Connected Vehicle Pilot Deployment Program Phase 2

Comprehensive Installation Plan – WYDOT CV Pilot

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16. Abstract

The Wyoming Department of Transportation's (WYDOT) Connected Vehicle (CV) Pilot Deployment Program is intended to develop a suite of applications that utilize vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) communication technology to reduce the impact of adverse weather on truck travel in the I-80 corridor. These applications support a flexible range of services from advisories, roadside alerts, parking notifications and dynamic travel guidance. Information from these applications are made available directly to the equipped fleets or through data connections to fleet management centers (who will then communicate it to their trucks using their own systems). The pilot will be conducted in three Phases. Phase I includes the planning for the CV pilot including the concept of operations development. Phase II is the design, development, and testing phase. Phase III includes a real-world demonstration of the applications developed as part of this pilot.

This Phase II document presents the Comprehensive Installation Plan for the software, hardware and maintenance for purchases in support of the Concept of Operations document.

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Table of Contents

1 Introduction

The WYDOT Comprehensive Installation Plan (CIP) provides an overview of the proposed installation approach that includes instructions as well as a schedule for installing all equipment related to the WYDOT CV Pilot project.

1.1 Purpose of the Plan

The purpose of this plan is to document the WYDOT CV Pilot's installation plan. This will be useful to demonstrate compliance with both the policies for the State of Wyoming and the Notice of Funding Opportunities (NOFO).

1.2 Organization of the Plan

The Comprehensive Installation Plan document is organized as follows:

- Chapter 2 provides an overview of the WYDOT acquisition plan including approach, schedule and vendor selection.
- Chapter 3 provides an overview of the WYDOT installation equipment including suppliers, procurement, and inventory management.
- Chapter 4 details the installation of vehicle/in-vehicle equipment.
- Chapter 5 details the installation of roadside equipment.
- Chapter 6 details the installation of mobile devices.
- Chapter 7 details the installation of equipment for the data center.
- Chapter 8 details the installation of other equipment for the pilot.
- Chapter 9 lists the bill of materials for equipment described in this document.
- Chapter 10 lists the glossary of terms used in this document.
- Chapter 11 lists the references cited in this document.

2 Acquisition Overview

The WYDOT CV Pilot acquisition program is in compliance with the NOFO and the State of Wyoming acquisition policies. To ensure full compliance with policies and laws for the State of Wyoming, all purchasing is being done directly through the state's purchasing system. WYDOT has a procurement process that allows the acquisition and tracking of equipment and software for client contracts. The procurement and accounting processes include the following staffing resources: legal/contracts, accounts receivable, accounts payable, inventory tracking, and reporting, and the process involves a subject matter expert to provide the product specifications. WYDOT is using a procurement team that includes WYDOT staff and Trihydro. The procurement team will manage the connected vehicle equipment and software acquisitions. The Trihydro team will assist WYDOT on equipment and software acquisition. WYDOT will make the acquisitions and Trihydro will write the specifications for software and hardware. The Trihydro team has former experience with scoping out the specifications, configuring equipment and then installing the equipment on behalf of WYDOT. Vendor specific additional language is included for WeatherCloud in section 4.3, and the appendix for Lear RSUs and SiriusXM to cover the CV specific hardware and software needed for this project.

A detailed description of each of the components is provided in the SDD.

2.1 Acquisition Approach

The approach for acquiring equipment and services is illustrated in Figure 2-1. In summary, the first step is to define the concept of operations (ConOps) based on the identified user needs. This process leads to the system requirements (SyRS), security management operating concept (SMOC), and application development (App. Dev.) plan, all completed in Phase 1. These documents provide enough information to describe the acquisitions needed for the vehicle, roadside and the WYDOT Traffic Management Center (TMC). Based on this, vendor research will be conducted to find vendors knowledgeable in each area that equipment or services are required. The heavy seasonal Winter workload of the WYDOT fleet will drive early procurement of some equipment. In some cases, the fleet vehicles and personnel which will install and utilize the equipment are only available for installation and testing during the summer months. Consequently, vendor selection criteria will consider vendor responsiveness for all areas including: software, hardware, support and their ability to deliver on time. Procurement of the equipment will be handled by a purchasing officer within the WYDOT acquisition team. The procurement process will follow these steps:

1. Evaluation of the purchase request by the team including any sole source justifications if necessary
2. Submittal of a purchase order to the vendor based on the agreed-upon purchase price of the equipment and quantities required
3. Tracking of the order confirmation and delivery schedule provided by the vendor
4. Receipt and inventory of the delivery to compare the purchase order and equipment received

The WYDOT purchasing office will be responsible for tracking and reporting on the equipment budget to the management team.
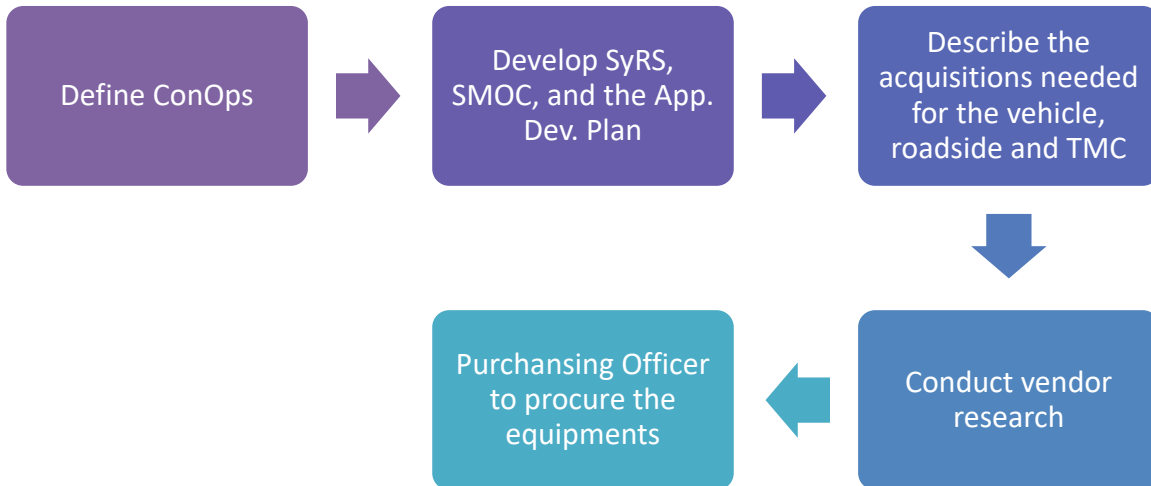
Figure 2-1. Approach for acquiring equipment and services.

2.2 Acquisition Schedule

The Wyoming Pilot will acquire one type of infrastructure RSU, three mobile types of OBUs, and one type of mobile weather sensor. This section describes the status of the type of element development, production, and schedule. A summary table of planned equipment purchases is provided in Table 2-1.

Table 2-1. Wyoming CV Pilot's Planned Equipment Purchases.

Item	Quantity	Schedule
RSUs	78	Initial set of 10 devices: December 2016. Fulfillment of devices (75 total devices): July 2017
OBU devices capable of bidirectional DSRC communications and receiving Traveler Information Messages (TIM) via satellite – no CAN Bus or environmental sensor support	28	Initial five devices: June 2017. Remaining devices: Sept 2017.
OBU devices capable of bidirectional DSRC communications and receiving TIMs via satellite – CAN Bus or environmental sensor would be supported	254	Set of devices will be purchased between December 2016 and April 2018.
OBU devices capable of DSRC bidirectional communications with no satellite capabilities – no CAN Bus or environmental sensor support	126	Initial 10 devices: December 2016. Additional 23 devices: Sept 2017. Remaining devices: April 2018.
Mobile weather sensors	53	Initial 10 devices: January 2017. Remaining devices: Sept 2017.

2.3 Vendor Outreach Plan

During Phase 1 the WYDOT team researched vendors of connected vehicle equipment, discussed with these vendors the pilot's requirements for software, hardware and services. After discussing with these vendors, the requirements and providing them the ConOps, SMOC, Application Development Plan and SyRS a proposal was requested from qualified vendors. Vendors were invited onsite for a meeting with the WYDOT CV Pilot leadership to discuss and demo equipment. Only RSU/OBUs that have passed USDOT-approved certification will be considered for acquisition. Currently, the pilot is obtaining proposals from vendors to provide turnkey solutions for certified hardware, software, installation support, and warranty support coverage for the roadside and on-board hardware and software for the pilot's duration.

3 Installation Overview

The WYDOT CV Pilot installation program is in compliance with the NOFO and the State of Wyoming installation policies. To ensure full compliance with policies and laws for the State of Wyoming, all installations involving state vehicles and infrastructure is being done directly through WYDOT staff. WYDOT has an established installation process that allows the installation and tracking of equipment and software. The installation processes include the following staffing resources: maintenance and vehicle support, inventory tracking, and the process involves a subject matter expert to provide the installation specifications. WYDOT is using an installation team that includes WYDOT staff and Trihydro. The installation team will manage the connected vehicle equipment and software installations. The Trihydro team will assist WYDOT on equipment and software installation. WYDOT will make the installations and Trihydro will write the installation guides for software and hardware. The Trihydro team has former experience with scoping out the specifications, configuring equipment and then installing the equipment on behalf of WYDOT.

3.1 Supplier Base

The WYDOT supplier base for the CV project consists of one type of infrastructure RSU, three mobile types of OBUs, and one type of mobile weather sensor. A summary table of suppliers and the equipment provided by each is provided in Table 3-1.

Table 3-1. Wyoming CV Pilot's suppliers and associated equipment.

Item	Vendor	Quantity
RSUs	Lear	78
OBU devices capable of bidirectional DSRC communications and receiving Traveler Information Messages (TIM) via satellite – no CAN Bus or environmental sensor support	Sirius XM	28
OBU devices capable of bidirectional DSRC communications and receiving TIMs via satellite – CAN Bus or environmental sensor would be supported	Lear	380
Mobile weather sensors	WeatherCloud	53

3.2 Procurement Method

During Phase 1 the WYDOT team researched vendors of connected vehicle equipment, discussed with these vendors the pilot's requirements for software, hardware and services. After discussing with these vendors, the requirements and providing them the ConOps, SMOC, Application Development Plan and SyRS a proposal was requested from qualified vendors. Vendors were invited onsite for a meeting with the WYDOT CV Pilot leadership to discuss and demo equipment. Only RSU/OBUs that have passed USDOT-approved certification will be considered for acquisition. The pilot obtained

proposals from vendors to provide turnkey solutions for certified hardware, software, installation support, and warranty support coverage for the roadside and on-board hardware and software for the pilot's duration. Based on the provided proposals vendors were evaluated and chosen.

3.3 Inventory Management

Inventory management for all CV related equipment is being handled through an Excel Spreadsheet for a detailed view of all equipment. Only equipment managers will have access to the Spreadsheet which will be stored in a OneDrive folder with version tracking enabled. This will allow equipment managers to track all changes made to the Spreadsheet and ensure correctness. After receiving equipment from a Vendor all equipment is entered into the inventory spreadsheet along with the current location and responsible owner. As equipment is distributed for installation and testing the spreadsheet is updated to reflect the current status as well as the responsible party for checking out the equipment. Equipment audits will be performed on a quarterly basis and the equipment manager will be responsible for reviewing the inventory spreadsheet and auditing the current in stock inventory as well as the equipment that has been checked out for testing and installation purposes. For inventory that is being distributed to private partners the inventory will be marked as checked out and the equipment manager will be responsible for contacting private partners monthly until all equipment has been installed and is in active use.

3.4 Configuration Management

Devices for this pilot will be able to be configured both manually as well as remotely. For OBU and RSU configuration the OBU/RSU management application will allow WYDOT to push new firmware out remotely to RSUs for immediate updates and provide a method to configure the RSUs/OBUs remotely through a web interface. Hardware configurations will be documented and stored on the WYDOT Confluence site. The configuration documents within the Confluence site will be considered living documents and updated as configurations are updated. The full configuration management process for RSU and OBU updates after deployments have been made will include the following.

1. Configuration updates are identified either from or with the help of Lear
2. Updates are tested in a controlled environment:
    a. On the bench top
    b. With equipped vehicles and test RSUs on a test track
    c. With equipped vehicles on a Road Test
3. If tests fail go back to step 1
4. Results are documented and handed to Vince Garcia for thumbs up/down
5. If rejected based on insufficient testing, go back to step 2
6. If rejected based on risk to equipment/project go back to step 1
7. If Approval is given, updates are scheduled for a time with low impact to CV vehicles
8. Configuration updates are rolled out to OBUs/RSUs.

If changes are made to this process then this document will be updated with the latest process.

3.5 High Level Equipment Inventory

Table 3-2 provides a high-level overview of the current total number of devices procured as well as the current number of devices that have been configured and installed within the WYDOT CV system.

Table 3-2. Equipment Inventory Summary

Equipment Type	Total # Procured	Total # Configured & Installed
RSUs	78	2
OBU devices capable of bidirectional DSRC communications and receiving Traveler Information Messages (TIM) via satellite – no CAN Bus or environmental sensor support	28	0
OBU devices capable of bidirectional DSRC communications and receiving TIMs via satellite – CAN Bus or environmental sensor would be supported	380	3
Mobile weather sensors	53	1
Dell PowerEdge R730 Server	2	2
Dell Storage Arrays	2	2
Dell Networking Switch	1	1

3.6 Installation Schedule

Table 3-3 shows a summary of the planned equipment purchases and the deployment schedule associated with each equipment type.

Table 3-3. Wyoming CV Pilot's Equipment Deployment Schedule

Item	Quantity	Schedule
RSUs	78	Initial set of 10 devices: December 2016. Fulfillment of devices (75 total devices): July 2017
OBU devices capable of bidirectional DSRC communications and receiving Traveler Information Messages (TIM) via satellite – no CAN Bus or environmental sensor support	28	Initial five devices: June 2017. Remaining devices: Sept 2017.
OBU devices capable of bidirectional DSRC communications and receiving TIMs via satellite – CAN Bus or environmental sensor would be supported	380	3 devices installed by March, 2017 120 devices installed by December 31, 2017 Remaining devices installed by April 30, 2018
Mobile weather sensors	53	December 31, 2017
Center Equipment (Servers, Storage Arrays, and Switch)	5	January 2017

3.7 Installation Plan

The Wyoming Pilot installation plan consists of plans for installing and configuring infrastructure hardware and software, Roadside Units and supporting hardware components, and Vehicle Equipment. The acquisition of all the equipment that is planned for installation is detailed in the Comprehensive Acquisition Plan. This document will reference the equipment detail in the acquisition plan and detail the installation of the equipment.

All equipment installed for the Wyoming CV Pilot project will be installed by qualified personnel with installation experience that have been approved by WYDOT or a partner for vehicle installations. All partners for the WYDOT CV project will be given detailed installation guides that detail the following information:

- Wiring, fiber optic splicing (if applicable) and interconnects
- Rack mount elevation of communications devices in the Control Center
- Electrical and power interface diagram(s) which include grounding and transient voltage surge suppression)
- Infrastructure hardware mounting details
- In-vehicle hardware mounting details
- Installation verification instructions

The installation guides will be provided to WYDOT for installation in Snow Plows as well as to Commercial Vehicle Operator partners. The guides will be written using this document as the base and then modifying it to incorporate the type of vehicle where the installation will take place. The guide will be provided to WYDOT by mid-November and distributed to Commercial Vehicle Operator partners by January 1, 2018.

4 Vehicle/In-Vehicle Equipment

The section describes equipment that will be installed within vehicles for the Wyoming CV pilot project.

4.1 Lear Locomate Roadstar Premium OBU Kit

4.1.1 Acquisition Information

The following sections describe the acquisition information related to the Lear Locomate Roadstar Premium OBU.

4.1.1.1 Technical Description/Specification

These OBUs are intended to be the primary communication link between WYDOT RSUs and vehicles. This OBU sub-system has the ability to:

- Receive TIMs via DSRC and Satellite.
- Integrate with the vehicle network via a Controller Area Network (CAN bus) connection.
- Receive BSM Parts I and II.
- Broadcast BSM Parts I and II.
- Broadcast TIMs via DSRC for Distress Notification.
- Transmit weather sensor data.

Further information on the design and requirements associated with this OBU can be found in section 3.2.1 of the Wyoming System Design Document (SDD).

4.1.1.2 Ancillary Equipment

This OBU will be purchased as part of a kit (part name: Lear Locomate Roadstar Premium). Additional components will be needed outside of the kit for a full vehicle installation. These include the following components:

- OBD2 16 pin to DB9 Serial Port Adapter

4.1.1.3 Part Numbers and Quantities

Table 4-1 shows the parts and quantities being acquired for the Wyoming CV Pilot Project.

Table 4-1. Lear Locomate Roadstar Premium Parts

Description	Part Number or Name	Quantity
OBU kit	Lear Locomate Roadstar Premium	347
OBD2 Adapter	Suntek Item# 14000219	347

HMI	Samsung SM-T580	TBD

4.1.1.4 Associated Software

All software associated with this equipment is preloaded onto the unit and is licensed with Lear. All software updates are managed over the air through Lear.

4.1.1.5 Acquisition Schedule

These devices (the OBU and the Samsung tablet) will be purchased between December 2016 and April 2018 with delivery occurring within days of the purchase.

4.1.2 Installation Information

The sections below detail the installation plan and information for the Lear Locomate Roadstar Premium OBU.

4.1.2.1 Supplier(s)

Table 4-2 lists the suppliers for the vehicle OBU.

Table 4-2. Locomate Roadstar Premium Suppliers

Description	Part Number or Name	Supplier
OBU kit	Lear Locomate Roadstar Premium	Lear
OBD2 Adapter	Suntek Item# 14000219	Suntek
HMI	Samsung SM-T580	Samsung

4.1.2.2 Inventory Control Method

All OBU's will be inventoried in a spreadsheet upon arrival. Equipment Managers will enter in all received equipment serial numbers to the spreadsheet which will be stored in a OneDrive folder with version tracking enabled. As equipment is distributed for installation and testing the spreadsheet is updated to reflect the current status as well as the responsible party for checking out the equipment.

4.1.2.3 Configuration(s)

Configurations for OBU devices will need to be done prior to distribution of the OBU devices in order to work correctly with different vehicle types. Vehicle Types and their configurations are seen in Table 4-3.

Table 4-3. Lear Locomate Roadstar Premium OBU Configuration Parameters

Vehicle Type	OBU Configuration Setup
Light Trucks / Cars / Snow Plows	• Disable Telnet Configuration • Reset default admin password • Enable ipservice application • Generate an SSH public key

	• Configure the offload application
	    o Specify application name: weathercloud
	    o Psid: 35
	    o userRequestType: 1
	    o serviceChannel: 176
	    o wsaType: 4
	    o psc: offload
	    o host server ip: \<ip address>
	    o host server destination directory: /tmp
	    o local source directory: /var/weather_cloud_files
	    o retrycount: 3
	• VehicleType – set to the appropriate vehicle type
	• VehicleWidth – set to the installation vehicles width
	• VehicleLength – set to the installation vehicles length

Commercial Vehicles	• Disable Telnet Configuration • Reset default admin password • Generate an SSH public key • VehicleType – set to the appropriate vehicle type • VehicleWidth – set to the installation vehicles width • VehicleLength – set to the installation vehicles length

4.1.2.4   Installation Diagram(s)

The figures below represent the detailed installation information for the Lear Locomate Roadstar Premium OBU.

Equipment Checklist		
Part No.	Item	Quantity
1	Locomate Roadstar OBU	1
2	12 Volt Adaptor plug	1
3	SiriusXM Antenna	1
4	Mounting Brackets	2
5	Anti-Vibraion Grommets	4
6	OBU Bracket Bolts	4
7	Mounting Bracket Bolts	4
8	Mounting Bracket Screws (opt)	4
9	Bluetooth Antenna	1
10	WIFI Antenna	3
11	Integrated GPS/DSRC Antenna	1
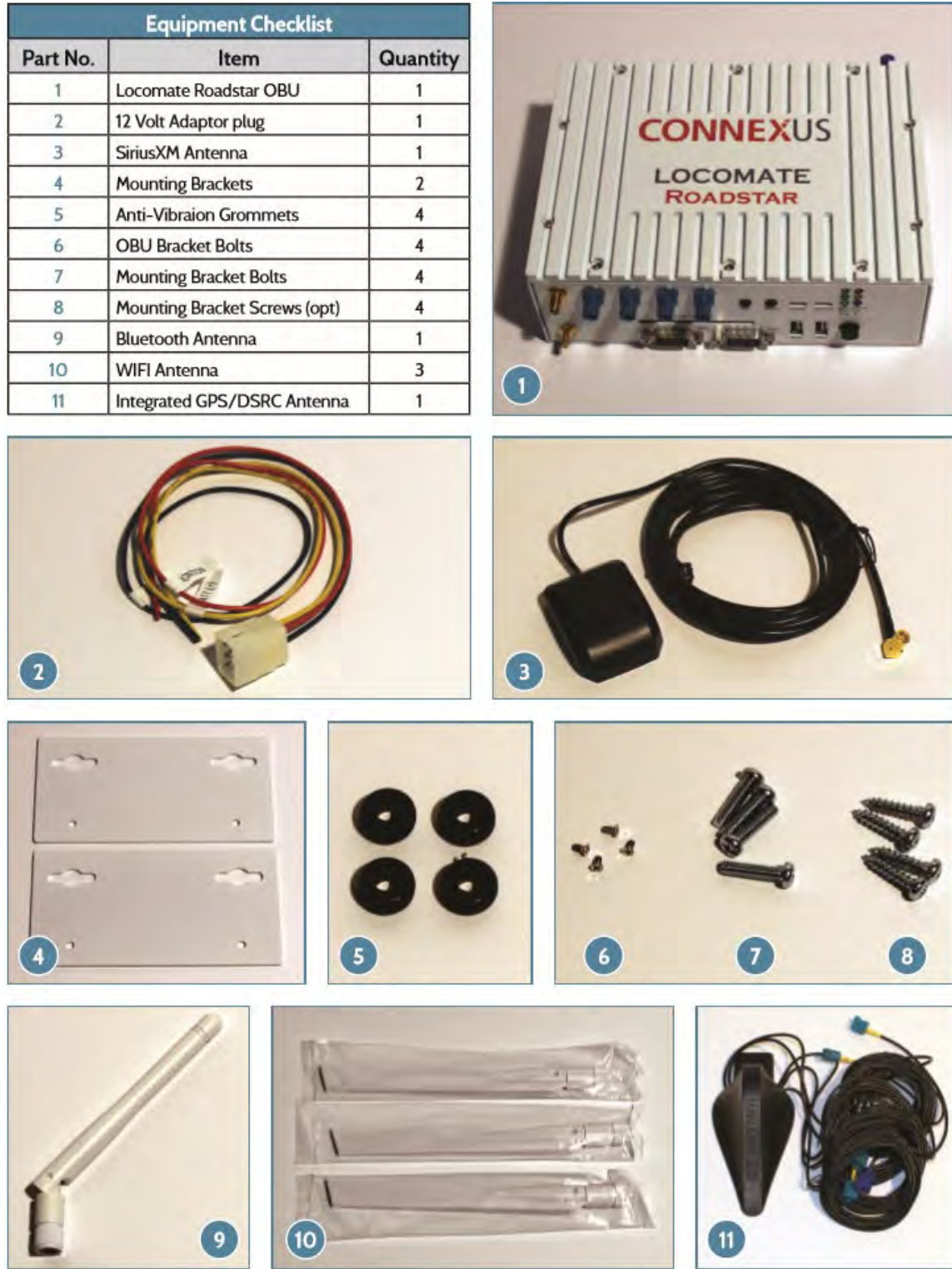
Figure 4-1. Lear Locomate Roadstar Premium OBU Parts List

OBU can be installed anywhere in passenger compartment where the space allows.

Example:
1. Inside center console
2. Under seat

Route the antenna cables accordingly.

Figure 4-2. OBU Base Unit Installation Diagram
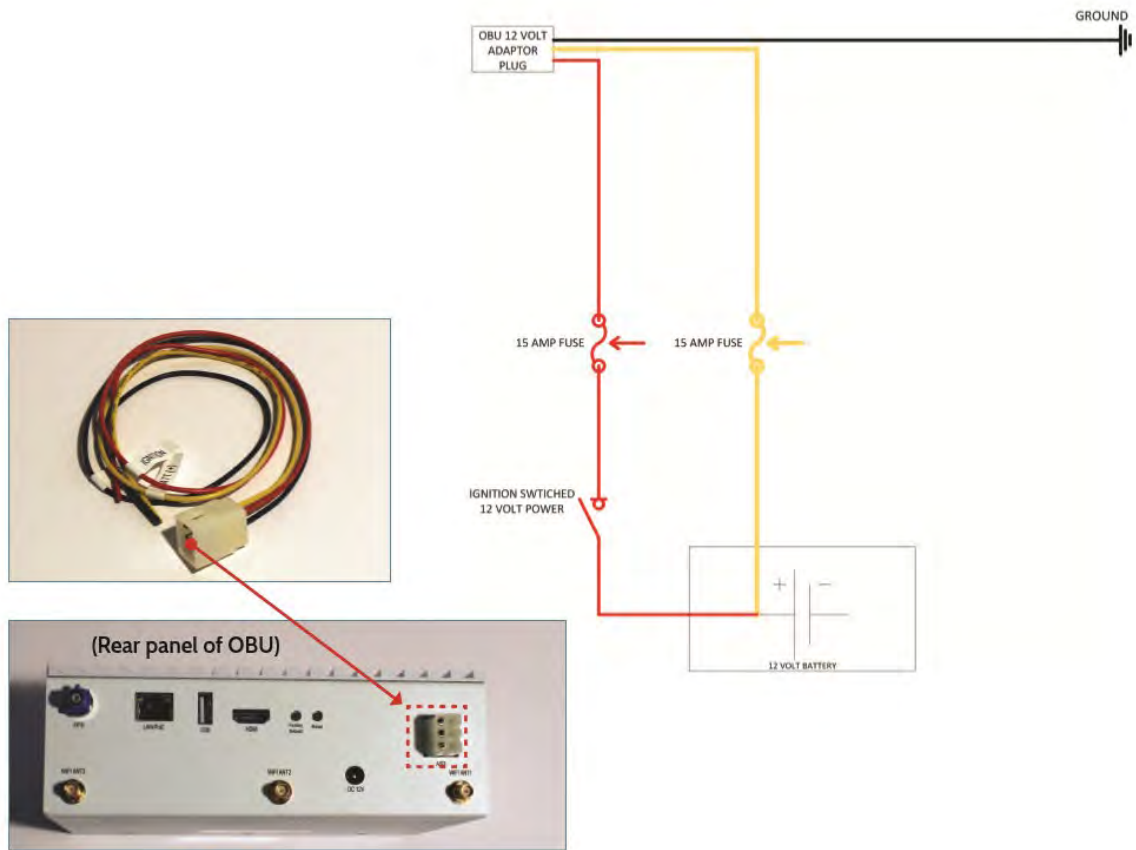
Figure 4-3. Lear Locomate Roadstar Premium Wiring Installation
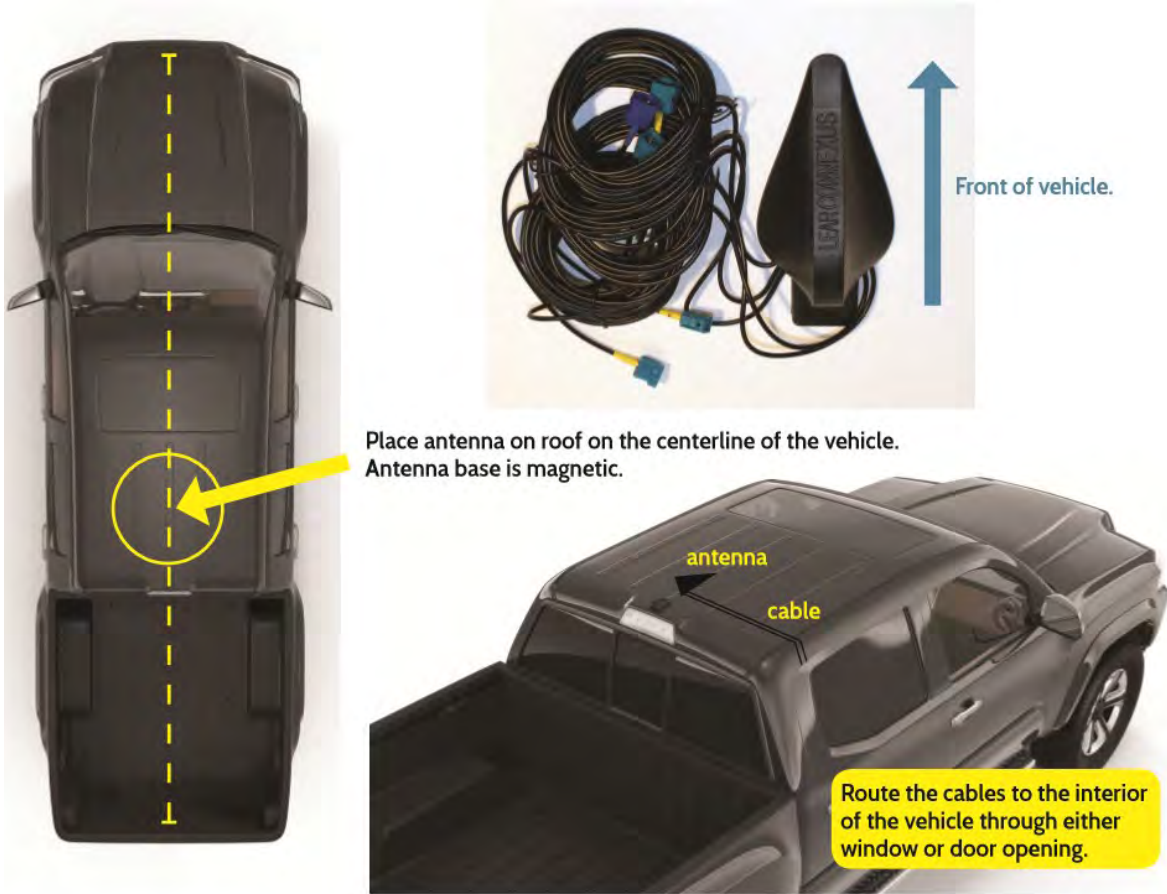
Figure 4-4. Lear Locomate Roadstar Premium Antenna Placement
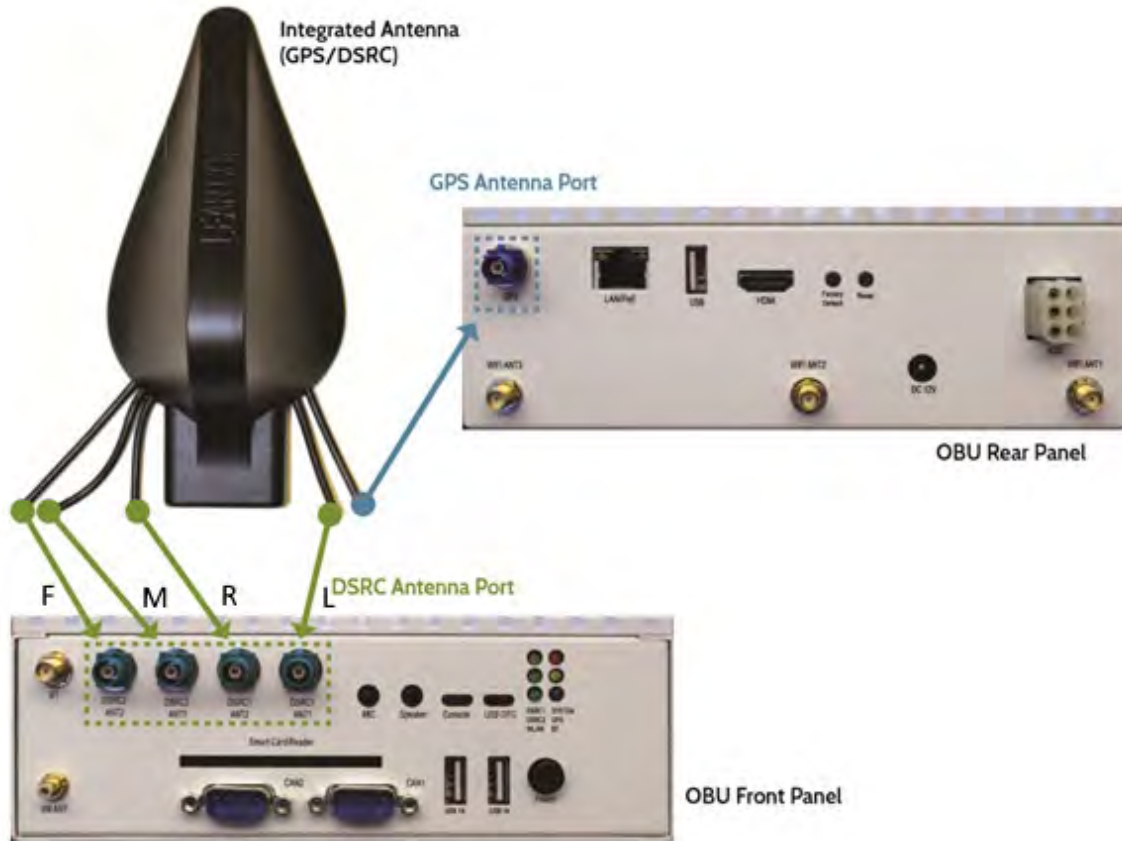
Figure 4-5. Lear Locomate Roadstar Premium Antenna Wiring

Figure 4-6. Lear Locomate Roadstar Premium CAN Bus Installation

Figure 4-7. HMI Kit

4.1.2.5   Installation Procedures

The following sub-sections include all of the procedures/checklists that ensure the device is ready for installation, is completely installed and was installed correctly and is operating as intended.

4.1.2.5.1   Pre-Installation Procedures/Checklist
Pre-installation procedures will require the installer to verify the contents of the OBU package. The Table 4-4. Installation Equipment Checklist should be used to verify the equipment was delivered properly. If the package is not complete, the vendor will be contacted for the missing components.

Table 4-4. Installation Equipment Checklist

Part No.	Item	Quantity
1	Locomate Roadstar OBU	1
2	12 Volt Adaptor plug	1
3	SiriusXM Antenna	1
4	Mounting Brackets	2
5	Anti-Vibration Grommets	4
6	OBU Bracket Bolts	4
7	Mounting Bracket Bolts	4

8	Mounting Bracket Screws (opt)	4
9	Bluetooth Antenna	1
10	WIFI Antenna	3
11	Integrated GPS/DSRC Antenna	1

Additionally, all equipment in the check list should be inspected for visual defects or visible signs of damage. All damage will be reported back to the Vendor and replacement equipment or fixes to the existing equipment will be requested. All OBUs being installed should also be verified that the latest version of the firmware is installed on the OBU and the unit is bootstrapped with security certificates.

4.1.2.5.2   Installation Procedures

Step 1: OBU Installation (mounting) **-** Figure 4-2
1. The OBU (part no. 1) can be installed anywhere in the passenger compartment where the space allows. When choosing the location to mount the OBU remember to leave ample room for the antennas and wiring. Locate the OBU in a location to avoid damage to the WIFI and Bluetooth antennas.
2. Attach the mounting brackets (part No. 4) to the back of the OBU using the mounting bracket screws (part no. 6).
3. Attach the Bluetooth (part no. 9) and WIFI (part no. 10) antennas to the OBU by screwing the antennas to the appropriate ports.
4. Insert the anti-vibration grommets (part no. 5) into the mounting brackets.
5. Mount OBU using the mounting bracket bolts or option metal screws (part no. 7 or 8).

Step 2: OBU Installation (12 volt wiring) **-** Figure 4-3
1. Using Diagram 2 connect wires based on the constant 12 volts, switched 12 volt and ground.
2. Use 15-amp fuses on the positive charged wires to ensure surge protection to the OBU.
3. Connect the 12-volt adaptor plug to the OBU to power the unit.

Step 3: Antenna Installation **-** Figure 4-4 and Figure 4-5
1. Locate the Integrated GPS/DSRC antenna (part no. 11) on the roof of the vehicle based on Diagram 3.1.
2. Run the wires from the Integrated GPS/DSRC antenna to the OBU through a window or door.
3. Connect the antenna wires to the OBU based on Figure 4-5. Please note the wires labeled F,M,R,L are connected to the ports consistent with Figure 4-5.

Step 4: Vehicle CAN Installation (optional) **-** Figure 4-6
1. Run the OBD2 16 Pin to DB9 Serial port adaptor cable from the OBU to the vehicles OBD2 port.
2. Secure the wires to avoid damage or accidental disconnects.
3. Plug in the OBD2 to the vehicles ODB2 port
4. Plug in the DB9 Serial port into the CAN1 port on the OBU.

Step 5: Vehicle HMI Installation - Figure 4-7
1. Mount the HMI to the dash of the vehicle using an approved vehicle tablet dash mount (example mount shown in Figure 4-7).
2. Attach the tablet to the vehicle mount.
3. Use the USB cable to power the tablet.
4. Power the tablet on and connect to the OBU via Bluetooth or WiFi.
5. Launch the Lear HMI App.

4.1.2.5.3 Post-Installation Procedures/Checklist

In order to verify that the installation succeeded and that the device installed is working properly the following steps should be followed immediately after installation in the vehicle is completed.

1. No power to the device should be verified based on no led lights light up after the vehicle has been turned off and key removed from the ignition for 1 minute. The device should be able to have some residual power to the unit in order to properly shut down immediately after the vehicle has been turned off.
2. Power to the device should be verified from the LED lights on the OBU device indicating power when the vehicle is turned on.
3. With the vehicle powered on a portable RSU unit should be setup and a set of test scripts run to verify that the OBU unit is properly sending BSMs and receiving TIMs.
4. With the vehicle powered on a portable OBU unit should be setup and a set of test scripts run to verify that the newly installed OBU unit is properly receiving BSMs.
5. Verify that TIMs are displayed on the HMI.
6. Record the OBU installation in the inventory spreadsheet. Items documented in the spreadsheet include OBU firmware version, OBU Serial Number, OBU make/model, and OBU location.

4.1.2.6 Quality Assurance/Quality Control Process

In order to verify the OBUs received from Lear are functioning properly and that the device has been installed correctly all pre-installation and post installation steps need to be followed. Pre-installation steps verify the unit integrity and allow WYDOT to verify that the configuration is setup correctly for each OBU. Post-installation steps verify that the unit is installed and functioning correctly within the WYDOT environment.

4.1.2.7 Installation Schedule

Table 4-5 details the delivery and installation schedule for the Lear Locomate Roadstar Premium OBU.

Table 4-5. Lear Locomate Roadstar Premium Installation Schedule

Vehicles	Quantity	Schedule
Initial OBU Delivery	10	December 2016
Test Vehicles (Trihydro) Installation	7	April 2017
WYDOT Snow Plow and Trihydro OBU Delivery	76	October 2017
WYDOT Snow Plow and Trihydro Installation	76	October 2017
Remaining OBU Delivery	261	April 2018
Remaining OBU Installation	261	May 2018

4.1.2.8 HW and SW Configuration Control Process

All hardware configuration will be managed through the installation procedures and instructions detailed above. Software configurations will be managed through a combination of the Lear HMI app (HMI) and through Over the Air updates managed by Lear. Over the Air updates will only be authorized after it has been tested in a benchtop, controlled track, and on road environment. After this

testing has passed and WYDOT has approved the update a time will be scheduled to make the Over the Air update available to OBUs so that vehicles are not impacted during times where road conditions may be hazardous. As OBUs are configured the configuration will be recorded within the inventory management spreadsheet in order to verify that the OBU has been configured prior to releasing the OBU for installation.

4.1.2.9 Sparing Strategy, Warranty and Contingency Plan

The Wyoming CV Pilot will carry 3 spare units for use in lab testing and as potential quick replacements for field units. These Units will also carry a full warranty for all hardware and software on the units for the life of the pilot project. The contingency plan for spares is to send defective units back to the Vendor for replacement units to quickly swap out OBU units.

4.2 Sirius OBU Kit

4.2.1 Acquisition Information

The following sections describe the acquisition information related to the Sirius XM OBU.

4.2.1.1 Technical Description/Specification

These OBUs are intended for trucks and other fleet vehicles that do not include integration with CAN bus data integration. This Sub-System intends to test the interaction between the systems within the WYDOT CV Pilot and external/commercial devices that are not developed as part of this pilot. In this manner, this Sub-System is intended to "simulate" a commercial-off-the-shelf (COTS) system that enables a vehicle to communicate data through DSRC to other connected devices and receive TIMs through DSRC and satellite. These devices will also receive BSM Parts I and II over DSRC. About 25 vehicles are expected in this category. This OBU sub-system has the ability to:

- Receive TIMs via DSRC and Satellite.
- Receive BSM Parts I and II.
- Broadcast BSM Parts I and II.

Further information on the design and requirements associated with this OBU can be found in section 3.2.1 of the Wyoming System Design Document (SDD).

4.2.1.2 Ancillary Equipment

This OBU will be purchased as part of a kit from Sirius XM. No additional components will be needed outside of the kit for a full vehicle installation.

4.2.1.3 Part Numbers and Quantities

Table 4-1 shows the parts and quantities being acquired for the Wyoming CV Pilot Project.

Table 4-6. Sirius XM OBU Parts

Description	Part Number or Name	Quantity
OBU kit	Sirius XM OBU	28

4.2.1.4   Associated Software

All software associated with this equipment is preloaded onto the unit and is licensed with Sirius.

4.2.1.5   Acquisition Schedule

These devices will be purchased between July 2017 and September 2017 with delivery occurring within days of the purchase.

4.2.2 Installation Information

The sections below detail the installation plan and information for the Sirius XM OBU. Please note that Sirius has provided a draft copy of their installation instructions that is attached to this document. Many of the sections below will reference the installation guide in the appendix.

4.2.2.1   Supplier(s)

Table 4-2 lists the suppliers for the vehicle OBU.

Table 4-7. Sirius XM OBU Suppliers

Description	Part Number or Name	Supplier
OBU kit	Sirius XM OBU	Sirius

4.2.2.2   Inventory Control Method

All OBU's will be inventoried in a spreadsheet upon arrival. Equipment Managers will enter in all received equipment serial numbers to the Spreadsheet which will be stored in a OneDrive folder with version tracking enabled. As equipment is distributed for installation and testing the spreadsheet is updated to reflect the current status as well as the responsible party for checking out the equipment.

4.2.2.3   Configuration(s)

Please see the Sirius installation guide for this information.

4.2.2.4   Installation Diagram(s)

Please see the Sirius installation guide for this information.

4.2.2.5   Installation Procedures

The following sections provide details on the installations procedures for the Sirius XM OBU.

4.2.2.5.1   Pre-Installation Procedures/Checklist

Pre-installation procedures will require the installer to verify the contents of the OBU package. If the package is not complete, the vendor will be contacted for the missing components. Contact information for the vendor will be provided in the final installation guide.

4.2.2.5.2   Installation Procedures

Please see the Sirius installation guide for this information.

4.2.2.5.3   Post-Installation Procedures/Checklist

In order to verify that the installation succeeded and that the device installed is working properly the following steps should be followed immediately after installation in the vehicle is completed.

1. No power to the device should be verified based on no BSMs being sent from the vehicle and no power being drawn from the device (using a voltmeter) when the vehicle is powered off.
2. With the vehicle powered on a portable OBU unit should be setup and a set of test scripts run to verify that the OBU unit is properly sending and receiving BSMs.

Additionally, the Sirius installation guide also details post-installation procedures that will need to be followed in order to verify that the installation has been completed successfully.

4.2.2.6   Quality Assurance/Quality Control Process

In order to verify the Sirius XM OBUs are functioning properly and that the device has been installed correctly all pre-installation and post installation steps need to be followed. Pre-installation steps verify the unit integrity and allow WYDOT to verify that the configuration is setup correctly for each OBU. Post-installation steps verify that the unit is installed and functioning correctly within the WYDOT environment.

4.2.2.7   Installation Schedule

Table 4-5 details the delivery and installation schedule for the Sirius XM OBU.

Table 4-8. Sirius XM OBU Installation Schedule

Vehicles	Quantity	Schedule
Initial OBU Delivery	10	December 2016
Test Vehicles (Trihydro) Installation	7	April 2017
WYDOT Snow Plow and Trihydro OBU Delivery	76	October 2017
WYDOT Snow Plow and Trihydro Installation	76	October 2017
Remaining OBU Delivery	261	April 2018
Remaining OBU Installation	261	May 2018

4.2.2.8   HW and SW Configuration Control Process

All Hardware configuration will be managed through the installation procedures and instructions detailed above. Software configurations will be managed through a Sirius XM user interface, details of which will need to be hashed out with Sirius XM at a later date.

4.2.2.9   Sparing Strategy, Warranty and Contingency Plan

The Wyoming CV Pilot will carry 3 spare units for use in lab testing and as potential quick replacements for field units. These Units will also carry a full warranty for all hardware and software on the units for the life of the pilot project. The contingency plan for spares is to send defective units back to the Vendor for replacement units to quickly swap out OBU units.

4.3 Weather Cloud Weather Sensors

4.3.1 Acquisition Information

The following sections describe the acquisition information related to the Weather Cloud weather sensors.

4.3.1.1 Technical Description/Specification

The Weather Cloud Environmental Sensors will collect and transmit data to the Android Tablet using the Weather Cloud GroundTruth application. The GroundTruth app is designed to be the gateway between the sensors and the HMI device. The GroundTruth app connects to the sensors using Bluetooth Low Energy (BLE) and writes the sensor data to a local file on the HMI.

4.3.1.2 Ancillary Equipment

The Weather Cloud Weather Sensors will be purchased as part of a kit. No additional components will be needed outside of the kit for a full vehicle installation.

4.3.1.3 Part Numbers and Quantities

Table 4-9 shows the parts and quantities being acquired for the Wyoming CV Pilot Project.

Table 4-9. Weather Cloud Weather Sensor Parts

Description	Part Number or Name	Quantity
Sky Environmental Sensor	Weather Cloud Sky Sensor	53[1]
Road Environmental Sensor	Weather Cloud Road Sensor	53[2]

4.3.1.4 Associated Software

All software associated with this equipment is preloaded onto the unit and is licensed with Weather Cloud. All software updates associated with the weather sensors are managed through App updates controlled by Weather Cloud.

4.3.1.5 Acquisition Method

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[1] Count includes 3 spare units for use in lab testing and as potential quick replacements for field units.
[2] Count includes 3 spare units for use in lab testing and as potential quick replacements for field units.

This equipment will be ordered by the Wyoming Acquisition team via a sole source purchase order. Vendor evaluations considered the technical maturity of the vendors' existing offerings, the vendors' willingness to update their software and hardware to the industry standards adopted by the Pilot. Our research and vendor interviews have led us to a single vendor for the Environmental Sensors.

4.3.1.6   Potential Vendors

Weather Cloud has been chosen as the vendor for this hardware. Further information on the selection process can be found in the Comprehensive Acquisition Plan.

4.3.1.7   Acquisition Schedule

These devices will be purchased between December 2016 and April 2018 with delivery occurring within days of the purchase.

4.3.2 Installation Information

The sections below detail the installation plan and information for the Weather Sensors.

4.3.2.1   Supplier(s)

Table 4-10 lists the suppliers for the vehicle weather sensors.

Table 4-10. Weather Sensor Suppliers

Description	Part Number or Name	Supplier
Sky Environmental Sensor	Weather Cloud Sky Sensor	Weather Cloud
Road Environmental Sensor	Weather Cloud Road Sensor	Weather Cloud

4.3.2.2   Inventory Control Method

All Weather Sensors will be inventoried in a spreadsheet upon arrival. Equipment Managers will enter in all received equipment serial numbers to the Spreadsheet which will be stored in a OneDrive folder with version tracking enabled. As equipment is distributed for installation and testing the spreadsheet is updated to reflect the current status as well as the responsible party for checking out the equipment.

4.3.2.3   Configuration(s)

No configurations will be required for the weather sensors. They will be put on vehicles as is received from the vendor.

4.3.2.4   Installation Diagram(s)

The diagrams below show the installation and description of the Weather Cloud Weather Sensors.

Required Tools and Parts

1. Roadpack
2. Power harness for Roadpack
3. ATM/ATO Fuse tap (Power harness positive connector)
4. Roadpack fuse
5. Ground return clamp (Power harness negative connector)
6. Zip ties
7. ~~Smart Hub (phone)~~
8. ~~USB to USB micro cable (Smart Hub power)~~

9. Skypack
10. OBD to USB mini cable (Skypack power cord)
11. USB to USB mini cable (alternate Skypack power cord)
12. Double USB car adapter
13. Flathead screwdriver
14. Nippers
15. Wrench
16. Socket wrench

Figure 4-8. Weather Cloud Required Tool and Parts List (Source: Weather Cloud)
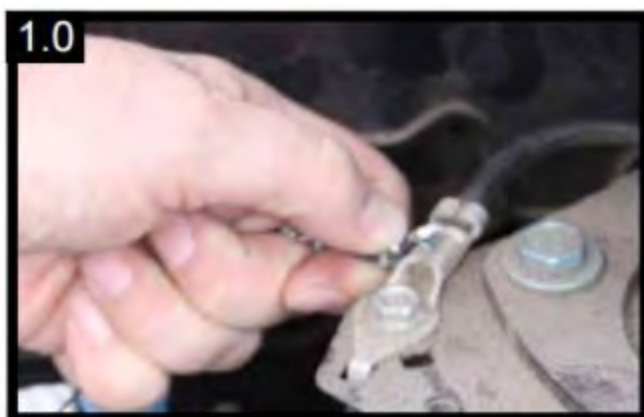

Figure 4-9. Attaching Ground Return Clamp to Vehicle (Source: Weather Cloud)

Figure 4-10. Attaching Fuse Tap to Power Harness (Source: Weather Cloud)

Figure 4-11. Attaching Fuse Tap to Power Harness (Source: Weather Cloud)

Figure 4-12. Attaching Fuse Tap to Power Harness (Source: Weather Cloud)

Figure 4-13. Replace Fuse Box Lid (Source: Weather Cloud)

Figure 4-14. Feed Power Harness through license plate. (Source: Weather Cloud)

Figure 4-15. Feed Power Harness through License Plate (Source: Weather Cloud)

Figure 4-16. Connect Roadpack to Power Harness (Source: Weather Cloud)

Figure 4-17. Attach Roadpack to License Plate Mounting Frame (Source: Weather Cloud)

Figure 4-18. Attach Roadpack to License Plate Mounting Frame (Source: Weather Cloud)
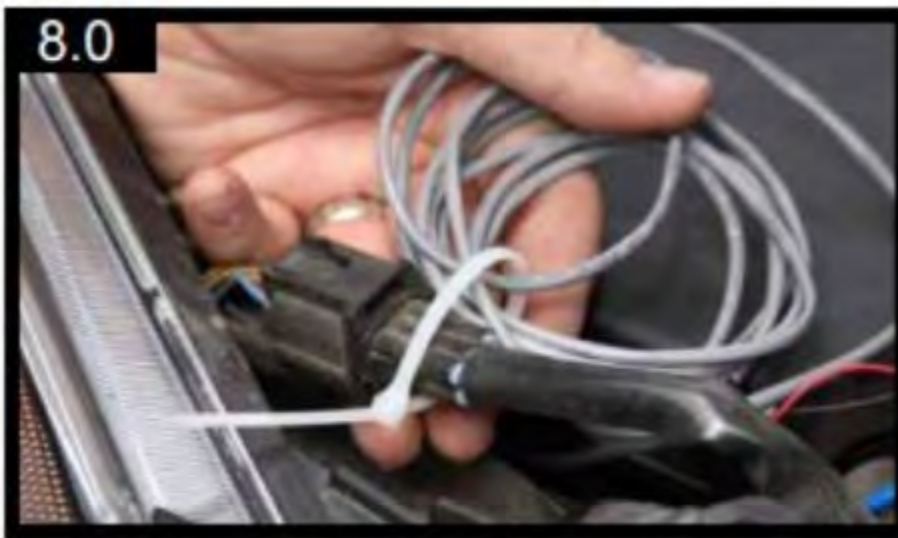
Figure 4-19. Coil and Tie Power Harness Slack (Source: Weather Cloud)

Figure 4-20. Attach Ground Return Clamp to Car (Source: Weather Cloud)

Figure 4-21. Plug in Skypack to Barrel Plug (Source: Weather Cloud)

Figure 4-22. Connect power cord to Skypack (Source: Weather Cloud)

Figure 4-23. Place Skypack on interior of windshield (Source: Weather Cloud)

Figure 4-24. Place Skypack on interior of windshield (Source: Weather Cloud)
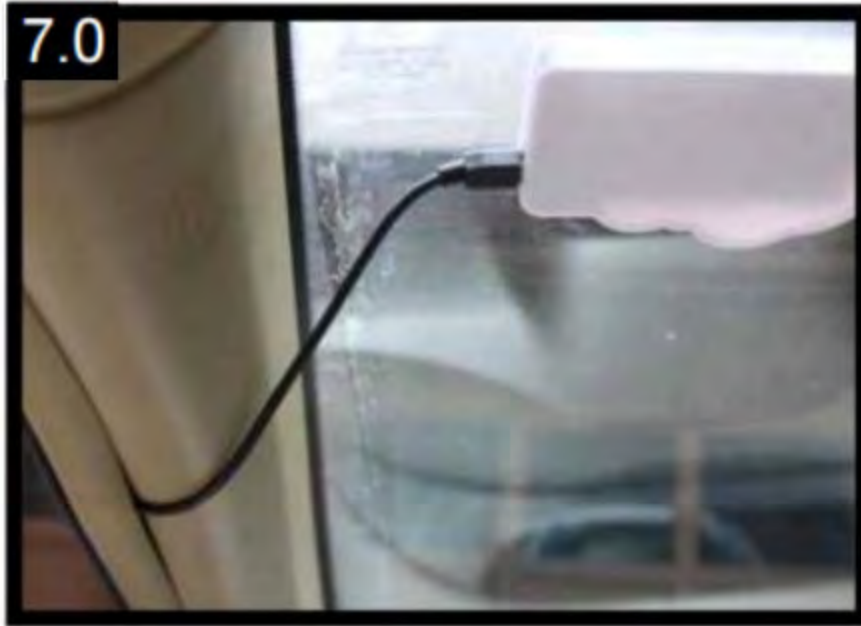
Figure 4-25. Tuck away power cord (Source: Weather Cloud)

4.3.2.5   Installation Procedures

The following sections provide details on the installation process for the Weather Cloud Weather Sensors.

