, etc – that need to be adjusted to grade?

Other Considerations

- Construction phasing should be checked to make sure that phase lines are consistent. Do proposed MOT schemes fit on the bridge decks and do the bridge construction joints work with the adjacent roadway and exiting structures.

CONSTRUCTABILITY REVIEW PROCESS

Stage 2 Constructability Review

Stage 2 is the phase between the Preliminary and Final Field Checks. Plans are 55% complete.

It is at this stage that the constructability review will be most effective and have the most significant impact.

Originally, Construction only reviewed plans and documents at the Preliminary Field Check and at the Final Field Check, which was too late to make changes without major consequences. By adding Stages 1, 2, and 3 to the Field Checks, review is more complete with opportunities to change and is progressively correct.

The sequence of the reviews in the PDP has been adjusted to include right of way and utility resolution in the Constructability Review.

Stage 2 covers eleven criteria:

- Plans - Road
- Plans - Bridge
- Cost Estimate
- Site Investigation
- Right of Way
- Utilities and Railroad
- Environmental
- Traffic Maintenance and Traffic Management Plan
- Construction Phasing
- Scheduling
- General Consideration

In **Stage 2**, bridge plans, costs and structural requirements, any special foundation considerations or materials involved, a review of all traffic requirements for the project. Preliminary quantities and right-of-way requirements are made. Signalization, phasing utilities plans and railroad needs are identified and developed. Signal plans, signing plans and pavement marking plans reviewed by Traffic Engineer? Right of Way, drainage, structure and geotech plans are finalized. Details of hydraulic requirements along with any special drainage structures. Review plans with respect to geotechnical recommendations.

CONSTRUCTABILITY REVIEW PROCESS

STAGE 2 PROJECT DEVELOPMENT PROCESS cont'd

Stage 2 Documents

- Preliminary Field Check Meeting Report
- Value Engineering Report
- Geotech and Soils Report
- Stage 2 Plans
- Cost Estimate
- Draft Traffic Control Recommendation
- Hydraulics Report/Plan including drainage layout
- Bridge General Plans with schedules, concepts, costs and preliminary quantities for all bridges
- Completed earthwork and grading plan
- Environmental Document complete
- Approved R/W Plan with any recommended mitigation or design and construction commitments
- A list of recommendations and commitments for permit requirements including schedules/commitments by the permitting agencies
- Bridge Foundation Review Form
- Verify if MOT can be supported on existing pavement or shoulders
- Commitment Report

Stage 2 plans have progressed the design further to a point where utility impacts have minimized and the final right of way of the project is set.

Once the Stage 2 plans are approved, there is little opportunity to go back and re-design for utility impacts.

This review should ensure that the design team including all of the involved offices have the necessary direction to proceed to the final design stage and that any major changes, revisions or special considerations are identified with resolution to be made and scheduled.

CONSTRUCTABILITY REVIEW PROCESS

STAGE 2 PROJECT DEVELOPMENT PROCESS cont'd

Stage 2

Commonly Missed Items to Check

- On projects with multiple bridges is the construction phasing consistent?
- Are the phase lines (horizontally) located to allow the contractor greater flexibility during construction?
- Are construction phase lines consistent? Do proposed MOT schemes fit on the bridge decks and do the bridge construction joints work with the adjacent roadway and existing structures?
- Is there enough horizontal clearance for barriers, shoring and construction access?
- Are there drainage structures that can conflict with the bridge foundations or retaining walls?
- Do the retaining walls excavation envelop conflict with construction phase lines?
- Does the median bridge rail, or divided highways, create horizontal sight distance restrictions?
- Are structures designed for clear zone (such as Graded-Box-End-Section) being placed behind guardrail?
- Are there any existing survey monuments – such as Section Corners – that need to be maintained?
- Are there any existing castings – such as survey monuments, manholes, inlets, valves, etc – that need to be adjusted to grade?
- Will temporary widening be required between MOT phasing?
- Are there any local festivals that MOT phasing needs to take account?
- Do Maintenance of Traffic plans reflect elevation differences?
- Are there any local restrictions that prohibit night work that may require a special provision?

