CGA DIRT

Damage Information Reporting Tool

2021 ANALYSIS & RECOMMENDATIONS

Vol. 18

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Dear Damage Prevention Stakeholders,

The Common Ground Alliance and our Data Reporting & Evaluation Committee are pleased to issue the only comprehensive accounting and analysis of damages to buried infrastructure in the U.S. and Canada with the release of our 2021 DIRT Report and Interactive Dashboard.

With the implementation of the Infrastructure Investment and Jobs Act in addition to already-high construction activity, the publication of the DIRT Report coincides with a critical moment in damage prevention. As we face increasing excavation activity across the U.S., it has never been more important for stakeholders to understand how and why buried facilities are damaged. Our analysis of damage trends reveals that over the last three years, damages have plateaued or slightly increased, while the root causes of these incidents have remained remarkably consistent.

As our Nation focuses on building – and rebuilding – its critical underground infrastructure, I urge every stakeholder to focus your damage prevention efforts on the recommendations found on pages 6-9, and to share the DIRT Report's important findings with your industry colleagues. Targeting outreach and training efforts on the persistent damage root causes will help the industry achieve the next meaningful breakthrough in reducing annual damages.

While we must tackle the issues that consistently contribute to damages, the industry must also commit to improving the quality of data submitted to DIRT. Better data means we can more accurately identify areas in which we need to focus our work – from stakeholder outreach to specific educational efforts. If you are not aware of your organization's Data Quality Index (DQI) score – or if your organization does not submit damage and near-miss data to DIRT – please work within your organization to understand and improve your data collection and submission processes. You can find submitter profiles that highlight organizations with high DIRT DQI scores on pages 53-55 that may be helpful.

Improving the quality of damage prevention data comprises an entire category of recommendations in our 2021 DIRT Report and is echoed by many of our other programs and initiatives, including the industry-advancing work of CGA's Next Practices Initiative. As CGA's work with Next Practices, Best Practices, DIRT and our newest arm – the Damage Prevention Institute – highlights, the industry needs more high-quality data as well as data-driven methods for evaluating the effectiveness of education and training programs, the efficacy of practices such as electronic white-lining, and the impact of investments in GIS mapping and other technologies in order to take the next steps toward our long-term goal of zero damages.

Please join me in thanking the Data Reporting and Evaluation Committee for their diligent work in preparing the important analysis and thoughtful recommendations included in this report. I also ask that you examine the self-evaluation questions on page 8, and consider how your organization can improve your damage prevention data and practices. These questions are especially helpful as you think about your stakeholder group's shared accountability in damage prevention.

Without the valuable time and information provided by our members and committees, CGA would not be able to produce our annual DIRT Report and recommendations. In addition to the key takeaways in the 2021 DIRT Report, be sure to visit the DIRT Interactive Dashboard to explore the data that is most relevant to your organization or stakeholder group.

Be safe,

Sarah K. Magruder Lyle
President & CEO
Common Ground Alliance

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EXECUTIVE SUMMARY

DAMAGE AND ROOT CAUSE TRENDS

- Statistical models used for three-year trend analysis point to an overall plateau or slight increase in damages since 2019.
- Increased construction spending has consistently proven to correlate with an increase in damages. Anticipated funding from the Infrastructure Investment and Jobs Act directed to communities across the U.S. is predicted to stress an already inundated damage prevention system.
- Locate requests to 811 centers (one call centers) increased by 8% over the previous year, with 811 centers seeing a significant shift in locate request methodology toward electronic rather than voice.
- Led by water and followed closely by sewer and telecom, utility work is the most prevalent type of work performed when damages occur.
- *No notification made to 811 center* remains the top root cause with over a quarter of all damages still attributed to *no notification*. CGA excavator research tells us that professional excavator awareness of 811 is very high,[1] yet 60% of all damages due to *no notification* can be attributed to professional excavators. It is important to note that 36% of those professional excavators failing to contact 811 were likely working on projects associated with utilities (natural gas, electric, telecommunications) and/or municipalities (water, sewer, road, sidewalks, etc.).
- Many damages involving Horizontal Directional Drilling (HDD) can be attributed to facility operators, or their subcontractors, hitting each other and/or themselves.
- Root cause analysis continues to paint a very clear picture. The vast majority of damages are caused by a limited number of issues: (1) digging without notification to the one call center/811; (2) excavators failing to pothole and failing to maintain sufficient clearance between digging equipment and buried facilities; and (3) facilities not being marked or being marked inaccurately due to locator error and/or incorrect facility records/maps.

SPOTLIGHTS ON KEY FACILITY TYPES (NATURAL GAS VS. TELECOM) AND EVENT SUBMITTERS (EXCAVATORS, ROAD BUILDERS AND ENGINEERING)

- Natural gas and telecommunications (including cable TV) are the facility types which incur the most damages, with excavation practices contributing to the majority of natural gas damages and locating practices contributing to the majority of telecom damages. Telecom facilities are damaged at shallower depths and by facility owners themselves, their subcontractors, or other service providers within their own industry about twice as often as natural gas facilities.

[1] 84% of professional excavators are aware of 811, according to CGA's 2019 national excavator survey.

- When excavators, road builders and engineering firms enter damages directly into DIRT, their reports have a much higher DQI than reports attributed to those sources submitted through 811 centers. These stakeholder groups are most likely to report damaging telecommunications facilities and point to locating practices as the root cause. Nearly a quarter of damages reported by excavators included downtime but improving the overall quality of excavator reports could help better quantify work stoppages incurred when utilities are damaged on the jobsite.

IMPACT OF DATA QUALITY

- Improving the quality of DIRT reports would give the industry a much clearer picture of how and why damages occur, and therefore more effective recommendations for reducing damages and near misses.
- Leaving fields blank and/or selecting “unknown/other” dramatically reduces the DQI of DIRT reports and the usefulness of the information.
- Several organizations with high DQI scores are profiled to reveal best practices in achieving informative datasets.

RECOMMENDATIONS

The following recommendations highlight specific actions for industry consideration across the damage prevention process as well as opportunities to enhance data analysis moving forward.

PRIORITIZE DAMAGE PREVENTION EFFORTS BASED ON IMMEDIATE NEEDS AND GREATEST IMPACT

- **Increase damage prevention outreach and stakeholder communication as rollout of the Infrastructure Investment and Jobs Act increases construction activity across the U.S.** DIRT analysis continues to establish a correlation between construction spending and total damages. As funds are directed toward the improvement of some of the facilities which have the highest incidence of damage during utility work – water, sewer and telecommunications infrastructure – the damage prevention process will be impacted. Increased outreach before and during projects will be instrumental to limiting damages to these utilities and surrounding facilities.
- **Strengthen engagement with public works stakeholders.** Municipal work such as water and sewer are the leading type of work being performed when a damage occurs. DIRT analysis tells us that other facilities such as natural gas and telecommunications are the most damaged facility types during municipal work. Increasing public works participation in damage prevention efforts at the local and national level will be increasingly important.
- **Educate professional excavators on areas with the greatest potential impact on damage prevention – consistent and efficient use of 811 for *all* projects, and safe excavation within the tolerance zone.** Measuring effectiveness of existing educational content and ensuring that new content targets the areas of greatest potential impact will ensure educational resources are being utilized effectively. Stakeholders can deploy available resources, such as CGA's video series "Tips for Effective Use of 811," that provides messaging on the important role excavators play in maintaining an efficient damage prevention process.
- **Tailor damage prevention efforts and investments to address the leading individual root causes.** The issues that consistently rise to the top each year are: (1) digging without notification to the 811 center; (2) a combination of failure to pothole and failure to maintain clearance between digging equipment and buried facilities; and (3) locating issues, with more accurate mapping consistently identified as an area with most potential to bring down damages.

INCREASE OPPORTUNITIES FOR ANALYSIS BY IMPROVING DATA EFFECTIVENESS

- **Improve data quality and reporting by industry.** High quality data is essential to identifying the factors that contribute to damages and near misses and ultimately to developing effective corrective actions. Large percentages of DIRT responses with "unknown" or left blank result in an inability to truly assess and understand the issues leading to damages.

- **Know your Data Quality Index (DQI) and identify steps for improvement going forward.** DQI measures the completeness of your data records. Reach out to CGA staff for assistance in interpreting your DQI and identifying opportunities for improvement.
- **Increase DIRT reporting directly from excavators.** The reports submitted directly from excavators are usually high quality, but the quantity is lower as the majority of excavator-attributed reports come via 811 centers (one call centers).
- **Enhance data collection process used by telecom/communications companies to gather more detailed incident information.** Locating Practices is the leading root cause group for damages to telecommunications and cable facilities. *Marked inaccurately* and *not marked due to locator error* are the leading individual root causes. Additional follow-up has shown that these more general root causes are selected, but often mask a more specific root cause such as issues with mapping, tracer wire or abandoned facilities. More granular data would be valuable for the entire damage prevention community, but more importantly, would prove to be valuable for telecommunication companies and would help identify the leading opportunities to reduce damages and repair costs.

IDENTIFY OPPORTUNITIES FOR ADDITIONAL ANALYSIS AND DOCUMENT EFFECTIVE STRATEGIES

- **Gather information on key motivating or influencing factors affecting an excavator's decision to contact 811, with the goal of separating out lack of awareness.** With failure to notify the 811 center remaining the top individual root cause of damages year after year, yet excavator awareness of 811 remaining high, it is imperative that we begin to better understand and address the reasons that 811-aware excavators do not always notify.
- **Identify new strategies to increase consistent use of 811 on every project (and document results).** Whether working with high-volume excavators within a state's 811 system or facility owner/operators' excavating subcontractors, finding opportunities to incentivize and increase consistent and responsible use of 811 on every project could lead the industry to its next significant reduction in damages to buried utilities.
- **Document effectiveness of specific policies, enforcement models and training/educational programs on prevalence of excavator errors in the field.** Finding more direct methods for evaluating the effectiveness of damage prevention training and education programs by tying them to excavators' damage data will help the industry better understand which educational interventions are most effective in achieving behavior change.
- **Identify methodology to measure and document the impact of greater availability of improved/accurate maps on the damage prevention process.** Leading-edge facility owner/operators are investing in improving their facility maps, and both CGA's Next

Practices Initiative and Locator White Paper have identified improved mapping as one of the most efficient paths for addressing locating issues and ultimately reducing damages. Being able to tie mapping investments and improvements to better damage prevention outcomes would support the business case for more facility owner/operators to make crucial mapping upgrades.

DIRT REPORT – OPPORTUNITY FOR SELF-EVALUATION

Examine your organization and stakeholder group's impact, role in the damage prevention process and potential opportunities for improvement.

- Are you collecting and submitting the highest quality DIRT data available to your company/industry? How are you utilizing this data to improve your damage prevention practices within your own company?
- Are you taking steps to minimize "noise"[2] in the 811 system?
    - Excavators: Does your number of locate requests accurately reflect your current workload?
    - Facility Owner/Operators: How many "renotification" requests are you submitting throughout the life of your facility maintenance and new construction projects?
- Are you requiring everyone that works for you or on your behalf to follow the most effective and proven safe digging practices to reduce the likelihood of the top root causes of damage?
    - Facility Owner/Operators or Project Owners: Do you insist on potholing by your contractors and ensure this is built into their project costs? If you are a utility company that uses vendors for locating or subcontracts excavation work, do you use contracts that incentivize following safety and damage prevention processes and procedures?
    - Excavators: Do your employees know they will not be penalized for any project delays caused by adhering to the 811 process? Do you require specific training for excavation within the tolerance zone?
- Are you using/investing in new technologies to improve mapping, locating and GIS data?
- Do you prioritize safety and damage prevention in your organization/company? If so, do you communicate that effectively to your employees?

[2] "Noise" is defined as locate requests that detract from locators' ability to process tickets and provide marks where and when they are actually needed. Practices that contribute to "noise" include:

- Locate requests for more work sites than can reasonably be started before the tickets expire.
- "Emergency tickets" that are not really emergencies.
- "Just-in-case" tickets so crews are not idle if work sites are not located on time.

INTRODUCTION - UNDERSTANDING THE DATA

INFORMATION COLLECTED AND SOURCE OF DATA

The Damage Information Reporting Tool (DIRT) collects underground damage and near miss reports from stakeholders across the U.S. and Canada. The database is used to identify the characteristics, themes and contributing factors leading to damages, downtime and near misses. The findings are summarized in the annual DIRT Report, and key findings inform CGA programs such as Next Practices, Best Practices and stakeholder white papers, as well as industry-wide damage prevention education and outreach initiatives.

Data is submitted into DIRT by a variety of stakeholders: facility owner/operators, locators, excavators, 811 centers (one call centers), and state and federal regulatory agencies. DIRT reporting is voluntary and confidential. However, some states' laws and/or rules require reporting all or some specific facility type events to DIRT.

DEFINING DAMAGES, EVENTS AND DATASETS

Understanding the differences between key terms such as **reported events** and **unique events** is critical to an accurate reading of the figures and tables on the following pages. Please review Appendix A for a complete glossary of terms used in the 2021 DIRT Report.

- **Damage** – Any impact or exposure that results in the need to repair an underground facility due to a weakening or the partial or complete destruction of the facility, including, but not limited to, the protective coating, lateral support, cathodic protection, or housing for the line, device, or facility. There does not need to be a release of product.
- **Event** – The occurrence of facility damage, near miss or downtime.
- **Near miss** – An event where damage did not occur but clear potential for damage was identified.
- **Reported events (damages or near misses) –** The number of reports originally entered into DIRT.
- **Unique reported events (damages or near-misses) –** The number after identifying and consolidating multiple reports of the same event. Annual DIRT Reports and online dashboards are based on unique damages.[3]
- **Comparable dataset** – When analyzing annual trends, this report uses what is referred to as a **comparable dataset**. Due to fluctuations in the makeup of DIRT contributors year-over-year, and to ensure consistent comparisons are made, data was used from companies that entered data for all three years (2019 – 2021), with the number of

[3] Click here for a report describing the process for handling multiple reports of the same event.

reports submitted above certain thresholds. That process is explained more fully in the trending section.

- **Known and unknown data –** Some DIRT questions can be left blank or answered with "unknown." When a DIRT figure or table indicates that unknown data is filtered out, it means blank or unknown values are not included. Similarly, a number presented as a percentage of "known" data means blank and unknown values are NOT included in the denominator.
- **Data Quality Index (DQI)** – Measure of the "completeness" of the data submitted or the extent that submitters avoided entering blank or unknown data. This is discussed in more detail in the "Impact of Data Quality" section of this report, which also spotlights three companies that had a high average DQI score for 2021 given the quantity of reports submitted.

DATA SUBMITTED FOR 2021

An overview of data submitted for 2021 analysis is included below. Unless otherwise noted, the 203,618 unique reported damage events are the basis for the exhibits and tables in the section of this report analyzing the 2021 dataset. Table 1 shows the 2021 totals for the United States and Canada:

Table 1—Total and unique damages and near misses in Canada and the United States in 2021

Country	Total Damage Reports	Unique Damages	Total Near Miss Reports	Unique Near Misses
Canada	11,270	10,873	255	242
United States	217,123	192,745	1,821	1,726
Total Reported Events	228,393	203,618	2,076	1,968

DATA OVERVIEW – SPOTLIGHT ON 2021

- **Locate volume increased in 2021, with 811 centers (one call centers) reporting an increase in locate requests as well as outgoing transmissions.**
- **Natural gas and telecommunications are the leading types of facilities damaged in the 2021 dataset.**
- **Contractors and backhoes are the excavator type and equipment type involved in the greatest number of damages.**
- **Types of work performed when a damage occurs is more varied, but water work leads, followed closely by sewer and telecommunications. This is true across a wide variety of states and provinces.**
- **Of the 25 individual root causes documented in DIRT, six root causes account for 76% of damage events.[4] This is remarkably consistent with past analysis, despite some minor reshuffling of the high-to-low order. Thus, focusing damage prevention efforts on the leading root causes will provide the greatest results in reducing damages.**
    - ***Failure to notify the 811 center* remains the largest individual root cause.**
    - ***Excavator failure to maintain clearance*, combined with *failure to pothole* and *other excavation practices* make up the most consistent causes of damages due to excavator error in the field.**
    - ***Facility not marked due to locator error* and *marked inaccurately due to locator error* are the leading individual root causes in the locating group.**
- **DIRT root cause groups of Excavation Practices and Locating Practices are roughly equal in terms of their contributions to the total number of damages, reinforcing that systemic improvements need to occur across each part of the damage prevention process.**

DIRT received over 230,000 reports on damages and near misses for 2021. The following analysis focuses on the 2021 dataset and specifically on the 203,618 unique damages reported into DIRT. In addition to providing a snapshot of damages in 2021, this section includes an overview of specific 811 center statistics for 2021.

811 CENTER (ONE CALL CENTER) DATA – 2021

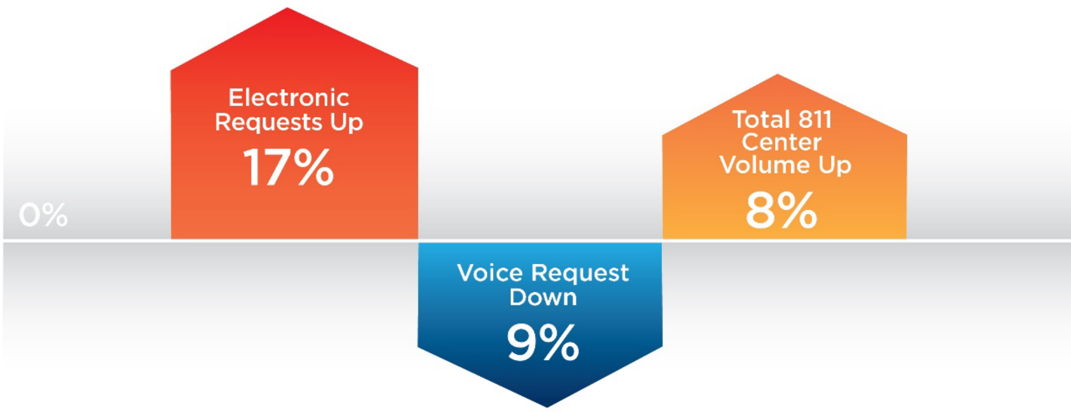
CGA's One Call Systems International (OCSI) committee, made up of 811 center representatives across the U.S. and Canada, spearhead CGA's effort to collect annual 811 center statistics. Currently, CGA gathers annual statistics on incoming locate requests and outgoing transmissions, among other pieces of information such as state laws (advance notice, life-of-ticket, exemptions, etc.).

[4] As discussed in the 2020 DIRT Report, this again approximates the pattern of the Pareto Principle (aka the 80-20 rule).

Figure 1 provides the 2021 totals for the various methods of incoming locate requests as well as outgoing transmissions. The figure is based on the 811 centers in the U.S. (45 states, 48 centers[5]) and Canada (9 provinces/centers) that submitted information for 2021.

Incoming Locate Requests / Outgoing Transmissions

Based on 811 Centers that Provided Data for 2020 and 2021



Ticket Type	Canada	U.S.	Total
Incoming Locate Requests			
• Voice	296,657	12,107,270	12,403,727
• Electronic	1,991,836	27,455,516	29,447,352
• Fax	0	2,749	2,749
Total Incoming Locate Requests	2,288,493	39,565,535	41,854,028
Total Outgoing Transmissions	9,681,348	272,673,947	282,355,295

Comparing information submitted by centers for both 2020 and 2021 we find:

- Incoming voice down 9%
- Incoming electronic up 17%
- Total incoming up 8%
- Total transmission up 5%

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Figure 1

OUTGOING TRANSMISSIONS – MEASURE OF DAMAGE PREVENTION ACTIVITY

While incoming locate requests are a useful indication of the amount of digging activity taking place across the country, outgoing transmissions (defined below) provide a possibly more accurate view of the potential for buried facilities to be impacted by excavation activity. Additionally, outgoing transmissions* provide us with greater insight into the overall impact each locate request has on the damage prevention process.

[5] Several states have multiple centers.

> ***Outgoing Transmissions**—The number of initial notices of intent to excavate sent by 811 centers to their member facility operators, including those sent directly to locating vendors on behalf of members. Each incoming locate request generates outgoing transmissions to several members, such as electric, gas, cable TV, water, sewer, telecommunications, etc.

