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TRANSPORTATION MOBILITY AND SAFETY DIVISION
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8-12
Minimum Utility Clearance Requirements

Neutral/Secondary

Primary

Neutral/Secondary

Primary

40" Min.

30" Min.

Joint User #1

Joint User #2

Joint User #3

Joint User #4

Notes

The attachment point for joint user #1 must maintain a minimum of 40" below power and/or a minimum of 30" below bottom of transformer (whichever is greater)

"Joint User" refers to the power company, CATV companies, NCDOT, phone company, cities, and others

NESC Clearance Requirements – Utilities

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
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NCDOT Minimum Attachment Clearances
From Other Joint Users at the Pole

<table>
<thead>
<tr>
<th>Clearance From</th>
<th>Min. Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral / Secondary</td>
<td>40&quot;</td>
</tr>
<tr>
<td>Power Service Drop</td>
<td>40&quot;</td>
</tr>
<tr>
<td>Power Service Drip Loop</td>
<td>40&quot;</td>
</tr>
<tr>
<td>Top of Power Riser</td>
<td>40&quot;</td>
</tr>
<tr>
<td>Bottom of Transformer</td>
<td>30&quot;</td>
</tr>
<tr>
<td>Guy Attachment</td>
<td>12&quot;</td>
</tr>
</tbody>
</table>

If the power service drip loop supplies power to an effectively grounded streetlight the minimum clearance requirement is reduced to 12"
Street Light Clearances

Minimum Separation Between Joint Users

1st Joint User

2nd Joint User

Street Light Bracket Effectively Grounded

Secondary Power

Street Light Drip Loop

40"

12"

4"

Minimum Separation Between Joint Users

1st Joint User

2nd Joint User

Street Light Bracket Effectively Grounded

Secondary Power

Street Light Drip Loop

40"

12"

4"

* All three of these minimum clearance requirements for effectively grounded street lights must be met.

**Both of these minimum clearance requirements for effectively grounded street lights must be met.

IF THE STREET LIGHT / STREET LIGHT BRACKET IS NOT EFFECTIVELY GROUNDED, THEN THE MINIMUM CLEARANCE REQUIREMENT IS INCREASED TO 40" BELOW Drip Loop

NESC Clearance Requirements – Streetlights

INTELLIGENT TRANSPORTATION SYSTEMS SECTION

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04
"Joint User" refers to the power company, CATV companies, NCDOT, phone company, cities, and others.

NESC Clearance Requirements – Power Risers

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TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
Table 1

<table>
<thead>
<tr>
<th>Nature of Surface Underneath Wires, Conductors or Cables</th>
<th>Minimum Clearance (H)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Track rails of railroad except electrified railroads using overhead trolley conductors</td>
<td>30 FT</td>
</tr>
<tr>
<td>2. Roads, streets and other areas subject to truck traffic</td>
<td>18 FT</td>
</tr>
<tr>
<td>3. Driveways, parking lots, and alleys</td>
<td>18 FT</td>
</tr>
<tr>
<td>4. Other land traversed by vehicles such as cultivated, grazing, forest orchards, etc.</td>
<td>18 FT</td>
</tr>
<tr>
<td>5. Spaces and travel ways subject to pedestrian or restricted traffic only</td>
<td>15.5 FT</td>
</tr>
</tbody>
</table>

*These values have been adopted by NCDOT (as well as various utility companies) and exceed the specifications as set forth in the National Electrical Safety Code (NESC).

Notes:

1. See Table 1 for acceptable minimum clearance values (H) over varying surfaces.
2. "H" is defined as the vertical distance (Height) as measured from the lowest point (Typically Midspan) of the wires, conductors or cables to the surface below.
3. Sag between poles should match the sag of existing utility lines.
Fiber Optic Cross Section

All dimensions in micrometers (microns)

1,000,000 Microns = 1 Meter

Typical Dimension of Multimode Fiber

Typical Dimension of Single Mode Fiber

Typical Dimension of Human Hair

Typical Signal Wavelengths

<table>
<thead>
<tr>
<th>Fiber Type</th>
<th>Signal Wavelength</th>
<th>Typical Losses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multimode</td>
<td>850 nm</td>
<td>3.5 dB /km</td>
</tr>
<tr>
<td></td>
<td>1300 nm</td>
<td>1.5 dB /km</td>
</tr>
<tr>
<td>Single Mode</td>
<td>1310 nm</td>
<td>0.35 dB /km</td>
</tr>
<tr>
<td></td>
<td>1550 nm</td>
<td>0.25 dB /km</td>
</tr>
</tbody>
</table>

Fiber Color Code

<table>
<thead>
<tr>
<th>Number</th>
<th>Color</th>
<th>Number</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Blue</td>
<td>1</td>
<td>Blue</td>
</tr>
<tr>
<td>2</td>
<td>Orange</td>
<td>2</td>
<td>Orange</td>
</tr>
<tr>
<td>3</td>
<td>Green</td>
<td>3</td>
<td>Green</td>
</tr>
<tr>
<td>4</td>
<td>Brown</td>
<td>4</td>
<td>Brown</td>
</tr>
<tr>
<td>5</td>
<td>Slate</td>
<td>5</td>
<td>Slate</td>
</tr>
<tr>
<td>6</td>
<td>White</td>
<td>6</td>
<td>White</td>
</tr>
<tr>
<td>7</td>
<td>Red</td>
<td>7</td>
<td>Blue</td>
</tr>
<tr>
<td>8</td>
<td>Black</td>
<td>8</td>
<td>Orange</td>
</tr>
<tr>
<td>9</td>
<td>Yellow</td>
<td>9</td>
<td>Green</td>
</tr>
<tr>
<td>10</td>
<td>Violet</td>
<td>10</td>
<td>Brown</td>
</tr>
<tr>
<td>11</td>
<td>Rose</td>
<td>11</td>
<td>Slate</td>
</tr>
<tr>
<td>12</td>
<td>Aqua</td>
<td>12</td>
<td>White</td>
</tr>
</tbody>
</table>

