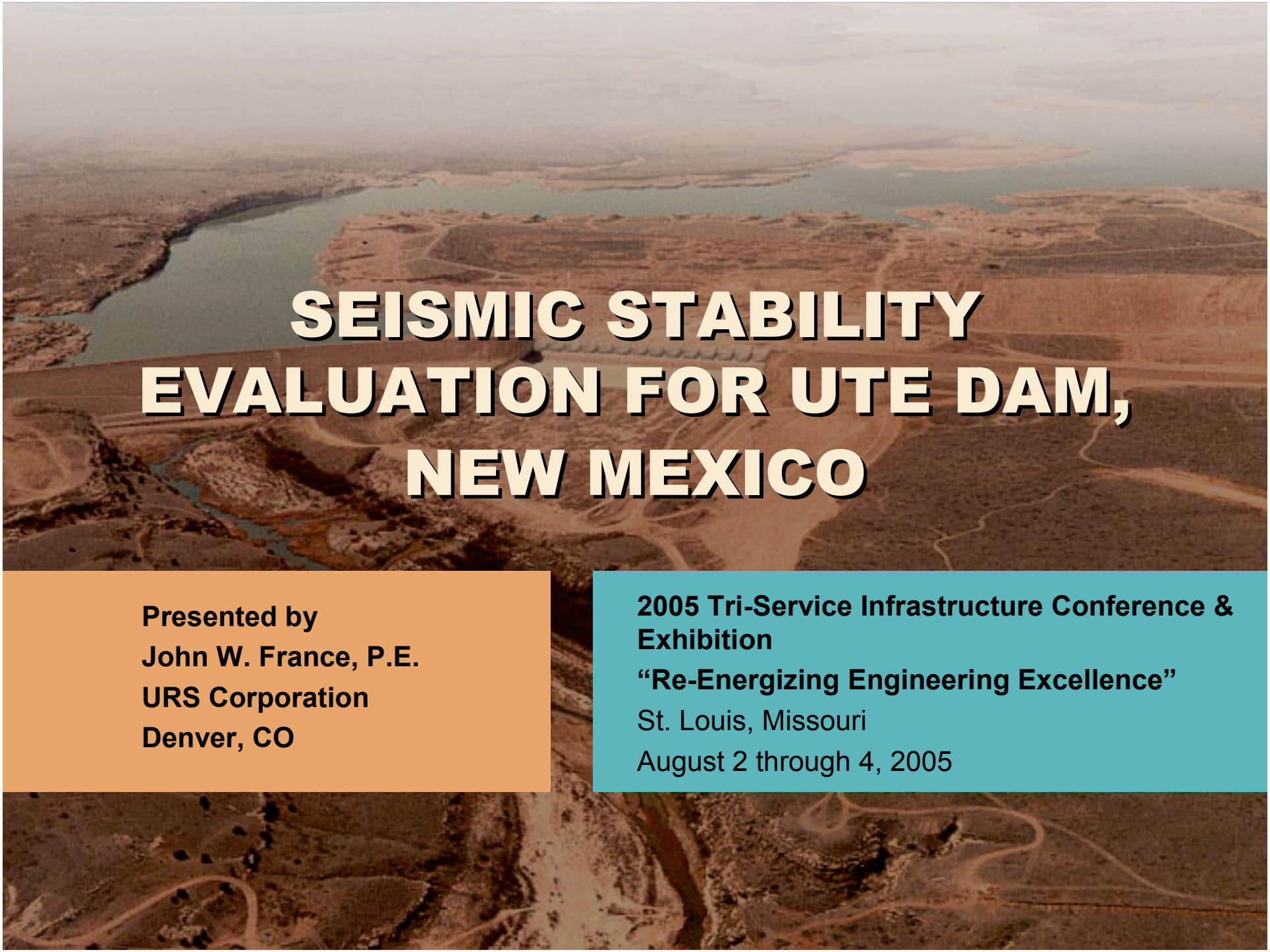

SEISMIC STABILITY EVALUATION FOR UTE DAM, NEW MEXICO

Presented by
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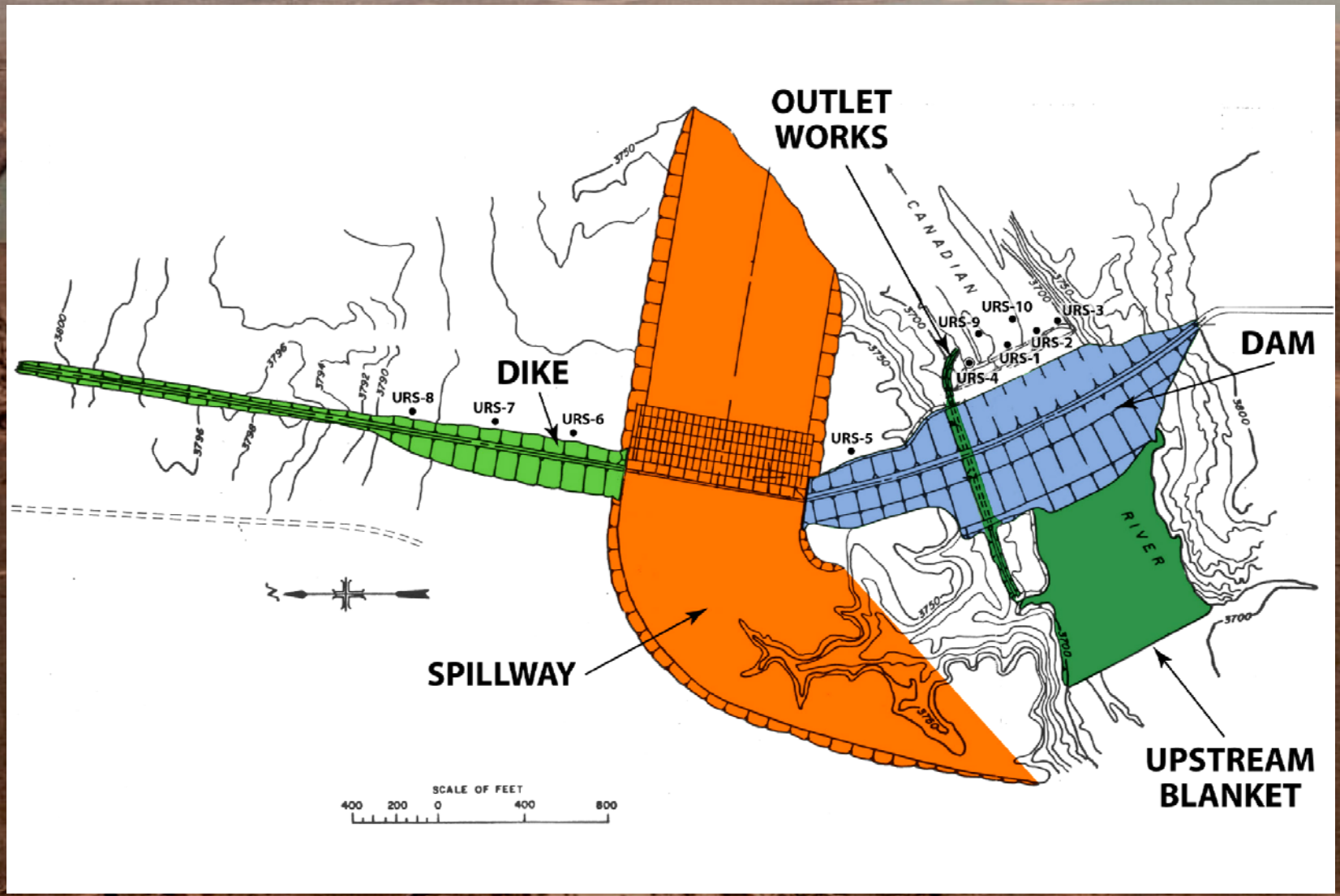
URS Corporation
Denver, CO

2005 Tri-Service Infrastructure Conference & Exhibition
"Re-Energizing Engineering Excellence"
St. Louis, Missouri
August 2 through 4, 2005

PROJECT LOCATION

PROJECT FEATURES



PROJECT HISTORY

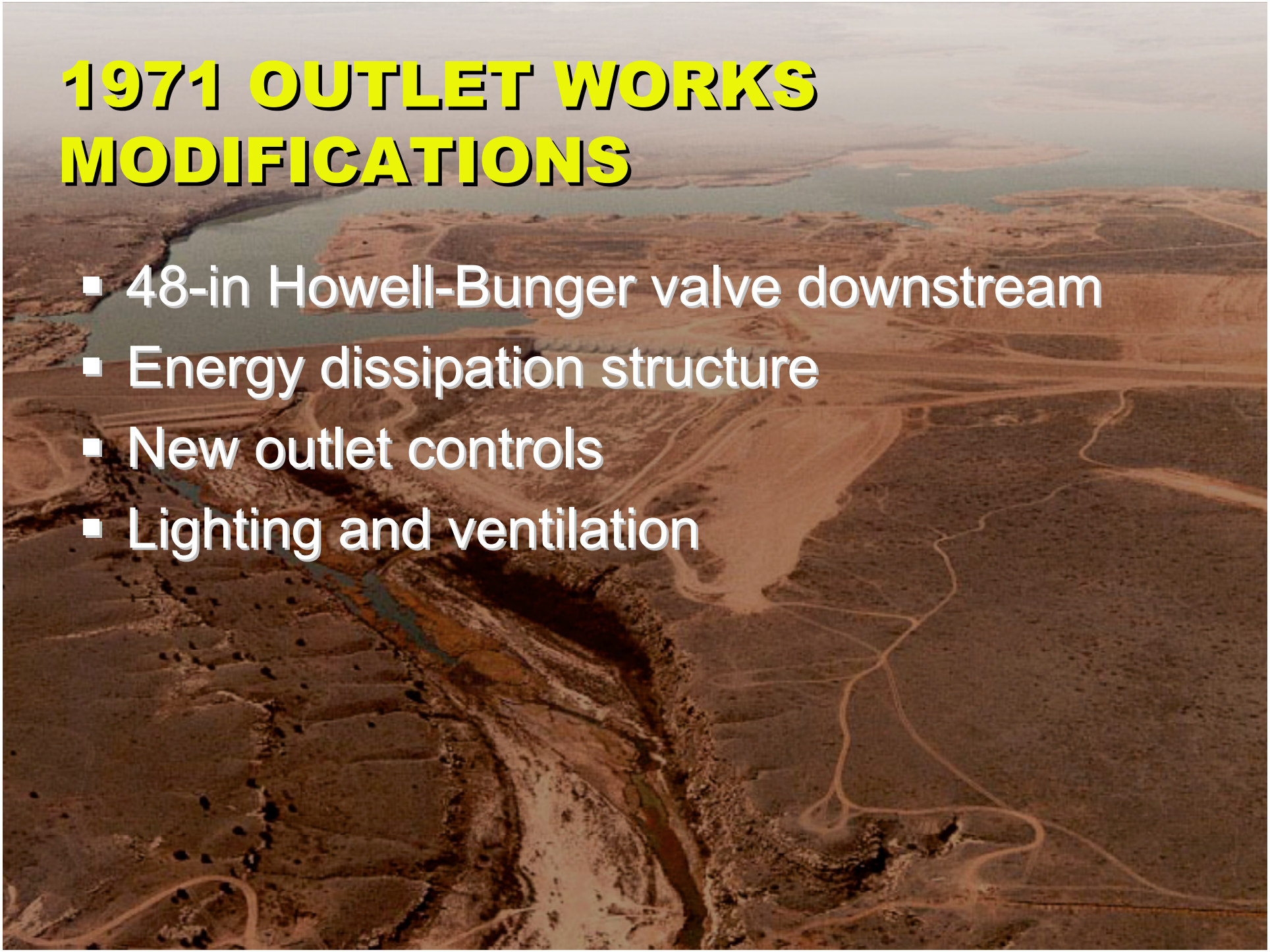
- Originally designed by Becthel for State of New Mexico
- Originally constructed 1962-63
- Outlet works modified twice: 1971 and 2000
- Embankment and spillway modified in 1984