4.3.2.5.1   Pre-Installation Procedures/Checklist
Pre-installation procedures will require the installer to verify the contents of the Weather Sensor package. Figure 4-8. Weather Cloud Required Tool and Parts Listshould be used to verify the equipment was delivered properly and that all necessary installation tools are available. If the package is not complete, the vendor will be contacted for the missing components.

Additionally, all equipment in the check list should be inspected for visual defects or visible signs of damage. All damage will be reported back to the Vendor and replacement equipment or fixes to the existing equipment will be requested.

4.3.2.5.2   Installation Procedures
Roadpack Installation
Read through all instructions before beginning installation process.
1. Attach ground return clamp to car (Figure 4-9) - Slide the bare end of the black, negative wire of Roadpack power harness into the grounding clamp. Tighten the screw with a flathead screw driver so that the bare wires are held tightly in place. Attach to grounding metal. Alternatively, a spade terminal connector can be crimped onto the end of the grounding wire, and attached to any grounding point on the vehicle.
2. Attach fuse tap to power harness (Figure 4-10) - Attach the fuse tap to the red, positive wire of power harness. Slide the bare wires of the red wire into the blue connector at the end of the fuse tap.
   a. Pinch the blue connector tightly around the bare wires with a set of plyers. Plug the entire fuse tap into an empty slot that is connected to key power in the fuse box. (Figure 4-11)

b.   Locate and remove the horn fuse (or any other safe fuse to remove that is connected to key power). (Figure 4-12)
c.   Place the fuse you just removed into the second slot of the fuse tap. (Figure 4-12)
d.   Plug the fuse tap in where the horn fuse was originally

3.   Replace fuse box lid: Make sure the wires don't get pinched or pulled loose when closing the lid. (Figure 4-13)
4.   Feed power harness through license plate.
a.   Feed the grey wire (black, plastic connector first), down through the hood near the radiator. (Figure 4-14)
b.   Pull the cord out through the grill or from beneath the car, where it can easily reach the license plate. (Figure 4-15)
5.   Connect Roadpack to power harness (Figure 4-16)
a.   Near the front bumper, connect the male connector from the Roadpack to the female connector of the power harness.
6.   Test Roadpack: If the Roadpack is powered correctly, you should see flashing lights coming out the front of plastic when vehicle power is on.
a.   Power on the provided Smart Hub. The WeatherCloud app will start automatically.
b.   Hold the Smart Hub close to the sensor pack for a quicker connection while testing.
c.   On home main screen of app Roadpack icon should turn green for a good connection.
7.   Attach Roadpack to license plate mounting frame.
a.   Remove the top two screws that hold the license plate in place. Use the provided, longer screws to attach the Roadpack. (Figure 4-17)
b.   When attached correctly the road temperature barrel will be facing toward the ground. (Figure 4-18)
8.   Coil and tie power harness slack
a.   Neatly coil the power harness slack and attach it to a secure and out of-the-way location under the hood with zip ties. (Figure 4-19)

Skypack Installation:
There are usually one or two fuse boxes located in the vehicles cab. They are either located on the passenger side panel under the glove box or the driver side under the steering wheel. Some larger vehicles will have both fuse boxes. Locate the preferred fuse box and start to think where to place the Skypack on the windshield for easy wire hiding. After that is decided, follow instructions for proper wiring.

1.   Attach ground return clamp to car (Figure 4-20)
a.   Slide the bare end of the black, negative wire of the barrel socket (wire without writing on it and without side ribs) into the grounding clamp. Tighten the screw with a flathead screw driver so that the bare wires are held tightly in place. Attach to grounding metal. Alternatively, a spade terminal connector can be crimped onto the end of the grounding wire, and attached to any grounding point on the vehicle
2.   Attach fuse tap to barrel socket
a.   Attach the fuse tap to the positive wire. Slide the bare wires into the blue connector at the end of the fuse tap.
b.   Pinch the blue connector tightly around the bare wires with a set of plyers. Plug the entire fuse tap into an empty slot that is connected to key power in the fuse box.
c.   Locate and remove the horn fuse (or any other safe fuse to remove that is connected to key power).
d.   Place the fuse you just removed into the second slot of the fuse tap.
e.   Plug the fuse tap in where the horn fuse was originally
3.   Replace fuse box lid
a.   Make sure the wires don't get pinched or pulled loose when closing the lid.

4. Plug in Skypack to barrel plug (Figure 4-21)
    a. Plug dual USB charger into barrel socket. Confirm red light comes on charger.
    b. Plug 10ft USB Skypack cable into dual USB charger.
    c. Use electrical tape or zip ties to secure barrel socket, dual USB charger and cord together so they do not become unplugged due to vibration.
5. Connect power cord to Skypack (Figure 4-22)
    a. Plug the 10ft USB cable into Skypack.
6. Place Skypack on interior of Windshield (Figure 4-23 & Figure 4-24)
    a. Remove the red tape from the adhesive on the back of the Skypack. Adhere the Skypack, clouds facing down, in a place on the inside of the windshield where the wipers will pass over it fully when in motion. Make sure the Skypack does not obstruct the driver's vision.
    b. Example: Lower left corner.
    c. Example: Upper right corner. Note: The Skypack adhesive will allow the device to be removed and replaced several times if reposition is necessary or windshield has become damaged and needs to be replaced.
7. Tuck away power cord (Figure 4-25)
    a. Tuck the cord away to ensure it will not interfere with driving operations or pull loose by accident. Suggestion: Use a seam in the dashboard, weather stripping along the door frame or the underside of the dash to hide the cord completely.
8. Test Skypack
    a. Skypack will connect automatically to WeatherCloud app on Smart Hub. Connection Status will turn green.
9. Enjoy Real-Time Data!
    a. Swipe to the WeatherCloud data display screen to view real-time data generated by the Skypack and Roadpack sensors.

4.3.2.5.3 Post-Installation Procedures/Checklist

In order to verify that the installation succeeded and that the device installed is working properly the following steps should be followed immediately after installation in the vehicle is completed.

1. No power to the device should be verified based on no lights being powered on and no power being drawn from the device (using a voltmeter) when the vehicle is powered off.
2. With the vehicle powered on the weather cloud app should display incoming weather sensor data from the weather sensors installed.
3. With a handheld weather meter verify the incoming weather sensor data is accurate. Verify the incoming sky data is accurate by observing atmospheric conditions in relation to what the sensor data is outputting.

4.3.2.6   Quality Assurance/Quality Control Process

In order to verify the weather sensors are functioning properly and that the device has been installed correctly all pre-installation and post installation steps need to be followed. Pre-installation steps verify the unit integrity and allow WYDOT to verify that the configuration is setup correctly for each weather sensor. Post-installation steps verify that the unit is installed and functioning correctly within the WYDOT environment.

4.3.2.7   Installation Schedule

Table 4-5 details the delivery and installation schedule for the Weather Cloud Weather sensors.

Table 4-11. Lear Locomate Roadstar Premium Installation Schedule

Vehicles	Quantity	Schedule
Senso Delivery	53	November 2017
Installation	50	December 2017 - January 2018

4.3.2.8   HW and SW Configuration Control Process

All Hardware configuration will be managed through the installation procedures and instructions detailed above. Software configurations will be managed through a combination of the Lear HMI app (HMI) and the Weather Cloud Weather sensor app. All software configuration for the Weather Cloud application will follow the steps laid out in section 3-4.

4.3.2.9   Sparing Strategy, Warranty and Contingency Plan

The Wyoming CV Pilot will carry 3 spare units for use in lab testing and as potential quick replacements for field units. These Units will also carry a full warranty for all hardware and software on the units for the life of the pilot project. The contingency plan for spares is to send defective units back to the Vendor for replacement units to quickly swap out weather sensors.

5 Roadside Equipment

The following sections describe the Road Side Unit (RSU) acquisition and installation plans for the Wyoming CV Pilot Project.

5.1 Lear LocoMate Roadstar RSU Acquisition Information

The following sections detail acquisition information related to the Lear LocoMate Roadstar RSU equipment.

5.1.1 Technical Description/Specification

This Sub-System describes the physical units for deployment as part of the system along I-80. Road Side Units (RSUs) include DSRC connectivity, application support, data storage, and other support services to enable CV applications, such as necessary certificates. WYDOT RSUs can be either fixed or portable equipment depending on the use. In general, RSUs serve as a two-way communication portal between connected vehicles that provide information through DSRC and the ODE. About 75 RSUs are planned to be deployed in the pilot.

5.1.2 Ancillary Equipment

The RSU will have the following equipment ordered as a single kit

- Dual DSRC radios
- GPS
- Bluetooth
- CPU
- Wi-Fi
- Sirius XM
- Power Adapter
- GPS Antenna
- Sirius XM Antenna
- Dual DSRC Antennas

These devices will be installed along I-80 as well as well as rest stops and WYDOT fueling areas. Locations have been selected based on availability for power, high speed back haul, and a mount at least 8 meters high. If an RSU is mounted higher than 8 meters, the EIRP must be adjusted to maintain compliance with FCC regulations.[3]

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[3] https://www.law.cornell.edu/cfr/text/47/90.377

5.1.3 Part Numbers and Quantities

Table 5-1 details the number of equipment to be acquired for the RSU.

Table 5-1. Equipment for the RSU.

Description	Part Number or Name	Quantity
RSU kit	Locomate Roadstar Premium	78[4]

5.1.4 Associated Software

Lear RSU software (including all WYDOT RSU applications).

5.1.5 Acquisition Method

This equipment will be ordered by the Wyoming Acquisition team via a sole source purchase order. Our research and vendor interviews have led us to a single vendor for the RSUs.

5.1.6 Potential Vendors

For the RSU we engaged with Cohda, Lear, Savari, and Commsignia.

We used a systematic selection process, derived from the objectives and requirements for the WYDOT CV Pilot system.

5.1.7 Acquisition Schedule

The plan is to get a few RSU kits in for proof of concept testing of the interactions with other devices in the ecosystem (OBUs, satellite messages, probe data, SNMP, etc.). Once these devices are validated, the team will purchase the remainder of the devices for the pilot based on the schedule presented in Table 5-2.

Table 5-2. Acquisition schedule for RSU (Arrival Dates).

Description	Date	Quantity
RSU kit	December 2016	10
RSU kit	September 2017	68

5.2 Lear LocoMate Roadstar RSU Installation Information

The sections below detail the installation plan and information for the Lear LocoMate Roadstar RSU.

5.2.1 Supplier(s)

Table 4-2 lists the suppliers for the RSU.

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[4] Count includes 3 spare units for use in lab testing and as potential quick replacements for field units.

Table 5-3. Locomate Roadstar Premium Suppliers

Description	Part Number or Name	Supplier
RSU kit	Locomate Roadstar Premium	Lear

5.2.2 Inventory Control Method

All RSU's will be inventoried in a spreadsheet upon arrival. Equipment Managers will enter in all received equipment serial numbers to the Spreadsheet which will be stored in a OneDrive folder with version tracking enabled. As equipment is distributed for installation and testing the spreadsheet is updated to reflect the current status as well as the responsible party for checking out the equipment.

5.2.3 Configuration(s)

Configurations for RSU devices will be done prior to installation. Table 5-4 details the configuration parameters that will be updated for each RSU prior to installation.

Table 5-4. Lear LocoMate Roadstar RSU Configuration Parameters

Equipment Type	RSU Configuration Setup
RSU	• Configure IPv6 for offloading to ODE Server • Reset default admin password • Setup TIM application for broadcasting

5.2.4 Installation Diagram(s)

The attached RSU Installation planning document that can be found in the appendix contains the bulk of the installation diagrams that are site specific installation planning for all of the RSUs along the I80 corridor. Additional and more generic installation diagrams are found below.
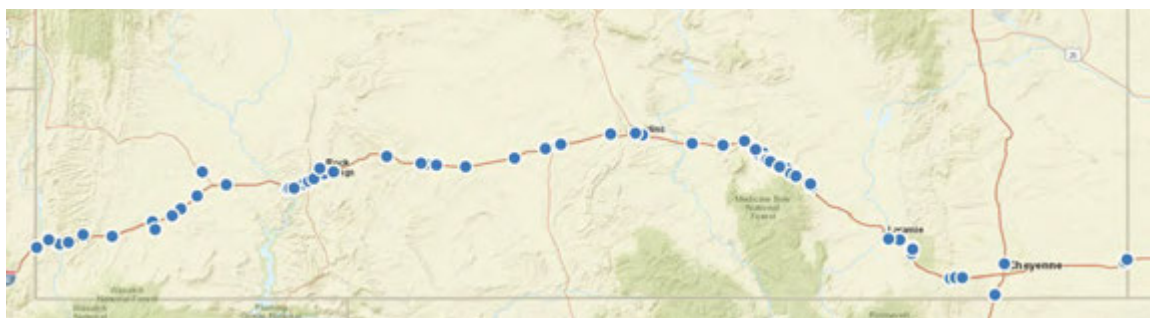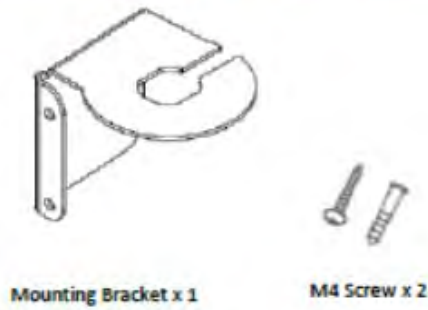

Figure 5-1. RSU Installation Locations.

Figure 5-2. Lear LocoMate Roadstar RSU Unit

Installing the XM + GNSS Combo Antenna

Mounting Bracket x 1   M4 Screw x 2

Install The Mounting Bracket Onto Enclosure
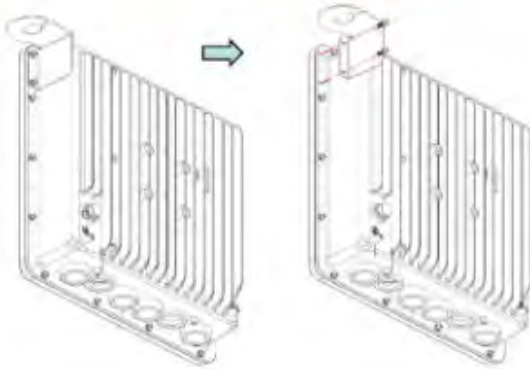
Attach the GPS mounting bracket to the left hand side
(Back view) and screwing it until tightened.

Assemble the GPS antenna with the mounting bracket.

Ensure the gasket is on top of the bracket and screw
the plastic nut until tighten.

Figure 5-3. XM Antenna Mounting Bracket Installation

Mounting Installation Package Content

Articulation Pole x 1   T-form Bracket x 1   W-Bar x 1

M8x80 Screw Bolts x 2   M8x90 Screw Bolts x 1   M6x16 Screw x 4   Nut x 1

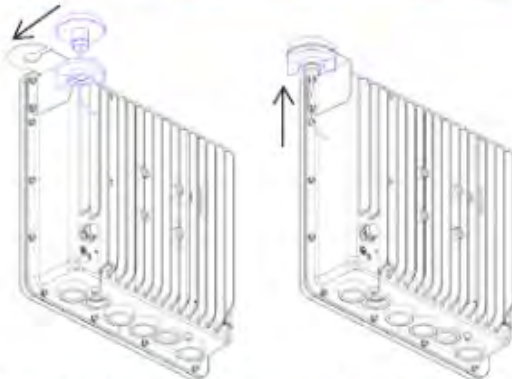Washer x 4   Spring Washer x 4   Wood Screw x 4 / Wood / Gyprock Plug x 4
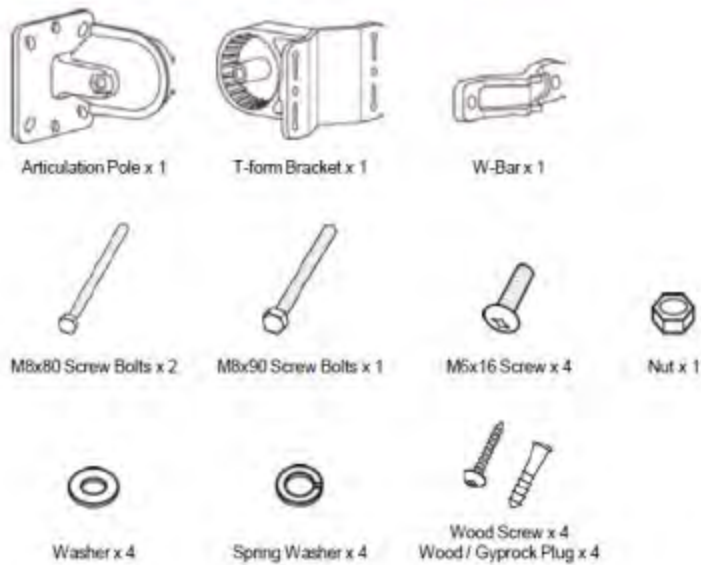
Figure 5-4. RSU Mounting Hardware (Included in Kit)

Install Enclosure On The Articulation Pole
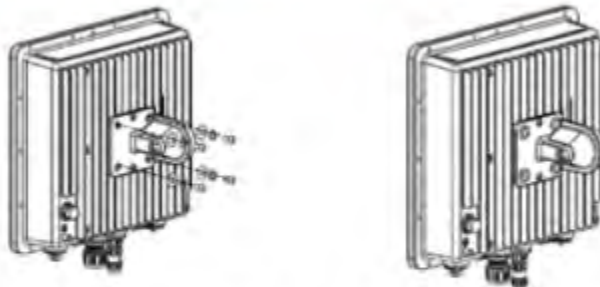
Attach the articulation pole to back of Unit using M6x16 screws & washers.

Figure 5-5. Articulation Pole Mount on RSU Unit

1. Mounting For Pole Less Than 1.5"(35mm)
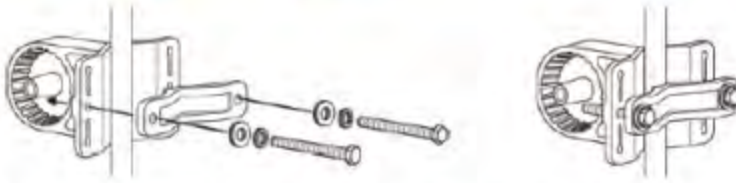
Attach mount base and W-bar to pole as shown using M8x80 bolts and washer.

2. Mounting For Pole Larger Than 1.5"(35mm) and Less Than 3" (80 mm)

Attach mount base and W-bar to pole as shown using M8x80 bolts and washer.
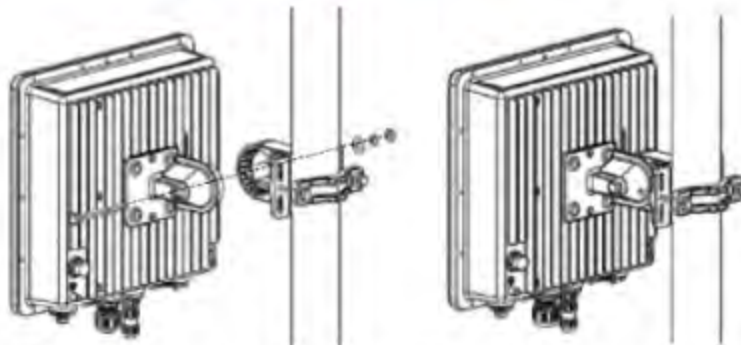
Figure 5-6. Pole Mounting

Install Enclosure On The Pole

Attach the articulation pole to the mount base articulation using M8x90 bolt, nut and washers.

Figure 5-7. RSU Mounting to Pole

5.2.5 Installation Procedures

The following sub-sections include all of the procedures/checklists that ensure the device is ready for installation, is completely installed and was installed correctly and is operating as intended.

5.2.5.1   Pre-Installation Procedures/Checklist

Pre-installation procedures will require the installer to verify the contents of the RSU package. The Table 5-5. Installation Equipment Checklist should be used to verify the equipment was delivered properly. If the package is not complete, the vendor will be contacted for the missing components.

Table 5-5. Installation Equipment Checklist

Item	Quantity
Locomate Roadstar RSU	1
12 Volt Adaptor PoE plug	1
DSRC Radio Antenna	4
WiFi Antenna	3
SiriusXM Antenna	1
Sirius XM Mounting Bracket	1
M4 Screw	2
Articulation Pole Mounting Bracket	1
T-form articulation pole Bracket	1
W-Bar	1
M8x80 Screw Bolts	2

M8x90 Screw Bolt	1
M6x16 Screw	4
Nut	1
Washer	4
Spring Washer	4
Wood Screw	4

All equipment in the check list should be inspected for visual defects or visible signs of damage. All damage will be reported back to the Vendor and replacement equipment or fixes to the existing equipment will be requested.
Additional pre-installation procedures are outlined in the RSU installation plan from WYDOT that can be found in the appendix.

5.2.5.2   Installation Procedures

Detailed installations procedures can be found in the attached WYDOT RSU installation plan found in appendix.

5.2.5.3   Post-Installation Procedures/Checklist

In order to verify that the installation succeeded and that the device installed is working properly the following steps should be followed immediately after installation in the vehicle is completed.

1. Power to the device should be verified based on the RSU LED light turned on.
2. Users should be able to log into the RSU via SSH from a secured connection.
3. Configuration for the RSU will then be setup to properly communicate with the ODE and with OBUs.
4. Drive-by's of the RSU will then be performed to verify that TIMs and BSMs are broadcasting correctly from the RSU and received log files/BSMs from an OBU are correctly forwarded to the ODE system.

5.2.6 Quality Assurance/Quality Control Process

In order to verify the RSUs received from Lear are functioning properly and that the device has been installed correctly all pre-installation and post installation steps need to be followed. Pre-installation steps verify the unit integrity and allow WYDOT to verify that the configuration is setup correctly for each RSU. Post-installation steps verify that the unit is installed and functioning correctly within the WYDOT environment. Additional QA/QC that will take place include continuous monitoring of installed and deployed RSUs for uptime. Any RSUs that have issues during deployment will be physically inspected for defects. If defects are found Lear will be contacted to help resolve the issues.

5.2.7 Installation Schedule

Table 4-5 details the delivery and installation schedule for the Lear LocoMate Roadstar RSU.

Table 5-6. Lear Locomate Roadstar Premium Installation Schedule

Vehicles	Quantity	Schedule
Initial RSU Delivery	10	December 2016

RSU Test Installations	2	April 2017
Remaining RSU Delivery	68	August 2017
Remaining RSU Installation	73	October 2017

5.2.8 HW and SW Configuration Control Process

All Hardware configuration will be managed through the installation procedures and instructions detailed above. Software configurations will be updated through firmware update scripts managed by WYDOT with input from Lear. Script updates will only be authorized after it has been tested in a benchtop, controlled track, and on road environment. After this testing has passed and WYDOT has approved the update a time will be scheduled to make the firmware/configuration update available to RSUs so that vehicles are not impacted during times where road conditions may be hazardous. As RSUs are configured the configuration will be recorded within the inventory management spreadsheet and in the WYDOT database in order to track RSU version and configuration information. All RSUs will be configured with the latest approved configuration script prior to installation.

5.2.9 Sparing Strategy, Warranty and Contingency Plan

The Wyoming CV Pilot will carry 3 spare units for use in lab testing and as potential quick replacements for field units. These Units will also carry a full warranty for all hardware and software on the units for the life of the pilot project. The contingency plan for spares is to send defective units back to the Vendor for replacement units to quickly swap out RSU units.

6 Mobile Devices

The WYDOT CV Pilot will not be purchasing any Mobile Devices.

7 Management Center Equipment

The following section describes the Management Center Equipment installation procedure for all CV related equipment. Please note that the Wyoming Pilot has recently found the need to acquire and install a Hardware Security Module (HSM) as part of the pilot project. Not enough information has been gathered yet on the HSM module that will be acquired or how the HSM will be installed within the TMC. Therefore, it has not been added to this Installation Plan document. A future version of this document will contain this information.

7.1 Servers

7.1.1 Server Acquisition Information

The following sections detail acquisition information related to the Server equipment.

7.1.1.1 Technical Description/Specification

The TMC will procure two servers to host the TMDD third party interface, ODE, Pikalert weather simulation and prediction software as well as management software for the RSU's. The Third Party Interface which publishes TMDD data, the Operational Data Environment and the Pikalert weather software are integral components of the WYDOT Pilot.

Both servers have redundant (RAID-1) boot devices, multi-path IO connections (iSCSI over 10GBase-T) to the Storage Array, redundant Ethernet connections for management and redundant 10GBase-T primary data links to both the public internet and to the existing WYDOT intranet.

Both servers will run Microsoft's Hyper-V 2016 Server edition and applications running on the servers will be hosted in Virtual Machines. All storage for Virtual Machines will be located on the Storage Array. Microsoft Failover Cluster Manager and Microsoft Cluster Shared Volumes will be used to enable live Virtual Machine migration between the servers and together with a regular backup plan will insure quick recovery for either a failed server or virtual machine.

Each server contains two Intel Xeon, 18 Core CPUs and 256 GB of DDR3 memory. The CPUs were selected based on price/performance per core up to the level where incremental price/performance began to diminish. The CPU and memory configurations were selected to maximize performance for virtual machine environments.

7.1.1.2 Ancillary Equipment

Each server is configured with:

- (2) Intel Xeon CPUs
- 256 GB of DDR memory
- (2) 120 GB Solid State Boot Drives

- Integrated RAID Controller, 2GB Cache
- (2) Intel 10GBASE-T, dual port Ethernet Adapters
- Broadcom 1GB, quad port, Ethernet Card
- iDRAC8 Enterprise, integrated Dell Remote Access Controller

Four years' hardware and software support

7.1.1.3   Part Numbers and Quantities

Table 7-1 details the number of equipment to be acquired for the servers.

Table 7-1. Equipment for the servers.

Description	Part Number or Name	Quantity
Dell PowerEdge R730 Server	210-ACXU	2
Intel Xeon 18 Core CPU	E5-2697 v4 2.3GHz	4
120 GB Solid State Drives, 6Gbps SATA	400-AEIB	4
32GB RDIMM, 2400MT/s, DDR	370-ACNS	16
PERC H730P Integrated RAID Controller	405-AAEH	2
Intel Ethernet X540 2-port Adapter	540-BBHZ	4
Broadcom 5720 4-port 1Gb Network	540-BBBW	2
iDRAC8 Enterprise Controller	385-BBHO	2

7.1.1.4   Associated Software

No additional software is purchased for these servers.

- The BIOS and firmware included with the servers is provided by Dell and covered under the product warranty.
- Both physical servers will run Microsoft Hyper-V Server 2016, which is a stand-alone product that contains only the Windows hypervisor, a Windows Server driver model, and virtualization components. This edition of Microsoft Server 2016 is available free of charge.

Open source Linux (Ubuntu & Debian) and existing licenses for Microsoft Windows Server will run on the virtual machines hosted by the servers.

7.1.1.5   Acquisition Method

This equipment will be ordered by the Wyoming Acquisition team via a sole source purchase order. Our research and vendor interviews have led to us to use a single vendor for the servers, storage and switch for the Management Center Equipment.

7.1.1.6   Potential Vendors

For the servers, we engaged with Dell and Hewlett Packard (HP).

We used a systematic selection process, derived from the objectives and requirements for the WYDOT CV Pilot system.

7.1.1.7 Acquisition Schedule

The servers will be acquired based on the schedule presented in Table 7-2.

Table 7-2. Acquisition schedule for servers.

Description	Date	Quantity
Dell R730 server	12/2016	2

7.1.2 Server Installation Information

The sections below detail the installation plan and information for the WYDOT TMC Servers.

7.1.2.1 Supplier(s)

Table 7-3 lists the suppliers for the Server.

Table 7-3. Server Suppliers

Description	Part Number or Name	Supplier
Server	Dell R730 Server	Dell

7.1.2.2 Inventory Control Method

All Servers will be inventoried in a spreadsheet upon arrival. Equipment Managers will enter in all received equipment serial numbers to the Spreadsheet which will be stored in a OneDrive folder with version tracking enabled. This equipment will all permanently reside in the TMC Server room.

7.1.2.3 Configuration(s)

The servers came with a default BIOS configuration which can be seen in the figures below.
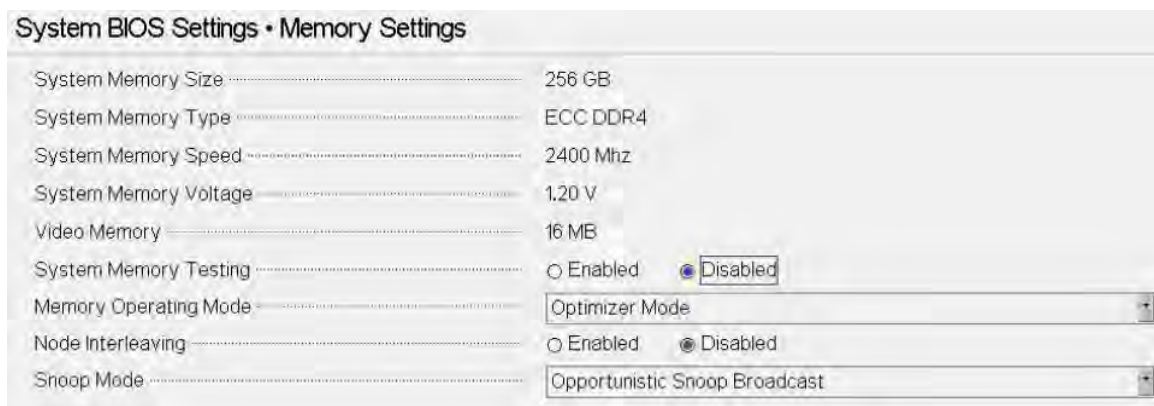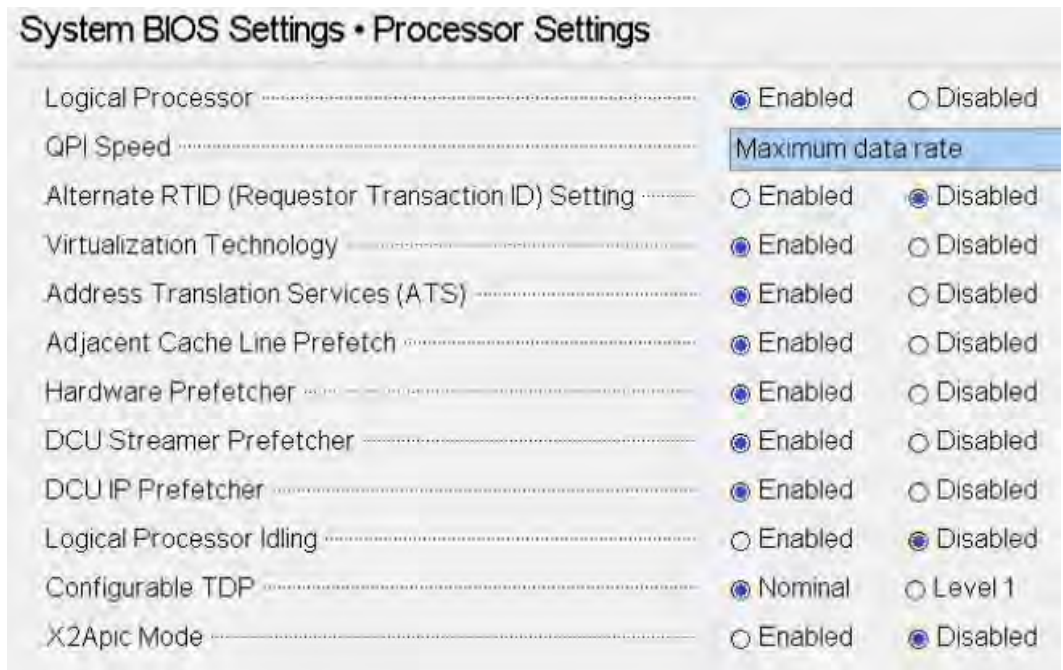

Figure 7-1. Default BIOS Memory Settings

Figure 7-2. Default BIOS Processor Settings
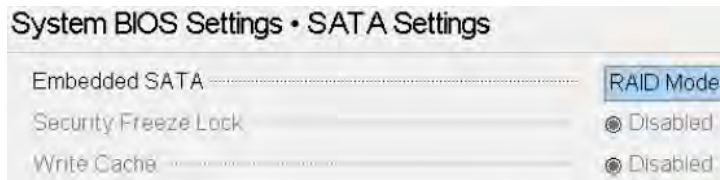
Figure 7-3. Default BIOS SATA Settings

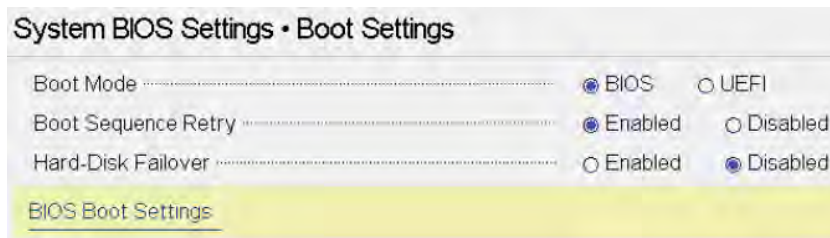**Figure 7-4. Default BIOS Boot Settings**

Figure 7-5. Default BIOS Integrated Devices Settings

Figure 7-6. Default BIOS Integrated Devices Settings Continued

Figure 7-7. Default BIOS Integrated Devices Settings Continued

System BIOS Settings • Serial Communication

Serial Communication	Auto
Serial Port Address	Serial Device1=COM2,Serial Device2=COM1
External Serial Connector	Serial Device 1
Failsafe Baud Rate	115200
Remote Terminal Type	⦿ VT100/VT220 ○ ANSI
Redirection After Boot	⦿ Enabled ○ Disabled

Figure 7-8. Default BIOS Serial Communication Settings

System BIOS Settings • System Profile Settings

CPU Power Management	⦿ Maximum Performance
Memory Frequency	⦿ Maximum Performance
Turbo Boost	⦿ Enabled
Energy Efficient Turbo	⦿ Disabled
C1E	⦿ Disabled
C States	⦿ Disabled
Write Data CRC	⦿ Disabled
Collaborative CPU Performance Control	⦿ Disabled
Memory Patrol Scrub	⦿ Standard
Memory Refresh Rate	⦿ 1x
Uncore Frequency	⦿ Maximum
Energy Efficient Policy	⦿ Performance
Number of Turbo Boost Enabled Cores for Processor 1	⦿ All
Number of Turbo Boost Enabled Cores for Processor 2	⦿ All
Monitor/Mwait	⦿ Enabled

Figure 7-9. Default BIOS System Profile Settings
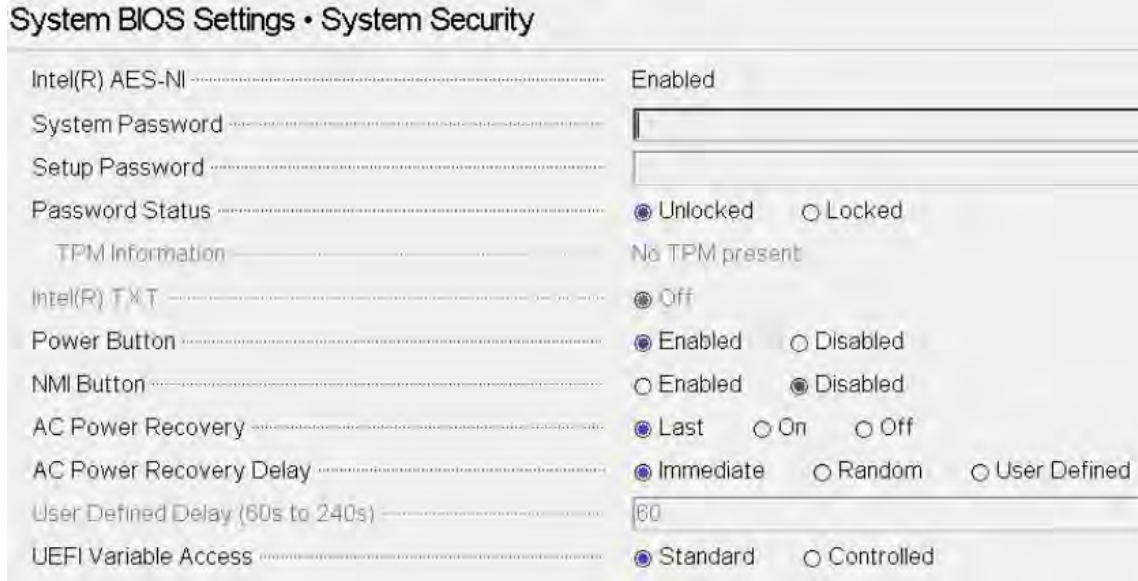
Figure 7-10. Default BIOS System Security Settings
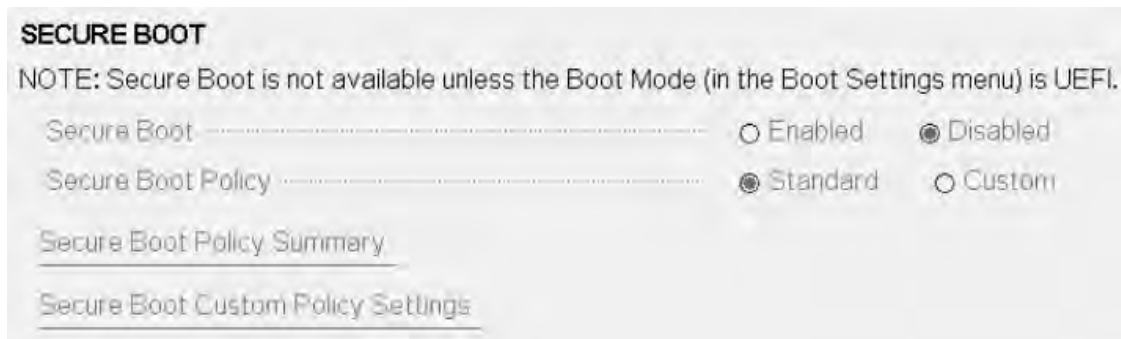
Figure 7-11. Default BIOS Secure Boot Settings
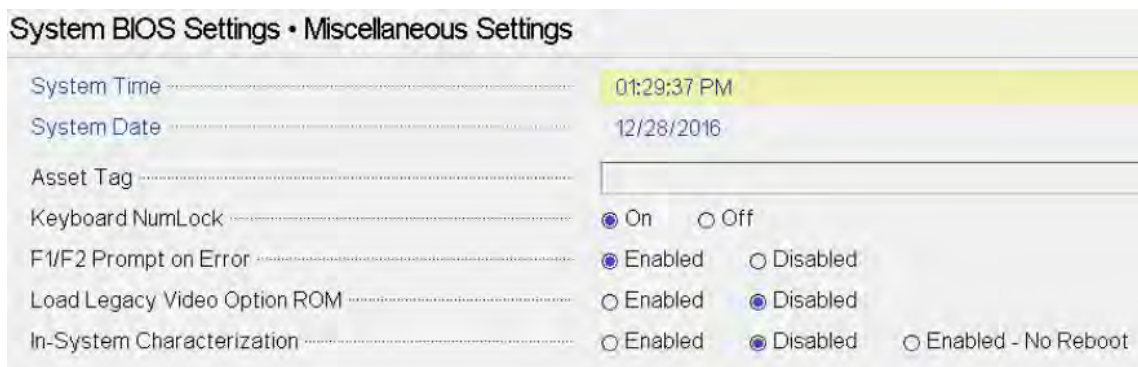
Figure 7-12. Default BIOS Miscellaneous Settings
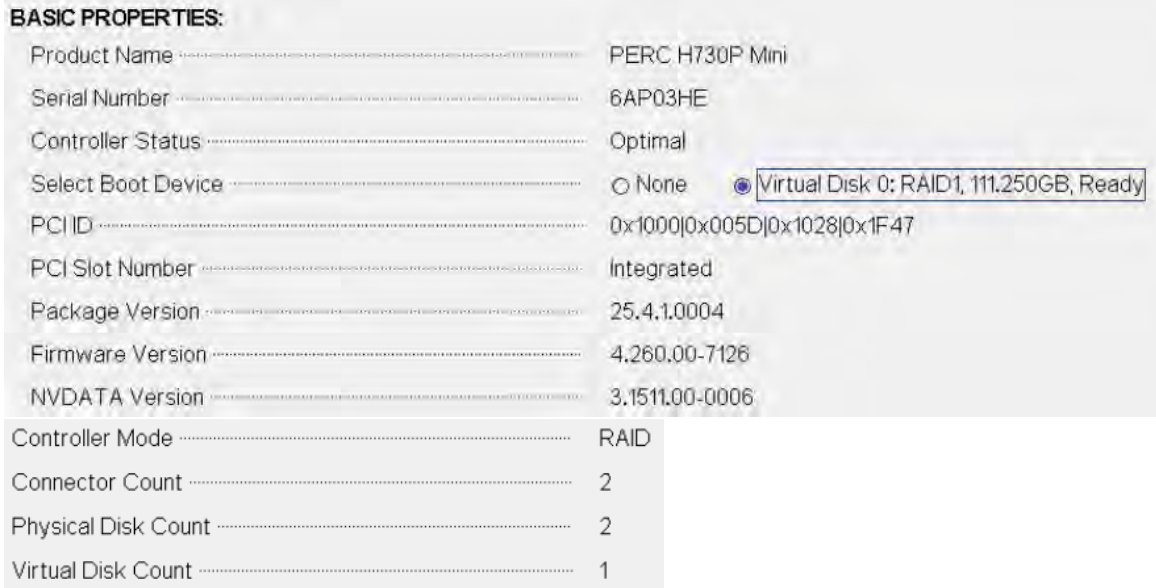
Figure 7-13. Local Boot Device Settings
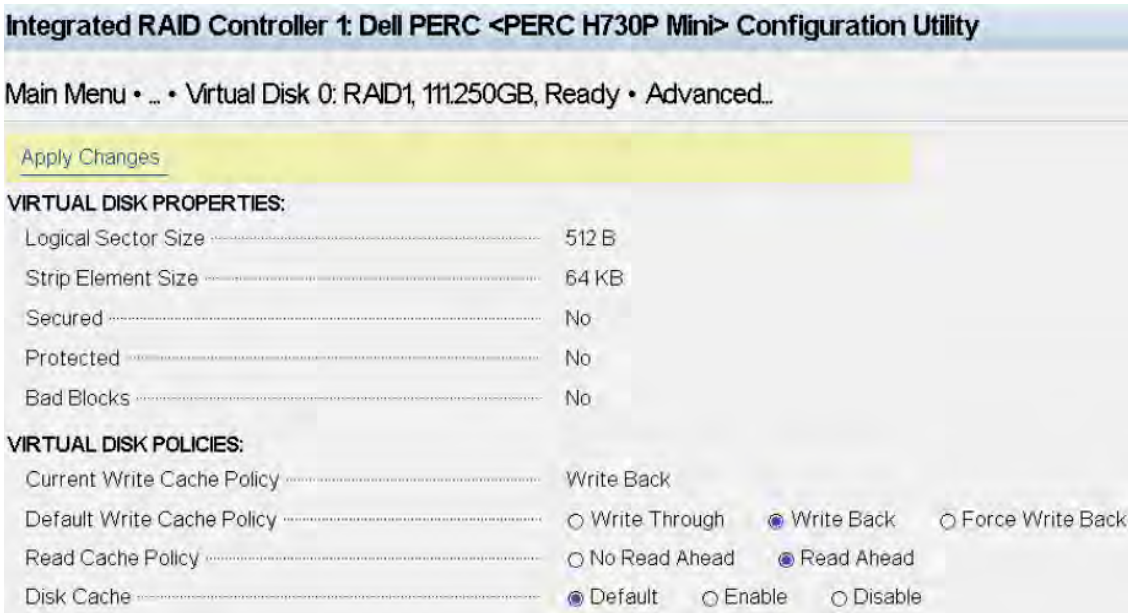
Figure 7-14. Local Boot Device Settings

Figure 7-15. Task Rates for RAID Controller Settings

Figure 7-16. NIC Configuration Settings

Figure 7-17. NIC Configuration Settings

Figure 7-18. NIC Configuration Settings
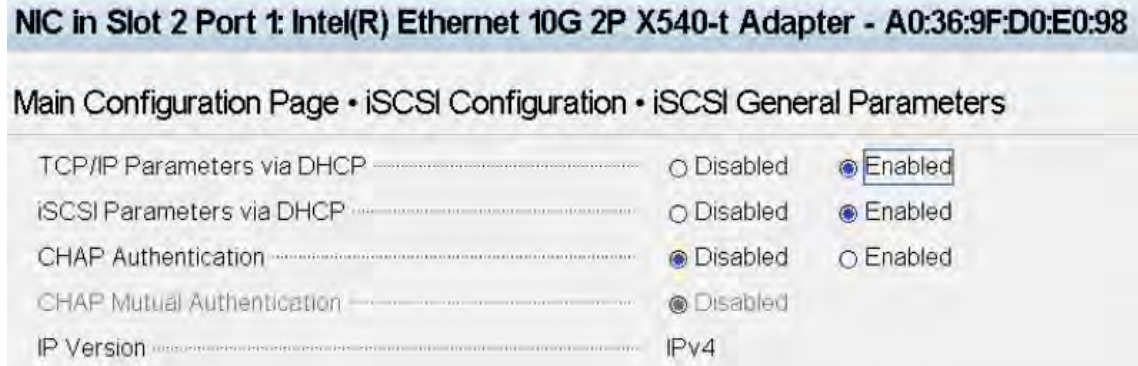
Figure 7-19. NIC Configuration Settings
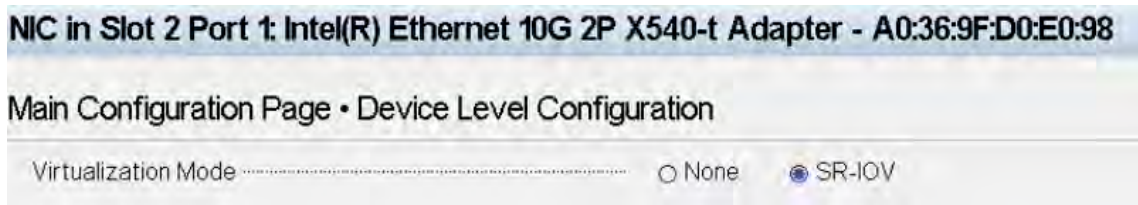
Figure 7-20. NIC Configuration Settings
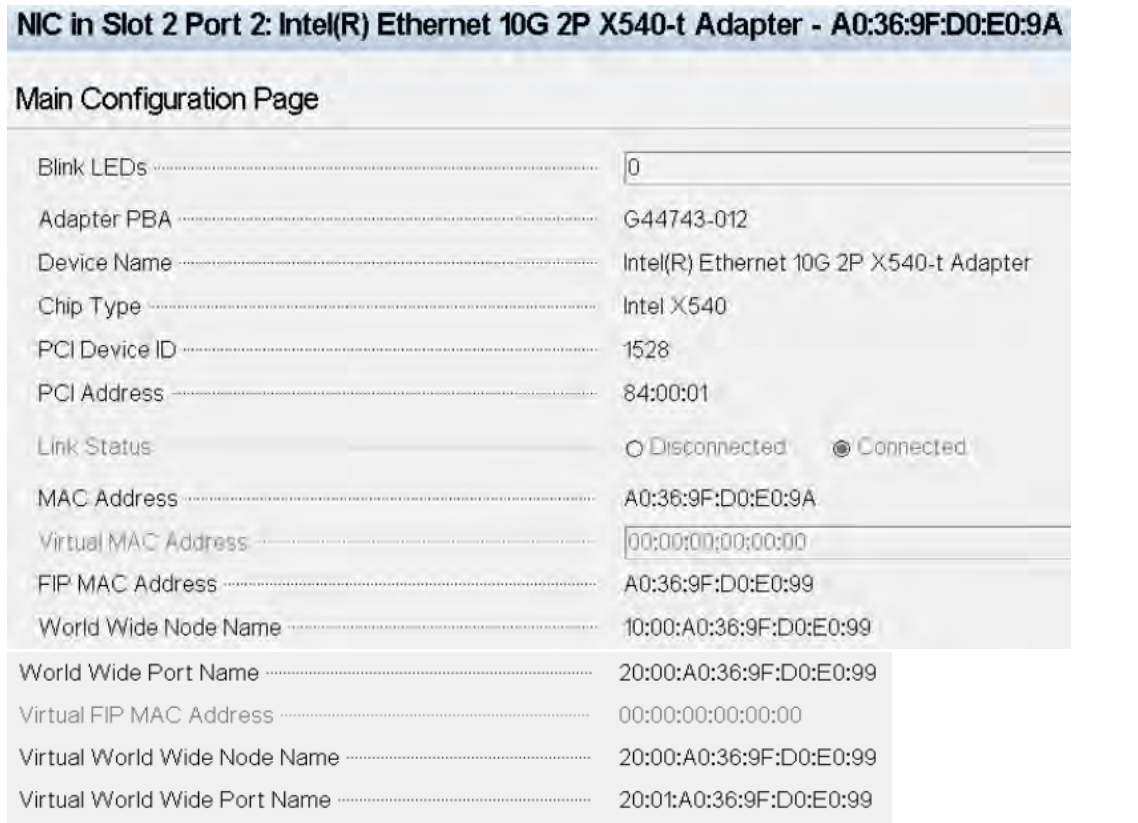
Figure 7-21. NIC Configuration Settings

