



# INDIANA DEPARTMENT OF TRANSPORTATION

## *CONSTRUCTION EVALUATION REVIEW*

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# CONSTRUCTION EVALUATION OVERVIEW

INDOT constructs hundreds of projects each year. During construction and at the close out of the project, INDOT's Construction Representatives are directed to evaluate the Plans and Contract Documents on a standardized review form. This form is submitted to INDOT's Quality Management Engineer for processing and evaluation. The purpose of this process is to have INDOT's Construction Division evaluate the quality and constructability of each project's plans and contract documents.

INDOT has directed Janssen and Spaans Engineering (JSE) to compile INDOT's Construction Evaluations of Plans and Contract Documents. The Construction Evaluations were completed by INDOT's Construction Project Supervisors for projects completed from 1999 to 2007. JSE was given over **673** project evaluations including the associated construction plans and Contract Books for many of the projects. The evaluations provided to JSE were from a small percentage of the projects constructed by INDOT in a given year. The database does not include evaluations from every INDOT project.

INDOT's Constructability Review Form (see following sample form) consists of the project information, contract number, INDOT District, designer (consultant, in-house designer or district designer), contractor, original contract amount, change order amount, etc. The form also includes 23 questions related to general contract items, construction plans, utilities/railroads, right-of-way, permits, traffic staging, structures and geotechnical issues associated with the construction of the project. The Project Supervisors are required to respond to each question with a yes or no answer and then include additional comments if necessary. The last page of the form is a "Summary of Constructability Screening". For each of the 23 questions, the Project Supervisor determined whether the change orders required on the project were major, moderate, minor, or none.

JSE input all the information contained in the construction evaluations into a Microsoft Access database. JSE developed summary reports for responses to each of the 23 questions including the summary of change orders.

After reviewing and compiling all evaluations, JSE summarized all the ratings and comments to determine trends, common errors and issues. Without reviewing the actual change orders, it is very difficult to determine if the change orders were due to designer error or if they were due to change of scope and/or unforeseen field conditions. Further study of the actual change orders would be needed to determine the actual cause.

After JSE analyzed all the data, we proposed possible resolutions of how to prevent some of the recurring change orders, contract document omissions and plan development problems. We have organized the review items from the construction evaluation form into groups. Those groups are:

- Quantities and Pay Items
- Utilities and Railroad
- Soils and Foundations
- Structures
- Plans, Specifications, Special Provisions
- R/W and Maintenance of Traffic
- Permits and Contract Work Days
- Overall Project Rating

# OVERALL CONSTRUCTION EVALUATION

## SUMMARY

- **673 project evaluations entered into database.** The breakdown of projects is as follows:

Designer	No. of Projects	Original Contact Amount	Change Order Amount	% Overrun
Consultant	320	\$680,996,031	\$44,290,598	6.50%
INDOT District	166	\$123,560,032	\$7,068,685	5.72%
INDOT Central Office	187	\$171,349,106	\$9,597,798	5.60%
Total	673	\$975,905,169	\$60,957,081	6.25%

48% of the projects entered into the database were designed by Consultants. The consultant designed projects resulted in a 6.5% average overrun of the original contract amount while the District designed projects had a 5.7% average overrun. The INDOT Central Office designed projects had a 5.6% average overrun of the original contract amount.

### ➤ **Types of Projects**

See the following form. There were 24 different project types identified on the evaluation form. The majority of the project types are as follows:

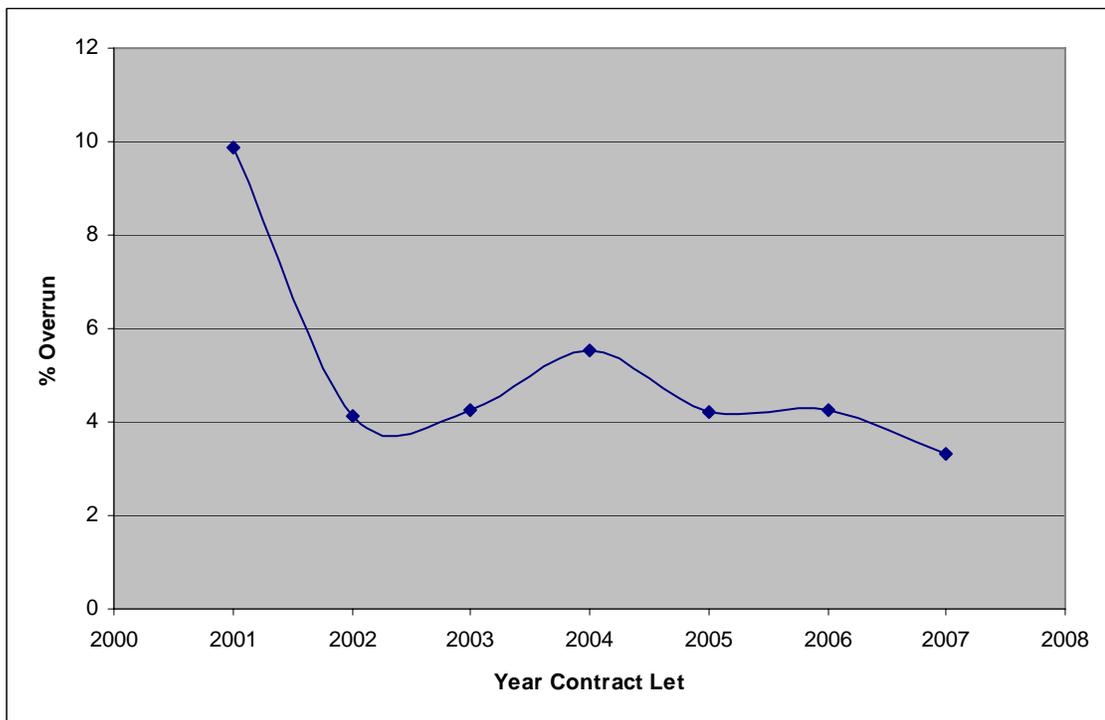
Type of Construction	No. Of Projects	Original Contact Amount	Change Order Amount	% Overrun
Bridge and Road	32	\$184,268,077	\$13,395,267	7.27%
Road	137	\$273,532,568	\$19,396,093	7.09%
Road Resurface	146	\$213,921,964	\$15,094,912	7.06%
Bridge	84	\$80,444,776	\$4,923,585	6.12%
Traffic Signal	54	\$9,955,817	\$499,998	5.02%
Bridge Rehabilitation	64	\$55,321,504	\$2,428,959	4.39%
Intersection	25	\$33,250,462	\$1,071,794	3.22%
Small Structure	29	\$19,045,782	\$452,783	2.38%

Of the total \$60,957,081 in change orders from the 673 projects, \$48,958,066 (80%) of the change orders were attributed to road construction projects. The combined total number of projects related to road construction was 340 (50.5%).

➤ **Change Orders By Year**

The following lists the change orders by year that the project was let. The database includes projects let in 1999 through 2007:

Year Contract Let	No. of Projects	Original Contract Amount	Change Order Amount	% Overrun
1999	3	\$14,372,264	\$255,123	1.78%
2000	16	\$58,202,685	\$10,820,486	18.59%
2001	65	\$166,968,442	\$16,452,391	9.85%
2002	105	\$213,037,408	\$8,807,665	4.13%
2003	148	\$154,068,508	\$6,550,692	4.25%
2004	152	\$200,522,867	\$11,108,935	5.54%
2005	101	\$96,799,725	\$4,081,488	4.22%
2006	70	\$53,584,278	\$2,270,331	4.24%
2007	13	\$18,348,992	\$609,971	3.32%



Since 2003, the percentage of change orders compared to the original contract amount has decreased each year. Many of the reviews from projects let in 2006 and 2007 are still under construction or we have not received the construction reviews. (Please note that the percent overruns for the contracts let in 1999 and 2000 were not used in the graph for comparison purposes due to the sparse amount of data available.)

INDOT typically contracts about \$700 million in construction projects each year.

➤ **Change Orders by District**

The following summarizes the change orders by District in which the project was constructed:

District	No. of Projects	Original Contact Amount	Change Order Amount	% Overrun
Crawfordsville	217	\$252,764,470	\$18,821,474	7.45%
Ft. Wayne	53	\$67,747,510	\$3,955,507	5.84%
Greenfield	46	\$79,813,244	\$7,737,232	9.69%
LaPorte	113	\$186,981,984	\$6,629,920	3.55%
Seymour	97	\$120,940,992	\$2,645,252	2.19%
Vincennes	147	\$267,656,970	\$21,167,696	7.91%
Grand Total	673	\$975,905,169	\$60,957,081	6.25%

It appears that Project Supervisors in the Crawfordsville, LaPorte, Vincennes and Seymour have either completed more projects or have provided more construction reviews than the Greenfield and Ft. Wayne Districts. Please note that some of the Project Reviews did not report a total change order amount. Of those reported, it appears that change orders in the LaPorte (3.6%) and the Seymour District (2.2%) were less than the other 4 Districts (5.8% to 9.7%).