The fact that the percentage increase in outgoing transmissions was less than that of total incoming notifications indicates that 811 centers are becoming more efficient at filtering out notices that do not need to be transmitted to member operators. For example, electronic white-lining* leads to a more accurate description of the work site, enabling the 811 center to identify the member facility operators impacted (or not) more accurately.

> ***Electronic White-Lining (EWL)**:[6] The process in which an excavator identifies where proposed excavation will occur by drawing a polygon shape on a GIS map; that shape is delivered electronically by the one-call center to its member facility operators.

Total Outgoing Transmissions: Green Analytics, CGA's statistical consultant, was able to estimate the total number of U.S. transmissions in 2021 to account for the 811 centers that did not submit annual statistics. Its estimate was 288.3 million, a 5% increase over its 2020 estimate of 273.9 million.

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The estimate of total number of U.S. transmissions was 288.3 million, a 5% increase over its 2020 estimate of 273.9 million.

[6] At the time of this report's publication, the Best Practices Committee had approved this definition for inclusion in the Best Practices Glossary of Terms and Definitions. If approved by the CGA Board of Directors, it will be included in the next Best Practices edition (19.0).

EVENT SOURCES AND FACILITY OPERATION DAMAGED

DIRT collects information from stakeholders across the damage prevention process. Figure 2 shows the stakeholder source of data submitted into DIRT by number and percentage “known” for 2021 damages.

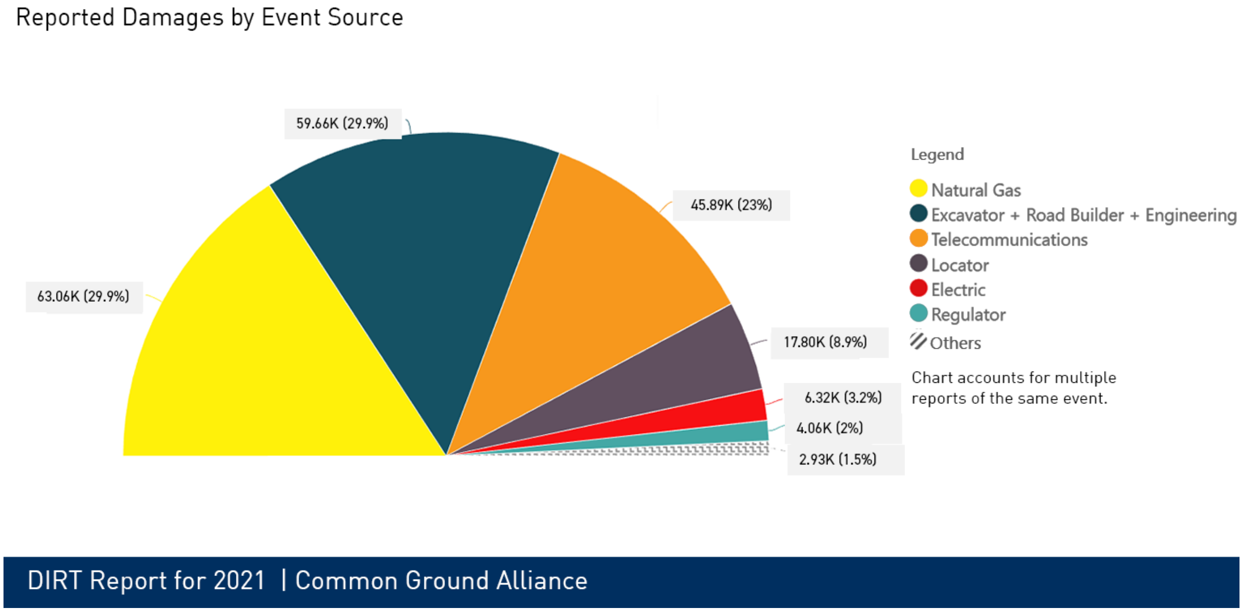

Figure 2

Figure 3 shows the number of reported damages for the top five types of facility operations. Not shown are liquid pipeline and steam, which would be negligible at this scale (but can be found and filtered in the online dashboard).

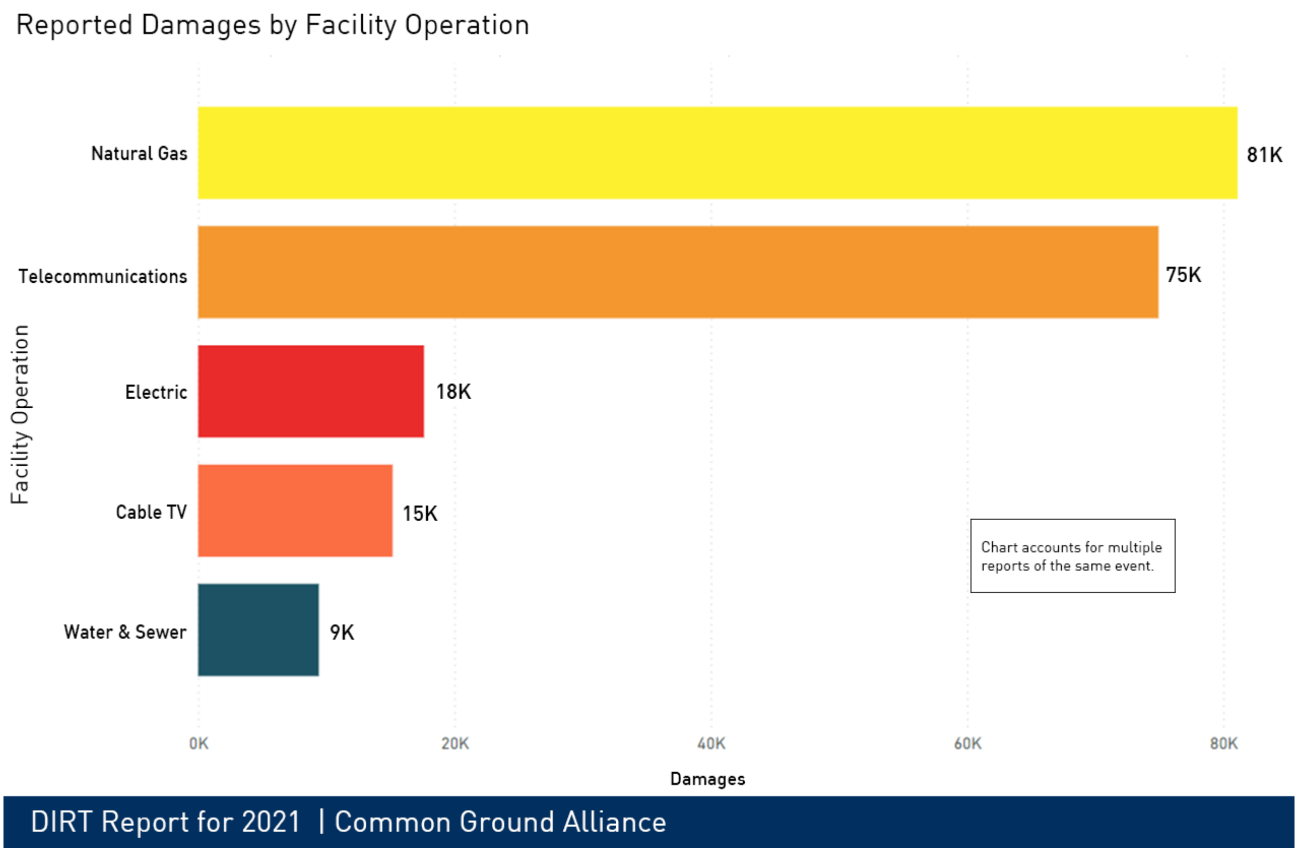

Figure 3

Figures 2 and 3 show natural gas as the leading event source and facility damaged. Most reports with natural gas as the facility damaged are entered by natural gas operators. Telecommunications is the second largest facility damaged, and if cable TV were added into the telecommunications category, the combination would exceed natural gas as the leading facility damaged. In addition to facility operators reporting damages to their own facilities, a substantial portion of telecommunication and cable TV damages are reported by excavators/road builders/engineers and locators,[7] the second and third largest sources of events.

The Natural Gas vs. Telecom Facility Spotlight section of this report compares and contrasts various DIRT fields for the two industries.

[7] Data points with low numbers, such as steam as a facility damaged and equipment manufacturers and railroad as event sources, are not included.

EXCAVATION INFORMATION - 2021

DIRT collects information on the type of excavation activity taking place when damages or near misses occurred, and the 2021 data sheds light on the most prevalent excavator type, equipment type and work performed when a damage happened. Figures 4, 5 and 6 depict the total "known" reports for those questions.

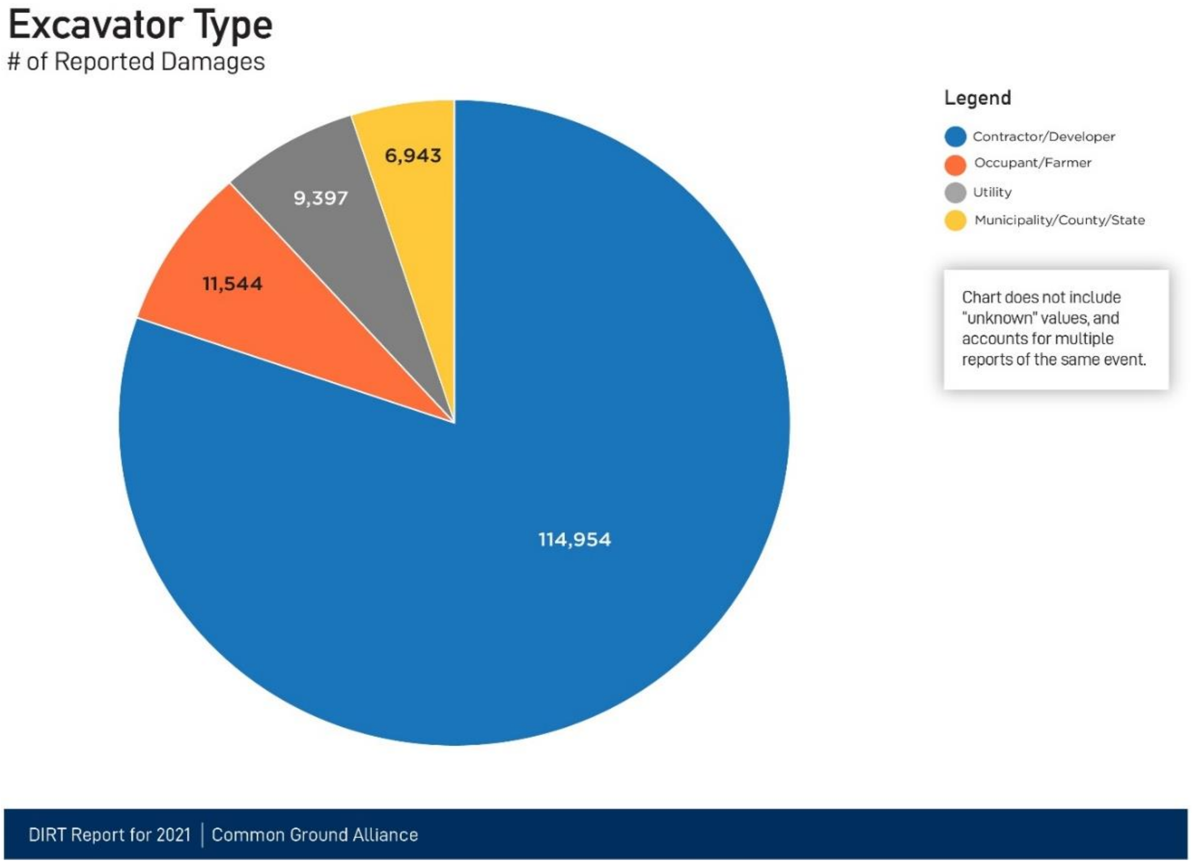

Figure 4

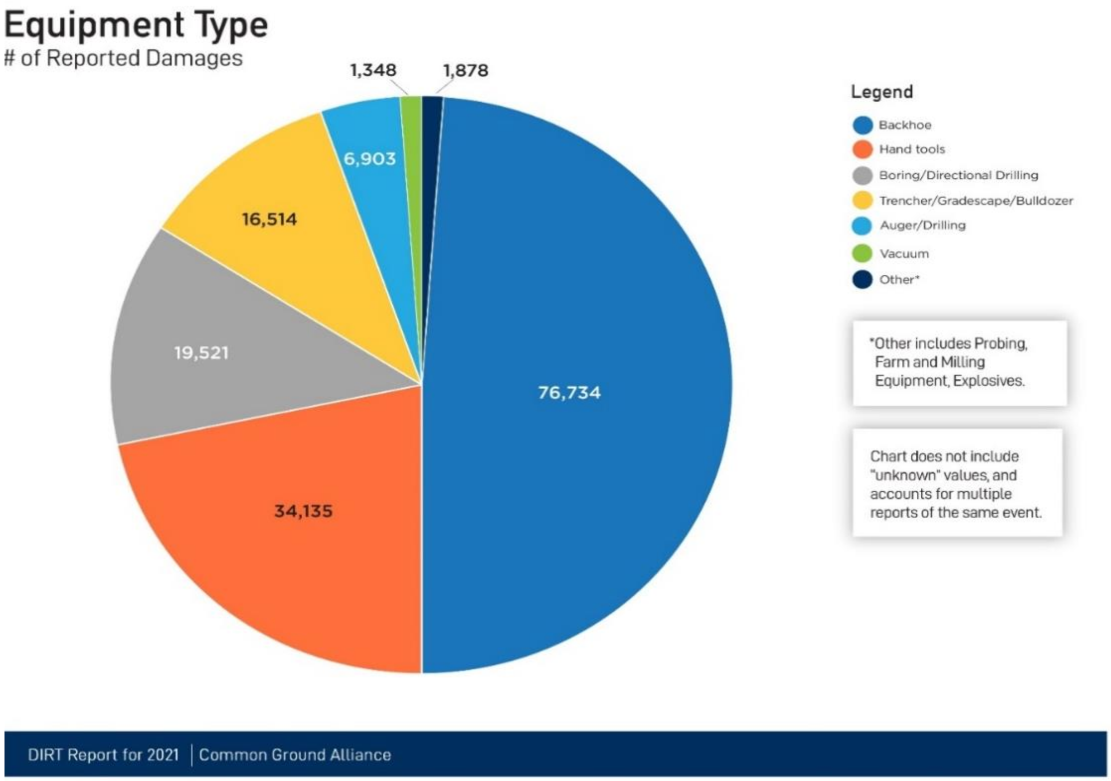

Figure 5

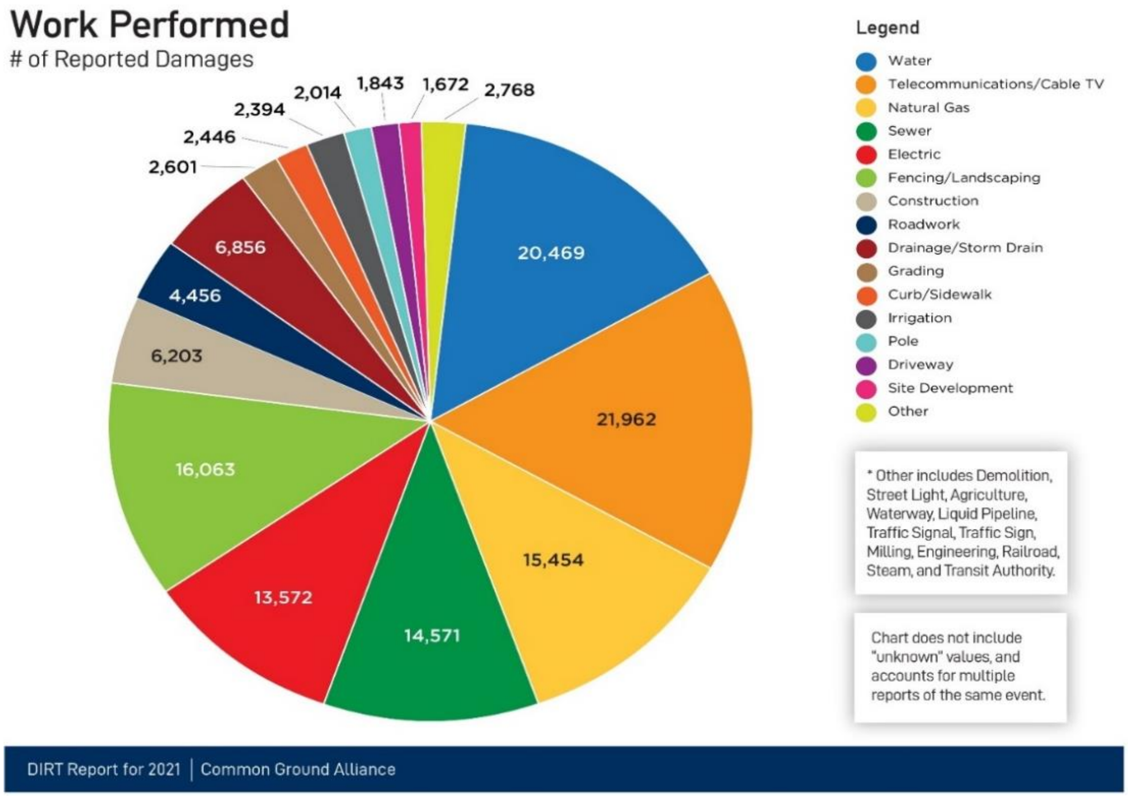

Figure 6

Contractors and backhoes are by far the leading excavator type and equipment type when a damage occurs, while types of work performed are more varied. Telecommunications/cable TV is the leading type of work performed, with water and sewer work also contributing to a large number of damages. There are likely several reasons water and sewer work make up more than 30% of the work performed. One primary contributor is that these facilities are often the deepest in urban and suburban streets. This means that to access them for installation or repair, the excavation must get past the shallower utilities like natural gas, telecommunications, electric, etc. Excavations to perform water and sewer work also tend to be wide and lengthy, increasing the probability of encountering other utilities. The Infrastructure Investment and Jobs Act passed in 2021 will increase federal investments in water and sewer systems, leading to an increase in related excavation work in the coming years.

Water and sewer work is often done by (or for) municipalities. Increasing engagement and accountability of municipalities will be critical to driving down damages.

ROOT CAUSE OVERVIEW – 2021

DIRT collects root cause information and has 25 individual "known" root causes to choose from as well as the option to choose "*root cause not listed*" or "*unknown/other*." The Data Reporting & Evaluation Committee sorts related individual root causes into groups to provide a higher-level snapshot of what went wrong in the damage prevention process. *No locate request* stands alone as its own root cause group and has consistently been the single leading root cause each year. Without a request to 811, the rest of the damage prevention process cannot be engaged and effective. "Unknown/other" is intended to be used when none of the other choices apply. When the term "known data" is used in DIRT Report text, figure or exhibit, it means "unknown/other" responses have been filtered out.

Root Cause Groups

- **No Locate Request** represents damages caused by the failure to provide notification to the 811 center (one call center) of the intent to dig.
- **Invalid Use of Request by Excavator**[8] captures situations where the excavator invalidates the ticket by commencing work too early or digging beyond the expiration date or outside the work area described on the ticket. This group also covers scenarios where the excavator provided incorrect information to the 811 center in the initial notification.
- **Excavation Issue** captures damages where something went wrong in the physical digging process.
- **Locating Issue** captures damages caused by inaccurate or missing marks.

[8] In DIRT Reports up to and including 2018, these were referred to as "Other Notification Practices."

- **Miscellaneous** captures damage causes that do not fit into a notification, locating or excavating category. These consist of deteriorated facilities, previous damage and 811 center error. These typically account for around 1% of damages combined.
- **Unknown/Other** captures damages where the root cause was not collected or none of the available choices adequately described the root cause. When this is selected, the DIRT system requires[9] the user to also provide a free-text comment. Ideally this would provide some indication of what caused the damage and why none of the available root cause choices fit.

