Streamlined Project Closeout for Construction at KYTC

Kentucky Transportation Center Research Report – KTC-17-12/SPR13-460-1F

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Research Report
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16. Abstract
Project closeout is the period between the end of construction and when a contract is finalized. During closeout, resources are held in encumbered funds intended for the project and in the contractor's bonding capacity. Although the Kentucky Transportation Cabinet's (KYTC) stated goal is to close out projects within 240 days of their ending, in 2016 the average duration of project closeout was 366 days. This report analyzes the Cabinet's project closeout procedures, summarizes project closeout best practices adopted by other state transportation agencies, and recommends ways to improve KYTC's practices. Streamlining project closeouts would free up sufficient funds to resurface approximately 2,000 to 7,000 total lane miles that would otherwise not be rehabilitated. To begin reforming project closeout, the Cabinet may benefit from 1) investigating ways to improve the preparation of final documentation and 2) reducing the amount of time allocated for development and completion of the materials check. Other recommendations for revamping project closeout include establishing a KYTC task force to conduct high-level analysis of the project closeout process; thoroughly implementing e-Construction methodologies, which can reduce paperwork and centralize record-keeping within tightly controlled and monitored databases; revising project closeout checklists to standardize the process and eliminate all steps that are unneeded or outdated; and optimizing project closeout processes at the district level to help personnel adopt best practices. More efficient project closeouts will benefit the public because of their potential to increase the amount of funding that can be dedicated to critical transportation projects that would otherwise remain unaddressed. As the Cabinet investigates ways to begin this process, it is important to keep in mind that strategies or methods for streamlining project closeout should be implemented by KYTC personnel, as this increases the likelihood that staff buy-in across the agency.

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Executive Summary

Project closeout encompasses the period between the end of construction and contract finalization. During project closeout, resources are constrained in encumbered funds intended for the project and in the contractor's financial bonding capacity. As such, project closeouts tie up resources that could be used for other highway improvements. The Kentucky Transportation Cabinet (KYTC) and its contractors have expressed concern about the prolonged duration of project closeouts. The Cabinet's stated goal is to close out a project within 240 days of construction ending; however, many projects take significantly longer. In 2016, the average duration of project closeout was 366 days. The objective of this project was to identify strategies and put forward recommendations to help the Cabinet streamline and therefore accelerate its project closeout process. Researchers from the Kentucky Transportation Center (KTC) analyzed KYTC's project closeout process, studied the policies of other state transportation agencies (STAs), and examined principles derived from lean construction, Six Sigma, and Civil Integrated Management (CIM) to formulate recommendations. Comparable initiatives undertaken at other STAs to improve project closeout have resulted in savings of up to 25 staff workdays per year.

An analysis of KYTC projects revealed that streamlining project closeouts could give the Cabinet the ability to resurface between 2,000 and 7,000 total lane miles that otherwise would not be rehabilitated. While these funds cannot be made available immediately after formal acceptance, streamlining the closeout process can mitigate these effects. Releasing funds encumbered by projects that have been completed but not yet finalized should be a common goal of KYTC leadership, field personnel, and contractors given that those funds could potentially be used for additional roadway improvements.

The Cabinet could realize time savings in a number of areas. The greatest time savings can be derived from improving work in the Resident Engineer's Office, which encompasses the completion of corrective work to the resident final check. Increasing the efficiency in the preparation and completion of the materials check could also help shorten project closeout time. Conducting final inspections and corrective work more efficiently could also result in significant time savings.

KTC's recommendations pertain the Cabinet's procedures, and potentially its policies. The suggested changes are best considered and executed by personnel internal to KYTC. The following list provides a foundation for applying improvements to the project closeout process, but implementing them should be the responsibility of Cabinet personnel. To accelerate and streamline project closeouts, KYTC should pursue the following:

- Develop a task force to conduct a high-level analysis of the project closeout process
- Emphasize that streamlining project closeouts will benefit the public by increasing publicly available funding
- Develop an incentive program to encourage more timely project closeouts
- Review and modify the KYTC's current duration goal(s) for closing out projects
- Review and edit project closeout checklists so they retain only the required steps; eliminate extraneous or outdated steps
- Consider strengthening implementation of e-Construction practices to automate steps of the project closeout process

1. Introduction

Background & Problem Statement

Project closeout encompasses the time and activities that fall between the completion of construction and finalization of a contract (i.e., final contract payment, submission of as-built project plans, verification of quantities). During project closeout resources are constrained in encumbered funds for the project. Contractors' resources are also a constraint in limitation of their financial bonding capacity. In the past, Kentucky Transportation Cabinet (KYTC) staff and the agency's contractors have voiced concern about the extensive length of project closeout. Currently, the Cabinet's stated goal is to complete project closeout within 240 days. Project closeout ties up resources that could be used elsewhere for highway improvements. Anecdotally, the length of project closeout has been attributed to the process itself and the current (limited) staffing levels, which increase the time required to complete the required tasks. This project investigated the closeout process of other agencies, as well as KYTC's process, to uncover sources of delay and identify methods to streamline and expedite closeout with the goal of reducing the time demands it places on the Cabinet's staff. The KYTC process was also compared to other state processes to identify extraneous activities that could be eliminated and areas to streamline.

Several techniques exist to streamline project closeout. For instance, Civil Integrated Management (CIM) is a collection of techniques aimed at improving the development and administration of civil engineering projects. This approach entails improving the collection, organization, management, and accessibility of data and information throughout the project lifecycle. Project Management Systems are a key component of CIM. They facilitate the electronic transmission, storage, and approval of documents; online real-time status of material sampling and testing; electronic verification of wage rates; maintenance of digital as-built documentation; and improved public relations. CIM is supported and promoted by the American Association of State Highway Transportation Officials (AASHTO), the American Road & Transportation Builders Association (ARTBA), AGC, and is part of the Federal Highway Administration's (FHWA) Every Day Counts initiative. Six Sigma and lean construction are useful practices as well. Six Sigma is a series of techniques developed to identify and eliminate causes of errors and variability. Lean construction seeks to improve processes with an emphasis on minimizing costs and maximizing value and efficiency. This project investigated strategies to apply these approaches to KYTC. A Kentucky Transportation Center (KTC) research team reviewed and analyzed the current KYTC process to suggest tools and strategies to streamline project closeout procedures.

2. Research Methods

Study Objectives

The project's objective was to help KYTC streamline its project closeout process by recommending new practices and ways to modify or replace its current procedures. Researchers generated recommendations based on their analysis of KYTC's project closeout process, strategies implemented by other agencies, and principles derived from lean construction, Six Sigma, and Civil Integrated Management (CIM). Other departments of transportation (DOTs) have pursued similar initiatives, which have resulted in savings of up to 25 staff-workdays per year (Colorado DOT, CDOT). Implementing new practices and adjusting current processes will reduce the time KYTC staff spend on project closeout. Making the process less intensive promises to increase its manageability given KYTC's current staffing levels.

Research Tasks

Researchers worked to identify strategies that will accelerate project closeout. The primary research tasks included:

- Review CIM, Six Sigma, and lean construction approaches used by DOTs to identify lessons learned. Agency manuals, documents, technical memoranda, and interviews with stakeholders were reviewed as part of this task.
- Review and analyze KYTC's current procedures and practices to complete project closeout, including staffing needs. Researchers performed a detailed examination of current requirements, tasks, and responsibilities of project closeout. They noted items that cause the process to lag. Information was collected through a review of manuals and internal documents as well as analysis of historical project data and informal interviews.
- Collect and organize best practices aligned with KYTC's closeout process. Researchers analyzed literature and best practices and attempted to align these with KYTC's process. This task was vetted through a presentation with the study advisory panel.
- Develop recommendations for a streamlined project closeout process and describe resource requirements.

3. Literature Review

Researchers used a variety of resources to conduct the literature review, including Transportation Research International Documentation (TRID) from the Transportation Research Board (TRB). Data were collected from state DOT websites and through interviews with agency stakeholders. Key findings from the literature review are organized into the following sections:

- FHWA Project Closeout Process
- e-Construction
- State Departments of Transportation
- Additional Research
- List of Best Practices

FHWA Project Closeout Process

FHWA defines project closeout as "the process that 'closes out' the financial award for a local public agency (LPA) when all applicable administrative actions and required work of the project have been completed for a Federal-aid highway project" (FHWA 2012). This process can be divided into four steps.

First, a state DOT must monitor the construction process. This includes "supervising and inspecting… actual construction or reconstruction of a Federal-aid highway construction operation and incurrence of all costs incidental to the construction or reconstruction of the Federal-aid highway construction project" (George-Nwabugwu and Dirks 2013). Project inspections should be conducted throughout the project. Construction inspections are defined as "on-site review[s] of the work in progress to evaluate the quality and progress of the work, and to follow-up on findings as applicable from previous inspections" (George-Nwabugwu and Dirks 2013). There are three types of inspections: 1) Initial, which take place at 10 percent completion; 2) Intermediate, which take place at 60 percent completion; and 3) Final, which take place at 95 percent to 100 percent completion.

Second, once a state DOT accepts the construction contract, which means the contractor has fulfilled their obligations to the contract, the project has reached final acceptance (George-Nwabugwu and Dirks 2013). At this stage, a state DOT reviews records to identify any outstanding claims, unfinished work, or other issues (FHWA 2012). George-Nwabugwu and Dirks define final acceptance as the "on-site review of the completed construction project, and all the documents generated during the life of the construction project, that support the project was actually completed per the contract requirements, to allow the FHWA to close-out the federal project agreement" (George-Nwabugwu and Dirks 2013). The contractor is responsible for notifying a state DOT that a project is complete and ready for its final acceptance (FHWA 2012).

The third step in the process is final voucher transactions. Here, the state DOT initiates the final financial payment to the contractor for project expenses. George-Nwabugwu and Dirks define the final voucher as "the final construction cost that is reimbursed to the SDOT [state DOT] to close a Federal-aid construction contract in FMIS" (George-Nwabugwu and Dirks 2013). This voucher is processed and approved by the local FHWA division office (FHWA 2012).

The final step is records retention. In this step, the "project records… collected and developed during project construction and contract administration have to be retained. Supporting documentation for [the] project must be securely filed and available upon request for audits or reviews by FHWA or other

government officials." (FHWA 2012, p. 2). Federal regulations mandate that documents and records for all Federal-aid projects be held "for a minimum of three years following the last 'action' on the project by the local public agency. In most cases, the last action is…final [acceptance of] reimbursement payment" (FHWA 2012).

For the process to work effectively, the FHWA makes the following recommendations (FHWA 2012) (George-Nwabugwu and Dirks 2013):

- Maintain accurate and complete records and reports throughout the life of a local Federal-aid project so that the agency can complete final acceptance
- Initiate a final payment request following the completion of project construction to the oversight agency
- Retain supporting project documentation for a minimum of three years for possible audits

e-Construction

e-Construction is part of Every Day Counts 3, a joint initiative of FHWA and the American Association of State Highway and Transportation Officials (AASHTO). The goal of the initiative is "to assist States with implementing a paperless construction administration and delivery process known as e-Construction" (FHWA and AASHTO 2015). e-Construction significantly reduces the amount of physical documentation needed for projects by promoting controlled access to digital documents secured within a document management system that can be accessed by project stakeholders. The system accommodates and encourages the use of electronic signatures, submissions, document routing, and digital management to save time and money (FHWA and AASHTO 2015).

e-Construction has been partially or fully implemented by many state DOTs. Many agencies are currently implementing these processes on a large scale: "e-Construction has the potential to increase the quality, efficiency, environmental sustainability, and productivity of the construction industry at large while helping agencies to save on printing costs, time, postage, legal involvement, and document storage as well as to introduce communication efficiencies" (FHWA and AASHTO 2015). States that have fully or partially implemented e-Construction include Texas, Michigan, Minnesota, Iowa, Florida, and Utah. Figures 1 and 2 show the implementation level each state has achieved. Some of the benefits enjoyed by states that have embraced e-Construction include:

- Reduction or elimination of paper (sustainable solution)
- Operation in a secure environment
- Ease of document access or searchable text
- Real-time document access
- Controlled and improved document distribution and workflow
- Standardization of reports or forms
- Reduction in storage and lost paperwork
- Enhanced disaster recovery
- Improved cash flow
- Reduction in claims
- Field staff on the job site for a higher percentage of time
- Easier access to manuals, plans, and project information
- Faster document approval

- Ability to sign electronic documents remotely
- Faster, more accurate payments to contractors
- Transparency — documents available for viewing by all project partners
- Integration with other core systems, such as accounting and asset management systems

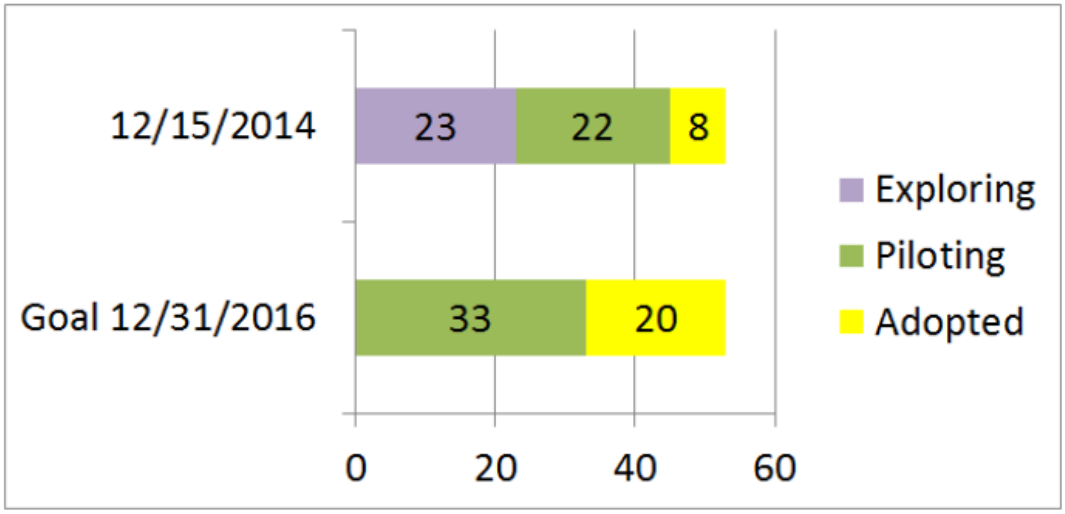


Figure 1 Current State of e-Construction (Current vs. Goal) (FHWA and AASHTO 2015)

Figure 2 Current State of e-Construction (FHWA and AASHTO 2015)

Adopting and implementing e-Construction on a wide scale presents many challenges. Factors that influence its implementation include budget restrictions, compatibility with existing state DOT programs, measurement of success, dedication to implementation, and shifting resources. Because state DOTs differ

from one another significantly, it is unlikely one solution will fit them all. It is also be challenging to set up and monitor measures of progress in each state, although this is critical to the expansion and evolution of e-Construction (FHWA and AASHTO 2015).

State Departments of Transportation
Researchers searched for the closeout practices of all 50 state DOTs. Of those 50, researchers identified and reviewed information on project closeout from six states. The following sections describe state-level practices.

Colorado Department of Transportation
The Colorado Department of Transportation (CDOT) has created a Project Closure Process Improvement Project Team to help streamline project closeout. The team consists of members from districts around Colorado. To date, it has streamlined the process by 25 days of work per year. Rework was also a major contributor to timeline delays on project closeout, so this has been a major focus (Paredes 2015). Project outcomes are listed below:

- Created a Finals Notebook to help organize and keep paperwork easily accessible
    - Paperwork is not a standard across all districts
- Changing Form 325 (the Final Request for Payment form), which provides outlines for final budgets, dates, and days used to complete the final estimate, to an electronic format
- Standardized the layout of ProjectWise, a document storage platform designed to house engineering documents for final paperwork documentation
- A Finals Administrator compiles closure paperwork using Adobe Acrobat, which is placed in ProjectWise upon completion. Paperwork is emailed to all headquarter departments and stakeholders in the project (Turvey 2015)

Michigan Department of Transportation
One of the first agencies in the country to adopt e-Construction, the Michigan Department of Transportation (MDOT) now has fully implemented it. MDOT "estimates that its programmatic adoption will result in approximately $12 million in added efficiencies and eliminate 7 million pieces of paper by using electronic document storage for its $1 billion average construction program. In addition, average contract time for complex contract modifications (change orders) is reduced from 30 days to 3 days" (FHWA and AASHTO 2015). MDOT is now 99 percent paperless, with paper currently only being used for material tickets. (FHWA 2015)

In addition to e-Construction, MDOT has benefited significantly from implementing the following procedures (FHWA and AASHTO 2015) (MDOT 2015):

- Electronic document management system
- Construction administration software
- Electronic plans and proposals
- Electronic bidding
- Digitally encrypted electronic signatures
- Process workflow
- Mobile devices
- I-books and online manuals
- Fillable forms

Many of these procedures are made possible through the use of ProjectWise, FieldManager, and Mobile Inspector, which MDOT has implemented for all projects. All inspectors can access these programs in the field using their iPads (FHWA 2015).

Utah Department of Transportation

The Utah Department of Transportation (UDOT) applies e-Construction on design-build projects and is currently 25 percent paperless (FHWA and AASHTO 2015, FHWA 2015). Like MDOT, the agency uses software programs to facilitate e-Construction, including ProjectWise, MasterWorks, and Interchange. MasterWorks is used to collect and record data in the field, while Interchange is a platform for project collaboration (FHWA 2015).

Along with e-Construction, UDOT has benefitted significantly from implementing the following procedures (FHWA and AASHTO 2015):

- Electronic plan sets and documentation (field laptops or digital cameras)
- Budget tracking and projections
- Schedules and projections
- Electronic signatures
- Electronic payroll verification
- 3D design

Researchers interviewed Aaron Watson, an engineer with UDOT, to understand their timeline for project closeout. The timeline is as follows (A. Watson, personal communication, December 7, 2015):

- Substantial completion — Contractor has completed all roadway work that affects the traveling public.
- Physical completion — 30 days from substantial. All work is done on the site.
- Contract completion — 30 days from physical. All final documents are finished and submitted.
- Resident Engineer (RE) has 30 days to compile all documents from contractor and submits to Region Contract Specialist (RCS) for quality control review
- RCS has 30 days to perform quality control review and submit to Central Construction/Civil Rights

This timeline/process is visible on UDOT's Project Closeout Network (Figure 3) (UDOT "Project Closeout Network").

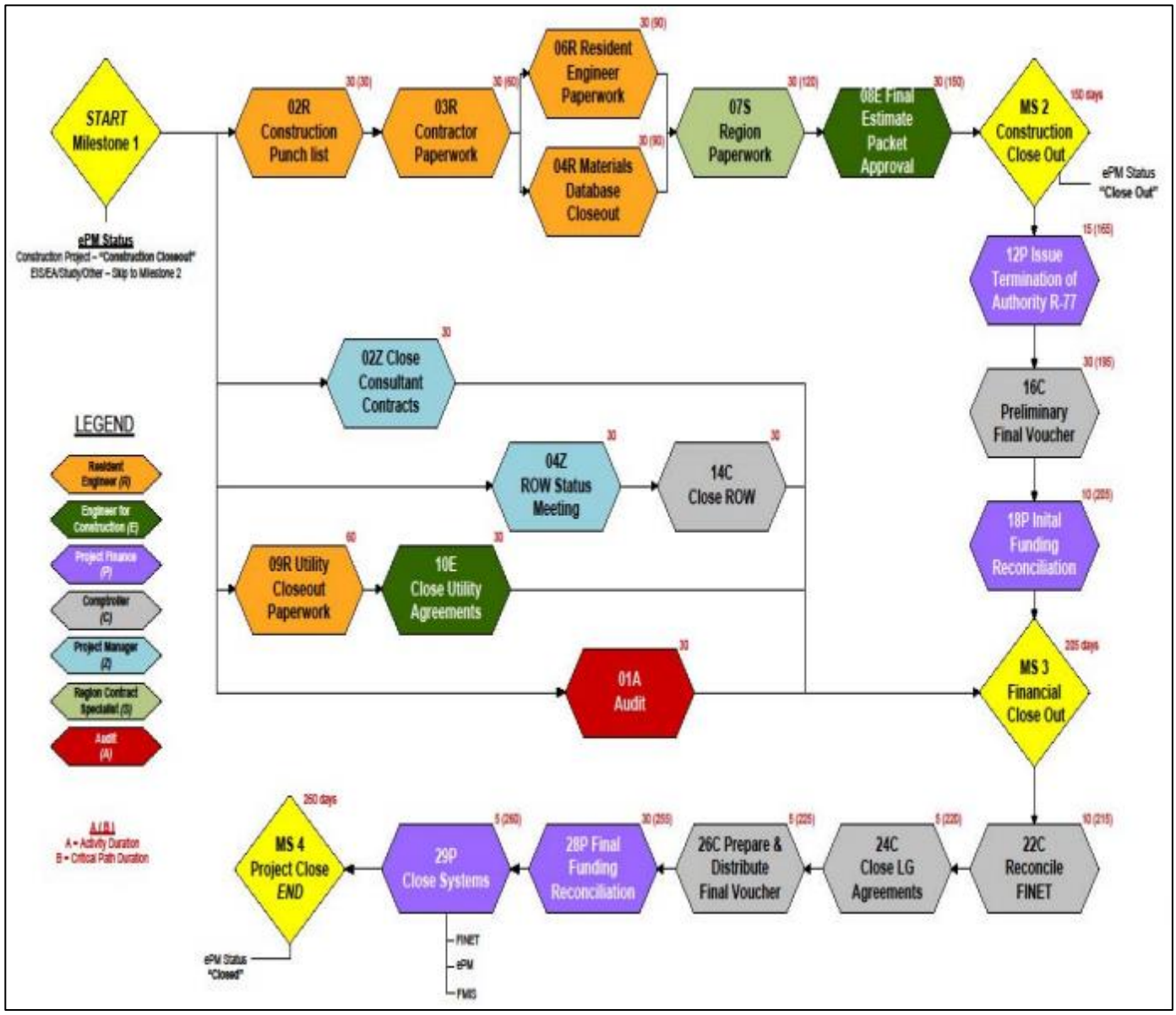


Figure 3 Project Closeout Network

Researchers also obtained a chart that tracks project closeout duration from 2008 to 2015. This chart is broken down by Central Office, Region, Contractor, and RE. This chart is shown in Figure 4. UDOT also has measures in place to ensure that all parties named in the contract are knowledgeable of deadlines and the date their documentation must be completed by (A. Watson, personal communication, December 7, 2015).

