Best Practices from WisDOT Mega and ARRA Projects - Request for Information: Benchmarks and Metrics

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Executive Summary

Successful highway construction is measured by cost, time, safety, and quality. One further measure of success is the quantity of Request for Information's (RFI) submitted and their impact. An RFI is a formal written procedure initiated by the contractor seeking additional information or clarification for issues related to design, construction, and other contract documents. The RFI process was identified as an important best practice for the delivery of major highway project and as a significant source of benchmarking and metric opportunities. Implementation of an RFI process is considered to be an integral part of successful project management for construction projects because it improves communication between the construction, design, and project management teams. The ability to quantitatively measure the performance of the RFI process has the potential to identify areas of concern within a project, to breakdown the reasons for why an RFI is submitted, and to understand the expected submittal rate of RFIs. However, there are no studies completed on the quantitative evaluation of the RFI process for highway construction. Even though the procedure for using RFIs has been documented by State Highway Agencies (SHAs), there are currently no available benchmarks or metrics identified as performance measures for use within the RFI process for major highway projects.

The primary purpose of this research is to develop performance measure indicators within the RFI process for major highway projects. The following objectives were completed to achieve this purpose: 1) provide a new method to classify RFIs because the current classification process used by WisDOT is not adequate due to lack of specificity and due to difficulties in deriving meaningful conclusions, 2) develop project benchmarks and

metrics for project performances and practices to aid project teams in assessing the performance of a transportation infrastructure project, and 3) provide best practices and recommendations to improve the RFI process and to allow for other SHAs to implement an effective RFI process.

Data on RFIs were collected from the construction of successful major highway projects in the Midwest including more than 63 bridges, 47 miles of roadway, and 17 interchanges totaling almost $1 billion dollars worth of construction documents. Success for a project is defined as on time, to budget, and no claims at the completion of the project. A formal three-step process was created and utilized to organize the construction data in a matter that would optimize the potential benefits. Six performance measures were created and verified using a Bootstrap statistical analysis to provide robust performance measures that are applicable to all major highway projects of a similar scope and size. The six performance measures include: 1) number of RFIs per million dollars of awarded contract, 2) percent of RFIs answered by the request date, 3) percent of RFIs submitted at the Notice to Proceed (NTP) date, 25-percent, 50-percent, and 75-percent complete based on the payment schedule, 4) average RFI response time, 5) percent of unjustified RFIs, and 6) percent of RFIs that become Contract Modifications.

These new performance measures are provided with an expected range of values and have the ability to be used on any major highway project. Leading and lagging performance measures are provided in order to be proactive in anticipating the impact on desired results and assessing the achievement of a project's objectives, respectively. The research was concluded with the development of a list of best practices and an RFI form. The RFI form easily enables the implementation of the newly developed three-step classification process as well as many of the best practices. State Highway Agencies can use this publication, along with the list of best practices as they look to improve or implement an RFI process.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 PROBLEM CONTEXT

The Wisconsin Department of Transportation (WisDOT) gave top priority for a research project to identify best practices for mega-projects. Best practices are processes or methods that lead to enhanced project performance when effectively executed (CII 2006). The research to identify best practices would distinguish procedures, standards, and programs used in these projects. The research would further evaluate the best practices' effectiveness, determine if the best practices have benefits for future use, and determine how the best practices could be adopted by WisDOT for mega-projects, which are referred to as major projects for this research.

The Federal Highway Administration (FHWA) has created the term "mega-project" for the effort due to the delivery of major highway design and construction projects that are extremely complex, requiring coordination and management of a multitude of organizational, technical, and resource-related issues. Additionally, a "mega-project" is a major infrastructure project that either costs more than $500 million dollars or attracts an elevated amount of public attention or political interest due to substantial direct and indirect impacts on the community, environment, and State budgets (Capka 2004). WisDOT has successfully completed one major project, the Marquette Interchange, and is in the process of delivering two additional major projects: I-94 North-South (N-S) Freeway corridor reconstruction in southeast Wisconsin and US Highway (USH) 41 expansion in northeast Wisconsin.

WisDOT would strongly benefit from a comprehensive evaluation of the specific processes used on major projects to determine their effectiveness and potential benefits. Several management processes established specifically for the Marquette Interchange were identified by the Construction Materials and Support Center (CMSC) research team at the University of Wisconsin – Madison as key best practices to be implemented for the delivery of future major construction projects. The CMSC research team at the University of Wisconsin – Madison identified four emphasis areas throughout the best practices research. The emphasis areas are (1) Project Management with Benchmarking and Metrics, (2) Project Change Management, (3) Document Control and Reporting, and (4) Financial Reporting. These four areas were chosen because the bulk of the new methods, processes, and procedures implemented for WisDOT's major highway projects are in these specific areas, which all occur in the construction phase. The majority of best practices are in the "Project Management with Benchmarking and Metrics" area. The research team selected best practices with the highest potential to create beneficial benchmarks and metrics to conduct an in-depth study. One of those was the best practice of using a Request for Information (RFI) process, which became the focus of this research.

The RFI process is an effective construction administration tool that facilitates communication between the contractor, the construction project manager, and the design team. RFIs formally record an identified need for information on the plans, specifications, or construction. The RFI process is important to implement because it is very useful to resolve issues due to the inevitability that the contract, drawings, and specifications will not adequately address every issue in the construction documents. These gaps, conflicts, or subtle ambiguities may require additional input and clarification. Common reasons for writing an RFI may include unclear specifications, plan and specification contradictions, vague construction documents, or unforeseen field conditions which lead to questions in interpretation. The response to an RFI allows the project team to assess their options when drafting the response, which includes potential issues and risks. An RFI process also documents the response and places it in the project records. If each RFI is appropriately tracked and classified, then: 1) patterns in the reasons for submittal and 2) timing of the RFIs will become evident.

1.2 PROBLEM STATEMENT

According to the National Cooperative Highway Research Program (NCHRP), less than 20-percent of projects over $5 million dollars in construction cost were on or under budget and only 35-percent were delivered on time (Jacobs 2009). This inability to meet budgets or maintain schedules is why successful projects need to be studied and their practices' benchmarked.

In February 2011, the CMSC completed a workshop to gather input on best practices identified by the CMSC as well as leverage the experience of 24 practitioners. The input about the individual best practices was gathered from the participants through the use of a qualitative ranking system. A series of 13 questions were asked about each best practice and with each question having a common ranking system. Typical questions asked about the best practices pertained to their respective effectiveness, importance, and implementation.

According to these participants at the best practices workshop, of which all members were familiar with RFIs, the implementation of an RFI process is very effective. The participants agreed that it is very important that this procedure be implemented on all major projects. Furthermore, the workshop participants said that it is not particularly difficult to implement the RFI process with only minimal potential cost increases to the State Highway Agency (SHA). These costs would likely be recouped through the benefits that the process offers. At the conclusion of the CMSC best practices workshop, the RFI process was identified as one of the top five most important Project Management best practices for implementation for WisDOT major highway project delivery.

There is a need to go beyond the qualitative thought process of implementing the RFI process to discuss the creation of useful quantitative benchmarks and metrics from construction administration practice and data. Particularly, there currently are no quantitative measures within the RFI process to compare project performance. In order to most effectively use RFIs, benchmarks and metrics that indicate project success must be created. The implementation of RFI project performance measures have the potential to provide an immediate comparison between present performance and past performance based on successful major highway projects within the WisDOT program.

1.3 RESEARCH OBJECTIVES

The primary purpose of this research is to develop quantitative performance measures of the RFI process. Specific research objectives include: 1) provide a new method to classify RFIs because the current classification process is not adequate due to lack of specificity, and due to difficulties in deriving meaningful conclusions, 2) develop project benchmarks and metrics using the Bootstrap method for project performance and practices to aid project teams in assessing the performance of a transportation infrastructure project, and 3) provide best practices and recommendations to improve the RFI process and to allow for WisDOT to implement an effective RFI process. The purpose of these three objectives is to establish a manageable number of effective and transferable benchmarks and metrics as performance targets for WisDOT and also to provide best practices and recommendations for efficient implementation.

1.4 RESEARCH SCOPE

This research focuses on successful, major highway projects by WisDOT. Success for a finished project is defined as on time, to budget, and no claims at the completion of the project. This is also the accepted definition of success according to a research report published by the Association of Researchers in Construction Management (Takim and Akintoye 2002). However, this thesis also contains data from in-progress projects. Success for an in-progress project closely follows the definition for a finished project and is defined as currently on time and to budget. The projects included in this study have a quality design document review process, defined scope, experienced contractors, and use the traditional Design-Bid-Build delivery process.

The two focal projects of this research are the Marquette Interchange and the I-94 N-S Freeway reconstruction, both in southeastern Wisconsin. The Marquette Interchange data set consisted of four contracts: North Leg, West Leg, South Leg, and Core. The Marquette Interchange had an estimated total cost of $810 million dollars with a schedule completion in November 2008. The awarded construction contracts totaled $493 million dollars of the $810 million dollars for the Marquette Interchange. It was completed ahead of schedule in August 2008 and $10 million dollars under budget (Held 2008). The second focal project was the I-94 N-S Freeway reconstruction. A targeted sample of 14 contracts was selected from the I-94 N-S Freeway project based on availability of the data. Thirteen of the 14 contracts are on average 99-percent complete and the fourteenth project was at 14-percent completed at the time of this thesis write-up. The I-94 N-S project has an estimated total cost of $1.91 billion dollars and a scheduled completion in late 2016. The data set of 14 contracts in this thesis has an awarded construction contract value of $364.4 million dollars as of March 7, 2011.

The Marquette Interchange and the I-94 N-S projects will be compared with a third project, the I-580 Freeway Extension project in western Nevada, to compare and contrast the WisDOT projects with an outside SHA's project. The I-580 project is an 8.5 mile, 6-lane freeway extension that is expected to be completed in late 2011 at an estimated construction cost of $393.4 million dollars. At the time of this thesis write-up, the I-580 Freeway project is 75-percent complete.

1.5 RESEARCH METHODOLOGY

The research methodology is based on gathering major highway project construction data from the Marquette Interchange and I-94 N-S Freeway reconstruction to achieve the three objectives of this study. The methods are summarized in Figure 1, which outlines research events to help ensure the completion of the research objectives. This section describes the general methods utilized to meet the objectives.

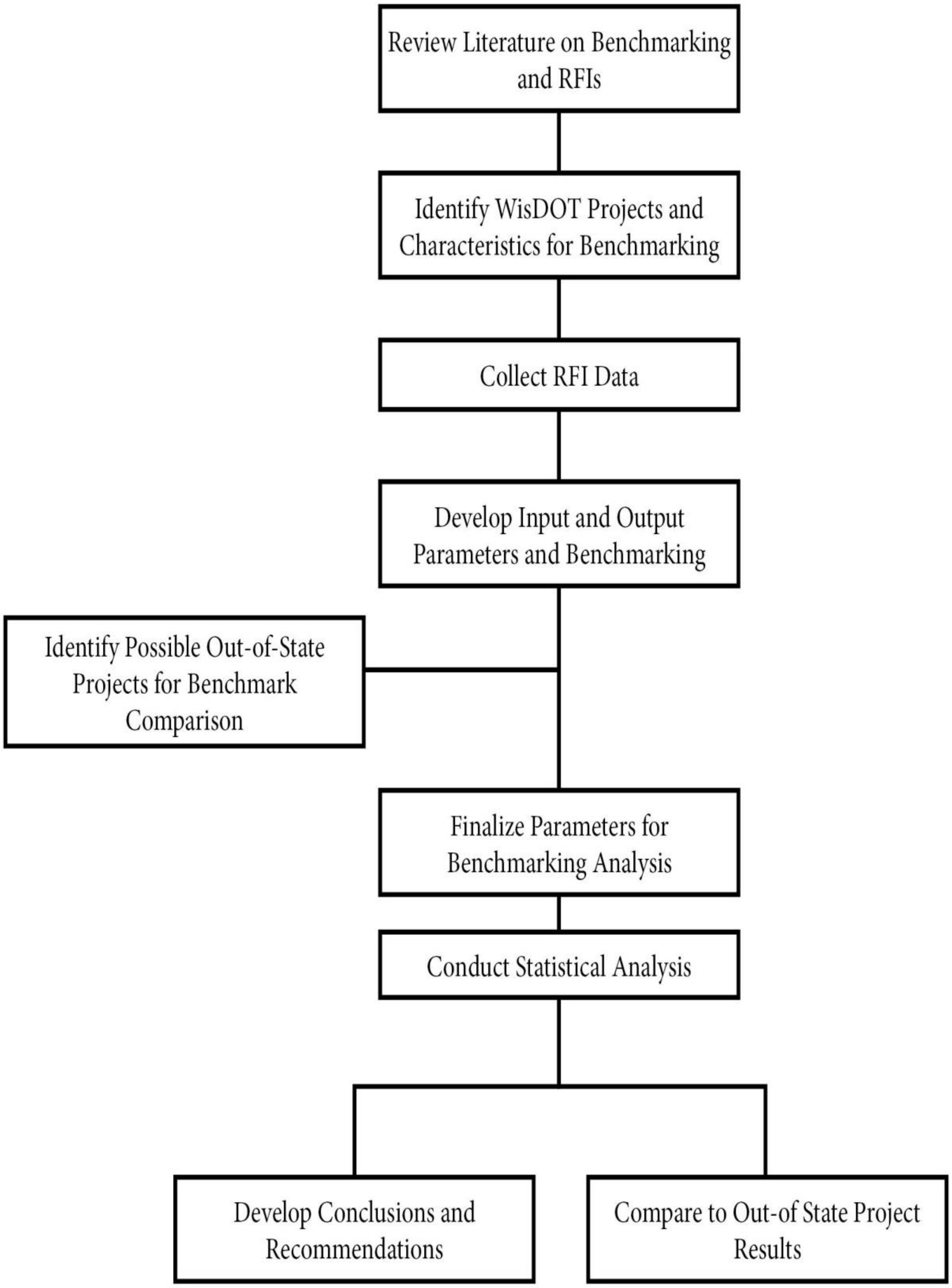


Figure 1 Research Methodology

Initially, the RFI process was determined as an excellent source of quantitative benchmarks and metrics for major highway projects. At the time of writing, there were no known benchmarks or attempts of measuring the RFI process for highway construction. The research team identified several possible project benchmarking and metrics opportunities. Those benchmark opportunities included the number of RFIs per million dollars, the processing time per RFI, and the reasons for RFI submittal.

A survey was then conducted to determine which SHAs employ an RFI process and their current level of standardization. This was necessary because the research team desired to eventually collect data from many major highway projects across the United States that implement an RFI process. Furthermore, the research team would like to understand what is needed to further implement the RFI process and provide recommendations.

To implement the RFI process effectively and efficiently, the research team decided to formulate a new classification process. The original classification process created by WisDOT is not adequate due to lack of specificity, and due to difficulties in deriving meaningful conclusions. The new classification process involved utilizing some current WisDOT definitions while also creating new, more effective reason codes for submittal. The new classification process focused on maximizing the potential future benefits of tracking and recording RFIs.

All documentation for the RFI process including *Multi-Project Request and Answer Reports*, *Contract Modification Logs*, and several other reports were collected for the Marquette Interchange and I-94 N-S Freeway reconstruction projects. Each log was carefully scrutinized and all necessary information was entered into a customized Excel spreadsheet. The individual RFIs entered into the spreadsheet were classified using the new classification process developed by the research team. Throughout the classification of the RFIs, the process was continually evaluated to improve its effectiveness.

The subsequent step in the research team's methodology involved analyzing the RFI spreadsheet data to create benchmarks and metrics. Statistical analyses were performed in order to create the most robust benchmarks for major highway projects. A comparative statistical analysis approach was used involving two methods: 1) weighted average and 2) Bootstrap, which is a computer intensive sampling procedure. Most of the results from the Bootstrap method were displayed in a box-and-whisker diagram, also known as box plots, which portray the range and the quartiles of the data. Then based on the statistical analyses, conclusions about the timing of RFI submittal, reasons for submittal, and multiple performance measures were derived.

RFI data was also solicited from outside SHAs to compare with the WisDOT projects' final conclusions. The Nevada Department of Transportation (NDOT) allowed the research team access into their project data for the I-580 extension project. The RFIs were classified using the new classification process. Data from the I-580 project was also analyzed in an identical manner to compare with the WisDOT results. However, due to limitations in the data collection from NDOT, not all conclusions could be compared. Of the six performance measures only three could be compared because the NDOT RFI form did not have a specified RFI response time, and the research team did not have access to their payment schedule or contract modification log.

Lastly, a list of recommendations and best practices for the RFI process were determined by the research team to be utilized by SHAs and contractors. The best practices provide guidance on how to most effectively use an RFI process in construction management. As part of the best practices for the RFI process, an updated standardized RFI form was created to implement the restructured classification process as well as to provide an effective form for SHAs that are just starting the implementation of an RFI process. The recommendations created by the research team are offered to supplement the identified best practices for successful implementation of an RFI process.

1.6 REVIEW

To best understand the performance of a major highway project, it needs to be compared to other successful projects. Prior WisDOT successful major highway projects can provide performance measures to improve the understanding of the performance of current major highway projects. In order to create new RFI benchmarks and metrics for major highway projects, this investigation was conducted using the methodologies described above. By reviewing current literature, meeting with experts, conducting a survey, and collecting construction data, this thesis leads to a series of conclusions that will assist State Highway Agencies in measuring the performance of their major highway projects.

The organization of this thesis parallels the research methodology of the study. Chapter 2 summarizes a wide, yet detailed collection of information from the literature review. Chapter 3 discusses the short survey and presents the results and foundation for the data analysis. Chapter 4 summarizes the data set of the major highway contracts and presents the results of the classification process. Chapter 5 presents the new benchmarks and metrics, also providing descriptive best practices with recommendations based on the conclusions of the research.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The literature review is divided into three sections to comprehensively discuss previous publications and research. The first section provides a background on performance measures which are the precursors to benchmarking in the construction industry. The second section discusses the application of benchmarks in construction. The final section is devoted to defining and describing the current Wisconsin Department of Transportation RFI process for highway construction.

2.2 PERFORMANCE MEASURES

An understanding of the literature on performance measures provides the framework for the current efforts in benchmarking for construction. Performance measures are represented by both quantitative and qualitative indicators, and are created in order to aid in the prediction of success. One method to measure performance is to use Key Performance Indicators (KPI). KPIs are data measures used to evaluate the performance of construction operations (Cox et al. 2003). Defining KPIs is fundamental for the success of benchmarking, thus KPIs must be defined precisely in terms that are consistent with normal ways of working in the industry (Bakens 2005, Cox et al. 2003). Only data which directly predicts performance for the task needs to be gathered and measured. Furthermore, performance measures must be directly tied to a transportation project's objectives in order to be effective because performance measures are used to determine whether the goals are met (Lai 2008).

To best evaluate the performance of a process, the actual and estimated performance needs to be compared.

Cox et al. (2003) maintains that the appropriate KPIs must be determined to assess their ability to measure performance or calculate effects of a change on a construction process. Here, Cox mentions that performance indicators can be defined by quantitative results of a construction process, i.e. $ per unit, which supports the units derived for this thesis. The purpose of Cox's research is to determine which quantitative units of measurement are perceived to be the most effective in the construction industry. The exact units of measurement are not important for this research because the units are for common KPIs, not specific construction processes. However, the concept of the most effective ratios such as units per man-hour or dollars per unit provides valuable insight into the perceived effectiveness of a performance indicator for the RFI research.

Cox suggests that the key indicators must be determined and monitored before an accurate analysis of construction performance can truly be attained. Another author, Louis Alfed (1988), further comments that in order to actually measure future performance against past performance, a baseline from past performances must be determined, i.e. a benchmark, to give a reference point. An indication of variance in performance could be determined if there are any variations from the created baseline or expected performance level. Variances can be either positive or negative (Cox et al. 2003). Cox and Alfed provide a general discussion on KPIs, as well as a comprehensive background on the importance of measuring current performance against historical data. These comparisons help to achieve an overall sense for the effectiveness of a general process.

Additionally, Costa et al. introduces two types of performance measures: lagging and leading. Lagging indicators are used to assess the achievement of a company's strategic objectives, while leading indicators help anticipate future results (Costa et al. 2006). Costa feels that both types of performance measures need to be utilized to create benchmarks. Also, understanding the translation of practices and measures from practical knowledge is important to understand, thereby identifying superior performance when creating benchmarks (Costa et al. 2006). Costa concluded that the most common performance measures considered in the construction industry are total project cost, cost deviation, and total project duration. He recommended that new performance measures be devised in order to better explain the performance of a variety of operations and processes. This recommendation reinforces the objectives of this research of developing new performance measures within construction processes, such as RFIs.

According to the "International Review of Benchmarking in Construction" from 2005, the performance indicators utilized in benchmarking systems must be: 1) accepted by stakeholders as meaningful and relevant measures of performance, 2) readily comprehended by users, and 3) based on reliable data and analyses (Bakens 2005). These requirements are necessary in order for performance indicators to be useful and reliable tools in the improvement of construction performance.

The report completed by the Construction Task Force, "Rethinking Construction," details the scope for improving the quality and efficiency of UK construction (Eagon 1998). The report highlights the essential requirements to deliver construction improvements: 1) ambitious targets and 2) effective measurement of performance. The report proposed a series of general targets for annual improvement and recommendations for more extensive use of performance data by the construction industry. According to this report, it is imperative that the construction industry put in place clear, measurable objectives to improve the quality and efficiency of construction processes.

To meet the Construction Task Force's objective, quantified targets, milestones, and performance indicators were established (Eagon 1998). A further analysis was required to interpret the previously derived KPIs that would lead to regular monitoring of progress towards them. This is the essential step in order to begin the development of benchmarks. Furthermore, the construction industry must have a means of measuring progress of its objectives and targets in order to create the measurable objectives. For example, measuring progress can be the maintaining of project documentation logs that are continually processed. This report concluded that the creation and implementation of structured performance measures allowed the construction industry to differentiate between the best performers and the rest. This differentiation allowed for the delivery of continuous improvements within construction processes (Eagon 1998).

Next, the KPI Working Group from the UK took the "Rethinking Construction" report and created a comprehensive framework which construction companies can use to measure their performance against the others in the industry. The KPI Working Group created a report in 2000 highlighting seven main groups of KPIs, of which two, Time and Cost, are relative to this research (Raynsford 2000). Each main group was given several indicators to measure the performance towards established best practices, thus creating benchmarks. The data used to estimate the indicators compared predicted times and cost versus actual times and costs, respectively. The KPI Working Group report explained a variety of indicators and provided the necessary guidance on how to use the indicators effectively towards implementing an outline of benchmarks.

Takim and Akintoye (2002) also discussed Key Performance Indicators in their research. They further discussed performance measurements and their relation to KPIs. According to these authors, the purpose of performance measures is to predict success. However, an individual performance measurement cannot solely predict success, but a collection of parameters can provide different perspectives and help improve their overall legitimacy. The overall objective of benchmarking is to identify an external standard by which an activity can be measured by understanding the relevant existing processes and activities. In summary, a benchmark is the best performance achieved in practice (Takim and Akintoye 2002). Thus, studying the RFI process is a beginning step of measuring performance to predict success for major highway projects. Examining the RFI process involves exploring the potential of establishing benchmarks for successful projects using an RFI process for the delivery of transportation infrastructure.

2.3 APPLICATION OF BENCHMARKING

Benchmarking is recognized as a leading best practice for improving project practices. The Construction Industry Institute, which recognizes benchmarking as one of the top eleven best practices for improving project performance, defined benchmarking as "a systematic process of measuring an organization's performance against recognized leaders for the purpose of determining best practices that lead to superior performance when adopted and utilized. (CII 2006)" Furthermore, a scan team from the NCHRP Best Practices study found that developing targets using historical benchmarks is one of the most important lessons learned regarding performances measures, and can be attributed to overall success in project delivery (Warne et al. 2007). Benchmarking is a vital part of the construction industry's process of continuous improvement and involves the "indirect transfer of ideas from the 'best-in-class' organizations to those seeking to improve. (CII 2002)"

Benchmarking involves seeking performance measures that indicate excellence, and enable activities that have produced exceptional results. Furthermore, benchmarking allows the establishment of reasonable goals for development, and strategies to achieve those goals. It facilitates learning, and allows for the discovery of new insights. Benchmarking then can be translated into action in order to study the results and allow for the observation of the consequences maximizes the opportunities to continually improve the benchmark and measure its effectiveness (Watson 1993). Gregory Watson (1993), formerly of the benchmarking services at the American Productivity & Quality Center and former Vice-President for Quality at Xerox Corporation, utilized the general process model for benchmarking, which is found in Figure 2. In the creation of this thesis, the research team follows three of the four parts: planning the study, collecting data, and analyzing the data. The fourth step of adapting the results from the data analysis is further discussed in the Recommendation section in Chapter 5.

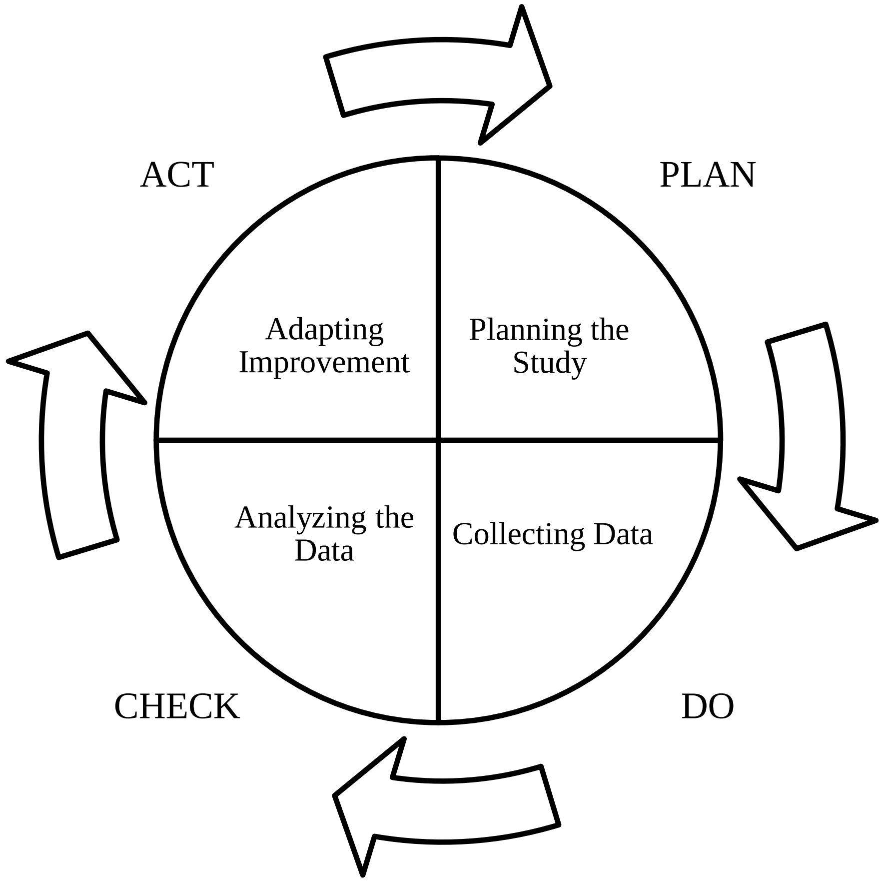


Figure 2 Benchmarking Process Model

The four steps include: 1) identify the performance measures, 2) identify the project's performance, 3) analyze the project's performance, and 4) measure the magnitude of improvement after implementation to recalibrate the benchmarks, if necessary (Watson 1993). Also, it is essential to validate the benchmarks in order for them to be used as effective tools for improvement (Rankin et al. 2008).

