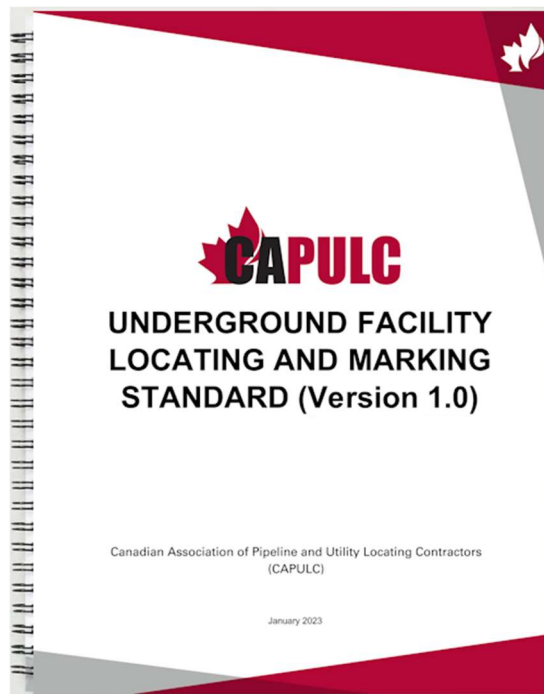


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# **UNDERGROUND FACILITY LOCATING AND MARKING STANDARD (Version 1.0)**

Canadian Association of Pipeline and Utility Locating Contractors  
(CAPULC)

January 2023

## ACKNOWLEDGEMENTS

This document was developed through the joint and continual support of all CAPULC (Canadian Association of Pipeline and Utility Locating Contractors) members.

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## **1 INTRODUCTION**

This standard provides the details related to the role of an Underground Facility Locator (“Locator”), in terms of planning for and conducting underground facility locating and marking in Canada. Areas of province-specific practices are noted and are beyond the scope of this document.

This document represents best practices based on the accumulated experience and consensus among the majority of CAPULC member companies for locating underground infrastructure and related tasks beyond those captured in regulation and current certification.

This document establishes a meaningful reference tool to enhance learning for a Locator and as a complement to the existing industry’s knowledge base and documentation (see Section 13).

## **2 PURPOSE**

The purpose of this document is to provide Locators with the necessary background and context regarding best practices for underground facility locating, beyond existing Canadian regulation. This document is not intended to be used in lieu of formal training, certification, regulation, or company-specific practices (which may vary based on individual circumstances); rather it is intended to provide complementary guidance to available sources of information.

## **3 SCOPE**

The scope of this document is limited to best practices for locating and marking underground infrastructure (e.g., electric power, lighting, communication and alarm cables; gas, oil, water, and sewer pipes). The document encompasses the entire process, from handling requests for underground facility locating, processing information, executing underground facility locating and marking work, to reporting guidelines for Locators. Additional relevant (federal) industry regulations and best practices can be found in Section 13.

## **4 REVISION TO THIS DOCUMENT**

This document will be reviewed periodically (as per existing CAPULC practices or as directed by the Board) to ensure the content within remains relevant and accurate. However, it remains the responsibility of the user to ensure that the most current version of documents (e.g., standards) are referenced, where appropriate.

## 5 HOW TO USE THIS DOCUMENT

To facilitate practicality and ease of use, this document is organized to reflect the typical locating and marking process for underground facilities and infrastructure. Foundational information common to all aspects of facility locating and marking is presented first, followed by sections specific to each step of underground facility locating and marking. Within each section, four main headings are used consistently:

- **Overview:** A brief description of the process step;
- **Inputs:** Detailed information regarding typical inputs the Locator may require;
- **Execution:** Detailed information regarding items the Locator should typically watch for. For ease of use, items are consistently formulated as actions using verbs such as ensure, monitor, confirm, and check; and
- **Outputs:** Detailed information listing typical items or records of activities the Locator may be required to produce for the Requestor.

The “Inputs” subsection within each section is intended to clearly identify the types of documents, specifications, and other information the Locator may need to gather and reference in that step of the process. The “Execution” subsection within each section provides detailed checklists, often grouped by major activities, identifying critical items that Locators should monitor in each step. Finally, the “Output” subsection within each section articulates items that the Locator is expected to produce or report on as it relates to that step of the process.

The use of the word “ensure” throughout this document is intended to convey that Locators make certain that the locating and marking work has been properly conducted through observing, monitoring, assessing, evaluating, verifying, deciding, resolving, reporting, and documenting to confirm that the locate requirements are met.

## 6 TERMS, DEFINITIONS, ACRONYMS, AND ABBREVIATIONS

**Table 1: Terms and Definitions**

<b>Term</b>	<b>Definition</b>
Active Locating	A method of locating an underground facility by means of signals (i.e., frequencies) generated by a transmitter.
Competency	An individual's proficiency in undertaking a specific function or set of tasks as characterized by four major components: theoretical knowledge, skill, experience, and behaviour.
Conductive Locating	A method of creating an electromagnetic field with a transmitter by employing a metal-to-metal connection between the transmitter and the pipe or cable to determine the location of metallic buried infrastructure. Also known as “Direct Connect”
Conductive Material	A material that allows the flow of electric current.

