RESEARCH
Oregon Department of Transportation

Research Notes

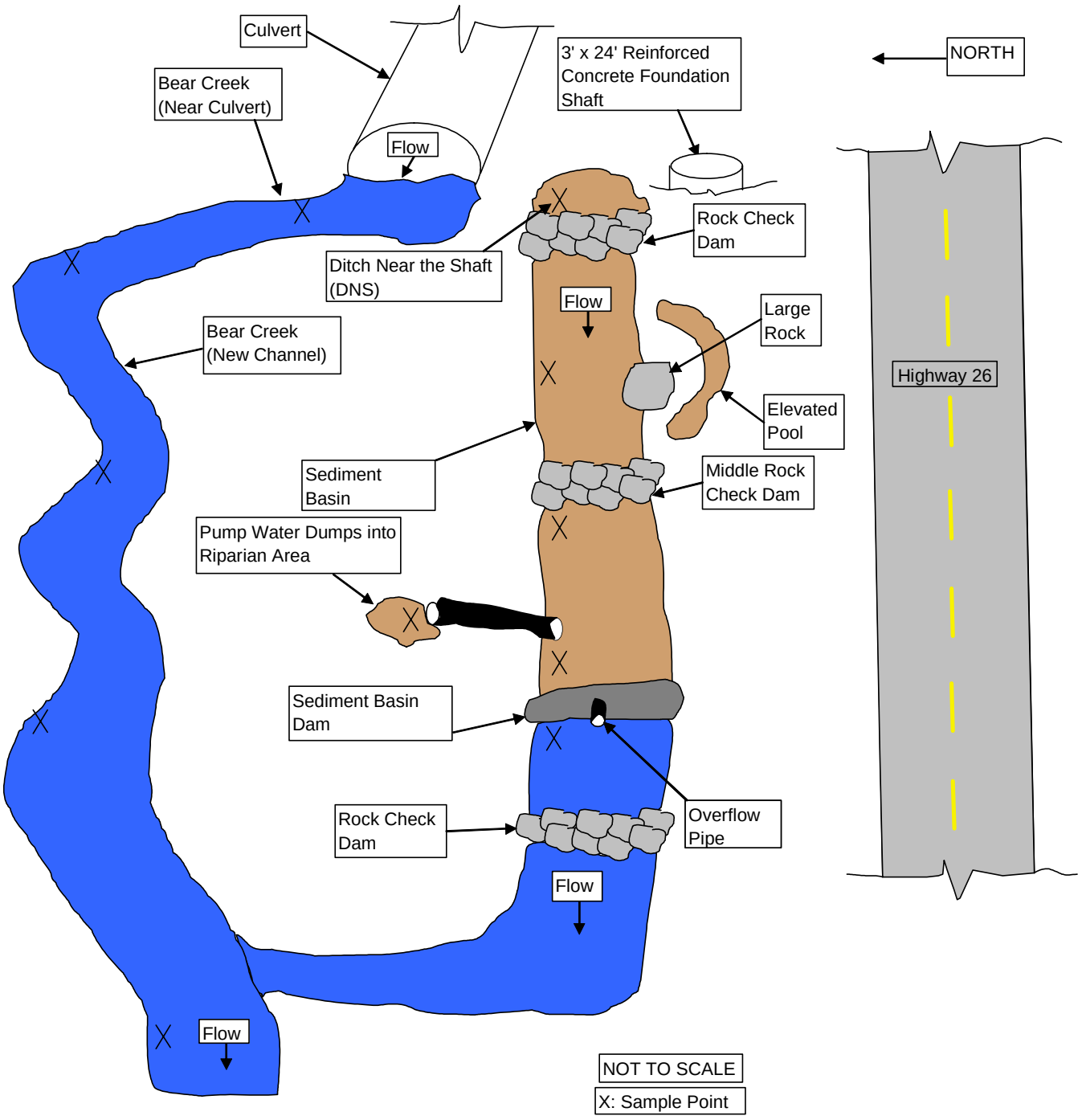
RSN 03-02 February 2003

The pH of Water in Contact with Fresh Concrete

The placement of fresh concrete in or near a waterway raises concerns about the environment of the waterway. One aspect is the pH of the water. If the pH of the water is suddenly raised a significant amount it may harm or kill threatened and endangered species. Biologically, a major concern for fish survival is not what the pH level is, but how fast the pH transitions up or down from normal ambient levels. Fish can sometimes acclimate to higher or lower levels of pH, within a range of lethal minimums and maximums, but if the rate of increase or decrease is too fast for fish to acclimate and they have no place to retreat, then mortality may be imminent.