Individual fibers can be identified by number and by color

When specifying by color it is customary to refer to the buffer tube color followed by the fiber color

"Orange/Green" is the green fiber in the orange buffer tube

If a cable contained 144 fibers arranged with 12 buffer tubes each containing 12 fibers, then the following would be true

"Blue/Blue" = Fiber 1
"Green/Brown" = Fiber 28
"Red/Red" = Fiber 79
"Aqua/Aqua" = Fiber 144

FIBER OPTIC CABLE

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

STD. NO.

8-04
COMMON DRAWING SYMBOLS

EXISTING SIGNAL POLE
NEW SIGNAL POLE
EXISTING METAL POLE
NEW METAL POLE
EXISTING METAL POLE WITH MAST ARM
NEW METAL POLE WITH MAST ARM
SIGNAL POLE
NEW JUNCTION BOX
EXISTING JUNCTION BOX
NEW CCTV CAMERA
EXISTING CCTV CAMERA
CABLE STORAGE RACK (SNOW SHOES)
NEW SPLICE CABINET
EXISTING SPLICE CABINET
AERIAL SPLICE ENCLOSURE
EXISTING SIGNAL CABINET
MASTER CONTROLLER CABINET

NEW DOWN GUY
NEW SIDEWALK GUY
NEW MICROWAVE VEHICLE DETECTION
EXISTING MICROWAVE VEHICLE DETECTION
NEW DYNAMIC MESSAGE SIGN
EXISTING DYNAMIC MESSAGE SIGN
NEW FIBER OPTIC COMMUNICATIONS CABLE
NEW TWISTED PAIR COMMUNICATIONS CABLE
EXISTING COMMUNICATIONS CABLE
EXISTING COMMUNICATIONS CABLE TO BE REMOVED
NEW AERIAL GUY ASSEMBLY
NEW CONDUIT
EXISTING CONDUIT
NEW DIRECTIONAL DRILLED CONDUIT
NEW BORED AND JACKED CONDUIT
YAGI ANTENNA (DOUBLE)
FOR REPEATER OPERATION
YAGI ANTENNA (SINGLE)
OMNI ANTENNA
SIGNAL INVENTORY NUMBER

NOTE:
DRAWING SYMBOLS SHOULD BE AT THE SAME SCALE AS THE PLAN SHEET
FOR INFORMATION ON SCALING LINE STYLES SEE "STANDARD SYMBOLOGY TABLES" SECTION 9.0

STD. NO.
3.0

Drawing Format Items – Symbology

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
### Understanding Construction Notes

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<thead>
<tr>
<th>Note</th>
<th>Description</th>
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<tbody>
<tr>
<td>1 4 12</td>
<td>Install one 12-fiber single mode fiber optic cable</td>
</tr>
<tr>
<td>2 5 6</td>
<td>Install two 6-fiber multi-mode fiber optic cables</td>
</tr>
<tr>
<td>1 14 2</td>
<td>Install one 2&quot; diameter polyethylene conduit</td>
</tr>
<tr>
<td>1 11 1</td>
<td>Install one 1&quot; diameter rigid, galvanized steel riser with weatherhead</td>
</tr>
</tbody>
</table>

### Construction Note Conventions

#### Place notes in numerical order

<table>
<thead>
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<th>Description</th>
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<tr>
<td>correct</td>
<td>incorrect</td>
</tr>
<tr>
<td>1 4 12</td>
<td>40</td>
</tr>
<tr>
<td>52</td>
<td>53</td>
</tr>
<tr>
<td>53</td>
<td>52</td>
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</table>

#### Orient vertically

<table>
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<th>Description</th>
</tr>
</thead>
<tbody>
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<tr>
<td>1 4 12</td>
<td>1 4 12</td>
</tr>
<tr>
<td>47</td>
<td>47 56</td>
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<tr>
<td>56</td>
<td>56</td>
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### Some Common Construction Notes

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<tr>
<th>Note</th>
<th>Description</th>
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<tr>
<td>1 4 12</td>
<td>base mounted cabinet (master location)</td>
</tr>
<tr>
<td>23 28</td>
<td>directional drilled conduit</td>
</tr>
<tr>
<td>50</td>
<td>new fiber optic and messenger cable</td>
</tr>
<tr>
<td>53</td>
<td>new oversized junction box</td>
</tr>
<tr>
<td>1 14 2</td>
<td>pole mounted cabinet</td>
</tr>
<tr>
<td>15</td>
<td>trenched or plowed conduit</td>
</tr>
<tr>
<td>18</td>
<td>new riser</td>
</tr>
<tr>
<td>51</td>
<td>aerial splice enclosure</td>
</tr>
</tbody>
</table>

For more information on construction notes, see sections 4-7 of this manual.
Case 1
New communications cable lashed to new messenger cable

Case 2
New communications cable lashed to existing messenger cable
Case 3
Existing communications cable and messenger cable are to be removed
new communications cable lashed to new messenger cable

Case 4
New communications cable lashed to existing signal/communications cable
Case 5

New communications cable lashed to new messenger cable and slack spanned.

