

PN-3616
PRJ-2.00

MEMORANDUM

To: Geology, Exploration & Instrumentation Group Files

Through: Richard A. Link
Program Manager, Geology, Exploration & Instrumentation Group

From: Edward W. Lyon, Jr.
Geologist, Geology, Exploration & Instrumentation Group

Subject: Fulton Diversion Dam Investigations, Methow Subbasin, Washington

Date: September 18, 2007.

Places or Office Visited: On September 18, 2007, Pacific Northwest (PN) Regional Geology, Exploration & Instrumentation Group (Geology Group) geologists Richard Link and Edward Lyon, Jr. traveled to Fulton Diversion Dam, Methow Subbasin, Washington.

Background: Fulton Diversion Dam was constructed through the fall of 2006 into the winter of 2007 per *Revisions to Final Solicitation/Drawings, Solicitation No. 06-1678-WA-010, Fulton Diversion Modifications – Phase 2*, dated August 9, 2006. Upon completion of the dam, Bureau of Reclamation surveyors conducted a topographic survey of the structure on August 23 and 24, 2007 (documented in e-mail message sent by Mr. Eduardo Lopez-Owsley on September 5, 2007). Cracks were observed along the Fulton pipeline along river right. On September 14, 2007 Bureau of Reclamation, PN Regional activity manager Mike Relf requested, via e-mail, that Geology Group geologists investigate the cause of the cracks. Geologists Link and Lyon conducted the investigations on September 18, 2007.

Purpose of Trip: (Objectives were described in Mr. Relf's e-mail message dated September 14, 2007.)

1. Investigate potential subsurface leakage from pipeline via limited excavations downslope (riverside) of pipe.
2. Assess materials used for backfill/riprap via two test pits, one in area of observed cracks/subsidence and one in control area.
3. Assess potential slide/slump issues in area of observed cracks/subsidence, as possible (to be determined in the field).

4. Inspect pipe interior. (Note: As interior of pipeline was not investigated, procedures were not in-place for a confined space entry.)
5. Determine in the field the informational value of assessing pipeline alignment/elevations via surveys of top centerline of pipe at several locations.

Observations: (See Figure 1 - Location Map, and Photograph Nos. 1 through 16, attached.)

1. Extension cracks and subsidence scarp were observed at the surface and painted orange for photographic documentation prior to excavation disturbance (see Photograph Nos. 1 through 5).
2. A red tracer dye was poured down one of the extension cracks with openness of about 20 mm to observe the trace of the crack during excavation. The crack was excavated (test pit TP-07-2; logs for all test pits are attached) and the dye trace was flagged and photographed (see Photograph No. 6).
3. Extension cracks observed during excavation penetrated about 3 vertical feet and then dipped toward the river where they encountered poorly graded sand with nonplastic fines that were wet.
4. A segment of the pipeline was exposed in an excavation on the riverside that revealed water leaking from perforations along the pipe that saturated the poorly graded sand with nonplastic fines placed as backfill (see Photograph Nos. 7 and 8).
5. Test pit TP-07-1 was excavated in a potential spoil pile west of the pipeline because of runoff concerns and the presence of low density material as observed when the backhoe traveled over the material (see Photograph Nos. 9 through 12).
6. Two test pits (TP-07-3 and TP-07-4) were excavated through the riprap that revealed a generally poorly graded mixture with the maximum rock size of less than 24 inches as measured along the intermediate axis (see Photograph Nos. 13 and 14). The bedding was comprised of predominantly poorly-graded coarse and fine cobbles, coarse to fine gravels, and sand with nonplastic fines.
7. Test pit TP-07-5 was excavated between the riprap placement area and the pipeline that contained predominantly coarse and fine cobbles, coarse to fine gravels, and sand with nonplastic fines, and hay bales and trash (see Photograph No. 15). The area had experienced considerable settlement, suggesting that it was not properly compacted.
8. The line of five large boulders placed at the downstream end of the headgate's concrete wall on the right bank was examined to determine the extent of scouring during the 2006 runoff. Significant scouring of backfill materials had occurred around the bases of the boulders and three were in jeopardy of toppling into the roughened channel (see Photograph No. 16).
9. Four excavations were conducted to expose the top of pipe. The top of pipe was surveyed by U.S. Forest Service engineer D. Fedak.
 - a. Pipe Station 1+36.84, Elevation 1775.70
 - b. Pipe Station 1+73.84, Elevation 1775.24 (slump area)
 - c. Pipe Station 1+99.84, Elevation 1774.86
 - d. Pipe Station 2+25.84, Elevation 1774.85

