Franklin County Dam Preliminary Engineering Report: Development of Alternatives to Restore Downstream Slope

FRANKLIN COUNTY WATER DISTRICT

TUESDAY, FEBRUARY 18, 2020

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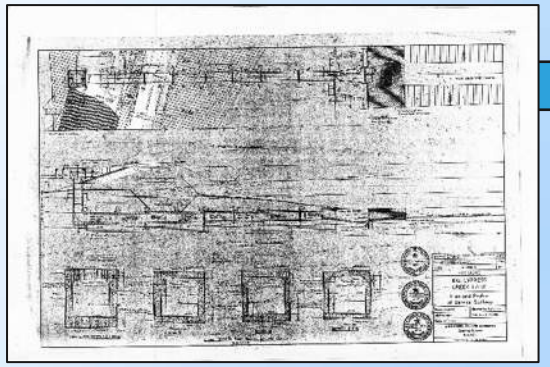
How did we get here?

Dam Construction



1966-1970

Dam Issues with Slope

2007

Dam Revitalization

2009-2010

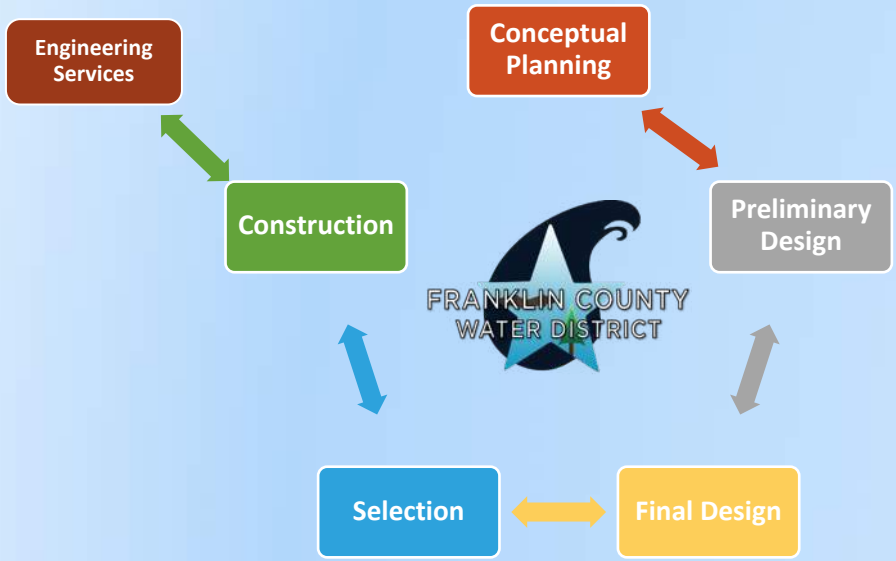
Dam Issues w/ Dispersive Soils

2012

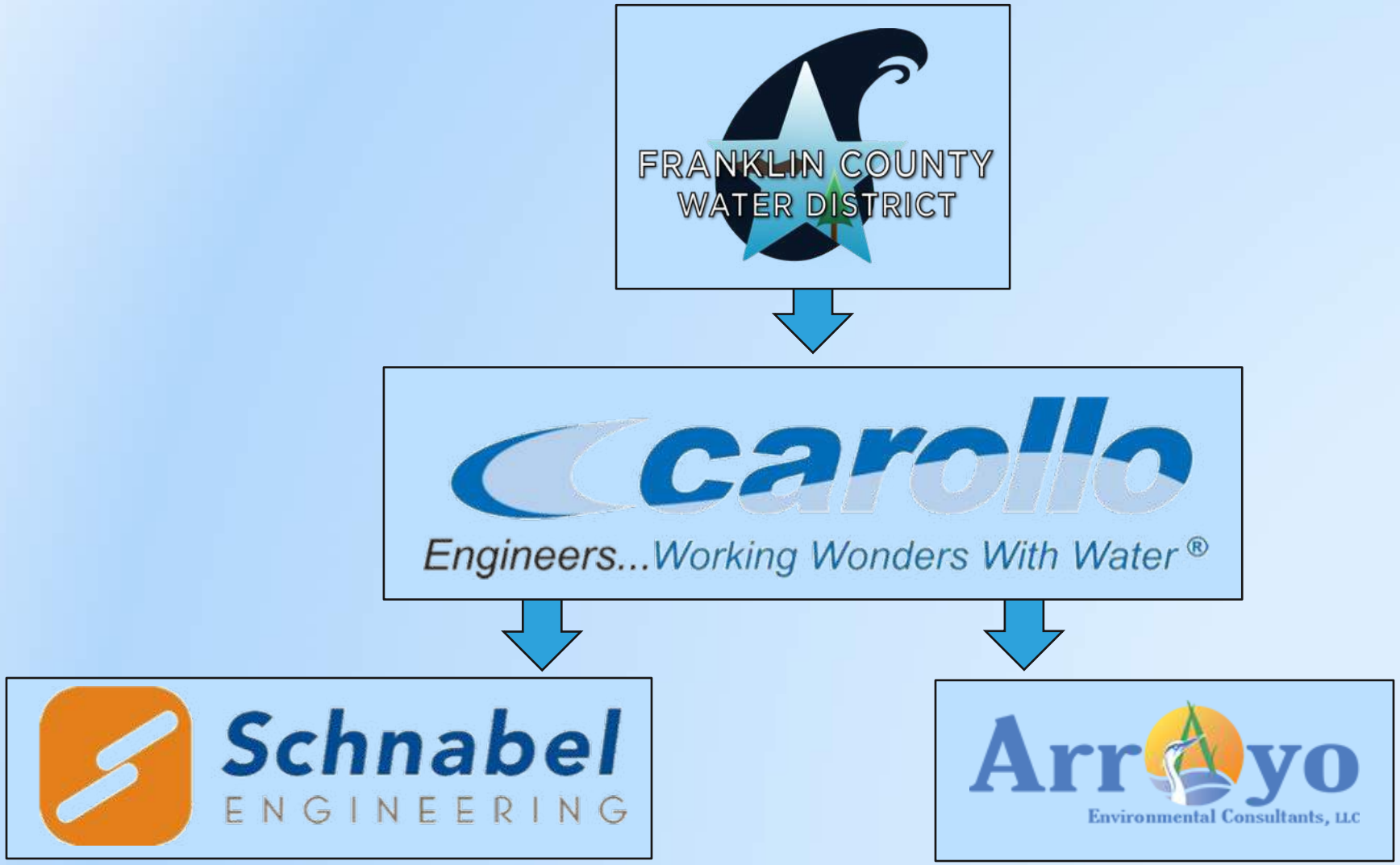
Lawsuit

2013-2017

Today's Embarkment



Your project team

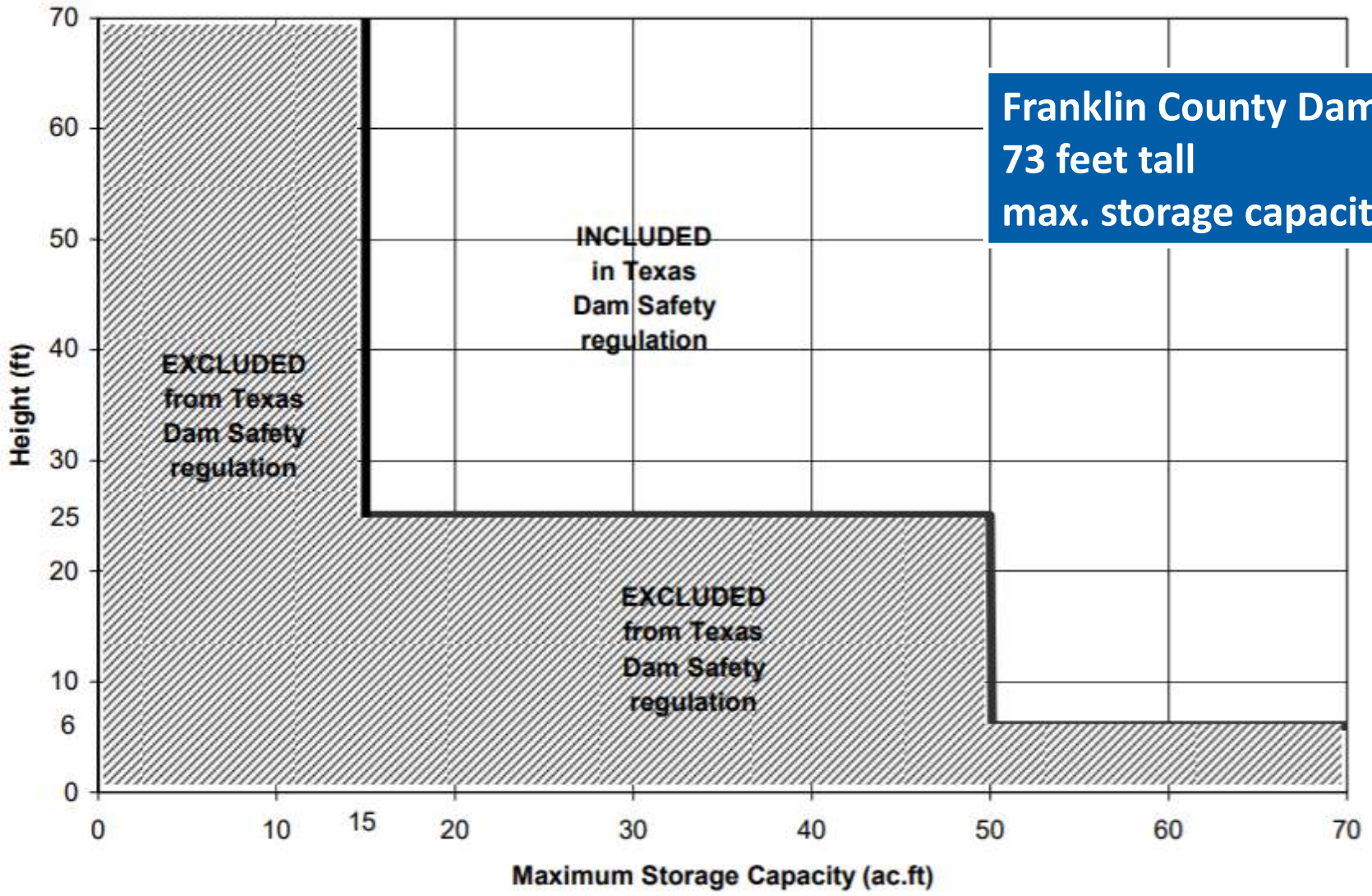


Project Objectives

- Archival document review
- Evaluate restoration alternatives for the Franklin County Dam downstream slope
- Perform environmental review and wetland delineation for proposed dam restoration alternatives

Project Goal: *Develop a cost-effective solution to provide long-term dam integrity that is mutually beneficial to all stakeholders of the dam and the reservoir it impounds*

Texas Dam Safety Overview



