VILLAGE OF RUIDOSO NEW MEXICO

313 CREE MEADOWS DRIVE
RUIDOSO, NM, 88345
575-258-4343

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**Date:** July 7, 2023

**Ref: ITB #2023-017B GRINDSTONE CANYON DAM CONCRETE REPAIR PRINCIPAL SPILLWAY AND NORTH DAM CREST**

**ADDENDUM #2**

**Purpose:** This addendum is to provide the Grindstone Dam Condition Assessment Report that is referenced in the Invitation to Bid.

If you have any questions regarding the procurement or the project, please contact Gresh Eckrich, PE at Yea and Associates, Inc. via email geckrich@yeh-eng.com.

You may also contact me at purchasing@ruidoso-nm.gov.

Sincerely,

Carol Kirkpatrick

Carol Kirkpatrick
Purchasing Agent

**Yeh and Associates, Inc.**
Geotechnical • Geological • Construction Services

391 Front Street, Suite D
Grover Beach, CA 93433
(805) 481-9590
www.yeh-eng.com

November 30, 2022 Project No. 219-218

Village of Ruidoso
313 Cree Meadows Drive
Ruidoso, NM 88345

Attn: Mr. Randy Koehn, Water Production Manager

**Subject: Grindstone Canyon Dam (OSE Filing No. D-513) Spillway and North Dam Crest Condition Assessment Report, Village of Ruidoso, New Mexico**

Dear Mr. Koehn:

Yeh and Associates, Inc. is providing engineering and design services related to the dam improvement projects for the Grindstone Canyon and Alto Lake Dams in the Village of Ruidoso, New Mexico. Our services are being performed in accordance with our Engineering Services Agreement dated July 23, 2019, and Task Order Number RFP# 2019-008P-08 dated August 30, 2022. The Yeh team for this task order consisted of Yeh and Associates and Hutton Consulting. The enclosed Grindstone Canyon Dam Spillway and North Dam Crest Condition Assessment Report prepared by Hutton Consulting presents the findings of our assessment, including photos and descriptions of selected spillway surface and north dam crest areas with observable deterioration, and concrete repair recommendations.

We appreciate the opportunity to be of service. Please contact Gresh Eckrich 805.616.0399 or geckrich@yeh-eng.com if you have questions or require additional information.

Sincerely,
**YEH AND ASSOCIATES, INC.**

GRESHAM DAVID ECKRICH
NEW MEXICO
26616
PROFESSIONAL ENGINEER

Gresham D. Eckrich, P.E.
Senior Project Manager

Copies: Mr. James Head, New Mexico Office of the State Engineer

Enclosures: Grindstone Canyon Dam Spillway and North Dam Crest Condition Assessment Report

**Colorado**
**Denver** | Colorado Springs | Durango | Glenwood Springs | Grand Junction | Greeley

**California**
Grover Beach | Ventura

# GRINDSTONE CANYON DAM (D-513) SPILLWAY AND NORTH DAM CREST CONDITION ASSESSMENT REPORT

Prepared for:

Village of Ruidoso
313 Cree Meadows Drive
Ruidoso, NM 88345

Prepared by:

Hutton Consulting, Inc.
1678 Tenderfoot Drive
Larkspur, CO 80118

November 30, 2022

# GRINDSTONE CANYON DAM
# SPILLWAY AND NORTH DAM CREST
# CONDITION ASSESSMENT REPORT

## Table of Contents

## LIST OF PHOTOS

**PHOTO NO.** **TITLE**



## PLATES

**APPENDICES**

# INTRODUCTION

This report documents the condition assessment program conducted at Grindstone Canyon Dam (Dam No. D-513) in Ruidoso, New Mexico. The condition assessment was performed by Yeh and Associates (Yeh) and Hutton Consulting (Hutton) to provide information for the development of concrete repair alternatives for the emergency spillway and north dam crest. The condition assessment was conducted October 4-6. The weather was clear and warm on October 4 and cloudy and rainy on October 5-6.

