

NCHRP REPORT 20-24 (37) A (01)

**MEASURING PERFORMANCE AMONG STATE DOTs:
SHARING BEST PRACTICES - CONSTRUCTION
SCHEDULE AND BUDGET PERFORMANCE UPDATE**

FINAL REPORT

Prepared for
National Cooperative Highway Research Program
Transportation Research Board
Of The National Academies

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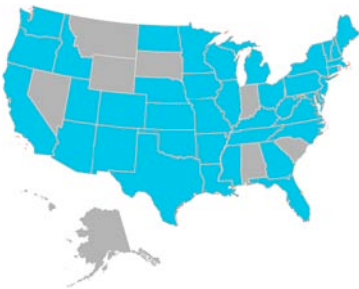
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Executive Summary

PURPOSE To compare performance and establish best practices of state DOTs in delivering transportation construction projects on time and on budget

39 STATES PARTICIPATED

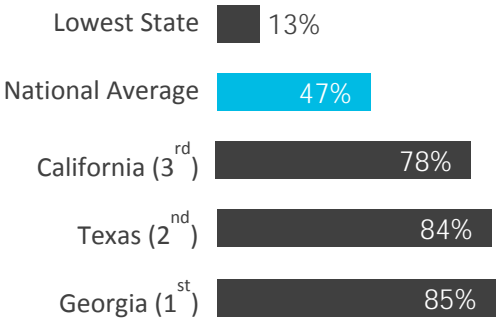


DEFINITION of ON BUDGET When the final cost of a project is at or below the original bid award amount.

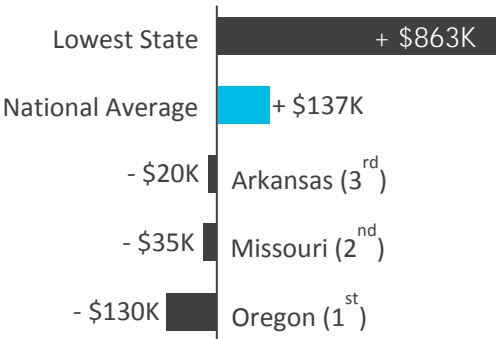
DEFINITION of ON TIME When the final completion date is on or before the original planned completion date or the working days used are equal or less than the original working days authorized.

PROJECTS ANALYZED Every state's construction projects completed between January 1, 2001 and June 30, 2010

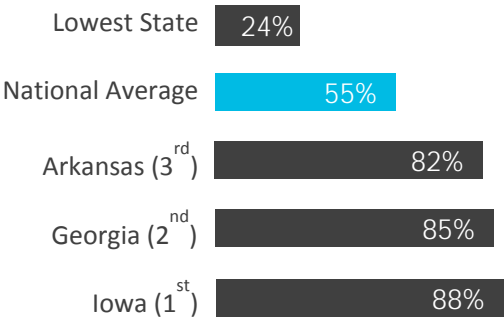
ON BUDGET RESULTS Percent of projects on budget



Average amount over budget per project



ON TIME RESULTS Percent of projects on time



YOUR STATE'S RESULTS

Participating states can review their results at: www.mydotperformance.org



BEST PRACTICES

To investigate the best practices, **a series of interviews was conducted in Feb 2011 with senior DOT staff** at the top 7 performing states. The following is a list of common best practices:

States interviewed:

Arkansas	Missouri
California	Oregon
Georgia	Texas
Iowa	

An established focus on construction project delivery that makes project delivery a high priority or important goal for top management.

Formal program or process to measure project delivery. Several states use cost and schedule measures similar to those used in the study.

Monitoring of schedules and budgets closely and continuously through regular project meetings and reports.

Publishing of performance results at a district or regional level to promote competition and share best practices.

A contract administration framework that holds contractors accountable with penalties ranging from liquidated damages to preventing a contractor from bidding on other state jobs.

A willingness to let staff have flexibility to find creative and efficient ways to keep projects on time and on budget.

A formal and strict process for changing schedules and budgets encourages project managers and contractors to keep projects moving and on budget.

Consideration of on time and on budget performance during the project design phase. Doing homework in pre-construction phases of project delivery helps improve performance.

NEXT STEPS

Experimentation with new performance measures naturally leads to scrutiny about how to improve them. These next steps would help advance the use and value of comparative cost and schedule performance measures:

Immediately – Establish a Regular Reporting Schedule: Establish a process for annual reporting of project delivery data beginning in the fall of 2011. One of the products of the project is a web-based database that could support this process with minimal effort.

Short Term – Enhance Database

Capabilities: Improve the accuracy and consistency of future results by updating the database analytics and investigating select data quality issues through a combination of mining the current data and a series of phone interviews

Medium Term – Establish a Multi-State

Peer Exchange: Bring states together to discuss the results, best practices, and the measures themselves. A series of peer exchanges or webinars would improve the value and accuracy of the measures, and improve the sharing of project delivery best practices.

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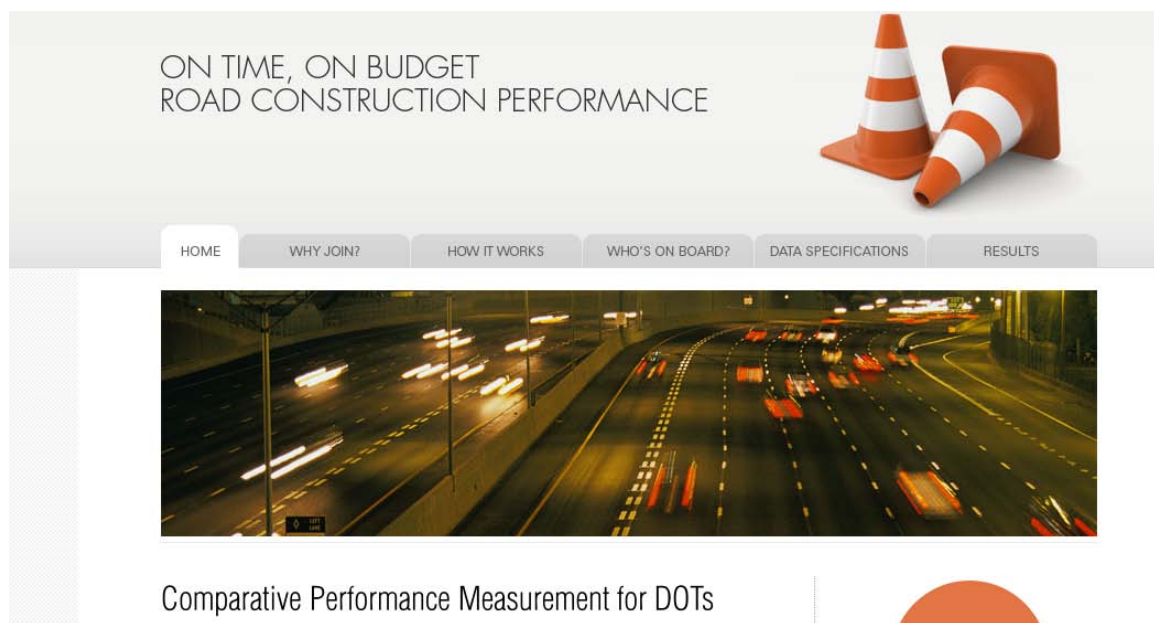
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1.0 Introduction

1.1 Study Background

This study evaluates the comparative performance of 39 state DOTs in delivering transportation construction projects within their originally anticipated cost and schedule. The study examines each state's performance track record for all projects finished over a period from January 1, 2001 to June 30, 2010. Typical projects included in the analysis span the full range of a DOT's activities including operations work, such as installation of ITS devices or traffic signals; maintenance activities, such as guard rail installation or striping; pavement preservation work, such as resurfacing; bridge preservation work, such as deck replacement; and capacity additions. A major work product of the study is a user-friendly web database that participating states can use to review their results. (See Figure 1.1)

Figure 1.1. Screenshot of Web-Based Project Cost and Schedule Performance Database



Adherence to planned budgets and schedules is a prerequisite of good performance for all state DOTs. At any time, a DOT has hundreds of projects – large and small – underway. Each project may take months or years from start to finish and without skillful planning and execution, delays or added costs can easily occur that are unacceptable.

The comparative construction project delivery performance study is part of a series of NCHRP-sponsored projects that have examined the comparative performance of state DOTs on various topics. Projects in the series have included a previous project delivery study, and studies on pavement condition, incident management, safety, and bridge condition. Over the course of these studies, comparative performance data has proven helpful for agencies interested in boosting their own performance by learning about the practices their peers use to achieve results.

The first national comparative study of project delivery performance was completed in 2007 with data from 20 states and spanning 5 years.¹ This study updates the 2007 report by adding 19 new states and 5 more years of project data. It also establishes a password protected, Internet-based project delivery performance reporting tool that participating states can use to compare their own performance to that of other states. The tool allows states to analyze their performance by year, project type, and contract value. Finally, the study also recommends some areas of improvement that can, over time, help states achieve a greater degree of consistency and comparability in using common project delivery performance measures across states.

1.2 Study Methodology

The study's approach included four major elements:

- *Data Collection and Analysis* - Solicitation of 39 participating states, collection of states' data, creation of a database for storing performance data, analysis and ranking of states based on the data, and identification of top performing states based on the rankings;
- *Identification of Good Practices* - Identification of practices in use among the seven top performing states that may have contributed to their successful cost or schedule performance;
- *Recommendations for Areas of Improvement* - Recommendations on immediate, short-term and medium-term actions that can be taken to improve availability of consistent comparative measures for assessing project delivery performance; and,

¹ NCHRP Project 20-24 (37) A (01), *Comparing State DOTs' Construction Project Cost & Schedule Performance – 28 Best Practices from 9 States*; April, 2007

- *Permanent Reporting Database* - Development of a user-friendly, web-based database that allows for easy continuation and expansion of comparative project delivery performance analysis.

2.0 Study Overview

2.1 State Participation

Thirty-nine states participated in the study. After joining in one of three informational conference calls held in September and October 2010 to learn about data reporting requirements and the overall purpose of the study, each state's contact person ensured data was submitted on all project contracts in their project management system that were finished between the beginning of 2001 and June 2010. Participating states included:

Arizona	Maine	North Dakota
Arkansas	Maryland	Ohio
California	Massachusetts	Oklahoma
Colorado	Michigan	Oregon
Connecticut	Mississippi	Pennsylvania
Delaware	Minnesota	Tennessee
Florida	Missouri	Texas
Georgia	Nebraska	Utah
Idaho	New Hampshire	Vermont
Illinois	New Jersey	Virginia
Iowa	New Mexico	Washington
Kansas	New York	Wisconsin
Louisiana	North Carolina	West Virginia

A list of the contact point information used to gather data for each of the 39 states above is provided in Appendix A.

2.2 Project Cost and Schedule Measures

The foundations of this study are two simple measures of whether a completed construction project's final cost and schedule met the planned cost and schedule:

- **Cost Performance Measure Definition** - Percent of states' completed contracts for which the final cost is at or below the original bid award amount.

"Original bid award amount" is tracked by all state DOTs. It represents the winning contractor's estimate of a contract's final cost at the time construction begins. During data collection, DOTs are instructed to exclude any contingencies or change orders that might be added to the original bid award amount.² Contractor costs are usually the lion's share of a project's budget although other costs may include construction inspection or state furnished materials. "Final cost" is a contract data point that all state DOTs also track within their electronic construction management systems. It is universally understood to represent the amount paid out to contractors under a contract.

- **Schedule Performance Measure Definition** - Percent of states' completed contracts for which either the contract's final completion date is the same as or earlier than the originally scheduled completion date or the number of working days used is equal to or less than the originally authorized number of working days.

State DOTs generally set a contract's schedule either by estimating a number of working days or choosing a calendar date deadline. Some agencies use both yardsticks, while others favor one. For this study, either yardstick is acceptable. While all 39 states in the study collect the necessary cost information to calculate performance, only 32 states in the study collect adequate schedule information to calculate performance. In several instances, some of these 32 states only provided information for a portion of their projects.

