California Underground Facilities Safe Excavation Board

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Agenda Item No. 12 (Information Item) – Staff Report

Geographic Information System (GIS) Workshop Update

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SUMMARY
On October 18, 2024, the Board's GIS Committee held a workshop[1] with operators and other stakeholders to explore use of GIS for asset management and damage prevention. Attendees discussed challenges with GIS records accuracy and completeness and provided insights for enhancing safety in excavation work.

STRATEGIC PLAN
2020 Strategic Plan Objective: Improve Accessibility of Buried Infrastructure Location Knowledge and Understanding

2024 Strategic Activity: Determine What New Facilities Need to be Incorporated into Utility Operator Geographic Information Systems

BACKGROUND
Former Senate Bill 865[2] added Government Code subsection 4216.3(a)(5), which states: "Commencing January 1, 2023, all new subsurface installations shall be mapped using a geographic information system and maintained as permanent records of the operator."[3]

In September 2022, the Underground Safety Board (the Board) received a request from the California Regional Common Ground Alliance (CARCGA) to define "new subsurface installation" as a "minimum standard."[4] CARCGA also noted that operators needed guidance from the Board on how to comply with the GIS mapping law so they can "make decisions regarding technologies and/or processes that will need to be updated, or new ones developed." In its

[1] October 18, 2024, GIS Workshop Notice and Agenda
[2] SB 865 (Hill, Ch. 307, Stats. 2020)
[3] Gov. Code § 4216.3 (a)(5) provides an exemption from the GIS mapping requirement for oil and gas flowlines three inches or less in diameter that are located within the administrative boundaries of an oil field as designated by the Geologic Energy Management Division of the California Department of Conservation.
[4] "Item 10: Idea Register Submission September," November 7-8, 2022.

annual review of Idea Register submissions for its 2023 Workplan[5], the Board decided to "look for opportunities to clarify, perhaps through regulation, what constitutes a 'new' subsurface installation pursuant to SB 865."

At the November 2023 Board meeting, staff presented results of a survey it conducted to understand how operators currently use GIS. Results[6] from 103 survey responses indicated:

- GIS mapping is in wide use across facility operator types (except for irrigation system operators), though it is less prevalent with non-government operators,

- Most operators record "approximate" locations of their subsurface installations, such as from digitized computer-assisted design (CAD) drawings, in GIS rather than taking field measurements, and

- Challenges included field data collection, updating and maintaining accurate GIS information, and integrating GIS with existing asset management or construction management systems.

In its 2024 Workplan[7], the Board chose to focus on determining which projects are "new subsurface installations" and, therefore, need to be incorporated in an operator's GIS. In July 2024, staff presented a second GIS report[8] to the Board with findings and recommendations on how to define "new subsurface installations" (hereafter referred to as the *July 2024 GIS Staff Report*). The Board directed staff to proceed with a draft regulation defining "new subsurface installations." It also directed staff to conduct more research before developing a regulation that would specify the attribute information operators must keep in their GIS records or a map-accuracy requirement.

In September 2024, staff presented findings from its report, entitled *Estimating the Economic Impacts of a Map-Accuracy Regulation*[9] (hereafter referred to as the *September 2024 GIS Staff Report*). To achieve high accuracy, staff assumed operators would collect location coordinates using centimeter-level accuracy global navigation satellite-signal (GNSS) receivers. Key unknowns, however, prevented staff from quantifying the statewide cost impacts of a map-accuracy regulation. These include how many operators would need to purchase GNSS receivers, how many new subsurface installations will operators construct over the next few years, and how many labor hours would be required and billed to collect the location records for those installations. The Board's GIS Committee directed staff to conduct a workshop to

[5] https://energysafety.ca.gov/wp-content/uploads/2023-annual-work-plan_ada.pdf, *Underground Safety Board 2023 Workplan*, April 2023, page 6.

[6] "Item 41: Geographic Information System (GIS) Development Update," Staff Report entitled "*Geographic Information System (GIS) Development Update: Outreach Survey Results*," November 13-14, 2023.

