



WESTMINSTER  
COLORADO

2019

# City of Westminster's Small Cell Infrastructure Guidelines

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# Chapter 1



THIS DOCUMENT ESTABLISHES GUIDELINES FOR INSTALLING SMALL CELL EQUIPMENT AND POLES IN THE CITY OF WESTMINSTER'S RIGHT OF WAY.

## 1. BACKGROUND AND PURPOSE

Wireless Network Providers and wireless infrastructure companies have been contacting the City of Westminster (herein referred to as the "City") with requests to locate small cell facilities – referred to by the Federal Communications Commission (FCC) as small wireless facilities – within the City's public rights of way. These low-powered small cell antennas provide cellular and data coverage to supplement the Network Provider's cellular networks. New small cell towers will improve Network Providers' abilities to meet current and future cellular needs.

The *City of Westminster's Small Cell Infrastructure Guidelines* (herein referred to as the "Guidelines") provide aesthetic requirements and specifications that all small cell towers installed within the public right of way must meet prior to installation within the City. Small cells not installed within the public right of way are subject to Westminster Municipal Code 11-16.

Network Providers shall consider the aesthetics of the existing streetlights and neighborhoods adjacent to proposed small cell locations prior to submitting an application to the City. New small cells shall match the existing infrastructure aesthetics when installed in a Special District or a neighborhood with unique streetlight assemblies. Unique assemblies may include, but are not limited to, mast arms, decorative pole bases, architectural luminaires, mounting heights, finishes, etc. that deviate from these Guidelines.

Four different types of small cell installations are permitted within the City. These types include attachments to utility poles and utility lines, attachments to existing wooden streetlights, removal and replacement of existing streetlights, and new freestanding installations. An overview of each type is shown in Figure 1-1. When submitting a *City of Westminster Telecom Right of Way Permit* for a small cell facility, the Network Provider shall consider the following hierarchy of locations:

1. Replace existing streetlight with new Type 3 combination metal small cell and streetlight.
2. Install a new Type 4 freestanding small cell.
3. Install a small cell facility on adjacent structure or building.
4. Install a small cell as a Type 1 utility attachment.

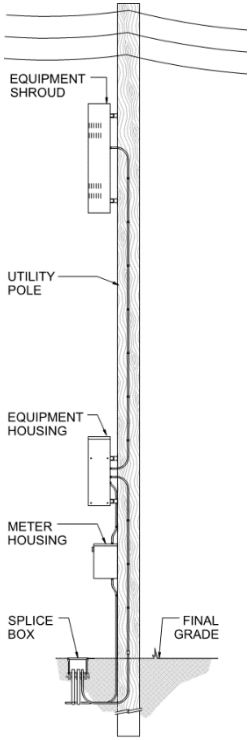
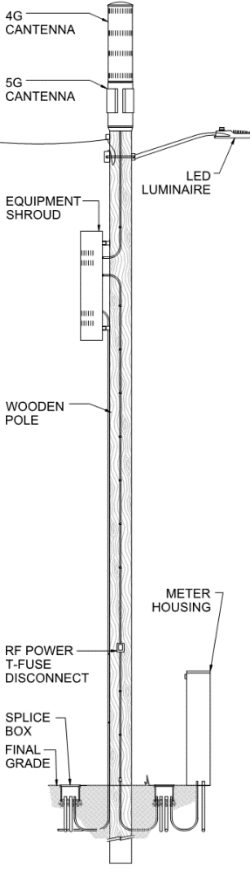
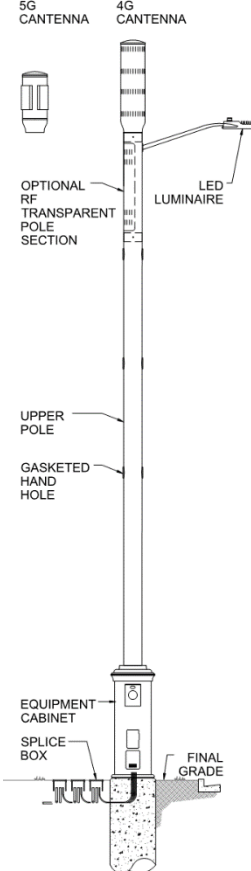
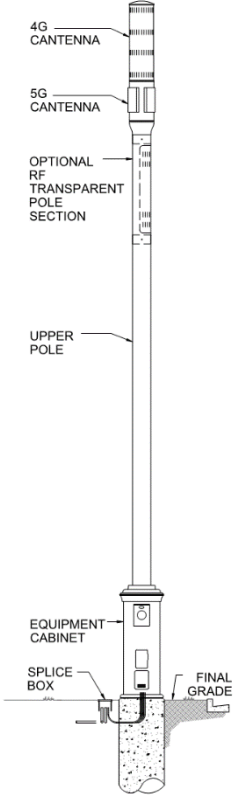
When a small cell facility is abandoned by a Network Provider, with no intention of further use, within three following months, the small cell facility shall be removed. If the facility is for telecommunications only, then the pole or structure supporting the small cell, caisson, foundation and any supporting infrastructure shall be removed. All utilities providing service to the small cell installation shall be disconnected, and the disturbed area shall be left in a condition acceptable to the City, (and to the electric utility provider, if applicable). In situations where the facility combined telecommunications equipment with other vertical infrastructure, such as a street light, the telecommunications equipment shall be removed, and the pole and supporting infrastructure shall be replaced / reconfigured to perform its original purpose and function.

The City reserves the right to approve deviation(s) from the Guidelines as long as the deviation(s) meet the general intent of the Guidelines.

All Figures in this document are for illustrative purposes only, unless specifically include guidance language.



Figure 1-1: Typical Small Cell Installations

Type 1 – Utility pole attachments	Type 2 – Existing wooden streetlight attachment	Type 3 – Combination metal small cell and streetlight	Type 4 – Freestanding small cell
			
<p>Utility pole mounted equipment must be approved by the appropriate electric utility provider and the City. All poles must be approved by a Professional Engineer registered in the State of Colorado for the additional small cell equipment load without additional guy-wires.</p>	<p>Small cell equipment may be attached to existing wooden streetlight poles when no structural modifications will be made to the existing wooden pole. A structural engineer must prove that the existing wooden pole is structurally sound and capable of handling the additional small cell equipment load without additional guy-wires.</p>	<p>Combination small cell and streetlight poles shall be installed in all situations that require the removal of an existing streetlight pole (wood, metal, fiberglass, etc.) and replacement with a new combination pole.</p> <p>No externally mounted equipment will be allowed by the City.</p>	<p>A privately-owned freestanding pole will be allowed by the City in situations where no existing streetlight or other appropriate location is adjacent to the proposed freestanding small cell location.</p>



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# Chapter 2



REFER TO CHAPTER 2 FOR INFORMATION REGARDING SMALL CELL EQUIPMENT THAT WILL BE ATTACHED TO EXISTING UTILITY POLES AND UTILITY LINES.

## 2. ATTACHMENTS TO UTILITY POLES AND UTILITY LINES

This chapter of the Guidelines is to be used when locating small cell attachments on existing utility poles or utility lines. All attachments to utility poles shall be approved by the City and private electric utility provider, typically Xcel Energy, prior to installation. All equipment shall meet electric utility provider's requirements and those of the *City of Westminster Telecom Right of Way Permit*.

All small cell equipment shall be shrouded. Applicants shall demonstrate that the additions of new equipment on an existing pole will be structurally feasible. Only two shrouds, including the antenna, shall be installed at each utility pole location. No ground-mounted shrouds, including those that would house backup power supply or other supporting equipment, shall be allowed within the public right of way. All equipment located within the public right of way shall be located such that it meets ADA requirements and does not obstruct, impede, or hinder reasonable pedestrian or vehicular travel.

All Network Provider equipment shall be removed and relocated, at no cost to the City, if the City or electric utility provider decides to underground the utility lines in the future. The equipment must be removed within a reasonable time frame, as determined by the electric utility provider. A reasonable time frame refers to a period of time that will not delay the electric utility provider's removal of the utility poles and overhead lines.

No strand-mounted small cell devices shall be installed on poles with mounted streetlights.



## 2.1 UTILITY POLE SMALL CELL ATTACHMENTS SPECIFICATION OVERVIEW

Prior to the Network Provider submitting a permit application, a Professional Engineer registered in the State of Colorado shall ensure that the supporting poles are appropriately sized and have sufficient strength to accommodate the additional small cell equipment loads. The small cell equipment loads shall be provided by the network provider.

A non-ionizing electromagnetic radiation (NIER) report shall be submitted to electric utility provider and retained on file for equipment type and model. The NIER report shall be endorsed by a Professional Radio Frequency Engineer.

All installations shall meet or exceed all applicable structural standards, clearance standards, and provisions of the latest National Electrical Safety Code (NESC), and the Standards and Specifications. In case of conflict, the most stringent requirements shall prevail. All necessary certifications shall be obtained by the Network Provider and provided to the electric utility provider and the City.

Figure 2-1: Utility Pole Attachment

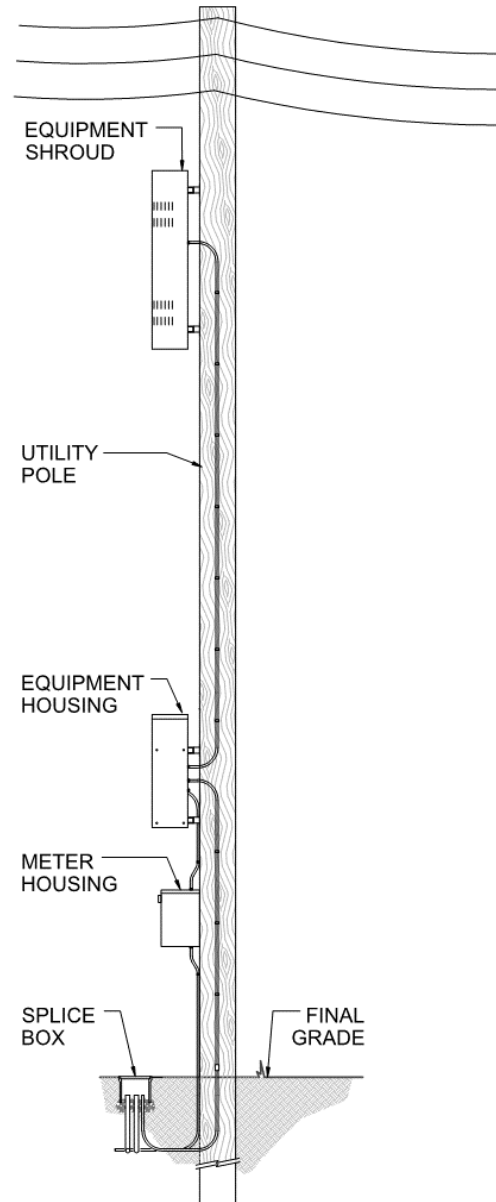


Table 2-1: Small Cell Attachments to Utility Pole Specification Overview

Utility Pole and Strand Mount Specification Overview	
Electrical Service	Per electric utility provider.
Grounding	Per electric utility provider and the NESC requirements.
Separation of Service	All new electrical conduit and fiber shall be separated by Owner.
Utility Equipment	Per electric utility provider.
Equipment Color	Visible attachments and hardware shall be colored to match pole, or colored gray (RAL 7038) if located on a wooden pole.
Equipment Shroud	<p>49"H x 19"W x 13"D maximum</p> <p>Only one equipment shroud, containing all required small cell equipment, shall be installed per pole. Except, one additional equipment shroud shall be allowed per pole if the antenna is located within the second equipment shroud.</p> <p>Equipment shall be located such that it meets the Americans with Disabilities Act of 1990 and does not obstruct, impede, or hinder the typical pedestrian or vehicular travel way.</p>
Antenna	<p>The cantenna shall include all the antenna, radio head, mounting bracket, and all other hardware necessary for a complete installation. The following equipment sizes shall be allowed per type of antenna installed:</p> <p>4G-LTE: Maximum 14" outer diameter, maximum height shall be 5'-0" from top of cantenna to pole attachment point. If the antenna is mounted to the side of the pole it shall be located inside a maximum shroud of 49"H x 19"W x 13"D.</p> <p>5G only: Maximum 16" outer diameter with 19" (maximum) protrusions for 5G antennas. Maximum height shall be 5'-0" from top of cantenna to pole attachment point. If the antenna is mounted to the side of the pole it shall be located inside a maximum shroud of 49"H x 19"W x 13"D.</p> <p>Dual technology (Typically 4G &amp; 5G): 16" outer diameter with 19" (maximum) protrusions for 5G antennas. Maximum height shall be 6'-8" from top of cantenna to pole attachment point. If the antenna is mounted to the side of the pole it shall be located inside a maximum shroud of 49"H x 19"W x 13"D.</p>
Radio Frequency Equipment Disconnect	Radio frequency equipment shall have a disconnect that meets or exceeds electric utility provider's and the City's requirements.
Pole Mounted Warning Label	If required, radio frequency warning labels shall be mounted on the exterior of the Network Provider's equipment.
Strand Mounted Warning Label	Radio frequency warning labels shall be mounted on the equipment, and clearly marked on both sides of the shrouds and be visible from the ground, roadside, and field side.
Owner Identification	A 4-inch by 6-inch (maximum) aluminum plate with the Network Provider's name, location identifying information, and emergency telephone number shall be permanently fixed to the equipment, 5 feet above finished grade.



## 2.2 STRAND MOUNTED SMALL CELL ATTACHMENTS SPECIFICATION OVERVIEW

Prior to submitting a permit application, the strand owner shall ensure that the supporting poles are appropriately sized and have sufficient strength to accommodate the additional equipment loads.

A (NIER) shall be submitted to the electric utility provider and retained on file for each equipment type and model. The NIER report shall be endorsed by a Professional Radio Frequency Engineer.

All installations shall meet or exceed all applicable structural standards, clearance standards, and provisions of the latest NESC and the Standards and Specifications. In case of conflict, the most stringent requirements shall prevail. All necessary certifications shall be obtained by the wireless carrier owner and provided to the utility owner and the City.

Aerial fiber and power strand installations are allowed even though Figure 2-2 shows an example of an undergrounded fiber and power installation.

Figure 2-2: Strand Mounted Attachment

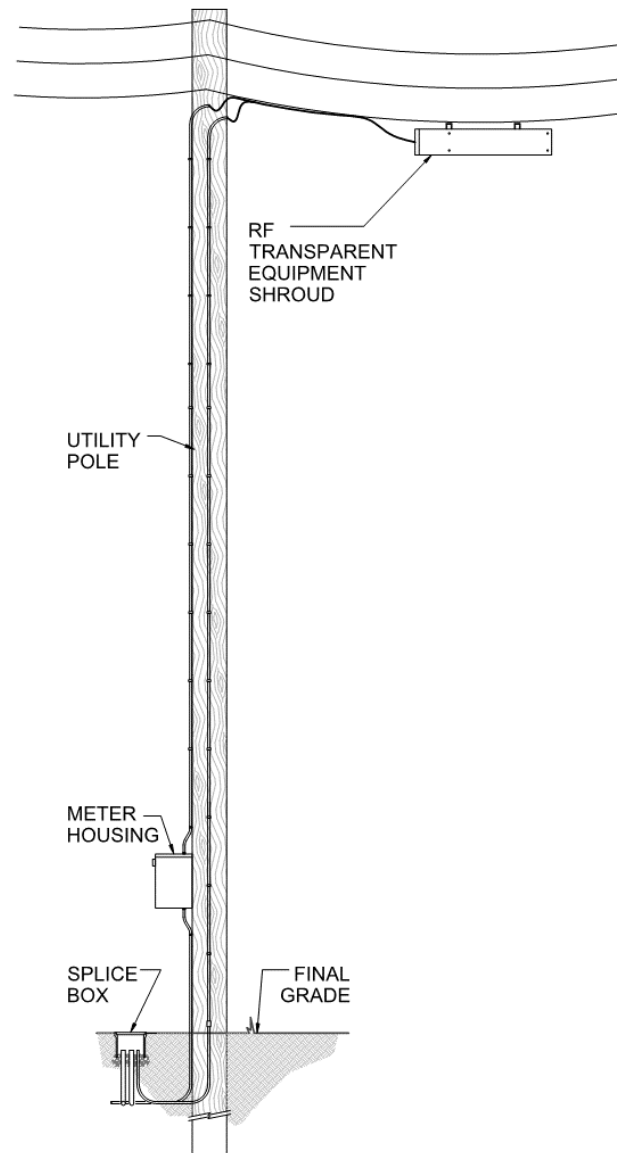


Table 2-2: Small Cell Attachments to Utility Pole and Utility Lines Specification Overview

Utility Pole and Strand Mount Specification Overview	
Electrical Service	Per electric utility provider.
Grounding	Per electric utility provider and the NESC requirements.
Separation of Service	All new electrical conduit and fiber shall be separated by Owner.
Utility Equipment	Per electric utility provider.
Equipment Color	Visible attachments and hardware shall be colored gray (RAL 7038).
Strand Mount Equipment Shroud	5.5 cubic feet maximum strand mount equipment shroud. Only one equipment shroud shall be installed per permit location.
Radio Frequency Equipment Disconnect	Radio frequency equipment shall have a disconnect that meets or exceeds the electric utility provider's and the City's requirements.
Pole Mounted Warning Label	If required, radio frequency warning labels shall be mounted on the exterior of the Network Provider's equipment.
Strand Mounted Warning Label	Radio frequency warning labels shall be mounted on the equipment, and clearly marked on both sides of the shrouds and be visible from the ground, roadside, and field side.
Owner Identification	A 4-inch by 6-inch (maximum) aluminum plate with the Network Provider's name, location identifying information, and emergency telephone number shall be permanently fixed to the equipment, 5 feet above finished grade.

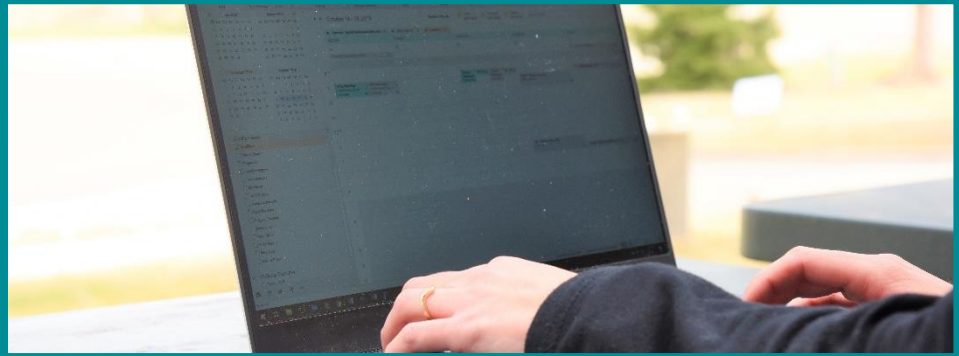
### 2.3 ATTACHMENTS TO UTILITY POLES AND UTILITY LINE PLACEMENT REQUIREMENTS

The small cell shall be located such that all new equipment, including but not limited to Network Provider's small cell equipment and electric utility provider's equipment, meets ADA requirements. Electric utility provider, and the City when applicable, shall approval all fiber and power source locations prior to installation.



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# Chapter 3



REFER TO CHAPTER 3 FOR INFORMATION ABOUT SMALL CELL EQUIPMENT LOCATED IN THE CITY OF WESTMINSTER'S RIGHT OF WAY AND MOUNTED TO AN EXISTING WOODEN STREETLIGHT.

## 3. ATTACHMENTS TO WOODEN STREETLIGHT POLES

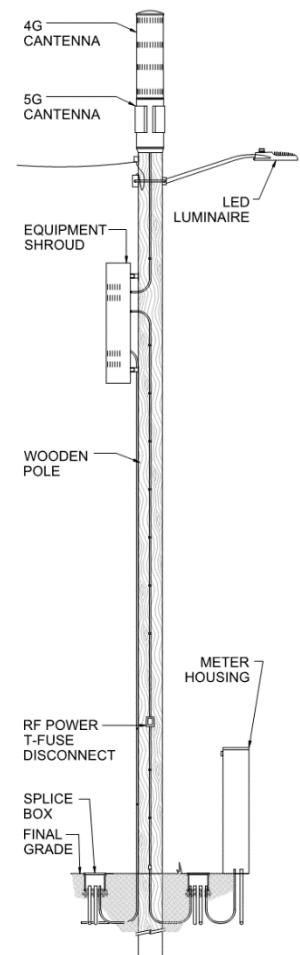
This chapter of the Guidelines is to be used when locating small cell equipment on existing wooden streetlights.

If a new pole is required for any purpose to replace an existing wooden streetlight pole that the small cell equipment is proposed on, then the Applicant shall be required to replace said pole with a metal pole that supports a combination small cell and streetlight assembly.

Prior to the Network Provider submitting a permitting application, a Professional Engineer registered in the State of Colorado shall ensure the supporting wooden poles are appropriately sized and have enough strength to accommodate the additional small cell equipment loads without the installation of additional guy-wires. The small cell equipment loads shall be provided by the Network Provider. Wooden poles deemed structurally deficient by a Professional Engineer registered in the State of Colorado shall be replaced with a new metal pole that supports a combination small cell and streetlight assembly. All installations shall meet or exceed all applicable structural standards, clearance standards, and provisions of the latest NESC or the National Electric Code (NEC) and the Standards and Specifications. In case of conflict, the most stringent requirements shall prevail. All necessary certifications shall be obtained by the Network Provider and provided to the electric utility provider and the City.

All attachments to wooden streetlights shall be approved by the City and the electric utility provider, typically Xcel Energy, prior to installation. All equipment shall meet the electric utility provider's requirements and the requirements of the *City of Westminster's Telecom Permit*.

Figure 3-1: Attachment to Wooden Streetlight Pole





All small cell carrier equipment shall be mounted behind a shroud. Only two shrouds, including the antenna, shall be installed at each location. No ground mounted shrouds, including those that would house backup power supply or other supporting equipment, shall be allowed within the public right of way. All equipment located within the public right of way shall be located such that it meets ADA requirements and does not obstruct, impede, or hinder reasonable pedestrian or vehicular travel. No small cell devices shall be installed without confirming that the intended installation has no impact on the streetlight's or street lighting control system's operational performance.

The lighting design shall meet the luminaire specifications and design requirements set forth in the *City of Westminster Standards and Specifications for the Design and Construction of Public Improvements*. These Guidelines provide information about luminaire aesthetics and details. The Network Provider shall provide all documentation required by the *City of Westminster Standards and Specifications for the Design and Construction of Public Improvements* to the City during the certification process.

All Network Provider equipment shall be removed and relocated, at no cost to the City, if the City or the electric utility provider decides to remove the wooden pole and streetlight in the future. The equipment must be removed within a reasonable time frame determined by the electric utility provider. A reasonable time frame refers to a period of time that will not delay the removal of the utility poles and/or overhead lines.

### **3.1 WOODEN STREETLIGHT WITH SMALL CELL SPECIFICATION OVERVIEW**

A (NIER) shall be submitted to the electric utility provider and retained on file for equipment type and model. The NIER report shall be endorsed by a Professional Radio Frequency Engineer.

Small cell facilities shall be located such that all new equipment, including but not limited to Network Provider small cell equipment and electric utility provider equipment, meets ADA requirements. The electric utility provider, and the City when applicable, shall approve all fiber and power source locations prior to installation.