## Document Review

The following documents were reviewed in preparation for conducting the condition assessment:

1. Grindstone Dam Record Drawings dated December 2, 1987
2. New Mexico Office of State Engineer Dam Safety Inspection Reports dated April 14, 2016; March 3, 2018; and June 21, 2019.
3. Grindstone Dam Completion Report Volume I dated January 14, 1988
4. Grindstone Dam Completion Report Construction Photos Volume II dated June 1986 and July 1987
5. Grindstone Dam Completion Report Volume III, Construction Materials Test Reports, March 1986
6. Grindstone Canyon Dam, Contract Documents and Construction Specifications, June 1985
7. Photos from NMOSE of spillway dated January 1989 and March 1990
8. Photos from VOR of seepage at bottom of spillway, date unknown
9. Photos of repaired vertical crack on spillway downstream face, dated December 12, 1989

# Project Description

## Roller Compacted Concrete Dam

Grindstone Canyon Dam is a 123-foot-high gravity roller-compacted concrete (RCC) structure. The dam is about 1,304 feet long and is oriented close to north/south. The reservoir is located on the western side of the dam. The maximum width of the dam at the base is about 102 feet and the crest width is about 12 feet. A parapet wall approximately 3.8-feet high is located on the upstream side of the north dam crest, and an 8-inch-high concrete curb and 3-foot-high chain link fence are located on the downstream side of the north dam crest. The concrete curb has 1-foot-wide openings for drainage spaced at about 20-foot intervals. The upstream slope of the dam is vertical. The downstream face below the 13-foot high (plus or minus) chimney section is nominally sloped at 0.75H:1V.

## Emergency Spillway

The 100-foot-wide emergency spillway is an ogee-shaped, concrete spillway located near the middle of the dam. The crest is at elevation 6,919.5 feet. The structural height of the spillway is approximately 123 feet. The downstream face of the spillway is sloped at 0.75H:1V (horizontal:vertical). The emergency spillway discharges over the downstream face of the dam into a 100-foot wide by 30-foot long by 3-foot-deep concrete lined stilling basin pool located at the downstream toe of the dam. The stilling basin continues downstream of the pool as a 100-foot-wide rectangular channel with vertical concrete walls, some scattered riprap and earth lined bottom. The emergency spillway discharges to the Grindstone Canyon Channel. The (1987) record drawings indicate the surface of the RCC on the emergency spillway chute was covered with 6-inch thick by 8-foot-high concrete facing panels reinforced with 4x4-4x4 welded wire fabric. The facing panels are anchored to the RCC with #4 hooked bars spaced at 24 inches on centers each way. There are no vertical contraction joints or waterstops in the 100-foot-wide concrete facing panels. The record drawings indicate a ¾-inch tooled chamfer along the horizontal joint between the facing panels. The spillway crest is 12 feet high and constructed of mass concrete with #8 bars spaced at 12-inch centers each way placed 3-inches from the exterior face.

## North Dam Crest

The record drawings indicate a 12-foot-wide reinforced concrete slab was constructed on top of the RCC on the non-overflow north dam crest section. The slab varies in thickness from 12-inches at the upstream edge of the crest to 10-inches at the downstream edge of the crest to create a slope in the downstream direction towards the curbs along the downstream edge. The slab is reinforced with one layer of #4 rebar at approximately 12-inches on center in the longitudinal direction and one layer of #4 rebar at 10-inches on center in the transverse direction. The cover on the reinforcement in the slab varies from 3.5 inches to 3.0 inches, upstream to downstream. A reinforced concrete parapet wall, 8-inches wide by 3.75 feet high, was constructed on the upstream side of the crest. Reinforced concrete curbs, 8-inches high and 14-inches high, were constructed on the downstream edge of the crest. The slab transverse reinforcement extends up into the parapet wall and curbs. The top of the curb is reinforced with 2-#4 rebar in the longitudinal direction. The drawings indicate 12-inch-wide drainage openings in the curbs spaced at 20-feet on centers. Transverse control joints are included in the slab at 16.0 feet on centers and are aligned with the vertical control joints on the upstream and downstream faces of the non-overflow crest section of the dam, except for the two locations shown on the Field Notes Drawing presented in Appendix A.

No records were provided or found regarding repairs to the dam crest since initial construction in 1985.

# Field Inspection and Testing Program

The field investigation program consisted of visual inspection, geology hammer soundings and rotary hammer soundings of the surface of the emergency spillway chute and north dam crest. All of these tasks were supervised by Mr. Gresh Eckrich, Yeh's Senior Project Manager.  Mr.

Chuck Hutton of Hutton Consulting also was on-site to assist in performing the visual inspection and rotary hammer soundings. The inspection of the emergency spillway chute was conducted from a man basket suspended from a crane that could reach all areas of the emergency spillway surface.

## Rotary Hammer Sounding

### *Emergency Spillway Chute Inspection and Testing*

A rotary percussion hammer sounding survey was performed over the surface of the emergency spillway chute and crest.  . The rotary percussion hammer used for the delamination survey is shown in Photo 1.

