PAINTED ROCKS DAM

2016 SPILLWAY CHUTE INESTIGATION

INFORMATION PACKET

PAINTED ROCKS SPILLWAY

ORIGINAL CONSTRUCTION DRAWINGS

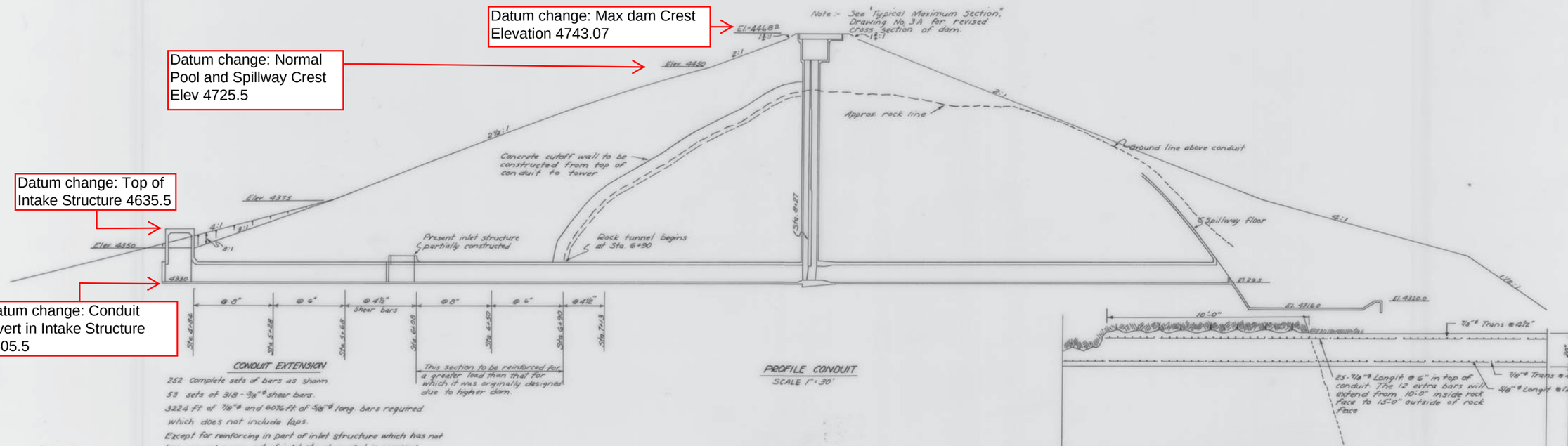
PAINTED ROCKS SPILLWAY

Datum change: Max dam Crest Elevation 4743.07

Datum change: Normal Pool and Spillway Crest Elev 4725.5

Datum change: Top of Intake Structure 4635.5

Datum change: Conduit Invert in Intake Structure 4605.5



CONDUIT EXTENSION

252 complete sets of bars as shown.
53 sets of 3/8 - 3/8"ϕ shear bars.
3224 ft. of 7/8"ϕ and 6076 ft. of 5/8"ϕ long bars required which does not include laps.
Except for reinforcing in part of inlet structure which has not been poured, a new set of inlet structure steel is required including hoop bars of varying diameter at mouth of conduit.

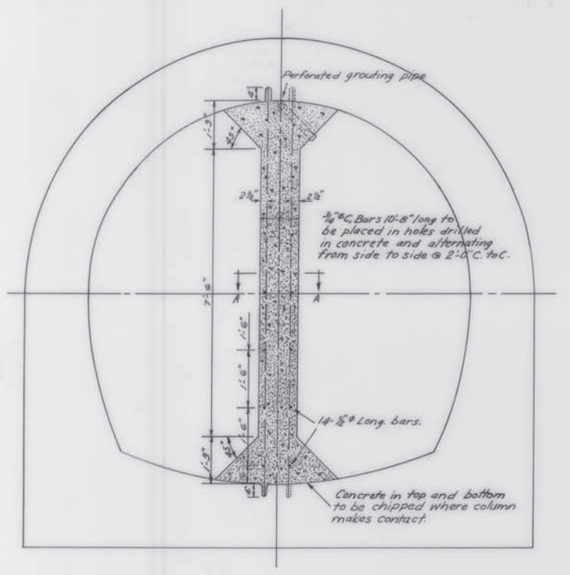
This section to be reinforced for a greater load than that for which it was originally designed due to higher dam.

PROFILE CONDUIT
SCALE 1" = 30'

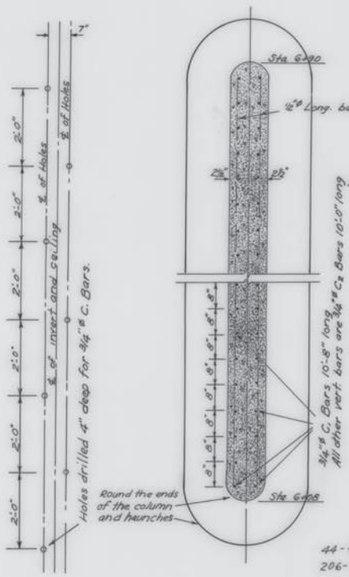
STATION	SPACING OF TRANS. BARS
6+08 to 6+50	8"
6+50 to 6+90	6"
6+90 to —	4½"

Omit shear bars from Sta. 6+08 to Sta. 6+90

SECTIONAL ELEVATION OF CONDUIT
SHOWING CHANGE FROM CUT AND COVER SECTION TO TUNNEL SECTION
SCALE - 3/8" = 1'
Added 3/20-39

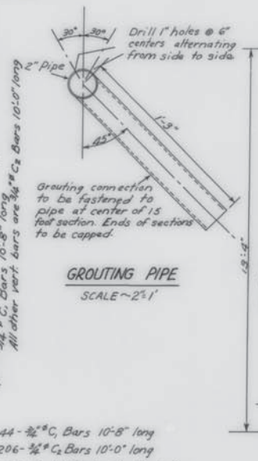


REINFORCED CONDUIT SECTION
STATION 6+08 TO 6+90
SCALE - ½" = 1'



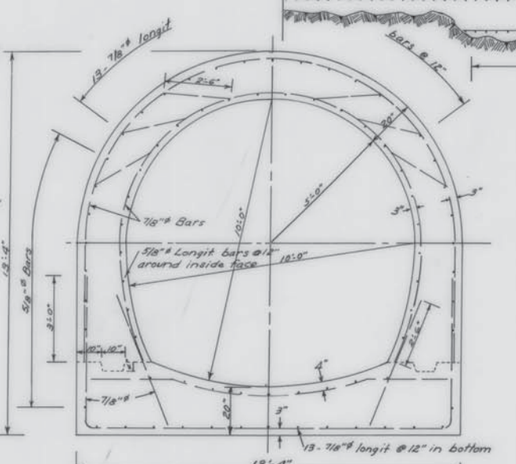
LOCATION OF HOLES
SCALE - ½" = 1'

SECTION A-A
SCALE - ½" = 1'



GROUTING PIPE
SCALE - 2" = 1'

44 - 1½"ϕ C, Bars 10'-8" long
206 - 3/4"ϕ C₂ Bars 10'-0" long
1148 ft. of 1½"ϕ longitudinal bars
5-15 ft. sections of 2" pipe.
12.607 cu. ft. of concrete per linear foot of column.



CUT AND COVER CONDUIT SECTION
SCALE - 1/8" = 1'
Added 3/20-39

CONDUIT REVISIONS
WEST FORK BITTERROOT STORAGE PROJECT
RAVALLI COUNTY

STATE WATER CONSERVATION BOARD
HELENA, MONTANA
NOV. 30, 1938
SCALE AS SHOWN

P.W.A. NO. 1053 D.S.
DWG. NO. 5A & 5B

Drawn by	W.J.	Revised 3/20-39	C.S.	Revised 10-31-39	A.C.H.
Traced 12-8-75	J.P.S.				

5-257-8

NOTE:~
See Section A-A Dwg.No.8A and Sectional Elevation of Bridge Seat Dwg. No. 9D for revisions

Datum change: Normal Pool and Spillway Crest Elev 4725.5

El. 4468.06
El. 4450
El. 4446
S = .0107
PT Sta 3+40
El. 4442.92
12" Concrete Bulkhead Behind Right Wall
2:1 Slope of Dam
El. 4375
Dumped rip rap as directed
4:1
El. 4345
Datum change: Floor of Slab Elev. 4593.5
Datum change: Floor of Stilling Basin Elev. 4587.5
Datum change: Top of Riprap Elev. 4597.5
Depth and distance downstream of rip rap to be determined in field
Slope 4' in 50'

SECTIONAL ELEVATION
SCALE ~ 1" = 20'

See Dwg. No. 2-A for upstream slope and crest curve

PLAN
SCALE 1" = 20'

Counterforts 4 @ about 12' ctrs.
Counterforts @ about 11'-6" ctrs.
Counterforts @ about 11'-3" ctrs.
See Detail "A" Dwg. No. 9AR
Joint
3" Weep pipes at 15' ctrs. b w from Sta. 3+70 to Sta. 4+55
Tunnel Portal
Bridge
P.C. 4+62.16
P.I. 6+07.46
P.I. 7+37.76
R=382.6'
R=371.05
Δ = 44°
D = 16°
T = 144.7'
L = 215.0'
R = 358.13'
Dumped Rip Rap as directed

TYPICAL CHUTE SECTION
Steep section not backfilled

SPILLWAY DATA

STATION	POINT	WIDTH	ELEVATION GRADE	ELEVATION T. WALL	STATION	POINT	WIDTH	ELEVATION GRADE	ELEVATION T. WALL
2+60		160.00	44.46	4465	3+65		87.22		
2+65		160.00		65	3+70		79.30	16.00	
2+71		160.00		65	3+75		76.59		
2+75		159.68		65	3+80		74.11	08.50	
2+80		158.42	46	65	3+85		71.84		
2+85		156.15	45 55		3+90		69.76	00.70	
2+90		152.80	4513	64.35	3+95		67.89		
2+95		148.34	44 55		4+00		66.22	4390.80	
3+00		142.30	4390	60.00	4+05		64.76		
3+05		136.01	4322		4+10		63.49	80.70	
3+10		130.04	42 42	55.65	4+15		62.42		
3+15		124.38	4150		4+20		61.55	70.00	
3+20		119.02	4035	51.30	4+25		60.87		
3+25		113.91			4+30		60.39	57.50	
3+30		109.09	37.63	46.95	4+35		60.07		
3+35		104.52			4+40		60.00	45.00	
3+40		100.22	33.90	42.60	4+60		60.00	16.00	
3+45		96.14			4+67.76		60.00	17.00	
3+50		92.32	29.00		6+12.76		125.00	18.00	
3+55		88.72							
3+60		85.36	23.00						

SPILLWAY LAYOUT
WEST FORK BITTERROOT STORAGE PROJECT
RAVALLI COUNTY
STATE WATER CONSERVATION BOARD
HELENA, MONT MAY 16 1939
SCALE ~ AS SHOWN

P.W.A. NO. 1053 D5 DWG. NO. 7AR

Drawn by C.S. Tr. JCK 4-47	Revised 9-7-39 LH	Revised 10-31-39 LH
Revised 8-1-39, 8-24-39 ACH	Revised 9-13-39 SYW	Revised 12-6-40 E.G.F.

5-257-11

PAINTED ROCKS DAM

2015 ANNUAL INSPECTION REPORT

DNRC 2015

DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

STEVE BULLOCK
GOVERNOR

DIRECTOR'S OFFICE (406) 444-2074
TELEFAX NUMBER (406) 444-2684

STATE OF MONTANA

WATER RESOURCES DIVISION (406) 444-6601
TELEFAX NUMBERS (406) 444-0533 / (406) 444-5918
http://www.dnrc.mt.gov

1424 9TH AVENUE
PO BOX 201601
HELENA, MONTANA 59620-1601

February 9, 2016

Mr. J.R. Iman
774 Highway 93 N.
Hamilton, MT 59840

Re: 2015 Painted Rocks Dam Safety Annual Inspection

Dear J.R.:

The annual dam safety inspection of the Painted Rocks Dam was conducted on October 20, 2015. A report, which includes observations, photos, and recommendations from the visit, is enclosed. The maintenance recommendations are also attached to this letter for your convenience.

I should note that the format of the report is revised compared to previous years. I hope that you will find it more convenient to review, but if you have any trouble or comments related to the new format please let me know.

If you have any questions, please call me at 444-6692.

Sincerely,

Josh R. Gilstrap, P.E.
Dam Safety Engineer
State Water Projects Bureau
jgilstrap@mt.gov

Enclosures

cc: Larry Schock, DNRC Missoula Region Engineer (email)
Al Pernichele, Painted Rocks Dam Operator (email)

RECOMMENDATIONS

Maintenance / Repair

ID	DESCRIPTION	STATUS
PR-10-02	Repair the holes in the outlet tunnel at the crown of the conduit just downstream of the gate. The department will assist the association with this repair.	Incomplete
PR-10-03	Continue to remove the large brush and trees from both faces of the dam. This removal is necessary to prevent the root systems from creating seepage paths through the embankment and abutments, and to facilitate visual inspection of the dam.	Ongoing
PR-10-06	Repair the holes in the outlet tunnel joint (joint #22) near the crown of the conduit approximately 50 feet downstream of the gate chamber. The department will assist the association with this repair.	Incomplete
PR-10-07	Develop an operation plan for tightly sealing both gate operating mechanisms. Modify gate seal locations as needed to obtain tight seals. The department will assist the water users with this effort.	Ongoing
PR-10-08	Repair the spalls on the ogee weir and seal the cracks on the upper portion of the spillway floor slab and walls with an appropriate crack sealant product. The department will assist the association with this repair.	Incomplete / pending 2016 inspection
PR-13-01	Inspect the entire spillway chute closely, assess if it is still functioning adequately and identify any areas in need of repair. The Department will be responsible for this recommendation.	Pending 2016
PR-15-01	Remove debris from log boom and from spillway crest prior to spilling.	New
PR-15-02	Replace the broken and detached buoy near the right end of the boom. The DNRC will complete this repair.	New
PR-15-03	Remove the trees and brush in the left downstream groin.	New

Annual Maintenance

ID	DESCRIPTION	STATUS
PR-AM-01	Remove the floating wood debris from the dam face, the spillway, spillway approach and log boom.	Ongoing
PR-AM-02	Lubricate and clean the both gate operating mechanisms. Tighten bolts on both gate seals.	Ongoing
PR-AM-03	Remove the few bushes that exist on the upstream face of the dam. Remove the large brush and small trees in the left downstream groin. Remove the bushes along the left spillway wall.	Ongoing
PR-AM-04	Operate the reservoir in the fall and winter months in such a way that the inlet remains submerged. The outflow from the dam should be limited to the inflow into the reservoir during the fall and winter months.	Ongoing
PR-AM-05	Reduce the flow through the outlet whenever the spillway is in use to minimize the splash at the toe of the dam.	Ongoing

DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
DAM SAFETY INSPECTION REPORT

NAME OF DAM: PAINTED ROCKS DAM

DATE OF INSPECTION: 10/20/2015

DAM INSPECTED BY: Josh Gilstrap, P.E.
Larry Schock
Jim Nave

WUA REP:

WEATHER: Partly cloudy
45 degrees

INVENTORY NO.:	MT-19	OWNER:	DNRC
HAZARD CATEGORY:	HIGH	OPERATOR:	DNRC
TYPE OF DAM:	Zoned Earth Fill	STREAM(S):	W.F. Bitterroot River
YEAR BUILT:	1938	DRAINAGE AREA:	316 square miles
YEAR REHABILITATED:	2011-2015		

RESERVOIR STORAGE STATUS

	Water Surface Elevation (Feet)	Storage (Acre-Feet)
At Time of Inspection:	4,659.50	5,458
At Spillway Crest:	4,725.50	32,362
At Min. Dam Crest Elevation:	4,743.10	45,756

1. EMBANKMENT

A. Crest

Height: 143 feet
Length: 800 feet
Width: 20.5 feet
Surface: Compacted Gravel

#	ITEM	YES	NO	REMARKS
1	Settlement		X	
2	Misalignment		X	
3	Transverse cracking		X	
4	Longitudinal cracking		X	
5	Traffic or roadway damage		X	
6	Other		X	

B. Upstream Face

Upper Slope Ratio: 2H:1V
Mid Slope Ratio: 2.5H:1V
Lower Slope Ratio: 4H:1V

#	ITEM	YES	NO	REMARKS
1	Erosion	X		See comments
2	Longitudinal cracks		X	
3	Transverse cracks		X	
4	Adequate riprap protection	X		
5	Riprap deterioration		X	See comments
6	Settlement / Depressions		X	
7	Slumps / Sloughs		X	
8	Nuisance vegetation	X		See comments
9	Debris	X		See comments
10	Other		X	

C. Downstream Face

Upper Slope Ratio: 2H:1V
Lower Slope Ratio: 4H:1V

#	ITEM	YES	NO	REMARKS
1	Erosion	X		See comments
2	Longitudinal cracks		X	
3	Transverse cracks		X	
4	Settlement / Depressions		X	
5	Slumps / Sloughs		X	
6	Seepage		X	
7	Adequate vegetation cover	X		
8	Nuisance vegetation	X		See comments
9	Traffic or animal damage	X		See 1.C.1
10	Debris		X	
11	Other		X	

2. ABUTMENT AND TOE

A. Downstream Toe

#	ITEM	YES	NO	REMARKS
1	Seepage		X	
2	Depressions / Bulges		X	
3	Boils		X	
4	Erosion		X	
5	Animal damage		X	
6	Nuisance vegetation		X	
7	Other		X	

B. Upstream Abutment

#	ITEM	YES	NO	REMARKS
1	Erosion		X	
2	Cracking		X	
3	Differential movement		X	
4	Slides / Depressions		X	
5	Nuisance vegetation		X	
6	Animal damage		X	
7	Debris	X		Minor, left groin
8	Other		X	

C. Downstream Abutment

#	ITEM	YES	NO	REMARKS
1	Erosion		X	
2	Cracking		X	
3	Differential movement		X	
4	Slides / Depressions		X	
5	Seepage		X	
6	Nuisance vegetation	X		See comments
7	Animal damage		X	
8	Debris		X	
9	Other		X	See 1.C.1

3. OUTLET WORKS

Location: Through right abutment Maximum Discharge: 1,100 CFS

A. Intake Structure

Not Visible During Inspection: X Date Inspected: 10/21/2009
Visible During Inspection: Type: Rectangular

#	ITEM	YES	NO	REMARKS
1	Settlement			Under water, not observed
2	Concrete cracking			As above
3	Concrete spalling			As above
4	Concrete erosion			As above
5	Exposed reinforcement			As above
6	Joint displacement			As above

3. OUTLET WORKS (Continued)

A. Intake Structure (Continued)

7	Open joints			As above
8	Problems with trash rack			As above
9	Corrosion of trash rack			As above
10	Erosion around intake			As above
11	Deposition around intake			As above
12	Other	X		See comments

B. Upstream Conduit

Not Visible During Inspection: X
Visible During Inspection:
Type: Reinforced Concrete Horseshoe
Size: 10 FT diameter

#	ITEM	YES	NO	REMARKS
1	Cracking			Underwater not observed
2	Spalling			As above
3	Erosion			As above
4	Exposed reinforcement			As above
5	Joint displacement			As above
6	Open joints or holes in the wall			As above
7	Leakage			As above
8	Misalignment of conduit			As above
9	Other			As above

C. Downstream Conduit

Not Accessible During Inspection:
Accessible During Inspection: X
Conduit Entrance Time: 11:20 AM
Type: Reinforced Concrete Horseshoe
Size: 10 FT diameter
Exit Time: 12:40 PM

#	ITEM	YES	NO	REMARKS
1	Cracking	X		None of immediate concern
2	Spalling	X		See comments
3	Erosion		X	
4	Exposed reinforcement	X		See 3.C.12
5	Joint displacement		X	
6	Loss of joint material	X		See comments
7	Open joints or holes	X		See comments
8	Leakage	X		See comments
9	Calcium deposits	X		See comments
10	Misalignment of conduit		X	
11	Material deposition		X	
12	Cavitation damage	X		See comments
13	Other	X		See comments

D. Gatehouse and Tower

#	ITEM	YES	NO	REMARKS
1	Vandalism		X	
2	Grating in good condition	X		

3. OUTLET WORKS (Continued)

D. Gatehouse and Tower (Continued)

3	Seepage from tower walls		X	See comments
4	Ladders in good condition		X	See comments
5	Tower walls in good condition	X		See comments
6	Problems with electrical		X	
7	O&M or EAP missing		X	
8	Other		X	

E. Guard Gate

Not Visible During Inspection: X
Visible During Inspection:

Type: Roller Chain
Size: 5 x 8 FT

#	ITEM	YES	NO	REMARKS
1	Operated during inspection	X		
2	Operational problems		X	
3	Cables in good condition	X		See comments
4	Drums and shieves good condition	X		
5	Leakage from gate	-	-	See comments
6	Gate leaf in good condition	-	-	See comments
7	Gate frame in good condition	-	-	See 3.E.6
8	Roller chains in good condition	-	-	See 3.E.6
9	Gate seals in good condition	-	-	See comments
10	Other	X		See comments

F. Operating Gate

Not Visible During Inspection: X
Visible During Inspection:

Type: Roller Chain
Size: 5 x 8 FT

#	ITEM	YES	NO	REMARKS
1	Operated during inspection	X		
2	Operational problems	X		See comments
3	Cables in good condition	X		See 3.E.3
4	Drums and shieves good condition	X		
5	Leakage from gate	X		See comments
6	Gate leaf in good condition			See comments
7	Gate frame in good condition			See 3.F.6
8	Roller chains in good condition			See 3.F.6
9	Gate seals in good condition			See comments
10	Air vents in good condition	X		See comments
11	Other		X	

4. SPILLWAY

Location: Right Abutment Type of Spillway: Uncontrolled Chute Max. Discharge: 42,000 CFS

A. Approach Area

Not Visible During Inspection:
Visible During Inspection: X

4. SPILLWAY (Continued)

A. Approach Area (Continued)

#	ITEM	YES	NO	REMARKS
1	Deposition / debris / obstructions	X		See comments
2	Nuisance vegetation		X	
3	Log boom in good condition	X		See comments
4	Other		X	

B. Spillway Bridge

#	ITEM	YES	NO	REMARKS
1	Bridge abutments in good condition	X		See comments
2	Bridge span in good condition	X		
3	Bridge piers in good condition	X		
4	Railing in good condition	X		See comments
5	Other		X	See comments

C. Weir

Not Visible During Inspection: _____ Type of Weir: Ogee Crest

Visible During Inspection: X Length: 160 FT

#	ITEM	YES	NO	REMARKS
1	Cracking of weir concrete		X	
2	Spalling of weir concrete	X		See comments
3	Exposed reinforcement		X	
4	Other		X	

D. Chute

Operating During Inspection: No Type: Uncontrolled Concrete Chute

#	ITEM	YES	NO	REMARKS
1	Concrete cracking - floor	X		See comments
2	Concrete cracking - walls	X		See comments
3	Concrete spalling - floor	X		See comments
4	Concrete spalling - walls	X		See comments
5	Concrete erosion	X		See comments
6	Exposed reinforcement	X		See 4.D.3
7	Exposed water stops		X	
8	Displacement or offset of joints	X		See comments
9	Joint sealant in good condition		X	See comments
10	Seepage from drains		X	See comments
11	Seepage not from drains		X	
12	Deposition of material	X		See comments
13	Fence and railing in good condition	X		
14	Nuisance vegetation	X		See comments
15	Other	X		See comments

E. Stilling Basin

Dewatered for Inspection: No

* Observations made from above left chute / basin wall, spillway not operating.

4. SPILLWAY (Continued)

E. Stilling Basin (Continued)

#	ITEM	YES	NO	REMARKS
1	Concrete cracking	X		See comments
2	Concrete spalling	X		See 4.E.1
3	Concrete erosion	X		See comments
4	Exposed reinforcement	X		See 4.E.3
5	Exposed water stops	-	-	
6	Deposition of material	-	-	
7	Energy dissipaters in place	-	-	See comments
8	Deterioration of dissipaters	X		See comments
9	Erosion of stilling basin	-	-	See 4.E.7
10	Debris in stilling basin	X		See comments
11	Fence and railing in good condition	X		
12	Other	X		See comments

5. RESERVOIR CONTROL

A. Development and Changes

#	ITEM	YES	NO	REMARKS
1	Recent upstream development		X	
2	Recent downstream development	X		Some new cabins
3	Slides in reservoir area		X	
4	Changes in basin hydrology		X	
5	Change in reservoir operation		X	
6	Large impoundment upstream		X	
7	Significant debris in reservoir	X		
8	Other		X	

6. INSTRUMENTATION

Piezometers Monitored Manually: X

Piezometers Monitored Automatically: _____

A. Instrumentation

#	ITEM	YES	NO	REMARKS
1	Description		X	
2	Damage to piezometers		X	
3	Atypical piezometer data		X	
4	Data available through DAMSMART/DAMNET	X		
5	Other		X	

7. DOWNSTREAM CONDITION

A. Downstream Land Use

Forest, agricultural, residential, recreation, and the town of Darby.

Report completed by: Josh Gilstrap, P.E.

COMMENTS

1.	EMBANKMENT	PHOTOS
1.B.1	There is a prominent erosion gully (three to four feet wide by 20 feet long) on the left upstream face near the left abutment in material that is occasionally replenished by the Ravalli County Road Department - the cause of the erosion is runoff from the road. Rills / gullies like this are not indicative of deficiency in the armoring of the upstream face of the dam. This is a maintenance issue that should be monitored and addressed as needed.	16
1.B.5	The riprap is in good shape, with only occasional clast degredation / weathering, zones of smaller clasts, and minor benching at high water line.	3, 10, 11, 12, 13
1.B.8	There is some knapweed and other small brush on the upstream face. The weeds in particular require management.	18
1.B.9	There is debris on the upstream face of the dam at the normal high water mark. The debris needs be removed and disposed of. This is an annual maintenance task. During the 2015 inspection there were several relatively large trees on the upstream face in addition to the normal smaller debris .	3, 4, 15-17
1.C.1	There are common access points on the downstream face (and abutment) by members of the public, and the pedestrian traffic creates trails that become can channel runoff / erosion. This is a maintenance issue that should be monitored and addressed as needed. In addition to these areas, there are shallow rills in the upper-most portion of the downstream face near the crest - these rills attenuate down the the slope in the proper, vegetated embankment (rather than the sparsely vegetated road cast-off material near the crest).	7, 9, 21, 30
1.C.8	The downstream face now has only a few bushes and small trees. Herbicide application with Milestone in 2010, 2011 and 2012 has been successful in killing most of the willows and small trees growing on the downstream face. There was no application in 2013. The embankment was sprayed on two (2) occasions during the 2014 season. An additional treatment was scheduled for 2015. During the 2015 inspection several knapweed bunches and small trees (at least six) were documented. These require furhter control / management.	19, 23
2.	**ABUTMENT AND TOE**	
2.C.6	The left groin has many large bushes and small to sized trees which should be removed. There are also small trees growing along the right abutment / left wall of the spillway.	26-29
3.	**OUTLET WORKS**	
3.A.12	The low level intake was last inspected in 2009. Prior to 1989 the reservoir was routinely drawn down below the top elevation of the intake structure in the winter months. As a result the concrete was damaged from freeze/thaw cycles. The structure has remained submerged since 1989. The top edges and corners are spalled to a depth of approximately 2-inches. The intake was designed with trash racks on three sides and the top. The existing racks have heavy surface corrosion but are operating as designed. Ideally, the intake is inspected on a 5 year cycle.	

