

## Verizon Wireless In-building Agreement

This In-building Agreement (the "Agreement") between Cellco Partnership, a Delaware General Partnership doing business as Verizon Wireless, on behalf of itself and its controlled and/or managed affiliates, ("Verizon Wireless" or "Consultant") and the City of Denver ("the City"), governs the installation, maintenance and operation by Verizon Wireless of an in-building coverage system for use with Wireless Service provided by Verizon Wireless ("Wireless Service.")

For purposes of this Agreement, "In-building Equipment" shall be defined as radio distribution or regeneration equipment, including repeaters, amplifiers, base station equipment, antennas and associated network devices, all provided by Verizon Wireless and installed in the Premises (as defined below) for use with Wireless Service. This Agreement does not include the installation of roof-top antennas by Verizon Wireless.

1. The City grants Verizon Wireless a License (the "License") to install, maintain and operate In-building Equipment in the premises owned or leased by the City (the "Premises") commencing on March 1, 2017 and ending on March 1, 2027. The License may be terminated only as provided in this Agreement.
2. The City will provide Verizon Wireless access to or use of the Premises, as required by Verizon Wireless, for the installation and operation of In-building Equipment in accordance with local codes and the National Electrical Code. Such facilities and services may include exterior or rooftop antenna placement, use of ducts, conduit, cables and conductors and electrical power with suitable terminals and power surge protection devices and metallic grounds.
3. Upon reasonable advance notice from Verizon Wireless, Verizon Wireless may require access to the Premises during the City's business hours to install, operate, test, upgrade, maintain, add, replace and/or repair In-building Equipment, to test radio frequency coverage or to investigate or remediate interference with Verizon Wireless' network or services. The City shall also provide or arrange to provide prompt access to the Premises as requested by Verizon Wireless in emergency situations when in Verizon Wireless' opinion urgent action is required to protect against threats to the security, integrity or safety of, and/or to remedy interference with, Verizon Wireless' network or services. The City may accompany Verizon Wireless during any access to the Premises, and any access shall be in accordance with safety and other rules applicable to the Premises. The City acknowledges that delays in providing access to the Premises for emergency repairs, maintenance and/or interference mitigation may cause service interruptions.
4. Verizon Wireless will deliver, install, test, operate, upgrade and maintain the In-building Equipment, either directly or using such subcontractors as Verizon Wireless may select. If the City is vacating all or part of the Premises, the City shall give Verizon Wireless thirty (30) days' prior written notice. If Verizon Wireless in its discretion opts to remove the In-building Equipment from the Premises being vacated, the City shall make all arrangements with its landlord or with other tenants, if necessary, to permit Verizon Wireless to remove the Equipment.
5. The City represents and warrants to the best of its knowledge that it owns or leases the Premises or otherwise has the right to grant the License and has obtained all required consents or approvals from any landlord, mortgagee or other person or entity ("Party In Interest") having an interest therein. If the City has knowledge of any equipment (such as equipment that may be sensitive to RF signals), wiring or other conditions on the Premises, it will so inform Verizon Wireless so that Verizon Wireless may determine whether such equipment may be adversely affected by, or may adversely affect, installation or operation of the In-building Equipment. At its sole discretion, Verizon Wireless may cease installation or operation of In-building Equipment until such time as the City corrects any condition that would be a breach of the above representations and warranties.
6. In consideration of the License, the City receives the benefit of enhanced Wireless Service coverage provided by the In-building Equipment. Unless otherwise agreed to in writing by Verizon Wireless, In-building Equipment remains Verizon Wireless' property and shall be operated and maintained solely by Verizon Wireless. Absent specific written agreement from Verizon Wireless, In-building equipment shall not become a fixture or a part of the real property where it is installed. The City shall so inform any current or future Party in Interest.
7. Verizon Wireless or its local affiliate is the exclusive FCC licensee of certain radio frequencies on which Verizon Wireless provides Wireless Service. Verizon Wireless shall not use any portion of the Premises in any way that causes measurable frequency interference with the operations of the City or any other party or occupant of the Premises present at the Premises as of the Commencement Date, including the operation of transmitting and receiving devices operated within their assigned frequencies and with FCC rules and regulations. The City shall ensure that any rights to use the roof of the Premises (including, without limitation, any rights to install antenna equipment), or any other lease or license for use of the Premises for communications uses, granted to third parties after the Commencement Date, shall not result in measurable frequency interference with the Facilities. The City shall use best efforts to prevent or stop such interference upon receiving notice thereof from Verizon Wireless. In determining such disputes, the underlying assumption is that the device installed later in time must have frequencies and operating characteristics that minimize interference with devices installed prior in time, but that all devices must be designed, maintained and upgraded to minimize interference with other devices in accordance with industry standards as they change from time to time. If the In-Building Equipment causes interference to any device installed prior in time, Verizon Wireless will take all steps necessary to correct and eliminate the interference. If this interference is not eliminated within a reasonable length of time, not to exceed ten days, Verizon Wireless agrees, at the request of the City, to immediately cease causing the interference and to remove the Equipment from the Premises and this Agreement shall then terminate without further obligation on the part of the City or Verizon Wireless, except as expressly provided otherwise herein. If any equipment is installed subsequent to the Verizon Wireless In-Building solution, by the City or other third party, and such installation results in interference to other currently installed equipment, then

the party installing such later equipment shall have the responsibility to abate any interference to prior installed equipment and devices. The provisions of this Article survive the expiration or earlier termination of this Agreement.

No modification, relocation, or other action taken with respect to the City's existing or Verizon Wireless's facilities for the purpose of identifying or ameliorating any radio frequency interference shall in any way affect the City's or Verizon Wireless's rights under this Agreement with respect to any such interference.

If the City experiences interference to its radio frequency operations on the City's property, or experiences radio frequency interference to its operations on the City's property, then the City and Verizon Wireless shall cooperate to conduct such joint testing as the City shall reasonably require as soon as practicable, and in any event within forty-eight (48) hours of the City's request, to identify the source of such interference.

The City shall cooperate with Verizon Wireless to identify the source of any interference of Verizon Wireless or any other party to the same extent to which Verizon Wireless is obligated to cooperate with the City. The City and Verizon Wireless will each keep its equipment within current FCC and manufacturer's technical specifications. Verizon Wireless shall pay for all costs associated with identifying and correcting the source of any interference caused by Verizon Wireless. If the cause of the interference cannot be determined or the parties cannot mutually agree on a remediation solution, Verizon Wireless shall have the unilateral right to remove its In-Building Solution and restore the area to its condition immediately prior to the in-building installation.

8. Upon written notice from the City to Verizon Wireless requesting that In-building Equipment be installed at other City locations, provided Verizon Wireless approves the request and determines that the requested solution may be governed by the terms and conditions of this Agreement, Verizon Wireless shall append supplemental attachments to this Agreement in the form of Attachment 1 that will serve to identify such other locations. Such supplemental attachments shall (i) render the other locations described thereon subject to the applicable terms and conditions of this Agreement, including the consideration set forth in this Agreement; (ii) be cumulative and not intended to replace any previous attachments unless specifically stated therein; and (iii) not require that the parties execute a new Agreement or re-execute this Agreement.
9. This Agreement shall become effective when signed by both Parties. This Agreement does not authorize the resale of Verizon Wireless's Wireless Service, whether on the City's Premises or elsewhere.