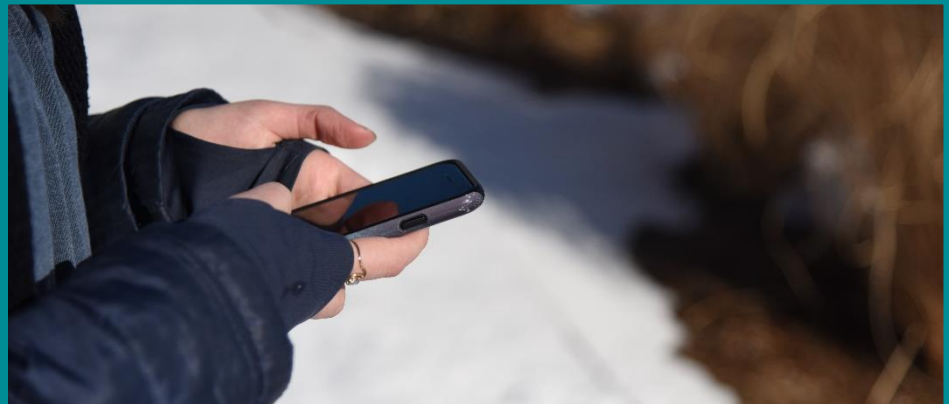
Table 3-1: Wooden Streetlight Attachments Specification Overview

General Specification Overview	
Luminaire	Per the City's and/or electric utility provider's standard depending on ownership.
Luminaire Mast Arm	Per the City's and/or electric utility provider's standard depending on ownership.
Luminaire Mounting Height	All luminaires shall be mounted at the same height as surrounding streetlights.
Electrical Service	Per the City's or electric utility provider's standard depending on ownership.
Grounding	Per the City's or electric utility provider's standard depending on ownership.
Separation of Service	All new electrical conduit and fiber shall be separated by Owner, in pull/splice boxes located adjacent to the wooden streetlight pole.
Utility Equipment	Per electric utility provider's requirements.
Color	Small cell equipment shall be colored gray (RAL 7038).
Equipment Shroud	49"H x 19"W x 13"D maximum.
Antenna	<p>The antenna shall include all the antenna, radio head, mounting bracket, and all other hardware necessary for a complete installation. The following equipment sizes shall be allowed per type of antenna installed:</p> <p>4G-LTE: Maximum 14" outer diameter, maximum height shall be 5'-0" from top of antenna to pole attachment point. If the antenna is mounted to the side of the pole it shall be located inside a maximum shroud of 49"H x 19"W x 13"D.</p> <p>5G only: Maximum 16" outer diameter with 19" (maximum) protrusions for 5G antennas. Maximum height shall be 5'-0" from top of antenna to pole attachment point. If the antenna is mounted to the side of the pole it shall be located inside a maximum shroud of 49"H x 19"W x 13"D.</p> <p>Dual technology (Typically 4G &amp; 5G): 16" outer diameter with 19" (maximum) protrusions for 5G antennas. Maximum height shall be 6'-8" from top of antenna to pole attachment point. If the antenna is mounted to the side of the pole it shall be located inside a maximum shroud of 49"H x 19"W x 13"D.</p>
Radio Frequency Equipment Disconnect	Radio frequency equipment shall have a disconnect that meets or exceeds electric utility provider's and the City's requirements.
Warning Label	Radio frequency warning labels shall be mounted on the equipment and clearly mark both sides of the shrouds and be visible from the ground, roadside, and field side. The warning labels shall be mounted on the exterior of the Network Provider's equipment.
Owner Identification	A 4-inch by 6-inch (maximum) plate with the Network Provider's name, location identifying information, and emergency telephone number shall be permanently fixed to the equipment, 5 feet above finished grade.



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# Chapter 4



REFER TO CHAPTER 4 WHEN REMOVING EXISTING STREETLIGHT POLES AND REPLACING WITH A METAL COMBINATION SMALL CELL AND STREETLIGHT POLE.

## 4. METAL COMBINATION SMALL CELL AND STREETLIGHT

This chapter of the Guidelines is to be used when replacing an existing streetlight pole with a metal pole that supports a combination small cell and streetlight assembly. Combination small cell and streetlight poles are often referred to as “combination poles” or “Type 3 pole” (see Figure 1.1) in the Guidelines.

All small cell Network Provider equipment shall be housed internal to the pole. No Network provider equipment shall be mounted to the exterior of the pole.

A combination metal small cell and streetlight pole should only be located where an existing streetlight pole can be removed and replaced, or at a new location where it has been identified that a streetlight is necessary. Existing streetlights are typically owned by Xcel Energy; Xcel Energy owned combination poles that replace existing streetlights shall meet Xcel Energy standards.

All combination poles shall be reviewed and approved with a Telecom Permit from the City.

Combination pole permit applications and aesthetics shall be approved by the City prior to installation. All equipment shall meet electric utility provider’s, typically Xcel Energy, requirements and the City of Westminster’s design aesthetics. New small cell poles that are introduced to an area must match the finishes, designs, colors, and other aesthetic characteristics already present in the existing poles of that area to maintain a cohesive appearance. Combination small cell aesthetics and proposed locations shall meet the requirements of the City’s Telecom Permit. The lighting design shall follow the luminaire specifications and design requirements set forth in the *City of Westminster Standards and Specification for the Design and Construction of Public Improvements*.

The street lighting chapter of the Standards and Specifications provides information on luminaire design aesthetics along with electrical and streetlight details. The Network Provider shall provide all documentation required by the Standards and Specifications to the City during the permitting process.



## 4.1 BASIS OF DESIGN

The following pages describe the City's requirements for installation of small cell facilities in the City's public rights of way. Combination pole design shall match the characteristics of existing streetlights installed adjacent to the pole. The Network Provider shall perform a visual inspection (Online street images are considered sufficient unless the pole standards were updated after the images were published) prior to submitting a permit application to determine existing aesthetic characteristics. The combination pole shall match the existing characteristics of the adjacent streetlights, neighborhood, or Special District.

The combination pole components include the foundation, equipment cabinet, upper pole, luminaire, mast arm, luminaire control node (if applicable), cantenna or antenna shrouds, and all hardware and internally integrated electrical equipment necessary for a complete assembly. The small cell components shall also be sized to be visually pleasing. For a combination pole to be considered visually pleasing, the transition between the equipment cabinet and upper pole should be considered. A decorative transition shall be installed over the equipment cabinet upper bolts. All hardware connections shall be hidden from view. No horizontal flat spaces greater than 1.5 inches shall exist on the equipment cabinet to prevent cups, trash, and other objects from being placed on the equipment cabinet. Each pole component shall be architecturally compatible to create a cohesive aesthetic. Examples of an unacceptable and an acceptable small cell installation can be found in Figure 4-1, Figure 4-2, and Figure 4-3.

Two variations of combination small cell equipment will be considered for installation in the City of Westminster: single technology (i.e., 4G or 5G equipment) and dual technology poles (i.e., 4G with 5G equipment). Each type can be found in Figure 4-4 and Figure 4-5. When installing a combination small cell pole, that may be considered for replacement in the future with a dual carrier pole, the foundation and subsurface infrastructure for said pole should be sized and installed to easily support future technology or dual carrier applications.

Figure 4-1: Unacceptable Combination Pole Installation

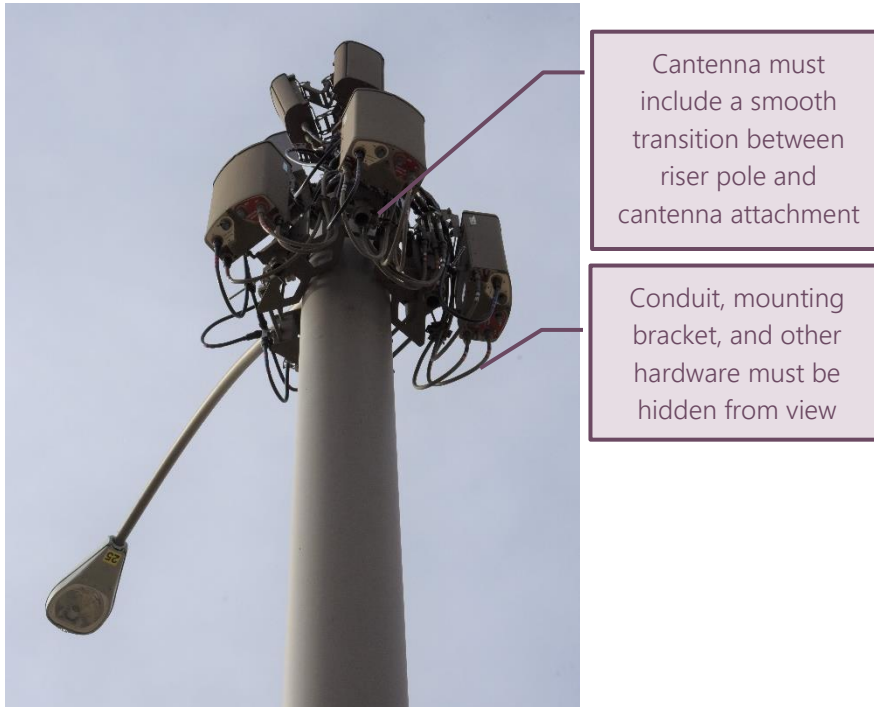


Figure 4-3: Unacceptable Combination Pole Installation

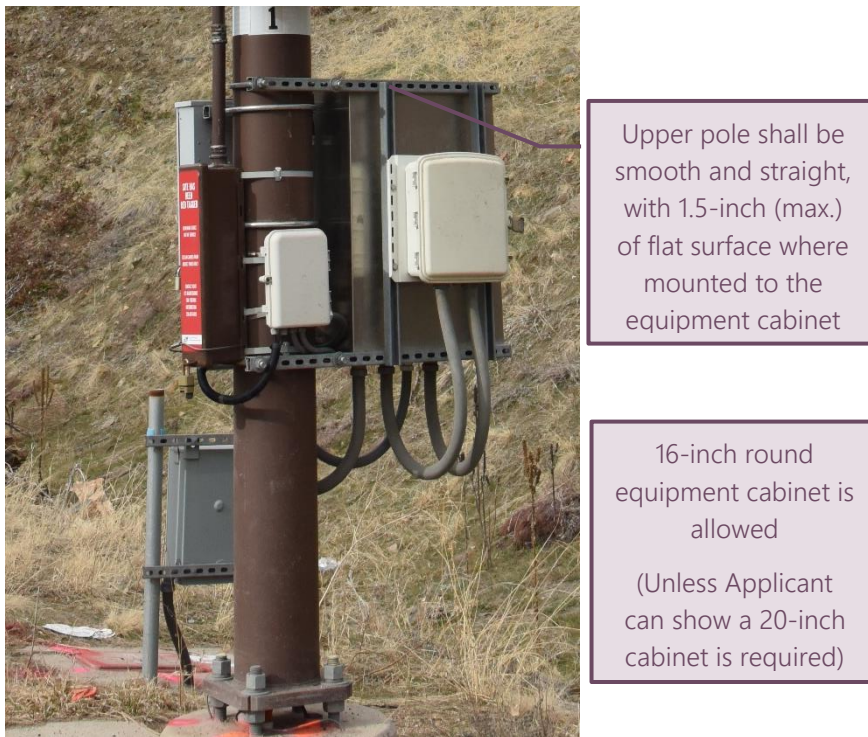
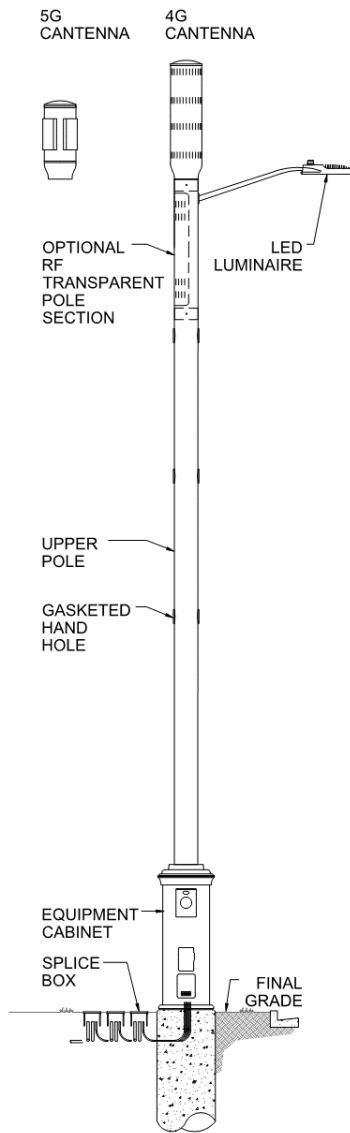


Figure 4-2: Acceptable Combination Pole Installation



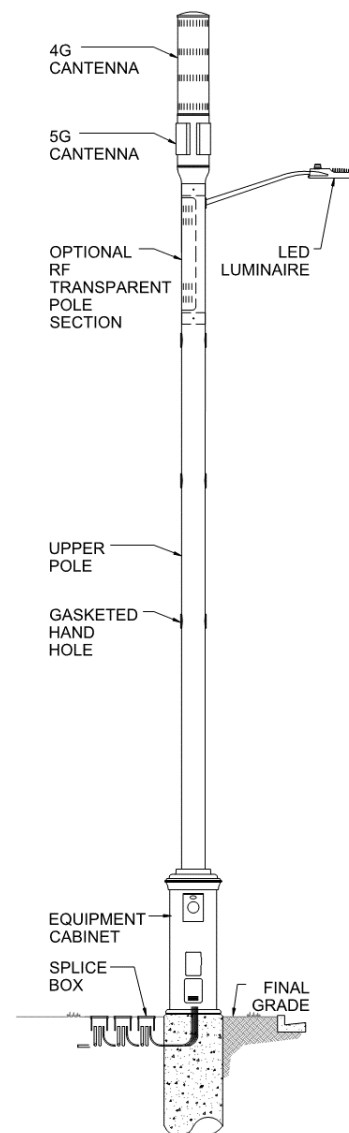


Figure 4-4: Single Technology Metal Combination Pole with Cantenna



The single technology combination pole is composed of an equipment cabinet, upper pole, streetlight, and cantenna containing either 4G-LTE or 5G). All equipment shall be located internal to the appropriate shrouds.

Figure 4-5: Multiple Technology Metal Combination Pole with Cantenna



The multiple technology combination pole is composed of an equipment cabinet, upper pole, streetlight, and cantenna containing multiple technologies (4G-LTE and 5G, or 4G-LTE and UE Relay). All equipment shall be located internal to the appropriate shrouds. This is the preferred standard for the City.



## 4.2 COMBINATION SMALL CELL AND STREETLIGHT SPECIFICATION OVERVIEW

Table 4-1: Streetlight Specification Overview

Technology Specific Specification		
4G – LTE only	Equipment cabinet dimension	Round, galvanized equipment cabinet. Maximum 5’-8” height, from top of foundation to top of transition shroud, with 16” outer diameter equipment cabinet. A 20” outer diameter will be allowed if Applicant can show that a smaller equipment cabinet is incapable of housing the necessary equipment.
	Cantenna dimension	Maximum 14” outer diameter, maximum height shall be 5’-0” from top of cantenna to top of upper pole attachment point. Luminaires shall be mounted at the same height as adjacent streetlights.
5G only	Equipment cabinet dimension	Round, galvanized equipment cabinet. Maximum 5’-8” height, from top of foundation to top of transition shroud, with 16” outer diameter equipment cabinet. A 20” outer diameter will be allowed if Applicant can show that a smaller equipment cabinet is incapable of housing the necessary equipment.
	Cantenna dimension	Maximum 16” outer diameter with 19” (maximum) protrusions for 5G antennas. Maximum height shall be 5’-0” from top of cantenna to top of upper pole attachment point. Luminaires shall be mounted at the same height as adjacent streetlights.
Dual technology (4G & 5G) Preferred Standard	Equipment cabinet dimension	Round, galvanized equipment cabinet. Maximum 5’-8” height, from top of foundation to top of transition shroud, with 20” maximum outer diameter.
	Cantenna dimension	Maximum 16” outer diameter with 19” (maximum) protrusions for 5G antennas. Maximum height shall be 6’-8” from top of cantenna to top of upper pole attachment point. Luminaires shall be mounted at the same height as adjacent streetlights.



Single and Dual Technology Specification Overview			
Equipment Cabinet Transition	All hardware attachments shall be hidden. Equipment cabinet and/or equipment cabinet cover shall not have a flat, horizontal surface larger than 1.5 inches.		
Equipment Cabinet Access Doors	Utility access	City access	Network Provider access
	Per electric utility provider's meter access requirements. The meter shall be recessed as much as possible into the pole base.	Hand hole	Lockable access door sized to install, maintain, and remove all small cell equipment as needed.
Required Equipment	Utility Equipment*	City Equipment*	Network Provider Equipment*
	Per electric utility provider's requirements.	Fused power disconnect	Per small cell Network Provider requirements.
	*All equipment shall be located internal to the equipment cabinet or recessed in the equipment cabinet to meet Utility requirements. All equipment shall be mounted per the Owner's requirements.		
Equipment separation	All equipment shall be separated by Owner. All access doors shall be secured by the Owner's requirements.		
Ventilation	Passive louvers and/or other passive ventilation systems shall be provided as the primary means of temperature control.		
Motorized Ventilation	If required, fan(s) shall not emit noise greater than 30dBa at one meter (3.28 feet).		
Hand Holes	Six (6) hand holes shall be provided along the upper pole, if requested by the City, each set to be spaced 5'-0" apart, to maintain City fiber and electrical service for streetlights and future IOT attachments.		
Grommets	Weatherproof grommets shall be integrated into the pole design to allow cable to exit the pole, future IOT attachments, without water seeping into the pole.		
Antenna Shroud Transition	The antenna and upper pole attachment shall be shrouded to meet City aesthetics. A tapered transition between the upper pole and antenna shall be included.		
Antenna Finish	Antenna shroud shall be finished and painted to match pole.		

Single and Dual Technology Specification Overview (Continued)	
Luminaire	Per the City's and/or electric utility provider's standard depending on ownership.
Luminaire Mast Arm	Per the City's and/or electric utility provider's standard depending on ownership.
Electrical Service	Per the City's or electric utility provider's standard depending on ownership.
Pole Requirements	At least 15% of the pole design structural capacity shall be reserved for future City IOT installations.
Pole Type	Round, straight, galvanized steel.
Finish	Galvanized in accordance with AASHTO M111 with powder-coated paint gray RAL 7038, or painted to match adjacent streetlight pole finish.
Design Wind Velocity	115 mph minimum per TIA-222 rev G, IBC 2012 with ASCE 710, and amendments for local conditions.
Foundation	Precast concrete or cast-in-place pole foundations shall be designed per the City standard to meet ACI 318. While the City accepts cast-in-place foundations, precast concrete foundations are preferred and should be installed whenever possible.
Conduit Sweeps in Foundation	Eight (8) 2" PVC conduit sweeps shall be installed. Conduit shall accommodate City electrical, City fiber, and small cell Network Provider electrical and fiber with spare sweeps capped off for future service.
Bolt Circle	24-inch bolt circle. Anchor bolts shall either be hidden from view, preferred, or treated and painted to match the pole color
Potential Shroud	All fixed connections shall be hidden from view.
Electrical Separation	An internal divider shall separate electrical wiring and fiber, per Owner. Separation of service shall meet electric utility provider's requirements.
Warning Label	If required, radio frequency warning labels shall be mounted on the exterior of the Network Provider's equipment.
Owner Identification	A 4-inch by 6-inch (maximum) aluminum plate with the Network Provider's name, location identifying information, and emergency telephone number shall be permanently fixed to the equipment, 5 feet above finished grade.



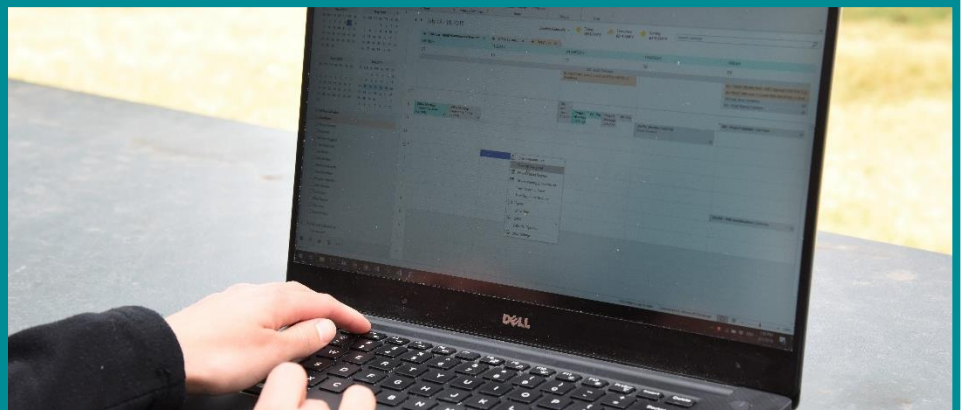
### 4.3 PLACEMENT REQUIREMENTS

A combination metal small cell and streetlight pole should only be located where an existing pole (typically Xcel Energy owned streetlight) can be removed and replaced, or at a new location where the City has identified that a streetlight is necessary. New streetlight equipment shall be installed at the Applicant's cost. Combination poles can either be owned by the electric utility provider (preferred – as approved by the electric utility provider, typically Xcel Energy) or by the applicant (as approved through a Telecom Permit).

Combination small cell poles will only be allowed by the City when the following placement requirements are met:

- In a manner that does not impede, obstruct, or hinder reasonable pedestrian or vehicular travel
- In alignment with existing trees, utility poles, and streetlights parallel to travel way
- Within the street amenity zone whenever possible (e.g. tree lawn area)
- Applicant shall replace all disturbed landscaping and irrigation to its original condition
- Equal distance between trees when possible, with a minimum of 15 feet separation such that no proposed disturbance shall occur within the critical root zone of any tree
- A minimum of 250 feet away from another Network Provider's small cell pole (combination pole or freestanding pole)
- A minimum of 750 feet away from a small cell pole (combination pole or freestanding pole) owned by the Applicant
- With appropriate clearance from existing utilities per Westminster Municipal Code
- Outside of the sight distance triangles at intersection corners, per the City's Standards and Specifications
- When possible, poles should be placed on (or in-line with) property lines separating adjoining parcels.
- Poles shall not be placed adjacent to the front plane of a building

# Chapter 5



REFER TO CHAPTER 5 WHEN INSTALLING FREESTANDING SMALL CELL POLES

## 5. FREESTANDING SMALL CELL INFRASTRUCTURE

This chapter of the Guidelines is to be used when installing a freestanding small cell, also referred to as a “stand-alone pole”.

The specifications provided in this chapter are for single carrier installations within the public right of way only. Dual carrier, dual technology installations, or small cell locations not in the public right of way may vary from these Guidelines with City approval.

All freestanding small cell permit applications shall be approved by the City prior to installation. All equipment shall meet the electric utility provider’s, typically Xcel Energy, electrical utility requirements and the City’s design aesthetic requirements.

The design of the freestanding pole shall match the aesthetic characteristics of existing streetlights installed along the same block as the proposed freestanding pole. The Network Provider shall perform a visual inspection (Online street images are considered sufficient unless the pole standards were updated after the images were published) prior to submitting a permit application to determine existing aesthetic characteristics. All small cell Network Provider equipment shall be housed internal to the equipment cabinet or hidden behind the cantenna. No Network Provider equipment shall be mounted on the outside of the pole.