The leading organizations currently maintaining construction-related benchmarks aimed at performance improvement are discussed in the "International Review of Benchmarking in Construction" (Bakens 2005). The two focal organizations that are discussed are the CII in the United States and KPI in the UK. These organizations have created and defined performance measures, and developed commonly accepted standards of good performance. The general concepts of KPIs created in the UK construction industry were discussed in the previous section of this literature review and are not further discussed.

The CII is the premier source of construction benchmarking literature in the United States. In 2002, they produced a Benchmarking and Metrics Summary Report from a web-based system of data collection, performance reporting, and industry analysis. The objectives of the CII Benchmarking and Metrics System are: 1) to provide the construction industry with a common set of metric definitions, 2) provide project performance standards, and 3) measure the use of selected metrics and best practices (CII 2002). The target of the CII Benchmarking services is to provide construction companies with the tools to complete internal self-analyses of project performance and identify improvement opportunities by providing well-defined performance metrics (CII 2002).

The database for the CII Benchmarking Program included 1,037 projects with an approximate value of $54.2 billion dollars. The expertise of the researchers and the depth of the sample size are the strengths of the CII research. However, less than 2-percent of these project types are related to the highway construction industry. A majority of the project data is from industrial manufacturing facilities. Thus, generalizing the resulting statistics from the CII Benchmarking program may not be possible for the entire construction industry and would be difficult to draw conclusions about highway projects due to the small sample size.

The CII's Benchmarking and Metrics Summary Report provides common performance metrics for cost, schedule, safety, change management, and rework based on four levels of project size in terms of contract dollars; however, this report did not include RFIs as a performance metric. The mean and median performance standards were provided to aid in measuring individual project performance against CII's data, which was collected via web-based questionnaire. The CII assessed the level of implementation of these performance metrics for feedback and quantified practice impacts on project performance. In conclusion, the CII Benchmarking and Metrics Report provided several broad benchmarks for the overall construction industry. The reporting method is very useful; however, the results are not specific to the highway construction industry. Furthermore, no benchmarks discussed any elements of the contract administration process.

The only known benchmark for the RFI process was discovered in a case study for the Wisconsin Institutes for Discovery (WID) on the University of Wisconsin – Madison campus from a presentation on Integrated Project Delivery (IPD) given at the 2010 Zurich Contractor summit (Mortenson 2010). WID is a $213 million dollar research facility focusing on enhancing human health and welfare. It has approximately 300,000 square feet divided among four vertical levels. According to the presentation, one step of achieving the maximum potential of IPD was establishing baseline, or target, metrics. The WID project had a baseline metric created for project management of less than 500 RFIs for the entire project. With an estimated construction cost of $150 million dollars (NEWS 2010), a target of 3.3 RFIs per million dollars of awarded contract was calculated by the research team.

2.4 REQUEST FOR INFORMATION

The Request for Information process was detailed by the Wisconsin Department of Transportation for the administration of construction contracts. The RFI process is outlined in the Project Relationships and Communication section of the Construction and Materials

Manual (CMM). Furthermore, a provision for including RFIs in highway contracts is described in the WisDOT Standard Specifications (SS).

The WisDOT CMM (2010) clearly identifies the purpose, submittal, response, administration, and resolution processes for RFIs. According to the CMM (2010), the purpose of an RFI is to identify and resolve issues arising in the field that require resolution to avoid potential contract disputes and claims issues. The CMM further states that RFIs are used to provide a systematic collection of the analysis and resolution of questions that arise before and during the construction of a highway project.

The contractor initiates the submittal of an RFI using the SHA standardized form; however, either the contractor or SHA can submit an RFI for clarification of an issue (CMM 2010). However, questions that can be answered through research and clarification before construction begins need to be done so and followed up with a record of the conversation. The CMM states that appropriate references to the specification, plans, and drawings for which clarification or change is needed, need to be attached to facilitate a timely response to the RFI. Hanna (2010) further adds that RFIs that allow for a simple “yes” or “no” answer need to be avoided. Essentially, RFIs are not to be used for minor questions because the procedure needs to focus on significant items that could impact the schedule or budget. These minor questions can be properly and more quickly answered through other means of communication such as telephones and electronic mail.

The response to an RFI needs to be provided on a timely basis so as to not impact the construction schedule (CMM 2010). According to the CMM, the engineer is responsible to monitor, track, and expedite the response of an RFI. The CMM further stresses that RFIs are time-sensitive, and that the responding party needs to make a significant effort to produce a response on a timely basis. In summary, responses to RFIs do not relieve the contractors from their responsibility to construct the projects according to the plans and specifications (I-94 Construction Management Plan 2010).

The administration process for RFIs is also completed by the engineer (CMM 2010). The engineer is responsible for sequentially numbering the RFIs as well as maintaining an RFI Log. Furthermore, the engineer needs to manage the response to submitted RFIs by consulting with other construction team members, i.e. project manager, designer, technical experts, to facilitate a timely response. According to the CMM, the engineer maintains a RFI Log to track the status of an RFI as well as catalog all of the RFIs submitted on a project. Whited (2009) states that in order to provide a systematic collection of the analysis and resolution of RFIs for a highway project, RFIs need to be gathered in a single location.

Lastly, the CMM (2010) describes the resolution of RFIs. According to the CMM, project progress meetings need to have agenda items discussing outstanding RFIs and potential RFIs to ensure that all RFIs are appropriate and to control the number of RFIs. Furthermore, the CMM (2010) states that any disagreements about the response to an RFI need to involve the project manager to quickly bring the RFI to resolution.

The WisDOT SS of 2011 briefly outlines the requirements of the RFI provisions for highway construction contracts. The specification details that each RFI must: 1) be of reasonable scope, 2) explain why a response is necessary to fulfill contract obligations, and 3) provide a requested response time. However, this outline is not expanded upon, requiring some interpretation by the parties of the contract. According to Whited (2009), the desired response time needs to be realistic and needs to indicate the necessity of the answer. Lastly, the SS (2011) briefly mentioned the method to submit and respond to RFIs, which could be done via email or hard copy with the response coming within the requested response time. In conclusion, the SS defines the contractor and department responsibilities of submitting and answering RFIs within the contract documents.

2.5 SUMMARY

The literature review revealed that there is a solid foundation for the creation of performance metrics at the general project level. The resources discussed throughout the literature review documented common performance measures for the construction industry based on typical construction processes, such as time, cost, safety, and quality. While these performance measures are useful, the construction industry needs more detailed evaluations of processes that are key best practices in order to continually improve.

There are no studies completed on the quantitative evaluation of the Request for Information process for highway construction. Even though the procedure for using RFIs has been well documented by WisDOT, there are currently no available benchmarks or metrics identified as performance measures for use within the RFI process for major highway projects. This study, detailed in the following chapters, was tailored to satisfy the industry need for a quantitative assessment and thorough examination of the RFI process for major highway projects.

CHAPTER 3

REQUEST FOR INFORMATION SURVEY

3.1 INTRODUCTION

The utilization of an RFI process is commonplace in vertical construction, and is considered an essential tool for the communication between the contractor, construction project manager, and designer. However, the use of RFIs in highway construction is just beginning to gain acceptance. A survey was conducted to understand the current usage and basic practices of the RFI process within State Highway Agencies (SHA) across the United States.

3.2 METHODOLOGY

The survey was created to determine which SHAs use an RFI process. The American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Construction state members were selected as the target group for this survey. The AASHTO Subcommittee on Construction was selected for their knowledge and expertise about their respective SHA programs and common practices.

A five question survey was created to gather information on the use of RFIs by SHAs. With the assistance of the WisDOT Project Services Chief, each AASHTO Subcommittee on Construction state member was sent an electronic form with the following questions:

1) Does the SHA use RFIs in the administration of construction contracts, and if yes;

2) Are RFIs used on all projects or just select projects;

3) Are RFIs required by contract or policy;

4) Does the SHA use a standardized RFI form;

5) Who would be a good contact should we need to follow-up for more information?

3.3 CHARACTERISTICS OF SURVEY RESULTS

The survey was conducted in the spring of 2010. Twenty-three of 50 states responded to the survey. Those states that responded are shown below in Figure 3.

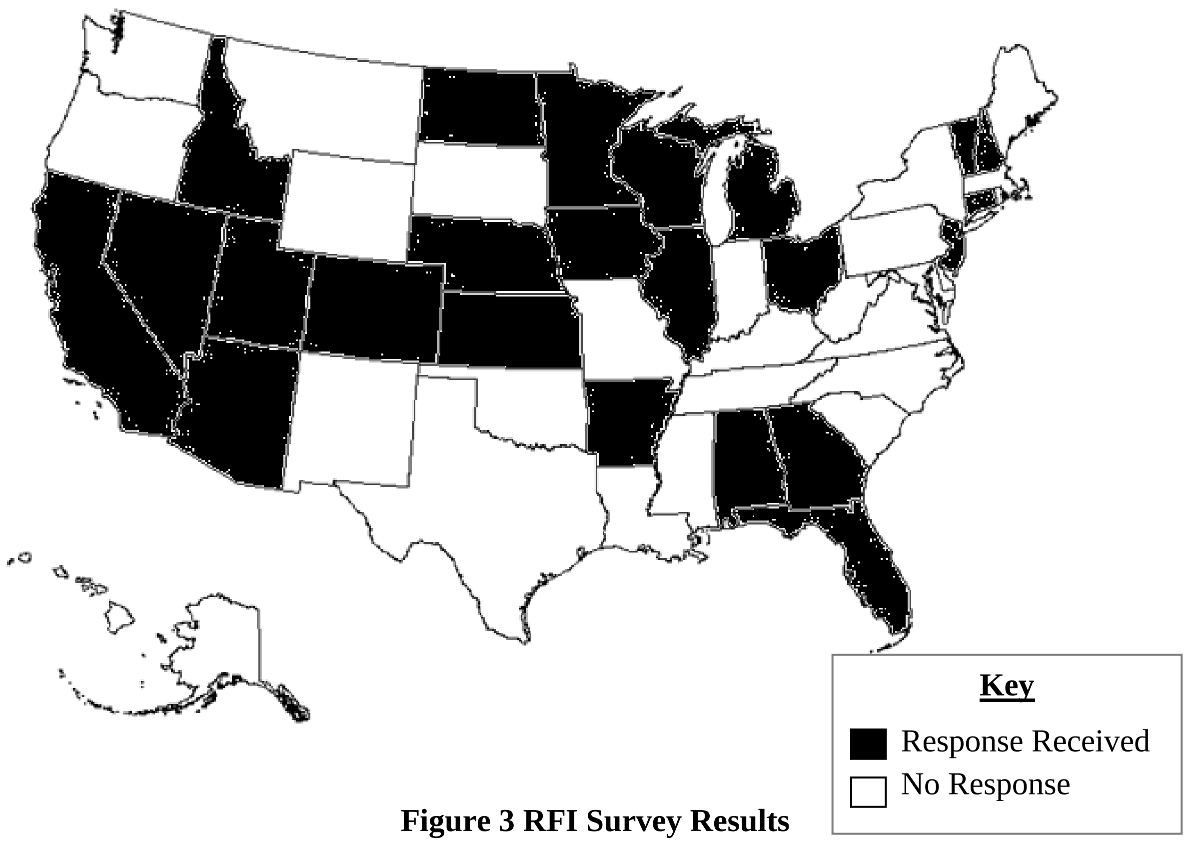


Figure 3 RFI Survey Results

Nine of the 23 states responding to the survey said they use an RFI process for the administration of construction contracts. Responses from those nine states are summarized below in Table 1.

Table 1 Survey Results for SHAs that Use RFIs

State	Type of Projects that RFIs are Used	Use of RFIs Required	Standardized RFI Form/Process
Connecticut	All	No	No
Florida	All	Policy	No
Illinois	All	No	No
Michigan	Complex/Unusual	No	No
Minnesota	Design-Build	No	No
Nevada	All	Policy	No
New Jersey	All	No	No
Utah	Design-Build	Contract	No
Wisconsin	All	Contract	Yes

From the nine states reporting the usage of RFIs and the 23 responses received, the following statistics were calculated. Twenty six percent of states use RFIs on the delivery of all projects. However, less than 13-percent of states have some written level of requirement to implement the RFI process, and less than 5-percent of states maintain a standardized form or process. All nine states that reported the usage of RFIs provided the contact information for an experienced individual to further inquire about RFIs. Project information was solicited from these references to develop a comparison to the research results.

3.4 SUMMARY

The survey provided workable results that gave an understanding of current RFI usage across the SHAs. It was determine that the RFI process is fairly new within SHAs. Future SHAs looking to utilize RFIs would greatly benefit from a variety of implementation tools such as a standardized form, best practices, and benchmarks to measure their process's performance against successfully implemented RFI processes.

CHAPTER 4

DATA ANALYSIS

4.1 INTRODUCTION

Employing an RFI process is beneficial because RFIs provide an orderly, reliable, and documented mechanism to resolve legitimate plan, specification, special provision, or other contract document questions. The response from the design engineer or SHA representative can provide valuable guidance and can result in clarification or supplemental instruction. RFIs provide a systematic collection of the questions and answers before and during a highway construction project which can be later analyzed. The CMSC team and WisDOT determined that it would be beneficial to have benchmarks and metrics to measure the performance of the RFI procedure. These performance measures would assist WisDOT in implementing an RFI system on major highway projects or improve an existing system, and set staffing levels to handle RFIs. This chapter details the basis of the principal research in obtaining and interpreting RFI Logs and Reports, and effectively utilizing the data to develop logical and significant performance measurements.

4.2 METHODOLOGY

Research began with determining the benchmarks and metrics that would potentially be derived from the Marquette Interchange and I-94 North-South Freeway projects. The research team originally decided to explore the following benchmarks and metrics:

Benchmarks

- **RFIs per Million Dollars of Awarded Contract.** Calculate a simple number for SHAs to use as a starting point for the expected number of RFIs for a major highway project.
- **Percent of RFIs Answered By Request Date.** Determine the quantity of RFIs answered on time (by the request date on the RFI form).

Metrics

- **Average Response Time.** Measure the response time of the RFIs for a major highway project by subtracting the respective RFI submittal date from the respective RFI answer date. An average of these response times is then calculated to produce this metric.
- **Percent of Unjustified RFIs.** Determine the quantity of unjustified RFIs submitted.

This list of possible benchmarks and metrics could potentially expand if additional meaningful conclusions can be drawn that add merit to the quality of the research and have a likely benefit to the WisDOT program.

The next step was to obtain the *Multi-Project Request and Answer Reports, Change Management Logs*, *Multi-Project Issue Report,* and *Construction Contract Payment Schedules* from the Marquette Interchange and I-94 North-South Freeway projects. An example of each Log or Report can be found in Appendix A. The *Multi-Project Request and Answer Reports* were the main source of RFI information for this thesis. The *Multi-Project*

Request and Answer Reports provided the detailed request, engineer's or SHA representative's answer, submittal dates, answer dates, and request dates. The *Change Management Logs* contained each contract modification, tracking number, and the respective cost implications, as well as contract cost summary data. The *Multi-Project Issue Report* contained construction issue notes with the dates of every action completed for the respective issue. Many of these issues were resolved before being recorded as a formal RFI. The *Multi-Project Issue Report* was used to assist in tracking an RFI from the *Multi-Project Request and Answer Reports* into the *Change Management Logs*. Lastly, the *Construction Contract Payment Schedules* listed each payment amount and date for every contract.

The 18 individual construction contracts from the two projects were combined to create a database of major highway projects. After the logs for the projects were examined, a list of inputs necessary to derive the benchmarks was created. This list was carefully crafted as the quality of any benchmark depends on the type of inputs (Shrestha et al. 2007). Next, the inputs were entered into separate Excel spreadsheets to properly organize the data and allow for future analyses. Inputs required for the creation of these benchmarks and metrics are listed below.

Inputs

1. Project
    a. Notice to Proceed date
    b. Awarded contract amount ($)
2. Multi-Project Request and Answer Report
    a. Quantity of RFIs

   b. Tracking number
   c. Issue (Division)
   d. Date submitted
   e. Date responded
   f. Date required
   g. Written request for information
   h. Written answer in response to request

3. Contract Modification Log
   a. RFI tracking number
   b. Contract modification
   c. Cost impact

4. Construction Contract Payment Schedules
   a. Payment request date
   b. Payment amount

The typical outputs from the Excel spreadsheets are listed below.

Outputs

1. Project
   a. RFI Processing time (calendar days)
   b. Requested response time (calendar days)

2. Description
   a. Division

b. Reason Code

The RFIs were classified by WisDOT using 10 division codes (also known as "Issues") and seven reason codes. The 10 divisions or general areas of construction, previously created by WisDOT are found below in Table 2. The definitions were created by the CMSC research team.

Table 2 WisDOT Division Descriptions

Division		**Description**
Bridge	*BR*	Approach slabs and bridges: abutments, piers, decks, wing walls parapets
Demo/Removal	*DM*	Demolition or removal of any highway construction
Earthwork	*EW*	Excavation, soils, or other earthwork-related items
General/Admin.	*GN*	Other category: material testing, construction documents, and general communications
Roadway	*RD*	Physical road and surrounding items: fence, barricades, shoulders
Sign Structure	*SS*	Message boards, road signs, and related structures.

Traffic	*TR*	Design of traffic flow and patterns.
Utilities – G/E	*DU*	Dry utilities: gas and electric.
Utilities – W	*WU*	Wet utilities: storm sewer, water, and sanitary sewer.
Wall	*WL*	Retaining and noise walls.

Not all of the submitted RFIs were identified with the appropriate Division code in the *Multi-Project Request and Answer Report*. In fact, 20-percent of the Marquette Interchange's RFIs and 67-percent of the I-94 North-South's RFIs had unlabeled Division codes. The Divisions for the unlabeled RFIs were classified by the research team based on the descriptions provided in the RFI and through comparing the descriptions with those RFIs with labeled Divisions. If necessary, the *Multi-Project Issue Report's* construction notes were used to complement the RFI descriptions.

The seven reason codes used by WisDOT to classify RFIs are provided in Table 3. The definitions are from the WisDOT Construction Management Manual published in 2010 (CMM 2010).

Table 3 WisDOT Reason Code Definitions (CMM 2010)

Reason Code		**Description**
Cost Reduction	*CR*	Items to compensate the contractor for cost saving proposals
Miscellaneous	*MI*	Items not covered by other codes
Plan Change	*PC*	Addition/deletion of items not originally contemplated or a changed condition not known during design but determined to be a necessary or advisable to construct the project
Plan Inadequacy	*PI*	Addition/deletion of items that are required to build the project, but were not included or portrayed inaccurately
Request by Others	*RO*	Post-let items of work added by request from others
Safety Enhancement	*SE*	Addition to contract to safely construct the project
Change/Credit Standards & Specs	*SS*	Items modified in original contract due to negotiation of change or acceptance items of substandard or different specifications

Most RFIs were not classified with a reason code. The only RFIs that were classified were those that resulted in a Contract Modification, and these RFIs were often grouped into single reason codes. The reason for this lack of information can be speculated as it was not standard practice to classify RFIs, the definitions are too broad and thus inadequately describe actual construction issues, or using the seven reason codes was not enforced due to a lack of foreseeable advantages.

After reviewing the RFI logs, the RFIs were tracked from the *Multi-Project Request and Answer Report* into the *Contract Modification Log*. The Division (Issue) code, along with the tracking number assigned to the RFI, had to be followed from the *Multi-Project Request and Answer Report* into the *Contract Modification Log*. This tracking process allowed the determination of a contract modification due to an RFI and the associated cost impact. The documents did not allow the determination of schedule impacts. Many RFIs that originally had a Division code in the *Multi-Project Request and Answer Report* became contract modifications. However, some contracts' request and answer reports had no RFIs with labeled Divisions, making it impossible to track contract modifications recorded in the *Contract Modification Log*. This inability to track RFIs between the *Multi-Project Request and Answer Report* and the *Contract Modification Log* forced the research team to only consider contracts whose RFIs had Division codes in the *Multi-Project Request and Answer Reports*. Thus, only contracts in which tracking RFIs between reports was possible were used to calculate the percent of RFIs that became contract modifications.

In order to create the benchmarks, the data needed to be reclassified. A simple three-step classification process was created to organize the WisDOT RFIs. The goal of this reclassification process was to make it applicable to any major highway project. The research team decided on the following reclassification method after a careful evaluation of current WisDOT forms and processes:

1. Division code. (General area of construction.)
2. Reason code. (Purpose of submittal.)
3. Justified. (Appropriate to be submitted.)

Each RFI was individually read and evaluated, and the necessary codes were entered into the new Excel spreadsheets created by the research team. The ideal RFI has a single question and a single answer (Hanna 2010); however, some RFIs submitted contained multiple questions. If an RFI contained multiple questions, the most dominant question or theme was classified to maintain an accurate reflection of the typical divisions or reason codes. The classification method and codes are described in detail in the Contract Results because the system is most easily understood when applied to the projects.

The individual contract results were then combined into a single data set to formulate the new benchmarks and metrics, and compared using two statistical methods. The first method used was calculating weighted averages of the benchmarks and metrics previously listed from each contract. To calculate the average of the 18 contracts, the individual numbers were weighted by their awarded contract dollar amount. The weight was applied because a benchmark calculation from a $400,000 dollar contract with one RFI does not have the same weight as the same benchmark from a $314 million dollar contract with 626 RFIs because the performance measures from the largest contracts have the most weight due to their awarded contract dollar amount. As an example, the work below shows the calculations for the percent of RFIs answered by the request date:

$$\text{Percent of RFIs Answered by the Request Date} := \frac{R_1 \times \$_1 + R_2 \times \$_2 + \cdots + R_n \times \$_n}{\sum_{n=1}^{i} \$}$$

R_i = Percent of RFIs answered by the request date for contract i
$\$_i$ = Contract award amount of contract i
$\sum_{n=1}^{i} \$$ = Sum of all contract award amounts

This same weighted average process was used to calculate all of the benchmarks and metrics.

The second statistical method used was Bootstrapping. The Bootstrap method is a computer-intensive procedure used to make inferences about the distribution of a general population by taking new samples randomly and repeatedly from the original data sample set (Whitlock and Schluter 2009). The original data set often has a small sample size and an unknown distribution. The advantages to the using the Bootstrap method include unbiased estimates, a reduction in the assumptions of the analysis, and the elimination of routine calculations involved with an accuracy assessment (Efron 1994). Furthermore, the Bootstrap method improves and reduces the variability within the data set; however, the Bootstrap method can be overly optimistic. The critical assumption for using the Bootstrap method is that the data set is a reasonable representation of the general population being considered. The WisDOT major highway project data are representative of the general population of major highway projects with respect to 1) sample size and 2) type of projects.

The steps used to complete a Bootstrap analysis for this thesis are as follows:

1. Take a random sample with replacement from the data set that has the same sample size and compute one of the six previously defined benchmarks.
    a. "Sample with replacement" indicates that each contract can be randomly chosen more than one time, or not chosen at all, within each sample.
2. Randomly resample 10,000 times and compute the benchmark for each new sample.
3. Derive the Bootstrap distribution of the benchmark from the 10,000 samples.
4. Report the mean of the Bootstrap distribution as the benchmark.

5. Create a box-and-whisker plot to represent the Bootstrap distribution variation of the individual benchmark.

Ten thousand random samples with replacement of 18 were taken from the 18 contracts in the data set for each respective benchmark and metric. The new distribution can be understood as a large number of samples that the research team would potentially see if they were to take an extremely large sample of major highway projects.

The distributions of the Bootstrap analyses for each benchmark and metric are presented in box-and-whisker plots, similar to the benchmarks produced by the CII in 2002 for their Benchmarking and Metrics Summary Report. The box-and-whisker plots displaying the results from this thesis are found in Section 5.2. A sample box plot was adapted from research by Lilin Liang (2005) for this thesis and is found below in Figure 4 to provide an example of a typical box plot. Also, general explanations of the featured details on the box plot are given below.

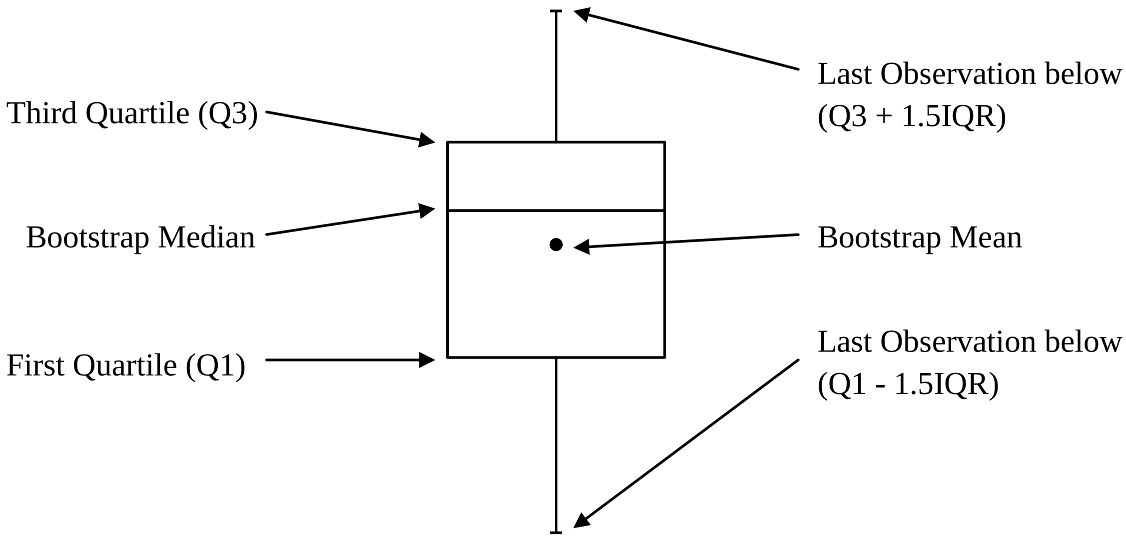


Figure 4 Sample Box and Whisker Plot (Box Plot)

The box consists of 50-percent of the Bootstrap data, from the first quartile (25th percentile) to the third quartile (75th percentile). This range between quartiles is also referred to as the interquartile range (IQR) (Whitlock and Schluter 2009). The horizontal line dividing the box is the median of the Bootstrap data, which is less sensitive to extreme scores. The mean is plotted as a point within the box. Plotting both the median and the mean offers an efficient way to indicate the central tendency of the benchmark. The whiskers extend outwards from the box, indicating the range of the data that is not considered an outlier, or extreme value (Whitlock and Schluter 2009). The end points of the whiskers represent the last data observation that falls within the 1.5 times the IQR limits. The whiskers and outliers are not shown in the final box plots for the results of this thesis because these observations and outliers are not beneficial to the implementation of the final benchmarks and metrics. Also, only plotting the 25th to 75th percentiles allows SHAs to focus on the data norms.

