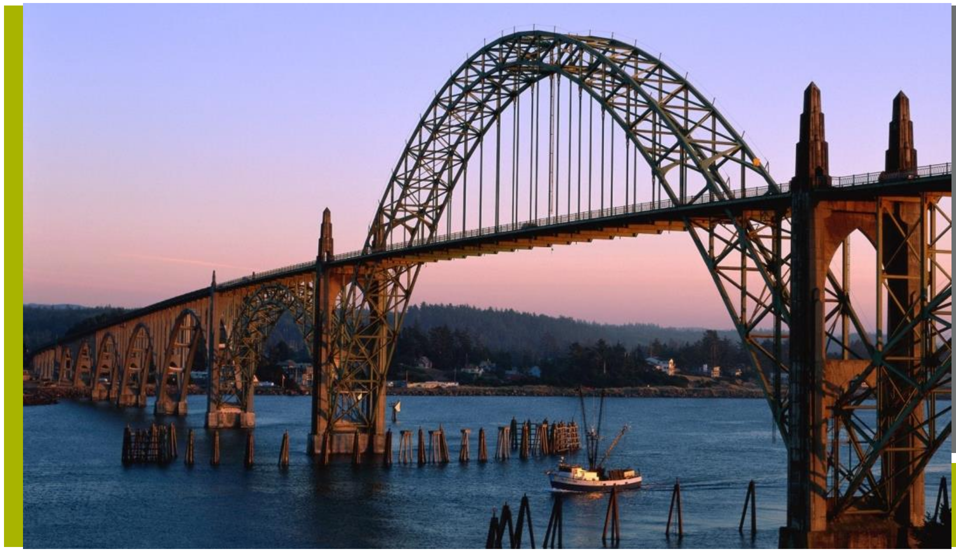
NEWPORT BIG CREEK DAMS

City Council Work Session
09-08-2015



Engineering Evaluation & Corrective Action Alternatives

Presented by
Keith Ferguson, P.E. HDR Engineering

Newport
Big Creek Dams

Overview

- The Newport Earthquake Hazard
- Verification of Seismic Deficiencies
- Corrective Action Alternatives
- Preliminary Environmental Review
- Decision Level Cost Estimates
- Conclusions
- Recommendations

The Earthquake Hazard at the Newport Dam Sites

Design Earthquake - Background

- Design earthquake event
  - The more critical and hazardous the infrastructure the longer the return period considered (e.g. Scoggins dam and other federal jurisdiction dams, 5,000 to 50,000-yr return periods)
  - Earthquakes have multiple parameters to describe them
    - Magnitude – length of rupture and total amount of energy released
    - Distance between location of rupture and critical structure
    - Return period – how often the energy is released
    - PGA – peak ground acceleration of the entire earthquake
    - Duration of strong shaking
    - Other factors
  - Cascadia Subduction Zone
    - High magnitude (M 8 to 9+), long duration (200+ seconds), high PGA (>0.5g)

Principal Seismic Sources in Oregon

- Cascadia Subduction Zone (CSZ)
- Crustal Faults

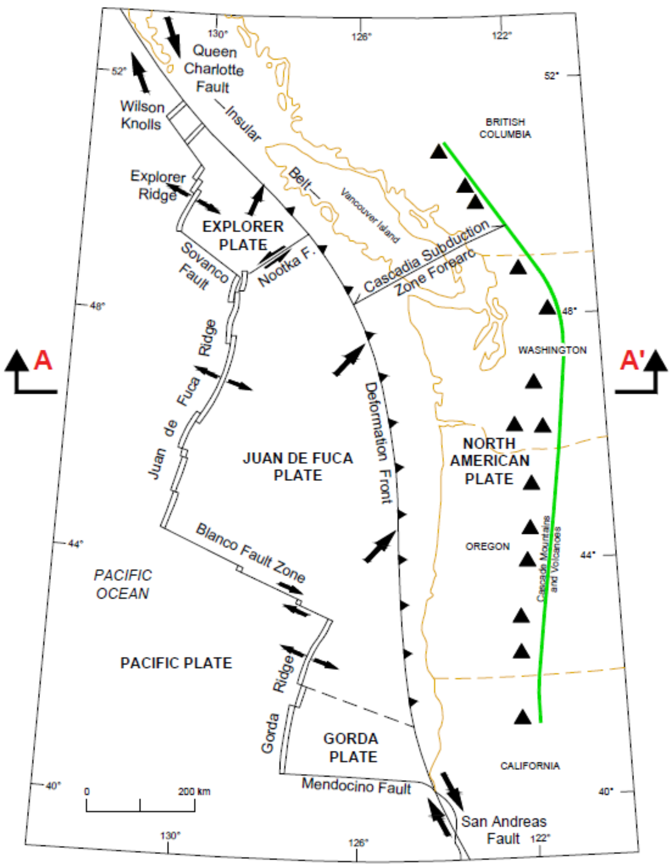
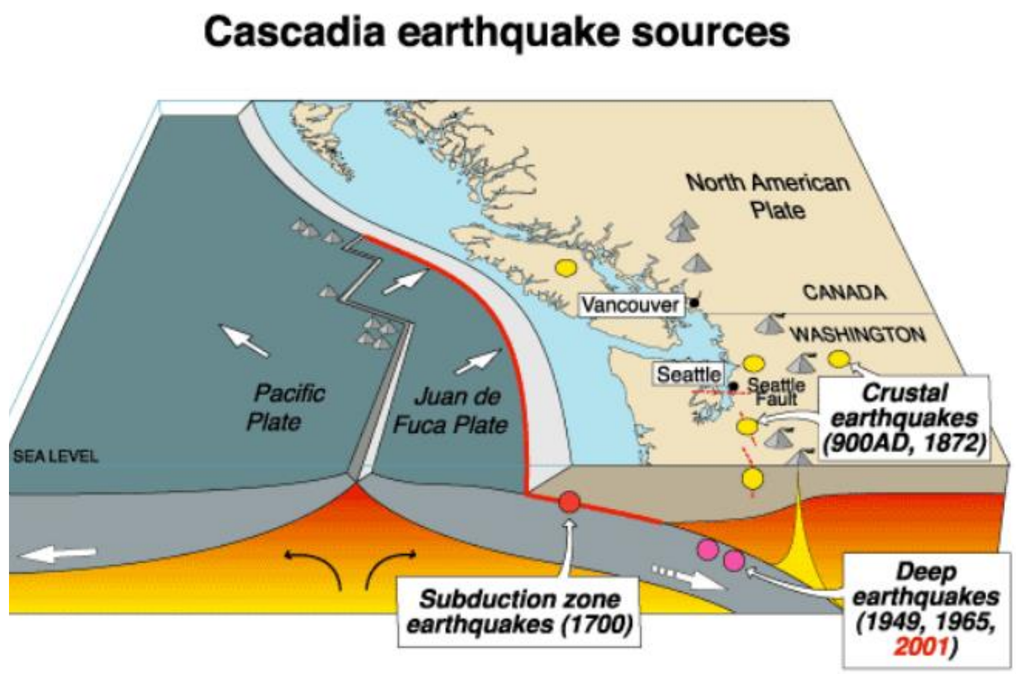


PLATE BOUNDARIES



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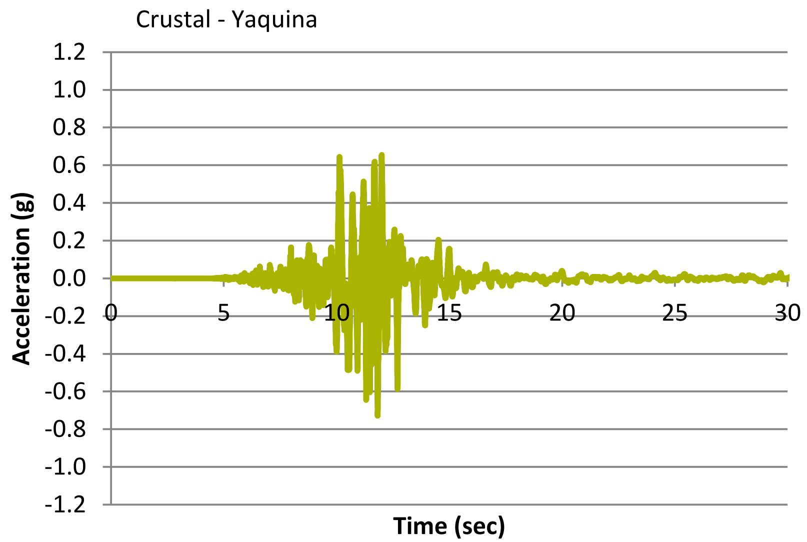
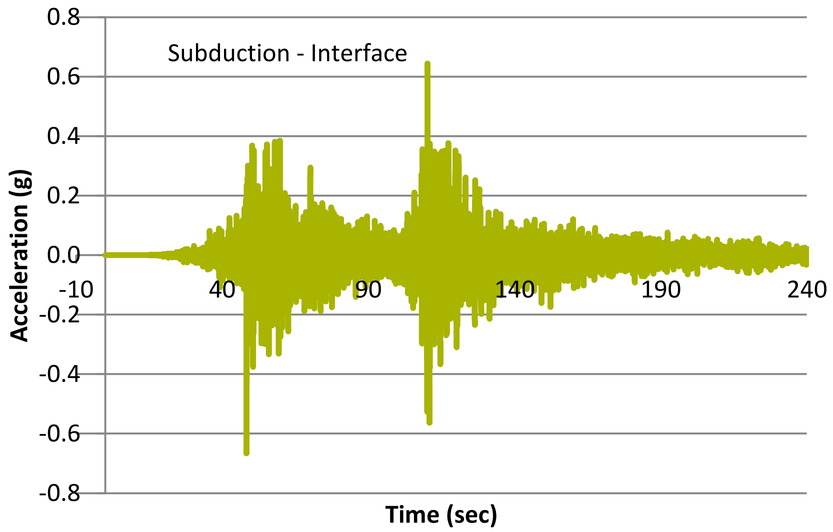
Response of Earth Embankments to Earthquakes