The cost and schedule performance definitions used in the study are precisely consistent with the ones used for the 2007 report, which were developed by a group of seven states working together to reach agreement on simple definitions of on time and on budget project delivery performance that could be used by any state. By maintaining these definitions, we have preserved continuity with the first study. The measures used in this study

² DOTs were allowed to make upward or downward adjustments to the original bid award amount for changes in fuel and materials costs, if any, or for incentive pavements, such as for pavement smoothness.

represent a strict way to define on budget and on time performance - cost or schedule overruns are not accepted for any reason. During the study, some states suggested that allowances could be added for legitimate additions to schedule or cost. As a practical matter, however, using such an approach to measure performance is challenging because states do not generally identify the cause of cost or schedule overruns in ways that can be analyzed easily on a widespread basis.

2.3 Methods for Calculating Performance

To calculate cost and schedule performance for each DOT, selected contract record data was gathered from participating DOTs. (See Appendix B for a list of data fields that were used to calculate and report performance.)

Methodologies for calculating cost and schedule performance using this information are as follows:

- **Cost Performance** – All 39 participating state DOTs’ construction offices were able to provide cost-related data from their construction management systems that allowed calculation of cost performance. A total of 100,934 contract records in the project database include sufficient data to calculate cost performance. Most states were able to provide data for the entire study period from 2001 to 2010, but four provided data for periods starting between 2002 and 2008 because of limitations in their data collection systems prior to these dates.

Every contract record with acceptable data was included in the study if it was completed between January 1, 2001 and June 30, 2010. Contracts were assumed to be complete if they had a final voucher date or equivalent data field that fell within the study period.³ If a state was able to include data on adjustments to the original bid award amount for either changes in fuel/materials costs or incentives paid for performance, these were factored into the performance calculation by adding them to the original bid award amount. Thirteen of the participating states provided information on adjustments.

³ Since our definition of “complete” requires a project to have a “final voucher date” or equivalent, the database has a tendency to exclude recently finished projects that are open to traffic or 95 percent complete, but that have not been finalized in terms of full close out. Sometimes close out can take many months and as a result the database may not include states’ very latest performance data.

A contract was considered “on budget” if its final cost was equal to or less than its original bid award amount. The original bid award amount does not include any change order costs. Several states suggested that future work in this area might include consideration of ways to account for some types of change orders.

- **Schedule Performance** – 32 of the 39 state DOTs’ construction office staff were able to provide schedule-related data for the study from their construction management systems that allowed calculation of schedule performance. A total of 72,803 contract records in the project database include sufficient data to calculate schedule performance. Of the states that shared schedule data, some were only able to generate schedule data for a portion of the contracts they submitted.

As with the cost performance analysis, every contract record with acceptable data was included in the on time component of the study if it was completed between January 1, 2001 and June 30, 2010. Contracts were assumed to be complete if they had a final voucher date or similar that fell within the study period.

A contract was considered on schedule if either the contract’s final completion date is the same as or earlier than the originally scheduled completion date or the number of working days used is equal to or less than its the originally authorized number of working days.

After the consultant team estimated schedule and cost performance, each state that supplied data for the project was provided an opportunity to review their own results.

2.4 Data Analysis Options

As part of this study, sufficient contract-related data was collected from states to allow various fine grain performance analysis options beyond basic on cost and schedule performance. The project’s web-based performance database allows individual states to further examine their own performance in detail. Performance can be examined by year, cost, acceptable over budget cushion, project type (preservation, capacity, pavement/bridge, operations/maintenance); and performance of ARRA projects:

- **Performance by Year of Project Completion** - Each state’s data can be examined on a year-by-year basis from 2001 to 2010. Data for most states includes this entire time range, however, four states were able only

to provide data for a subset of these years.

- **Performance by Project Cost** – Each state’s data can be examined by cost, which enables performance results to be sorted by projects costing less than \$500,000 to over \$100 million.
- **Performance by Project Type** – Where possible, states’ data can be examined by project type, including bridge preservation projects, pavement preservation projects, bridge capacity projects, pavement capacity projects, maintenance projects and operations projects. This data should be treated with caution, however, because states’ individual contract classification systems are not always well suited to generalization.

In addition, performance can be tracked for ARRA projects and performance can be assessed using a budget contingency cushion of anywhere between zero (0) percent and twenty (20) percent above original budget.

2.5 Project Delivery Performance Web-based Database

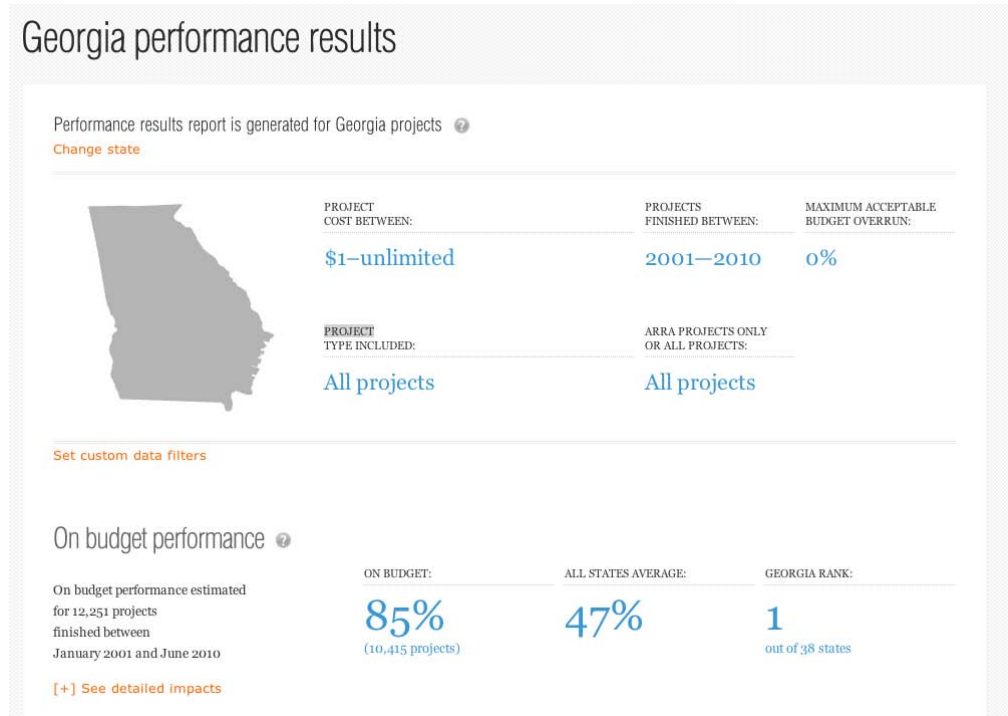
Data collected as part of this project is stored in a password-protected, database that serves two functions:

- **Data Import Tool** – A user with administrative privileges may use the website to maintain the database by adding new data from states as needed. The administrator can “clean” and post data provided by state DOTs in a Comma Separated Value (CSV) file format. Cleaning data involves standardizing states’ unique date and dollar cost formats and mapping states’ individual field terms to standard database definitions. The data import function is described in detail in Appendix C.
- **Performance Analysis Tool** – Users with state-specific privileges may review their states’ cost and schedule performance results compared to those of other states in the database. They can use the web tool either to get a simple snapshot of their state’s performance or to examine their state’s performance by project type, year or cost. A screenshot of the performance analysis tool is shown in Figure 2.1.

The website is accessible at www.mydotperformance.org. A password is needed to access state specific results.⁴

⁴ Please contact Joe Crossett, 240 252 5111 to obtain password information.

Figure 2.1. Database Screenshot of State-Level Performance Results



3.0 Comparative Performance Analysis Results

3.1 Project Delivery Cost Performance

Review of the 39 states' project delivery cost data shows the following:

- **Nationwide Project-by-Project Cost Performance** – Forty-seven (47) percent of projects were completed at or below their original contract award amount on average, as shown in Figure 3.1. (Based on calculation of the mean share of contracts completed at or below their original contract award amount among 39 states for all projects finished between January 1, 2001 and June 30, 2010.) Best performers out-performed the average of their peers by a large margin:

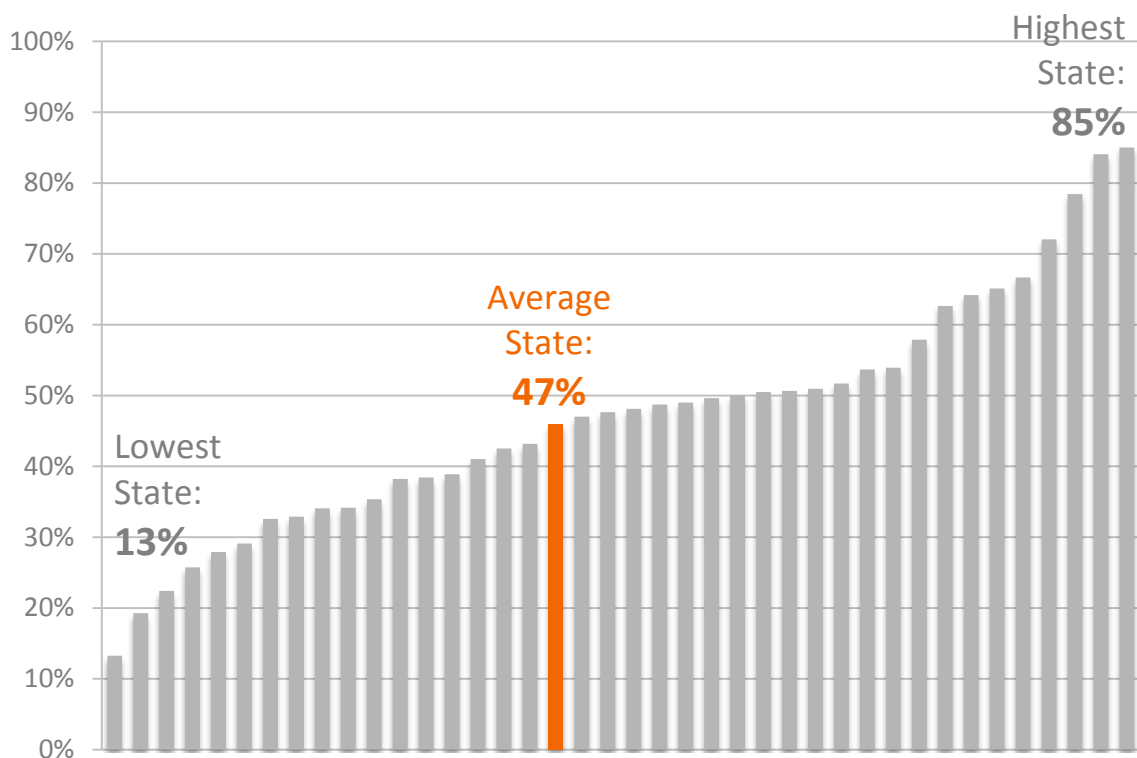
Best Performers: Georgia DOT – 85 percent of projects on budget

Texas DOT – 84 percent of projects on budget

California DOT – 78 percent of projects on budget

Range in Performance: In contrast to Georgia DOT's delivery of eighty-five (85) percent of projects for their anticipated cost, the weakest performer in the data series delivered thirteen (13) percent of projects for their anticipated cost, as shown in Figure 3.1.

