California Underground Facilities Safe Excavation Board

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Agenda Item No. 9 Information Item – Staff Report

Estimating the Economic Impacts of a Map-Accuracy Regulation

PRESENTERS

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SUMMARY

The Underground Safety Board asked staff to quantify the potential magnitude of costs to operators if it were to adopt a map-accuracy regulation. Such a regulation could require that operators be certain of their buried assets' locations within a few inches, or it could require operators to collect location coordinates using high-accuracy satellite-signal receivers while the new subsurface installation is still exposed. The magnitude of cost impacts will vary widely among different operators with different resources available. Staff recommends the Board engage operators, locators, and excavators on their opinions about a regulation's potential costs and discuss whether they want operators' maps to become more accurate than the tolerance-zone measurements defined in the Dig Safe Act, and if they prefer map accuracy be defined as a measurable accuracy goal.

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

Senate Bill 865[1] added Government Code subsection 4216.3(a)(5), which states:
"Commencing January 1, 2023, all new subsurface installations shall be mapped using a

[1] SB 865 (Hill, Ch. 307, Stats. 2020)

geographic information system and maintained as permanent records of the operator."[2]

In September 2022, the Underground Safety Board received a request from the California Regional Common Ground Alliance (CARCGA) to define "new subsurface installation" as a "minimum standard."[3] It also noted that operators needed guidance from the Board on how to comply with the geographic information system (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 annual review of Idea Register submissions for its 2023 Workplan[4], the Board decided to "look for opportunities to clarify, perhaps through regulation, what constitutes a 'new' subsurface installation pursuant to SB 865."

In July 2023, the Board created the GIS Mapping Committee. In November 2023, staff presented results of a survey it conducted to understand how operators currently use GIS. Results[5] from 103 survey responses indicated:

- GIS mapping is in wide use across all 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[6], the Board chose to focus on determining what facilities need to be incorporated in an operator's GIS. In July 2024, staff presented a second GIS report[7] to the Board containing findings and recommendations regarding 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 proceeding with developing a regulation that would set a

[2] Gov. Code § 4216.3 (a)(5) exempts from the GIS mapping requirement 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.
[3] "Item 10: Idea Register Submission September," November 7-8, 2022.
[4] https://energysafety.ca.gov/wp-content/uploads/2023-annual-work-plan_ada.pdf, *Underground Safety Board 2023 Workplan*, April 2023, page 6.
[5] "Item 41: Geographic Information System (GIS) Development Update," Staff Report entitled *Geographic Information System (GIS) Development Update: Outreach Survey Results*," November 13-14, 2023.
[6] https://energysafety.ca.gov/wp-content/uploads/2024/03//2024_plan_final.pdf, *Underground Safety Board Workplan 2024*, page 5.
[7] "*Item 12: Clarifying the GIS Mapping Statute in Regulations,"* Staff Report, *Clarifying the GIS Mapping Statute in Regulations*, July 8-9, 2024.

minimum-content requirement for operators' GIS records or a map-accuracy requirement. Specifically, the Board directed staff to identify the magnitude of financial costs and benefits prior to drafting a map-accuracy regulation.

DISCUSSION

The Board's role is not only to implement and enforce the GIS-mapping law, but to provide guidance to operators – through regulations or voluntary safety standards – on how to comply with that law. The GIS requirement was added to the Dig Safe Act to aid the regional notification centers in "accurately and precisely" identifying dig site locations, which "often include areas of new construction."[8]

ACCURACY AND PRECISION IN GIS MAPPING

When discussing a proposed regulation regarding the quality of the GIS data operators are required to collect and retain, it is important to understand the difference between accuracy and precision. The location records of an underground utility asset should be both accurate and precise. They should show where it's buried (accuracy) and if location measurements are taken again later, those measurements should be a close match to the original ones (precision). PennState College of Mineral and Earth Sciences explained the importance of having GIS data that is both accurate and precise:

> "Accuracy in GIS is the degree to which information on a map matches real-world values. It is an issue that pertains both to the quality of the data collected and the number of errors contained in a dataset or a map. One everyday example of this sort of error would be if an online advertisement showed a sweater of a certain color and pattern, yet when you received it, the color was slightly off.
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> Precision refers to the level of measurement and exactness of description in a GIS database. Map precision is similar to decimal precision. Precise location data may measure position to a fraction of a unit (meters, feet, inches, etc.). Precision attribute information may specify the characteristics of features in great detail. As an example of precision, say you try on two pairs of shoes of the same size but different colors. One pair fits as you would expect, but the other pair is too short…
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> Highly precise data does not necessarily correlate to highly accurate data nor does highly accurate data imply high precision data. They are two separate and distinct measurements."[9]

[8] Ass. Comm. On Utilities and Energy., hrg. July29, 2020 on Sen. Bill No. 865 (2019-2020 Reg. Sess.) as amended July 27, 2020. https://leginfo.legislature.ca.gov/faces/billAnalysisClient.xhtml?bill_id=201920200SB865#

[9] https://www.e-education.psu.edu/geog469/node/253

Under the Dig Safe Act, operators are required to maintain and continually update their maps and they are required to use GIS to store records digitally and permanently. The issue before the Board now is whether it should specify some degree of mapping accuracy and/or precision to meet its public policy mission or whether operators should set their own accuracy and/or precision specifications, as well as document (in their GIS records) the personnel, methods and tools used to collect location data?

FOUR POSSIBLE APPROACHES:

The *July GIS 2024 Staff Report* listed four possible approaches to regulating the quality of GIS information for new subsurface installations:

- Mandate Sub-Inch Accuracy/Precision – a "performance" standard stating a measurable precision goal. Operators would have full discretion regarding how they achieve it, so long as the "as-built" data is accurate within a mandated level of accuracy and/or precision,[10]

- Specify Methods and Tools – a "prescriptive" standard telling operators how they must collect location data for their GIS records,

- Report how Accurate/Precise the Location Measurements Are – an information-reporting regulation requiring disclosures of how location data was collected and/or rates the precision and accuracy of data within a "quality level" ranking, and

- Continual Improvement – possibly a voluntary safety standard that reminds operators of the Dig Safe Act's provisions regarding their on-going obligation to amend and update location records (now using GIS).

With any quality standard, the more accurate and precise the data is, the greater the cost to both collect and store that data.[11] This report discusses the economic impact of a regulation that would govern the quality of in-field data collection, either by the "mandate sub-inch accuracy/precision" approach or the "specify methods and tools" approach, and compares that economic impact with the other two self-directed approaches ("reported precision information" and "continual improvement.")

[10] From these specifications, data producers (e.g., surveyors or other mappers) can determine the instrumentation, procedures, and quality control processes required to obtain and verify the defined accuracies.
[11] https://www.e-education.psu.edu/geog469/node/253

MANDATE SUB-INCH ACCURACY/PRECISION

With current technology, maps of underground facilities can have "sub-inch precision," "centimeter-level" accuracy,[12] or "survey-grade" precision.[13] This report will use the term "sub-inch accuracy" to capture these concepts of finer-level location specific data. "Sub-Inch accuracy" means that each pair of geospatial coordinates (representing the location of one component of a subsurface installation) is within less than an inch of its "actual" or "true" location on the Earth. The means of collecting this data would be through in-field data collection.