The value of the box plot of the Bootstrap data for each benchmark in this thesis is to represent the distribution of the 10,000 samples generated from the original data set. The most important result is the mean, which is the reported value for the benchmark. The median can also be considered to distinguish how the mean may be affected by extreme values in the data set. Furthermore, a smaller box, which represents a tight IQR, indicates less variation around the mean. This smaller box suggests a more robust benchmark, and implies that there is minimal variation within the original data set. The actual values and box plots for the benchmarks and metrics produced in this research are found in Section 5.2 of this thesis.

The complete description of the methods used throughout this research provides the necessary background information to understand the process of gathering and summarizing the Marquette Interchange and I-94 N-S Freeway contract data. The next section in this thesis describes the contract results from the Marquette Interchange and I-94 N-S Freeway projects from the RFI spreadsheets. These results are the individual contracts' benchmarks and metrics calculated to be further analyzed using the weighted average method and the Bootstrap method.

4.3 CONTRACT RESULTS

The data for the performance measures were derived from four Marquette Interchange contracts and 14 I-94 North-South Freeway contracts. This section discusses in detail the results from the four main contracts from the Marquette Interchange and the four largest contracts from the I-94 N-S project. These eight contracts were chosen because they have the largest effect on the data set, and they accurately describe the scope and the central features of the two projects. The results from the other 10 contracts for the I-94 N-S project can be found in Appendix B. In the final data analysis, all 18 contracts are considered according to their respective weight. Each of the eight contracts described below discusses typical characteristics about the contract and the respective RFIs including contract award amount, quantity of RFIs, and an investigation into the timing and patterns of the submitted RFIs.

4.3.1 MARQUETTE INTERCHANGE

The Marquette Interchange is at the intersections of Interstate-94, Interstate-43, and Interstate-794 in downtown Milwaukee, WI. The new interchange was built to higher safety and traffic standards than the original interchange that was constructed in 1963. It was the largest road construction project in Wisconsin when opened in August 2008 at a cost of $810 million dollars (AASHTO 2010). The Marquette Interchange had five main contracts, four of which are discussed below. The average awarded contract value for the four main contracts was over $123 million dollars. It is important to note that the one additional contract for the Marquette Interchange titled “Clybourn Street” was a utility relocation project and the first contract let on the project. The RFI process was not yet fully utilized on the Clybourn Street contract, resulting in incomplete data; therefore it was not considered in this research.

4.3.1.1 NORTH LEG

The North Leg for the Marquette Interchange involved total reconstruction of a small length of I-43 and the reconstruction of a side interchange (MI CMP 2005). It had an awarded contract value of $102,760,288 and was completed in December 2006. There were 153 RFIs submitted on this project, resulting in 1.5 RFIs per million dollars of awarded contract. Approximately 10-percent of the RFIs were submitted before the Notice to Proceed (NTP) of October 4, 2004. The average response time for a North Leg RFI was 5.2 calendar days. As a result, 80-percent of the RFIs were answered by the requested date specified on the RFI forms, which averaged 7.0 calendar days.

In addition to the number of RFIs, it is important to examine the relationship between the timing and number of the submitted RFIs. Figure 5 shows the number of RFIs submitted per month for the North Leg contract. The NTP date is represented by the thin, vertical line and marks the earliest date construction may begin. The last RFI was submitted in October 2006. Figure 5 shows over 26-percent of the RFIs are submitted by the third month of the contract with a peak monthly total near the NTP date. After the North Leg reaches its peak monthly total of RFIs in month three, the number of RFIs per month quickly declines as the contract proceeded. The purpose of this graph is to understand when RFIs are submitted and their pattern of submittal over time.

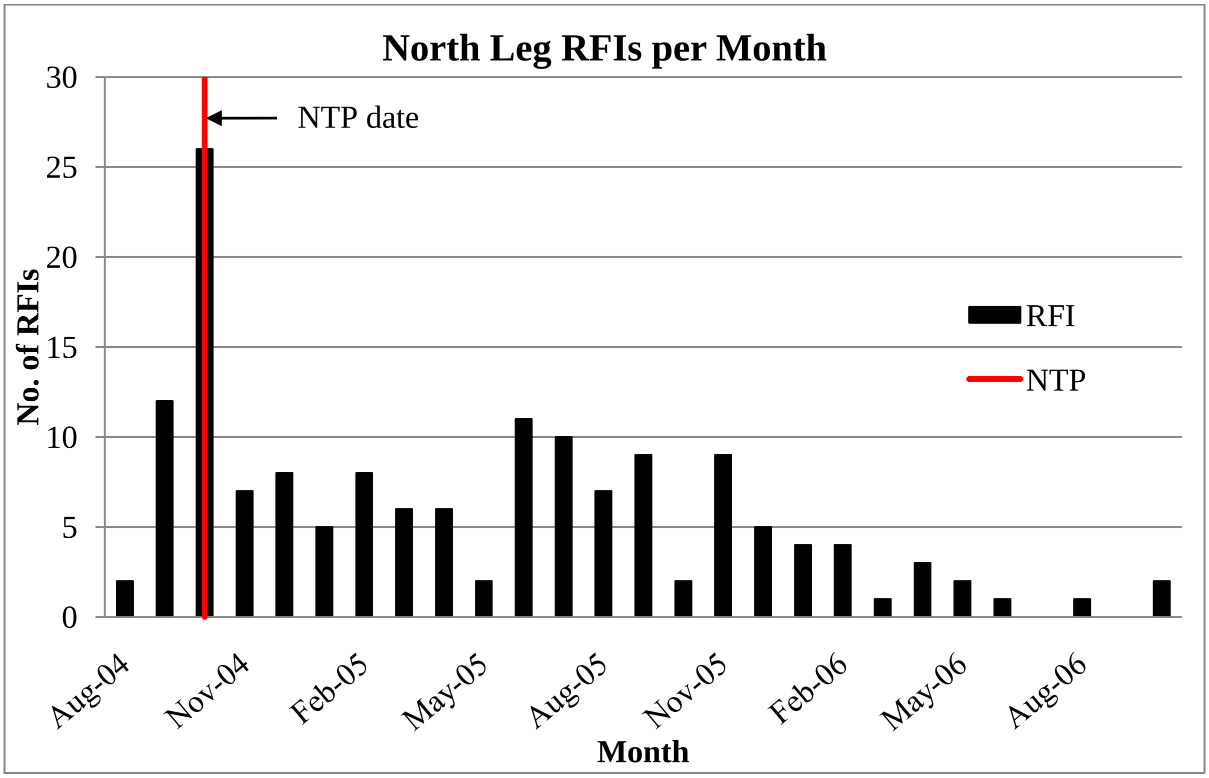


Figure 5 North Leg RFIs per Month

Table 4 relates the percent of total RFIs to the percent complete for the North Leg contract based upon the payment schedule. In order to produce this table, the number of RFIs submitted between every payment was calculated and summed in order to calculate the cumulative percent of RFIs. Also, the cumulative percent complete based on the dollar amounts from the payment schedule was calculated. Then, the cumulative percentage of the North Leg RFIs was compared against the percent complete of the payment schedule. A linear relationship was assumed between each point of the payment schedule to estimate the percent of RFIs at the specific intervals of 25-percent, 50-percent, and 75-percent complete.

Table 4 North Leg Percent of RFIs vs. Percent Complete Based on Payment Schedule

Percent Complete (Based on the Payment Schedule)	**Percent of Total RFIs**
NTP	10%
25%	55%
50%	73%
75%	94%
100%	100%

The NTP date denotes the percentage of North Leg RFIs submitted before construction began. The goal of Table 4 is to calculate the collective average percentage of RFIs for the entire data set at set intervals based on the percent complete from the payment schedule as benchmarks for the RFI process. However, only contracts that are 100-percent complete in the data set from the Marquette Interchange and I-94 N-S Freeway can be used because the total number of RFIs for the individual contracts needs to be known.

4.3.1.2 WEST LEG

The West Leg for the Marquette Interchange involves total reconstruction of parts of I-94, construction of entrance and exit ramps to westbound I-94, and reconstruction of a main roadway (MI CMP 2005). It had an awarded contract value of $30,555,660 and was completed in December 2006. There were 122 RFIs submitted on this project, resulting in 4.0 RFIs per million dollars of awarded contract. Approximately 23-percent of the RFIs were submitted before the NTP of January 25, 2005. The average response time for a West Leg RFI was 11.4 calendar days. Consequently, only 48-percent of the RFIs were answered by the requested date specified on the RFI forms, which averaged 8.3 calendar days.

Figure 6 shows the number of RFIs submitted per month for the West Leg contract. Again, the NTP is represented by the thin, vertical line which signifies the earliest date construction may begin. The pattern of submitted RFIs is very similar to the North Leg contract with the peak number of RFIs in month building up to the NTP, and an average decline in the ensuing months.

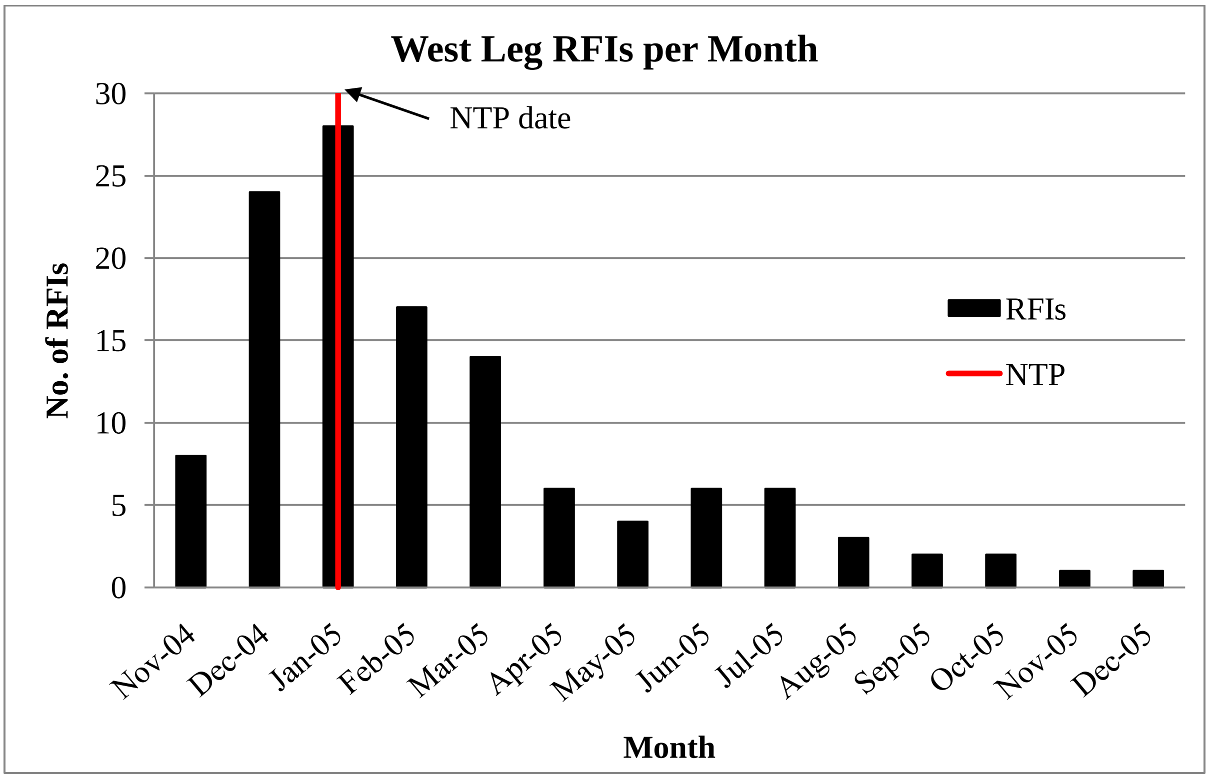


Figure 6 West Leg RFIs per Month

Table 5 relates the percent of total RFIs to the percent complete for the West Leg contract based on the payment schedule. This table was calculated in the same manner as the North Leg Percent of RFIs vs. Percent Complete based on the payment schedule table.

Table 5 West Leg Percent of RFIs vs. Percent Complete Based on Payment Schedule

Percent Complete (Based on the Payment Schedule)	**Percent of Total RFIs**
NTP	23%
25%	75%
50%	85%
75%	95%
100%	100%

4.3.1.3 SOUTH LEG

The South Leg for the Marquette Interchange involves constructing new bridges for interchange service ramps and bridge rehabilitation work. This contract had an awarded contract value of $44,826,419. There were 181 RFIs submitted on this project, resulting in 4.0 RFIs per million dollars of awarded contract. Less than 2-percent of the RFIs were submitted before the NTP of September 30, 2005. The average response time for a South Leg RFI was 5.6 calendar days. Consequently, 78-percent of the RFIs were answered by the requested date specified on the RFI forms, which averaged 7.1 calendar days.

Figure 7 show the number of RFIs submitted per month for the South Leg contract. The pattern of submitted RFIs is similar to the North Leg and West Leg contracts with the peak number of RFIs occurring in month three near the NTP, and an average decline in the following months.

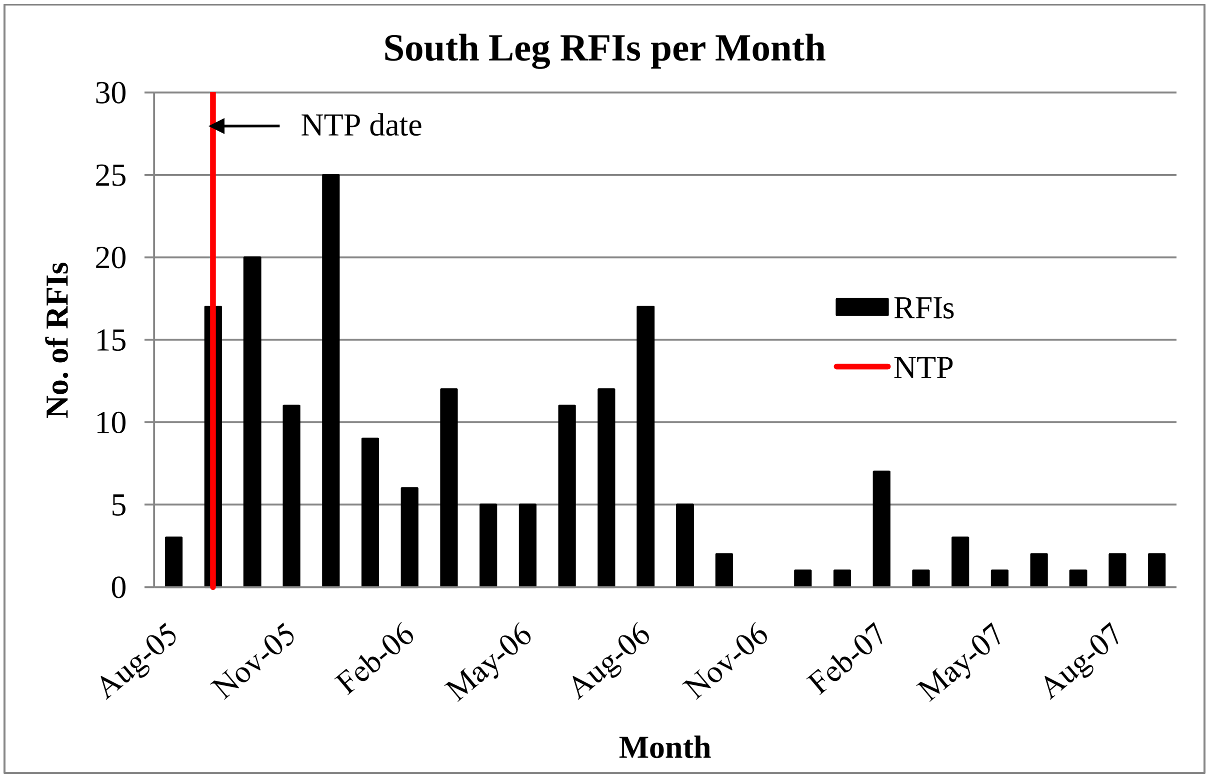


Figure 7 South Legs RFIs per Month

Table 6 relates the percent of total RFIs to the percent complete for the South Leg contract based on the payment schedule. This table was calculated in the same manner as the North Leg Percent of RFIs vs. Percent Complete based on the payment schedule table.

Table 6 South Leg Percent of RFIs vs. Percent Complete Based on Payment Schedule

Percent Complete (Based on the Payment Schedule)	**Percent of Total RFIs**
NTP	2%
25%	47%
50%	60%
75%	78%
100%	100%

4.3.1.4 CORE

The Core for the Marquette Interchange involves the total reconstruction of the ramps connecting I-43, I-94, and I-794, rebuilding of a section of interstate roadway, and the demolition and rebuilding of a major bridge (Marquette Interchange Construction Management Plan 2005). It was the largest contract in the Marquette Interchange project with an awarded contract value of $314,759,250. There were 626 RFIs submitted on this project, resulting in 2.0 RFIs per million dollars of awarded contract. Approximately 4-percent of the RFIs were submitted before the NTP of October 21, 2005. The average response time for a Core RFI was 6.1 calendar days. Accordingly, 71-percent of these RFIs were answered by the requested date specified on the RFI forms, which averaged 7.0 calendar days.

Figure 8 show the number of RFIs submitted per month for the Core contract. The last RFI was submitted in September 2008. The pattern of submitted RFIs is very similar to the other three contracts with the peak number of RFIs occurring early in the project, specifically month five of the contract, and declining on average in the subsequent months.

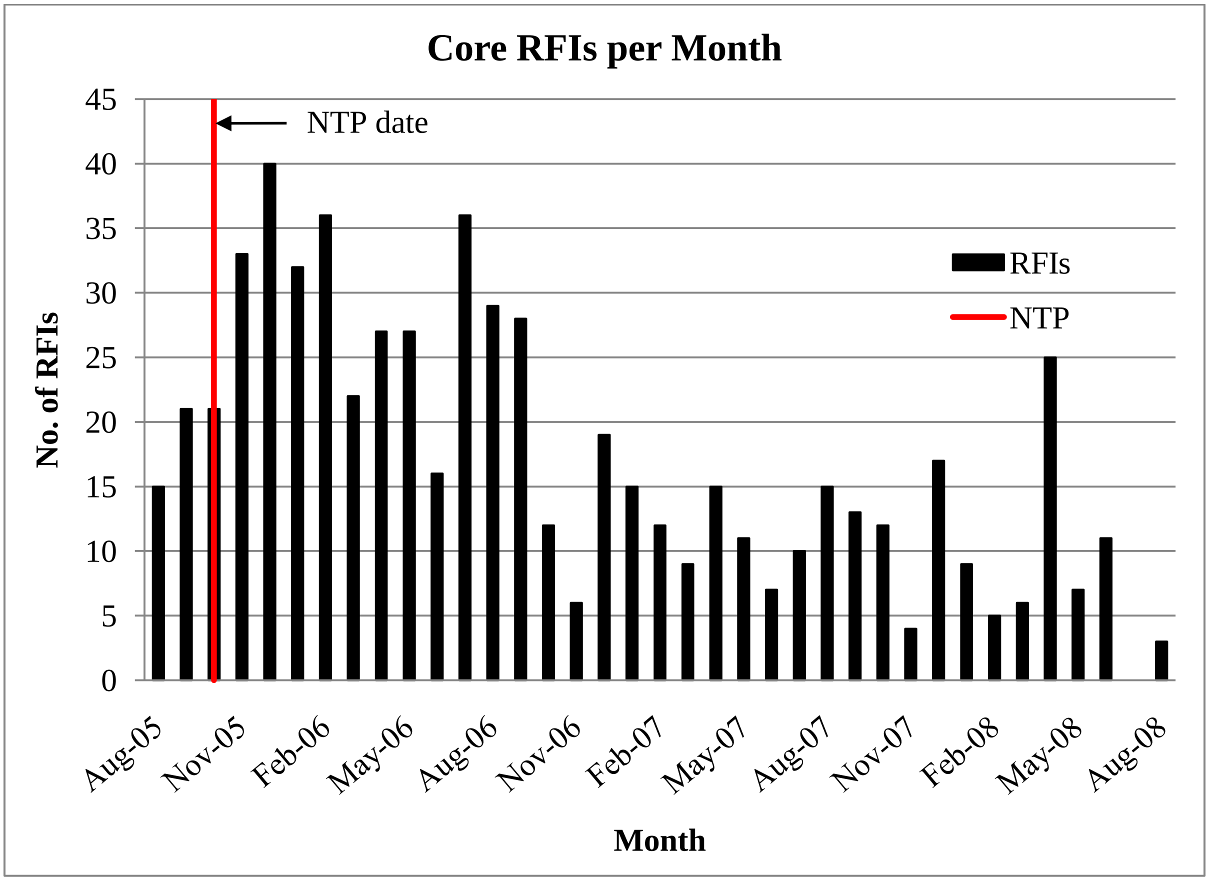


Figure 8 Core RFIs per Month

Table 7 relates the percent of total RFIs to the percent complete for the contract based on the payment schedule. This table was calculated in the same manner as the North Leg Percent of RFIs vs. Percent Complete based on the payment schedule table.

Table 7 Core Percent of RFIs vs. Percent Complete Based on Payment Schedule

Percent Complete (Based on the Payment Schedule)	**Percent of Total RFIs**
NTP	4%
25%	39%
50%	63%
75%	78%
100%	100%

4.3.2 I-94 N-S FREEWAY RECONSTRUCTION

The I-94 North-South reconstruction is a 35-mile transportation project that runs from the Illinois state line to General Mitchell International Airport in Milwaukee, Wisconsin. The project will improve safety, help ease congestion, and modernize the transportation corridor by constructing an additional lane in each direction, replacing deteriorating pavement and structures, moving ramp exits to the right side of the freeway, and by providing aesthetic treatments to the interstate (WisDOT 2011).

This will be the largest highway construction project in Wisconsin when it is completed in late 2016 at an estimated construction cost of $1.64 billion dollars which will expand the interstate to four lanes in each direction and reconstruct 17 interchanges (I-94 Construction Management Plan 2010). The I-94 N-S Freeway reconstruction has 53 contracts in-progress as of the first quarter of 2011 with a total expected number of contracts to be 102. Many of the contracts in-progress during the first of quarter of 2011 are relatively small contracts not involving significant amounts of construction. A sample was chosen based on the availability of the contracts in-progress for the I-94 N-S Project. Due to the construction beginning in 2009, this sample of contracts contained the first 14 construction contracts of the project based on their NTP. The sample of 14 contracts was deemed acceptable based on the variety of construction and size of contracts. All typical areas of highway construction are incorporated throughout the sample set, including roadway, structures, and utilities. The size of the individual contracts varied from an awarded contract amount of $360,000 dollars to $163 million dollars with an average contract value over $26 million dollars. The two largest projects within the data set, which consist of four individual contracts, are described in detail below. The important data from the other 10 contracts in the I-94 N-S sample is located in Appendix A.

4.3.2.1 LAYTON AVE.

The Layton Ave. contract for the I-94 N-S Freeway reconstruction involves the reconstruction of a major bridge, freeway lanes, and road resurfacing. This contract had an awarded contract value of $81,496,582. There were 188 RFIs submitted on this project, resulting in 2.3 RFIs per million dollars of awarded contract. Approximately 15-percent of the RFIs were submitted before the NTP of February 16, 2010. The average response time for a Layton Ave. RFI was 6.9 calendar days. However, only 60-percent of these RFIs were answered by the requested date specified on the RFI forms, which averaged 7.0 calendar days.

Figure 9 show the number of RFIs submitted per month for the Layton Ave. contract. The last RFI was submitted in December 2010. The pattern of submitted RFIs is very similar to the Marquette Interchange contracts with the peak number of RFIs occurring in the first months of the contract near the NTP, and a decline in the subsequent months. Specifically, Layton Ave reached its peak number of RFIs by month two of the contract with over 40-percent of its RFIs submitted.

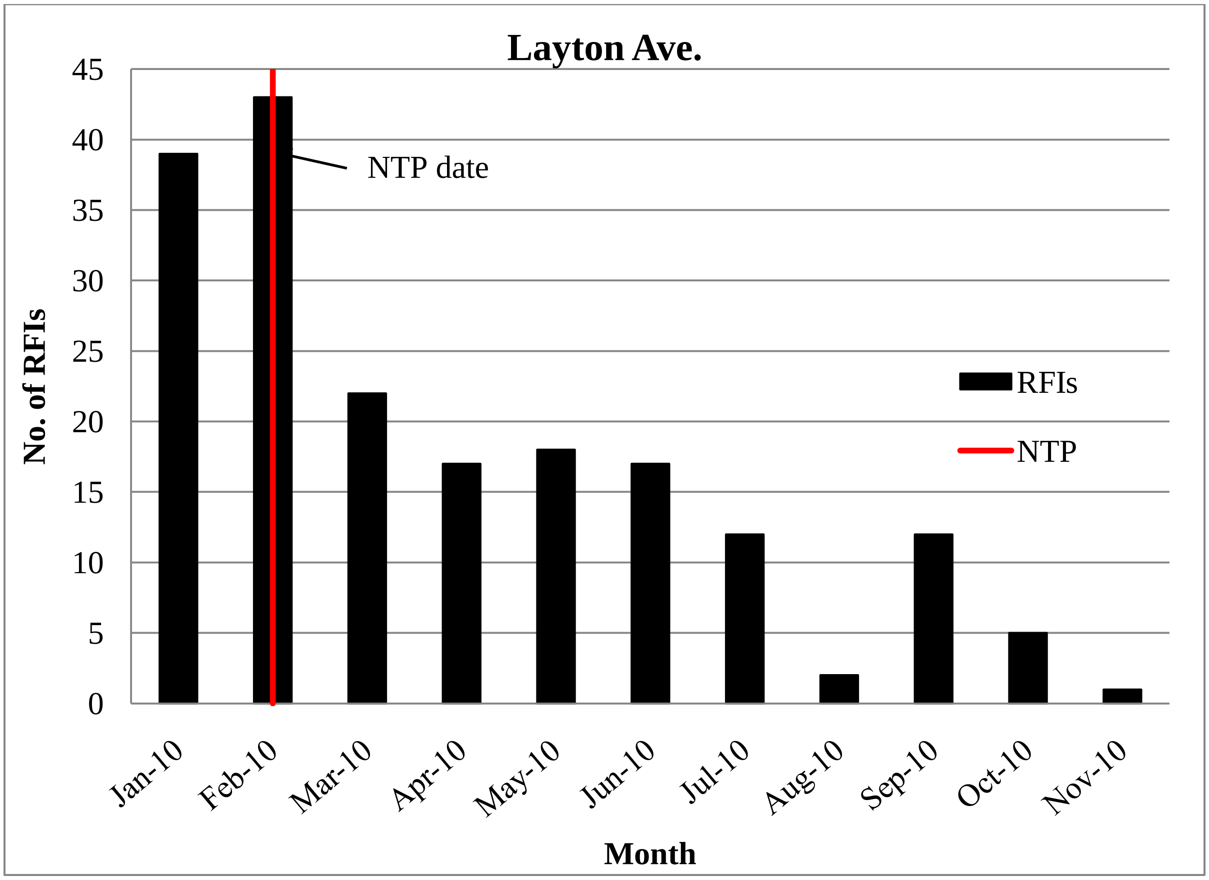


Figure 9 Layton Ave. RFIs per Month

Table 8 relates the percent of total RFIs to the percent complete for the Layton Ave. contract based upon the payment schedule. In order to produce this table, the number of RFIs submitted between every payment was calculated and summed in order to calculate the cumulative percent of RFIs. Also, the cumulative percent complete based on the dollar amounts from the payment schedule was calculated. Then, the cumulative percentage of the Layton Ave. RFIs was compared against the percent complete of the payment schedule. A linear relationship was assumed between each point of the payment schedule to estimate the percent of RFIs at the specific intervals of 25-percent, 50-percent, and 75-percent complete.