Term	Definition
Electromagnetic Locator	Equipment used for detecting conductive underground facilities (e.g., pipes and cables).
Electronic Marker	An electromagnetic device used to establish the location for underground infrastructure. See also <i>Marker Ball</i> .
Inductive Clamp	A device with an internal coil to clamp around an individual conductor, designed to induce a signal onto a conductor without making electrical connection or direct contact with the said conductor.
Inductive Locating	A method of applying an electromagnetic field from the transmitter onto a facility without a direct connection. The electromagnetic field is applied to the target facility by means of an inductive antenna in the transmitter. The transmitter is placed near the facility and the electromagnetic field is induced onto the facility to determine its underground location.
Locate Report	The output of the “Create Documentation” step. Alternatively known as a Locate Sheet.
Locator	An individual tasked with detecting infrastructure buried beneath the ground using specialized equipment.
Marker Ball	A specific type of electronic marker (i.e., with a coil tuned to a specific frequency).
Passive Locating	A method of locating metallic buried infrastructure where an electromagnetic field is not actively generated.
Private Locate Request	A request received directly from a Requestor (i.e., without going through any centralized notification service, such as One Call) to detect potential underground facilities in an area.
Public Locate Request	A request typically managed by a centralized notification service (e.g., One Call) to detect potential underground facilities in an area.
Requestor	An individual or entity proposing or intending to disturb the ground and requiring further information regarding underground infrastructure in the area.
Transmitter	A piece of equipment used to generate and transmit electromagnetic signals or fields to detect underground facilities.
Underground Facility	Specific buried assets such as pipes, cables, wires, ducts, conduits, and tanks used in connection with utility services.
Underground Infrastructure	The entirety of cables, lines, pipes, conduits, or structures used to gather, store, or convey products or services.



## 7 FOUNDATIONAL INFORMATION

The items covered in this section are those that are relevant through all steps of the underground facility locating and marking process (see Figure 1). As such, any specific content in other sections of this publication is intended to be used in conjunction with the information provided within this section.



**Figure 1: Typical Facility Locating and Marking Process**

The typical underground facility locating and marking process also forms the basis for information presented in the remainder of the document; the process can be summarized as follows: based on the locate request, the Locator searches for and identifies buried infrastructure with a defined physical location, reports on search findings, and may provide guidance to any party planning to conduct ground disturbance in the defined location. The Locator abides by Landowner and site access requirements, conducts, and monitors underground facility locating and marking activities in accordance with federal, provincial and/or municipal codes and standards; regulatory requirements; company-specific safety and environmental requirements, drawings, plans, and specifications; as well as the terms of the locating contract or agreement. The Locator may also support other damage prevention activities, if required.

### 7.1 Roles and Responsibilities

Locators performing locating and marking services may do so in response to either a public or private locate request and, as a result, specific details regarding the Locator's role can vary. Since this document is based on the typical role of a Locator, individuals should understand their role and requirements given the type and nature of the specific situation. In particular:

- Roles of the Locator should be established before performing the locating and marking work to align with any identified hazards, site access and/or permit requirements.
- If the Locator performs facility locating and marking unassisted and without any third-party quality verifications, the Locator should be clear about the level of quality checks to be implemented and make sure that facility locating and marking methods are correct. The Locator must also ensure that equipment used should be properly function tested with each use and be calibrated and/or certified to manufacturers recommendations.
- The Locator has “stop work” authority when there is imminent danger to people, environment and infrastructure, as one of the key responsibilities of the Locator is ensuring a safe work environment for all personnel as well as the public.

## **7.2 Code of Conduct**

As the Locator typically represents a Company and carries out services on behalf of the Requestor or Facility Owner, they should always act ethically, professionally, objectively, consistently, and honestly when performing the required roles and responsibilities. More specifically, the actual ethical conduct required from Locators is typically governed by the Company's Code of Conduct, which may include (but is not limited to) the items listed below.

- **Behaving in an Ethical Manner**
  - Abide by confidentiality agreements;
  - Not accepting gratuities of any kind that may be perceived to affect judgment in the work being performed as a Locator; if gratuities are offered, this information should be reported to the Company;
  - Endeavor to be fair, reasonable, and objective towards performing work requirements at all times;
  - Do not make assumptions; consult with the Requestor if there are uncertainties in the scope of work
  - Comply with all relevant codes, standards, systems, permits, contracts, agreements, specifications, procedures, approved drawings, line lists, etc., record any deviations from documentation, and when required, report in an appropriate manner for approval.
  
- **Professional Approach to Work**
  - Be knowledgeable of and understand the relevant parts of the underground facility locating and marking process;
  - Be knowledgeable of and understand a Company's standards and specifications;
  - Be knowledgeable of and understand relevant industry and government standards;
  - Ensure all applicable permits required to access the site and execute the work are in place prior to commencing the work;
  - Uphold a Company's industry practices to ensure safety, minimize risk, and avoid hazards in the workplace;
  - Understand the role relative to other stakeholders in the underground facility locating and marking process and engage other expertise accordingly;
  - Make accurate decisions by being well informed and familiar with all contract documents and locate requirements;
  - Obtain all applicable documents before the start of locating and marking activities;
  - If questions arise that cannot be answered, seek those that have the authority to resolve; and
  - Be proactive in problem solving and raise issues/concerns to the attention of the Requestor and/or designated supervisory authority.

- **Positive Image in Representation of Locating Service Company**
  - Behave in a courteous manner;
  - Conduct oneself in a respectable manner at all time including off-time hours;
  - Show respect through good driving habits on the right of way (ROW), and on public and private roads; and
  - Check the work area for good housekeeping and tidiness (e.g., equipment and consumables should be correctly handled, stored, and maintained).

