



Gannett Fleming

Excellence Delivered As Promised

BUCKEYE LAKE DAM HISTORY, EVALUATION, REMEDIATION

DANIEL P. STARE
DR. DONALD A. BRUCE



61ST AEG Annual Meeting
13th IAEG Conference
San Francisco, CA
September 2018



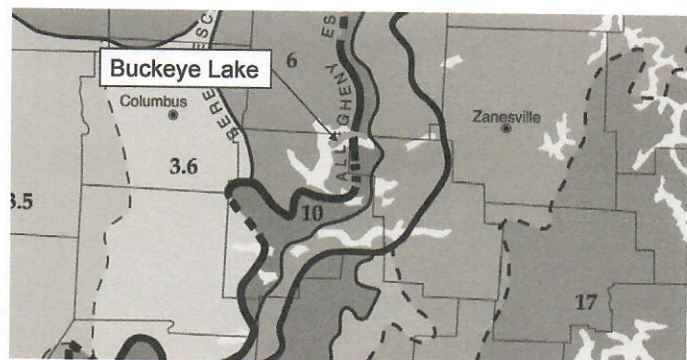
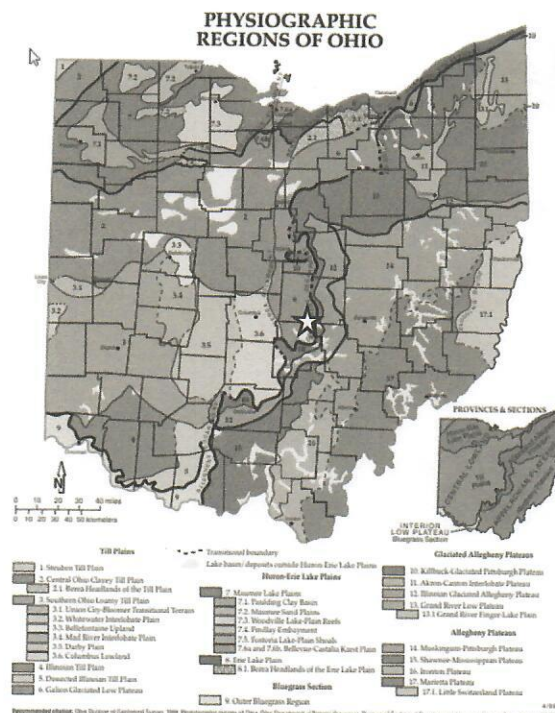
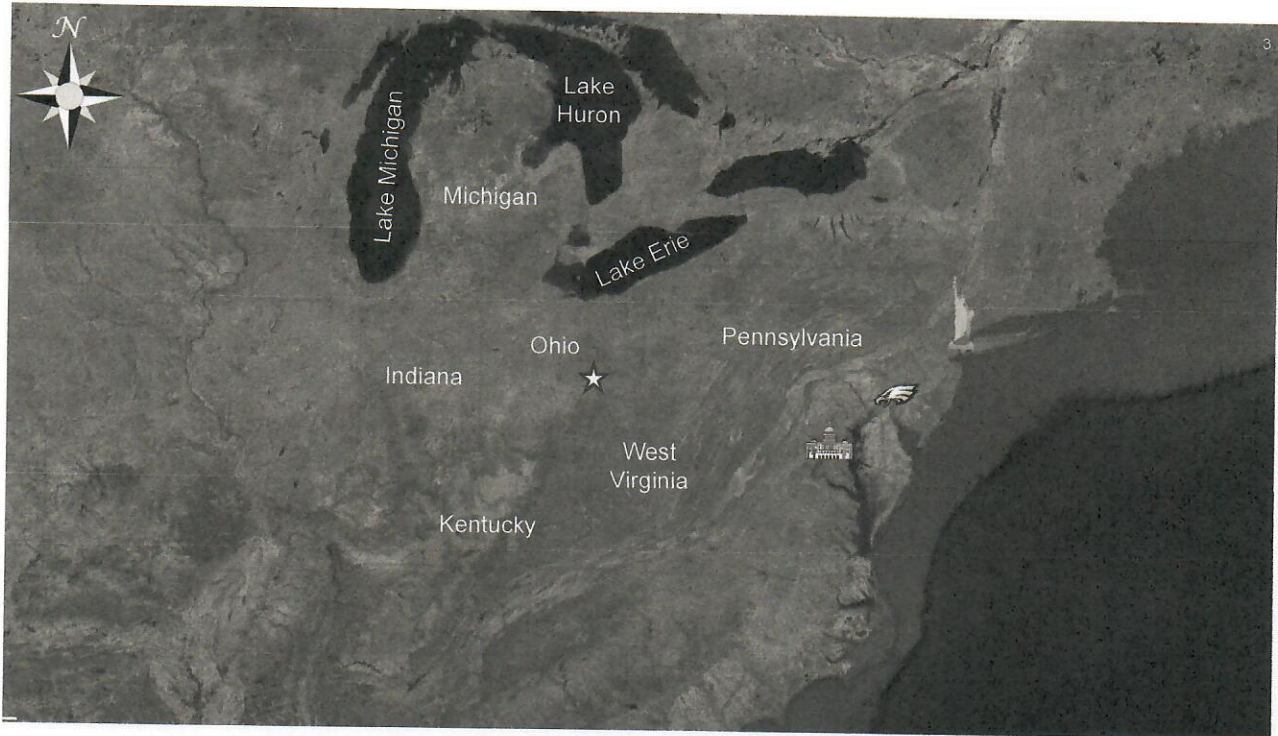
BUCKEYE LAKE DAM HISTORY, EVALUATION, REMEDIATION

- **Agenda**
- **Site Location & Geology**
- **Original Dam & Site History**
- **Dam Performance & Call to Action**
- **Interim Risk Reduction Measures**
- **New Dam Design**
- **New Dam Construction**
- **Questions**



Gannett Fleming

Excellence Delivered As Promised

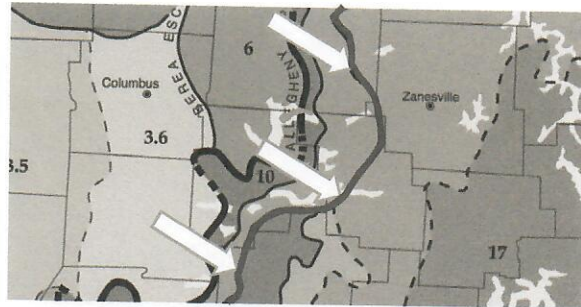


- Lake basin/deposits outside Huron-Erie Lake Plains
- 6. Galien Glaciated Low Plateau
- 10. Killbuck-Glaciated Pittsburgh Plateau