CONSTRUCTABILITY REVIEW PROCESS

STAGE 2 cont'd

Other Considerations

- Will there be grade differences between MOT phasing? If so, applicable Cross Sections will be needed.
- The design should consider stability during construction of a bridge structure of large roadway cuts, of large roadway embankments, and of significantly large excavations needed for storm water structures.
- Bridge drawings and road drawings are not matching up. Phase line retentions, MOT configurations, Construction limits per phase. (Contractor comments)
- Review potential conflicts; drainage issues, existing utilities, tie in to existing construction. (Contractor comments)
- Proposed foundations should be located such that conflicts with existing foundations are not likely. Do not assume that be existing foundations (below grade) were constructed to plan. Allow extra room between the existing and proposed foundations.
- If the proposed structure will have significant deflections with deck pour (and you are constructing in phases) consider providing a closure pour to avoid problems with longitudinal joints.
- Keep close watch on lengthy special provisions. Sometimes designers like to lump multiple issues into one special. Special provisions should be specific with all information relative to the item and set up as a section of the standard specifications.
- Make sure that proprietary materials are not used or have been approved by FHWA prior to placing them in contract.
- Use the appropriate retaining wall type for the site. Some wall types are more conducive for use in fill construction, while others are left in cut situations. The geotechnical engineer should provide the most appropriate system.
- Make sure all permanent retaining wall elements fit in the R/W. Cut walls placed close to the R/W may require easements for construction.
- If the proposed structure will have significant deflections at the deck pour and you are constructing in phases, consider providing a closure pour to avoid problems with the longitudinal joints.