NOTE: Slack spanning should be used as a last resort. In this case, a guy could not be placed on pole NRE75 to counteract the tension of the aerial installation along Third Street. Therefore, slack span to pole RF16AS and place down guy at that pole.
Case 1

Underground communications cable run installed in new conduit trenched or plowed

Case 2

Underground communications cable run installed in existing conduit

Construction Notes for Trenched or Plowed Conduit

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

STD. NO. 4.1

SHEET 1 OF 3
Case 3

Underground communications cable run
installed in new conduit directionally drilled

Case 4

Reserved for future use
Case 5

Underground communications cable run installed in new galvanized steel conduit

NOTE: This method is typically used for crossing under railroad tracks. However, it can be used for other applications requiring galvanized steel conduit.

Case 6

Reserved for future use

Construction Notes for Bored and Jacked Conduit

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
Case 1

Fiber routed from a pole riser to a base mounted signal cabinet at the end of a run with standard guy assembly.

Case 2

Fiber routed from a junction box to a base mounted signal cabinet at the end of a run (underground installation - no riser required).

NOTE: If this is the master controller, add construction note #50.
Case 3

Fiber routed from a pole riser to a pole mounted signal cabinet at the end of a run with standard guy assembly

NOTE: If this is the master controller, add construction note #50.

Case 4

Fiber routed from a junction box to a pole mounted signal cabinet at the end of a run (underground installation - no riser required)

NOTE: If this is the master controller, add construction note #50.
Case 5
Fiber routed from a pole riser to a base mounted signal cabinet and back up through riser to continue to next location

CASE 6
Fiber routed from a junction box to a base mounted signal cabinet then up the pole riser to continue to next location (transition from underground to aerial - riser and guy required)

NOTE: If this is the master controller, add construction note #50.
Case 7

Fiber routed from a pole riser to a pole mounted signal cabinet and back up through riser to continue to next location

NOTE: If this is the master controller, add construction note #50.

Case 8

Fiber routed from a junction box to a base mounted signal cabinet and back to the junction to continue to next location (underground installation - no riser required)

NOTE: If this is the master controller, add construction note #50.

Construction Notes for Signal Cabinets

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

STD. NO. 4.2
SHEET 4 OF 4
Depicts installation of oversized junction box and delineator marker, ample storage on snow shoe nearby eliminates the need for extra cable storage.

Case 2
Depicts installation of oversized junction box without delineator marker.
Line of sight, aesthetics, underground utilities are all factors in determining the need for markers. Extra cable storage is needed.

Note 1 should read: Store XXX feet of communications cable in junction box.

Case 3
Depicts installation of oversized junction box and delineator marker, more than the standard 20 feet of extra cable storage is needed.

Case 4
Depicts installation of oversized junction box and delineator marker. Extra cable storage needed.

Case 5
Depicts installation of oversized junction box without delineator marker.
Line of sight, aesthetics, underground utilities are all factors in determining the need for markers. Extra cable storage not needed.

Note: Distance between junction boxes may vary.

Construction Notes for Oversized Junction Box

7-04

STD. NO.

4.3

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
Case 1

Cable routed to an aerial splice enclosure with one cable in and one cable out

NOTE: In this case, the splice enclosure would be for a future traffic signal, camera, or dynamic message sign. This is also the method used for tying into an existing cable left terminated at the pole.

Case 2

Cable routed to an aerial splice enclosure with one cable in and two cables out

Construction Notes for Splice Enclosures
Case 3
Cable routed to an underground splice enclosure with one cable in and one cable out

Case 4
Cable routed to an underground splice enclosure with one cable in and two cables out

NOTE: In this case, the splice enclosure would be for a future traffic signal, camera, or dynamic message sign. This is also the method used for tying into an existing cable left terminated at the junction box.
Case 5

Cable routed to an aerial splice enclosure with one trunk cable in, one trunk cable out and a drop cable routed to a cabinet

Case 6

Cable routed to an underground splice enclosure with one trunk cable in, one trunk cable out and a drop cable routed to a cabinet

Construction Notes for Splice Enclosures

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04
Fiber Routing Detail Drawing for Splice Cabinets

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
Case 1

Aerial cable run routed through a riser to a base mounted splice cabinet with one in and one cable out

Case 2

Aerial cable run routed through a riser to a base mounted splice cabinet with one cable in and two cables out

NOTE: In this case, the splice cabinet would be for a future traffic signal, camera, or dynamic message sign. This is also the method used for tying into an existing cable left terminated at the pole.
Case 3

Aerial cable run routed through a riser to a pole mounted splice cabinet with one cable in and one cable out

Case 4

AERIAL CABLE RUN ROUTED THROUGH A RISER TO A POLE MOUNTED SPLICE CABINET WITH ONE CABLE IN AND TWO CABLES OUT

NOTE: In this case, the splice cabinet would be for a future traffic signal, camera, or dynamic message sign. This is also the method used for tying into an existing cable left terminated at the pole.
Case 5

Underground cable run routed through a junction box to a base mounted splice cabinet with one cable in and one cable out

NOTE: In this case, the splice cabinet would be for a future traffic signal, camera, or dynamic message sign. This is also the method used for tying into an existing cable left terminated at the junction box.

