

**PRACTICAL APPLICATION OF  
ODOT'S PLAN OF ACTION  
DATABASE TO ASSIST  
MAINTENANCE DISTRICTS DURING  
FLOODING EVENTS**

by

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# REAL – TIME MONITORING OF SCOUR CRITICAL BRIDGES


Two computers collect and analyze incoming data 24-hrs a day.  
Each serves as a back-up for the other.

## Computers monitor:

- USGS Stream flow data
- AHPS (Advanced Hydrologic Prediction Service) forecast data
- NWS (National Weather Service) rainfall data
- NWRFC (Northwest River Forecast Center) data
- National Climatic Data Center NEXRAD (Next Generation Radar) data

# Real-Time Monitoring of hydrologic data.

Bridge Hydrologic Data Monitor
Close



## BridgeAlerts

Oregon Department of Transportation  
Scour-Critical Bridges  
Hydrologic Data Monitoring System

Current Task:	Last Run (PDT):	Duration (min.):	Interval (min.):	Status:
<input type="radio"/> Refresh Flow Gage Data <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <span>78 Stations</span> </div>	07/07/2010 10:28:18	1:24	20	OK
<input type="radio"/> Refresh AHPS Forecast Data <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <span>89 Stations</span> </div>	07/07/2010 10:28:56	12:01	20	OK
<input type="radio"/> Refresh AHPS Recaps <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <span>89 Stations</span> </div>	07/07/2010 10:17:56	1:18	20	OK
<input checked="" type="radio"/> Refresh Rainfall Data <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <span>28 Stations</span> </div>	07/07/2010 10:23:15	1:12	20	OK
<input type="radio"/> Refresh Rainfall Predictions <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <span>550/722 Bridges</span> <div style="width: 100px; height: 10px; background-color: black; position: relative;"> <div style="width: 75%; height: 100%; background-color: black;"></div> </div> </div>	07/07/2010 09:41:28	30:34	20	Running
<input type="radio"/> Refresh NEXRAD Tabular Data <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <span>12 Stations</span> </div>	07/07/2010 10:27:47	1:06	6	OK


**Data Monitoring Paused**
 **State-Owned Bridges Only**

Start Data Monitor

Pause

Current Time (PDT):

07/07/2010 10:32:09



Close

CPU Usage
0 %
RAM Left
3,468,881,920 (B)

Home page for the Plan of Action database

Oregon DOT Bridge Alerts (POA Client)

File List Filtering Actions Help

Welcome, hwy93z  
Computer: XDE7400AH

## Oregon Scour-Critical Bridges Plan of Action

Select Bridge: 04660A

Filter Bridges Three Rivers, Hwy 9

Filtered Count 769 ?

Default: State Bridges  
 Remember Filter

Display Published POA  
Print POA  
Edit POA  
Triggers  
Edit Trigger/Stable Bridges  
Publish POA Request  
Risk-Based Management Guidelines  
Hydrology  
Scour Analysis  
Quit

Show Data Monitor

Message Status: Ready.



# Hydrologic stations associated with each bridge. (trigger page)

Bridge Alert Triggers - SCOUR-CRITICAL TRIGGER BRIDGE

Bridge Alert Triggers for Bridge No. 01992 @ 42.255242,-123.169342 Applegate River, Hwy 272 at MP 18.04 (Applegate) [Filter Bridges](#) Count 774 [Close](#)

**Triggers**

Rainfall Gage: **KMFR - ROGUE VALLEY INTERNATIO** Location: 42.380000,-122.870000  
Latest Report: 9/12/2011 12:53  
1-hr: .00  
3-hr: .00  
6-hr: .00

Flow Gage: **14366000 - APPLGATE RIVER NEAR** Location: 42.241511,-123.140049  
Latest Report: 9/12/2011 13:15  
Discharge: 374.00  
Stage: 1.98

**AHPS Recaps**

Forecast Station: [Get AHPS Web Forecasts](#)  
APR03 - APPLGATE RIVER NEAR APPLGATE

Observation:  
Flood Stage: 13.0 ft  
Latest Observation: 1.98 ft  
Observation Time: 09/12/2011 11:15 PDT\*

Forecast:  
Flood Stage: 13.0 ft  
Latest Observation: 1.98 ft  
Observation Time: 09/12/2011 11:15 PDT\*  
Highest Forecast: 1.98 ft  
Highest Forecast Time: 09/14/2011 11:00 PDT\*  
Last Forecast: 1.85 ft  
Last Forecast Time: 09/22/2011 05:00 PDT\*