COMMENTS

3.	OUTLET WORKS (Continued)	PHOTOS
3.C.2	Near the middle of the conduit, just downstream of the 16th joint, there are two relatively small popouts (2x2x2 and 8x2x2 inches in size) at about 11 o'clock. This will need scaffolding to repair, and is not currently a dam safety concern.	
3.C.6	At the sixth joint downstream of the gate chamber, there are three openings in the joint filler / patch material at 1:30, 2:30 and 3:30. These are shallow and do not penetrate through the joint. For more information, see the 2008 joint inventory report - the condition of the joints have not changed appreciably since 2008.	
3.C.7	There is a small hole on the crown of the outlet conduit approximately 1-foot downstream from the end of the gate. Attempts the patch this hole in the late 1990's were unsucessful due to gate leakage. There are also shallow holes in the crown about 20 feet downstream from the gate chamber. These holes resemble a rock pocket defect cast in-place during the original construction.	
3.C.8	Some of the joints leak a non-measurable amount of water.	
3.C.9	There are calcium deposits at some of the joints, cracks, and repairs.	33-37
3.C.12	There is ongoing cavitation that damages concrete immediately downstream from the gate chamber (repairs have been made several times in the past, in 2013 and 1978 for example). There is a 4 feet by 5 feet area of exposed aggregate and exposed reinforcement on the left expansion wall. The damage at this location does not appear to be progressing but needs to be monitored. The right side of the conduit downstream from the gate has similar cavitation damage, although the cavitation area is not as large and not as pronounced. During the 2015 inspection the main left side repair appeared to be in great shape - essentially fully intact with only minor edge loss. Other areas appeared the same as 2013.	42, 45
3.C.13	In general, the conduit is in good condition. There is an epoxy coating on the floor downstream of the gate chamber - during the 2015 inspection this coating was eroded for about 20-ft (about 1/2 of its total length).	
3.D.3	When the guard gate tower is full and the operating gate tower is dry there is usually a small seep through a construction joint in the wall that separates the two towers. During the fall (October/November) of 2014 a small seep (approximately ½-1 gpm) appeared on the downstream face of the operator tower, approximately 12 ft. below the gatehouse pit floor. The seepage formed an ice block that would not allow the operator gate to move down the tower. This seep was dry during the 2015 inspection.	48
3.D.4	In 2006, the tower ladders were inspected and found to be heavily corroded, missing anchors, and were deemed to be very unsafe and not to be used without a safety line. The ladder is no longer used for inspecting the tower and gate chamber. Access is accomplished using a ladder to enter at the conduit's outlet.	48, 49

COMMENTS

3.	OUTLET WORKS (Continued)	PHOTOS
3.D.5	The gate tower was inspected by video camera in October 2006. Prior to the 2006 inspection the tower was last inspected in 1982. The camera was lowered approximately 100-feet and the concrete appeared to be in good condition. The camera could not be lowered into the gate chamber due to the high velocity spray.	
3.E.3	The hoist cables are to be replaced approximately every ten years. The cables on both the operator gate and the guard gate were replaced in October and November of 2014. The gate and hoist mechanisms were inspected during the cable replacement in 2014, and lubrication points on the hoist and gate chock block were lubricated.	47
3.E.5	The guard gate has a history of being difficult to close and seal tightly. During the 2009 inspection the gate seal plate bolts were tightened. The gate seems to seal best when it is in a hydraulically balanced condition. A suggested operating guidance was prepared in October 2008. During the 2011 and 2013 inspections there was difficulty getting the gate to seal. It was raised and lowered several times before it sealed adequately. A special inspection and work effort is needed to adjust the gate seals. The chamber between the guard gate and operating gate was not inspected in 2015.	
3.E.6	The guard gate was rehabilitated in the spring of 2006. Work included replacing the roller chains and repainting the gate. The gates were inspected by a consultant (MWH) in October 2006.	
3.E.9	The sealing surface on the guard gate had linear gouges on both sides near the bottom in 2010 (not inspected 2015).	
3.E.10	In the summer of 2007 the slotted holes on the guard gate seal were extended 1-inch in order to lower the gate seal this amount. In 2007, the seal could only be lowered approximately 1/2-inch due to the vertical spacing of the bolts being unequal to the vertical spacing of the top edges of the slotted holes, the seal was riding on the bottom row of bolts and there is a gap of approximately 3/8-inches along the top row of bolts. In the summer of 2008 the slotted holes on the guard gate seal were extended another 1-inch in order to lower the gate seal this amount. A spanner wrench was fabricated in 2007 for operating the lock nuts and is left at the gate house.	
3.F.2	The gates have a history of being difficult to manage relatively small flows (< 100 cfs). Gate rehabilitation efforts and adjustments to the gate seal plates have helped this situation. A recommended operating guide was prepared in October 2008. There is also noticeable vibration in the electric motor when operating the gate machinery.	
3.F.5	The operating gate has a history of being difficult to close and seal tightly. In 2010, the gate seal plate on the operating gate was raised 3/4 of an inch. The bolts were torqued using a torque wrench and Lock-Tite was applied to keep the bolts from backing off. The gates (both) had to be set three times during the 2015 inspection in order to create a seal that would allow conduit entrance.	41
3.F.6	The operating gate was refurbished in 2008, which included replacing roller chains, refurbishing chain raceways and repainting the steel.	

COMMENTS

3.	OUTLET WORKS (Continued)	PHOTOS
3.F.9	In 2010 a linear gouge on the gate seal was noted on the left side near the bottom.	
3.F.10	There are two air vents - a 6-inch and a 42 inch diamter. The larger vent was constructed during the repair work in 1978, a larger air vent was constructed to reduce cavitation damage. Some past inspections (2010, 2011) have documented a slight water leak appearing to originate 9 corrugations up from the bottom of the vent. This was not visible during the 2015 inspection.	46
4.	**SPILLWAY**	
4.A.1	During the 2015 inspection there was debris on the spillway approach. This should be removed if not already done. Debris removal continues to be an annual maintenance task for the WUA.	50
4.A.3	The log boom and its anchors are in good condition. The log boom was replaced after the previous one was destroyed in the spring of 2002. During the 2015 inspection there was, however, a damaged and detached buoy near the far right side of the boom - this was placed in the gatehouse. This should be repaired.	54
4.B.1	There is concrete damage at the top of the left spillway wall / left bridge abutment.	66
4.B.4	The USFS replaced the bridge railing during the 2014/2015 winter. The project was completed in January of 2015.	55, 56
4.B.5	Bridge maintenance is the responsibility of the USFS. The USFS inspected the bridge in September 2011.	55
4.C.2	The weir has spalling / freeze-thaw damage at the following locations: middle bay near the center joint (3.5 feet long), four feet right of the left pier (three feet of hollow conrete), and near the left wall.	57
4.D.1	The spillway floor has severe transverse cracking in the steeper portion of the chute above the low level outlet. A few of the cracks are diagonal. The cracks are approximately 2-inches deep and as wide in several locations. They are large enough that they can be seen from a good distance away.	58-62
4.D.2	The spillway walls near the crest (and isolated locations on the bridge piers) have minor pattern cracking. The spillway walls have vertical cracking their entire length with maximum widths of approximately 1-inch. Some of the previously repaired areas remain in good condition while others have cracked and spalled. Reinforcing steel is exposed in some areas.	
4.D.3	There is moderate spalling adjacent to joints and the reinforcing steel is exposed at some locations. The damage does appear to have worsened when compared to inspection photos from 2003 (2014 review). The upper portion of the spillway slab is in much better condition. Previous cracking and spalling damage has been repaired with grout that has for the most part remained in place. During the 2015 inspection the following items were documented (on the upper portion of the spillway that is accessible): on the first transverse joint downstream of the left pier the left end of an old repair is hollow, and near the right wall where downstream of the bridge an old triangular shaped repair is hollow.	58-62

COMMENTS

4.	SPILLWAY (Continued)	PHOTOS
4.D.4	There are many areas of freeze-thaw damage / spalling on the left spillway wall. The right wall cannot be safely inspected. The condition of the walls should be inventoried / inspected in conjunction with the anticipated 2016 effort.	67-72
4.D.5	There is some erosion along the base of both spillway walls extending approximately 8 to 12-inches up from the floor slab. There are a couple of places on the floor that have evidence of erosion around previously repaired areas. The erosion damage is also more severe at the steeper portion of the chute. The eroded areas are up to 1-inch deep in some places.	
4.D.8	Some of the joints, in particular a transverse joint in the upper right spillway seem to have a wide gap (see photo).	65
4.D.9	Many of the joints have nonexistent or compromised joint material. The joint sealant is pulling out of the second joint downstream from the piers.	
4.D.10	The upper drains were checked with a five foot long rod during the 2015 inspection - they were clear.	
4.D.12	The right wall cannot be safely inspected without being tied off. There is an accumulation of ravelled material behind and on top of the right spillway wall.	
4.D.14	There are also many small trees and bushes growing along both walls (outside) of the spillway.	
4.D.15	The bottom portion of the spillway is very steep and therefore was not closely inspected this year. The steep portion (except for bottom 50-feet) of the spillway was inspected by a consultant (MWH) in October 2006. On August 26, 2014 an aerial camera platform (ACP) was used to investigate an object that had been seen protruding from the spillway earlier in the year. Although the object was no longer protruding from the face of the spillway, the photos and video from that work indicated that the object was most likely a stick that wedged into a joint in the spillway. A thorough spillway inspection is planned to 2016.	
4.E.1	The right wall is spalled at the base of the spillway chute and reinforcing steel is exposed. Portions of the stilling basin wall tops were repaired in 1987. Cracks were sealed in 2002 with a methacrylic crack sealer. These previous repairs in general are holding up adequately. However, in areas that were not repaired in 1987 the concrete has deteriorated severely, and there is some deterioration of 1987 repairs.	73-75
4.E.3	During the 2006 inspection, it was determined that there is significant erosion damage (12-inch depth or more, exposed reinforcing) of the stilling basin floor primarily between the second and third rows of baffle blocks. The floor is also lightly eroded (2-inch or less depth) at the base of the spillway. This was confirmed during the 2009 dive inspection. Divers inspected the stilling basin in 2014 and the results of the inspection showed continued deterioration of the stilling basin floor	

COMMENTS

4.	SPILLWAY (Continued)	PHOTOS
4.E.7	During the 2006 dive inspection three baffle blocks were missing (vertical reinforcing steel in place), and three unattached baffle blocks were located upstream of the baffle wall. The energy dissipaters were again inspected in 2009 and 2014. See, Inspection Report Liquid Engineering October 2014 for the most recent notes.	
4.E.8	During the 2006 inspection, it was determined that the first row of baffle blocks was generally in good condition; six baffle blocks were in poor condition in rows two, three and four. The six baffle blocks in poor condition had significant erosion up to 6-inches deep in some places. The 10/21/2014 Dive inspection revealed that the deterioration is continuing	
4.E.10	Dive inspections have shown that there is significant buildup of debris upstream and against the baffle wall. Two large steel plates are lying on the floor. The plates are reportedly from the outlet conduit prior to the repair work conducted in the 1970's.	
4.E.12	Overall the spillway stilling basin is in poor condition. A thorough stilling basin inspection is planned for 2016.	
5.	**RESERVOIR CONTROL**	
6.	**INSTRUMENTATION**	
7.	**DOWNSTREAM CONDITION**	

RECOMMENDATIONS

Maintenance / Repair

ID	DESCRIPTION	STATUS
PR-10-02	Repair the holes in the outlet tunnel at the crown of the conduit just downstream of the gate. The department will assist the association with this repair.	Incomplete
PR-10-03	Continue to remove the large brush and trees from both faces of the dam. This removal is necessary to prevent the root systems from creating seepage paths through the embankment and abutments, and to facilitate visual inspection of the dam.	Ongoing
PR-10-06	Repair the holes in the outlet tunnel joint (joint #22) near the crown of the conduit approximately 50 feet downstream of the gate chamber. The department will assist the association with this repair.	Incomplete
PR-10-07	Develop an operation plan for tightly sealing both gate operating mechanisms. Modify gate seal locations as needed to obtain tight seals. The department will assist the water users with this effort.	Ongoing
PR-10-08	Repair the spalls on the ogee weir and seal the cracks on the upper portion of the spillway floor slab and walls with an appropriate crack sealant product. The department will assist the association with this repair.	Incomplete / pending 2016 inspection
PR-13-01	Inspect the entire spillway chute closely, assess if it is still functioning adequately and identify any areas in need of repair. The Department will be responsible for this recommendation.	Pending 2016
PR-15-01	Remove debris from log boom and from spillway crest prior to spilling.	New
PR-15-02	Replace the broken and detached buoy near the right end of the boom. The DNRC will complete this repair.	New
PR-15-03	Remove the trees and brush in the left downstream groin.	New

Annual Maintenance

ID	DESCRIPTION	STATUS
PR-AM-01	Remove the floating wood debris from the dam face, the spillway, spillway approach and log boom.	Ongoing
PR-AM-02	Lubricate and clean the both gate operating mechanisms. Tighten bolts on both gate seals.	Ongoing
PR-AM-03	Remove the few bushes that exist on the upstream face of the dam. Remove the large brush and small trees in the left downstream groin. Remove the bushes along the left spillway wall.	Ongoing
PR-AM-04	Operate the reservoir in the fall and winter months in such a way that the inlet remains submerged. The outflow from the dam should be limited to the inflow into the reservoir during the fall and winter months.	Ongoing
PR-AM-05	Reduce the flow through the outlet whenever the spillway is in use to minimize the splash at the toe of the dam.	Ongoing

Photo 1 Downstream face from left abutment

Photo 2 Crest from left abutment

Photo 3 Upstream face from left abutment

Photo 4 Upstream face from near gatehouse

Photo 5 Crest from near gatehouse

Photo 6 Downstream face from near gatehouse

Photo 7 Downstream face, right

Photo 8 Downstream face, center

Photo 9 Downstream face, left

Photo 10 Upstream face, view left

Photo 11 Upstream face, view right

Photo 12 Upstream face, view right near water level

Photo 13 Upstream face, view left near water

Photo 14 Upper upstream face, view right

Photo 15 Upper upstream face, view left

Photo 16 Erosion near left upstream end of dam. Erosion is in material that is regularly replaced.

Photo 17 Debris at high water line

Photo 18 Knapweed on upstream face / right abutment

Photo 19 Downstream view of dam, looking right, note small trees

Photo 20 Downstream face of dam, looking left

Photo 21 Foot access trail near left downstream groin

Photo 22 Shallow erosion, note that erosion is limited to the location / material related to crest material cast-off

Photo 23 Knapweed, downstream face of dam

Photo 24 Left upstream groin

Photo 25 Left upstream groin

Photo 26 Left downstream groin

Photo 27 Left downstream groin

Photo 28 Brush and small trees in left downstream groin

Photo 29 Brush and small trees in left downstream groin

Photo 30 Right downstream groin

Photo 31 Access into outlet conduit

Photo 32 Access into outlet conduit

Photo 33 Diagonal crack in conduit

Photo 34 Condition of old repair in conduit

Photo 35 Condition of old repair in conduit

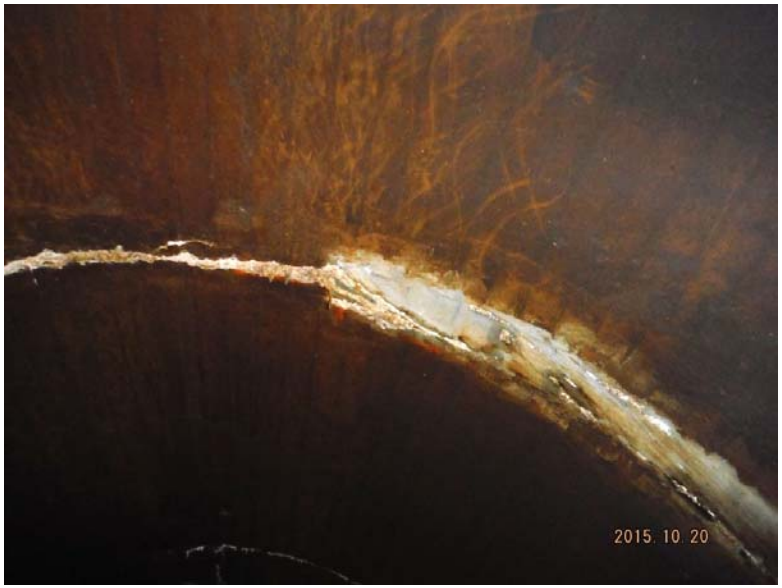


Photo 36 Example old joint repair and calcification

Photo 37 Larry Schock inspecting conduit joint

Photo 38 Recently installed hand rail at gatehouse, installed by Larry Shock and Jim Nave

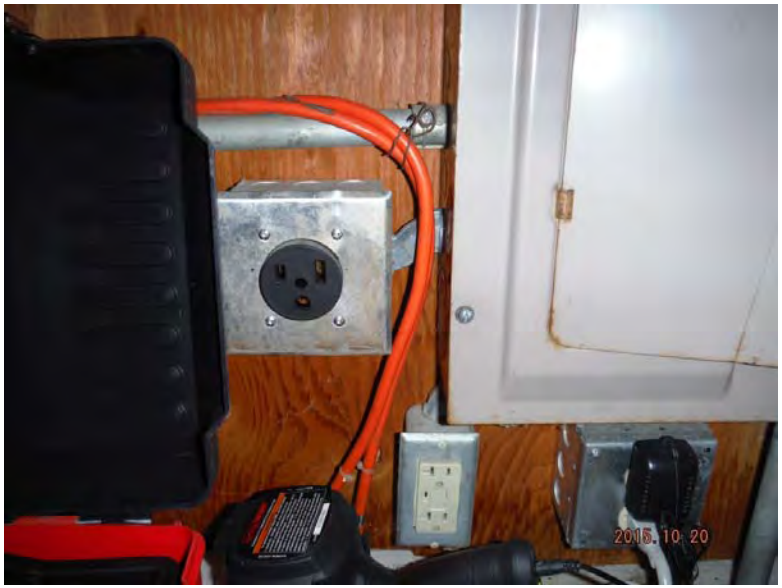


Photo 39 Power upgrades in gatehouse

Photo 40 Power upgrades in gatehouse (new 240V outlet)

Photo 41 Downstream side of operating gate

Photo 42 Condition of 2013 cavitation repair - in great shape with only minor edge loss

Photo 43 Old spall / pop out just downstream of operating gate. According to the previous inspector, this condition has not changed (e.g. not erosion)

Photo 44 Amount of gate leakage

Photo 45 Exposed reinforcement left of left downstream thimble (stable condition)

Photo 46 Air vent

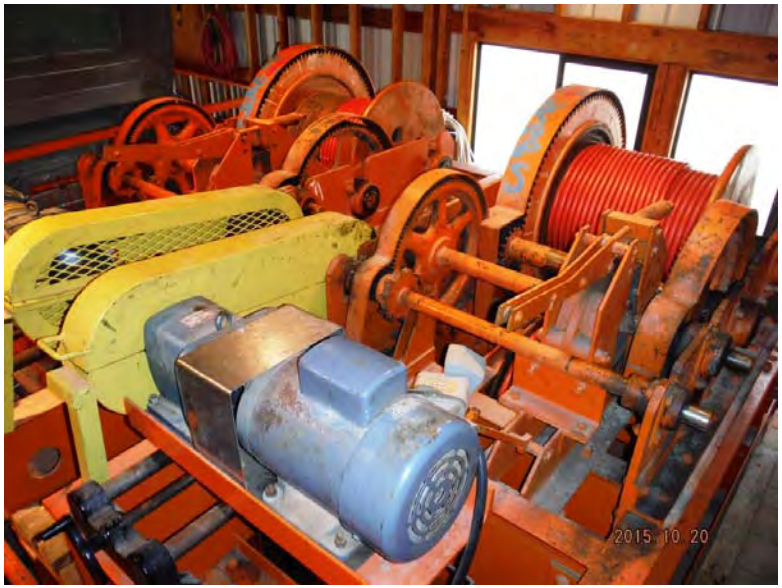


Photo 47 Gate operators

Photo 48 Operating gate tower - no seepage

Photo 49 Guard gate tower

Photo 50 Spillway approach and log boom, note some debris

Photo 51 Right spillway abutment

Photo 52 Left spillway wall / abutment

Photo 53 Spillway, weir, and bridge

Photo 54 Broken buoy near right end of log boom

Photo 55 Bridge, with new railing

Photo 56 Outer view of new railing, installed by USFS

Photo 57 Example of spalling damage on spillway weir

Photo 58 View of steep portion of spillway

Photo 59 View of steep portion of spillway

Photo 60 View of steep portion of spillway

Photo 61 View across steep portion of spillway - white areas void of moss may be concrete spalling / erosion, or wear moss is eroded from concrete

Photo 62 View down spillway and stilling basin above conduit outlet portal

Photo 63 Exposed reinforcement on left side of outlet conduit portal (same condition as previous years)

Photo 64 Condition of 2013 joint repair - sound with light surface scaling

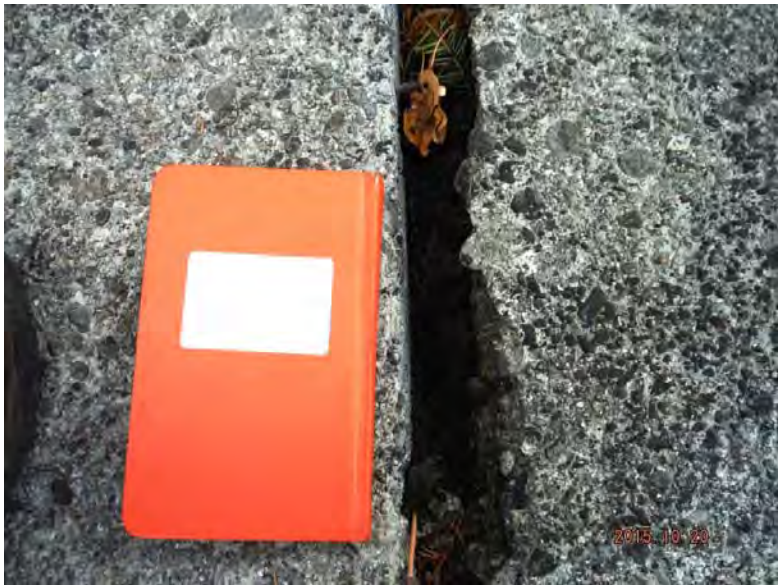


Photo 65 Transverse joint separation - spillway upper right

Photo 66 Concrete damage on top of spillway approach wall

Photo 67 Concrete damage at top of left spillway wall

Photo 68 View down left spillway wall

Photo 69 Concrete damage at top of left spillway wall

Photo 70 Concrete damage at top of left spillway wall

Photo 71 Concrete damage at top of left spillway wall

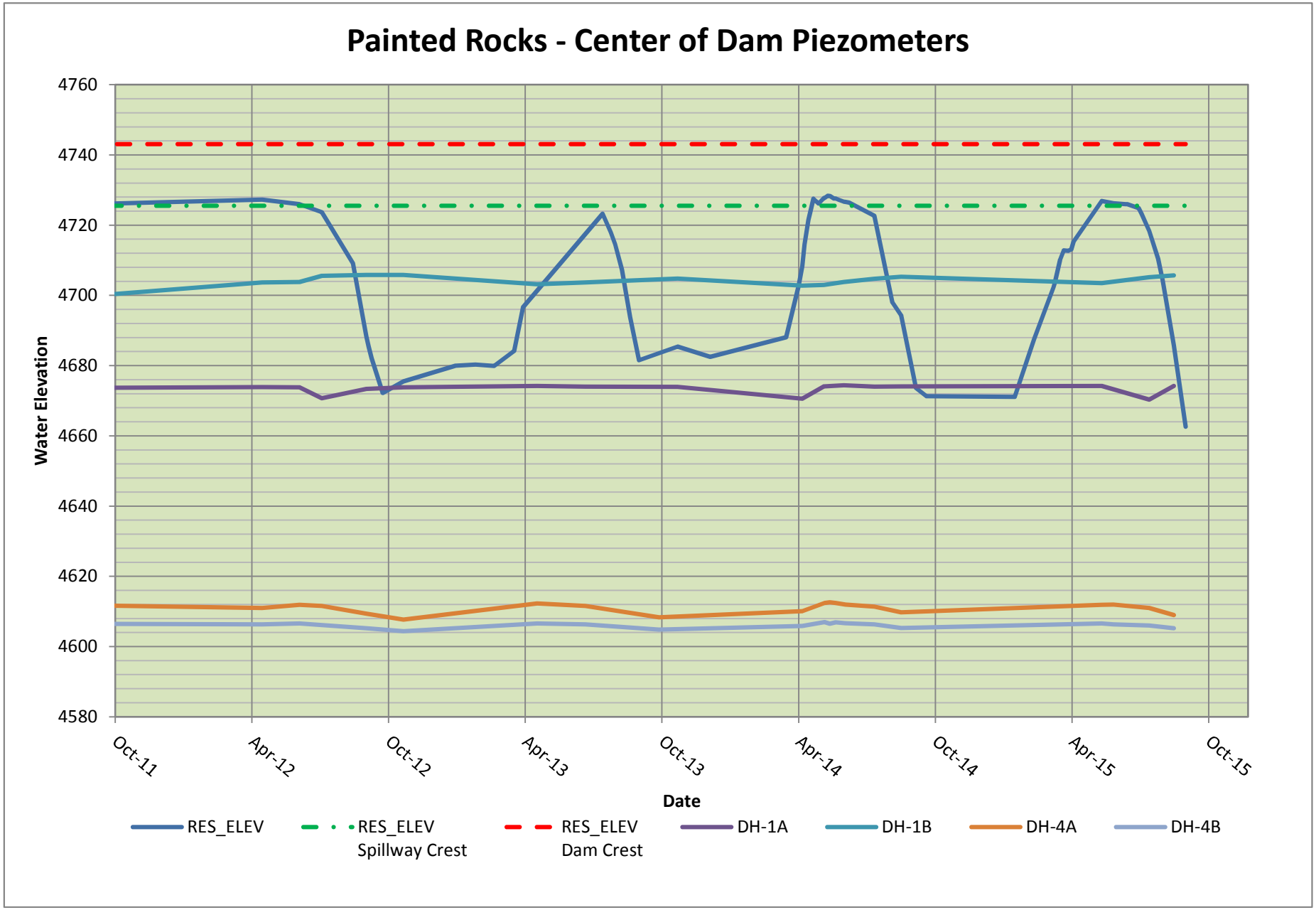
Photo 72 Concrete damage at top of left spillway wall

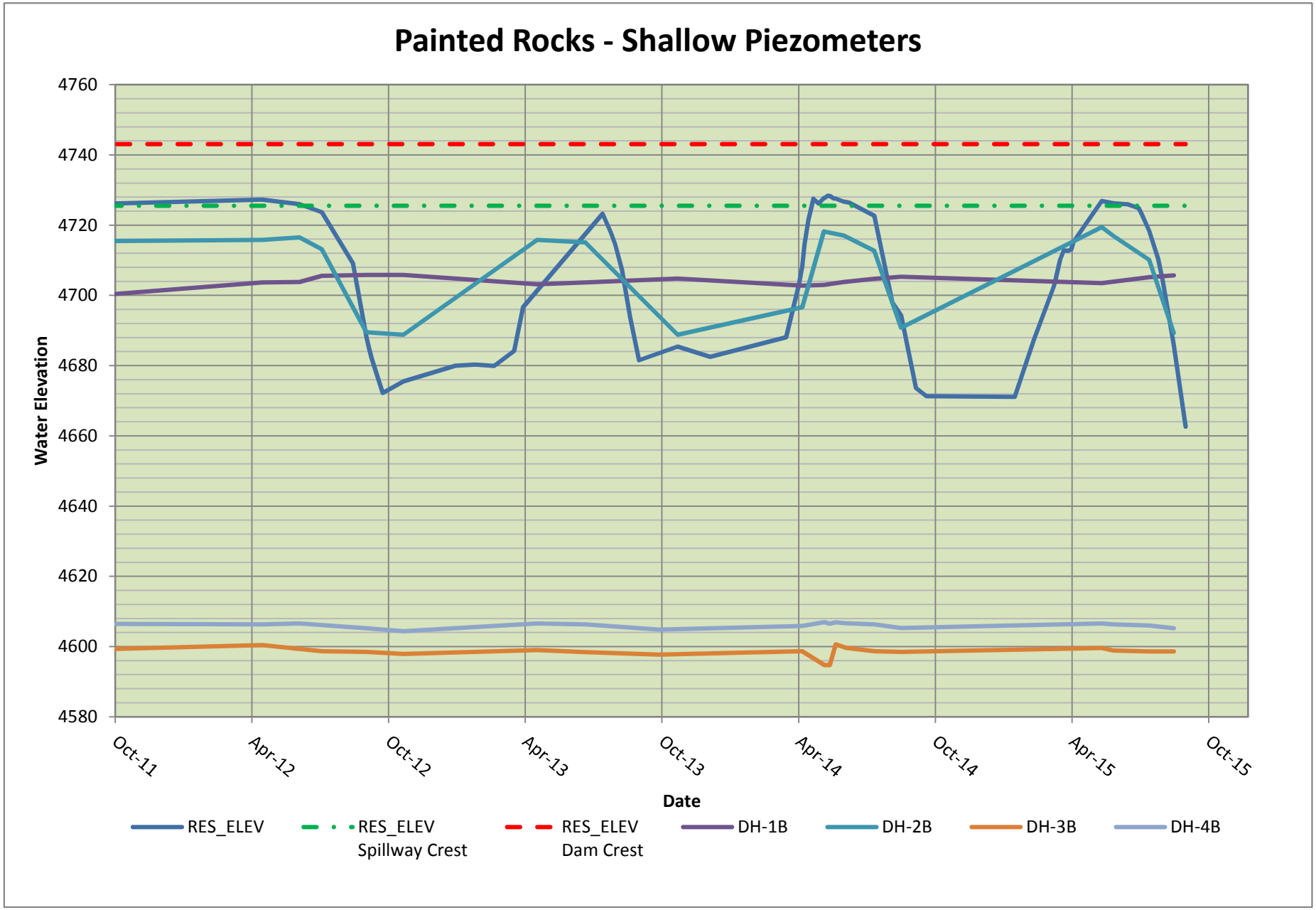
Photo 73 Debris and brush at top of right spillway wall