Figure 3.1. Nationwide Average Project-by-Project Cost Performance

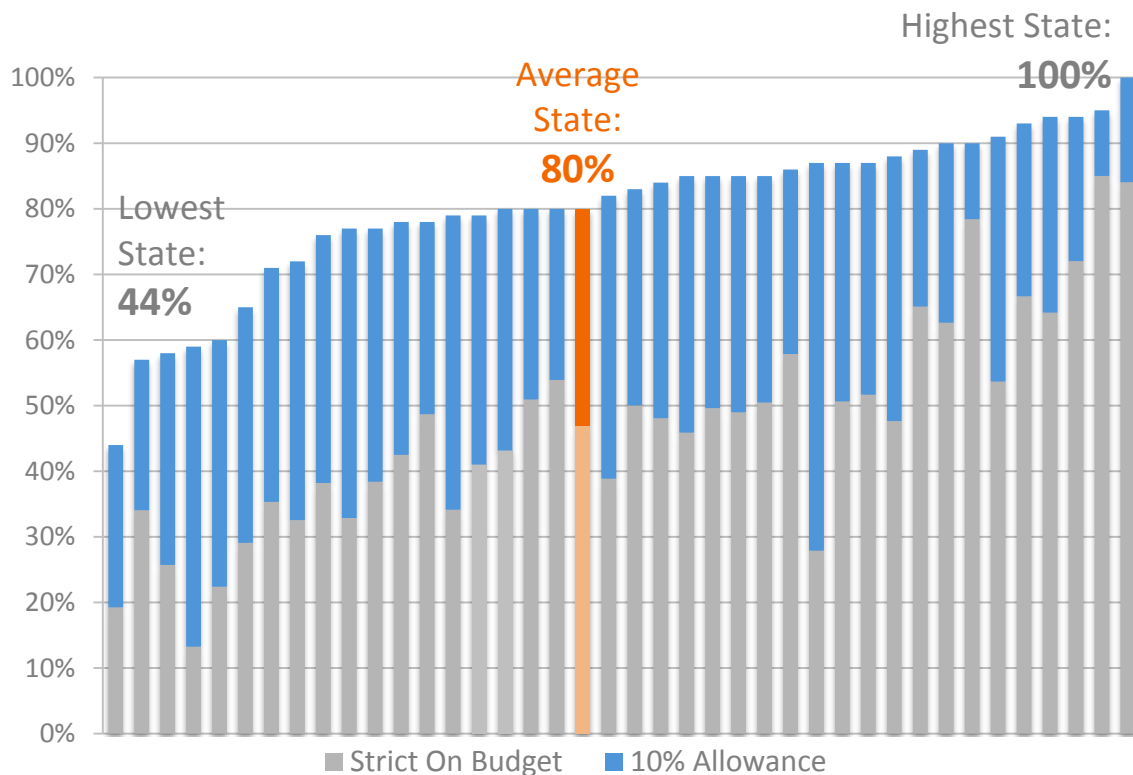


Average Amount Over Original Contract Award: For the 39 participating states, the average project was finished approximately \$90,000 over its original bid award amount. If projects at or below their original bid award amount are excluded, this figure rises to approximately \$300,000 per project or fourteen (14) percent of the original bid award amount.

Effect of a Ten (10) Percent Contingency: If a ten (10) percent contingency is added to all original bid award amounts, states' average performance rises from forty-seven (47) percent of projects completed at or below their original contract award amount on average to eighty (80) percent on average, as shown in Figure 3.2. Using this contingency amount, the average project was finished approximately \$113,000 under its original bid award amount.

Performance for Projects over \$10 Million: Four (4) percent of projects in the database had an original bid award amount of over \$10 million. Among the 39 states, eighty-one (81) percent of projects in this cost range were not completed for less than their original contract award amount on average and the average amount over the original award was \$2.8 million.

Figure 3.2. Nationwide Average Project-by-Project Cost Performance (+10%)



- **Performance Based on Combined Cost of All Projects** – States may manage costs among many projects – adding costs on some and saving costs on others – rather than aiming to keep every project within budget. With the right mix of cost savings among projects, a middling project-by-project based cost performance score could mask good program-wide performance. To account for this possibility, totals were calculated for each state’s original bid award amounts and final costs. States were then ranked according to their relative cost savings or additions on a per project basis.

On average, states delivered projects with a net additional cost of \$137,000 over the original bid award amount. Five (5) states out of 39 delivered all their projects with a total final cost at or below the total original contract award amount. The top three best performers using this method are as follows:

Best Performers: Oregon DOT – \$130,000 cost savings per project⁵

Missouri DOT – \$35,000 cost savings per project

Arkansas DOT – \$20,000 cost savings per project

The earlier best performers were ranked 5 (Texas), 6 (Georgia) and 25 (California) respectively, using this alternate ranking approach.

Range in Performance: In contrast to Oregon DOT’s delivery of its projects with an average \$130,000 savings per project below their anticipated cost, the weakest performer in the data series delivered its projects with an average added cost of \$733,000 per project over anticipated cost.

3.2 Project Delivery Schedule Performance

Review of the 32 states out of 39 participants that provided project schedule cost data suggests the following results:

- **Nationwide Project-by-Project Schedule Performance** – Fifty-five (55) percent of projects were completed on or before their original completion date, as shown in Figure 3.3. (Based on calculation of the mean share of

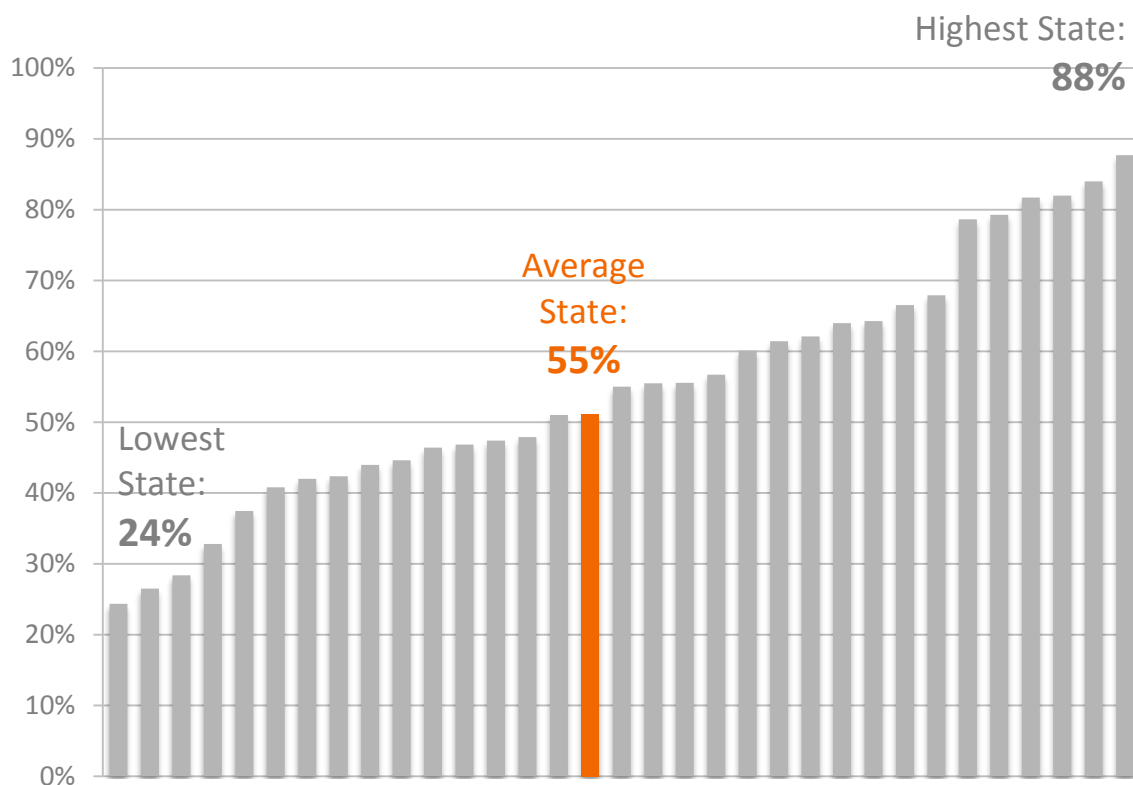
⁵ Interviews with Oregon DOT staff revealed that the agency included a 3.5 percent contingency in the data it provided for the study, which may reduce their real ranking. By contrast Missouri DOT specified that it included no contingency in its data.

contracts completed on or before their original contract award amount among 32 states for all projects finished between January 1, 2001 or later and June 30, 2010.) Best performers out-performed the average of their peers by a large margin:

Best Performers: Iowa DOT – 88% of projects on schedule
Georgia DOT – 85% of projects on schedule
Arkansas DOT – 82% of projects on schedule⁶

Range in Performance: In contrast to Iowa DOT's delivery of eighty-eight (88) percent of projects on time, the weakest performer in the data series delivered twenty-four (24) percent of projects for their anticipated cost, as shown in Figure 3.3.

Figure 3.3. Nationwide Average Project-by-Project Cost Performance



⁶ Arkansas was jointly ranked 3rd, but the other 3rd ranked state only provided schedule data for 2008-2010.

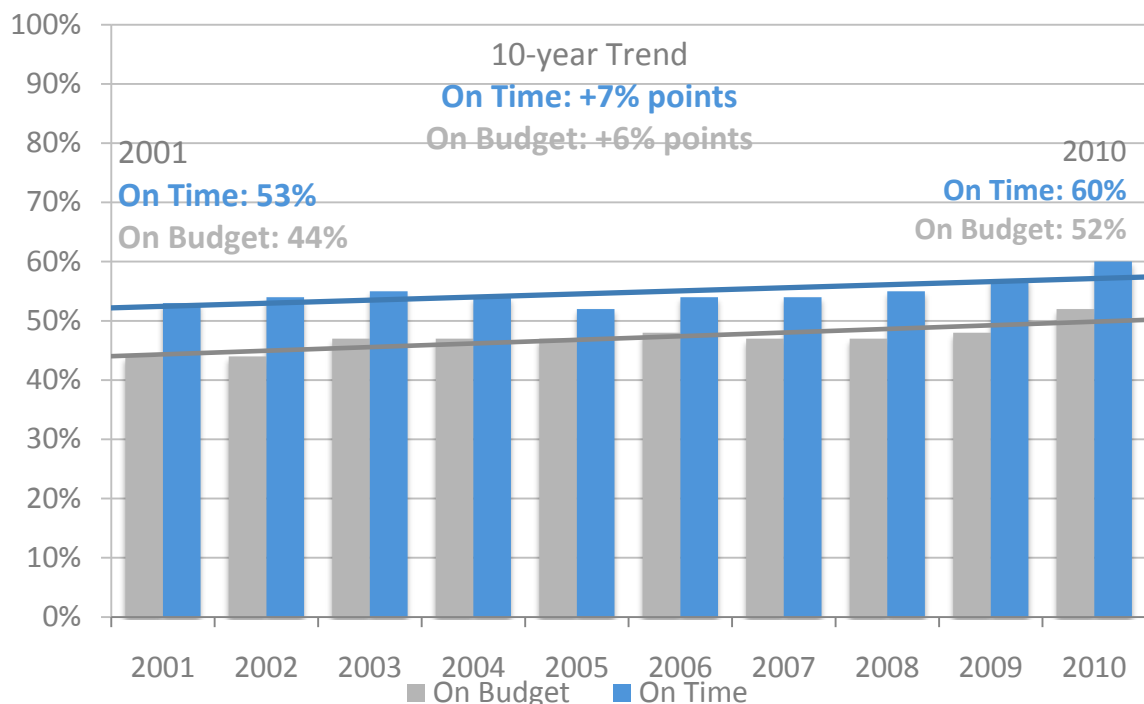
Average Amount of Delay - For the 32 participating states, the average late project was finished 114 days after its originally scheduled completion date or allotted amount of working days.

Performance for Projects over \$10 Million - Four (4) percent of projects in the database had an original bid award amount of over \$10 million. Among the 32 states for which schedule performance results are available, sixty-six (66) percent of projects in this cost range were not completed within their original schedule on average and the average amount over the original schedule was 240 days.

3.3 Change in States' Performance Over Time

Over time, states appear to be making modest improvements in the share of projects they complete within planned budgets and schedules. Figure 3.4 shows that average cost performance has improved by six (6) percentage points since 2001, although most of this improvement occurred in 2003 and 2009. Figure 3.4 also shows that average schedule performance has improved by seven (7) percentage points since 2001, although most of this improvement occurred in 2009 and 2010.