Franklin County Dam:
73 feet tall
max. storage capacity > 160,000 acre-feet

Project Overview

- Archival Document Review
- Dam History
- Piezometer and Drain Data Review
- Recommended Strategic Exploration and Instrumentation Program
- Potential Slope Restoration Concepts

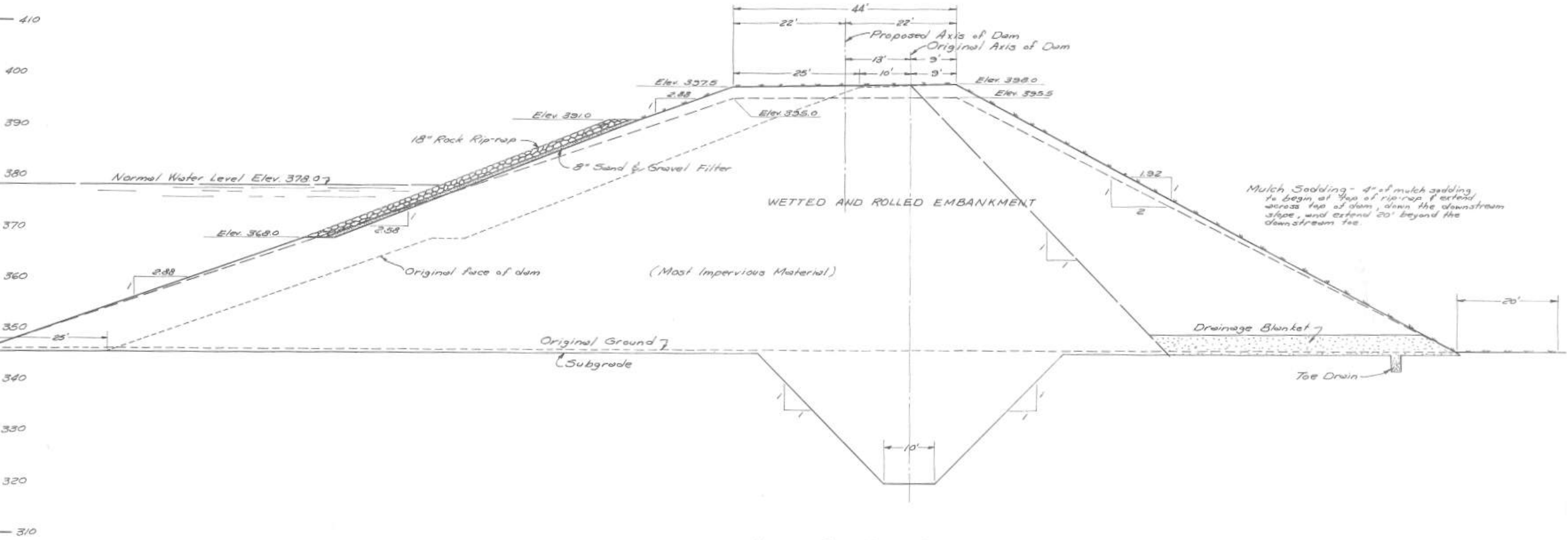
Archival Document Review

- 1967 Design Documents
  - Wisenbaker, Fix, and Associates
  - Trinity Testing Laboratories
- 1980-1981 Slope Stability Evaluation & Investigation
  - Mason-Johnston & Associates
  - Woodward-Clyde Consultants
- 1982 Modifications
  - URS

Archival Document Review, cont'd

- 2003 Slope Maintenance
  - NRS Consulting Engineers
- 2008-2010 Slope Rehabilitation
  - Freese & Nichols
- 2017-2018 Litigation Data
- Inspection Reports
  - USACE
  - TCEQ & Predecessor Agencies

Original Dam Cross-Section

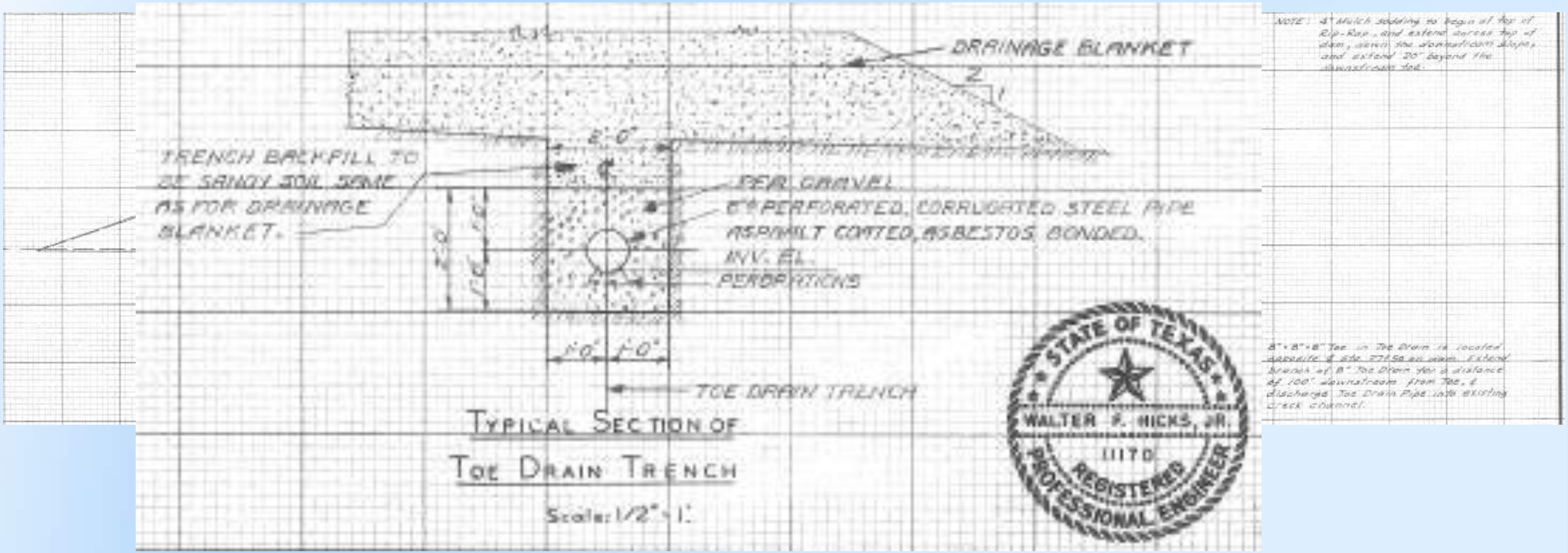


TYPICAL DAM CROSS-SECTION

Scale: 1" = 10'

NOTE: Slopes & Elevations are to remain the same as shown on the original cross-sections in the approved plans.

