Central Federal Lands Division
Data Collection Packages

Final Report
March 2011

U.S. Department
of Transportation
**Federal Highway
Administration**

Federal Lands Highway

Commitment to Excellence

**Department of Transportation
Federal Highway Administration
Central Federal Lands Division
12300 W. Dakota Avenue
Lakewood, CO 80228**

[Type text]

About WTI

Designated by the U.S. Department of Transportation's Research and Innovative Technology Administration as one of the 10 National University Transportation Centers, we fulfill our charge of advancing the field of transportation and developing the next generation of professionals by conducting cutting-edge, multidisciplinary research.

Acknowledgements

Notice

This document is disseminated under the sponsorship of the U.S. Department of Transportation in the interest of information exchange. The U.S. Government assumes no liability for the use of the information contained in this document.

The U.S. Government does not endorse products or manufacturers. Trademarks or manufacturers' names appear in this report only because they are considered essential to the objective of the document.

Quality Assurance Statement

The Federal Highway Administration (FHWA) provides high-quality information to serve Government, industry, and the public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. FHWA periodically reviews quality issues and adjusts its programs and processes to ensure continuous quality improvement.

[Type text]

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Central Federal Highways Division Data Collection Packages – Final Report		**5. Report Date** 31 March 2011	
		6. Performing Organization Code	
7. Author(s) Douglas Galarus, Daniell Richter, Kelvin Bateman		**8. Performing Organization Report No.**	
9. Performing Organization Name and Address Western Transportation Institute P.O. Box 174250 Montana State University Bozeman, MT 59717-4250		**10. Work Unit No. (TRAIS)**	
		11. Contract or Grant No. DTFH68-07-E-00045	
12. Sponsoring Agency Name and Address Department of Transportation Federal Highway Administration Central Federal Lands Division 12300 W. Dakota Avenue Lakewood, CO 80228		**13. Type of Report and Period Covered** Final Report	
		14. Sponsoring Agency Code	
15. Supplementary Notes NA			

16. Abstract

The purpose of this research study was to develop a proof of concept, prototype electronic data-collection and reporting system to facilitate the completion of Emergency Relief for Federally Owned (ERFO) Roads Damage Site Reports (DSR). The system would replace current reports, which are hand-written in the field and converted to an electronic format later. Researchers developed the prototype system, which integrates a Tablet PC, digital camera, GPS, and satellite and cellular modems. Users completing road damage reports have the capability to summarize basic information, map locations, download topographic maps and aerial photos for reference, import and annotate photos using a stylus pen, free-hand sketch using the stylus pen, and automatically generate reports. The system was successfully tested in the lab and demonstrated to the FHWA. Anticipated benefits of the new method include more detailed, accurate and timely reporting of incidents in the field, which may facilitate and expedite emergency response and road repair activities.

17. Key Words Incident management, Reports, Road maintenance, Data collection, Data Transmission systems, Mobile Communication Systems, Global Positioning System, Systems Engineering		**18. Distribution Statement** No restrictions.	
19. Security Classification (of this report) Unclassified	**20. Security Classification. (of this page)** Unclassified	**21. No. of Pages** 60	**22. Price** NA

SI* (MODERN METRIC) CONVERSION FACTORS

	APPROXIMATE CONVERSIONS TO SI UNITS			
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: volumes greater than 1000 L shall be shown in m^3			
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^{o}F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^{o}C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

TABLE OF CONTENTS

LIST OF FIGURES

EXECUTIVE SUMMARY

The purpose of this research study was to develop a proof of concept, prototype electronic data-collection and reporting system to replace hand-written methods for Emergency Relief for Federally Owned (ERFO) Roads Damage Site Reports (DSR) used by Federal Highway Administration (FHWA) Central Federal Lands Division (CFLD) staff. The prototype system is based largely on the Redding Responder System, previously developed for the California Department of Transportation (Caltrans) by the Western Transportation Institute. The Responder System facilitates documenting and reporting incidents using a Tablet PC, digital camera, GPS, and satellite and cellular modems.

The current method of collecting information and preparing reports for ERFO DSRS involves a clipboard, paper and digital camera. Information is eventually compiled into electronic form at workstations in agency offices. The new method would facilitate more accurate and timely reporting in the field, with most of the information collected onsite at an incident.

The scope of this project was to develop and test the prototype system to include local storage and recall of the ERFO data and creation of a form equivalent to the existing form. The scope did not include server-side storage of the data collected or electronic transmission of the data from the field.

Key functionality of the system includes:

- Summary of basic information, including automatic location via GPS.
- Cost estimation using a list of cost items for emergency and permanent repairs.
- Mapping, including road maps, aerial photos and USGS topographical maps, as well as GPS information.
- Import of photos from a digital camera, including ability to annotate photos using the pen/stylus from the Tablet PC.
- Free-hand sketches using the pen/stylus from the Tablet PC.
- Report generation, to generate a PDF report equivalent to current ERFO DSR reports.

The system was developed as planned and a rugged tablet/laptop was purchased and configured for prototype testing. The system was lab-tested and demonstrated to FHWA at the WTI facility. Unfortunately, no testing was conducted in the field by prospective users, because no prospective users were assigned to this project during its performance period.

The following items were requested during the performance period of the project, but were not addressed:

- Detailed cost estimate items, and mechanism for updating this information.
- Determination of the project champion and a corresponding test location.
- Prototype testing and feedback from real use in the field.

In the absence of these items and considering that the objective of this study was the development of a prototype, the system is not ready for production use.

The system has been prepared for delivery to the sponsor and will be sent to the sponsor at the conclusion of the project.

CHAPTER 1.   INTRODUCTION

OVERVIEW

The work conducted in this project stems from discussions with FHWA CFLD and three prior and on-going efforts at the Western Transportation Institute (WTI).   In a project entitled, "Blackfeet Automated Accident Reporting System," WTI researched the problem of underreporting of accidents on Indian reservations in Montana.   WTI developed a prototype accident collection and reporting device, which consisted of a Tablet PC and custom-developed software. In the Caltrans-sponsored Redding Responder project, WTI developed a system for the collection and reporting of incidents on California highways by Caltrans maintenance personnel. The Redding Responder system uses satellite and cellular data communication to transmit incident information including photos and sketches from the incident to a transportation management center in near real time.   Finally, in the Roadkill Observation Collection System (ROCS) project, WTI developed a system for recording roadkill observations to increase the accuracy and coverage of reported observations. This PDA-based system focused on ease of use, automated location reporting via GPS, and a centralized repository and web interface for access to data collected using the system.

The Responder and ROCS systems were demonstrated to CFLHD representatives at TRB in January 2007, and several potential applications were discussed including a retaining wall inventory program.   The general intent was to demonstrate a system that could replace paper-based data collection. In a conference call on July 23, 2007, the list of potential applications was expanded to include:

- Crash data documented by field unit personnel
- ERFO (Emergency Relief on Federal Owned Property) damage assessment
- Wall inventory
- Traffic barriers

Other aspects were discussed including communication system limitations and the desired form factor – laptop versus PDA, tablet-based versus voice activated, etc. It was indicated that the wall inventory and traffic barrier applications might not be ready for development in time, so one of the other two applications (crash data or ERFO) would be selected. Ultimately, the ERFO forms application was selected. It was further determined that data communication capability from the field was not necessary at this time.

ERFO DSR FORM EXAMPLES

Emergency Relief on Federal Owned Property (ERFO) Damage Survey Reports (DSR) are standard forms used to document incidents and associated repair costs. Typically these forms are completed through a combination of field data collection, including photographs, and in office documentation, potentially including engineering diagrams and detailed cost estimates. A flow chart associated with the process is shown in Figure 1. (However, this flow was not implemented in the logic of the application that was subsequently developed.)

The CFLHD representatives provided four examples of these reports. Figure 2 shows the first page of an ERFO DSR form from the first incident example. This page includes the general information about the location, applicant and cost estimates. Additional information is supplied via supplemental sheets, as shown in Figure 3, where a hand-drawn sketch depicts one aspect of the work to be conducted. Photos can be included on supplemental sheets, as shown in Figure 4. Figure 5, Figure 6, Figure 7, Figure 8 and Figure 9 show a report for the second incident. Figure 6 shows hand-drawn, detailed sketches and Figure 8 shows a topographic map of the area. Figure 10, Figure 11, Figure 12, Figure 13 and Figure 14 show a third incident, including a "Betterment Justification" sub-form (Figure 11), and an annotated map (Figure 14). Figure 15, Figure 16, Figure 17, Figure 18, Figure 19 and Figure 20 show the fourth ERFO DSR example, including diagrams that appear to have been generated using additional software, and an annotated map.

These examples are the extent of the information provided to the development team for this project. It is unknown whether there are other types of information typically included in these reports. The associated necessary functionality apparent from these examples includes:

- Capability to complete form fields, including free-form text entry and potential for pre-population of location information and agency-specific information associated with the user of the system.
- Drawing/sketching capability, although advanced drawing capability such as CAD was considered outside the scope of the project – the ability to import images produced with other packages was considered sufficient.
- Capability to incorporate photos – this includes the capability to draw annotations on photos, although that use was not demonstrated in the examples.
- Capability to incorporate maps, including annotations on maps.
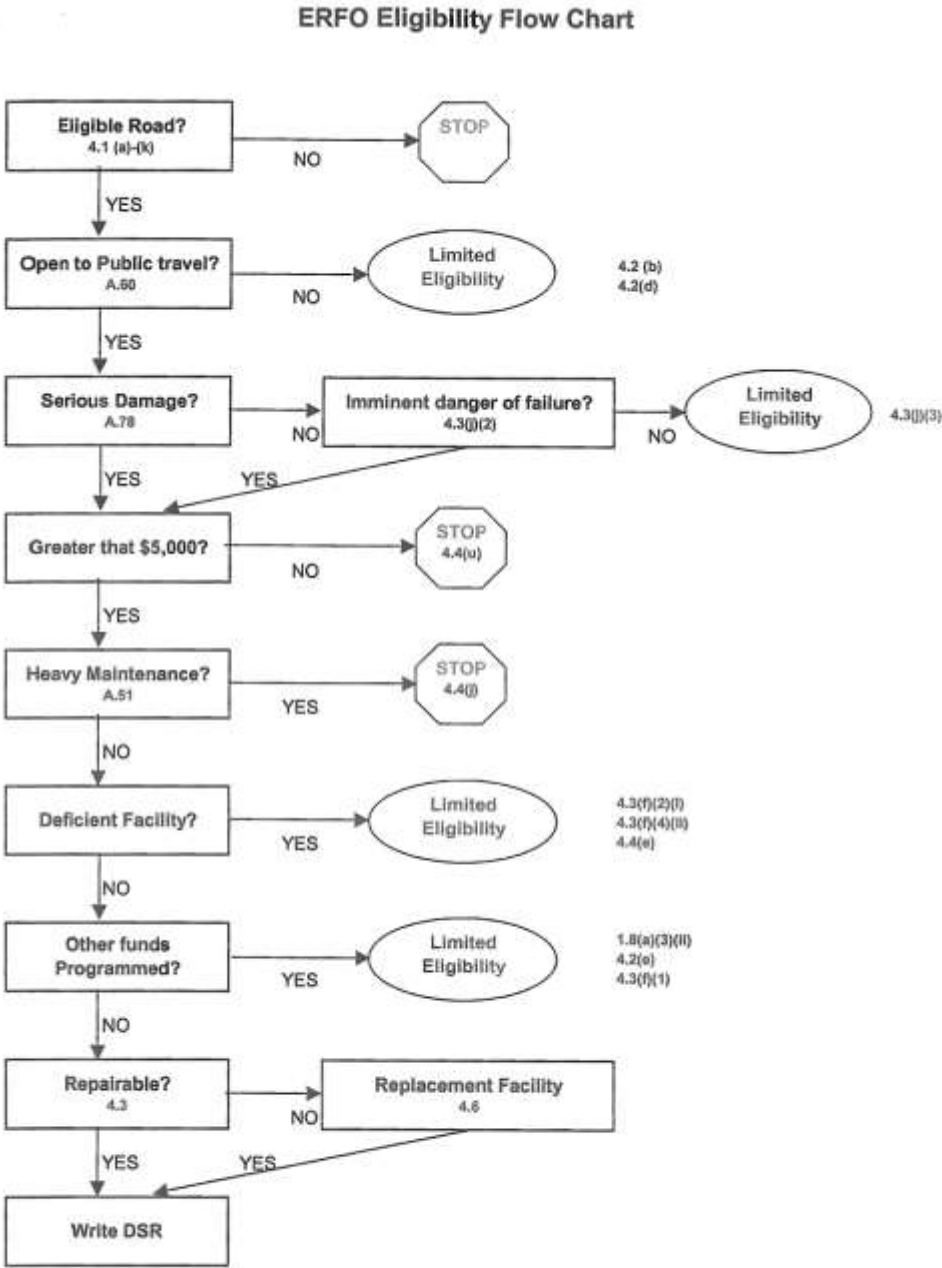
ERFO Eligibility Flow Chart

Figure 1: ERFI Eligibility Flow Chart

FEDERAL HIGHWAY ADMINISTRATION, Federal Lands Highway
DAMAGE SURVEY REPORT
(Title 23, Federal-Aid System/Federal Domain)

Sheet No:	1	of	3
DSR No:	1		
Disaster No: CA 2004-1 FS			

Applicant: Tahoe National Forest	County: Nevada	State: CA	Inspection Date: 8/23/2004

Location of Damage (Route No., Name of Road and Mile Post) Road 14-1-3 MP 1.6 Mooney Creek	ADT: <20

Bridge Data:	Road Data:	Classification:		Photograph #:
Type:	Traveled Way Width: 12'	Surface Type: Agg	Thickness: 4"	
ID#:	Shoulder Width: 1'	Surface Type: Agg		

Description and Cause of Damage:
Raging waters got under a 72"CMP and lifted the inlet 5' out of the ground - The pipe now points out of the streambed (see photos)

Scope/Description of Repair: Reinstall
same CMP in same location. Rebed CMP and replace bands that connect pipe together. Replace 150' of 3/4" crushed aggregate that was washed away.