SPECIFIED METHODS AND TOOLS

A regulation prescribing the methods and tools for in-field data collection would attempt to achieve high precision without stating a measurable goal. This type of regulation could be easier for operators to ascertain compliance provided it is based on well-established products and practices. The *July 2024 GIS Staff Report*, however, warned that specifying methods and tools "might lead to regulations which can quickly become out of date as the technology and data-correction software continue to improve."[14] Below are some options for the Board to consider for a prescriptive regulation to improve map accuracy:

- Collect all geospatial data in the field while the new subsurface installations are still exposed,[15,16]
- Use a Global Navigation Satellite System (GNSS) receiver[17,18,19] that the manufacturer specifies as having "sub-decimeter" or "centimeter-level" accuracy or that it characterizes as "professional grade" or "survey grade,"[20]
- Use a real-time data-correction method.[21]

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[12] "Increasing Surveying Accuracies and Productivity." by Matteo Luccio, *GPS World*, August 11, 2022." https://www.gpsworld.com/increasing-surveying-accuracies-and-productivity/,

[13] https://energysafety.ca.gov/wp-content/uploads/docs/underground/locate-and-mark-response-from-usa-north-811-copy.pdf, "Outstanding Issues in the Locate and Mark Process from USA North 811's Perspective," page 5.

[14] TGIS technology possibly becoming obsolete was not an issue raised in any legislative committee analyses – nor public comments incorporated therein - regarding SB 865.

[15] "No More Excuses - Capture Those Utilities!," by Geoff Zeiss, https://geospatial.blogs.com/geospatial/2022/08/no-more-excuses-capture-those-utilities.html

[16] The regulation must also accommodate trenchless installations.

[17] GNSS receivers can receive satellite radio signals from other countries' satellites, which increases the likelihood of more accurate readings. GPS receivers can only receive signals from American GPS satellites.

[18] A Brief History of GPS, https://aerospace.org/article/brief-history-gps

[19] *The GPS Playbook Report: How a space-based technology generated the largest venture outcomes in history* by Space Capital and Silicon Valley Bank, 2020, https://www.svb.com/contentassets/c0e37e68e9894f5a9719b0dacadb1aaf/the-gps-playbook-2020.pdf

[20] "Survey-grade GPS receivers may be required for tasks where the highest precision is required-for example in locating underground facilities where being off by a half a meter while digging might damage other proximal infrastructure." https://www.power-grid.com/news/using-gps-in-utilities-accuracy-and-applications/#gref, "Using GPS in Utilities: Accuracy and Applications," Dr. Will Shepard, Enspiria Solutions, Power Grid International, September 1, 2007.

[21] Current options are real time kinematic (RTK) and precise point positioning. Some GNSS receiver models have integrated RTK, eliminating the need for an RTK subscription services. A third data-correction option is post-processing.

As with the mandated sub-inch precision approach, a specified methods and tools approach to regulation would require in-field data collection to sub-inch precision, the economic impact of which is discussed below:

Economic and Fiscal Impact of In-Field Data Collection for Sub-Inch Accuracy and Precision

This report estimates the potential magnitude of costs to operators of complying with a mapping accuracy regulation. This initial cost-impact assessment was prepared to help the Board decide whether to proceed with a map-accuracy regulation.

Formula for the Economic Impact Calculation

The economic impact of a regulation requiring in-field data collection is the sum of the impact for each operator to comply with a regulation that would require in-field data collection of sub-inch precision. Operator compliance requires operators to acquire the necessary equipment and to use it to collect the in-field data. Acquiring the necessary equipment includes both the cost of the necessary hardware (such as a GNSS receiver) and the cost of a software subscription service to use the hardware. The cost of collecting the data is usually expressed in terms of the cost of labor to do the in-field collection.