Case 6

Underground cable run through a junction box to a base mounted splice cabinet with one cable in and two cables out

Construction Notes for Splice Cabinets

INTelligent transportation systems section
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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STD. NO. 4.5
SHEET 4 OF 5
Case 7

Cable routed to a pole splice cabinet with one trunk cable in, one trunk cable out and a drop cable routed to a cabinet.

Case 8

Cable routed to a base mounted splice cabinet with one trunk cable in, one trunk cable out and a drop cable routed to a cabinet.
Case 1
CCTV assembly mounted on an existing pole at the end of a run

Case 2
CCTV assembly on an existing pole in the middle of a run

Construction Notes for CCTV Camera Assemblies
INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

STD. NO. 5.0
SHEET 1 OF 3
Case 3

CCTV assembly mounted on a new wood pole at the end of a run

Case 4

CCTV assembly mounted on a new wood pole in the middle of a run

Construction Notes for CCTV Camera Assemblies

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
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STD. NO. 5.0

7-04 SHEET 2 OF 3
Construction Notes for CCTV Camera Assemblies

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
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Case 5
CCTV assembly mounted on a new metal pole at the end of a run

Case 6
CCTV assembly mounted on a new metal pole in the middle of a run
Wireless Communications – Typical Detail

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

8-12

STAD. NO. 6.0
SHEET 1 OF 2
NOTES FOR WIRELESS COMMUNICATIONS:
1. INSTALL COAXIAL CABLE:
   A. ON WOOD POLES, REQUIRING A NEW RIGID GALVANIZED STEEL RISER, INSTALL A 2" RISER WITH WEATHERHEAD AND ROUTE THE COAXIAL CABLE TO THE ANTENNA.
   B. ON METAL POLES WITH MAST ARMS, RUN COAXIAL CABLE UP THROUGH THE POLE AND OUT THE MAST ARM; FIELD DRILL A 1/2" HOLE UP THROUGH THE BOTTOM OF MAST ARM FOR INSTALLATION OF THE COAXIAL CABLE TO THE ANTENNA.
   C. ON METAL STRAIN POLES, RUN COAXIAL CABLE UP THROUGH THE POLE AND OUT THE WEATHERHEAD AND ROUTE THE COAXIAL CABLE TO THE ANTENNA.
   D. BETWEEN THE POINT OF EXITING THE RISER, METAL POLE OR MAST ARM AND THE ANTENNA, SECURE THE COAXIAL CABLE TO THE STRUCTURE USING 3/4" STAINLESS STEEL STRAPS EVERY 12".

2. IF AN EXISTING 2" SPARE RIGID GALVANIZED STEEL RISER IS AVAILABLE, INSTALL THE COAXIAL CABLE IN THE SPARE RISER.

3. INSTALL WIRELESS ANTENNA ON POLE WITH RF WARNING SIGN.
   (NOTE: RF WARNING SIGN NOT REQUIRED WHEN ANTENNA IS INSTALLED ON AN NCDOT-OWNED POLE.)

4. MAINTAIN PROPER CLEARANCE FROM ALL UTILITIES PER THE NATIONAL ELECTRICAL SAFETY CODE.

5. INSTALL WIRELESS SERIAL RADIO MODEM WITH EXTERIOR DISCONNECT SWITCH LOCATED ON CABINET.
   (NOTE: RF ANTENNA DISCONNECT SWITCH AND DECAL ARE NOT REQUIRED WHEN THE ANTENNA IS INSTALLED ON AN NCDOT-OWNED POLE)

6. REFERENCE "WIRELESS RADIO ANTENNA TYPICAL DETAILS."
# Wireless - Standard Construction Notes

## Yagi Vertically Polarized
- Install 8.5 dB Gain Yagi Antenna Vertically Polarized
- Install 13 dB Gain Yagi Antenna Vertically Polarized

## Yagi Horizontally Polarized
- Install 8.5 dB Gain Yagi Antenna Horizontally Polarized
- Install 13 dB Gain Yagi Antenna Horizontally Polarized

## Omni Vertically Polarized
- Install 3 dB Gain Omni Antenna Vertically Polarized

## Attachment Notes
- Attach Antenna 12" Above Signal Cable
- Attach Antenna 6" Above Signal Cable
- Attach Antenna 12" Below Signal Cable
- Attach Antenna 6" Below Signal Cable
- Attach Antenna 40" Below Power
- Attach Antenna Along Mast Arm A Minimum of 6 Feet Away From The Vertical Shaft Member

Note: Attachment notes for the antenna can also be changed to reference other utilities (i.e., phone, cable, etc.)

Note: For underground conduit installations include the following note — "Provide coaxial cable suitable for wet locations."