COST ESTIMATE for EMERGENCY REPAIRS*

Quantity	Unit	Item Description	Unit Price	Cost
				$0
				$0
				$0
				$0
				$0
				$0
				$0
Proposed:	Force Account	Contract	Total Emergency Repairs	$0

COST ESTIMATE for PERMANENT REPAIRS*

Quantity	Unit	Item Description	Unit Price	Cost
1	LS	Mobilization	1000	$1,000
10	CY	Borrow and Culvert Bedding Material	15	$150
30	CY	Aggregate	20	$600
10	HR	Foreman	35	$350
10	HR	Laborer	30	$300
5	HR	Excavator - (Remove and rebed culvert)	150	$750
2	HR	Grader	150	$300
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
			Subtotal Permanent Repairs (continuation sheet)	
Proposed:	Force Account X	Contract	Total Permanent Repairs	$3,450

Identify Betterment, if any, and provide justification*	Preliminary Engineering	$500
	Construction Engineering	
	Right-of-Way	
	Other	
	TOTAL ESTIMATED COST (Emergency and Permanent Repairs)	$3,950

Submitted By: (Name and Title)	Signature:	Date:

Reviewed By: (Name and Title) FLH FIELD ENGINEER	Eligible / (Ineligible)	Signature:	Date:

Recommended By: (Name and Title) FLH ERFO COORD.	Eligible / (Ineligible)	Signature:	Date:

*Attach Supplemental Sheets if necessary   BELOW $5000 THRESHOLD

Figure 2: ERFO DSR Example 1, Page 1

FEDERAL HIGHWAY ADMINISTRATION, Federal Lands Highway			Sheet No: __2__ of __3__
DAMAGE SURVEY REPORT *(Supplemental Sheet)*			DSR No: __1__
(Title 23, Federal-Aid System/Federal Domain)			Disaster No:CA 2004-1FS
Applicant: Tahoe National Forest	County: Nevada	State: California	Inspection Date: 8/23/2004
Location of Damage (Route No., Name of Road and Mile Post) Road 14-1-3, Milepost 1.6, Mooney Creek			ADT: <20

150'

REMOVE & RESET
72" X 40' CMP

MOONEY CK.

PLAN

14'

REPLACE AGG.
4-INCH DEPTH

SECTION A-A

ITEM		Calculated Amount	DSR Amount
Aggregate	(4"/12)(14')(150') / 27 =	26 cy	30 cy

Figure 3: ERFO DSR Example 1, Page 2

Figure 4: ERFO DSR Example 1, Page 3

FEDERAL HIGHWAY ADMINISTRATION, Federal Lands Highway			Sheet No: 1 of 4
DAMAGE SURVEY REPORT			DSR No: 14-1
(Title 23, Federal-Aid System/Federal Domain)			Disaster No: WA 2004-1 NPS

Applicant: Mount Rainier NP	County: Pierce	State: WA	Inspection Date: 11/06/03

Location of Damage (Route No., Name of Road and Mile Post) Route 014, MP 3.57, Nisqually to Paradise Road			ADT:

Bridge Data: Kautz Creek	Road Data:	Classification:		Photograph #:
Type:	Traveled Way Width: 24	Surface Type: ACP	Thickness:	
ID#:	Shoulder Width: 0	Surface Type:		

Description and Cause of Damage: High water caused heavy erosion at bridge piers and upstream/downstream revetment.	Scope/Description of Repair: Install riprap mat under bridge. Install riprap bank protection for a maximum of 50' upstream and 25' downstream of bridge. Grout voids behind west pier.

COST ESTIMATE for EMERGENCY REPAIRS*

Quantity	Unit	Item Description	Unit Price	Cost
				$0
				$0
				$0
				$0
				$0
				$0
				$0
Proposed:	Force Account	Contract	Total Emergency Repairs	$0

COST ESTIMATE for PERMANENT REPAIRS*

Quantity	Unit	Item Description	Unit Price	Cost
580	TON	Excavate and install riprap mat	50	$29,000
1200	TON	Excavate and install riprap revetment (200 LF)	50	$60,000
190	CY	Drill behind west pier and grout voids	175	$33,250
80	HRS	Traffic control	40	$3,200
1	LS	Mobilization @ 10%	12000	$12,000
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
			Subtotal Permanent Repairs (continuation sheet)	
Proposed:	Force Account	Contract	Total Permanent Repairs	$137,450

Identify Betterment, if any, and provide justification*	Preliminary Engineering	$6,873
	Construction Engineering	$6,873
	Right-of-Way	$0
	Other	
	TOTAL ESTIMATED COST (Emergency and Permanent Repairs)	$151,195

Submitted By: (Name and Title)	Signature:	Date:
Reviewed By: (Name and Title) FLH FIELD ENGINEER (Eligible) Ineligible	Signature:	Date:
Recommended By: (Name and Title) FLH ERFO COORDINATOR (Eligible) Ineligible	Signature:	Date:

*Attach Supplemental Sheets if necessary

Figure 5: ERFO DSR Example 2, Page 1

Figure 6: ERFO DSR Example 2, Page 2
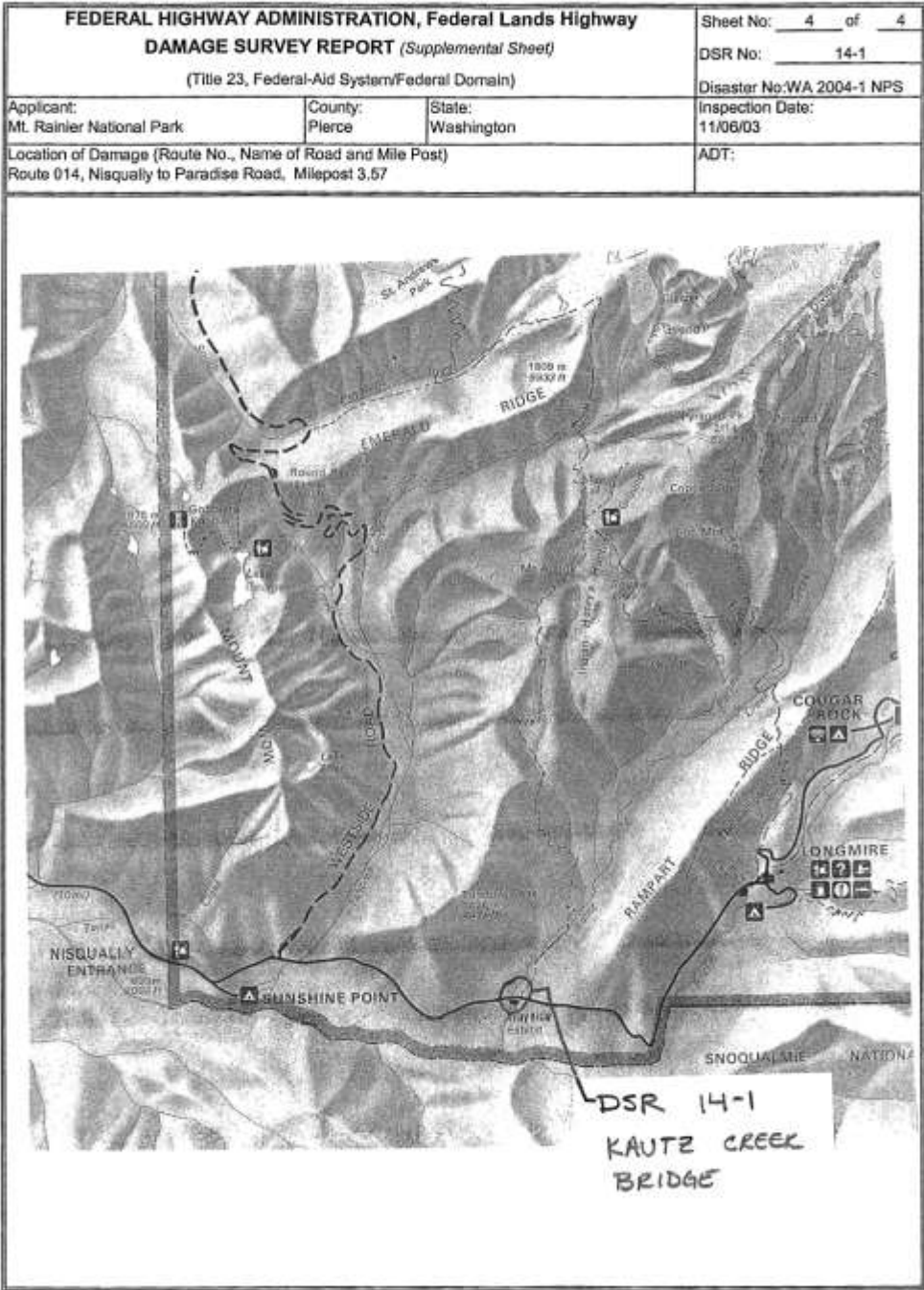
8

Figure 7: ERFO DSR Example 2, Page 3

Figure 8: ERFO DSR Example 2, Page 4

Bridge Foundation Scour – repair completed

Figure 9: ERFO DSR Example 2, Page 5

11

FEDERAL HIGHWAY ADMINISTRATION, Federal Lands Highway

DAMAGE SURVEY REPORT

(Title 23, Federal-Aid System/Federal Domain)

Sheet No: 1 of 4			
DSR No: OLYM 8			
Disaster No: WA 2004-1 NPS			

Applicant: Olympic National Park	County: Clallam	State: Washington	Inspection Date: 10/23/03

Location of Damage (Route No., Name of Road and Mile Post) Park Route No. 103, Sol Duc Road, Milepost 7.2	ADT: 200

Bridge Data:	Road Data:	Classification:		Photograph #:
Type:	Traveled Way Width: 22'	Surface Type: ACP	Thickness: 3"	
ID#:	Shoulder Width: 1'	Surface Type: ACP		

Description and Cause of Damage:	Scope/Description of Repair:
Sol Duc River eroded bank and washed out part of the road prism, closing one lane over a length of 100 lineal feet. Riprap bank protection was destroyed.	Install grouted and rock bolted riprap bank hardening, fill the eroded area with pit run rock, cap with 1 1/4" minus crushed rock, spread 5/8" minus crushed rock for base, compact, and lay hot mix asphalt paving.