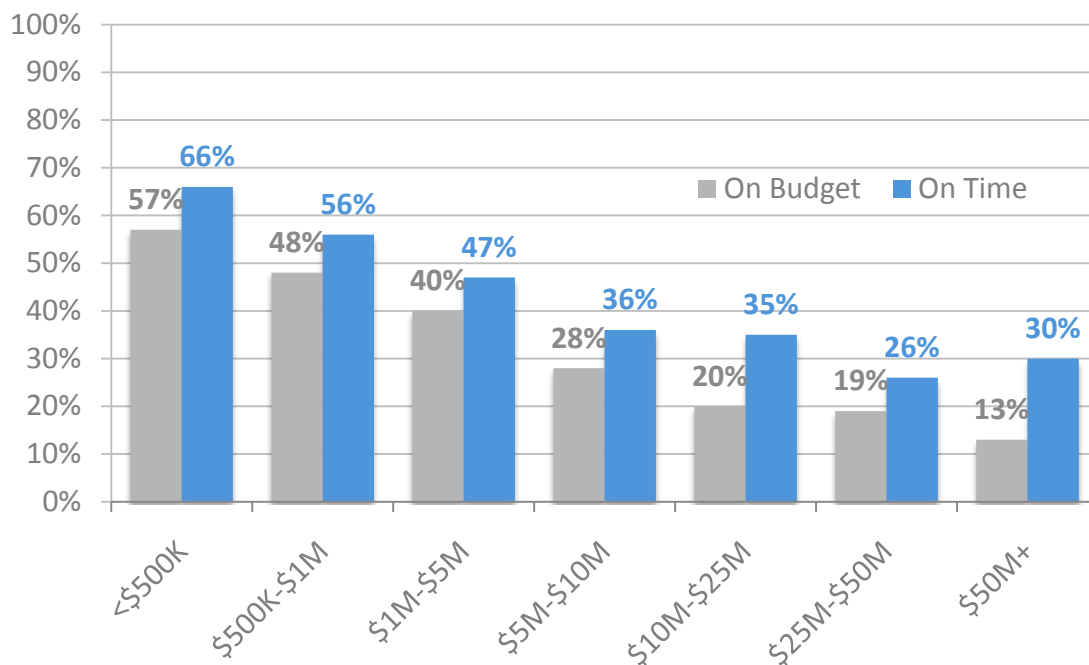
Figure 3.4. Nationwide Improvement in Performance, 2001-2010



3.4 Performance by Project Cost

States' ability to keep projects within their original budgets and schedules varies significantly by project cost. Fifty-seven (57) percent of projects under \$500,000 are completed within their anticipated cost and sixty-six (66) percent are completed for their anticipated schedule. As shown in Figure 3.5, these figures decrease steadily as project cost increases; only thirteen (13) percent of projects over \$50 million are completed for their anticipated cost and thirty-one (31) percent are completed within their anticipated schedule.

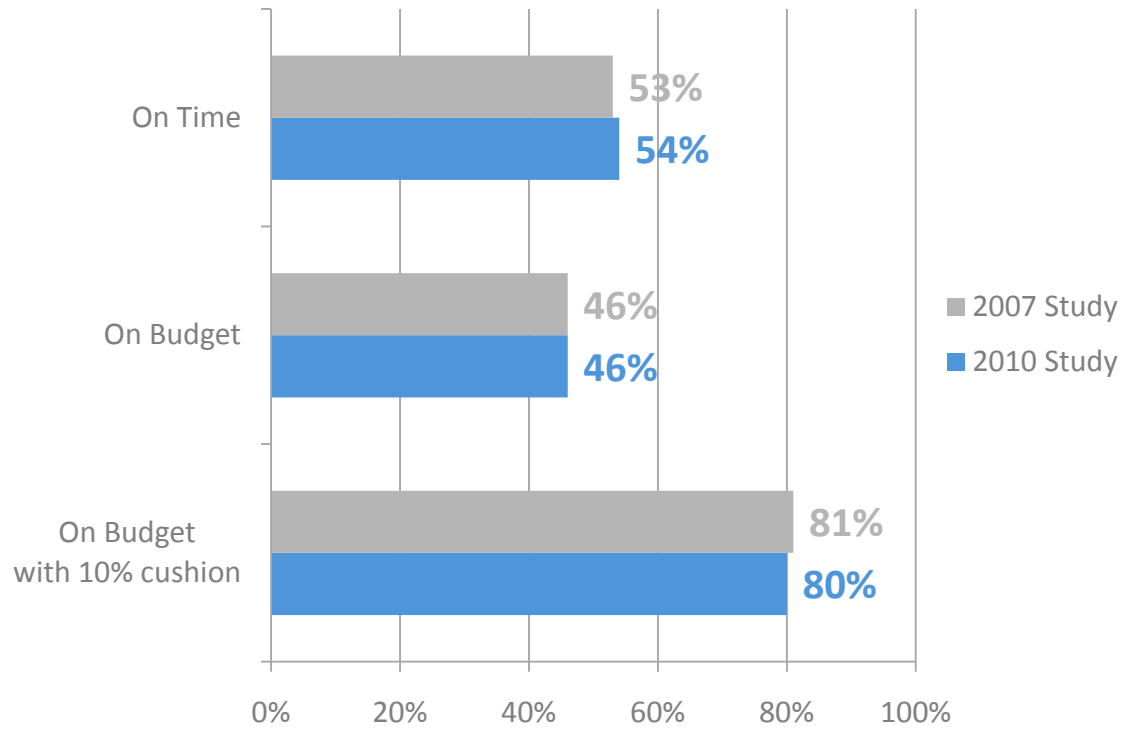
Figure 3.5. Performance by Project Cost, All States Average (2001 to 2010)



3.5 Consistency with 2007 Study Results

The first national comparative study of project delivery performance was completed in 2007 with data from 20 states and spanning 5 years from 2001 to 2005. This study updates the 2007 report by adding 19 new states and 5 more years of project data. Despite a doubling in the number of states that participated, the results of the 2007 study are very similar to those of the 2010 study for the period 2001 to 2005, as shown in Figure 3.6.

Figure 3.6. Comparison of All States Average Cost and Schedule Results (2007 Study Versus 2010 Study)



4.0 State Interview Findings

Results for the measures described in Section Three suggest that states vary in their ability to deliver projects within originally anticipated costs and schedules. These results beg the question - “what do strong performers do to keep their projects within original cost and schedule limits?”

This section reports on activities and processes that the best performers in the study group of 39 states say they are undertaking to deliver projects on or below their original anticipated cost and schedule.

4.1 What Defines a Strong Performer?

- **Strong Cost Performers** - Among the states studied, the share of projects completed within their original bid award amount ranged from 13 (thirteen) percent to 85 (eighty-five) percent. On average, forty-seven (47) percent of projects were completed at or below their original contract award amount, as shown in Figure 3.1. The top three best performers out-performed the rest of their peers by a margin that ranged from 6 (six) to thirteen (13) percent and were thus selected for interview:

- Georgia DOT – 85 percent of projects at or below cost
- Texas DOT – 84 percent of projects at or below cost
- California DOT – 78 percent of projects at or below cost

Georgia, Texas, and California are obvious starting places for seeking out good practices used by states to keep projects on budget.

Since many states focus on managing overall program budgets as well as individual project budgets, the top three states with the best records in achieving overall cost savings were also identified, including:

- Oregon DOT – \$130,000 average cost savings per project
- Missouri DOT – \$35,000 average cost savings per project
- Arkansas DOT – \$20,000 average cost savings per project

By contrast 33 of the 39 states added an average of \$164,000 per project.

- **Strong Schedule Performers** - Among the states studied, the share of projects completed within their original scheduled timeframe ranged from 24 percent to 88 percent. On average, fifty-five (55) percent of projects were completed at or below their original contract award amount, as shown in Figure 3.3. The three best performers out-performed the average of their peers by a margin of 27 to 33 percent:

- Iowa DOT – 88 percent of projects on schedule
- Georgia DOT – 85 percent of projects on schedule
- Arkansas DOT – 82 percent of projects on schedule ⁷

4.2 What Performance Good Practices Were Found?

In late February 2011, phone interviews were conducted with senior staff at each of the seven highest performing states shown in the list below:

- Arkansas State Highway and Transportation Department (AHTD): Scott Bennett, Assistant Chief Engineer for Planning;
- CalTrans: Elizabeth Dooher, Chief, Office of Engineering Management;
- Georgia DOT (GDOT): Thomas Howell, Director, Division of Construction;
- Iowa DOT (IDOT): John Smythe, Construction Engineer;
- Missouri DOT (MoDOT): Travis Koestner, Assistant State Construction and Materials Engineer;
- Oregon DOT (ODOT): Jeff Gower, State Construction and Materials Engineer; and
- Texas DOT (TxDOT): Ken Barnett, Director, Construction Division.

Together, the ideas uncovered in the interviews with these individuals provide some practical tips for any state considering ways to strengthen its project delivery performance. No single state employs every good practice on the list, but the ideas provide a menu of transferable strategies to which any state may wish to give further consideration.

- **Top Performers Focus on Project Delivery; Some have done so for a Long Time** – All of the states interviewed indicated that keeping within planned project schedules and budgets is a high management priority – some, including Texas, Arkansas and Georgia DOTs, emphasized that this is a critical issue in their states. Several of the top performers interviewed for the study say they have emphasized cost and schedule performance for many years. At Oregon DOT, for example, performance in this area has been measured for “at least 15 years” according to Jeff Gower, ODOT’s

⁷ Arkansas was jointly ranked 3rd, but the other 3rd ranked state only provided schedule data for 2008-2010.

state construction engineer. At Arkansas SHTD, according to Scott Bennett, the agency has emphasized on time and on budget delivery for “many years.” They suggest that good performance results do not occur overnight.

- **Project Delivery Performance Measures are Usually Part of Top Performers’ Performance Initiatives** – Several of the seven states interviewed indicate that they track cost and schedule performance measures similar to those used in this study, examples include:
 - *CalTrans*: California’s state DOT tracks a robust set of 39 measures for construction, including measures that match those used in this study. Caltrans’ construction measures focus on six areas of project delivery including contract administration, contracting, claims, environmental compliance, safety, and arbitration. The measures are primarily used internally for improving management practices and holding staff accountable.
 - *Missouri DOT*: Performance measurement is part of MoDOT’s culture and the DOT includes a section in its quarterly “Tracker” performance measures report called “*Fast Projects that are of Great Value*.”⁸ This section reports several measures including “percent of programmed project cost as compared to final project cost;” “percent of projects completed within programmed amount;” and “percent of projects completed on time.” MoDOT uses its measures for internal management accountability and to communicate with the public and its stakeholders.
 - *Oregon DOT*: Oregon DOT’s “*Annual Performance Progress Report*” tracks project-level schedule performance in terms of “the percent of projects with the construction phase completed within 90 days of original contract completion date.” and project budget performance is measured in terms of “the percent of original construction authorization spent,” which is a measure of whether the DOT’s overall construction program stays within anticipated costs. Measures are used internally for management of the construction program, but they also are reported to the state legislature.

⁸ 2010 Tracker Report; http://www.modot.mo.gov/about/general_info/Tracker.htm (checked Feb 28, 2011)

- *Texas DOT*: TxDOT's online "TxDOT Tracker" reports "the number of construction projects completed where the days assessed do not exceed the allocated number of days" and the "final project construction cost compared to original low bid price."⁹ The measures are reported on TxDOT's website and to the state legislature. They also are used to keep staff accountable.

In each of these examples, project delivery performance measures are part of a broad agency-wide culture of using measures to track performance on many important topics. The measures are seen as a way to provide accountability to stakeholders, set leadership priorities, and motivate and manage staff. Use of performance measures has helped these and other states keep a strong focus on project delivery.

- **Some Top Performers have Externally Driven Project Delivery Performance Mandates** – Several of the states interviewed, are specifically held accountable by their state legislatures for tracking project delivery performance, examples include:
 - *Oregon DOT*: In Oregon, the DOT is required to provide the State Legislature with an "Annual Performance Progress Report" that includes various "Key Performance Measures" including measures of project delivery performance.¹⁰
 - *Texas DOT*: In Texas, state law since 2009 has mandated use of specific project delivery performance measures and even sets goals and timelines for achievement. (S.B. 1, 81st Legislature, Regular Session, General Appropriations Act)

Performance mandates such as these give states further reason to improve their project delivery performance.