Table 8 Layton Ave. Percent of RFIs vs. Percent Complete Based on Payment Schedule

Percent Complete (Based on the Payment Schedule)	**Percent of Total RFIs**
NTP	15%
25%	71%
50%	87%
75%	92%
100%	100%

The NTP date denotes the percentage of Layton Ave. RFIs submitted before construction began. The goal of Table 8 is to calculate the collective average percentage of RFIs for the entire data set at set intervals based on the percent complete from the payment schedule as benchmarks for the RFI process. However, only contracts that are 100-percent complete in the data set from the Marquette Interchange and I-94 N-S Freeway can be used because the total number of RFIs for the individual contracts needs to be known.

4.3.2.2 COUNTY HIGHWAY C

The County Highway (CTH) C mainline project for the I-94 N-S Freeway reconstruction involves full road reconstruction and interchange work. Three contracts in the data set combined to make up the CTH C mainline project with a total awarded contract value of $60,201,399. There were 99 RFIs submitted on this project, resulting in 1.7 RFIs per million dollars of awarded contract. There were no RFIs submitted before the NTP of

May 29, 2009. The average response time for a CTH C RFI was 9.8 calendar days. However, approximately 59-percent of the RFIs were answered by the requested date specified on the RFI forms, which averaged 7.1 calendar days.

Figure 10 show the number of RFIs submitted per month for the CTH C contract. The last RFI was submitted in November 2010. The pattern of submitted RFIs for a contract within a major highway project is now very clear, as all of the aforementioned contracts display a similar flow and timing pattern of RFIs.

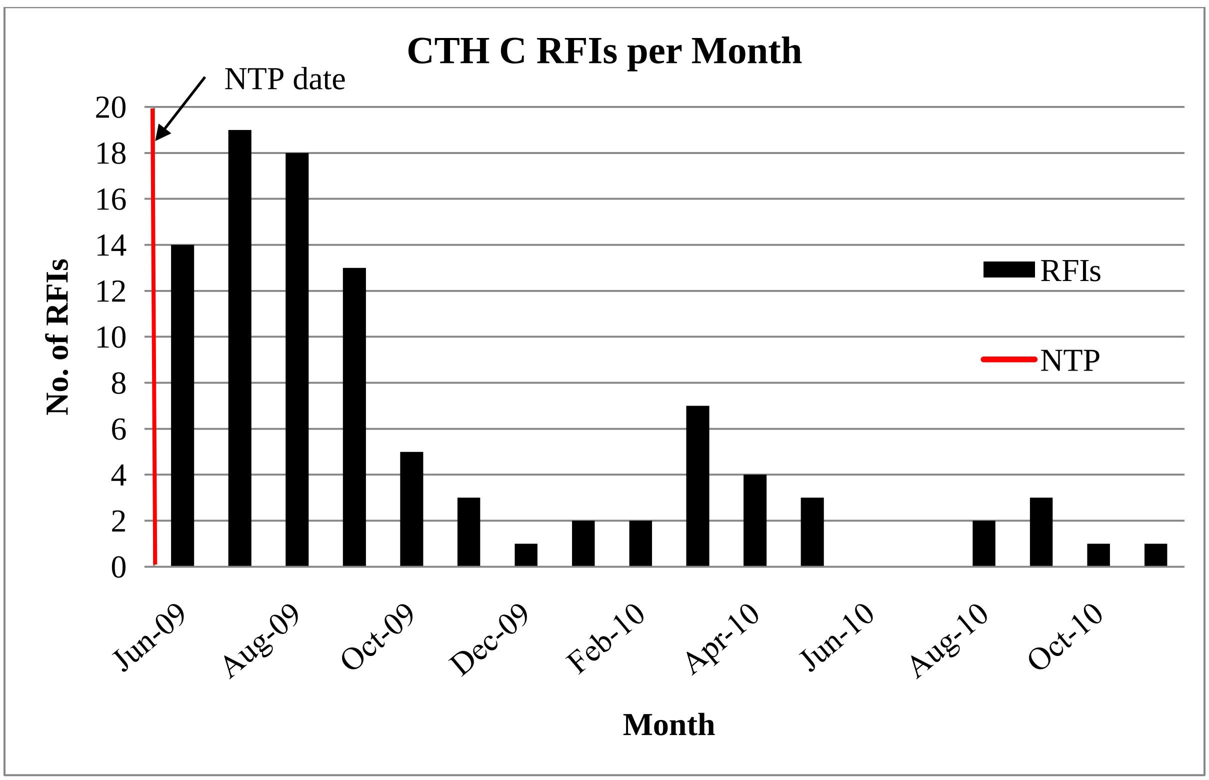


Figure 10 CTH C RFIs per Month

Table 9 relates the percent of total RFIs to the percent complete for the CTH C contract based upon the payment schedule.

Table 9 CTH C Percent of RFIs vs. Percent Complete Based on the Payment Schedule

Percent Complete (Based on the Payment Schedule)	**Percent of Total RFIs**
NTP	0%
25%	63%
50%	92%
75%	95%
100%	100%

4.3.3 PROJECT DATA SUMMARY

To summarize the data for all 18 contracts in the data set, a comparative analysis of all of the details described from each contract was conducted. The project summary data listed in the charts and graphs below were used in the Bootstrap analysis discussed previously in the Methodology section. The results from the Bootstrap analysis can be found in Section 5.2.

Table 10 below provides the complete results of the 18 contracts in the data set. The result type in the heading of each column was discussed in detail for the four contracts from the Marquette Interchange project and the four contracts from the I-94 N-S Freeway project. This table organizes these eight contracts along with the other 10 contracts from the I-94 N-S Freeway with respect to their awarded contract value. A description of the other 10 contracts can be found in Appendix B.

Table 10 Contract Data Summary

Contract	Awarded Contract Value	No. of RFIs	RFIs per Million Dollars	Response Time (days)	Answered Within Request Period	Requested Response Time (days)
Bolivar Ave	$367,577	1	2.7	0.0	100%	13.0
STH 50 IC	$2,729,084	16	6.3	12.4	62%	10.4
STH 142 IC	$3,445,360	1	0.3	-	-	7.0
CTH G IC	$4,205,893	2	0.5	4.0	50%	7.0
STH Mainline	$4,552,255	1	0.2	13.0	0%	7.0
CTH G Bridges/Ramps	$5,568,133	6	1.1	16.8	60%	10.8
CTH G Mainline	$9,854,138	3	0.3	7.7	33%	7.0
Utilities	$11,032,751	11	1.0	3.0	100%	7.1
27th St Bridges	$11,307,989	1	0.1	-	-	7.0
College Ave	$11,714,661	54	4.6	17.5	64%	6.8
CTH C Mainline/Ramps	$24,564,583	78	3.2	7.8	71%	7.7
West Leg	$30,555,660	122	4.0	11.4	48%	8.3
CTH C Ramps	$31,084,561	20	0.7	10.9	58%	6.6
South Leg	$44,826,419	181	4.0	5.6	77%	7.1
Layton Ave	$81,496,582	188	2.3	6.9	60%	7.0
North Leg	$102,760,288	153	1.5	5.2	80%	7.0
Mitchell IC	$162,465,471	218	9.9	10.0	47%	6.9
Core	$314,759,250	626	2.0	6.1	72%	7.0

Seventeen of the 18 contracts are on average 99-percent complete; however, the Mitchell Interchange is only 14-percent complete at the time of this thesis write-up. Two contracts, 27th Street Bridges and STH 142 Interchange, did not have the answer date provide in the *Multi-Project Request and Answer Report*, thus the response time and the percent of RFIs answered within the request period could not be calculated.

Figure 11 displays the distribution of RFIs per month based on each contract's NTP date, which is represented by the number 0 on the x-axis. This chart shows the total number of RFIs submitted each month before and after a single, generic NTP. Figure 11 was created to illustrate the timing of RFI submittal over the course of an entire project, which includes all of its respective contracts.

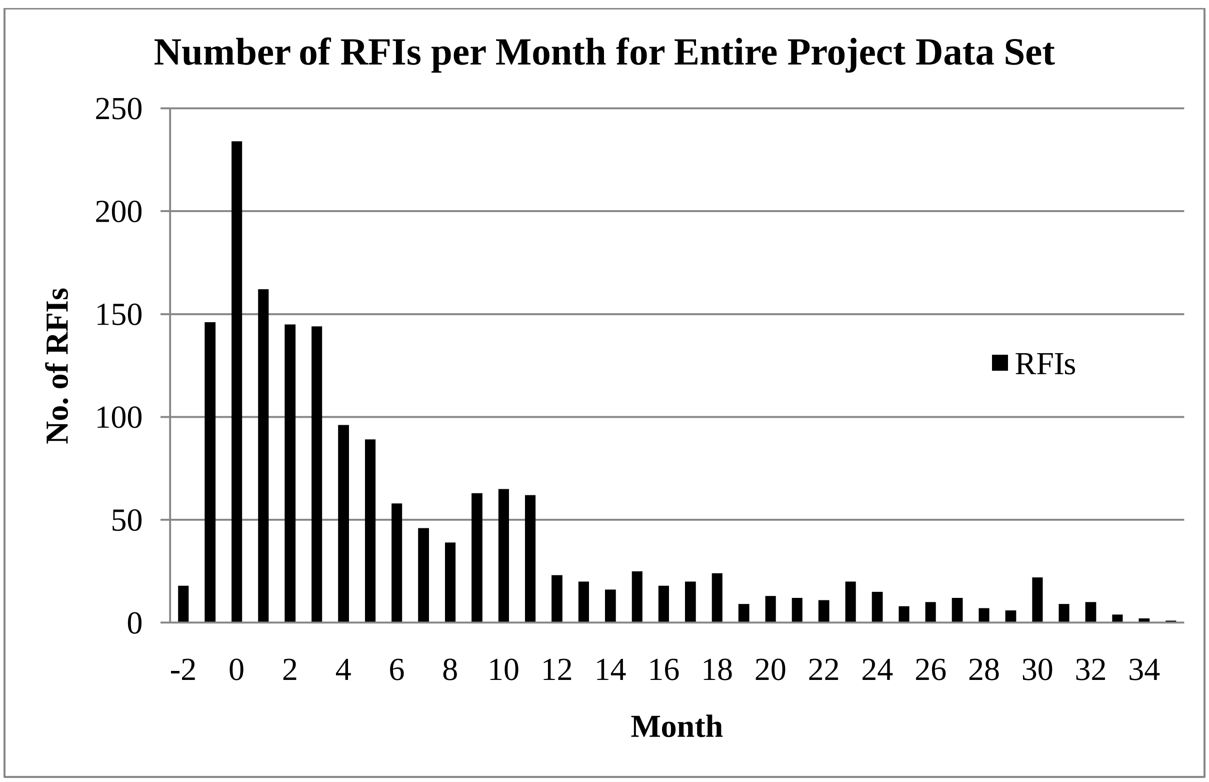


Figure 11: Number of RFIs per Month for All Contracts

All of the individual contract graphs displaying the number of RFIs per month resemble Figure 11 above. For a major highway project, the maximum expected number of RFIs should occur near the NTP date, which again is represented by the number 0 on the x-axis. The project team can then expect a decline in the number of RFIs submitted as the project continues. In order to accurately estimate appropriate staffing levels at the NTP, 25-percent, 50-percent, and 75-percent complete, the respective percent of RFIs submitted needs to be known.

Table 11 represents the actual percent of RFIs versus the percent completed based on the payment schedule for the eight completed contracts within the data set. This chart was created to show the variation in submittal rates for contracts within a project.

Table 11 Completed Projects Percent of RFIs vs. Percent Complete Based on Payment Schedule

	North Leg	**West Leg**	**South Leg**	**Core**	**Layton Ave**	**College Ave**	**Utilities**	**CTH C**
NTP	10%	23%	2%	4%	15%	9%	18%	0%
25%	55%	75%	47%	39%	71%	91%	91%	63%
50%	73%	85%	60%	63%	87%	98%	100%	92%
75%	94%	95%	78%	78%	92%	100%	100%	95%
100%	100%	100%	100%	100%	100%	100%	100%	100%

Each of the complete contracts varies with respect to the cumulative percent of RFIs based on the percent complete from the payment schedule. Contracts with smaller awarded contract values tended to reach their maximum number of submitted RFIs earlier than larger contracts. The data from these eight completed contracts will be analyzed using the

Bootstrap method to produce a robust average at the NTP, 25-percent, 50-percent, and 75-percent complete. The results from this Bootstrap analysis are discussed in Section 5.2.

4.4 RFI CLASSIFICATION

This section illustrates the specific characteristics of the RFIs for both major highway projects using the three-step reclassification process created by the research team. The results are displayed graphically for visual comparison and readability.

The first step was to categorize the RFI based on its division, or general area of construction. The divisions are used to sort the RFIs into 10 general areas of construction. The RFI is classified under the most specific division to understand the complete breakdown of submitted RFIs. An analysis of RFIs submitted was completed using the 10 divisions created by the WisDOT to suitably divide among different aspects of construction. It is important to use a wide variety of divisions to accurately describe the type of construction, which will highlight areas that may have a significantly higher proportion of RFIs. A high percentage of RFIs either describes the project's focal type of construction or any problem areas. Figure 12 and Figure 13 show the categorization of divisions for the entire Marquette Interchange project and the current I-94 North-South Freeway RFIs, respectively.

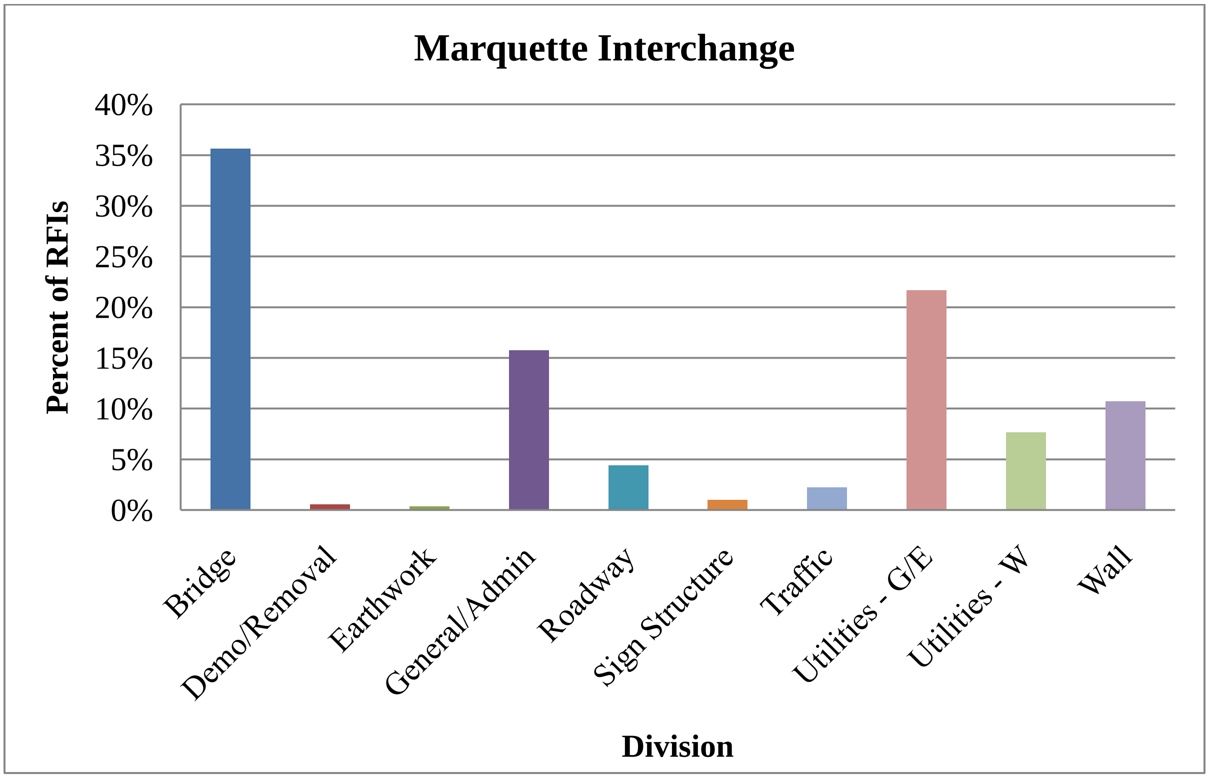


Figure 12 Marquette Interchange Divisions

The Marquette Interchange project's general properties can be described using the Figure 12 above, which distributes the RFIs between the 10 divisions previously created by WisDOT. Bridges and Walls (retaining and/or noise) accounted for 47-percent of the project RFIs for the Marquette Interchange project as the construction primarily consisted of structures; 2,000,000 square feet of deck surface on 63 bridges (Hubbard et al. 2004) and 5 miles of retaining walls (Paddock 2004). Utilities summed to 30-percent of the RFIs, which is logical because the construction took place in an aging urban environment.

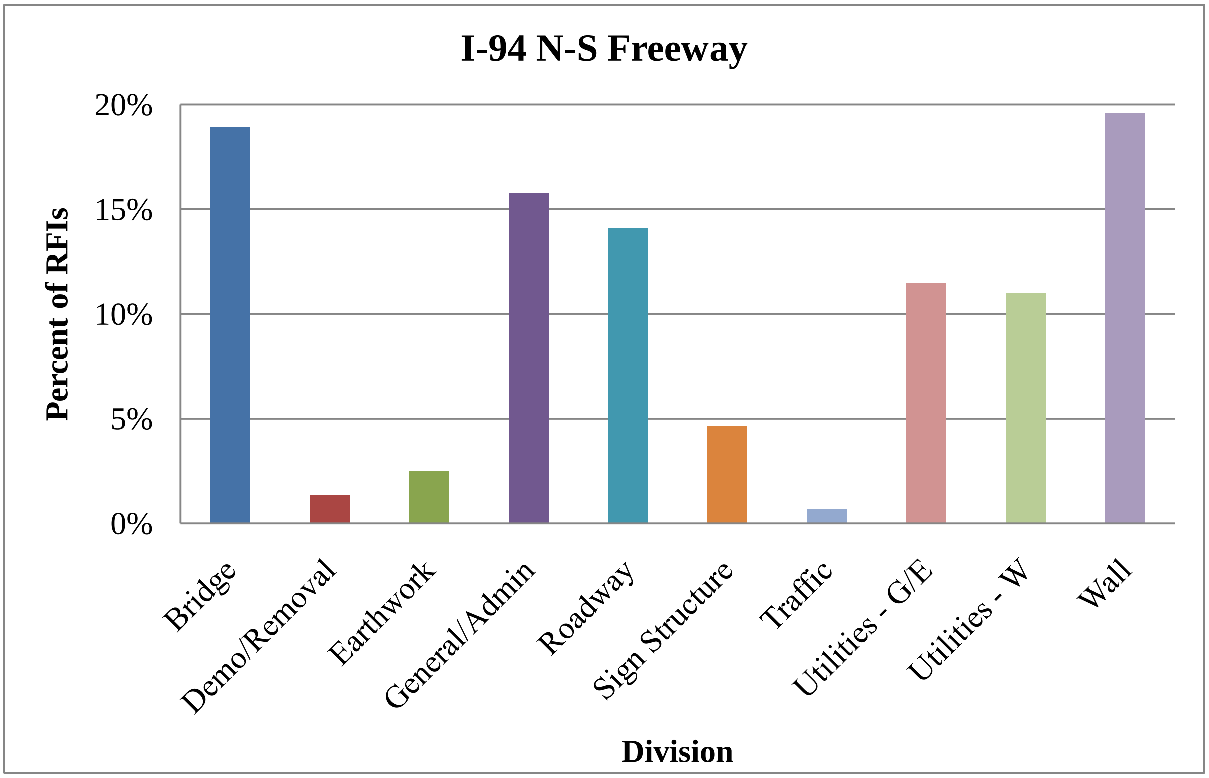


Figure 13 I-94 N-S Freeway Divisions

The I-94 N-S Freeway reconstruction is more evenly divided between the Roadway, Bridges, Walls, Utilities, and General/Admin divisions. The even distribution in Figure 13 can be attributed to the significant size of the project, and the typical highway project characteristics involving grading, paving, and structures along a 35-mile corridor.

The second step involved classifying each RFI with a reason code to describe the cause for submission. As stated before, a small percentage of RFIs were originally submitted with a WisDOT reason code. WisDOT's current system for classifying contract modifications (and RFIs) has seven broad reason codes discussed earlier in Table 3. However, the original seven reason codes is considered by the research team to be too general and created difficulties in deriving meaningful conclusions. Thus, fifteen new reason codes were created by the research team in order to reclassify the RFIs from the SHA's projects in a manner that would allow for future statistical use and provide possible metrics. Table 12 lists the CMSC reason codes that were generated based on technical and professional experiences of the research team.

Table 12 CMSC Reason Codes

Reason Code		Description
Added Scope	*AD*	Addition of items to the original project scope
Construction Coordination	*CC*	Organizing and coordinating construction related procedures, schedules, and safety items
Constructability Issues	*CI*	Difficulty in constructing an item as detailed or designed
Change of Staging/Phasing	*CS*	Sequence of construction previously determined deemed inadequate or in need of reorganizing due to resource limitations and manpower organization
Design Change	*DC*	Request to implement an alternative design, modify a design to simplify efforts by construction team, or to correct an error in construction
Design Clarification	*DL*	Additional information requested to further understand and clarify components of the design and its related constituents
Different Method	*DM*	Change in installation technique or construction process
Design Coordination	*DR*	Organizing and coordinating the design and related documents between entities

Deleted Scope	*DS*	Scope or line items to be removed from the project
Incomplete Plans/Specs	*IP*	Error or omission in the plans/specifications
Material Change	*MC*	Different material requested to replace another than what is specified due to having an excess material readily available, or experience demonstrates another material has an improved performance
Differing Site Conditions	*SC*	Impediments discovered at the site that were previously unknown or were not in the condition as described in the contract
Utility Conflict	*UC*	Utility pipes, lines, or boxes prevent the construction strategy from proceeding as planned
Value Engineering	*VE*	Cost-reduction and construction improvement techniques
Other	*OR*	Any justified RFI submitted that does not fit into one of the other 14 categories including but not limited to payment methods, certification requirements, penalties, warranties, and non-design related documents

Using the CMSC reason codes listed in Table 12, the RFIs were sorted to identify areas that had the most information requests. It is important to enter the reason code that best describes the source of the RFI because this will help identify trends in areas requiring additional attention.

The 15 new reason codes were derived to improve the understanding of why RFIs are submitted. The RFIs are classified by first reading and interpreting both the question and answer for the RFI to understand the fundamental reason for why it was submitted. Oftentimes, the answer to an RFI provides the necessary detail to understand why the RFI was submitted. The RFI was classified under the most specific reason code available, as there are varying levels of specificity within the list. There are minor amounts of overlap between the reason codes but it is necessary to account for all RFIs.

The distribution of the CMSC reasons codes for the Marquette Interchange and I-94 N-S Freeway are presented below in Figures 14 and 15. Each reason code is displayed as a percentage of the total number of RFIs submitted for each project.