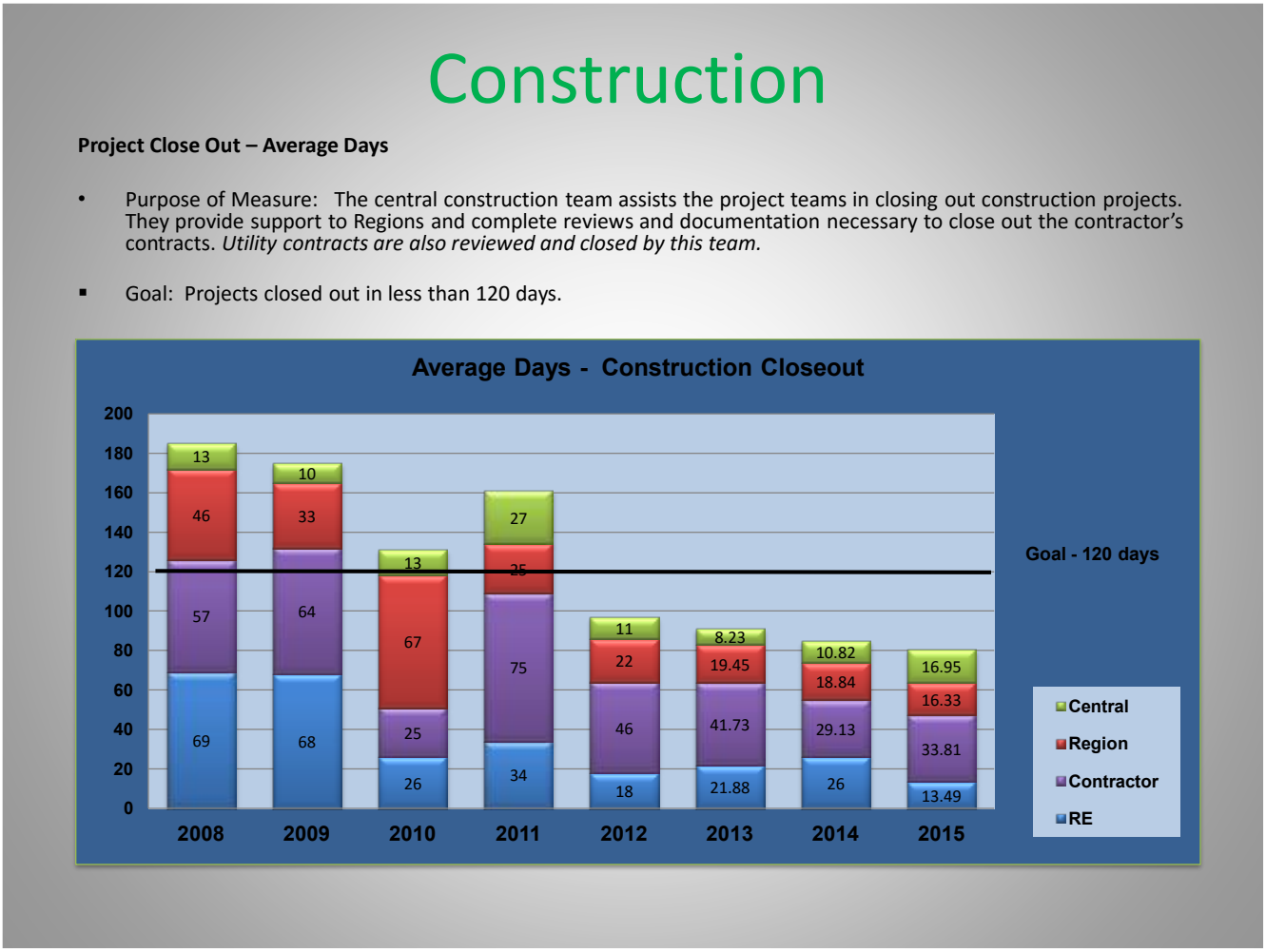


Figure 4 UDOT Project Closeout Durations

Florida Department of Transportation

The Florida Department of Transportation (FDOT) applies e-Construction to design-build projects (FHWA and AASHTO 2015). By expanding the use of mobile devices, the agency replaced over 20,000 pieces of paper on four projects. FDOT uses many software programs that aid in e-Construction, including SiteManager (a field project management software for inspectors), Citrix (an interface to access SiteManager on iPads), ProjectSolve (project collaboration software), Electronic Document Management System (EDMS, a database for storing final project records), Hummingbird (for document storage), IdenTrust (for digital signatures), and Blue Beam (for electronically editing as-builts and field changes) (FHWA 2015).

In addition to e-Construction, FDOT has benefitted significantly from implementing the following procedures (FHWA and AASHTO 2015):

- Project letting (complemented to e-Construction)
- 3D design models
- Collaborative sharing site

- Mobile devices
- Digital signatures (encrypted)
- Form automation
- Electronic as-builts

FDOT has established performance measures to accelerate project closeout. For example, its target for offering final payment to the contractor after final project acceptance is 30 days. Its target for full payoff from final acceptance is 275 days (D. Sadler, personal communication, December 8, 2015). It has also set objectives for grading contractor performance, accurate and timely final payment, setting project manager guidelines, and holding contract training. Monitoring performance indicates where improvements are needed (FDOT 2016).

Iowa Department of Transportation

The Iowa Department of Transportation (Iowa DOT) applies e-Construction on design-bid-build projects (FHWA and AASHTO 2015). The agency is currently 99 percent paperless; paper is only used for weigh tickets and scale information. Iowa's DOT uses a multitude of software to facilitate e-Construction, including Doc Express (a document management system), Electronic Reference Library (ERL — for online specs, construction manuals, and standards), Adobe Connect (a web meeting service), FieldBook and FieldManager (for field project management), SiteManager LIMS (material library and management system), and ArcGIS Collector (GIS data collection) (FHWA 2015).

Along with e-Construction, Iowa DOT has realized significant benefits from the following procedures (FHWA and AASHTO 2015):

- As-let plans from contracts
- Electronic as-builts in the field
- New electronic shop drawing process (DocExpress)
- Straight-line diagraming for project plans
- 3D project plan vision
- GIS-based smart plans

Texas Department of Transportation

The Texas Department of Transportation (TxDOT) applies e-Construction to design-build projects (FHWA and AASHTO 2015). TxDOT is "currently using e-Construction for design applications, contract administration, archiving, and planning for data collection, materials, and core custody" (FHWA 2015). The agency uses many software programs to facilitate e-Construction, including ExeVision (for electronic bidding), HeadLight (for mobile inspection documents), SiteManager, ProjectWise, Primavera Scheduling, EquipmentWatch (for equipment rental rates on change orders), and StockPile Reports (for measuring and estimating stockpile volumes).

In addition to e-Construction, TxDOT has enjoyed significant benefits from implementing the following procedures (FHWA and AASHTO 2015):

- Design (ProjectWise and 3D modeling)
- Pre-letting (advertising, BPRS, pre-bid questions)
- Letting (CDA)
- Contract administration (FieldManager, SiteManager, P6, EPRS, iPads, YouTube)

- Archiving (EDMS)
- Electronic data collection, materials, core custody

Additional Research

Given that many agencies have sought ways to shorten project closeout timelines, project closeout has been a fruitful research area. Kaul (2014) looked at how closeout delays could be removed with the use of better practices. O'Neill (2015) studied ways to update the Alaska Department of Transportation's project documentation to streamline closeout. Many factors influence the pacing of project closeout, including technical, administrative, financial, and psychological variables. A single problem can significantly delay the process. Kaul listed some of these factors (Figure 5).

Factors	Types
I] Psychological	• Project manager or superintendent demobilized before final completion • Stress of learning new technology due to manpower shortage (Example: Software related to the client's database, in order to submit the required documentation to the client). • Lack of urgency in approach, enthusiasm and motivation of parties involved due to achieving substantial completion • Demotivation of team members losing their coworkers due to project downsizing • Leadership of the project team • Barrier in communication flow
II] Financial:	• Owner directed change orders • Delay by owner for payment of work before substantial completion • Contractor project team bonuses or other incentives for timely final completion
III] Technical:	• Technical Expertise • LEED / Other commissioning requirements (certification) • Lack in planning and resource allocation • Unclear directives for closeout, in specifications and contractual requirements • Accidents to people/equipment after substantial completion. • Procedural inexperience of owner representative or architect.
IV] Administrative	• Improper / Untimely contractual closeout documentation • Subcontract closeout requirements. • Multiple punch lists • Shortage / Late-arrival of resources, i.e., manpower, materials and equipment • State and Municipal regulatory requirement • Federal regulatory requirement

Figure 5 Factors Affecting Closeout (Kaul 2014)

Kaul concluded that the closeout phase is more often than not under-planned. Less experienced employees typically underestimate the importance of project closeout. From the survey Kaul conducted, industry stakeholders indicated that punch list items are the leading cause for delays. Solutions to this problem include addressing simple reminders to the contractors and keeping only one running punch list (Kaul 2014). O'Neill (2015) concluded that improvements could be made in many areas. For example, staff should not postpone paperwork that can be finished during slow periods. Postponing paperwork leads to it being overlooked, misplaced, or neglected entirely, especially if there are not enough employees on staff to complete it all.

Project Closeout Duration Goals by State

This section highlights some initiatives that DOTs have introduced to boost the efficiency of their project closeout processes.

Indiana Department of Transportation

The Indiana Department of Transportation (INDOT) furnishes contractors with a punch list during the pre-final inspection. Contractors have five days to complete this punch list, before the final inspection can take place. From this point, it takes nine days to reach final acceptance. Figure 6 illustrates this process (INDOT 2015).

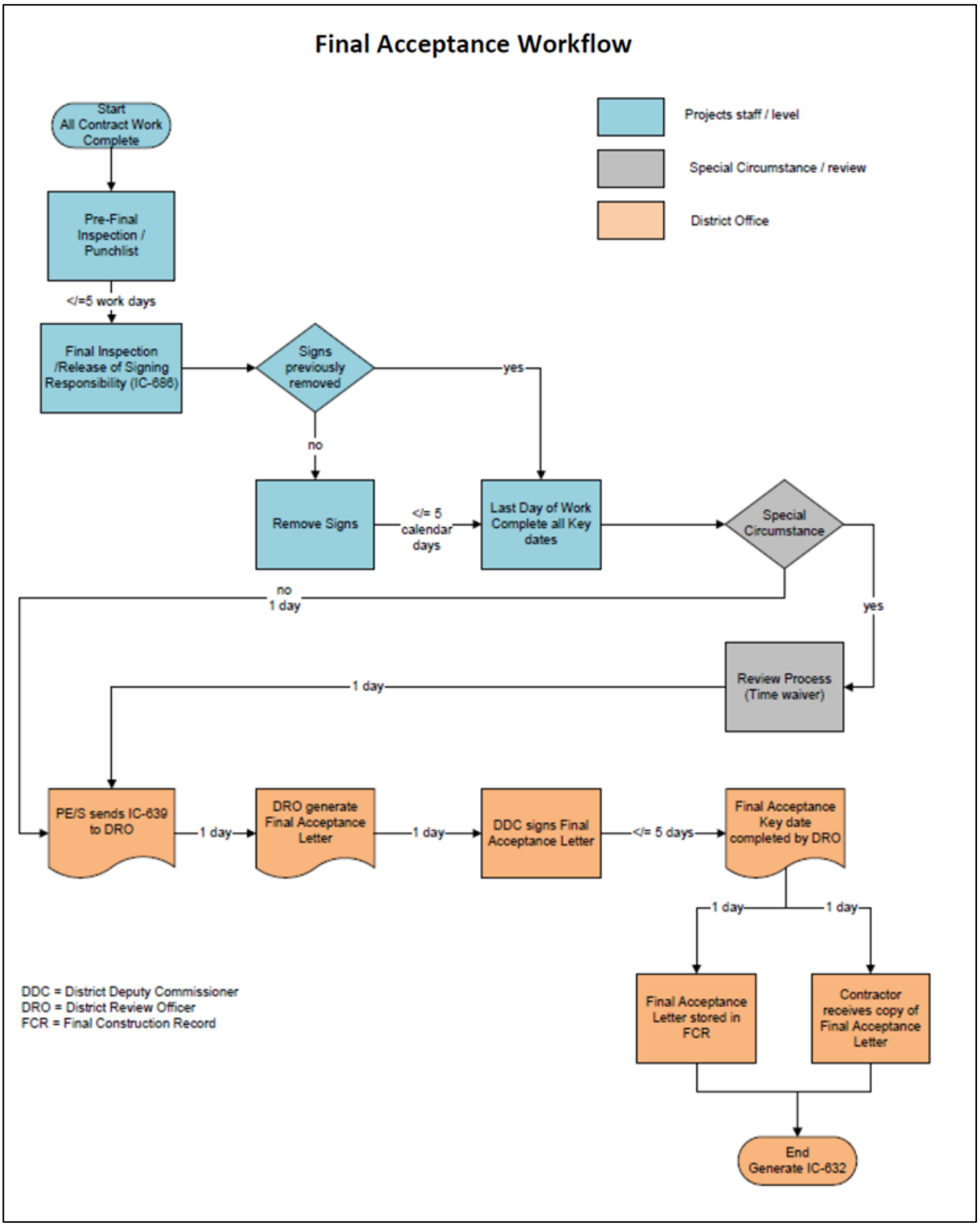


Figure 6 Indiana DOT Final Acceptance Flowchart

Virginia Department of Transportation

The Virginia Department of Transportation (VDOT) has adopted the following workflow, which extends from final acceptance to final payment (Figure 7). This phase must be completed within 90 days (VDOT 2014).

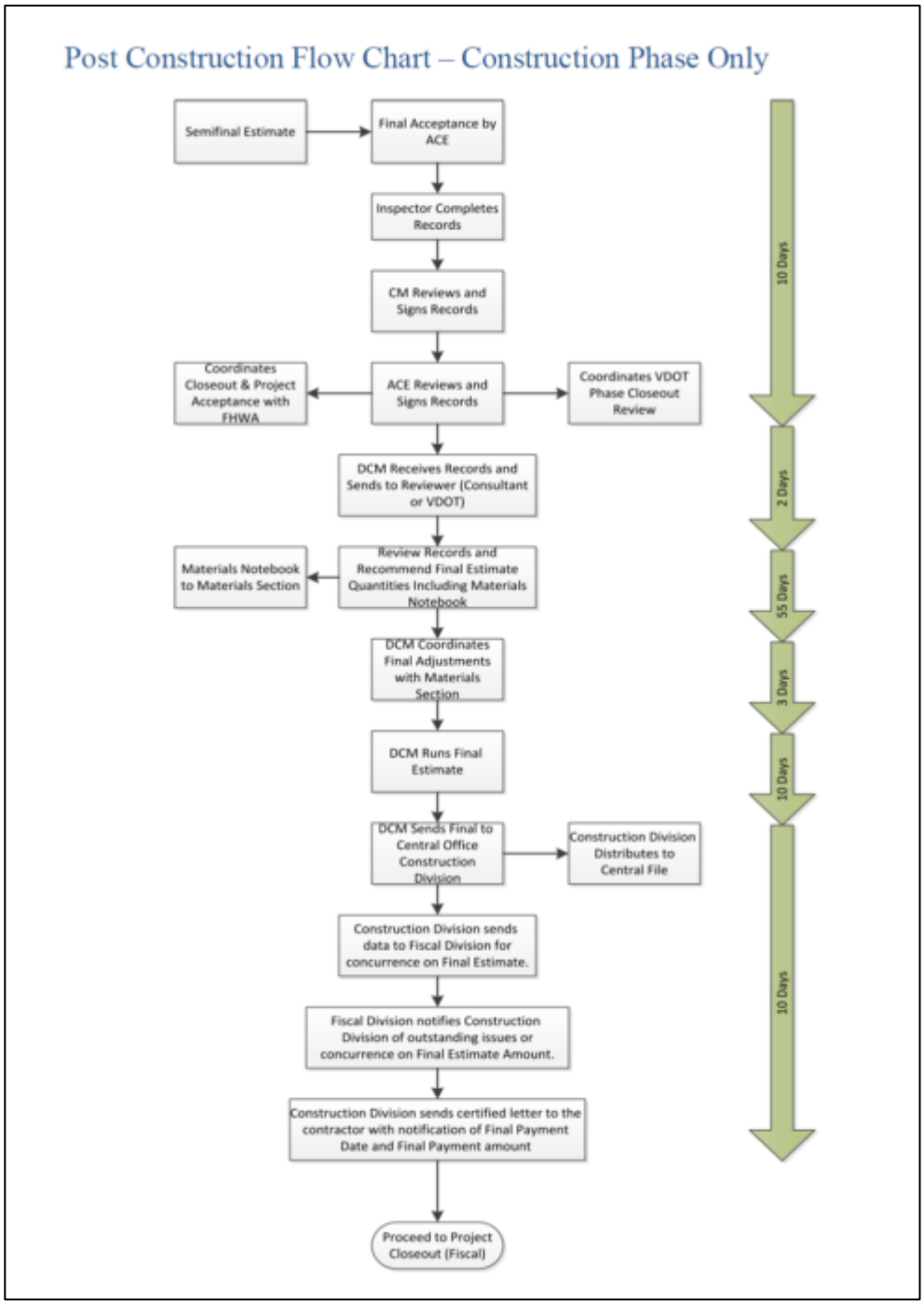


Figure 7 Virginia DOT Flowchart

Ohio Department of Transportation
The Ohio Department of Transportation's (ODOT) goal is to attain final acceptance and determine the final value of a contract within six months of physical work being completed (ODOT 2013).

Iowa Department of Transportation
According to Iowa DOT, final inspection is to be conducted within two weeks of substantial completion. After final inspection, the contractor has 30 days to complete the punch list (Iowa DOT 2015).

Kentucky Transportation Cabinet
KYTC's stated goal for the closeout process is 240 days, which includes 90 days from substantial completion to acceptance, 90 days from acceptance to critical final release, and 60 days from critical final release to contract items complete. Figure 8 depicts this process.

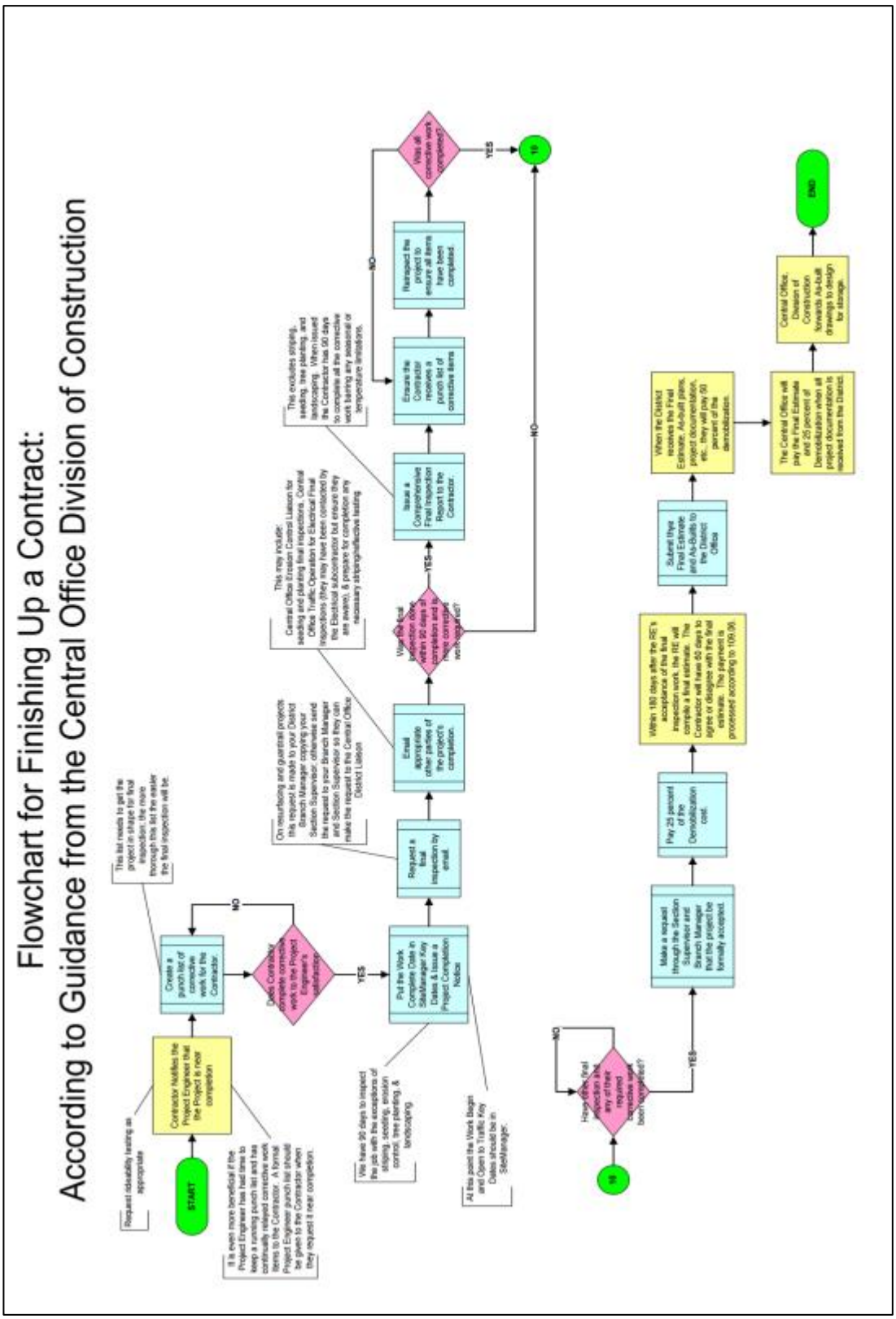


Figure 8 KYTC Project Closeout Process

Best Practices

The following table lists best practices identified from the literature review.