**Photo 1: Rotary Percussion Hammer**

Yeh and Hutton performed the non-destructive rotary percussion hammer sounding according to ASTM D 4580-12 Standard Practice for Measuring Delaminations in Concrete by Sounding - Procedure C – Rotary Percussion. The rotary hammer included a 10-foot aluminum tube extension. An additional 10-foot aluminum extension was purchased and added to the rotary hammer to extend the reach from the man-basket. The additional extension magnified the sound from the rotary hammer.

Areas found to exhibit soundings of delamination, surface deterioration, spalling, and cracking, including the extent of the affected area, were marked with white spray paint on the concrete surface, when possible, and recorded on a sketch of the spillway (see Photo 2 and Appendix A). All marked areas were located by measuring distances from the spillway training walls and construction joints and formwork lines between the reinforced concrete facing elements constructed on the surface of the spillway chute. Vertical reference lines were marked with blued spray paint. The areas on the spillway exhibiting delamination, spalling, cracking, erosion and deterioration are shown in Plate 1 and listed in the field notes in Appendix A. Photographs of observed conditions are included in Appendix B.

**Photo 2: Grindstone Canyon Dam Spillway (October 5, 2022)**

### *North Dam Crest Inspection and Testing*

A rotary percussion hammer sounding survey also was performed over the surface of the concrete on the north dam crest. Areas found to exhibit soundings of delamination, surface deterioration, and cracking including the extent of the affected area, were marked with white paint, when and where possible, and recorded on sketches of the dam crest. All marked areas were located by measurements from the four survey monuments on the dam crest and the upstream parapet wall. The areas on the north dam crest exhibiting delamination, spalling, cracking and deterioration are shown on Plate 2 and listed in the field notes in Appendix C. Photographs of the observed conditions are included in Appendix D.

## Visual Observations

### *Emergency Spillway*

The concrete placed in the facing elements on the surface of the emergency spillway is two different colors and appeared to consist of two different types of concrete as indicated by the different degree of surface deterioration. The concrete over approximately the upper one-third of the spillway chute is dark grey in color and exhibits surface scaling over the entire area. The concrete over approximately the lower two-thirds of the spillway chute is lighter in color and does not exhibit any significant surface scaling, but does exhibit other forms of deterioration and flaws, such as spalling, erosion, exposed reinforcement and form support inserts as detailed in the following paragraphs and in the field notes. No information was found on the record drawings, construction specifications or in the construction completion reports indicating different concrete was used for the 6-inch-thick facing elements on the spillway chute surface.

The record drawings indicate the facings elements were to e 8 feet high along the spillway slope from the top of the stilling basin to the bottom of the mass concrete at the spillway crest. It was observed that the facing elements vary from 4 to 8 feet high, as shown on Plate 1, instead of the 8-foot high facing elements shown on the record drawings. The record drawings do not indicate any vertical joints in the facing elements.

Seven vertical cracks, up to 1/8 inch wide, were observed extending downward from the horizontal joint at the bottom of the mass concrete crest section. The vertical crack at the centerline of the spillway and the vertical crack at the right quarter point of the spillway extend from the horizontal crack at the bottom of the mass concrete section down to the top of the severely deteriorated facing elements at the bottom of the spillway. These vertical cracks are up to 1/8 inch wide, but no offsets were observed. These vertical cracks are likely due to the absence of vertical joints in the facing elements. Other vertical cracks are located randomly over the surface of the spillway chute, as shown on Plate 1. Horizontal cracks, up to ½ inch wide and 50 feet long, were observed at random locations on the spillway slab face as noted in Appendix A. None of the horizontal cracks extend across the entire width of the spillway or appear to be offset.

Drummy concrete detected by the rotary hammer and geologist hammer soundings indicated shallow delamination along several areas on the spillway crest. Areas of drummy concrete also were detected on the spillway face between the bottom of the mass concrete crest and the bottom of the spillway, where there is a concentration of drummy concrete and evidence of extensive freeze-thaw damage on the facing elements. This freeze-thaw damage was likely due to the extensive seepage that occurred in this area of the spillway immediately following filling of the reservoir and before any seepage mitigation work was completed. The erosion of concrete damaged by freeze-thaw has resulted in an eroded surface up to approximately 4 inches below the adjacent, undamaged spillway surface (see Photo 23).

The sealant smeared on the vertical crack on the downstream face of the spillway in December 1989 has failed and is peeling off of the concrete. It appears this crack was not prepared properly prior to installation of the sealant.

