

# Project Inspection Using Mobile Technology — Phase III

Workflow Identification Research

WA-RD 840.3

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July 2016



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Department of Transportation**

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**Research Report  
Agreement K780 – Amendment 3  
WA-RD 840.3  
Project Inspection Using Mobile Technology**

**Project Inspection Using Mobile Technology – Phase III  
Workflow Identification Research**

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## Table of Contents

Field Note Record Workflow Investigation.....	1
Executive Summary.....	1
Introduction .....	2
Data .....	2
Background .....	2
FNR Workflow Process.....	4
Drafting the FNR Form .....	8
Reviewing the FNR Form.....	10
Processing the FNR Form into CAPS .....	13
Conclusions .....	14
Recommendations .....	14
Appendix A.....	16
Force Account Workflow Investigation.....	20
Executive Summary.....	20
Introduction .....	22
Data .....	22
Background .....	22
FA Workflow Process .....	23
Drafting the FA Form .....	26
Reviewing the FA Form .....	27
Processing the FA Items into CAPS .....	31
Conclusions .....	32
Recommendations .....	33
Feasibility Report: Creating a Construction Terminology Dictionary for Apple iPads .....	34
Executive Summary.....	34
Introduction .....	35
Text Replacement Method .....	35
Custom Keyboard Method.....	37
Conclusion.....	37
Appendix B: A list of 60 commonly used transportation construction terminology .....	39
Appendix C: Custom Keyboard Development Process from Apple Inc.....	40

# Field Note Record Workflow Investigation

## Executive Summary

This report summarizes the research done by Pavia Systems, Inc. for the Washington State Department of Transportation (WSDOT) on investigating how WSDOT project engineering offices complete the Field Note Record (FNR) process for payment. The FNR workflow processes were observed for the Everett Project Engineering Office (PEO), SR-520 West Approach Bridge North PEO, and Fife PEO.

This study determined that the FNR workflow process can be broken down into the following three parts: drafting, reviewing, and processing the FNR form. The drafting processes, where a field inspector obtains and completes the FNR form, were found to be similar across all three PEOs. All inspectors completed the header section of the FNR form in a similar manner as the header contains fields asking for specific inspection-related data. The inspectors included the same content in the body portion of the FNR form, but the depiction of this information may vary in format as this section is free of any fields or written instructions. If there are materials involved in the FNR, material acceptance and verification information is transferred from the Records of Material (ROM) database to the FNR form. Since all inspectors involved in this study use an electronic version of the FNR form, materials-related information from the ROM database is auto-filled into the form once the inspector specifies the bid item worked on by the Contractor or Subcontractor.

There were some procedural differences in the review process of the FNR form. Depending on the PEO, there may be one or more personnel that reviews and accepts the content on the FNR form. One PEO was observed to include one office personnel to review and accept the form while the other two PEOs included more than two office personnel in the review process. If there are materials involved in the FNR, all three PEOs have their material engineer review the material section of the form. One PEO has their material engineer include their initials and date in the body section of the form to document concurrence. Material engineers from the other two PEOs do not sign off or document concurrency directly on the form.

The procedures involved in processing the FNR information for payment were all similar for all interviewed PEOs. The information on the form is transposed to the Contract Administration and Payment System (CAPS) by office personnel in charge of processing payment. Payment ledger information from CAPS is transposed back into the FNR form and the form is peer reviewed by another payment engineer. Once accepted, the form is stored as an electronic or physical filing system.

Conclusions from this study include the following:

- **Field inspectors create and complete the FNR forms using the same procedures across all PEOs involved in this report.**
- **The review process of completed FNRs are different for each PEO involved in this report.**
- **Not all verification information is directly incorporated into the FNR form.**
- **The FNR forms used by the PEOs involved in this report are not the same forms available on the WSDOT Forms website.**
- **The InfoPath FNR form is linked to the ROM database so that material acceptance and verification information can be shown directly on the form.**

The following recommendations provide some opportunities for process improvements:

- **Automate pieces of information that have already been collected through Contract documents and inspection documents on the FNR form.**
- **Consider intelligent, integrated form capabilities other than InfoPath as it will be discontinued by Microsoft.**
- **Include all review concurrence information directly on the FNR form.**
- **Enhance form security to improve document integrity and availability.**

## Introduction

This report summarizes the research done by Pavia Systems, Inc. for the Washington State Department of Transportation (WSDOT) on investigating how WSDOT project engineering offices complete the Field Note Record (FNR) process for payment. The FNR workflow process were observed for three WSDOT project engineering offices (PEO). Using the findings discovered through this investigation, this study identifies opportunities to improve the current FNR workflow process.

## Data

The information presented in this report reflects the FNR workflow processes used by three WSDOT PEO offices. These PEOs include:

- Everett PEO [Linda Sarpy and Ana Nguyen – Office Engineer Reference] – ORG 412337 (Saweyer) and ORG 412330 (Lindberg)
- SR-520 West Approach Bridge North (WABN) PEO [Jody Alseth and Zach Archer – Business Manager Reference] – ORG 587180
- Fife PEO [Dale Latham – Assistant Office Engineer] – ORG 434305

Office engineers and business managers from the PEOs listed above participated in face-to-face conversational interviews to describe how their PEO creates, reviews, and processes FNRs. The information obtained from the conversations and observations were used to create workflow process diagrams to summarize the personnel involved in the FNR process and their respective tasks.

## Background

Section 9-1.5 of the WSDOT Construction Manual (January 2016) states that FNRs are used by field inspectors to:

1. Document the verification of permanent materials conforming to contract requirements
2. Affirm payment of the work item

Section 11-2 of the WSDOT Construction Manual (January 2016) states that there are multiple formats of the FNR form. The various types of FNR forms include:

- **Field Note Record (Form 422-635; Rev 03/2008)** – FNR form with a table intended for area calculations on the second page.
- **Field Note Record (Form 422-636; Rev 9/96)** – FNR form with sketch grid on the second page.
- **Field Note Record For Drainage (Form 422-637; Rev 03/2008)** – Similar to the generic FNR but with the second page providing a table for structure excavation calculations.

The general requirements on filling out field notes are provided in section 10-3.12 of the Construction Manual. This section does not directly reference FNR forms but the figures shown as sample field notes show completed FNR forms. This report assumes the terms *field note* and *field note record* are interchangeable in this section of the Construction Manual. The following figures show templates of the FNR forms available from the WSDOT Forms website.

*Figure 1. Template of a Field Note Record Form with area summary on second page*

*Figure 2. Template of a Field Note Record Form with sketch area on second page*

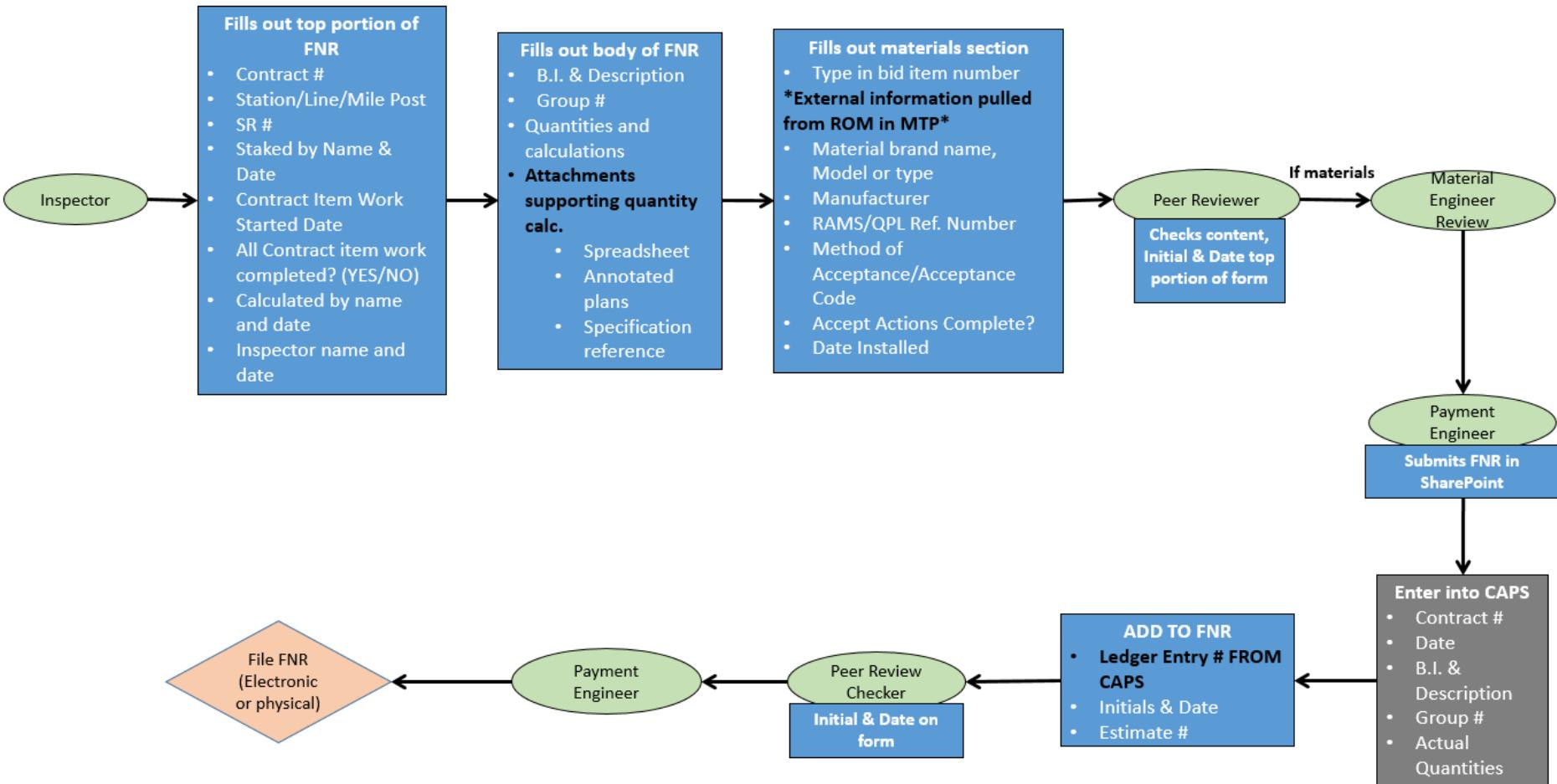
*Figure 3. Template of a Field Note Record form with structure excavation worksheet on second page*

In summary, section 10-3.12 states the following general requirements:

- “Field notes should show the initials of the persons or person making them, the date, and the weather conditions if appropriate.”
  - “The notes shall also show the dates that quantities are computed and checked along with the initials of those persons doing the work.”
  - “The quantities for payment for each item of work in the field notebook shall correspond directly to entries in the CAPS project ledger. Adequate cross-referencing must be made between the field notebook and the project ledger in order to trace item quantities and entries from one to the other.”

## FNR Workflow Process

The FNR workflow process discovered from the interviews are shown below.



## FNR Workflow Process – Everett Project Engineering Office

Figure 4. Everett Project Engineering Office Field Note Record Workflow Process

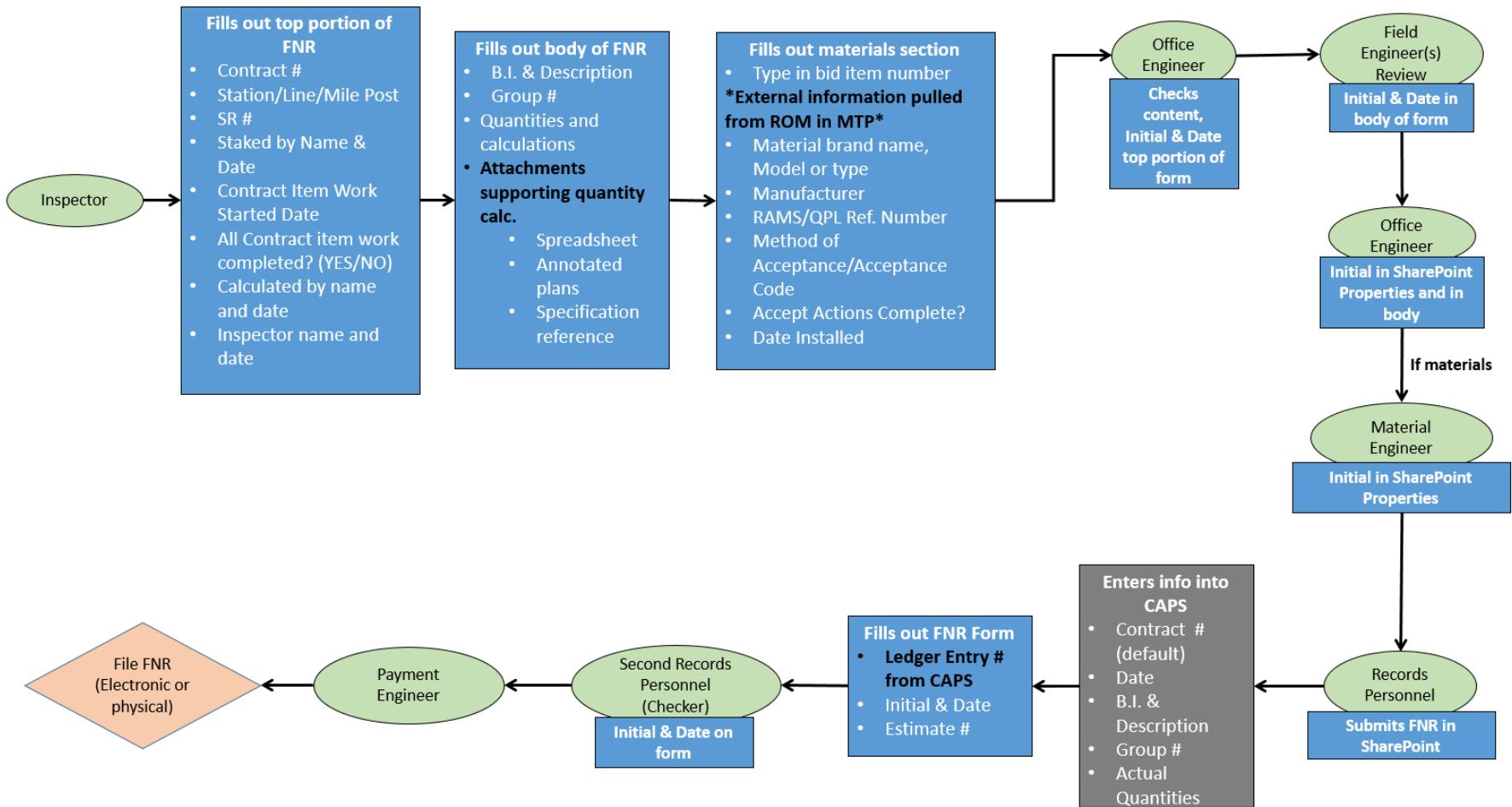


Figure 5. Fife Project Engineering Office Field Note Record Workflow Process

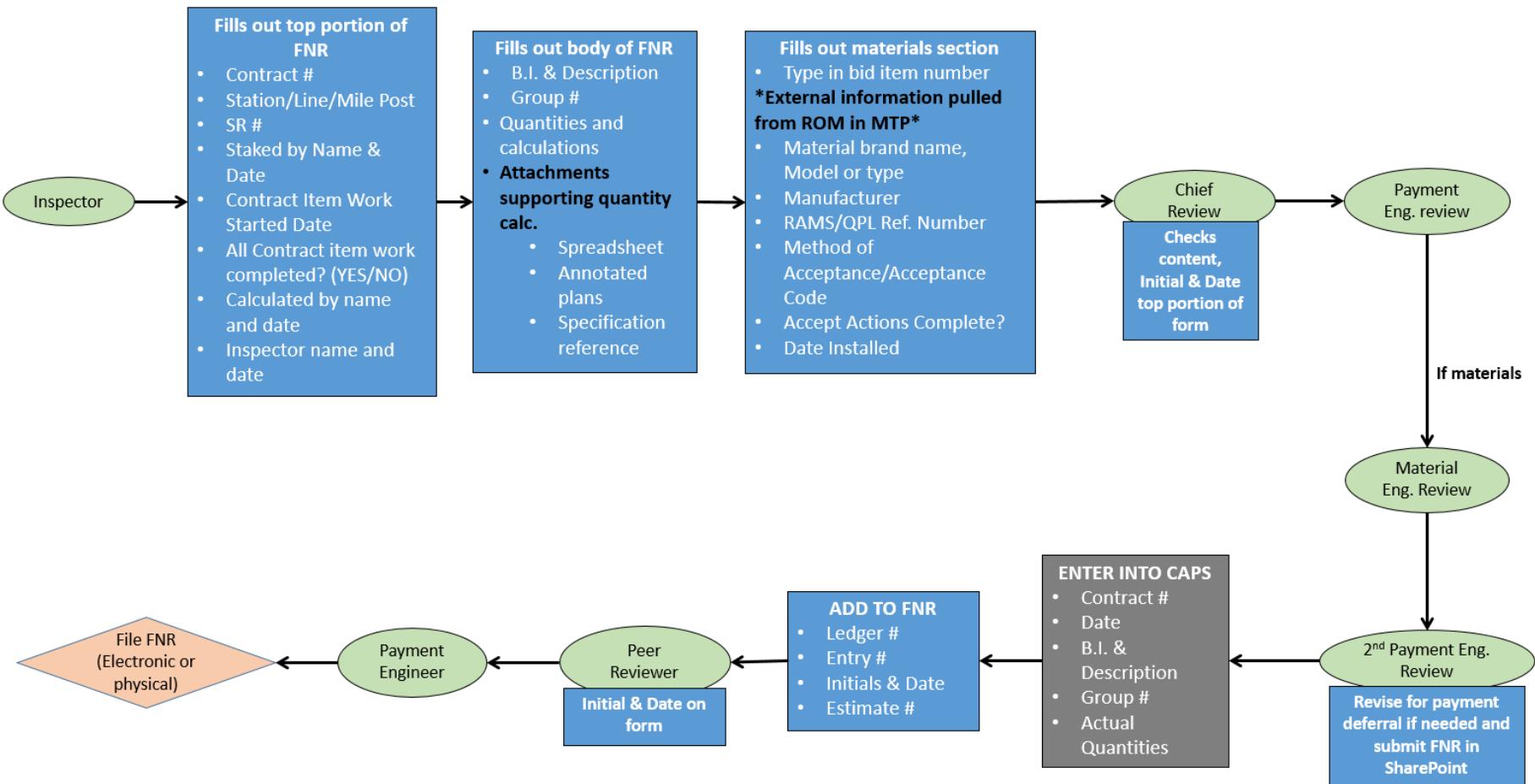


Figure 6. WABN Project Engineering Office Field Note Record Workflow Process

The following section breaks apart the FNR process into three parts: drafting, reviewing, and processing the FRN form.