Table 1 List of Project Closeout Best Practices

No.	Best Practice	Source
1	Identify lessons learned/ project evaluation session (meeting with all parties)	FTA
2	"Explicitly define the time limit for completion of punch list work as that for contractual completion of work, or the start date of liquidated damages. This would legally bind the contractor to reach substantial completion ahead of contract end date, and allow for punch list items."	NYSDOT
3	Expeditiously review completed purchase orders and contracts to close out for prompt closeout	Wisc.DOT
4	Identify close out items that can be worked on simultaneously or in parallel	Wisc.DOT
5	Maintain running Punchlists for management of closeout items	Wisc.DOT, Kaul 2014
6	Maintain material finals through out project	Wisc.DOT
7	Conduct periodic review of preliminary finals to expedite final closeout	Wisc.DOT
8	Review documenting procedures periodically to adjust for more efficient procedures and for future demands.	Wisc.DOT
9	Provide clear and searchable records for future reference	Wisc.DOT
10	Have set goals for timeline from substantial completion to final check	UDOT
11	Have notification/measures in place to keep all parties up to date on deadlines and how long they have to complete their documentation	UDOT
12	Objectives for grading contractor performance, accurate and timely final payment, seting project manager guidelines, and cinducting contract training	FDOT
13	Use electronic files and file sharing software	FHWA and AASHTO 2015

4. Data Analysis

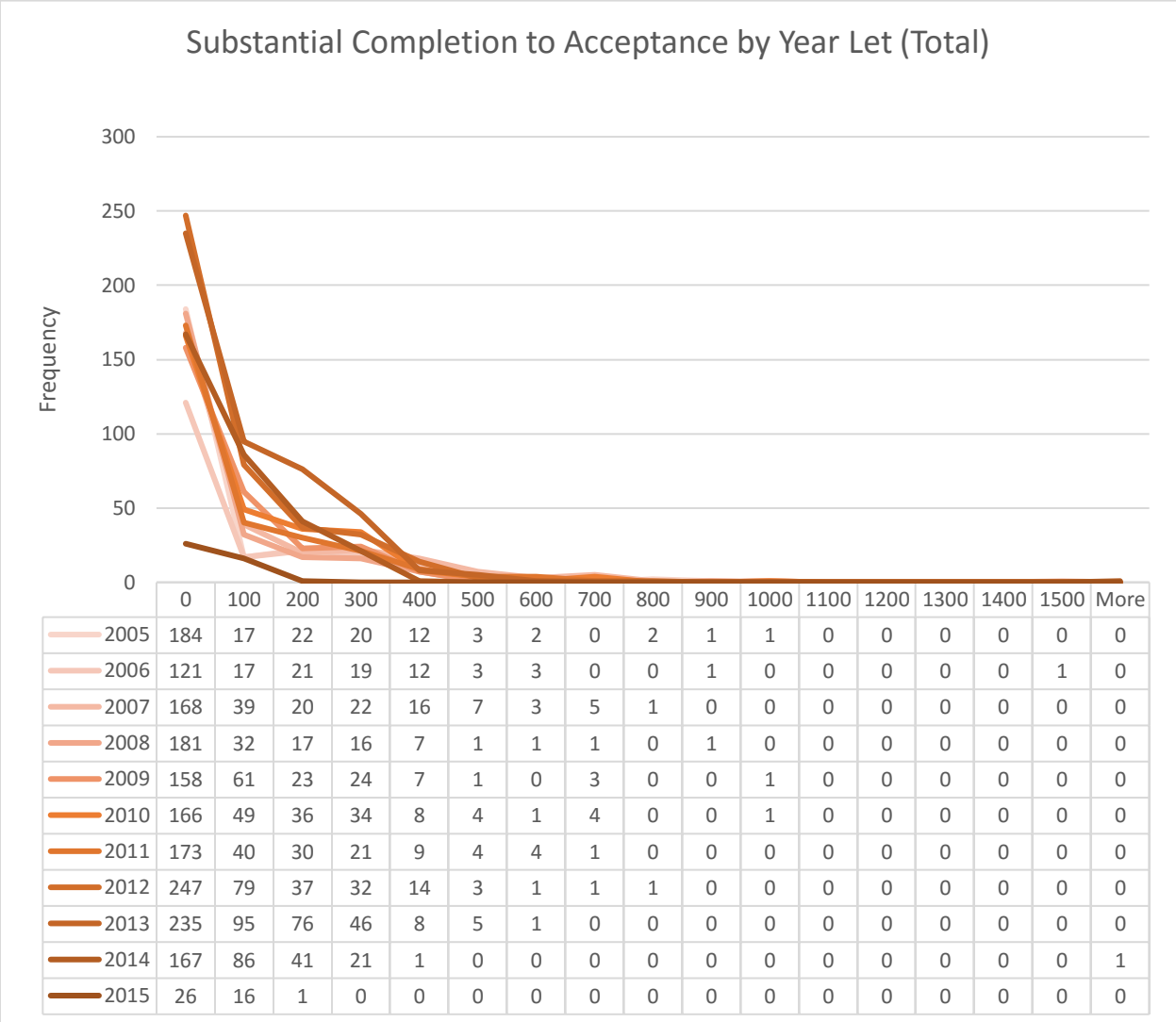
Key Dates by Year

Researchers collected information from KYTC on project closeout, including project date tables and KYTC Standard Specifications (2012). Additional data were collected by reviewing the Cabinet's data records. A sample of the master data sheet analyzed as part of this project is presented below.

Table 2 Contract ID Data

Contract ID	Contract Items Complete Date	Substantial Work Complete Date	Accepted Date	Critical Final Release	Open to Traffic Date	C	Substantial Complete to Open to Traffic	Substantial Complete to Acceptance	Acceptance to Critical Final Release	Critical Final release to Contract Items Complete	Year Let	Year Accepted
000555	10/24/2008	05/16/2005	05/16/2008	10/20/2008	05/16/2005	0	0	1096	157	4	2000	2008
000622	05/01/2007	11/17/2004	04/15/2005	01/16/2007	11/17/2004	0	0	149	641	105	2000	2005
000750	10/19/2010	07/27/2004	04/29/2008	08/31/2010	07/24/2004	0	-3	1372	854	49	2000	2008
010409	05/15/2007	11/30/2004	05/23/2006	05/08/2007	09/18/2003	0	-439	539	350	7	2001	2006
010707	08/25/2010	03/21/2008	07/24/2008	08/18/2010	03/21/2008	0	0	125	755	7	2001	2008
020099	09/07/2010	11/02/2005	09/28/2009	08/31/2010	10/26/2005	0	-7	1426	337	7	2002	2009
020297	04/07/2010	05/27/2005	08/15/2005	03/29/2010	05/27/2005	0	0	80	1687	9	2002	2005
020299	08/20/2007	03/23/2005	03/23/2005	08/14/2007	03/23/2005	0	0	0	874	6	2002	2005
020416	05/29/2007	06/16/2005	09/28/2005	05/18/2007	06/16/2005	0	0	104	597	11	2002	2005
020515	07/29/2010	06/20/2005	01/17/2006	07/29/2010	11/23/2004	0	-209	211	1654	0	2002	2006
020596	05/15/2008	06/29/2005	04/04/2006	05/15/2008	06/29/2005	0	0	279	772	0	2002	2006
020602	08/19/2014	08/20/2009	11/23/2009	08/11/2014	08/20/2009	0	0	95	1722	8	2002	2009
020645	01/22/2009	06/30/2005	05/31/2006	01/05/2009	06/30/2005	0	0	335	950	17	2002	2006
020697	04/15/2008	01/16/2004	12/10/2004	04/04/2008	01/16/2004	0	0	329	1211	11	2002	2004
020714	10/14/2008	08/31/2005	05/10/2007	10/01/2008	08/22/2005	0	-9	617	510	13	2002	2007
020719	08/08/2013	07/22/2008	05/15/2009	04/22/2013	12/06/2006	0	-594	297	1438	108	2002	2009
020732	11/13/2009	08/10/2005	07/24/2007	11/16/2009	08/10/2005	0	0	713	846	-3	2002	2007
020737	08/06/2007	06/12/2006	06/12/2006	07/30/2007	06/12/2006	0	0	0	413	7	2002	2006
030004	03/16/2009	06/13/2003	06/30/2003	03/06/2009	06/13/2003	0	0	17	2076	10	2003	2003
030056	11/10/2009	07/30/2005	09/16/2005	09/21/2009	07/30/2005	0	0	48	1466	50	2003	2005
030062	01/05/2006	06/14/2004	06/17/2005	01/03/2006	04/09/2005	0	299	368	200	2	2003	2005
030133	05/15/2008	06/24/2005	05/18/2007	05/15/2008	07/08/2005	0	14	693	363	0	2003	2007
030135	03/16/2011	05/20/2004	12/15/2005	02/16/2011	05/07/2004	0	-13	574	1889	28	2003	2005
030215	03/16/2009	10/03/2003	06/07/2004	02/19/2009	10/03/2003	0	0	248	1718	25	2003	2004
030233	07/31/2008	05/26/2004	06/01/2006	07/28/2008	10/05/2005	0	497	736	788	3	2003	2006
030334	10/01/2007	09/02/2004	04/26/2006	09/21/2007	09/02/2004	0	0	601	513	10	2003	2006
030339	02/12/2007	11/30/2004	06/18/2005	02/12/2007	11/30/2004	0	0	200	604	0	2003	2005
030344	05/29/2007	07/06/2005	02/21/2007	05/21/2007	07/01/2005	0	-5	595	89	8	2003	2007
030444	04/15/2008	08/23/2006	08/23/2006	03/17/2008	08/23/2006	0	0	0	572	29	2003	2006
030456	11/10/2009	05/13/2005	06/01/2006	10/19/2009	10/18/2004	0	-207	384	1236	22	2003	2006
030519	10/01/2007	09/14/2006	09/14/2006	09/18/2007	09/14/2006	0	0	0	369	13	2003	2006
030671	07/31/2008	12/29/2005	08/01/2006	07/23/2008	07/18/2005	0	-164	215	722	8	2003	2006
030680	03/12/2007	10/31/2006	10/31/2006	03/12/2007	11/20/2003	0	-1076	0	132	0	2003	2006
030705	06/10/2009	10/10/2005	01/18/2008	06/03/2009	10/10/2005	0	0	830	502	7	2003	2008
030706	04/15/2009	11/15/2005	11/10/2008	04/06/2009	11/15/2005	0	0	1091	147	9	2003	2008
030708	08/03/2009	07/28/2006	07/28/2006	07/28/2009	06/23/2006	0	-35	0	1096	6	2003	2006
030710	04/15/2008	11/29/2005	08/14/2006	03/24/2008	10/11/2005	0	-49	258	588	22	2003	2006
030712	02/22/2008	06/27/2005	06/27/2005	12/12/2007	06/27/2005	0	0	0	898	72	2003	2005
030731	11/13/2007	03/24/2005	03/08/2006	10/30/2007	03/24/2005	0	0	349	601	14	2003	2006
030755	08/10/2011	05/07/2008	02/23/2009	08/02/2011	05/07/2008	0	0	292	890	8	2003	2009
030758	05/19/2010	07/03/2006	05/22/2007	05/10/2010	06/27/2006	0	-6	323	1084	9	2003	2007
030768	01/22/2008	09/09/2005	09/09/2005	01/10/2008	09/09/2005	0	0	0	853	12	2003	2005
030792	05/08/2008	12/14/2005	12/14/2005	04/21/2008	12/14/2005	0	0	0	859	17	2003	2005
030800	10/01/2007	08/04/2004	08/04/2004	09/24/2007	08/08/2004	0	4	0	1146	7	2003	2004
040015	12/28/2007	06/30/2005	06/30/2005	12/28/2007	06/21/2005	0	-9	0	911	0	2004	2005
040022	04/05/2007	08/01/2006	08/01/2006	04/05/2007	08/01/2006	0	0	0	247	0	2004	2006
040070	10/30/2012	08/10/2005	05/09/2007	10/30/2012	08/10/2005	0	0	637	2001	0	2004	2007
040075	03/30/2009	02/22/2005	02/22/2005	02/11/2009	02/22/2005	0	0	0	1450	47	2004	2005
040090	03/29/2006	09/30/2005	11/23/2005	03/27/2006	09/30/2005	0	0	54	124	2	2004	2005
040104	11/10/2005	05/02/2005	05/02/2005	11/07/2005	05/02/2005	0	0	0	189	3	2004	2005
040106	05/24/2006	06/24/2005	06/24/2005	05/22/2006	06/24/2005	0	0	0	332	2	2004	2005
040118	10/14/2008	11/26/2004	11/26/2004	10/06/2008	11/26/2004	0	0	0	1410	8	2004	2004
040132	05/24/2006	05/02/2005	05/02/2005	05/22/2006	05/02/2005	0	0	0	385	2	2004	2005
041004	06/15/2006	05/11/2005	07/22/2005	06/12/2006	05/11/2005	0	0	72	325	3	2004	2005
041006	03/17/2006	05/05/2005	05/05/2005	03/13/2006	05/05/2005	0	0	0	312	4	2004	2005
041008	05/23/2008	06/03/2005	06/03/2005	05/23/2008	06/03/2005	0	0	0	1085	0	2004	2005
041011	07/03/2008	05/04/2005	12/31/2005	06/24/2008	05/04/2005	0	0	241	906	9	2004	2005
041019	02/19/2010	01/27/2006	05/19/2006	02/01/2010	01/27/2006	0	0	112	1354	18	2004	2006
041020	09/17/2007	09/02/2005	06/30/2006	09/17/2007	09/02/2005	0	0	301	444	0	2004	2006
041021	03/09/2010	07/22/2005	10/28/2005	02/25/2010	04/11/2006	0	263	98	1581	12	2004	2005
041022	02/14/2006	09/12/2005	09/12/2005	02/13/2006	09/12/2005	0	0	0	154	1	2004	2005
041104	01/12/2011	12/01/2006	12/19/2007	12/17/2010	11/15/2006	0	-16	383	1094	26	2004	2007
041108	10/03/2006	06/09/2005	12/06/2005	09/22/2006	06/06/2005	0	-3	180	290	11	2004	2005
041110	06/28/2012	12/05/2007	05/20/2010	06/28/2012	08/01/2008	0	240	897	770	0	2004	2010
041115	06/10/2009	04/20/2005	04/20/2005	06/02/2009	04/20/2005	0	0	0	1504	8	2004	2005
041117	05/15/2007	05/20/2005	09/02/2005	05/08/2007	05/20/2005	0	0	105	613	7	2004	2005

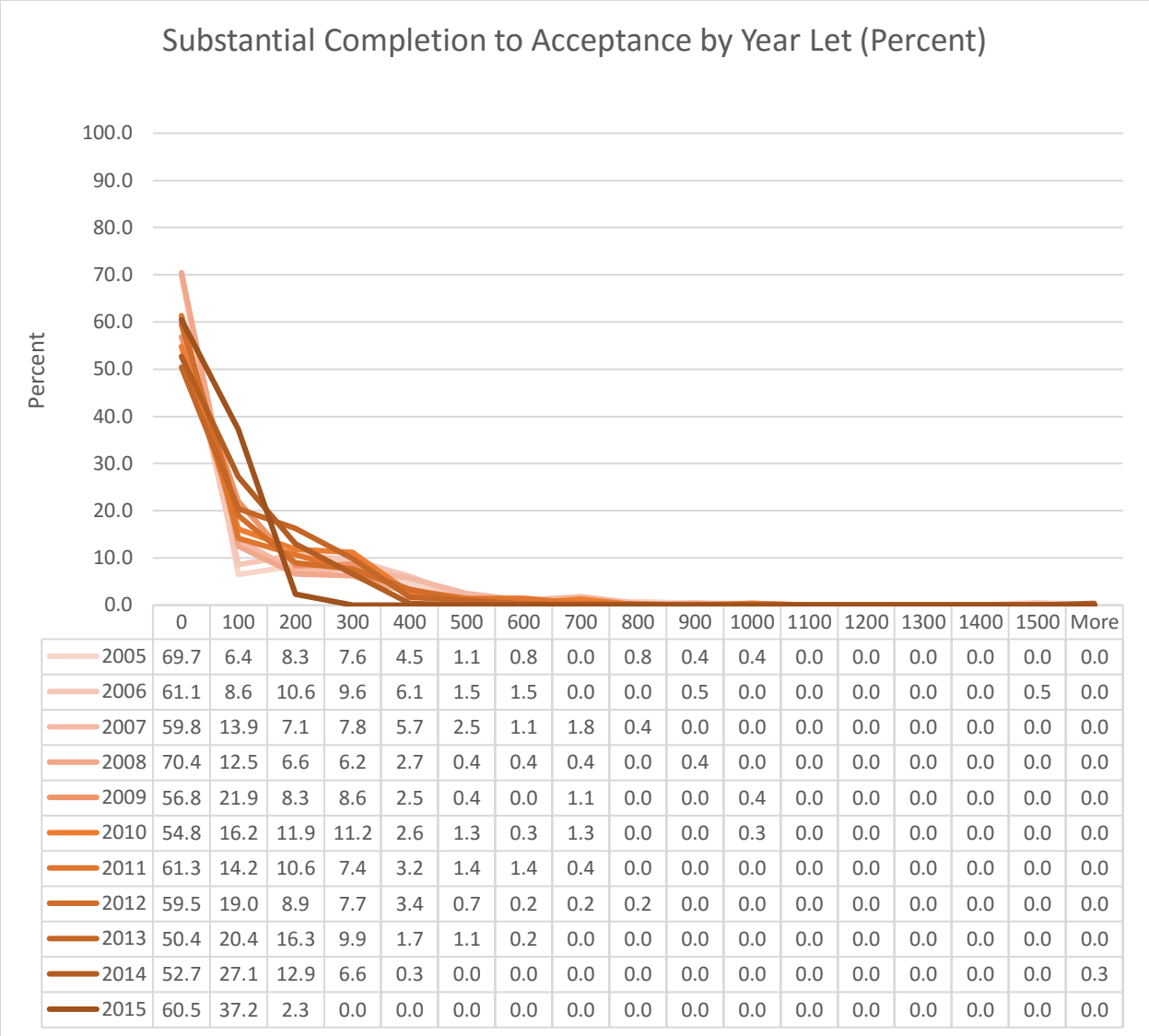
Four key dates found in the data indicate the progress of a project through the closeout phase: 1) the substantial completion date, 2) the acceptance date, 3) the critical final release date, and 4) the contract items complete date. Researchers calculated the number of days between these milestones for each project. Columns 8–10 of Table 2 present these results. Researchers developed histograms illustrating the durations based on the year in which projects were let. Figures 9–14 present these histograms. The histograms reveal that most problems arise between the acceptance date and critical final release date.



	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	More
2005	184	17	22	20	12	3	2	0	2	1	1	0	0	0	0	0	0
2006	121	17	21	19	12	3	3	0	0	1	0	0	0	0	0	1	0
2007	168	39	20	22	16	7	3	5	1	0	0	0	0	0	0	0	0
2008	181	32	17	16	7	1	1	1	0	1	0	0	0	0	0	0	0
2009	158	61	23	24	7	1	0	3	0	0	1	0	0	0	0	0	0
2010	166	49	36	34	8	4	1	4	0	0	1	0	0	0	0	0	0
2011	173	40	30	21	9	4	4	1	0	0	0	0	0	0	0	0	0
2012	247	79	37	32	14	3	1	1	1	0	0	0	0	0	0	0	0
2013	235	95	76	46	8	5	1	0	0	0	0	0	0	0	0	0	0
2014	167	86	41	21	1	0	0	0	0	0	0	0	0	0	0	0	1
2015	26	16	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 9 Substantial Completion to Acceptance (Totals)

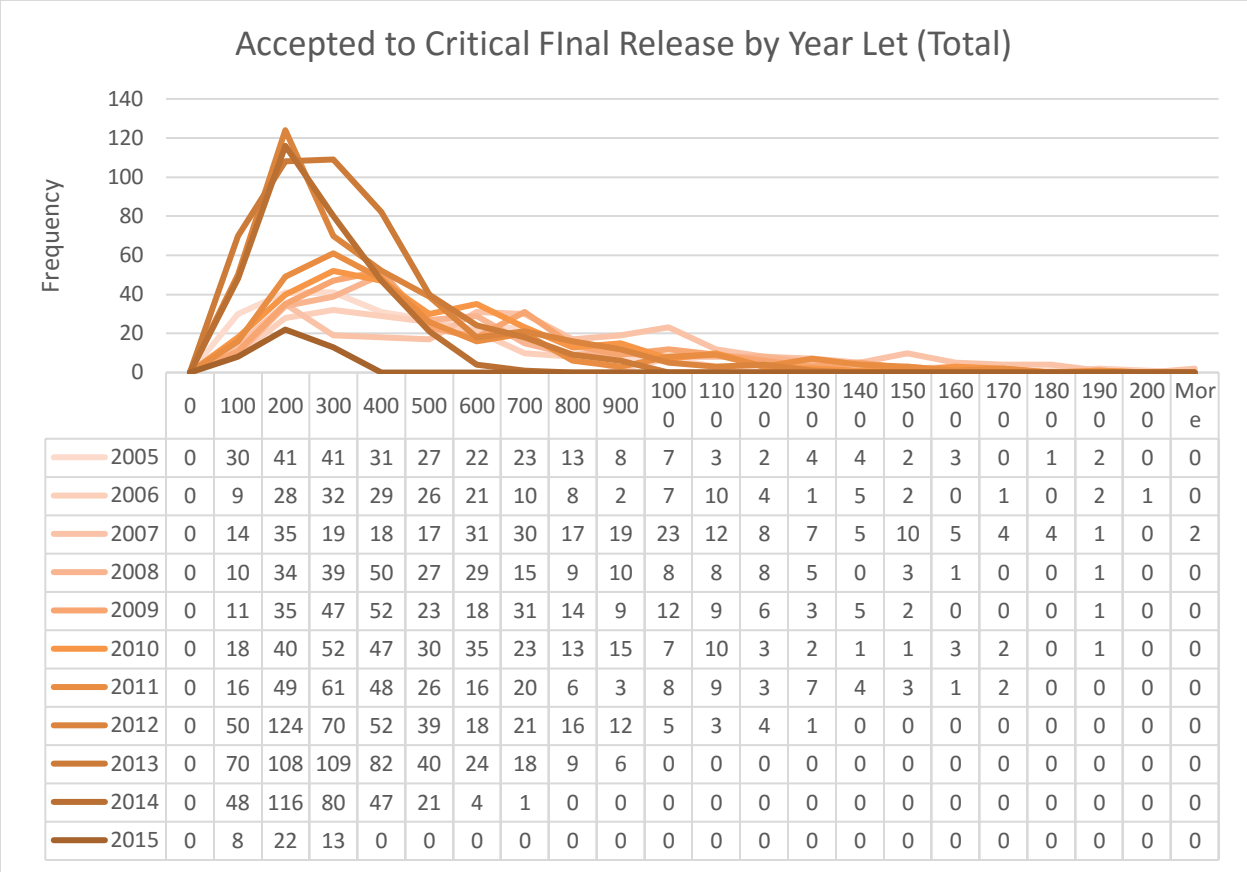
Figure 9 shows the number of days needed for a project to move from Substantial Completion to Acceptance, sorted by the year of project letting. This graph is based on the total number of projects from each year. This graph shows a slight jump in the frequency of higher durations in recent years.