Ohio Division of Geological Survey, 1998, Physiographic regions in Ohio: Ohio Department of Natural Resources, Division of Geological Survey

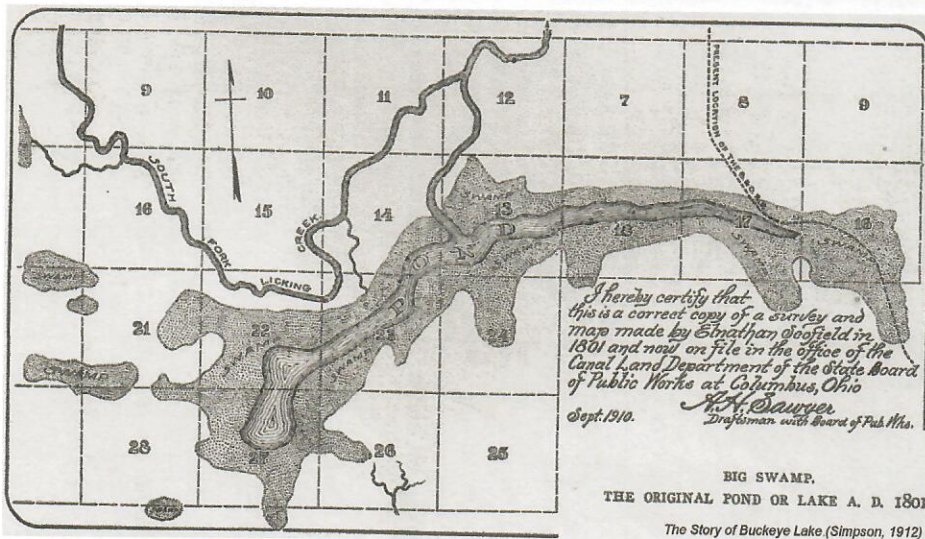
SURFICIAL GEOLOGY

- **Glacial Impacts**
 - Deposition of glacial outwash
 - Subsequent advances eroded much of the outwash
 - Till deposited
- **Advance extent just east of the site - Terminal Moraines**
 - Post-glacial lake formation
 - Lake bed sediment accumulation
- **Resulting Conditions**
 - Lacustrine sediments
 - Outwash sediments
 - Till at varying depth
 - Mississippian Age shale, siltstone and sandstone
~100 feet below grade



Gannett Fleming
Excellence Delivered As Promised

Pre-Development Conditions



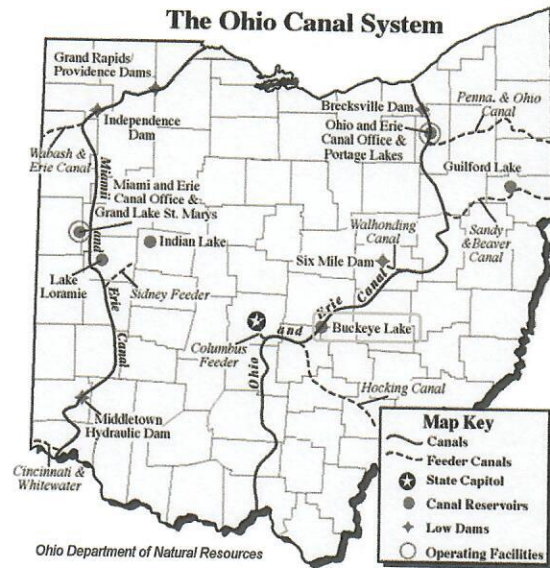
Gannett Fleming
Excellence Delivered As Promised

- 1751 - First expedition to map "lands for purchase" by the "Ohio Company"
- Area known to Native Americans as "Big Swamp"
- First known survey of the area developed in 1801

Ohio & Erie Canal System

- **Goal**
 - Link Lake Erie (Cleveland, OH) to the Ohio River (Portsmouth, OH)
 - Means for barge navigation
 - Promote economic development
- **Construction**
 - Began in 1825
 - Dug by labor
 - Wages reported to be \$5 per month plus housing, board and rations of Ohio whiskey
 - \$4.3-mil construction cost
 - Over 300 miles in length
 - 146 locks

