Increased Safety in HDD Installations Using Bore Planning

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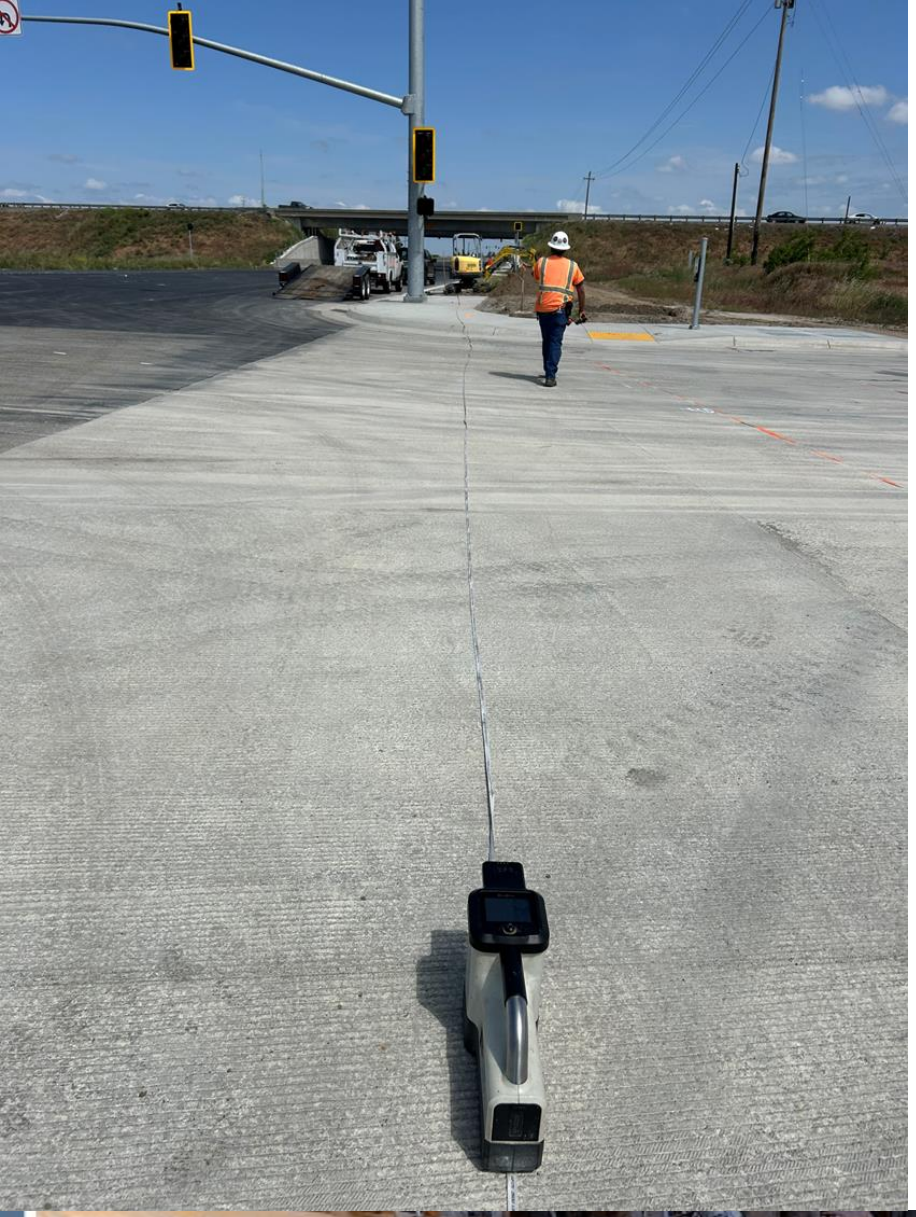
DIGITAL CONTROL