ROOT CAUSE ANALYSIS 2021 – CONSISTENT ISSUES UNDERSCORED

Table 2—Damages by root cause for 2021 (color coded by root cause group)

Reported Damages by Root Cause for 2021

Coded by Root Cause Group

	Root Cause	Reports	2021 % of Total
1	No notifiction made to 811 center	34,617	25.72%
2	Facility not marked due to locator error	19,341	14.37%
3	Excavator failed to maintain clearance after verifying marks	18,782	13.95%
4	Improper excavation practice not listed elsewhere	12,181	9.05%
5	Marked inaccurately due to locator error	10,763	8.00%
6	Excavator dug prior to verifying marks by potholing	7,090	5.27%
7	Excavator failed to shore excavation/support facilities	3,584	2.66%
8	Marks faded, lost or not maintained	3,449	2.56%
9	Facility not marked due to no response from operator/contract locator	3,138	2.33%
10	Facility marked inaccurately due to incorrect facility record/map	2,764	2.05%
11	Excavator dug prior to valid start date/time	2,704	2.01%
12	Excavator dug after valid ticket expired	2,678	1.99%
13	Facility not marked due to unlocateable facility	2,532	1.88%
14	Facility not marked due to incorrect facility record/map	2,500	1.86%
15	Site marked but incomplete at damage location	1,985	1.47%
16	Excavator dug outside area described on ticket	1,750	1.30%
17	Facility marked inaccurately due to abandoned facility	1,099	0.82%
18	Excavator provided incorrect notification information	961	0.71%
19	Previous damage	662	0.49%
20	Facility not marked due to abandoned facility	548	0.41%
21	Facility marked inaccurately due to tracer wire issue	548	0.41%
22	Facility not marked due to tracer wire issue	294	0.22%
23	Deteriorated facility	282	0.21%
24	811 center error	207	0.15%
25	Improper backfilling	151	0.11%
	Total	134,612	100.00%

Legend
- Excavation Practices
- Invalid Use of Request by Excavator
- Locating Practices
- Miscellaneous
- No Locate Request

Chart does not include "unknown" values, and accounts for multiple reports of the same event.

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Table 2 includes the "known" individual root causes for reported damages in 2021, sorted high-to-low and color-coded to match subsequent figures based on root cause groups.

[9] Filling in this comment field is optional when any other root cause is selected.

Of the 25 root causes documented in DIRT, the 2021 dataset once again points to a tightening number of issues causing the majority of damages: As shown in Figure 7, in 2021, 76% of all damages were attributed to one of the top six individual root causes with each of the major[10] DIRT root cause groups represented.

Top Reported Damages by Root Cause for 2021

Coded by Root Cause Group

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1	No notifiction made to 811 center	34,617	25.72%
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	76.36%		

Legend
- Excavation Practices
- Invalid Use of Request by Excavator
- Locating Practices
- Miscellaneous
- No Locate Request

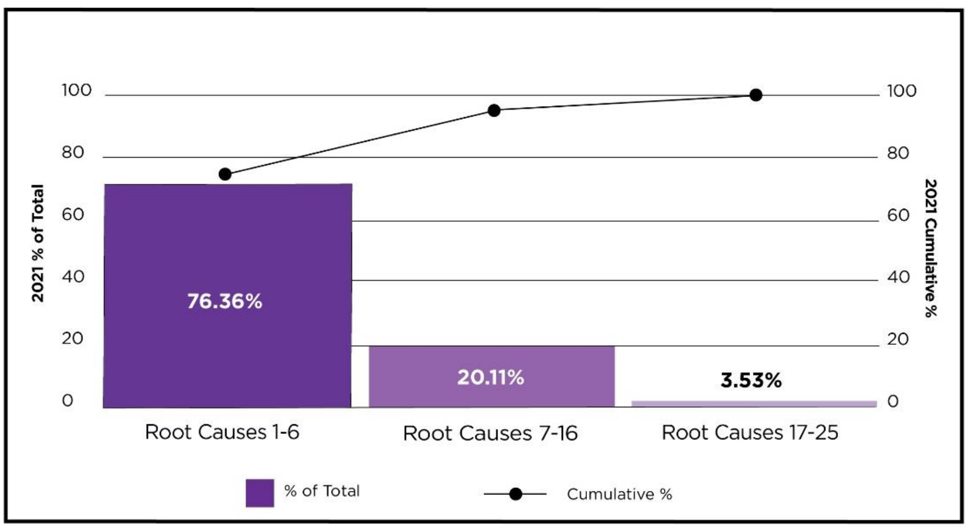

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Figure 7

Digging without notification to the 811 center; excavators failing to pothole and failing to maintain sufficient clearance between digging equipment and buried facilities; and *facilities not being marked or being marked inaccurately due to locator error* and/or *incorrect facility records/maps* are the primary root causes of damages to buried infrastructure in the U.S., year over year. Tailoring damage prevention research, metrics, outreach and initiatives to addressing these consistent damage drivers is imperative to move the damage prevention industry forward.

[10] "Major" means No Locate Request, Excavation Practices and Locating Practices.

ROOT CAUSE GROUPS 2021 – EVEN DISTRIBUTION ACROSS PROCESS

The root causes reported in 2021 are fairly evenly distributed across the three major root cause groups (Excavation Practices, Locating Practices and No Locate Request). This consistent theme points to an increasing need for not only shared responsibility, but shared accountability, and taking ownership of each industry's impact across the entire damage prevention process. Stakeholders must examine their own role and influence on the damage prevention process as a whole.

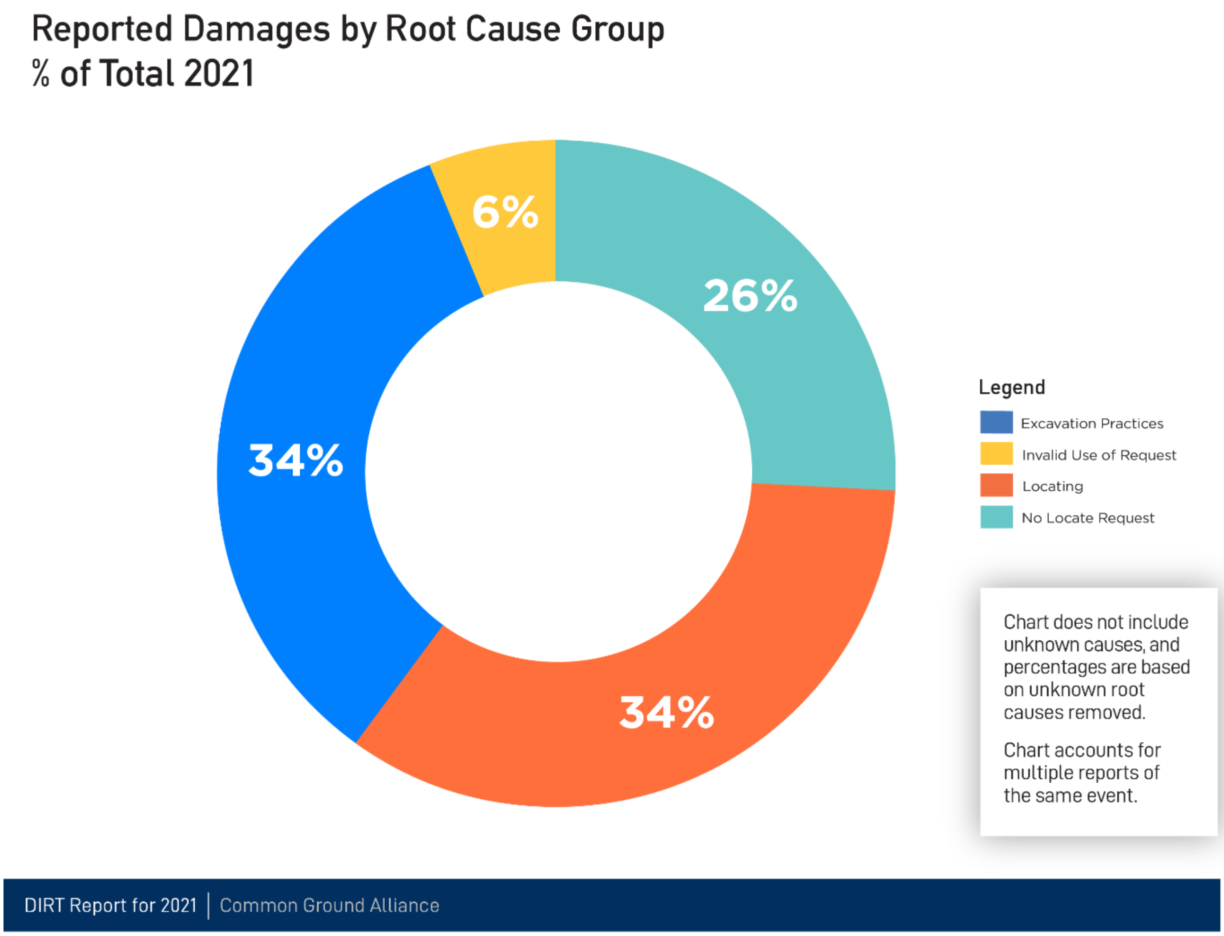

Figure 8

Figure 8 shows the damage percentages when the individual root causes are sorted into broader root cause groups. Miscellaneous is omitted because it accounts for less than 1% of all damages.

The Excavation Practices, Invalid Use of Request and Locating Practices root cause groups each consist of several individual root causes. Figures 9, 10, and 11 on the following pages provide additional detail on the individual root causes that make up those groups.

EXCAVATION PRACTICES – FOCUS ON FAILURE TO POTHOLE AND MAINTAIN CLEARANCE

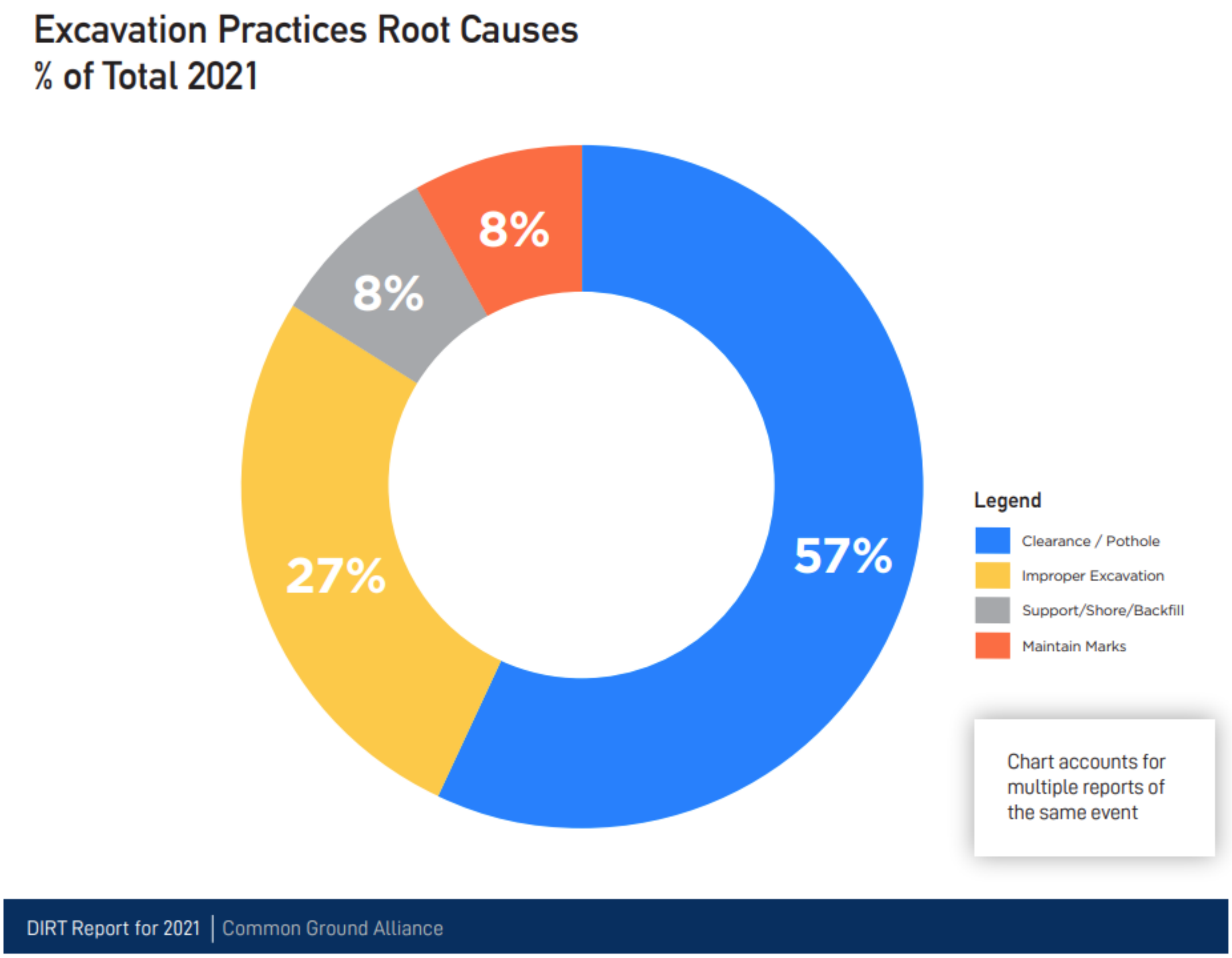

Figure 9

The majority of damages attributed to Excavation Practices point specifically to *failure to maintain clearance* and/or *failure to pothole.* These root causes are combined here because they are closely related, often selected interchangeably in damage investigations and involve safe excavation within the tolerance zone.

CGA's Excavator White Paper, published in 2019, took a closer look at awareness and execution of safe digging practices within the excavator community. The paper noted that "excavators have limited knowledge about regulations beyond the need to notify before beginning work," with the survey "showing that concepts such as potholing, needing to maintain marks or request re-marks, and other critical but lesser-emphasized excavation Best Practices do not have the same level of awareness and compliance as making the notification."

Increased emphasis on safe digging practices specifically within the tolerance zone would have an impact on excavator errors in the field. However, awareness and education are only one contributing factor. Other steps that could contribute to more widespread use of potholing include:

- Project owners (including facility owner/operators) requiring and adequately compensating for potholing.
- Applying emerging mapping/GIS technologies in project design and subsurface utility engineering (SUE). CGA's 2022 Technology Report included case studies highlighting opportunities for improved mapping and use of design/SUE. Improved mapping can actually reduce potholing and associated expenses by reducing wasteful or unsuccessful potholes (not finding the utility searched for).

INVALID USE OF REQUEST – IMPORTANCE OF UNDERSTANDING 811 REQUIREMENTS

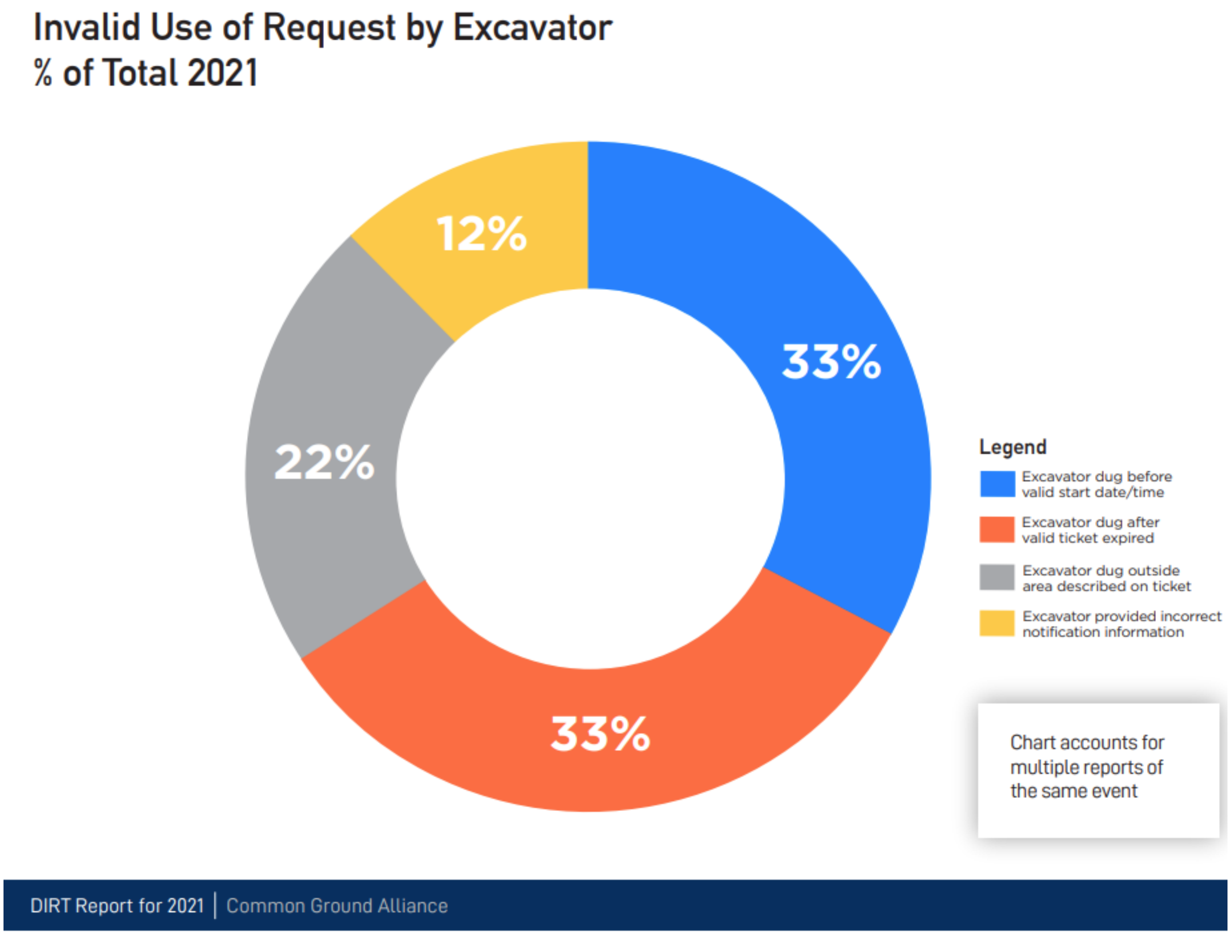

Figure 10

The Invalid Use of Request root cause group covers situations where a locate request was made, but something still went awry leading to a damage. The issue is obviously not a lack of awareness of the 811 system, or a choice not to use 811. Instead, this category highlights a lack of understanding of the entire spectrum of regulations and requirements governing the use of the 811, including advance notice requirements, wait time, expiration date, etc. This root cause may also reflect limited understanding of how an excavator's actions impact the entire damage prevention system.

CGA's Educational Programs Committee launched the development of a video series focusing on this very topic. The video series "Tips for Effective Use of 811" provides messaging on the important role of an excavator in maintaining an efficient damage prevention process. The video addresses key messages that contribute to the Invalid Use of Request root causes and encourages excavators utilizing the 811 locate request process to:

- Be as specific as possible about the work site (use white-lining).
- Limit the size of the request to area an area that will actually be excavated.
- Limit requests to sites where work is reasonably expected to start before the ticket expires.
- Don't put in requests for "back-up" or "just-in-case" worksites.
- Be aware of ticket expiration rules in your state and renew tickets as needed, but stop renewing tickets once the work is complete.
- Provide good contact information and an accurate description of the work to be performed.

LOCATING PRACTICES – LOCATOR ERROR DOMINATES

DIRT collects information on eleven individual locating root causes. However, several locating root causes appear[11] in two situations: (1) not marked at all, and (2) marked but inaccurate. For example, submitters can select *facility not marked due to inaccurate maps/records* or *facility marked inaccurately due to inaccurate maps/records*. For the following analysis, we have combined the not-marked and marked-inaccurately totals. This provides a better sense of what the leading issues are within the Locating Practices root cause group, but readers can refer to Table 2 as well as the DIRT Dashboard for a further breakdown.

[11] The Locating Practices root causes that appear twice involve locator error, bad maps, abandoned facilities and tracer wire issues.