Spalling was observed at several of the joints between the facing elements. In addition, surface erosion was observed on the spillway slab and training walls at several locations on the spillway. Also, several rusted form support inserts and rebars were observed exposed on the spillway surface as indicated in the photographs in Appendix B. The concrete has spalled around some of the exposed form support inserts resulting in a conical depression in the spillway surface. Voids due to poor consolidation of the concrete were observed along the horizontal joint at the bottom of the facing elements at multiple locations, particularly in the bottom facing elements, just above the stilling basin.

An approximately 4-inch by 3-foot piece of lumber was observed embedded in the concrete surface near the left side of the spillway about one-third of the distance from the bottom of the spillway (see note 16 on Plate 1). Previous observations during routine inspections indicated this was an exposed rebar. A photograph of the piece of lumber is included in Appendix B.

Extensive concrete erosion up to 2.5 inches deep was observed along the horizontal joint between the facing elements at the bottom of the spillway, just above the stilling basin pool. The welded wire fabric reinforcement in the facing elements is exposed in at least three locations along this joint. Drummy concrete also was identified in several areas below this joint. This erosion was likely due to seepage through the joint and freeze-thaw damage immediately following construction and filling of the reservoir. A January 1989 photograph shows extensive seepage and formation of ice on this lower part of the spillway (see Photo 3).


**Photo 3: January 1989 Photo of Lower Right Spillway Surface**

Nine areas of active seepage through the facing elements was observed along the bottom of the spillway just above the top of the stilling basin. Operating staff reported that the seepage increases during the winter, probably due to lower temperatures causing contraction of the concrete and opening of the cracks and joints.

All of the observed concrete deficiencies are shown on Plate 1 and described in the field notes in Appendix A and shown in the photographs in Appendix B.

### *North Dam Crest*

The concrete placed on the dam crest is two different colors and appears to consist of two different types of concrete as indicated by the different degree of surface deterioration. The concrete from Station 7+84 to Station 10+84 is dark grey in color and exhibits surface scaling over the entire area. Drummy concrete also was identified at numerous random locations throughout this area of the dam crest. The concrete from Station 7+60 to 7+84 on the south end of the north dam crest and from Station 10+84 to Station 16+34 on the north end of the north dam crest is lighter in color and does not exhibit significant surface scaling. No information was found on the record drawings or in the construction completion reports indicating different concrete was used in the different sections of the dam crest. A thin layer of deteriorated concrete will need to be removed from the dam crest from Station 7+84 to Station 10+84 and replaced with a new thin overlay and protective coating.

Concrete spalling and exposed reinforcement were observed on curbs 17 and curbs 23 through 29 and they will need to be repaired or replaced. Severe concrete deterioration was observed on curbs 38 through 45, on the far north end of the north dam crest, and these curbs will need to be replaced.

Six rusted reinforcing bars about 18 inches long, spaced 10 inches on centers, were observed at the surface at Station 7+84. This reinforcement is not shown on any of the drawings provided by the VOR or NMOSE. The purpose, exact length and number of reinforcing bars are unknown. There is another small group of similar reinforcing bars embedded in the surface a short distance north of Station 7+84. These reinforcing bars will need to be removed to replace the deteriorated concrete on the dam crest.

Transverse cracking and small areas of drummy concrete and delamination were observed in the dam crest at Stations 11+92, 12+10 and 13+22. The crack at Station 13+22 was previously caulked with sealant.

The transverse control joints in the dam crest are 16 feet apart, except at Station 9+39 where the joints are spaced approximately 16.8 feet, 10 inches apart, from Station 10+22 to 10+34, where the joints are spaced at 14 feet and 18 feet and at Station 10+84 where the joint spacing is 15 feet.

Ponding was observed against the curbs over the entire length of the north dam crest and may contribute to some of the deterioration and delamination.

The areas of surface spalling, erosion, delamination, deterioration, and cracking are described in the field notes and on Plate 2, and shown in the photographs in Appendix D.

# Conclusions

## Emergency Spillway

Based on the results from the field investigations, the following conclusions can be made regarding the condition of the emergency spillway concrete:

1. Extensive severe surface scaling and a different color of concrete was observed on the upper one-third of the spillway compared to the lower two-thirds.
2. The rotary hammer soundings identified multiple areas with potential near surface delamination on the spillway chute. Sounding with a hand-held geologist hammer confirmed the potential near surface delamination areas identified with the rotary hammer. The observed depth of surface delamination on the spillway chute varies from about 1/8-inch to 2-inches.
3. The facing elements on the spillway appear to be typically spaced at 6 feet instead of the 8-foot spacing shown on the record drawings.
4. The facing elements do not include vertical joints. Vertical cracks were observed on the facing elements at a horizontal spacing of approximately 25 feet.
5. Spalling was observed at multiple locations on the horizontal joints between facing elements and at the intersection of vertical cracks with the horizontal joints.
6. Poor consolidation with exposed aggregate was observed at multiple locations on the spillway slab and training walls.
7. Rusted form support inserts and reinforcing bars were observed exposed on the surface of the spillway facing elements.
8. Voids due to poor consolidation of the concrete were observed at multiple locations along the bottom of the horizontal joints between the facing elements.
9. An approximately 4-inch by 3-foot piece of lumber was observed embedded in the surface of the spillway slab.
10. Extensive concrete erosion was observed along the horizontal joint between the facing elements at the bottom of the spillway, just above the stilling basin pool.
11. Multiple areas of active seepage were observed through the facing elements along the bottom of the spillway just above the stilling basin pool.
12. All of the concrete deterioration detailed above should be considered for repair.

## North Dam Crest

Based on the results from the field investigations, the following conclusions can be made regarding the condition of the north dam crest.

1. Extensive severe surface scaling and a different color of concrete was observed on the dam crest from approximately Station 7+84 to Station 10+84. Drummy concrete indicating shallow delamination was observed at numerous random locations throughout this area.
2. The concrete on the dam crest from approximately Station 7+60 to 7+84 and Station 10+84 to 16+34 was observed to be a lighter color and did not exhibit surface scaling.

3. Moderate concrete scaling and exposed rusted reinforcement were observed on curbs 17 and 23 through 29 and they need to be considered for repair.

4. Very severe concrete scaling and exposed rusted reinforcement was observed on curbs 38 through 45 at the far north end of the north dam crest and they need to be replaced.

5. Exposed and rusted reinforcement was observed at the surface of the slab at about Station 7+84.

6. Transverse cracking and drummy concrete was observed at approximately Stations 11+92, 12+10 and 13+22.

7. All of the concrete deterioration detailed above should be considered for repair.

## References


1. ASTM D4580-12 Standard Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding
2. ACI 201.1 R-92 Guide for Making a Condition Survey of Concrete in Service
3. US Army Corps of Engineers EM 1110-2-2002 Evaluation and Repair of Concrete Structures

# Appendix A: SPILLWAY OBSERVATIONS AND MEASUREMENTS

GRINDSTONE DAM SPILLWAY ASSESSMENT FIELD NOTES

1. Cracks on surface; width varies; up to ~1/8” wide; appear to terminate at bottom of mass concrete.
2. Horizontal crack in surface, width varies, up to ~ ½” wide ; up to ~ 1: deep; needs repair.
3. Drummy area; up to ~1/2” deep.
4. Horizontal crack; width varies up to ~2”; depth up to 1.5”; needs repair.
5. Vertical crack; width varies; appears to have been previously repaired w/ surface caulk.
6. Drummy area; up to ~ 1” deep; needs repair; ~2’ tall x ~12’ wide.
7. Drummy area; up to ~1” deep; previously (and poorly) repaired.
8. Apparent cuts in concrete; ~18” tall x 8” wide; up to ~1” deep.
9. Spalling; up to ~ ¾” deep.
10. Spalling at joint; up to ~2” wide; up to ~1” deep; appears to be transverse joint for mass concrete; needs repair.
11. Spalling at joint or crack; up to ~2” wide; up to ~1” deep; needs repair.
12. Spalling at joint; up to ~3” wide; upt to ~2.5” deep; needs repair.
13. Open joint; some spalling; up to 2” wide; up to ~1” deep; may need repair.
14. Surface void in concrete; ~2” x 2”; up to 1” deep; may need repair.
15. Steel form ties; rusted; spalling up to 1.5” deep; four locations ~3” center-to-center; may need repair.
16. Rotted lumber embedded in spillway surface; needs repair.
17. Poor consolidation at joint; voids up to ~1/2” deep; may need repair.
18. Intersection of vertical crack & horizontal joint; up to ~1/2” deep; may need repair.
19. Horizontal joint with exposed aggregate & possibly rusted steel; voids up to ~1” deep; likely needs repair.
20. Spalling at horizontal crack or joint; up to ~1.5” wide; up to ~3/4” deep; width varies; likely needs repair.
21. Horizontal joint; poor consolidation; voids up to ½” deep; voids vary in length; may need repair.
22. Exposed rebar; ~11” exposed; oriented horizontally parallel to surface; may need repair.
23. Poor consolidation along horizontal joint; up to ~1” wide; up to ~3/4” deep; may need repair.
24. Poor consolidation along horizontal joint (rock pocket); up to 1” deep; may need repair.
25. Transition from relatively good concrete to deteriorated concrete (freeze-thaw damage); up to 2.5” offset between surfaces; formwork lines visible on deteriorated concrete original surface; drummy area ~2’x12” located ~3’ from right training wall; aggregate up to ~1”; needs repair.
26. Exposed welded wire mesh; ~2.5” to 4” below apparent original surface; needs repair.
27. Exposed rebar at surface; ~1”x1” void around bar; may need repair.
28. Spalling along vertical crack; up to ~4” wide; ~7” tall; up to ~1/2” deep; may need repair.
29. Spalling along vertical crack; up to ~2” wide; up to ~1/2” deep; may need repair.