Original Dam Internal Drainage System



Abbreviated Dam History

- July 1970 – Impoundment of Lake Cypress Springs begins
- February 1971 – Franklin County Dam construction completed
- July 1972 – Severe erosion and seepage on downstream slope
- 1976 – Sinkhole observed in previous seepage area; surface erosion
- April 1977 – Principal spillway vacuum breaking; downstream slope slides; seepage, boils, and migration of soil
- December 1978 – Principal spillway inspection reveals joint separation; toe drain outlet cannot be located
- 1978 – Construction of Fort Sherman Dam begins (Lake Bob Sandlin
- April 1980 – Downstream slope slides; boil

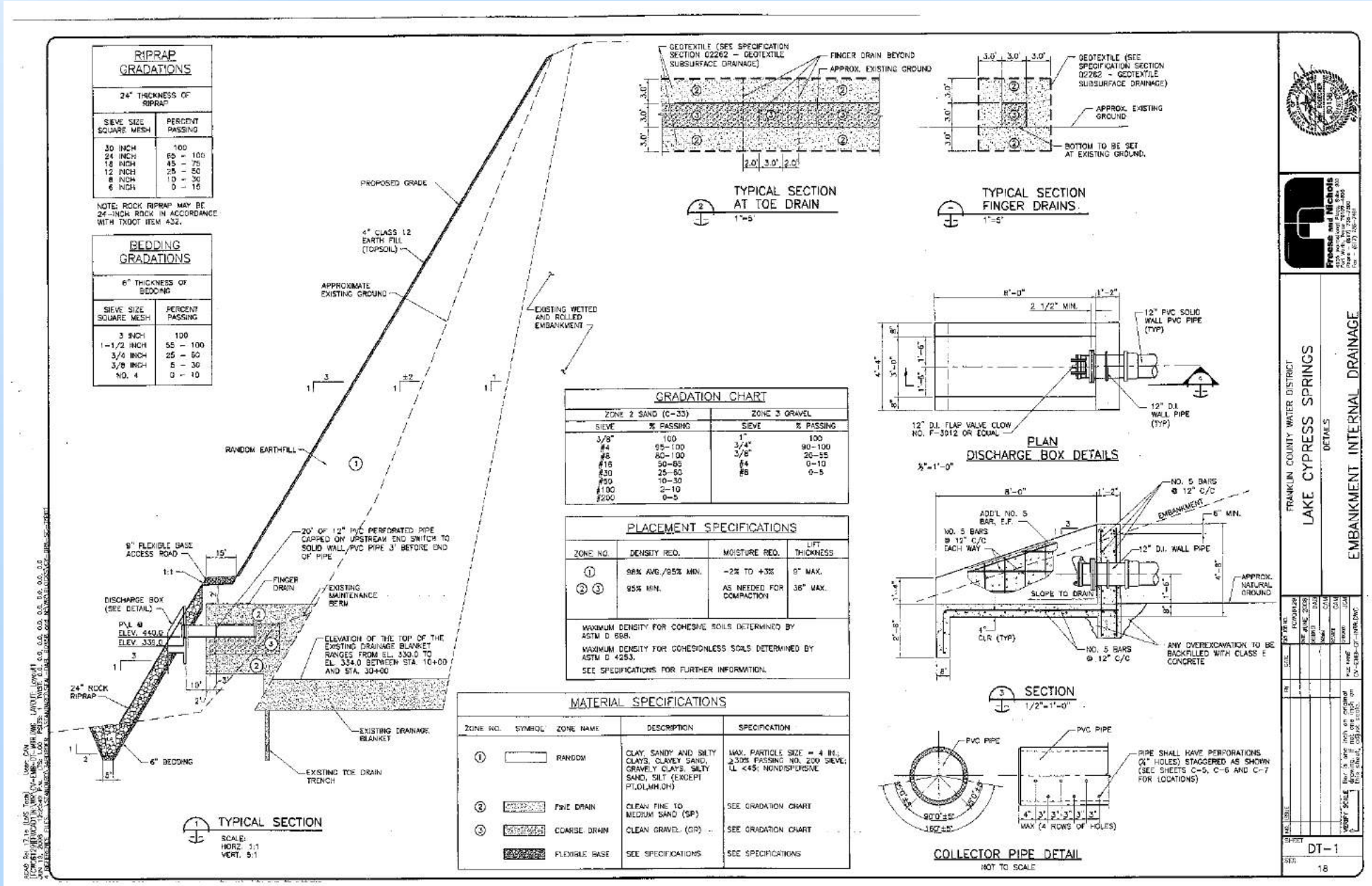
Abbreviated Dam History, cont'd

- June 1980 – Seven piezometers installed
- June 1981 – Slope stability evaluation determines blanket drain is working; dam stated to be stable
- December 1981 to November 1982 – Downstream slope maintenance; filter installed over boil zone
- November 1985 – Erosion gullies and tunnels, sink holes, slide
- 1990 to 1994 – Inspections revealed that there were sunken/benched areas in riprap on upstream slope; erosion gullies, and slides on downstream slope.
- 1997-1998 – Fish screen added to morning glory drop inlet; six new piezometers installed.

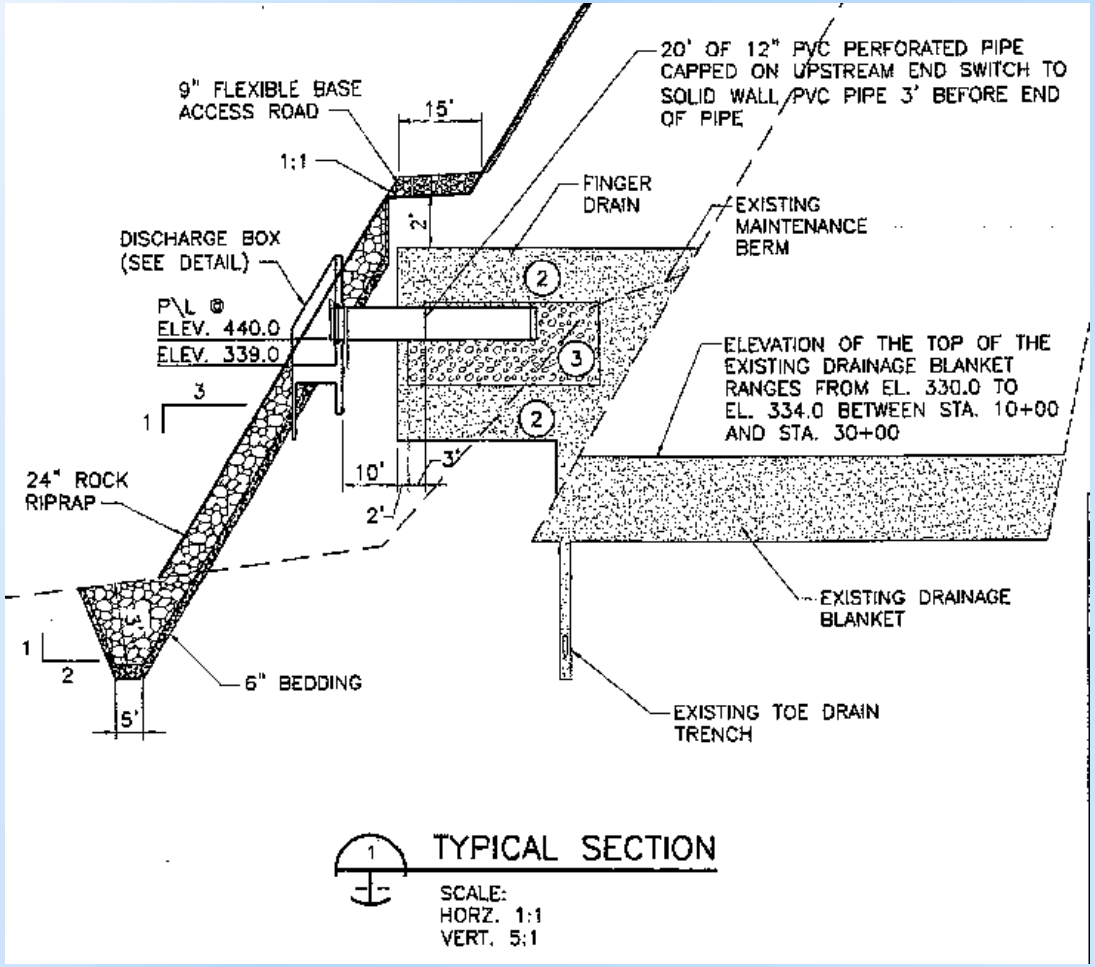
Abbreviated Dam History, cont'd

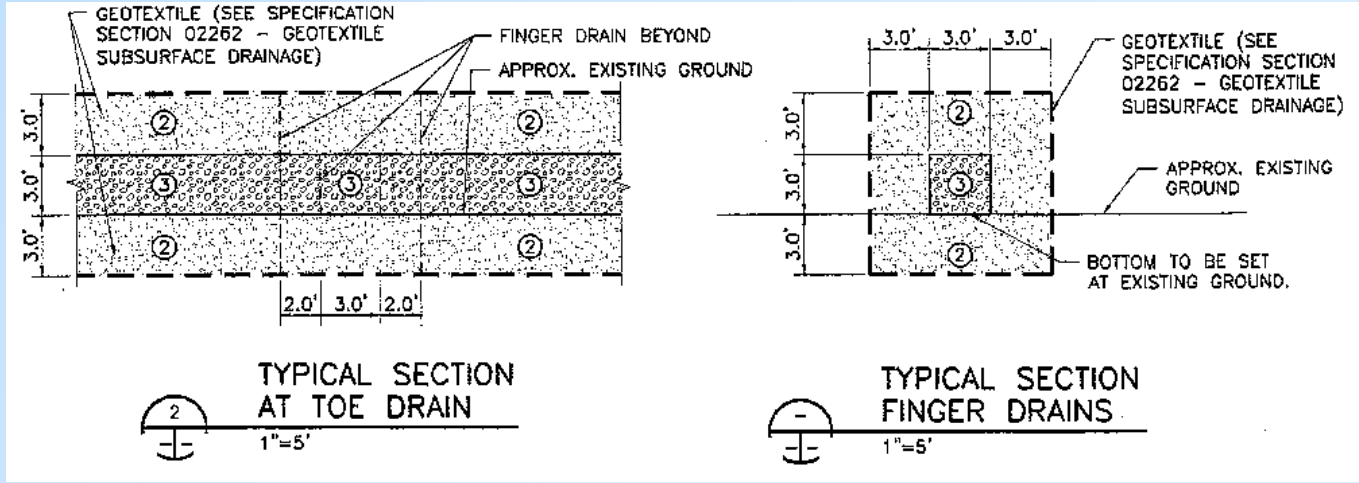
- May 2002 – TCEQ inspection notes burrows and slides on downstream slope; wet area south (right) of principal spillway about 75 feet from downstream toe
- September 2005 – TCEQ inspection states downstream slope in poor condition with substantial erosion in several areas; slopes ranging from 1.5H:1V to 1H:1V; slides on downstream slope; seepage at both downstream abutments; standing marsh at north end of downstream slope; seepage at south end of downstream area near principal spillway
- July 2008 – Slope rehabilitation construction plans approved
- April 2010 – Rehabilitation completed