10. The bottom of the test pits were surveyed by U.S. Forest Service engineer D. Fedak.
 - a. Test pit TP-07-1, Elevation 1773.15
 - i. Stratigraphic change at elevation 1773.62
 - b. Test pit TP-07-2, Elevation 1773.57
 - i. Surface elevation of crack 1778.31
 - ii. Base plane of crack at elevation 1774.75
 - c. Test pit TP-07-3, Elevation 1774.65
 - d. Test pit, TP-07-4, Elevation 1774.17
 - e. Test pit TP-07-5, Elevation 1772.32

Attachments – Photograph Nos. 1 through 16

Logs of Test Pits TP-07-1 through -5

Figure 1 – Location Map

cc: PN-1010 (Personius), PN-1710 (Dailey), PN-1750 (Spinazola), PN-3020 (Jarsky),
PN-3025 (Maguire), PN-3400 (Jennings), PN-3437 (Armer-Brinkman), PN-3611
(McAffee), PN-3616 (Lyon), PN-3823 (Relf) (each w/att)
UCA-1600 (Kaumheimer), UCA-1615 (Knott, Molesworth) (each w/att)

WBR:EdwardLyon:shennefer:9/27/07:208-378-5234

rf:h:\users\shennefer\wp51\lyon\TR_091807.DOC



Photograph No. 1. View is to the north looking at extension cracks (orange paint) along the Fulton irrigation pipeline. Fulton Dam, Methow Subbasin, Washington – Bureau of Reclamation Photograph by E. Lyon, September 18, 2007.



Photograph No. 2. View of to the north looking at extension cracks (orange paint) along the western side of the “slump” along the Fulton irrigation pipeline. Red dye was poured in the center crack prior to excavation. Fulton Dam, Methow Subbasin, Washington – Bureau of Reclamation Photograph by E. Lyon, September 18, 2007.



Photograph No. 3. View is to the north looking at the scarp (dashed orange paint) where the surface has settled about ± 1 -foot along the Fulton irrigation pipeline. Fulton Dam, Methow Subbasin, Washington – Bureau of Reclamation Photograph by E. Lyon, September 18, 2007.



Photograph No. 4. View is to south looking at voids along the east side of the Fulton irrigation pipeline and the settlement area (orange paint). Fulton Dam, Methow Subbasin, Washington – Bureau of Reclamation Photograph by E. Lyon, September 18, 2007.



Photograph No. 5. View is to the east looking over the settlement area with extension cracks and slump marked by orange paint. Fulton Dam, Methow Subbasin, Washington – Bureau of Reclamation
Photograph by E. Lyon, September 18, 2007.



Photograph No. 6. View is to the south looking at trace of extension cracks (red flags) exposed in test pit TP-07-2. A diluted red tracer dye was flushed down the extension crack so that it could be mapped during excavation. Fulton Dam, Methow Subbasin, Washington – Bureau of Reclamation
Photograph by E. Lyon, September 18, 2007.



Photograph No. 7. View is to west looking at the Fulton irrigation pipeline exposed at depth. Note the horizontal alignment of the perforations leaking water along the pipe and the openness of the joint (left center in photograph). Fulton Dam, Methow Subbasin, Washington – Bureau of Reclamation Photograph by E. Lyon, September 18, 2007.



Photograph No. 8. View is to northwest looking at the perforations along the Fulton irrigation pipeline and the perforations leaking water. Fulton Dam, Methow Subbasin, Washington – Bureau of Reclamation Photograph by E. Lyon, September 18, 2007.



Photograph No. 9. View is to southwest looking at test pit TP-07-1. Fulton Dam, Methow Subbasin, Washington – Bureau of Reclamation Photograph by R. Link, September 18, 2007.



Photograph No. 10. View is to west looking at location of test pit TP-07-1 where a depression was filled with spoils along the Fulton irrigation pipeline. Fulton Dam, Methow Subbasin, Washington – Bureau of Reclamation Photograph by R. Link, September 18, 2007.



Photograph No. 11. View of spoil material overlying native or backfill material in test pit TP-07-1. Fulton Dam, Methow Subbasin, Washington – Bureau of Reclamation Photograph by E. Lyon, September 18, 2007.



Photograph No. 12. View is to south looking at an excavated extension crack that generally dips to the east toward the river exposed in test pit TP-07-1. Fulton Dam, Methow Subbasin, Washington – Bureau of Reclamation Photograph by E. Lyon, September 18, 2007.



Photograph No. 13. View is to the south looking at test pit TP-07-3 excavated through the placed riprap along the roughened channel on river right. Fulton Dam, Methow Subbasin, Washington – Bureau of Reclamation Photograph by E. Lyon, September 18, 2007.



Photograph No. 14. View is to the north looking at test pit TP-07-4 excavated through the placed riprap along the roughened channel on river right. Fulton Dam, Methow Subbasin, Washington – Bureau of Reclamation Photograph by E. Lyon, September 18, 2007.