- **Many Top Performers "Drill Down" from State-wide Performance Results to Support Project Management** – Of the states interviewed, those that use project delivery performance measures indicate they are reporting statewide results on an annual basis, but that they also are "drilling down" more frequently into performance data to provide

⁹ Texas DOT Tracker; http://www.txdot.gov/about_us/sppm/txdot_tracker.htm (checked Feb 28, 2011)

¹⁰ Oregon DOT 2010 Annual Performance Report
<http://www.oregon.gov/ODOT/CS/PERFORMANCE/index.shtml> (checked Feb 28, 2011)

district-level, or even manager-level performance reports that are used as a regular part of their project management activities:

- *CalTrans*: Every phase in delivery of the program is broken out and measured – at a program level, at a district level, and at a project level. A report is put out by CalTrans headquarters every quarter that helps to share best practices within the agency and promotes competition within the agency to perform better.
- *Oregon DOT*: At ODOT, region and manager-level data is shared on a monthly basis so that construction staff in the regions can see their performance results and discuss them.
- *Texas DOT*: At TxDOT, cost and schedule data are regularly shared with construction managers in each of the DOT's 25 Districts for the purpose of ensuring projects are delivered on time and on budget.

Each of the above states places great importance on using drill down performance data as a powerful tool and motivation for regions and managers to work on improving their performance.

- **Top Performers Often Build Groundwork for On Time and On Budget Performance into Project Design** – Several of the states interviewed describe different ways that they are able to assure good performance during construction by doing their “homework” in pre-construction, for example:
 - *Arkansas HTD*: Staff reports that most project design work is done in-house, which helps assure predictable and accurate standards that make the contractors’ job of keeping projects on schedule and on budget easier.
 - *Georgia DOT*: At GDOT, a lot of time is spent upfront during preliminary field plan review and final plan review to create the very best set of plans as a way to avoid having to issue supplemental change orders.
 - *Iowa DOT*: At IDOT, project cost estimates are carefully calculated using detailed information about item level costs to ensure that budgets are not found lacking during construction.
 - *Texas DOT and Missouri DOT*: MoDOT and TxDOT describe similar approaches for building flexibility into their project designs that allow contractors more freedom to select options for completing projects

without going over budget or falling behind schedule by altering project elements where needed to save time or money.

- **Several Top Performers make Changes to Schedules and Budgets Arduous** – Some of the states interviewed in the study report that they deliberately rely on tough protocols that make changes to project cost or schedule difficult to approve, for example:
 - *Arkansas HTD*: All project change orders of \$20,000 to \$75,000 must be approved by the District Engineer and Arkansas HTD headquarters must approve all change orders over \$75,000.
 - *Oregon DOT*: At ODOT, project managers have no authority to overrun a project's budget; they must get approval from the area manager for increases of up to \$500,000 and the Oregon Transportation Commission must approve changes over \$500,000. Likewise, a project manager cannot add more than 14 days to a project's schedule without approval.
 - *Texas DOT*: At TxDOT, cost overruns are taken out of a District's overall budget. A District Engineer must find ways to pay for a project that goes over budget by cutting costs from other projects in their District portfolio.

By making changes to schedules or budgets difficult, states keep managers focused on finding ways to save costs and time.

- **Top Performers Monitor Schedules and Budgets Closely** – Most of the states interviewed indicated that they regularly monitor schedules and budgets, for example:
 - *Georgia DOT*: Contractors must submit regular project progress reports. If they get more than 15 percent behind schedule they must submit a revised schedule to show how they will get the project back on time. If they don't submit a revised schedule, GDOT stops payments until they do.
 - *Oregon DOT*: At ODOT, all project managers are expected to update their project schedule and budget monthly to ensure problems are spotted early. Likewise, contractors must provide regular schedule updates for complex projects.
- **Top Performers Hold Contractors Accountable** – Several of the states interviewed mention that they use various strategies to hold contractors

accountable for cost and schedule performance:

- *Arkansas HTD*: If a project falls more than 25 percent behind schedule, the contractor receives a letter from the resident engineer. If the project goes more than 50 percent behind schedule, a letter is sent from the chief engineer. Contractors are prevented from bidding on new jobs if they have late projects.
- *Georgia DOT*: If a contractor gets two or more projects more than 15 percent behind schedule, they are prevented from bidding on new jobs for 6 months. Staff reports that the threat of not letting them bid on new work keeps projects moving.
- *Oregon DOT*: At Oregon DOT, liquidated damages are used to ensure that contractors have an incentive to stay on schedule.
- **Top Performers Let Staff Have Flexibility** – Some of the states interviewed emphasize that they give staff flexibility to find project solutions that work, for example:
 - *Georgia DOT*: Construction staff is given the authority to and are expected to resolve issues at the lowest possible level.
 - *Oregon DOT*: At ODOT, staff is given flexibility to respond to issues as they emerge and to find alternate solutions that help keep their projects within schedule and on budget.
- **Top Performers Meet Regularly to Discuss Project Delivery** – Several of the states interviewed mentioned that they hold regular leadership meetings to discuss project delivery performance, for example:
 - *Arkansas HTD*: Top project delivery staff at Arkansas HTD meet monthly to review active projects and discuss issues, including on time and on budget performance.
 - *CalTrans*: At CalTrans, quarterly meetings are held to discuss the status of each project – every functional unit involved in the project attends to discuss what’s going well, not just in construction, but also in design and other areas.
 - *Iowa DOT*: At Iowa DOT, monthly reviews are held to identify reoccurring reasons for cost overruns on projects that are over budget and to better understand the causes and solutions.
 - *Oregon DOT*: At ODOT, the “construction leadership team” tracks performance measures. It is made up of DOT representatives from

around the State and it meets regularly to make a variety of policy level decisions about how to manage projects.

- **Top Performers Motivate Senior Executives to Deliver Projects** – In California, the DOT’s Director has established a formal “Contract for Delivery” with each individual Division Director that outlines the projects that are to be delivered that year. Out of 1,600 projects only 1 was not delivered in 2010.

5.0 Next Steps for Cost and Schedule Reporting

A process of continual learning and improvement often characterizes performance measurement. Experimentation with new performance measures naturally leads to scrutiny about how to improve upon them. In this section, recommended next steps and associated costs for continuing to advance the use of comparative cost and schedule performance measures are outlined. The next steps are grouped by their approximate time horizon for implementation:

- *Immediate continuation of cost and schedule reporting* - States supply updated 2011 project delivery data in Fall 2011. (Costs could consist of in-kind support from public agencies or \$20,000 to \$30,000 for consultant support).
- *Short-term adjustments to cost and schedule measures* – Use consultant support to make minor enhancements in database analytics and to validate core data elements. (Costs could be met with in-kind support or about \$25,000 in consultant support.)
- *Medium-term peer exchange dialogue and refinement of measurement approaches* – Establish an ongoing peer exchange process among states to promote better on time and on budget performance. (Costs could be met with in-kind support or about \$40,000 in consultant support.)

5.1 Immediate Continuation of Cost and Schedule Reporting

With modest effort, the on time and on budget performance reporting presented in this study can easily be continued after the project is complete. One of the project’s products is a MySQL database tool that offers a user-friendly, Internet-based interface for collecting and analyzing project delivery performance data. The web-based database could continue to be hosted by an independent third party, or hosting could be taken over by

AASHTO or a state DOT interested in supporting comparative performance measurement.

Steps Required for Immediate Continuation - Maintaining annual reporting of cost and schedule performance using the database is a four-step process:

- **Step 1: Determine Who Leads Reporting** – Prior to initiating the next round of cost and schedule reporting, a decision must be made on what agency will take the lead in coordinating data efforts.

Time: Minimal

Cost: In kind

- **Step 2: Invite States to Participate** – Lead agency (e.g., AASHTO's Standing Committee on Performance Management (SCOPM)) invites states to participate in a new round of reporting using a combination of email and phone contact with the 39 states from this study as a starting point (Participating states and points of contact listed in Appendix A.) The www.mydotperformance.org website, which provides basic background on DOTs' comparative performance efforts could also be used to help promote participation. In addition, efforts could be made to reach out to states that did not participate in the current study.

Time: 20 to 60 hours

Cost: In kind

- **Step 3: Request for States' Data** – Lead agency sends a data request to each state via email using the qualitative description of data needs in Appendix B and an Excel spreadsheet template to be used for reporting data, as shown in Appendix C. Use of the standard template for reporting data ensures it can be easily exported to a database in Step 4.

Time: 40 to 60 hours

Cost: In kind

- **Step 4: Upload States' Data** – Lead agency verifies that each state's data is consistent with the Excel template. Data is saved in CSV file format and transferred to the online database via the automated web tool, which walks users through the steps required to clean data for inclusion in the

database. Appendix D provides a detailed description and screenshots of the protocol for using the web tool to upload states' data.

Time: 80 to 100 hours

Cost: In kind

By following these steps, regular comparative project delivery performance reports will be automatically generated for participating states. The most significant barriers to immediate continuation of cost and schedule reporting are identification of a lead agency to coordinate the reporting process and maintaining states' interest in providing data. The web-based database could easily be folded into a broader electronic comparative measurement website.

Estimated Immediate Continuation Costs – Costs for immediate continuation of cost and schedule reporting are assumed to be minimal if a public agency takes over responsibility for gathering and uploading data. The estimated personnel time required to conduct one round of reporting per year is 140 to 220 hours, or about 7 to 10 percent of one full time employee's time. If management of the data collection was outsourced to a consultant, costs might range from \$20,000 to \$30,000, based on the level of effort described.

5.2 Short-Term Adjustments to Cost and Schedule Reporting

In the short-term, i.e., before the next round of cost and schedule data collection, some high benefit, low cost optional adjustments could help to improve accuracy and value of future results:

Updates to Database Analytics - The on time, on budget database analytics could be updated, based on additional scrutiny of states' data to help provide improved insights on states' performance:

- **Add State Rankings Based on Aggregate Cost Performance** - The primary cost performance measure used in this study, which was agreed to in 2006 by a small group of states as part of the earlier NCHRP study, lists the share of each participating state's completed projects that were finished at or below their originally anticipated cost. These results are used to provide a relative ranking of each participating state's performance.

States may, however, manage costs among many projects – adding costs on some and saving costs on others – rather than aiming to keep every

project within budget. With the right mix of cost savings among projects, a middling project-by-project based cost performance score could mask good program-wide performance. An aggregated approach that ranks states according to their ability to keep within a total budget across all projects would help address this concern.

Adapting the database analytics to accommodate these concerns would require modest additional web design work and some analytic research to determine appropriate action.

Time: 40 hours

Cost: \$5,000 (For out-sourced web design services/consultant support)

Phone Interviews with States to Investigate Selected Data Quality Issues

– Phone interviews with state contact points could further affirm the quality of data used in the study and provide insights on areas where quality improvements can be easily implemented. Two key data quality issues to address in these interviews should include:

- **Causes for the Disparity in Total Projects Reported by Each State –**
The number of projects completed by each state is expected to vary due to factors such as, but not limited to, transportation system scale, age, and contracting practices. Data submissions by some states, however, suggest that they may be over or underreporting completed projects. One large northeast state, for example, reported only 409 projects for the ten-year period compared to an average of 2,593 projects per state. Another state reported over 4,000 more projects than the next closest state. Such inconsistencies should be further investigated to determine if they affect data quality.
- **Stricter Detection of Contingencies Built into Original Cost or Schedule Data –** States were asked to exclude contingencies in their reporting of “original bid award amount” and “original schedule” data, however, one state indicated after the fact that they could not or did not back out cost contingencies. Inclusion of any contingency creates a favorable bias in a state’s performance results that may lead to a better ranking than is deserved, therefore a clear picture of whether contingencies are included in any state’s data would be valuable. If contingencies are known, they can be backed out during the data upload process.

Phone interviews with 39 states would take approximately 3 hours per state to organize, conduct and summarize for a total of about 120 hours.

Time: 120 hours

Cost: In kind or \$20,000 (For consultant support)

Estimated Short-Term Adjustments Costs – Costs for short-term adjustments to cost and schedule reporting are based on some consultant/web design support to carry out the activities described above. The estimated personnel time required is 160 hours. If adjustments are outsourced to a consultant, costs might be in the range of \$25,000.