### **7.3 Worker and Site Safety**

All Locators have “stop work” authority should a safety situation arise. In addition to safety items detailed in the following sections for specific steps of the marking and locating process, the Locator should also consider the items listed below.

- **General**
  - Understands their role and responsibility with respect to safety in the execution of the work
  - Conduct relevant safety checks prior to commencing safety sensitive work
  - Be aware of changes in work activities or site conditions that could impact safety (e.g., material change in weather, such as blizzard), along with any changes to precautions that need to be taken as a result of these changes
  - Promote a safe working environment of continuous improvement through communications of work issues and solutions
  - Confirm that required emergency response plans are in place
  - Monitor for compliance to safety regulations
  - Confirm that emergency and after-hours contact information is available and within reach on site
  - Ensure compliance to personal protective equipment (PPE) requirements
  - Ensure “safety zones” are identified at overhead powerline locations or areas with pedestrian traffic
  - Ensure certification for use of all-terrain vehicles (ATVs) and/or snow machines is up to date, when necessary
- **Safety Audits**
  - Participate in regular site-specific safety audits and communicate safety issues to the Company and/or Landowner

In support of a safe work environment, Company safety policies typically applicable to Locators include (but are not limited to) those listed below.

- Working Alone Policy
- Hazard Assessment Policy

- Restricted Work Areas Policy
- Confined Space Entry Practice
- Hearing Conservation Practice
- Manual Lifting and Carrying Practice
- Vehicle and Equipment Safety Practice
- Drug and Alcohol Policy
- Job Safety Analysis
- Fit to Work Policy
- Other Company or site-specific requirements, as applicable

#### **7.4 Environmental Considerations**

Compliance with applicable environmental regulations is a mandatory and shared responsibility among all Stakeholders. Typically, there is no unique individual assigned to oversee environmental compliance, however, all Locators have a responsibility for stewardship of the environment, as listed below.

- Be aware of any environmental concerns, special conditions, regulations, and specific permit conditions applicable to the site and the locate work itself (e.g., clubroot management procedure in agricultural areas);
- Ensure to minimize their disturbance or damage to the environment;
- In case of unanticipated disturbance or damage caused by locating activities, contact the Landowner or Requestor and mitigate as soon as possible to restore affected areas to their original condition (to the extent possible) in a manner satisfactory to the company the Locator represents, Landowners, and regulatory authorities;
- Ensure equipment is not fueled or serviced within specified distances of water bodies;
- Ensure that hazardous materials are stored away from specified distances of water bodies;
- Ensure that all debris (e.g., rags) and garbage is collected and disposed of to an approved facility off the work site;
- Report all wildlife deaths and nuisance animals to the relevant environmental authority;
- Ensure locating and marking activities avoid interference with the normal flow of water in any natural or manmade watercourse; and
- Ensure all environmentally sensitive material is properly disposed of.

#### **7.5 Records Management**

A critical element of the Locator's role is to support the record keeping, which is typically a requirement for the long-term management of underground facilities. For example, details captured during the "Performing Facility Locating and Marking" step of the locating process can be one of the critical pieces of information necessary when maintaining the underground facility. These details also support

the prevention of mechanical damage while performing any form of ground disturbance within the area in the future. While specific record keeping requirements are identified within each section, foundational requirements are listed below.

- Ensure the timely completion and submission of all required documentation to the Requestor
- Ensure all forms, reports, and submitted data are as complete and accurate as possible
- Obtain and retain formal approval, permit, and written agreement from the Requestor and/or Landowner prior to commencing any locating and marking activity on site
- Confirm that incident reports are completed and submitted to the supervising authority and appropriate stakeholders (e.g., Requestor, Facility Owner, Regulatory Authority) for the locate work
- Continually gather and document data to support a post-locate analysis and evaluation
- Retain records accessed during the planning step for the locating and marking work

## **7.6 Personnel Qualifications and Certifications**

Competency is an important aspect of an individual's qualification and is composed of the following four components:

- Theoretical knowledge;
- Skills;
- Experience; and
- Behaviour.

Theoretical knowledge (e.g., book knowledge) and skills (e.g., application of book knowledge under ideal conditions) are acquired more directly. Experience is achieved by applying the knowledge multiple times to address a wide range of situations and is gained over time. In contrast, behavior can be observed in the decisions or actions taken by the individual based on the combination of knowledge, skills, and experience as they apply to a specific situation. Facility Locators seeking to improve their competency are encouraged to take training programs that align with this standard and are offered by competent and qualified training providers.

For Locators to safely and effectively complete underground facility locating and marking, they should have a fundamental understanding of both the technical and non-technical concepts necessary for facility locating and marking. These areas of knowledge include, but are not limited to:

- Theory of electromagnetic locating (e.g., signals, Ohm's law, and capacitance);

- Use of transmitters and receivers (e.g., signal strength and receiver gain, antenna configurations, signal distortion, unwanted coupling, frequencies, output power, current and milliamps, and depth measurement);
- Knowledge of facilities (e.g., gas distribution, electric power, telecommunications, transmission pipelines, oil and gas facilities, and water and sewer systems);
- Application of visual observation skills (e.g., signs of facilities);
- Marking procedures, practices, and applicable guidelines (e.g., APWA colour code);
- Safety practices and regulations (e.g., site hazard identification and assessment and emergency response procedures);
- Locate request procedure, documentation, and mapping;
- Applicable federal, provincial, and municipal regulations; and
- Ground disturbance training.