Fresh concrete can significantly change the pH of water. To study the impacts, the pH of a few drilled shaft pours on Bear Creek near Zigzag (US Highway 26, MP 42.6) were monitored in order to aid discussion on future similar work. The concrete was placed in the concrete foundation shaft from the bottom up using a tremie tube. As the water/fresh concrete interface neared the surface, the pH of the water in the ditch near the shaft increased, as described in the next sections. In the image below, concrete had not yet been placed in the shaft (with rebar cage). Note that the groundwater level is near the surface of the shaft.

Concrete foundation shaft rebar cage



NOTES:

*pH is a measure of a solution's hydrogen ion concentration (acidity)

*0 to 6.9: Acid

*7.0: Neutral

*7.1 to14.0: Base

*All pH measurements taken with a "pHastcheck" meter by VWRbrand

SITE PLAN VIEW

PROJECT DESCRIPTION

In the site plan view on the previous page, the waterway to the left side is Bear Creek, which is approximately 0.6 m (2.0 ft) above the water level in the ditch at the ditch near the shaft (DNS). With the water level in the ditch at the DNS lower than the water level of the adjacent creek, the chances of contaminant transfer were reduced. The waterway in the center of the site plan view is the roadway ditch. The roadway ditch is approximately 60 m (196.9 ft) in length, and varies from 2 to 6 m (6.6 to 19.7 ft) in width. While there was a surface water connection between the ditch and the stream, the ditch contained no fish. Prior to work commencing, fish were removed from the ditch by ODOT and ODFW biologists. A sandbag dam and sediment fences in the lower portion of the ditch near its confluence with Bear Creek were placed to prevent fish from entering the ditch during project construction.

The water from the concrete foundation shaft flowed into the DNS, then through two rock check dams before pooling upstream of the sediment basin dam. There was an overflow pipe in the sediment basin dam for higher water levels to pass through, but water was pumped out from above the sediment basin dam into a riparian area in order to keep the water level well below the overflow pipe. The water flowed slowly through the sediment basin dam and the last rock check dam before entering Bear Creek.

DATA SUMMARY

The pH of Bear Creek from the culvert to below the confluence of the ditch ranged from 6.8 to 7.2 during this study. Thus it appears that the methods used kept the Bear Creek pH unaffected from the concrete placement in the shafts.

At the DNS, the pH jumped from 6.7 to 9.9 during the Day 2 pour, when the concrete was 3.0 m (10 ft) below the surface of the ground. The pH increased to 10.4 near the end of the pour. After 31 hours, the DNS pH had dropped to 8.2. During the Day 3 pour of a separate foundation shaft, the pH at the DNS increased to 10.0 when the concrete was 3.0 m (10 ft) below the surface of the ground. The pH increased to 10.9 at the end of the pour. Approximately four days later, the DNS pH was 9.6. For each pour, the pH was significantly increased by the water displaced from concrete placement when the concrete/water interface was around 3.0 m (10 ft) from the ground surface. The pH of the ditch water increased when the concrete was as low as 4.3 m (14 ft) from the surface (i.e. only 3.0 m (10 ft) of the 7.3 m (24 ft) shaft was filled with concrete). This pH increase may occur because water in the foundation shaft churns as the concrete is placed in the shaft, thus exposing much of the water to the wet concrete and subsequently raising the pH of the entire water column in the shaft.

Further down the ditch, the water pH at the large rock was 9.6 after the Day 2 pour was complete. After 31 hours, the pH at the large rock had dropped to 7.3, only to return to a pH of 9.2 just after the Day 3 pour was complete. Approximately four days later, the pH at the large rock had again returned to 7.6.

The water pH at the middle rock check dam was 7.6 after the Day 2 pour was complete. The pH raised to 8.4 after the Day 3 pour was complete.

Above the sediment basin dam, the pH ranged from 6.6 to 6.9 during the trial. The water pumped out of the ditch into the riparian area ranged from pH 6.6 to 6.9 as well. Below the sediment basin dam, the pH ranged from 6.3 to 6.6 during the trial, indicating that the pH of the ditch was lowered as the water moved downstream, likely due to the groundwater and ditch water mixing.

SUPPORTING DATA AND INFORMATION

The pH readings from all three days at the site and the concrete mix design are included in the following pages.