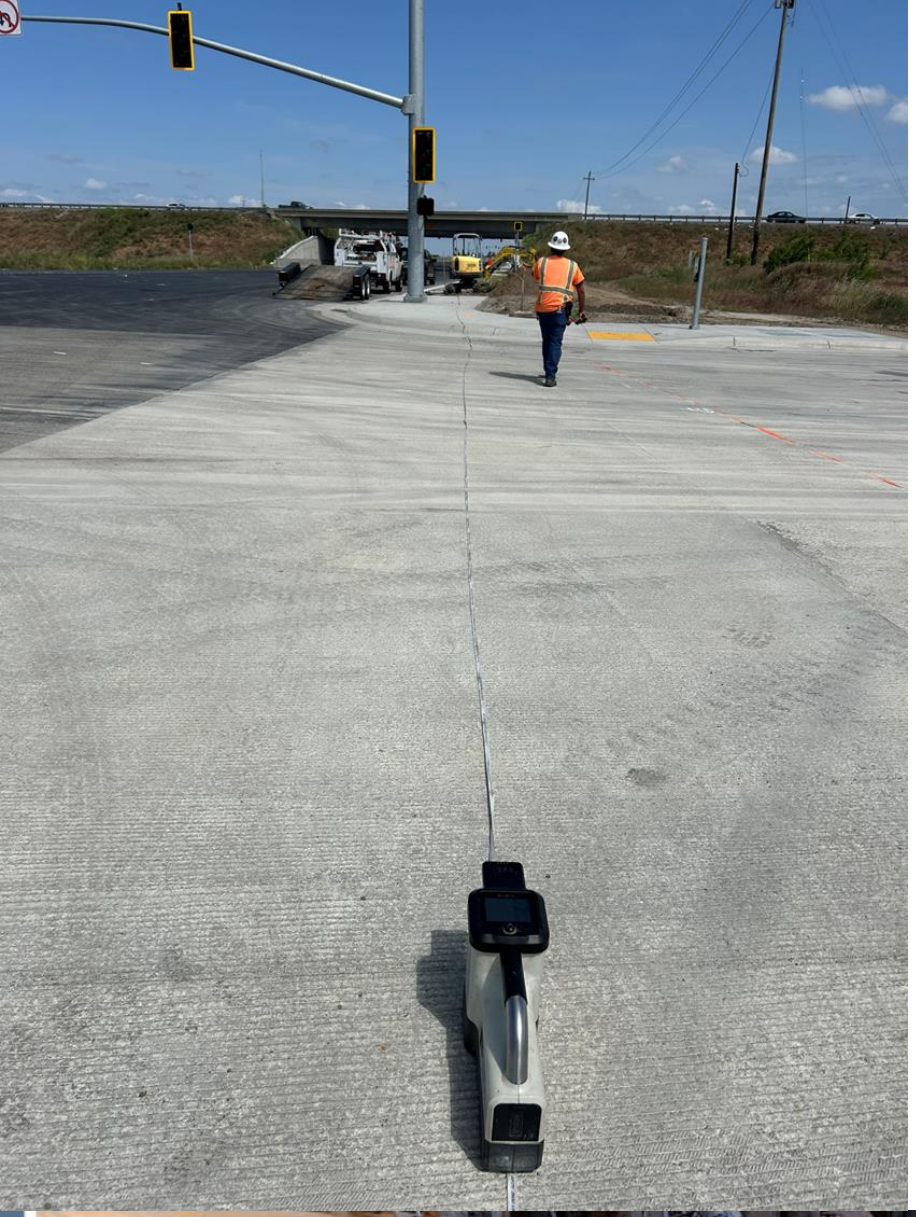
Overview

- Bore planning in general
- Benefits of a bore plan
- Safety aspects of a bore plan
- Concluding thoughts



What is a bore plan?

- Everyone “plans”, the definitions of a plan differ
- “Enter the ground here, come out over there, and stay around this depth”
- Comprehensive survey of the terrain, yielding a rod-by-rod plan
- Detailed survey with Geotech analysis, load and hydrofracture calculations



What is a bore plan?

- For the purpose of this discussion, I will be focusing on bores done with a walkover locating system
- Comprehensive survey of the terrain, yielding a rod-by-rod plan

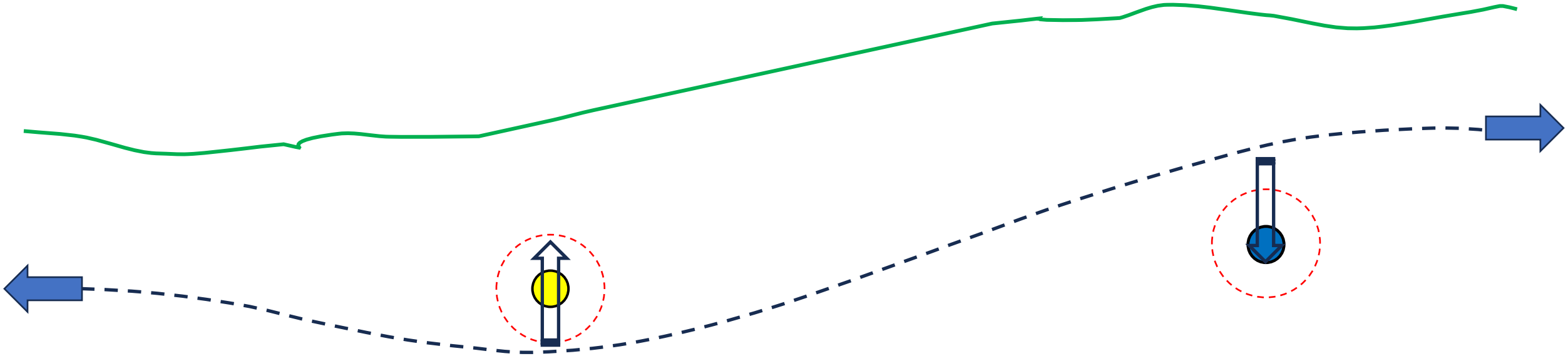
Why are most bores drilled without a plan?