➤ **Consultant Reviewed Projects**

Of the 673 construction evaluations analyzed, 89 of the projects were processed through the Consultant Review Group (either the JSE team or the Burgess & Niple/ Beam Longest & Neff team). The other 584 projects were either reviewed by INDOT Central Office staff or by INDOT District staff. The following summarizes the change orders by reviewer:

Reviewer	No. of Projects	Original Contact Amount	Change Order Amount	% Overrun
JSE	62	\$106,371,113	\$4,184,516	3.93%
B&N/BLN	27	\$84,434,183	\$4,321,999	5.12%
INDOT	584	\$785,099,873	\$52,450,566	6.68%

The Consultant Review contract started in December, 2001. The reason for so few projects reviewed by the Consultant Review Group (CRG) could be that the Central Office design groups kept most of their projects that were in the final plan stages. Most of the initial project assignments to the CRG teams were projects in the beginning plan stages. It has taken several years for these projects assigned to the CRG to be let.

In addition, 280 of the 673 construction evaluations analyzed are a combination of District Maintenance, Resurface, and Traffic contracts. These types of projects are typically not reviewed by the Consultant Review Group.

**Of the 89 projects that were reviewed by the CRG, the percentage of change order overruns are less than those not reviewed by the CRG. The average overrun for the CRG reviewed projects is about 4.5% while those not reviewed were about 6.7%.**

## ***Total Change Orders by Type of Construction***

<i>Type of Construction</i>	<i>Change Orders</i>	<i>Original Contract</i>	<i>Change Orders \$</i>	<i>% Overrun</i>
	14	\$28,414,426.07	\$1,471,307.71	5.18%
<i>ACCESS CONTROL</i>	1	\$74,000.00	\$0.00	
<i>ADDED TRAVEL LANES</i>	7	\$48,235,497.65	\$494,387.88	1.02%
<i>BIKE/PEDESTRIAN FACILITY</i>	1	\$813,581.34	\$27,957.84	3.44%
<i>Bridge &amp; Road Reconstruction</i>	32	\$184,268,076.91	\$13,395,266.89	7.27%
<i>Bridge Painting</i>	7	\$2,027,420.25	\$2,060.00	0.10%
<i>Bridge Rehab</i>	64	\$55,321,503.77	\$2,428,959.30	4.39%
<i>Bridge Replacement</i>	84	\$80,444,776.44	\$4,923,585.32	6.12%
<i>Building Demolition</i>	13	\$383,846.47	\$38,761.26	10.10%
<i>Construction of Security Fence</i>	1	\$36,941.00	\$0.00	
<i>Debris Removal</i>	1	\$216,876.00	\$10,000.00	4.61%
<i>ENHANCEMENT PROJECT</i>	3	\$2,339,971.96	\$0.00	
<i>Guard Rail Maintenance</i>	1	\$206,195.00	\$206,195.00	100.00%
<i>Guardrail</i>	1	\$0.00	\$0.00	
<i>Guardrail Improvement</i>	2	\$974,297.05	\$0.00	
<i>Intersection</i>	23	\$32,269,643.39	\$1,061,539.32	3.29%
<i>Intersection Improvement</i>	2	\$980,818.93	\$10,255.15	1.05%
<i>Landscaping/ Wetland Mitigation</i>	5	\$997,478.19	\$170,617.86	17.10%
<i>Lighting Project</i>	4	\$1,618,615.02	\$11,952.00	0.74%
<i>Maintenance Work</i>	17	\$5,446,842.15	\$603,917.06	11.09%
<i>New Bridge Construction</i>	1	\$723,882.64	\$8,380.00	1.16%
<i>NON-HIGHWAY DEMONSTRATION/EARMAR</i>	1	\$258,929.00	\$4,770.00	1.84%
<i>PAVEMENT MARKING</i>	1	\$183,566.40	\$0.00	
<i>Pipe Structures</i>	5	\$121,152.00	\$5,582.50	4.61%
<i>Road</i>	136	\$269,647,110.02	\$19,483,618.91	7.23%
<i>Road Reconstruction</i>	1	\$3,885,458.44	(\$87,526.27)	-2.25%
<i>Road Resurface</i>	146	\$213,921,963.89	\$15,094,912.38	7.06%
<i>RPM INSTALLATION</i>	2	\$698,756.72	\$33,349.30	4.77%
<i>Safety Barrier Installation</i>	1	\$1,625,120.00	\$0.00	
<i>Sidewalk Project</i>	1	\$425,369.69	\$4,681.60	1.10%
<i>Sight Distance Correction</i>	6	\$8,258,962.20	\$614,758.88	7.44%
<i>Signing Project</i>	3	\$1,138,699.73	\$16,142.44	1.42%

<i>Type of Construction</i>	<i>Change Orders</i>	<i>Original Contract</i>	<i>Change Orders \$</i>	<i>% Overrun</i>
<i>Slide Correction</i>	1	\$392,671.00	\$2,984.51	0.76%
<i>Slip Liner</i>	1	\$123,103.00	\$0.00	
<i>Small Structure</i>	29	\$19,045,781.82	\$452,783.28	2.38%
<i>Traffic Signal</i>	54	\$9,955,816.63	\$499,997.78	5.02%
<i>Wedge &amp; Level</i>	1	\$428,017.96	(\$34,117.20)	-7.97%
<b><i>Grand Total</i></b>	673	\$975,905,168.73	\$60,957,080.70	6.25%







**UTILITIES/RAILROADS (Continued)**

9. Were the needs of utilities and/or railroads considered? If no, what changes should have been made?

- Yes     No     N/A

Overhead power lines at SR32 and CR1000W need relocated. There was not enough room between the road and power lines to place a strain pole and maintain proper clear distance from each

10. Was all coordination and work finalized with the railroad prior to the construction stages? If no, what problems did this cause? What additional information needs to be provided prior to construction?

- Yes     No     N/A

**RIGHT-OF-WAY**

11. Was all right-of-way cleared prior to construction? If no, what problems did this cause?

- Yes     No

12. Was adequate right-of-way available? If no, what changes should have been made and what difficulties did it cause?

- Yes     No     N/A

Curb was placed in Fortville at US36/SR67 and SR13. An island was built that extended all the way to the limits of the ROW. The adjacent parking lot was damaged and repair work was needed.





**GEOTECHNICAL**

21. Was soil information adequate? If no, what further information should have been provided?

- Yes     No     N/A

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22. Were soil difficulties described and addressed? If no, what was omitted?

- Yes     No     N/A

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**23. Evaluation of Project Constructability Quality.**

Evaluation Criteria	Better Than Expected	Met Expectations	Needs to Improve	Serious Problem	No Opinion
Construction drawings and specs were complete	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Construction drawings and specs were accurate	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Number of contractor questions and clarifications	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Impact of drawings and contract documents on contractor's ability to meet construction schedule	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Impact of drawings and contract documents on construction costs	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Overall assessment of constructability	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Other comments:

*As stated previously, an undistributed loop quantity to replace failed loops would have led to less change orders and more manageable budgeting.*

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# EXAMPLE INPUT FORM

## INDOT Construction Evaluation of Plans and Contract Documents

**Contract** R-27471

**Review Question**

	Yes	No	N/A	Comments	
1 Were the plans with sufficient detail?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
2 Were the special provisions clear and detailed?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
3 Were the std specs and dwgs clear?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
4 Were the quantities reliable?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
5 Did the pay items match the work to be performed?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
	<b>Too Few</b>	<b>Too Many</b>	<b>About Right</b>	<b>N/A</b>	
6 Did the contract have the right amount of work days?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	<b>Yes</b>	<b>No</b>	<b>N/A</b>		
7 Were the utilities shown accurately?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
8 Were the utilities shown on the plans?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
9 Were the needs of utilities and/or RR considered?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>		
10 Was all utility coordination complete prior to constr?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>		
11 Was all R/W cleared?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
12 Was adequate R/W available?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
13 Were all the permits obtained prior to constr?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
14 Was the staging practical and constructable?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
15 Was the MOT plan adequate?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
16 Were the plans complete enough to submit shop dwgs?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
17 Were critical dimensions, details, elevs w/in tolerance?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
18 Problems w/assembling fabricated components?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
19 Were shop dwgs free from revisions?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
20 Were details ok to erect, brace str members?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
21 Was soil information adequate?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
22 Were soil difficulties addressed in plans?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		

**23 Constructability**

	Better Than Expected	Met Expectations	Needs to Improve	Serious Problem	No Opinion
a Were construction documents complete?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b Were construction documents accurate?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
c Were there a large number of contractor questions?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d Did construction documents impact contractor's ability to meet schedule?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e Did construction documents impact construction costs?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

# EXAMPLE INPUT FORM

## Summary of Constructability Screening

### Project Data

District   
 Contract   
 Des #

### Design Data

Type of Construction   
 In House / Consultant   
 Designer   
 Consultant Reviewer

### Contract Data

Contractor   
 Proj Supervisor Review Date   
 Letting Date   
 Final Acceptance Date   
 Original \$   
 Programmed Constr \$   
 Change Order \$   
 Change Order Cause

Constructability: If you were required to make changes, how would you describe the magnitude of those changes?