ORIGINAL PROJECT

- 121-foot high zoned embankment dam:
  - crest elevation = 3801
  - crest length = 2,050 ft
- 27-foot high, 2,860-foot long dike
- Concrete ogee crest spillway:
  - crest elevation = 3760
  - crest length = 840 ft
- Conduit outlet works through base of embankment

ORIGINAL OUTLET WORKS

- Inlet structure on reservoir floor
- 60-in diameter concrete-encased steel conduit to gate chamber
- Gate chamber and 7-foot diameter horseshoe tunnel
- 42-in butterfly valve
- 36-in diameter steel pipe
- Concrete-lined discharge channel


1971 OUTLET WORKS MODIFICATIONS
48-in Howell-Bunger valve downstream
Energy dissipation structure
New outlet controls
Lighting and ventilation

2000 OUTLET WORKS MODFICATIONS

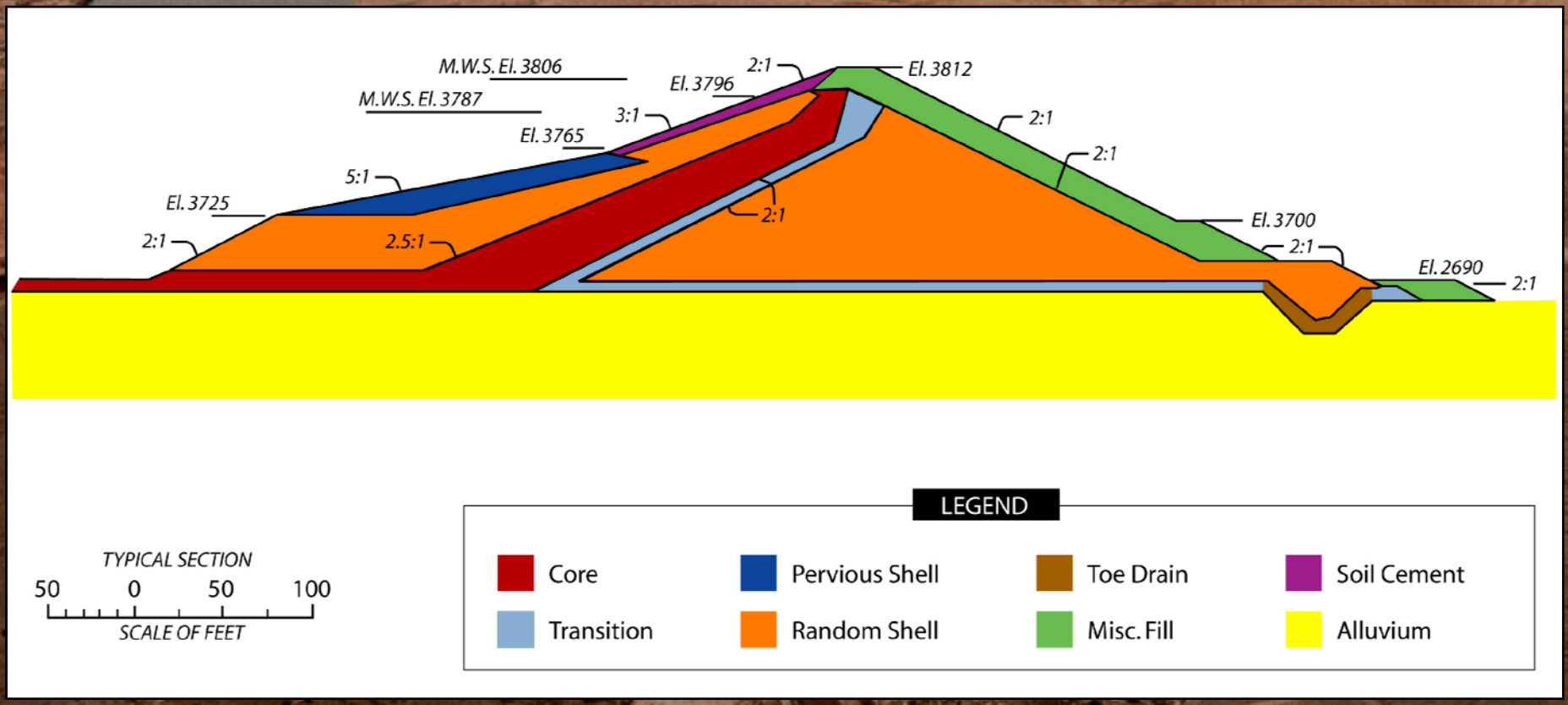
- Replacement of:
  - 36-in diameter pipe with 42-in diameter pipe
  - 42-in butterfly valve with new valve of same size
  - Ventilation blower and tunnel lighting
- Designed by USACE

1984 EMBANKMENT AND SPILLWAY MODIFICATIONS

- Raised embankment and dike crests 11 feet to elevation 3812
- Raised spillway crest 27 feet to elevation 3787
- Constructed labyrinth weir upstream of ogee weir
- Increased storage by 160,000 af to 229,000 af
- Designed by the Bureau of Reclamation


EXISTING EMBANKMENT DAM
132-foot high zoned embankment
Placed and compacted according to modern standards
Constructed on up to 66 feet of alluvial soils over bedrock

EMBANKMENT DAM CROSS SECTION



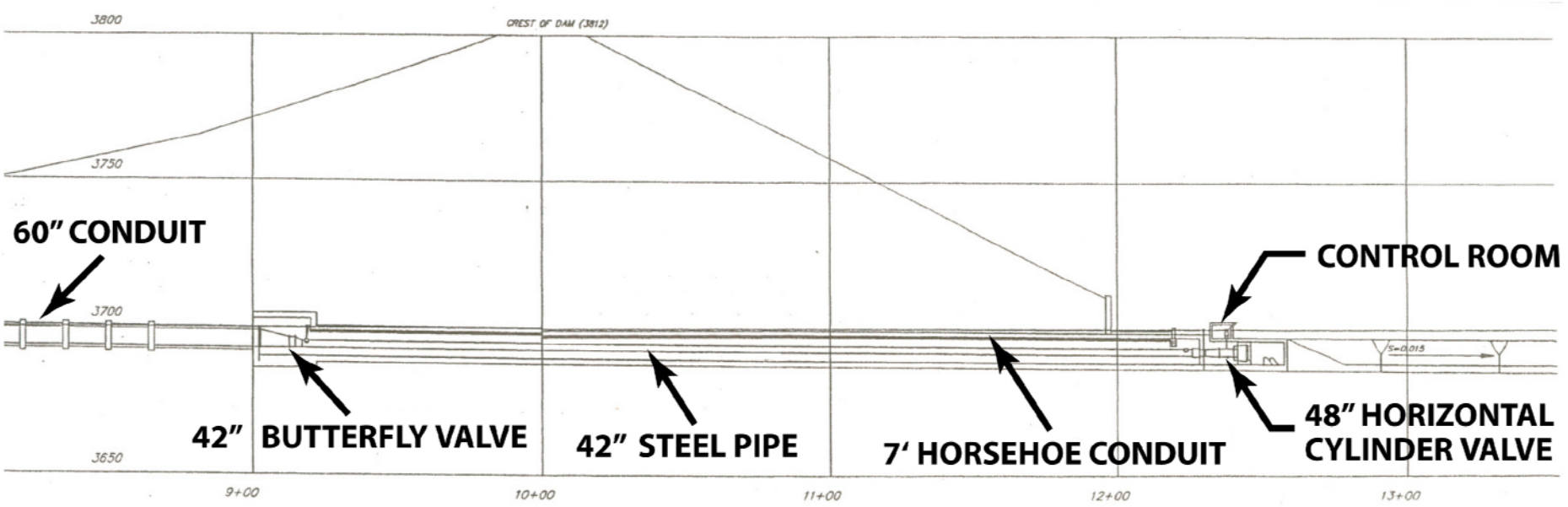
EXISTING DIKE

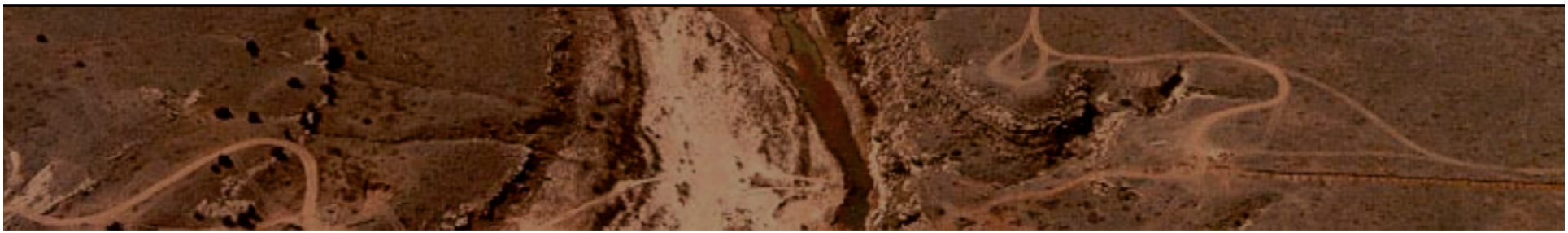
- 38-foot high zoned embankment
- Placed and compacted according to modern standards
- Constructed on up to 40 feet of alluvial soils over bedrock

