

**TRANSPORTATION ENGINEERING DESIGN
SEMESTER TERM PROJECT
FALL 2021**

Term Project Title - COLLECTOR ROAD DESIGN

TOPICS COVERED IN TERM PROJECT

- 1. Design Calculations**
- 2. Horizontal Alignment**
- 3. Vertical Alignment**
- 4. Earthwork and Mass Diagram**
- 5. Drainage**
- 6. Roadway Cross-Sectional Sketches**
- 7. Intersection Selection and Re-Design**
- 8. Parking Design**
- 9. Traffic Signage, Markings, etc.**
- 10. Landscaping**
- 11. Total Cost of Construction**

ASSIGNMENT STATEMENT/QUESTIONS & GRADING SCHEME FOR ASSIGNMENT

Updated 16 November 2021

**Prairie View A&M University
College of Engineering
Civil & Environmental Engineering Department
CVEG 4302 – Transportation Engineering Design
Fall 2021**

**Project - COLLECTOR ROAD DESIGN
Given: 21 September 2021 (*Updated 16 November 2021*)
Due: 1 December 2021**

ABET Outcome “1”- an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics and ABET Outcome “5c”- an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

Student Learning Outcomes - (1) be able to demonstrate the **fundamentals of transportation engineering design**; (2) be able to demonstrate their knowledge of contemporary issues; and (3) be able to demonstrate an understanding of multi-objective decision-making.

Scope of Work

The purpose of this assignment is to provide an AUTOCAD or MicroStation geometric design for a section of a collector road connecting traffic from Bailey Jester Road to State Route 16. The design will require the newly constructed road to traverse two county jurisdictions (Spalding County and Burns County) in the state of Georgia. The project will begin at Point A (North/South/Center of Cabin Creek Bridge), station 0 + 00 and terminate at Point B (TBD) so that traffic can reach the unfinished end of State Route 16. Each group will receive the following materials:

1. Contour maps of the area
2. COGO and YARD++ software given during the semester
3. Roy G. Perry College of Engineering Senior Design Manual

The roadway section will begin at Point A and ends at Point B (TBD). The design will be in accordance with the provisions indicated below.

The following information is given:

1. AADT for current year is _____ vehicles per day (vpd). Present volume growth rate is _____ per year and will serve as an estimate of the growth rate for traffic analysis period.
2. The traffic analysis period is 20 years; i.e., the design year is 20 years hence.
3. D (directional distribution) =

Updated 16 November 2021

4. T (truck factor) = _____ Maximum Grade = _____
5. V (design speed) = _____
6. K factor (from studies on existing parallel facility) = _____
7. Desired average running speed during design hour of design year = _____ mph,
corresponding to LOS = _____
8. Maximum super elevation, $e^{\max}$ = _____ ft/ft
9. PHF = _____
10. Terrain is considered to be _____.
11. Divided roadway _____
12. Number of lanes required to provide the desired LOS during the design year = _____
13. Coordinates of Point A:

Elevation: _____

Grade: _____

Initial Bearing: _____
14. Coordinates of Point B: N
E

Elevation: _____

Grade: _____

Final Bearing: _____

Task 1 – Design Calculations

Compute the future AADT and DHV. Note that the percent of the route offering passing sight distance is a determinant of design capacity. Determine what percent of your route must meet the sight distance criterion, if applicable.

Task 2 – Horizontal Alignment

Use the contour maps to facilitate the lay out of a horizontal alignment from Point A to Point B, beginning and ending with the given bearings you identify. Insofar as is possible adhere to the general controls for horizontal alignment. Avoid houses and other buildings, swampy areas and lakes, consider the effect of your alignment on intersecting roadways and adjacent land uses, and avoid steep topographical features. Design a “flowing” alignment that avoids unnecessary earthwork, but, at the same time, be alert to the need for providing “sufficient” passing sight distance. Given special attention to coordinating the horizontal alignment with vertical alignment, to avoid intolerable earthwork operations.

Updated 16 November 2021

The final horizontal alignment will need to be on plan and profile sheets, which should be part of the final project deliverable. Give horizontal curve data D, R, T, E, "T" angle and superelevation for each circular curve. Show the stations of P.C.'s, P.I.'s, P.T.'s, Points A and B, and the bearing of each line. Show a north arrow on each plan and profile sheet. COGO is available for use for all alignment computations. When alternative design software is used, the COGO parameters will need to be submitted with the deliverables.

Task 3- Vertical Alignment

Using the contour maps provided, to lay out the vertical alignment and ensure it coordinates with the horizontal alignment. Determine both existing ground and proposed vertical alignment elevations. Plot these elevations on the plan and profile sheet(s). A horizontal scale of 1" = 200' (it must be the same for both alignments) and a vertical scale of 1" = 10' or 1" = 20' is suggested (you may use an alternate scale).

To promote safety and driver comfort, flat grades are desirable. Determine the maximum allowable grade. In the interests of good drainage, avoid long lengths of 0.0% grades. The length of any grade shall abide by a **15mph** allowable speed reduction for trucks. The length of any vertical curve shall abide by sight distance requirements.

Consistent with design standards and objectives, minimize cuts and fills. Insofar as is possible, adhere to the general controls for vertical alignment. Tie to the given elevation and grade at Point A and B.

Your profile drawing should show (in addition to ground profile), the percent grade for all tangents. For each vertical curve, show the station V.P.I, elevation V.P.I., and length of vertical curve. Again, COGO is available for use for all alignment computations. When alternative design software is used, the COGO parameters will need to be submitted with the deliverables.

Task 4 - Earthwork and Mass Diagram

At each 100-foot station, determine the elevations of the earth along the roadway. (You may scale their values from the plan and profile sheets. COGO output can be used to plot elevations for the proposed vertical alignment.) Compute earthwork volumes and mass diagram ordinates assuming that excavated material will (**shrink**) or (swell) **6%** when placed and compacted in fill areas. Plot the mass diagram and profile in the usual manner, using a horizontal scale of 1" = 200'. Analyze the mass diagram using the following standards:

- a. Free haul distance = 600-ft
- b. Limit of economic haul = 1200-ft

Show free haul, overhaul, borrow and waster on the profile above the mass diagram. Determine the total quantities of excavation, embankment, free haul, over-haul, borrow, and waste for the project. The computer program YARD++ is available for use for all earthwork computations. When alternative earthwork software is used, the YARD++ parameters will need to accompany the deliverables.

Updated 16 November 2021

Task 5 – Drainage

Divide the highway corridor into “drainage areas.” For one of the areas located entirely within the bounds of the contour map provided, determine the “drainage area” by the count squares method. Using the charts provided for the Georgia Department of Transportation determine the discharge in cubic feet per second (making necessary adjustments). Also, determine the discharge using the rational method. Based on the two methods, select a discharge amount and design a drainage structure for the drainage area selected. Place the location of the drainage structure on the plan and profile sheet(s). Show the station on the plan view and show station, elevation, discharge, and diameter size on the profile view.

Task 6 – Roadway Cross-Sectional Sketches

Provide a sketch of a typical cross-section of the roadway reflecting the entire right-of-way. Provide a sketch of a typical super-elevated cross-section of the roadway reflecting the entire right-of-way.

Task 7 – Intersection Selection and Re-Design

Intersection studies help to evaluate the performance of an intersection’s geometrics, signal control, etc. For this task, provide a sketch of the following: (1) a typical cross-sectional of the intersection (including traffic signs, markings, etc.), (2) one project designated intersection cross-section detailing vehicular conflicts, and (3) using the project designated intersection from #2, provide a cross-section of the intersection re-design showing reduced or eliminated vehicular conflicts. Only non-signalized intersections are options for re-designing in this project.

Task 8 – Parking Design

Requirements to achieve under this task, reference the parking handout for the Rest Area Facility originally dated 21 September 2021. However, please use the version with the latest assigned date.

Task 9 – Traffic Signage, Markings, etc

Properly select and locate within the right-of-way of the roadway all-appropriate traffic signs, markings, etc. The selection of traffic control devices will have to adhere to appropriate regulation(s).

Task 10 – Landscaping

Landscaping is a component of the project that not only adds to the beautification of the transportation facility, but can assist with satisfying drainage requirements as well. Identification and placement of appropriate landscaping requirements for the entire roadway and for Task 8 must occur. The requirements will have to adhere to local and/or state ordinances.

Task 11 – Total Cost of Construction

Discuss assumptions and/or design constraints to compute the cost of constructing the collector roadway design per Tasks 1 - 10. Completion of this task will have to adhere to appropriate regulation(s).

Updated 16 November 2021

Suggested References

1. American Association of State Highway and Transportation Officials (AASHTO), A Policy on Geometric Design of Highways and Streets, 6th Edition, 2011.
2. Transportation Research Board (TRB), National Research Council, Highway Capacity Manual 2010, 5th Edition, 2010.
3. US Department of Transportation, Federal Highway (FHWA), Manual on Uniform Traffic Control Devices 2009 Edition, January 2010. (An on-line reference).
4. American Association of State Highway and Transportation Officials (AASHTO), Guide for Design of Pavement Structures, 1993.
5. American Association of State Highway and Transportation Officials (AASHTO), Roadside Design Guide, 4th Edition, 2011.
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Deliverables

Below is a list of the deliverables that will need to be submitted by the project due date located on page 1 of this document.

1. A soft and hard copy of the final presentation.
2. A hard copy of a technical report, which includes the results to Tasks 1 – 11.

Grading

Detailed discussions regarding the format used to grade the presentation (soft and hard copy) occurs throughout the semester.

The following rubric will serve as the template to grade the project technical report deliverables:

A – Superior. No major errors or omissions. Project displays a high standard of workmanship and accuracy.

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C – Acceptable. Project has some major errors/omissions.

D – Poor effort, inferior quality.

The following is a suggested checklist for the technical report:

- A. Design capacity calculations---show all work in detail
 - AADT
 - DHV
 - Determine the % of proposed alignment that's restricted to sight distance
 - Number of lanes required

Updated 16 November 2021

- B. Alignment calculation from COGO (or alternative design software used) along with a neat sketch showing points and pertinent information.
- C. Plan and Profile Sheets must include the following:
- Horizontal and vertical alignment, including terrain profile and design grades.
 - Horizontal curve data—D,R,T,E,"I" angle, and superelevation rate
 - Vertical curve data—station of VPI, elevation of VPT, and length of curve (LC)
 - Show station of PC's, PT's, PI's, Point A and Point B.
 - Indication bearing of each tangent line—Plan only
 - Show North Arrow in upper right-hand corner of the plan view
 - Show location of drainage structures—plan (stations only) and profile (station, elevation and discharge amount)
 - Existing conditions—contours, road, houses, etc.
- D. Earthwork
- Provide a table of the YARD++ output (or alternative earthwork software is used)
 - Show one set of earthwork calculations
 - Draw mass diagram with a profile diagram (to the same scale) directly above
 - Indicate on the profile diagram the direction of overhaul and free haul. Indicate on the mass diagram overhaul areas, borrow and/or waste areas, free haul areas, balance points, and a chart describing total cut, fill, borrow, overhaul and waste in cubic yards.
- E. Drainage calculations describe each step in detail. On the original contour map, show a boundary around the drainage area with arrows indicating the direction of water flowing within that area. The original map(s) must accompany the final report.
- F. Roadway Cross-Section
- A typical roadway cross-section reflecting the entire right-of-way
 - A typical super-elevated roadway cross-section reflecting the entire right-of-way
- G. Results of the intersection design/re-design and signage
- A typical intersection cross-section
 - Select a project related intersection and provide a typical intersection cross-section showing vehicular conflicts
 - Use the selected project related intersection and provide a typical intersection cross-section showing reduced or eliminated vehicular conflicts
- H. Results of the Rest Area Facility design.

Updated 16 November 2021

- I. Traffic Signage, markings, etc. - selections applicable for the entire roadway and its components.
- J. Results of landscaping design and layout.
- K. Results for total cost of construction.
- L. Conclusions—this should be a brief summation of the project, problems encountered, resolutions employed, suggestions on design approach, etc. Also, include suggestions (if any) to make to the term design project better in the future.
- M. References

Updated 2 November 2021

**Prairie View A&M University
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CVEG 4302 – Transportation Engineering Design
Fall 2021**

**Term Project Parking Task
REST AREA FACILITY**

Given: 21 September 2021 (*Updated 2 November 2021*)

Due: 1 December 2021

Introduction

The North Carolina Department of Transportation (NCDOT) is conducting a feasibility study regarding a Rest Area Facility to be placed on the 40.6-acre site located near Highway 66 and Old Salem Road. A key component of the feasibility study is to create a 2D conceptual layout design of the overall Rest Area Facility as well as the detailed parking design for the facility in order to capture major features and functions that will need to be articulated to meet design specifications.

Engineering Constraints:

1. Maximize FULL use of the 40.6-acre site.
2. Currently, there is a 75,000 square foot two-story concrete structure on the site. You need to demolish and remove it before any new construction can begin.
3. For the demolition effort, determine the following: (1) truck type used, (2) number of trucks, (3) location of dumping site, (4) transportation cost, and (5) total demolition cost.
4. Design speed of Highway 66 is 50 mph. The post speed limit is 45 mph.
5. Assume that Highway 66 would have to be widened to include a center left turn-lane.
6. All widening should take place west of Highway 66 that is opposite the construction site.
7. A right-turn lane is required at the main entrance driveway and the shoulder will need to accommodate right-turns.
8. At-grade channelization should be considered at intersections as well as to accommodate right-turns.
9. The lanes should be 12-feet wide.
10. All roadway design should meet North Carolina Department of Transportation (NCDOT) specifications.
11. Parking lot design should accommodate vehicles, motorcycles, buses, and vans. Separate bus and van parking from other vehicles.
12. Maximize the quantity of parking supplied to this type of facility, while allowing vehicles to park with only one distinct maneuver.
13. Sidewalks are required within the Rest Area boundary.
14. Use five-foot sidewalks that are set three-feet back from the curb and gutter.
15. Landscaping requirements should adhere to North Carolina specifications.
16. Gravity sewer main is located along Highway 66.
17. Existing water is located along Highway 66.

Updated 2 November 2021

18. Identify the elevations for the facility, parking lot, and other amenities and services available at the facility. However, you are not required to perform any grading calculations.
19. No grading calculations are required for the widening the any roads.
20. Site plan must meet Winston-Salem Forsyth County's Unified Development Ordinances.

Additional Notes:

1. Report any assumptions that you make.
2. Some parking operations considerations to guide your thinking:
 - a. Construction Details
 1. Pavement – slightly sloping for runoff.
 2. Drainage – slope greater than 1% to catch basins; curb inlets
 3. Curb/Sidewalks – place along the perimeter. Can have concrete curb/gutters. The concrete curbs should be 4-inches thick.
 4. Car Stops – concrete curbs; concrete, plastic, or wooden wheel stops; and posts 36 inches high.
 5. Lighting - place on the centerline of double row of car stalls and of the two opposing car stalls; lights around the perimeter of the lot; should harmonize with the surrounding architecture.
 6. Stripping - white or yellow paint
 7. Fencing - use when security dictates. Should be a 6-foot high chain link fence.
 8. Landscaping
 - b. Entrance Considerations
 1. Locate as far from the roadway, an intersection, and conflicting points as possible.
 2. Multiple entrances may ease access and reduce restriction on adjacent roadways.
 3. Place mid-block when possible.
 4. Local ordinances and codes can restrict the number of entrances.
 - c. Internal Considerations
 - d. Exit Considerations
 1. Multiple exit lanes help right turning vehicles avoid waiting for left turning vehicles.
 2. Place mid-block when possible.
 3. Local ordinances and codes can restrict the number of exits.
3. Some maneuvers to guide your thinking:
 - a. Vehicle enters from the street (space provide by entry driveway).
 - b. Vehicle searches for parking stall (space provided by circulation and/or access aisles).
 - c. Vehicle enters the stall (space provided by the access aisle).
 - d. Vehicle is parked (stall designed to accommodate the vehicle's length and with plus space to open vehicle doors).
 - e. Pedestrians access the building or destination (usually via the aisles).
 - f. Vehicle exits the parking stall (space provided by the access aisle).
 - g. Vehicle searches for an exit (space provided by the access and circulation aisle).
 - h. Vehicle enters the street network (space provided by the exit driveways).

Updated 2 November 2021

Term Project Deliverables:

1. Provide an overall 2D conceptual layout design drawn in AutoCAD.
2. Angle parking data for Teams - (1) 30-degrees, (2) 45-degrees, and (3) 60-degrees. The Client will assign the angle parking.
3. Provide a detailed 2D parking design drawn in AutoCAD showing at a minimum the following: curve setbacks, stall dimensions, internal circulation, entrance/exit control features (if any), large and/or compact car parking stalls (if any), designated area for trucks to park, handicapped parking stalls (if any), end aisle features (if any), approach lane(s), merge lane(s), maintenance, security, lighting, etc. Use a horizontal scale of your choice. Ensure the horizontal scale selected aligns with other project related drawings you submit.

(Updated 2 November 2021)

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**Project Data - COLLECTOR ROAD DESIGN
Given: 21 September 2021 (*Updated 2 November 2021*)
Due: 1 December 2021**

Given Data for the design and layout:

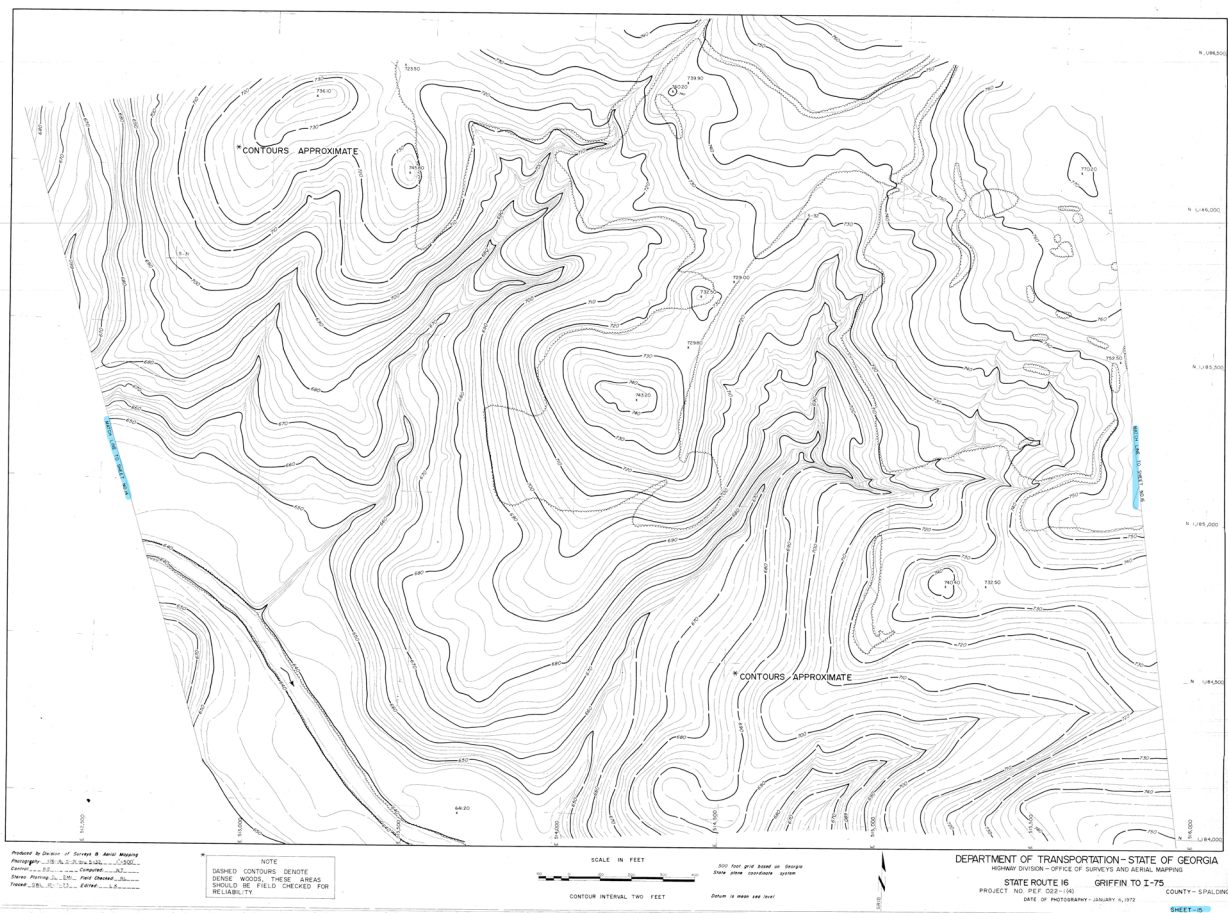
Bailey Jester Road AADT - 2,625 vehicles per day
AADT for the current year is 80% of Bailey Jester Road's AADT
Present volume growth rate is 2% per year
Design year is 20 years hence
The truck factor is 8%
The design speed is 50 mph
The posted speed limit = students determine from references
The desired average running speed = students determine from references
The Level of Service is B
The maximum superelevation = students determine from references
The terrain is considered to be rolling
The maximum grade is 4.5%
The maximum degree of curvature is 5°
Divided
PHF = students determine from references
D = students determine from references
K = students determine from references
Lane Widths = students determine from references

Given data for earthwork calculations:

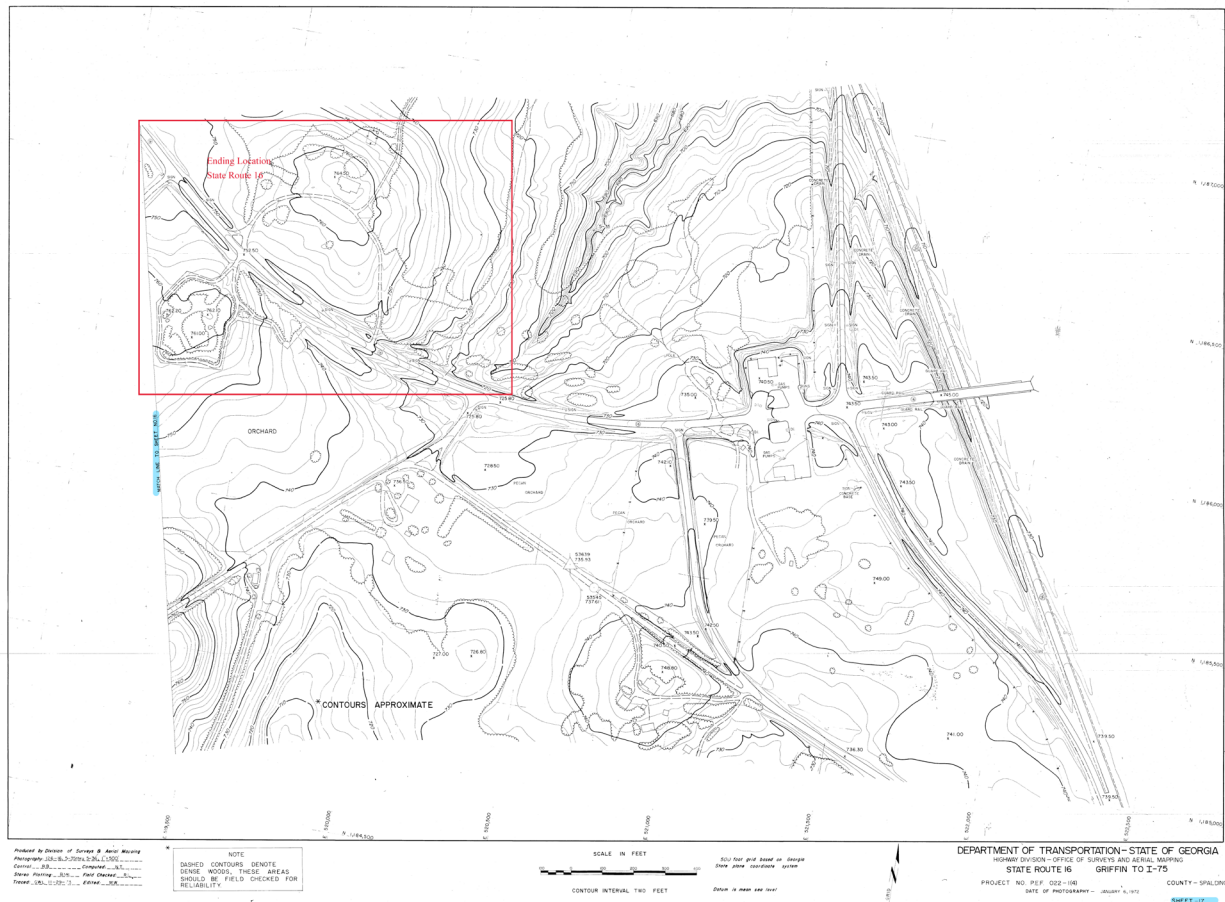
The free haul distance is 600-ft
The limit of economic haul is 1200-ft
The **shrink** or swell factor is 6%.

Given data for drainage calculations:

The design year is 25 years hence
The terrain is considered to be rolling
The rainfall duration is 60 minutes
The land type is considered to be mixed cover and the steepness is over 2%
Additionally, the drainage area will have 50% concrete and bituminous pavement, 8% slight previous soil, 42% impervious soil
Entrance type is square edge with headwall. The headwater depth in diameter (H_f/D) is 1.5-ft
Notes: (1) You can have no more than 3 horizontal curves; (2) When necessary for your alignment to intersect with other roadways shown on the map, the angle of intersection must be 90 degrees; and (3) use a minimum distance of 200-feet between the PT of a given horizontal curve and the PC of the curve that immediately follows.









ABOVE AVERAGE

Updated 16 November 2021

Suggested References

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- C – Acceptable. Project has some major errors/omissions.
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The following is a suggested checklist for the technical report:

A. Design capacity calculations---show all work in detail

- AADT
- DHV
- Determine the % of proposed alignment that's restricted to sight distance
- Number of lanes required

+20

✓
✓
✓
✓
✓

Updated 16 November 2021

- +5
-5
- B. Alignment calculation from COGO (or alternative design software used) along with a neat sketch showing points and pertinent information.

C. Plan and Profile Sheets must include the following:

- +35
-5
- ✓ Horizontal and vertical alignment, including terrain profile and design grades.
 - ✓ Horizontal curve data—D, R, T, E, "I" angle, and superelevation rate
 - ✓ Vertical curve data—station of VPI, elevation of VPT, and length of curve (LC)
 - ✓ Show station of PC's, PT's, PI's, Point A and Point B.
 - ✓ Indication bearing of each tangent line—Plan only ~~X~~ -5
 - ✓ Show North Arrow in upper right-hand corner of the plan view
 - ✓ Show location of drainage structures—plan (stations only) and profile (station, elevation and discharge amount)
 - ✓ Existing conditions—contours, road, houses, etc.

D. Earthwork

- +15
+2.5
-2.5
- ✓ Provide a table of the YARD++ output (or alternative earthwork software is used)
 - ✓ Show one set of earthwork calculations
 - ✓ Draw mass diagram with a profile diagram (to the same scale) directly above
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- +30
- E. Drainage calculations describe each step in detail. On the original contour map, show a boundary around the drainage area with arrows indicating the direction of water flowing within that area. The original map(s) must accompany the final report.

F. Roadway Cross-Section

- +5 -5
- ✓ A typical roadway cross-section reflecting the entire right-of-way
 - ~~X~~ A typical super-elevated roadway cross-section reflecting the entire right-of-way

G. Results of the intersection design/re-design and signage

- +15
- ✓ A typical intersection cross-section
 - ✓ Select a project related intersection and provide a typical intersection cross-section showing vehicular conflicts
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H. Results of the Rest Area Facility design.