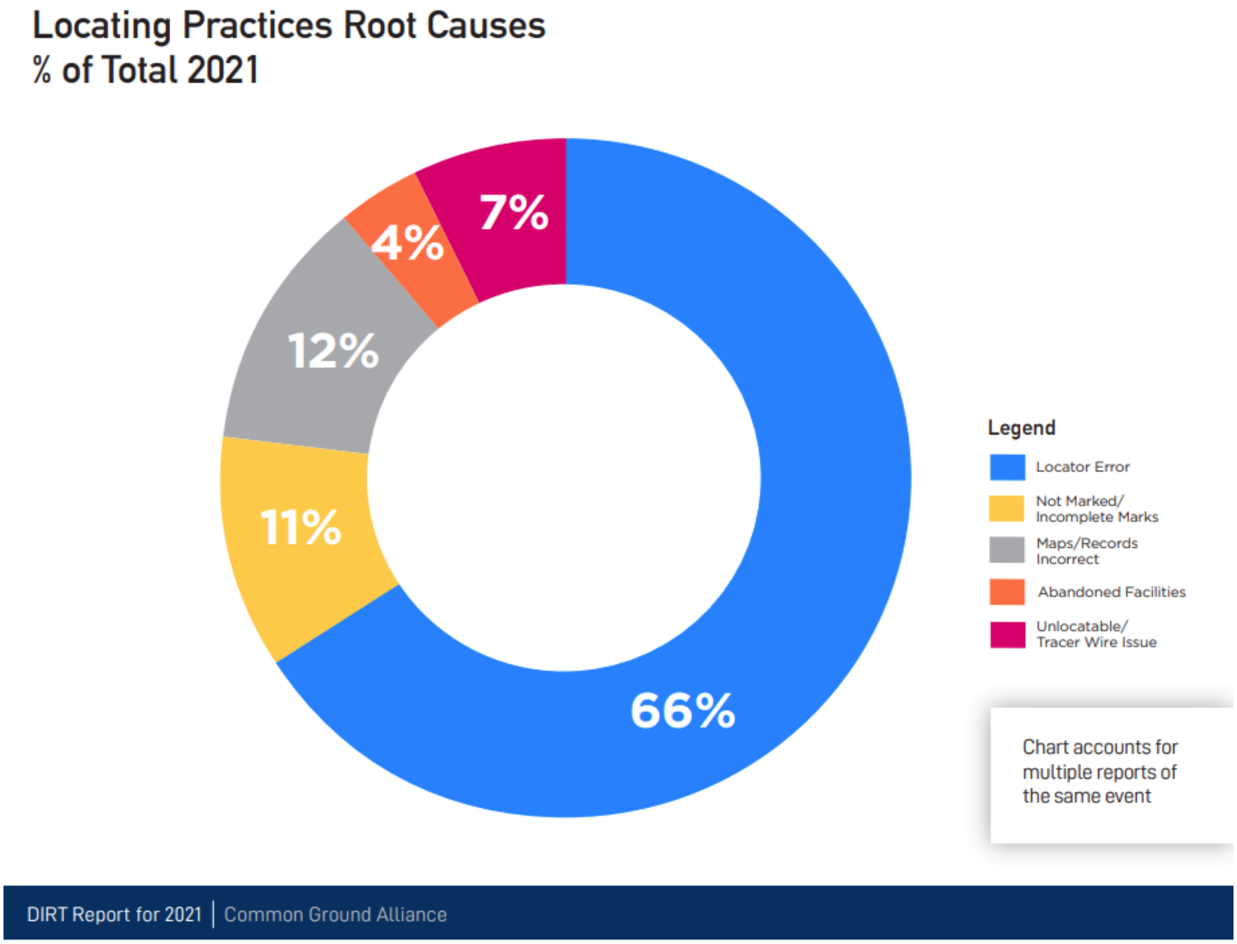

Figure 11

Although the vast majority of damages attributed to Locating Practices specify *locator error* as the primary root cause, additional follow-up has shown *locator error* is often selected when a more specific root cause is not collected. For example, an excavator may only know that marks are inaccurate, while a locator or facility operator may be better able to determine if it was a mapping, tracer wire, or abandoned facility issue. Those can lead to an inaccurate locate even if the locator followed all proper procedures. Therefore, *locator error* represents a broader representation of general locate issues.

Figure 11 shows *incorrect maps/records* at 12%; however, there are likely many other mapping related damages masked by the options to indicate locator error. *Mapping issues* could be an underlying factor for some damages in the *not marked/incomplete category*. CGA Next Practices reports, the Locator White Paper and Natural Gas White Paper all identify up-to-date mapping as an effective method to improve locating.

CGA's 2022 Technology Report featured several case studies highlighting new technologies that capture information in the field and enable the production and sharing of updated, accurate maps. The report also discussed some of the barriers to creating and sharing GIS facility maps.

This is an area where technology is rapidly advancing and has the potential to reduce damages and make the entire damage prevention system more efficient. There are several stakeholder groups, and steps in the damage prevention process, where improved mapping could have an impact, including:

- Excavation project owners/designers – Project design and Subsurface Utility Engineering (SUE)
- Facility owners and contract locators – Locating and marking
- 811 centers (one call centers) – Identifying work areas for electronic tickets and electronic white lining

ROOT CAUSE GROUP ANALYSIS – BY SOURCE, EXCAVATOR TYPE AND FACILITY DAMAGED

A deeper understanding of the data emerges when the root cause groups are cross-tabulated with other DIRT fields.[12] Significant differences in the root cause group percentages by event source are seen in Figure 12. Excavators, engineering and road builders have similar characteristics and concerns, and therefore are combined. If shown individually, their stacked bars would all look very similar with a greater emphasis on the Locating Practices root causes.

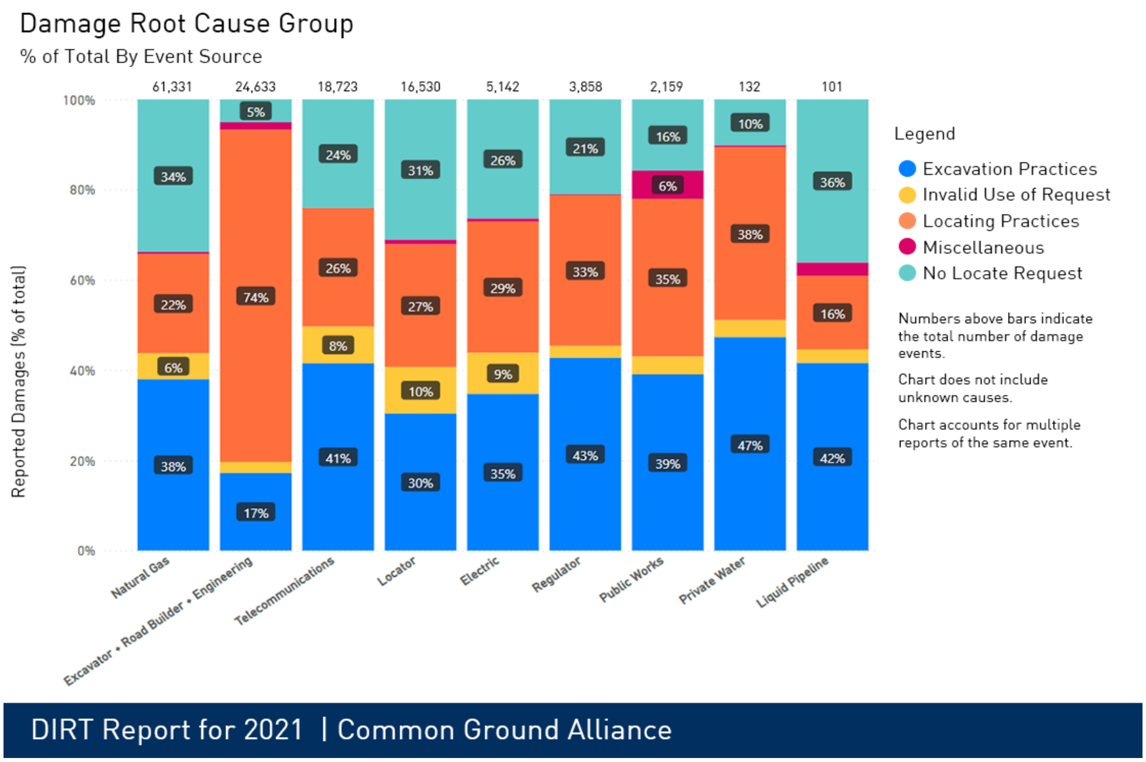

Figure 12

[12] While root cause groups are used in this figure, individual root causes can be viewed by using additional filters on the online dashboard.

Figure 13 shows root cause groups by type of excavator involved (not necessarily indicating that excavators caused the damage). As is the case in most years, occupants and farmers have high percentages of *no locate request*, while for most other excavator types, locating and excavating practice-related issues dominate.

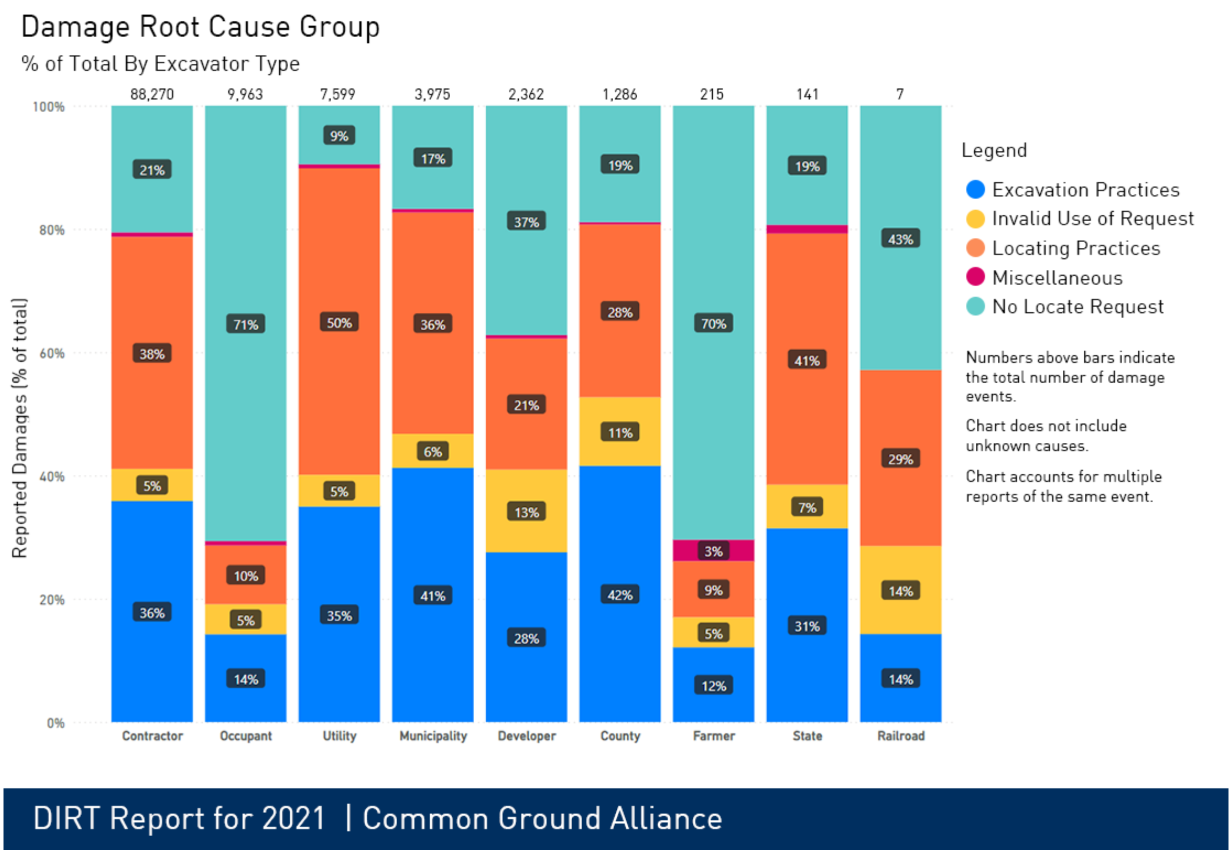

Figure 13

Figure 14 demonstrates the relationship between damaged facilities and root cause groups.

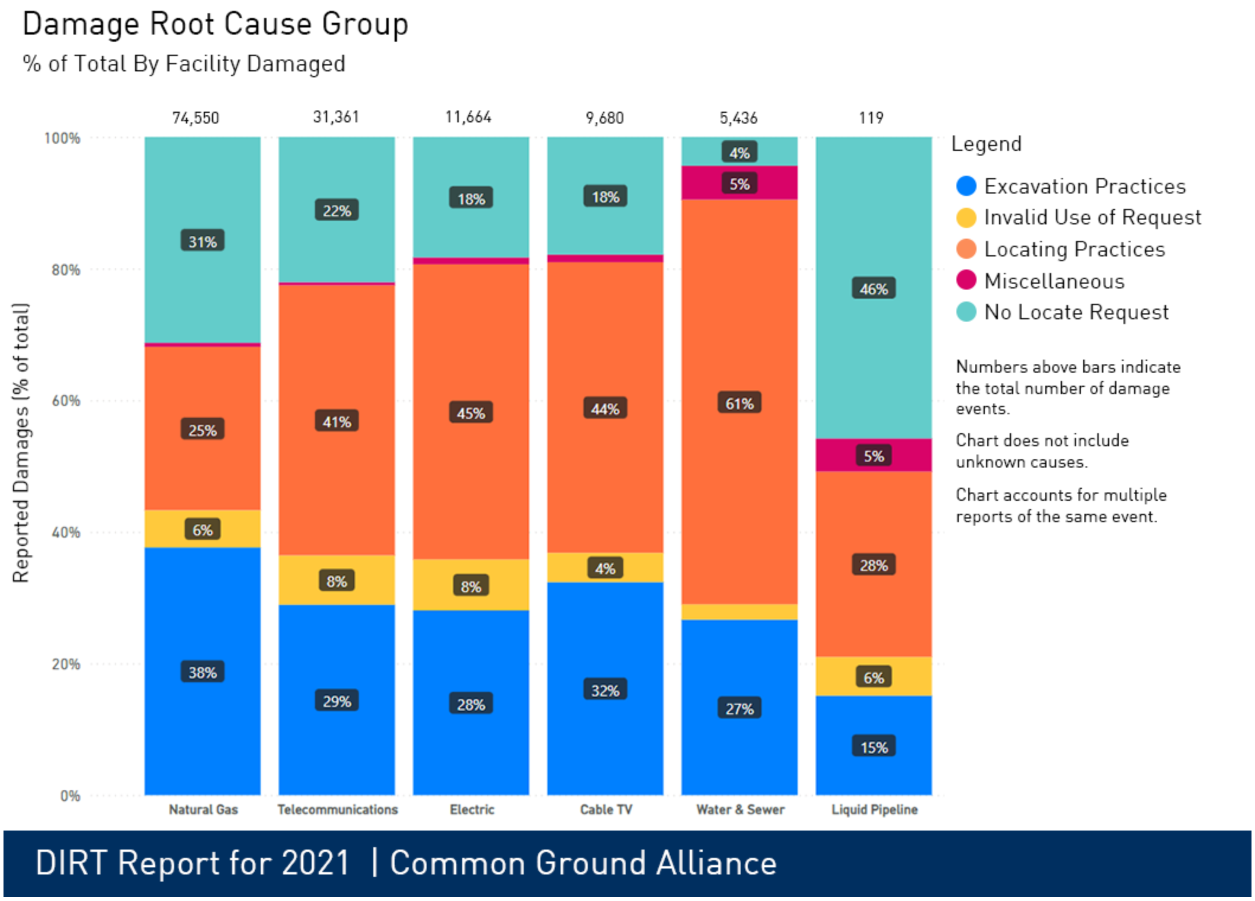

Figure 14

The Miscellaneous group is negligible in the context of the entire dataset, but as data is filtered down into smaller slices, it starts to come into focus. This can be seen here for sewer and liquid pipelines. For both facility types, *previous damage* was the leading individual root cause specified within the Miscellaneous group.

TREND ANALYSIS (2019-2021)

- **Statistical models used to analyze three-year damage trends in the U.S. point to damage counts remaining fairly level, or slightly increasing, when accounting for factors that influence damages.**
- **Increased construction spending has consistently proven to correlate with an increase in damages. Anticipated funding from the Infrastructure Investment and Jobs Act directed to communities across the U.S. is likely to stress an already inundated damage prevention system.**
- **The most prevalent damage root causes have remained very consistent year-to-year.**
- **811 center (one call center) transmissions are increasing relative to increasing construction spending, which may be somewhat attributable to "noise" in the system.**

Voluntary data submission allows for a change in the makeup of the dataset year over year and can complicate annual trending. Beginning with the 2021 DIRT report, CGA utilized a consistent dataset compiled specifically for three-year trending which is referred to as the **comparable dataset**. The dataset includes a balanced representation of stakeholder data from companies that entered reports for *all* three years (2019, 2020 and 2021). The dataset includes a representative sample of reporting stakeholders matching the typical distribution of reporting stakeholders in a given year and includes data from facility owners/operators, 811 centers, locators, excavators,[13] public and private water, and regulatory agencies.

Table 3—Comparable Dataset Totals

Year	Total Reports	Unique Reports	Data Quality Index (DQI)
2019	170,298	157,003	65.5
2020	174,975	163,052	66.5
2021	198,676	176,317	67.6

The unique reports numbers are used in the **Trend Analysis 2019-2021** figures and tables in this section of the report.

CGA's statistical consultant, Green Analytics, used the **comparable dataset** to analyze high-level damage trends in the U.S. from 2019 to 2021. The objective of this year's statistical analysis was to evaluate how damage counts in the United States are changing over recent years after accounting for important factors driving damages.

The statistical analysis largely indicates that **damage counts have remained consistent** over the 2019 to 2021 period. However, there is some evidence from one of the statistical models to

[13] The 811 centers (one call centers) also entered reports with excavators as the event source.

suggest that damages in 2021 were higher than those in 2019 and 2020, although this finding is statistically significant at a lower level of confidence. This detailed analysis is summarized in Appendix B and provides more detail on the inputs and variables used by Green Analytics.

Overall, the data suggests that damage counts have remained steady from 2019 through 2021, with the possibility of an increase in counts for 2021 relative to previous years. Table 3 shows an increasing number of damages each year for the comparable dataset. However, Green Analytics' analysis accounted for factors that influence damage counts, such as construction spending and activity, changes in state population, 811 center transmissions, etc. With the factors considered, damage counts are, at best, holding steady. Furthermore, damage counts have been proven to correlate with infrastructure spending. Based on historical trends, as infrastructure spending increases in the coming year(s), stakeholders would likely see a proportional increase in damages, all else being equal.

COMPARABLE DATASET - EVENT SOURCES AND FACILITIES DAMAGED

Event Sources – Comparable Dataset

Table 4—Top four event sources for comparable datasets

Event Source	Percentage of Total (2019-2021)
Excavator, Road Builder, Engineering	29% - 31%
Natural Gas	27%
Telecomm	25% - 27%
Locator	9% - 10%

Facility Damaged – Comparable Dataset

Table 5—Top five facilities damaged for comparable datasets

Facility Damaged	Percentage of Total (2019-2021)
Telecomm	41% - 44%
Natural Gas	37% - 39%
Electric	8%
Cable TV	7% - 8%
Water & Sewer	4%

Due to the makeup of the comparable dataset, facilities damaged remains very consistent. For contributing facility owners/operators, the majority of their DIRT reports identify their own facility as damaged. Excavators and 811 centers (one call centers) are not as directly linked to a particular facility type, so the facilities damaged they report may fluctuate a bit year-to-year.

