

APPENDIX B

Uniform Color Code and Marking Guidelines

The information contained in this appendix is intended to supplement information for existing practices found within CGA Best Practices.^{8/}

BEST PRACTICES CHAPTER 4—LOCATING AND MARKING

Practice Statement 4-3: Color Code: A uniform color code and set of marking symbols is adopted nationwide.

Uniform Color Code^{9/}

The following APWA uniform color code (ANSI Z535.1) shall be adopted as the uniform color code for marking excavation sites and underground facilities in conflict with an excavation. This recommendation is not intended to preempt any existing state requirement that specifies other colors.

White	Proposed Excavation
Pink	Temporary Survey Markings
Red	Electric Power Lines, Cables, Conduit, and Lighting Cables
Yellow	Gas, Oil, Steam, Petroleum, or Gaseous Materials
Orange	Communication, Alarm or Signal Lines, Cables, or Conduit
Blue	Potable Water
Purple	Reclaimed Water, Irrigation, and Slurry Lines
Green	Sewers and Drain Lines

References:

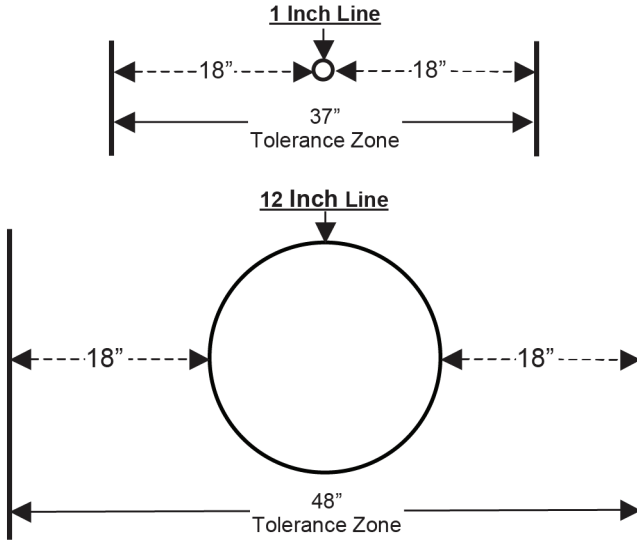
- APWA Uniform Color Code
- Existing operating practices from various states' 811 centers
- Existing 811 laws from various states
- ANSI Standard Z535.1 Safety Color Code

BEST PRACTICES CHAPTER 5—EXCAVATION

Practice Statement 5-19: Excavation Tolerance Zone: The excavator observes a tolerance zone that is comprised of the width of the facility plus 18 in. on either side of the outside edge of the underground facility on a horizontal plane. This practice is not intended to preempt any existing state/provincial requirements that currently specify a tolerance zone of more than 18 in.

Tolerance Zone^{40/}

The following examples are of tolerance zones for a 1 in. and 12 in. line:

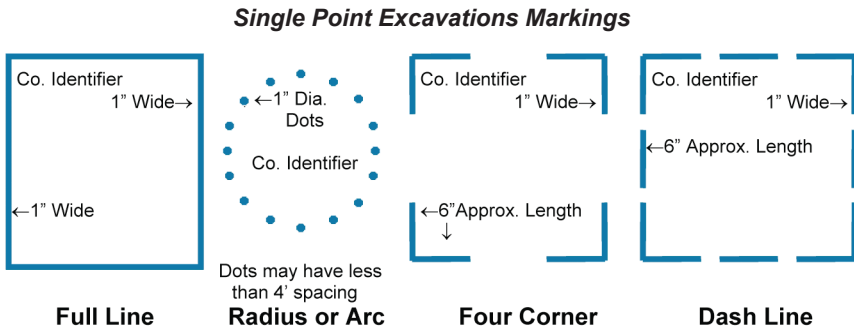


BEST PRACTICES CHAPTER 5—EXCAVATION

Practice Statement 5-2: White Lining^{67/}: When the excavation site cannot be clearly and adequately identified on the locate ticket, the excavator designates the route and/or area to be excavated using white pre-marking, either onsite or electronically (when available through the 811 center), prior to or during the request for the locate ticket.

