# CE 4990/6990 - *The Paving Process – Summer 2016*
# Abbreviated & Slightly Altered Final Presentations for Website Display


**Instructor -Isaac L. Howard**

This hands on course initiative was financially supported by MAPA, with numerous others shown on the following slides providing, technical support, mentoring, facility access, and many other in-kind services. This course was an industry, agency, and university partnership at the most fundamental level. Thank you to everyone!

# The Paving Process
# Technical & Logistical Supporting Groups

EUTAW

Hunt Refining Company

PHILLIPS CONTRACTING
Columbus, MS

STATE

NEEL-SCHAFFER
Solutions you can build upon

HONESTY · EXCELLENCE
SINCE 1927
MMC MATERIALS, INC.
CONTINUOUS IMPROVEMENT


Mississippi Asphalt Pavement Association

apac

MDOT
Mississippi Department of Transportation

# Individual Acknowledgements


- Everyone listed below supported this hands-on educational initiative in at least one way.

- Kyle Beckman, Mike Bogue, Dennis Bonds, Jason Brewer, Keith Clark, David Coleman, Don Conrad, Ben Cox, Jennifer Crowe, Codrin Daranga, Mike Hemsley, David Howell, Mark Holley, Jeff Johnson, Jason Keith, Kyle LaPorte, Jamie McDonald, Brandon McGarrity, Mike Miller, Nan Mitchell, Jonathan Myrick, Derrick Olive, Bob Phillips, Saunders Ramsey, Kari Babski-Reeves, Roy Robertson, Mike Tagert, Dennis Truax, Josh Walden, Amy Walker, Travis Wampler, Dan Whatley, and Taylor Wilson

# South Entrance or South Gateway Project (i.e. Hail State Boulevard)

- This project served as the project for this class
- Their goal was to understand all aspects of what is required to have a transportation corridor connecting two points
  - Engineering
  - Construction
  - Materials
  - Financing
  - Public relations, public support
  - The list goes on….

# The Paving Process – Enrolled Students

| Name | Classification | Hometown |
|---|---|---|
| Brad Hansen | Graduate | Long Beach, MS |
| Robert Moore | Graduate | Tupelo, MS |
| Carl Pittman | Senior | Helena, AR |
| Jayme Williams | Senior | Carrollton, MS |
| Corbin Coker | Senior | Petal, MS |
| Jonathan Buckley | Senior | Brookhaven, MS |
| Joseph Arthur | Senior | Hernando, MS |
| Chancedy Pulliam | Senior | Houston, MS |
| Westin Graves | Junior | Jackson, MS |

# Introduction & Background

**Presenter:**

**Carl Pittman**

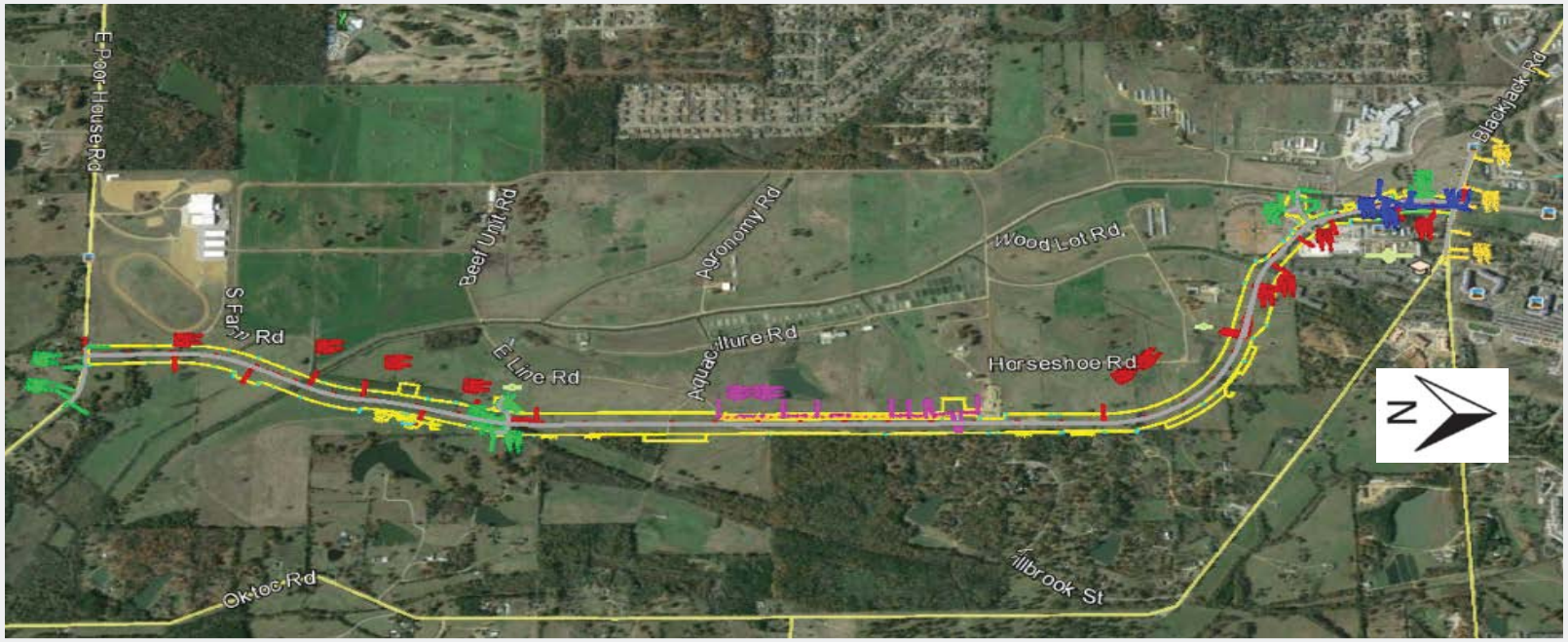
*Undergrad Research Assistant for CMRC*

*Undergrad Civil Engineering Student*

*Mississippi State University*

# MSU South Entrance

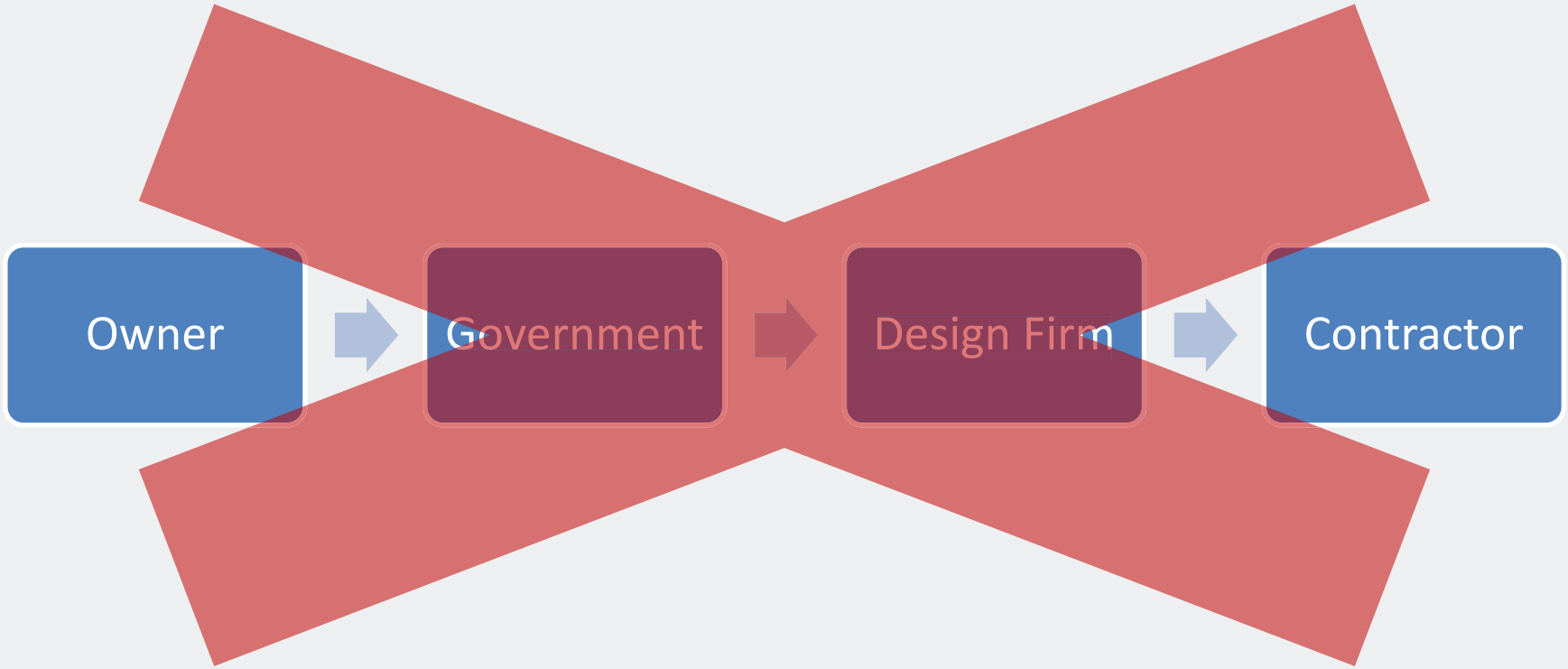
- 3.5 miles long
- 1 bridge
- 2 box bridges
- 3 box culverts
- Primary Contractor- Eutaw
- $18 million total budget