+26
-11

Updated 16 November 2021

- +10 I. Traffic Signage, markings, etc. - selections applicable for the entire roadway and its components.
- +30 J. Results of landscaping design and layout.
- +10 K. Results for total cost of construction.
- +6 L. Conclusions—this should be a brief summation of the project, problems encountered, resolutions employed, suggestions on design approach, etc. Also, include suggestions (if any) to make to the term design project better in the future.
- +6 M. References

+2 Cover

+2 Letter

+2 Table of Content

221.5

250

Updated 2 November 2021

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- ✓ 4. Design speed of Highway 66 is 50 mph. The post speed limit is 45 mph.
- ✓ 5. Assume that Highway 66 would have to be widened to include a center left turn-lane.
- ✓ 6. All widening should take place west of Highway 66 that is opposite the construction site.
- ✓ 7. A right-turn lane is required at the main entrance driveway and the shoulder will need to accommodate right-turns. -1
- ✓ 8. At-grade channelization should be considered at intersections as well as to accommodate right-turns. -2
- ✓ 9. The lanes should be 12-feet wide.
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Updated 2 November 2021

- ✓ 18. Identify the elevations for the facility, parking lot, and other amenities and services available at the facility. However, you are not required to perform any grading calculations. - 21
19. No grading calculations are required for the widening the any roads.
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✓ **Additional Notes:**

1. Report any assumptions that you make.
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- 3

Prairie View A&M University



CVEG 4302-P01 Transportation Engineering Design:

Transportation Engineering Design Project

Submitted By: Nathaniel Smith, Michael LeBlanc, Maalvika Aggarwal, Luis Guzman, Omar

Hunter

Given: 22 September 2021

Due: 4 December 2021

Submitted to: Dr. Perkins

Table Of Contents

Letter of Transmittal	3
Abstract	4
Project Scope	
Project Planning and Task Definition	
Preliminary Review	
Detailed System Design	
Results and Discussion	
Conclusion	
References	

Letter of Transmittal

December 4, 2021

Dr. Judy, Perkins, PE

Civil Engineering Department

Roy G. Perry Engineering Building

Prairie View A&M University

Dear Dr. Perkins,:

The attached technical design report contains the preliminary data and background information needed to start the design of the collector road design and rest area facility. The design period for the city is twenty (20) years and the project will be carried out in two stages. Constraints of the report were issued in-class on September 22, 2021. The report contains the abstract, introduction, summary, the equations used for analysis of the data, the raw experimental data, tabulated presentation of the important results, discussion, interpretation of the results, and recommendations. Please contact me at 346-932-9337 or by email at maggarwal@pvamu.edu if you have any questions or concerns regarding the report.

Sincerely,

Maalvika Aggarwal

Michael LeBlanc

Luis Guzman

Omar Hunter

Nathaniel Smith

Abstract

The objective of the project is to provide an AUTOCAD geometric design for a section of a collector road connecting traffic from Bailey Jester Road to State Route 16. The design will require the newly constructed road to possibly traverse two county jurisdictions, the Spalding County and the Burns County, in the state of Georgia. In addition to that, a rest area facility was designed on the 40.6-acre site located near Highway 66 and Old Salem Road. A 2D conceptual layout design of the overall Rest Area Facility as well as the detailed parking design for the facility, in order to capture major features and functions that will need to be articulated to meet the design specifications, was designed.

In order to meet these objectives, the project was divided into eleven different tasks, including design calculations, horizontal and vertical alignment, earthwork and mass diagram, drainage, roadway cross-sectional sketches, intersection sketches, parking design, traffic signage, landscaping, and total cost of construction.

Project Planning and Task Definition

Task 1 - Design Calculations

Calculate the AADT and DHV for the future. It's worth noting that the percentage of the route with passing sight distance is a factor in design capacity. If relevant, determine what percentage of your route must match the sight distance condition..

Task 2 - Horizontal Alignment

Give horizontal curve data D, R, T, E, "Δ" angle and super-elevation for each circular curve. Show the stations of PC's, PI's, PT's, Points A and B, and the bearing of each line. Show a north arrow on each plan and profile sheet. You will use at least one curve in your alignment and not exceed a total of three curves.

Task 3 - Vertical Alignment

Determine existing ground elevations at places along the proposed route using the contour map given, and plot these elevations on the plan and profile sheets. A horizontal scale of 1 inch equals 100 feet and a vertical scale of one inch equals 10 feet..

Task 4 - Earthwork and Mass Diagram

Determine the height of the cut or fill at each 100-foot station. Determine the cross-sectional areas for each 100-foot station using the earthwork equations given. Calculate earthwork volumes and mass diagram ordinates assuming that excavated material will shrink or swell by 6% when placed in fill regions and compacted. In the normal way, plot the mass diagram and profile. It's suggested that you choose a horizontal scale of 1" = 100'. Apply the following criteria to the mass diagram: [Limit of economic haul = 1200'] & [Free haul distance = 600'] On the profile above the mass diagram, show free haul, overhaul, borrow, and waste. Calculate the project's total excavation, embankment, free haul, over-haul, borrow, and garbage volumes.

Task 5 - Drainage

The roadway corridor should be divided into "drainage areas." Determine the "drainage area" for one of the areas totally inside the confines of the contour map provided using the count squares approach. Also, use the rational technique to calculate the discharge. Select a discharge amount and construct a drainage structure for the drainage region based on the two methods. On the plan

and profile sheets, mark the placement of the drainage structures. Show station in plan view and profile view, as well as elevation, discharge, and diameter size.

Task 6 - Roadway Cross-Section Sketches

Draw a diagram of a typical cross-section of the road, taking into account the whole right-of-way. Draw a diagram of a typical super-elevated cross-section of the road that encompasses the whole right-of-way.

Task 7 - Intersection Selection and Re-Design

Intersection studies are performed to assess the geometrics, signal control, and other aspects of an intersection's performance. Provide a sketch of a typical cross-sectional of the intersection (with traffic signs, markings, and so on) as well as a detailed description of the intersection's vehicular conflicts. In this project, only non-signalized junctions are employed.

Task 8 - Parking Design

Create a 2D conceptual layout design of a Rest Area Facility in North Carolina on a 40.6 acre site located near Highway 66 and Old Salem Road as well as the detailed parking design for the facility. There is also a school that is in the proposed site that needs to be demolished. Calculate the demolition and transportation costs. Assume that Highway 66 would have to be widened to include a center left turn-lane. All widening should take place west of Highway 66 that is opposite the construction site.

Task 9 - Traffic Signage, Markings, etc

Ensure that traffic signs, markings, etc. are selected and properly located within the right-of-way of the roadway. The selection of traffic control devices will have to adhere to appropriate regulation(s).

Task 10 - Landscaping

Landscaping is an important part of the project because it not only beautifies the transportation facility but also helps to meet drainage standards. Task 8 requires the identification and placement of acceptable landscaping requirements for the entire highway. Local and/or state ordinances will have to be followed in order for the requirements to be met.

Task 11 - Total Cost of Construction

To calculate the cost of constructing the collector roadway design per Tasks 1 - 10, discuss assumptions and/or design restrictions. This task must be completed in accordance with all applicable regulations (s).

Preliminary Review

- Given Data for Collector Road
 - AADT for current year is 2,625 vpd
 - Present volume growth rate is 2% per year
 - Design year and traffic analysis period is 20 years
 - Directional Distribution, $D = 0.5$
 - Truck Factor, $T = 8\%$
 - Design Speed, $V = 50$ mph
 - K factor = 0.09
 - Desired average running speed during design hour of design year = mph, corresponding to LOS =
 - Maximum Super Elevation, $e =$ ft/ft
 - PHF = 0.9
 - Terrain is considered to be urban
 - Divided Roadway
 - Number of lanes required to provide the desired LOS during the design year = 2 lanes
 - Coordinates of Point A:
 - Elevation: 720.00 ft
 - Grade: -1.68
 - Initial Bearing
 - N 1184875.00
 - E 512500.00
 - Coordinates of Point B:
 - Elevation: 750.00 ft
 - Grade: -0.11
 - Final Bearing
 - N 1186900.00
 - E 519500.00
- Given Data for Rest Area Facility
 - 40.6 acre site located near Highway 66 and Old Salem Road
 - 75,000 sq ft, two-story concrete structure on site that needs to be demolished and removed before any new construction can begin
 - Design Speed, $V = 50$ mph
 - Posted Speed Limit is 45 mph
 - Lanes should be 12-feet wide

Detailed System Design

Task 1 - Design Calculations

- AADT
 - $AADT = 0.80 * 2625 vpd = 2100 vpd$
 - $AADT_n = AADT(1 + i)^n$ $AADT_{20} = 3120.49 vpd$
 - $AADT_{20} = 2100 vpd(1 + 0.02)^{20 years}$
 - $AADT_{20} = 3120.49 vpd$
- DDHV
 - $DDHV = AADT * D * K$
 - $DDHV = 3120.49 vpd * 0.5 * 0.09$
 - $DDHV = 140.42 vphpd$
- Number of Lanes, N
 - $N = \frac{DDHV}{(SFL * f_E * PHF)}$
 - $N = \frac{140.42 vphpd}{(900 * 0.9 * 0.9)}$
 - $N = 0.19 \approx 1 lane$
 - So, total number of lanes = 2 (One in Each Direction)

Stopping Sight Distance (SSD) is the sufficient distance to allow a vehicle traveling at or near design speed to stop before reaching a stationary object in path.

Passing Sight Distance (PSD) is the distance that drivers must be able to see along the road ahead to safely and efficiently initiate and complete passing maneuvers of slower vehicles

The given design speed was, $u = 50$ mph and Coefficient of friction was, $f = 0.14$ (Table 3.3, textbook)

According to design speed,

SSD = 425 ft (2011 AASHTO, Exhibit 3-34, 3-155)

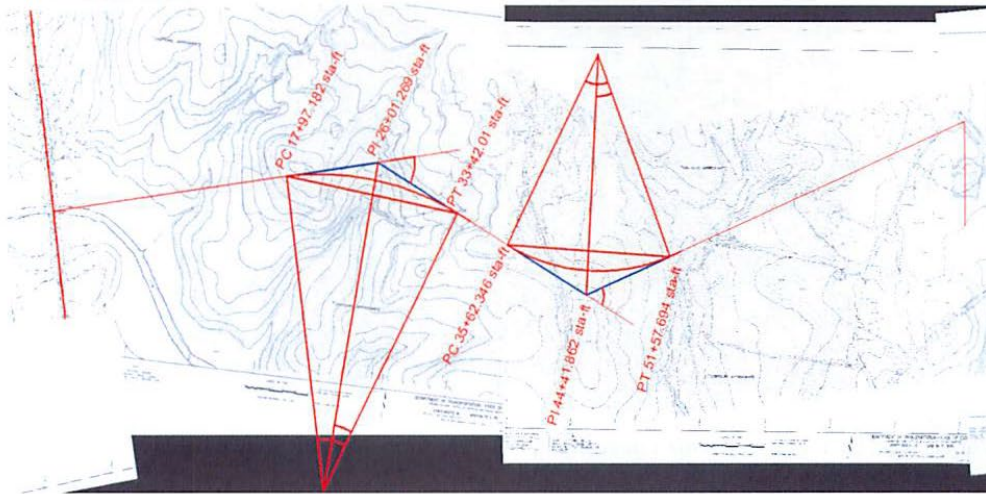
PSD = 800 ft (2011 AASHTO, Exhibit 3-4, 3-9)

Percent of proposed roadway assigned to PSD:

$$\begin{aligned} \% PSD &= PSD / \text{Length of Roadway} = 800 \text{ ft} / 7938.96 \text{ ft} \\ &= 10.07\% \end{aligned}$$

Task 2 - Horizontal Alignment

- Plan View



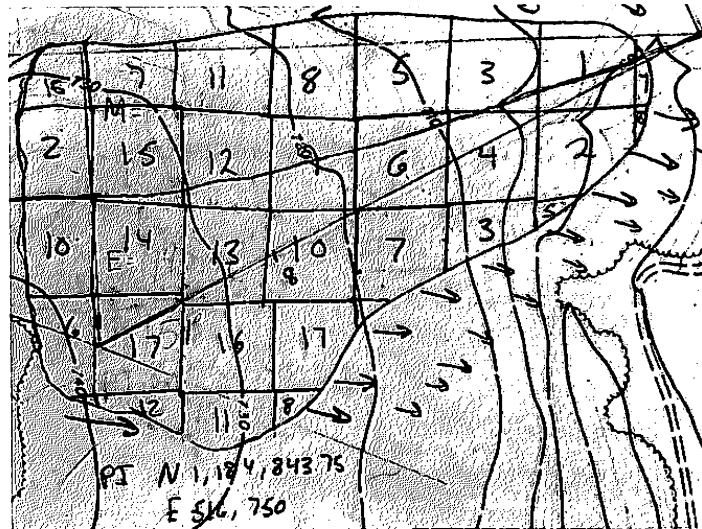
Task 3 - Vertical Alignment

Task 4 - Earthwork and Mass Diagram

Task 5 - Drainage

We start by calculating the area by using the count squares method.

$$17 \text{ whole squares} + 6 * \left(\frac{1}{2} \text{ squares}\right) + 2 * \left(\frac{1}{3} \text{ squares}\right) + 5 * \left(\frac{1}{6} \text{ squares}\right) = 21.5 \text{ squares}$$



For Georgia we found the rainfall intensity, i , is 3 in/hr from the chart shown below.

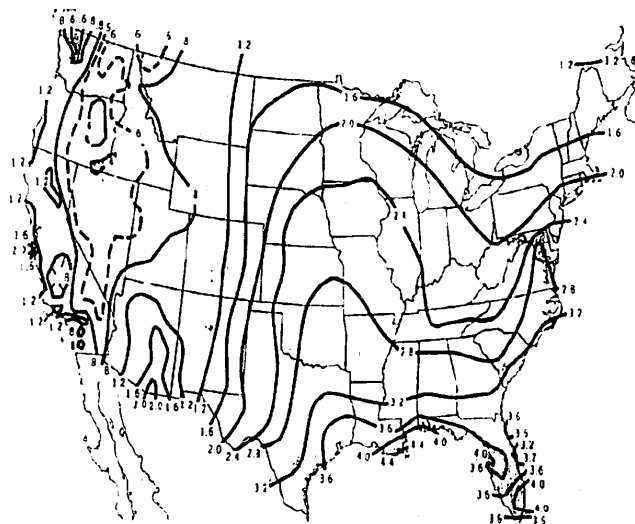


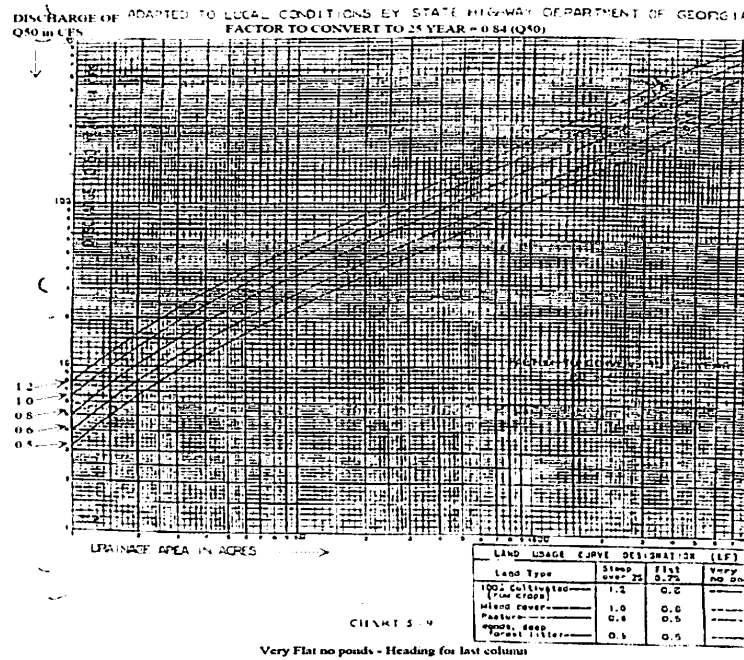
FIGURE 11-2 Map of the contiguous United States, showing 2-year, 24-hour rainfall intensity. (Courtesy Federal Highway Administration.)

Then we estimate it to 60 minutes and 25 years.

$$i = 3 \text{ in/hr} \cdot (0.6)(1.9) = 3.42 \text{ in/hr}$$

Area = 4.8 acres

Based on the chart shown below



$$Q_{50} = 25.6 \text{ cfs}$$

$$Q_{25} = 25.6 \text{ cfs} (.84) = 21.504 \text{ cfs}$$

Diameter of culvert from chart Table 16.17

D = 26.5 inches (Use)

The other method used was the rational method.

Q = CIA

$$Q = (0.82)(3.42 \text{ in/hr})(4.80 \text{ acres}) = 13.46 \text{ cfs}$$

From here we were able to establish a diameter from the chart for the culvert which was 21.5 inches.

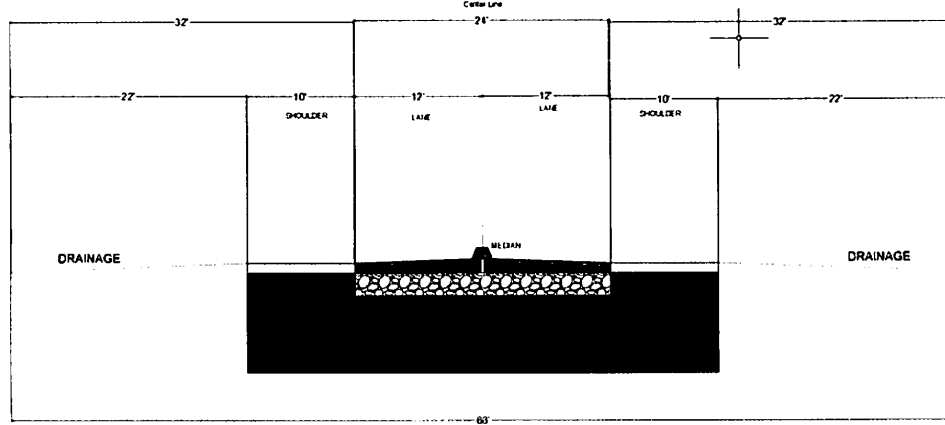
The values from the GDOT method were used because they were larger.

Task 6 - Roadway Cross-Section Sketches

The Roadway cross-section sketches included two AutoCAD drawings. The first drawing was for the typical cross-section of roadway with normal crown. The second drawing displayed the typical cross-section that was superelevated. All the components, including the drainage, shoulders, lanes, base course, and sub base were shown with proper dimensions. It was scaled and printed for final deliverables.

Cross Section

TYPICAL CROSS-SECTION



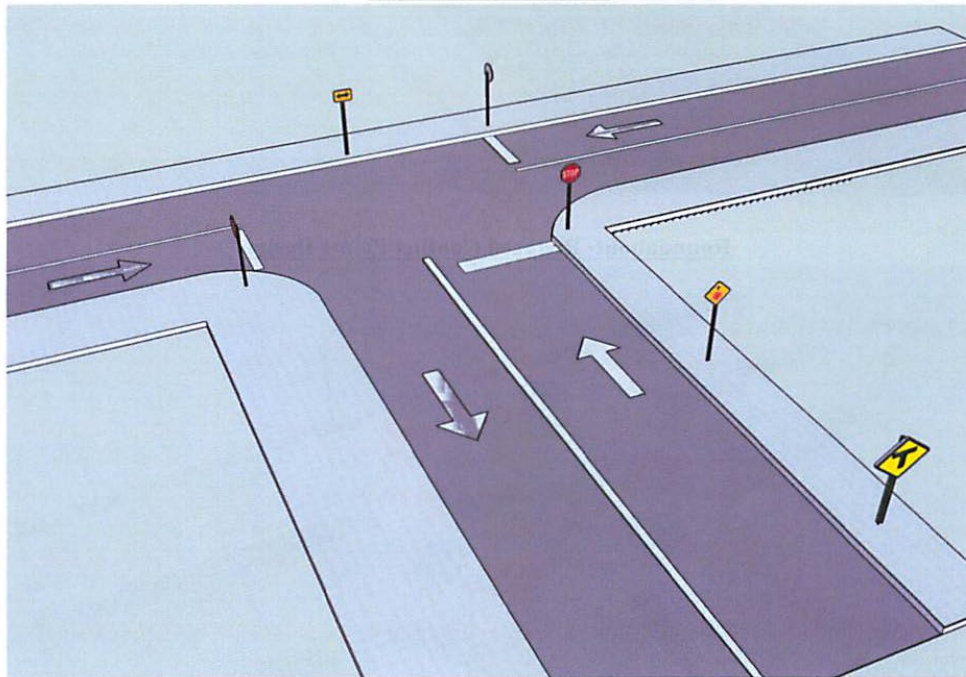
Task 7 - Intersection Selection and Re-Design

A T-intersection was used for our collector road design project. There were sketches prepared.

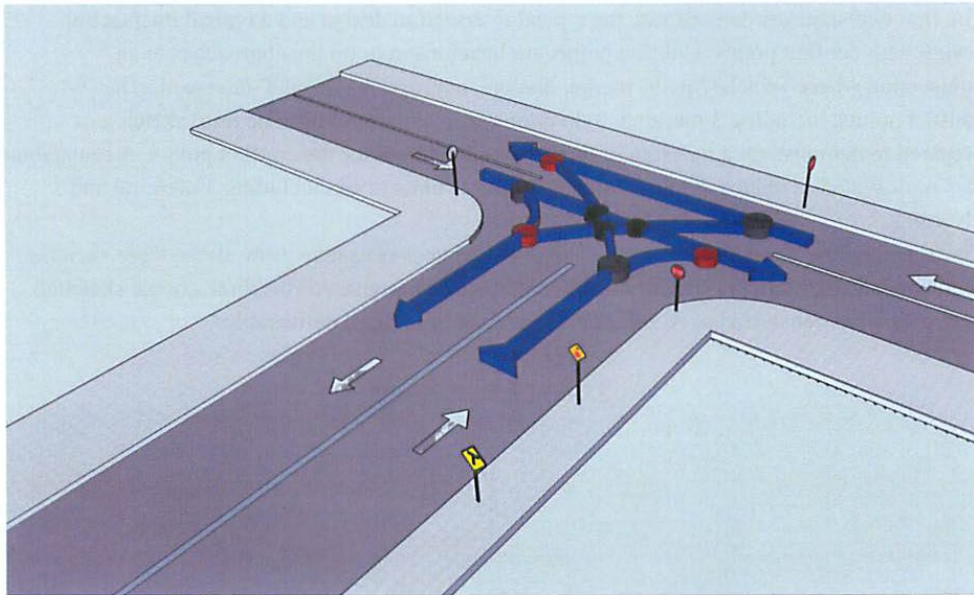
The first two sketches demonstrate the typical intersection design and a typical intersection design with conflict points. Conflict points are locations in or on the approaches to an intersection where vehicles' paths merge, diverge, or cross. A typical T-intersection has 9 conflict points, including 3 merging, 3 diverging, and 3 intersecting. The third sketch was prepared to demonstrate a redesign of the intersection to reduce the conflict points. A roundabout was re-designed to reduce the nine existing conflict points to six, including 3 merging and 3 diverging.

The 3D modeling computer program, Google Sketchup was used to draw all the three sketches. It allowed us to design 3D sketches for the intersection designs. All the three google sketchup drawings were transferred to AutoCAD for the final printing of deliverables.

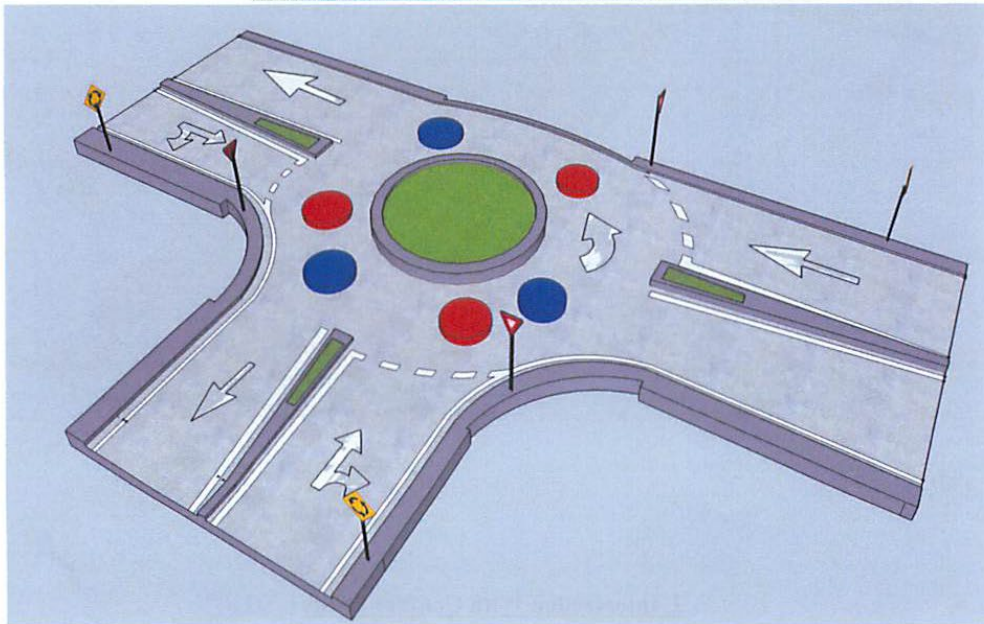
Typical T-Intersection



T-Intersection With Conflict Points



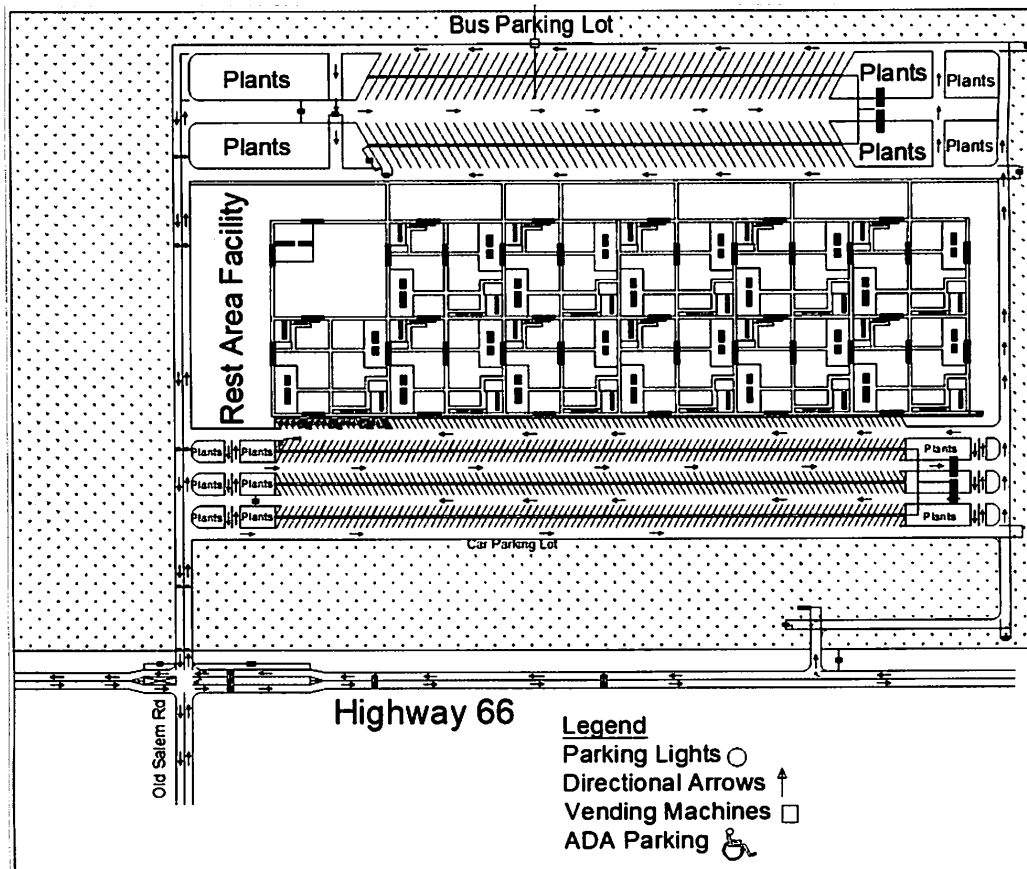
Roundabout- Reduced Conflict Points Design



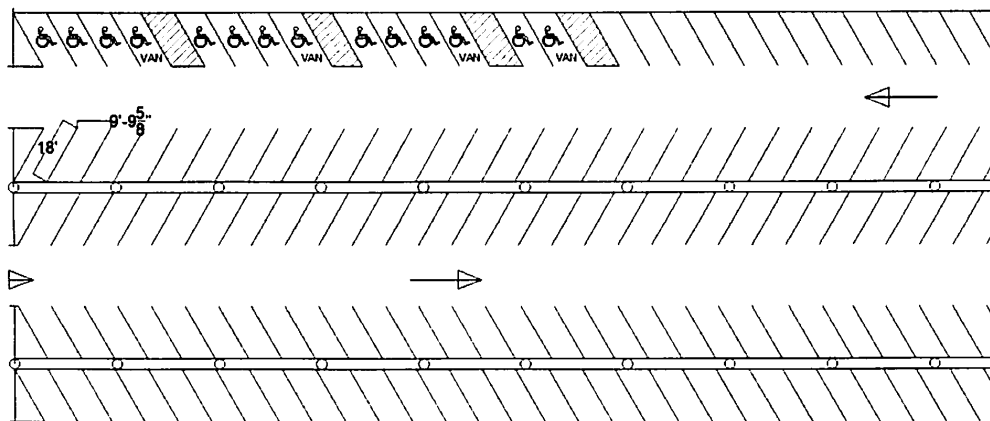
Task 8 - Parking Design

Before any construction for the Rest Area Facility can be done, a two story school must be demolished. All demolition debris and waste will be disposed of at Piney Hills Acres, a dumping site approximately 11 minutes away from the proposed site on Highway 66. For the transportation effort, 15 tri-axle dump trucks will be used to move the debris. The transportation cost for moving will be \$337,500 and the demolition cost was determined to be \$457,000.