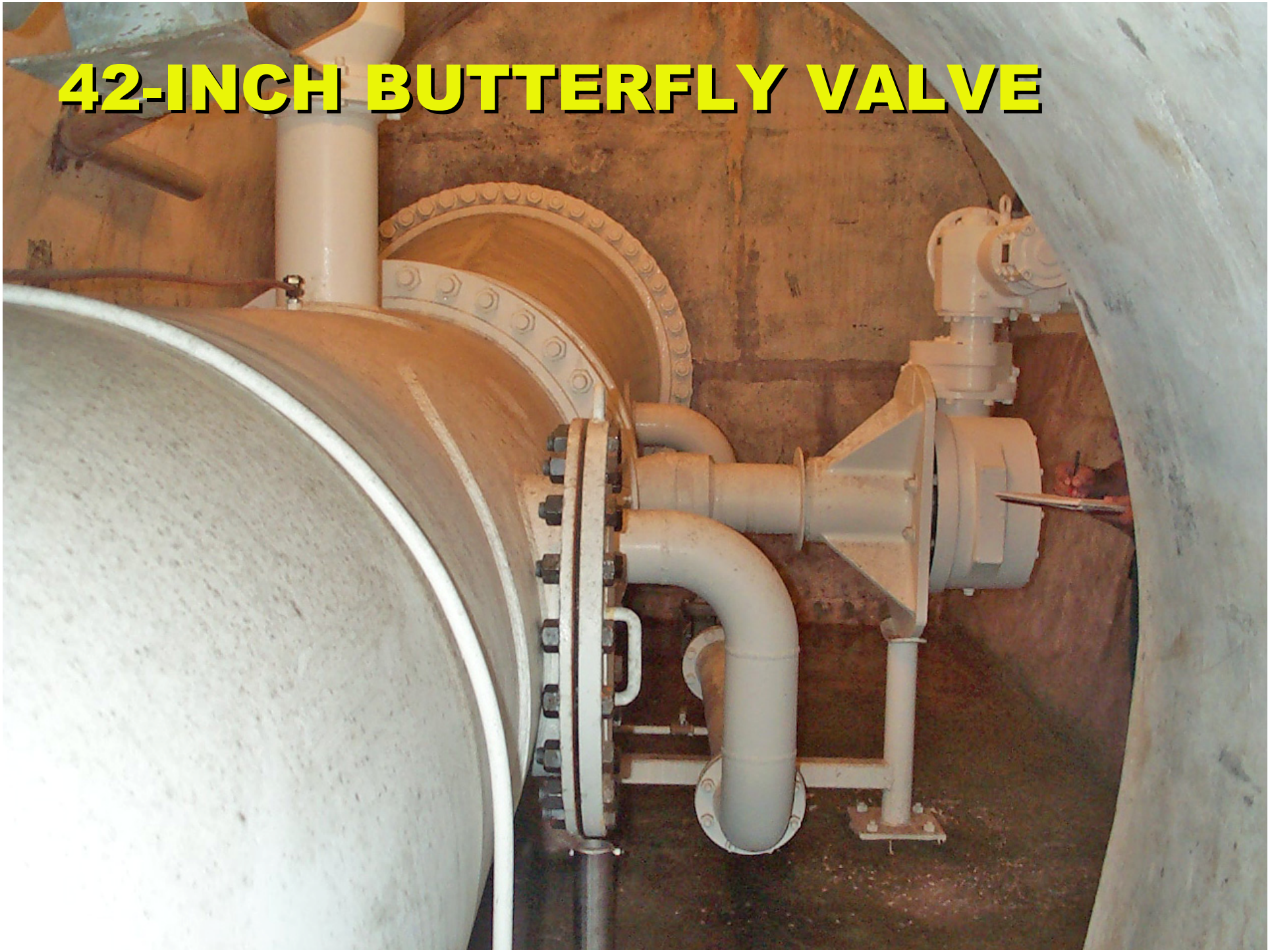
EXISTING SPILLWAY

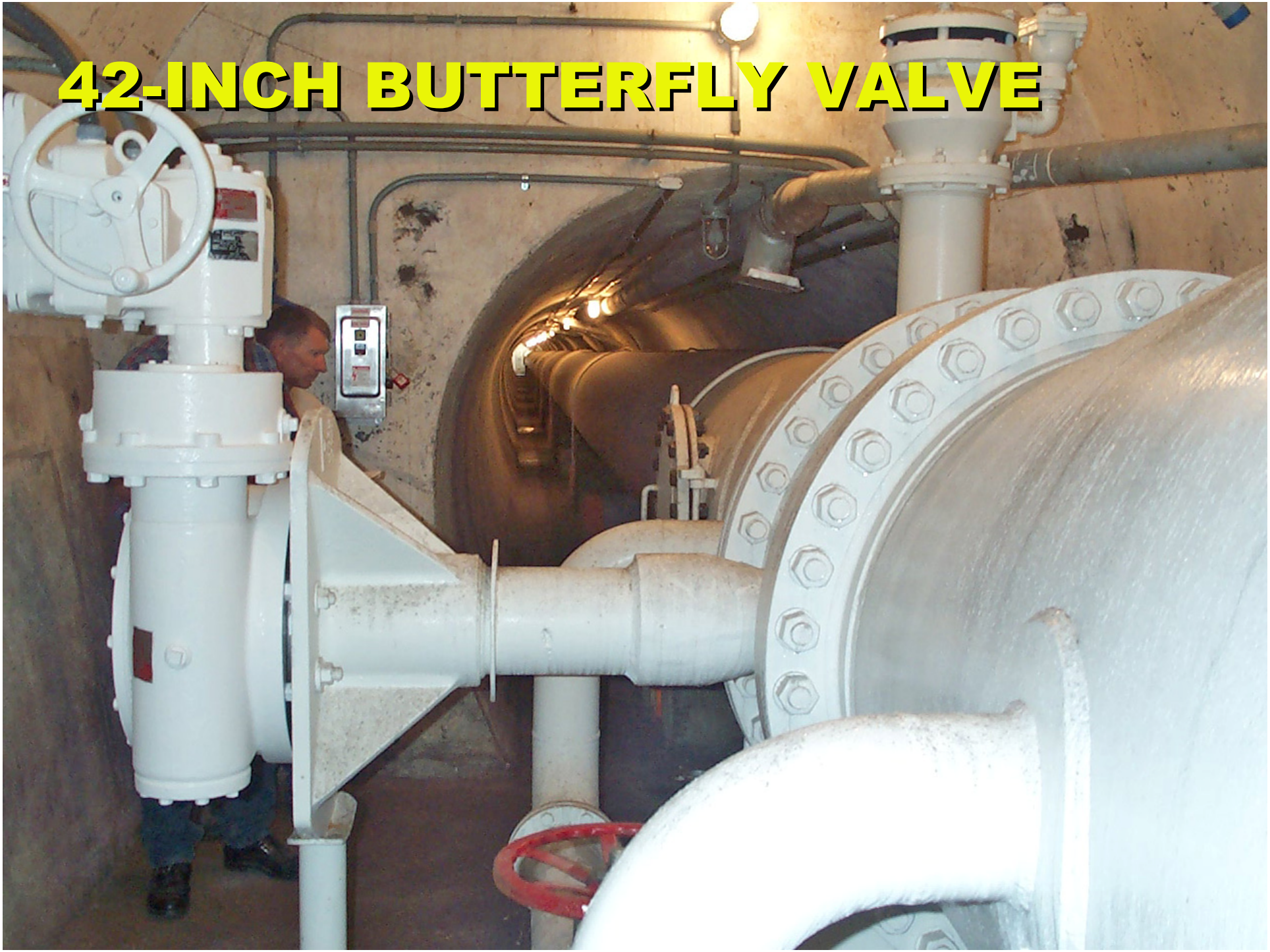
- Labyrinth weir
- Ogee crest
- Concrete chute
- Excavated rock channel