**VERIZON WIRELESS**

By: \_\_\_\_\_

Name: \_\_\_\_\_

Title: \_\_\_\_\_

Date: \_\_\_\_\_

**CITY OF DENVER**

By: \_\_\_\_\_

Name: \_\_\_\_\_

Title: \_\_\_\_\_

Date: \_\_\_\_\_

**ATTACHMENT 1 to  
In-building Addendum**

**Customer Name: The City and County of Denver**

**Premises Address: In-building Equipment to be installed at:  
1200 Federal Avenue  
Denver, Colorado**

**Solution**

## **ATTACHMENT 2 to In-building Agreement Denver City Clauses**

1. **TERMINATION:** The City has the right to terminate the Agreement upon effective upon sixty (60) days prior written notice to the Consultant.
2. **EXAMINATION OF RECORDS:** Any authorized agent of the City, including the City Auditor or his or her representative, has the right to access and the right to examine any pertinent books, documents, papers and records of the Consultant, involving transactions related to the Agreement until the latter of three (3) years after the final payment under the Agreement or expiration of the applicable statute of limitations.
3. **INSURANCE:**
  - a. **General Conditions:** Consultant agrees to secure, at or before the time of execution of this Agreement, the following insurance covering all operations, goods or services provided pursuant to this Agreement. Consultant shall keep the required insurance coverage in force at all times during the term of the Agreement, or any extension thereof, during any warranty period, and for three (3) years after termination of the Agreement. The required insurance shall be underwritten by an insurer licensed or authorized to do business in Colorado and rated by A.M. Best Company as "A-"VII or better. Each policy shall contain a valid provision or endorsement requiring notification to the City in the event any of the above-described policies be canceled or non-renewed before the expiration date thereof. Such written notice shall be sent to the parties identified in the Notices section of this Agreement and shall reference the City contract number listed on the signature page of this Agreement. Said notice shall be sent thirty (30) days prior to such cancellation or non-renewal unless due to non-payment of premiums for which notice shall be sent ten (10) days prior. If such written notice is unavailable from the insurer, Consultant shall provide written notice of cancellation, non-renewal and any reduction in coverage to the parties identified in the Notices section by mail. Consultant shall be responsible for the payment of any deductible or self-insured retention. The insurance coverages specified in this Agreement are the minimum requirements, and these requirements do not lessen or limit the liability of the Consultant. The Consultant shall maintain, at its own expense, any additional kinds or amounts of insurance that it may deem necessary to cover its obligations and liabilities under this Agreement.
  - b. **Proof of Insurance:** Consultant shall provide a copy of this Agreement to its insurance agent or broker. Consultant may not commence services or work relating to the Agreement prior to placement of coverages required under this Agreement. Consultant certifies that the certificate of insurance attached as **Exhibit 2A**, preferably an ACORD certificate, complies with all insurance requirements of this Agreement. The City requests that the City's contract number be referenced on the Certificate. The City's acceptance of a certificate of insurance or other proof of insurance that does not comply with all insurance requirements set forth in this Agreement shall not act as a waiver of Consultant's breach of this Agreement or of any of the City's rights or remedies under this Agreement.
  - c. **Additional Insureds:** For Commercial General Liability and Auto Liability, Consultant and subcontractor's insurer(s) shall name the City and County of Denver, its elected and appointed officials, employees and volunteers as additional insured.
  - d. **Waiver of Subrogation:** For all coverages required under this Agreement, Consultant's insurer shall waive subrogation rights against the City.
  - e. **Subcontractors and Subconsultants:** All subcontractors and subconsultants (including independent contractors, suppliers or other entities providing goods or services required by this Agreement) shall be subject to all of the requirements herein and shall procure and maintain the same coverages required of the Consultant. Consultant shall include all such subcontractors as additional insured under its policies (with the exception of Workers' Compensation) or shall ensure that all such subcontractors and subconsultants maintain the required coverages. Consultant agrees to provide proof of insurance for all such subcontractors and subconsultants upon request by the City.
  - f. **Workers' Compensation/Employer's Liability Insurance:** Consultant shall maintain the coverage as required by statute for each work location and shall maintain Employer's Liability insurance with limits of \$100,000 per occurrence for each bodily injury claim, \$100,000 per occurrence for each bodily injury caused by disease claim, and \$500,000 aggregate for all bodily injuries caused by disease claims. Consultant expressly represents to the City, as a material representation upon which the City is relying in entering into this Agreement, that none

of the Consultant's officers or employees who may be eligible under any statute or law to reject Workers' Compensation Insurance shall effect such rejection during any part of the term of this Agreement, and that any such rejections previously effected, have been revoked as of the date Consultant executes this Agreement.

**g. Commercial General Liability:** Consultant shall maintain a Commercial General Liability insurance policy with limits of \$1,000,000 for each occurrence, \$1,000,000 for each personal and advertising injury claim, \$2,000,000 products and completed operations aggregate, and \$2,000,000 policy aggregate.

**h. Business Automobile Liability:** Consultant shall maintain Business Automobile Liability with limits of \$1,000,000 combined single limit applicable to all owned, hired and non-owned vehicles used in performing services under this Agreement.

**i. Additional Provisions:**

(i) For Commercial General Liability, the policy must provide the following:

(a) That this Agreement is an Insured Contract under the policy;

(b) A severability of interests, separation of insureds provision (no insured vs. insured exclusion);

and

(c) A provision that coverage is primary and non-contributory with other coverage or self-insurance

maintained by the City.

(ii) For claims-made coverage:

(a) The retroactive date must be on or before the contract date or the first date when any goods or services were provided to the City, whichever is earlier.

**4. DEFENSE AND INDEMNIFICATION**

**a.** Consultant agrees to defend, indemnify, reimburse and hold harmless City, its appointed and elected officials, agents and employees for, from and against all liabilities, claims, judgments, suits or demands for damages to persons or property arising out of, resulting from, or relating to the work performed under this Agreement ("Claims"), unless such Claims have been specifically determined by the trier of fact to be the sole negligence or willful misconduct of the City. This indemnity shall be interpreted in the broadest possible manner to indemnify City for any acts or omissions of Consultant or its subcontractors either passive or active, irrespective of fault, including City's concurrent negligence whether active or passive, except for the sole negligence or willful misconduct of City.

**b.** Consultant's duty to defend and indemnify City shall arise at the time written notice of the Claim is first provided to City regardless of whether Claimant has filed suit on the Claim. Consultant's duty to defend and indemnify City shall arise even if City is the only party sued by claimant and/or claimant alleges that City's negligence or willful misconduct was the sole cause of claimant's damages.

**c.** Consultant shall defend any and all Claims which may be brought or threatened against City and shall pay on behalf of City any expenses incurred by reason of such Claims including, but not limited to, court costs and attorney fees incurred in defending and investigating such Claims or seeking to enforce this indemnity obligation. Such payments on behalf of City will be in addition to any other legal remedies available to City and will not be the City's exclusive remedy.

**d.** Insurance coverage requirements specified in this Agreement in no way lessen or limit the liability of the Consultant under the terms of this indemnification obligation. The Consultant is responsible to obtain, at its own expense, any additional insurance that it deems necessary for the City's protection.

**e.** This defense and indemnification obligation shall survive the expiration or termination of this Agreement.

**5. NO EMPLOYMENT OF ILLEGAL ALIENS TO PERFORM WORK UNDER THE AGREEMENT:**

**a.** This Agreement is subject to Division 5 of Article IV of Chapter 20 of the Denver Revised Municipal Code, and any amendments (the "Certification Ordinance").

**b.** The Consultant certifies that:

(1) At the time of its execution of this Agreement, it does not knowingly employ or contract with an illegal alien who will perform work under this Agreement.

(2) It will participate in the E-Verify Program, as defined in § 8-17.5-101(3.7), C.R.S., to confirm the employment eligibility of all employees who are newly hired for employment to perform work under this Agreement.

**c.** The Consultant also agrees and represents that:

(1) It shall not knowingly employ or contract with an illegal alien to perform work under the Agreement.

(2) It shall not enter into a contract with a subconsultant or subcontractor that fails to certify to the Consultant that it shall not knowingly employ or contract with an illegal alien to perform work under the Agreement.

(3) It has confirmed the employment eligibility of all employees who are newly hired for employment to perform work under this Agreement, through participation in either the E-Verify Program.