Question	Project Element	Major	Moderate	Minor	None	
1	Plans					
	Right of Way	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Alignments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Environmental Considerations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Structure Details	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Earthwork Distribution	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Drainage Plans	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Erosion Control	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Staging	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Utility/Railroad	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Material Specifications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	2	Specifications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	3	Standards	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	4	Quantities	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5	Pay Items	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	6	Work Days	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	7	Utilities / RR Accuracy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	8	Utilities / RR Unknown	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	9	Utilities / RR Needs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	10	Utilities / RR Work Finalized	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	11	R/W Cleared	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	12	R/W Sufficient	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
13	Permits	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
14	Staging	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
15	Work Zone Traffic Control	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
16	Structures, Field Measurement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
17	Structures, Critical Dimensions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
18	Structures, Assembly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
19	Structures, Shop Drawings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
20	Structures, Erection	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
21	Soils, Information	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
22	Soils, Difficulties	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

### ACCURACY

	Poor	Fair	Good	Very Good
Existing topography and Utilities	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Soils and foundation information	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Estimate of quantities	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Structures	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Bid items	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Contract Time	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Project Rating	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

# QUANTITIES/ PAY ITEMS

*Question #4: Were the quantities reliable?*

	YES	NO	Total Responses	N/A	Not Answered
Reviews	375	278	653	11	12
% Yes/No	57%	<b>43%</b>			

*Question #5: Did the pay items used match the work to be performed?*

	YES	NO	Total Responses	N/A	Not Answered
Reviews	535	118	653	16	7
% Yes/No	82%	<b>18%</b>			

## SUMMARY OF CONSTRUCTABILITY SCREENING MAGNITUDE OF CHANGES

### Plans- Earthwork Distribution--

- 23 Major Changes
- 39 Moderate Changes
- 97 Minor Changes
- 422 None

Summary: 62 Of 581 (**11 %**) Rated Major and Moderate Changes

### Quantities –

- 56 Major Changes
- 129 Moderate Changes
- 279 Minor Changes
- 132 None

Summary: 185 of 596 (**31%**) Rated Major and Moderate Changes

### Pay Items -

- 39 Major Changes
- 94 Moderate Changes
- 276 Minor Changes
- 181 None

Summary: 133 of 590 (**23%**) Rated Major and Moderate Changes

## ACCURACY SUMMARY

### Estimate of Quantities

- 6% Poor**
- 39% Fair**
- 50% Good
- 5% Very Good

### Bid Items

- 3% Poor**
- 27% Fair**
- 63% Good
- 7% Very Good

# Quantities/ Pay Items Summary

## QUANTITIES

- The most notable figure from this study of Construction Evaluations is that on average, **43% of the Construction Project Supervisors do not feel that the calculated quantities are reliable.**
- **45% of the supervisors rated the accuracy of the quantity calculations as fair or poor.**
- Of the actual change orders due to quantity errors or omissions, 31% were rated as major or moderate changes. It appears that when there are change orders due to quantity miscalculations, the required change orders for over 25% of the projects are significant.

## PAY ITEMS

- In addition, on average, **18% of the Supervisors feel that the pay items in the Itemized Proposals do not match the work to be performed.**
- **30% rate the accuracy of bid items as fair to poor.**
- Of the actual change orders due to pay item revisions or omissions, 23% were rated as major or moderate changes. When change orders due to pay items are required, almost 20% of the time, the changes are considered significant.

## EARTHWORK DISTRIBUTION

- **11% of the Project Supervisors rated change orders due to earthwork distribution as major or moderate.** Earthwork distribution calculations do not appear to be a significant problem as compared to other incorrect pay items and quantities.

## Example Review Comments

Some items were on plan sheets but not on summary sheets or proposal. Other items had different quantities on plan sheets than proposal. Some items had obvious plan quantity errors.

Many new pay items were required. The survey was 20 years old and new development had taken place within the project limits. The consultant did not update the survey. Consultant's response was that City officials did not want to pay to update the survey. The consultant decided not to hold a final field check. Many change orders and new pay items were added to match plans to existing conditions. Pay items for utility relocations were very poorly defined. Contract had 136 original items, 218 final pay items.

Slope wall quantity did not include the toe which caused this quantity to be off by as much as 45%. CAB quantity was too low. The wrong types of pavement markings were specified.

Compacted agg, riprap, geotextiles, topsoil, concrete class A, reinforcing steel all had significant quantity underruns.

Bituminous items had to be added and increased resulting in a change order. Pay items duplicated between Road and Bridge Plans. Insufficient R/W for utilities & construction of Slopes, which caused a delay of work. Utilities never considered in the Design. Adequate R/W was biggest problem of the project. No one paid attention to soils report.

Left out quantity for Paved Shoulders and Auxiliary lanes. Error resulted in shortage of QC/QA HMA Surface, QC/QA HMA Intermediate and surface milling. Compacted Aggregate, No. 73 item was calculated using the wrong typical.

Asphalt quantities were off. Lacked info in one corner of intersection that was to be widened. Items that were unreliable were Sidewalk Removal; Compacted Aggregate, O, 53; HMA Base 25.0mm, Mainline; HMA Intermediate 12.5mm, Mainline; HMA Surface 9.5mm, Mainline and Sidewalk, Concrete, 100mm.

Incorrect quantities for epoxy rebar; concrete, B; footings, concrete, A, substructure; structural members, concrete box beam; geotextiles; dense graded subbase. 10 new pay items were added to the contract. Quantities for class A and class B concrete on plan sheets were switched on the bridge summary sheet. Resulted in large change order to fix.

Inaccurate quantities for removal items, CAB, Patching, Joints, and Rebar.

Erroneous Quantities for: Compacted Aggregate, O, 53; HMA for Approaches; Revetment Riprap; Mulched Seeding; Shear Stud Connectors; Flashing Arrow. Only ½ of the crossover material was provided in the quantities. There was only ½ the approach material for the bridge approaches

Many items were overlooked. 38 new pay items were added by change orders.

There was not enough HMA Partial Depth Patching. Shoulder Stone quantity was way under, do to the shoulders being broken down about 3” on the majority of the project. That almost doubled the plan quantity. The underseal stations went beyond the project limits.

Error in surface seal quantity (for bridge approaches.) Crossover quantities were underestimated. There was no mulched seeding specified for the crossover removal areas. The shoulder corrugations pay item was omitted from the proposal.

Pavement removal not included in estimate. Reinforced concrete pavement underestimated. Spandrel walls were in worse condition than anticipated and had to be replaced resulting in a significant overrun.

Most original pay items had significant overruns or underruns. Original contract had 39 items, final contract had 60. Contract overran by 26%.

# Conclusions

Based on the results of this study, it appears that overall, designers are not consistently calculating quantities correctly nor are they using the correct pay items on the Itemized Proposals. On the majority of the projects with incorrect quantities, the calculations for road items including asphalt pavement and compacted aggregate base for the shoulder wedging are some of the most common items requiring change orders. Typical errors also include pay items called out on the plans and in tables not matching quantity calculations nor the itemized proposal. In addition, on bridge projects there were several incidences where the concrete and re-bar quantities were tabulated for one element (i.e. one pier), but the quantities were not multiplied by the number of similar elements (i.e. other piers that were similar, but not detailed).

## Ideas for Improvement

### *Reduction of Quantity & Pay Item Change Orders*

- Require designers to perform two independent checks of quantity calculations with a final sign-off of approval by the project manager.
- Expand Indiana Design Manual (IDM) chapter 17 to include more examples of quantity calculations procedures for all the common pay items. The IDM should also include detailed checking procedures. Involve District construction personnel in updating and expanding this chapter.
- Standardize quantity calculation format and submittal requirements for INDOT projects.
- Update Estimator program periodically to only include current pay items descriptions and codes. Estimator currently contains numerous out of date pay item codes and descriptions that do not match the specifications.
- Require designers to do detailed, thorough cross review of plans, summary tables on plans, and quantity calculations against the itemized proposal. Require designer and project engineer to initial itemized proposal insuring that this cross review has been completed.
- Require Final Field Checks (FFC) on all major and moderate sized projects. Final Field Check plan distribution should include itemized proposal and unique special provisions. Major pay items and special provisions to be reviewed at FFC with attendees.
- Allow enough time and manpower for District Construction personnel perform a thorough review of the plans, provisions and the cost estimate prior to letting. On major projects, require designer and District Construction meet prior to letting to discuss and review these items.