EXISTING OUTLET WORKS



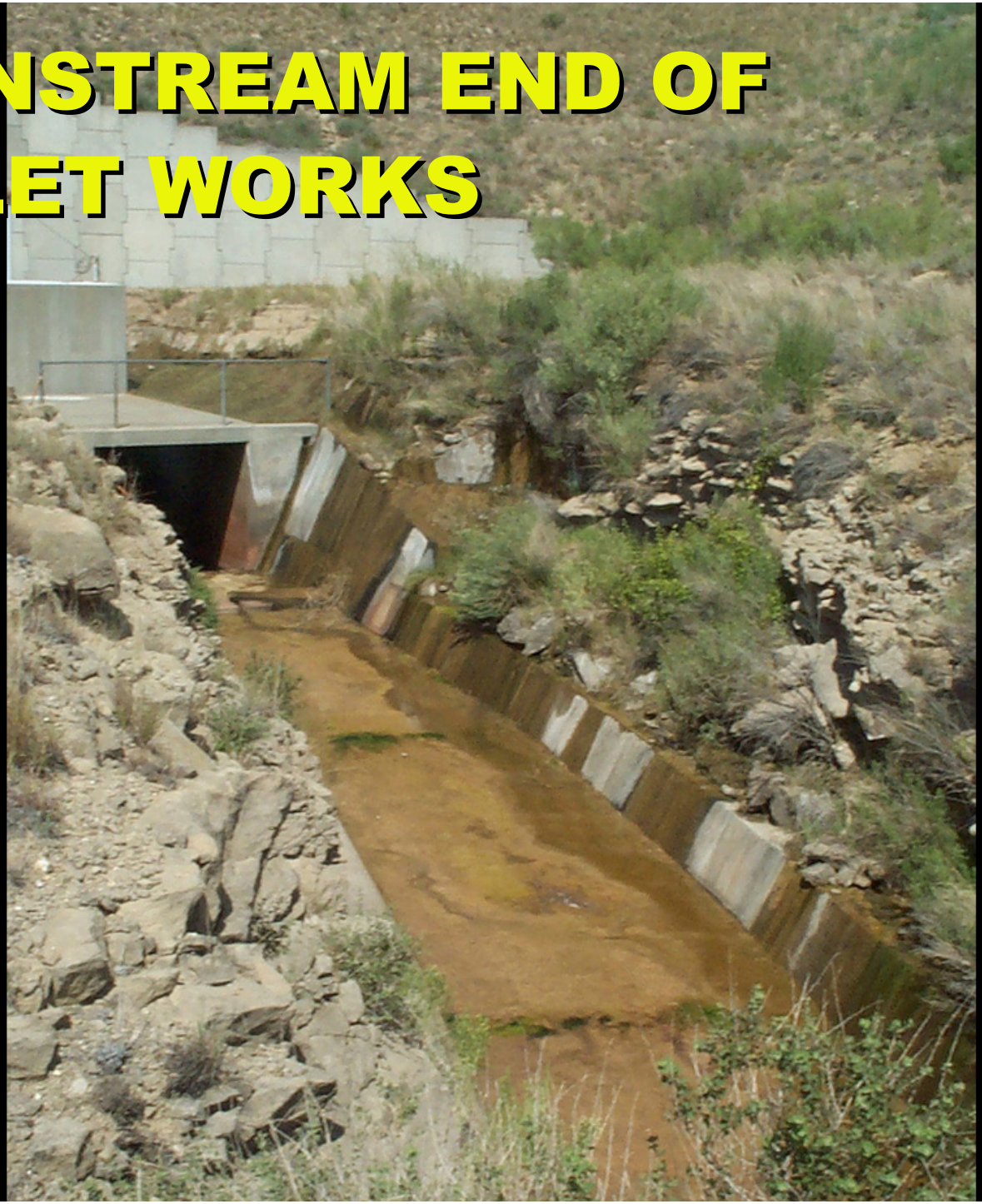



42-INCH BUTTERFLY VALVE


42-INCH BUTTERFLY VALVE


42-INCH STEEL PIPE

DOWNSTREAM END OF OUTLET WORKS




OUTLET WORKS DISCHSRGE
CHANNEL

REASONS FOR SEISMIC STABILITY EVALUATION

- No up-to-date assessment of earthquake ground motions
- No data for evaluation of liquefaction potential of foundation alluvium
- No record of state-of-the-practice seismic stability analysis of dam or appurtenant structures

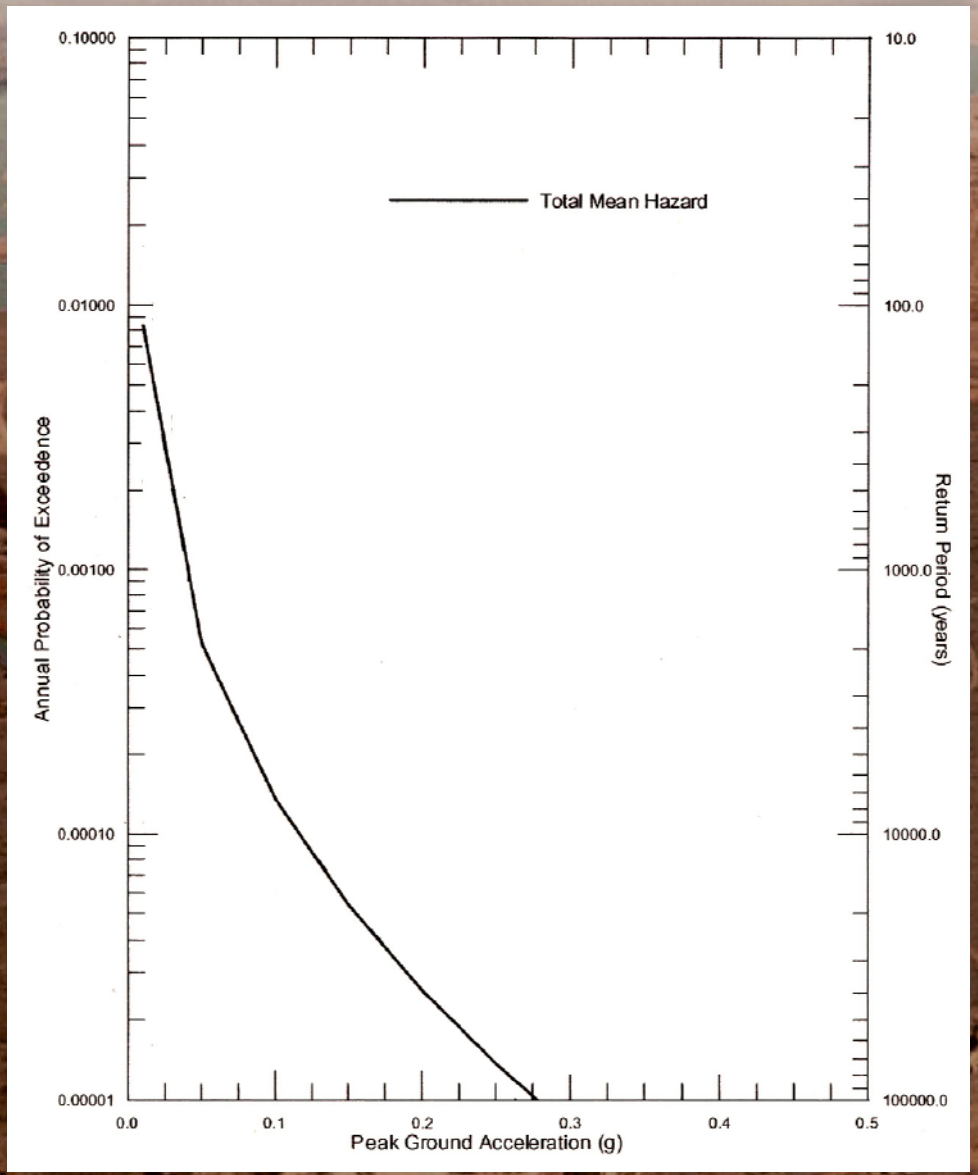
SCOPE OF THE STUDY

- Probabilistic seismic hazard analysis (PSHA) – ground motion study
- Field and laboratory investigation
- Liquefaction potential evaluation
- Embankment seismic stability evaluation
- Appurtenant structure seismic stability analysis

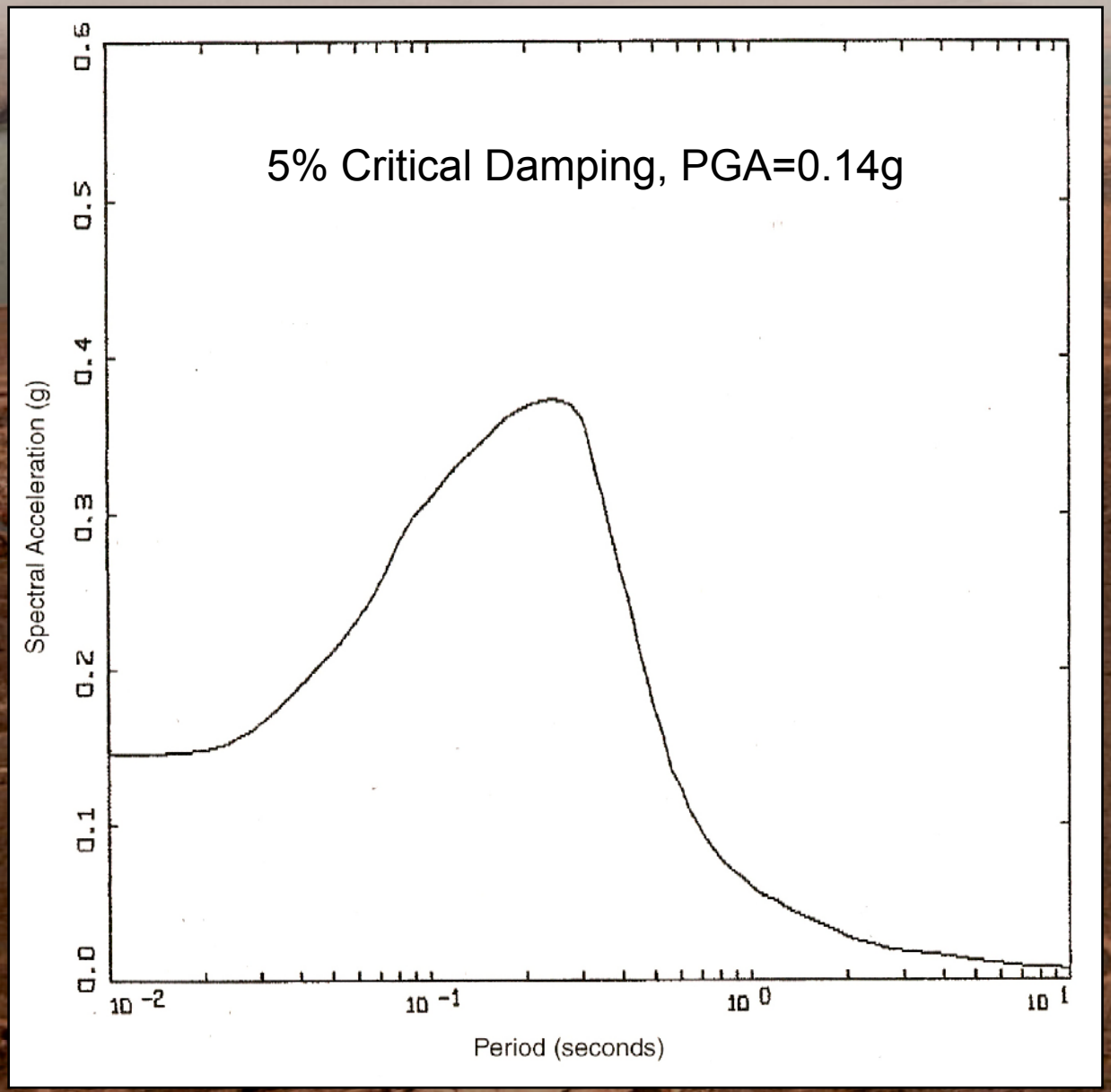
PSHA - SCOPE

- Evaluate historical seismicity
- Review available data and aerial photography
- Complete quantitative PSHA
- Develop site response recommendations