	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	More
2005	69.7	6.4	8.3	7.6	4.5	1.1	0.8	0.0	0.8	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0
2006	61.1	8.6	10.6	9.6	6.1	1.5	1.5	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.5	0.0
2007	59.8	13.9	7.1	7.8	5.7	2.5	1.1	1.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2008	70.4	12.5	6.6	6.2	2.7	0.4	0.4	0.4	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2009	56.8	21.9	8.3	8.6	2.5	0.4	0.0	1.1	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
2010	54.8	16.2	11.9	11.2	2.6	1.3	0.3	1.3	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
2011	61.3	14.2	10.6	7.4	3.2	1.4	1.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2012	59.5	19.0	8.9	7.7	3.4	0.7	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2013	50.4	20.4	16.3	9.9	1.7	1.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2014	52.7	27.1	12.9	6.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
2015	60.5	37.2	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 10 Substantial Completion to Acceptance (Percent)

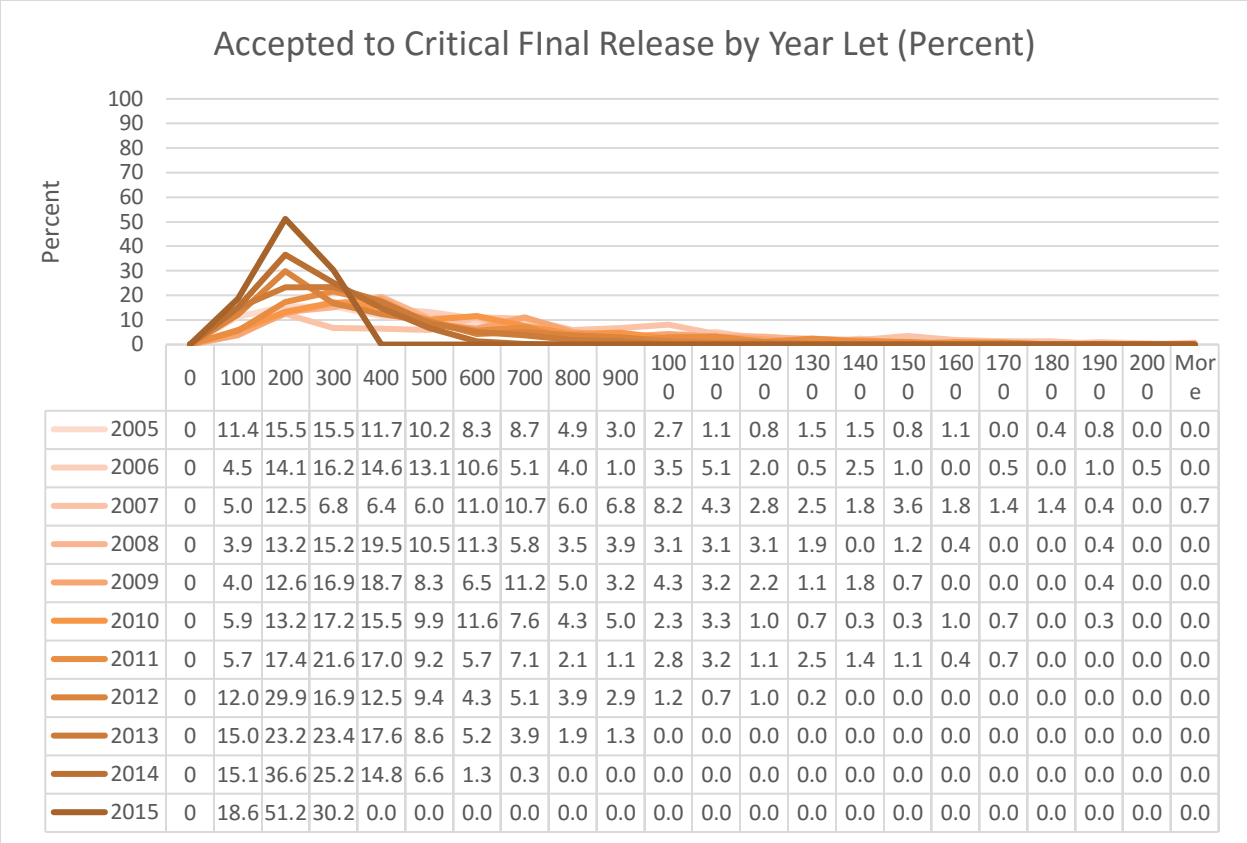
Figure 10 also shows the histogram of the number of days for a project to move from Substantial Completion to Acceptance, sorted by the year of project letting. This graph was normalized by taking the averages of each year for each duration bin. In recent years, there has been a slight increase in the frequency of higher durations.



	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	More
2005	0	30	41	41	31	27	22	23	13	8	7	3	2	4	4	2	3	0	1	2	0	0
2006	0	9	28	32	29	26	21	10	8	2	7	10	4	1	5	2	0	1	0	2	1	0
2007	0	14	35	19	18	17	31	30	17	19	23	12	8	7	5	10	5	4	4	1	0	2
2008	0	10	34	39	50	27	29	15	9	10	8	8	8	5	0	3	1	0	0	1	0	0
2009	0	11	35	47	52	23	18	31	14	9	12	9	6	3	5	2	0	0	0	1	0	0
2010	0	18	40	52	47	30	35	23	13	15	7	10	3	2	1	1	3	2	0	1	0	0
2011	0	16	49	61	48	26	16	20	6	3	8	9	3	7	4	3	1	2	0	0	0	0
2012	0	50	124	70	52	39	18	21	16	12	5	3	4	1	0	0	0	0	0	0	0	0
2013	0	70	108	109	82	40	24	18	9	6	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	48	116	80	47	21	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	8	22	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 11 Acceptance to Critical Final Release (Totals)

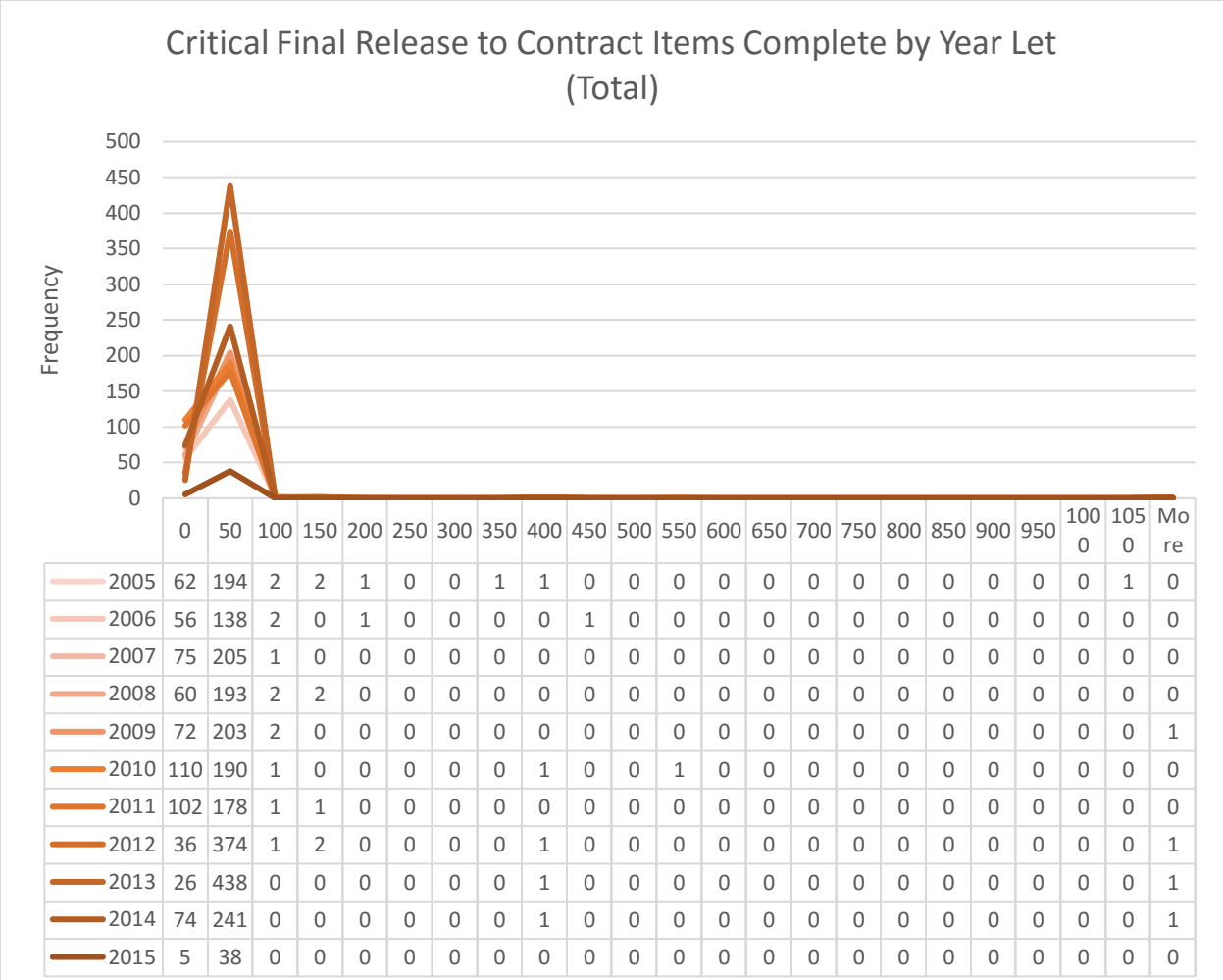
Figure 11 is the histogram of the number of days for a project to move from Acceptance to Critical Final Release, sorted by the year of project letting. This graph is based on the total number of projects from each year. There has been a significant increase in the frequency of higher durations, both recently and historically.



	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	More
2005	0	11.4	15.5	15.5	11.7	10.2	8.3	8.7	4.9	3.0	2.7	1.1	0.8	1.5	1.5	0.8	1.1	0.0	0.4	0.8	0.0	0.0
2006	0	4.5	14.1	16.2	14.6	13.1	10.6	5.1	4.0	1.0	3.5	5.1	2.0	0.5	2.5	1.0	0.0	0.5	0.0	1.0	0.5	0.0
2007	0	5.0	12.5	6.8	6.4	6.0	11.0	10.7	6.0	6.8	8.2	4.3	2.8	2.5	1.8	3.6	1.8	1.4	1.4	0.4	0.0	0.7
2008	0	3.9	13.2	15.2	19.5	10.5	11.3	5.8	3.5	3.9	3.1	3.1	3.1	1.9	0.0	1.2	0.4	0.0	0.0	0.4	0.0	0.0
2009	0	4.0	12.6	16.9	18.7	8.3	6.5	11.2	5.0	3.2	4.3	3.2	2.2	1.1	1.8	0.7	0.0	0.0	0.0	0.4	0.0	0.0
2010	0	5.9	13.2	17.2	15.5	9.9	11.6	7.6	4.3	5.0	2.3	3.3	1.0	0.7	0.3	0.3	1.0	0.7	0.0	0.3	0.0	0.0
2011	0	5.7	17.4	21.6	17.0	9.2	5.7	7.1	2.1	1.1	2.8	3.2	1.1	2.5	1.4	1.1	0.4	0.7	0.0	0.0	0.0	0.0
2012	0	12.0	29.9	16.9	12.5	9.4	4.3	5.1	3.9	2.9	1.2	0.7	1.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2013	0	15.0	23.2	23.4	17.6	8.6	5.2	3.9	1.9	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2014	0	15.1	36.6	25.2	14.8	6.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2015	0	18.6	51.2	30.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 12 Acceptance to Critical Final Release (Percent)

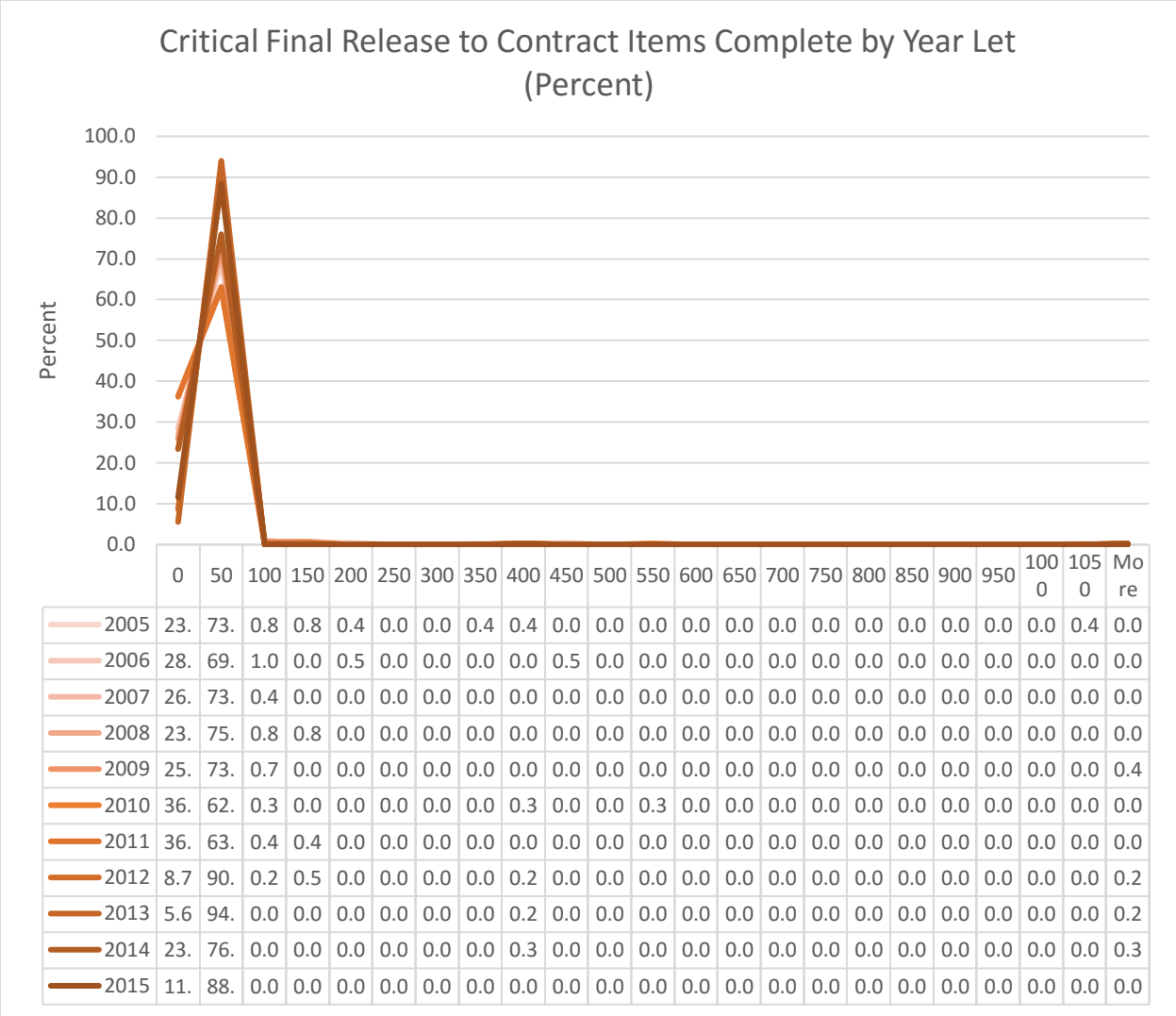
Figure 12 presents the histogram of the number of days needed for a project to move from Acceptance to Critical Final Release, sorted by the year of project letting. However, this graph was normalized by taking the averages of each year for each duration bin. As with Figure 11, this graph displays a noticeable increase in frequency for higher durations, historically as well as in more recent years.



	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	More
2005	62	194	2	2	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
2006	56	138	2	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	75	205	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	60	193	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2009	72	203	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2010	110	190	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
2011	102	178	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2012	36	374	1	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2013	26	438	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2014	74	241	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2015	5	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 13 Critical Final Release to Contract Items Complete (Totals)

Figure 13 contains the histogram of the number of days required for a project to move from Critical Final Release to Contract Items Complete, sorted by the year of project letting. This graph is based on the total number of projects from each year. Across the study period, there was little change in duration.



	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	More
2005	23.	73.	0.8	0.8	0.4	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
2006	28.	69.	1.0	0.0	0.5	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2007	26.	73.	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2008	23.	75.	0.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2009	25.	73.	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
2010	36.	62.	0.3	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2011	36.	63.	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2012	8.7	90.	0.2	0.5	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
2013	5.6	94.	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
2014	23.	76.	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
2015	11.	88.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 14 Critical Final Release to Contract Items Complete (Percent)

Figure 14 also depicts the histogram of the number of days for a project from Critical Final Release to Contract Items Complete, sorted by the year of project letting. However, this graph was normalized by taking the averages of each year for each duration bin. The graph shows little change in duration over the study period.

Key Dates by Project Type

Researchers sorted projects into the following categories: bridge maintenance, HSIP (Highway Safety Improvement Program), mowing and litter, road maintenance, and originated in design. Data were evaluated and histograms generated based on key dates. Figure 15–17 show the results of this analysis. It is apparent that most delays emerge between Acceptance and Critical Final Release, irrespective of project type.

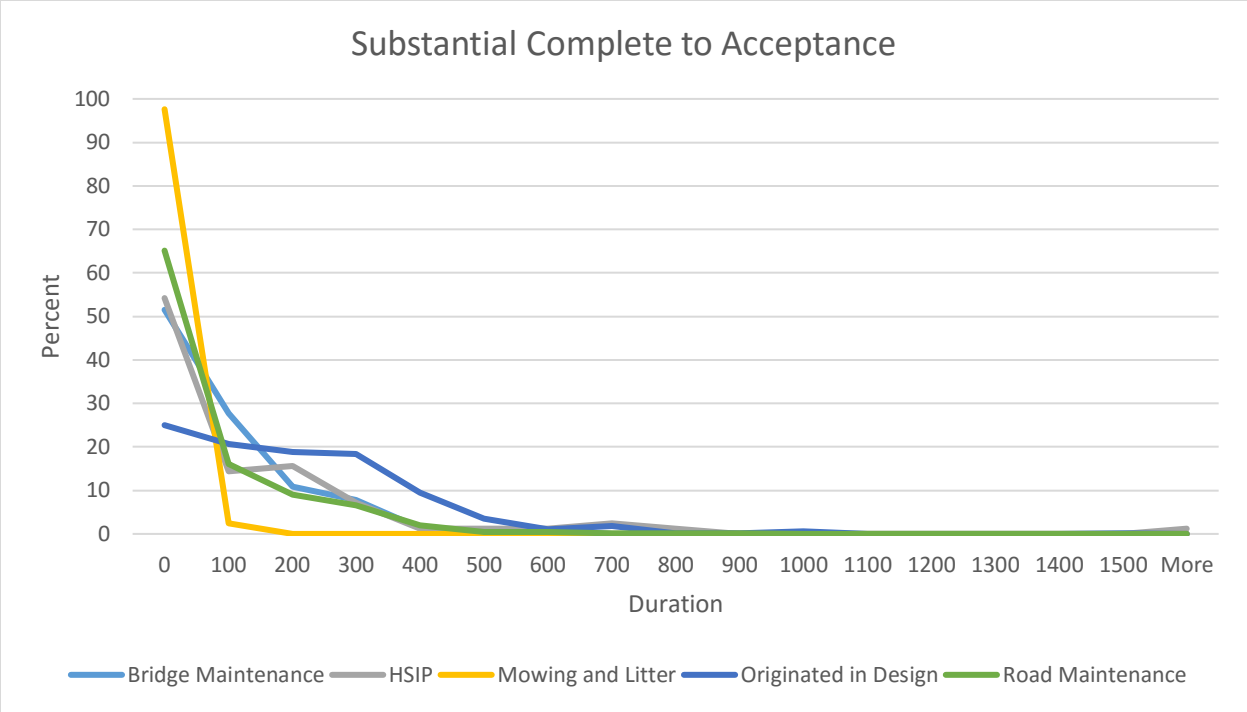


Figure 15 Substantial Complete to Acceptance

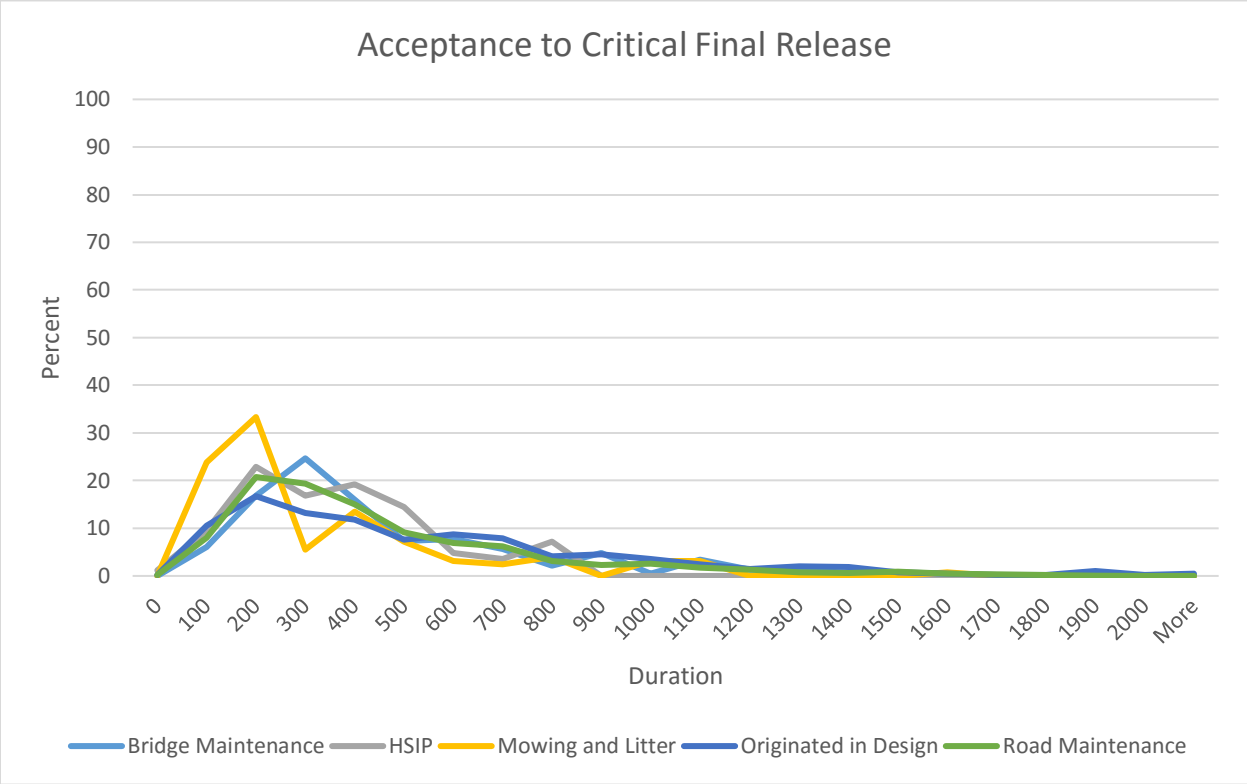


Figure 16 Acceptance to Critical Final Release

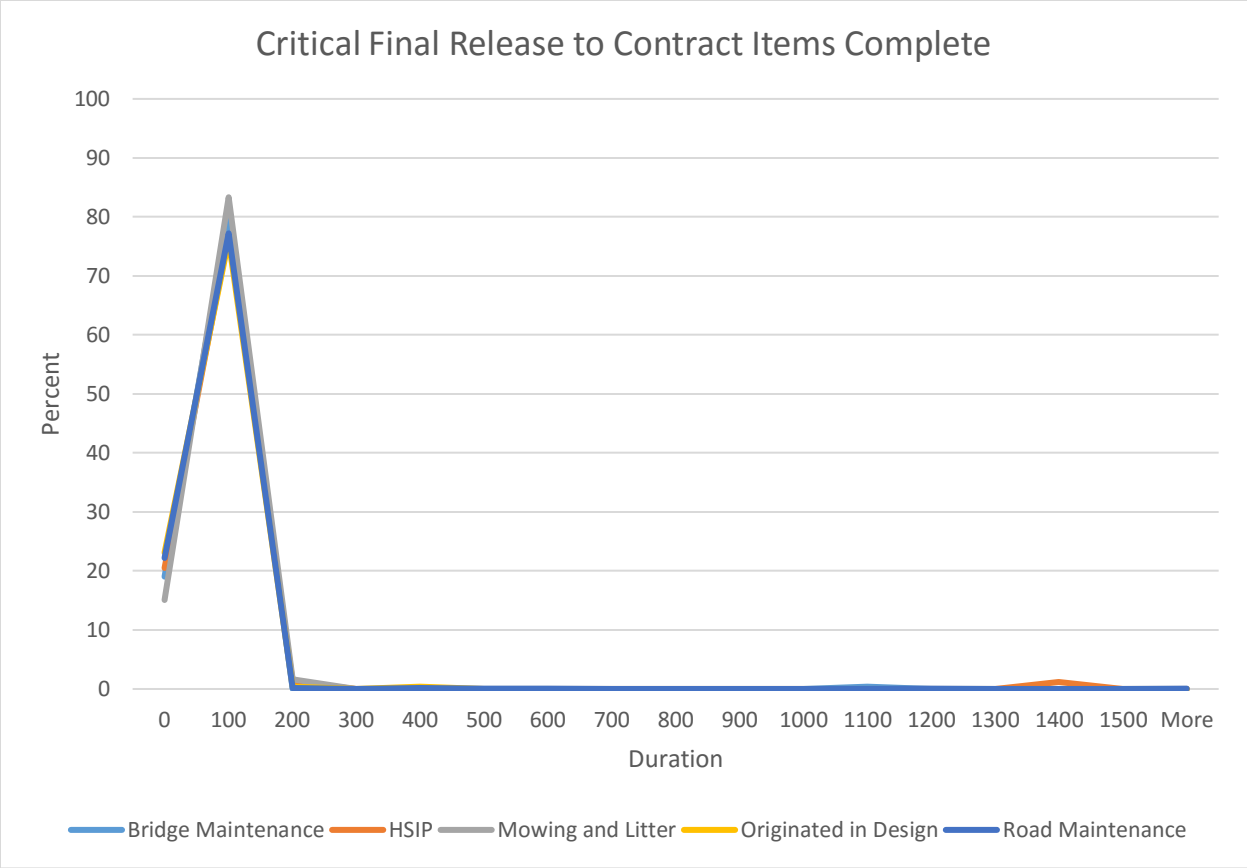


Figure 17 Critical Final Release to Contract Items Complete

Graphing project types separately corroborates this finding (Figures 18–22). The trend of most delays emerging between Acceptance and Critical Final Release is especially pronounced for projects that originated in design and road maintenance projects.