Day 1

pH Readings for ZigZag to Rhododendron Phase 1 (11/19/02)*

(pH measurements taken by Brett Sposito, ODOT Research)

	Reading	Correction	**Actual pH**
Check of 7.0 Solution	7.3	-0.3	**7.0**
Bear Creek (near culvert)	7.2	-0.3	**6.9**
Ditch Near the Shaft (DNS)	7.1	-0.3	**6.8**
Sediment Basin Dam (above dam)	6.9	-0.3	**6.6**
Concrete Wash Water (in a bucket)	11.5	-0.3	**11.2**
Check of 7.0 Solution	7.5	-0.5	**7.0**

*Placement of concrete in drill shaft was postponed.

Day 2

pH Readings for Zigzag to Rhododendron Phase 1 (11/20/02)*

(pH measurements taken by Lisa Hemesath, ODOT Biologist)

	Reading	Correction	**Actual pH**
Check of 7.0 Solution	7.6	-0.6	**7.0**
Bear Creek	7.5	-0.6	**6.9**
DNS	7.3	-0.6	**6.7**
**********BEGAN CONCRETE POUR IN FIRST SHAFT**********			
DNS-concrete 5.8m(19ft) below ground level	7.3	-0.6	**6.7**
DNS-concrete 4.6m(15ft) below ground level	7.3	-0.6	**6.7**
DNS-concrete 3.0m(10ft) below ground level	10.5	-0.6	**9.9**
Sediment Basin Dam (above dam)	7.5	-0.6	**6.9**
Sediment Basin Dam (below dam)	7.2	-0.6	**6.6**
DNS (pulling up casing; near end of pour)	11.0	-0.6	**10.4**
Bear Creek (near culvert)	7.8	-0.6	**7.2**
Sediment Basin Dam (above dam)	7.2	-0.6	**6.6**
Sediment Basin Dam (below dam)	6.9	-0.6	**6.3**
**********AFTER CONCRETE POUR WAS COMPLETE**********			
Large Rock	10.2	-0.6	**9.6**
Middle Rock Check Dam	8.2	-0.6	**7.6**
Sediment Basin Dam (above dam)	7.3	-0.6	**6.7**
Pump Water (water pumped from sediment basin to riparian area)	7.2	-0.6	**6.6**
Bear Creek was sampled in 5 different places starting from the culvert and going downstream to the confluence of the ditch. All readings taken ranged from 6.8 to 7.0.			
Check of 7.0 Solution	7.6	-0.6	**7.0**

*For readings taken after concrete pour: readings were taken twice at each location, about 30 minutes apart. pH did not significantly vary between readings, so only one pH reading is given.

*Concrete pour began around 7:00am. Last pH reading was taken around 9:00am.

Day 3

pH Readings for ZigZag to Rhododendron Phase 1 (11/21/02)*

(pH measurements taken by Lisa Hemesath, ODOT Biologist)

	Reading	Correction	**Actual pH**
Check of 7.0 Solution	7.6	-0.6	**7.0**
Bear Creek (near culvert)	7.5	-0.7	**6.8**
DNS	9.6	-0.7	**8.9**
Large Rock	8.0	-0.7	**7.3**
Sediment Basin Dam (above dam)	7.6	-0.7	**6.9**
**********BEGAN CONCRETE POUR IN SHAFT**********			
DNS-beginning of pour 7.3m(24ft) below ground level	8.9	-0.7	**8.2**
DNS-concrete 4.3m(14ft) below ground level	10.2	-0.7	**9.5**
DNS-concrete 3.0m(10ft) below ground level	10.7	-0.7	**10.0**
DNS-concrete less than 3.0m(10ft) below ground level	11.1	-0.7	**10.4**
DNS (concrete at ground level)	11.6	-0.7	**10.9**
**********AFTER CONCRETE POUR WAS COMPLETE**********			
Large Rock (5 minutes after pour complete)	9.9	-0.7	**9.2**
Middle Rock Check Dam	9.1	-0.7	**8.4**
Sediment Basin Dam (above dam)	7.6	-0.7	**6.9**
Sediment Basin Dam (below dam)	7.0	-0.7	**6.3**
Pump Water (water pumped from sediment basin to riparian area)	7.6	-0.7	**6.9**
Bear Creek (below confluence of ditch)	7.8	-0.7	**7.1**
Bear Creek (halfway up middle reach)	7.7	-0.7	**7.0**
Bear Creek (near culvert)	7.6	-0.7	**6.9**
Check of 7.0 Solution	7.8	-0.8	**7.0**

*Check of 7.0 Solution differed by 0.2 from the start of experiment. The average of the checked 7.0 solution (-0.7) was subtracted from the readings for Day 3.
*Concrete pour started at 4:00pm. Last pH reading taken around 5:00pm.
*Higher pH numbers in the DNS due to residual water from previous drilled shafts from the day before.