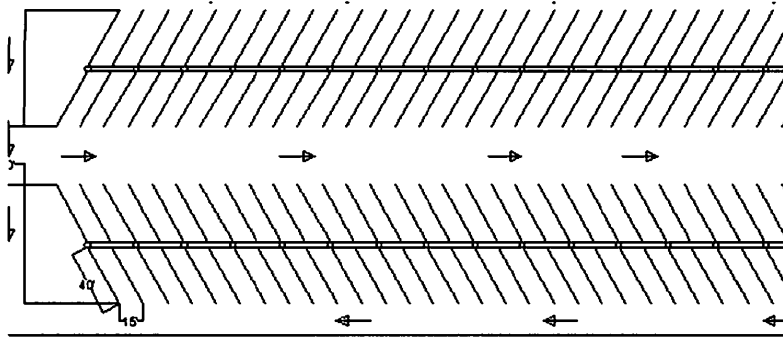
- Demolition Effort
 - Truck Amount Determination:
 - 1 truck can hold 18yd³ of debris
 - Total cubic yardage of building was 55,556yd³
 - For 1 day: 55,556yd³ * (1 truck/18yd³) = 3086 trucks
 - 3086 trucks/7 loads= 441 trucks carrying 7 loads each
 - (441 trucks/load)/28 days = 15 trucks carrying 7 loads each over 28 days
 - Transportation Cost
 - \$3/ton to move
 - 75,000 ft²(20ft)*(150lb/ft³)*(1 ton/2000lb)= 112,500 ton
 - \$3/ton * (112,500 ton)= \$337,500
 - Demolition Cost
 - Abatement work: \$30,000
 - Abatement report: \$2500
 - Demo for concrete: \$175,000
 - Demo for other debris: \$50,000
 - Permits and Landfill fees: \$200,000
 - Total= \$30,000+\$2500+\$175,000+\$50,000+\$200,000= \$457,500
 - Total Cost
 - \$337,500+\$457,500= \$795,000
- Rest Area Facility
 - 40.6 acre site
 - Rest area facility equipped with several restrooms, vending machines, picnic areas, and dog parks. All parts of the facility are connected by sidewalks. There is also
 - Car parking lot with approximately 700 parking spaces with 14 ADA parking spaces
 - Bus parking lot with approximately 192 parking spaces
 - Highway 66 widened to include a left middle turning lane



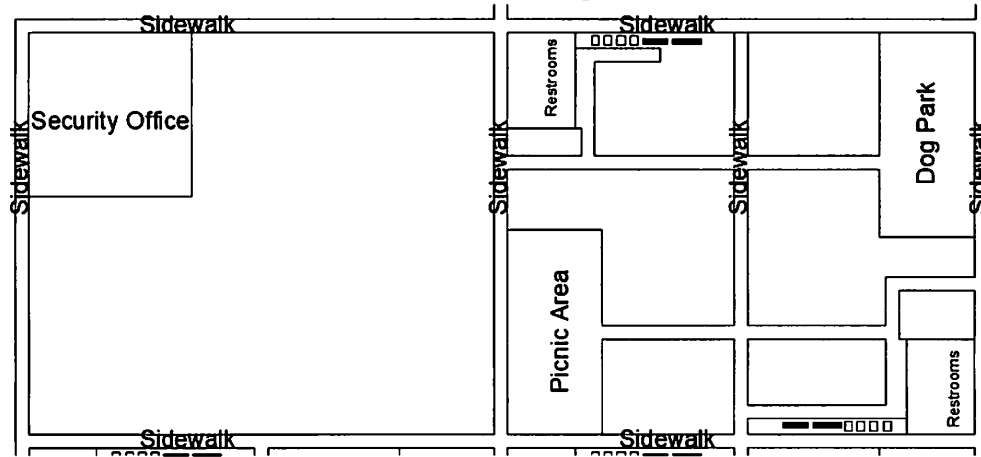
Overview of Total Site



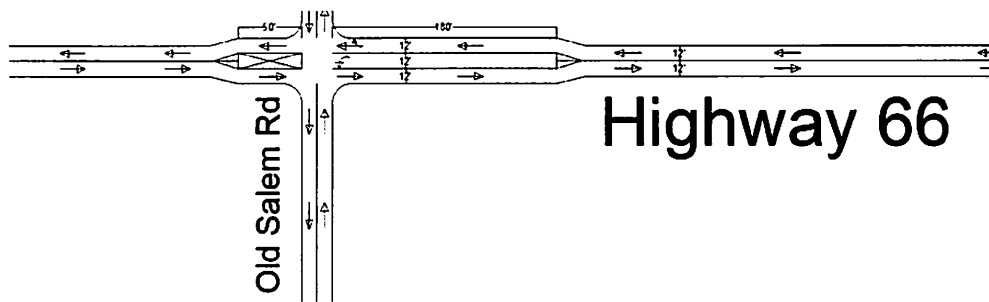
Portion of Car Parking Lot With ADA Parking Spaces



Portion of Bus Parking Lot



Portion of Rest Area Facility



Highway 66 widened to include left middle turn lane

Task 9 - Traffic Signage, Markings, etc

The traffic signage and marking information was obtained from the Manual on Uniform Traffic Control Devices for streets and highways. There are a total of four signs selected for the traffic signage. The first sign is the stop sign. It is designated as R1-1. The stop sign is placed on the right-hand side of the roadway where they are easily recognized and understood by road users. Second is the Stop Ahead sign. It is designated as W3-1a. The purpose of the STOP AHEAD sign is to warn drivers of a downstream regulatory STOP sign. Since the design speed for the project is 50 miles per hour, the stop sign and the stop ahead sign must be 30x30 inches for official street applications.

The third sign is the T-intersection sign. It is designated as W2-2. The T-intersection sign is used in advance of an intersection to indicate the presence of an intersection and the possibility of turning or entering traffic. Similar to the stop sign and the stop ahead sign, it must also be 30x30 inches. The last sign was the Two-way traffic sign. It is designated as W1-7. The Two-Direction Large Arrow shall be installed on the far side of a T-intersection in line with, and at approximately a right angle to, traffic approaching from the stem of the T-intersection. It must be 48x24 inches.



W3-1a



W2-2



W1-7



R1-1

Task 10 - Landscaping

Landscaping is an important part of the project because it not only beautifies the transportation facility but also helps to meet drainage standards. The landscaping had to be done for the collector road in Georgia and for the rest area facility in North Carolina.

According to the Georgia Department of Transportation (GDOT) specifications, there is a limit to the months in which landscape related work for trees and shrubs can occur. Plant installations are to be done between the dates of October 15 and March 15 only. Also, it requires the use of Georgia grown trees, shrubs, and other nursery plants for Right of Way plantings.

The shrub chosen for the collector road design was *Lagerstroemia Indica*, commonly known as Crepe Myrtles. They are the most useful flowering shrubs grown in Georgia and are native to the place. They provide abundant summer color with a minimum of maintenance. Thus, proving to be cost-effective. They are long-lived and can also withstand droughts. However, they do require some time to establish themselves. Lastly, they are free of diseases and insect difficulties.

The tree that was chosen for landscaping was *Quercus phellos*. It is also known as Willow Oak.

Willow Oak is a deciduous tree with medium-fine texture and a medium growth rate that requires moist and fertile soils, but tolerates adverse sites relatively well. It has many uses. It can be used as a shade or specimen tree. It provides lumbar and is easy to plant. Especially, its acorns that produce plenty of nutrition for squirrels, deer, turkeys, and birds.

Both these species of plants are non-invasive. This means that they grow there naturally, provide habitat and food for wildlife, and don't cause any harmful effects on the environment. This is important as GDOT does not allow invasive species of plants to be used for landscaping.

Landscaping is required within parking areas as they intend to shade and improve the attractiveness of large areas of pavement. In North Carolina, according to the North Carolina Department of Transportation, the parking lot planting yards must include at least one canopy tree for every 12 parking spaces. The tree chosen for this rest area facility was *Oxydendrum arboreum*, more commonly known as the Sourwood tree. It is native to North Carolina and prefers rich soil, mixed hardwood and softwood forests. However, it is adaptable. It has multiple uses, including providing an impressive summer bloom of delicate, white, very fragrant flowers. It also has a spreading canopy that is great for blocking sunlight.

Task 11 - Total Cost of Construction

The total cost of construction for the collector road design and the rest area facility was calculated to be \$1,412,906.13. This was calculated by adding all the individual costs of intersections, roundabouts, demolition, and the construction of rest area facilities.

Conclusion

In conclusion, based on our COGO data and our YARD+ data, we were able to design a successful collector road and rest area facility. Our parking lot had 700 parking spaces and 2% of that were ADA. For the buses, we had 192 spaces.

Overall, it was a successful project and all objectives were met.

References

- <https://www.greensboro-nc.gov/Home/ShowDocument?id=2977>
- <https://extension.uga.edu/publications/detail.html?number=B987&title=Native%20Plants%20for%20Georgia%20Part%20I:%20Trees,%20Shrubs%20and%20Woody%20Vines#WillowOak>
- <https://mutcd.fhwa.dot.gov/htm/2009/part2/part2c.htm>
- <https://mutcd.fhwa.dot.gov/htm/2009/part2/part2c.htm#section2C36>
- <https://connect.ncdot.gov/resources/roadside/AestheticEngineeringDocuments/PlantingGuidelines.pdf>
- <http://mydocs.dot.ga.gov/info/gdotpubs/Publications/6755-9.pdf>
- <https://www.greensboro-nc.gov/home/showpublisheddocument/46017/637279215193100000>
- <https://www.greenscapeinc.com/blog/the-best-trees-for-north-carolina-shade-flowering-privacy>
- <https://www.trafficsigns.com/>
- <https://www.greenwoodnursery.com/sourwood-oxydendrum-arboreum-tree>
- <https://myperfectplants.com/products/willow-oak-tree>

AVERAGE

**NO AVERAGE STUDENT WORK SAMPLE FOR
TERM PROJECT REPORT**

BELOW AVERAGE

Updated 16 November 2021

ANDROMEDA CONSTRUCTION

Suggested References

1. American Association of State Highway and Transportation Officials (AASHTO), A Policy on Geometric Design of Highways and Streets, 6th Edition, 2011.
2. Transportation Research Board (TRB), National Research Council, Highway Capacity Manual 2010, 5th Edition, 2010.
3. US Department of Transportation, Federal Highway (FHWA), Manual on Uniform Traffic Control Devices 2009 Edition, January 2010. (An on-line reference).
4. American Association of State Highway and Transportation Officials (AASHTO), Guide for Design of Pavement Structures, 1993.
5. American Association of State Highway and Transportation Officials (AASHTO), Roadside Design Guide, 4th Edition, 2011.
6. Institute of Transportation Engineers (ITE), Traffic Engineering Handbook, 7th Edition, John Wiley & Sons 2016.

Deliverables

Below is a list of the deliverables that will need to be submitted by the project due date located on page 1 of this document.

1. A soft and hard copy of the final presentation.
2. A hard copy of a technical report, which includes the results to Tasks 1 – 11.

179.91

250

Grading

Detailed discussions regarding the format used to grade the presentation (soft and hard copy) occurs throughout the semester.

The following rubric will serve as the template to grade the project technical report deliverables:

A – Superior. No major errors or omissions. Project displays a high standard of workmanship and accuracy.

B – Good. Project essentially complete, but lacking in attention to detail in some respects

C – Acceptable. Project has some major errors/omissions.

D – Poor effort, inferior quality.

The following is a suggested checklist for the technical report:

A. Design capacity calculations---show all work in detail 20 points

- AADT ✓
- DHV ✓
- Determine the % of proposed alignment that's restricted to sight distance ✓
- Number of lanes required 100

Updated 16 November 2021

B. Alignment calculation from COGO (or alternative design software used) along with a neat sketch showing points and pertinent information. 10 points *NO*

C. Plan and Profile Sheets must include the following: 40 points

- Horizontal and vertical alignment, including terrain profile and design grades.
- 1.67* • Horizontal curve data—D, R, T, E, "I" angle, and superelevation rate *$e = E$ missing*
- 1.67* • Vertical curve data—station of VPI, elevation of VPT, and length of curve (LC) *missing*
- Show station of PC's, PT's, PI's, Point A and Point B.
- Indication bearing of each tangent line—Plan only
- 2.5* • Show North Arrow in upper right-hand corner of the plan view *Incorrect location*
- 3.75* • Show location of drainage structures—plan (stations only) and profile (station, elevation and discharge amount) *missing*
- Existing conditions—contours, road, houses, etc. ✓

D. Earthwork 20 points

- 5* • Provide a table of the YARD++ output (or alternative earthwork software is used)
- 5* • Show one set of earthwork calculations
- Draw mass diagram with a profile diagram (to the same scale) directly above ✓
- 2.5* • Indicate on the profile diagram the direction of overhaul and free haul. Indicate on the mass diagram overhaul areas, borrow and/or waste areas, free haul areas, balance points, and a chart describing total cut, fill, borrow, overhaul and waste in cubic yards. *Not done*

✓ E. Drainage calculations describe each step in detail. On the original contour map, show a boundary around the drainage area with arrows indicating the direction of water flowing within that area. The original map(s) must accompany the final report. 30 points

F. Roadway Cross-Section 10 points

- 5* ✓ • A typical roadway cross-section reflecting the entire right-of-way
- A typical super-elevated roadway cross-section reflecting the entire right-of-way

G. Results of the intersection design/re-design and signage 15 points

- ✓ • A typical intersection cross-section
- ✓ • Select a project related intersection and provide a typical intersection cross-section showing vehicular conflicts
- ✓ • Use the selected project related intersection and provide a typical intersection cross-section showing reduced or eliminated vehicular conflicts

✓ H. Results of the Rest Area Facility design. 37 points

Updated 16 November 2021

- ✓ I. Traffic Signage, markings, etc. - selections applicable for the entire roadway and its components. 10 points
- 15 J. Results of landscaping design and layout. 30 points *mostly discussed in narrative*
- 5 K. Results for total cost of construction. 10 points
- ✓ L. Conclusions—this should be a brief summation of the project, problems encountered, resolutions employed, suggestions on design approach, etc. Also, include suggestions (if any) to make to the term design project better in the future. 6 points
- M. References 6 points ✓
- Cover Page - 2 points ✓
- TOC - 2 points ✓
- Transmittal Letter - 2 points NO

Updated 2 November 2021

**Prairie View A&M University
College of Engineering
Civil & Environmental Engineering Department
CVEG 4302 – Transportation Engineering Design
Fall 2021**

**Term Project Parking Task
REST AREA FACILITY**

Given: 21 September 2021 (Updated 2 November 2021)

Due: 1 December 2021

Introduction

The North Carolina Department of Transportation (NCDOT) is conducting a feasibility study regarding a Rest Area Facility to be placed on the 40.6-acre site located near Highway 66 and Old Salem Road. A key component of the feasibility study is to create a 2D conceptual layout design of the overall Rest Area Facility as well as the detailed parking design for the facility in order to capture major features and functions that will need to be articulated to meet design specifications.

Engineering Constraints: 37 points

1. Maximize FULL use of the 40.6-acre site.
2. Currently, there is a 75,000 square foot two-story concrete structure on the site. You need to demolish and remove it before any new construction can begin.
3. For the demolition effort, determine the following: (1) truck type used, (2) number of trucks, (3) location of dumping site, (4) transportation cost, and (5) total demolition cost.
4. Design speed of Highway 66 is 50 mph. The post speed limit is 45 mph.
5. Assume that Highway 66 would have to be widened to include a center left turn-lane.
6. All widening should take place west of Highway 66 that is opposite the construction site.
7. A right-turn lane is required at the main entrance driveway and the shoulder will need to accommodate right-turns.
8. At-grade channelization should be considered at intersections as well as to accommodate right-turns.
9. The lanes should be 12-feet wide.
10. All roadway design should meet North Carolina Department of Transportation (NCDOT) specifications.
11. Parking lot design should accommodate vehicles, motorcycles, buses, and vans. Separate bus and van parking from other vehicles.
12. Maximize the quantity of parking supplied to this type of facility, while allowing vehicles to park with only one distinct maneuver.
13. Sidewalks are required within the Rest Area boundary.
14. Use five-foot sidewalks that are set three-feet back from the curb and gutter.
15. Landscaping requirements should adhere to North Carolina specifications.
16. Gravity sewer main is located along Highway 66.
17. Existing water is located along Highway 66.

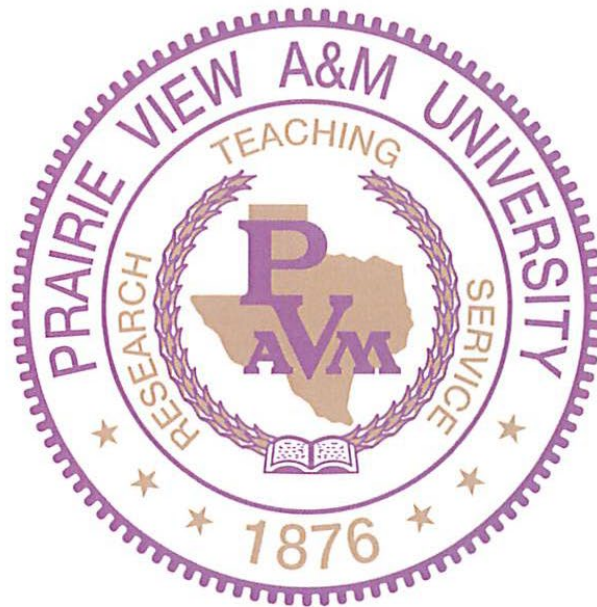
Updated 2 November 2021

18. Identify the elevations for the facility, parking lot, and other amenities and services available at the facility. However, you are not required to perform any grading calculations.
19. No grading calculations are required for the widening the any roads.
20. Site plan must meet Winston-Salem Forsyth County's Unified Development Ordinances.

Additional Notes:

1. Report any assumptions that you make.
2. Some parking operations considerations to guide your thinking:
 - a. Construction Details
 1. Pavement – slightly sloping for runoff.
 2. Drainage – slope greater than 1% to catch basins; curb inlets
 3. Curb/Sidewalks – place along the perimeter. Can have concrete curb/gutters. The concrete curbs should be 4-inches thick.
 4. Car Stops – concrete curbs; concrete, plastic, or wooden wheel stops; and posts 36 inches high.
 5. Lighting - place on the centerline of double row of car stalls and of the two opposing car stalls; lights around the perimeter of the lot; should harmonize with the surrounding architecture.
 6. Stripping - white or yellow paint
 7. Fencing - use when security dictates. Should be a 6-foot high chain link fence.
 8. Landscaping
 - b. Entrance Considerations
 1. Locate as far from the roadway, an intersection, and conflicting points as possible.
 2. Multiple entrances may ease access and reduce restriction on adjacent roadways.
 3. Place mid-block when possible.
 4. Local ordinances and codes can restrict the number of entrances.
 - c. Internal Considerations
 - d. Exit Considerations
 1. Multiple exit lanes help right turning vehicles avoid waiting for left turning vehicles.
 2. Place mid-block when possible.
 3. Local ordinances and codes can restrict the number of exits.
3. Some maneuvers to guide your thinking:
 - a. Vehicle enters from the street (space provide by entry driveway).
 - b. Vehicle searches for parking stall (space provided by circulation and/or access aisles).
 - c. Vehicle enters the stall (space provided by the access aisle).
 - d. Vehicle is parked (stall designed to accommodate the vehicle's length and with plus space to open vehicle doors).
 - e. Pedestrians access the building or destination (usually via the aisles).
 - f. Vehicle exits the parking stall (space provided by the access aisle).
 - g. Vehicle searches for an exit (space provided by the access and circulation aisle).
 - h. Vehicle enters the street network (space provided by the exit driveways).

**Prairie View A&M University
Civil & Environmental Engineering Department
CVEG 4302 Transportation Engineering Design
Fall 2021**



**Collector Road Design Term Project Final Report
Submitted by: Nyja' Kennedy, Paige Hines, Jonathan Warrior,
Armando Gomez and Mouni Yamba
Date Given: September 21, 2021
Date Submitted: December 4, 2021**

Table Of contents

Project Scope	3-6
Organizational Structure	7
Gantt chart	7
Roadway Design Details	8
Task 1: Design Calculations	9-10
Task 2: Horizontal Alignment	11-12
Task 3: Vertical Alignment	13-14
Task 4: Earthwork and Mass Diagram	15-16
Task 5: Drainage	17-20
Task 6: Roadway Cross-Sectional Sketches	21
Task 7: Intersection Design	22-23
Task 8: Parking Design	24-29
Task 9: Traffic Signage and Markings	21
Task 10: Landscaping	30-34
Task 11: Cost of Construction	35
References	36

Project Scope

For the fall semester term project in Transportation Engineering Design Fall of 2021, students were broken up into groups and given a task to design a roadway that begins at Point A and ends at Point B. The design will be in accordance with provisions indicated below using the given materials and information. The given materials for this project were; a contour map of the roadway in the state of Georgia and North Carolina, cogo and yard plus alignment softwares that was made available to the class, and the Roy G. Perry College of Engineering Senior Design Manual. The roadway data is provided in the body of this report in the section titled *Roadway Design Details*. Using the given tools and information for each group were to complete the eleven task that are outlined below.

Task 1 – Design Calculations

Compute the future AADT and DHV. Note that the percent of the route offering passing sight distance is a determinant of design capacity. Determine what percent of your route must meet the sight distance criterion, if applicable.

Task 2 – Horizontal Alignment

Use the contour maps to facilitate the layout of a horizontal alignment from Point A to Point B, beginning and ending with the given bearings you identify. Insofar as is possible adhere to the general controls for horizontal alignment. Avoid houses and other buildings, swampy areas and lakes, consider the effect of your alignment on intersecting roadways and adjacent land uses, and avoid steep topographical features. Design a “flowing” alignment that avoids unnecessary earthwork, but, at the same time, be alert to the need for providing “sufficient” passing sight distance. Special attention should be given to coordinating the horizontal alignment with vertical alignment, to avoid intolerable earthwork operations. The final horizontal alignment will need to be on plan and profile sheets, which should be part of the final project deliverable. Give horizontal curve data D, R, T, E, “I” angle and super elevation for each circular curve. Show the stations of

P.C. 's, P.I. 's, P.T. 's, Points A and B, and the bearing of each line. Show a north arrow on each plan and profile sheet. COGO can be used for all alignment computations. When alternative design software is used, the COGO parameters must be submitted with the deliverables.

Task 3- Vertical Alignment

Using the contour maps provided, to lay out the vertical alignment and ensure it coordinates with the horizontal alignment. Determine both existing ground and proposed vertical alignment elevations. Plot these elevations on the plan and profile sheet(s). A horizontal scale of 1" = 200' (it must be the same for both alignments) and a vertical scale of 1" = 10' or 1" = 20' is suggested (you may use an alternate scale).

To promote safety and driver comfort, flat grades are desired. Determine the maximum allowable grade. In the interests of good drainage, avoid long lengths of 0.0% grades. The length of any grade is governed by a 15mph allowable speed reduction for trucks. The length of any vertical curve is governed by sight distance requirements.

Consistent with design standards and objectives, minimize cuts and fills. Insofar as is possible, adhere to the general controls for vertical alignment. Tie to the given elevation and grade at Point A and B.

Your profile drawing should show (in addition to ground profile), the percent grade for all tangents. For each vertical curve, show the station V.P.I., elevation V.P.I., and length of vertical curve. Again, COGO can be used for all alignment computations. When alternative design software is used, the COGO parameters must be submitted with the deliverables.

Task 4 - Earthwork and Mass Diagram

At each 100-foot station, determine the elevations of the earth along the roadway. (You may scale their values from the plan and profile sheets. COGO output can be used to plot elevations for the proposed vertical alignment.) Compute earthwork volumes and mass diagram ordinates assuming that excavated material will (shrink) or (swell) 6% when placed and compacted in fill areas. Plot the mass diagram and profile in the usual manner, using a horizontal scale of 1" = 200'. Analyze

the mass diagram using the following standards: a. Free haul distance = 600-ft b. Limit of economic haul = 1200-ft Show free haul, overhaul, borrow and waste on the profile above the mass diagram. Determine the total quantities of excavation, embankment, free haul, overhaul, borrow, and waste for the project. The computer program YARD++ should be used for all computations. When alternative earthwork software is used, the YARD++ parameters must be submitted with the deliverables.

Task 5 – Drainage

Divide the highway corridor into “drainage areas.” For one of the areas located entirely within the bounds of the contour map provided, determine the “drainage area” by the count squares method. Using the charts provided for the Georgia Department of Transportation determine the discharge in cubic feet per second (making necessary adjustments). Also, determine the discharge using the rational method. Based on the two methods, select a discharge amount and design a drainage structure for the drainage area selected. Place the location of the drainage structure on the plan and profile sheet(s). Show the station on the plan view and show station, elevation, discharge, and diameter size on the profile view.

Task 6 –

Roadway Cross-Sectional Sketches provide a sketch of a typical cross-section of the roadway reflecting the entire right-of-way. Provide a sketch of a typical super-elevated cross-section of the roadway reflecting the entire right-of-way.

Task 7 – Intersection Design

Intersection studies are used to evaluate the performance of an intersection’s geometrics, signal control, etc. Provide a sketch of a typical cross-sectional of the intersection (including traffic signs, markings, etc.) and intersection detailing vehicular conflicts. Only non-signalized intersections are used in this project.

Task 8 – Parking Design Requirements to achieve under this task, reference the parking handout for the Rest Area Facility originally dated 21 September 2021. However, please use the version

with the latest assigned date.

Task 9 – Traffic Signage, Markings, etc. Ensure that traffic signs, markings, etc. are selected and properly located within the right-of-way of the roadway. The selection of traffic control devices will have to adhere to appropriate regulation(s) properly located within the right-of-way of the roadway. The selection of traffic control devices will have to adhere to appropriate regulation(s).