(4) It is prohibited from using either the E-Verify Program procedures to undertake pre-employment screening of job applicants while performing its obligations under the Agreement, and it is required to comply with any and all federal requirements related to use of the E-Verify Program including, by way of example, all program requirements related to employee notification and preservation of employee rights.

(5) If it obtains actual knowledge that a subconsultant or subcontractor performing work under the Agreement knowingly employs or contracts with an illegal alien, it will notify such subconsultant or subcontractor and the City within three (3) days. The Consultant shall also terminate such subconsultant or subcontractor if within three (3) days after such notice the subconsultant or subcontractor does not stop employing or contracting with the illegal alien, unless during such three-day period the subconsultant or subcontractor provides information to establish that the subconsultant or subcontractor has not knowingly employed or contracted with an illegal alien.

(6) It will comply with any reasonable request made in the course of an investigation by the Colorado Department of Labor and Employment under authority of § 8-17.5-102(5), C.R.S., or the City Auditor, under authority of D.R.M.C. 20-90.3.

**d.** The Consultant is liable for any violations as provided in the Certification Ordinance. If Consultant violates any provision of this section or the Certification Ordinance, the City may terminate this Agreement for a breach of the Agreement. If the Agreement is so terminated, the Consultant shall be liable for actual and consequential damages to the City. Any such termination of a contract due to a violation of this section or the Certification Ordinance may also, at the discretion of the City, constitute grounds for disqualifying Consultant from submitting bids or proposals for future contracts with the City.

**6. GOVERNING LAW; VENUE:** The Agreement will be construed and enforced in accordance with applicable federal law, the laws of the State of Colorado, and the Charter, Revised Municipal Code, ordinances, regulations and Executive Orders of the City and County of Denver, which are expressly incorporated into the Agreement. Unless otherwise specified, any reference to statutes, laws, regulations, charter or code provisions, ordinances, executive orders, or related memoranda, includes amendments or supplements to same. Venue for any legal action relating to the Agreement will be in the District Court of the State of Colorado, Second Judicial District (Denver District Court).

**7. NO DISCRIMINATION IN EMPLOYMENT:** In connection with the performance of work under the Agreement, the Consultant may not refuse to hire, discharge, promote or demote, or discriminate in matters of compensation against any person otherwise qualified, solely because of race, color, religion, national origin, gender, age, military status, sexual orientation, gender variance, marital status, or physical or mental disability. The Consultant shall insert the foregoing provision in all subcontracts.

**8. ELECTRONIC SIGNATURES AND ELECTRONIC RECORDS:** Consultant consents to the use of electronic signatures by the City. The Agreement, and any other documents requiring a signature under the Agreement, may be signed electronically by the City in the manner specified by the City. The Parties agree not to deny the legal effect or enforceability of the Agreement solely because it is in electronic form or because an electronic record was used in its formation. The Parties agree not to object to the admissibility of the Agreement in the form of an electronic record, or a paper copy of an electronic document, or a paper copy of a document bearing an electronic signature, on the ground that it is an electronic record or electronic signature or that it is not in its original form or is not an original.

**Contract Control Number:** TECHS-201733294-00

**Contractor Name:** Verizon Wireless

By: 

Name: Steve LeVar  
(please print)

Title: Director Network Field Engineering  
(please print)

**ATTEST: [if required]**

By: \_\_\_\_\_

Name: \_\_\_\_\_  
(please print)

Title: \_\_\_\_\_  
(please print)



**Contract Control Number:**

IN WITNESS WHEREOF, the parties have set their hands and affixed their seals at Denver, Colorado as of

SEAL

**CITY AND COUNTY OF DENVER**

ATTEST:

By \_\_\_\_\_

\_\_\_\_\_

APPROVED AS TO FORM:

REGISTERED AND COUNTERSIGNED:

By \_\_\_\_\_

By \_\_\_\_\_

By \_\_\_\_\_





# Denver Human Services - Castro Building, Denver, Colorado



## SpiderCloud Antenna System Design Drawings

Revised history

Project name

Denver Human Services - Castro Building

Designer name

Tucker Reddy

Plan name

Cover Page



**ICC WIRELESS**  
 A SUBSIDIARY OF INTERFACE COMMUNICATIONS

ICC Wireless  
 10 Inverness Dr E Suite 100  
 Englewood CO 80118

**Cables legend**  
 CAT5e/6 VCU-VAP

**Calculations legend**  
 Verizon - 700 MHz - LTE  
 Verizon - 2100 MHz - AWS - LTE

**Revision history**


**Project name**  
 Denver Human Services - Castro Building

**Designer name**  
 Tucker Reddy

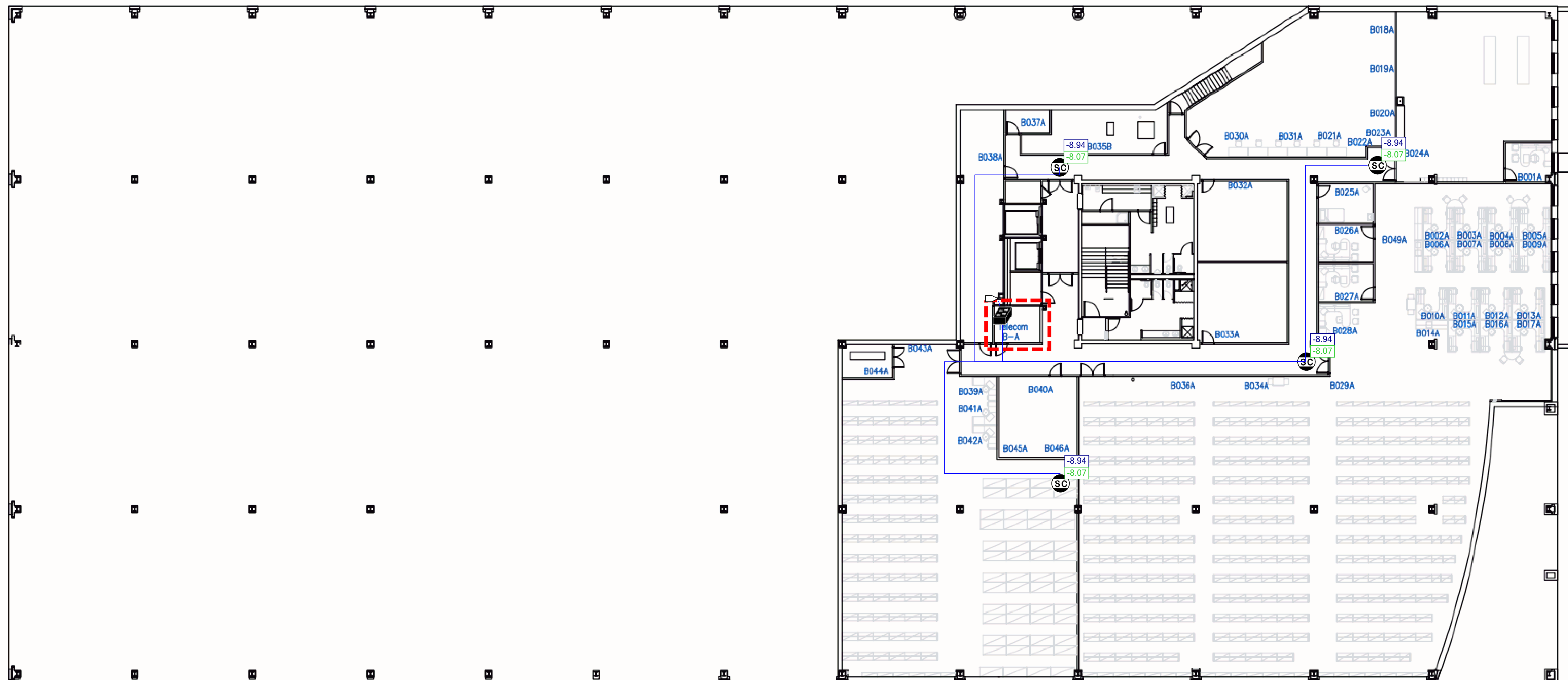
**Plan name**  
 Design plan

12/14/2015  
 Page 2 of 8

**Systems information legend**

Verizon / 700 MHz - LTE / 46 Sectors  
 Verizon / 2100 MHz - AWS - LTE / 46 Sectors