Alert(s):  
Alert conditions are not currently being met.  
Alert Stage: 12.0 ft  
Flood Stage: 13.0 ft  
Latest Observation: 1.98 ft  
Observation Time: 09/12/2011 11:15 PDT\*  
Highest Forecast: 1.98 ft  
Highest Forecast Time: 09/14/2011 11:00 PDT\*  
Last Forecast: 1.85 ft  
Last Forecast Time: 09/22/2011 05:00 PDT\*

**NEXRAD Radar**

NEXRAD Station: [Get NEXRAD Radar Map](#)  
KMAX - MEDFORD  
Product: NOR - Base Reflectivity

Add/Delete Stations [Configure Bridge Stations](#)

Google Maps  
[Bridge](#)  
[Flow Gage](#)  
[Rainfall](#)  
[Rainfall Forecast](#)  
[AHPS Forecast](#)  
[NEXRAD Station](#)  
[Simulate Weather Event](#)



Scour Bridge: 01992 | Applegate River, Hwy 272 at MP 18.04 (Applegate) @ 42.255242,-123.169342

URL: [file:///C:/Share/ScourPlanOfAction/Temp/Map\\_01992\\_cpjio4k.ua1.htm](file:///C:/Share/ScourPlanOfAction/Temp/Map_01992_cpjio4k.ua1.htm)

# **Real time data is used to alert maintenance staff of potentially hazardous conditions**

Each scour-critical bridge has been associated with hydrologic stations best suited to indicate potential scour problems.

When a discharge, rainfall, or event forecast exceeds a predetermined threshold, a text-message and e-mail are sent to the maintenance personnel responsible for that bridge.

These events are called trigger events, with the defaults set for 10 year recurrence-interval events.

# Trigger Bridge

## Definition:

- **A trigger bridge is representative of scouring conditions at all scour-critical bridges in the drainage basin it is within.**
- **It is used as a field indicator of scour risk during flooding in its basin.**
- **On site monitoring of the water surface elevation marked on each trigger bridge will cause specific actions to take place.**
  - **Generally, the first action would be to inspect all of the bridges located in that drainage basin for scour damage**

# Why are trigger bridges necessary?

- **Real time monitoring data is regional in nature.**
- **Seldom are the monitored hydrologic sites very accurate indicators of what is actually happening at a specific bridge**
- **By physically observing the time when the trigger elevation is reached the values of the monitored hydrologic data can be determined and their values changed to trigger at these new values.**
- **The change is made in an attempt to better determine when the water surface elevation trigger will be reached.**
- **The assumption is that by matching the regional data to the actual trigger events each scour-critical bridge will have more accurate alerts.**



# Trigger Bridge Marked



# Advantages and Disadvantages

## Advantages:

- **When several drainage basins are flooding, maintenance personnel can concentrate their field inspections to the basins triggered.**
- **The bridges used as basin triggers were chosen by the maintenance personnel responsible for the basin.**
- **The actual trigger elevations are determined with the help of the hydraulics unit.**

## Disadvantage:

- **Actual field review is required before the trigger alert is activated.**
  - **Remote monitors do exist that will be put in place on each trigger bridge as funding becomes available**
- **Hydrologic monitoring stations are more regional in their coverage.**

# e-mails sent when alert event occurs

ODOT BridgeAlerts Weather Event Alert - Message (HTML)

From: John.R.WOODROOF@odot.state.or.us Sent: Tue 8/16/2011 8:41 PM  
To: WOODROOF John R; NEWKIRK Don E; TALLEY Devon B  
Cc:  
Subject: ODOT BridgeAlerts Weather Event Alert

**BridgeAlerts**

The ODOT **BridgeAlerts** system has detected a discharge forecast alert condition from AHPS forecast station SERO3 (John Day River at Service Creek) for the following bridges:

Bridge No.	District No.	Bridge Name
02233A	District 12	Harper Creek, Hwy 5
02236A	District 12	Alder Creek, Hwy 5
04979A	District 12	Juniper Creek, Hwy 5
04981A	District 12	Mathias Creek, Hwy 5

This level of 84,300 cfs is calculated to be a 500-year event+ at this site.