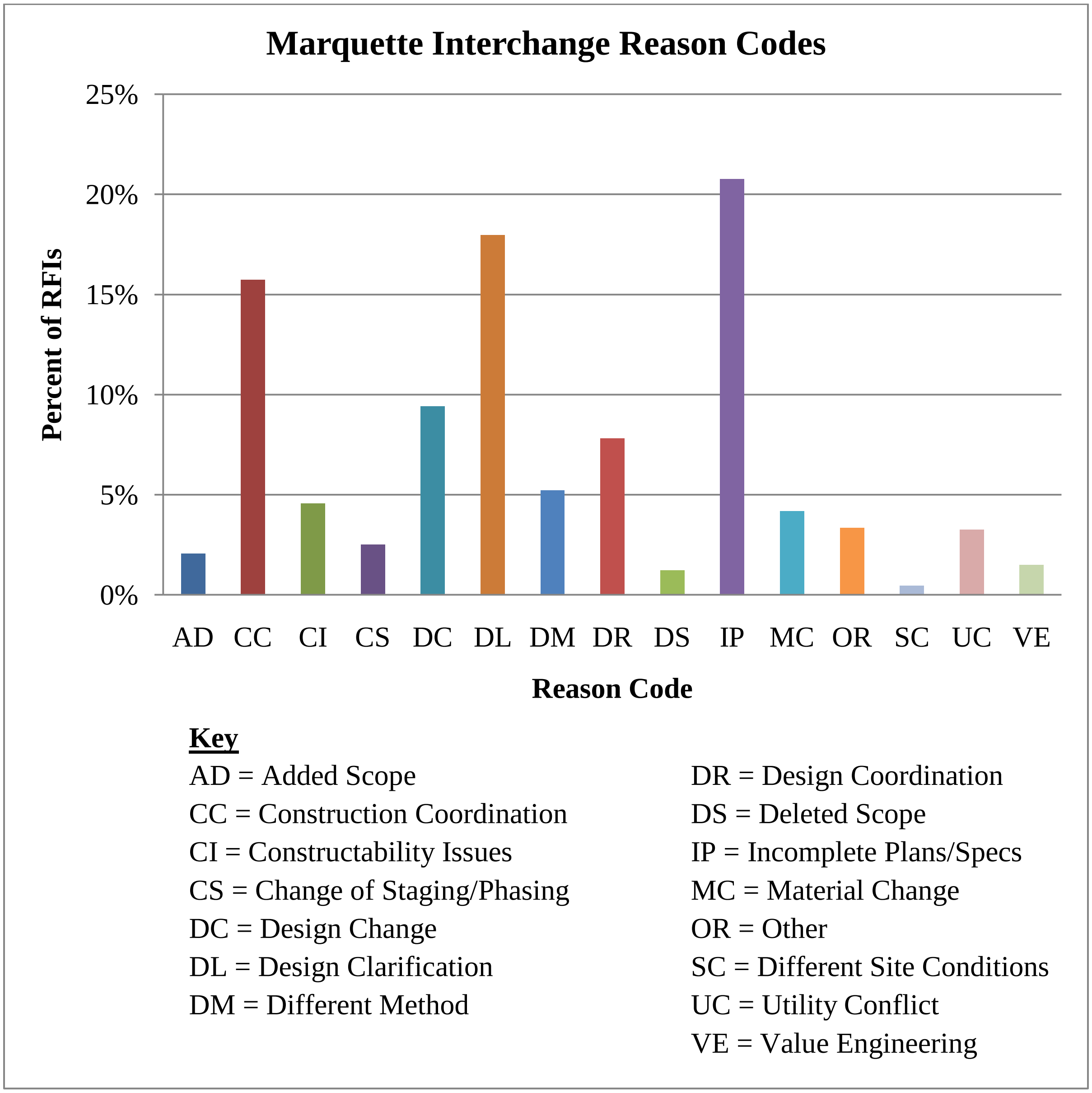


Figure 14 Marquette Interchange Reason Codes

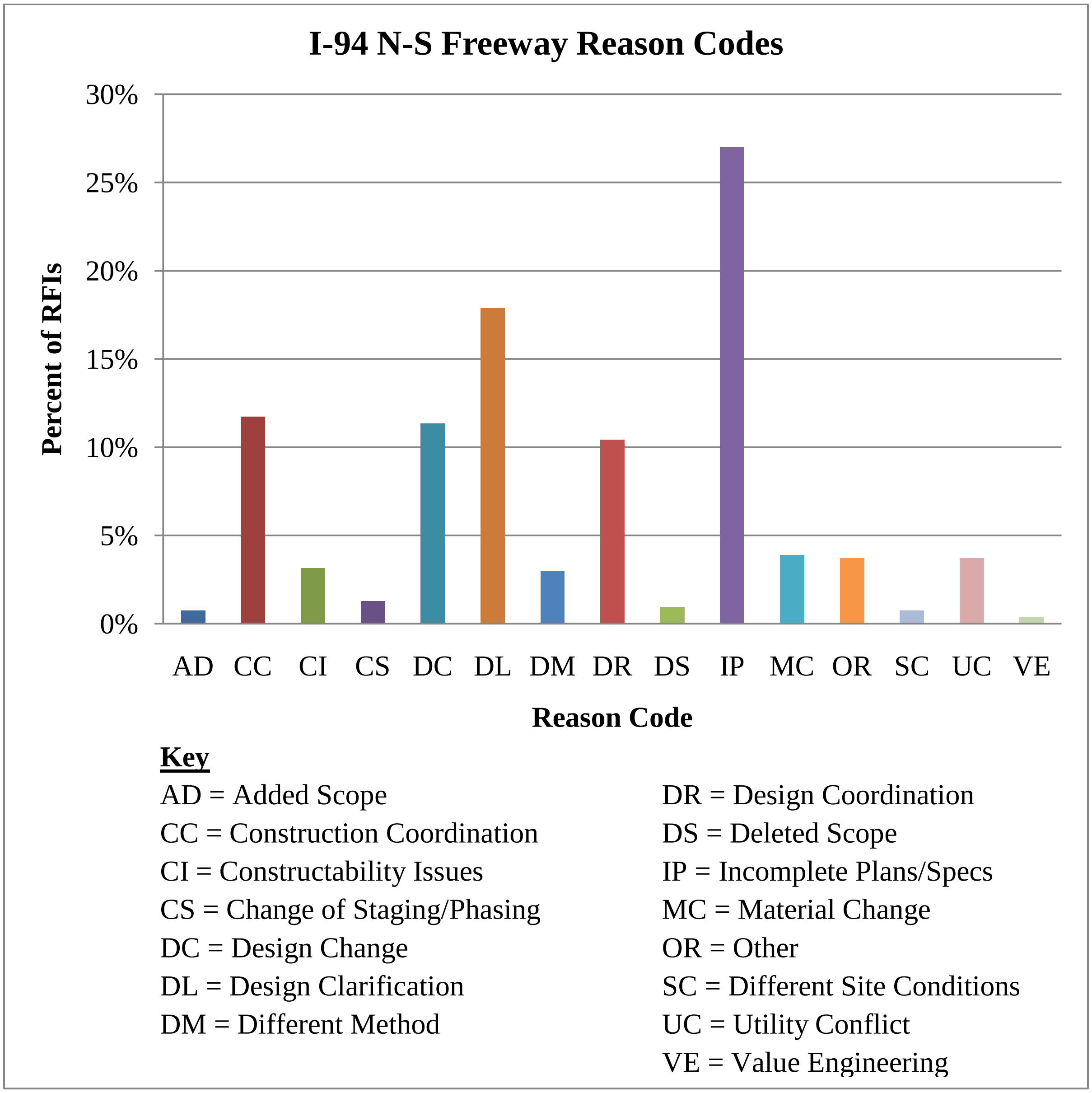


Figure 15 I-94 N-S Freeway Reason Codes

The most important characteristics to recognize from Figures 14 and 15 are the similar distribution of reason codes among projects. Even though each project has a very different allocation of divisions, the reason codes are extremely comparable. Table 13 below compares the reason code distribution for the Marquette Interchange and the I-94 N-S Freeway projects.

Table 13 Reason Code Project Comparison

Reason Code		**Marquette Interchange**	**I-94 N-S Freeway**
Added Scope	*AD*	2.0%	0.7%
Construction Coordination	*CC*	15.7%	11.7%
Constructability Issues	*CI*	4.6%	3.2%
Change of Staging/Phasing	*CS*	2.5%	1.3%
Design Change	*DC*	9.4%	11.4%
Design Clarification	*DL*	18.0%	17.9%
Different Method	*DM*	5.2%	3.0%
Design Coordination	*DR*	7.8%	10.4%
Deleted Scope	*DS*	1.2%	0.9%
Incomplete Plans/Specs	*IP*	20.8%	27.0%
Material Change	*MC*	4.2%	3.9%
Differing Site Conditions	*SC*	3.4%	3.7%
Utility Conflict	*UC*	0.5%	0.7%
Value Engineering	*VE*	3.3%	3.7%
Other	*OR*	1.5%	0.4%

An examination of Figures 14 and 15 shows that at least 70-percent of the RFIs submitted for both projects fall into one of the following five categories: Construction Coordination (CC), Design Change (DC), Design Clarification (DL), Design Coordination (DR), and Incomplete Plans/Specs (IP). The most frequently submitted RFI for both projects was in the Incomplete Plans/Specs (IP) reason code, accounting for 21-percent of Marquette Interchange's RFIs and 27-percent of I-94 N-S Freeway's RFIs.

A helpful method to identify problem areas would be to highlight the most often submitted RFI reason codes and further classify those RFIs within the selected reason codes. As shown in the bar charts for the Marquette Interchange and the I-94 N-S Freeway Reconstruction, the Incomplete Plans/Specs (IP) reason code accounts for more than 20-percent of all RFIs submitted. Thus, a breakdown within the IP reason code was completed for each project to isolate potential areas of concern. This reason code was divided into five sub-categories to identify the problem areas in the plans and specifications. Table 14 provides an explanation of these five sub-categories. The sub-categories are based on the research team's experience in roadway construction as well as problem areas that appeared frequently while analyzing the *Multi-Project Request and Answer Reports*.

Table 14 Reason Code "IP" Sub-Categories

Category	**Description**
Dimension	Missing, incorrect, or mislabeled dimensions or stationing
Drawing	Missing, incorrect, or mislabeled plan details
Elevation	Missing, incorrect, or mislabeled elevation or grades
Line Item	Missing, incorrect, or mislabeled line item or quantity
Rebar	Missing, incorrect, or mislabeled bar numbers, bend details, or quantities

Figure 16 and Figure 17 show the percentage of each of the five sub-categories within the IP reason code for the Marquette Interchange and the I-94 N-S Freeway, respectively.

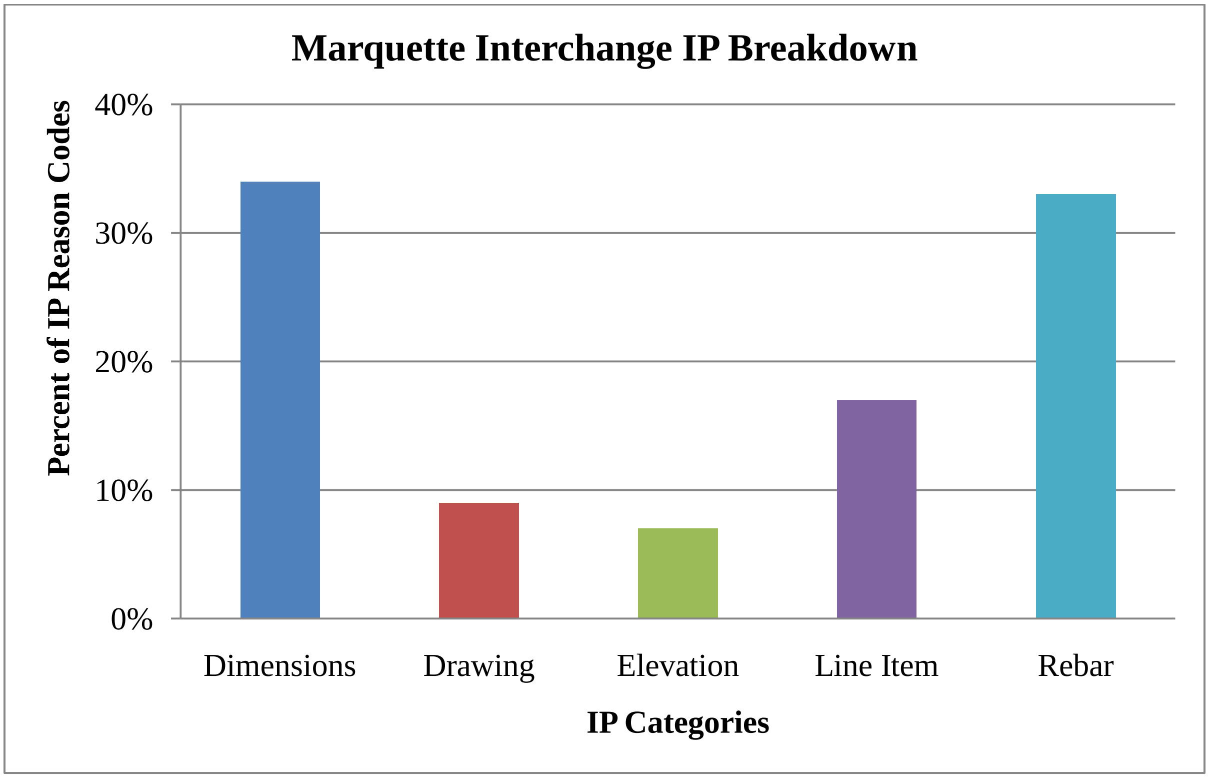


Figure 16 Marquette Interchange IP Breakdown

In the Marquette Interchange, the 67-percent of plan and specification errors were due to incorrect dimensions or stationing and to steel reinforcement (rebar) mistakes.

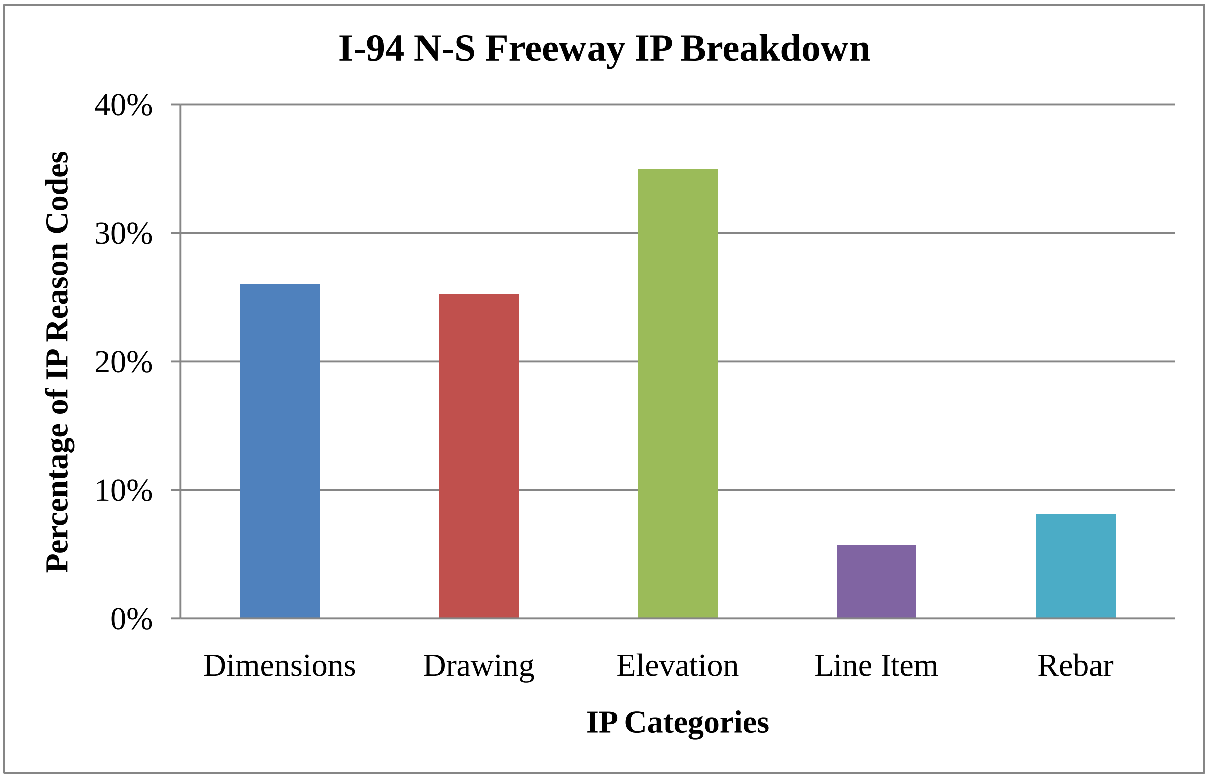


Figure 17 I-94 N-S Freeway IP Breakdown

In the I-94 N-S project, greater than 86-percent of the plan and specifications errors were incorrect, missing, or mislabeled dimensions, drawings/details, or elevations.

The major cause for a variety in the IP breakdowns between the two projects are due to the scope differences. The higher percentage of concrete bridge work in the Marquette Interchange is the reason for the high percentage of steel reinforcement errors. As stated before, the I-94 N-S Freeway is a typical corridor project, which a diversity of general plan errors could be derived from all aspects of structures and roadways. This useful breakdown method could be completed again with different, customized categories for any of the other 14 reason codes.

Lastly, the RFIs were critically evaluated to determine if they were justifiable. A justifiable RFI is defined as a question, concern, or observation that cannot be explained or answered in the contract documents. An RFI is unjustified if it asks a question whose answer is provided in the contract documents, questions means or methods, or requests a design change that is not considered by the project team. An RFI can be denied, yet still justified if the contractor has a legitimate concern that they felt must be clarified due to possible errors or improvements in the construction techniques.

Figure 18 shows the distribution of the unjustified RFIs for the entire Marquette Interchange based upon the month of submittal. The chart below compares the quantity of unjustified RFIs to the total number of RFIs for each month of the entire Marquette Interchange project, which are represented by the gray and black shading, respectively.

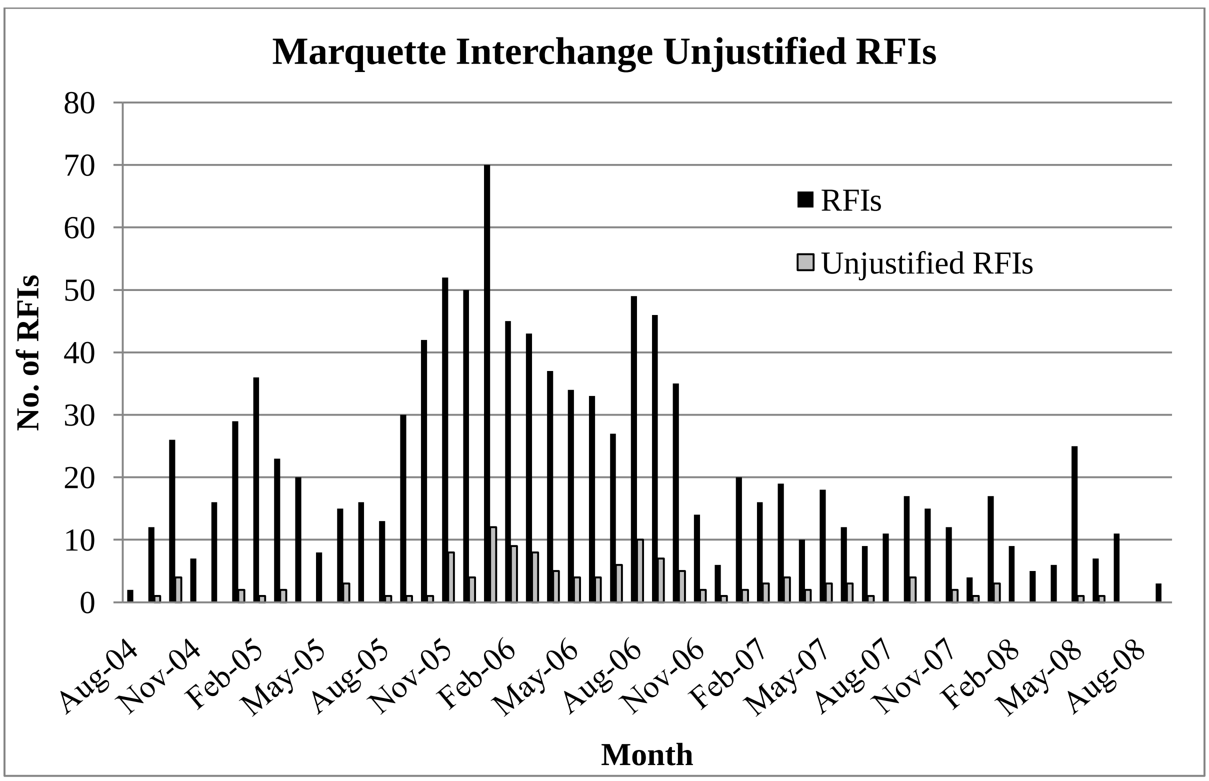


Figure 18 Marquette Interchange Unjustified RFIs

The unjustified RFIs follow a similar pattern to that of the total number of RFIs submitted each month, signifying that the number of unjustified RFIs rises and lowers at the same time as the total number of RFIs. This suggests that unjustified RFIs are approximately a constant percentage of each month's total number of RFIs. This is important because it signifies that an average unjustified rate describes the pattern throughout the Marquette Interchange project. The Marquette Interchange averaged 12-percent unjustified RFIs. To further describe the unjustified RFIs, their reason codes and respective distributions for the Marquette Interchange are located below in Table 15.

Table 15 Marquette Interchange Unjustified RFI Reason Codes

Reason Code	Percent of Total Number of RFIs Submitted	Unjustified Percent of Total Number of RFIs Submitted by Reason Code	Unjustified Percent of Total Number of Unjustified RFIs
AD	2.0%	18.2%	3.1%
CC	15.7%	13.6%	17.6%
CI	4.6%	6.1%	2.3%
CS	2.5%	3.7%	0.8%
DC	9.4%	10.9%	8.4%
DL	18.0%	26.4%	38.9%
DM	5.2%	10.7%	4.6%
DR	7.8%	2.4%	1.5%
DS	1.2%	15.4%	1.5%
IP	20.8%	8.1%	13.7%
MC	4.2%	6.7%	2.3%
SC	0.5%	0.0%	0.0%
UC	3.3%	0.0%	0.0%
VE	1.5%	12.5%	1.5%
OR	3.4%	13.9%	3.8%

The reason code column contains the abbreviations of the CMSC reason codes defined previously in Table 12. The second column, Percent of the Total Number of RFIs Submitted, displays the percent of all the Marquette Interchange RFIs that were classified with each respective reason code. The third column, Unjustified Percent of the Total Number of RFIs Submitted by Reason Code, shows the percentage of unjustified RFIs submitted with respect to the number of RFIs submitted under each individual reason code. The fourth column, Unjustified Percent of the Total Number of Unjustified RFIs submitted, lists the percent of unjustified RFIs under each reason code with respect to the total number of unjustified RFIs for the Marquette Interchange.

The ideal distribution for Table 15 is equal percentages for the individual reason codes in the Percent of the Total Number of RFIs Submitted (Column 1) and the Unjustified Percent of the Total Number of RFIs Submitted (Column 4) columns. This would indicate that no reason code was interpreted as unjustifiable in a disproportionate manner compared to its respective percent of the total number of RFIs. The important reason codes to consider in this table are those that have a large difference between the RFIs considered as unjustifiable and the total number of submitted RFIs. For example, the IP reason code describes the majority of the RFIs (20.8-percent), but represents a much lower percentage of the unjustified RFIs (13.7-percent), signifying that a majority of the requests were justified, or necessary. Furthermore, only 8-percent of the RFIs with the IP reason code were unjustified. The reason code of concern for the Marquette Interchange is Design Clarification, DL, accounting for 39-percent of all unjustified RFIs, but only 18-percent of the total number of

RFIs. Also, more than 26-percent of the RFIs classified as DL were unjustified. There are obviously some disagreements on what constitutes a valid design clarification question.

Figure 19 shows the same distribution of unjustified RFIs compared to the number of RFIs submitted in each month for the contracts available from the I-94 N-S Freeway project. The distribution compares the quantity of unjustified RFIs to the total number of RFIs for each month of the available I-94 N-S Freeway project data.

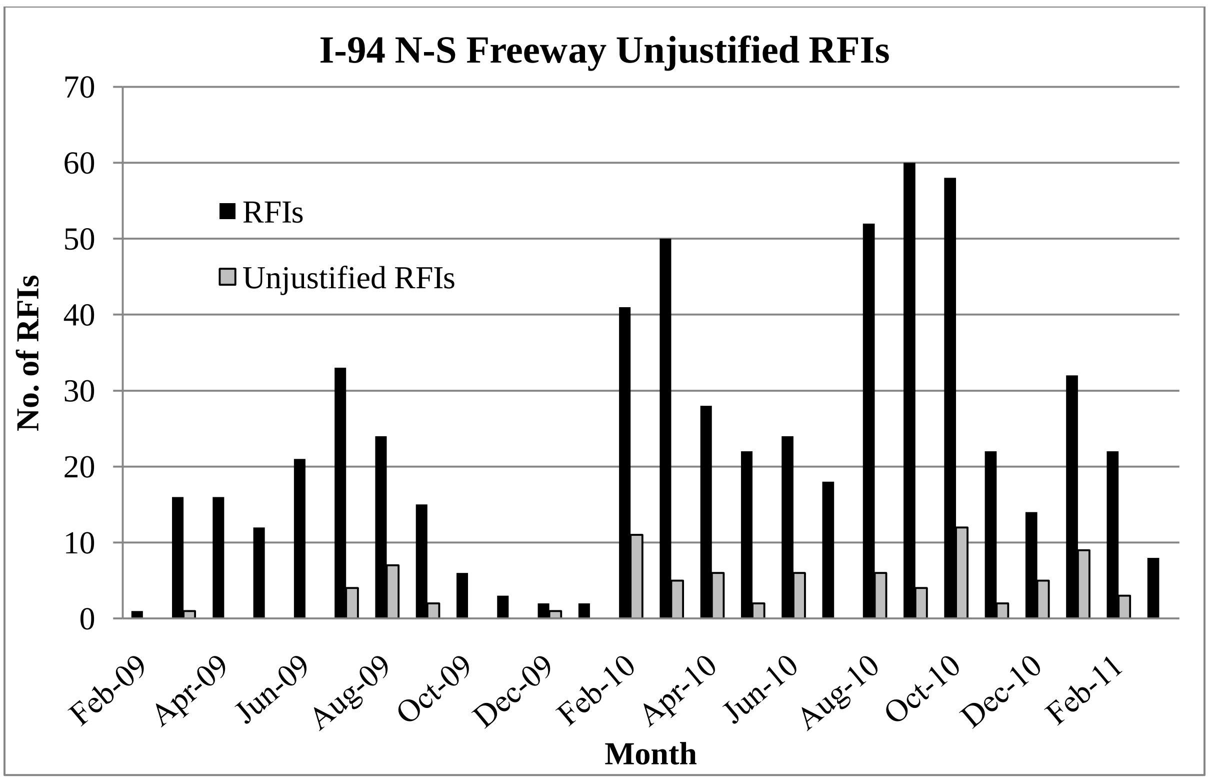


Figure 19 I-94 N-S Unjustified RFIs

Even though the pattern of the total number of RFIs submitted each month varies compared to the Marquette Interchange pattern, the unjustified RFIs continue to follow a similar pattern compared to the total number of RFIs submitted each month. This further strengthens the research team's rationale that one average value of unjustified RFIs can adequately describe the pattern of unjustified RFIs throughout a project. The I-94 N-S averaged 16-percent unjustified RFIs.

To further describe the unjustified RFIs for the I-94 N-S Freeway reconstruction, their reason codes and respective distributions are located below in Table 16.

Table 16 I-94 N-S Unjustified RFI Reason Codes

Reason Code	Percent of Total Number of RFIs Submitted	Unjustified Percent of Total Number of RFIs Submitted by Reason Code	Unjustified Percent of Total Number of Unjustified RFIs
AD	0.7%	0.0%	0.0%
CC	11.7%	9.5%	7.1%
CI	3.2%	0.0%	0.0%
CS	1.3%	14.3%	1.2%
DC	11.4%	9.8%	7.1%
DL	17.9%	20.8%	23.5%
DM	3.0%	12.5%	2.4%
DR	10.4%	21.4%	14.1%
DS	0.9%	20.0%	1.2%
IP	27.0%	17.9%	30.6%
MC	3.9%	19.0%	4.7%
SC	0.7%	25.0%	0.0%
UC	3.7%	0.0%	2.4%
VE	0.4%	10.0%	0.0%
OR	3.7%	0.0%	5.9%

The reason code column contains the abbreviations of the CMSC reason codes defined previously in Table 12. The second column, Percent of the Total Number of RFIs Submitted, displays the percent of all the I-94 N-S Freeway RFIs that were classified with each respective reason code. The third column, Unjustified Percent of the Total Number of RFIs Submitted by Reason Code, shows the percentage of unjustified RFIs submitted with respect to the number of RFIs submitted under each individual reason code. The fourth column, Unjustified Percent of the Total Number of Unjustified RFIs submitted, lists the percent of unjustified RFIs under each reason code with respect to the total number of unjustified RFIs for the I-94 N-S Freeway.