Deviations from the Guidelines shall be approved on a case-by-case basis by the City prior to installation.

Figure 5-1: Freestanding Small Cell



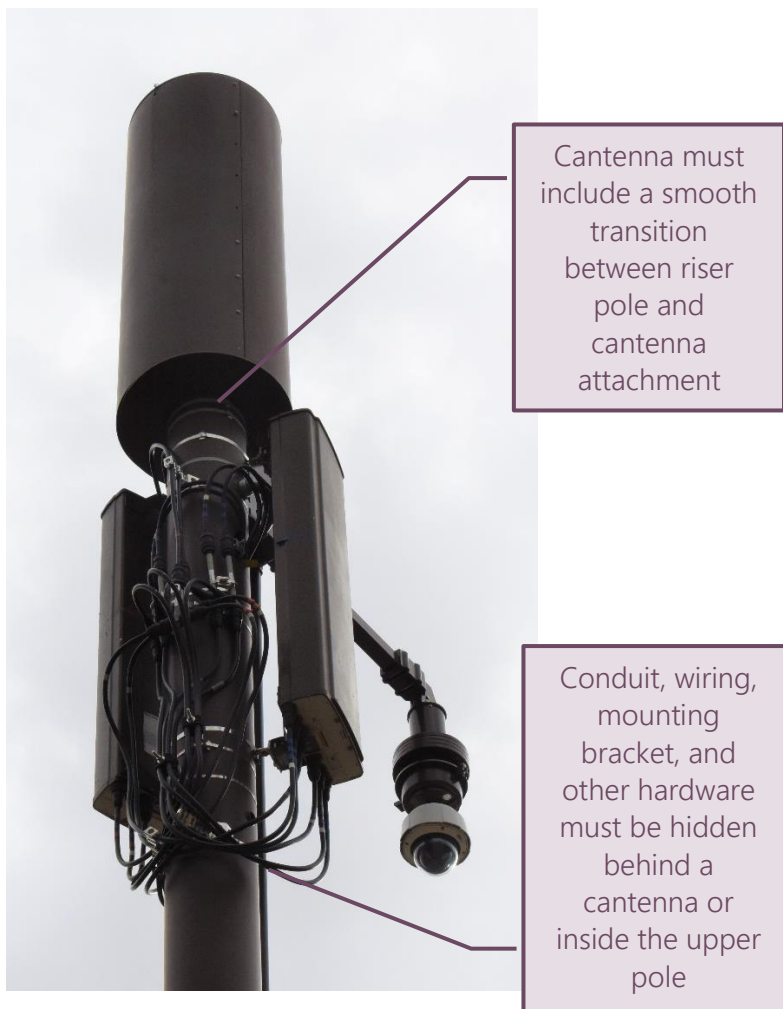
## 5.1 BASIS OF DESIGN

The following pages describe the City's requirements for installation of freestanding small cell poles in the City's public rights of way. Such a pole would not serve as a streetlight pole or support other types of infrastructure.

The freestanding pole components include the foundation, equipment cabinet, upper pole, antenna, and all hardware and internally integrated electrical equipment necessary for a complete assembly. The small cell components shall also be sized to be visually pleasing. For a combination pole to be considered visually pleasing, the transition between the equipment cabinet and upper pole should be considered. A decorative transition shall be installed over the equipment cabinet upper bolts. All hardware connections shall be hidden from view. No horizontal flat spaces greater than 1.5 inches shall exist on the equipment cabinet to prevent cups, trash, and other objects from being placed on the equipment cabinet. Each pole component shall be architecturally compatible to create a cohesive aesthetic. Examples of an unacceptable and an acceptable small cell installation can be found in Figure 5-2 and Figure 5-3, below.

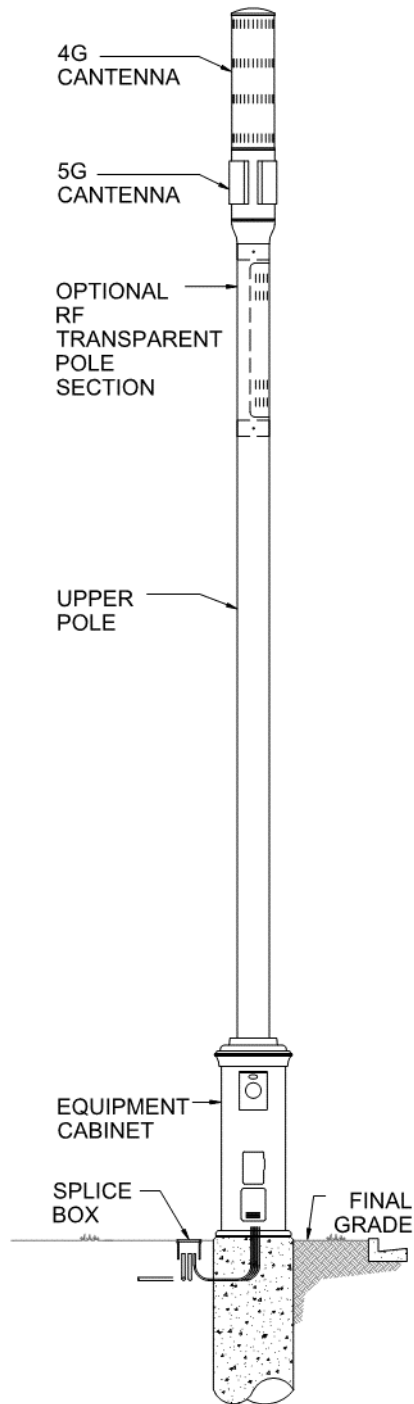
Figure 5-2: Unacceptable Freestanding Installation

Figure 5-3: Acceptable Freestanding Installation



Freestanding small cell pole components include the foundation, equipment cabinet, upper pole, upper pole radio frequency transparent housing, antenna, and all hardware and electrical equipment necessary for a complete assembly, as shown in Figure 5-4. A freestanding small cell specification overview is found in Appendix C.

Figure 5-4: Freestanding Small Cell Assembly





## 5.2 FREESTANDING SMALL CELL SPECIFICATION OVERVIEW

Table 5-1: Freestanding Small Cell Infrastructure Specification Overview

Standalone Specific Specification		
4G – LTE only	Equipment cabinet dimension	Round, galvanized equipment cabinet. Maximum 5’-8” height, from top of foundation to top of transition shroud, with 16” outer diameter equipment cabinet. A 20” outer diameter will be allowed if Applicant can show that a smaller equipment cabinet is incapable of housing the necessary equipment.
	Cantenna dimension	14” maximum outer diameter. The top of the cantenna shall be located no more than 30 feet above finished grade.
5G only	Equipment cabinet dimension	Round, galvanized equipment cabinet. Maximum 5’-8” height, from top of foundation to top of transition shroud, with 16” outer diameter equipment cabinet. A 20” outer diameter will be allowed if Applicant can show that a smaller equipment cabinet is incapable of housing the necessary equipment.
	Cantenna dimension	16” maximum outer diameter with 19” (maximum) protrusions for 5G antennas. The top of the cantenna shall be located no more than 30 feet above finished grade.
Dual technology (4G & 5G)	Equipment cabinet dimension	Round, galvanized equipment cabinet. Maximum 5’-8” height, from top of foundation to top of transition shroud, with 20” maximum outer diameter.
	Cantenna dimension	16” maximum outer diameter with 19” (maximum) protrusions for 5G antennas. The top of the cantenna shall be located no more than 30 feet above finished grade.

Standalone Specification Overview		
Equipment Cabinet Transition	All hardware attachments shall be hidden. Equipment cabinet and/or equipment cabinet cover shall not have a flat, horizontal surface larger than 1.5 inches.	
Equipment Cabinet Access Doors	Utility access	Network Provider access
	Per electric utility provider's meter access requirements. The meter shall be recessed as much as possible into the pole base.	Lockable access door sized to install, maintain, and remove all small cell equipment as needed.
Required Equipment	Utility Equipment*	Network Provider Equipment*
	Per electric utility provider's requirements.	Per small cell Network Provider's requirements.
	*All equipment shall be located internal to the equipment cabinet or recessed in the equipment cabinet to meet Utility requirements. All equipment shall be mounted per the Owner's requirements.	
Equipment separation	All equipment shall be separated by owner. All access doors shall be secured by owner requirements.	
Ventilation	Passive louvers and/or other passive ventilation systems shall be provided as the primary means of temperature control.	
Motorized Ventilation	If required, fan(s) shall not emit noise greater than 30dBa at one meter (3.28 feet).	
Hand Holes	Six (6) hand holes shall be provided along the upper pole, each set to be spaced 5'-0" apart, to maintain City fiber and electrical service for streetlights and future IOT attachments.	
Grommets	Weatherproof grommets shall be integrated into the pole design to allow cable to exit the pole, future IOT attachments, without water seeping into the pole.	
Antenna Shroud Transition	The antenna and upper pole attachment shall be shrouded to meet City aesthetics. A tapered transition between the upper pole and antenna shall be included.	
Antenna Finish	Antenna shroud shall be colored to match pole.	



Standalone Specification Overview (Continued)	
Electrical Service	Per electric utility provider's standards.
Pole Type	Round, straight, galvanized steel.
Finish	Galvanized in accordance with AASHTO M111 with powder-coated paint gray RAL 7038, or painted to match adjacent streetlight pole finish.
Design Wind Velocity	115 mph minimum per TIA-222 rev G, IBC 2012 with ASCE 710, and amendments for local conditions.
Foundation	Precast concrete or cast-in-place pole foundations shall be designed per the City standard to meet ACI 318. While the City accepts cast-in-place foundations, precast concrete foundations are preferred and should be installed whenever possible.
Conduit Sweeps in Foundation	Eight (8) 2" PVC conduit sweeps shall be installed. Conduit shall accommodate small cell electrical and fiber with spare sweeps capped off for future service.
Bolt Circle	24-inch bolt circle. Anchor bolts shall either be hidden from view, preferred, or treated and painted to match the pole color
Potential Shroud	All fixed connections shall be hidden from view.
Electrical Separation	An internal divider shall separate electrical wiring and fiber, per Owner. Separation of service shall meet electric utility provider's requirements.
Warning Label	If required, radio frequency warning labels shall be mounted exterior to the pole.
Owner Identification	A 4-inch by 6-inch (maximum) aluminum plate with the Network Provider's name, location identifying information, and emergency telephone number shall be permanently fixed to the pole.

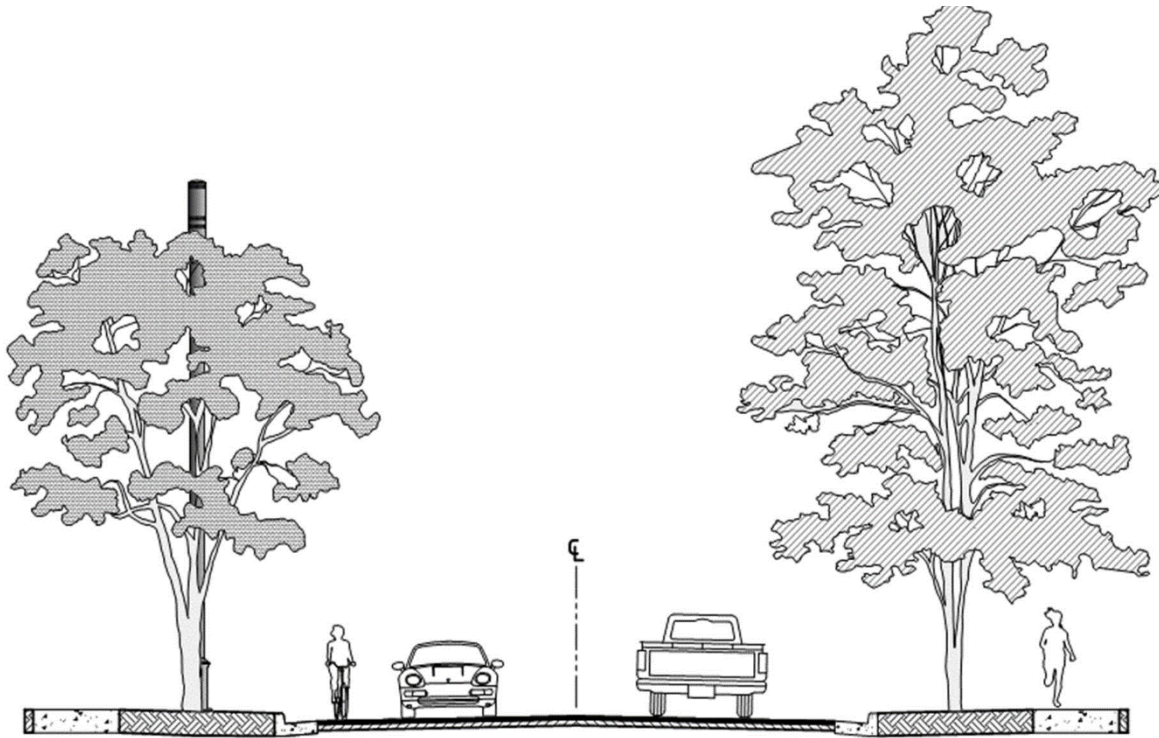
### 5.3 PLACEMENT REQUIREMENTS

All freestanding small cell poles shall be privately owned and must be permitted by the City via the Telecom Permit, and situated:

- In a manner that does not impede, obstruct, or hinder pedestrian or vehicular travel
- So as not to be located along the frontage of a Historic building, deemed historic on a federal, state, or local level
- So as not to significantly create a new obstruction to property sight lines
- On (or in-line with) property lines, and along secondary property street facing
- At building corners rather than in front of building planes
- Within the street amenity zone whenever possible (e.g., tree lawn area)
- In alignment with existing trees, utility poles, and streetlights, parallel to travel way

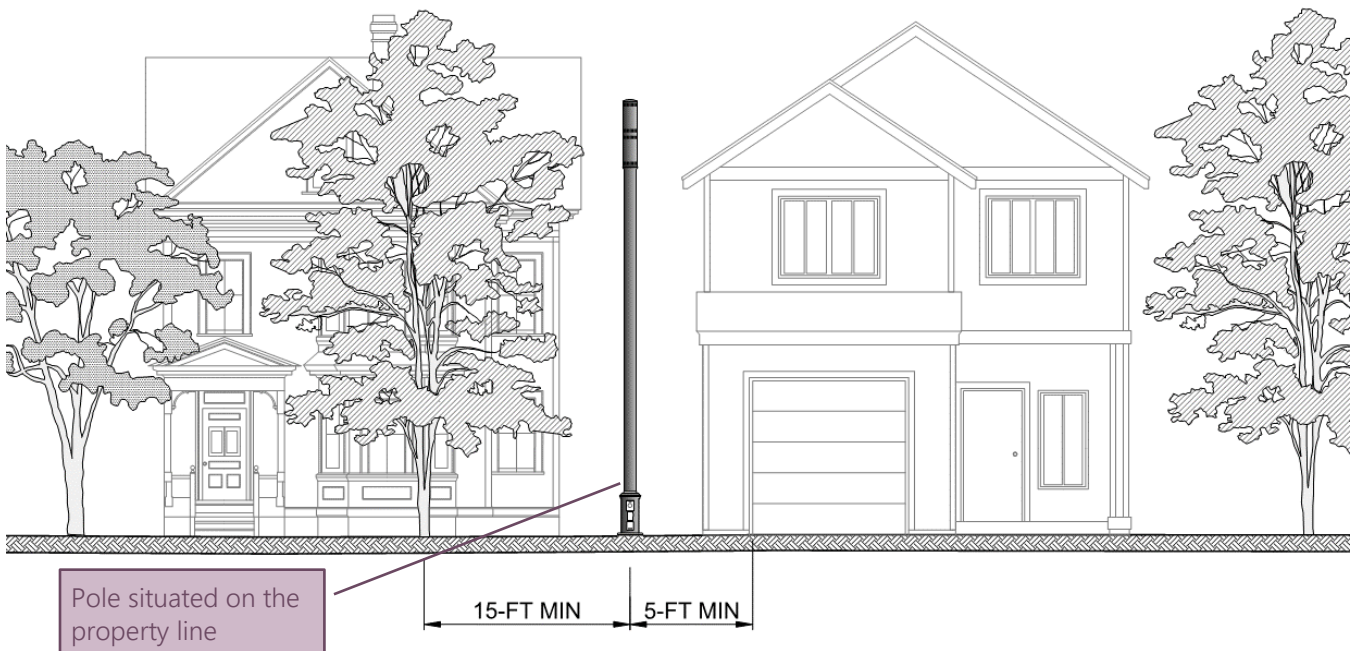


Figure 5-6: Freestanding Small Cell in Amenity Zone



Freestanding small cells shall be located such that they in no way impede, obstruct, or hinder reasonable pedestrian or vehicular travel, affect public safety, obstruct the legal access to or use of the public right of way, violate applicable law, violate or conflict with public right of way design standards, specifications, or design district requirements, violate the Federal Americans with Disabilities Act of 1990, or in any way create a risk to public health, safety, or welfare.

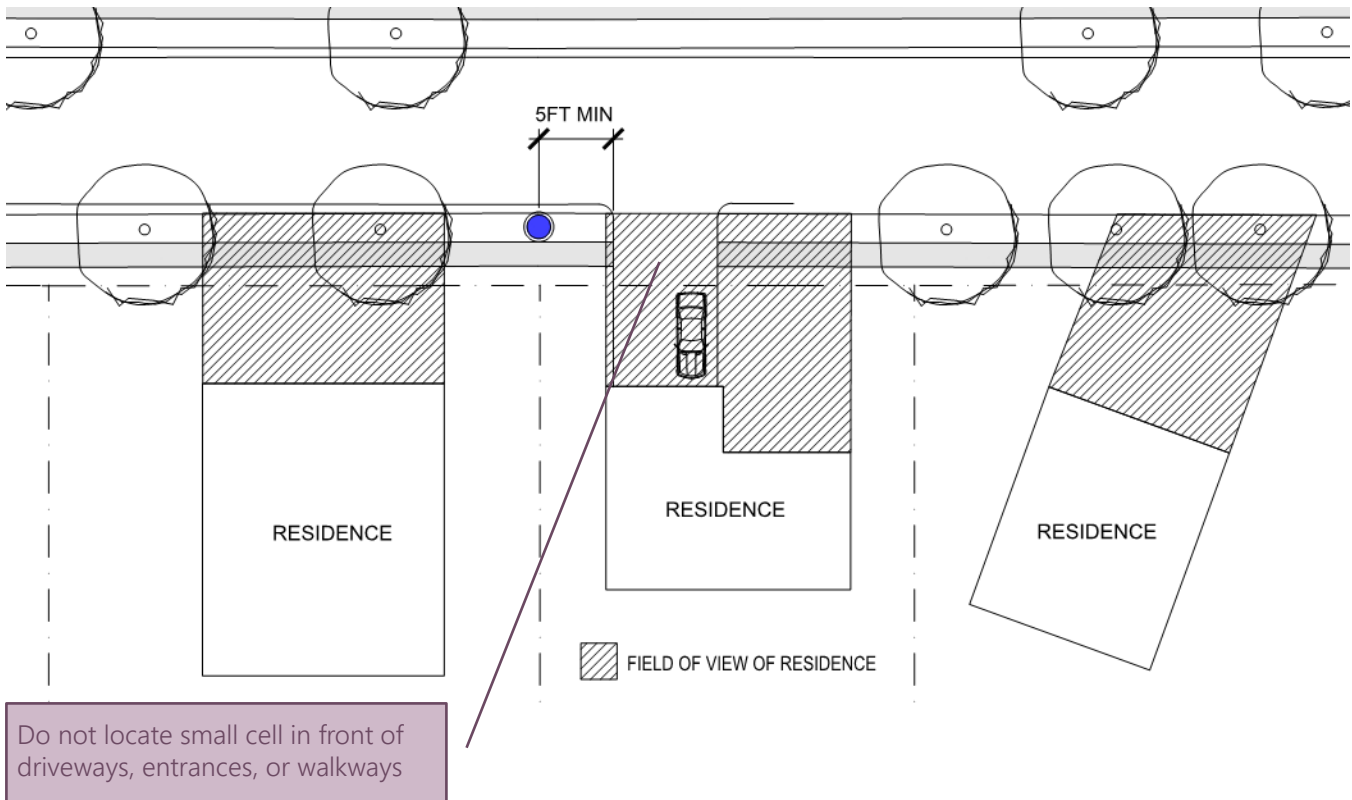
Figure 5-7: Freestanding Small Cell Location Between Property and Trees



Freestanding small cells shall be located at intersecting property lines as much as possible. Whenever possible, the freestanding small cell shall be located on the secondary street. Small cells shall also be located a minimum of 15 feet away from trees to prevent disturbance within the critical root zone of any tree, as shown in Figure 5-7.

The small cells shall not be installed between the perpendicular extension of the primary street-facing wall plane of any single or two-family residence as shown in Figure 5-8.

Figure 5-8: Freestanding small cell between property lines



When located adjacent to a commercial establishment, such as a shop or restaurant, or multi-story residential, care should be taken to locate the small cell such that it does not negatively impact the structure. Small cells shall not be located in-front of store front windows, primary walkways, primary entrances or exits, or in such a way that it would impede a delivery to the building. Small cells should be located between properties as much as possible, as shown in Figure 5-9.





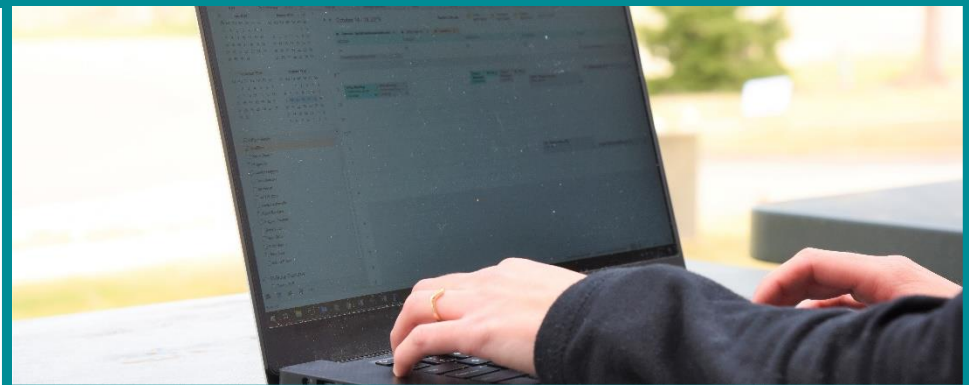
Figure 5-9: Small Cell in Commercial Area





# Appendix

# A



REFER TO APPENDIX A FOR THE CITY OF WESTMINSTER'S SMALL CELL TERMINOLOGY

## A GLOSSARY

Following are general definitions used in this Guideline.

Abandoned - shall mean a Small Cell Facility that is unused with no intent by the owner for further use within three (3) months. The pole or structure supporting the Small Cell Facility infrastructure is removed, all utilities providing service to the Small Cell Facility infrastructure disconnected, the caisson or foundation is removed, and the disturbed area is left in a condition acceptable to the City.

Antenna - shall have the same definition as Antenna(s) as defined in Section 11-16-2 Westminster Municipal Code.

Cantenna - shall mean the Antenna and all necessary equipment contained within a cylindrical shroud attached to the top of a Small Cell Pole.

City - shall mean the City of Westminster, in the State of Colorado, acting by and through the City Manager, Mayor, and City Council.

City Code - shall mean the currently adopted Westminster Municipal Code.