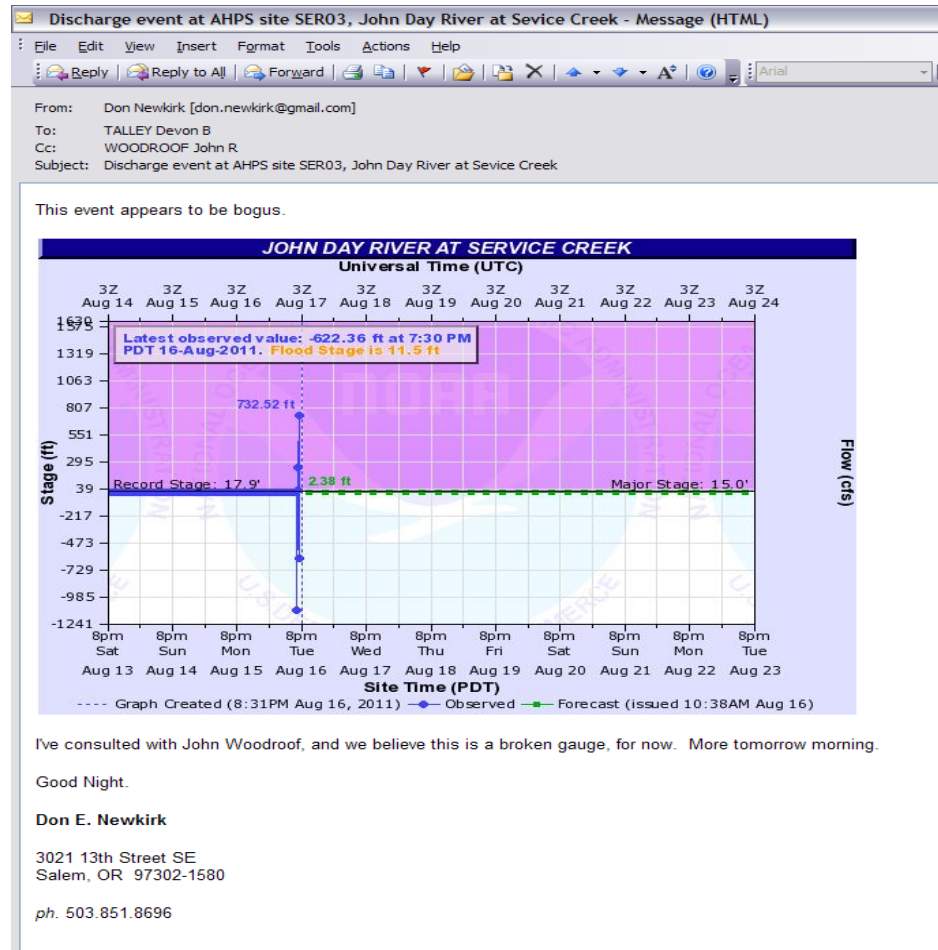
This message was generated automatically by the ODOT BridgeAlerts system. The bridges listed are associated with the station mentioned above, and may be impacted by the reported measurement(s) or forecast(s).