30. Spalling along horizontal joint; intersection with vertical crack; up to 4” wide; up to ~1” deep; may need repair.
31. Thin (<1/8”) concrete layer; likely from formwork above leaking during construction.
32. Eroded concrete areas (from freeze-thaw); up to 8” wide; up to ~1.5” deep; spalling concrete; needs repair.
33. Eroded concrete along horizontal joint; up to ~6” wide; up to ~1.5” deep; needs repair.
34. Active seeps at horizontal joint; Brent (VOR) notes flow appears to increase in winter; possibly due to concrete contraction; needs to be considered for repair.

Note: Numbers in the list above correspond to the numbers in circles on Plate 1.

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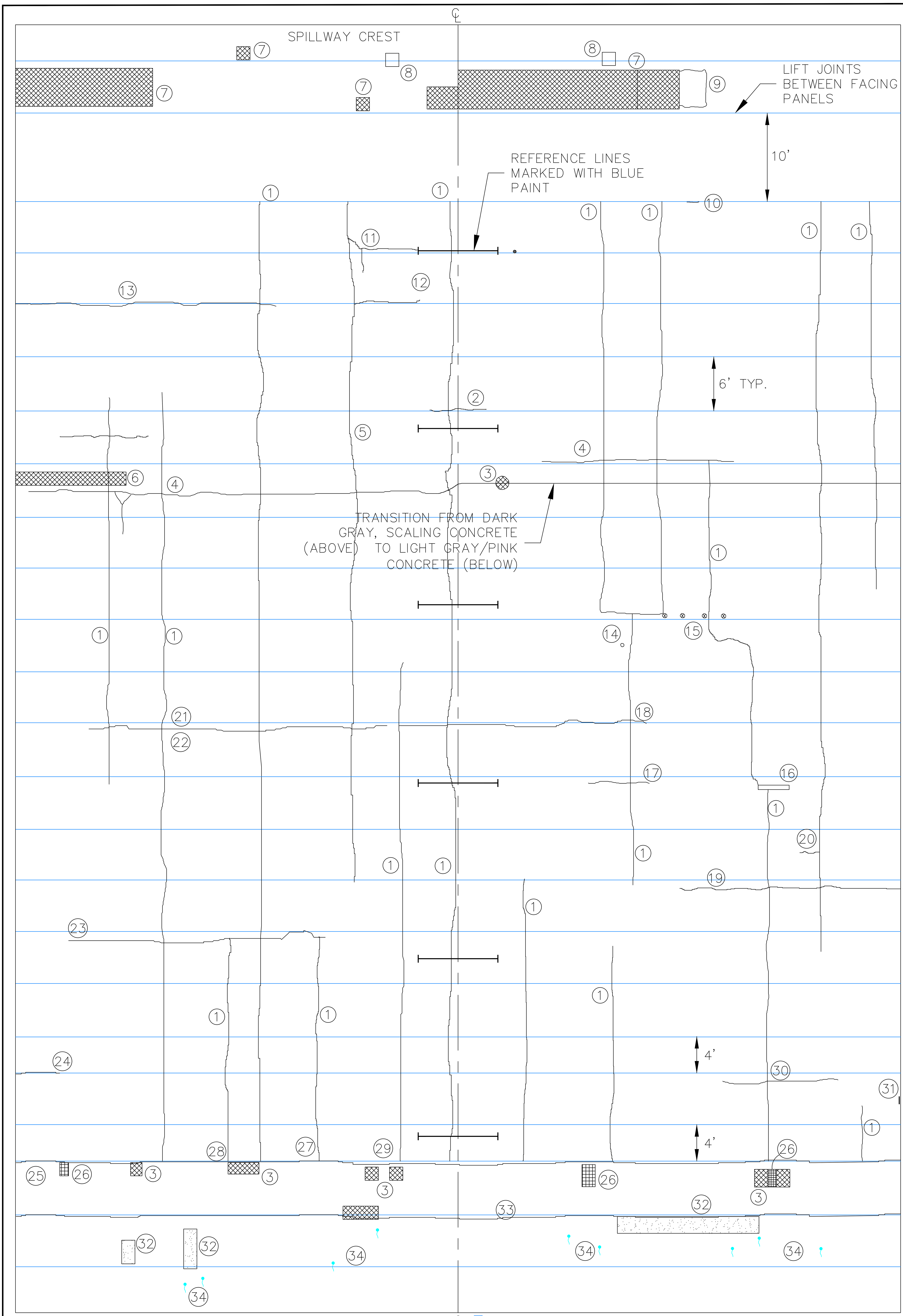



