

NC Department of Transportation

Plans Reading Manual



May 1995

J.R. Hatfield

EMPLOYEE'S NAME

PLAN READING COURSE

SSC 030

MAY 1995

This course is designed to be completed in three months.
Your completion date is 7-9-97.

Materials needed: Lead Pencil
Engineer's Scale (Either triangular or flat)

ACKNOWLEDGMENTS

This course was developed by the North Carolina Department of Transportation because of a determined need for Highway Personnel to be able to read, interpret, and relate to a standard set of highway plans.

Several sources were consulted during the development of this Highway Plan Reading Course.

Special thanks due to the Plan Reading Update Committee who worked many hours in preparation of this material. The committee was composed of: *John Emerson (Co-Chairman), Construction; Harry Thompson (Co-Chairman), Roadway Design; Eddie Beverly, Geotechnical Unit; Danny Burwell, Location and Surveys; JoAnn Oerter, Traffic Control; Glenn Grigg, TEB, Signing; Ray Moore, Structure Design; Richard Mullinax, Signals and Geometrics; David Franks, Hydraulics Unit; Frank Pace, Maintenance; Ken Pace, Roadside Environmental Unit; Don Sellers, Right of Way; Gerald Smitherman, Design Services; Barry W. Saunders, Personnel Training; Bobby Wood, Photogrammetry.*

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PURPOSE OF THE COURSE

Objectives - The Objectives of this Plan Reading Course are to present a step-by-step procedure to teach you how to read, interpret, and relate to a standard set of highway plans; to help you identify and interpret symbols used in a standard set of plans; and to interpret a set of plans in non-technical terms to laymen (property owners and others).

What it is - The Plan Reading Course is different from the ordinary "textbook", with which you may be familiar. The subject matter is arranged so that the student may work at his/her own speed. Each part of the course builds on the information which precedes it, and prepares you for the information that follows. Most of the sections present new information. Some sections review important facts that have been introduced to you earlier in the program.

Application - This self-instructional course in Highway Plan Reading has four distinct applications:

1. As a Highway Plan Reading Course for presently employed personnel in Roadway Design, Bridge Design, Construction, Right-of-Way and Utilities.
2. As a training course in Plan Reading for new employees.
3. As a refresher course for existing employees.
4. As a Highway Plan Reading Course for any highway employee whose duties involve the reading and interpretation of highway plans.

Upon *completion* of this Plan Reading Course, a comprehensive examination will be given to the student. If the student passes the comprehensive examination, then other applicable courses, which are a continuation of specific information for technicians in Construction, Roadway Design, Bridge Design, Location and Traffic, may be requested. Right-of-Way personnel will end their study of Plan Reading at the end of this course.

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HIGHWAY PLANS READING COURSE

GOOF SHEET

While studying this course, you will aid future students and contribute to the improvement of instructional material by recording on this sheet any technical mistakes and printing errors that you may come across.

INSTRUCTIONS:

1. As you work through the course, record mistakes and printing errors as you come across them.
- *2. If you have recorded any mistakes or printing errors, return this sheet to us.
3. Do not use this sheet for asking questions or making comments that require a reply; please write a separate letter for such questions or comments.
4. Do not use this sheet for comments and opinions on the quality of the course. An evaluation questionnaire is included with the course for that purpose in Appendix H.

I have noted the following mistakes and printing errors.		
Page #	Paragraph	Remarks

Use the opposite side of this page if necessary

*Please mail this sheet to:
ATTN: DOT Training Section
State of North Carolina
Department of Transportation
Box 25201
Raleigh, NC 27611

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HOW TO USE THIS MATERIAL

Begin at the beginning. Even though you might already know some of the basic information, it will be a good review for you to start on page 1-1 and work your way through the book. Make certain you thoroughly understand what you are doing before going on to the next part of the book.

Complete each of the questions in this book and check your answers in Appendix G. If you miss an answer, be sure to go back and study the information that you missed. **NEVER LEAVE AN ANSWER WRONG** - research studies show that once you learn incorrect information, it is difficult to go back and re-learn the information correctly - so **CORRECT ALL ERRORS** that you make.

This book has been assigned to you, an employee of the North Carolina Department of Transportation, and becomes your property. When you finish this course, it is suggested that you keep this book as a reference source, or use it later as a "refresher" course in Highway Plan Reading.

This course contains two different parts:

One - The **MANUAL** you are now reading.

Two - **PLAN SHEETS** - There is one package of plans used in this course. It is assembled from three sets of plans. The selected sheets are bound together in the order of their plan sheet numbers. This set includes two partial sets of "Roadway" and one partial set of "Structure" plans, and one set of "Signal" plans.

LOOK TO BE SURE YOU HAVE THESE. LOOK NOW.

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GET SET

You will learn to read plans by actually doing just that. This manual will show you how. Your sample plan sheets have been reduced to half their original size. This is done so you can handle them easily - keep this fact in mind as you read the sheets.

Be sure to FOLLOW THE DIRECTIONS CAREFULLY. Do exactly what the book tells you to do - try not to skip anything. Even though you may know some parts of this book, it will be good review for you.

ARE YOU READY? Get a couple of pencils with erasers on them and begin (try to devote as much of your spare time as you can for this course - if you "lay off" a week or so you may have to start over again - so devote as much time as you can for as many evenings you can until you complete the course).

GOOD LUCK!

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SPECIAL NOTE REGARDING A SET OF PLANS:

Although not a part of the construction drawings, the Specifications, the Supplemental Specifications, the Standard Special Provisions, and all supplementary documents are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. In case of discrepancy, calculated dimensions shall govern over scaled dimensions; supplemental or special provision specifications shall govern over standard specifications; plans shall govern over supplemental specifications and standard specifications; standard special provisions shall govern over plans, supplemental specifications, and standard specifications, and project special provisions shall govern over standard special provisions, plans, supplemental specifications, and standard specifications.

SAFETY

As an employee of the North Carolina Department of Transportation, it is your responsibility to direct your concern to one goal - to provide the traveling public with the best and safest roadway system that can be constructed. With this goal constantly in mind, it is the responsibility of each Department of Transportation employee to observe, suggest, and act to achieve a safe system of roadways throughout the State. Regardless of a specific assigned duty, it is the responsibility of all employee of the North Carolina Department of Transportation, Division of Highways to call to his/her supervisor's attention any item, whether in design or construction, that appears to be an obvious hazard to the traveling public or to the health and safety of other state employees. Safety is our business and will remain as one of the primary factors in designing and constructing a highway.

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CHAPTER ONE: TITLE SHEET AND STATIONING

A. TITLE SHEET (Identification)

The Front Sheet on a set of plans is called the TITLE SHEET. It tells you the Title (or name) of the project (roadway or structure to be built). It shows you the geographical location of the project, what the project consists of (grading, drainage, surfacing, culverts, etc.), design data, length of roadway, structures (bridges or culverts over 20' wide), and the total length of the project in miles.

1. DESCRIPTION

Open your sample set of plans (I.D. #R-1025) to the TITLE SHEET and read the following description of the project:

DEPARTMENT OF TRANSPORTATION
PLAN AND PROFILE OF PROPOSED
STATE HIGHWAY

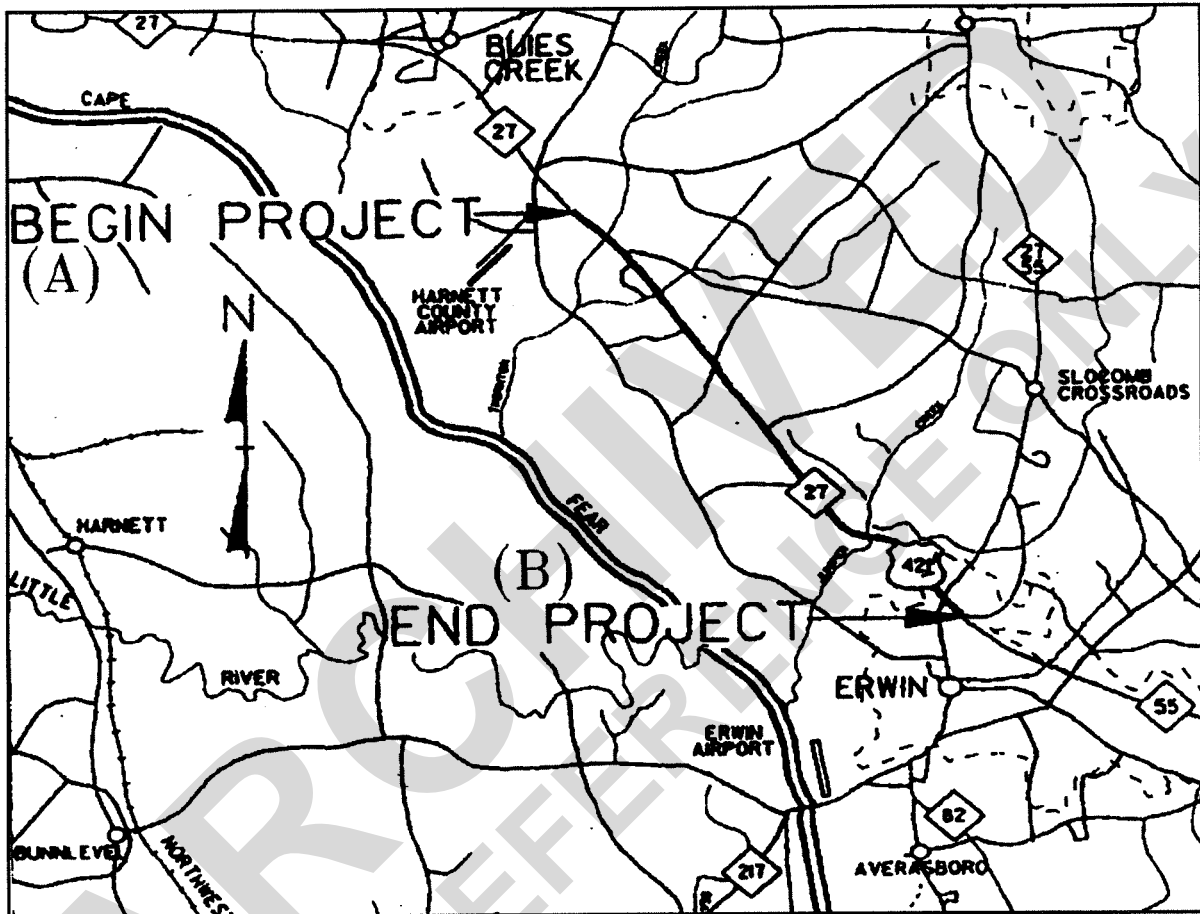
HARNETT COUNTY

LOCATION: US 421 FROM SOUTHEAST OF BUIES CREEK TO SOUTHEAST
OF NC 55-NC 217 AT ERWIN

TYPE OF WORK: GRADING, DRAINAGE, PAVING, GUARDRAIL, CULVERT EXTENSIONS,
THERMOPLASTIC PAVEMENT MARKINGS, AND SNOWPLOWABLE
PAVEMENT MARKERS.

2. LOCATION MAP

In the upper left corner of the Title Sheet is a VICINITY MAP of the general geographical area of the project. This map shows the beginning and the ending of the project.

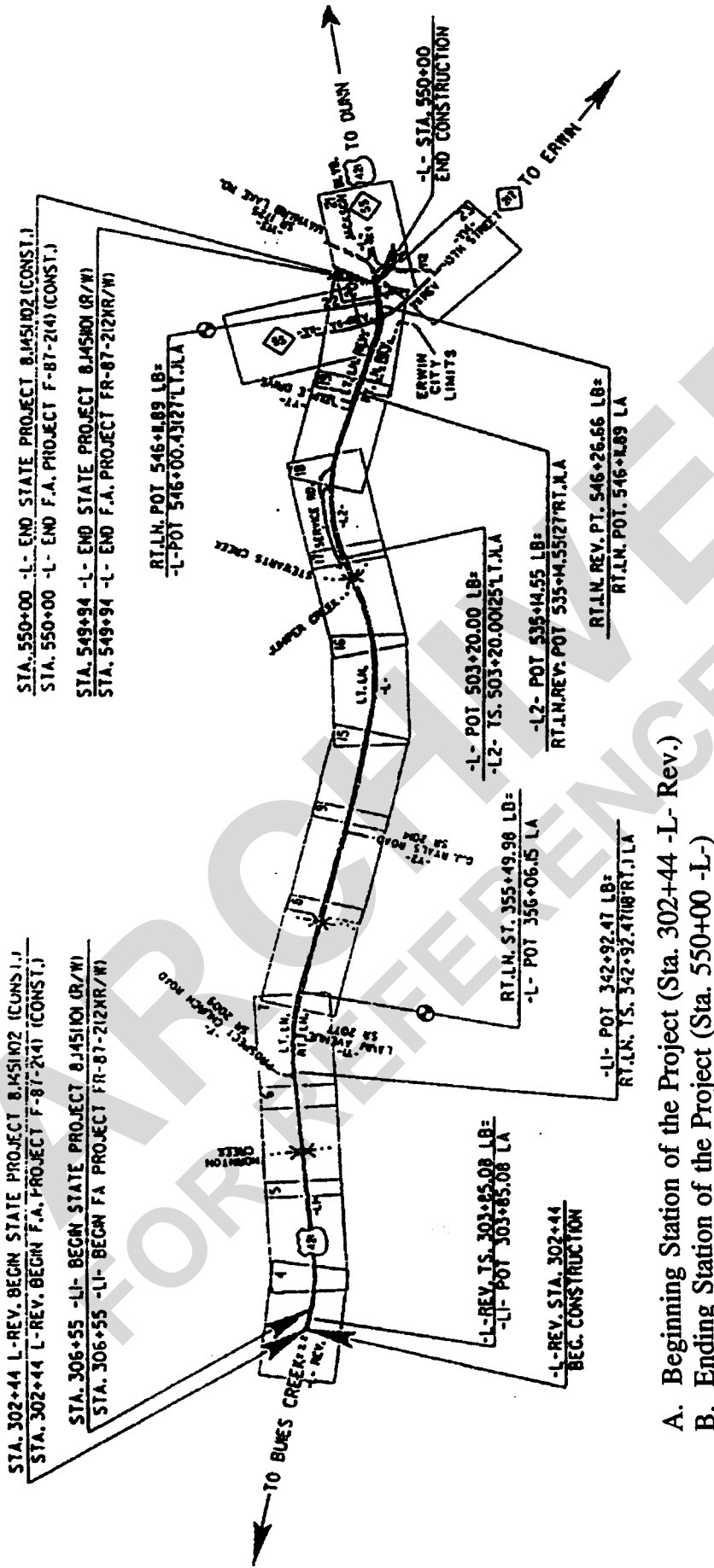


VICINITY MAP OF
PROJECT 8.1451102

- A. Beginning of the Project
- B. Ending of the Project

3. LAYOUT VIEW

In the center of the Title Sheet, is a LAYOUT VIEW. This View shows the beginning station A and the ending station B of the project.



Note:
 The Layout above is a "PLAN VIEW" of the project. You will be exposed to a PLAN VIEW later in this book. If you were flying in an airplane over this project and looked down, this graphic representation or the PLAN VIEW is what you would see. Also note that certain parts of the project are "blocked off" and each "block" is given a number in its upper right corner. These "block" numbers are the numbers of the Plan Sheets. For example, if you wanted to see a detail of the SR 2009 area, you would turn to Plan Sheet 7 in your Sample Set of Plans. (See the number 7 in the upper right corner of the "block" in the SR 2009 area).

4. PROJECT IDENTIFICATION

Now look in the upper right corner of the Title Sheet and see the box like the one shown below. Each Title Sheet on a set of plans has a similar box for standard identification of a set of plans for a given project.

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	8.1451102	1	
STATE PROJ. NO.	F.A. PROJ. NO.	DESCRIPTION	
(A) 8.1451101	(C) FR-87-2(2)	P.E., R/W, & UTL.	
(B) 8.1451102	(C) F-87-2(4)	CONST.	

- A. This is the number assigned to this particular project and indicates that number is to be used for preliminary engineering, right-of-way costs, and utilities.
- B. This is the number assigned to this particular project and indicates that this number is to be used for Construction.
- C. These are numbers assigned to this particular project and indicate that the Federal Highway Administration (FHWA) is participating in this project.
- D. The Title Sheet will always be SHEET #1 of any project. When you are referred to a Plan Sheet, this is where you should look for the plan sheet number.

Now look at the left margin of the Title Sheet. The Project number is written in the lower left margin and the Transportation Improvement Program (TIP) number is in the upper left margin. Projects are more commonly referred to by the TIP number for Design and Project Number for Construction.

*Note: For unfamiliar words or terms, turn to Appendix D.

5. SPECIFICATIONS & APPROVALS

Look next at the lower center part of the Title Sheet and see:

1990 STANDARDS SPECIFICATION

This statement means that the Standard Specifications for Roads and Structures of the North Carolina Department of Transportation Division of Highways, including changes and supplemental specifications listed in the proposal, govern this improvement. The 1990 Specifications are to be used with this set of plans, even if more recent standard specifications have been issued.

Also in the lower center of the Title Sheet is the name of the Project Engineer and the Project Design Engineer that prepared the set of plans and the letting date for the particular project.

APPROVALS - Along the lower right side of the Title Sheet you will find where this set of plans has been approved by the State Highway Engineer-Design.

Approval of the design by the Roadway Design Project Engineer and hydraulic design, by the State Hydraulic Engineer are also located here.

F.H.W.A. APPROVAL - In the lower right hand corner of the Title Sheet a space has been provided for the approval signature of the appropriate Federal Highway Administration official.

6. INDEX OF SHEETS

The Index of Sheets lists is shown on each sheet or series of sheets in the entire set of plans. Since you were given mixed sets of plans, you will not have an index of sheets for the second set. See Sheet No. 1A in plans.

7. CONVENTIONAL (SYMBOLS) AND ABBREVIATIONS

Conventional Symbols

Look next at the Conventional Symbols located on Sheet 1-B. These Conventional Symbols will always be the same on any set of plans you might see. For example, the symbol for a proposed chainlink fence will always look like:



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Highway plans are a means of communicating the thoughts of the designer to other interested parties. Each symbol on a set of highway plans is important to the engineer, draftsman, or person who uses the plans. One need not be an engineer to read plans, but it is necessary to learn the meaning of CONVENTIONAL SYMBOLS used in order to understand what the plan means.

See APPENDIX B for a more complete listing of Symbols.

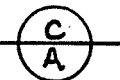
Abbreviations

It is often necessary to abbreviate words on plan sheets. Some standard abbreviations are:

Ahd	=	Ahead
Beg	=	Begin
Emb	=	Embankment
Hwy	=	Highway
Pd	=	Pond
R/W	=	Right-of-Way

If you run across an abbreviation you don't understand, turn to Appendix E in the back of this book.

Use Appendix B and E to complete these questions:

- The symbol  means: _____
- The symbol -- E -- is: _____
- JB is an abbreviation for: _____
- Topo is an abbreviation for: _____

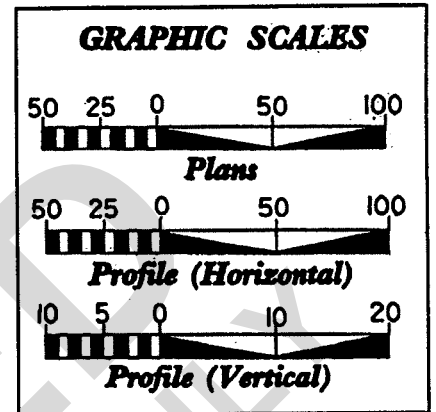
Now turn to Appendix G (page G-1) in the back of this book and check your answers.

8. GRAPHIC SCALES

Look next at the GRAPHIC SCALES on the Title Sheet (lower corner). The items and lines on plan sheets are drawn to "scale" - or exact length so that they represent a real distance on the ground or a dimension of a real object.

On a "full-size plan" sheet, the scale is:

- 1" = 50 feet (Plans) or 1" = 20'
- 1" = 50 feet (Profile - Horizontal) or 1" = 100'
- 1" = 5 feet (Profile - Vertical) or 1" = 10'
- No Scale



Therefore, on these ½ size sheets, ½" = 50 feet or 1" = 100 feet (Plans, Profile - Horizontal, etc.) This ½ reduction applies to all scales on your sheets. Since there may be some distortion in the reduction process, you should measure by the *Graphic Scale* on the Title Sheet.

See if you can answer these questions on scales:

1. If 1" = 100', then 4" = _____
2. If 1" = 10', then ½" = _____
3. If 1" = 1000', then 2½" = _____
4. If 1" = 100', then ¾" = _____

Turn to Appendix G (page G-1) in the back of this book and check your answers. If you missed more than one question, turn to Appendix F for some more help on scales.

9. DESIGN DATA

The design of a highway is based on traffic data for that particular highway.

The DESIGN DATA appears on the TITLE SHEET. Look at your *Title Sheet* and see the following information:

DESIGN DATA	
ADT1990	= 6900-8700
ADT 2010	=11300-14300
DHV	= 10%
D	= 60%
T	= 13%
V	= 60 MPH

See Appendix D for definitions of terms.

10. PROJECT LENGTH

The length of each project appears on the Title Sheet (see lower center). The length is normally shown for the roadway, the structures, and combined roadway-structure length.

11. CONTROL OF ACCESS

A note appears on the Title Sheet stating the type of controlled access. "*This is a controlled access project with access being limited to interchanges.*" Or, "*This is a partial controlled access project with access being limited to points shown on the plans.*" No note is required for a non-controlled project. See Title Sheet for type of control for Project R1025.

12. GENERAL NOTES

Turn to Plan Sheet 1A. This sheet shows the *General Notes* (on the right side) which contain information that cannot be shown by a "picture" in other sections of the plans.

B. STATIONING

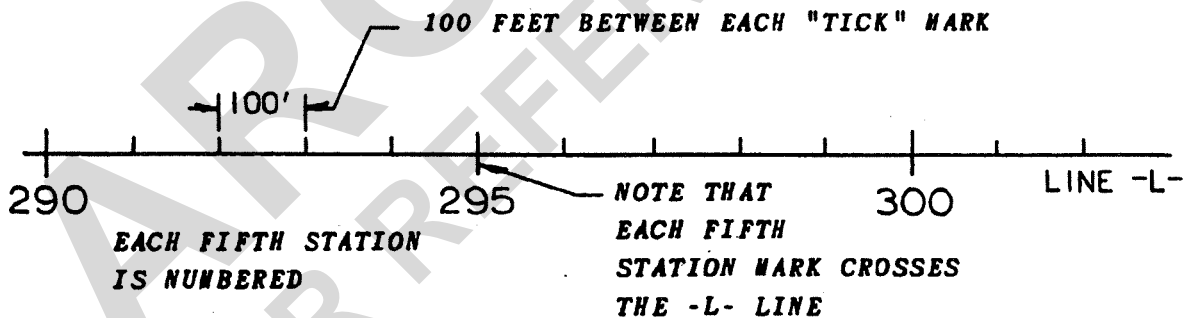
Since STATIONING is fundamental to highway plans, a discussion of *stationing* should be offered before you get involved with the plans. A station is the HORIZONTAL UNIT OF MEASUREMENT along the SURVEY LINE of a project, and is defined as 100'. Distances are measured and points are identified on plans with reference to *station numbers*. Highway stationing might be compared with a rope having knots at 100-foot intervals. The beginning end of the rope being station 10+00, the first knot at 100 feet being station No. 11+00, and so on.

Station numbers usually *increase* from the beginning of the project to the end of the project. Also, stationing usually runs from the *South to the North* or from the *West to the East*.

The beginning station of a project is usually arbitrary, it quite often will start with 10+00 or 100+00.

Since all "items" on the PLAN are referenced to the SURVEY LINE, any particular item can be located by giving its stationing and the perpendicular distance left or right of the SURVEY LINE.

The length of the project may be arrived at by subtracting the beginning station from the end station (making allowances for equalities) and multiplying by one hundred. For instance, if a project *begins* at station 650+00 and *ends* at station 920+00, the length is $(920 - 650) \times 100 = 27,000$ feet. This can easily be converted to miles by dividing 5280 feet per mile.



* Note: The survey line is indicated on plans as either: survey line, line -L-, or Centerline (Ⓞ).

THINK of STATIONS in this way:

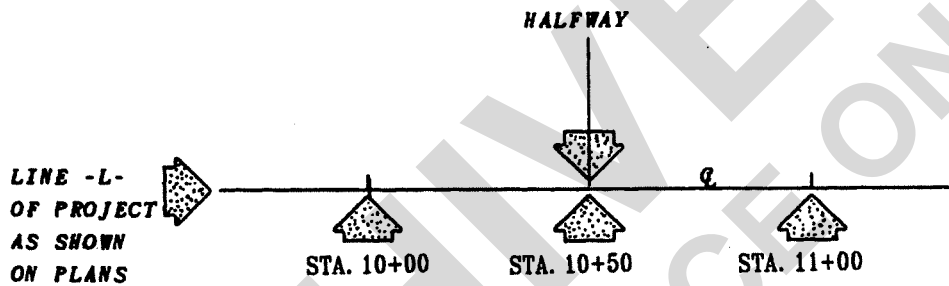
Just as 12 inches make 1 foot, 100 feet make 1 station. It is 100 feet from Station 1+00 to Station 2+00, or from Station 493+00 to Station 494+00, etc.

Write the answer:

How many feet make 1 station? _____

Did you write 100 in the blank above? If not, do that now.

Since it is 100 feet from one station to the next, 50 feet is half way from one station to the next. To show this location, you must write +50 after the station number.



Any point between two stations is shown in the same way. For example, 2 feet ahead of Station 10+00 is written Station 10+02. Numbers less than 10 are indicated as 01, 02, 03, etc. 99 feet ahead of Station 10+00 is written as Station 10+99. 100 feet ahead of Station 10+00 is Station 11+00. To show that a point is exactly on a station, +00 is usually written after the station number. This means plus "no" feet.

To find the distance between two stations (except where station equalities are involved) simply subtract the lower station from the higher one, **IGNORING THE PLUS SIGN**. You'll get the answer in feet.

To find the distance from Station
20 + 60 to Station 12 + 80 you can 2060
write the numbers like this: -1280
WITHOUT THE + SIGN 780 feet

It is 780 feet from Station 20 + 60 to Station 12 + 80. To check this:

From Station 12 + 80 to 13 + 00 = 20 feet
From 13 + 00 to 20 + 00 (7 stations) = 700 feet
From 20 + 00 to 20 + 60 = 60 feet
Total 780 feet

You do these:

1. The distance from Station 14 + 10 to 15 + 00 is _____ feet.

$$\begin{array}{r} 1500 \\ -1410 \\ \hline \end{array}$$

2. The distance from Station 80 + 10 to 85 + 20 is _____ feet.
3. The distance between Station 48 + 76.2 and Station 51 + 24.8 is _____ feet.

Turn to Appendix G (page G-1) and check your answers. Did you answer each question correctly? If not, find your mistake and correct it.

On the Plan Sheets, the **Station Numbers** are usually written along the **Survey line**. Stationing is sometimes along a baseline, or along one lane of a multiple lane highway. On a project, AHEAD means in the direction in which Station Numbers **increase** (usually toward the END of a project). BACK means in the direction in which Station Numbers **decrease** (usually toward the **Beginning** of the project).

Look at your TITLE SHEET again at the "Project Layout". Note that Project R-1025 begins at station 302+44 and ends at Station 550+00.

1. How far is it from Station 410+00 to Station 411+00? _____ feet.
2. How far is it from Station 409+00 to Station 409+69? _____ feet.
3. How far is it from Station 410+30.17 to Station 412+89.29? _____ feet.
4. What is the Station number of a point on Line L 50 feet AHEAD of Station 412+00?

- ~~5. What is the Station number of a point 50 feet BACK of Station 412+00?
_____~~
6. What is the distance between Station 411+50 and Station 412+50?
_____ feet.

Now turn to Appendix G (page G-1) and check your answers. Never leave an answer wrong - ALWAYS correct a wrong answer.

Generally station numbers progress (increase) from WEST to EAST or from SOUTH to NORTH. Since highways curve and change direction, the above statement is not always true on any one segment of the road.

REMEMBER!

When you say *AHEAD* you mean toward a higher or "up" station.

When you say *BACK* you mean toward a lower or "down" station.

1. THE STATION EQUALITY

Sometimes it is necessary to relate one system of stationing to another system, as at the connection between two projects or to account for an increase or decrease in project length due to a change in horizontal alignment.

STATION EQUALITIES are written to describe a point on a survey line where the station numbers of one system change to the station numbers of another system.

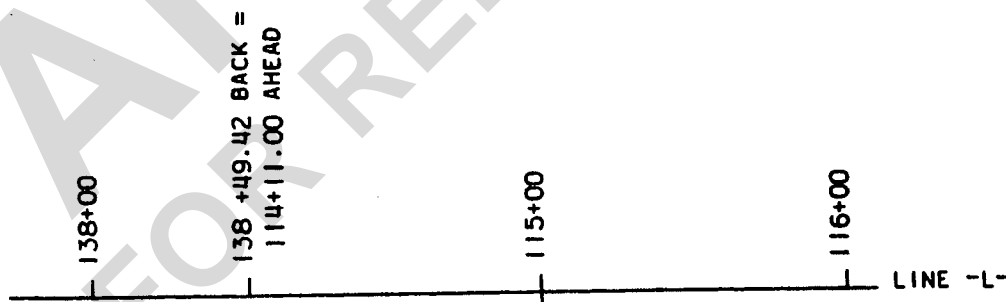
Here is one equality:

Station 138+49.42 LB = Station 114+11.00 LA.

THIS FIRST NUMBER
IS THE STATIONING
THAT IS ENDING.

THIS LAST NUMBER
IS THE STATIONING
THAT IS BEGINNING.

On a plan sheet this equation would look something like this:



Did you read the last page carefully?

If not, go back and do it now, before you start answering these questions.

Write the answers:

1. If you are walking along the (\mathbb{C}) reading the station numbers written on the stakes and these numbers are getting larger as you go, there is a good chance that you are walking toward the _____ (West, East) or _____ (North, South).
2. If a station equality is given as

Station 550+00 BACK =
Station 2+00 AHEAD

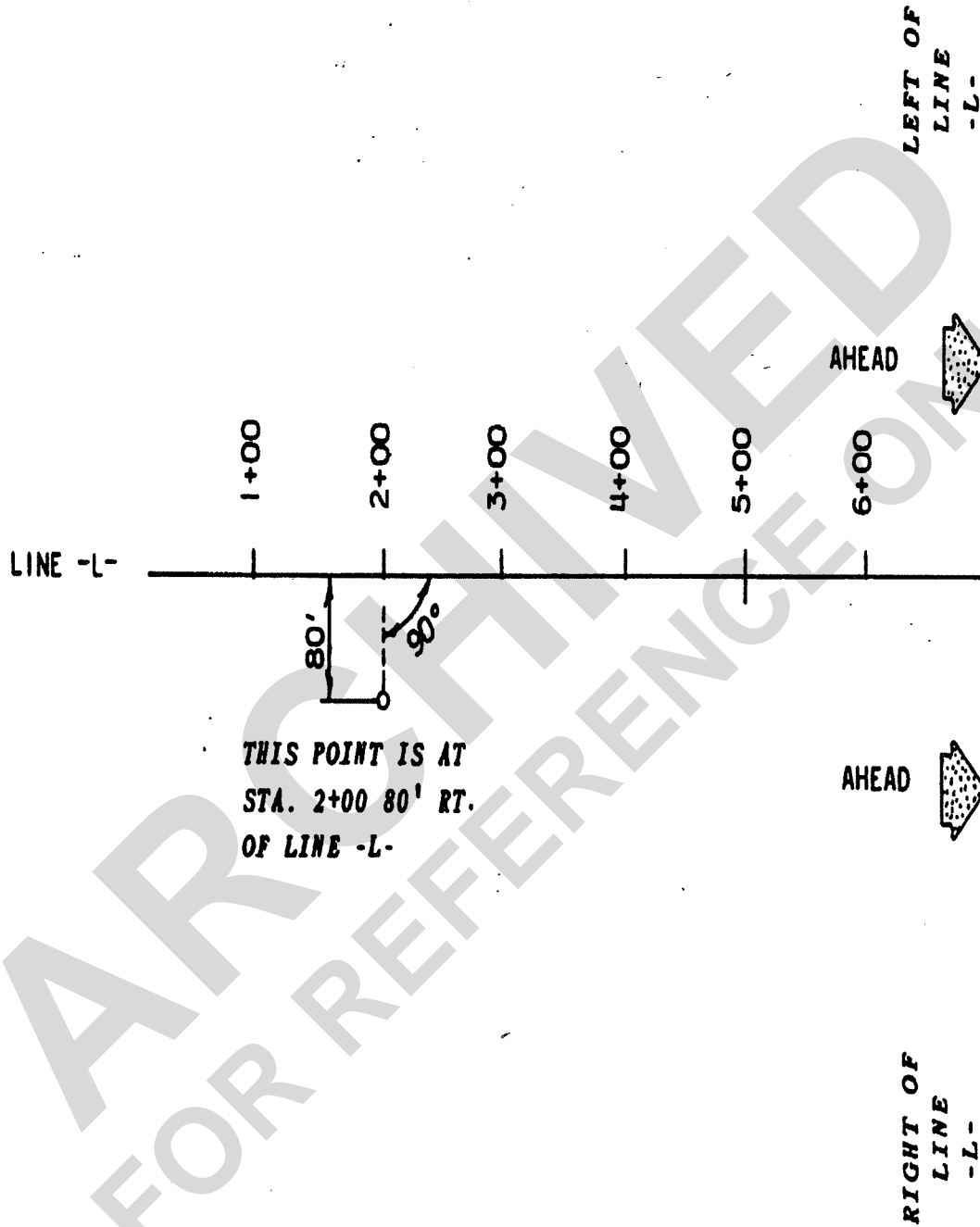
- (a) What is the Station Number of a point 50 feet BACK of the equation?

- (b) What is the Station Number of a point 50 feet AHEAD of the equation?

Turn to Appendix G (page G-1) and check your answers.

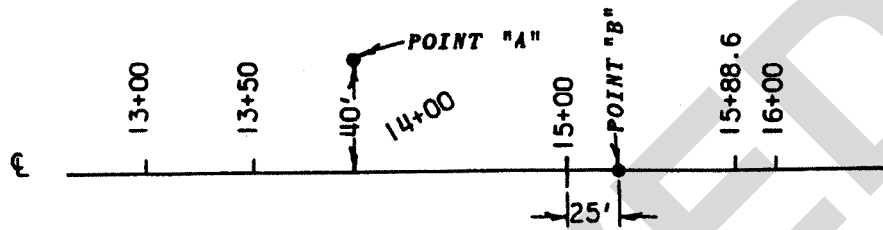
Any point pertaining to a project may be located on the ground and on the plans by its Station and the number of feet LEFT or RIGHT of (-L-) the survey line. Left and Right of (-L-) the survey line is oriented as if you were facing AHEAD.

See this below:



2. QUESTIONS ON STATIONING

Do NOT look back at any pages in this manual until you have written the answers to all the questions below. Refer to the sketch below as needed.



1. What is the station location of point A on the sketch above?

2. What is the station location of point B on the sketch above?

3. Station numbers generally increase toward the _____.
4. How far (in feet) is Sta. 15+88.60 from Sta. 15+00? _____
5. Is Sta. 13+00 ahead of, or back of Sta. 14+00? _____
6. How far is it from Sta. 13+50 to Sta. 16+00? _____
7. What station is 100 ft. AHEAD of a point at which this equality is given? Sta. 1142+40 BK. = Sta. 1+00 AHD.? _____
8. What station is 100 feet BACK of a point at which the equality in question #7 is given? _____

Turn to Appendix G (page G1) and check and correct your answers very carefully. If you make a mistake, go back and review the pages which presented that part. Be sure you UNDERSTAND any corrections you make.

3. DETERMINATION OF THE PROJECT LENGTH

IF THERE ARE NO STATION EQUALITIES on the PROJECT, you can subtract the beginning station from the end station and have the length of the PROJECT in feet.

A project ends at station	701+50.00
It begins at station	<u>409+69.00</u>
	291+81.00 feet

Remember - this 29,181.00 (291.81 stations X 100 ft/station) is the *length* of the project *only* if no equations occur between the beginning and the end of the project.

You can change feet to miles as follows:

		5.526 miles in this project
Number of feet in one mile:	5280	<u>29181.00</u>

Look now at Sheet No. 7 (R-74AA) in your sample plans for an example of an equality. Notice that the equality is shown like this:

POT Sta. 83+57.11 Ser. Rd. 'C' LB =
POT Sta. 83+35.04 Ser. Rd. 'C' LA.

which means that station 83+57.11 L.B. equals station 83+35.04 L.A.

CHAPTER TWO: VIEWS

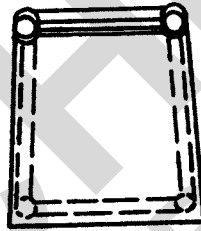
- A. VIEWS - Before going any further, you need to know more about the different viewing angles from which various things are shown in a set of plans. A **VIEW** is the way you look at or "see" the different items that are shown on a set of plans.

A *view* may show something observed from the inside or from the outside. These views are drawn to give you clear and complete pictures of how the fence, pipe, ditch, or culvert, etc., should be built or placed. To get the information you need, you must be able to look at the view and "see" what is being pictured. You need to know from which angle the item is shown. To help you do this, this page and the next show an item that you are familiar with - a chair. Because you already know what a chair looks like, you should have no trouble with the various views shown.

This is a **PLAN** showing a chair

1. A **PLAN VIEW** - is a view from directly **ABOVE** the object.

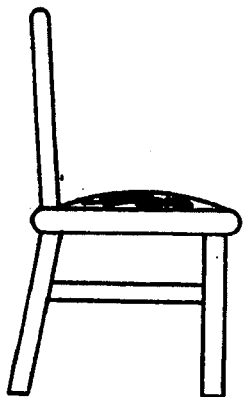
(A Top view looking **DOWN** on the chair)



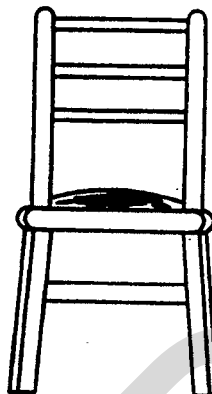
Dotted lines show parts of the chair you would **NOT** see.
(The legs and cross-pieces would be hidden by the seat and you would not see them.)

Now look at the set of plans you were given with this material. The first sheet, or **TITLE SHEET** (sheet No. 1) shows a **PLAN VIEW** of the entire project. If you were flying an airplane high over this project and looked down, the **PLAN VIEW** is what you would see.