Collocation - shall have the same definition as Collocation as defined in Section 11-16-2 Westminster Municipal Code.

Equipment Cabinet - shall mean the area where any equipment, other than an Antenna, that is used in conjunction with small cell technology.



Equipment Shroud - shall mean a maximum 49" height by 19" width by 13" depth radio frequency transparent enclosure that contains small cell equipment.

Luminaire - shall mean a complete electrical light unit.

Mounting height - shall mean the distance from the pole base plate to the Luminaire connection to the Luminaire mast arm.

Network Provider - shall mean the entity that wishes to provide service from the small cell wireless infrastructure.

New Pole - shall mean a Small Cell Pole that currently does not exist.

Non-ionizing Electromagnetic Radiation Report (NIER) - is a written document of the proposed Small Cell Facility describing the radio frequencies being used for the facility. It shall include minimum approach distances to the general public as well as electrical and communication workers that are not trained for working in an RF environment (uncontrolled) when accessing the pole by climbing or bucket.

Right of Way - shall have the same definition as Public Right(s)-of-Way as defined in Section 11-16-2 Westminster Municipal Code.

Planning Manager - shall mean the City's Planning Manager or his/her designee.

Sight-Triangle - shall mean the required distance or area from a stopped vehicle in an intersection that no obstruction can be installed. See Chapter 6 of the City of Westminster's Standards and Specifications for the Design and Construction of Public Improvements for requirements.

Small Cell Facility - shall have the same definition as Small Cell Facility as defined in Section 11-16-2 Westminster Municipal Code.

Small Cell Pole - shall mean a freestanding structure designed or used to support, or capable of supporting, Small Cell Facilities.

Spacing Radius - shall mean the radius from an existing Small Cell Pole in which no other new facility can be installed.

Splice/Pull Box - shall mean a polymer concrete enclosure with a minimum 22,000 pound load rating which is flush-mounted to the existing grade to facilitate fiber or electrical conduit and cable.

Standards and Specifications - shall be understood that reference is made to the City of Westminster Standards and Specifications for the Design and Construction of Public Improvements.

Strand-mounted - shall mean small cell equipment proposed to be attached to an existing aerial utility wire.

Structurally Sound - shall mean the existing utility infrastructure can support the proposed additional equipment load of the Small Cell Facility without additional guy wire or other structural support, and the proposed design is signed and sealed by a Professional Engineer registered in the State of Colorado.

Telecom Permit - shall mean a duly issued permit from the City allowing the installation of the therein described Small Cell Facility, which shall include a Right of Way Permit and Building Permit.

Utility Pole - shall mean an existing pole in the public Right of Way for the purpose of providing utility services.



# Appendix

# B



REFER TO APPENDIX B FOR CONSTRUCTION DETAILS RELATING TO SMALL CELLS.

## B DETAILS

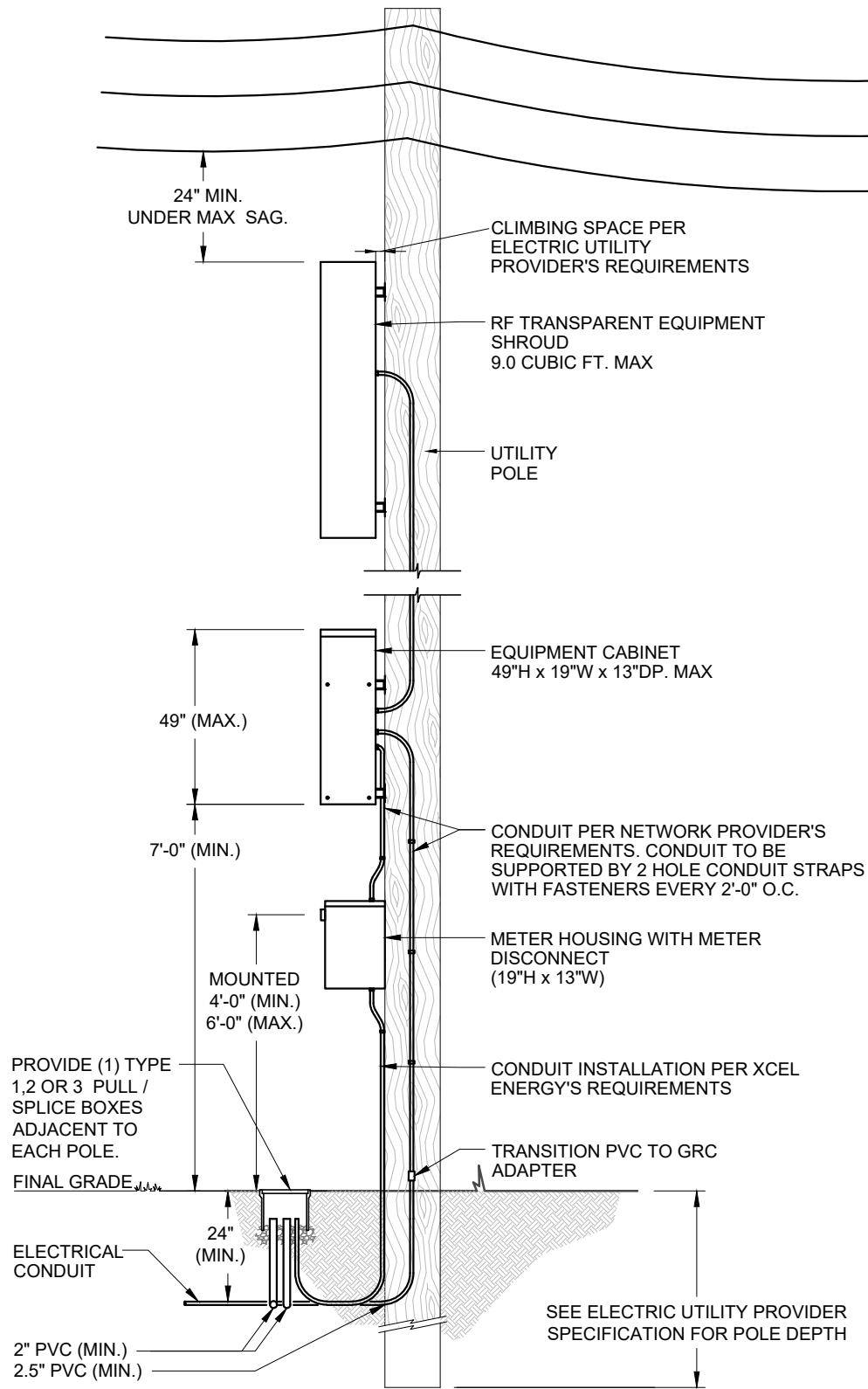
The following pages provide details to be used in all City of Westminster small cell installations. These pages detail the components required for each type of small cell installation, and include conduit burial, pull box dimensions, pole bases, grounding, and foundations.

The details include the City's electrical requirements and Xcel Energy's electrical requirements. The appropriate details, based on either the specification STANDARDS AND SPECIFICATIONS or the electric utility provider's specification (typically Xcel Energy), and should be selected based on which entity will own and maintain the system after the installation has been completed.



# LIST OF DETAILS

Type 1A: Typical Utility Pole Mounted Detail .....	SS-01
Type 1B: Typical Utility Pole Strand Mounted Detail .....	SS-02
Type 2: Typical Combination Small Cell – Streetlight on Wooden Pole .....	SS-03
Typical Combination Pole Equipment Cabinet Detail .....	SS-04
Type 3: Typical Combination Pole Detail .....	SS-05
Type 4: Typical Freestanding Small Cell Pole Detail .....	SS-06
Type 3 Combination Pole Conduit Burial Detail .....	SS-07
Typical Conduit Burial Detail .....	SS-08
Pull Box/ Splice Box Typical Dimensions .....	SS-09
Typical In-Grade Pull Box/ Splice Box Detail .....	SS-10
Typical Small Cell Electrical Detail in Softscape .....	SS-11
Typical Small Cell Electrical Detail in Hardscape .....	SS-12
Typical Small Cell Electrical Detail Notes .....	SS-13
Typical Non-Breakaway Pole Base Standard Detail .....	SS-14



**TYPE 1A UTILITY POLE WITH MOUNTED EQUIPMENT SHROUD**

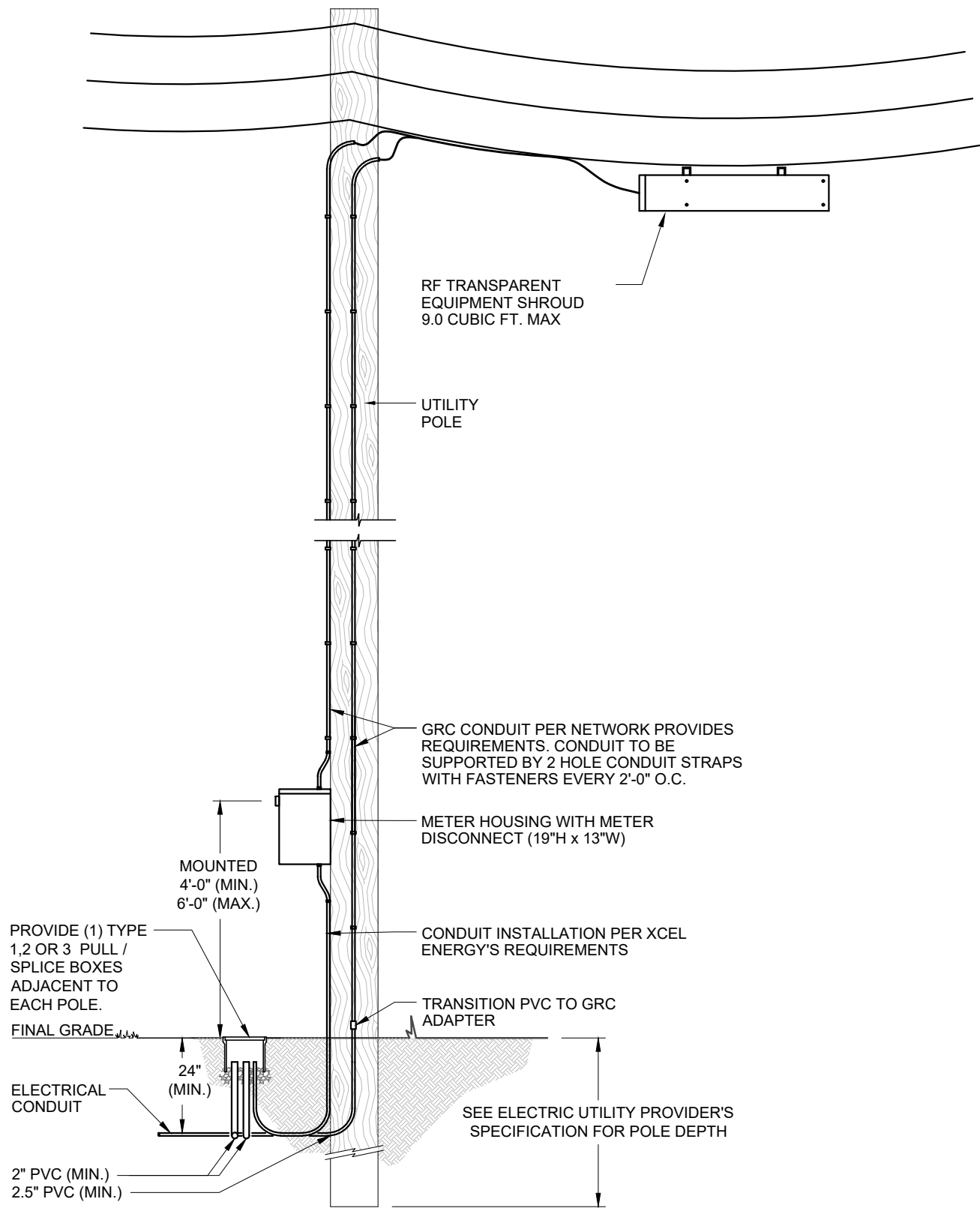


City of Westminster  
 Department of Public Works

Date:  
 April 2019

TYPE 1A: TYPICAL UTILITY POLE MOUNTED DETAIL

Std. Dwg. No.  
 SS-01



**TYPE 1B UTILITY POLE WITH STRAND MOUNTED SHROUD**



City of Westminster  
 Department of Public Works

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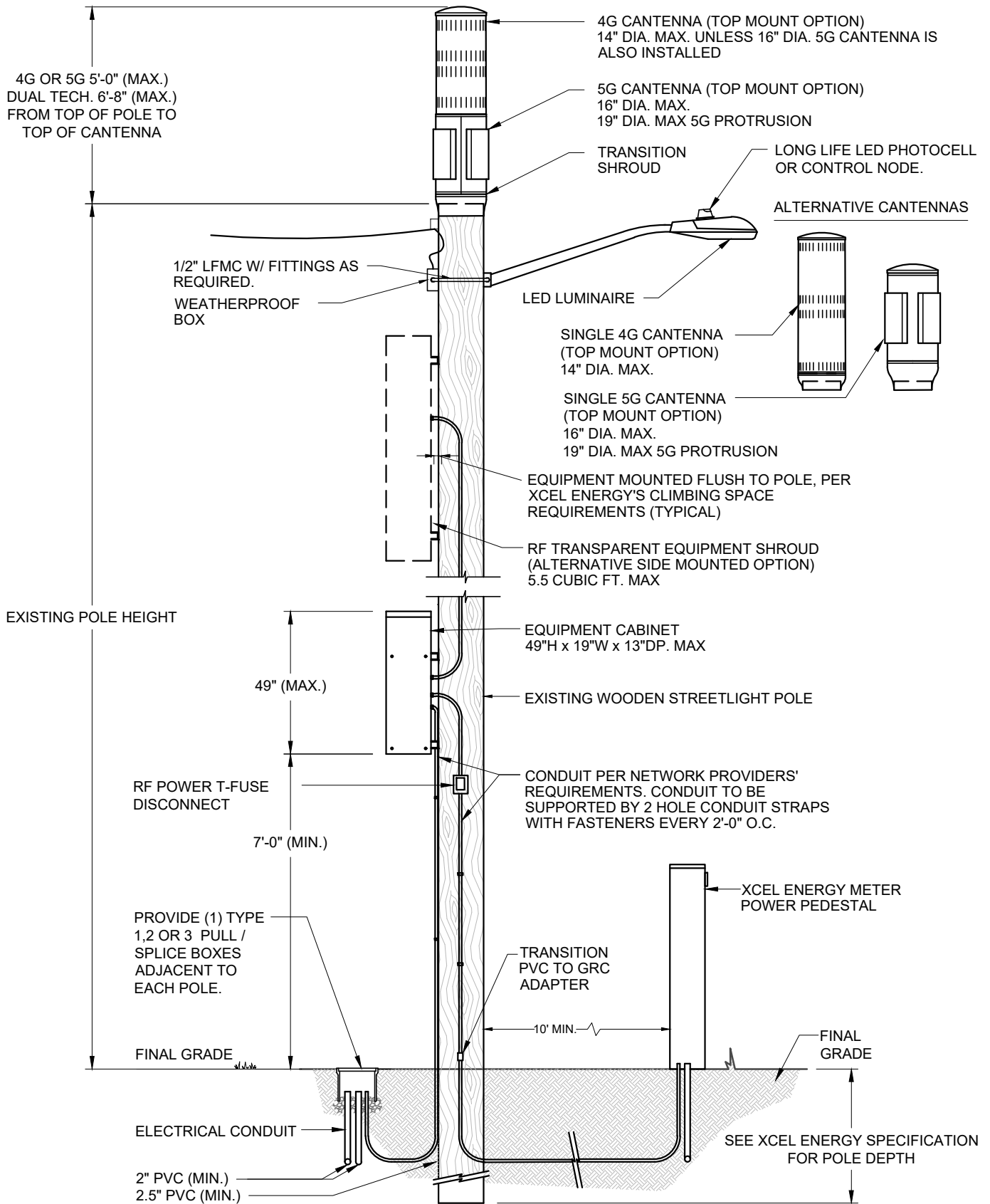
TYPE 1B:TYPICAL UTILITY POLE STRAND MOUNTED  
 DETAIL

Date:  
 April 2019

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Std. Dwg. No.  
 SS-02



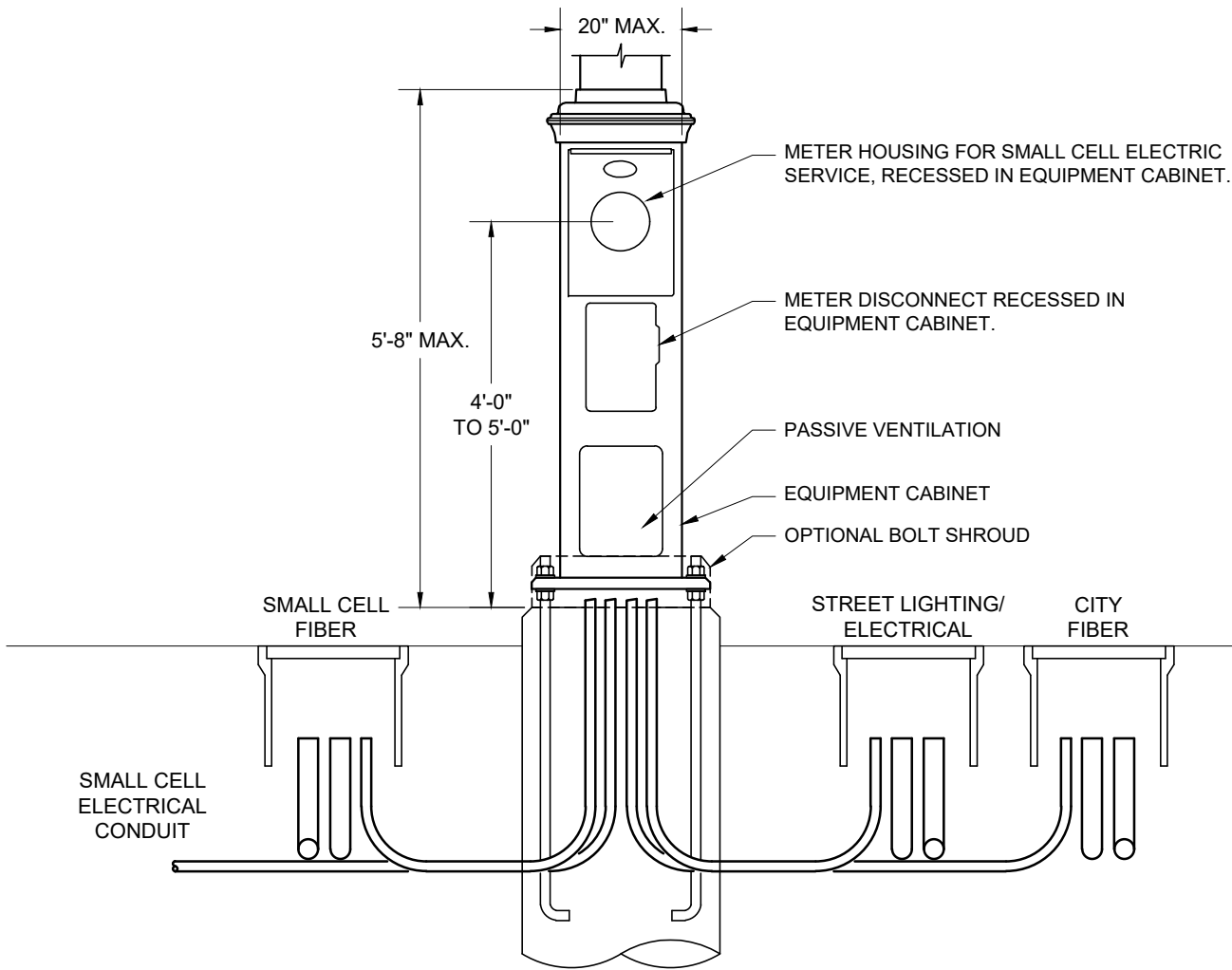
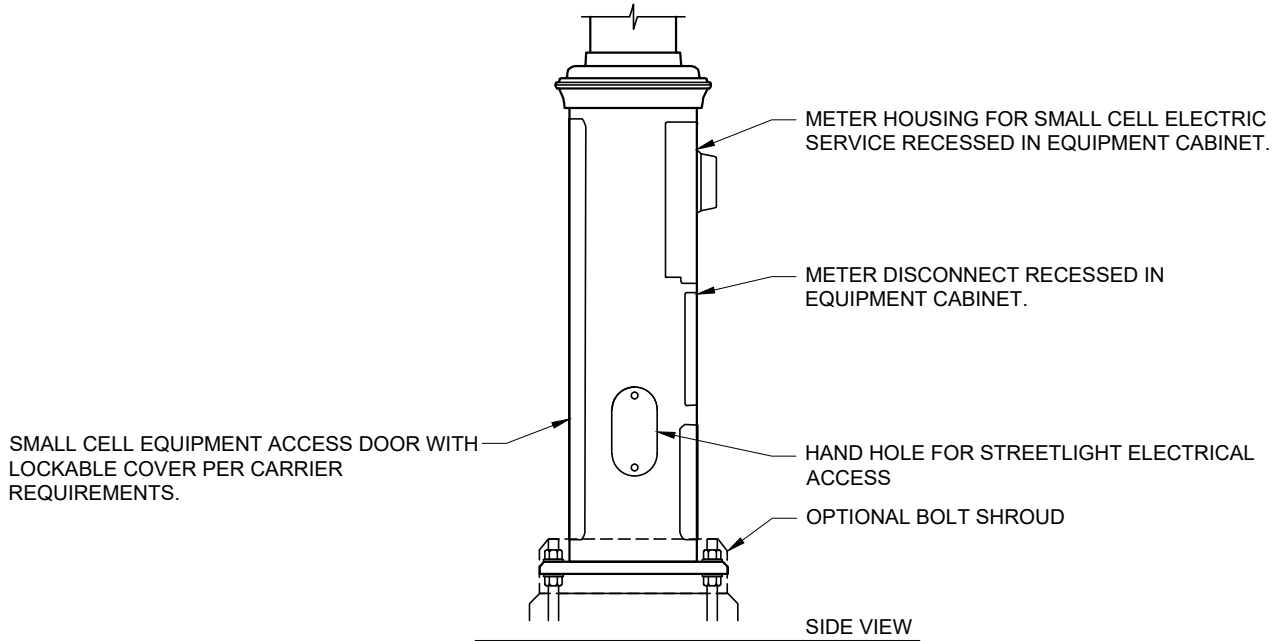


