

# Staff Report

for the Regular Meeting of the Board of Directors, July 12, 2017

**TO:** Board of Directors

**FROM:** Gary D. King PE, PhD, Engineering Manager  
Doug Roderick PE, Senior Engineer

**DATE:** July 3, 2017

**SUBJECT:** Centennial Reservoir Project – Phase III Geotechnical Investigation  
(FATR # 7013) – Informational Item

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## ***ENGINEERING***

### **RECOMMENDATION:**

Discuss the results of Phase III of the Preliminary Geotechnical Investigation

### **BACKGROUND:**

AECOM has completed Phase III of the preliminary geotechnical investigation for the Centennial Reservoir project. Phase III field work included additional seismic refraction surveys, core borings and geophysical testing located along the axis 2 alignment. AECOM has also developed conceptual design and revised opinion of probable cost.

AECOM staff will make a presentation of the findings/recommendations from the Phase III geotechnical investigation, including conceptual design and revised costs.

Staff will have the final Phase III Preliminary Geotechnical Report available for public review on the project website, [www.centennialreservoir.org](http://www.centennialreservoir.org) shortly after the board meeting.

### **BUDGETARY IMPACT:**

None

### **Attachments:**

Power Point Presentation

GDK/DR

A 3D perspective rendering of a dam and reservoir. The dam is a grey, multi-bay structure spanning a valley. The reservoir is a large body of teal water behind the dam. The surrounding landscape is green and hilly, with a blue river or stream visible in the distance. The text is overlaid in yellow on the teal water.

# Nevada Irrigation District Centennial Reservoir Project Draft Conceptual Engineering Report

July 12, 2017



**AECOM**

# Agenda

Ø Alternative Selection

Ø Dam Foundation and Rock Borrow Area Characterization

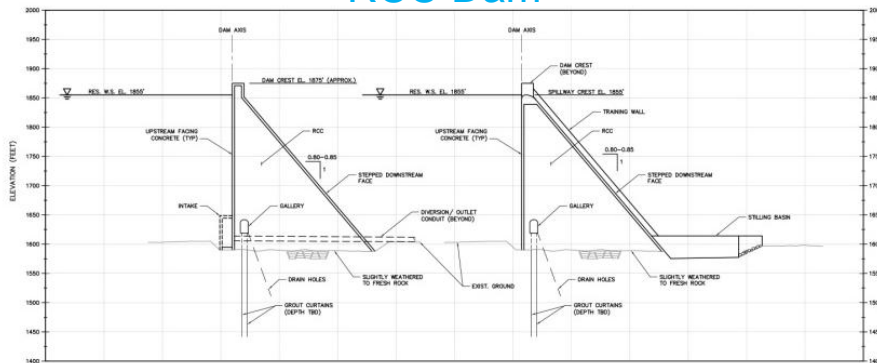
Ø Dam and Appurtenant Works

Ø Construction Schedule and Cost Estimate

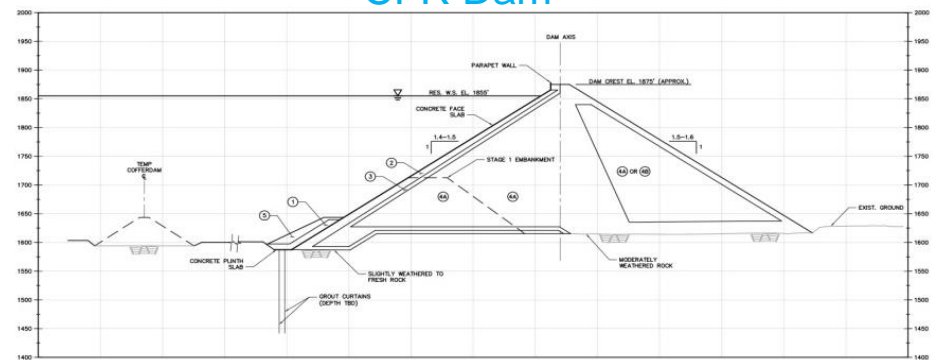
## Selection of RCC Dam at Axis 2

- Considered roller compacted concrete (RCC) dam and concrete face rockfill (CFR) dam at Axes 2 & 6
  - RCC dam alternative at Axis 2 has lowest expected construction cost of alternatives.
  - RCC dam could be constructed in less time than a CFR dam.
  - RCC dam more capable of withstanding flood overtopping during construction than CFR dam.
  - Axis 2 would have a 3-foot lower reservoir elevation than for Axis 6 to store 110,000 acre-feet.
    - Lower reservoir elevation would reduce level of inundation around reservoir
- RCC dam at Axis 2 carried forward to design.

RCC Dam

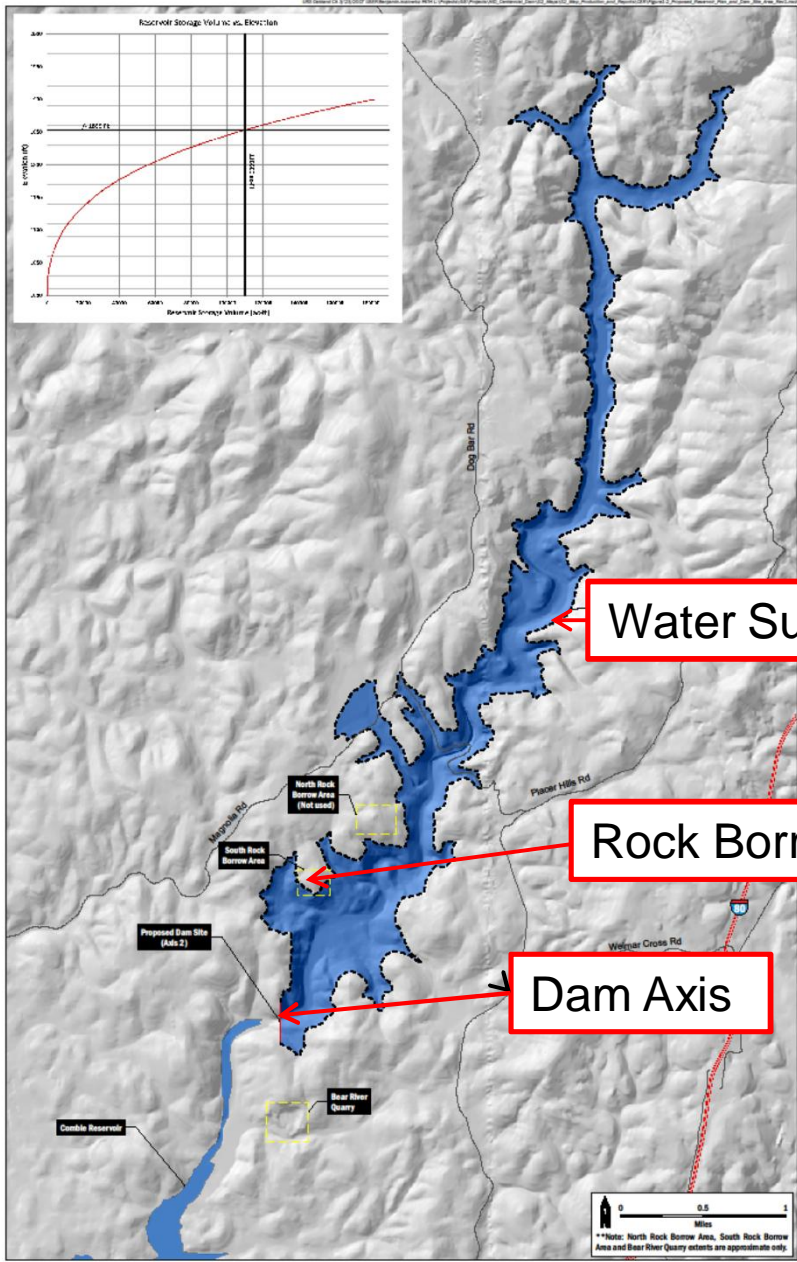


CFR Dam



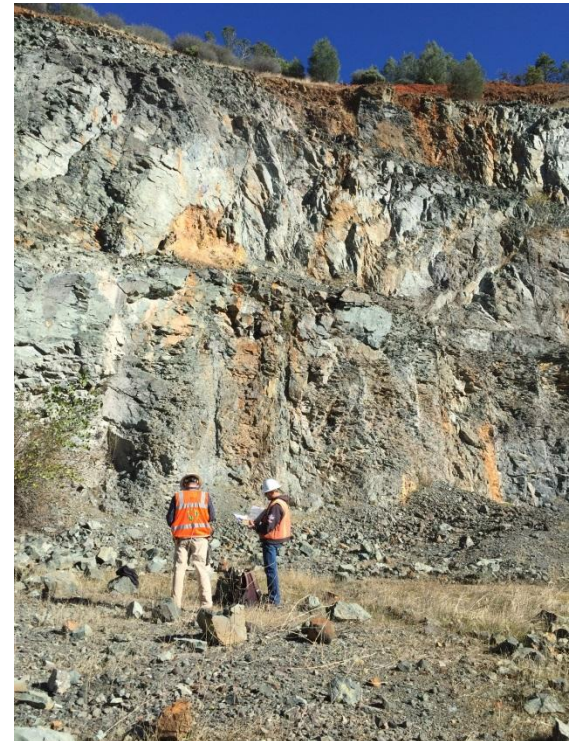


# Proposed Reservoir and Dam Axis Location



## Dam Foundation and Rock Borrow Area

- Summary of site investigation activities
- Geotechnical conditions at Dam Site
- Geotechnical conditions at South Rock Borrow Area