**John Woodroof**  
Phone: (503)986-3366

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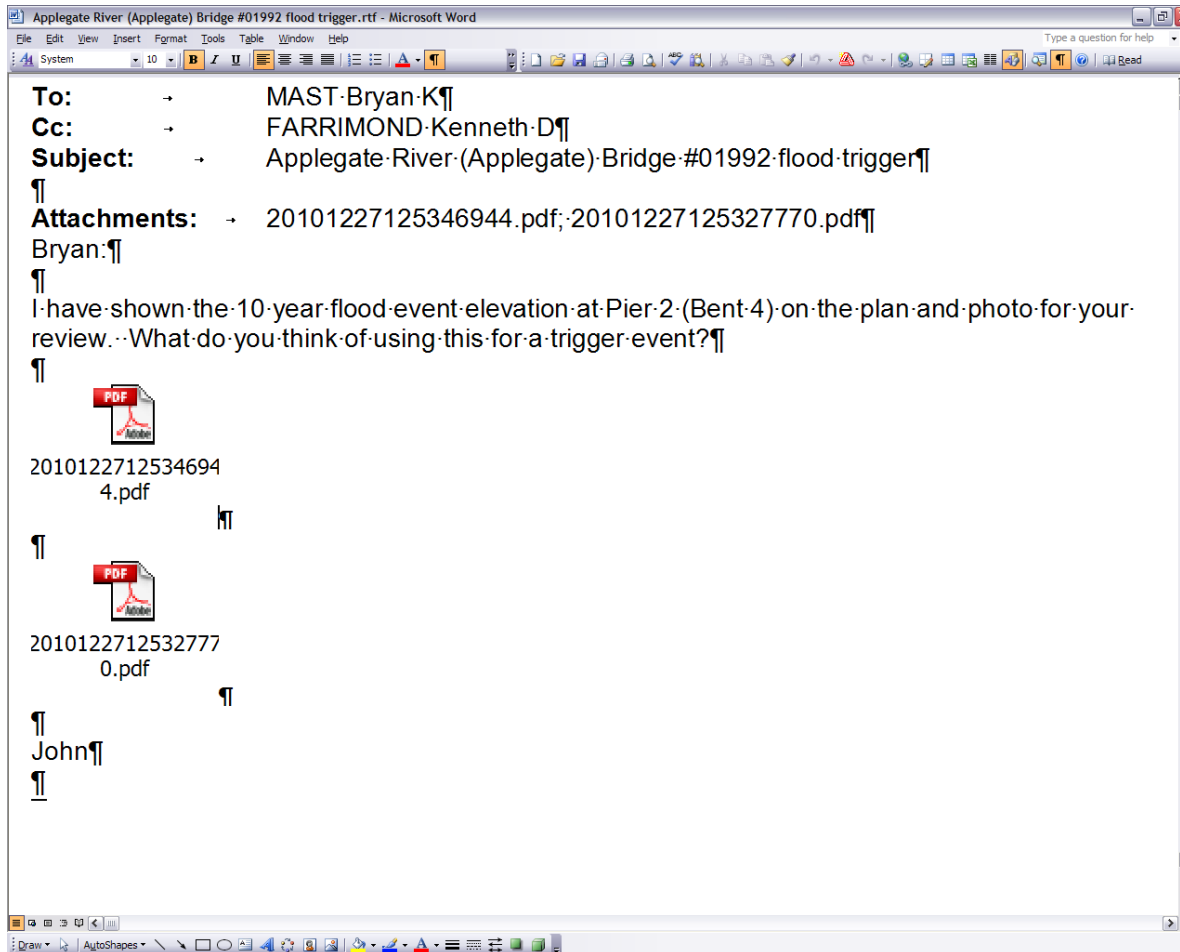
Senior Hydraulics Engineer  
ODOT Bridge Engineering Section  
4040 Fairview Industrial Drive SE  
Salem, OR 97302

# Sent Alerts are verified by hydraulics engineer for accuracy



## ▪ **Trigger Bridge Creation**

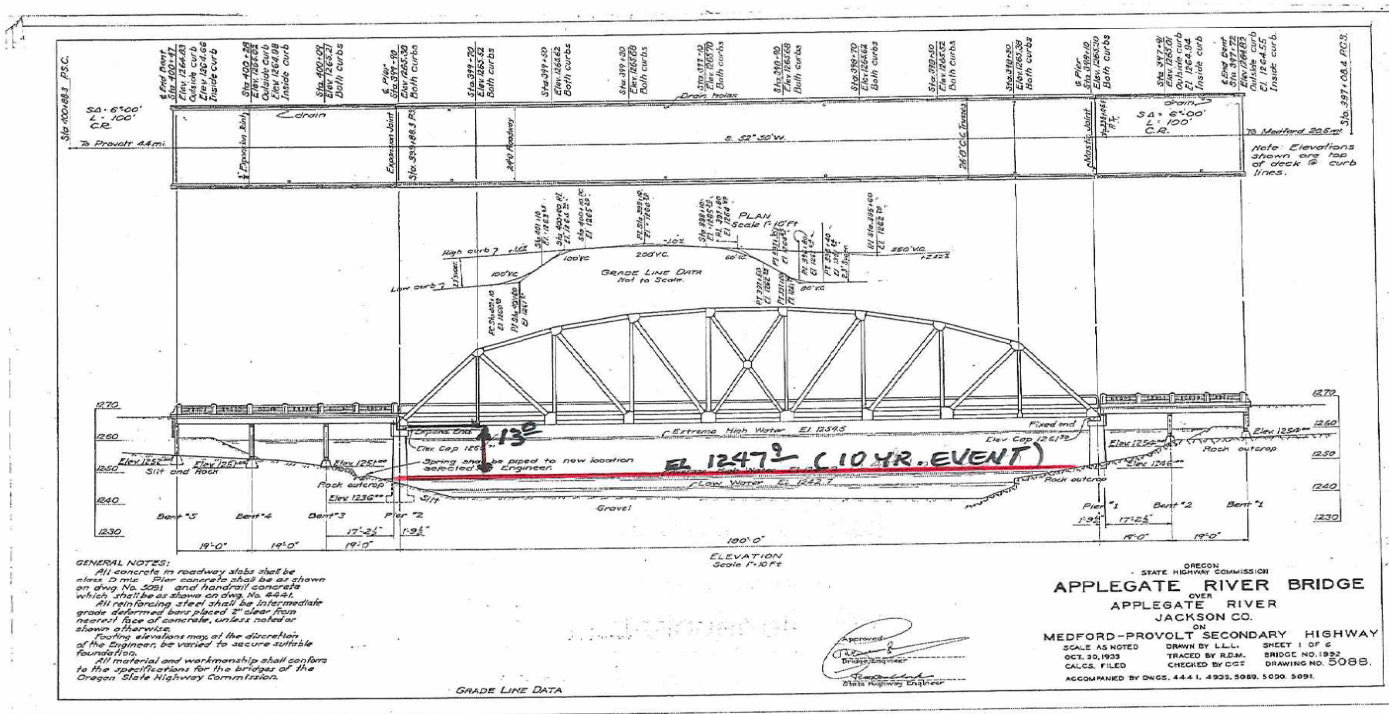
# E-mail between maintenance and headquarters regarding proposed trigger bridge