Gannett Fleming
Excellence Delivered As Promised

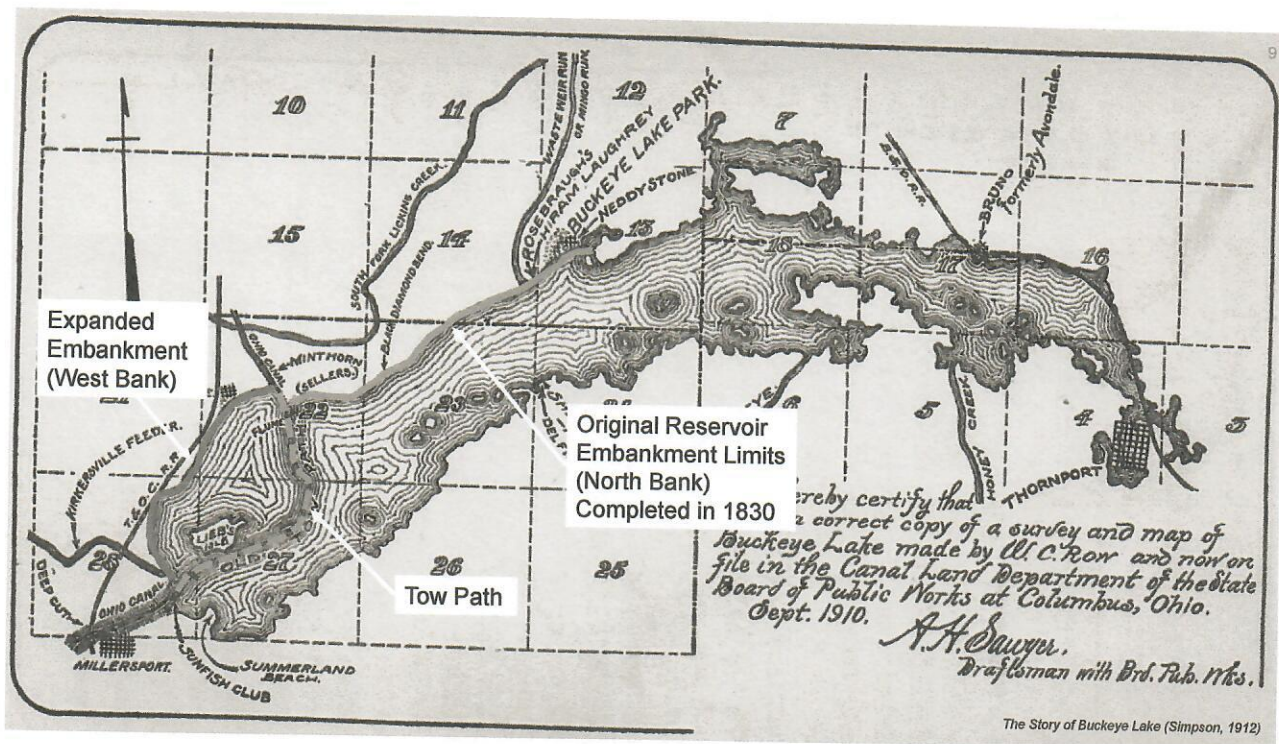


Ohio & Erie Canal System

- **Importance of Licking Summit Reservoir (Buckeye Lake)**
 - Topographic high along route
 - Natural reservoir already existed
 - Provided "adequate" volume for canal system
 - Fed water both directions
 - Principal water source from Licking Summit to Ohio River



Gannett Fleming
Excellence Delivered As Promised

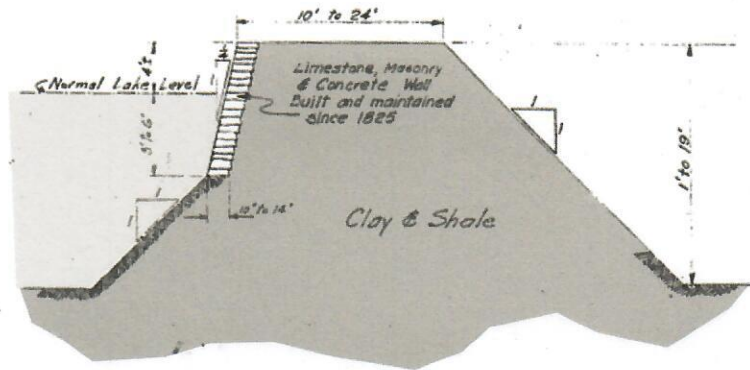


Typical 1800's Canal Boat



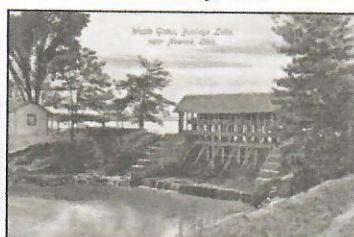
Modified Embankment Section

- **Original Embankment**
 - Unfaced upstream slope
 - Failed in 1832 due to wave action flooding areas downstream
- **Modified Embankment**
 - Masonry wall constructed on upstream face
 - 10,000 wagon loads hauled 6 miles to the lake then barged from there to the dam
 - Material sourced from prehistoric Native American burial mound east of the site



Late 1800's to Early 1900's

- **Downfall of Canal**
 - Extreme competition with railroads
 - Occasional lack of water in the canal
 - Many portions of canal abandoned or repurposed
 - 1894: Ohio General Assembly repurposes all feeder reservoirs into public parks
 - Licking Summit Reservoir renamed Buckeye Lake



- **Public Use**
 - Lots on dam sold/leased to the public
 - Cabins and cottages begin to be prevalent