## Other Commonly Used Notes

### Master Note
- Install Telephone Service

### Joint Use Pole Note
- Joint Use Pole
  - Include Disconnect Switch, Warning Sign and Decal

---

Wireless Communications – Sample of Wireless Notes

Intelligent Transportation Systems Section
Transportation Mobility and Safety Division
North Carolina Department of Transportation

STD. NO. 6.2  
Sheet 1 of 1
Samples

Install Telephone Service

Install 8.5 dB Gain Yagi Antenna
Vertically Polarized
Attach Antenna 12" Above Signal Cable

Install 13 dB Gain Yagi Antenna
Vertically Polarized
Attach Antenna 6" Below Signal Cable Weatherhead

Wireless Communications – Sample Intersection with Wireless Notes

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

STD. NO. 6.3
SHEET 1 OF 1
ANTENNA DESIGN NOTES

OMNI ANTENNAS ARE ALWAYS INSTALLED VERTICALLY POLARIZED.

YAGI ANTENNAS CAN BE INSTALLED EITHER VERTICALLY POLARIZED OR HORIZONTALLY POLARIZED.

OMNI ANTENNAS CAN COMMUNICATE WITH BOTH OMNI ANTENNAS AND YAGI ANTENNAS. HOWEVER, IF COMMUNICATIONS IS DESIRED BETWEEN AN OMNI ANTENNA AND A YAGI ANTENNA, THEN THE YAGI ANTENNA MUST BE INSTALLED IN THE VERTICALLY POLARIZED POSITION.

YAGI ANTENNAS INSTALLED IN THE VERTICALLY POLARIZED POSITION CAN ONLY COMMUNICATE WITH OTHER YAGI ANTENNAS THAT ARE ALSO VERTICALLY POLARIZED.

YAGI ANTENNAS INSTALLED IN THE HORIZONTALLY POLARIZED POSITION CAN ONLY COMMUNICATE WITH OTHER YAGI ANTENNAS THAT ARE ALSO HORIZONTALLY POLARIZED.

WHEN DEALING WITH A DUAL ANTENNA DESIGN (REPEATING OPERATION) THE ANTENNAS CAN BOTH BE INSTALLED HORIZONTALLY POLARIZED OR VERTICALLY POLARIZED. ADDITIONALLY, ONE ANTENNA CAN BE INSTALLED HORIZONTALLY POLARIZED AND THE SECOND ANTENNA CAN BE INSTALLED VERTICALLY POLARIZED.
Wireless Communications – Sample Plan – Wireless Communications Plan (Stand Alone)

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

8-12

NOTES FOR WIRELESS COMMUNICATIONS:

1. INSTALL COAXIAL CABLE:
   A. ON WOOD POLES, REQUIRE A NEW RIGID GALVANIZED STEEL RISER, INSTALL A 2" RISER WITH WEATHERHEAD AND ROUTE THE COAXIAL CABLE TO THE ANTENNA.
   B. ON METAL POLES WITH MAST ARMS, RUN COAXIAL CABLE UP THROUGH THE POLE AND OUT THE MAST ARM; FIELD DRILL A 1/2" HOLE UP THROUGH THE BOTTOM OF MAST ARM FOR INSTALLATION OF THE COAXIAL CABLE TO THE ANTENNA.
   C. ON METAL STRAIN POLES, RUN COAXIAL CABLE UP THROUGH THE POLE AND OUT THE WEATHERHEAD AND ROUTE THE COAXIAL CABLE TO THE ANTENNA.
   D. BETWEEN THE POINT OF EXITING THE RISER, METAL POLE OR MAST ARM AND THE ANTENNA, SECURE THE COAXIAL CABLE TO THE STRUCTURE USING 3/4" STAINLESS STEEL STRAPS EVERY 12".
   E. IF AN EXISTING 2" SPARE RIGID GALVANIZED STEEL RISER IS AVAILABLE, INSTALL THE COAXIAL CABLE IN THE SPARE RISER.
   F. INSTALL WIRELESS ANTENNA ON POLE WITH RF WARNING SIGN.
      [NOTE: IF WARNING SIGN NOT REQUIRED WHEN ANTENNA IS INSTALLED ON AN NCDOT-OWNED POLE]
   G. INSTALL WIRELESS SERIAL RADIO MODEM WITH EXTERIOR DISCONNECT SWITCH LOCATED ON CABINET.
      [NOTE: IF ANTENNA DISCONNECT SWITCH AND DECAL ARE NOT REQUIRED WHEN THE ANTENNA IS INSTALLED ON AN NCDOT-OWNED POLE]
   H. REFERENCE "WIRELESS RADIO ANTENNA TYPICAL DETAILS."
Wireless Communications – Sample Plans – Fiber (Local Intersection) to Wireless Intersection

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

NOTES FOR WIRELESS COMMUNICATIONS:

1. INSTALL COAXIAL CABLE:
   A. ON WOOD POLES, INSTALLING A NEW RIGID GALVANIZED STEEL RISER, INSTALL A 2" RISER WITH WEATHERHEAD AND ROUTE THE COAXIAL CABLE TO THE ANTENNA.
   B. ON METAL POLES WITH MAST ARMS, RUN COAXIAL CABLE UP THROUGH THE POLE AND OUT THE MAST ARM. FIELD DRILL A 3/4" HOLE UP THROUGH THE BOTTOM OF MAST ARM FOR INSTALLATION OF THE COAXIAL CABLE TO THE ANTENNA.
   C. ON METAL STRAIN POLES, RUN COAXIAL CABLE UP THROUGH THE POLE AND OUT THE WEATHERHEAD AND ROUTE THE COAXIAL CABLE TO THE ANTEENA.
   D. BETWEEN THE POINT OF EXITING THE RISER, METAL POLE OR MAST ARM AND THE ANTENNA, SECURE THE COAXIAL CABLE TO THE STRUCTURE USING 3/4" STAINLESS STEEL STRAPS EVERY 12".