7.1.2.4   Installation Diagram(s)

This section should provide the detailed installation diagram(s).
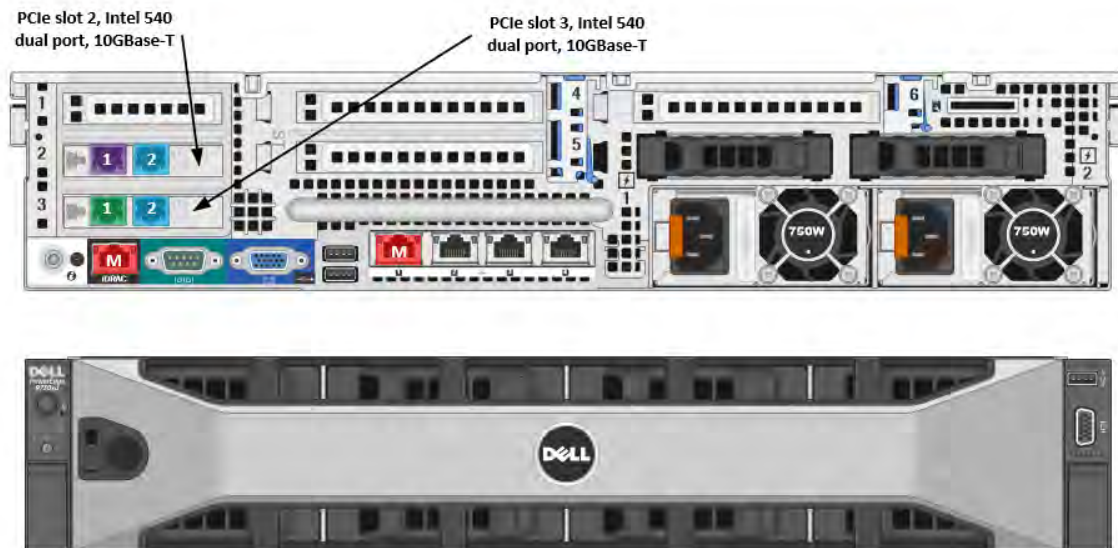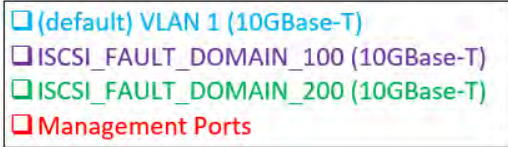
Figure 7-22. Dell R730 Server Diagram

Connected Vehicle - 10GBase-T Storage Area Network

❑ (default) VLAN 1 (10GBase-T)
❑ ISCSI_FAULT_DOMAIN_100 (10GBase-T)
❑ ISCSI_FAULT_DOMAIN_200 (10GBase-T)
❑ Management Ports

R730_1 Intel 540 DP (slot 2/1) to Te1/0/1
MAC: A036.9FD0.E098 -- IP: 192.168.51.1

R730_1 Intel 540 DP (slot 3/1) to Te1/0/23
MAC: A036.9FD1.15E4 -- IP: 192.168.50.1

R730_2 Intel 540 DP (slot 2/1) to Te1/0/3
MAC: A036.9FD1.169C -- IP: 192.168.51.2

R730_2 Intel 540 DP (slot 3/1) to Te1/0/21
MAC: A036.9FD0.E4C0 -- IP: 192.168.50.2

SAN Controller 1 (iSCSI 1) to Te1/0/4
MAC: A036.9FBE.A978 - IP: 192.168.51.4

SAN Controller 1 (iSCSI 2) to Te1/0/22
MAC: A036.9FBE.A97A - IP: 192.168.50.4

SAN Controller 2 (iSCSI 1) to Te1/0/2
MAC: A036.9FBE.AD7C - IP: 192.168.51.5

SAN Controller 2 (iSCSI 2) to Te1/0/24
MAC: A036.9FBE.AD7E - IP: 192.168.50.5

Figure 7-23. SAN Network Configuration

Connected Vehicle – 10GBase-T Data Network

❑ (default) VLAN 1 (10GBase-T)
❑ ISCSI_FAULT_DOMAIN_100 (10GBase-T)
❑ ISCSI_FAULT_DOMAIN_200 (10GBase-T)

R730_1 Intel 540 DP (slot 2/2) to Te1/0/8
MAC: A036.9FD0.E09A - IP: 10.145.9.135

R730_1 Intel 540 DP (slot 3/2) to Te1/0/6
MAC: A036.9FD1.15E6 - IP: 10.145.9.244

R730_2 Intel 540 DP (slot 2/2) to Te1/0/5
MAC: A036.9FD1.169E - IP: 10.145.9.146

R730_2 Intel 540 DP (slot 3/2) to Te1/0/7
MAC: A036.9FD0.E4C2 - IP: 10.145.9.150

Te1/0/14 - Uplink

Wydot TMC:
- Oracle Server
- Clients needing to access Pikalert Server
- Clients needing to access ODE server
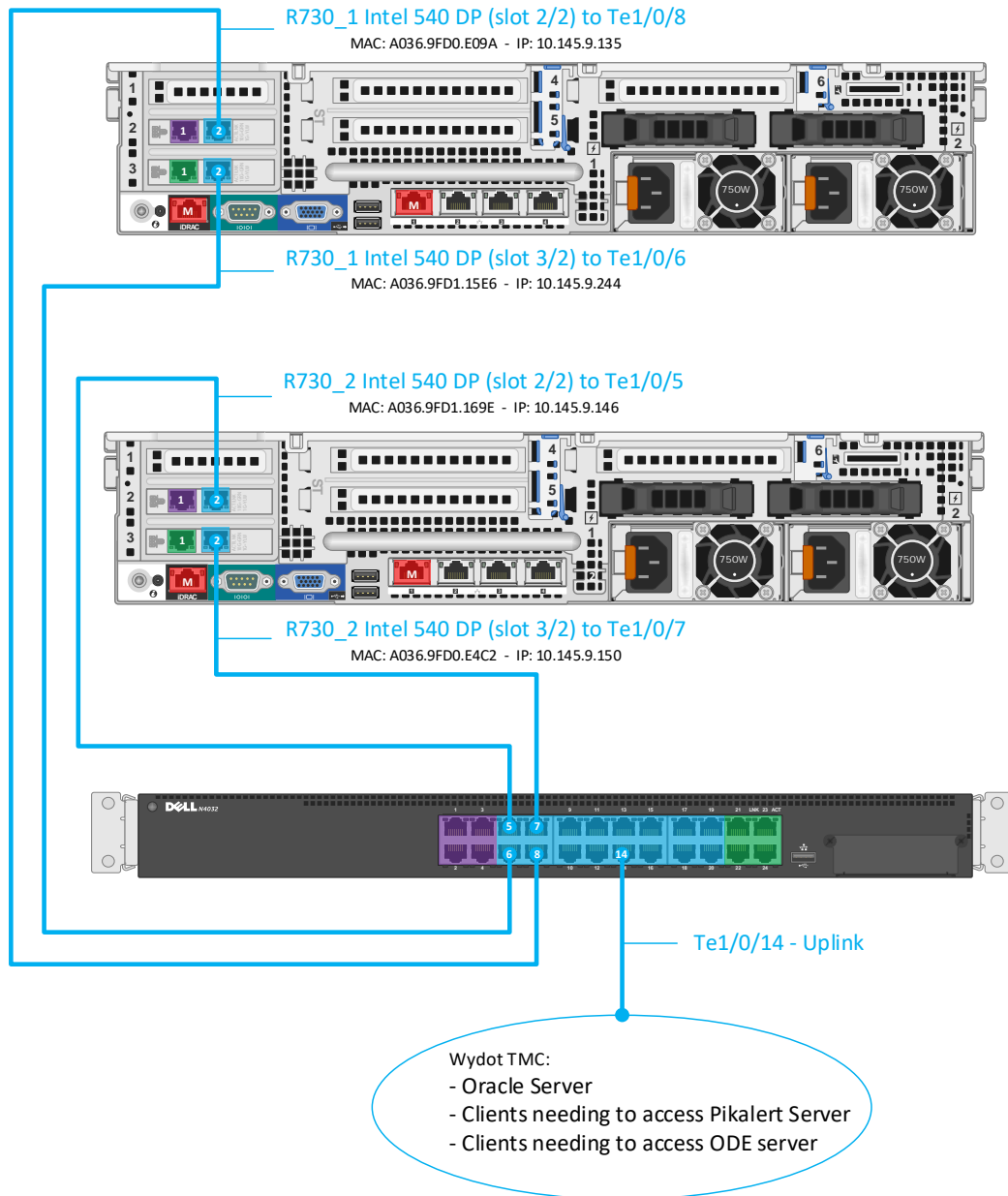
Figure 7-24. Server Network Configuration

Connected Vehicle Management Network

☐ (default) VLAN 1 (10GBase-T)
☐ ISCSI_FAULT_DOMAIN_100 (10GBase-T)
☐ ISCSI_FAULT_DOMAIN_200 (10GBase-T)
☐ Management Ports

Dell R730_1 iDRAC
MAC: 1866.DA7D.4027
IP: 10.145.9.242

Dell R730_1, quad port 1, Hyper-V Mgmt.
MAC: 1866.DAED.9134 - IP: 10.145.9.106

Dell R730_2 iDRAC
MAC: 1866.DA7D.3D88
IP: 10.145.9.243

Dell R730_2, quad port 1, Hyper-V Mgmt.
MAC: 1866.DAED.92F8 - IP: 10.145.9.142

Dell N4032 OOB port
IP: 10.145.9.240

SAN Controller 1, Mgmt.
IP: 10.145.9.239 (241)

SAN Controller 2, Mgmt.
IP: 10.145.9.239 (134)

TBD switch

Network with Servers Hosting:

- SNMP trap receiver
- Dell Storage Manger client
- Dell Storage Data Collector
- Hyper-V Manager

Figure 7-25. Management Network Configuration

7.1.2.5   Installation Procedures

The following sub-sections include all of the procedures/checklists that ensure the device is ready for installation, is completely installed and was installed correctly and is operating as intended.

7.1.2.5.1   Pre-Installation Procedures/Checklist

Pre-installation procedures will require the installer to verify the contents of the Server package. Each server should be inspected for visual defects or visible signs of damage. All damage will be reported back to the Vendor and replacement server should be requested.

7.1.2.5.2   Installation Procedures

The following steps should be followed in order to properly install and configure the Servers.

1. Install the server in the Rack.
2. Updated the BIOS Configuration

    Key BIOS configuration changes were made as follows:

    1. Updated firmware for iDRAC, NIC cards, Raid controllers, backplane, power supplies, SSDs and the BIOS itself.

    2. Establish RAID configuration for dual, internal SSDs. Configured as RAID 1 for booting Hyper-V.

    3. General settings:

        a. enabled USB 3.0,

        b. enable OS Watchdog Timer

    4. Virtualization performance settings:

        a. enable SR-IOV

    5. RAID default task rates:
        a. change setting Rebuild: 30 -> 90
        b. change setting BGI (background initialization): 30 -> 50
        c. change setting Reconstruction: 30 -> 90

3. Update the Hyper-V Configuration as follows:
    a. boot source: redundant SSDs
    b. Install Windows 2016 Server Hyper-V (redundantly on SSD's)
    c. Configure Management Network
        i. Configure Lan on Motherboard, quad port, NIC #1 for static IP & default WYDOT settings.
    d. Install Microsoft Updates
    e. Microsoft Updates:
        i. Disable automatic Updates
        ii. Disable automatic Download of Updates
    f. Remote Management:
        i. Enable remote desktop (authentication: all)
        ii. Enable remote management for Failover Cluster Manager
        iii. Enable: respond to ping
    g. set hostname
    h. Add system to Domain: gisits.local
    i. Microsoft telemetry setting: Security
    j. Set time zone to MST/7
    k. Set NTP server to WYDOT default.

l.   Configure additional NICs for TMC network access
  i.   Configure Intel PCIe card, dual-port, 10G NIC slot 3/2 for static IP & default WYDOT settings.
  ii. Configure Intel PCIe card, dual-port, 10G NIC slot 2/2 for static IP & default WYDOT settings.
m.   Configure additional NICs for iSCSI
  i.   Configure Intel PCIe card, dual-port, 10G NIC slot 2/1 for static IP & iSCSI settings.
  ii. Configure Intel PCIe card, dual-port, 10G NIC slot 3/1 for static IP & iSCSI settings.

4. Add the servers to the Domain, the servers need to be added to the WYDOT AD Domain and DNS. These servers run Windows Server 2016 Hyper-V so we will need to use the *sconfig* interface text menus to add these servers to the domain.

5. Add local administrator privileges for CV-731 and CV-732 to domain user or if you want to designate a new cluster manager account please provide me that information.
Create a *Cluster Name Object* (CNO) for the new failover cluster: CV-CLUSTER-ODE. This name will be registered as the cluster computer object (aka. CNO) in AD DS. If you specify a NetBIOS name for the cluster, the CNO is created in the same location where the computer objects for the cluster nodes reside. This can be either the default Computers container or an OU.

The cluster requires a static IP for management.

6. Create Cluster Shared Volumes in a Failover Cluster

There are three steps to create a Cluster Shared Volume.

a. Run Get-Disk to show LUNS mounted and online for the current server. Next run "Get-ClusterAvailableDisk" to see which disks are visible to all servers in the cluster and via the same LUN. Only such disk are available to be added to Cluster.

b. Now add the available disks to the cluster:

```
PS C:\Users\tenglish> Get-ClusterAvailableDisk | Add-ClusterDisk

Name            State  OwnerGroup         ResourceType
----            -----  ----------         ------------
Cluster Disk 1 Online Available Storage Physical Disk
Cluster Disk 2 Online Available Storage Physical Disk


PS C:\Users\tenglish> Get-ClusterAvailableDisk
PS C:\Users\tenglish> _
```

Run *Get-ClusterResource* to see the new disk resources along with other Cluster resources:

```
PS C:\> Get-ClusterResource

Name                         State  OwnerGroup         ResourceType
----                         -----  ----------         ------------
Cluster Disk 1               Online Available Storage Physical Disk
Cluster Disk 2               Online Available Storage Physical Disk
Cluster IP Address           Online Cluster Group     IP Address
Cluster Name                 Online Cluster Group     Network Name
Virtual Machine Cluster WMI Online Cluster Group      Virtual Machine Cluster WMI
```

c.   Now the Cluster has "Available Storage". The next step is to convert Cluster Disks into full blown CSV's:

Convert Available Storage resource into CSV

   PS C:\Users\tenglish> Add-ClusterSharedVolume –Name "Cluster Disk 2"

7.   Mount the CSVs on both servers
8.   Create Ubuntu Virtual Machines on the CSVs

7.1.2.5.3   Post-Installation Procedures/Checklist
In order to verify that the installation succeeded and that the servers installed are working properly the following steps should be followed immediately after the installation is completed.

1.   Power the server on and verify the server appears on the network and users are able to login successfully on the server from a valid domain account.
2.   Verify the Server is pingable on the network.
3.   Verify the server has access to all required resources (network, database, etc.)
4.   Verify the server firewall is correctly setup by checking access restrictions.

7.1.2.6   Quality Assurance/Quality Control Process

In order to verify the Servers received from Dell are functioning properly and that they has been installed correctly all pre-installation and post installation steps need to be followed. Pre-installation steps verify the unit integrity and allow WYDOT to verify that the configuration is setup correctly for

each Server. Post-installation steps verify that the unit is installed and functioning correctly within the WYDOT environment.

7.1.2.7 Installation Schedule

Table 7-4 details the delivery and installation schedule for the Servers.

Table 7-4. Dell Server Installation Schedule

Vehicles	Quantity	Schedule
Initial Server Delivery	2	December 2016
Server Installation	2	December 2016

7.1.2.8 HW and SW Configuration Control Process

All Hardware configuration will be managed through the installation procedures and instructions detailed above. Software configurations will be managed through a Confluence page setup specifically for documenting the OS and BIOS configuration. As configurations change the Confluence page is updated to reflect the changes.

7.1.2.9 Sparing Strategy, Warranty and Contingency Plan

The Wyoming CV Pilot will not carry any spare units but will instead have a strategy of failover from one of the two servers to the other server. If both servers fail the CV system will still be operable by bypassing the ODE servers and going directly to the ODE from other servers in the WYDOT Traffic Management Center. These Server will also carry a full warranty for all and software on the units for the life of the pilot project.

7.2 Storage Array

7.2.1 Storage Array Acquisition Information

The following sections detail acquisition information related to the Storage Array equipment.

7.2.1.1 Technical Description/Specification

The storage array contains (24) 1.2TB SAS HDDs and has a formatted capacity of 19TB. The storage array uses RAID configuration, hot spare disks and dual redundant controllers to insure data integrity and fault tolerance. The storage array is connected to both servers using multi-path iSCSI over 10GB Ethernet.

The storage array will host Virtual Machine images for servers hosting the TMDD third party interface, ODE, Pikalert weather simulation and prediction software as well as management software for the RSU's according to the system requirements.

7.2.1.2 Ancillary Equipment

The storage array is configured with:

- (24) Dell 1.2TB, SAS 12Gb, 10K, 2.5", HDD

- Four years' hardware and software support

7.2.1.3   Part Numbers and Quantities

Table 7-5 details the number of equipment to be acquired for storage.

Table 7-5. Equipment for storage.

Description	Part Number or Name	Quantity
Dell SCv2020 ISCSI	210-ADRU	1
Dell 1.2TB, SAS 12Gb, 10K, 2.5", HDD	400-AHEB	24

7.2.1.4   Associated Software

No additional software is purchased for the storage array.

7.2.1.5   Acquisition Method

This equipment will be ordered by the Wyoming Acquisition team via a sole source purchase order. Our research and vendor interviews have led to us to use a single vendor for the servers, storage and switch for the Management Center Equipment.

7.2.1.6   Potential Vendors

For the storage array, we engaged with Dell and HP.

We used a systematic selection process, derived from the objectives and requirements for the WYDOT CV Pilot system.

7.2.1.7   Acquisition Schedule

The storage array will be acquired based on the schedule presented in Table 7-6.

Table 7-6. Acquisition schedule for servers.

Description	Date	Quantity
Dell SCv2020 storage array	12/2016	1

7.2.2 Storage Array Installation Information

Each item that is being installed, and its' associated components required for full installation and operation, should have its' own section with the following sub-sections.

7.2.2.1   Supplier(s)

Table 7-7 lists the suppliers for the Server.

Table 7-7. Server Suppliers

Description	Part Number or Name	Supplier
Storage Array	Dell SCv2020 storage array	Dell

7.2.2.2   Inventory Control Method

The Storage Array will be inventoried in a spreadsheet upon arrival. Equipment Managers will enter in all received equipment serial numbers to the Spreadsheet which will be stored in a OneDrive folder with version tracking enabled. This equipment will all permanently reside in the TMC Server room.

7.2.2.3   Configuration(s)

No configuration updates were needed for the Storage Array.

7.2.2.4   Installation Diagram(s)

The following figures represent the installation diagrams related to the Storage Array.

Connected Vehicle - 10GBase-T Storage Area Network

❑ (default) VLAN 1 (10GBase-T)
❑ ISCSI_FAULT_DOMAIN_100 (10GBase-T)
❑ ISCSI_FAULT_DOMAIN_200 (10GBase-T)
❑ Management Ports

R730_1 Intel 540 DP (slot 2/1) to Te1/0/1
MAC: A036.9FD0.E098 -- IP: 192.168.51.1

R730_1 Intel 540 DP (slot 3/1) to Te1/0/23
MAC: A036.9FD1.15E4 -- IP: 192.168.50.1

R730_2 Intel 540 DP (slot 2/1) to Te1/0/3
MAC: A036.9FD1.169C -- IP: 192.168.51.2

R730_2 Intel 540 DP (slot 3/1) to Te1/0/21
MAC: A036.9FD0.E4C0 -- IP: 192.168.50.2

SAN Controller 1 (iSCSI 1) to Te1/0/4
MAC: A036.9FBE.A978 - IP: 192.168.51.4

SAN Controller 1 (iSCSI 2) to Te1/0/22
MAC: A036.9FBE.A97A - IP: 192.168.50.4

SAN Controller 2 (iSCSI 1) to Te1/0/2
MAC: A036.9FBE.AD7C - IP: 192.168.51.5

SAN Controller 2 (iSCSI 2) to Te1/0/24
MAC: A036.9FBE.AD7E - IP: 192.168.50.5

Figure 7-26. Storage Array Network Wiring

7.2.2.5   Installation Procedures

The following sub-sections include all of the procedures/checklists that ensure the device is ready for installation, is completely installed and was installed correctly and is operating as intended.

7.2.2.5.1 Pre-Installation Procedures/Checklist

Pre-installation procedures will require the installer to verify the contents of the Storage Array package. The Storage Array should be inspected for visual defects or visible signs of damage. All damage will be reported back to the Vendor and replacement storage array should be requested. The Storage Array should also be plugged n and hooked up to a computer to verify it is operating correctly and the Storage Array is working properly.

7.2.2.5.2 Installation Procedures

The following steps should be followed in order to properly install and configure the Storage Array.
1. Install the storage array in the Rack.
2. Hook up the wiring according to Figure 7-26.

7.2.2.5.3 Post-Installation Procedures/Checklist

In order to verify that the installation succeeded and that the storage array has been installed and is working properly the following steps should be followed immediately after the installation is completed.

1. Power the storage array on and mount the storage array from a computer.
2. Verify the Storage Array is on the network and accessible.
3. Verify files can be added, removed, and accessed from the Storage Array.

7.2.2.6   Quality Assurance/Quality Control Process

In order to verify the Storage Array received from Dell is functioning properly and that it has been installed correctly all pre-installation and post installation steps need to be followed. Pre-installation steps verify the unit integrity and allow WYDOT to verify that the configuration is setup correctly for the Storage Array. Post-installation steps verify that the unit is installed and functioning correctly within the WYDOT environment.

7.2.2.7   Installation Schedule

Table 7-10 details the delivery and installation schedule for the Storage Array.

Table 7-8. Lear Locomate Roadstar Premium Installation Schedule

Vehicles	Quantity	Schedule
Initial Storage Array Delivery	1	December 2016
Storage Array Installation	1	December 2016

7.2.2.8   HW and SW Configuration Control Process

The Storage Array requires no configuration.

7.2.2.9   Sparing Strategy, Warranty and Contingency Plan

The Storage Array will have a warranty for the life of the pilot project.

7.3 Switch

7.3.1 Switch Acquisition Information

The following sections detail acquisition information related to the network switch.

7.3.1.1   Technical Description/Specification

The switch has (24) 10GBase-T copper Ethernet ports, redundant power supplies and supports layer-2 and layer-3 capabilities.

The switch serves as the interconnect fabric for the servers and storage array. The switch also connects to the existing WYDOT intranet.

7.3.1.2   Ancillary Equipment

The following additional items were purchased for the switch:

- Cat6 Ethernet cables
- Four years' hardware and software support

7.3.1.3   Part Numbers and Quantities

Table 7-9 details the number of equipment to be acquired for the switch.

Table 7-9. Equipment for switch.

Description	Part Number or Name	Quantity
Dell Networking N4032, 24x 10GBaset-T switch	210-ABVS	1
C2G 2t Cat6 Unshielded Ethernet cables	A7523371	21

7.3.1.4   Associated Software

No additional software is purchased for the switch.

7.3.1.5   Acquisition Method

This equipment will be ordered by the Wyoming Acquisition team via a sole source purchase order. Our research and vendor interviews have led to us to use a single vendor for the servers, storage and switch for the Management Center Equipment.

7.3.1.6   Potential Vendors

For the switch, we engaged with Dell, Cisco and HP.

We used a systematic selection process, derived from the objectives and requirements for the WYDOT CV Pilot system.

7.3.1.7   Acquisition Schedule

The switch will be acquired based on the schedule presented in Table 7-10.

Table 7-10. Acquisition schedule for servers.

Description	Date	Quantity
Dell Networking N4032, 24x 10GBase-T switch	12/2016	1

7.3.2 Switch Installation Information

The sections below detail the installation plan and information for the WYDOT TMC Servers.

7.3.2.1 Supplier(s)

Table 7-7 lists the suppliers for the Server.

Table 7-11. Server Suppliers

Description	Part Number or Name	Supplier
Switch	Dell Networking N4032, 24x 10GBaset-T switch (210-ABVS)	Dell
Ethernet Cables	C2G 2t Cat6 Unshielded Ethernet cables (A7523371)	Dell

7.3.2.2 Inventory Control Method

The Switch will be inventoried in a spreadsheet upon arrival. Equipment Managers will enter in all received equipment serial numbers to the Spreadsheet which will be stored in a OneDrive folder with version tracking enabled. This equipment will all permanently reside in the TMC Server room.

7.3.2.3 Configuration(s)

No configuration updates were needed for the Switch.

7.3.2.4 Installation Diagram(s)

The following figures represent the installation diagrams related to the Switch.

Connected Vehicle - 10GBase-T Storage Area Network

❏ (default) VLAN 1 (10GBase-T)
❏ ISCSI_FAULT_DOMAIN_100 (10GBase-T)
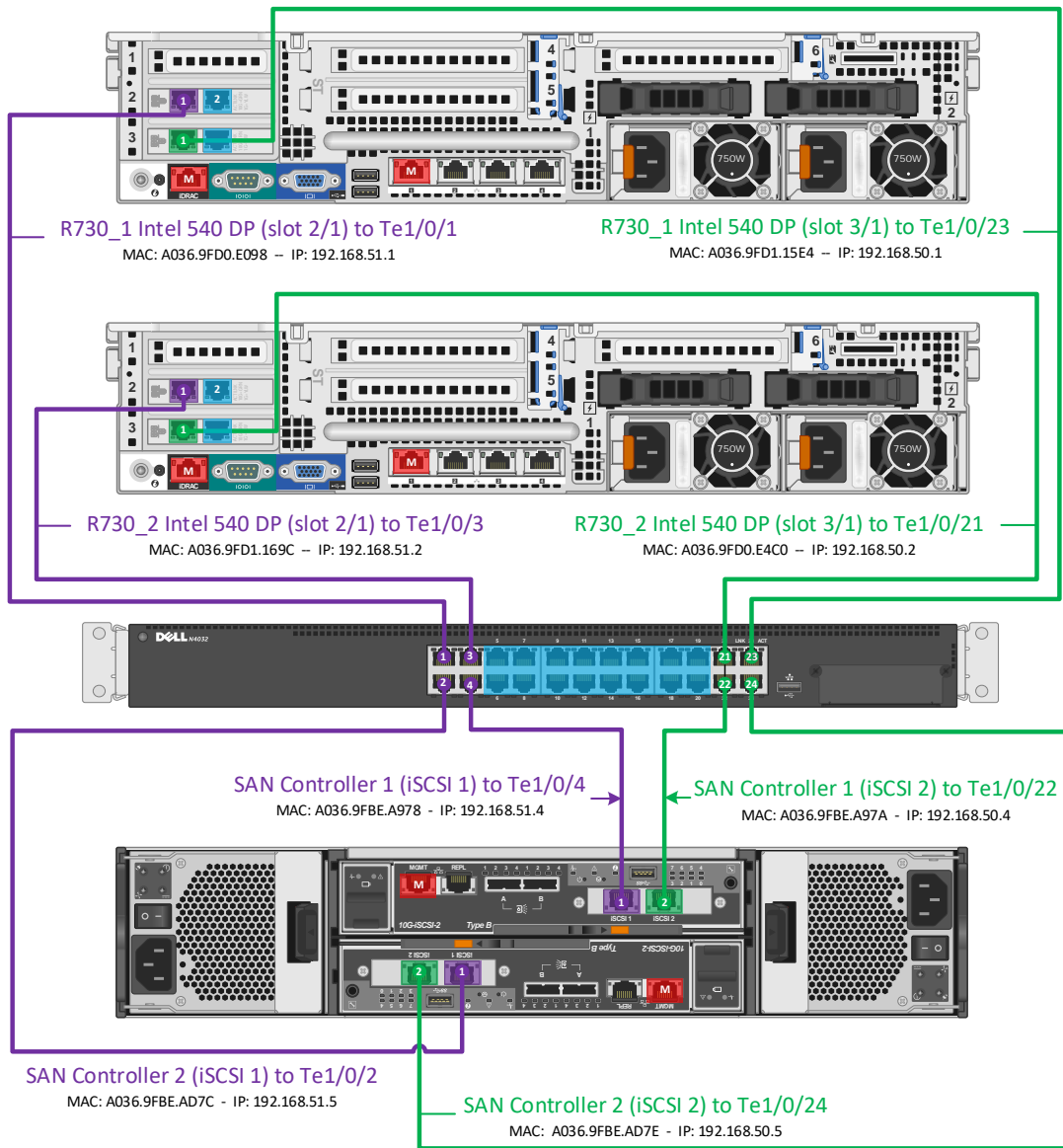❏ ISCSI_FAULT_DOMAIN_200 (10GBase-T)
❏ Management Ports

R730_1 Intel 540 DP (slot 2/1) to Te1/0/1
MAC: A036.9FD0.E098 -- IP: 192.168.51.1

R730_1 Intel 540 DP (slot 3/1) to Te1/0/23
MAC: A036.9FD1.15E4 -- IP: 192.168.50.1

R730_2 Intel 540 DP (slot 2/1) to Te1/0/3
MAC: A036.9FD1.169C -- IP: 192.168.51.2

R730_2 Intel 540 DP (slot 3/1) to Te1/0/21
MAC: A036.9FD0.E4C0 -- IP: 192.168.50.2

SAN Controller 1 (iSCSI 1) to Te1/0/4
MAC: A036.9FBE.A978 - IP: 192.168.51.4

SAN Controller 1 (iSCSI 2) to Te1/0/22
MAC: A036.9FBE.A97A - IP: 192.168.50.4

SAN Controller 2 (iSCSI 1) to Te1/0/2
MAC: A036.9FBE.AD7C - IP: 192.168.51.5

SAN Controller 2 (iSCSI 2) to Te1/0/24
MAC: A036.9FBE.AD7E - IP: 192.168.50.5

Figure 7-27. Switch Network Wiring

7.3.2.5   Installation Procedures

The following sub-sections include all of the procedures/checklists that ensure the device is ready for installation, is completely installed and was installed correctly and is operating as intended.

7.3.2.5.1   Pre-Installation Procedures/Checklist

Pre-installation procedures will require the installer to verify the contents of the Switch package. The Switch should be inspected for visual defects or visible signs of damage. All damage will be reported back to the Vendor and replacement switch should be requested. The Switch should also be plugged in and hooked up to a computer to verify it is operating correctly.

7.3.2.5.2   Installation Procedures

The following steps should be followed in order to properly install and configure the Switch.
1.   Install the Switch in the Rack.
2.   Hook up the wiring according to Figure 7-27.

7.3.2.5.3   Post-Installation Procedures/Checklist

In order to verify that the installation succeeded and that the Switch has been installed and is working properly the following steps should be followed immediately after the installation is completed.

1.   Power the switch on.
2.   Verify the Switch is accessible and correctly routing network traffic.

7.3.2.6   Quality Assurance/Quality Control Process

In order to verify the Switch received from Dell is functioning properly and that it has been installed correctly all pre-installation and post installation steps need to be followed. Pre-installation steps verify the unit integrity and allow WYDOT to verify that the configuration is setup correctly for the Switch. Post-installation steps verify that the unit is installed and functioning correctly within the WYDOT environment.

7.3.2.7   Installation Schedule

Table 7-12 details the delivery and installation schedule for the Switch.

Table 7-12. Lear Locomate Roadstar Premium Installation Schedule

Vehicles	Quantity	Schedule
Initial Switch Delivery	1	December 2016
Switch Installation	1	December 2016

7.3.2.8   HW and SW Configuration Control Process

The Switch requires no configuration.

7.3.2.9   Sparing Strategy, Warranty and Contingency Plan

The Switch will have a warranty for the life of the pilot project.

8 Other Equipment

The WYDOT CV Pilot will not be purchasing any other equipment.

9 Bill of Materials

The table below the bill of materials for the items in this document. OBUs installations were not contracted, so no costs are provided for installation. It was found to take about 4 hours to install a simple light duty vehicle OBU and 8 hours for a complicated light duty vehicle (Highway Patrol) or heavy dual antenna vehicles. These installs were completed by fleet management groups. OBU and RSU hardware costs included 3 years of software and hardware support/upgrades.

	RSU/OBU/Computer	Number	Cost	HMI/ Mounting	Total	Justification
Equipment Contracts						**The following list of equipment is necessary for deploying on-board and roadside elements of the CV Pilot**
WYDOT snowplow fleet device	OBU hardware kit	110	$775	$600	$151,250	All OBU costs were determined based on a review of quotes from several OBU vendors including Lear, Sirius XM, Siemens, Savari, Cohda. This OBU has satellite TIM capability.
14' dual truck antennas	OBU antennas	110	$300		$33,000	For snowplows/fleet semi's
Commercial truck device with dual antennas	OBU hardware kit	200	$2,200	$300	$500,000	This OBU has satellite TIM capability and includes dual antenna truck mounts.
State Patrol device/light duty vehicle with single antenna	OBU hardware kit	110	$1,500	$300	$198,000	This OBU has satellite TIM capability.

RSUs	RSU hardware kit	78	$1,400		$109,200	RSU costs were determined based on quotes from several vendors including Lear and Savari. Included mount kits.
Mobile weather sensors	Vehicle weather sensors	50	$400		$20,000	Weather sensors costs were developed using quotes from WeatherCloud.
CV hardware TOTAL					$1,011,450	
Support Contracts						The following line-items support functions for the hardware and software equipment
Weather Cloud support/dev	Vehicle weather sensors support				$10,000	This includes a quote for 3-year support of weather sensors and any custom development for weather-related data.
RSU Installation Support	Roadside installation service and hardware				$253,700	This cost is estimated based on installation of 75 RSUs with 10 being major installs (need significant upgrades to comm, power, structures).
WYDOT HW/SW	Computer equipment				$75,000	This cost includes a line-item to support upgrades of Wyoming TMC's software and hardware systems including servers, database storage etc. These were estimated based on WYDOT TMC data.
O&M Vendor Support	Computer support services				$50,000	Miscellaneous vendor support costs for OBU and RSU equipment through the lifecycle of the pilot. Estimated based on quotes from vendors. For example SCMS management addon.
WYDOT GIS/IT Contractors	Computer support services				$75,000	Supplemental scope with current GIS/ITS contractors to support upgrades to current WYDOT TMC system interfaces.
Support Contracts TOTAL					$463,700	
TOTAL					$1,475,150	

10 Glossary

This section provides a glossary of terms and acronyms used in this document.

Table 10-1. Glossary of Terms.

Term	Definition
Basic Safety Message	Connected V2V safety applications are built around the capability to transmit BSMs, following the Society of Automotive Engineers (SAE) J2735 standard. The BSM is transmitted over DSRC over a range of approximately 300 meters. In general, BSMs are broadcast frequently to provide connected vehicles with data content necessary for the different safety-oriented applications. The BSM is divided into two parts: • Part I, transmitted approximately 10 times per second, contains the core data elements: Message Count, Temporary ID, Time (through a Second Mark), Latitude, Longitude, Elevation, Positional Accuracy, Transmission State, Speed, Heading, Steering Wheel Angle, Acceleration, Brake System Status, and Vehicle Size. • Part II, transmitted less frequently, is added to Part I depending on events (e.g., Anti-lock Braking System (ABS) activated) and contains a variable set of data elements drawn from many optional data elements (availability by vehicle model varies)
Broadcast	Sharing data with no specific destination. All broadcast data is sent unencrypted but is signed with a certificate (based on the Institute of Electrical and Electronics Engineers (IEEE) standard 1609.2).
Data	Data is raw (unorganized and unprocessed) digital messages sent between components. From SAE J2735: Representations of static or dynamic entities in a formalized manner suitable for communication, interpretation, or processing by humans or by machines.
Information	Processed data that is organized, structured or presented in a given context to make it useful
Message	A well-structured set of data elements and data frames that can be sent as a unit between devices to convey some semantic meaning in the context of the applications (adapted from SAE J2735).
On-Board Unit	This represents the package of DSRC radios, computing, sensors and HMI that will be installed on a vehicle. This is similar to the Retrofit Safety Device used in the Safety Pilot Program.
Requirements	Set of information necessary to accomplish one action.
Roadside Units	This represents the package of DSRC radios, computing, communications that will be installed on the roadside on I-80
Transmit	Sharing data directed to a specific receiver. In the case of transmission between Systems, all transmitted data is signed and encrypted, where required, based on SAE J2945/1.
Transportation Management Center	Center that collects information and informs the public about changing travel conditions.
WGS-84	Latest revision of the standard for use in cartography, geodesy, and navigation including by global positioning systems (GPS).

Table 10-2. Acronym List.

Acronym/ Abbreviation	Definition
ABS	Anti-lock Braking System
App. Dev.	Application Development
BSM	Basic Safety Message
CAN bus	Controller Area Network bus
CAP	Comprehensive Acquisition Plan
ConOps	Concept of Operations
CV	Connected Vehicle
DMS	Dynamic Message Signs
DN	Distress Notification
DOT	Department of Transportation
DSRC	Dedicated Short Range Communications
FCW	Forward Collision Warning
FHWA	Federal Highway Administration
GB	Giga byte
GPS	Global Positioning System
HMI	Human-Machine Interface
I2V	Infrastructure-to-vehicle
I-80	Interstate 80
IEEE	Institute of Electrical and Electronics Engineers
ITS	Intelligent Transportation System
NOFO	Notice of Funding Opportunities
NWS	National Weather Service
OBU	On-Board Unit
ODE	Operational Data Environment
RSU	Roadside Units
SAE	Society of Automotive Engineers
SMOC	Security Management Operating Concept
SCMS	Security Credential Management System
SWIW	Spot Weather Impact Warning
SyRS	System Requirements Specification
TBD	To be Determined
TIM	Traveler Information Message
TMC	Transportation Management Center
TMDD	Traffic Management Data Dictionary
V2I	Vehicle-to-infrastructure
V2V	Vehicle-to-vehicle
VSL	Variable Speed Limit
WYDOT	Wyoming Department of Transportation
WZW	Work Zone Warning

11 References

The following table lists the documents, sources and tools used and referenced to develop the concepts in this document.

Table 11-1. References.

#	Documents, Sources Referenced
1.	Gopalakrishna, et al. (2016). *Connected Vehicle Pilot Deployment Program Phase 1, Concept of Operations (version 2), ICF/Wyoming (FHWA-JPO-16-287).* U.S. Department of Transportation.
2.	Gopalakrishna, et al. (2016). *Connected Vehicle Pilot Deployment Program Phase 1, System Requirements Specification (version 2) – ICF/Wyoming (FHWA-JPO-16-291).* U.S. Department of Transportation.
3.	Gopalakrishna, et al. (2016). *Connected Vehicle Pilot Deployment Program Phase 1, Security Management Operating Concept (version 2), ICF/Wyoming (FHWA-JPO-16-288).* U.S. Department of Transportation.
4.	Gopalakrishna, et al. (2016). *Connected Vehicle Pilot Deployment Program Phase 1, Comprehensive Deployment Plan (version 2), ICF/Wyoming (FHWA-JPO-16-297).* U.S. Department of Transportation.
5.	Wyoming Department of Transportation (WYDOT), System Design Document (SDD) – Wyoming CV Pilot, Version 4, September 1, 2017
6.	Wyoming Department of Transportation (WYDOT), Interface Control Document (ICD) – Wyoming CV Pilot, Version 2, June 17, 2017
7.	Wyoming Department of Transportation (WYDOT), Comprehensive Acquisition Plan (CAP) – Wyoming CV Pilot, Version 2, May 2017

Appendix – Installation Guide

1. Auriga Hardware Installation Guide
2. WYDOT RSU Installation Plan

Auriga Hardware Installation Guide

Table of Contents

Introduction

Safety and Care Information

- Do not expose to extreme temperatures (above 185°F or below -40°F, or above 85°C or below -40°C).
- Do not expose the Under Dash Module to moisture. Do not use near or in water.
- Do not touch the Display Screen or Under Dash Module with wet hands.
- Do not let any foreign matter spill into device.
- Do not store in dusty areas.
- Do not expose to chemicals such as benzene and thinners. Do not use liquid or aerosol cleaners. Clean with a soft damp cloth only.
- Do not expose to direct sunlight for a prolonged period of time, and do not expose to fire, flame, or other heat sources.
- Do not try to disassemble and/or repair the device yourself.
- Do not drop your device or subject it to severe impact.
- Do not place heavy objects on device.
- Do not subject device to excessive pressure.
- If the LCD screen is damaged, do not touch the liquid crystal fluid.

Warning!

- Opening the case may result in electric shock.
- If the liquid crystal fluid comes in contact with your skin, wipe the skin area with a cloth and then wash the skin thoroughly with soap and running water. If the liquid crystal fluid comes into contact with your eyes, flush the eyes with clean water for at least 15 minutes and seek medical care. If the liquid crystal fluid is ingested, flush your mouth thoroughly with water. Drink large quantities of water, and induce vomiting. Seek medical care.
- When using this product, it is always important to keep your eyes on the road and hands on the steering wheel. Not doing so could result in personal injury, death, and/or damage to your device, accessories, and/or to your vehicle or other property.
- Vehicle installation, service activation, and Radio configuration functions should not be performed while driving. Park your vehicle in a safe location before beginning installation.
- This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.
- Your device should be placed in your vehicle where it will not interfere with the function of safety features, e.g., deployment of airbags. Failure to correctly place device may result in injury to you or others, if the unit becomes detached during an accident and/or obstructs the deployment of an airbag.

SiriusXM Limit of Liability Statement

IMPORTANT! Installation instructions and tips are provided for your convenience. It is your responsibility to determine if you have the knowledge, skills, and physical ability required to properly perform an installation. SiriusXM shall have no liability for damage or injury resulting from the installation or use of any SiriusXM or third party products. It is your responsibility to ensure that all products are installed in adherence with local laws and regulations and in such a manner as to allow a vehicle to be operated safely and without distraction. SiriusXM product warranties do not cover the installation, removal or reinstallation of any product.

What's in the Box?
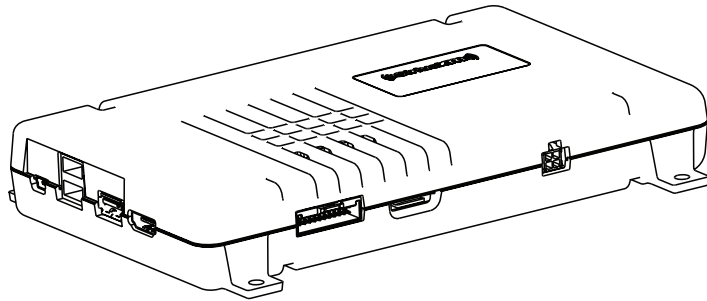
Under Dash Module
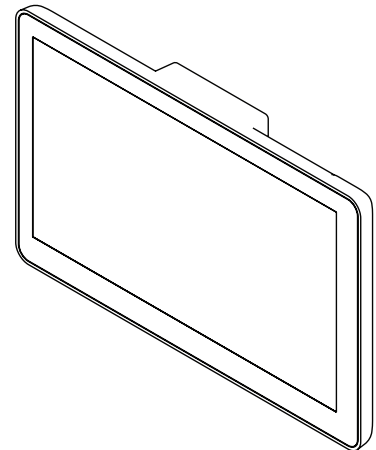
7" Touch Screen Display
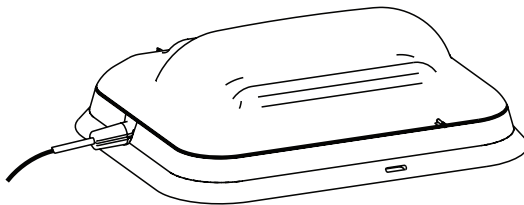
Digital Antenna and Cable

Audio Speaker
and Mounting Hardware
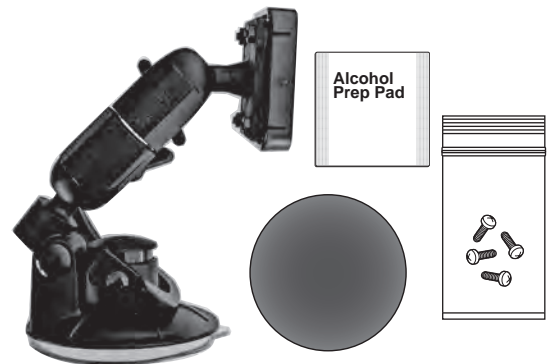
Display Mounting Bracket and
Mounting Accessories
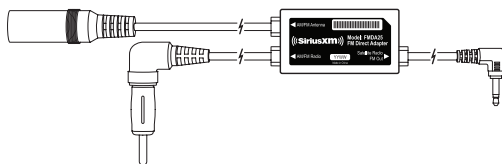
FM Direct Adapter

Touch Screen
Display Cable

External Accessories
Cable

HDMI
Display Cable
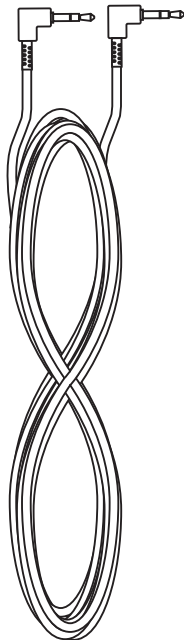
Aux Audio
Cable
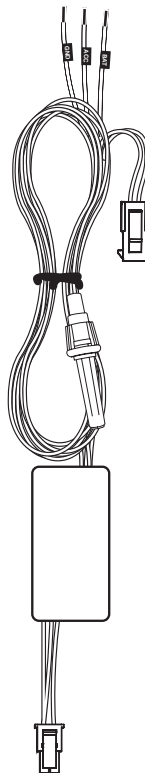
Power
Control Cable
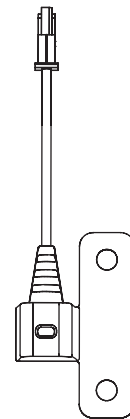
Reset Switch

Auriga Component Connector Identification

Under Dash Module

The following illustrations identify the connections of the Under Dash Module used with Auriga.

Mini-USB Debugging and Configuration Connector

2x USB Accessory Connector

Display Touch Screen Connector

HDMI Display Connector

External Accessories Connector

MicroSD Slot

Power Control Cable Connector

Cable Tie Molded Indents

FM Direct Adapter Connector

Digital Antenna Connector

Audio Speaker Connector

AUX Audio Connector
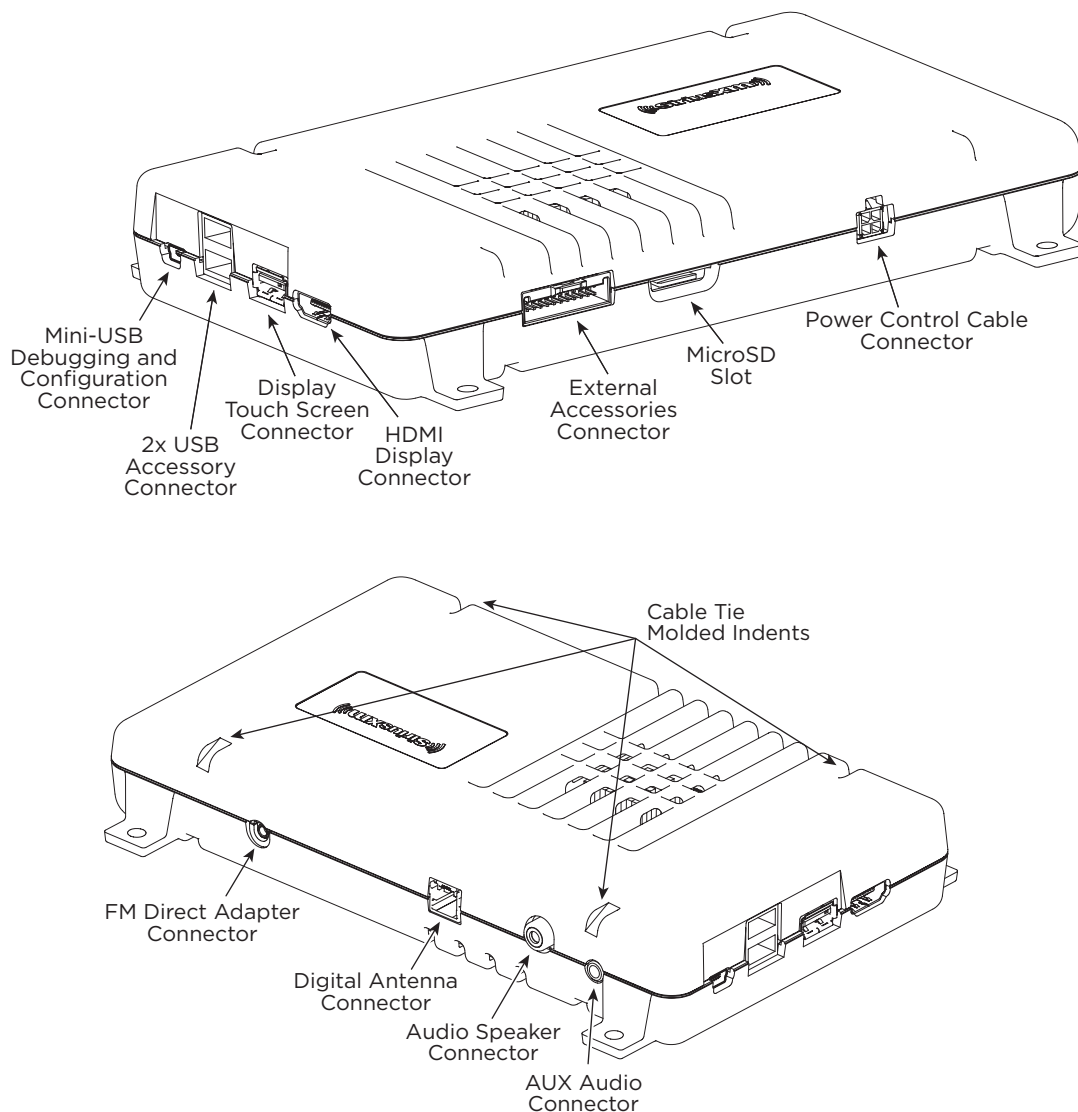
The following table summarizes the connectors and connections to the Under Dash Module.

Connector	Connects to
Mini-USB Debugging and Configuration	This connection is used for debugging and configuration of Auriga.
USB Accessory (2)	Not Used.
Display Touch Screen	Connects to the touch screen connection on the 7" Display Screen. Cable provided.
HDMI Display	Connects to the HDMI connection on the 7" Display Screen. Cable provided.
External Accessories	Connects to the External Accessories Cable. This cable connects to several components of the vehicle in which Auriga is installed. Refer to the next table for the specific connections of the cable. Cable provided.
MicroSD Slot	Accommodates a MicroSD memory card. Not provided.
Power Control Cable	Connects to the vehicle's 12v battery power, and the ACC connection of the vehicle. Cable provided.
FM Direct Adapter	Connects to the FM Direct Adapter. This is used when the audio connection for the SiriusXM Radio Service is using an FM connection to the vehicle's FM radio.
Digital Antenna	Connects to the Digital Antenna of Auriga.
Audio Speaker	Connects to the Audio Speaker included with Auriga.
AUX Out	Connects to the auxiliary input connection of the vehicle's audio system. This is when the audio connection for the SiriusXM Radio Service is directly connected. Aux cable not provided.

External Accessories Cable

The following table provides the pin connections for the External Accessories Cable. This cable is used when connections are needed for external LED indicators, and when general purpose inputs and outputs are needed. Left and right turn signal connections, and reverse light connections are noted, but other connections which are specific to each installation are not specified.

All signals need to be connected to a wire that goes high (12 volt) when the associated signal is active. For example the wire that is connected to the reverse light (lamp) is 12 volt when the light is on, or ~0 volt when light is off.

Pin	Wire Color	Type of Connection
Odd Pins	All Black	Common Grounds
2	Purple	LED Output Buffer 0, 5V limited to <20mA
4	White	LED Output Buffer 1, 5V limited to <20mA
6	Orange	LED Output Buffer 2, 5V limited to <20mA
8	Green	LED Output Buffer 3, 5V limited to <20mA
10	Blue	LED Output Buffer 4, 5V limited to <20mA
12	Yellow	General Purpose Output 0, 5V limited to <10mA
14	Brown	General Purpose Output 1, 5V limited to <10mA
16	Pink	General Purpose Output 2, 5V limited to <10mA
18	Red	Accessory Power Output, 5V limited to <650mA
20	Gray	General Purpose Input 0 Accepts raw switch closure 2V< V>13.8V ESD/surge protected **Right Turn Signal**
22	Light Blue	General Purpose Input 1 Accepts raw switch closure 2V< V>13.8V ESD/surge protected **Left Turn Signal**
24	Light Green	General Purpose Input 2 Accepts raw switch closure 2V< V>13.8V ESD/surge protected **Reverse Light**

Power Control Cable

The following illustration provides the wire connections for the Power Control Cable.
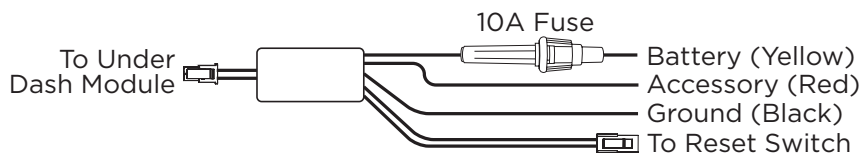
Touch Screen Display

The following illustrations identify the connections of the Touch Screen Display used with Auriga.
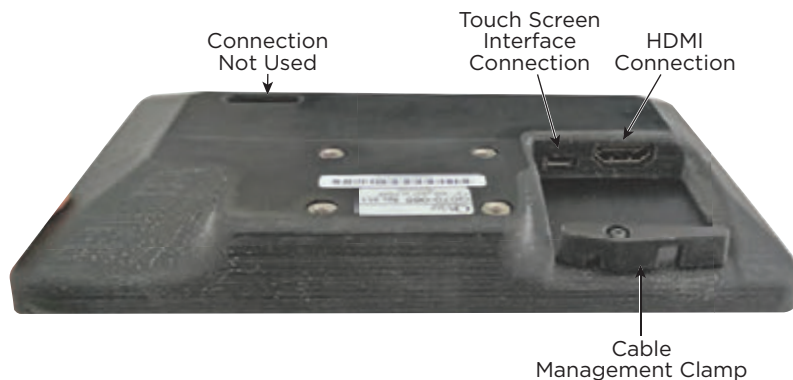
Digital Antenna Mounting Template

The Digital Antenna has strong magnets which will keep it secured to the vehicle, however, it can also be permanently attached to the vehicle using four screws.