2010 Dam Modifications



2010 Dam Modifications - Drain Details





Abbreviated Dam History, cont'd

- October 2011 – TCEQ inspection notes erosion holes and tunnels on north end of downstream slope; seepage at outlet headwall
- May 2012 – Erosions areas linked to dispersive clay
- 2013 – More holes and tunnels develop on downstream slope; focus on dispersive soils
- May 2018 – TCEQ inspection notes that downstream slope is in poor condition; numerous holes and tunnels; toe drain outlet flap valves not opening frequently enough; erosion on both slopes and downstream contact points; seepage at both ends of downstream slope

Downstream Slope Erosion

- Dispersive soils

- Crack Development
  - Drying
  - Differential settlement
  - Shear displacement

- Seepage
  - Insufficient foundation cutoff
  - Absence of impermeable foundation layer in right abutment
  - Along spillway conduit (no core material or filter around conduit)

Review of Instrumentation Data

- History of dam includes an incomplete account of the installation and abandonment/removal of piezometers

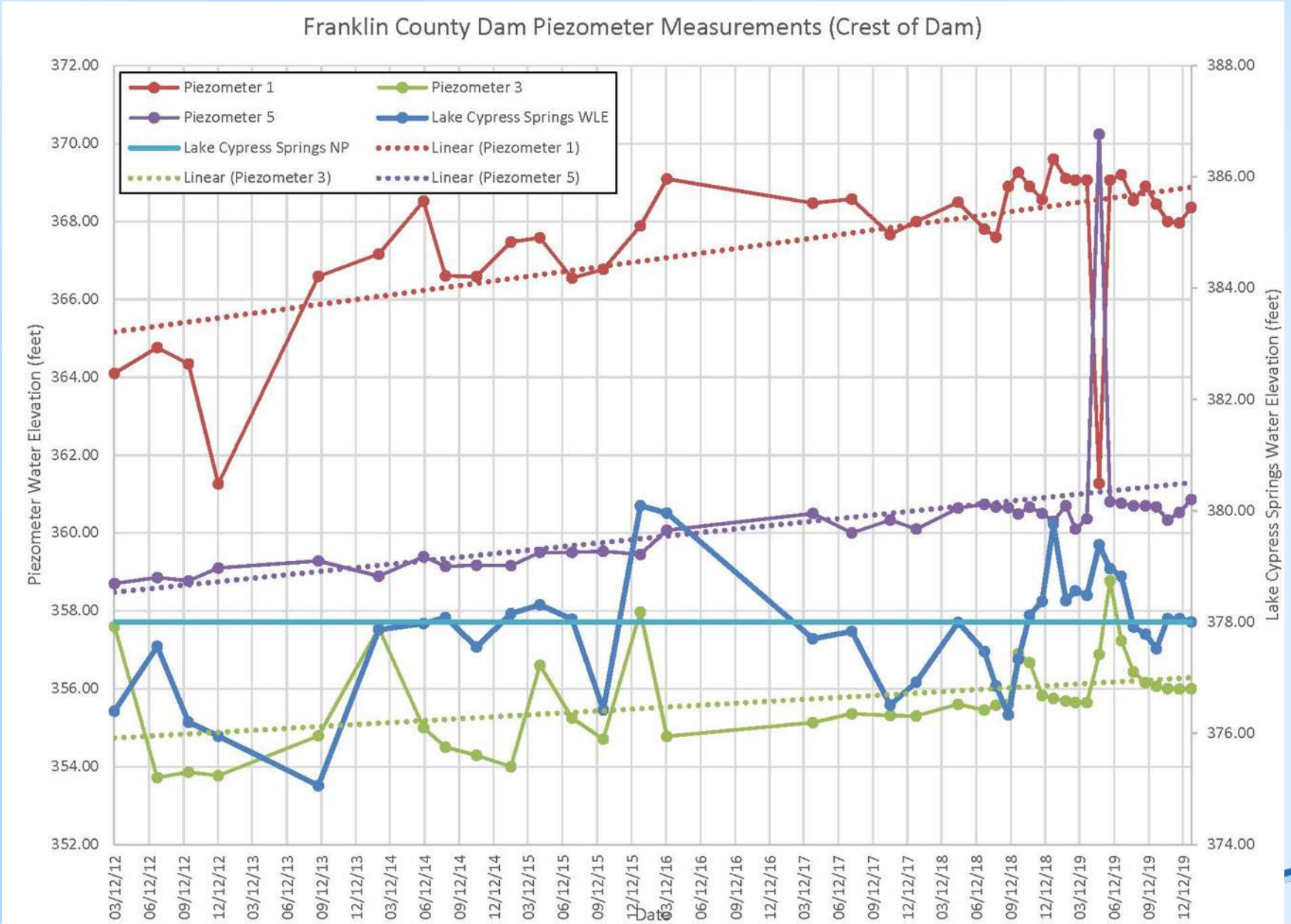
- Current piezometer data limited to six piezometers
  - Three (3) located along the downstream edge of the dam crest
  - Three (3) located along the upstream side of the access road/berm on the downstream slope


N
LAKE BOB SANDLIN
PIEZOMETER 2
PIEZOMETER 1
0+00
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
9+00
10+00
11+00
12+00
13+00
14+00
FARM TO MARKET ROAD 3007
LAKE CYPRESS SPRINGS
DAM SECTION 'A'
DAM SECTION 'B'
SCALE 1"=50'
NOTE: PIEZOMETER LOCATIONS HAVE BEEN APPROXIMATED BASED ON FCWD RECORDS