Breach Through Transverse Cracks and Overtopping

Figure 8: View of Breach in Fujinuma Main Dam from Right Abutment
(N37.3014˚, E140.1957˚, April 23, 2011)

The Earthquake Hazard at Newport Dam Sites

Table 2A. Probabilistic Seismic Hazard Deaggregation Contributions at PGA

Return Period	PGA (g)	Contributions from Principal Sources at PGA (%)			
		Gridded (other crustal)	Yaquina Faults	Cascadia Subduction Zone Interface[1]	Cascadia Subduction Zone Intraslab
475-year	0.30	4.4	30.4	59.0	4.4
975-year	0.52	<3	35.8	60.4	<3
2,475-year	0.86	<3	35.2	63.5	<3
4,975-year	1.15	<3	32.8	66.6	<3
9,950-year	1.47	<3	29.8	69.9	<3

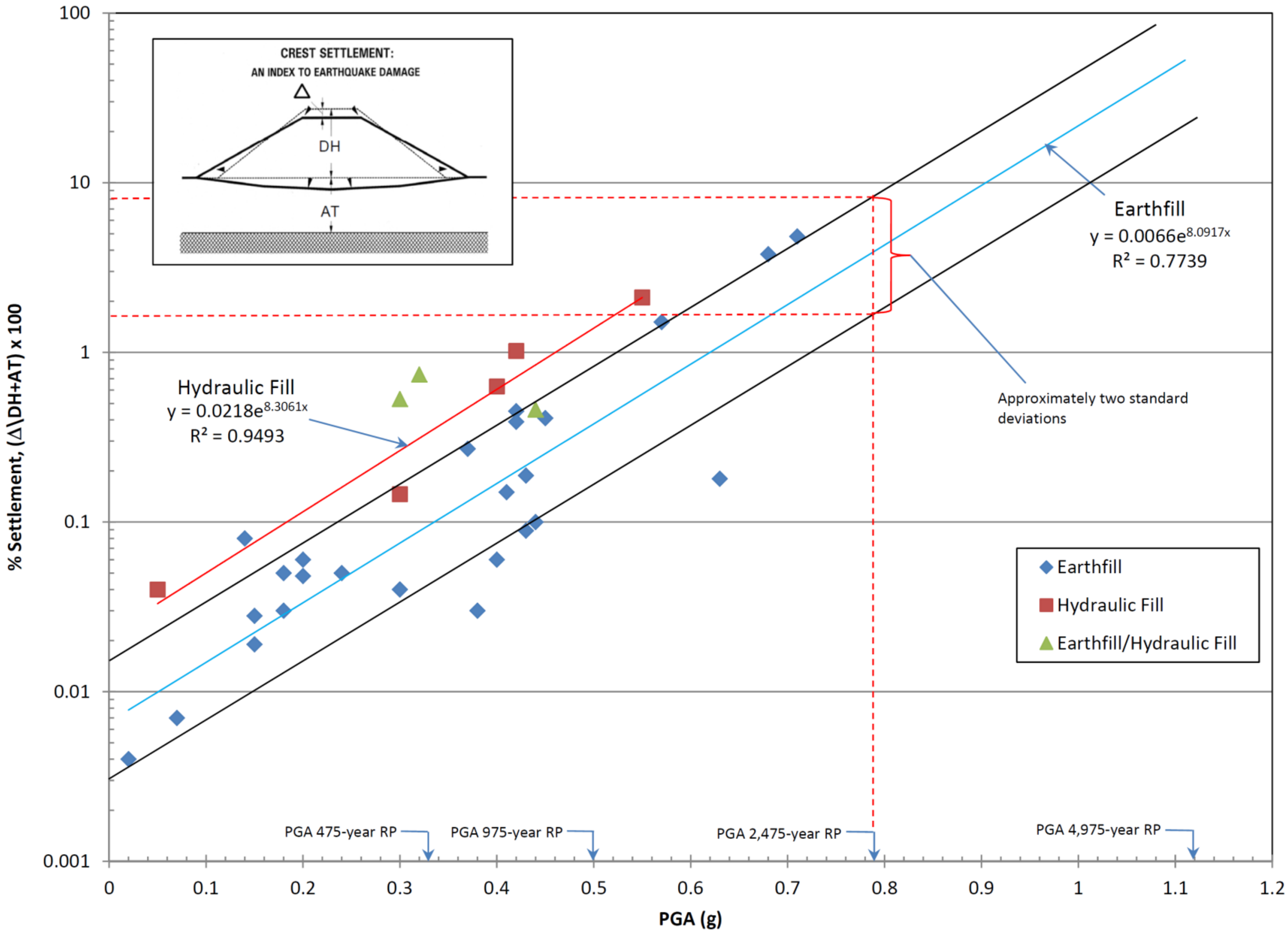
[1]CSZ Interface includes Cascadia M8.0-M8.2 floating, M8.3-M8.7 floating and megathrust sources

Deficiency Verification

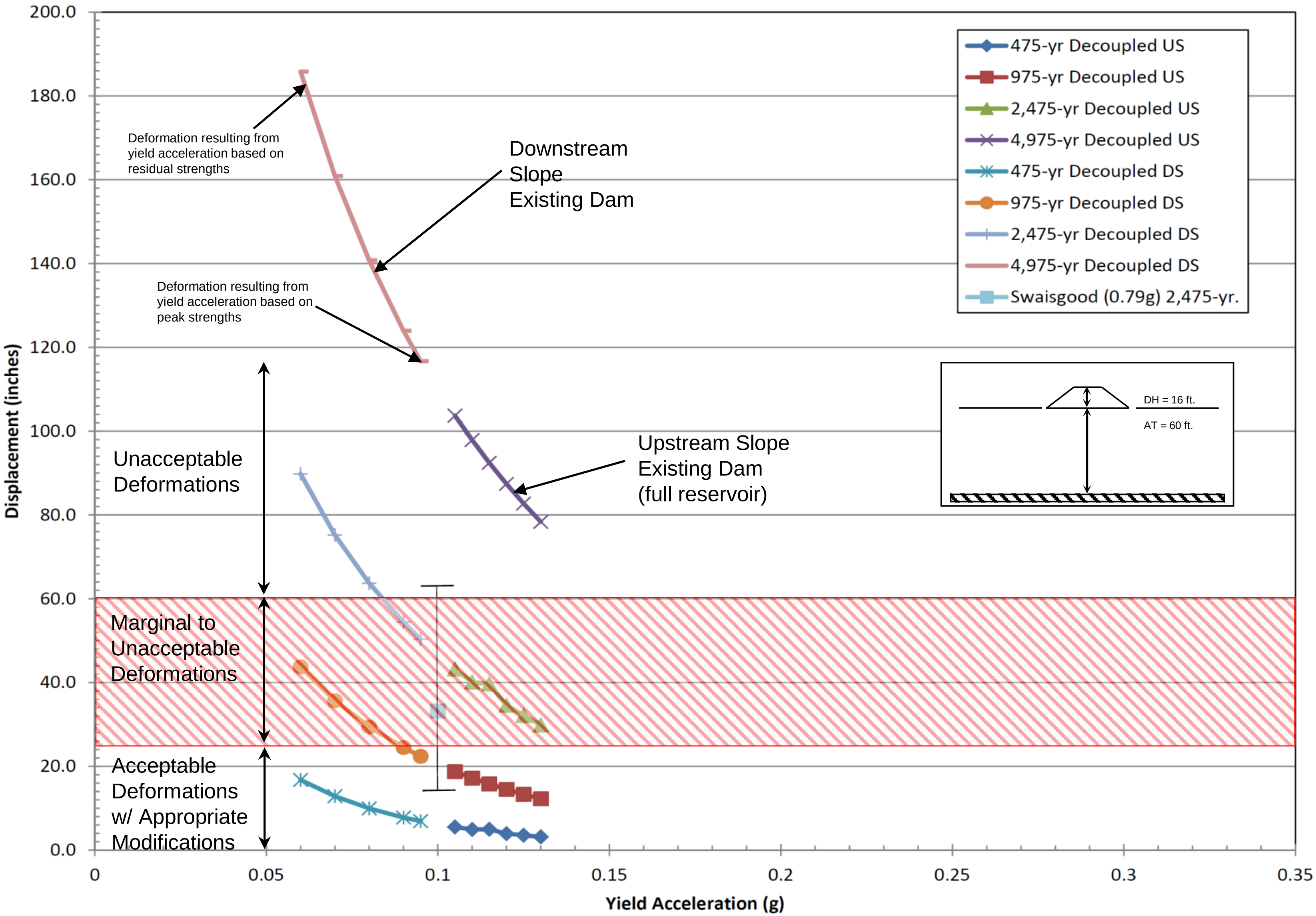
Project Timeline

Timeline		Activity
April 2011	→	1st boring sample– discovered the issue
Dec 2011	→	2nd round of sampling
Jan - May 2012	→	Laboratory testing of 2nd round samples
Feb 2013	→	Report "Geotechnical Investigation & Seismic Evaluation"
Nov 2013	→	3rd round of sampling
Jan - June 2014	→	Laboratory testing of 3rd round samples
June 2015	→	Report "Engineering Evaluation & Corrective Action Alternatives"