If the antenna will be permanently attached, below is the template for the holes which will need to be drilled into the mounting surface to attach the antenna.
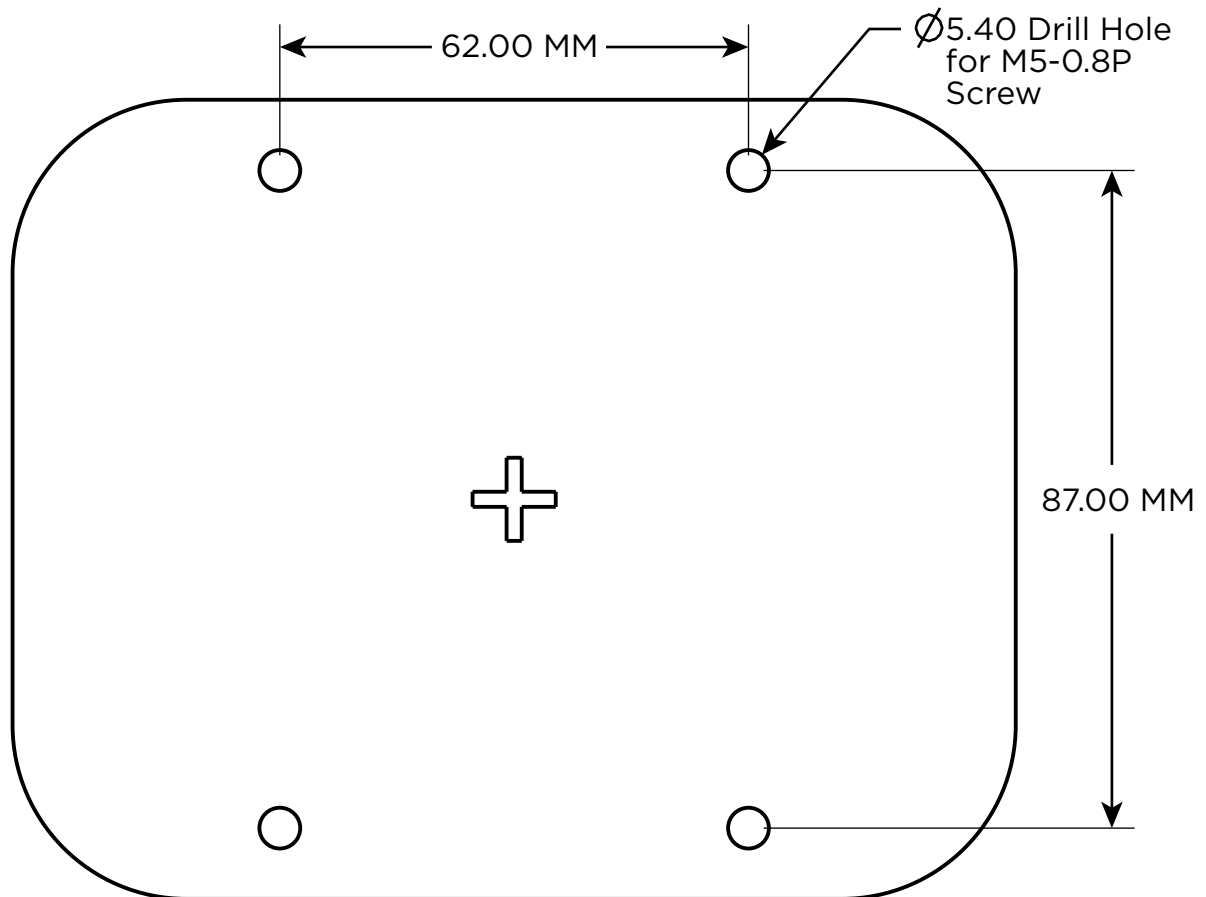
Installation Overview

Installation of Auriga consists of the following steps:

1. Find a location to mount the Under Dash Module. This must be done first determine the location where the cables from the other components of Auriga will be routed.
2. Install the Digital Antenna, and route the antenna cable. Record information about the vehicle and the antenna location.

3. Install the Touch Screen Display, and route the cables.

4. Install the Reset Switch.

5. Install the Power Control Cable and route the cables.

6. Install the Audio Speaker and route the cable.

7. For the SiriusXM Radio Service audio, install either the Aux Cable, or the FM Direct Adapter.

8. Install the Under Dash Module, and connect all the cables.

9. Connect the External Accessories Cable, if connections are being made to the vehicle.

Overall Wiring Diagram

The following illustration is an overview of Auriga, the components and connections. Detailed installation instructions follow for each component of Auriga.
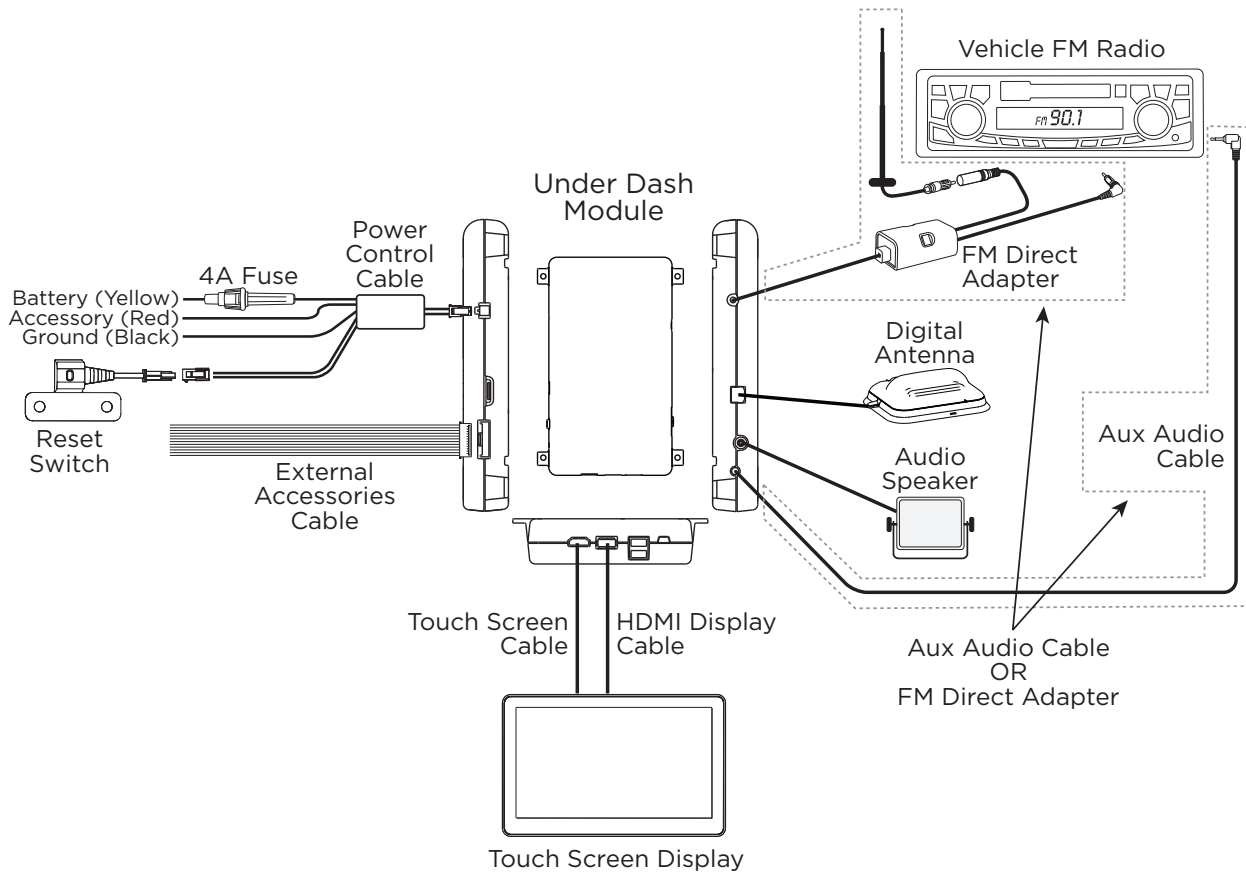
Installation Considerations

When planning to install Auriga, consider the following:

- Consult the Specifications section of this Installation Guide for the various cable lengths to assist in planning the locations of each of Auriga's components, to be sure the cables are of sufficient length to reach from one component to the other.

- The Under Dash Module has a number of connections that need to be made to three sides of the module. In addition, it may be necessary to connect a USB cable or install/remove a MicroSD card at some future time for debugging and configuration purposes. Choose a location where there is sufficient space for these connections, easy access, good ventilation, and a dry location. Hiding it behind the dashboard or under a front seat of the vehicle would be ideal. It should not be mounted where it could interfere with the vehicle's control pedals (accelerator, brake, clutch), nor where it can be accidentally kicked. It should not be mounted where it would interfere with the operation of the vehicle's airbags.

- The Under Dash Module can be secured with wire ties or with screws. If using wire ties, the module should be mounted securely so that it does not move when the vehicle is in motion. If using screws, caution should be observed so as not to compromise any of the vehicle's systems or wiring with the screws, where the point of the screw could puncture something important in the vehicle. Wire ties or four screws (#8) will need to be provided by the installer.

- Once the Digital Antenna has been successfully mounted on the vehicle, you will need to record some vehicle information and measurements, and also measurements which pinpoint the location of the antenna on the vehicle relative to the front left corner of the vehicle, and the height of the antenna. This information will need to be entered into Auriga later. Instructions and space to record these measurements are provided.

- The Display Mounting Bracket has a suction cup mount, but it should not be attached to the windshield. A number of states have prohibitions against attaching devices to windshield. Use the adhesive disc mounting accessory which provides a flat surface for attaching the suction cup mount.

- The Touch Screen Display should be mounted where it is visible to the driver of the vehicle, but where it does not block the view of the driver, or is located where it would be particularly distracting to the driver. It should not be mounted where it would interfere with the operation of the vehicle's airbags.

- The Audio Speaker will need to be mounted where the driver is able to hear it, but where it does not interfere with the vehicle's control pedals, is not accidentally kicked, and does not interfere with the operation of the vehicle's airbags.

- The power connection for Auriga requires both a constant 12-volt source, and a power source that is switched on and off with the vehicle's ignition (ACC).

- Some installations of Auriga may have connections to some of the vehicle's systems, such as the reverse switch, left/right blinkers and LED indicators. Connection points are provided from the External Accessories Cable, but the additional lengths of wire are required from the External Accessories Cable to the vehicle's systems, and will need to be provided by the installer. A table is included with detailed information about the each of this cable's possible connections.

- For the SiriusXM Radio Service audio connection, the FM Direct Adapter is provided for an FM audio connection and an Aux Audio Cable for a direct connection. Decide which audio connection will be used.

Install the Digital Antenna

The Digital Antenna should be mounted on the roof of the vehicle, on a horizontal surface, where there are no obstructions to a clear view of the sky. For a soft-top vehicle, the antenna should be mounted on the rear trunk lid. The antenna should not be mounted adjacent to another antenna on the vehicle, or where a roof rack might block the antenna's view of the sky in any direction.
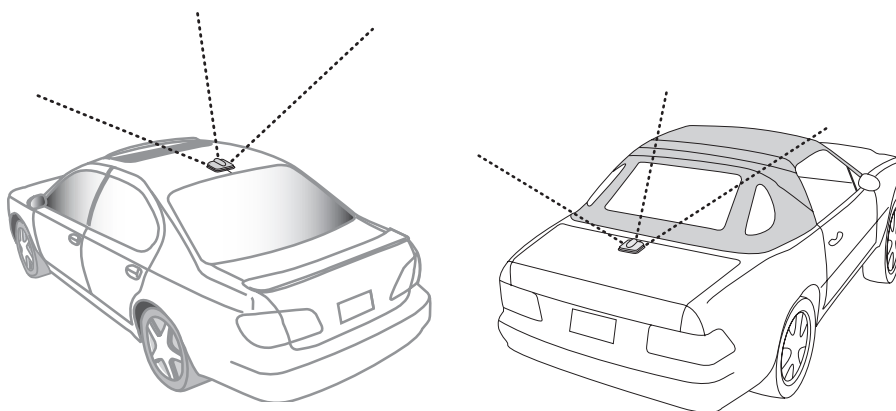
Mounting Location Restrictions

Observe the following cautions, and do not install the antenna in these locations.

CAUTION! Don't mount the antenna inside the vehicle, for example, on the dashboard.
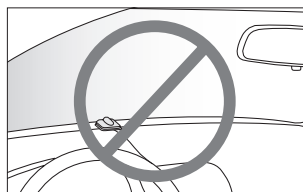
CAUTION! Don't mount the antenna on any of the vehicle's front, back or side pillars.

Installation
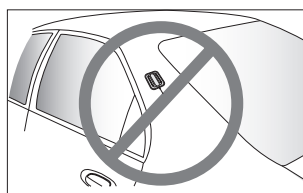
CAUTION! Don't mount the antenna close to a roof rack. Adjust the rack so it's further away from the antenna or move the antenna closer to the center of the roof.
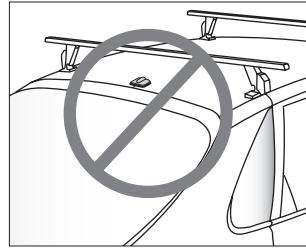
CAUTION! Don't mount the antenna close to another antenna. Mount it at least 3 inches away.
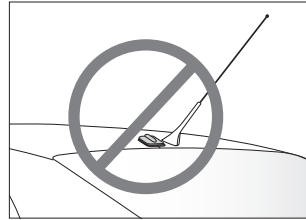
The antenna has strong magnets which will keep it secured to the vehicle. Once the magnet has adhered to the vehicle, do not attempt to lift the antenna off the vehicle by using the antenna cable.

CAUTION! The antenna cable is fragile. Don't pull it excessively, or puncture it during installation. Don't lift the Digital Antenna by the cable.

Suggested Antenna Locations for Different Types of Vehicles

Choose the best location for your antenna considering the vehicle type. Pay particular attention to any roof accessories such as luggage or ski racks to be sure the Digital Antenna is not blocked by them, or in the way of them, or would be blocked when the racks are loaded.

Sedan/Coupe: The recommended mounting location is just above either the front windshield or the back window, as shown.
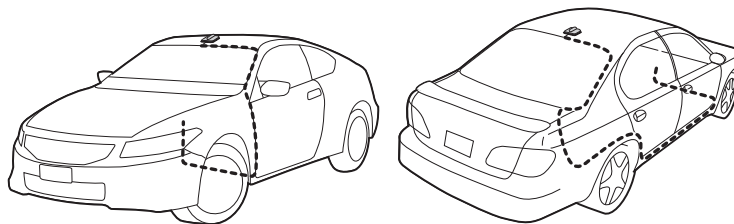
SUV: The recommended mounting location at the rear of the roof, as shown. If this is not possible, mount the antenna just above the front windshield.
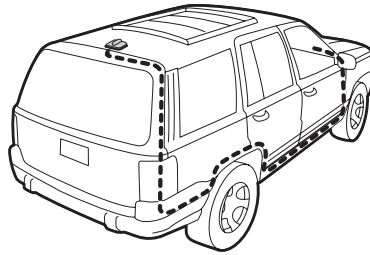
Pickup Truck: We recommend mounting the antenna just above the front windshield, as shown. (do not mount it in the bed of the pickup.)
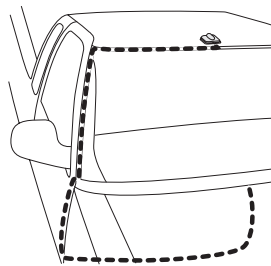
Installing the Digital Antenna

1. Once a location has been determined for the antenna, clean the surface of the selected mounting location using an alcohol preparation pad and let it dry thoroughly.

2. Attach the antenna to the vehicle:

   a. If you are using the antenna's magnet to hold it to the surface, place the antenna on the roof. Then check that the magnets are holding it in place (don't pull it by the cable). Orient the cable toward the nearest edge of the roof.

   b. If you are permanently attaching the antenna using 4 screws, you will need to drill four holes in the vehicle for the screws. Refer to the "Digital Antenna Mounting Template" on page 12 for a template for positioning the holes. Secure the antenna using four number M5, 0.8 pitch screws.

3. Route the antenna cable into the vehicle, and to the Under Dash Module location that was chosen. The following illustrations provide a visual overview of the cable routing for a typical sedan, and is followed by a step-by-step installation instructions for different types of vehicles.

   TIP! Always be careful to include enough slack in your cable to accommodate open doors or trunk lids. Use things typically found around the home, like electrical tape, to secure the cable in critical areas so that hinges do not pinch the cable with the door. Hide any excess cable in the trim.

Use a blunt plastic putty knife, a credit card, a plastic knife, or a similar blunt tool to lift the rubber window moulding

Tuck the cable under the moulding around the window

Feed cable under rubber moulding around window
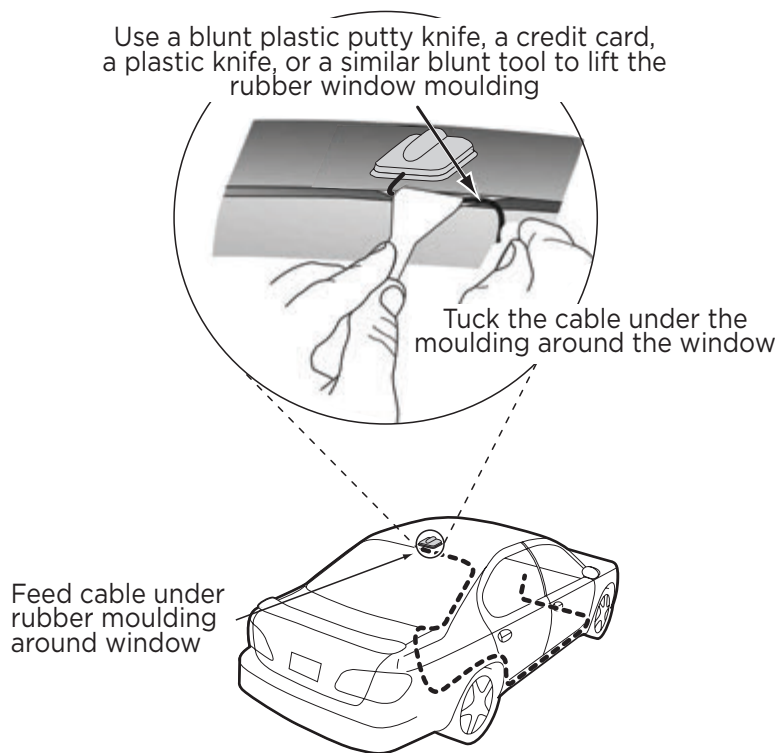
Route cable out from under rear windshield moulding and tuck into weatherstripping around trunk opening
Avoid sharp bends by running cable through weatherstripping for several inches

Pull weatherstripping from trunk opening

Tuck cable into weatherstripping. Route cable through weatherstripping several inches to avoid sharp bends
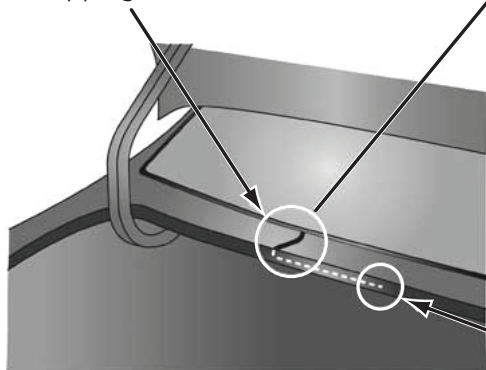
Pull cable out of weatherstripping and route through trunk to cabin
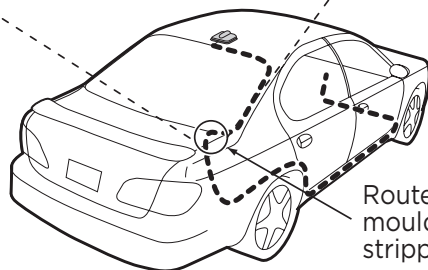
Route cable out of window moulding and into weather-stripping around trunk opening

Bring cable out of weatherstripping and into trunk
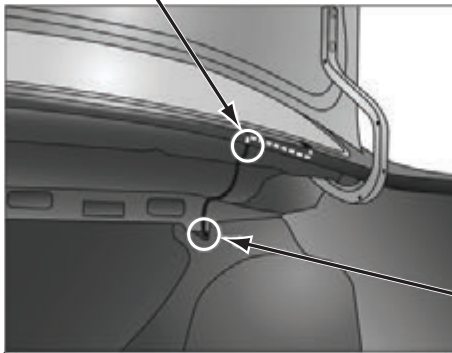
Route cable along trunk wall and into cabin through gap or conduit, along existing wiring harness

Route cable along trunk wall and into cabin

Use a blunt plastic putty knife or similar blunt tool to lift edge of interior trim and tuck cable under trim. Continue towards front of vehicle

Route cable under trim or upholstery

Continue routing cable under trim or carpet towards front of vehicle

Route cable from trunk under interior trim, into cabin and towards front of vehicle

Continue routing cable under carpet or console to the location of the Under Dash Module

Coil excess cable under carpet or mat

Pull carpet or mat back

Bring cable out from trim

Bring cable out from trim and route under carpet the location of the Under Dash Module

These next several sections contain step-by-step instructions for routing the antenna cable in different kinds of vehicles. Follow the instructions for the vehicle that most closely matches the vehicle in which Auriga is being installed.

Sedan/Coupe With Antenna Placed at the Rear of the Roof:

A. Feed the antenna cable from the antenna underneath the rubber molding around the rear window. Use a blunt plastic putty knife or similar blunt tool to lift the rubber molding around the rear window and tuck the antenna cable underneath the molding. Route the antenna cable around and down the window to the lowest point. If your rear window does not have rubber molding, we recommend consulting a professional installer.

B. Route the antenna cable out of the window molding and into the rubber weather stripping around the trunk opening. Lift the weather stripping from the opening and tuck the cable inside it, then replace the weather stripping. To avoid sharp bends in the cable, run the cable inside the weather stripping for a few inches, then remove the cable from the weather stripping inside the trunk. Keep the cable away from hinges, gears, etc., that could damage it.

C. Route the cable out from the rubber weather stripping and along the trunk wall. Continue routing the cable into the vehicle cabin through a conduit or along an existing wiring harness.

D. Route the cable through the main cabin area under the interior trim, towards the front of the vehicle. Use a blunt plastic putty knife or similar blunt tool to lift the plastic trim just enough to tuck the cable under underneath. Avoid side airbag locations on back pillars and above the doors. Airbag locations are marked with "SRS" logos. Be careful not to crimp or cut the cable.

E. Bring the cable out from the trim near the front of the cabin and route it under the carpet toward the dashboard or console. Coil any excess cable in a hidden location, such as under the carpet, keeping it away from any vehicle pedals or controls. Secure the excess cable with wire ties (purchased separately).

F. Bring the end of the cable out where the Under Dash Module will be located. Leave yourself enough cable so you can easily connect the cable to the Under Dash Module.
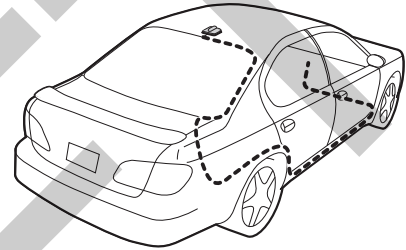
Sedan/Coupe With Antenna Placed at the Front of the Roof

A. Feed the antenna cable from the antenna underneath the rubber molding around the windshield. Use a blunt plastic putty knife or similar blunt tool to lift the rubber molding around the windshield and tuck the antenna cable underneath the molding. Route the antenna cable around and down the windshield to the lowest point.

B. At the lowest corner of the windshield, route the cable
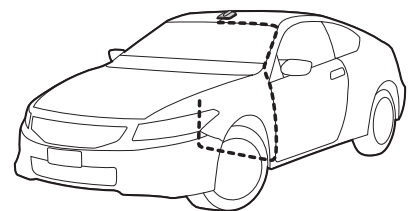
out of the windshield molding and into the rubber weather stripping around the door opening. Lift the weather stripping from the opening and tuck the cable inside it, then replace the weather stripping. Run the cable inside of the weather stripping to the bottom of the door opening.

C. Pull the cable out of the weather stripping at the bottom of the door opening and route it under the carpet toward the dashboard. Coil any excess cable in a hidden location, such as under the carpet, keeping it away from any vehicle pedals or controls. Secure the excess cable with wire ties.

D. Bring the end of the cable out where the Under Dash Module will be located. Leave yourself enough cable so you can easily connect the cable to the Under Dash Module. Continue with step 4 on page 26.

Sport Utility Vehicle (SUV)

A. Feed the antenna cable underneath the rubber weather stripping of the rear tailgate window/door and route the cable along the rear hatch. Lift the weather stripping from the opening and tuck the cable inside it, then replace the weather stripping. Pull the cable out from weather stripping and route it into the cabin under the interior trim. Avoid hinges or gears that could crimp or cut the cable.

B. Route the cable through the SUV's main cabin area under the interior trim, towards the front of the vehicle. Use a blunt plastic putty knife or similar blunt tool to lift the plastic trim just enough to tuck the cable under underneath. Avoid side airbag locations on back pillars and above the doors. Airbag locations are marked with "SRS" logos. Be careful not to crimp or cut the cable.

C. Bring the cable out from the trim near the front of the cabin and route it under the carpet toward the dashboard or console. Coil any excess cable in a hidden location, such as under the carpet, keeping it away from any vehicle pedals or controls. Secure the excess cable with wire ties (purchased separately).

D. Bring the end of the cable out where the Under Dash Module will be located. Leave yourself enough cable so you can easily connect the cable to the Under Dash Module. Continue with step 4 on page 26.
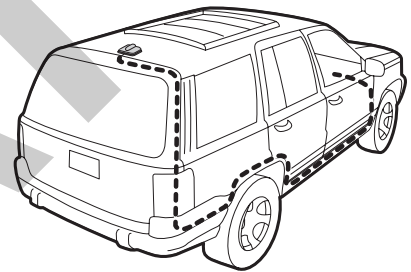
Pickup Truck

A. Use a blunt plastic putty knife or similar blunt tool to lift the rubber molding around the windshield and tuck the antenna cable underneath it.

B. Continue tucking the cable underneath the windshield molding around the windshield to the lowest corner.

C. At the lowest corner of the windshield, route the cable out of the windshield molding and into the rubber weather stripping around

Installation
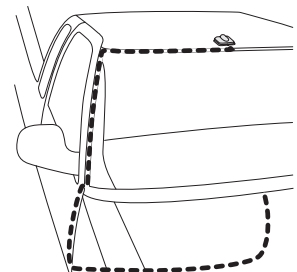
the door opening. Lift the weather stripping from the opening and tuck the cable inside it, then replace the weather stripping. Run the cable inside of the weather stripping to the bottom of the door opening.

D. Pull the cable out of the weather stripping at the bottom of the door opening and route it under the carpet toward the dashboard. Coil any excess cable in a hidden location, such as under the carpet, keeping it away from any vehicle pedals or controls. Secure the excess cable with wire ties.

E. Bring the end of the cable out where the Under Dash Module will be located. Leave yourself enough cable so you can easily connect the cable to the Under Dash Module.

4. Record Vehicle Information and the Location of the Digital Antenna. Once the Digital Antenna has been successfully mounted on the vehicle, you will need to record some information concerning the vehicle itself, and measurements which pinpoint the location of the Digital Antenna relative to the front left corner of the vehicle. Enter this information in the space provided in each of the following sub-steps.

    a. Record the following measurements for the length, width, height, and weight (GVWR) of the vehicle. You may be able to find this information in the vehicle's owners manual, or ascertain it from the manufacturer's website. All measurements should be in centimeters, and the weight in kilograms.
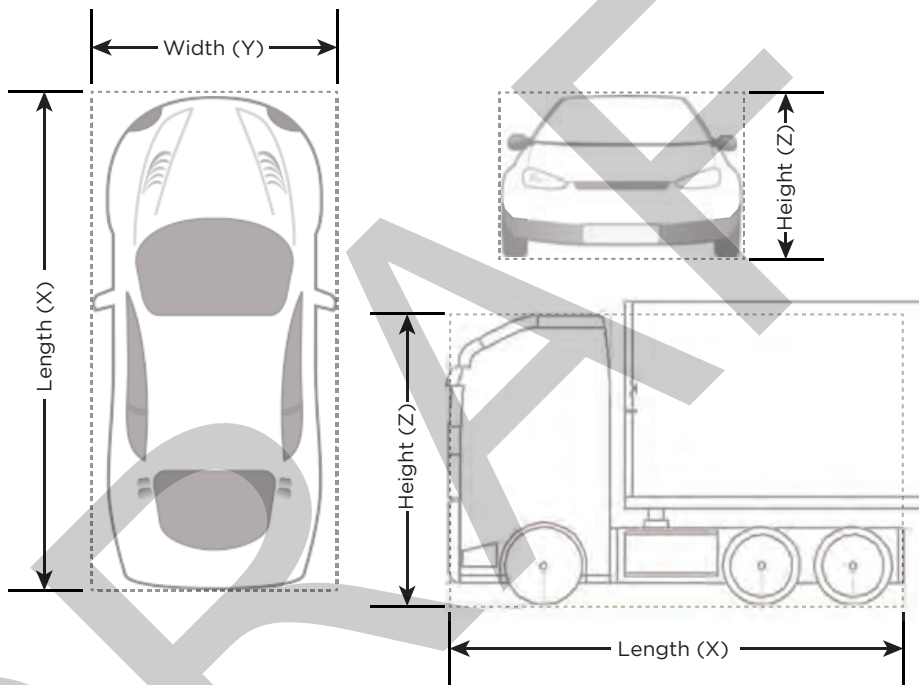
Type of Vehicle	
Vehicle Length (X)	
Vehicle Width (Y)	
Vehicle Height (Z)	
Vehicle Weight (GVWR)	

b. Record the following measurements for the rear axle(s). For tractor trailers additional measurements for the pivot and both rear axles are needed. All measurements should be in centimeters.
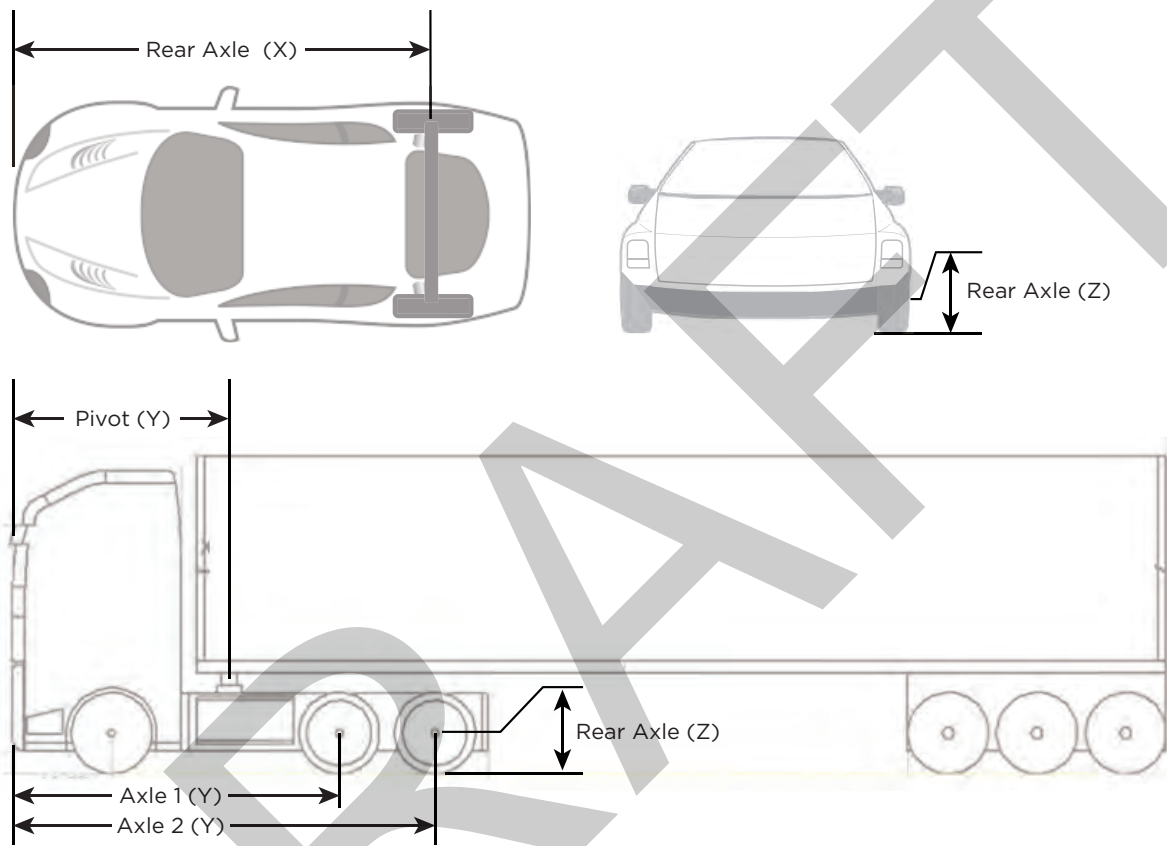
Rear Axle (X)	
Rear Axle (Z)	
Pivot (Y)	(Tractor Cab only)
Axle 1 (Y)	(Tractor Cab only)
Axle 2 (Y)	(Tractor Cab only)

c. Record the measurements which pinpoint the location of the Digital Antenna relative to the front left corner of the vehicle. Measurements should be in centimeters.
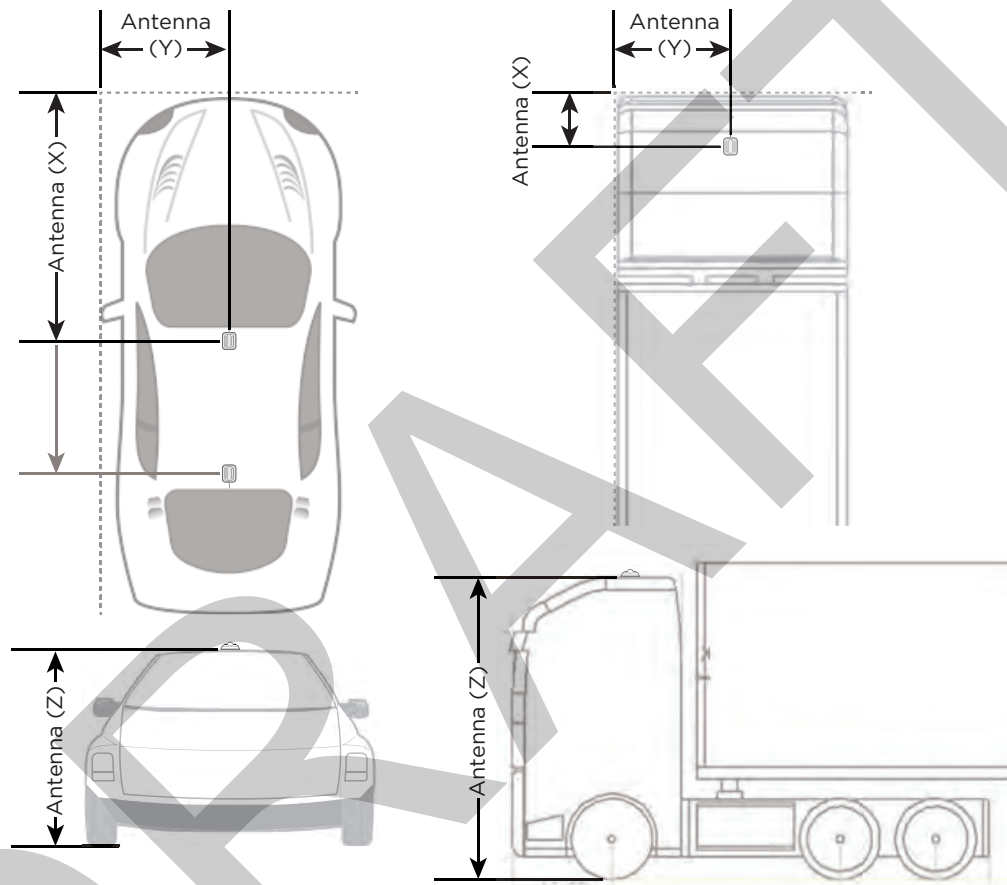
Antenna (X)	
Antenna (Y)	
Antenna (Z)	

Installation

Install the Touch Screen Display

The Touch Screen Display is mounted onto the Display Mounting Bracket. The bracket is installed to the vehicle using the suction cup on the bracket. The bracket has a removable clip to which the display is mounted using the four provided screws.

1. Remove the mounting clip from the Display Mounting Bracket.

2. Decide if the Reset Switch will be attached to the display. It is designed to sandwich between the clip and the display. If so, insert the Reset Switch between the clip and the display.

3. Attach the display to the mounting clip using the four provided screws. Orient the large tab on the mounting clip so that it faces the center of the display, as shown.

4. Reattach the mounting clip to the display to the Display Mounting Bracket.

5. Select a location in the vehicle for the Touch Screen Display where it is visible to the driver of the vehicle, but where it does not block the view of the driver, or is located where it would be particularly distracting to the driver. Mount it do that the display hangs below the dashboard as much as possible.

    It should not be mounted where it would interfere with the operation of the vehicle's airbags.

    Do not mount on the windshield with the suction cup as laws in many states prohibit windshield mounts.

Use the several adjustments on the bracket to orient the display so it can be seen by the driver. The surface where the suction cup foot will rest should be a fairly flat surface and not curved.

6. Take the flat round disc that was included with the Display Mounting Bracket and remove the adhesive from the back of the disc. Press and hold the disk in place for 30 seconds.
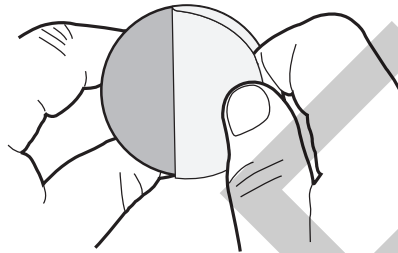
7. Allow the adhesive to cure for 2-4 hours before attaching the bracket suction cup to the disc.

8. Connect the HDMI Display Cable and the Touch Screen Display Cable to the Touch Screen Display. Use the cable management clamp to hold the cables and prevent them from accidentally being disconnected.

Connection Not Used

Touch Screen Interface Connection

HDMI Connection

Cable Management Clamp
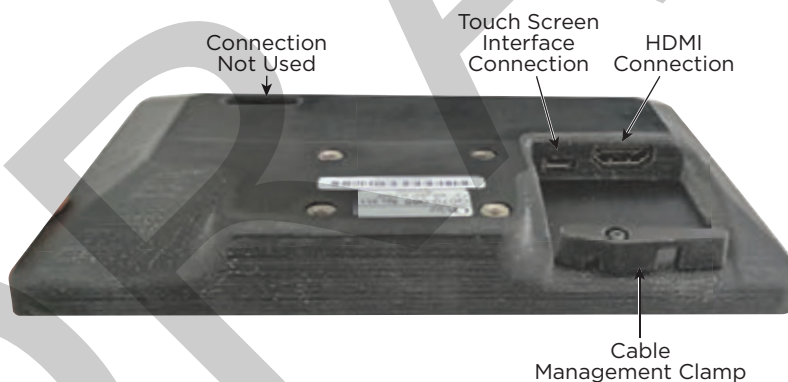
9. Route both cables to the location where the Under Dash Module will be located.

Install the Reset Switch

The Reset Switch is designed to be sandwiched between the Touch Screen Display and the removable clip on the Display Mounting Bracket. (Refer to "Install the Touch Screen Display" on page 29.) If you already installed the switch using that method, skip ahead to the next installation step.

The Reset Switch can be mounted in any location that is convenient to access. The switch can be secured using wire ties or two screws. If using screws, caution should be observed so as not to compromise any of the vehicle's systems or wiring with the screws, where the point of the screw could puncture something important in the vehicle.

This side of the Reset Switch must be accessible
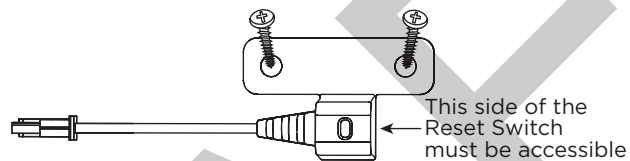
Install the Power Control Cable

The power connection for Auriga requires both a constant 12-volt source, and a power source that is switched on and off with the vehicle's ignition (ACC).

To Under Dash Module

10A Fuse

Battery (Yellow)
Accessory (Red)
Ground (Black)
To Reset Switch
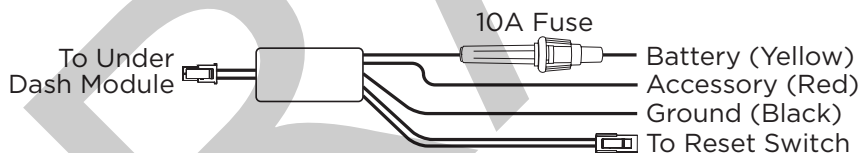
1. Connect the Yellow battery wire to a constant 12 volt battery power source in the vehicle.

2. Connect the Red accessory wire to the vehicle's ACC 12 volt connection, one which is switched on/off with the vehicle's ignition.

3. Connect the Black ground wire to a ground point in the vehicle.

4. Route the Reset Switch cable that has the connector with the Green and White wires to the Reset Switch and connect it to the switch.

5. Route the Under Dash Module cable that has the connector with the Yellow, Red, and Black wires to the location where the Under Dash Module will be located.

Install the Audio Speaker

The Audio Speaker should be mounted where the driver is able to hear it, but where it does not interfere with the vehicle's control pedals, is not accidentally kicked, and does not interfere with the operation of the vehicle's airbags.

1. Attach the U-shaped mounting bracket to the vehicle using the provided screws. Clips are also provided that can act as retainers for the screws if the speaker is being mounted on a thin surface. Caution should be observed so as not to compromise any of the vehicle's systems or wiring with the screws, where the point of the screw could puncture something important in the vehicle.

2. Attach the speaker to the bracket using the two knurled knobs.

3. Route the speaker cable to the location where the Under Dash Module will be located.
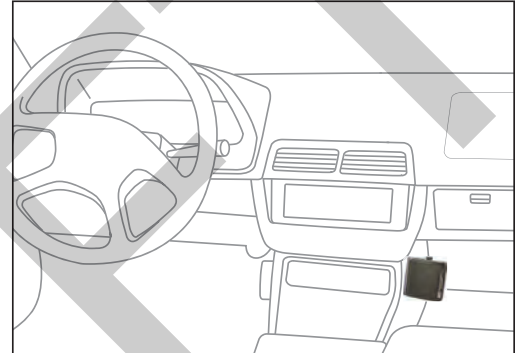
Install the Aux Audio Cable or FM Direct Adapter

The audio connection for the SiriusXM Radio service can be made using the Aux Audio Cable direct connection (preferred), or by using the FM Direct Adapter to receive the audio via the vehicle's FM radio.

Connecting the Audio Using the Aux Audio Cable

Connect the provided Aux Audio Cable to the vehicle's Aux connection, and route the cable to the location where the Under Dash Module will be located.

Connecting the Audio Using the FMDA25 FM Direct Adapter

Certain vehicle models will require adapters to connect the vehicle's AM/FM antenna to the FMDA25, and to connect the FMDA25 to the vehicle's radio. These adapters are sold separately by most professional installers.

1. Remove the vehicle's radio from the dash and disconnect the AM/FM antenna cable from the rear of the vehicle's radio.
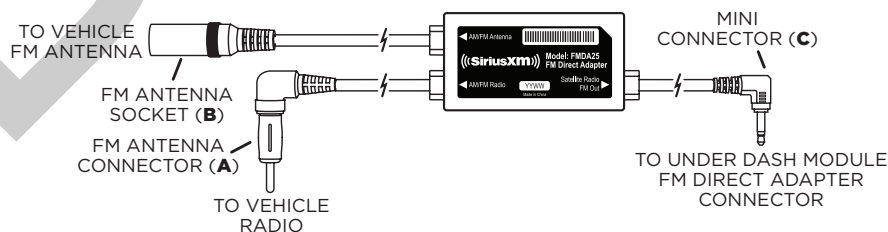
2. Plug the FM Antenna Connector **(A)** from the FMDA25 into the same connector on the vehicle's radio. (Additional antenna adapter may be required.)

3. Plug the vehicle's AM/FM antenna cable into the female FM Antenna Socket **(B)** of the FMDA25. (Additional antenna adapter may be required.)

4. The FMDA25 should be secured behind the vehicle's radio location or under the dash using a wire tie (not included). Wrap the wire tie around the molded indents of the FMDA as shown to prevent the FMDA25 from slipping, and secure the FMDA25 to a bracket or wiring harness using the wire tie. Avoid brackets with sharp edges and any moving parts such as gas, clutch, and brake pedals.

5. Reinstall the vehicle's radio into the dash.

6. Route the Mini Connector **(C)** cable to the location of the Under Dash Module.
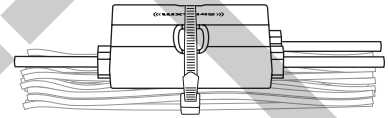
NOTE: Auriga and the vehicle's FM radio must be tuned to the same FM channel to hear the SiriusXM audio.

Install the Under Dash Module

The Under Dash Module has a number of connections that need to be made to three sides of the module. In addition, it may be necessary to connect a USB cable or install/remove a MicroSD card at some future time for debugging and configuration purposes. Choose a location where there is sufficient space for these connections, easy access, good ventilation, and a dry location. Hiding it behind the dashboard or under a front seat of the vehicle would be ideal. It should not be mounted where it could interfere with the vehicle's control pedals (accelerator, brake, clutch), nor where it can be accidentally kicked. It should not be mounted where it would interfere with the operation of the vehicle's airbags.

The Under Dash Module can be secured with wire ties or with screws. If using wire ties, the module should be mounted securely so that it does not move when the vehicle is in motion. There are grooves moulded into the top surface module to accommodate the wire ties, and keep them from slipping.
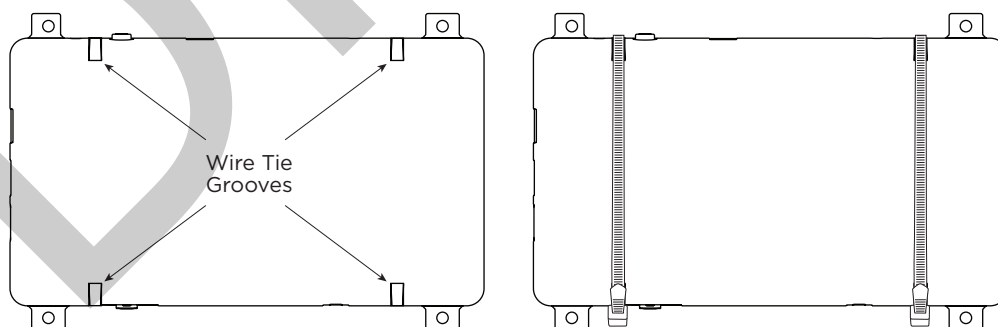
Wire Tie Grooves

If using screws, caution should be observed so as not to compromise any of the vehicle's systems or wiring with the screws, where the point of the screw could puncture something important in the vehicle. Wire ties or four screws (#8) will need to be provided by the installer.
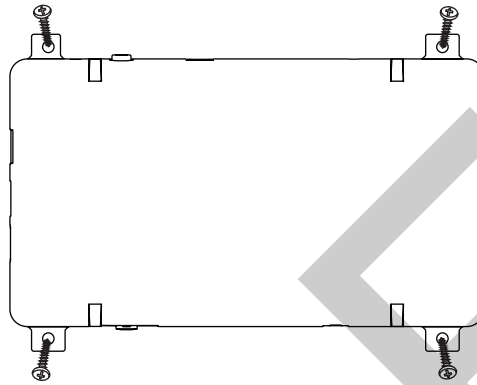
Under Dash Module Cable Connections

At this point in the installation process all the cables should have been routed to the location where the Under Dash Module is installed. Connect all the cables to the Under Dash Module.

1. Connect the Touch Screen Display Cable.

2. Connect the HDMI Display Cable.

3. If needed, connect the External Accessories Cable.

4. Connect the Power Control Cable.

5. Connect either the FM Direct Adapter Cable, or the Aux Audio Cable. Do not connect both.

6. Connect the Digital Antenna Cable.

7. Connect the Audio Speaker Cable.
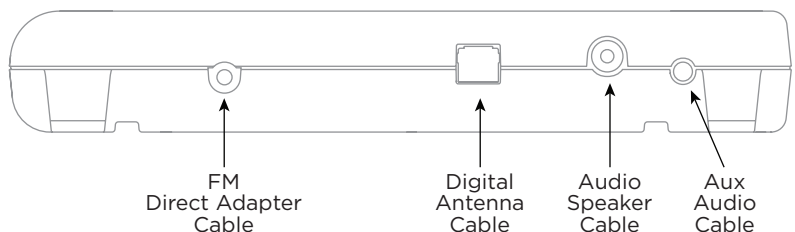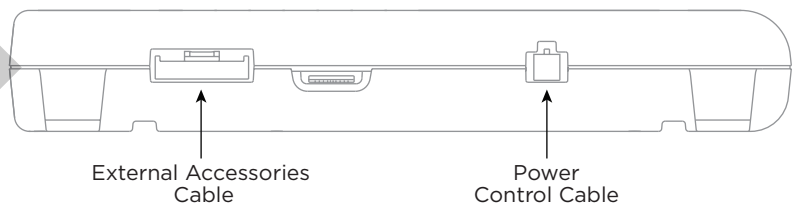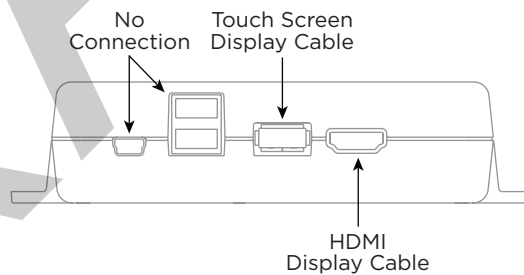
External Accessories Cable Connections

If connections are being made to the External Accessories Cable, complete these connections. Refer to the table on page 9 for details concerning the External Accessories Cable.

The antenna module contains an Inertial Measurement Unit that must be calibrated after installation.

The calibration procedure require good GNSS signal conditions as well as periods during which the vehicle both stationary and moving (including turns). The duration of the calibration procedure mostly depends on the quality of the GNSS signals and the dynamics encountered by the vehicle.

Therefore the vehicle should be driven to an open and flat area like an empty open to the sky parking area, for example. The calibration drive should contain phases where the vehicle is stopped a few minutes (with engine turned-on), phases where the vehicle is doing normal left and right turns, and phases where the vehicle is travelling in a straight line with the speed above 30 km/h, under good GNSS reception conditions.

For a faster calibration, the following steps are recommended.

1. Park the vehicle in open to the sky area, leave vehicle engine running, and stay stationary under good GNSS signal reception conditions for at least 3 minutes.

2. After being stationary for 3 minutes, start driving with a minimum speed of 20 km/h and do a series of approximately 10 left and right turns of at least 90 degrees each. Each turn should be completed as if the vehicle would drive in a sharp roundabout.

3. Drive for at least 500 meters at a minimum speed of 20 km/h. To shorten this calibration step, the vehicle should be driven at higher speed (around 50 km/h) for at least 10 seconds under good GNSS visibility and signal reception.