## UTILITIES and RAILROAD

*Question #7: Were the utilities accurately shown on the plans?*

	YES	NO	Total Responses	N/A	Not Answered
Reviews	260	91	<b>351</b>	319	6
% Yes/No	74%	<b>26%</b>			

*Question #8: Was the project free of unknown utilities?*

	YES	NO	Total Responses	N/A	Not Answered
Reviews	538	104	<b>642</b>	30	4
% Yes/No	84%	<b>16%</b>			

*Question #9: Were the needs of utilities and/or railroads considered?*

	YES	NO	Total Responses	N/A	Not Answered
Reviews	284	37	<b>321</b>	344	11
% Yes/No	88%	<b>12%</b>			

*Question #10: Was all coordination and work finalized with the railroad prior to the construction stages?*

	YES	NO	Total Responses	N/A	Not Answered
Reviews	78	14	<b>92</b>	576	8
% Yes/No	85%	<b>15%</b>			

### SUMMARY OF CONSTRUCTABILITY SCREENING MAGNITUDE OF CHANGES

#### Plans- Utility Railroad –

20 Major Changes  
40 Moderate Changes  
51 Minor Changes  
463 None

Summary: 60 of 574 (**10%**) Rated Major and Moderate Changes

#### Utilities/ RR Accuracy –

19 Major Changes  
32 Moderate Changes  
60 Minor Changes  
460 None

Summary: 51 of 571 (**9%**) Rated Major and Moderate Changes

**Utilities/ RR Unknown -**

11 Major Changes  
22 Moderate Changes  
48 Minor Changes  
489 None

Summary: 33 of 570 (**6%**) Rated Major and Moderate Changes

**Utilities/ RR Needs -**

11 Major Changes  
20 Moderate Changes  
49 Minor Changes  
486 None

Summary: 31 of 566 (**5%**) Rated Major and Moderate Changes

**Utilities/ RR Work Finalized -**

21 Major Changes  
26 Moderate Changes  
41 Minor Changes  
477 None

Summary: 47 of 565 (**8%**) Rated Major and Moderate Changes

**ACCURACY SUMMARY:**

Existing Topography and Utilities

**6% Poor**  
**25% Fair**  
59% Good  
10% Very Good

## **Utilities and Railroad Summary**

### **UTILITIES**

- **Over 26% of the projects had utilities that were not shown accurately on the plans.**
- **Over 16% of the projects had utilities on-site that were not shown on the construction plans.**
- **Over 31% of the supervisors rated the accuracy of the existing topography and utilities as fair or poor.**
- **Of the actual change orders that were required due to utility impacts, 10% were rated as major or moderate changes.**

### **RAILROADS**

- **For projects involving railroads, the coordination with railroads was not complete for over 15% of the projects.**

## **Example Review Comments**

There were several utilities within the project that were not shown on the plans. The project was delayed by over one year due to utility relocations.

Gas lines and water lines were not shown on plans. Both required new pay items and time delays to relocate.

Pipeline utility did not relocate in time which delayed the project 1 year. There were overhead power lines directly over the location where the structure was to be placed. The lines had to be relocated due to OSHA requirements prior to culvert installation. This relocation was not included in the contract documents and also delayed construction.

There was a water line under the road that was old and fragile. Water line should have been moved before construction began.

Ameritech did not complete their relocation work in time causing a delay to the project.

The project was delayed because the RR could not supply a flagman.

There was adequate R/W for construction, but since space was shared with utilities, there was not enough R/W overall. This required many field adjustments, temporary shoring, additional time and money. Need to better accommodate sanitary sewers that operate on gravity flow as these have limited options for relocation.

Not all power poles were shown on the plans. One omitted pole was in the sight line of intersection that had to be relocated. Completion date had to be extended 3 months to get pole moved.

“There was a sanitary sewer line and a water line installed by the city of Goshen prior to the beginning of construction of this project. Neither of these utilities were shown on the plans nor was any mention made of them.”

## **Conclusions**

Based on the results of our study, it appears that for many different reasons, the locations or existence of all utilities within the project limits are not correctly shown on the construction plans. It appears that on many projects, it is assumed during the design process that there are no utility conflicts. Once in construction, utility conflicts with proposed construction is discovered that then requires the utility to relocate. This undiscovered relocation results in costly overruns and delays to the contract.

# Ideas for Improvement

## *Reduction of Utility Related Change Orders*

- Implement the recommendations as proposed in INDOT's Utility Task Force Plan.
- Perform utility Constructability Reviews early and often throughout the project development process.
- On medium and large scale projects, perform Subsurface Utility Engineering (SUE).
- ON those projects that do not have SUE, at the Final Field Check stage require all utilities to be located (marked with paint) in the field. Require designers to field verify that the utilities are shown accurately and that they match what is shown on the plans. Final field check agenda to include discussion of probable utility impacts during construction and relocation time frames.
- Major utility lines that would be costly to relocate should be identified at the preliminary field check stage or earlier. Alternatives to avoid relocation should be developed by designers so that the decision of whether to relocate a major utility can be made earlier in the design process.
- Require the project surveyor to contact all utility companies directly (not just Holey Moley) to obtain current contact names, existing utility plans, and to request the utility to show up on-site to determine if Holey-Moley marked their facilities correctly.
- Once the field survey is plotted, require designers and/or surveyors to send utility companies a set of plans to determine accuracy of plotted utility lines. By the Preliminary Field Check (PFC), all the existing utility lines should be presented and shown accurately on the design drawings. Decisions can be made at the PFC whether certain utilities need to be relocated. At the PFC stage, decisions can be made whether to attempt to revise the design to avoid utilities or if additional R/W is needed for utility relocations. Typically, these decisions are pushed off until the final design stages.
- Require utility companies to give specific time frames for relocations.

## **SOILS AND FOUNDATIONS**

*Question #21: Was the soil information adequate?*

	YES	NO	Total Responses	N/A	Not Answered
Reviews	205	56	<b>261</b>	401	14
% Yes/No	79%	<b>21%</b>			

*Question #22: Were soil difficulties described and addressed?*

	YES	NO	Total Responses	N/A	Not Answered
Reviews	134	55	<b>189</b>	472	15
% Yes/No	71%	<b>29%</b>			

### SUMMARY OF CONSTRUCTABILITY SCREENING MAGNITUDE OF CHANGES

#### Soils Information –

18 Major Changes  
26 Moderate Changes  
55 Minor Changes  
467 None

Summary: 44 of 566 (**8%**) Rated Major and Moderate Changes

#### Soils Difficulties –

19 Major Changes  
34 Moderate Changes  
54 Minor Changes  
461 None

Summary: 53 of 568 (**9 %**) Rated Major and Moderate Changes

### ACCURACY SUMMARY:

#### Soils and Foundation Information

4% **Poor**  
29% **Fair**  
60% Good  
7% Very Good

### Soils and Foundations Summary

- **On over 29% of the projects, the supervisors were of the opinion that soil difficulties were not addressed adequately during the design stage.**
- **On over 33% of the projects, the supervisors rated the accuracy of the soils and foundation information as poor or fair.**
- Of the actual change orders that were required due to soil impacts, 8% were rated as major or moderate changes.

## Example Review Comments

Designers had no knowledge of aquifers. Farm and adjoining property owner had knowledge of aquifers but were never approached by designers. No riprap or geotextiles in original contract. Soil condition almost pure sand. See the following e-mail response from project supervisor. Extensive aquifers and poor soil conditions existed on project that were unknown to designers. Change orders and time delays to fix soil problems were required.

Piles reached refusal well above those anticipated in soils report. Minimum tip elevation was tied to scour elevation.

“Only boring in plans were at bridge, not near enough borings to properly design the MSE wall, we had to do more borings in order to design the MSE wall. The rock excavation was up and down the length of the MSE wall.”

“Needed more test borings’, unpredictable soil during pile driving.”

“No one used the information from the soil report in designing the project.”

“Unclassified excavation set up with no allowance for rock excavation. Cross sections show near vertical cut slope at 11+500 left, looking like rock cut – no rock – only drawn this way so slope would fit within right of way. Almost all rock cuts from 11+600 to 12+250 but no notes anywhere.”

“Common excavation needed to be increased 89% to remove unsuitable material (topsoil) under roadway.”

“When we were building the temporary runaround at Baker Ditch we encountered some soils that were questionable as to whether or not the runaround would last around 4-5 months without having to repair it without restricting the road. There wasn’t a common excavation item set up to address this problem at Baker.”

“The settlement issues discussed in the geotechnical report were not addressed in the contract or in the plans. As a result 12 settlement plates and \$355,000 in wick drain items were added.”

## Conclusions

Based on the results of our study, it appears that for a significant percentage of projects, poor soil conditions are not discovered during the design and plan development process. Especially on road projects, it appears that additional soils investigations are needed. Not enough research into the presence of existing poor soil areas is being accomplished. In addition, the impacts of poor soils are contributing significantly to change orders.

# Ideas for Improvement

## *Reduction of Soils Related Change Orders*

- On projects involving new alignments, require soils consultant or INDOT's Engineer to conduct a thorough investigation of soils conditions including a field review to determine potential soil problems.
- Surveyors are required to notify all the adjacent property owners that they may have to enter on their property to survey the project. In addition, on bridge projects over water, the surveyors are required to interview adjoining property owners to determine the historic high water elevations. Either through the early notice letter or during the interview, the surveyor could question the property if know the existence of poor soil areas in the project vicinity. Several reviews included comments that the farmer next to the bridge knew of the poor soil area, but INDOT or the Local Public Agency (LPA) was not aware of the area.
- Geotechnical work is typically ordered after the Preliminary Field Check. Soils engineers are invited to the field check. At the PFC, the soils engineers should interview local property owners for knowledge of site conditions and known soil problems. The local testimony should become part of the soils report.
- Utilize new subsurface technologies to determine poor soil conditions.