2. SIDE ELEVATION

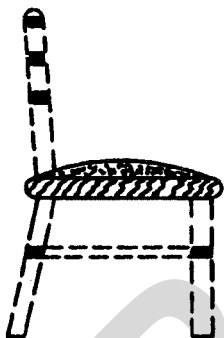


3. REAR ELEVATION

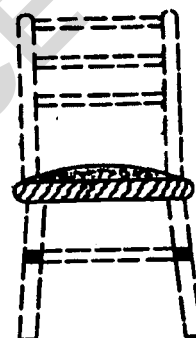


These views show the *elevation* (height) of the chair from the *side* and *rear*. The view might also be shown from the other side or from the front.

4. LONGITUDINAL CROSS SECTION (Sliced Lengthwise) 5. FRONTAL CROSS SECTION



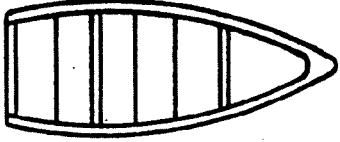




As you face the side of the chair, a section has been "sliced" away. You see the inside of the seat from the side. Also note the inside of the cross-pieces at the top and bottom of the chair.



As you face the front of the chair, a section has been "sliced" away. Here the chair was sliced across the seat. You see the layers (cushions and seat) inside the seat. The rest of the chair, shown by the dotted lines is *behind* the point where the "slice" was made.

Below is an OLD BOAT. Five views are shown of it. YOU WRITE the name of the view above each one. HERE ARE THE NAMES: "CROSS SECTION" "LONGITUDINAL CROSS SECTION" "PLAN" "REAR ELEVATION" "SIDE ELEVATION"

You FIT THE VIEW TO THE BOAT! Look back on pages 2-1 and 2-2 if you need to.

<p>1. _____ (Fill In)</p>  <p>(Hint-From the top)</p>	<p>2. _____ (Fill In)</p>  <p>(Hint-A section has been sliced away, cross the boat)</p>
<p>3. _____ (Fill In)</p>  <p>(Hint-A section has been sliced away, longways)</p>	<p>4. _____ (Fill In)</p>  <p>(Hint-You're looking at it from the side)</p>
<p>5. _____ (Fill In)</p>  <p>(Hint-Rear view)</p>	<p>Turn to Appendix G, page G-1)</p>

If you missed any of the names of the views on the preceding page, be sure you **CORRECT** them. Make sure you **UNDERSTAND** your corrections. If you need to, turn back and read pages 2-1, 2-2, and 2-3.

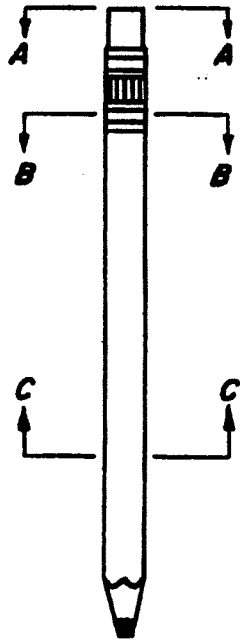
When you are reading plans, you will not be required to name the views. However, you should know what the names *mean* so that when looking at a plan, you will know whether you are seeing the item from the **REAR** (rear elevation), from the **INSIDE** (cross-section, etc.). This will help you "see" the item better.

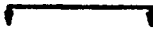
Of course, the actual views on a set of plans also give dimensions, materials used in construction, and many other construction details.

The **ELEVATIONS** generally show the item from the **OUTSIDE**. These views are usually very clear drawings, almost like a picture.

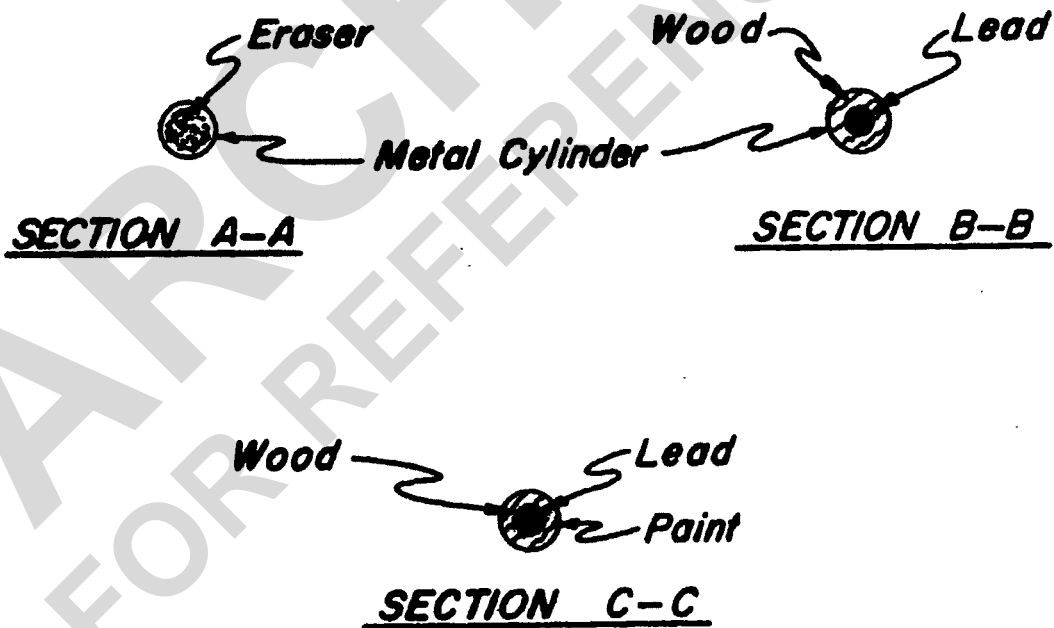
The **CROSS-SECTIONS** always show an inside view -- something has been "sliced" away to show you how the inside part should be. These slices may be made at any point and would be compared to cutting an apple into two parts with a knife. The next pages show you how you can generally tell where the section is (where the "cut" was made). Turn this page and see.

Suppose for example, sections of a pencil were used to show the inside materials at different places along the length. See how this is shown below.



The lines between the letters A-A, B-B, and C-C show where the section is taken. The arrows on the ends of the lines like these, , show which way you're looking toward when you look at the section.

The sections, labeled A-A, B-B, C-C, etc to correspond with the letters on the overall diagram, will always be close by. See below.



Write the answers to the following questions by looking at the "pencil" on the preceding page. (page 2-5)

1. Consider the eraser end the "back" of the pencil and the pointed end the "front". Is elevation A-A looking toward the back or the front of the pencil? _____
2. What direction are you looking toward in section B-B? _____
In section C-C? _____
3. In section C-C, what material is shown in the center of the pencil?
_____ What material surrounds the lead? _____
4. In Section C-C, is the lead in front of, or behind the eraser? _____

Now turn to Appendix G (page G-1) and check yourself. Correct any errors - be sure you understand your corrections.

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FOR REFERENCE ONLY

B. TYPICAL SECTIONS

The **TYPICAL SECTION** is a picture, with dimensions, of how a cross-sectional view of the roadway would appear after construction of the roadway is completed.

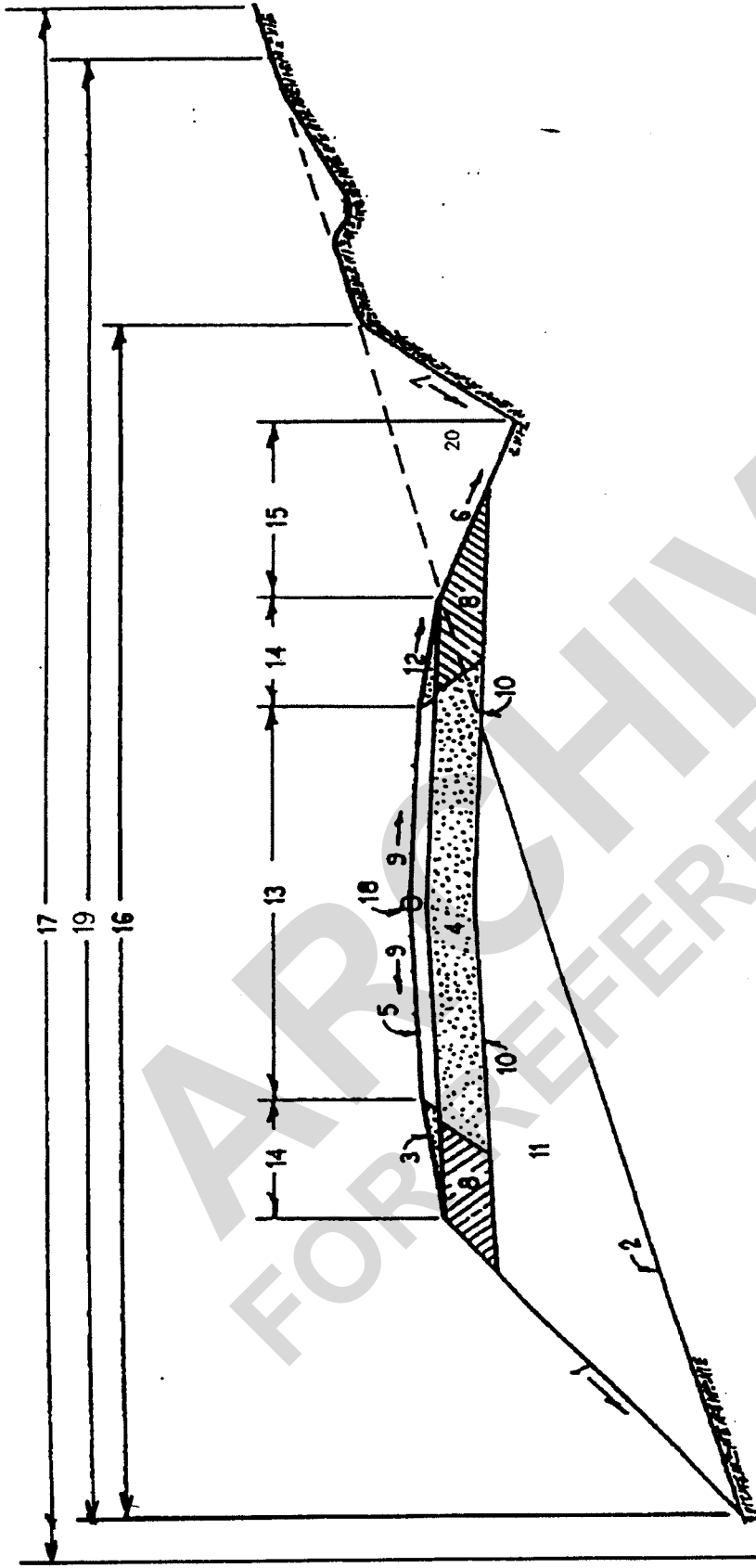
On the following page is an idealized roadway typical section with the various elements identified. Study this drawing and become familiar with the various items which are identified.

Now turn to **PLAN SHEET 2A (Use R74AA)** and look at **Typical Section 2**. Here are some of the significant features you should know about a Typical Section:

1. This is a 4-lane divided roadway.
2. The *travel lanes** in each roadway are 24' wide.
3. There is a 10' paved shoulder on the outside of each roadway and a 4' paved shoulder in the median.
4. The *Grade Point** is at the median EOP of each lane.
5. The *location* where the typical section is to be used is shown.

The *right* side of **Typical Section 2** illustrates how the roadway is to be constructed in a *fill* or cut area. The left side of this **Typical Section 2** illustrates the same. We will talk in more detail about "cut" and "fill" later.

*Note: For *definitions* of unfamiliar terms or words, turn to **APPENDIX D**.



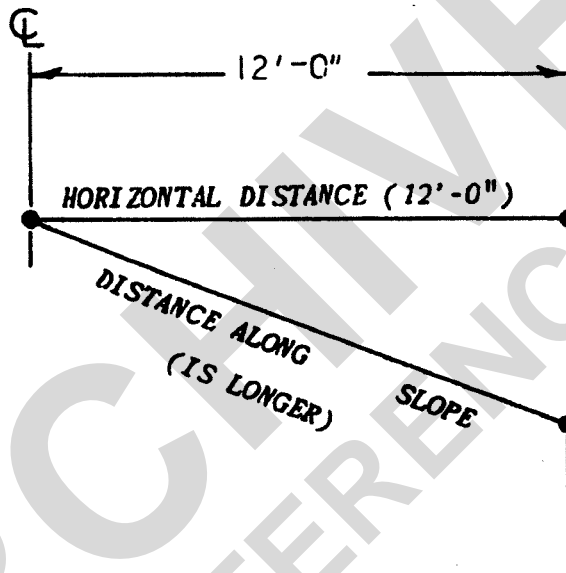
- | | | | |
|------|-------------------------|------|----------------------|
| 1 - | FILL SLOPE | 11 - | EMBANKMENT |
| 2 - | ORIGINAL GROUND | 12 - | SHOULDER SLOPE |
| 3 - | SHOULDER SURFACING | 13 - | TRAVEL LANES |
| 4 - | BASE COURSE | 14 - | SHOULDER |
| 5 - | SURFACE COURSE | 15 - | DITCH OR FRONT SLOPE |
| 6 - | FRONT SLOPE (SIDE) | 16 - | SLOPE STAKE LIMITS |
| 7 - | CUT SLOPE OR BACK SLOPE | 17 - | RIGHT OF WAY |
| 8 - | SHOULDER BASE | 18 - | GRADE POINT |
| 9 - | CROWN SLOPE | 19 - | CONSTRUCTION LIMITS |
| 10 - | SUBGRADE | 20 - | EXCAVATION |

TYPICAL ROADWAY SECTION

1. HORIZONTAL DISTANCE

IMPORTANT - The dimensions given for Typical Sections are HORIZONTAL dimensions. This means that the distances are *not* measured along the slopes of the roadway. For example, the distance from the Centerline of the right lane of Typical Section Number 1 to the edge of the pavement is written as 12'. The distance measured along the $\frac{1}{4}$ " per foot slope would be slightly longer than 12'. The sketch below exaggerates that difference to make it clear for you.

(Centerline of the Right Lane)



All of the dimensions shown by level lines are HORIZONTAL DISTANCES.

Explanations of Slopes will be discussed later in this book.

2. PAVEMENT SCHEDULE (Use Sheet 2 From R-74AA)

Look in the lower left section of Plan Sheet number 2 at the PAVEMENT SCHEDULE for the Typical Sections. This schedule tells you the type of pavement to be used for the typical sections. The circled letters of the schedule correspond to those used on the Typical Section which indicate the various pavement items that make up a particular Typical Section. For example, find A1 on the Typical Section number 2 and then read in the Pavement Schedule what A1 in the section consists of. You should read that A1 is composed of: Prop. 10" Portland Cement Concrete Pav't. (See Appendix E for meaning of abbreviations).

Note: Certain items that appear in the Pavement Schedule may not be called for on Plan Sheet 2A, but would show up on other Typical Section Plan Sheets. For instance, A2 is not called for on Plan Sheet 2A, but would be on another Plan Sheet of Typical Sections.

3. QUESTIONS ON TYPICAL SECTIONS

Use R 74-AA and look at Plan Sheet 2A, Typical Section 2, to find the answers to the questions below. (If you need help in understanding them, turn to Appendix D - Definitions in the back of this book.)

1. What is the total thickness of the pavement structure? _____
(Hint: See Plan Sheet 2)
2. How wide is the normal median? _____
3. How wide is the outside paved shoulder? _____
4. What is the slope required on the outside paved shoulder? _____
5. How many lanes make up the normal section of this roadway? _____
6. What is the maximum fill slope? _____

Now turn to Appendix G (page G-1) and check yourself. If you missed any of the above questions, be sure you understand why you made the mistake.

CHAPTER THREE: SUMMARY OF QUANTITIES (Use R-1025)

Turn next to the SUMMARY OF QUANTITIES found on Plan Sheet 3.

The Summary of Quantities shows the total quantities (or amounts) of all items included in this particular contract. These quantities are used by the State in preparing the engineers' estimates and are used by the contractors in preparing their bids for this project.

There are various other types of summaries that may be included in a set of highway plans. For example, summaries for: guardrail, pavement removal, drainage, shoulder drains, under drains, etc. For those included in the project plans accompanying this course, refer to the Index Sheet, Sheet 1-A.

Use your Plan Sheet 3 to answer the questions below:

1. How many tons of Aggregate Base Course are included in this project?

2. How many linear feet of Steel Beam Guard Rail are included in this project? _____
3. How many Masonry Drainage Structures (listed per each) are included in this project?

4. How many Square yards of 6" concrete driveways are included in this project?

Note: Other summary sheets showing location and quantities of specific items (Drainage, guardrail, etc.) normally follow Plan Sheet number 3. The "Summary of Quantities" sheet is always plan sheet number 3.

Turn to Appendix G (page G-1) and check your answers very carefully. If you made any mistakes, read the Summary of Quantities again to see where you were wrong. Always correct your errors.

CHAPTER FOUR: STANDARDS & DETAILS

A. INTERSECTION DETAILS

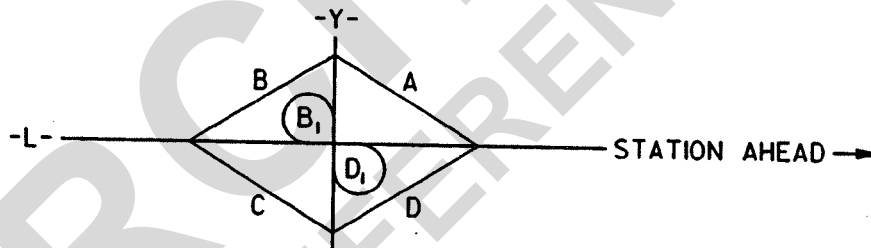
In R-1025 sheets 3-J thru 3-Q show details of the proposed intersections. These larger views show detailed information that could not easily be shown on the smaller Plan and Profile sheets. Such information would include type and location of traffic islands, turning lanes, and other construction details.

B. INTERCHANGE DETAILS

Turn to Plan Sheet 6 (R-74AA). This sheet shows details of the proposed interchange of Line L and Line Y (SR-1147).

Also shown in the lower left corner of sheet 6 is the design traffic diagram. The figures indicate estimated traffic movements for the years 1990 and 2010.

Each ramp in an interchange is identified by a letter designation. These are usually assigned as shown below:



Interior ramps or loops may be designated with a subscript A1, A2, etc., or as Loop A, Loop B, etc.

C. STANDARD DRAWINGS

Turn back to Plan Sheet 1A. You will note that the Standard Drawings are listed separately from the Index of Sheets. This is because they will be found in the Roadway Standard Drawings Manual. They are used for the construction of various items in the project.

CHAPTER FIVE: PLAN AND PROFILE SHEETS

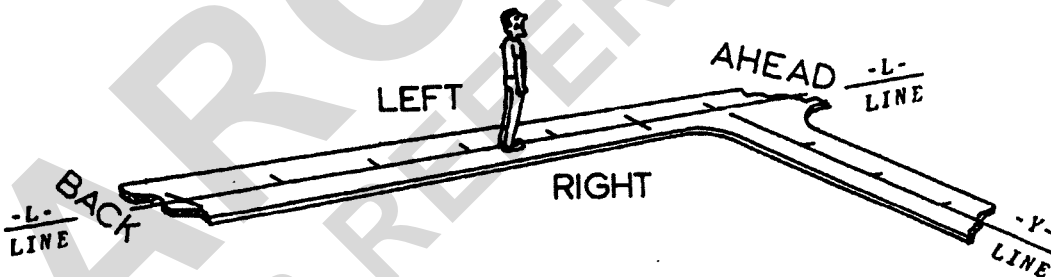
Now you are ready to begin reading a major part of a set of plans - the PLAN SHEETS AND PROFILE SHEETS. Some projects combine the plan and profile on the same sheet. This example project has separate plan and profile sheets to improve clarity.

These sheets give a PLAN VIEW and a PROFILE VIEW of the entire project. They normally begin with the *lowest* station number at the *beginning* of the project and show all the roadway ahead to the end of the project.

A. PLAN VIEW (Use Project R-1025)

1. EXPLANATION

Remember that a PLAN VIEW shows the roadway as if you were flying over the project in an airplane looking down. Turn to Plan Sheet 4 - the beginning Plan Sheet of this project. On this plan sheet, the PAVEMENT LINES (edge of the pavement) are shown. You can also see the SURVEY LINE (or the "L" Rev line) running from the left of the sheet "ahead" to the right of the sheet, then continuing on to Plan Sheet 5. (Note at Station 300+40, the notation "L" Rev). The top of the Plan Sheet (above -L- Rev) is considered *left* of the Survey Line. *Below Line L Rev* is considered *right* of the Survey Line as though you were standing on the Survey Line facing AHEAD. See the below illustration:



Notice on the above illustration, a -Y- line intersects the -L- line. Survey lines for roads other than the main line (L line) are usually designated as "Y-Lines". On Plan Sheet 7, note that Line -Y- intersects the -L- Rev line.

Remember - Throughout this course and when speaking of plans - LEFT refers to *LEFT of Line L* and RIGHT refers to the *RIGHT of Line L* as shown above. NOT left and right on the Plan Sheet.

On all highway construction plans and right-of-way plans, there is an arrow-like symbol indicating North. The direction of all control and boundary lines are in reference to this North arrow.



The direction of a Survey Line as you are advancing in stationing, as expressed by a bearing, defines the relationship between the direction of the survey line and a North-South line.

It is customary to orient drawings so the North direction is to the TOP of the plan. However, since plans for a complete highway project can seldom be confined to a single sheet, and must be a series of sheets, it is an accepted practice to make the plans extend from left to right without regard to the North direction. Look again at Plan Sheet 4 and see the NORTH ARROW at the top center part of the Sheet. Remember that Station Numbers *usually* increase from SOUTH to NORTH or WEST to EAST.

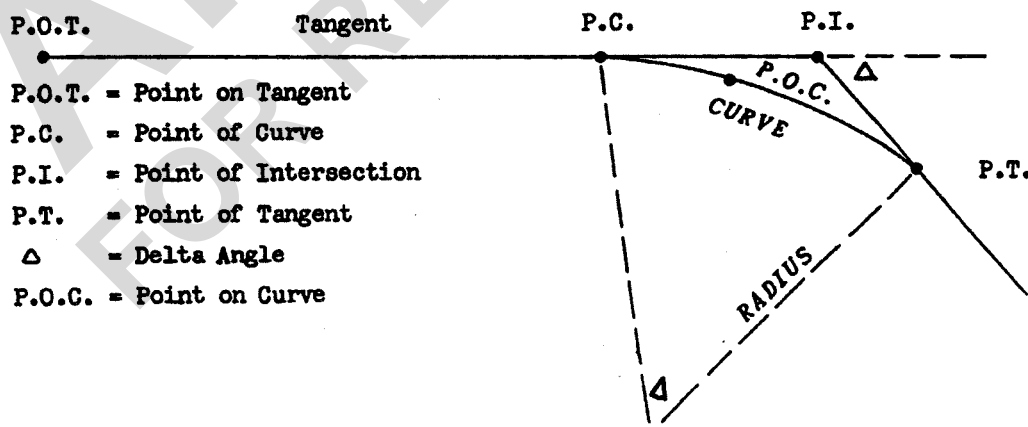
* Note: See APPENDIX D for definition of unfamiliar words or terms.

2. HORIZONTAL ALIGNMENT

Horizontal Alignment consists of tangents and curves and shows a *Plan View* of the direction of the roadway. Plan Sheet 4 shows the Horizontal Alignment - Sheet 24 shows the Vertical Alignment. (Vertical Alignment will be discussed later)

- a. **Tangent** - is any straight segment of the alignment. (Or a straight segment of roadway)
- b. **Circular Curve** - is an arc (segment of a circle) joining two tangents.

TYPICAL NOMENCLATURE:



Turn to Plan Sheet 11 (R-1025) and see the CURVE DATA in the bottom left corner of the sheet.

-Y3-REV
P.I. = 12+29.12
 Δ = 16°46'15" RT.
D = 10°00.00'
T = 84.46'
L = 167.71'
R = 572.9578'
SUPER = .06 FT./FT.
RUNOFF = 120'

-Y3-REV
P.I. = 15+39.27
 Δ = 27°38'15.92" LT.
D = 38°1'49.9'
T = 36.90'
L = 72.36'
R = 150.00'
SUPER = .04 FT./FT.
RUNOFF = 60'

-Y3-REV
P.I. = 18+84.08
 Δ = 17°01'53" RT.
D = 10°00.00'
T = 85.79'
L = 170.31'
R = 572.9578'
SUPER = .06 FT./FT.
RUNOFF = 120'

- P.I. = Point of intersection
- Δ = Delta angle of the curve
- D = Degree of curve
- T = Tangent length of curve
- L = Length of curve arc
- R = Radius of curve
- Super = Superelevation slope in feet/feet
- Runoff = Distance required to rotate super from flat to full super.
See Standard 100.02.

Questions on Horizontal Alignment:

1. At what station does State Project 8.1451102 begin? _____
2. Is the horizontal alignment on Plan Sheet 6 on a tangent or on a curve?

3. What do we call sheets that give Horizontal Alignment Information?

Answer these questions: (from the CURVE DATA on Plan Sheet 11)

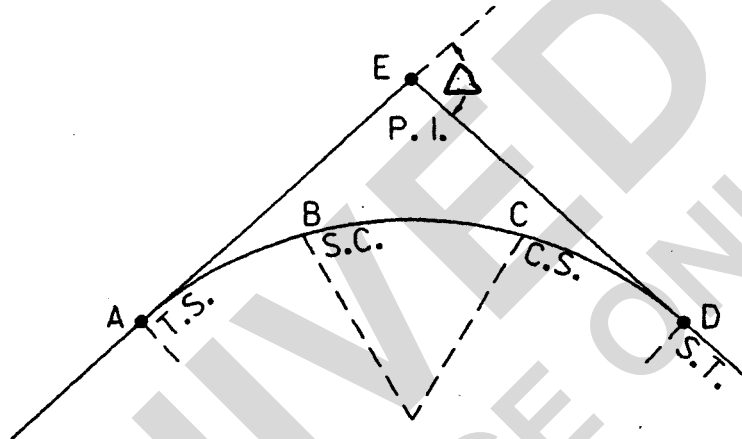
4. What is the station of the P.C. for the curve at P.I. Station 12+29.12?

5. What is the degree of curve for this curve? 16.43
6. Is the culvert at -L- Station 501+00 on a curve or a tangent?

Turn to APPENDIX G (page G-1) and check your answers.

- c. **Spiral Curves** - (transition curves) are introduced for the purpose of connecting a **tangent** with a **circular curve** in such a manner that the steering change from tangent to curve takes place gradually.

A **spiral** is a curve in which the degree of curve increases directly with the length of curve measured from the point where the curve leaves the tangent. The degree of curve is zero at the **tangent**, and, at the point at which the **spiral** meets the circular curve, it is equal to the degree of circular curve.



T.S. = TANGENT TO SPIRAL

S.C. = SPIRAL TO CIRCLE

C.S. = CIRCLE TO SPIRAL

S.T. = SPIRAL TO TANGENT

△ = DELTA ANGLE

Turn to Plan Sheet 7 (R-1025) and see the Curve Data in the lower left corner of the sheet:

RT.LN.
P.I. = 349+25.94
Δ = 19° 9' 1.00" RT.
D = 2' 0" 0.00"
L _s = 300'
θ _s = 3' 00"
T _s = 633.47'
L _c = 657.51'
R = 2864.789'
U = 200.0287'
V = 100.0261'
P = 1.3089'
Q = 149.9863'
SUPER = 05 FT./FT.

LT.LN.
P.I. = 349+76.15
Δ = 19° 09' 1.00" RT.
D = 2' 0" 0.00"
L _s = 300'
θ _s = 3' 00"
T _s = 633.47'
L _c = 657.51'
R = 2864.789'
U = 200.0287'
V = 100.0261'
P = 1.3089'
Q = 149.9863'
SUPER = 05 FT./FT.

Now turn to Plan Sheet 11 (R-1025) and look at the CURVE DATA for the first curve on -Y-3 Rev. Notice in the curve data for this particular curve that the SUPERELEVATION is 0.06. FT./FT. and the RUNOFF is 120 feet.

- d. **Superelevation of Curves** - "Superelevate" may be defined as the rotating or banking of the roadway CROSS SECTION to overcome the centrifugal force that acts on the motor vehicle while it is traversing *curved sections*. In other words, when you are in a curve, your car tends to be thrown to the outside of the curve. So, to overcome centrifugal force, the normal roadway cross section will be "tilted" to the superelevated cross section. This tilting is accomplished by means of rotating the cross section about the inner edge of the pavement for divided highways so the inner edge retains its normal grade but the centerline grade is varied. On 2 lane pavements, the tilting is accomplished by means of rotating the section about the point of grade, normally the center of the pavement.

The distance required for accomplishing the transition from a NORMAL to a SUPERELEVATED SECTION is a sum of the "Runoff" and the "Runout", and is a function of the design speed, degree of curvature, and the rate of superelevation. See Standard No. 100.01 and 100.02 in the Roadway Standard Drawings book to see the elevation for 2 lane pavements and divided highways.

Answer these questions: (See Plan Sheet 7 R-1025 for the answers)

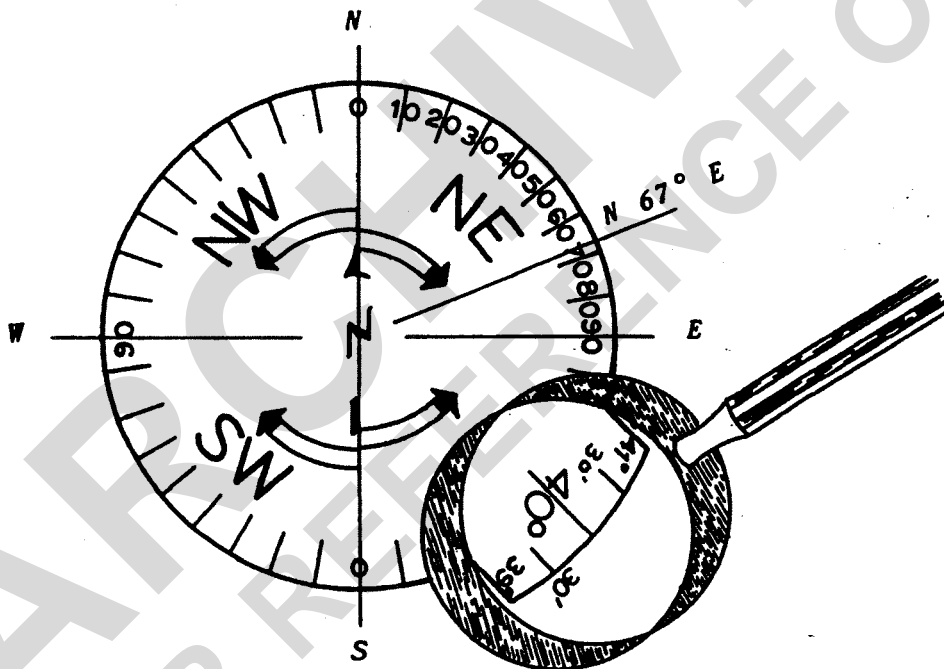
1. What is the station number of the C.S. (curve to spiral) for this curve on the LEFT lane? _____
2. What is the length of the radius for the curve on the left lane? 2000'
3. What is the SUPER ELEVATION for this curve? 0.06

Turn to Appendix G (page G-1) and check your answers.

- e. **Bearings** are used on a set of plans to indicate *direction* of the SURVEY LINE; also, direction of PROPERTY LINES.

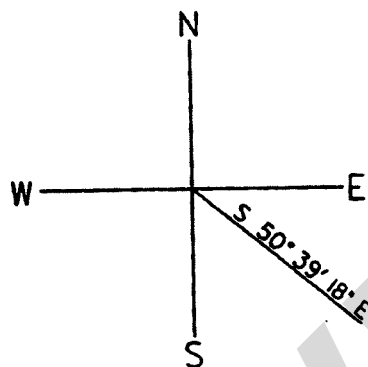
All Bearings on the plans must be accurately described as to direction, in degrees, minutes and seconds. It is not sufficient to describe a line or bearing simply as Northeast or Southwest. The bearing must be described as so many degrees, minutes and seconds in the direction in which the line is progressing. The accuracy of calculations are dependent on exact measurements of distances and bearings. A bearing might be written as N 65° 15' 30" E.

There are 360 degrees in a full circle. There are 60 minutes for each degree and 60 seconds in each minute. When shown as a compass circle, the circle is divided at North, East, West and South points into four sections of 90° each. The four 90° sections are called QUADRANTS and designated: Northeast (N.E), Northwest (N.W.), Southeast (S.E.), and Southwest (S.W.). This is illustrated by the sketch which follows:



Bearings are the angular measurement of a line running East or West of due North; and East or West of due South. Bearings do not go beyond 89° 59' 59" (read: 89 degrees, 59 minutes, 59 seconds), so after that they are either due East or due West, or in another quadrant. Due East is 90°00'00" of due North.

Turn to Plan Sheet No. 5 (R-1025) and note that the bearing S 50° 39'18"E is shown on Line L1 in reference to the North Arrow. This means that this line is running 50 degrees, 39 minutes, and 18 seconds East of due South.



Note also that on your reduced plan sheets, in the PLAN VIEW, scale is 1" = 100'. In the PROFILE VIEW, (Vertical Alignment) scale is 1" = 20' (Vertical), 1" = 100' (Horizontal). Keep this difference in mind when you look at the Vertical Alignment sections of the Plan Sheets.

Answer these questions (using Plan Sheet 6) (R-1025).

1. What is the Bearing of the property line which runs right of -L1- Station 336+35±?

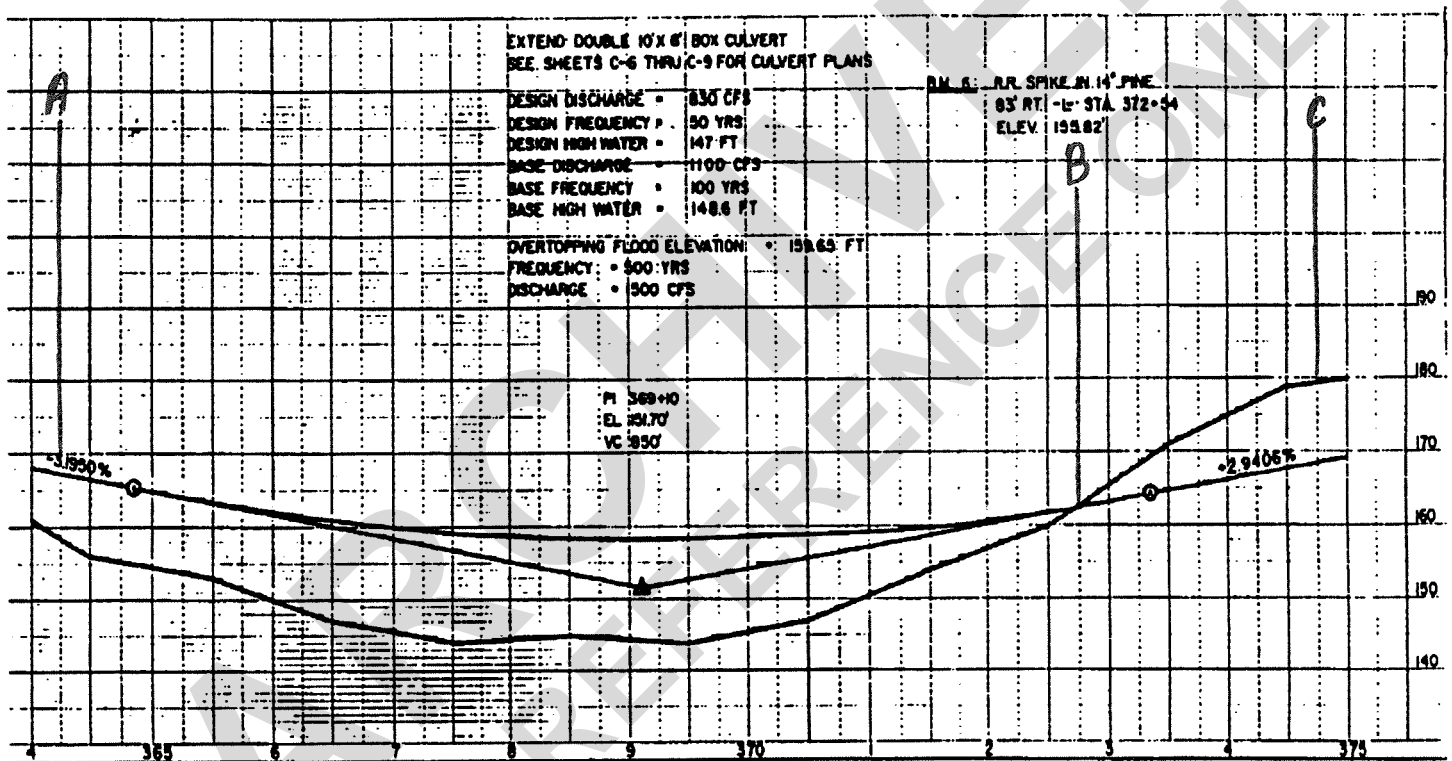
2. What angle does this bearing make with the due South direction? _____

Turn to Appendix G (page G-1) and check your answers.

B. VERTICAL ALIGNMENT

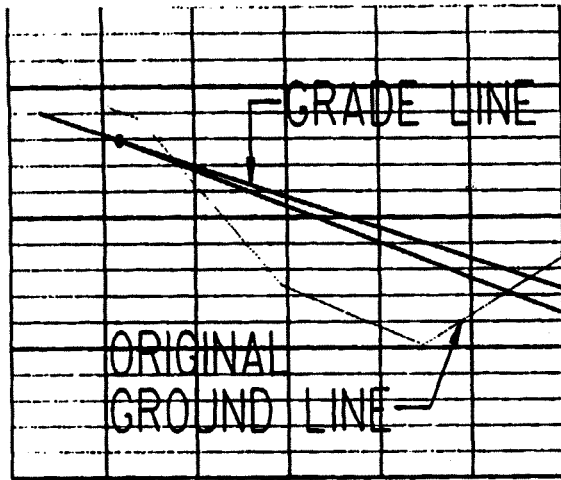
Now turn to Plan Sheet 27 (R-1025). The next few pages in this book are about the PROFILE VIEWS (or Vertical Alignment).

A PROFILE is like a "cross" section along the length of the roadway; rather than left to right across the roadway. NOTE: The profile shows *vertical alignment* (Grade Point) along the roadway (at the center line, survey line (Line L), or other line). The cut or fill at a point on the profile does not necessarily mean that the cut or fill will be the same at any other point on the cross section. For instance, the Left side of the roadway might be in a "cut" section, while the right side might be in a "fill" section.