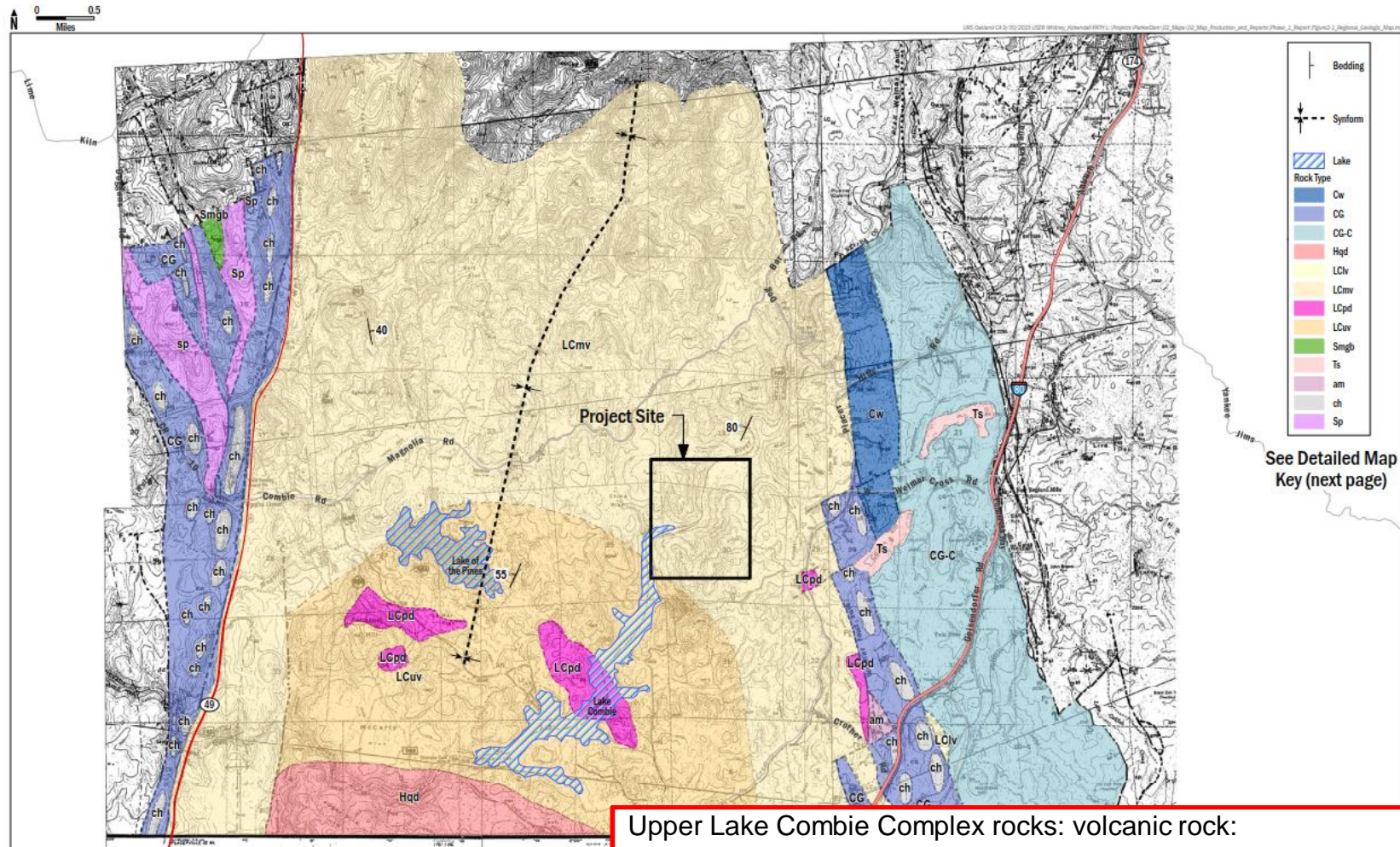


## Summary of Field Investigations

- Three phases of investigations:
  - Phase I: 2015
  - Phase II: 2015
  - Phase III: 2016
- Geologic mapping
- Seismic refraction surveys
- Core borings
- Hydraulic conductivity testing
- Bore hole geophysical surveys
- Rock strength testing

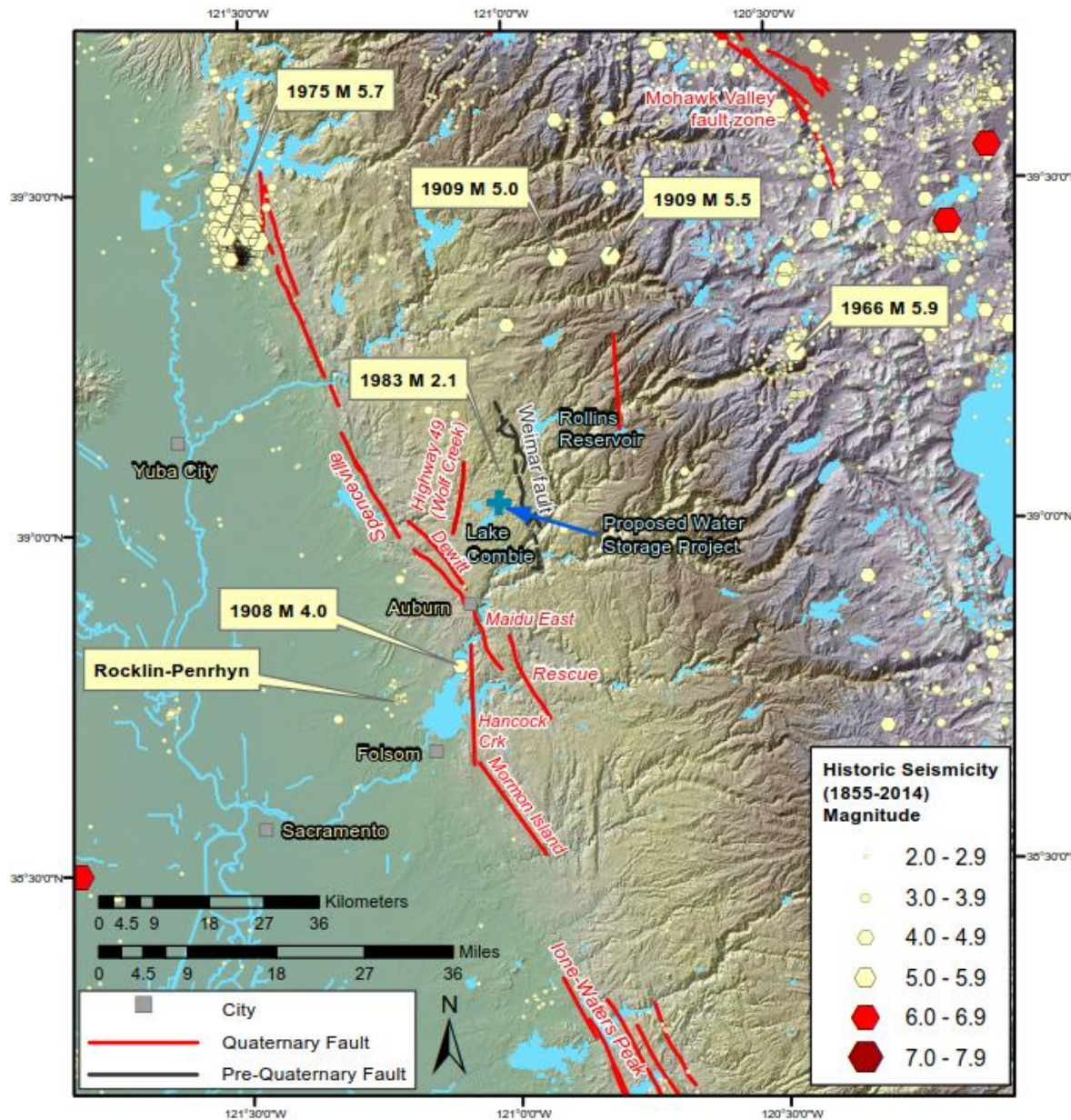


# Regional Geologic Map





# Historical Seismicity and Regional Fault Map



# Geologic Mapping

- Mapping of rock outcrops, alluvium and landslides
- Evaluation of photo lineaments
- Developed plans for seismic line and boring locations
- Confirmed regional geologic mapping



Strike (Degrees Az.)	Dip (Degrees)	Discontinuity Type	No. of Data points
120-130	12 SW	Bedding	25
8-20	80 E	Joint Set 1	37
277-292	85 N	Joint Set 2	29



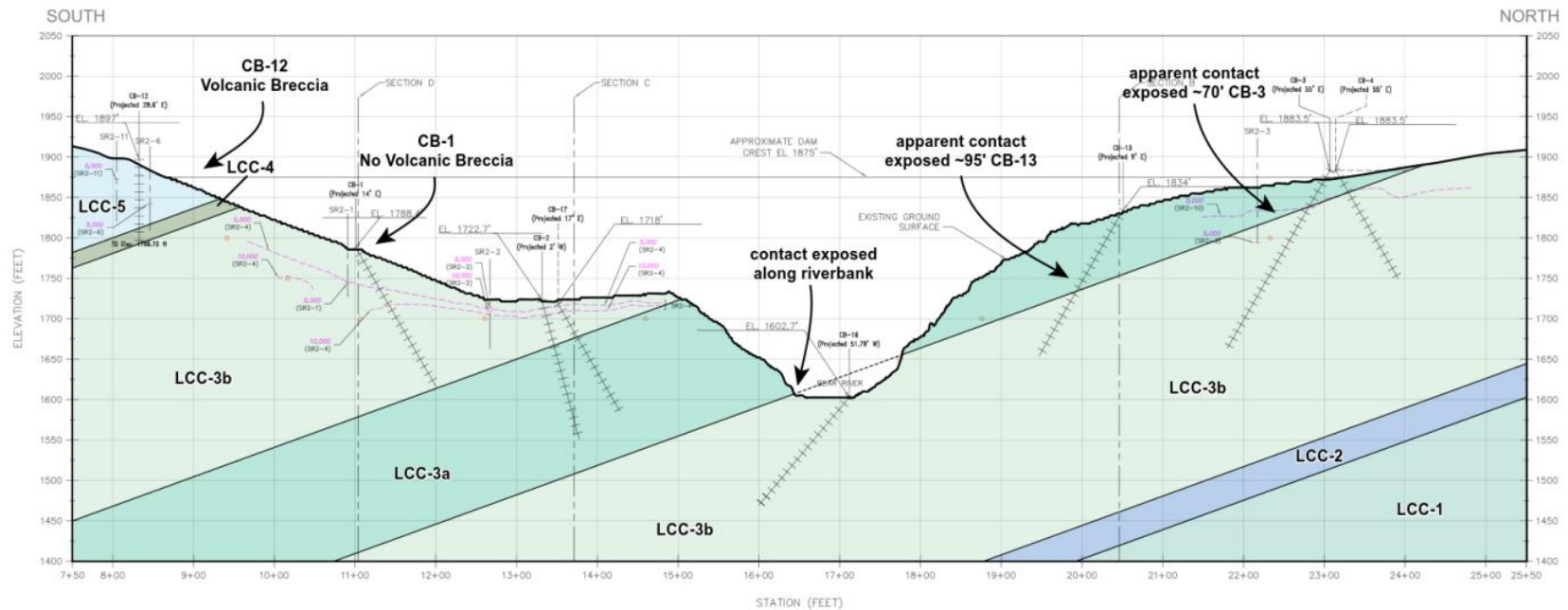


# Independent Evaluation of Potential for Active Faulting

## Conclusions

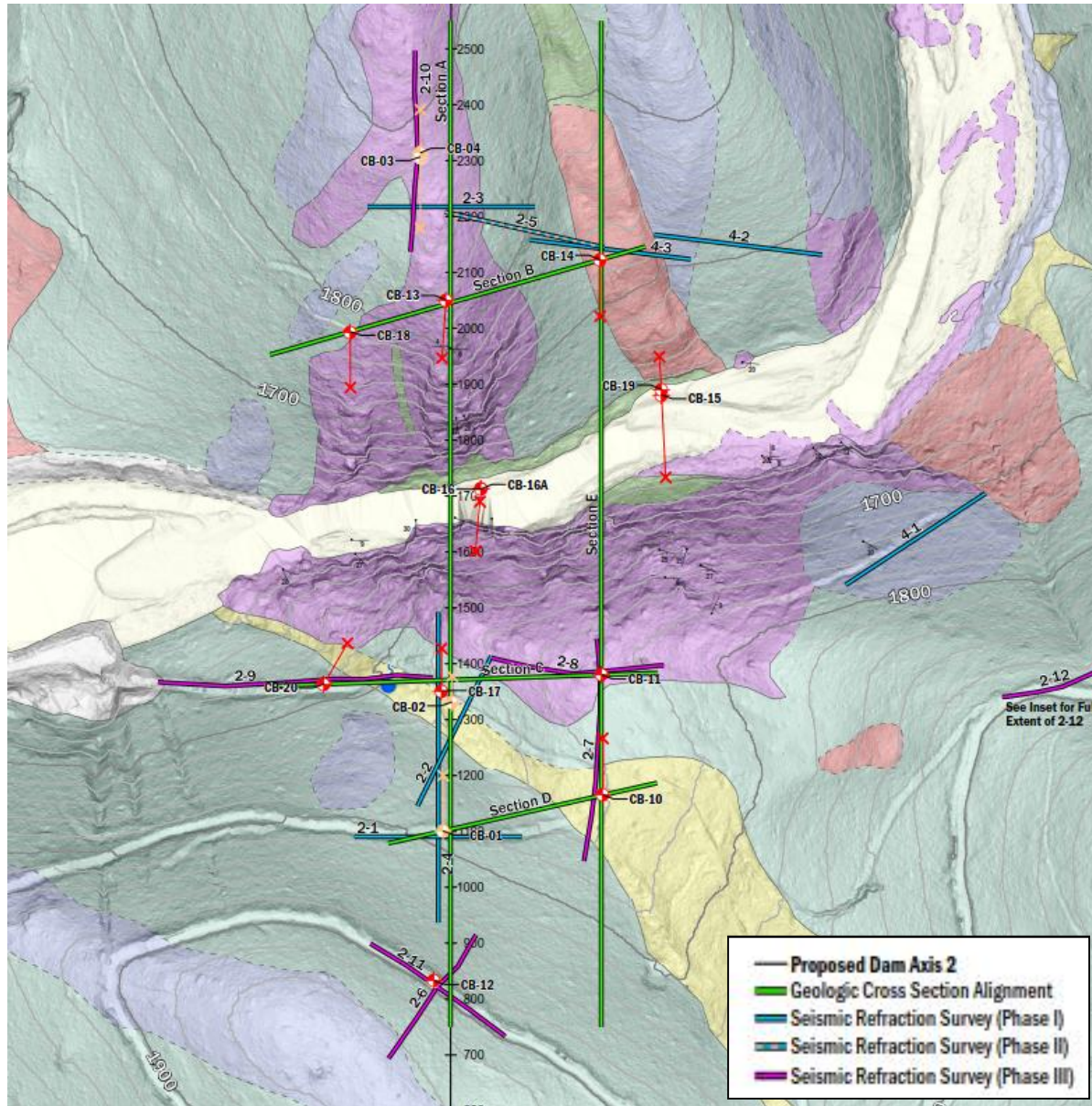


- Lack of positive evidence of active faulting at Axis 2 site.
- Stratigraphy near Axis 2 site appears to be consistent across the river.
  - Absence of vertical separation of contacts supports conclusion that faulting is not present.