COST ESTIMATE for EMERGENCY REPAIRS*

Quantity	Unit	Item Description	Unit Price	Cost
				$0
				$0
14	EA	Temporary Concrete Barrier	$ 50.00	$700
1	LS	Traffic Control Signs	$ 200.00	$200
				$0
				$0
				$0
Proposed:	Force Account	Contract	Total Emergency Repairs	$900

COST ESTIMATE for PERMANENT REPAIRS*

Quantity	Unit	Item Description	Unit Price	Cost
1	LS	Mobilization	4000	$4,000
1	LS	Staking	1000	$1,000
1	LS	Quality Control, Schedule	1000	$1,000
240	CY	Class 1 riprap	40	$9,600
350	CY	Class 5 riprap	40	$14,000
20	CY	5/8" minus crushed rock	25	$500
40	CY	1 1/4" minus crushed rock	25	$1,000
30	TON	Hot mix asphalt	150	$4,500
1	LS	Temp Traffic Control	500	$500
80	Hours	Flaggers	35	$2,800
1	LS	Permanent Traffic Control	300	$300
1	LS	~~Relocate Utilities~~ ← *NOT ELIGIBLE* Betterment	1000	~~$1,000~~
				$0
70	CY	Grout for Riprap	300	$21,000
25	EA	Rock Dowel	100	$2,500
1	LS	Betterment Mobilization	2400	$2,400
		Subtotal Permanent Repairs (continuation sheet)		5
Proposed:	Force Account	Contract	Total Permanent Repairs	$68,100

Identify Betterment, if any, and provide justification*		
This site was damaged during the WA 97-1 NPS ERFO disaster. Replacement in-kind repair failed. Betterment consisting of grouted riprap and rock dowels into bedrock is needed to prevent future damage. Site is at a bend in the Sol Duc River. Cost of Betterment is $25,900.	Preliminary Engineering	$9,915
	Construction Engineering	$6,610
	Right-of-Way	
	Other	
	TOTAL ESTIMATED COST (Emergency and Permanent Repairs)	~~$83,525~~ #82,525

Submitted By: (Name and Title) APPLICANT	Signature:	Date:
Reviewed By: (Name and Title) FLH FIELD ENGINEER (Eligible) ineligible	Signature:	Date:
Recommended By: (Name and Title) FLH ERFO COORDINATOR (Eligible) ineligible	Signature:	Date:

*Attach Supplemental Sheets if necessary

Figure 10: ERFO DSR Example 3, Page 1

DSR No. OLYM8

Betterment Justification

Construct grouted riprap revetment with rock dowels

	REPAIR IN-KIND				BETTERMENT			
	Replace Embankment and Riprap				Grout Riprap and place Rock Dowels			
	UNIT	QUANITY	UNIT PRICE	COST	UNIT	QUANITY	UNIT PRICE	COST
Repair in-kind w/o Betterment	LS	1	$57,625	$57,625				$0
Betterment				$0	LS	1	$25,900	$25,900
				$0				$0
				$0				$0
				$0				$0
TOTAL				$57,625				$25,900

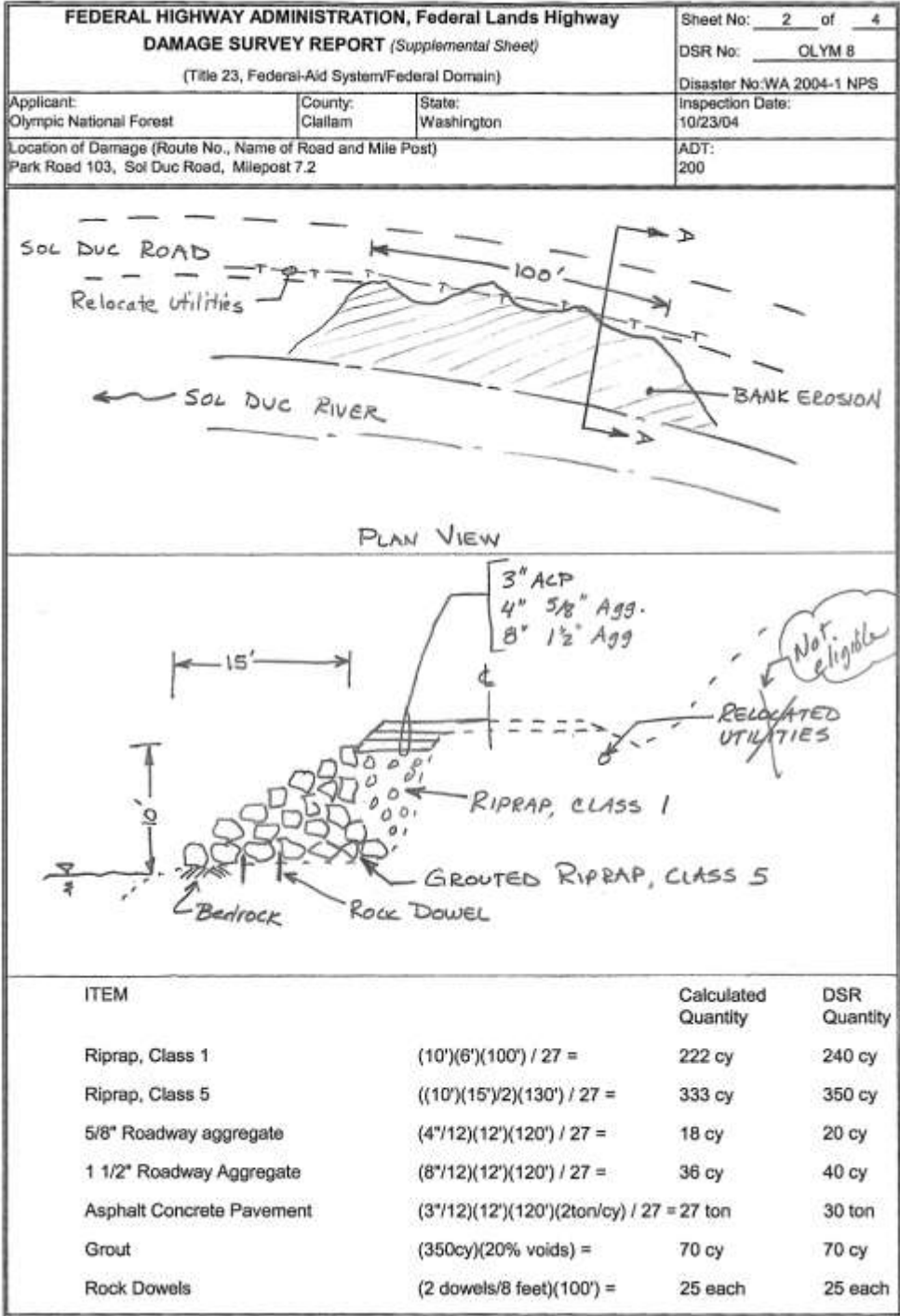|	
Cost to Repair damage in the future (w/Betterment)	Assume $10,000
BENEFIT	(P/F,7%,10yrs)(Cost to repair damage in the future (w/o Betterment) minus cost to repair damage in the future (w/ Betterment)) = (0.5083+0.2584)($57,625 - $10,000) — $36,514
COST	The additional cost to repair the site as a result of adding the Betterment — $25,900
BENEFIT/COST	1.4

Figure 11: ERFO DSR Example 3, Page 2

	FEDERAL HIGHWAY ADMINISTRATION, Federal Lands Highway			Sheet No: 2 of 4
	DAMAGE SURVEY REPORT *(Supplemental Sheet)*			DSR No: OLYM 8
	(Title 23, Federal-Aid System/Federal Domain)			Disaster No:WA 2004-1 NPS
Applicant: Olympic National Forest	County: Clallam	State: Washington		Inspection Date: 10/23/04
Location of Damage (Route No., Name of Road and Mile Post) Park Road 103, Sol Duc Road, Milepost 7.2				ADT: 200

PLAN VIEW

ITEM		Calculated Quantity	DSR Quantity
Riprap, Class 1	(10')(6')(100') / 27 =	222 cy	240 cy
Riprap, Class 5	((10')(15')/2)(130') / 27 =	333 cy	350 cy
5/8" Roadway aggregate	(4"/12)(12')(120') / 27 =	18 cy	20 cy
1 1/2" Roadway Aggregate	(8"/12)(12')(120') / 27 =	36 cy	40 cy
Asphalt Concrete Pavement	(3"/12)(12')(120')(2ton/cy) / 27 = 27 ton		30 ton
Grout	(350cy)(20% voids) =	70 cy	70 cy
Rock Dowels	(2 dowels/8 feet)(100') =	25 each	25 each

Figure 12: ERFO DSR Example 3, Page 3

FEDERAL HIGHWAY ADMINISTRATION, Federal Lands Highway			Sheet No: 3 of 4
DAMAGE SURVEY REPORT (Supplemental Sheet)			DSR No: OLYM 8
(Title 23, Federal-Aid System/Federal Domain)			Disaster No:WA 2004-1 NPS
Applicant: Olympic National Forest	County: Clallam	State: Washington	Inspection Date: 10/23/04
Location of Damage (Route No., Name of Road and Mile Post) Park Road 103, Sol Duc Road, Milepost 7.2			ADT: 200

Picture looking downstream

Picture looking upstream

Figure 13: ERFO DSR Example 3, Page 4

FEDERAL HIGHWAY ADMINISTRATION, Federal Lands Highway			Sheet No: 4 of 4
DAMAGE SURVEY REPORT (Supplemental Sheet)			DSR No: OLYM 8
(Title 23, Federal-Aid System/Federal Domain)			Disaster No:WA 2004-1 NPS
Applicant: Olympic National Forest	County: Clallam	State: Washington	Inspection Date: 10/23/04
Location of Damage (Route No., Name of Road and Mile Post) Park Road 103, Sol Duc Road, Milepost 7.2			ADT: 200

Figure 14: ERFO DSR Example 3, Page 5

16

FEDERAL HIGHWAY ADMINISTRATION, Federal Lands Highway				Sheet No: 1 of 5		
DAMAGE SURVEY REPORT				DSR No: OLYM 6		
(Title 23, Federal-Aid System/Federal Domain)				Disaster No: WA 2004-1 NPS		
Applicant: Olympic National Park		County: Jefferson	State: Washington	Inspection Date: 10/23/03		
Location of Damage (Route No., Name of Road and Mile Post) Park Route No, 107, Hoh Valley Road, Milepost 5.0				ADT: 428		
Bridge Data:	Road Data:	Classification:		Photograph #:		
Type:	Traveled Way Width: 20'	Surface Type: ACP	Thickness: 3"			
ID#: N/A	Shoulder Width: 2'	Surface Type: ACP				

Description and Cause of Damage:
Bank along a side channel of the Hoh River eroded and washed out the road over a length of 100 lineal feet. The bend in the side channel extends across the road, and the depth of the washed out area is 8 feet.

Scope/Description of Repair:
Reconstruct road, construct permanent bank protection utilizing riprap, and construct log cribbing mitigation along riprap to create complex interface with future flows.

COST ESTIMATE for EMERGENCY REPAIRS*

Quantity	Unit	Item Description	Unit Price	Cost
				$0
				$0
1	LS	Temporary Traffic Control	$ 500.00	$500
				$0
				$0
				$0
				$0
Proposed:	Force Account	Contract	Total Emergency Repairs	$500

COST ESTIMATE for PERMANENT REPAIRS*

Quantity	Unit	Item Description	Unit Price	Cost
1	LS	Mobilization	8000	$8,000
820	CY	Quarry Spalls	25	$20,500
650	CY	Class 5 riprap rock	30	$19,500
130	CY	1 1/4" minus crushed rock	35	$4,550
70	TON	Hot mix asphalt	150	$10,500
60	LF	24" rigid plastic culvert pipe	40	$2,400
1	LS	Log cribbing (logs and revegetion materials)	20000	$20,000
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
			Subtotal Permanent Repairs (continuation sheet)	

Proposed: Force Account Contract	Total Permanent Repairs	$85,450

Identify Betterment, if any, and provide justification*		
Log cribbing is needed as mitigation for riprap to comply with US FWS requirements. Cribbing will be beneficial to fish habitat and riprap is not.	Preliminary Engineering	$4,273
	Construction Engineering	$1,709
	Right-of-Way	$0
	Other	
	TOTAL ESTIMATED COST (Emergency and Permanent Repairs)	$91,932

Submitted By: (Name and Title) *APPLICANT*	Signature:	Date:
Reviewed By: (Name and Title) *FLH FIELD ENGINEER* (Eligible) Ineligible	Signature:	Date:
Recommended By: (Name and Title) *FLH ERFO COORDINATOR* (Eligible) Ineligible	Signature:	Date:

*Attach Supplemental Sheets if necessary
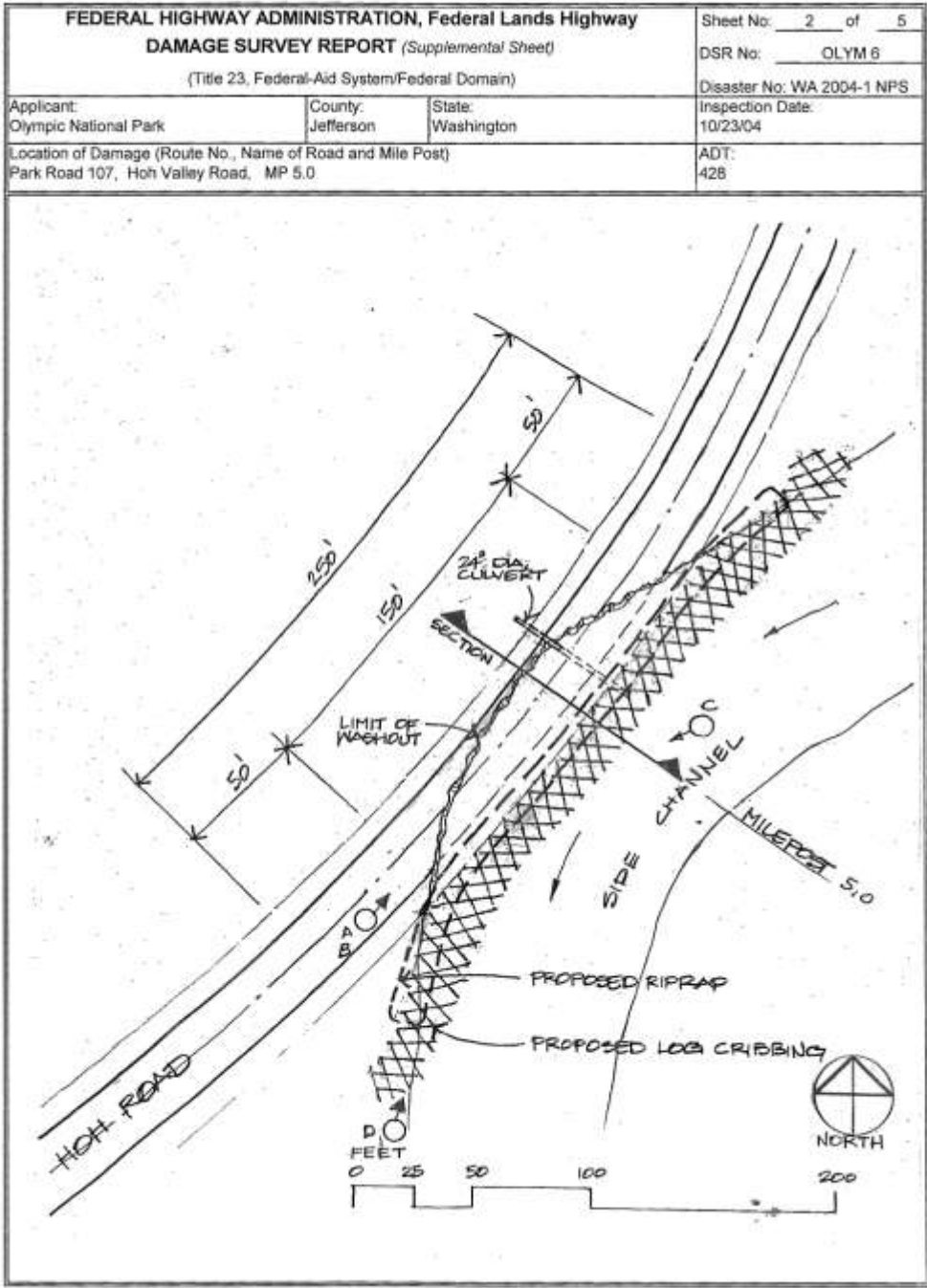
Figure 15: ERFO DSR Example 4, Page 1
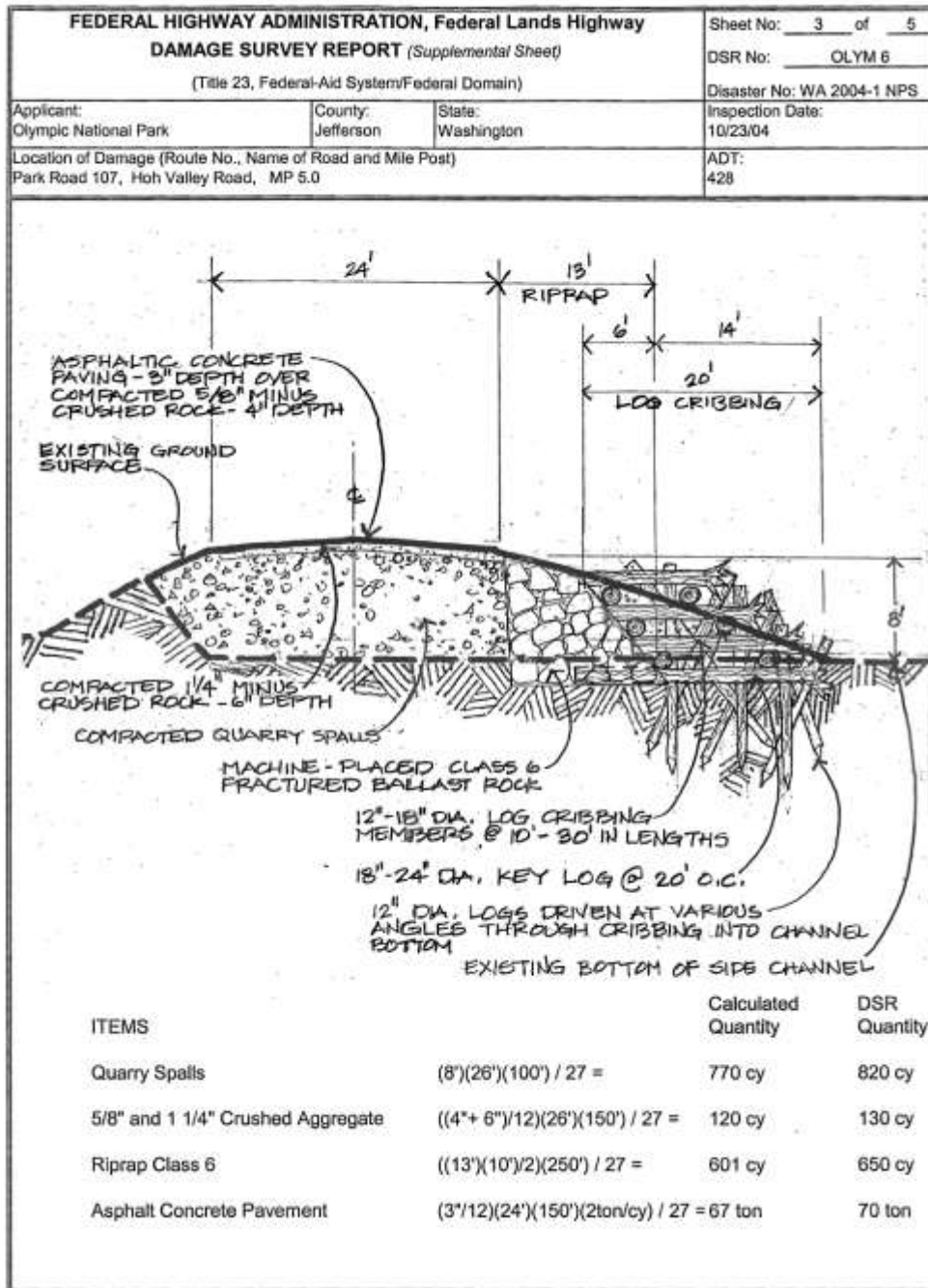
Figure 16: ERFO DSR Example 4, Page 2

18

Figure 17: ERFO DSR Example 4, Page 3

FEDERAL HIGHWAY ADMINISTRATION, Federal Lands Highway			Sheet No: 4 of 5
DAMAGE SURVEY REPORT *(Supplemental Sheet)*			DSR No: OLYM 6
(Title 23, Federal-Aid System/Federal Domain)			Disaster No: WA 2004-1 NPS
Applicant: Olympic National Park	County: Jefferson	State: Washington	Inspection Date: 10/23/04
Location of Damage (Route No., Name of Road and Mile Post) Park Road 107, Hoh Valley Road, MP 5.0			ADT: 428

Figure 18: ERFO DSR Example 4, Page 4

20
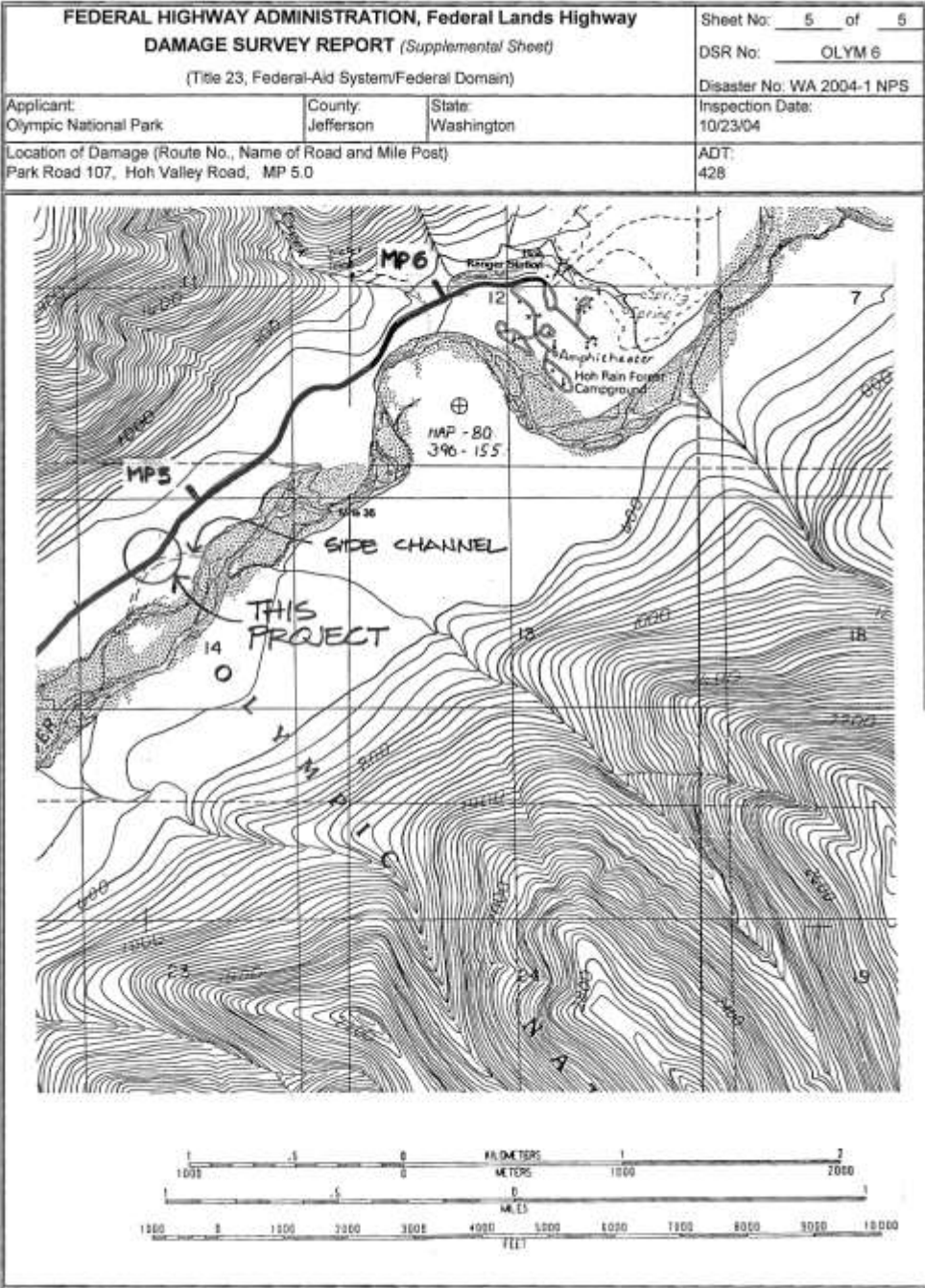
Figure 19: ERFO DSR Example 4, Page 5

Roadway Washout - emergency/permanent repairs completed (without final surfacing and log crib mitigation)

Figure 20: ERFO DSR Example 4, Page 6

CALTRANS REDDING RESPONDER

The Caltrans Redding Responder System was developed in two major research and development phases funded by Caltrans, as well as a minor phase funded by the WTI University Transportation Center (UTC). A third major phase from Caltrans is pending, with a goal of fully preparing the system for deployment, including specifications that can be used for procurement and installation of hardware, as well as preparation of software for production deployment, including provisions for maintenance and support of the associated software. Including the pending third phase, total funding for research and development of the Responder system is nearly $1,000,000. That investment has been of benefit to this project for FHWA CFLD, because it provided a platform and experience upon which to build the associated prototype. It should be noted further that Responder benefited in a similar, although not as significant manner from the WTI UTC "Blackfeet Automated Accident Reporting System." Aside from the difference in the funding associated with these projects, another significant difference and benefit is that the Responder System was thoroughly tested by Caltrans personnel while documenting real incidents. That testing and the associated feedback greatly added to the research team's ability to develop a prototype to meet the needs of CFLHD.

Caltrans Redding Responder Phase 1

In the first phase of the Caltrans Redding Responder project, WTI developed the system concept and associated requirements, and proceeded to develop a proof-of-concept system that was used for testing by WTI staff and demonstration to Caltrans personnel. The proof-of-concept system demonstrated that such a system was viable and potentially useful, and Caltrans decided to proceed with development in a second phase.

Emphasis was placed on ease of use, because end users would not use an overly-complicated or unreliable system. Functionality focused on tasks used to document an incident and to transmit the information from virtually anywhere in the state, including the most remote, rural areas, to transportation management centers so that resources could be dispatched to clear incidents. The system would automatically pinpoint the user's location and populate the incident record with that location, increasing the accuracy of reporting and reducing the reporting burden of the end user. Pen annotation capability via the tablet stylus was very well received. It was noted that pictures are worth a thousand words, and annotated pictures could convey even more information with minimal effort compared to traditional voice communication or typed information on a mobile data terminal. When information documenting the incident was ready for transmission, the user would simply press a "Send" button in the application, and the system would determine whether to use cellular or satellite communication depending on signal strength and pattern for the given location. If the transmission failed, the system would retry, and information was compressed automatically to maximize information transmitted while reducing the chance of failure.