### Drafting the FNR Form

Field inspectors at all three PEOs use the same procedures to draft their FNR form for review. The process starts with the inspector creating a new FNR InfoPath form for their project in the SharePoint system. The inspector fills out the header portion of the FNR form (area shown in red in figure 7). The header contains specific project-related information such as contract number, location of work performed, and the date of when the work was performed. It also states the author of the FNR as well as personnel responsible for staking work and calculations for the bid item.

Field Note Record					
 Washington State Department of Transportation	Contract Number	Station / Line / Mile Post	SR No.		
008607	MDSI5 3505+54 to MDSI5 3514+52		5		
Staked by	Date	Contract Item Work Started Date	All Contract Item Work Completed?		
WSDOT	9/7/2014	9/24/2014	Yes <input type="checkbox"/>	No <input type="checkbox"/>	(Partial Payment)
Calculated by	Date	Checked by (Formulas & Calcs)	Date	Inspector	Date
John Doe	10/15/2014	Jane Doe	10/17/2014	John Doe	10/15/2014
Installed the following timber poles and posts per ITS plans:  FB-03 MDSI5 3514+52 (114 LT) WTNX-11 MDSI5 3513+00 (167 LT) RM-02 MDSI5 3508+08 (75 LT) WTNX-10 MDSI5 3507+92 (110 LT) WTNX-09 MDSI5 3505+54 (108 LT)					
Poles installed for Ramp Metering is 5% of Lump Sum Breakdown (see attached) \$153,811.58  5% of \$153,811.58 = \$7,690.58      Pay \$7,690.58					
Materials approved QPL 059 for timber Poles from Conrad Wood Preserving.					

Figure 7. The header portion (shown in red) filled out by the inspector

The inspector then completes the body of the form. The following information are included in the body:

- Bid item number and the associated description and unit of measurement
- Supporting calculations showing the arithmetic used to arrive at the final quantity value
- Statement approving the contractor for payment associated with the item quantity
  - Example: "Pay contractor 950 C.Y."

Quantities and supporting calculations must be segregated by group numbers as stated in section 10-3.12 of the Construction Manual. An example of the completed body section is shown in figure 8. If additional supporting documentation was used to determine the total payment quantity, those documents are included with the FNR form as attachments. For example, Lump Sum Breakdown documents are commonly included as attachments for lump sum sub-bid items to support the percentage allocated for the specific work that was completed. The information from the body is then used to fill out the section shown in figure 9.

Field Note Record											
Contract Number	Station / Line / Mile Post	SR No.									
008607	MDSIS 3605+54 to MDSIS 3514+52	16									
Staked by	Date	Contract Item Work Started Date	All Contract Item Work Completed?								
WSDOT	8/17/2014	9/24/2014	Yes <input type="checkbox"/>	No <input type="checkbox"/>	(Partial Payment)						
Calculated by	Date	Checked by (Formulas & Calcs)	Date	Inspector	Date						
John Doe	10/15/2014	Jane Doe	10/17/2014	John Doe	10/15/2014						
Installed the following timber poles and posts per ITS plans:											
FB-03 MDSIS 3514+52 (114 LT) WTNX-11 MDSIS 3513+00 (167 LT) RM-02 MDSIS 3508+08 (75 LT) WTNX-10 MDSIS 3507+92 (110 LT) WTNX-09 MDSIS 3505+54 (108 LT)											
Poles installed for Ramp Metering is 5% of Lump Sum Breakdown (see attached) \$153,811.58  5% of \$153,811.58 = \$7,690.58  <b>Pay \$7,690.58</b>											
Item Num	Material Brand Name, Model or Type	Manufacturer	RAMS/QPL Ref. No.	Method of Accept. / Accept. Code	Accept Actions Complete?						
					<input type="checkbox"/> Yes <input type="checkbox"/> No						
Item Num	Item Description	Grp	Date Work Complete	Unit	Quantity	Ledger Entry No.	Posted By Init.	Posted By Date	Checked By Init.	Checked By Date	Est. No.
0267	ITS	01	10/5/2014	L.S.	7,690.58	00390	SMW	10/20/14	gl	10/20/14	003

Figure 8. The body portion (shown in green) filled out by the inspectors

Installed the following timber poles and posts per ITS plans:											
FB-03 MDSIS 3514+52 (114 LT) WTNX-11 MDSIS 3513+00 (167 LT) RM-02 MDSIS 3508+08 (75 LT) WTNX-10 MDSIS 3507+92 (110 LT) WTNX-09 MDSIS 3505+54 (108 LT)											
Poles installed for Ramp Metering is 5% of Lump Sum Breakdown (see attached) \$153,811.58  5% of \$153,811.58 = \$7,690.58  <b>Pay \$7,690.58</b>											
Item Num	Material Brand Name, Model or Type	Manufacturer	RAMS/QPL Ref. No.	Method of Accept. / Accept. Code	Accept Actions Complete?						
					<input type="checkbox"/> Yes <input type="checkbox"/> No						
Item Num	Item Description	Grp	Date Work Complete	Unit	Quantity	Ledger Entry No.	Posted By Init.	Posted By Date	Checked By Init.	Checked By Date	Est. No.
0267	ITS	01	10/5/2014	L.S.	7,690.58	00390	SMW	10/20/14	gl	10/20/14	003
<b>Attachments</b>											
 Lump Sum Breakdown.pdf Adobe Acrobat Document 102 KB											
DOT Form IP422-635 EF Revised 01/2011											

Figure 9. Bid item quantity designation area (shown in blue) filled out by the inspector

As a final step in creating an FNR form, the inspector includes material verification and acceptance information. This is only done if the bid item includes the placement of any permanent materials. If

there are no materials associated with the bid item, this section is left blank. The inspector specifies the bid item number in the InfoPath form and SharePoint retrieves and displays the material verification and acceptance information from the Record of Materials (ROM) database. This step ensures that the materials placed onsite have been approved and is in accordance with the contractor submitted QPL or the approved RAM. Figure 10 below shows an example of the materials section of the form.

<p>section B1 and plan width is 14' per plan sheet PD1. Cores to determine thickness have not yet been drilled so plan depth is being used for initial payment and the quantity will be adjusted after cores are taken.  <math>1,917.12' \times 0.95' \times 14' / 27 \text{ C.F.C.Y.} = 944.36 \text{ C.Y.}</math></p> <p><b>Pay 944.36 C.Y.</b></p> <p>Measurements based off plan limits except west end where existing CCP was not at plan limits so a steel tape was used to measure from the nearest survey hub.</p>																							
<table border="1"> <thead> <tr> <th>Item Num</th> <th>Material Brand Name/Model Type</th> <th>Manufacturer</th> <th>Brand Name/Model Type</th> <th>RAMS/QPL Ref. No.</th> <th>Appr/Acc Code</th> <th>Basis of Accept</th> </tr> </thead> <tbody> <tr> <td>180.01</td> <td>PCC Pavement GMC6SK</td> <td>Gary Merlino Construction</td> <td>GMCC6SK - Erie MG11C</td> <td>RAM-0203.1</td> <td>1, 8</td> <td>/ Test</td> </tr> <tr> <td>180.07</td> <td>Liquid Membrane Curing Compounds</td> <td>W.R. Meadows</td> <td>1600 - White</td> <td>QPL-0151</td> <td>1115</td> <td>/ Test or Visual of Appr Lots</td> </tr> </tbody> </table>		Item Num	Material Brand Name/Model Type	Manufacturer	Brand Name/Model Type	RAMS/QPL Ref. No.	Appr/Acc Code	Basis of Accept	180.01	PCC Pavement GMC6SK	Gary Merlino Construction	GMCC6SK - Erie MG11C	RAM-0203.1	1, 8	/ Test	180.07	Liquid Membrane Curing Compounds	W.R. Meadows	1600 - White	QPL-0151	1115	/ Test or Visual of Appr Lots	
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180.07	Liquid Membrane Curing Compounds	W.R. Meadows	1600 - White	QPL-0151	1115	/ Test or Visual of Appr Lots																	
<table border="1"> <thead> <tr> <th>Item Num</th> <th>Item Description</th> <th>Grp</th> <th>Date Work Complete</th> <th>Unit</th> <th>Quantity</th> <th>Ledger Entry No.</th> <th>Posted By Init.</th> <th>Checked By Init. Date</th> <th>Est. No.</th> </tr> </thead> <tbody> <tr> <td>0180</td> <td>CEMENT CONC. PAVEMENT</td> <td>1</td> <td>9/2/2015</td> <td>C.Y.</td> <td>944.36</td> <td>4285</td> <td>DMM</td> <td>09/21/15 EK</td> <td>09/21/15 48</td> </tr> </tbody> </table>		Item Num	Item Description	Grp	Date Work Complete	Unit	Quantity	Ledger Entry No.	Posted By Init.	Checked By Init. Date	Est. No.	0180	CEMENT CONC. PAVEMENT	1	9/2/2015	C.Y.	944.36	4285	DMM	09/21/15 EK	09/21/15 48		
Item Num	Item Description	Grp	Date Work Complete	Unit	Quantity	Ledger Entry No.	Posted By Init.	Checked By Init. Date	Est. No.														
0180	CEMENT CONC. PAVEMENT	1	9/2/2015	C.Y.	944.36	4285	DMM	09/21/15 EK	09/21/15 48														
<p><b>Attachments</b></p> <p><input type="checkbox"/> File Attachment</p> <p>DOT Form IP 422-635ER EF Revised 4/2009</p>																							

Figure 10. Material verification section (shown in purple) filled out by the inspector

### Reviewing the FNR Form

There were some procedural differences in the review process of the FNR forms between the three PEOs. For example, the Fife PEO has at least five personnel of different roles reviewing the FNR submitted by the inspector. In contrast, the Everett PEO has three personnel of different roles reviewing the FNR. The section below describes the general review process of the FNR form.

After the field inspector completes the FNR form, the form is then peer reviewed. The reviewer thoroughly checks the information in the header as well as any formulas, calculations, and other supporting attachments used to determine the total bid item quantity. To accept the contents in the FNR form, the peer reviewer completes the *checked by* and *date* section located in the header section as shown in figure 11.

Field Note Record					
Contract Number 008607	Station / Line / Mile Post MDSI5 3506+54 to MD SIS 3514+52	SR No. 5			
Staked by WSDOT	Date 9/17/2014	Contract Item Work Started Date 9/24/2014	All Contract Item Work Completed? <input type="checkbox"/> Yes <input type="checkbox"/> No (Partial Payment)		
Calculated by John Doe	Date 10/15/2014	Checked by (Formulas & Calcs) Jane Doe	Date 10/17/2014	Inspector John Doe	Date 10/15/2014
Installed the following timber poles and posts per ITS plans:  FB-03 MDSI5 3514+52 (114 LT) WTNX-11 MDSI5 3513+00 (167 LT) RM-02 MDSI5 3508+08 (75 LT) WTNX-10 MDSI5 3507+92 (110 LT) WTNX-09 MDSI5 3505+54 (108 LT)					
Poles installed for Ramp Metering is 5% of Lump Sum Breakdown (see attached) \$153,811.58  5% of \$153,811.58 = \$7,690.58      Pay \$7,690.58					

Figure 11. Checked by and Date section (shown in yellow) filled out by the peer reviewer

The peer reviewer is typically the inspector's direct supervisor such as the chief inspector. However, some PEOs may assign an office or payment engineer to perform the initial form review.

PEOs with larger office staff may include more personnel to review the form before it is submitted in the SharePoint system. For example, the Fife PEO includes field and office engineers as part of their review process. The engineers that review the form will include their name or initial and the date in the body of the form (figure 12). Engineers and additional checkers at the Fife PEO also include their initials and date in the *properties* function of the InfoPath form as shown in figure 13. The information included in the InfoPath *properties* function is not directly incorporated into the FNR form but is saved as an InfoPath property.

Calculated by	Date	Checked by (Formulas & Calcs)	Date	Inspector	Date
John Doe	10/15/2014	Jane Doe	10/17/2014	John Doe	10/15/2014
Installed the following timber poles and posts per ITS plans:  FB-03 MDSI5 3514+52 (114 LT) WTNX-11 MDSI5 3513+00 (167 LT) RM-02 MDSI5 3508+08 (75 LT) WTNX-10 MDSI5 3507+92 (110 LT) WTNX-09 MDSI5 3505+54 (108 LT)					
Poles installed for Ramp Metering is 5% of Lump Sum Breakdown (see attached) \$153,811.58  5% of \$153,811.58 = \$7,690.58      Pay \$7,690.58					
Materials approved QPL 059 for timber Poles from Conrad Wood Preserving. FAR-0042 LD - 10/18/14 RN - 10/20/14 PAC - 10/20/2014					
Item Num	Material Brand Name, Model or Type	Manufacturer	RAMS/QPL Ref. No.	Method of Accept. / Accept. Code	Accept Actions Complete?

Figure 12. Additional reviewers may enter in their initials and date in the body section (shown in orange)

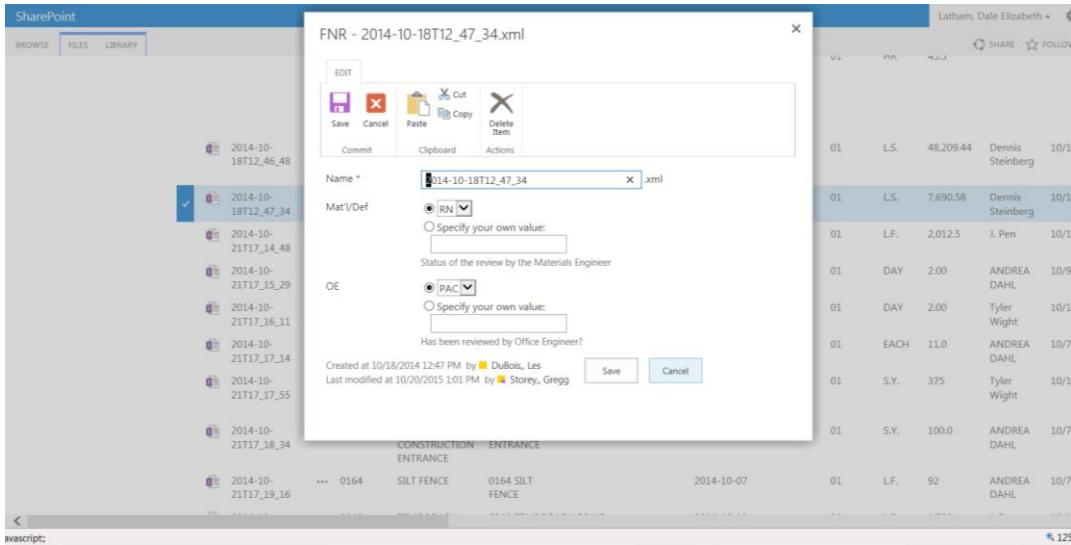


Figure 13. Additional reviewers entering their initials and date in the InfoPath Properties function

If there are materials involved in the FNR, the material engineer reviews the form to ensure that the material placed is the same material that has been approved through Qualified Products List (QPL) or Request for Approval of Materials (RAM) forms. This information resides in the ROM database which is linked to the project SharePoint system. The FNR form does not have a specific section for the material engineer to record their review process. They are not required to document their review process on the FNR form but PEOs such as the Fife PEO require the material engineer to include their initials and date in the body of the form as well as include their information in the *properties* function of the InfoPath form (figure 14).