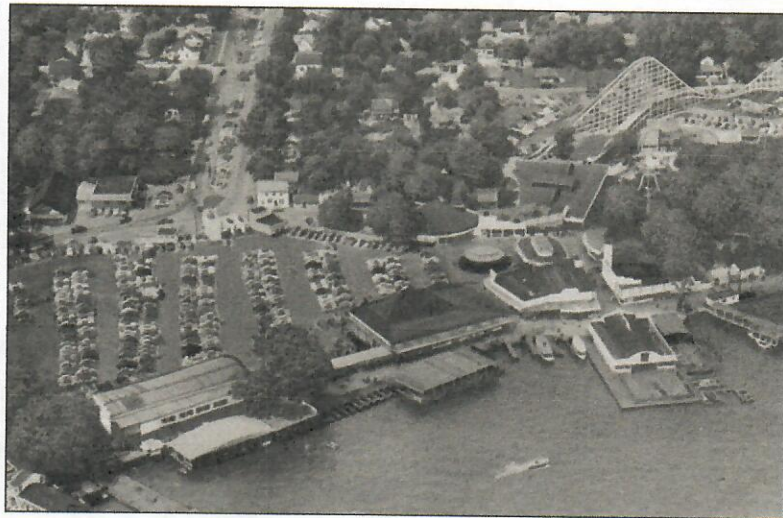
Early 1900's



Gannett Fleming

Excellence Delivered As Promised

Early 1920's to 1960's



Gannett Fleming

Excellence Delivered As Promised

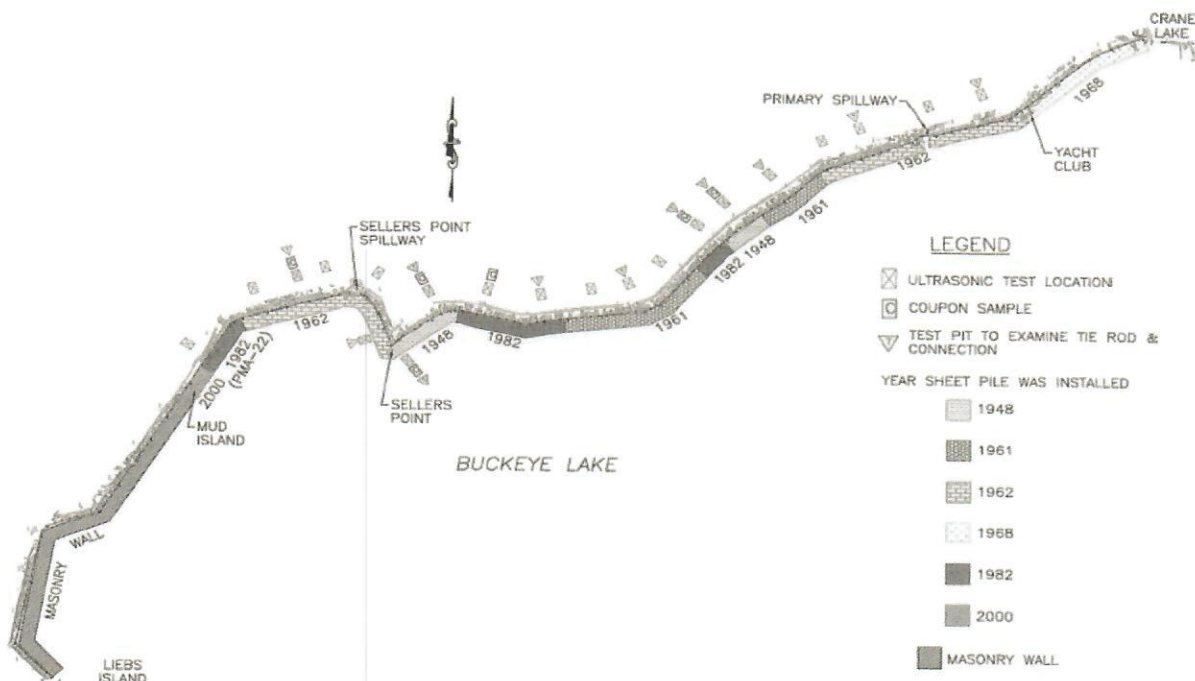
Various Phases Late 1940's and Beyond

• Shoreline Improvements

- Flat sheet piling installed upstream of dam
- Waler with tendons extend to reaction piles / deadmen
- Backfilled with bank run material
- Sheet piling installed at various phases beginning in the late 1940's

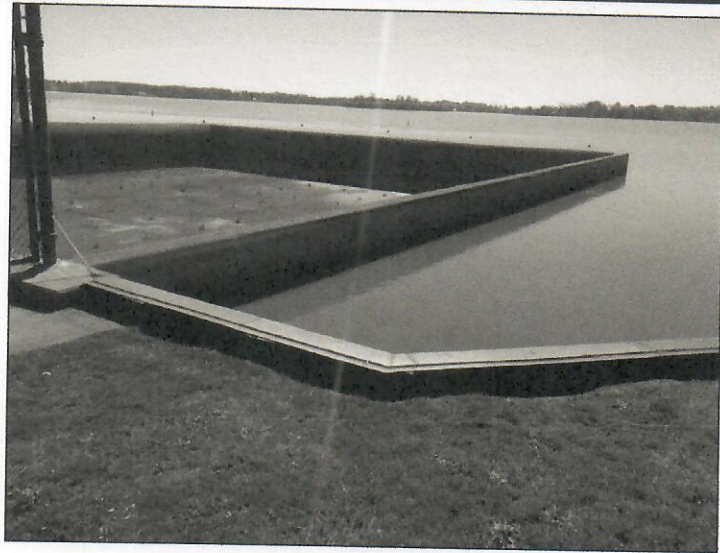


Gannett Fleming
Excellence Delivered As Promised



1990's Discharge Capacity Improvements

17



Gannett Fleming

Excellence Delivered As Promised

Dam Performance & Call to Action

18

- **ODNR & USACE**
 - USACE involved in project since 1939 (USACE Special Report)
 - ODNR requests emergency assistance from USACE Huntington District in 1968 and 1990
 - Elevated pool events, overtopping possible, some house foundations in distress
 - June 2014, USACE assesses condition of Buckeye Lake Dam at ODNR request
 - Previous seepage and current outbreaks
 - Previous internal erosion episodes
 - Upstream face deterioration
 - Trees rooted in embankment
 - Subsidence features
 - 370 houses and associated structures on/in the dam *"unprecedented in the experience of the District"*
 - USACE Conclusions (March 2015)
 - Among others.....interim risk reduction measures should be implemented immediately



Gannett Fleming

Excellence Delivered As Promised

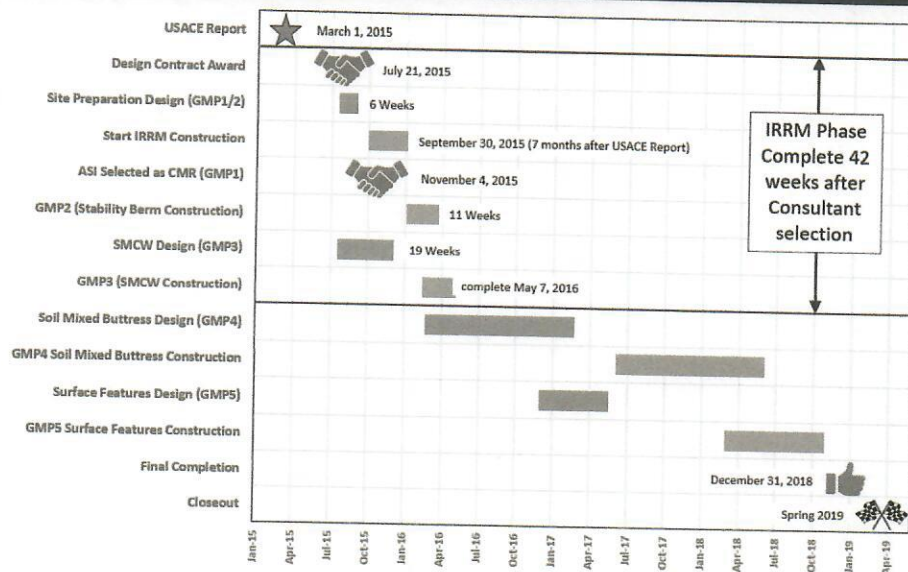

Gannett Fleming
Excellence Delivered As Promised

 **Gannett Fleming**
Excellence Delivered As Promised

Project Schedule

- **ODNR Procurement**

- Pre-qualify consultants prior to selection
- Selection of GF in July-2015
- GF recommends Construction Manager At-Risk delivery model
- Pre-qualify CMR contractors
- Section of ASI as CMR in November-2015



Gannett Fleming

Excellence Delivered As Promised

Project Delivery and Goals

- **Why CMAR?**
 - Allows for fast-track delivery
 - Contractor engaged early in design
 - Design control maintained by owner
 - Frequent cost/risk discussion among all parties (all cards are on the table)
- **Phased Construction**
 - IRRM = Rapid reduction of risk
 - Can be structural or non-structural (both in this case)
- **IRRM Goals for Buckeye Lake**
 - Reduce risk of failure due to seepage
 - Provide access for the work and emergency response
 - Collect information necessary for subsequent phases



Gannett Fleming

Excellence Delivered As Promised

Interim Risk Reduction Measures

- Site Constraints (370 houses 10'-20' feet from upstream face)