**Indoor prediction legend**



**Calculations legend**

Verizon - 700 MHz - LTE  
 Reference signal power [dBm]  
 Verizon - 2100 MHz - AWS - LTE  
 Reference signal power [dBm]

**Cables legend**

CAT5e/6 VCU-VAP

**Pictograms legend**

- Network Equipment
- Small Cell
- Via

**Revisions history**

Revision	Description

**Project name**

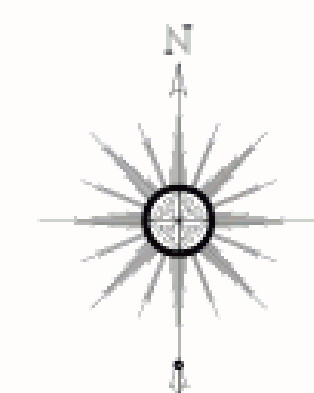
Denver Human Services - Castro Building

**Designer name**

Tucker Reddy

**Plan name**

Basement



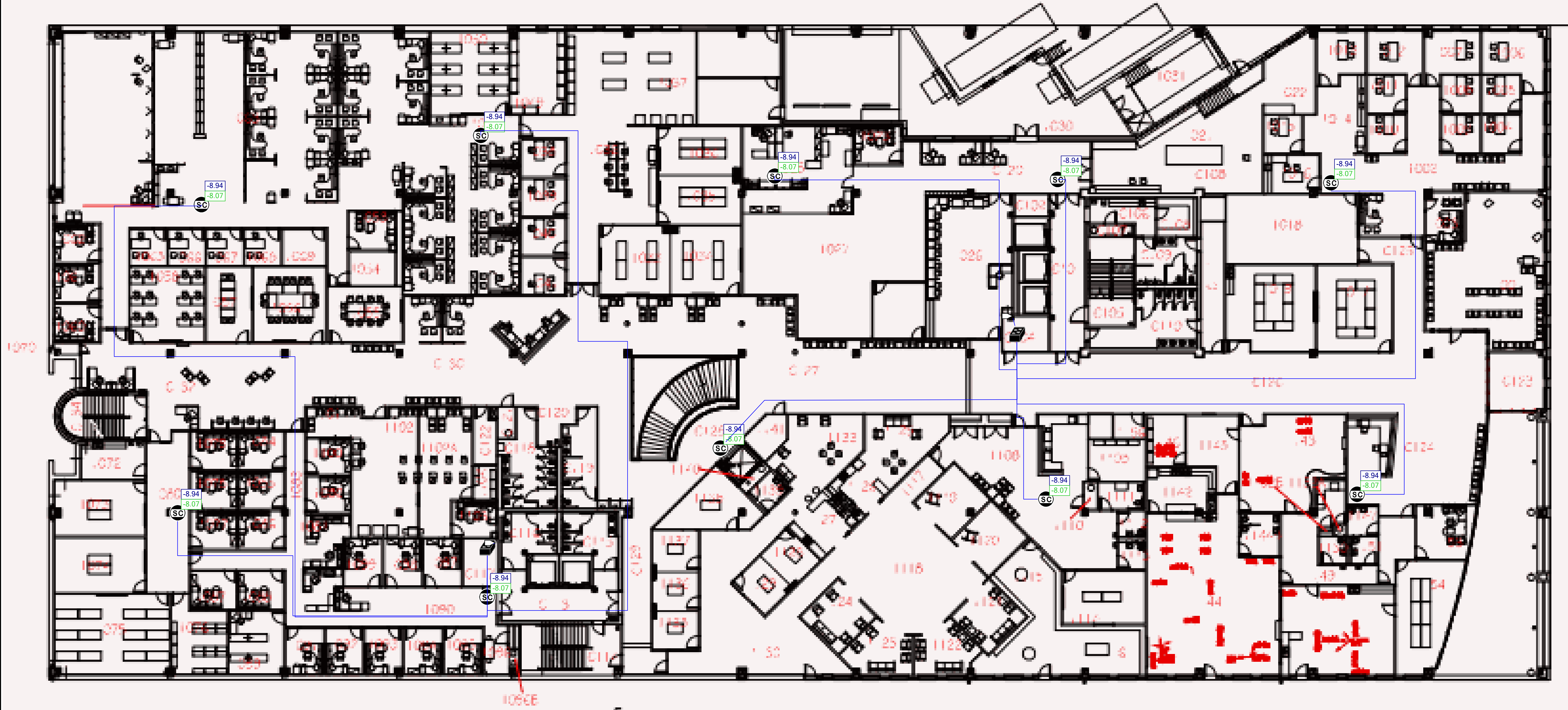
**CITY AND COUNTY OF DENVER**  
 Department of Human Services  
 Castro Building - Basement



100.00 ft

Systems information legend  
 Verizon / 700 MHz - LTE / 46 Sectors  
 Verizon / 2100 MHz - AWS - LTE / 46 Sectors

Indoor prediction legend



Calculations legend  
 Verizon - 700 MHz - LTE  
 Reference signal power [dBm]  
 Verizon - 2100 MHz - AWS - LTE  
 Reference signal power [dBm]