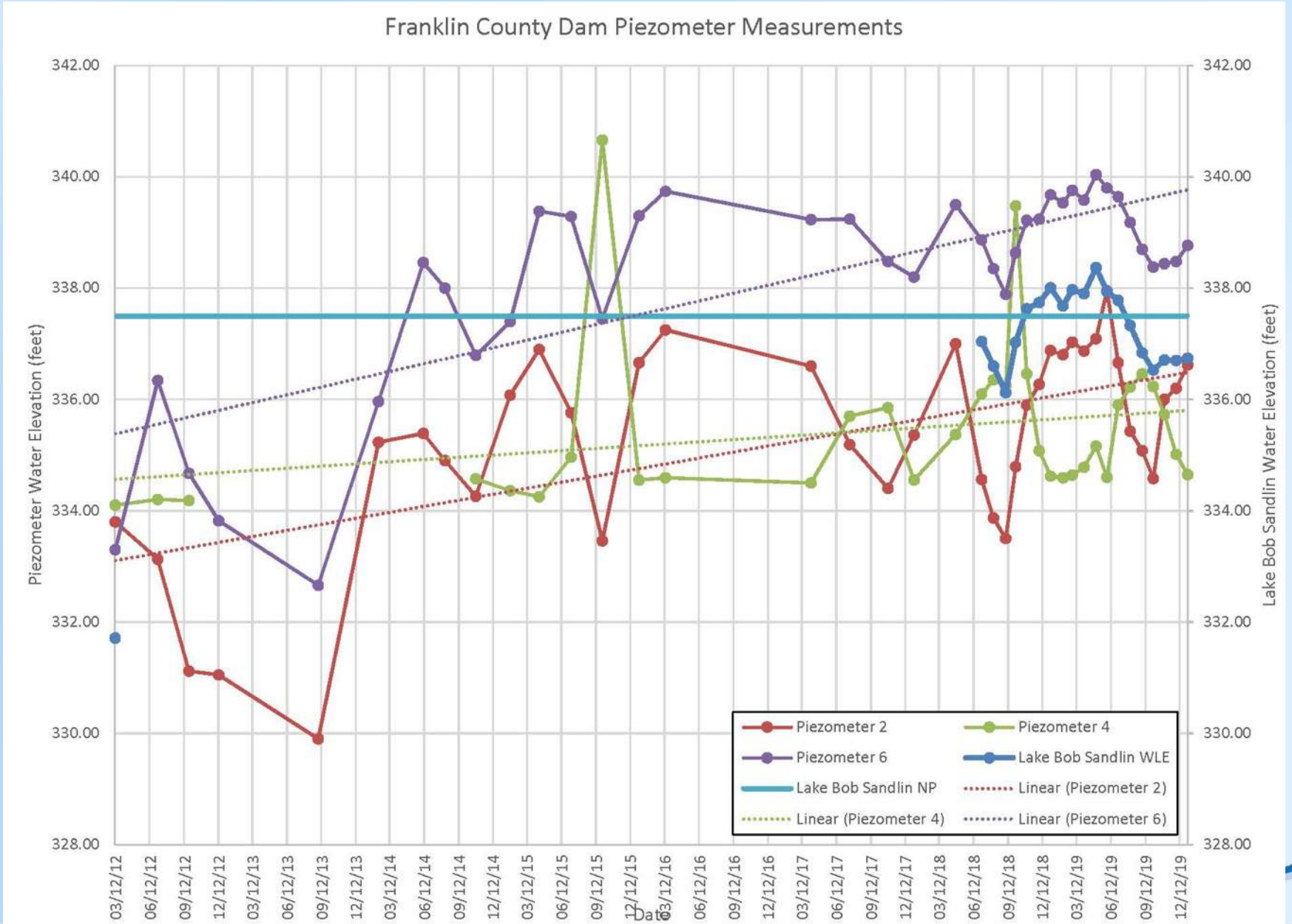

N
LAKE BOB SANDLIN
PIEZOMETER 4
PIEZOMETER 3
15+00
16+00
17+00
18+00
19+00
20+00
21+00
22+00
23+00
24+00
25+00
26+00
27+00
28+00
FARM TO MARKET ROAD 3007
DAM SECTION 'A'
DAM SECTION 'B'
LAKE CYPRESS SPRINGS
DAM SECTION 'B'
DAM SECTION 'C'
SCALE 1"=50'
0
50'
100'
NOTE: PIEZOMETER LOCATIONS HAVE BEEN APPROXIMATED BASED ON FCWD RECORDS


N
LAKE BOB SANDLIN
PIEZOMETER 6
PIEZOMETER 5
FARM TO MARKET ROAD 3007
DAM SECTION 'B'
DAM SECTION 'C'
LAKE CYPRESS SPRINGS
NOTE: PIEZOMETER LOCATIONS HAVE BEEN APPROXIMATED BASED ON FCWD RECORDS

Review of Piezometer Data



Review of Piezometer Data



Review of Drain Discharge Data

- Data for fourteen (14) drain outlets reviewed
- Data was limited to “yes” or “no” which refers to whether or not water was observed to be discharging from a given drain outlet
- Change in characterization from “yes” to “no” is episodic

Original Construction Plans – Highlighted Items

- Cracking of embankment materials
- Uncontrolled seepage
  - Lack of chimney or vertical drainage system
  - Lack of filter around toe drain collector
- Inability to observe drain discharges due to presence of Lake Bob Sandlin
- Degradation of foundation materials and potential migration of foundation soils due to seepage

Slope Modification Plans – Highlighted Items

- New or supplemental drainage system may not be sufficient to capture seepage through the existing embankment
- Geotextile fabric (FEMA states geotextile should not be used for critical applications) will likely clog over time and reduce the effectiveness of the drainage system
- Are six piezometers adequate to monitor a structure of this length? The distance between piezometers increases the probability of developing seepage issues going unnoticed

Recommended strategic exploration and instrumentation program

- Install additional piezometers and other monitoring instrumentation
- Collect geotechnical data and samples during piezometer installation
- Collect samples from downstream slope materials to evaluate potential for future dispersive soil activity
- Perform preliminary engineering analyses

Proposed Piezometer Locations

Proposed Piezometer Locations

Proposed Piezometer Locations

Perform interim surficial repairs to downstream slope to facilitate maintenance

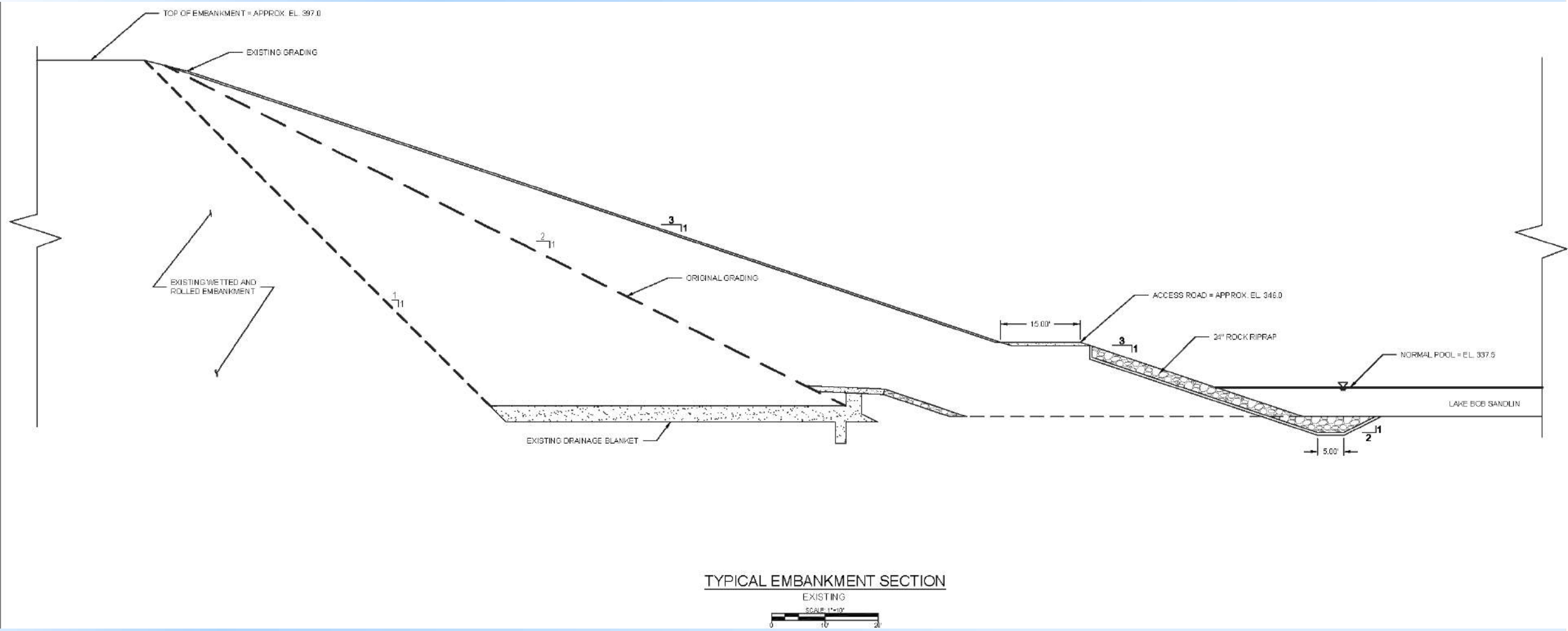
- Erosion holes pose significant challenges to maintenance of dam
- Options for filling these holes will be developed and evaluated based on data gathered during strategic exploration and instrumentation program

Potential Recommended Course of Action

- Remove and replace the materials associated with the 2008-2010 slope modifications
  - Augment the removed materials with lime and place the augmented soil as engineered fill
  - Or, reconstruct the embankment utilizing non-dispersive soils from an acceptable borrow source

- In conjunction with replacement of embankment soils, install a chimney filter/drain between the original downstream slope and the new soil embankment