# Plan and Elevation showing proposed trigger elevation

Plan and Elevation with proposed trigger elevation shown



Elevation photo showing proposed trigger elevation





# Trigger bridge after it has been marked



# Plan of Action Monitoring page

Scour-Critical Bridge - Plan of Action

File Tools Help **SCOUR-CRITICAL BRIDGE - PLAN OF ACTION** **TRIGGER BRIDGE** Close

Filter Bridges Find Structure #: 01992 | Applegate River, Hwy 272 Bridge: 01992  Published  Revised

§ 7 Countmeasures § 8 Bridge Closure § 9 Detour Route § 10 Attachments § 11 Comments § 12 Trigger Bridge Control Panel  
§ 1 General § 2 Responsibility § 3 Scour Vulnerability § 4 Summary § 5 NBI Coding § 6a Monitoring (beg.) § 6b Monitoring (end)

### 6. MONITORING PROGRAM (beginning)

**Regular Inspection Program**  w/surveyed cross sections  
Items to Watch:

**Increased Inspection Frequency of**  mo.  w/surveyed cross sections  
Items to Watch:

**Underwater Inspection Required**  
Items to Watch:

**Increased Underwater Inspection Frequency of**  mo.  
Items to Watch:

**Fixed Monitoring Device(s)**  
Type of Instrument:   
Installation location(s):   
Sample Interval:  30 min.  1 hr.  6 hrs.  12 hrs.  Other   
Frequency of data download and review:  Daily  Weekly  Monthly  Other   
Scour alert criteria for each pier/abutment:   
Scour critical criteria for each pier/abutment:   
Survey ties:   
Criteria for termination of fixed monitoring program:

**Flood Monitoring Program**  
Type:  Visual Inspection   
 Instrument (check all that apply):  
 Portable  Geophysical  Sonar  Other Soundings at piers and abutments

**Trigger Bridge:** (This bridge may be triggered on a weather event on a Drainage Basin or Traffic Corridor)  
Bridge ID: 01992 - Applegate River, Hwy 272 at MP 18.04 (Applegate)

Ready

# 2<sup>nd</sup> page of Monitoring information

Scour-Critical Bridge - Plan of Action

File Tools Help **SCOUR-CRITICAL BRIDGE - PLAN OF ACTION** **TRIGGER BRIDGE** Close

Filter Bridges Find Structure #: 01992 | Applegate River, Hwy 272 Bridge: 01992  Published  Revised

§ 7 Countermeasures § 8 Bridge Closure § 9 Detour Route § 10 Attachments § 11 Comments § 12 Trigger Bridge Control Panel

§ 1 General § 2 Responsibility § 3 Scour Vulnerability § 4 Summary § 5 NBI Coding § 6a Monitoring (beg.) § 6b Monitoring (end)

### 6. MONITORING PROGRAM (conclusion)

Flood monitoring required:  Yes  No  
Flood monitoring event defined by (check all that apply):

Discharge 10 yr./33,100 cfs USGS 14366000 - APPLGATE RIVER NEAR APPLGATE,

Rainfall 10 yr./2.0 in KMFR - ROGUE VALLEY INTERNATIONAL AIRPORT

NEXRAD Forecasting NEXRAD Station KMAX - MEDFORD

Flood forecasting information: } AHPs Station APRO3 - Applegate River near Applegat

Flood warning system:

Frequency of flood monitoring:  1 hr.  3 hrs.  6 hrs.  Other

Post-flood monitoring required:  No  Yes within 1 days

Frequency of post-flood monitoring:  Daily  Weekly  Monthly  Other

Criteria for termination of flood monitoring: Below trigger threshold for one day

Criteria for termination of post-flood monitoring: No continued scour detected

Scour alert criteria for each pier/abutment: Determined by DM.