Gannett Fleming
Excellence Delivered As Promised



Interim Risk Reduction Measures



Gannett Fleming
Excellence Delivered As Promised

IRRM Construction – Boat Docks and Foundation Prep

27



Gannett Fleming
Excellence Delivered As Promised

Photo Courtesy of ASI

IRRM Construction – Embankment Stability Berm

28



Gannett Fleming
Excellence Delivered As Promised

IRRM Construction – Embankment Stability Berm

29

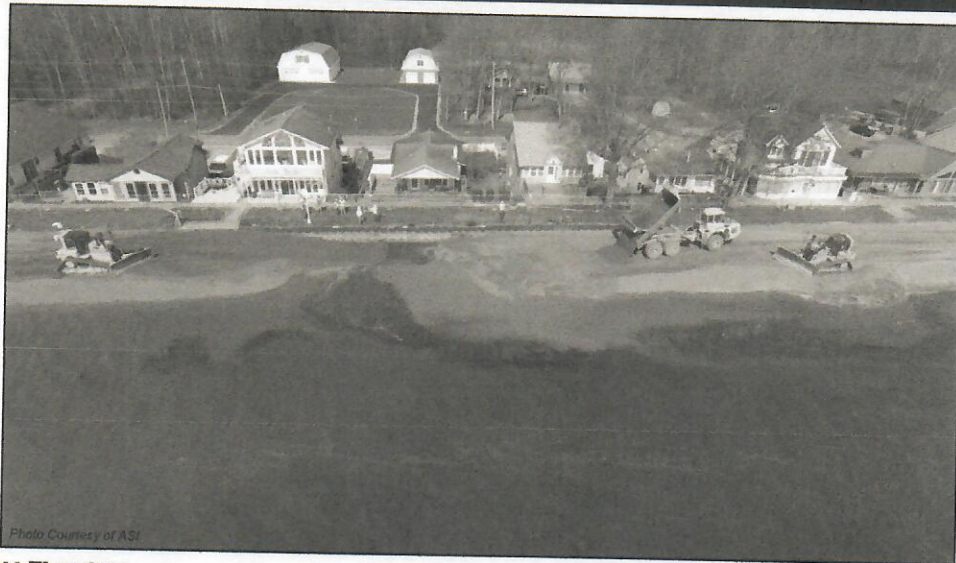


Photo Courtesy of ASI



Gannett Fleming

Excellence Delivered As Promised

IRRM Construction – Access

30

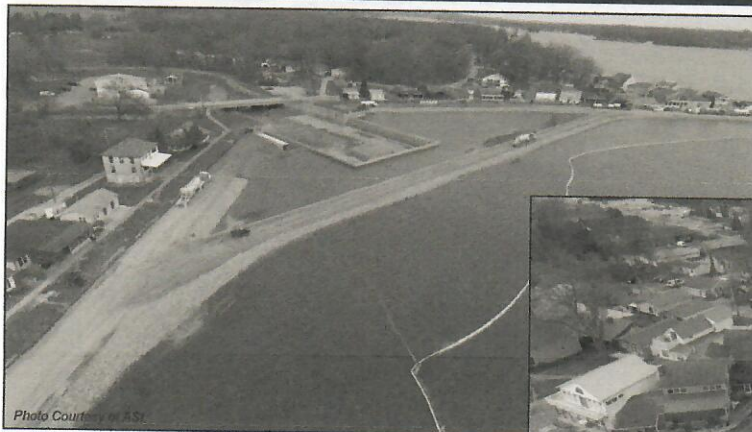


Photo Courtesy of ASI



Photo Courtesy of ASI



Gannett Fleming

Excellence Delivered As Promised