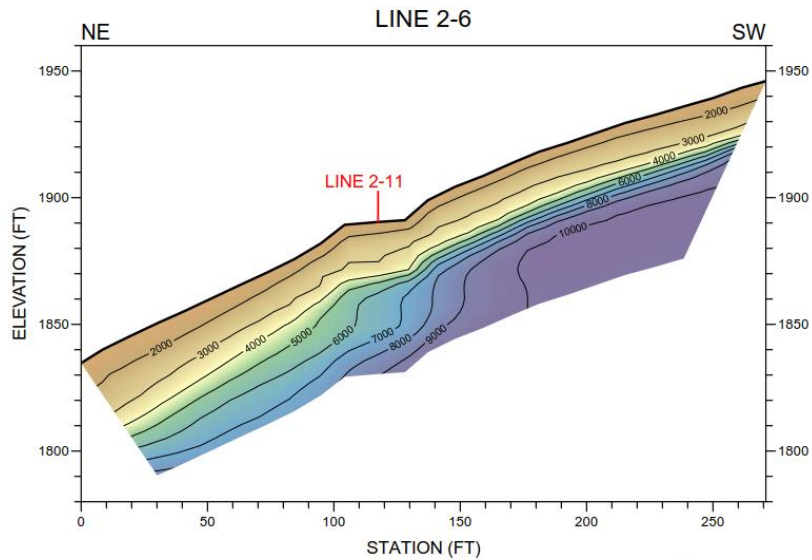




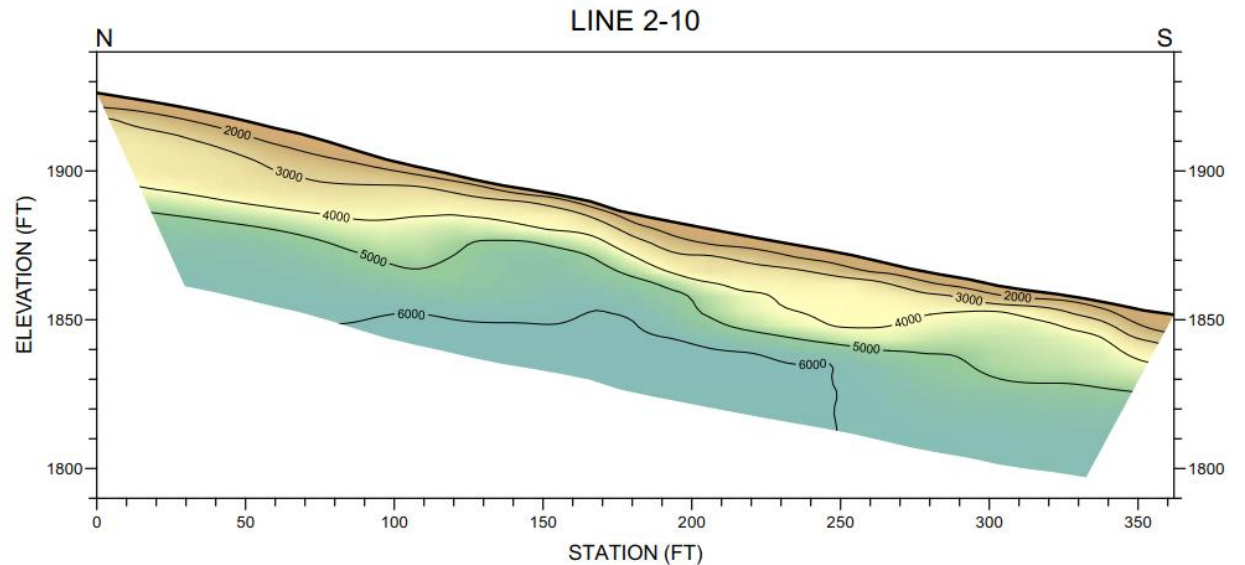
# Site Exploration Map – Seismic Refraction Surveys



# Surface Geophysical Surveys



- 15 seismic refraction survey lines at Axis 2 site
- Close confirmation with bore hole data





## Geotechnical Drilling Investigation – Axis 2

- 16 core borings
  - 2 vertical
  - 14 inclined
  - Up to 254 feet deep
  - Total drilling 2715 feet
- Water pressure (packer) testing
- Televiwer and caliper logging
- Downhole seismic velocities
- Rock strength testing