PSHA – SEISMIC HAZARD CURVES



PSHA – RESPONSE SPECTRA



PSHA – MEAN PEAK GROUND ACCELERATIONS (PGAs)

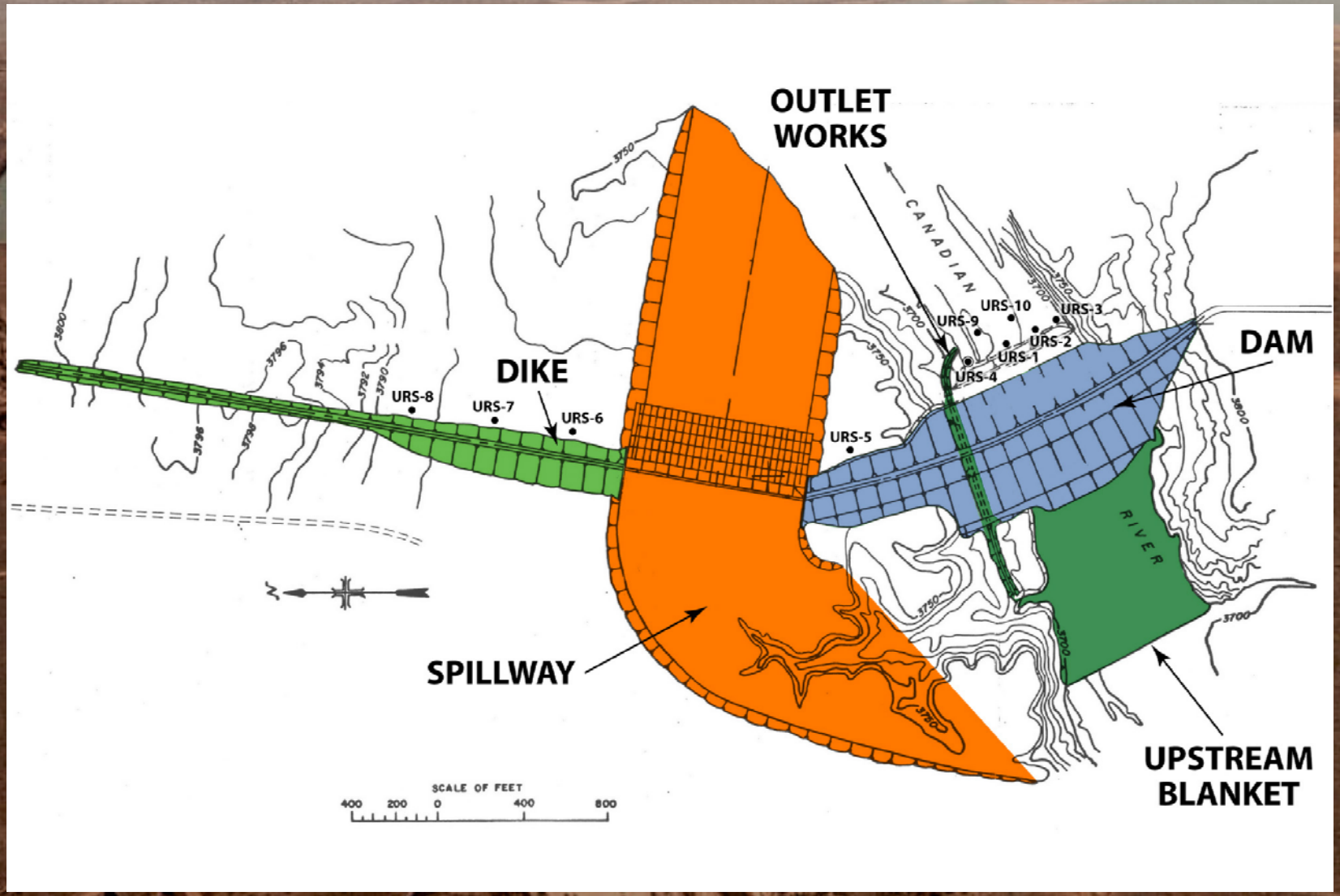
Return Period	Alluvium	Soft Rock
2,500 years	~0.10g	0.06g
5,000 years	0.14g	0.08g
10,000 years	0.20g	0.12g

All PGAs are for M 5.5 events

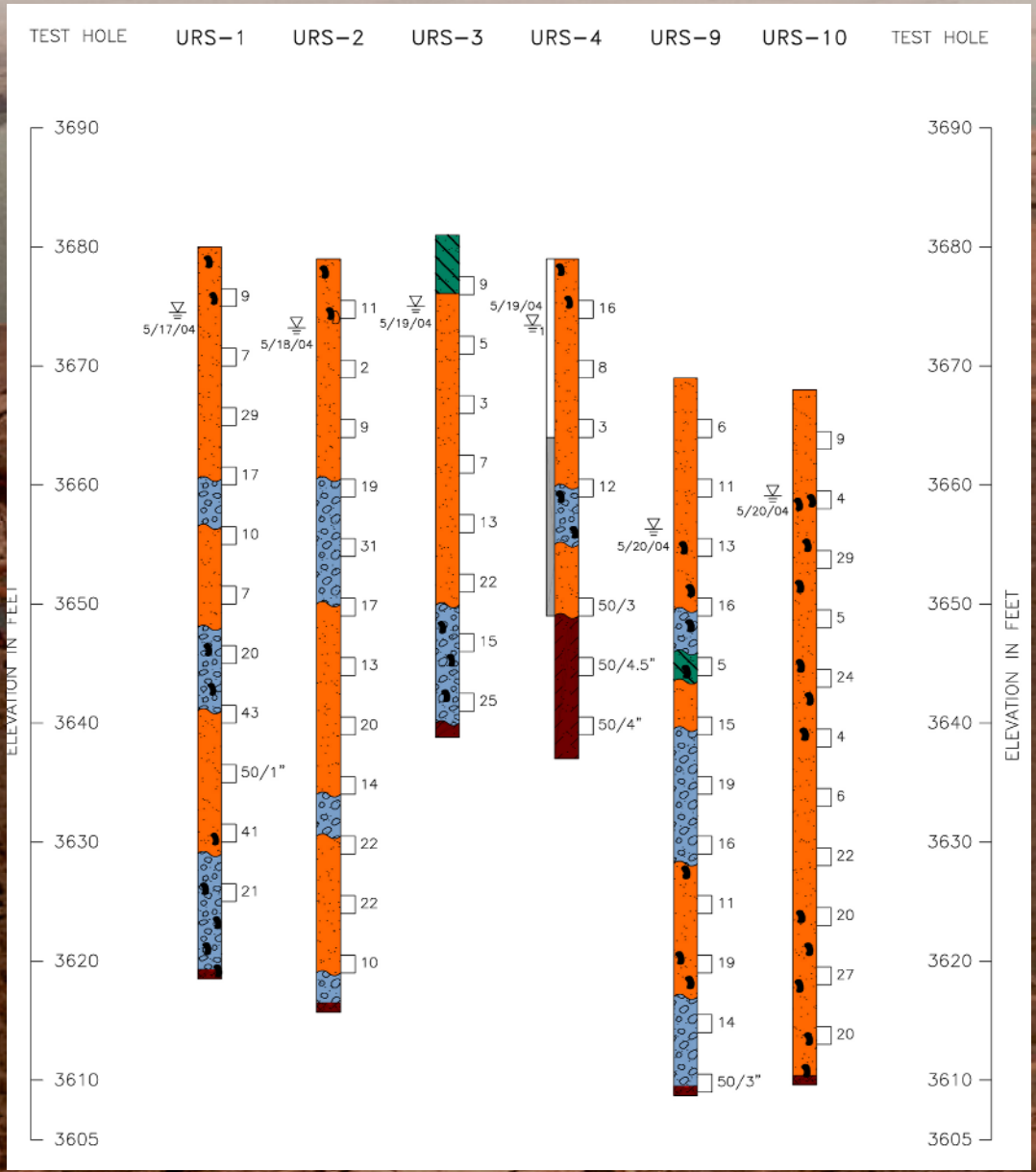
PSHA – REQUIRED AND RECOMMENDED PGAs

- New Mexico OSE requires at least 2,500 year PGA for Ute Dam
- ICOLD recommends 3,000 to 10,000 year event
- 5,000 year and 10,000 year PGAs considered in this study