Field Note Record					
Contract Number	Station / Line / Mile Post	SR No.			
008607	MDSIS 3505+54 to MDSIS 3514+52	5			
<b>Staked by</b>	<b>Date</b>	<b>Contract Item Work Started Date</b>		<b>All Contract Item Work Completed?</b>	
WSDOT	9/17/2014	9/24/2014		Yes <input type="checkbox"/>	No <input type="checkbox"/> (Partial Payment)
<b>Calculated by</b>	<b>Date</b>	<b>Checked by</b> (Formulas & Calcs)	<b>Date</b>	<b>Inspector</b>	<b>Date</b>
John Doe	10/15/2014	Jane Doe	10/17/2014	John Doe	10/15/2014
Installed the following timber poles and posts per ITS plans:					
FB-03 MDSIS 3514+52 (114 LT) WTNX-11 MDSIS 3513+00 (167 LT) RM-02 MDSIS 3508+08 (75 LT) WTNX-10 MDSIS 3507+92 (110 LT) WTNX-09 MDSIS 3505+54 (108 LT)					
Poles installed for Ramp Metering is 5% of Lump Sum Breakdown (see attached) \$153,811.58					
5% of \$153,811.58 = \$7,690.58 <b>Pay \$7,690.58</b>					
Materials approved QPL 059 for timber Poles from Conrad Wood Preserving.					
FAR-0042					
LD - 10/18/14 RN - 10/20/14 PAC - 10/20/2014					
Item Num	Material Brand Name,	Manufacturer	RAMS/QPL Ref.	Method of	Accept
					Date

Figure 14. Material approval information added into the body section (shown in red) filled out by materials engineer

After all review personnel complete their review process, the form is submitted to the personnel responsible for processing the FNR form into the CAPS database.

### Processing the FNR Form into CAPS

The procedures involved in processing the FNR information into the CAPS database were all similar for all interviewed PEOs. The personnel responsible for processing the FNR information into the CAPS database officially submits the FNR form into the SharePoint system. Once submitted in SharePoint, the FNR form is no longer considered a draft and is now a source document as described in section 10-1.3 of the Construction Manual.

The processing personnel enters the following information from the FNR form into the CAPS database:

- Contract number
- Date
- Bid item number and description
- Group number
- Total item quantity

After transcribing the above five items into CAPS, the following information is added back to the FNR form:

- Ledger entry number
- Initials and date of CAPS entry

A second processing personnel reviews the FNR form to ensure that the CAPS information is accurate in both the CAPS database and the FNR form. The second individual fills out their initials and the date of review on the form. Figure 15 shows the section where processing personnel enter in their respective information.

		5% of \$153,811.58 = \$7,690.58      Pay \$7,690.58								
Materials approved QPL 059 for timber Poles from Conrad Wood Preserving. FAR-0042 LD - 10/18/14 RN - 10/20/14 PAC - 10/20/2014										
Item Num	Material Brand Name, Model or Type	Manufacturer		RAMS/QPL Ref. No.	Method of Accept. / Accept. Code		Accept Actions Complete?	Date Installed		
							<input type="checkbox"/> Yes <input type="checkbox"/> No			
Item Num	Item Description	Grp	Date Work Complete	Unit	Quantity	Ledger Entry No.	Posted By Init. Date	Checked By Init. Date	Est. No.	
0267	ITS	01	10/5/2014	L.S.	7,690.58	00390	SMW   10/20/14	gl   10/20/14	003	
Attachments										
 Lump Sum Breakdown.pdf Adobe Acrobat Document 102 KB										
DOT Form IP422-635 EF Revised 01/2011										

Figure 15. FNR-CAPS processing information (shown in green) filled out by the processing personnel

The FNR form is then stored electronically or physically depending on the PEO's preference of office level policy.

The processing personnel's title vary depending on the PEO. The Everett PEO and WABN PEO assign *payment engineers* to process the FNR form into the CAPS database. The Fife PEO uses a combination of records personnel and payment engineers.

## Conclusions

There were major similarities observed in creating, reviewing, and processing FNR forms between three different PEOs. The workflow diagrams shown in figures 4 through 6 show that procedural differences mainly occurred in the FNR review stage. This is primarily due to the PEOs having more office staff available to accommodate additional reviews of the FNR form. Another reason for having procedural differences can be due to the lack of review procedures provided in section 10-3.12 of the Construction Manual. Section 10-3.12 describes the content requirements for the FNR form but does not provide prescriptive directions on how to review and accept the forms. Other conclusions include:

- **Not all verification information is directly incorporated into the FNR forms.** Form reviewers can document their review process using the InfoPath *properties* function. Reviewers can record their initials and date of review in the *properties* function as shown previously in figure 13. This review verification information is not directly recorded on the FNR form.
- **The FNR forms available on the WSDOT Forms website were not the same forms used by the three PEOs.** All three PEOs use a newer revision of the FNR InfoPath forms. The second page of the FNR intended for sketches or area calculations were often omitted and substituted with external supporting documents such as customized spreadsheets and annotated plan drawings. PEOs have the ability to reformat the forms using InfoPath tools.

## Recommendations

The following recommendations provide some opportunities for process improvements:

- **Automate pieces of information that have already been collected through Contract documents and inspection documents on the FNR form.** There are several fields in the header section of the FNR form that can be automatically populated. Figure 16 shows fields that can be populated automatically from existing references such as the Contract Documents and Daily Construction Reports. The field highlighted in blue represents information that can be retrieved and populated from Contract documents. The field highlighted in green represent information that can be retrieved from Daily Construction Reports. The fields highlighted in orange can be populated through a secure, login feature to access the form. Once logged in, the user can specify where they would like to depict their concurrence entry (initial and date).

Field Note Record					
Contract Number	Station / Line / Mile Post	SR No.			
011607	MD5SIS 3506+54 to MD5SIS 3514+52	0			
Staked by	Date	Contract Item Work Started Date	All Contract Item Work Completed?		
WSDOT	01/17/2014	02/4/2014	Yes <input type="checkbox"/>	No <input type="checkbox"/>	(Partial Payment)
Calculated by	Date	Checked by (Formulas & Calcs)	Date	Inspector	Date
John Doe	01/15/2014	Jane Doe	10/17/2014	John Doe	01/15/2014
Installed the following timber poles and posts per ITS plans:					
FB-03 MD5SIS 3514+52 (114 LT) WTNX-03 MD5SIS 3508+00 (75 LT) RN-02 MD5SIS 3508+00 (75 LT) WTNX-10 MD5SIS 3507+92 (110 LT) WTNX-09 MD5SIS 3505+54 (108 LT)					
Poles installed for Ramp Metering is 5% of Lump Sum Breakdown (see attached) \$153,811.58					
5% of \$153,811.58 = \$7,690.58      Pay \$7,690.58					
Materials approved QPL 059 for timber Poles from Conrad Wood Preserving.					
FAR-0042					
LD - 10/18/14 RN - 10/20/14 PAC - 10/20/2014					
Item Num	Material Brand Name, Model or Type	Manufacturer	RAMS/QPL Ref. No.	Method of Accept. / Accept. Code	Accept Action Complete?
					<input type="checkbox"/> Yes <input type="checkbox"/> No
Item Num	Item Description	Grp	Date Work Complete	Unit	Quantity
C267	ITS	01	10/5/2014	L.S.	7,690.58
				Ledger Entry No.	Posted By Init. Date
				00390	SMW 10/20/14
				Checked By Init. Date	Est. No.
				0	10/20/14 003
Attachments					
 Lump Sum Breakdown.pdf Adobe Acrobat Document 102 KB					
DOT Form IP422-435 EF Revised 01/2011					

Figure 16. Highlighted areas represent fields that can be automatically populated through existing references.

- Consider intelligent, integrated form capabilities other than InfoPath as it will be discontinued by Microsoft. More information on InfoPath support is shown in Appendix A of this report.
- Include all review concurrence information directly on the FNR form. Some reviewers were including their initials and date in the InfoPath *properties* feature to accept the document as shown previously in figure 13. It is encouraged to include all review and acceptance concurrence (initial and date) on the FNR form itself to reflect the true review workflow. The current static form is inflexible and only provides two fields for the reviewers to document concurrence. A dynamic form removes this limitation and allows the form to dynamically show the actual workflow process so review and acceptance concurrence from every personnel are shown.
- Enhance form security to improve document integrity. In the current SharePoint system, users with access to the FNR form can modify the contents on the form. If the user prints the document after making the changes and does not save the form, there will be two different versions of the FNR form. To prevent issues such as the one described above, every edit made to the FNR should automatically track the modifications made, the identity of the user making the changes, and the time and date of the modifications.

## Appendix A

Information on Microsoft's decision to discontinue InfoPath:

<http://www.formotus.com/17893/blog-infopath/infopath-news-year-review-look-forward>

4/5/2016

InfoPath News: Year in Review and Look Forward

InfoPath News: Year in Review and Look Forward



InfoPath's retirement was announced a year ago and discussed by Microsoft back in March, but what's new since then, and what's next? *This was originally published by Glen Furnas on his [SharePoint Community blog](#).*

Updated February 6, 2015, with new info from Microsoft about FoSL and IPFS.

It's been about a year now since Microsoft announced its retirement plan for InfoPath. The retirement was somewhat expected yet still it was surprising that a product with such an enormous enterprise installed base would simply be discontinued without a clear roadmap to the future for companies that depend on it.

The January announcement promised further information would be presented at the SharePoint Conference in March. An overflow crowd showed up at that [SPC348](#) session to learn what Microsoft's plan would be for replacing InfoPath forms technology. The first thing the audience learned was – almost in so many words – that no new InfoPath replacement would be presented. Instead what was shown was a grab-bag of potential alternatives, both internal and 3rd-party.

## Streamlined technical product roadmap

FORM TYPES	USER SCENARIOS		TIMEFRAME	
Excel Surveys	Design Excel Online—Excel Surveys	Completion Web	Online Continuously shipping	On-premises Included with Office 2013
List Forms	Design ‘FoSL’—Forms on SharePoint Lists	Completion SharePoint	Online Summer 2014–October 2015	On-premises SharePoint vNext
Structured Documents	Word		Plans at the end of 2014	
App Forms	Design Access	Completion SharePoint	Online Continuously shipping	On-premises Included with Office 2013

Microsoft Slide from SPC 2014

The Microsoft presentation at the SharePoint conference has been much re-hashed so I don't need to repeat that exercise here. Instead I want to address some questions about what has (or hasn't) happened since last March.

Has FoSL been released?

No, or perhaps not anymore. Forms on SharePoint Lists (FoSL) is a new SharePoint feature for editing lists using built-in forms as a partial replacement for InfoPath browser forms.

### February Update: FoSL has been cancelled

Just the second cancelled feature to be listed on the [Office 365 Roadmap](#):



### Forms on SharePoint Lists

The ability to create custom SharePoint Listforms is an important scenario. We are refining our plans in this space as part of a more comprehensive set of forms investments. We will update the roadmap when we have more information to share.

Any news about Word and structured form documents?

Nothing I can find. Of the four Microsoft technologies called out in March (FoSL, Access, Excel and

Word) the notion that Word might replace InfoPath as a structured document editor was the least developed. Basically Microsoft had nothing to tell us about it except to expect a plan by the end of 2014. To date I've seen no hint of progress being made on Word or anything else to replace InfoPath for structured documents. Has anyone else?

How long will InfoPath really be supported?

Some act like InfoPath is already dead and buried – there was even a mock funeral at the SharePoint Conference. That's clearly not the case, despite the eagerness of some to exaggerate the urgency of moving to an alternative. But the blanket statement that InfoPath will be fully supported until 2023 is also a little misleading, because there are some nuances around browser forms and product availability to consider.

### InfoPath vs Forms Services

While InfoPath is supported until 2023 there is no such policy in place for Forms Services, the SharePoint feature that enables InfoPath forms to be rendered in a browser. Therefore the question is pertinent as to how long InfoPath browser forms will be supported on SharePoint.

The prognosis is different for SharePoint Online and on premises. On-prem SharePoint should support InfoPath browser forms for as long as the environment is not upgraded beyond SharePoint 2013. Given typical migration patterns, this could leave several more years of browser form support in many enterprises.

SharePoint Online, on the other hand, will lose Forms Services immediately with the next on-prem release of SharePoint, as we learned in June. We've been told to expect a one-year notice before that happens.

**February Update:** The original Microsoft blog post has been updated with an Editors Note, reading in part:

Specifically, InfoPath Forms Services will be included in the next on-premises release of SharePoint Server 2016, as well as being fully supported in Office 365 until further notice. – *Office Blog Editor's Note*

This raises an important question: How can InfoPath Forms Services be "fully supported" in Office 365" when Office will no longer include InfoPath?

How available will InfoPath be in the future?

It's one thing to say InfoPath is supported, and another thing to say how it can be obtained. I see an ongoing trend to make InfoPath generally less available over time. Actually, the fact that InfoPath Filler was never made available separately from Designer meant that Microsoft never embraced a wide-adoption model a la Acrobat Reader. But I digress.

One major step (backward) taken in the InfoPath 2013 release was to make InfoPath unavailable separately from a high end Office suite. There simply was no longer any InfoPath box to buy. And for a period of time the only way to obtain InfoPath from Microsoft was through volume license agreements for high-end Office.

With the appearance of Office 365 InfoPath once again became available for easy purchase, now by subscription to a plan as inexpensive as Midsize Business. But [in July we learned](#) the Midsize Business subscription is being phased out and replaced by plans without InfoPath. Soon only Enterprise E3 level subscriptions will include InfoPath, and then surely only until the next version of Office is released.

It was interesting and telling to me that in December Microsoft released a [hotfix to InfoPath 2013](#). The fix was to make it possible for old InfoPath 2013 to run alongside newer versions of Office. That's a good move toward supporting InfoPath for companies that continue to rely on it, but it raises an important question: How will one be able to acquire InfoPath 2013 in the future?

Dear Microsoft, why not make InfoPath free?

The next version of Office promises to bring a crisis to the availability of InfoPath. If it's no longer available with Office ProPlus or Office 365 E3, then it won't be available for purchase at all. Nor will there be boxes of old InfoPath 2013 to buy from 3rd parties, because those boxes don't exist.

Yet companies that continue to rely on InfoPath forms will still need to provision their employees with InfoPath.

So why not make it available for free? No revenue will be lost because it's not for sale anymore. Making it available as a legacy download will help fulfill the promise of support until 2023. It will be a tremendous boon for enterprises navigating the long migration away from InfoPath not to have to worry about how to provision employees still needing to use the product. And there are precedents for discontinued Microsoft products going free – Money, Flight Simulator, and probably more.

So what do you say, Microsoft, is the next big news about InfoPath that it will be free?

*Word cloud image courtesy of Nviron*

# Force Account Workflow Investigation

## Executive Summary

This report summarizes the research done by Pavia Systems, Inc. for the Washington State Department of Transportation (WSDOT) investigating how WSDOT project engineering offices process force account (FA) work. The FA workflow processes were observed for two WSDOT project engineering offices (PEO).

This study determined that the FA workflow process can be broken down into the following three parts: drafting, reviewing, and processing the *Daily Report of Force Account Worked* form. The drafting processes, where a project inspector typically obtains and completes a physical paper version of the *Daily Report of Force Account Worked* form, were found to be similar across all PEOs involved in this study. All inspectors manually completed the header and *Time Worked Record* section of the form in a similar manner as they contain fields asking for specific project and FA bid item data. The *Time Worked Record* section documents the time spent on the following three key force account items: labor, equipment, and materials & services. The form is reviewed and signed off by the inspector and the Contractor's representative to document concurrence.