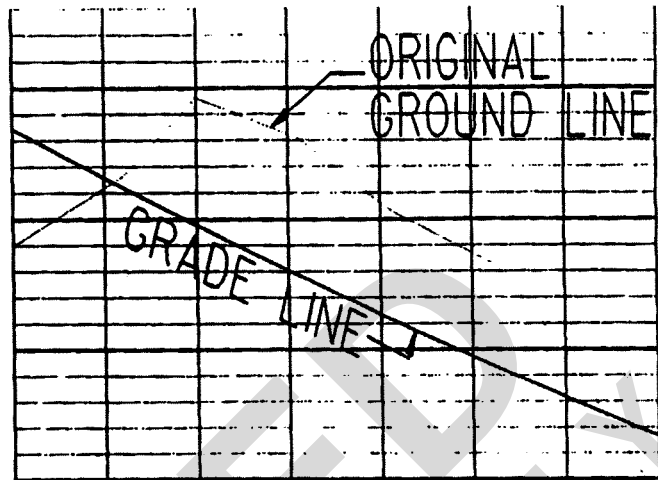


The Original Ground Line shows how the land was *before* construction began. When the Original Ground Line is drawn *higher* than the proposed Grade Line, you can see that some ground must be "CUT away" (B to C in above sketch). We call this a CUT AREA. When the original ground is drawn *below* the proposed Grade Line (A to B in above sketch), you can see that the area must be "filled in" to reach the elevation needed. We call this a FILL AREA. This CUT and FILL is the same as you will see on the cross sections.

A



B



In sketch A above, is the area beneath the Grade Line in a cut or fill? _____

You should have written FILL in the blank above. The *original ground line* is *lower* than the grade line. The area must be "filled in" to reach the elevation shown by the grade line.

Does the majority of sketch B above show a cut or fill area? _____

You should have written CUT in the blank above. The *original ground* is higher than the specified elevation of the Profile Grade Line. The ground must be "cut" away to get to the Profile Grade Line.

On the Profile View, the Profile Grade Line is usually shown by a heavy dark line. It is regular and smooth as the top of the roadway must be. The original ground line is usually irregular since the original ground is irregular (or bumpy) *before* construction begins.

The primary purpose of the Profile is to show the relationship between the proposed *Grade Line* and the *Original Ground Line*.

2. Proposed Grade Line

The GRADE LINE (PGL) is a graphical representation (picture) of the proposed elevations of the roadway at some designated point. The Typical Section will indicate at what point the elevations shown on the PGL refer. Example: Turn to Plan Sheet 2A, (R-1025) Typical Section 1, and note that the Grade Point is on \mathcal{C} of the -L- Rev.

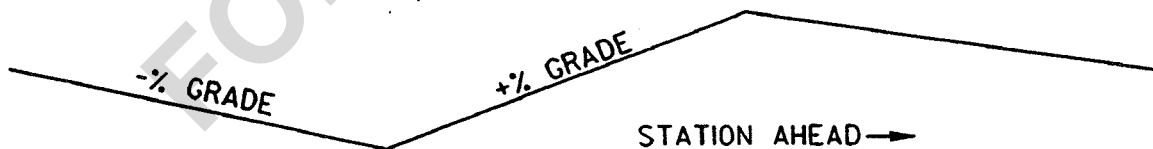
a. Elevations (Use R-1025)

Elevations are given in feet above an arbitrary datum plane (usually sea level). Look at the grade point of intersection (PI) on Plan Sheet 30. Note that the PI numbers are elevations (in feet) *above* sea level. At Station 492+70, for example, the elevation is 150 feet above sea level. The reference elevations are also located on the right and left edges of the grid. Reference points of known elevations are set by the engineers so they measure differences in elevations (vertical distances). Sometimes, markers will be set in trees or on structures and their elevations determined and recorded. These markers are called BENCH MARKS (BM) and are shown by Numbers (BM #1, BM #2, etc.). These BENCH MARKS are listed on Profile Sheets. Look at Plan Sheet 31 in the Top Right and find BM #17. Note the following notation: "BM #17: Railroad Spike in base of 24" pine, 94' right -L- Station 479+03, Elev. 188.59."

b. Grade

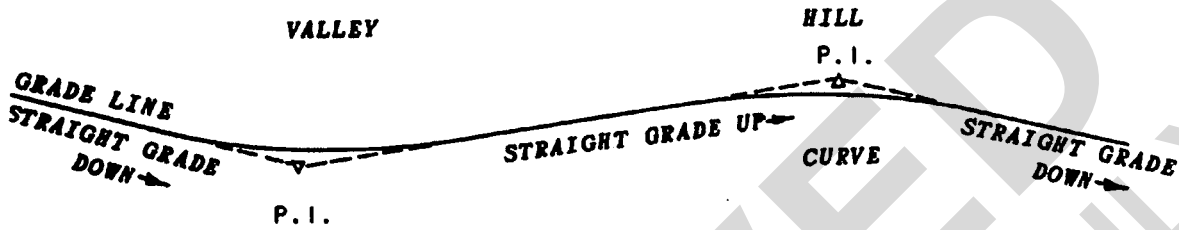
Grade is the slope of the roadway with a vertical rise or fall expressed as a percentage of the horizontal distance. That is, a +3% grade means a RISE of 3 feet per 100 feet of horizontal distance.

The grade is considered to be + (positive) or - (negative) depending upon whether it rises or falls as you proceed along the GRADE LINE in the direction of increasing stations. Look at Plan Sheets 31 and 32. What is the Grade at STA. 490+00? What is the Grade at STA. 501+00? You should have answered -3.2807% and +0.7426%. Although the GRADE LINE looks to be a hill & valley, the slope is only 3.2807% "downhill" and 0.7426% "uphill".



c. Vertical Curves

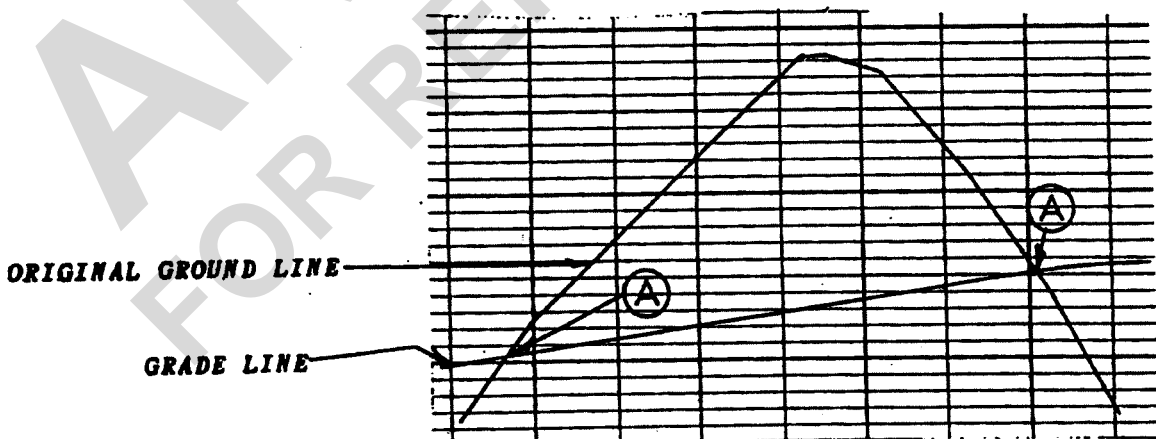
When the road goes over a hill or mountain, it must curve over the top, or, if it goes down in a valley, it will curve down and up, as shown below. These are VERTICAL (up and down) CURVES and are shown on the PROFILE SHEETS. Vertical Curves are parabolic in shape.



The P.I. (Point of Intersection) is shown by a small triangle at the intersection of the tangents. These P.I.'s are similar to the P.I.'s (Point of Intersection) for horizontal curves (turn back to page 5-2 and note this). See the P.I.'s on the sketch above. Notice that the P.I.'s are NEVER on the actual grade. They will be either above grade or below grade.


d. Grade Point

The *Grade Point* is a point where the *profile grade line* crosses the *original ground line*. (See sketch below) Point A shown in the sketch is a *Grade Point*. These Grade Points are good locations for intersecting side roads or driveways since the amount of cut or fill will be small. However, the first consideration for locating side roads or driveways would be safety.



Turn to Sheet 11 on plans.

The P.C. (Point of Curve) of the first curve on Y3 is at station 11+44.66.

1. What is the station of the P.T. for this curve? 11+70.31
2. Which direction does the curve that starts at station 15+02.37 go?
(right or left) left
3. On which side of Line -L- does Y3 begin? _____
4. How many minutes equal one (1) degree? _____
5. How many seconds equal one (1) minute? _____
6. Is the roadway section opposite the one-story frame dwelling located Lt. of Sta. 410+00 left lane in cut or fill? fill
7. On sheet 7, (R-74AA) at station 80+00 -L-, are the CONTROL OF ACCESS lines (represented by Symbol  shown on the Lt. of Line "L", Rt. of Line "L", or on both sides of Line "L"? _____
8. What is the elevation of B.M. #5 (R-1025)? _____
9. Where is B.M. #21 located (R-1025)? 7

Now look in your plans and answer these questions:

10. What is the P.I. (Point of Intersection) elevation at station 478+55?
1167.9
11. What is the elevation of the Profile Grade Line at Station 364+00?
1166.7
12. At station 360+00, what is the Grade?

13. If the property owner Rt. of Sta. 380+50 on Line L asked you whether the proposed roadway adjacent to his property is in a "cut" or a "fill", what would you tell him?

14. How many feet of "cut" would there be to the PROFILE GRADE from the ORIGINAL GROUND at this station? _____

NOW CHECK YOUR ANSWERS BY TURNING TO APPENDIX G (page G-2).

HOW DID YOU DO? IF YOU MISSED ANY, BE SURE AND GO BACK TO SEE WHERE YOU WENT WRONG - CORRECT ANY ERRORS.

C. CONSTRUCTION ITEMS

In addition to showing the *horizontal* and *vertical alignment* discussed in the preceding sections, the PLAN and PROFILE Sheets contain a picture and a description of the work to be done on this project. In the following section, you will be given examples to help you locate these items on the Plan and Profile Sheets and on other sheets in the plans.

1. PAVING LIMITS

Paving Limits are the LENGTH and WIDTH of roadway to be paved on any portion of a project. Look now at Plans R-74AA at Sta. 33+44.97 Y and you will see the following note: "Station 54+32.82 Ser. Rd. 'C' - Begin Construction." Now turn to Plan Sheet 2-D (R-74AA) and see Typical Section No. 14. This section shows the *Width of Pavement*, etc. to be used on this service road.

Question: How wide is the pavement for Ser. Rd. 'C'? _____
Make certain you see this width on Plan Sheet 2D, Typical Section No. 14.
NOW TURN TO APPENDIX G (page G-2) AND CHECK YOUR ANSWER.

2. EARTHWORK

Earthwork is the amount of "cut" and "fill" earth to be moved between particular stations. Earthwork is expressed in cubic yards. Areas to be "cut" will be expressed as excavation; areas to be "filled" will be expressed as embankment.

a. Construction Limits & Slope Stake Line

The lateral (side) limits of grading are shown on PLAN Sheet 7 (R-1025) by a dashed line and noted by -C- and -F-. Find the SLOPE STAKE LINE on Sheet 8. Notice on the *right* side at Sta. 361+00 the limits change from a "cut" section to a "fill" section. Follow along the slope stake line on the right of the Plan portion of sheet 8 and list the approximate stations where the earthwork changes from cut to fill or from fill to cut.

1. Sta. 361+00
2. Sta. 361+50
3. Sta. 361+75

TURN TO APPENDIX G (page G-2) AND CHECK YOUR ANSWERS.

The SLOPE STAKE LINE will not always be the same as the *construction limits*. The exceptions would be where lateral ditches, berm ditches, etc., fall outside of the slope stake line. Look at Sta. 362+00 to Sta. 364+30 on Sheet 8 on the Rt. side. You will note that a lateral "V" ditch is *outside* the slope stake line. Also, the construction limit is 5 ft. beyond the slope stake in a cut section (see Std. 200.03).

b. Earthwork Summary (R-74AA)

The EARTHWORK SUMMARY is normally shown in the No. 3 series Plan Sheets (See Sheet 3D). These figures indicate the "summary" of earthwork volumes between different break points. Each Break Point is sub-totaled. Look at the 5th summary. In this SUMMARY, 105,557 cubic yards of *cut* and 43,475 cubic yards of *fill* is needed. Therefore, the remaining 62,082 cubic yards of earthwork is classified as *waste*.

Look at Plan Sheet (R-74AA) 3D for the answer to this question:

1. How much fill material is required in the summary from Sta. 34+00 to Sta. 60+50 _____ ?

TURN TO APPENDIX G (G-2) AND CHECK YOUR ANSWER.

3. DRAINAGE

Look at Sheet 7 of the Roadway Plans for Project R-74AA. In Plan View note that storm drains are shown with heavy dark lines (see an example of pipe at -L- Sta. 78+50). Also, the size of pipe is written on the Plan View and additional pipe detail may be given on the Profile View. (The Station, Length, Size and Class of each pipe is noted in the "List of Pipe, Endwalls, etc." on Sheet 3A & 3B). Example: Look at Station 78+50 and see a heavy dark line which extends across the entire roadway. See the note 108' - 15" RCP which indicates the size and length of pipe to be used. Now look in the List on Sheet 3A at Station 78+50 and note that 108 feet of 15" R.C. Pipe Class III is required at structure 56B. Also note that a MDI Type B is required, with grates and frame. Sheet 7 indicates that there are two grates (2GI) on each structure.

Answer these questions on Pipe:

1. What total length of pipe is required at Sta. 83+50? 200'
2. What size of pipe is required at Sta. 75+65? 24"
3. What class of pipe is required at Sta. 75+65? 24, 70'
4. What type of pipe is required at Sta. 75+00? 7.5'

TURN TO APPENDIX G (Page G-2) AND CAREFULLY CHECK YOUR ANSWERS.

A NUMERICAL DRAINAGE LAYOUT is used on most projects. The group of structures 56A, B, & C, 58 & 59 on Sheet 7 is an example of a complex drainage system. Structures 57 on Sheet 7 and 63 & 64 on Sheet 8 are examples of simple drainage systems.

Minor Drainage Structures consist of: drop inlets, junction boxes, manholes, spring boxes, catch basins, headwalls, and flared end sections. Look at Sta. 78+50 on Sheet 7 and see the numbers and letters 2GI. Look at Sta. 88+90 on Sheet 8 and see 3GI at Structures 60, 61 & 62. This indicates that drop inlets with 2 grates are required on each side of -L-Line and at the median centerline at Sta. 78+50, and that drop inlets with 3 grates are required on earth side of Service Road "C" and the median centerline at Sta. 88+90.

Answer these questions:

1. On Plan Sheet 7, what type of inlet is proposed for the DROP INLETS at Station 83+50? 2GI
2. At Station 83+00, what type of inlet is required on the RIGHT side at Structure 57? 3GI

TURN TO APPENDIX G (page G-2) AND CHECK YOUR ANSWERS.

Look at Roadway Plan Sheet 8 at station 86+44.95 and you will notice that a 3BBL 11' x 10' Conc. Box Culvert is shown. Now look at Sheet 20 and at station 86+44.95 you will see this note: Exist. 3-11'x10'. On the Profile Grade Line you will see a rectangular box which indicates the approximate FLOW LINE ELEVATION of the culvert and the elevation at the top of the culvert. For the exact flow line elevations, it will be necessary to see the culvert plans in the structure plans for the project.

Note: You will be given more detailed information on Culverts when you get to the "Structure" section of this course.

Answer the following questions using Culvert Plan Sheet C1 in the Structure Plans for Project R-74AA (all culvert plans are at the back of the structure plans):

1. How many pounds of reinforcing steel (total) are proposed for the left Culvert Extension at Sta. 86+44.95? _____
2. How many cubic yards of Class A Concrete (total) is proposed for this left culvert extension? _____

TURN TO APPENDIX G (page G-2) AND CHECK YOUR ANSWERS.

4. FENCING

Look at Sheet 1B (R-1025) and notice the conventional symbol for a Proposed Woven Wire Fence. Notice on Plan Sheet No. 5, (R-74AA) the proposed woven wire fence on the left side of Ramp B continues along the proposed right-of-way line.

Answer the following questions by using Sheet 5 as reference:

1. At approximately what station does the woven wire fence begin on the left side?
86+10
2. At approximately what station does the woven wire fence end on the left side?
86+11

TURN TO APPENDIX G (page G-2) AND CHECK YOUR ANSWERS.

5. UTILITIES (PROJECT R-74AA)

Utilities are shown on the plans using symbols with appropriate annotation. Utilities include water mains, sanitary sewers, gas mains, underground power cables and conduits, underground telephone cables and conduits, underground television cables, and aerial power, telephone and CATV lines. Note that the aerial utility lines are not shown, but only the poles and towers to which they are attached are shown.

On *Plan Sheet 1A*, the general notes include a listing of all known utility owners on the project.


The roadway plans show the various utility facilities as topographic features of the area.

The **Utility Construction** plans show any utility work which is to be performed by the highway Contractor as part of the highway construction. *Plan Sheet U-2* is an example. Notice the proposed 6" water line is left of Service Road C. The various pieces of the proposed water line are labeled in the boxed areas. Notice the portion of the existing 6" water line which is to be abandoned. Notice the detail drawings on this plan sheet and on *Plan Sheet U-10*. Any details necessary to further describe the requirements for the proposed utility work will be shown.

The **Utility Conflicts** plans show any utility work which is to be performed by others (usually by the utility owner). These plans are included as information to aid in the coordination of the highway construction work. Notice on *Plan Sheet U-13* the existing buried telephone cable to be abandoned, the existing power and telephone poles to be removed, and the proposed power and telephone poles.

6. MISCELLANEOUS (Refer to Project R-74AA)

a. Guard Rail

Turn to Sheet 1B of your sample set of plans and note that the Conventional Symbol for Guard Rail is:  Now look at Sheet 5 at Station 26+90, Lt. side and notice that the proposed Guard Rail is shown from Sta. 26+90 to 32+24 (beginning of bridge). Turn to the Summary of Guard Rail, on Sheet 3C and see the breakdown of all Guard Rail on this project. Sheet 3C shows Sta. to Sta., Rt., or Lt., Line, Linear Feet, Shop Curved, Bridge Anchor Unit and Types, Tie Rod Anchors, and Terminal Sections. This summary also shows the Grand Total of each estimated quantities of Guard Rail and etc., that is proposed on this project.

Answer the Following Questions (R-1025):

1. On sheet 6, the Guard Rail begins at L1 Sta. 330+00 on the left side - what Station does the guard rail end? _____
2. Look at Plan Sheet 3E. How many Linear Feet of Straight Guard Rail are shown in the summary? _____

TURN TO APPENDIX G (page G-2) AND CHECK YOUR ANSWERS.

b. Obliteration of Existing Road

Look at the RIGHT SIDE of Plan Sheet 11 on the Plan View and you will see Proposed Obliteration of Existing Pavement. This symbol means that part of the roadway is to be obliterated on this Plan Sheet.



c. Right-of-Way Markers (R-1025)

Turn to Plan Sheet 1-B of your sample set of plans and under "Conventional Symbols" note the sign for a "Proposed Right-of-Way Marker" (by others). Now turn to Plan Sheet 8 and look at the left side of Line "L" (above Sta. -L- 356+00) and you will see the symbol for the proposed right-of-way marker. Note locations where the right-of-way changes in width. Near the right-of-way markers, you will see the *station plus* and *distance from the survey line shown*. As an example, look at Sta. 367+60, Lt. side (Plan Sheet 8). This means that the distance from the *Survey Line* is 95 feet and the station is 367+60.

Answer the following questions:

1. How many right-of-way *markers* are proposed on the *left* side of the project from Sta. 355+00 to Sta. 370? _____
2. What is the distance from the Survey Line -L- to the right-of-way marker on the Lt. side of Sta. 424+36.01? _____

TURN TO APPENDIX G (page G-2) AND CHECK YOUR ANSWERS.

D. EROSION AND SEDIMENTATION CONTROL

The Sedimentation Control Act of 1973 requires those persons engaged in land disturbing activities to plan and implement effective temporary and permanent control measures to prevent accelerated erosion and off-site sedimentation. The law prohibits visible off-site sedimentation from construction sites but permits that land-disturber to determine the most economical and effective methods for erosion and sedimentation control. The Department of Transportation's commitment is to take all reasonable measures to protect all public and private property from siltation damage caused by any departmental activity. In order to meet these goals, the set of erosion and sedimentation plans are prepared consistent with current changes in the rules and regulations and utilize designs and design criteria for application of our program.

The plan prepared as discussed above utilizes some of the following erosion control devices:

(See plan sheet EC-9/Const. 7 R-74 AA)

On Service Road "C" station 76+50 left, a Temporary Rock Sediment Dam Type-B is shown at the end of a 2 ft. base ditch. A Temporary Rock Sediment Dam Type-B is a small dam structure with a rock weir outlet and a built-in sediment basin. This device is used in drainage ditches to detain sediment-laden runoff and to trap sediment to protect receiving streams and adjacent property.

The Temporary Rock Silt Check Type-A shown in the 2 ft. base ditch at station 83+50 left on Service Road "C" is used in the same manner as the temporary rock sediment dams. This measure however, does not have a defined sediment pit, but utilizes the base ditch or a natural formed pit as a silt storage area.

On Service Road "C" station 75+00 right, a Silt Basin Type-B is shown at the 2 G.I. located in the ditch line. The Silt Basin Type-B is a temporary basin built to collect sediment flowing through a drainageway. The Type-B basin is generally built in conjunction with temporary rock silt checks and other devices that control or slow down water flow. At this location, the Type-B basin is used in conjunction with an inlet protection measure for a 2 G.I.

From station 81+00 to 83+60 left on Service Road "C", a Temporary Silt Ditch is shown. This measure is used at the toe of fill slopes to divert sediment laden runoff into sediment basins, temporary rock sediment dams, temporary rock silt checks, and other sedimentation control measures. Note that 3 temporary rock silt checks Type-B are shown in the proposed temporary silt ditch. Type-B rock silt checks are used in ditches to prevent gullying by reducing water flow velocity.

A Temporary Slope Drain is shown at station 84+40 left on Service Road "C". A temporary slope drain is a flexible tubing or pipe used to carry concentrated runoff from the top to the bottom of a cut or fill slope without causing erosion along the slope. Slope drains are generally used in conjunction with an earth berm to convey runoff down the slope until permanent water disposal measures can be installed.

These erosion control devices are designed consistent with standards promulgated by the N.C. Sediment Control Commission. If implemented accurately in the field, these devices along with the other measures shown on the erosion control plans will prevent off-site sediment damage until permanent vegetation is established.

ANSWER THE FOLLOWING QUESTIONS:

1. A temporary slope drain is used to carry concentrated runoff from the top to the bottom of a slope.

(True or False) _____

2. Temporary rock sediment dams constructed of Class-B stone and #5 sediment control stone are used _____ before they empty off the project site or into streams.

(along fill slopes, in channels)

3. A _____ cover is the most effective way to protect against sedimentation and erosion.

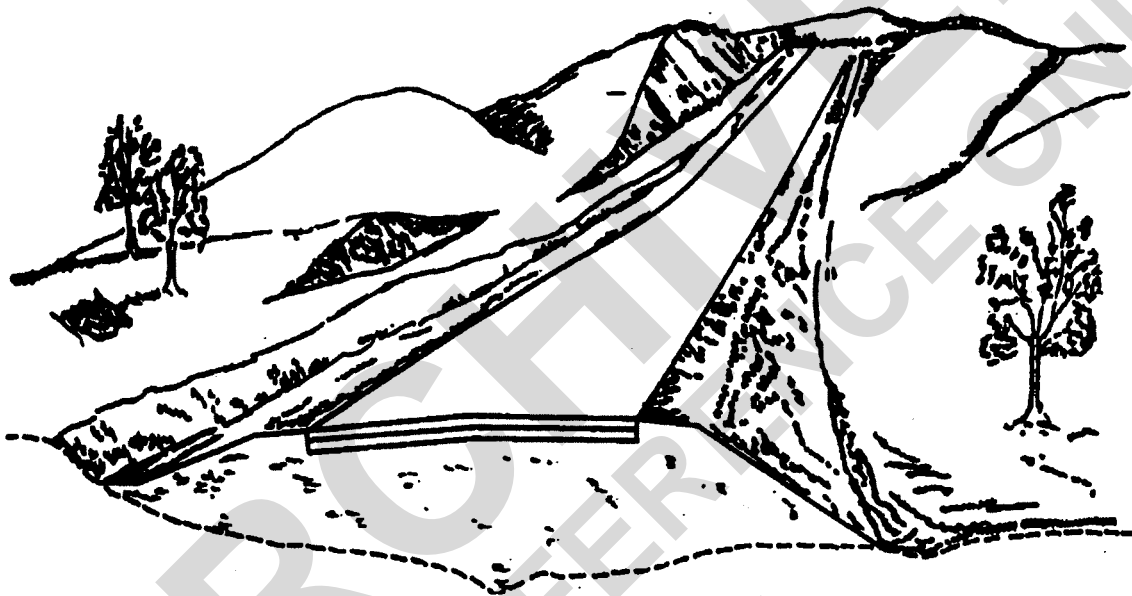
(temporary mulch, vegetative, topsoil)

TURN TO APPENDIX G (page G-2) AND CHECK YOUR ANSWERS.

CHAPTER SIX: CROSS SECTIONS

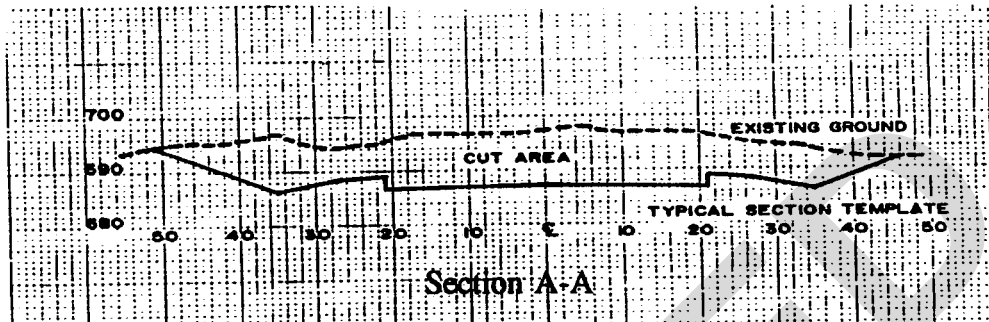
A. Definitions

A typical terrain is illustrated on the next page, upon which is shown a two-lane roadway. The illustration can only be a general picture, but it does convey a third dimension—depth which a plan view cannot show. Within the illustration, you can see one item of construction that is changing from station to station or foot to foot, and that item is earthwork (quantity of soil to be moved).

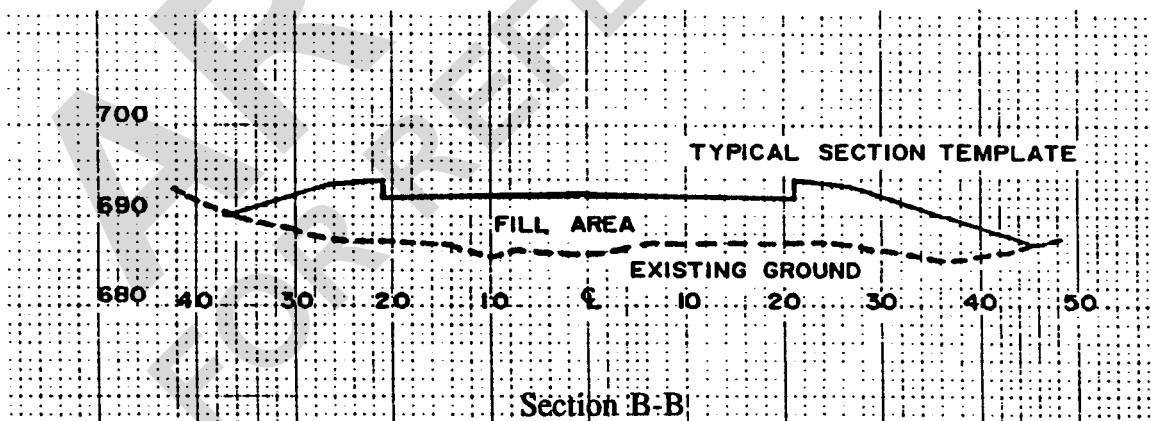


Earthwork is usually a major cost in highway construction. Its quantity, as well as many others, must be accounted for in the estimate prepared for the project. One method used to accomplish this is by using CROSS-SECTIONS. You will recall CROSS-SECTIONS were previously mentioned in the section of the Text called VIEWS.

Remember that the cross-section shows what you would see if the highway were cut at right angles to the centerline. See the illustration below with examples of cross-sections taken in cut and in fill:



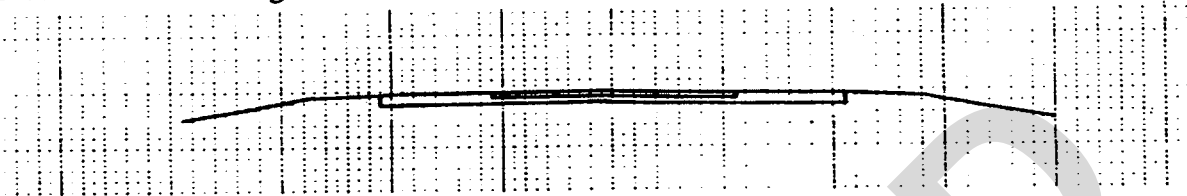
A-A CROSS SECTION—EARTH CUT AREA



The cross-section is not always all cut or all fill as shown above; it may also be part cut and part fill.

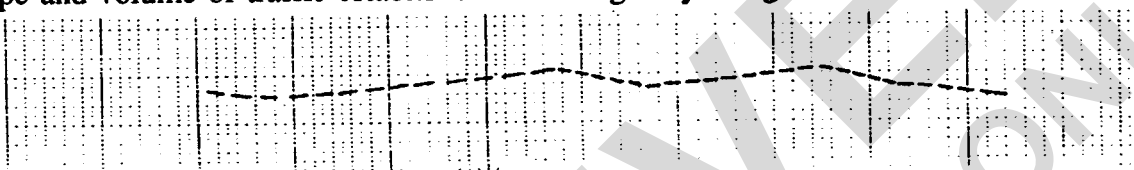
TYPICAL CROSS SECTIONS

Many factors are considered before combining a typical section of the roadway with a cross-section of the ground.



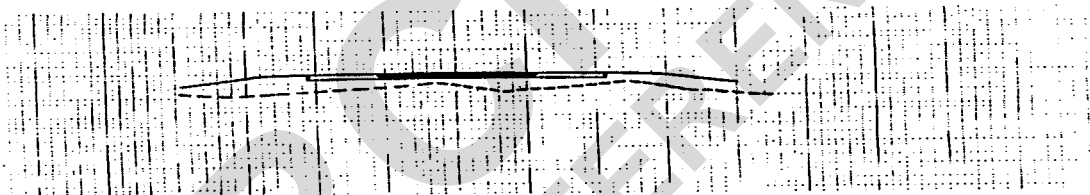
Typical Section

First, the typical section represents an end view of the pavement necessary to carry the type and volume of traffic established in the highway design.

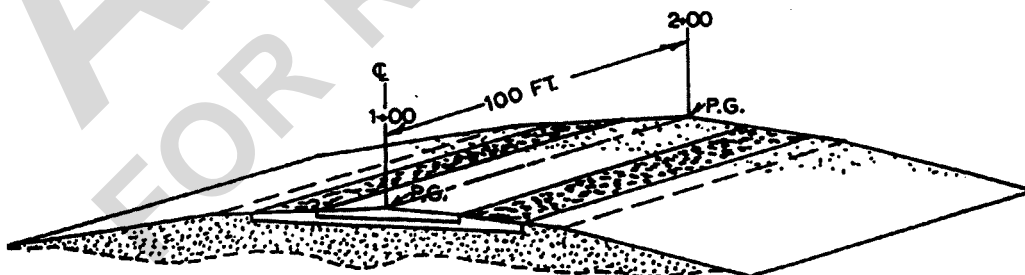


Existing Ground

Second, the cross section of the original ground is unique for every location along the centerline.

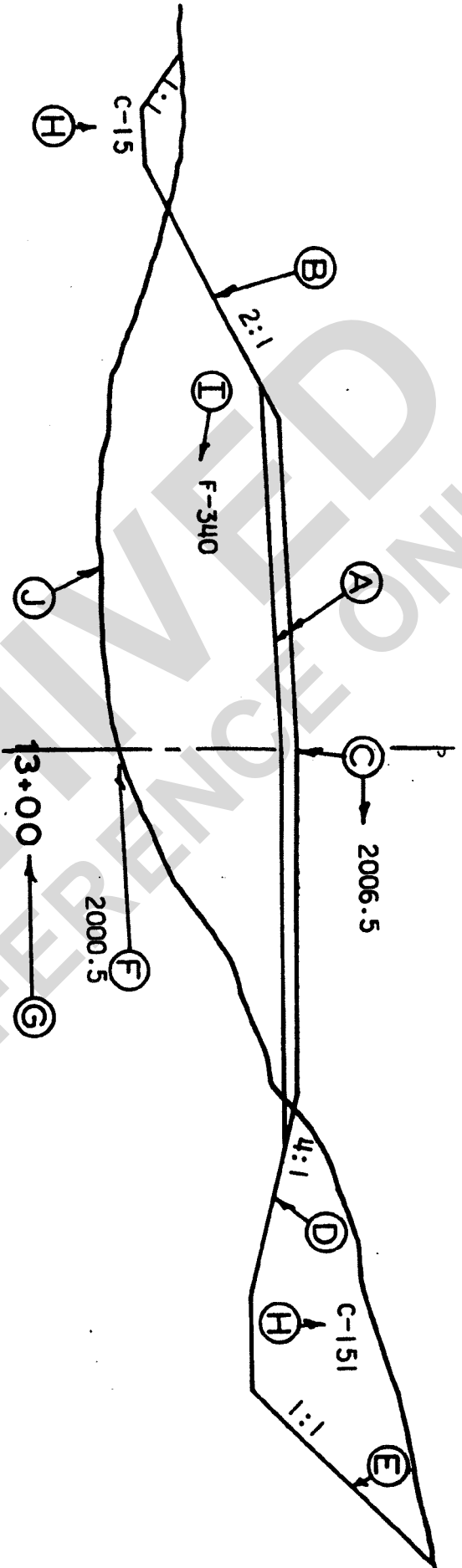


Third, by combining the typical section (referred to as the "template" when on a cross section) and the cross section of the original ground, a determination is made of the area of cut, fill, or both.



Fourth, the illustration above shows how the distance between cross sections is multiplied by an averaging of end areas to give a "volume" answer. The vertical point of reference for a typical section at a particular location along the roadway is called the Grade Point. Elevations change uniformly along the roadway and the line so formed is referred to as profile grade.

TYPICAL CROSS SECTION



THE FOLLOWING IS A LISTING OF FUNDAMENTAL ITEMS TO BE RECOGNIZED ON CROSS-SECTIONS.

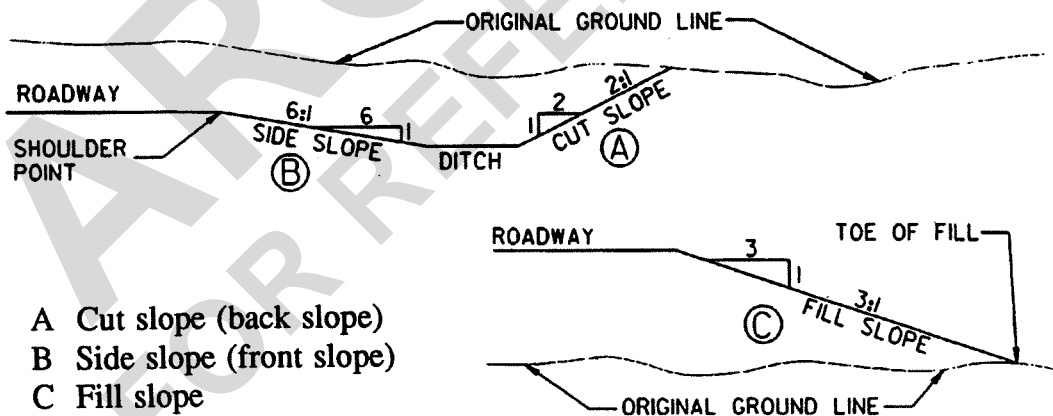
- (A) TYPICAL SECTION TEMPLATE
- (B) FILL SLOPE
- (C) ELEVATION OF FINISHED ROADWAY @ CENTER LINE (GRADE POINT)
- (D) SIDE SLOPE (FRONT SLOPE)
- (E) CUT SLOPE (BACK SLOPE)
- (F) ELEVATION OF ORIGINAL GROUND LINE @ CENTER LINE
- (G) STATION NUMBER OF THIS PARTICULAR CROSS-SECTION
- (H) AREA OF CUT (IN C.Y. PER 100 FT.)
- (I) AREA OF FILL (IN C.Y. PER 100 FT.)
- (J) ORIGINAL GROUND LINE

B. Grade (R-1025)

Now look at Plan Sheet X-5, a cross-section sheet, and note Station 328+00 and you will see the *sub-grade* (top surface of the roadbed prepared as foundation for pavement) *template* plotted for this station. (The subgrade is at El. 158.6). Now look back at Sheet 24, Sta. 328+00 in the Profile View and notice that the *Profile Grade Line* is plotted on the *Finished Grade* of the proposed surfacing which is at El. 160.00 (remember that you read the elevation numbers - in feet - on the Rt. or Lt. side of the Profile Section). Now look at Sheet 2a, Typical Section No. 1, and see that this particular section calls for Prop. Aggregate Base Course (A.B.C.) and which gives a total of surfacing. Therefore, the cross-section template *subgrade elevation* at this point is 160.0 (elevation) - 1.4' (pavement structure) = 158.6' elevation which you see plotted on the cross section on Plan Sheet 1 at Sta. 328+00. Also, the *profile grade* line is shown on Sheet 2A, typical section No. 1 and noted as: "Grade Point".

C. SLOPES

Slopes are usually referred to as "cut slopes" (back slopes), "fill slopes" and "side slope" (front slopes). A *cut slope* is that portion of the roadway between the side drainage ditch and the top of the cut. A *fill-slope* is that portion of roadway between the shoulder point of the roadway and the *toe* of the fill. The *side slope* is that portion of the roadway between the shoulder point and the adjacent drainage ditch. These slopes are measured as a ratio of horizontal distance versus each foot of decrease or increase in elevation (height). Below are some views of the various slopes used on cross-sections:



A 2:1 slope means that for every 2 feet of horizontal distance, the elevation (or vertical distance) increases (cut section) or decreases (fill section) 1 foot, depending on the type of slope shown in the preceding page.