Photo 74 Trees and brush adjacent to right spillway wall

Photo 75 Debris at / above right spillway wall, and concrete damage at top of wall

Photo 76 Spillway and right downstream abutment


Painted Rocks - Center of Dam Piezometers
Water Elevation
4760
4740
4720
4700
4680
4660
4640
4620
4600
4580
Oct-11
Apr-12
Oct-12
Apr-13
Oct-13
Apr-14
Oct-14
Apr-15
Oct-15
Date
RES_ELEV
RES_ELEV Spillway Crest
RES_ELEV Dam Crest
DH-1A
DH-1B
DH-4A
DH-4B


Painted Rocks - Shallow Piezometers
Water Elevation
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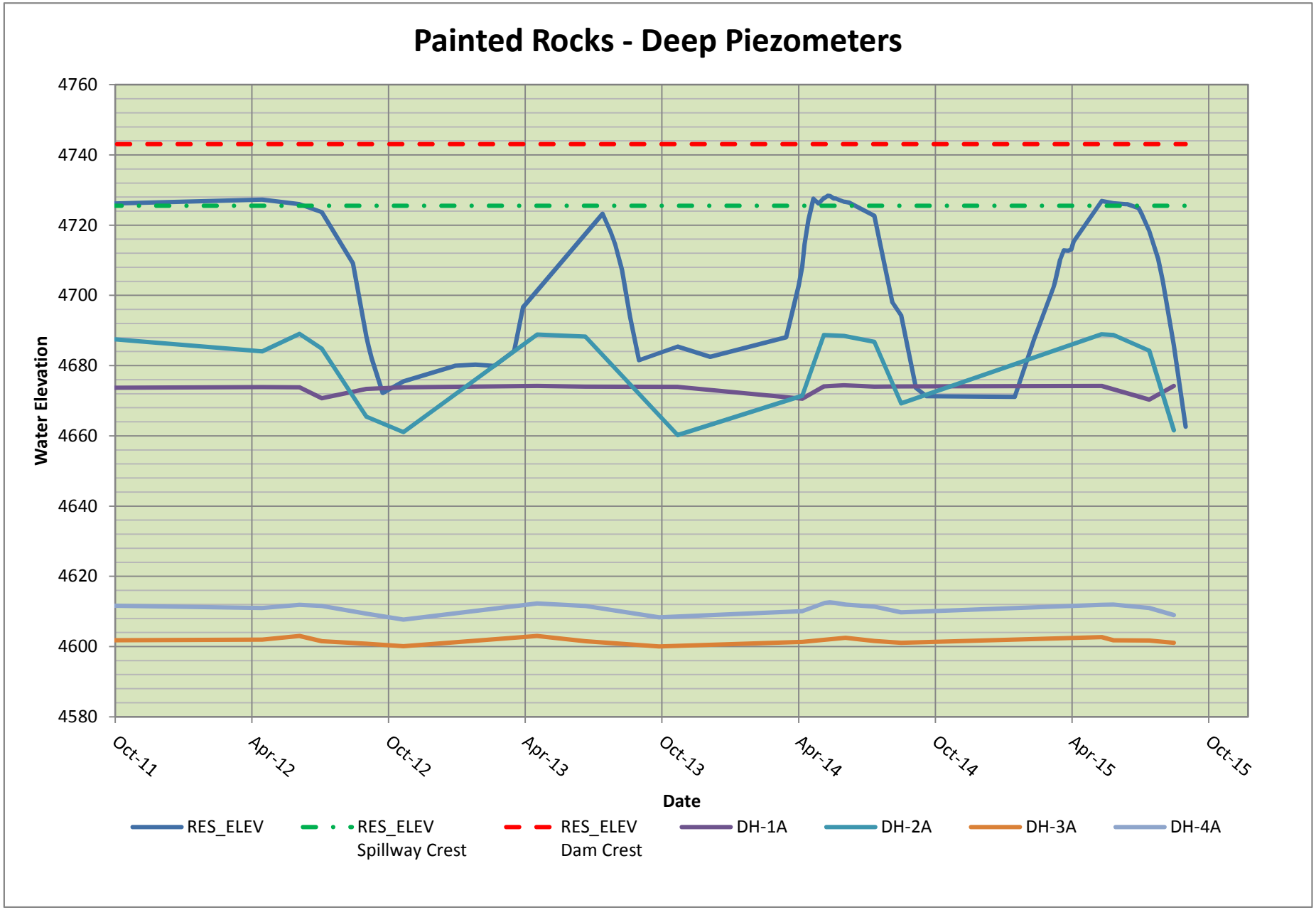
4740
4720
4700
4680
4660
4640
4620
4600
4580
Oct-11
Apr-12
Oct-12
Apr-13
Oct-13
Apr-14
Oct-14
Apr-15
Oct-15
Date
RES_ELEV
RES_ELEV Spillway Crest
RES_ELEV Dam Crest
DH-1B
DH-2B
DH-3B
DH-4B


Painted Rocks - Deep Piezometers
Water Elevation
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4740
4720
4700
4680
4660
4640
4620
4600
4580
Oct-11
Apr-12
Oct-12
Apr-13
Oct-13
Apr-14
Oct-14
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Oct-15
Date
RES_ELEV
RES_ELEV Spillway Crest
RES_ELEV Dam Crest
DH-1A
DH-2A
DH-3A
DH-4A

INSPECTION REPORT EXCERPTS

RELATIVE TO SPILLWAY

MWH 2007

The main issue associated with the gates at Painted Rocks is the fact that they will not close all the way. During the October 2006 inspection, several attempts were made to reduce the leakage by closing both the emergency gate and regulating gate as far as possible. This was done by allowing the gates to "freefall". With the reservoir level at approximately El. 4664.5, it was possible to reduce the leakage to approximately 25-cfs.

From the tunnel, it was noted that the control gate was leaking heavily at the bottom but not around the top and sides. Refer to **Photograph 10**. This is an indication that the gate bottom seal may not be adjusted properly.

The gate hoists were generally in good condition and well maintained. Refer to **Appendix B** for inspection notes and nameplate data for the gate hoists. Refer to **Photographs 15 through 19** for views of the hoists. In general the significant findings of the hoist inspection were as follows:

- Bearings were generally well lubricated.
- Gears generally were lacking recent lubrication.
- Belts were in good condition. No evidence of fraying was noted.
- The epoxy coated wire ropes, which are approximately 6 years old appeared to be in good condition. No evidence of fraying or significant corrosion was noted.
- Light to moderate scuffing was noted on several of the gear teeth of both hoists. Refer to **Photograph 18**.
- No maintenance schedule is kept for the equipment.
- There is no backup power source for the gate.
- Control Panel was new and in good condition. All operations were functional.

5.6 Inspection Findings – Spillway Chute and Training Walls

A close up visual inspection of the spillway chute and training walls was conducted by an engineer utilizing rappelling and ascending equipment. The close up inspection consisted of a visual assessment of the concrete, and limited testing of the concrete utilizing a Schmidt hammer and a rock hammer. Photographic documentation of the spillway inspection was taken with a digital camera by the inspector on the spillway, and limited digital video (with audio commentary) was taken by the observing engineer from the left and right abutments.

Below are the significant observations from the inspection of the Spillway chute and training walls:

- The spillway floor at the spillway crest appears to generally be competent with minor abrasion damage. Previous spalling damage has been repaired with grout and spillway joints have been filled. There was minimal spalling or cracking observed at the entrance to the spillway. **Refer to Photographs 23 through 28.**

- Wing walls at the spillway crest showed significant portions of medium pattern cracking and efflorescence. Previous work has been done to repair the top portions of these walls. **Refer to Photograph 29 and 34.**

- Localized efflorescence and medium pattern cracking was observed in key locations on the spillway bridge piers. Schmidt hammer readings of 18 indicate a concrete cylinder compressive strength of approximately 1,350 psi. **Refer to Photographs 30 and 31.**

- Periodic efflorescence was observed on both training walls. At one particular location downstream of the spillway bridge on the east training wall, efflorescence deterioration of the training wall was severe. **Refer to Photograph 32**.

- Abrasion damage was observed along the lower portion of the training walls along the entire length of the spillway. The height of this abrasion damage on the walls appears to correlate to the average depth of flow over the spillway. Depth of the damage ranged from approximately 1/16-inch to ½-inch. **Refer to Photograph 33.**

- Vertical cracking in both training walls was evident throughout the entire length of the spillway, including the areas that appear to have been rehabilitated in 1986. Crack patterns and widths range from micro spider cracking to greater than one inch vertical cracks. **Refer to Photographs 34 and 35.**

- The upper portion of the spillway floor (above approximate Station 3+55) was noted to have spalling/pitting over the majority area, ranging from 1/8-inch to 2-inches deep. Floor slab cracking was observed to generally run perpendicular to the spillway, but some longitudinal cracking is also present. **Refer to Photograph 36 through 38.**

- At the transition from the flatter to steeper spillway slopes (approximately Station 3+55), the abrasion damage on the slab becomes more severe, ranging from ½-inch to greater than one inch in depth. The horizontal and vertical cracking also becomes more severe in this area, with large cracks developing at and between the construction joints. Crack widths range from one to four inches wide with significant joint spall up to three inches deep. Reinforcing bars are exposed at several joint spall locations. There is also a section of discolored concrete (light brown color), that is more severely deteriorated than observed elsewhere. The discolored concrete was dusting, broke apart quite easily, and had Schmidt hammer readings of 10-15. **Refer to Photographs 39 through 41.**

It is important to note that while the Schmidt hammer readings were used to develop estimates for concrete compressive strength in the tested areas, in nearly all instances the readings are below the lower bound (Schmidt hammer reading of 20) for the compressive strength correlation curves, and the strength parameter was estimated by extrapolating the curves downward.

Refer to **Appendix C** for a plan of the spillway, divided into zones based on the level of observed deterioration. The map also indicates locations of several photographs identified above.

These detailed inspection observations confirm initial recommendations from the reconnaissance inspection. It is the MWH Team's recommendation that additional materials testing of selected areas be conducted to better understand the deterioration and strength parameters of the spillway materials. This would include coring various sections of the

concrete and performing petrographic and chemical analyses on these cores Given the variability of the existing concrete, and the degree of localized deterioration, at a minimum, predicting the remaining useful service life would require the acquisition additional materials testing data; however, because of the degree of some of the observed deterioration, even with additional materials testing data, it may not be possible to determine a meaningful estimation of the remaining useful life of the structure without providing some level of rehabilitation recommendations.

5.7 Inspection Findings – Stilling Basin and Basin Walls

The stilling basin was inspected by divers equipped with a helmet-mounted video camera. Refer to **Appendix D** for inspection notes for the stilling basin. Refer to **Appendix E** for the underwater inspection video. The stilling basin was found to be in poor condition. Major defects observed were as follows:

- Three baffle blocks were dislodged and/or missing. Several other baffle blocks were eroded near the base and along the edges.

- Heavy erosion of the stilling basin floor was identified at several locations. Concrete was eroded away over a significant area of the basin floor to as much as 12 in. Reinforcing bars were completely exposed at several locations.

- A large Buildup of Rock, Cobble and Timber Debris have built up at the base of the baffle wall.

- The right stilling basin wall was moderately scaled above the waterline over a large area. Reinforcing bars were exposed at several locations. The reinforcing bars did not appear to have been covered sufficiently during construction.

- The concrete stilling basin extension downstream of the baffle wall was in good condition. No defects were noted.

END DOCUMENT

Photograph 23 General Arrangement of Spillway Crest and Bridge Piers. (2003 Photo by DNRC).

Photograph 24 General View of Spillway Crest and Bridge Piers.

Photograph 25 Spillway Chute and Right Training Wall.

Photograph 26 Spillway Chute and Right Training Wall.

Photograph 27 Spillway Crest.

Photograph 28 Spillway Crest Repair.

Photograph 29 Left Wing Wall.

Photograph 30 Spillway Bridge Pier.

Photograph 31 Spillway Bridge Pier Bearing Seat.

Photograph 32 Effloresence Deterioration on East Training Wall.

Photograph 33 East Training Wall – Abrasion.

Photograph 34 West Training Wall – Rehabilitation Patches & Cracking.

Photograph 35 Cracking in West Training Wall.

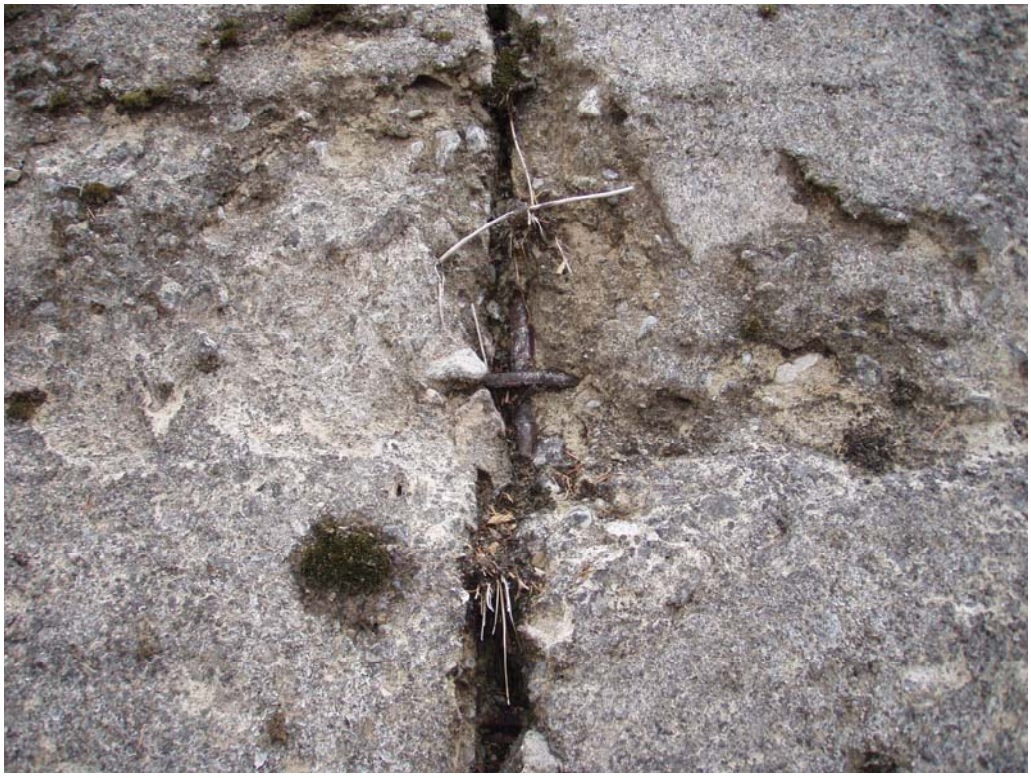
Photograph 36 Spillway Floor & West Training Wall.

Photograph 37 Spalling/Pitting on Spillway Floor.

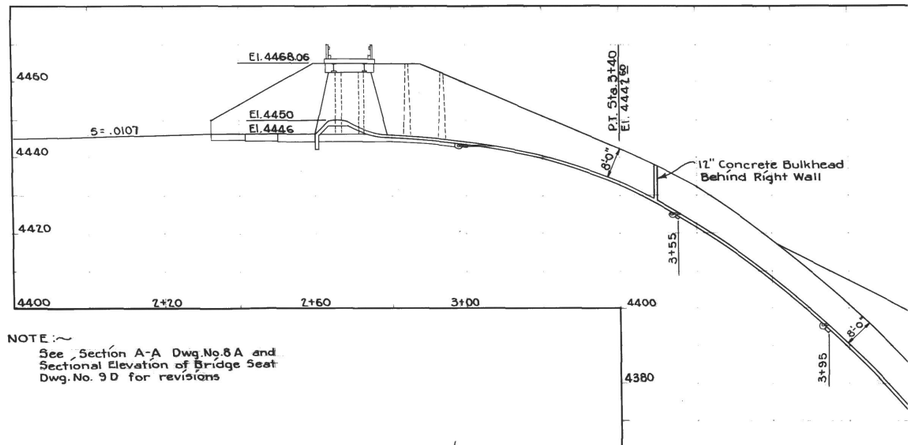
Photograph 38 Horizontal Cracking on Spillway Floor.

Photograph 39 Pitting in Spillway Floor.

Photograph 40 Deterioration of Spillway Floor Concrete.



Photograph 41 Exposed Reinforcing Bar in Spillway Floor Slab.



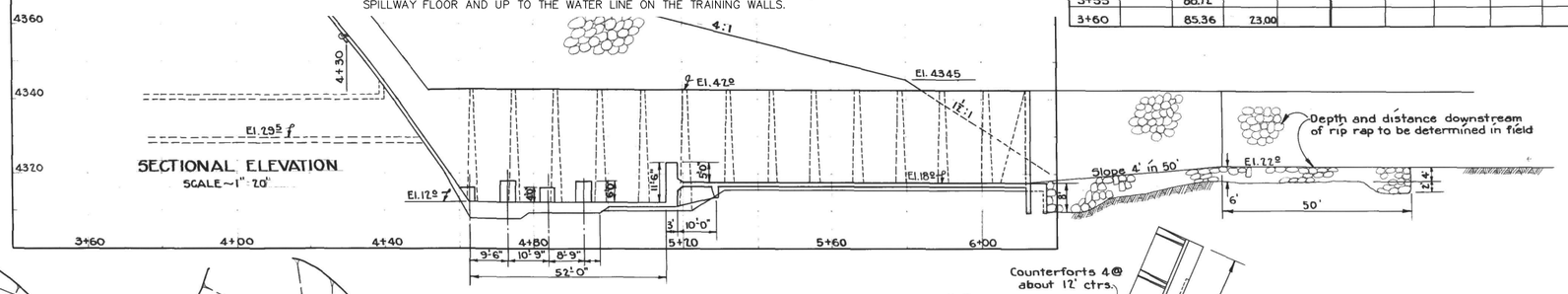
NOTE :~
See Section A-A Dwg.No.8A and Sectional Elevation of Bridge Seat Dwg.No. 9D for revisions

LEGEND

- ± ⅛" DEEP ABRASION/CRACKING OVER MAJORITY OF FLOOR; ± ¼" DEEP ABRASIONS NEAR INTERSECTION OF JOINTS; SEALED FLOOR JOINTS; LONGITUDINAL FLOOR CRACK, 15 FT. LEFT OF CENTERLINE, ¼" TO 1½" WIDE.
- ¼" TO ½" PITTING OF FLOOR SLAB; LOCALIZED AREA OF PITTING TO 2" AT JOINT.
- PITTING AND EXPOSED AGGREGATE TO 2" DEEP AT JOINTS; LONGITUDINAL CRACK ¼" WIDE
- LARGE PITTING/SPALLING AT CENTER JOINT; ABRAIDED SURFACE > 1" DEEP WITH EXPOSED STEEL PLATE; TRANSVERSE CRACK 1" – 5" WIDE, 3" DEEP AND CONTINUES UP WALL; SEVERELY DETERIORATED IN THIS AREA.
- HORIZONTAL CRACKS 2" – 3" DEEP, UP TO 4" WIDE
- LARGE CRACK NEAR LEFT TRAINING WALL, 8" WIDE, 2½" – 3" DEEP; CRACK NARROWS TO 4" WIDE TOWARDS THE CENTER OF THE SPILLWAY, 2" – 3" DEEP; CRACK DOES NOT APPEAR TO GO THROUGH ENTIRE SLAB; LARGE AREA OF INCREASED SPALLING ½" – 2"+; POROUS/PITTING TO 4" W/EXPOSED REBAR; SEVERELY DEGRADED CONCRETE OBSERVED IN THIS AREA.
- SPALLING FROM ¼" TO ½" OVER SPILLWAY FLOOR AND UP TO THE WATER LINE ON THE TRAINING WALLS. LOCALIZED DISCOLORATION OF CONCRETE WITH SEVERELY DETERIORATED CONCRETE; TRANSVERSE CRACK AT COLD JOINT 1" – 2" DEEP, ½" – 2" WIDE; CONTINUED ABRASION ¼" TO ½" OVER REMAINDER OF SPILLWAY FLOOR AND UP TO THE WATER LINE ON THE TRAINING WALLS.

SPILLWAY DATA

STATION	POINT	WIDTH	ELEVATION GRADE	ELEVATION T.WALL	STATION	POINT	WIDTH	ELEVATION GRADE	ELEVATION T.WALL
2+60		160.00	4446	4465	3+65		82.22		
2+65		160.00		65	3+70		79.30	16.00	
2+71		160.00		65	3+75		76.59		
2+75		159.68		65	3+80		74.11	08.50	
2+80		158.42	46	65	3+85		71.84		
2+85		156.15	4555		3+90		69.76	00.70	
2+90		152.80	4513	64.35	3+95		67.89		
2+95		148.34	4455		4+00		66.22	4390.80	
3+00		142.30	4390	60.00	4+05		64.76		
3+05		136.01	4322		4+10		63.49	80.70	
3+10		130.04	42.42	55.65	4+15		62.42		
3+15		124.38	4150		4+20		61.55	70.00	
3+20		119.02	4035	51.30	4+25		60.87		
3+25		113.91			4+30		60.39	57.50	
3+30		109.09	3763	46.95	4+35		60.07		
3+35		104.52			4+40		60.00	45.00	
3+40		100.22	3390	42.60	4+60		60.00	16.00	
3+45		96.14			4+62.76		60.00	17.00	
3+50		92.32	29.00		6+12.76		125.00	18.00	
3+55		88.71							
3+60		85.36	23.00						



SPILLWAY LAYOUT
WEST FORK BITTERROOT STORAGE PROJECT
RAVALLI COUNTY
STATE WATER CONSERVATION BOARD
HELENA, MONT MAY 16 1939
SCALE ~ AS SHOWN

P.W.A. NO. 1053 DS	DWG. NO. 7 AR
Drawn by C.S. Tr. JCK 4-47 / Revised 9-7-39 LH	Revised 10-31-39 LH
Revised 8-1-39, 8-24-39 ACH / Revised 9-13-39 SYW	Revised 12-6-40 EGF

No.	Revision	By	Date

WARNING
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PAINTED ROCKS DAM
WEST FORK BITTERROOT RIVER
TECHNICAL MEMORANDUM #1 SUPPLEMENTAL EXHIBIT
SPILLWAY INSPECTION OBSERVATIONS

Project No. 15A260.101 • DRAWING_7AR.DWG • FEB 2007 • ??

HKM ENGINEERING
1015 S Montana St
PO Box 3588
Butte, MT 59701-2839
Phone: (406) 723-8213
Fax: (406) 723-8328

Sheet No. 1

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PRE-BLAST SURVEY REPORT

FHWA - 1994

PLEASE [redacted] RETURN TO:
[redacted]
[redacted] 11th AVE.
([redacted]) [redacted] 4667

GEOTECHNICAL REPORT NO. 13-94

PREBLAST SURVEY REPORT FOR THE PAINTED ROCKS DAMSITE

WEST FORK BITTERROOT RIVER ROAD

MONTANA FOREST HIGHWAY PROJECT PFH 66-1(1)

BITTERROOT NATIONAL FOREST
RAVALLI COUNTY
MONTANA

AUGUST 1994

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN FEDERAL LANDS HIGHWAY DIVISION

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PAINTED ROCKS SPILLWAY LAYOUT MAP SHEET

INTRODUCTION

The proximity of the Painted Rocks Dam to the proposed construction of the West Fork Bitterroot Road requires that the upmost care be taken to assure that no damage to the dam will occur during the rock excavation.

Controlled blasting procedures have been designed into the specifications of the contract to provide safe rock blasting techniques. Provisions in the contract include a recognized blasting specialist to design each blasting plan, field monitoring of actual ground vibration produced during the blasting, construction record monitoring during blasting activities, on-site rock blasting - monitoring test section, and blasting intensity limits. The construction zone alongside of the dam (Sta. 38+00 to Sta. 55+00) has been designated as a blasting restricted area that requires that the excavation from the beginning of the project to Station 38+00 +/- will be constructed before blasting in the restricted area to utilize this blasting experience and information gained with cut sections of similar rock type before blasting near the dam.

This preblast survey defines baseline data for the surface concrete and surficial features in the dam site area prior to blasting. This report has been prepared in order that the Montana Department of Natural Resources and Conservation (DNRC), the dam owner, and the road construction contractor can review and agree to the preblast conditions of the dam structures. The contract requires that the contractor, upon his review and approval, will provide a signed statement concerning this report and the preblast conditions of the Painted Rocks Dam.

The contract rock blasting parameters and the controlled blasting procedures provide a conservative means to construct the roadway while providing safe ground vibration levels to prevent damage to the dam.

PURPOSE

The purpose of this preblast inspection is to document the condition of the Painted Rock Dam structures prior to any construction blasting and the ground vibration motion that may be introduced by the construction blasting. The records contained in the report will:

1. Determine the existing condition of the concrete structures at the Painted Rock Dam site.

2. Verify the effects of the ground vibration and any damage that result from the rock blasting.

SITE CONDITIONS

The determination of site conditions have been defined by the condition of the spillway structures. The upper portion of the spillway will be approximately 85 feet from the closest construction blasting. The concrete in this portion of the spillway should be a good indicator area to measure any damage to the dam structures from the construction blasting.

Considering the 54 to 56 years of present use, the concrete in the spillway and stilling basin in general can be considered in good condition. The preblast inspections show extensive erosional conditions, concrete spalling, and many types of cracking throughout the concrete structures. The photo mapping section in this report details the observed concrete defects.

Concrete maintenance work to repair damaged concrete such as spalled areas, crack sealing and patching have been noted and are described and shown in the photo mapping section of this report.

Very little separation or settlement type of problems were observed which indicates stable foundation conditions.

On April 5, 1994 the FHWA, United States Forest Service (USFS), and DNRC personnel met on-site to inspect the spillway structure and the outlet tunnel. Originally, the outlet tunnel was planned to be a structural element of the preblast survey but the outlet gates could not be closed during this field review. Therefore the outlet tunnel could not be inspected. A decision was made that the spillway, due to its closeness to the proposed blasting and the high degree of surface exposure, will be used to evaluate the effect of the proposed road construction.

This meeting was also used to determine the extent of the ground survey and photography requirements.

INVESTIGATION

The preblast survey investigation consisted of field surveying and field mapping to define the concrete defects in the spillway structures that exist prior to the construction of the proposed West Fork Bitterroot Road in the Painted Rocks Dam Area.

The investigation included a ground survey grid to establish reference points for the upper spillway concrete mapping. Figure 1 is a plan view of the spillway with the ground survey grid superimposed on it. Vertical and horizontal control was established along the dam axis and bench reference points on the bedrock west of the dam and the existing USGS Brass Cap on the EAST BRIDGE END BENT were used for the preblast survey.

Several sets of photographs have been taken throughout the road design phase that show various conditions of the dam site, including a photo set taken in February, 1994 from a helicopter to be used in photo mapping portion of this report.

In addition, a professional photographer was commissioned to provide high quality photographs of the study area that were then used as base maps for the photo mapping. An index of these photographs and a photo log to assist in map orientation can be found in the Photo Mapping Section.

Mr. Peter Sheeran, a blasting and ground vibration consultant conducted a field review on April 12 to 13, 1994 to evaluate the blasting and ground vibration conditions with respect to the Painted Rocks Dam, and to review the blasting and vibration monitoring specification for the proposed contract. Mr. Sheeran's report is a part of this Preblast Survey and can be found in Appendix A.

PHOTO MAPPING

The photo mapping details the existing concrete defects and with the accompanying summary statements will be used as the basis for comparison of the before and after construction blasting. The final photo mapping was conducted on May 5 and 6, 1994. Additional photographs taken during the design phase of this project have been filed in the geotechnical file in the Vancouver, Washington office. These photographs may be used as refernce photos if clarification is required.

The following index sheets and photo log have been prepared for easy reference to the photo mapping.