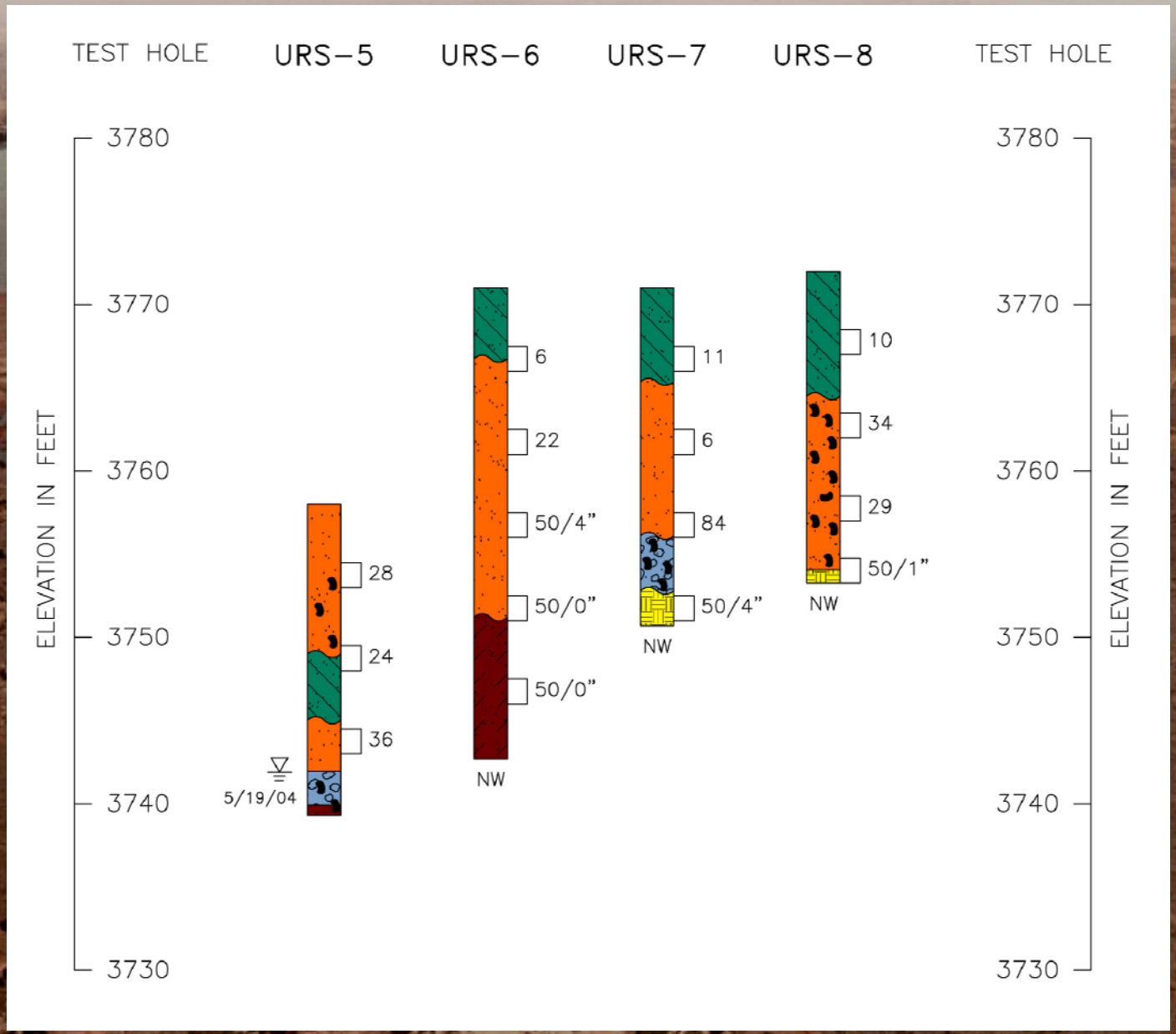
FIELD INVESTIGATIONS



TEST BORINGS - DAM



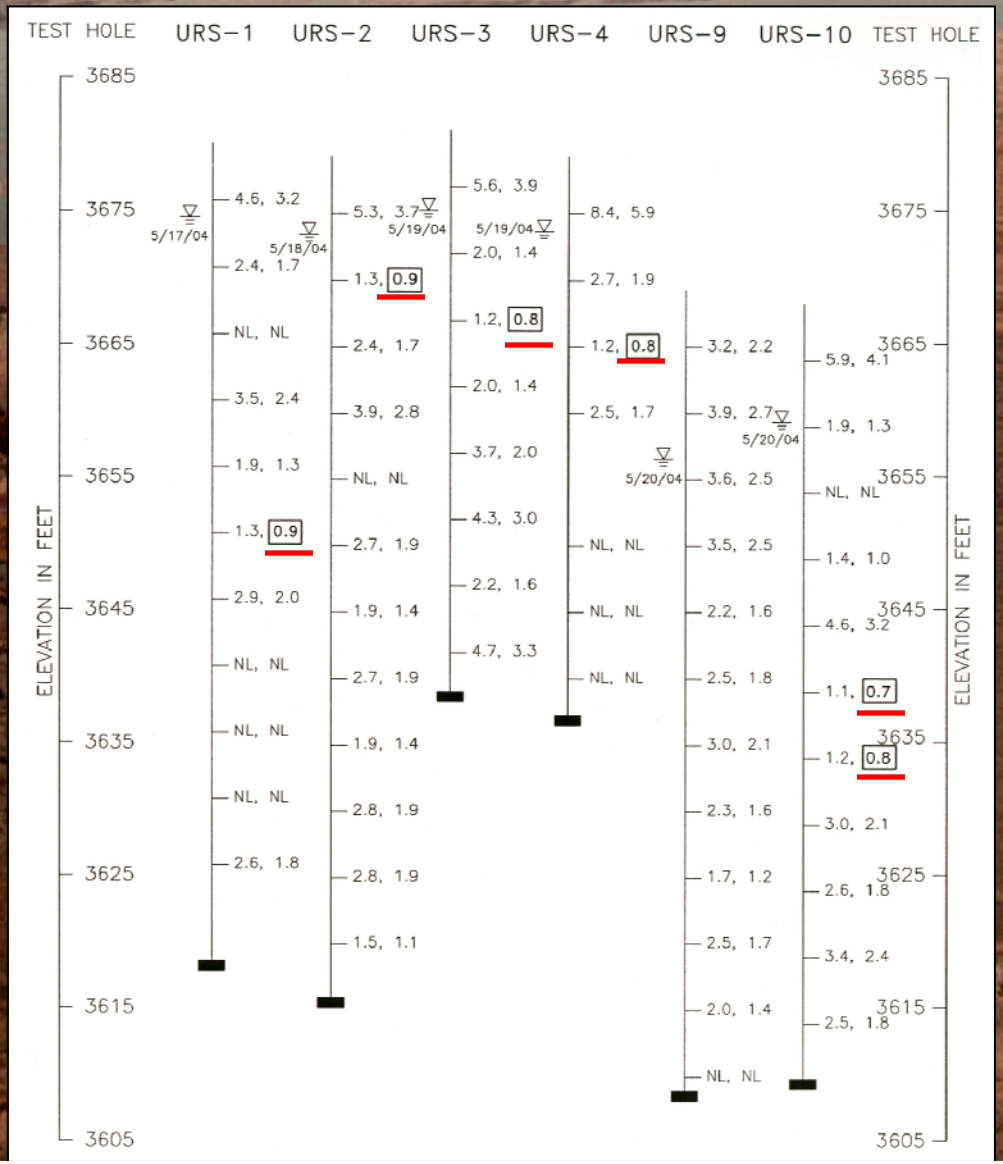
TEST BORINGS - DIKE



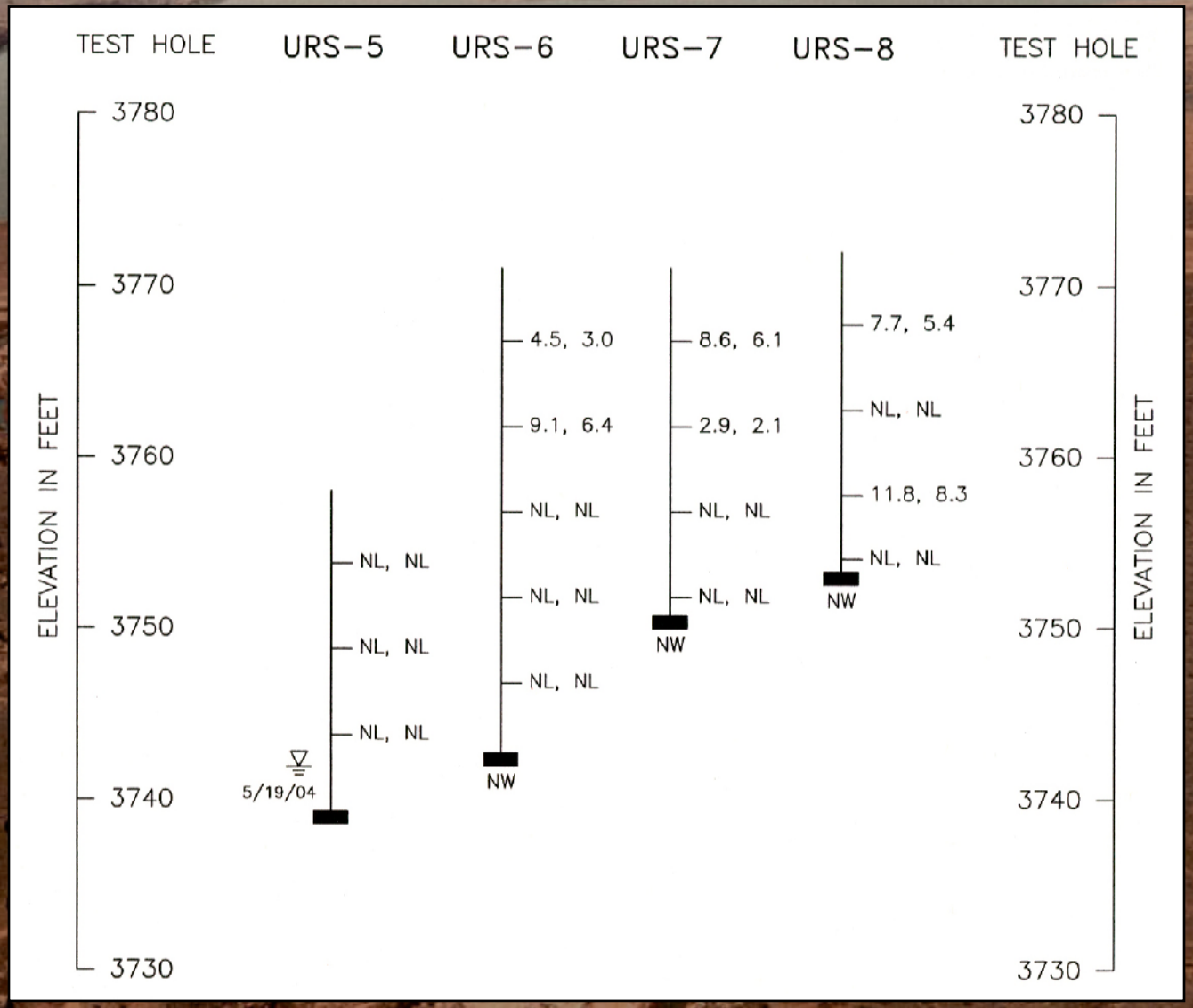
LIQUEFACTION ANALYSIS METHOD

- Procedures based on SPT blowcounts and empirical charts, Youd et al, 2001
- Comparison of cyclic resistance ratio (CRR) with cyclic stress ratio (CSR)
- Analysis included adjustments for:
  - earthquake magnitude
  - fines content
  - overburden pressure
  - depth
  - SPT hammer
- Consideration of gravel effects