In addition to the areas on knowledge, confirming the qualifications of locators allowed on site is an important element of ensuring safe facility locating and marking work as well as ensuring that the work meets an acceptable level of quality. Qualifications and certifications should also comply with applicable regulatory requirements or standards.

When required, the Locating Service Company should confirm that assigned Locators are properly trained and knowledgeable about application and operation techniques and locating and marking equipment and materials.

## 7.7 Types of Underground Facility Infrastructure

The types of underground facilities can vary significantly and the type of material the facility is constructed from will help to determine the specific considerations during the locating and marking process. For example, the electrical conductivity of the underground facility material is a major consideration when selecting techniques for performing the locate. Table 2 below describes the common material compositions found with the specific types of underground infrastructure.

**Table 2: Material Composition of Typical Underground Infrastructure**

	Underground Infrastructure	Material
1	Electrical distribution	<ul style="list-style-type: none"> <li>• Metal cables (e.g., copper, and aluminium)</li> </ul>
2	Gas distribution	<ul style="list-style-type: none"> <li>• Metal (e.g., carbon steel and aluminium)</li> <li>• Non-metal (e.g., concrete and polyethylene)</li> </ul>
3	Petroleum pipelines	<ul style="list-style-type: none"> <li>• Metal (e.g., carbon steel and aluminium)</li> <li>• Non-metal (e.g., concrete and polyethylene)</li> </ul>

	Underground Infrastructure	Material
4	Communication lines and cables (including shielded fibre optics)	<ul style="list-style-type: none"> <li>• Metal (e.g., copper) typically enclosed in plastic (i.e., polyethylene) sheath</li> </ul>
5	Potable water	<ul style="list-style-type: none"> <li>• Metal (e.g., galvanized carbon steel, cast iron, and copper)</li> <li>• Non-metal (e.g., cross-linked polyethylene [PEX], chlorinated PVC [CPVC], and acrylonitrile butadiene styrene [ABS] plastic)</li> </ul>
6	Storm water	<ul style="list-style-type: none"> <li>• Metal (e.g., steel)</li> <li>• Non-metal (e.g., PVC)</li> </ul>
7	Sanitary sewers	<ul style="list-style-type: none"> <li>• Metal (e.g., cast iron)</li> <li>• Non-metal (e.g., clay and high-density polyethylene [HDPE])</li> </ul>

## 7.8 Locating Equipment

### 7.8.1 Equipment Types, Usages, Advantages, and Limitations

There are different types of equipment used to locate underground infrastructure based on the properties of the facility. The choice of equipment is dependent on several factors such as specifics of the locate request, locating method, and material of the buried infrastructure.

Examples of equipment used to locate underground infrastructure are shown in Table 3 below, these equipment types should be used with caution in congested areas.

**Table 3: Electromagnetic Locating Equipment Types, Usage, Advantages, and Limitations**

Equipment Type	Method	Usage	Advantages	Limitations
Electromagnetic Locators	Active, conductive locating	Locate conductive facilities (e.g., carbon steel)	<ul style="list-style-type: none"> <li>• Provides the strongest signal for long distance locating</li> <li>• Multiple frequency and power output options</li> </ul>	<ul style="list-style-type: none"> <li>• Not suitable for live cable</li> <li>• Access points for target facility may not always be available</li> <li>• Not best suited for common bonded facilities</li> </ul>
	Active, inductive locating	Locate conductive facilities (e.g., carbon steel)	<ul style="list-style-type: none"> <li>• Easiest way to apply a signal</li> <li>• No cables required</li> <li>• Direct access to facility not required</li> <li>• Useful in searching for unknown facilities within the locate area</li> </ul>	<ul style="list-style-type: none"> <li>• Cannot locate non-metallic facilities without the use of conductive attachments</li> </ul>
	Passive locating	Locate conductive facilities using signals that originate from sources other than the transmitter	<ul style="list-style-type: none"> <li>• Can be used in three modes (i.e., radio, live/energized AC cable power, cathodic protection system)</li> </ul>	<ul style="list-style-type: none"> <li>• Unreliable signals</li> <li>• Unable to distinguish between conductive facilities in proximity</li> <li>• Insufficient as a stand-alone locating method</li> </ul>



Equipment Type	Method	Usage	Advantages	Limitations
Inductive Clamp	Active, inductive locating	Locate conductive facilities	<ul style="list-style-type: none"> <li>• Electrical contact with facility not required</li> <li>• Improved isolation of target facility</li> </ul>	<ul style="list-style-type: none"> <li>• Signal dissipates faster than active conductive method</li> <li>• Fewer frequencies available compared to direct connect method</li> <li>• Clamp is sometimes too small for target facility</li> <li>• Not suitable for high-voltage cables</li> </ul>

Although electromagnetic locators are the most reliable in detecting signals generated by alternating currents flowing along underground facilities, there are other technologies capable of detecting buried facilities. These technologies include:

- Ground penetrating radar (GPR);
- Magnetic locators; and
- Software based radio frequency identification (RFID).

Each facility locating method and equipment has its own limitations. These limitations may be related to obstacles faced during locating or problems encountered while tracing buried facilities. Therefore, Locators should use a combination of locating equipment to compensate for the limitations of each technology and maximize the chances of accurately locating underground infrastructure in any given area.