IRRM Construction – Soil Mixed Cutoff Wall

31

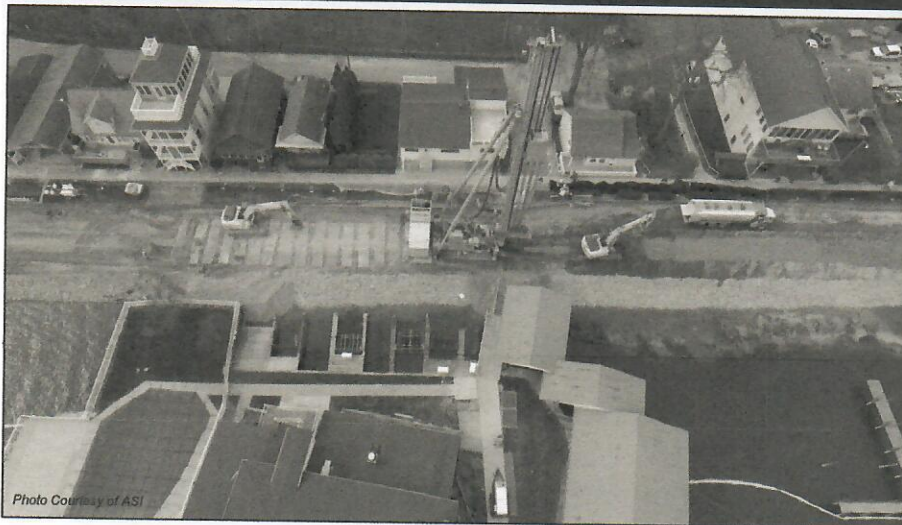


Gannett Fleming

Excellence Delivered As Promised

IRRM Construction – Soil Mixed Cutoff Wall

32



Gannett Fleming

Excellence Delivered As Promised

IRRM Construction – Soil Mixed Cutoff Wall

33



Photo Courtesy of ASI



Gannett Fleming

Excellence Delivered As Promised

IRRM Construction – Soil Mixed Cutoff Wall

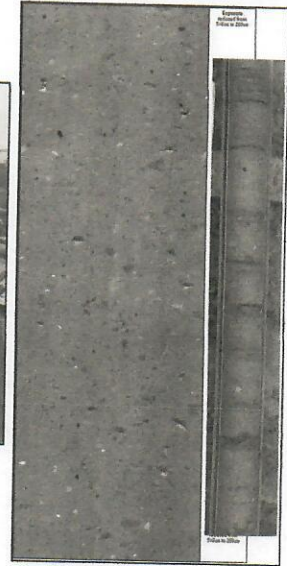
34



Gannett Fleming

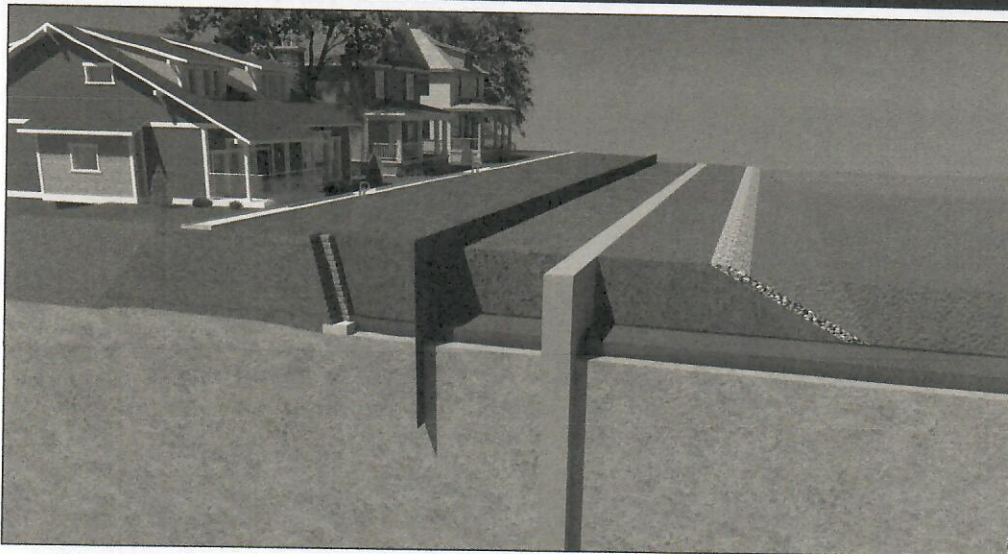
Excellence Delivered As Promised

IRRM Construction – Soil Mixed Cutoff Wall



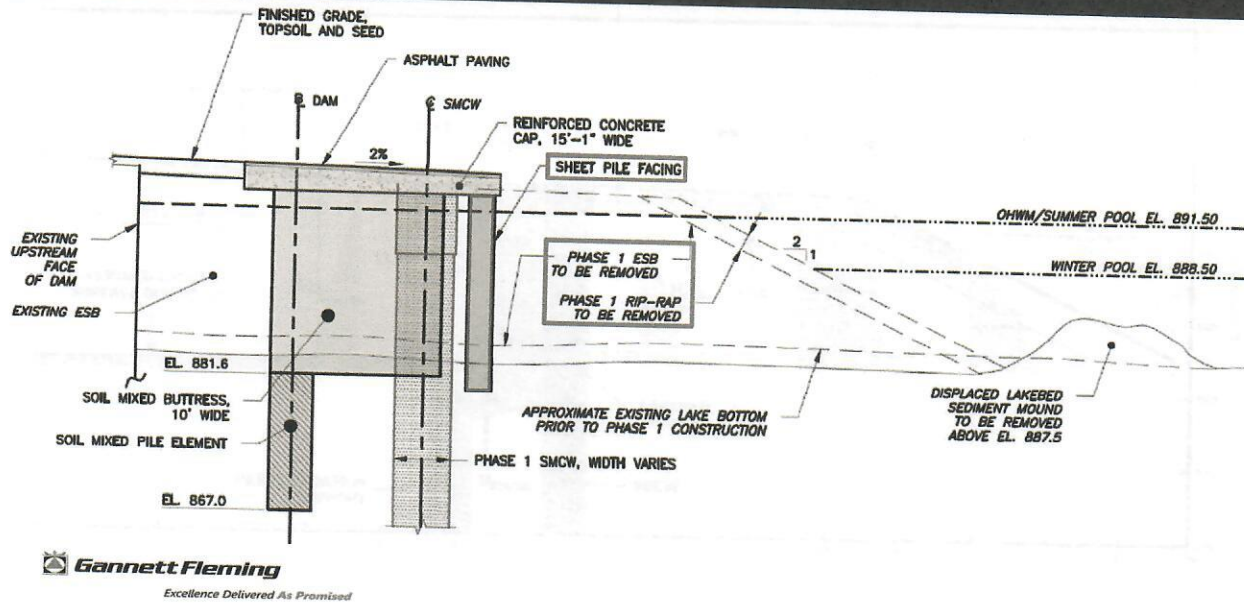
Gannett Fleming
Excellence Delivered As Promised