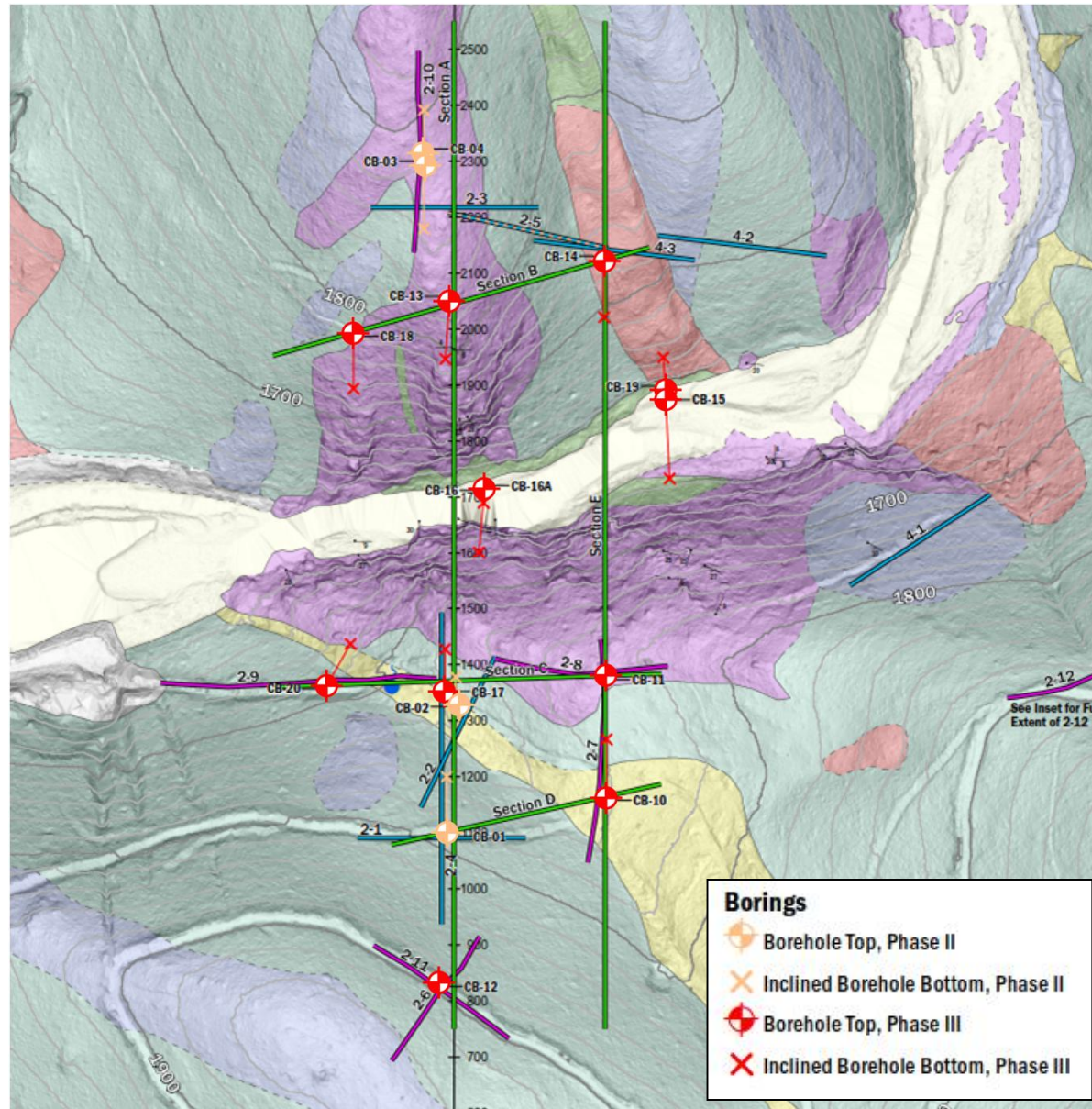


## Boring CB-15 on Bear River

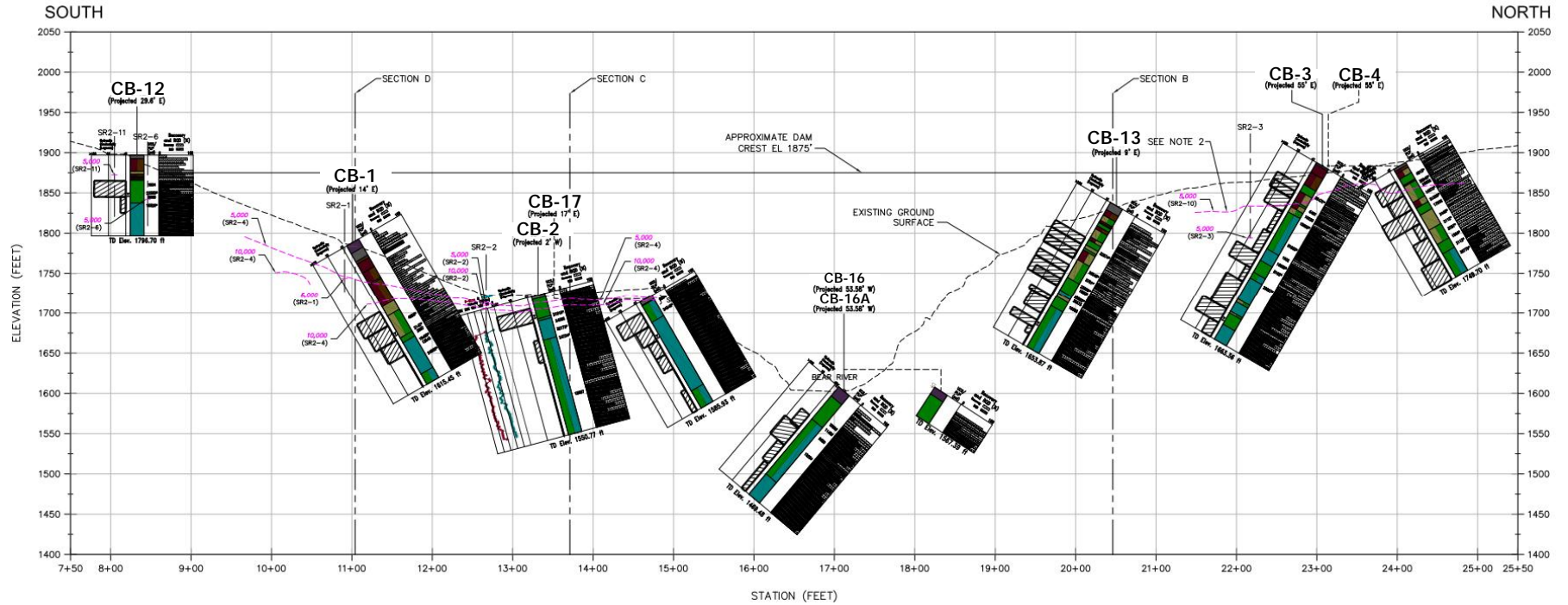




# Site Exploration Map - Borings

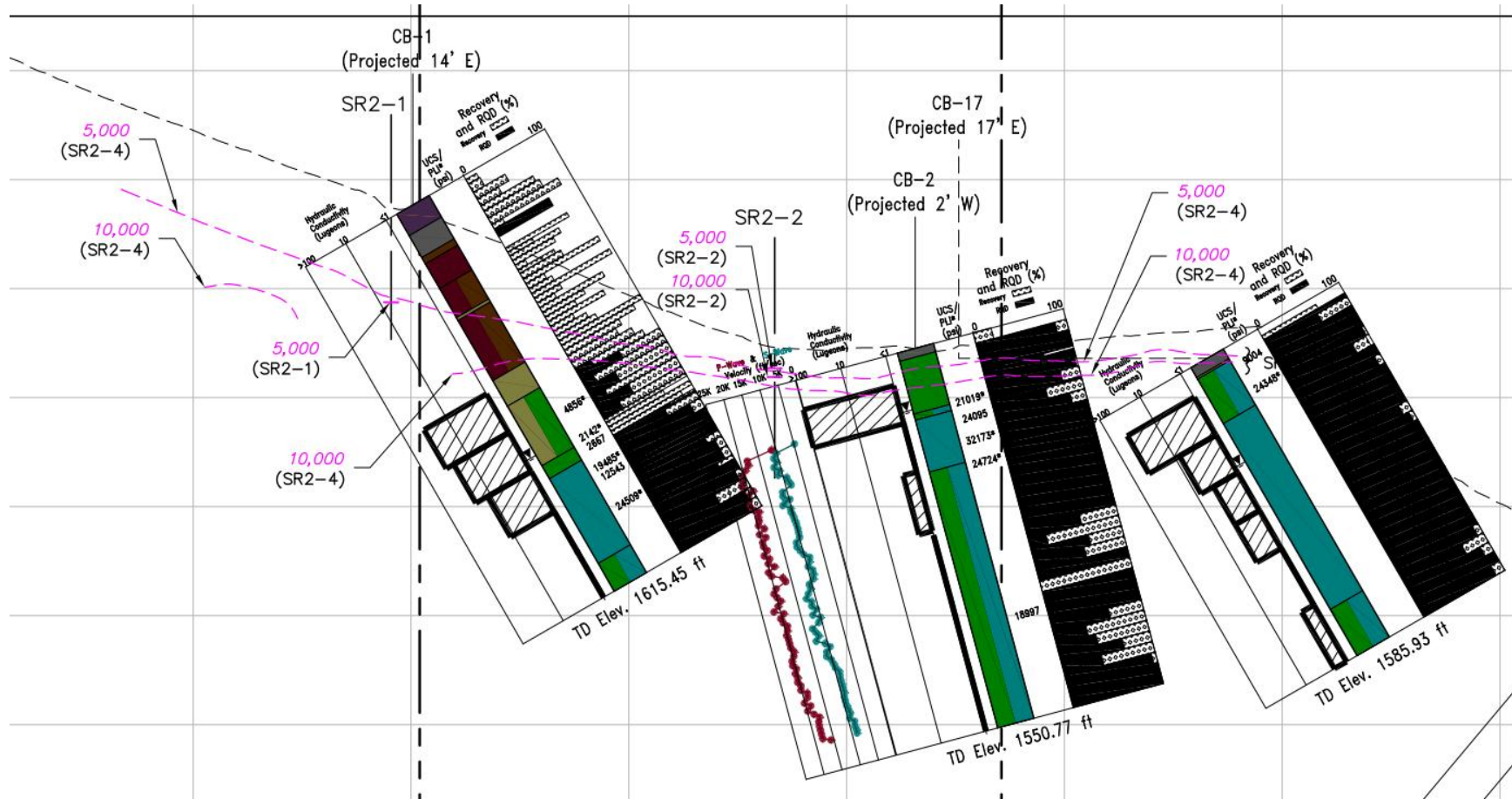


# Geotechnical Profile - Axis 2



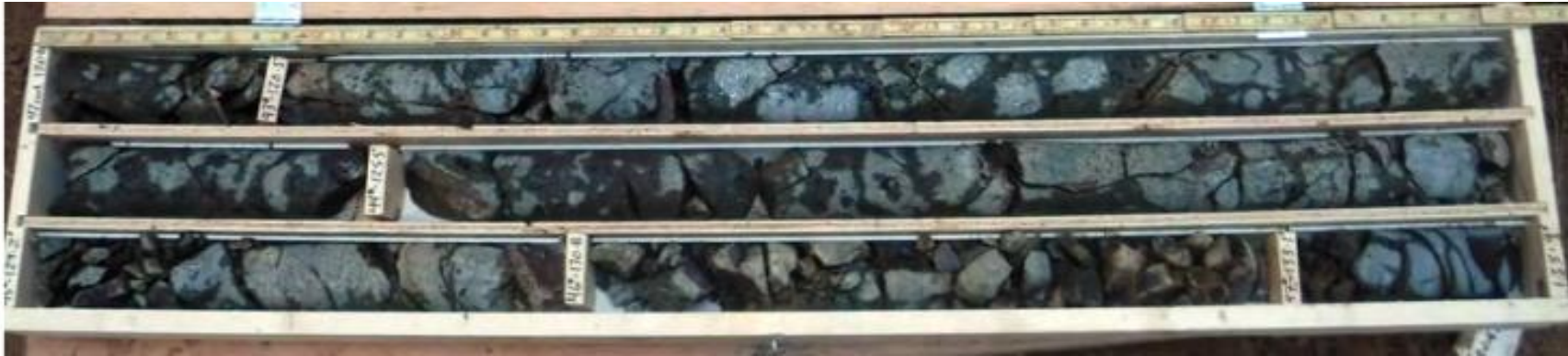


# Detail of Exploratory Boring “Stick Logs”



## Core Boring Sample: south (left) abutment

CB-1, 120.0 – 133.9 ft.



CB-1, 133.9 – 147.5 ft.

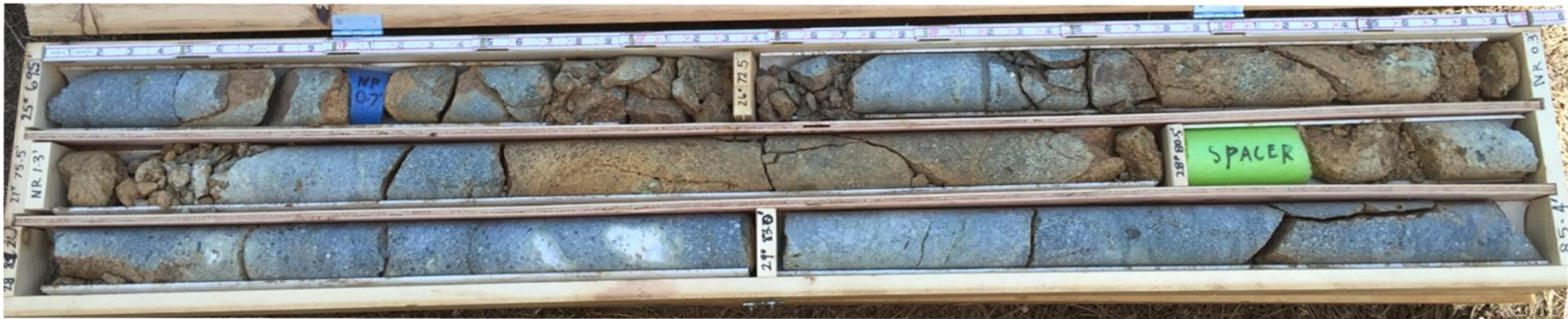


∅ Weathering and fracturing decrease with depth

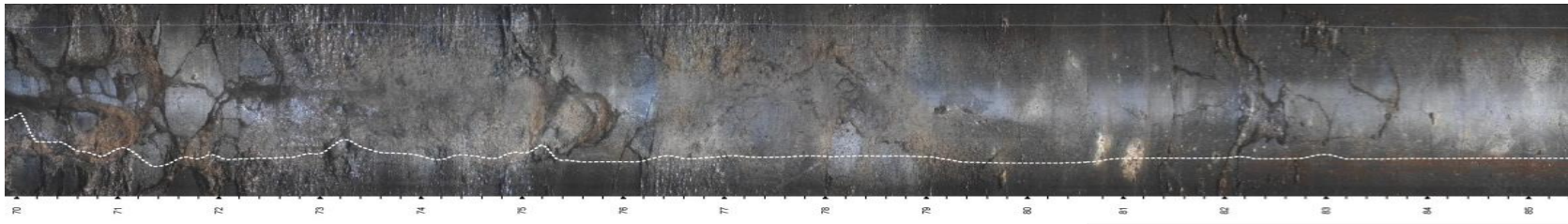


# Rock Core and Televiwer Log: north (right) abutment

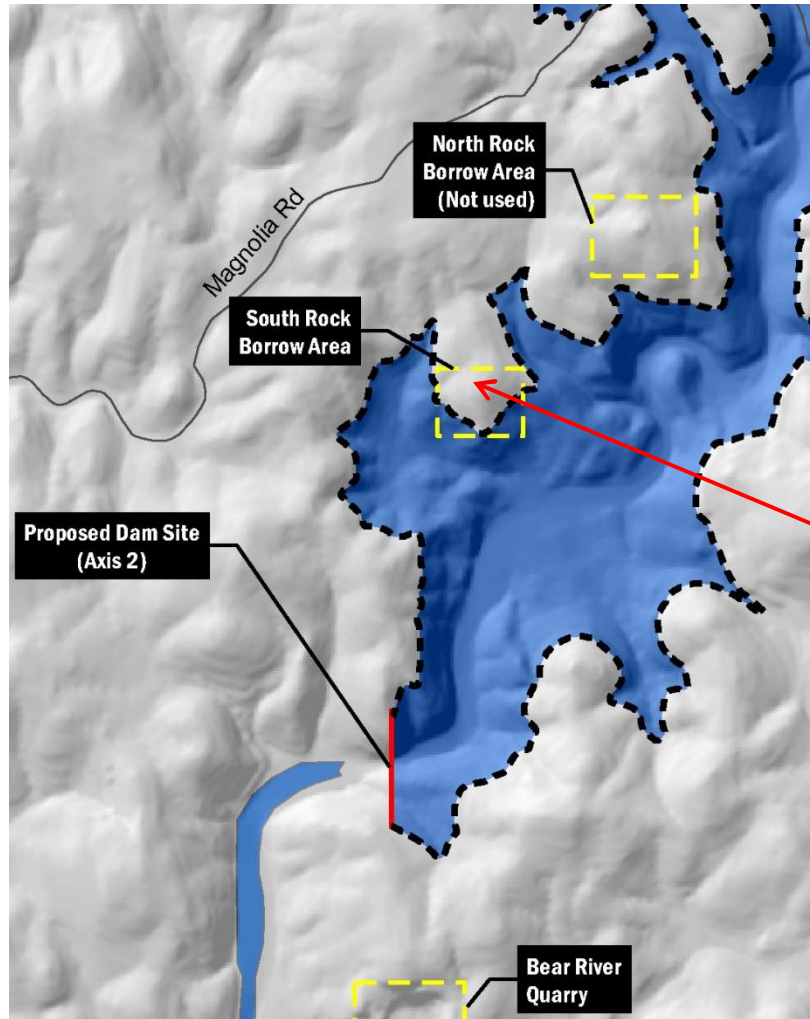
Rock Core: CB-13, 69.5 – 85.4 ft.