At most test sites, pH readings were higher on the second day of the experiment due to previous concrete pours contaminating ditch water from the day before.

On 11/25/02, Lisa Hemesath, ODOT Biologist, took a few additional readings:
*The elevated pool was pH 6.4.
*The large rock sample point was pH 7.6.
*The DNS was pH 9.6.

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Contract No.: **EA No.: IN7872** **Lab No.: 02-004687**

Project: CONCRETE MIX DESIGN- CLASS 30 DRILLED SHAFT

Highway: **County:** **Data Sheet No.: NONE**
Contractor: **FA No.:**
Project Manager: **Org Unit:** **Bid Item No.:**
Submitted By: WAYNE NORMAND **Org Unit:** **Sample No.:** NA
Material Source: MORSE BROS. SUNDIAL PLANT **Qty Represented:** NA
DATE-Sampled: NA **Received:** 02/11/ 1 **Tested:** 02/11/ 1 **Reported:**
Type of Test: Mix Design Review - Structural **Use:** Class 30.0-19.0 mm - Class 4350 psi

NOV 12 200

REVIEW OF CONTRACTOR CONCRETE MIX DESIGN - TM 741x

Mix Producer: MORSE BROS. SUNDIAL PLANT **Contractor Mix Design No.:** MB 261-44N1K3S9

The request to review Class 30 concrete mix design for Drilled Shafts was evaluated according to the Standard Specifications.

Average Compressive Strength: 48.8 MPa @ 28 days

Based on a review of the mix proportions and the available data it has been determined that the mix design complies with the specifications. This mix design is approved for use on ODOT projects for one year.

Mix proportions as submitted by MORSE BROS. SUNDIAL PLANT :

Cement	380 kg/m3	ASH GROVE	Type I Durkee	
Fly Ash	71 kg/m3	ISG	Class F Centralia	
19-4.75	1097 kg/m3 SSD	Gssd : 2.700 Abs : 1.3 %	Source : 05-037-1	
4.75-0	610 kg/m3 SSD	Gssd : 2.650 Abs : 3.0 %	Source : 05-037-1	FM : 2.65
Water	158 kg/m3	W/C Ratio : 0.36	Slump : 150 mm	
Air Content	5.0 %			
Density	2318 kg/m3			

Air Entrainment Agent : WR Grace/Daravair
Water Reducer : WR Grace/WRDA-64
HRWR Admixture : Mstr Bldrs/Glennium 3000 NS

This report does not supersede, delete or amend the project specifications. Our review of this mix design does not relieve the Contractor of the responsibility to produce satisfactory concrete.

741X =$ 0.

TOTAL CHARGES: $ 0.00

REMARKS:
Mix Design **DOES** comply with specifications.

*

ODOT
Earl Mershon PM
RECEIVED
NOV 13 2002

C: FILES ; R. KESSLER-CONSTRUCTION ; MORSE BROS. SUNDIAL PLANT
RAS 1; QAC 1; PM MERSHON

Noted ☐ ☐ ☐
PM APM

Kenneth L. Stanton
STATE CONSTRUCTION AND MATERIALS ENGINEER

CONCLUSION AND RECOMMENDATIONS

Contamination of Bear Creek was avoided by pumping the contaminated water into the riparian area for filtration. This greatly reduced the opportunity for the high pH water to enter the stream. In addition to filtration, much of the highly contaminated water at the DNS was pumped and removed. However, the most important factor in the dilution of the high pH water was the large amount of ground water seeping into the ditch and diluting the drilled shaft water as it flowed down the ditch.

Water in contact with wet concrete is a contaminant and needs to be disposed of carefully. Future work in placing wet concrete near surface water or areas of high ground water should take into account the high pH of foundation shaft water. Construction Specifications should include directions on how to dispose of the contaminated water. Construction crews are advised to work with ODOT Environmental Services on the proper disposal of contaminated water so as to avoid impacts to aquatic species and federally and state listed species.

ACKNOWLEDGMENT

Thanks to Ken Scott, ODOT Materials Lab, for the use of the pH meter; Earl Mershon, ODOT Project Manager, and Lisa Hemesath, ODOT Biologist, for their assistance; and to McGregor Lynde and Joni Reid, ODOT Research for editing this report.

The shaft and the ditch near the shaft (DNS) are pictured below to aid in the understanding of the site plan as described on page 2. Note that Highway 26 is the left bank of the ditch looking downstream from the DNS.

Ditch Near the Shaft (DNS)

DNS looking downstream

Oregon Department of Transportation

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For more information on ODOT's Research Program and Projects, check the website at
http://www.odot.state.or.us/tddresearch/