5.3 Medium-Term Refinement of Measurement Approaches

Each of the seven top performers interviewed as part of this project declared a strong interest in continuing to compare performance. In the medium-term, potentially after the next round of cost and schedule data collection is completed, an ongoing peer exchange series could be established to give states a regular forum for discussing comparative performance issues. The peer exchanges could be held about once a year and they would give states an opportunity to discuss performance results and investigate more complex questions about how to measure and compare project delivery performance. Topics for dialogue could include:

- **Accommodating Alternate Performance Thresholds** - If a state gears its construction management practices toward achieving different thresholds for on time and on budget performance than the ones used in this study, it may consistently fail to meet the study's thresholds – resulting in a poor performance ranking. A state, for example, may consider projects to be finished on budget, if final costs come within a set percentage of the original bid award amount.

The extent to which states are using alternate definitions for on time and on budget performance was not examined as part of this study. Further review would help determine if states are managing to other definitions and whether they should be allowed to replace “original bid award amount” or “original schedule” with customized measures of performance that are based on their preferred definitions. Ideally, a process would be established to make each state's definition transparent to other participating states. This would be an ideal topic for further research and dialogue among states.

- **Accounting for “Acceptable” Change Orders** - Some states (including several top performers) do not routinely anticipate or support “change orders” that result in added project costs or time; they expect the difference to be made up elsewhere on a project. Other states, however, consider “change orders” that sometimes add costs or time to a project as a reasonable part of project management. Discussion is needed to determine if and how reasonable “change orders” could be tracked and incorporated into the performance measures used for this study. As a practical matter, it may be difficult to collect standardized data that indicates when additional costs or time are legitimate.
- **Relationship Between Contract Risk Management and Performance Measurement** - Project schedule and cost can be altered by unanticipated events during construction. States have differing philosophies about how to manage risk during the contracting process. Some states seek to account for risk early by cushioning original bid award amounts and schedules; alternatively, they may push risk to contractors who account for it in their bids. Under these circumstances, original bid award amounts are likely to provide a reasonable projection of final costs. Other states manage unforeseen risks, if they occur, via changes in scope after the project letting. Since states differ in their approaches, a one-size-fits-all measurement approach may favor one group over others. Further research and dialogue is needed to examine the extent to which risk management practices in contracting influence comparative performance measurement practices.
- **Accounting for Differences in States’ Budgeting Practices** - The way a state sets its budget for a program of transportation projects may influence how accurately the comparative measures used in this study reflect its performance. If a state adheres to a fixed budget once projects are programmed, then the original anticipated cost and schedule are likely to be a reliable baseline for gauging performance. If, however, a state tends to make conservative scope assumptions about projects at their outset with the anticipation that scopes, costs and schedules may be expanded later when, or if, additional funds become available, then the original anticipated cost and schedule are a less reliable baseline for gauging performance.

The extent to which states participating in the study use a fixed budgeting approach that favors the current comparative measures is not known.

Likewise, the extent to which states may vary their practices over time in response to changing budgetary conditions is unknown. A qualitative assessment is needed of the potential impact that states' budgeting practices may have on the value and credibility of the current comparative performance measures. This could be achieved via a national dialogue on comparative project delivery performance measures. If necessary, consideration could be given to allowing states to justify alternate baselines for cost and schedule performance that reflect their budgeting practices.

- **Changes to States' Project Delivery Data Collection Practices** – As part of the dialogue process, states also could evaluate opportunities for greater standardization in their contract data collection practices that would support comparative performance measurement, one example of an area where greater standardization could occur is states' classifications for project type: States do not use standard terminology to describe project type (e.g. bridges versus highways or preservation versus capacity) and some states choose from hundreds of non-standard terms to describe projects. At present, each state's project types must be mapped to a standard list used for the web database, which requires considerable time and subjective interpretation. Alternately, states could move to use of a standard project classification system in place of, or alongside their own classification systems. The value of presenting performance by project type must be evaluated in the context of the added burden required of states to make it meaningful.
- **Other Issues Related to Measuring Project Delivery Performance** – Many other issues are likely to arise as states become more familiar with the concept of comparative project delivery. Some states, for example, have suggested exploring performance differences between urban and rural projects, while others are concerned about how construction season length affects their performance rating relative to other states. Other states have raised concerns about use of "working days" as a way to measure schedule performance; they question whether it accurately portrays a commitment to complete a project by a set date. Another factor of concern is the ability of states to provide contract adjustment information that may alter their performance results. The peer exchanges could be used to explore issues such as these as they arise.

Time: 240 hours to organize a one-day workshop and produce summary report

Cost: \$35,000 to 40,000

Time: Unknown

Cost: Unknown

Estimated Medium-Term Refinement Costs – Costs for medium term refinement of on time and on budget reporting are assumed to include consultant support to carry out a workshop. The estimated personnel time required is 240 hours at a cost of about \$40,000.

Appendix A – State Contact Points

Arizona

Dallas Hammit

dhammit@azdot.gov

Arkansas

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(501) 569 2241

California

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Todd Rumbah

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(304) 558 9569

Appendix B - Contract Record Reporting Fields

For each contract record provided by a state, the following data will be submitted:

1. Unique contract identifier;
2. Working day or calendar day contract type;
3. State's final voucher date or similar that indicates project is complete and all costs are paid;
4. Field that indicates whether contract is funded with all/or some ARRA money;
5. Field that indicates whether contract is for project on local or state system, if available;
6. Project type (e.g. bridge replacement, repaving, etc.);
7. Original number of working days allowed (for working day contracts);
8. Working days charged (for working day contracts);
9. Original specified completion date (for calendar day contracts);
10. Substantial completion date or similar (for calendar day contracts);
11. Original contract bid award amount excluding contingencies, if any;
12. Final cost;
13. If available, final cost adjustment for performance bonus or penalty; and
14. If available, final cost adjustment for inflation in materials costs.

Appendix C – Excel Template for States’ Data

Contract ID	Final Voucher Date	Local Project	ARRA Project

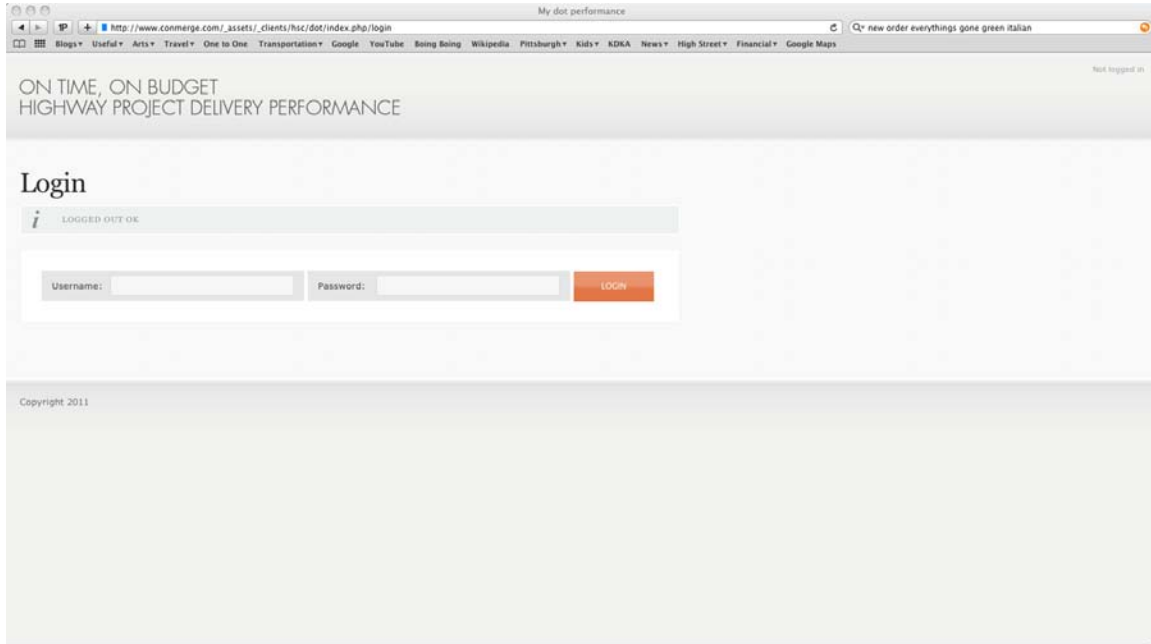
Contract Schedule Type	Contract Project Type	Notice to Proceed Date	Original Working Days Approved

Final Working Days Approved	Total Working Days Charged	Original Specified Completion Date	Final Specified Completion Date

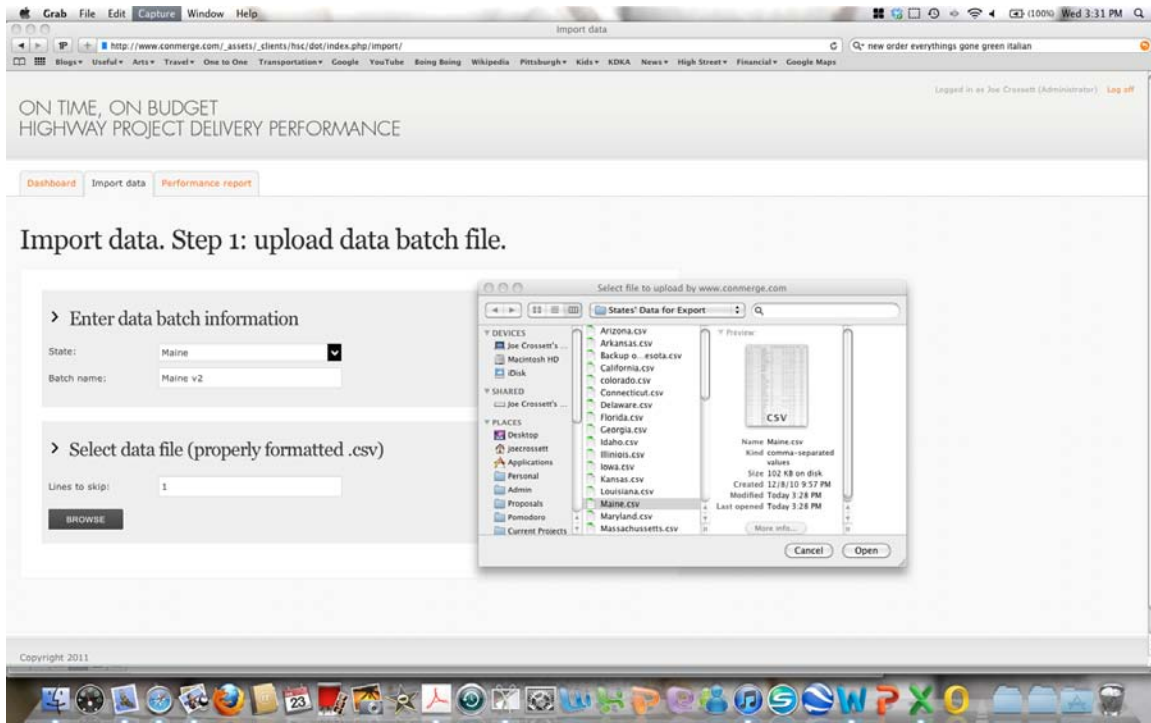
Substantial Completion Date	Original Bid Award Amount	Original Bid Award Plus Adjustments	Final Cost	Liquidated Damages Days