Cables legend  
 CAT5e/6 VCU-VAP

Pictograms legend  
 Network Equipment  
 Small Cell  
 Via

Revision history

Project name

Denver Human Services - Castro Building

Designer name

Tucker Reddy

Plan name

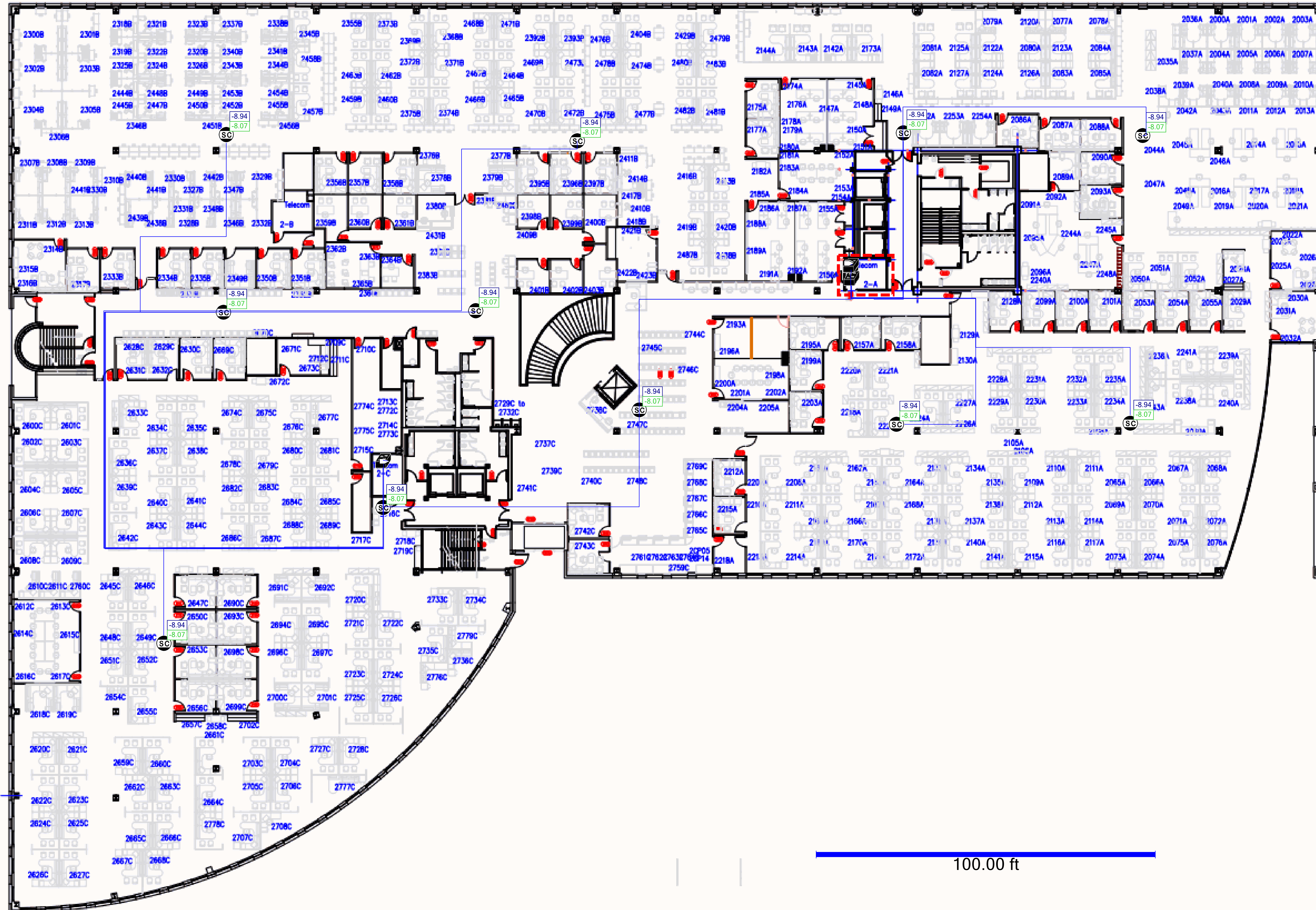
1st

Systems information legend

Verizon / 700 MHz - LTE / 46 Sectors

Verizon / 2100 MHz - AWS - LTE / 46 Sectors

Indoor prediction legend



Calculations legend

Verizon - 700 MHz - LTE  
Reference signal power [dBm]  
Verizon - 2100 MHz - AWS - LTE  
Reference signal power [dBm]

Cables legend

CAT5e/6 VCU-VAP

Pictograms legend

- Network Equipment
- Service Node
- Small Cell
- Via

Revisions

Rev	Description

Project name

Denver Human Services - Castro Building

Designer name

Tucker Reddy

Plan name

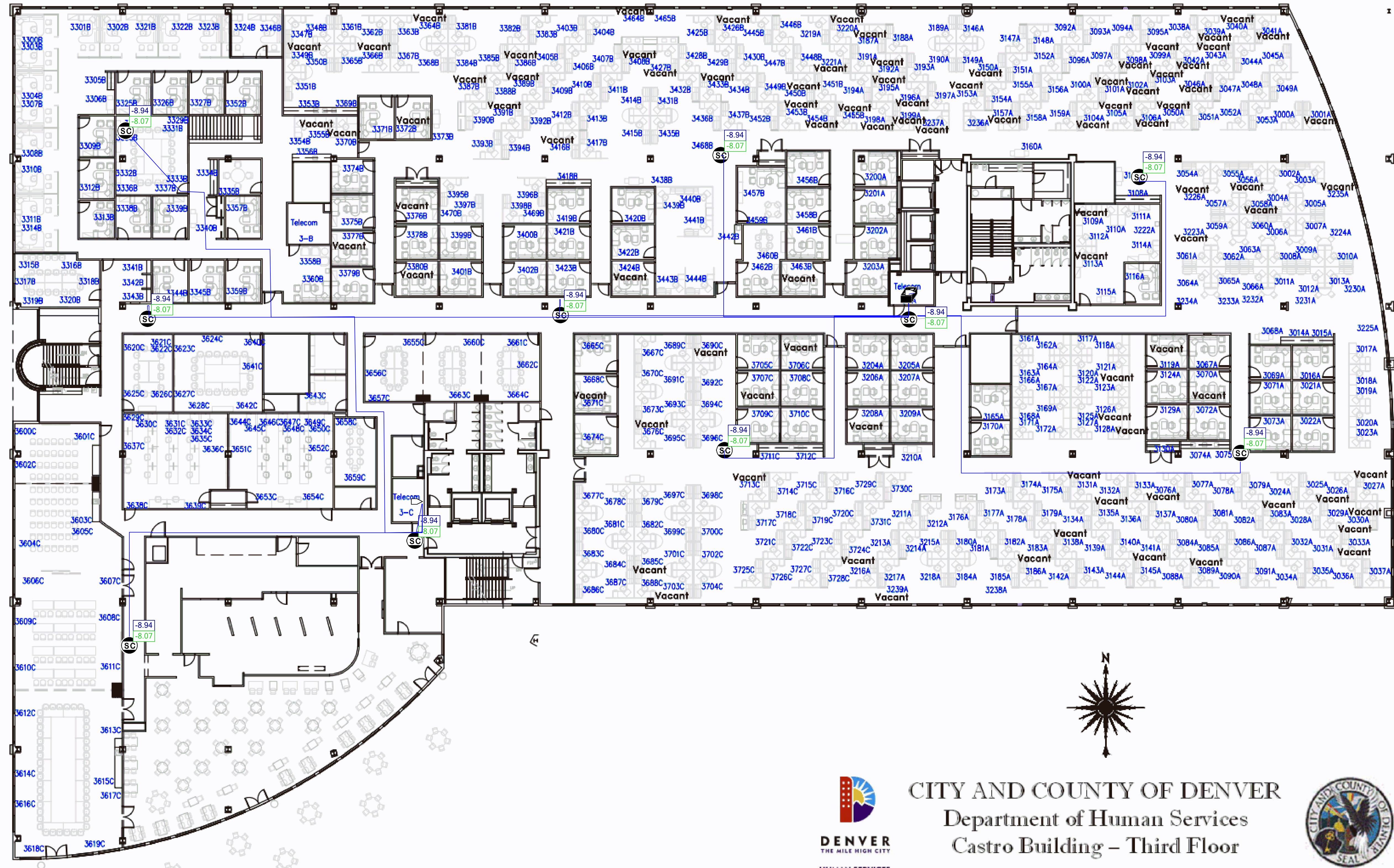
2nd

Systems information legend

Verizon / 700 MHz - LTE / 46 Sectors

Verizon / 2100 MHz - AWS - LTE / 46 Sectors

Indoor prediction legend



Calculations legend

Verizon - 700 MHz - LTE  
Reference signal power [dBm]  
Verizon - 2100 MHz - AWS - LTE  
Reference signal power [dBm]

Cables legend

CAT5e/6 VCU-VAP

Pictograms legend

Network Equipment  
Small Cell  
Via

Revision history

Revision	Description

Project name

Denver Human Services - Castro Building

Designer name

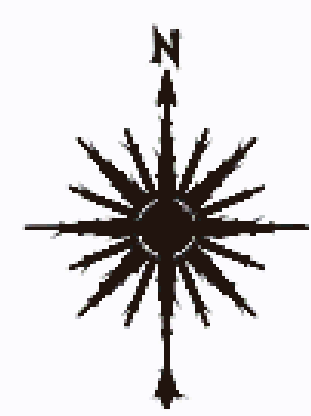
Tucker Reddy

Plan name

3rd



CITY AND COUNTY OF DENVER  
Department of Human Services  
Castro Building - Third Floor