Cost of Equipment

Each operator's selection of equipment and services will depend upon its unique needs and frequency of use.[22] Staff collected more than 50 sources of price information for centimeter-level and decimeter-level accuracy GNSS receivers but was unable to compile a comprehensive price list for these GNSS receivers because of the magnitude of options and suppliers. Approximately 40 GNSS manufacturers sell centimeter-level GNSS receivers in the United States today. Many companies offer GNSS receivers within a field kit that includes all the basic equipment as well as data-collection apps compatible with the operator's choice of smart phone or tablet. GNSS receiver kits can also be rented or purchased second-hand. Proprietary RTK-network service is sold on an hourly, monthly or annual basis, providing flexibility to operators. Operators, however, may be able to avoid purchasing RTK data correction subscription services after paying a $100 registration fee to access a free California Real Time Network.[23]

Operators may need additional field equipment to perform in-field data collection, including:

[22] Government agencies might also limit vendor choice with procurement policies such as "Buy American."
[23] See https://sopac-csrc.ucsd.edu/index.php/crtn/. Also, CalTrans's RTK network is available to public agencies with which it has information-sharing agreements. https://dot.ca.gov/caltrans-near-me/district-6/district-6-programs/d6-land-surveys/d6-rtn-gps and https://dot.ca.gov/-/media/dot-media/programs/research-innovation-system-information/documents/research-notes/task4120-rns-08-22-a11y.pdf. And https://www.sandiegocounty.gov/content/sdc/dpw/surveyor/SDCRTNstatus.html

a "smart device" such as a smart phone or tablet that is loaded with a field-mapping app; GNSS with built in RTK; GNSS with built in an inertial measurement unit; a smart phone or tablet; rugged cover for smart phone or tablet; tempered glass cover for smart phone or tablet; software or app for in-field data collection; cloud storage for collected field data; a tripod or fixed-height pole upon which the GNSS receiver would be mounted for better reception; a clamp assembly to mount the smartphone or tablet to the pole; access to a communication network for transferring data from the receiver to the smart device; access to a communication network for transferring data from the smart device directly into the operator's GIS; bar code scanner; batteries; laser scanners; reflectorless total stations; and other equipment, examples of which can be found at *GPS World's 2024 Buyers Guide published in GPS World*, June 2024.[24]

Number of Operators Needing Equipment

In addition to the number of variables regarding the cost of equipment above, it is unknown how many operators will need to acquire the necessary equipment, and how many already have purchased such equipment. While a conservative estimate would assume that no operators are currently using GIS equipment, it is likely that some percentage of operators (to be determined) are already collecting accurate location data in the field. A map-accuracy regulation would not impact those operators who are already meeting the requirement voluntarily.

For example, the GIS survey results indicated that between 17 and 27 percent of survey respondents were already collecting field data for their GIS records. If those percentages were applicable to the entire population of operators, then approximately 73 percent of operators would be impacted by the (widely variable) cost of acquiring the necessary equipment and software subscription services.

In addition to not knowing what percentage of operators need to acquire equipment that would meet an in-field data collection standard (such as specified methods and tools or mandatory sub-inch accuracy), it is unknown what the budgets are of the operators who do not currently have such equipment and would therefore need to acquire all equipment and software necessary to conform to a mandatory sub-inch precision or a specified methods and tools approach.

COSTS OF FIELD DATA COLLECTION

The cost of collecting the data in the field is essentially the cost of labor to do the real-time, in-field data collection once the equipment has been acquired. Many variables, such as type of utility network, number of personnel, and number of data points, affect how many labor hours must be spent at an installation site to collect data. Additionally, if the Board's regulation

[24] https://editions.mydigitalpublication.com/publication/?m=59713&i=822898&p=24&ver=html5, pages 25- 49.

requires operators to certify the accuracy of their maps, operators would likely hire licensed surveyors to perform the in-field data collection – and pay a higher labor rate – rather than their using their own field crews.

Regardless of these labor-cost variables, the cost of labor to collect field-data can be expressed as a cost per hour, cost per day, or cost per linear foot. Below are examples of cost information illustrating each type.