No specific reason code has a significantly disproportionate percent of unjustified RFIs associated with it in Table 16. The IP reason code has the most unjustified RFIs, but that would be expected because it also contains the majority of submitted RFIs. Likewise, the DL reason code has the second most RFIs in both columns, but not a large disparity between them.

4.5 NEVADA DOT COMPARISON

In order to perform a qualitative comparison with the WisDOT projects, the research team solicited data from SHAs that currently employ an RFI process with a major highway project in-progress or recently completed. References provided from the survey in Chapter 3 were solicited for the major highway project data. The Nevada Department of Transportation (NDOT) agreed to allow the project team access to their construction administration web-program for the Interstate-580 Freeway extension. The research team collected the NDOT data to perform a qualitative comparison with the WisDOT projects.

The Interstate 580 Freeway extension project in western Nevada is adding 8.5 miles of 6-lane roadway to provide a safer and more efficient route to serve growing traffic needs (NDOT 2010). The project originally began as two contracts, A and B, and was to take place from November 2003 through December 2010. A constructability disagreement between NDOT and the prime contractor led to a mutual contract termination of Contract A in May 2006. The work left to be performed within this contract was the construction of four major bridges and portions of several retaining walls. When Contract A was terminated, Contract B was repackaged to absorb all of the remaining tasks. Contract B was let several months after the original plan and ultimately included: five bridges, grading, and paving for the 8.5 miles of roadway, construction of a major interchange, completion of another interchange, and other small excavation and retaining walls tasks (NDOT 2010).

The I-580 extension project had an awarded contract value of $393,393,393 and has a scheduled completion in late 2011. The I-580 project is 75-percent complete based upon the payment schedule at the time of this thesis write-up. No RFIs were submitted before the NTP of January 7, 2007. As of March 31, 2011, there are 265 RFIs submitted on this project, which calculates to 0.9 RFIs per million dollars of awarded contract. These contract results were compared with the Marquette Interchange and the I-94 N-S Freeway contract data found above in Table 10. Figure 20 represents the current RFIs per month on the I-580 Freeway extension project.

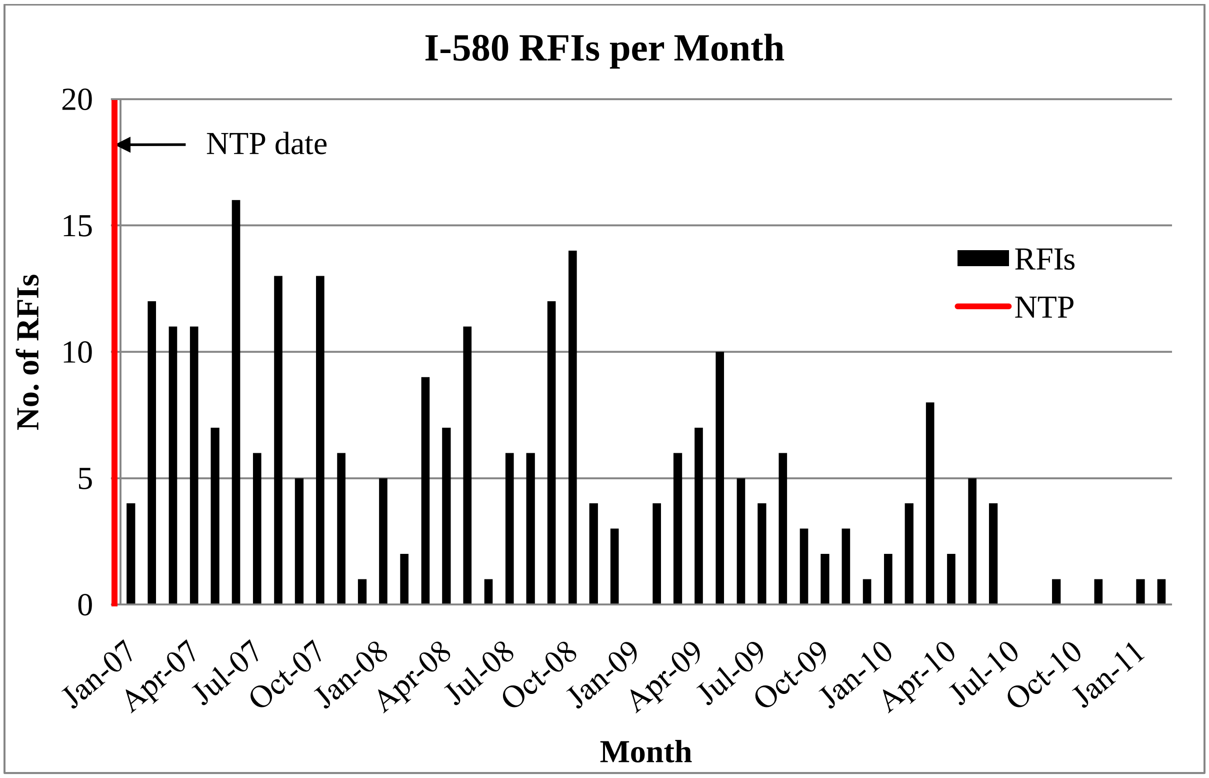


Figure 20 I-580 RFIs per Month

The average response time for an RFI in this chart was 13.9 calendar days, compared to 6.2 calendar days and 8.9 calendar days for the Marquette Interchange and I-94 N-S projects, respectively. There was no option to enter the request by date on the NDOT RFI form, thus this statistic cannot be reported and compared. The RFIs follow a similar distribution on a monthly basis compared to the WisDOT projects, as the contract reaches its peak number of RFIs by month six and on average, declined as the contract continued. The peak number of RFIs submitted occurred at month six with 23-percent of the RFIs submitted at the time of this thesis write-up. The pattern of submittal was still a general decline over the current portion of the contract after the peak, but many apparent low points occurred during the winter months, which were not particularly discernable in the WisDOT projects.

The I-580 RFIs were put through the same three-step classification process as the WisDOT projects. There was no apparent classification process originally utilized by NDOT. The first step was to organize the RFIs with respect to their division. Figure 21 displays the Divisions for the 265 I-580 RFIs.

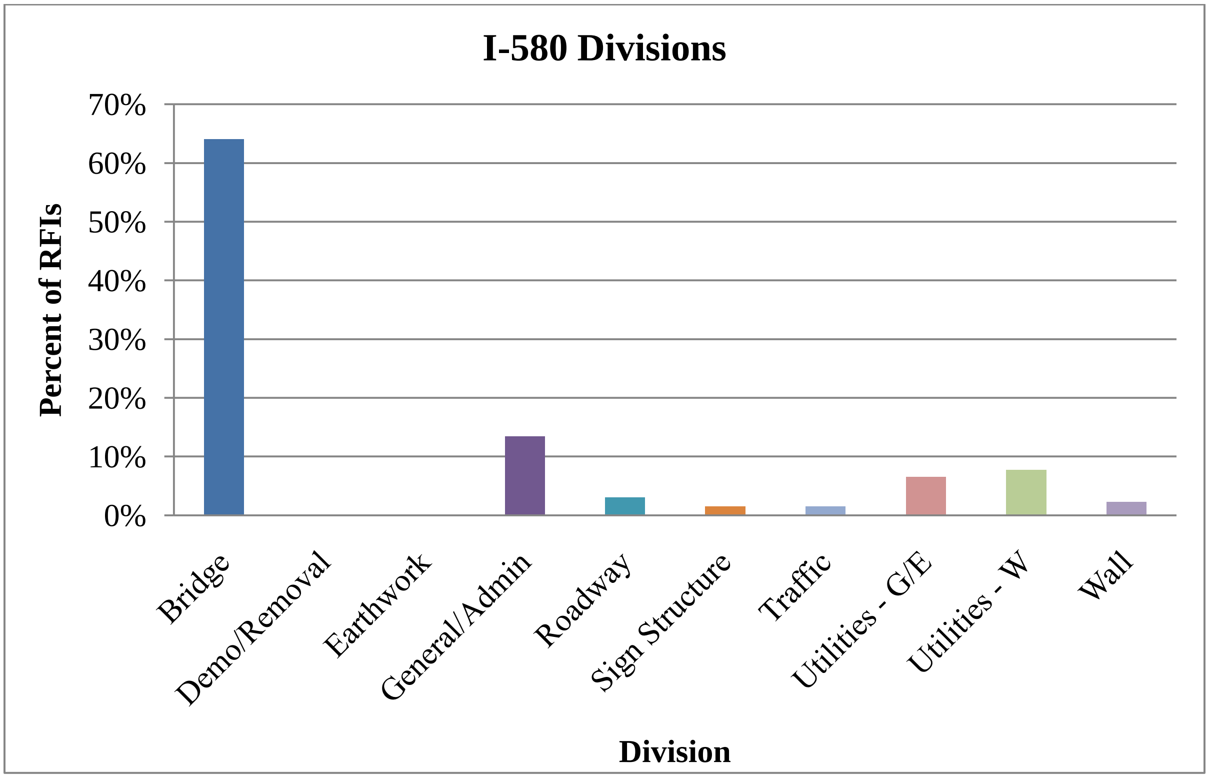


Figure 21 I-580 Divisions

The overwhelming percentage of Bridge-related RFIs can be partially attributed to the complex pilot truss bridge work that was originally a part of Contract A. Furthermore, many information requests stemmed from concerns of possible errors committed by the previous contractor, which became apparent from the RFI Logs. The second highest percentage of RFIs was distributed in the General/Admin division. A majority of the General/Admin RFIs were focused on clarifying project specifications or requesting specification modifications, such as adjusting concrete mixes or determining appropriate steel coatings.

After the division code distribution was created, the I-580 RFIs were classified with the CMSC reason codes. Figure 22 represents the reason code distribution for the NDOT project.

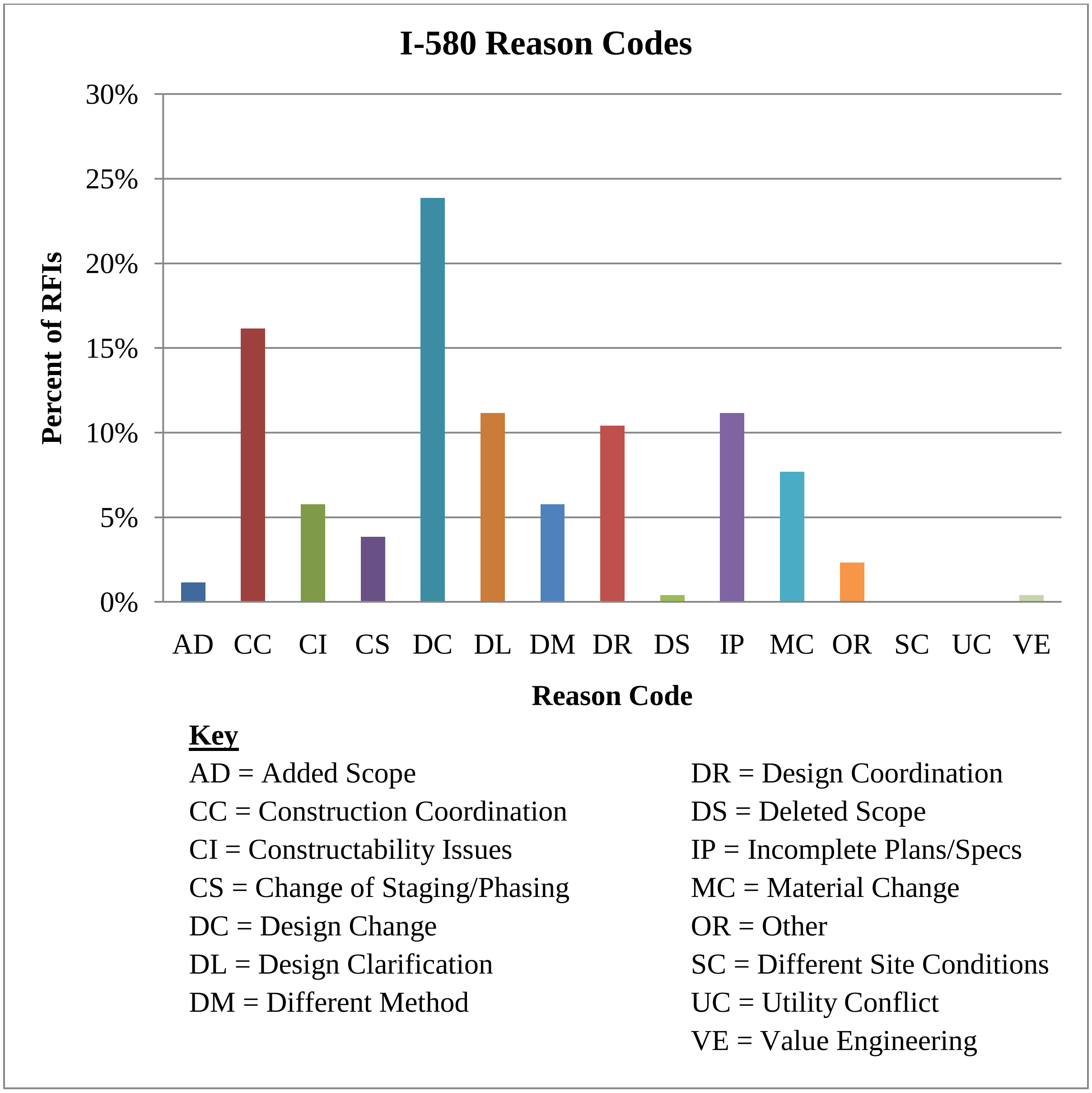


Figure 22 I-580 Reason Codes

The distribution of CMSC reason codes of the I-580 project is very similar to the WisDOT projects, further emphasizing that this distribution of reason codes is a reasonable representation of what can be expected on major highway projects. The comparison between the WisDOT projects and the I-580 project reason code distribution can be found below in Table 17.

Table 17 I-580 Reason Code Distribution Comparison to WisDOT Projects

Reason Code	Percent of Total Number of RFIs Submitted		
	Marquette Interchange	**I-94 N-S Freeway**	**I-580 Extension**
AD	2.0%	0.7%	1.2%
CC	15.7%	11.7%	16.2%
CI	4.6%	3.2%	5.8%
CS	2.5%	1.3%	3.8%
DC	9.4%	11.4%	23.8%
DL	18.0%	17.9%	11.2%
DM	5.2%	3.0%	5.8%
DR	7.8%	10.4%	10.4%
DS	1.2%	0.9%	0.4%
IP	20.8%	27.0%	11.2%
MC	4.2%	3.9%	7.7%
SC	0.5%	0.7%	2.3%
UC	3.3%	3.7%	0.0%
VE	1.5%	0.4%	0.0%
OR	3.4%	3.7%	0.4%

Similarly to the Marquette Interchange and the I-94 N-S Freeway projects, over 70-percent of RFIs in the I-580 Freeway project were allocated between Construction Coordination (CC), Design Change (DC), Design Clarification (DL), Design Coordination

(DR), and Incomplete Plans/Specs (IP). The most prevalent reason code for the I-580 extension project was Design Change (DC). However, to compare this project with the WisDOT projects, the IP reason code was further classified using the same five sub-categories. The results from this second classification can be found below in Figure 23.

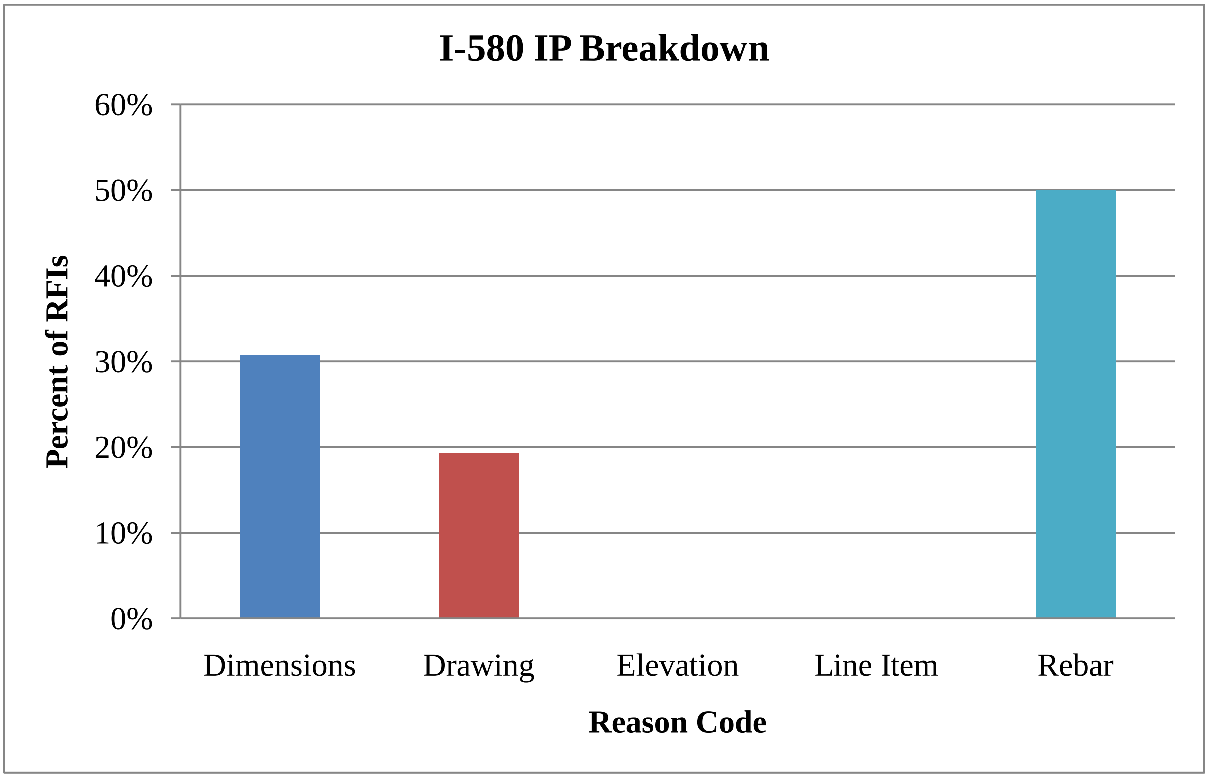


Figure 23 I-580 IP Breakdown

Similarly to the Marquette Interchange, the I-580 had complex concrete bridge construction which is apparent by the high number of questions concerning steel reinforcement. Many requests were the result of dimensioning errors in the plans. Table 18 below compares the I-580 IP reason code breakdown with the two WisDOT projects. Each project has a different distribution due to the differences in scope, contractors, and project teams.

Table 18 I-580 IP Reason Code Comparison to WisDOT Projects

IP Sub-Categories	IP Reason Code Breakdown		
	Marquette Interchange	I-94 N-S Freeway	I-580 Extension
Dimensions	34%	26%	31%
Drawing	9%	25%	19%
Elevation	7%	35%	0%
Line Item	17%	6%	0%
Rebar	33%	8%	50%

The final step to comparing the I-580 extension against the WisDOT projects was to determine the amount of unjustified RFIs. The NDOT RFIs were evaluated based upon the same criteria as the WisDOT projects, and a similar distribution was created, which is found below in Figure 24.

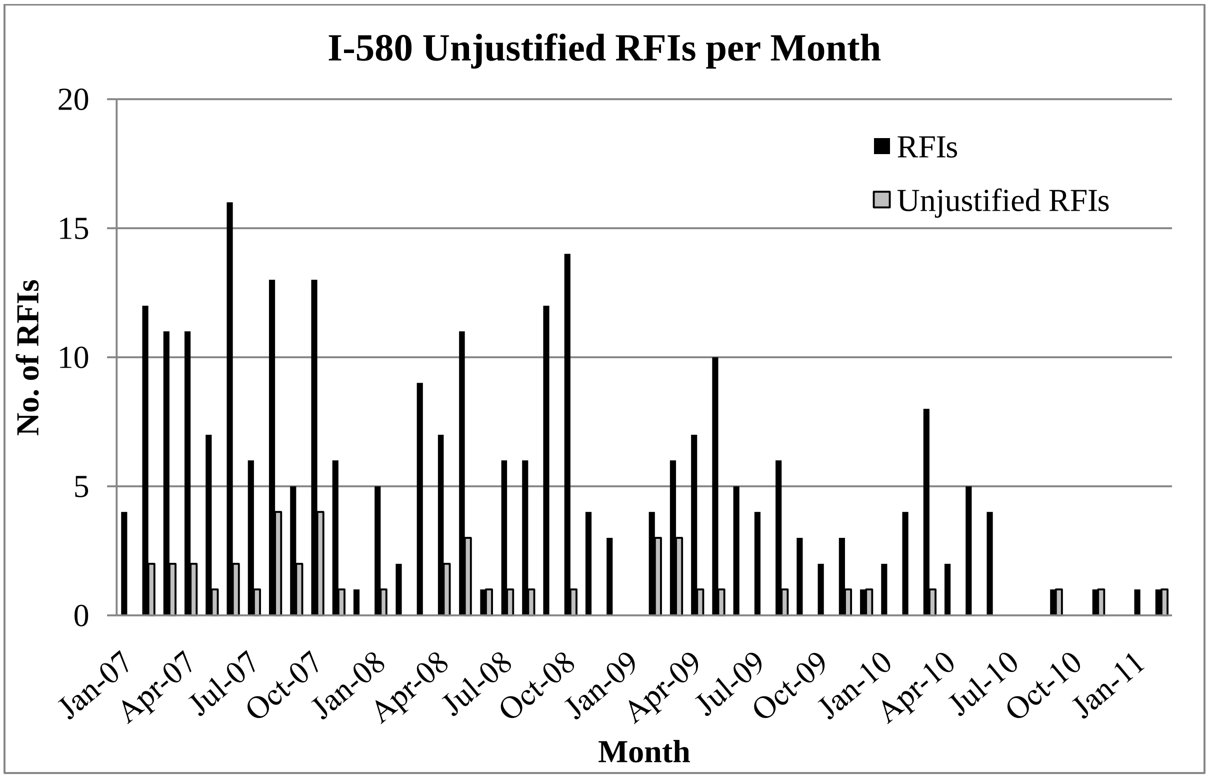


Figure 24 I-580 Unjustified RFIs

The flow of unjustified RFIs per month show the same trend as the total number of RFIs submitted each month for the I-580 Freeway extension project. This signifies that the percent of unjustified RFIs per month was constant throughout this project. Seventeen-percent unjustified RFIs for the I-580 project agrees with 12-percent unjustified and 16-percent unjustified for the Marquette Interchange and the I-94 N-S Freeway, respectively. To further describe the unjustified RFIs for the I-580 Freeway extension, their reason codes and respective distributions are located below in Table 19.

Table 19 I-580 Unjustified RFI Reason Codes

Reason Code	Percent of Total Number of RFIs Submitted	Unjustified Percent of Total Number of RFIs Submitted by Reason Code	Percent Unjustified of Total Number of Unjustified RFIs
AD	1.2%	33.3%	2.2%
CC	16.2%	11.9%	10.9%
CI	5.8%	20.0%	6.5%
CS	3.8%	30.0%	6.5%
DC	23.8%	27.4%	37.0%
DL	11.2%	17.2%	10.9%
DM	5.8%	33.3%	10.9%
DR	10.4%	3.7%	2.2%
DS	0.4%	0.0%	0.0%
IP	11.2%	10.3%	6.5%
MC	7.7%	15.0%	6.5%
SC	0.0%	-	0.0%
UC	0.0%	-	0.0%
VE	0.4%	0.0%	0.0%
OR	2.3%	0.0%	0.0%

The reason code column contains the abbreviations of the CMSC reason codes defined previously in Table 12. The second column, Percent of the Total Number of RFIs Submitted, displays the percent of all the I-580 Freeway extension RFIs that were classified with each respective reason code. The third column, Unjustified Percent of the Total Number of RFIs Submitted by Reason Code, shows the percentage of unjustified RFIs submitted with respect to the number of RFIs submitted under each individual reason code.

The fourth column, Unjustified Percent of the Total Number of Unjustified RFIs submitted, lists the percent of unjustified RFIs under each reason code with respect to the total number of unjustified RFIs for the I-580 Freeway extension.

According to Table 19, the I-580 project had a disproportionate percent of unjustified RFIs associated with the reason code DC, even though it was the most common reason code for I-580. The research team found many disagreements on what constitutes a valid suggestion offered by the contractor in the RFI Logs. Again, this could be minimized earlier in the project through carefully defining design changes to reiterate what would be considered valid. Monitoring this specific reason code as well as organizing a project team meeting to discuss the significant disproportion of unjustified RFIs in the DC reason code could be utilized at several points throughout the project.

In conclusion, the I-580 Freeway extension offered a different perspective on major highway construction. The purpose of gathering the I-580 Freeway extension data was to compare the contract results of the Marquette Interchange and I-94 N-S Freeway projects against another major highway project. This project allowed the research team to test the classification process and its associated definitions on a different SHA's project.

4.6 SUMMARY

This chapter provided a comprehensive look at the principal research of this thesis. The majority of this chapter analyzes the interpretation of RFIs from the Marquette Interchange and the I-94 N-S Freeway. Between the two WisDOT projects, 1,684 RFIs were submitted from $857 million dollars of awarded contracts. The three-step reclassification process created by the research team was intricately described to fully understand each phase.

The 10 divisions allowed for the RFIs to be organized among general areas of construction, while the 15 reason codes described the motivations for submission. The last step was to determine if the RFI was justifiable, which is important when considering the cost of reading, classifying, and answering each RFI.

The individual contract results from within the two projects were described by presenting the timing and flow of RFIs based on date of submission, as well as the payment schedule. The results from the classification of the RFIs were displayed on a per-project basis to understand the trends of each project. The results from each of the three steps were explicitly described to demonstrate the capabilities of the system and to highlight important conclusions. Lastly, the data from a NDOT project was analyzed in the same manner as the two WisDOT projects. This data was collected to compare the results of the major highway projects and utilize the newly developed classification process on an outside source.

CHAPTER 5

PERFORMANCE MEASURES, CONCLUSIONS, AND RECOMMENDATIONS

5.1 INTRODUCTION

The conclusion of this research was the creation of three new benchmarks and three new metrics for the RFI process. These benchmarks and metrics allow for the assessment of the performance of a transportation infrastructure project, as well as a method for classifying and further examining individual RFIs. A list of best practices with recommendations was also developed for establishing and improving an RFI process in the administration of construction contracts.

First, each new benchmark and metric is presented with a box plot to represent the mean, median, and middle 50-percent of the data and a short description. After each of the six performance measures are described, the benchmarks and metrics were qualitatively compared to NDOT's I-580 Freeway extension project. After this comparison, the research is summarized and the final conclusions are stated. Then, recommendations and a list of best practices are presented by the research team. Finally, this thesis finishes with recommendations for future research.