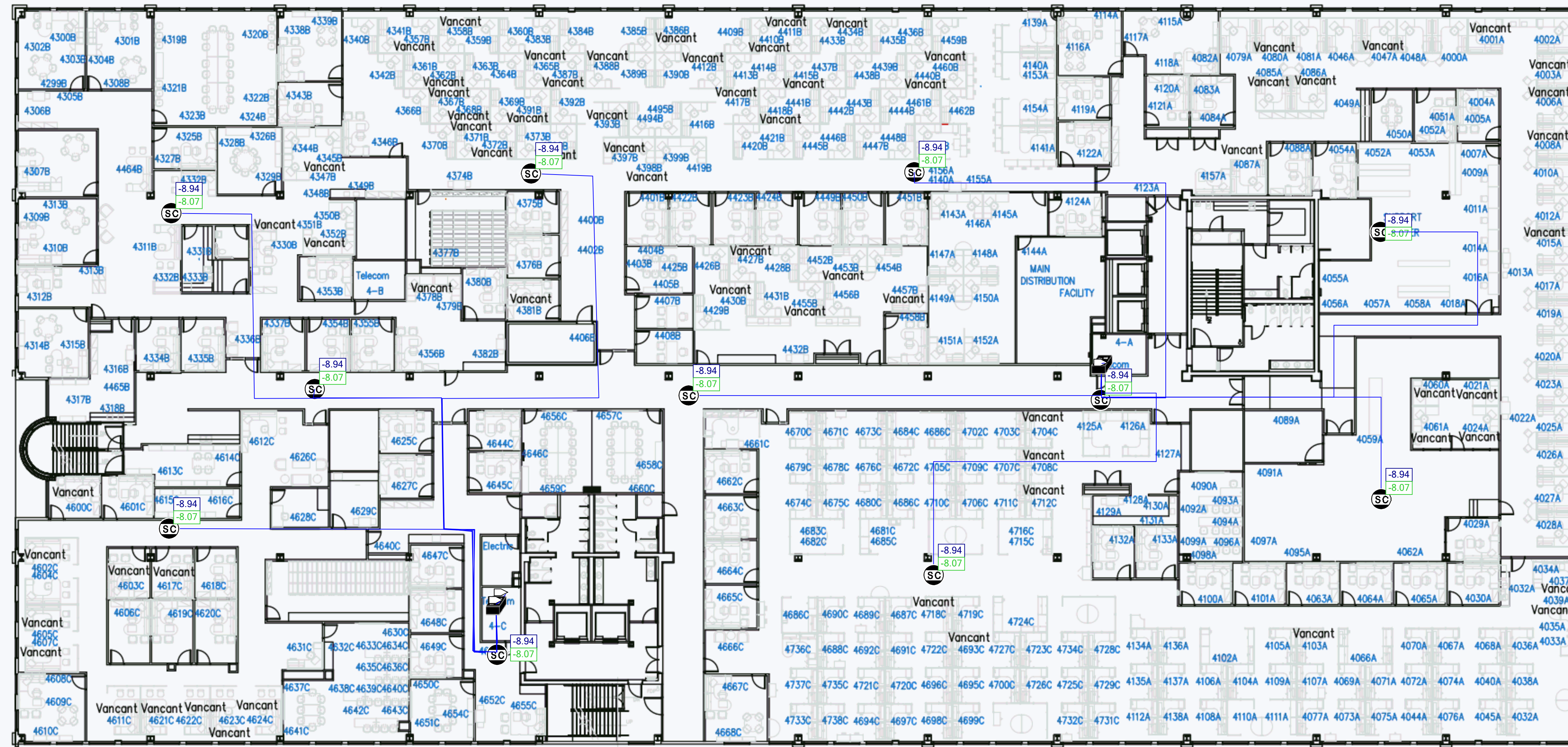


100.00 ft

Systems information legend

Verizon / 700 MHz - LTE / 46 Sectors

Verizon / 2100 MHz - AWS - LTE / 46 Sectors



Indoor prediction legend

Calculations legend  
 Verizon - 700 MHz - LTE  
 Reference signal power [dBm]  
 Verizon - 2100 MHz - AWS - LTE  
 Reference signal power [dBm]

Cables legend  
 CAT5e/6 VCU-VAP

Pictograms legend  
 Network Equipment  
 Small Cell  
 Via

Revision history


Project name

Denver Human Services - Castro Building

Designer name

Tucker Reddy

Plan name

4th



CITY AND COUNTY OF DENVER  
Department of Human Services  
Castro Building - Fourth Floor





Revised history

Project name

Denver Human Services - Castro Building

Designer name

Tucker Reddy

Plan name

Google Earth



## **Exhibit C**

### **Minimum Technical Standards**

Note: Some standards may not apply to your facility due to frequency of operation or type of service.

#### **1.0 General**

1.1 Posting of Information. The following information shall be posted on or near your cabinet:

Copy of FCC license (if applicable)

Equipment Identification Card with the following information:

Transmit and receive frequencies (or frequency bands in case of wireless operators)

Type of service

Authorized output power & ERP

Antenna model number

Transmission line model number and type

Name of licensee

Contact information for responsible person (name, phone, email)

Unidentified equipment shall be considered unauthorized and may be red tagged and removed after 30 days.

1.2 Installations at City Fire Stations. The City may require that the Tenant (Licensee) upgrade City radio equipment to ensure interference-free coexistence. Specifically, there is a problem with installing an isolator on the existing 900 MHz Alligator Model 1888 MAS transceiver used at most City fire stations. The isolator must be installed only on the transmit line, but the transceiver uses a duplexed (switched) output whereby both the transmitter and the receiver share the same antenna line. Similarly, separate cavity filters are required for the receiver and transmitter, but it is not possible to install both on a single duplexed line. For this reason, the City usually directs that the Alligator Model 1888 be replaced with a Model 1800 Master unit with separate transmit and receive antenna ports. A duplexer cavity filter should be used to combine transmit and receive into the existing antenna. Contact the City's Technical Representative for recommended vendors for these components.

1.3 Changes. Notify the City's Technical Representative immediately of any changes to frequencies, antennas or other equipment configuration. Obtain City's approval prior to making those changes as required by the Lease (License). Approved changes shall be shown on an updated Equipment ID Card.

#### **2.0 Mobile Wireless Services**

2.1 Land Mobile Radio Filter and Isolator Requirements. For land mobile radio (LMR), as a

minimum, each transmitter shall employ a dual stage isolator followed by a single cavity bandpass filter. All transmitters shall have built-in or external harmonic (low pass) filters. The low pass filter must be a true low pass filter, not a notch filter tuned to just one or two harmonic frequencies. Harmonic rejection shall be at least 60 dB at the second harmonic and at least 50 dB at the third harmonic. The following minimum isolator and bandpass cavity filter specifications apply:

30-50 MHz

Isolators - None required.

TX cavity - minimum of 20 dB rejection at + 0.5 MHz

72-76 MHz

Isolators - Minimum of 25 dB

TX cavity - minimum of 20 dB rejection at + 0.5 MHz

138-174, 216-222 MHz

Dual Stage Isolators - minimum of 60 dB

TX cavity - minimum of 20 dB rejection at + 1.5 MHz

406-512 MHz

Dual Stage Isolators - minimum of 60 dB

TX cavity - minimum of 20 dB rejection at + 3.5 MHz

698-941 MHz (excluding airphone)

Dual Stage Isolators - minimum of 60 dB

Tx cavity - minimum of 20 dB rejection at + 6 MHz

Explanation. The bandpass filter and lowpass filter must follow the isolator because ferrite isolators are nonlinear and can create harmonics. Please note that most bandpass cavity filters will pass odd harmonics of the tuned frequency, so an external lowpass filter following the isolator is also required. Transmitter combiners will be considered on a case-by-case basis. Please provide all combiner technical information to the City's Technical Representative.

2.2 Airphone (849-851 MHz transmit, 894-896 MHz receive)

Transmitter out-of-band emissions shall not cause harmful interference to cellular base station receivers (824-849 MHz). Tenant (Licensee) shall submit plans, including bandpass filter response curves, to the City's Technical Representative for approval prior to installation. Tenant (Licensee) shall install adequate receiver bandpass filtering to preclude receiver desensitization or receiver intermodulation caused indirectly by cellular base stations on the site.