LIQUEFACTION ANALYSIS RESULTS – DAM FOUNDATION



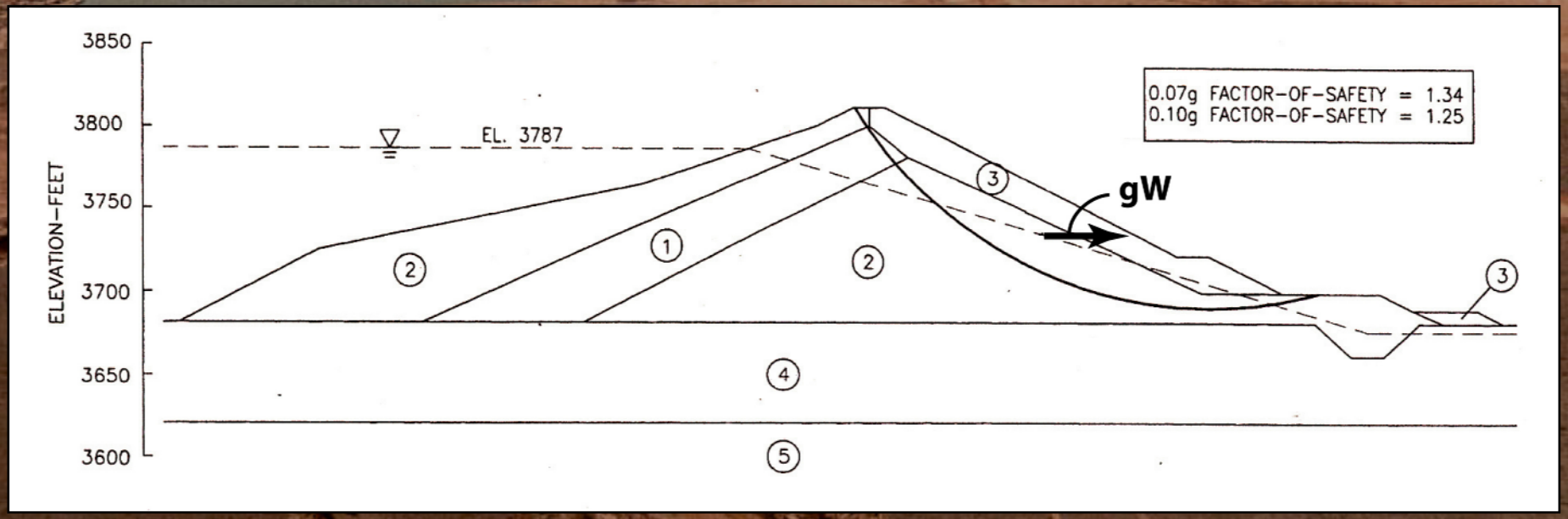
LIQUEFACTION ANALYSIS RESULTS – DIKE FOUNDATION



PSUEDO-STATIC STABILITY ANALYSES

- Psuedo-static coefficients:
  - 5,000 year: 0.07g
  - 10,000 year: 0.10g
- 50% of alluvium PGAs
- NMOSE requires “50% of bedrock acceleration, but not less than 0.05g”
- Analysis coefficients are conservative

EXAMPLE P-S STABILITY ANALYSES



PSUEDO-STATIC ANALYSIS RESULTS

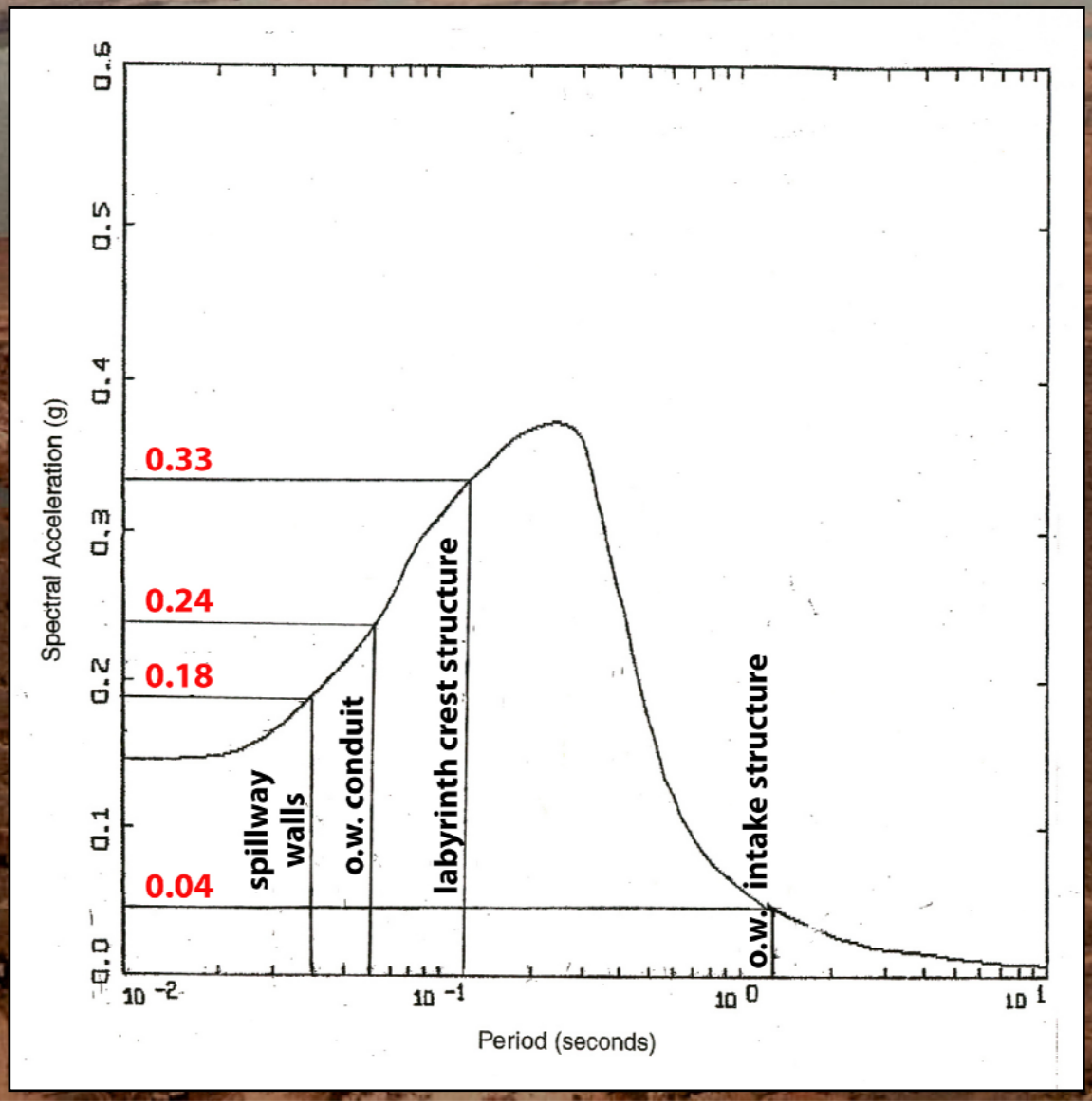
Case	Calculated Factors of Safety	
	5,000 year 0.07g	10,000 year 0.10g
Downstream	1.34 to 1.48	1.25 to 1.36
Upstream	1.77 to 1.85	1.54 to 1.62

NMOSE requires FS $\geq$ 1.1

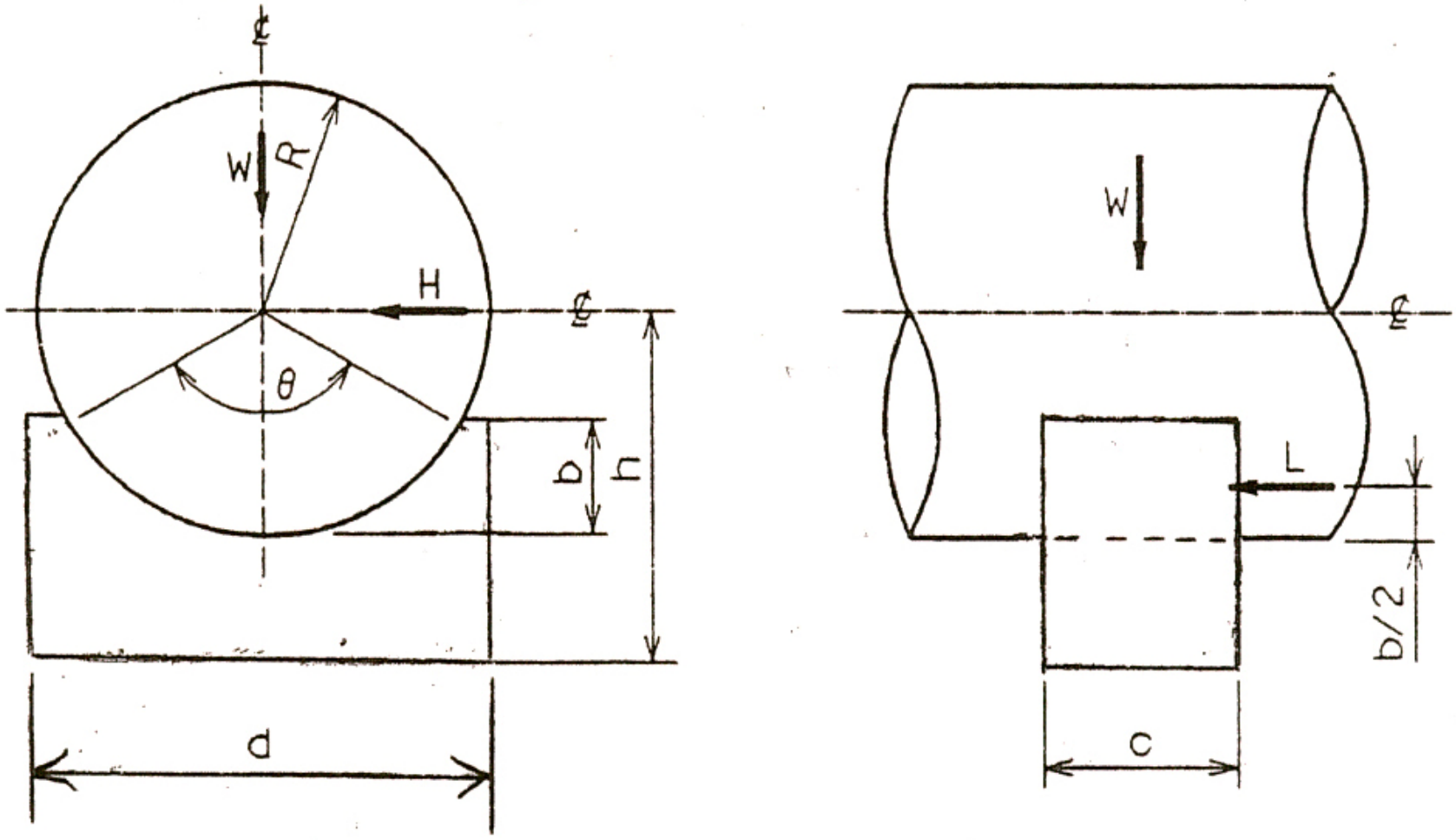
OUTLET WORKS SEISMIC STABILITY ANALYSIS

- Psuedo-dynamic analysis
- EQ load based on response spectrum
- Components analyzed:
  - Intake structure
  - 42-inch steel pipe and saddles
  - Valves
- Components not analyzed:
  - Upstream conduit
  - Horseshoe tunnel