City of Westminster  
Department of Public Works

Date:  
April 2019

TYPE 2: TYPICAL COMBINATION SMALL  
CELL-STREETLIGHT ON WOODEN POLE

Std. Dwg. No.  
SS-03

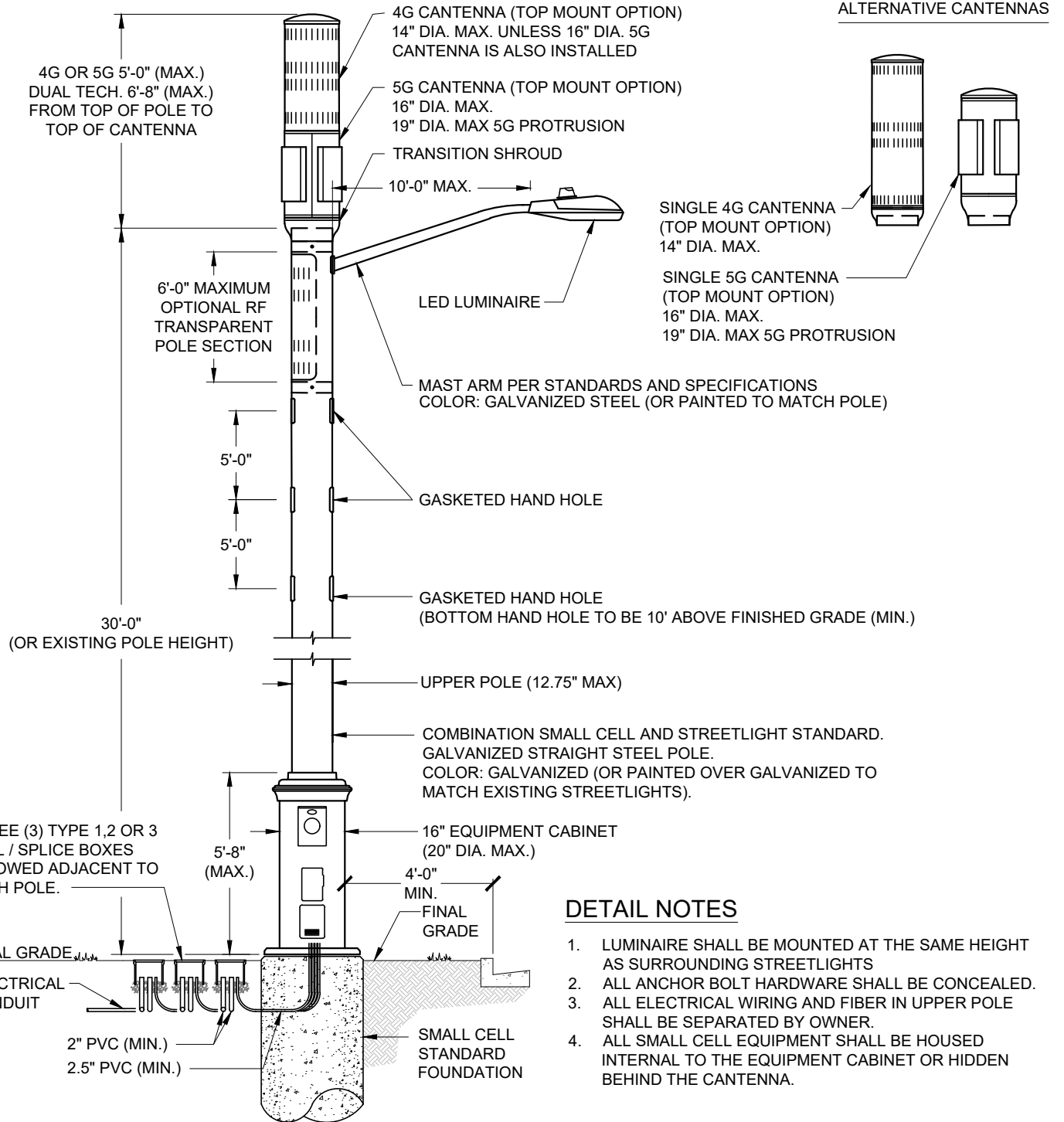
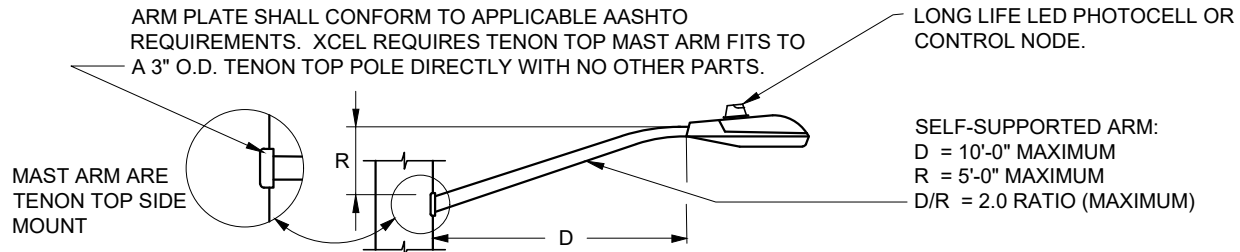


City of Westminster  
Department of Public Works

Date:  
April 2019

TYPICAL COMBINATION POLE EQUIPMENT  
CABINET DETAIL

Std. Dwg. No.  
SS-04



**DETAIL NOTES**

1. LUMINAIRE SHALL BE MOUNTED AT THE SAME HEIGHT AS SURROUNDING STREETLIGHTS
2. ALL ANCHOR BOLT HARDWARE SHALL BE CONCEALED.
3. ALL ELECTRICAL WIRING AND FIBER IN UPPER POLE SHALL BE SEPARATED BY OWNER.
4. ALL SMALL CELL EQUIPMENT SHALL BE HOUSED INTERNAL TO THE EQUIPMENT CABINET OR HIDDEN BEHIND THE ANTENNA.

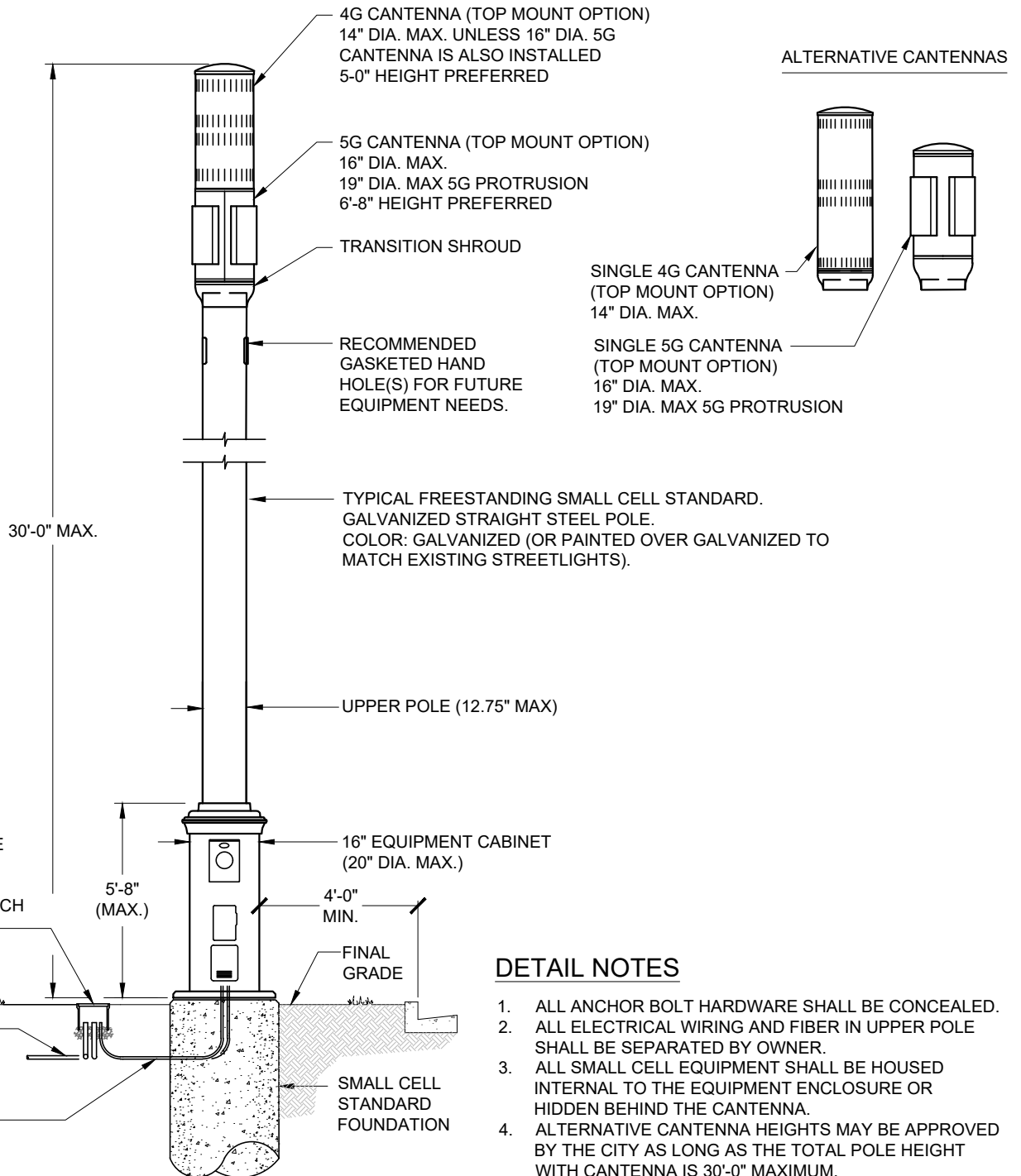


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 Department of Public Works

Date:  
 April 2019

TYPE 3: TYPICAL COMBINATION POLE DETAIL

Std. Dwg. No.  
 SS-05



**30 FT. STANDARD**

**DETAIL NOTES**

1. ALL ANCHOR BOLT HARDWARE SHALL BE CONCEALED.
2. ALL ELECTRICAL WIRING AND FIBER IN UPPER POLE SHALL BE SEPARATED BY OWNER.
3. ALL SMALL CELL EQUIPMENT SHALL BE HOUSED INTERNAL TO THE EQUIPMENT ENCLOSURE OR HIDDEN BEHIND THE ANTENNA.
4. ALTERNATIVE ANTENNA HEIGHTS MAY BE APPROVED BY THE CITY AS LONG AS THE TOTAL POLE HEIGHT WITH ANTENNA IS 30'-0" MAXIMUM.



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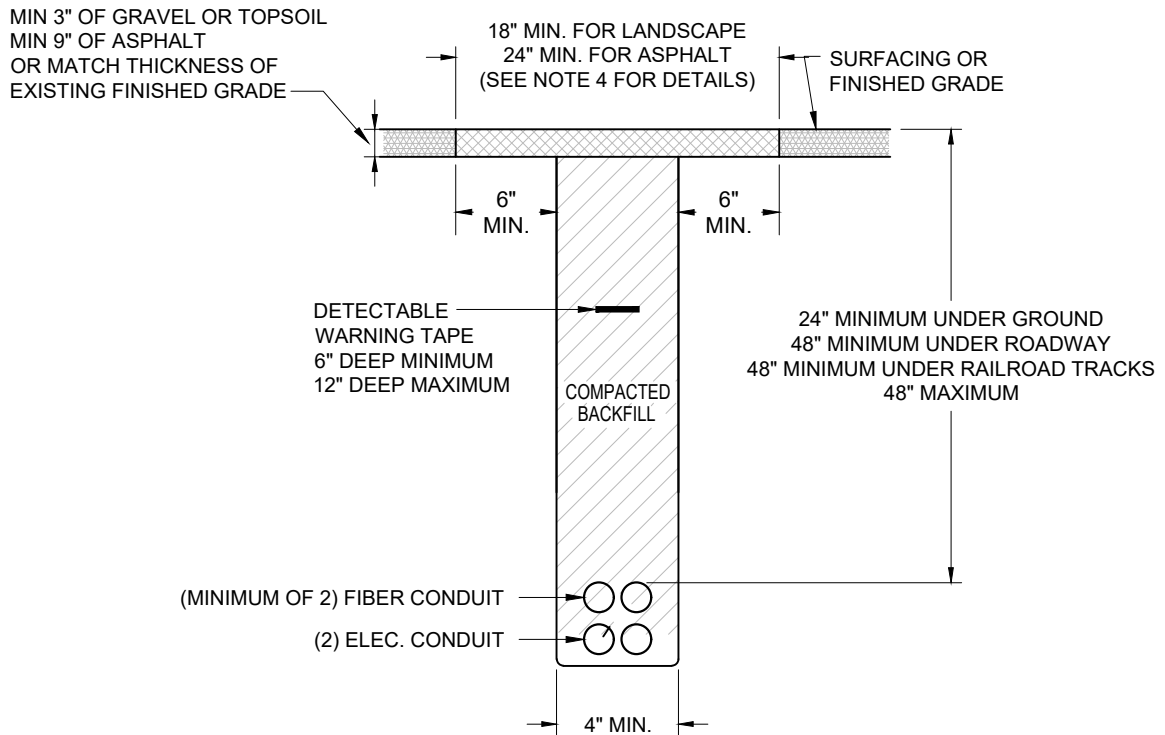
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TYPE 4: TYPICAL FREESTANDING SMALL CELL DETAIL

Date:  
April 2019

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Std. Dwg. No.  
SS-06



### DETAIL NOTES

1. CONTRACTOR SHALL COORDINATE BORING, DRIVING, OR TRENCHING WITH OTHER UNDERGROUND UTILITIES. CONTRACTOR SHALL USE COMMON TRENCHES WHEREVER POSSIBLE.
2. WHENEVER POSSIBLE, CONDUIT OR CABLE SHALL BE INSTALLED BY BORING, DRIVING, OR ANY OTHER ACCEPTABLE MEANS UNDER CONCRETE UNITS. OPEN CUTTING SHALL BE USED ONLY UNDER SPECIAL CIRCUMSTANCES AND ONLY WITH APPROVAL OF PUBLIC WORKS.
3. MINIMUM WIDTH AND TYPE OF RESTORATION TO BE DETERMINED BY PW INSPECTOR, BASED ON CONTRACTOR'S PRE-ACTIVITY PHOTOS, TO MATCH PRE-EXISTING CONDITIONS.
4. SOD REPLACEMENT SHALL BE A MINIMUM OF 18" IN WIDTH. ASPHALT REPLACEMENT SHALL BE A MINIMUM OF 24" IN WIDTH. CONCRETE REPLACEMENT SHALL BE PER THE DEPARTMENT OF PUBLIC WORKS TRANSPORTATION STANDARD DETAILS 12.3.
5. ANY HARDSCAPE (CONCRETE OR PAVERS) SHALL BE REPLACED IN FULL PANELS OR PAVERS OF THE SAME TYPE, COLOR, AND SIZE AS BEFORE.
6. 1-#12 AWG LOCATE WIRE AND A NYLON OR POLYESTER PULL TAPE WITH 1,250 LBS TEST STRENGTH AND FOOTAGE MARKINGS IN ALL EMPTY CONDUITS.
7. ALL CONDUIT, LANDSCAPE RESTORATION, ASPHALT RESTORATION, AND CONCRETE RESTORATION MUST BE INSTALLED IN ACCORDANCE WITH THE STANDARDS AND SPECIFICATION DETAILS.
8. SEPARATE CONDUIT SHALL BE PROVIDED FOR STREETLIGHT ELECTRICAL CONDUIT, CITY FIBER, SMALL CELL ELECTRIC CONDUIT AND SMALL CELL CARRIER FIBER.
9. ALL CONDUIT SHALL BE ELECTRONICALLY LOCATABLE.

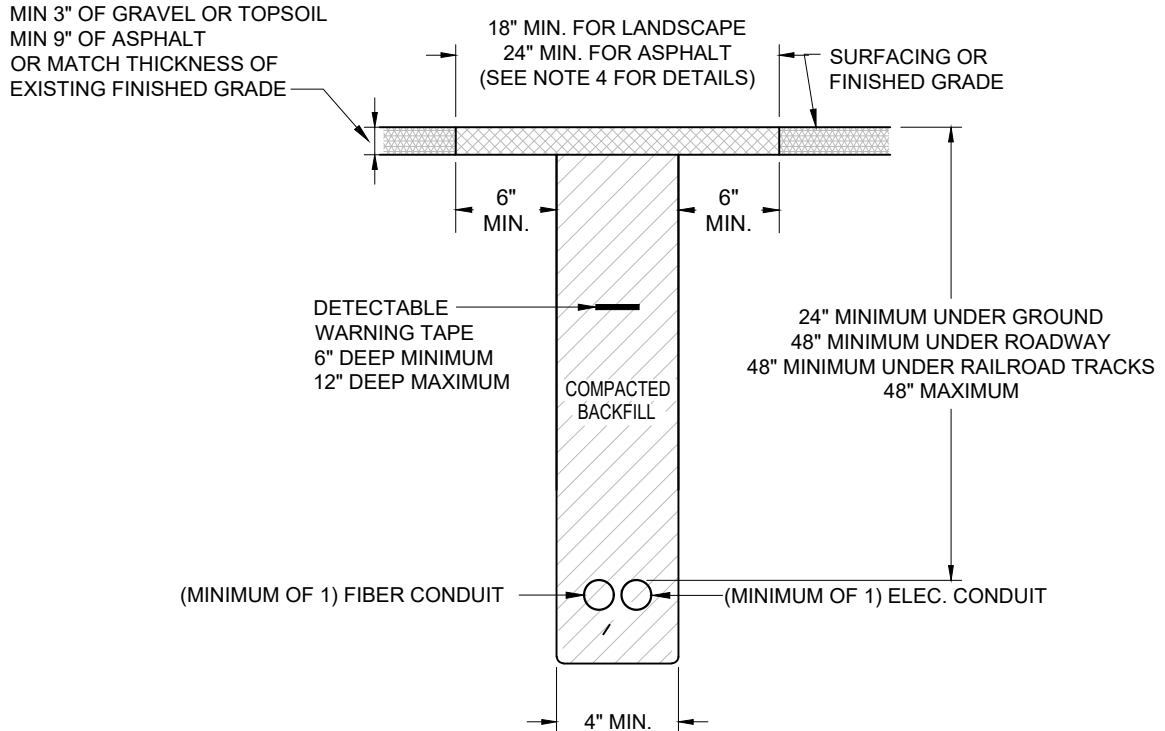


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April 2019

TYPE 3 COMBINATION POLE CONDUIT  
BURIAL DETAIL

Std. Dwg. No.  
SS-07



### DETAIL NOTES

1. CONTRACTOR SHALL COORDINATE BORING, DRIVING, OR TRENCHING WITH OTHER UNDERGROUND UTILITIES. CONTRACTOR SHALL USE COMMON TRENCHES WHEREVER POSSIBLE.
2. WHENEVER POSSIBLE, CONDUIT OR CABLE SHALL BE INSTALLED BY BORING, DRIVING, OR ANY OTHER ACCEPTABLE MEANS UNDER CONCRETE UNITS. OPEN CUTTING SHALL BE USED ONLY UNDER SPECIAL CIRCUMSTANCES AND ONLY WITH APPROVAL OF PUBLIC WORKS.
3. MINIMUM WIDTH AND TYPE OF RESTORATION TO BE DETERMINED BY PW INSPECTOR, BASED ON CONTRACTOR'S PRE-ACTIVITY PHOTOS, TO MATCH PRE-EXISTING CONDITIONS.
4. SOD REPLACEMENT SHALL BE A MINIMUM OF 18" IN WIDTH. ASPHALT REPLACEMENT SHALL BE A MINIMUM OF 24" IN WIDTH. CONCRETE REPLACEMENT SHALL BE PER THE DEPARTMENT OF PUBLIC WORKS TRANSPORTATION STANDARD DETAILS 12.3.
5. ANY HARDSCAPE (CONCRETE OR PAVERS) SHALL BE REPLACED IN FULL PANELS OR PAVERS OF THE SAME TYPE, COLOR, AND SIZE AS BEFORE.
6. 1-#12 AWG LOCATE WIRE AND A NYLON OR POLYESTER PULL TAPE WITH 1,250 LBS TEST STRENGTH AND FOOTAGE MARKINGS IN ALL EMPTY CONDUITS.
7. ALL CONDUIT, LANDSCAPE RESTORATION, ASPHALT RESTORATION, AND CONCRETE RESTORATION MUST BE INSTALLED IN ACCORDANCE WITH THE DEPARTMENT OF PUBLIC WORKS TRANSPORTATION STANDARD DETAILS.
8. SEPARATE CONDUIT SHALL BE PROVIDED FOR SMALL CELL ELECTRIC CONDUIT AND SMALL CELL CARRIER FIBER.
9. ALL CONDUIT SHALL BE ELECTRONICALLY LOCATABLE.

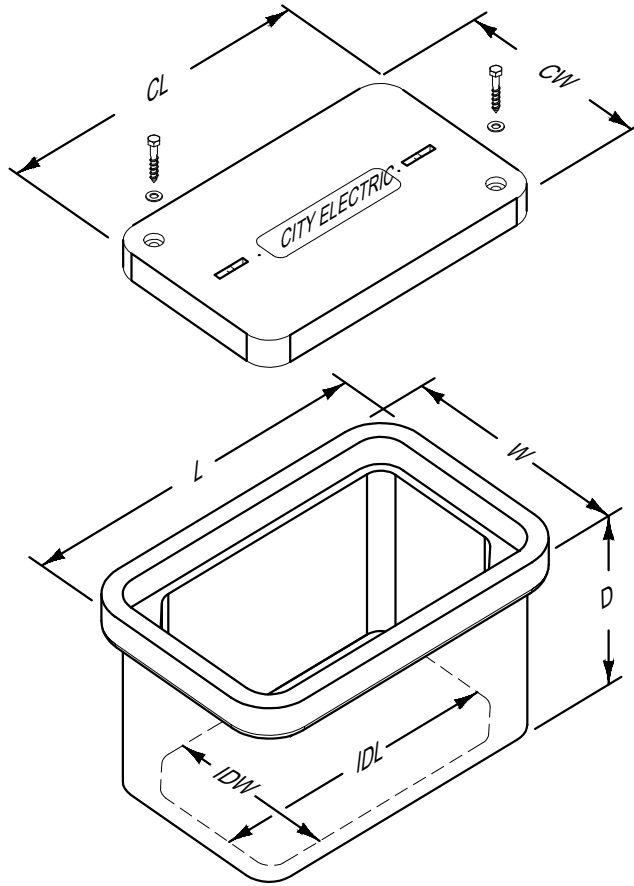


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TYPICAL CONDUIT BURIAL DETAIL

Std. Dwg. No.  
SS-08



PULL BOX / SPLICE BOX - COMPOSITE MINIMUM DIMENSIONS		
TYPE 1	TYPE 2	TYPE 3
L = 20"	L = 25"	L = 32"
W = 13"	W = 15"	W = 19"
D = 12"	D = 12"	D = 12"
IDL = 17"	IDL = 21"	IDL = 28"
IDW = 10"	IDW = 11"	IDW = 15"
CL = 18"	CL = 23"	CL = 30"
CW = 11"	CW = 13"	CW = 17"

**DETAIL NOTES**

BOX COVERS MUST BE POLYMER CONCRETE WITH FIBERGLASS REINFORCEMENT, TIER 22 INCIDENTAL TRAFFIC RATED AND BOLTED COVER.

- BOX COVERS SHALL BE LABELED AS FOLLOWS:
  - PULL BOXES CONTAINING STREETLIGHT ELECTRIC SERVICE SHALL BE LABELED "STREETLIGHT"
  - PULL BOXES CONTAINING CITY FIBER SHALL BE LABELED "CITY FIBER"
  - PULL BOXES CONTAINING SMALL CELL CARRIER FIBER SHALL BE LABELED WITH THE NAME OF THE PROVIDER.
 LABELING MUST BE CAST INTO THE COVER AND NOT A SEPARATE INDEPENDENT TAG.
- REFER TO N.E.C. ARTICLE 314 "PULL AND JUNCTION BOXES AND CONDUIT BODIES MINIMUM SIZE" FOR BOX SIZE REQUIREMENTS BASED ON CONDUIT AND WIRE SIZES.
- THE WIRE TERMINATIONS IN THIS BOX SHALL BE MADE USING SUBMERSIBLE INSULATED PEDESTAL LUG CONNECTIONS. PROVIDE ONE MULTI-LUG CONNECTOR FOR EACH PHASE, NEUTRAL AND GROUND CONDUCTOR TO BE SPLICED IN THIS IN-GRADE SPLICE BOX.