2.3 LMR Duplexers. Notch duplexers are not adequate. The duplexer must also have a bandpass characteristic to ensure other transmit signals do not enter the transmitter or over drive the receiver. This is especially important for VHF repeaters which are vulnerable to FM broadcast signals and other closely-spaced VHF transmitters.

2.4 Personal Wireless Services. These services include, but are not limited to the 698-806, 806-869, 1710-1755, 1850-2000, 2110-2155, 2500-2600 MHz bands (excluding 700 and 800 MHz public safety bands). Because the wireless provider is assumed to have exclusive use of a band of frequencies, out-of-band emissions are expected to be attenuated significantly by the manufacturer's standard combiners, duplexers and cross-band couplers. Ferrite isolators may not be required. Submit your plans to the City's Technical Representative for approval.

2.5 Unlicensed Band (License-Free) Radios. Unlicensed band radios and shared-band services, including, but not limited to those operating in the 902-928 MHz, 2.4-2.4835 GHz, 3.5 GHz, 4.9 GHz (public safety only) and 5 GHz bands are not allowed unless specifically authorized in the Tenant's (Licensee's) Lease (License). When authorized, Tenant (Licensee) shall not change operating frequencies without first getting approval from City. License-free radios are notorious for their poor quality in a harsh RF environment and specific make, model and technical specifications must be provided to the City's Technical Representative for approval. Additional protective devices, shielded CAT 6 cable and shielded NEMA cases may be required before such devices can be installed on the tower.

2.6 Receivers. The site may have relatively high radio frequency (RF) levels in all mobile radio bands. Your receiver amplifier must be robust to work in this environment. Ensure the receiver has good intermodulation (IM) rejection and high 1 dB compression point. If interference is encountered and we find the receiver is not performing up to the standards exhibited by state-of-the-art equipment, the City may require receiver improvements or upgrades before requiring changes to other tenant (licensee) equipment or configurations. This requirement applies to both new and existing tenants (licensees).

Filters are required for mobile radio receivers. Single receivers must employ a minimum of a single 7" diameter (or equivalent) cavity bandpass filter with a rejection curve corresponding to 1 dB insertion loss or better. Additional filter isolation may be required in special cases. Receiver multicouplers must use a bandpass filter (preselector) prior to the multicoupler amplifier.

2.7 Antennas. Select antennas designed to minimize passive intermodulation generation. Note that antennas that pass intermodulation tests at the factory may not provide good intermodulation rejection after years of exposure to heat, cold, vibration from wind, and humidity. Only new antennas are allowed for new installations. Select antennas specifically designed to reject intermodulation over the life of the antenna. Unless the antenna is a duplex configuration, transmit and receive antennas should be separated vertically on the tower. If the tower is owned by the City, the City will designate antenna locations. Antennas must be DC grounded to the tower for lightning protection.

2.8 Transmission Lines. Coaxial cable should be grounded at the top and the bottom of the run with an Andrew ground kit or equivalent. Ensure that ground conductors run straight down with no sharp bends because bends will increase the impedance of the grounding conductor. We also require that the line be marked so we can identify it later. We suggest bands of colored electrical tape at the bottom, middle and top of the run (similar to a resistor color code). Install a Huber-Suhner (or equivalent) coaxial surge arrester at the bulkhead. All exterior transmission lines

must be solid outer conductors. If possible, receive and transmit lines should be separated by at least one foot from cabinet to antenna.

2.9 Connectors. Connectors are often sources of RF leakage and passive intermodulation. UHF connectors (PL259) are not allowed on connections external to the radio cabinet. Type “N” connectors are allowed below 512 MHz. 7/16 DIN connectors should be used at 698 MHz and above and are required above 1.7 GHz. Connectors using dissimilar metal contacts or ferrous materials (e.g., nickel plating) are not allowed. The preferred connector uses a silver plated body with gold plated inner conductor. Brass bodies and silver or brass inner conductors are also allowed.

2.10 Additional Protective Devices May Be Required. The specifications above are minimum requirements. Additional protective devices may be required based upon evaluation of the following information:

- Theoretical TX mixes, particularly second and third order
- Antenna location and type
- Combiner/multicoupler configurations
- Transmitter specifications
- Receiver specifications
- Historical problems
- Transmitter to transmitter isolation
- Transmitter to antenna isolation
- Transmitter to receiver isolation
- Calculated and measured level of IM products
- Transmitter output power
- Transmitter ERP
- Spectrum analyzer measurements
- VSWR measurements
- Existing cavity selectivity
- Antenna to antenna proximity

### **3.0 FM & IBOC Broadcast (Part 73, ERP > 1 kW)**

3.1 FM Broadcast Transmitters. FM and IBOC Broadcast transmitters will be either combined with other stations into a common antenna or stand-alone. If combined, the combiner design shall be approved by the City's Technical Representative. If stand-alone, the transmitter shall employ a bandpass cavity filter with the following minimum performance specifications:

3.1.1. Rejection. The bandpass filter shall provide the following minimum rejection for Class C, C0 and C1 stations:

From Center +/-	Minimum Rejection
800 kHz	22 dB
1 MHz	28 dB

1.2 MHz	32 dB
1.4 MHz	38 dB
1.6 MHz	43 dB

Note that four cavities are required to meet this specification. Class C2 and C3 stations may use three-cavity filters. These filter requirements also apply to stations with FM & IBOC combined outputs. A stand alone IBOC transmitter and antenna shall comply with the following requirements: IBOC ERP greater than 5,000 Watts: 4 cavity filter (see rejection above), IBOC ERP less than or equal to 5,000 Watts: 3 cavity filter.

3.1.2 Gain Flatness. +/-0.5 dB from +/-200 kHz from center frequency.

3.1.3. Group Delay Flatness. No greater than +/- 150 nanoseconds (symmetrical) in +/- 200 kHz (I.e., minimum to maximum delay difference shall be no greater than 300 nanoseconds in the band  $f_c - 200$  kHz to  $f_c + 200$  kHz).

3.1.4. VSWR. No greater than 1.1:1 in +/- 200 kHz (assuming filter is terminated in perfect 50 ohm load).

3.1.5. Insertion Loss. No greater than 0.3 dB in +/- 200 kHz.

The transmitter should comply with current FCC rules regarding out-of-band emissions at transmitter output (before the bandpass cavity filter). The external filter is required to provide further rejection of out-of-band emissions to ensure electromagnetic compatibility with other users on the site.

3.2 FM Broadcast Antennas. FM Broadcast antennas mounted below 250' AGL (center of radiation) shall employ short element spacing to reduce downward radiation and ensure compliance with CFR 47, Parts 1.1307-1.1310. This requirement does not apply to stations that employ a single element antenna. Examples of short element spacing are a 6 bay antenna with half-wavelength spacing or an 8 bay antenna with 3/4 wavelength spacing. Submit a plot of predicted power density versus distance at ground level for City's Technical Representative Approval.

#### **4.0 Full-Power Television**

4.1 Full-power television transmitters shall include band pass and low pass filters.

4.2 For television transmitters, measured out-of-band emissions (including harmonics) greater than 3 MHz from the respective channel edge shall be more than 80 dB below the measured power over the entire channel. Both measurements shall use a 6 MHz measurement bandwidth.

#### **5.0 Low Power Television (analog and digital)**

5.1 Low Power Television (LPTV) transmitters and television translators must have low pass

filters that attenuate all harmonics and spurious products at least 80 dB below the power measured at the carrier frequency. To facilitate measurements of spurious products, each LPTV and translator transmitter shall have installed a line section and appropriate directional coupler element. For routine use, the line section may employ a standard DC element and be connected to a wattmeter capable of measuring forward and reflected power. In addition, the Tenant (Licensee) shall own or have access to an RF load capable of dissipating the full power of the transmitter for troubleshooting purposes.