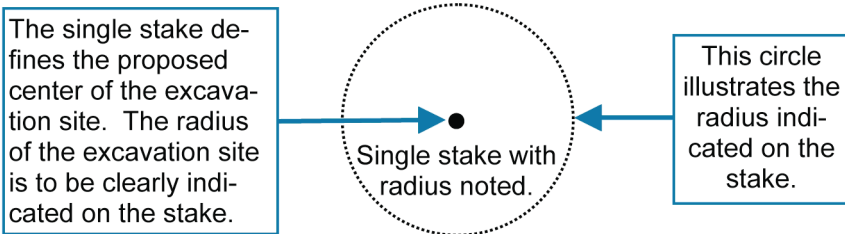
Guidelines for Excavation Delineation^{9/}

The following marking illustrations are examples of how excavators may choose to mark their area of proposed excavation. The use of white marking products (e.g., paint, flags, stakes, whiskers or a combination of these) may be used to identify the excavation site.



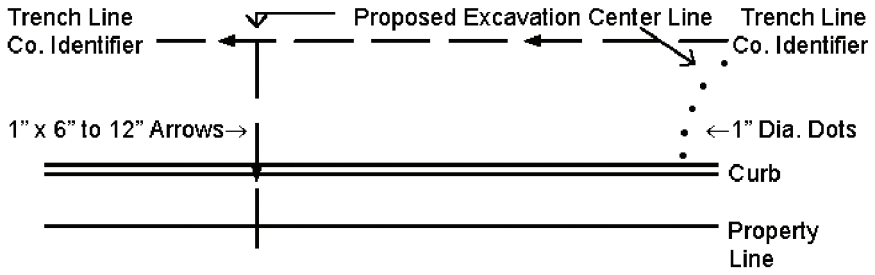
Delineate in white^{62/} the proposed area of excavation using a continuous line, dots marking the radius or arcs, dashes marking the four corners of the project, or dashes outlining the excavation project. Limit the size of each dash to approximately 6 in. to 12 in. long and 1 in. wide with interval spacing approximately 4 ft. to 50 ft. apart. Reduce the separation of excavation marks to a length that can reasonably be seen by the operator’s locators when the terrain at an excavation site warrants. Dots of approximately 1 in. diameter typically are used to define arcs or radii and may be placed at closer intervals in lieu of dashes.

Single Stake Marking Center Point of Excavation Site



When an excavation site is contained within a 50 ft. maximum radius or less, it can be delineated with a single stake that is positioned at the proposed center of the excavation. If the excavator chooses this type of delineation, they must convey that they have delineated the excavation site with a single stake at the center of the excavation and include the radius of the site in the notification to the 811 center. This single stake is white in color and displays the excavator’s company identifier (name, abbreviations or initials) and the radius of the excavation site in black letters on the stake or with a notice attached to the stake.

Trenching, Boring or Other Continuous-Type Excavations



Continuous Excavation Marking

Mark in white^{62/} the proposed centerline of planned excavation using 6 in. to 12 in. x 1 in. arrows approximately 4 ft. to 50 ft. apart to show direction of excavation. Reduce the separation of excavation marks to a length that can reasonably be seen by the operator’s locators when the terrain at an excavation site warrants. Mark lateral excavations with occasional arrows showing excavation direction from centerline with marks at curb or property line if crossed. Dots may be used for curves and closer interval marking.

Stake, Flag or Whisker Excavation Markers



Delineate the proposed area of excavation using stakes, flags or whiskers instead of spray paint to mark radius or arcs, the four corners of the project, or when outlining the excavation project. Limit the interval spacing to approximately 4 ft. to 50 ft. Reduce the separation of excavation marks to a length that can reasonably be seen by the operator’s locators when the terrain at an excavation site warrants. Stakes, flags or whiskers provided to illustrate arcs or radii may be placed at closer intervals to define the arc or radius. Stakes, flags or whiskers are white in color and display the excavator’s company identifier (name, abbreviations or initials).

BEST PRACTICES CHAPTER 4—LOCATING AND MARKING

Practice Statement 4-3: Color Code: A uniform color code and set of marking symbols is adopted nationwide.

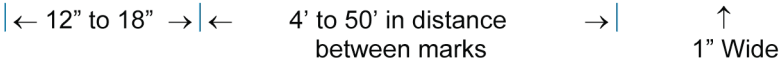
Guidelines for Operator Facility Field Delineation^{9/}

Operator markings of facilities include the following:

- The appropriate color for their facility type
- Their company identifier (name, initials or abbreviation) when other companies are using the same color
- The total number of facilities and the width of each facility
- A description of the facility (HP, FO, STL, etc).