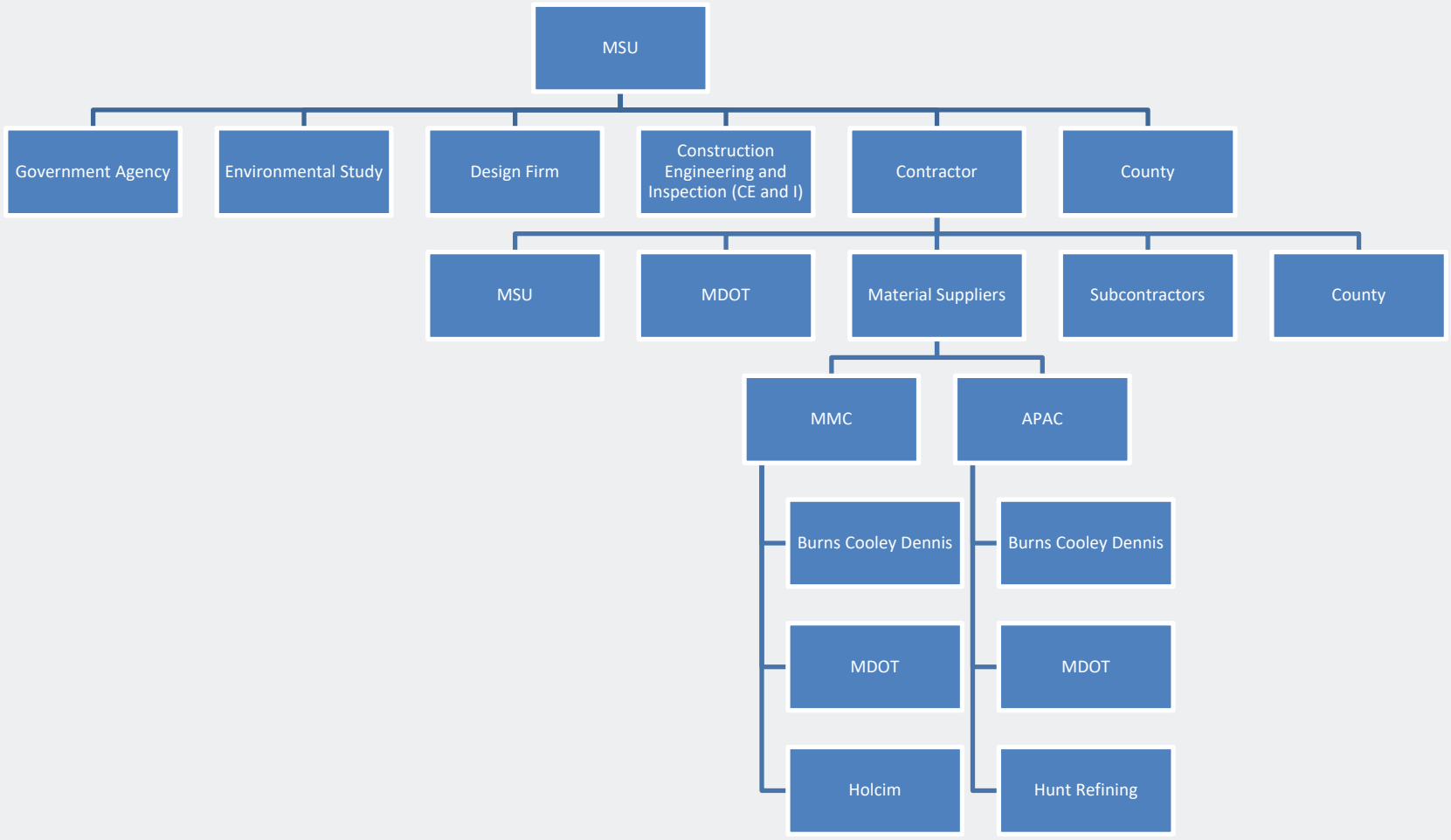
# Approximate Timeline

- 2006: Initial Idea
  - Memorandum of Understanding signed in April
- 2007-2010: Environmental study and design
- 2010-2015: Approving drawings and acquiring funds
- Fall 2015: Bid accepted
- Feb. 1st 2016: Notice to proceed issued to Eutaw
- Fall 2017: Estimated completion

# Project Management



# Project Management



# Entities Involved

- MSU
- MDOT
- FHWA
- OSHA
- Neel-Schaffer
- Burns Cooley Dennis, Inc.
- Oktibbeha County
- Eutaw Construction Co., Inc.
- MMC Materials, Inc.
- APAC Mississippi, Inc.
- Hunt Refining Co.
- Holcim US, Inc.
- Corps of Engineers
- Volkert Inc.
- Riverside Traffic Systems
- Traffic Maintenance Service
- Mississippi Paving and Construction, Inc.
- A-1 Sealing, Inc.
- Simmons Erosion Control
- Atwood Fence Co. LLC
- Stewart Environmental Construction, Inc.
- Sunbelt Sealing, Inc.
- Columbus Fence Co. LLC
- Eubank Construction Co., Inc.
- Phillips Contracting Co., Inc.