4. Drive straight for at least 100 meters at a minimum speed of 40 km/h.

5. At this point, the Auriga unit should indicate that it has been calibrated.

Specifications

Auriga System

Power Requirements . . . . 8-16 V DC
Operating Current . . . . 6 A @ 12 V (max)
Off Mode Current . . . . 10 mA (max)
Operating Temperature . . . . -40°F to + 185°F (-40°C to +85°C)

Under Dash Module

Dimensions . . . . 8.15 in x 5.4 in x 1.26 in x 1.4 in
(207 mm x 138 mm x 32 mm)
Weight . . . . 15.23 oz (432 g)

Digital Antenna

Dimensions . . . . 4.74 in x 3.54 in x
(120 mm x 90 mm x 36 mm)
Weight . . . . 15.52 oz (440 g)
Cable Length . . . . 22 ft.

Touch Screen Display

Dimensions . . . . 7.07 in x 4.5 in x .85 in
. . . . (180 mm x 116 mm x 21.5 mm)
Weight . . . . 12.6 oz (351 g)

FMDA25 FM Adapter

Dimensions (WxHxD) . . . . 1.75 in x 1.0 in x .6875 in
(44.5 mm x 25.5 mm x 17.5 mm)
Satellite Radio FM Cable Length . . . . 6 ft (1.82 m)
FM Radio Plug Motorola (Male) Length . . . . 8 in (203 mm)
FM Antenna Jack Motorola (Female) Length . . . . 8 in (203 mm)
Weight . . . . 2.1 oz (60 g)

Reset Switch

Cable Length . . . . 22 ft. (6 m)
Weight . . . . 2.15 oz (61 g)

Power Cable

Wire Identification . . . . BAT (Yellow), ACC (Red),
2x GND (Black)
In line fuse (BAT Wire) . . . . 10 A (AGC Type)
Length . . . . 12.6 in (320 mm)
Weight . . . . 3.17 oz (90 g)

Touch Screen Display Cable

Connectors . . . . USB Type A to USB Micro
Cable Length . . . . 6 ft (1.80 m)

(continued on next page)

HDMI Display Cable

Connectors . . . . SDMI Type A to HDMI Type A

Length . . . . 6 ft (1.8 m)

Aux Audio Cable

Connectors . . . . 1/8 in (3.5 mm) to 1/8 in (3.5 mm)
stereo male

Cable Length. . . . . 4 ft (1.2 m)

Patent Information

It is prohibited to, and you agree that you will not, copy, decompile, disassemble, reverse engineer, hack, manipulate, or otherwise access and/or make available any technology incorporated in this product. Furthermore, the AMBE® voice compression software included in this product is protected by intellectual property rights including patent rights, copyrights, and trade secrets of Digital Voice Systems, Inc. The software is licensed solely for use within this product. The music, talk, news, entertainment, data, and other content on the Services are protected by copyright and other intellectual property laws and all ownership rights remain with the respective content and data service providers. You are prohibited from any export of the content and/or data (or derivative thereof) except in compliance with applicable export laws, rules and regulations. The user of this or any other software contained in a Sirius XM Radio Inc is explicitly prohibited from attempting to copy, decompile, reverse engineer, hack, manipulate or disassemble the object code, or in any other way convert the object code into human-readable form.

Environmental Information

Follow local guidelines for waste disposal when discarding packaging and electronic appliances.

Perchlorate Material - special handling may apply. See www.dtsc.ca.gov/hazardouswaste/perchlorate (Applicable to California, U.S.A.)

The user is cautioned that changes or modifications not expressly approved by Sirius XM Radio Inc. can void the user's authority to operate this device.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.

2. This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the installation instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna of the affected receiver.
- Increase the separation between the SiriusXM equipment and the affected receiver.
- Connect the SiriusXM equipment into an outlet on a circuit different from that to which the affected receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

WARNING! The FCC and FAA have not certified this Satellite Radio Receiver for use in any aircraft (neither portable nor permanent installation). Therefore, Sirius XM Radio Inc. cannot support this type of application or installation.

IMPORTANT NOTICE: REQUIRED SUBSCRIPTION

Hardware and subscription sold separately, and activation fee required. Other fees and taxes may apply. **Subscriptions governed by SiriusXM Customer Agreement; see www.siriusxm.com**. <u>**Service automatically renews into the subscription Package you choose (which may differ from the Package which arrived with the Radio), for additional periods of the same length, and automatically bills at then-current rates, after any complimentary trial or promotional period ends. You must call us to cancel at 1-866-635-2349.**</u> Fees and programming are subject to change.

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WARNING: This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

Sirius XM Radio Inc.
1290 Avenue of the Americas
New York, NY 10104

1.866.635.2349

siriusxm.com

WYDOT RSU Installation Plan

INDEX OF SHEETS

STATE OF WYOMING
WYOMING DEPARTMENT OF TRANSPORTATION

CONNECTED VEHICLE PILOT PROJECT
I - 80 CORRIDOR ROAD-SIDE UNITS
UINTA, SWEETWATER, CARBON, & LARAMIE COUNTIES

CONNECTED VEHICLE

I-80 RM 0.00

I-80 RM 401.00

N

I - 80 CORRIDOR - SEE SHEETS 13 - 15 FOR LOCATIONS

APPROVED:

_____ 05-12-17
CHIEF ENGINEER   DATE

DESIGNED BY **TRAFFIC** _____

PROFESSIONAL SEALS

"AS CONSTRUCTED PLANS"

RESIDENT ENGINEER

"DESIGN PLANS"

TRAFFIC	TRAFFIC (ELECTRICAL)	ITS

TOTAL ESTIMATED QUANTITIES

ITEM NO.	ITEM	UNIT	QUANTITIES ROADWAY CODE 21
109.04000	FORCE ACCOUNT WORK	$$	$2,000
109.08000	MOBILIZATION	LS	LUMP SUM
215.01000	CONTRACTOR STORM WATER CONTROL	LS	LUMP SUM
506.01030	DRILLED SHAFT FOUNDATIONS 30 in	FT	80
701.81300	ITS COMMUNICATION SYSTEM	LS	LUMP SUM
703.03100	FLAGGING	HR	100
703.03110	TEMPORARY TRAFFIC CONTROL	LS	LUMP SUM

GENERAL NOTES:

1. PRIOR TO THE INSTALLATION OR THE USE OF HDPE DUCT OR HDPE FITTINGS THE CONTRACTOR IS TO SUBMIT AND OBTAIN APPROVAL FROM WYDOT TRAFFIC.

2. ALL SERVICE POINTS TO MEET CURRENT WYDOT STANDARDS. REMOVED SERVICE EQUIPMENT TO BECOME THE PROPERTY OF THE CONTRACTOR, WITH THE EXCEPTION OF THE POWER COMPANY METERS.

3. COORDINATE ALL SERVICE POINT WORK WITH THE SERVICING UTILITY. IT IS THE CONTRACTOR'S RESPONS-IBILITY TO CONTACT THE LOCAL ELECTRICAL INSPECTOR FOR ANY "HOME RULE" THAT MAY APPLY TO, AND/OR AFFECT THE TIMELY INSTALLATION OF THE ELECTRICAL SYSTEM.

4. CONTRACTOR TO ADHERE TO THE NEC, LATEST EDITION, ARTICLE 110.12 "MECHANICAL EXECUTION OF WORK" AS DESCRIBED IN ANSI/NECA 1-2006.

5. PERFORM ALL WORK UNDER TRAFFIC. PROVIDE CONTINUOUS ACCESS TO ALL ADJACENT LANDOWNERS AND BUSINESS ESTABLISHMENTS AT THE EXISTING DRIVEWAYS AND APPROACHES AT ALL TIMES AS APPROVED BY THE ENGINEER.

6. WYDOT PERSONNEL TO INSTALL THE TRAFFIC SIGNAL CONTROLLER CABINET AND ALL ASSOCIATED AUXILIARY EQUIPMENT. GIVE THE DISTRICT TRAFFIC ENGINEER 2 WEEKS ADVANCE NOTICE FOR INSTALLATION OF THE CABINET AND EQUIPMENT PRIOR TO TURN ON. THE ELECTRICAL CONTRACTOR IS TO BE PRESENT AT EACH TRAFFIC SIGNAL TURN ON.

7. PRIOR TO THE START OF DRILLING OR EXCAVATION WORK, COORDINATE THE ANTICIPATED WORK WITH THE LOCAL MUNICIPALITY AND/OR UTILITY COMPANIES AND OBTAIN THE NECESSARY UTILITY LOCATES IN THE VICINITY OF THE WORK. LEAVE NO HOLES UNPROTECTED AT THE END OF EACH DAY'S OPERATION. ALL ELEVATIONS AND FINAL LOCATIONS OF FOOTINGS AND PULL BOXES ARE TO BE APPROVED BY THE ENGINEER. DO NOT TRENCH WITHOUT PRIOR APPROVAL OF THE ENGINEER.

8. CONDUCTORS AND CONDUIT QUANTITIES LISTED ARE APPROXIMATE SINCE THEY ARE BASED ON THEORETICAL DIMEN-SIONS AND CONDITIONS. PERFORM AN ON SITE JOB INSPECTION, CAREFULLY EXAMINE THE PLANS, PREPARE A TAKEOFF OF QUANTITIES AND BID ACCORDINGLY. FINAL LUMP SUM PAYMENT(S) ARE NOT ADJUSTED FOR OVERRUNS/UNDERRUNS.

9. ENSURE THAT, AFTER ROADWAY LUMINARIES AND/OR OVERHEAD SIGN LIGHTS ARE INSTALLED, THEY ARE LEVELED PER MANUFACTURER'S RECOMMENDATIONS.

10. THE CONDUIT RUNS SHOWN, ARE FOR THE MOST PART, STRAIGHT BETWEEN THE RESPECTIVE PULL BOXES. THE INTENT IS TO MINIMIZE CONDUIT BENDS. THEREFORE, NO MORE THAN 270 degrees IN BENDS WILL BE ALLOWED BETWEEN PULL BOXES. THIS INCLUDES THE 90 degree BENDS INTO THE PULL BOXES. NO DEVIATIONS TO THIS ARE TO BE ALLOWED UNLESS, PRE APPROVED BY DISTRICT TRAFFIC PERSONNEL AND CLEARLY DOCUMENTED ON THE PLANS. ALL FOREIGN OBJECTS (WATER, GRAVEL, ECT.) MUST BE REMOVED FROM THE CONDUITS AND ALL WIRING IS TO MOVE FREELY WITHIN. PROVIDE ALL CONDUITS WITH 1/2" WOVEN POLYESTER PULL TAPE WITH SEQUENTIAL FOOTAGE MARKINGS.

MISCELLANEOUS SUMMARY

ITEM	UNIT	TOTAL AND FOR ESTIMATE
FORCE ACCOUNT WORK (1)	$$	$2,000
MOBILIZATION	LS	LUMP SUM
CONTRACTOR STORM WATER CONTROL	LS	LUMP SUM

(1) FOR ANY UNFORESEEN WORK.

ELECTRICAL SUMMARY

ITEM	NOTE	UNIT	QUANTITY
DRILLED SHAFT FOUNDATIONS 30 in		FT	80
ITS COMMUNICATION SYSTEM	1	LS	LUMP SUM

NOTES:
1. FOR BREAKDOWN OF QUANTITIES SEE " BILL OF MATERIALS FOR THE LUMP SUM BID ITEM 'ITS COMMUNICATIONS SYSTEM'".

BILL OF MATERIALS FOR THE LUMP SUM BID ITEM "ITS COMMUNICATION SYSTEM"
(THIS BILL OF MATERIALS IS FOR INFORMATIONAL PURPOSES ONLY)

ITEM	UNIT	FOR ESTIMATE	SUBMIT FOR APPROVAL
AC STANDALONE RSU	EA	4	YES
STANDALONE RSU	EA	6	YES
ROAD-SIDE UNIT	EA	73	YES
DC-TO-DC CONVERTER	EA	3	YES
ETHERNET SWITCH	EA	2	YES
5.8 GHZ ETHERNET RADIO	EA	38	YES
POWER STRIP	EA	1	YES
ROOF MOUNT	EA	11	YES
CONDUIT-RIGID PVC 2"	FT	625	YES
SINGLE CONDUCTOR WIRE #8 AWG	FT	1875	YES
CAT5e ETHERNET CABLE	FT	4710	YES

*SURGE PROTECTORS ARE REQUIRED FOR EACH RSU AND RADIO, MODEL ETH-SP BY UBIQUITI

TRAFFIC CONTROL SUMMARY

ITEM	UNIT	TOTAL AND FOR ESTIMATE
FLAGGING	HR	100
TEMPORARY TRAFFIC CONTROL	LS	LUMP SUM

LEGEND:

⊗   DRILLED SHAFT FOUNDATION 30"

–■–   STANDALONE RSU

�X   HIGH MAST LIGHTING CONTROLLER CABINET

— —   CONDUIT RIGID PVC

[30]

PVC 2
2-#8 AWG RHW
1-#8 AWG EGC
PT

STANDALONE RSU
Lat 41.264683°
Long -110.911091°

SCALE:

0   50   100   200 ft.

FLAG NOTES:

1▷   CONTRACTOR IS TO CONNECT POWER TO SIGN LIGHTING 20A 2-POLE BREAKER IN HIGH MAST CABINET

2▷   SEE STANDALONE RSU INSTALLATION DETAIL SHEET

POLE TO BE MOUNTED ON SLIP BASE - SEE SLIP BASE DETAIL SHEET

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL
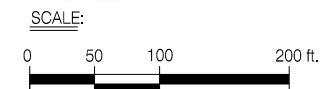
STANDALONE RSU LAYOUT
RM 7.7

DESIGNER: JAB	DATE: 3/20/17	REV:
ENGINEER: JAB	SHEET _ OF	

LEGEND:

⊗ DRILLED SHAFT FOUNDATION 30"

─■─ STANDALONE RSU

Ⅺ HIGH MAST LIGHTING CONTROLLER CABINET

— — CONDUIT RIGID PVC

PVC 2
2-#8 AWG
1-#8 AWG EGC
PT

STANDALONE RSU
Lat 41.262234°
Long -110.895779°

1

2

SCALE:

0   50   100   200 ft.

FLAG NOTES:

1 ▷ CONTRACTOR IS TO CONNECT POWER TO SIGN LIGHTING 20A 2-POLE BREAKER IN HIGH MAST CABINET

2 ▷ SEE STANDALONE RSU INSTALLATION DETAIL SHEET

POLE TO BE MOUNTED ON SLIP BASE - SEE SLIP BASE DETAIL SHEET

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

STANDALONE RSU LAYOUT
RM 8.55

DESIGNER: JAB	DATE: 3/20/17	REV:
ENGINEER: JAB	SHEET _ OF	

LEGEND:

⊗   DRILLED SHAFT FOUNDATION 30"

–■–   STANDALONE RSU

STANDALONE RSU
Lat 41.331339°
Long -110.434597°

SCALE:

0   50   100   200 ft.

SEE STANDALONE RSU INSTALLATION DETAIL SHEET

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

STANDALONE RSU LAYOUT
RM 34.50

DESIGNER: JAB	DATE: 3/20/17	REV:
ENGINEER: JAB	SHEET _ OF	

LEGEND:

⊗ DRILLED SHAFT FOUNDATION 30"

▬ STANDALONE RSU

STANDALONE RSU
Lat 41.492582°
Long -110.014823°
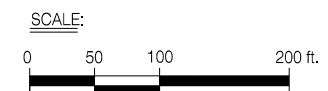
SCALE:

0   50   100   200 ft.

SEE STANDALONE RSU INSTALLATION DETAIL SHEET

POLE TO BE MOUNTED ON SLIP BASE - SEE SLIP BASE DETAIL SHEET

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

STANDALONE RSU LAYOUT
RM 59.67

DESIGNER: JAB	DATE: 3/20/17	REV:
ENGINEER: JAB	SHEET _ OF	

LEGEND:

⊗   DRILLED SHAFT FOUNDATION 30'

—■—   STANDALONE RSU

Standalone RSU
Lat 41.542923º
Long -109.827202º

374

30

SEE STANDALONE RSU INSTALLATION DETAIL SHEET

POLE TO BE MOUNTED ON SLIP BASE - SEE SLIP BASE DETAIL SHEET

SCALE:

0   50   100   200 ft.
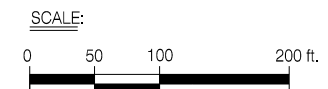
WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL
STANDALONE RSU LOCATION
RM 70.55

DESIGNER: JAB	DATE: 3/20/17	REV:
ENGINEER: JAB	SHEET _ OF	

LEGEND:

⊗   DRILLED SHAFT FOUNDATION 30"

─■─   STANDALONE RSU

Standalone RSU
Lat 41.734668°
Long -107.699266°

SEE STANDALONE RSU INSTALLATION DETAIL SHEET

POLE TO BE MOUNTED ON SLIP BASE - SEE SLIP BASE DETAIL SHEET

SCALE:

0   50   100   200 ft.

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

STANDALONE RSU LAYOUT
RM 188.81

DESIGNER: JAB	DATE: 3/20/17	REV:
ENGINEER: JAB	SHEET _ OF	

LEGEND:

⊗   DRILLED SHAFT FOUNDATION 30"

─■─   STANDALONE RSU

Standalone
⊗
■ Lat 41.739147°
Long -107.682966°

SCALE:

0   50   100   200 ft.
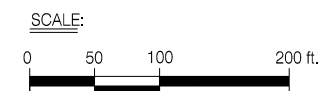
SEE STANDALONE RSU INSTALLATION DETAIL SHEET

POLE TO BE MOUNTED ON SLIP BASE - SEE SLIP BASE DETAIL SHEET

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

STANDALONE RSU LAYOUT
RM 189.65

DESIGNER: JAB	DATE: 3/20/17	REV:
ENGINEER: JAB	SHEET _ OF	

LEGEND:

⊗   DRILLED SHAFT FOUNDATION 30"

–■–   STAND ALONE RSU

⊠   EXISTING ITS CABINET

■   EXISTING PULL BOX

— —   CONDUIT RIGID PVC

▷1

PVC 2
2-#8 AWG
1-#8 AWG EGC

STANDALONE RSU
Lat 41.429443°
Long -110.120157°

◁2

I-80 WBL

I-80 EBL

FLAG NOTES:

1▷   CONTRACTOR IS TO CONNECT TO EXISTING POWER IN PULL BOX

2▷   SEE STAND ALONE RSU INSTALLATION DETAIL SHEET
POLE TO BE MOUNTED ON SLIP BASE - SEE SLIP BASE DETAIL SHEET

SCALE:
0   50   100   200 ft.
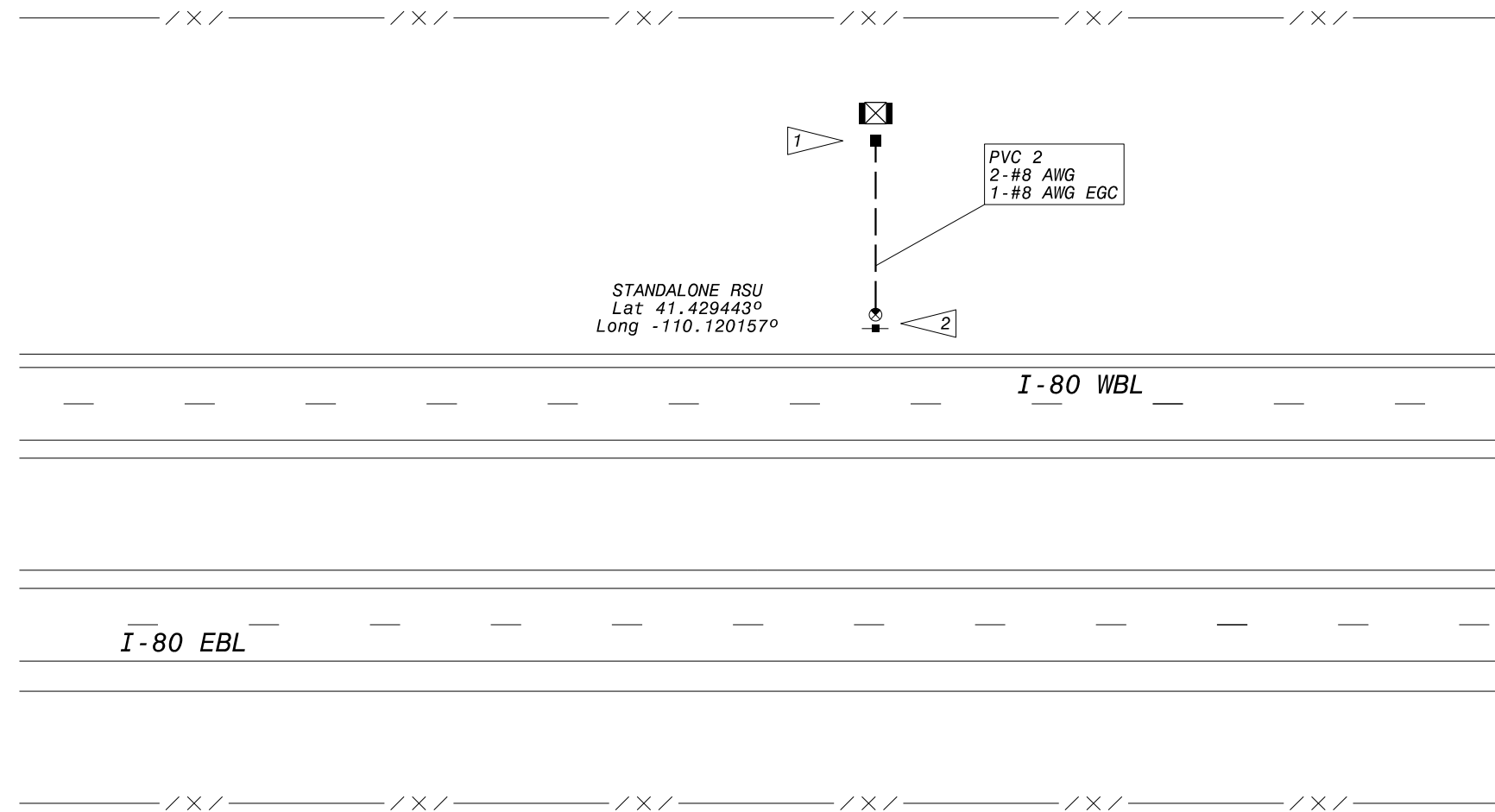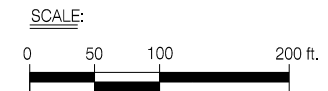
WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

STAND ALONE RSU LAYOUT
RM 52.65

DESIGNER: JAB	DATE: 3/20/17	REV:
ENGINEER: JAB	SHEET _ OF	

LEGEND:

⊗   DRILLED SHAFT FOUNDATION 30"

—■—   STAND ALONE RSU

⊠   EXISTING ITS CABINET

■   EXISTING PULL BOX

— —   CONDUIT RIGID PVC

I-80 WBL

I-80 EBL

PVC 2
2-#8 AWG
1-#8 AWG EGC

◁ 2   STANDALONE RSU
Lat 41.645780°
Long -108.583098°

◁ 1

FLAG NOTES:

1▷   CONTRACTOR IS TO CONNECT TO EXISTING POWER IN PULL BOX

2▷   SEE STAND ALONE RSU INSTALLATION DETAIL SHEET
POLE TO BE MOUNTED ON SLIP BASE - SEE SLIP BASE DETAIL SHEET

SCALE:

0   50   100   200 ft.

SEE STAND ALONE RSU INSTALLATION DETAIL SHEET

POLE TO BE MOUNTED ON SLIP BASE - SEE SLIP BASE DETAIL SHEET

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL
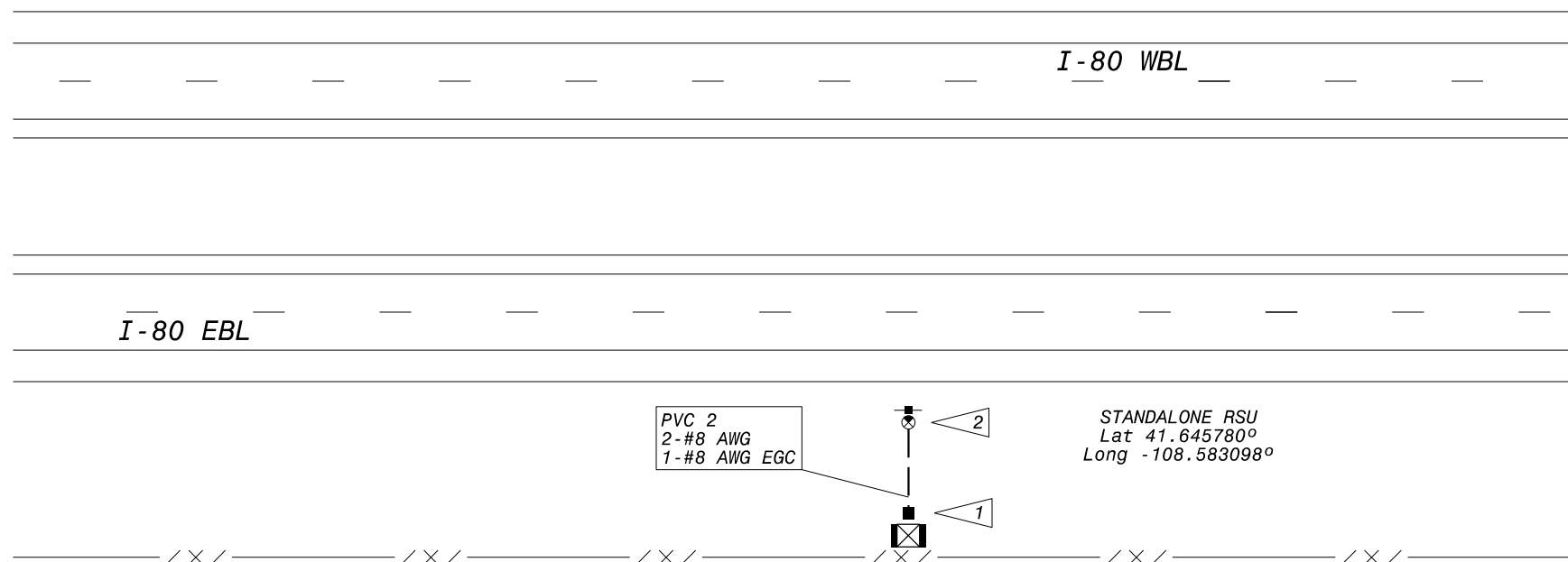
STAND ALONE RSU LAYOUT
RM 141.83

DESIGNER: JAB	DATE: 3/20/17	REV:
ENGINEER: JAB	SHEET _ OF	

LEGEND:

⊗   DRILLED SHAFT FOUNDATION 30"

─■─   STAND ALONE RSU

I-80 WBL

I-80 EBL

STANDALONE RSU
Lat 41.625192º
Long -106.259626º

SEE STAND ALONE RSU INSTALLATION DETAIL SHEET

SCALE:

0   50   100   200 ft.
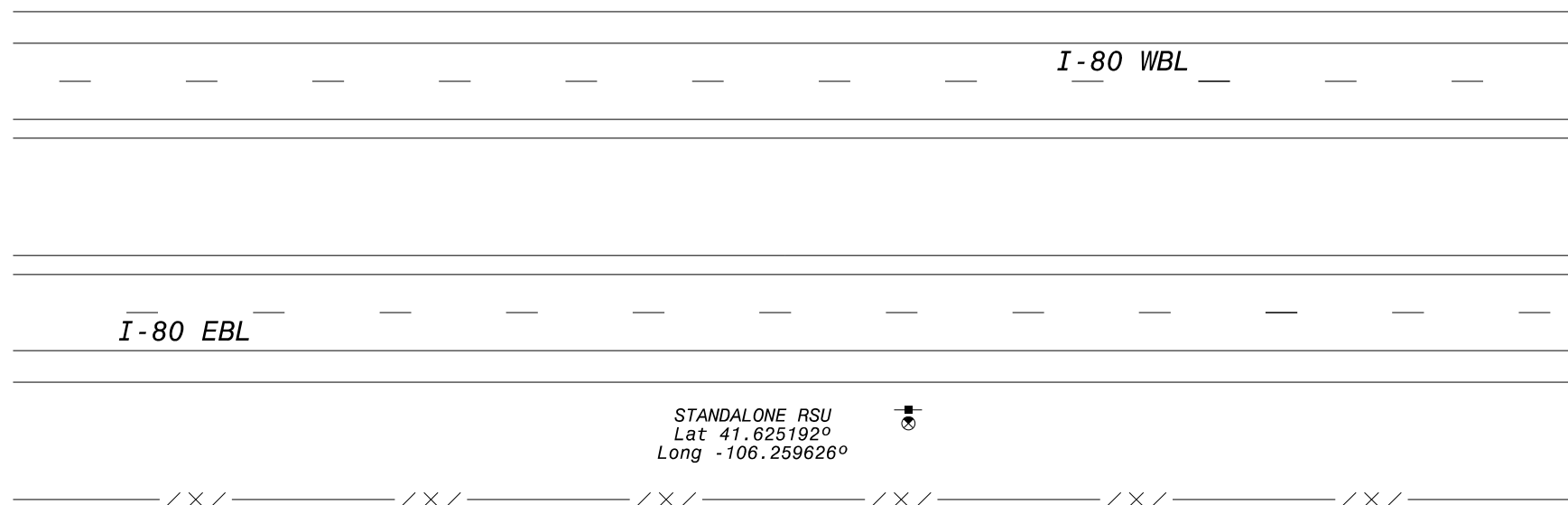
WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

STAND ALONE RSU LAYOUT
RM 268.60

DESIGNER: JAB	DATE: 3/20/17	REV:
ENGINEER: JAB	SHEET _ OF	

NOTE(S)	WYDOT CONTACT	ROADWAY	MILEPOST	DIRECTION	EXISTING ITS DEVICE/INSTALLATION TYPE	BELDEN 7919A TO PROVIDE (FT)	NETWORK AVAILABILITY	AVAILABLE POWER IN CABINET	POWER SOURCE
(2)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	0.4	EB	EXISTING POE COMM TOWER	60	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(8)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	7.7	MEDIAN	EB EVANSTON PARKING AREA NEW AC STANDALONE	40	SEE DETAIL	SEE DETAIL	SEE DETAIL
(2),(5)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	11.86	EB	EXISTING COMM TOWER (SOLAR)	70	EXISTING W/ AVAILABLE PORT	12VDC SITE W/ 12-24VDC CONVERTER	EXISTING SOLAR ARRAY
(6)	MARK KELLY (307) 777-4838	I80	41.99	EB	LYMAN REST AREA NON-PENETRATING ROOF MOUNT	70	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET IN ELECTRICAL ROOM	AC
(1)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	59.67	EB	LYMAN PARKING AREA NEW SOLAR STANDALONE	40	SEE DETAIL	SEE DETAIL	SEE DETAIL
(1)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	70.55	EB	LITTLE AMERICA NEW SOLAR STANDALONE	40	SEE DETAIL	SEE DETAIL	SEE DETAIL
(2)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	91.99	EB	EXISTING COMM TOWER	90	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	92.8	EB	EXISTING COMM TOWER	110	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(3)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	97	EB	EXISTING DMS - MONOTUBE	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	97.9	EB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	99.9	EB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	105.65	EB	EXISTING COMM TOWER	130	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(8)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	141.83	EB	NEW AC STANDALONE	40	SEE DETAIL	SEE DETAIL	SEE DETAIL
(6)	MARK KELLY (307) 777-4838	I80	144.2	EB	BITTER CREEK REST AREA NON-PENETRATING ROOF MOUNT	70	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET IN ELECTRICAL ROOM	AC
(2)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	184.3	EB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(1)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	188.81	EB	WAMSUTTER-RAWLINS PARKING AREA NEW SOLAR STANDALONE	40	SEE DETAIL	SEE DETAIL	SEE DETAIL
(4)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	234.54	EB	EXISTING DMS - TRUSS	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET - PROVIDE POWER STRIP MODEL CPS-1215RMS BY ATLANTIC SCIENTIFIC	AC
(3)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	245	EB	EXISTING DMS - MONOTUBE	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	256.17	EB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	262	EB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	262.4	EB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(7)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	263.6	EB	EXISTING SPEED SENSOR	40	SEE DETAIL	SEE DETAIL	EXISTING 24V SOLAR
(3)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	266	EB	EXISTING DMS - MONOTUBE	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(6)	MARK KELLY (307) 777-4838	I80	267.19	EB	WAGONHOUND REST AREA TRIPOD MOUNT	70	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET IN ELECTRICAL ROOM	AC
(2)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	267.71	EB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(1)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	268.6	EB	NEW SOLAR STANDALONE	40	SEE DETAIL	SEE DETAIL	SEE DETAIL
(2)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	280.36	EB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(4)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	317.2	EB	EXISTING DMS - TRUSS	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	317.68	EB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(4)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	324.9	EB	EXISTING DMS - TRUSS	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	341.6	EB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	343.24	EB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(6)	MARK KELLY (307) 777-4838	I80	401.46	EB	PINE BLUFFS REST AREA NON-PENETRATING ROOF MOUNT	70	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC

NOTES:
(1) SEE "STANDALONE ROAD-SIDE UNIT (RSU) INSTALLATION DETAIL" PGs 1-4 AND LAYOUT SHEET FOR REQUIREMENTS.
(2) SEE "EXISTING COMMUNICATION TOWER ROAD-SIDE UNIT (RSU) INSTALLATION DETAIL" FOR REQUIREMENTS.
(3) SEE "EXISTING DYNAMIC MESSAGE SIGN OVERHEAD -MONOTUBE STRUCTURE- ROAD-SIDE UNIT INSTALLATION DETAIL" FOR REQUIREMENTS.

(4) SEE "EXISTING DYNAMIC MESSAGE SIGN -TRUSS STRUCTURE- ROAD-SIDE UNIT INSTALLATION DETAIL" FOR REQUIREMENTS.

(5) EXISTING SITE IS SOLAR, BATTERIES ARE WIRED IN 12VDC CONFIGURATION WITH EXISTING 12VDC-24VDC CONVERTER.
CONTRACTOR IS TO PROVIDE A NEW 24VDC- 48VDC CONVERTER MODEL QUINT-PS/24DC/48DC/5 PART# 2320128 BY PHOENIX CONTACT,
OR APPROVED EQUAL. WYDOT CONTACT IS TO BE CONTACTED PRIOR TO INSTALLATION.

(6) CONTRACTOR IS TO CONTACT MARK KELLY WITH WYDOT TELECOMMUNICATIONS PRIOR TO INSTALL AND CONCERNING NON-PENETRATING ROOF/TRIPOD MOUNT.

(7) SEE "EXISTING STANDALONE SITE - ROAD-SIDE UNIT (RSU) INSTALLATION DETAIL" FOR REQUIREMENTS.

(8) SEE "STANDALONE AC ROAD-SIDE UNIT (RSU) INSTALLATION DETAIL" PGs 1-4 AND LAYOUT SHEET FOR REQUIREMENTS.

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

I80 ROAD-SIDE UNIT LOCATIONS EASTBOUND DIRECTION

DESIGNER: JAB	DATE: 3/20/17	REV:
ENGINEER: JAB	SHEET _ OF	

NOTE(S)	WYDOT CONTACT	ROADWAY	MILEPOST	DIRECTION	RSU INSTALLATION TYPE	BELDEN 7919A TO PROVIDE (FT)	NETWORK AVAILABILITY	AVAILABLE POWER IN CABINET	POWER SOURCE
(7)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	8.55	MEDIAN	WB EVANSTON PARKING AREA NEW ACSTANDALONE	40	SEE DETAIL	SEE DETAIL	SEE DETAIL
(3)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	17.66	WB	EXISTING CABINET MOUNT INSTALLATION	20	EXISTING W/ AVAILABLE PORT	12VDC SITE W/ 12-24VDC CONVERTER	EXISTING SOLAR ARRAY
(2) , (5)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	27.6	WB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	12VDC SITE W/ 12-24VDC CONVERTER	EXISTING SOLAR ARRAY
(1)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	34.5	WB	LYMAN PARKING AREA 2 - NEW SOLAR STANDALONE	40	SEE DETAIL	SEE DETAIL	SEE DETAIL
(7)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	52.65	WB	NEW SOLAR STANDALONE	40	SEE DETAIL	SEE DETAIL	SEE DETAIL
(3)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	94.2	WB	EXISTING CABINET MOUNT INSTALLATION	20	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	101.71	WB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	103.2	WB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	104.55	WB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(3)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	106.8	WB	EXISTING CABINET MOUNT INSTALLATION	20	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	110.3	WB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	129.8	WB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(6)	MARK KELLY (307) 777-4838	I80	143.5	WB	BITTER CREEK REST AREA NON-PENETRATING ROOF MOUNT	70	EXISTING PORT IN ELECTRICAL ROOM	EXISTING 120VAC OUTLET IN ELECTRICAL ROOM	AC
(2)	TOMMY SCOTT (307) 389-0373 AND ROYCE FUNDELL (307) 389-3015	I80	156.72	WB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(1)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	189.65	WB	WAMSUTTER-RAWLINS PARKING AREA NEW SOLAR STANDALONE	40	SEE DETAIL	SEE DETAIL	SEE DETAIL
(4)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	206.9	WB	EXISTING DMS - MONOTUBE	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(4)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	217.5	WB	EXISTING DMS-MONOTUBE	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(4)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	257.08	WB	EXISTING DMS - MONOTUBE	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	259.77	WB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	266.58	WB	EXISTING COMM TOWER	80	PROVIDE 120VAC RUGGEDCOM RS400	EXISTING 120VAC OUTLET	AC
(2)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	269.5	WB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	271.8	WB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(4)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	273.85	WB	EXISTING DMS - MONOTUBE	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	279.36	WB	EXISTING COMM TOWER	80	PROVIDE 8 PORT UBIQUITI TOUGHSWITCH	EXISTING 120VAC OUTLET	AC
(2)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	322.6	WB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(3)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	323.05	WB	EXISTING CABINET MOUNT INSTALLATION	20	PROVIDE 8-PORT UBIQUITI TOUGHSWITCH	EXISTING 120VAC OUTLET	AC
(6)	MARK KELLY (307) 777-4838	I80	323.3	WB	SUMMIT REST AREA NON-PENETRATING ROOF MOUNT	70	EXISTING PORT IN ELECTRICAL ROOM	EXISTING 120VAC OUTLET IN ELECTRICAL ROOM	AC
(2)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	345.56	WB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC
(2)	DONNA OLIVARES-BRAISTED (307) 287-1656	I80	401.8	WB	EXISTING COMM TOWER	80	EXISTING W/ AVAILABLE PORT	EXISTING 120VAC OUTLET	AC

NOTES:

(1) SEE "STANDALONE ROAD-SIDE UNIT (RSU) INSTALLATION DETAIL" PGs 1-4 AND LAYOUT SHEET FOR REQUIREMENTS.
(2) SEE "EXISTING COMMUNICATION TOWER ROAD-SIDE UNIT (RSU) INSTALLATION DETAIL" FOR REQUIREMENTS.
(3) SEE "EXISTING CABINET ROAD-SIDE UNIT INSTALLATION DETAIL" FOR REQUIREMENTS.
(4) SEE "EXISTING DYNAMIC MESSAGE SIGN OVERHEAD -MONOTUBE STRUCTURE- ROAD-SIDE UNIT INSTALLATION DETAIL" FOR REQUIREMENTS.

(5) EXISTING SITE IS SOLAR, BATTERIES ARE WIRED IN 12VDC CONFIGURATION WITH EXISTING 12VDC-24VDC CONVERTER. CONTRACTOR IS TO PROVIDE A NEW 24VDC- 48VDC CONVERTER MODEL QUINT-PS/24DC/48DC/5 PART# 2320128 BY PHOENIX CONTACT, OR APPROVED EQUAL. WYDOT CONTACT IS TO BE CONTACTED PRIOR TO INSTALLATION.
(6) CONTRACTOR IS TO CONTACT MARK KELLY WITH WYDOT TELECOMMUNICATIONS PRIOR TO INSTALLATION AND FOR DETAILS CONCERNING NON-PENETRATING ROOF/TRIPOD MOUNT
(7) SEE "STANDALONE AC ROAD-SIDE UNIT (RSU) INSTALLATION DETAIL" PGs 1-4 AND LAYOUT SHEET FOR REQUIREMENTS.

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL
I80 ROAD-SIDE UNIT LOCATIONS WESTBOUND DIRECTION

DESIGNER: JAB	DATE: 3/20/17	REV:
ENGINEER: JAB	SHEET _ OF	

*DEPARTMENT YARD ROAD-SIDE UNIT INSTALLATIONS

LOCATION	ADDRESS	POWER SOURCE	WYDOT CONTACT	RSU INSTALLATION TYPE
PINE BLUFFS DEPARTMENT YARD	99 WALNUT ST. PINE BLUFFS, WY	AC	MARK KELLY (307) 777-4838	COMM TOWER MOUNT
CHEYENNE HEADQUARTERS DEPARTMENT YARD	5300 BISHOP BLVD. CHEYENNE, WY	AC	MARK KELLY (307) 777-4838	COMM TOWER MOUNT
ARLINGTON DEPARTMENT YARD	ML105B, MILEPOST 16.85	AC	MARK KELLY (307) 777-4838	NON-PENETRATING ROOF MOUNT
ELK MOUNTAIN DEPARTMENT YARD	ML404, MILEPOST 15.29	AC	MARK KELLY (307) 777-4838	NON-PENETRATING ROOF MOUNT
RAWLINS DEPARTMENT YARD	301 AIRPORT RD. RAWLINS, WY	AC	MARK KELLY (307) 777-4838	COMM TOWER MOUNT
WAMSUTTER DEPARTMENT YARD	334 MURRAY AVE. WAMSUTTER, WY	AC	MARK KELLY (307) 777-4838	NON-PENETRATING ROOF MOUNT
PATRICK DRAW DEPARTMENT YARD	6160 PATRICK DRAW RD. PATRICK DRAW, WY	AC	MARK KELLY (307) 777-4838	NON-PENETRATING ROOF MOUNT
ROCK SPRINGS - D3 HQ DEPARTMENT YARD	3200 ELK ST. ROCK SPRINGS, WY	AC	MARK KELLY (307) 777-4838	COMM TOWER MOUNT
GRANGER DEPARTMENT YARD	COUNTY RD. 4-16 GRANGER, WY	AC	MARK KELLY (307) 777-4838	NON-PENETRATING ROOF MOUNT
LYMAN DEPARTMENT YARD	608 E. CLARK LYMAN, WY	AC	MARK KELLY (307) 777-4838	NON-PENETRATING ROOF MOUNT
EVANSTON DEPARTMENT YARD	555 COUNTY RD. EVANSTON, WY	AC	MARK KELLY (307) 777-4838	COMM TOWER MOUNT

*CONTACT MARK KELLY WITH WYDOT TELECOMMUNICATIONS PRIOR TO INSTALLATION AT DEPARTMENT YARDS. SEE ONE-LINE DIAGRAM FOR SITES NEEDING NEW COMMUNICATIONS.

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

DEPARTMENT YARD ROAD-SIDE UNIT INSTALLATION LOCATIONS

DESIGNER: JAB	DATE: 3/20/17	REV:
ENGINEER: JAB	SHEET _ OF	

Connected Vehicle RSU Locations for New Comms Revised 3/30/17

I80 W RM 401 Existing Comms
Lat 41.17558N Long 104.06868W
Ubiquiti 5.8 GHz Power Beam
Tower mount

Pine Bluffs WYDOT
Lat 41.18483N Long 104.05946W
Ubiquiti 5.8 GHz Power Beam
Ubiquit 8 port Tough Switch
RSU
2 ea tower mount

WYO 13 Existing Comms
Lat 41.59893N Long 106.21015W
Ubiquiti 5.8 GHz Power Beam
Tower mount

Arlington WYDOT
Lat 41.60445N Long 106.20680W
Ubiquiti 5.8 GHz Power Beam
Ubiquit 8 port Tough Switch
RSU
Non penetrating roof mount

I80 W RM 257.08 Existing Comms
Lat 41.71276N Long 106.43561W
Ubiquiti 5.8 GHz Nano Bridge
with armor kit.

Elk Mtn WYDOT
Lat 41.69170N Long 106.42406W
RSU
Ubiquiti 5.8 GHz Nano Bridge
with armor kit.
Ubiquit 8 port Tough Switch
Non penetrating roof mount

9 Mile Telecom Site
Lat 41.88108N Long 107.32311W
Ubiquiti 5.8 GHz Nano Bridge
with armor kit.

Rawlins WYDOT
Lat 41.79201N Long 107.20523W
RSU
Ubiquiti 5.8 GHz Nano Bridge
with armor kit.
Ubiquit 8 port Tough Switch
2 ea Tower mount

I80 E RM 173.45 Existing Comms
Lat 41.67440N Long 107.98050W
Ubiquiti 5.8 GHz Power Beam

Wamsutter WYDOT
Lat 41.67089N Long 107.98022W
Ubiquiti 5.8 GHz Power Beam
Ubiquit 8 port Tough Switch
RSU
Non penetrating roof mount

Bitter Creek WB Rest Area
Lat 41.64435N Long 108.54784W
Ubiquiti 5.8 GHz Nano Bridge
with armor kit.

Patrick Draw WYDOT
Lat 41.63884N Long 108.48374W
RSU
Ubiquiti 5.8 GHz Nano Bridge
with armor kit.
Ubiquit 8 port Tough Switch
Non penetrating roof mount

Lyman Rest Area
Lat 41.36515N Long 110.29734W
Ubiquiti 5.8 GHz Power Beam

Lyman WYDOT
Lat 41.32998N Long 110.28355W
Ubiquiti 5.8 GHz Power Beam
Ubiquit 8 port Tough Switch
RSU
Non penetrating roof mount

Dashed Lines = New
Solid Lines = Existing

* ALL LISTED EQUIPMENT IS TO BE INCIDENTAL TO THE 5.8GHZ ETHERNET RADIO BID ITEM

I.T.S.

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

ONE-LINE DIAGRAM
- WYDOT SHOPS

DESIGNER: JAB	DATE: 3-20-17	REV: 1
ENGINEER: JAB	SHEET 1 OF 3	

Connected Vehicle RSU Locations for New Comms Revised 3/30/17

Wamsutter-Rawlins EB Parking Area
Lat 41.73464N Long 107.69920W
RSU
Ubiquiti 5.8 GHz Rocket with 30 dB
dish and radome.
2ea Tower/structure mount.
Ubiquiti 8 port tough switch

Nine Mile Telecom Tower
Lat 41.88108N Long 107.32311W

Wamsutter-Rawlins WB Parking Area
Lat 41.73894N Long 107.68309W
RSU
Ubiquiti 5.8 GHz Rocket with 30 dB
dish and radome.
2ea Tower/structure mount
Ubiquiti 8 port tough switch

I80 E RM 69.7
Lat 41.54251N Long 109.84367W
Ubiquiti 5.8 GHz Nanostation
Loco.

Little America Parking Area
Lat 41.54316N Long 109.82674W
RSU
Ubiquiti 5.8 GHz Nanostation
Loco.
2ea Tower/structure Mount.
Ubiquiti 8 port tough switch

I80 W 52.65 Existing Comms
Lat 41.42989N Long 110.12042W
Ubiquiti 5.8 GHz Nano Station Loco
Tower/structure Mount.
Ubiquiti 8 port tough switch

I80 W 52.65
Lat 41.42944N Long 110.12016W
RSU
Ubiquiti 5.8 GHz Nano Station Loco
Tower/structure Mount.
Ubiquiti 8 port tough switch

Lyman Parking Area
Lat 41.49278N Long 110.01496W
RSU
Ubiquiti 5.8 GHz Rocket with 30 dB
dish and radome.
2ea Tower/structure Mount.
Ubiquiti 8 port tough switch

Church Buttes Telecom Tower
Lat 41.41523N Long 110.08265W
2 EA, Ubiquiti 5.8 GHz Rocket
with 30 dB dish and radome.
Ubiquiti 8 port tough switch
Tower mount at 60' & 100'

Lyman Parking Area 2
Lat 41.39798N Long 110.17402W
RSU
Ubiquiti 5.8 GHz Rocket with 30 dB
dish and radome.
2ea Tower/structure Mount.
Ubiquiti 8 port tough switch

I80 E 141.83 Existing Comms
Lat 41.64551N Long 108.58314W
Ubiquiti 5.8 GHz Nano Station Loco
Tower/structure Mount.
Ubiquiti 8 port tough switch

I80 E 141.83
Lat 41.64578N Long 108.58310W
RSU
Ubiquiti 5.8 GHz Nano Station Loco
Tower/structure Mount.
Ubiquiti 8 port tough switch

Evanston WB Parking Area
Lat 41.26223N Long 110.89578W
RSU
Ubiquiti 5.8 GHz Nano Beam
Tower/structure Mount.
Ubiquiti 8 port tough switch

I80 E 8.45 Existing Comms
Lat 41.26217N Long 110.89768W
2 EA, Ubiquiti 5.8 GHz Nano Beam
2ea Tower/structure Mount.
Ubiquiti 8 port tough switch

Evanston EB Parking Area
Lat 41.26468N Long 110.91109W
RSU
Ubiquiti 5.8 GHz Nano Beam
Tower/structure Mount.
Ubiquiti 8 port tough switch

* ALL LISTED EQUIPMENT IS TO BE INCIDENTAL TO THE 5.8GHZ ETHERNET RADIO BID ITEM

Dashed Lines = New
Solid Lines = Existing

I.T.S.