[7] https://energysafety.ca.gov/wp-content/uploads/2024/03//2024_plan_final.pdf, *Underground Safety Board Workplan 2024*, page 5.

[8] "Item 12: Clarifying the GIS Mapping Statute in Regulations," Staff Report entitled "*Clarifying the GIS Mapping Statute in Regulations*," July 8-9, 2024.

[9] "Item 9: Estimating the Economic Impacts of a Map-Accuracy Regulation" Staff Report entitled "*Estimating the Economic Impacts of a Map-Accuracy Regulation*," September 9, 2024.

collect information from operators about the accuracy of their current maps and GIS records and their use of GIS for asset management and damage prevention.

WORKSHOP OUTCOMES AND KEY FINDINGS

This report summarizes information received from operators and other stakeholders who participated in the October 18, 2024, GIS Workshop.[10] The two-hour workshop collected stakeholders' answers to questions about these three topics: the Role of GIS in Asset Management, the Role of GIS in Damage Prevention, and Map Accuracy. The workshop format allowed for an "organic" conversation, but staff generated the following summaries to sort stakeholder input by topic.

Role of GIS in Asset Management

The GIS Committee first asked about the role of GIS in asset management. Specifically, the Committee chair asked:

- At which stage in an asset's lifecycle are GIS records created and provided three options: "Design, Bid [or] Build?"
- Are new facilities designed using GIS?
- Do requests for bids include GIS deliverables?
- How do redlines and as-builts become GIS records?
- How soon should a GIS record should be created for a new asset?

Only one attendee mentioned that their (former) employer used GIS to design new subsurface installations. All other workshop attendees reported creating GIS records for new assets after the "build" stage. Specifically, they used "as-builts," because those documents include changes to the final design plan made during construction.

The general process of creating as-builts and then creating GIS records from them includes:

- The contractor employed to build a new subsurface installation receives plans and specifications from the operator's design engineer.[11] Engineering design of new subsurface installations is typically created as a CAD drawing.

- During construction, the contractor may need to change the intended path of the installation due to an unanticipated conflict (such as encountering an unmarked line).

- The contractor should record deviations from the final design plan on the plan's blueprint using "red-line" marks.

[10] Thirteen attendees spoke. They represented six local jurisdictions, two investor-owned utilities, one regional notification center and two professional consultants. Approximately 80 percent of the 104 workshop attendees participated remotely, but staff could not ascertain the names and/or affiliations of 38 on-line participants. From the voluntary in-person sign-in sheet and the on-line attendees' report, staff counted representatives from four state agencies, 16 local jurisdictions, four investor-owned utilities, both California regional notification centers, a few engineering design firms, private GIS service providers, locator-equipment vendors, and one excavator. Two locators also attended.

[11] The contractor might receive the final design during the bidding process or soon after the contract starts.

- At project "close out," the contractor will compile all red-line marks and provide an "as-built" deliverable to the operator's design engineer.

- The design engineer uses the red-lines or as-built deliverable to create a preliminary final as-built.[12]

- The design engineer provides this preliminary final as-built to the operator's inspector for field verification.

- The operator's inspector checks the accuracy of the preliminary final as-built using one of the following methods: 1) collecting location coordinates of the subsurface installation in the field using a global positioning satellite (GPS) receiver; 2) collecting location coordinates using tradition survey instruments and methods, including nearby survey monuments as reference; or 3) "reviewing the land base and making sure the assets have dimensions to … a fixed land-based reference, like a right-of-way, property line, or parcel."

- Field-verified as-builts are signed and stamped by the operator's design engineer.[13]

- GIS staff must "georeference" CAD drawing deliverables (identify longitude and latitude coordinates) before they can be transferred into GIS. GPS records collected by field inspectors, however, can be transferred directly into GIS.