# Financing and How it Affects Those Involved From the Owner to the Observer

**Presenter:**

**Corbin Coker S.M. ASCE**

*President MSU ASCE*

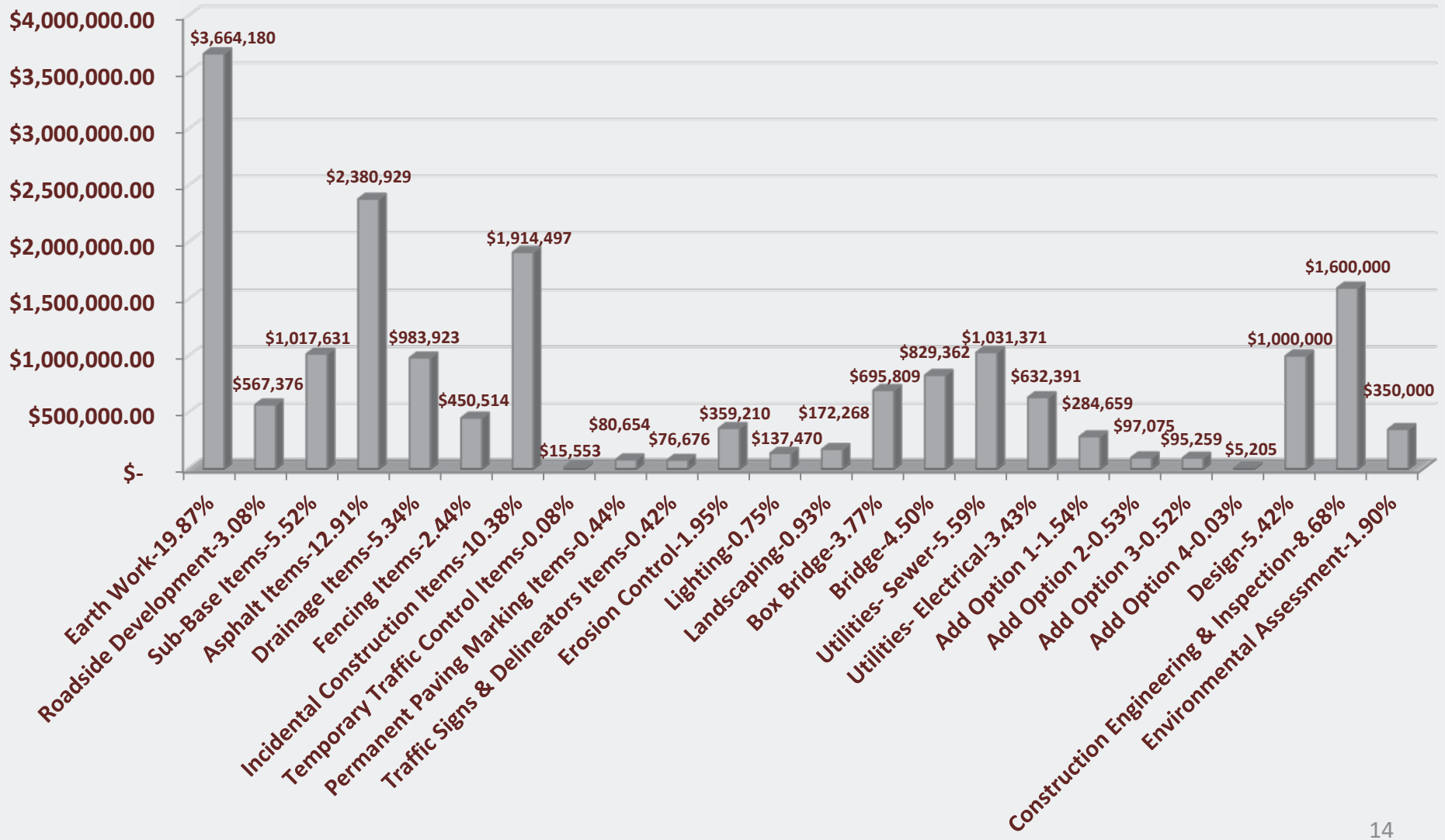
*Student Chapter*

# Finances

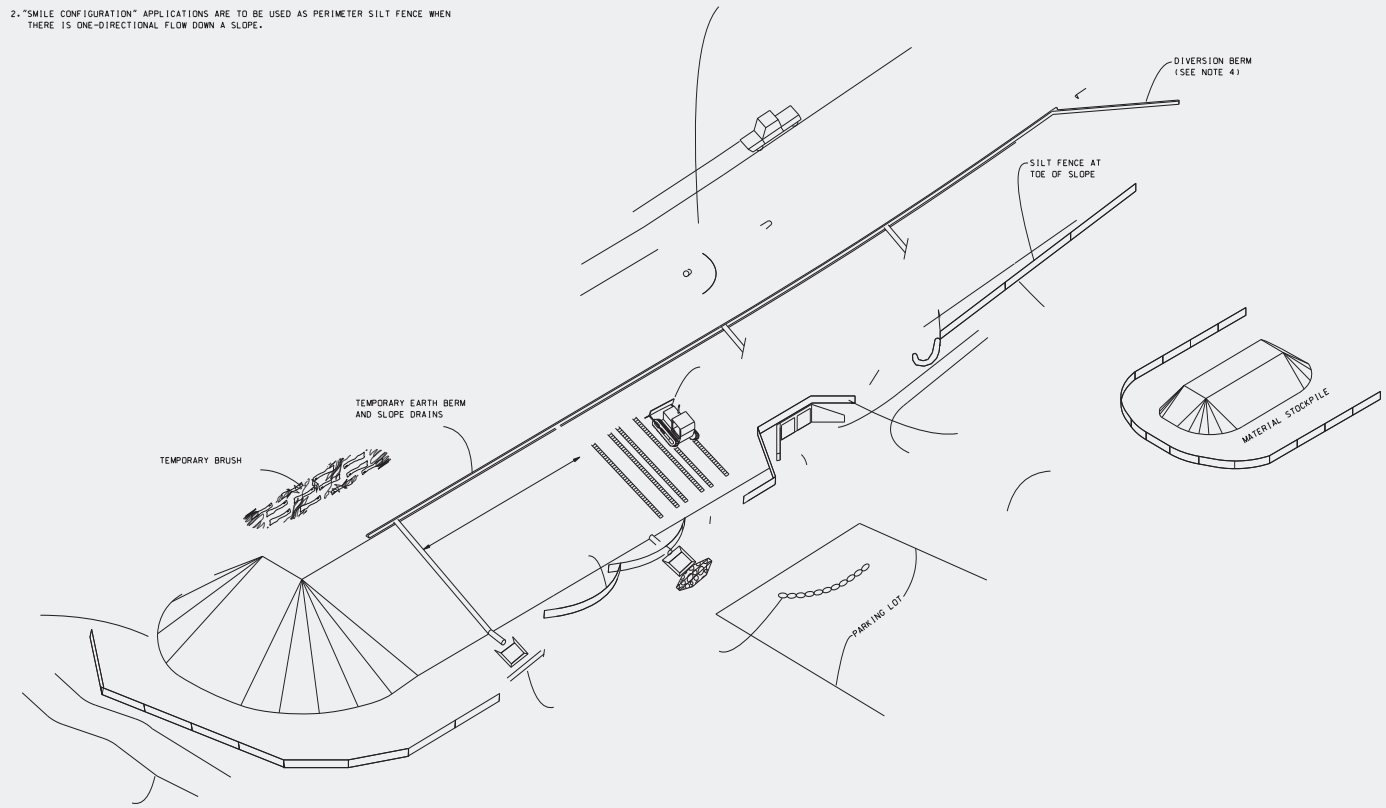
The Effect it has on Everyone Involved

Where the Financing comes from
FHWA/USDOT is one large source

# Where the Money goes

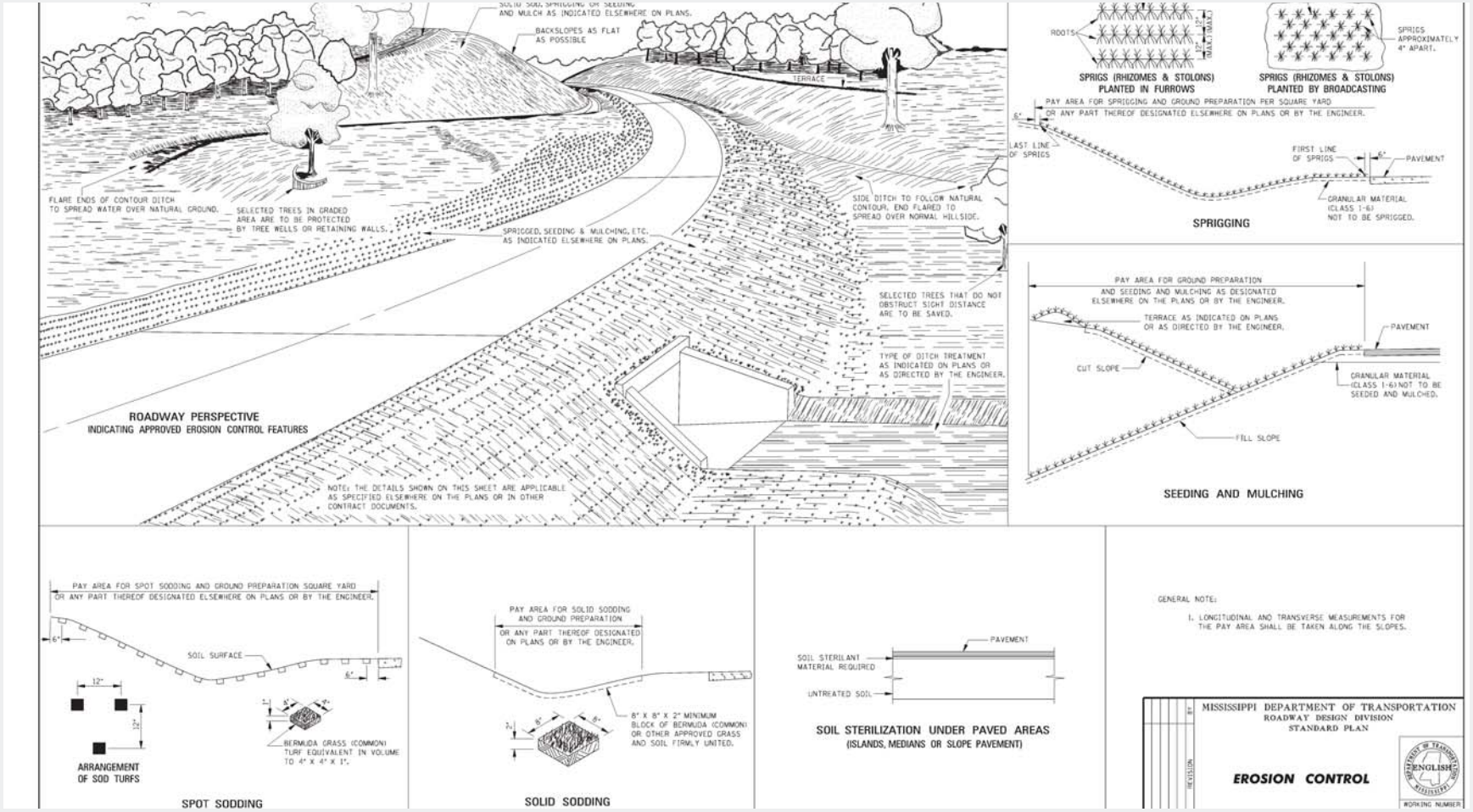


# Road Site Development-3.08%



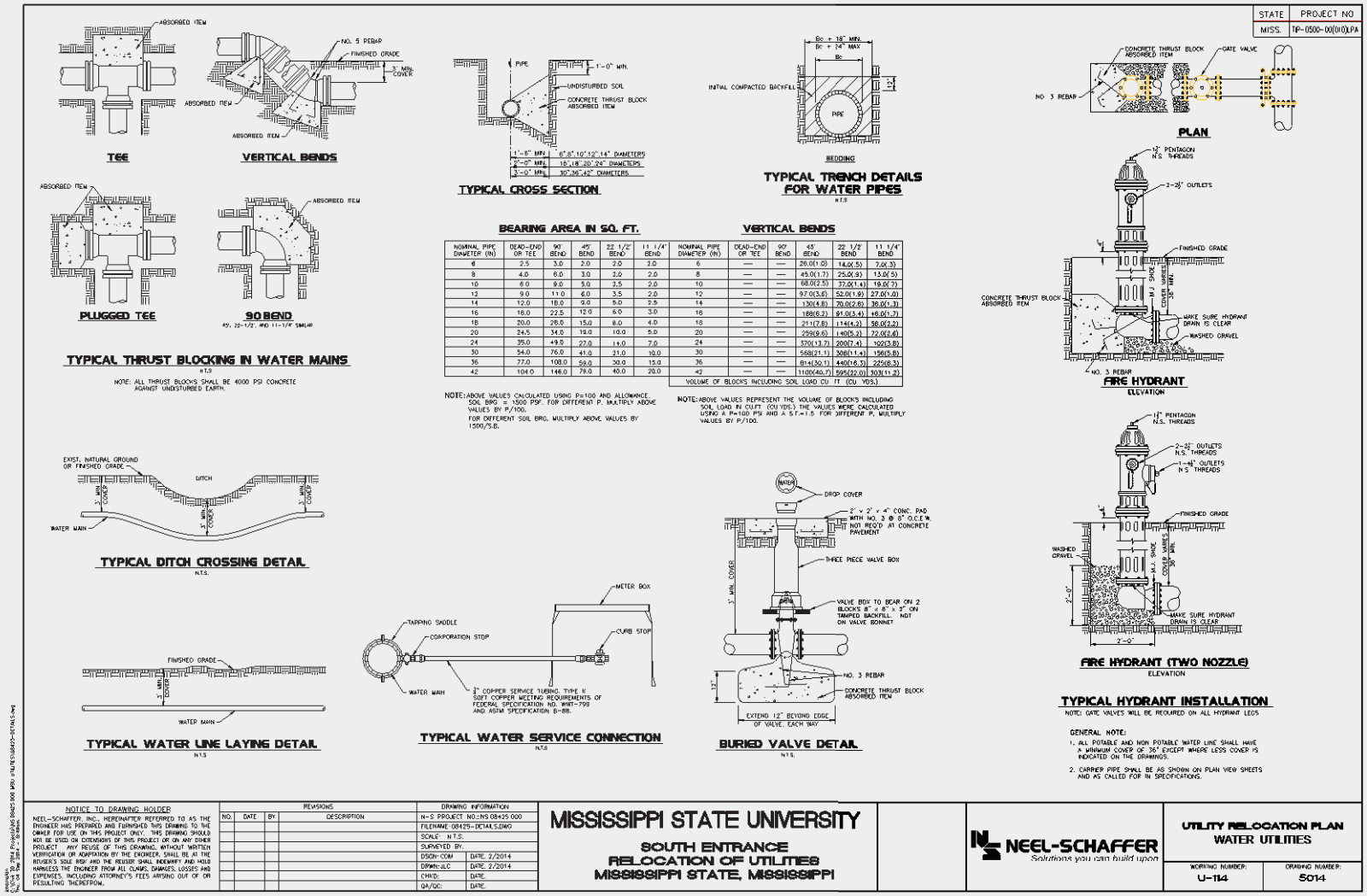
# Earth Works and its financial impact-19.87%