Scour critical criteria for each pier/abutment: Determined by DM.

Note: Additional details for action(s) required may be included in Section 8.

Action(s) required if scour alert criteria detected (include notification and closure procedures):  
Site investigation.

Action(s) required if scour critical criteria detected (include notification and closure procedures):  
Soundings at piers and abutments.

**Contact Person:** (include name, title, telephone, pager, e-mail):  
LONIE Josh E/Region 3 Bridge Inspector/TRANSPORTATION REG 3/ODOT  
541.957.3587/(no pager/cell)/Josh.E.LONIE@odot.state.or.us

Ready


# Scour Evaluation

- Points are surveyed along the stream channel by a survey crew
- Data collected is used to determine hydraulic grade line of the stream.
- Videos are taken at the bridge and at each point surveyed to gather enough information to do a preliminary hydraulic analysis




Hydrology determined from ODOT Regression Equations or from USGS "Stream - Stats" program

Calculate Flow Predictions



# BridgeAlerts

ODOT Bridge Hydrology Data Monitoring System



ID: 547 Regression Equation: UW1 USGS w1 - Coastal watersheds

Bridge: 04660A Three Rivers, Hwy 9

Drainage Area (square miles)	37.7
2-Year 24-Hour Precipitation Intensity (inches)	4.52
Mean January Temperature (°F)	47.4
Soil Storage Capacity (inches)	0.18
Soil Permeability (inches per hour)	1.35

Calculate

- Flow Gage History
- Regression Equations
- Manual Entry

Comments:

---

***Discharge in Cubic Feet per Second for the n-Year Recurrence Interval***

Q2	Q5	Q10	Q25	Q50	Q100	Q500
3501.75	4894.12	5818.70	7017.93	7916.21	8823.64	10929.69

View Regression Equations

Quit

383 of 716

# Three Rivers Bridge scour viewer

ODOT Bridge Alerts Program Scour Analysis Viewer

## Bridge Alerts

## Scour Analysis Viewer

Close

Bridge No: 04660A [Scour Analysis File Versions](#) [Refresh Bridge List](#)

Three Rivers, Hwy 9

Bridges Profiles Analysis Browser Text Backup Log

Raw Survey Data

- 04660A.pdf
- 4660.GSI
- 4660A3RIVRS.LOG

Video Clips

- SANY0046.MP4
- SANY0047.MP4
- SANY0048.MP4
- SANY0050.MP4
- SANY0051.MP4
- SANY0052.MP4
- SANY0054.MP4

brEASE Spreadsheets

- 04660A analysis 7-27-10.pdf

Slope Profiles

- 04660A\_Profile.pdf

02283

02284

04442A

04444

04445

04468A

05978

07295

07347

07940

07965A

08076

08117

08363

09793

16883

00231A (Polk County)

00491A

00745

01251A

01344C

01756A

02081

04573

04585

04587A

04588A

04589A

04590A

04599A

06662

07615

07616

09848

10193

10261A

10265A

04659 (Tillamook County)

04660A

# Scour Analysis Viewer

ODOT Bridge Alerts Program Scour Analysis Viewer

## Bridge Alerts

## Scour Analysis Viewer

Close

Bridge No: 04660A [Scour Analysis File Versions](#) [Refresh Bridge List](#)

Three Rivers, Hwy 9

Bridges Profiles Analysis **Browser** Text Backup Log

1 (1 of 1) 29.1%

Find

Raw Survey Data

- 04660A.pdf
- 4660.GSI
- 4660A3RIVRS.LOG

Video Clips

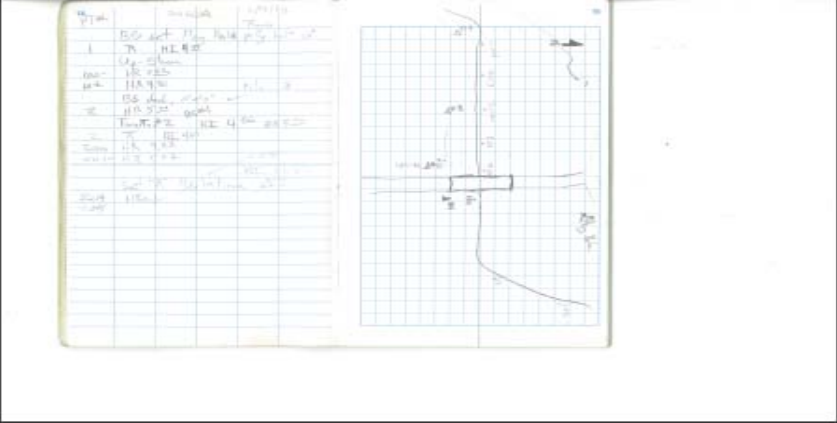
- SANY0046.MP4
- SANY0047.MP4
- SANY0048.MP4
- SANY0050.MP4
- SANY0051.MP4
- SANY0052.MP4
- SANY0054.MP4