ROOT CAUSE TRENDS (2019-2020) - CONSISTENT FINDINGS OVER TIME

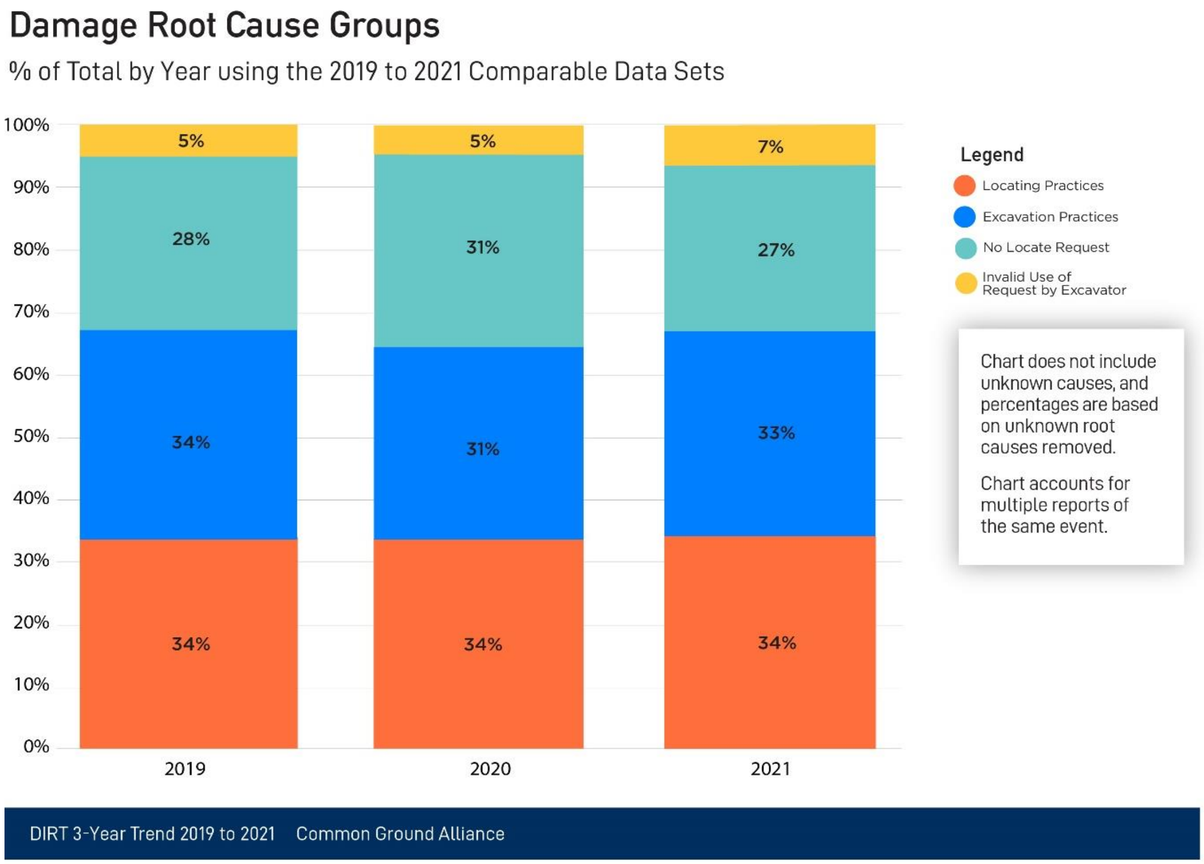

Figure 15

When comparing damage root cause groups as a percentage of the total, *no locate request* increased slightly in 2020 and then decreased for 2021. A likely contributing factor was the change in behavior during the initial year of the COVID-19 pandemic. As indicated in the 2020 DIRT Report, 811 centers (one call centers) reported increases in homeowner tickets that year, as people were doing more home improvement projects including landscaping, pools, decks, fencing, etc. Furthermore, we know that as an excavator type, homeowners consistently have a high percentage of damages due to *no locate request*. With the increase in homeowner tickets, there were likely many home improvement projects occurring without 811 notifications.[14] Using the comparable dataset, the "known" percentages of damages attributed to homeowners in 2019, 2020 and 2021 were 7.31%, 8.86% and 8.07% respectively.

Analysis of trends in root cause groups and the individual root causes all show very minor fluctuations year-to-year within the comparable dataset. The comparable dataset used for 2021 accounts for 86% of the complete 2021 dataset used in the Data Overview 2021 section of this

[14] In some instances, 811 notification may not have been required due to exemptions for homeowners, hand tools or depth.

report. In each of the following root cause figures (16 through 18), none of the totals for 2021 differ from the comparable dataset by more than 2%. These figures demonstrate the consistency of the data and findings. The Data Overview 2021 section of this Report contains analysis and commentary that would apply here as well.

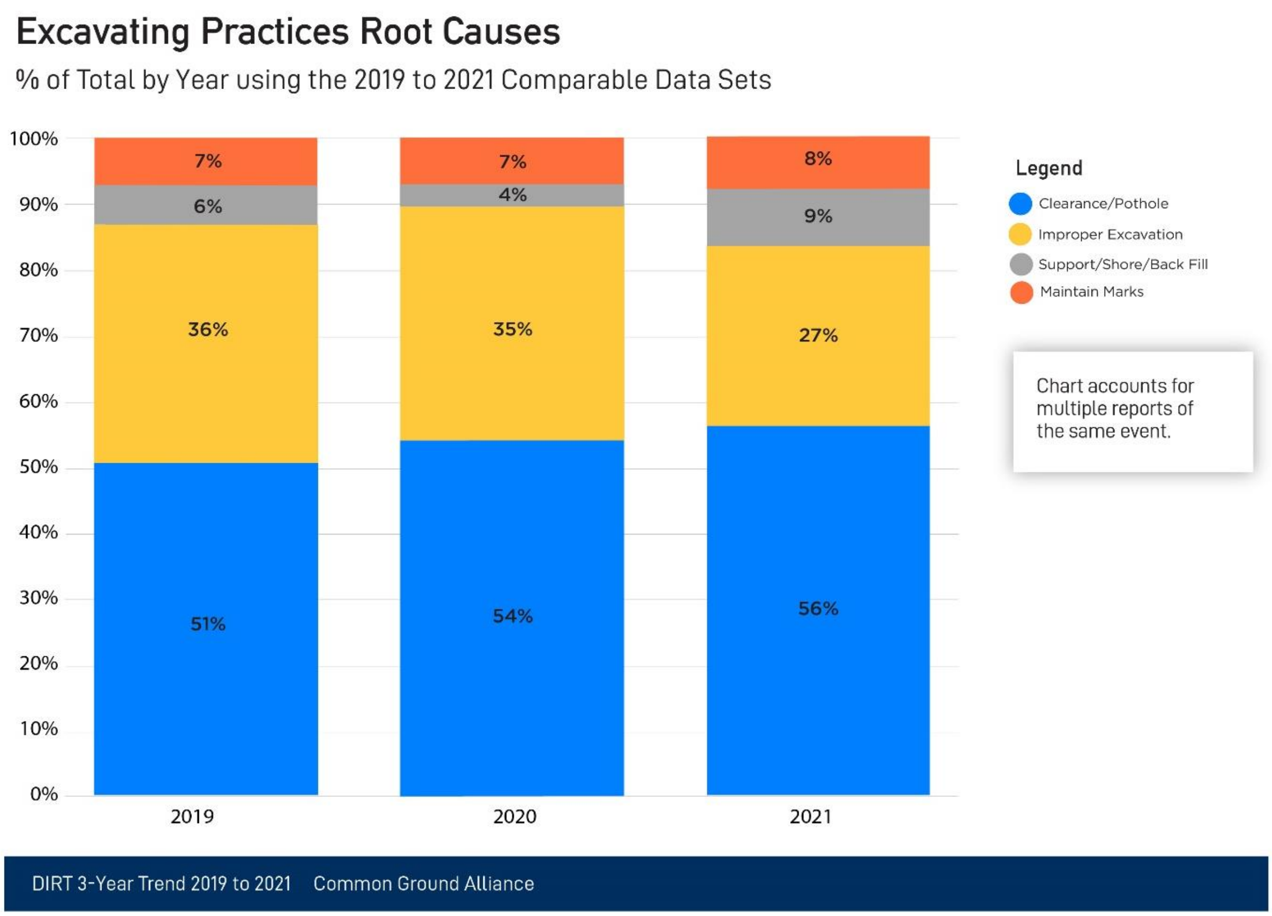

Figure 16

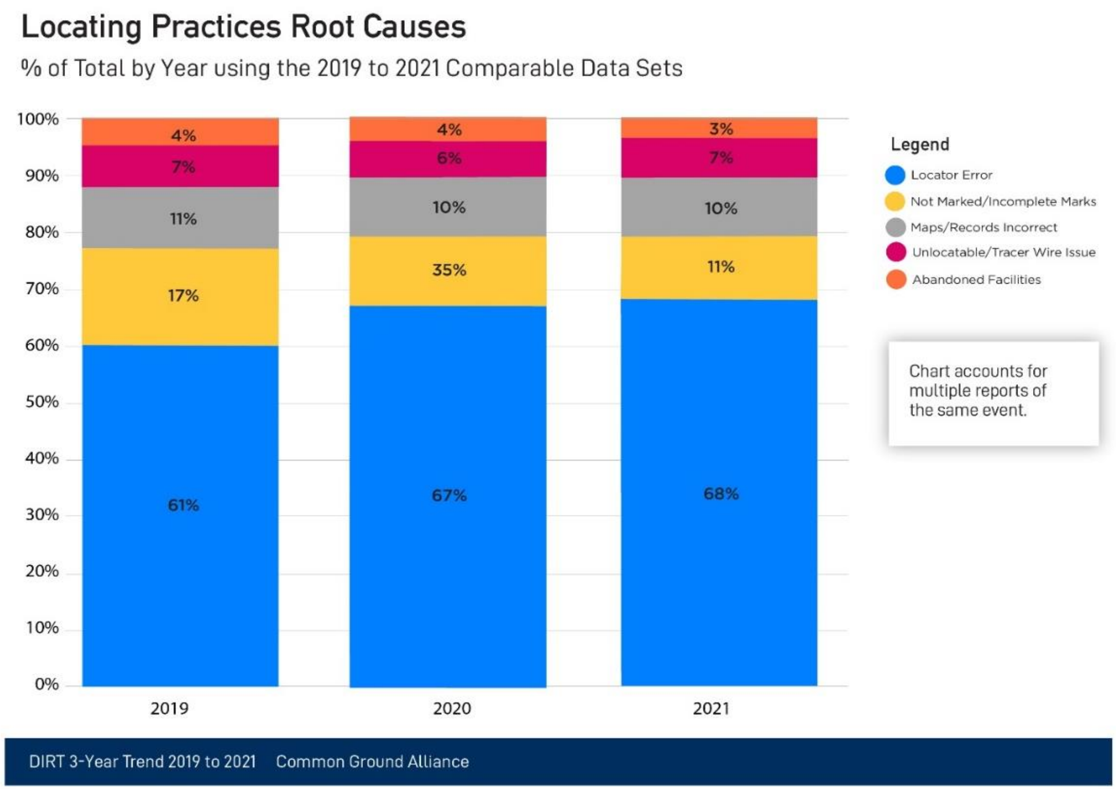

Figure 17

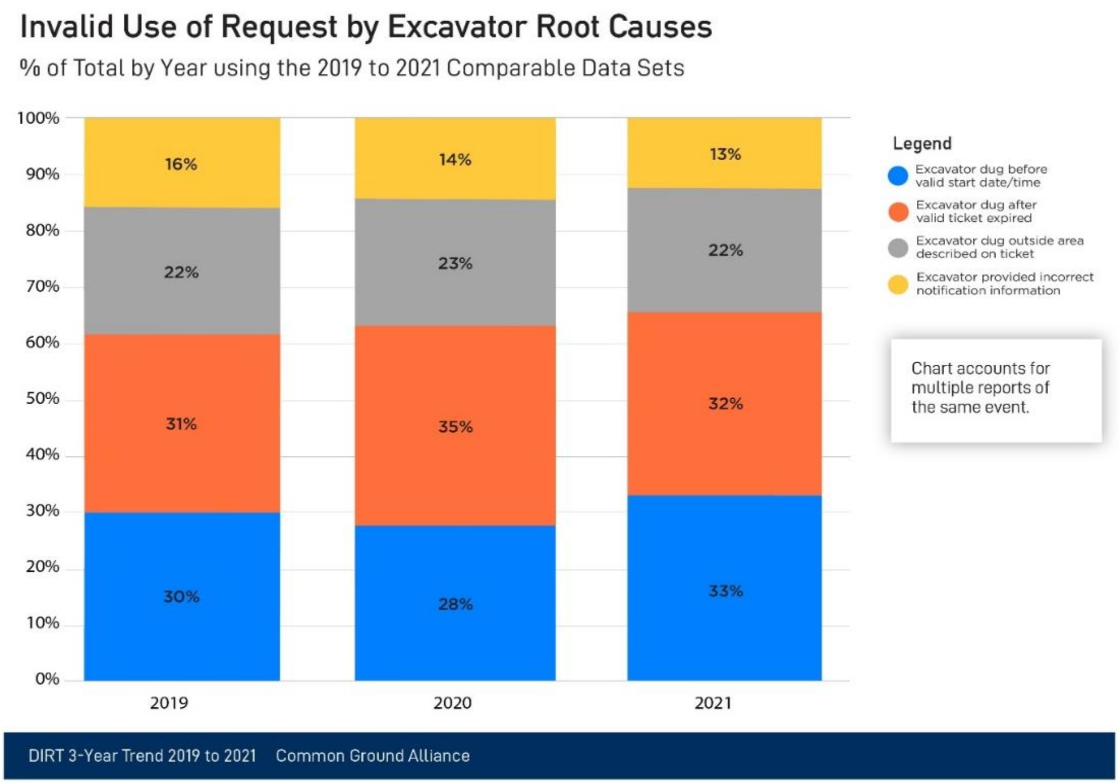

Figure 18

811 CENTER (ONE CALL CENTER) TRANSMISSIONS, CONSTRUCTION SPENDING AND DAMAGES IN THE U.S.

The DIRT report has traditionally used 811 center transmission statistics and construction spending data as important indicators of overall excavation activity. More transmissions and/or more construction spending (measured in constant dollars), generally implies more digging and excavation activity.

Table 6 provides a summary of trends in transmission data from 2016 to 2021. During this period, transmissions increased each year, with 2021 transmission levels roughly 30% higher than in 2016. Meanwhile, construction spending (as measured in 2021 USD) increased by 13% over the same period. To further explore the relationship between transmissions and construction spending, an estimate of transmissions per million dollars of construction spending is also provided in Table 6. This ratio increased from 155 in 2016 to a peak of 180 in 2019, and levelling off at 177 in 2021.

Table 6—Trends in digging activity as measured by transmissions and construction spending

Variable	2016	2017	2018	2019	2020	2021
Total Estimated 811 Center Transmissions (Millions)	221.9	234.9	244.3	267.6	273.9	288.3
Construction Spending (Millions 2021 USD)	1,434,334	1,467,242	1,462,365	1,489,721	1,576,142	1,626,444
Transmissions Per Million Dollars of Construction Spending	155	160	167	180	174	177

Figure 19 displays the trend data graphically.

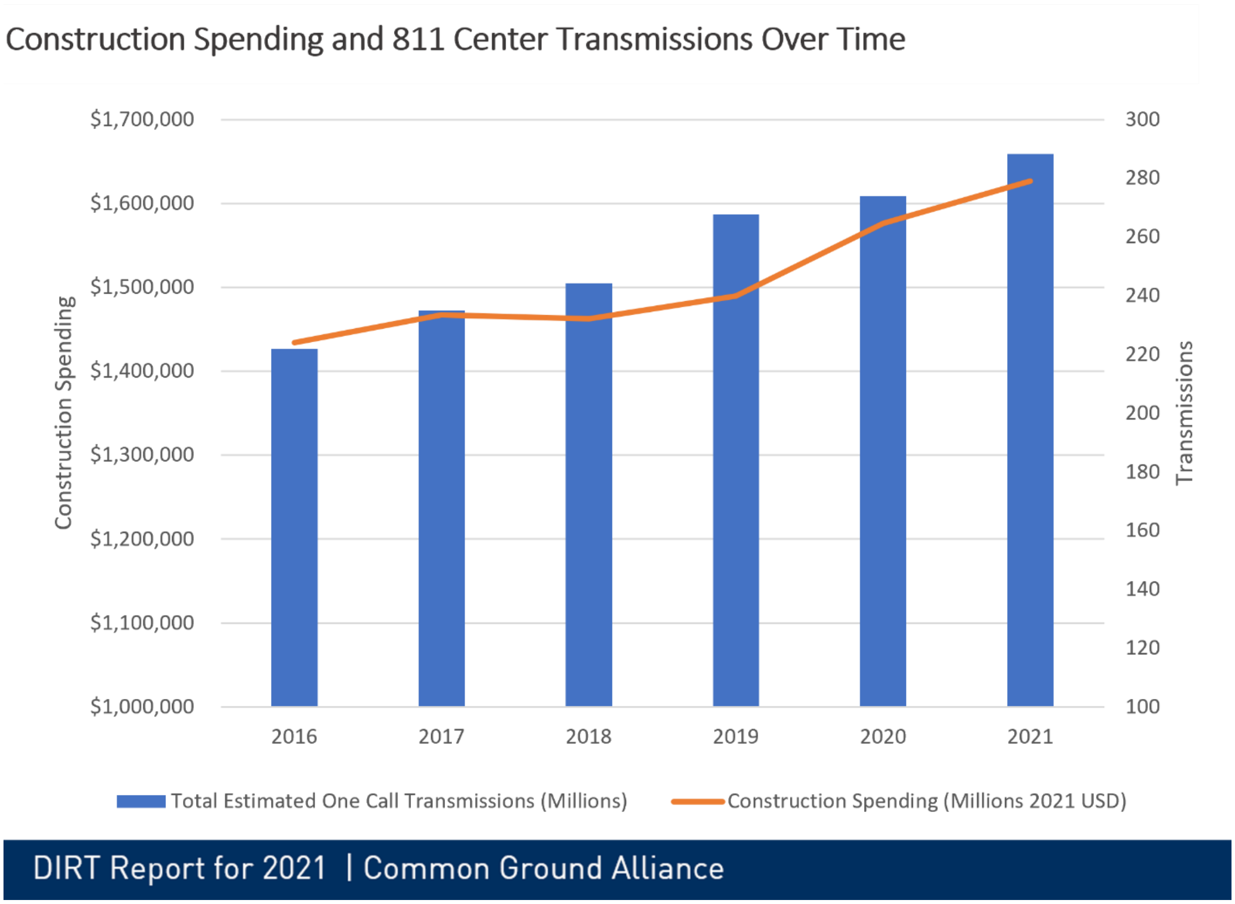

Figure 19

As noted in the 2020 DIRT report, the challenges and uncertainties that all sectors and industries faced over the last few years have added new complications for interpreting these trends over time. For instance, current inflation pressures and in particular the disproportionate rates of inflation between different sectors require a closer examination of construction spending. Similar to what was done in 2020, construction spending has been adjusted to constant 2021 U.S. dollars using a construction-specific price index.[15]

The general increase in the ratio of transmissions per million dollars of construction spending over time may be an indication of increasing 811 awareness and compliance. However, another contributor may be an issue that has generated discussion in the damage prevention industry in recent years – the use of "just in case" locate tickets. When demand is high and unpredictable,

[15] Note that the 2020 Report used the Producer Price Index for Building Materials and Supplies Dealers to capture the unique price pressures being experienced for construction materials. While these price pressures continue, over the course of 2021, broader inflation has become a greater concern. Therefore, the 2021 DIRT shifted to using broader construction sector price index: U.S. Bureau of Labor Statistics, Producer Price Index by Commodity: Construction (Partial) [WPU80], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/WPU80

locators (contract and in-house) struggle to keep up with demand, resulting in locates being late or not getting done. In response, excavators have acknowledged requesting more locates than needed in an effort to have one jobsite ready for work on a specific start date, ensuring their crews are not idle. This adds to the total number of locates being requested without an overall increase in construction activity (or spending).

Table 7 provides a summary of damage events from 2019 to 2021 using the comparable datasets. Using this data, the standard DIRT metrics of damages per million dollars of construction spending and damages per 1,000 transmissions are reported. The results suggest a small decline in damages between 2019 and 2020 followed by a small increase from 2020 to 2021. Overall, the data supports the conclusion that **damage events have been holding relatively stable from 2019 through 2021**.

Table 7—Trends in damages and key indicators, based on total U.S. damages (consistent reporting entities only)

Variable	2019	2020	2021
Reported Unique Damages (Comparable Dataset)	149,627	154,766	164,202
Total Estimated Transmissions in U.S. (Millions)	267.6	273.9	288.3
Value of Construction Spending (Millions of 2021 USD)	1,489,721	1,576,142	1,626,444
Damages per Dollar of Construction Spending	0.100	0.098	0.101
Change in Damages per Construction Spending	Baseline	-2%	+3%
Damages per 1,000 Transmissions	0.559	0.565	0.570
Change in Damages per 1,000 Transmissions	Baseline	-1%	+1%

A U.S. Department of Transportation's Pipeline & Hazardous Materials Safety Administration (PHMSA) website[16] provides publicly available data on damages to natural gas facilities compiled from annual reports from regulated facility operators. PHMSA's data for this population shows damage counts remaining fairly level since 2018 at around 84,000 (plus or minus 500), but damages per one call ticket trending slightly downward due to growth in ticket volumes. This is very consistent with Green Analytics' findings.