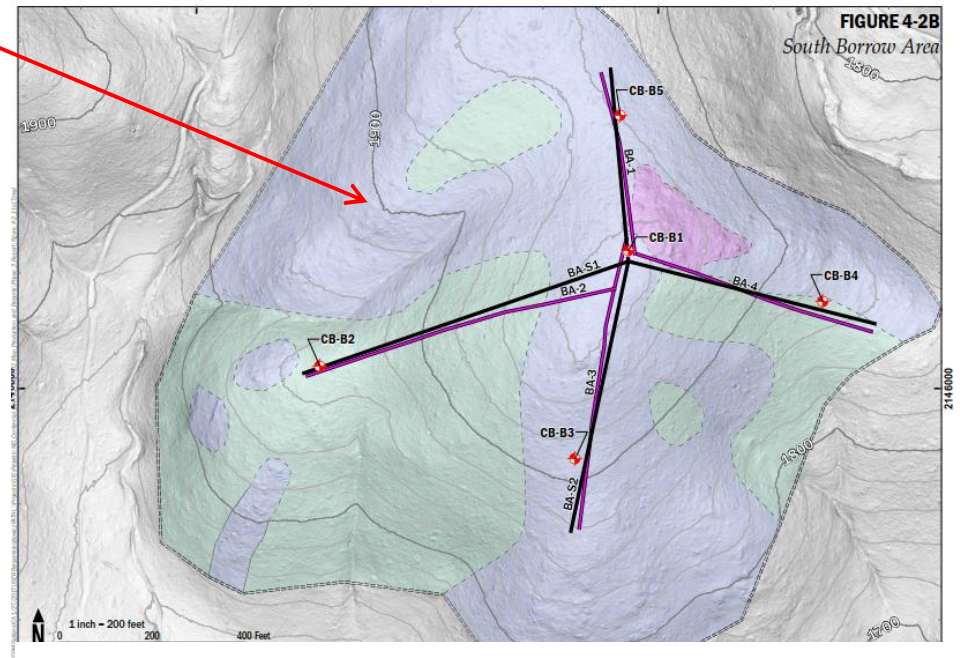
Optical Televiwer Log: CB-13, 69.5 – 85.4 ft.



# Potential Rock Borrow Area Investigation



- Geologic mapping
- Seismic refraction surveys
- 5 core borings totaling 585 feet
- Downhole seismic velocities
- 2 piezometers
- Rock strength testing
- Durability testing

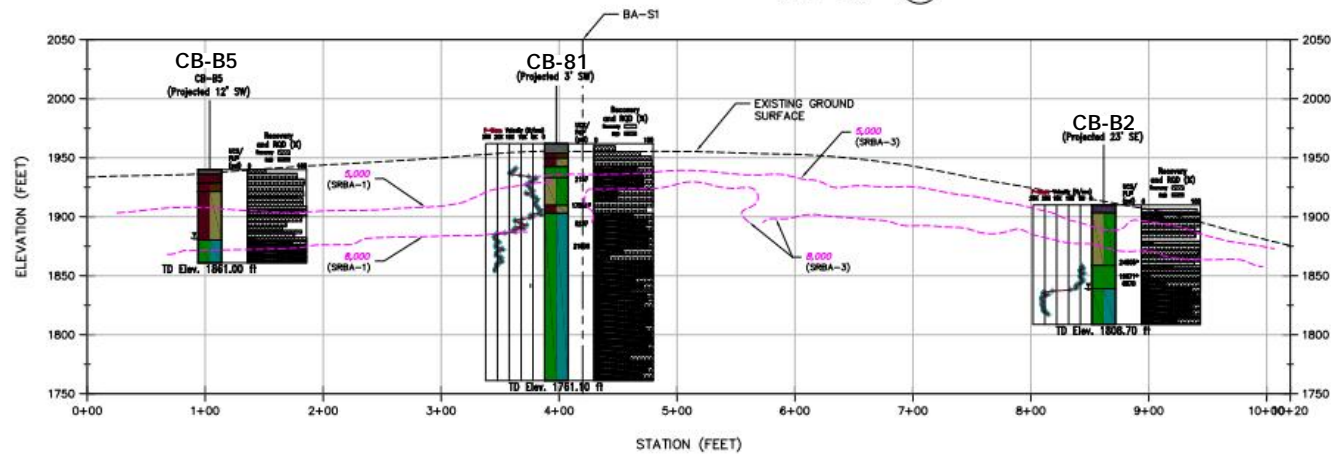
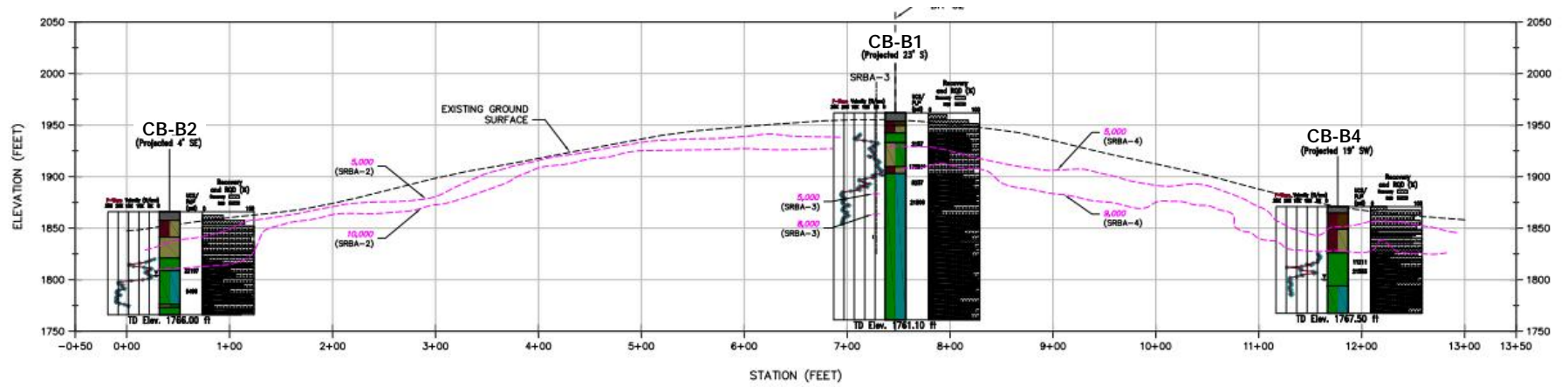


## Findings

- Hard basaltic rock
- Favorable topographic conditions
- Close to the dam site area



# Geotechnical Sections South Borrow Area



## Geotechnical Investigation Findings – Foundation Conditions

- Depth to weathered rock generally less than 20 ft.
- Weathered rock found to depths of 100 – 130 ft. at some locations
- All borings encountered less fractured rock with depth
- Evaluation of significant joint sets and shears indicates a lack of persistence between adjacent bore holes
- Hydraulic conductivities mostly decrease with depth and with decreasing fracture intensity



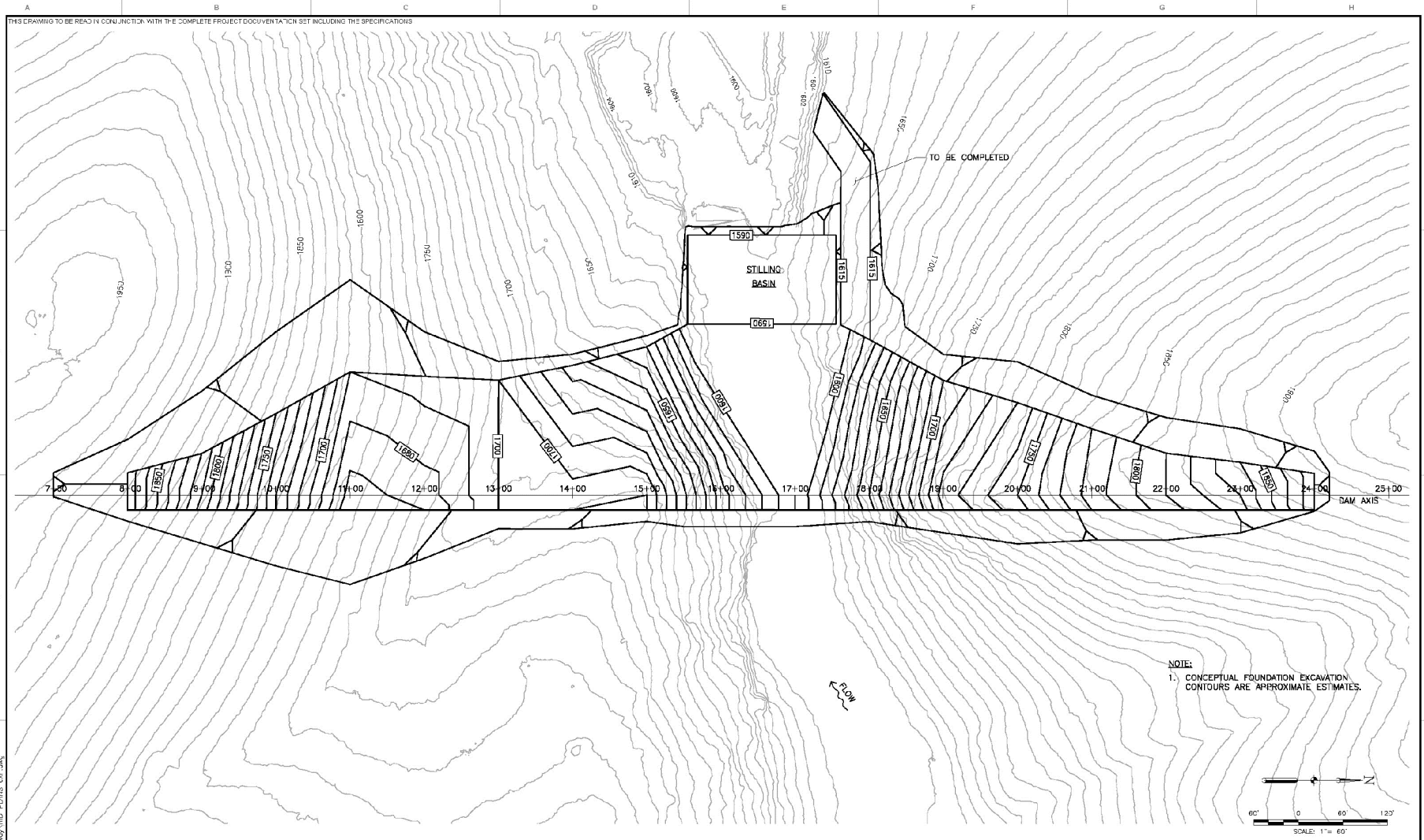
## Geotechnical Investigation - Conclusions