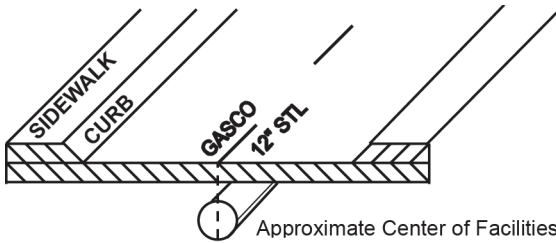
Use paint, flags, stakes, whiskers or a combination to identify the operator's facility(s) at or near an excavation site.

1. Marks in the appropriate color are approximately 12 in. to 18 in. long and 1 in. wide, spaced approximately 4 ft. to 50 ft. apart. When marking facilities, the operator considers the type of facility being located, the terrain of the land, the type of excavation being done, and the method required to adequately mark the facilities for the excavator.

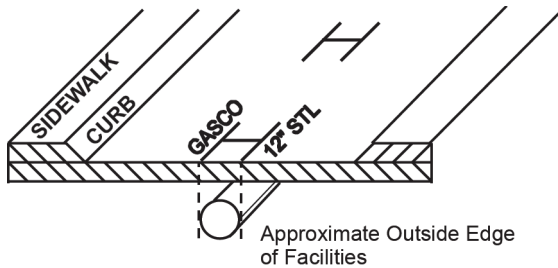


2. The following marking examples illustrate how an operator may choose to mark their subsurface installations:

- a. **Single Facility Marking:** Used to mark a single facility. This can be done in one of two ways—1) placing the marks over the approximate center of the facility:



or 2) placing the marks over the approximate outside edges of the facility with a line connecting the two horizontal lines (in the form of an H) to indicate there is only one facility:

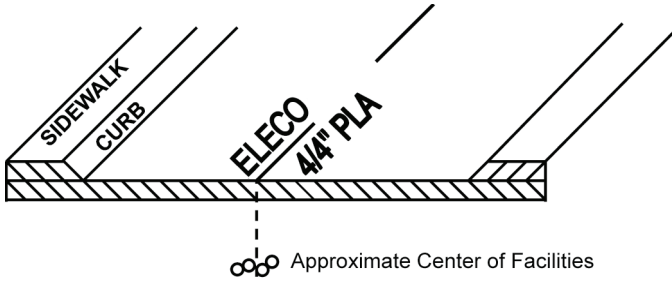


These examples indicate an operator's 12 in. facility. When a facility can be located or toned separately from other facilities of the same type, it is marked as a single facility.^{41/}

- b. **Multiple Facility Marking:** Used to mark multiple facilities of the same

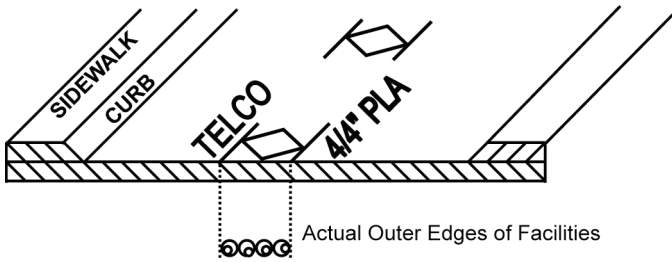
type (e.g., electric), where the separation does not allow for a separate tone for each facility, but the number and width of the facilities is known. Marks are placed over the approximate center of the facilities and indicate the number and width of the facilities.

Example: four plastic facilities that are 4 in. in diameter (4/4" PLA)



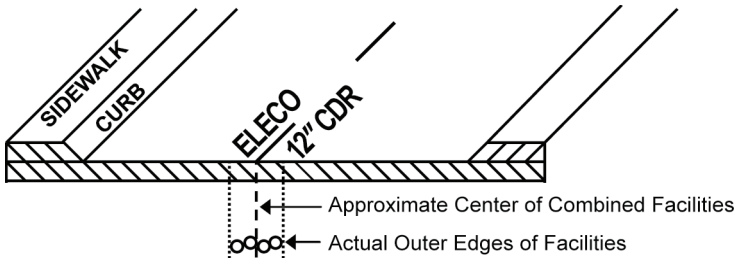
- c. **Conduit Marking:** Used for any locatable facility being carried inside conduits or ducts. The marks indicating the outer extremities denote the actual located edges of the facilities being represented.