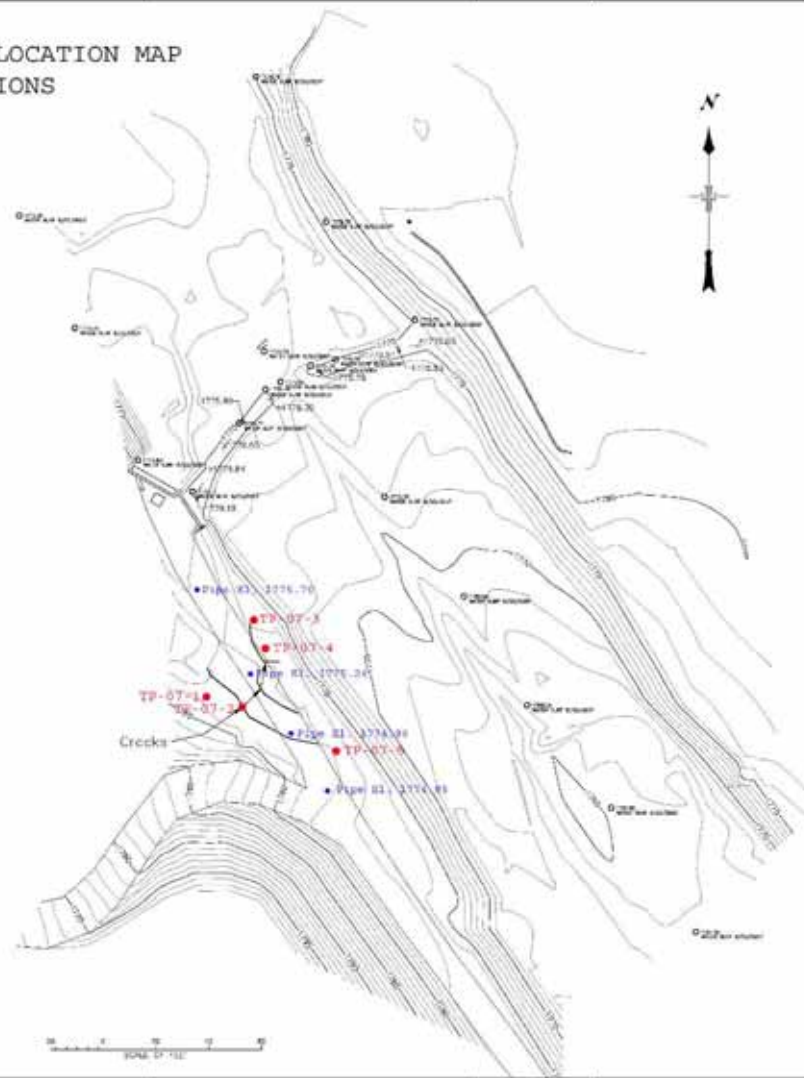


Photograph No. 15. View is to the south looking at test pit TP-07-5 excavated west of the riprap placed along the roughened channel on river right. Fulton Dam, Methow Subbasin, Washington – Bureau of Reclamation Photograph by E. Lyon, September 18, 2007.



Photograph No. 16. View is to the west looking at scour that has occurred at the base of the 4-foot-diameter boulders placed on the right bank along the roughened channel. Three of the boulders are precariously held in place and are in jeopardy of toppling. Fulton Dam, Methow Subbasin, Washington – Bureau of Reclamation Photograph by E. Lyon, September 18, 2007.

FIGURE 1: LOCATION MAP OF EXPLORATIONS



- LEGEND**
- Test Pit locations and designations
 - Excavations to determine elevations along top of pipeline

ALWAYS THINK SAFETY

FULTON DIVERSION DAM
THE BUCH BULK
SITE TOPOGRAPHY
AUGUST 23, 2007, SURVEY

SCALE 1" = 50'

Logs of Test Pits

Used in describing earth materials sampled in the following test pits were: The Unified Soil Classification System, Designation USBR 5000, "Procedure for Determining Unified Soil Classification (Laboratory Method)"; and USBR 5005, "Procedure for Determining Unified Soil Classification (Visual Method)", both located in *Earth Manual, Part II*, 3rd Edition, (U.S. Department of the Interior, Bureau of Reclamation, 1990).

Also note that descriptive terms appearing on geologic logs describe the physical characteristics of materials and conform to standard definitions as given in *Engineering Geology Field Manual, Volume I*, Second Edition (U.S. Department of the Interior, Bureau of Reclamation, 1998) and *Engineering Geology Field Manual, Volume II*, Second Edition (U.S. Department of the Interior, Bureau of Reclamation, 2001).