Multiple workshop attendees mentioned situations where this process might break down, hampering creation of GIS records from as-builts. Examples included:

- The operator's bid package may not specify that as-builts must include geospatial data (that is, a "readily usable format" for GIS). Instead, the deliverable may be a CAD file or a .pdf of a CAD drawing.[14]

- Operators may not enforce their own as-built specifications (for example, requiring use of a particular coordinate system).

- Inspectors may only field-check the new installation's appearance without collecting location data. Or, the inspector may perform a GPS survey for some asset classes (for example, high-pressure pipelines), but not others.

- Contractors may not report changes to the final design (as red-lines), because reporting them would cause payment delays.

[12] During the workshop, attendees used the terms 'red-lines' and 'as builts' interchangeably.
[13] The official as-built must be on paper, not in CAD.
[14] CAD drawings must be "georeferenced" to become GIS records.

- When multiple facilities (owned by different companies) are co-located and all encounter the same obstacle during installation, they must all work around that obstacle, creating a cascade of undocumented path changes. These changes often will not be documented unless design engineers or inspectors conduct field visits.

- The contractor may create red-lines, but they are not delivered to the design engineer. Instead, they "stay in the trailer." (Also expressed as "Red-lines are not getting into the CAD deliverables.")

- Contractors may deliver all red-lines and as-builts at the close of construction, rather than throughout the construction project. Receiving them all at once at the end of construction creates a "time crunch" for the design engineers to update the CAD files, for the inspectors to review and approve them, and for GIS staff to create the records.

- Contractors may not be using "high-quality GPS" receivers to check the accuracy of their installations relative to design plans.

Ideally, qualified personnel would capture GPS coordinates as the construction project progresses (while the new facilities are still exposed in trenches), or GIS staff would work closely with field inspectors during construction close-out to verify locations of new subsurface installations and capture their location coordinates accurately.

Workshop attendees also spoke about the problems created when operators create GIS records by georeferencing as-built records of their existing subsurface installations. If an operator digitized "multiple generations" of as-built maps to create its GIS records and those maps contained inaccuracies, its GIS records will have those errors as well. As a result, when an operator provides GIS data to contractors who are preparing construction bids, the GIS data comes with a warning that the data may be inaccurate. Furthermore, operators' GIS records may be incomplete. They typically only contain the operator's infrastructure, not those operated by other utilities, and they may not include abandoned or unmarked lines.

Some operators use GIS for storing location coordinates of their assets but use different asset management software for recording the assets' attributes (that is, the other properties and characteristics).[15] The Committee chair asked how these two business systems – GIS and asset management – are harmonized. No workshop participant answered that question, except to note that their two systems are linked so that records from both systems can be accessed simultaneously. For example, operations personnel can direct field personnel where to go to perform scheduled maintenance or respond to emergencies.[16]

Two workshop participants answered the question about whether GIS is the system of record. They said it was not. One organization uses SAP and the other uses its computerized

[15] One attendee stated some attribute records are stored in GIS, but most are stored in the asset-management system. These duplicate attribute records are stored in GIS to make them more accessible to field personnel.

maintenance management system (CMMS) as the system of record.

No operators attending the workshop answered the question about whether they used the American Society of Civil Engineers (ASCE) *Standard Guideline for Recording and Exchanging Utility Infrastructure Data* (ASCE 75-22) as their data-content specification for as-builts.

Role of GIS in Damage Prevention

The GIS Committee chair encouraged workshop attendees to describe how GIS might help create a safer world for excavation workers and the public.

Many workshop attendees described how GIS records help operators respond to emergencies and plan how to restore customer service after a shutdown. Water utility representatives said they use GIS to avoid service interruptions, because such interruptions could create water quality problems.

Participants were also asked whether a time delay (referred to a "latency" during the workshop) between receiving the final as-built and entering its information into GIS might increase public or worker safety risks. Multiple attendees mentioned their GIS staff have work backlogs. One operator reported updates to asset management records typically take two- to six weeks. Another operator noted that delays in adding a new asset into GIS shortens that asset's warranty period, because the asset record in GIS is used to plan its maintenance schedule. They also mentioned that not having GIS data for new subdivisions (before street addresses exist) hampers local law enforcement's ability to respond to reports of vandalism at construction sites.