Example: four plastic conduits that are 4 in. in diameter (4/4" PLA), and the marks are 16 in. apart, indicating the actual left and right edges of the facilities



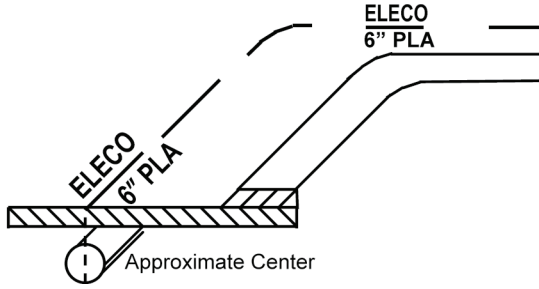
- d. **Corridor Marking:** Used to mark multiple facilities of the same type (e.g., electric), bundled or intertwined in the same trench, where the total number of facilities is not readily known (operator has no record on file for the number of facilities). Marks are placed over the approximate center of the facilities and indicate the width of the corridor. The width of the corridor is the distance between the actual located outside edges of the combined facilities.

Example: a 12 in. corridor (12" CDR)

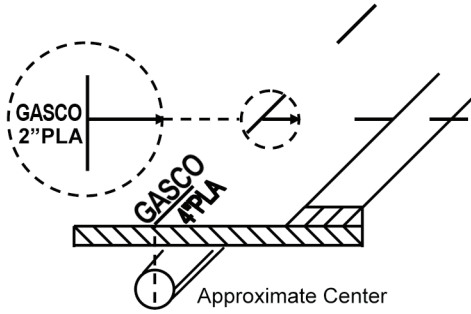


3. Changes in direction and lateral connections are clearly indicated at the point where the change in direction or connection occurs, with an arrow indicating the path of the facility. A radius is indicated with marks describing the arc. When providing offset markings (paint or stakes), show the direction of the facility and distance to the facility from the markings.

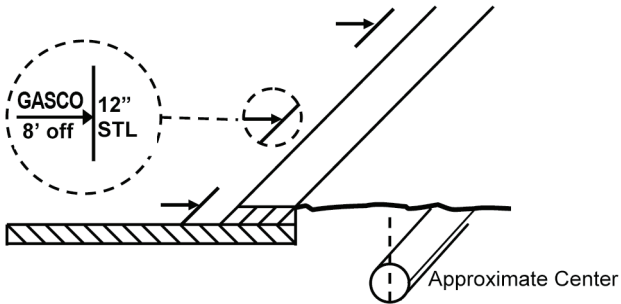
Example: radius



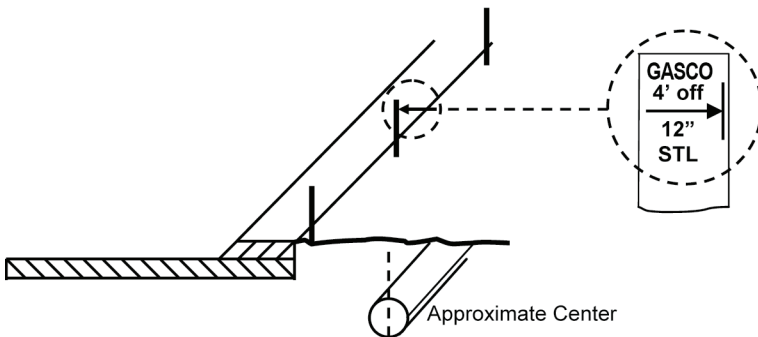
Example: lateral connection



Example: painted offset (off)



Example: staked offset (off)



- An operator's identifier (name, abbreviation or initials) is placed at the beginning and at the end of the proposed work. In addition, subsequent operators using the same color mark their company identifier at all points where their facility crosses another operator's facility using the same color. Reduce the separation of excavation marks to a length that can reasonably be seen by the operator's locators when the terrain at an excavation site warrants.

Examples:

CITYCO

ELECO

TELCO

- Information regarding the size and composition of the facility is marked at an appropriate frequency.

Examples: the number of ducts in a multi-duct structure, width of a pipeline, and whether it is steel, plastic, cable, etc.

TELCO
9/4" CAB

GASCO
4" PLA

WATERCO
12" STL

- Facilities installed in a casing are identified as such.

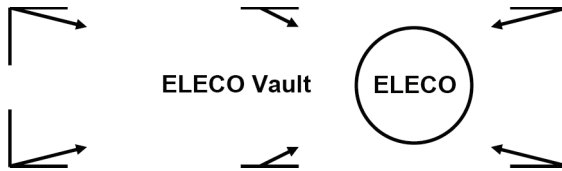
Examples: 6 in. plastic in 12 in. steel and fiber optic in 4 in. steel

GASCO
6" PLA/12" STL

TELCO
FO (4" STL)

- Structures such as vaults, inlets and lift stations that are physically larger than obvious surface indications are marked so as to define the parameters of the structure.