PSHA – RESPONSE SPECTRUM – 5% CRITICAL DAMPING



ILUSTRATION OF METHOD



SADDLE SUPPORT SATBILITY DIAGRAM

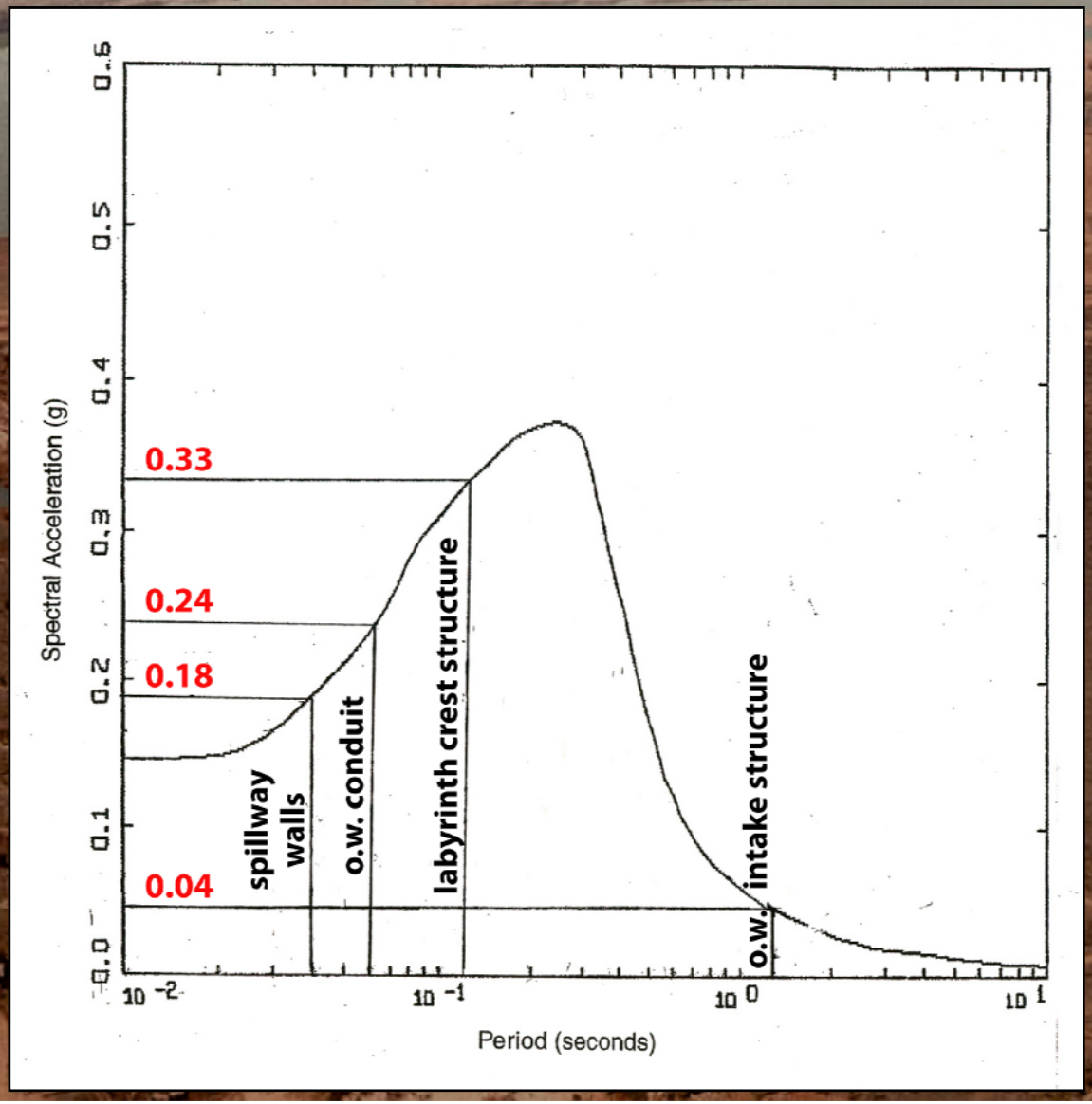
OUTLET WORKS SEISMIC STABILITY ANALYSIS RESULTS

- For all components analyzed:
  - Stability is acceptable
  - Calculated stresses are acceptable

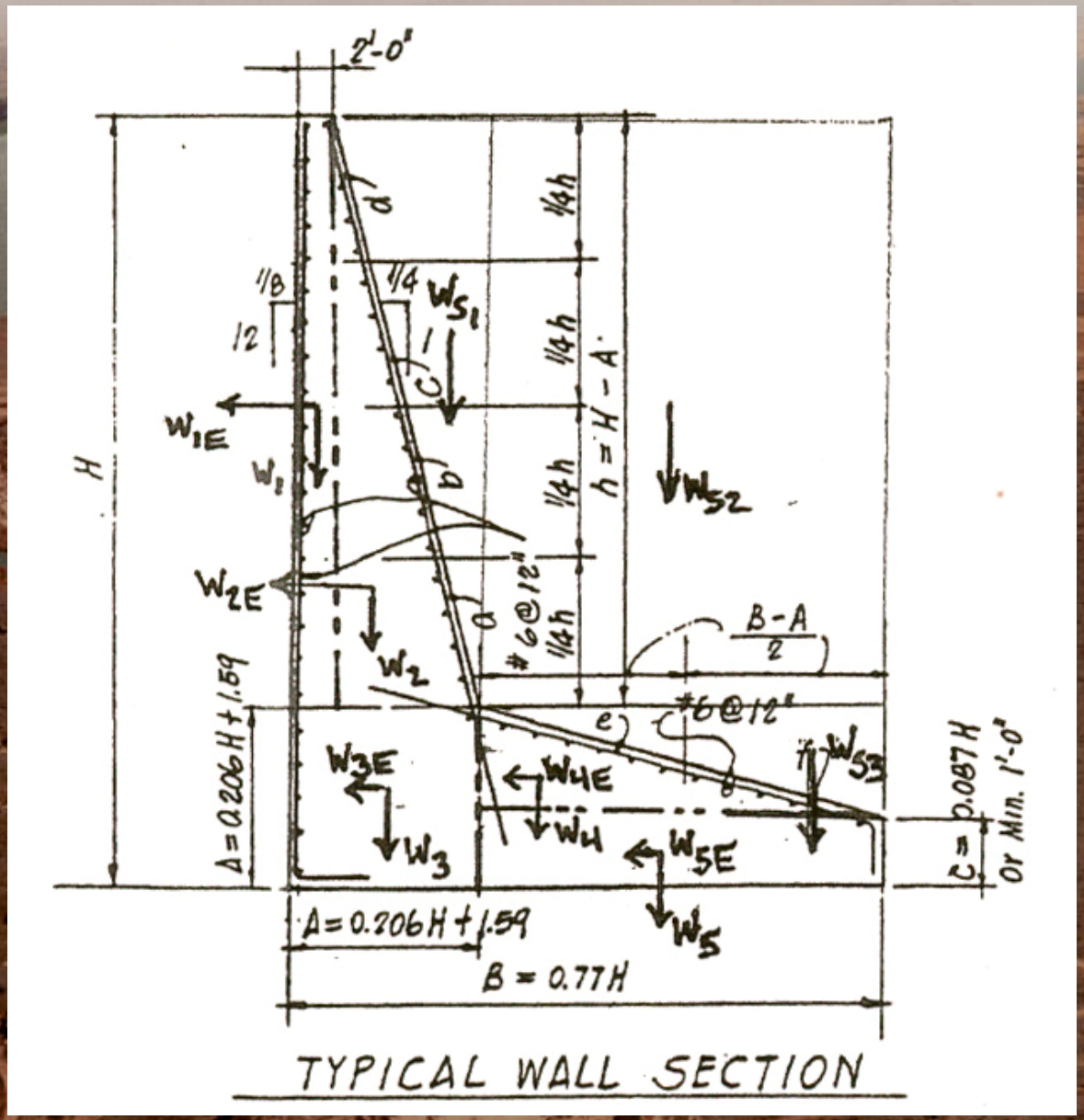
OUTLET WORKS SEISMIC STABILITY ANALYSIS

- Same method of analysis used for outlet works
- Components analyzed:
  - Labyrinth crest structure
  - Spillway gravity side walls
- Components not analyzed:
  - Ogee crest structure
  - Downstream chute

PSHA – RESPONSE SPECTRUM – 5% CRITICAL DAMPING



ILUSTRATION OF METHOD



TYPICAL WALL SECTION

SPILLWAY SEISMIC STABILITY ANALYSIS RESULTS

- For all components analyzed:
  - Stability is acceptable
  - Calculated stresses are acceptable

SUMMARY AND CONCLUSIONS

- Site seismicity is relatively low
- Liquefaction potential judged to be low
- Embankment psuedo-static stability is adequate
- Appurtenant structure expected seismic performance judged to be acceptable
- No remedial action required


QUESTIONS?

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