The cracking definitions are generally based on the FHWA's BRIDGE INSPECTOR'S TRAINING MANUAL. An exception is an additional crack pattern described as CRAZING. This crack pattern is thought to be associated with concrete aging and probably develops from thermal changes in the concrete. The pattern developed is somewhat similar to the alligator crack pattern found in pavements. The crazing cracking is very common throughout the spillway structures. The following pattern size has been used to describe the crazing cracks as follows.

Fine Pattern = less than 2 inches between cracking
Medium Pattern = from 2 inches to 6 inches between cracking
Coarse Pattern = greater than 6 inches between cracking

Specific cracking such as cracks caused by impact from falling rocks or spalling cracks have been described individually on the following summary statement sheets.

The following directional guidelines have been used to describe the locations of

individual features of the dam.

1. Downstream - Facing downstream, features are described either right or left based on this orientation

2. Upstream

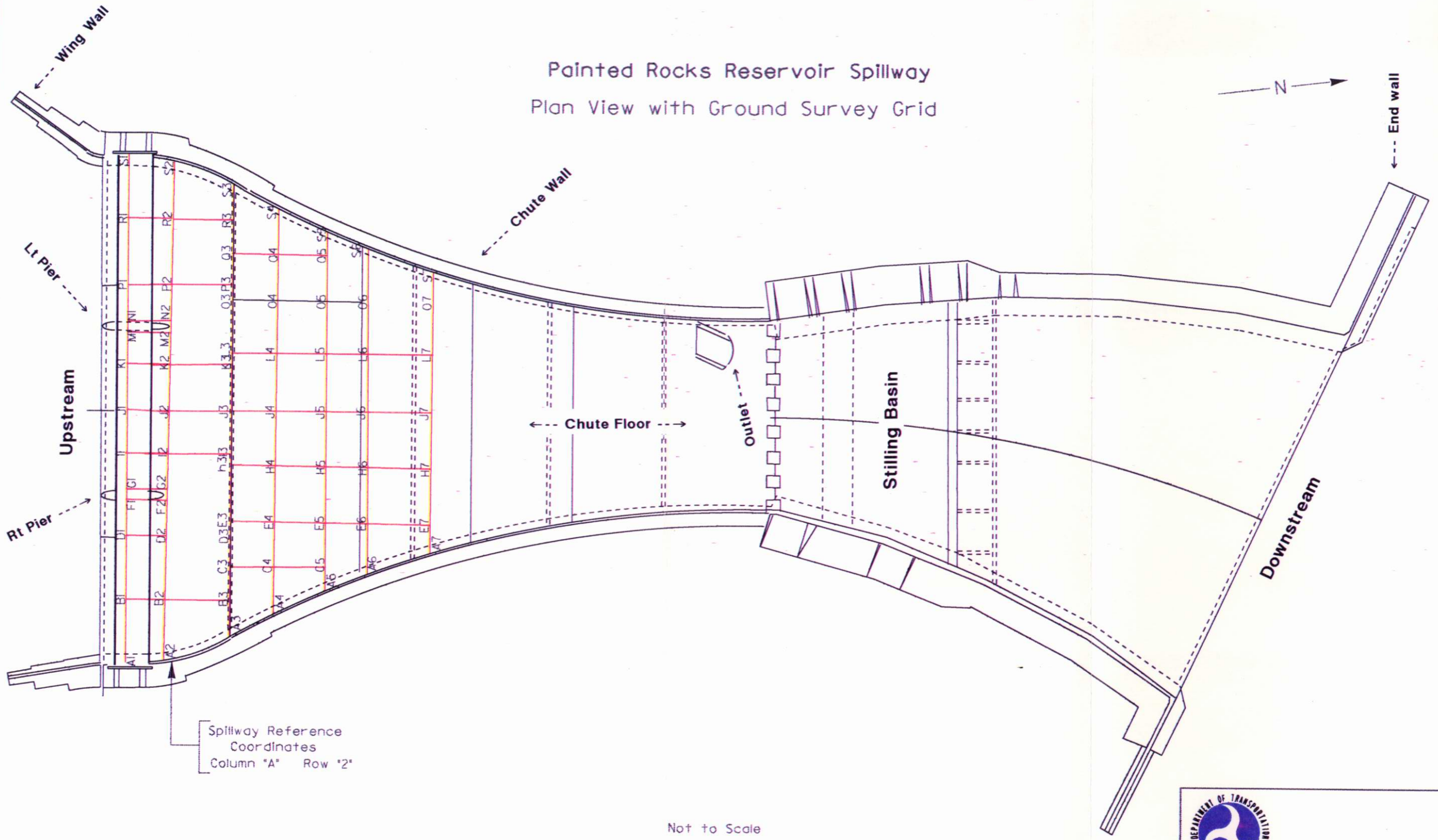
FURTHER WORK

1. The back side of the spillway walls are somewhat exposed and it is recommended that additional photographs be taken of this face prior to blasting.

2. Recommend additional scribing along selected cracks just before construction to provide immediate observation areas adjacent to the blasting. These points should be established just prior to the construction blasting.

Painted Rocks Reservoir Spillway

Plan View with Ground Survey Grid



Not to Scale

Note: Right and left are based on looking downstream.

DEPARTMENT OF TRANSPORTATION UNITED STATES OF AMERICA

Project West Fork Bitterroot

Subject Painted Rocks Dam Pre-Blast Survey

FIGURE 1

APPENDIX A

Blasting and Vibration Consultants, Inc.
Report April 20, 1994

BLASTING AND VIBRATION CONSULTANTS, INC.
P. O. Box 75 Cheney, Washington 99004 (509) 235-6569

Federal Highway Administration
Western Direct Federal Division
Project Development Branch
c/o Dave Lofgren
610 East Fifth Street
Vancouver, WA 98661

April 20, 1994

Re: Painted Rocks Dam, blasting and vibration concerns.

Dear Dave:

At your request, I visited the site and met with Joe Armstrong (Geotechnical Consultant) and Max Ulver on April 12 and 13, 1994. Joe gave me copies of the preliminary special contract requirements, project plans, cross-sections, geotechnical report, and other significant historical plans and reports. We discussed how to go about the pre-blast survey of the dam and other vibration concerns of the Department of Natural Resources and Conservation (DNRC) and other related aspects of the closer road cuts.

Dam Spillway

When we arrived, the survey team was stencil spray-painting the indicator X's ,T's, and bars to help in locating the cracks for the crack mapping with the use of professionally taken and enlarged photos. The photos will improve the accuracy of the pre-blast survey. In addition a series of photos will be taken of a single location; 1square yard, 1 square foot, and 9 square inches, all with a common corner. This will help to establish the general overall hairline and crazing cracks that are prevelant throughout all the concrete. These conditions exist in all concrete to varying degrees. Freeze-thaw cycling can be extremely destructive. There is quite a bit of surface repair evident to the spillway walls and bridge piers. Surface or topping coats have been applied a number of times.

The actual condition of the dam spillway is good, with respect to the concrete. Some minor latteral displacements at cracks were seen. There are a few larger cracks but they appear to be stable with no evidence of settling. This is probabaly due to the spillway being constructed on rock. The July 1980 Phase 1 Inspection Report, National Dam Safety Program, states in 2.1.1 "Grouted rock anchors were placed 4 feet into rock along the spillway." I did not get a complete set of the original plans, but it appears that the spillway contours closely followed the existing rock contours with as little blasting of the native rock as possible. I suspect that the spillway was poured directly on rock in many locations, with minimum fill or bedding on the rest. The plans I have do not show this, and lack many specific details.

Vibration

In the letter of January 8, 1992 from Kurt Hafferman (State of Montana, Dept. of Natural Resources and Conservation) to Pierre C.Henrichsen (U.S. D.O.T., Federal Highway Administration) some concern is expressed in regard to the spillway side walls, the outlet gates, the outlet conduit, and the liquefaction potential of the hydraulic fill in the non-overflow portion of the dam. Hafferman asks for a pre-analysis of the g-forces anticipated during the construction and blasting.

At this point in time we are recommending a maximum vibration limit of 2 inches per second at the closest portion of the dam. This will be the southeast corner of the dam spillway at about el. 4742, where the bridge crosses the spillway. This will be the main vibration control point. Being the closest point, no vibration will be higher than at this location. (See Oriard Prediction Curve, Scaled Distance versus Particle Velocity, figure 1.) Vibration decreases at a logarithimic proportion as the distance to the blast increases. The 2"/sec. limit is in fact a conservative limit used for residential blasting construction where the normal Hz levels are high, and displacement is small. The majority of the blasting will be similar to construction blasting rather than to quarry blasting in regards to the vibration produced. The spillway sidewalls should not be adversly affected at these proposed vibration levels. The spillway itself will recieve even less vibration than the closest wall because it is at a lower elevation, and farther from the actual charges. Again, as distance increases, vibration decreases. The outlet gates are about 360 ft. from the closest blasting. If a Scaled Distance (S.D.) of 20 is used at the closest point to the dam, then the outlet gates will be at a S.D.= 84, or less than 0.25"/sec. vibration. The outlet conduit is in rock for the majority of the tunnel, and such tunnels are not usually subject to vibration damage, even at vibration levels up to 20"/sec. The hydraulic fill on the southwest side of the dam at the spillway elevation is approximately 250 ft. from the closest blast, at a S.D.=58, or an estimated 0.5"/second vibration, or less. There is a near vertical feature in the rock, buried in the fill near the dam axis about 100 ft. northwest of the control tower. Up to this point, the majority of vibration transmitted to the hydraulic filled core will be in rock. That buried face in the existing granite is approximately 450 ft. from the closest blast, at S.D.=100, or about 0.175"/sec. vibration. This is a very low vibration level. These predictions are based on the Oriard Prediction Curve, using the normal upper limit line. I would actually expect less vibration at this site. A regression curve based on actual site blast vibration information will give us a better picture of what vibration to expect at specific Scaled Distances.

Frequency (Hz.) levels and acceleration should be discused. The point I chose at a S.D.=100 is a point where the material changes from granite rock to the hydraulic fill almost completely throughout the dam cross-section. The Hz levels should be between 15Hz and 40Hz at this location. The chart below shows the displacement and corresponding acceleration for a prediction of 0.175"/sec. vibration.

	Frequency	Displacement	Acceleration	Modified-Mercalli Intensity Scale
	10 Hz	0.00278"	0.01812 g	na
	20 Hz	0.00139"	0.03623 g	na
Particle Velocity = 0.175"/sec.	30 Hz	0.00092"	0.0543 g	na
@ Scaled Distance=100	40 Hz	0.000696"	0.07246 g	na
	50 Hz	0.000557"	0.0905 g	na
Hebgen Lake, MT. Earthquake 8-17-59 (approx. 150 mi.)	2 Hz	0.1223"	0.05 g ± .015	VI (six)
Borah Peak, ID. Earthquake 10-28-83 (approx. 100 mi.)	2 Hz	0.1223"	0.05 g ± .015	VI

Note: Painted Rocks Dam was within the class VI zone for both of these major earthquakes. G-forces for zone VI may have been higher or lower. Typical Hz levels may have ranged between 1 and 4.

Notice that the acceleration for the same Particle Velocity (P.V.) at 50 Hz is 5 times as high as for 10 Hz., and the reverse is true for displacement. Acceleration is not normally used for establishing blasting safety parameters. The displacement values and particle velocities are

generally better indicators, and normal in the industry for this type of blasting. These are the highest displacements that could occur at this point 450 ft. from the closest shot, where the rock meets the fill. There should be no liquefaction potential with these obviously low displacements. I would expect a slightly lower particle velocity to be transmitted to the fill because of a reflection of the vibration wave caused by the density change between the rock and the fill. Also, the dominant jointing in the granite dips 45-70 degrees in a northerly direction with an east-west strike in this area, and this should cause the vibration to attenuate out at a quicker rate before it reaches the main body of the fill. There are no geotechnical borings that indicate if the impervious core material is saturated, or if it is, to what extent. The downstream side appears to be a free draining material with no marked vegatation at wet zones. The crest of the non-overflow portion of the dam also appears to be stable, without any noticable settling. This dam has weathered the two major earthquakes cited above without any noticable settling. If a low water level is maintained behind the dam during blasting, the upper fill material will be more stable and will not transmit vibration as easily. This will further reduce the risk percieved with blasting near the dam. Late summer/early autumn is a normal draw-down period for irrigation in the Bitterroot Valley and this coincides with the project schedule as I understand it. The noted earthquakes also occured during this draw-down period.

The Pinnacles

Blasting at stations 31+50 and 35+00 will remove the pinnacles. At the same time, back slope work will minimize rock-fall hazards and create a more stable slope. The back-slope behind the larger pinnacle must first be worked down to the "notch" to establish a safe working bench for access to the upper pinnacle blasting. After that, the back slope and remainder of the pinnacle at 35+00 will be taken down in lifts. The cross-sections show this perspective quite well.

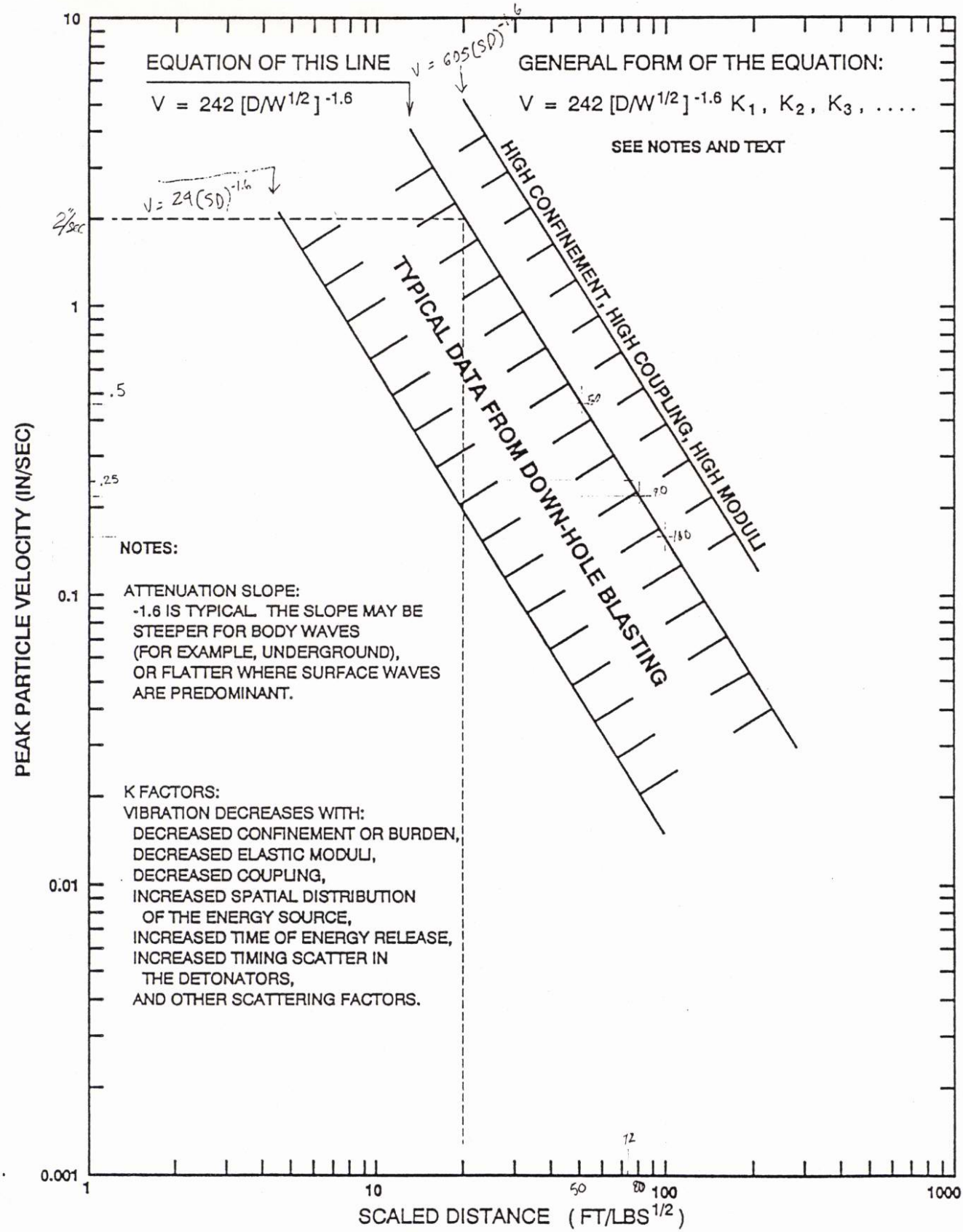
The pinnacle is bordered on both sides by natural chutes which will help divert muck from the upper blasting from impacting the pinnacle. The main pinnacle is approximately 5,000 cu.yds. in volume and 11,000 tons. It appears to be sitting on a rock ledge or series of ledges with steep day-lighted jointing running to the notch location. The day-lighted jointing in this pinnacle makes it's foundations unstable with the possibility that it could fall any time. If it were to fall enmasse it could take out about 50 to 100 feet of the roadway bench.

The top 50 ft. will be shot similar to pioneering blasting, with a horizontal and upward angled fan drilling pattern. The remainder of the pinnacle will primarily involve angled holes and relatively light loading, with longer than usual delays between the series of holes. This will direct the muck to parallel the road, and increase its chance of staying on the road. Lower lifts will be taken down as safety and geology permits. A 20 ft. lift height may be the maximum in this area. This will also help to minimize the vibration to the lower portion of the pinnacle. To decrease the chance of destabilizing the pinnacle the pounds/delay of explosives will be minimized by delays. A hydra-hammer and/or secondary blasting may be necessary to remove some of the material to the waste area. Vibration monitoring during blasting at these locations can be used to establish a vibration prediction curve for the dam site.

Sincerely,

Peter E. Sheeran
President, B.V.C. Inc.

cc: Max Ulver (FHwA, Darby MT)
Joe Armstrong (Geologist, Helena MT)



GROUND VIBRATIONS FROM BLASTING

(ORIARD, 1963, 1970, 1980, ETC.).

FIGURE 1

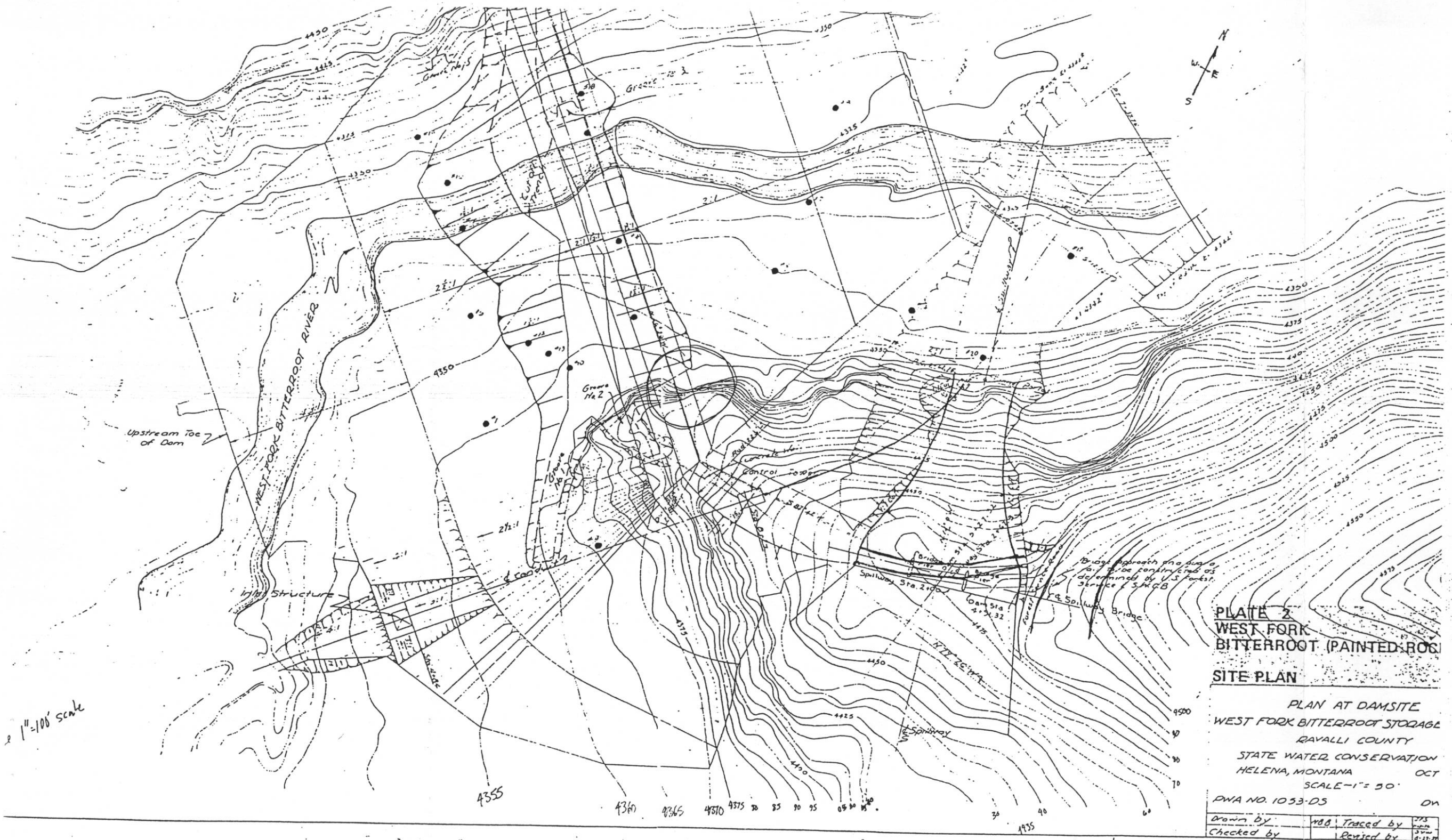


PLATE 2
WEST FORK
BITTERROOT (PAINTED ROC

SITE PLAN

PLAN AT DAMSITE
WEST FORK BITTERROOT STORAGE
RAVALLI COUNTY
STATE WATER CONSERVATION
HELENA, MONTANA OCT
SCALE-1" = 50'
PWA NO. 1033-05 On

Drawn by	WAB	Traced by	TTS
Checked by		Revised by	

IGURE 1.--Isoseismal map for the Borah Peak, Idaho, earthquake of 28 October, 1983 UTC

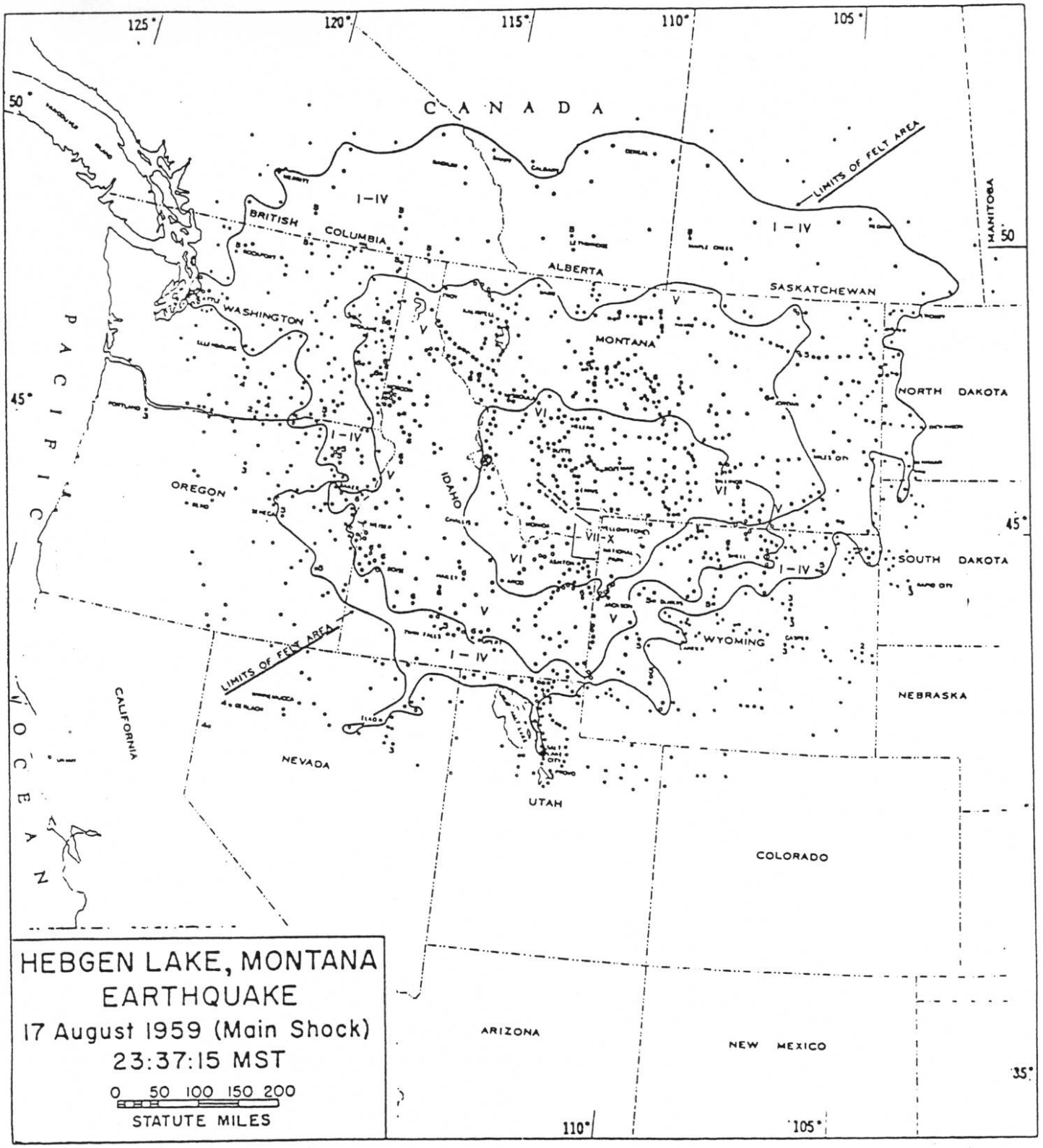


FIGURE 2.--Isoseismal map for the Hebgen Lake, Montana, earthquake of 1 August 1959 UTC (Eppley and Cloud, 1959).

Intensity

Earthquake intensity is a measure of the effects of an earthquake at a particular place. Intensity is determined from observations of an earthquake's effect on people, structures, and the Earth's surface. The first intensity scale to gain wide use was developed in Europe in 1883 by M. S. DeRossi of Italy and F. G. Forel of Switzerland. The Rossi-Forel Scale grouped earthquake effects into 10 steps of intensity beginning with I for the least noticeable. The Rossi-Forel Scale proved too peculiar to 19th century Europe to be universally applicable. In 1902, Giuseppe Mercalli introduced an improved scale which also had 10 grades of intensity (later increased to 12). A modified and condensed version, the Modified Mercalli Intensity Scale (MM), is used extensively in the United States today.

Modified Mercalli Scale (Abridged)

I. Not felt except by a very few under especially favorable circumstances. (I Rossi-Forel Scale.)

II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing. (I to III Rossi-Forel Scale.)

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing truck. Duration estimated. (III Rossi-Forel Scale.)

IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, and doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably. (IV to V Rossi-Forel Scale.)

V. Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. (V to VI Rossi-Forel Scale.)

VI. Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of falling plaster or damaged chimneys. Damage slight. (VI to VII Rossi-Forel Scale.)

VII. Everybody runs outdoors. Damage *negligible* in buildings of good design and construction; *slight to moderate* in well built ordinary structures; *considerable* in poorly built or badly designed structures. Some chimneys broken. Noticed by persons driving motorcars. (VIII Rossi-Forel Scale.)

VIII. Damage *slight* in specially designed structures; *considerable* in ordinary substantial buildings, with partial collapse; *great* in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motorcars disturbed. (VIII+ to IX Rossi-Forel Scale.)

IX. Damage *considerable* in specially designed structures; well-designed frame structures thrown out of plumb; *great* in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. (IX+ Rossi-Forel Scale.)