UTILITY COORDINATION FLOW CHART – INDOT PROJECT

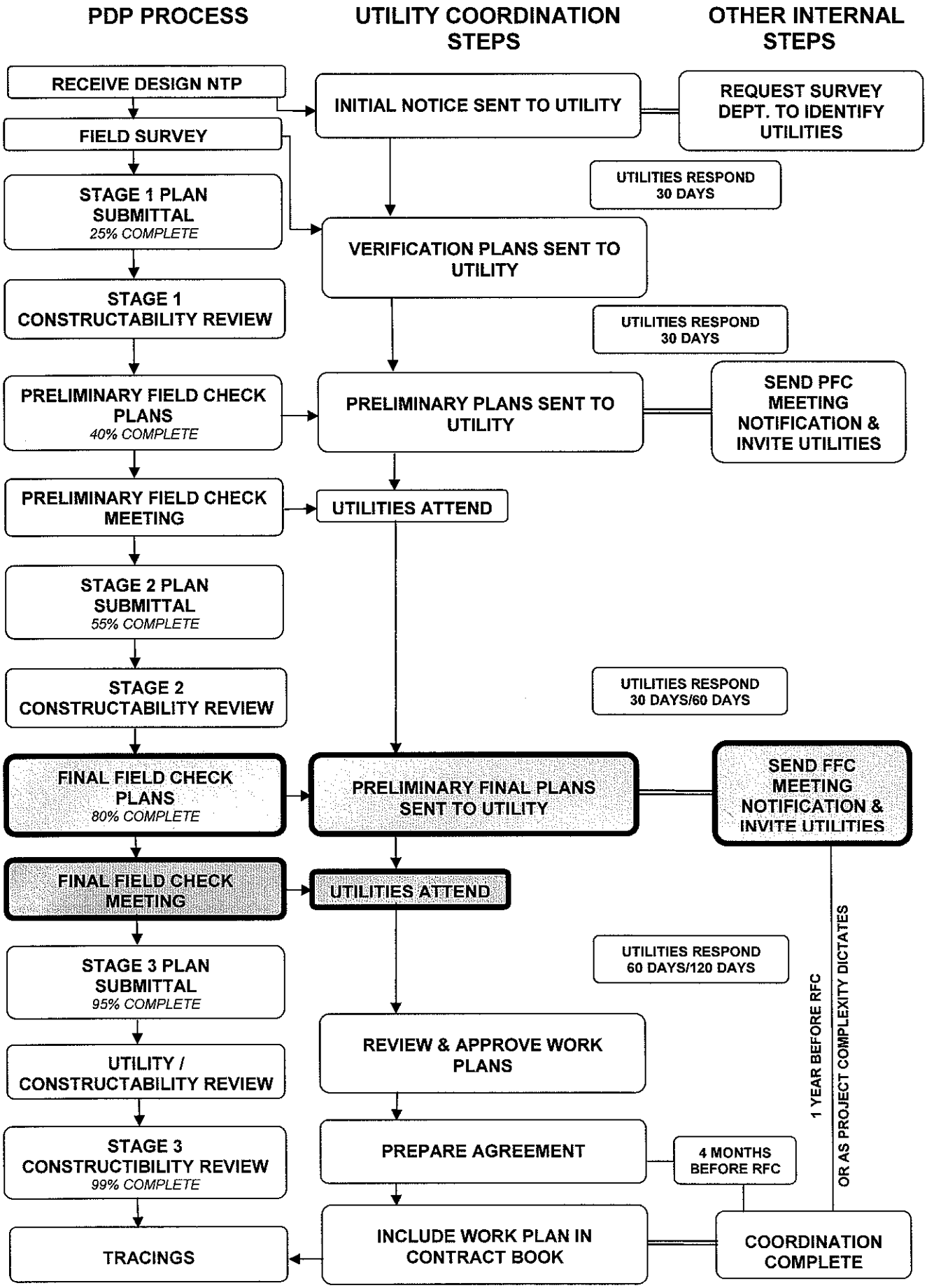

Figure U-2

CONSTRUCTABILITY REVIEW PROCESS

Final Field Check

Final Field Check plans are 80% complete. Previous Stage 2 Review comments have been accounted for.

The Project Manager has continued coordination with utility companies through Stage 2 to minimize their impacts.

For the Final Field Check, the utilities have each received the Final Field Check Plans (Preliminary Final Plans) with the Utility Checklist (See Appendix 4). It is important for the Project Manager to work with each utility to determine the best time frames, per checklist questions 6-9. From these, the Project Manager can determine some of the risks involved.

In this phase, review the bridge design and requirements, final Maintenance of Traffic plans, signalization, signs and striping plans. Finalize construction restrictions and review traffic and community impact. Request utility relocation plans, update utility relocation impact, and review and update necessary permits. Obtain right of entry on all R/W parcels.

Offices Involved:

- Project Management
- Construction
- Design
- Maintenance
- Traffic
- Environmental
- Hydraulics
- Geotech
- Right of Way
- Bridge/Structures

The intent of the Final Field Check plans **(See Figure U-2, opposite page)** is to have the final design complete to the point that the utility companies can prepare their work plans for relocation. The project manager needs feedback from the utility companies as soon as possible for the Designer after the Final Field Check.

Items to Review at Final Field Check

- What recent changes, existing/planned, on the job site?
- What are changes to drainage structures and grading in the Traffic Maintenance Plan?
- Any changes to signage and traffic signals in the Traffic Maintenance Plan?
- Have temporary pavement markings (temporary/removable) and line removal been addressed in the phasing?
- Have the traffic signals, traffic signal detection, and signage been addressed in each phase?
- Are erosion control measures (temporary seeding, mobilization/demobilization, etc.) addressed in each phase?
- Has the Utility's relocation plan addressed erosion control requirements?

CONSTRUCTABILITY REVIEW PROCESS

FINAL FIELD CHECK cont'd

Other Considerations

- Ensure that nothing has changed since the time that the topographic and alignment & grade survey was completed (i.e., pavement has been overlaid, drives have been added, drainage has been changed, etc.).
- Temporary signals and official actions should be discussed at this point. The affect of the temporary signals and OA's on MOT, utilities, railroad, etc should be reviewed.
- Utilities should discuss their operations and cooperation with other utilities. Who moves first, who needs to move first, timelines, construction issues, responsibility of removing poles, and seeding and sodding. This may modify phasing, letting dates, intermediate completion dates, etc.
- Check Commitment Report.