One workshop attendee said their GIS staff places a priority on adding newly installed fire hydrants into GIS records.

A locator stated they do not trust the accuracy of GIS maps and do not rely on them for locate-and-mark assignments.

Another participant felt the GIS mapping law will support damage prevention by improving map accuracy. At a minimum, operators must indicate in GIS which side of the street a new facility was placed.

Map Accuracy

Operators of subsurface installations are required to map their new subsurface installations using GIS, but the Dig Safe Act does not specify how accurate those maps must be.[17] The Committee chair asked how accurate and precise GIS records should be to prevent damage to underground installations and asked operators to state whether their as-built specifications have an accuracy measurement.

One operator advised against setting a map-accuracy measurement in regulation that is applicable to all utility types. They noted that mapping just one type of utility system is complex, especially in urban areas where multiple linear facilities have been placed together

[17] A workshop participant indicated that a map accuracy standard exists in the California Public Resources Code, but did not provide a section number. They said the minimum standard is 18" and is based on trench width.

within linear structures, such as conduits. The contents of the GIS map must be tailored to the needs of the field personnel who will use it.

One participant mentioned their former employer started using GIS to keep records of the distance (lengths) of cable installed, but the location coordinates were inaccurate. Distance measurements had to be accurate to within one foot. They explained California's 24-inch tolerance ("buffer") zones were established because the electromagnetic devices used by locators to find metal pipes and cables were inaccurate. The width of these buffer zones, however, creates problems for excavators, who must dig expensive potholes and hydro-evacuate large areas to confirm the exact locations of existing facilities. GPS receivers have become more accurate, affordable, and easy to operate. They advocated for a one-to "few"-inch accuracy requirement and identified many benefits from improved map accuracy, including reduced wide-area hydro evacuations, cheaper installations, reduced damage, and quicker repairs.

One participant interpreted the question to mean how complete operators' GIS records should be. They described a pipeline installation project that had to be re-routed after their staff encountered an unmarked line. In an ideal world, design engineers would indicate in final design plans the locations of abandoned lines and other conflicts within the right-of-way before start of construction.

Another stakeholder mentioned that engineering plans for some types of new subsurface installations are already highly accurate and could be recorded in GIS during the design phase (rather than wait until construction is completed) provided the installation had no "red-lines" later. They stressed the importance of specifying that design plans use a common reference system for horizontal and vertical positions, such as the California State Plane Coordinate System and the North American Vertical Datum 1988. They also stated each GIS location record needs to include metadata, which explains the source of the location record, including the date and time stamp when the data was collected.

Another workshop participant explained they perform "control point surveys" using GPS along the future right-of-way, which provide "breadcrumbs" showing where to lay high-pressure pipeline segments. These pipelines must be laid within five feet of the GPS-survey points. Medium-pressure pipelines, however, are not GPS-surveyed. Instead, the utility employs "relative" mapping, which means locations are referenced to property lines and road centerlines. (They purchase the geospatial data for these reference points from a third party.)

One local jurisdiction had its surveyor establish its own grid of 111 monuments, some of which are US Geological Survey monuments. Regardless of the measurement technique — GPS or traditional survey instruments — using these monuments will produce five (or 10)-millimeter accuracy for maps of subsurface installations.[18] At this local jurisdiction, an in-house inspector produces the construction-project red-lines and arranges for in-field data collection using GPS to produce the record map. (Record maps submitted as deliverables by contractors were too

[18] Different participants from the same local jurisdiction stated different accuracy measurements.

inaccurate.) The best time to collect GPS data is when the new installation is still exposed.

Another workshop participant reported they record the locations of marker balls in GIS.

An operator noted their jurisdiction's Underground Service Alert staff will collect GPS data of centerline and curb block locations so that the GIS staff can add those locations to their records. In an ideal world, that operator would like to have three-dimensional maps of its subsurface installations. They noted rim elevations and depth records are becoming important.