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL
ONE-LINE DIAGRAM
STANDALONE RSU SITES

DESIGNER: JAB	DATE: 3-20-17	REV: 1
ENGINEER: JAB	SHEET 2 OF 3	

Connected Vehicle RSU Locations for New Comms Revised 3/30/17

Church Buttes Telecom Tower
Lat 41.41523N Long 110.08265W

Use the Same radio for
Lyman Parking Area 2

Lyman Rest Area
Lat 41.36515N Long 110.29734W

RSU
Ubiquiti 5.8 GHz Rocket with 30 dB
dish and radome.
Cabinet, UPS, 2ea Tower/structure mount
Ubiquiti 8 port tough switch
Non penetrating roof mount

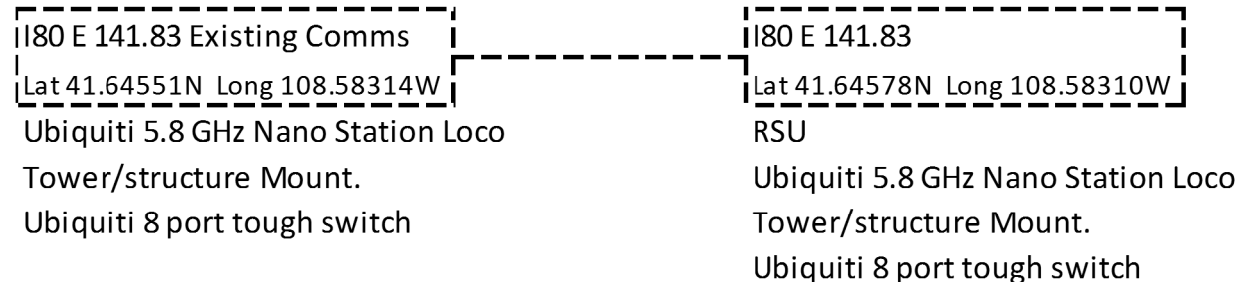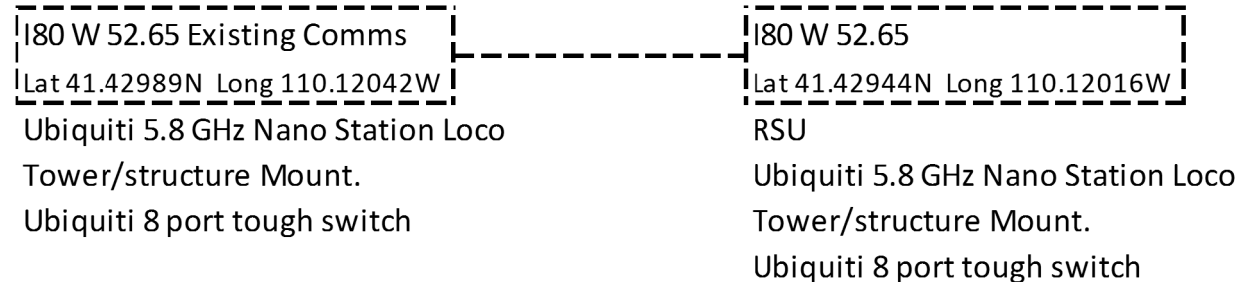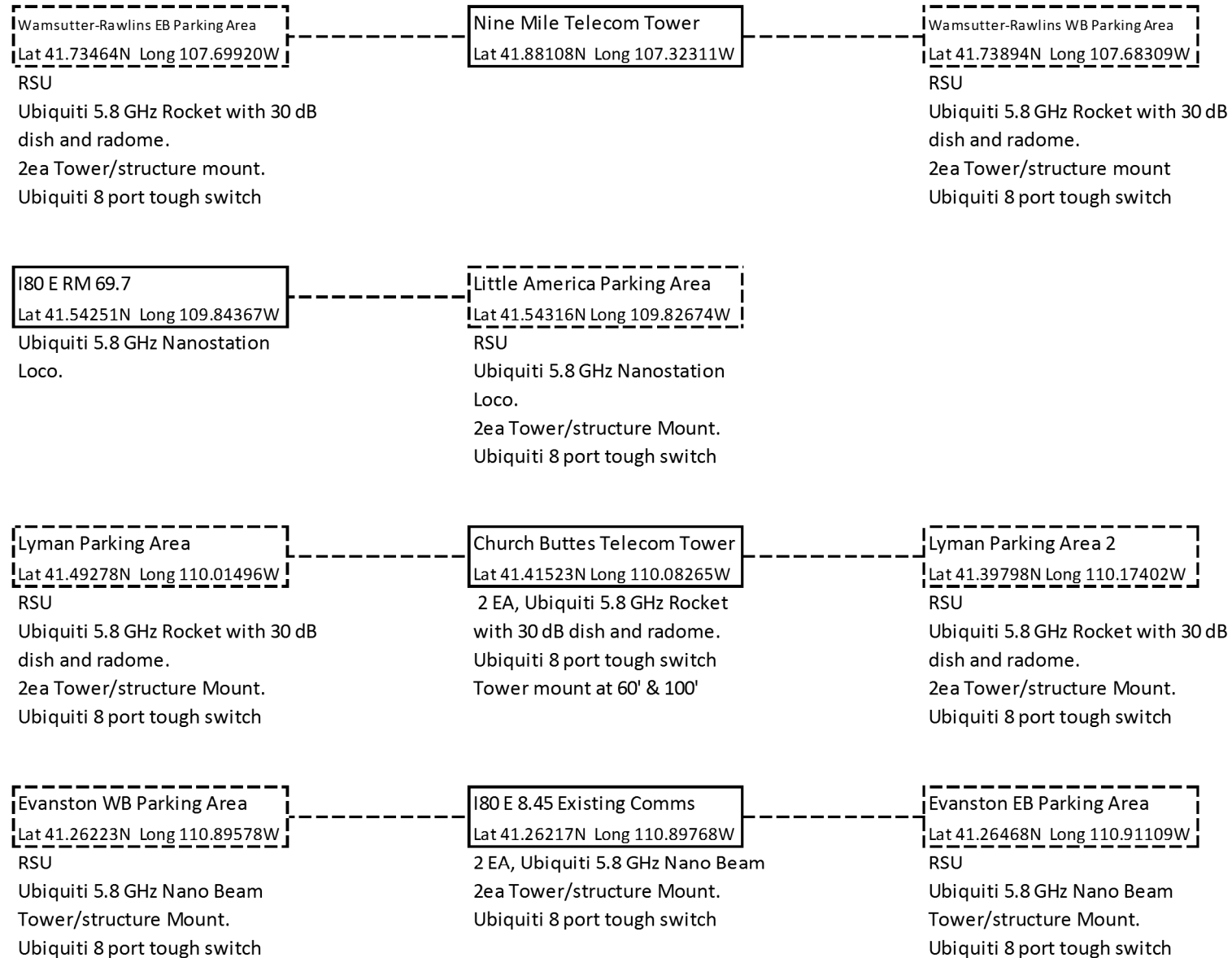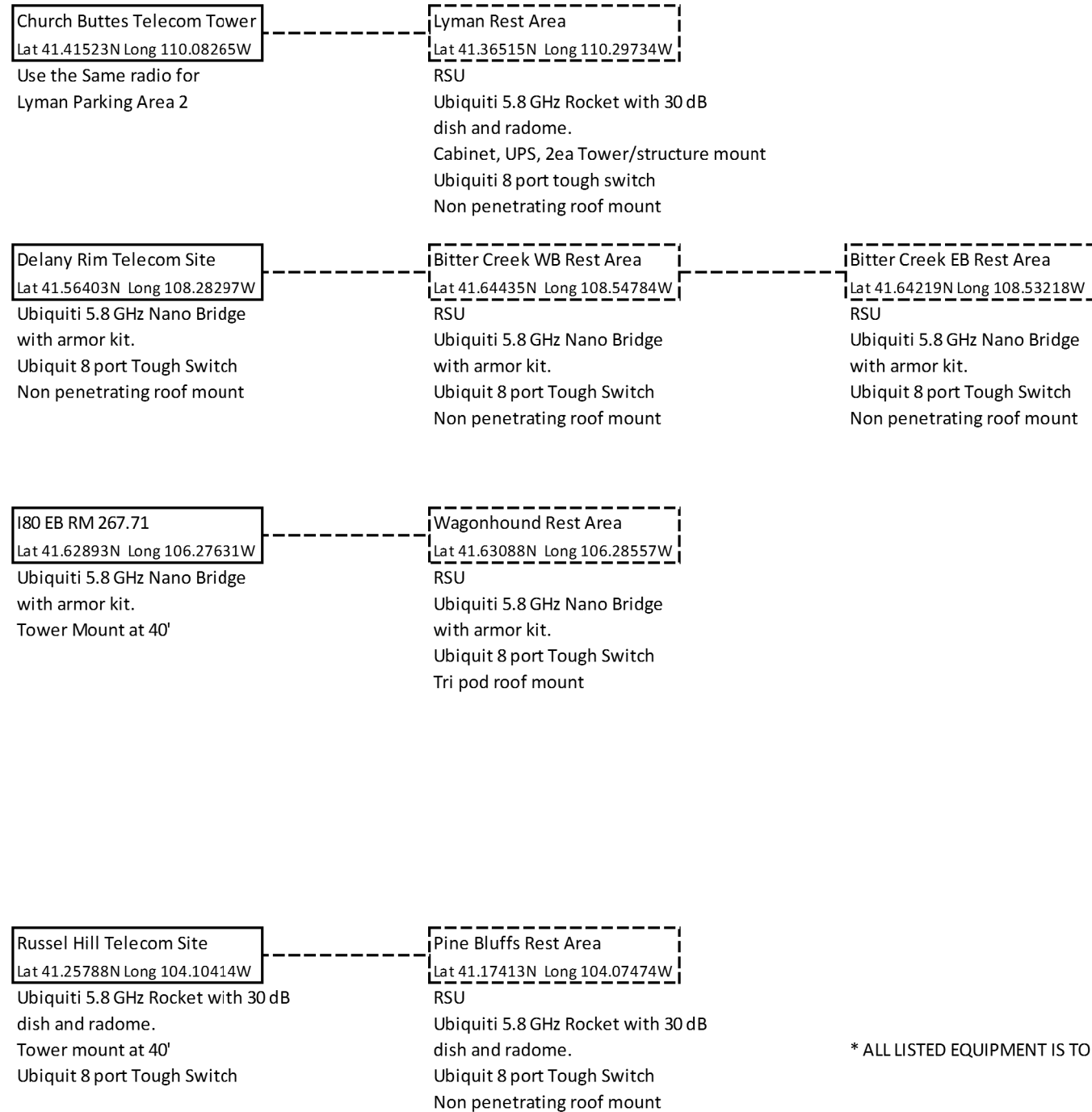| Delany Rim Telecom Site |
|---|
| Lat 41.56403N Long 108.28297W |

Ubiquiti 5.8 GHz Nano Bridge
with armor kit.
Ubiquit 8 port Tough Switch
Non penetrating roof mount

Bitter Creek WB Rest Area
Lat 41.64435N Long 108.54784W

RSU
Ubiquiti 5.8 GHz Nano Bridge
with armor kit.
Ubiquit 8 port Tough Switch
Non penetrating roof mount

Bitter Creek EB Rest Area
Lat 41.64219N Long 108.53218W

RSU
Ubiquiti 5.8 GHz Nano Bridge
with armor kit.
Ubiquit 8 port Tough Switch
Non penetrating roof mount

I80 EB RM 267.71
Lat 41.62893N Long 106.27631W

Ubiquiti 5.8 GHz Nano Bridge
with armor kit.
Tower Mount at 40'

Wagonhound Rest Area
Lat 41.63088N Long 106.28557W

RSU
Ubiquiti 5.8 GHz Nano Bridge
with armor kit.
Ubiquit 8 port Tough Switch
Tri pod roof mount

Russel Hill Telecom Site
Lat 41.25788N Long 104.10414W

Ubiquiti 5.8 GHz Rocket with 30 dB
dish and radome.
Tower mount at 40'
Ubiquit 8 port Tough Switch

Pine Bluffs Rest Area
Lat 41.17413N Long 104.07474W

RSU
Ubiquiti 5.8 GHz Rocket with 30 dB
dish and radome.
Ubiquit 8 port Tough Switch
Non penetrating roof mount

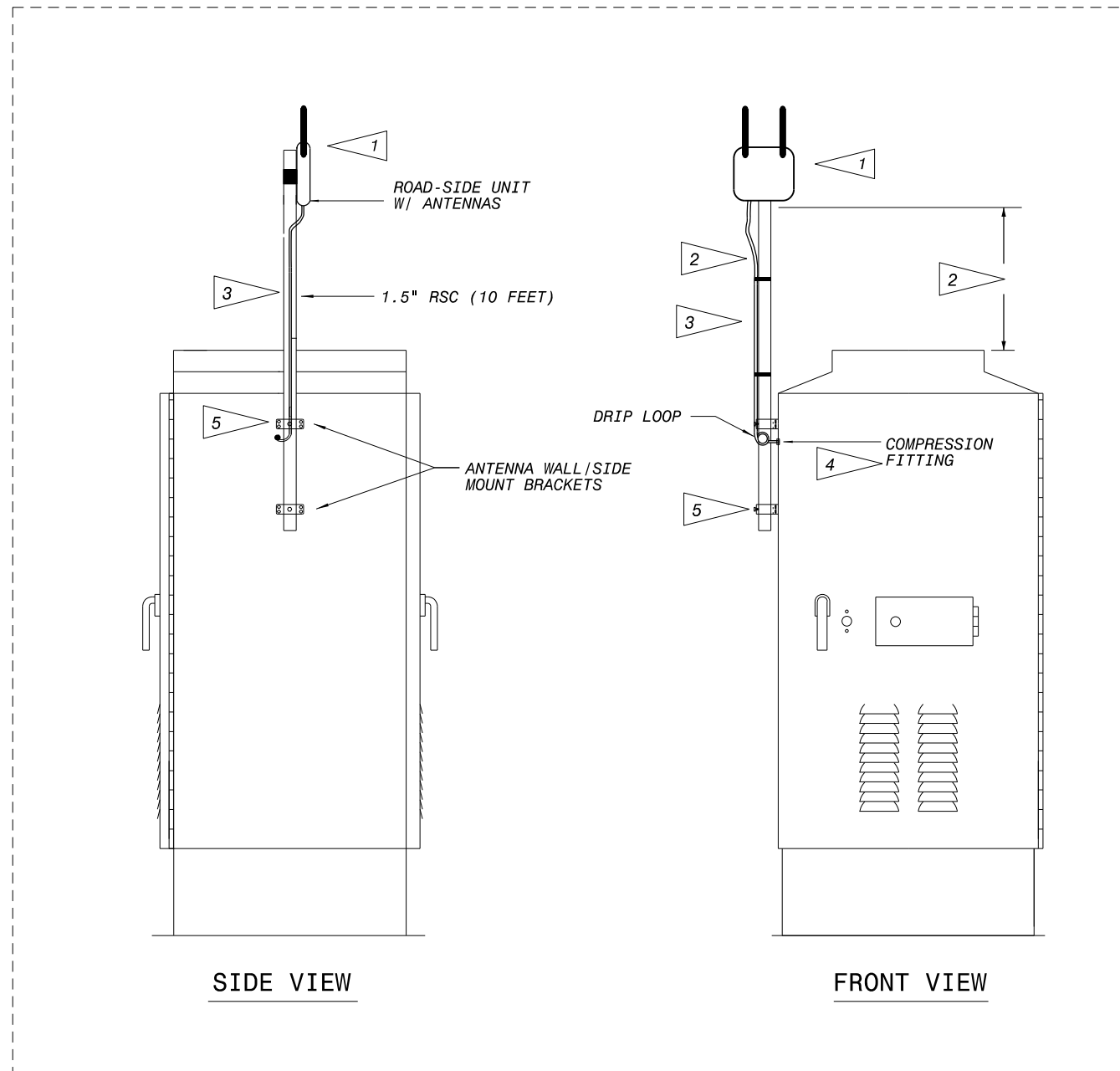Dashed Lines = New
Solid Lines = Existing

* ALL LISTED EQUIPMENT IS TO BE INCIDENTAL TO THE 5.8GHZ ETHERNET RADIO BID ITEM

I.T.S.

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

ONE-LINE DIAGRAM
- REST AREAS

DESIGNER: JAB	DATE: 3-20-17	REV: 1
ENGINEER: JAB	SHEET 3 OF 3	

SIDE VIEW

ROAD-SIDE UNIT W/ ANTENNAS

1.5" RSC (10 FEET)

ANTENNA WALL/SIDE MOUNT BRACKETS

FRONT VIEW

DRIP LOOP

COMPRESSION FITTING

OMNI ANTENNA MOUNTING

FLAG NOTES:

1. PROVIDE LOCOMATE ROADSTAR PREMIUM RSU BY ARADA SYSTEMS, INCLUDING: POE INJECTOR, POLE/WALL MOUNTING KIT, MOUNTING KIT FOR GPS, GPS ANTENNA, AND DSRC 5.9 GHZ ANTENNA. MOUNT RSU PER MANUFACTURER RECOMMENDATION.

2. MOUNT RSU TO 1.5" RSC BY AN APPROVED METHOD. MOUNTING BRACKET(S), ANTENNAS, AND POWER-OVER-ETHERNET INJECTOR ARE INCIDENTAL TO THE ROAD-SIDE UNIT. RSU MUST BE MOUNTED 26 FEET ABOVE THE ROADWAY SURFACE, ANY DEVIATIONS MUST BE CLEARED THROUGH WYDOT TELECOMMUNICATIONS. ANTENNA SHALL NOT BE MOUNTED MORE THAN 49 FEET ABOVE THE SURFACE OF THE ROADWAY.

3. INSTALL CAT5E CABLE FROM RSU TO CABINET. INSTALL DRIP LOOP AS SHOWN AND FASTEN CABLE TO 1.5" RSC CONDUIT USING UV RATED ZIP TIES OR BY ANOTHER APPROVED METHOD. ROUTE CABLE INSIDE CABINET IN A NEAT AND EFFICIENT MANNER. CABLE IS TO BE CONNECTED TO EXISTING OR NEW ETHERNET SWITCH IN CABINET. INSTALLATION IS FINISHED WHEN RSU IS OPERATIONAL AND SIGNED OFF BY A WYDOT REPRESENTATIVE. ALL NECESSARY MATERIALS NEEDED FOR A COMPLETE INSTALL INCLUDING CABLE TIES, JUMPER CABLES, RJ45 CONNECTORS, ETC. ARE INCIDENTAL TO THE CAT5E CABLE BID ITEM.

4. CABLE IS TO ENTER CABINET THROUGH A STAINLESS STEEL OR ALUMINUM 1/2" CGB CONNECTOR.

5. MOUNT 1.5" RSC CONDUIT TO STRUCTURAL MEMBER, AS SHOWN, BY AN APPROVED METHOD. HARDWARE AND MOUNTING BRACKETS ARE INCIDENTAL TO THE 1.5" RSC CONDUIT BID ITEM.

RSU INSTALLATION NOTE:

1. ALL ITEMS NOT LISTED, SHOWN, OR OTHERWISE NOTED, BUT NECESSARY FOR A COMPLETE INSTALLATION ARE INCIDENTAL TO THE ROAD-SIDE UNIT BID ITEM.

2. DRAWINGS ARE INTENDED TO BE A GENERAL GUIDELINE AND ARE ILLUSTRATIVE ONLY. ACTUAL SITE CONDITIONS MAY VARY.

**   PROVIDE ALUMINUM HOT DIPPED GALVANIZED STEEL.

I.T.S.

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

EXISTING CABINET
ROAD-SIDE UNIT INSTALLATION DETAIL

DESIGNER: JAB	DATE: 3-20-17	REV: 1
ENGINEER: JAB	SHEET 1 OF 1	

EXISTING 40' TOWER WITH
TYPICAL LOADING SHOWN

EXISTING RADIO ARRAY
(6 RADIOS MAX)

DRILLED SHAFT
FOUNDATION

ROAD-SIDE UNIT
TO BE INSTALLED

RSC CONDUITS

18"

6"

2" 3" 3" 2"

5" 6" 5"

TOP VIEW
(TYPICAL)

NEMA 4
ENCLOSURE

4'

FRONT VIEW
(TYPICAL)

EXISTING
STEEL TOWER
BASE SECTION

ROAD-SIDE UNIT CAT5E
TO BE INSTALLED

EXISTING
PULL BOX
(type B)

GRADE

EXISTING CABINET FOOTING

EXISTING PVC TO PULL BOX:
2-2" PVC (typical)
2-3" PVC (typical)

SIDE VIEW
(TYPICAL)

FLAG NOTES:

1. PROVIDE LOCOMATE ROADSTAR PREMIUM RSU BY ARADA SYSTEMS, INCLUDING: POE INJECTOR, POLE/WALL MOUNTING KIT, MOUNTING KIT FOR GPS, GPS ANTENNA, AND DSRC 5.9 GHZ ANTENNA. RSU MUST BE MOUNTED 26 FEET ABOVE THE ROADWAY SURFACE, ANY DEVIATIONS MUST BE CLEARED THROUGH WYDOT TELECOMMUNICATIONS. ANTENNA SHALL NOT BE MOUNTED MORE THAN 49 FEET ABOVE THE SURFACE OF THE ROADWAY.

2. MOUNT RSU TO TOWER BY AN APPROVED METHOD. MOUNTING BRACKET(S), ANTENNAS, AND POWER-OVER-ETHERNET INJECTOR ARE INCIDENTAL TO THE ROAD-SIDE UNIT.

3. INSTALL CAT5E CABLE FROM RSU TO CABINET. INSTALL DRIP LOOP AS SHOWN AND FASTEN CABLE TO COMMUNICATION TOWER LEG USING UV RATED ZIP TIES OR BY ANOTHER APPROVED METHOD. LEAVE 5' OF SLACK IN THE PULL BOX AND BASE OF THE CABINET. ROUTE CABLE INSIDE CABINET IN A NEAT AND EFFICIENT MANNER. CABLE IS TO BE CONNECTED TO EXISTING OR NEW ETHERNET SWITCH IN CABINET. INSTALLATION IS FINISHED WHEN RSU IS OPERATIONAL AND SIGNED OFF BY A WYDOT REPRESENTATIVE. ALL NECESSARY MATERIALS NEEDED FOR A COMPLETE INSTALL INCLUDING CABLE TIES, JUMPER CABLES, RJ45 CONNECTORS, ETC. ARE INCIDENTAL TO THE CAT5E CABLE BID ITEM.

4. RSU CAT5E CABLE IS TO BE ROUTED THROUGH TOWER CABINET. USE AN EXISTING CONDUIT WHICH IS FREE OF POWER SUPPLY WIRES. LEAVE 2' OF SLACK IN TOWER CABINET. IF CABINET HOUSES EXISTING ETHERNET SWITCH, CAT5E CABLE MAY BE TERMINATED AT SWITCH IN TOWER CABINET.
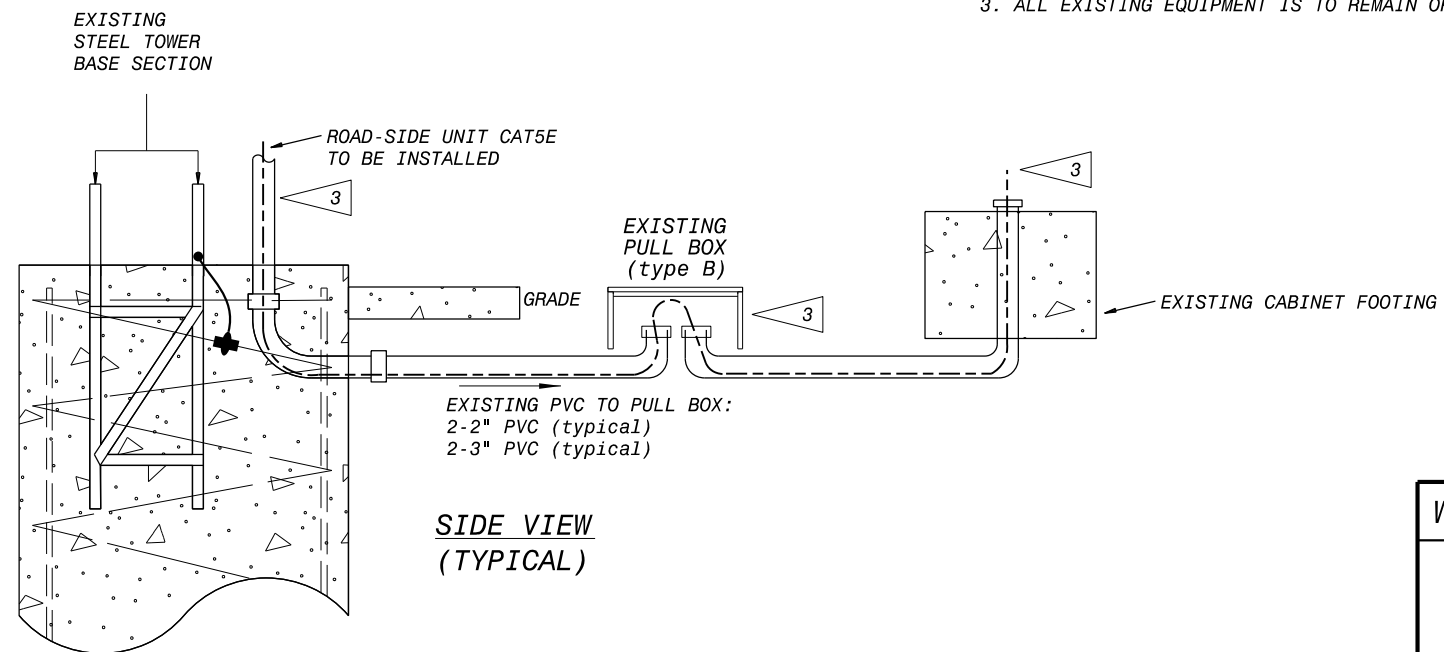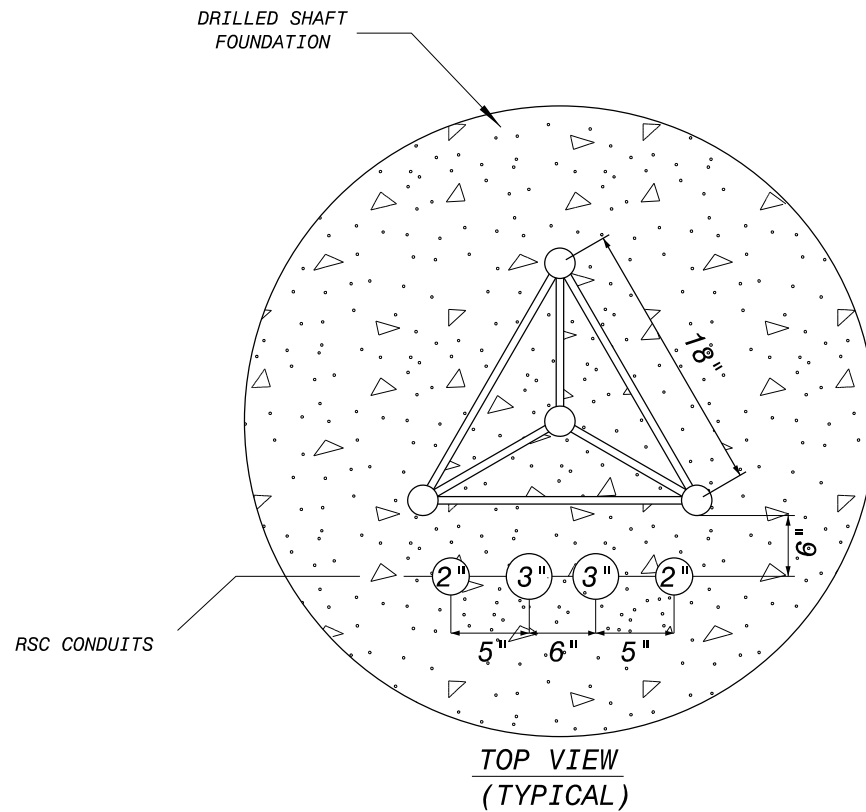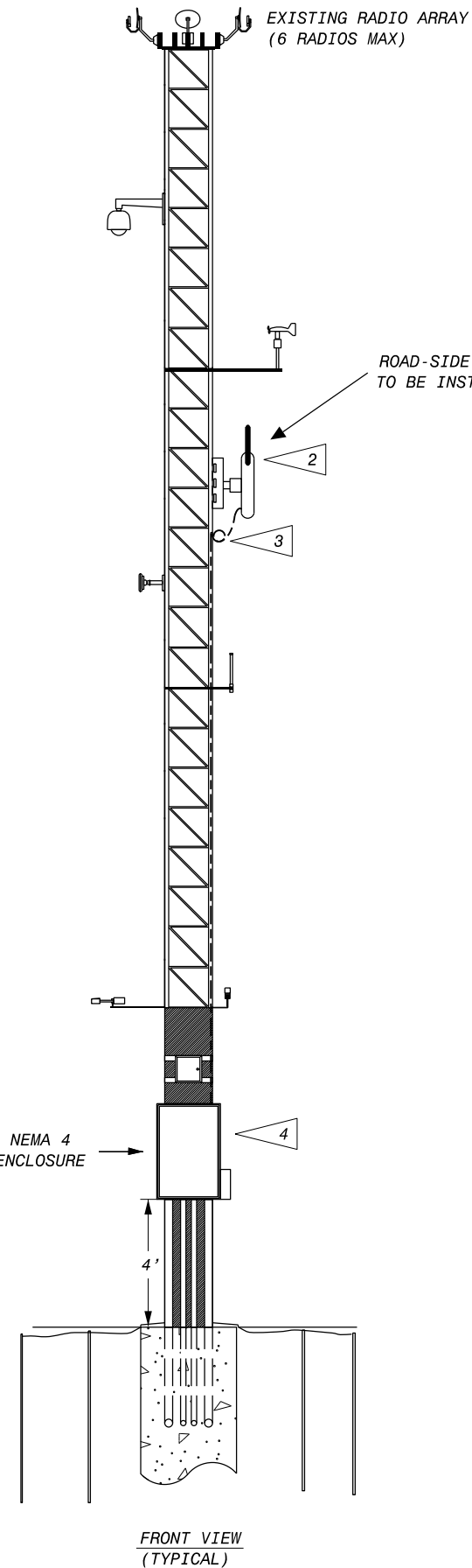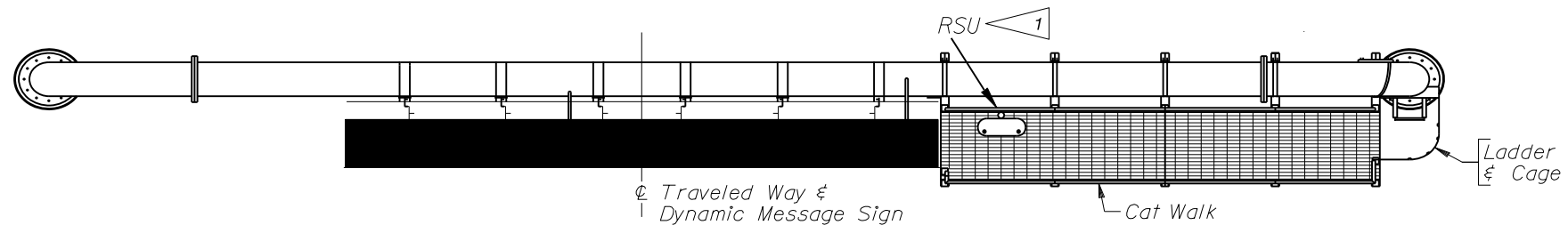
RSU INSTALLATION NOTE:

1. ALL ITEMS NOT LISTED, SHOWN, OR OTHERWISE NOTED, BUT NECESSARY FOR A COMPLETE INSTALLATION, ARE INCIDENTAL TO THE ROAD-SIDE UNIT BID ITEM.

2. DRAWINGS ARE INTENDED TO BE A GENERAL GUIDELINE AND ARE ILLUSTRATIVE ONLY. ACTUAL SITE CONDITIONS MAY VARY.

3. ALL EXISTING EQUIPMENT IS TO REMAIN OPERATIONAL.
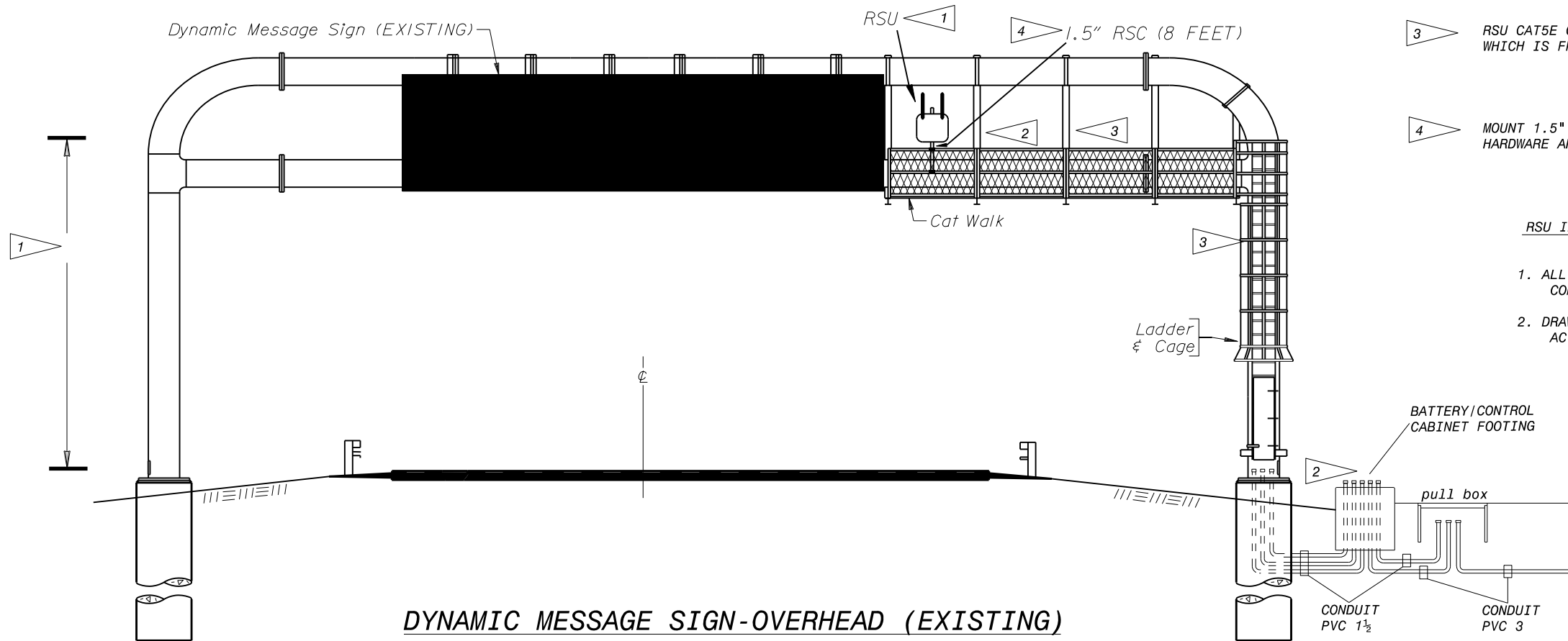
WYOMING DEPARTMENT OF TRANSPORTATION
ELECTRICAL
EXISTING COMMUNICATION TOWER ROAD-SIDE UNIT (RSU) INSTALLATION DETAIL

DESIGNER: JAB	DATE: 02/15/2017	REV:
ENGINEER: JAB	SHEET 1 OF 1	

TOP VIEW

RSU ◁ 1

Ladder & Cage

¢ Traveled Way & Dynamic Message Sign

Cat Walk

Dynamic Message Sign (EXISTING)

RSU ◁ 1

4 ▷ 1.5" RSC (8 FEET)

2 ◁   3 ◁

Cat Walk

3 ◁

1 ▷

¢

Ladder & Cage

BATTERY/CONTROL CABINET FOOTING

2 ▷

pull box

CONDUIT PVC 1½   CONDUIT PVC 3

DYNAMIC MESSAGE SIGN-OVERHEAD (EXISTING)

FLAG NOTES:

1 ▷ PROVIDE LOCOMATE ROADSTAR PREMIUM RSU BY ARADA SYSTEMS, INCLUDING: POE INJECTOR, POLE/WALL MOUNTING KIT, MOUNTING KIT FOR GPS, GPS ANTENNA, AND DSRC 5.9 GHZ ANTENNA. MOUNT RSU TO 1.5" RSC BY AN APPROVED METHOD. RSU MUST BE MOUNTED 26 FEET ABOVE THE ROADWAY SURFACE, ANY DEVIATIONS MUST BE CLEARED THROUGH WYDOT TELECOMMUNICATIONS. MOUNTING BRACKET(S), ANTENNAS, AND POWER-OVER-ETHERNET INJECTOR ARE INCIDENTAL TO THE ROAD-SIDE UNIT. ANTENNA SHALL NOT BE MOUNTED MORE THAN 49 FEET ABOVE THE SURFACE OF THE ROADWAY.

2 ▷ INSTALL CAT5E CABLE FROM RSU TO CABINET BY AN APPROVED METHOD. INSTALL DRIP LOOP AND FASTEN CABLE TO 1.5" RSC CONDUIT USING UV RATED ZIP TIES OR BY ANOTHER APPROVED METHOD. LEAVE 5' OF SLACK IN THE BASE OF THE CABINET. ROUTE CABLE INSIDE CABINET IN A NEAT AND EFFICIENT MANNER. CABLE IS TO BE CONNECTED TO EXISTING OR NEW ETHERNET SWITCH IN CABINET. INSTALLATION IS FINISHED WHEN RSU IS OPERATIONAL AND SIGNED OFF BY A WYDOT REPRESENTATIVE. ALL NECESSARY MATERIALS NEEDED FOR A COMPLETE INSTALL INCLUDING CABLE TIES, JUMPER CABLES, RJ45 CONNECTORS, ETC. ARE INCIDENTAL TO THE CAT5E CABLE BID ITEM.

3 ▷ RSU CAT5E CABLE IS TO BE ROUTED THROUGH STRUCTURE LEG. USE AN EXISTING CONDUIT WHICH IS FREE OF POWER SUPPLY WIRES.

4 ▷ MOUNT 1.5" RSC CONDUIT TO STRUCTURAL MEMBER, AS SHOWN, BY AN APPROVED METHOD. HARDWARE AND MOUNTING BRACKETS ARE INCIDENTAL TO THE 1.5" RSC CONDUIT BID ITEM.
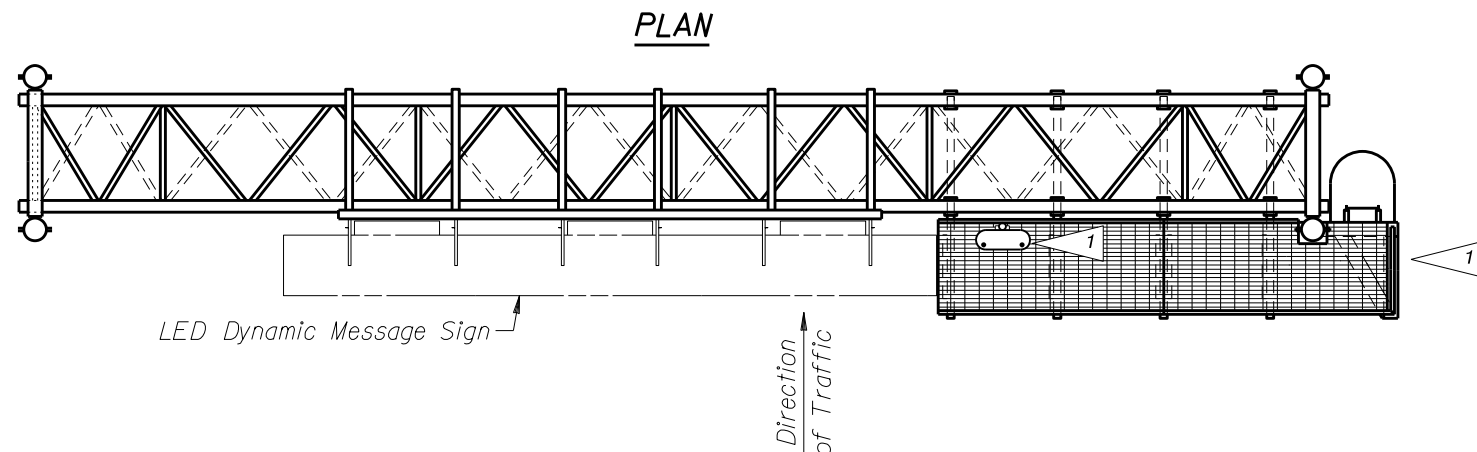
RSU INSTALLATION NOTE:

1. ALL ITEMS NOT LISTED, SHOWN, OR OTHERWISE NOTED, BUT NECESSARY FOR A COMPLETE INSTALLATION, ARE INCIDENTAL TO THE ROAD-SIDE UNIT BID ITEM.

2. DRAWINGS ARE INTENDED TO BE A GENERAL GUIDELINE AND ARE ILLUSTRATIVE ONLY. ACTUAL SITE CONDITIONS MAY VARY. DO NOT MOUNT RSU OVER ROADWAY.

NOT TO SCALE

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL
EXISTING DYNAMIC MESSAGE SIGN
OVERHEAD -MONOTUBE STRUCTURE-
ROAD-SIDE UNIT INSTALLATION DETAIL

DESIGNER: JAB	DATE: 3/20/17	REV:
ENGINEER: JAB	SHEET 1 OF 1	

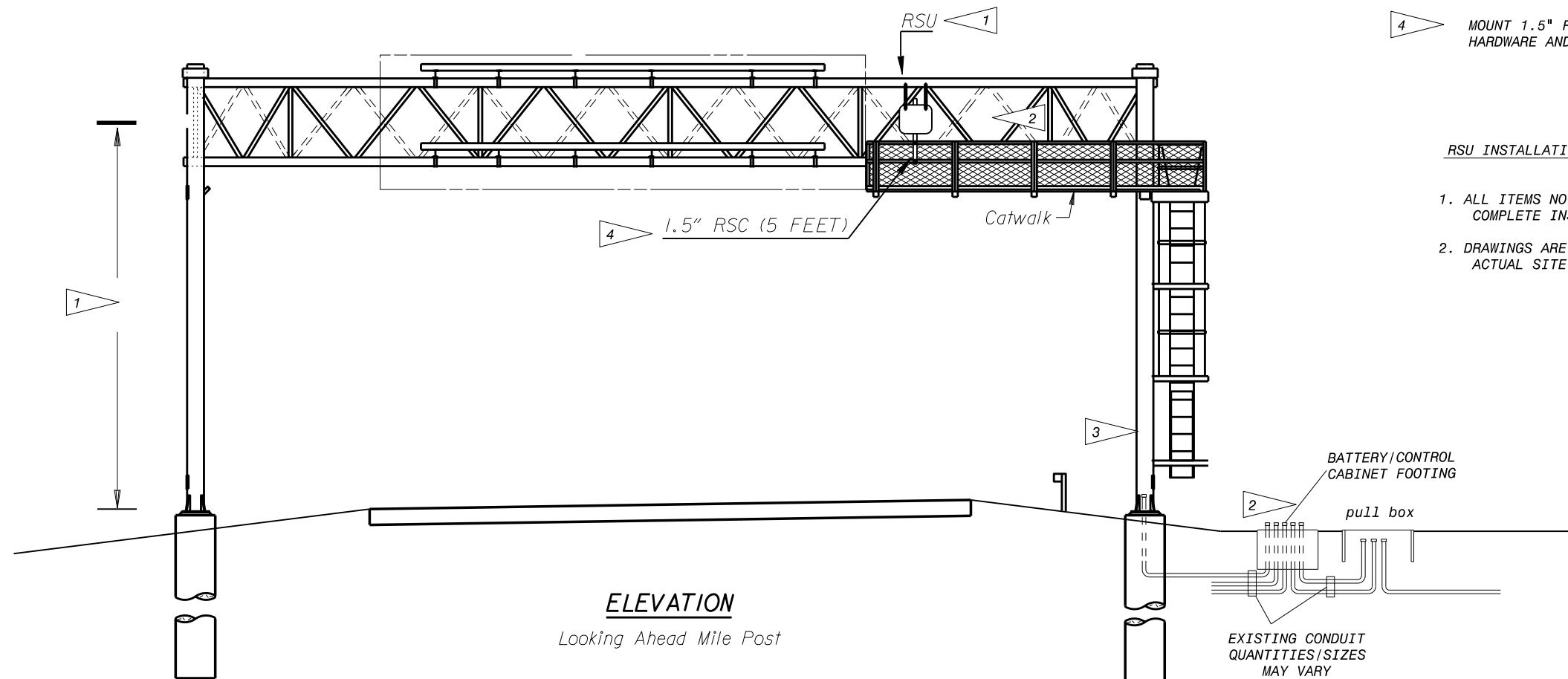## PLAN

LED Dynamic Message Sign

Direction of Traffic

FLAG NOTES:

1. PROVIDE LOCOMATE ROADSTAR PREMIUM RSU BY ARADA SYSTEMS, INCLUDING: POE INJECTOR, POLE/WALL MOUNTING KIT, MOUNTING KIT FOR GPS, GPS ANTENNA, AND DSRC 5.9 GHZ ANTENNA. MOUNT RSU TO 1.5" RSC BY AN APPROVED METHOD. RSU MUST BE MOUNTED 26 FEET ABOVE THE ROADWAY SURFACE, ANY DEVIATIONS MUST BE CLEARED THROUGH WYDOT TELECOMMUNICATIONS. ANTENNA SHALL NOT BE MOUNTED MORE THAN 49 FEET ABOVE THE SURFACE OF THE ROADWAY. MOUNTING BRACKET(S), ANTENNAS, AND POWER-OVER-ETHERNET INJECTOR ARE INCIDENTAL TO THE ROAD-SIDE UNIT.

2. INSTALL CAT5E CABLE FROM RSU TO CABINET. INSTALL DRIP LOOP AND FASTEN CABLE TO 1.5" RSC CONDUIT USING UV RATED ZIP TIES OR BY ANOTHER APPROVED METHOD. LEAVE 5' OF SLACK IN THE BASE OF THE CABINET. ROUTE CABLE INSIDE CABINET IN A NEAT AND EFFICIENT MANNER. CABLE IS TO BE CONNECTED TO EXISTING OR NEW ETHERNET SWITCH IN CABINET. INSTALLATION IS FINISHED WHEN RSU IS OPERATIONAL AND SIGNED OFF BY A WYDOT REPRESENTATIVE. ALL NECESSARY MATERIALS NEEDED FOR A COMPLETE INSTALL INCLUDING CABLE TIES, JUMPER CABLES, RJ45 CONNECTORS, ETC. ARE INCIDENTAL TO THE CAT5E CABLE BID ITEM.

3. RSU CAT5E CABLE IS TO BE ROUTED THROUGH STRUCTURE LEG. USE AN EXISTING CONDUIT WHICH IS FREE OF POWER SUPPLY WIRES. CABLE IS TO ENTER STRUCTURE LEG THROUGH A STAINLESS STEEL OR ALUMINUM 1/2" CGB CONNECTOR.

4. MOUNT 1.5" RSC CONDUIT TO STRUCTURAL MEMBER, AS SHOWN, BY AN APPROVED METHOD. HARDWARE AND MOUNTING BRACKETS ARE INCIDENTAL TO THE 1.5' RSC CONDUIT BID ITEM.
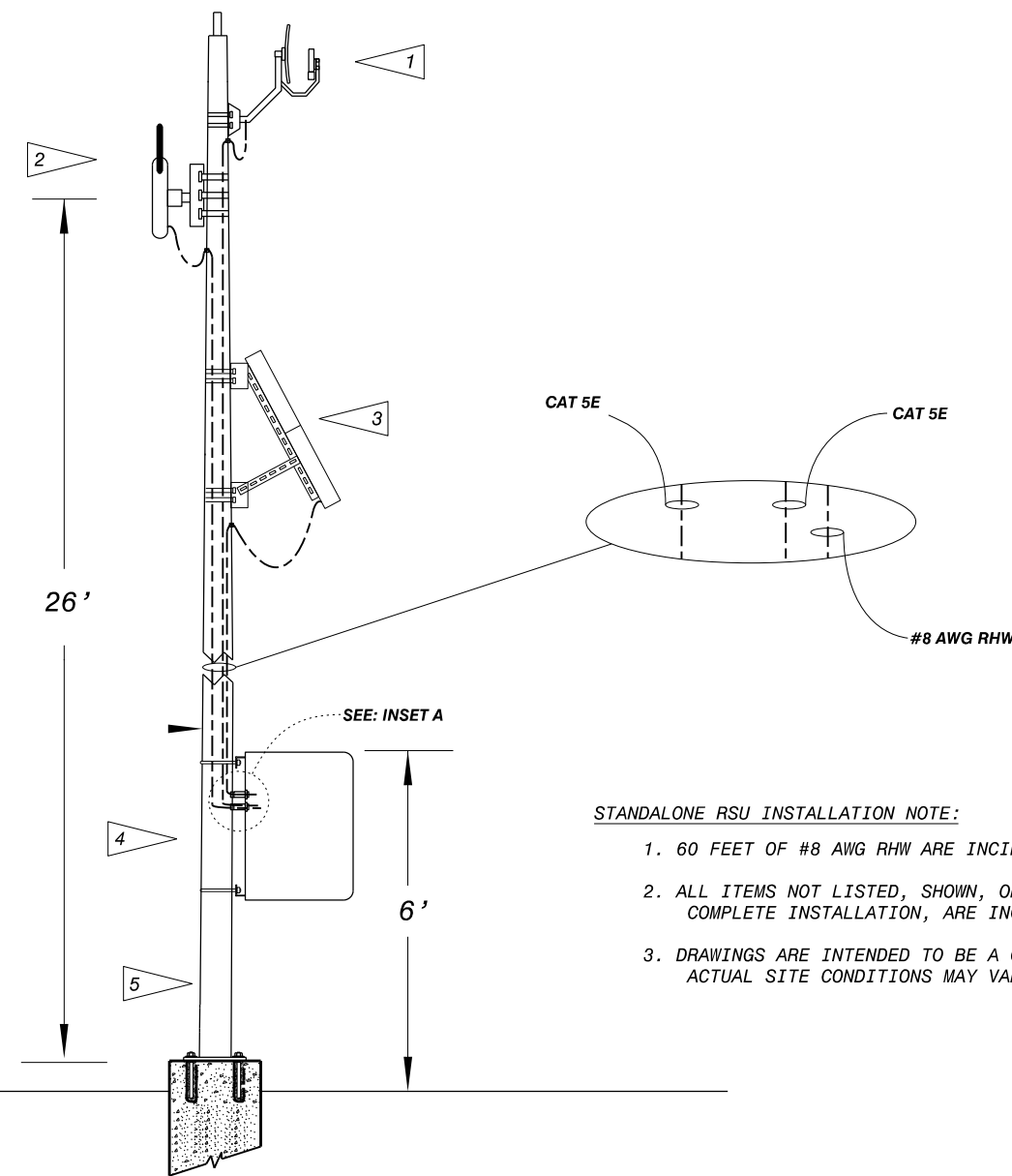
RSU INSTALLATION NOTE:

1. ALL ITEMS NOT LISTED, SHOWN, OR OTHERWISE NOTED, BUT NECESSARY FOR A COMPLETE INSTALLATION, ARE INCIDENTAL TO THE ROAD-SIDE UNIT BID ITEM.

2. DRAWINGS ARE INTENDED TO BE A GENERAL GUIDELINE AND ARE ILLUSTRATIVE ONLY. ACTUAL SITE CONDITIONS MAY VARY. DO NOT MOUNT RSU OVER ROADWAY.

RSU

1.5" RSC (5 FEET)

Catwalk

BATTERY/CONTROL CABINET FOOTING

pull box

ELEVATION

Looking Ahead Mile Post

EXISTING CONDUIT QUANTITIES/SIZES MAY VARY

NOT TO SCALE

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL
EXISTING DYNAMIC MESSAGE SIGN
-TRUSS STRUCTURE-
ROAD-SIDE UNIT INSTALLATION DETAIL

DESIGNER: JAB	DATE: 3-20-17	REV:
ENGINEER: JAB	SHEET 1 OF 1	

A: CONDUIT ENTRANCE

TYPE VI POLE

RSC 1½ 1-COMM. CABLE

1½ MEYERS HUBS

1½ MEYERS HUBS

RSC 1½ 1-COMM. CABLE

CABINET

26'

6'

SEE: INSET A

CAT 5E

CAT 5E

#8 AWG RHW

STANDALONE RSU INSTALLATION NOTE:
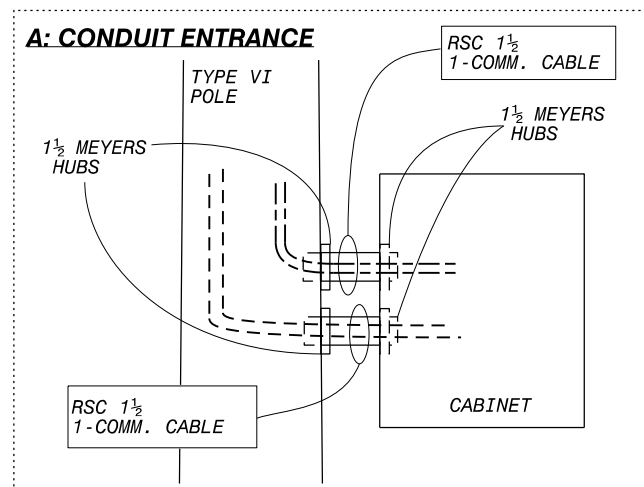
1. 60 FEET OF #8 AWG RHW ARE INCIDENTAL TO THE STANDALONE RSU BID ITEM.

2. ALL ITEMS NOT LISTED, SHOWN, OR OTHERWISE NOTED, BUT NECESSARY FOR A COMPLETE INSTALLATION, ARE INCIDENTAL TO THE ROAD-SIDE UNIT BID ITEM.

3. DRAWINGS ARE INTENDED TO BE A GENERAL GUIDELINE AND ARE ILLUSTRATIVE ONLY. ACTUAL SITE CONDITIONS MAY VARY. DO NOT MOUNT RSU OVER ROADWAY.
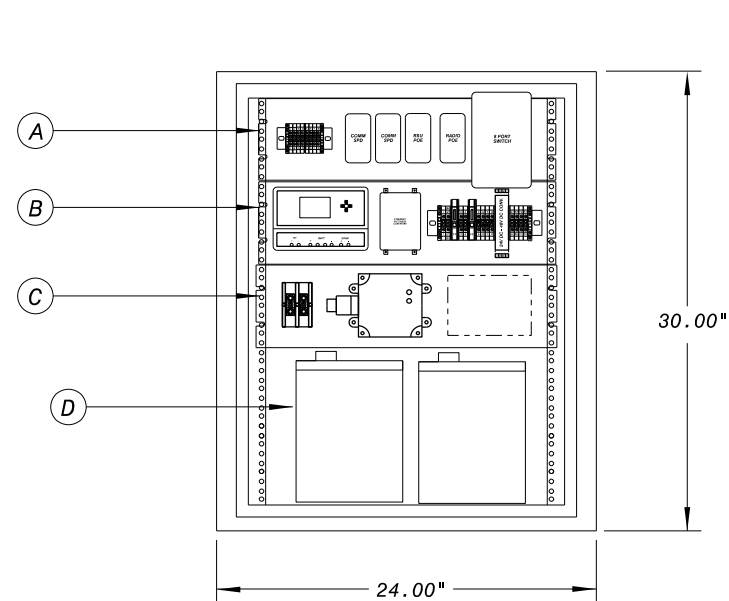
FLAG NOTES:

1. COMMUNICATION DEVICE:
(ETHERNET RADIO/CELLULAR MODEM)
A. INSTALL AS PER MANUFACTURERS INSTRUCTIONS.

B. INSTALL USING SINGLEBOLT ¾" SLOT BRACKETS AND ¾" STAINLESS STEEL BANDING.

2. ROADSIDE UNIT (RSU):
A. PROVIDE LOCOMATE ROADSTAR PREMIUM RSU BY ARADA SYSTEMS, INCLUDING: POE INJECTOR, POLE/WALL MOUNTING KIT, MOUNTING KIT FOR GPS, GPS ANTENNA, AND DSRC 5.9 GHZ ANTENNA.