- Confirmed no fatal flaws at Dam Axis 2 site
- Hard volcanic and metavolcanic rock is suitable dam foundation
- Evidence for lack of active faulting along mapped lineaments at site
- Potential rock borrow area present on north side of reservoir, upstream of dam
- Further investigations needed to develop final design





# Excavation Plan

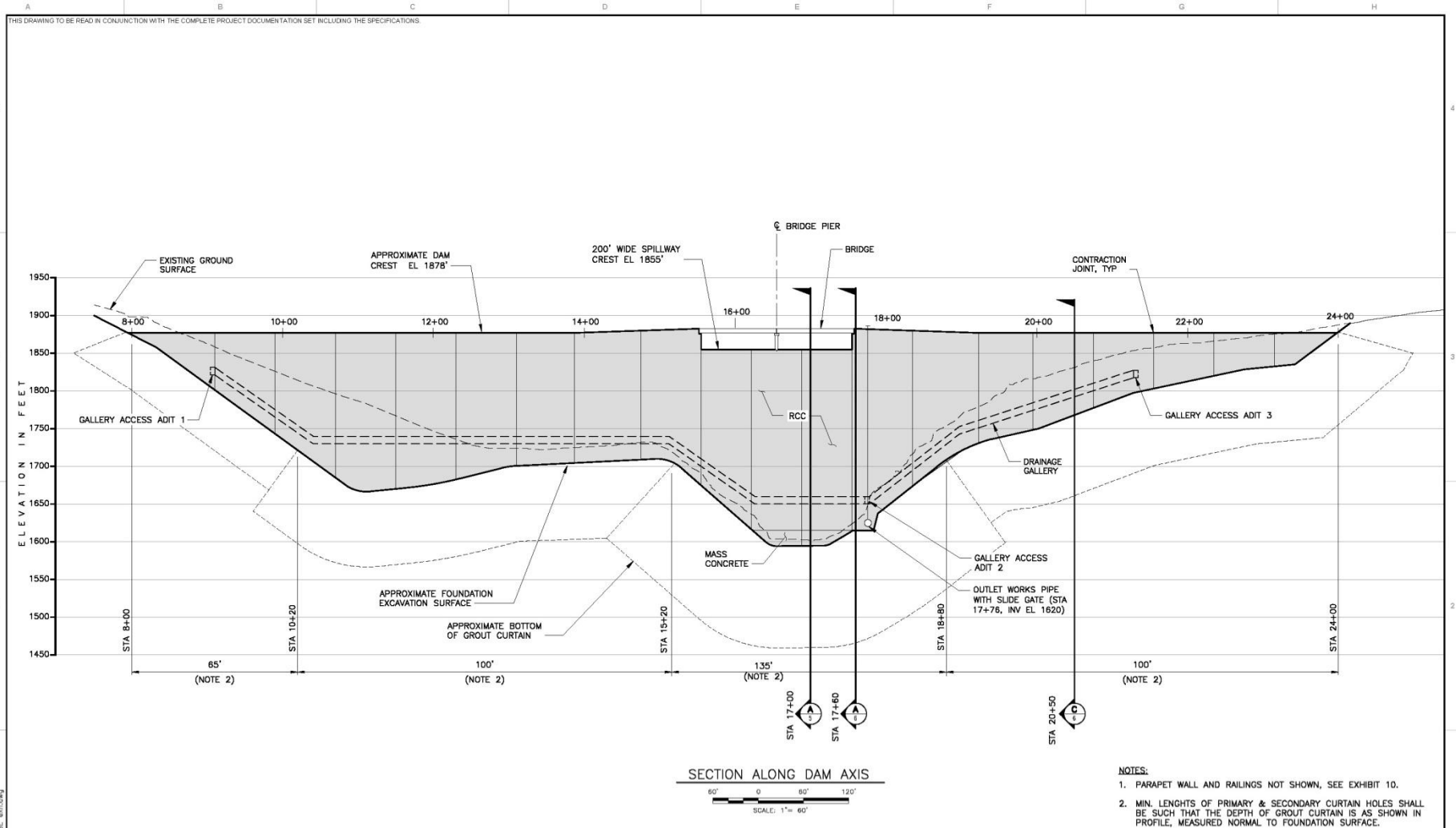


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	<b>PRELIMINARY DRAFT</b> NOT FOR CONSTRUCTION					DRAWN	SCALE AS NOTED		EXCAVATION PLAN	SHEET	EXHIBIT 2	
						CHECK-DC	CAD FILE D PLANS EXH.DWG					

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# Dam Profile



- NOTES:**
1. PARAPET WALL AND RAILINGS NOT SHOWN, SEE EXHIBIT 10.
  2. MIN. LENGTHS OF PRIMARY & SECONDARY CURTAIN HOLES SHALL BE SUCH THAT THE DEPTH OF GROUT CURTAIN IS AS SHOWN IN PROFILE, MEASURED NORMAL TO FOUNDATION SURFACE.

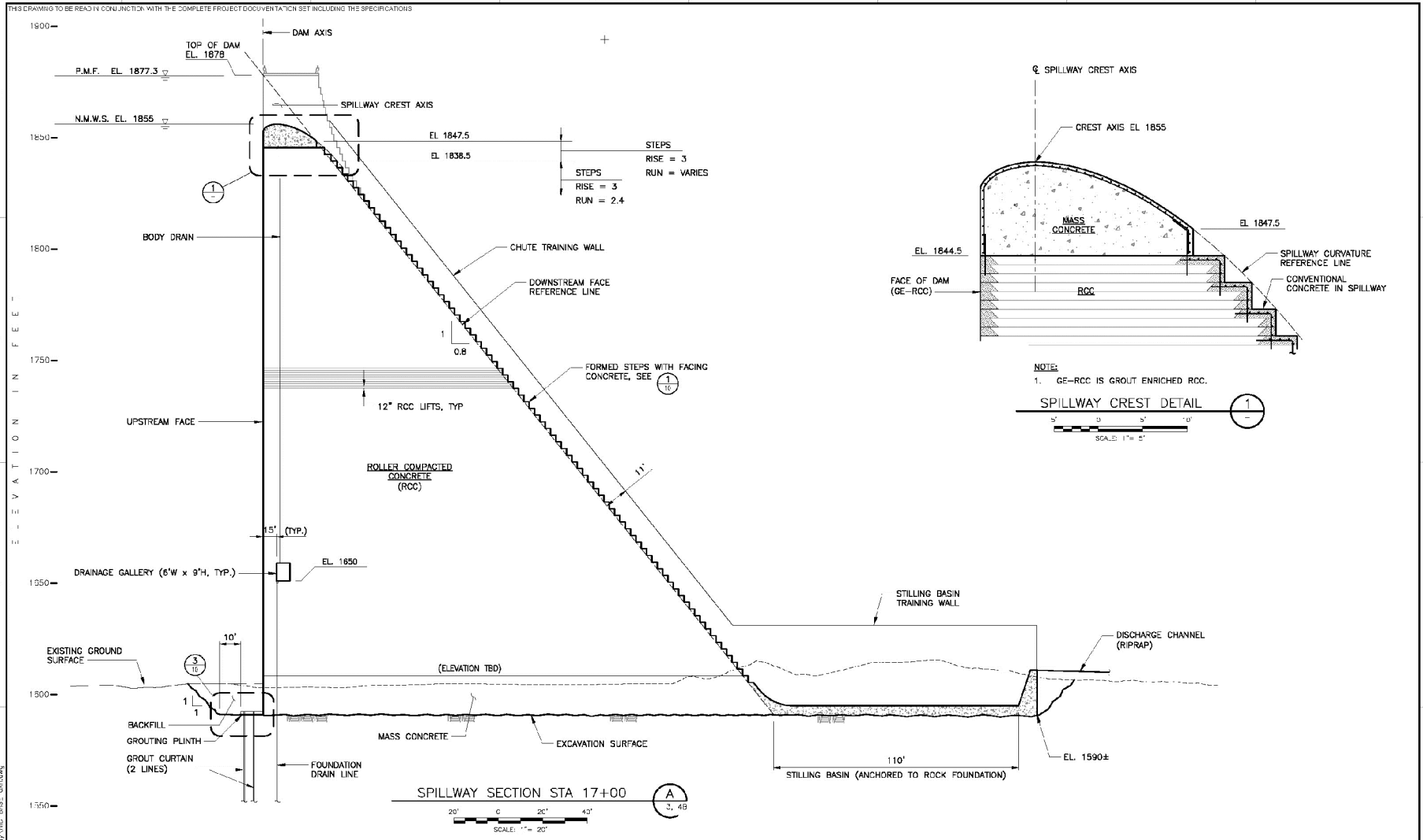
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<b>AECOM</b> <small>               300 Lakeside Drive, Suite 400, Concord, CA 94612                Tel: (916) 466-3600 Fax: (916) 474-3308             </small>							<b>Nevada Irrigation District</b> Grass Valley, California		EXHIBIT 4B _ OF _	