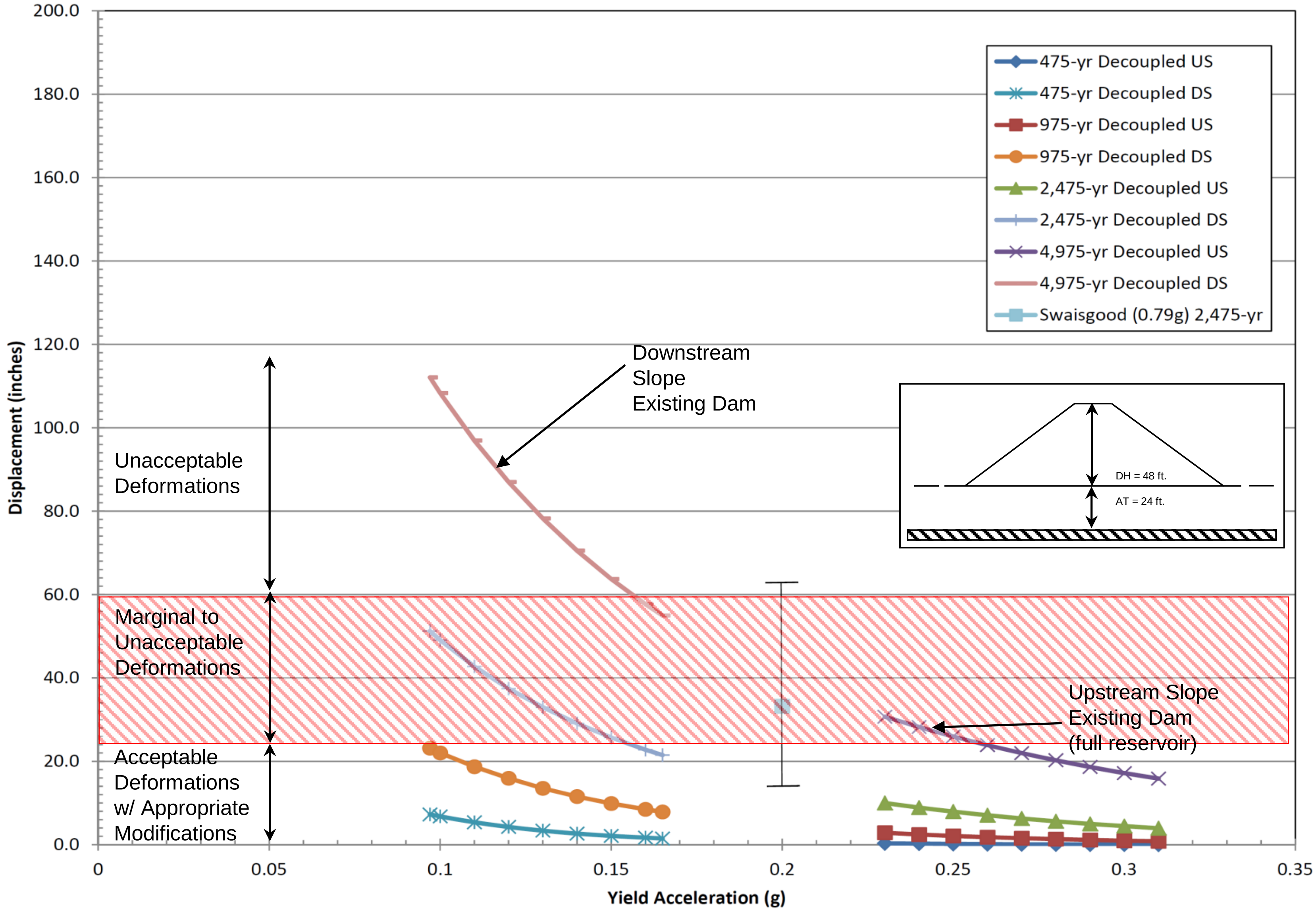
Swaisgood Estimates of Crest Displacement



Newmark Displacements CSZ – BC 1



Newmark Displacements CSZ – BC 2



Summary of Estimated Deformations of Newport Dams

Table 1: Summary of Estimated Embankment Crest/Downstream Slope Deformations at BC-1 and BC-2

Recurrence Interval Event (years)	Estimated Peak Ground Acceleration (PGA – g's)	Est. Deformations - Empirical (Swaisgood, 2003) (inches)			Est. Deformations – Newmark (inches)		
		Lower Bound	Best Estimate	Upper Bound	Lower Bound	Best Estimate	Upper Bound
BC 1							
2475	0.79	15	33	68	50	>76	90
4975	1.12	218	478	>478	116	>160	184
BC 2							
2475	0.79	15	33	68	32	>48	54
4975	1.12	218	478	>478	56	>96	112

Green – Acceptable, no corrective actions required
Yellow – Marginal to unacceptable, corrective actions required
Red - Unacceptable, expedited corrective actions needed

Engineering Analysis/Deficiency Verification

- BC-1:
  - Will fail by settlement and overtopping during a large earthquake.
  - Smaller earthquakes will result in significant damage to the dam, outlet works, water supply pump station, and ability to operate the reservoir
  - Foundation material is very deep. Remediation is challenging and expensive.
  - Small amount of storage in the reservoir and the very large anticipated remediation costs, rehabilitation of this dam is judged as non-feasible.

Engineering Analysis/Deficiency Verification

- BC-2:
  - Unacceptable deformations large earthquake events
  - Likely to fail due to overtopping and/or seepage through transverse cracks after the shaking
  - Significant damage during more frequent seismic events
  - Deformations of the upstream slope will be significant for the larger earthquakes resulting in damage or failure of the outlet works, intake structure, and discharge pipeline (similar to BC1)

Corrective Action Alternatives

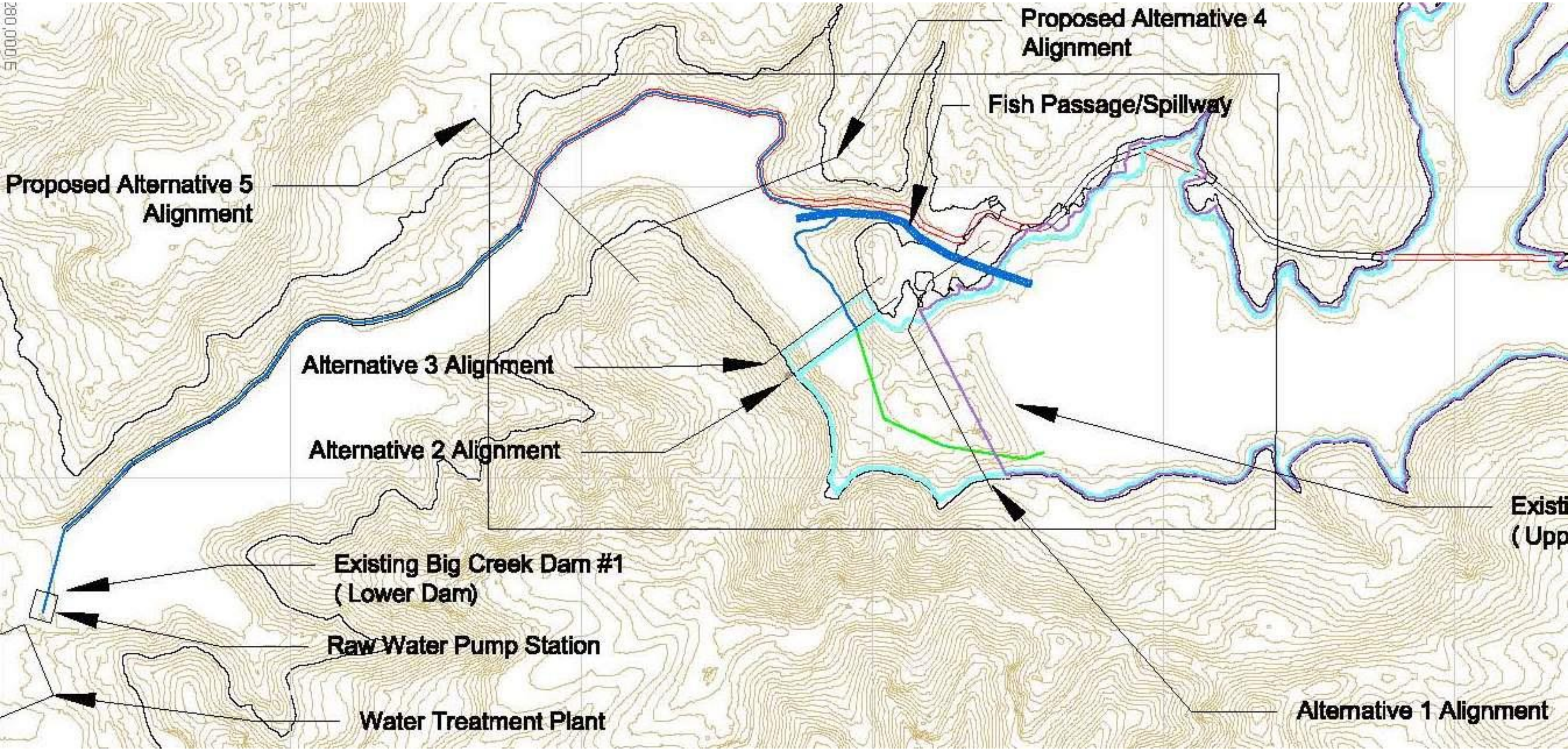
Alternatives for Corrective Actions – Storage Capacity