Post-IRRM Construction

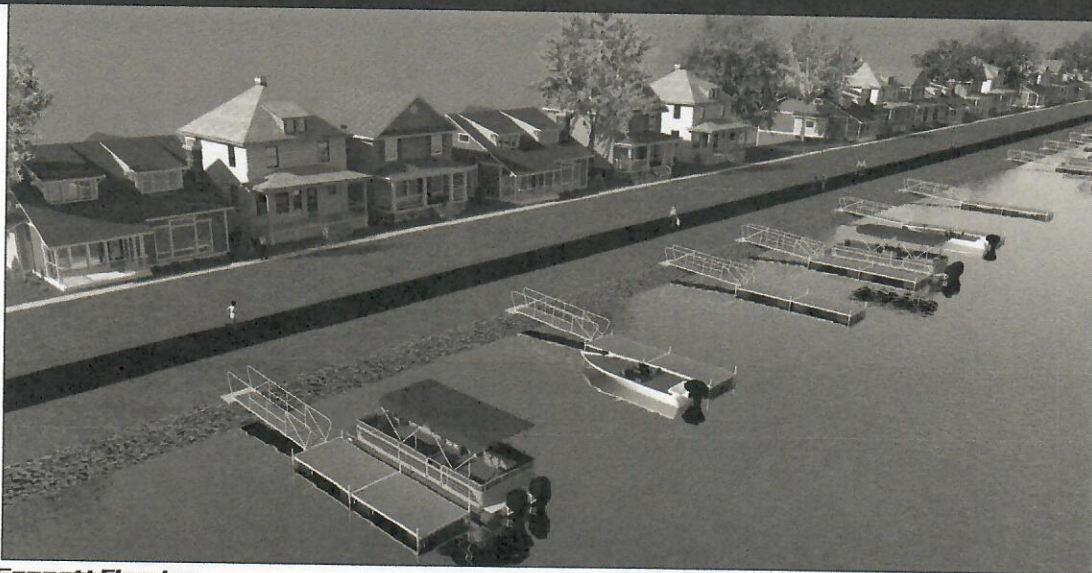


Gannett Fleming
Excellence Delivered As Promised

Phase 2 Design Concept



Phase 2 Final Design



Phase 2 Construction – Soil Mixing

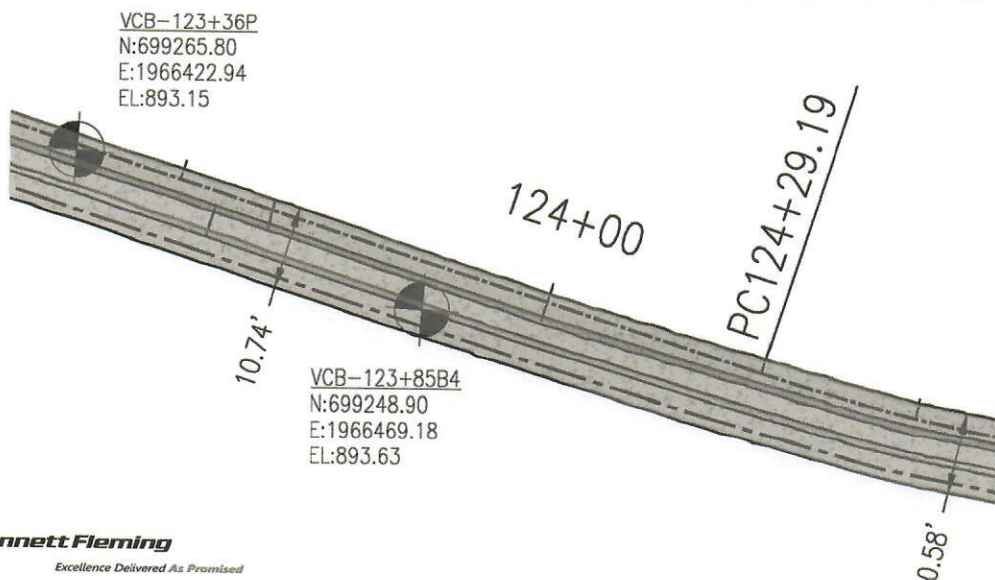
41



Gannett Fleming
Excellence Delivered As Promised

Phase 2 Construction – Soil Mixing

42



Gannett Fleming
Excellence Delivered As Promised

Phase 2 Construction – Soil Mixing

43



Gannett Fleming

Excellence Delivered As Promised

Phase 2 Construction – Soil Mixing

44



Gannett Fleming

Excellence Delivered As Promised

Phase 2 Construction – Sheet Piling

45



Photo Courtesy of ASI



Gannett Fleming

Excellence Delivered As Promised

Phase 2 Construction – Sheet Piling

46



Photo Courtesy of ASI



Photo Courtesy of ASI



Gannett Fleming

Excellence Delivered As Promised

Phase 2 Construction – Jet Grouting

47



Photo Courtesy of ASI



Photo Courtesy of ASI

Gannett Fleming

Excellence Delivered As Promised

Phase 2 Construction – Passive Anchors

48

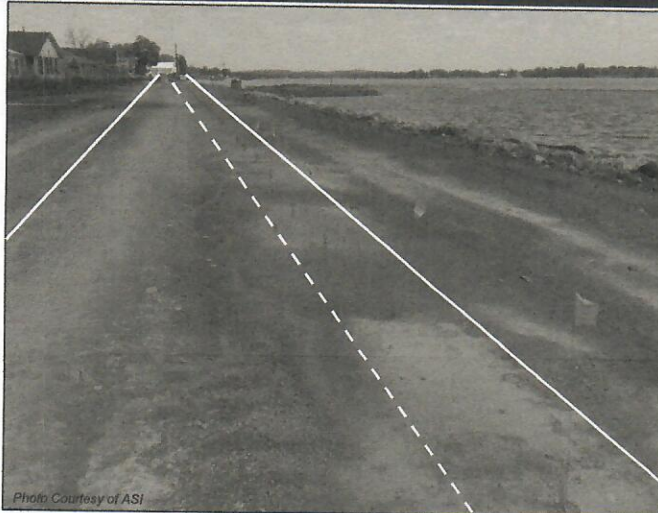


Photo Courtesy of ASI

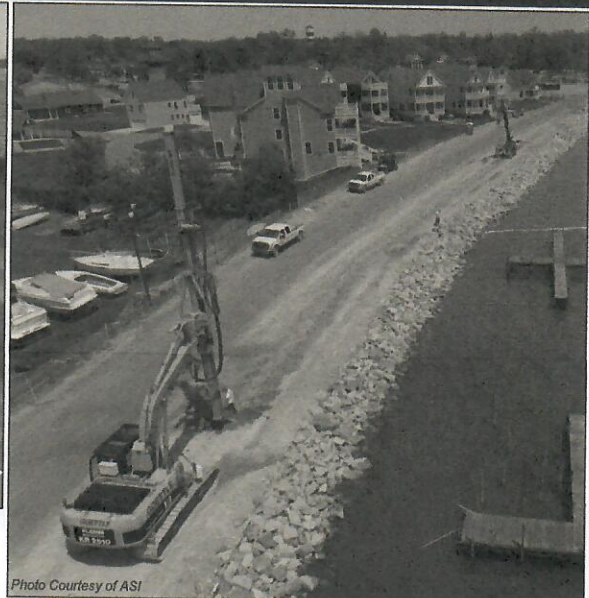
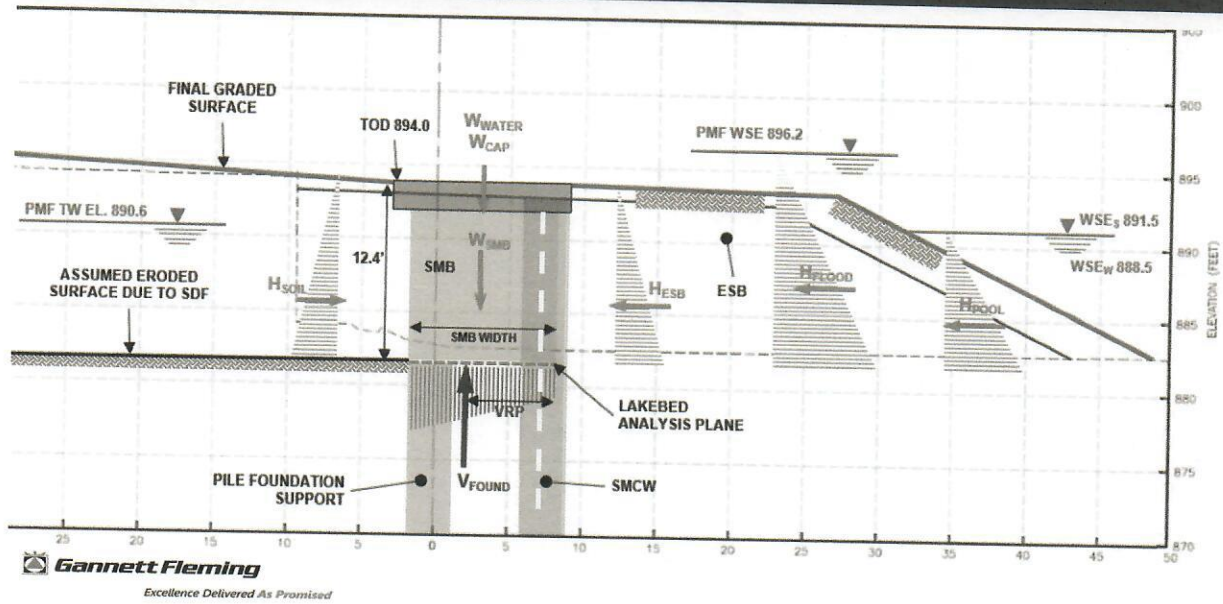