Common limitations to facility locating methods and equipment include:

- Facility changes: Changes in facility direction, depth, size, and material composition can cause signal distortion, fluctuations, and unwanted coupling. These changes can lead to misinterpreting signals, consequently leading to mis-locates.
- Technology limitations: There are no locating technologies without its limitations. It is unlikely to find a locating method and equipment that can detect all buried facilities irrespective of material composition, depths, or soil types. Most signals are affected by interference from nearby objects.
- Extreme environments: Extreme weather conditions (e.g., strong winds, heavy rain, lightning storm, heavy snow, extreme temperatures – hot or cold) can negatively impact the effectiveness of locating equipment. In these scenarios, the Locator's ability is impaired and/or the locating equipment may be damaged (e.g., the LCD on the receiver may freeze in extremely cold temperature). Also, thick vegetation, snow, pavement, concrete, ornamental stones, or soil conditions may impact electromagnetic signals, leading to mis-locates or undetected underground facilities.

### **7.8.2 Equipment Calibration**

Locating equipment is specialized and must follow manufacturers specifications for pre-use function testing, certified repair facilities and recommended intervals for calibration. It is the Locator's responsibility, prior to use, to complete a pre-use function test and ensure the locating equipment is properly calibrated and/or certified. This documentation should be readily available if requested.

## 7.9 Facility Marking

Underground facilities can be marked either physically (e.g., using colored stakes) or electronically (i.e., using RFID tags). In both cases, facilities should be marked in accordance with the APWA uniform colour code unless there is a site-specific or Facility-Owner-specific designated colour code.

Markings used may include one or a combination of the following and should consider Landowner requests.

- Paint;
- Chalk;
- Flags or stakes; and
- Brush / whiskers.

Locators should ensure that:

- Markers are clearly visible.
- Marker material is appropriate for the environment.
- Marker frequency is appropriate for the situation (e.g., more frequent marking of bends).
- Marker size is appropriate for the materials being used and the situation.
- Field markings should be easily viewed intervals, as specified by facility owner or at Requestor/Client request
- Field markings should denote the location of an underground facility's centerline.
- Offset markings (paint or stakes) are used to show the direction of the facility and the distance to the facility from the marking.
- Where two located facilities share the same colour code (e.g., telephone and cable TV lines), both facilities should be marked. In such cases, there may be a need to use a site-specific colour code or other distinguishing marks.

### 7.9.1 American Public Works Association (APWA) Uniform Colour Code

APWA uniform colour code is outlined in Table 4 below.

**Table 4: APWA's Uniform Colour Code**

Colour	Identification
White	Proposed excavation site(s)
Pink	Temporary survey markings
Red	Electric power lines, cables, conduit, and lighting cables
Yellow	Gas, oil, steam, petroleum, or gaseous materials

Colour	Identification
Orange	Communication, alarm or signal lines, cables, or conduit
Blue	Potable water
Purple	Reclaimed water, irrigation, and slurry lines
Green	Sewers and drain lines

Markers used to indicate underground facilities should include the following information:

- The appropriate colour for the facility-type as stated in APWA uniform colour code;
- An identifier for the Facility Owner (e.g., name, initials); and
- Description of facility, if required.

### 7.9.2 Electronic Markers

Electronic markers or marker balls can be used to mark underground electronic facilities. This is typically accomplished by assigning a unique frequency to the marker ball for an underground facility. The facility is identified by locating the marker ball that generates the assigned electromagnetic radio frequency. A Locator would need to be aware of the assigned frequency and, with the right equipment, be able to identify specific types of underground facilities and mark them aboveground using the associated APWA colour-code. Marker balls are typically company-specific and are associated with the underground facility at the time of installation.

### 7.10 Incident Reporting

Incidents may occur if proper facility locating and marking measures are not taken before ground disturbance activities. The causes of these incidents may include, but are not limited to, the following:

- Failure to identify and mark facilities at adequate intervals;
- Failure to sufficiently mark located facilities (i.e., marking not easily visible);
- Failure to accurately locate and mark facilities;
- Failure to verify a locate;
- Failure to adequately communicate and provide documentation; and
- Failure to verify records.

Should an incident occur, the Locator is expected to assist the Requestor and/or the Facility Owner (and, where necessary, the local authorities) in conducting a formal and objective incident report. In particular, if an incident occurs, it is recommended that the Locator, as soon as practical:

- Takes action to ensure injuries are attended to and/or emergency services contacted;
- Reports all injuries, vehicle incidents, near misses, and any unsafe conditions to the company they represent and the Requestor;
- Participates in incident investigations (as required); and
- Report incidents to Damage Information Reporting Tool (DIRT).

Locators are encouraged to report incidents (e.g., facility damage, near-misses) to DIRT, an online database that allows anonymous reporting and collates data on incidents that, when analysed, help industry Stakeholders identify opportunities to improve safety.

## 8 RECEIVE REQUEST FOR FACILITY LOCATING AND MARKING

### 8.1 Overview

Receiving a locate request is the first step towards detecting and marking facilities at a specific site.

### 8.2 Inputs

There are multiple ways for a Locator to receive a locate request depending on the type of locate request (i.e., public, or private locate request). Table 5 below outlines the typical ways a Locator will receive the request. The level of information received depending on the type of locate request can vary significantly.