## STRUCTURES

**Question #16: Were the plans specific enough to enable you to submit the rewired shop drawings, cofferdam drawings, jacking and shoring plans, etc. without extensive field measurements?**

	<u>YES</u>	<u>NO</u>	<u>Total Responses</u>	<u>N/A</u>	<u>Not Answered</u>
Reviews	221	16	<b>237</b>	428	11
% Yes/No	93%	7%			

**Question #17: Were critical dimensions, details, and elevations given within reasonable tolerance?**

	<u>YES</u>	<u>NO</u>	<u>Total Responses</u>	<u>N/A</u>	<u>Not Answered</u>
Reviews	304	43	<b>347</b>	318	11
% Yes/No	88%	<b>12%</b>			

**Question #18: Was difficulty experienced in assembling fabricated components?**

	<u>YES</u>	<u>NO</u>	<u>Total Responses</u>	<u>N/A</u>	<u>Not Answered</u>
Reviews	24	223	<b>247</b>	418	11
% Yes/No	<b>10%</b>	90%			

**Question #19: Were shop drawings free from revision?**

	<u>YES</u>	<u>NO</u>	<u>Total Responses</u>	<u>N/A</u>	<u>Not Answered</u>
Reviews	224	20	<b>244</b>	420	12
% Yes/No	92%	<b>8%</b>			

**Question #20: Were there sufficient details addressing the erection, bracing or stabilization of structural members during the construction stages?**

	<u>YES</u>	<u>NO</u>	<u>Total Responses</u>	<u>N/A</u>	<u>Not Answered</u>
Reviews	158	6	<b>164</b>	501	11
% Yes/No	96%	4%			

### SUMMARY OF CONSTRUCTABILITY SCREENING MAGNITUDE OF CHANGES

#### Plans- Structure Details –

22 Major Changes  
42 Moderate Changes  
108 Minor Changes  
406 None (includes road projects)

Summary: 64 of 172 (**37%**) Rated Major and Moderate Changes

#### Structures- Field Measurements-

12 Major Changes  
27 Moderate Changes  
92 Minor Changes  
444 None (includes road projects)

Summary: 39 of 131 (**30%**) Rated Major and Moderate Changes

### **Structures- Critical Dimensions –**

12 Major Changes

26 Moderate Changes

62 Minor Changes

472 None (includes road projects)

Summary: 38 of 100 (**38%**) Rated Major and Moderate Changes

### **Structures- Assembly –**

5 Major Changes

15 Moderate Changes

38 Minor Changes

509 None (includes road projects)

Summary: 20 of 58 (**34 %**) Rated Major and Moderate Changes

### **Structures- Shop Drawings-**

1 Major Changes

17 Moderate Changes

36 Minor Changes

518 None (includes road projects)

Summary: 18 of 54 (**33%**) Rated Major and Moderate Changes

### **Structures- Erection-**

3 Major Changes

17 Moderate Changes

33 Minor Changes

516 None (includes road projects)

Summary: 20 of 53 (**38%**) Rated Major and Moderate Changes

## **ACCURACY SUMMARY: STRUCTURES**

**2% Poor**

**25% Fair**

64% Good

9% Very Good

## **Structures Summary**

- Of the 673 projects, approximately 159 of them involved bridges. The number of responses included in the “none” category above includes road projects. It is assumed that there are about 175 bridge related projects in the database.
- **On over 27% of the projects, the supervisors rated the accuracy of the structures information as poor or fair.**
- **Of the actual change orders that were required due to structures, approximately 30% to 38% were rated as major or moderate changes.**
- **About 10% of the supervisors had difficulty fabricating components and had to revise shop drawings.**

## Example Review Comments

“A massive temporary retaining wall had to be designed and built along the south side of existing road in order to excavate for the MSE wall. The original cross section were accurate but the MSE wall excavation shown on this cross section was just drawn in to fit with no regard for whether rock or dirt would be encountered. They would show a vertical cut that would fit but in the field impossible to excavate since it is dirt, requiring the temporary retaining wall. Also, new bridge overlapped existing bridge, once it was started requiring design change to new bridge 2’ south.”

“All information was on plans but sometimes hard to locate correctly. End bent drawing very confusing – hard to tell if dimensions are measured on square or skewed. Not much thought put into designing MSE wall – three smaller walls shown in plans not even required since their location was in a rock cut. The strap lengths required for the other 2 walls not plotted on cross section correctly – need much longer straps than shown thus increasing the excavation required and excavation closer or into the existing road.”

“The dimensions for the rebar holes through the beams for the midspan diaphragms was incorrect on the plans and subsequently carried over to the shop drawings. This was not caught and the beams were fabricated with incorrect drawings.”

“During field erection of structural steel it was found that pre-drilled holes in steel beams for jacking frame members at pier #3 location were in the wrong location.”

“Incorrect dimensions shown on the plans was not caught in time, so revisions to the shop drawings were not made.”

The modular block retaining wall could not be built as per plan. The design diverted water back on to the property owner’s house.

Existing roadway elevations shown in plans were incorrect. Roadway had been resurfaced with an overlay in 2003. No corrections had been made to the plans.

## Conclusions

Based on the results of our study, it appears that overall, the project supervisors are rating structure related items higher than most of the other categories. As noted previously, 80% of the change orders are from road related projects. Overall the ratings for this category are high, of concern is that 27% of the project supervisors are rating the accuracy of the details as fair or poor.

## Ideas for Improvement

### *Reduction of Structure Related Change Orders*

- Expand Chapter 17 of the IDM to include more examples of how to calculate bridge quantities.
- Require designers to include top checks of all elevations, rebar quantities, re-bar lengths, and structure dimensioning.

# PLANS/ SPECIAL PROVISIONS / SPECIFICATIONS

## *Question #1: Were the plans clear with sufficient detail?*

	<u>YES</u>	<u>NO</u>	<u>Total Responses</u>	<u>N/A</u>	<u>Not Answered</u>
Reviews	482	175	<b>657</b>	14	5
% Yes/No	73%	<b>27%</b>			

## *Question #2: Were the special provisions clear and in sufficient detail?*

	<u>YES</u>	<u>NO</u>	<u>Total Responses</u>	<u>N/A</u>	<u>Not Answered</u>
Reviews	603	63	<b>666</b>	6	4
% Yes/No	90%	<b>10%</b>			

## *Question #3: Were the Standard Specifications and the Standard Drawings clear?*

	<u>YES</u>	<u>NO</u>	<u>Total Responses</u>	<u>N/A</u>	<u>Not Answered</u>
Reviews	607	36	<b>643</b>	12	20
% Yes/No	94%	<b>6%</b>			

## **SUMMARY OF CONSTRUCTABILITY SCREENING MAGNITUDE OF CHANGES**

### **Plans – Alignments –**

13 Major Changes  
39 Moderate Changes  
75 Minor Changes  
456 None

Summary: 52 of 583 (**9%**) Rated Major and Moderate Changes

### **Plans – Drainage Plans-**

25 Major Changes  
52 Moderate Changes  
108 Minor Changes  
398 None

Summary: 77 of 583 (**13%**) Rated Major and Moderate Changes

### **Plans – Material Specifications-**

11 Major Changes  
34 Moderate Changes  
84 Minor Changes  
448 None

Summary: 45 of 577 (**8%**) Rated Major and Moderate Changes

### **Specifications –**

14 Major Changes  
33 Moderate Changes  
86 Minor Changes  
446 None

Summary: 47 of 579 (**8%**) Rated Major and Moderate Changes

## **Standards –**

11 Major Changes

30 Moderate Changes

85 Minor Changes

451 None

Summary: 41 of 577 (7%) Rated Major and Moderate Changes

## **Plans, Special Provisions, Specifications Summary**

- **On over 27% of the projects, the supervisors felt that the plans were not clear and did not have sufficient detail.**
- Of the actual change orders that were required due to plans, provisions and specifications, approximately 7% to 13% were rated as major or moderate changes.

## **Example Review Comments**

P.G. elevations did not match at the intersection. Plot plan spot elevations were needed at all intersections. Temporary pavement dimensions were not specified. Under drain flow lines were sometimes below the ditch flow lines. Inadequate cover for many pipes. One structure had the top of it extending into the pavement. The structure had to be redesigned resulting in a \$141,000 change order. Signal strain poles and proposed light poles conflicted with proposed storm sewer. Many field changes required for storm structures. Quantities for compacted agg and common excavation were off.

Standard drawing for curb ramps was not clear resulting in all ramps built wrong. Ramps had to be removed and replaced.

## **Conclusions**

Based on the results of our study, it appears that overall the project supervisors are not having difficulties dealing with the special provisions or the standard drawings. 22% though, rate the plans as not being clear nor having sufficient detail. Apparently, in general, the construction plans are lacking enough details for the projects to be constructed.