There were some procedural differences in the review process of the *Daily Report of Force Account Worked* form. The PEOs involved in this study used different methods to track the number of *Daily Report of Force Account Worked* forms submitted and processed for payment as well as to track material and service invoices submitted by the Contractor. For example, one PEO creates and maintains a PEO specific FA invoice tracking database while the other PEO creates and maintains a PEO specific spreadsheet to track FA invoices. After updating the PEO specific spreadsheets and databases, office personnel in charge of processing payment use the FA Application, using MS Access, to create another version of the *Daily Report of Force Account Worked* form that includes pay rate information and all applicable types of payment markups. The markups are included to cover overhead, profits and other costs incurred by the Contractor to perform the FA work.

The procedures involved in processing the *Daily Report of Force Account Worked* form were similar for all interviewed PEOs. The information from the *Daily Report of Force Account Worked* form created from the FA application is entered into the Contract Administration and Payment System (CAPS) by office personnel in charge of processing payment. Payment ledger information from CAPS is transposed back onto the *Daily Report of Force Account Worked* form generated from the FA application and the form is reviewed and accepted by another individual. Once accepted, the form is stored in a physical or electronic filing system.

Conclusions from this study include the following:

- **The FA worksheet available on the WSDOT Forms website is being used.**
- **Two *Daily Report of Force Account Worked* forms are created for every FA item.**
- **PEOs involved in this study maintain databases and spreadsheets separate from the FA database application** to track all incoming and paid FA items as the FA Database Application can only accept a unique pay rate for every labor and equipment classification. When pay rates are modified, all previous reimbursement calculations in the system are modified using the new pay rate. To keep a historic record of the FA worksheets, these separate databases and spreadsheets are used.

The following recommendations provide some opportunities for process improvements:

- Reduce the amount of FA worksheets generated to just one form for every FA item.
- Allow the FA Database Application (or any method used to calculate total dollar amounts) to accept multiple labor and equipment pay rates to preserve the integrity of previously accepted FA worksheets.
- Provide drop down menu options for labor and equipment classifications to field inspectors so the classifications shown on the FA worksheet match the classifications shown on the *Project Labor List* and on the Rental Rate Blue Book from the AGC/WSDOT Equipment Rental Agreement.

## Introduction

This report summarizes the research done by Pavia Systems, Inc. for the Washington State Department of Transportation (WSDOT) on investigating how WSDOT project engineering offices (PEO) process force account (FA) work. The FA workflow process were observed for two WSDOT project engineering offices. Using the findings discovered through this investigation, this study identifies opportunities to improve the current FA workflow processes.

## Data

The information presented in this report reflects the workflow processes used by two WSDOT PEO offices. These PEOs include:

- SR-520 West Approach Bridge North (WABN) PEO [Jody Alseth and Zach Archer – Business Manager Reference] – Org. 587180
- Fife PEO [Dale Latham – Assistant Office Engineer] – Org. 434305

Office engineers and business managers from the PEOs listed above participated in face-to-face conversational interviews to describe how their PEO creates, reviews, and processes FA worksheets. The information obtained from the conversations and observations were used to create workflow process diagrams to summarize the personnel involved in the FA process and their respective tasks.

## Background

Section 1-09.6 in the 2014 WSDOT Standard Specifications (M 41-10) states the measurement and payment requirements to reimburse the Contractor for all costs associated with force account work. The specification states the requirements to process the following FA items for payment:

- **Labor** – Reimbursement calculations based on “Project Labor List” prepared and submitted by the Contractor & Subcontractors. If list is not submitted, WSDOT Engineer will develop one using the best data available. Agency will pay 29% of the sum of the labor reimbursement costs to cover Contractor overhead and profit.
- **Materials & Services** – Reimbursements are based on Contractor submitted copies of vendor invoices. If invoices are not available, Contractor is to certify the cost of the materials by affidavit. Agency will pay 21% of the sum of the material reimbursement costs to cover Contractor overhead and profit.
- **Equipment** – Reimbursement for usage of Contractor-owned equipment is determined by using the equipment rental rate listed in the Rental Rate Blue Book from the AGC/WSDOT Equipment Rental Agreement. Agency will pay 21% of the sum of the equipment reimbursement costs to cover Contractor overhead and profit.
- **Contractor Markup on Subcontractor’s Work** – Reimbursement calculations for the Prime Contractor Markup based on the work performed by Subcontractor(s). Figure 1 shows the Prime Contractor markup breakdown. “The markup is a graduated step down rate, which gets smaller for each force account item as the amount of work increases.”

d. The firm appears to be responsible for liability arising from the Work.

Markups on Work Performed by Subcontractor(s):

(1) On amounts paid for Work performed by each Subcontractor on each force account and calculated through <b>Subsections 1-4,</b>	up to \$25,000	12 percent
(2) On amounts greater than	\$25,000 up to \$100,000	10 percent
(3) On amounts greater than	\$100,000	7 percent

The amounts and markup rates shall be calculated separately for each Subcontractor on each force account item established.

Figure 17. Prime Contractor markup breakdown as shown in Section 1-09.6 in the WSDOT Standard Specifications

Section SS1-09.6 of the WSDOT Construction Manual (January 2016 M 41-01.24) states that the *Daily Report of Force Account Worked* (DOT Form 422-008) should be used to keep accurate daily time records of all force account work.

The general requirements of process force account work are provided in Section SS 1-09.6 of the Construction Manual. The construction manual states that the *Daily Report of Force Account Worked* (DOT Form 422-008) should be used to keep accurate daily time records of all force account work. The following figure shows a template of the Daily Report of Force Account Worked form available from the WSDOT Forms website.

Daily Report of Force Account Worked					
Contract Number	Date	Item Number	Item Name		
Prime Contractor		Subcontractor / Lower Tier Subcontractor			
Line / Station	Group	Basis of Material Acceptance	RAM Number		
Description of Work Performed					
Time Worked Record					
Workers and/or Equipment Working	Occupation of Workers or Equipment Size	Hours Worked	Reg. Rate	O.T. Rate	Amount
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
Calculated By	Date	Checked By	Date	Total	
Ledger Entry Number	Entered By	Date	Entry Verified	Date	
Inspector's Signature	Contractor's Representative Signature		Title		
DOT Form 422-008 EF Revised 04/2012					

Figure 18. Daily Report of Force Account Worked template available on the WSDOT Forms website

## FA Workflow Process

The FA workflow process discovered from the interviews are shown below

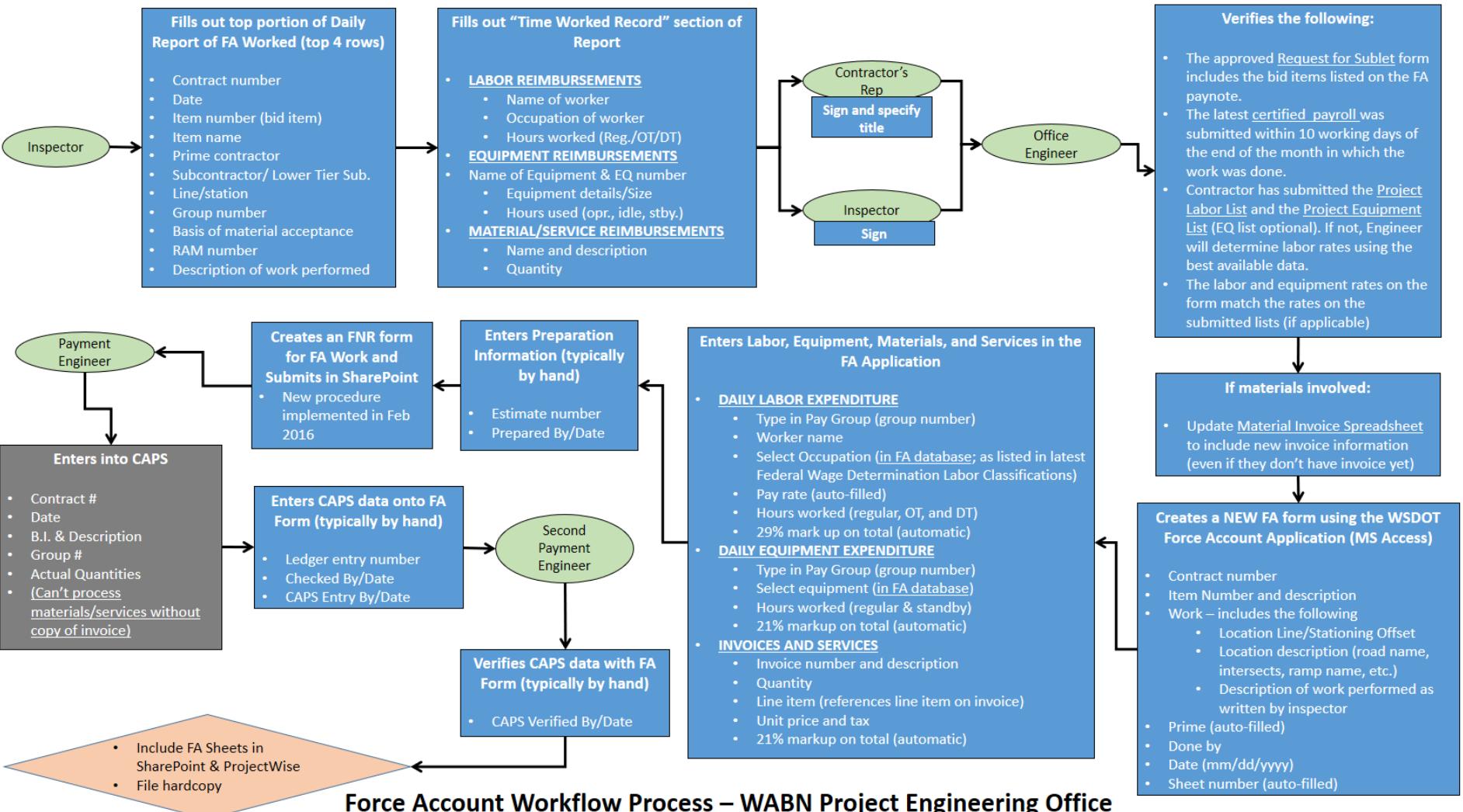


Figure 19. WABN Project Engineering Office force account workflow process

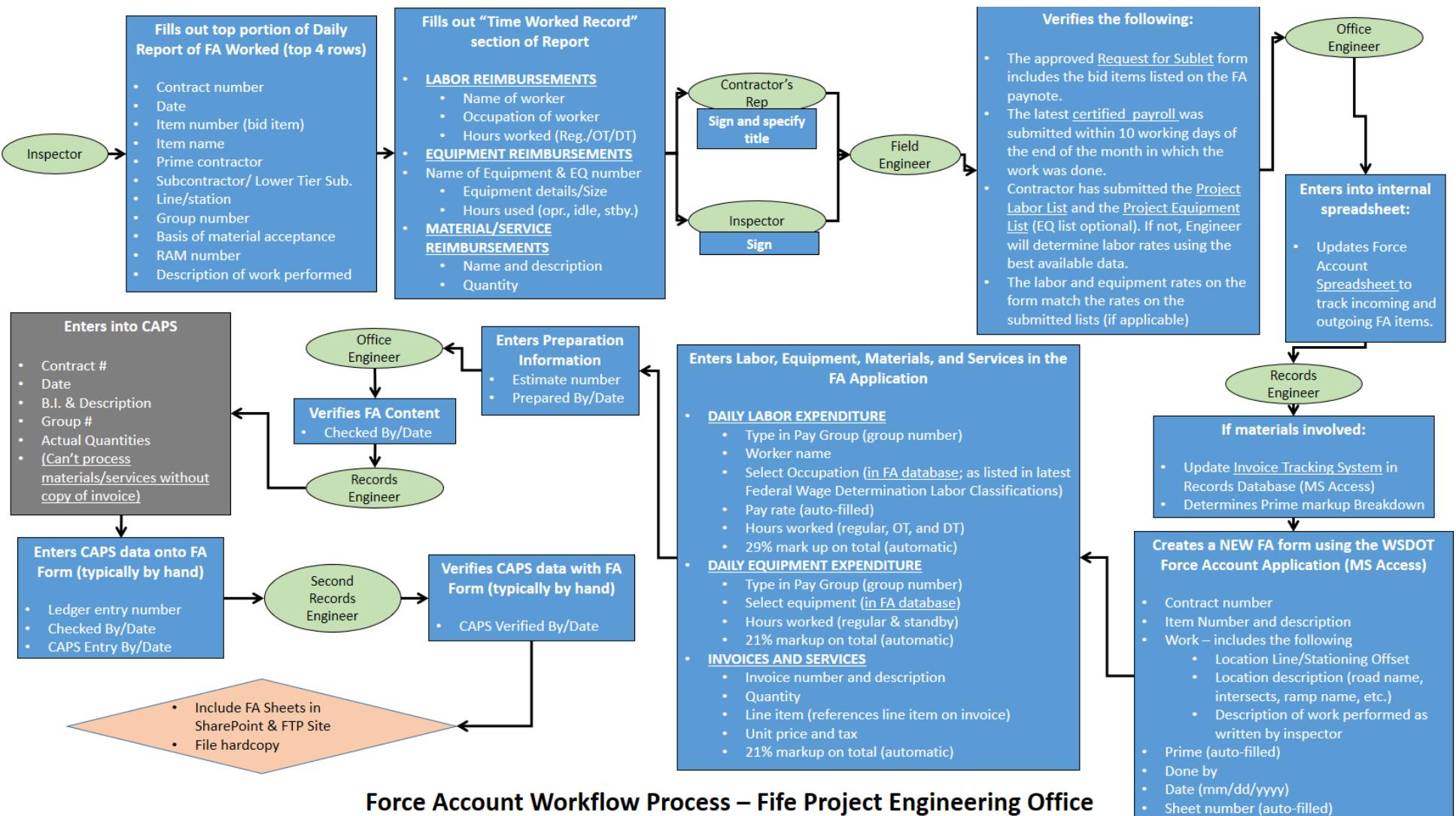


Figure 20. Fife Project Engineering Office force account workflow process

The following section breaks apart the FA process into three parts: drafting, reviewing, and processing the FA worksheet.

### Drafting the FA Form

Field inspectors at both PEOs use the same procedures to draft their Daily Report of Force Account Work form for review. The general process starts with the inspector obtaining a FA form template (DOT Form 422-008) electronically or in physical form. The inspector fills out the header portion of the FA form, or the first 4 rows (area shown in red in figure 5). The header contains specific project-related information such as contract number, the location and date of when the work was performed, the item worked on and the Contractor or Subcontractor that performed the work. If materials are involved, the approved RAM number and its basis for acceptance is entered.

Washington State Department of Transportation				Daily Report of Force Account Worked					
Contract Number 008607	Date 1/20/2016	Item Number 331	Item Name TESC Water Management						
Prime Contractor ABC Contractors		Subcontractor / Lower Tier Subcontractor XYZ Construction							
Line / Station 15SB 523+18.8 (83.0 Lt)	Group 1	Basis of Material Acceptance N/A			RAM Number N/A				
Description of Work Performed Removal of TESC drainage structure EC23-5 and connection of existing 12" RCSSP from DR03-019 to DR03-004 for TESC Water Management.									
Time Worked Record									
Workers and/or Equipment Working		Occupation of Workers or Equipment Size		Hours Worked	Reg. Rate	O.T. Rate	Amount		
1	LABOR								
2	John Doe	Operator Foreman		6.0			12/20/16		
3	Jane Doe	Operator - Excavator 15 to 30 MT		6.0			12/20/16		
4	John Johnson	Laborer-General		6.0			12/20/16		
5									
6									
7	EQUIPMENT								
8	#H-124, 2010 Komatsu PC270LC	Excavator, Diesel, 30.1 ton, 187.0 H.P.		6.0			12/20/16		

Figure 21. The header portion (shown in red) filled out by the inspector

The inspector then completes the *Time Worked Record* portion of the form. The *Time Worked Record* section is broken down into the following three parts:

- **Labor** – Tracks the name of each labor personnel, their occupation and the work-hours associated with the FA work.
- **Equipment** – Tracks the name of equipment, the description of the equipment and the work-hours associated with the FA work.
- **Materials & Services** – Tracks the name of the material or service used, description of the material or service and the quantity used.