**Table 5: Types of Requests a Locator May Receive**

Type of Request	Description
Public	Typically received through a notification service (e.g., One Call Centre) or directly from the Facility Owner when they have received it through a notification service. <ul style="list-style-type: none"> <li>• Necessary data (e.g., drawings) and access to facilities are provided to the Locator through the notification service.</li> </ul>
Private	Typically received directly from the Requestor. <ul style="list-style-type: none"> <li>• The Locator requests for necessary data about the locate from the Requestor. The Requestor may not have all the information available to pass along (e.g., drawings, records).</li> </ul>

### **8.3 Execution**

A locate request should include, at minimum, the following:

- Requestor name;
- Requester phone number;
- Requestor company name (if applicable);
- Requestor company address (if applicable);
- Requestor company phone number (if applicable);
- Location of the proposed ground disturbance (e.g., address, legal land description);
- Start date and time of the ground disturbance; and
- Description of the ground disturbance.

Depending on the situation, additional information (e.g., Requestor email, postal code of site, and lot number of site) may be captured with the request to ensure the site can be found.

### **8.4 Outputs**

Once the locate request has been received, the Locator plans a response to the locate request. In some cases, the request may be cleared without a field locate.

## **9 PLAN FACILITY LOCATING AND MARKING**

### **9.1 Overview**

Planning is an integral part of facilities locating and marking and refers to the activities that must be done prior to any field work needed for the identification of underground infrastructure and placement of markers (e.g., stakes, pins, lath, and hubs). This stage requires gathering as much information as possible, from a broad range of sources, to increase the confidence level of any work completed in the field.

### **9.2 Inputs**

When preparing for facility locating and marking, the Locator uses the locate request information as a starting point for gathering additional information about the site conditions and expectations.

### **9.3 Execution**

The Locator should typically gather information from a variety of sources about the facilities that may be present at the work site and familiarize themselves with overall site conditions. Typical information needed for planning a facility locate is identified in

Table 6 below and should be reviewed prior to executing locating activities, if applicable.

**Table 6: Information Needed to Plan a Facility Locate**

Information Type	Guidance	Information Source
Drawings	Drawings refer to approximate locations of the site without full surveys or GPS locations (e.g., drawings may not be to scale). Drawings should be referenced to identify the expected location of underground facilities. Typical examples include access road drawings and sketches.	Locator records
Surveys	<p>Surveys refer to all designs and specifications developed by the Facility Owner, such as:</p> <ul style="list-style-type: none"> <li>• Issued-for-Construction (IFC) drawings;</li> <li>• Line lists (e.g., special concerns for each Landowner);</li> <li>• GPS or other datum coordinates and elevations;</li> <li>• Site and appurtenance surveys;</li> <li>• Boundary surveys;</li> <li>• Building permit surveys;</li> <li>• Construction surveys; and</li> <li>• Legal/registered plans of survey (i.e., dispositions).</li> </ul>	<ul style="list-style-type: none"> <li>• Facility Owner</li> <li>• Third-party databases (e.g., AbaData, GDM)</li> <li>• Publicly available sources (e.g., Land titles)</li> <li>• Publicly available databases (e.g., Provincial government registry)</li> </ul>
Public / Third-Party Databases	Public or third-party databases can be used to understand the conditions of the site. The weather, overall terrain, ground conditions, and land usage (e.g., public, military, agriculture, or water-based crossing) will inform Locators of how they should prepare (e.g., appropriate clothing and whether additional equipment, such as ATVs, is needed).	<ul style="list-style-type: none"> <li>• Publicly available platforms (e.g., Google Maps)</li> <li>• Third-party databases (e.g., AbaData, GDM).</li> </ul>



Information Type	Guidance	Information Source
Contracts	<p>Relevant contracts and agreements are those that were already in place and relate to:</p> <ul style="list-style-type: none"> <li>• Road use;</li> <li>• Crossings for buried facilities;</li> <li>• Landowner agreements; and</li> <li>• Third-party crossing agreements.</li> </ul>	<ul style="list-style-type: none"> <li>• Requestor</li> <li>• Facility Owner</li> <li>• Landowner</li> </ul>
Permissions and Permits	<p>Permissions may be written or verbal. Permits are often obtained when access to a site is required.</p> <p>Permits may relate to:</p> <ul style="list-style-type: none"> <li>• Environmental considerations;</li> <li>• Road use; and</li> <li>• Third-party crossings.</li> </ul>	<ul style="list-style-type: none"> <li>• Requestor</li> <li>• Landowner</li> <li>• Facility Owner</li> <li>• Government Agencies</li> </ul>
Safety Plans	<p>The Locator service company's specific safety plans and other safety-related documents, include (but are not limited to):</p> <ul style="list-style-type: none"> <li>• Traffic control plans;</li> <li>• Requirements PPE; and</li> <li>• Emergency response plans.</li> </ul>	<ul style="list-style-type: none"> <li>• Requestor</li> <li>• Facility Owner</li> <li>• Locator service company</li> </ul>
Other	<p>Other project-specific considerations may relate to site access limitations and past work orders.</p>	<ul style="list-style-type: none"> <li>• Requestor</li> <li>• Facility Owner</li> <li>• Locator service company</li> </ul>

In addition to gathering information on the site conditions from a range of sources, the Locator should also ensure that sufficient information is available to identify the appropriate locating and marking equipment necessary to conduct the locate. The Locator uses the information gathered to prepare the appropriate equipment required for the locating and marking phase.

#### **9.4 Outputs**

Once the locate has been planned, the Locator confirms the scheduled date for the locating and marking work and can then proceed with executing, based on the plan.