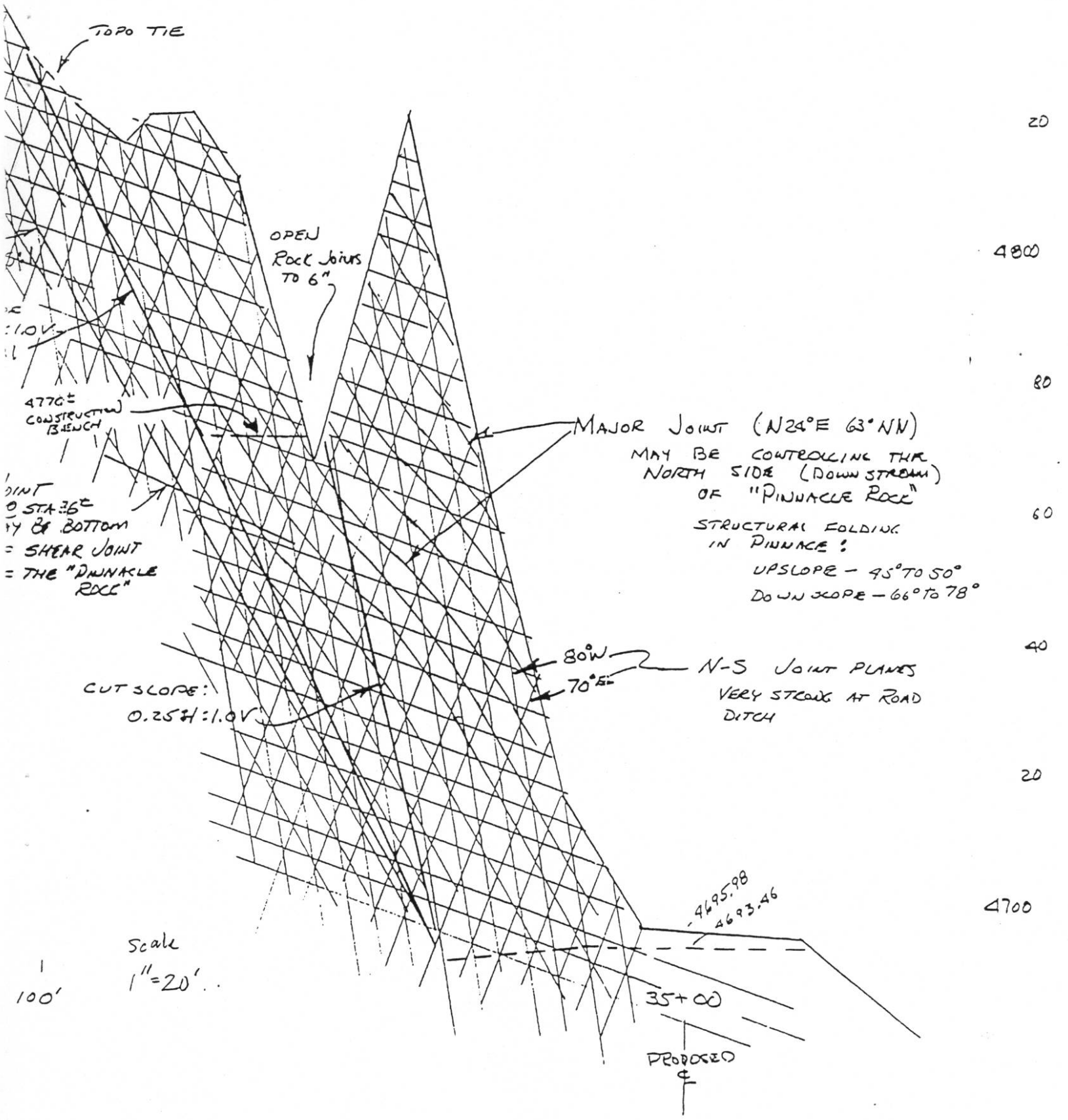
X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks. (X Rossi-Forel Scale.)

XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII. Damage *total*. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.

NOTE:

Geology and notations by Joe Armstrong. Df.



APPENDIX B

Photo Log

PHOTO LOG

FOR THE

PAINTED ROCKS DAMSITE

The following photographic proof sheets have been numbered according to roll and frame number and are the photo index sheets for the commercial photography taken on 04/26/94 by Bryant Photograph, Missoula Montana.

Photo No.	Photo View	Comments
A-1	Upstream View-Spillway	Vertical side walls - Little backfill bedrock exposed on both sides of spillway
A-6	Right stilling basin wall	Note top of wall repairs
A-9	Upstream View-Spillway	
A-10	Right stilling basin wall	
A-11	Left end wall	Note "Dental work" along top of wall
B-2	Right end - stilling basin wall	Note "Dental work" along top of wall
B-3	Upstream View Spillway	Good overall photo
B-4	Left spillway chute	Good view of Lower left Chute Wall
B-5	Upper Right Spillway Chute	Good view of Upper right Chute Wall
B-6	Spillway Upper Chute right spillway wall	Note the realignment of Spillway bridge and separate right end bent
B-7	Same view as B-6	Larger photo scale
B-8	Spillway Upper Chute Area - left side	Good view of top of earth fill Note - No visual signs of seepage

Photo No.	Photo View	Comments
B-11	Same as camera position as B-8 of mid-spillway chute - left side	Good photo size
B-12	Same as camera position as B-8 of lower spillway chute - left side	Note view of backside of right spillway chute
C-2	left stilling basin wall	Note - view of downstream face of Dam - Bedrock contact at left edge of photo
C-3	Continued view of C-2	Note - view of downstream face of dam, no visual signs of seepage
C-4	Upstream view - lower spillway chute and tunnel outlet	Note bedrock outcrop at mid-photo
C-5	Upstream view, right end wall	
C-7	downstream - inlet of spillway area	Note offset of bridge in right pier
C-8	Right spillway wing wall	Extensive repair work completed
C-9	right upper spillway and right bridge bent	Note - rock outcrop fractures above right chute wall and rock fall into chute. End bent may be a vibration monitoring station
C-10	top of spillway and right side of the left Bridge Pier	
C-11	top of spillway and right side of the left Bridge Pier	Note - repair work on pier seat
C-12	top of spillway and left side of right Bridge Pier	
D-1	top of spillway left side of left Bridge Pier	Larger photo scale

Photo No.	Photo View	Comments
D-2	top of spillway and left Wing Wall and left Bridge end bent	Note - "dental work" on top of Wing Wall and wing wall joint separation
D-3	left Upper Spillway Area and left Spillway Wall	
D-4	Close-up of Upper right spillway Wall	Yellow marks of one square yard
D-5	Further close-up of lower left corner of same view as D-4	Note the surfacing wash coarseover the surface and reflected hairline cracking
D-6	downstream Upper right Spillway Area	
D-7	right side, close-up of Upper Spillway	
D-8	downstream Upper Spillway	Photo at I, looking J-2
D-9	downstream - Upper Spillway	Looking at K-3
D-10	downstream of Upper Spillway Area	
D-11	Upper Spillway and left Spillway Wall	
E-1	Upper Spillway and right Spillway Wall	
E-2	downstream Spillway Bridge of Upper Spillway	
E-3	downstream - upper center chute area	
E-4	upper left side chute area	

C-8
A-1
B-1
D-1
A-2
1
2
3
4
5
6
7
8

SUMMARY SHEET
PHOTO C-8

C-8 The right face of the spillway retaining wall and wing wall

1. The large more recent patch approximately 4 feet deep and the length from A1 to A2 to the joint on the wing wall. This repair was assumed to be from the change of the bridge location providing the present curvature of the spillway bridge. White leachate stains in the center of the No. 1 area is a portion of one of the transverse cracks along the top so that transverse crack goes down into near the bottom of that staining, which indicates minor seepage through the dental concrete work. Close inspection of the surfacing material shows some of the crazing cracking having a rather fine texture pattern throughout this face.

2. The repair on top of the wingwall shown as part number 5 along with this comment for mark No. 2. There is a transverse cracking pattern along the top of the wall with spacing from 2 to 4 feet along that top surface, hairline cracks. The hairline cracks are continued in vertical cracking at that same spacing through the new concrete and stop along the new concrete contact along the wall. A very fine crazing pattern can also be seen in the new concrete surface throughout this area. A very slight hairline crack is presently developed along the contact between the new concrete and the old concrete.

3. Is a fairly large two foot high and eight inch wide spalling repair crack along the joint between the wing wall and the spillway wall. A fracture reflecting the construction joint can be seen.

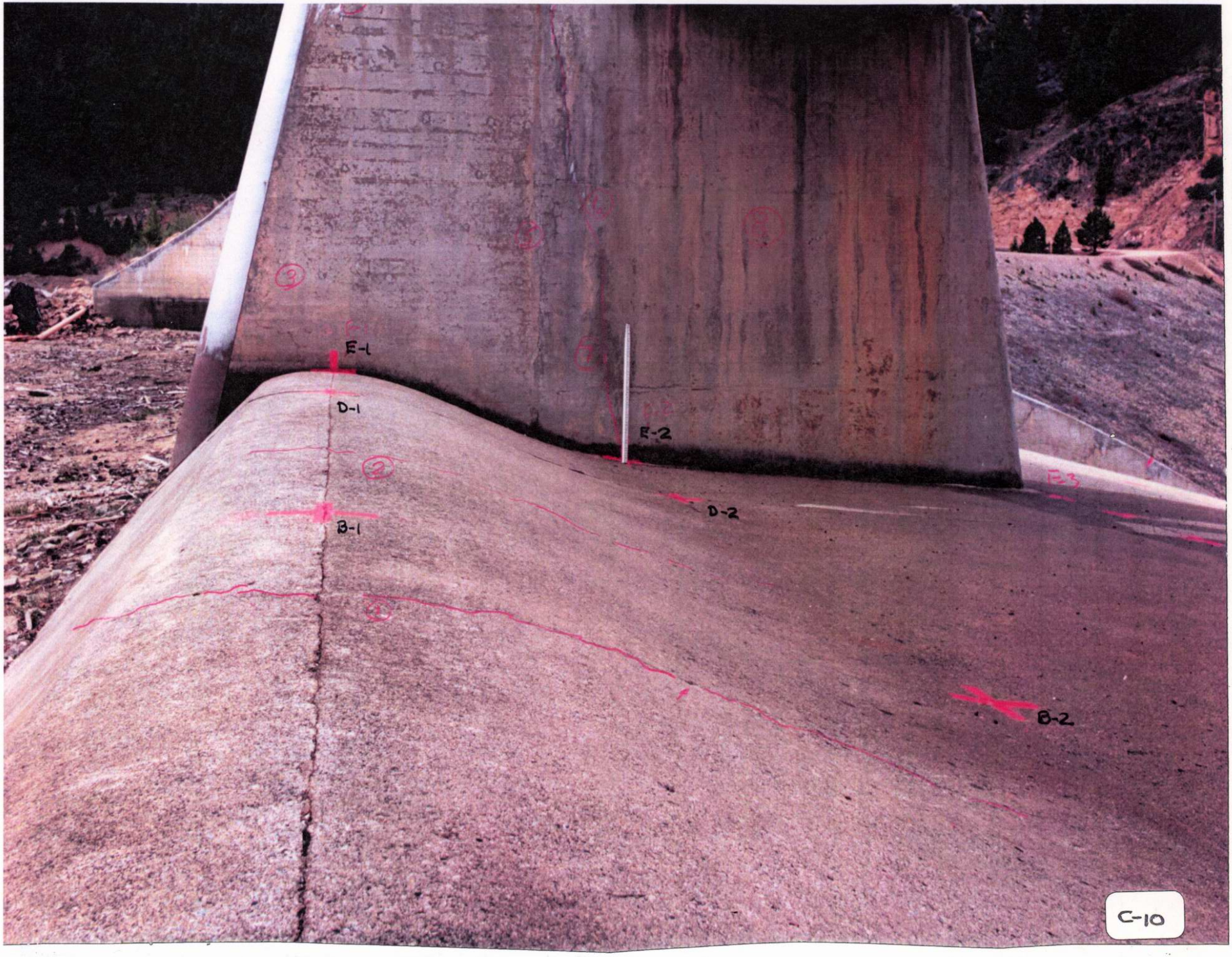
4. Transverse cracking along that top of wall surface.

6. This is the typical plotted diagonal fractures that are associated with the transverse type cracking. These are spaced here from 1 to 2 feet, and only a few have been plotted. They're hairline cracks basically with an occasional 1/16th of an inch crack in this area.

7. Is also shown on photographs D-4 and D-5. It is a one square yard area on D-4 and then it is enlarged on D-5 to show only the lower left corner of this area. These photos are taken to document the crazing medium pattern. The cracks are hairlined to someplaces up to probably 1/16 of an inch. This cracking is typical. It is common throughout the concrete. It's most likely derived from freeze-thaw conditions existing in the concrete and probably accompanies spalling under severe conditions. This is not thought to be critical its only to be noted to be very common. These fine crack patterns need to be recognized. The blow-up D-4 and D-5 speak for themselves as to scale and magnitude of this type of cracking and serve to be common crazing pattern that will be discussed throughout the survey.

8. Depicts the horizontal cracking along the right spillway wall. The leaching coming from these cracks causing the white staining in the photographs indicate that these cracks most likely go through the wall. The spacing is from 1/2 inch to approximately 1 foot in distance. The leaching buildup comes out from the wall surface up to a maximum of 1 inch in this area. A coarse crazing pattern also exists through these fractures.

9. A transverse crack that goes through the crest about 7 feet downstream of B-1 and goes through the construction joint and continues on down through the next concrete construction section. Crack openings from 1/2 inch to 1 inch with an average of 1/16 to 1 inch opening. It should be noted that minor spalling in two or three locations was found at the reservoir and crest contact.


E-1
D-1
E-2
D-2
B-1
B-2
C-10

SUMMARY SHEET
PHOTO C-10

C-10 View left, right face of right pier

1. Longitudinal hairline crack along the crest area between A-1 and B-1 as shown. Note break in the slope of a small spall in this area.

2. Transverse crack between B-1 and B-2 through the crest to the next construction joint. Its been described before in Photo C-8. It has a maximum 1/4 inch+ opening with an average of about 1/16 of an inch.

3. Crazing cracking on the upstream edge of the construction joint. Note vertical cracking along the construction joint in the extended portion of this pier. Medium crazing is common in this area. The cracking extends in circular patterns around the grouted tieback points and is seen as small circles in the photograph.

4. Note the random cracking along the top edge of the pier and then the spalling that is found on the top surface. That may have been in part due to the relocation of the bridge structure.

5. Patch area. There is faint hairline crack along the patch probably due to construction. The crazing pattern in the area of 5 beyond that to the south is a combination between the very fine and large crazing crack pattern.

6. The vertical crack mapped as shown is a hairline to 1/16 of an inch opening. This crack continues clear to the base at F-2. This crack has a fairly fresh appearance to it and is most likely related to freeze-thaw and the connection between the older concrete upstream. This is a crack that should be looked at and observed during the construction blasting.

7. Along the vertical crack three scribe marks have been scribed to use for reference to evaluate this crack in the future. Note the staining in the upper portion of this vertical crack.

8. The downstream end of the pier, indicates the surfacing has been trowelled to subdue and underlying concrete conditions. There is a crazing pattern of fine to medium texture reflecting through and so areas in this section show some small portions of hairline type cracks. Small pieces only an inch or two in length could be observed in this area. The circular grout filings for the tiebacks can be seen throughout this section. General comments - It should be noted that the two different types of work are the earlier work using board forming with the horizontal board pattern shown and then the edge where a plywood forming was obviously to give a much bigger forming section.


G-1
G-2
I-1
I-1
I-2
J-2
K-1
K-2
C-12

SUMMARY SHEET
PHOTO C-12

C-12 Left face of the right pier

1. The radial cracking on the upper corner with the staining and the spalling along the surface is the same as the other side of this pier. The upstream half of the pier on this side also shows the mid to medium pattern of the crazing cracking. It is very well pronounced in this area with clean, fine hairline cracks measured throughout the area. Moisture differences accent this crack pattern in this area.

3. Large spall on the pier wall and also a spall just upstream from control point G-1.

4. Transverse, short cracks about 2 to 4 feet in length and approximately 1 to 2 foot in spacing. The openings are maximum 1/4 inch with the most common about 1/8 inch. They are on the down stream from the crest. Several of these type of cracks are in the section bound by G-1, I-1, I-2, G-2 square. Old concrete patching is seen along note No. 5 the joint on line 2. There may be different ages of cracking as we continue from I-2 to J-2.

6. Vertical crack, rather fresh, corresponds to same note 6 on photo C-10. This crack appears to be fairly fresh and very clean. It's 1/16 of an inch occasionally maybe a little larger to hairline in size, but a rather new and undoubtedly it's a fracture that is through the pier wall.

7. Is a vertical crack marking the contact of the new and the old work on this pier. A small perpendicular crazing pattern developed on both sides of this crack. This crack also looks very fresh and is continuous and is also reflected through the other side of the pier.

8. The new finishing with a topping coarse that is masking the concrete below, similar to the other side of this pier.

9. Downstream edge of this pier shows a fine to medium crazing pattern developing in parts of this structure.

10. Transverse cracking between I-1 and J-1 along the crest of the spillway. Note on the reservoir side some spalling associated with the longitudinal crack. Crack is about 1/8 to 1/4 inch in width and moves down to line 2 of the next concrete pour. Old patch lines developing between K-1 and J-1 along the crest line that have some the upstream portion shows some radial-type minor cracking. At J-1 there is a small longitudinal crack parallel to the joining D-like cracking pattern. It's very small and is the first one noted. Large longitudinal crack on the upstream edge, some spalling, some rock aggregate exposed. There is obviously a need for some minor repair work on this crack. This crack is quite strong, it's anywhere from 1/2 inch to 3/4 inch throughout it's length and goes down through K-2 and into the next slab.

M-1
K-1
J-1
I-1
K-2
J-2
M-2
C-11

SUMMARY SHEET
PHOTO C-11

C-11 View to left of left pier

1. Typical short transverse cracking that is open 1/4 inch found in the block I-1, I-2, J-1, J-2.

2. Longitudinal crack extending over the upstream side of the crest. Note some spalling at the bottom of that crack. This crack is a 1/8 to 1/4 inch. It extends down through the first two construction sections. It's an old crack. Note the white patch in No. 3 is the typical patching that's been previously described from spalling activity along the crest. Roughly along this crest are 11 areas that have been patched for spalling. All of them appear to be fairly old and appear as white splotches on the photograph.

4. Shows the recent patching for the bridge seats on the pier on the middle beam and on the upstream beam. The downstream beam appears most likely pretty near it's original position.

5. A small amount of very fine crazing cracks are found in the center girder area and below the center girder. The iron stained portion of the right face of the left pier has a very thin surface coating that is masking the crazing cracking that can be seen along the upstream edge of this pier. A medium to large texture on the crazing cracks noted.

6. Is vertical cracking along with a rectangular crazing pattern that appears to be a contact area between two different pours or perhaps ages of concrete work. It is assumed here that this pier has been extended downstream to provide for the relocation of the bridge. There is a fairly clean vertical joint, not quite as extensive, along and above point M-2.

7. There is a fairly fresh crack. It's probably between 1/16 and hairline. It also looks very much like the left pier in that it's very closely associated to the construction of the additional pier work.

8. The fine surfacing that was applied to this area shows some of the crazing cracking reflecting through. The texture is very fine and interesting, because at first appearance, there is no cracking. It seems to be a very stable piece of concrete. Looking at the crazing, we see the typical weathering situation.

9. The small grouting along the construction joint along line 2 between H and I and part way to J are really clean, new, and with no cracking showing in them.

C-7

SUMMARY SHEET
PHOTO C-7

C-7 View of spillway crest

1. The small circular marks are from spalling along the crest area. They are all quite minor. Some of them have been patched previously and are spalling again over the old repair work.


S-4
S-5
R-3
Q-3
P-3
O-3
Q-4
Q-5
S-6
L-3
K-3
J-3
J-4
J-5
I-3
H-3
H-4
H-5
E-3
E-4
E-5
D-3

SUMMARY SHEET
PHOTO B-8

B-8 View to left, upper spillway

1. Is a 1/2 inch longitudinal crack along a narrow construction joint. It is also a longitudinal crack that goes along the base of the left pier. There are some large chunks out of this joint up to 2 inches in width and ends at that structural joint.

2. A structural joint at the trailing edge of the downstream edge of the piers. The small circular marks in this area are spalled areas, the first one is shown.

3. Old patching between points K-3 and L-3 and between the narrow joint plate.

4. Is longitudinal cracking that probably is part of the joint system that is upstream. Longitudinal crack that goes down to line on 4 then turns and makes an abrupt angle over to the wall and joins a vertical joint at the wall. It's a structural crack, and varies from 1 1/2 inches wide down to an average of about 1/8 to 1/4 of an inch. It's an old crack and it extends up into the plate P-2, P-3, Q-2, Q-3 grid segment.

6. Is a vertical crack on the left spillway wall. There are some large pop-outs, and it's a deep crack. It measures about a maximum of 2 inches wide. It undoubtedly goes thorough the wall. It shows some horizontal offset, and perhaps is some of the active spalling. The patch on the top of the wall worked it's way through the dental work. The bottom of the crack comes to S-4. Note the small spalling at the toe of the wall at this point.

7. Are small 2 foot transverse cracks that appear to be a part of the wear from material coming over the crest of the spillway. Cracking is anywhere from 1/2 inch to 1 inch wide and 2 feet long.

8. A grouted patch along the construction joint. The joint is very clean with very little cracking in the repair. It is a good repair and should be used as a control point.

9. Is a 7 to 8 foot long transverse crack from line 4. It goes to the next construction joint about 5 feet north of L-5.

10. A large patch with some of the medium to fine crazing cracking, There is also a transverse crack which may actually be a small joint in the concrete. The square patch that is found at J-3 control point is new in 2 parts. There is no cracking in it, and it may be a good monitoring point.

11. Hairline to 1/16 inch longitudinal crack. Looks like it has been there for quite a while and has very little activity.

12. Is a longitudinal crack about 3/4 inch wide at the downstream side down to 1/8 of an inch at the joint at the upstream side. It's an old fracture, and it doesn't appear to have movement recently.

14. Upper weep holes. The three drain pipes that were placed along the spillway all show fairly good staining, indicating the drainage is working.

15. A small round 1/2 inch pop-out. The pop-out is quite deep, and there is a lot of iron staining coming out from under it. It's interesting because the pop-out and iron ball are not very common in this concrete.

B-6

SUMMARY SHEET
PHOTO B-6

Photograph B-6 has been covered by Photo E-2.

1. Use Photograph E-2 as a close-up. It should have a better definition than this photograph.

2. This photograph is useful for the extensive view of the overhanging rock outcrop above the right wall.

D-1

SUMMARY SHEET
PHOTO D-1

D-1 View right of the crest of the spillway and the left face of the right pier

1. Small concrete spalling.

2. Longitudinal crack with a about an inch maximum opening on the upstream side of the crest and about 1/2 inch to 3/4 inch down from the crest to almost to construction joint on line 2. About 3 feet from the construction joint, the crack ends on a hairline crack.

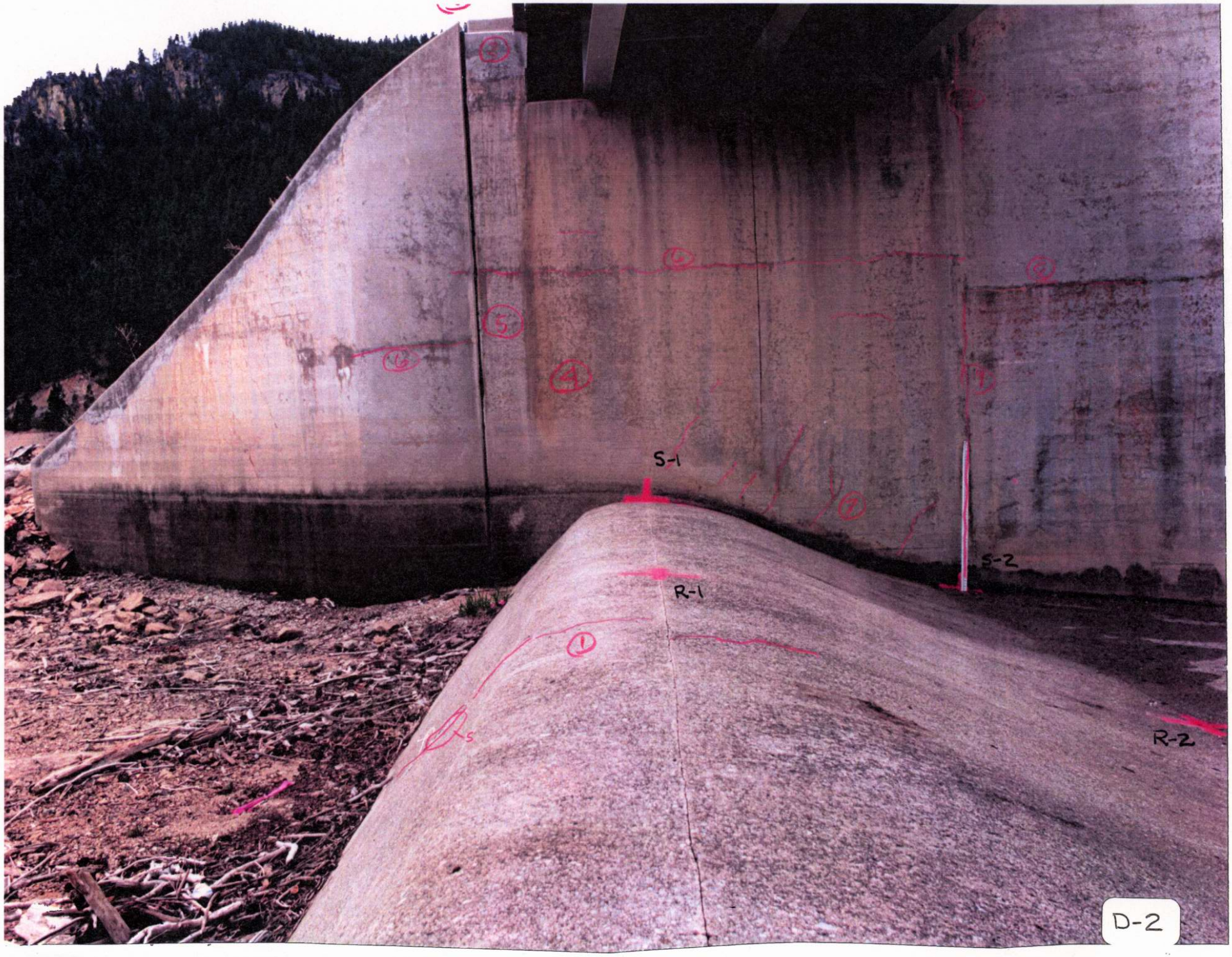
3. Longitudinal crack between P-2 - R-2 beginning along that construction joint. It's an old crack, probably. It's a very small deep cracking and it continues on beyond the next 2 or 3 construction joints and ties into a vertical crack that we described previously in Photo B-8, comment 4.

4. The upstream part of the right pier had a finishing coat. Crazing cracking with a fine textured pattern in the surface cover underneath is starting to reflect through the finishing coat. These are hairline cracks.

5. Is in the middle of the pier. There is a minor hairline vertical crack that develops through this area. Along with it is a coarse crazing pattern. Again this looks like a part of the construction joint that has been observed on the other side of these piers. A couple of minor pop-outs have occurred on this face.

6. A very fine crazing cracking is reflected through the surfacing with a very small 1/2 inch or less in pattern extending for about 4 feet wide on the downstream section. The yellower looking concrete has a coarser pattern of the crazing cracking with a few of the tieback grouted hole reflecting through.

7. Gray colored concrete with a surface cover. Crazing has been reflected through all the surfacing on a very fine pattern to medium size pattern as you get to the end of the pier downstream. These are all hairline cracks.


S-1
S-2
R-1
R-2
D-2

SUMMARY SHEET
PHOTO D-2

D-2 View left of left wing wall and beginning of the spillway wall

1. Some longitudinal cracking, rather tight. The maximum crack width is 1/8 inch. On the upstream side of the crest there is some spalling that is occurring. This area has been patched before, but has recracked. The crack looks to be fairly deep on the crest.

2. Is dental work on the upstream end bent of new concrete. Note the crazing cracking along the contact between the old and new concrete.

3. The wingwall joint with the left spillway wall. The displacement shown in the photograph indicates a slight settlement of the wingwall towards the reservoir or upstream.

4. A light coat finishing on this area. There are horizontal cracking and the crazing cracking starting to develop through the surface coat. These are hairline cracks at this time, but they are quite extensive in the horizontal direction in this area. They should be observed during construction activity.