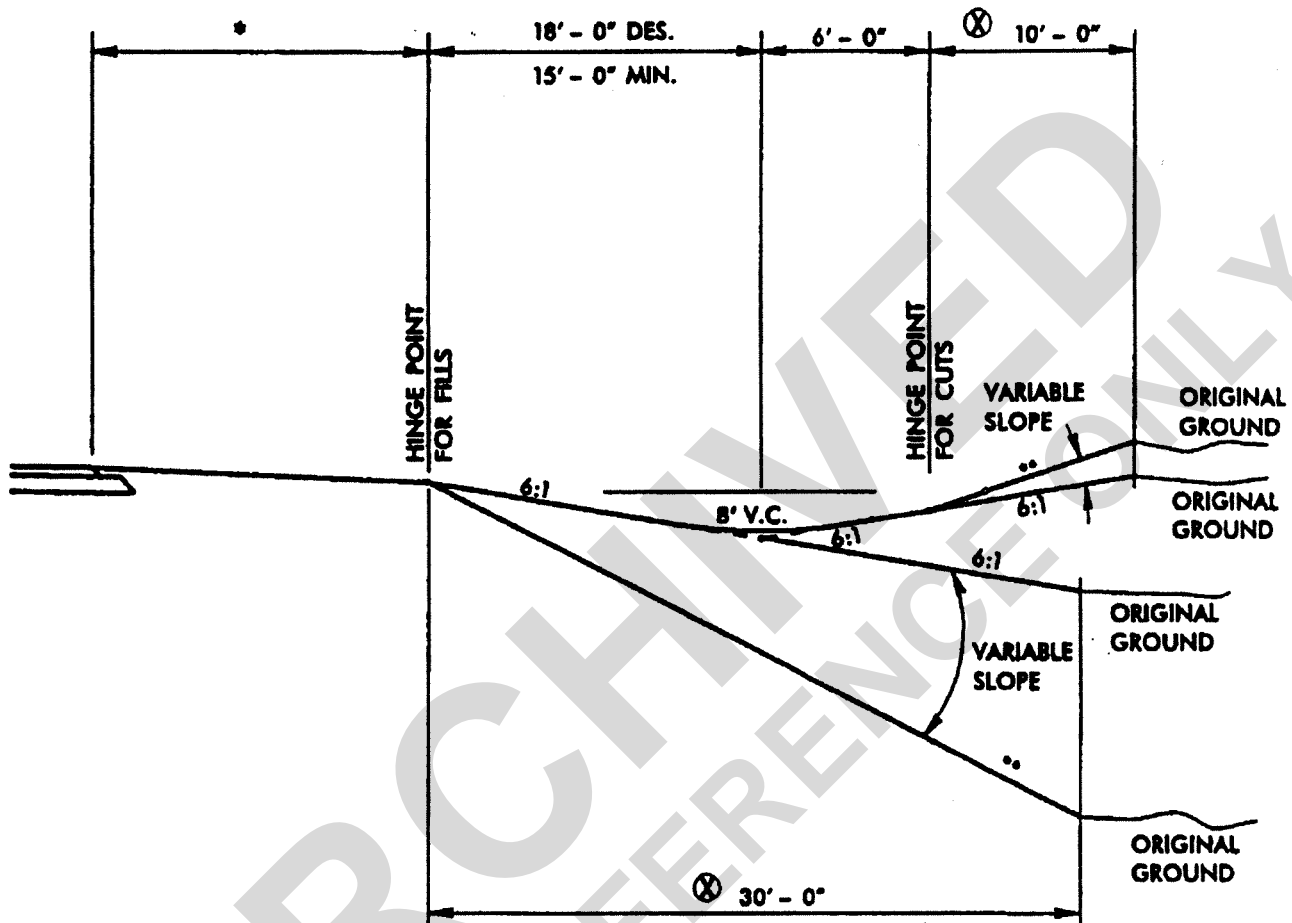
Now turn to Cross-Section Sheet X-3 and look at Sta. 310+47.00 (Rt. side of Plan Sheet). Notice that the slope shown here is a 3:1 slope which is a "fill slope".

D. HINGE POINT SLOPE DESIGN

The "Hinge Point" method of slope design is used on Rural Freeway Projects and many arterial projects wherever design considerations suggest its use and right-of-way is available. The hinge point method features variable slopes intersecting the original ground at a fixed distance from the edge of the pavement. Normal slope design methods use fixed slopes depending on cut or fill height.

The hinge point method has two major advantages. The first concerns safety since a wide area of reasonably flat slopes is available adjacent to the travel lanes for a recovery area for out-of-control vehicles. Secondly, these variable slopes blend more naturally into the existing topography presenting a more pleasing appearance.

(A) INTERSTATES, FREEWAYS, EXPRESSWAYS & OTHER FOUR LANE FACILITIES



* FOR SHOULDER WIDTHS, SEE ROADWAY DESIGN MANUAL, PART I, CHAPTER 1-4b, F-1.

⊗ WHEN SLOPE-STAKE POINT FALLS OUTSIDE THE HINGE POINT DISTANCE, MAINTAIN APPROPRIATE MAXIMUM OR MINIMUM SLOPE.

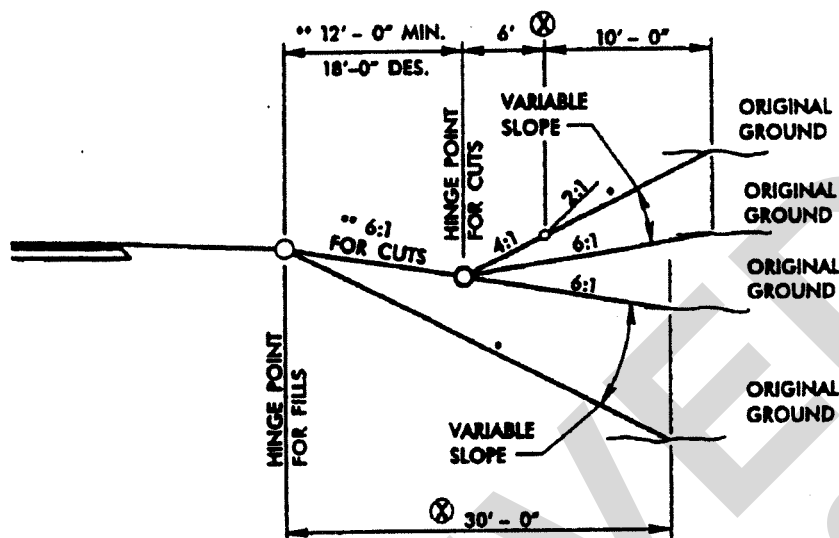
**INTERSTATE SIDE SLOPES SHOULD NOT BE STEEPER THAN 2:1 EXCEPT IN ROCK EXCAVATION OR WHERE THERE ARE OTHER SPECIAL CONDITIONS.

ON FREEWAYS AND EXPRESSWAYS, THE STEEPEST PRACTICAL SLOPES AS DETERMINED BY THE SOILS AND FOUNDATION SECTION SHOULD BE UTILIZED. NORMALLY THESE SLOPES WILL RANGE FROM 1 1/2 TO 2:1.

NOTE:

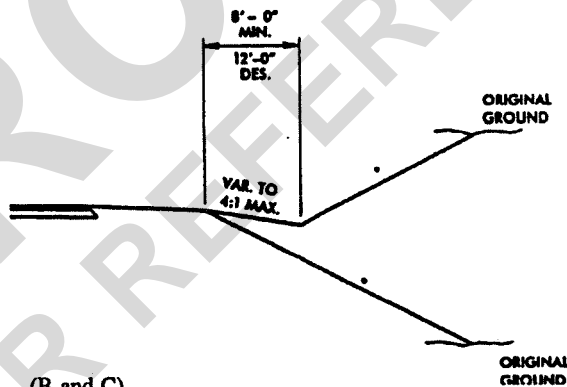
These guidelines are to be used along with sound engineering judgment. Special conditions such as soil type or the need for additional fill material may warrant the use of flatter or steeper slopes than those shown in these recommendations.

(B) ARTERIALS (OTHER THAN EXPRESSWAYS AND FOUR LANE FACILITIES), COLLECTORS, AND LOCALS (OVER 400 ADT DESIGN YEAR TRAFFIC)



⊗ WHEN THESE DISTANCES INDICATE SLOPES OUTSIDE THE LIMITS 6:1 TO *, THE DISTANCE BECOMES VARIABLE AND THE MAXIMUM MINIMUM SLOPE MAINTAINED.

(C) LOCALS (400 ADT OR LESS DESIGN YEAR TRAFFIC)



NOTE: (B and C)

** May vary to suit drainage requirements. Two-foot minimum ditch depth is required to cover driveway pipe.

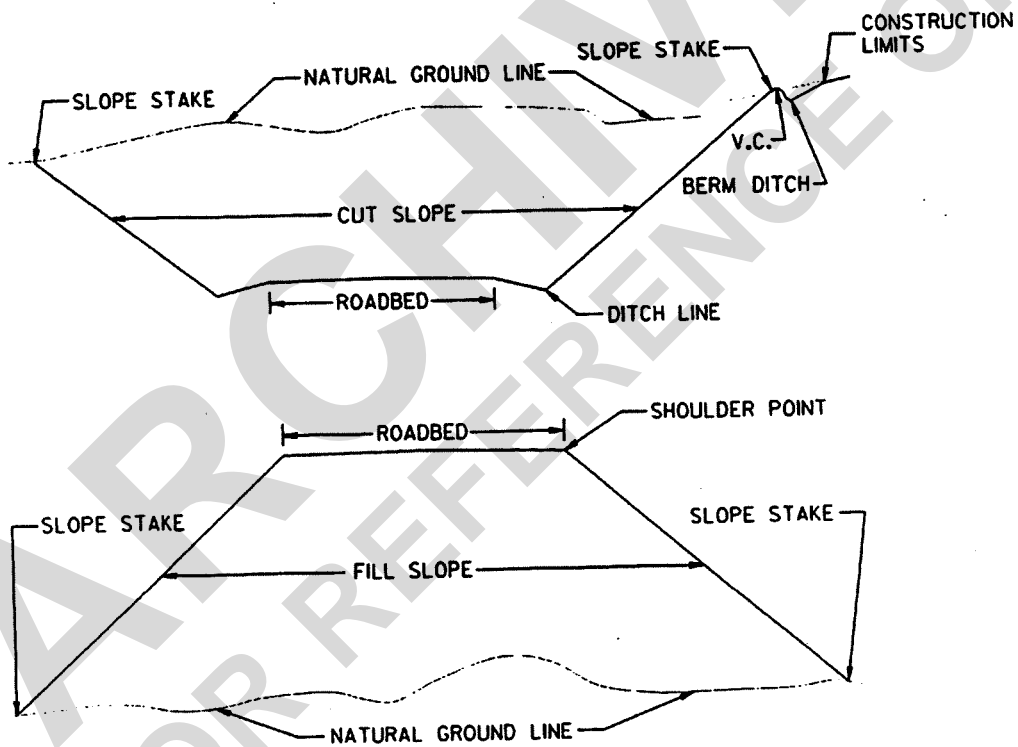
* The steepest practical slopes as determined by the Soils and Foundation Section should be utilized. Normally these slopes will range from 1 1/2:1 to 2:1. A guardrail study will be required for fill slopes steeper than 4:1.

E. SLOPE STAKE LINE

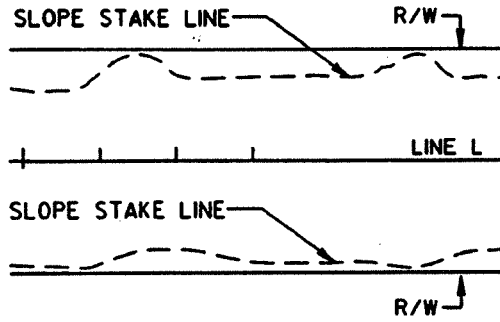
These stakes contain information that tells the Contractor how much "cut" or "fill" is required from the point of the stake to the ditch line (or shoulder point) of the roadway, depending on whether the stake is in a cut or in a fill section.

Slope stakes are placed at the point of intersection of the cut or fill slope and the natural ground line.

Example:



Example:



Now turn to Plan Sheet #10 (R-1025). Can you locate the slope stake line? Locate -L- Sta. 391+00. Scale the distance from the -L- Line to the Lt. slope stake line at this location. What is this distance? Place your answer here _____.

Now turn to Appendix G (page G-2) and check your answer.

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F. SUMMARY OF EARTHWORK (R-74AA)

Look now at Plan Sheet 3D - Summary of Earthwork. This sheet shows a breakdown of EARTHWORK on this particular project and consists of: Station to Station (for each *breakdown), Unclassified Excavation (amount of), Undercut Excavation, Embankment (plus percent shrinkage or swell), Borrow (excavation from outside project), and Waste (excavated material not used in project construction). Notice that a "SUBTOTAL" is shown for each breakdown. These Subtotals are very important in showing the amount of each item as described above at the end of each breakdown. This sheet also shows the GRAND TOTAL amount of each item.

Answer the Following Questions:

1. How many cubic yards of undercut exc. is proposed for this project? _____
2. Does the summary of earthwork on this project indicate Borrow or Waste? _____

* A "breakdown" may be determined by the length that earth moving equipment can reasonably move earth material (normally approximately 3000'-3500'). The "breakdowns" are also determined by the presence of bridges because of the inability of earth moving equipment to cross.

CHAPTER SEVEN: STRUCTURES

A. DEFINITION

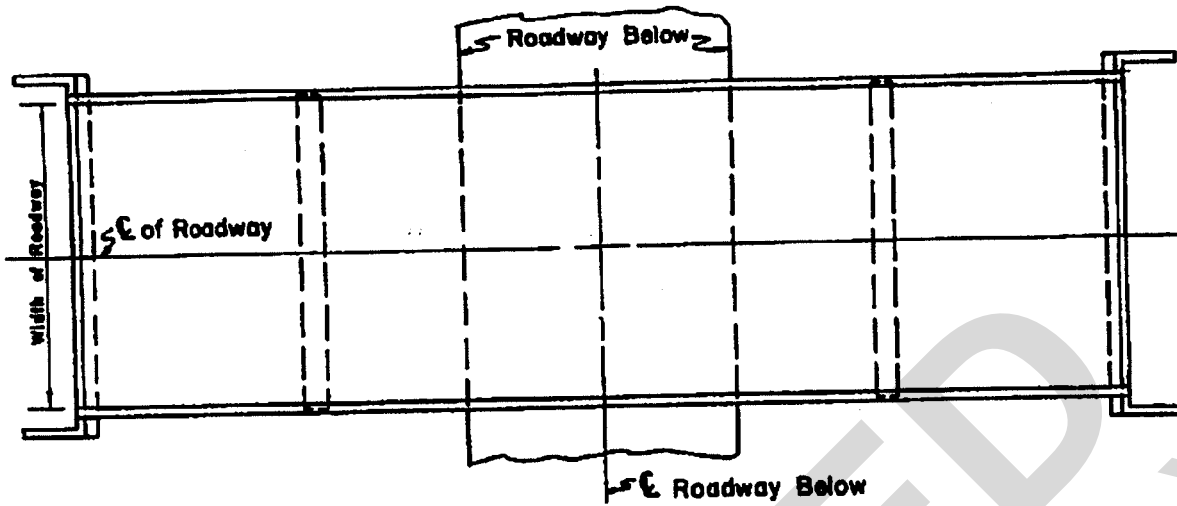
Structures normally consist of bridges, culverts, or retaining walls. It is important that you become familiar with structures that will be found in a set of plans.

Look at Plan Sheet 6, Sta. 59+87.88 -L- = Sta. 40+37.48 -Y- (R74 - AA) to see what a bridge looks like on a Plan Sheet. Look on Plan Sheet 19 for the Profile View.

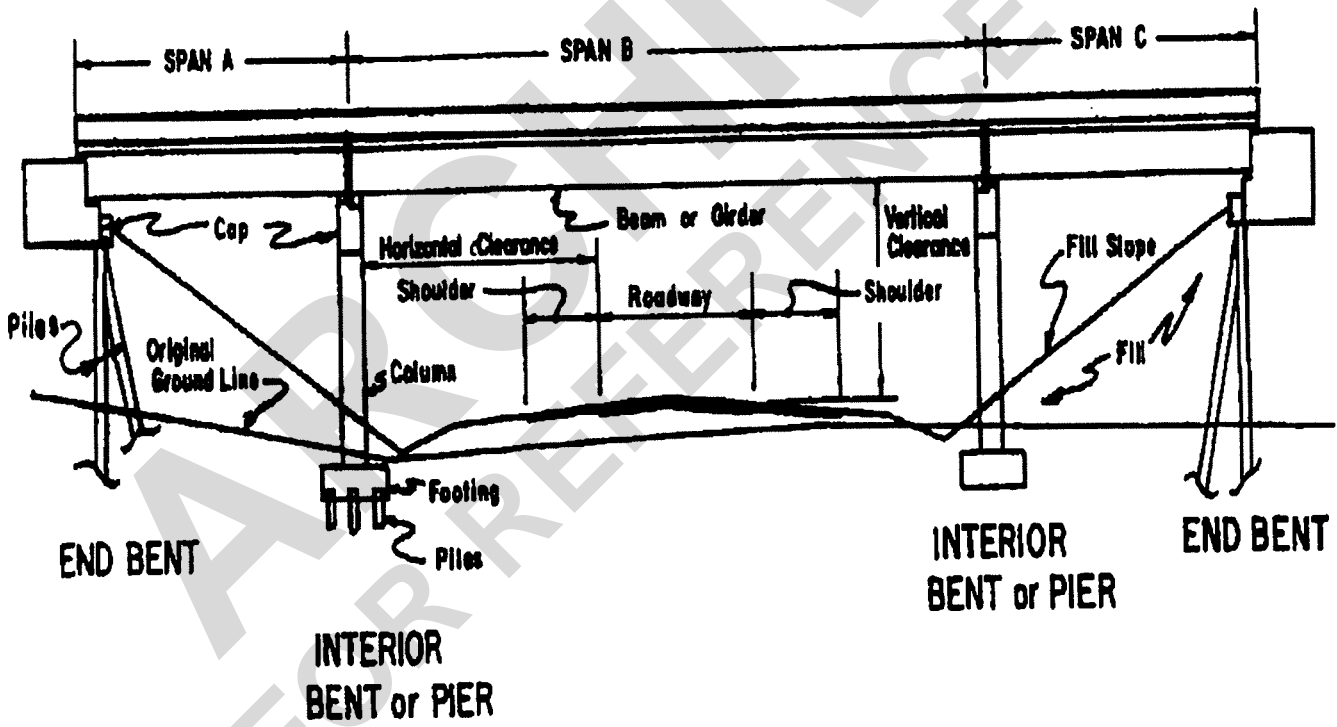
B. BRIDGE

A *bridge* is constructed over a roadway, stream, or railroad, or a combination of these. Shown on the following page are two views of a three-span bridge over a roadway. Look this structure over carefully.

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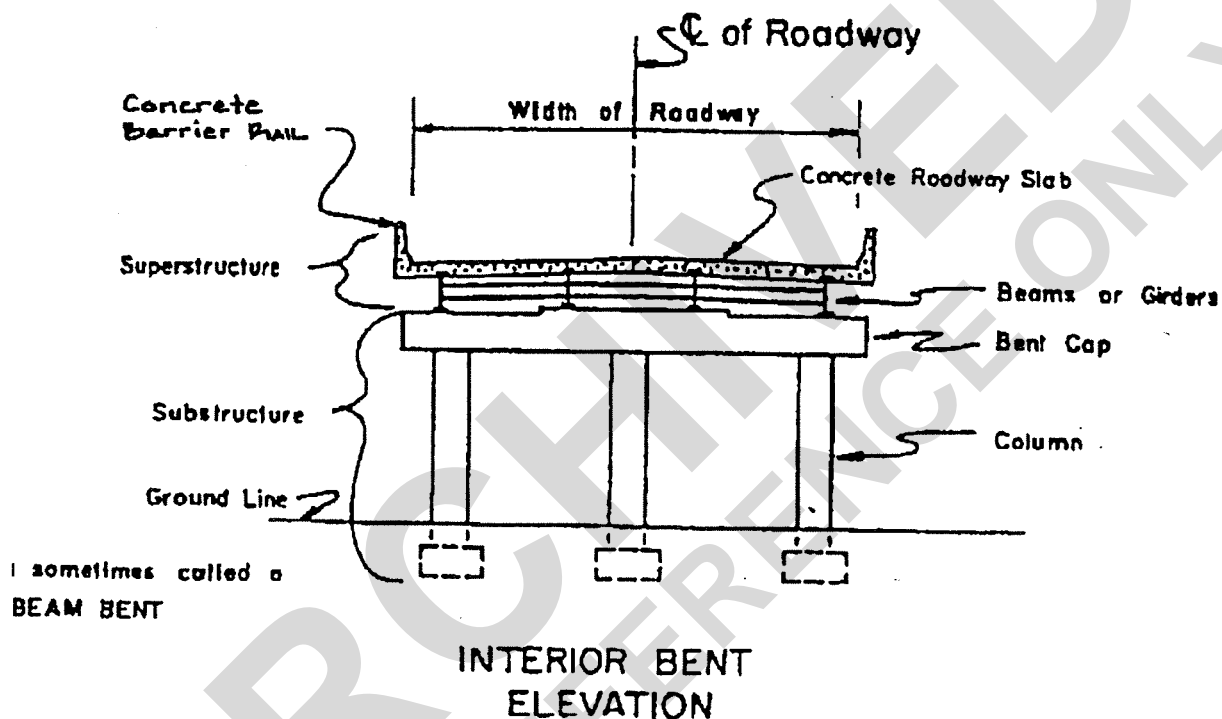
PLAN VIEW OF BRIDGE



ELEVATION VIEW OF BRIDGE

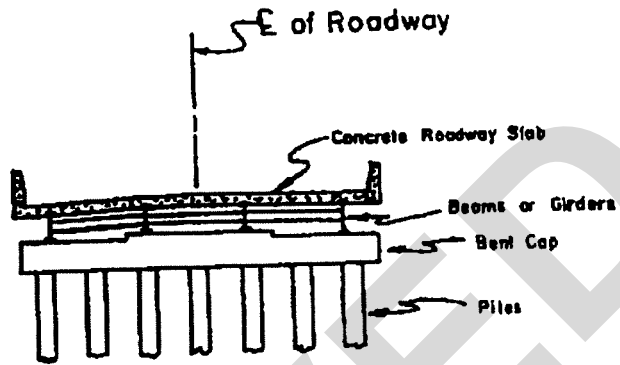
1. BENTS

The following are views of the most common types of *Interior* and *End Bents* that you will find in structure plans. The views show what you would see if you cut a section across a bridge *between* bents.



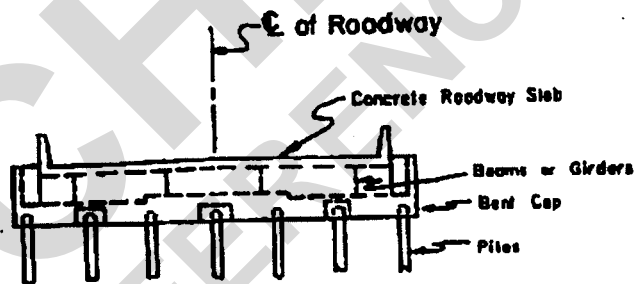
Turn to Plan Sheet S-68 (Plan Sheets for STRUCTURE & CULVERTS are numbered in the lower right corner). Note that the entire Substructure of the bridge (except footings) at Station 124+74.16 -L- is shown (the *Superstructure* is not shown). Bents 1, 2 and 3 are POST and BEAM BENTS with Footings on Piles. Look now at Sheet S-73 and see the Plan View of Span A of the bridge. Sheets S-96 thru S-101 are the plan sheets for Bents #1, #2 and #3.

At times you will see a PILE INTERIOR BENT over a stream



INTERIOR BENT ELEVATION

End bents are most often supported by piles driven into the ground.



PILE END BENT ELEVATION

Turn to Sheet S-68 which shows End Bents 1 & 2 as PILE END BENTS. Also, look at Sheet S-93 at plans for END BENT #1.

Write the answers or fill in the blanks to the following questions:

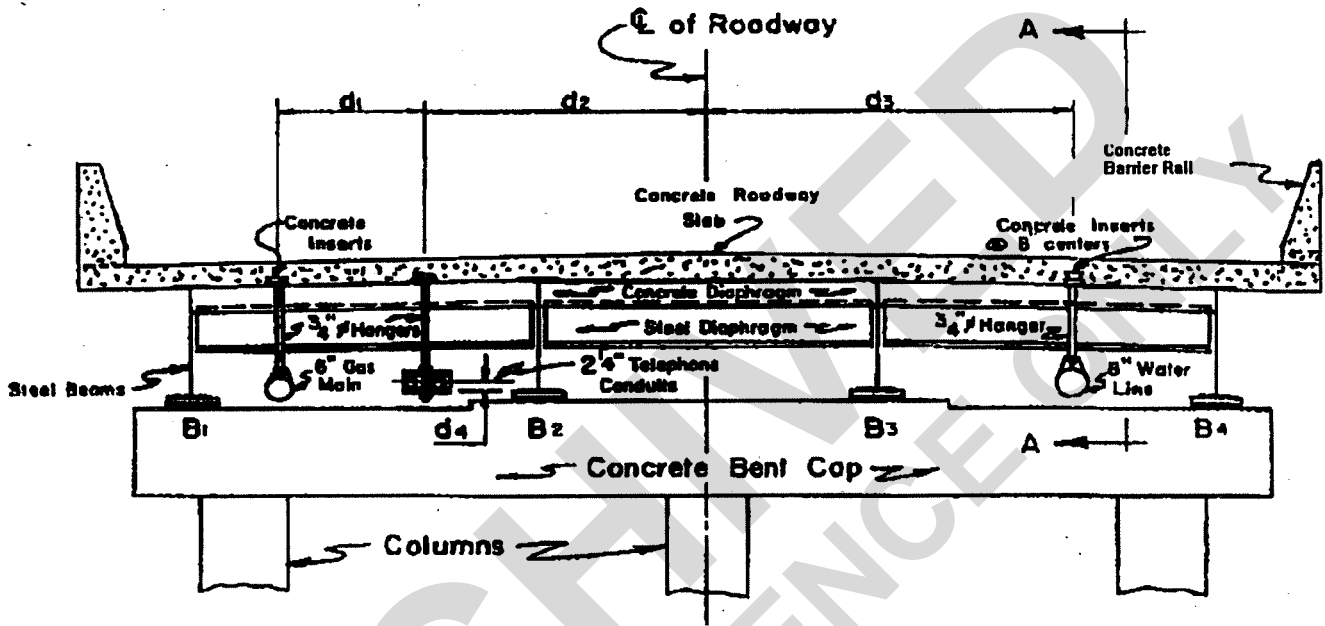
1. The two main parts of a bridge are superstructure and substructure.
(Hint-above & below bent cap)
2. The supporting members that hold up (directly support) the roadway slab and the traffic on this slab are _____ or _____.
3. The supporting members in question #2 are supported at each end by a _____ or _____.
4. The portions of the bridge that support the Superstructure are called Abutments.
5. What are the two types of bents that are shown in the Bent-Elevation views?
end and interior.
6. Depending on the ground beneath, Bent footings may be supported in two ways. These are piles or timber.
7. What are the two types of piles normally used? _____ and _____.
8. What two materials are beams or girders made of? _____ or concrete.

Now turn to appendix G (page G-2) and check your answers. If you missed any, go back and find where you went wrong - always correct a wrong answer.

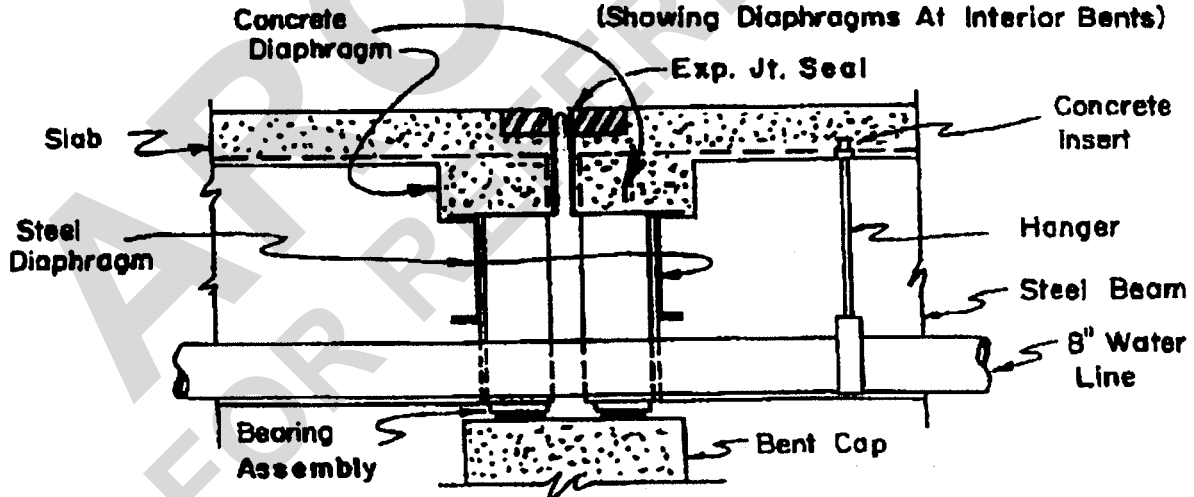
2. UTILITIES

Often it is necessary for **UTILITIES** such as water lines, gas lines, telephone lines, power lines and others to cross the roadway spanned by a bridge. You see below a "blown-up" cross-section of a bridge. This is done to show you some parts you have not seen up to this point and to show how *utilities* are supported below a bridge slab.

Examine both diagrams carefully.



**CROSS SECTION OF BRIDGE
(Showing Diaphragms At Interior Bents)**



**SECTION A-A
(See Cross Section of Bridge)**

Notice the following things shown on the Cross-Section of a Bridge and in Section A-A: (note that you are looking at a cross-sectional *side* view in Section A-A)

1. The concrete inserts are placed in the slab when the concrete is poured. The 3/4" hangers are then screwed into the bottom of the insert when the utility is put in place.
2. The utilities are normally placed inside the exterior beams and above the bottom of the beam so they cannot be readily seen by anyone passing under the bridge in a vehicle.
3. The utilities must clear the steel diaphragm. At times the diaphragm may have to be adjusted up or down to permit the utility to be placed on the bridge.
4. The lines or conduits are normally located by the dimensions d_1 , d_2 , d_3 , and d_4 as shown.

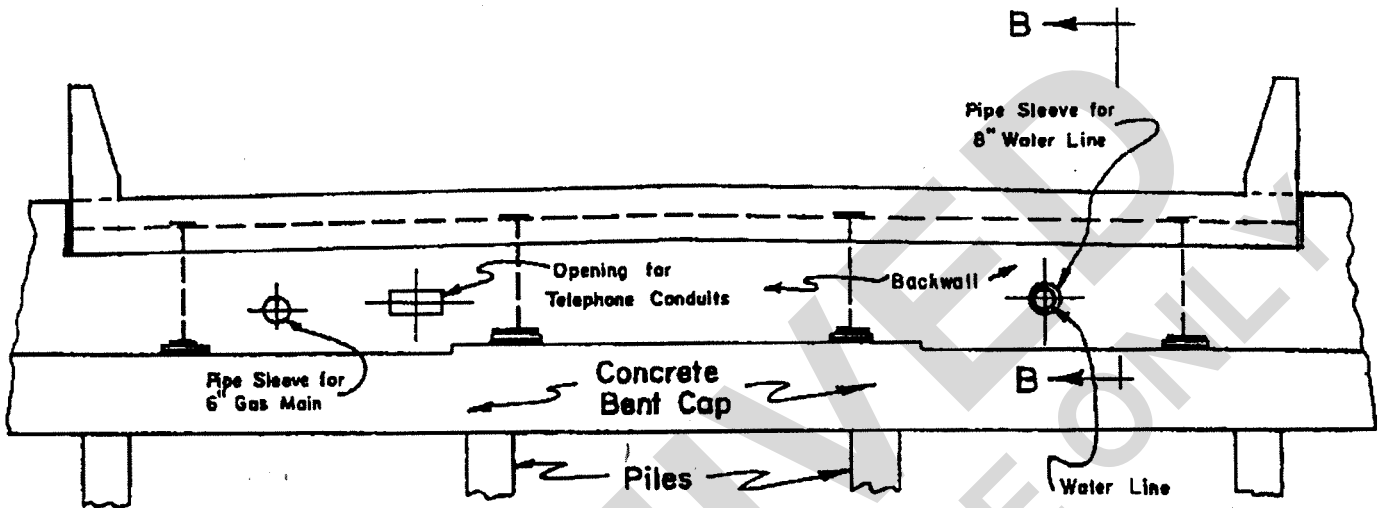
Write the answers or fill in the blanks to the following questions:

1. What three utilities are shown in the cross-section?
(1) _____, (2) _____, (3) _____.
2. How many and what size telephone conduits are shown? _____.

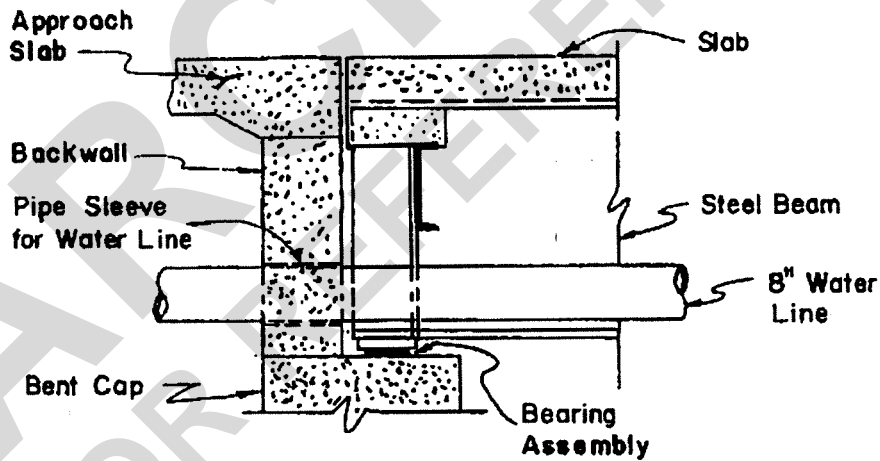
Now turn to appendix G (page G-2) and carefully check your answers to the above questions. If you missed anything, turn back and find where you went wrong.

2. Utilities (cont.)

Shown below are views of a bridge. The top view is one looking at the beginning or the ending end of a bridge which shows the backwall that pipes and conduits must pass through. Examine each diagram carefully.



END ELEVATION AT END BENT
(Showing Backwall)



SECTION B-B
(See End Elevation At End Bent)

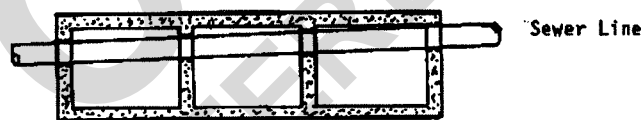
Notice the following things shown on the End Elevation and in Section B-B:

1. The Backwall that the utilities must pass through is a reinforced concrete wall that is poured after the end bent cap is poured.
2. Note the pipe sleeves that are cast in the back wall for the pipes to pass through. Also, see the opening that is left for the telephone conduits.

There are occasions when it is necessary for utility lines to be placed in the barrel of a box culvert. Two of these placements are illustrated in the first sectional view below. The utility pipes (gas or water) are supported or held in place by means of straps attached to the concrete slab and walls. Additional information about BOX CULVERTS is found beginning on the following page.



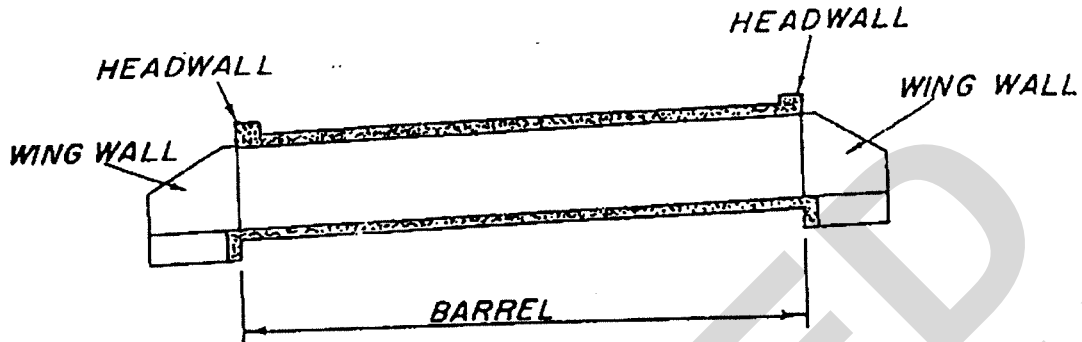
The next view shows a sewer line passing through the walls of a box culvert:



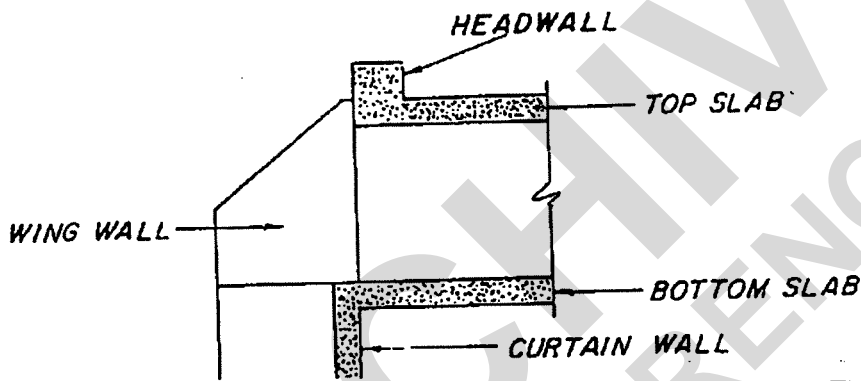
The placements shown above are to be *avoided* whenever possible. Any obstructions in the barrels of a culvert will restrict the flow of water through the culvert and can cause trash and debris to accumulate in the culvert. It is quite possible that water would be backed up and that flooding would result from placing utility lines within a culvert barrel.