One speaker mentioned GIS staff will occasionally collect location data (using GPS) of existing subsurface installations exposed at construction sites to validate their locations.

New Issues and Concerns

The following is a list of other issues and concerns raised by workshop attendees:

- One operator would like all the other operators within their region to agree to share their GIS data (of more than subsurface installations) with each other so that everyone's GIS maps become more complete.

- A representative from a regional notification center encourages operators to have a separate "station code" for each of their utility types. They state that this approach would eliminate excavator confusion about whether all utility types have been located and marked (or cleared) within a proposed excavation site. They also encouraged operators to submit separate GIS shapefiles to the regional notification center for each utility type.

- One participant noted that some devices used by locators to detect buried utilities now have GPS capability (that is, they can collect geospatial coordinates). Locators, therefore, could help collect location coordinates of existing subsurface installations as well as provide the locate-and-mark service.

- Another stakeholder suggested that utility operations and maintenance (O&M) personnel be included in the planning and design of new subsurface installations. By including them early in this process, they would learn firsthand where the new facility will be buried.[19] Some installations are so rushed that O&M staff only learn of them after the fact when they are expected to respond to emergencies. In addition, operations personnel, which use GIS maps in the field to address equipment failures, frequently find GIS mapping errors. Maintenance staff will note ("red-line") the correct locations in their own CMMS, but do not forward their notes to GIS staff.

- A participant mentioned difficulty integrating GPS locations of new subsurface

[19] One operator noted their organization creates work-area polygons in GIS to advise field personnel of future construction work or construction work in progress.

installations into GIS records of existing facilities. Location records for new assets do not "fit" into those of existing facilities.

- A stake holder mentioned that the pace of fiber optic cable installation is fast due to government financial support and local ordinances allowing expedited permits for microtrenching. Many small companies are competing for market share and are not performing post inspections to verify locations or complying with the GIS mapping law. Electric line undergrounding will also be fast paced. Operators' design engineers must hold the installation contractors accountable for reporting red-lines by going into the field themselves to verify placement. Design engineers should be sensitized to the risk of asset damage if they do not verify where assets were installed.

- Someone mentioned the Underground Safety Board should recommend which methods and tools to use in the field to achieve high accuracy measurements.

- An attendee mentioned that the Dig Safe Act prescribes use of GIS for mapping new subsurface installations, and as such, the law would need to be amended if GIS were replaced with a better recordkeeping system.

In summary, stakeholders recognized that improved map accuracy would provide a variety of benefits to operators and excavators, but they had different opinions about whether the Board should pursue a map-accuracy regulation for GIS records of new subsurface installations or what that accuracy measurement should be. The GIS Committee received helpful suggestions for a data-content regulation. The regulation would identify some minimum attributes to store in GIS, including metadata to document the coordinate system used and the source and vintage of location data.

Stakeholders agreed their biggest problem is dealing with GIS records of existing underground facilities that are inaccurate and incomplete, because they were created by digitizing historical as-builts containing errors. Until GIS records of existing infrastructure are corrected, locators will not trust them and "final" engineering designs might not be built as planned without course corrections in the field. Location changes in the field must be documented by contractors as red-lines and as-built deliverables, but even those deliverables can be inaccurate.

In an ideal world, staff believe more complete and accurate GIS maps of existing subsurface installations would result in better designs of new subsurface installations and fewer, if any, changes to those designs during construction. More accurate GIS maps would also help operators during the O&M stage of an asset's lifecycle. Operators' staff would be better informed of asset locations and the asset's other attributes, such as date of installation, while responding to emergencies or performing routine maintenance. Absent an ideal world, many GIS staff supported the idea of changing their organization's bid specifications to require as-built deliverables in GIS format rather than CAD so that new assets could be uploaded more quickly into both GIS and asset management records.

RECOMMENDATION

Staff recommends the Board consider the following next steps:

1) Conduct additional stakeholder sessions
2) Draft a data-content regulation for GIS records
3) Develop a map-accuracy regulation