5.2 PERFORMANCE MEASURES

Six performance measures were established by the CMSC team to monitor the performance of WisDOT's mega highway projects. The six performance measures were: 1) RFIs per million dollars of awarded contract, 2) percent of RFIs answered within the request period, 3) percent of RFIs submitted based on percent complete from payment schedule, 4) average RFI response time, 5) percent of unjustified RFIs, and 6) percent of RFIs resulting in contract modifications. As discussed earlier, the project data were first analyzed using a weighted average technique to produce these metrics. The original benchmarks discussed at the beginning of this research resulted in a weighted average of 1) 2.4 RFIs per million dollars of awarded contract, and 2) answer 67-percent of RFIs within the request period. All six performance measures were first calculated using by the weighted average technique. However, to improve the robustness of the benchmarks for major highway projects, a more complex statistical analysis was then completed for all six performance measures.

With a sample size of 18 contracts, the benchmarks and metrics were recalculated using Bootstrapping to make more robust inferences about major highway projects. The Bootstrap analysis provided very similar results for the original benchmarks of 1) 2.4 RFIs per million dollars of awarded contract, and 2) answer 66-percent of RFIs within the requested time period.

The Bootstrap analysis was completed for all six performance measures to compare against the weighted average results. Box plots were calculated for five of the six performance measures to provide an expected middle range of results for contracts within a major highway project. Based upon the similar results from both analyses, the Bootstrap results were chosen to report the RFI benchmarks and metrics based on their improved robustness. Thus, the following benchmarks were found:

- **2.4 RFIs per Million Dollars of Awarded Contract:** The expected number of RFIs for a major highway project based on the awarded contract value. The larger the contract, the closer to this expected value. Smaller contracts within the major projects tended to have more variation.

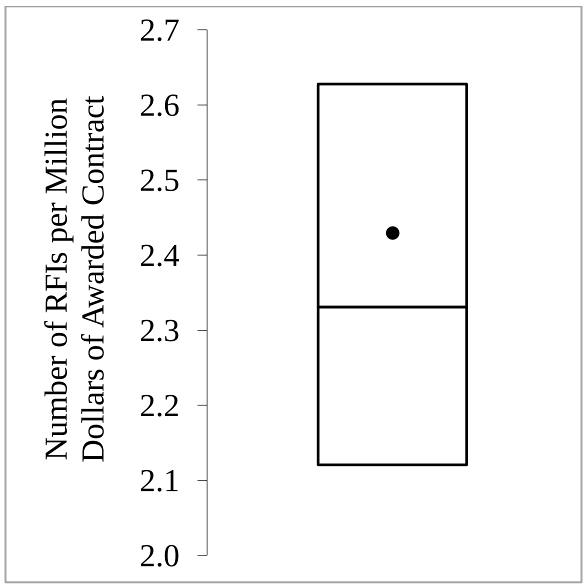


Figure 25: Number of RFIs per Million Dollars of Awarded Contract Box Plot

- **66-percent of RFIs Answered Within Requested Period:** Answer a minimum of 66-percent of RFIs by the requested date on the RFI form. A majority of the data shows that there is not a significant variation in the percentage of RFIs answered within the request period.

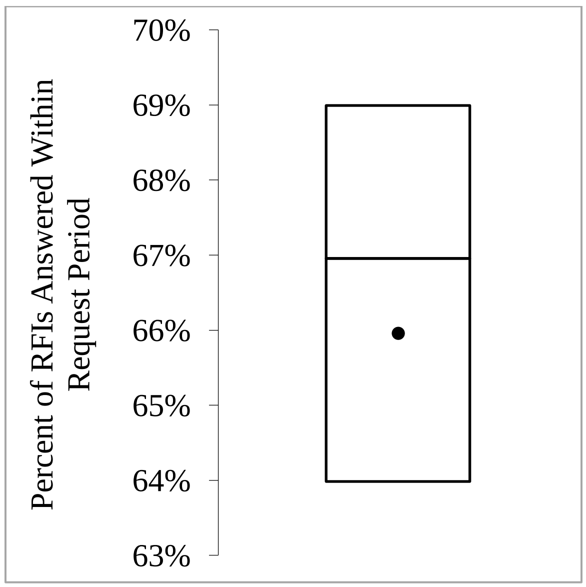


Figure 26 Percent of RFIs Answered Within Request Period Box Plot

- **Percent of RFIs Submitted by Percent Complete (Payment Schedule):** See Table 20 for a breakdown of the expected cumulative percentage of RFIs submitted at 25-percent complete intervals based on the contract payment schedules. The importance of this table is for a SHA to have the ability to confirm that their contract is performing near other successful contracts based on the RFI process at multiple intervals throughout the project. This table was calculated from contracts within the original data set that were 100-percent complete with at least 10 RFIs. Very small contracts within the WisDOT projects with less than 10 RFIs were not included because they heavily front loaded the percent of RFIs submitted, creating atypical results for the projects.

Table 20 Percent of RFIs Submitted by Percent Complete (Payment Schedule)

Percent Complete (Payment Schedule)	Cumulative Percent of RFIs Submitted
NTP	8%
25%	54%
50%	74%
75%	87%
100%	100%

The data from the Marquette Interchange and the I-94 North-South Freeway have offered additional metrics that provide helpful insight for future projects. These metrics verify current WisDOT practices and goals, as well as introduce new performance measures.

- **7.1-Day Average Response Time:** The average response time for an RFI was 7.1 calendar days. This number was compared to WisDOT's 7-day program goal of responding to an RFI to provide a reasonable amount of time for a sufficient answer as well as minimizing the effect on cost or schedule. The similarity confirms that allowing a seven calendar day time period between the submission of an RFI and the receiving of an answer is an appropriate amount of time. In fact, over 75-percent of the RFIs were answered in fewer than 7.5 days. The Marquette Interchange was completed three months ahead of schedule and the I-94 N-S project is currently on time in which both projects had a program goal of a 7-day request period for RFIs.

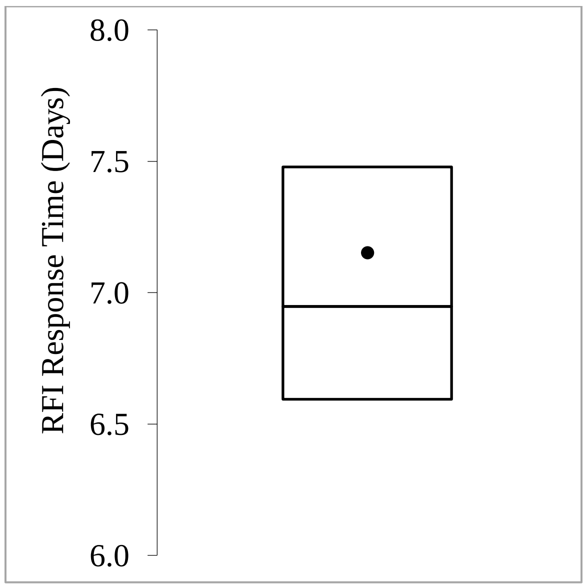


Figure 27 RFI Response Time Box Plot

- **12-Percent Unjustified:** Approximately 12-percent of RFIs received are unjustified, or unnecessarily submitted. There is little variation in the data which proves that a constant value of the percent of unjustified RFIs on a monthly basis is a valid assumption.

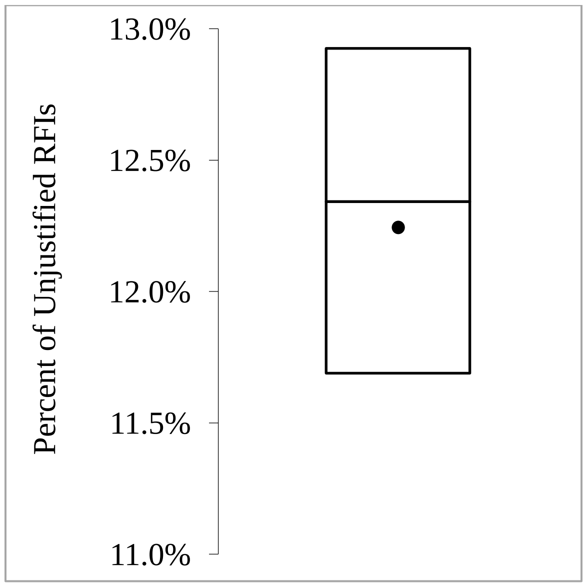


Figure 28 Percent Unjustified Box Plot

- **17-Percent of RFIs Result in Contract Modifications:** Approximately one in every six RFIs submitted result in a Contract Modification. The data results below show a large variation in the data suggesting that a project can expect a wide range of values between contracts.

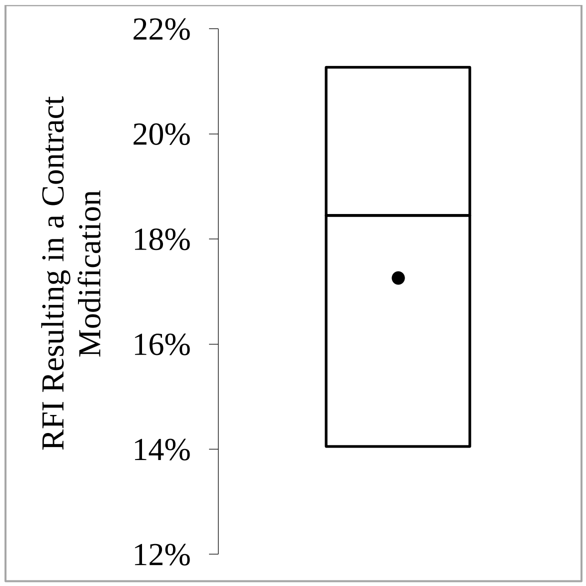


Figure 29 RFIs Resulting in Contract Modifications

These six performance measures are the analytical results of a thorough quantitative analysis of the RFI process from the Marquette Interchange and the I-94 N-S Freeway reconstruction. Each benchmark and metric has the ability to create an immediate impact in measuring the performance of the RFI process with respect to the success of the overall project and allow project managers to use the RFI process with confidence.

5.2.1 NDOT RESULTS

Three of the six benchmarks and metrics were also calculated for the NDOT I-580 Freeway extension project due to the availability of the data. These results do not affect the final benchmarks and metrics above but were calculated only to compare. The following benchmarks and metrics were calculated from the I-580 Freeway project data:

- 0.9 RFIs per Million Dollars of Awarded Contract
- 17.4-percent Unjustified
- 13.9 Day Average Response Time

The I-580 Freeway extension project has considerably fewer RFIs per million dollars than the WisDOT projects, which had 2.4 RFIs per million dollars of awarded contract. This caused the NDOT benchmark to be almost a third of the calculated WisDOT benchmark. Secondly, a higher percentage of RFIs were unjustified, 17-percent vs. 12-percent for the I-580 and WisDOT projects, respectively. It is difficult to compare this value to the WisDOT benchmark because the NDOT specifications could be written differently and the overall program of major highway projects for NDOT operates differently. Many design suggestions were submitted by the contractor, which was the largest source of unjustified RFIs for the I-580 Freeway extension. The research team suggests that the SHA and contractor need to discuss what types of design changes might be accepted to minimize the number of unjustified design suggestions. The last benchmark that could be compared was the average response time. The I-580 Freeway extension averaged twice the length of time to respond as the WisDOT projects, 14 days vs. 7 days, respectively. This was due to the lack of a “request by date” on the NDOT RFI Form for the contractor to fill in, as well as the failure to discuss and agree upon an accepted goal response time frame. These benchmarks and metrics provide an informative look at another SHA’s project and provide a comparison to the WisDOT projects.

5.3 SUMMARY OF RESEARCH

The Best Practices study funded by the WisDOT Policy Research Program has singled out the RFI process as an important best practice for the delivery of major highway project and is a significant source of benchmarking and metric opportunities. The ability to quantitatively measure the performance of the RFI process has the potential to identify significant areas of concern within a project, to breakdown the reasons for why an RFI is submitted, and to understand the expected submittal rate of RFIs. If the project team can identify why an RFI is submitted, mitigation plans can be implemented to further investigate the issues and monitor their effect on the overall project. Furthermore, a project team that has the knowledge of the expected number of RFIs as well as the expected rate of submission has the ability to know if their project is maintaining similar performance levels based on other successful projects and where they can expect to be in terms of amount of RFIs at various levels of completion.

The research began with reviewing existing literature on performance measures, benchmarking in construction, and the RFI process. To the best of the researchers’ knowledge, there were currently no quantitative measures within the RFI process for the delivery of transportation infrastructure. A survey was then completed to understand the current levels of RFI usage throughout the United States in SHAs. A summary of the responses provided the research team with the necessary data to formulate the research and develop recommendations.

After collecting almost $1 billion dollars worth of construction documents, a formal three-step process was created and utilized to organize the data in a matter that would optimize the potential benefits. Almost two thousand RFIs were evaluated and interpreted, and then an intricate statistical analysis was completed to provide robust benchmarks and metrics. These new performance measures are provided with an expected range of values and have the ability to be used on any major highway project. Leading and lagging performance measures are provided in order to be proactive in anticipating the impact on desired results and assessing the achievement of a project's objectives, respectively. The research was concluded with the development of the RFI form and a list of best practices. The RFI form is an updated version of the current WisDOT form that easily enables the implementation of the newly developed three-step classification process. WisDOT can use this publication, along with the list of best practices as they look to improve or implement an RFI process.

5.4 CONCLUSIONS

The RFI process is a best practice of highway construction that provides documented communication between the contractor and project team. It allows a need for information on the plans, specifications, and construction to be formally recorded and tracked. Furthermore, the use of RFIs forces communication between all participants in the construction process. In order to give WisDOT the guidance and tools to improve an existing RFI process or implement the most effective RFI process, a defined classification process, performance measures, and best practices need to be utilized.

The successful implementation of the new three-step classification process is necessary to achieve the full benefits of the RFI process. Classifying each RFI will allow WisDOT to have the ability to identify problem areas and improve the effectiveness of the RFI process by categorizing RFIs by division and reason code. Each major highway project will have a different respective distribution among division codes; however, projects that are of a similar size and scope as the two WisDOT major highway projects in this research will have a similar distribution of CMSC reason codes. The majority of RFIs will be classified within the following five categories: Construction Coordination (CC), Design Change (DC), Design Clarification (DL), Design Coordination (DR), and Incomplete Plans/Specs (IP). Furthermore, individual reason codes can be broken down into specific subcategories to identify actual problem areas. For example, the IP reason code breakdown for the Marquette Interchange showed that original plans needed additional review time that focused on dimensioning and rebar. This advantageous knowledge is a lagging performance measure to be incorporated into future major highway projects with a similar scope to the Marquette Interchange. Also, the IP reason code breakdown for the I-94 N-S project showed that the plans needed additional review time that focused on the plan details especially individual labels pertaining to dimensioning and elevations.

A well-defined set of RFI performance measures is a critical tool that assists in the evaluation of a major highway construction project. These six benchmarks and metrics are the result of a complete statistical analysis of two successful major highway projects. Each benchmark or metric has the normal range of values provided in a box plot, which shows the middle 50-percent of the Bootstrap data. With some variation expected, other major highway projects can use these performance measures to critically evaluate their project based on the RFI process. In conclusion, the development of the new classification process and performance measures was derived from successful projects for other project teams to compare their project's performance, as well as implement an effective RFI process.

5.5 RECOMMENDATIONS

The authors provide the following recommendations for successful implementation of an RFI process. The first recommendation is to employ the new classification process for RFI submittal once all project managers and design team members are on-board. A revised RFI form was created to easily implement this new classification process, which is found in Appendix B. The engineer that answers the RFIs is also the individual responsible for classifying the RFIs, including Division codes, reason codes, and justifiability. A step-by-step process has been provided with all the necessary definitions to implement the new classification process with ease. The project managers will immediately have the ability to identify problem areas, monitor their progress, and implement corrective strategies earlier than before. As shown above with both projects, it may be necessary to create a further breakdown of a single reason code due to it being a high percentage of the overall project's reason codes, such as Incomplete Plans/Specifications.

Secondly, the research team recommends the integration of the newly created benchmarks and metrics immediately into major highway projects. These measures will help project managers evaluate the performance of their projects by providing thresholds to meet and indications of project success. However, several of the performance measures should also be goals for a project team to meet and surpass. Achieving a 66-percent rate of answering RFIs within their requested time period should not be the standard to settle at, but would be useful knowledge for WisDOT to know whether their staffing levels are appropriate and the effectiveness of their overall RFI process. Also, a response date requested by the contractor is critical to minimizing the effect on a project of a delayed response to an RFI. As shown by the difference in response time between the I-580 extension project and the calculated benchmark, 13.9 days and 7.1 days respectively, a requested response date is very important. Furthermore, realizing 12-percent unjustified RFIs for a project should be the approximate maximum for a major highway project. Minimizing repetitive and unnecessary RFIs saves the project team time and money.

In order to maintain less than 12-percent of unjustified RFIs, the research team recommends providing monthly RFI reports for the prime Contractor describing which RFIs were unjustified and reasons how to potentially minimize the number of future unjustified RFIs, as well as the number of open or unresolved RFIs. Reason codes with significant disproportions between justified and unjustified percentages need to be monitored and a potential meeting may need to be organized to discuss the significant disproportion of unjustified RFIs. Furthermore, the definitions of these reason codes may need to be reiterated and clarified. These proactive methods will provide clear communication between members of the project team and allow the expectations to be openly discussed.

5.5.1 BEST PRACTICES

To supplement these three recommendations, a list of best practices was identified because it can be helpful for project teams just starting to use RFIs to have guidance on the most effective use of the RFI process in construction management. Thus, the following list of best practices was created based upon work previously completed by the research team to identify best practices in the RFI process. The list is sub-divided into best practices for the target audiences, the Department and Contractor, individually and as a team.

- **Department**
    1. Establish an RFI process that informs the Contractor how RFIs are to be submitted and where the RFIs need to be directed.
    2. Create a standardized RFI submittal form that contains the following information:
        a. Project name
        b. Date of submittal
        c. Name of submitter
        d. Information requested
        e. Date answer is required
        f. Date response is provided
        g. Name of responder
        h. Response
    3. Assign a unique tracking number to each RFI when it is received.
    4. Establish a *Request for Information Log* and enter the RFI number and status. The status remains "OPEN" until the RFI has a response.

5. Respond to the RFI in a timely and accurate manner. If the response time will be longer than the required date identified on the RFI submittal form, notify the submitter of the anticipated response time.
6. Once a response has been received, the status in the *RFI Log* is changed to "CLOSED" and the response is distributed to all affected parties.
7. If the response to the RFI will result in an increase in the scope of work or a change in contract conditions, the Project Manager needs to immediately initiate a change order request by processing a Change Order Proposal.

- **Contractor**
  1. Create a list of questions of potential issues prior to project startup and meet with the Project Manager to resolve any issues.
     a. For example: The field supervisor performs a constructability review by examining the plans and specifications in order to assemble a list of discrepancies and issues that need to be resolved. Resolve this list as quickly as possible to help initiate the RFI process. Consider holding an individual meeting to resolve these issues.
  2. Establish a hierarchy to be followed when identifying and processing RFIs. Crew members address questions to their crew foreman. The crew foreman fills out the Request for Information form and forwards it to the Field Supervisor. The Field Supervisor reviews the form and forwards it to the Project Manager.

3. Submit the RFI to the Project Manager using the standardized RFI form that contains the following:
    a. A single question or clarification.
    b. A detailed, yet concise description of the requested information along with a reference to the applicable drawing number and specification to show that the request has been researched (DE ABC-AIA, 2004).
    c. A possible solution to a problem to potentially speed up the response time and result in a favorable outcome.
    d. Any needed price or schedule change to show evidence that the request has been properly considered by the contractor and to potentially speed up the response time (DE ABC-AIA, 2004).
    e. Required response date.

- **Department and Contractor**
    1. Mutually agree on a timeframe for responding to submitted RFIs.
    2. Mutually agree on the type and scope of issues that necessitate the submittal of an RFI, and work together to ensure that submitted RFIs are appropriate. This well help to control the number of RFIs.
    3. Efficiently use Project Program Meetings to share information and foster respectful, open exchanges between the project teams.

5.6 RECOMMENDATIONS FOR FUTURE RESEARCH

The research team recommends that the remaining contract data from the I-94 N-S Freeway reconstruction be gathered and classified to strengthen the newly created benchmarks and metrics. Furthermore, WisDOT is currently beginning their third major highway project in the spring of 2011 in northeastern WI on US Highway 41. The USH-41 reconstruction project data could be another source of RFI information that could improve and verify the results from the Marquette Interchange and I-94 N-S Freeway. Lastly, the research team recommends implementing the finalized benchmarks on future major highway projects in Wisconsin, such as the potential I-90 reconstruction from the Illinois state line to Madison, WI or the Zoo Interchange in Milwaukee, WI, to perform case study analyses to verify results and realize potential improvements. This would allow the research team to assess the level of implementation and effectiveness of the newly created benchmarks and metrics. Furthermore, case study analyses will provide feedback to improve the clarity of the definitions and recommendations for the overall RFI process.

APPENDIX A: WisDOT LOG AND REPORT SAMPLES

Multi-Project Request and Answer Report

Multi-Project Request and Answer Report

*Some information not displayed due to security restrictions.

Project: 10302071 LAYTON AVE, C-D RDS

Type	To	Request	From	Number	Issue	Title	Answer	Status	Dated	Responded	Required
RFI	WCP			00007		Struct. Mounted Wall Design Loading		CLO	2/9/2010	2/10/2010	2/16/2010
		Structure Mounted Noise Wall: Our current structure mounted design has the post mounted to the barrier using upper and lower steel plates, each with either two or four drilled epoxy anchors. This is slightly different from the 4 upper drilled in anchors and 2 lower cast in place anchors shown in the contract documents. The drilled in anchors provide more flexibility for the installation. With this anchor design, the maximum working reaction force on the anchor assembly (four anchors) is 35.9kip (for 22' height wall and 10' spacing), which is slightly higher than the proposed allowable load of 29 kip. This higher reaction force applies only at maximum wall heights, and at all other heights reaction force is around 30 kips. Please confirm that this loading of the barrier will be acceptable?					The contract documents states the maximum pullout design loading for the anchor assembly noise barrier not to exceed 29 kips. The contract documents show the lower anchor assembly to be poured in place; however, the design for the wall may allow for the anchors to be drilled and epoxy in as long as the maximum pullout does not exceed the 29 kips. This RFI response is intended for clarification only and the Department does not anticipate any cost or schedule impacts to your contract. If this is not the case, please forward your official notification in accordance with Section 104.3 of the WisDOT Standard Specifications.				
RFI	WCP			00008		Temporary NoiseWall Design Criteria		CLO	2/9/2010	2/9/2010	2/16/2010
		Temporary Noise Wall: What design criteria shall be used for the temporary noise wall (TN-1)? Is it acceptable to use lower criteria given that the wall is temporary?					Please refer to Article 225 of the Special Provisions for the design criteria needed to use for the temporary noise wall (TN-1). This RFI response is intended for clarification only and the Department does not anticipate any cost or schedule impacts to your contract. If this is not the case, please forward your official notification in accordance with Section 104.3 of the WisDOT Standard Specifications.				
RFI	WCP			00009		RW-T2 Temporary Wall Offsets		CLO	2/9/2010	2/16/2010	2/16/2010
		We have laid a straight segment out to the inside of the radius and using a 50' arc length - the offset is 1'-2". Using a 100' arc length - the offset is 2'-4". Will either of these cause an impact as asked below? What is the maximum offset(s) that the temporary wall alignment on the curve with a radius of 531 feet that will not impact the 6'-0" shoulder in front of the wall on Ramp WSA nor the existing traffic that will be maintained behind the wall? Could someone give me a call to discuss this issue?					Please refer to sheets 2063 and 2065 of the plan sheets for the offset information for RW-T2. Sheet 2063 shows that sta. 9+39.11-13+44.41of RW-T2 has a 6' offset to the R/L Ramp WSA. The typical section located on sheet 2065 shows that the distance between the front face of wall and the outside shoulder point ranges from 0'-0" (minimum) to 12'-3" (maximum). This RFI response is intended for clarification only and the Department does not anticipate any cost or schedule impacts to your contract. If this is not the case, please forward your official notification in accordance with Section 104.3 of the WisDOT Standard Specifications.				
RFI	WCP			00010		RW-T2 Revised Layout Drawing		CLO	2/9/2010	2/16/2010	2/16/2010
		Can Gillen be furnished a "revised" layout drawing, (that does not impact traffic or Ramp WSA) for RW-T2, in straight segments of 50' lengths for that portion of the curved wall that does not require tiebacks or a waler and in 18' straight segments for that portion of the curved wall that will receive tiebacks and wales. The 18' length(s) would allow for the waler to span over 4 tiebacks with a waler cantilevering 2.25 feet on each end. Again time constraints will not allow Gillen to procure a "rolled" section of waler to the specified curve radius.					Please respond with a detailed layout the the proposed adjustments to the RW-T2 wall. Layout should include, but not limited to, typical sections of the differing whalers with respect to the shoulder of the Ramp WSA (temporary west to south ramp) as well as the plan view of the wall including the straight runs of sheet pile. This RFI response is intended for clarification only and the Department does not anticipate any cost or schedule impacts to your contract. If this is not the case, please forward your official notification in accordance with Section 104.3 of the WisDOT Standard Specifications.				
RFI	WCP			00011		Survey- Plan Sheet 1019		CLO	2/9/2010	2/16/2010	2/16/2010
		Sheet 1019: The vertical profile ends in a curve at STA 653+20. The VPI is given at STA 653+20 but there is no data at the VPT. Using the VCL and K, I calc a VPT at 653+95 to be el 679.01 & grade 2 being -0.925%. Please verify					The VPT is beyond the project limits and should not be needed. The contractor has to match the existing pavement at the project limits. The existing pavement elevations should be used to confirm the new pavement grades. This RFI response is intended for clarification only and the Department does not anticipate any cost or schedule impacts to your contract. If this is not the case, please forward your official notification in accordance with Section 104.3 of the WisDOT Standard Specifications.				