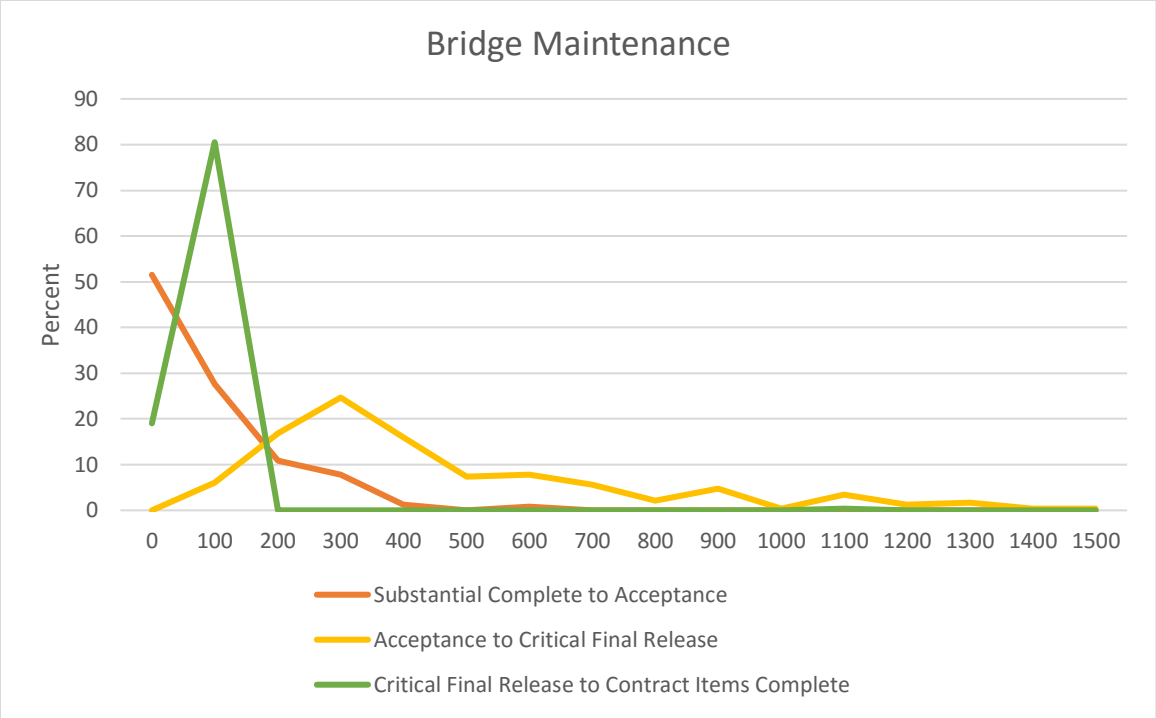


Figure 18 Bridge Maintenance

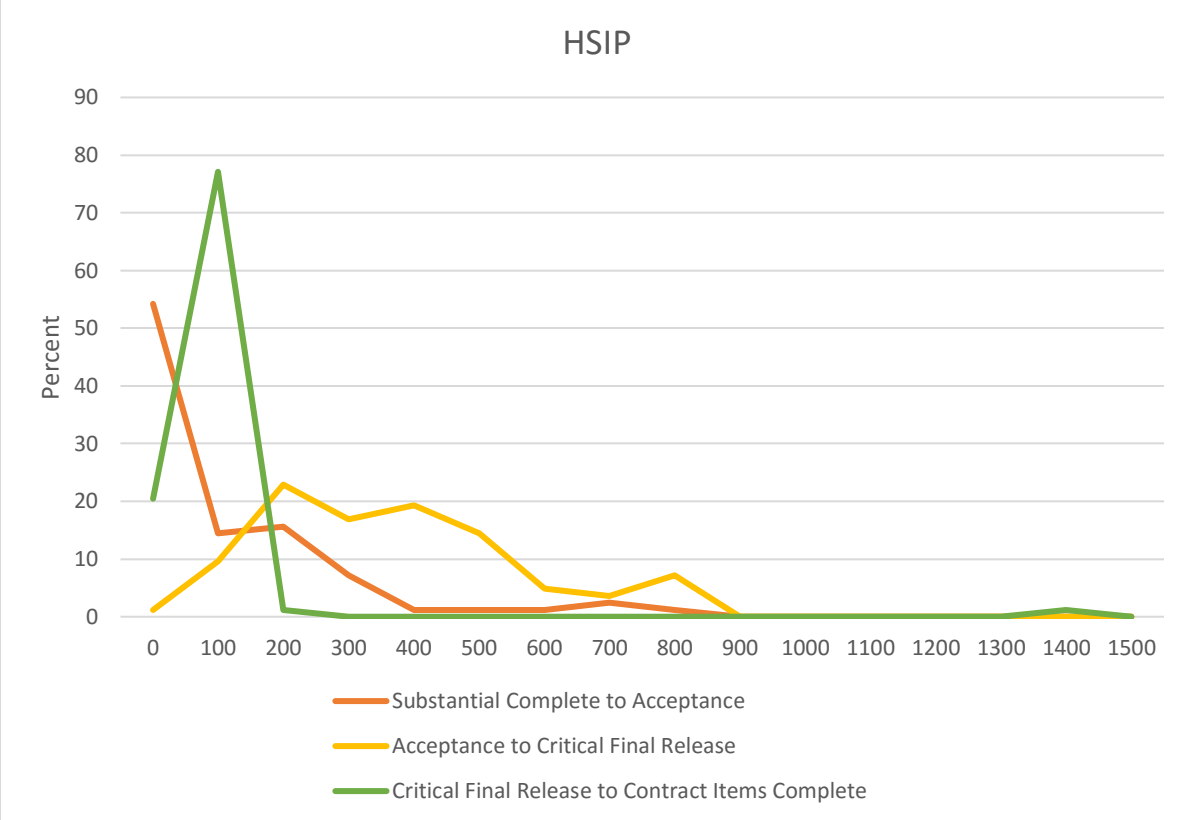


Figure 19 HSIP

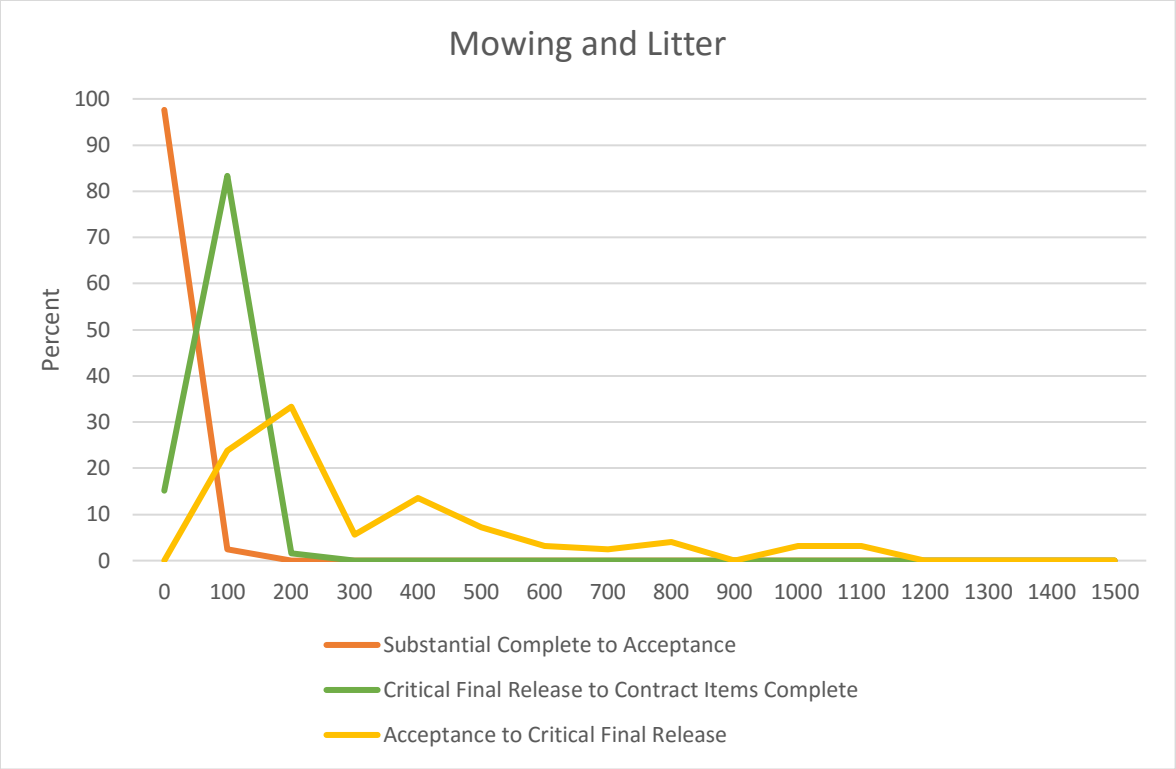


Figure 20 Mowing and Litter

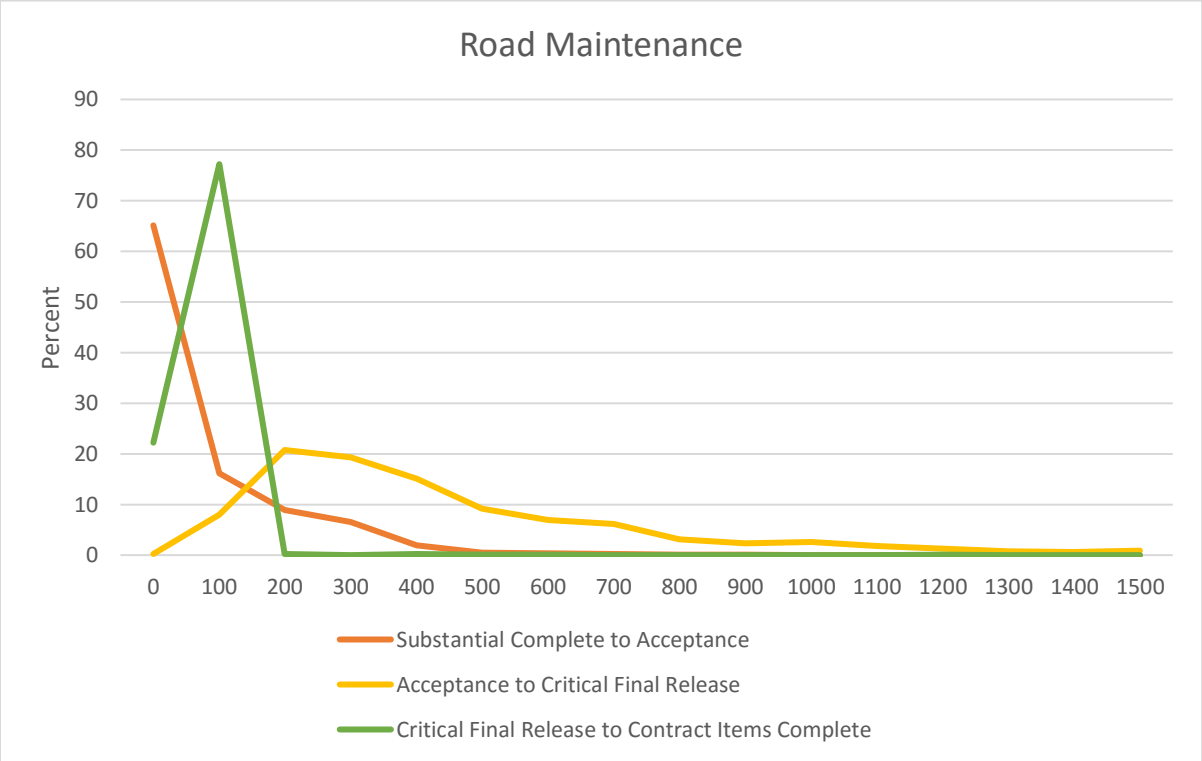


Figure 21 Road Maintenance

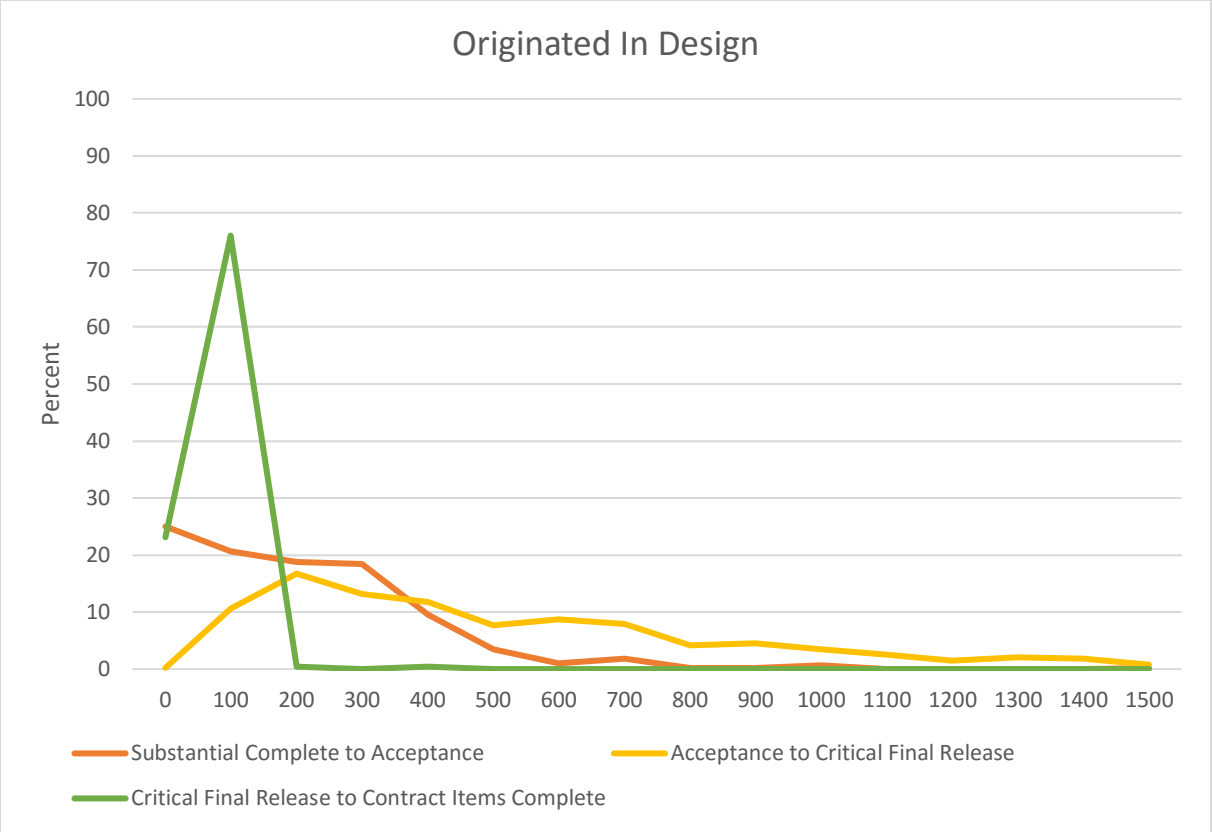


Figure 22 Projects Originating in Design

Duration vs Year by Project Type

Table 3 lists the goals KYTC has set for completing each phase of project closeout.

Table 3 Duration for Closeout Phases (KYTC)

Key Dates	Duration (days)
Substantial Completion to Acceptance	90
Acceptance to Critical Final Release	90
Critical Final Release to Contract Items Complete	60
Total	240

Figures 23–25 depict how well each job type — on an annual basis — meets these goals. Goals were not met for the period between acceptance and critical final release. The time from acceptance to critical final release has also been problematic, with the 90-day goal not being achieved throughout the study period.