Existing Embankment Profile



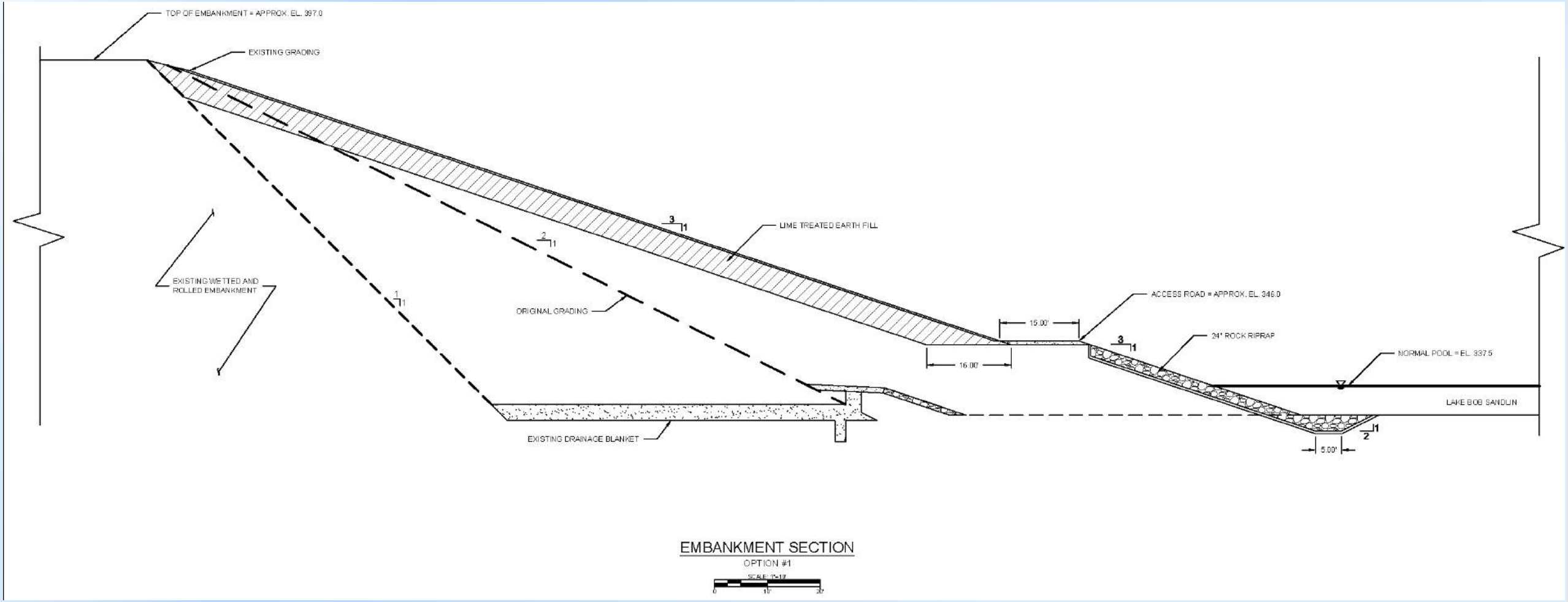
TYPICAL EMBANKMENT SECTION

EXISTING

SCALE: 1"=10'

0 10' 20'

Option 1 Profile




COUNTY ROAD SE 4210
ROCKY POINT ROAD
N
COUNTY ROAD SE 4385
REDFEARN ROAD
FORESTED WETLAND PLOT
AREA = 23 ACRES
LAKE BOB
SANDLIN
COUNTY ROAD SE 3122
FARM TO MARKET ROAD 3007
COLLINS LANE
DOWNSTREAM SLOPE OF DAM
AREA = 14 ACRES
OFF-ROAD TRUCK HAUL ROUTE
LENGTH SHOWN = 4,300 FEET
LAKE CYPRESS
SPRINGS
LIME TREATMENT STAGING SITE
AREA = 16 ACRES
AUXILIARY
SPILLWAY
DEER COVE ROAD
PROPOSED BORROW SITE
(TOPSOIL ONLY)
AREA = 34 ACRES
HERMITAGE FARM ROAD
S SHORE DRIVE
TRIPLE S DRIVE
HILLTOP DRIVE
LARSEN LANE
COVE DRIVE

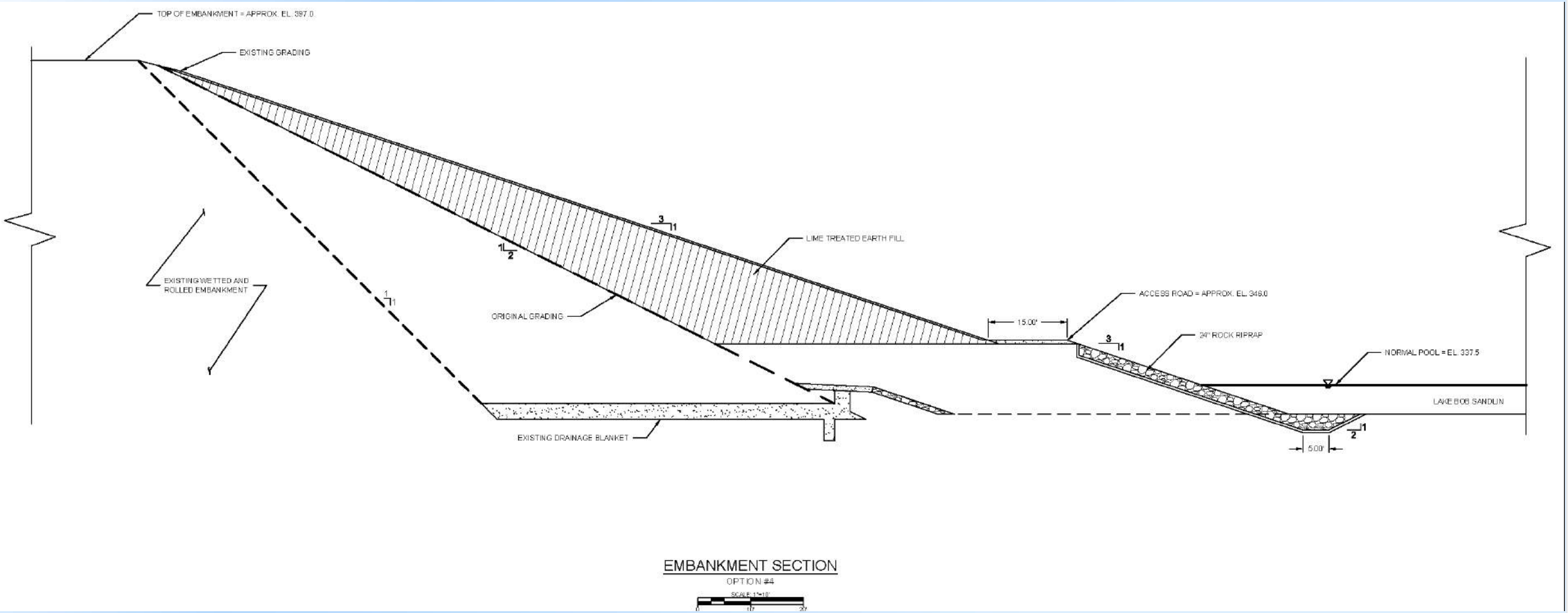
Option 1 Advantages

- Ability to re-use current material
- Reduces the amount of additional material that would need to be identified and tested
- Lime-treatment is a proven method for remediating dispersive soils

Option 1 Disadvantages

- The lime-treatment process can be very dusty
- Lime-treated soils can impede the ability to establish permanent turf
- Additional topsoil thicknesses are recommended over areas associated with the lime-treatment process to facilitate the establishment of adequate vegetative cover

Option 2 Profile



EMBANKMENT SECTION

OPTION #4

SCALE: 1"=10'


COUNTY ROAD SE 4210
ROCKY POINT ROAD
N
COUNTY ROAD SE 4385
REDFEARN ROAD
EXISTING FILL DISPOSAL SITE
AREA = 14 ACRES
LAKE BOB
SANDLIN
COUNTY ROAD SE 3122
FARM TO MARKET ROAD 3007
COLLINS LANE
DOWNSTREAM SLOPE OF DAM
AREA = 14 ACRES
OFF-ROAD TRUCK HAUL ROUTE
LENGTH SHOWN = 4,300 FEET
LAKE CYPRESS
SPRINGS
AUXILIARY
SPILLWAY
DEER COVE ROAD
PROPOSED BORROW SITE
(EARTHFILL & TOPSOIL)
AREA = 34 ACRES
HERMITAGE FARM ROAD
S SHORE DRIVE
TRIPLE S DRIVE
HILLTOP DRIVE
LARSEN LANE
COVE DRIVE

Option 2 Advantages

- Favorable process for removing and disposing of the soils placed during the slope modification (nearby original borrow site)
- Avoids lime-treatment process
- Topsoil thickness to facilitate turf establishment would not be as thick as the amount required for lime-treated areas

Option 2 Disadvantages

- Need to identify a large quantity of non-dispersive soils
- Potentially long haul distance to import non-dispersive soil material
- Depending on depths of non-dispersive borrow soils, larger disturbed areas would need to be re-vegetated