brEASE Spreadsheets

- 04660A analysis 7-27-10.pdf

Slope Profiles

- 04660A\_Profile.pdf



The scanned document contains a handwritten table with columns for 'Date', 'Time', 'Location', 'Depth', and 'Notes'. The table lists several measurements taken at different locations along the bridge. To the right of the table is a cross-section diagram of a bridge structure, showing the bridge deck, piers, and abutments, with various dimensions and annotations.

# Stream profile is plotted using Micro-Station

ODOT Bridge Alerts Program Scour Analysis Viewer

## Bridge Alerts

## Scour Analysis Viewer

Close

Bridge No: 04660A [Scour Analysis File Versions](#) Refresh Bridge List

Three Rivers, Hwy 9

Bridges Profiles Analysis **Browser** Text Backup Log

Raw Survey Data

- 04660A.pdf
- 4660.GSI
- 4660A3RIVRS.LOG

Video Clips

- SANY0046.MP4
- SANY0047.MP4
- SANY0048.MP4
- SANY0050.MP4
- SANY0051.MP4
- SANY0052.MP4
- SANY0054.MP4

brEASE Spreadsheets

- 04660A analysis 7-27-10.pdf

Slope Profiles

- 04660A\_Profile.pdf

THIS IS THE FILENAME LOCATION: [unreadable] 00-000-1111 [unreadable] USERNAME

# Typical Video taken at each point surveyed



# Hydraulics Calculation Summary

ODOT Bridge Alerts Program Scour Analysis Viewer

## Bridge Alerts

## Scour Analysis Viewer

Close

### Raw Survey Data

04660A.pdf  
 4660\_GSI  
 4660A3RIVRS.LOG

### Video Clips

SANY0046.MP4  
 SANY0047.MP4  
 SANY0048.MP4  
 SANY0050.MP4  
 SANY0051.MP4  
 SANY0052.MP4  
 SANY0054.MP4

### brEASE Spreadsheets

04660A analysis 7-27-10.pdf

### Slope Profiles

04660A\_Profile.pdf

Bridge No: 04660A

Scour Analysis File Versions

Refresh Bridge List

Three Rivers, Hwy 9

Bridges Profiles Analysis **Browser** Text Backup Log

12 / 17 66.4% Find

### Hydraulic Calculations for Bridge No. 04660A

Summary of Normal Depth Calculations for WSEL in English Units			
Total Flow	3245.0	at WSEL	49.88

Hydraulic Input		Breakdown for Normal Depth Calculations			
Known Q	3245	Location	Left Overbank	Main Channel	Right Overbank
Known WSEL	Not Given	Mannings Value	0.110	0.040	Varies
Channel Slope	0.0050	Ave. Velocity	0.43	7.20	0.00
Mannings No.	Varies	Froude No.	0.14	0.59	0.00
LT OB Station	1+42.00	Area of Flow, A	1.20	450.66	0.00
RL OB Station		Top Width, T	3.31	98.30	0.00
Normal Angle	0.00	Ave. Depth, ft	0.31	4.58	0.00
Normal Offset	1+02	Flow	0.52	3244.48	0.00

X-Section: 4   01/26/2009								
			Mannings Calculations for 500 yr flood event					
			Left Overbank		Main Channel		Right Overbank	
Normalized Station	Elevation	Mannings Number, n	Area of Section, A	Wetted Perimeter, P	Area of Section, A	Wetted Perimeter, P	Area of Section, A	Wetted Perimeter, P
0+50.00	55.35	0.11	1.08	3.75				
0+39.80	49.10	0.11	0.12	0.20				
0+40.00	49.08	0.04			177.78	55.25		
0+95.00	43.82	0.04			118.47	17.14		
1+12.00	41.61	0.04			113.35	16.12		
1+28.00	43.59	0.04			41.07	11.13		
1+38.30	47.80	0.04						