It should be noted that pay rates or invoice value of the labor performed, equipment used or the material/service used is not included in this field generated FA worksheet. The payment component for these items will be determined in the office in the subsequent steps. If there are material or service items on the FA worksheet, the inspector must obtain the corresponding invoices from the Contractor

and include them as attachments. The field generated FA worksheet can be reviewed by the office without the invoice. However, reimbursement for materials or services related to the FA work cannot be processed without the invoice (the item becomes deferred until the Contractor submits the invoice). Figure 6 shows an example of a completed *Time Worked Record* section as well as the invoice attached for the material used.

Daily Report of Force Account Worked					
Contract Number 008607	Date 1/20/2016	Item Number 331	Item Name TESC Water Management		
Prime Contractor ABC Contractors	Subcontractor / Lower Tier Subcontractor XYZ Construction				
Line / Station ISSB 523+18.8 (83.0 Lt.)	Group 1	Basis of Material Acceptance N/A	RAM Number N/A		
Description of Work Performed Removal of TESC drainage structure EC23-5 and connection of existing 12" RCSSP from DRB1-019 to DRB1-004 for TESC Water Management.					
<b>Time Worked Record</b>					
Workers and/or Equipment Working	Occupation of Workers or Equipment Size	Hours Worked	Reg. Rate	O.T. Rate	Amount
<b>1 LABOR</b>					
2 John Doe	Operator Foreman	~6.0			
3 Jane Doe	Operator - Excavator 15 to 30 MT	~6.0			
4 John Johnson	Laborer-General	~6.0			
5					
6					
<b>7 EQUIPMENT</b>					
8 #H-124, 2010 Komatsu PC270LC	Excavator, Diesel, 30.1 ton, 187.0 H.P.	~6.0			
9					
10 #FB-55, 2008 On-Highway Flatbed	Truck, Diesel, 4x2, H.P. 200.0	~6.0			
11					
12					
13					
<b>14 MATERIAL</b>	<b>PAY BY INVOICE</b>				
15 (2) Bags Each of Fast Patch	concrete grout				
16 Basaltic Concrete Products,	DuPont, WA -				
17 Per approved RAM-0042					
18					
19					
20					
Calculated By	Date	Checked By	Date	Total	
Ledger Entry Number	Entered By	Date	Entry Verified	Date	
Inspector's Signature John Washington	Contractor's Representative Signature John Doe	Title Forsman			
DOV Form 422-008 EF Revised 04/2012					

1/27/2016 Spectrum Document Imaging

INVOICE <b>CADMAN</b> HEIDELBERG - EASTON CLOUD	Agent for: Cedman (Rock), Inc. #2 - High Rock Quarry #3 - Rock Quarry (Aggregate) #4 - Dry River (Aggregate)	Customer Locations: #1 - Redmond (Aggregate) #2 - Issaquah (Aggregate) #3 - Monroe (Aggregate) #4 - Mt. Creek (Concrete) #5 - Issaquah Paint (Concrete) #6 - Monroe Paint (Concrete) #7 - Monroe (Concrete) #8 - Bellevue Paint (Concrete) #9 - Building Materials	REMITTANCE ADDRESS																								
X2Y Construction Inc. PO BOX 198 MUL蒂ED, WA 98275	DATE 01/20/2016	INVOICE NUMBER 30499507	PAGE 1																								
	CUSTOMER NO. 789320	RECEIPT # 30499507																									
Receipt Comments: JOB 848 PACIFIC AVE																											
<table border="1"> <thead> <tr> <th>DATE</th> <th>QUANTITY</th> <th>PRODUCT CODE</th> <th>PRODUCT DESCRIPTION</th> <th>UNIT PRICE</th> <th>EXTENSION</th> </tr> </thead> <tbody> <tr> <td>01/15/2016</td> <td>72.00</td> <td>BRICK 2X4X8</td> <td>2X4X8 BRICK (750 PALLET)</td> <td>\$3.30**</td> <td>\$244.80</td> </tr> <tr> <td>01/15/2016</td> <td>56.00</td> <td>FAST PATCH</td> <td>FAST PATCH 5LB/BBL 50PALLET</td> <td>\$19.20**</td> <td>\$1,117.20</td> </tr> <tr> <td>01/15/2016</td> <td>3.00</td> <td>FLATBED DELIVERY</td> <td>FLATBED DELIVERY 100+1 HOUR</td> <td>\$0.00*</td> <td>\$0.00</td> </tr> </tbody> </table> <p>* Discounted Price</p>				DATE	QUANTITY	PRODUCT CODE	PRODUCT DESCRIPTION	UNIT PRICE	EXTENSION	01/15/2016	72.00	BRICK 2X4X8	2X4X8 BRICK (750 PALLET)	\$3.30**	\$244.80	01/15/2016	56.00	FAST PATCH	FAST PATCH 5LB/BBL 50PALLET	\$19.20**	\$1,117.20	01/15/2016	3.00	FLATBED DELIVERY	FLATBED DELIVERY 100+1 HOUR	\$0.00*	\$0.00
DATE	QUANTITY	PRODUCT CODE	PRODUCT DESCRIPTION	UNIT PRICE	EXTENSION																						
01/15/2016	72.00	BRICK 2X4X8	2X4X8 BRICK (750 PALLET)	\$3.30**	\$244.80																						
01/15/2016	56.00	FAST PATCH	FAST PATCH 5LB/BBL 50PALLET	\$19.20**	\$1,117.20																						
01/15/2016	3.00	FLATBED DELIVERY	FLATBED DELIVERY 100+1 HOUR	\$0.00*	\$0.00																						
<p>TERMS: A FINANCE CHARGE OF 1% PER ANNUM CHARGED ON ALL PAST DUE ACCOUNTS.</p> <table border="1"> <tr> <td>Tax</td> <td>\$0.00</td> </tr> <tr> <td>Invoice Total</td> <td>\$1,362.00</td> </tr> <tr> <td></td> <td>\$0.00</td> </tr> <tr> <td>Total Due</td> <td>\$1,362.00</td> </tr> </table>				Tax	\$0.00	Invoice Total	\$1,362.00		\$0.00	Total Due	\$1,362.00																
Tax	\$0.00																										
Invoice Total	\$1,362.00																										
	\$0.00																										
Total Due	\$1,362.00																										

Figure 22. The Time Worked Record section (shown in green) filled out by the inspector and the invoice attachment

As a final step in drafting the FA worksheet, the inspector and the Contractor's representative both sign and date the form to affirm the information on the form. Figure 7 shows the portion of the form where both parties sign for concurrence. The two rows above the signature section are generally not filled out on the field generated FA worksheet.

18				
19				
20				
Calculated By	Date	Checked By	Date	Total
Ledger Entry Number	Entered By	Date	Entry Verified	Date
Inspector's Signature John Washington	Contractor's Representative Signature John Doe	Title Forsman		
DOV Form 422-008 EF Revised 04/2012				

Figure 23. The signature section (shown in blue) completed by the inspector and the Contractor's representative

### Reviewing the FA Form

There were some procedural differences in the review process of the FA forms between the two PEOs. There may be multiple databases and spreadsheets shared on a local drive that need to be updated with the submission of each field generated FA worksheet. For example, the WABN PEO separately tracks every item that requires submission of invoices in a spreadsheet that resides in their shared local drive.

Similarly, the Fife PEO tracks all FA items on a separate spreadsheet to ensure that all incoming FA items submitted from the Contractor is processed and paid. The Fife PEO also tracks every item that requires submission of invoices in a *Records Database* (MS Access database). This database is used to track whether invoices have been submitted and calculates all FA items worked to date for every Subcontractor. The Subcontractor worked FA items are tracked in the *Records database* as the total dollar amount they worked determines the Prime Contractor markup percentage (as mentioned in the background section of this report). The section below describes the general review process of the field generated FA worksheet.

After the inspector completes the FA worksheet, the form is then peer reviewed by an office or payment engineer. The reviewer thoroughly checks the information in the header as well as any information shown in the *Time Worked Record* section. The reviewer also verifies the following:

- The approved *Request for Sublet* form includes the bid items listed on the FA worksheet.
- The latest *Certified Payroll* has been submitted within ten working days of the end of the month in which the FA work was done.
- Contractor has submitted an up-to-date *Project Labor List*. The Contractor can voluntarily submit a similar list for the equipment they own. If either lists are not available, the WSDOT Engineer of Record will determine the pay rates using the best data available.
- The labor and equipment rates on the FA worksheet match the rates on the approved labor and equipment list.

After verifying the information on the FA worksheet, any internal databases or spreadsheets used by the PEO are updated. These spreadsheets and databases typically track FA items received and processed to date as well as if a required invoice has been submitted. PEOs track these items separately from the FA database application because the FA database includes historic labor and equipment rates. When the pay rates are modified, the database updates all previous payments using the modified rate (consequently making previous FA worksheets inaccurate). For this reason, the FA application is mainly used to generate an office version of the *Daily Report of Force Account Worked* form (the WABN PEO creates a Field Note Record (FNR) document for the FA items shown in the FA worksheet to keep track of the total reimbursement values incurred over the course of the project). The office generated FA worksheet uses the hours and quantities recorded by the inspector and the pay rates in the FA database to determine the total reimbursement cost for the FA items.

In general, office engineers or the records engineers are responsible for creating the office generated FA worksheet. The information shown in the header portion of the field generated FA worksheet is copied into the FA application. An example of an office generated FA worksheet with a completed header section is shown in figure 8.

Daily Report of Force Account Worked													
Contract: 008607 - I-5, M ST TO PORTLAND AVE - HOV						Prime: ABC Contractors							
Item No: 0331 - FORCE ACCOUNT TESC WATER MANAGEMENT						Done By: XYZ Construction							
Work: I5 SB 523+18.8 (83 LT) Removing existing EC23-005 and connection to DR03-019.						Date:	January 20, 2016		Sheet:		1		
<b>Labor Worked:</b>													
Worker Name	Occupation	Pay Group	Rates			Hours			Total				
John Doe	Equip. Operator - Grp 2	1	62.58	83.89	105.20	6	0	0	\$375.48				
Jane Doe	Operator Foreman	1	64.28	86.44	108.60	6	0	0	\$385.68				
John Johnson	General Laborer	1	49.85	68.27	86.69	6	0	0	\$299.10				
											<b>Subtotal</b>	\$1,060.26	
											<b>Overhead / Profit</b>	29%	\$307.48
											<b>Labor Total</b>	\$1,367.74	
<b>Equipment Worked:</b>													
Equip#	Type	Manufacturer	Model	Year	Capacity	Group	Reg Rate	Standby Rate	Reg Hours	Standby Hours	Total		
FB-55	On-Highway FB Truck	Ford	F-450	2008	20,000 GV	1	23.89	3.67	6	0	\$143.34		
H124	Excavator	Komatsu	PC270LC-8	2010	1.85 CY	1	113.08	27.19	6	0	\$678.48		
											<b>Subtotal</b>	\$821.82	
											<b>Overhead / Profit</b>	21%	\$172.58
											<b>Equipment Total</b>	\$994.40	
											<b>Grand Sub Total</b>	\$2,362.14	
											<b>Prime Markup*</b>	\$165.35	
											<b>Grand Total</b>	\$2,527.49	

Figure 24. The header portion (shown in red) of the office generated FA worksheet

The *Time Worked Record* section from the field generated FA worksheet is then used to complete the *Labor Worked*, *Equipment Worked* and *Invoiced Items* section in the FA application. Figure 9 shows an example of the *Labor Worked*, *Equipment Worked* and *Invoiced Items* section.

Daily Report of Force Account Worked													
Contract: 008607 - I-5, M ST TO PORTLAND AVE - HOV						Prime: ABC Contractors							
Item No: 0331 - FORCE ACCOUNT TESC WATER MANAGEMENT						Done By: XYZ Construction							
Work: I5 SB 523+18.8 (83 LT) Removing existing EC23-005 and connection to DR03-019.						Date:	January 20, 2016		Sheet:		1		
<b>Labor Worked:</b>													
Worker Name	Occupation	Pay Group	Rates			Hours			Total				
John Doe	Equip. Operator - Grp 2	1	62.58	83.89	105.20	6	0	0	\$375.48				
Jane Doe	Operator Foreman	1	64.28	86.44	108.60	6	0	0	\$385.68				
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											<b>Subtotal</b>	\$1,060.26	
											<b>Overhead / Profit</b>	29%	\$307.48
											<b>Labor Total</b>	\$1,367.74	
<b>Equipment Worked:</b>													
Equip#	Type	Manufacturer	Model	Year	Capacity	Group	Reg Rate	Standby Rate	Reg Hours	Standby Hours	Total		
FB-55	On-Highway FB Truck	Ford	F-450	2008	20,000 GV	1	23.89	3.67	6	0	\$143.34		
H124	Excavator	Komatsu	PC270LC-8	2010	1.85 CY	1	113.08	27.19	6	0	\$678.48		
											<b>Subtotal</b>	\$821.82	
											<b>Overhead / Profit</b>	21%	\$172.58
											<b>Equipment Total</b>	\$994.40	
											<b>Grand Sub Total</b>	\$2,362.14	
											<b>Prime Markup*</b>	\$165.35	
											<b>Grand Total</b>	\$2,527.49	

\* Prime Markup Breakdown 12%: 0.00 10%: 0.00 7%: 2362.14

Item No:	0331 - FORCE ACCOUNT TESC WATER MANAGEMENT	Done By:	XYZ Construction																																																																																								
Work:	I5 SB 523+18.8 (83 LT) Removing existing EC23-005 and connection to DR03-019.	Date:	January 20, 2016																																																																																								
Sheet: 2																																																																																											
<b>Invoiced Items:</b>																																																																																											
<table border="1"> <thead> <tr> <th>Invoice No</th> <th>Line Item</th> <th>Description</th> <th>Group</th> <th>Tax</th> <th>Quantity</th> <th>Price</th> <th>Total</th> </tr> </thead> <tbody> <tr> <td>30496637</td> <td>1</td> <td>Fast Pitch Concrete Grout</td> <td>1</td> <td>9.50%</td> <td>2</td> <td>\$19.95</td> <td>\$43.69</td> </tr> <tr> <td colspan="4"></td><td colspan="2"><b>Subtotal</b></td><td></td><td>\$43.69</td></tr> <tr> <td colspan="4"></td><td colspan="2">Overhead / Profit</td><td>21%</td><td>\$9.18</td></tr> <tr> <td colspan="4"></td><td colspan="2"><b>Invoice Total</b></td><td></td><td>\$52.87</td></tr> <tr> <td colspan="4"></td><td colspan="2"></td><td></td><td></td></tr> <tr> <td colspan="4"></td><td colspan="2"><b>Grand Sub Total</b></td><td></td><td>\$52.87</td></tr> <tr> <td colspan="4"></td><td colspan="2">Prime Markup*</td><td></td><td>\$3.70</td></tr> <tr> <td colspan="4"></td><td colspan="2"></td><td></td><td></td></tr> <tr> <td colspan="4"></td><td colspan="2"><b>Grand Total</b></td><td></td><td>\$56.57</td></tr> <tr> <td colspan="4"></td><td colspan="2"></td><td></td><td></td></tr> </tbody> </table>				Invoice No	Line Item	Description	Group	Tax	Quantity	Price	Total	30496637	1	Fast Pitch Concrete Grout	1	9.50%	2	\$19.95	\$43.69					<b>Subtotal</b>			\$43.69					Overhead / Profit		21%	\$9.18					<b>Invoice Total</b>			\$52.87													<b>Grand Sub Total</b>			\$52.87					Prime Markup*			\$3.70													<b>Grand Total</b>			\$56.57								
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Figure 25. Example of the Labor Worked and Equipment Worked section (shown in green) created using the FA application

To complete the *Labor Worked* section, a series of fields and drop down menus are presented to the user in the FA application. Information is entered in using the following sequence:

1. Type in the Pay Group (Group Number on field generated FA worksheet).
2. Worker information is entered in.
  - a. Type in the pay group of worker.
  - b. Select occupation classification from a drop down list (information from the latest Federal Wage Determination Labor Classifications in the Contract).
  - c. Occupation and pay rate are automatically filled out by the FA application.
  - d. Type in the hours worked in terms of regular time, overtime and double time.
  - e. The total price is automatically calculated.
3. A 29% markup is automatically applied to the total dollar amount associated with the labor worked item(s) to cover project overhead, general company overhead, profit, bonding, insurance, B&O tax and any other costs incurred.