# Ideas for Improvement

## *Reduction of Specs, Special Provisions, and Plans Related Change Orders*

- Allow district construction engineers to review final plans for all projects prior to letting.
- On major projects, hold pre-bid meetings. Solicit contractors input on plan details, lack of details and overall plan clarity.
- INDOT should publish and make available all approved unique special provisions to designers. Too often, designers have to re-write unique provisions that were previously used and approved by INDOT.
- Pre-bids meetings prior to lettings should be encouraged on all major projects. Contractor's input and questioning of the contract documents and plans is very valuable prior to the actual bid. Confusing plan details or special provisions can be cleaned up and clarified prior to letting.
- Update IDM Chapter 14 to include example plan details for both road and bridge projects.
- Allow enough time in the schedule for INDOT's Project Manager and Area Engineer to perform a detailed review of the contract documents.
- Ensure that all special provisions, pay items, plans, etc. are current and up to date before the letting. A large percentage of change orders are attributed to changes made to plans and estimate after the project is advertised.
- Many change orders are attributed to last minute plan and contract document revisions required by design memos. Consider extending effective date of memos so that they don't adversely effect projects that are ready for letting.

## R/W AND MAINTENANCE OF TRAFFIC

**Question #11: Was all the R/W cleared prior to construction?**

	YES	NO	Total Responses	N/A	Not Answered
Reviews	566	50	<b>616</b>	50	10
% Yes/No	92%	<b>8%</b>			

**Question #12: Was adequate R/W available?**

	YES	NO	Total Responses	N/A	Not Answered
Reviews	402	56	<b>458</b>	207	11
% Yes/No	88%	<b>12%</b>			

**Question #14: Was the staging shown in the plans practical and constructible?**

	YES	NO	Total Responses	N/A	Not Answered
Reviews	319	42	<b>361</b>	307	8
% Yes/No	88%	<b>12%</b>			

**Question #15: Was the traffic control plan adequate?**

	YES	NO	Total Responses	N/A	Not Answered
Reviews	531	66	<b>597</b>	62	17
% Yes/No	89%	<b>11%</b>			

### SUMMARY OF CONSTRUCTABILITY SCREENING MAGNITUDE OF CHANGES

**Plans- Right of Way –**

21 Major Changes  
 36 Moderate Changes  
 65 Minor Changes  
 463 None

Summary: 57 of 585 (**10%**) Rated Major and Moderate Changes

**Plans - Staging-**

10 Major Changes  
 38 Moderate Changes  
 70 Minor Changes  
 456 None

Summary: 48 of 574 (**8%**) Rated Major and Moderate Changes

**Work Zone Traffic Control-**

17 Major Changes  
 44 Moderate Changes  
 134 Minor Changes  
 382 None

Summary: 61 of 577 (**11%**) Rated Major and Moderate Changes

## R/W and MOT Summary

- **On over 12% of the projects, there was not enough R/W to build the project.**
- **On over 11% of the projects, the supervisors felt that the traffic control plan was inadequate.**
- Of the actual change orders that were required due to R/W and MOT related impacts, approximately 8% to 11% were rated as major or moderate changes.

## Example Review Comments

Did not take into consideration R/W needed to excavate ditch banks. Back Hoe needed to set out side of R/W to place new structure as well.

Sight distance at intersection was insufficient. Additional R/W had to be purchased to cut back slope to have sight line.

“Right of way very close most of job length, four locations - just not enough to build as planned. Could not build ditch and slope. Had to place a box culvert along road (in planned ditch) to keep work on R/W. Back slope placed at 1:1 and rip rapped to stay on R/W. MSE wall location – just barely enough R/W to build.”

“You should design the project before you buy the R/W and if you are going to let every utility on the project then buy R/W for them. Utilities were never considered in the design, R/W buying of this project & R-25919 and this cost the State of Indiana considerably.”

“There was insufficient R/W for utilities and construction of slope. In most cases the top of slope and the R/W were the same. I cannot allow the off set for utilities and set R/W marker. Also after the starts additional utilities should not be give a permit to relocate when you don't have the R/W with out talking to the project people.”

There was not enough right-of-way on the north side of the bridge to allow equipment to go down the slope and work on the cofferdam for pier three. The contractor had to encroach on private property to perform the work.

Curb was placed in Fortville at US 36/SR 67 and SR 13. An island was built that extended all the way to the limits of the row. The adjacent parking lot was damaged and repair work was needed.

“Generally practical but lacking in details like the plans in general. No details shown for tie-in areas to existing pavement – some needed 12 inches of blacktop and had to be placed while maintaining traffic on some area, requiring temporary wedging. No mention of how to maintain access to drives in each phase of construction.”

“The job was very difficult to understand why we were building a temporary runaround and bridge at Baker (out in the middle of no where). We were working on a tight schedule with all of the restriction that were placed on the project.”

“We needed more signs, barricades, RMA’s, road closure assemblies. The plans did not do a good job of taking care of traffic so a lot of field changes were made. We received a lot of complaints from the public placing the the MOT scheme like the plans called for”

“The staging plan was two dimensional and looked good till you work in a three dimensional world. We need someone to check the vertical elevation. You cannot work with a three feet and more difference in elevation with only two feet between the construction and live traffic. It required in one situation that a run around to be built so that the original run around could be built.”

“We created a 55 mph zone through the runaround because it wasn’t designed for the interstate. Improper use of anchored and non-anchored barrier wall on plans. SAFETY is a big concern (why switch traffic at night) something should be allowed during days. Why did we have two different sets of rules when the bridges were 2 miles apart.”

“Never take 2 lanes & 1 ramp of I-65 to 1 lane with 1 arrow board & one taper.”

“INDOT needs someone to check plans with some experience and can think in three dimensions.

“The plan left the general impression that the HMA would take place principally inside the limits of the temporary runaround. However, after studying the details it became clear that the runaround was too short. This situation also confused the utilities and consequently some of their facilities were still in the way.”

## **Conclusions**

Based on the results of our study, it appears that on some projects, designers are not providing enough room between the construction limits and the proposed R/W. It appears that on many projects, providing room for utility relocations is not being considered when designing R/W. Projects have been delayed while utilities are purchasing R/W for relocations. Overall it appears that designers are not looking closely enough at the construction phasing and constructability aspects of the project. Designers are looking at constructability in plan view and not in section view.

# Ideas for Improvement

## *Reduction of MOT and R/W Related Change Orders*

- At the preliminary field check stage, the designer and INDOT's R/W representative, identify sensitive and costly parcels within the project limits. Designers should investigate alternatives to reduce and/or eliminate acquisition from these parcels.
- Designers and R/W engineers should work closely together in an effort to reduce the number and amount of R/W acquisition for the project.
- At the final field check, designer and construction engineer should perform detailed review of the construction limits and the proposed R/W to insure that there is enough room to construct the project.
- At the final field check, designer and construction engineer should perform detailed review of the MOT plan to insure that the proposed phasing plan is constructible. Verify that there is enough construction space between phase lines to adequately build the project.
- Each design consultant should have a designated engineer responsible for constructability reviews of their firms' maintenance of traffic and construction detail submittals. INDOT should develop a checklist for constructability reviews including review procedure guidelines.
- Construction engineers and designers need to interact more often with each other throughout the entire design process. Identify MOT issues early in the design process.
- Encourage designers to avoid significant profile grade changes in urban settings. Grade revisions in urban settings create MOT and property access issues and challenges. Large grade differences create big constructability and safety problems in construction.
- Encourage joint effort with all parties to insure there is adequate R/W to construct the project.
- INDOT's Design Manual Part VIII should be updated and expanded to provide guidance to designers. INDOT Construction should put on a constructability training session for all designers.

• **PERMITS AND CONTRACT WORK DAYS**

**Question #6:** *If the contract had working days rather than a completion date, was the number of days too few, too many, about right, N/A?*

	Too Few	Too Many	About Right	Total Responses	N/A	Not Answ.
Reviews	30	8	303	<b>341</b>	307	28
% Yes/No	<b>9%</b>	2%	89%			

**Question #13:** *Were all the permits obtained and in place prior to construction?*

	YES	NO	Total Responses	N/A	Not Answered
Reviews	592	18	<b>610</b>	59	7
% Yes/No	97%	3%			

**SUMMARY OF CONSTRUCTABILITY SCREENING MAGNITUDE OF CHANGES**

**Plans- Environmental Considerations –**

14 Major Changes  
 37 Moderate Changes  
 71 Minor Changes  
 456 None

Summary: 51 of 578 (**9%**) Rated Major and Moderate Changes

**Plans -Erosion Control-**

8 Major Changes  
 29 Moderate Changes  
 107 Minor Changes  
 437 None

Summary: 37 of 581 (**6%**) Rated Major and Moderate Changes

**Work Days –**

17 Major Changes  
 50 Moderate Changes  
 84 Minor Changes  
 426 None

Summary: 67 of 577 (**12%**) Rated Major and Moderate Changes

**Permits –**

10 Major Changes  
 9 Moderate Changes  
 31 Minor Changes  
 525 None

Summary: 19 of 575 (**3%**) Rated Major and Moderate Changes

**ACCURACY SUMMARY: CONTRACT TIME**

**2% Poor**  
**19% Fair**  
 68% Good  
 11% Very Good

## Permits and Contract Work Days Summary

- **On over 9% of the projects, the supervisors felt that there was not enough work days provided for in the contract.**
- Of the actual change orders that were required due to environmental, erosion control and contract workdays, approximately 3% to 12% were rated as major or moderate changes.
- On over 21% of the projects, the supervisors rated the accuracy of the contract time as fair to poor.

## Example Review Comments

None at this time.