[16] https://portal.phmsa.dot.gov/analytics/saw.dll?Portalpages.

NATURAL GAS VS. TELECOMMUNICATIONS FACILITY DAMAGES – A CLOSER LOOK

- **Excavation Practices is the leading root cause group for natural gas, while Locating Practices leads for telecommunications.**
- **Telecommunications stakeholders and their subcontractors damage their own facilities and other service provider facilities within their industry about twice as often (14.22%) as natural gas stakeholders and their subcontractors do (7.18%).**
- **Excavators (including engineering and road builders) and locators submit a significant number of reports for damages to both natural gas and telecom facilities.**
- **Telecom facilities are often damaged at shallower depths than natural gas.**
- **Reports of damages to natural gas facilities have higher quality (DQI) than reports involving telecommunications facilities.**

In this section, we take a closer look at DIRT data involving natural gas and telecommunications facilities, which as we saw in the Data Overview 2021 section are the leading types of facilities damaged. In this section, the full 2021 DIRT dataset (reported unique damages) is used, and telecom includes cable TV.

DIRT DATASET – NATURAL GAS AND TELECOMMUNICATIONS TOTALS

Tables 8 and 9 provide specific information on the dataset used for this analysis. "% of Total-All" means the percentage shown includes "unknown" values in the denominator. "% of Total-Known" means "unknown" responses are subtracted from the denominator, which causes the resulting percentage to be higher. A similar approach will be applied to the analyses of other DIRT data fields within this section.

Table 8 - Event Sources for Natural Gas as Facility Damaged

Natural Gas Facility Unique Damages (2021)			
Event Source	**Damages**	**% of Total-All**	**% of Total-Known**
Natural Gas	62,337	76.86%	77.88%
Excavator/Road Builder/ Engineering	8,571	10.57%	10.71%
Locator	4,691	5.78%	5.86%
Total *(including others not shown)*	81,105	**DQI = 82.57**	

Table 9 - Event Sources for Telecommunications as Facility Damaged

Telecom Facility Unique Damages (2021)			
Event Source	**Damages**	**% of Total-All**	**% of Total-Known**
Telecommunications	45,364	50.34%	50.88%
Excavator/Road Builder/ Engineering	31,948	35.45%	35.83%
Locator	10,198	11.32%	11.44%
Total *(including others not shown)*	90,109 *15,174 CATV* *74,935 TELC*	**DQI = 57.75**	

Natural gas and telecom both self-report the majority of their damages, followed by excavators and then locators. Excavators make up a significantly larger percentage of telecommunications event sources when compared to natural gas. The DQI for telecommunications reports are appreciably lower than that of natural gas.

ROOT CAUSE – NATURAL GAS V. TELECOMMUNICATIONS

As seen previously in the report, we know that Locating Practices is the leading "known" root cause group for telecommunications and cable TV, and for natural gas it is Excavation Practices. Examining the top individual root causes for each industry provides additional granularity (note: same color code means same root cause group).

Natural Gas: Reported Damages by Root Cause

Top Root Causes Coded by Group

Root Cause	Reports	% of Tota All Datal	% of Total Known Datal
No Locate Request	23,316	28.75%	31.28%
Failure to Pothole/Maintain Clearance	16,631	20.50%	22.31%
Locator Error	9,256	11.41%	12.42%
Insufficient Excavation	7,518	9.27%	10.08%
Other	6,556	8.08%	
Bad Map	3,724	4.59%	4.99%

Excavation Practices | Locating | No Locate Request | Other

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Figure 20

In Figure 20, when *failure to pothole/maintain clearance* and *insufficient excavation* root causes are combined, they exceed *No Locate Request*. Note that in DIRT, *failure to pothole* and *failure* *to maintain clearance* are separate individual root causes. Also, here Bad Map combines *marked inaccurately* and *not marked at all*.

Telecommunications: Reported Damages by Root Cause

Top Root Causes Coded by Group

Root Cause	Reports	% of Tota All Datal	% of Total Known Datal
Other	49,068	54.45%	
Locator Error	13,634	15.13%	33.22%
No Locate Request	8,648	9.60%	21.07%
Failure to Pothole/Maintain Clearance	5,793	6.43%	14.12%
Insufficient Excavation	3,869	4.29%	9.43%
Failure to Support/Protect	1,870	2.08%	4.56%

Excavation Practices   Locating   No Locate Request   Other

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Figure 21

In Figure 21, the Locator Error-attributed damages alone exceed the combined total of all three root causes from the Excavation Practices group. However, Locator Error here is the sum of *marked inaccurately* and *not marked at all*.

For telecommunications, the high percentage of "unknown/other" responses is a major contributor to this sector's lower DQI score, as DIRT's root cause field is weighted heavily in the DQI calculation.

It should be kept in mind that root causes within the Locator Error group do not always mean the locate technician is at fault. For example, an excavator may only know that the facility was not marked or marked inaccurately and therefore selected a Locator Error root cause,[17] whereas a facility operator or locating contractor would be better positioned to determine if it was a mapping, abandoned facility, or tracer wire issue. Excavators are a higher percentage of the telecommunication damage event sources.

[17] This is preferable to choosing "unknown," because it is in the Locating root cause group.

FACILITY TYPE AFFECTED – NATURAL GAS V. TELECOMMUNICATIONS

Table 10 – Facilities Affected for Natural Gas and Telecom

	Natural Gas			Telecom		
Facility Affected	**Damages**	**% of Total-All**	**% of Total-Known**	**Damages**	**% of Total-All**	**% of Total-Known**
Distribution	30,465	37.56%	40.25%	28,587	31.72%	43.74%
Gathering	133	0.16%	0.18%			
Service drop	44,824	55.27%	59.22%	34,771	38.59%	53.20%
Transmission	272	0.34%	0.36%	2,003	2.22%	3.06%
Unknown	5,411	6.67%		24,723	27.44%	

When "unknown" root causes are eliminated, the two industries appear quite similar when examining the percentages of distribution and service drop in facilities affected. Telecommunications has a higher percentage of transmission than does natural gas.[18] In the telecommunications industry, long-haul fiber is considered transmission. Again, the high percentage of "unknown" contributes to the lower DQI for telecommunications events.

DEPTH OF FACILITY – NATURAL GAS V. TELECOMMUNICATIONS

Table 11 shows the depth of the facility damaged. Neither industry does particularly well in answering this question. Note how damages at a depth of less than 18 inches and those at depths 18-to-36 inches are nearly reversed for the two industries, with damaged telecommunications facilities more often at a shallow depth. Federal and state pipeline safety regulations have depth of cover requirements at time of installation, while there are no equivalent rules for telecommunications.

[18] Telecommunications also had a handful of "gathering" as facility affected. These were probably data-entry errors and were set aside for this analysis.

Table 11—Depth of damaged facility for natural gas and telecom

	Natural Gas			Telecommunications		
Depth	**Reported Damages**	**% of Total-All**	**% of Total-Known**	**Reported Damages**	**% of Total-All**	**% of Total-Known**
Unknown/Blank	50,942	62.81%		55,728	61.85%	
Embedded	116	0.14%	0.38%	152	0.17%	0.44%
< 18"	5,151	6.35%	17.08%	23,255	25.81%	67.64%
18" - < 36"	18,548	22.87%	61.49%	5,919	6.57%	17.22%
36 & >	6,349	7.83%	21.05%	5,054	5.61%	14.70%

DOWNTIME – NATURAL GAS V. TELECOM

Table 12 shows how the question "Did the excavator incur downtime?" is answered. Again, this question is seldom completed, but when it is, damages to telecommunication facilities involve a "yes" answer more often. This is likely due to a higher percentage of these reports coming from the excavator as event source.

Table 12—Excavator downtime incurred for natural gas and telecom damages

	Natural Gas			Telecommunications		
Downtime	**Damages**	**% of Total-All**	**% of Total-Known**	**Damages**	**% of Total-All**	**% of Total-Known**
Blank	57,028	70.31%		61,468	68.22%	
No	13,874	17.11%	57.62%	9,870	10.95%	34.46%
Yes	10,203	12.58%	42.38%	18,771	20.83%	65.54%

TYPE OF EXCAVATOR AND TYPE OF EQUIPMENT – NATURAL GAS V. TELECOMMUNICATIONS

For the excavator type and equipment type questions, the two industries are very similar in terms of the leading contributors – contractors and backhoes lead the way for both industries. This is logical, since we saw in the Data Overview 2021 section that those were the leaders for the entire 2021 dataset. Specific data and tables can be obtained from the online dashboard.

TYPE OF WORK – NATURAL GAS V. TELECOMMUNICATIONS

Tables 13 and 14 show the top types of work involved in damages for the respective industries. Water is the leading type of work for both industries, which is also consistent with what we saw in the Data Overview 2021 section. Telecommunications have a higher percentage of "unknown." Although both industries damage facilities within their industry (their own crews or subcontractors), **telecommunications does so about twice as often as natural gas (when "unknown" is removed – 14.22% vs. 7.18%).**

Table 13—Leading work types involving natural gas damages

Natural Gas – Leading Work Types Involved in Damages			
Work Type	**Damages**	**% of Total-All**	**% of Total-Known**
Water	11,176	13.78%	15.89%
Unknown	10,784	13.30%	
Sewer	9,108	11.23%	12.95%
Telecommunications	7,615	9.39%	10.83%
Electric	5,921	7.30%	8.42%
Natural Gas	5,052	6.23%	7.18%

Table14—Leading work types involving telecom damages

Telecommunications – Leading Work Types Involved in Damages			
Work Type	**Reported Damages**	**% of Total-All**	**% of Total-Known**
Unknown	48,665	54.01%	
Water	6,363	7.06%	15.35%
Telecommunications	5,894	6.54%	14.22%
Natural Gas	5,722	6.35%	13.81%
Electric	5,045	5.60%	12.17%
Sewer	3,394	3.77%	8.19%

In the Data Overview 2021 section of this report, was saw that the top five "known" work types for the entire data set were (in this order): water, telecommunications, natural gas, sewer and electric. When we isolate damages to natural gas and telecom facilities, we find similar results.

SPOTLIGHT ON REPORTS FROM EXCAVATORS, ROAD BUILDERS AND ENGINEERING

- The majority of DIRT reports entered by excavators indicate root causes from the Locating Practices root cause group.
- Telecommunications is the leading damaged facility in reports entered by excavators.
- Excavators indicate downtime is experienced in 24% of their reports.
- Data quality is high for excavators entering directly into DIRT (as opposed to excavator data entered through an 811 center [one call center]), but the quantity of direct data entered by excavators is low.

In this section, we take a closer look at reports submitted by excavators, road builders and engineering firms. For this analysis, these reports will be attributed to the umbrella name “excavators” and the 59,660 unique damages entered by these groups for 2021 will be the basis for all figures and tables in this section, unless otherwise noted.

ROOT CAUSE – REPORTS FROM EXCAVATORS

As seen in Figure 12 (Damage Root Cause Group by Event Source), Locating Practices is the leading “known” root cause group (74%) for reports entered by excavators. Examining the top individual root causes reveals that four of the top six “known” are from the Locating Practices root cause group, with Locator Error alone over 57% (see Figure 22).[19]

Reported Damages by Root Cause Based on Reports from Excavators

Top Root Causes Coded by Group

Root Cause	Damages	% of Total All	% of Total Known
Other	35,027	58.71%	
Locator Error	14,111	23.65%	57.29%
Failure to Pothole/Maintain Clearance	3,117	5.22%	12.65%
Mapping Issue	1,258	2.11%	5.11%
No Locate Request	1,247	2.09%	5.06%
No Response from operator/contract locator	1,076	1.80%	4.37%
Site marked but incomplete at damage location	577	0.97%	2.34%

Excavation Practices Locating No Locate Request Other

DIRT Report for 2021 | Common Ground Alliance

Figure 22

[19] Locator Error and Mapping Issues combine the *not marked* and *inaccurately marked* individual root causes.

As discussed in the Data Overview 2021 section, Locator Error tends to be a catchall when a more specific root cause is not collected.

To provide a sense of what excavators commonly encounter, recent root cause free-text comments submitted by excavators are included below:[20]

- “Line was not buried as deep as it was supposed to”
- “2 services to house and only 1 was marked”
- “2nd line found under gas line”
- “8' off the mark”
- “A piece of concrete fell due to cave-in and damaged lines”
- “Abandoned service was spotted, working facility was not at a deeper depth”
- “Area was not marked an no providers on the one call are claiming the fiber”
- “Backhoe came in contact with miss marked water service”
- “Cable embedded in asphalt, unknown if utility is active or abandoned”
- “Cables were installed only 6 inches in depth inside the asphalt”
- “Called in second notice and still was not properly marked”
- “Company not registered with 811”
- “Line was not marked”

[20] A comment is required if “other” is chosen as the root cause, otherwise it is optional.

Figure 23 shows the root cause groups by facility damaged for this dataset.

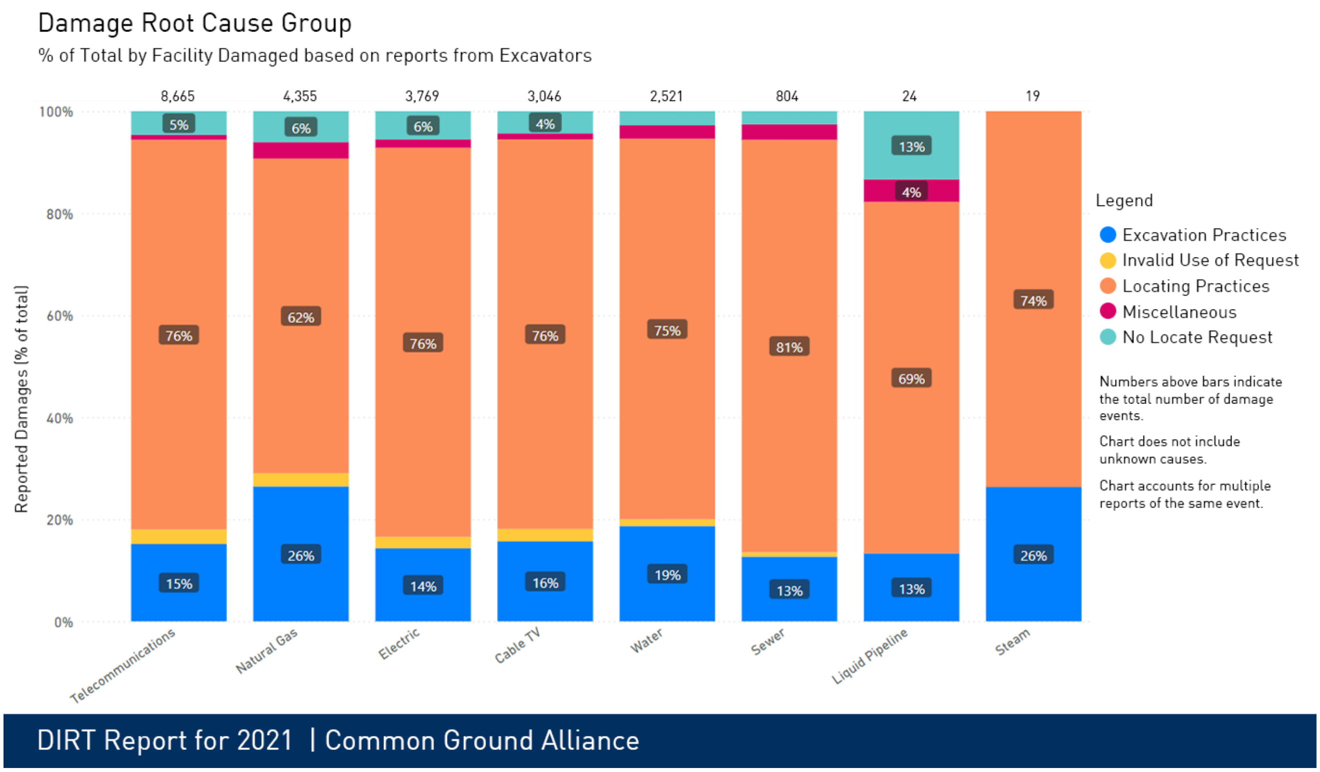

Figure 23

For all types of facilities damaged, Locating Practices is the leading root cause group, ranging from 62% for natural gas to 81% for sewer.

DOWNTIME – REPORTS FROM EXCAVATORS

We already looked at downtime in the natural gas versus telecommunications comparison. Here we take a closer look based only on the excavator-as-source subset of data. Because the number of non-blank entries for some of these questions becomes much smaller, in order to minimize further compression of the dataset we will use total number of damages, as opposed to unique damages. The percentage calculations change only very slightly.

Table 14—"Did the excavator incur downtime?" answers for all reports from excavators

How Often Downtime Question is Answered - All Damage Reports from Excavators			
Downtime	**Damage Reports**	**% of Total-All**	**% of Total-Known**
Blank	26,960	38.32%	
Yes	26,695	23.70%	61.57%
No	16,660	37.98%	38.43%

In the natural gas-versus-telecommunications comparison, telecommunications had higher numbers of reports with downtime indicated. When focusing on those two facilities damaged within this excavator dataset, it is evident why that occurs.

Table 15 shows a subset of Table 14, with natural gas as the facility damaged.

Table 15—"Did the excavator incur downtime?" answers for natural gas damage reports from excavators

How Often Downtime Question is Answered - Natural Gas Damages from Excavators			
Downtime	**Damage Reports**	**% of Total-All**	**% of Total-Known**
Blank	4,865	39.99%	
Yes	5,210	42.82%	71.35%
No	2,092	17.19%	28.65%

Table 16 shows a similar subset for telecommunications/cable TV as the damaged facility.

Table 16—"Did the excavator incur downtime?" answers for telecom damage reports from excavators

How Often Downtime Question is Answered -Telecom Damages from Excavators			
Downtime	**Damage Reports**	**% of Total-All**	**% of Total-Known**
Blank	14,646	39.41%	
Yes	12,640	34.01%	56.13%
No	9,881	26.59%	43.87%

For both natural gas and telecommunications, the percentage of blank responses to this question are about the same, but the total number of telecommunications damage reports is about three times that of natural gas.

DATA QUALITY INDEX (DQI) – IMPACT OF DATA QUALITY

- **DIRT fields with high percentages of unknown data lead to greater uncertainty about the accuracy of analysis.**
- **Higher quality data across all stakeholder groups is critical to identifying and focusing efforts on factors that have an impact on reducing damages.**

Data Quality Index (DQI) is a feature within DIRT to score data quality. It was developed to provide submitters with confidential feedback based on measures of the completeness and/or quality of the reports they submit. For each DIRT field, points are assigned based on the importance or value of that question to overall data analysis. If fields are left blank or if "unknown" is selected, the submitter receives zero DQI points for that particular field. The intent is to identify opportunities for DIRT users to improve their score by completing as many optional DIRT fields as possible.

When a DIRT submission is entered, the user is shown a chart as shown below. The middle column (weighting %) shows the maximum value of that "part." The first column (Score (/100)) shows the percent of the weighting achieved for the report (or the average of all reports in a bulk file upload).

Damage Report Submitted Successfully:

Damage Report Id:			**4440029**
Overall Data Quality Score out of 100: (more info...)			**83**
Data Quality Details:	**Score (/100)**	**Weighting %**	**Weighted Score**
Part A: Original Source of Event Information	100	5 %	5.0
Part B: Type, Date and Location of the event	100	10 %	10.0
Part C: Affected Facility Information	85	20 %	17.0
Part D: Excavation Information	65	20 %	13.0
Part E: Notification and Locating	75	5 %	3.8
Part G: Excavator Downtime	0	5 %	0.0
Part H: Interruption and Restoration	80	5 %	4.0
Part I: Description of the Root Cause	100	30 %	30.0
Part J: Additional Comments	n/a	n/a	n/a

For example, Part D[21] has a weighting of 20%, and includes these questions (as answered for example above).