# Fencing and Temporary Erosion Control-4.39%



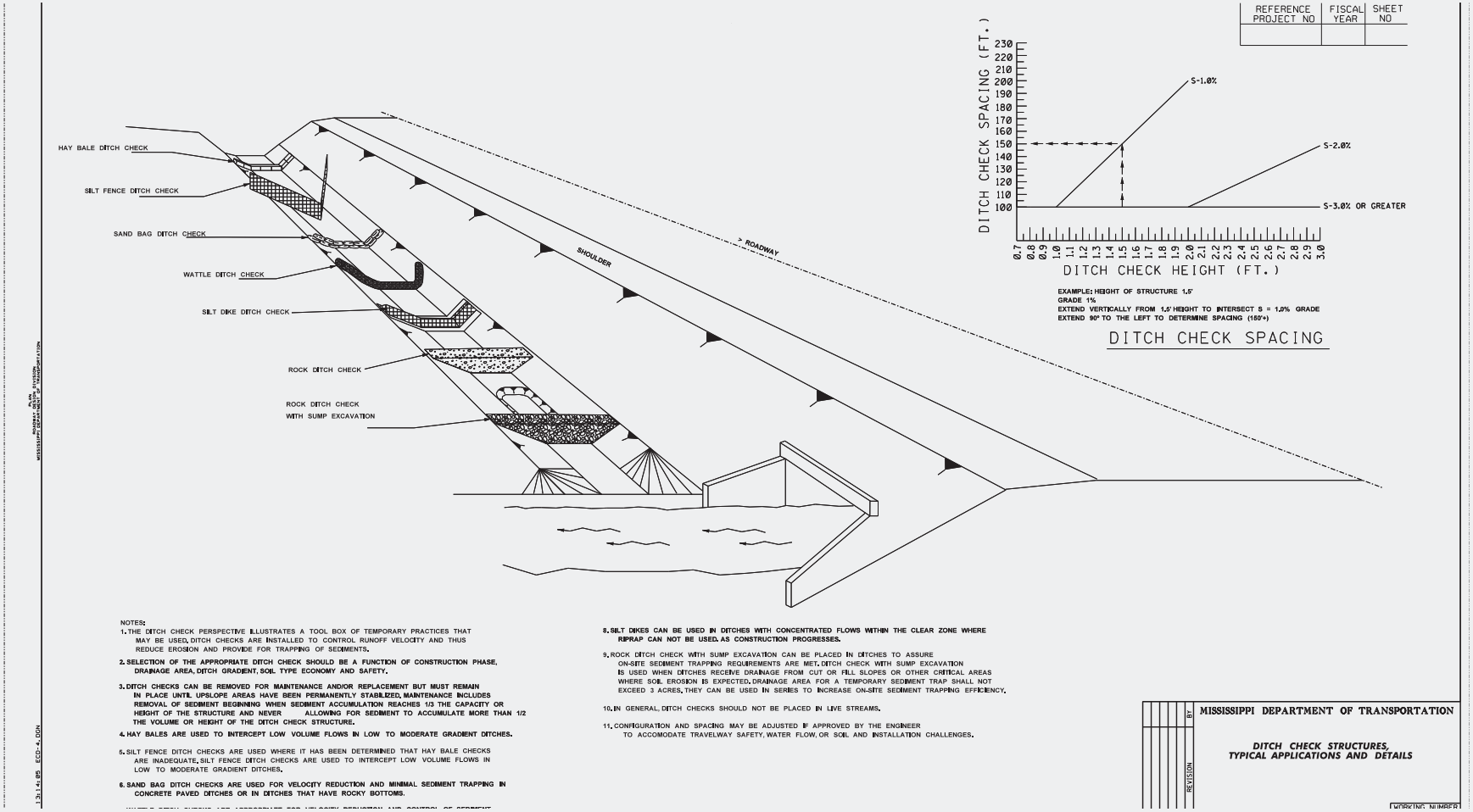
# Bridge and Culverts-8.27%

# Utilities-9.02%

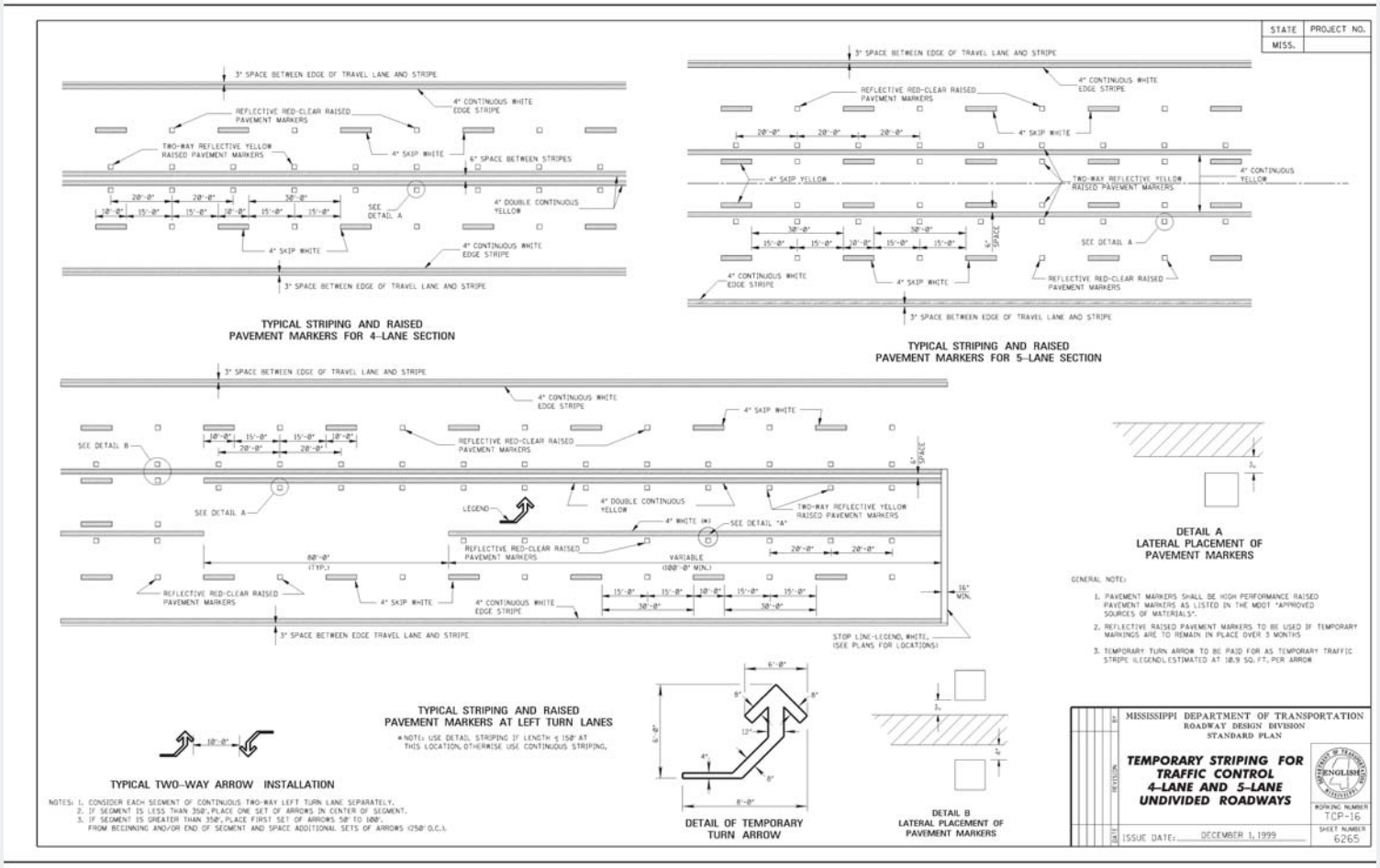


# Drainage-5.34%

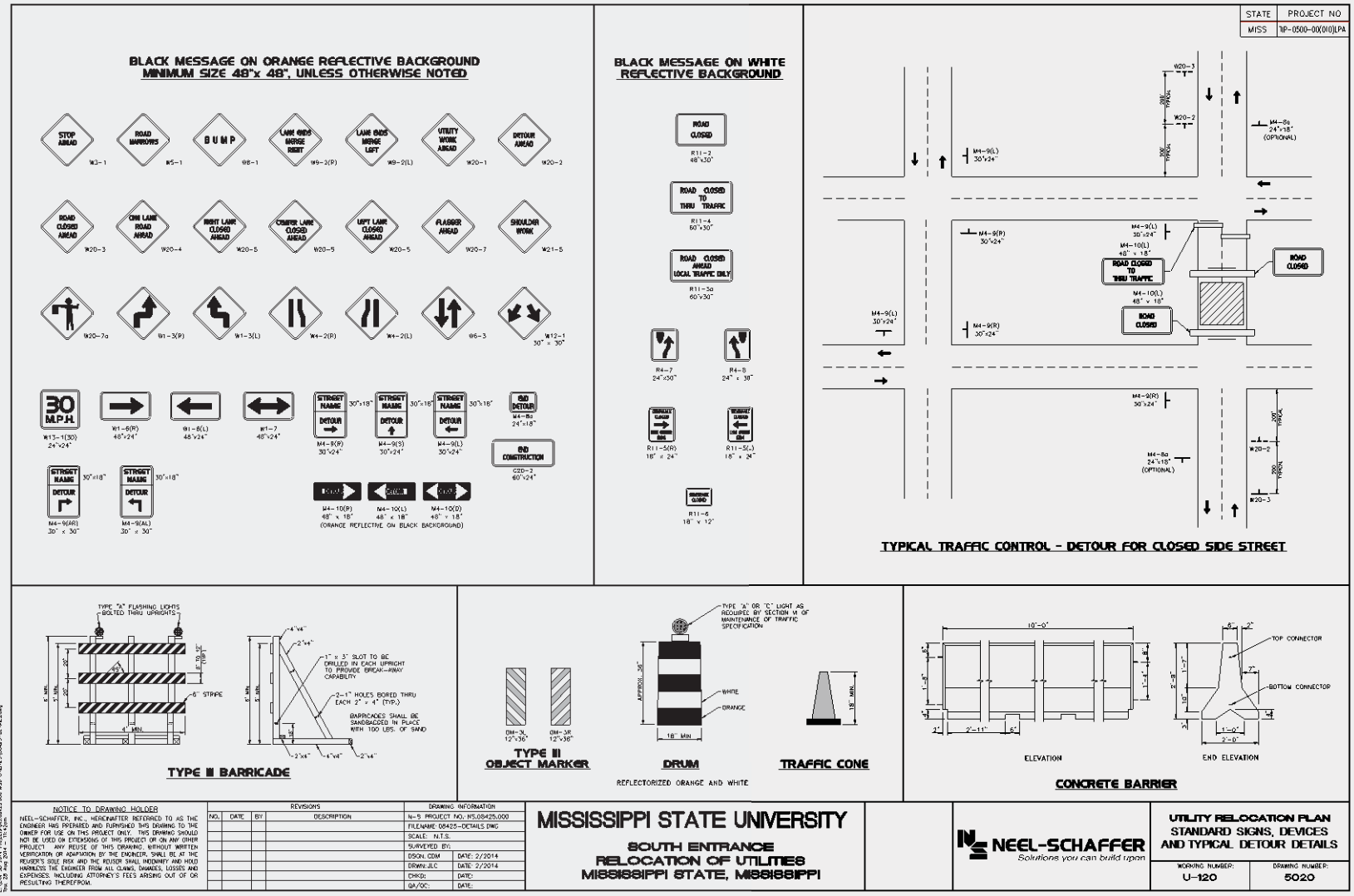
# Subbase and Asphalt-18.43%



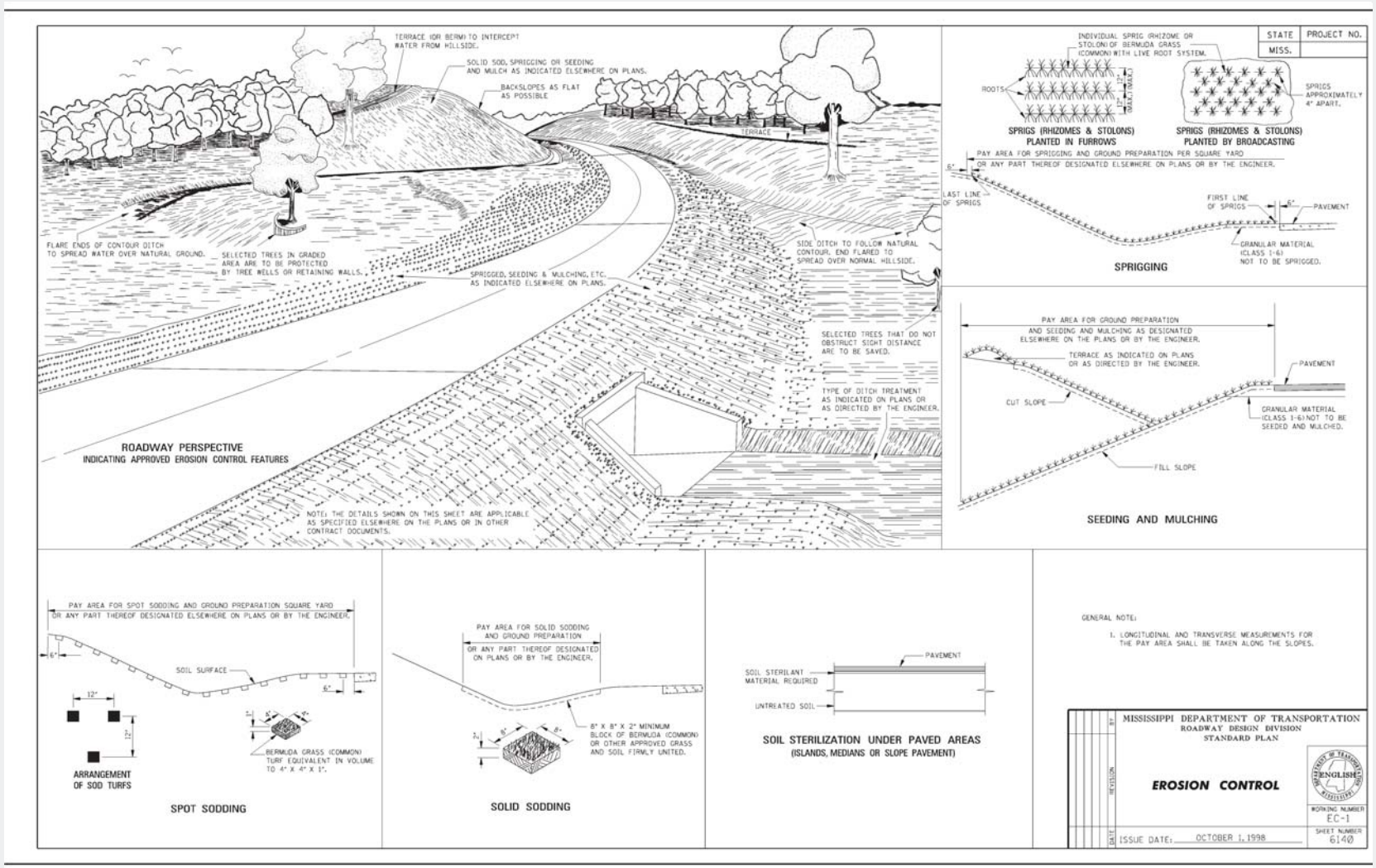
# Temporary Traffic Items-0.08%



# Signage, Striping, and Marking of Roadway-0.86%



# Landscaping 0.93%



# ADD OPTIONS

- Lime Stabilization-1.54%
- Traffic lighting-0.53%
- Road Side Barriers-0.52%
- Landscape Irrigation system-0.03%

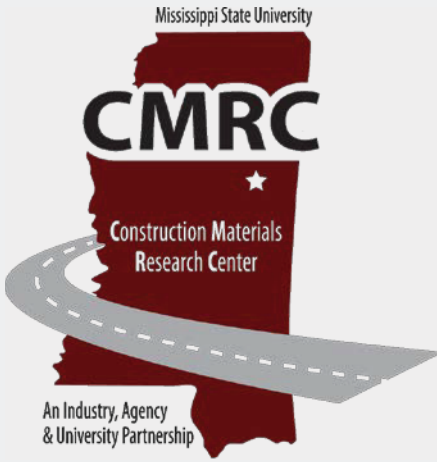
# Construction Safety

**Presenter:**

**Chancedy Pulliam**


*Civil and Environmental Engineering Student*

*Mississippi State University*



# Safety & Practices

- Construction Safety
  - PPE
  - People
  - Training
  - Equipment
  - E-MOD
- Construction Practices
  - Eubank pipeline replacement
  - Phillips Bridge Design

# Construction Safety

- Each year 20,000 workers are injured in road construction work zones
- Top Injuries throughout the US
  - Contact with equipment
  - Slips/Falls
  - Overexertion
  - Transportation incidents
  - Exposure to harmful substances

# Construction Safety

- Fatalities in road construction typically account for 1.5%-3% of all workplace fatalities annually
- 2014 Mississippi only reported 8 fatalities occurring during road construction work and zoning.