## Conclusions

Based on the results of our study, it appears that there are not enough days allowed for in the contract (21% rated the accuracy of the time as fair to poor, but only 9% felt there was not enough work days).

## Ideas for Improvement

### *Reduction of Permits & Contract Work Days Related Change Orders*

- INDOT needs to develop recurring special provisions and standard details for erosion control items. Each designer is basically required to develop their own special provisions and some non-standard details for each project assignment.
- Require designers to check permit status prior to FFC and letting to insure that permits are valid and that they have not expired.

## CAUSES OF CHANGE ORDERS

When a project supervisor submits for a change order, he is required to identify the reason for the change of scope. We did not obtain the actual change orders for each of the **569** projects for this study. In reading the construction evaluations, it was very difficult or impossible to ascertain what the cause of the change order was. The possible causes of change orders are as follows:

- Change of Scope
- Errors and Omissions
- Unforeseen Existing Conditions

## OVERALL SUMMARY AND PROJECT RATING

**Question #23A: Were the construction drawings and specifications complete?**

	<u>Reviews</u>	<u>%</u>
Better than Expected	32	5%
Met Expectations	485	72%
Needs to Improve	80	<b>12%</b>
Serious Problem	9	<b>1%</b>
No Opinion	20	3%
Not Answered	50	7%

**Question #23B: Were the construction drawings and specifications accurate?**

	<u>Reviews</u>	<u>%</u>
Better than Expected	30	4%
Met Expectations	465	69%
Needs to Improve	97	<b>14%</b>
Serious Problem	14	<b>2%</b>
No Opinion	19	3%
Not Answered	51	8%

**Question #23C: Were there a large number of contractor questions?**

	<u>Reviews</u>	<u>%</u>
Better than Expected	32	5%
Met Expectations	483	71%
Needs to Improve	70	<b>10%</b>
Serious Problem	8	<b>1%</b>
No Opinion	33	5%
Not Answered	50	8%

**Question #23D: Did the construction documents impact contractor's ability to meet schedule?**

	<u>Reviews</u>	<u>%</u>
Better than Expected	30	4%
Met Expectations	488	72%
Needs to Improve	56	<b>8%</b>
Serious Problem	15	<b>2%</b>
No Opinion	34	5%
Not Answered	53	9%

**Question #23E: Did construction documents impact construction costs?**

	<u>Reviews</u>	<u>%</u>
Better than Expected	19	3%
Met Expectations	448	66%
Needs to Improve	100	<b>15%</b>
Serious Problem	19	<b>3%</b>
No Opinion	39	6%
Not Answered	51	7%

## **ACCURACY SUMMARY: PROJECT RATING**

**2% Poor**

**24% Fair**

**67% Good**

**6% Very Good**

## **Overall Project Summary**

- **On over 12% of the projects, the supervisors felt the construction drawings were neither complete nor accurate.**
- **As a result of the incomplete or inaccurate plans, the supervisors felt that the number of contractor questions was a serious problem and that improvement is needed.**
- **On over 10% of the projects, the construction documents impacted the contractor's schedule. On over 18% of the projects, the inadequacy of the construction documents had a negative impact on the construction costs.**
- **Overall, the Construction Project Supervisors rate 28% of the projects as fair to poor.**

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**Question 1:**      *Were the plans clear with sufficient detail?*

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
	5	\$5,920,728.47	\$207,422.54	3.50%
<i>Yes</i>	482	\$601,348,413.40	\$29,146,580.89	4.85%
<i>No</i>	175	\$352,298,150.81	\$27,449,525.48	7.79%
	14	\$13,440,714.52	\$945,067.56	7.03%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 2:**      *Were the special provisions clear  
and in sufficient detail?*

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	4	\$20,241,665.59	\$51,207.00	0.25%
<i>Yes</i>	603	\$803,724,348.07	\$42,193,705.52	5.25%
<i>No</i>	63	\$146,046,548.66	\$15,369,595.49	10.52%
<i>N/A</i>	6	\$2,995,444.88	\$134,088.46	4.48%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 3:      *Were the Standard Specifications and the Standard Drawings clear?***

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	20	\$45,234,426.11	\$173,336.90	0.38%
<i>Yes</i>	607	\$831,837,806.27	\$49,916,561.11	6.00%
<i>No</i>	36	\$67,049,048.07	\$6,713,193.94	10.01%
<i>N/A</i>	13	\$28,886,726.75	\$945,504.52	3.27%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 4:      *Were the quantities reliable?***

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	12	\$24,825,113.57	\$356,852.61	1.44%
<i>Yes</i>	375	\$407,964,227.42	\$22,510,668.54	5.52%
<i>No</i>	278	\$489,596,432.81	\$32,780,774.33	6.70%
<i>N/A</i>	11	\$50,622,233.40	\$2,100,300.99	4.15%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 5:      *Did the pay items used match the work to be performed?***

---

<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	7	\$4,511,774.12	\$99,635.54	2.21%
<i>Yes</i>	535	\$734,228,719.05	\$38,409,618.58	5.23%
<i>No</i>	118	\$191,103,627.37	\$17,622,800.08	9.22%
<i>N/A</i>	16	\$43,163,886.66	\$1,616,542.27	3.75%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 6:**     *If the contract had working days rather than a completion date, was the number of days...*

---

<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	28	\$32,696,809.36	\$373,265.10	1.14%
<i>Too Few</i>	30	\$81,314,301.45	\$12,963,559.82	15.94%
<i>Too Many</i>	8	\$5,419,251.51	(\$6,585.25)	-0.12%
<i>About Right</i>	303	\$351,250,712.41	\$18,809,991.06	5.36%
<i>N/A</i>	307	\$502,326,932.47	\$25,608,365.74	5.10%
<b><i>Grand Total</i></b>		<b>\$973,008,007.20</b>	<b>\$57,748,596.47</b>	

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**Question 7:      *Were the utilities accurately shown on the plans?***

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	6	\$3,444,208.42	\$1,436,838.12	41.72%
<i>Yes</i>	260	\$562,027,382.50	\$34,863,149.58	6.20%
<i>No</i>	91	\$174,511,522.35	\$8,362,366.47	4.79%
<i>N/A</i>	319	\$233,024,893.93	\$13,086,242.30	5.62%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 8:      *Was the project free of unknown utilities?***

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	4	\$14,440,914.88	\$616,262.00	4.27%
<i>Yes</i>	538	\$694,820,501.61	\$36,974,242.36	5.32%
<i>No</i>	104	\$242,896,321.44	\$18,087,920.25	7.45%
<i>N/A</i>	30	\$20,850,269.27	\$2,070,171.86	9.93%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 9:**      *Were the needs of utilities and /or railroads considered?*

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	11	\$24,897,522.21	\$154,537.21	0.62%
<i>Yes</i>	284	\$498,479,033.52	\$24,043,779.54	4.82%
<i>No</i>	37	\$113,341,697.43	\$11,489,424.80	10.14%
<i>N/A</i>	344	\$336,289,754.04	\$22,060,854.92	6.56%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 10:**     *Was all coordination and work finalized with the railroad prior to the construction stages?*

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	8	\$23,577,561.16	\$153,111.11	0.65%
<i>Yes</i>	78	\$213,905,447.52	\$10,587,833.39	4.95%
<i>No</i>	14	\$31,540,675.05	\$1,055,930.46	3.35%
<i>N/A</i>	576	\$703,984,323.47	\$45,951,721.51	6.53%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 11:     *Was all right-of-way cleared prior to construction?***

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	10	\$29,164,585.65	\$151,786.41	0.52%
<i>Yes</i>	566	\$757,759,605.88	\$38,683,072.86	5.10%
<i>No</i>	50	\$153,172,273.02	\$17,264,879.66	11.27%
<i>N/A</i>	50	\$32,911,542.65	\$1,648,857.54	5.01%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 12:     *Was adequate right-of-way available?***

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	11	\$28,051,314.93	\$154,537.21	0.55%
<i>Yes</i>	402	\$572,257,436.45	\$30,239,257.64	5.28%
<i>No</i>	56	\$162,818,564.17	\$20,678,841.76	12.70%
<i>N/A</i>	207	\$209,880,691.65	\$6,675,959.86	3.18%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 13:    *Were all permits obtained and in place prior to construction?***

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	7	\$3,593,778.94	\$164,882.95	4.59%
<i>Yes</i>	592	\$875,511,113.78	\$49,687,726.01	5.68%
<i>No</i>	18	\$18,079,368.35	\$1,040,967.80	5.76%
<i>N/A</i>	59	\$75,823,746.13	\$6,855,019.71	9.04%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 14:**     *Was the staging shown in the plans practical and constructable?*

---

<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	8	\$4,547,324.34	\$183,112.85	4.03%
<i>Yes</i>	319	\$617,787,662.01	\$32,282,444.85	5.23%
<i>No</i>	42	\$131,304,377.37	\$15,108,961.98	11.51%
<i>N/A</i>	307	\$219,368,643.48	\$10,174,076.79	4.64%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 15:     *Was the traffic control plan adequate?***