You need to know the *names* of the different culvert parts. *Examine the diagrams below very carefully.*

C. BOX CULVERTS



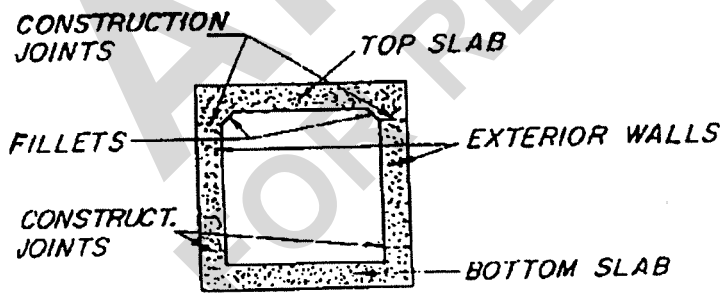
The barrel is shaped rather like a "square barrel." It may be long or short.



LONGITUDINAL CROSS SECTION

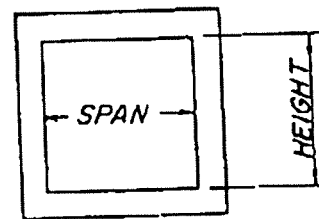
The curtain wall hangs down, like a curtain.

The "BARREL" has these parts



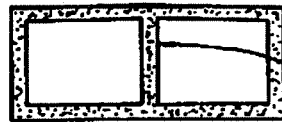
CROSS SECTION

The dimensions are measured like this:



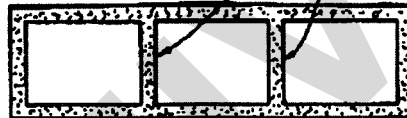
Note: A 7' x 5' Box Culvert means the SPAN is 7' and HEIGHT is 5'

Culverts may also be built with more than one barrel. Shown below are examples of these.



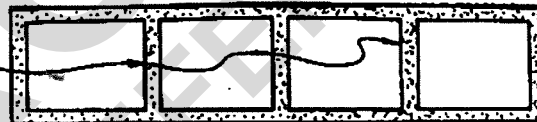
DOUBLE CULVERT

INTERIOR WALLS



TRIPLE CULVERT

INTERIOR WALLS



QUADRUPLE CULVERT

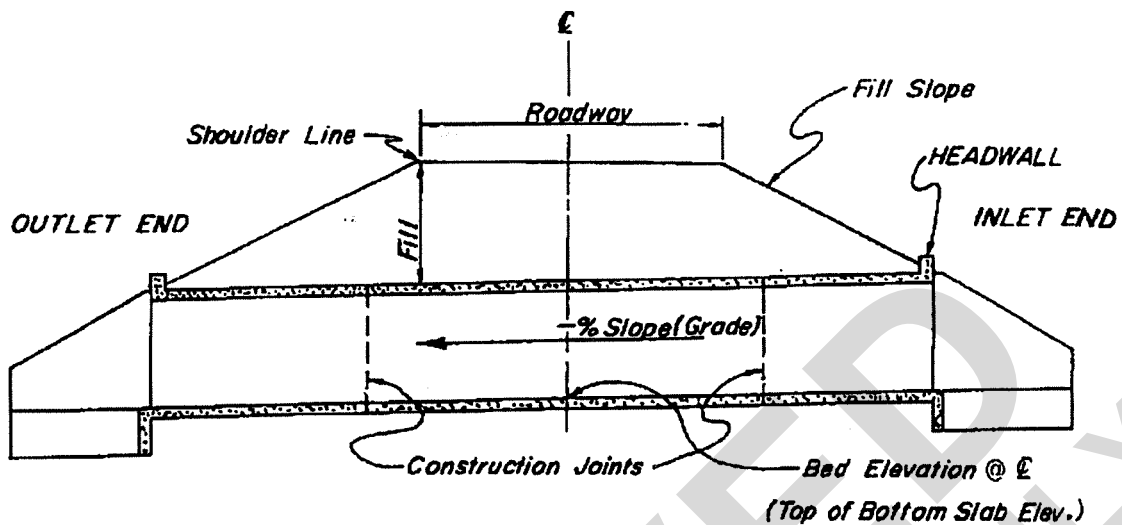
Refer to page 7-10 as you write the answers to the following questions:

1. What are the three MAJOR parts of a box culvert?
a. _____ b. wall c. top
2. What "hangs down" below the bottom slab at each end of the barrel?
manhole
3. The barrel walls become _____ walls at each end of the barrel.
wing
4. Is the horizontal or vertical distance considered to be the box culvert SPAN? _____
5. Is the horizontal or vertical distance considered to be the box culvert HEIGHT?
V
6. What is the SPAN and HEIGHT of each barrel of the TRIPLE 9' x 10' Box Culvert shown on Plan Sheet R-1025 C-1? _____ and
10'

Now turn to Appendix G (page G-2) and find the answers to the above questions.

If you made a mistake, ERASE IT. Look back at page 7-10 and see why you were wrong - then write in the CORRECT ANSWER.

NEVER LEAVE AN ANSWER WRONG! You're most likely to remember it the way you leave it.



1. LONGITUDINAL SECTION

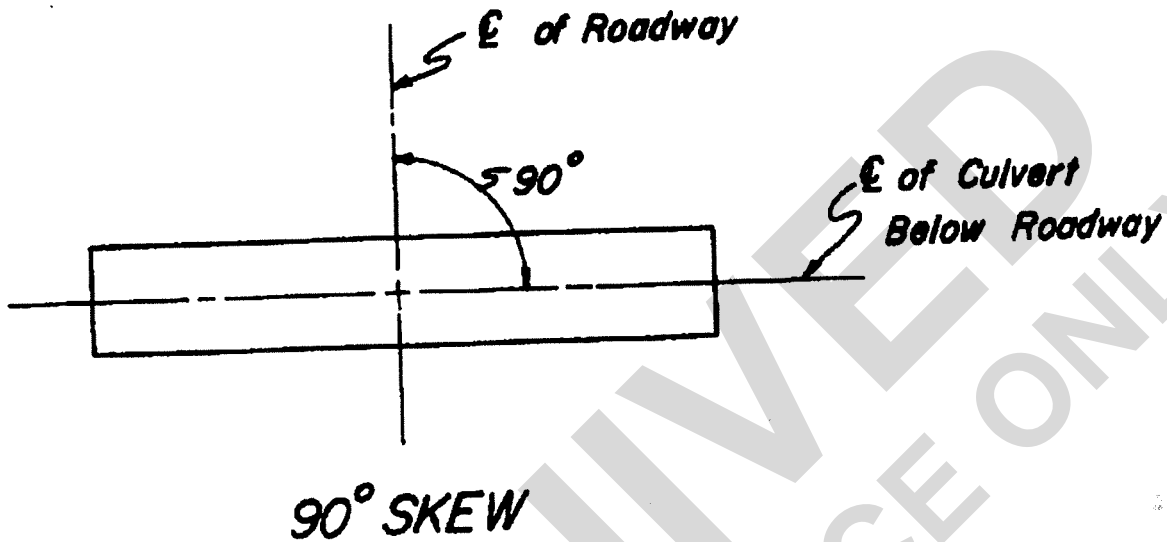
Shown above is a LONGITUDINAL SECTION of a BOX CULVERT.

Notice these things particularly:

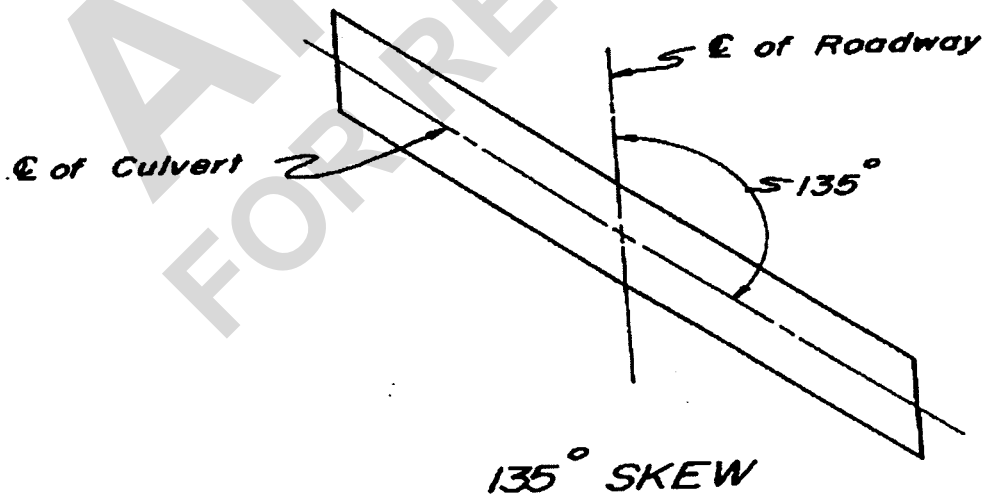
- a. The INLET and OUTLET ends - water goes in the INLET and flows from the OUTLET end of a culvert. The INLET end is always the HIGHER end of the culvert.
- b. The BED ELEVATION - is the elevation of the top of the bottom slab shown at the centerline of the roadway. This elevation is shown on all culvert plans in the location sketch.
- c. The PERCENT OF SLOPE for the culvert BARREL - this slope is shown in the longitudinal section on the Culvert Plan Sheet. Using this % SLOPE, the BED ELEVATION, and the distance to each end of the barrel - the ELEVATIONS at each end of the culvert can be computed.
- d. The slope of the FILL - is from the back of the HEADWALL up towards the roadway.
- e. The CONSTRUCTION JOINTS - show where one concrete pour ends and another begins. (A permitted construction joint is one which is optional.)

2. PLAN VIEW

Look at the PLAN VIEW (shown below) of the box culvert. Wing Walls and Headwalls are not shown. This Plan View shows the culvert from the TOP. See the CL of the roadway. Notice that the culvert is on a line PERPENDICULAR to the roadway CL . This culvert is said to be on a 90° SKEW.



The SKEW ANGLE is the angle that the CL of the culvert makes with the CL of the Roadway as measured in a clockwise direction from the CL of Roadway to the CL of Culvert when looking "ahead". See below for a diagram of a 135° skew condition.



C. (Box Culvert - Cont.)

As you answer the below questions, refer to the preceding pages on CULVERTS.

1. The end of the culvert that the water goes IN is called the _____ end. This is the _____ end.

(higher)

(lower)

2. The culvert slopes DOWN to the _____ end.
3. A place at which one concrete pour may end and join another concrete pour is called _____.
4. The toe of the fill slope meets the back of the _____.
5. A skew angle is the angle formed by what two lines? _____ and _____.

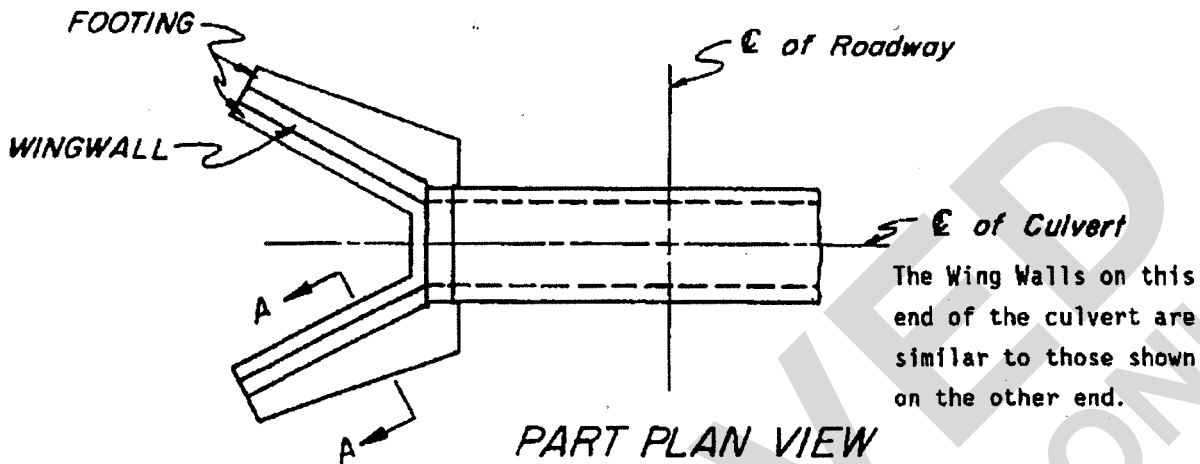
Turn now to Plan Sheet C-4 of R-74AA Structure Plans and answer these questions:

6. What is the SKEW ANGLE of the CULVERT as shown in the location sketch? _____
7. Does water flow from Left to Right, or from Right to Left in this culvert? _____ to _____.

Turn to Appendix G (page G-2) and check your answers.

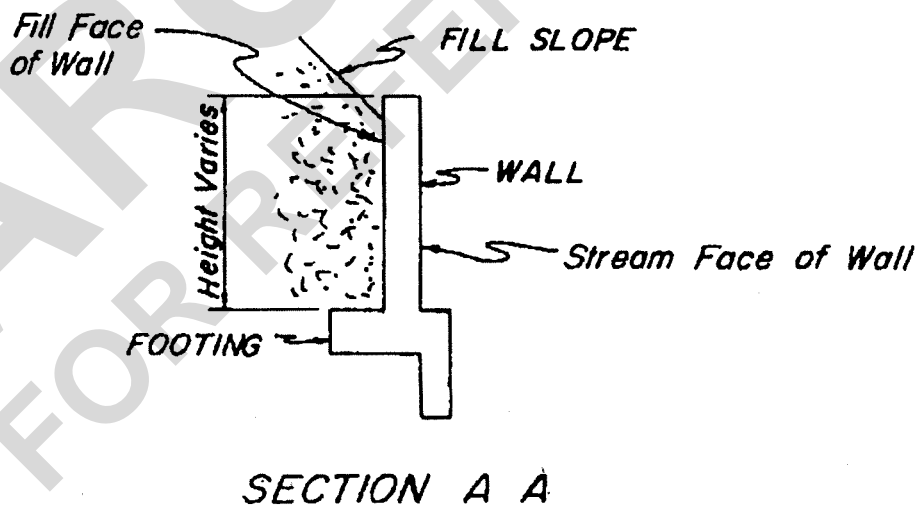
3. WING WALLS

Up to this point we have been concerned mostly with the box culvert barrel. Lets look now at the WING WALLS and their relationship to the barrel.



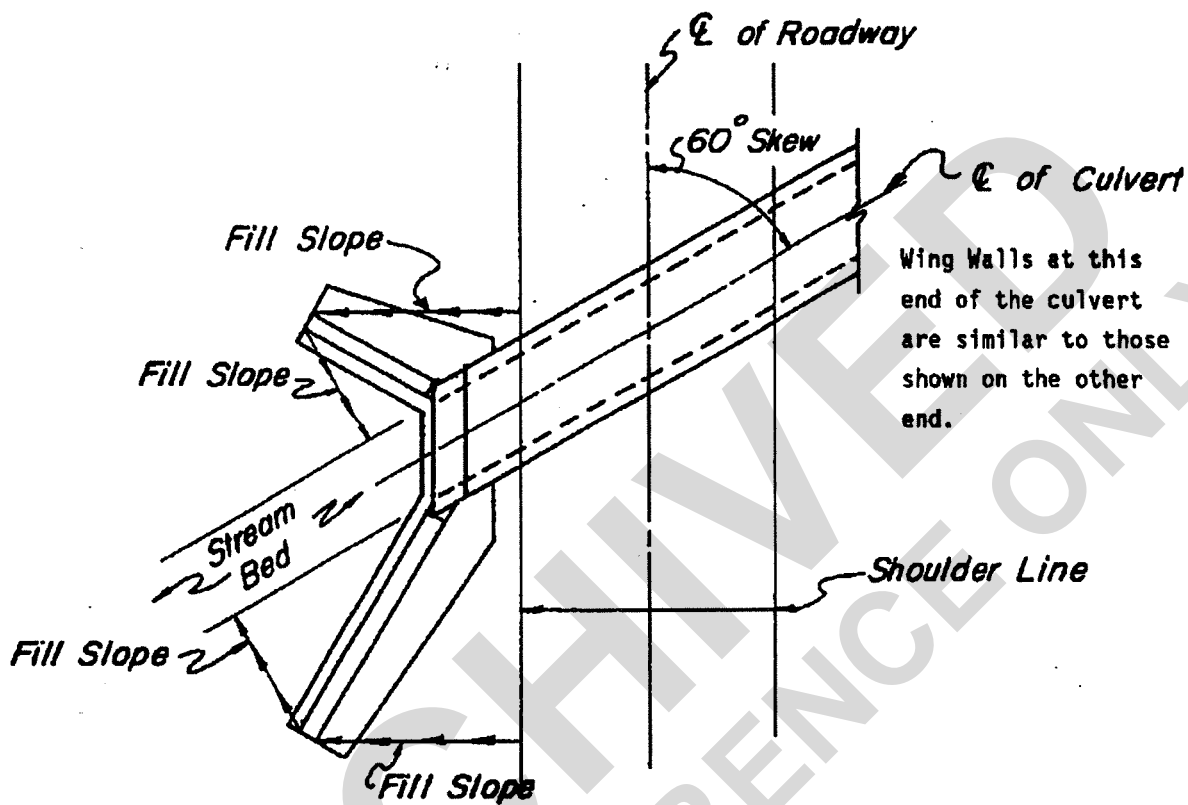
The purpose of wing walls is to keep the earth "fill" above the culvert from spilling into the stream bed.

Shown below is a section of the wing wall on the above culvert.



Wing Walls are extensions of the barrel walls that flare out away from the stream.

Shown below is a box culvert on a 60° skew. Notice how one wing is shorter than the other.

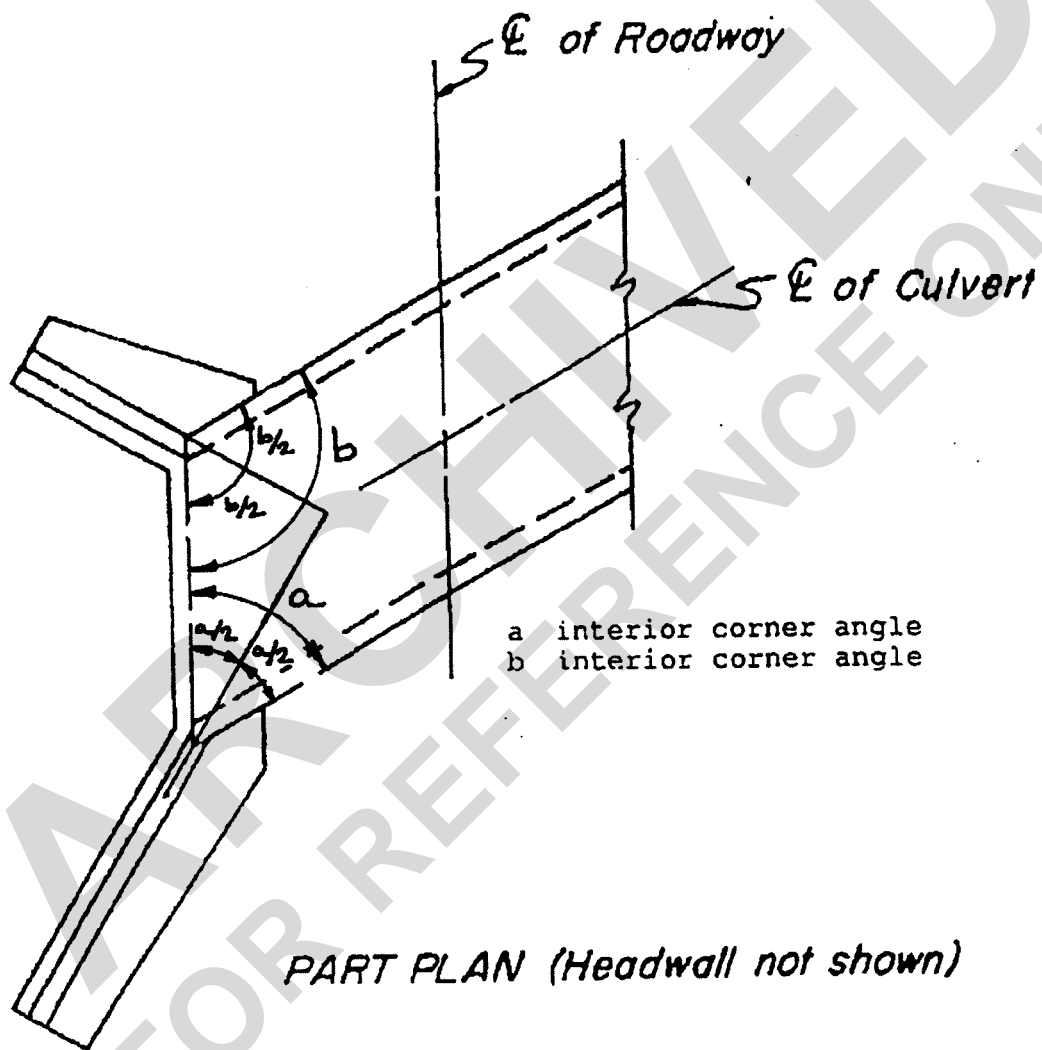


Note that the length of each wing is such that the fill slope, as indicated by the arrowed lines, proceeds down the slope from the shoulder line of the roadway, around the end of the wing, and then down to the edge of the stream bed.

Therefore, the wing lengths will vary from culvert to culvert - depending upon the height of the culvert, the slope of the fill, and skew angle of the culvert.

Turn to Plan Sheet C-3 and notice the *lengths* of Wing W1 and Wing W2. These *varying wing lengths* are examples of short and long wings.

The angles that the wings make with the barrel are illustrated in the part plan shown below. Note that the wings are parallel to lines that cut in half (bisect) the interior corner angles of the culvert.



a interior corner angle
 b interior corner angle

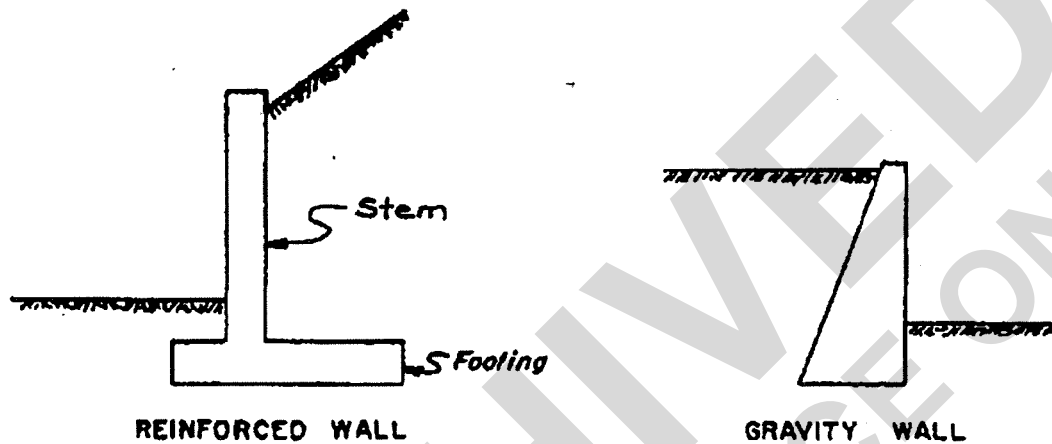
This procedure is the normal or standard method of establishing the direction of the wings.

There are special occasions (not very often) when the wings cannot be placed as shown in the "part plan" above. The plans will specify when (if) and how a variance occurs.

D. RETAINING WALLS

One other type of structure that you should become familiar with is a *retaining wall*. As its name implies, this type of wall holds back earth. In highway work, a retaining wall is normally used to keep earth on property adjacent to a highway from falling onto the highway, or on the highway right-of-way, or to keep earth that supports a highway from falling outside the highway right-of-way.

A retaining wall will normally be one of the types shown below:



A reinforced concrete or brick wall is constructed of either concrete or brick and reinforcing steel. This type of wall utilizes the weight of the earth behind it and the ability of the stem in resisting the overturning force of the retained material. It is used for walls up to about 30 feet high.

A gravity wall is constructed of either concrete, brick or an earth filled bin. It retains the bank of earth entirely by its own weight. You will find that a gravity wall is used for low-height walls. Mechanically stabilized earth walls are also a type of gravity wall, but can be 80 to 100 feet high because metal straps embedded in the earth support the face of the wall.

Other types of wall that you may encounter are tied back walls, mechanically stabilized earth walls and pile panel walls.

We will not take the space to describe each type of wall in this manual.

The main thing to remember is how the shape of each wall might affect the right-of-way line or the placement of a utility.

Write the answers or fill in the blanks to the following questions:

1. The two main types of retaining walls are (1) gravity walls,
(2) cantilever walls.
2. Which wall stays in place because of its own weight? _____.
3. Which wall has a footing that extends on either side of the vertical wall?
anchored
4. A gravity wall can be used up to about 30 feet.
5. A concrete or brick gravity wall is used for _____ walls.

Now turn to Appendix G (page G-3) and carefully check your answers. How did you do?
Great! Keep up the good work!!

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CHAPTER EIGHT: RIGHT-OF-WAY

A. INTRODUCTION

In order to construct any highway, the Right-of-Way Branch must be successful in securing the needed land for right-of-way purposes. The Right-of-Way Agent, in most instances, is the first official contact that the property owner will have with the Department of Transportation. It is imperative that the Right-of-Way Agent be competent in highway plan reading so that he or she can properly interpret the plans for a highway project to the property owner.

The property owner, above anyone else, is most vitally concerned as to how a proposed highway will affect his own property. The Right-of-Way Agent will be required to answer questions concerning the plans in addition to the general questions concerning the right-of-way acquisition procedure. On the initial contact with the property owner, it is of prime importance for the Right-of-Way Agent to properly interpret the highway plans for the owner as well as explain other phases of the right-of-way acquisition procedure. The Right-of-Way Agent must be knowledgeable in all aspects of highway plan reading in order to properly interpret the plans.

Many times the owner will ask the Right-of-Way Agent questions regarding ingress and egress (exit from) a proposed highway, how cuts and fills will affect his property, and how his residence or business will be affected by the highway project. The farmer is particularly interested in such matters as how his fields and pastures will be divided by a proposed highway, how his woodland will be affected, how the access to water will be affected, and the appropriation and relocation of fencing. Farmers will also ask questions regarding the movement and protection of livestock, how the construction schedule of the project will affect his planting, growing, and harvesting seasons, and many other questions such as the appropriation of farm outbuildings and his access to the proposed highway facility. These are only a few of the questions that a Right of Way Agent may be asked by a property owner, and the importance of highway plan reading cannot be stressed too strongly. If a Right-of-Way Agent is hesitant about answering questions regarding the plans due to his or her lack of knowledge, the property owner may become defensive and then the Agent may have a difficult time in settling the claim.

In urban areas, the Right-of-way Agent should be particularly careful in noting the "cuts" and "fills" as indicated on the plans. Major "cuts" and "fills" can affect locations as to where driveways can be reconnected. It is entirely possible that the depth of a cut or the height of a fill could eliminate a driveway from being reconnected even though the project has no limited or control of access. Urban property owners are particularly interested in such matters as to the appropriation of landscaping, the nearness of a roadway to a dwelling or business, driveway re-connections, and parking on a proposed street. Property owners may have many more questions regarding highway construction. In many instances a property owner will move a residence or commercial building which is located

within the right-of-way limits of a highway project to a new location. The owner may move the buildings outside of the right-of-way on his remaining property, if he has enough property remaining after the right-of-way appropriation.

For these reasons, it is imperative that the Right-of-Way Agent properly and accurately interpret the plans and read slope stakes.

The Right-of-Way Branch consists of a Negotiating Unit, an Appraisal Unit, a Utilities Unit, a Property Management and Relocation Unit, and an Administrative Unit. Highway plan reading is of vital importance to employees of all sections of the Right-of-Way Branch, and all employees should take full advantage of this Plan Reading course.

B. RIGHT-OF-WAY TERMS AND DEFINITIONS (See Appendix D)

C. FINDING RIGHT OF WAY ON PLAN SHEETS

1. Exercise One
Project ID R-74AA

Plan Sheet 4 is an example of a plan sheet showing the beginning of the project. Carefully note the station numbers for the beginning of both the State and Federal Aid Project numbers. On Plan Sheet 5, note the controlled access right of way on the western or left side of the project. You will see the symbol for right of way fencing on the western controlled access right of way or boundary. The western right of way boundary is subject to full control of access with no ingress or egress to the project or highway being permitted north of Sta. 27+08.24 Survey Line L on this plan sheet. Also on Plan Sheet 5, look at the service road on the eastern or right side of the project. Note that the eastern right of way limits of the service road are not subject to access control. Ingress and egress to the service road are permitted. You will also see that the control of access limits and fencing symbol on the east or right side of the project are between the proposed main traveled lanes of the project and the service road. No ingress or egress to the project is permitted from the west side of the service road.

Look for the NOTE on the Title Sheet that tells you this is a full control of access project with access being limited to interchanges.

QUESTIONS FOR EXERCISE ONE

1. What is the beginning station number for State Project 8.T600405?
_____.
2. What is the Federal Aid number applicable to this project?
_____.
3. The proposed right of way markers or monument on the northwestern right-of-way boundary of the project located on the southern property line of Billy E. Stewart, Parcel 2, are located _____ feet and _____ feet left of or northwesterly of survey line.
4. Ingress and egress will be permitted to the west side of the project from Parcel 15 after the project is constructed as it was prior to the time the project was constructed. _____ (True or False)
5. The proposed right of way marker or monument shown left or northwesterly of survey station 35+98.02 survey Line L is located _____ feet from the survey line of Ramp B.

TURN TO APPENDIX G (page G-3) AND CHECK YOUR ANSWERS.

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FOR REFERENCE ONLY

2. EXERCISE TWO
Project R-1025

This is a non-control of access project. You will not find a NOTE on the Title Sheet in regard to control of access. Ingress and egress to the project would be allowed by driveway permit except at those points where it might be denied for safety reasons under police powers. This project is an example of upgrading an existing highway by adding additional lanes.

On Plan Sheet 11 you will note that there are drainage easements required outside of the right of way right or southwesterly of survey station 401+50 Survey Line L. There is a permanent drainage easement and a temporary drainage easement at this location. You will also note that there is a temporary construction easement required right or westerly of survey station 15+00 Survey Line Y3 Rev. These are examples of easements which are required beyond the normal right of way limits of the project.

QUESTIONS FOR EXERCISE TWO (R-1025)

1. A _____ foot by _____ foot permanent drainage easement is required right or southwesterly of survey station 364+35 Survey Line L.
2. The westernmost corner of the permanent drainage easement located right of or southwesterly of survey station 364+33.59 is located _____ feet from Survey Line L.
3. The southernmost corner of the temporary drainage easement located right or southwesterly of survey station 364+35 Survey Line L is located _____ feet southwesterly of survey station _____ Survey Line L.
4. The construction easement required left or northeasterly of survey station 364+50 Survey Line L exceeds the right of way by a distance of _____ feet.
5. There is a proposed right of way marker or monument located left or northeasterly of Survey Station 355+49.98 Survey Line L. _____ (True or False)
6. The owner of Parcel 362 is _____.
7. To find the land areas involved on any parcel, one should refer to the _____ data sheets. (Hint: Look at the right of way definitions).

NOW TURN TO APPENDIX G (page G-3) AND CHECK YOUR ANSWERS.

3. EXERCISE THREE

Plan Sheets 8 & 9 on Project R-1025 show examples of small tracts of land and how they are affected by right of way acquisition. You will note that there are many buildings or improvements shown on these plan sheets. Carefully observe the abbreviations that designate the types of buildings and the property lines.

QUESTIONS FOR EXERCISE THREE

1. The right-of-way boundary or limits for the project on the northeast side of U.S. 421 on Plan Sheets 8 & 9 is _____. (A - Limited Access, B - Partial Control Access, C - Non-Control of Access)
2. Parcel 347 is an example of _____. (A - Total Take, B - Partial Take)
3. The abutting land owner on the north and east of Parcel Number 334 is _____, and is Parcel _____.
4. What types of improvements are located within the right-of-way limits on Parcel Number 347 and must be removed prior to the construction of the Project?

5. The symbol left on approximate survey Station 381+00 Survey Line Lt. Ln. represents an _____ which will have to be relocated or removed.
6. The house trailer shown on Parcel 347 is generally considered to be _____ property. (A - Real, B - Personal)

NOW TURN TO APPENDIX G (page G-3) AND CHECK YOUR ANSWERS. CORRECT ALL WRONG ANSWERS.

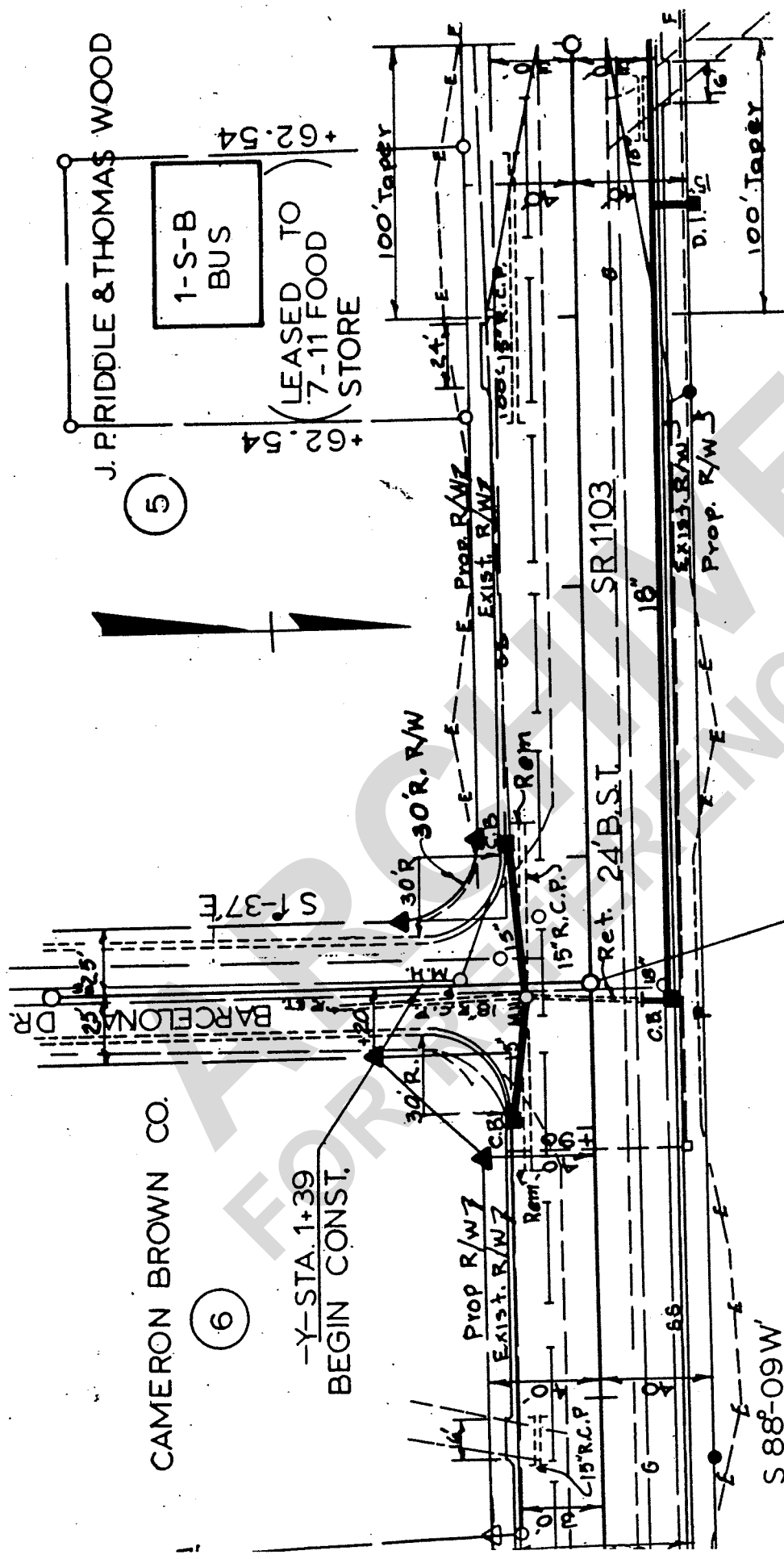
4. EXERCISE FOUR

Plan Sheet 6, 11 & 12 of Project R-74AA show the relocation of an existing state maintained secondary road which intersects the project. The right of way limits of Survey Line Y, beyond the control of access limits of the main line of the project, are not subject to control of access.

QUESTIONS FOR EXERCISE FOUR

1. Within the main right of way limits of the project, existing Secondary Road 1147 is to be _____.
2. On Plan Sheet 11 the construction's limits are _____ the proposed right of way limits. (A - Within, B - Outside)
3. The easements being acquired left of Survey Station 62+05.06 and Survey Station 65+05.06 Survey Line Y are being secured for _____ purposes. (A - temporary construction or slope easement, B - work area, C - drainage).
4. On Plan Sheet 11, the right of way on existing Secondary Road 1147 is to be _____.
5. The 15" pipe shown at approximate Survey Station 62+00 Survey Line Y is being installed for (A - driveway, B - encroachment, C - drainage) purposes.

TURN TO APPENDIX G (page G-3) AND CHECK YOUR ANSWERS.



CAMERON BROWN CO.

(6)

-Y- STA. 1+39
BEGIN CONST.

(5)



J. P. RIDDLER & THOMAS WOOD

1-S-B
BUS

(LEASED TO)
7-11 FOOD
STORE

SR1103

Ret. 24' B.S.T.