Test Pit TP-07-1

Location: Pipe Station 170+00±; offset about 21 feet southwest

Pit Dimensions: Length 11.5 feet; width 7.6 feet; depth 4.7 feet

Depth: 0 to 3.7 feet

Typical Name: Poorly Graded Sand with Silt, Gravels, Cobbles, and Boulders

Group Symbol: (SP-SM)gcb

Soil Description:

Oversize: About 35% hard, subrounded to subangular boulders with a maximum size of 600 mm (as measured along the intermediate axis); about 10% hard, subrounded to subangular cobbles.

Remainder: About 55% coarse to fine, hard, angular sand; about 35% coarse to fine, hard, subrounded gravel; about 10% nonplastic fines; dark brown, moist.

Excavation Conditions: Excavation was easy, moderately smooth, and very fast.

Geologic Interpretation: Backfill

Depth: 3.7 to 4.7 feet

Typical Name: Poorly Graded Sand with Gravel

Group Symbol: (SP)g

Soil Description:

About 85% coarse to fine, hard, angular sand; about 10% coarse to fine, hard, subrounded gravel; about 5% nonplastic fines; dark brown, moist.

Excavation Conditions: Excavation was easy, moderately smooth, and very fast.

Geologic Interpretation: Backfill

Test Pit TP-07-2

Location: Pipe Station 181+00±; offset about 10 feet southwest

Pit Dimensions: Length 11.0 feet; width 7.0 feet; depth 4.6 feet

Depth: 0 to 3.4 feet

Typical Name: Poorly Graded Gravel with Silt, Sand, Cobbles, and Boulders

Group Symbol: (GP-GM)scb

Soil Description:

Oversize: About 15% hard, subrounded to subangular cobbles; trace of hard, subrounded boulders with a maximum size of 400 mm (as measured along the intermediate axis).

Remainder: About 60% coarse to fine, hard, subrounded to subangular gravel; about 30% coarse to fine, hard, subrounded to subangular sand; about 10% nonplastic fines; brown, moist.

Excavation Conditions: Excavation was easy, smooth, and very fast.

Geologic Interpretation: Backfill

Depth: 3.4 to 4.6 feet

Typical Name: Poorly Graded Sand with Silt and Gravel

Group Symbol: (SP-SM)

Soil Description:

About 85% coarse to fine, hard, subangular sand; about 10% nonplastic fines; about 5% coarse to fine, hard, subrounded gravel; brown, moist.

Excavation Conditions: Excavation was easy, smooth, and very fast.

Geologic Interpretation: Backfill

Test Pit TP-07-3

Location: Pipe Station 157+00₊; offset about 11 feet northeast

Pit Dimensions: Length 12.0 feet; width 7.6 feet; depth 3.6 feet

Depth: 0 to 3.6 feet

Typical Name: Poorly Graded Sand with Silt, Gravel, Cobbles, and Boulders

Group Symbol: (SP-SM)gcb

Soil Description:

Oversize: About 20% hard, angular boulders with a maximum size of 500 mm (as measured along the intermediate axis); about 20% hard, rounded to subangular cobbles.

Remainder: About 60% coarse to fine, hard, subangular sand; about 30% coarse to fine, hard, subrounded gravel; about 10% nonplastic fines; brown, moist.

Excavation Conditions: Excavation was moderately easy, moderately smooth, and fast.

Geologic Interpretation: Backfill

Test Pit TP-07-4

Location: Pipe Station 167+00₊; offset about 11 feet northeast

Pit Dimensions: Length 8.6 feet; width 6.3 feet; depth 3.2 feet

Depth: 0 to 3.2 feet

Typical Name: Silty Gravel with Sand, Cobbles, and Boulders

Group Symbol: (GM)scb

Soil Description:

Oversize: About 25% hard, angular boulders with a maximum size of 500 mm (as measured along the intermediate axis); about 15% hard, subrounded to subangular cobbles.

Remainder: About 50% coarse to fine, hard, rounded to subrounded gravel; about 35% coarse to fine, hard, subrounded to angular sand; about 15% nonplastic fines; brown, moist.

Excavation Conditions: Excavation was moderately easy, moderately smooth, and fast.

Geologic Interpretation: Backfill

Test Pit TP-07-5

Location: Pipe Station 215+00+; offset about 13 feet northeast

Pit Dimensions: Length 9.3 feet; width 9.0 feet; depth 4.3 feet

Depth: 0 to 4.3 feet

Typical Name: Poorly Graded Gravel with Sand, Cobbles, and Boulders

Group Symbol: (GP)scb

Soil Description:

Oversize: About 5% hard, rounded boulders with a maximum size of 400 mm (as measured along the intermediate axis); about 10% hard, rounded to subrounded cobbles.

Remainder: About 55% coarse to fine, hard, rounded to subrounded gravel; about 40% coarse to fine, hard, subrounded to angular sand; about 5% nonplastic fines; brown, moist.

Excavation Conditions: Excavation was easy, smooth, and very fast

Geologic Interpretation: Backfill