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	17	\$18,824,171.05	\$196,002.15	1.04%
<i>Yes</i>	531	\$711,192,584.85	\$40,210,085.30	5.65%
<i>No</i>	66	\$164,515,654.08	\$15,687,101.11	9.54%
<i>N/A</i>	62	\$78,475,597.22	\$1,655,407.91	2.11%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 16:**     *Were the plans, specific enough to enable you to submit the required shop drawings, cofferdam drawings, jacking and shoring plans, etc. without extensive field measurements?*

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	11	\$7,639,276.66	\$164,882.95	2.16%
<i>Yes</i>	221	\$425,280,927.13	\$22,515,602.97	5.29%
<i>No</i>	16	\$55,531,873.42	\$11,391,373.67	20.51%
<i>N/A</i>	428	\$484,555,929.99	\$23,676,736.88	4.89%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 17:**     *Were critical dimensions, details and elevations given within reasonable tolerance?*

---

<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	11	\$29,713,922.80	\$270,474.01	0.91%
<i>Yes</i>	304	\$570,279,574.10	\$37,378,641.40	6.55%
<i>No</i>	43	\$57,962,391.85	\$5,986,751.88	10.33%
<i>N/A</i>	318	\$315,052,118.45	\$14,112,729.18	4.48%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 18:**     *Was difficulty experienced in assembling fabricated components?*

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	11	\$26,636,850.06	\$302,062.86	1.13%
<i>Yes</i>	24	\$65,688,166.31	\$3,546,170.44	5.40%
<i>No</i>	223	\$442,211,521.93	\$31,999,414.94	7.24%
<i>N/A</i>	418	\$438,471,468.90	\$21,900,948.23	4.99%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 19:     *Were shop drawings free from revision?***

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	12	\$26,629,990.64	\$307,085.80	1.15%
<i>Yes</i>	224	\$454,662,724.80	\$30,981,249.17	6.81%
<i>No</i>	20	\$60,653,984.33	\$4,157,983.02	6.86%
<i>N/A</i>	420	\$431,061,307.43	\$22,302,278.48	5.17%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

**Question 20:**     *Were there sufficient details addressing the erection, bracing or stabilization of structural members during the construction stages?*

<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	11	\$26,167,051.39	\$276,020.01	1.05%
<i>Yes</i>	158	\$357,555,872.84	\$28,888,049.38	8.08%
<i>No</i>	6	\$18,480,058.48	\$597,130.64	3.23%
<i>N/A</i>	501	\$570,805,024.49	\$27,987,396.44	4.90%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 21:     *Was the soil information adequate?***

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	14	\$8,284,767.82	\$85,331.99	1.03%
<i>Yes</i>	205	\$476,896,364.58	\$28,239,281.07	5.92%
<i>No</i>	56	\$129,085,918.72	\$11,034,470.74	8.55%
<i>N/A</i>	401	\$358,740,956.08	\$18,389,512.67	5.13%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 22:     *Were soil difficulties described and addressed?***

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	15	\$8,351,677.89	\$115,343.60	1.38%
<i>Yes</i>	134	\$284,222,890.53	\$11,710,331.35	4.12%
<i>No</i>	55	\$158,408,840.72	\$21,711,676.16	13.71%
<i>N/A</i>	472	\$522,024,598.06	\$24,211,245.36	4.64%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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## Question 23A: *Were construction drawings and specifications complete?*

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	50	\$88,788,303.34	\$635,534.25	0.72%
<i>Better Than Expected</i>	32	\$65,710,596.56	\$2,878,215.43	4.38%
<i>Met Expectations</i>	485	\$611,268,880.49	\$28,970,988.75	4.74%
<i>Needs to Improve</i>	80	\$159,088,524.61	\$20,920,557.52	13.15%
<i>Serious Problem</i>	9	\$25,241,042.94	\$3,442,121.20	13.64%
<i>No Opinion</i>	20	\$22,910,659.26	\$901,179.32	3.93%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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## Question 23B: *Were construction drawings and specifications accurate?*

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	51	\$88,923,472.66	\$635,534.25	0.71%
<i>Better Than Expected</i>	30	\$74,933,068.60	\$2,531,288.52	3.38%
<i>Met Expectations</i>	465	\$571,735,065.87	\$28,064,436.52	4.91%
<i>Needs to Improve</i>	97	\$162,823,103.47	\$15,665,667.09	9.62%
<i>Serious Problem</i>	14	\$53,885,251.09	\$10,375,272.23	19.25%
<i>No Opinion</i>	19	\$20,708,045.51	\$476,397.86	2.30%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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## Question 23C: *Were there a large number of contractor questions?*

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	50	\$85,168,648.76	\$277,189.35	0.33%
<i>Better Than Expected</i>	32	\$42,198,706.72	\$2,592,538.52	6.14%
<i>Met Expectations</i>	483	\$654,335,279.79	\$36,666,466.22	5.60%
<i>Needs to Improve</i>	70	\$144,530,717.99	\$15,507,017.89	10.73%
<i>Serious Problem</i>	8	\$17,822,759.03	\$1,428,578.40	8.02%
<i>No Opinion</i>	33	\$28,951,894.91	\$1,276,806.09	4.41%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

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**Question 23D: *Did construction documents impact contractor's ability to meet schedule?***

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	53	\$92,308,241.59	\$1,173,203.25	1.27%
<i>Better Than Expected</i>	30	\$43,200,902.29	\$865,591.64	2.00%
<i>Met Expectations</i>	488	\$630,156,867.24	\$34,267,777.02	5.44%
<i>Needs to Improve</i>	56	\$100,908,628.87	\$11,914,027.95	11.81%
<i>Serious Problem</i>	15	\$51,066,244.96	\$6,684,106.39	13.09%
<i>No Opinion</i>	34	\$55,367,122.25	\$2,843,890.22	5.14%
<b><i>Grand Total</i></b>		<b>\$973,008,007.20</b>	<b>\$57,748,596.47</b>	

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## Question 23E: *Did construction documents impact construction costs?*

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<i>Answer</i>	<i>Number Of Records</i>	<i>Original Contract</i>	<i>Change Order Amt</i>	<i>Percent Overrun</i>
<i>Not Answered</i>	51	\$85,450,464.02	\$252,662.04	0.30%
<i>Better Than Expected</i>	19	\$24,716,153.34	\$217,238.34	0.88%
<i>Met Expectations</i>	448	\$550,228,521.13	\$27,968,434.66	5.08%
<i>Needs to Improve</i>	100	\$165,255,243.43	\$13,828,472.69	8.37%
<i>Serious Problem</i>	19	\$60,133,367.10	\$10,998,543.95	18.29%
<i>No Opinion</i>	39	\$87,224,258.18	\$4,483,244.79	5.14%
<i>Grand Total</i>		\$973,008,007.20	\$57,748,596.47	

# Accuracy Summary

	<i>POOR</i>	<i>FAIR</i>	<i>GOOD</i>	<i>VERY GOOD</i>
Existing topography and utilities	31	127	297	50
Soils and foundation information	18	130	272	32
Estimate of quantities	37	225	286	25
Structures	12	118	306	43
Bid Items	17	157	360	40
Contract Time	14	111	390	58
Project Rating	12	137	378	36

	<i>POOR</i>	<i>FAIR</i>	<i>GOOD</i>	<i>VERY GOOD</i>
Existing topography and utilities	6.14%	25.15%	58.81%	9.90%
Soils and foundation information	3.98%	28.76%	60.18%	7.08%
Estimate of quantities	6.46%	39.27%	49.91%	4.36%
Structures	2.51%	24.63%	63.88%	8.98%
Bid Items	2.96%	27.35%	62.72%	6.97%
Contract Time	2.44%	19.37%	68.06%	10.12%
Project Rating	2.13%	24.33%	67.14%	6.39%

## *Summary of Constructability Screening Questions*

<i>QUESTION</i>	<i>MAJOR</i>	<i>MODERATE</i>	<i>MINOR</i>	<i>NONE</i>
1. Plans: Right of Way	21	36	65	463
Alignments	13	39	75	456
Environmental Considerations	14	37	71	456
Structure Details	22	42	108	406
Earthwork Distribution	23	39	97	422
Drainage Plans	25	52	108	398
Erosion Control	8	29	107	437
Staging	10	38	70	456
Utility/Railroad	20	40	51	463
Material Specifications	11	34	84	448
2. Specifications	14	33	86	446
3. Standards	11	30	85	451
4. Quantities	56	129	279	132
5. Pay Items	39	94	276	181
6. Work Days	17	50	84	426
7. Utilities / RR Accuracy	19	32	60	460
8. Utilities / RR Unknown	11	22	48	489
9. Utilities / RR Needs	11	20	49	486
10. Utilities / RR Work Finalized	21	26	41	477
11. R/W Cleared	12	14	41	507
12. R/W Sufficient	16	29	58	480
13. Permits	10	9	31	525
14. Staging	8	38	50	477
15. Work Zone Traffic Control	17	44	134	382
16. Structures, Field Measurement	12	27	92	444
17. Structures, Critical Dimensions	12	26	62	472
18. Structures, Assembly	5	15	38	509
19. Structures, Shop Drawings	1	17	36	518
20. Structures, Erection	3	17	33	516
21. Soils, Information	18	26	55	467
22. Soils, Difficulties	19	34	54	461