# Safety Practices

- PPE (Personal Protective Equipment)

# Construction Safety

- Three key factors
  - People
    - PPE, Safety meetings, 3 points of contact, and alertness
  - Training
    - OSHA training course, First Aid and CPR Training
  - Environment
    - Animals, Heat Exhaustion, and Prevention Methods

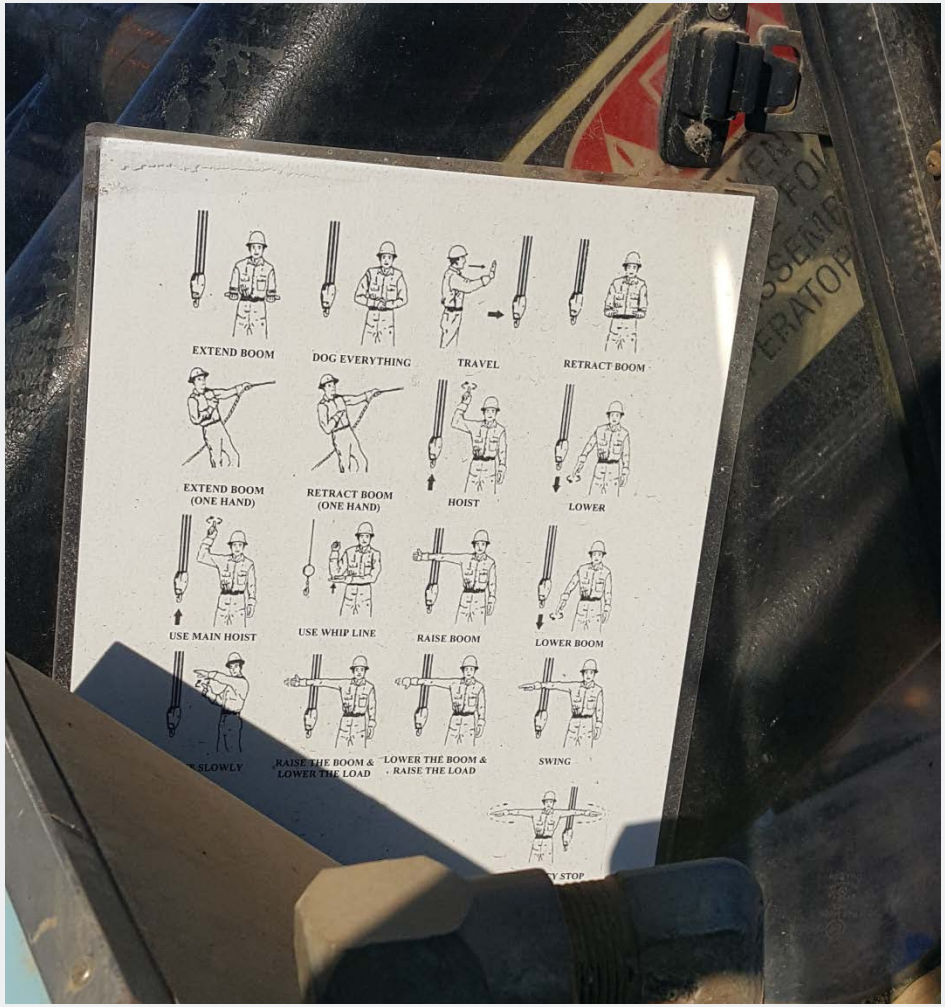
# Construction Safety

# Construction Safety

- Insurance Cost
  - E-MOD (Experience Modification Ranking)
  - E-MOD below 1.0
  - E-MOD's effect on construction contracts
- Equipment Safety
  - Proper Equipment training
  - Equipment maintenance
  - Worker and equipment signals

# Construction Safety

## Equipment Signals



# Construction Practices

North End

South End

# Construction Practices

- Removal of current piping system
- Why PVC?
- Recycling Materials?

# Construction Practices

- Just Remove the PIPES?
  - Sewage
  - Bypass Pumps

# Construction Practices

- PVC pipe installation process
  - Excavator
  - Grade
  - Numbering
- Rocks instead of soil

# Construction Practices

# Construction Practices

# Construction Practices

- As Future civil engineers how do we plan for the unexpected?

# Site Design

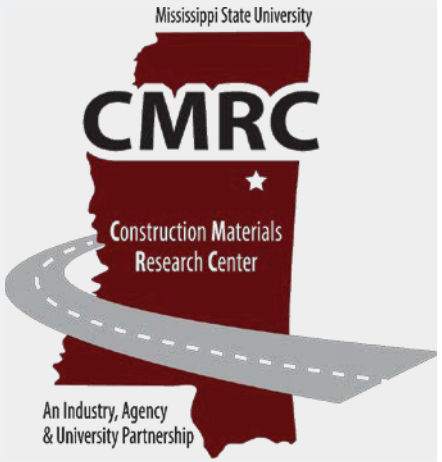
**Presenter:**

**Jonathan Buckley**


*Civil and Environmental Engineering Student*

*Civil and Environmental Engineering Dept.*

*Mississippi State University*



# Master Plan

- Four lane boulevard from Blackjack to Poorhouse road.
- Bike/pedestrian path along the entire route.
- Funding
- Survey of entire proposed project area

# Design Issues

- Funding
- South Farm
- Material supplier limitations

# Design

- Began approximately 5 years from the initial memorandum of understanding.
- Includes bridges, culverts, asphalt, and alignment.
- After environmental documents are approved, the channel is investigated to determine how the bridge bents will be arranged.

# Environmental Document

- Three classes of environmental action
  - CE, example: Overlay or sidewalk.
  - Environmental assessment (FONSI)
  - EIS-(ROD), example: Actions that negatively impact environment that cannot be mitigated.
- The environmental study ensures no negative impacts to:
  - Native American religious sites, burial grounds, or artifacts
  - Noise
  - Endangered Species

# ROW Plans

- Preliminary plans are set at 30% design completion.
- Field review is at 60% design completion

# Field Review

- Right of ways are defined, appraised, and acquired.
- Right of ways can be sold back to the public with last owner having the first opportunity.
- Utility agreements are approved and utilities relocated.

# Final Design Phases

- Soil profile
  - performed at 30% design.
- Office review
  - Performed at 100% design.
- Final plans are sent to contractors for bid development.
- Bid letting and awarding.

# Earthwork Planning and Procedure

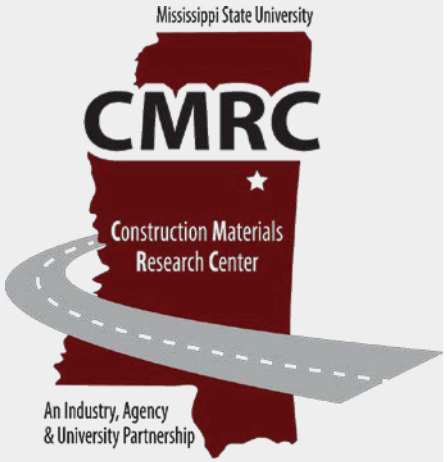
**Presenter:**

**James “Jayme” Williams**

*Research Assistant for CAVS*

*Civil Engineering Bachelor’s Degree Student*

*Mississippi State University*

# Overview

- Borings/Subsurface Exploration
- Construction of Geotechnical Structures

# Borings/Subsurface Conditions

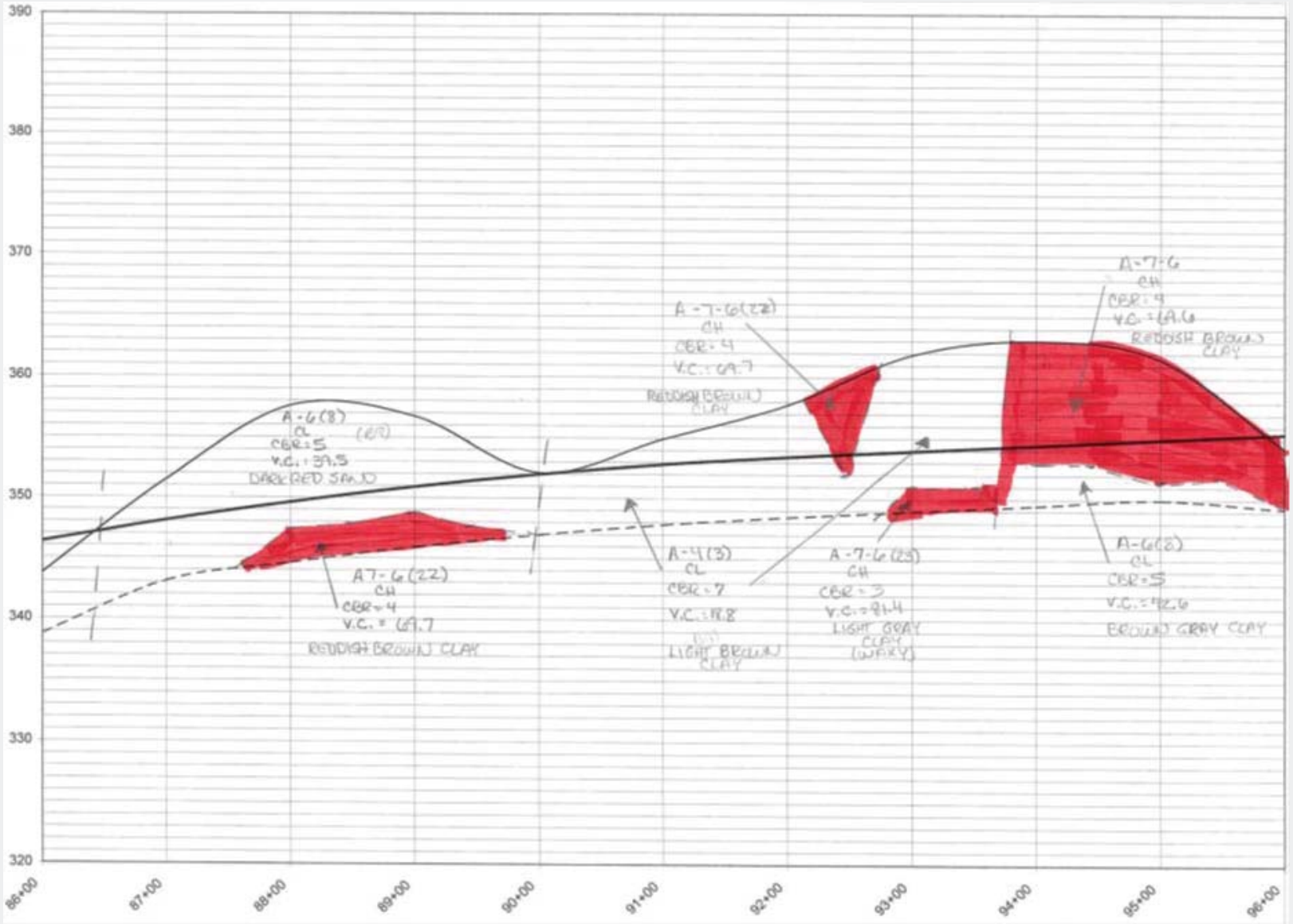
- Borings are taken at points of interest
- Information from the borings are used to determine soil profiles for design
- Additional information was required for the bridge's foundation design