*Type of Excavator: Occupant
*Type of Excavation Equipment: Unknown/Other
*Type of Work Performed: Fencing

Type of excavator and equipment are both worth seven points, and type of work is worth six. Since "unknown/other" was selected for type of equipment in the sample report, 13 out of 20 possible points (65%) were achieved for Part D. This presents an opportunity for improvement. If the type of excavation equipment is available, the report could be edited, raising the total DQI from 83 to 90. If not available for this particular event, it may be possible to start collecting this data point for future events.

In general, DQI scores above 80 could be considered "good," with scores of 60 to 80 considered "fair." Table 17 below shows the points for the "high-value" DIRT questions. If none of these questions are answered with "known" data, the DQI is under 40. These questions are considered high-value because they focus on what is being damaged, by who, why, and how. Combinations of these data points are the most useful for identifying opportunities for improvement.

Table 17—High-value DIRT questions

DIRT Question	DQI Value
Root Cause	30
Facility Operation (electric, natural gas, CATV....)	8
Facility Affected (distribution, service/drop, transmission….)	6
Type of Excavator	7
Type of Equipment	7
Type of Work	6

[21] Although the bulk upload files do not indicate the Part the questions come from, there are several ways to find this: (1) consult the DIRT Users Guide, (2) look at the two-page Field Form, (3) use the "Enter Report" feature on the DIRT Main Menu to scroll through the form (stop short of hitting Submit).

Figure 24 provides a depiction of the number of companies entering DIRT data, their number of reports, and average DQI scores for 2021 reports.

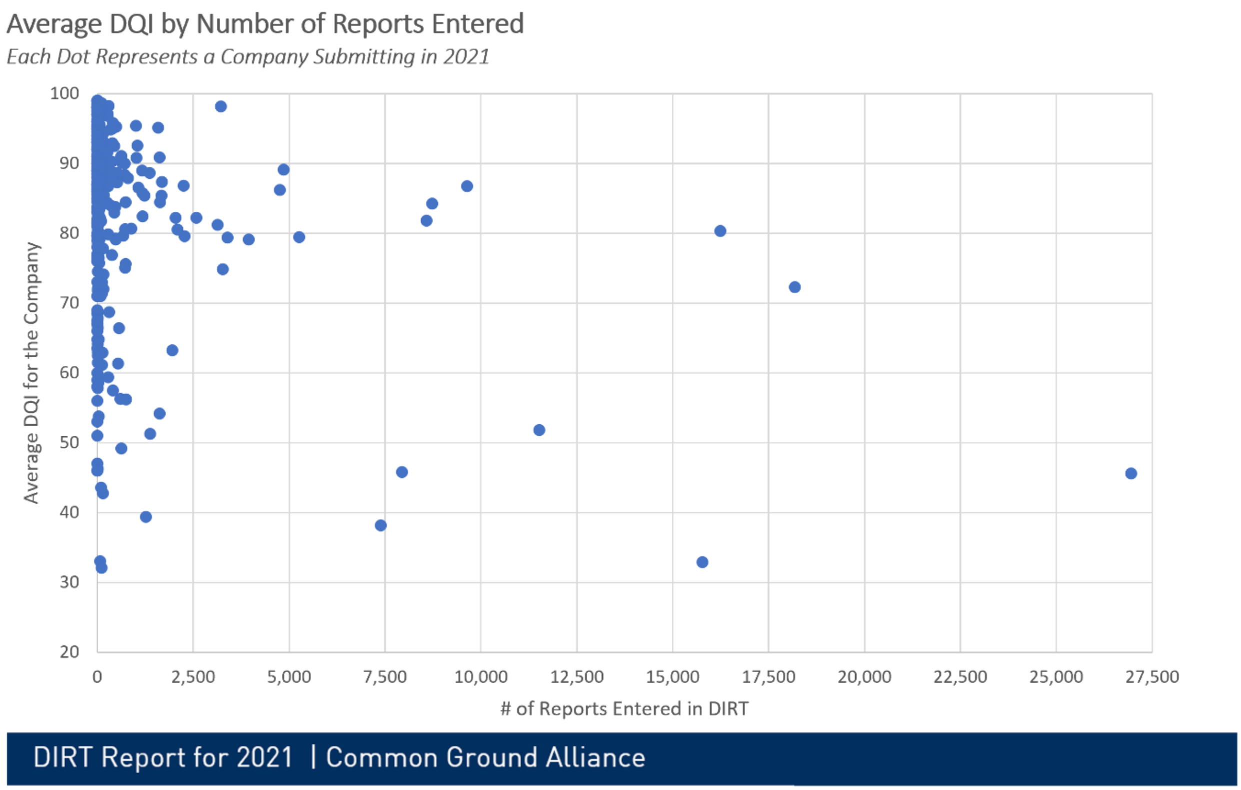

Figure 24

Most exhibits in DIRT Reports are based on "known" data, meaning that "unknown" selections or blank fields are filtered out. This requires an assumption that the data masked by the "unknowns" is proportional to the known slices. For example, for type-of-excavator, the full 2021 dataset has 55.27% contractor and 29.85% "unknown." When we remove "unknown"[22] from the total denominator, contractor jumps to 78.78%[23] – a difference of more than 20%. This is the best assumption we can make given the data, but the reality may differ. Occupants and/or utility might really be higher, and contractors could be lower. The *no locate request* root cause increases from 17% to 26% respectively with "unknowns" included versus excluded in the denominator. Reducing unknowns, especially in these high-DQI-value questions, reduces the margin for error and makes analysis more accurate.

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[22] 55.27 / (100 – 29.85) = 78.78

[23] Using the DIRT Explorer page of the DIRT Interactive Dashboard, you can recreate this analysis and examine the impact of removing "unknowns" for other DIRT fields.

Table 18 shows the number of reports by DQI range. It is encouraging that the largest band in terms of report count – nearly half – are in the "good" DQI range. However, nearly 35% of reports are below 60, indicating room for improvement.

Table 18—Reports by DQI Ranges of 20

DQI Range	Report Count	% of Report Count
<40	42,416	18.57%
40-59	36,589	16.02%
60-79	36,330	15.91%
80-100	113,058	49.50%

Table 19 shows the average DQI by event source for all 2021 reports.

Table 19—Average DQI by Event Sources

Event Source	Average DQI
Electric	73.53
Engineering	80.76
Excavator	60.94
Liquid Pipe	82.84
Locator	73.87
Equipment Manufacturer	80.43
Natural Gas	86.29
Private Water	79.94
Public Water	78.77
Railroad	66
Regulator	79.37
Road Builder	68.74
Telecommunications	52.41
Unknown	60.01
Total Weighted Average	69.42

Many reports attributed to excavators as the event source are initially reported to an 811 center (one call center), which then enters the DIRT report. Table 19 shows a DQI of 60.94 for excavators. This is a blend of reports submitted through 811 centers (56.46) and reports submitted directly by excavators (84.51).

Because the volume of reports submitted through 811 centers is much higher, the blended result is skewed in the lower direction. There actually is a wide range of DQI scores for excavator reports submitted through 811 centers. Of the ten 811 centers that gather information from excavators, six have a DQI of 75 or above, three are below 40, and one is in the low 50s.

Colorado 811, one of the high volume/high DQI submitters spotlighted in this section, demonstrates the potential for high DQI utilizing the 811-center-entered data submission model.

The 811 centers with DQI below 40 occasionally enter “known” values for the high-DQI-value DIRT fields, but mostly enter “unknown.” These reports provide us with a count of damages and indicators of overall trends, but provide limited additional information such as identifying root causes and types of excavator, equipment, work performed, etc. 811 centers have an opportunity to provide more complete data and greater insight into the excavator submitted damages.

DQI SPOTLIGHT ON SUBMITTERS

This year, the Data Reporting & Evaluation Committee set out to spotlight companies that submit a high volume of data and maintain a high DQI. The goal is to hear from those who are submitting more complete reports, understand more about their process, and learn about how this higher quality data affects their own data analysis. DIRT data submission is anonymous; however, three high DQI-high volume companies – CenterPoint, Colorado 811 and UtiliQuest – have agreed to participate as “DQI Spotlight” submitters. Representatives from each organization participated in an interview and answered a series of questions related to their current data collection/reporting process. The goal is to document lessons learned that can be shared with the broader damage prevention community.

Several commonalities among the spotlighted high volume/high DQI organizations were identified:

- They attempt to gather the relevant information as soon as possible. In addition to DIRT data, they may be collecting information to support their claims process or state or federal regulatory reporting requirements. The natural gas and locating companies send personnel to the site. The 811 center receives telephone notices, but its personnel ask relevant questions.
- They have automated internal processes to transfer the information and enter it into DIRT. DIRT has features that support automated processes to enter data.[24]
- In addition to contributing DIRT data to the broader damage prevention industry, they use it within their own organizations to identify ways to reduce damages.
- Within their organization, they emphasize the importance of good data quality to their employees.
- When reviewing DQI, each focused on where they have additional opportunities for improvement and began making immediate changes to their process to see additional gains.

[24] https://identity.cga-dirt.com/cgareg/control/submitting.do#data-entry-options.

CENTERPOINT ENERGY: ACHIEVING HIGH DQI THROUGH ONSITE DAMAGE DATA COLLECTION AND EMPHASIS ON DATA IN ORGANIZATIONAL CULTURE

Company:	CenterPoint Energy
Stakeholder Group:	Natural Gas
High Quality Field(s):	Excavation Information (Part D) and Root Cause (Part I)

The collection of accurate and complete damage data is incentivized at CenterPoint Energy by emphasizing the data as a crucial tool for the business model throughout the organization. Damage data collection is viewed as a shared responsibility and begins in the field to ensure that the damage information is collected by individuals who actually responded to the location. The field crew takes photos and completes a digital form associated with the work order, and that system automatically interfaces with the damage reporting system to transfer the information for the damage prevention department. The form provides a wealth of helpful information about the damage, including excavator type, the facility affected, type of work being performed, initial locate information, and more.

Once a damage is thoroughly investigated by a member of the CenterPoint's Damage Prevention team, it is processed to claims and regulatory for reporting. This damage data is then incorporated into CenterPoint's online damage prevention scorecard, an internal dashboard that enables the company to analyze a number of data points year-over-year to inform decision-making across the organization. The insights are used for a variety of functions, from budgeting and claims management to providing insights into public awareness campaigns that reach the largest contributors of damages to facilities. The data allows the company to identify trends, areas for improvement, and areas where additional training may be needed. Consistent reporting of this data also allows CenterPoint to analyze areas of improvement in its own data collection processes, which has helped improve its damage data quality over time. CenterPoint has found that sharing the data and its impact on decision-making across the organization positively influences the field crew when collecting data and the overall shared responsibility culture.

DIRT Analyst Perspective: CenterPoint increased its DQI score from the mid 70s in 2019 to the mid 80s in 2020 and 2021. The leading areas of improvement were in Part C - Facility Affected Information and Part D - Excavation Information, each worth 20 points. CenterPoint also went from leaving Part H -Interruption and Restoration entirely blank to answering those questions over 90% of the time.

COLORADO 811: STREAMLINING DAMAGE NOTIFICATION PROCESS TO ACHIEVE HIGHER DQI AS 811 CENTER

Company:	Colorado 811
Stakeholder Group:	811 Center (One Call Center)
High Quality Field(s):	Excavation Information (Part D) and Root Cause (Part I)

Colorado 811's DQI is among the highest for 811 centers. While mandatory damage reporting in Colorado drives a large quantity of damage data, Colorado 811's high data quality is also due in large part to its emphasis on logging accurate, complete damage data from excavators. When an excavator calls Colorado 811 to report a damage, the call center employee is trained to glean as much information from the excavator as possible. This is done through Colorado 811's improved damage data collection process and form, which was recently reconstructed to capture the most pertinent damage information that the excavator can provide, based on the fields of the DIRT damage submission form. Colorado 811 uses an automated (XML) process to enter this information into DIRT, which saves the center staff time that would be required to enter the DIRT data as a separate step. With the well-constructed form and a staff trained to make the process as streamlined as possible for the excavator, this process adds only about 30-35 seconds to the call.

The data is then used by Colorado 811 to help target its marketing and outreach efforts to the trends that are happening in the field. Because it allows the 811 center to track damages from specific efforts over time, Colorado 811 has used its data to work with large state natural gas providers to provide educational resources for excavators with frequent damages. Colorado 811 also refers to the data's overall root cause trends to support legislation. It also provides counties with "report cards" that assess the area's public awareness efforts, damage prevention efficacy and a composite of both components to evaluate damage prevention trends at a more local level.

DIRT Analyst Perspective: Colorado 811 improved its DQI from the low 60s in 2018 to the low 80s in subsequent years. The largest area of improvement was in Part I - Root Cause, where the 811 center increased from a "known" root cause in less than 30% of reports to nearly 80% in 2021.

UTILIQUEST: INVESTIGATING AND DOCUMENTING EVERY DAMAGE AS A CONTRACT LOCATING COMPANY

Company:	UtiliQuest
Stakeholder Group:	Locator
High Quality Field(s):	Facility Damaged (Part C), Excavation Information (Part D) and Root Cause (Part I)

UtiliQuest's data-driven operations and culture support rigorous damage investigations that result in high-DQI contributions to CGA's DIRT database, particularly around damage root causes. Specially trained damage investigators are dispatched when UtiliQuest is alerted of a damage. Damage investigations and utility locating functions are intentionally separate jobs to ensure the integrity of the investigation process. Damage investigators strive to arrive on the scene while excavating equipment is still present and they utilize a tablet or laptop to complete a thorough damage report including photos. The collected data is then delivered into UtiliQuest's ticket management system. Mandatory reporting fields enable consistency in data gathering and reporting. Management reviews each report before it is delivered to the client. Importantly, UtiliQuest also maintains these damage reports enabling identification of root causes to target further damage reductions and to submit annually into DIRT.

UtiliQuest uses damage data to continually monitor key performance indicators such as top root causes, clients' damages per thousand tickets and/or utility type, etc. The organization-wide focus on thoroughly investigating every damage and providing detailed reports not only helps UtiliQuest improve its own operations but also assist their clients in identifying root causes that both parties can impact. While the organization's DQI is relatively high for a locating company, there are areas for continuous improvement.

DIRT Analyst Perspective: UtiliQuest has made improvements in its DQI over the past three years, with a leading area being Part D - Excavation Information. Based on the DQI review and spotlight discussions, UtiliQuest identified and implemented immediate actions for further improvement.

HORIZONTAL DIRECTIONAL DRILLING (HDD)

- **When horizontal directional drilling (HDD) is the equipment type, excavators (including engineering) are the leading source of damage reports, locating is the leading root cause group identified, and telecommunications (including cable TV) is the leading type of work performed.**
- **Many damages involving HDD are facility operators, or their subcontractors, hitting each other and/or themselves.**
- **HDD projects can be expected to increase in future years due to increased infrastructure spending.**

In this section, we take a closer look at damages associated with horizontal directional drilling (HDD), a selection for "type of excavation equipment" in DIRT. For this subsection of data, total reports entered (9,054) was used for analysis. There is little difference in percentage calculations between total event and unique event totals, especially when "unknowns" are filtered out.

HDD is often used as an alternative to open trenching for installing buried facilities. It requires an entry and exit pit, but these are often in an unpaved area that can be more easily restored. By avoiding cutting pavement, restoration issues such as unsightly patches, uneven settlement, water infiltration and freeze-thaw cycles leading to cracks, etc. are avoided. When used under roadways, it can minimize traffic disruption. HDD is also often used to cross under water bodies, wetlands, railroads and other sensitive areas where traditional excavation is impractical or environmentally harmful. However, the downside with HDD is that unless potholing is performed, there is no visual verification that the drill path has successfully crossed existing buried facilities with no contact. Additionally, if the drill does damage another buried facility, some time may pass before it is realized.

Figure 25 shows the event sources for this dataset. Excavator/engineering is the largest contributor.

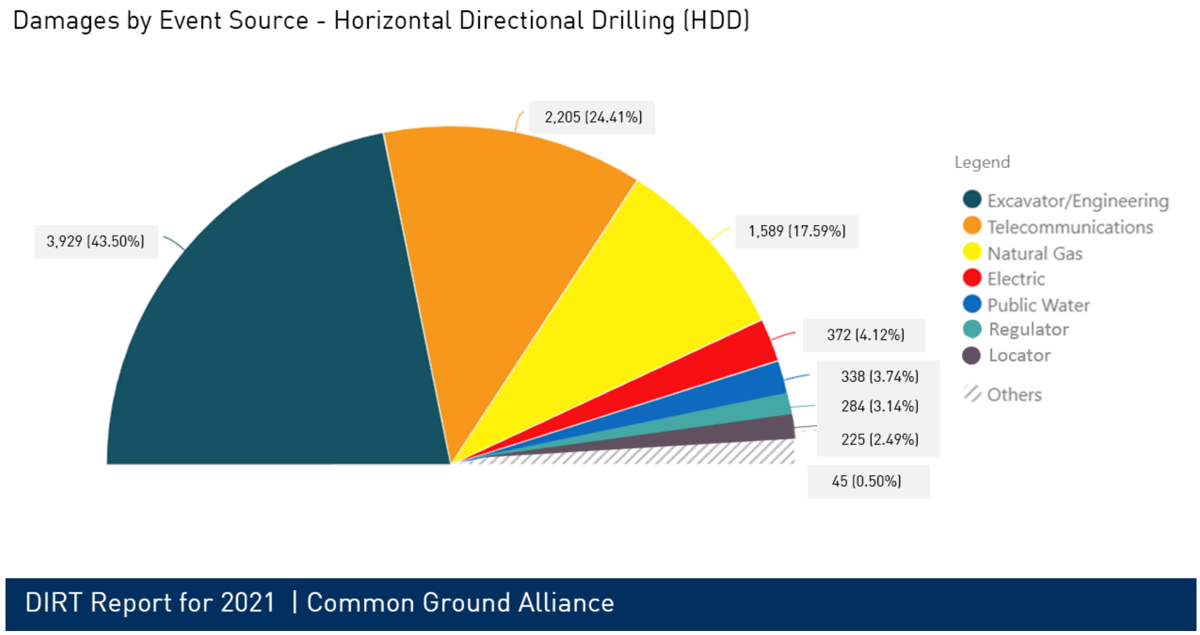

Figure 25

Figure 26 shows the root cause groups for this dataset. In contrast to the full dataset, *no locate request* becomes a much smaller slice.

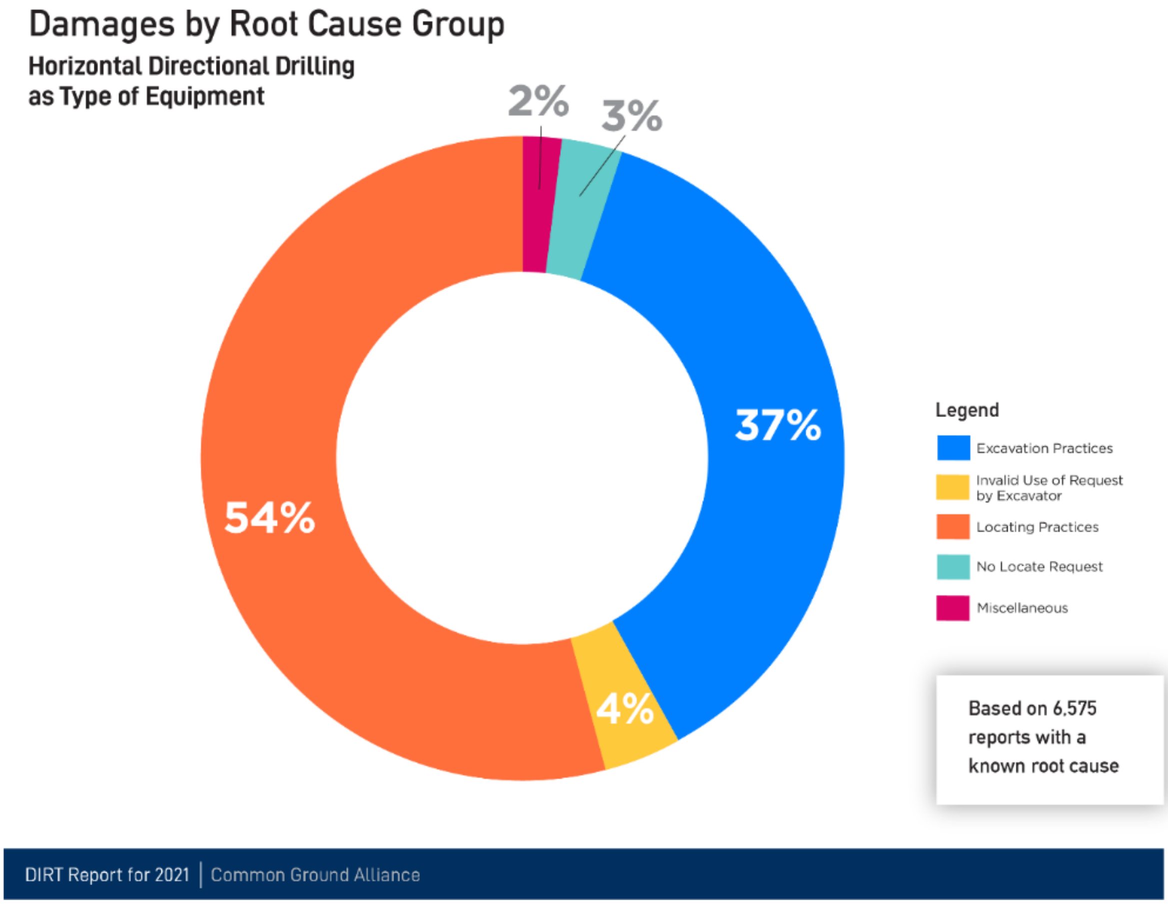

Figure 26

Figure 27 further shows the root cause groups for the leading types of facility damaged when HDD is used.