Appendix D – Screenshots of Data Upload Protocol

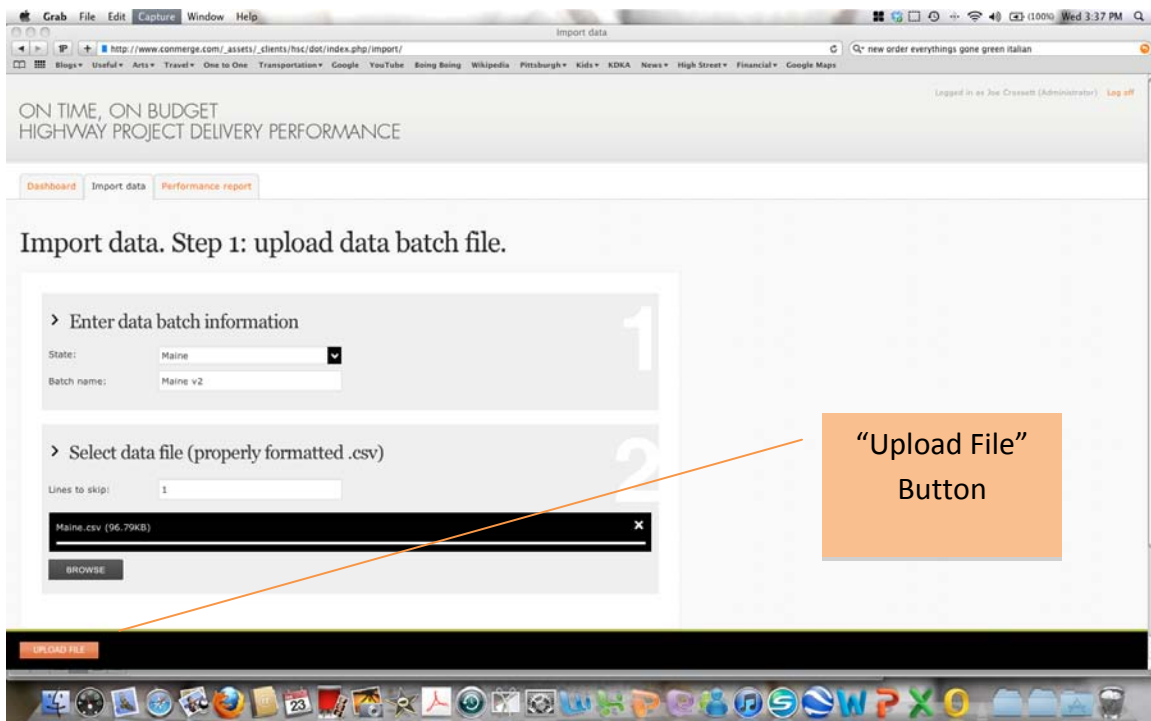
A: User logs in with administrator privileges to web tool



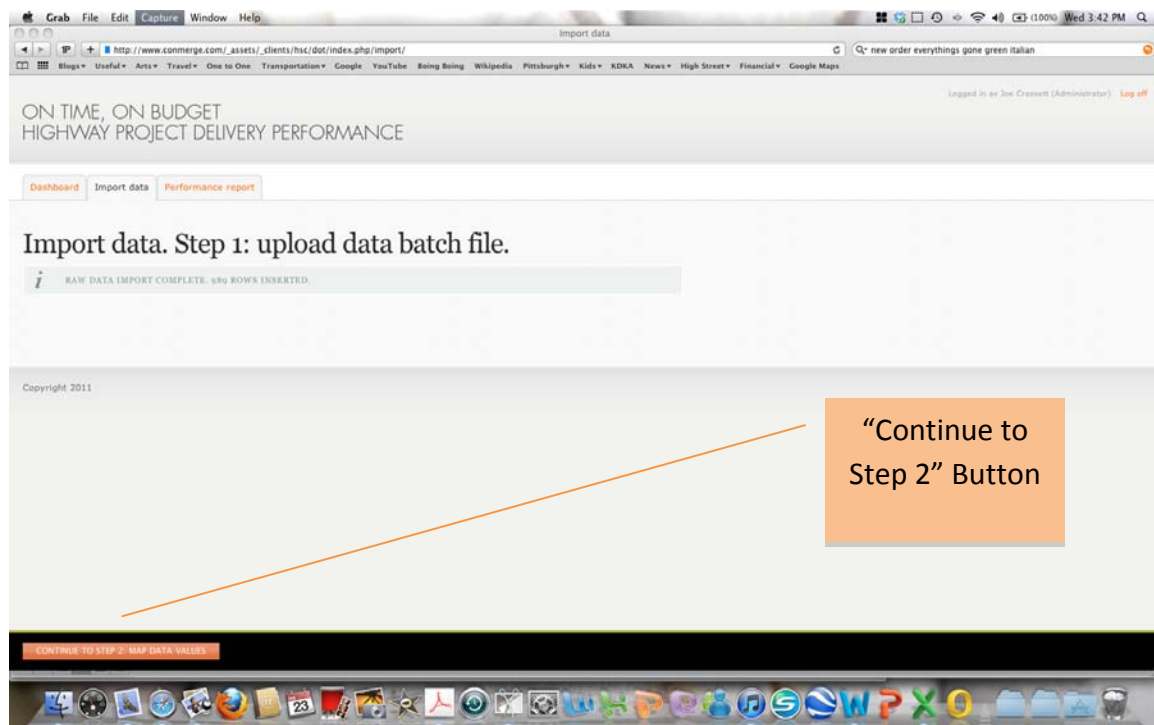
B: User selects state's name from drop down menu; creates a unique "batch name" for state's data file; tells uploader to skip 1st line of data file (which contains column headers); and clicks "browse" to choose CSV data file to upload from user's hard drive.



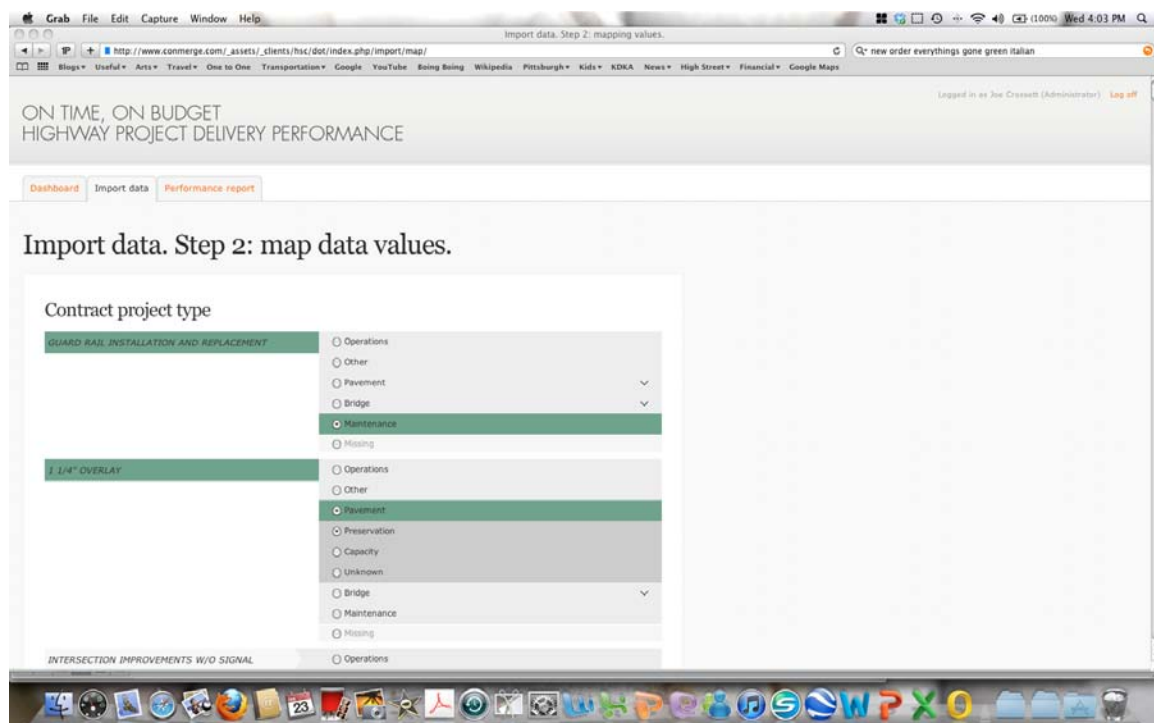
C: User clicks on orange "Upload File" button in bottom left of window



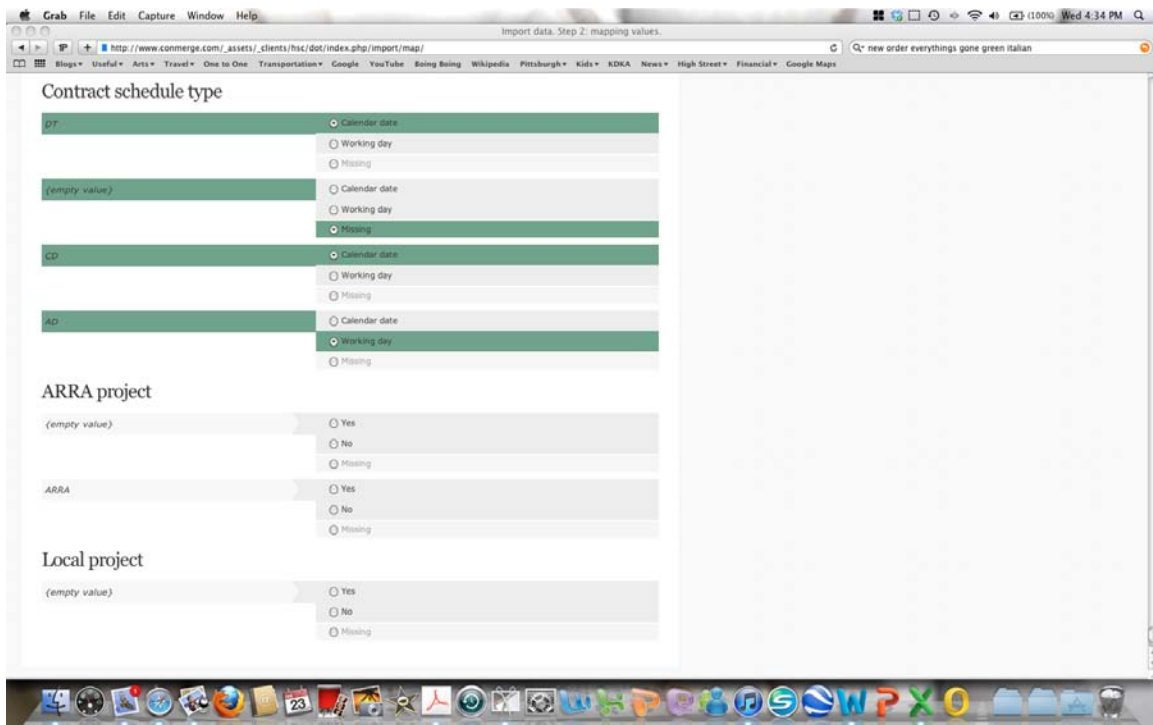
D: If data uploads successfully, display will show a message stating “Raw data import complete. XXX rows inserted.” User must click on “Continue to Step 2” button.



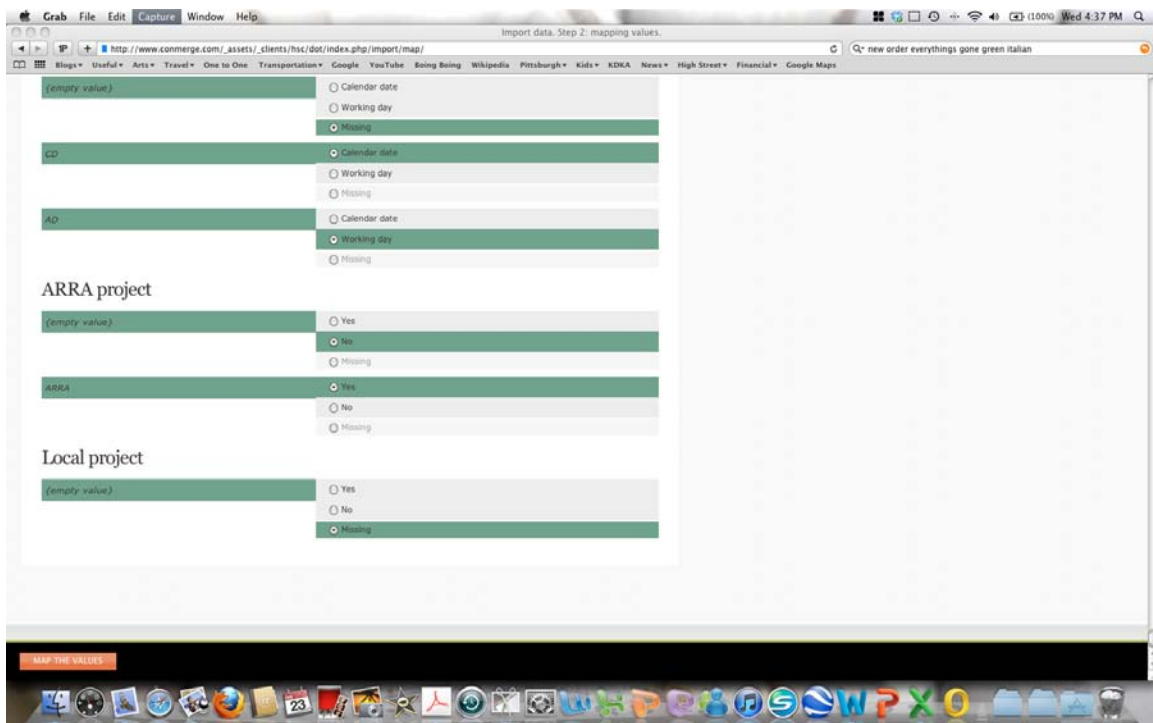
E: User maps each unique “contract type” field term used by a state to a standard contract type used in the database (Operations, Pavement, Bridges, etc.).