UTILITY COORDINATION FLOW CHART – INDOT PROJECT

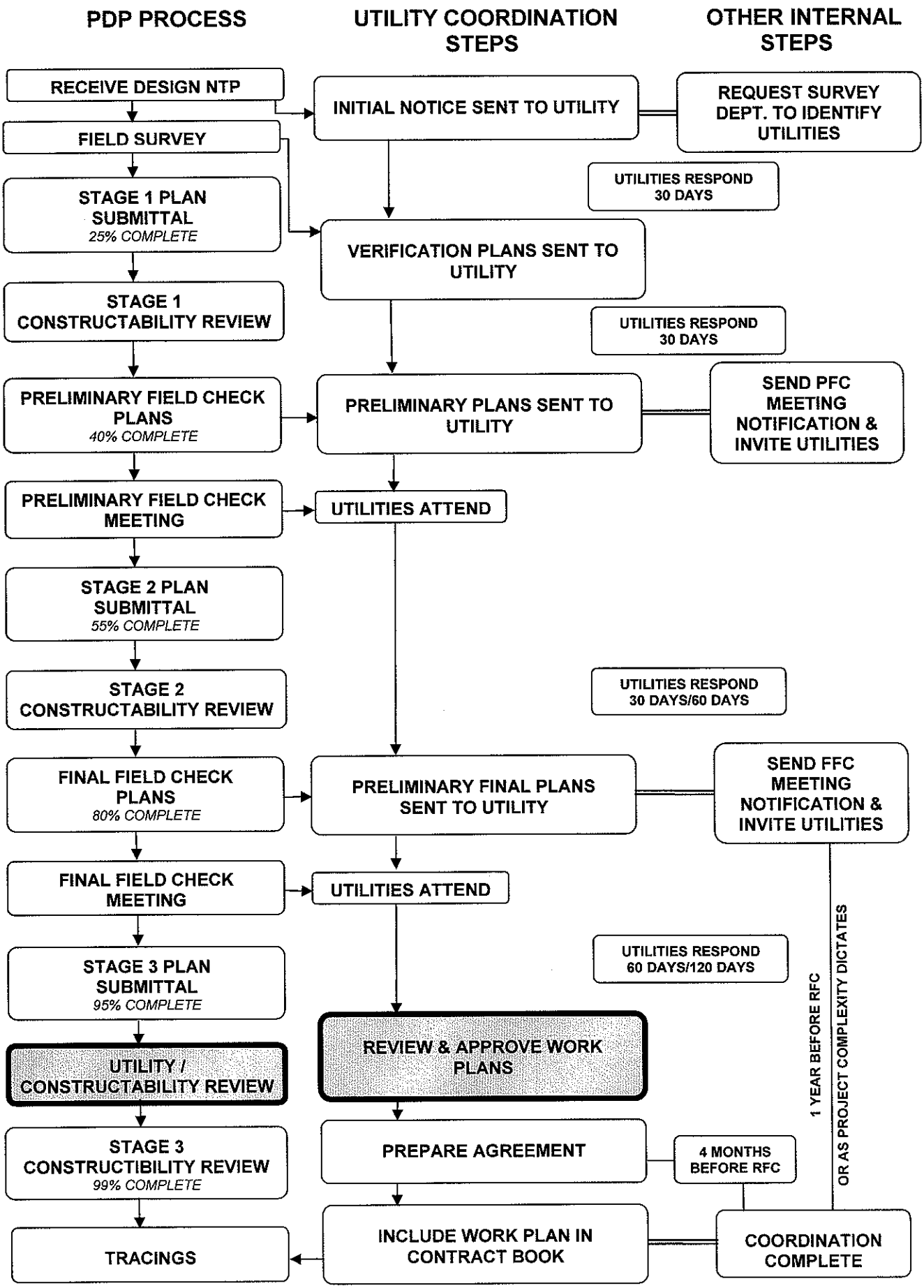

Figure U-3

CONSTRUCTABILITY REVIEW PROCESS

Constructability/Utility Conference

The resolution of the utilities' relocation is a major constructability issue. It is the Number 1 constructability impediment. Construction phasing and scheduling can be significantly impacted by utilities. Contract "Time Set" cannot be decided until after their resolution.

In order to facilitate their resolution, the Stage 3 Constructability Review is moved to the Final Plan Review. This leaves no opportunity to review, make comments and changes.

The Project Manager and the Construction Manager will confer with the Designer/Utility Coordinator to determine the statues of the utilities in the project. The "preliminary final plans" will have been sent to the utilities to prepare a work plan **(See Figure U-3, opposite page).** As work plans and agreement are approved, utility permits and NTP are issued.