Example:



- Termination points or dead ends are indicated as such.

Example:



- When there is "No Conflict" with the excavation, complete one or more of the following:

- Operators of a single type of facility (e.g., TELCO) mark the area "NO" followed by the appropriate company identifier in the matching APWA color code for that facility.

Example: NO TELCO

- Operators of multiple facilities mark the area "NO" followed by the appropriate company identifier in the matching APWA color code for that facility with a slash and the abbreviation for the type of facility for which there is "No Conflict."

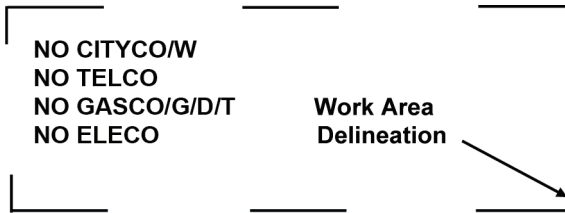
Example: NO GASCO/G/D illustrates that GASCO has no gas distribution facilities at this excavation site. The following abbreviations are used when appropriate: /G/D (gas distribution); /G/T (gas transmission); /E/D (electric distribution); /E/T (electric transmission).

- Place a clear plastic (translucent) flag that states “No Conflict” in lettering matching the APWA color code of the facility that is not in conflict. Include on the flag the operator’s identifier, phone number, a place to write the locate ticket number and date. Operators of multiple facilities indicate on the flag which facilities are in “No Conflict” with the excavation (see the previous example).
- If it can be determined through maps or records that the proposed excavation is obviously not in conflict with their facility, the locator or operator of the facility may notify the excavator of “No Conflict” by phone, fax or email, or through the 811 center, where electronic positive response is used. Operators of multiple facilities indicate a “No Conflict” for each facility (see the previous examples).
- Place “No Conflict” markings or flags in a location that can be observed by the excavator and/or notify the excavator by phone, fax or email that there is “No Conflict” with your facilities. When the excavation is delineated by the use of white markings, place “No Conflict” markings or flags in or as near as practicable to the delineated area.

Caution: Allow adequate space for all facility mark-outs.

“No Conflict” indicates that the operator verifying the “No Conflict” has no facilities within the scope of the delineation; or when there is no delineation, there are no facilities within the work area as described on the locate ticket.

Example:



Color Code Identifiers

White	Proposed Excavation
Pink	Temporary Survey Markings
Red	Electric Power Lines, Cables, Conduit, and Lighting Cables
Yellow	Gas, Oil, Steam, Petroleum, or Gaseous Materials
Orange	Communication, Alarm or Signal Lines, Cables, or Conduit
Blue	Potable Water
Purple	Reclaimed Water, Irrigation, and Slurry Lines
Green	Sewers and Drain Lines

Common Abbreviations

Facility Identifier

CH	Chemical
E	Electric
FO	Fiber Optic
G	Gas
LPG	Liquefied Petroleum Gas
PP	Petroleum Products
RR	Railroad Signal
S	Sewer
SD	Storm Drain
SS	Storm Sewer
SL	Street Lighting
STM	Steam
SP	Slurry System
TEL	Telephone
TS	Traffic Signal
TV	Television
W	Water
W	Reclaimed Water "Purple"

Underground Construction Descriptions

C	Conduit
CDR	Corridor
D	Distribution Facility
DB	Direct Buried
DE	Dead End
JT	Joint Trench
HP	High Pressure
HH	Hand Hole
MH	Manhole
PB	Pull Box
R	Radius
STR	Structure (vaults, junction boxes, inlets, lift stations)
T	Transmission Facility

Infrastructure Material

ABS	Acrylonitrile - Butadiene - Styrene
ACP	Asbestos Cement Pipe
CI	Cast Iron
CMC	Cement Mortar Coated
CML	Cement Mortar Lined
CPP	Corrugated Plastic Pipe
CMP	Corrugated Metal Pipe
CU	Copper
CWD	Creosote Wood Duct
HDPE	High Density Polyethylene
MTD	Multiple Tile Duct
PLA	Plastic (conduit or pipe)
RCB	Reinforced Concrete Box
RCP	Reinforced Concrete Pipe
RF	Reinforced Fiberglass
SCCP	Steel Cylinder Concrete Pipe
STL	Steel
VCP	Vitrified Clay Pipe

Guide for Abbreviation Use

Follow these guidelines when placing abbreviations in the field:

- Place the Company Identifier at the top or at the left of the abbreviations.
- Place the abbreviations in the following order: Company Identifier / Facility Identifier / Underground Construction Descriptions / Infrastructure Material

Example: TELCO/TEL/FO/PLA indicates that TELCO has a telecommunication fiber optic line in a single plastic conduit. The use of the abbreviation /TEL is not necessary, because the orange marking would indicate that the facility was a communication line; but its use is optional.