# Subsurface Conditions

# MSU South Entrance Boring Plan

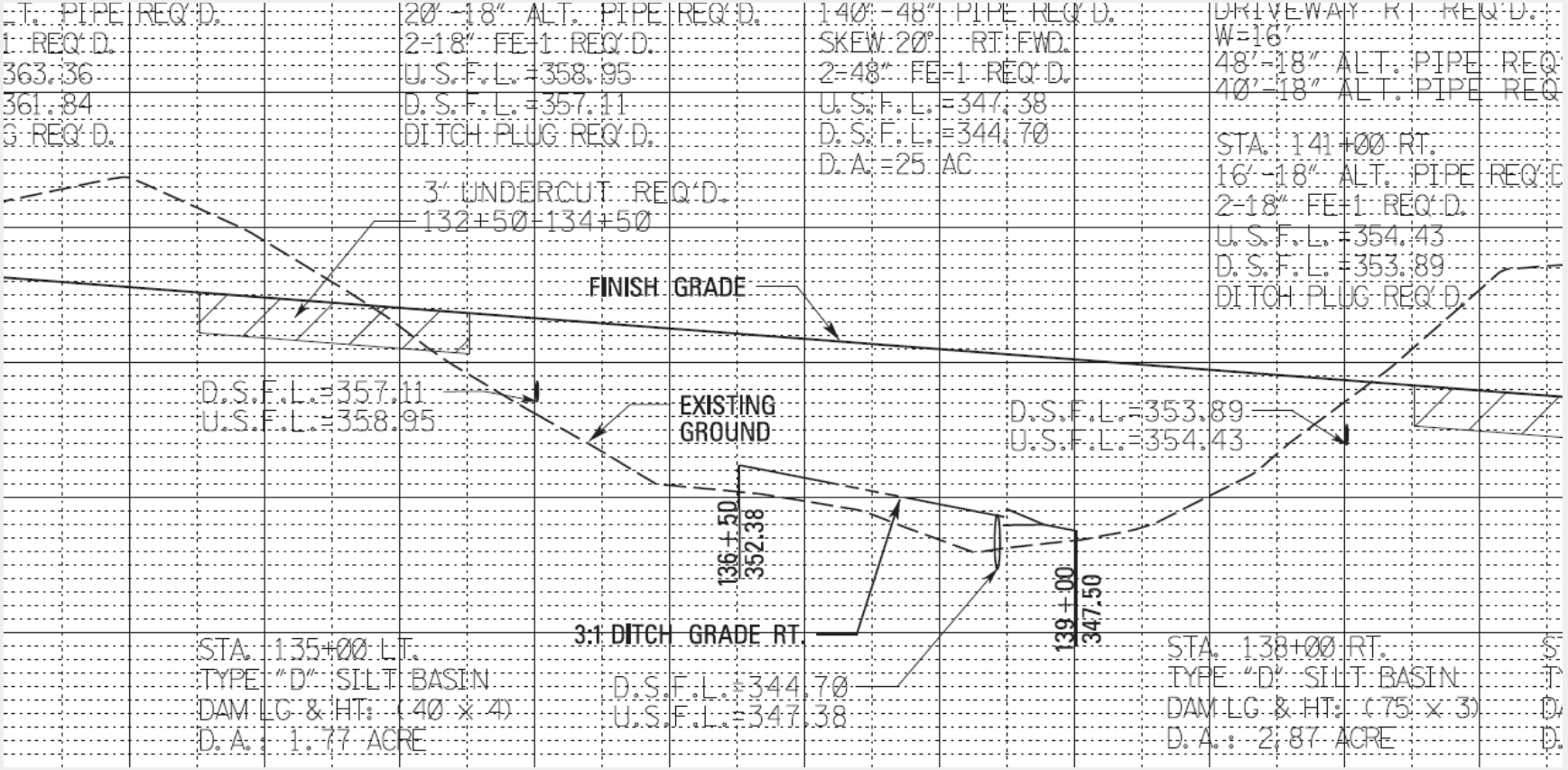
- Original borings were taken at 100’ intervals in cut sections and 200’ intervals in fill
  - Indicated high volume change (HVC) soils
- After construction began additional borings were required
  - New plan used 50’ intervals  and indicated less HVC material

# Soil Profile



# Test Pile

# Finished Grade



# Material Supply

- Earthen material can be provided by the site itself or hauled in from a borrow pit.
  - Initial estimates required 17,000 truck loads.
- For this project the contractor was required to deal with county about the damage hauling will cause.

# Construction

- Geotechnical structures used in roadways primarily included earthen structures and bridge foundations.
- Construction of the roadbed and embankments is completed using cuts and fills
- Bridge foundation construction typically relies on piles

# Cut and Fill

# Earthwork Quantities

| Pay Item No. | Description | Quantity, $yd^3$ |
|---|---|---|
| 203-EX017 | Borrow Excavation, AH, FME, Class B9 | 88384 |
| 203-EX035 | Borrow Excavation, AH, FME, Class B9-6 | 51975 |
| 203-A003 | Unclassified Excavation, FM, AH | 71984 |
| 203-G003 | Excess Excavation, FM, AH | 141624 |
| 203-H003 | Surplus Excavation | 78301 |
| 206-A001 | Structure Excavation | 4111 |
| 206-B001 | Select Material for undercuts (Contractor Furnished) | 544 |

# Removal of HVC Material, Placement, and Compaction

# Erosion & Sediment Control

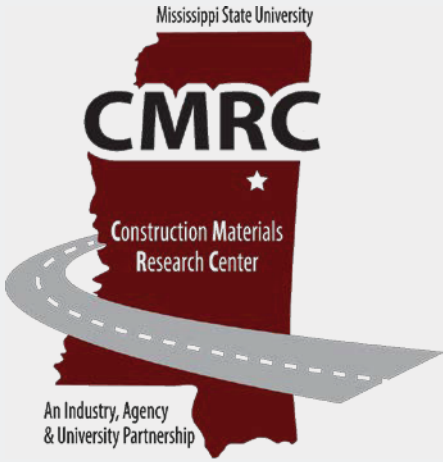
**Presenter:**

**Robert "Drew" Moore**

*Research Assistant for CMRC*

*Civil Engineering Master's Degree Student*

*Mississippi State University*

# Erosion & Sediment Control for South Entrance Project

- Roughly $1 million of overall bid
  - including silt fencing
- Monitored daily by MDOT
- Maintained by EUTAW
- Subcontractor:
  - Simmons Erosion Control, Inc.

# Project’s Site Erosion and Sediment Plan

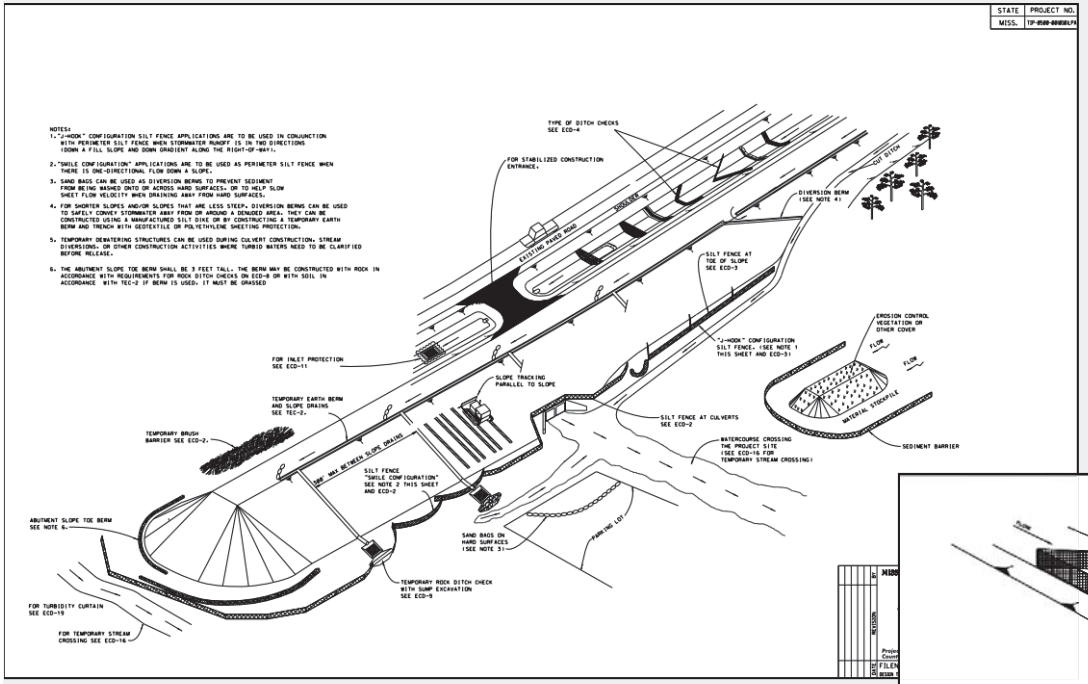



Figure 4: Erosion Control Plans (ECP)

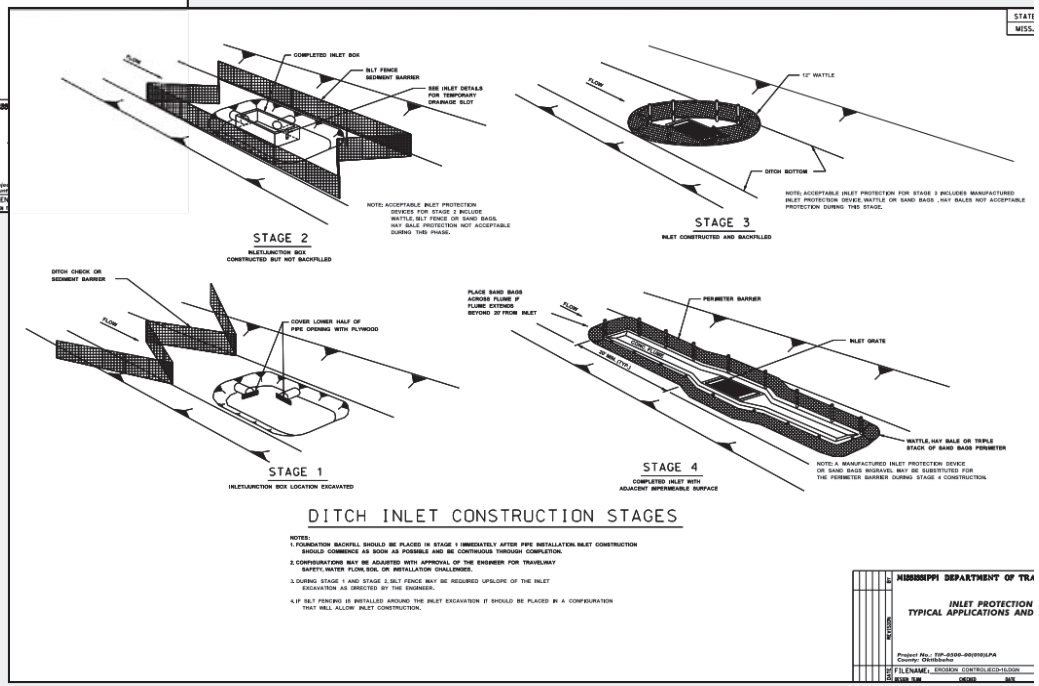



Figure 5: Sediment Control Plans

# What is Erosion?

- The removal of land surface (soil and rock) by erosive forces.

# What is Sediment?

- Land surfaces that are removed by the erosive forces.

# Factors that Influence Erosion

- Climate
  - Precipitation, wind, and frost
- Soil
  - Structure, permeability, and soil gradation
- Topography
  - Steepness, length, and configuration
- Groundcover

# Erosion and Sediment Control

**Erosion Control**

- First line of defense. “If there is no erosion, there can be no sediment.”
- Easy to Install
- Vegetative
- Surface Cover

**Sediment Control:**

- Subordinate to erosion control practices; second line of defense.
- Structural
- Perimeter Controls

# Erosion Control Common Practices

- Preserving vegetation
- Hydroseeding
- Mulching
- Erosion control blankets
- Soil stabilizers
- Soil Tracking
- Other techniques.