Change Management Log

Change Management Log (by CM#)

Contract Mod #	Title	Status	Date	Reason Code	Change Issue	Engineer ROM	Contractor Proposal	Negotiated AJR	Final Value	Change Mgmt #
Project No.: 1030-20-71					**LAYTON AVE, C-D RDS**					
013	Jobsite Access Locations NB	APP	04/30/10	SE	TR0007	$0.00	$0.00	$0.00	$0.00	M00062
						$0.00	$0.00	$0.00	$0.00	
014	Plan Rev# 5-Revised Quantity Adjust	APP	04/26/10	PC	GN0024	$223.12	$0.00	$223.12	$223.12	M00047
						$223.12	$0.00	$223.12	$223.12	
015	NB/SB Lane 1 Asphalt Repair	APP	03/30/10	PC	RD0015	$162,780.00	$0.00	$175,938.00	$175,938.00	M00032
015	Removing Asphaltic Surface Milling	APP	03/19/10	SE	RD0008	($24,526.22)	$0.00	($24,500.12)	($24,500.12)	M00023
						$138,253.78	$0.00	$151,437.88	$151,437.88	
016	Non-Conforming Backfilling Material	APP	04/08/10	SS	GN0021	($7,000.00)	$0.00	($12,960.00)	($12,960.00)	M00039
						($7,000.00)	$0.00	($12,960.00)	($12,960.00)	
017	Backfilling Median Pier (B-40-814)	APP	05/10/10	PC	BR0010	$3,675.00	$0.00	$3,625.00	$3,625.00	M00071
017	B-40-828 HP Piling Points	APP	04/15/10	PC	BR0009	$41,411.70	$41,411.70	$41,412.00	$41,412.00	M00041
017	90% Payment Item	APP	05/13/10	SS	GN0029	$1.00	$0.00	$1.00	$1.00	M00075
						$45,087.70	$41,411.70	$45,038.00	$45,038.00	
018	Select Crushed Unit Change	APP	07/12/10	SS	GN0027	$0.00	$0.00	$1,137.60	$1,137.60	M00139
						$0.00	$0.00	$1,137.60	$1,137.60	
019	Changing Staining Concrete to PPQ	APP	05/17/10	MI	GN0032	$0.00	$0.00	$0.00	$0.00	M00080
						$0.00	$0.00	$0.00	$0.00	
020	Access Locations - SB - Revised TMP	APP	06/02/10	PC	TR0011	$0.00	$0.00	$0.00	$0.00	M00108
						$0.00	$0.00	$0.00	$0.00	

Multi-Project Issue Report

Multi-Project Issue Report
Construction ID's Only

*Some information not displayed due to security restrictions.

Project No.: 1030-20-71 LAYTON AVE, C-D RDS

Number	Title	Ball In Court	Project Issue	Program Reference	Opened	Closed	Change Involved	Status
00025	S-40-434, 435, 551, 565 Median Barrier Removal	WCP - GML	SS0001		02/19/10	04/23/10	N	CLO

2/19/10 (MAM-JJK) Issue started from RFI 24. The plans did not address median barrier removals at the sign structure foundations south of College Ave. As a result, we will pay for removing concrete barrier, concrete barrier temporary precast left in place, and temporary thrie beam connection at the contract prices. ROM, draft WAF, and draft AJR available. WAF 003 sent - additional bid items.
03/03/10 (JH-Mort): Greg Lemerond reported that the AJR has been signed by Jay O. and is awaiting FHWA approval. Issue to be included in contract modification #2.
03/17/10 (JH-Mort): FHWA has approved AJR.
3/23/10 (MAM-JJK) Mod #2 sent to Walsh for signature.

4/23/10 (MAM-JJK) Fully executed mod sent to the contractor. Issue closed.

Number	Title	Ball In Court	Project Issue	Program Reference	Opened	Closed	Change Involved	Status
00026	CRI #3 - Timber Lagging Substitution Request	WCP - GML	RW0004		02/23/10	04/23/10	Y	CLO

2/19/10 (JH-Mort): Opened issue to track CRI associated with substituting Treated Timber Lagging with Hardwood Timber Lagging. During the 02/17/2010 CRI meeting, Walsh claimed that nontreated hardwood lagging had been used on multiple projects with IDOT and will be stamped by an engineer. It was also stated that lagging is only a temporary structural component and once face concrete is installed, lagging is no longer necessary. Walsh to proceed with submitting formal proposal.
2/23/10 (JH-Mort): Sent letter to Walsh indicating design concept had been accepted and they could proceed with submitting a formal proposal.
03/03/10 (JH-Mort): Jay O. indicated in issue meeting that proposal was to be received this week.
03/04/10 (MAM-KHM) Received Serial Letter WCC0017. In this letter Walsh submitted the CRI- Proposal. Walsh indicates that the CRI proposal will not affect the interim completion date nor the final completion date of the submitted CPM schedule. Estimates cost saving is available. Need review and response.
03/08/10 (MAM-KHM) Response to Serial Letter WCC0017- CRI Proposal, sent to the contractor informing him that the department has accepted the CRI proposal.
03/09/10 (MAM-KHM) ROM available.
03/10/10 (JH-Mort): Greg L. is finalizing the AJR and will deliver to Jay O. for approval. Issue will be included in contract modification #5.
03/17/10 (JH-Mort): Jay O. has signed AJR and sent to FHWA for approval.
3/26/10 (MAM-JJK) AJR signed by FHWA.
03/31/10 (JH-Mort): Contract Mod is being reviewed by FHWA.
4/1/10 (MAM-JJK) Mod #5 sent to the contractor for signature.

4/23/10 (MAM-JJK) Fully executed mod sent to contractor. Issue closed.

Number	Title	Ball In Court	Project Issue	Program Reference	Opened	Closed	Change Involved	Status
00027	Additional Temp Barrier at Layton Approaches	WCP - GML	RD0001		02/25/10	04/23/10	N	CLO

2/25/10 (MAM-JJK) Adding Concrete Barrier Temporary Precast at the East and West Approaches of EB and WB Layton Avenue at Removal Limits as a Safety Enhancement. ROM available. WAF 006 sent to the contractor - using bid items.
03/03/10 (JH-Mort): Greg L. indicated that issue will be included in Contract Modification #2.
03/17/10 (JH-Mort): FHWA is currently reviewing AJR and had a few questions regarding back-up to costs associated with penny bid items.
3/23/10 (MAM-JJK) Mod #2 sent to Walsh for signature.

4/23/10 (MAM-JJK) Fully executed mod sent to the contractor. Issue closed.

Number	Title	Ball In Court	Project Issue	Program Reference	Opened	Closed	Change Involved	Status
00028	Procurement of State-Furnished Equipment	WISDOT - AXD	EL0005		02/25/10	11/24/10	N	CLO

2/25/10 (MAM-JJK) Issue started as a placeholder to track the procurement of state-furnished equipment for this project. Ahmet has sent a list to Dean Beekman (FTMS) for delivery status. Waiting to hear back.
03/03/10 (JH-Mort): A material list needs to be sent to Charles Landey so that he can begin procuring any long lead time electrical equipment.
03/10/10 (JH-Mort): Ahmet reported that the ITS coordination meeting is to happen next week.
03/17/10 (JH-Mort): List of equipment was ordered and delivery dates are to be discussed at today's ITS meeting.
3/24/10 (MAM-JJK) The state-furnished equipment is all ITS (There is no lighting or signals.) We should have all of it by 9/1/2010. This is acceptable with the current schedule.
03/31/10 (MAM-JTH): Issue status changed to OLD.
04/28/10 (MAM-KHM) Only waiting on fiber.
07/21/10 (MAM-KHM) The fiber optic cables have been delivered. Issue closed.
11/17/10 (MAM-KHM) Issue re-opened. Some materials are not what thought we were going to get. Also, the TOC gave fiber optic to another project.

11/24/10 (MAM-KHM) Per Jay O. TOC gave our project's fiber optic to another project in Kenosha. However, TOC has provided the required quantity to our project afterward and the fiber optic has been installed. Issue can be closed.

Number	Title	Ball In Court	Project Issue	Program Reference	Opened	Closed	Change Involved	Status
00029	Type 5 Manholes at Angle Points	WCP - DJT	WU0003		02/25/10	03/31/10	Y	CLO

02/25/10 (MAM-KHM) The office reviewer has identified pipe angle and construction issues with MH's 802 and 803. DIN#26 sent inquiring about how does a Type 5 manhole fit with inbound and outbound pipes at a angle point.
03/03/10 (MAM-KHM) DIN#26 response is available.
03/03/10 (JH-Mort): During issue meeting Jay O. directed Drew T. to issue a no-cost WAF for providing an alternate type manhole.
3/4/10 (MAM-JJK) WAF #13 sent to contractor. This is a no-cost WAF, and gives the contractor a more constructible option for a manhole at the 54" pipe angle points.
03/10/10 (JH-Mort): Walsh has not submitted a response to the no-cost WAF. All work associated with WAF is scheduled to be completed within 3-weeks, after which time issue will be closed.
03/17/10 (JH-Mort): During issue meeting it was reported that work is on-going and thus far not additional costs have been requested.
03/23/10 (JH-Mort): Received submittal from Walsh requesting the use of a Base Tee Alternative to Type 5 Manholes (Submittal No. SPV.611.201-04)
3/24/10 (MAM-JJK) We accepted Walsh's request for Base Tees. Will send no-cost WAF.
03/25/10 (MAM-KHM) No cost WAF# 19, Base Tee Alternative to Type 5 Manhole, sent to the contractor.

3/31/10 (JH-Mort): Only specific structures were allowed to use the Base Tee Alternative and currently no expected cost impact. Issue closed.

Construction Contract Payment Schedule

Vouchers for Contract: 20100120001 Return to Initial Selection Page

Contractor: WALSH CONSTRUCTION COMPANY
Surety: TRAVELERS CASUALTY AND SURETY CO.
Location: I 43/94/894 MILWAUKEE COUNTY
Description: N-S FREEWAY / COLLEGE AVE - HOWARD AVE

Time charged:	293	**Total Earnings:**	$90,778,817.20
Time Allowed:	12/17/2010	**Material Allowance:**	$0.00
Percent Time:	99.65	**Gross Earnings:**	$90,778,817.20
Current Contract Amount:	$89,707,812.92	**Retainage:**	$818,707.27
Awarded Contract Amount:	$81,496,581.63	**Net Earnings:**	$89,960,109.93
Percent Complete Work:	101.19	**Liquidated damages:**	$0.00
Projects:		**Payments:**	89,960,109.93

1030-20-71
1060-22-93

Note: This report is for informational purposes only. Printer-friendly version
It is not an actual payment document. CSV Export
Prime Contractors should expect payment 5 - 15 days from the "Pay Period" date. Glossary of Terms

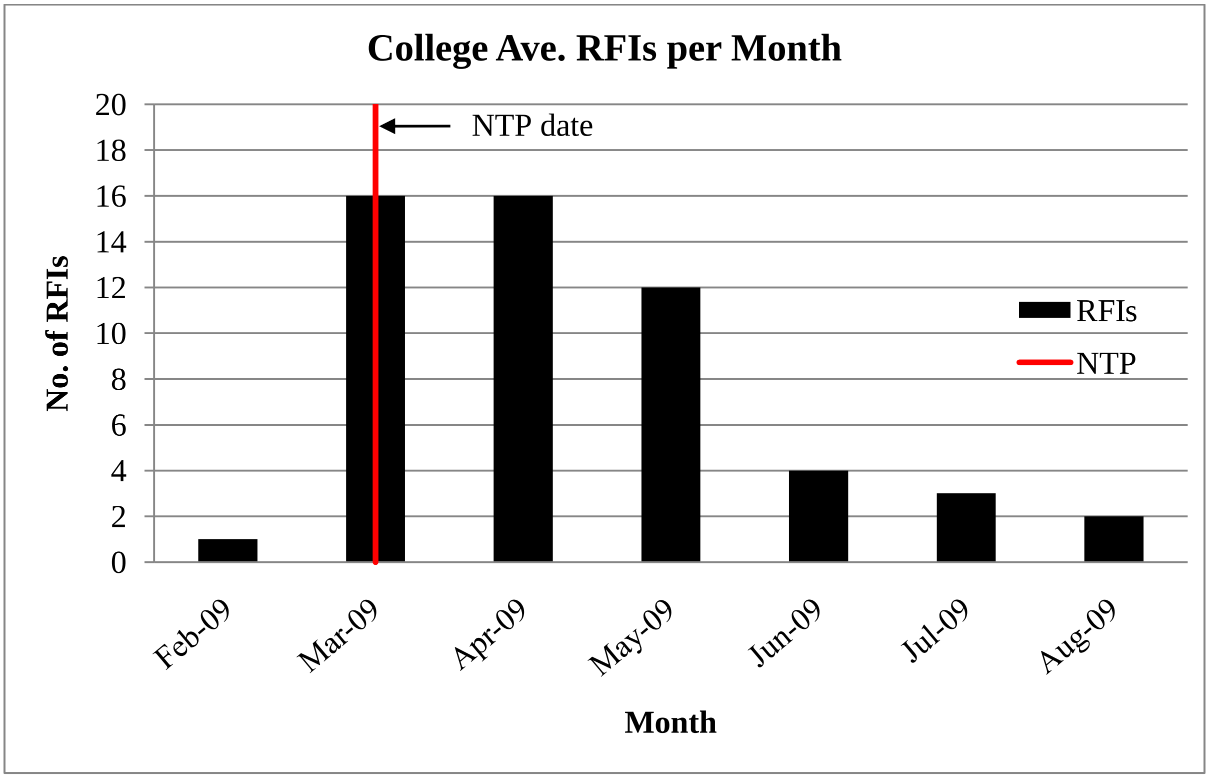
Voucher	Type	Pay Period	Total Earnings ($)	Material Allowance ($)	Retainage ($)	Liquidated Damages ($)	Payment ($)	% Paid
0000	SM	00/00/0000	0.00	0.00	0.00	0.00	0.00	0.00
0000	SM	00/00/0000	0.00	0.00	0.00	0.00	0.00	0.00
0001	SM	03/05/2010	874,693.18	0.00	0.00	0.00	874,693.18	0.98
0002	SM	03/12/2010	631,185.65	52,991.90	0.00	0.00	684,177.55	0.76
0003	SM	03/26/2010	1,221,292.42	167,830.20	0.00	0.00	1,389,122.62	1.55
0004	SM	04/02/2010	1,436,812.34	0.00	0.00	0.00	1,436,812.34	1.60
0005	SM	04/09/2010	750,577.17	-2,966.13	0.00	0.00	747,611.04	0.83
0006	SM	04/23/2010	2,018,095.62	35,647.00	0.00	0.00	2,053,742.62	2.29
0007	SM	04/30/2010	2,582,778.24	0.00	0.00	0.00	2,582,778.24	2.88

APPENDIX B: CONTINUATION OF I-94 CONTRACT DATA

The I-94 North-South Freeway reconstruction data set consists of 14 contracts. Four are previously described in Chapter 4, and the data from the other 10 contracts are detailed below. Graphs shown in Chapter 4 were only reproduced for one of the 10 contracts, College Avenue Interchange, due to the low number of RFIs for each of the other nine contracts. Graphs were not produced for these nine contracts because no conclusions about the timing or pattern of RFIs could be shown with such a small number of RFIs. The ten contracts are ordered below with respect to their NTP date.

The 27th Street Bridges and Approaches contract had an awarded contract value of $11,307,989. There was 1 RFI submitted on this project, resulting in 0.1 RFIs per million dollars of awarded contract. The Notice to Proceed (NTP) date was March 16, 2009. The single RFI is closed, but no response date was provided.

The College Avenue Interchange had an awarded contract value of $11,714,661. There were 54 RFIs submitted on this project, resulting in 4.6 RFIs per million dollars of awarded contract. Approximately 9-percent of the RFIs were submitted before the NTP of March 23, 2009. The average response time for a College Ave. Interchange RFI was over 17 calendar days. However, 64-percent of these RFIs were answered by the requested date specified on the RFI forms, which averaged 6.8 calendar days. Fourteen percent of the College Ave. Interchange RIFs were unjustified. The figure below shows the number of RFIs submitted per month for the College Ave. contract. The NTP is represented by the thin, vertical line.



The table below relates the percent of total RFIs to the percent complete for the Layton Ave. contract based upon the payment schedule. In order to produce this table, the number of RFIs submitted between every payment was calculated and summed in order to calculate the cumulative percent of RFIs. Also, the cumulative percent complete based on the dollar amounts from the payment schedule was calculated. Then, the cumulative percentage of the Layton Ave. RFIs was compared against the percent complete of the payment schedule. A linear relationship was assumed between each point of the payment schedule to estimate the percent of RFIs at the specific intervals of 25-percent, 50-percent, and 75-percent complete.

Percent Complete (Based on the Payment Schedule)	**Percent of Total RFIs**
NTP	9%
25%	91%
50%	98%
75%	100%
100%	100%

The CTH G Interchange had an awarded contract value of $4,205,893. There were 2 RFIs submitted on this project, resulting in 0.5 RFIs per million dollars of awarded contract. No RFIs were submitted before the NTP of May 23, 2009. The average response time for a College Ave. Interchange RFI was 4 calendar days. Half of these RFIs were answered by the requested date specified on the RFI forms, which averaged 7.0 calendar days. None of the CTH G Interchange RIFs were unjustified. The last RFI was submitted in June 2010.

The CTH G Bridges and Ramps contract had an awarded contract value of $5,568,133. There were 6 RFIs submitted on this project, resulting in 1.1 RFIs per million dollars of awarded contract. No RFIs were submitted before the NTP of May 23, 2009. The average response time for a CTH G Bridges and Ramps RFI was 16.8 calendar days. Approximately 60-percent of these RFIs were answered by the requested date specified on the RFI forms, which averaged 10.8 calendar days. Seventeen percent of the CTH G Bridges and Ramps contract's RIFs were unjustified. The last RFI was submitted in December 2009.

The CTH G Mainline contract had an awarded contract value of $9,854,138. There were 3 RFIs submitted on this project, resulting in 0.3 RFIs per million dollars of awarded contract. No RFIs were submitted before the NTP of May 23, 2009. The average response time for a CTH G Mainline RFI was 7.7 calendar days. Only 33-percent of these RFIs were answered by the requested date specified on the RFI forms, which averaged 7.0 calendar days. None of the CTH G Mainline contract's RIFs were unjustified. The last RFI was submitted in April 2010.One of the Utilities Contract had an awarded contract value of $11,032,751. There were 11 RFIs submitted on this project, resulting in 1.0 RFIs per million dollars of awarded contract. Approximately 18-percent of the RFIs were submitted before the NTP of July 17, 2009. The average response time for a College Ave. Interchange RFI was 3 calendar days. All of the RFIs were answered by the requested date specified on the RFI forms, which averaged 7.1 calendar days. None of the Utilities Contract RIFs were deemed unjustified. The last RFI was submitted in October 2009.

The Bolivar Avenue Realignment had an awarded contract value of $367,577. There was 1 RFI submitted on this project, resulting in 2.7 RFIs per million dollars of awarded contract. The NTP date was July 30, 2009. The single RFI took zero days to respond, and was unjustified.

The STH 42 Interchange had an awarded contract value of $3,445,360 and is at 96-percent complete at the time of this write-up. There was 1 RFIs submitted on this project, resulting in 0.3 RFIs per million dollars of awarded contract. The NTP date was April 10, 2010. The single RFI is closed, but no response date was provided.

The STH 50 Interchange had an awarded contract value of $2,729,084 and is 93-percent complete based on the payment schedule at the time of this write-up. There were 16 RFIs submitted on this project, resulting in 6.3 RFIs per million dollars of awarded contract. No RFIs were submitted before the NTP of May 10, 2010. The average response time for a STH 50 Interchange RFI was 12.4 calendar days. However, 62-percent of these RFIs were answered by the requested date specified on the RFI forms, which averaged 10.4 calendar days. Eight-percent of the STH 50 Interchange contract's RIFs were unjustified. The last RFI was submitted in October 2010.

The Mitchell Interchange is the largest contract within the I-94 N-S Freeway reconstruction project and involves the full reconstruction of the interchange near the General Mitchell International Airport. The Mitchell Interchange is 14-percent completed at the time of this write-up based on the payment schedule. This contract has an awarded contract value of $162,465,471. There are currently 218 RFIs submitted on this project with a NTP of September 15, 2010. The average response time thus far for a Mitchell Interchange RFI is 9.7 calendar days, while the requested date specified on the RFI forms averages 6.9 calendar days. As of this write, 17-percent of the Mitchell Interchange RFIs are unjustified.

APPENDIX C: REQUEST FOR INFORMATION FORM

Company Name: REQUEST FOR INFORMATION
Address: Phone: Company Initials - Number
Fax:
Email:

DATE: **STARTED:**
TITLE: **COMPLETED:**
PROJECT: Contract #/s: **REQUIRED:**
TO: Project Leader
WisDOT
Address

REQUEST:

References:

Possible Solution:

Cost Estimate ($): ____________
Additional Time (MH): ____________

Requested By: ____________ Date: ______
Signed: ____________

ANSWER:

Division

☐ BR ☐ DM ☐ EW ☐ GN ☐ RD ☐ SS ☐ TR ☐ DU ☐ WU ☐ WL

Tracking Number: ______

Reason Code

☐ AD ☐ CC ☐ CI ☐ CS ☐ DC ☐ DL ☐ DM ☐ DR ☐ DS ☐ IP ☐ MC ☐ SC ☐ UC ☐ VE ☐ OR

Justified

☐ Yes ☐ No

Answered By: ____________ Date: ______
Signed: ____________

1/4

Legend:

Divisions

Divison		Description
Bridge	BR	Approach slabs and bridges: abutments, piers, decks, wing walls parapets
Demol/Removal	DM	Demolition or removal of any highway construction
Earthwork	EW	Excavation, soils, or other earthwork-related items
General/Admin.	GN	Other category: material testing, construction documents, and general communications
Roadway	RD	Physical road and surrounding items: fence, barricades, shoulders
Sign Structure	SS	Message boards, road signs, and related structures.
Traffic	TR	Design of traffic flow and patterns.
Utilities – G/E	DU	Dry utilities: gas and electric.
Utilities – W	WU	Wet utilities: storm sewer, water, and sanitary sewer.
Walls	WL	Retaining and noise walls.

Reason Codes

Reason Code		Description
Added Scope	AD	Addition of items to the original project scope
Construction Coordination	CC	Organizing and coordinating construction related procedures, schedules, and safety items
Constructability Issues	CI	Difficulty in constructing an item as detailed or designed
Change of Staging/Planning	CS	Sequence of construction previously determined deemed inadequate or in need of reorganizing due to resource limitations and manpower organization
Design Change	DC	Request to implement an alternative design, modify a design to DC simplify efforts by construction team, or to correct an error in construction
Design Clarification	DL	Additional information requested to further understand and clarify components of the design and its related constituents
Different Method	DM	Change in installation technique or construction process
Design Coordination	DR	Organizing and coordinating the design and related documents between entities
Deleted Scope	DS	Scope or line items to be removed from the project
Incomplete Plans/Specs	IP	Error or omission in the plans/specifications
Material Change	MC	Different material requested to replace another than what is specified due to having an excess material readily available, or experience demonstrates another material has an improved performance
Differing Site Conditions	SC	Impediments discovered at the site that were previously unknown or were not in the condition as described in the contract
Utility Conflict	UC	Utility pipes, lines, or boxes prevent the construction strategy from proceeding as planned
Value Engineering	VE	Cost-reduction and construction improvement techniques
Other	OR	Any justified RFI submitted that does not fit into one of the other 14 categories including but not limited to payment methods, certification requirements, penalties, warranties, and non-design related documents

Justified

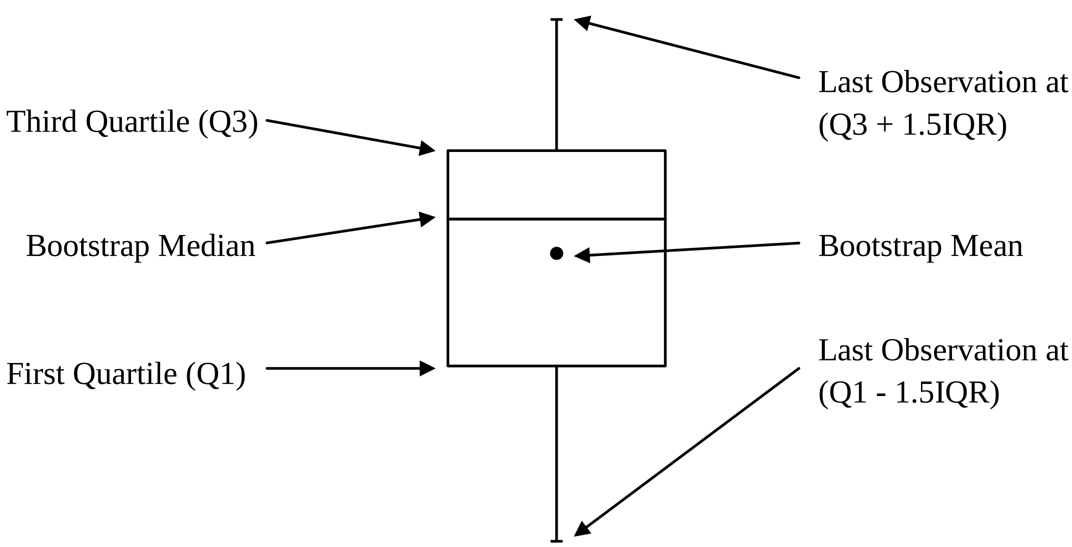
	Description
Justified	A question, concern, or observation that cannot be explained or answered in the contract documents.
Unjustified	A question, concern, or observation whose answer is provided in the contract documents, questions means or methods, or requests a design change that is not considered by the project team.

APPENDIX D: GLOSSARY

Benchmark **–** A systematic search for and application of significantly better practices (Watson 1993). Benchmarking is the measuring of the performance of a process for the purpose of determining best practices that lead to superior performance when adopted and utilized (CII 2002).

Bootstrap Method **–** A computer-intensive procedure used to make inferences about the distribution of a general population by taking new samples randomly and repeatedly from the original data set (Whitlock and Schluter 2009).

Box-and-Whisker Plot (adapted from research by Lilin Liang (2005)) **–**



Box (Interquartile Range (IQR)) – 50-percent of the Bootstrap data, from the first quartile (25th percentile) to the third quartile (75th percentile).

Whiskers – Indicate the range of the data that is not considered an outlier, or extreme value (Whitlock and Schluter 2009). The end points of the whiskers represent the last data observation that falls within the 1.5 x IQR limits.

Key Performance Indicator (KPI) **–** Compilations of data measures used to assess the performance of a construction operation. These evaluations typically compare the actual and estimated performance in terms of effectiveness, efficiency, and quality in terms of both workmanship and product (Cox et al. 2003).

Metric **–** A type of measurement used to gauge a quantifiable component of a company's performance.

Request for Information (RFI) **–** A communication tool to obtain clarification of the plans, specifications, special provisions, or other contract documents, with the intent of avoiding contract disputes and claims (CMM 2010). RFIs provide a systematic collection of the analysis and resolution of questions that arise during the construction of the project.

Weighted Average **–** An average (mean) in which each quantity has an assigned weight. These weightings determine the relative importance of each quantity on the average.

RFIs per Million Dollars **–** The total number of RFIs divided by the awarded contract amount in millions of dollars.

***Answered Within Request Period* –** The number of RFIs answered by the request date on the RFI form divided by the total number of RFIs submitted.

***Requested Response Time* –** The average number of calendar days calculated by subtracting the request date from the submittal date on the RFI form.

***Percent of RFIs Submitted by Percent Complete based on the Payment Schedule* –** The cumulative percent of RFIs compared to the cumulative percent complete based on the dollar amounts from the payment schedule. A linear relationship was assumed between each point of the payment schedule to estimate the percent of RFIs at the specific intervals of 25-percent, 50-percent, and 75-percent complete.

***Percent of RFIs Becoming Contract Modifications (Change Orders)* –** The number of RFIs resulting in a contract modification divided by the total number of RFIs submitted.

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