Photo Courtesy of ASI

Gannett Fleming

Excellence Delivered As Promised

Phase 2 Construction – Passive Anchors



Phase 2 Construction – Cap Construction

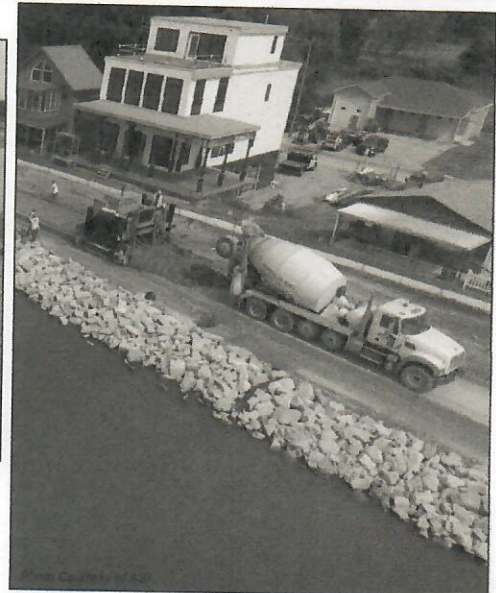


Phase 2 Construction – Cap Construction

51



 **Gannett Fleming**
Excellence Delivered As Promised



Phase 2 Construction – Rip-Rap Placement

52



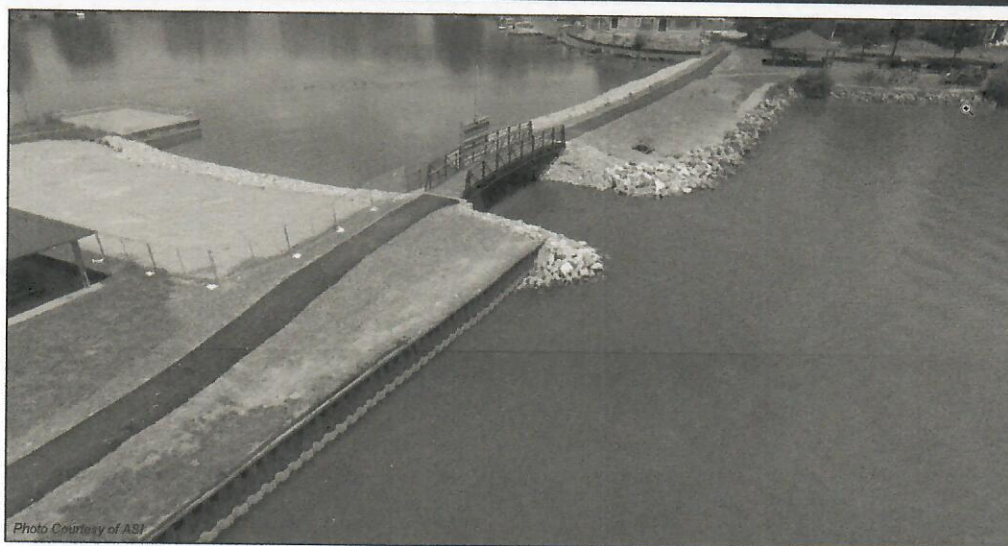
 **Gannett Fleming**
Excellence Delivered As Promised

Phase 2 Construction – Topsoil Placement



 **Gannett Fleming**
Excellence Delivered As Promised

Phase 2 Construction – Crane Lake Final



 **Gannett Fleming**
Excellence Delivered As Promised

Phase 2 Construction – Watkins Island BLYC

56

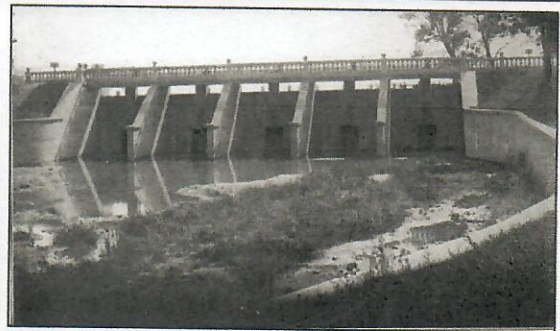


Gannett Fleming

Excellence Delivered As Promised

200 Years of the Amil Spillway

56



Gannett Fleming

Excellence Delivered As Promised

Phase 2 Construction – Amil Spillway

57



Gannett Fleming

Excellence Delivered As Promised

Phase 2 Construction – Amil Spillway

58



Gannett Fleming

Excellence Delivered As Promised

Phase 2 Construction



Gannett Fleming

Excellence Delivered As Promised

Project Statistics

- **IRRM**
 - Embankment Stability Berm: 390,000 CY (500 truckloads per day, 1 truck per minute)
 - Soil Mixed Cutoff Wall: ~90,000 CY (83 calendar days)
- **Phase 2**
 - Soil Mixed Buttress: ~130,000 CY
 - Passive Anchors: ~4,000 EA
 - Concrete: ~14,000 CY
 - Rip-Rap: ~45,000 CY
 - Sheet Piling: ~37,000 SF
- **Geotechnical Construction Methods:**

Soil Mixing	Micro-Piles	Driven Sheet piling
Anchors	Driven Piles	Press-In Sheet piling
Jet Grouting	Vibrated Sheet piling	Soil Stabilization



Gannett Fleming

Excellence Delivered As Promised

?? Questions ??

61