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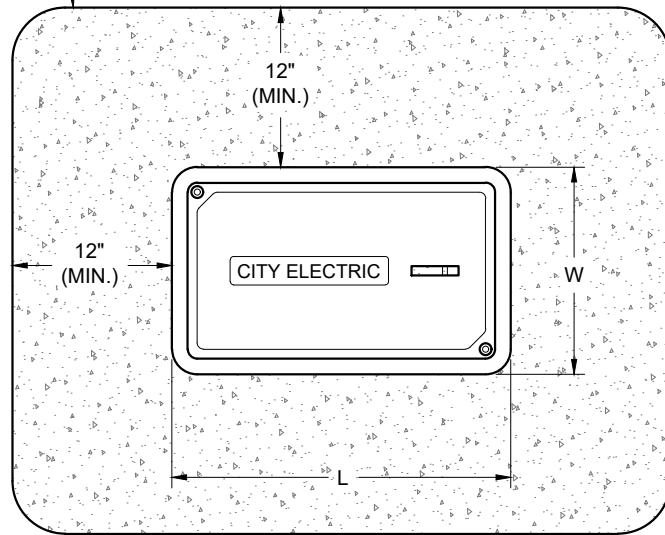
PULL BOX / SPLICE BOX TYPICAL DIMENSIONS

Date:  
April 2019

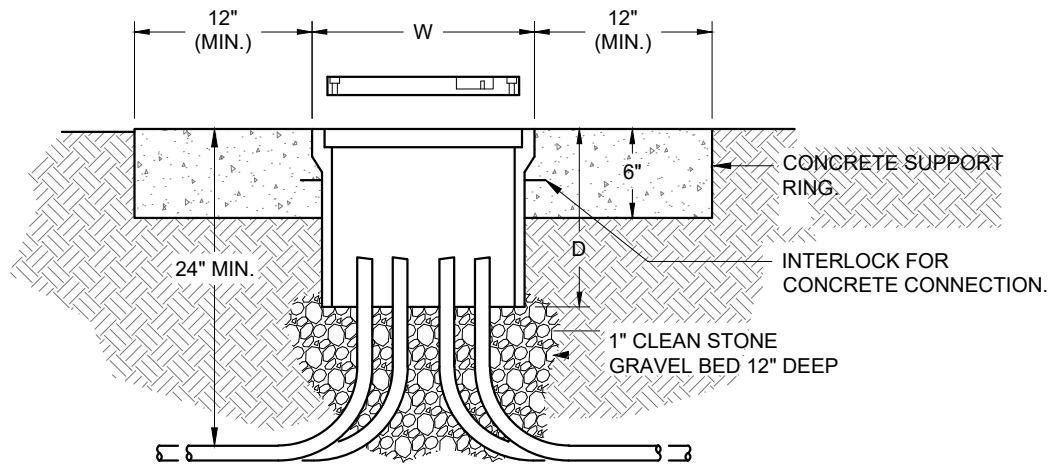
Std. Dwg. No.  
SS-09



CONCRETE (CLASS B) SUPPORT RING (NOT REQUIRED WHEN EMBEDDED IN CONCRETE SIDEWALK OR OTHER SUITABLE CONCRETE PAD)



PLAN VIEW



SECTION

TYPICAL PULL BOX / SPLICE BOX

DETAIL NOTES

1. ALL PULL OR SPLICE BOXES SHALL BE INCIDENTAL TRAFFIC RATED TO TIER 22 MINIMUM.
2. REFER TO SS-11 FOR PULL BOX SIZE REQUIREMENTS.
3. REFER TO SS-13 FOR STREETLIGHT GROUNDING DETAILS.



City of Westminster  
 Department of Public Works  
 TYPICAL IN-GRADE PULL BOX / SPLICE BOX DETAIL

Date:  
 April 2019  
 Std. Dwg. No.  
 SS-10

GENERAL NOTES:

1. CITY FIBER AND STREETLIGHT ELECTRICAL SPLICE BOXES MAY NOT BE REQUIRED FOR TYPE 1, TYPE 2, OR TYPE 4 SMALL CELL INSTALLATIONS.

TOP OF FOUNDATION SHALL BE 2" ABOVE ADJACENT SOFTSCAPE WITH CHAMFER TOP EDGE.

TIER 22 FLUSH-IN-GRADE POLYMER CONCRETE PULL BOX WITH INCIDENTAL TRAFFIC RATED COVER.

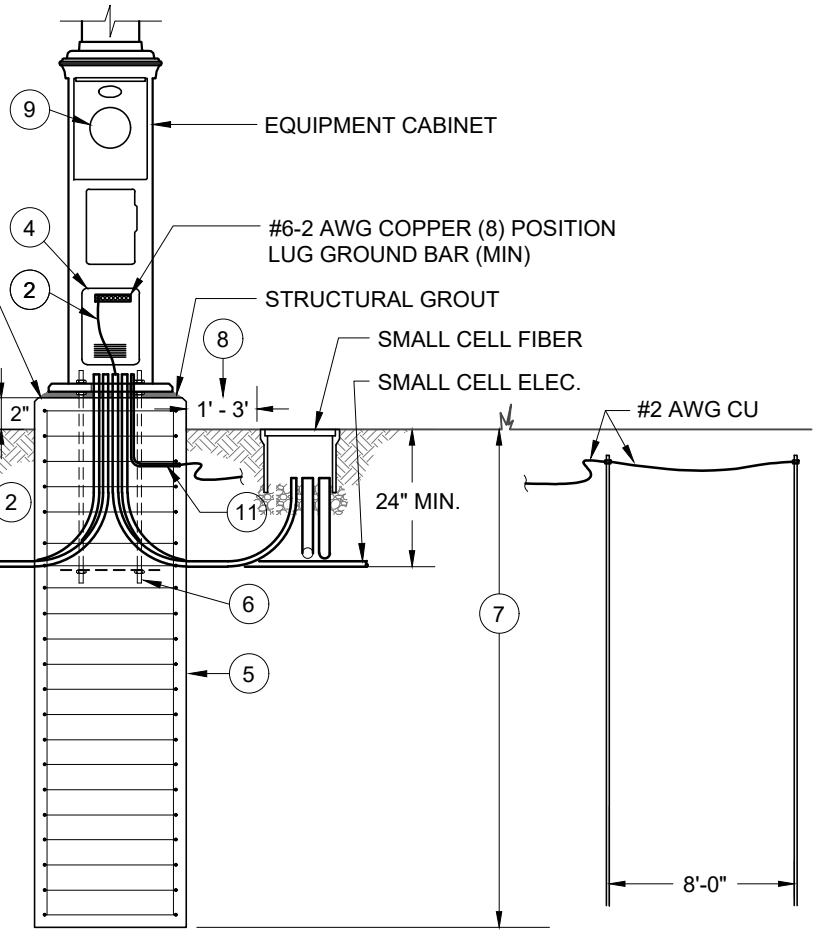
FINAL GRADE

CITY FIBER  
STREETLIGHT ELEC.

2" PVC (MINIMUM)  
CONDUITS IN AND OUT.

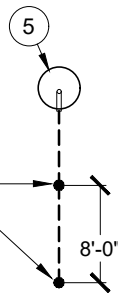
2.5" PVC (MINIMUM), CONNECT TO  
CIRCUIT AS DESIGNATED ON PLANS.

5/8" DIA. X 10'-0" LG. COPPER CLAD  
DRIVEN GROUND ROD IN SPLICE BOX  
6" (MIN.) AWAY FROM CONCRETE BASE  
(1' MIN. - 3' MAX. FOR XCEL).  
EXOTHERMIC WELD OR  
UNDERGROUND RATED LUG CONNECT  
CONDUCTOR TO GROUND ROD.

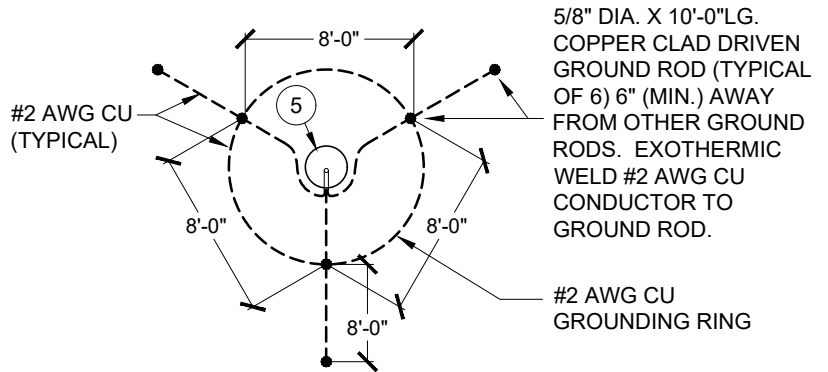


**ELEVATION SECTION VIEW**

5/8" DIA. X 10'-0" LG.  
COPPER CLAD DRIVEN  
GROUND ROD (TYPICAL  
OF 2) 6" (MIN.) AWAY  
FROM OTHER GROUND  
RODS. EXOTHERMIC  
WELD #2 AWG CU  
CONDUCTOR TO  
GROUND ROD.



**11 GROUNDING OPTION 1  
LINEAR GROUNDING  
PLAN VIEW**



**10 GROUNDING OPTION 2  
RADIAL GROUNDING WITH INNER RING  
PLAN VIEW**

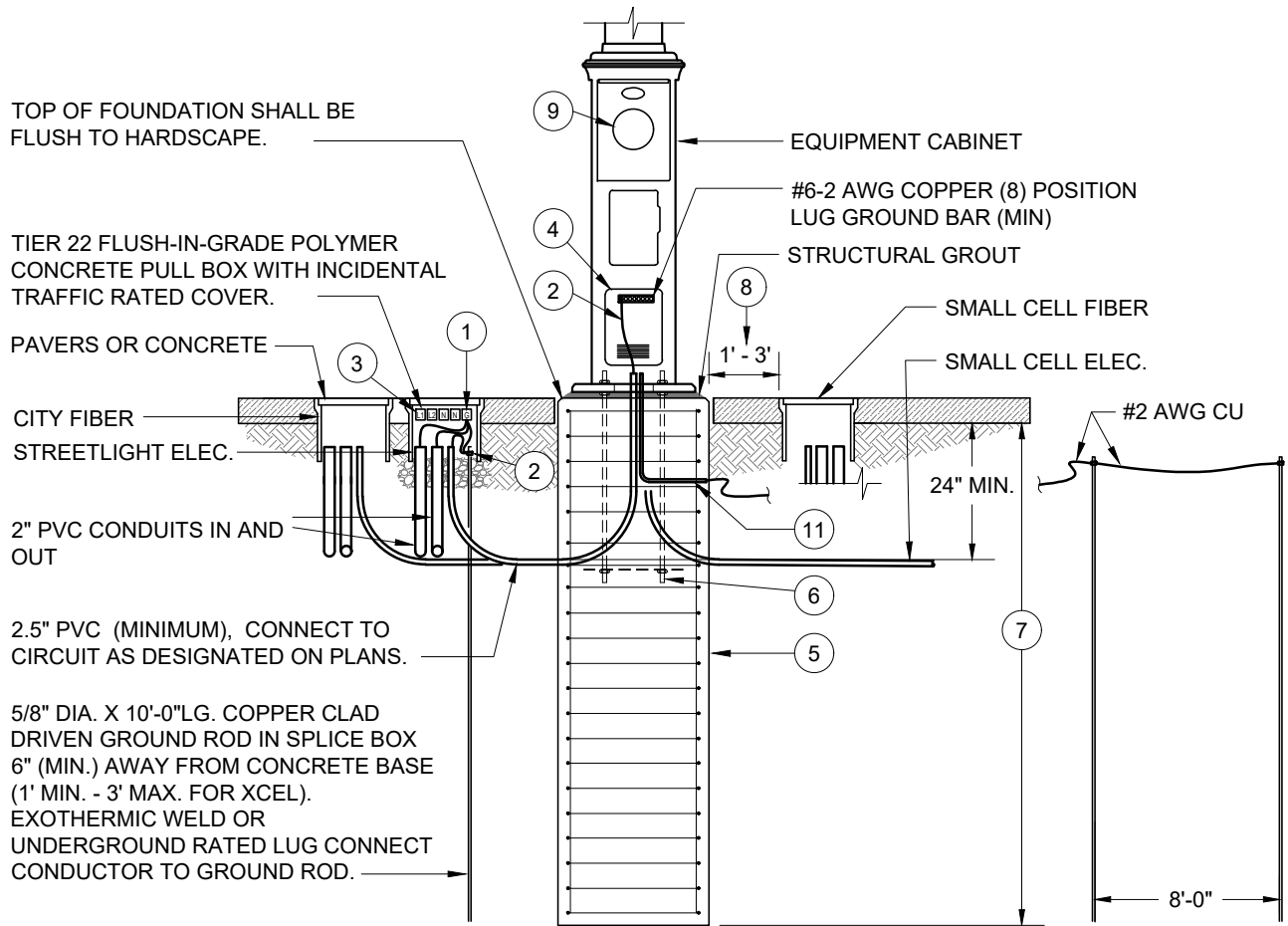


City of Westminster  
Department of Public Works  
TYPICAL SMALL CELL ELECTRICAL DETAIL  
IN SOFTSCAPE

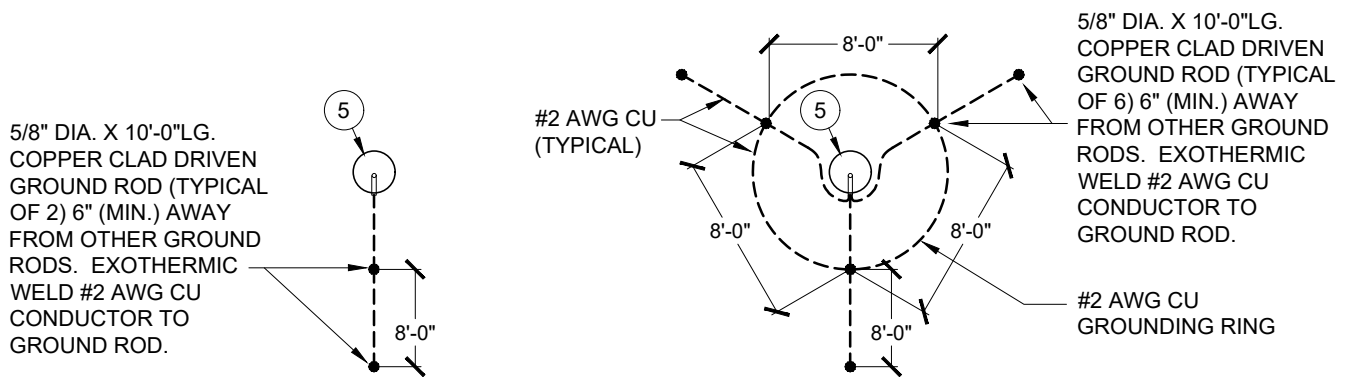
Date:  
April 2019  
Std. Dwg. No.  
SS-11

**GENERAL NOTES:**

1. CITY FIBER AND STREETLIGHT ELECTRICAL SPLICE BOXES MAY NOT BE REQUIRED FOR TYPE 1, TYPE 2, OR TYPE 4 SMALL CELL INSTALLATIONS.



**ELEVATION SECTION VIEW**



**11 GROUNDING OPTION 1  
LINEAR GROUNDING  
PLAN VIEW**

**10 GROUNDING OPTION 2  
RADIAL GROUNDING WITH INNER RING  
PLAN VIEW**



City of Westminster  
Department of Public Works

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TYPICAL SMALL CELL ELECTRICAL DETAIL  
IN HARDSCAPE


Date:  
April 2019

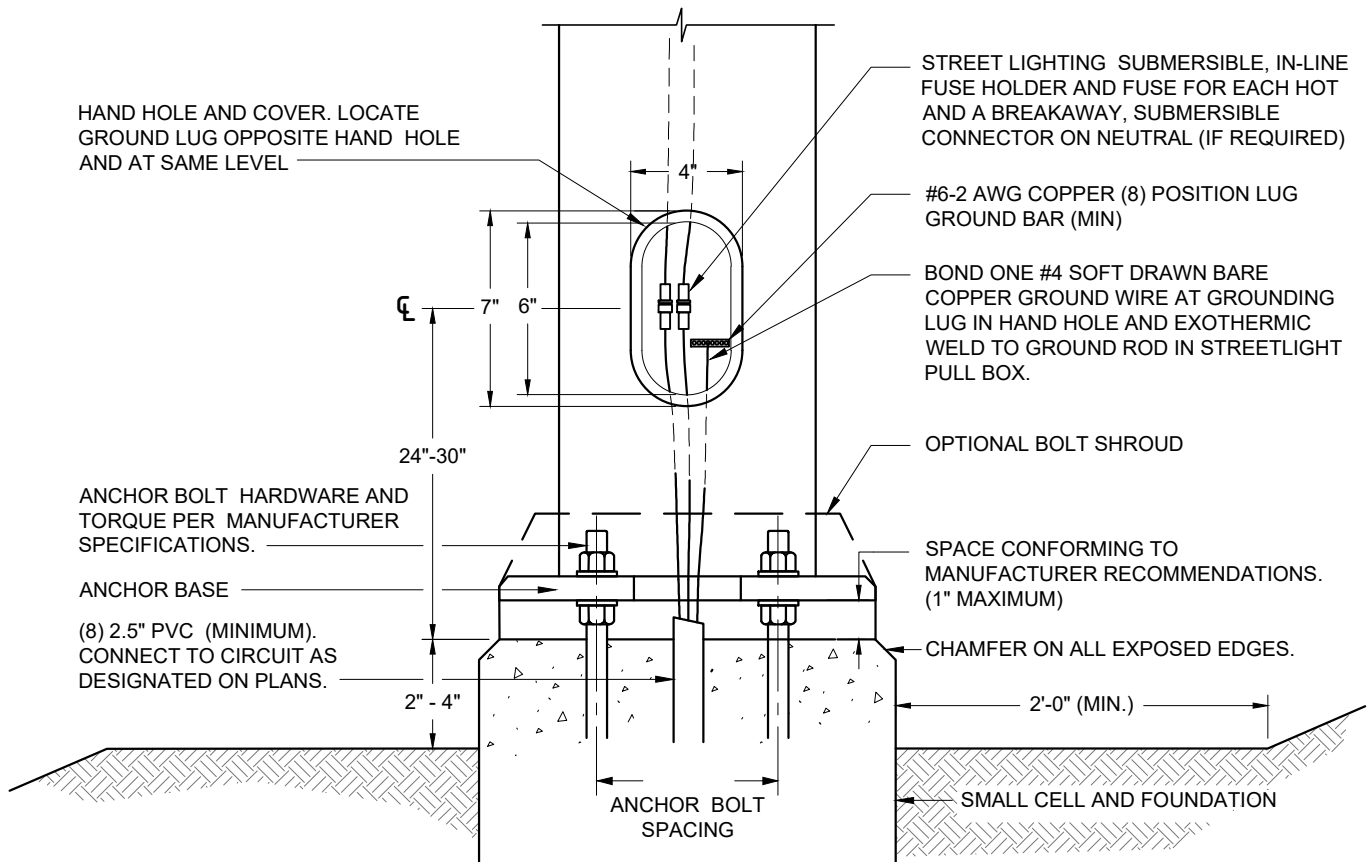
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Std. Dwg. No.  
SS-12

### FOUNDATION DETAIL NOTES

- ① BOND RACEWAY GROUND TO GROUND ROD IN ELECTRICAL PULL BOXES / SPLICE BOXES.
- ② BOND (1#4 SOFT DRAWN BARE CU) TO GROUND ROD IN ELECTRICAL PULL BOXES / SPLICE BOXES AND GROUNDING LUG IN EQUIPMENT CABINET HAND HOLE. XCEL REQUIRES 1#4 CU.
- ③ PROVIDE 3-TERMINAL SUBMERSIBLE UNDERGROUND RATED LUG CONNECTORS TO FIT #14AWG - #4AWG COPPER WIRE, BY BURNDY OR ILSO NIMBUS OR APPROVED EQUAL. MAXIMUM OF (5) REQUIRED OR (1) FOR EACH CONDUCTOR IN HOME RUN. XCEL REQUIRES 4-LUG TERMINAL FOR HOT CONDUCTORS AND 6-LUG TERMINAL FOR NEUTRAL/GROUND CONDUCTORS, 3-CONNECTIONS MAX. XCEL ALSO REQUIRES #12 AWG, 350 KCMIL CU.AL.
- ④ AT EACH EQUIPMENT CABINET HAND HOLE, PROVIDE A SUBMERSIBLE, WATERPROOF, IN-LINE FUSE HOLDER BY EATON OR APPROVED EQUAL WITH FNQ-R 15A FUSE FOR EACH HOT AND A SUBMERSIBLE, WATERPROOF CONNECTOR ON NEUTRAL (IF REQUIRED).
- ⑤ COMBINATION SMALL CELL AND FREE STANDING SMALL CELL FOUNDATION EMBEDMENT DEPTH, DIMENSIONS AND REINFORCEMENT SHALL BE AS DESIGNED BY A PROFESSIONAL STRUCTURAL ENGINEER REGISTERED IN THE STATE OF COLORADO.
- ⑥ ANCHOR BOLT CIRCLE SHALL BE 24" AND CENTERED ON FOUNDATION WITH AN ANCHOR BOLT TEMPLATE.
- ⑦ DEPTH OF FOUNDATION PER SS-21 THROUGH SS-24 OR AS DESIGNED BY A STRUCTURAL ENGINEER LICENSED IN THE STATE OF COLORADO.
- ⑧ THE CLOSEST EDGE OF PULL BOX SHALL BE 1' TO 3' FROM FOUNDATION EXCEPT WHEN FIELD CONDITIONS DICTATE OTHERWISE.
- ⑨ METER SHALL BE PROPERLY GROUNDED PER N.E.S.C. CURRENT ADDITION.
- ⑩ RADIAL GROUNDING OPTION: BOND (1 #2 SOFT DRAWN BARE CU) TO GROUND ROD RING WITH (6) 5/8" x 10'-0" GROUND RODS IN RADIAL DESIGN WITH LOOP RING ON INSIDE (3) RODS. EXOTHERMIC WELD CONDUCTOR TO EACH ROD.
- ⑪ LINEAR GROUNDING OPTION: BOND (1#2 SOFT DRAWN BARE CU) TO (2) 5/8" x 10'-0 GROUND RODS IN LINEAR ARRANGEMENT . EXOTHERMIC WELD CONDUCTOR TO EACH ROD.
- ⑫ PROVIDE 3/4" GRC SLEEVE IN FOUNDATION FOR GROUNDING CONDUCTORS.