Task 10 – Landscaping is a component of the project that not only adds to the beautification of the transportation facility, but can assist with satisfying drainage requirements as well. Identification and placement of appropriate landscaping requirements for the entire roadway and for Task 8 must be accomplished. The requirements will have to adhere to local and/or state ordinances.

Task 11 – Total Cost of Construction Discuss assumptions and/or design constraints to compute the cost of constructing the collector roadway design per Tasks 1 - 10. Completion of this task will have to adhere to appropriate regulation(s).

```
graph TD; A[Dr. Perkins, P.E.  
Georgia DOT Representative] --> B[Nyja Kennedy  
Team Lead  
■ Vertical Alignment  
■ Horizontal Alignment  
■ Intersection Design  
■ Landscaping]; B --> C[Paige Hines  
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■ Horizontal Alignment  
■ Intersection Design  
■ Parking Design, North Carolina]; B --> D[Jonathon Warrior  
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● Horizontal Alignment  
● Earth Work  
● Landscaping  
● Drainage  
● Total Cost of construction, North Carolina]; B --> E[Armando Gomez  
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■ Parking Design, North Carolina  
■ Landscaping]; B --> F[Mouni Yamba  
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● Horizontal Alignment  
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```

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● Landscaping
● Drainage
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■ Parking Design, North Carolina
■ Landscaping

Mouni Yamba
Researcher
● Vertical Alignment
● Horizontal Alignment
● Total Cost of construction, North Carolina

[illegible]

Roadway Design Details

Given Data for the Design and layout

AADT for the current year is 2100 vehicles per day present volume growth rate is 2% per year

The design year is 25 years hence

The traffic analysis period is 20 years

The truck factor is 8%

The design speed 50 mph

The maximum grade is 4.5%

The maximum degree of curvature is 5°

The desired average running speed is 45-50mph. The level of service is B.

The maximum super elevation is

The terrain rolling

Divided Highway

PHF = 0.9

Lane width = 12ft

K= 0.15

D = 0.65

Task 1: Design Calculation

Compute the future AADT and DHV. Note that the percent of the route offering passing sight distance is a determinant of design capacity. Determine what percent of your route must meet the sight distance criterion, if applicable.

Future AADT:

$$\text{AADT} = \text{AADT (present)} \times (1 + \square)^{\square}$$

$$= 2100 \times (1 + 0.02)^{20}$$

$$= 3120 \text{ vehicles per day}$$

DHV:

$$\text{DHV} = \text{AADT}_{(\text{future})} \times K$$

$$= 3120 \times 0.15$$

$$= 468 \text{ vehicles per day}$$

DDHV:

$$\text{DDHV} = \text{AADT}_{(\text{future})} \times K \times D$$

$$= 3120 \times (0.15) \times (0.15)$$

$$= 304 \text{ vehicles per day}$$

Percent of Road that meets criterion:

Not applicable due to the roadway being divided, passing is not permitted

Number of lanes:

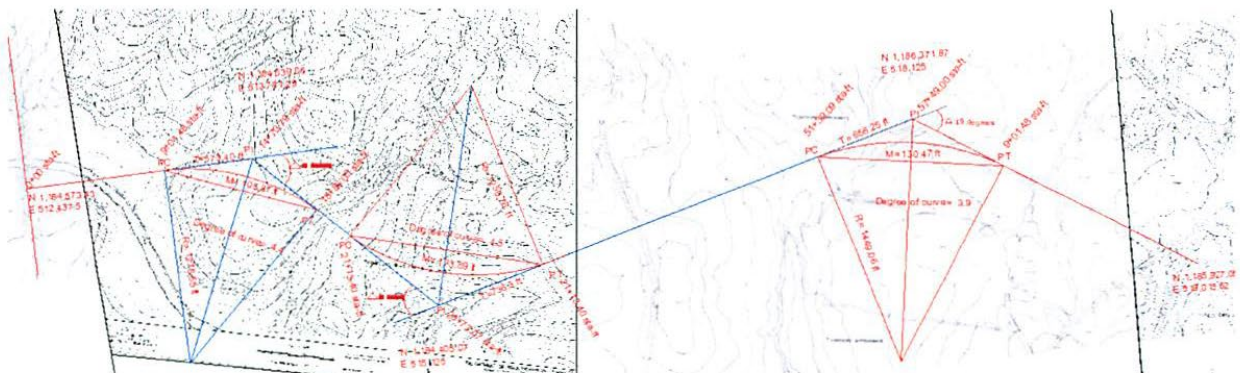
$$\begin{aligned}\text{Number of lanes} &= \frac{DDHV}{SFL \cdot f_e \cdot PHF} \\ &= \frac{304}{(900) \cdot (0.9) \cdot (0.9)} \\ &= 1 \text{ lane in direction}\end{aligned}$$

Task 2: Horizontal Alignment

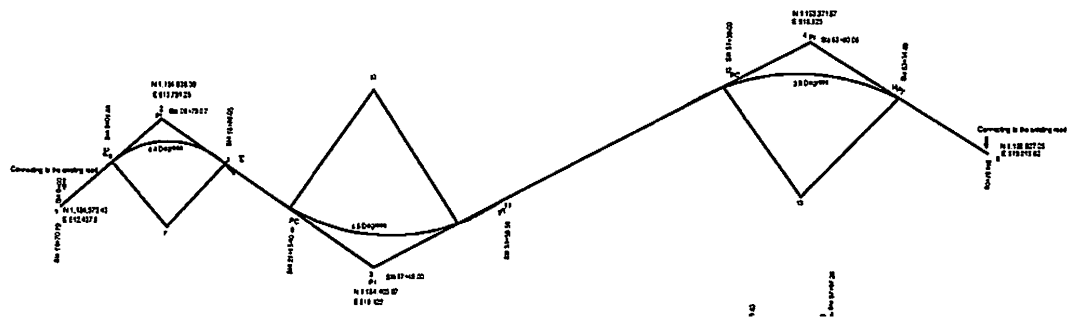
The roadway horizontal alignment is a series of horizontal tangents, circular curves, and spiral transitions. It shows the proposed roadway location in relation to the existing terrain and adjacent land conditions. Together with the vertical alignment and roadway cross-section such as lanes, shoulders, curbs, medians, roadside slopes, ditches, sidewalks. The horizontal alignment helps to provide a three-dimensional roadway layout. Establishing a horizontal alignment from point A to point B, while avoiding existing houses and other buildings, swampy areas and lakes, make considerations of the roadway intersecting other roads at a 90 degree angle.

Physically using the contour map and a twelve inch ruler to measure the horizontal alignment. Also using the 12 inch ruler to obtain the stations of P.C. 's, P.I. 's, P.T. 's, Points A and B, and the bearing of each line. Using equations given in the *Traffic and highway Engineering textbook* by Nicholas J. Gaber and Lester A. Hoel to find; radius, external distance, degree of curvature, intersection angle, tangent distance, and length of middle ordinate. Not only did we use the physical map, inserting the horizontal alignment into the 2020 AutoCAD software to make sure the horizontal alignment was accurate. Putting the horizontal alignment into AutoCAD gave us the accurate horizontal alignment. As well as using AutoCAD cogo (coordinate geometry) with correct north and east coordinates, the software cogo gave the accurate horizontal and vertical alignment.

PLAN VIEW 1



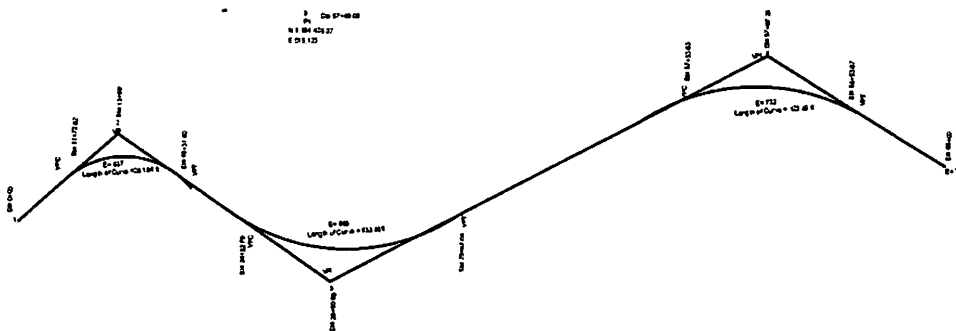
PLAN VIEW 2



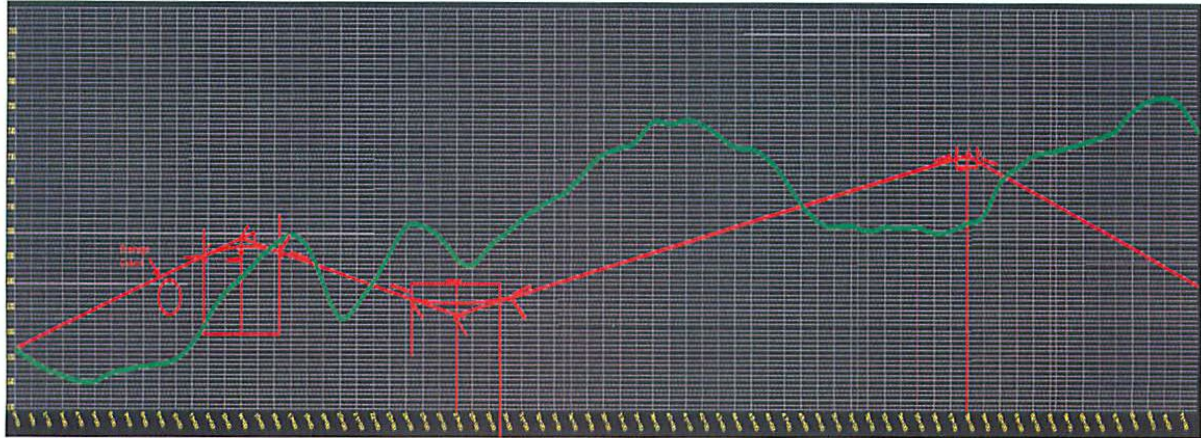
Task 3: Vertical Alignment

Using the contour maps provided the lay out the vertical alignment and ensure it coordinates with the horizontal alignment. Indicating existing ground and proposed vertical alignment elevations. As well as having the elevations on the plan and profile view. The profile drawing indicates the percent grade for all tangents. For each vertical curve, showing the station V.P.I, elevation V.P.I., and length of vertical curve. Again, COGO can be used for all alignment computations. When alternative design software is used, the COGO parameters must be submitted with the deliverables.

PROFILE VIEW 1

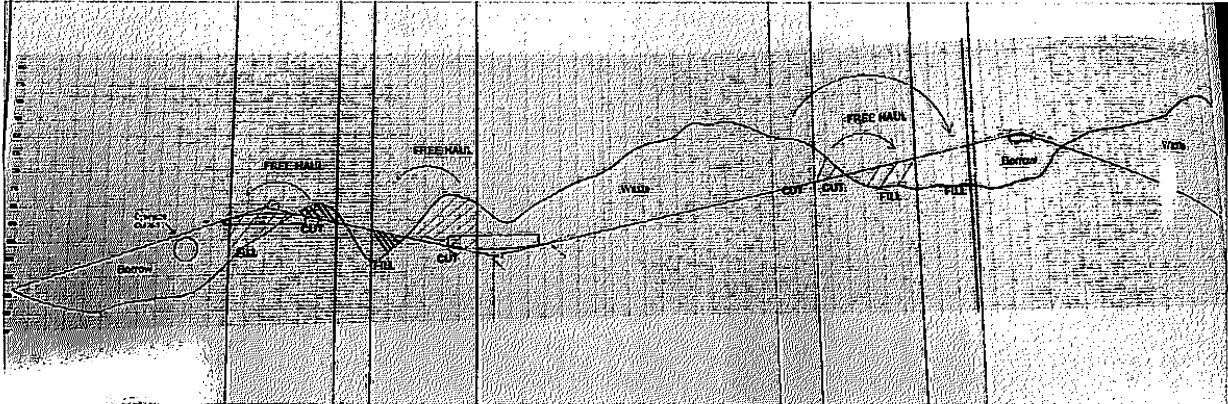


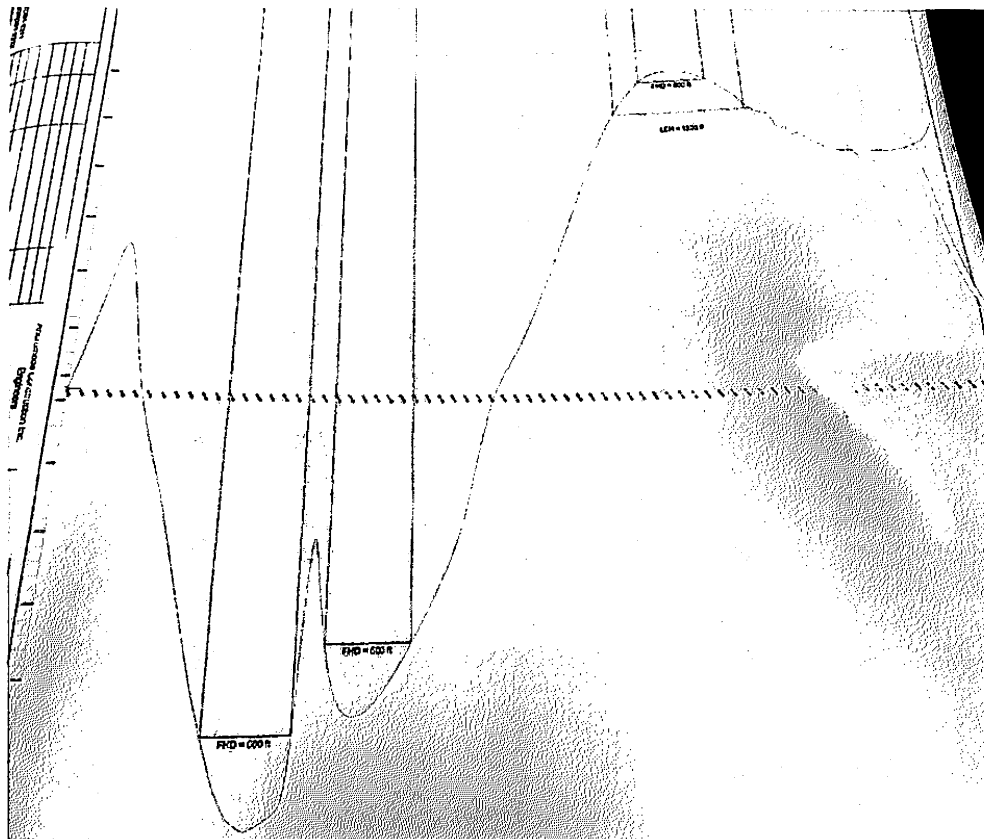
PROFILE VIEW 2



(Profile view 2 displays the vertical alignment and ensures the coordinates with the horizontal alignment. Showing both existing ground and proposed vertical alignment elevations.)

Task 4: Earthwork and Mass Diagram





Task 5: Drainage

In order to properly obtain the drainage area, consideration must be taken from several factors regarding the type of soil and structures that occupy the watershed. These factors include: the size and shape of the drainage basin, type of surface, and whether the flow is entirely over land or partially channelized. With this information, we are able to determine the values of runoff coefficient. In the project, we were given the types of soil as well as the structures that occupy the area as impervious soil, slightly impervious soil, and Concrete/Bituminous Pavement.

After obtaining our runoff coefficient value, the rainfall intensity was the next crucial step. To derive the accurate rainfall for our design year, our group was provided a figure given by the Federal Highway Administration. In the figure provided, 30-min rainfall intensities for a 2-year recurrence year at various locations for the 48 contiguous states.

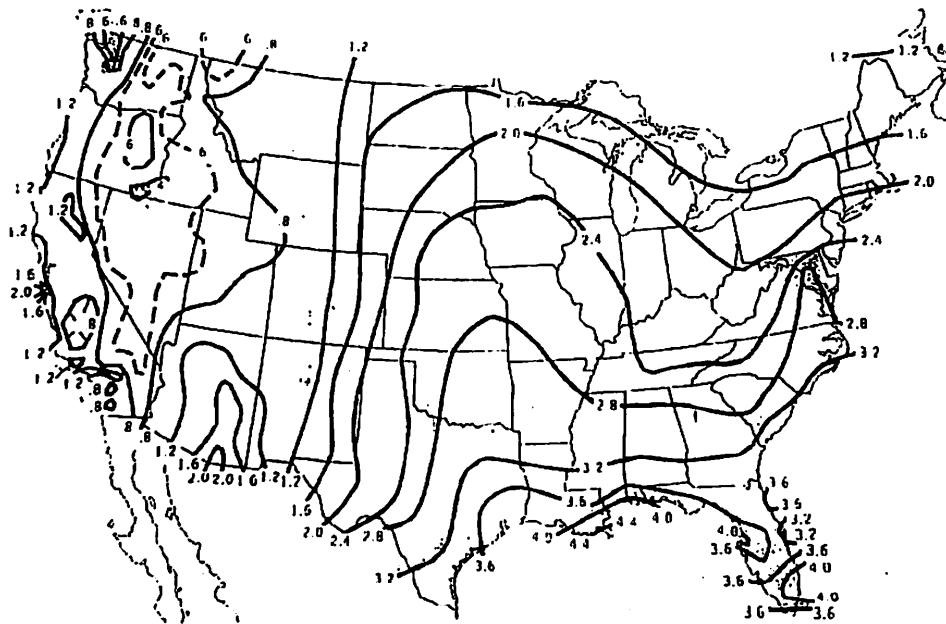
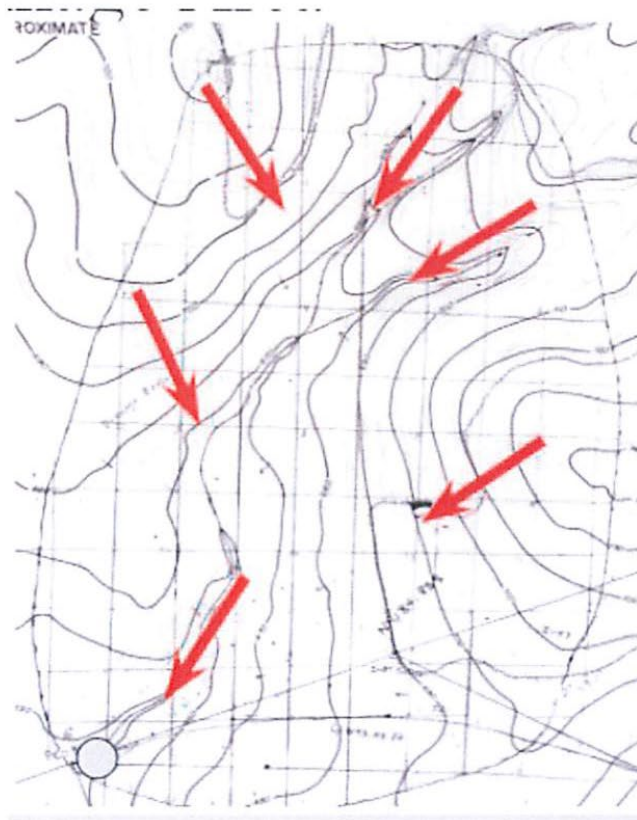


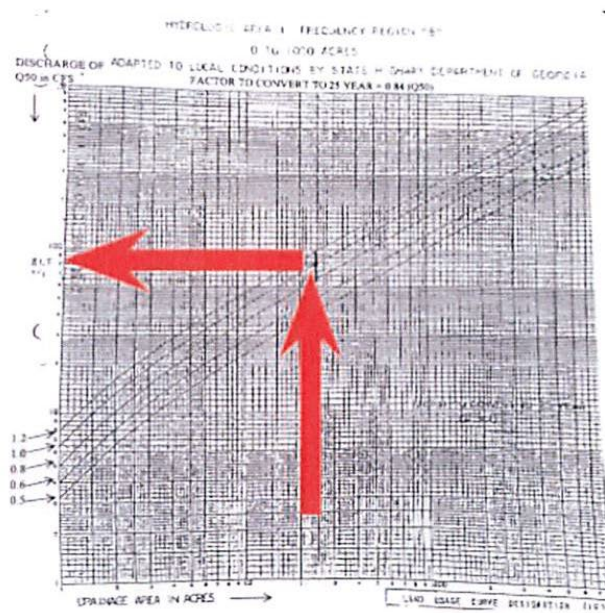
FIGURE 11-2 Map of the contiguous United States, showing 2-year, 30-min rainfall intensity. (Courtesy Federal Highway Administration.)

The map that contained all of the rainfall intensity data for the United States was adapted from many references within the FHWA and it was used to determine the approximate rainfall intensity as well as rainfall duration data when specific site data was not available. Using the conversion factors provided, our company was able to convert the values from the 2-year, 30 minutes duration to our desired rainfall intensity for 25 years, 60 minutes duration.

Now that the runoff coefficient value and the rainfall intensity have been finalized, the drainage area was then derived using the Counting Squares method. Throughout determining the drainage basin, it was noted as having both partially channelized and gently sloping terrain. This allows for water to congregate at high volume in multiple segments of the basin, resulting in a larger drainage area to compensate for the higher possible discharge.



Two methods were used to determine the most accurate discharge in regards to the amount of acres in our drainage area. First, a chart was provided by the Georgia Department of Transportation in which the hydrologic area, the type of terrain, and land type were used to obtain our discharge for our designated design year. Then, the values of the rainfall intensity, the runoff coefficient, and the drainage area were applied to the Rational Method.



Given Information:

Land Type: Mixed Cover = 1.0

Entrance Type: Square Edge with Headwall

Headwater Depth Diameter = 1.5 ft

Drainage Area = 24.7 acres

Using the figure provided, the discharge for the design year of 25 years was derived by

the equation $[Q(25 \text{ years}) = 0.84(81.5 \text{ cfs})]$ The discharge is equal to 68.45 cfs

Rational Method Equation

$$Q = CIA$$

Where,

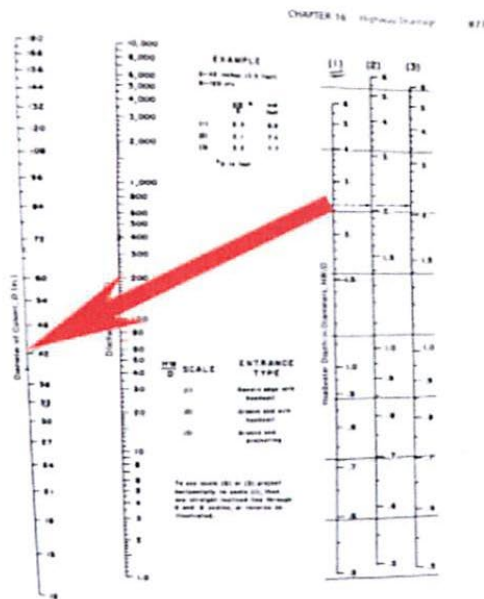
C, Runoff Coefficient (unitless) = 0.77

I, Rainfall Intensity = 3.31 in/hr

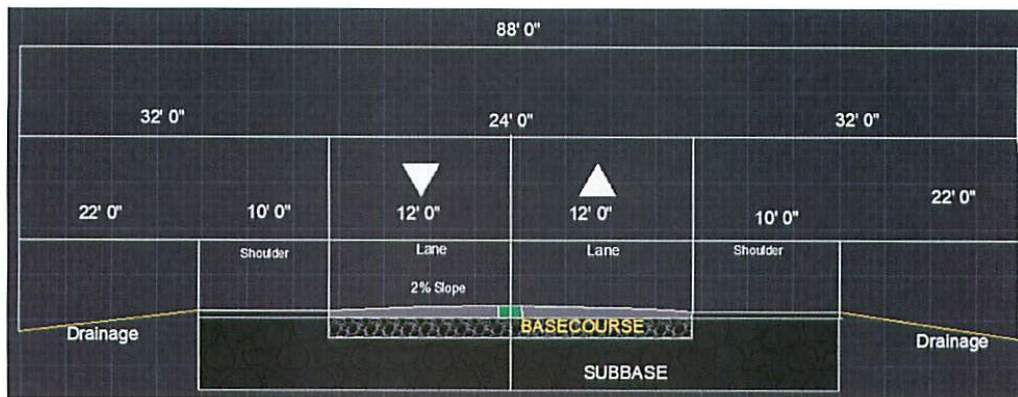
A, Drainage Area = 24.7 acres

$$Q = (0.77)(3.31)(24.7) = 62.95 \text{ cfs for 25 years}$$

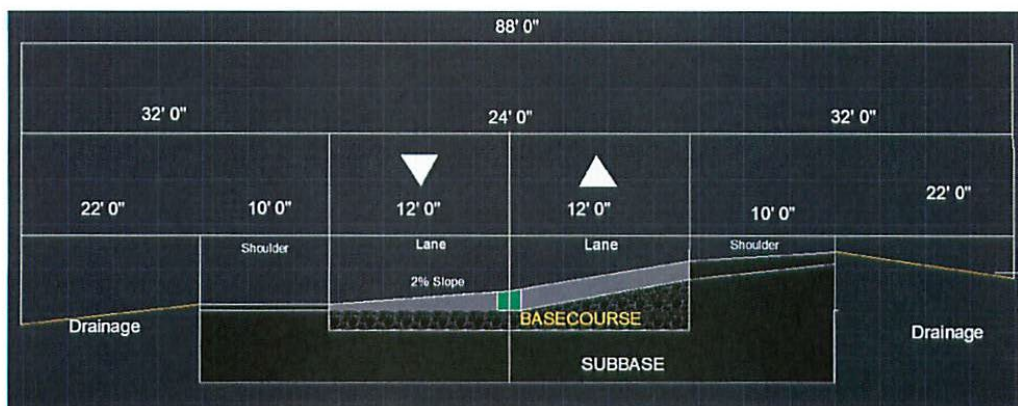
After comparing the two discharges derived from the two methods used, the higher value of the two were used to determine the size of the drainage structure by using Figure 16.17. By applying the headwater depth and using the chart to finalize the diameter of the culvert that was used.



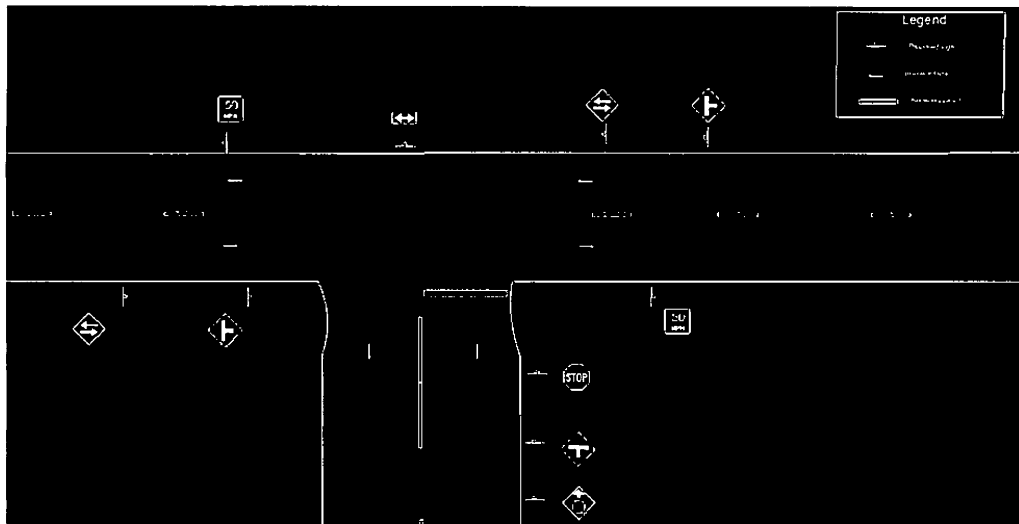
Task 6: Roadway Cross way Sectional Sketches



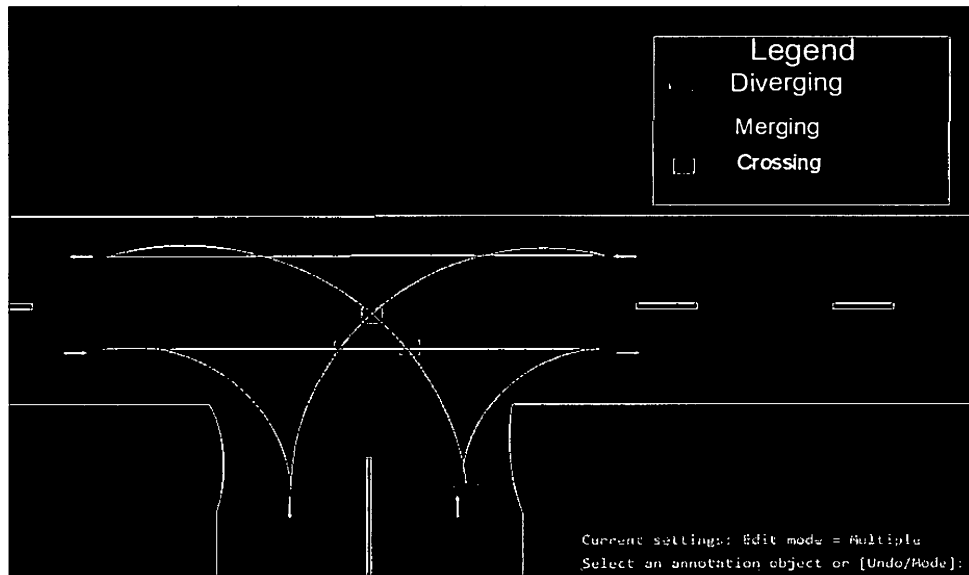
The image above displays the typical cross section of the entire right of way. The dimensions for the lanes, shoulders and areas for drainage surrounding the roadway. The image below is a representation of the entire right of way on a superelevated curve. Emphasis was reflected on the idea that this roadway will be considered a divided highway as a grassy median was used to separate the two lanes from one another in the opposing directions. Wide shoulders have also been placed in order to alleviate traffic in the possibility of car accidents or vehicular breakdowns.



Task 7: Intersection Design

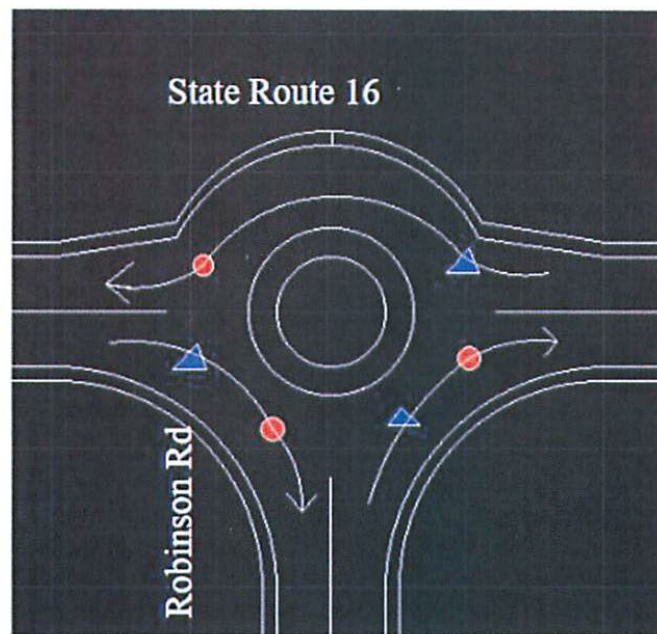


A typical T-intersection on State Route 16 and Robinson Rd.



9 conflict points in a t-intersection

The image above indicates the conflict points for a t-intersection. There are 9 total conflict points in a T-intersection, which are three crossing conflicts, three diverging conflicts, and three merging conflicts. Crossing conflicts are caused by two traffic streams which are the most extreme of all conflicts. Diverging conflicts occur when the flow of traffic is traveling in one direction and split into a different direction. Merging conflicts occur when two vehicles are making the same changes as one another in a single lane which causes an accident.



Roundabout to reduce conflict points

To reduce the 9 conflicts in a t-intersection we redesign the t-intersection into a roundabout. Reducing the conflict point to nine to four. Which will make this intersection as safe as possible for drivers on the road in the state of Georgia.

Task 8 - Rest Area Facility

The Rest Area Facility is to be located off Highway 66 South and Old Salem Road in North Carolina. There is currently an existing 75,000 ft² two-story facility that will need to be demolished prior to work for the new Rest Area Facility is to commence. This will require having to obtain the necessary permits, rental equipment, contracting with a demolition contractor, demolition of existing structure and hauling of debris to the designated landfill for disposal. The cost for the demolition is as follows below.



Figure 01: Existing 75,000 ft² building that is to be demoed

Where,

Permit = \$300 - \$1000

Cost Demolition = \$10 per ft²

Facility = 75,000 ft²

Cost of existing facility demolition: 75000 ft². * \$10 = \$750,000

The cost for hauling off the debris of the demolished building is broken down as depicted below.

Height of building = 20ft

Facility = 75,000 ft²