To complete the *Equipment Worked* section, a series of fields and drop down menus are presented to the user in the FA application. Information is entered in using the following sequence:

1. Type in the pay group of equipment used.
2. Equipment information is entered in.
  - a. Select equipment to be added from a drop down list (users can add new equipment and specify equipment pay rates).
  - b. The equipment number, type, manufacturer, model, year and capacity are automatically filled out by the FA application.
  - c. Type in the hours worked in terms of regular and standby hours.
  - d. Type in accepted equipment hourly rates by classification description provided in the Contract Provisions.
  - e. The total price is automatically calculated.
3. A 21% markup is automatically applied to the total dollar amount associated with the equipment item(s) used to complete FA work to cover project overhead, general company overhead, profit, bonding, insurance, B&O tax and any other costs incurred.

To complete the *Invoice Items* section, information is entered in using the following sequence:

1. Type in the pay group of the material or service.
2. Invoice information is entered in.
  - a. Type in invoice number.
  - b. Type in description of the material or service.

- c. Type in the line item number. For example, if the FA material was the fifth line item on the invoice, '5' would be entered in.
  - d. Type in tax percentage.
  - e. Type in quantity of material or service.
  - f. Type in the unit price of material or service.
  - g. The total price is automatically calculated.
3. A 21% markup is automatically applied to the total dollar amount associated with the invoice item(s) used to complete FA work to cover project overhead, general company overhead, profit, bonding, insurance, B&O tax and any other costs incurred.

When all the labor, equipment, materials and services FA items are entered into the FA application, the Prime Contractor Markup rates are entered in if one or more approved Subcontractors, lower-tier subcontractors or suppliers performed FA work. Figure 1, shown previously in the *Background* section, shows the basis on how the Prime Markup Rates are selected. This is a supplemental markup paid to the Prime Contractor to cover project overhead, general company overhead, profit, bonding, insurance, B&O tax and any other costs incurred. As shown in figure 10, the Prime Markup rate is applied to labor, equipment, materials and service items listed on the FA worksheet.

							Rate	Rate	Hours	Hours	
FB-55	On-Hiway FB Truck	Ford	F-450	2008	20,000 GV	1	23.89	3.67	6	0	\$143.34
H124	Excavator	Komatsu	PC270LC-8	2010	1.85 CY	1	113.08	27.19	6	0	\$678.48
<b>Subtotal</b>											\$821.82
<b>Overhead / Profit</b>											21% \$172.58
<b>Equipment Total</b>											\$994.40
* Prime Markup Breakdown 12%: 0.00 10%: 0.00 7%: 2362.14											
<b>Grand Sub Total</b>											\$2,362.14
<b>Prime Markup*</b>											\$165.35
<b>Grand Total</b>											\$2,527.49
Ledger #	Item						Group	Total			
07246	0331 - FORCE ACCOUNT TESC WATER MANAGEMENT						1	\$2,527.49			
Est. #	Prepared By / Date		Checked By / Date		CAPS Entry By / Date		CAPS Verified By / Date				
0246	01/26/16 SL	IND	1/27/2016	IND	1/27/2016	SL	2/9/16				

Figure 26. Prime Markup Breakdown section (shown in blue) completed in the FA application

The FA worksheet generated using the FA application is printed out and signed and dated by the engineer that prepared the worksheet. The form, along with the field generated FA worksheet and its invoice attachments, are handed off to the personnel responsible for processing the payment in WSDOT's Contract Administration and Payment System (CAPS).

### Processing the FA Items into CAPS

The procedures involved in processing the FA information into the CAPS database were similar for the two PEOs involved in this study. The personnel responsible for processing the FA information into the CAPS database follows the standards shown in Section SS 1-09.9 of the Construction Manual.

The processing personnel enters the following information from the office generated FA worksheet into the CAPS database:

- Contract number
- Date
- Bid item number and description

- Group number
- Total item quantity

Materials and service FA items cannot be processed until the Contractor submits a valid copy of the invoices. After transcribing the above five items into CAPs, the following information is added back to the FNR form:

- Ledger entry number
- Initials and date of personnel checking the office generated FA worksheet
- Initials and date of CAPS entry

The FA worksheet is then handed off to the second processing personnel who checks the form to ensure that the CAPS processing information is accurate in both the CAPS database and the FA form. The second individual fills out their initials and the date of review on the form. Figure 11 shows the section where processing personnel enter in their respective information.

H124 Excavator		Komatsu	PC270LC-8	2010	1.85 CY	1	113.08	27.19	6	0	\$678.48
Subtotal \$821.82 Overhead / Profit 21% \$172.58 Equipment Total \$994.40											
Grand Sub Total \$2,362.14 Prime Markup* \$165.35 Grand Total \$2,527.49											
Ledger #	Item				Group	Total					
07246	0331 - FORCE ACCOUNT TESC WATER MANAGEMENT				1	\$2,527.49					
Est. #	Prepared By / Date	Checked By / Date	CAPS Entry By / Date	CAPS Verified By / Date							
024	01/26/16 SL JJD	1/27/2016	JJD	1/27/2016	SL	2/3/16					

Figure 27. Signature section (shown in orange) completed by the processing personnel

The processing step is completed by the processing personnel scanning the FA worksheet package and entering them into their project drive in the SharePoint system. The copy of the package is sent to the Contractor via a shared FTP website or email. Copies of the FA package is filed physically or electronically.

## Conclusions

The workflow diagrams shown in figures 3 and 4 show that procedural differences mainly occurred in the FA review stage. PEOs have to track FA items received and processed to date as well as if a required invoice has been submitted. As noted previously, PEOs track these items separately from the FA database application because the FA database includes historic labor and equipment rates. When the pay rates are modified, the database updates all previous payments using the modified rate (consequently making previous FA worksheets inaccurate). For this reason, PEOs may decide to track FA items separately using MS Access databases or spreadsheets.

Other conclusions include:

- **The FA worksheet available on the WSDOT Forms website is being used.** Inspectors working for both PEOs involved in this study use DOT Form 422-008 (04/2012) to record FA information.
- **Two Daily Report of Force Account Worked forms are created for every FA item.** The inspector creates the field generated FA worksheet which includes labor and equipment hours and material or service quantities used for FA work and excludes any information related to pay

rates and costs. The office generated FA worksheet uses the FA Application to include pay rates and costs needed to process the FA items.

- **PEOs involved in this study maintain databases and spreadsheets separate from the FA database application** to track all incoming and paid FA items as the FA Database Application can only accept a unique pay rate for every labor and equipment classification. When pay rates are modified, all FA reimbursement calculations in the system are modified using the new pay rate. To keep a historic record of the FA worksheets, these separate databases and spreadsheets are used.

## Recommendations

There are a number of opportunities to improve the current process used to draft, review and process FA worksheets. Recommendations for process improvements include:

- **Reduce the amount of FA worksheets generated to just one form.** Currently, two separate Daily Report of Force Account Worked forms are generated for each force account items processed. It is recommended to reduce the form output to one form per force account item to enhance the accuracy of the forms and to reduce the potential of transcription errors.
- **Allow the FA Database Application (or any method used to calculate total dollar amounts) to accept multiple labor and equipment pay rates to preserve the integrity of previously accepted FA worksheets.** The current FA Database Application only accepts one unique pay rate value for each equipment and labor classification type. When a pay rate is modified, the database updates all previous payments using the modified rate (consequently making previous FA worksheets inaccurate). Allowing multiple pay rates in the current FA Database Application, or using a different type of database application system that accommodates multiple pay rates for each equipment and labor classification, can consolidate or eliminate the efforts involved in maintaining PEO specific FA spreadsheets and databases.
- **Provide drop down menu options for labor and equipment classifications to field inspectors** so the classification shown on the FA worksheet match the classifications shown on the *Project Labor List* and on the Rental Rate Blue Book from the AGC/WSDOT Equipment Rental Agreement. This can save time and effort for the individual responsible for assigning an equipment or labor pay rate to the information shown in the *Time Worked Record* section.

# Feasibility Report: Creating a Construction Terminology Dictionary for Apple iPads

## Executive Summary

This report summarizes the research done by Pavia Systems, Inc. for the Washington State Department of Transportation (WSDOT) investigating the feasibility of adding commonly used transportation and construction terminology to the keyboard setting on the Apple iPad tablet computer. Certain words and acronyms, such as shotcrete and HMA, are unique to the transportation construction industry. When words unique to the industry are typed into the tablet computer, the autocorrect function may automatically change the word to a similarly spelled word that exists in the Apple mobile operating system (iOS) keyboard dictionary. This can result in users spending additional time and effort reselecting the incorrect word and replacing it with the intended word.

This research identified two methods to address this problem. The first method involves using the *Text Replacement* feature under the general keyboard settings. The *Text Replacement* feature allows users to add a word, acronym or phrase to the existing iOS keyboard dictionary. Once these words are added to the iOS keyboard dictionary, the intended transportation construction terms will no longer be changed by the autocorrect feature. It may even suggest the intended word after providing the first few letters of the word. Based on the trials conducted by the research team, this method may take the user approximately ten minutes to add sixty words into the iOS keyboard dictionary. This method is not scalable unless all users use the same Apple iTunes account. The list of words included in the *Text Replacement* feature is saved to the user's iTunes account and users must be signed in and stay signed in to the iTunes account to keep the list of terms. If the agency policy requires all users to have their own unique iTunes account, this method would not be scalable.

The second method involves the development of a custom keyboard supported in iOS. A list of transportation construction terms can be included in the custom keyboard's dictionary. This approach is scalable and requires all users to download the custom keyboard to their devices. Once the user specifies the use of the custom keyboard in place of the iOS keyboard, the autocorrect feature will no longer change industry terms as it is incorporated to the keyboard dictionary. Unlike the *Text Replacement* method, this method is scalable and doesn't require additional configuration by the user. However, the disadvantage of this method include the inability to use the device microphone. Without access to the device microphone, users using the custom keyboard will not be able to use the *dictation* or the voice recognition feature. The *dictation* feature converts the user's speech into text, allowing users to input text without using their hands.

In conclusion, the *Text Replacement* method is a simple approach but may require each user to spend about ten minutes to enter a list of sixty words, acronyms, or phrases to the iOS keyboard dictionary. The custom dictionary method requires the expertise of software engineers and upfront development time but is scalable and relatively effortless to the users.

## Introduction

This report summarizes the research done by Pavia Systems, Inc. for the Washington State Department of Transportation (WSDOT) investigating the feasibility of adding commonly used transportation and construction terminology to the keyboard dictionary setting on the Apple iPad tablet computers. Certain words and acronyms, such as shotcrete and HMA, are unique to the transportation construction industry. When words unique to the industry are typed into the tablet computer, the autocorrect function may automatically change the word to a similarly spelled word that exists in the Apple mobile operating system (iOS) keyboard dictionary. This can result in users spending additional time and effort reselecting the incorrect word and replacing it with the intended word.

To address this issue, a list of transportation construction terms must be included in the keyboard dictionary. This report discusses the following three methods to add industry related terms to the keyboard dictionary:

- *Text Replacement* method
- Custom keyboard method

The following sections discuss the two methods in more detail.

### Text Replacement Method

The *Text Replacement* feature allows users to add words, acronyms or phrases to the existing iOS keyboard dictionary. Once these words are added to the iOS keyboard dictionary, the intended transportation construction terms will no longer be changed by the autocorrect feature. It may even suggest the intended word after typing the first few letters of the word. Users can access the *Text Replacement* feature by accessing the *Keyboards* setting which can be found under the *Settings* menu. Figure 1 illustrates the process used to access the *Text Replacement* feature.

Users can add a phrase and a shortcut using the *Text Replacement* feature. The transportation construction terminology is entered into the ‘phrase’ field. The term is saved to the iOS keyboard dictionary and becomes an acceptable word in the autocorrect feature. This process can be repeated to add a list of industry words into the iOS keyboard dictionary. Figure 2 illustrates the process of adding the acronym “CDF” to iOS keyboard dictionary.

In addition to adding words to the dictionary, the ‘shortcut’ feature in *Text Replacement* allows users to type in the short hand notation of the text entered into the ‘phrase’ field. For example, the word “controlled density fill” can be added under the *phrase* field and “CDF” can be added to the *shortcut* field. When the word CDF is typed into the keyboard, the keyboard dictionary can suggest the expanded version of the acronym, “controlled density fill”, to the user.

Based on the trials conducted by the research team, this method may take the user approximately ten minutes to add sixty words into the iOS keyboard dictionary. A table containing 60 transportation construction terms, used for the trials, have been included in *Appendix B* of this report. The *Text Replacement* method is not scalable unless all users use the same Apple iTunes account. The list of words included in the *Text Replacement* feature is saved to the user’s iTunes account and users must be signed in and stay signed in to the iTunes account to keep the list of terms. If the agency policy requires all users to have their own unique iTunes account, this method would not be scalable.