Generic use for incident reporting was considered essential so that the system could be used by Caltrans as well as other public safety agencies (such as law enforcement and fire) to document nearly any type of incident. As such, the system included a minimal amount of agency-specific information, while favoring more generic capabilities such as mapping, sketching, and inclusion of photos, with the ability the annotate maps and photos.

23

Caltrans Redding Responder Phase 2

Five Responder Systems were developed in Phase 2, and four of these systems were tested by Caltrans personnel. The fifth system was kept by WTI for further research and development, as well as for demonstration. At least one of these systems was tested in seven of Caltrans' twelve districts, in environments ranging from urban (San Francisco and Los Angeles) to very rural (Death Valley and the East slope of the Sierra, the Northern Sierra and high desert plains, the Central and Sacramento Valleys, and Coastal areas.) Response from field testing was very positive in terms of utility and usability, and it was estimated that initial demand for Responder Systems throughout Caltrans would be nearly 80 units, if not more. A key to the systems' utility was satellite communication, which was included in the units having a communications briefcase. Figure 21 and Figure 22 show the Responder communications boxes that were pilot tested by Caltrans Personnel. The Responder System for each of these also includes a Panasonic Toughbook® Tablet PC. Both boxes include cellular and satellite modems, as well as a wireless router and a GPS. Figure 23 shows the WTI demonstration system, including a Toughbook® Tablet. This system includes a cellular modem and two satellite modems, in addition to a wireless router and GPS. The Toughbook® for the WTI demonstration system includes an integrated cellular modem and GPS, allowing for standalone use. The remaining two Responder systems tested by Caltrans consisted of stand-alone Tablets with GPS and communication capability, along with a standard digital camera used for all of the systems.

Figure 21: Responder Communication Box #1

Figure 22: Responder Communication Box #2

Figure 23: WTI Demonstration Communication Box

The Responder software application is shown in Figure 24 through Figure 29. Figure 24 shows the Responder splash screen. Figure 25 shows the summary tab in the Responder Incident Organizer. This tab includes observer, time, location and description information. Again, the intent is that this information will be generic and applicable for use by multiple agencies. Figure 26 shows capability to add a photo from a digital camera to the incident record. Figure 27 shows forecast weather conditions specific to the location of the responder. The system retrieves weather information from the National Weather Service using either cellular or satellite communication. Figure 28 shows an annotated photo. Users annotate photos, maps or new sketches using the tablet stylus. Figure 29 shows status of an incident record transmitted as an email via either cellular or satellite communication.
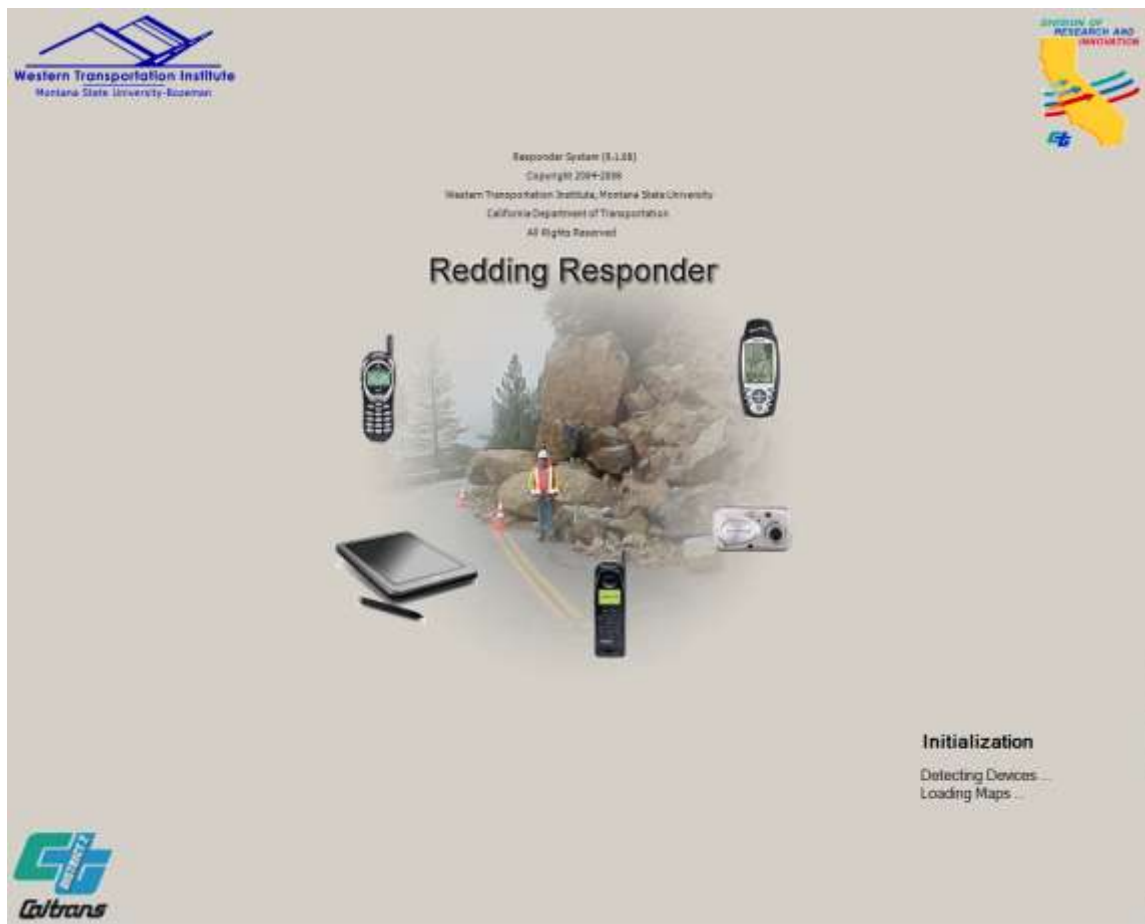
Figure 24: Responder Initial Screen

Figure 25: Responder Incident Organizer

Figure 26: Responder Add Photos Dialog
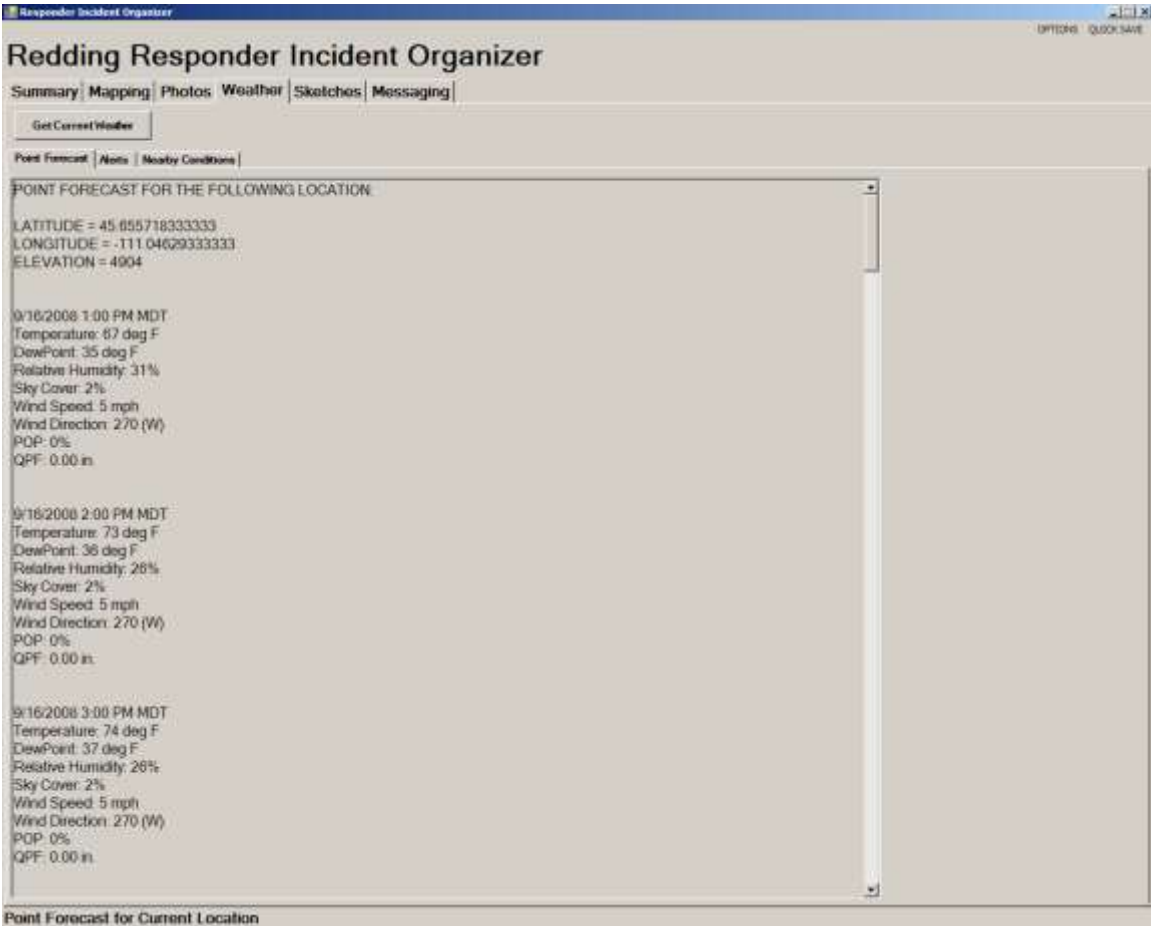
Figure 27: Responder Weather Tab
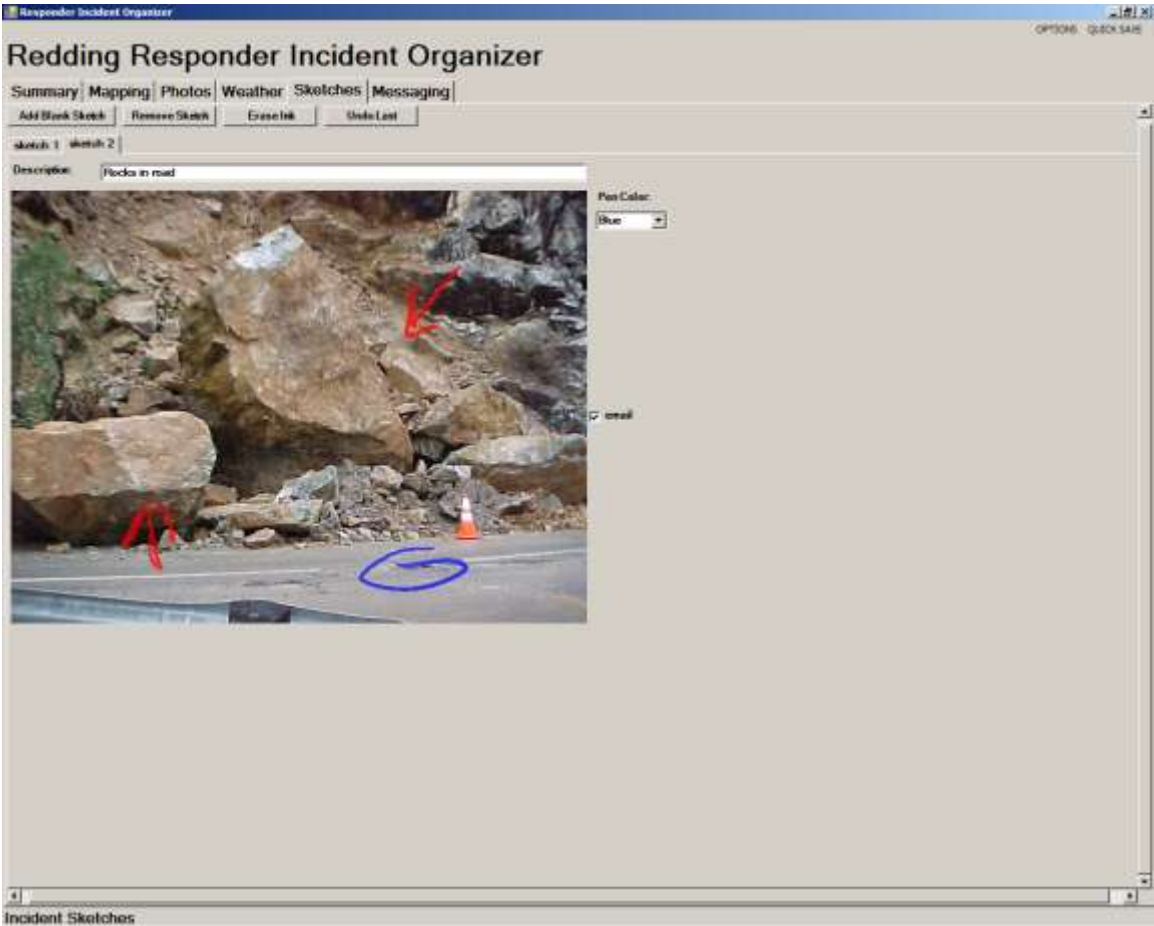
Figure 28: Responder Sketches Tab
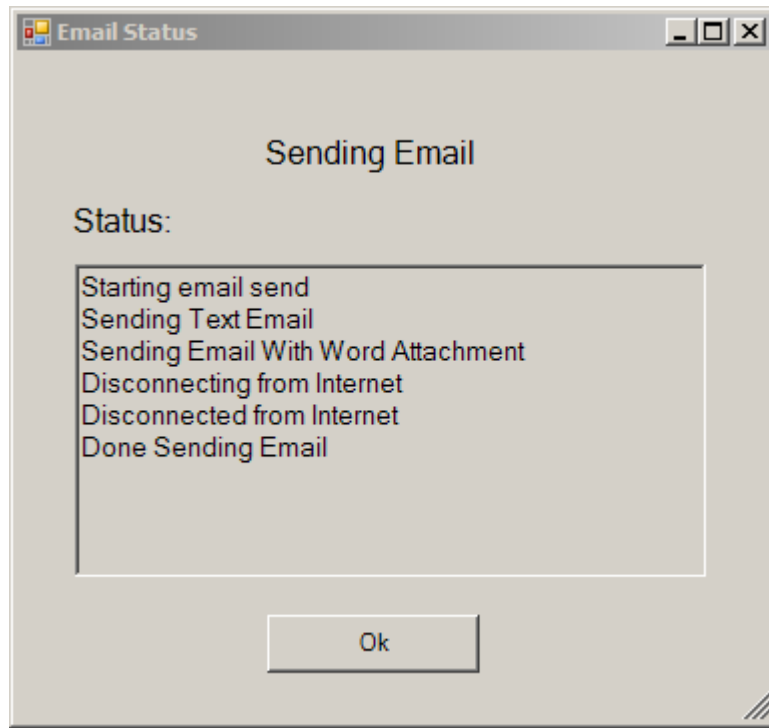
Figure 29: Responder Email Status – Transmission of an Incident Report