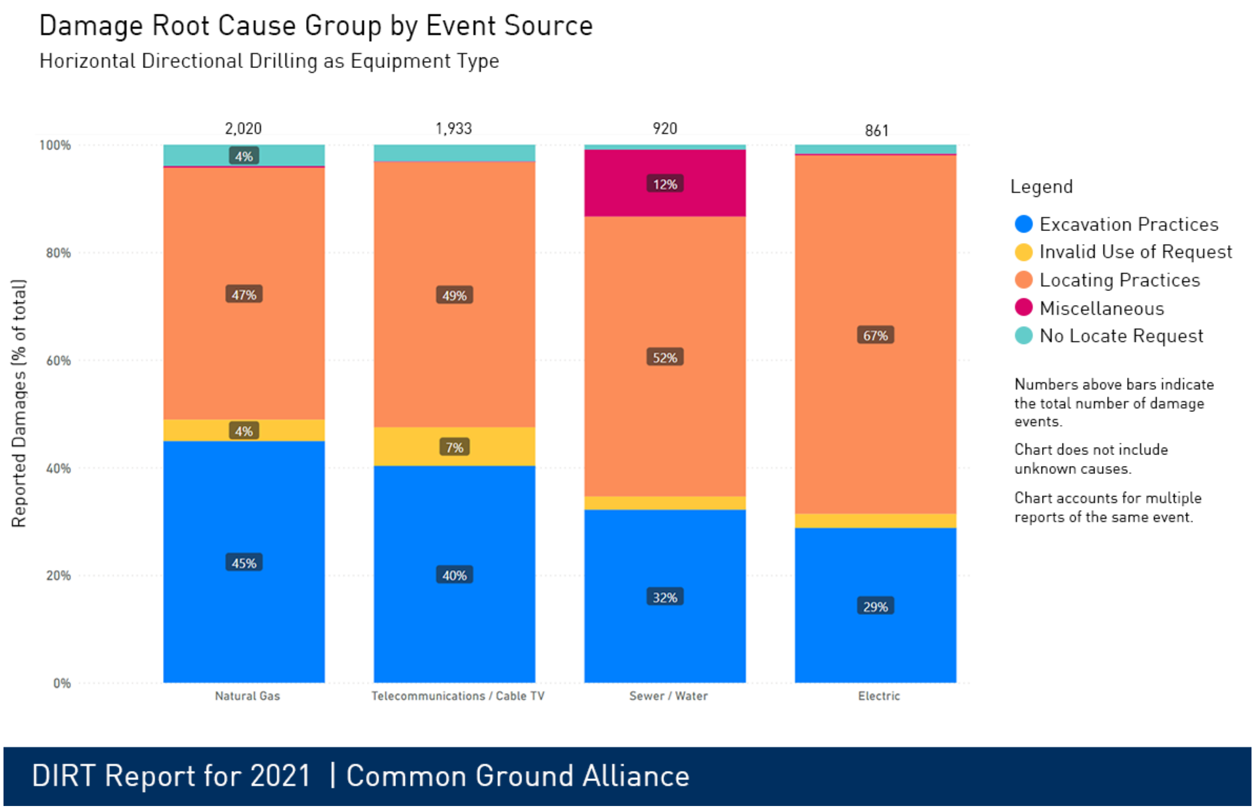

Figure 27

For each facility type depicted within the Excavation Practices root cause group, *failure to pothole* and/or *maintain clearance* are the leading individual root causes. Within the Locating Practices root cause group, the leading individual root causes indicate locator error (*not marked* and *marked inaccurately*). At this level of granularity, we find reports with a root cause from the Miscellaneous group associated with sewer/water as the damaged facility. Most of those involved sewer, with *previous damage* as the leading individual root cause.

Table 20 shows the facility damaged by types of work for the leading contributing combinations. The 6,081 total reports are 95% of the reports where parameters are “known.”

Table 20—Report totals for facility damaged and work performed with HDD as equipment

Facility Damaged	Work Performed				
	Natural Gas	Telecom/CATV	Sewer/Water	Electric	Total
Natural Gas	330	1,714	83	286	2,413
Telecom/CATV	197	992	30	232	1,451
Sewer/Water	304	699	28	132	1,163
Electric	108	716	15	215	1,054
Total	939	4,121	156	865	6,081

Table 20 shows that Telecom/CATV is the leading type of work for all facility damaged types. The top "known" excavator types for the entire dataset of 9,054 records were contractor (95%) and utility (4%). Most of the contractors involved were likely working for the affected utility (ex: a subcontractor for a gas operator installing gas mains or services). This likely explains the very small percentage of damages caused by *no locate request*: The facility operators impress the importance of 811 notification upon their subcontractors and in-house crews. This analysis emphasizes that most of the damages around horizontal directional drilling involve facility operators damaging each other *and* themselves, largely due to locating and excavation practice root causes.

The use of HDD for telecommunications/cable TV work will likely increase in the coming years as a result of the Infrastructure Investment and Jobs Act of 2021. As discussed above, Locator Error is the leading root cause associated with HDD and telecom/CATV work. Locator Error can be considered a general "catch-all" root cause that masks deeper root causes such as bad maps, tracer wire and abandoned facility issues. Choosing Locator Error as a root cause is preferable to choosing "unknown."[25]

[25] Locator Error lets us know we're in the Locating Practices root cause group and achieves 30 DQI points instead of zero. See the Impact of Data Quality section of this report. There are several telecommunications companies that are high volume/low DQI.

APPENDIX A: TERMINOLOGY USED IN THIS REPORT

Damage—Any impact or exposure that results in the need to repair an underground facility due to a weakening or the partial or complete destruction of the facility, including, but not limited to, the protective coating, lateral support, cathodic protection, or housing for the line, device, or facility. There does not need to be a release of product.

DIRT—Damage Information Reporting Tool.

Downtime—Time that an excavator must delay an excavation project due to failure of one or more stakeholders to comply with applicable damage prevention regulations or best practices. There may or may not be a damage associated with the downtime.

Event—The occurrence of facility damage, near miss, or downtime.

Facility Affected—The type of facility that is involved in a damage event: distribution, service/drop, transmission, or gathering.

Facility Damaged—The facility operation that is affected by a damage event: cable TV, electric, natural gas, sewer, water, etc.

Known Data—DIRT data, excluding unknown data. Unknown data depends on the DIRT field but usually is denoted as “unknown” or “unknown/other.”

Near Miss—An event where damage did not occur but clear potential for damage was identified.

Pothole—(a.k.a. Test Hole): Exposure of a facility by safe excavation practices used to ascertain the precise horizontal and vertical position of underground lines or facilities. Accepted safe excavation practices vary by state/local jurisdiction, but the preferred techniques include hand digging with extreme caution and/or vacuum excavation. (See Best Practice 5-32).

Root Cause—The primary reason that the event occurred. For purposes of DIRT, the point where a change in behavior would reasonably be expected to lead to a change in the outcome, i.e., avoidance of the event.

Tolerance Zone—The space in which a line or facility is located and in which special care is to be taken.

Transmissions—The number of initial notices of intent to excavate sent by one call centers to their member facility operators, including those sent directly to locating vendors on behalf of members. Each incoming notice of intent to excavate generates outgoing transmissions to several members, such as electric, gas, cable TV, water, sewer, telecommunications, etc.

Unique Events—The number of events after identifying and consolidating multiple reports of the same event. Unless otherwise noted, this is the number used in annual DIRT reports and on the online interactive dashboard.

APPENDIX B – GREEN ANALYTICS TRENDING REGRESSION ANALYSIS

Objective

The objective of this analysis is to estimate whether damage counts are changing significantly over time in the United States after accounting for several potential driving factors (e.g., economic growth, dig activity, etc.).

Method

A regression analysis was performed to relate damage counts by month and state to a set of explanatory variables including factors related to the economy, demographics, dig activity and others as noted below. The analysis focused on trends over time using a set of year variables to account for changes over the three years included in the analysis (2019 to 2021).

$$Damages_{Month}^{State} = f(Years, Economic, Demographic, Dig\ Activity, Other) \quad [\mathbf{1}]$$

Given that the damage data are structured as count data, Poisson and negative binomial count models were used for the analysis. Both models are designed to deal with the unique characteristics of count data, but the negative binomial model relaxes a key assumption of the Poisson model (via an overdispersion parameter). Models were run with and without clustering the standard errors on the geographic unit (state) which accounts for the panel nature of the data. The coefficients of interest for the trend analysis are those corresponding to the years variable in Equation 1. By using Equation 1, the year coefficients can be assessed while holding all other measures (i.e. economic and dig activity) equal. Doing so allows us to determine if damages are flat or trending up (or down) for reasons not related to economic or dig activity, if year coefficients are found to be statistically significant.

Before running the regression models, standard data assessments were completed to ensure the regression results are not impacted by known data issues. For instance, multicollinearity between variables was assessed using variance inflation factors (VIF). Since multicollinearity can influence how regression coefficients for certain variables are interpreted, highly collinear variables were iteratively removed if their VIF was above 5. This resulted in the primary models having a reduced set of variables with limited collinearity, and regression analyses were conducted on this reduced set as well as the total set of variables. Variables that were dropped due to multicollinearity were added back into the model one-by-one after the primary models were estimated to assess whether results differed (e.g., if variable ‘A’ was dropped initially then it was added back into the primary model by itself, if variable ‘B’ was dropped initially then it was added back into the primary model by itself, and so on).

Data

A subset of the U.S. damage data was assembled for the 2019 to 2021 period. To help reduce the impact to analysis stemming from variations in company reporting behavior from year to year, rather than actual changes in damages, the damage count dataset was assembled from companies that consistently reported during the past three years. The team also reviewed the makeup of companies to ensure the comparable dataset included representative from facility owner/operators and 811 center stakeholders as well as locator, electric, telecom/CATV, excavator, and water stakeholders.

Damages in the final set of data were distributed across the 50 states and the District of Columbia as well as the 36 months over the 2019 to 2021 period. Damage counts reported for certain states are zero or very low and are thus not well represented in the analysis (i.e., Alaska, Hawaii, Maine, and Vermont). However, other states appear poorly represented relative to past years and these states were flagged in consultation with CGA staff (i.e., Arizona, Connecticut, Idaho, Kansas, Montana, North Dakota, New Hampshire, New Mexico, Nevada, Wisconsin, and West Virginia). Data on other variables, including weather, demographics, economics (e.g., GDP or employment), construction, dig activity (e.g., transmissions), as well as PHMSA data on damages and tickets were also collected (Table B1).

Results and Conclusion

The initial multicollinearity check revealed that many of the variables in Table B1 were highly collinear and these variables were removed from the regression analysis. However, the variables of interest, year_2020 and year_2021 were not substantially correlated with the other explanatory variables in the model.

Though results of the primary Poisson model with the reduced set of variables suggest that damage counts are not changing over time (Table 2), the results of the negative binomial model suggest that damages in the year 2021 differ from those in 2019, although this relationship is weakly significant[26] (10% level of significance).[27] Additional testing suggests that damages in 2021 do not differ significantly from those in 2020. These general findings are the same regardless of model specification for the Poisson model (e.g., primary model with the reduced set of variables, the models adding collinear variables back in on a one-by-one basis, or the models with the full set of variables). However, this is not the case for the negative binomial model as the coefficients on the year variables stemming from the specification with the full set of variables do not differ significantly from zero, although the results of the negative binomial models that added the collinear variables back in on the one-by-one basis largely confirm the results of the primary model. Finally, these general findings are the same for models that cluster the standard errors and those that do not.

Assuming that the assembled data is representative of trends in all sectors and parts of the United States and given the time period considered, the models indicate that damages are remaining level at best, and there is some weak evidence that counts in 2021 differ (upward) significantly from those in 2019 after accounting for key driving factors. Again, “significant” is

[26] In statistics, “significant” means you can feel confident the effect is real rather than random, i.e., that you didn’t just get lucky (or unlucky) in choosing the sample.

[27] The results of the negative binomial model are preferred given that the dispersion parameter (alpha) differs from zero.

used in a statistics context, which differs from casual conversation where it may mean large or very important.

Table B1: Variables Initially Used in the Regression Analysis

Variable Name	Description	Variable is in Primary Model?	Notes
year_2020	Indicator (dummy) variable accounting for the year 2020	Yes	Variable of interest. If the variable's coefficient is significant then counts in 2020 differ significantly from 2019.
year_2021	Indicator (dummy) variable accounting for the year 2021	Yes	Variable of interest. If the variable's coefficient is significant then counts in 2021 differ significantly from 2019.
pop	Annual estimate of state population	No (dropped due to high VIF)	
popchangeP	Percent change in state population from previous year	Yes	
AreaKm2	State area in kilometers squared	Yes	
density	Population density	Yes	
tavg_Value	Average monthly temperature in a state in Fahrenheit	Yes	
pcp_Value	Monthly precipitation in a state in inches	Yes	
Real	Monthly estimate of real GDP per state (all sectors)	Yes	
Construction_Real	Monthly estimate of real GDP per state (construction sector only)	No (dropped due to high VIF)	
Permits	Monthly estimate of building permits issued per state	Yes	
emp_remodel_NA	Monthly estimate of employment in renovation and remodeling sector at the national level	Yes	Not seasonally adjusted
csU_total	Monthly estimate of total construction spending at the national level	No (dropped due to high VIF)	Not seasonally adjusted
TotalStarts_NSA	Monthly estimate of total housing starts at the regional level	Yes	Regions include Northeast, Midwest, South, and West
Unemp_NSA	Monthly estimate of the unemployment rate per state	Yes	Not seasonally adjusted
ConstGeneral_NSA	Monthly employment in the construction sector per state	No (dropped due to high VIF)	Not seasonally adjusted
TotalEmp_NSA	Monthly employment for all sectors per state	No (dropped due to high VIF)	Not seasonally adjusted
PHMSA_Damages	Annual PHMSA damage counts per state	Yes	
PHMSA_Tickets	Annual PHMSA ticket counts per state	No (dropped due to high VIF)	

Variable Name	Description	Variable is in Primary Model?	Notes
OneCall_Trans	Annual OneCall center transmissions per state	No (dropped due to high VIF)	
month_jfm	Indicator (dummy) variable for the months January, February, or March (roughly winter)	Yes	
month_amj	Indicator (dummy) variable for the months April, May, or June (roughly spring)	Yes	
month_jas	Indicator (dummy) variable for the months July, August, or September (roughly summer)	Yes	
month_ond	Indicator (dummy) variable for the months October, November, or December (roughly fall)	Yes (but see note)	Does not appear in model output as this is the reference season.
month_amjjas	Indicator (dummy) variable for the months April through September (roughly spring and summer)	No (used individual season indicators instead)	
low_counts	Indicator (dummy) variable accounting for states that are not well-covered by the data	Yes	They have lower counts than one might expect

Table B2: Primary Count Models Relating Damages to Explanatory Variables with Standard Errors Clustered on Geography[a]

Variable	Poisson Model	Negative Binomial
year_2020	0.0066264	0.1396216
	(0.1384777)	(0.1333183)
year_2021	0.016635	0.3181472*
	(0.2398704)	(0.1841542)
AreaKm2	-0.00000706	-0.00000068
	(0.00000191)	(0.00000177)
tavg_Value	0.0183398**	0.0278379***
	(0.0085293)	(0.0106641)
pcp_Value	-0.0265536	-0.0872928*
	(0.0193185)	(0.046825)
popchangeP	0.3531989	0.3966561
	(0.2483274)	(0.2584109)
Real	0.000000409	0.0000000189
	(0.000000433)	(0.000000557)
Permits	0.0000768*	0.0000893
	(0.0000466)	(0.0000936)
emp_remodel_NA	-0.0035606	-0.006691
	(0.0044479)	(0.0066367)
TotalStarts_NSA	0.0134491	-0.0063448
	(0.0137669)	(0.0127965)
Unemp_NSA	0.0046945	-0.0454165
	(0.032807)	(0.0487075)
PHMSA_Damages	0.000332***	0.0004386*
	(0.0001097)	(0.0002264)
density	-0.0041672**	-0.0003985***
	(0.0019499)	(0.0001518)
month_jfm	0.0057922	-0.1060727
	(0.0606405)	(0.0851081)
month_amj	-0.0875143	-0.1250074
	(0.1452539)	(0.2276354)
month_jas	-0.1719384	-0.2810573
	(0.1698518)	(0.2819143)
low_count	-2.590025***	-2.414872***
	(0.6206466)	(0.5517371)
Constant	5.96513***	5.948148**
	(1.50125)	(2.419352)
lnalpha (dispersion parameter)	N/A	0.201455
		(0.2182386)
alpha	N/A	1.223181
		(0.2669453)
Log-likelihood (pseudo)	-137,629.62	-10,029.549
R^2 (pseudo)	0.6940	N/A
Observations	1836	1836

[a] Cells contain model coefficients and associated standard errors in round brackets

***, **, and * indicate that the coefficient is significantly different from zero at the 1%, 5%, and 10% level of significance

APPENDIX C – BEST PRACTICES UPDATE

- **The Best Practices Committee took action to address all recommendations outlined in the 2019 and 2020 DIRT Reports, establishing five new working groups.**

The CGA Best Practices manual includes more than 160 practices that cover all phases of the 811 process, agreed to by each of CGA's 16 stakeholder groups. All practices go through a seven-step process that includes review by a task team, the full Best Practices Committee, and finally the CGA Board of Directors. Two fundamental principles must apply for a Best Practice to be adopted by CGA—it must: (1) actually be in use somewhere, and (2) achieve consensus from representatives of all CGA stakeholder groups.

A description of the process can be found here: https://bestpractices.commongroundalliance.com/1-Introduction/14-Best-Practices-Process.

The 2019 and 2020 DIRT Reports included sections relating leading damage root causes to corresponding Best Practices and provided recommendations based on the review. CGA's Best Practices Committee formed working groups to review the suggestions. An update on the Best Practices Committee and an overview of practices approved by the committee can be found at https://bestpractices.commongroundalliance.com.

DIRT recommendations resulted in the advancement of multiple practice proposals. During the past year, the Best Practices Committee approved updates to the following practices:

- 2-19 – Underground Electronic Utility Markers
- 3-1 – Proactive Public Awareness, Education and Damage Prevention Activities
- 3-2 – Specifically Defined Geopolitical Service Area with No Overlap
- 3-3 – Formal Agreements with Members
- 3-4 – One Call Center Governance
- 3-6 – Hours of Operation
- 4-4 – Single Locator (removed)
- 4-17 – Forecasting/Planning for Predictable Workload Fluctuations
- 5-2 – Delineate Area of Proposed Excavation
- 6-17 – Accuracy of Location Information
- Appendix B – Marking Guidelines, Guidelines for Underground Electronic Marker Technology
- Update reference to "one call center" in the Best Practices to reflect "811 center"
- Definition of "electronic white-lining"