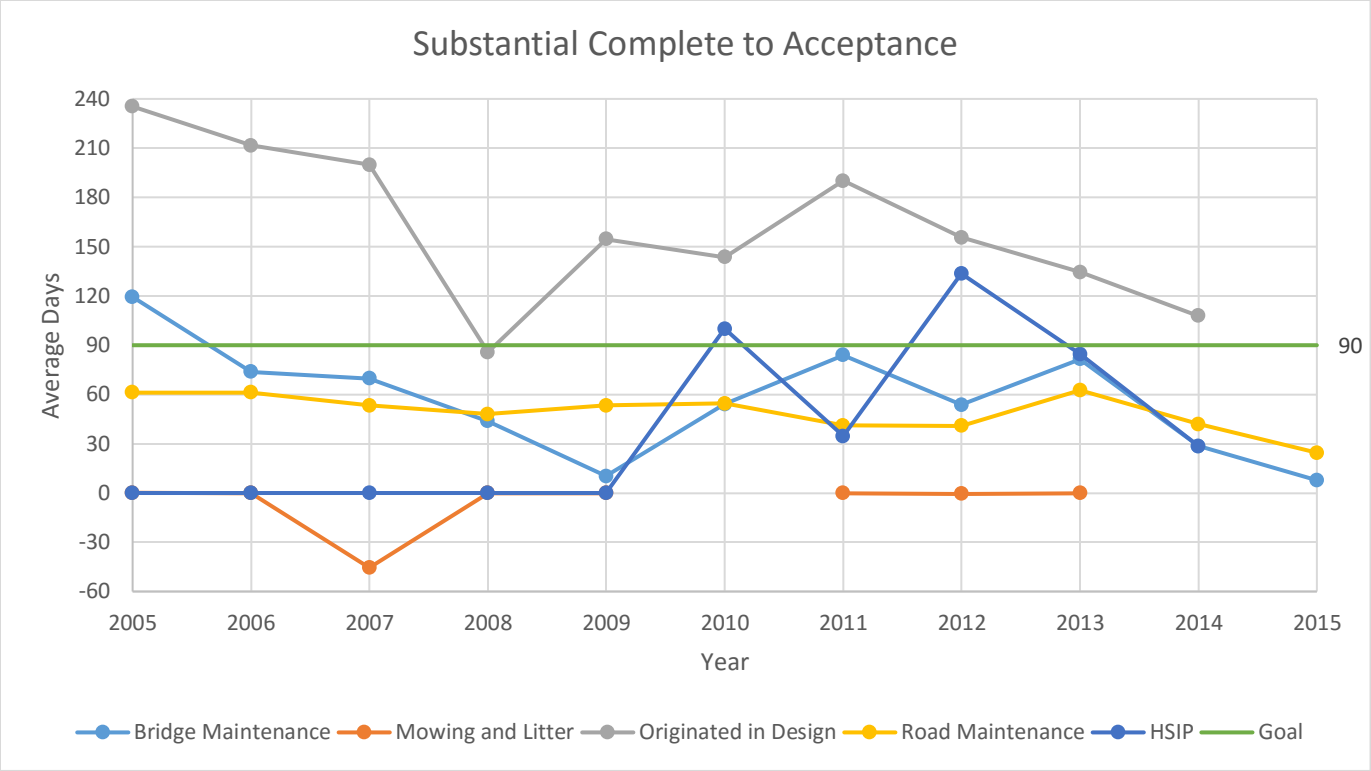


Figure 23 Substantial Complete to Acceptance

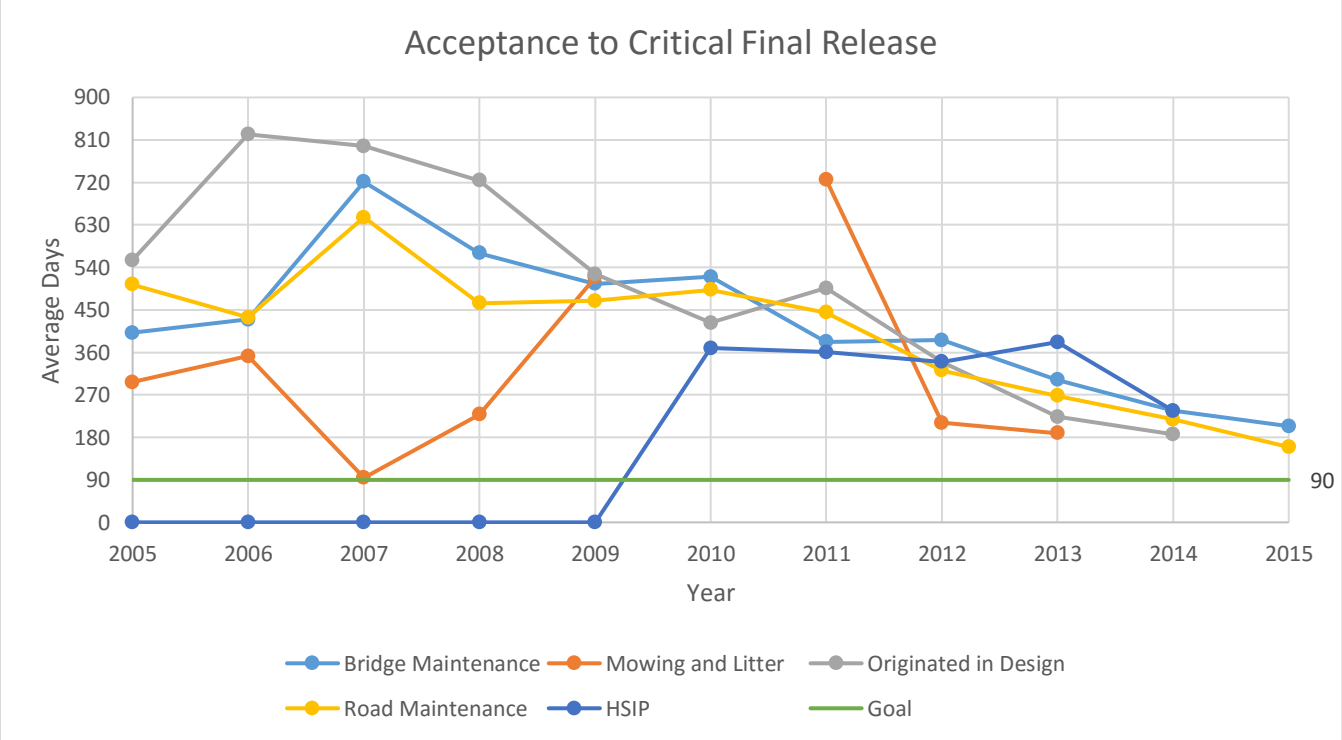


Figure 24 Acceptance to Critical Final Release

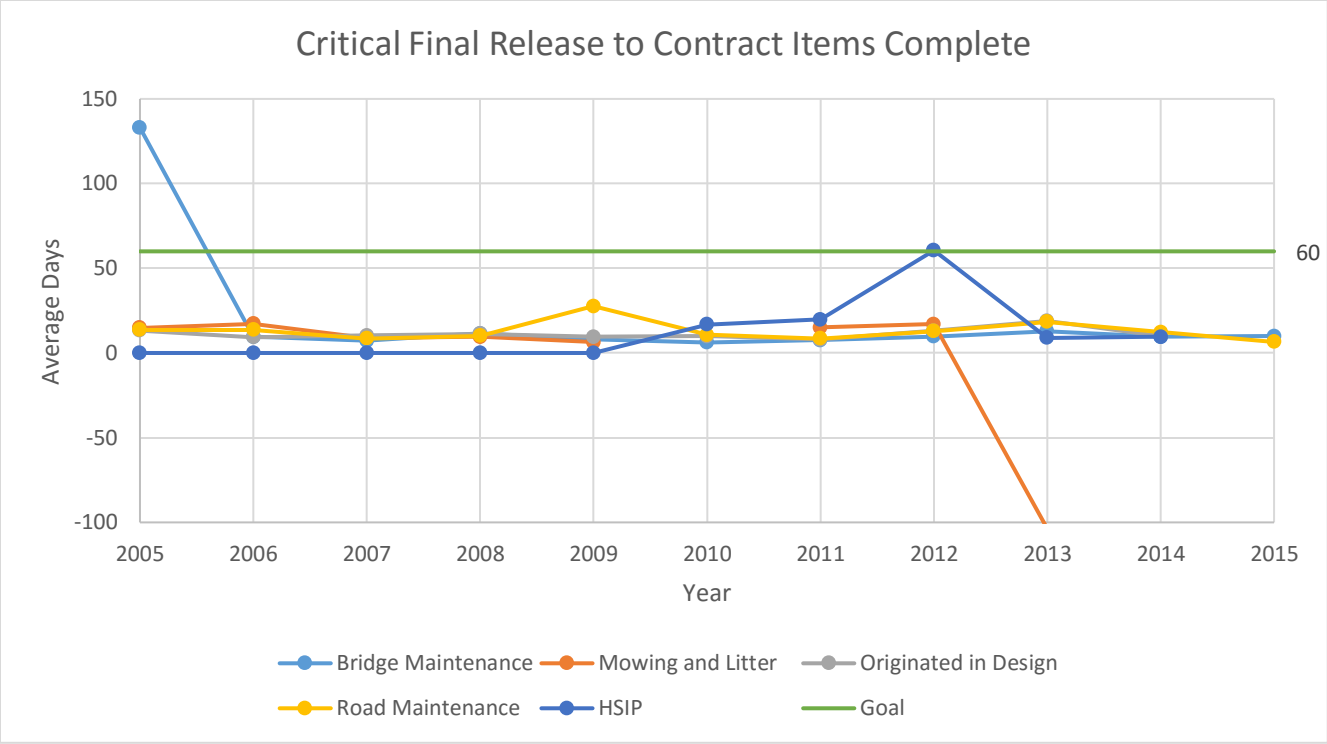


Figure 25 Critical Final Release to Contract Items Complete

Duration vs Year by Key Dates

As the ensuing graphs demonstrate (Figures 26–29), in 2014 (the most recent year for which significant data are available), no project type — on average — met the 240-day goal for project closeout. The 240-day threshold is depicted as a horizontal line on each graph. For all years and project types, the period from acceptance to final release duration is by far the longest. Shortening the duration of this phase would place the 240-day goal within reach.

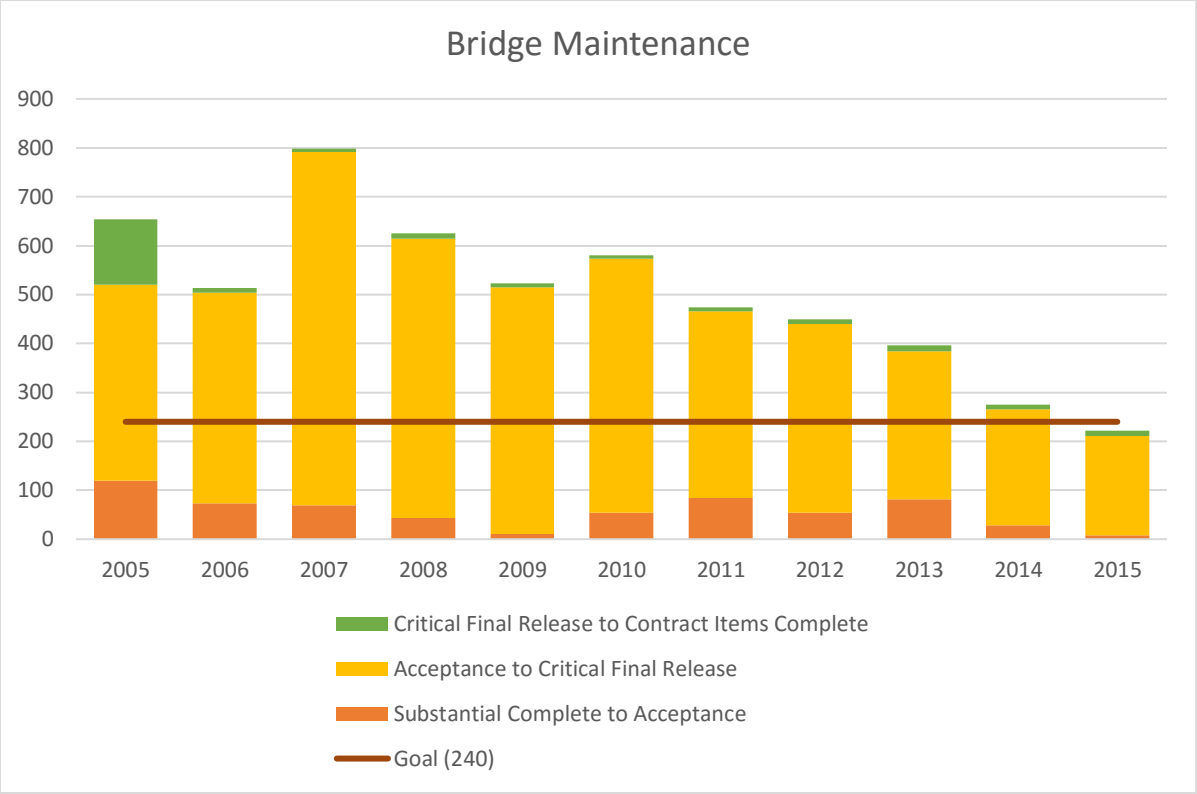


Figure 26 Bridge Maintenance

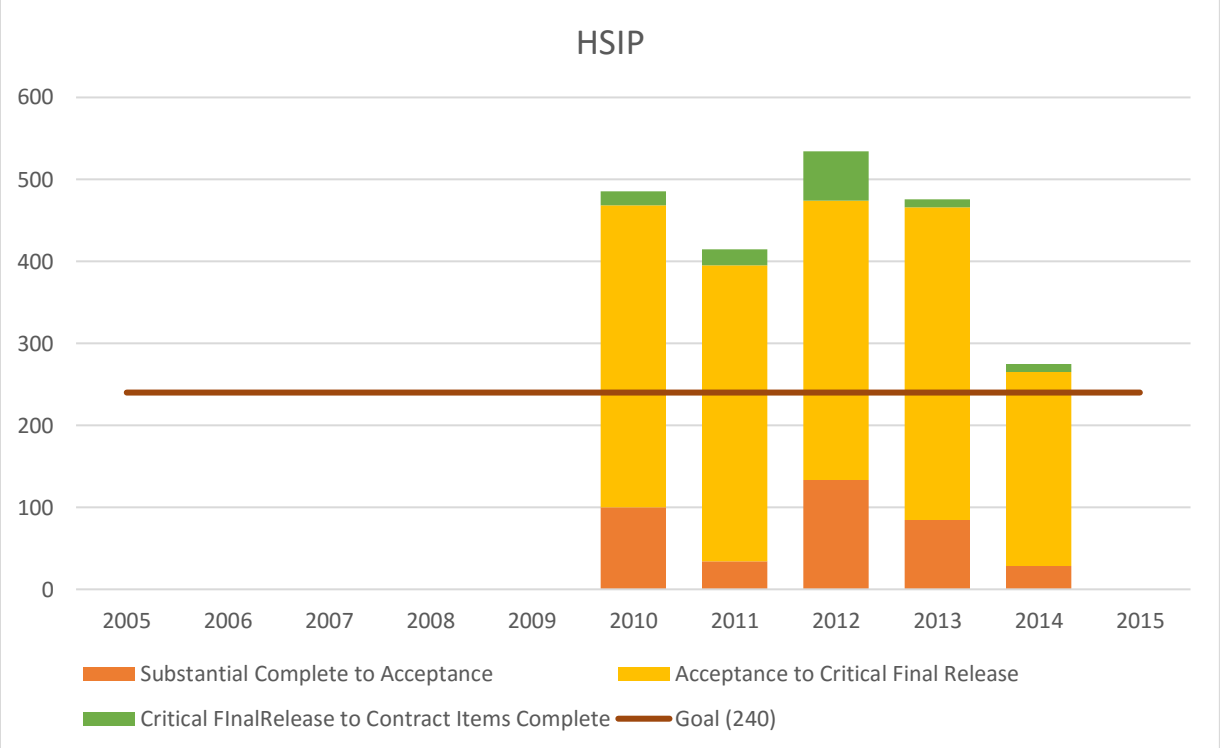


Figure 27 HSIP

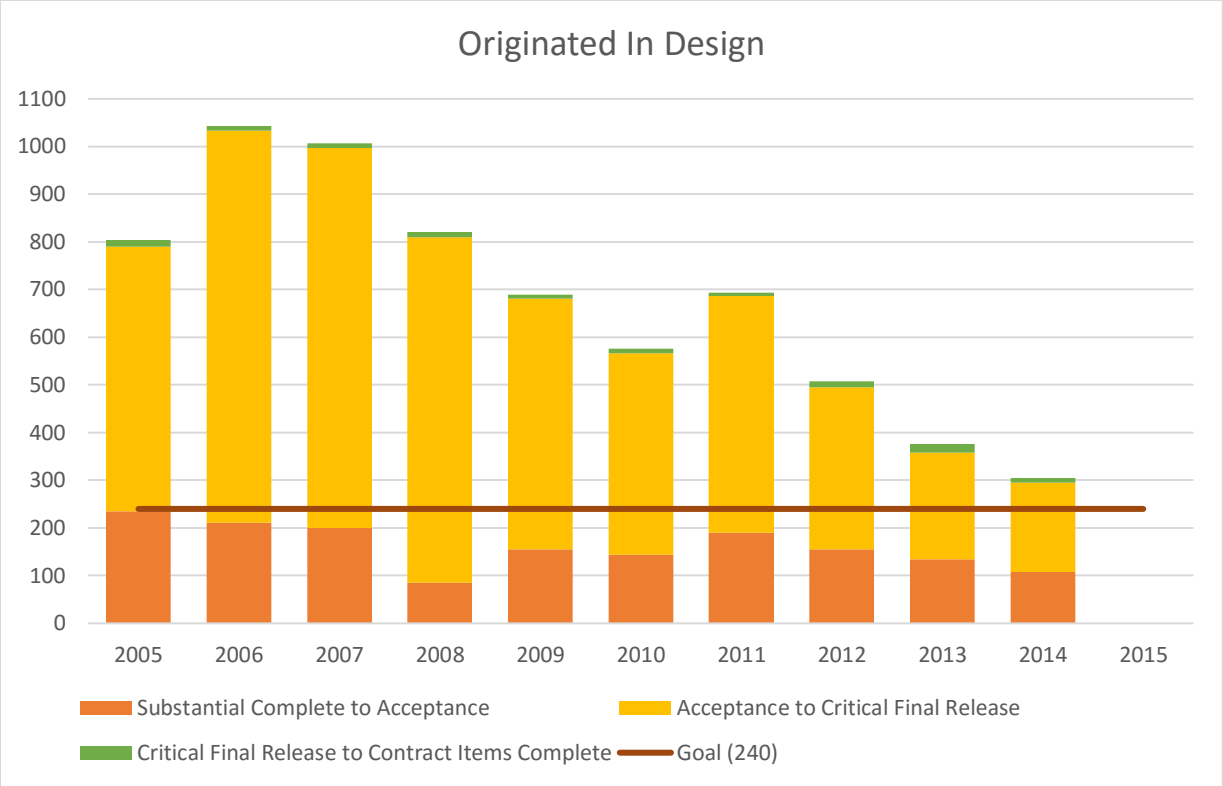


Figure 28 Originated in Design

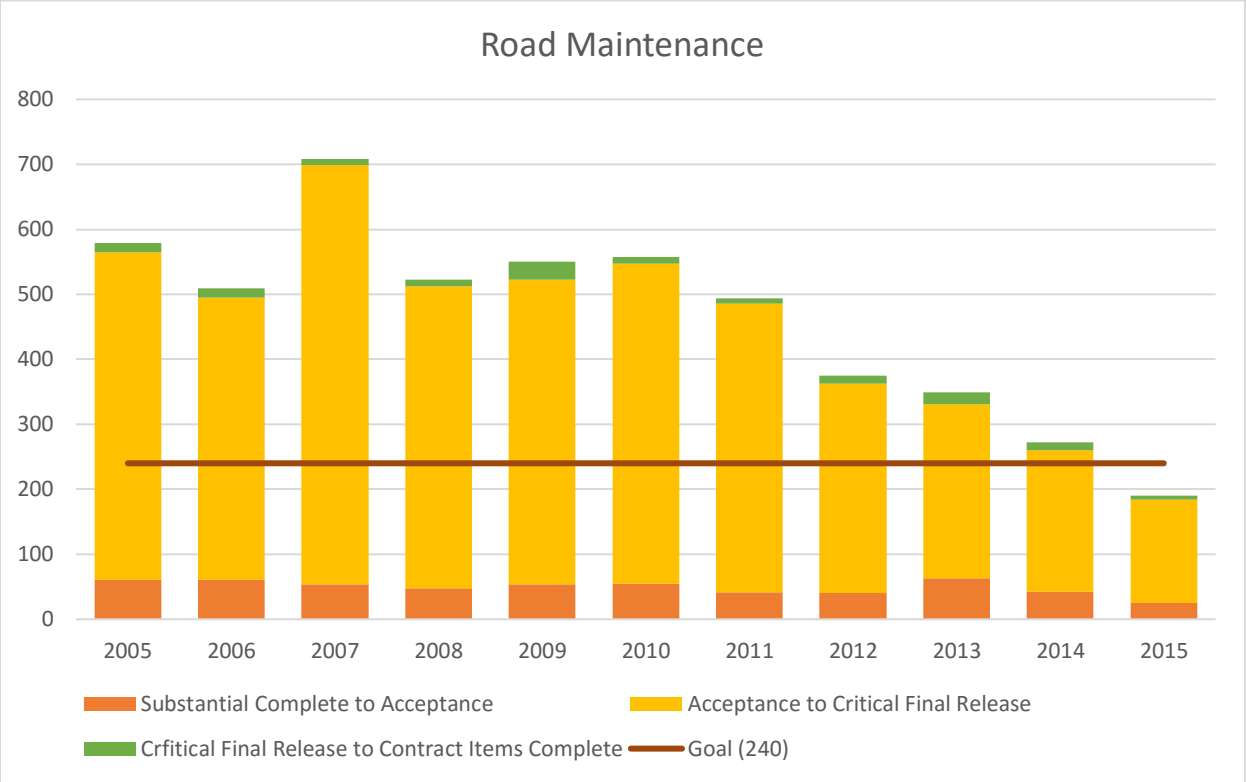


Figure 29 Road Maintenance

Additional Dates and Further Data Analysis

KYTC provided researchers with additional data on dates to strengthen their analysis of the closeout process. For each project from 2005 through 2015, the following dates were given:

- Open to Traffic Date
- Work Complete Date
- Comprehensive Corrective Work Notification Date
- Corrective Work Complete Date
- Ready for Materials Final Check — RE
- Ready for Materials Final Check — DME
- Resident Final Check
- Files Received in District Office Date
- District Final Check Date
- Files Received in Central Office Date
- Central Office Final Check Date

The flowchart presented in Figure 30 illustrates the ordering of these dates across a project. Dates are ordered sequentially and linearly, except for the Ready for Materials Check RE and DME, which occur at the same time as the Resident Final Check.

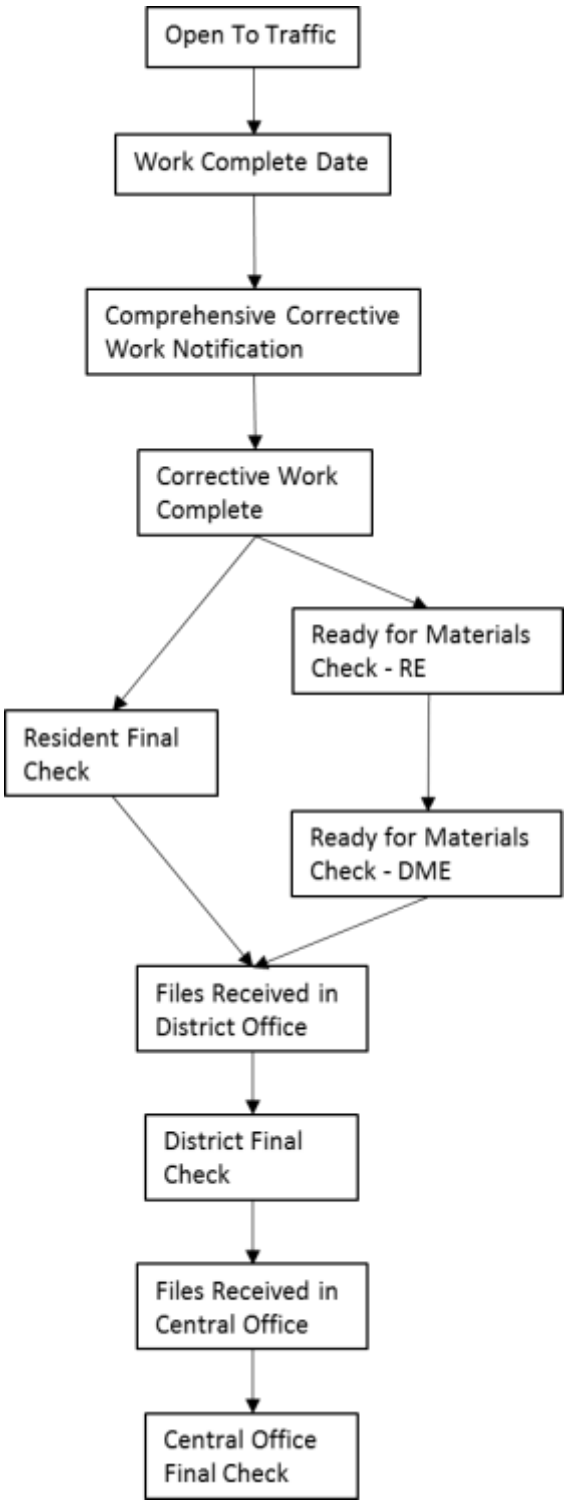


Figure 30 Project Closeout Flowchart

Figures 31 and 32 indicate the average and median duration for each step in the project closeout workflow.