Cost per Hour – Staff found an example of the cost per hour where the City of Albany approved a professional services contract in June 2024, which included a task for "Field Data Gathering and Condition Assessment"[25] The consultants must collect data in the field to update the City's inventory of storm drain assets and update the city's GIS inventory. The budget for this work is approximately $13,500, which is the cost for four individuals working 48 hours. It should be noted that the proposal for this labor was to map accuracy of the existing storm drain system to within 1–3-foot accuracy, not sub-inch accuracy.[26]

Cost per Day – Many companies advertise their utility mapping services online, but none provide their rate information. One company, based in England, provided the following information, "...the cost of an underground utility mapping survey is primarily charged on a day rate basis that reflects the level of input needed, including whether one land surveyor can conduct the survey or if multiple members of staff are needed. The office time required to produce the completed map and report are also included in the day rate that we use to generate a tailored quote...On average, it would be likely for our clients to expect a fee somewhere between £600 (currently $775) and £1,500 (currently $1,940) *per day*."[27,28]

Cost per Linear Foot – As an example of the cost per linear foot, the City of Santa Ana awarded a support contract for SUE services in September 2020. The company was required to "locate and identify underground utilities during the planning, design, pre-construction, and construction phases of Water Resources Division capital improvement projects. The cost to provide "surface location services required for underground utilities," was based on mapping 20,000 linear feet at an average cost of $1.17 per linear foot. [29]

[25] https://www.albanyca.org/Home/Components/News/News/12316/, Request for Proposals, Professional Engineering Services Watershed Management Plan, release data February 12, 2024 and https://albanyca.primegov.com/Portal/Meeting?meetingTemplateId=11151, City Council Agenda Item 7-9, Contract #C24-32 Agreement for Consultant Services between the City of Albany and Wood Rodgers, Inc for Project: Watershed Management Plan Update, approved June 3, 2024. Contract can be found here: https://albanyca.primegov.com/portal/viewer?id=21559&type=2

[26] See proposal attached to contract: https://albanyca.primegov.com/portal/viewer?id=21559&type=2

[27] https://thesurveyhouse.co.uk/utility-mapping/

[28] This is for mapping facilities that are already underground, not for new installation/as-builts.

[29] https://santa-ana.primegov.com/portal/viewer?id=6735&type=2, Agreement to Provide Subsurface Utility Engineering Services, City of Santa Ana, September 15, 2020, [Contract A-2020-188-03]

CASE STUDY: PARADISE SEWER PROJECT

Staff identified the Paradise, CA rebuild project – specifically the construction of a sewer system – as a potential case study to examine the fiscal impact to an individual operator, in this case, the town of Paradise, CA.

Before the Camp Fire, Paradise was the largest unsewered community in California.[30] The sewer project is currently in the Design phase and, according to the project website,[31] is still seeking funding sources for the estimated $152 million dollar cost of construction. Based on the 2020 Executive Report by the engineering firm in charge of the project, it does not appear that this $152 million construction cost estimate includes the cost of in-field data collection to any accuracy standard, or acquisition and implementation of a "methods and tools" approach that would also include in-field data collection.

The current project includes construction of an 18-mile-long pipeline to connect the Paradise Sewer Project to the City of Chico Water Treatment Plant, in addition to some gravity fed collection lines and several pumps. The current proposed "Sewer Service Area" is expected to serve 1,469 of the approximate 11,000 total parcels in Paradise.

It does not appear that "survey-level" or "centimeter-level" in-field data collection is a specifically budgeted portion of the sewer project.[32] If sub-inch level precision were required (either through specified methods and tools or through a mandatory sub-inch precision regulation) and were to be billed by linear foot, the cost of collecting GIS in-field data for the 18-mile connecting pipeline alone could be over $100,000 (5,280 feet per mile, times 18 miles, times $1.17 per linear foot for centimeter-accurate mapping = $111,196.80). This does not factor in the cost of mapping any of the subsurface installations within the proposed Sewer Service Area or those that would connect the Sewer Service Area and the 18-mile pipeline. It also does not factor in the cost of acquiring the equipment or software necessary to gather or store sub-inch precision in-field positional data.