CHAPTER 2.   SYSTEM OVERVIEW

GOALS

The goal of this project for FHWA CFLHD was to:

- Develop a location aware prototype of a system for creating Damage Survey Reports in the field that is intuitive to use and requires minimal training.

REQUIREMENTS

The high-level requirements of the project were left general, pending further guidance from field-testing feedback:

- The system shall include rugged hardware for field use.
- The system shall easily incorporate photos, sketches and maps.
- The system shall facilitate creation of free-form sketches.
- The system shall facilitate annotation of maps and photos via sketches.
- The system shall facilitate entry of cost estimate information.
- The system shall produce output in pdf format.
- The system shall be capable of saving information collection.

THE SYSTEM

Hardware

The primary hardware for the system is a Panasonic Toughbook® 19, Tablet PC version with the following configuration:

- Windows XP® Tablet PC Edition
- 64-bit, 1.06 GHz Intel Core 2 Duo
- 80 GB Hard drive
- 1 GB RAM
- 10.4" TFT 1024 x 768 (XGA)
- Lithium Ian 7 Hour Battery
- Gigabit Ethernet Network Adapter
- WLAN : 802.11a/b/g
- Bluetooth® 2.0 EDR
- SD Memory Card Reader
- Integrated GPS
- Integrated CDMA® 2000 1X EV-DO Rev. A cellular modem

Any digital camera with USB connectivity should work with the system, as long as the USB connection creates a drive letter for the camera. A camera was not purchased to accompany the Toughbook®, since the preferences of field users were unknown. It is recommended that a rugged, weather-proof camera be used since primary use is outdoors.

Software

The software was developed to run on Windows XP®, Tablet Edition. No testing has been conducted to determine if the software will run on Windows Vista® or Windows 7®. In all likelihood, the code would have to be modified and rebuilt to run on the most recent version of the Windows® Operating System. Windows XP®, Tablet Edition was the current, stable version of the Windows® operating system when this project was initiated, and is the operating system for which the Responder System was developed.

The software does require that Microsoft MapPoint® and Microsoft Office® are installed on the computer.

The Toughbook® should be running in Tablet mode for proper operation of the software, although convertible mode will be necessary for keyboard use.

The initial screen shows a splash page and indicates device availability (GPS) and status of loading maps. If a GPS fix is available, maps will be automatically loaded to correspond to the user location, and the user location will be automatically populated in the applications forms.

Figure 30: Damage Survey Report Initial Screen

The software application is organized using a tabbed view to break up the form fields into sections that are manageable within a single screen. An effort was made to organize the tabs by functionality, and the result is very similar to what was originally done for Caltrans in the Redding Responder project.

The Summary Tab is the next tab that a user will see. The summary information displayed in this tab corresponds to information on the DSR ERFO form. Note that location and applicant information is pre-populated, if that information is available. Otherwise, the user can enter information for each of the fields by either using the Tablet stylus or the keyboard.

Figure 31: Summary Tab

The Photos tab allows users to add photos from a digital camera. The photos become part of the incident record and are stored by the application with the incident information.

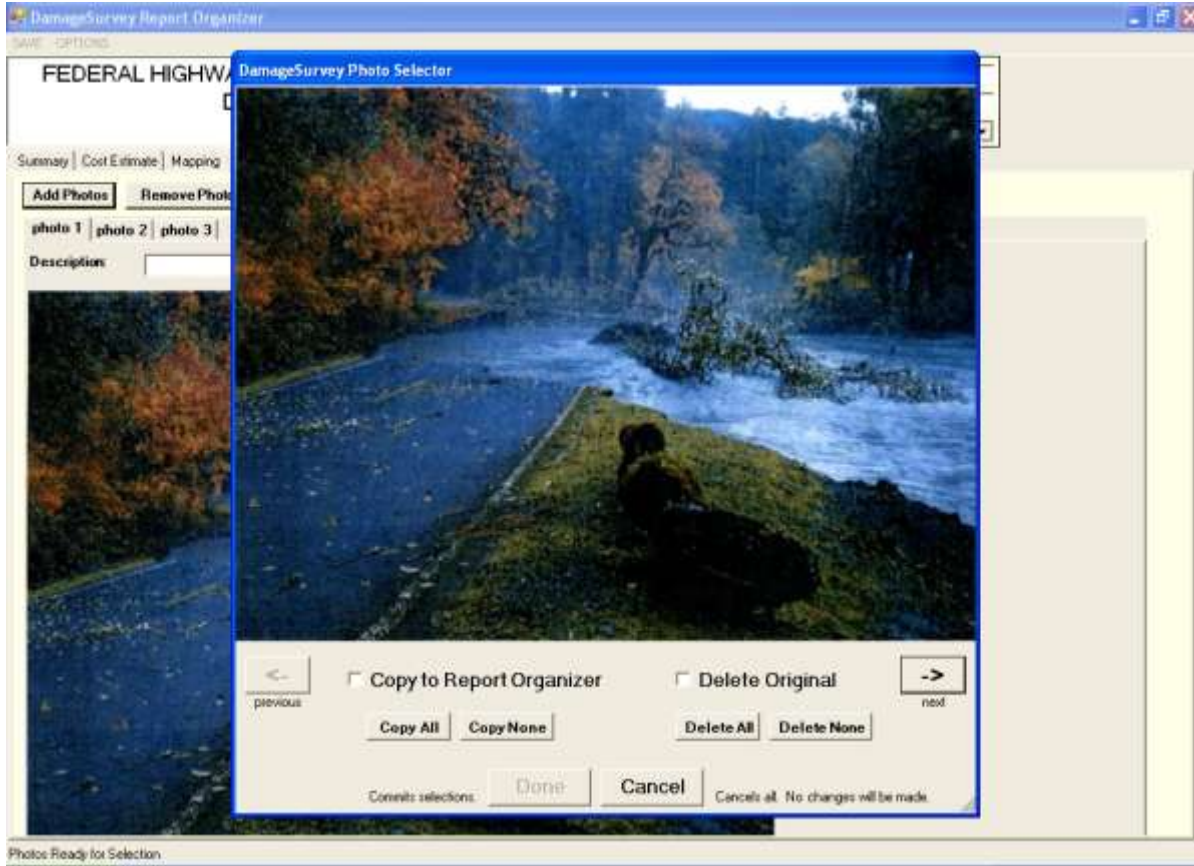**Figure 32: Camera Connection to Toughbook®**

Figure 33: Add Photos Dialog

The Sketches tab allows users to use the Tablet stylus to annotate maps or photos that were previously copied to the "Sketches" area. Users can also add a blank sketch to create a free form drawing to help describe the incident. In addition, a cost estimate can be added to a sketch to indicate permanent or emergency repair costs associated with what is depicted in the sketch.
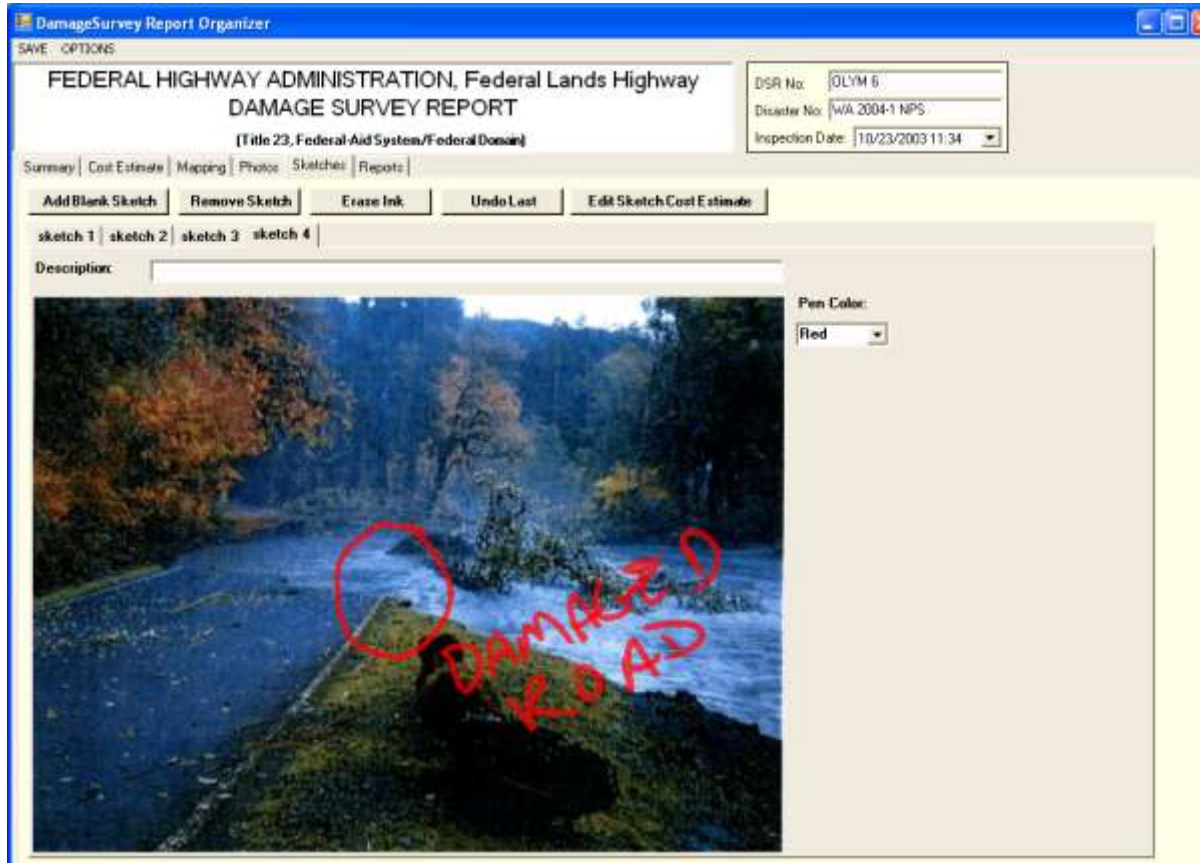

Figure 34: Sketches Tab

	ITEM	Calculation	Unit	Calculated Quantity	DSR Quantity	Type
▶	Quarry Spalls	(8')(26')(100')/27 =	CUYD	770	820	Permanent R...
	Aggregate	((4''+6'')/12)(26')(150')/27 =	CUYD	120	130	Permanent R...
	Riprap, Class__	((13')(10')/2)(250')/27 =	CUYD	601	650	Permanent R...
	Asphalt concrete pavement	(3''/12)(24')(150')(2ton/cuyd)/...	TON	67	70	Permanent R...
✳						

OK

Figure 35: Add Cost Estimate Calculation Dialog Box

39

The Cost Estimate tab allows users to enter costs that are associated with the repairs outlined in the damage survey report. Users can enter items associated with either emergency repairs or permanent repairs. Detailed cost estimate items and a mechanism for updating this information are not included in the prototype system. These items were requested but were not available within the performance period for this project. The information included with the system and shown below are for example only.