LEGEND

3 DRUMMY AREA   26 EXPOSED WELDED WIRE MESH   32 ERODED AREAS

| Yeh and Associates, Inc. Geotechnical • Geological • Construction Services | EMERGENCY SPILLWAY FRONT FACE ELEVATION | PROJECT NAME: GRINDSTONE CANYON DAM CONCRETE ASSESMENT | PROJECT NUMBER: 219-218 | REVISION DATE: | PLATE 1 |
|---|---|---|---|---|---|

# Appendix B: SPILLWAY PHOTOGRAPHS

**Photo 4: Emergency spillway**

**Photo 5: Dam crest drummy concrete surface delamination**

**Photo 6: Delaminated areas on spillway crest**

**Photo 7: Failed crack repair (Field Note 5)**

**Photo 8: Spalling at vertical crack on spillway**

**Photo 9: Spalling at horizontal joint on spillway**

**Photo 10: Rebar exposed on spillway concrete surface (Field Note 22)**

**Photo 11: Deterioration and spalling at vertical joint on spillway surface.**

**Photo 12: Poor consolidation and cracking on spillway left training wall**

**Photo 13: Wood embedded in concrete surface**

**Photo 14: Poor consolidation at horizontal joint between facing panels**

**Photo 15: Exposed welded wire fabric at top of third facing element above bottom of spillway**

**Photo 16: Exposed welded wire fabric at top of third facing element above bottom of spillway**

**Photo 17: Erosion on concrete surface on lower facing elements**

**Photo 18: Exposed and rusted form support insert on spillway surface**

**Photo 19: Spalling at embedded form insert on spillway**

**Photo 20: Deteriorated facing panels on bottom of spillway**

**Photo 21: Deteriorated and delaminated areas on spillway lower facing elements**

**Photo 22: Deteriorated facing elements at bottom of spillway (note horizontal form lines)**

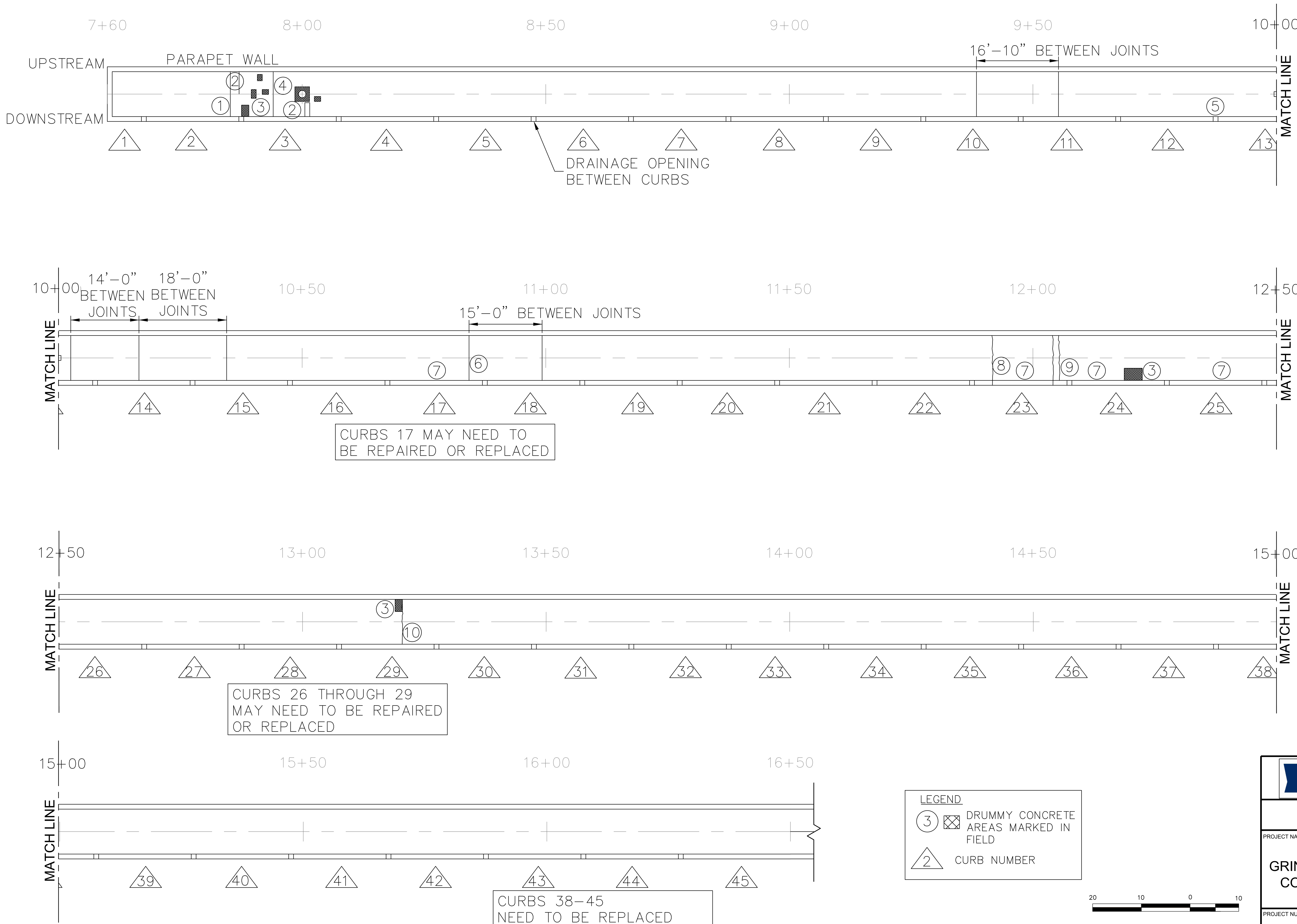
**Photo 23: Depth of erosion at top of third facing element above bottom of spillway**