# Sediment Control Common Practices

- Silt fences
- Wattles
- Rock berms
- Sediment Basins
- Other techniques

# Erosion & Sediment Control (MDOT)$_{(2)}$

| Minor/No Deficiencies | Deficiencies | Major Deficiencies |
|---|---|---|
| • Minor Best Management Practice (BMP) device maintenance | • Loss of Sediment from the project<br>• Widespread BMP failure/ maintenance | • Loss in Sediment into Waters of the US and/or wetland |

- After the second month of “Deficiencies” a warning letter is sent to contractor.
- A “Major Deficiency” or a 3rd month of “Deficiencies” in a row, the contractor is given 7 days to remediate the project site before construction is halted and reimbursement is withheld.

# Impact of Weather on Erosion Control

- Project site does not shut down.
  - MDOT and Contractor inspect the sediment control parameters in use.
- Preventative actions often taken on projects.
  - Soil tracking, emptying of sediment basins, avoid causing damage to existing ground cover.
- Rainy day ≠ Day Off

# Erosion & Sediment Control Practices On-Site

# Erosion & Sediment Control Practices On-Site Cont.

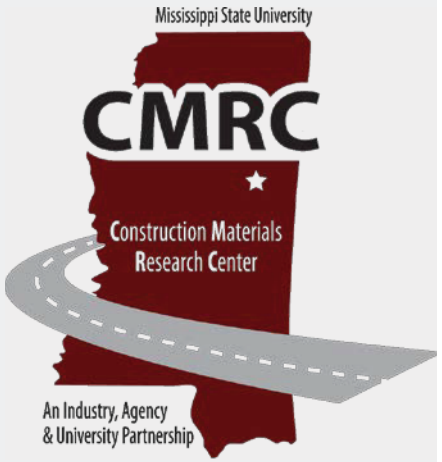
# MSU South Entrance Bridge

**Presenter:**

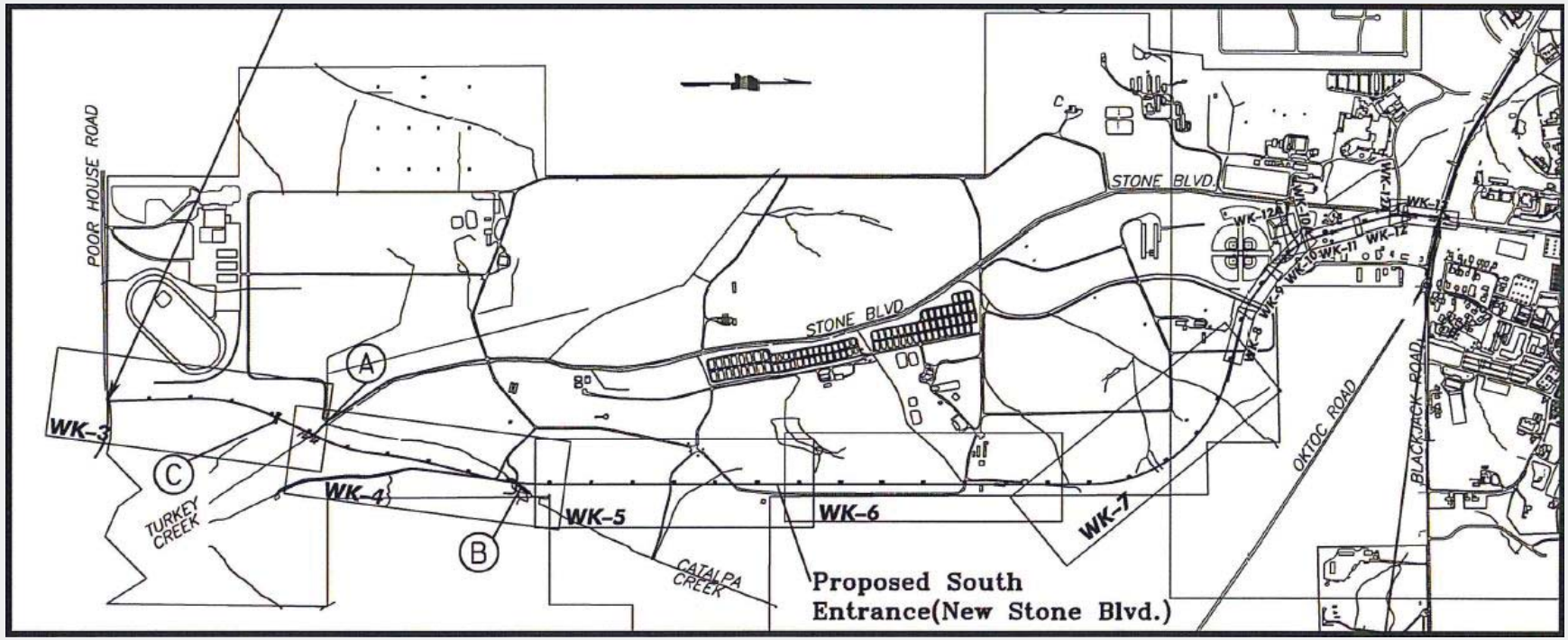
**James Joseph Arthur**


*Civil and Environmental Engineering Dept.*

*Mississippi State University*



# Site Map


POOR HOUSE ROAD
STONE BLVD.
STONE BLVD
WK-3
WK-4
WK-5
WK-6
WK-7
WK-10
WK-11
WK-12
WK-12A
A
B
C
TURKEY CREEK
CATALPA CREEK
OKTOC ROAD
BLACKJACK ROAD
Proposed South
Entrance(New Stone Blvd.)

# Bridge Piles

- 35’ and 40’ long
- 4 rows
- 51 total
- Battered

# Battered Piles

# Battered Piles Cont.

# Encasing Piles

- Typical Type AA Concrete
  - Maximum W/C
    - 0.45
  - Specified Compressive Strength
    - 4,000 psi
  - Maximum Permitted Slump
    - 3 inches
  - Nominal Air Content
    - 4.5%
  - Maximum Temperature
    - 90° F

# MDOT S.P. No. 907-804-16

- Allowed for the use of
  - Fly Ash Type F
  - Structural Fibers
  - High Range Water Reducer
- Increased slump allowable to 8 inches
- Increased maximum allowable temperature to 95° F

# Concrete Delivered

- Added water reducer, structural fibers, and ice

- Slump = 7 inches
- Temp = 90.5°F
- Air = 4%
- Unit Weight = 142.2 lb/ft$^3$

# Encased Piles

# Capped Piles

# Bridge Construction (7/28/16)

# Future Bridge Construction

- Beam Placement
- Diaphragm Construction
- Bridge Deck Construction

# Culvert Construction

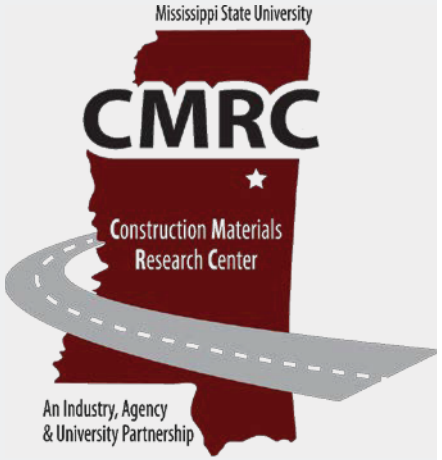
**Presenter:**

**Bradley Hansen E.I.**


*Graduate Research Assistant*

*Civil and Environmental Engineering Dept.*

*Mississippi State University*



# Summary

- 3 box culverts
- 2 box bridge culverts
- Only 2 culverts were observed during construction
  - Box bridge culvert
    - 14’ x 8’
  - Double barrel culvert
    - Two 10’ x 6’ boxes next to each other
  - Both culverts had 3:1 sloped wing walls

# Box Bridge Culvert

# Stilts for the roof

# Mortar Patching

- For all the holes or seams in concrete a combination of cement, sand, and water was used.  Also called Mortar.

# Formwork for the Wing Wall

# 1 Cubic Yard Bucket

- The 1 cubic yard bucket is filled up and then swung over to the formwork by a track hoe.
- Eutaw workers directed the bucket over the formwork and then pushed down the lever to release the concrete into the form.

# Pouring of Wing Wall

# Vibrating of Concrete

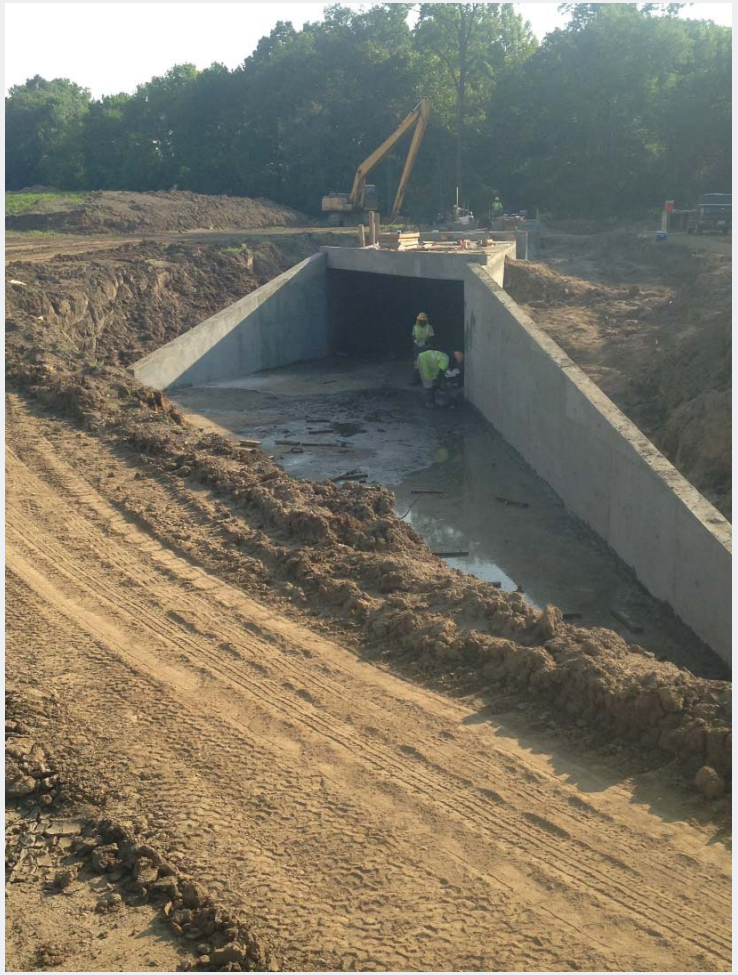
# Finishing of wing wall

- The finishing occurred after the placement and vibration of the concrete.
- The finishing  and curing must be done correctly or the concrete could become deficient.