Overall Goal: provide a reliable drinking water source for Newport

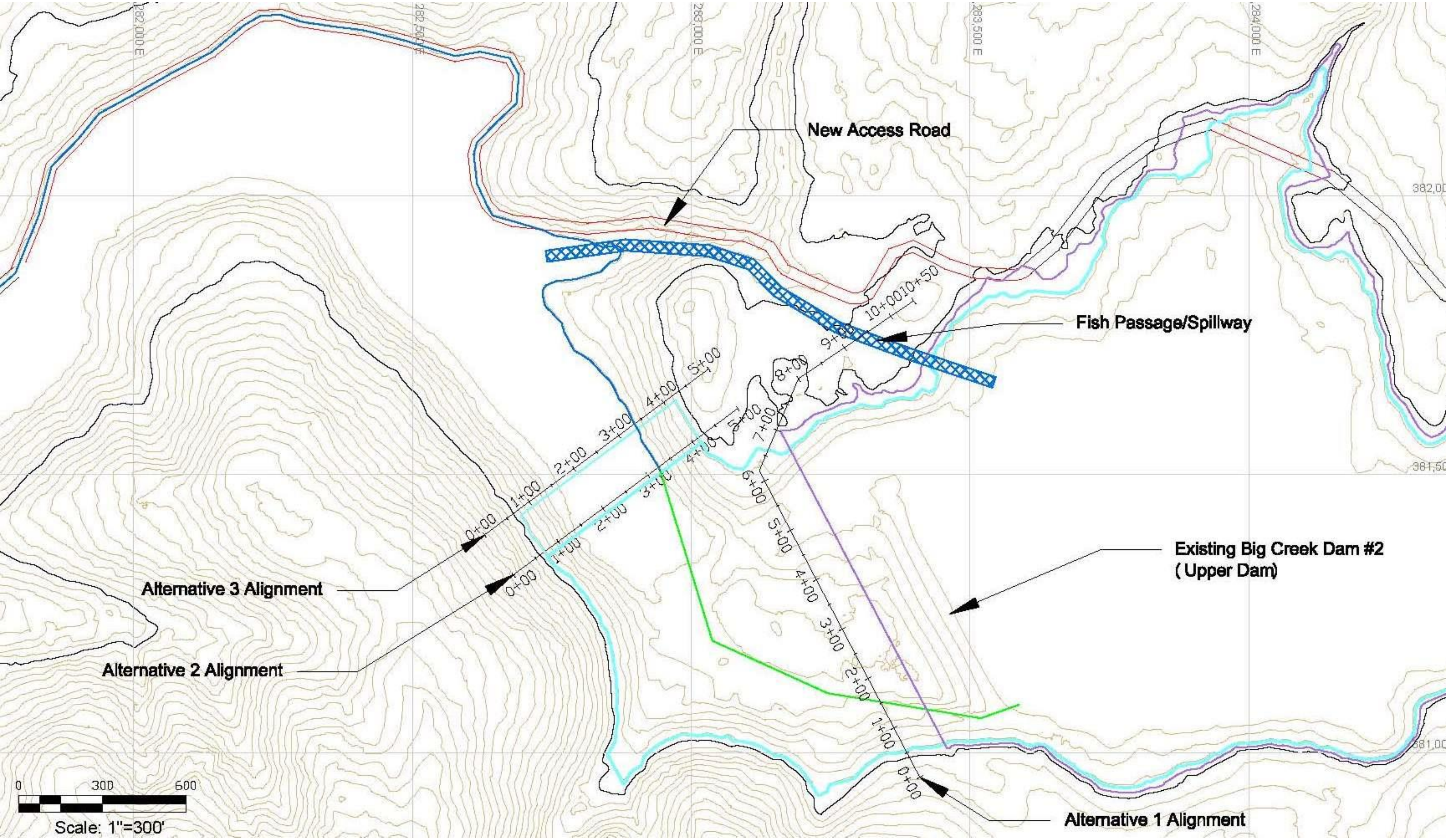
- Storage capacities:

BC-1	= 200 acre-feet
BC-2	= 970 acre-feet
Future projection	= 1000 acre-feet
Sediment storage	= 100 acre-feet
Total Future	**= 2,270 acre-feet**

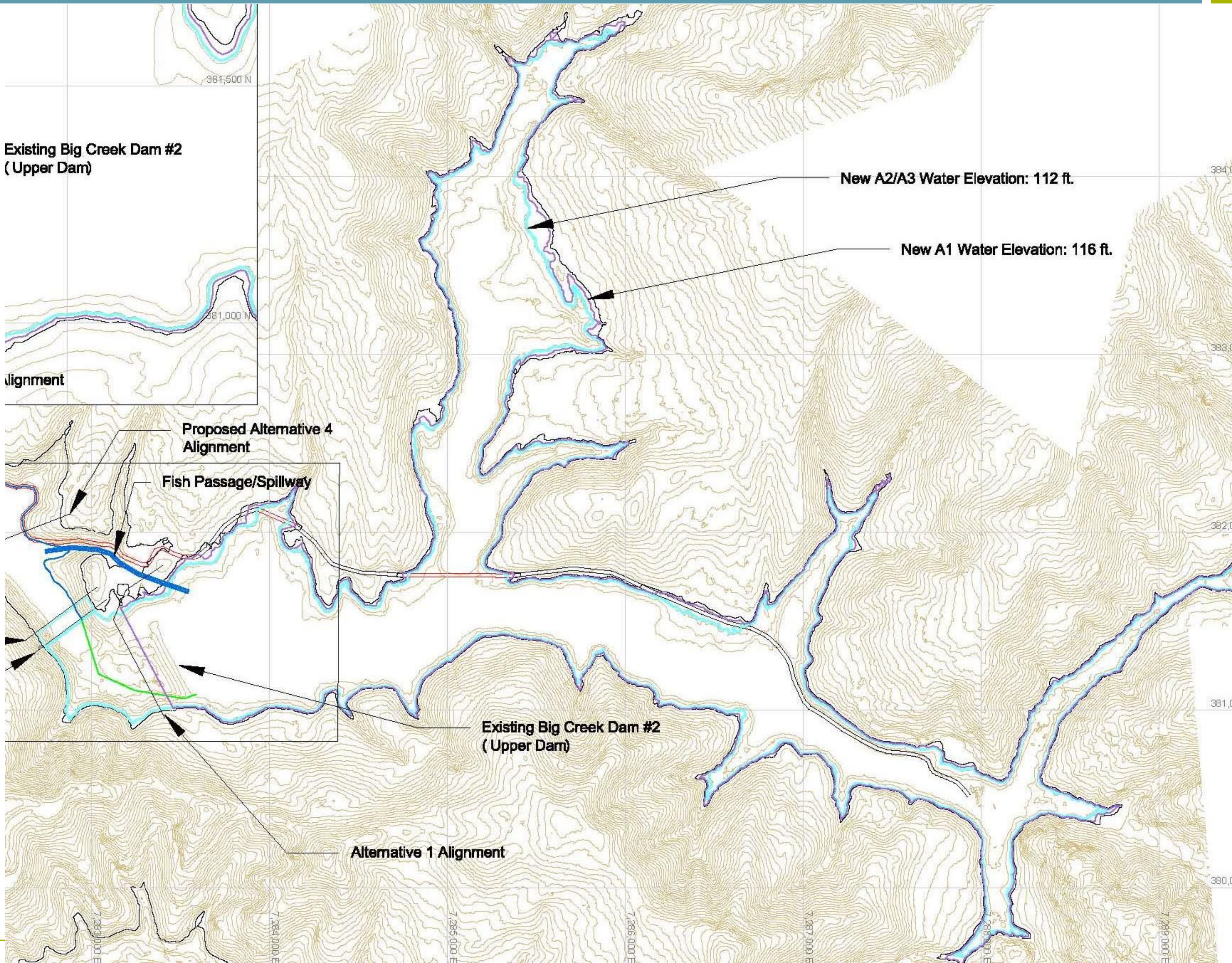
Alternatives for Corrective Actions – 5 Options



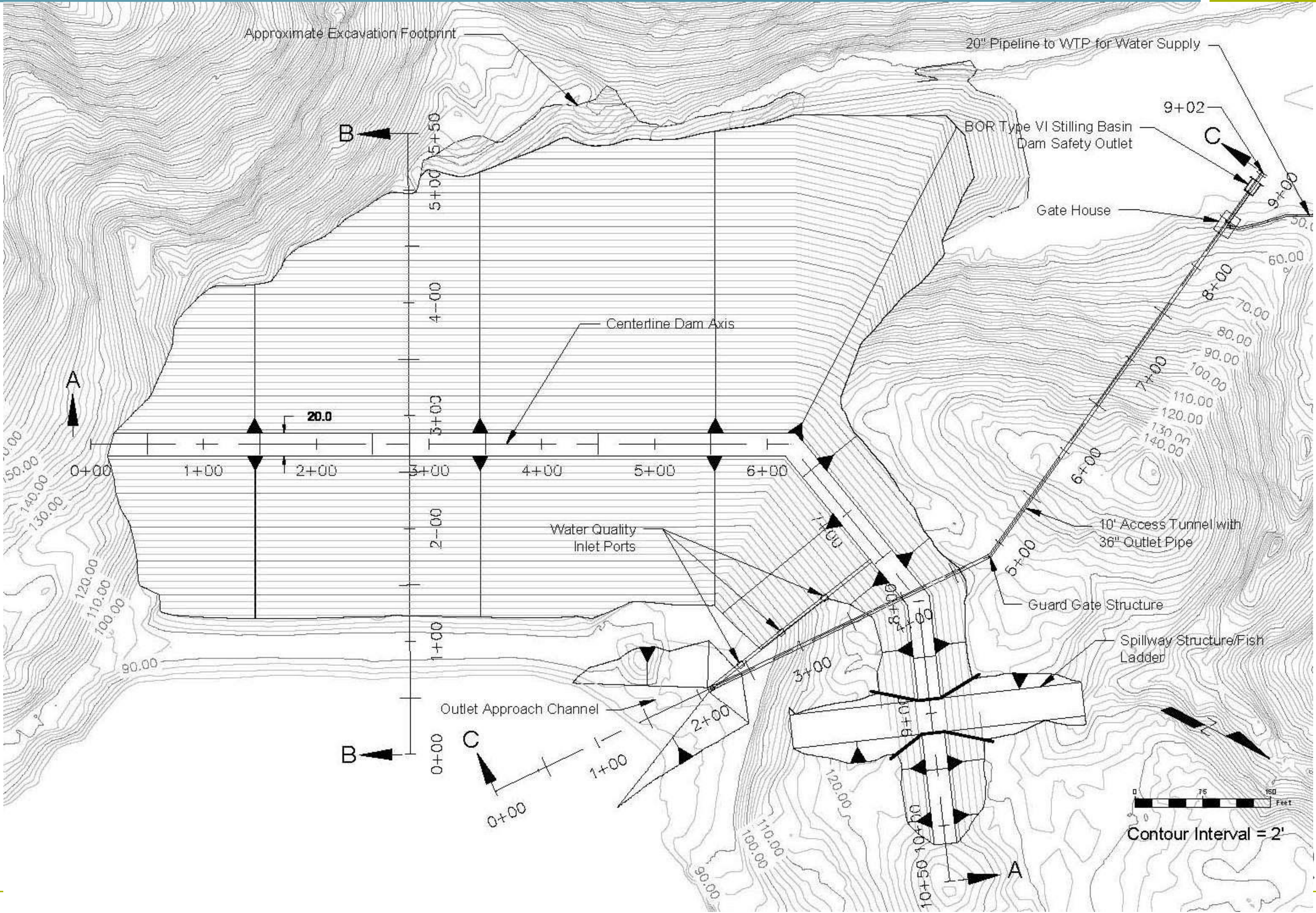
Alternatives for Corrective Actions – 3 Options