The Utility Coordinator has completed the Utility Relocation Plan Checklist. (See Appendix 5)

This Constructability/Utility Conference is the stage where the Project Manager and the Construction Manager must decide if INDOT can move forward with the project on the current schedule. If the utility relocation cannot be completed before construction, can the project be let with exceptions? What effect would this have on the schedule and costs?

Items to determine at this review:

- How many utilities are involved with the project?
- Are all known utilities shown on the plans?
- Have all utilities submitted relocation plans?
- Does project phasing address utility relocation?
- Do utilities conflict with drainage?
- Are the relocations dependant on another utility?
- Can the utilities be relocated concurrently?
- Any methods of construction conflict with underground/overhead utilities?
- Is there a drawing of all proposed utility locations using road and/or bridge plans?
- With R/W acquired, is a clearing contract considered?

CONSTRUCTABILITY REVIEW PROCESS

CONSTRUCTABILITY/UTILITY REVIEW cont'd

- Are reimbursable agreements with utilities complete?
- Have permits and NTP been issued?
- Have any utilities been relocated?
- What utilities will remain in place that the contractor must work around?

The Project Manager must determine the R/W and Permit status.

- Is all R/W cleared?
- When will R/W be cleared?
- Are all Permits in place?
- When will permits be complete?

The Construction Manager after conferring about utilities, right of way, and permit status, should consider other items for "Time Sets".

The Designer needs to have the utilities' final plan in order to complete the special provisions regarding the utility relocation work and their expected completion date.

CONSTRUCTABILITY REVIEW PROCESS

Stage 3 Project Constructability Review

Constructability reviews are intended to improve the effectiveness of a set of plans, specifications and bid documents. The plans should be clear for the contractor to be able to provide accurate bids and understand INDOT's requirements during construction.

The basic objective of the Constructability Review is to seek out overlooked problems that increase costs, impair the schedule, and decrease quality and safety margins.

The Stage 3 Review is conducted jointly by the Project Manager and the Construction Manager to achieve the best bid package.

Stage 3 Constructability Review is Final Plan Package Phase with Plans 95% complete and Utility and Railroad permits have been issued.

Stage 3 encompasses two categories, Biddability and Constructability, that details items that Construction and contractors have identified as frequent errors and omissions. The accuracy and completeness of the bid package is critical for the designer.

In the Stage 3 Review, there are fourteen review criteria:

- Plans - Road
- Plans - Bridge
- Pay Items
- Quantities
- Special Provisions
- Utilities
- Environmental
- Site Investigation
- Right of Way
- Construction Phasing
- Traffic Maintenance & TMP
- Schedule & Special Considerations
- Special Materials/Conditions
- Final Estimates

Stage 3 Review occurs at the Final Plan Package. The intent of the Stage 3 plans is to have the plans, special provisions and cost estimates in final form.

- Final Field Check and Constructability/Utility Conference comments have been accounted for.
- Right of Way is complete or accounted for.
- Utilities Permits and NTP have been issued or accounted for.

CONSTRUCTABILITY REVIEW PROCESS

STAGE 3 PROJECT DEVELOPMENT PROCESS cont'd

- If required, Railroad Permits and NTP have been issued.
- Final Construction Cost Estimate and Final Special Provisions (including all water way permits) are complete.
- Compare the cost estimate with the quantity calculations, quantity tables in the plan set, and look for any missing pay items.

Items to Review at Stage 3

- Check for conflicts between items and plans and special provisions and specifications. They should be consistent throughout.
- Check for any specification updates that might impact the item needed.
- The items used need to match the specification items.
- Watch for specialty items that have supplemental descriptions.