### **10 PERFORM FACILITY LOCATING AND MARKING**

#### **10.1 Overview**

This step of the facility locating process involves selecting and calibrating (if necessary) the equipment and applying appropriate locating methods to locate buried facilities. Depending on the type of underground infrastructure in the area, the Locator may use one or more locating methods and different equipment to detect buried facilities. Each located facility is subsequently marked based on APWA uniform color codes, unless specified otherwise by the Requestor.

#### **10.2 Inputs**

To perform underground facility locating and marking on site, the Locator relies on the plan developed during the planning step. In some cases, a plan developed prior to being on site may be changed for various reasons (e.g., site condition, facilities on site but not on record).

#### **10.3 Execution**

Typical activities that the Locator undertakes when performing underground facility locating and marking are identified in Table 7 below.

**Table 7: Facility Locating and Marking Activities**

Item	Description
Conduct Safety Checks	<p>To minimize hazards on the site when performing a locate, the Locator should:</p> <ul style="list-style-type: none"><li>• Ensure communication with other personnel on site (e.g., excavating Contractors);</li><li>• Become familiar with site safety requirements and emergency procedures (e.g., required PPE);</li><li>• Evaluate the vehicular and/or pedestrian traffic control status on site (e.g., evaluate traffic pattern and density);</li><li>• Assess surrounding environmental factors (e.g., weather conditions);</li><li>• Identify nearby sources of energy (e.g., overhead powerlines); and</li><li>• Identify trip and fall hazards (e.g., slippery surfaces).</li></ul>
Assess Environmental Conditions	<p>Environmental conditions that need to be considered and can impact locating and marking include:</p> <ul style="list-style-type: none"><li>• Weather conditions (e.g., heavy rain and snow, high winds, high tides, and extreme temperatures);</li><li>• Disruptive noises;</li><li>• Terrain conditions (e.g., type of vegetation);</li><li>• Restricted areas (e.g., Indigenous traditional lands and no entry zones for ATVs);</li><li>• Cleaning requirements (eg. clubroot); and</li><li>• Soil conditions.</li></ul>
Perform Visual Observation (Pre-Locate)	<p>Prior to on-site locating and marking, the Locator performs a visual observation of the work site to ensure that facilities at the site match those shown on information sources (e.g., records). The Locator may also conduct a job briefing, if necessary. At the site, the Locator can use visible indicators to identify the possible existence of an underground facility. To achieve this, the Locator looks out for indicators, including:</p> <ul style="list-style-type: none"><li>• The facility's plant features (e.g., utility poles, pedestals, gas meters, and manhole covers);</li><li>• The facility's ROWs (e.g., cutline); and</li><li>• Signs of previous ground disturbance (e.g., excavation scars).</li></ul>

Item	Description
Select Locate Method and Equipment	<p>Typically, active conductive locating is preferred over other locating methods and equipment. Where active conductive locating is not feasible, a combination of active inductive locating, passive locating, and/or any other locating method and equipment may be used. Depending on the chosen locating method(s), to improve the chances of accurately locating underground facilities, the Locator should:</p> <ul style="list-style-type: none"> <li>• Perform equipment operation checks or tests per the manufacturer's instructions;</li> <li>• Confirm proper equipment calibration requirements and initiate corrective action for equipment, if necessary;</li> <li>• Correctly place the transmitter and ensure all connections are correctly installed, including grounding, where applicable;</li> <li>• Correctly use direct connection, induction clamps, and/or any chosen equipment;</li> <li>• Adjust the frequency, sensitivity, and/or gain of applicable equipment to allow for the best possible facility detection;</li> <li>• Identify the most effective frequency, as required;</li> <li>• Correctly the use circle sweep, tracing, or blind sweep to establish the existence and approximate horizontal alignment of buried facilities;</li> <li>• Place the receiver at the required distance from the transmitter to avoid air coupling; and</li> <li>• Adequately recognize and react appropriately to abnormal operating conditions.</li> </ul>
Conduct Marking	<p>Located facilities are adequately identified depending on surrounding environmental conditions. Locators adapt the marking process to suit the weather, land use (e.g., agricultural), and existing surface conditions. Once on the site, the Locator should re-evaluate their plan, then confirm and execute the following:</p> <ul style="list-style-type: none"> <li>• Colour of selected markings for located underground facilities follow APWA uniform colour codes, unless communicated otherwise;</li> <li>• Markings are placed such that the horizontal alignments of located facilities are clear and unambiguous; and</li> </ul>

Item	Description
	<ul style="list-style-type: none"> <li>• Markings are clear and consistent with the foundational requirements identified in Section 7.8.</li> </ul>
Create Sketch	The Locator should create one or more detailed sketches or drawings as part of the locate record.
Take Photos	The Locator should take photographs or note GPS location and points of reference for the work area.
Conduct Quality Checks (Visual Inspection During and After the Locate)	<p>To ensure the integrity of the locate, Locators also conduct visual inspection and checks during and after performing underground facility locating and marking. The checks performed by the Locator include:</p> <ul style="list-style-type: none"> <li>• Verifying that all facilities are located and marked within the work area as per the locate request;</li> <li>• Comparing records to existing conditions and/or results of locate work; and</li> <li>• Identifying, documenting, and communicating any identified discrepancies to the Requestor, Facility Owner, Landowner and/or notification service as appropriate.</li> </ul>

## 10.4 Outputs

After performing the facility locating and marking work, the Locator is required to report on completed locate work such that the report satisfies the requirements of the locate request within relevant federal, provincial, or municipal regulations, as well as any applicable Company or Owner policies. At this stage, the following information may be captured:

- Acknowledgement indicating verification that all facilities requested for locating and marking were identified;
- Photographs of key reference points at location / work area;
- GPS location and/or measurements of key reference points at location / work area;
- Detailed sketch showing all located facilities and reference points;
- Record identifying key discrepancies and/or locating challenges or difficulties; and
- Other project-specific metadata related to the site.