2. IF AN EXISTING 2" SPARE RIGID GALVANIZED STEEL RISER IS AVAILABLE, INSTALL THE COAXIAL CABLE IN THE SPARE RISER.

3. INSTALL WIRELESS ANTENNA ON POLE WITH RF WARNING SIGN.
   (NOTE: RF WARNING SIGN NOT REQUIRED WHEN ANTENNA IS INSTALLED ON AN NCDOT-OWNED POLE.)

4. MAINTAIN PROPER CLEARANCE FROM ALL UTILITIES PER THE NATIONAL ELECTRICAL SAFETY CODE.

5. INSTALL WIRELESS SERIAL RADIO MODERN WITH EXTERIOR DISCONNECT SWITCH LOCATED ON CABINET.
   (NOTE: RF ANTENNA DISCONNECT SWITCH AND DECAL ARE NOT REQUIRED WHEN THE ANTENNA IS INSTALLED ON AN NCDOT-OWNED POLE.)

6. REFER TO "WIRELESS RADIO ANTENNA TYPICAL DETAILS."
NOTE PART NUMBER

2070 CONTROLLER LOCAL

INTERSECTION LOCATION
SR 2215 (BUFFALOE RD) AT
1-540 (NORTHERN WAKE EXP) WB RAMPS
SIG. INV. # 05-0003

INTERSECTION LOCATION
SR 2215 (BUFFALOE RD) AT
FORESTVILLE ROAD
SIG. INV. # 05-0003

Legend:
- X = Fusion Splice

Notes:
- Unused fibers left coiled and stored in splice tray.
- Unused fibers left coiled and stored in splice tray.

Wireless Communications – Sample Plans – Fiber Splicing (Local Intersection) to Wireless Intersection

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

8-12

STD. NO.
6.5

SHEET 3 OF 5
NOTES FOR WIRELESS COMMUNICATIONS:

1. INSTALL COAXIAL CABLE:
   A. ON WOOD POLES, REQUIRE A NEW RIGID GALVANIZED STEEL RISER, INSTALL A 2" RISER WITH WEATHERHEAT AND ROUTE THE COAXIAL CABLE TO THE ANTENNA.
   B. ON METAL POLES WITH MAST ARMS, RUN COAXIAL CABLE UP THROUGH THE POLE AND OUT THE MAST ARM, FILL DRILL A 1/2" HOLE UP THROUGH THE BOTTOM OF MAST ARM, FOR INSTALLATION OF THE COAXIAL CABLE TO THE ANTENNA.
   C. ON METAL STRAIN POLES, RUN COAXIAL CABLE UP THROUGH THE POLE AND OUT THE WEATHERHEAT AND ROUTE THE COAXIAL CABLE TO THE ANTENNA.
   D. BETWEEN THE POINT OF EXITING THE RISER, METAL POLE OR MAST ARM AND THE ANTENNA, SECURE THE COAXIAL CABLE TO THE STRUCTURE USING 3/4" STAINLESS STEEL STRAPS EVERY 12".

2. IF AN EXISTING 2" SPARE RIGID GALVANIZED STEEL RISER IS AVAILABLE, INSTALL THE COAXIAL CABLE IN THE SPARE RISER.

3. INSTALL WIRELESS ANTENNA ON POLE WITH RF WARNING SIGN.
   (NOTE RF WARNING SIGN NOT REQUIRED WHEN ANTENNA IS INSTALLED ON AN NCDOT-OWNED POLE.)

4. MAINTAIN PROPER CLEARANCE FROM ALL UTILITIES PER THE NATIONAL ELECTRICAL SAFETY CODE.

5. INSTALL WIRELESS SERIAL RADIO MODUL WITH EXTERIOR DISCONNECT SWITCH LOCATED ON CABINET. 
   (NOTE: RF ANTENNA DISCONNECT SWITCH AND DECAL ARE NOT REQUIRED WHEN THE ANTENNA IS INSTALLED ON AN NCDOT-OWNED POLE.)

6. REFERENCE "WIRELESS RADIO ANTENNA TYPICAL DETAILS."
DMS Site Selection and Design Process

- Obtain recommended locations from Congestion Management Section
- Identify points of interest:
  - Alternate route(s)
  - Venues (Stadiums, Motor Speedways, Sports / Concert Arenas)
- Set up a field investigation event with the following people:
  - Division Incident Management Engineer
  - Regional ITS Engineer
  - Regional Traffic Engineer
  - Signing Project Design Engineer
- Select a location that meets the following criteria:
  - Select location that is 2–4 miles in advance of the point of interest
  - Ensure that display has at least 1200' of unobstructed sight distance
  - Avoid placement in curves
  - Select location where shoulder is widest to avoid future lane closure
  - Ensure an ideal location at least 50 feet in advance of the display can be selected for the controller cabinet
  - Consider phone and power service availability
  - For 1–2 lanes (each direction) consider pedestal type assembly
  - For 3 or more lanes (each direction) consider full span assembly
  - Ensure all parties agree on the selected location
- Confirm the location by sending emails to all parties involved
  - Reference the location from the nearest mile marker
  - If no mile marker exists, use bridge or intersection as reference