# Drainage Issues

# Finished Side

- One completed side with wing walls
- After the box bridge culvert is completed:
  - Removal of Dirt Road
  - Redirection of stream to original direction through box bridge culvert



# Completed Box Culvert

# Double Barrel Culvert

- Construction techniques are the same as the box bridge culvert
- Only real difference in culverts is wall thickness and size
- Designed on 100 year storm
- Also large enough to allow cattle to walk through

# Challenge of Double Barrel Wall

- The steel for the walls is packed together tightly
- The tightness of the steel matrix makes stiffer concrete harder to place and vibrate

# Completed Double Barrel

# Concrete Quality Control & Quality Assurance

**Presenter:**

**Bradley Hansen E.I.**

*Graduate Research Assistant*

*Civil and Environmental Engineering Dept.*

*Mississippi State University*

# QC VS. QA

- QC is completed by contractor
  - Burns Cooley Dennis, Inc.
- QA is completed by MDOT
- By MDOT's Standards need 3 QA tests for every 10 QC tests
  - Most states only require 1 QA for every 10 QC

# Sampling (MDOT)$_{(4,5)}$

- Contractor specifies amount of yardage for each mixture for the day
- Then the frequency of sampling is based off of Table 4 Section 804 from the MDOT Red Book
- The sampling is done randomly
- The Location of sampling is also random

**TABLE 4**
**CONTRACTOR'S MINIMUM REQUIREMENTS FOR QUALITY CONTROL**

| Portland Cement Concrete | | |
|---|---|---|
| **Control Requirement** | **Frequency** | **AASHTO/ASTM Designation** |
| **A. PLANT AND TRUCKS** | | |
| 1. Mixer Blades | Monthly | |
| 2. Scales | | |
| a. Tared | Daily | |
| b. Calibrate | Every 6 months | |
| c. Check Calibration | Weekly | |
| 3. Gauges & Meters - Plant & Truck | | |
| a. Calibrate | Every 6 months | |
| b. Check Calibration | Weekly | |
| 4. Admixture Dispenser | | |
| a. Calibrate | Every 6 months | |
| b. Check Operation & Calibration | Daily | |
| **B. AGGREGATES** | | |
| 1. Sampling | | T 2 |
| 2. Fine Aggregate | | |
| a. Gradation / FM | 250 yd³ Concrete | T 27 |
| b. Moisture | Check Meter Against Test Results Weekly | T 255 |
| c. Specific Gravity / Absorption | 2500 yd³ Concrete | T 84 |
| 3. Coarse Aggregates | | |
| a. Gradation / FM | 250 yd³ Concrete | T 27 |
| b. Moisture | Minimum of once daily or more as needed to control production | T 255 |
| c. Specific Gravity / Absorption | 2500 yd³ Concrete | T 85 |
| **C. PLASTIC CONCRETE** | | |
| 1. Sampling | | T 141 |
| 2. Air Content | First load then one per 50 yd³ | T 152 or T 196 |
| 3. Slump | First load then one per 50 yd³ | T 119 |
| 4. Compressive Strength | One set ( two cylinders ) for 0-100 yd³ inclusive and one set for each additional 100 yd³ or fraction thereof for each class concrete delivered and placed on a calendar day from a single supplier. A test shall be the average of two cylinders. | T 22, T 23, T 231 |
| 5. Yield | Each 400 yd³ | T 121 |
| 6. Temperature | With each sample | C 1064 |

# Quality Control Sampling

# QC/QA tests

**Table 1**

| | |
|---|---|
| AASHTO: T 2 | Sampling Aggregates |
| AASHTO: T 19 | Bulk Density ("Unit Weight") and Voids in Aggregates |
| AASHTO: T 22 | Compressive Strength of Cylindrical Concrete Specimens |
| AASHTO: T 23 | Making and Curing Concrete Test Specimens in the Field |
| AASHTO: T 27 | Sieve Analysis of Fine and Coarse Aggregates |
| AASHTO: T 84 | Specific Gravity and Absorption of Fine Aggregate |
| AASHTO: T 85 | Specific Gravity and Absorption of Coarse Aggregate |
| AASHTO: T 119 | Slump of Hydraulic Cement Concrete |
| AASHTO: T 121 | Mass per Cubic Meter (Cubic Foot), Yield, and Air Content (Gravimetric) of Concrete |
| AASHTO: T 126 | Making and Curing Concrete Test Specimens in the Laboratory |
| AASHTO: T 141 | Sampling Freshly Mixed Concrete |
| AASHTO: T 152 | Air Content of Freshly Mixed Concrete by Pressure Method * |
| AASHTO: T 196 | Air Content of Freshly Mixed Concrete by the Volumetric Method * |
| AASHTO: T 231 | Capping Cylindrical Concrete Specimens |
| AASHTO: T 248 | Reducing Field Samples of Aggregate to Testing Size |
| AASHTO: T 255 | Total Evaporable Moisture Content of Aggregate by Drying |
| ASTM: C 1064 | Temperature of Freshly Mixed Portland Cement Concrete |

# QC/QA Equipment

# Possible additions to QC/QA

- Paste cylinder compressive strength and setting time
- Potential monitoring throughout placement and early hours after placement
- Long term durability tests

# Asphalt Production and Quality Control

**Presenter:**

**Westin Graves**

*Undergraduate Research Assistant for CRMC*
*Civil Engineering Student*
*Mississippi State University*

# Overview

- Performance Grading System
- Hunt Refining
- APAC Mississippi
- Quality Control

# What is Asphalt?

- Comes mostly from fractional distillation
- Comes from the bottom of the barrel of crude oil
- Two main types of Crude oil
  - Sweet crude (Less than 2% Sulfur)
  - Sour crude (Greater than 2% Sulfur)
- Asphalt binder is the most expensive single part of the mix

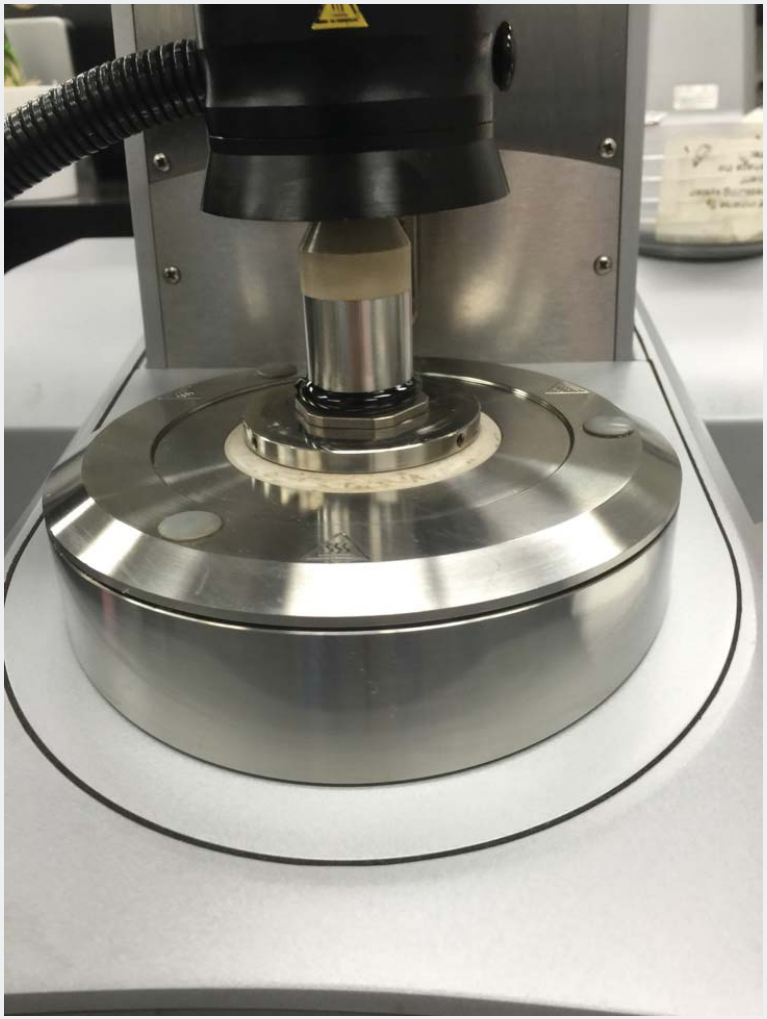
# Asphalt Grading

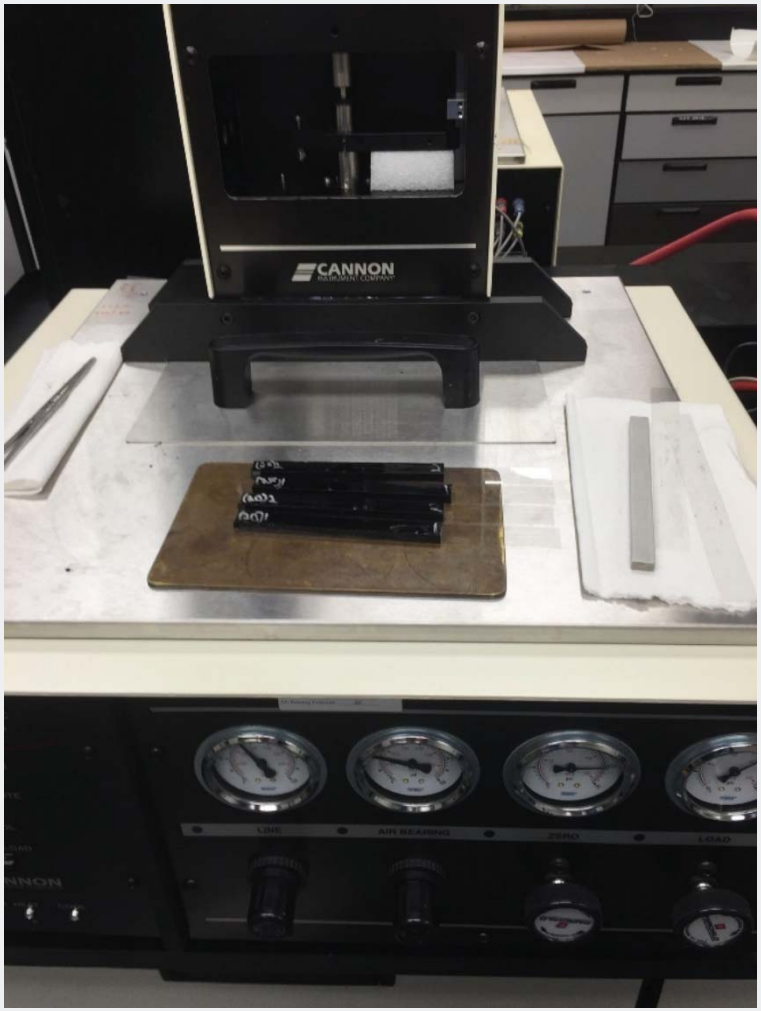
- Beginning in the 1970s, asphalts were specified as viscosity grades
  - Not directly related to its performance throughout the anticipated life
  - Examples are: AC-20 and AC-30
- Performance Grading System (PG)
  - A new asphalt specification for selecting binder for pavement performance
  - Rutting, fatigue cracking, and thermal cracking
  - Standard notation: PG XX-YY or PG 67-22 for example

# Determining PG grades

- Rotational Viscometer
  - Test that ensures that the asphalt can be pumped off the truck
- Dynamic Shear Rheometer (DSR)
  - Determines the measurement of the deformation resistance of asphalt binders
  - Used to grade the maximum temperature of asphalt binders
- Bending Beam Rheometer (BBR)
  - Test method that provides a means for measuring the flexural creep stiffness
  - Determines the pass or fail value for the minimum temperature

# Asphalt Binder Testing: DSR and BBR





# Where is the Asphalt Coming from?

## Hunt Refining Co.

- Supplying the asphalt binder for project site
  - PG 67-22
  - Asphalt contents 5.36% (9.5mm mix) and 3.80% (19mm mix)

## APAC Mississippi, Inc.

- Producing the asphalt mix to the South Entrance Project
- Two lifts
  - ST 9.5mm and ST 19mm
- Aggregates being used
  - ¾” and ½” Crushed Gravel
  - #67 and #89 Limestone
  - Coarse Sand
  - Reclaimed Asphalt Pavement (RAP)
  - Hydrated Lime

# MSU South Entrance Project

- 3.4 million dollars of roughly 18.2 million overall
- Planned placing August 2016
- About 3.5 miles long
- 28,000 tons of asphalt

# Pay Factors and Quality Control

- Asphalt Content
  - Troxler Asphalt Content Gauge
- Density
  - Bulk Specific Gravity (AASHTO T166)
  - Nuclear Gauge
- Gradation
  - MT-31
    - Aggregate Wash
    - Sieve Test

# Quality Control Testing



# Conclusion

- Objectives Learned:
  - Size and scale of transportation construction
  - Competition aspects
  - Communication and people skills

# References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# Questions?