- Takes time
- Requires a survey of some sorts
- Engineers typically do bore planning
- Most jobs don’t have the budget
- “I’m only going a few hundred feet and not very deep, I don’t need a plan!”

Without a plan..

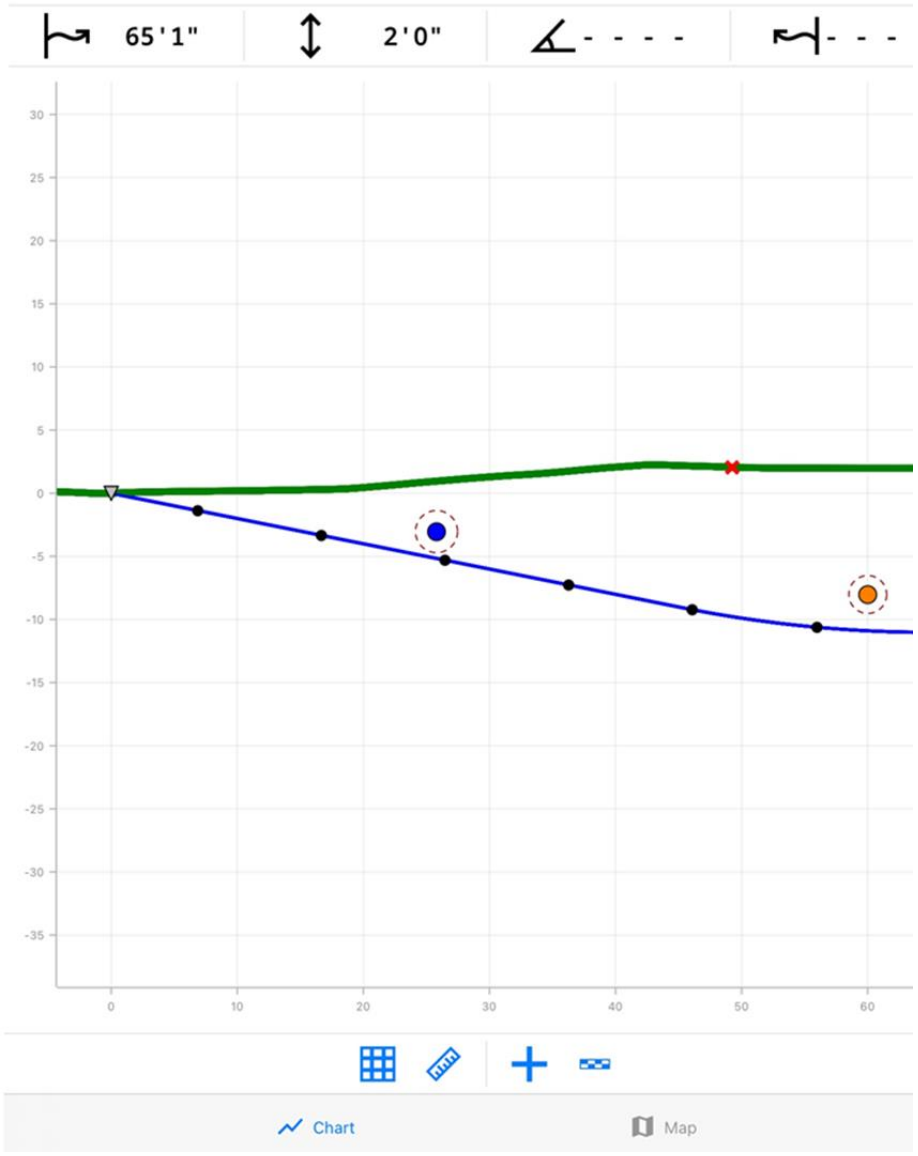
- Steering decisions more reactionary
- Changes in terrain often dictate the options
- Good clearance around utilities much more complicated
- A decision made a few rods ago can limit the steering options for the current rod
- Entire bore and all the obstacles and utilities are not accounted for
- Time spent deciding next steps

Steering near a utility (reactive)



Benefits of planning

- Provides entry-to-exit view
- Utility locations are translated from paint marks on the surface
- “What-if” scenarios can be run
- Underscores the relationship between the terrain, pitch changes, and resulting depths