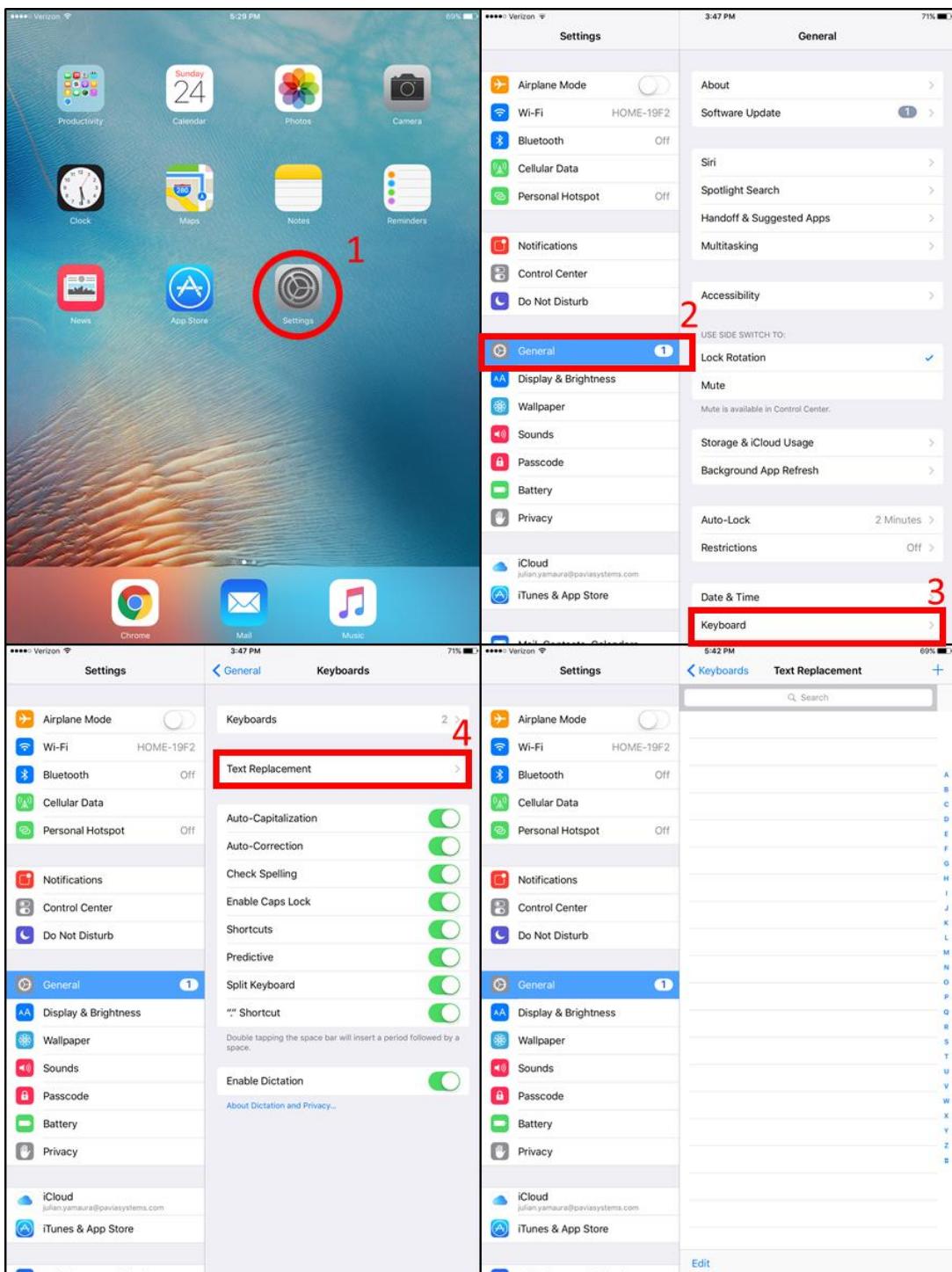


Figure 28. Process in accessing the Text Replacement feature

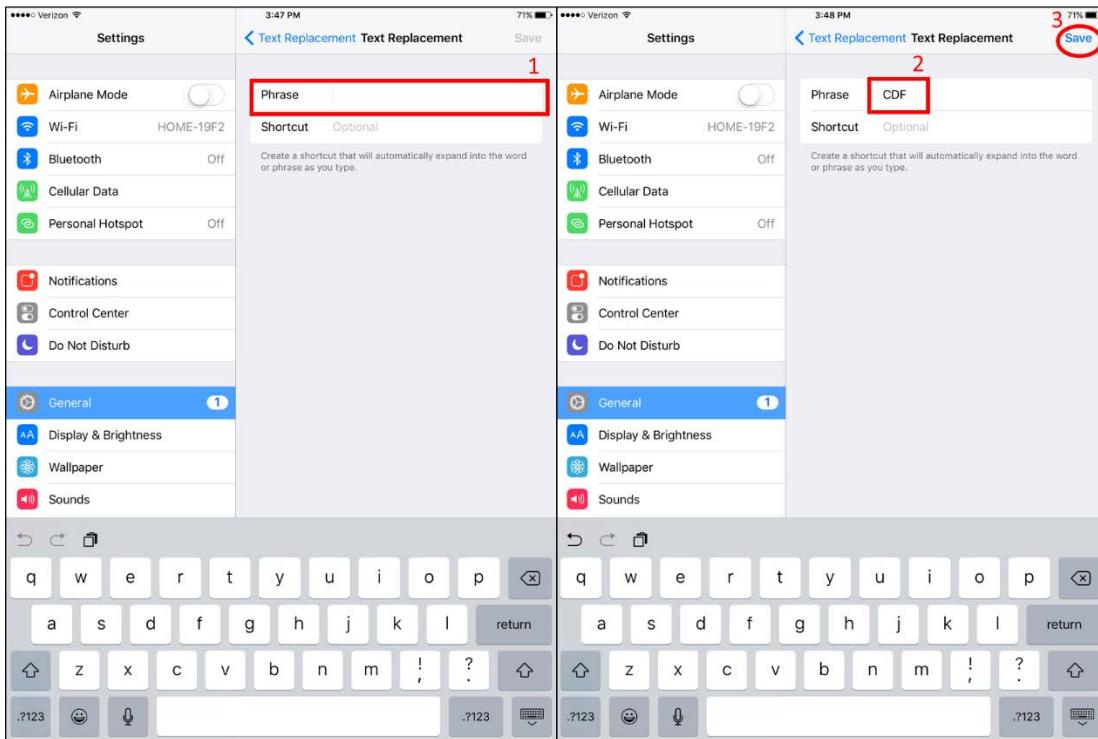


Figure 29. Process in adding a term into the iOS keyboard dictionary

## Custom Keyboard Method

The second method involves the development of a custom keyboard supported in iOS. A list of transportation construction terms can be included in the custom keyboard's dictionary. This approach is scalable and requires all users to download the custom keyboard to their devices. Once the user specifies the use of the custom keyboard in place of the iOS keyboard, the autocorrect feature will no longer change industry terms as it is incorporated to the keyboard dictionary. Unlike the *Text Replacement* method, this method is scalable and doesn't require additional configuration by the user. However, a limitation of this method include the inability to use device microphone. Without access to the device microphone, users using the custom keyboard will not be able to use the *dictation* or the voice recognition feature. The *dictation* feature converts the user's speech into text, allowing users to input text without using their hands. More information on the development process of a custom keyboard is shown in *Appendix C* of this report.

## Conclusion

This report discusses two methods to add commonly used transportation and construction terminology to the keyboard setting on the Apple iPad tablet computers. When words unique to the industry are typed into the tablet computer, the autocorrect function may automatically change the word to a similarly spelled word that exists in the Apple mobile operating system's keyboard dictionary. This can result in users spending additional time and effort reselecting the incorrect word and replacing it with the intended word.

The *Text Replacement* method is a simple approach that allows the user to add words, acronyms, and phrases to the existing iOS keyboard dictionary. Through trials conducted by the research team, a user may spend about 10 minutes to enter in a list of 60 transportation industry terms. This method is not

scalable throughout the agency if the agency policy requires every user to have a unique iTunes account. The list of words included in the *Text Replacement* feature is saved to the user's iTunes account and users must be signed in and stay signed in to the iTunes account to keep the list of terms.

The custom dictionary method requires the expertise of software engineers and upfront development time and effort, but is scalable and relatively effortless to the users. The known limitations to this method involve the inability to use the tablet computer's microphone. Speech-to-text function automatically converts the user's speech into text so they do not have to type in their statements. This function will be unavailable due to the inaccessibility to the device's microphone.

## Appendix B: A list of 60 commonly used transportation construction terminology

<b>Construction Terminology</b>	<b>Definition</b>	<b>Construction Terminology</b>	<b>Definition</b>
ASA	Aggregate Source Approval	PEO	Project Engineer Office
AST	Asphalt Treated Base	planer	-
Backhoe	-	Planing	-
Bituminous	-	PPE	Personal Protective Equipment
BST	Bituminous Surface Treatment	Precast	-
bulldozer	-	Prestressed	-
CDF	Controlled Density Fill	PVC	Polyvinyl Chloride
Cementitious materials	-	QPL	Qualified Product List
CMO	Certificate of Materials Origin	RAM	Request for Approval of Material
compactor	-	RAP	Recycled Asphalt Pavement
CPF	Composite Pay Factor	Rebar	Reinforcement bar
CPM	Critical Path Method	reclaimer	-
dozer	-	Roadbed	-
ESAL	Equivalent Single Axle Loads	Roadside	-
excavator	-	Roadway	-
genset	Diesel Generator	roller	-
grader	-	ROM	Record of Materials
hauler	-	ROW	Right of Way
HDPE	High Density Polyethylene	shuttle buggy	-
HMA	Hot Mix Asphalt	Skid steer	-
JMCIF	Job Mix Compliance Incentive Factor	Subcontractors	-
JMF	Job Mix Formula	Subgrade	-
Loader	-	Substructure	-
LS	Lump Sum	Superstructure	-
MCC	Manufacturer's Certificate of Compliance	TBM	Tunnel boring machine
MTV	Material Transfer Vehicle	trencher	-
MUTS	Minimum Ultimate Tensile Strength	VC	Vitrified Clay
NTP	Notice to proceed	VFA	Voids Filled with Asphalt
paver	-	VMA	Voids in Mineral Aggregate
PCPS	Precast Prestressed	VMS	Variable Message Sign

## Appendix C: Custom Keyboard Development Process from Apple Inc.

Reference Website:

[https://developer.apple.com/library/ios/documentation/General/Conceptual/ExtensibilityPG/CustomKeyboard.html#/apple\\_ref/doc/uid/TP40014214-CH16](https://developer.apple.com/library/ios/documentation/General/Conceptual/ExtensibilityPG/CustomKeyboard.html#/apple_ref/doc/uid/TP40014214-CH16)

See next page for content.

## Custom Keyboard

A custom keyboard replaces the system keyboard for users who want capabilities such as a novel text input method or the ability to enter text in a language not otherwise supported in iOS. The essential function of a custom keyboard is simple: Respond to taps, gestures, or other input events and provide text, in the form of an unattributed `NSString` object, at the text insertion point of the current text input object.

### BEFORE YOU BEGIN

Make sure a custom, systemwide keyboard is indeed what you want to develop. To provide a fully custom keyboard for just your app or to supplement the system keyboard with custom keys in just your app, the iOS SDK provides other, better options. Read about custom input views and input accessory views in [Custom Views for Data Input](#) in [Text Programming Guide for iOS](#).

After a user chooses a custom keyboard, it becomes the keyboard for every app the user opens. For this reason, a keyboard you create must, at minimum, provide certain base features. Most important, your keyboard must allow the user to switch to another keyboard.

## Understand User Expectations for Keyboards

To understand what users expect of your custom keyboard, study the system keyboard—it's fast, responsive, and capable. And it never interrupts the user with information or requests. If you provide features that require user interaction, add them not to the keyboard but to your keyboard's containing app.

### Keyboard Features That iOS Users Expect

There is one feature that iOS users expect and that every custom keyboard *must* provide: a way to switch to another keyboard. On the system keyboard, this affordance appears as a button called the globe key. iOS 8 provides a specific API for your "next keyboard" control, described in [Providing a Way to Switch to Another Keyboard](#).

The system keyboard presents an appropriate key set or layout based on the `UIKeyboardType` trait of the current text input object. With the insertion point in the To: field in Mail, for example, the system keyboard period key changes: When you press and hold that key, you can pick from among a set of top-level domain suffixes. Design your custom keyboard with keyboard type traits in mind.

iOS users also expect autocapitalization: In a standard text field, the first letter of a sentence in a case-sensitive language is automatically capitalized.

These features and others are listed next.

- Appropriate layout and features based on keyboard type trait
- Autocorrection and suggestion
- Automatic capitalization
- Automatic period upon double space
- Caps lock support
- Keycap artwork
- Multistage input for ideographic languages

You can decide whether or not to implement such features; there is no dedicated API for any of the features just listed, so providing them is a competitive advantage.

### System Keyboard Features Unavailable to Custom Keyboards

## App Extension Programming Guide: Custom Keyboard

Your custom keyboard does not have access to most of the general keyboard settings in the Settings app (Settings > General > Keyboard), such as Auto-Capitalization and Enable Caps Lock. Nor does your keyboard have access to the dictionary reset feature (Settings > General > Reset > Reset Keyboard Dictionary). To give your users flexibility, create a standard settings bundle, as described in [Implementing an iOS Settings Bundle in Preferences and Settings Programming Guide](#). Your custom settings then appear in the Keyboard area in Settings, associated with your keyboard.

There are certain text input objects that your custom keyboard is not eligible to type into. First is any *secure* text input object. Such an object is defined by its `secureTextEntry` property being set to `YES` and is distinguished by presenting typed characters as dots.

When a user taps in a secure text input object, the system temporarily replaces your custom keyboard with the system keyboard. When the user then taps in a nonsecure text input object, your keyboard automatically resumes.

Your custom keyboard is also ineligible to type into so-called phone pad objects, such as the phone number fields in Contacts. These input objects are exclusively for strings built from a small set of alphanumeric characters specified by telecommunications carriers and are identified by having one or another of the following two keyboard type traits:

- `UIKeyboardTypePhonePad`
- `UIKeyboardTypeNamePhonePad`

When a user taps in a phone pad object, the system temporarily replaces your keyboard with the appropriate, standard system keyboard. When the user then taps in a different input object that requests a standard keyboard via its type trait, your keyboard automatically resumes.

An app developer can elect to reject the use of all custom keyboards in their app. For example, the developer of a banking app, or the developer of an app that must conform to the HIPAA privacy rule in the US, might do this. Such an app employs the `application:shouldAllowExtensionPointIdentifier:` method from the `UIApplicationDelegate` protocol (returning a value of `NO`), and thereby always uses the system keyboard.

Because a custom keyboard can draw only within the primary view of its `UIInputViewController` object, it cannot select text. Text selection is under the control of the app that is using the keyboard. If that app provides an editing menu interface (such as for Cut, Copy, and Paste), the keyboard has no access to it. A custom keyboard cannot offer inline autocorrection controls near the insertion point.

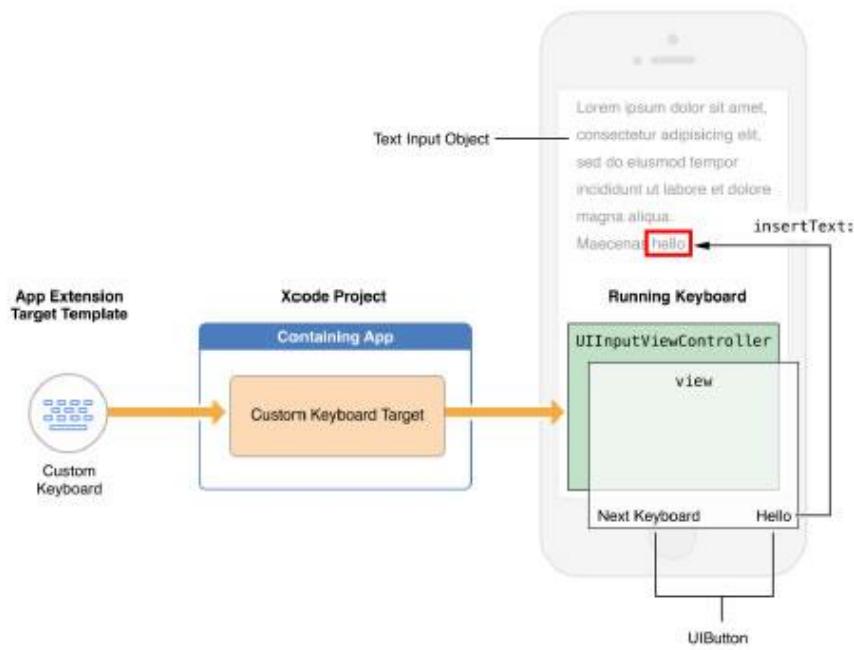
Custom keyboards, like all app extensions in iOS 8.0, have no access to the device microphone, so dictation input is not possible.

Finally, it is not possible to display key artwork above the top edge of a custom keyboard's primary view, as the system keyboard does on iPhone when you tap and hold a key in the top row.

## API Quick Start for Custom Keyboards

This section gives you a quick tour of the APIs for building a keyboard. Figure 8-1 shows some of the important objects in a running keyboard and where they come from in a typical development workflow.

**Figure 8-1** Basic structure of a custom keyboard



The Custom Keyboard template (in the iOS "Application Extension" target template group) contains a subclass of the `UIInputViewController` class, which serves as your keyboard's primary view controller. The template also includes a basic implementation of the required "next keyboard" button, which calls the `advanceToNextInputMode` method of the `UIInputViewController` class. Add objects such as views, controls, and gesture recognizers to the input view controller's primary view (in its `inputView` property), as suggested in Figure 8-1. As with other app extensions, there is no window in the target, and, therefore, no root view controller per se.

The template's `Info.plist` file comes preconfigured with the minimal values needed for a keyboard. See the `NSExtensionAttributes` dictionary key in the keyboard target's `Info.plist` file. The keys for configuring a keyboard are described in [Configuring the Info.plist file for a Custom Keyboard](#).

By default, a keyboard has no network access and cannot share a container with its containing app. To enable these things, set the value of the `RequestsOpenAccess` Boolean key in the `Info.plist` file to `yes`. Doing this expands the keyboard's sandbox, as described in [Establishing and Maintaining User Trust](#).

An input view controller conforms to various protocols for interacting with the content of a text input object:

- To insert or delete text in response to touch events, employ the `UIKeyInput` protocol methods `insertText:` and `deleteBackward`. Call these methods on the input view controller's `textDocumentProxy` property, which represents the current text input object and which conforms to the `UITextDocumentProxy` protocol. For example:

```
[self.textDocumentProxy insertText:@"hello"]; // Inserts the string "hello" at the
                                             insertion point

[self.textDocumentProxy deleteBackward];      // Deletes the character to the left of
                                             the insertion point

[self.textDocumentProxy insertText:@"\n"];        // In a text view, inserts a newline
                                             character at the insertion point
```

- To get the data you need to determine how much text is appropriate to delete when you call the `deleteBackward` method, obtain the textual context near the insertion point from the `documentContextBeforeInput` property of the `textDocumentProxy` property, as follows:

```
NSString *precedingContext = self.textDocumentProxy.documentContextBeforeInput;
```

You can then delete the appropriate text—for example, a single character, or everything back to a

whitespace character. To delete by semantic unit, such as by word, sentence, or paragraph, employ the functions described in [CFStringTokenizer Reference](#) and refer to related documentation. Note that each language has its own tokenization rules.

- To control the insertion point position, such as to support text deletion in a forward direction, call the `adjustTextPositionByCharacterOffset:` method of the `UITextDocumentProxy` protocol. For example, to delete forward by one character, use code similar to this:

```
1 - (void) deleteForward {
2     [self.textDocumentProxy adjustTextPositionByCharacterOffset: 1];
3     [self.textDocumentProxy deleteBackward];
4 }
```

- To respond to changes in the content of the active text object, or to respond to user-initiated changes in the position of the insertion point, implement the methods of the `UITextInputDelegate` protocol.

To present a keyboard layout appropriate to the current text input object, respond to the object's `UIKeyboardType` property. For each trait you support, change the contents of your primary view accordingly.