Page 12 Printed by john on 7/30/2010



# Preliminary Scour Analysis Summary

## Raw Survey Data

04660A.pdf  
 4660.GSI  
 4660A3RIVRS.LOG

## Video Clips

SANY0046.MP4  
 SANY0047.MP4  
 SANY0048.MP4  
 SANY0050.MP4  
 SANY0051.MP4  
 SANY0052.MP4  
 SANY0054.MP4

## brEASE Spreadsheets

04660A analysis 7-27-10.pdf

## Slope Profiles

04660A\_Profile.pdf

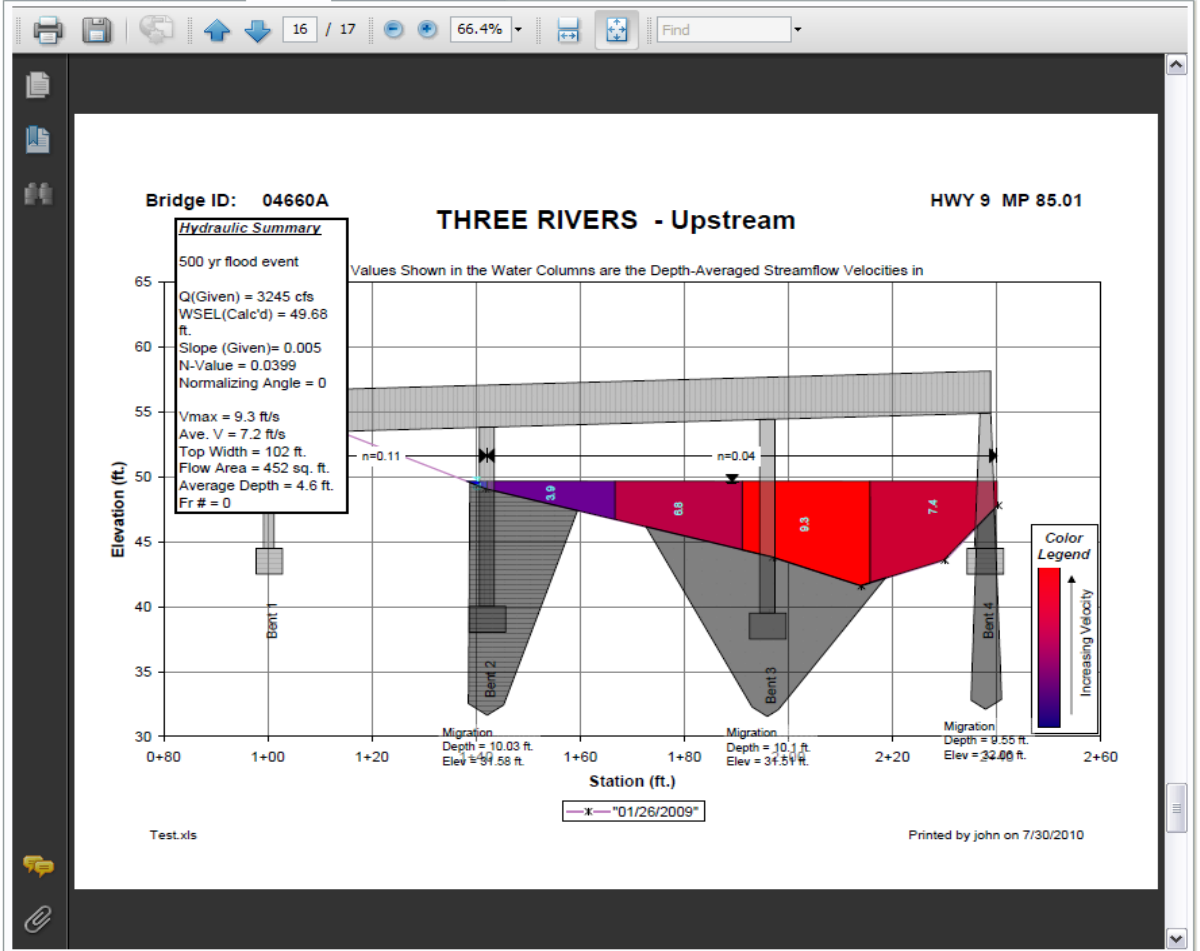
Bridge No: 04660A

Scour Analysis File Versions

Refresh Bridge List

Three Rivers, Hwy 9

Bridges Profiles Analysis **Browser** Text Backup Log



# Scour Code Revision

Given:

1. The preliminary hydraulics analysis for scour
2. Geotechnical information
3. Structural input
4. The scour code can be changed if necessary

# What about unknown foundation bridges?

- ODOT treats them as scour critical.
- Each unknown foundation bridge has a Plan of Action and is in the Bridge Alerts System.
- NCHRP document 107 (Risk Based Management Guidelines for Scour Critical Bridges with Unknown Foundations) has had its proscribed process transferred to a flow chart for reference.

# Unknown Foundation Flowchart