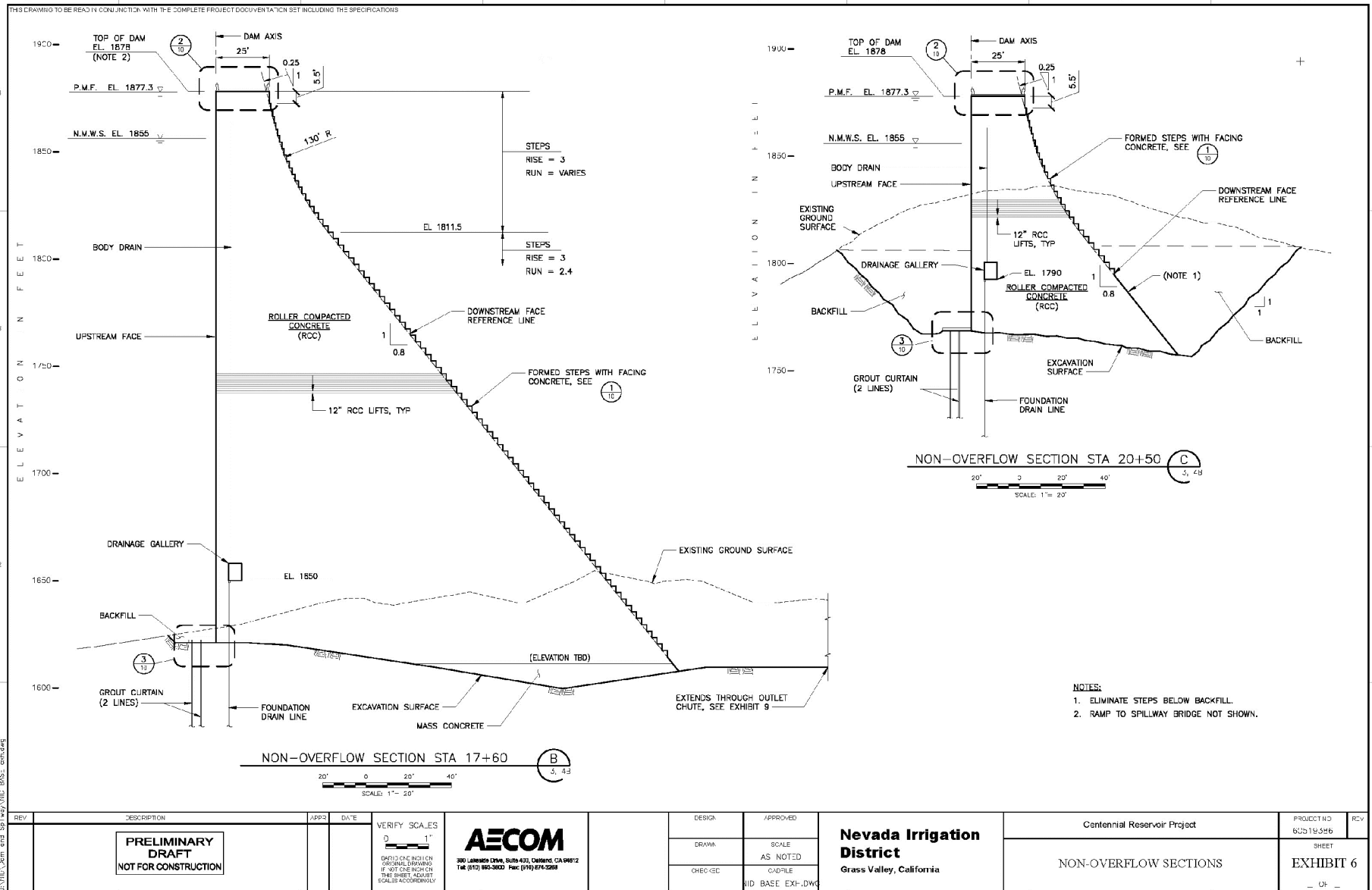
# Maximum Spillway Section



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# Non-Overflow Sections

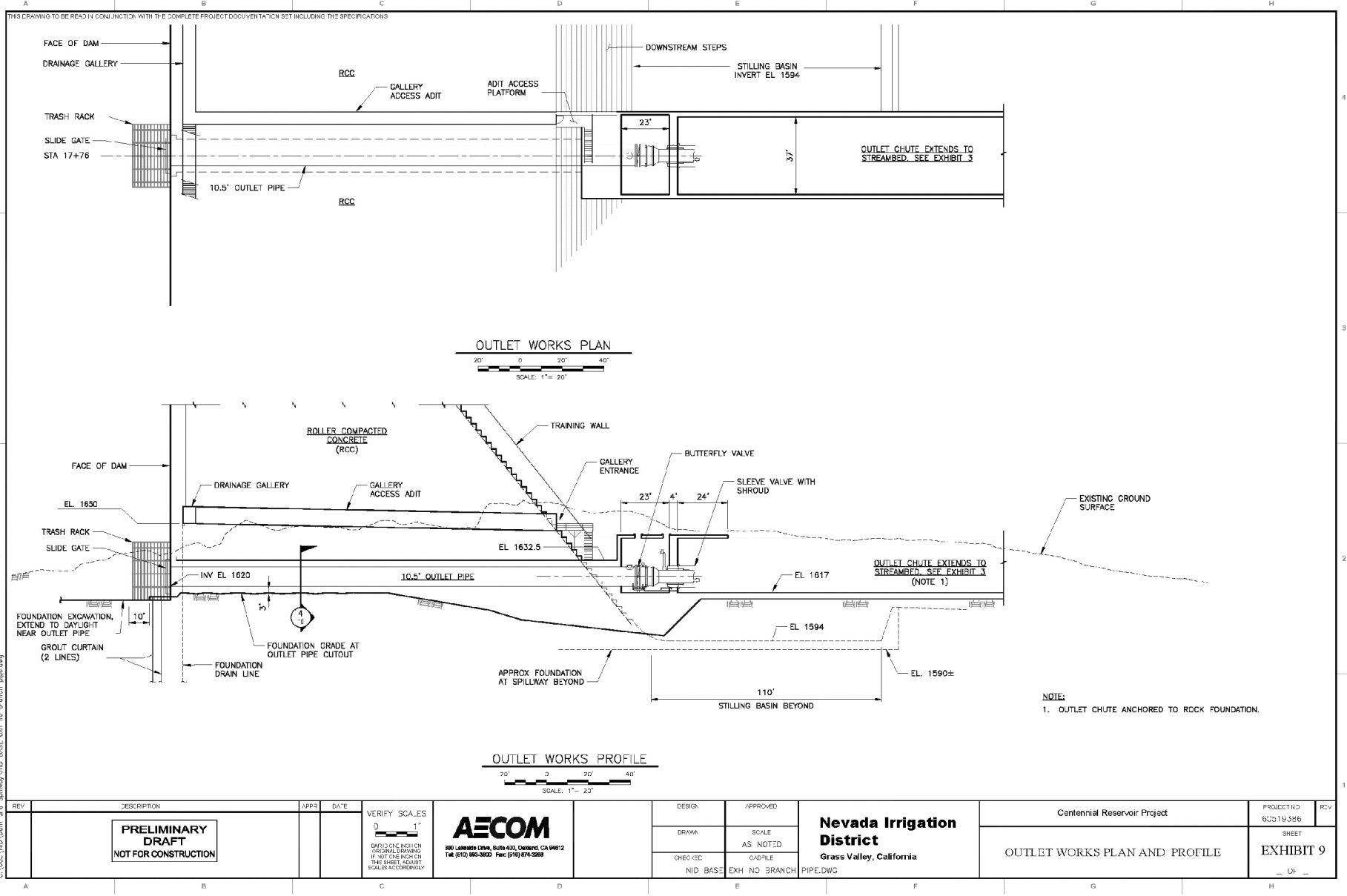


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# Outlet Works



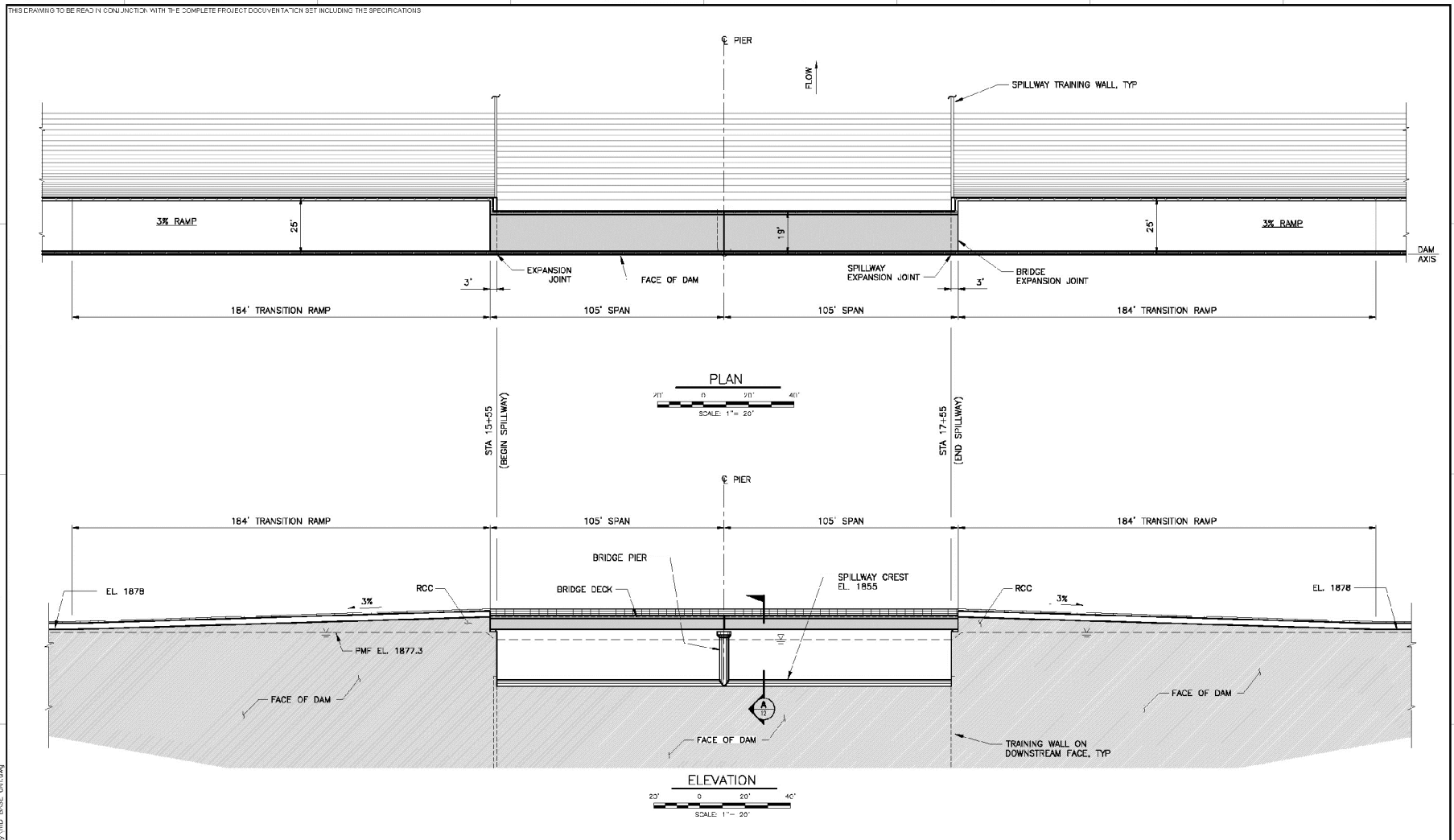
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							CENTENNIAL RESERVOIR PROJECT		SHEET	
							OUTLET WORKS PLAN AND PROFILE		<b>EXHIBIT 9</b>	
							PIPE.DWG		_ OF _	





# Spillway Bridge

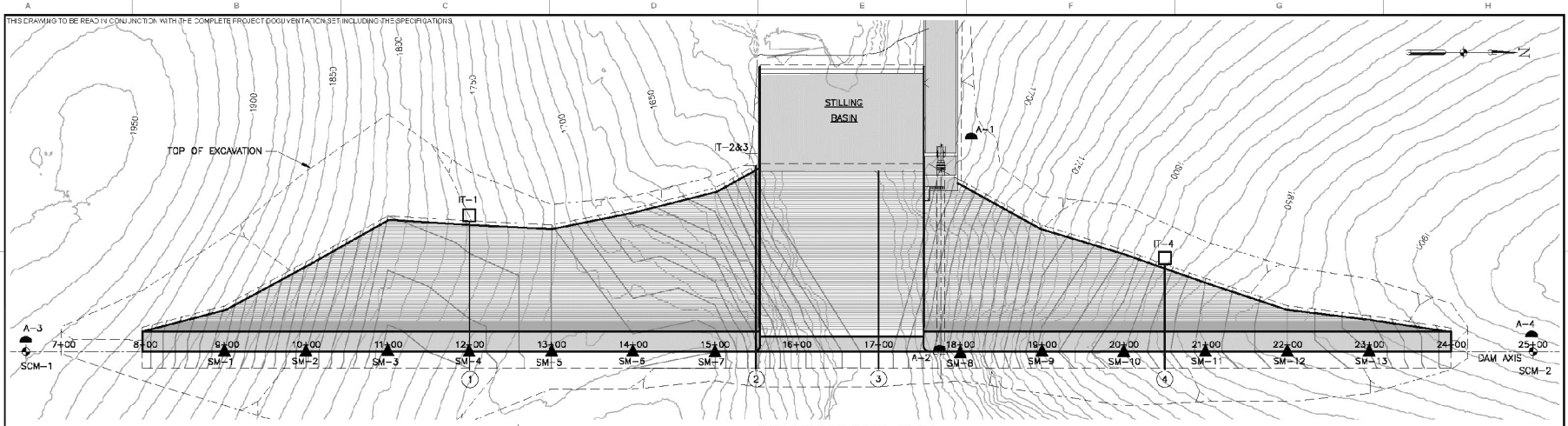


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					CHECK/CC	CAD FILE				EXHIBIT 11
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# Instrumentation Plan

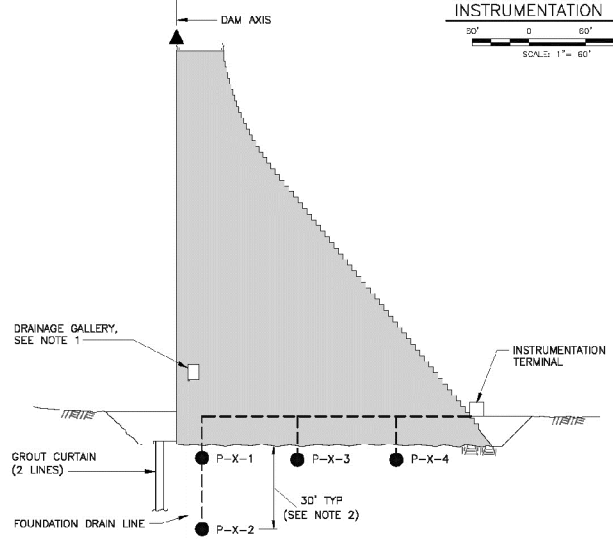


INSTRUMENTATION PLAN  
 SCALE: 1" = 60'

- NOTES:**
1. SEEPAGE V-NOTCH WEIRS TO BE LOCATED IN GALLERY GUTTERS.
  2. PIEZOMETERS INSTALLED IN DRILLED HOLES.