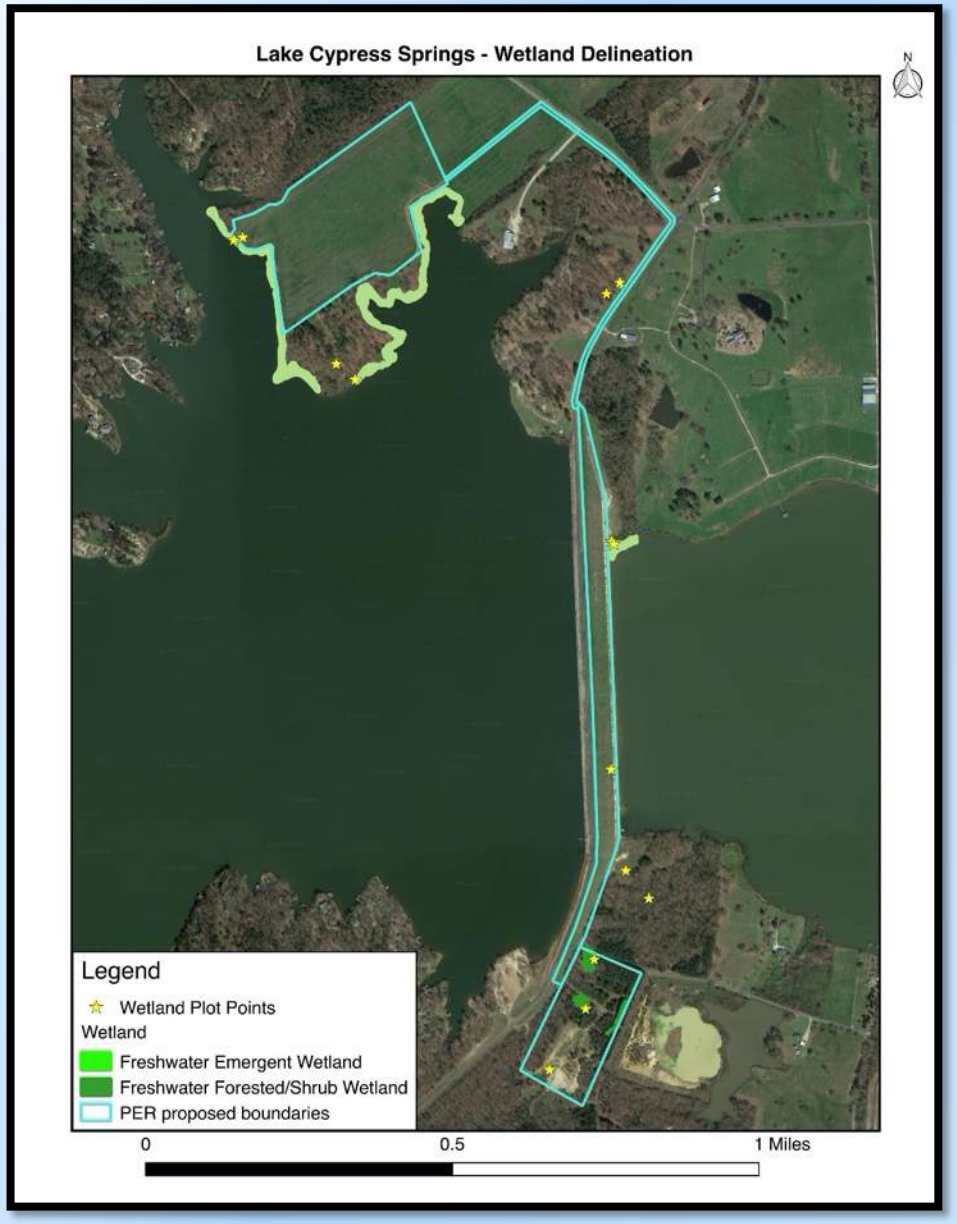
Drainage System Modifications

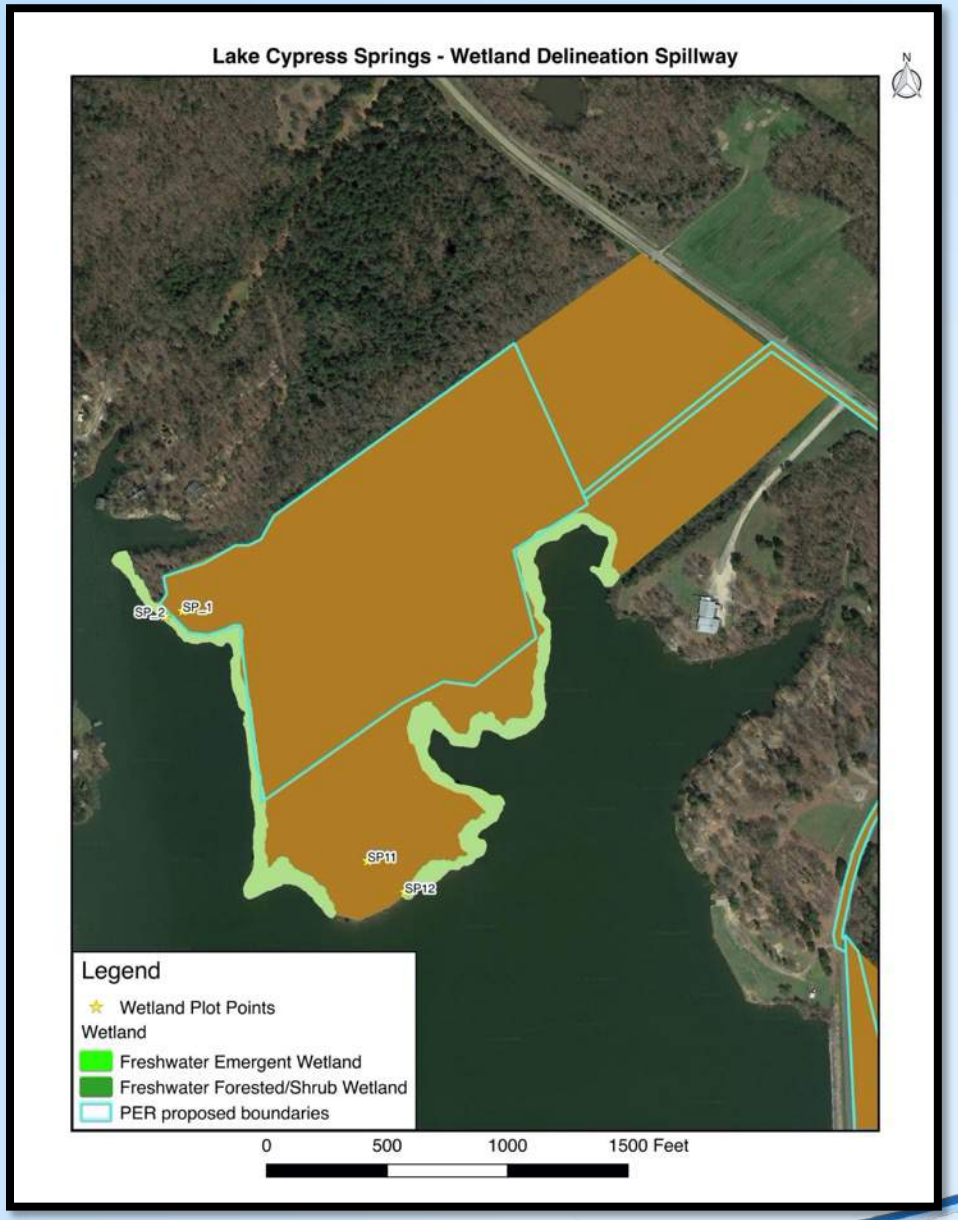
- For all alternatives, an adequate internal drainage system is recommended
  - Chimney drain
  - Adequate filter
  - Sufficient outlets
- Due to concerns related to the potential for latent defects in the original construction, an adequate internal drainage system is critical to the long-term performance of the dam

Environmental Evaluation by Arroyo

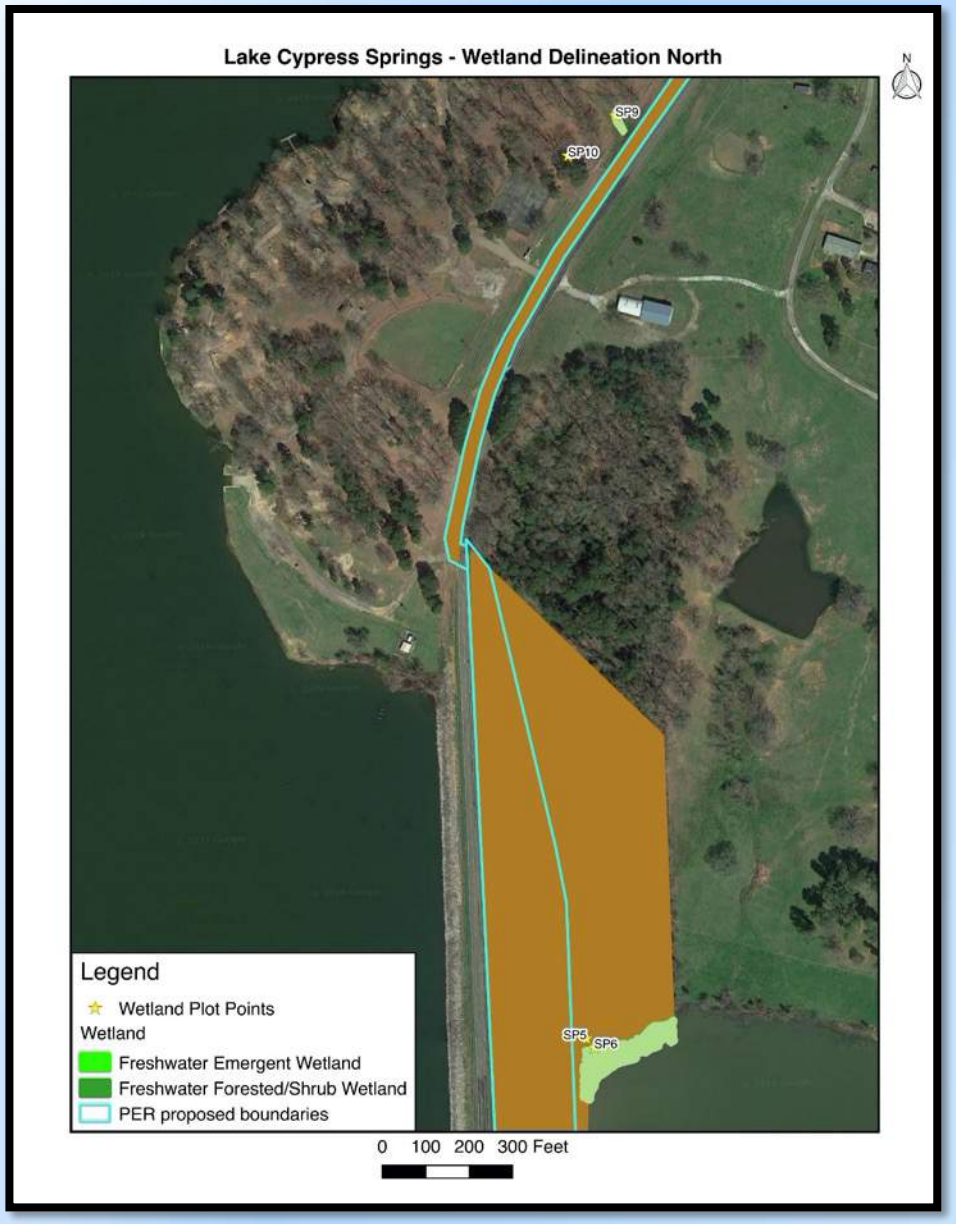
- Desktop review:
  - Threatened and endangered species review
  - Jurisdictional waters and wetlands review
  - Historical / archeological area review
  - Permitting requirements and agency coordination
- Wetland determination and delineation