To support more than one language in your custom keyboard, you have two options:

- Create one keyboard per language, each as a separate target that you add to a common containing app
- Create a single multilingual keyboard, dynamically switching its primary language as appropriate  
To dynamically switch the primary language, use the `primaryLanguage` property of the `UIInputViewController` class.

Depending on the number of languages you want to support and the user experience you want to provide, pick the option that makes the most sense.

Every custom keyboard (independent of the value of its `RequestsOpenAccess` key) has access to a basic autocorrection lexicon through the `UILexicon` class. Make use of this class, along with a lexicon of your own design, to provide suggestions and autocorrections as users are entering text. The `UILexicon` object contains words from various sources, including:

- Unpaired first names and last names from the user's Address Book database
- Text shortcuts defined in the Settings > General > Keyboard > Shortcuts list
- A common words dictionary

You can adjust the height of your custom keyboard's primary view using Auto Layout. By default, a custom keyboard is sized to match the system keyboard, according to screen size and device orientation. A custom keyboard's width is always set by the system to equal the current screen width. To adjust a custom keyboard's height, change its primary view's height constraint.

The following code lines show how you might define and add such a constraint:

```
1 CGFloat _expandedHeight = 500;
2 NSLayoutConstraint *_heightConstraint =
3     [NSLayoutConstraint constraintWithItem: self.view
4                                     attribute: NSLayoutAttributeHeight
5                                     relatedBy: NSLayoutRelationEqual
6                                         toItem: nil
7                                         attribute: NSLayoutAttributeNotAnAttribute
8                                         multiplier: 0.0
9                                         constant: _expandedHeight];
3 [self.view addConstraint: _heightConstraint];
```

#### NOTE

In iOS 8.0, you can adjust a custom keyboard's height any time after its primary view initially draws on screen.

## Development Essentials for Custom Keyboards

There are two development essentials for every custom keyboard:

- **Trust.** Your custom keyboard gives you access to what a user types, so trust between you and your user is essential.
- A “next keyboard” key. The affordance that lets a user switch to another keyboard is part of a keyboard’s user interface; you must provide one in your keyboard.

### Designing for User Trust

Your first consideration when creating a custom keyboard must be how you will establish and maintain user trust. This trust hinges on your understanding of privacy best practices and knowing how to implement them.

#### NOTE

This section provides guidelines to help you create a custom keyboard that respects user privacy. In terms of factors under your control and described here as responsibilities. To learn about iOS program requirements, read [App Store Review Guidelines](#), [iOS Human Interface Guidelines](#), and [iOS Developer Program License Agreement](#), all linked to from Apple’s [App Review Support](#) page. Also review [Supporting User Privacy In App Programming Guide for iOS](#).

For keyboards, the following three areas are especially important for establishing and maintaining user trust:

**Safety of keystroke data.** Users want their keystrokes to go to the document or text field they’re typing into, and not to be archived on a server or used for purposes that are not obvious to them.

**Appropriate and minimized use of other user data.** If your keyboard employs other user data, such as from Location Services or the Address Book database, the burden is on you to explain and demonstrate the benefit to your users.

**Accuracy.** Accuracy in converting input events to text is not a privacy issue per se but it impacts trust: With every word typed, users see the accuracy of your code.

To design for trust, first consider whether to request open access. Although open access makes many things possible for a custom keyboard, it also increases your responsibilities (see Table 8-1).

**Table 8-1 Standard and open access (network-enabled) keyboards—capabilities and privacy considerations**

Open access	Capabilities and restrictions	Privacy considerations
Off (default)	<ul style="list-style-type: none"> <li>• Keyboard can perform all the normal duties expected of a basic keyboard</li> <li>• Access to a common words lexicon for autocorrect and text suggestion</li> <li>• Access to the text shortcuts list in Settings</li> <li>• No shared container with containing app</li> <li>• No access to file system apart from keyboard’s own container</li> <li>• No ability to participate directly or indirectly in iCloud, Game Center, or In-App Purchase</li> </ul>	<ul style="list-style-type: none"> <li>• Users know that keystrokes go only to the app that is using the keyboard</li> </ul>
	<ul style="list-style-type: none"> <li>• All capabilities of a nonnetworked custom keyboard</li> </ul>	

### App Extension Programming Guide: Custom Keyboard

<b>On</b>	<ul style="list-style-type: none"> <li>• Keyboard can access Location Services and Address Book, with user permission</li> <li>• Keyboard and containing app can employ a shared container</li> <li>• Keyboard can send keystrokes and other input events for server-side processing</li> <li>• Containing app can provide editing interface for keyboard's custom autocorrect lexicon</li> <li>• Via containing app, keyboard can employ iCloud to ensure settings and autocorrect lexicon are up to date on all devices</li> <li>• Via containing app, keyboard can participate in Game Center and In-App Purchase</li> <li>• If keyboard supports mobile device management (MDM), it can work with managed apps</li> </ul>	<ul style="list-style-type: none"> <li>• Users know that keystrokes are available to the keyboard developer</li> <li>• You must adhere to networked keyboard guidelines in <i>App Store Review Guidelines</i> and <i>iOS Developer Program License Agreement</i>, linked from Apple's <a href="#">App Review Support</a> page.</li> </ul>
-----------	---	---

If you build a keyboard without open access, the system ensures that keystrokes cannot be sent back to you or anywhere else. Use a nonnetworked keyboard if your goal is to provide normal keyboard functionality. Because of its restricted sandbox, a nonnetworked keyboard gives you a head start in meeting Apple's data privacy guidelines and in gaining user trust.

If you enable open access (as described [Configuring the Info.plist file for a Custom Keyboard](#)), a variety of possibilities open up but your responsibilities increase as well.

**NOTE**

To submit an open-access keyboard to the App Store, you must adhere to all pertinent guidelines in the documents linked from Apple's [App Review Support](#) page.

Each keyboard capability associated with open access carries responsibilities on your part as a developer, as indicated in Table 8-2. In general, treat user data with the greatest possible respect and do not use it for any purpose that is not obvious to the user.

**Table 8-2 Open-access keyboard user benefits and developer responsibilities**

Capability	Example user benefit	Developer responsibility
Shared container with containing app	Management UI for keyboard's autocorrect lexicon	Consider the autocorrect lexicon to be private user data. Do not send it to your servers for any purpose that is not obvious to the user.
Sending keystroke data to your server	Enhanced touch-event processing and input prediction via developer's computing resources	Do not store received keystroke or voice data except to provide services that are obvious to the user.
Dynamic autocorrect lexicon based on network supplied data	Names of people, places, and current events in the news added to autocorrection lexicon	Do not associate the user's identity with their use of trending or other network-based information, for any reason that is not obvious to the user.
	Names, places, and phone	Do not use Address Book

### App Extension Programming Guide: Custom Keyboard

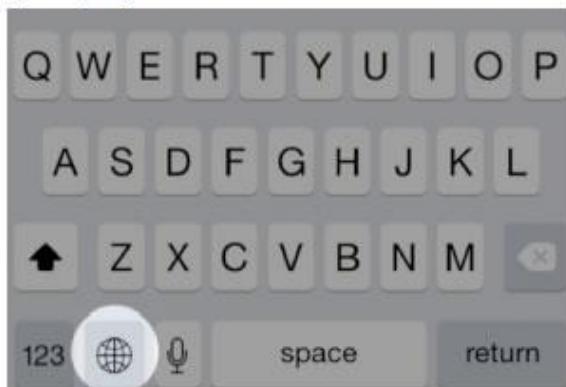
Address Book access	numbers relevant to the user added to autocorrection lexicon	data for any purpose that is not obvious to the user.
Location Services access	Nearby place names added to autocorrection lexicon	Do not use Location Services in the background. Do not send location data to your servers for any purpose that is not obvious to the user.

An open-access keyboard and its containing app can send keystroke data to your server, which enables you to apply your computing resources to such features as touch-event processing and input prediction. If you employ this capability, do not store received keystroke or voice data beyond the time needed to provide text back to the user or to provide features that you explain to the user. Refer to Table 8-2 for additional responsibilities you have when using open-access-keyboard capabilities.

### Providing a Way to Switch to Another Keyboard

The system keyboard's globe key lets a user choose a keyboard when more than one keyboard is enabled. See Figure 8-2.

Figure 8-2 The system keyboard's globe key



Your custom keyboard must also provide a way to switch to another keyboard.

NOTE

To pass App Review, you must provide obvious UI in your custom keyboard to allow a user to switch to another keyboard.

To ask the system to switch to another keyboard, call the `advanceToNextInputMode` method of the `UIInputViewController` class. The system picks the appropriate "next" keyboard; there is no API to obtain a list of enabled keyboards or for picking a particular keyboard to switch to.

The Xcode Custom Keyboard template includes the `advanceToNextInputMode` method as the action of its Next Keyboard button. For best user experience, place your next-keyboard control close to the same screen location as the system keyboard's globe key.

## Getting Started with Custom Keyboard Development

In this section you learn how to create a custom keyboard, configure it according to your goals, and run it in iOS Simulator or on a device. You'll also learn about some UI factors to bear in mind when replacing the

## Using the Xcode Custom Keyboard Template

The steps to create a keyboard and its containing app differ slightly from those for other app extensions. This section walks you through getting a basic keyboard up and running.

### To create a custom keyboard in a containing app

1. In Xcode, choose File > New > Project, and in the iOS Application template group choose the Single View Application template.
2. Click Next.
3. Name the project (for example, "ContainingAppForKeyboard"), then click Next.
4. Navigate to the location you want to save the project in, then click Create.

At this point, you have an empty app for your project to serve the simple role, for now, of containing the keyboard target. Before you submit a containing app to the App Store, it must perform some useful function. See [App Store Review Guidelines](#), linked from Apple's [App Review Support](#) page.

5. Choose File > New > Target, and in the iOS "Application Extension" target template group choose the Custom Keyboard template, then click Next.
6. Name the target as you'd like the keyboard's name to appear in the iOS user interface (for example, Custom Keyboard).
7. Ensure that the Project and the "Embed in Application" pop-up menus display the name of the containing app, then click Finish.

If you are prompted to activate the scheme for the new keyboard target, click Activate.

You can now optionally customize the keyboard group name as it appears in the Purchased Keyboards list in Settings, as described next.

### To customize the keyboard group name

1. In the Xcode project navigator, choose the containing app's `Info.plist` file, located in the app's Supporting Files folder. The property list editor opens, showing the contents of the file.
2. Hover the cursor over the "Bundle name" row, then click the "+" button that appears. This creates a new, empty property list row and selects its Key field.
3. Start typing `Bundle display name` and when the name autocompletes, press Return.
4. Double-click in the Value field in the same row to obtain a cursor there, then enter the keyboard group name you want.
5. Choose File > Save to save your changes to property list file.

Table 8-3 summarizes the UI strings for your custom keyboard that you can configure in the `Info.plist` files for the keyboard and its containing app.

Table 8-3 User interface strings specified in target and containing app `Info.plist` files

iOS user interface text	<code>Info.plist</code> key
• Keyboard group name in Purchased Keyboards list in Settings	Bundle display name in containing app's <code>Info.plist</code> file
• Keyboard name in Settings • Keyboard name in globe key menu	Bundle display name in custom keyboard target's <code>Info.plist</code> file

Now you can run the template-based keyboard in iOS Simulator, or on a device, to explore its behavior and capabilities.

### To run the custom keyboard and attach the Xcode debugger

1. In Xcode, set a breakpoint in your view controller implementation.

For example, set a breakpoint in the `viewDidLoad` method.

## App Extension Programming Guide: Custom Keyboard

2. Use the Xcode toolbar to ensure that the active scheme popup menu specifies the keyboard's scheme and an iOS Simulator or attached device.
  3. Choose Product > Run, or click the Play button at the upper left of the Xcode project window. Xcode prompts you to select a host app. Select an app with a readily-available text field, such as Contacts or Safari.
  4. Click Run.
- Xcode runs your specified host app. If this is your first time deploying your keyboard extension to iOS Simulator or a device, use Settings to add and enable the keyboard, as follows:
1. Go to Settings > General > Keyboard > Keyboards.
  2. Tap Add New Keyboard.
  3. In the Purchased Keyboards group, tap the name of your new keyboard. A modal view appears with a switch to enable your keyboard.
  4. Tap the switch to enable your keyboard. A warning alert appears.
  5. In the warning alert, tap Add Keyboard to finish enabling your new keyboard. Then tap Done.
5. In iOS Simulator or on the attached device, invoke your custom keyboard.

To do this, tap to place the insertion point in a text field—in any app, or in the Spotlight field in Springboard—to display the system keyboard. Then press and hold the globe key and choose your custom keyboard.

Now you can explore your custom keyboard's behavior, but the debugger is not yet attached. The bare-bones keyboard built from the template has only one behavior, indicated by its Next Keyboard button: allowing you to switch back to the previously used keyboard.

Before continuing, ensure that your custom keyboard is active.

6. Dismiss your keyboard (so that in step 8 you can hit the `viewDidLoad` breakpoint by again invoking the keyboard).

7. In Xcode, choose Debug > Attach to Process > By Process Identifier (PID) or Name.

In the sheet that appears, enter the name of your keyboard extension (including spaces) as you specified it when creating it. By default, this is the name for the app extension's group in the project navigator.

8. Click Attach.

Xcode indicates in the Debug navigator that it is waiting to attach.

9. In any app in iOS Simulator or the device (depending on which you are using), invoke the keyboard by tapping in a text field.

As your keyboard's main view begins to load, the Xcode debugger attaches to your keyboard and Xcode hits your breakpoint.

## Configuring the `Info.plist` file for a Custom Keyboard

The information property list (`Info.plist` file) keys that are specific to a custom keyboard let you statically declare the salient characteristics of your keyboard, including its primary language and whether it requires open access.

To examine these keys, open an Xcode project to which you've added a Custom Keyboard target template. Now select the `Info.plist` file in the Project navigator (the `Info.plist` file is in the Supporting Files folder for the keyboard target).

In source text form, the keys for a custom keyboard are as follows:

```
1  <key>NSExtension</key>
2  <dict>
3      <key>NSExtensionAttributes</key>
4      <dict>
5          <key>IsASCIICapable</key>
6          <false/>
7          <key>PrefersRightToLeft</key>
8          <false/>
```

```

9      <key>PrimaryLanguage</key>
10     <string>en-US</string>
11     <key>RequestsOpenAccess</key>
12     <false/>
13   </dict>
14   <key>NSEExtensionPointIdentifier</key>
15   <string>com.apple.keyboard-service</string>
16   <key>NSEExtensionPrincipalClass</key>
17   <string>KeyboardViewController</string>
18 </dict>

```

Each of these keys is explained in [App Extension Keys](#). Use the keys in the `nsextensionAttributes` dictionary to express the characteristics and needs of your custom keyboard, as follows:

**IsASCIIICapable**—This Boolean value, `no` by default, expresses whether a custom keyboard can insert ASCII strings into a document. Set this value to `yes` if you provide a keyboard type specifically for the `UIKeyboardTypeASCIICapable` keyboard type trait.

**PrefersRightToLeft**—This Boolean value, also `no` by default, expresses whether a custom keyboard is for a right-to-left language. Set this value to `yes` if your keyboard's primary language is right-to-left.

**PrimaryLanguage**—This string value, `en-us` (English for the US) by default, expresses the primary language for your keyboard using the pattern `<language>-<REGION>`. You can find a list of strings corresponding to languages and regions at <http://www.opensource.apple.com/source/CF/CF-478.14/CFLocaleIdentifier.c>.

**RequestsOpenAccess**—This Boolean value, `no` by default, expresses whether a custom keyboard wants to enlarge its sandbox beyond that needed for a basic keyboard. If you request open access by setting this key's value to `yes`, your keyboard gains the following capabilities, each with a concomitant responsibility in terms of user trust:

- Access to Location Services, the Address Book database, and the Camera Roll, each requiring user permission on first access
- Option to use a shared container with the keyboard's containing app, which enables features such as providing a custom lexicon management UI in the containing app
- Ability to send keystrokes, other input events, and data over the network for server-side processing
- Ability to use the `UIPasteboard` class
- Ability to play audio, including keyboard clicks using the `playInputclick` method
- Access to iCloud, which you can use, for example, to ensure that keyboard settings and your custom autocorrect lexicon are up to date on all devices owned by the user
- Access to Game Center and In-App Purchase, via the containing app
- Ability to work with managed apps, if you design your keyboard to support mobile device management (MDM)

When considering whether to set the `RequestsOpenAccess` key's value to `yes`, be sure to read [Designing for User Trust](#), which describes your responsibilities for respecting and protecting user data.