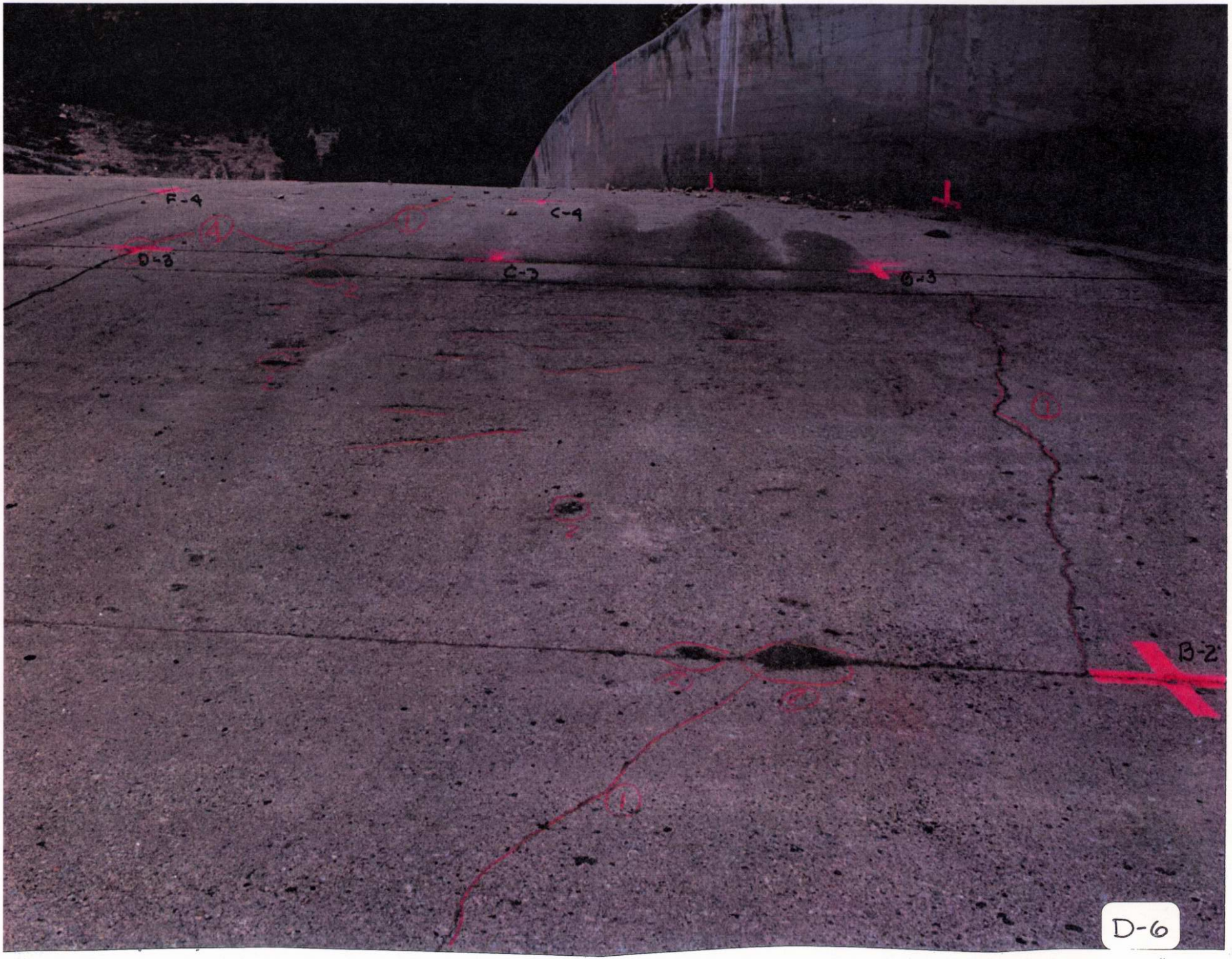
5. The light gray area is representative of fine textured crazing cracking with occasional horizontal cracks. A typical crack is shown about 7-8 feet in length marked at top of No. 5.

6. A continuous horizontal fracture crack located about 8 feet from the crest. It's about 1/8 inch to hairline in size. It's interesting that it also extends into the wingwall for a short distance. Other prominent horizontal joints are also mapped that were mapped along with this No. 6 in area.

7. Diagonal cracking along the toe of the wall between S-1 and S-2. This cracking is probably related to transverse or freeze-thaw cycle type cracking of the wall. These are about 1/8 inch to hairline in size and also connect and combine in with the crazing cracking that we see in this area.

8. Is a horizontal crack in the wall. It's a hairline crack.

9. Is a vertical crack, undoubtedly related to the wall construction. It is hairline in size.


F-4
C-4
D-3
C-3
B-3
B-2
D-6

SUMMARY SHEET
PHOTO D-6

D-6 View to downstream - upper spillway - right side of spillway floor

1. A longitudinal crack that begins a little above point B-2 and extends to the joint just above the B-3 line. Crack openings are spalling minor D-type cracking open to about 1/2 to 3/4 inch in width.

2. Are minor spall areas.

3. Will be used to show the short transverse cracking believed to be due to the wear of the materials coming over the crest of the spillway. These are short 2 feet to 1 foot in length and are more like a spalling crack than anything else. They're about an 1/8 inch to 1/4 inch in width.

4. Are small patches of spalling cracks. A big crack about 1/2 inch in width extends through those places showing further deterioration in these areas.

C-3
A-4
D-7

SUMMARY SHEET
PHOTO D-7

D-7 Detailed view to right floor in upper spillway area

1. Shows the patch left of C-3. Note the big cracks in the patch. See comment on photograph D-6.

D-8

SUMMARY SHEET
PHOTO D-8

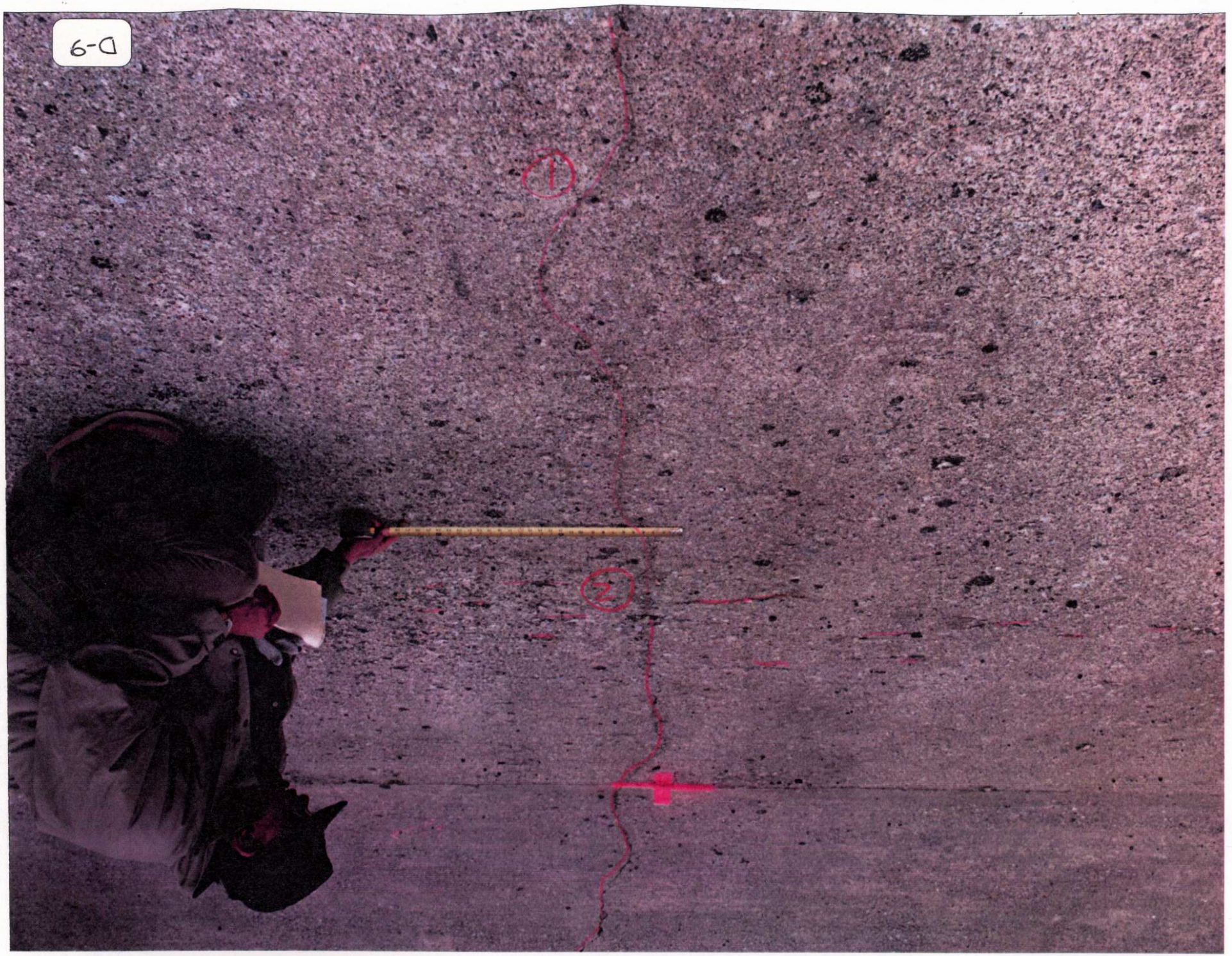
D-8 View downstream of upper spillway floor. General - field observations were not recorded and the observed cracking is shown without comments and will require field examine to evaluate these cracks.

1. Short transverse cracking described in comment No. 3 on Photo D-6.

2. Longitudinal crack.

3. Spalling cracks along construction joint.

5. Longitudinal crack.

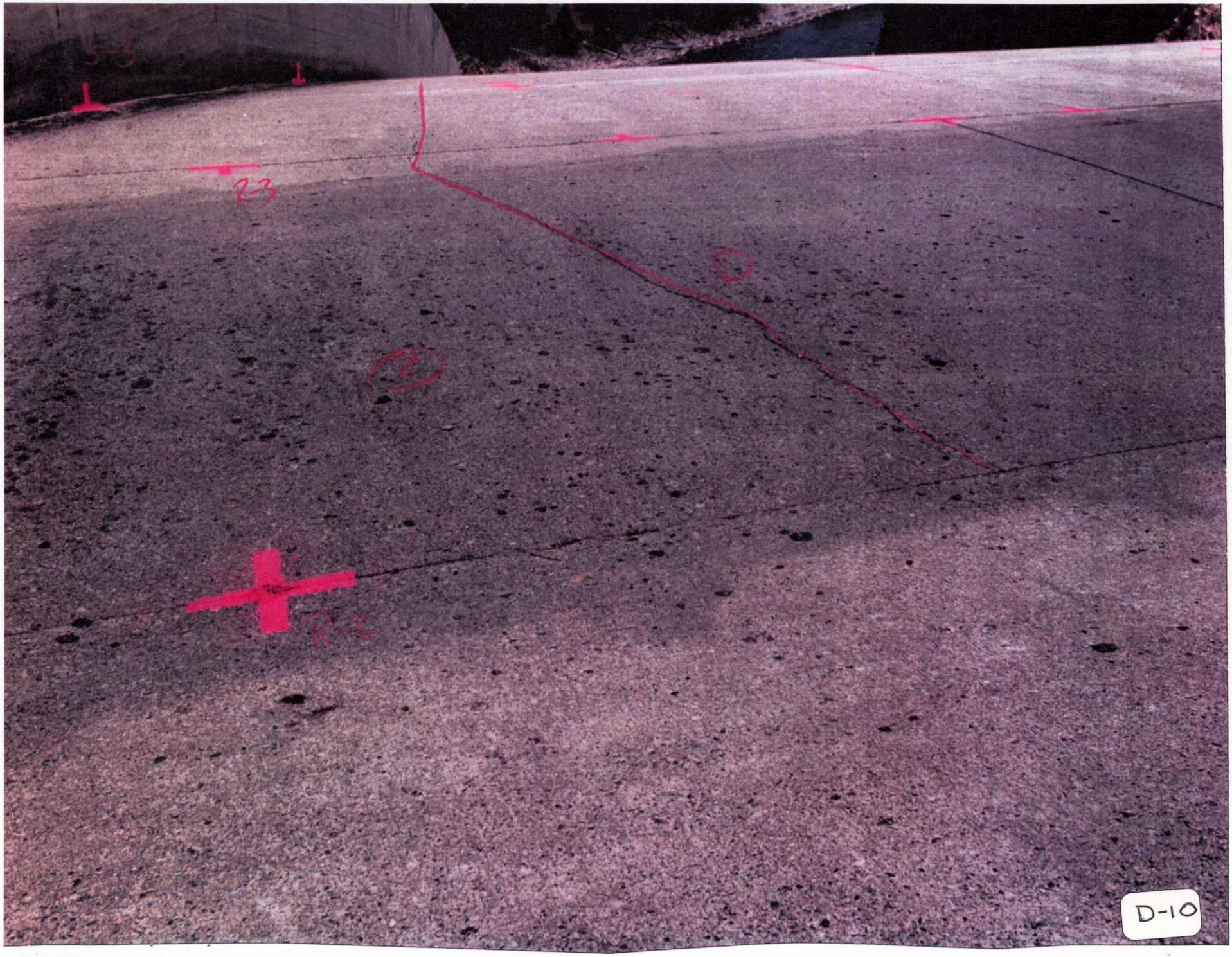

6-D
1
2

SUMMARY SHEET
PHOTO D-9

D-9 View downstream of upper spillway floor. General- field observations were not recorded and the shown features will require field examination for cracking details.

1. Longitudinal cracking.

2. Short transverse cracks - see comment No.3 on Photo D-6 for description.


S-3
R-3
1
R-2
D-10

SUMMARY SHEET
PHOTO D-10

D-10 View downstream of upper spillway floor, left side. General - field observations were not recorded and the shown features will require field examination for cracking details.

1. Longitudinal cracking.

2. Concrete spalling.


A-1
A-5
C-2
E-5
A-6
E-6
H-5
15¢
H-4
13¢
J-4
J-5
H-6
13¢
A-7
C-7
J-6
L-5
L-6
D-5
C-3
D-3
E-3
C-4
F-4

SUMMARY SHEET
PHOTO B-5

B-5 View to right, upper spillway

1. There's a crack running full panel parallel with the spillway from panel L-5 to L-6. Maximum crack size appears to be 1 inch tapering down to a hairline crack of less than 1/32 inch.

C-9

SUMMARY SHEET
PHOTO C-9

C-9 View right of upper spillway wall

1. Horizontal crack approximately 14 inches long.

2. Stained area with extensive crazing. Crazing ranges from fine to medium. A snap-tie patch appears to be popping out.

3. 2 inch diameter patch appears to be snap-tie hole. It's broken out approximately 3/8 of an inch in depth into the wall.

4. Points to several vertical cracks running along the base of the wall. They are approximately 16 inches in length.

5. Delineates a vertical crack that runs from the base of the right wall. Crack runs approximately 4 1/2 feet short of the top of the wall and breaks over into a horizontal crack. Some apparent spalling has taken place. Patch is about 8 inches long.

6. Is a vertical crack around full height of the wall. Above that crack a rock has apparently hit the wall and broken the edge. There is damage is about 1 foot in length and as much as 1 1/2 inch of penetration at the edge of the wall.

8. Is a vertical crack running full height of the right upper chute wall. It appears to be a construction joint and is opened up as much as 2 1/2 to 3 inches. The concrete aggregate is exposed, and it's one of the more severe cracks on the structure.

9. References the wood form marks in the wall. You also see some of the normal rock fallout from the outcrop directly above the wall.

10. Parallels a hairline crack that runs through the wood form marks in the wall it stops about 3 feet from the top of the wall.

E-1

SUMMARY SHEET
PHOTO E-1

E-1 View right of upper spillway wall

1. The vertical crack is 7/16 of an inch in width from unbroken concrete face to the unbroken concrete face on the other side of the crack. The vertical crack is 1 9/16 inches wide near the top of the wall.

3 to 8 Diagonal cracking starting from the top of the upper south wall traveling down. All of the cracks 3 through 8 are all hairline cracks with openings less than 1/16 of an inch.

9 & 10 Extensive repair that has been made along the cap of the retaining wall.

B-7

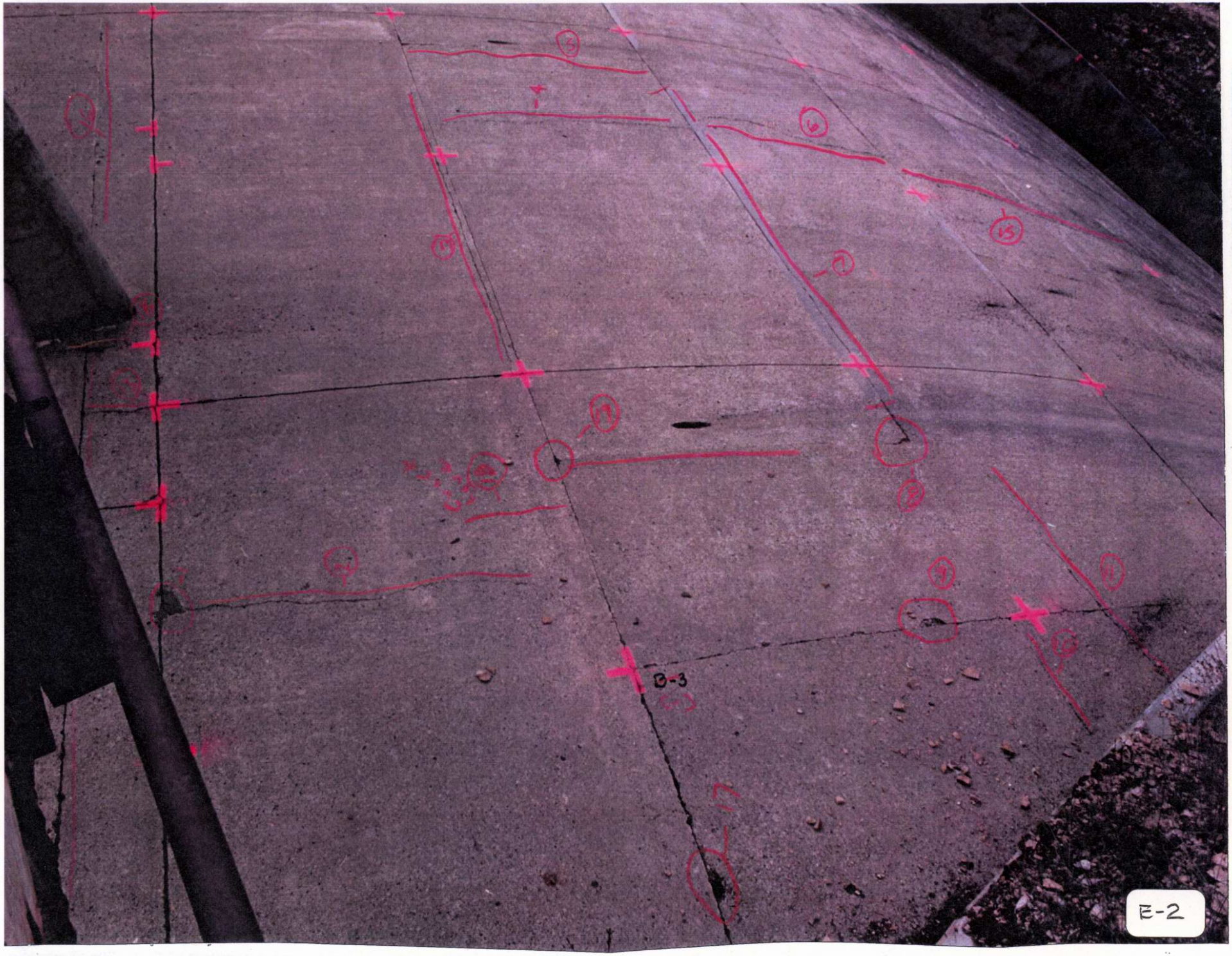
SUMMARY SHEET
PHOTO B-7

B-7 View to northeast of upper spillway and right spillway wall

1 & 2 Diagonal cracks which verge on each other. Crack No.1 is open about 1/8 of an inch at the bottom. Crack No. 2 is open about 1/16 at the bottom and transitions into hairline type crack.

3. More of the cap repair done on the right upper chute wall. In the area of note No. 1 & 3 there is also quite a bit of calcium leaching through the cracks of the wall.

5. Shows the extensive erosion that the right chute wall has undergone due to hydraulic action. There is some aggregate exposed at the base of the wall where the concrete has been eroded off.


B-3
E-2

SUMMARY SHEET
PHOTO E-2

E-2 View from spillway bridge of upper floor spillway floor

3. Is a transverse crack that parallel the joint for row 4. It runs from a hairline crack to an inch wide in places with about an overall crack width of about 3/8 inch.

5. A panel joint at the top of the panel at note 5 near the weep hole, the corner is broken and there is a triangle section that is missing from the panel. It measures approximately 5 by 7 inches. There is also more chipping and breaking down the joint of that panel and the panel. Overall, is undergoing some apparent erosional effects from the hydraulic activity over it.

6. Longitudinal crack, full panel width. The crack is up to an inch wide with a minimum width of 3/8 inch. It terminates into a V at the upper end of the panel.

7. Adjacent to note 6 is some extensive joint repair that has been done on the spillway. It appears to be relatively intact at this time. Some cracking extends into note 4, which is also a longitudinal crack that is approximately 3/4 of an inch wide at the widest portion and about 3/8 of an inch at the narrowest point. It runs full panel length also.

8. A construction joint with a broken corner similar to the other one at note No. 5.

9. A fairly deep pocket in the spillway panel with a transverse crack leading out of it. It ranges in width from about 1/8 up to about 2 inches in width. In the area there is also some exposed aggregate due to hydraulic erosion.

10. A transverse crack, opened up about 1 1/2 inches at the widest part and about 3/8 at the narrowest part. It's about 3 1/2 feet long.

11. A transverse crack that runs from the right spillway chute wall across 2 panels. The crack that intercepts at the wall appears to be a continuous crack going across the floor and up the wall.

13. A longitudinal crack that ranges from about 1/4 inch in width to about 1 inch in width at the maximum area. There are also some signs of hydraulic scouring on the concrete here.

14. Crack that ranges from greater than a hairline at the narrow spot up to about 3 inches across where 4 panels come together at the corner.

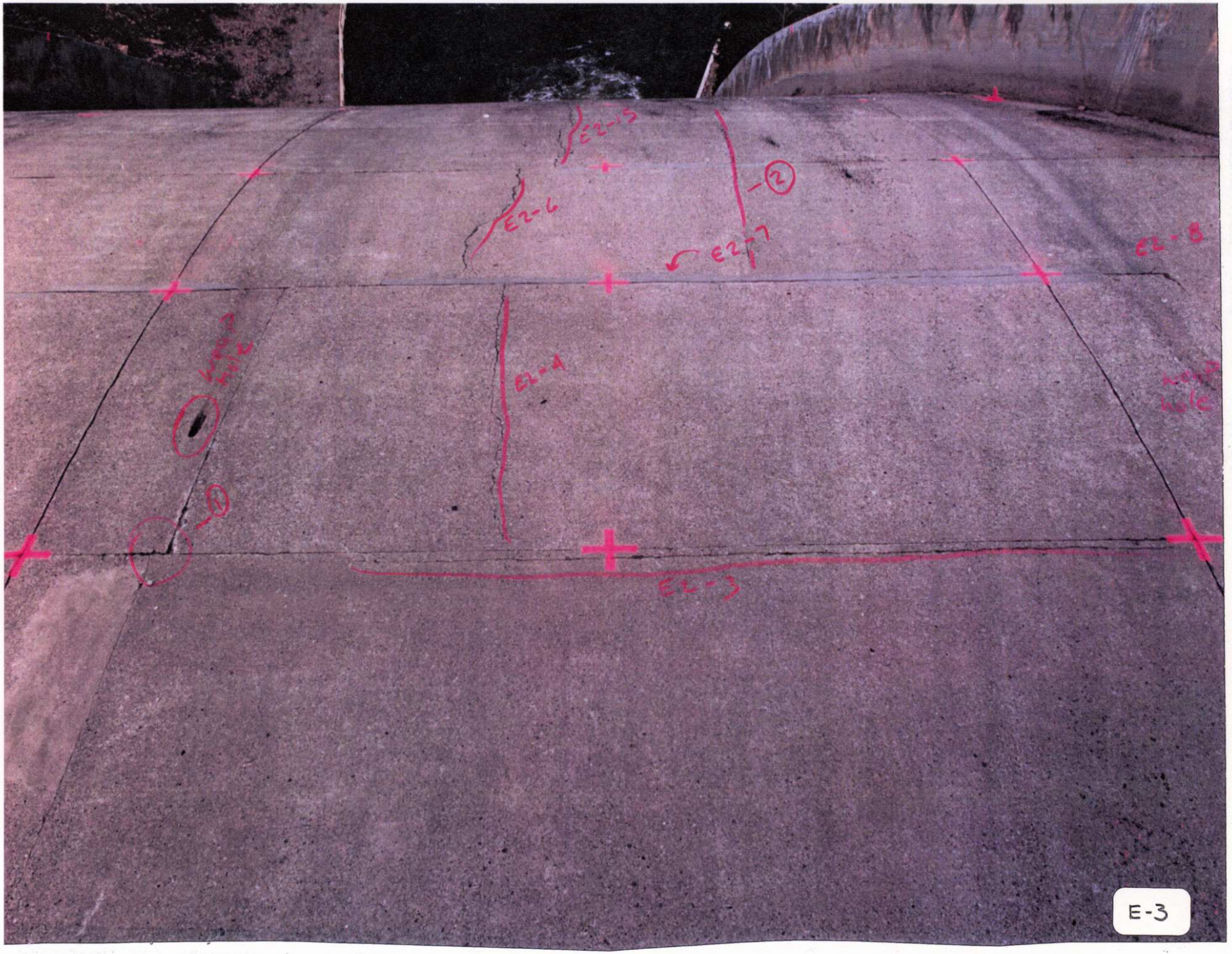
15. Longitudinal cracking. Crack is full panel length and it looks to be greater than 1 inch wide continuous. It has some vegetation growing in the crack at this time.

16. A construction joint running from the right retaining wall to the full width of the spillway. It appears to be undergoing some distress from original construction and it varies in width from about 1/8 to 1 inch in width.

17. A chunck of concrete that's missing along the construction joints. It's about 2 inches in depth about 9 inches in length. Part of the upper panel is exposed.

18. A longitudinal crack. It's about 1/8 of an inch at the narrowest part and flares out to an inch of disturbance at the top of the crack.

19. Construction joint that comes longitudinally down the spillway. The area is spalled approximately 1 1/2 inches in diameter and 3/4 in depth.


E2-5
E2-6
E2-7
E2-8
E2-4
E2-3
manhole
manhole
1
2
3

SUMMARY SHEET
PHOTO E-3

E-3 View downstream of upper spillway. Photo E-3 has several redundant features with Photo E-2

1. Just above the weep hole there is a bad panel connection. Quite a bit of concrete is spalled out of the panels (It's right near note No. 5 on photograph E-2).

2. A longitudinal joint that has quite a bit of spalling and disturbance on the joint line. It's spread about 3/8 inch at the maximum.

E-4

SUMMARY SHEET
PHOTO E-4

E-4 View downstream of upper left chute wall

1. A longitudinal crack. It starts at the base of the crest on the downstream side and runs to row 3 and travels on down to row 4 at note 3. Some patching has been done on a joint, and it seems to be in fairly good shape. Some edges around the patch are cracked. This crack that runs from note 1,2,3 is about 1/8 of an inch in width up to about 1/2 inch at the maximum. At row 4 it veres off at the wall with a large pop-out at point 17. That pop-out at point 17 is triangluar in shape with a base of about 4 1/2 and a height of about 3 1/2 inches. A crack on the left upper chute wall is vertical and has a width of about 1/32 inch to a width of about 1/8 inch. The left side upper chute wall has some patching every 7 or 8 feet on top of the wall. It doesn't appear that rockfall has damaged it, but it may have resulted from freeze-thaw damage to the concrete in those areas.

9. A vertical crack that splits about 1/2 way up the wall. At the spilt there is aggregate exposed and cracking to a depth of about 3/4 inch. The crack runs from about 1/32 to 1/8 of an inch in width and some calcium leaching going on here also.

14. A vertical crack on the upper part of the left chute wall. It ranges in width from about 1/16 to 1/4 inch. Cracks 12 and 13 are also vertical cracks on the left chute wall. They are hairline type and appear to be less that 1/32 inch in width.

15. A 1 1/2 inch diameter weep hole. The hole appears to have been cut into the spillway, and it appears to go full depth of the concrete.

16. A transverse crack approximately 9 inches long and a width of 5/8 of inch maximum. There are several of these cracks in this panel which is in between row 3 and row 4. The other cracks don't show up on the photograph very well.