Facility Volume = 75000 ft² x 20 ft => 1,500,000 ft³ / 27 (ft³ / yd³) = 55555.56 yd³

Number of Truck per day = 55555.56 yd³/ 19 yd³per truck = 2923.98 truck

Trucks Per load = 2924 trucks / 6 loads per day = 487.33 trucks

Trucks per day = 487.33 trucks / 21 days = 23 - 24 trucks per day

Weight of Building = 1,500,000 ft³ x 150 (lb/ ft³) => 225,000,000 lbs / 2000lb = 112500 tons

Item	# of Units	Unit Cost	Total
Permit	1	\$1,000	\$1,000
Facility Demolition	75,000 ft ²	\$10 /ft ²	\$750,000
Waste Disposal	112,500 tons	\$3 /tons	\$337,500
		Sum Total	\$1,088,500

Table 01: Demolition Cost Summary



Figure 02: Proposed Rest Area Facility

The Rest Area Facility is to be located in a 40.6-acre lot in North Carolina. The designated posted speed limit on Highway 66 South is 45 mph. There are two entrances to the Rest Area Facility. The first is located NW in the corner of Highway 66 South and Old Salem Road. It is a 4-way intersection with stop signs for incoming traffic. South bound on Highway 66 S. 3 lanes with a left turn lane entering the Rest Area Facility and 2 lanes going North. There are also 3 lanes exiting the Rest Area Facility with a designated left turn lane to avoid traffic delays. The Second entrance is located on Highway 66 South SW. This entrance is a T-intersection with traffic being controlled by stop signs. Mounted at 7ft to the bottom of the signs. South bound on Highway 66 S. 3 lanes with a left turn lane entering the Rest Area Facility and 2 lanes going north. There are 3 lanes exiting RAF with designated left turn lane and two lanes entrance. This is the designated entrances for RV's, Buses, big rigs and trailer trucks.

The new Rest Area Facility is to be 117,315 ft² which offers public restrooms, public showers, overnight parking stays, information center, shops and vending machines. The Facility

has additional amenities for the public during their stay. Such amenities are 25 covered bench seating for barbecuing and to have picnics. The canopies are 50 ft x 50 ft that provide shade for the park bench seating. There is a children's playground that provides swings, slides, and jungle gym. The Children's playground is 100 ft x 100 ft with ample room to accommodate the playground equipment. The Rest Area Facility also provided five circular splash pads which cover an area of 707 ft² each. There is a 52,000 ft² dog park for those traveling with their pets. It is a fenced in dog park that provides ample space for the pets to roam free without having them run into the road. There are side walls that surround the whole rest area facility for walking or for jogging.

This facility is being built on a 40.6-acre lot. This facility usage is to be for public use and would have to meet its parking intended use. The rest area facility parking lot must meet local ordinances, state standards and ADA requirements. All off-street parking requirements for the city of as recreational public facility.

OFF-STREET PARKING REQUIREMENTS

PRINCIPAL USES	MINIMUM REQUIREMENTS	NOTES
Signs, Off-Premises	None	
Storage Services, Retail	5 spaces, plus 1 additional space for each 100 storage units, or fraction thereof, in excess of 500 units	Minimum 21-foot wide aisle width or building spacing shall be provided for parking at units
Testing and Research Laboratory	1 space per 1,000 SF GFA*	
Veterinary Services	1 space per 400 SF GFA*	
Warehousing	2 spaces per 3 employees plus 1 space per vehicle used in the operation	
RECREATIONAL USES		
Fishing, Fee Charged	2 spaces per acre of water area	Parking shall be located not less than one hundred (100) feet from any right-of-way or property line.
Golf Course	4 spaces per tee	
Golf Driving Range	1 space per tee plus 1 space per 200 SF GFA* for retail uses	
Recreation Facility, Public	1 space per 7,500 SF land area	
Recreation Services, Indoor, Billiard Parlors	2 spaces per table	

Figure 03: Kernersville, NC Off-Street Parking Requirements

Where

Total Area Rest Area Facility 40.6 Acres =>1,764,180 SF

Parking spaces required = 1,764,180 SF / 7,500 SF = 235.22 => 236 Parking Spaces

Rest Area Facility Available parking:

424 Parking spaces

14 ADA Parking spaces, 4 Van ADA Parking spaces, 12 ADA Trailer truck parking Spaces, 2

RV ADA Parking Spaces

20 Employee Parking

266 Trailer truck parking

48 RV Parking

Sum Total Parking (Excluding ADA) = 424 + 20 + 266 + 48 = 758 > 236 Parking Spaces

The amount of parking spaces meets the minimum parking space requirements for the facility usage as a public recreational facility.

Minimum Number of Accessible Parking Spaces

2010 Standards (208.2)

Total Number of Parking Spaces Provided in Parking Facility (per facility)	(Column A) Minimum Number of Accessible Parking Spaces (car and van)	Minimum Number of Van-Accessible Parking Spaces (1 of six accessible spaces)
1 to 25	1	1
26 to 50	2	1
51 to 75	3	1
76 to 100	4	1
101 to 150	5	1
151 to 200	6	1
201 to 300	7	2
301 to 400	8	2
401 to 500	9	2
500 to 1000	2% of total parking provided in each lot or structure	1/6 of Column A*
1001 and over	20 plus 1 for each 100 over 1000	1/6 of Column A*

*one out of every 6 accessible spaces

Figure 04: ADA Parking Requirements

Where

Parking lot 1 = 232 Parking Spaces + 10 Employee parking spaces = 242 total spaces

Parking Lot 01 ADA parking spaces Per Figure 04

- 7 minimum vehicle accessible parking => 8 Accessible Parking spaces used
- 2 minimum van access parking

Parking lot 02 = 172 Parking Spaces + 10 parking spaces = 182 total space

Parking lot 02 ADA parking spaces Per Figure 04

- 6 minimum vehicle accessible parking
- 1 minimum van accessible parking => 2 van accessible parking spaces used

Parking lot 03 = 266 Trailer Trucks Parking spaces

Parking lot 03 ADA Parking spaces per Figure 04

- 7 minimum vehicle accessible parking => 12 accessible parking used

Parking lot 04 = 48 RV Parking spaces

Parking lot 04 ADA Parking space per Figure 04

- 2 RV ADA Parking Spaces

Available ADA parking requirements are met per each parking lot area and some exceeded the minimum requirements. All parking spaces are at 45° angles. The parking dimensions for the vehicles are 9 ft wide x 18 ft long with all two way traffic spacing at minimum 24 ft and one way at 12ft spacing. Large big rig parking spaces are 15 ft wide x 40 ft long with all two way traffic spacing at minimum 30 ft and one way at 15ft spacing. The RV parking spaces are at 30ft wide x 60ft long with a minimum two-way traffic spacing of 30ft. Lighting for the facility parking lot are spaced out through the parking lot and for safety.

The landscape turf grass for the facility is Kentucky bluegrass as it is very tolerant in cold weather but does good in warm weather. It might discolor some during the warmer months but is very tolerant. The Kentucky bluegrass is low maintenance and provides good aesthetics for the facility. Red Maple trees will also be planted in the front of the building to provide a buffer yard between the facility and the roadway.

Task 10 Landscaping

Having plants on the side of the corridor road reduces erosion, controls flooding and absorbs water runoff. This has an initial low cost and maintenance of utilizing grass that is to be located along the corridor. The corridor road is located in zone 2 of the Georgia planting zones. The recommended type of grass for this zone is that of common bermuda grass and bahaia grass.

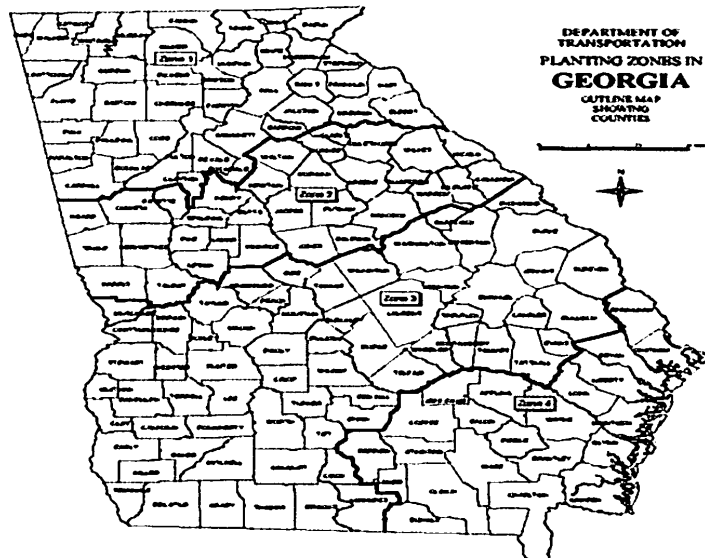


Figure 01 : The State of Georgia Planting Zones

Common Name	Botanical Name	Class/Type	Rate/Acre	Planting Zone	Planting Dates
Common Bermuda Grass (Hulled)	<i>Cynodon dactylon</i>	Required Permanent Grass	10 (11)	1	April 16 – August 31
Common Bermuda Grass (Unhulled)			10 (11)		
Common Bermuda Grass (Hulled)	<i>Cynodon dactylon</i>	Required Permanent Grass	10 (11)	2,3,4	April 1 – October 15
Common Bermuda Grass (Unhulled)			10 (11)		
Bahia Grass	<i>Paspalum notatum</i>		10 (11)		
Rye Grass, Millet, Cereal Grass (Oats)	<i>Lolium perenne</i> spsp. <i>Multiflorum</i> , <i>Echinochloa crusgalli</i> , <i>Avena sativa</i>	Temporary Grass	50 (56)	1	September 1- April 15
Rye Grass, Millet, Cereal Grass (Oats)	<i>Lolium perenne</i> spsp. <i>Multiflorum</i> , <i>Echinochloa crusgalli</i> , <i>Avena sativa</i>	Temporary Grass	50 (56)	2,3,4	October 16- March 31

Figure 02 : Non-Native Grass Seeding Table1 (Temporary and Permanent Seed Types for Shoulders, Medians and Slopes 3:1 of Flatter)

The vegetation required in North Carolina is not the same as it would be used in Georgia. North Carolina has both warm and cool season grasses. The topography and climate of North Carolina does not allow for any particular grass to do great all year round. Seeding is by far the most economical method to cover grass vegetation over a large area. This provides control over erosion and flooding.

Turfgrass	
Cool-Season	Warm-season
Tall Fescue	Centipedegrass
Hard Fescue	Bermudagrass
Kentucky Bluegrass	Zoysiagrass
	Pensacola Bahiagrass
Groundcovers	
Temporary	Permanent
German Millet	Weeping Lovegrass
Rye Grain	Sericea Lespedeza
Kobe Lespedeza	Bicolor Lespedeza
Sweet Sudan	Korean Lespedeza
	Crown Vetch

Figure 03 : North Carolina Vegetation Management

That grass that is to be planted in the Rest Area Facility is to be Kentucky Bluegrass. This type of grass is quite resilient to cold weather. The typical winter month in Kernersville, NC can drop down to 31°. This temperature drop would not have a negative effect on the Kentucky Bluegrass and would do fine in the warmer months. Red Maple trees are also common in the area and would provide a buffer between the facility and the roadway.



Figure 04: Kentucky Bluegrass



Figure 05: Red Maple Tree

Average High and Low Temperature in Kernersville, NC

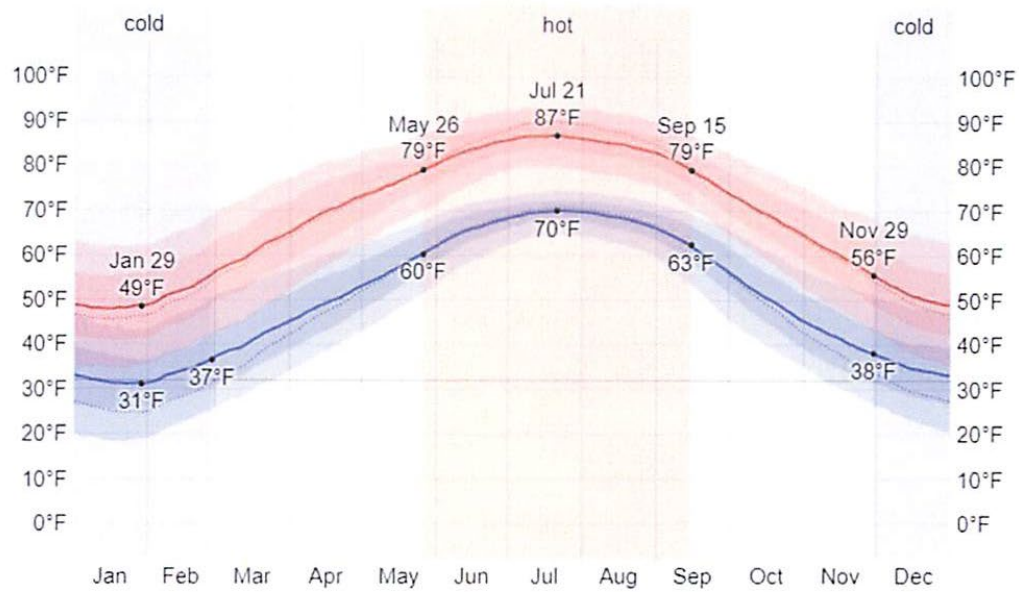


Figure 04: The daily average high (red line) and low (blue line) temperature, with 25th to 75th and 10th to 90th percentile bands. The thin dotted lines are the corresponding average perceived temperatures.

Task 11: Total Cost of Construction

The construction cost for the construction of the collector road in Georgia is dependent on the type of road that is to be built and its characteristics. The characteristics of the collector road are as described below.

Terrain type is rolling

Type of road is Large Urban collector minor

2 Lanes going opposite directions

Total length of road 3,050 ft $\Rightarrow 3,050 \text{ ft} / 5,280 \text{ (ft /mile)} = .58 \text{ miles}$

2 lane Urban collector minor cost per mile = \$3 - \$5,000,000 per mile

Cost 2 Lane collector minor road $\Rightarrow .58 \text{ miles} * \$5,000,000 \text{ per mile} = \$2,900,000$

The total cost for 2 lane collector minor roads in urban locations is an estimated value of \$2,900,000.

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Landscape Georgia

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Landscape North Carolina

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Standard Roadway signs (MUTCD)

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Total Cost

1. <https://www.artba.org/about/faq/#::~:~:text=Construct%20a%20new%204%2Dlane,per%20mile%20in%20urban%20areas>.

**TRANSPORTATION ENGINEERING DESIGN
SEMESTER TERM PROJECT ORAL PRESENTATION
FALL 2021**

**Term Project Oral Presentation Title -
COLLECTOR ROAD DESIGN**

TOPICS COVERED IN TERM PROJECT ORAL PRESENTATION

- 1. Group organizational structure**
- 2. Gantt chart**
- 3. Design Calculations**
- 4. Horizontal Alignment**
- 5. Vertical Alignment**
- 6. Earthwork and Mass Diagram**
- 7. Drainage**
- 8. Roadway Cross-Sectional Sketches**
- 9. Intersection Selection and Re-Design**
- 10. Parking Design**
- 11. Traffic Signage, Markings, etc.**
- 12. Landscaping**
- 13. Total Cost of Construction**

**ASSIGNMENT STATEMENT/QUESTIONS
&
GRADING SCHEME FOR ASSIGNMENT
Prairie View A&M University
College of Engineering
Civil & Environmental Engineering Department
CVEG 4302 – Transportation Engineering Design
Fall 2021**

DD/MMM/YYYY

FINAL PROJECT PRESENTATION

Start Time: _____

End Time: _____

Student Last Names	Technical Content	Visual Aids		Presenting		
		Use of Figures/Graphs	Legible	Organization	Delivery	Appearance