Figure 36: Cost Estimate tab

40

The Mapping tab allows users to view Road maps, Aerial photos, and USGS Topographical maps of the damage area. Users can also check the status of the GPS device. The Road Map option shows a road map using Microsoft MapPoint® . MapPoint® is also used to identify street name and address, given the latitude/longitude location of the user.
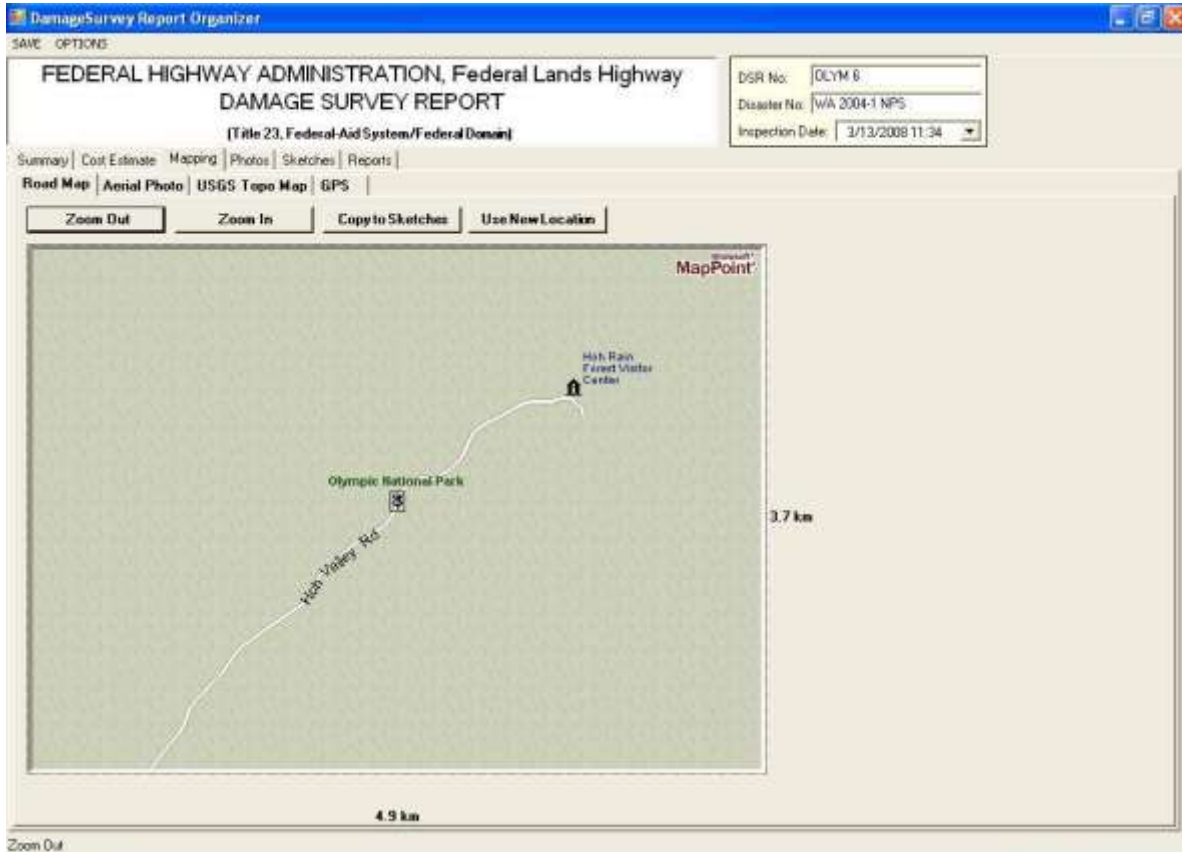

Figure 37: Mapping Tab

The Reports tab allows users to format the report pages and create the report as a PDF document. By default the first page of the report will contain the Summary and Cost Estimate information. The Reports tab allows users to pick which photos and sketches to include in the PDF report or quickly add all photos and sketches, one per page. When users initially use the Reports tab for a new damage survey report, they will see a list of photos and sketches on the bottom right of the screen and a blank photo Placement area for Page 1 on the left.
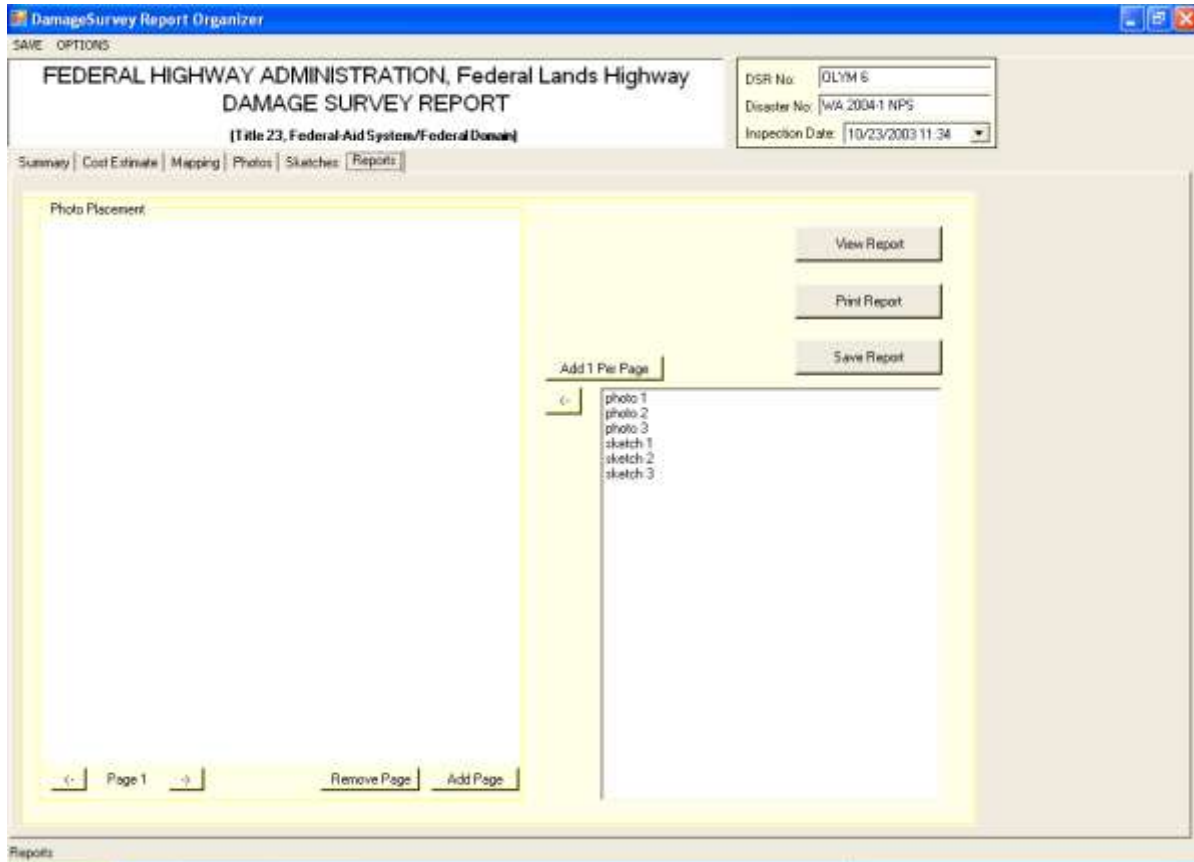

Figure 38: Reports Tab

EXAMPLE REPORT

The following example report was generated using the prototype system, and is intended to correspond to the format used for actual DSRs. The sample report is displayed in Figures 39 - 46. It was generated using information from an actual hard copy DSR, previously displayed in Chapter 1, Figures 15-20.

Figure 39 shows the front page of the DSR, including cost estimates and a general overview of the incident and associated repairs, along with the date and time. Figure 40, Figure 41 and Figure 42 shows photos that were imported into the incident record. Figure 43 and Figure 44 show sketches of the repairs. Note that these sketches were not generated within the prototype system, but were instead imported as images into the system. Figure 45 shows an annotated map and Figure 46 shows an annotated photo. The annotations were added using the tablet stylus.

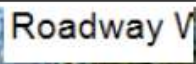This report demonstrates that the system can be used successfully to create an ERFO DSR conforming to the current format.

FEDERAL HIGHWAY ADMINISTRATION, Federal Lands Highway DAMAGE SURVEY REPORT (Title 23, Federal-Aid System/Federal Domain)			Sheet No: _____1_____ of _____8_____ DSR No: _____OLYM 6_____ Disaster No: WA 2004-1 NPS	

Applicant: Olympic National Park		County: Jefferson	State: Washington	Inspection Date: 10/23/2003 11:34

Location of Damage (Route No., Name of Road and Mile Post) Hoh Valley Rd Route No. 107, MP 5.0 (47.8508316166699, -123.956403359771)			ADT: 428

Bridge Data:	Road Data:	Classification:	Photograph #:
Type:	Traveled Way Width: 20'	Surface Type: ACP Thickness: 3"	
ID# N/A	Shoulder Width: 2'	Surface Type: ACP	

Description and Cause of Damage:
Bank along a side channel of the High River eroded and washed out the road over a length of 100 lineal feet. The bend in the side channel extends across the road, and the depth of the washed out area is 8 feet.

Scope/Description of Repair:
Reconstruct road, construct permanent bank protection utilizing riprap, and construct log cribbing mitigation along riprap to create complex interface with future flows.

COST ESTIMATE for EMERGENCY REPAIRS*

Quantity	Unit	Item Description	Unit Price	Cost
1	LS	Traffic Control	$500.00	$500.00

Proposed:	Force Account	Contract	Total Emergency Repairs	$500.00

COST ESTIMATE for PERMANENT REPAIRS*

Quantity	Unit	Item Description	Unit Price	Cost
1	LS	Mobilization	$8,000.00	$8,000.00
60	LNFT	Culvert 24" Rigid Plastic	$40.00	$2,400.00
1	LS	Clearing and Grubbing	$20,000.00	$20,000.00
820	CUYD	Quarry Spalls	$25.00	$20,500.00
130	CUYD	Aggregate 5/8" and 1 1/4" Crushed	$35.00	$4,550.00
650	CUYD	Riprap, Class__ Class 6	$30.00	$19,500.00
70	TON	Asphalt concrete pavement	$150.00	$10,500.00

		Subtotal Permanent Repairs (continuation sheet)	
Proposed: Force Account Contract		Total Permanent Repairs	$85,450.00

Identify Betterment, if any, and provide justification* log cribbing is needed as mitigation for riprap to comply with US FWS requirements. Cribbing will be beneficial to fish habitat and riprap is not.0	Preliminary Engineering	$4,273.00
	Construction Engineering	$1,709.00
	Right-of-Way	$0.00
	Other	$0.00
	TOTAL ESTIMATED COST (Emergency and Permanent Repairs)	$91,932.00

Submitted By:(Name and Title) Applicant	Signature:	Date:
Reviewed By:(Name and Title) FLH Field Engineer (Eligible) Ineligible	Signature:	Date:
Recommended By:(Name and Title) FLH ERFO Coordinator (Eligible) Ineligible	Signature:	Date:

*Attach Supplemental Sheets if necessary

Figure 39: Generated DSR Front Page

FEDERAL HIGHWAY ADMINISTRATION, Federal Lands Highway			Sheet No: 2 of 8
DAMAGE SURVEY REPORT *(Supplemental Sheet)*			DSR No: OLYM 6
(Title 23, Federal-Aid System/Federal Domain)			Disaster No: WA 2004-1 NPS
Applicant: Olympic National Park	County: Jefferson	State: Washington	Inspection Date: 10/23/2003 11:34
Location of Damage (Route No., Name of Road and Mile Post) Hoh Valley Rd Route No. 107, MP 5.0 (47.8508316166699, -123.956403359771)			ADT: 428

Figure 40: Generated DSR Supplemental Sheet Including a Photo

FEDERAL HIGHWAY ADMINISTRATION, Federal Lands Highway
DAMAGE SURVEY REPORT *(Supplemental Sheet)*
(Title 23, Federal-Aid System/Federal Domain)

Sheet No: 3 of 8
DSR No: OLYM 6
Disaster No: WA 2004-1 NPS

Applicant: Olympic National Park
County: Jefferson
State: Washington
Inspection Date: 10/23/2003 11:34

Location of Damage (Route No., Name of Road and Mile Post)
Hoh Valley Rd Route No. 107, MP 5.0 (47.8508316166699, -123.956403359771)
ADT: 428