B. INSTALL AS PER MANUFACTURERS INSTRUCTIONS.

C. INSTALL USING ¾" STAINLESS STEEL BANDING IF NECESSARY.

D. RSU MUST BE MOUNTED 26 FEET ABOVE THE ROADWAY SURFACE, ANY DEVIATIONS MUST BE CLEARED THROUGH WYDOT TELECOMMUNICATIONS. ANTENNA SHALL NOT BE MOUNTED MORE THAN 49 FEET ABOVE THE ROADWAY SURFACE

3. SOLAR PANEL AND MOUNT:
A. INSTALL AS PER MANUFACTURERS INSTRUCTIONS.

B. PROVIDE 1 - 340 WATT MIN. SOLAR PANEL. PROVIDE KYOCERA MODEL KU340-8BCA

C. MOUNT SOLAR PANELS FACING SOUTH WITH A 60½ OFFSET.

D. PROVIDE A SIDE-OF-POLE SOLAR PANEL MOUNT. INSTALL USING SINGLEBOLT ¾" SLOT BRACKETS AND ¾" STAINLESS STEEL BANDING. SOLAR PANELS ARE TO LIE IN THE SAME PLANE.

4. NEMA 3R ENCLOSURE:
A. INSTALL AS PER MANUFACTURERS INSTRUCTIONS.

B. ENCLOSURE DIMENSION 30"x24"x20".

C. MAX HEIGHT OF ENCLOSURE SHALL BE 6' FROM GROUND ELEVATION.

D. ENSURE PROPER BONDING OF ENCLOSURE TO EQUIPMENT GROUNDING CONDUCTOR.

5. STL POLE TYPE VI:

A.) TYPE VI POLE IS TO BE 34' IN LENGTH AND INCLUDES A 2"X12" TENON.

B.) BASE TYPE IS TO BE FIXED BASE UNLESS OTHERWISE NOTED ON LAYOUT SHEET.

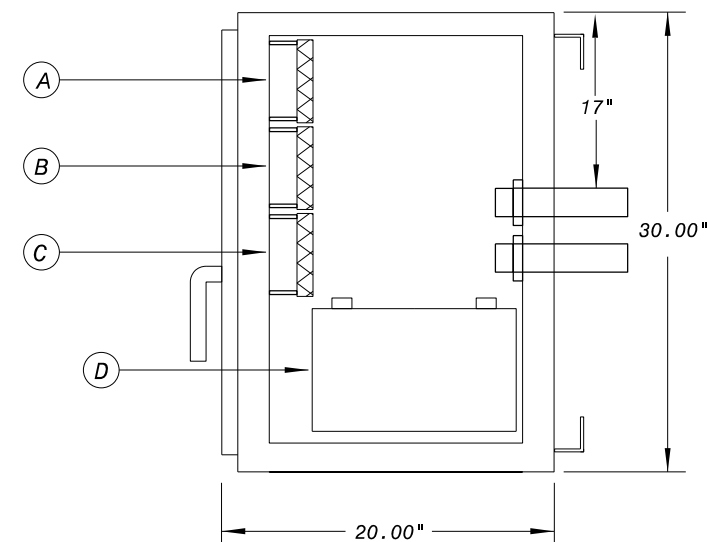C.) INSTALL 1.5" MEYERS HUBS AT EACH CONDUIT ENTRANCE

WYOMING DEPARTMENT OF TRANSPORTATION
ELECTRICAL
STANDALONE ROAD-SIDE UNIT (RSU) INSTALLATION DETAIL

DESIGNER: JAB	DATE: 02/15/2017	REV:
ENGINEER: JAB	SHEET 1 OF 4	

FRONT ELEVATION
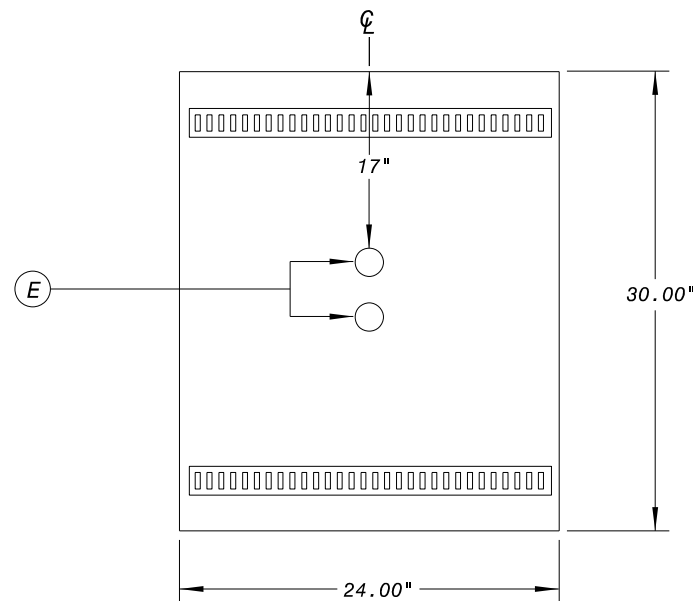
30.00"

24.00"

REAR ELEVATION

₵

17"

30.00"

24.00"

SIDE ELEVATION

17"

30.00"

20.00"

NOTES:

ALL LISTED ITEMS ARE CONSIDERED COMPONENTS OF THE
STANDALONE ROAD-SIDE UNIT.

PLEASE SEE EACH RESPECTIVE SHEET FOR FURTHER INFORMATION

BATTERY
PROVIDE ABSORBED GLASS MAT (AGM), DEEP CYCLE,
MAINTENANCE FREE TYPE BATTERIES, NO EXCEPTIONS. PROVIDE
2 BATTERIES WITH A 24 HOUR RATE @ 77 F OF AT LEAST 104 AH AS PROVIDED BY
CONCORDE BATTERY CORPORATION, EAST PENN (DEKA), OR APPROVED EQUAL.
APPROXIMATE DIMENSIONS: 13" (L) x 7" (W) x 9" (H).

ENCLOSURE
PROVIDE AN INSULATED ENCLOSURE WITH APPROXIMATE DIMENSIONS
30"x24"x20" AND CAPABLE OF POLE MOUNTING. ENCLOSURE SHALL
INCLUDE ONE DOOR CAPABLE OF OPENING TO 90 AND 180 DEGREES
WITH RETAINER FOR OPEN POSITION. ENSURE THE ENCLOSURE IS
NEMA 3R RATED. USE HEAVY DUTY 3-POINT LATCHING HARDWARE WITH
PAD LOCKABLE HANDLES. ENSURE ENCLOSURE IS CAPABLE OF MOUNTING
STANDARD EIA 19" EQUIPMENT PANELS AND RACKS. INCLUDE ONE
FLUORESCENT LIGHT WITH DOOR SWITCH.

PROVIDE 3" STANDOFFS OR RECESS MOUNTED PANELS.

PROVIDE ALL NECESSARY EQUIPMENT TO POLE MOUNT THE ENCLOSURE.
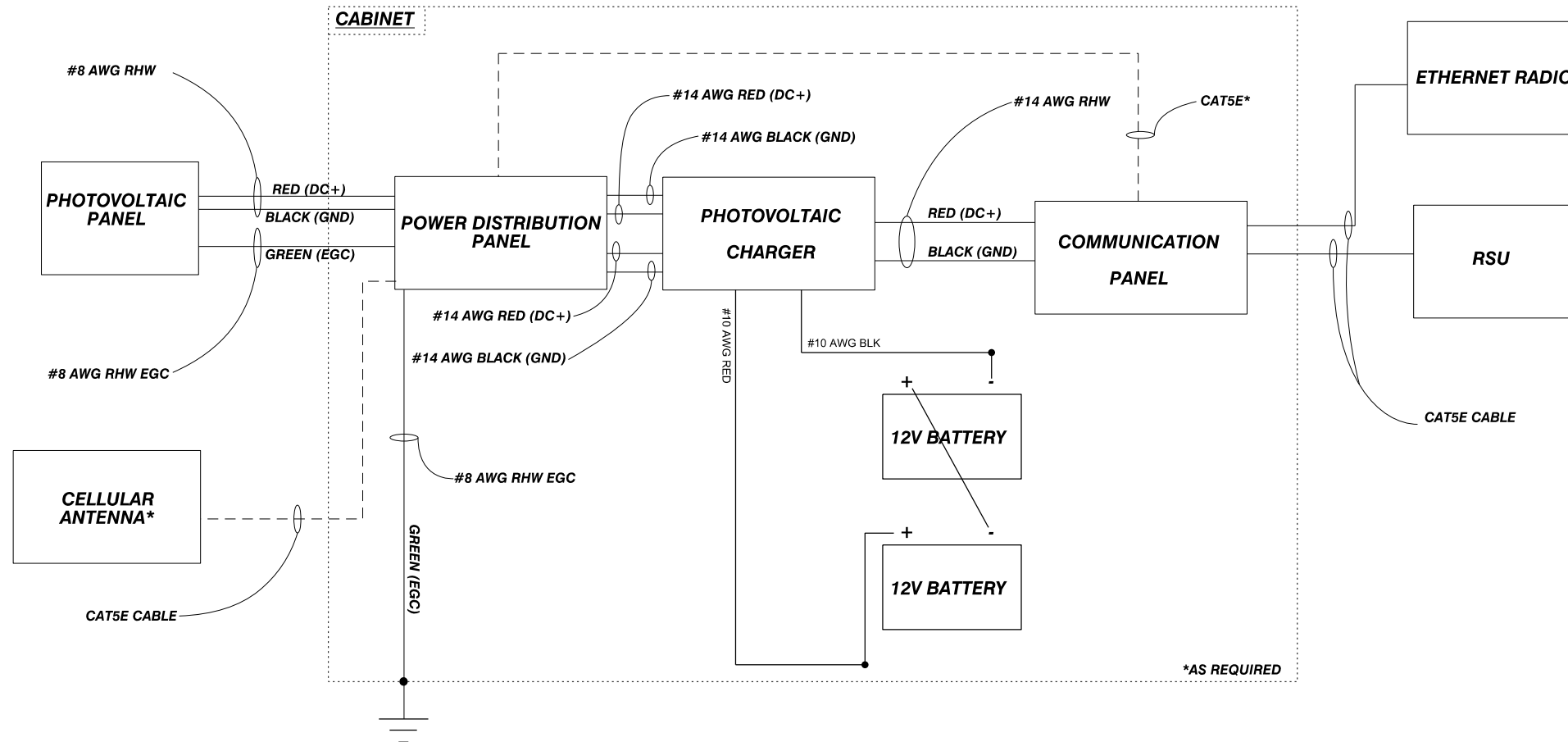
COMPONENTS
A.   COMMUNICATION PANEL
B.   PHOTOVOLTAIC TERMINAL PANEL
C.   POWER DISTRIBUTION PANEL
D.   BATTERY
E. $1\frac{1}{2}$" CONDUIT ENTRANCES
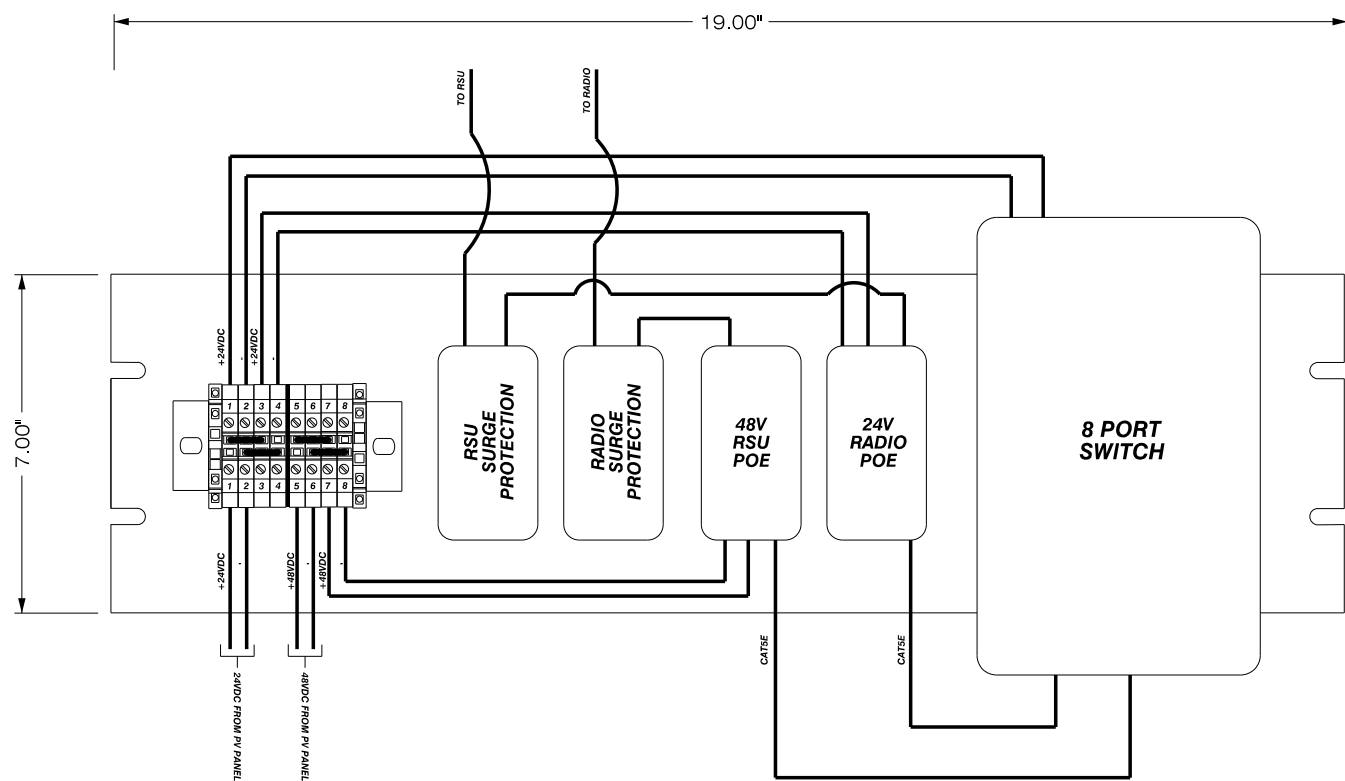
WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

STANDALONE ROAD-SIDE UNIT (RSU)
INSTALLATION DETAIL

DESIGNER: JAB	DATE: 02/15/2017	REV:
ENGINEER: JAB	SHEET 2 OF 4	

BLOCK DIAGRAM

CABINET

PHOTOVOLTAIC PANEL

#8 AWG RHW

#8 AWG RHW EGC

RED (DC+)
BLACK (GND)
GREEN (EGC)

POWER DISTRIBUTION PANEL

#14 AWG RED (DC+)
#14 AWG BLACK (GND)

#14 AWG RED (DC+)
#14 AWG BLACK (GND)

PHOTOVOLTAIC CHARGER

#14 AWG RHW

CAT5E*

RED (DC+)
BLACK (GND)

COMMUNICATION PANEL

ETHERNET RADIO

RSU

CAT5E CABLE

#10 AWG RED

#10 AWG BLK

12V BATTERY

12V BATTERY

CELLULAR ANTENNA*

#8 AWG RHW EGC

GREEN (EGC)

CAT5E CABLE

*AS REQUIRED

COMMUNICATION PANEL

19.00"

7.00"

TO RSU
TO RADIO

RSU SURGE PROTECTION
RADIO SURGE PROTECTION
48V RSU POE
24V RADIO POE
8 PORT SWITCH

24VDC FROM PV PANEL
48VDC FROM PV PANEL
CAT5E
CAT5E

TOP TERMINALS			
TERMINAL	AWG	COLOR	DESCRIPTION
1	22	RED	SWITCH POWER (24VDC+)
2	22	BLACK	SWITCH POWER (DC-)
3	22	RED	RADIO POE POWER (24VDC+)
4	22	BLACK	RADIO POE POWER (DC-)
BOTTOM TERMINALS			
TERMINAL	AWG	COLOR	DESCRIPTION
1	22	RED	24VDC SUPPLY FROM PV PANEL
2	22	BLACK	DC-
5	22	RED	48VDC SUPPLY FROM PV PANEL
6	22	BLACK	DC-
7	22	RED	RSU POE POWER (48VDC+)
8	22	BLACK	RSU POE POWER (DC-)

NOTES:

PROVIDE THE FOLLOWING APPROVED DEVICES LISTED BELOW:
1. RUGGEDCOM RS900 INDUSTRIAL ETHERNET SWITCH
2. 48V POE INJECTOR APPROPRIATE FOR USE WITH THE RSU.
3. 24V POE INJECTOR APPROPRIATE FOR USE WITH THE RADIO.
4. 2 ETHERNET SURGE PROTECTORS MODEL ETH-SP, BY UBIQUITI NETWORKS.

PROVIDE TWO DIN RAIL TERMINAL STRIP WITH THE FOLLOWING COMPONENTS FROM PHOENIX CONTACT, INC.:
- 8 UNIVERSAL TERMINAL BLOCKS, UT-4, PART #3044102,
- 2 TERMINAL ENDS, CLIPFIX 35-5, PART #3022276,
- 4 PLUG-IN BRIDGE, FBS 3-6, PART #3030242
- 1 PARTITION PLATE ATP-UT, PART #3047167
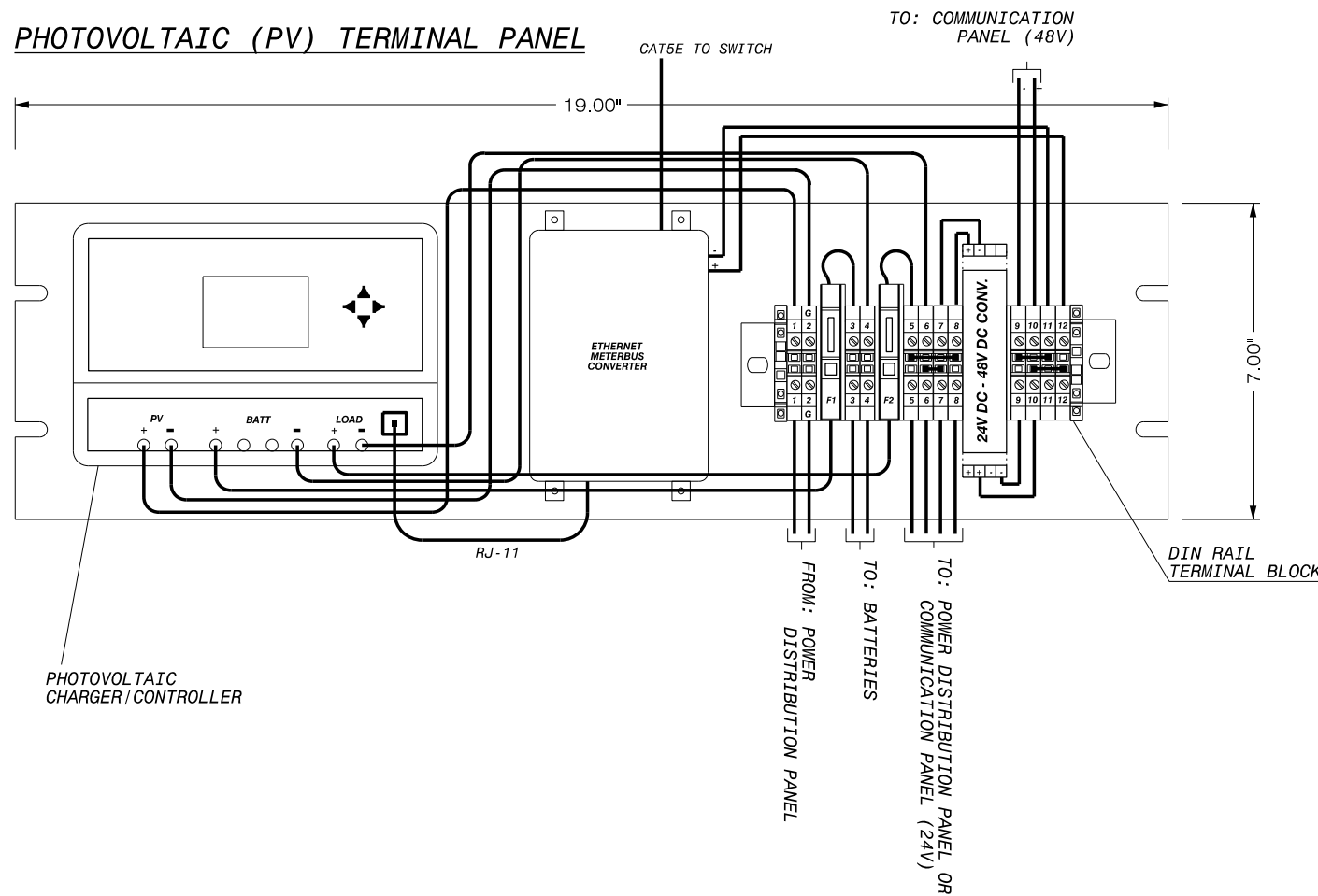- 1 DIN RAIL 35MM (W) x 175MM (L) x 7.5MM (H), PERFORATED.

PROVIDE A 14 GAUGE GALVANIZED OR POWDER COATED STEEL BACK PANEL; DIMENSIONS: 7.00 INCH x 19 INCH, OR 4U RACK SPACE UNITS.

MOUNT PANEL TO THE RAILS IN THE CABINET, PROVIDE A RECESSED PANEL OR STANDOFFS IF THE PANEL COLLIDES WITH THE DOOR TO ENSURE THE DOORS WILL CLOSE.

LABEL ALL WIRES AND TERMINALS. USE COLOR CODED WIRE APPROPRIATE TO THE APPLICATION.

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

STANDALONE ROAD-SIDE UNIT (RSU) INSTALLATION DETAIL

DESIGNER: JAB	DATE: 02/14/2017	REV:
ENGINEER: JAB	SHEET 3 OF 4	

PHOTOVOLTAIC (PV) TERMINAL PANEL

CAT5E TO SWITCH

TO: COMMUNICATION PANEL (48V)

19.00"

7.00'

ETHERNET METERBUS CONVERTER

24V DC - 48V DC CONV.

DIN RAIL TERMINAL BLOCK

PV BATT LOAD

RJ-11

PHOTOVOLTAIC CHARGER/CONTROLLER

FROM: POWER DISTRIBUTION PANEL

TO: BATTERIES

TO: POWER DISTRIBUTION PANEL OR COMMUNICATION PANEL (24V)

TOP TERMINALS			
TERMINAL	AWG	COLOR	DESCRIPTION
1	8	RED	DC+ FROM SOLAR PANEL
2	8	BLACK	DC- FROM SOLAR PANEL
3	8	RED	BATT+ FROM PV CONTROLLER VIA F1
4	8	BLACK	BATT- FROM PV CONTROLLER
5	14	RED	LOAD+ FROM PV CONTROLLER VIA F2
6	14	BLACK	LOAD- FROM PV CONTROLLER
7	14	BLACK	DC- SUPPLY TO DC-DC CONVERTER
8	14	RED	DC+ SUPPLY TO DC-DC CONVERTER
9	14	BLACK	DC- TO COMM PANEL
10	14	RED	48VDC SUPPLY TO COMM PANEL
11	14	RED	48VDC SUPPLY TO EMC-1
12	14	BLACK	DC- TO EMC-1
BOTTOM TERMINALS			
TERMINAL	AWG	COLOR	DESCRIPTION
1	8	RED	DC+ FROM PD PANEL
2	8	BLACK	DC- FROM PD PANEL
3	8	RED	DC+ TO BATTERY BANK
4	8	BLACK	DC- TO BATTERY BANK
5	14	RED	24VDC SUPPLY TO DEVICES
6	14	BLACK	DC-
7	14	RED	24VDC SUPPLY TO COMM PANEL
8	14	BLACK	DC-
9	14	BLACK	DC-
10	14	RED	48VDC SUPPLY FROM DC-DC CONVERTER

NOTES:

PROVIDE ONE THE FOLLOWING APPROVED PHOTOVOLTAIC CHARGERS LISTED BELOW:
1. MORNINGSTAR CORPORATION, PROSTAR MODEL PS-MPPT-40M

PROVIDE AN ETHERNET METERBUS CONVERTER, MORNINGSTAR CORPORATION, MODEL EMC-1.

PROVIDE A DIN RAIL TERMINAL STRIP WITH THE FOLLOWING COMPONENTS FROM PHOENIX CONTACT, INC.:
   - 12 UNIVERSAL TERMINAL BLOCKS, UT-4, PART # 3044102,
   - 2 TERMINAL ENDS, CLIPFIX 35-5, PART #3022276,
   - 2 COVER PLATES, D-UT/4-TWIN, PART # 3047141,
   - 2 COVER PLATES, D-UT2.5/10, PART #3047028,
   - 2 DIN RAIL FUSE HOLDER, UT-6-HESI, PART # 3046401,
   - 1 DIN RAIL 35MM (W) x 175MM (L) x 7.5MM (H), PERFORATED.

PROVIDE ONE 10A AND ONE 20A, FAST-ACTING, 32V, GLASS FUSE WITH DIMENSIONS: 0.25 INCH X 1.25 INCH, OR 6.3MM X 32MM.

PROVIDE A 14 GAUGE GALVANIZED OR POWDER COATED STEEL BACK PANEL; DIMENSIONS: 7.00 INCH x 19 INCH, OR 4U RACK SPACE UNITS.

PROVIDE A 24VDC-48VDC CONVERTER MODEL QUINT-PS/24DC/48/DC/5 PART #2320128 BY PHEONIX CONTACT, OR APPROVED EQUAL.

PROVIDE A PACKETFLUX TECHNOLOGIES SITEMONITOR FOR MORNINGSTAR (METERBUS), OR APPROVED EQUAL.

PROVIDE A PACKETFLUX TECHNOLOGIES SITEMONITOR BASE UNIT II, OR APPROVED EQUAL.

MOUNT PANEL TO THE RAILS IN THE CABINET, PROVIDE A RECESSED PANEL OR STANDOFFS IF THE PANEL COLLIDES WITH THE DOOR TO ENSURE THE DOORS WILL CLOSE.

LABEL ALL WIRES AND TERMINALS. USE COLOR CODED WIRE APPROPRIATE TO THE APPLICATION.

POWER DISTRIBUTION (PD) PANEL

TO PHOTOVOLTAIC TERMINAL PANEL (TERMINALS 1 & 2)

ADDITIONAL HARDWARE MOUNTING AREA

ETHERNET SURGE SUPPRESSOR OR AIRLINK RavenX CELLULAR MODEM (WHEN REQUIRED)

7.00'

EGC GND 24V

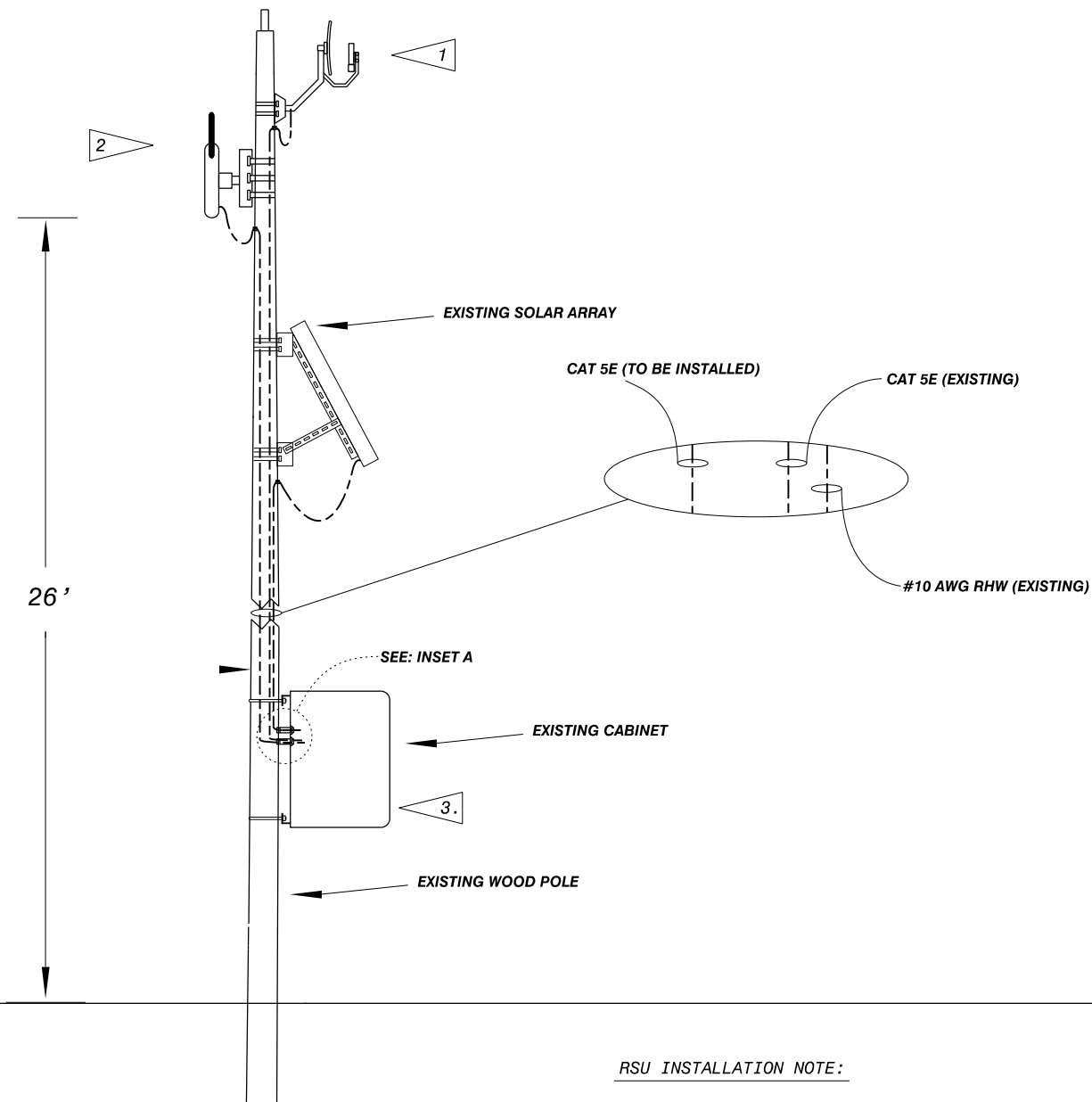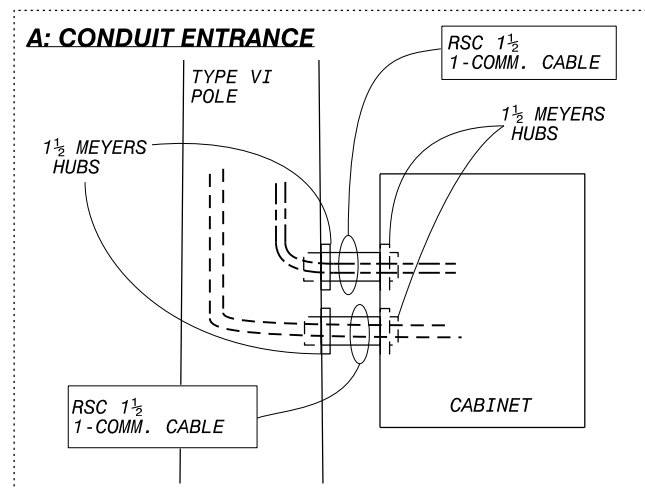FROM PHOTOVOLTAIC ARRAY

POWER SPLICER BLOCK

19.00"

SURGE SURPRESSOR
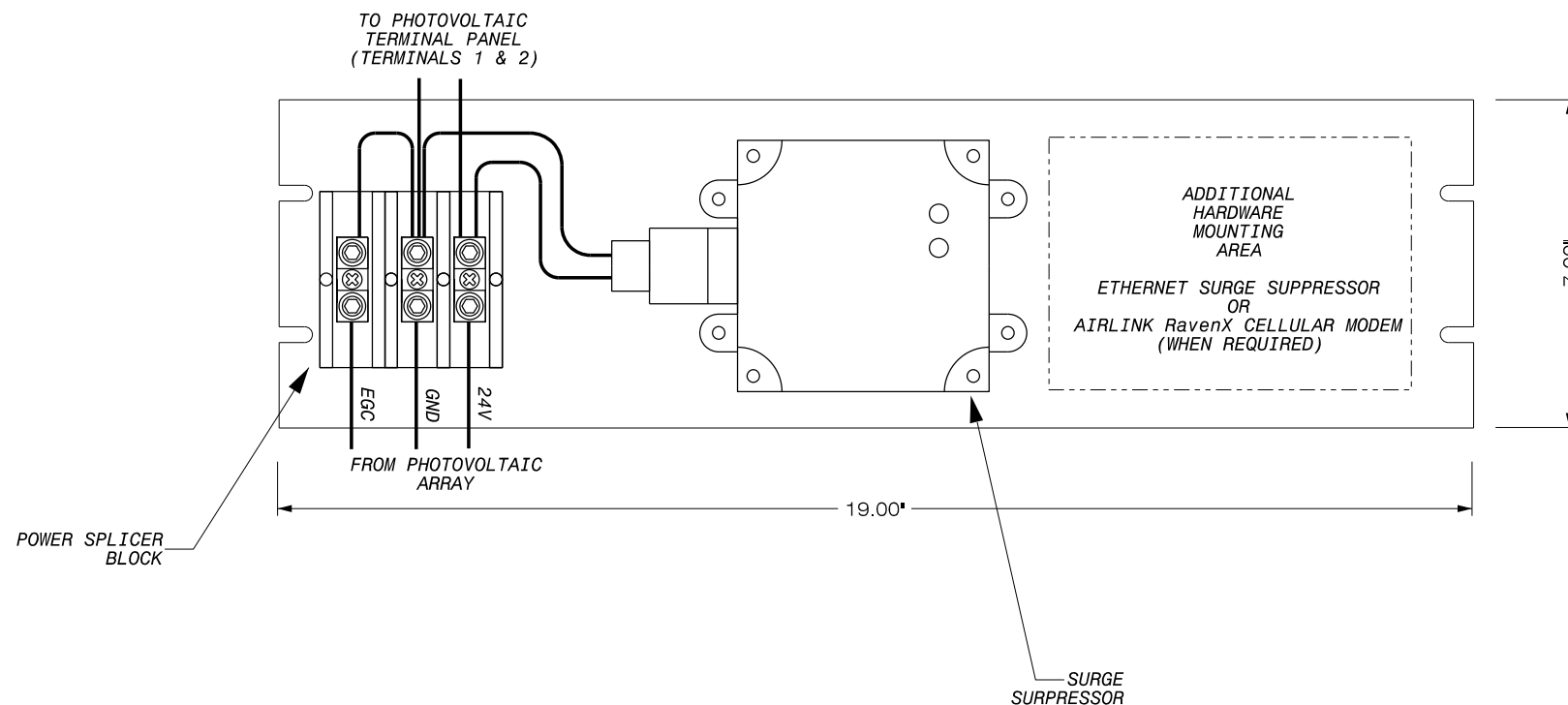
NOTES:

PROVIDE AN ATLANTIC SCIENTIFIC, MODEL 14624, 24DC PANEL MOUNT SURGE PROTECTOR.

PROVIDE A UL LISTED, PANEL MOUNT POWER SPLICER BLOCK WITH 2 POLES. LINE WIRE RANGE #2 - #14 AWG, LOAD WIRE RANGE #2 - #14 AWG, AND RATED FOR AT LEAST 600V. PROVIDE WITH TERMINAL COVERS.

PROVIDE A 14 GAUGE STEEL PANEL WITH DIMENSIONS 7.00 INCH x 19 INCH, OR 4U RACK SPACE UNITS TO MOUNT THE ABOVE EQUIPMENT.

MOUNT PANEL TO THE RAILS IN THE CABINET, PROVIDE A RECESSED PANEL OR STANDOFFS IF THE PANEL COLLIDES WITH THE DOOR TO ENSURE THE DOORS WILL CLOSE.

LABEL ALL WIRES AND TERMINALS. USE COLOR CODED WIRE APPROPRIATE TO THE APPLICATION.

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

STANDALONE ROAD-SIDE UNIT (RSU) INSTALLATION DETAIL

DESIGNER: JAB	DATE: 02/15/2017	REV:
ENGINEER: JAB	SHEET 4 OF 4	

A: CONDUIT ENTRANCE

RSC 1½
1-COMM. CABLE

TYPE VI
POLE

1½ MEYERS
HUBS

1½ MEYERS
HUBS

1½ MEYERS
HUBS

RSC 1½
1-COMM. CABLE

CABINET

1

2

EXISTING SOLAR ARRAY

CAT 5E (TO BE INSTALLED)

CAT 5E (EXISTING)

#10 AWG RHW (EXISTING)

26'

SEE: INSET A

EXISTING CABINET

3.

EXISTING WOOD POLE

FLAG NOTES:

1. COMMUNICATION DEVICE (WHEN REQUIRED):
   A. INSTALL AS PER MANUFACTURERS INSTRUCTIONS.

   B. INSTALL USING SINGLEBOLT ¾' SLOT BRACKETS
       AND ¾" STAINLESS STEEL BANDING.

2. ROADSIDE UNIT (RSU):
   A. PROVIDE LOCOMATE ROADSTAR PREMIUM RSU BY ARADA SYSTEMS,
       INCLUDING: POE INJECTOR, POLE/WALL MOUNTING KIT,
       MOUNTING KIT FOR GPS, GPS ANTENNA, AND DSRC 5.9 GHZ
       ANTENNA.

   B. INSTALL AS PER MANUFACTURERS INSTRUCTIONS.

   C. INSTALL USING ¾" STAINLESS STEEL BANDING IF
       NECESSARY.

   D. RSU MUST BE MOUNTED 26 FEET ABOVE THE ROADWAY SURFACE,
       ANY DEVIATIONS MUST BE CLEARED THROUGH WYDOT
       TELECOMMUNICATIONS. ANTENNA SHALL NOT BE MOUNTED
       MORE THAN 49 FEET ABOVE THE ROADWAY SURFACE

3. EXISTING SYSTEM IS 24VDC. PROVIDE 24VDC-48VDC CONVERTER MODEL
   QUINT-PS/24DC/48DC/5 PART # 2320128 BY PEHONIX CONTACT, OR
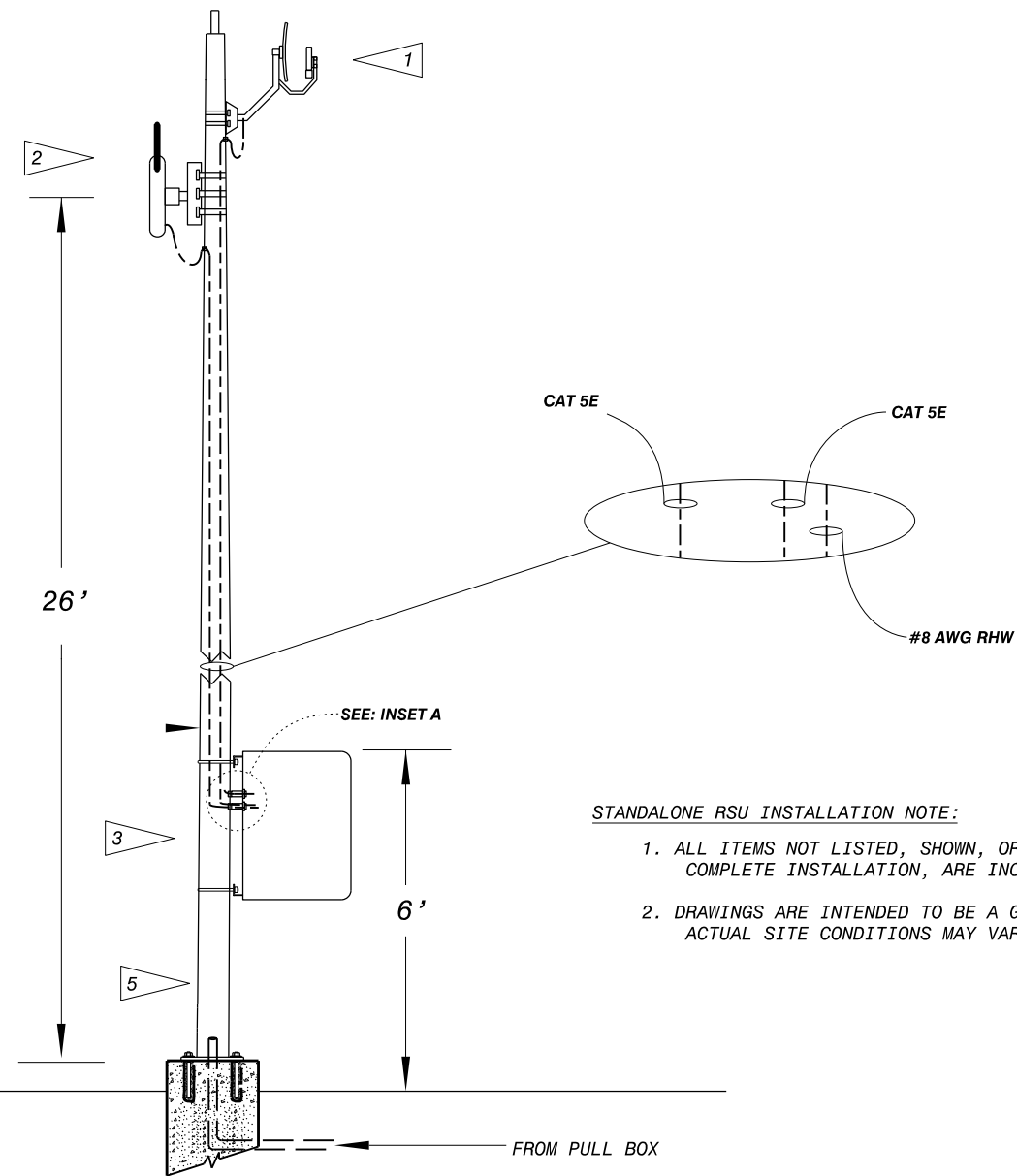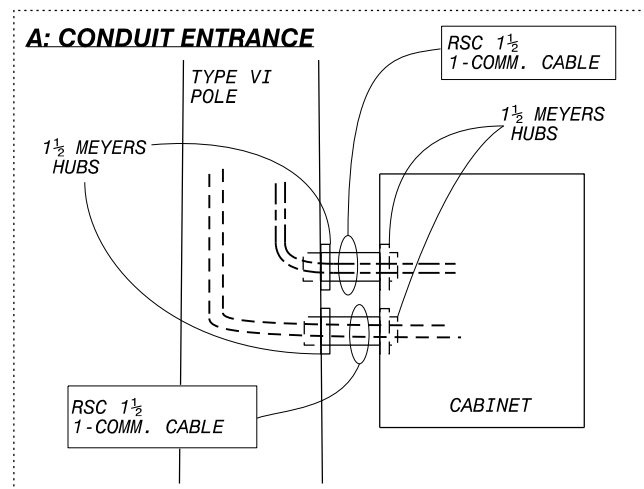   APPROVED EQUAL.

RSU INSTALLATION NOTE:

1. ALL ITEMS NOT LISTED, SHOWN, OR OTHERWISE NOTED, BUT NECESSARY FOR A
   COMPLETE INSTALLATION, ARE INCIDENTAL TO THE ROAD-SIDE UNIT BID ITEM.

2. DRAWINGS ARE INTENDED TO BE A GENERAL GUIDELINE AND ARE ILLUSTRATIVE ONLY.
   ACTUAL SITE CONDITIONS MAY VARY. DO NOT MOUNT RSU OVER ROADWAY.

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL
EXISTING STANDALONE SITE -
ROAD-SIDE UNIT (RSU)
INSTALLATION DETAIL

DESIGNER: JAB	DATE: 02/15/2017	REV:
ENGINEER: JAB	SHEET 1 OF 4	

A: CONDUIT ENTRANCE

TYPE VI POLE

RSC 1½
1-COMM. CABLE

1½ MEYERS HUBS

1½ MEYERS HUBS

1½ MEYERS HUBS

RSC 1½
1-COMM. CABLE

CABINET

CAT 5E

CAT 5E

#8 AWG RHW

26'

SEE: INSET A

6'

FROM PULL BOX

STANDALONE RSU INSTALLATION NOTE:

1. ALL ITEMS NOT LISTED, SHOWN, OR OTHERWISE NOTED, BUT NECESSARY FOR A COMPLETE INSTALLATION, ARE INCIDENTAL TO THE ROAD-SIDE UNIT BID ITEM.

2. DRAWINGS ARE INTENDED TO BE A GENERAL GUIDELINE AND ARE ILLUSTRATIVE ONLY. ACTUAL SITE CONDITIONS MAY VARY. DO NOT MOUNT RSU OVER ROADWAY.

FLAG NOTES:

1. COMMUNICATION DEVICE:
   (ETHERNET RADIO/CELLULAR MODEM)
   A. INSTALL AS PER MANUFACTURERS INSTRUCTIONS.

   B. INSTALL USING SINGLEBOLT ¾" SLOT BRACKETS
      AND ¾" STAINLESS STEEL BANDING.

2. ROADSIDE UNIT (RSU):
   A. PROVIDE LOCOMATE ROADSTAR PREMIUM RSU BY ARADA SYSTEMS,
      INCLUDING: POE INJECTOR, POLE/WALL MOUNTING KIT,
      MOUNTING KIT FOR GPS, GPS ANTENNA, AND DSRC 5.9 GHZ
      ANTENNA.

   B. INSTALL AS PER MANUFACTURERS INSTRUCTIONS.

   C. INSTALL USING ¾" STAINLESS STEEL BANDING IF
      NECESSARY.

   D. RSU MUST BE MOUNTED 26 FEET ABOVE THE ROADWAY SURFACE,
      ANY DEVIATIONS MUST BE CLEARED THROUGH WYDOT
      TELECOMMUNICATIONS. ANTENNA SHALL NOT BE MOUNTED
      MORE THAN 49 FEET ABOVE THE ROADWAY SURFACE

3. NEMA 3R ENCLOSURE:
   A. INSTALL AS PER MANUFACTURERS INSTRUCTIONS.

   B. ENCLOSURE DIMENSION 30"x24"x20".

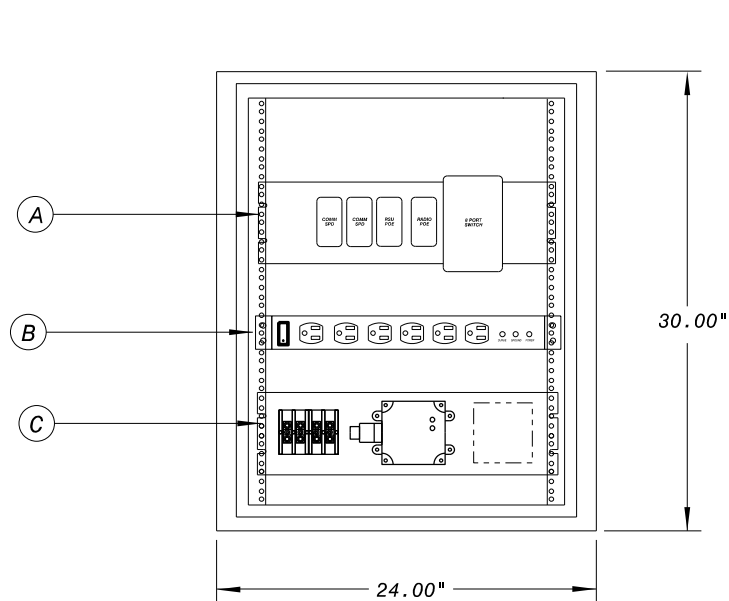   C. MAX HEIGHT OF ENCLOSURE SHALL BE 6'
      FROM GROUND ELEVATION.

   D. ENSURE PROPER BONDING OF ENCLOSURE TO
      EQUIPMENT GROUNDING CONDUCTOR.

5. STL POLE TYPE VI:

   A.) TYPE VI POLE IS TO BE 34' IN LENGTH AND INCLUDES A 2"X12" TENON.

   B.) BASE TYPE IS TO BE FIXED BASE UNLESS OTHERWISE NOTED ON
       LAYOUT SHEET.
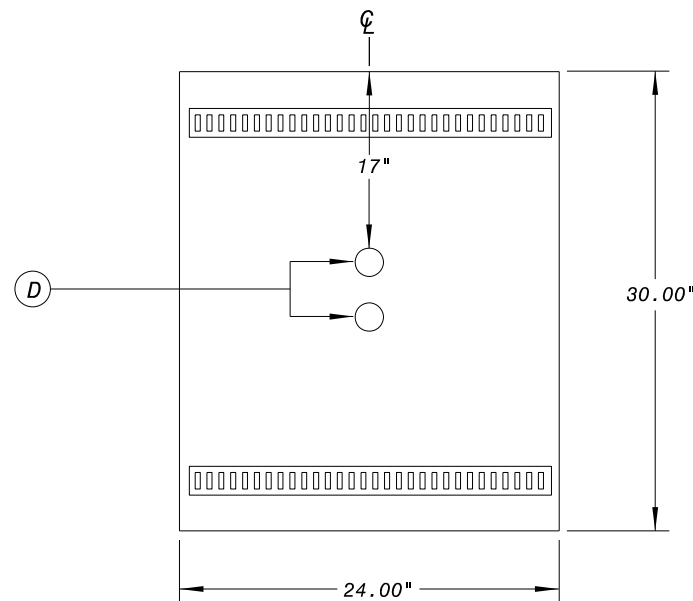
   C.) INSTALL 1.5" MEYERS HUBS AT EACH CONDUIT ENTRANCE

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

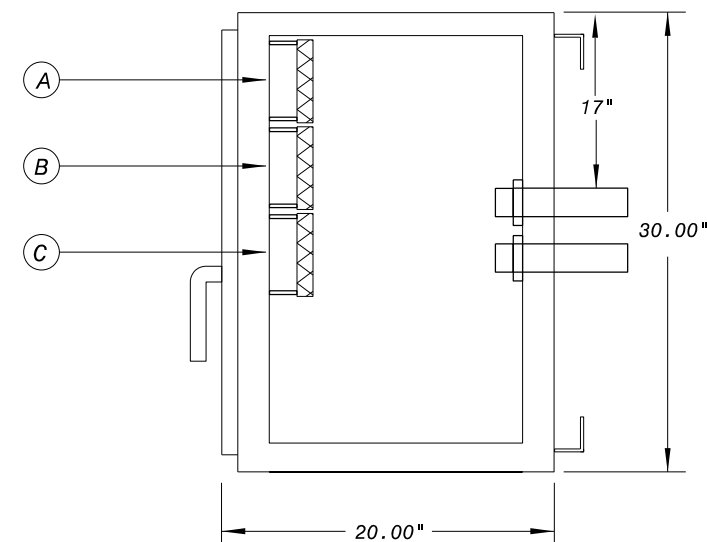*STANDALONE AC ROAD-SIDE UNIT (RSU)
INSTALLATION DETAIL*

DESIGNER: JAB	DATE: 02/15/2017	REV:
ENGINEER: JAB	SHEET 1 OF 4	

30.00"

24.00"

FRONT ELEVATION

17"

30.00"

24.00"

REAR ELEVATION

17"

30.00"

20.00"

SIDE ELEVATION

NOTES:

ALL LISTED ITEMS ARE CONSIDERED COMPONENTS OF THE
STANDALONE AC ROAD-SIDE UNIT.