Note: Please rate from 5 (best) to 1 (worst)

Remarks (Continue on back, if needed):

Reviewer Name: _____

Date: _____

ABOVE AVERAGE

**Prairie View A&M University
College of Engineering
Civil & Environmental Engineering Department
CVEG 4302 – Transportation Engineering Design
Fall 2021**

6 December 2021

FINAL DESIGN PROJECT BRIEFING PRESENTATIONS

Start Time: 12PM

End Time: 1PM

Student Last Names	Technical Content	Visual Aids		Presenting		
		Use of Figures/Graphs	Legible	Organization	Delivery	Appearance
Tilmutt	4.5	5	5	5	4	4
Carter	3.5	5	5	5	4	4
Rafey	4.5	5	5	5	5	5
Patterson	3.5	5	5	5	3	3

Note: Please rate from 5 (best) to 1 (worst)

Remarks (Continue on back, if needed):

Tilmutt - Good leadership skills.
Carter - Didn't say much but was knowledgeable and attentive.
Rafey - Super knowledgeable and direct.
Patterson - Has to be presentable, study your scope more.

Overall good job guys! Very proud to see PV still producing productive panthers.

Reviewer's Name: Will Arnold

Date: 12/6/21

**Prairie View A&M University
College of Engineering
Civil & Environmental Engineering Department
CVEG 4302 – Transportation Engineering Design
Fall 2021**

6 December 2021

FINAL DESIGN PROJECT BRIEFING PRESENTATIONS

Start Time: 12:00 PM

End Time: 1:00 PM

Student Last Names	Technical Content	Visual Aids		Presenting			
		Use of Figures/Graphs	Legible	Organization	Delivery	Appearance	
<i>Tillmuth</i>	<i>4.5</i>	<i>5</i>	<i>5</i>	<i>5</i>	<i>4</i>	<i>4</i>	<i>27.5</i>
<i>Carter</i>	<i>3.5</i>	<i>5</i>	<i>5</i>	<i>5</i>	<i>3.5</i>	<i>4</i>	<i>26</i>
<i>Rafey</i>	<i>4.5</i>	<i>5</i>	<i>5</i>	<i>5</i>	<i>4</i>	<i>5</i>	<i>28.5</i>
<i>Patterson</i>	<i>3.5</i>	<i>5</i>	<i>5</i>	<i>5</i>	<i>3</i>	<i>3</i>	<i>24.5</i>

Note: Please rate from 5 (best) to 1 (worst)

Remarks (Continue on back, if needed):

Mr. Tillmuth needs a jacket. / speak up

Rafey looks Great / speak up

Patterson needs to work on dress / Be Confident

Carter looks good / I don't feel like she had enough scope

Reviewer's Name: *Devin D. Evans*

Date: *12.6.2021*

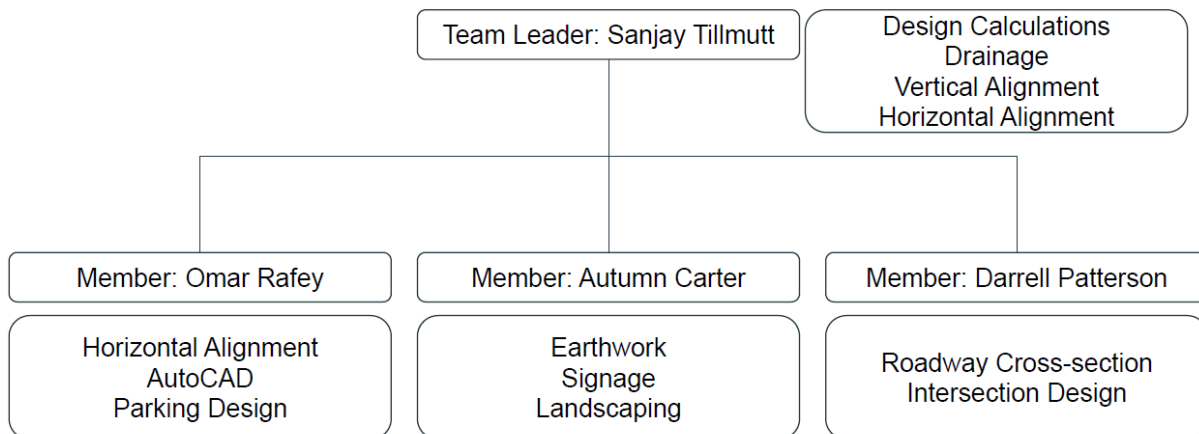
On Point Engineering

Collectors Road Design and Rest Area Facility Parking Design

Sanjay Tillmutter
Autumn Carter
Omar Rafey
Darrell Patterson

1

Organizational Structure



2

What is a Suburban Collector?

A road, street or highway that provides both land access service and traffic circulation within residential neighborhoods, commercial or industrial areas.

(Design Policy Manual for GDOT)



Principal Arterial



Minor Arterial



Collector



Local Street

**Function of
Roadway
System
for
Urban Areas**

3

Overview



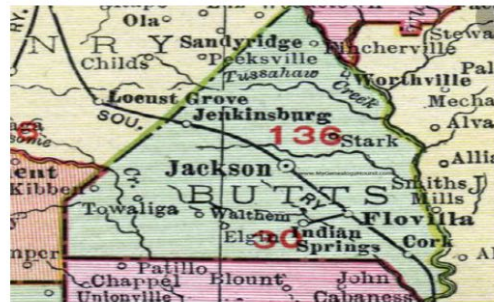
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Introduction

- Project was assigned to On Point Engineering to do geometric design of an urban collector road traversing through Burns and Spalding County, Ga.
- Road was to begin on the northern segment of Bailey Jester Rd and connect to Route 16
- A rest area was also to be designed after demolishing a 75,000 sq. ft existing structure
- An estimated cost for demolition and transport was to be determined, as well as the number of trucks (and how long) it would take to remove the material
- On point Engineering was responsible for selecting an area to dump the rubble

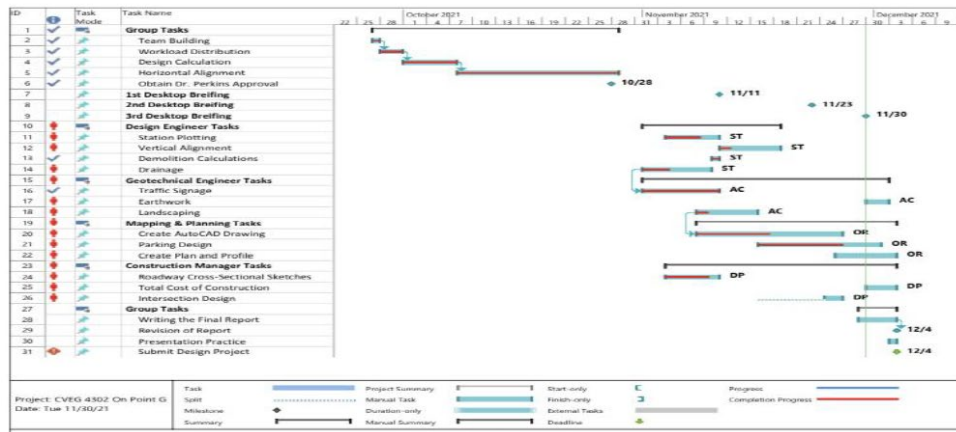
5

Collector Road County Region



6

Gantt Chart



7

Design Calculations: Given

Annual Average Daily Traffic (AADT) for current year = 2100 vehicles per day (vpd)

Present Volume Growth Rate = 2 % per year

Design Year = 20 years

Truck Factor = 8 %

Level of Service (LOS) = B

Rolling Terrain

Divided Roadway

Peak Hourly Factor (PHF) = 0.92 (Highway Capacity Manual)

Directional Distribution (D) = 0.5 (Highway Capacity Manual)

K = 0.10 (Highway Capacity Manual)

8

Design Calculations

Find: Future AADT, DDHV, Number of Lanes

Approach: $AADT_f = AADT_p (1 + i)^n$
 $= 2100 \text{ vpd} (1 + 0.02)^{20} = 3120.5 \text{ vpd}$

$DDHV = AADT_f \times D \times K$
 $= 3120.5 \text{ vpd} \times 0.50 \times 0.10 = 156.03 \text{ veh/hr/day}$

9

Design Calculations

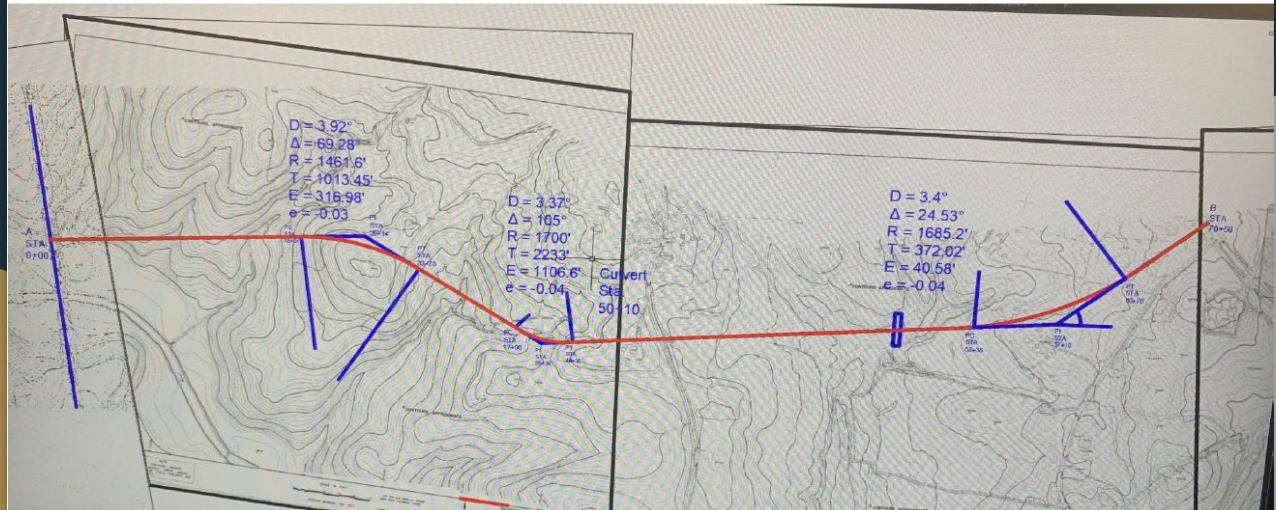
of Lanes

Given: DDHV = 156.03 veh/hr/day, $f_E = 0.9$, PHF = 0.92, rolling terrain, Truck Factor = 8%, LOS = B

Approach: # of Lanes = $(DDHV)/(SFL \times f_E \times PHF)$
 $= (156.03 \text{ veh/hr/day})/(900 \text{ veh/hr/lane} \times 0.9 \times 0.92) = 0.21 \sim 1 \text{ Lane in each Direction}$
 $= 2 \text{ Lanes}$

10

Horizontal Alignment



11

Horizontal Alignment Calculations

Curve 1

$$M = 53.42 \text{ ft}$$

$$E = 55.17 \text{ ft}$$

$$L = 790.82 \text{ ft}$$

$$T = 400 \text{ ft}$$

$$R = 1468.75 \text{ ft}$$

$$\Delta = 31^\circ$$

$$D = 3.92^\circ$$

$$e = -0.03$$

$$T = R \tan(\Delta/2) \quad 400 \text{ ft} = 1468.75 \tan(\Delta/2)$$

$$(\Delta/2) = (1/\tan)(400/1468.75)$$

$$\Delta = 31^\circ$$

$$D = (5729.6/R)$$

$$(\Delta/2) = 15.5^\circ$$

$$D = (5729.6/1468.75) = 3.92^\circ$$

12

Horizontal Alignment Calculations

Curve 2

$$M = 11.78 \text{ ft}$$

$$T = R \tan(\Delta/2)$$

$$200 \text{ ft} = 1700 \tan(\Delta/2)$$

$$E = 11.87 \text{ ft}$$

$$(\Delta/2) = (1/\tan)(200/1700)$$

$$(\Delta/2) = 6.75^\circ$$

$$L = 400 \text{ ft}$$

$$\Delta = 13.5^\circ$$

$$T = 200 \text{ ft}$$

$$D = (5729.6/R)$$

$$D = (5729.6/1700) = 3.37^\circ$$

$$R = 1700 \text{ ft}$$

$$\Delta = 13.5^\circ$$

$$D = 3.37^\circ$$

$$e = -0.04$$

13

Horizontal Alignment Calculations

Curve 3

$$M = 69.49 \text{ ft}$$

$$T = R \tan(\Delta/2)$$

$$500 \text{ ft} = 1687.5 \tan(\Delta/2)$$

$$E = 72.38 \text{ ft}$$

$$(\Delta/2) = (1/\tan)(500/1687.5)$$

$$(\Delta/2) = 16.5^\circ$$

$$L = 970.59 \text{ ft}$$

$$\Delta = 33^\circ$$

$$T = 500 \text{ ft}$$

$$D = (5729.6/R)$$

$$D = (5729.6/1687.5) = 3.4^\circ$$

$$R = 1687.5 \text{ ft}$$

$$\Delta = 33^\circ$$

$$D = 3.4^\circ$$

$$e = -0.04$$

14

Passing Sight Distance

US Customary				
Design speed (mph)	Assumed speeds (mph)		Passing sight distance (ft)	
	Passed vehicle	Passing vehicle	From Exhibit 3-6	Rounded for design
20	18	28	706	710
25	22	32	897	900
30	26	36	1088	1090
35	30	40	1279	1280
40	34	44	1470	1470
45	37	47	1625	1625
50	41	51	1832	1835
55	44	54	1984	1985
60	47	57	2133	2135
65	50	60	2281	2285
70	54	64	2479	2480
75	56	66	2578	2580
80	58	68	2677	2680

Figure 10: Passing Sight Distance

The Passing sight distance (PSD) was found to be 1835 feet. The percent of route offered past sight distance for the proposed roadway to 1% for the full length of Patterson Rd.

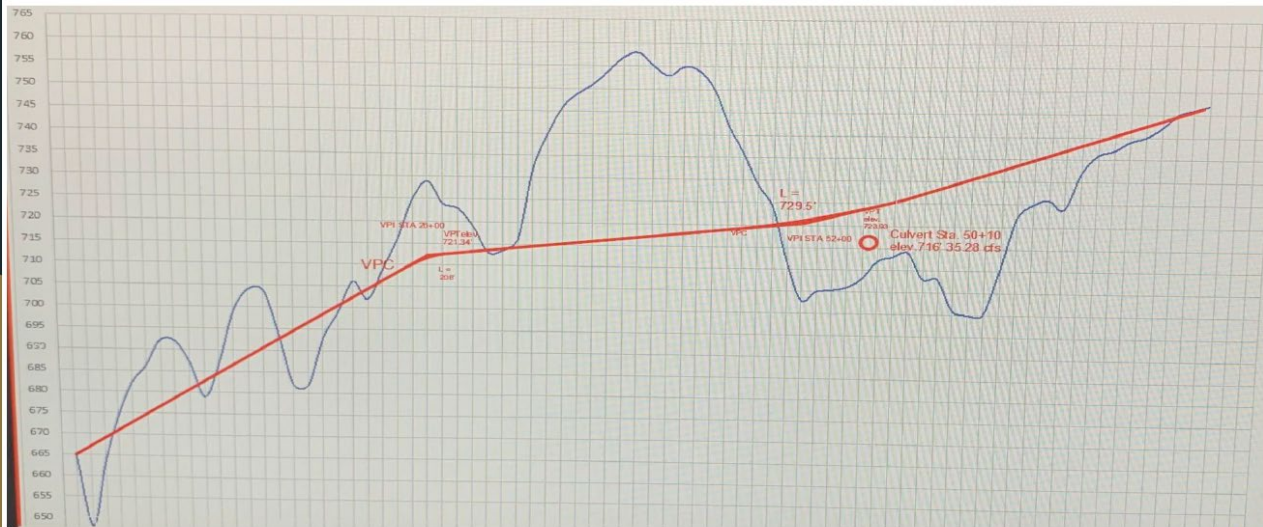
$$\% PSD = \frac{PSD (ft.)}{Length Section of Road (ft.)}$$

Figure 11: Equation for Passing Sight Distance

$$\% PSD = \frac{1835ft}{7058.58ft} = 0.26 = 1\%$$

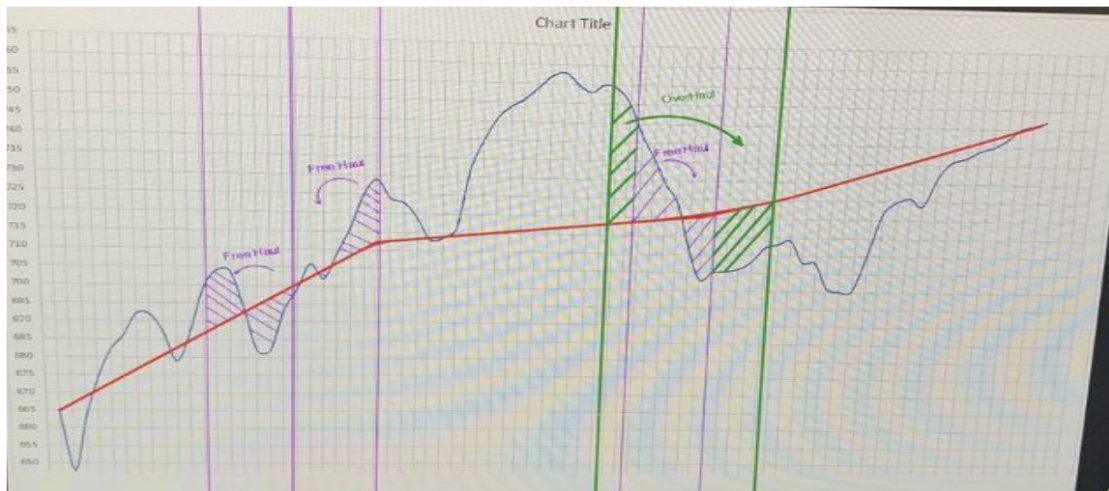
15

Vertical Alignment



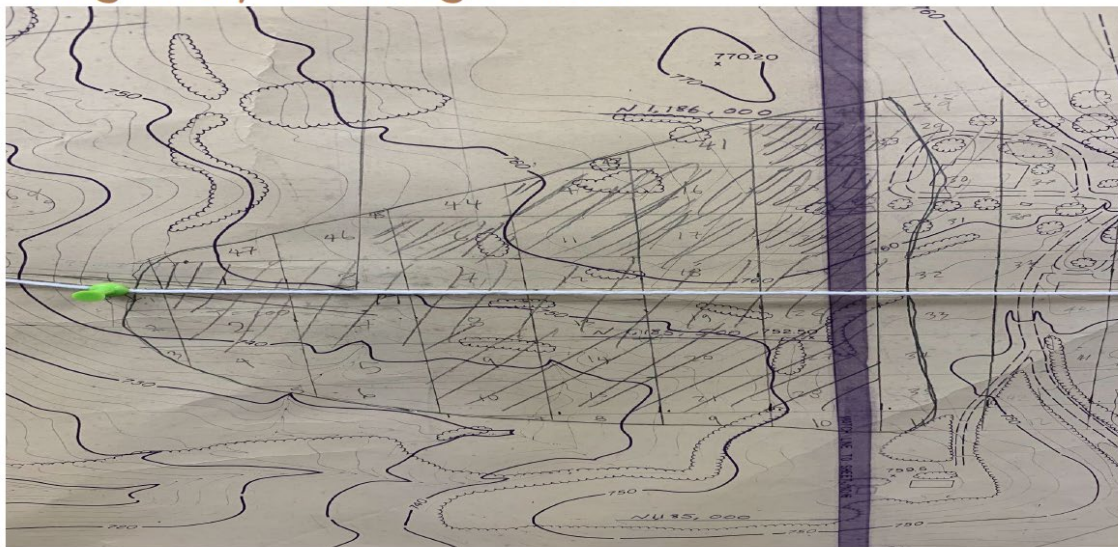
16

Earthwork



17

Highway Drainage Area



18

Count Squares Method

There were a total of 31 full squares, 2 half squares, 4 quarter squares, 9 third of a square, and 5 fifths of a square. Each square is 1in x 1in, which is equivalent to 100ft x 100ft = 10,000 ft².

So by the count squares method we ended up with:

of squares = 28 + (10/2) + 8 = 41 squares

Area = 37 squares x 10,000 ft² = 370,000 ft²

370,000 ft² x (1 acre/43,560 ft²) = 8.5 acres

19

Drainage Calculations

Given: Design year = 25 years, rolling terrain, rainfall duration = 60 mins, Land type is mixed cover and steepness over 2%, 50% concrete and bituminous pavement, 8% slight pervious soil, 42% impervious soil.

Entrance Type: Square Edge with Headwall

H_r/D: 1.5 ft

Find: Discharge in CFS using Georgia DOT Method

Discharge in CFS using Rational Method

Select one of the discharges and design a drainage structure for the drainage area selected

20

Drainage Calculations

Approach: Using Table 16.2a from Textbook, area is assumed as urban and coefficients:

Conc & Bituminous Pvmnt = 0.9

About 50% of area impervious = 0.65

Flat commercial withy about 90% of area impervious = 0.80

$$C = (0.5 \times 0.9) + (0.42 \times 0.65) + (0.08 \times 0.8) = 0.45 + 0.273 + 0.064 = 0.79$$

$$I = 2.9 \text{ in/hr} \times 0.6 \times 1.9 = 3.31 \text{ in/hr}$$

$$Q_{25} = 0.79 \times 3.31 \text{ in/hr} \times 8.5 \text{ acres} = 22.22 \text{ cfs (Rational Method)}$$

21

Drainage Calculations

Georgia DOT Method

$$Q_{25} = 0.84 \times Q_{50}$$

From the Georgia DOT Handout Q_{50} is found to be 87 cfs.

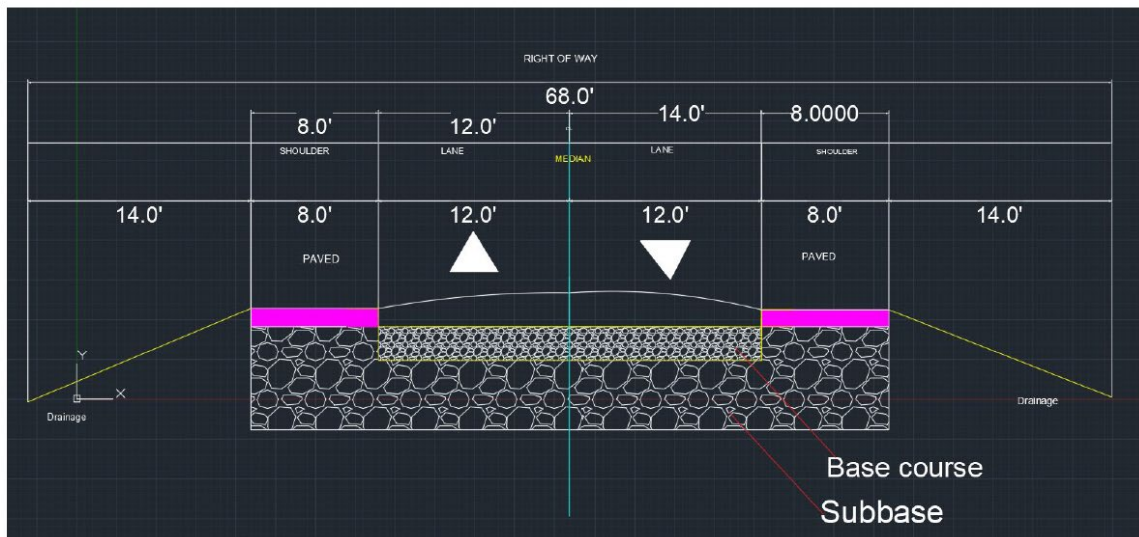
$$Q_{25} = 0.84 \times 42 \text{ cfs} = 35.28 \text{ cfs}$$

We select the greater discharge which is the 35.28 cfs found through the Georgia DOT Method.

Using Fig. 16.17 in the Textbook, the diameter of the pipe culvert is found to be 30 in

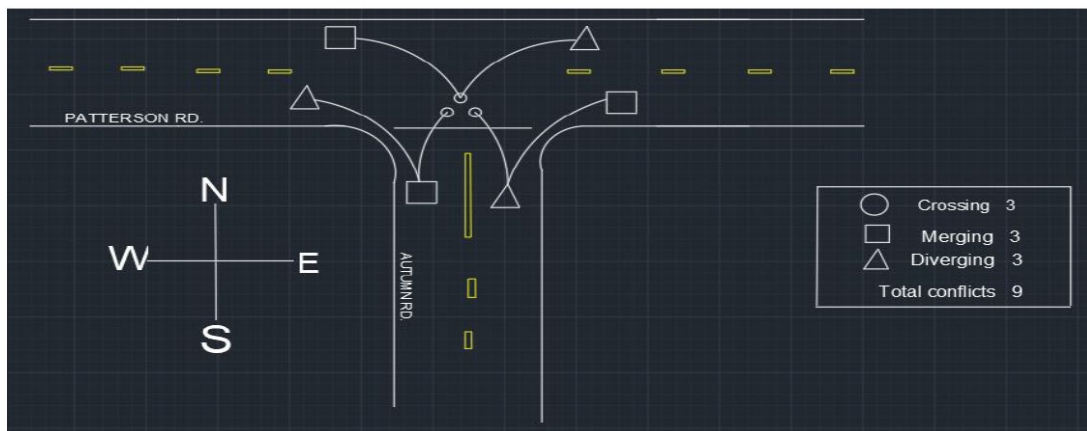
22

Typical Urban Roadway Cross-section



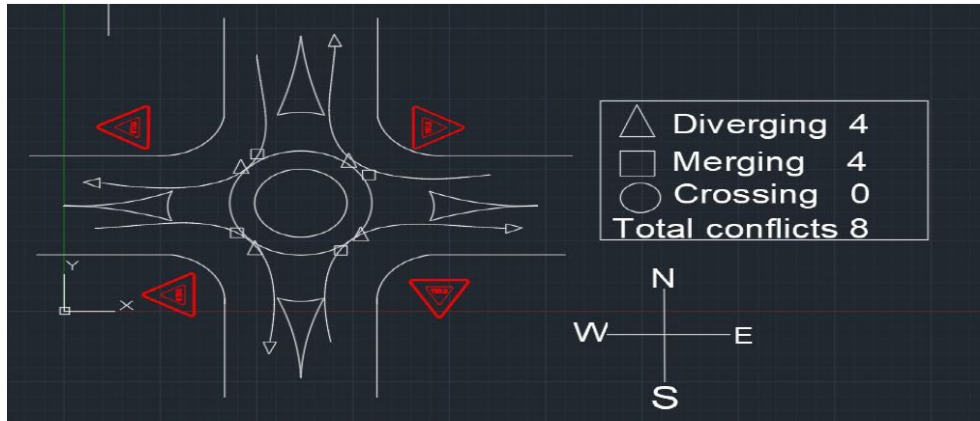
23

Points of Conflict at T-Junction



24

Intersection Redesign



25

Signage



R1-1

Stop Sign



W3-1

Stop Ahead



W1-7

Double Arrow Sign



W2-4

T-Intersection



W2-2

T-Intersection

- Stop sign placed right of lane controls and located approximately four feet in advance of line.
- MUTCD states for posted speed limit of 45 mph to use 775 ft as a guideline for placement of signs such as Stop Ahead Sign.

26

Georgia Landscaping

- Shrubs exceeding 30 in in height cannot be planted within the horizontal clearance zone in medians.
- Trees planted in medians must be limbed up to a minimum of 7 feet from the ground.
- Street trees within medians and in pedestrian traffic areas are to be limbed up a minimum of 7 feet.

Horizontal Clearances for Trees and Shrubs	
Posted / Design Speed	Minimum Horizontal Clearance ¹
≤ 35 mph (Commercial Area ²)	4-ft. 8-ft. in median
≤ 35mph	8-ft. 8-ft. in median
40 mph	10-ft. 16-ft. in median ³
45 mph	14-ft. 22-ft. in median ³
>45 mph	Outside the clear zone
Interstates	120% of the clear zone requirement

27

Plants used in Georgia

- GDOT requires the use of Georgia grown trees shrubs, and other nursery plants for right of way planting.
- 75 percent of all trees should be native, large canopy shade trees.

28

NC Rest Area Landscaping

Elevation:

Drainage Purposes: Paved surfaces should have a minimum slope of 1 percent. If elevation at the location is more than 1%, develop a catch basin for runoff and design curb inlets.

29

Plants used in North Carolina

- WELCOME CENTERS, REST AREAS, AND VISITOR INFO. CENTERS - USE OF REGIONAL INDIGENOUS SPECIES OF PLANTS TO PROMOTE SCENIC BEAUTY OF TOPOGRAPHICAL REGIONS OF NORTH CAROLINA (CREPE MYRTLES, DOGWOODS, AZALEAS, RHODODENDRON, ETC.) & TO ENHANCE & COMPLEMENT BUILDING STRUCTURES.



Azaleas



Crepe Myrtle



Rhododendron

30

Parking Design

North Carolina DOT requests 2D conceptual layout of a 40.6 acre site Near Highway 66 and Old Salem Road.

- Overall Rest Area facility
- Detailed Parking Design



31

Demolition of Existing Structure

Existing 75,000 ft² two-story Catholic School

\$4.25 per ft² of haul for a total of 50,400 cubic yards

120 dump trucks each with a 16 cubic yard capacity

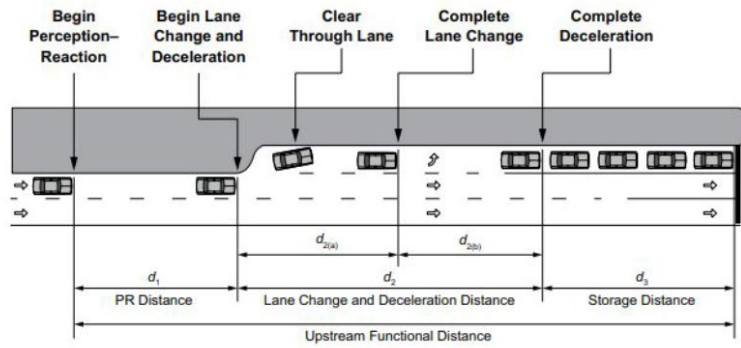
3150 truck loads at 26 trips for each truck

Each truck making 5 trips per day will take about 5 days

Transportation cost \$93,730

Total Demolition cost \$225,000

32



Where:

- d_1 = distance traveled while driver recognizes upcoming turn lane and prepares for the left-turn maneuver
- $d_{2(a)}$ = distance traveled while decelerating and changing lanes from the through-lane into the turn lane
- $d_{2(b)}$ = distance traveled during deceleration after lane change
- d_3 = distance provided for the storage of the queue of stopped vehicles waiting to turn

Figure 9-32. Functional Area Upstream of an Intersection Illustrating Components of Deceleration Lane Length

33

Turn Lane Specifications

U.S. Customary	
Speed (mph)	Lane Change and Deceleration Distance (ft)
20	70
25	105
30	150
35	205
40	265
45	340
50	415
55	505
60	600
65	700
70	815

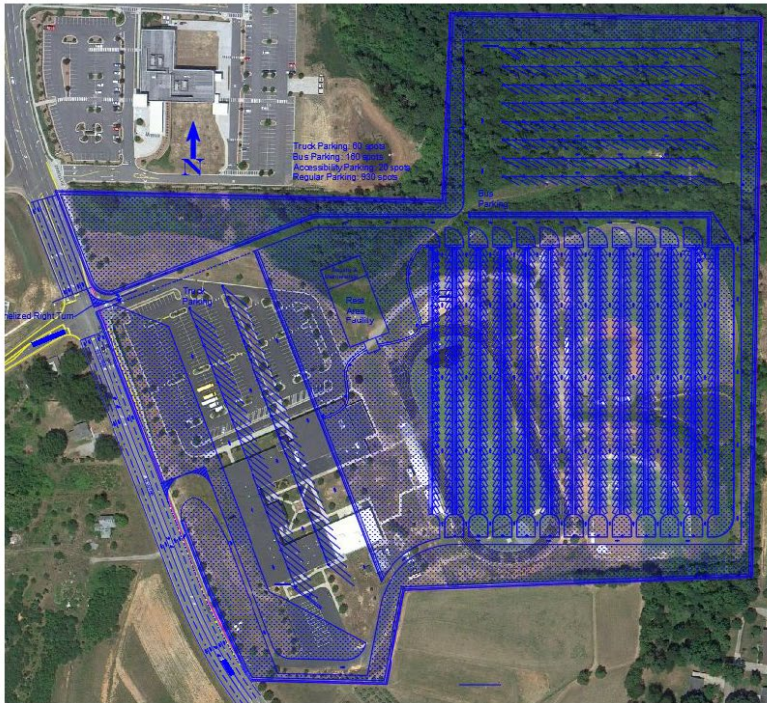
Percent Trucks	U.S. Customary
	Assumed Storage Length (ft) per Vehicle in Queue
≤ 2	25
5	28
10	32
15	35
20	38
25	41

A Policy on Geometric Design of Highways and Streets, 7th Edition, 2018