Alternatives for Corrective Actions – Inundation Area



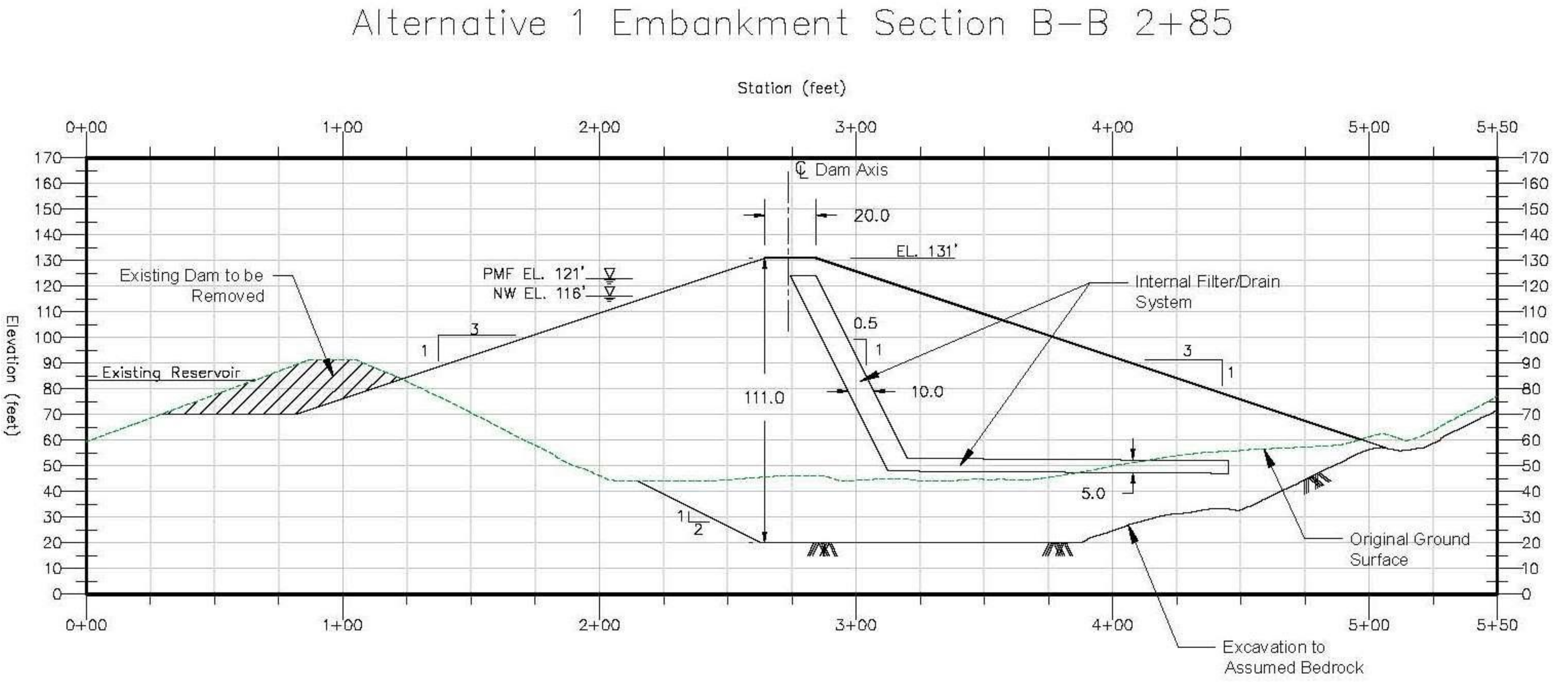
Alternatives 1 – Raising & Modifying Existing Dam



Alternatives 1 – Raising & Modifying Existing Dam

- Dam is a continuation from existing upstream slope
- Total height = 111 feet at elevation 131 feet
- New water surface elevation = elevation 116 feet
- Foundation soil of existing dam remain in place & excavation for new soil for new dam portion

Alternatives 1 – Raising & Modifying Existing Dam



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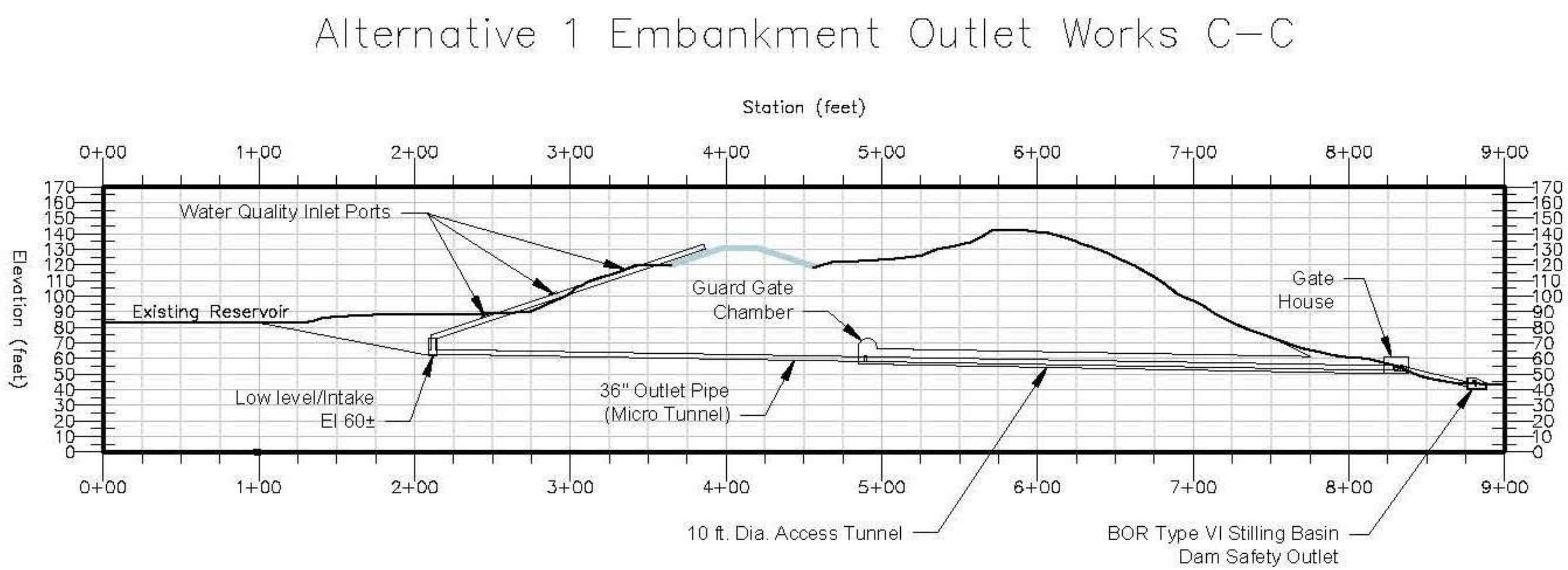
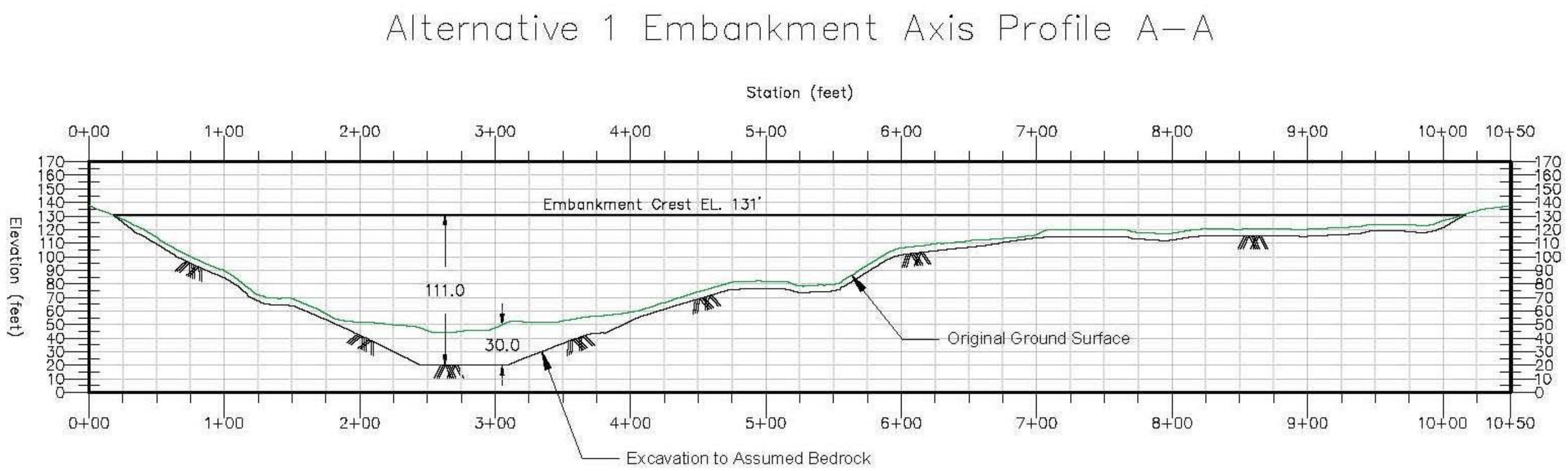
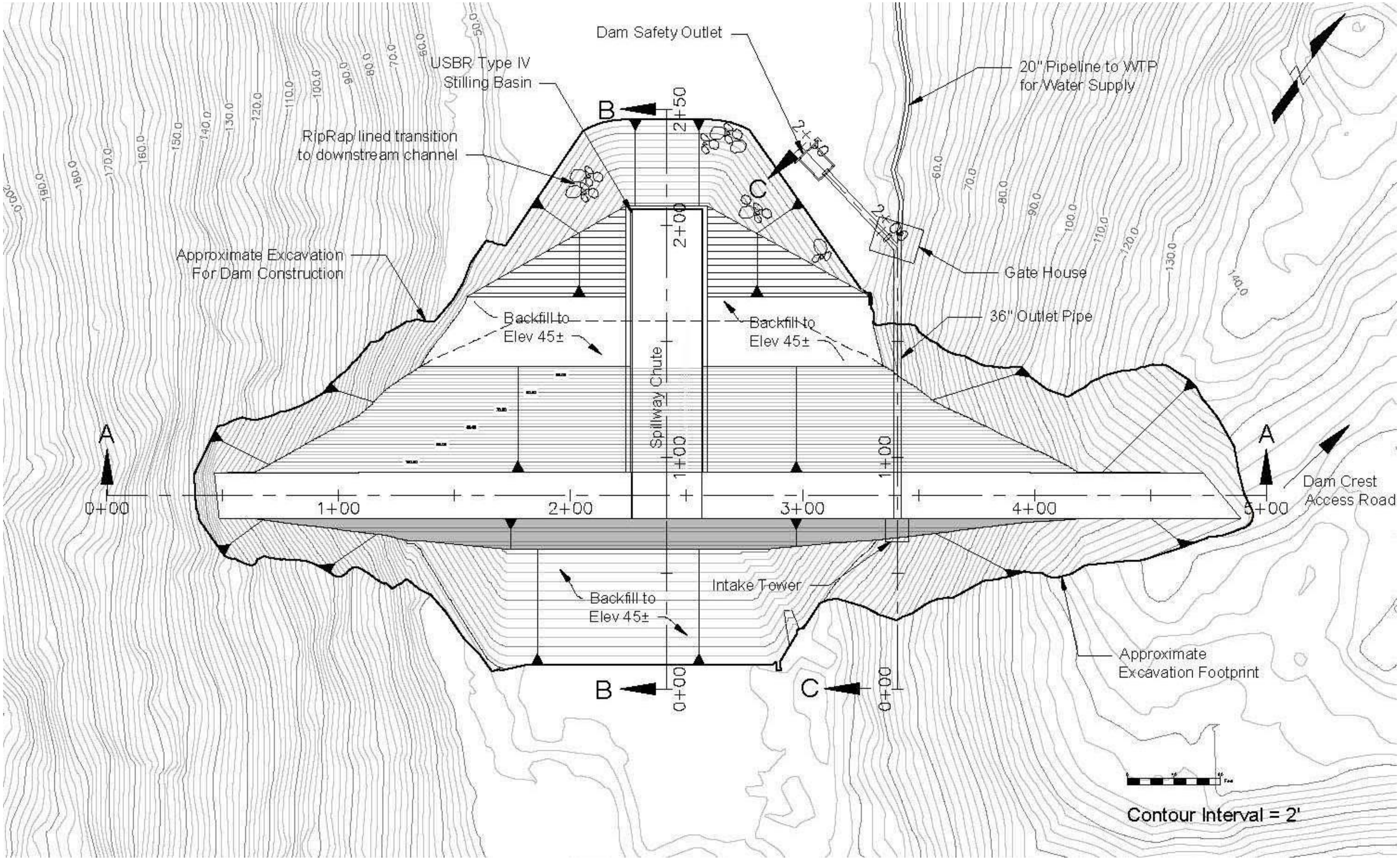