# Appendix C: NORTH DAM CREST OBSERVATIONS AND MEASUREMENTS

GRINDSTONE DAM
NORTH DAM CREST CONDITION ASSESSMENT FIELD NOTES

1. Transition from good concrete to deteriorated concrete; deteriorated surface up to ½” below apparent original surface
2. Rusted rebar exposed at surface; spaced at 10”; ½” below original surface
3. Some drummy concrete areas marked in field; need repair
4. Horizontal transverse joint in deteriorated concrete; typical spacing 16’ (aligned w/ joints on downstream face); exceptions to typical spacing are noted on the drawing
5. Exposed rebar on curbs 12 and 13; exposed rebar between most curbs
6. Transition from deteriorated concrete to good concrete; drummy concrete areas randomly located throughout deteriorated concrete area
7. Southern most curb in need of repair (curb 17), also repair or replace curbs 23, 24, 25, 27, 28, and 29; repair could replace 8” height, 3” width, 19’ length.
8. Crack in concrete; up to 6” long, up to ½” wide; crack persists through curb.
9. Crack in concrete; up to 24” long; less than 1/8” wide.
10. Crack in concrete up to 1/2'” long; up to ¼” wide; previously sealed.

Note: Numbers in the list above correspond to the numbers in circles on Plate 2.




Yeh and Associates, Inc.
Geotechnical • Geological • Construction Services

NORTH DAM CREST PLAN

PROJECT NAME:
GRINDSTONE CANYON DAM CONCRETE ASSESMENT

PLATE
2

PROJECT NUMBER: 219-218

REVISION DATE:

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# APPENDIX D: NORTH DAM CREST PHOTOGRAPHS

**Photo 24: Rebar embedded at surface on south end of north dam crest**

**Photo 25: Deteriorated curb and exposed rebar on dam crest**

**Photo 26: Severely deteriorated curbs at north end of north dam crest**

**Photo 27: Deteriorated curb on north end of north dam crest**

**Photo 28: Severely deteriorated curbs and ponding on north end of north dam crest**

**Photo 29: Delamination and cracking on dam crest, note previous caulking of crack with sealant**

**Photo 30: Delamination and cracking on dam crest**

**Photo 31: Exposed rebar along side of curb on dam crest**

**Photo 32: Ponding at curbs on dam crest**

**Photo 33: Change from severely deteriorated curb to non-deteriorated curb on dam crest**

**Photo 34: Deteriorated concrete surface on dam crest**

**Photo 35: Transition from good to deteriorated concrete at south end of north dam crest**

**Photo 36: Transition from deteriorated concrete to good concrete on the dam crest.**