S 888-09W

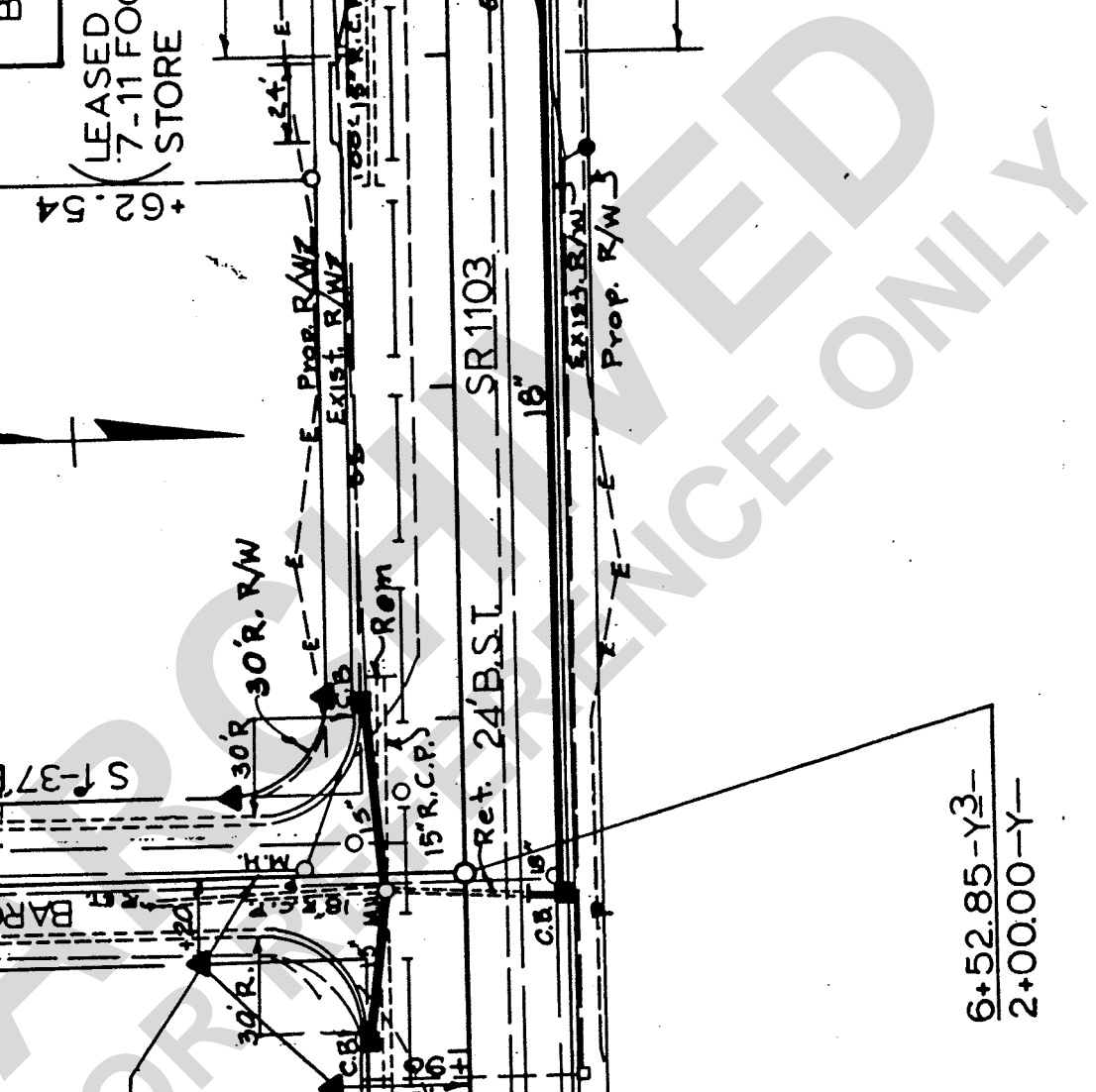
100' Taper

(2)

W.R. CO.

8-7

6+52.85-Y3-
2+00.00-Y-



5. EXERCISE FIVE

Page 8-7 one is an example of a proposed curb and gutter section to be constructed on Secondary Road Number 1103. This is another example of the right-of-way limits not being subject to control of access. Ingress and egress from the properties adjacent to the right-of-way limits will be permitted. Note the E line or clearance line which exceeds the right of way on the south and north side of Survey Line Y-3, SR 1103. It will be necessary to secure a construction easement beyond the proposed right-of-way to the maximum distance the E line exceeds the right-of-way. Clearance lines or E lines are limits beyond the top of a cut or toe of a fill which are necessary for clearance and construction purposes. In this case the E line is behind the proposed curb and gutter. Look carefully at this plan view and answer the questions for Exhibit Five.

QUESTIONS FOR EXERCISE FIVE

1. A driveway entrance _____ feet in width is proposed at the property leased to 7-11 Food Store.
2. The proposed curb and gutter section on this exhibit is _____ feet face to face.
3. A driveway entrance _____ feet in width is proposed at the property of Cameron Brown Company, the owner of Parcel No. 6.
4. The proposed right-of-way of Secondary Road 1103, Survey Line Y-3 is _____ feet each side of Survey Line Y-3, or an overall right-of-way of _____ feet in width.
5. Note that the proposed right-of-way in the southwest quadrant of the intersection of Survey Line Y with Survey Line Y-3 is on curve. This curve has a radius of _____ feet.
6. Survey Line Y-3 intersects Survey Line Y at Survey Station _____ on Survey Line Y-3.
7. On this exhibit, the E line or clearance line exceeds the proposed right-of-way on the property of W. R. Company, Parcel No. 2 _____ (True or False)
8. An easement from the property owner will be necessary to install the proposed drop inlet shown on the property of W. R. Company, Parcel No. 2 _____ (True or False)

TURN TO APPENDIX G (Page G-3) and check your answers.

CHAPTER NINE: GEOTECHNICAL APPLICATIONS

With the exception of specific undercut and rock lines, geotechnical subsurface information is not shown on construction plans. It is made available to other design and construction units for use in the design of roadways and structures. The information is also available to contractors for their use in evaluation of subsurface conditions on a project. The following figures represent a typical plan view and cross section data provided by the Geotechnical Unit for a structure.

Figure 1 is a plan view of the project as it traverses Swearing Creek. Represented on this plan view are bore holes denoted by two shaded triangles in a circle at each bent location along the 90 degree skew of the proposed bridge. Geotechnical subsurface investigations are necessary at bridge sites in order to determine the best suited bridge foundation based on the geology and engineering properties of the soil and rock encountered in our test borings. Since proposed bent locations are sometimes impossible to access with truck and/or ATV mounted drill machines due to existing structures, utilities, harsh terrain, and water conditions, it is sometimes necessary to offset or omit boring locations as evidenced by the placement of borings on the right lane of the plan view drawing.

For general information purposes it should also be mentioned that borings to determine geologic subsurface conditions are not exclusive to bridge layouts. Borings along proposed and existing roadway alignments and structures are of equal importance in the information they supply for the planning, design, and construction of highways and related structures.

Figure 2 is a geologic cross section which visually represents the subsurface soil and rock formations along the proposed bridges interior bent 2. The various soil and rock formations having similar geologic and/or engineering properties are depicted by connecting the zones or layers in adjacent borings with a dashed boundary line. Static groundwater level is measured after a 24 hour or more period of time and represented on this cross-section by a shaded triangle with the month and year of measurement. Each soil type encountered is represented by a different symbol which represents a grouping of AASHTO soil classifications. In all there are 12 AASHTO soil classifications, each having distinct engineering properties. In this figure only, 5 classifications of soil were encountered plus the addition of weathered rock representing the sixth symbol. The ellipse represents a density and soil strength test at 2.5' and 5' intervals in the bore hole. This test is shown as a **Standard Penetration Test** and the numerical value associated with it is most often referred to as the Blow Count. Each soil and/or rock type is given a written description of its physical soil properties which are derived from a combination of field notes and laboratory tests performed on soil samples taken in the field.

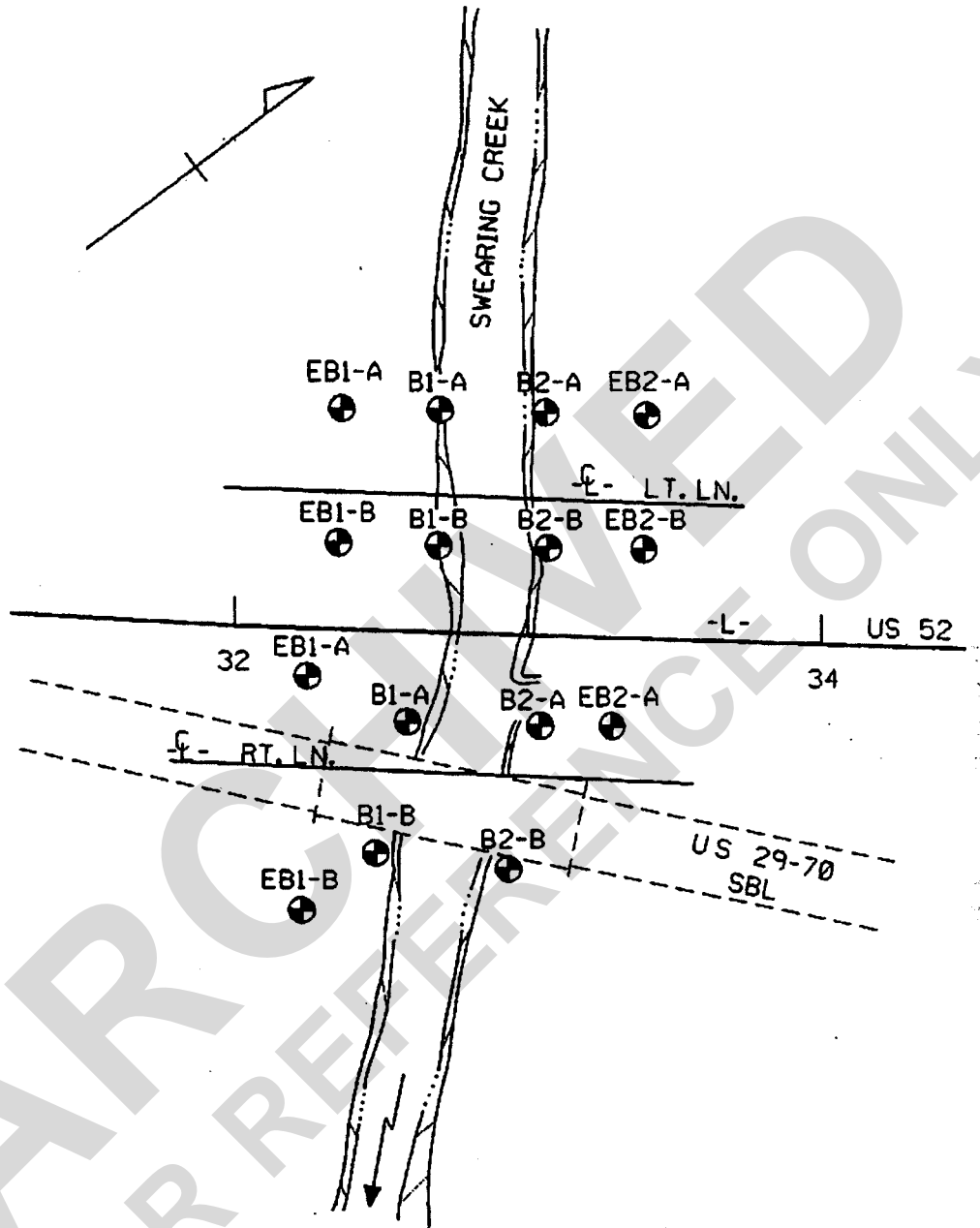


Figure 1

SECTION THRU BENT 2 LT. LN. 8.T600405 (R-74AA)
SHEET 5 OF 32

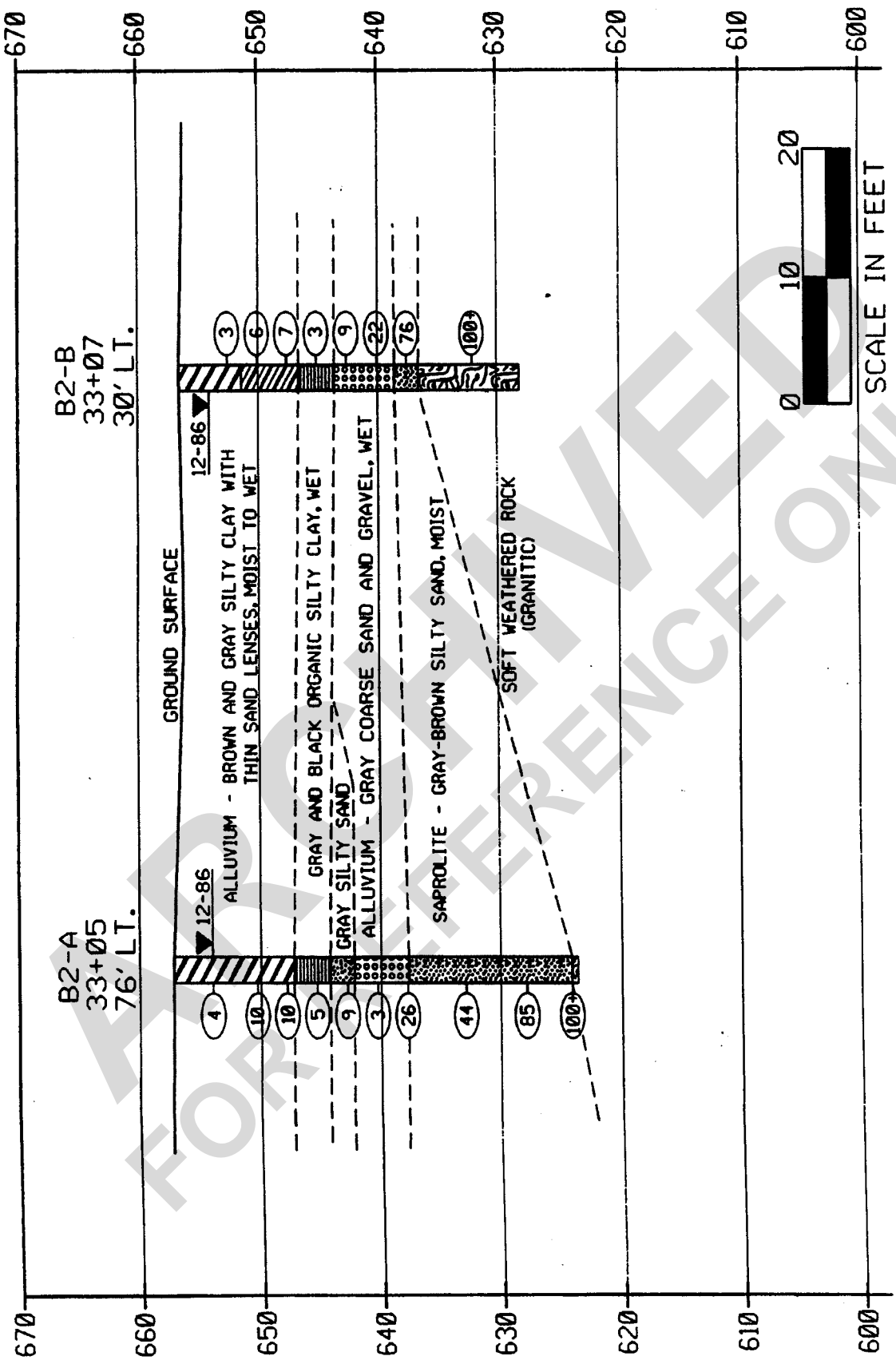


Figure 2

Chapter Ten: TRAFFIC CONTROL PLAN

A. WHY DO WE NEED A TRAFFIC CONTROL PLAN?

A *Traffic Control Plan* (TCP) is a plan for moving traffic safely through a specific highway or street workzone or project. These plans range in scope from very detailed TCP designs solely for a specific project to simply a reference to typical plans and/or a section of the Manual on Uniform Traffic Control Devices (MUTCD). The degree of detail in a TCP will depend on the project complexity, exposure to hazards and traffic interference with construction activity.

B. 2 CHOICES FOR TRAFFIC CONTROL PLANS

The Engineer has two choices when developing the Traffic Control Plan. He/She may either develop a Traffic Control Plan for the proposed project or he/she may opt not to develop a plan. The second alternative is rarely chosen. When a plan is prepared, there are three types of Traffic Control Plans which can be developed.

If the engineer chooses to develop a Traffic Control Plan, it may vary from a site specific traffic control plan to a very simple agreement. The three types of plans which are developed if the engineer selects to prepare a plan include an encroachment agreement, a resurfacing project and the site specific plan.

Now let's discuss in more detail the different types of plans which can be developed.

First, encroachment agreements are the least straight-forward in terms of traffic control because the Contractor is responsible for all traffic control devices, safety and the TCP itself. References to the MUTCD, the NC Supplement to the MUTCD, and possibly the Roadway Standard Drawings are basically the only TCP contained in most encroachment agreements.

Second, resurfacing projects, are basically purchase order contracts or specifications written in contract proposal form. They may contain some safety and traffic control devices requirements, but, for the most part, the TCP is left to the Contractor. In this case, the cost for traffic control is incidental to the other pay items in the contract.

Finally, the type of plan discussed in this course and the one which is used most often is the site specific traffic control plan. In this concept, all traffic control requirements are generally listed in some form. These plans incorporate some type of traffic control phasing, typical drawings, detailed drawings, and a pavement marking plan. We'll discuss this in greater detail later within the text. The other choice which the engineer has is the

"Do Nothing" plan. This plan is exercised when work is going on for a very short period with hardly any traffic (i.e. one hundred cars per day) at low speed locations (35 mph or less). However, this alternative is very rarely chosen. There is too much risk and liability in not preparing a Traffic Control Plan. If the engineer chooses not to prepare a plan, he may be liable for any injuries, whether they are construction workers, pedestrians, or motorists, that may occur within the project limits.

So what have we learned so far? First, the **degree of detail** in a traffic control plan will depend on the project complexity, exposure to hazards, and traffic interference with construction activity. Second, there are **two choices** an engineer can make when deciding to prepare a traffic control plan. He/she may prepare a Traffic Control Plan or "Do Nothing Plan". Also, there are three types of TCP's which an engineer may develop: encroachment agreements, resurfacing projects, and site specific plans.

C. ELEMENTS OF A TRAFFIC CONTROL PLAN

Two main elements of a TCP are references (contract proposal, Roadway Standard Drawings and *N. C. Standard Specifications for Roads and Structures*) and the actual plan sheets.

1. REFERENCES

The references listed above are not included in the plan package, but are integral parts of the entire TCP. The contract proposal contains information such as intermediate contract times, contract restrictions and specific traffic control specifications. The Roadway Standard Drawings are referred to within the construction phasing, general and project notes and detail drawings which are located in the actual plan sheets. Reference to the Roadway Standard Drawings eliminates the inclusion of typical drawings in the plan set that are generally applicable to any project. Finally, Sections 150 and 950 of the 1990 N. C. Standard Specifications for Roads and Structures provide a general overview of the maintenance of traffic not specifically discussed within the actual plan sheets and the requirements of the traffic control devices.


2. PLAN SHEETS

Now, let's take a look at a Traffic Control Plan.

The plan sheets of a Traffic Control Plan are labeled as TCP-sheets in the upper right hand title block and are made up of five basic parts: title sheet, project notes, construction phasing, detail drawings and miscellaneous sheets. Flip through the plan sheets of project R-1025 until you reach Sheet No. TCP-1 (located directly after roadway plan sheets).

a. Title Sheet

Like the front sheet on a set of roadway plans, the front sheet of a TCP is also called the title sheet. It generally consists of a legend, person(s) responsible for design, general notes, list of Roadway Standard Drawings, and an Index of Sheets. For this particular project, as for any other project where room allows, the project notes and a pavement marking schedule are also included on the title sheet.

Take a look at the legend located always on the title sheet (TCP-1). You may be wondering, "Wasn't this discussed earlier in the Roadway Design Section?" Yes and No. This legend functions the same as the Conventional Signs on the title sheet of the roadway plan, but it is used only for TCP and is found only on the title sheet of the TCP. It reflects all devices shown on the TCP sheets. Any devices not shown in the legend shall be labelled as they appear within the TCP. These symbols will usually be the same on any set of TCP you might see with minor exceptions. For example, the sign for flagger will always look like: 

The name of the person(s) responsible for the design can always be found in the lower right hand side of the plan sheet along with the engineer's seal. All plans must be sealed by a professional engineer. In this case, an engineering consultant is responsible for the design. Names of NCDOT contact person(s) also can be found in the lower right hand side.

Exercise: (See TCP-1)

1. Who is the Traffic Control Project Engineer for NCDOT on this project?

Turn to Appendix G (page G-3) and check your answers.

Now, take a look at the general notes located on the far left hand side of the standard traffic control title sheet. On larger plans, general notes may be located on sheet TCP-2. These notes apply at all times to the entire construction phasing and details of the TCP; therefore, they are not referenced individually throughout the plan sheets and are only found on the title sheet. A set of general notes (alphabetically listed "A" through "K") will appear on the standard title sheet for all projects. Additional general notes tailored to a particular project may be added to this list continuing the alphabetical listing. Use of General Notes that pertain to the entire project will minimize the number of project notes referred to within the phasing.

Exercise:

1. Which note tells the contractor to ballast or weight a sign if necessary?

Turn to Appendix G (page G-3) and check your answers.

b. Project Notes

On the other hand, project notes, which are numerically listed, are specific to certain parts or phases of the TCP. They are referred to only for specific situations within the construction phasing and on corresponding detail drawings. If a note is seldom used it will be written out where it applies in the construction phasing or details. The list of project notes is found either on Sheet TCP-1 if there is adequate room or immediately after on Sheet TCP-2.

Exercise: (See TCP-1)

1. Which project notes apply to pavement markings? _____
2. Look at project notes and determine which Rdwy. Std. Dwg. No. is used for pavement markings? _____

Turn to Appendix G (page G-3) and check your answers.

Now, turn to Sheet TCP-2 and read the very last paragraph on the far right side of the page listed under PHASE IV. The last few words read **SEE NOTES 24, 26, 27.** These notes are the project notes that are specific to the construction activity described within the paragraph.

c. Construction phasing

Now, turn to the Phasing located on Sheet TCP-2. Phasing is a clear and concise step-by-step write-up telling the contractor where to begin and how to proceed toward completion of the project while maintaining traffic. It is also the one element of the TCP that ties every other part together. While it communicates to the contractor how to maintain traffic during various stages of construction, the construction phasing also

references the project notes, roadway standard drawings, intermediate contract times and any detail or typical drawings found within the TCP.

Notice how the phasing is written in an outline form. Most importantly, the phasing details how to physically switch traffic from one traffic pattern to the next. Construction phasing is composed of a number of phases, with each phase required to be completed in order, before proceeding to the next phase. Each phase is composed of a number of steps. All the steps in each phase are required to be completed in order, before proceeding to the next phase. In other words, the phasing sequence PHASE I must be completed before PHASE II etc. and STEP 1 must be completed before STEP 2 in each phase, except if otherwise noted. Let's call this outline form the *phase-step method*.

Exercise:

1. Take for example this phasing sequence:
PHASE I, STEP 1
PHASE I, STEP 4
PHASE II, STEP 1

Is this outline in proper format? _____ If not, which phase(s) and step(s) is/are missing? _____

2. In which phase and step do the traffic control plans tell the contractor to shift US 421 traffic to the right side from Sta. 302+00 to Sta. 350+00 ? (See TCP-2)

Turn to Appendix G (page G-3) and check your answers.

Another outline form, *phase-area-step* method is also composed of a number of phases. Each phase is composed of a number of areas, and each area may be composed of a number of steps. Phases and steps are required to be followed in numerical order. The requirements of each area in a phase are to be met before the phase will be considered complete. If an area includes steps, all the requirements of each step in the area are to be met before the area will be considered complete. Work may be performed simultaneously in all areas of an individual phase, except if otherwise noted.

Improper word usage in the phasing creates loop holes that contractors will jump on.

Take a look at PHASE I, STEP 1:

**STEP 1 - CONTRACTOR SHALL INSTALL ADVANCED CONSTRUCTION . .
. . DRAWING NO. 150.04A.**

"*SHALL*" is used throughout the phasing because it binds the contractor. In other project phasing you may see the word, *WILL*, used. "*WILL*" is used in the phasing to state that the state forces will do a certain construction activity at their discretion. "*MAY*" is used when we are allowing the contractor to begin a certain step of work at his discretion.

Exercise: (See TCP-2)

1. Where in the phasing do we state the traffic shall be in a 5-lane pattern from Sta. 302+44 to Sta. 350+00 ? _____

Turn to Appendix G (page G-3) and check your answers.

d. Detail drawings

In this particular TCP we have two types of details, **typical** (sometimes referred to as general details) and **special** details.

Typical details in a TCP are details or pictures that show how to handle similar situations, whether it may be placing traffic control devices, placing intermediate pavement marking, shifting traffic, etc. Everything in a typical detail remains constant (dimensions, traffic control devices, references to project notes and roadway standard drawings, etc.) except for the location where the typical detail applies. You can find an example of a typical detail on Sheet TCP-4. The detail on TCP-4, shows how to close any median cross-over within the construction limits using type III barricades and non-metallic drums. Although it shows the cross-over at the intersection of -Y2- SR 2014 and US 421, this detail will apply to any median cross-over location.

Exercise: (See TCP-4)

1. In this typical, which note do we refer to and what type of note is it?

Turn to Appendix G (page G-3) and check your answers.

Look again on Sheet TCP-4 at the detail for Location of Precast Barrier at Culvert Extension. This detail is another example of a typical detail. Once again, when using this drawing, the contractor must use the same dimensions and traffic control devices and refer to the same project notes that are shown in the detail.

All the other drawings on Sheets TCP-3 to Sheet TCP-11 are called special details. They are only applicable to the specific area shown in the detail. For example, see Detail 'C' shown on sheet TCP-8. This special detail shows a schematic drawing of PHASE III, STEP 1 and must only be used for that particular construction operation.

Exercise: (See TCP-8)

1. On this sheet, do we refer to any Rdwy. Std. Dwg. No., if so, which one(s)?

Turn to Appendix G (page G-3) and check your answers.

Other details not used in this plan may include an overview of a particular construction stage, typical drawings (same as typical details except typical drawings are applicable to any project and may later be included in the Roadway Standard Drawings), special barrier details, Iowa weave details and traffic control device details.

e. Miscellaneous Sheets

No miscellaneous sheets are included in project R-1025. Examples of miscellaneous sheets are sheets showing sign designs for nonstandard construction signs to be furnished by the Contractor, off site detours where the contractor will install signs, and special coordinations with plans from other units such as crossover pavement design or structure staging which are specific to the project.

f. Miscellaneous Information on Plan Sheets

- TITLE SHEET (TCP-1)**
- *always labeled sheet TCP-1 in upper right hand title block.*
 - *construction number and TIP number are always located along the left hand side of the page.*

f. Miscellaneous Information on Plan Sheets (cont)

- DETAIL SHEETS (TCP-2 THROUGH 11)** - *lower right hand title block should contain description, "PHASING", "PHASE AND/OR STEP", "DETAILS," etc., if applicable.*
- *reference to sheet with project notes if applicable.*
 - *reference to sheet with pavement marking schedule if applicable.*
 - *bearings of drawings should be the same as those on roadway plan indicated by north arrow.*

Exercise:

1. Which traffic control plan sheet refers to:

Phase I, Step 2,4, Sta. 396+00 to Sta. 410+00 ? _____

Phase II, Step 1,2, Sta. 300+00 to Sta. 340+00? _____

Turn to Appendix G (page G-3) and check your answers.

CHAPTER ELEVEN: PAVEMENT MARKING PLAN

A. WHY DO WE HAVE A PAVEMENT MARKING PLAN?

The purpose of a the Pavement Marking (PM) plan is to show how traffic will be operating on a facility at the completion of a project in a clear and understandable manner. A plan is required when a Contractor is required to place pavement markings on the final wearing surface. If a project is not redesigned and is simply a rehabilitation and/or an overlay resurfacing type project without any widening, a full fledged PM plan is usually not required. Instead, reference can be made in the construction phasing to replace existing markings using Roadway Standard Drawing No. 920.01A thru 920.12. Clarity and neatness are of utmost importance since a multitude of people are usually involved in reading these plans during the design and construction stages of the project.

B. ELEMENTS OF A PAVEMENT MARKING PLAN

A PM plan consists of several elements such as references (Roadway Standard Drawings and N. C. Standard Specification) and the plan sheets which are made up of detail drawings (actual pavement marking drawings, typical drawings, symbol details, etc.) labeled as PM-sheets in the upper right hand title block. The PM plan shows the types and locations of pavement marking lines and/or symbols and/or pavement markers and delineation of the final wearing surface of a roadway. The pavement marking plan is part of the Traffic Control Plan package and is located after the TCP-sheets.

1. REFERENCES

The references listed above are not included in the plan package, but are integral parts of the entire PM plan. The Roadway Standard Drawings are referred to on the plan sheets and eliminate the inclusion of typical drawings in the plan set that are generally applicable to any project. For example, turn to sheet PM-1 (located directly after the TCP sheets) and read the notes listed at the lower right hand side: SEE NCDOT STD. 920.01 FOR SYMBOL DETAILS. SEE NCDOT STD. 935.02 FOR PLACEMENT OF PAVEMENT MARKERS. These notes reference the Roadway Standard Drawings Nos. 920.01 and 935.02.

The N. C. Standard Specifications provide detailed and exact statements of construction requirements (materials, construction methods, measurements and payment) for pavement markings and pavement markers.

2. PLAN SHEETS

Before we look at the PM plan, look at the roadway plans, identify the type of facility and try to get a preliminary picture of how the final pavement marking will look. Usually, as in this case, the roadway plan has thin solid light lines indicating where lanes should be and shows painted islands and marked out areas. The roadway plan for project R-1025 also shows lane arrows indicating traffic movement. However, these lane configurations shown on the roadway plans shall in no way supersede that which is shown in the PM plan.

Before moving on, be sure to look at the roadway plan thoroughly.

Ok, now that you have an idea of how the final pavement marking will look on this facility, let's take a look at the PM plan for project R-1025. Flip through the plan sheets of project R-1025 until you reach Sheet No. PM-1 (located directly after TCP sheets). As mentioned earlier, the PM plan shows the types and locations of pavement marking lines and/or symbols and/or pavement markers on the final wearing surface of a roadway through the use of references and detail drawings.

a. Pavement Marking Schedule

In chapter ten, we briefly mentioned that the pavement marking schedule is sometimes located on the Traffic Control Plan title sheet, and is referred to within the TCP and PM plan. On larger plans we may have separate pavement marking schedules depending on what type of work is being done. Turn back to sheet TCP-1 and take another look at the pavement marking schedule. The pavement marking schedule can be considered as a legend for the PM plan where the symbols for the types of pavement markings are listed in the first column from A to EE. All types of pavement markings and pavement markers are referred to with a letter in the pavement marking schedule. The second column lists the pay item as you will find them listed in the Summary of Quantities on sheet 3 of the Roadway Plan. The third column lists a description for each pay item.

Before we continue our discussion of the PM plan, let's practice reading the pavement marking schedule.

Refer to the pavement marking schedule and complete the following exercise.

1. Which symbol denotes a 4" SOLID LINE that is WHITE, REMOVABLE TAPE?

Solution:

First, if we look down the description column we notice that there are three descriptions that are 4" solid line. However, only one has the pay item 4" removable tape, white. Therefore, the answer is BB.

Try this one yourself:

Exercise: (See TCP-1)

1. Which symbol denotes a PAINTED, WHITE 4" X 2" MINISKIP?

Turn to Appendix G (page G-3) and check your answer.

b. Pavement Marking Details

Let's go back to sheet PM-1. Sheet PM-1 shows the pavement marking detail for the -L- line (US 421) from station 302+44 -L- to station 550+00 -L- as stated in the lower right hand side title block. Notice at station 302+44 the pavement marking begins: BEGIN (K) (L) (P). If you turn back to sheet TCP-1 and refer to the pavement marking schedule for the descriptions of (K) (L) and (P), you will find that a 4" white thermoplastic edgeline, a 4" X 10' white thermoplastic skip and a 4" yellow thermoplastic edgeline are beginning at sta 302+44. The beginning and ending stations for the pavement markings will be shown throughout the pavement marking plan.

Exercise: (See PM-1, and TCP-1)

1. What pavement marking(s) is/are beginning and/or ending at station 527+25?

2. What type of pavement marking is denoted by the symbols U and T?

Turn to Appendix G (page G-3) and check your answer.

In Chapter Ten we discussed the function of typical details within the TCP. Typical details are used also in PM plan for similar pavement marking and marker situations throughout the plan that are not covered in the Roadway Standard Drawings. Take, for example, the typical detail shown on sheet PM-2 : TYPICAL FOR PLACEMENT OF PAVEMENT MARKERS AT MEDIAN CROSSOVERS.

This typical detail is used for all median crossover locations on the project. It was developed because this situation (pavement markers at median crossovers) is not handled in the Roadway Standard Drawings, and instead of showing the same detail more than once throughout the plan this typical detail can be referred to at all median crossover locations.

Exercise:

1. What is the typical spacing for reflective markers? (See PM-2)

2. What symbol does N denote? (See TCP-1)

3. On PM-2, what is the spacing for the left turn arrows?

Turn to Appendix G (page G-4) and check your answer.

CHAPTER TWELVE: TRAFFIC SIGNALS

Traffic signals are installed on highways where potentially hazardous situations exist or where other traffic control devices (signs, markings) do not provide adequate control. Traffic signals are used to control vehicle and pedestrian right of way by alternately directing traffic to stop and proceed. From your package of sample plans, locate the plans labeled "Traffic Signal Plans for Crossroads Plaza". The project number will be 4.6332072. These are the plans that will be used in this section of your manual.

Shown on the next page are two views of a simple signal span. Notice these things on the views of the signal span.

Spanwire - This part of the installation supports the signal heads, traffic signs, and related hardware. Occasionally, metal mast arms may be substituted.

Signal Heads - For the motorist and the pedestrian, this is the most visual part in an installation. It alternately directs them to stop and to proceed.

Controller Cabinet - A cabinet that houses the controller and other associated equipment. It protects this equipment from weather, vandalism, theft, etc...

Pedestrian Head with Pushbutton - This consists of a signal face advising pedestrians to "WALK" and to "DON'T WALK", and a push-button to allow the pedestrian to place a call to the controller for right of way.

Wood Poles - The most common type poles used in a signal installation. Some signal installations may use metal poles.

Standard Guy - The guy wire is used to provide stability for the signal installation.

Sidewalk Guy - Used for the same purpose as the standard guy. However, it is used where conditions do not permit standard guys (not enough right of way, buildings or other structures close to the poles, etc...).

Signal Cable - An electrical cable used to supply current from the controller to the signal heads.

Underground Conduit - Used to protect the detector lead-in cable which runs from the loop detector to the controller. Most signal installations are made of more than one signal span, placed in various arrangements.

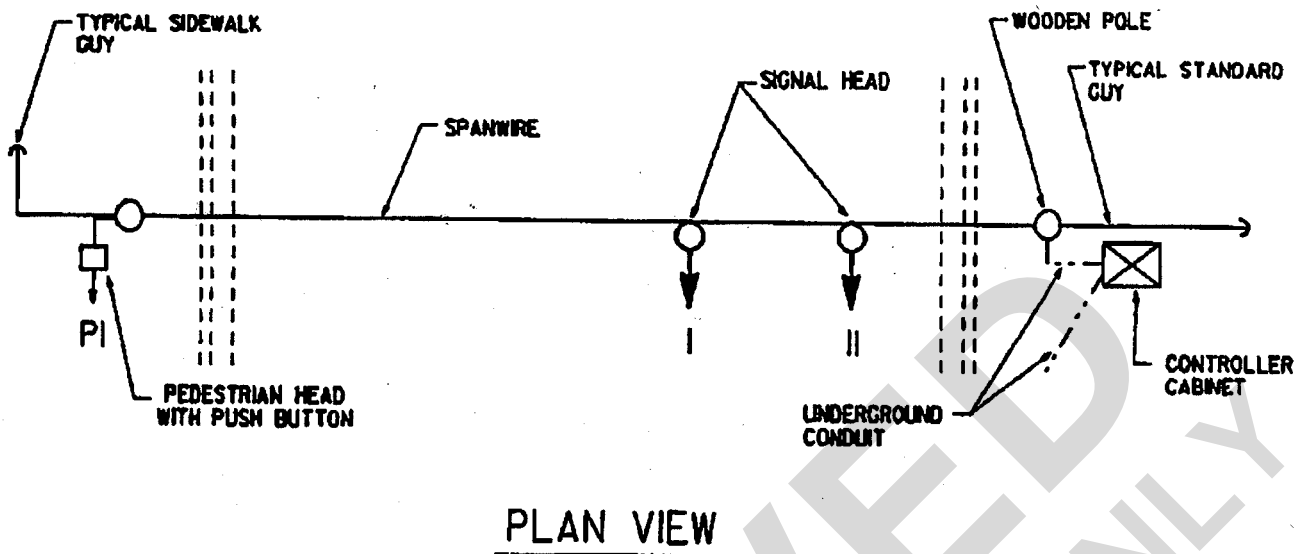


Figure 1

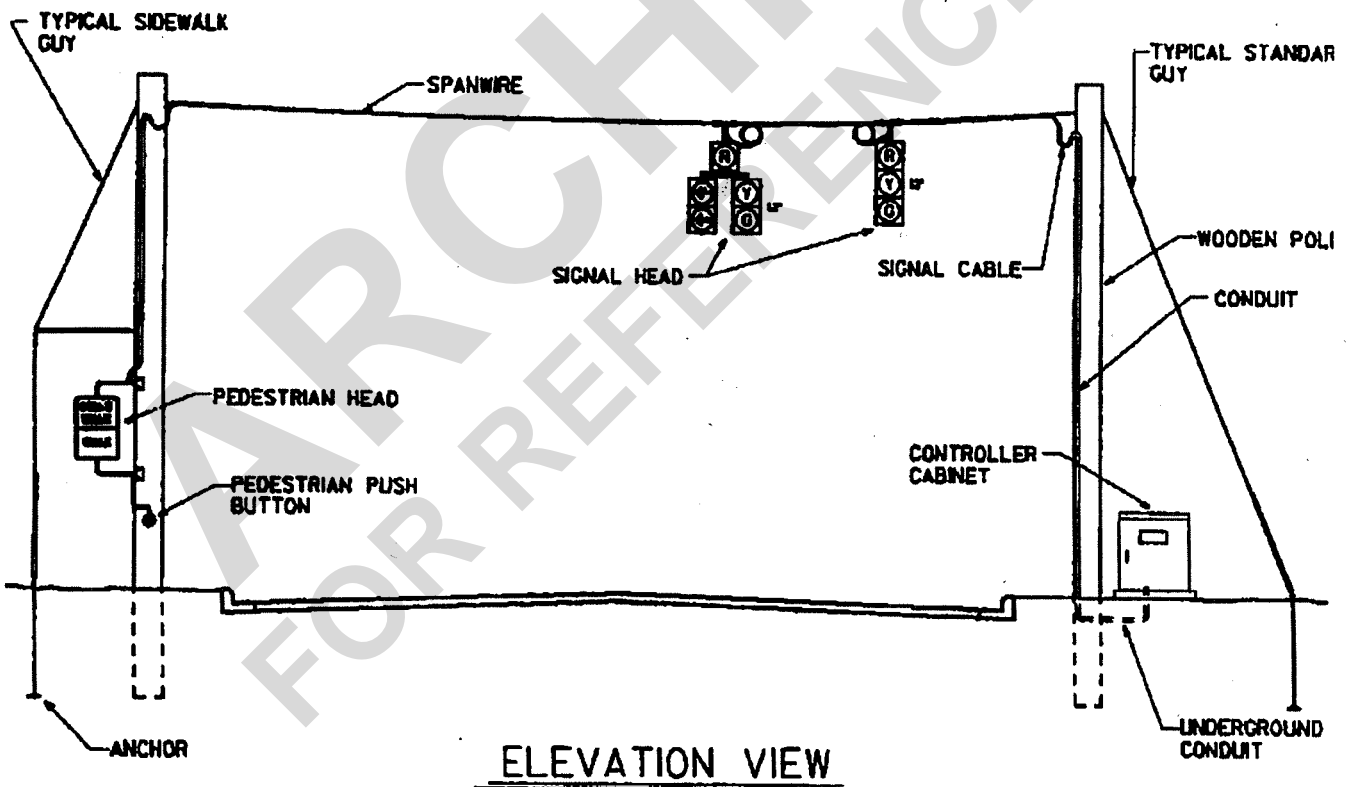


Figure 2

From the plan view of the signal span, notice that the signal heads are numbered 1, 11, and P1. Look at the sample Signal Face. I.D. Chart below:

SIGNAL FACE I.D.