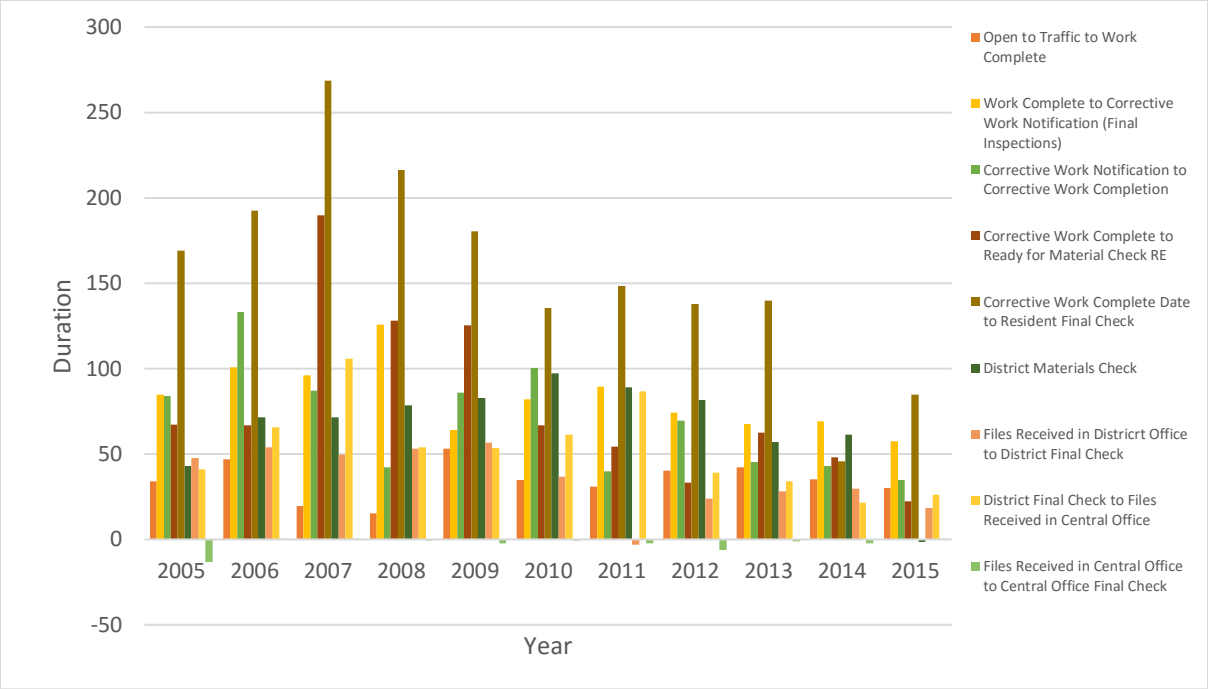


Figure 31 Average Durations for Project Closeout Workflow

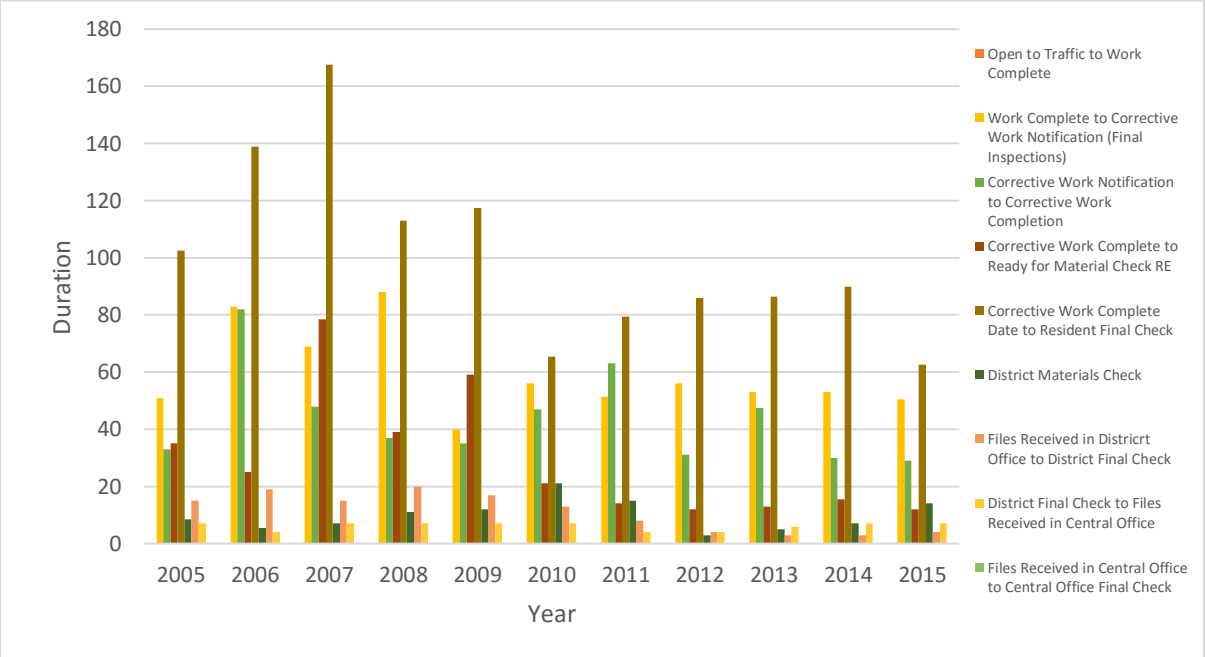


Figure 32 Median Durations for Project Closeout Workflow

Moving from Corrective Work Complete to Resident Final Check consistently takes the most time (both average and median durations). During this step, the Resident Office completes the project finalization documentation — this occurs alongside the Ready for Materials Check RE and DME steps. Comparing the two branches of the flowchart that occur parallel to one another, it appears the Corrective Work Complete to Resident Final Check also, especially in recent years, has taken longer than the Ready for Materials Check RE and DME combined (Figure 33).

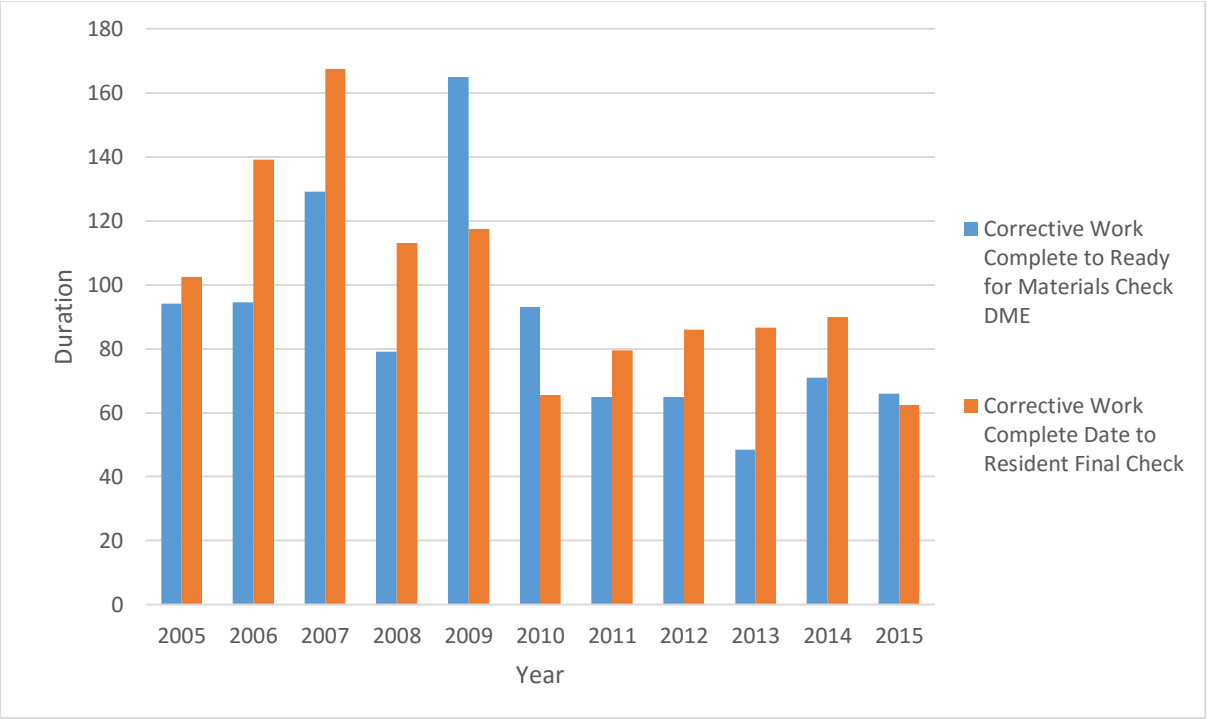


Figure 33 Parallel Dates Duration Comparison

To better understand this timeframe, researchers examined histograms of these processes. The histograms for Corrective Work Complete to Resident Final Check and Corrective Work Complete to Ready for Materials Check DME indicate that both steps have a long duration on a significant number of projects, which confirms the narrative laid out in previous figures. Each of the three steps that happen in parallel are significant. Any steps taken to shorten one step will be limited by the existing average durations of the other two processes.

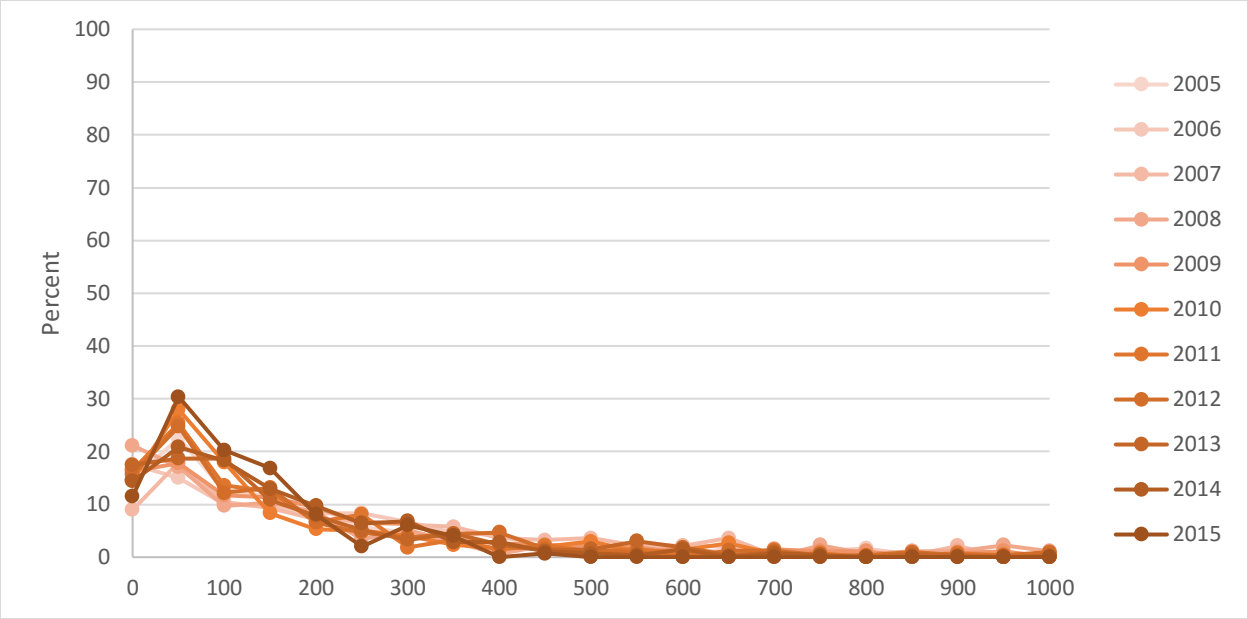


Figure 34 Corrective Work Complete Date to Resident Final Check

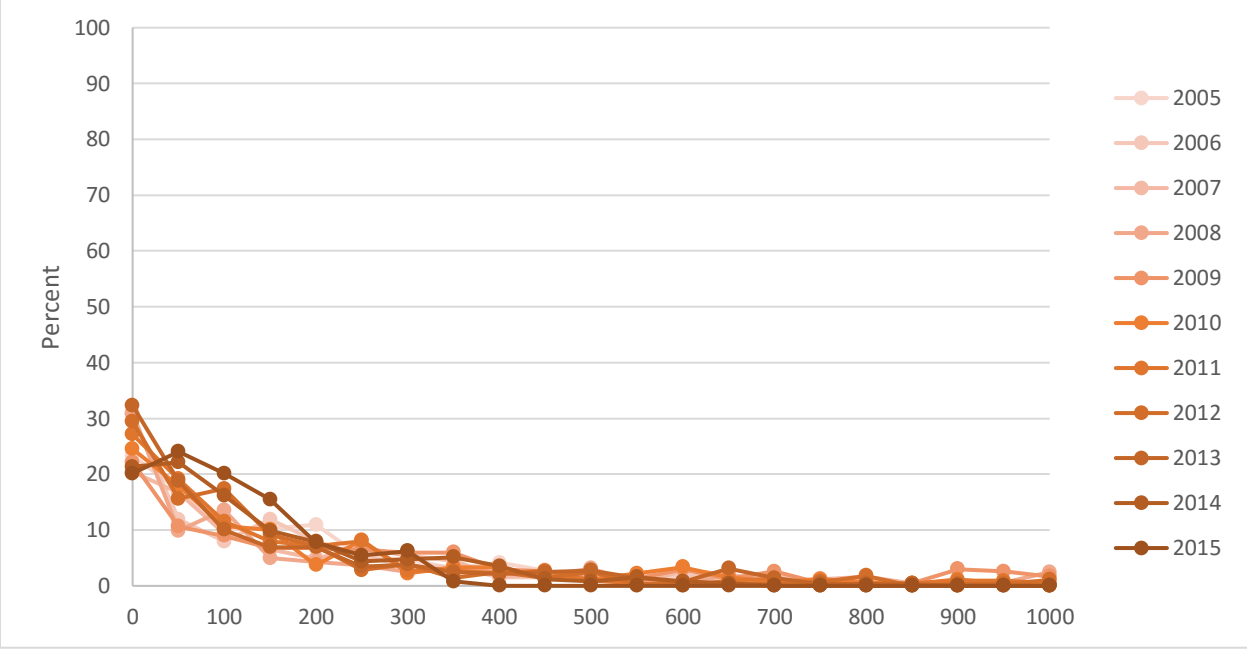


Figure 35 Corrective Work Complete Date to Ready for DME Materials Check

Figures 36–42 present histograms for other steps in the process. They reveal that final inspections and corrective work routinely have extended durations. The steps between Files Received in District Office and Central Office Final Check are not a primary reason for slowing of the project closeout process.

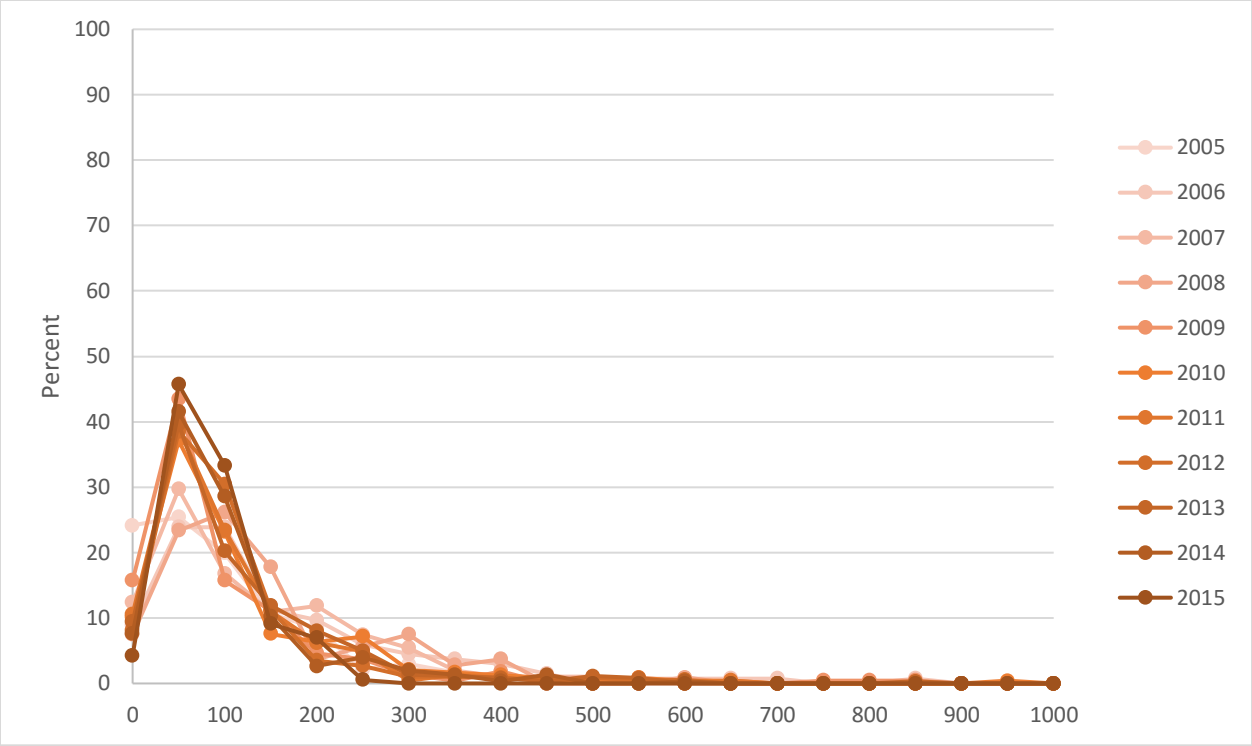


Figure 36 Work Complete Date to Comprehensive Corrective Work Notification (Final Inspections)

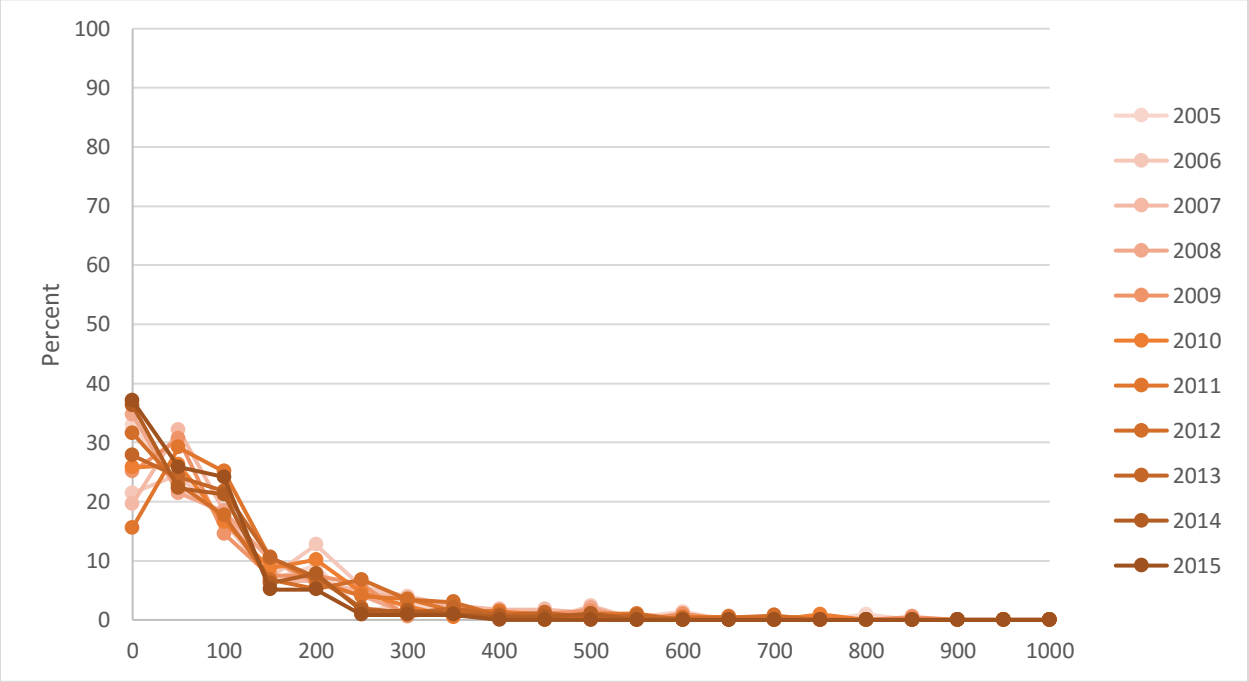


Figure 37 Comprehensive Corrective Work Notification to Corrective Work Complete (Corrective Work)