Stage 3 Documents

- Stage 3 Plans
- Final Field Check Meeting Minutes
- Constructability/Utility Review Minutes
- Special Provisions
- Permits (Environmental, Railroad, & Utility)
- Final Environmental Document
- Rule 5 Erosion Control Submission
- Geotechnical Investigation Report
- Pavement Design Approval
- Hazardous Materials Investigation Report
- Quantity Calculations
- Cost Estimate
- Transportation Management Plan
- Commitment Report

CONSTRUCTABILITY REVIEW PROCESS

STAGE 3 PROJECT DEVELOPMENT PROCESS cont'd

Commonly Missed Items to Check

- Pavement removal
- RPM removal
- Remove traffic signal
- Line removal for phasing
- Pavement message marking removal
- Pipe removal. Either include an item for this and quantify it with a table or include it in clearing or right of way.
- CZ units for barrier wall
- Mob/Demob for seeding
- Missed pavement marking items
- Road closure sign assemblies

Other Considerations

- A "clearing of R/W" description helps.
- "HMA for approaches" conflicts between specs, plans and special provisions.
- Sometime it is better to not have an item rather than to do a "just in case" item that is undistributed.
- Low quantity items can hurt us, especially if there is a "quantity basis".
- Usage of Message Boards is not "per day". It should be "each".
- The direction sign on the Detour Route Marker assemblies are left out of the plans.
- Barricade quantities are too low.
- At site closure items are missed. The designers are good about the detours, but not right at the point of closure.
- Preformed loops rarely work into the phasing.
- Asphalt pavement vs. concrete: Is there enough room for construction staging for concrete pavement.

CONSTRUCTABILITY REVIEW PROCESS

Pre-Letting

From the Final Tracing submittal to the bid letting, the Project Manager and the Construction Manager shall work together with the Designer to check the Final Estimate, Special Provisions, and answer any inquiries by prospective bidders.

If a Pre-Bid Meeting is to be held, the Project Manager will organize and, with the Construction Manager, hold the meeting with the Designer.

CONSTRUCTABILITY REVIEW PROCESS

CONSTRUCTION

Pre-Construction Conference

The Construction Manager shall organize and run the Pre-Construction Conference. Before arranging time and date, he/she will coordinate with the Project Manager's schedule to insure his/her participation, including the Designer.

The Project Manager shall establish his/her support role with the Project Engineer/Supervisor. Should the Project Engineer/Supervisor have any questions, whether it is design, geotechnical, R/W, utilities, or the like, the Project Manager will get solutions in a timely response. All such communications should go through the Project Manager.

Mid-Contract Constructability Review

The results of this review are determined by identifying the change orders, causes, and accountability in these categories:

- Errors and omissions
- Scope Changes
- Changed Field Conditions
- Failed Materials
- Incentive/Disincentive Contract Completion Time
- Standard/Specs Update or Changes

Most of a project's change orders will likely occur during the first half of construction. The Project Engineer/Supervisor will have copied the Project Manager on all change orders. They will be most attentive to any possible change of scope.

They will also confer and discuss any changes designated "error and omissions" to determine the impact and responsibility (See appendix 12). It is important that such evaluation has merit and is consistent with these directions.

Data assimilation into Site Manager is being reviewed for better prosecution.

CONSTRUCTABILITY REVIEW PROCESS

Post-Construction Review

The Post Construction Review is conducted when a project's construction is 90% complete, "lessons learned" have occurred and they are still "hot" in the minds of all.

Some advantages of this review are:

- Helps eliminate repeated mistakes on future projects
- Increases communication between parties
- Addresses maintenance concerns on the recently finished project

Depending on the Level of Review, INDOT should consider participation by members of these organizations in their post-construction reviews.

INDOT STAFF	EXTERNAL STAFF
Road Design	Designer
Bridge Design	Contractor Supervisor
Geotechnical	Contractor Estimator
Hydraulics	Key Subcontractors
Construction	Utility Companies
Environmental	IDEM/DNR
Traffic	Railroads
Maintenance Personnel	Local Municipality
Utility Coordinator	

This review provides the opportunity for those partners who have constructed the project to critique the efforts of those who developed the project and vice versa. How well did the construction deliver the project? Frank, candid discussions will produce better understanding for project delivery.

CONSTRUCTABILITY REVIEW PROCESS

"LESSONS LEARNED" DISSEMINATION

From the construction inspector to the project manager, construction is an experience-based industry. Knowledge of past problems can identify potential problems earlier in future projects and reduce their impact.

To address this issue, INDOT is developing a data collection process to store the "lessons learned" for future reference for designers, INDOT staff and local agencies.

The key component of improving a project's design is sharing of "lessons learned" from various participants' experience and expertise.