## **6.0 Grounding, Bonding and Shielding**

6.1 Shielding. RF interference can get directly into the electronics of a receiver or transmitter. Cabinet shielding must be in place and maintained to the manufacturer's specifications. Do not leave cabinet doors open because open cabinet doors defeat the shielding.

6.2 Grounding. Equipment grounding and bonding should be accomplished in accordance with Mil Std 188-124, Military Handbook 419 and Motorola R56. Contact the City's Technical Representative for guidance on grounding and bonding at your particular facility.

## **7.0 Site Work**

7.1 Tower Work Insurance and Experience Requirements. All tower riggers or installers of antennas, transmission lines, cabinets, wiring or similar hardware or apparatus must meet the minimum basic requirements of the City. These will include, but not be limited to, the following:

- The rigging company must have a current Certificate of Insurance on file with the City. The certificate will include, but not be limited to the following minimum requirements:

1. Commercial General Liability: \$1,000,000 single limits/\$2,000,000 aggregate
2. Business Automobile Liability: \$1,000,000
3. Workers' Compensation/Employer's Liability : Statute/ \$100,000 per occurrence, \$500,000 aggregate

- The City and County of Denver, its elected and appointed officials, employees and volunteers must be listed as Additional Insured as respects the Commercial General Liability and Business Auto policy.
- Demonstrated experience on similar tower types and similar work activity on similar towers within the past two years with a list of at least two recent clients or professional references with actual knowledge of experience and necessary qualifications, or in lieu thereof; previous working relationship with the City and known by the City's personnel.

City reserves the right, at its sole discretion, to reject the use of any person or tower rigging company on City-owned towers or properties.

7.2 Work Standards. The installation of any and all materials on the tower and in the

accompanying shelter must be pre-authorized and approved by the City's Technical Representative. The following guidelines will be strictly enforced:

7.2.1 Equipment or cabinets mounted on platforms will be constructed of galvanized or stainless steel and will be securely attached to the tower members or platforms with J-bolts, U-bolts or similar clamping devices which do not penetrate tower members or any part of the galvanized coating. All mounting hardware must be hot-dipped galvanized or stainless steel (NOT PLATED). All mounting nuts, bolts, washers or similar must be Grade 5 or better.

7.2.2 Antennas and the mounting thereof must be approved in advance of installation. Data in reference to antenna type, weight, wind loading, gain, bandwidth and mounting details must be provided to the City's Technical Representative and may not be modified or replaced without expressed written permission of City. Installation of antennas on City-owned towers may require a new structural study at the Tenant (Licensee)'s expense.

7.2.3 Transmission lines and hardware must be approved in advance of installation by the City's Technical Representative and must be specified as to manufacturer, size and type and shown on the City's New Tenant Questionnaire. All the mounting hardware must be of appropriate type and design to support the transmission lines with strain-reliefs installed at the manufacturer's recommended intervals. Under no circumstances will stainless steel automotive-type hose clamps be used to secure transmission lines or cables to tower members. Where not previously designated, all lines will be positioned on the tower to minimize wind loading and provide a minimum of obstruction to climbing or removal/replacement of other lines. Each line will be mounted independently of other lines on the tower. Cable trays, waveguide entrances, tower ladders, elevator rails and other similar members are to be kept clear of all cables on the tower. Stainless steel lashing ties are acceptable for use on the tower but are not to be used as strain reliefs.

7.2.4 Antenna jumper cables or cables to/from crossband couplers or similar devices on the tower will be kept to minimum required lengths and will be made of solid shield outer conductor cables with outer jackets capable of withstanding severe weather and ultraviolet rays. All such cable types must be pre-approved by the City.

7.2.5 UNDER NO CIRCUMSTANCES –

- will welding or drilling of tower members be allowed;
- will modifications to the tower, bridge, building entrance fittings or similar be permitted;
- will transmission line splices (a pair of connectors at other than the top or bottom of the run on the tower) be permitted except by prior approval or necessitated by damage only repairable by splicing;
- will any tampering, retuning, rerouting or other modifications be permitted to equipment owned by City or other tenants.

7.2.6 All installations will be performed in accordance with good engineering practice and within the guidelines of this document. Any deviation from these minimum requirements and technical standards must be approved in writing prior to installation or modification.

7.3 Removal of Unused Antennas and Lines. Tenant (Licensee) shall remove all unused antennas, transmission lines and associated mounting hardware from City's tower within 90 days of the date an antenna is no longer in service.

7.4 NO PRESENT INSTALLATION WILL BE "GRANDFATHERED" and must conform to these work standards within a reasonable time period to be determined by the City's Technical Representative. Periodic inspections may be performed to ensure that all installations meet technical standards.

## **8.0 Shelters**

8.1 Cable Dressing Inside Building or Shelter. All wiring and cables within a given rack will be properly dressed and/or bundled with cable ties with excess cut close to the barbs. Twisted wire, tape, rope, twine, phone wire and similar bits of debris usually available on site ARE NOT ACCEPTABLE substitutes for proper securing hardware. All inter-rack cables and wiring must be properly routed and utilize the cable trays provided even if between adjacent racks. Overhead cables and RF lines must be easily removed or reworked within the cable trays. Proper care must be taken to ensure that new cables added to the trays are not stressed or intertwined with existing cables. OVERHEAD CABLES MAY NOT CROSS PERPENDICULARS OR BE SUSPENDED IN MID AIR WITHOUT SUPPORTS. NO SUPPORTS MAY BE INSTALLED WITHOUT PRIOR APPROVAL. All long cable runs must be properly identified at each end indicating the opposite cable end address. All cabling within the building must be cut to proper length except phasing harnesses, where required.

## **9.0 Towers**

9.1 Tenant (Licensee) may not erect new towers without the City's prior written consent, which may be granted or denied in City's sole discretion, and towers that are approved may only be constructed after plans for the tower have been approved by the City and by the zoning authority.

9.2 New towers shall comply with TIA-222-G or the most recent edition adopted by the local zoning authority. Changes to an existing tower, including addition or replacement of antennas requires that TIA-222-G or the most recent edition be used. Tenant (Licensee)-owned towers that present an immediate safety hazard shall be corrected by Tenant (Licensee) regardless of the status of the current lease or the particular edition of TIA-222 in use at the time of tower construction. Installation of antennas on City-owned towers may require a new structural study at the Tenant (Licensee)'s expense.

## **10.0 Permits**



10.1 Tenant (Licensee) shall comply with all local and Federal regulations. Tenant (Licensee) is responsible for acquiring all applicable permits, including, but not limited to FCC construction permits and building permits. Tenant (Licensee) is also responsible for performing any required studies, including RF exposure and RF interference studies required by the FCC, local government, and City. Tenant (Licensee) shall furnish all applicable permits, studies, and approvals to the City for approval before starting any construction, including antenna installation.

## **11.0 Radio Frequency Safety**

11.1 The engineering, design, configuration, installation, and maintenance of high power (> 1 kW ERP) radio facilities on the site shall be accomplished in a manner that minimizes downward radiation. Changes to proposed systems may be directed by City to comply with this objective.

11.2 Everyone on the site shall follow these guidelines:

- All personnel entering the site must be authorized
- Obey all posted signs
- Assume all antennas are active unless proven otherwise
- Before working on an antenna, notify the owner and disable the transmitter
- Use a radio frequency (RF) personal monitor when working near antennas
- Never operate transmitters without shields

11.3 Power densities on towers can be much higher than at ground level. For this reason, tower climbers should request power reductions from high-power tenants and carry RF personal monitors when climbing towers. The City's Technical Representative can tell you which transmitters should be turned down before climbing the tower.

11.4 Federal Government guidelines regarding human exposure to radio frequency energy are found in the Code of Federal Regulations (CFR) Title 47, Parts 1.1307-1.1310.



Figure 1 - Warning Sign to be Posted at Base of Tower  
(Available from Tescos, Holaday, Narda and other Sources)