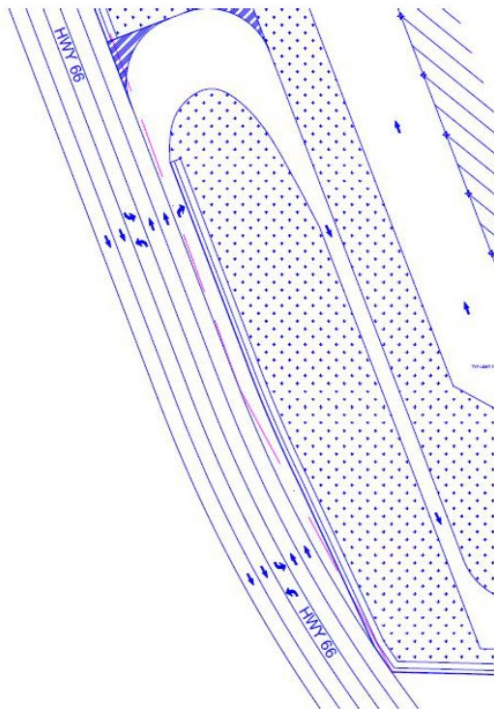
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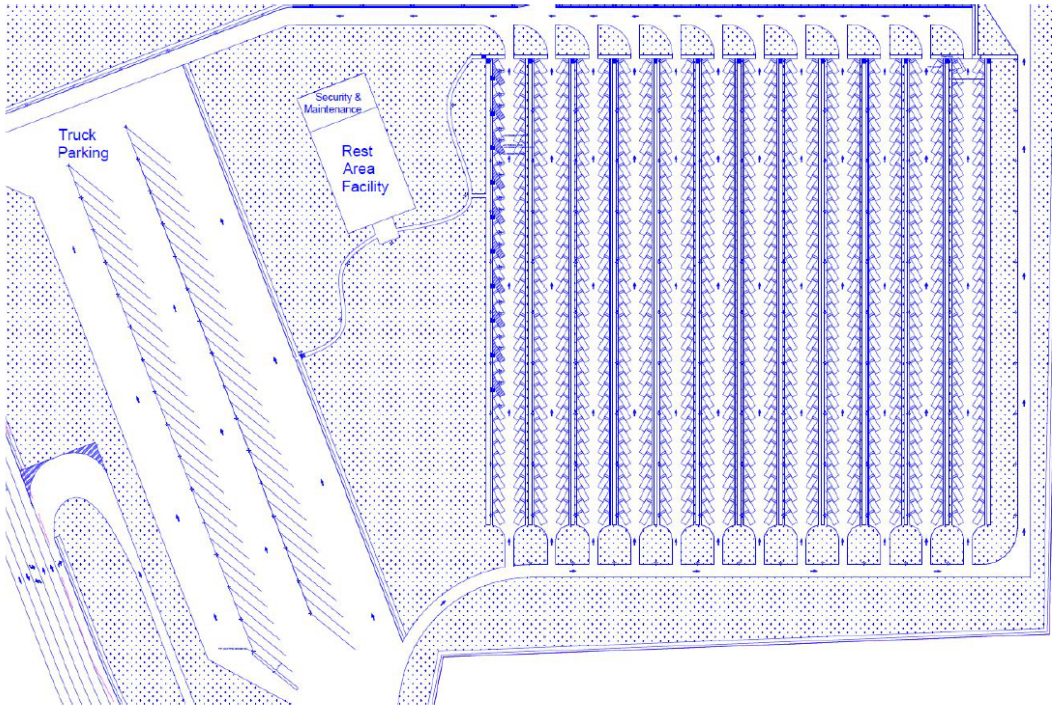
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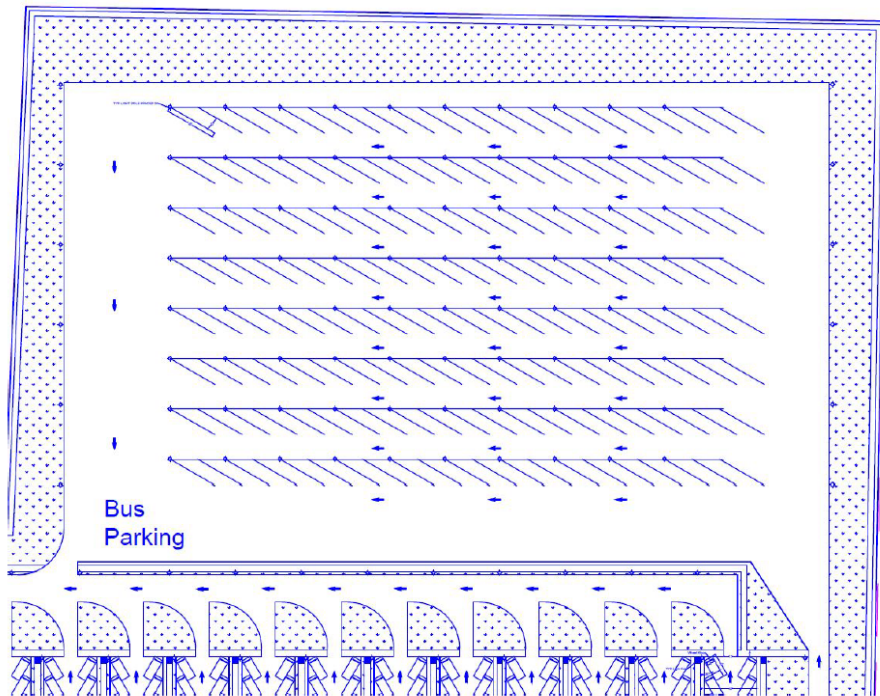
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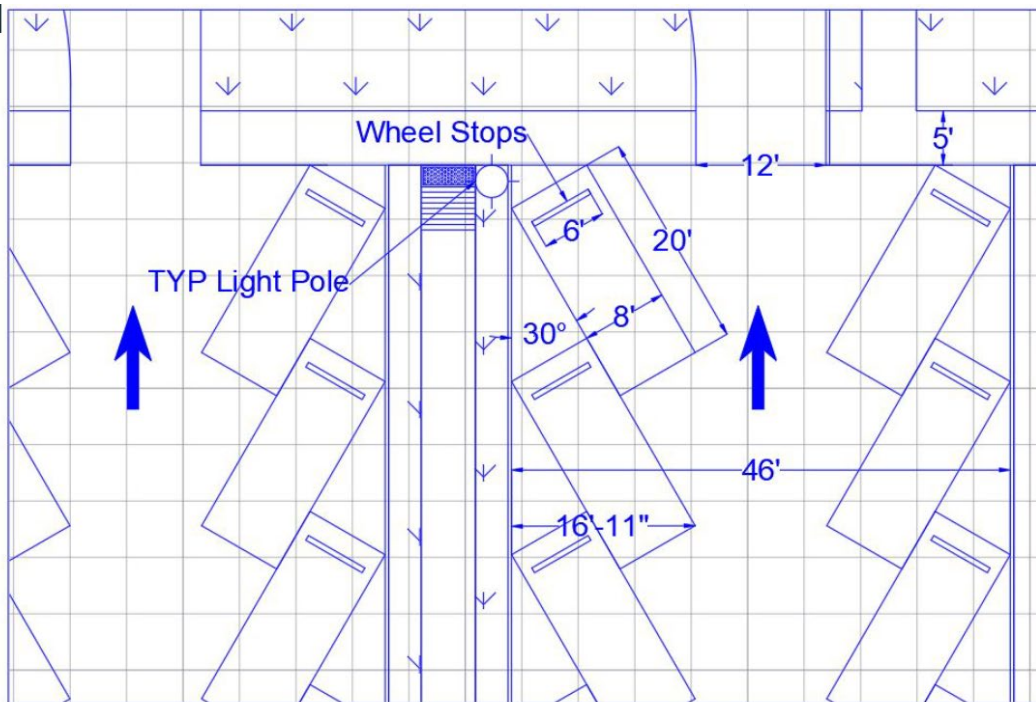
36



37



38



39

TYPICAL PARKING BOOTH DIMENSIONS



TYPICAL ACCESSIBILITY MARKING DETAIL

40

References

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2. <http://www.dot.ga.gov/PartnerSmart/DesignManuals/smguide/GDOT%20SIGNING%20AND%20MARKING%20DESIGN%20GUIDELINES.pdf>
3. [Landscapes \(ga.gov\)](#)
4. <http://mydocs.dot.ga.gov/info/gdotpubs/Publications/6755-9.pdf>
5. <https://connect.ncdot.gov/resources/roadside/AestheticEngineeringDocuments/PlantingGuidelines.pdf>
6. <https://connect.ncdot.gov/resources/Environmental/PDEA%20Procedures%20Manual%20Documents/NCDOT%20Highway%20Landscape%20Planting%20Policy.pdf>
7. <https://mutcd.fhwa.dot.gov/htm/2009/part2/part2b.htm>

41

References

1. <https://mutcd.fhwa.dot.gov/htm/2009/part2/part2b.htm>
2. <https://extension.uga.edu/publications/detail.html?number=B987&%20Shrubs%20and%20Woody%20Vines#title5>
3. <https://ncdot.maps.arcgis.com/apps/webappviewer/index.html?id=964881960f0549de8c3583bf46ef5ed4>
4. <https://connect.ncdot.gov/projects/Roadway/Roadway%20Design%20Manual/09.%20At%20Grade%20Intersections.pdf>
5. <https://m2enterprises.com/advice/four-types-drainage-solutions>

42

Q&A

AVERAGE

**NO AVERAGE STUDENT WORK SAMPLE FOR
TERM PROJECT ORAL PRESENTATION**

BELOW AVERAGE

**Prairie View A&M University
College of Engineering
Civil & Environmental Engineering Department
CVEG 4302 – Transportation Engineering Design
Fall 2021**

8 December 2021

FINAL DESIGN PROJECT BRIEFING PRESENTATIONS

Start Time: _ 12:00 _____

End Time: _ 1:00 _____

Student Last Names	Technical Content	Visual Aids		Presenting		
		Use of Figures/Graphs	Legible	Organization	Delivery	Appearance
GOMEZ	3.5	4	3.5	4	4	3.5
HINES	3.5	4	3.5	4	4	3.5
KENNEDY	3.5	4	4	4	4	3.5
YAMBA	3.5	4	3.5	4	4	3.5
WARRIOR	3.5	4	4	4	4	3.5

Note: Please rate from 5 (best) to 1 (worst)

Remarks (Continue on back, if needed):

Reviewer's Name: JOHNNY GANT

Date: 12-11-21

Prairie View A&M University
College of Engineering
Civil & Environmental Engineering Department
CVEG 4302 – Transportation Engineering Design
Fall 2021

8 December 2021

FINAL DESIGN PROJECT BRIEFING PRESENTATIONS

Start Time: 12:00 pm

End Time: 12:30 pm

Student Last Names	Technical Content	Visual Aids		Presenting		
		Use of Figures/Graphs	Legible	Organization	Delivery	Appearance
Hines	2	2	2	4	2	3
Kennedy	2	2	2	4	2	3
Yamba	2	2	2	4	2	3
Warrier	2	2	2	4	2	3
Gomez	2	2	2	4	2	3

Note: Please rate from 5 (best) to 1 (worst)

Remarks (Continue on back, if needed):

Technical Content:

I gave this score a two due everyone important data missed.

- Slide 10: Based on the lengths of curves determined, all of the PT values were incorrect. Also, there was a portion of the PT value in Curve 2 that did not display.
- Slide 23: It would be helpful to show what kind of soil that will be hauled. This could also be displayed on slide 32.
- Slide 24: Did not have contain any numbers representing the graph displayed. There was not any cut, fill, nor waste volumes, elevations nor distances, and hauling information was not shown on the graph.
- Slide 32: My first recommendation would be to show 2% cross slope going in both directions from the crown in the road. Also, it is displayed that there is a grass median, but based on lane widths, there is no room for it according to the drawing. In addition, it is also shown that the grass median is on top of the base course. If the median is established by seeding processes, the grass would not grow. On the other hand, the grass would grow on the sub base depending on what type of soil is present. If the median is actually being constructed, maybe two types of soil would work. One that has a high PI to use for the median and plating for the drainage slopes, and a high strength soil for the roadway.
- Slide 33: The cross slope of the right lane is not shown. This slide also contains the same concerns as Slide 32, but if the section was supposed to have super elevation, then the cross slopes of both sections would have been the same sloping in the same direction.

- Second to last slide: If this slide was supposed to represent the total project cost, then there is information may have been missing. I did not see the breakdown of the cost of earthwork, drainage, or the parking and rest area facilities.

Visual Aids:

- Slide 2: The map containing the satellite view on slide 2 was difficult to read. In addition, I didn't know what the red arrows were supposed to represent. I would assume the beginning and end of the project, but it was not labeled.
- Slide 10: The horizontal curve values displayed on the plan view were not legible without straining. Also, I could not see any of the stations and elevations in the profile view. Maybe if the plan and profile were on two different slides, it may have been easier to read.
- Slide 17: The graphic displaying stopping site distance is not legible without straining. It would have also been helpful to explain the graphic.
- Slide 20: Variables shown in formulas were not defined as they were in slide 19.
- Slide 30: The values where the arrows are pointing were difficult to read. It would have been easier if the result was displayed larger next to the flat end of the red arrow.
- Slide 31: Where the arrow is shown, it could have been displayed the size of pipe needed, and also what kind of pipe. (Reinforced Concrete, Corrugated metal etc.)
- Slides 34 and 35: Reference points showing sign spacing and distances were not shown. The legend in slide 34 is also not legible without straining.

Presenting:

The delivery had some highs and lows. There were a few presenters who explained some of topics better, but there were a few that just read from the slides. I also believe some of the slides were rushed and could have been explained more in depth, especially the slides that did had missing information and ones that were not legible. For a formal presentation, the attire of all did not represent anyone who is trying to convince a client to be interested in their project. I also believed the presentation should have been practiced more than it has. Technical data should have been reviewed by the project manager to limit errors, and if practiced as a whole, it would have been noticed that certain slides were not legible. However, the organization of the presentation transition did not appear that one topic was out of place and should have been discussed in a different order. Based on the presentation, there is room for improvement, and I know they will be able to do just that.

Reviewer's Name: Steven Lewis

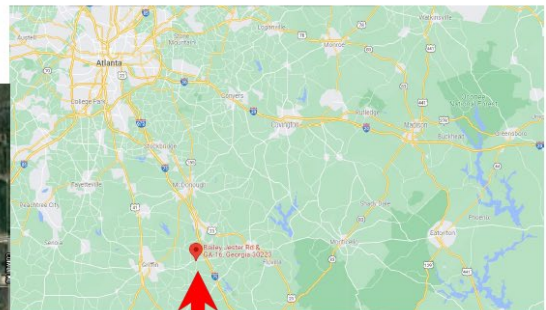
Date: 12/08/2021

Andromeda Construction

Prepared by: Paige Hines, Nyja Kennedy, Mouni Yamba, Jonathan Warrior and Armando Gomez

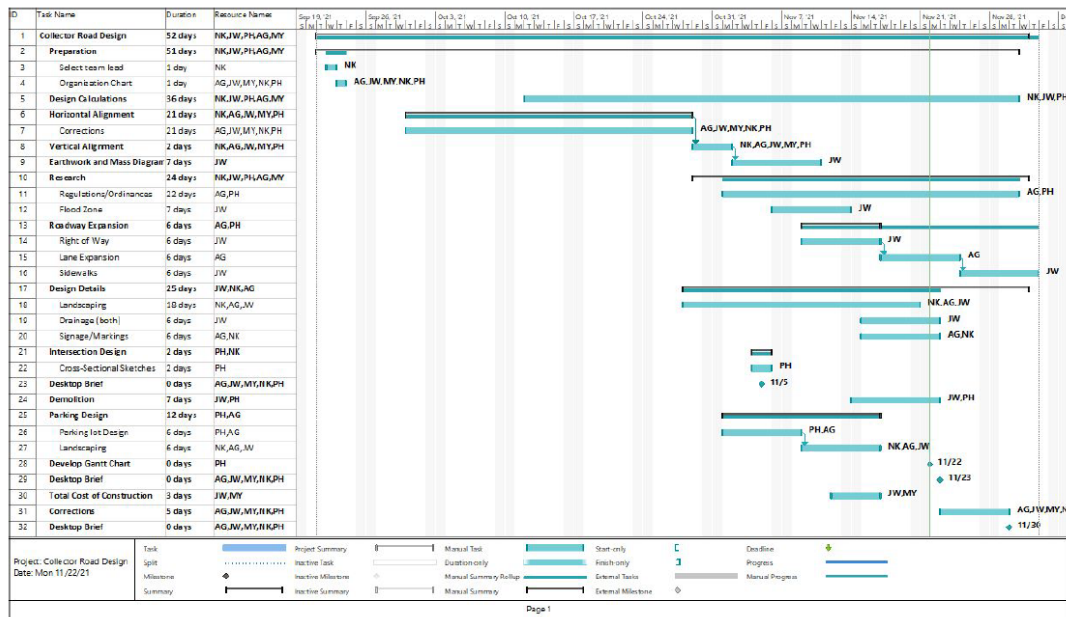
1

Project Summary



Bailey Jester Rd.
Griffin, Georgia 30224

Gantt Chart



3

Scope Of Work

Completed	Completed
Task 1: Design Calculations	Task 7: Intersection Design
Task 2 : Horizontal Alignment	Task 8: Demolition
Task 3: Vertical Alignment	Task 8: Parking Design
Task 4: Earth work and Mass	Task 9: Traffic Signage, Marking
Task 5: Drainage	Task 10: Landscaping
Task 6: Roadway Cross Section	Task 11: Total Cost of Construction

4

Given Data

Design and Layout	Data
Future Annual Average Daily Traffic (AADT)	3120 vpd
Present Volume Growth rate	2%
Design year	2041
Truck Factor	8%
Maximum grade	4.5%
Design Speed	50 mph
(Posted Speed)	45 mph
Desired average running speed	45 mph
Peak Hour Factor (PHF)	0.9
Terrain	Rolling

5

Given Data

Design and Layout	Data
Lane Width	12 feet
K (Percentage of AADT)	0.15
D (Direction of Distribution in peak direction flow)	0.65

6

Design Calculations

Future AADT= **Current AADT**(1+G)ⁿ = 2100vpd(1+0.02)^{20yrs} = 3120 vpd

AADT= Annual Average Daily Traffic

DDHV= **AADT** ***K*****D** = 3120 (0.15)(0.65) = 304 vph

K (Percentage of AADT) = 0.15 (Taken from an existing parallel facility)

D (Direction off distribution in peak direction of flow) = 0.65 (Derived from the road capacity and Level of Service denoted as B)

Recommended Maximum Grade = **4.5%** (Given in Handout)

Number of Lanes = **DDHV**/(**SFL*****fe*****PHF**) = 304/(900*0.9*0.9) = 0.417

=1 lane per direction (2 lanes in total)

DDHV= Direction of Travel in the design Hour volume

SFL= Service flow rate per lane

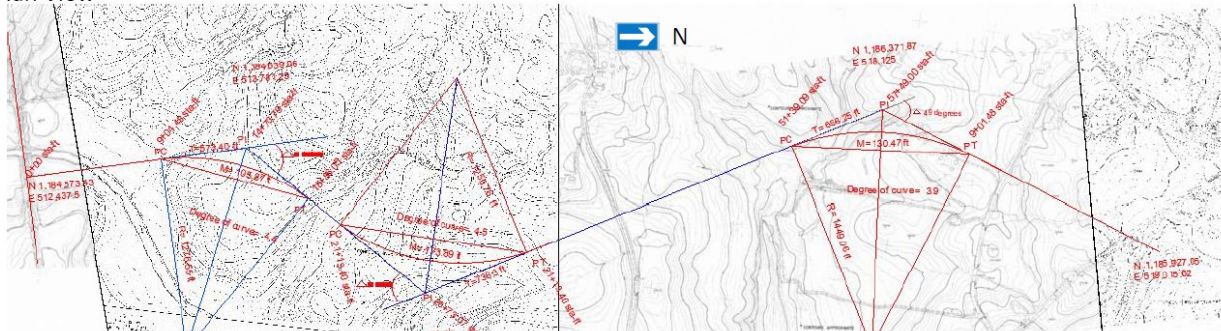
Fe= adjustment fact (Environmental Factor Chart)



7

Plan and Profile View

Plan View



Profile View



10

Horizontal Alignment Calculations

H.A	Curve 1	Curve 2	Curve 3
R (Radius of Circular Curve)	1276.58 ft	1256.76	1449.06 ft
Intersection angle, I	47°	61°	48.8°
Degree of curvature	4.4°	4.5°	3.9°
External Distance	129.01 ft	201.82 ft	142.11 ft
Tangent Length	573.40 ft	763.3 ft	656.25 ft
Middle Ordinate	105.87 ft	173.89 ft	130.47 ft
External Distance	129.01 ft	201.82 ft	142.11 ft
Superelevation, e	-0.01	-0.01	-0.03

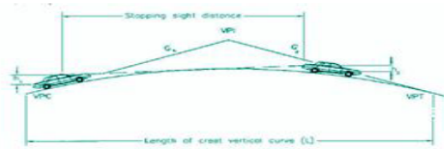
Design Calculations

Stopping Sight Distance (SSD) for Horizontal Alignment

- Sufficient distance to allow a vehicle traveling at or near design speed to stop before reaching stationary object in path.

Percent of route offering past sight distance

- GDOTs Design Policy Manual adopts criteria as standard for Stopping Sight Distance for roadways from :
AASHTO Green Book, "A policy on geometric Design Of Highways and Streets"
AASHTO "A policy on Design Standards-Interstate System"



Design Calculations

- Stopping Sight Distance (SSD) for horizontal Alignment

Data for Curve in SSD Calculation Example

- Where,

* SSD for each curve then is:

Curve 1 = 424.05 ft

Curve 2 = 422.80 ft

Curve 3 = 422.86 ft

$$SSD = 1.47 * 50 \text{ mph} * t + \frac{(50)^2}{30(\frac{12 \text{ ft}}{32.2} - 0.0314)}$$

18

Design Calculation

- Stopping Sight Distance (SSD) for Horizontal Alignment

- Where,

Design Speed, u = 50 mph

Break Reaction Time, t = 2.5 sec

Deceleration Rate, a = 11.2 ft/s²

Grade, G (Calculated)

Grade 1 = 0.031%

Grade 2 = -0.02 %

Grade 3 = 0.02 %

Grade 4 = 0.03 %

Cogo Output

Grade 1 = 3.07%

Grade 2 = -2.23%

Grade 3 = 2.06%

Grade 4 = 1.00%

$$SSD = 1.47 * u * t + \frac{u^2}{30(\frac{a}{32.2} \pm G)}$$

$$\text{grade 1} = \frac{698 - 654}{1400} = 0.0314$$

$$\text{grade 2} = \frac{698 - 668}{2700 - 1400} = \frac{30}{1300} = -0.023$$

$$\text{grade 3} = \frac{64}{5800 - 2700} = 0.0206$$

$$\text{grade 4} = \frac{32}{6700 - 5800} = 0.0355$$

19

Minimum Length of Curve Calculation

Curve 1 (crest curve)

Case 1

$$L_{min} = 2S - \frac{2158}{A} \text{ (for } S > L \text{)}$$

$$L_{min} = 2 * 424.05 \text{ ft} - \frac{2158}{5.61}$$

$$l_{min} = 463.43 \text{ ft} \text{ (} 424.05 \text{ ft} < 463.43 \text{ ft) (This is not appropriate since } S > L \text{)}$$

Case 2

$$L_{min} = \frac{AS^2}{2158} \text{ (for } S < L \text{)}$$

$$L_{min} = \frac{5.61(424.05^2)}{2158}$$

$$L_{min} = 467.46 \text{ ft} \text{ (This is appropriate since } 424.05 \text{ ft} < 463.46 \text{ ft)}$$

$$\text{Therefore, } S < L \text{ } l_{min} = 467.46 \text{ ft}$$

20

Minimum Length for Curve 1, 2, 3

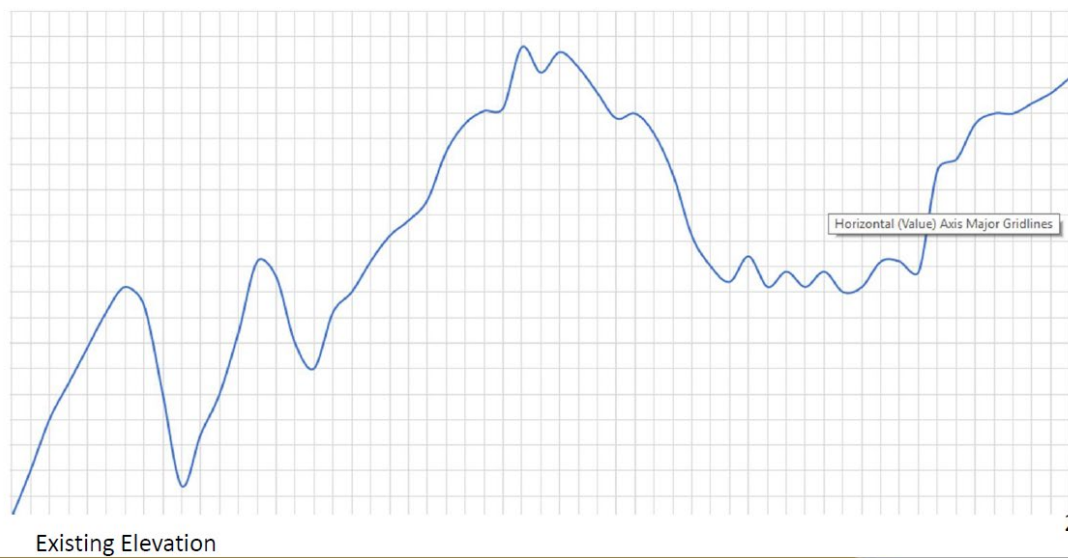
Curve 1	467 ft
Curve 2	553.48 ft
Curve 3	123.46 ft

Given Data - Earthwork

Earthwork calculations	Data
Free Haul Distance	600 ft
Limit of Economic Haul	1200 ft
Shrink Factor	6%

23

Earthwork and Mass Diagram



24

AUTOCAD (Existing elevations)

stations	ground elevations		
0+00	654	19+00	680
1+00	647	20+00	662
2+00	646	21+00	672
3+00	643	22+00	680
4+00	641	23+00	692
5+00	640	24+00	706
6+00	643	25+00	703
7+00	646	26+00	690
8+00	647	27+00	685
9+00	648	28+00	696
10+00	649	29+00	700
11+00	656	30+00	706
12+00	665	31+00	711
13+00	675	32+00	714
14+00	682	33+00	718
15+00	689	34+00	727.5
16+00	696	35+00	733
17+00	701	36+00	735.5
18+00	697.5	37+00	736
		38+00	748
		39+00	743
		40+00	747
		41+00	744

25

AUTOCAD(Existing elevations)

42+00	739	57+00	706
43+00	734	57+84.38	706
44+00	735	58+00	704