Alternatives 2 – RCC Dam (Roller Compacted Concrete)



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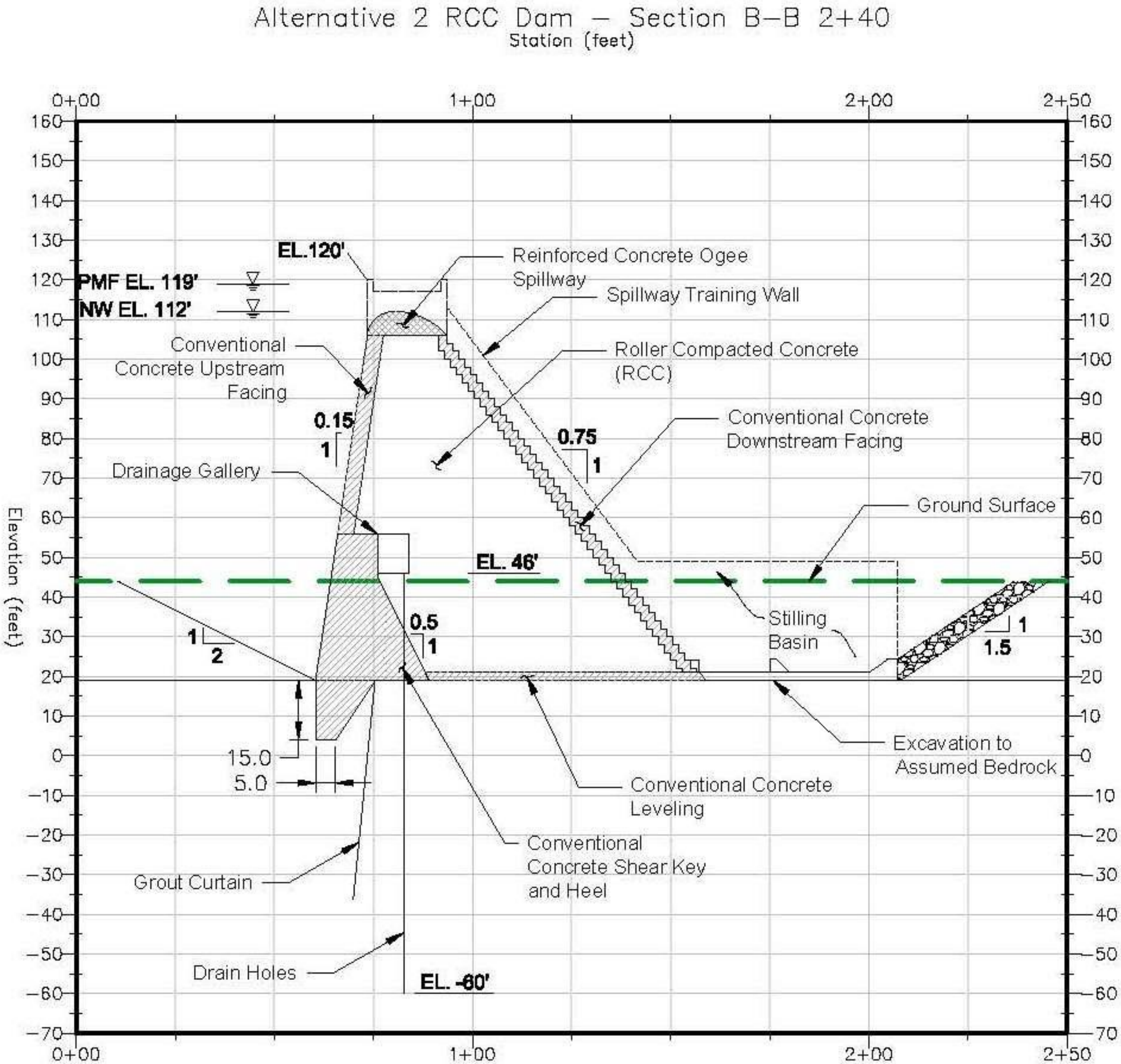
Alternatives 2 – RCC Dam (Roller Compacted Concrete)

Alternatives 2 – RCC Dam (Roller Compacted Concrete)

- Total height = 100 feet at elevation 120 feet
- New water surface elevation = elevation 112 feet
- Excavation to bedrock for new foundation soil

Alternatives 2 – RCC Dam (Roller Compacted Concrete)