	City of Westminster Department of Public Works	Date: April 2019
	TYPICAL SMALL CELL ELECTRICAL DETAIL NOTES	Std. Dwg. No. SS-13



**TYPICAL NON-BREAKAWAY BASE DETAIL**  
FOR USE ONLY OUTSIDE CLEAR ZONE OR IN PROTECTED INSTALLATIONS.

**NOTES**

1. SMALL CELL STANDARD FOUNDATIONS SHALL BE PRECAST CONCRETE.
2. ALL CONDUCTORS SHALL BE SIZED IN CONFORMANCE WITH N.E.C. REQUIREMENTS 3/C COPPER #12 AWG CABLE MINIMUM.
3. UTILITY PROVIDER IS GOVERNED BY THE N.E.S.C. INSTEAD OF N.E.C.
4. ALL EQUIPMENT SHALL BE LOCATED INTERNAL TO THE EQUIPMENT CABINET OR RECESSED IN THE EQUIPMENT CABINET TO MEET UTILITY REQUIREMENTS.
5. EQUIPMENT CABINET SHALL BE SIZED TO HANDLE THE EQUIPMENT REQUIRED BY THE OWNER.
6. EQUIPMENT SHALL BE INSTALLED IN SEPARATED COMPARTMENTS WITH LOCKABLE ACCESS COVER PER OWNER REQUIREMENTS.
7. ANCHOR BOLT CIRCLE SHALL BE 24" (MAX.) AND CENTERED ON FOUNDATION. USE ANCHOR BOLT TEMPLATE.



City of Westminster  
Department of Public Works

Date:  
April 2019

TYPICAL NON-BREAKAWAY POLE BASE  
STANDARD DETAIL

Std. Dwg. No.  
SS-14

# Appendix

## C



REFER TO APPENDIX C FOR SMALL CELL INFRASTRUCTURE SPECIFICATIONS.

## C SPECIFICATIONS

The following sections describe in detail the foundation and electrical specifications. All work completed in the public right-of-way (ROW) must be in accordance with the City of Westminster (City) STANDARDS AND SPECIFICATIONS.

### C.1 SMALL CELL POLE

#### Description

This work consists of furnishing and installing foundations, small cell poles, conduit, junction boxes, cable, wiring, junction boxes, and incidental materials for small cell installation in accordance with these specifications and in conformance with the details, lines, grades, and locations shown on the plans.

#### Materials

Small cell materials shall conform to small cell and electrical materials.

- a) *Foundations.* Concrete bases and equipment pads shall be pre-cast or cast-in-place concrete per the STANDARDS AND SPECIFICATIONS. A complete foundation includes the concrete, reinforcing steel, anchor bolts, leveling nuts, conduit stubs, ground rod and wire, excavation and backfill, restoration, accessories as required to provide a complete unit. Banner arm (if required) wind loading shall be incorporated into standard structural design.
- b) *Small Cell Standard.* A complete small cell standard includes the metal upper pole, mounting bracket, mast arm(s) if required, antenna, equipment cabinet, grounding system, and all hardware. The upper pole shall have six (6) handholes at the top to provide weatherproof, gasketed access points for conduits to exit the standard. An optional handhole shall be provided at the bottom of the upper pole if fiber and electrical service cannot be accessed

from the equipment cabinet. For metal combination small cell poles the complete standards also includes the mast arm(s) if required, and luminaire.

- c) *Conduit.* Conduit includes conduit, trenching, backfill, jacking, augering, fittings, drainage tees, sealing, restoration, and accessories as required to provide a complete installation.
- d) *Electrical Warning Tape.* Detectable electrical warning tape shall consist of pre-manufactured non-adhesive polyethylene material that is unaffected by acids, alkalines, and other soil properties. The color of the tape shall be red, and it shall be, at a minimum, 3.5 mils thick and 6 inches wide. Its tensile strength shall be 2,500 psi lengthwise.

The electrical tape shall include the following identification printed in black letters continuously along the length of the tape: "CAUTION BURIED ELECTRIC LINE BELOW".

The identification note and color of tape shall conform to the requirements of the "American Public Works Association (APWA) Uniform Color Codes (Red) – Electrical Power Lines, Cables, Conduit and Lighting Cables."

- e) *Conductors.* Conductor includes ground wiring, service entrance wiring, control wiring, luminaire wiring, main circuit wiring, pulling, splicing, connections, testing, and all other wiring necessary for a complete installation.
- f) *Pull boxes.* Pull box includes pull box, cover with bolts, excavation, gravel base, backfill, sealing, restoration, and accessories as required to provide a complete installation.
- g) *Materials List.* At the preconstruction conference, the Contractor shall submit to the City three copies of a list of all materials and equipment to be incorporated into the work. The Contractor shall include the following items on the list:
  - a. Small cell standards
  - b. Pull box
  - c. Fuse holders
  - d. Conductors
  - e. Conduit
  - f. Wireless lighting control and monitoring system
  - g. Small cell foundations
  - h. Equipment pads
  - i. All other items required for a complete installation

The City will return lists that are incomplete or that include unacceptable materials to the Contractor for correction and re-submission.

The Contractor shall not order materials or equipment until the City and the party or agency responsible for maintenance have reviewed and approved the materials and equipment list. The City's approval of the list shall not relieve the Contractor responsibility for the proper functioning of the completed installation.





- h) *Technical Support.* During the warranty period, technical support shall be available from the manufacturer via telephone within 24 hours of the time the call is made from the Contractor, and this support shall be made available from factory certified personnel or factory certified installers at no additional charge to the City.

#### General

All work shall conform to these specifications and the National Electrical Code (NEC) when the small cell pole is owned by the City or the Applicant, or the National Electrical Safety Code (NESC) when the small cell pole is owned by Xcel Energy.

The Contractor and/or Applicant shall keep fully informed of and comply with all Federal, State, and local laws, ordinances, and regulations, and all orders and decrees of bodies or tribunals having any jurisdiction or authority, which may affect those engaged or employed on the work, or affect the conduct of the work. The Contractor and/or Applicant shall protect and indemnify the City and its representatives against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order or decree, whether by the Contractor and/or Applicant, the subcontractors, suppliers of materials or services, or their employees.

Each system shall be installed as shown on the plans or as designated. The Contractor and/or Applicant shall furnish and install all incidentals necessary to provide a complete working unit or system.

#### Concrete Foundation Pads and Small Cell Standard Foundations.

Foundations shall be installed as shown on the plans, complete with grounding. The Contractor and/or Applicant shall test and report soil conditions to the City as necessary to ensure proper installation of foundations. Foundations shall be installed at the final grade.

All anchor bolts shall be positioned by means of steel templates. The center of the template shall coincide with the center of the foundation. Anchor bolt size and 19.5-inch bolt circle shall accommodate a 16-inch equipment cabinet per manufacturer's requirements. Anchor bolt size and 24-inch bolt circle shall accommodate a 20-inch equipment cabinet per manufacturer's requirements.

All small cell standard foundations shall be as detailed.

Conduits shall be properly positioned and anchored before the concrete is placed.

Coordinate the base setback and orientation with the City.

All foundations shall have ground rods conforming to the NEC or NESC. All foundations on structures shall be grounded to the structural steel by a method that is in accordance with the NEC or NESC and which is approved by the City.

#### Small Cell Standards

Poles, equipment cabinets, and bolts shall be galvanized stainless steel. Galvanizing will be performed in accordance with ASTM 123 and meet the following galvanization and paint requirements.

1. Galvanizing will be SSPC-SP1 Solvent wiped where needed and the Galvanizing will receive a sweep blast to a uniform dull appearance. Any areas of fracture will be repaired. Any excess

zinc build-up should be blended to no higher than the height of a dime with no thick edges or areas that may cause paint entrapment potentially leading to a premature coating failure.

The first epoxy coat typically should be applied within 120-180 minutes of abrasive blasting. Items shall be cleaned free of blast debris before coating. Compressed air should be used to clean items; items should be free of oil, residue, and any other contaminants/debris.

- Epoxy Primer Gray- B107989EA80K-A
- Impact Resistance Direct 100 IN/LBS @ 2.0-3.0 Mils (ASTM D2794)
- Impact Resistance Indirect- 100 IN/LBS @ 2.0-3.0 Mils (ASTM D2794)
- Cross- Hatch Adhesion 5B (ASTM D3359)
- Conical Mandrel 1/8" (ASTM D522)
- Pencil Hardness 2H (ASTM D3363)
- Specific Gravity 1.58 +/- 0.05 G/ML
- Theoretical Coverage 121.63 ft<sup>2</sup>/LB @ 1.0 Mil
- 60 Percent Gloss 75-85 (ASTM D523)

The Epoxy prime coat shall be applied on poles for an DFT Average of 5.0 Mils for the bottom eight feet, 3.0 Mils DFT above that. Arms have the epoxy prime applied for a 3.0 mil DFT. DFT readings shall be taken in accordance with SSPC-PA2.

Top coat to be applied for an DFT of 3.0 mils average unless noted otherwise.

Aerosol touch up should be used for coverage on areas that were masked by a hanging device (Hanging hook or chain, etc.) or used to repair small scratches or imperfections.

Poles shall be set plumb, and centered, on the small cell standard foundation using leveling nuts when installed.

Defects and scratches on painted, powder-coated, or anodized poles shall be primed and painted with a color-matched paint to match undamaged pole sections. Defects and scratches on galvanized poles shall be re-galvanized in the field.

Stainless steel mounting hardware shall be used to mount access doors, antenna, equipment cabinet, luminaires, mast arms, and other hardware to the poles. Apply an approved zinc-based anti-seize compound to all mounting hardware prior to assembly.

Banner arms (if required) shall be incorporated into small cell standard structural design.

#### Conduit

The electrical conduit system shall be installed in accordance the following:

In the conduit system, the locations of conduit, junction boxes, and expansion joints shown on the plans are approximate. Actual locations shall be established during construction. The conduit system shall be located to avoid interference with known present or known construction installations. All underground conduit runs and conduit risers on poles shall be installed as needed even though they may not be shown on the plans.



All conduit shall be installed within the public Right of Way and shall be at least two-inch (2" minimum) inside diameter unless otherwise designated on the plans. The Contractor and/or Applicant may use larger conduit than specified. If larger conduit is used, it shall be for the entire run from outlet to outlet. Reducer couplings shall not be used. Larger conduits shall be sized to accommodate the constraints established by the hole in the pole anchor base plate.

Conduit terminating in standards or pedestals shall extend approximately two inches past the foundations and shall slope toward the junction box opening. Conduit entering pull boxes shall terminate two inches inside the box wall and two to five inches above the bottom, and shall slope toward the top of the box to facilitate pulling of conductors. Conduit entering through the bottom of a pull box shall be located near the end walls to leave the major portion of the box clear. At all outlets, conduits shall enter from the direction of the run.

The ends of all conduits, whether shop or field cut, shall be reamed to remove burrs and rough edges. Cuts shall be made square and true so that the ends will butt or come together for their full circumference.

Non-metallic conduit shall be cut with a hacksaw or other approved tool. Non-metallic conduit connections shall be the solvent-weld type.

Conduit connections at junction boxes shall be tightly secured and waterproofed. All conduit ends shall be sealed with duct seal after installation of wiring. The duct seal shall be rated for outdoor use.

When specified, conduit shall be installed under existing pavement by boring operations. Where plans show that existing pavement is to be removed, jacking the conduit is not required. Jacking or drilling pits shall maintain a minimum of two feet clear of the edge of pavement. Water shall not be used as an aid in the jacking or drilling operations.

Trenching shall be in conformance with City standards. Backfill shall be per the City standards.

Detectable red electrical warning tape shall be installed between six inches and 12 inches below finished grade for all underground conduit runs.

Underground conduit shall be buried a minimum of two feet below finished grade. There shall be no sag between boxes. Conduit within the public ROW shall be buried 48 inches (maximum) below finished grade.

Junction Boxes shall be placed at conduit ends, at all locations where conduit bends in a single run would equal 360° or greater per NEC requirements, and at all other locations shown on the plans. The Contractor may install additional pull boxes to facilitate the work.

Excavate minimum 24 inches below base depth of each junction box, backfill and compact with pea rock to permit draining of water.

Placement and setback of the junction boxes shall be coordinated with the City.

Unless otherwise shown on the plans or directed by the City, junction boxes shall be installed so that the covers are level with the sidewalk grade. Covers shall be flush with the surrounding finished ground when no grade is established.

Where a conduit stub-out is called for on the plans, a sweeping elbow shall be installed in the direction indicated. All conduit stub outs shall be capped.

## Wiring

All wiring shall be copper, 600 Volt rated, Type: Conform to the applicable UL and ICEA Standards for the use intended. Copper conductors with 600-volt insulation unless otherwise specified or noted on the drawings. Stranded conductors for No. 8 and larger, except for the ground rod conductor which shall be #6 AWG solid, bare, copper.

Aluminum Conductors Prohibited: Aluminum conductors will not be permitted.

Insulation: Type THWN/THHN insulation minimum unless otherwise specified or noted on the drawings.

Size: No. 12 minimum unless otherwise specified or noted on the drawings. Not less than NEC (NESC if Utility owned) requirements for the system to be installed.

Color Coding: Phase, neutral and ground conductors color-coded in accordance with NEC (NESC if Utility owned). Connect all Conductors of the same color to the same phase conductor as follows:

208Y/120V-3PH-4W color coding shall be:

- 1) Phase = Black
- 2) Phase = Red
- 3) Phase = Blue
- 4) Neutral = White
- 5) Ground = Green

120/240V-1PH-3W color coding shall be:

- 1) Line 1 = Black
- 2) Line 2 = Red
- 3) Neutral = White
- 4) Ground = Green

Unless otherwise authorized, the multiple system of electrical distribution shall be used. Conductors of the size and material specified shall be installed for small cell equipment wiring, City IOT wiring, main circuit wiring, ground wiring, service entrance wiring, control wiring, luminaire wiring, and all other wiring necessary for a complete installation.

Conductors shall be sized to prevent a voltage drop of more than three percent per feeder run. All conductors shall be installed in conduit.

All power and lighting circuits shall include an insulated green grounding conductor.

A complete grounding system shall be installed for the entire lighting installation. Grounding shall consist of ground cables, conduits, grounding rods, wire or strap, and ground fittings, as required by the NEC (or NESC if Utility owned).

Type THWN conductors shall be used for all underground conduit runs. Leave sufficient lengths of branch conductors to allow conductor splices to be extracted from pole base for maintenance. Type XHHW shall be used for the service entrance conductors.

Extend three conductor SOW cable feeder leads to the luminaires from the cables in the pole base.

Install in-the-line fuses on each feeder lead. Leave sufficient lengths of feeder conductors to allow fuses and conductors to be extracted from pole base for maintenance.



Provide a No. 6 AWG solid, bare, copper wire connection to ground rod with ample length to allow connection to small cell standard, and system ground conductor.

Attach grounding conductor to the energy suppliers neutral at the service point. Terminate grounding conductor with less than 25 ohms ground reference at the service point. If ground resistance is greater than 25 ohms, add additional ground rod(s) or other ground reference bond to bring the resistance to under 25 ohms resistance to earth. Provide ground rods elsewhere as shown on the drawings.

Butt splices within the bases are not acceptable.

At each pole, provisions shall be made for convenient sectionalizing of the circuits. This shall be done by providing ample length (18 to 24 inches) of branch conductor ends and performing splices using submersible type (Burndy Uni-tap connectors or an approved equal). Wire nuts are not an acceptable method for splicing. Splicing shall only be performed within the pole bases and splice boxes where applicable.

Separation of service shall be provided within the pole by conduit or dividers. Electrical wiring and fiber shall be separated by Owner within.

#### Testing

Prior to final acceptance, the Contractor and/or Applicant shall demonstrate to City's satisfaction that all electrical and lighting, when applicable, equipment installations are in proper working condition. Temporary power and all cable connections required for testing shall be provided by the Contractor and/or Applicant.

The Contractor and/or Applicant shall perform grounding tests to show ground resistance of 25 ohms or less.

#### As-built Drawings and O&M Manual

Contractor shall supply accurate as-built drawings of the project to the City. Drawings shall indicate location and setback of conduit, lighting control center, and utility service point, and pole locations along the roadway measured from a reliable location.

The Contractor shall collect, gather and assemble into one book the installation details, instructions, schematics of actual equipment and operations directions supplied by the manufacturer with all equipment. Final acceptance of the work will be withheld until such data has been presented complete to the City. The manual shall be available for instruction of operations and maintenance of the equipment and systems.

END OF SECTION

## C.2 SMALL CELL MATERIALS

#### General

Materials shall be of a standard line from a name brand manufacturer or as specified in this document. Electrical material shall be listed by the Underwriters' Laboratories, Inc. (UL), and shall conform to the National Electrical Code (NEC) when the small cell facility is owned by the City or Applicant, or the National Electrical Safety Code (NESC) when the streetlights are owned by the electric utility.

Material shall be the same as, or compatible with, that used and accepted by the agency responsible for maintenance.

The City may inspect all material and all electrical materials and all other materials and accept or reject them at the project site. Samples may be taken, or manufacturer's certifications may be accepted in lieu of samples.

#### Concrete Bases and Concrete Equipment Pads

Concrete shall be Class B.

Anchor bolts shall be designed by the Contractor's and/or Applicant's Engineer or as shown on the working drawings. The threaded ends of the anchor bolts, the nuts, and the washers shall be galvanized in accordance with ASTM A153.

Reinforcing steel shall conform to Section C.5.

#### Small Cell Standards

- a) *General.* All structural components of small cell standard, base, equipment cabinet, couplers, anchor bolts, luminaires, cantenna, and other attachments to be used shall be designed for a minimum of 115 MPH wind velocity, in accordance with AASHTO's *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*, TIA-222 rev G and ASC 710 with IBC 2012 (or latest standard). Foundations shall meet ACI 318-11 and ACI 318-14.
- b) *Metal Small Cell Standards.* Metal small cell standards shall be fabricated of steel unless otherwise approved by the City. Whenever metal small cell standard is specified, the Contractor and/or Applicant shall furnish galvanized steel. Material type and shape of small cell standards shall be the same throughout the design district, unless otherwise approved by the City.

All standards shall have weatherproof cable-entrance grommets located in conformity with the type of mounting used. Metal surfaces shall be free of imperfections marring the appearance and of burrs or sharp edges that might damage the cable.

All metal poles shall be straight and shall be supplied with pole caps when applicable.

Steel mast arms shall be made of Schedule 40 standard steel pipe conforming to ASTM A 53.

All steel poles, base flanges, and other steel equipment shall be hot-dip galvanized in accordance with ASTM A 123. Units on which the spelter coating has been damaged shall be repaired as provided in AASHTO M 36, or other approved method.

Base flanges for steel poles shall have continuous welds both inside and outside, unless otherwise permitted. Base flanges inserted into the pole and bonded shall meet the requirements for materials and strength stated herein.

Each metal standard shall be wired with a breakaway fused connector of proper capacity rating. The fused connector shall be located in the equipment cabinet. If the standard has no equipment cabinet, the fused connector shall be located in the pole at the hand hole.



All equipment cabinets or bases shall have vandal resistant, removable access doors.

Hardware used with steel standards shall be either cadmium plated steel, hot dip galvanized steel, or stainless steel.

#### Conduit

Unless otherwise specified, conduit shall be rigid non-metallic electrical conduit currently recommended and approved by Underwriters' Laboratories, Inc. for the proposed use conforming to ASTM-F 441 schedule 40, (Schedule 80 or bored HDPE where installed under roadways). Fittings shall be the type used outside the conduit and PVC cement welded. Ingrade submersible type fittings shall connect the conduit in a manner that makes the joints watertight.

All in-grade Pull Boxes shall be polymer concrete, bottomless and tier 22 rated bolted covers. 13 inches by 24 inches and 18 inches deep manufactured by Quazite; Cat. # PG1324BA18, unless otherwise noted on the plans. Covers shall be Cat. # PG1324HH00 with stainless steel bolts and the owners and contained equipment shall be molded into the top (i.e. "COW ELECTRIC").

#### Wiring

Conductors shall be standard copper with 600-volt insulation, type THWN or XHHW for underground installation in conduit, and for aboveground installation within poles and service cabinets. The size and type shall be as shown on the plans.

#### Fuses

Fuse connectors shall be installed in the phase wires of their respective circuits at the pull box located adjacent to the standards or in the pole base. Each luminaire in the 120-volt system shall be fused with one 6-amp fuses. The fuses shall be mounted in inline single-pole molded fuse connector/holders. The fuse holders shall be a Duraline-16998, or approved equal. Fuses shall be of the breakaway type. The Contractor shall provide sufficient excess conductor length to allow withdrawal of the connected fuse holder. The grounding wires shall not be fused. Fuses and fuse holders shall be "UL" listed and shall be installed in such a manner that the fuse stays with the load side when holder is separated. In addition, the Contractor shall form loops in the leads on each side of the fuse holders and so position the fuse holders so that they may be easily removed or inserted through the opening at top of pull box.

#### Secondary Service Pedestals

The service cabinet shall include all equipment necessary to connect to the energy provider's secondary conductors or transformer.

All-In-One commercial meter/power pedestal and non-metered/power pedestals shall meet or exceed the City standards.

END OF SECTION



### C.3 MOISTURE AND DENSITY CONTROL

#### Construction of Moisture and Density Control Areas

Maximum dry density of all soil types encountered or used will be determined in accordance with AASHTO T 99, AASHTO T 180, or a modification thereof.

The amount of water to be used in compacting A-2-6, A-2-7, A-4, and A-6 through A-7 soils shall not deviate from optimum on the dry side by more than two percentage points as determined by AASHTO T 99, T 180, or a modification thereof, as designated in the Contract. A-4 soils which are unstable at the above moisture content shall be compacted at a lower moisture content to the specified density. The amount of water used in compacting all other soils shall be as required to obtain the percent relative compaction required.

Table 0-1: Soil Compaction

Soil Classifications (AASHTO M 145)	AASHTO T 99 Minimum Relative Compaction (Percentage)	AASHTO T 180 Minimum Relative Compaction (Percentage)
<b>A-1</b>	<b>100</b>	<b>95</b>
<b>A-3</b>	<b>100</b>	<b>95</b>
<b>A-2-4</b>	<b>100</b>	<b>95</b>
<b>A-2-5</b>	<b>100</b>	<b>95</b>
<b>All Others</b>	<b>95</b>	<b>90</b>

Additional work involved in drying backfill material to the required moisture content shall be included in the contract price paid for electrical conduit with no additional compensation.

The percent of relative compaction specified shall be equal to or greater than minimum values as shown in the following table for the various classes of soil and type of compaction.

END OF SECTION



## C.4 STRUCTURAL CONCRETE

### Description

This work consists of furnishing and placing portland cement concrete in accordance with these specifications and in conformity with the lines, grades and dimensions as shown on the plans.

### Classification

The classes of concrete shown in Table 0-2 shall be used when specified in the Contract.

Table 0-2: Concrete Table

Concrete Class	Required Field Compression Strength (psi)	Cementitious Material Content: Minimum or Range (lbs/yrd <sup>3</sup> )	Air Content: % Range (Total)	Water/Cementitious Material Ratio: Maximum or Range
<b>B</b>	<b>4500 at 28 Days</b>	<b>N/A</b>	<b>5 – 8</b>	<b>0.45</b>
<b>D</b>	<b>4500 at 28 Days</b>	<b>615 to 660</b>	<b>5 – 8</b>	<b>0.45</b>
<b>H</b>	<b>4500 at 56 Days</b>	<b>580 to 640</b>	<b>5 – 8</b>	<b>0.38 to 0.42</b>
<b>P</b>	<b>4500 at 28 Days</b>	<b>660</b>	<b>4 – 8</b>	<b>0.44</b>

Class B concrete is an air entrained concrete for general use. Class D, H or P concrete may be substituted for Class B concrete. Additional requirements are: The coarse aggregate shall have a nominal maximum size of 1½ inches or smaller.