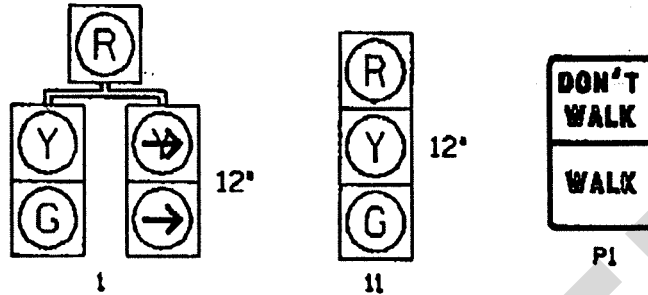


Figure 3

The "Signal Face I.D." Chart tells you what a signal face will look like. On a signal plan, each signal face will be identified by it's own number. This makes it easy to cross-reference the signal face to other areas of the plans. Now, look at your sample signal plans and see if you can identify the Signal Face I.D. charts on Sheet No.'s 3, and 5. After you have done this, see if you can identify where each signal face goes on the spanwire. Observe, that the signal installations on these plans are made up of more than one signal span.

From Sheet No. 5, sketch below what the signal faces will look like for signal heads 4, 333, and 999.

Check your sketches in Appendix G-4.

For a traffic signal face to direct traffic to stop and to proceed properly, it must display the correct color signal indication. In your signal plans, look for the charts labeled "Color Sequence Chart" on Sheet No.'s 4, and 6. This chart shows what signal lens are to be illuminated in each signal face during each possible interval of a cycle. The "R/W" column shows which signal faces will display right of way (green ball or green arrow) for a particular phase. Next, the "Clear" column shows the color sequence the signal indications must go through before the signals change right of way to another phase. Notice the "Clear" column is broken down into the different phases that the right of way

can change to as indicated in the Phasing Diagram. This in turn is broken down into two intervals. These intervals are the clearance intervals. In reading the color sequence chart, notice how the signal face is identified by it's own number.

From the Color Sequence Chart on Sheet No. 4, answer the following:

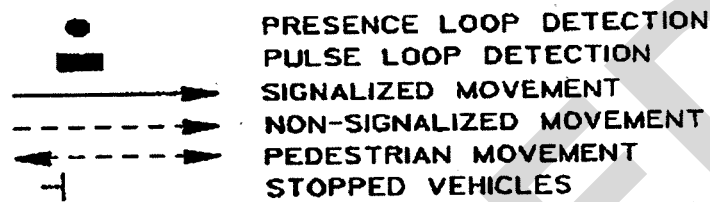
- 1) Which phases can phase 1+5 clear to?
_____, _____, _____, _____, and _____.
- 2) Which signal faces will flash yellow when the signals are in the flash mode? _____, _____, _____, and _____.
- 3) For phase 3, which signal faces will display green ball or green arrow?
_____, _____, _____, and _____.

Go to Appendix G-4, and check your answers. If they are wrong, go back and find out why.

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To help visualize what is happening in an intersection, a "Phasing Diagram" is provided. This diagram shows which movements are going or stopped for each phase in a cycle. It shows what sequence the phases can be called up and the number of phases in a cycle. Also, it shows which movements are being detected during each phase and the type of detection used for that movement.

Shown below, are descriptions of the various symbols used in the phasing diagram.



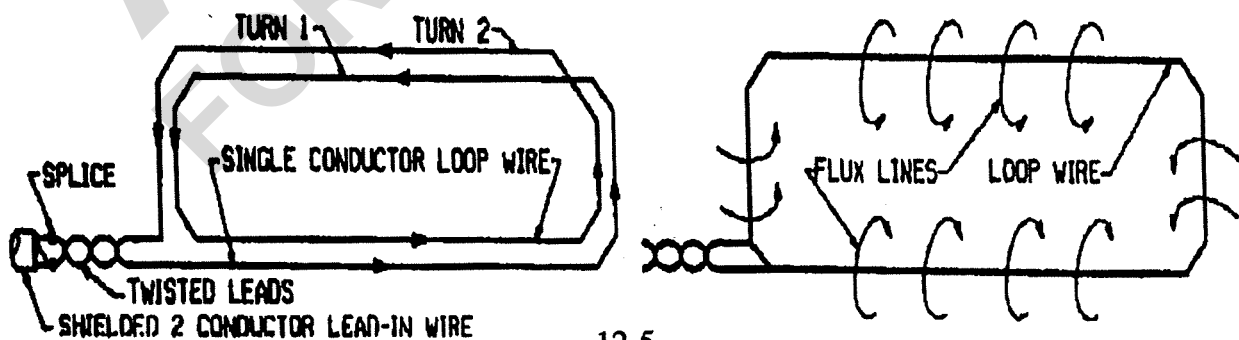
On Sheet No. 's 4 and 6 of your sample plans, find the phasing diagrams. On the phasing diagram, the number of arrows corresponds with the number of lanes for that approach and the movements permitted from each lane. See if you can visualize what is happening to the traffic movements on the sample signal plans.

From Sheet No. 4, using the Phasing Diagram, answer the following questions:

- 1) How many through lanes are progressing in phase 1+6? _____
- 2) What type of detection, pulse or presence, calls up phase 2+6? _____
- 3) Which phases may be served after phase 1+5?
_____, _____, and _____.

Now, check your answers in Appendix G-4. If they are incorrect, go back and correct them.

A traffic actuated signal installation uses detectors to determine when vehicles are present or approaching an intersection. The most common method of vehicle detection is the inductive loop detector. Using the inductive loop detector, a loop is formed by placing a number of turns of wire in a pattern in the pavement (see below).



When an electrical current passes through this wire, an electrical field (flux) is created. Metal in a vehicle passing over the loop disrupts this field. This disruption is registered and a call is placed to the controller. Go to your sample signal plans on Sheet No's 3 and 5. Look at the legend and find the symbol for the detector loop. Next, look at each signal plan design and find the detector loops. Notice how the detector loops are numbered in a similar fashion to the signal heads, except the numbers have a circle around them. Now, find the "Loop Installation Chart". Information on loop installations is contained in the Loop Installation Chart. This chart will show the size and location of each detector loop in relationship to the stop bar, the number of turns of wire needed to make a detector loop, the signal phase the detector will be calling, the amplifier to which the detector will be attached, and any other special feature. The detector loops are referenced to the Loop Installation Chart by the circled number next to the loop on the plans. Other important information on the loop installations is contained on Sheet No.'s 7, 8, 9, and 10. These sheets are titled "Typicals for Loop Detectors Configuration and Installation", "Typical Loop Lead In Cable Connections and Splicing". These sheets contain information on loop detector configurations, pavement sawcutting, quadruple loop wire winding, and standards for cable splicing and connections. Information on Controller programming and wiring is also contained on these sheets. Take a few minutes to look over these four sheets in your sample signal plan.

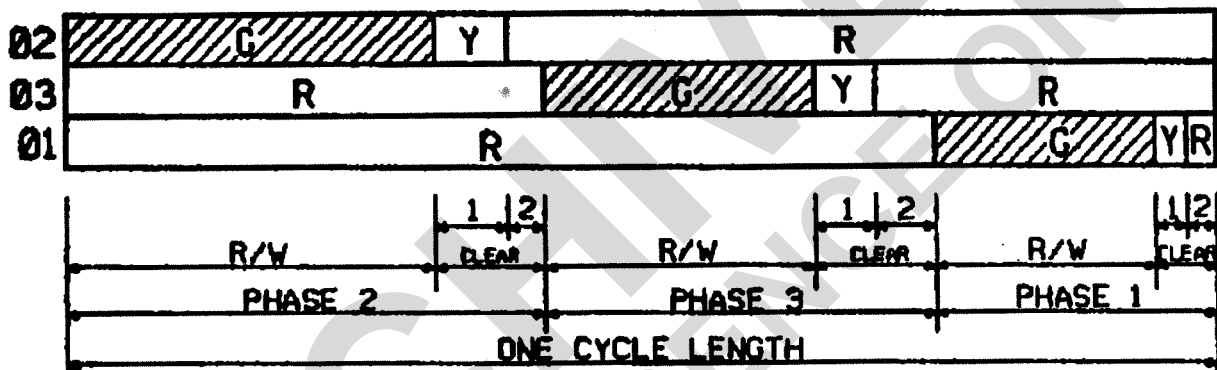
Now, go back to the Loop Installation Chart on Sheet No. 5, and answer the following:

- 1) Which loops call phase (Function 3)?
_____ and _____
- 2) What type of detection is used (pulse or presence) to call phase 3? (Hint: Remember, you may need to look to other areas of the plans such as the Phasing Diagram as mentioned previously!!!) _____
- 3) Find loop no. 31 on the same Loop Installation Chart.
List its size and location: _____ located at _____ the stopbar.
Observe that for this loop, the turns are listed as 2-4-2. On Sheet No. 7, Figure 5, is an illustration of this type loop. Notice how section A-A has 2-4-2 turns of wiring in the sawcut.

Once again, check your results in Appendix G-4, and correct them.

The last standard chart located on your sample signal plans is the "Timing Chart". This chart shows the timing to be set on the controller for each signal phase interval. It also shows what memory position is to be set on the controller. Essentially, the times needed for a vehicle actuated signal installation are Green Time, Yellow Clearance, Red Clearance, and Passage/Gap. The Green Time will have a minimum amount of time that it must stay green. This is called the Minimum Green or the Initial Time on the Timing Chart. In addition to the Minimum Green time, the green time will also have a maximum time it may stay green when

a call is received on a conflicting movement. This is called Max. 1 and Max. 2 on the Timing Chart. Max. 1 and Max. 2 are two different maximum times such that the controller can be programmed to use Max. 1 at certain times of the day, and to use Max. 2 at other times. The Red Clearance and the Yellow Clearance are the amounts of time for the yellow display and the all-red display, respectively. The last of the necessary times needed for a vehicle actuated controller, the Passage/Gap, is the time the controller extends the green time between vehicles crossing the loop detector. As an example, on the Timing Chart on Sheet No. 6, observe that phase 2 has a 2 second passage/gap. This means vehicles can pass over the detectors for this phase at intervals of 2 seconds or less, and the controller will recognize them as one continuous call. The difference between a vehicle actuated controller and a pretimed controller is that the Green Time is fixed (the Minimum Green Time equals the Maximum Green Time) and there is no Passage/Gap Time. Below, is a bar graph to help better visualize the times on the timing chart.



Also on the Timing Chart, are two rows labeled Recall Position, and Vehicle Call Memory. Both of these are programmed into the controller. Recall Position means that a call is automatically assumed for that particular phase unless it is marked "none." Vehicle Call Memory, if it is "unlocked", is telling the controller to remember the call after the vehicle has left the detection zone until right of way has been satisfied for the call. "Nonlock" means the controller will forget the call after the vehicle leaves the detection zone. The Timing Charts on your sample plans are located on Sheet No.'s 4, and 6.

From Sheet No. 4, answer these questions on the Timing Chart:

- 1) What is the Maximum Green for phase 2? 27 sec.
- 2) What is the recall position for phase 2? 10.
- 3) How much passage/gap is allowed for phase 6? 10 sec.
- 4) What is the total clearance time for phase 1? 27 sec.

Check your results in Appendix G-4.

New designs will gradually feature new methods of vehicle detection, and programming to controllers to make full use of their capacities. One of these methods of programming is called Volume/Density. With Volume/Density the Minimum Green Time and the Passage/Gap Time are variable, instead of fixed. This allows the signal installation to be more traffic responsive. With the advancement of technology, signal plans and installations will be in a continuous state of evolution. It is hoped that this chapter has given you a good basic understanding of signal plans so that you can expand on your own as signal plans evolve.

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CHAPTER THIRTEEN: HIGHWAY SIGNING PLANS

Highway Signing Plans Overview

Refer to the sample signing plan sheets from TIP project R-74AA which are a part of this course. Plan sheets included are typical of those in a complete set of signing plans.

Sign-1 is the "Summary of Quantities" sheet which contains the individual pay items for the signing work. If signing is a stand alone project, then the summary will include pay items for mobilization and traffic control. This project included other types of work and hence these two pay items are shown elsewhere. The sheet also refers to typical sheets in the "Roadway Standards", which are a part of these plans.

Sign-2 is "Standard Exit Panel Mounting Details" and is one of several standard sheets included as they have been revised since the last publication of "Roadway Standards". As standards are incorporated into "Roadway Standards" the individual sheets can be eliminated from plan packages. The standard shows the contractor the proper mounting methods to attach signs to break-away steel sign supports.

Sign-5 is a typical "Overhead Assembly" drawing. This drawing is used to locate the sign structure footings and to identify where signs are to be installed on the structures. The Department of Transportation does not design the individual structures, but allows the contractor to design and build the overhead sign structures. Their designs are checked by the Structure Design Branch. Note the dotted outlines. These represent a designed sign the structure must be capable of supporting. This allows for excess capacity to enable us to make sign revisions later.

Sign-6 is a typical sheet for "Lighting System for Overhead Sign Assemblies" which shows details of how power service poles are to be built and wired. It also shows mounting details for the mercury vapor lighting used on overhead signs.

Sign-7 contains additional standards for lighting, including the circuits and a table of specific dimensions for all lighting on the project.

Sign-8 is a chart and details for ground mounted signs installed on break-away sign supports titled "Support Information for A & B Signs". Type A signs are those manufactured with horizontal stringers and from more than one sheet of aluminum. Type B signs have stringers but can be made from a single sheet of aluminum and do not have splice plates. Refer to Roadway Standards 100.50 and 100.51 for details of type A and B sign construction. The table contains support details needed for fabrication of the supports. Refer to Roadway Standards 100.52 and 100.53 for details on the break-away sign supports.

Sign-9 and Sign-10 "Type A and B signs" show the individual sign designs. These designs are produced using microcomputer programs which space the lettering and other components on the signs. Please note the "SIGNS FURNISHED BY STATE". Most signing projects have the signs supplied by the State and not by the contractor. The Department orders the signs from the North Carolina Department of Corrections, which under its Correction Enterprises Division, manufactures highway signs at a large plant in Bunn, NC.

Sign-11 "Type D Signs" is representative of designs for type "D" signs or signs manufactured without horizontal stringers. These smaller signs are commonly used on ramps and on crossing "Y" lines.

Sign-19, Sign-20, and Sign-21 are representative of signing plan sheets which show the location of "existing", "proposed", and "future" signs. Note the symbols used to represent the actual sign locations. They indicate the use of single or multiple supports; however, the actual number of supports and sign offsets must be obtained from the break-away support chart or by the use of standard 100.56. Individual sign faces are shown and signs to be installed by the contractor are numbered.

All type A and B signs also have station numbers given. Overhead signs are numbered starting with "1", and if a panel is installed above a sign, then letters are also used. Ground mounted type A and B signs are numbered starting with "101". Exit gore signs are numbered starting with "201".

Type "D" signs are numbered starting with "301".

Type "C" signs are no longer used, these were small signs with stringers mounted onto round supports. The use of round supports was stopped when more stringent break-away requirements were adopted by the American Association of State Highway and Transportation Officials (AASHTO).

Type "E" signs are standard regulatory and warning signs contained in the "Manual on Uniform Traffic Control Devices" (MUTCD), and these are numbered starting with "401". Type "F" signs are route marker assemblies and they are numbered starting with "501".

The "Manual on Uniform Traffic Control Devices"

The "Manual" is the document on which Traffic Engineers rely for guidance in highway signing, signal design, and pavement marking. The MUTCD is published by the Federal Highway Administration but its content is controlled by the National Committee on Uniform Traffic Control Devices, of which AASHTO is a member. A companion publication titled "Standard Highway Signs" gives detailed design information on the standard signs that appear in the MUTCD.

Part II, "SIGNS" of the MUTCD, contains the basic rules for signing roadways used throughout the United States. North Carolina has adopted the MUTCD as a guideline along with associated State supplements. The Parts of most importance to technicians designing freeway signing are contained in Parts 2E and 2F which cover expressway and freeway guide signing. **Please review Part II of the MUTCD.** Refer to page 2E-4 and 2E-5 for a table of letter sizes used on the different types of guide signs. A similar table is also in Part 2F for freeways. Refer to the drawing in Part 2-F which shows the advance guide sign sequences required on freeways.

"Standard Specifications for Roads and Structures"

The "Standard Specifications for Roads and Structures" contains specifications for materials used in signing work and describes the standard "pay items" used in signing plans. They contain specifications for highway sign materials including sign fabrication, erection, and removal; and materials used in sign fabrication, including the reflective sign sheeting.

Refer to the Standard Specifications for additional information about the materials used for signs and supports.

Guide Signing Copy Determination and Design

A large part of the work of developing highway signing plans is the process of determining the location and messages that will go on the critical guide signs on freeways and expressways. Consideration must be given to the proper spacing of signs to allow for driver comprehension and message overloading. Guide signs are routinely placed at 800 foot intervals, while other signs on freeways may be placed as close as 400 feet. Signs on ramps and crossing "Y" lines may be as close as 100 feet, depending on operating speeds at the various locations.

Choosing proper letter sizes for signs is important if the sign can be read from appropriate distances. A rule of thumb is to have 1 inch of letter height for each 50 feet of visibility. The trend toward older drivers in the United States has led officials to question the need to increase letter sizes by 25%.

The process of designing a sign face has been somewhat simplified in recent years by the use of microcomputer applications. The Signing Unit is now automating the design of signs on the CAD system. However, the actual design process used on microcomputers and CAD is beyond the scope of this course.

Other Signing Placement

Standard drawings are used by the Signing Unit to assist the signing technicians with proper placement of all signs. They must consider first the placement of required major guide signs, the advance guide signs, exit directional guide signs, exit gore signs, supplemental guide signs, and logo signing. Next they must locate any required warning signs, such as lane drop signs and ramp or exit speed warning signs. They must then locate regulatory signs, such as speed limit signs, and finally locate other informational signs, such as distance signs.

The signing technician must then locate required signing on the ramps and "Y" lines using a similar order of placement. Route junction and destination signing is important for motorists approaching a freeway, so these types of signs must be carefully considered. Review Sign-19, 20, and 21 at this time to study the placement of the different sign types. Note several instances of "Future" signs planned for but not installed by this project.

Sign Support Designs

AASHTO guidelines are in place that require all sign supports that are located within 30 feet of the edge of travelways on freeways to be built so they will break-away. If a sign is not installed on such supports then it must be shielded by guardrail.

The Federal Highway Administration has been supervising the crash testing of sign support systems for many years and a listing of suitable break-away designs exist. North Carolina uses break-away supports even when they are installed 30 feet from the edge of pavement, to provide even greater safety to the traveling public.

The type "D", "E", and "F" signs are routinely installed on 3 pound per foot "U" channel supports which are considered break-away when no more than 2 supports are used in any 7 foot path. Larger type "A" and "B" signs are installed on slip base supports, which slide apart upon impact. Refer to roadway Standards 100.52 and 100.53 for design details of the supports.

The design of break-away sign supports is done with the use of a microcomputer application which can size the supports once it is given sign sizes and shoulder slope information. Support Summary charts are incorporated into the Signing plans giving the detailed support information necessary for the contractor to order supports from steel fabricators. See Sign-8 for the chart. Field support elevation measurements are taken by the signing technicians or support elevations are determined from plan cross-sections as a part of support designs. The difference in elevation at the support location and the edge of the travel way is expressed as dimension "S" for each support on the Support Chart.

Overhead Sign Structures

The State does not design sign structures, instead it uses structures designed by independent fabricators. A structure cross-section is drawn for each overhead or cantilevered sign structure showing the pavement profile at the structure and the placement of support footings and centerlines of all support trusses. The placement of signs over the travel lanes is also shown.

Overhead signing is used for guide signs when 3 or more travel lanes exist in one direction. This is done so that motorists in inside lanes can see signs even if traveling to the left of trucks that would block their view to ground mounted signs. Cantilevered signs can be used for advance guide signs when only one sign is required at a location and the mast arm does not exceed 50 feet in length. Full sign bridges are used where sign placement precludes the use of a cantilever structure or where more than one guide sign is required. Full sign structures in excess of 150 feet in length have been installed. If possible, some signs can be installed on overpass structures.

The Signing unit has developed software that contains solutions for many sign sizes thus simplifying the task for the signing technician. Mercury vapor fixtures are installed on overhead signs to improve their legibility. While all signs are faced with retroreflective sign sheeting, the use of lighting on overhead signs is done because of the difficulty of automobile headlights reaching the tops of overhead signs. Refer to Sign-5, 6, and 7 for details of overhead sign lighting.

Completion of Highway Signing PS&E Package

Once the signing plans are completed, specifications and any required special provisions for non-standard bid items, or non-standard construction details must be written, and an engineer's estimate done. This information is referred to as the (PS&E) package. The package is then reviewed by a supervising engineer, and when all revisions are made, the engineer seals the plans. The package is then submitted to Design Services for inclusion into a complete project bid package.

Construction Oversight

The Signing Unit has responsibilities even after the projects are awarded. It is the Unit's responsibility to place orders for highway signs to the North Carolina Department of Corrections if the project has State provided signs. The order for signs is done after the Resident Engineer has conferred with the signing subcontractor and determined the date signs will be required. The contractors are responsible for the condition of the signs when they acquire them from Correction Enterprises until project acceptance, so they often attempt to minimize this time.

The Signing Unit also must be available to make any project revisions requested by the Resident Engineer, most notably, the Resident is required to "field verify" sign support elevations. This often results in minor revisions to the support charts in the signing plans.

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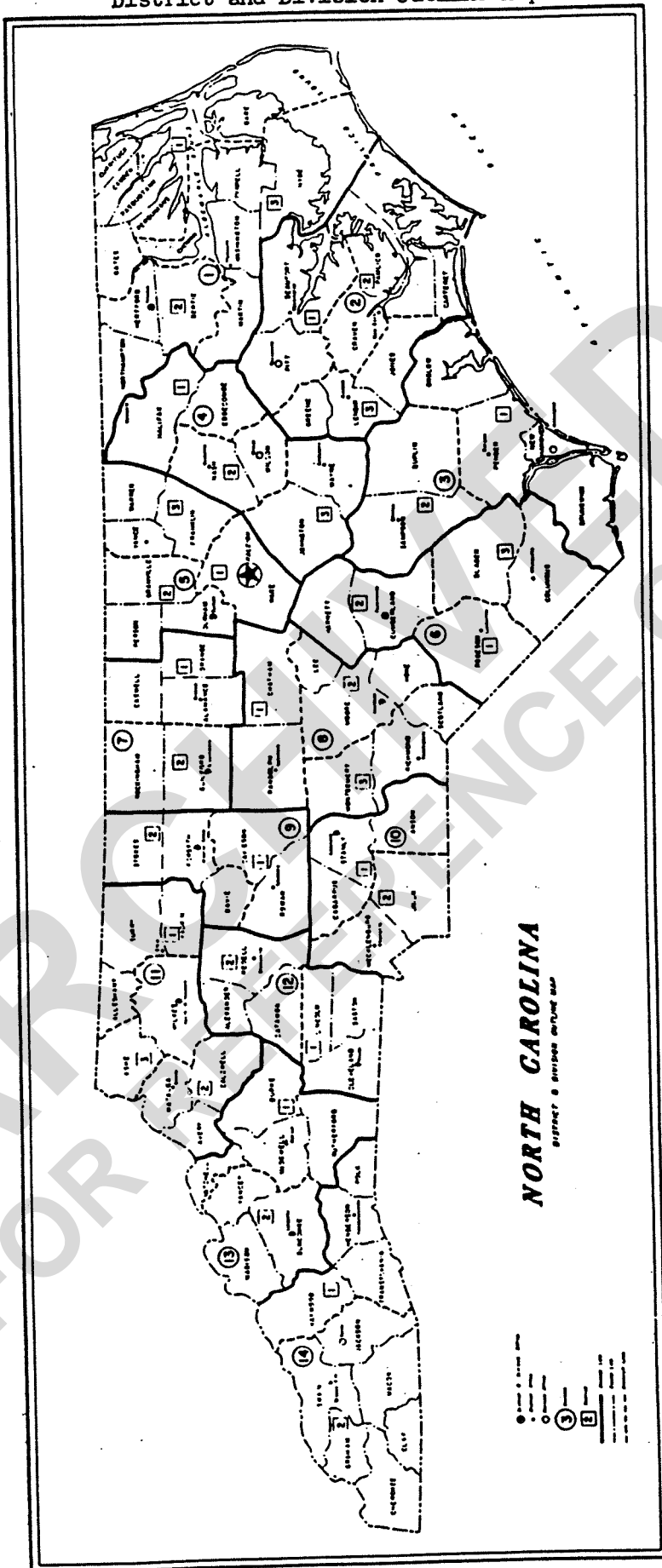
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**APPENDIX B
CONVENTIONAL SYMBOLS**

For Conventional Symbols, please see your sample set of plans, Sheet 1B.

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APPENDIX C
 District and Division Outline Map



APPENDIX D TERMS AND DEFINITIONS

-A-

A.A.S.H.T.O. - American Association of State Highway and Transportation Officials.

Abandonment - the act of the cessation (stoppage) of use of a right-of-way with no intention to reclaim or use the right-of-way again for highway purposes.

Abutting Land Owners - the owners whose land adjoin (abut) the land spoken of.

Acceleration Lane - a connecting lane leading from a ramp to a freeway and designed to enable the motorist to merge into freeway traffic at highway speed.

Acquisition or Taking - the acquiring of a property in its entirety or a portion thereof for highway purposes.

Acre - a measure of land area; i.e., 160 square rods; 4,840 square yards; 43,560 square feet.

Aggregate Base Course (A.B.C.) - crushed stone used as a part of the roadway base to support pavement.

Alignment - see "Horizontal Alignment" and "Vertical Alignment."

All Red Interval - The time of display of a red indication for all intersection approaches, used following a yellow interval to permit vehicles or pedestrians sufficient time to clear an intersection before opposing vehicles receive a green *indication*.

Angle - the figure formed by the intersection of two straight lines.

Arc - a segment of a circle.

Area Data Sheets - sheets in a set of plans which show the areas of the property to be appropriated and the remaining areas shown in acres or square feet or portions thereof.

Average Daily Traffic (ADT) - The total volume during a given time period (in whole days), greater than one day and less than one year, divided by the number of days in that time period.

Azimuth - direction to or toward an object, measured as an angle in the horizontal plane. In surveying, the azimuth is measured clockwise from the South.

APPENDIX D TERMS AND DEFINITIONS

-B-

Backfill - material used to replace (or act of replacing) material used during the construction of a project.

Back Plate - A black metal plate attached to a signal head used for the sole purpose of increasing target value of the signal face (used when signal face not readily visible to motorist due to competing background lighting such as commercial signs and lights, sunlight, etc...).

Backslope - that portion of roadway between the side drainage ditch and the top of the cut - usually measured as a ratio of horizontal distance versus vertical distance; i.e., 4 to 1 slope.

Balance Stations - stations between which excavated earth material approximately equals the amount of embankment material required.

Barrel - the part of a culvert that water flows through.

Base Course - a part of the pavement structure between the surface course and the subgrade.

Beam - placed lengthwise along the bridge with its end resting on a cap or a bent-made of steel or concrete.

Beams or Girders - These are placed lengthwise along the bridge (parallel to the of the bridge as shown in the PLAN VIEW) with each end resting on the BENT CAP. They can be made of steel or concrete.

Bearing - 1) a method used to express direction. The bearing of a line is the angle and direction which the line makes with respect to a North-South, East-West line.

2) The part of a bridge that bears weight or acts as support (of a girder).

Bed Elevation of a Culvert - the elevation of the top of the bottom slab of a culvert at the centerline of the roadway.

Bench Mark (B.M.) - a point of known elevation, usually a mark of some durable material such as a stone, a concrete post, or a bronze plate to serve as a reference point in running a line of levels for the determination of the elevation.

Bent - considered to be composed of the BENT CAP, the COLUMN, the FOOTING, and the PILES beneath the footing or the Bent Cap and the Piles supporting the cap (in some instances, there are no columns or footings - such as a stream crossing).

APPENDIX D TERMS AND DEFINITIONS

Bent Cap - a part of a bridge - constructed of reinforced concrete and supported either by means of columns or piles.

Bent Caps - These are constructed of reinforced concrete and are supported either by means of concrete or steel PILES or of reinforced concrete columns. End Bents normally use Piles.

Berm Ditch - an open water course constructed for the collection and handling of surface drainage.

Borrow - suitable material from sources outside the project limits used primarily for embankments.

Borrow Pit - an area (pit) from which suitable material from sources outside the project limits is excavated. This material is generally used for embankments.

Boundary - that which fixes (or indicates) a limit of extent to a parcel of land.

Box Culvert - (see culvert)

Bridge - a structure having a span over twenty feet, erected over a roadway, stream, railroad, depression, or combination of these. (Multiple lines of pipe culvert regardless of their length are not considered a bridge.)

-C-

Cabinet - An enclosure for housing the controller and associated *equipment*.

Call - A registration of demand for traffic to the traffic signal controller unit.

Catch Basin - An opening into a storm drain system suitable for use in a curb and gutter section. A combination of grate and curb opening.

Cattle Pass - an opening under a roadway which allows movement of livestock from one side of the road to another. The opening usually consists of pipe culvert or box culvert.

Centerline - the longitudinal mid-point of all contiguous travel lanes. Surveyed stations are normally on the centerline of travel lanes or median.

Channel Change - a man-made change or diversion in the natural flow of water - or a man-made change of flow in the channel of a ditch, stream, creek, or river.

Circular Curve - an arc (segment) of a circle.

APPENDIX D TERMS AND DEFINITIONS

Class (III), (IV): - The strength indicator for concrete pipe. Class IV pipe will withstand greater loads than Class III pipe.

Clearance Interval - The yellow plus all red indication interval time to advise vehicles or pedestrians of an end to right of way and allow a safe stop or permit a vehicle already in the intersection to safely clear the intersection.

Clearing - the work done by the contractor to remove and dispose of all trees, stumps, brush, trash, buildings, fence, signs, etc. within the limits of the total project.

Coarse Aggregate Base Course (C.A.B.C.) - crushed stone used as a part of the roadway base to support pavement.

Collar - A concrete band used to join two dissimilar pipes. May be used to accommodate an angular turn. Roadway Standard: 840.72

Color Sequence Chart - A chart which shows what signal lens are illuminated in each signal head during each possible signal interval of a cycle.

Communication Line - a utility.

Concrete Flume: - An open concrete chute to carry storm water from the highway and at bridge approaches. Roadway Standard No. 100.11

Concrete Pipe, Reinforced Concrete Pipe: - Drainage pipe made of reinforced concrete.

Condemned Property - property which has been acquired for highway purposes by the exercise of the right or power of eminent domain (stoppage).

Construction Easement - an easement which extends to the farthest limits of construction beyond the right-of-way limits as shown on the plans.

Construction Items - work to be done on a project; i.e., paving limits, grading, structures, etc.

Construction Joint - the place where one concrete pour ends and another begins.

Construction Limits - the limits shown on the plans by symbols which designate the limits of construction; also, the lateral (side) limits of grading.

Contract - an agreement between two or more persons or parties to build a section of roadway or structure.

Control - a system of points with established horizontal positions or elevations, or both, which are used as fixed references in positioning and correlating map features.

APPENDIX D TERMS AND DEFINITIONS

Control of Access - the condition whereby the NCDOT controls the right-of-way property owners or occupants of abutting property have to enter or leave a highway. A line designated as C/A which indicates no access from property adjacent to the R/W will be allowed. A fence is usually constructed along the C/A line.

Conventional Symbols - symbols used by the designer to convey a meaning to whoever is reading a set of plans. A Conventional Symbol will represent quantities, items, or things.

Coordinated Signals - Signal installation at two or more locations which operate together in such a manner as to allow traffic along the major street to flow through the intersections after passing through the first.

Coordinates - 1) grid coordinates - a plane rectangular coordinate system based on, and mathematically adjusted to, a map projection so that geographic positions in terms of latitude and longitude can be readily transformed into plane coordinates, and the computations relating to them made by the ordinary methods of plane surveying. 2) State plane coordinates - a series of grid coordinates systems prepared by the Federal Government for the entire United States, with a separate system for each state.

Corrugated Metal Pipe, Corrugated Steel Pipe: -Rigid drainage pipe, made of aluminum or steel.

Cross Section - a view of an object where the object has been "sliced away" - produced by a vertical plane cutting through the roadway at right angles to the centerline showing the profile of existing and proposed earth.

Crown - the transverse slope on the finished surface of a roadway.

Cul-De-Sac - a street or road which is open at one end only - with special provision for turning around at the closed end.

Culture - features of the terrain that have been constructed by man. Included are such items as roads, buildings, and canals; boundary lines; and in a broad sense, all names and legends on a map.

Culvert - a structure not classified as a bridge which provides an opening under a roadway - usually for water drainage -- normally a box culvert (square or rectangular) or a pipe culvert (round or oval).

Curtain Wall - a concrete wall extending below the slab of a culvert at each end of the culvert to prevent scouring (erosion) action below the slab. Or, a concrete wall at each end of a bridge extending from the bridge slab down to the end of the bent cap.

APPENDIX D TERMS AND DEFINITIONS

Curve - an arc (segment) of a circle.

Cut - a term used to describe an excavation or removal of earth.

Cut Slope - The slope beneath a bridge can also be a cut slope. This would be the case where the bridge is to be built on an existing roadway and the earth below the bridge must be removed to provide for the roadway below.

Cycle - See time cycle.

-D-

Datum Plane - 1) horizontal datum - the geodetic position (latitude and longitude) of reference assigned to an area. North American Datum of 1927, North American Datum of 1983, or a local datum.

2) vertical datum - any level surface taken as a surface of reference. (as, for example, mean sea level)

Deed of Easement - an instrument by which a right is acquired by the NCDOT to use or control property for highway purposes.

Deflection - 1) a change in the horizontal direction of a line, the magnitude of which is expressed in degrees.

2) Additional deviation, after construction of a bridge, due to addition of live load.

Degree - a unit of angular measurement - a degree represents 1/360th part of a circle.

Degree of Curve - the number of degrees of angular measure at the center of a circle subtended by a chord 100 feet in length. In highway surveying, a 100-foot arc is sometimes used instead of a 100-foot chord.

Delay Detection - The ability of a detector to delay its output for a predetermined length of time after the vehicle enters the detection zone.

Delineation: - The method of providing positive guidance to the vehicle operator in accordance with the alignment of the highway. (See also MUTCD 3D-1 and NCDOT Delineation Policy)

APPENDIX D TERMS AND DEFINITIONS

Delineators: - Light-reflecting devices mounted at the side of the roadway, in series, indicating the roadway alignment. Effective for night and wet/night guidance. (See also MUTCD 3D-1 and NCDOT Delineation Policy).

Delta Angle - represented by the symbol Δ ; it is the angle formed by the intersection of the forward and back tangent.

Design Hour Volume (DHV) - The 30th highest hourly volume of the future year chosen for design. The design volume represents the "load" that the highway must accommodate. It is one factor in determining the required number of lanes and other geometric features. The DHV is normally determined by multiplying it times a design hour volume factor, generally a percentage from 8% - 12%.

Detector Loop - A loop of electrical wire placed in the roadway for vehicle detection.

Detour: - An alternate route utilizing onsite and/or offsite facilities when provided by the plans, contract, or as directed by the engineer to facilitate highway construction.

Diaphragm - steel or concrete members found on a bridge that are used to connect beams or girders together for the purpose of distributing loads to all supporting members. Diaphragms are normally placed perpendicular to the beams of the bridge.

Directional Factor (D) - A factor used to determine the one-way traffic volume. It is multiplied by the ADT.

Ditch Slope - see Side Slope.

Ditch - an open course constructed for the collection and handling of surface water drainage.

Drainage Easement - an instrument or easement granting the NCDOT the necessary property beyond the right-of-way limits as shown on the plans to provide for proper drainage of a roadway.

Drop Inlet: - An opening into a storm drain system suitable for use in areas subject to pedestrian traffic; may be used as yard inlets and in driveways behind curb & gutter. Roadway Standard: 840.14B & .15C

-E-

Earthwork - amount of cut and fill earth to be worked with between any two specific stations (measured in cubic yards of earth).

APPENDIX D TERMS AND DEFINITIONS

Earthwork Sheet - a sheet produced by a computer showing the amount of cut and/or fill at each station on the project.

Easement - a property right to use or control the real property of another person - may be temporary or permanent.

Edit - the process of checking a map or chart in its various stages of preparation to insure accuracy, completeness, and correct preparation.

Egress - the act of leaving.

Elevation - vertical distance from the datum (usually mean sea level) to a point or object on the earth's surface.

Embankment - a wall of material, such as dirt, to raise the height of a roadway -or where a "cut" section has been made through an undulating (up and down) surface.

Eminent Domain - the government's acquiring private property for public use by virtue of the superior dominion of the government over all lands within its jurisdiction.

Encroachment - the use of highway right-of-way by private persons for an indefinite term with or without permission, usually involving man-made obstructions either above or below the highway.

End Bent - that part of a bridge, on either end, that supports the beams.

Equality - a point on the survey line where the station numbers of one system change to the station numbers of another system.

Error of Closure - the amount by which a quantity obtained by a series of related measurements differs from the true or fixed value of the same quantity.

-F-

Federal Highway Administration (FHWA) - the office within the Department of Transportation in the U.S. Government which reviews, recommends, and approves the details concerning Federal participation on our highway system.

Fee Simple Title - Absolute ownership of property including also the unlimited right to control same for any purpose whatsoever.

Fence - an item, usually made of woven wire, to keep persons or animals off a controlled-access roadway.

APPENDIX D TERMS AND DEFINITIONS

Fill - use of material (usually earth or gravel) to equalize or raise topography to a certain elevation; to build up will fill; to fill low ground with sand, gravel, or earth.