**LEGEND**

- ⊕ INSTRUMENTATION SECTION No.
- SCM-1 ⊕ SURVEY CONTROL MONUMENT (4 TOTAL, 2 SHOWN)
- SM-1 ▲ SURVEY MONUMENT
- P-X-1 ● VIBRATING WIRE PIEZOMETER (2 AT EACH LOCATION)
- PIEZOMETER CABLE
- A-1 ⊕ ACCELEROGRAPH
- IT-1 □ INSTRUMENTATION TERMINAL



TYPICAL INSTRUMENTATION SECTION  
 NO SCALE

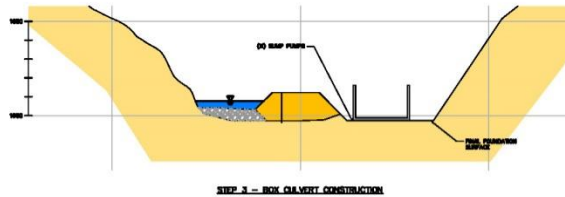
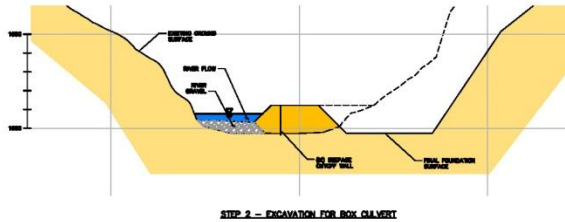
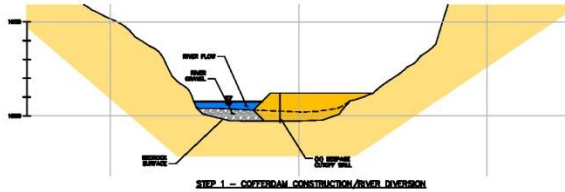
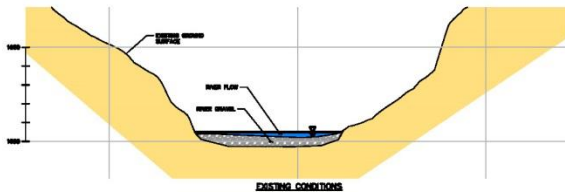
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				<b>AECOM</b> 300 Lakeside Drive, Suite 400, Oakland, CA 94612 Tel: (510) 885-3820 Fax: (510) 874-3288	DESIGN	APPROVED	Nevada Irrigation District Grass Valley, California		EXHIBIT 13	
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				30' TYP (SEE NOTE 2)	CHECKED	CADFILE				
					N/D PLANS	EXH.NO BRANCH				



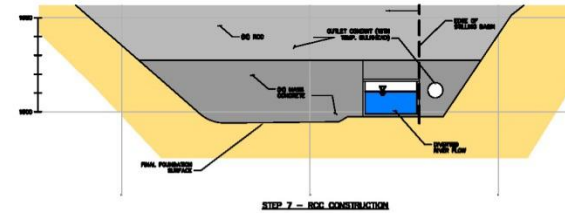
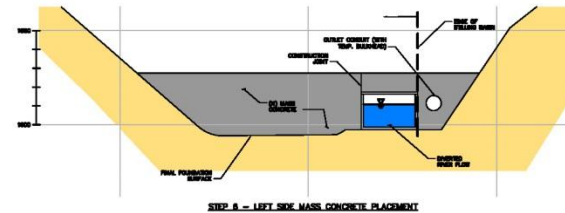
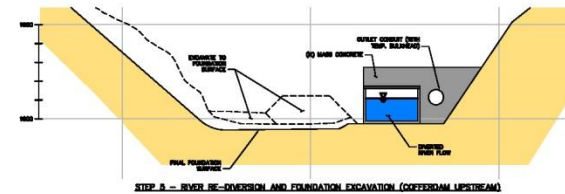
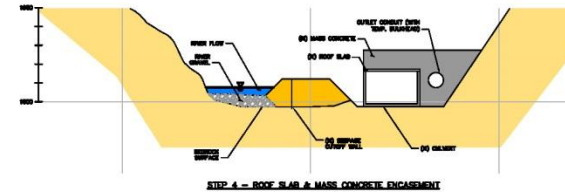
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# River Diversion Concept

THIS DRAWING TO BE READ IN CONJUNCTION WITH THE COMPLETE PROJECT DOCUMENTATION SET INCLUDING THE SPECIFICATIONS.



- NOTES**
1. NOT TO SCALE
  2. EXCAVATE AND BRACE LOWER DOWNSTREAM
  3. FOUNDATION BRACING NOT SHOWN



Mar 27, 2017 - 10:11am  
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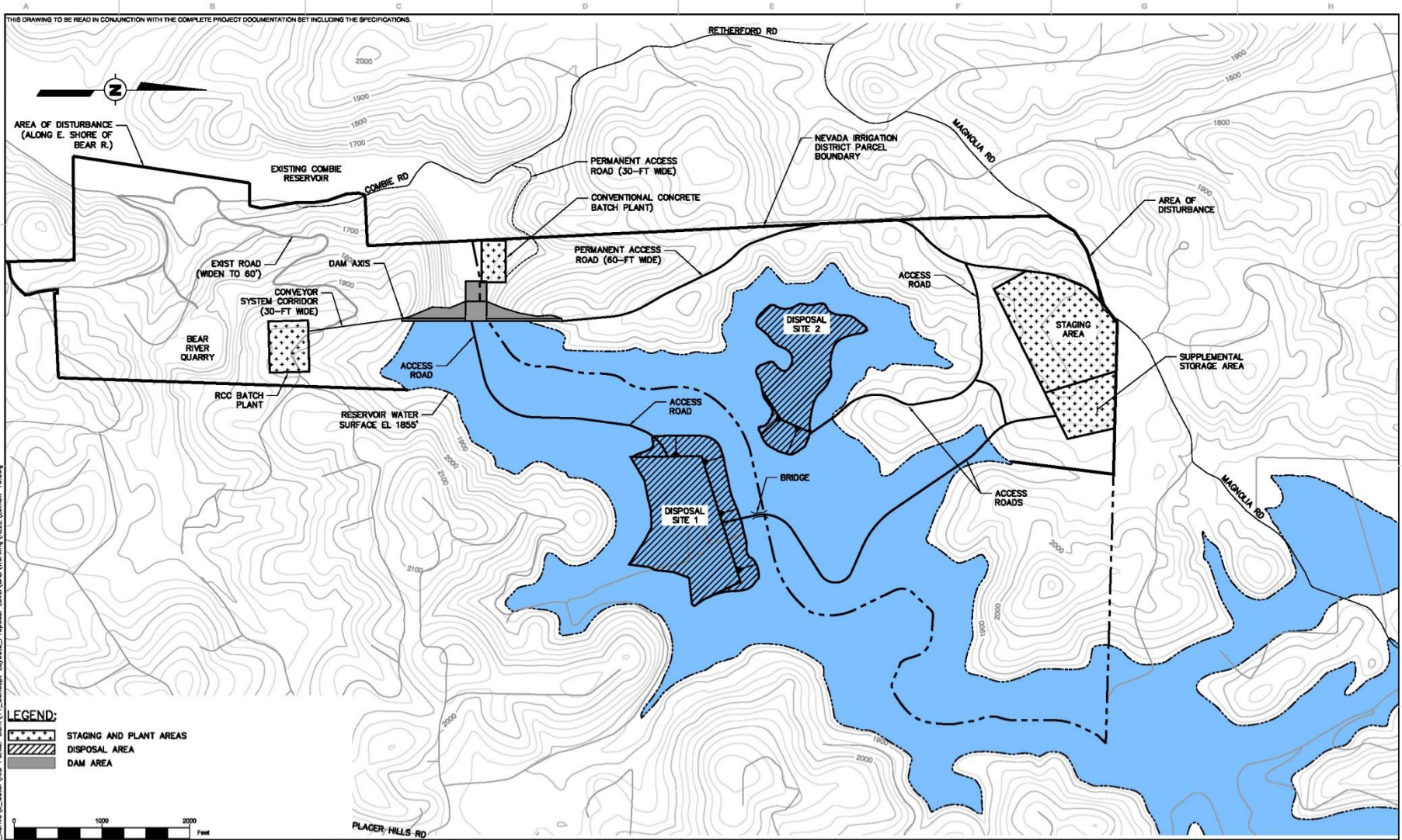
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									<b>DIVERSION CONCEPT</b>		<b>EXHIBIT 14</b>
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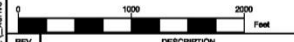




# Construction Site Layout – 2 (Bear River Quarry Borrow)



**LEGEND:**  
 STAGING AND PLANT AREAS  
 DISPOSAL AREA  
 DAM AREA



REV	DESCRIPTION	APPR	DATE	VERIFY SCALES 0 1" BARS IN ONE INCH ON ORIGINAL DRAWING IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY	 300 Lakeside Drive, Suite 400, Oakland, CA 94612 Tel: (510) 865-3600 Fax: (510) 874-3286	DESIGN	APPROVED	Nevada Irrigation District Grass Valley, California	Centennial Reservoir Project		PROJECT NO 60519396	REV
	PRELIMINARY DRAFT NOT FOR CONSTRUCTION					DRAWN	SCALE AS NOTED		CONSTRUCTION SITE LAYOUT CONCEPT PLAN 2		SHEET	EXHIBIT 16
						CHECKED	CADFILE EXHIBIT 16.DWG				OF	

## Basis of Construction Schedule

- Work performed up to 6 days per week, 2 shifts per day
- No overly restrictive constraints on trucking materials to the site
- Dam foundation excavation: 15,000 cubic yards per week
- Foundation grouting (drilling and grouting): 600 linear feet per week for each drill rig and grout plant.
- RCC construction: 16,000 cubic yards per week





## Opinion of Probable Construction Cost (2017 dollars)

WBS Category	Description	Category Total	Category % of Total
A	Mobilization and Demobilization	\$18,737,000	7.3%
B	Site Development	\$21,497,000	8.4%
C	River Diversion	\$2,600,000	1.0%
D	Dam Foundation	\$41,862,000	16.3%
E	RCC, Facing Concrete and Gallery	\$136,325,000	53.3%
F	Spillway and Dam Crest	\$12,766,000	5.0%
G	Spillway Bridge	\$2,340,000	0.9%
H	Outlet and Intake Structures and Pipe	\$14,759,000	5.8%
I	Miscellaneous Civil	\$3,224,000	1.3%
J	Instrumentation and SCADA	\$1,950,000	0.8%
	<b>Total OPCC</b>	<b>\$256,059,000</b>	<b>100.0%</b>
	<b>Estimated Range - Low (-15%)</b>	<b>\$217,685,000</b>	
	<b>Estimated Range - High (+20%)</b>	<b>\$307,320,000</b>	

Thank You

**AECOM**