PLEASE SEE EACH RESPECTIVE SHEET FOR FURTHER INFORMATION

ENCLOSURE
PROVIDE AN INSULATED ENCLOSURE WITH APPROXIMATE DIMENSIONS
30"x24"x20" AND CAPABLE OF POLE MOUNTING. ENCLOSURE SHALL
INCLUDE ONE DOOR CAPABLE OF OPENING TO 90 AND 180 DEGREES
WITH RETAINER FOR OPEN POSITION. ENSURE THE ENCLOSURE IS
NEMA 3R RATED. USE HEAVY DUTY 3-POINT LATCHING HARDWARE WITH
PAD LOCKABLE HANDLES. ENSURE ENCLOSURE IS CAPABLE OF MOUNTING
STANDARD EIA 19" EQUIPMENT PANELS AND RACKS. INCLUDE ONE
FLUORESCENT LIGHT WITH DOOR SWITCH.

PROVIDE 3" STANDOFFS OR RECESS MOUNTED PANELS.

PROVIDE ALL NECESSARY EQUIPMENT TO POLE MOUNT THE ENCLOSURE.
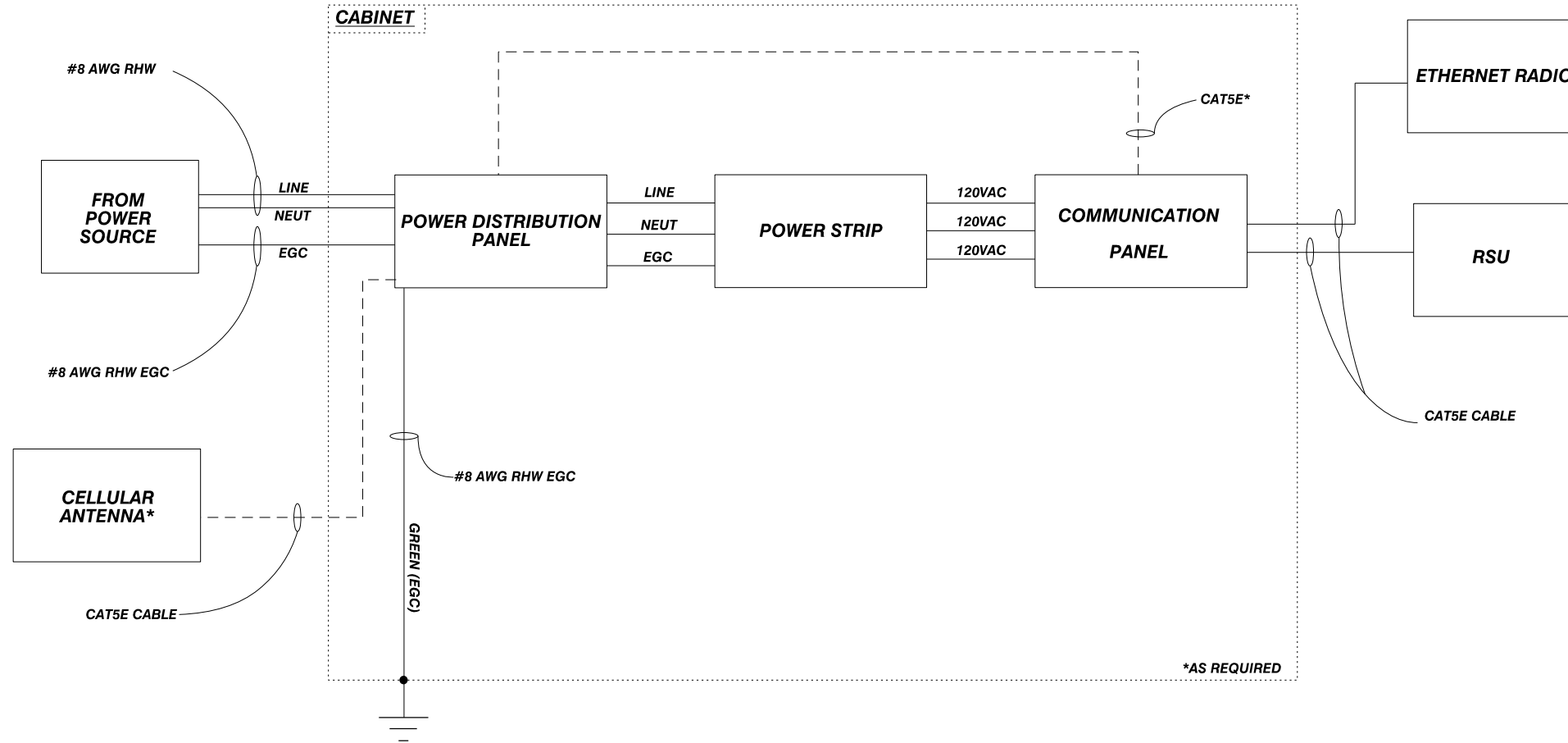
COMPONENTS
A.   COMMUNICATION PANEL
B.   POWER STRIP
C.   POWER DISTRIBUTION PANEL
D. $1\frac{1}{2}$" CONDUIT ENTRANCES
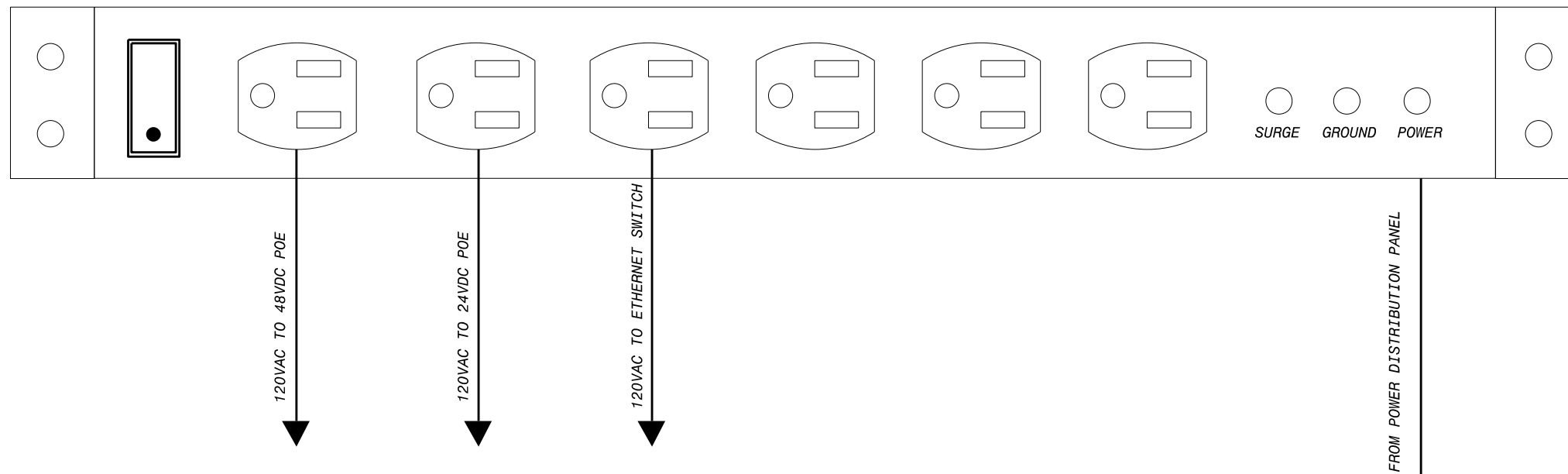
WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

STANDALONE AC ROAD-SIDE UNIT (RSU)
INSTALLATION DETAIL

DESIGNER: JAB	DATE: 02/15/2017	REV:
ENGINEER: JAB	SHEET 2 OF 4	

BLOCK DIAGRAM

CABINET

#8 AWG RHW

FROM POWER SOURCE

LINE
NEUT
EGC

#8 AWG RHW EGC

POWER DISTRIBUTION PANEL

LINE
NEUT
EGC

POWER STRIP

120VAC
120VAC
120VAC

CAT5E*

COMMUNICATION PANEL

ETHERNET RADIO

RSU

CAT5E CABLE

CELLULAR ANTENNA*

#8 AWG RHW EGC

GREEN (EGC)

CAT5E CABLE

AS REQUIRED

POWER STRIP

SURGE   GROUND   POWER

120VAC TO 48VDC POE

120VAC TO 24VDC POE
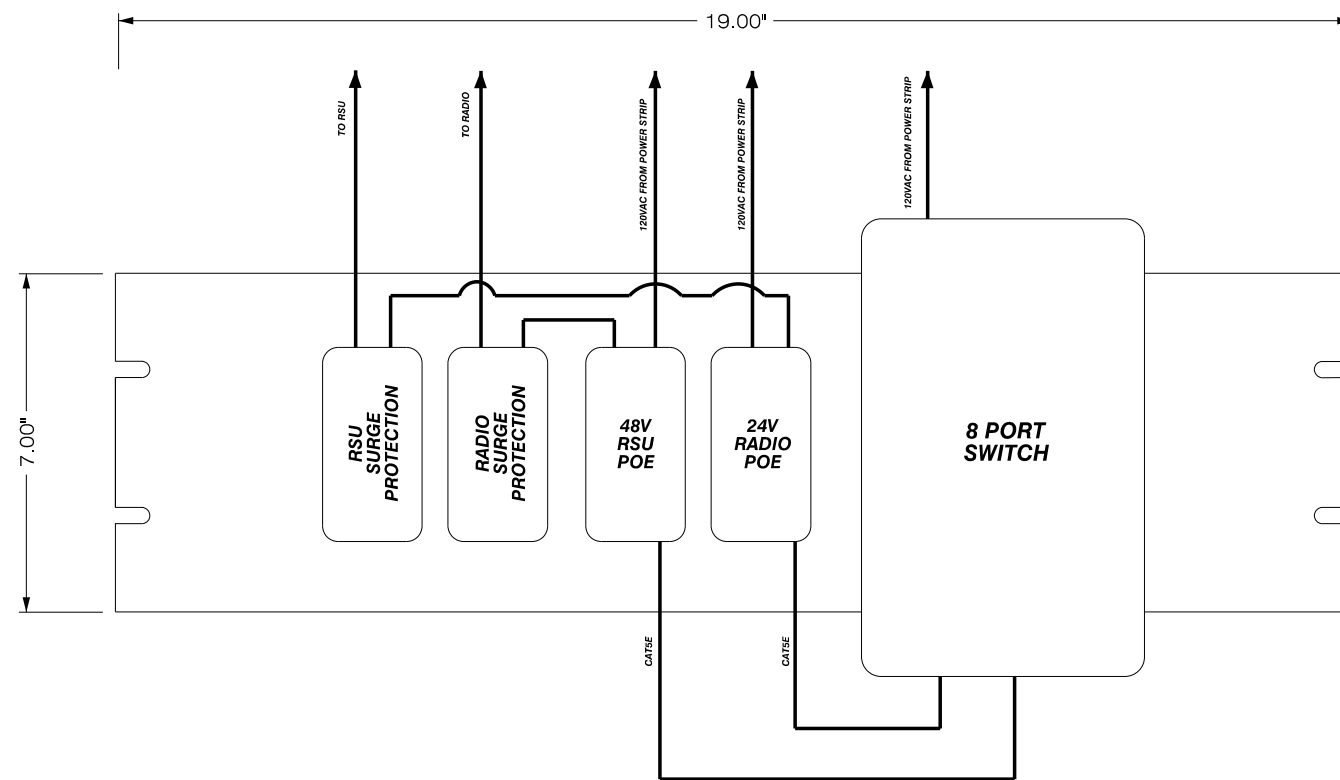
120VAC TO ETHERNET SWITCH

FROM POWER DISTRIBUTION PANEL

NOTES:

PROVIDE THE FOLLOWING APPROVED DEVICE LISTED BELOW:

ATLANTIC SCIENTIFIC MODEL CPS-1215RMS, OR APPROVED EQUAL

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

STANDALONE AC ROAD-SIDE UNIT (RSU) INSTALLATION DETAIL

DESIGNER: JAB	DATE: 02/14/2017	REV:
ENGINEER: JAB	SHEET 3 OF 4	

COMMUNICATION PANEL

19.00"

7.00"

TO RSU

TO RADIO

120VAC FROM POWER STRIP

120VAC FROM POWER STRIP

120VAC FROM POWER STRIP

RSU SURGE PROTECTION

RADIO SURGE PROTECTION

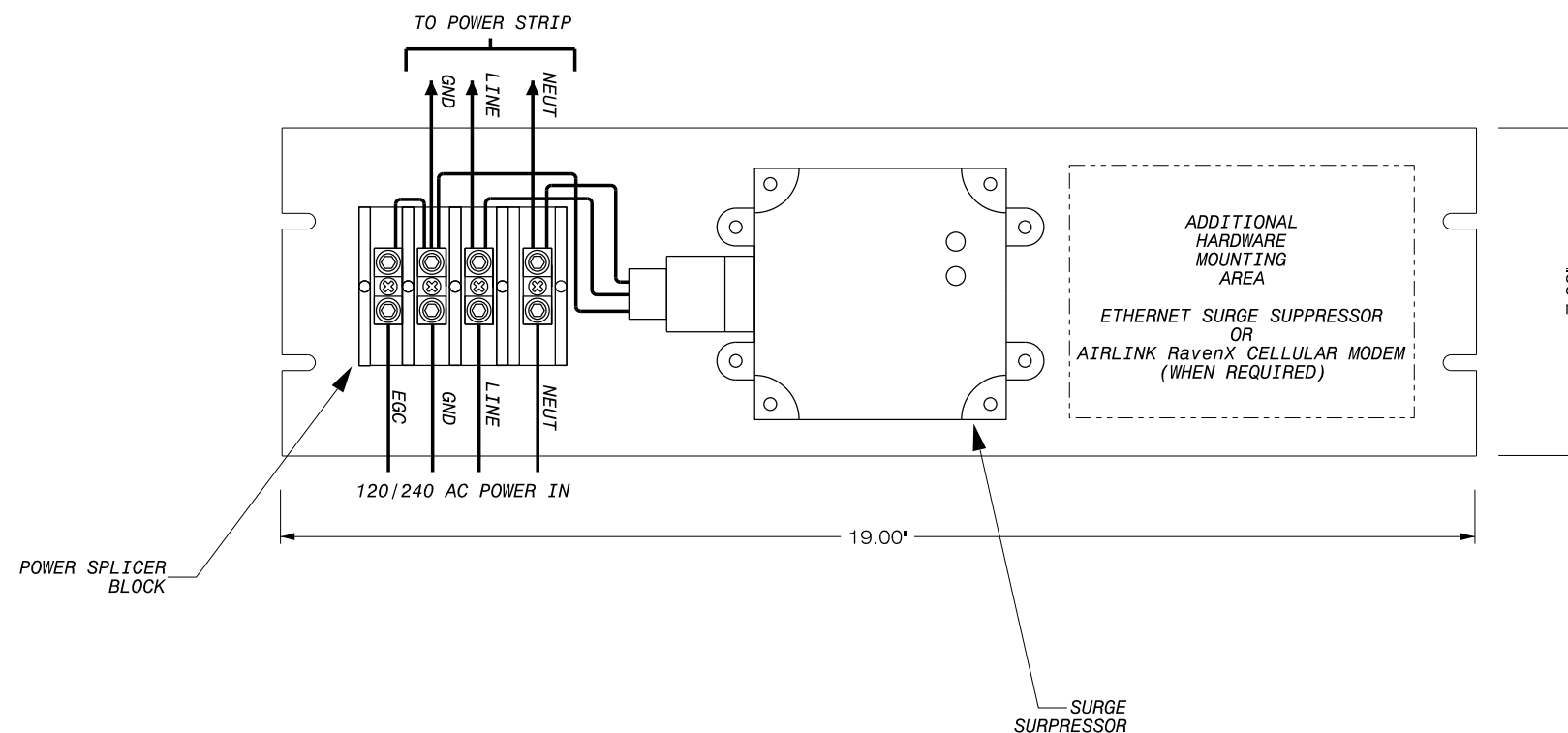48V RSU POE

24V RADIO POE

8 PORT SWITCH

CAT5E

CAT5E

NOTES:

PROVIDE THE FOLLOWING APPROVED DEVICES LISTED BELOW:
1. 120VAC SUPPLIED, RUGGEDCOM RS900 INDUSTRIAL ETHERNET SWITCH
2. 120VAC SUPPLIED, 48V POE INJECTOR APPROPRIATE FOR USE WITH THE RSU.
3. 120VAC SUPPLIED, 24V POE INJECTOR APPROPRIATE FOR USE WITH THE RADIO.
4. 2 ETHERNET SURGE PROTECTORS MODEL ETH-SP, BY UBIQUITI NETWORKS.

PROVIDE A 14 GAUGE GALVANIZED OR POWDER COATED STEEL BACK PANEL; DIMENSIONS: 7.00 INCH x 19 INCH, OR 4U RACK SPACE UNITS.

MOUNT PANEL TO THE RAILS IN THE CABINET, PROVIDE A RECESSED PANEL OR STANDOFFS IF THE PANEL COLLIDES WITH THE DOOR TO ENSURE THE DOORS WILL CLOSE.

LABEL ALL WIRES AND TERMINALS. USE COLOR CODED WIRE APPROPRIATE TO THE APPLICATION.

POWER DISTRIBUTION (PD) PANEL

TO POWER STRIP

GND   LINE   NEUT

EGC   GND   LINE   NEUT

120/240 AC POWER IN

ADDITIONAL HARDWARE MOUNTING AREA

ETHERNET SURGE SUPPRESSOR OR AIRLINK RavenX CELLULAR MODEM (WHEN REQUIRED)

7.00"

19.00"

POWER SPLICER BLOCK

SURGE SURPRESSOR

NOTES:

PROVIDE AN ATLANTIC SCIENTIFIC, MODEL 16800, 120V SINGLE PHASE AC PANEL MOUNT SURGE PROTECTOR.

PROVIDE A UL LISTED, PANEL MOUNT POWER SPLICER BLOCK WITH 4 POLES. LINE WIRE RANGE #2 - #14 AWG, LOAD WIRE RANGE #2 - #14 AWG, AND RATED FOR AT LEAST 600V. PROVIDE WITH TERMINAL COVERS.

PROVIDE A 14 GAUGE STEEL PANEL WITH DIMENSIONS 7.00 INCH x 19 INCH, OR 4U RACK SPACE UNITS TO MOUNT THE ABOVE EQUIPMENT.

MOUNT PANEL TO THE RAILS IN THE CABINET, PROVIDE A RECESSED PANEL OR STANDOFFS IF THE PANEL COLLIDES WITH THE DOOR TO ENSURE THE DOORS WILL CLOSE.
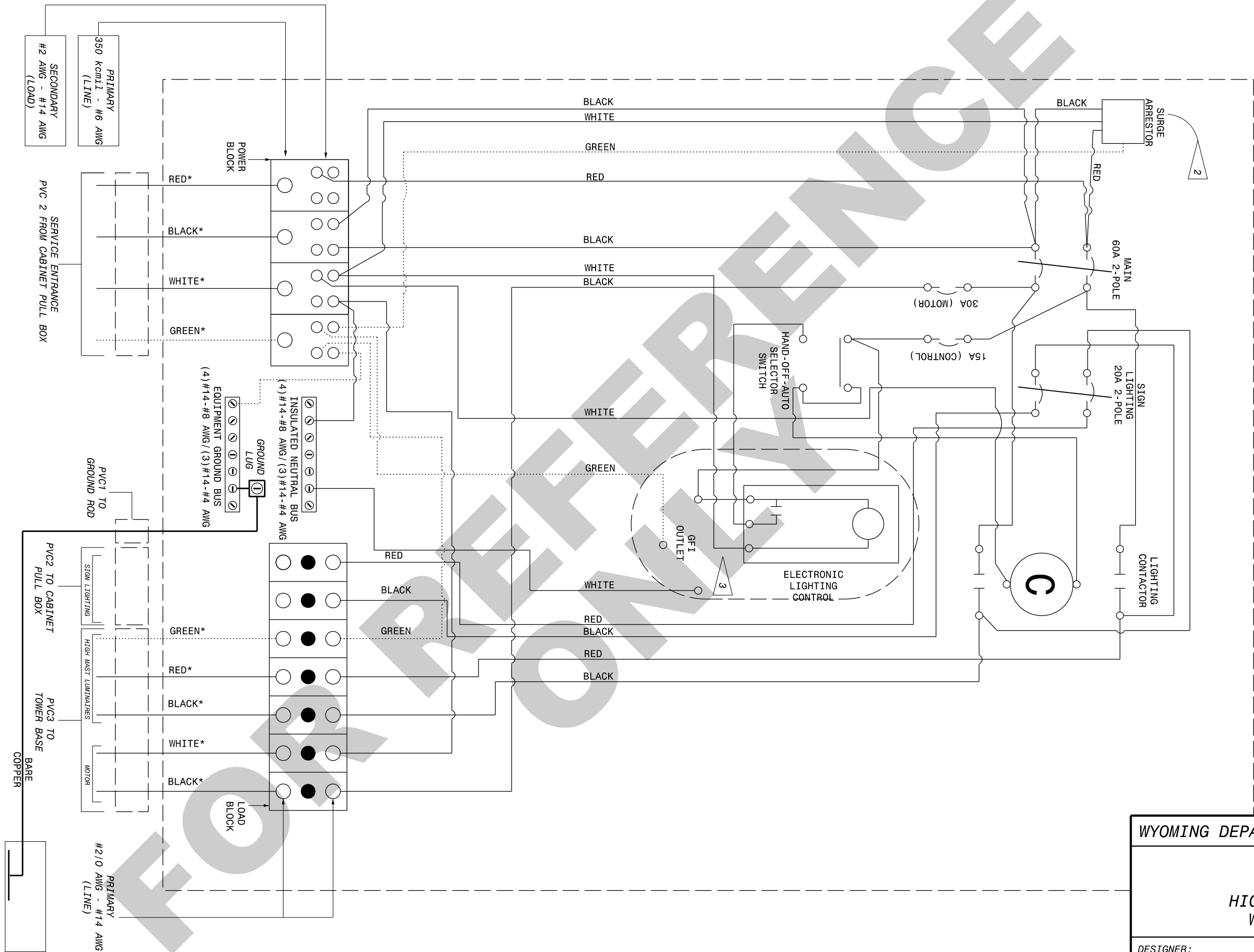
LABEL ALL WIRES AND TERMINALS. USE COLOR CODED WIRE APPROPRIATE TO THE APPLICATION.

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL

STANDALONE AC ROAD-SIDE UNIT (RSU) INSTALLATION DETAIL

| DESIGNER: JAB | DATE: 02/15/2017 | REV: |
| ENGINEER: JAB | SHEET 4 OF 4 | |

WYDOT HIGH MAST LIGHTING UL508 △ 1
DEFINITE PURPOSE ENCLOSURE
WIRING DIAGRAM

FLAG NOTES:

△ 1 CABINET COMPONENTS AND WIRING IS TO BE LAYED OUT AS SHOWN ON THIS SHEET AND RESPECTIVE FLAG NOTES. THE CABINET WIRING WILL MEET THE LATEST NEC REQUIREMENTS.

△ 2 THE SURGE ARRESTOR IS TO BE MOUNTED IN A LOCATION THAT IS READILY ACCESSIBLE FOR EASE OF MAINTENANCE.

△ 3 THE GFI DUPLEX OUTLET IS TO BE INSTALLED SO THAT IT IS ACCESSIBLE FROM THE FRONT PANEL.
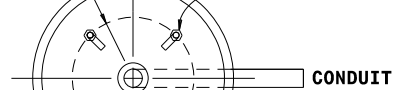
NOTE* GAUGE OF CONDUCTORS IS SHOWN ON LAYOUT SHEETS.

WYOMING DEPARTMENT OF TRANSPORTATION
ELECTRICAL
HIGH MAST LIGHTING WIRING DIAGRAM

DESIGNER:	DATE: 8-8-05	REV:
ENGINEER:	SHEET 2 OF 2	

BOLT CIRCLE AS PER POLE SUPPLIERS SHOP DRAWINGS

ANCHOR BOLTS, AS PER POLE SUPPLIERS SHOP DRAWINGS
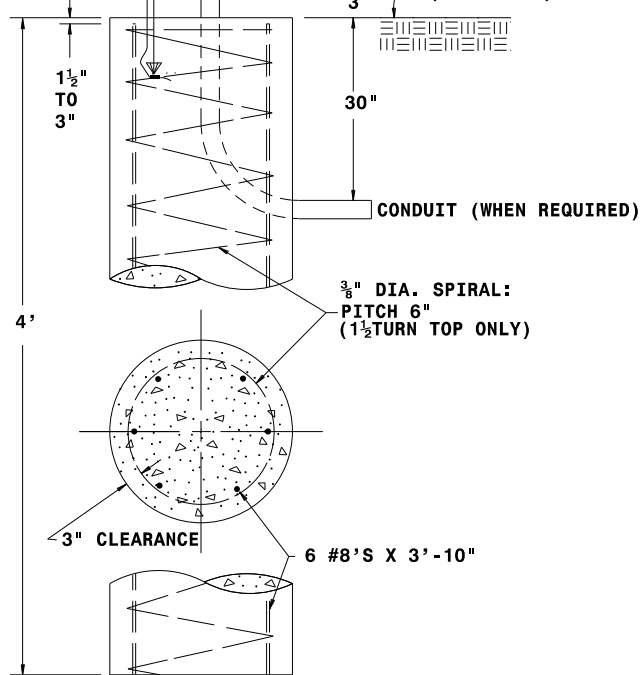
CONDUIT

INSTALL EXPANSION-JOINT MATERIAL IN ACCORDANCE WITH SUBSECTION 609.4.3.2, EXPANSION JOINTS.

24"

#6 AWG SOLID COPPER W/GROUND CLAMP ATTACHED TO STEEL SPIRAL CAGE

TO GROUNDING ANGLE

SET THE TOP OF THE FOUNDATION AT THE SAME ELEVATION AS THE EXISTING (OR FUTURE) BACK OF CURB ELEVATION

3'

1½" TO 3"

30"

CONDUIT (WHEN REQUIRED)

⅜" DIA. SPIRAL: PITCH 6" (1½ TURN TOP ONLY)

4'

3" CLEARANCE

6 #8'S X 3'-10"

DRILLED SHAFT FOUNDATION

(STL POLE TYPE I & DECORATIVE LIGHTING POLE)

BOLT CIRCLE AS PER POLE SUPPLIERS SHOP DRAWINGS

ANCHOR BOLTS, AS PER POLE SUPPLIERS SHOP DRAWINGS

CONDUIT

INSTALL EXPANSION-JOINT MATERIAL IN ACCORDANCE WITH SUBSECTION 609.4.3.2, EXPANSION JOINTS.

30'

#6 AWG SOLID COPPER W/GROUND CLAMP ATTACHED TO STEEL SPIRAL CAGE

TO GROUNDING ANGLE

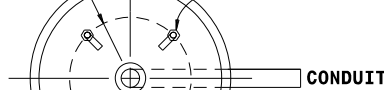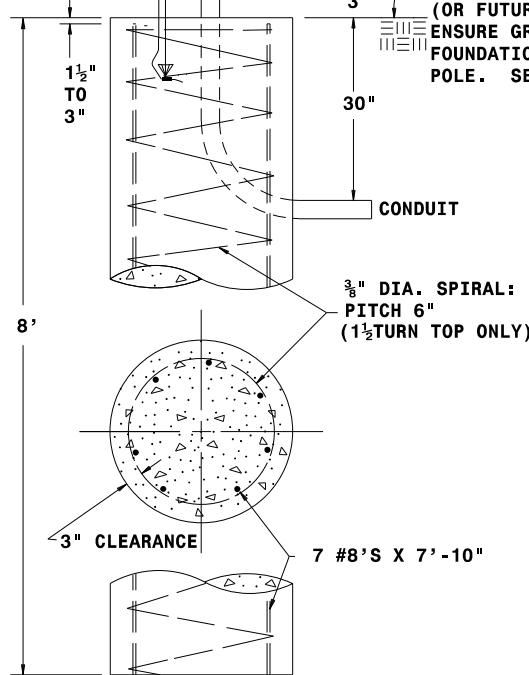SET THE TOP OF THE FOUNDATION AT THE SAME ELEVATION AS THE EXISTING (OR FUTURE) BACK OF CURB ELEVATION. ENSURE GROUND LINE IS AT OR ABOVE THE TOP OF FOUNDATION WHEN SLIP BASE ASSEMBLY IS USED ON POLE. SEE NOTE 6 ON 4-BOLT SLIP BASE DETAILS.
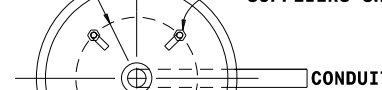
3'

1½" TO 3"

30"

CONDUIT

⅜" DIA. SPIRAL: PITCH 6" (1½ TURN TOP ONLY)

8'

3" CLEARANCE

7 #8'S X 7'-10"

DRILLED SHAFT FOUNDATION

(LUMINAIRE POLE & ROAD CLOSURE POLE)

BOLT CIRCLE AS PER POLE SUPPLIERS SHOP DRAWINGS

ANCHOR BOLTS, AS PER POLE SUPPLIERS SHOP DRAWINGS

CONDUIT

INSTALL EXPANSION-JOINT MATERIAL IN ACCORDANCE WITH SUBSECTION 609.4.3.2, EXPANSION JOINTS.

36'

#6 AWG SOLID COPPER W/GROUND CLAMP ATTACHED TO STEEL SPIRAL CAGE
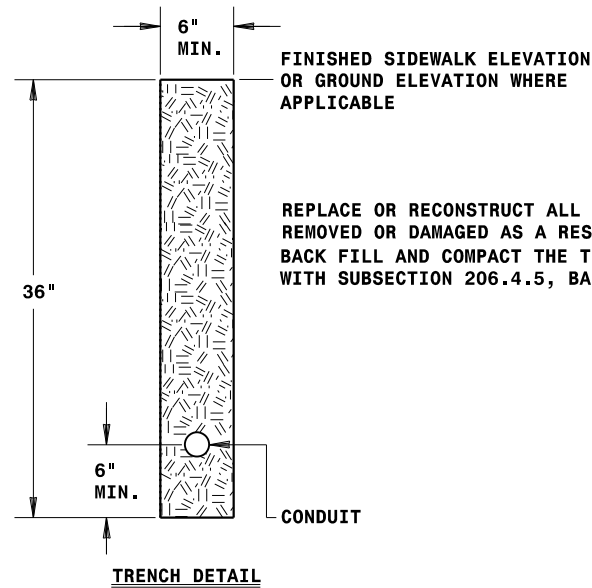
TO GROUNDING ANGLE

SET THE TOP OF THE FOUNDATION AT THE SAME ELEVATION AS THE EXISTING (OR FUTURE) BACK OF CURB ELEVATION

3'

1½" TO 3"

30"

CONDUIT

½" DIA. SPIRAL: PITCH 6" (1½ TURN TOP ONLY)

9'

3" CLEARANCE

9 #9'S X 8'-10"
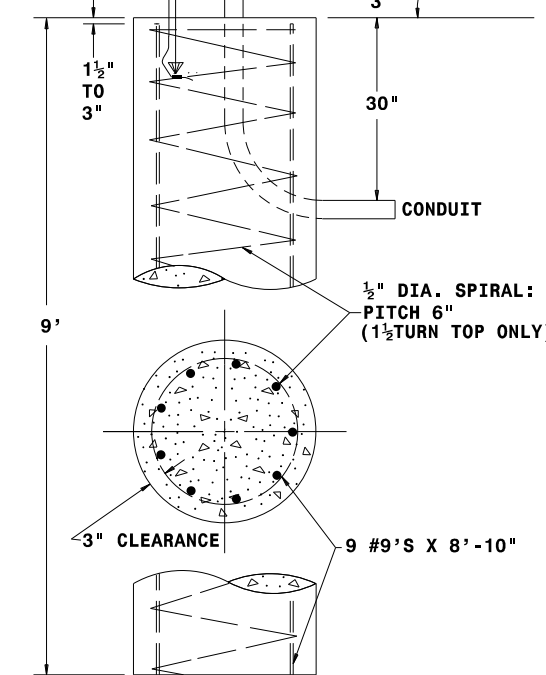
DRILLED SHAFT FOUNDATION
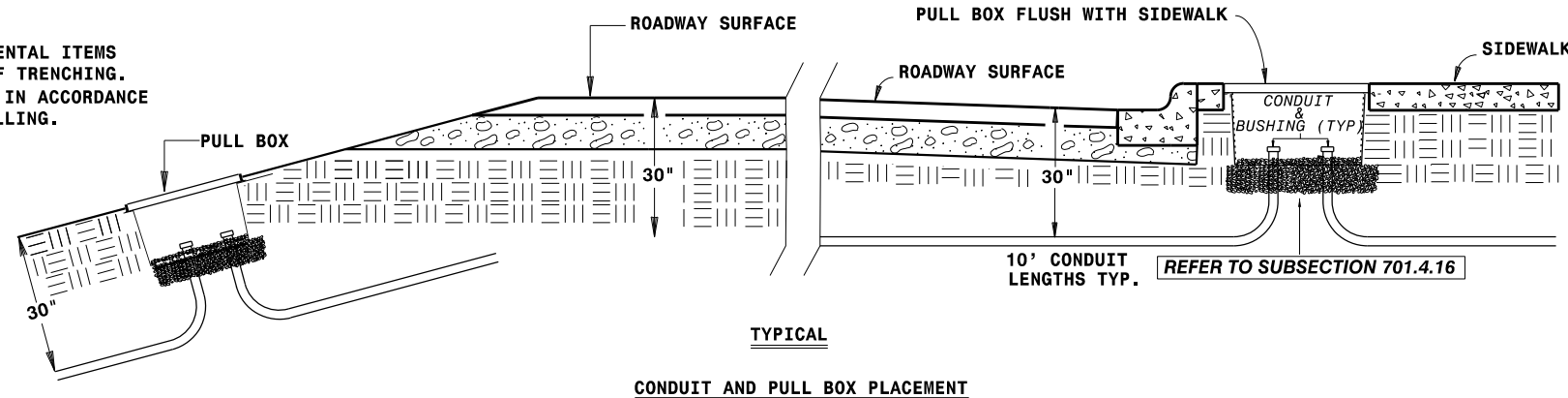
(SIGNAL POLE)

6" MIN.

FINISHED SIDEWALK ELEVATION OR GROUND ELEVATION WHERE APPLICABLE

REPLACE OR RECONSTRUCT ALL INCIDENTAL ITEMS REMOVED OR DAMAGED AS A RESULT OF TRENCHING. BACK FILL AND COMPACT THE TRENCH IN ACCORDANCE WITH SUBSECTION 206.4.5, BACK FILLING.

36"

6" MIN.

CONDUIT

TRENCH DETAIL

ROADWAY SURFACE

PULL BOX FLUSH WITH SIDEWALK

ROADWAY SURFACE

SIDEWALK

PULL BOX

CONDUIT & BUSHING (TYP)

30"

30"

30"

10' CONDUIT LENGTHS TYP.

REFER TO SUBSECTION 701.4.16

TYPICAL

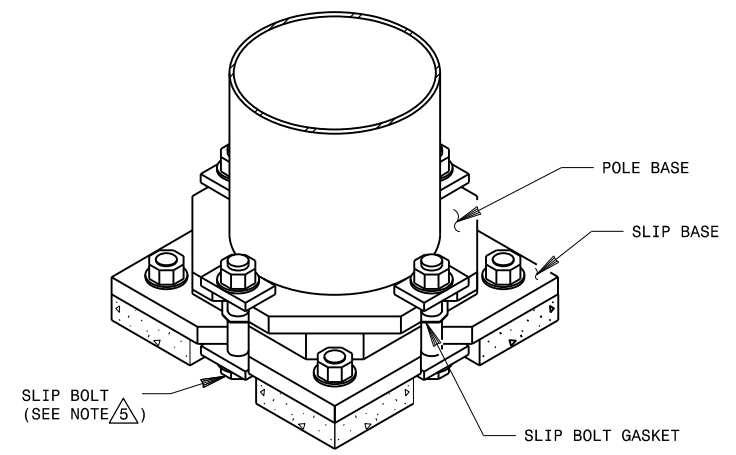**CONDUIT AND PULL BOX PLACEMENT**

WYOMING DEPARTMENT OF TRANSPORTATION

ELECTRICAL
DRILLED SHAFT FOUNDATION,
TRENCH & CONDUIT PLACEMENT
DETAIL

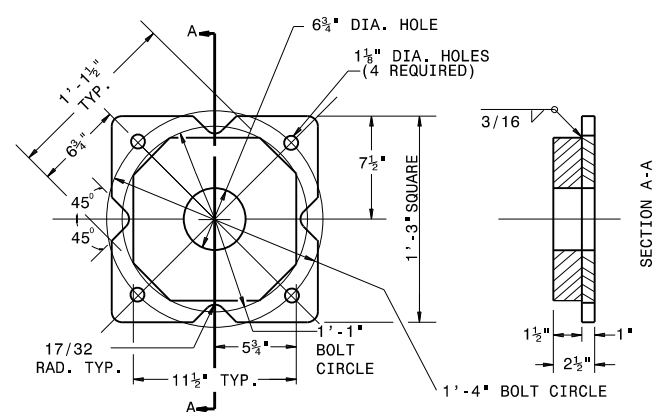| DESIGNER: EP	DATE: 10/29/2015	REV:
ENGINEER: RA	SHEET 1 OF 1	

ELECTRICAL DETAILS

4" x 8" HANDHOLE ⟨8⟩
GROUNDING ANGLE ⟨9⟩
BONDING LUG FOR GROUNDING POLE ⟨9⟩
1" MIN.
⟨7⟩
SHEAR PLANE OF SLIP BASE ASSEMBLY
4"
GROUND LINE
ANCHOR BOLT (1 OF 4)
DRILLED SHAFT FOUNDATION
CONDUIT AND WIRING

FOUR BOLT SLIP BASE

POLE BASE
SLIP BASE
SLIP BOLT (SEE NOTE ⟨5⟩)
SLIP BOLT GASKET
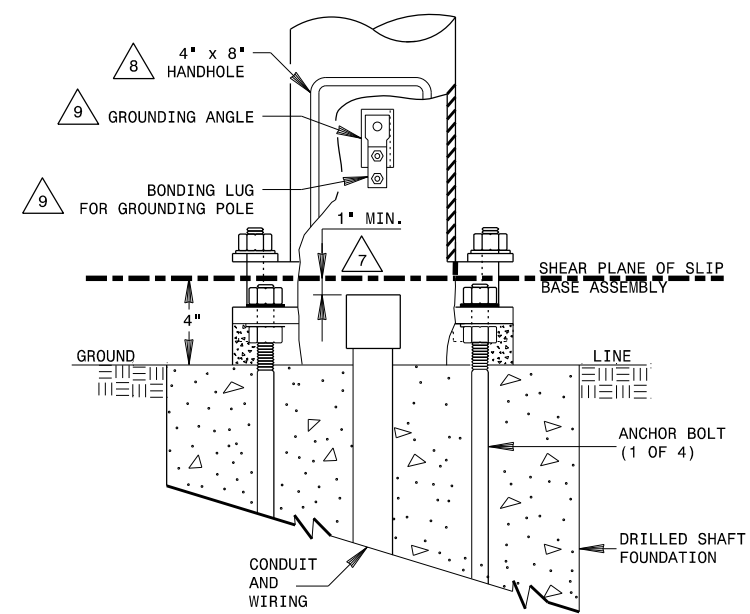
NOTES:

⟨1⟩ USE GASKET CONFORMING TO ASTM A 653 GRADE 33 WITH COATING DESIGNATION G90.

⟨2⟩ ENSURE ALL PLATES SHOWN CONFORM TO ASTM A 709 (GRADE 36).

⟨3⟩ ENSURE ALL STRUCTURAL STEEL IS GALVANIZED AFTER FABRICATION TO ASTM A 123, AND ALL CONTACT AREAS OF STRUCTURAL STEEL ARE FREE OF GALVANIZING BEADS AND RUNS.

⟨4⟩ ENSURE ALL CONNECTING HARDWARE (HIGH STRENGTH BOLTS, HEAVY HEX NUTS AND STD. WASHERS) IS ELECTRO-PLATED CADMIUM IN ACCORDANCE WITH ASTM B 766 CLASS 12.

⟨5⟩ KEEP ALL SLIP BOLT HEADS AND WASHERS COMPLETELY MECHANICALLY ACCESSIBLE, AND FREE OF GROUT, SO THE BOLTS WILL BE FREELY PUSHED OUT DURING VEHICLE IMPACT.

⟨6⟩ TO PREVENT A VECHICLE'S UNDERCARRIAGE FROM SNAGGING ON THE GROUND BASE PLATE REMAINING IN PLACE AFTER IMPACT, FINISH THE GROUND SURFACE TO NOT BE LOWER THAN THE TOP OF THE FOUNDATION WITHIN A 3'-9" DISTANCE IN ALL DIRECTIONS FROM THE CENTER OF THE FOUNDATION.

⟨7⟩ KEEP THE TOP OF THE ELECTRICAL CONDUIT AT LEAST 1" BELOW THE SHEAR PLANE OF THE THE SLIP BASE ASSEMBLY.

⟨8⟩ ENSURE THE REINFORCED HANDHOLE FRAME IS ORIENTED 90 DEGREES TO THE LUMINAIRE ARM.

⟨9⟩ OPPOSITE OF THE HANDHOLE, WELD 1½" x 1½" x ¼" GROUNDING ANGLE WITH 5/16 " DIA.-18 UNC TAP. USE BONDING LUG FOR BONDING CONDUCTORS THROUGH NO.4 AND BOLT TO ANGLE FOR GROUNDING OF THE POLE.

** ⟨10⟩ KEEP THE TOP OF THE ANCHOR BOLTS BELOW THE SHEAR PLANE OF THE SLIP BASE ASSEMBLY SO THE POLE'S BREAKAWAY SYSTEM WILL FUNCTION AS REQUIRED.
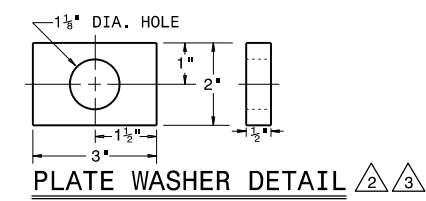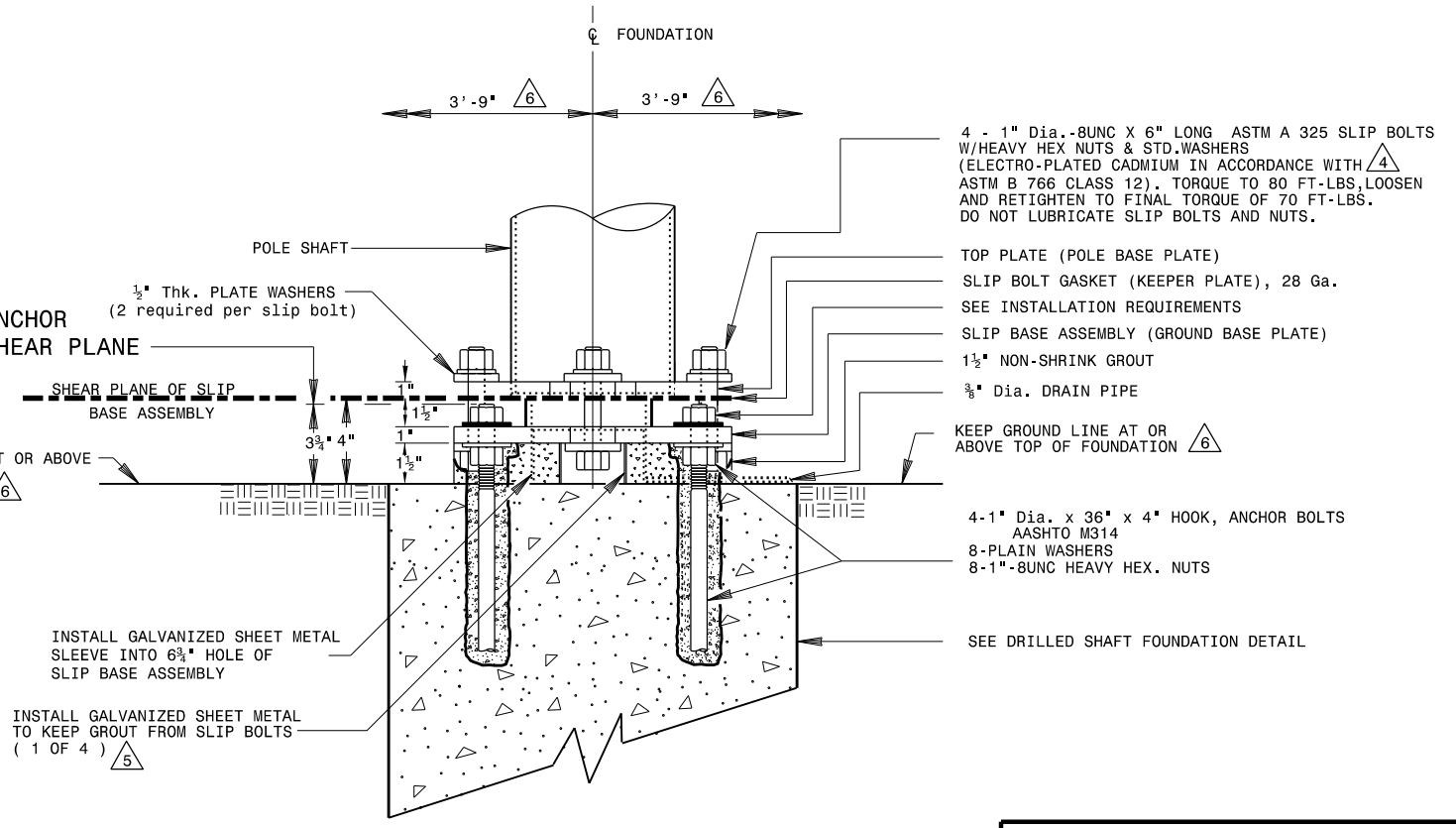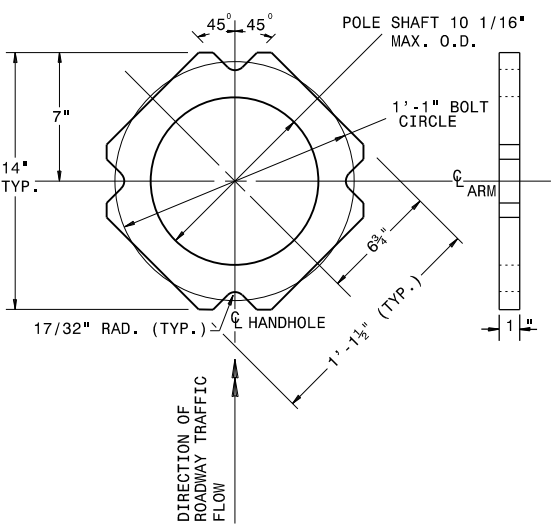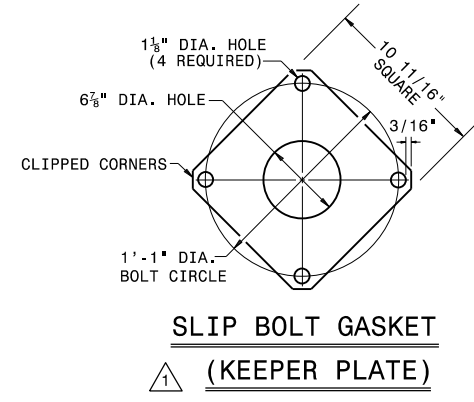
SLIP BASE ASSEMBLY (GROUND BASE PLATE) ⟨2⟩⟨3⟩

6¾" DIA. HOLE
1⅛" DIA. HOLES (4 REQUIRED)
3/16
1'-1⅛" TYP.
6¾"
7½" SQUARE
45°
45°
SECTION A-A
17/32 RAD. TYP.
5¾"
11½" TYP.
1'-1" BOLT CIRCLE
1'-3" SQUARE
1'-4" BOLT CIRCLE
1½" 1"
2½"

PLATE WASHER DETAIL ⟨2⟩⟨3⟩

1⅛" DIA. HOLE
1"
2"
1½"
3"
½"

TOP PLATE (POLE BASE) ⟨2⟩⟨3⟩

45° 45°
POLE SHAFT 10 1/16" MAX. O.D.
7"
1'-1" BOLT CIRCLE
14" TYP.
6¾"
17/32 RAD. (TYP.)
℄ HANDHOLE
℄ ARM
1'-1½" (TYP.)
1"
DIRECTION OF ROADWAY TRAFFIC FLOW

SLIP BOLT GASKET (KEEPER PLATE) ⟨1⟩

1⅛" DIA. HOLE (4 REQUIRED)
6⅞" DIA. HOLE
10 11/16" SQUARE
3/16
CLIPPED CORNERS
1'-1" DIA. BOLT CIRCLE

BREAKAWAY BASE DETAIL ⟨2⟩ ⟨3⟩ ⟨4⟩

℄ FOUNDATION
3'-9" ⟨6⟩   3'-9" ⟨6⟩

** ⟨10⟩ KEEP TOP OF ANCHOR BOLTS BELOW SHEAR PLANE

POLE SHAFT
½" Thk. PLATE WASHERS (2 required per slip bolt)
SHEAR PLANE OF SLIP BASE ASSEMBLY
3¾" 4"
KEEP GROUND LINE AT OR ABOVE TOP OF FOUNDATION ⟨6⟩
INSTALL GALVANIZED SHEET METAL SLEEVE INTO 6¾" HOLE OF SLIP BASE ASSEMBLY
INSTALL GALVANIZED SHEET METAL TO KEEP GROUT FROM SLIP BOLTS (1 OF 4) ⟨5⟩

4 - 1" Dia.-8UNC X 6" LONG ASTM A 325 SLIP BOLTS W/HEAVY HEX NUTS & STD.WASHERS (ELECTRO-PLATED CADMIUM IN ACCORDANCE WITH ⟨4⟩ ASTM B 766 CLASS 12). TORQUE TO 80 FT-LBS, LOOSEN AND RETIGHTEN TO FINAL TORQUE OF 70 FT-LBS. DO NOT LUBRICATE SLIP BOLTS AND NUTS.
TOP PLATE (POLE BASE PLATE)
SLIP BOLT GASKET (KEEPER PLATE), 28 Ga. SEE INSTALLATION REQUIREMENTS
SLIP BASE ASSEMBLY (GROUND BASE PLATE)
1½" NON-SHRINK GROUT
⅜" Dia. DRAIN PIPE
KEEP GROUND LINE AT OR ABOVE TOP OF FOUNDATION ⟨6⟩
4-1" Dia. x 36" x 4" HOOK, ANCHOR BOLTS AASHTO M314
8-PLAIN WASHERS
8-1"-8UNC HEAVY HEX. NUTS
SEE DRILLED SHAFT FOUNDATION DETAIL

INSTALLATION REQUIREMENTS FOR ANCHOR BOLT NUTS

WRENCH TIGHTEN ALL BOTTOM NUTS FIRMLY AGAINST GROUND BASE PLATE BEFORE TIGHTENING TOP NUTS. USE STICK WAX TO FIELD LUBRICATE BEARING FACE AND THREADS OF TOP ANCHOR BOLT NUTS. TIGHTEN TOP NUTS TO SNUG-TIGHT. SNUG-TIGHT IS DEFINED AS THE TIGHTNESS THAT EXISTS WHEN THE GROUND BASE PLATE IS IN FIRM CONTACT WITH THE TOP AND BOTTOM NUTS, AND IS ATTAINED BY THE FULL EFFORT OF A MAN USING A WRENCH WITH A LENGTH OF 21".

AFTER THE SNUG-TIGHT CONDITION IS ATTAINED, RETIGHTEN BOTTOM NUTS TO ENSURE FIRM CONTACT AGAINST THE GROUND BASE PLATE. ROTATE THE TOP NUTS AN ADDITIONAL ⅛ TURN (45 DEG). TIGHTEN IN TWO SEPARATE PASSES OF 1/16 TURN IN EACH PASS. ROTATION TOLERANCES ARE PLUS 20 DEGREES AND MINUS 0 DEGREES.

REVISION

REMOVED REFERENCE TO THE USE OF LOCK WASHERS WITH REGARD TO THE ANCHOR BOLTS. 10-March-2014

WYOMING DEPARTMENT OF TRANSPORTATION

LIGHTING POLE 4-BOLT SLIP BASE DETAILS

DATE: 10-March-2014   SHEET 1 OF 1

U.S. Department of Transportation