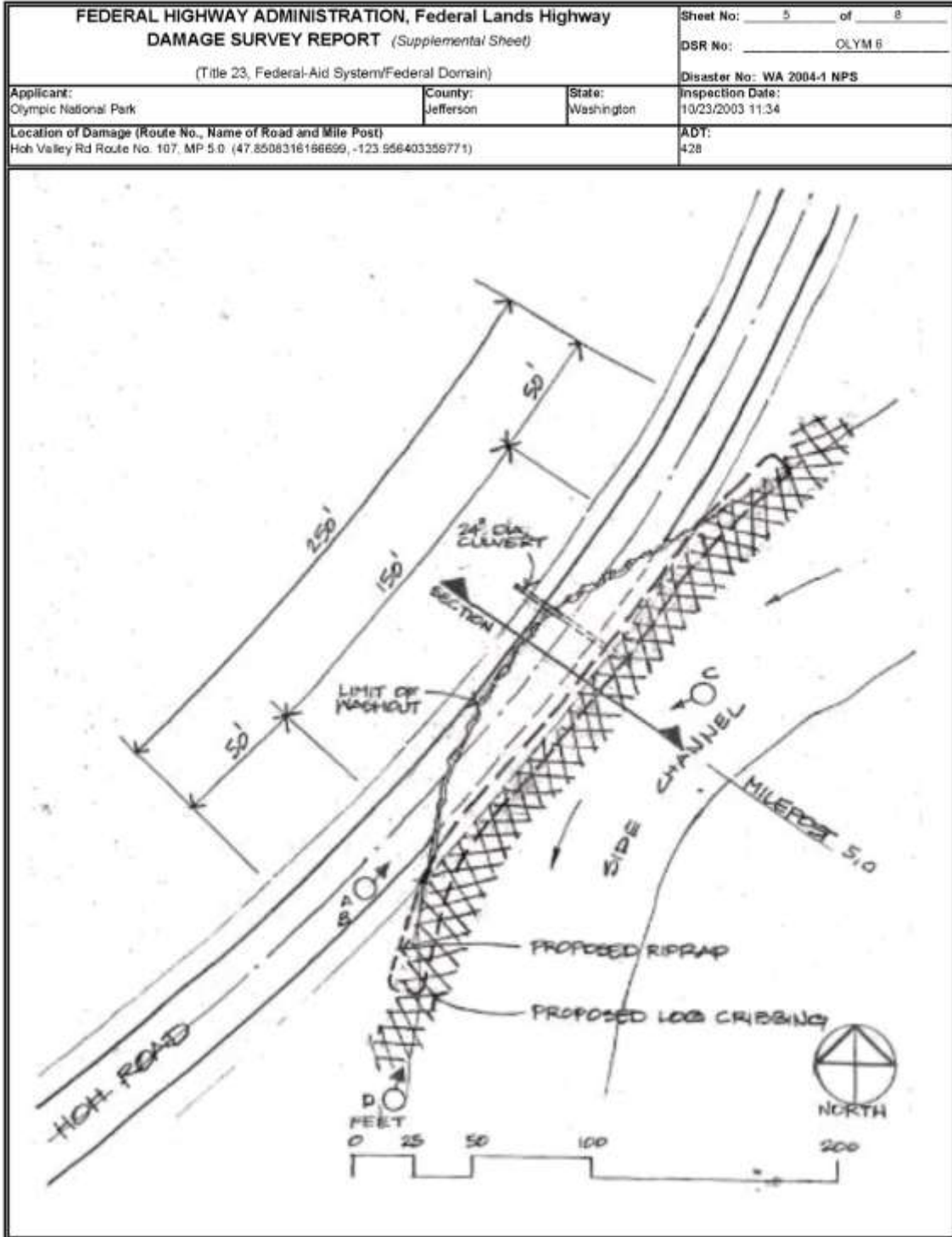**Figure 41 Generated DSR Supplemental Sheet Including a Photo**

FEDERAL HIGHWAY ADMINISTRATION, Federal Lands Highway	Sheet No: 4 of 8
DAMAGE SURVEY REPORT *(Supplemental Sheet)*	DSR No: OLYM 6
(Title 23, Federal-Aid System/Federal Domain)	Disaster No: WA 2004-1 NPS

Applicant: Olympic National Park	County: Jefferson	State: Washington	Inspection Date: 10/23/2003 11:34
Location of Damage (Route No., Name of Road and Mile Post) Hoh Valley Rd Route No. 107, MP 5.0 (47.8508316166699, -123.956403359771)			ADT: 428

Figure 42 Generated DSR Supplemental Sheet Including a Photo

Figure 43: Generated DSR Supplemental Sheet Including a Sketch created with other Software
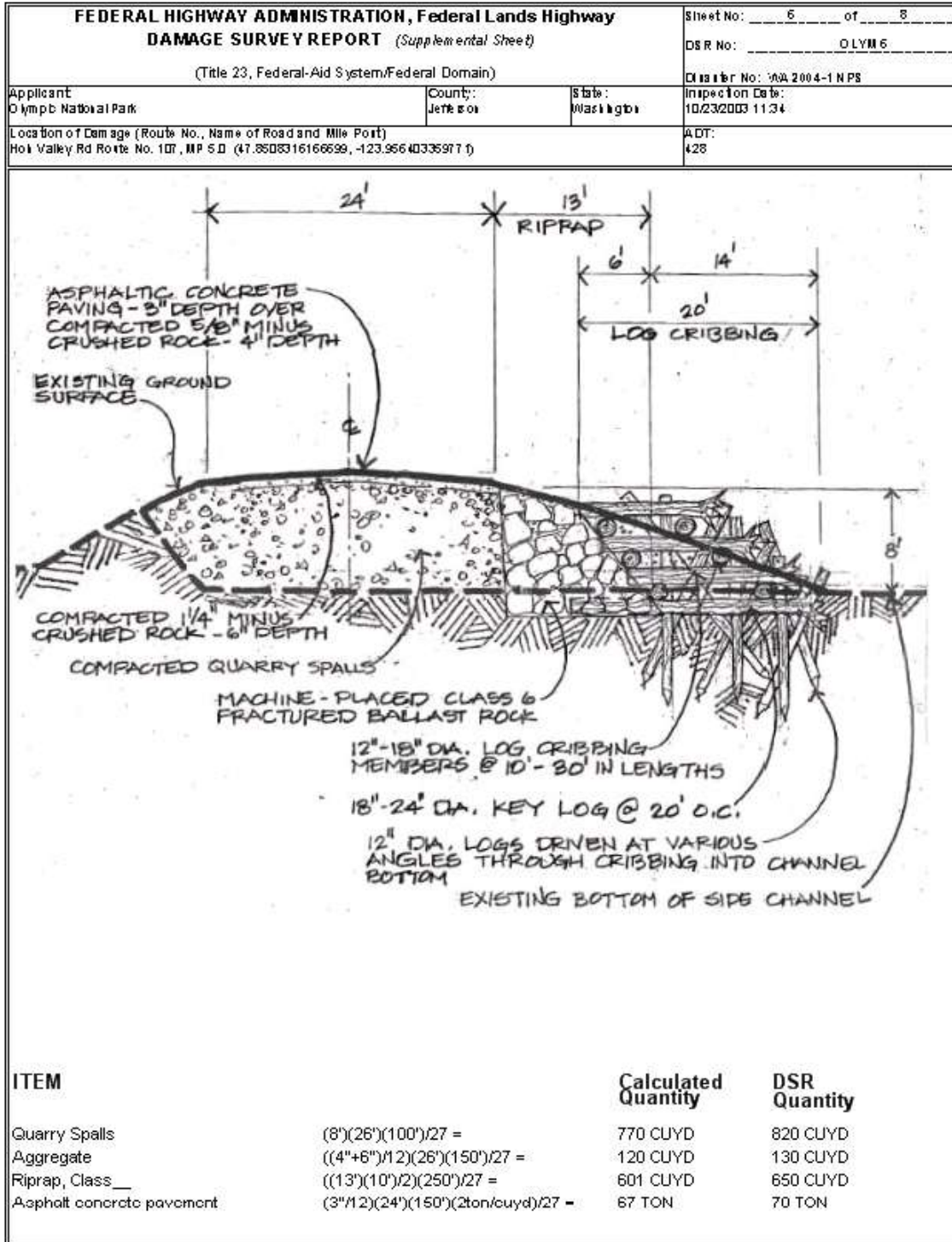
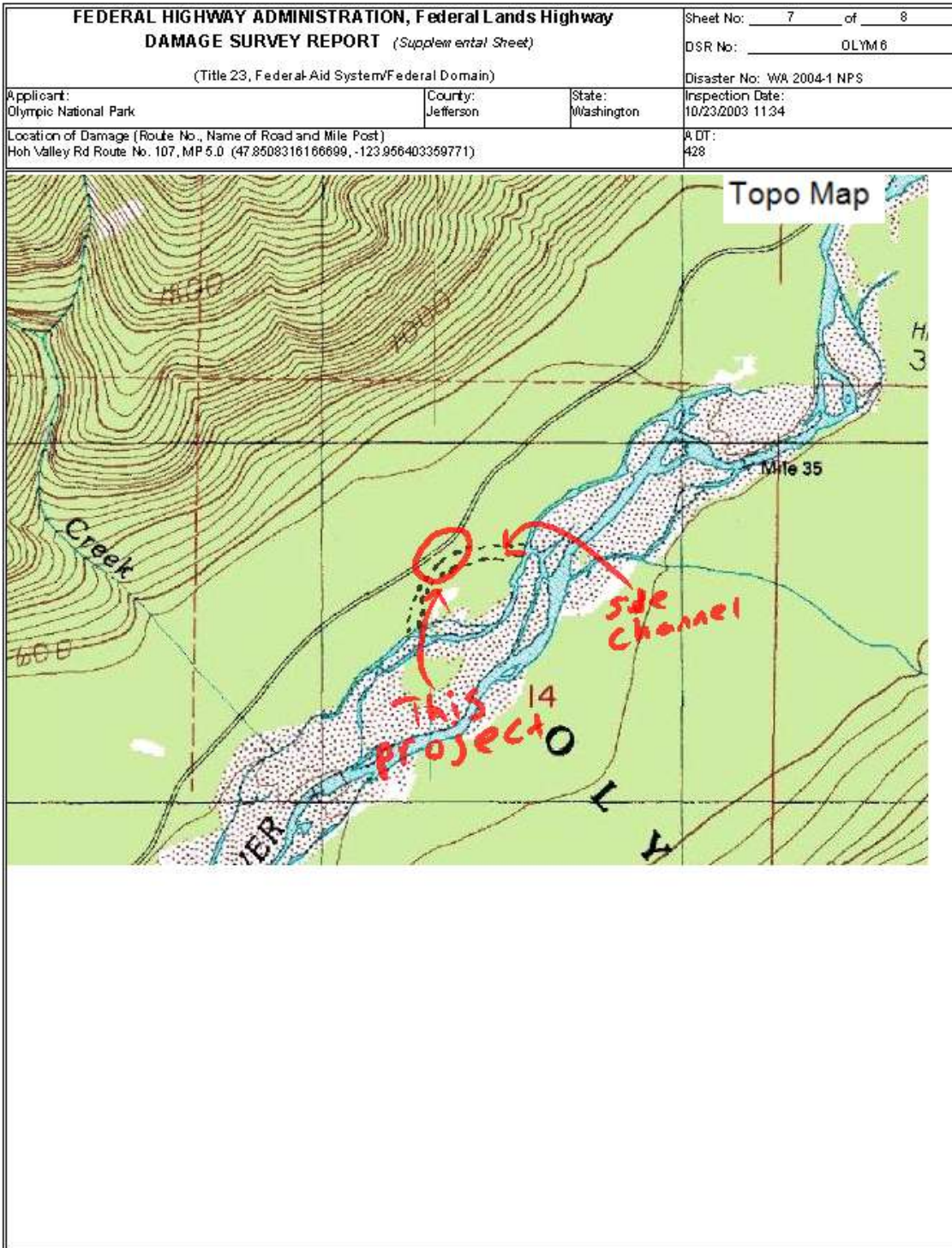**Figure 44: Generated DSR Supplemental Sheet Including a Sketch created with other Software**

Figure 45: Generated DSR Supplemental Sheet Including a Topographic Map with a Sketched Annotation

Figure 46: Generated DSR Supplemental Sheet Including a Photo with a Sketched Annotation

CHAPTER 3.   CONCLUSIONS

Through this scope of work, the research team designed and built a prototype system, and successfully demonstrated it to FHWA CLHD staff. Unfortunately, the prototype system was not field-tested by FHWA CFLHD staff. The project team made numerous requests for field testing, but neither an area nor a crew was identified by CFLHD for testing. As such, the system remains a lab prototype, and is in no way considered ready for production use.

The software developed for this project was based largely on the software developed previously for the Caltrans Redding Responder system. The base code for this prototype system used the Responder base code as a starting point. As such, a bulk of the research and development that was necessary for this project had been conducted within prior research and development for Caltrans. Otherwise, it would not have been possible to develop the system to the extent that it has been developed within the scope and budget of this project. Since this research and development project had a primary outcome of a prototype, formal arrangements for maintenance and support of the code were not considered within this scope. Caltrans would certainly need to be involved in subsequent discussions of how to proceed. As such, the principal deliverables are considered to be the software prototype (executables) and the demonstration hardware on which it has been installed, as well as this report and associated system documentation.

In general, this application does appear to be viable and the prototype system demonstrates its viability. However, it is unclear whether users are receptive to the idea of replacing the current method of producing ERFO DSRs. Other applications such as general incident management and reporting, similar to what Caltrans has used the Redding Responder system for, should be considered for alternate, similar use.