### Sulfate Resistance.

The Contractor shall provide protection against sulfate attack on concrete structures by providing concrete manufactured according to the requirements of Table 0-3. The sulfate exposure for all concrete shall be Class 2 unless otherwise specified on the plans. A higher level of requirements may be used for a lower level of exposure.

If the Contractor provides test reports that show another class of exposure exists at a structure location, then the City may accept a concrete mix for that location that meets the corresponding sulfate protection requirements.

Table 0-3: Concrete Sulfate Protection Requirements

Severity of Sulfate Exposure	Water-Soluble Sulfate (SO <sub>4</sub> ) in Dry Soil, Percent	Sulfate (SO <sub>4</sub> ) in Water, Ppm	Maximum Water to Cementitious Material Ratio	Cementitious Material Requirements
<b>Class 0</b>	<b>0.00 to 0.10</b>	<b>0 to 150</b>	<b>0.45</b>	<b>Class 0</b>
<b>Class 1</b>	<b>0.11 to 0.20</b>	<b>151 to 1500</b>	<b>0.45</b>	<b>Class 1</b>
<b>Class 2</b>	<b>0.21 to 2.00</b>	<b>1501 to 10,000</b>	<b>0.45</b>	<b>Class 2</b>
<b>Class 3</b>	<b>2.01 or greater</b>	<b>10,001 or greater</b>	<b>0.40</b>	<b>Class 3</b>

Cementitious material requirements are as follows:

- a) Class 0 requirements for sulfate resistance shall be one of the following:
  - a. ASTM C 150 Type I, II or V
  - b. ASTM C 595 Type IP, IP(MS) or IP(HS)

- c. ASTM C 1157 Type GU, MS or HS
- d. ASTM C 150 Type III cement if it is allowed, as in Class E concrete
- b) Class 1 requirements for sulfate resistance shall be one of the following:
  - a. ASTM C 150 Type II or V; Class C fly ash shall not be substituted for cement
  - b. ASTM C 595 Type IP(MS) or IP(HS); Class C fly ash shall not be substituted for cement.
  - c. ASTM C 1157 Type MS or HS; Class C fly ash shall not be substituted for cement.
  - d. When ASTM C 150 Type III cement is allowed, as in Class E concrete, it shall have no more than 8 percent C3 A. Class C fly ash shall not be substituted for cement
- c) Class 2 requirements for sulfate resistance shall be one of the following:
  - a. ASTM C 150 Type V with a minimum of a 20 percent substitution of Class F fly ash by weight
  - b. ASTM C 150 Type II or III with a minimum of a 20 percent substitution of Class F fly ash by weight. The Type II or III cement shall have no more than 0.040 percent expansion at 14 days when tested according ASTM C 452
  - c. ASTM C 1157 Type HS; Class C fly ash shall not be substituted for cement.
  - d. ASTM C 1157 Type MS plus Class F fly ash where the blend has less than 0.05 percent expansion at 6 months or 0.10 percent expansion at 12 months when tested according to ASTM C 1012
  - e. A blend of Portland cement meeting ASTM C 150 Type II or III with a minimum of 20 percent Class F fly ash by weight, where the blend has less than 0.05 percent expansion at 6 months or 0.10 percent expansion at 12 months when tested according to ASTM C 1012.
  - f. ASTM C 595 Type IP(HS); Class C fly ash shall not be substituted for cement.
- d) Class 3 requirements for sulfate resistance shall be one of the following:
  - a. A blend of Portland cement meeting ASTM C 150 Type II, III, or V with a minimum of a 20 percent substitution of Class F fly ash by weight, where the blend has less than 0.10 percent expansion at 18 months when tested according to ASTM C 1012.
  - b. ASTM C 1157 Type HS having less than 0.10 percent expansion at 18 months when tested according to ASTM C 1012. Class C fly ash shall not be substituted for cement
  - c. ASTM C 1157 Type MS or HS plus Class F fly ash where the blend has less than 0.10 percent expansion at 18 months when tested according to ASTM C 1012.
  - d. ASTM C 595 Type IP(HS) having less than 0.10 percent expansion at 18 months when tested according to ASTM C 1012. Class C fly ash shall not be substituted for cement.
  - e. When fly ash is used to enhance sulfate resistance, it shall be used in a proportion greater than or equal to the proportion tested in accordance to ASTM C1012, shall be the same source and it shall have a calcium oxide content no more than 2.0 percent greater than the fly ash tested according to ASTM 1012.

### Proportioning

The Contractor shall submit a Concrete Mix Design for each class of concrete being placed on the project. Concrete shall not be placed on the project before the Concrete Mix Design Report has been reviewed and approved by the City. The Concrete Mix Design will be reviewed and approved following the procedures of CP 62. The Concrete Mix Design will not be approved when the laboratory trial mix data are the results from tests performed more than two years in the past or aggregate data are the results from tests performed more than two years in the past. The concrete mix design shall show the weights and sources of all ingredients including cement, pozzolan,



aggregates, water, additives and the water to cementitious material ratio (w/cm). When determining the w/cm, the weight of cementitious material (cm) shall be the sum of the weights of the cement, fly ash and silica fume.

The laboratory trial mix data shall include results of the following:

- a) AASHTO T 119 (ASTM C 143) Slump of Hydraulic Cement Concrete.
- b) AASHTO T 121 (ASTM C 138) Weight per Cubic Foot, Yield, and Air Content (Gravimetric) of Concrete.
- c) AASHTO T 152 (ASTM C 231) Air Content of Freshly Mixed Concrete by the Pressure Method
- d) ASTM C 39 Compressive Strength of Cylindrical Concrete Specimens shall be performed with at least two specimens at 7 days and three specimens at 28 days. Three additional specimens tested at 56 days shall be required for Class H concrete.
- e) Class H concrete shall include a measurement of permeability by ASTM C 1202 Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
- f) Class H concrete shall include a measurement of cracking by AASHTO T334 Standard Practice for Estimating the Cracking Tendency of Concrete. The sample shall be cured at a temperature of 65 to 75 °F and relative humidity not exceeding 40 percent.
- g) Class P concrete shall include AASHTO T 97 (ASTM C 78) Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading) performed with at least two specimens at seven days and four specimens at 28 days. The Contractor shall provide maturity meters and all necessary wires and connectors.

The Contractor shall be responsible for the placement and maintenance of the maturity meters and wires. Placement shall be as directed by the City.

The maximum slump of the delivered concrete shall be the slump of the approved concrete mix design plus 1½ inch. The laboratory trial mix must produce an average compressive strength at least 115 percent of the required field compressive strength specified in Table A-5.

The laboratory trial mix shall have a relative yield of 0.99 to 1.02. If the produced concrete does not have a relative yield of 0.99 to 1.02 for two consecutive yield determinations, concrete production shall cease, and the Contractor shall present a plan to correct the relative yield to the City.

Aggregate data shall include the results of the following:

- a) AASHTO T 11 (ASTM C 117) Materials Finer Than 75 um (No. 200) Sieve in Mineral Aggregates by Washing.
- b) AASHTO T 19 (ASTM C 29) Unit Weight and Voids in Aggregate.
- c) AASHTO T 21 (ASTM C 40) Organic Impurities in Fine Aggregate for Concrete.
- d) AASHTO T 27 (ASTM C 136) Sieve Analysis of Fine and Coarse Aggregates.
- e) AASHTO T 84 (ASTM C 128) Specific Gravity and Absorption of Fine Aggregate.
- f) AASHTO T 85 (ASTM C 127) Specific Gravity and Absorption of Coarse Aggregate.
- g) AASHTO T 96 (ASTM C 131) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- h) AASHTO T 104 (ASTM C 88) Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
- i) CP 37 Plastic Fines in Graded Aggregates and Soils by use of the Sand Equivalent Test

- j) ASTM C 535 Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- k) ASTM C1260 Determining the Potential Alkali Reactivity of Aggregates (Accelerated Mortar-Bar Method). When an aggregate source is known to be reactive, ASTM C1567 results may be submitted in lieu of ASTM C1260 results.

Any aggregate tested by ASTM C1260 with an expansion of 0.10 percent or more, or that is known to be reactive, shall not be used unless mitigative measures are included in the mix design.

Test results from ASTM C1293 Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction may be substituted for ASTM C1260 test results. The ASTM C1293 test shall be run on an individual source of aggregate. The ASTM C1293 test shall not use fly ash or slag as part of the cementitious material content. Any aggregate source tested by ASTM C1293 with an expansion greater than or equal to 0.04 percent at one year shall not be used unless mitigative measures are included in the mix design.

Mitigative measures shall be tested using ASTM C1567 and exhibit an expansion less than 0.10 percent by one of the following methods:

- a) Combined Aggregates. The mix design sources of aggregates, cement and mitigative measures shall be tested. The proportions of aggregates, cement and mitigative measures shall be those used in the mix design.
- b) Individual Aggregates. Each source and size of individual aggregates shall be tested. The source of cement and mitigative measures shall be those used in the mix design. The highest level of mitigative measures for any individual aggregate shall be the minimum used in the mix design.

The Concrete Mix Design Report shall include Certified Test Reports showing that the cement, fly ash and silica fume meet the specification requirements and supporting this statement with actual test results. The certification for silica fume shall state the solids content if the silica fume admixture is furnished as slurry.

Approved fly ash may be substituted for ASTM C150 cement up to a maximum of 20 percent Class C or 30 percent Class F by weight of total cementitious material.

For all concrete mix designs with ASTM C595 or C1157 cements, the total pozzolan content shall not exceed 30 percent by weight of the cementitious material content.

When the Contractor's use of fly ash results in any delay, necessary changes in admixture quantities or source, or unsatisfactory work, the cost of such delays, changes, or corrective actions shall be borne by the Contractor.

The Contractor shall submit a new Concrete Mix Design Report meeting the above requirements when a change occurs in the source, type, or proportions of cement, fly ash, silica fume or aggregate. When a change occurs in the source of approved admixtures, the Contractor shall submit a letter stamped by the Concrete Mix Design Engineer approving the changes to the existing mix design. The change will be approved by the City prior to use.

The use of approved accelerating, retarding or hydration stabilizing admixtures to existing mix designs will be permitted at the discretion of the City when documentation includes the following:

- a) Manufacturer's recommended dosage of the admixture



- b) A letter stamped by the Concrete Mix Design Engineer approving the changes to the existing mix design.

Unless otherwise permitted by the City, the product of only one type of hydraulic cement from one source of any one brand shall be used in a concrete mix design.

Review and approval of the Concrete Mix Design by the City does not constitute acceptance of the concrete. Acceptance will be based solely on the test results of concrete placed on the project.

#### Batching

Measuring and batching of materials shall be done at a batching plant in accordance with AASHTO M 157.

The Contractor shall furnish a batch ticket (delivery ticket) with each load for all classes of concrete. Concrete delivered without a batch ticket containing complete information as specified shall be rejected. The Contractor shall collect and complete the batch ticket at the placement site and deliver all batch tickets to the City on a daily basis. The City shall have access to the batch tickets at any time during the placement. The following information shall be provided on each batch ticket:

- a) Supplier's name and date
- b) Truck number
- c) Project number and location
- d) Concrete class designation and item number
- e) Cubic yards batched
- f) Time batched
- g) Mix design number
- h) Type, brand, and amount of each admixture
- i) Type, brand, and amount of cement and fly ash
- j) Weights of fine and coarse aggregates
- k) Moisture of fine and coarse aggregate
- l) Gallons (Pounds) of batch water (including ice)
- m) Gallons of water added by truck operator plus quantity of concrete in the truck each time water is added
- n) Number of revolutions of drum at mixing speed (for truck mixed concrete)
- o) Discharge time
- p) Location of batch in placement
- q) Water to cementitious material ratio (required for deck concrete only)

The drum on each truck mixer shall be reversed prior to charging to eliminate any wash water remaining in the mixer.

- a) *Portland Cement and Fly Ash*. Either sacked or bulk cement may be used. No fraction of a sack of cement shall be used in a batch of concrete unless the cement is weighed.

All bulk cement shall be weighed on an approved weighing device. The bulk cement weighing hopper shall be sealed and vented to preclude dusting during operation. The discharge chute shall be so arranged that cement will not lodge in it or leak from it.

Separate storage and handling equipment shall be provided for the fly ash. The fly ash may be weighed in the cement hopper and discharged with the cement.

- b) *Water.* Unless water is to be weighed, the water-measuring equipment shall include an auxiliary tank from which the measuring tank shall be filled. The measuring tank shall be equipped with an outside tap and valve to provide for checking the calibration unless other means are provided for readily and accurately determining the amount of water in the tank. The volume of the auxiliary tank shall be at least equal to that of the measuring tank. In lieu of the volume method specified above, the Contractor will be permitted to use a water metering device that is accurate within the prescribed limits.
- c) *Aggregates.* Aggregates from different sources and of different gradings shall not be stockpiled together.

Aggregate shall be handled from stockpiles or other sources to the batching plant in such manner as to secure a uniform grading of the material. Aggregates that have become segregated, or mixed with earth or foreign material, shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Rail shipment requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage. In case the aggregates contain high or non-uniform moisture content, storage or stockpile period in excess of 12 hours may be required.

- d) *Bins and Scales.* The batching plant may include bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate. If cement is used in bulk, a bin, hopper, and scale for cement shall be included. A single weighing hopper with an accumulative scale will be permitted, provided a separate scale is used for weighing cement.

### Mixing

Concrete may be mixed in stationary mixers, in a central-mix plant, in truck mixers, or in self-contained mobile mixers. Mixing time shall be measured from the time all materials, except water, are in the drum.

Silica fume, when specified, shall be added to the mix during initial batching.

- a) *Mixing General.* The concrete shall be deposited in place within 90 minutes after batching when concrete is delivered in truck mixers or agitating trucks, and within 60 minutes when delivered in non-agitating trucks.
  - a. The 90 minute time limit for mixer or agitating trucks may be extended to 120 minutes if:
    - i. No water is added after 90 minutes.
    - ii. The concrete temperature prior to placement is less than 90 °F
  - b. The 90 minute time limit for mixer or agitating trucks may be extended to 180 minutes if:
    - i. No water is added after 90 minutes.
    - ii. The concrete temperature prior to placement is less than 90 °F.





- iii. The approved concrete mix contains a water reducing and retarding admixture which conforms to AASHTO M 194, Type D.
- b) *Stationary Mixing.* When mixed in a central mixing plant, the mixing time shall be between 50 and 90 seconds. Four seconds shall be added to the specified mixing time if timing starts the instant the skip reaches its maximum raised position. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers is included in mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein.

The volume of concrete mixed per batch may exceed the mixer's nominal capacity, as shown on the manufacturer's standard rating plate on the mixer, up to 10 per cent provided concrete test data for strength, segregation, and uniform consistency are satisfactory, and provided spillage of concrete does not occur.

The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform, and all water shall be in the drum by the end of the first 15 seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.

The timing device on stationary mixers shall be equipped with a bell or other suitable warning device adjusted to give a clearly audible signal each time the lock is released. In case of failure of the timing device, the Contractor will be permitted to operate while it is being repaired, provided the Contractor furnishes an approved timepiece equipped with minute and second hands. If the timing device is not placed in good working order within 24 hours, further use of the mixer will be prohibited until repairs are made.

- c) *Truck Mixing.* Truck mixed concrete shall conform with one of the following:
  - a. Concrete mixed entirely in a truck mixer equipped with a mechanical counter shall be partially mixed at the plant or in transit for not less than 20 revolutions of the drum at mixing speed. The revolutions of the drum at charging speed shall not be counted as mixing revolutions. The concrete shall be mixed between 50 and 100 revolutions of the mixer drum at mixing speed at the delivery site before discharge of the concrete.
  - b. Concrete partially mixed in a stationary central mixing plant with mixing brought to completion in a truck mixer (known as shrink mixing) shall be mixed for a minimum of 30 seconds in the stationary mixer. Mixing shall be completed in the truck mixer for at least 20 but not more than 100 revolutions of the mixer drum at mixing speed at the delivery site before discharge of the concrete.
  - c. Concrete mixed entirely in a stationary mixer and delivered to the job in a truck mixer shall be remixed for a minimum of 20 revolutions of the mixing drum at mixing speed at the job site prior to discharge.

When water is added at the delivery site to control the consistency of the concrete, the concrete shall be mixed for at least 20 revolutions of the mixer drum at mixing speed for each addition of water before discharge. These revolutions are in addition to the minimum revolutions required for mixing at the delivery site. Water from all sources shall be documented by the ready mix producer on the delivery slip for each load of concrete.

The Contractor shall provide a Concrete Truck Mixer Certification. This certification shall show the various pick-up and throw-over configurations and wear marks so that the wear on the blades can be checked. Blades shall be replaced when any part or section is worn 1 inch or more below the original height of the manufacturer's design. A copy of the manufacturer's design, showing the dimensions and arrangement of blades, shall be available to the City at all times.

The Contractor shall furnish a water-measuring device in good working condition, mounted on each transit mix truck, for measuring the water added to the mix after the truck has left the charging plant. Each measuring device shall be equipped with an easy-to-read gauge. Water shall be measured to the accuracy prescribed in AASHTO M 157.

- d) *Self-Contained Mobile Mixer.* Proportioning and mixing equipment shall be of the self-contained, mobile, continuous mixing type subject to the following:
- a. The mixer shall be self-propelled and be capable of carrying sufficient unmixed dry, bulk cement, fine aggregate, coarse aggregate, admixtures and water to produce on the site not less than 6 cubic yards of concrete. The mixer shall have one bin for each size aggregate.
  - b. The mixer shall be capable of positive measurement of cement being introduced into the mix. A recording meter visible at all times and equipped with a ticket printout shall indicate the quantity of total concrete mix.
  - c. The mixer shall provide positive control of the flow of water into the mixing chamber. Water flow shall be indicated by flow meter and be readily adjustable to provide for minor variations in the aggregate moisture.
  - d. The mixer shall be capable of being calibrated to automatically proportion and blend all components of indicated composition on a continuous or intermittent basis as required by the finishing operation, and shall discharge mixed material through a conventional chute directly in front of the finishing machine.
  - e. The Contractor shall perform calibration tests according to the equipment manufacturer's recommendations at the beginning of each project, and when there is a change in the mix design proportions or source of materials. The City may require a calibration test or yield check whenever a change in the characteristics of the mixture is observed. The tolerances in proportioning the various ingredients shall be according to subsection 6.8 of AASHTO M 241.

#### Air Content Adjustment

When a batch of concrete delivered to the project does not conform to the minimum specified air content, an air entraining admixture conforming to AASHTO M 154 may be added. After the



admixture is added, the concrete shall be re-mixed for a minimum of 20 revolutions of the mixer drum at mixing speed. The concrete shall then be re-tested by QC.

#### Acceptance and Pay Factors

These provisions apply to all concrete. The Contractor shall sample concrete items for both QC and QA in accordance with CP 61. The City will witness the sampling and take possession of the QA samples at a mutually agreed upon location.

- a) *Air Content.* The first three batches at the beginning of production shall be tested by QC and QA for air content. When air content is below the specified limit, it may be adjusted in accordance with Section 6.4 – Air Content Adjustment. Successive batches shall be tested by QC and witnessed by COW until three consecutive batches are within specified limits. After the first three batches, the City will follow the random minimum testing schedule. Air content shall not be adjusted after a QA test.
- b) *Slump.* Slump acceptance, but not rejection, may be visually determined by COW. During the placement of the concrete, when a batch exceeds the maximum slump specified, the following procedure shall be used to analyze the acceptability of the concrete.
  - a. A batch that exceeds the maximum slump specified by more than 2 inch will be rejected. If the slump is greater than 2 inches lower than the approved concrete mix design, the load may be adjusted by adding a water reducer or by adding water and retested.
- c) *Strength (When Specified).* The concrete will be considered acceptable when the running average of three consecutive strength tests is equal to or greater than the specified strength and no single test falls below the specified strength by more than 500 psi. A test is defined as the average strength of three test cylinders cast in plastic molds from a single sample of concrete and cured under standard laboratory conditions prior to testing. If the compressive strength of any one test cylinder differs from the average by more than 10 percent that compressive strength will be deleted and the average strength will be determined using the compressive strength of the remaining two test cylinders.

For concrete having specified strength of 4500 psi or greater, when the compressive strength test is below the specified strength by more than 500 psi but not more than 1000 psi, the concrete represented will be evaluated by CCD for removal, corrective action, or acceptance at a reduced price. All costs of the evaluation shall be at the Contractor's expense. When the compressive strength test is below the specified strength by more than 1000 psi, the concrete represented will be rejected.

If the concrete in the structure is still found to be deficient, resulting time delays will be considered non-excusable for this evaluation.

Unless otherwise stated in the plans or specifications, tolerances for concrete construction and materials shall be in accordance with ACI 117.

END OF SECTION

## C.5 REINFORCING STEEL

### Description

This work consists of furnishing and placing reinforcing steel in accordance with these specifications and in conformity with the plans.

### Reinforcing Steel

Reinforcing steel shall conform to the requirements of the following specifications:

Deformed and Plain Billet-Steel Bars for Concrete Reinforcement	ASTM A 615
Axle-steel Deformed and Plain Bars for Concrete Reinforcement	ASTM A 996
Low-Alloy Steel Deformed Bars for Concrete Reinforcement [to be Welded]	ASTM A 706
Fabricated Deformed Steel Bar Mats for Concrete Reinforcement	ASTM A 184

Unless otherwise designated, bars conforming to ASTM A 615 & ASTM A 996 shall be furnished in Grade 60 for # 5 bars and larger and Grade 40 or 60 for bars smaller than # 5.

In ASTM A 184, bar material conforming to ASTM A 616 will not be permitted.

### Bar List

Two copies of a list of all reinforcing steel and bending diagrams shall be furnished to the City at the site of the work at least one week before the placing of reinforcing steel is begun. Such lists will not be reviewed for accuracy. The Contractor shall be responsible for the accuracy of the lists and for furnishing and placing all reinforcing steel in accordance with the details shown on the plans.

Bar lists and bending diagrams which are included on the plans, do not have to be furnished by the Contractor. When bar lists and bending diagrams are included on the plans, they are intended for estimating approximate quantities. The Contractor shall verify the quantity, size and shape of the bar reinforcement against those shown on the plans and make all necessary corrections before ordering.

### Protection of Materials

Reinforcing steel shall be protected at all times from damage. When placed in the work, the reinforcing steel shall be free from dirt, loose mill scale, paint, oil, loose rust, or other foreign substance.

### Bending

Unless otherwise permitted, all reinforcing bars shall be bent cold. Bars partially embedded in concrete shall not be field bent except as shown on plans or permitted. Bars shall not be bent or straightened in a manner that will injure the material. Should the City approve the application of heat for field bending reinforcing bars, precautions shall be taken to assure that the physical properties of the steel will not be materially altered.

### Placing and Fastening

The minimum spacing center to center of parallel bars shall be  $2\frac{1}{2}$  times the diameter of the bar. However, the clear distance between the bars shall not be less than  $1\frac{1}{2}$  times the maximum size of the coarse aggregate or  $1\frac{1}{2}$  inches, whichever is greater.



All reinforcement shall have a clear coverage of 2 inches, except as shown on the plans. Clear coverage shall be measured from the surface of the concrete to the outside of the reinforcement.

The placing, fastening, splicing and supporting of reinforcing steel reinforcement shall be in accordance with the plans and the latest edition of "CRSI Recommended Practice for Placing Reinforcing Bars." In case of discrepancy between the plans and the CRSI publication stated above, the plans shall govern.

END OF SECTION