In addition, results of completed locate work should be communicated to relevant Stakeholders.

## 11 CREATE DOCUMENTATION

### 11.1 Overview

To complete the locate process, it is necessary to provide clear and sufficient information that captures and confirms the output of the locate activity in the form of a locate report. This information should be provided in a report that is legible and that groups similar types of information in a logical and consistent order. The information provided in the report should be structured such that users of the report who plan to conduct ground disturbance activities are able to correlate the facilities on the report with the marks in the field and understand the instructions, warnings, and limitations of the locate.

### 11.2 Inputs

To create the necessary documentation after the completion of a locate, the Locator collates and documents information gathered and verified during the locate.

### 11.3 Execution

Typical activities performed to create the necessary report for the locate work are listed in Table 8 below. The final number of reports provided to the Requestor or Facility Owner may vary depending on the nature of information captured while executing facility locate activities.

**Table 8: Activities for Creating Locate Documentation**

Activity	Description
Choose Locate Report Format	Locate report formats can be electronic or paper. <ul style="list-style-type: none"><li>• Electronic: Each page of the Locate report should be accessible, legible, and viewable in its entirety for the Requestor or Ground Disturber.</li><li>• Paper: Locate report should be accessible, legible, and free of defects for the Requestor or Ground Disturber, with a minimum document size of 8.5 in. by 11 in.</li></ul>
Populate Locate Report	The primary locate report captures core information about the executed locate and marking activities.

Typical information that may be captured in a Locate Report is listed below.

- Sketches or drawings indicating approximate horizontal alignments of located facilities
- Locator name
- Date locate was performed
- Requestor and/or Facility Owner name

- Location of work
- Contact information for Locator, Requestor and/or Facility Owner
- Site-specific marking system
- Area scanned or work-area boundary
- Surface equipment or structures
- Type of locating equipment used
- Facilities located
- Size, type, and material of facility
- Legend, measurements, and/or coordinates of facility
- Locating limitations, obstacles, errors, or omissions (e.g., captured as stamps, stickers or warning messages)
- Locate conflict, if applicable

#### **11.4 Outputs**

The output of this step is a completed, error-free report that can be clearly communicated to the Requestor.

## **12 SEND FINAL DOCUMENTATION**

### **12.1 Overview**

Sending the locate report and supporting documentation is the final step in the locating and marking process.

### **12.2 Inputs**

The completed report from the previous step is the main input for this step along with the contact information of the Requestor.

### **12.3 Execution**

The locate report is sent to the Requestor and/or Facility Owner via email or by providing an access link to an online location where the locate report has been uploaded.

### **12.4 Outputs**

Once the final documentation has been provided to the Requestor, the Locator has completed the locating and marking for the site. Documentation from the locate activity is archived according to Company-established record keeping procedures.

In some scenarios, the Requestor may provide feedback to the Locator about locate records provided after the locate work has been performed. Any update implemented by the Locator is dependent on the nature of feedback provided by the Requestor. If necessary, the locate report may be updated based on new information.

## 13 REFERENCES

- American Public Works Association. (1999). *Uniform colour code*. Retrieved from <https://www.apwa.net/Library/Resources/Uniform-Color-Code.pdf>
- Applied Science Technologists and Technicians of British Columbia. (2015). *Underground Utility Locator Certification Board Policy*. Surrey, BC: Author.
- Canadian Association of Pipeline and Utility Locating Contractors. (2006). *Canadian Locator Technician Standards: Version 1*. Canada: Author.
- Canadian Common Ground Alliance. (2018). *Underground Infrastructure Damage Prevention Best Practices: Version 3.0*. Calgary, AB: Author.
- Canadian Standards Association - CSA Group. (2015). *Damage Prevention for the Protection of Underground Infrastructure*. (CSA Z247-15).
- Canadian Standards Association - CSA Group. (2020). *Mapping of Underground Utility Infrastructure*. (CSA Z250:20).
- Common Ground Alliance. (n.d.). Best Practices Guide: *Definitive Guide for Damage Prevention and Safety version 18.0*. Home. Retrieved from <https://bestpractices.commongroundalliance.com/>
- Locate Management Institute. (2020). *Underground Facility Locator's Field Task Competency Manual: Version 3.0*. Canada: Author.
- Hill, D., Ireland, Y., Yaremko, J., Harvey, C., & Sahney, R. (2020). *Investigation and adoption of APGA's pipeline engineer competency system: The Canadian experience*. International Pipeline Conference. Calgary, AB, Canada. <https://doi.org/10.1115/ipc2020-9561>
- National Utility Locating Contractors Association (NULCA) – representing utility locating professionals (n.d.). *Accreditation*. Retrieved from <https://www.nulca.org/Accreditation>
- Radio detection, an SPX Company. (2008). *The Theory of Buried Pipe and Cable Location*. Concord, ON: Author.