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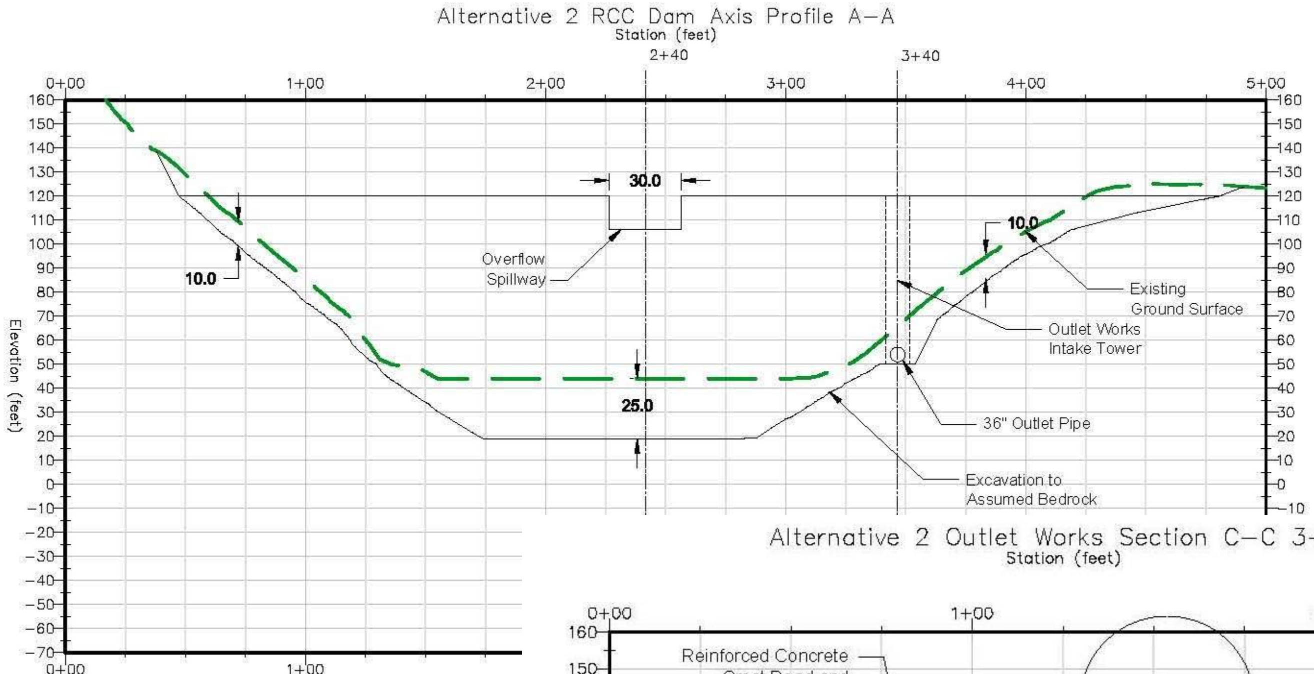
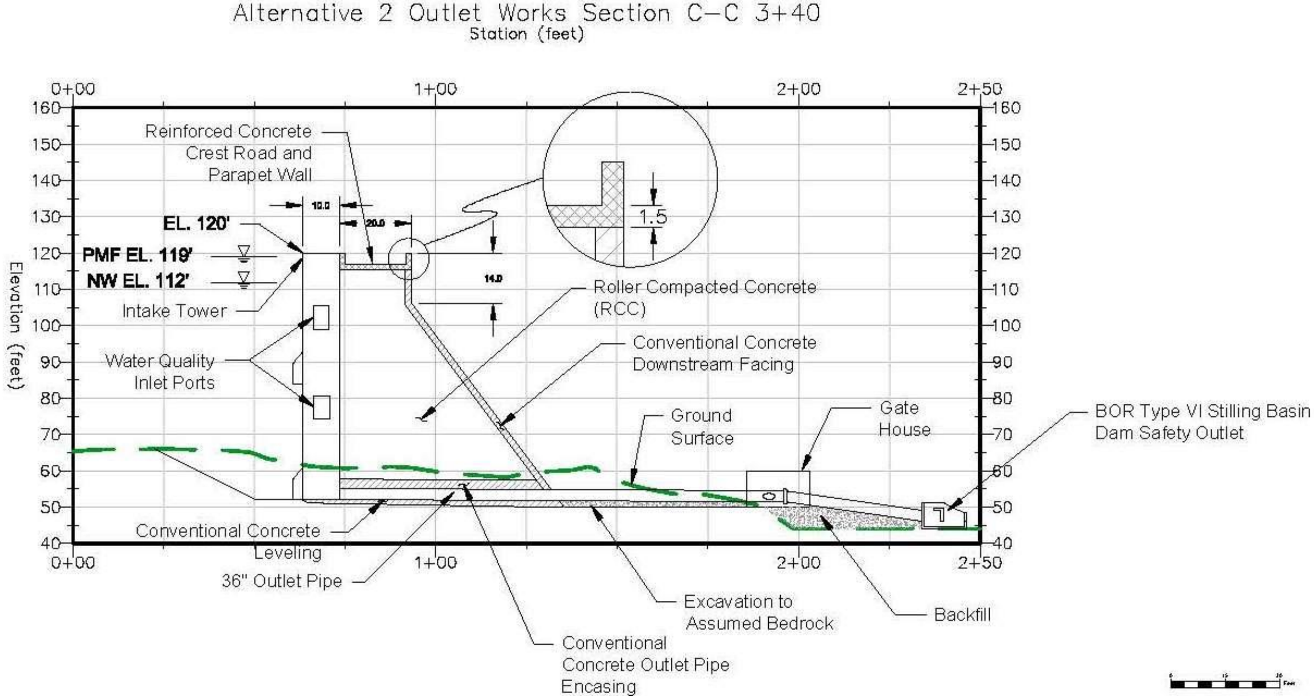
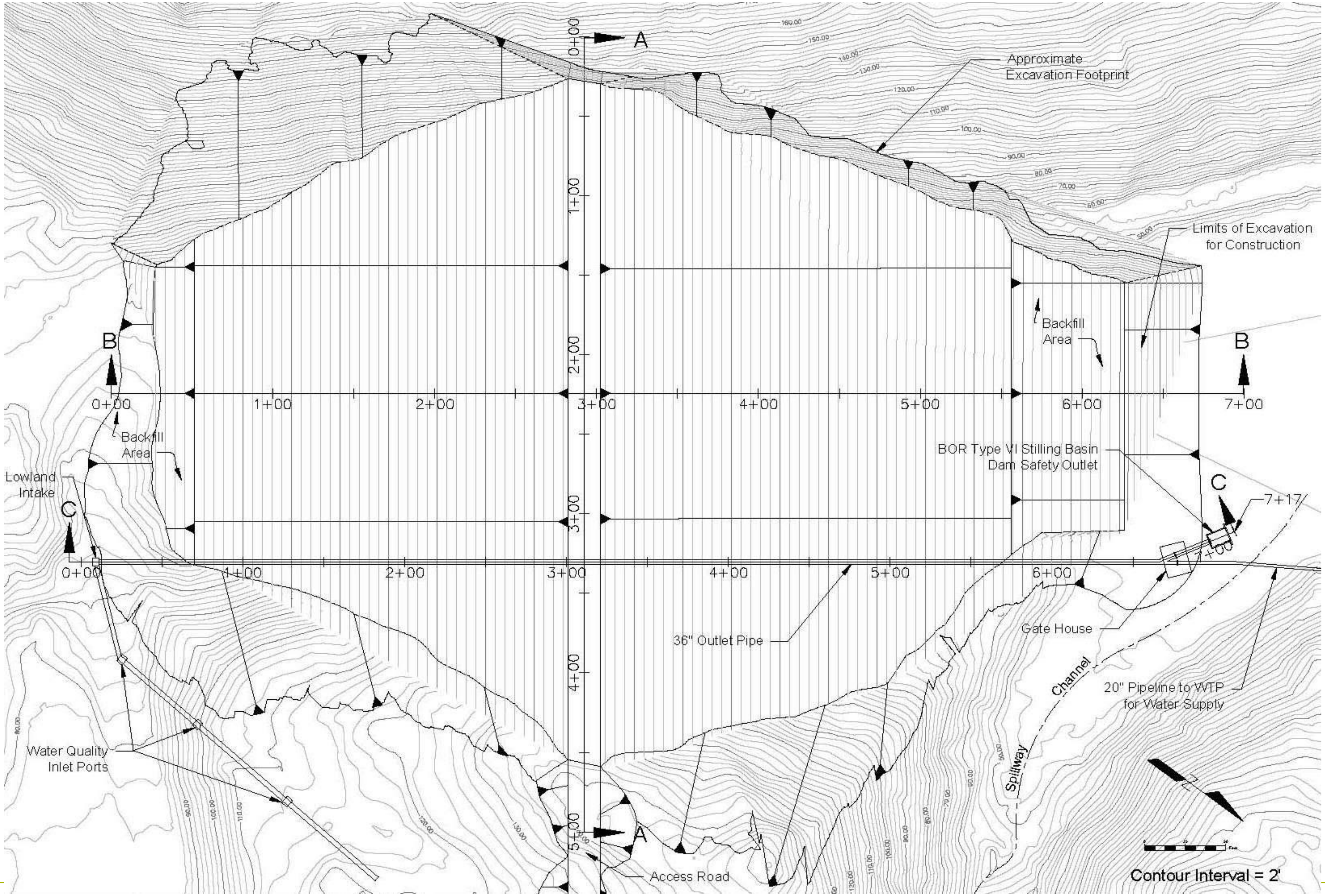




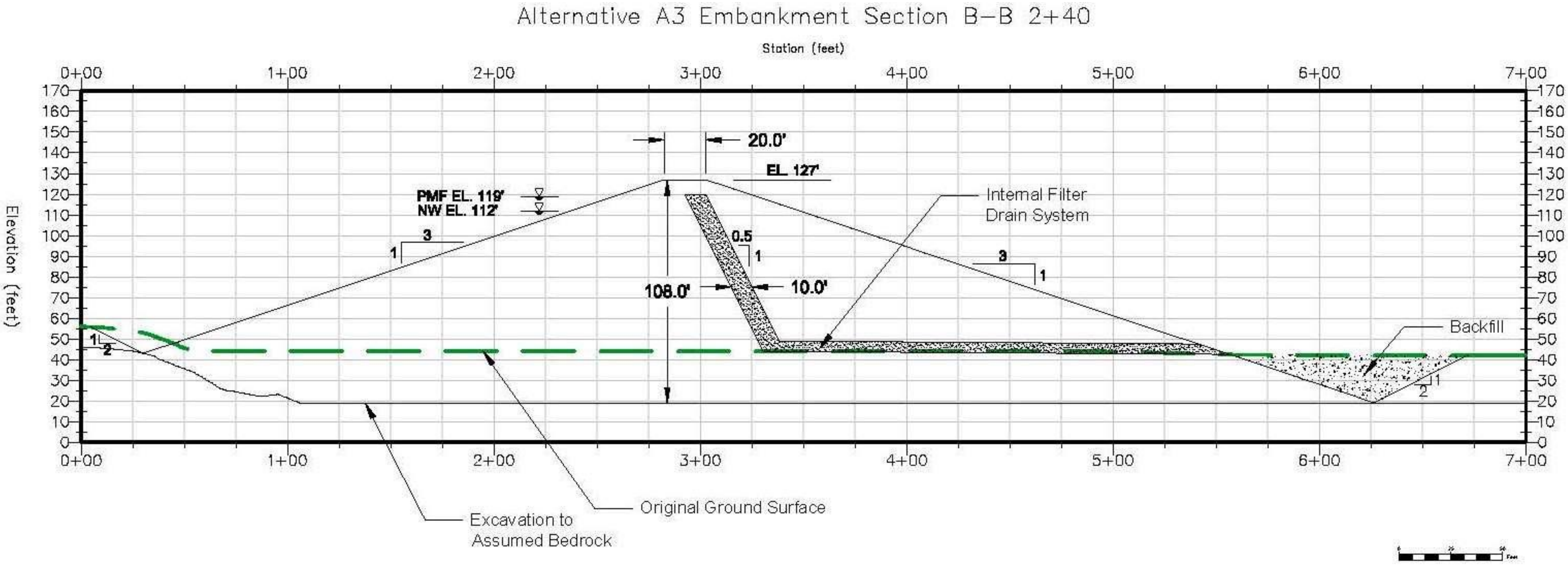
Alternatives 3 – New Embankment Dam



Alternatives 3 – New Embankment Dam

- Total height = 108 feet at elevation 128 feet
- New water surface elevation = elevation 112 feet
- Excavation to bedrock for new foundation soil