- To omit one or more of the abbreviation types, use the order described above but omit the slash and abbreviation that does not apply.

Example: to omit /TEL), the result would be TELCO/FO/PLA.

Guidelines for Underground Electronic Utility Marker Technology^{74/}

Underground electronic utility markers incorporate unique frequencies and/or data transfer capabilities to identify an underground asset. In general, radio frequency identification (RFID) has been in use for a few decades and incorporates unique frequencies for each type of utility; this allows locators and operators to identify specific types of underground utilities. Data-transfer RFID allows users to write to and read information from the marker. Advantages of utility-specific frequency RFID markers include greater depth of detection, no need to read data to identify a utility type, and tradition of use. Advantages of data-transfer RFID markers include utility agnosticism (does not require different frequencies to communicate utility type) and ability to write and read specific underground utility information from the marker.

Underground electronic utility markers fall into two primary use case categories:

point marking and path marking. Both device types generate an electromagnetic radio frequency to provide accurate location information. Point markers are installed along the vertical axis to identify the specific location of an underground facility feature, component or utility type. Path markers are installed along the horizontal axis along a buried underground facility and provide a running line direction and location of an underground utility. Examples of point markers include: ultra-high frequency (UHF) RFID subsurface tags, high frequency (HF) subsurface markers, UHF RFID magnets, active UHF RFID subsurface tags, marker balls, disk markers, near surface markers, full range markers, mini markers, box markers, tap tee markers, duct markers, and RFID tags. Path markers include intrinsically locatable plastic pipe, UHF RFID tape and rope, and HF RFID tape and rope.

Facility owners/operators consider several factors associated with the installation, location and data integration of electronic markers, including the following:

Installation Factors

- Signal drift, burial depth and power loss over time due to changing environmental conditions
- Signal loss that occurs with distance traveled
- Electronic markers' operating specifications to maximize underground facility and marker lifetime
- Ease of integration with other systems

According to VDOT's paper, Electronic RFID Marking and GPS Based Utility As-Built Mapping System, additional potential spacing protocols for electronic point marker placement for new construction are:

- Every 25 ft. along the facility path
- At significant horizontal and vertical changes in direction
- At critical utility crossings, tees and service connection
- On appurtenances that are important to the utility owner

Location Factors

The quality of the locating frequency may deteriorate if the underground utility marker is adjacent to a plurality of underground facilities with underground utility markers operating at a similar frequency. The following potentially applicable point marker locating frequencies, according to VDOT's paper (Electronic RFID Marking and GPS Based Utility As-Built Mapping System), can be used to avoid signal interference and identify and locate a specific utility type. The verification frequency associated with the RFID tag can vary.

Commonly-Used Frequencies for Various Underground Electronic Utility Markers

Underground Facility	Point Frequencies	Path Frequencies	US UHF RFID
Power	169.8 kHz	34.9kHz	902-928 MHz
Water	145.7 kHz	73.5kHz	902-928 MHz
Wastewater	121.6 kHz	41.4kHz	902-928 MHz
Telecommunication	101.4 kHz	48.8kHz	902-928 MHz
Gas	83 kHz	53.9kHz	902-928 MHz
Cable TV and Communications	77 kHz	48.8 kHz	902-928 MHz
General Purpose/ Reclaimed Water	66.35 kHz	44.9 kHz	902-928 MHz

Data Integration Factors

Additional factors are related to the storage and labeling of data tagged to an underground utility marker via RFID technology, including:

- Information to be stored with the unique identifier
- Metadata template definition and creation to promote data collection consistency and underground utility marker operation across varying technology solutions
 - Sample data elements to collect may include: asset type, asset material, asset class, asset owner, burial depth, latitude/longitude, EM manufacturer and emergency contact information.
- Underground utility marker with RFID tagging integration into routine QLA investigations (subsurface utility engineering quality level) to label the location and burial distance of the exposed pipe