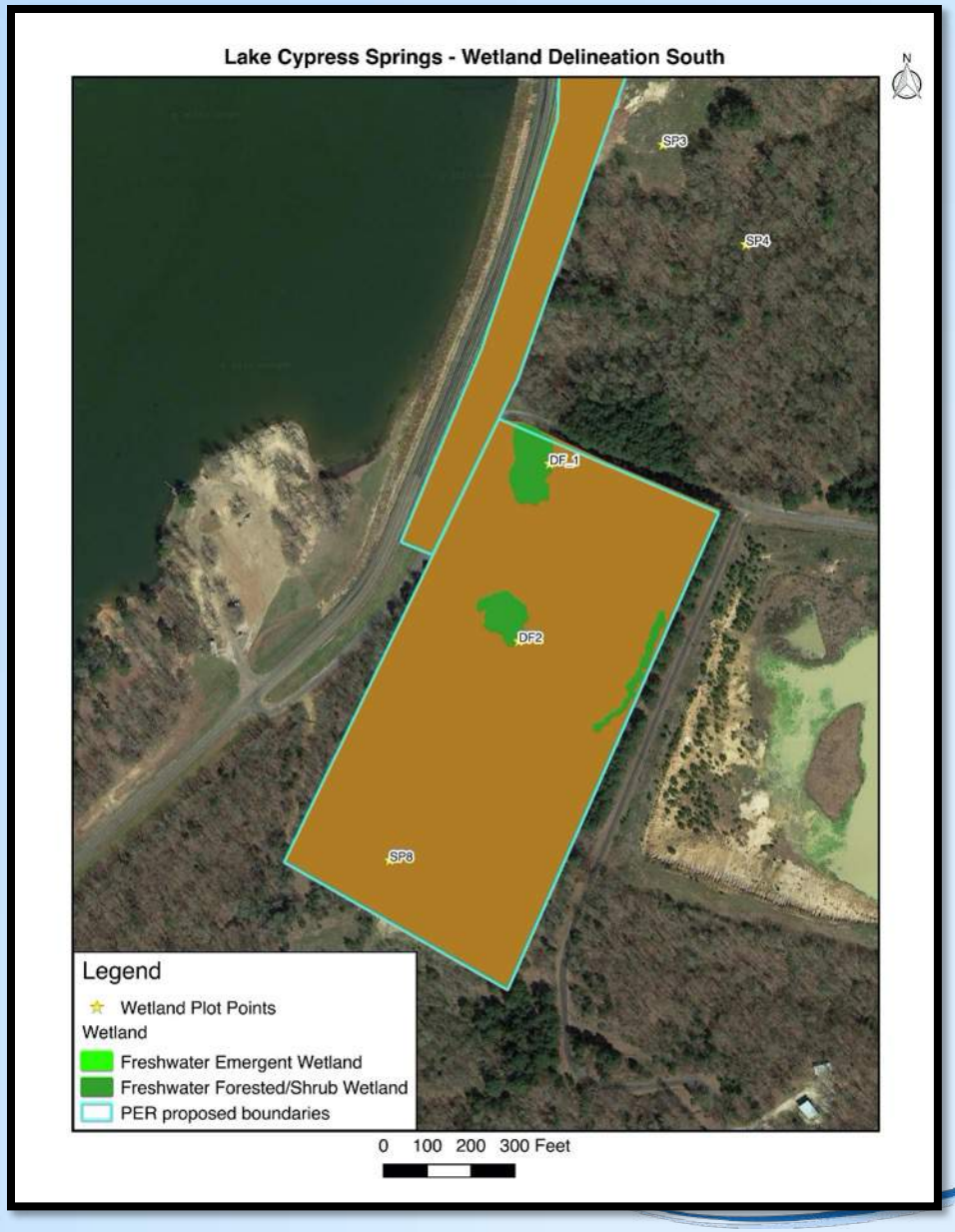
Identified Wetlands





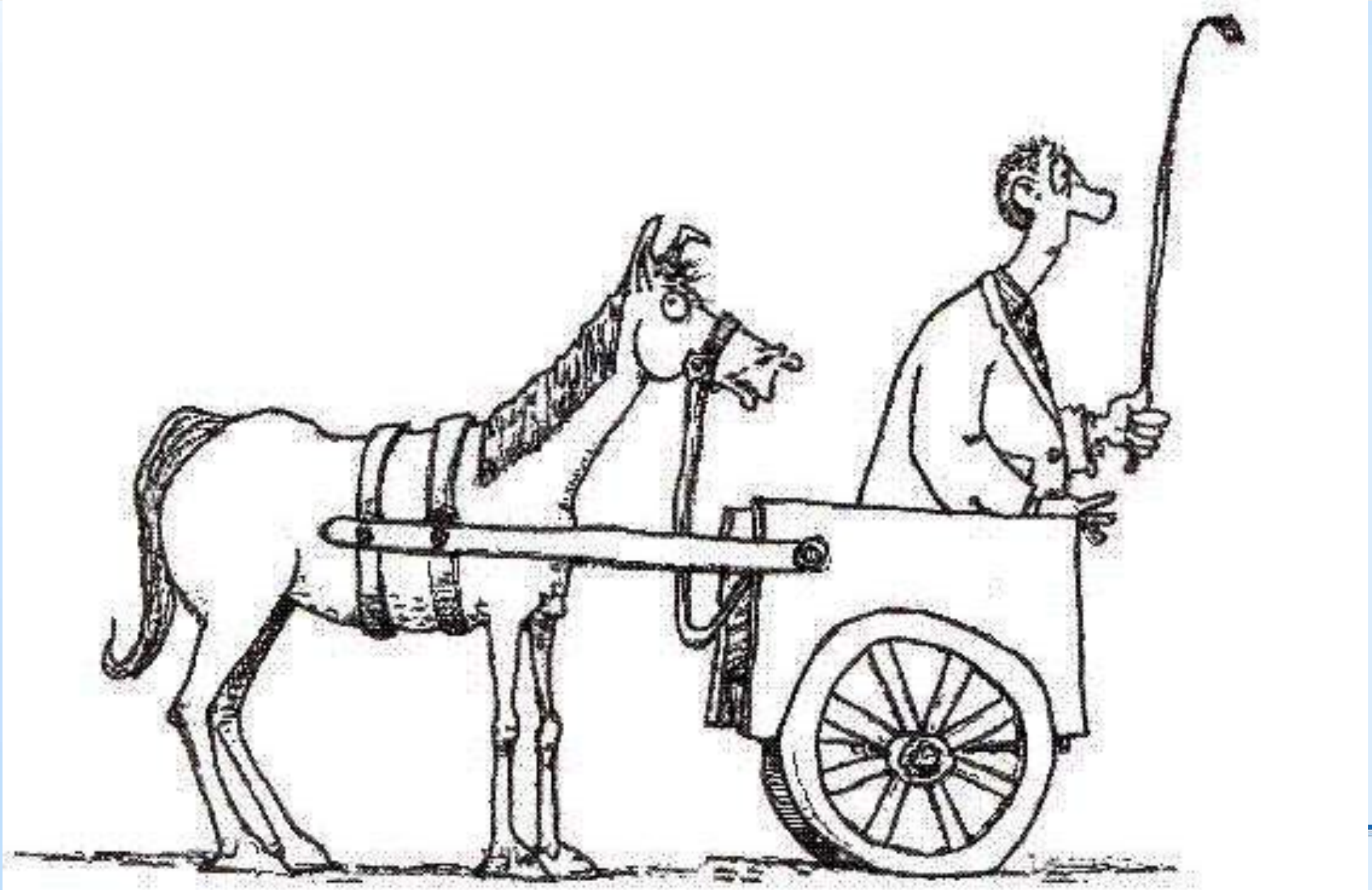
Identified Wetlands





Recommended Strategic Environmental Plan

- Section 404 Permit required regardless of the dam restoration alternative selected
- Identified approximately 5.5 acres of wetlands in proximity of the project boundaries
- Additional efforts to be fully defined include:
  - Possible additional wetland determination and delineation
  - Critical habitat survey for threatened and endangered species
  - Coordination with THC to address any archeological concerns



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Chimney Drain