Alternatives 3 – New Embankment Dam



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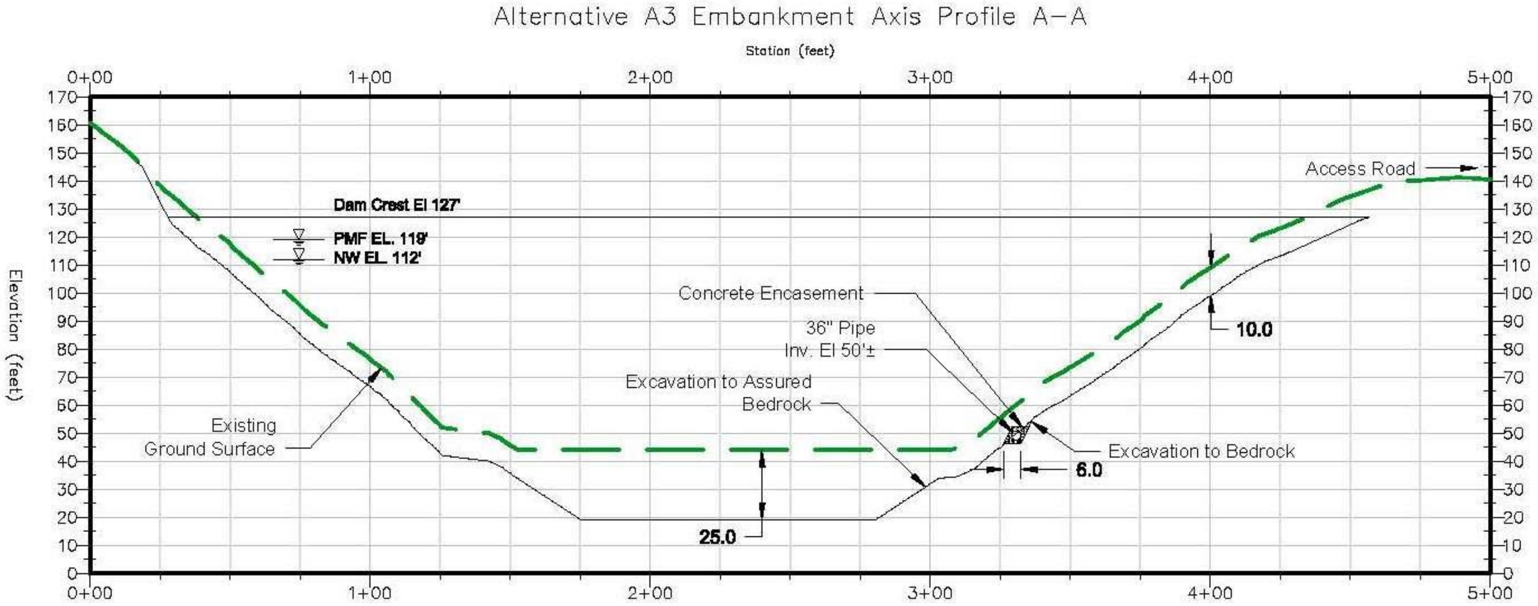

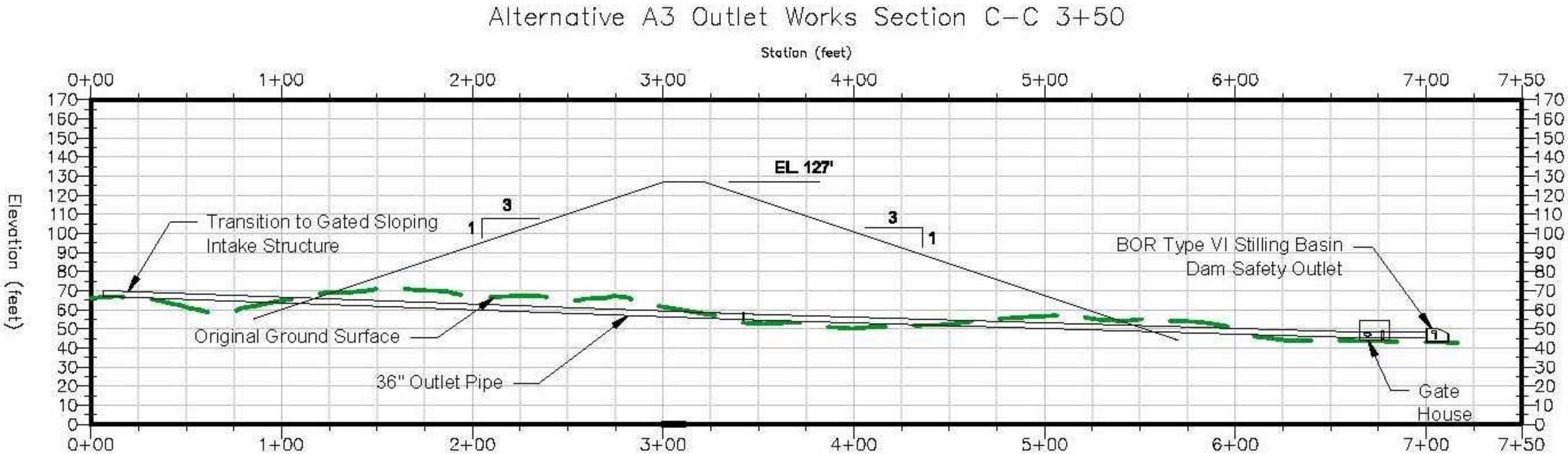

All Alternatives – Related Structures

- Intake structure/sloping intake pipe
- Low level dam safety outlet w/ stilling basin
- Raw water pipeline to Water treatment plant
- Spillway (for embankment option only)
- Fish Ladder
- Access road to and around reservoir

All Alternatives – Comparison

- Constructability
- Excavation volume
- Construction material
- Foundation conditions
- Spillway design
- Intake structure
- Outlet works
- Dewatering
- Seismic resiliency
- Hydraulic resiliency
- Environmental impacts
- Maintenance
- Total costs

Preliminary Environmental Review

Preliminary Environmental Review – Major Permits & Timelines

Required Permit	Timeline	Submittal Occurs at Engineering Design Level (approximate)
National Environmental Policy Act (NEPA)	12-18 months	15-30%
Clean Water Act Section 404/401 and Oregon Removal-Fill permit Other permits processed concurrently with applications: • Endangered Species Act Section 7 • Magnuson Stevens Fishery Conservation and Management Act (Magnuson Stevens Act) • National Historic Preservation Act (NHPA), Section 106 • Migratory Bird Treaty Act • Oregon Fish Passage • Coastal Zone Management Act	6-18 months	30%
Bald and Golden Eagle Protection Act (if required)	4-6 months	30%
Oregon Water Rights	9-12 months	30%
Clean Water Act Section 402 National Pollutant Discharge Elimination System (NPDES) 1200-C	60 days	100%
City of Newport Conditional Use Permit	30 days	60%
City of Newport Building, Electrical, Plumbing, Mechanical, Sewer/Water Permit	30 days	100%
Oregon State Engineer Design Review and Approval	2 months	100%

Preliminary Environmental Review – Major Permits & Timelines

- Anticipated environmental studies:
  - cultural resource evaluation
  - wetland and waters delineation
  - developing mitigation plans
  - updating Emergency Action Plan
  - preparing a biological assessment.

- Costs: range from 1 to 6 percent of the overall construction costs.

Alternatives – Decision Level Cost Estimates

- **Cost numbers for comparison purposes NOT for budgeting purposes!**

  (assist in selecting the preferred alternative)

- Items not explicitly included in cost estimate:
  - fish ladder
  - spillway (for embankment option)
  - access road to the dam
  - access road around the reservoir
  - pipeline from the dam to the water plant

Alternatives – Decision Level Cost Estimates

- Alternative 1 – no cost estimate
- Alternative 2 & 3 estimate includes:
  - Site preparation
  - Main dam work
  - Intake structure/fish screens/pipeline through dam
  - Base construction cost
  - Contingencies

Alternative 2 RCC dam = $ 19,000,000

Alternative 3 new embankment dam = $ 17,800,000 (spillway not included)

Similar costs - decision needs to be based on advantages / disadvantages

Conclusions

1. Phase 3 explorations and engineering analyses confirmed significant seismic deficiencies with both BC 1 and BC 2 dams
2. Analysis indicated both dams are unsafe due to excessive deformations
3. Lower dam (BC-1) not economically feasible to save – rehabilitation or decommissioning will be required by the state
4. Current & future water storage combined at upper/new site
5. Several alternatives have been identified – two feasible alternatives remain on the table (RCC dam & new embankment dam)
6. Configuration level studies are configured for a 5000 year recurrence interval earthquake
7. This complies with state and federal requirements

Recommendations

Based on cost estimate & advantages/disadvantages:

Alternative 2 – RCC Dam

- Constructability
- Spillway included
- Less construction time
- Less footprint – less excavation
- Better intake structure
- Less environmental impacts
- Better seismic resiliency
- Less maintenance

What's Next ?

Pre-Design = Comprehensive Characterization of new dam site

- Define dam failure consequences
- Identify appropriate design criteria
- Geotechnical verification
- Budgetary Cost estimate
- Begin of environmental permitting process
- Comprehensive survey of dam site and access road site

Additional modeling per state requirements:

- To determine design requirements for dam

Update of Emergency Action Plan

Questions?