Fill Slope - that portion of a roadway between the outside of the shoulder and the toe of the slope.

Finished Grade Line - proposed elevations along the finished surface of the roadway.

Flared-End Section - a minor drainage structure.

Footing - that part of a bridge that supports the column and is usually constructed of reinforced concrete.

Footings - These support the columns and are constructed of reinforced concrete. Footings are supported either on piles or firm soil. Footings are not seen once the bridge has been constructed since they will be covered with earth.

Front Elevation - a view from the front side of an object.

Funnel Drain (Slope Drain): - A metal storm drain designed to convey water from a paved or unpaved roadway down a slope to a point of disposal.

-G-

Gauge (6 Gauge, 14 Gauge) - The thickness specification for metal storm drains (cmp, csp)

General Notes - a list of stipulations that commonly and appropriately apply to all projects, but are not peculiar to any project. General notes alone are not to be considered comprehensive for any project.

Grade - the slope of the roadway with a vertical rise or fall expressed as a percentage of the horizontal distance. That is, a 3% grade means a vertical rise of 3 feet per 100 feet of horizontal distance.

Grade Point - a point where the profile grade line crosses the original ground line.

Grated Drop Inlet - An opening into a storm drain system suitable for use in areas both subject to pedestrian traffic and not subject to pedestrian traffic; may be used in roadway ditches, non-curbed shoulders, adjacent to barriers, and other off-roadway locations. (2" or less opening when subject to pedestrian traffic.) Roadway Standard: 840.17 & .26

"Green Arrow" - Illumination of a green arrow lens.

APPENDIX D TERMS AND DEFINITIONS

"Green Ball" - Illumination of a circular green *lens*.

Grid - two sets of parallel lines intersecting at right angles and forming squares; the grid that is superimposed on maps, charts, and other similar representations of the earth's surface in an accurate and consistent manner to permit identification of ground locations.

Grubbing - (usually associated with clearing) - removal of roots and vegetating mass prior to starting earthwork.

Guard Rail - a protective barrier placed between travel lanes of the roadway and a safety hazard (such as high fill, bridge piers, etc.).

-H-

Hanger - usually located below a bridge to hold a water line, gas line, or telephone line.

Headwall - that part of a culvert that retains fill.

Horizontal Alignment - a series of tangents and curves on the "Plan View" which show the direction of the road.

Horizontal Dimensions - measurements on a Typical Section from the centerline of the roadway to the various control points on the cross section. The slope is *not* taken into consideration in a horizontal distance - all horizontal measurements are level lines.

-I-

Improvement Designations - symbols shown on the plans which identify specific improvements or items of real or personal property.

Index of Sheets - a brief summary of each sheet or series of sheets in a set of plans.

Ingress - the act of entering.

Inlet - a minor drainage structure. 1) Drop inlet 2) Median drain (grated inlet).

Inlet End of a Culvert - the end that the water enters.

Insert - an item embedded in the concrete of a structure. A hanger screwed into an insert to hold a water line, gas line, telephone conduit, or (sometimes) a guard rail.

Interior Bent - that part of a bridge that supports the beam.

APPENDIX D TERMS AND DEFINITIONS

Intermediate Contract Time (Days/Months) - The number of calendar days or months inclusive between the date of availability and the completion date, as set forth in the special provisions, including authorized extensions to the intermediate completion date. (See also NCDOT Standard Specifications, January 1, 1990, Sections 101-15, 101-17, 101-29, 101-45, 101-47, 101-71, pp. 3-9).

Intermediate Contract Time (Hours) - The number of hours inclusive between the time of availability and the intermediate completion time, as set forth in the special provisions, including authorized extensions to the intermediate completion time. (See also NCDOT Standard Specifications, January 1, 1990, Sections 101-46, 101-48, 101-71, 101-88, pp. 7-11).

Intermediate Pavement Markings - Pavement marking lines and symbols used to direct and control the movement of traffic during specific construction stages until final pavement markings can be placed according to traffic control plans.

Intersection - 1) a place where two roads join at a common point. 2) a place where two lines join at a common point.

Intersection Details - sheets in a set of plans showing a smaller scale view of detailed information of proposed intersection on a particular project.

Interval - Any of several divisions of the time cycle during which signal indications do not change.

Isolated Signal - A signal installation which operates independent of any other signal installations within the vicinity.

-J-

Junction Box - A structure in storm drain systems used to join two different sizes of pipe or to accommodate significant turns in same size pipes, where access for maintenance is not necessary, and when water inlet is not required. If access is required, a junction box may be used with a manhole. Roadway Standard: 840.31

-L-

Lambert Projection - a conformal map projection of the conical type, on which all geographic meridians are represented by straight lines which meet in a common point outside the limits of the map.

APPENDIX D TERMS AND DEFINITIONS

Latitude - (plane surveying) - the perpendicular distance in a horizontal plane of a point from an east-west axis of reference.

Layout View - larger than the location map, this layout view is found on the Title Sheet, and shows the beginning station and the ending station of the project.

Legend - a description, explanation, table of symbols, and other information, printed on a map to provide a better understanding and interpretation of it.

Level Control - a series of bench marks or other points of known elevation, established throughout a project.

Limited Access - ingress (entrance to) and egress (exit from) to a highway are at points designated by the NCDOT.

Line -

- a. Center Line - A line indicating the division of the roadway between traffic traveling in opposite directions (not necessarily the center of the roadway).
- b. Channelizing Line - A line which directs traffic and indicates that traffic should not cross but may proceed on either side.
- c. Edge Line - A line which indicates the edge of roadway.
- d. Lane Line - A line separating two lanes of traffic in the same direction.
- e. Stop Line or Stop Bar - A line which indicates where vehicles should stop when directed by a traffic control *device*.

Line L - survey line designation. (see: Survey Line).

Liquidated Damages - The sum of money in the amount stipulated in the special provisions that is charged against the contractor for each calendar day/month, each hour, or portion thereof that work described in the special provisions remains uncompleted after the expiration of the completion date, intermediate completion date, or the intermediate completion time shown in the special provisions, not as a penalty, but as liquidated damages. (See also NCDOT Standard Specifications, January 1, 1990, Section 108-11, pp. 79-80)

Location Map - a small map found on the Title Sheet which shows the location of the project. (The beginning and ending of the project).

Longitude - a linear or angular distance measured east or west from a reference meridian (usually Greenwich) on a sphere or spheroid.

APPENDIX D TERMS AND DEFINITIONS

Longitudinal Cross-Section - a view of the side of an object that has been "sliced away".

Loop Detector - A device that senses a change in the inductance of its wire loop (detector loop) caused by a vehicle moving over the *loop*.

Loop Installation Chart - A chart which shows the size and location of each detector loop in relation to the stop bar for that lane, the number of turns needed to make the detector loop, the signal phase the detector loop will be controlling, the amplifier to which the detector loop is connected, and a list of special features the detector is to *have*.

-M-

Manhole - An opening into a storm drain system used for physical access only. May be used alone or in combination with a junction box. Roadway Standard: 840.51

Maximum Green Interval - The maximum possible green indication time displayed for a phase.

Minimum Green Interval - Minimum green indication time displayed for a *phase*.

Median - the center section of divided highway which separates the traffic lanes in one direction from the traffic lanes in the opposite direction.

Median Edge of Pavement - on a dual lane road, the inside pavement edge (or line).

Mile - A measure of distance - 5,280 feet.

Minor Drainage Structure - an inlet, junction box, manhole, spring box, catch basin, or flared-end section.

MUTCD (Manual on Uniform Traffic Control Devices) - published by the U. S. Government. The MUTCD sets forth the National Standards, guidelines, and policies for the design of traffic control devices and their utilization.

-N-

Natural Ground Line - see: Original Ground Line

Narrow Drop Inlet - An opening into a storm drain system suitable for use in mountable curbed median roadway sections. Roadway Standard: 840.12

APPENDIX D TERMS AND DEFINITIONS

Non-Metallic Drums - Traffic control devices used most commonly to channelize or delineate traffic flow. But may also be used singly or in groups to mark specific hazards. They shall be approximately 36" in height and a minimum of 18" in diameter with appropriate markings attached (reflectorized strips) constructed of forgiving materials other than metal.

North Arrow - on all construction and right-of-way plans, there is an arrow-like symbol with the point indicating North. The direction of all control and boundary lines are in reference to this North-South arrow.

NCDOT - North Carolina Department of Transportation.

N.C. Supplement to the MUTCD - published to provide a document containing standards, guidelines, and policies for traffic control devices not contained in the MUTCD, which are approved by the NCDOT, or required by N.C. General Statutes. Should there be points of disagreement between this supplement and the MUTCD, the MUTCD shall prevail.

-O-

Obliteration - a term that means to render an existing roadway impassable to highway traffic.

Offset Slope Stake -sometimes, in order to allow the contractor to perform his work without destroying the slope stake, slope stakes are placed farther back from the centerline of the roadway.

Original Ground Line - shows how the land was before construction began.

Outlet End of a Culvert - the end of a culvert that the water exits.

Overlay Resurfacing - to put, lay, or place a new layer of asphalt over the existing pavement surface.

Ownership - the legal right of possession of real or personal property. Ownership of property designated on the plans is shown by the owner's name appearing in print on the plans.

-P-

Partial Take - The acquiring of a portion of a property for highway purposes.

Passage/Gap - After one vehicle crosses a detector, the time the controller extends the green time.

APPENDIX D TERMS AND DEFINITIONS

Pedestrian Clearance Interval - The time of display of the flashing "Don't Walk" indication following the "Walk" interval.

Pedestrian Signal Head - Signal indication advising pedestrians to "Walk" or "Don't Walk".

Phase - A part of the time cycle where one or more traffic movements receive the right of way.

Phasing Diagram - Diagram showing the number of lanes and which movements are going or stopped during each phase of the cycle. It also shows which lanes/movements are being detected during each phase and the type of detection (pulse or presence) used for the movement. It shows which phase the signal may progress to during the cycle.

Pretimed Signal Controller - A type of control mechanism which operates on a predetermined time schedule allotting a fixed amount of time to each phase in the sequence.

Parcel Number - the number designated on the plans generally enclosed by a circle which designates a parcel or tract of land.

Part Plan - a plan view of an item when only a part of the item is shown.

Partial Control of Access - Similar to Limited Access in that the Department of Transportation will give preference to through traffic; however, access connection may be provided with selected public roads. There may be grade crossings and some private driveway connections allowed at designated locations.

Pavement Lines - the edge of the travelway on a roadway.

Pavement Markings - paint, thermoplastic, tape, epoxy, etc. in the form of lines and symbols applied to the pavement surface to provide direction and control for traffic movements in accordance with the plans and specifications. Pavement markings may serve to supplement the regulations or warnings of other devices such as traffic signs and signals. (See also NCDOT Standard Specifications, January 1, 1990, Section 920-1, p. 588; MUTCD 7C-1, and Roadway Standard Drawing No. 920).

Pavement Markers - devices used as supplementary positioning guides or, in some cases, substitution for other types of markings. The color of markers shall conform to the color of the marking for which they serve as a positioning guide, or for which they supplement or substitute. (see also MUTCD 3A-4, and Roadway Standard Drawing No. 930).

Pavement Schedule - a statement showing the type and quantity of pavement to be used in a Typical Section.

APPENDIX D TERMS AND DEFINITIONS

Paving Limits - the total length and width to be paved on any portion of a project.

Permanent Easement - an easement in perpetuity (always) which gives the NCDOT the right to utilize property for an unlimited time.

Perpendicular - a line at right angles to a given line or plane.

Personal Property - the right or interest in personal things which are movable or transferable from one place to another.

Phasing - project phasing is a clear and concise step-by-step write-up telling the contractor where to begin and how to proceed toward completion of the project. The main objective is to communicate to the contractor how to safely maintain traffic during the various stages of construction. (See also Traffic Control, Pavement and Delineation Guidelines. 7/89)

Piles - used in construction of a bridge when there is no firm material available to support a footing of a bridge bent.

Plan Sheet - a sheet in a set of plans showing the "Plan View" of a part of the particular project.

Plan View - a two-dimensional view (length and width) from directly above the object or project.

Planimetric Map - a map which presents only the horizontal positions for the features represented; distinguished by the omission of contour lines.

Plug - A concrete or brick termination to a pipe storm drain. Roadway Standard: 840.71

Profile Grade - a longitudinal length view of the roadway showing the engineered (designed) "up and down" (rise & fall) of the roadway.

Profile Grade Line - the trace of a vertical plane intersecting the top surface of the proposed roadway (wearing surface) usually along the longitudinal centerline of the roadbed.

Profile View - longitudinal view of a roadway showing an elevation of the original ground line and the elevation of the proposed roadway.

Project - a specific planned undertaking for the construction of a roadway or structure.

Property Lines - the boundaries or limits outlining the ownership of a tract or parcel of land.

APPENDIX D
TERMS AND DEFINITIONS

-R-

Real Property - the rights and interests in land and those items or things of a permanent nature affixed to the land and generally whatever is growing upon the land.

Rear Elevation - a view from the back side of an object.

"Red Arrow" - Illumination of a red arrow lens.

"Red Ball" - Illumination of a circular red lens.

Rehabilitation of Asphalt - to restore existing asphalt to its original design capacities.

Reinforced Concrete, Reinforced Concrete Pipe - Storm drain pipe made of concrete with steel reinforcing

Retaining Wall - a vertical wall usually constructed adjacent (abutting) to the roadbed.

Right of Access - the right of ingress (entering into) or egress (leaving from) to a highway from abutting property.

Right-of-Way - a term denoting land, interest therein, or property which is acquired for highway purposes.

Right-of-Way Boundary or Limits - the limits or boundaries as shown on the plans which show how much property is to be acquired for right-of-way in order to properly construct a roadway.

Right-of-Way Marker or Monument - a marker indicated by the symbol which shows the land or property which has been acquired for highway purposes.

Right-of-Way Plans - Are plans which contain all necessary information for the acquisition of right-of-way as found on design plans with the addition of any additional information that may be helpful in the acquisition of right-of-way.

Rip Rap - Rock protection used for slope protection, to control scour at pipe outlets or to line ditches to control scour. Rip rap comes in 2 sizes: Class I & Class II.

Roadway - the graded portion of a highway upon which the base course, surface course, shoulders and median are constructed.

APPENDIX D

TERMS AND DEFINITIONS

Roadway Cross-Section - a view of a roadway showing the inside of the roadway "sliced away" or cut at right angles to the centerline of the highway.

Roadway Standard Drawings - typical drawings that have become standardized for the purpose of establishing a common criteria by which roadway projects are constructed. Reference to the Roadway Standard Drawings eliminates the inclusion of typical drawings in the plan set that are generally applicable to any project. (Refer to Roadway Standard Drawing No. 150 -- for TCP).

Runoff - 1) distance required to accomplish transition from a *Normal* to a *Superelevated* section of roadway.

2) water flowing from a tributary area.

-S-

Scale - the measurement (length) used on a set of plans to represent a larger measurement. For instance, 1" in a set of plans may represent 100'.

Shoulder - the portion of roadway adjacent to the traveled surface for accommodation of stopped vehicles for emergency use, and for lateral (side) support of base and surface courses.

Shrinkage - when earth is taken from its original position and placed in a fill area, it is compacted. Shrinkage takes place due to the decrease in volume from the fill being compacted.

Side Elevation - a view from the right or left side of an object.

Side Slope - that portion of the roadway between the shoulder point and the adjacent drainage ditch.

Sight Distance - the length of roadway visible to the driver of a vehicle at any given point on the roadway when the view is unobstructed. That area or property designated on the plans to be acquired for sight distance purposes in order to ensure the driver an unobstructed view.

Signal Controller - A controller is the complete timing mechanism which controls the signal phases at an intersection.

APPENDIX D

TERMS AND DEFINITIONS

Signal Detector - A device by which vehicles or pedestrians are enabled to register their presence with a traffic actuated controller.

- a. **Presence Detector** - A type of detector that will send a pulse to the controller the instant a vehicle is detected and will continue to send a pulse to the controller as long as the vehicle remains within the detection field.
- b. **Pulse Detector** - The ability of a vehicle detector to detect the passage of a vehicle moving through the detection zone and to ignore the presence of a vehicle stopped in the detection zone.

Signal Face - That part of a traffic control signal provided for controlling traffic movements in a single direction.

Signal Head - An assembly containing one or more signal faces.

Signal Face Identification Chart - A pictorial chart showing what each signal face will look like and the size of the lenses used to make up the signal face. Each signal face is given a number so that it can be cross referenced to other parts of the signal plan.

Signal Indication - The illumination of a signal head.

Signal Installation - All of the equipment and material involved in the control of traffic at one intersection by a traffic control signal.

Signal Lens - That part of the signal head section which redirects the light coming from the light source.

Signal System - Two or more signal installations operating in coordination.

Skew Angle - the angle that a pipe, culvert, bridge, or other structure makes with the centerline of the roadway as measured in a clockwise direction from the centerline.

Slope - a ratio of horizontal distance versus each foot of decrease or increase in elevation. (see also: Grade)

Slope Stake - a stake that contains information that tells the contractor how much "cut" or "fill" is required from the point of the stake to the ditch line (or shoulder point) of the roadway.

Span - a portion of a bridge made up of the bridge slab and beams that cross over the roadway or stream below. The span is supported at each end by bents or abutments. A culvert span is that portion of the top slab between the walls of a barrel.

APPENDIX D TERMS AND DEFINITIONS

Spring Box - A drainage device used to reduce subgrade moisture content where a source of spring water is known or suspected, to convey spring drainage to an exposed slope or to a designed storm drain system. Roadway Standard: 840.41

Standard Drawings - a separately published group of plan sheets for the construction of various items in a project.

Standard Specifications - a book published by the NCDOT which gives various standards for different items.

State Forces - employees of the State who are responsible for performing highway maintenance work and contract work which is not included as part of the contractor's duties and obligations.

Station - the horizontal measurement along the survey line of a project (normally from West to East, or South to North). Stations are measured in 100' intervals. Used as a location, a station is a designated point on the project.

Stone: - Rock protection used for slope protection, to control scour at pipe outlets or to line ditches to control scour. Stone comes in two sizes: Class A & Class B.

Stretch Detection - The ability of a traffic signal detector to continue its output for a predetermined length of time following an actuation and after the vehicle leaves the detection zone.

Structure - consists of a bridge, culvert, or retaining wall.

Subgrade - the top surface of a roadbed that is prepared as a foundation for the pavement structure.

Substructure of a Bridge - that part of the bridge that is below the top of the bent cap.

Summary of Quantities - a plan sheet which shows the total amounts of all items included in a particular contract.

Superelevation - that amount of elevation required on the surface of a pavement in order to overcome the centrifugal force that acts on a motor vehicle. The difference in elevation between the edges of a traffic lane applied where curves in the roadway alignment are used.

APPENDIX D TERMS AND DEFINITIONS

Superstructure (of a Bridge) - that part of a bridge that is above the top of the bent cap.

Surface Course - the top layer of the pavement structure.

Survey Line - a line established by surveying to mark the location of a highway.

Symbol - a conventional sign used in writing or printing which represents quantities, items, or things.

-T-

T - Truck percentage. Multiply this factor by the ADT to determine the amount of mixed trucks in the daily traffic, or by the DHV to determine the number of trucks in the hourly volume of vehicles.

TCP (Traffic Control Plan) - a plan for handling traffic through a specific highway or street work zone or project. These plans range in scope from very detailed TCP designs solely for a specific project to simply a reference to typical plans and/or a section of the MUTCD. (See also NCDOT Policy & Procedure for TC through construction work zones. July 1, 1982, pp. 3-5, and Attachment 2)

Tangent - any straight section of the roadway (alignment). A tangent to a curve is a line that touches the curve at one point and is also at right angles to the radius at the point of contact with the curve.

Temporary Easement - an easement granted to the NCDOT on a temporary basis usually for a specified time and a specified purpose. A right for the NCDOT to use land during construction which, upon completion, the right reverts to the owner.

The Location of Monuments and Ties in Relation to Property Lines - Those Locations designated on the plans by distance from and/or reference to a point on the survey line which designates the location of a property line intersecting a right-of-way boundary or which designates the location of a right-of-way monument on the right-of-way boundary.

Time Cycle - The time period required for one complete sequence of signal indications.

Timing Chart - A chart showing the timing to be set on the controller for each phase interval. It also shows what memory position is to be set on the controller for each *phase*.

APPENDIX D

TERMS AND DEFINITIONS

Title Sheet - the front sheet on a set of plans which describes the project, shows the location of the project, gives the general layout of project, and other information (always sheet #1 in a set of plans).

Topographic Map - a map which represents the horizontal and vertical positions of the features represented; distinguished by the addition of contours to show mountains, valleys, and plains.

Tort Liability - A liability of committing a wrongful behavior (aside from breach of contract) for which a civil action will lie. The liability of the unprivileged commission (or omission) of an act whereby another person incurs loss of life or injury. Such breach of duty as resulting in damage to the plaintiff.

Total Take - the acquiring of a property in its entirety for highway purposes.

Traffic Actuated Signal Controller - A type of controller in which the intervals are varied in accordance with the demands of traffic registered by the detectors.

- a. **Fully Actuated Signal** - A type of traffic actuated signal in which means are provided for detection on all approaches.
- b. **Pedestrian Actuated Signal** - A type of traffic control system which may be actuated by a pedestrian.
- c. **Semi Actuated Signal** - A type of traffic control signal in which means are provided for detection in one or more, but not all approaches to the intersection.

Traffic Control Devices - all signs, signals, markings and devices placed on, over, or adjacent to a street or highway by authority of a public body or official having jurisdiction to regulate, warn, or guide traffic. (Refer to MUTCD, NCMUTCD, Roadway Standard Drawings and the NC Standard Specifications)

Traffic Signal - Any power operated traffic control device by which traffic is alternately directed to stop and to proceed.

Travel Lanes - lanes in which vehicles move.

Type III Barricades - portable or fixed traffic control devices having three rails with appropriate markings and are used to control traffic by closing, restricting, or delineating all or portion of the right-of-way.

Typical Section - a cross-sectional view of a roadway showing how the roadway would appear after the roadway is completed.

APPENDIX D
TERMS AND DEFINITIONS

-U-

Utility - physical plant and operating facilities which provide public or private utilities consisting mainly of communication lines, electric power lines, gas lines, water mains, sewer mains, and other pipe lines, and the supporting structures for these facilities.

-V-

V - This is the design speed of the project.

Vertical - perpendicular to the plane of the horizon or to a primary axis.

Vertical Alignment - see Profile View.

Vertical Curve - a parabolic curve drawn tangent to intersecting grade lines to provide a smooth transition from one grade to another.

View - the way you look at or "see" different items that are shown in a set of plans.

Visor (Hood) - That part of the signal head section which protects the lens face from direct light (sunlight).

Volume-Density - A type of vehicle detection with a variable passage-gap time and a variable minimum green.

-W-

Waste - that portion of excavated material from a project that is not used in the construction of the project.

Waste Area - an area or location in which excess or unsuitable material obtained during construction is deposited.

Wing Wall - a part of a culvert that extends at an angle to keep earth from spilling into the stream bed.

Work Zone - any continuous tract or area of a roadway in which construction or maintenance is being performed.

APPENDIX D
TERMS AND DEFINITIONS

-XYZ-

Yellow or Warning Interval - The time of display of the signal indication following the green interval.

Y-Lines - the designation used on a survey line for side roads.

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APPENDIX E ABBREVIATIONS

A

Aband - abandoned
Ac - acre
ADT - average daily traffic
Ahd or Ah - ahead
Asph - asphalt
Ave - avenue
Az - azimuth

B

B - barn
Bd - board
Bdy - boundary
Beg - begin
BK - brick
Bk - back, brick
Bldg - building
BLK - block
Blvd - boulevard
BM - bench mark
Bn - beacon
Br - bridge, branch
Brg - bearing
BST - bituminous surface treatment
Bus - business
BW - barbed wire

C

C - curb
C/A - control of access
CABC - coarse aggregate base course
CB - catch basin
Cem - cemetery
CH - courthouse
Ch - church
CHL - chain link (fence)
CL (III), (IV) - class (III), (IV)
CM - corrugated metal
CMB - concrete median barrier
CMP - corrugated metal pipe

Co - county
Comb - combination
Conc - concrete
Const - construction
Coord - coordinate
Cor - corner
CP, RCP - concrete pipe, reinforced concrete pipe
Cr - creek
Cs - corrugated steel
CSP - corrugated steel pipe
CY - cubic yards

D

Δ - delta angle
D - dwelling, degree of curve
DI - drop inlet
Dist - district
Div - division
Dr - drive

E

E - East
El - electric, elevated
Elev - elevation
EMB - embankment
EXCAV - excavation
Expwy - expressway
Ext - extension
Exp - expansion

F

F - frame, face of curb
Fd - ford
FES - flared end section (pipe)
For - forest
FR - frame
Ft - fort
Fwy - freeway
Fy - ferry

APPENDIX E ABBREVIATIONS

G

GA - gauge
Gals - gallons
G - garage, gutter
GI - grated inlet
GI 2GI 3GI - grated drop inlet
Gr - gravel

H

H - hydrant
Hdqtrs - headquarters
Horiz - horizontal
Hosp - hospital
HPT - horizontal photo tie
H Tr - house trailer
Hwy - highway

I

ID - inside diameter
Ind - Indian
IP - iron pin
1SBD - one story brick dwelling
1SFD - one story frame dwelling

J

JB - junction box
Junc - junction
Jt. - joint

L

L - lake, line, location, lane
Lbs - pounds
Ldg - landing
LF - linear feet
LH - lighthouse
LS - lump sum
Lt - light, left

M

M - masonry
Max - maximum
Med - median
MH - manhole
Mi - mile
Mil - military
Min - minimum
Mon - monument
MP - milepost
MPOC - (midpoint) point on curve
Mt - mount
Mtn - mountain
Mts - mountains

N

N - North
Nat - national
NBL - northbound lane
NDI - narrow drop inlet
No - number

O

Obs - observation
OH - outside toilet, outhouse
Orch - orchard

P

P - property line
Pav't - pavement
PC - point of curve
Pd - pond
PG - profile grade point
PGL - profile grade line
PH - powerhouse
PI - point of intersection of tangents
(curve)
PINC - point of intersection - no curve
PIS - point of intersection of tangent (spiral)
Pk - peak

APPENDIX E ABBREVIATIONS

Pkwy - parkway
PL - property line
Plan - planimetry
PO - post office
POC - point on curve
POS - point on spiral
POST - point on sub-tangent
PP - power pole
PRC - point of reverse curve
Priv - private
Prop - proposed
PT - point of tangent
Pt - point
PVC - polyvinyl chloride (pipe) - point of vertical curvature
PVI - point of vertical intersection
PVT - point of vertical tangency

R

R - river
RC, RCP - reinforced concrete, reinforced concrete pipe
RCBC - reinforced concrete box culvert
Rd - road
Rem - remove
Res - reservation, reservoir
RR - railroad
Rt - right
R/W - right-of-way

S

S - sewer, shack, shed, South, storm, strand
SB - spring box
SBL - southbound lane
Sch - school
SE - super elevation
Spr - spring
Sq Yds - square yards
SR - secondary road
SS - sanitary sewer
St - street
Sta - station

Stk - stock
SY or Sq Yds - square yards

T

TBM - temporary bench mark
TC - terra cotta
TCP - terra cotta pipe
Tel - telephone, telegraph
Temp - temporary
Topo - topography
TP - telephone pole
Trans - transmission

U

UC - under construction
UG - underground
UNCL - unclassified

V

V - valve
VA - vertical angle
VC - vertical curve, vitreous clay
Vert - vertical
VPT - vertical photo tie

W

W - water, well, well house, West
WL - water level
WM - water main, water meter
WW - waterworks, woven wire

XYZ

X Sects - cross sections
Y-line - survey line for side road

APPENDIX F SCALES

Roadway and Structure plans are drawn to scale in order that they might be presented on easy-to-use sheets. Roadway plans are normally drawn with an engineer's scale while structure plans use both engineer's and architect's scales.

The engineer's scale is one that expresses "scale" as 1 inch = 10 feet; 1 inch = 20 feet, 1 inch = 50 feet, 1 inch = 1 mile, etc. It is usually 1-foot long and may be triangular or flat. The scales are divided into decimal parts of an inch such as 1/10 inch, 1/20 inch, etc. The triangular, or six-scale scale, has scales with 10, 20, 30, 40, 50, and 60 divisions to the inch. (see fig. 1 below).

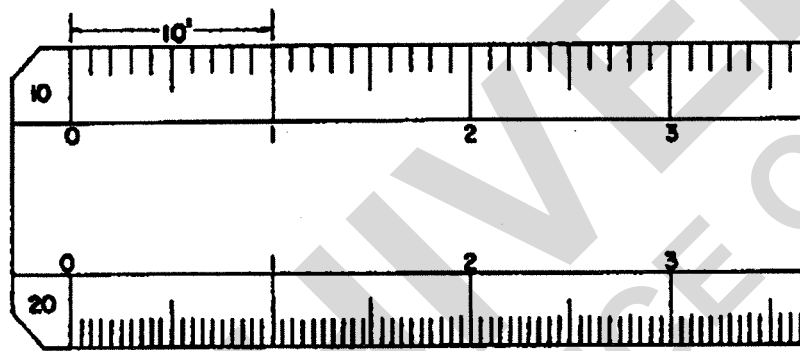
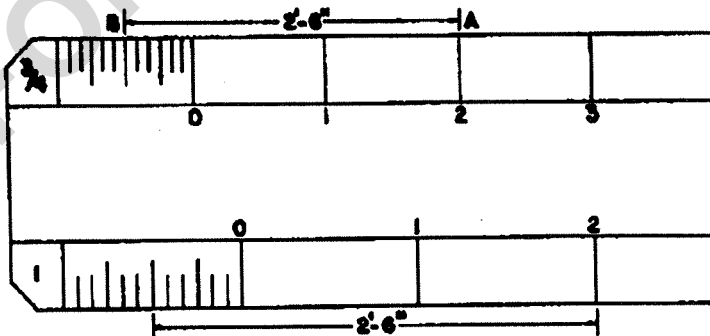


Figure 1

(each division equals 1 foot - in the 1" = 10' scale, there are 10 divisions to the inch)

The architect's scale expresses scale as 1 inch = 1 foot, 1/2 inch = 1 foot, etc. This indicates that one inch on the drawing would be equal to 1 foot of the actual structure, or 1/2 inch on the drawing would equal 1 foot of the actual structure. This scale is usually 1 foot long and may be triangular or flat. The scales are divided into fractions of inches such as 1/8's, 1/4's, 1/2's, 3/4's, etc. Figure 2 shows the details of an architect's flat scale, with 3/4 and 1 inch to the foot scales.



F-1

Question: On a scale with $\frac{3}{4}$ inch = 1 foot, how do you lay off a distance of 2'-6"?

Answer: In figure 2, place the $\frac{3}{4}$ scale with division 2 at the given point A, then the zero division on the scale will be at a distance of 2 feet. Observe that the end space is divided into twelve parts, each of which equals one inch. six divisions therefore equal six inches, making the distance AB equal 2'-6".

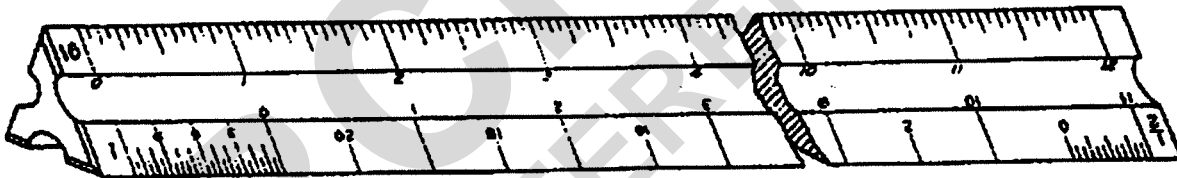
Some drawings are made on scales larger than objects. Drawings of small objects are sometimes made two or three times larger than actual size for clearness. Architect's scale may have scales being 1 1/2:1, 3:1, etc., meaning one and one-half times actual size, three times actual size, etc.

Shown below is a triangular architect's scale. The engineer's triangular scale is similar.

A civil engineer's scale. Divisions are 10, 20, 30, 40, 50, and 60 parts to the inch.



An architect's (or mechanical engineer's) scale. Reduction in size is based on proportion of a foot.



APPENDIX G
Answers to Questions/Exercises in Course

Page 1-7

Proposed Control of Access Line
Easement Line
junction box
topography

Page 1-8

1. 400'
2. 5'
3. 2500'
4. 325'

Page 1-12

1. 90
2. 510
3. 248.6

Page 1-13

1. 100'
2. 69'
3. 259.12'
4. 412+50
5. 411+50
6. 100'

Page 1-15

1. East or North
2. (a) 549+50
(b) 2+50

Page 1-17

1. Sta. 14+00 40' Lt. of (or Line L)
2. Sta. 15+25 on Line L
3. East or North
4. 88.6 feet
5. back of
6. 250 feet
7. 2+00
8. 1141+40

Page 2-3

1. Plan
2. Cross-Section
3. Longitudinal Cross Section
4. Side Elevation
5. Rear Elevation

Page 2-6

1. front
2. front, back
3. lead, wood
4. front

Page 2-10

1. 15"
2. 68'
3. 10'
4. ½":1' in normal crown
5. 4
6. 2:1

Page 3-1

1. 55,300
2. 2,625
3. 79
4. 475

Page 5-3

1. 302+44
2. tangent
3. plan sheets
4. 11+44.66
5. 10°
6. tangent

Page 5-5

1. 353+00.19
2. 2864.79'
3. 0.05'FT./FT.

Page 5-7

1. S39°-42'20" • W
2. 39°-42'20"

APPENDIX G
Answers to Questions/Exercises in Course

Page 5-12

1. 13+12.37
2. left
3. left
4. 60
5. 60
6. cut
7. both sides
8. 190.07'
9. 74' Lt. -L- Sta. 519+56
10. 196.69'
11. 168'
12. -3.1950%
13. a cut section
14. 8'

Page 5-13

- 24'
1. 358+50
 2. 359+50
 3. 361+50

Page 5-14

1. 49,340 c.y.

Page 5-15 (Pipe)

1. 216'
2. 24"
3. CL III
4. Reinforced Concrete Pipe

Page 5-15 (Inlets)

1. M.D.I. Type "B"
2. M.D.I. Type "A"

Page 5-16 (culverts)

1. 107,035
2. 687.6

Page 5-16 (Fencing)

1. 26+90
2. 33+00 LT

Page 5-18 (Guard Rail)

1. 336+75
2. 2625'

Page 5-18 (Right of Way Markers)

1. 4
2. 95'

Page 5-20

1. True
2. in channels
3. vegetative

Page 6-10 (Slope Stakes)

115 (plus or minus)

Page 6-11

1. 7,000 cy
2. waste

Page 7-5

1. superstructure, substructure
2. beams or girders
3. bent or bent cap
4. bent caps
5. end bent, interior bent
6. piles, firm soil
7. steel, concrete
8. steel or concrete

Page 7-7

1. (1) gas, (2) telephone, (3) water
2. 2-2¼"

Page 7-12

1. a. headwall, b. wingwall, c. barrel
2. curtain wall
3. wing
4. horizontal
5. vertical
6. 9' and 10'

Page 7-15

1. inlet, higher
2. outlet
3. a construction joint
4. headwall
5. of roadway and of culvert
6. 120 degree
7. left to right

APPENDIX G
Answers to Questions/Exercises in Course

Page 7-21

1. (1) reinforced and
(2) gravity
2. gravity
3. reinforced
4. reinforced
5. low-height

Page 8-3 Exercise One

1. Survey Station 19+00 Survey Line L
2. FA# F-37-1(39)
3. 100.25 ft and 115 feet
4. False
5. 120 feet

Page 8-4 Exercise Two

1. 12 feet by 10 feet
2. 85 feet
3. 115 feet, 364+55
4. 15 feet
5. False
6. Martin L. Byrd
7. land area

Page 8-5 Exercise Three

1. C
2. B
3. Bernice Johnson, Parcel 330
4. House Trailer, one-story frame dwelling and garage
5. existing power pole
6. B

Page 8-6 Exercise Four

1. Obliterated
2. A
3. C
4. Abandoned
5. C

Page 8-8 Exercise Five

1. 24 feet
2. 64 feet
3. 16 feet
4. 40 feet, 80 feet
5. 30 feet
6. 6+52.85
7. True
8. True (because it is outside the proposed R/W)

Page 10-3

R.W. Webber Jr.

Page 10- 4

General Note C

Page 10- 4

1. 17, 18, 19, 20, 22 & 23
2. Rdwy. Std. Dwg. No. 920. 01 (See either note 17, 18, 19, or 22)

Page 10- 5

1. No
2. Phase I, Step 2 and Phase I, Step 3
3. Phase II, Step 1

Page 10- 6

1. Phase III, Step 3
2. 12, Project Note (Remember, general notes are lettered and project notes are numbered)

Page 10- 7

1. Yes, 920.01, Island Detail

Page 10- 8

1. TCP-7, TCP-5

Page 11-3

1. DD
1. END M
BEGIN EE
2. U - Thermoplastic right turn arrow, (120 mils)
T - Thermoplastic left turn arrow, (120 mils)

APPENDIX G

Answers to Questions/Exercises in Course

Page 11-4

1. 40' spacing is typical
2. thermoplastic pavement marking lines, (8" white, 90 mils)
3. 50' spacing for arrows

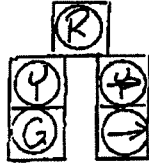
Page 12-3



4



333



999

Page 12-4

1. Phase 1+5 can clear to phase 2+6, 3, 4, 1+6, and 2+5.
2. Signal faces 1, 11, 2 and 22 will flash yellow.
3. Signal faces 3, 33, 7 and 77 will display either.

Page 12-5

1. There are two thru lanes running in phase 1+6.
2. Phase 2+6 is called up by presence detection.
3. After phase 1+5, phases 2+6, 3, 4, 1+6, and 2+5 can be served. They should match what you put down for question 1, page 4.

Page 12-6

1. Phase 3 is called by loops 8, 9, 10, 11, 12, 13, 17, 18, and 19.
2. From the Phasing Diagram, presence detection calls phase 3.
3. Loop 31 is a 6' X 25' loop located 5' beyond the stopbar.

Page 12-8

1. Phase 2 maximum green is 24 sec.
2. Phase 2 recall position is min/soft recall.
3. Phase 6 has a passage/gap of 0 sec.
4. Total clearance for phase 1 is 5.4 sec. (Remember, total clearance is your yellow time plus all the red time.)

APPENDIX G
Answers to Questions/Exercises in Course

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