45+00	731	59+00	724
46+00	723	60+00	726
47+00	711	61+00	733
48+00	705	62+00	735
49+00	702	63+00	735
50+00	707	64+00	737
51+00	701	65+00	739
52+00	704	66+00	742
53+00	701		
54+00	704		
55+00	700		
56+00	701		

26

Finding the Runoff Coefficient

Runoff Coefficient Derivation

Percentage of Area

- | | |
|---|-----|
| • Concrete and Bituminous Pavement: 0.8 - 0.9 | 50% |
| • Impervious Soil: 0.7 - 0.8 | 42% |
| • Slight Impervious Soil: 0.3 - 0.4 | 8% |

Using Equation (16.1) from the textbook, the Runoff Coefficient is derived below;

$$[(0.85 \times 0.5) + (0.75 \times 0.42) + (0.35 \times 0.08)] / (0.50 + 0.42 + 0.08) = 0.77$$

$$C_w = \frac{\sum_{i=1}^n C_i A_i}{\sum_{i=1}^n A_i}$$

27

Obtaining the Rainfall Intensity

- Using Figure 11-2, the rainfall intensity, I , for 2 year, 30 minute duration is given as 2.9 in/hr

- In order to properly obtain the design year and rainfall duration needed, we must convert using the FHWA Chart

Where,

0.6 is the duration factor

1.9 is the recurrence factor

$2.9 \text{ in/hr} (0.6) (1.9) = 3.31 \text{ in/hr}$

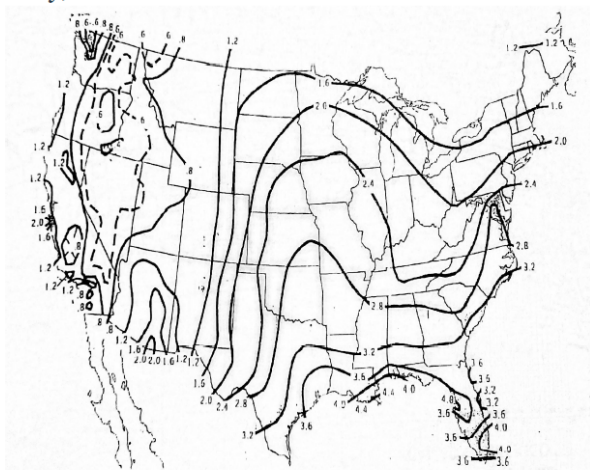


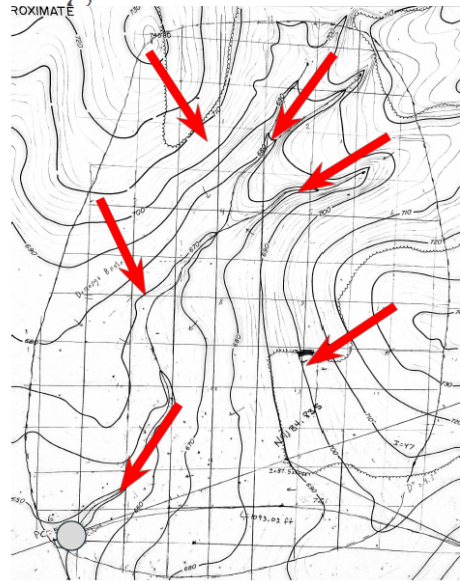
FIGURE 11-2 Map of the contiguous United States showing 2-year, 30-min rainfall intensity. (Courtesy Federal Highway Administration.)

28

Obtaining the Drainage Area

- The drainage area was derived using the counting squares method where each square was represented by 100ft x 100ft
- The area consists of 108 squares or 1,080,000 sq ft and 1 acre = 43,560 sq ft
- To convert to acres, we use the equation below:

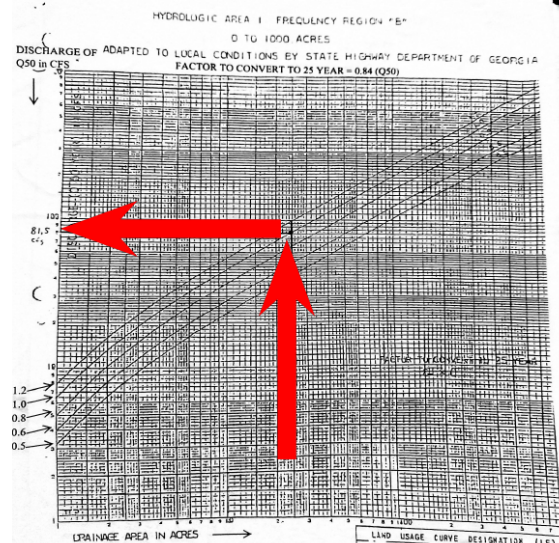
$$1,080,000 \text{ sq ft} / 43,560 \text{ sq ft} = 24.7 \text{ acres}$$



29

Applying the GDOT Method

- Given Information:
 Land Type: Mixed Cover = 1.0
 Entrance Type: Square Edge with Headwall
 Headwater Depth Diameter = 1.5 ft
 Drainage Area = 24.7 acres
- Using the figure provided, the discharge for the design year of 25 years was derived by the equation [$Q(25 \text{ years}) = 0.84(81.5 \text{ cfs})$]
- The discharge is equal to 68.45 cfs



30

Applying the Rational Method

Rational Method Equation

$$Q = CIA$$

Where,

C, Runoff Coefficient (unitless) = 0.77

I, Rainfall Intensity = 3.31 in/hr

A, Drainage Area = 24.7 acres

$$Q = (0.77)(3.31)(24.7) = 62.95 \text{ cfs for 25 years}$$

- Using Figure 16.17 from the Textbook, our diameter for the culvert selected will be taken from the higher discharge given by the GDOT Method (68.45 cfs)
- Thus, the diameter of the culvert must be 39 inches, approximately 3.25 feet

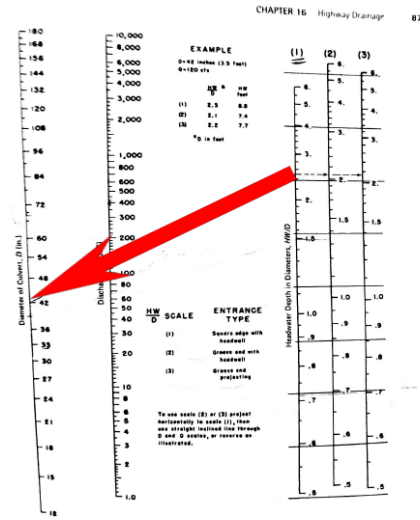
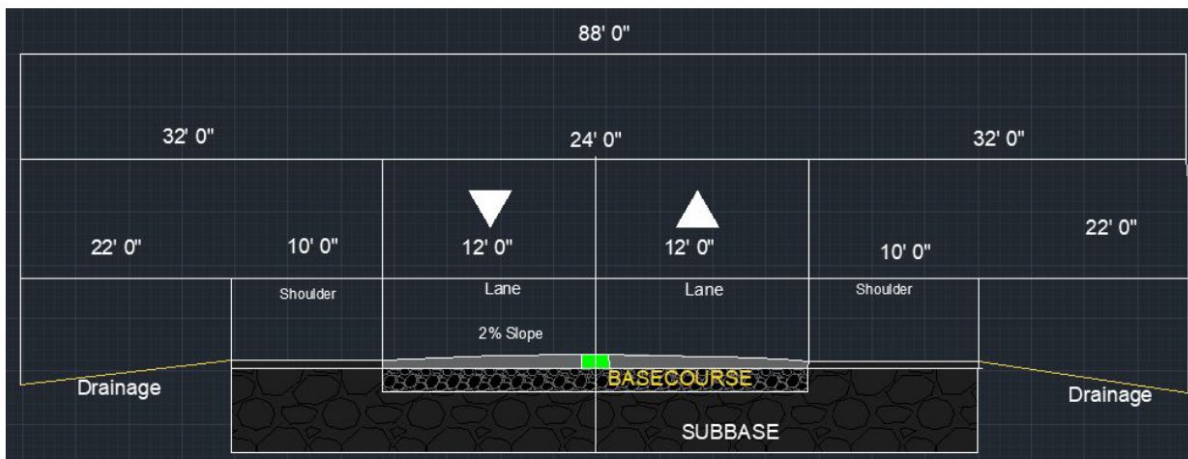


Figure 16.17 Headwater Depth for Concrete Pipe Culverts with Inlet Control

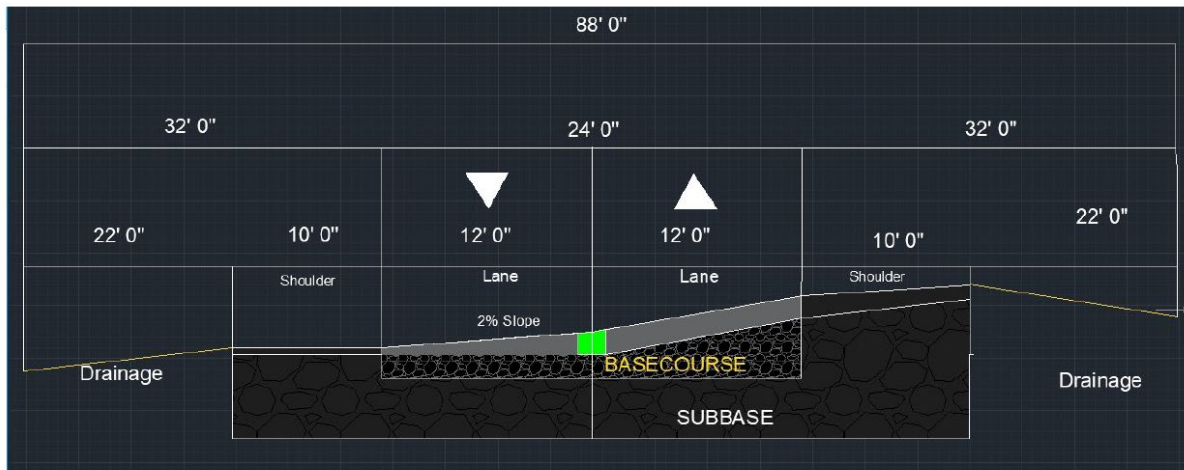
31

Typical Cross Section



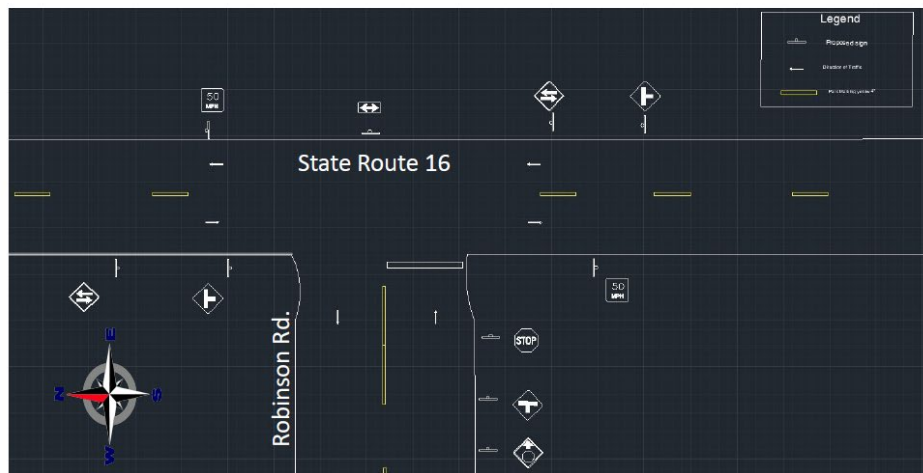
32

Typical Super-Elevated Cross Section



33

Intersection Design



T intersection at the location of State Route 16.
1 lane per direction
The pavement markings indicate the direction of traffic and follow Federal Highway Administration regulations.

Taken from MUTCD (Manual on Uniform Traffic Controls) browser

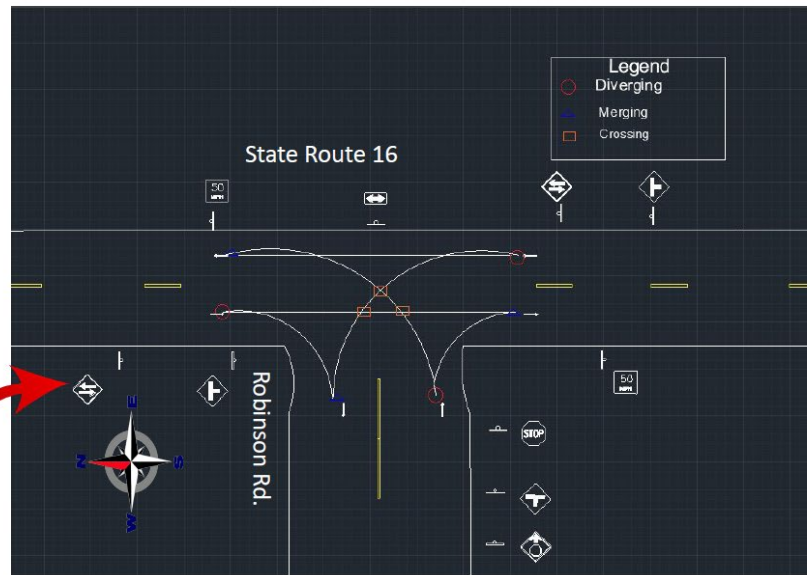
34

Intersection Conflict Points

There are 9 total conflict points in a T-intersection:

- 3 crossing conflicts
- 3 diverging conflicts
- 3 merging conflicts

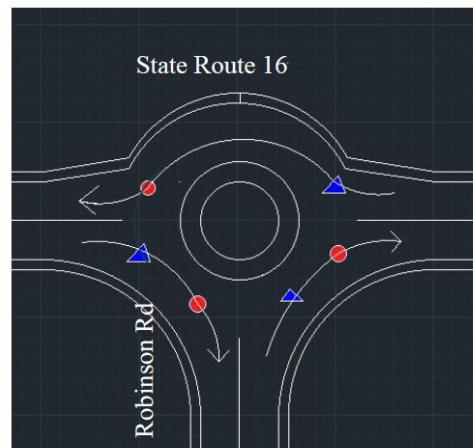
Signage for State Route 16 and Robinson Rd. T-intersection.



35

Reducing 3 Way Intersection Conflicts

- In order to reduce the amount of Conflict Points in a Typical 3 way Intersection, we decided to propose a Roundabout.
- This will effectively reduce the amount of Total Conflict Points from 9 to 4



37

North Carolina Rest Area Facility



- Demolition of existing 75,000 ft² facility for construction of a new Rest Stop Facility.
- Provide a cost analysis of the demolition and duration for removal
- Design of a Rest Area Facility that is to be located on a 40.6 Acre lot in North Carolina
- Widening of existing road way to provide left turn lane into New Rest Area Facility.

38

Demolition Process

- Obtaining necessary permits
- Equipment needed for demolition
- Demolition of structure
- Hauling debris to permitted landfill



39

Demolition Process: Company Used

- Silas Ridge Construction, Winston-Salem, N.C.
 - 2420 Darwick Rd, Winston-Salem, NC 27127
- Old Salisbury Road Construction and Demolition Landfill
 - 3336 Old Salisbury Rd., Winston-Salem, NC 27127
- Permits
 - \$300 - \$1000
- Demolition
 - \$10 per sq. ft.
 - 75000 sq. ft. * \$10 = \$750,000

40

Demolition Process: Number of Trucks

- Building Volume
 - 75000 sq. ft. x 20 ft = 1,500,000 cu. ft
 - $1,500,000 \text{ cu. ft} / 27 (\text{cu. yd} / \text{cu. ft}) = 55555.56 \text{ cu. Yd}$
- Number of trucks in one day
 - $55555.56 \text{ cu. Yd} / 19 \text{ cu. Yd per truck} = 2923.98 \text{ truck}$
- Trucks per load
 - $2924 \text{ trucks} / 6 \text{ loads per day} = 487.33 \text{ trucks}$
- Trucks per day
 - $487.33 \text{ trucks} / 21 \text{ days} = 23 - 24 \text{ trucks per day}$



41

Demolition Process: Total Cost of Demolition

- Permits
 - \$300 - \$1000
- Building Volume
 - 75000 sq. ft. x 20 ft = 1,500,000 cu. ft
- Weight of building
 - 1,500,000 cu. ft x 150 (lb/cu. ft) = 225,000,000 lbs
 - 225,000,000 lbs / 2000 lbs = 112500 tons
- Cost to move waste
 - 112500 tons x \$3 per ton = \$337500
- Total cost of Demolition
 - 75000 sq. ft. x \$10 = \$750000
 - \$750000 + \$337500 + \$1000 = \$1,088,500

42

Demolition Process: Equipment



➤ ZAXIS 1000K



➤ Tri Axle
Dump Truck



➤ Hydraulic
Excavator

43

Rest Area Facility - North Carolina



44

Rest Area Facility - Entrances and Exits

- Highway 66 S and Old Salem Road NW entrance
- 4-way intersection controlled by stop signs. Mounted 7ft to bottom.
- South bound on Highway 66 S. 3 lanes with a left turn lane entering Rest Area Facility(RAF) and 2 lanes going N.
- 3 lanes exiting RAF with designated left turn lane and two lanes for entrance
- The posted speed limit is 45mph



Rest Area Facility - Entrances and Exits



- Highway 66 S SW entrance
- T-intersection controlled by stop signs. Mounted 7ft to bottom.
- South bound on Highway 66 S. 3 lanes with a left turn lane entering (RAF) and 2 lanes going N.
- 3 lanes exiting RAF with with designated left turn lane and two lanes entrance
- Entrance for RV's, Buses, trailer trucks

Rest Area Facility - Required Parking Spaces

Table 3.8
OFF-STREET PARKING REQUIREMENTS

PRINCIPAL USES	MINIMUM REQUIREMENTS	NOTES
Recreation Facility, Public	1 space per 7,500 SF land area	

- Total Area Rest Area Facility
 - 40.6 Acres => 1,764,180 SF
 - $1,764,180 \text{ SF} / 7,500 \text{ SF} = 235.22 \Rightarrow 236 \text{ Parking Spaces}$
- Parking Spaces
 - 424 Parking spaces
 - 14 ADA Parking spaces, 4 Van ADA Parking spaces, 12 ADA Trailer truck parking Spaces, 2 RV ADA Parking Spaces
 - 20 Employee Parking
 - 266 Trailer truck parking
 - 48 RV Parking
- Sum Total Parking (Excluding ADA)
- $424 + 20 + 266 + 48 = 758 > 236 \text{ Parking Spaces}$

Taken from Town of Kernersville
Unified Development Ordinance

Rest Area Facility - ADA requirements

Minimum Number of Accessible Parking Spaces

2010 Standards (208.2)

Total Number of Parking Spaces Provided in Parking Facility (per facility)	(Column A) Minimum Number of Accessible Parking Spaces (car and van)	Minimum Number of Van-Accessible Parking Spaces (1 of six accessible spaces)
1 to 25	1	1
26 to 50	2	1
51 to 75	3	1
76 to 100	4	1
101 to 150	5	1
151 to 200	6	1
201 to 300	7	2
301 to 400	8	2
401 to 500	9	2
500 to 1000	2% of total parking provided in each lot or structure	1/6 of Column A*
1001 and over	20 plus 1 for each 100 over 1000	1/6 of Column A*

*one out of every 6 accessible spaces

Taken from ADA.gov

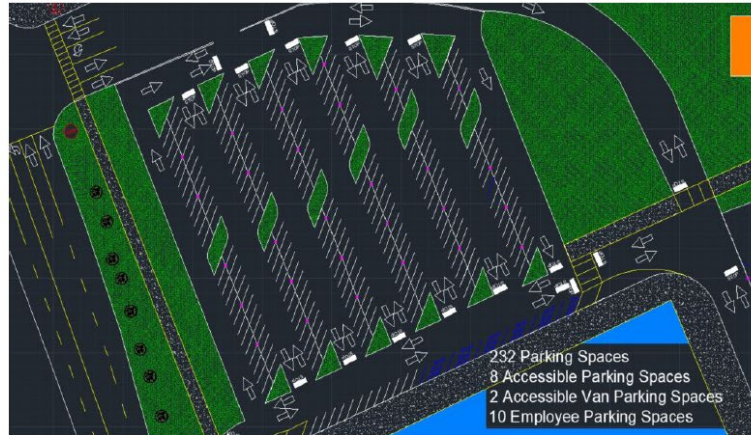
Rest Area Facility - Local Ordinances

- All off-street parking shall be provided to the rear or to the side of the principal structure with the exception of two (2) parking spaces which may be located in front of the structure. The side parking area may be no closer to the street than the principal structure.
- Common recreation areas shall be attractively landscaped and provided with sufficient natural or constructed screening
- Unless grading for construction or erosion control requires the removal, existing healthy trees having a diameter of twelve inches (12") or greater, located within any required streetyard, bufferyard and parking lot planting area shall be preserved.

Taken from Town of Kernersville
Unified Development Ordinance

Rest Area Facility - Parking Lot 01

- The angle parking for the vehicles is 45°
- Parking spaces for standard vehicles are 9 ft wide by 18 ft long
- ADA Parking w/access aisles at 9 ft wide by 18 ft long
- 232 Parking Spaces , 8 handicap parking spaces, 2 handicap van parking spaces, 10 Employee parking spaces
- Minimum Aisle width 24ft two-way vehicle flow



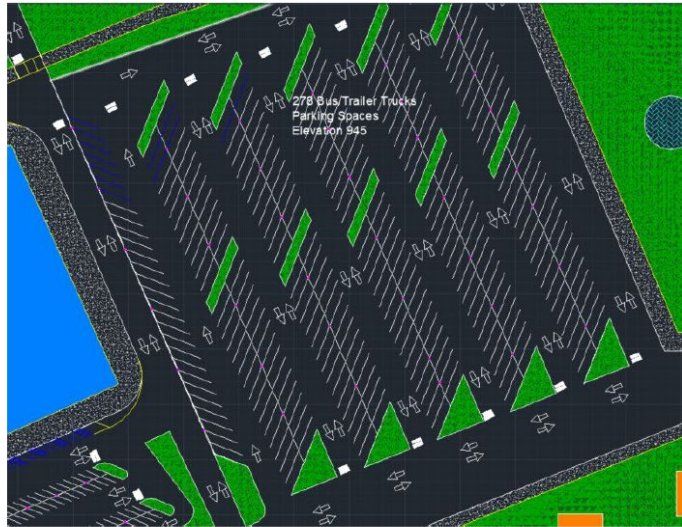
Rest Area Facility - Parking Lot 02



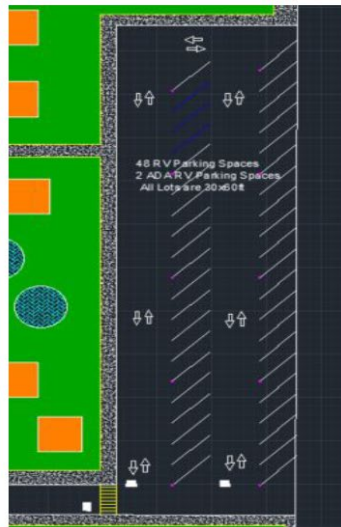
- The angle parking for the vehicles is 45°
- Parking spaces for standard vehicles are 9 ft wide by 18 ft long
- ADA Parking w/access aisles at 9 ft wide by 18 ft long
- 172 Parking Spaces , 6 handicap parking spaces, 2 handicap van parking spaces, 10 Employee parking spaces
- Minimum Aisle width 24ft two-way vehicle flow

Rest Area Facility - Parking Lot 03

- The angle parking for the busses, big rigs and truck trailers are 45°
- Parking spaces 15 ft wide by 40 ft long
- 266 Parking spaces Parking Spaces , 12 handicap parking spaces
- Minimum Aisle width 30 ft two-way vehicle flow



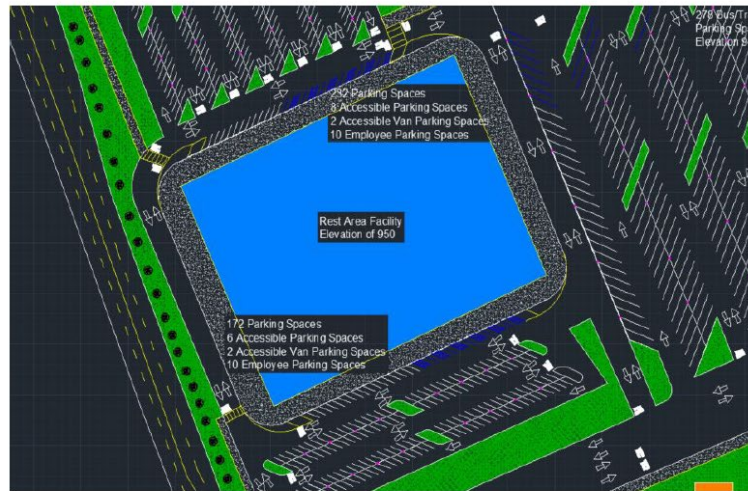
Rest Area Facility - Parking Lot 04



- The angle parking for the for all RV's are 45°
- Parking spaces 30 ft wide by 60 ft long
- 48 Parking spaces Parking Spaces
- 2 handicap parking spaces
- Minimum Aisle width 30 ft two-way vehicle flow

Rest Area Facility - Amenities

- The Rest Area Facility is 117,315 sqft
- Public restrooms, showers, overnight stays, information center, and vending machines
- The Rest Area Facility has a total of 25 Park Beach Canopies
- The dimensions of the canopies are 50 ft x 50 ft
- Children's playground that measures 100 ft x 100 ft
- 5 splash pads



Rest Area Facility - Amenities



- 52,000 sqft Dog Park for travelers and their pets.
- The Dog park is to be fenced in so pets can run freely.
- Sidewalks surround the entire rest area facility to be a minimum of 5ft wide (Taken from Town of Kernersville Unified Development Ordinance)

Rest Area Facility - Amenities

- Slope for the site is at 1%
- Landscape to be used for the turf grass is Kentucky bluegrass. As it is very tolerant to cold and does well in warm weather.
- Red Maple Trees to be planted at front of building as buffer between roadway and facility



Rest Area Facility - Landscape

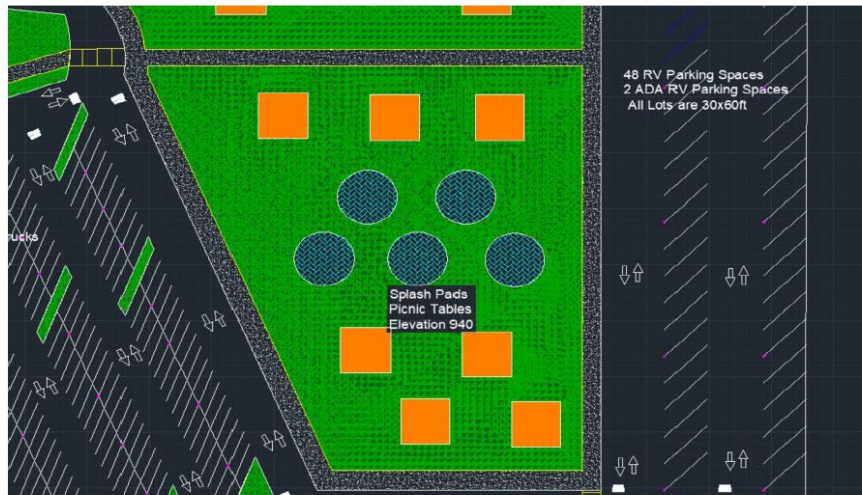


Kentucky Bluegrass

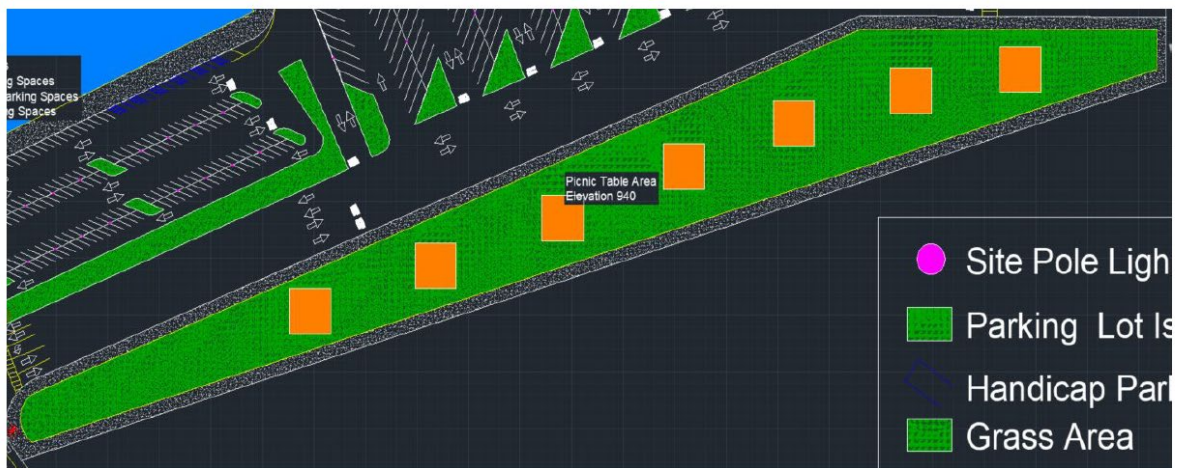


Red Maple Tree

Rest Area Facility - Amenities



Rest Area Facility - Amenities



Landscaping Georgia and North Carolina

Georgia

- Is broken down 4 planting zones
- The corridor road is located in planting Zone 2
- Good For Soil erosion and sedimentation
- Permanent Grass (Bermuda, Bahaia)
- Temporary Grass (Rye, Millet, Cereal)
- Low Cost and Maintenance

North Carolina

- NC Vegetation Management
- Cool-Season (CS)
- Warm-Season (WS)
- TurfGrass CS (Fescue, Kentucky bluegrass)
- TurfGrass WS (Centipede, Bermuda)
- Red Maple Trees

54

Total Cost of Construction

- Terrain type is rolling
- Type of road is urban collector minor
- 2 lanes going opposite directions
- Total length of road 3,050 ft => $3,050 \text{ ft} / 5,280 \text{ (ft /mile)} = .58 \text{ miles}$
- 2 lane urban collector minor cost per mile = \$3 - \$5,000,000 per mile
- Cost 2 Lane collector minor road => $.58 \text{ miles} * \$5,000,000 \text{ per mile} = \$2,900,000$

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11.

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6. AASHTO "Policy on Geometric Design" for the 2001 2004 2011 Editions (2,3,4)
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