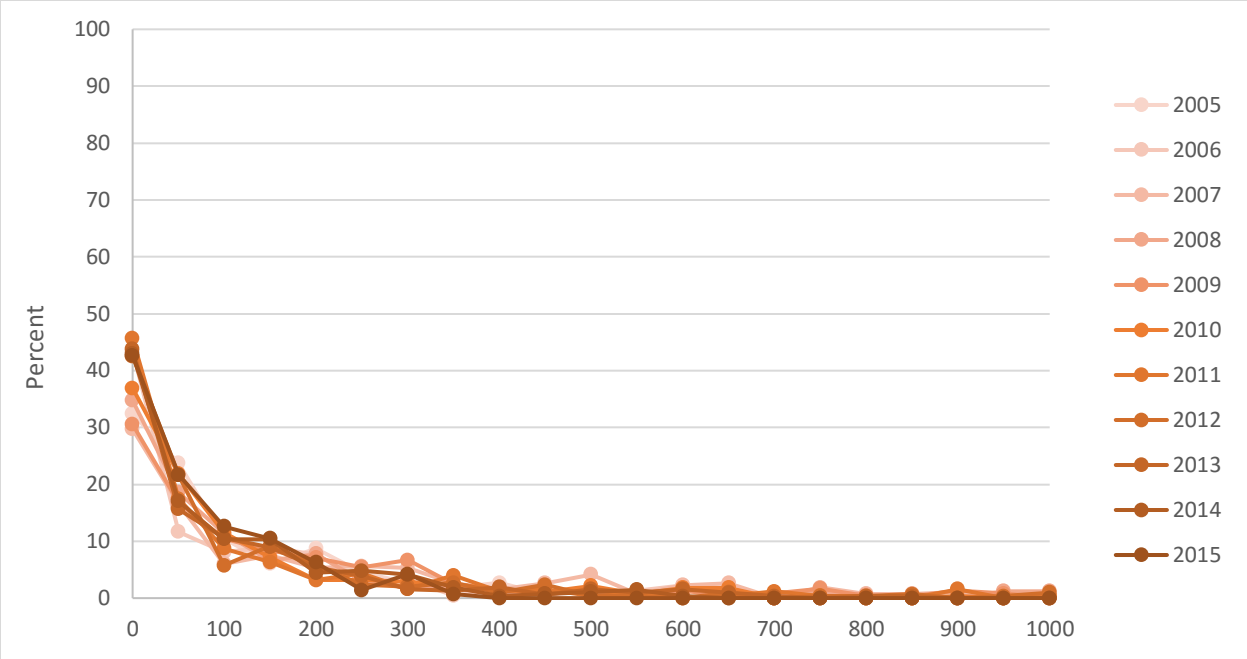


Figure 38 Corrective Work Complete to Ready for Materials Check RE

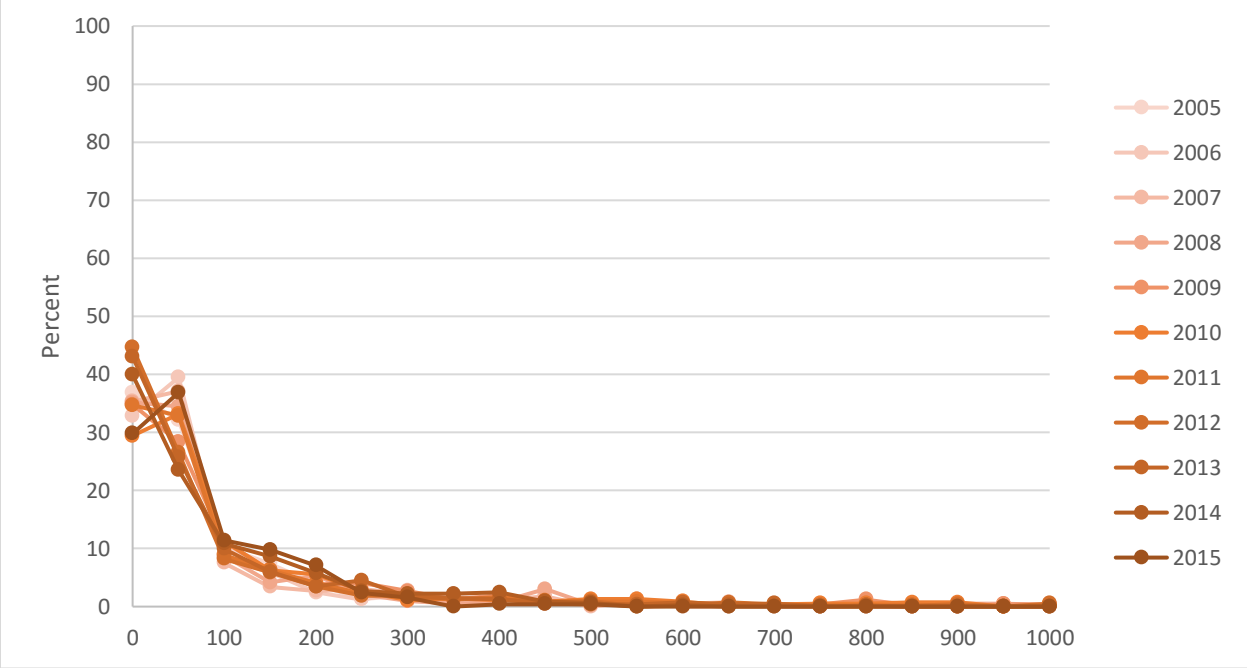


Figure 39 Ready for Materials Check RE to Ready for Materials Check DME

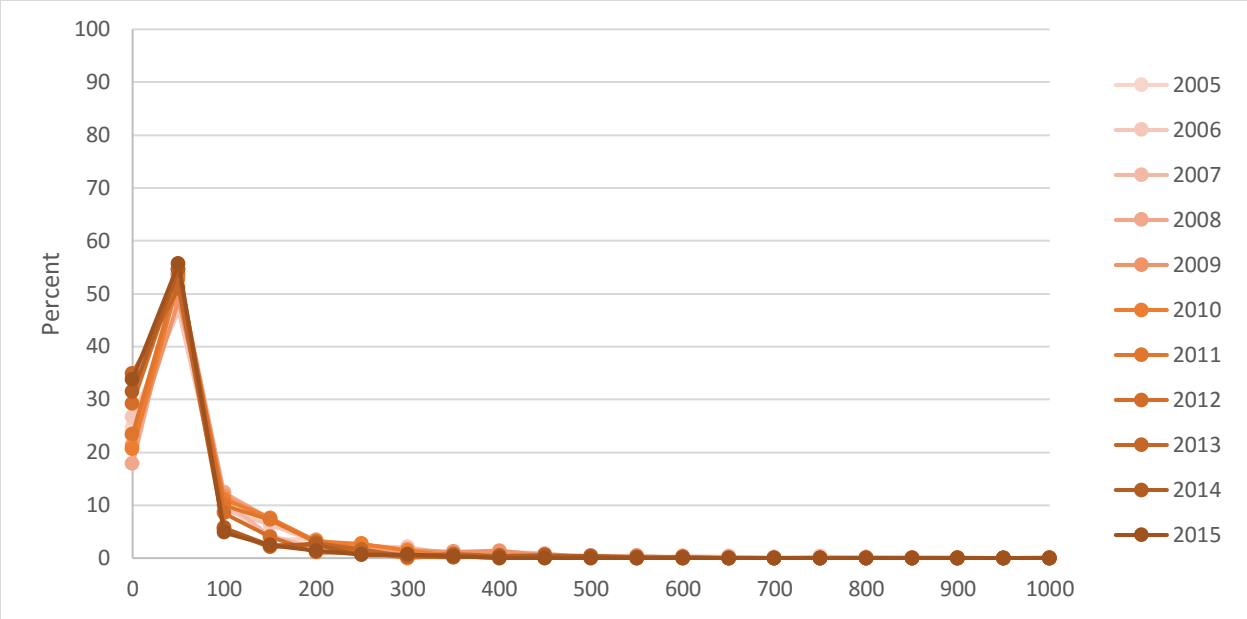


Figure 40 Files Received in District Office to District Office Final Check

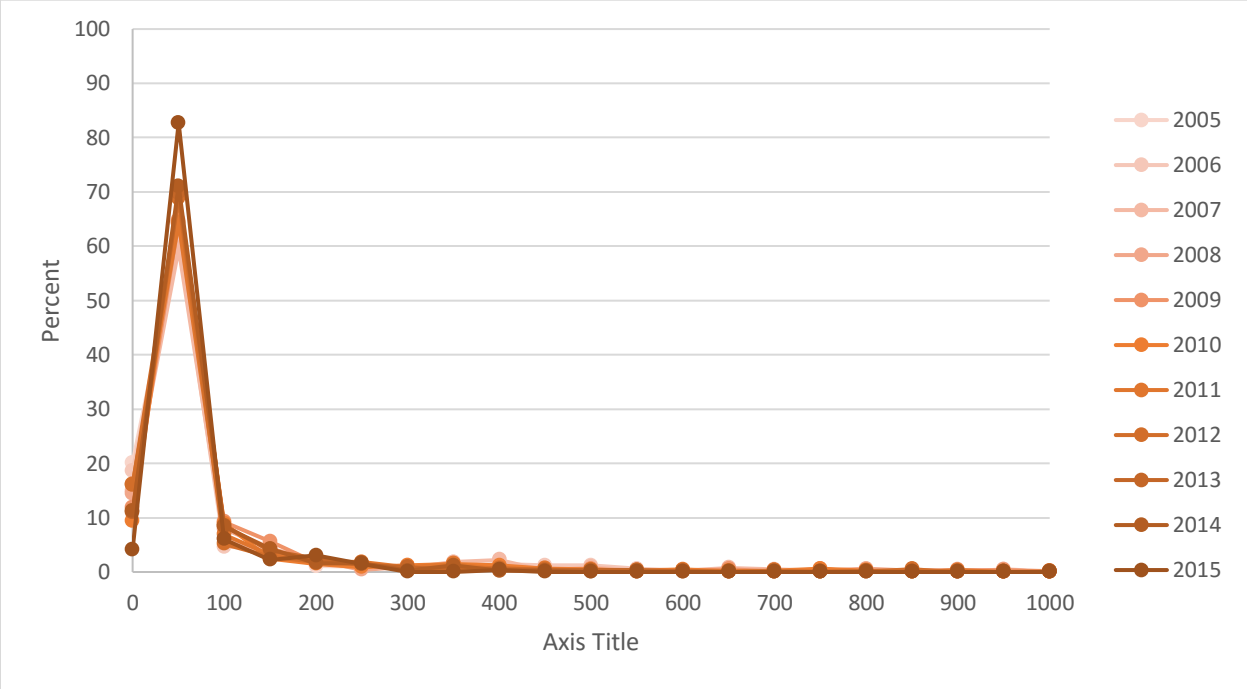


Figure 41 District Final Check to Files Received in Central Office

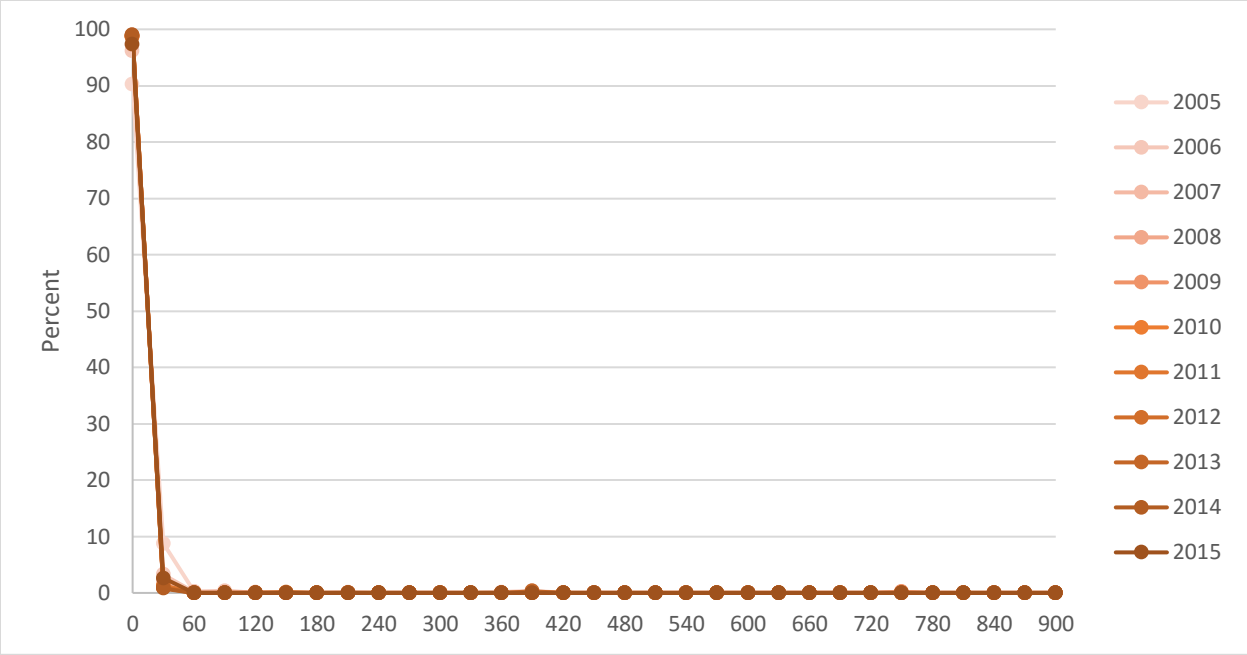


Figure 42 Files Received in Central Office to Central Office Final Check

Cost Data Analysis

As noted, between the formal acceptance and final payout of a project, funds allocated within the project budget are tied up and cannot be applied to new projects. Therefore, delayed closeout processes cause financial stagnation and reduce the purchase power of dollars that would otherwise be available. Quantifying how much funding is tied during this period underscores the importance of streamlining and standardizing project closeouts.

One avenue for analysis is taking data available on KYTC's Engineer's Resource Center webpage as a starting point (the *Project Information* Excel file). Each row of the sheet details project information going back to 2005, including: Total Contract Amount, Amount Paid to Date, Percentage Complete, Acceptance Date, and Date Paid Off. For each year (2005 to 2013), researchers calculated the average project difference and total difference between Total Contract Amount and Amount Paid to Date. Researchers omitted from their analysis projects whose completion was either 100% or less than 75%. Using FHWA Highway Construction Cost Indices (averaged over the year), these values were converted to 2016 dollars. Table 4 presents FHWA's cost indices.

Table 4 FHWA Cost Indices

CONSTRUCTION COST TRENDS FOR HIGHWAYS			
Apr 2015		TABLE PT-1	
YEAR	QUARTER	NHCCI Index	Yearly Average
2003	March	1.0000	1.0031
	June	1.0156	
	September	1.0038	
	December	0.9929	
2004	March	1.0260	1.0664
	June	1.0638	
	September	1.0849	
	December	1.0910	
2005	March	1.1189	1.1788
	June	1.1489	
	September	1.2045	
	December	1.2429	
2006	March	1.2727	1.3492
	June	1.3464	
	September	1.4084	
	December	1.3693	
2007	March	1.3425	1.2899
	June	1.3118	
	September	1.2691	
	December	1.2363	
2008	March	1.2500	1.2948
	June	1.2938	
	September	1.3521	
	December	1.2835	
2009	March	1.1818	1.0970
	June	1.0901	
	September	1.0752	
	December	1.0410	
2010	March	1.0683	1.0617
	June	1.0671	
	September	1.0595	
	December	1.0520	
2011	March	1.0524	1.0728
	June	1.0691	
	September	1.0817	
	December	1.0880	
2012	March	1.1147	1.1270
	June	1.1468	
	September	1.1315	
	December	1.1148	
2013	March	1.1002	1.1029
	June	1.1092	
	September	1.1195	
	December	1.0827	
2014	March	1.0947	1.1116
	June	1.1007	
	September	1.1354	
	December	1.1158	
2015	March	1.1334	1.1196
	June	1.1436	
	September	1.1163	
	December	1.0850	
2016	March	1.0728	1.0728

Aggregating each year's data in 2016 dollars shows the total average difference per project is $34,371, and the total sum of differences $174,654,804. Removing 3% to account for demobilization adjusts these numbers to $33,339 and $169,415,160, respectively. However, presenting these dollar amounts as lane miles of resurfacing more accurately highlights issues associated with a delayed closeout process. This analysis focuses on complete or nearly complete projects (through reference to their funds paid on the project). Another approach is to look at projects which have been formally accepted but not yet received final payment. Ryan Griffith, Director of the Division of Construction, presented this information at the Spring 2017 Section Engineer's Meeting. Of 1,292 open projects, 448 had been formally accepted, with $84,279,740.76 encumbered within those projects. Removing 3% for demobilization and expenses leaves $81,751,348.55 encumbered yet unneeded funds. Table 5 provides an overview of the calculations that convert total and average 2016 dollars into both 1" and 1.5" Class 2 resurfacing. Note that the unit price for CL 2 Surface was taken from the 2016 KYTC unit bid price spreadsheet.

Table 5 Miles of Resurfacing Calculations

Resurfacing Item	CL 2 Surface, 64-22	CL 2 Surface, 64-22	CL 2 Surface, 64-23
$/Ton	$ 65.44	$ 65.44	$ 66.44
Avg. 2016 $	$ 34,370.57		$ 33,339.45
Total 2016 $	$ 174,654,804.24	$ 81,751,348.55	$ 169,415,160.11
lbs/cf	145	145	145
Ln. Width (ft)	12	12	12
1" Overlay Ln. Miles for Avg. Project	**1.37**		**1.31**
1.5" Overlay Ln. Miles for Avg. Project	**0.91**		**0.87**
1" Overlay Ln. Miles for Total	**6972.13**	**3263.47**	**6661.17**
1.5" Overlay Ln. Miles for Total	**4648.08**	**2175.65**	**4440.78**
Notes		KYTC Internal Review presented in 2017 - Ryan Griffith	3% Removed for 75% Demobilization and 1% Other Items

Based on this analysis, the total number of additional lane miles that could be resurfaced if the closeout process were streamlined is between 2,000 and 7,000. While these funds cannot be made immediately available after formal acceptance, funds could be made available potentially four or more months sooner by streamlining the closeout process, which has been shown to consistently overshoot the 240-day goal (the average final date from formal acceptance for 2016 was 366 days). Releasing the encumbered funds tied up in projects that have been completed but not finalized should be a common goal of KYTC leadership, field personnel, and contractors as freeing up funds can potentially finance additional roadway improvements.

5. Conclusions and Recommendations

This project investigated the duration and process of project closeouts at KYTC. Project closeout encompasses the period between acceptance and critical final release. The amount of time needed to complete project closeout has consistently exceeded the Cabinet's goal of 240 days. To identify strategies to improve closeout processes, researchers analyzed the project closeout timelines for a significant number of projects, breaking the timeline into multiple stages. KYTC's closeout goal is currently longer than several other DOTs, which suggests the process warrants improvement. Specifically, two concomitant processes should be investigated for improvement (Figure 30). First, is the step during which the project final documentation is prepared in the Resident Engineer's Office from Corrective Work Complete to Resident Final Check. This appears to be where the greatest time savings could be realized during the closeout process. Additionally, the Cabinet should investigate reducing the time to prepare and complete the materials check, from Corrective Work Complete to Ready for Materials Check DME, as it occurs alongside the Corrective Work Complete to Resident Final Check. KYTC could also derive significant time savings during the final inspection and corrective work steps.

Researchers developed several recommendations based on their analysis. Examining the project closeout checklist at the district level may present an opportunity to expedite the generation of the final estimate by including a semi-final estimate in the closeout steps. VDOT's closeout process (90 days from acceptance to contract complete) specifies that a semi-final estimate is to be completed by either the Project Inspector or the Construction Manager. Each party reviews this document until the final estimate is submitted to the central office from the district. With multiple parties being responsible in some measure for the estimate, stakeholders share the time burden instead of it being delegated to a single district engineer.

VDOT also requires that a materials notebook be maintained and updated during the construction phase; this notebook contains testing information, materials certifications, and other applicable documentation. District offices must verify that the notebooks have been checked for sufficient test quantities within the district checklist. Materials management is also a concern for KYTC. It currently uses SiteManger LIMS to conduct materials management. However, Cabinet personnel have encountered problems with it in the field, with access sometimes being troublesome. Problems have also arisen related to materials changes, which can instigate conflicts or produce discrepancies, which then require justifications or explanations for missing tests or certifications. Sometimes personnel do not realize that additional documentation is needed until the project closeout stage, which can create significant issues. This is an area that should be investigated at KYTC to determine methods for improvement and their impact on the project closeout process.

Implementing e-Construction could also reduce delays in checking documents. Many DOTs have adopted electronic recordkeeping for their weigh tickets, storing them in a single database. KYTC is in the process of adopting aspects of e-Construction, and additional research on electronic ticketing is underway. These practices should be investigated internally and carefully tied into the project closeout process. Inconsistency also exists in project closeout. If a database such as SiteManager is used for e-Construction and key date notifications, it is imperative that staff responsible for close out make use of the database and enter information correctly. Otherwise, the system may not help reduce delays. Once the closeout process is optimized and approved at the central office level, the Cabinet should work to standardize the process across district offices.

Revising checklists provided in the Section Engineer's Manual could also improve project closeout. Compared to KYTC, VDOT provides more explicit steps and details in its closeout manual (Appendix A). Instead of two main checklists for the district and central offices, checklists are included for individual staff members — Project Inspector, Construction Manager, Area Construction Engineer, and District Contract Manager. Revising KYTC's checklists to be more explicit will help to standardize the execution of project closeout. Where ambiguities exist in the process, such as the timing and the party responsible for completing checklist items, staff members will vary how and when they complete the work.

Comparing KYTC's practices to VDOT's indicates very few differences in the checklists used at the central office level. Based on this, the greatest opportunity for improving the closeout process resides at the district level. As noted, the process should be optimized and then standardized among all districts to ensure all personnel adopt best practices. The knowledge and recommendations of the staff at the district level will be valuable for optimizing the process, as they are most familiar with the potential advantages and disadvantages of the current district checklist.

The recommendations discussed above pertain to KYTC's procedures, and potentially its policies. The suggested changes are best considered and executed by personnel internal to KYTC. The following list provides a foundation for applying improvements in the project closeout process, but implementing these items should be the responsibility of Cabinet personnel. To accelerate and streamline project closeouts, KYTC should pursue the following:

- Develop a task force to conduct a high-level analysis of the project closeout process
- Emphasize that streamlining project closeouts will benefit the public as it will increase publicly available funding
- Develop an incentive program to encourage more timely project closeouts
- Review and modify the KYTC's current duration goal(s) for closing out projects
- Review and edit project closeout checklists so they retain only the required steps; eliminate all extraneous or outdated steps
- Consider strengthening implementation of e-Construction practices to automate steps of the project closeout process

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Appendix A: VDOT/KYTC Comparison

- Note that pairs colored as blue text indicate where items appear to match between agencies.

VDOT	KYTC
District Contract Manager	**District Checklist**
Review DWR's	Check that DWR's are approved
Check rideability has been entered	Check rideability has been entered
Compare As-Builts to final summaries	Submit As-Builts to Central Office
Verify pavement thickness reports	Verify pavement thickness reports
Review non-spec items for pay deductions	Review non-spec items for pay deductions
Receive materials certifications from DME	Materials certifications approved
Prepare final estimate draft	Submit final estimate to central office
Verify that documents of items paid by tonnage are in compliance 2012 guidebook	Verify change orders are approved/denied
Verify that Materials Section has checked notebooks for evidence of sufficient test quantities to cover all pay items	Submit claims, disputes, and liquidated damage reviews, if applicable
Check notebooks for certification by Inspector, CM, and ACE	If applicable, check lot pay adj. worksheets, and verify any payments or deductions have been paid
Check Signatures on weight sheets, DWR's, as builts, Form C-79	Check critical dates in site manager for formal acceptance
Make sure that work completed by State is separate from Contractor items	Mark all key dates and final inspection dates
Contractor has 10 days to review Final Estimate, then DCM forwards to Central	Send Plan Sheets to central office, check pay quantities against final estimate

VDOT	KYTC
Project Inspector (or CM if needed)	**District Checklist**
Contractor evaluations due at completion	Complete and submit contractor evaluations
Send applicable supporting data to CM - weight tickets, invoices	Run tapes and verify tickets
Attach applicable printed out electronic files to support semi final estimate sent to CM	
Send DWR's to CM	
Complete As-Builts	
Use Change Orders/Bid quantities to complete Reason for Differences Report and to complete semifinal paid quantities	
Complete semi final estimate	
Complete all books and reports from construction phase	
Obtain signed disposal and borrow pit releases from Contractor	Verify Stockpile Balance is zero
Area Construction Engineer	
Verify asphalt price adjustments and tonnages	Verify asphalt price adjustments and tonnages
Review Semi final estimate	
Enter Administer Contract Actual End Date and ensure that the project status changes to CN Complete	
Send letter to contractor within 5 days of acceptance informing them of the acceptance, address DBE goals/requirements, and delinquet documention	
Submit project records to DCM within 10 days of final acceptance	
Construction Manager	
List items accepted by visual inspection	
Letter concerning fulfillment of Right of Way Agreements	
Letter of Contractor certification that materials, labor, equipment, and supplies have been paid	
Letter of Contractor's Certification of Compliance of use of domestic material (as applicable)	
Letter advising if a final survey is needed	
Review project records for completeness	
Sign and date project books	
Review Semi Final estimate	
Deliver records/books to ACE	

VDOT	KYTC
Central Office	
Enter key dates	Enter key dates, check dates and critical dates
Generate Final Estimate - forward to Fiscal Division and Contractor	Generate Final estimate - mailed out
Send out final balance due to contractor	Confirm that all lump sum items have been paid 100% (demob/mob/maintain and control traffic)
Check for Claims after 60 day claim period, check balance due to VDOT or not, verify change orders	Check for outstanding change orders
Review data submitted from District/Area Level, change orders, IRI, material price and pay adjustments	Check DWR's have been approved
Check site manager dates	Check missing checklist event dates
Check if any NOI's exist, continue to maintain the Division contract file if yes	Check if FAA is necessary for project
	Checked on appropriateness or an LD report and make sure they match the amounts previously paid
	Generated and double checked Final Release - mailed out