D-3
S-4
S-3
S2
R-3
R-2
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4

SUMMARY SHEET
PHOTO D-3

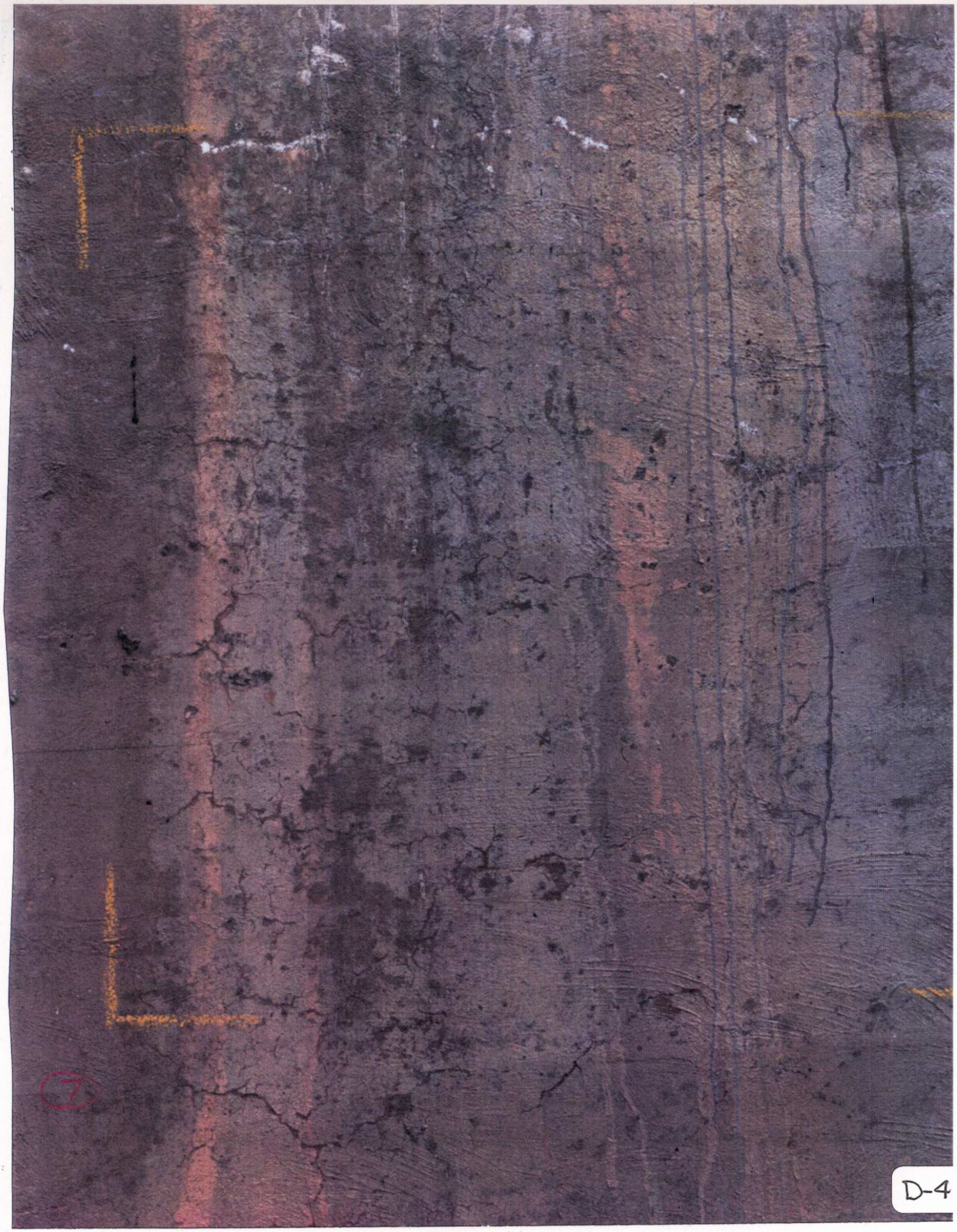
D-3 View left, upper spillway wall

1. A vertical crack on left side, upper spillway wall. The crack is about 3 in width. One spot has a large concrete pop-out. The reinforcing bar is visible, and looks to be about 2 1/2 to 3 inches deep. The bottom of the crack tappers down to a hairline crack and the average width is about 1/8 in width. This crack has pretty severe spalling with some calcite leaching.

2. A Large chunk of concrete missing from the left side wall. It's on about row 4 of the spillway.

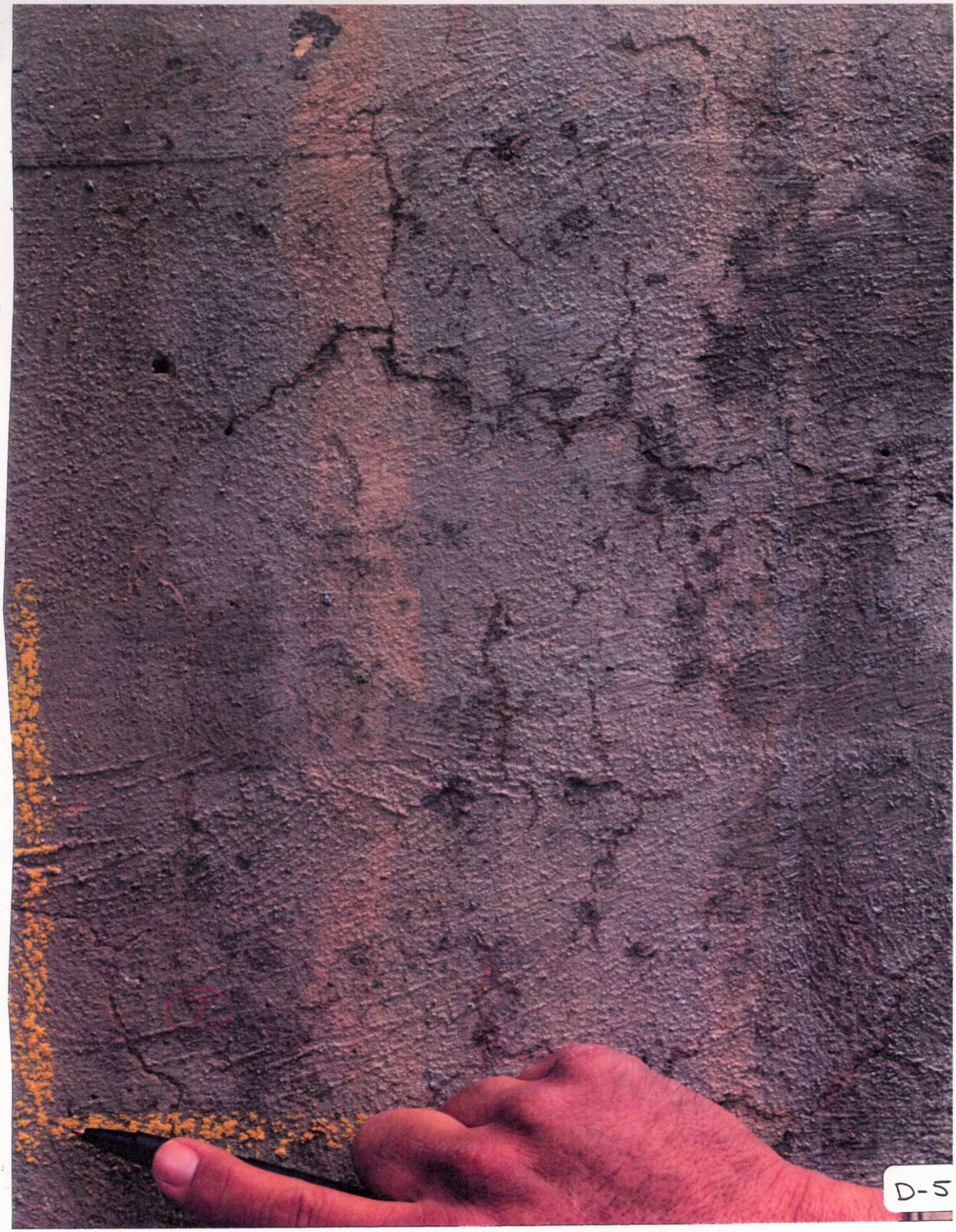
3. A vertical crack. It's basically a hairline crack with maximum opening of about 1/8 of an inch.

4. The crazing cracking at row 2 shows staining. Most of that tan staining is a crazing pattern, coarse crazing cracking in the middle of that wall. In that section, same one at row 2, the crazing goes from coarse to probably medium coarse, pinches out by the upper 2/3 of the wall, for the most part. Looking just above the 3 inch diameter iron weep hole pipe in the left side wall is some extensive crazing cracking from about 2 1/2 feet up. It ranges from coarse to medium coarse pattern and runs up to about 2/3 of the wall height. The staining that is coming through the crazing is probably calcium leaching. At row 3 there appears to have been some remedial treatment done to the left side wall and there is some rough textured hand trowelled finish here and very little crazing cracking that can be seen. There is a hairline crack at row 3 in the photograph it is covered up by some kind of scale that was put in the photograph but it's a hairline that starts from the discolored eroded material on the bottom of the west side wall and it's no greater than 1/16 of an inch and provigates up the wall and seem to end about 1/2 way up. Just before row 4 there is quite a bit of crazing cracking. It runs from coarse to medium coarse type cracking, there is even some fine cracking. Past row 4 quite a bit of medium, medium sized crazing cracking here, mostly in the middle 1/3 of the wall, pretty difficult to see. Extensive pitting of the lower 1/3 of the left side of the wall in between rows 4 and 5 a lot of exposed aggregate and pock marks up to about 1 inch in diameter. It appears that they have been filled at one time and are now starting to weather out again.


7
D-4

SUMMARY SHEET
PHOTO D-4

D-4 A close-up photo of area near comment No. 7 on Photo C-8 loacted on right spillway wall - - that illustrates the fine texture pattern of the crazing cracking that is typical throughout the spillway structures.


D-5

SUMMARY SHEET
PHOTO D-5

D-5 A more dteailed photo of the lower left corner of the crazing crack pattern described on summary sheet D-4. This cracking pattern is referenced by comment No. 7 in Photo C-8.

D-11

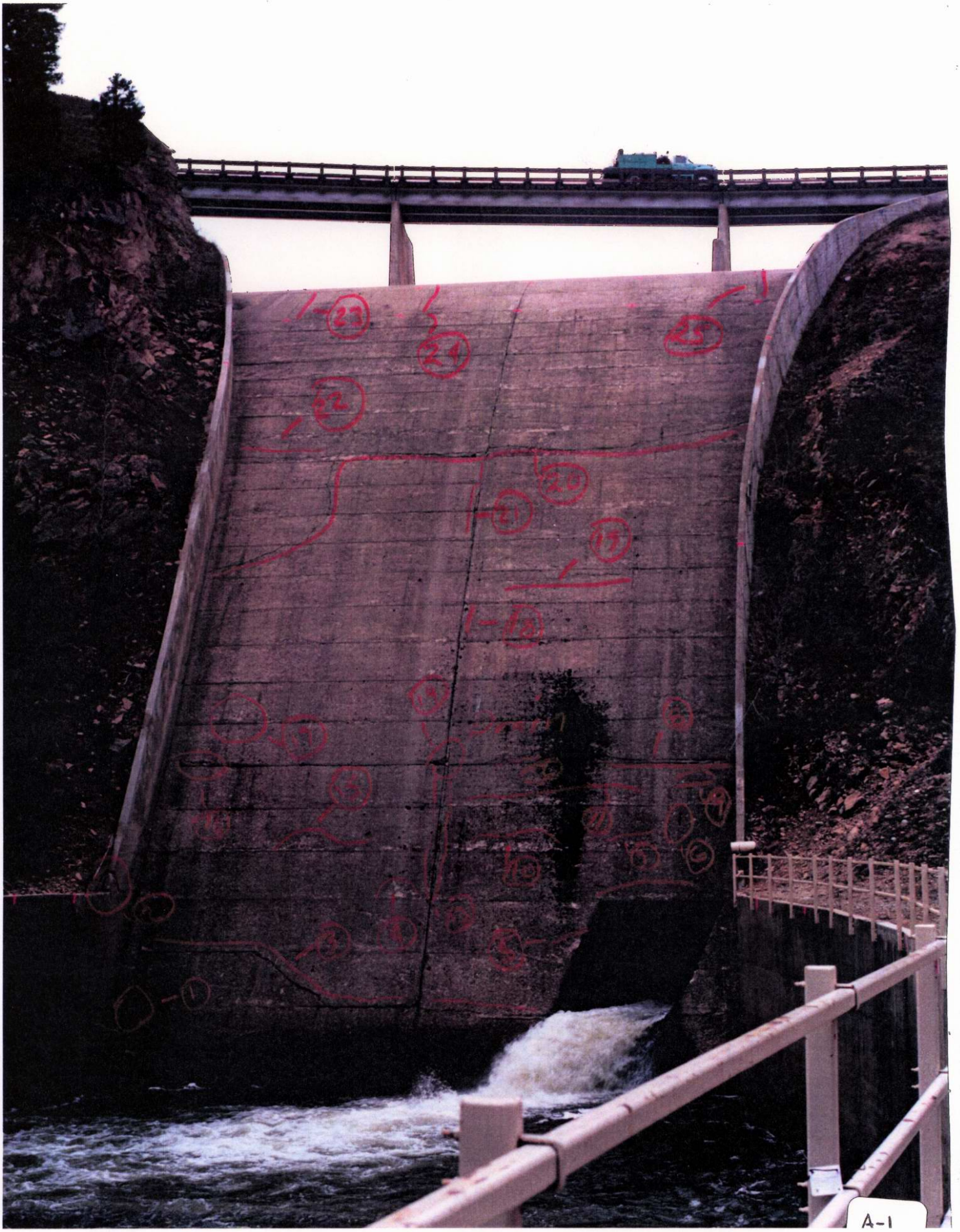
SUMMARY SHEET
PHOTO D-11

D-11 View of left spillway wall in upper spillway area

1. Vertical cracking in between panels 4 and 5. It starts out from a construction joint of the spillway floor and runs in widths from about 1/32 to about 3/4 inch at the widest spot where spalling is located.

2. A hairline crack running from a left side retaining wall cap down to mid wall heigth.

3 & 4 A vertical crack starting from the spillway floor that splits at out the mid point into 2 separate cracks. They range from about 1/16 to 1/4 inch in width and 1 inch in width at places where concrete is spalled out of the wall. There is some patching on the cap where the crackes fan out into crazing cracking.


A-1

SUMMARY SHEET
PHOTO A-1

A-1 Of the spillway looking upstream.

1. Appears to be some seepage out of it, possibly an old drain pipe. There is extensive spalling or a hydraulic scouring of the concrete on the panels down here throughout most of the spillway. A lot of the original smooth concrete surfaces have been eroded off and is now shown quite a bit of aggregate.

2. Is 2 large cracks and spalling areas on the spillway, right side chute wall, possibly due to rock fall. There is now a timber barrier set up behind it to protect it.

3. Quite a long and wide transverse crack that starts on one of the panels and transitions into a diagonal crack. Maximum width is greater than 3 inches.

4. Some concrete spalling and erosion of concrete surface. Same with 5.

6. It appears that this is an old pop-out of concrete which it has been patched now. Part of that patch is cracked and dropped off.

7. Another big kind of a transverse pop out area about consistent 3 1/2 inches wide over about 2 1/2 feet.

8. A longitudinal crack just above the construction joint for a panel and it has a maximum width of about 1 inch, and it never gets below 3/8 of an inch.

9. A spalling condition similar to 7 and 6, located just below feature in 8.

10. An extensive area of erosion and spalling about 10 inches wide and 5 feet long length transverse to spillway.

11. A similar feature, not quite as deep as 10 above.

12. A transverse crack that is about 1/2 inch wide and hooks up with feature No. 8.

13. A vertical crack that could be part of a construction joint. It is pretty ragged at this time.

14. A 3 or 4 inch iron pipe drain out of the face. The concrete is spalled off around it, and you can see the aggregate showing.

15. Another spalling area similar to 10 above.

16. A transverse crack running from the right side wall. It appears to be about 5 feet long. Aggregates exposed in the concrete maybe a depth of and inch or so, maximum width in one spot is greater than 1 inch.

17. Another area of spalling concrete on the spillway that is similar to comment 10.

18. A vertical crack about 1/4 inch in width. It runs one full panel length.

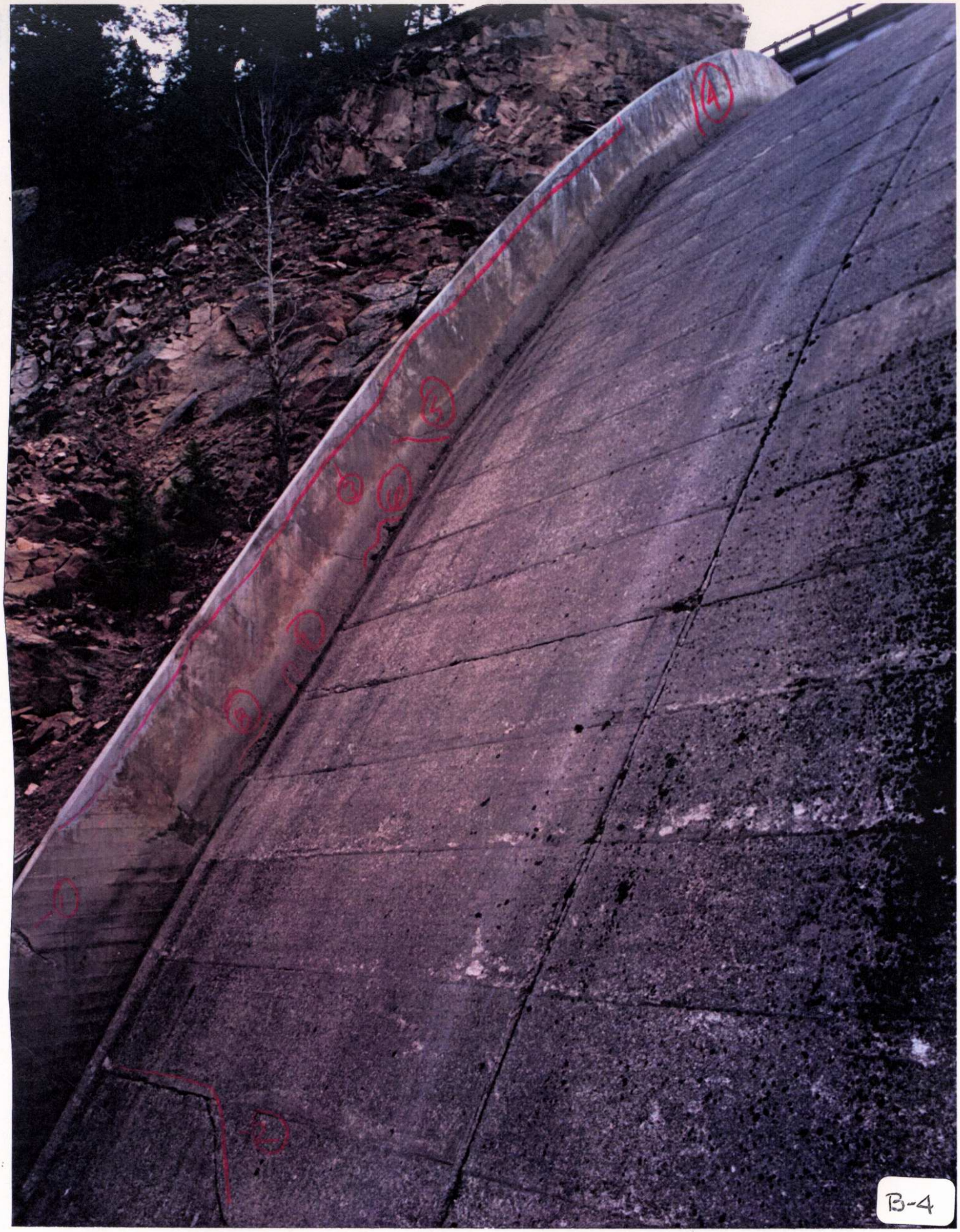
19. A translational track runs transverse to the spillway. Maximum width appears to be greater than 1 inch.

20. A large crack that runs full length of the chute. It's one of the more predominant cracks on the spillway. It runs from the left wall to the right wall about half way through the right half of the spillway panel and goes downstream for 4 panels then over to the right side panel wall.

21. A vertical crack right below the one just described on item 20 above.

22. A translational crack that starts over near the right side retaining wall. The maximum width appears to be greater than 1 inch and about 5 feet in length.

23 to 25 Vertical cracks up on the transition on the upper portion of the spillway, the very steep face of the spillway.


B-4

SUMMARY SHEET
PHOTO B-4

B-4 The spillway portion of the right side of the retaining wall.

1. Cracking where the spillway comes down and interest the stilling basin wall. It's been covered in photograph A-1, item 2. It appears to have been struck by some rocks.

2. A large transverse crack. It starts from the right side and comes left about half way through a panel and diverts into a diagonal crack. It's greater than 1 inch wide at the widest part.

3. Concrete dental work that has been done all along the right side spillwall. Patching is extensive.

4. Vertical crack high on the spillway on the right side wall. It appears to be about 1 1/2 inch in width at the widest part and appears to be full height.

5. A diagonal crack on the right side spillway wall. It starts at the bottom at the eroded portion of the concrete, and then comes up and disappears in the dental work repair.

6. Large pockets in the bottom of the right side wall. These pockets could be spalling or could have been bad coverage of concrete when cast.

7. A vertical crack in the retaining wall on the right side. It has a width of about an inch at the widest part and an average width 3/8 to 1/4. There is a section of hairline crack in the middle.

8. Large rock pockets in the bottom of the right side wall, similar to comment 6. A lot of concrete spalled out and quite a bit of aggregate is exposed.

A-6

SUMMARY SHEET
PHOTO A-6

A-6 Looking at the stilling basin wall, right side.

1. Dental type work on the cap of the stilling basin wall.

2. Erosion due to hydraulic forces. A lot of aggregate is exposed for the entire length of the wall.

3. A pocket of concrete that has spalled out or popped out.

4. A vertical crack with calcite leaching out of it. It is pretty much a hairline crack.

5. Another hairline crack running from the top of the wall about 4 feet in length.

6. A vertical crack with some calcite leaching out. This could also be the construction joint.

7. Horizontal cracks along the stiling basin basin wall. Quite a bit of calcite leaching out of the concrete.

8. A vertical crack running from the top down to the top 2/3 of the wall.

9 to 11 Hairline cracking with calcite leaching out of it. Crazing cracking not apparent.

A-9

SUMMARY SHEET
PHOTO A-9

A-9 A view upstream of the chute area

1. See comments on Photo A-1.


A-10

SUMMARY SHEET
PHOTO A-10

A-10 A view of the right basin wall

1. See Photo A-6 for comments.

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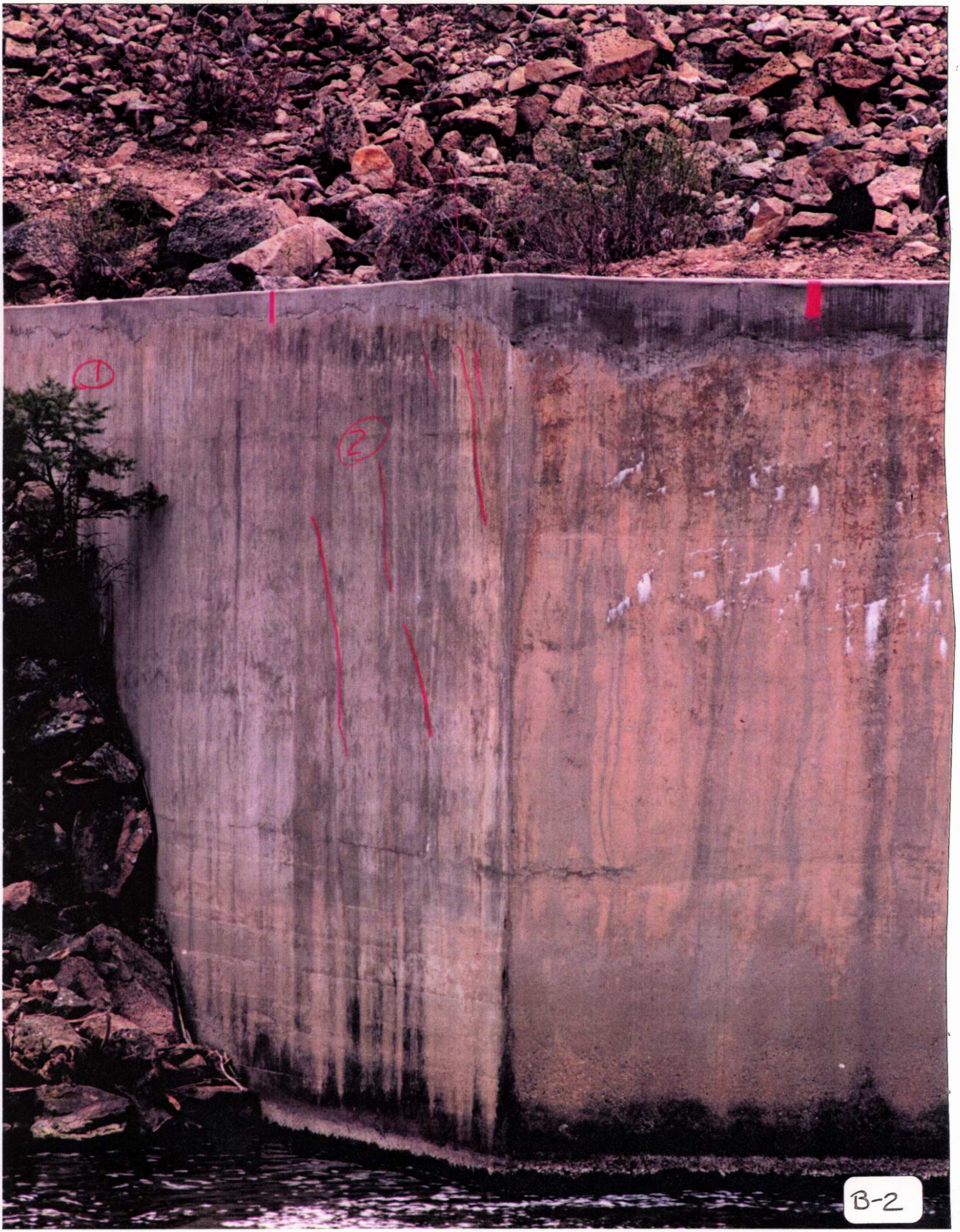
SUMMARY SHEET
PHOTO A-11

A-11 Left end wall - View upstream

1. Dental work along the end wall.
2. A vertical hairline crack and possibly some crazing cracking.
3. Vertical hairline cracks.
4. Vertical hairline crack.
5. Coarse to medium type crazing cracking.
6. A vertical crack which is slightly bigger than hairline.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B-2

SUMMARY SHEET
PHOTO B-2

B-2 View of end wall, right side.

Transverse cracks along the top of the stilling basin wall - right side were counted by standing on the wall. 56 transverse cracks from the corner of the stilling basin wall and the end wall going upstream showed 1 to 2 foot spacings. 22 transverse types of cracks normal to the end wall with spacing from 1 to 2 feet were observed along the top of the right end wall. Most of these cracks are contained in the capping corrective work and do not reflect into the original wall.

2. At the corner of the right end - stilling basin wall are 2 transverse cracks reflecting the construction of the corner joint.

3. 3 areas were observed along the right stilling basin wall that indicate rockfall hits on the inside since the dental capping work.

4. Note leached grazing cracks on the downstream portion of the stilling basin wall.

B-3

SUMMARY SHEET
PHOTO B-11

B-11 Left spillway wall and the chute section of spillway. There's old numbers that were put in there by the DNRC that will be used for reference.

1. A diagonal joint upstream from 1 to 7. It's an open joint and has 2 spalled areas, one about a foot from the top and the other about a foot from the bottom of the chute. The spalled areas look to be about 2 inches deep and about 1 1/2 inches across and 3 inches long.

2. A diagonal/transverse crack. It begins at the top of the spalled dental work section and is a fairly tight joint.

3. A tight hairline diagonal crack.

4. A series of diagonal and perpendicular or vertical the same as 1 and 3. They are actually vertical cracks probably. Moisture is seeping from the lower three cracks in number 4 area above. The diagonal cracks are all around 1+18.5.

5. A large spalling area on the top of the wall at the 18.5 mark.

6. An open crack begins at the dental work at the top of the wall just upstream from 1+24.5. On the upstream side of that dental work there is a crack that exists. This crack is open to probably up to 1/2 inch size.