- Confirm availability of utilities by coordinating with Division personnel and Utility agents
- Develop Project Special Provisions
  - Determine if a particular brand is to be specified
    - Ensure integration section and pay item is included
    - Ensure that a bench test unit is not required
    - Determine if training is required
    - Determine if UPS, Modem, and Modem Reset devices are needed
    - Determine if desktop / laptop computers are needed
    - Determine if software upgrade is required
    - Determine if Fiber Optic Communication is to be used
    - Determine if dial-up backup system is not required
      - Ensure that dial up modems and related devices are not required
- Follow up with the Signing Section on the development of Structure line drawings, Traffic Control, and Roadway Plans
- If assembling the package for submission to Design Services, obtain plans from Traffic Control and Roadway and confirm quantities
- Ensure DMS Grounding Detail is inserted into the ITS Plans
- Ensure DMS Project Special Provisions are included with ITS Package
I. Cabinets
   A. Note cabinet location
   B. Note signal inventory number
      (usually marked on cabinet)
      Example: 01-0459
   C. Note cabinet type
      (base mount/pole mount)
   D. Check inside cabinet for space conduit
      (signal technician must be present before doing this)

II. Poles
   A. Note pole type
      (wood, metal, metal with mast arm)
   B. Note pole number
      (if applicable)
      Use "SP" for signal pole
   C. Determine NCDOT attachment height
   D. Note any clearance problems or
      adjustments required in order to
      assume the desired attachment height
   E. See section 1.0 for NESC clearance requirements
   F. Record distances between poles
      using laser range finder or measuring wheel
   G. When evaluating adjustment options, be mindful
      of 'height over grade' clearances
   H. If adjustments are required on a pole,
      record the attachment heights of all
      existing utilities using the laser range finder
   I. Determine vertical clearance over road as needed.
      Use the laser range finder.
      Measure from the roadway to the lowest
      point on the span.

III. Roads and Structures
   A. Record all road names and
      state road (SR) numbers if applicable
   B. Note any bridges (grade separations)
   C. Record any landmarks, buildings, or
      other structures for reference purposes
      as needed

IV. Railroads
   A. When the cable route crosses over
      or under a railroad, special wire-line
      agreements must be made.
   B. The following information is needed
      for wire line agreements:
      1. Crossing number (if available)
         usually found on cross arm mechanism
         or crossing controller cabinet
      2. Distance from center line of track to the
         nearest pole on each side of the track
         (for aerial installation)
      3. Vertical clearance from the top of the rail
         to the lowest existing overhead utility
         (aerial installation)
      4. Distance from crossing to the nearest
         railway mile marker.
         This information may be obtained through
         NCDOT Railway Division, Railroad Company
         Right of Way, or NCDOT Right of Way.
Case 1

A. If proposed NCDOT communications cable attachment height is 40° below power

**Typical Adjustment Notes**

- no adjustment required
- there is adequate clearance

B. If proposed NCDOT communications cable attachment height is 12° below CATV

**Typical Adjustment Notes**

- CATV raise to 40° below power (or phone 2 lower to 24° below CATV)
- phone 1 lower to 12° below phone 2

**Typical Utility Tree**

- 25' -04" Power
- 21' -00" CATV
- 20' -00" Phone 2
- 19' -00" Phone 1

Case 2

A. If proposed NCDOT communications cable attachment height is 40° below power

**Typical Adjustment Notes**

- CATV lower 52° below power

B. If proposed NCDOT communications cable attachment height is 12° below CATV

**Typical Adjustment Notes**

- no adjustment note required (there is adequate clearance)

**Typical Utility Tree**

- 25' -04" Power
- 22' -00" CATV
- 20' -00" Phone 2
- 19' -00" Phone 1

Utility Make Ready – Common Adjustment Notes

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
8.1

SHEET 1 OF 2
Case 3

A. If proposed NCDOT communications cable attachment height is 40" below power

   Typical Adjustment Notes

   All utilities to lower 12"
   or
   CATV lower to 52" below power
   Phone 2 lower to 64" below power
   Phone 1 lower to 76" below power
   or
   CATV lower to 52" below power
   Phone 2 lower to 12" below CATV
   Phone 1 lower to 12" below Phone 2

B. If proposed NCDOT communications cable attachment height is 12" below CATV

   Typical Adjustment Notes

   Phone 1 and Phone 2 lower 12"
   or
   Phone 2 lower to 24" below CATV
   Phone 1 lower to 12" below Phone 2

   Typical Utility Tree

   25' - 04" Power
   22' - 00" CATV
   21' - 00" Phone 2
   20' - 00" Phone 1

Case 4

If proposed NCDOT communications cable attachment height is 40" below power or 12" below CATV

   Typical Adjustment Notes

   Required adjustments would put lowest utility (phone 1) below 18' above grade

   Therefore the existing pole must be replaced with a taller pole

   Typical Utility Tree

   20' - 00" CATV
   18' - 00" Phone 2
   18' - 00" Phone 1

Utility Make Ready – Common Adjustment Notes

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.