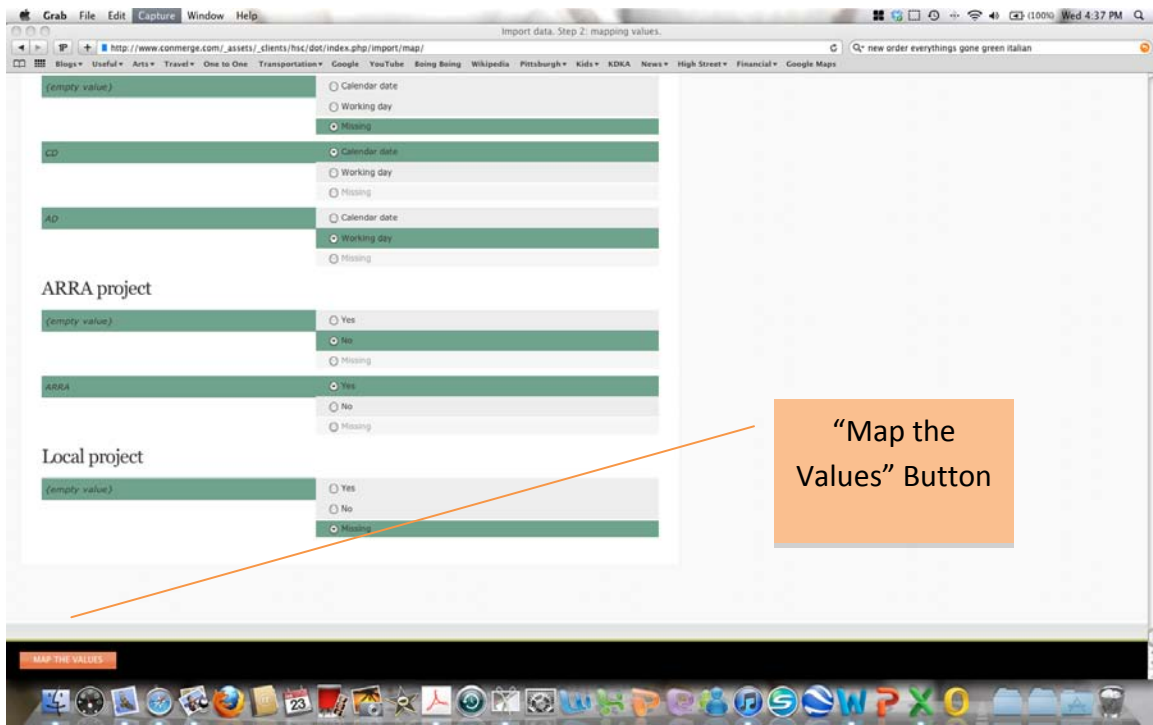
F: User maps each unique “contract schedule” field term used by a state to a standard contract type used in the database (Working Days, Calendar Days, Unknown).



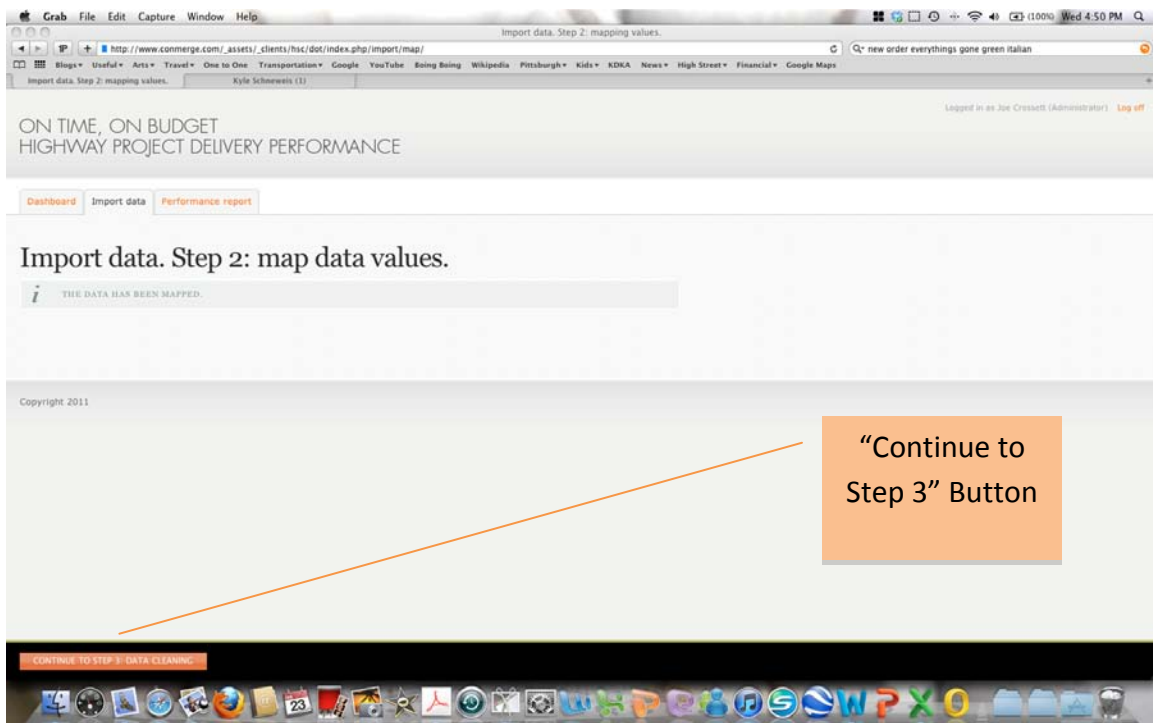
G: User maps each unique “ARRA” and “Local Project” field term used by a state to a standard contract type used in the database (ARRA: Y/N; Local Project: Y/N).



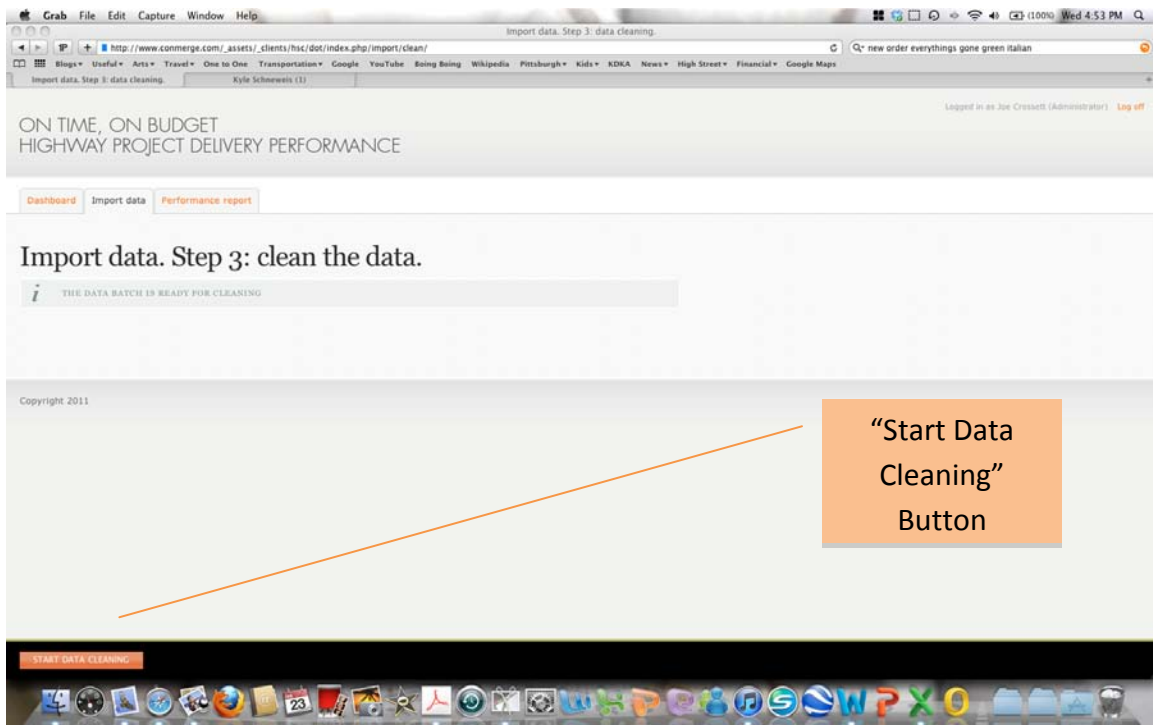
H: User clicks on orange “Map the Values” button in bottom left of window to continue.



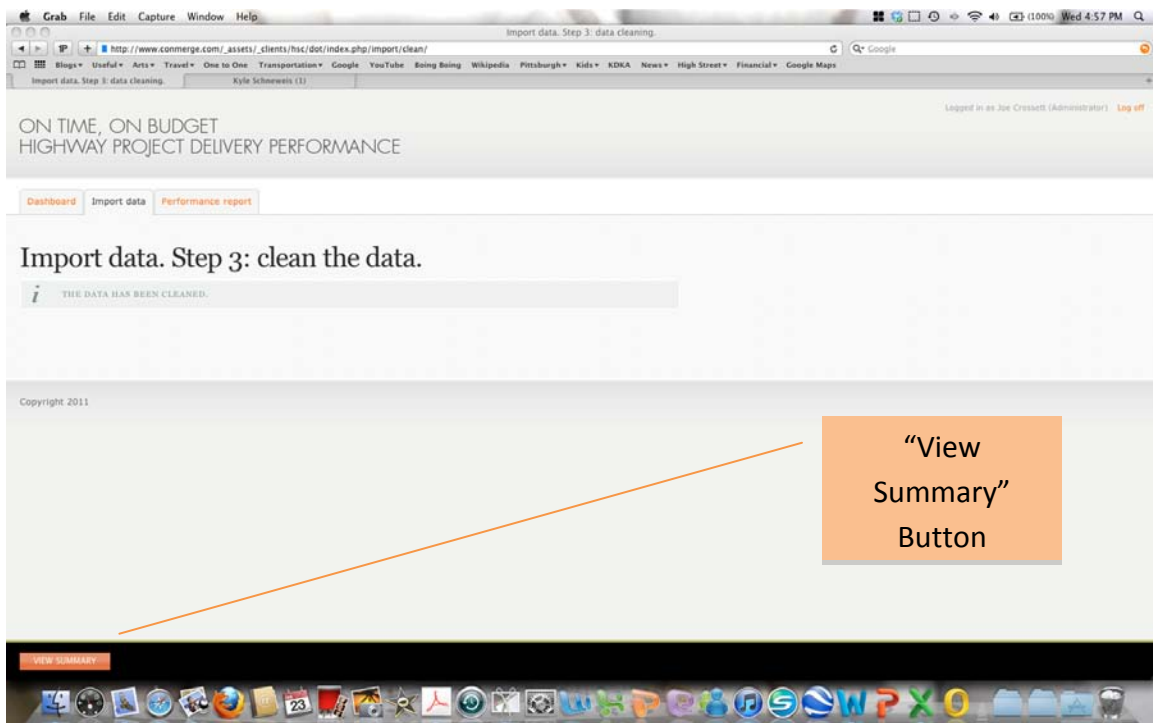
I: If data mapping is successful, display will show a message stating “The data has been mapped.” User must click on “Continue to Step 3” button to begin data cleaning



J: Display will show a message stating “The data is ready for cleaning.” User must click on “Start Data Cleaning” button.



K: If operation is successful, display will show a message stating “The data has been cleaned.” User must click on “View Summary” button to finish upload.



L: User must click on “Complete the Import” button to finish upload.