It appears that, as of the writing of this report, Paradise is still seeking funding sources for the full cost of the project – not including the costs associated with a sub-inch precision or specified methods and tools standard.[33] It is not clear at this time how a sub-inch level

[30] "2020 Executive Summary" https://paradisesewer.com/wp-content/uploads/2021/02/6c-Attachment-1-HDR-Engineering-Phase-1-Executive-Summary.pdf

[31] https://paradisesewer.com

[32] See 2020 Executive Summary, Section 10.2: Funding Needs. https://paradisesewer.com/wp-content/uploads/2021/02/6c-Attachment-1-HDR-Engineering-Phase-1-Executive-Summary.pdf

[33] https://paradisesewer.com/project-materials/ As of 8/22/2024, the FAQ portion of the Sewer Project website states: "The Town will pursue a number of potential funding sources during Phase 2 to fund both design and right-of-way efforts (Phase 3) and construction (Phase 4). Potential funding sources include A state appropriation (working in conjunction with the City and the Central Valley Regional Water Quality Control Board); U.S. Department of Agriculture, Rural Development funds; California Department of Housing and Community Development, Community Development Block Grants – Disaster Relief (CDBG-DR); and U.S. Economic Development Administration (EDA)"

precision standard, or a prescribed methods and tools standard, would affect the cost of this project or the ability of Paradise to find a funding source for that cost. This may not be the case for every operator in California; as explained above, it is not known how many operators have already acquired the equipment necessary, are already collecting in-field data with sub-inch level precision, or are already employing licensed land surveyors to do so. However, Paradise may be an illustrative example for the Board to discuss the impact on smaller operators who would need to acquire such equipment to comply with a regulation that required either sub-inch level precision or specified the methods and tools required to collect in-field GIS positional data.

ECONOMIC IMPACT OF "REPORTED PRECISION INFORMATION" APPROACH

Under the "Reported Precision Information" approach, operators would be required to collect GIS data regarding new subsurface installations, but the method or precision of that data collection would not be specified by regulation. Instead, the Board could adopt a regulation that would require operators to include information about the precision of their GIS information, including the methods by which the data was collected and the precision of that data. In this case, the economic impact of collecting sub-inch level data would be something that operators would assume based on their choices. The Board could also require that operators affirm that the data was collected in a manner that yields accurate and precise data within a specified margin of error. Since statute already requires operators to generate and retain maps of new subsurface installations "using a geographic information system," there is minimal-to-no economic impact of a regulation that would only require operators to record how they collected that GIS data and how precise that data is. This approach would provide excavators with information about how precise the GIS data should be, including whether that data is accurate to within an inch or less, but it would not require all operators to gather data to a specific, sub-inch level of precision as new subsurface installations are built.

ECONOMIC IMPACT OF "CONTINUAL IMPROVEMENT"

As with the "reported precision information" approach, an approach that merely encouraged operators to continually improve their mapping accuracy and precision would not have an economic impact. Unlike an enforceable regulation, encouraging "continual improvement" of mapping accuracy would likely be a voluntary safety standard. A "continual improvement" approach would encourage operators to continually update the accuracy and precision of their maps, but – as with the "reported precision information" approach – would not require operators to acquire or use any specific equipment or achieve a specified precision standard. As a result, operators would only be expected to improve map accuracy, and the means by which they do so would be up to each operator.

RECOMMENDATIONS

The Board should discuss the initial costs of a mandatory sub-inch precision regulation or a specified methods and tools regulation which would produce sub-inch precise mapping of new subsurface installations, and determine whether staff should engage operators, locators, and excavators about the potential cost of a sub-inch precision regulation.

From a policy perspective, staff would benefit from hearing the Board discuss whether it:

- Wants operators' maps to become more precise than the tolerance-zone measurements defined in the Dig Safe Act, and

- Prefers map precision be defined as a measurable precision goal and if so, what that measurement should be.