8.1

SHEET 2 OF 2
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### Standard Sheet Layout – TMS Standard CADD Symbology

**INTELLIGENT TRANSPORTATION SYSTEMS SECTION**

**TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH**

**NORTH CAROLINA DEPARTMENT OF TRANSPORTATION**

**STANDARD SHEET LAYOUT – TMS STANDARD CADD SYMBOLOGY**

**7-04**
Standard Sheet Layout - UMR Title Sheet

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS

DURHAM COUNTY

LOCATION: NC 54 FROM SR 1999 (DAVIS DRIVE) TO SR 1959 (MIAMI BOULEVARD)

TYPE OF WORK: UTILITY MAKE READY

VICINITY MAP

LEGEND

VICINITY MAP

DURHAM COUNTY

LOCATION: NC 54 FROM SR 1999 (DAVIS DRIVE) TO SR 1959 (MIAMI BOULEVARD)

TYPE OF WORK: UTILITY MAKE READY
Notes

Number UMR plan sheets in the upper title block

Utility Make Ready plans are not sealed by a professional engineer do not include seal in lower block

Typical Upper Title Block

Typical Lower Title Block

Utility Make Ready Plans

DIVISION 02  DURHAM COUNTY  DURHAM

PLAN DATE: JANUARY 2004  REVISED BY: J. HOOKER

PREPARED BY: J. HOOKER  REVISED BY:

REVISIONS  INNL.  DATE

SIGNATURE DATE

CADD Filename:

Standard Sheet Layout – Title Blocks – UMR

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO. 9.1

SHEET 3 OF 5
No Utility Make Ready Work Required This Sheet
STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS

DURHAM COUNTY

LOCATION: NC 54 FROM SR 1999 (DAVIS DRIVE)
TO SR 1959 (MIAMI BOULEVARD)

TYPE OF WORK: COMMUNICATIONS CABLE AND CONDUIT ROUTING

Let Date: 12/14/04

Communications Cable and Conduit Routing Plans

NCDOT CONTACT:
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
G.J. MURR, JR., PE - TRAFFIC ENGINEERING SYSTEMS ENGINEER

Standard Sheet Layout – Sample Cable Routing Title Sheet
INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

STD. NO. 9.2
SHEET 2 OF 5
Notes

Number Cable Routing plan sheets in the upper title block.

For Closed Loop System projects do not number the sheets. They are numbered later as part of a larger plan package.

Typical Upper Title Block

Typical Lower Title Block

Standard Sheet Layout – Title Blocks – Cable Routing
Bond tracer wire to equipment ground bus

Unless otherwise noted, all NCDOT attachment points are 40" below power, front side of pole.

Over-sized junction boxes to be placed approximately 400 feet apart unless otherwise noted.

Seal conduit ends with mechanical sealing devices at all junction box/cabinet entrances.

Standard Sheet Layout – Sample Cable Routing Plan Sheet

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
Attachment of signal cable height front side of pole

Bond messenger cable and riser to pole ground

Attach 12" above CATV front side of pole

Attach 12" above signal cable front side of pole

Unless otherwise noted, all NCDOT attachment points are 40" below power, front side of pole

Over-sized junction boxes to be placed approximately 400 feet apart unless otherwise noted

Seal conduit ends with mechanical sealing devices at all junction box/cabinet entrances
**Fiber Optic Cable**

**Intersection Location:**
NC 54 at SR 1999 (Davis Dr)
Sig. Inv. # 05-0977

**Legend:**
- **X** = Fusion Splice

**Color Code (DANS 318-A):**
- (1) Blue
- (2) Orange
- (3) Green
- (4) Brown
- (5) Blue
- (6) White

**Notes:**
- Unused fibers left coiled and stored in splice tray.
- Unused Buffer Tubes left coiled and stored in splice tray.

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**Intersection Location:**
NC 54 at Business Drive
Sig. Inv. # 05-1081

**Legend:**
- **X** = Fusion Splice

**Color Code (DANS 318-A):**
- (1) Blue
- (2) Orange
- (3) Green
- (4) Brown
- (5) Blue
- (6) White

**Notes:**
- Unused fibers left coiled and stored in splice tray.
- Unused Buffer Tubes left coiled and stored in splice tray.

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**Intersection Location:**
NC 54 at SR 1999 (MAMIS BVOL)
Sig. Inv. # 05-0432

**Legend:**
- **X** = Fusion Splice

**Color Code (DANS 318-A):**
- (1) Blue
- (2) Orange
- (3) Green
- (4) Brown
- (5) Blue
- (6) White

**Notes:**
- Unused fibers left coiled and stored in splice tray.
- Unused Buffer Tubes left coiled and stored in splice tray.

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**Master Controller**

**Splice Tray**

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**Standard Sheet Layout – Splice Plan**

**INTELLIGENT TRANSPORTATION SYSTEMS SECTION**
**TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH**
**NORTH CAROLINA DEPARTMENT OF TRANSPORTATION**

STD. NO. 9.3
SHEET 1 OF 2

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Transceiver termination configurations are generic. Contractor is responsible for determining and ensuring proper terminations.
Fiber Optic Cable

Intersection Location
NC 54 at Business Drive
Sig. Inv. # 05-1081

Notes:
Unused fibers left coiled and stored in splice tray.
Unused Buffer Tubes left coiled and stored in splice tray.

Legend
X = Fusion Splice

Color Code
TIA/EIA 598-A

1. Blue
2. Orange
3. Green
4. Brown
5. Slate
6. White

Transceiver termination configurations are generic. Contractor is responsible for determining and ensuring proper terminations.