7. A tight vertical crack. Starting at station 1+24.5 there is a transverse very deep, very large crack that is very well pronounced in the photograph, That crack undoubtedly is cracked clear through the floor.

8. A vertical crack, beginning again at the base of the dental work. This dental work has some fine hairline cracks in it.

9. Three vertical cracks. The first crack goes right through the one that has a kind of diagonal and vertical combination to it. There's a repair of a spall near the base of the wall. The next vertical crack is rather open at the top. Both of these cracks have transverse cracking across the top of the new dental work on the top of the wall. There is also some salt seeps in this area. The second crack area has small opening parts about 6 inches or 7 inches, but generally it's very tight. The first one seems to be quite tight as well, it also has leached salt stains. It also has seepage salts. The third crack is a much smaller and is tight. There is some radial spalling cracks along the leading edge of the wall in this area also above 1+48.5. Leachate precipitation is there too.

12. A vertical transverse crack. It's open and there's several small spall areas along the sides of it. It also extends into a transverse crack along the floor. It goes through 1+60.5.

13. A vertical/diagonal crack just down stream from 1+72.5. It's open 1/16 inch, and reflects through the top. It goes out into the floor pretty close to the joint about 8 feet, just above the, heavy moss stain.

14. A crack through the new dental work. It goes down right through the floor and comes off in a transverse crack across the floor or into a joint. There's some leaching salt in the open crack. It has some 1/4, 1/16 inch opening in few places along that are normally tight. A little salt leaching in this crack.

15. Dental work with some crazing cracking. It looks like there might have been more than 1 patch in this area, but there is a medium textured crazing right at the lower end of the patching. The last vertical joint that is shown as number 15 is filled leached salts. It's undoubtedly the same thing. It does not go across the floor.

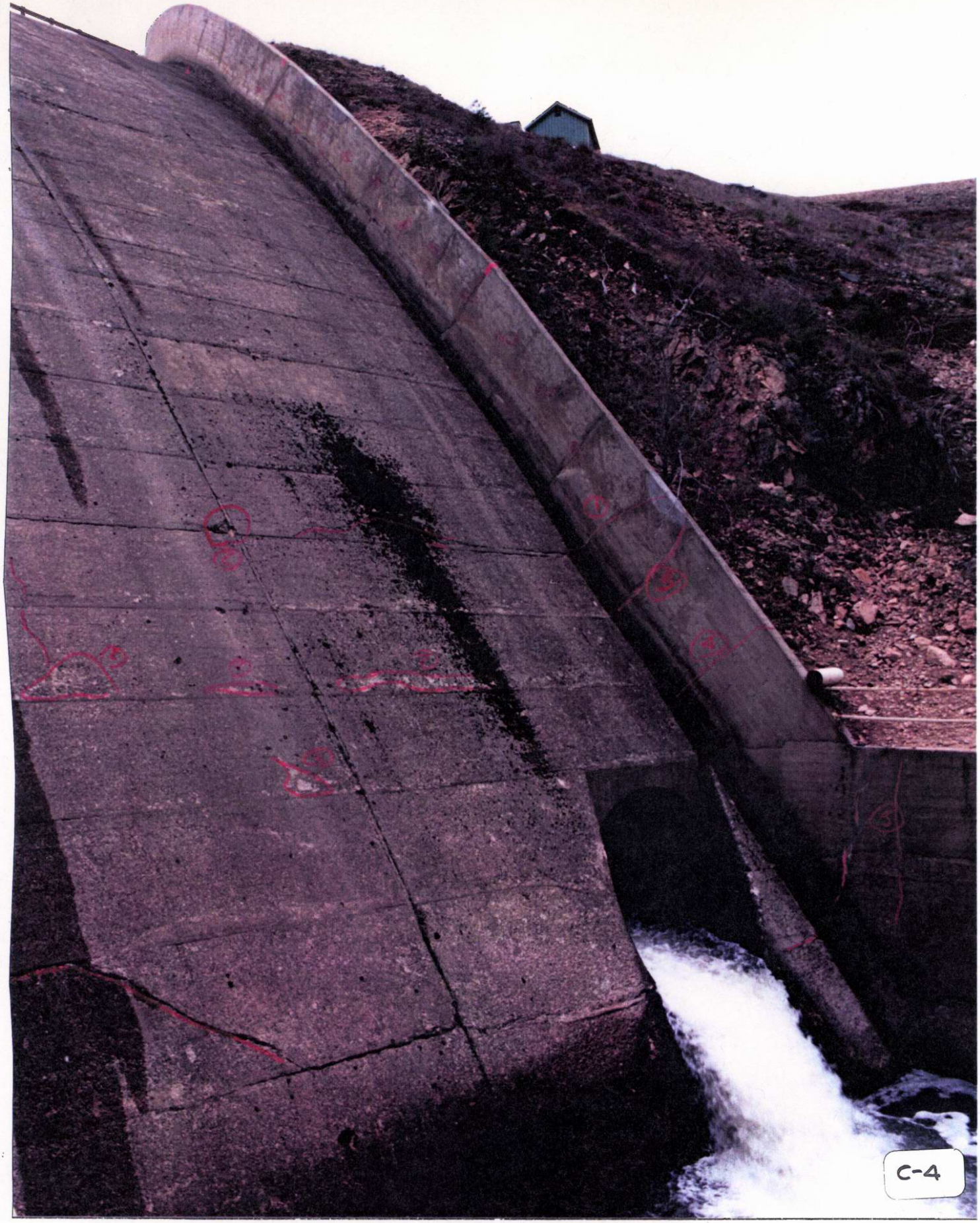
General note - the floor cracking was not mapped on this photograph. It's interesting to note that the seepage that was wetting the concrete nearly ended near station 1+02, that crack was large enough, it accepted most of the water into that crack.


B-12

SUMMARY SHEET
PHOTO B-12

B-12 View of the back side of right spillway wall and lower spillway area

No marks are made on the photograph, but there are several transverse cracks on the outside of the wall. These vary in size but are assumed to be associated with the transverse type freeze-thaw conditions. Note the new cap over the entire top of the wall in the chute area.


C-4

SUMMARY SHEET
PHOTO C-4

C-4 View of lower left spillway

1. A vertical diagonal crack. It extends into a transverse crack across the floor of the spillway. Note that this crack extends through the most recent repair work on the left wall indicating activity along this crack line.

2. Drain hole and spalled concrete. Is shown in several other places in this lower part of the chute floor.

3 & 4 Very tight diagonal vertical cracks. There is also a transverse crack along the surface which goes through some of the repair work.

5. Two vertical cracks, the upper parts have been grouted and replaced. However there is a hairline in the lower downstream one and then there are a couple cracks at the base and along the edges of the upstream of this crack. This cracking goes right over to a construction joint and then goes on across to the tunnel outlet.

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SUMMARY SHEET
PHOTO C-2

C-2 View left of stilling basin wall

1. A vertical open crack goes to about 2/3 of the way to the water line, then stops. Maximum opening would be 1/4 inch.

2. A construction joint. There is minor spalling along the joint.

3. A leached filled crack that is tight. It goes half way down the wall.

4. A vertical crack. It is very tight and with leached infilling almost to the water's edge.

5. A tight crack, near a possible construction seam joint. Some seepage, more recent on this. Note the dental patch all along the top of the wall.

General note - There seems to be an absence of crazing cracking from 1 to number 5, then crazing seems to be more common towards the end of the stilling basin wall.

7. Spalling along the construction joint. The spalling is pretty extensive in the area circled.

8. Two vertical hairline cracks.

2'-3"

SUMMARY SHEET
PHOTO C-3

C-3 View to left of stilling basin wall

1. A fine, vertical hairline crack.

2. A fairly tight vertical crack. This crack is probably near a construction joint and shows some seepage.

3. Diagonal fine cracking with small amounts of seepage. Generally the concrete quality of the wall looks a lot better in the stilling basin wall area than it does in the chute area.

4. A spalled area.

5. Fine crazing cracking.

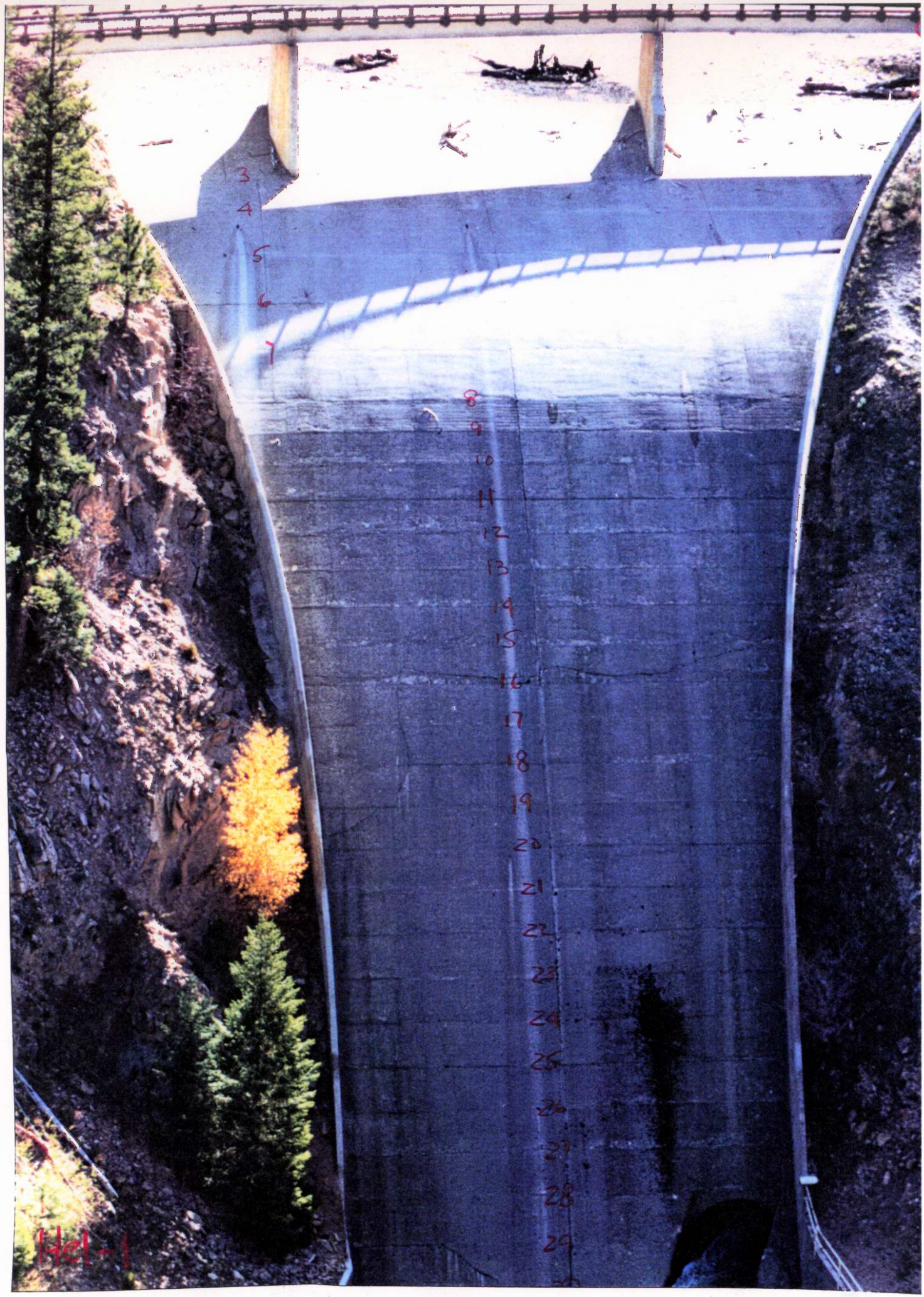

C-5

SUMARY SHEET
PHOTO C-5

C-5 Right end wall

1. A medium crazing to a large crazing pattern that beginning area of the end section.

2. Some diagonal cracking right at the end section. Cracks show some seepage in parts of them. They probably connect to the concrete or surfacing finishing coat that has been put on part of this end section. Some of the crazing cracking is beginning to reflect through at this time. The construction joint is about 5 feet from the water surface and shows some signs of seepage.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Hel-1

SUMMARY SHEET
PHOTO H-1

Helicopter-1

1. Corner of the spillway wall at the bridge end shows a lot of spalling and/or breakage of the top of the wall. The reinforcing steel is exposed in this area with a lot of deterioration. There is no photograph of this, so this is the only statement for this condition.

   General statement - The construction joint work along the spillway floor has been numbered in our survey 1-7 for the upper spillway region. The main chute has been numbered on Helicopter number 1 photograph for reference purposes the data contained in this portion of the survey uses these joint systems and joint numbering hopefully to describe various crack conditions that are observed.

   General comment - The general marks and the overall view has been done and can be seen in photograph A-1 and that this photograph can be used to show a slightly larger blow-up of this site.

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SUMMARY SHEET
PHOTO H-6

Helicopter-6

1. A diagonal crack that begins at the top and the cracked or spalled area right at the horizontal and diagonal wall line fracture breakout. That fine line is a diagonal line and goes down and meets the floor at a minor spalled area it's a hairline fracture. With the next major spalling area which is only about 2 feet on the incline wall from the horizontal intersection, the spalled area is about 2 1/2 feet long and roughly 8 inches wide at the end of that is another diagonal crack that is open for about 2 feet with a small spalled area, then it becomes a hairline crack down to the floor and crosses the floor into the minor spalled area, on the floor at point number 2.

3. A major crack opening that begin at joint number 29 and then moves diagonally down along the floor to joint number 30. This is a very large crack and it's open. The photograph indicates leakage from underneath, staining and there is minor spalling or scour along this joint fracture opening. The remaining part of joint number 29 is tight and looks good to the outlet tunnel.

4. A seepage drain hole that is functioning quite regularly indicating some seepage near the toe of the chute area. Joint 30 is fairly tight all the way to the intersection of the fracture mentioned in note number 3. The joint becomes open from the connection of that joint to the main longitudinal construction joint. Left of the longitudinal construction joint, the joint is tight to the tunnel. Joint number 28 is tight for the entire width.

5. The longitudinal joint appear to be fairly well eroded from the activity on the spillway. There is minor cracking, almost D-type cracking, along large parts of this.

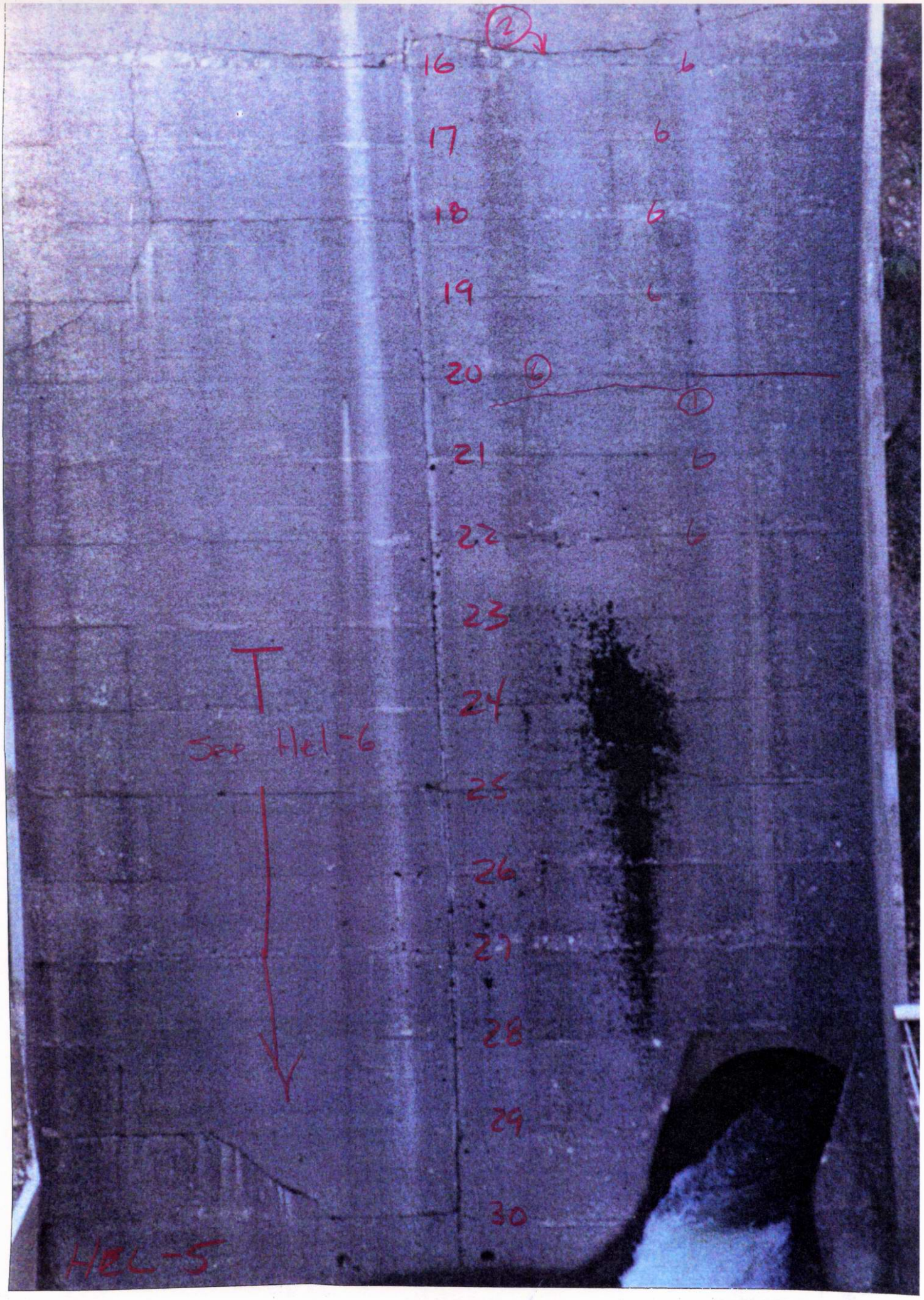
6. Construction joint 26 is tight.

7. A transverse crack and it's horizontal component from the drain hole at number 8 is rather tight. The main part of the crack begins from joint 25 and is open with a crack of perhaps 1 inch in width. It's an older crack along the left portion, seems to be a little bit newer crack in the mid section of near mid chute floor. When this crack hits joint number 25 that joint appears to be fractured and open. A defined fracture moves off diagonally along the edge of the construction joint and the right half appears to have that joint open. From the intersection of the fracture on number 7, on the left half of the bridge deck seems to be tight.

8. The longitudinal drain hole is in an area that is badly spalled in the intersection between joint and joint number 25. It appears that this is very little leakage from this particular drain hole. No staining can be noted, or very little at least in the photograph and on the concrete floor.

9. Joint number 23 is tight for it's entirety. There is a diagonal fracture that is controlled to this construction joint on the right wall, fairly tight.

SUMMARY SHEET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HEL-5

PHOTO H-5

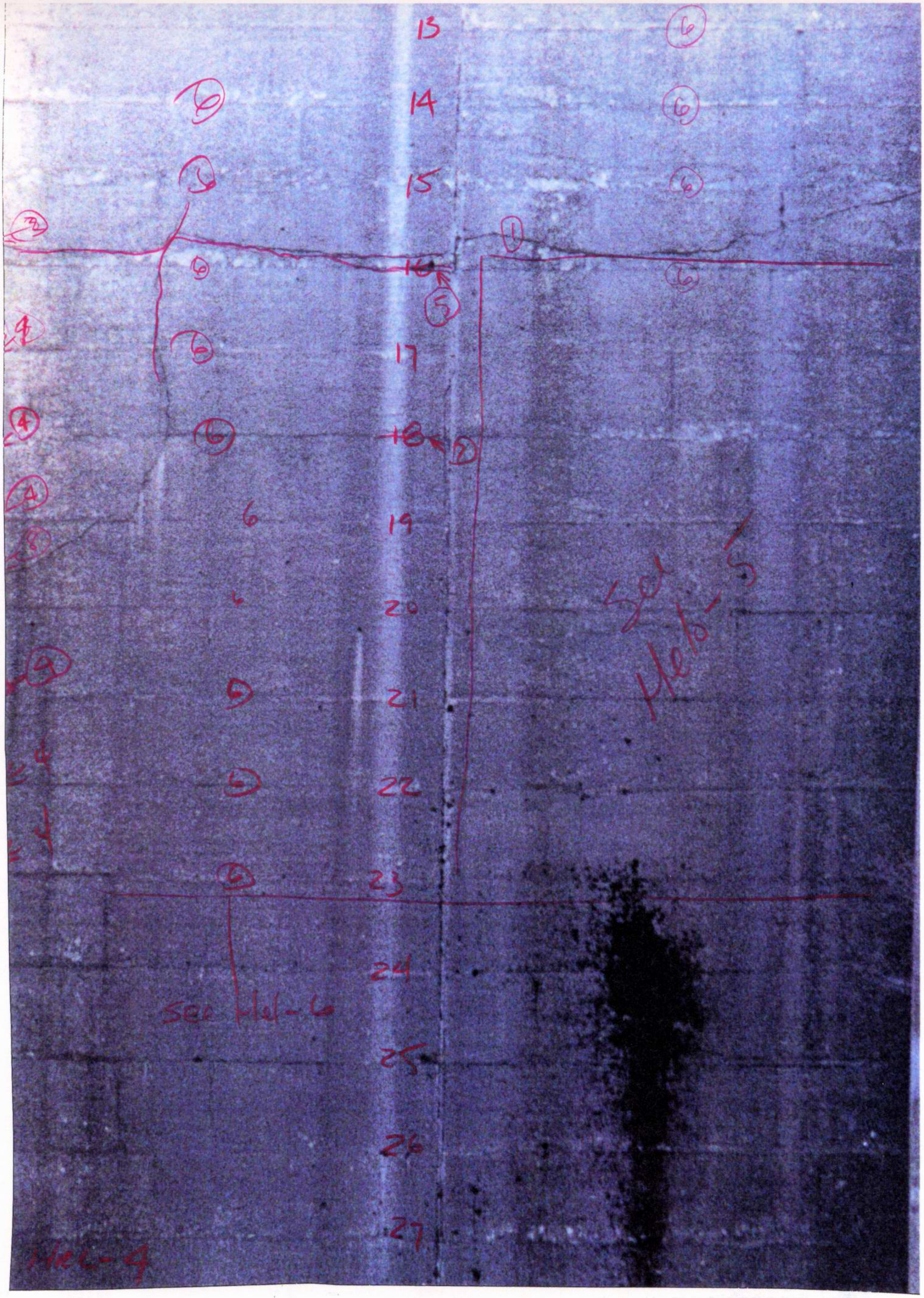
Helicopter-5

Note that from construction joint 23 to bottom of the chute floor is covered in helicopter - 6 photograph. This photograph will use just the right half of the floor from 22 to 16.

1. A transverse crack. It's slightly open and less than 1/8 of an inch in width. Some minor spalling has occurred along this crack. This crack works it's way to the construction joint 20, and it appears to be open with some minor leakage along that joint. The remaining portion of this joint (right half) is tight.

2. See comment number 20 on A-1.

6. Tight solid construction joints.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See Hel-5
See Hel-6
Hel-4

SUMMARY SHEET
PHOTO H-4

Helicopter-4

Note the areas of overlap on this photograph that were shown on data on other photographs. This photograph will use the left half of the chute floor from joint 13 to 23.

1. Note amount of erosion and deterioration on this larger crack. Large pieces have been broken out, reflecting the poor condition of the concrete in this area.

   Starting on the right half of the chute floor from joint number 13 down to number 23.

2. The floor fracture that has been referenced in A-1 note number 20, ends in diagonal cracking on the right wall.

4. Construction joint number 17 is tight. The diagonal crack in the wall begins at the intersection of the joint to the wall.

5. A dry weep hole. The longitudinal joint is opened up and a lot of spalling in that area and along the joint. A crack is slightly above weep hole.

6. Tight construction joints as shown.

7. Right from the longitudinal joint out a short distance on 18 there is some moss that appears be growing in this crack which has a little opening for a short distance. Joint 19 is tight all the way, except where the large longitudinal crack is controlled by joint 19 for a short distance, approximately a foot, other than that, that joint is tight. Also the construction joint acts as a diagonal cracking at the wall.

8. The floor cracking that comes into the wall also is a point for a slight 1/4 inch to hairline crack diagonally up on the wall. Also the crack shows some leaching on the wall face.


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HEL-2

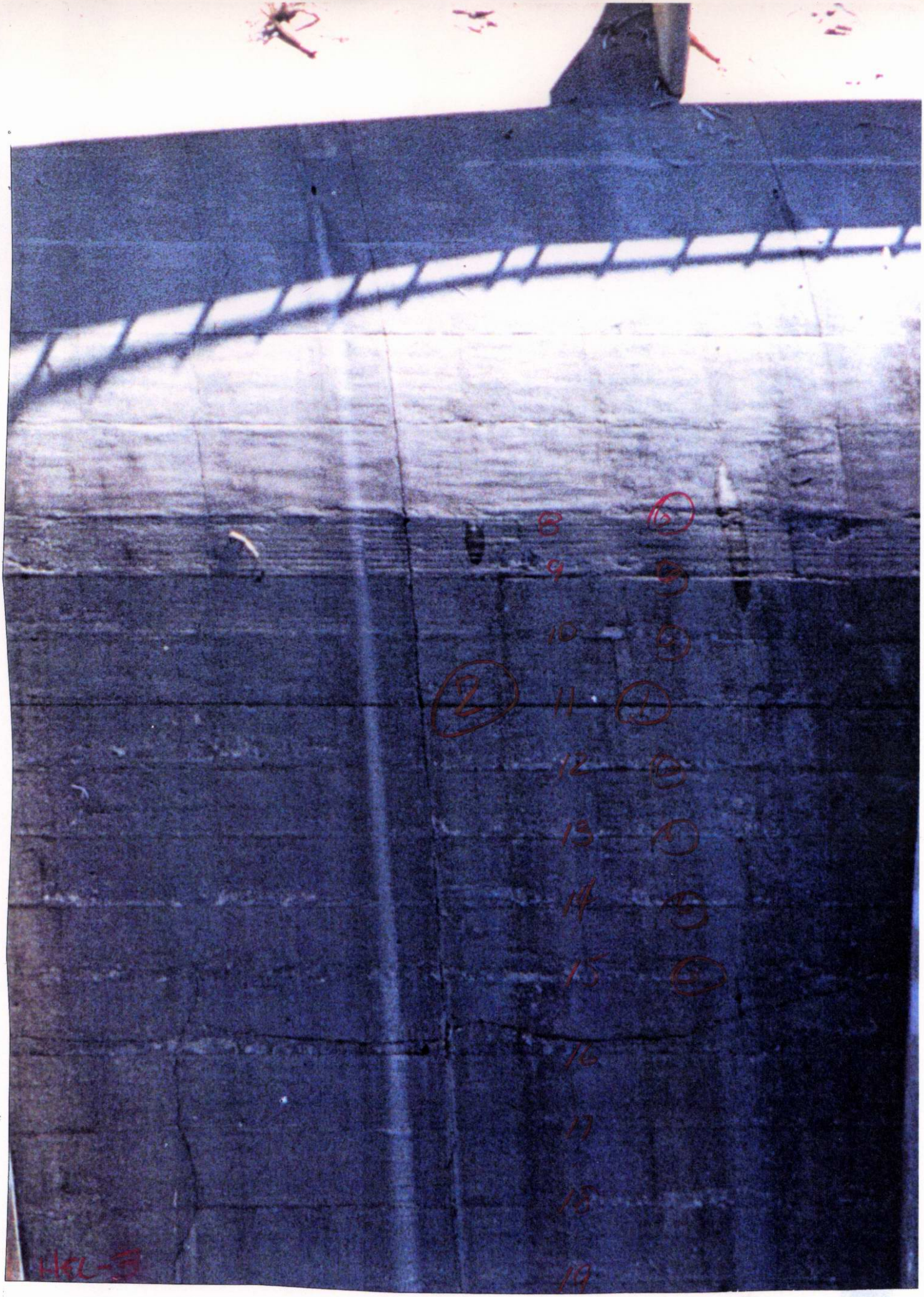
SUMMARY SHEET
PHOTO H-2

Helicopter-2

1. Joint is open.

4. Diagonal crack that is related to the construction joint.

6. Tight joints.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HEL-3

SUMMARY SHEET
PHOTO H-3

Helicopter-3

1. Lateral joint number 11 is an open joint. There doesn't seem to be any serious leakage coming from it.

   General comment on the condition of the degree of spalling on the chute floor. The spalling is so common that it really can't be mapped. It shows up really well in the photographs. The abrasion caused by the spillage has been significant over the years. It should be noted that a lot of spalling exists.