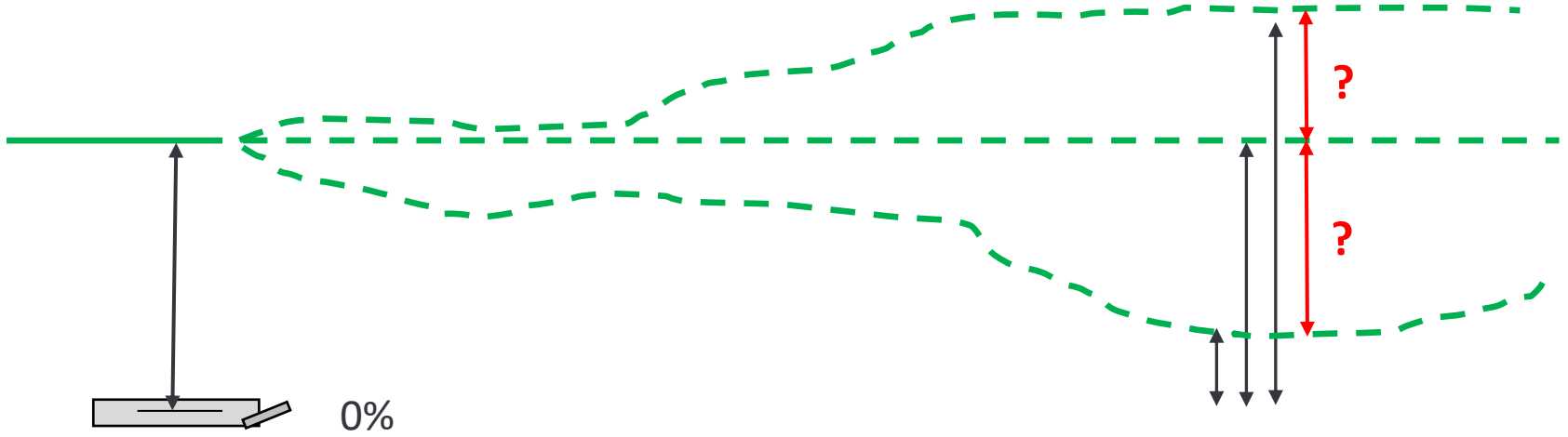
Benefits of planning

- Excellent training tool for green crews
- Increased productivity and elimination of guesswork
- Less wear and tear on the drill and drill pipe
- Reduction in other variable costs
- Better Product and more professionalism

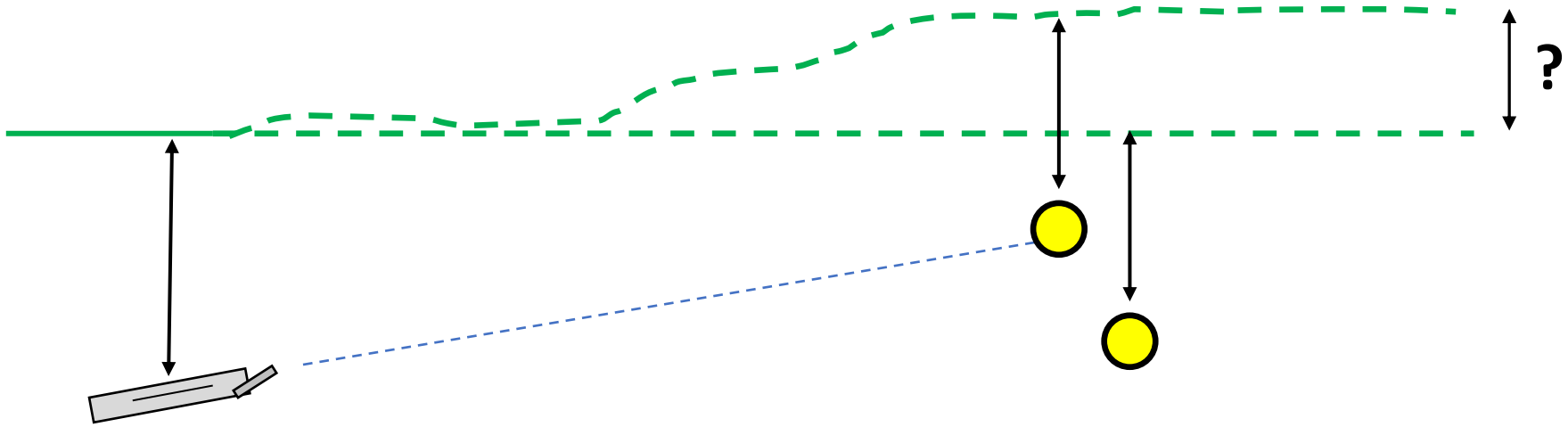
Some thoughts on depth in the context of walk-over locating

- Depth is referenced from the surface
- In HDD, typically means the drill head, utilities, or other points of interest
- Very difficult to ***know*** anything about depth changes without knowledge of the terrain

More on Depth



More on Depth

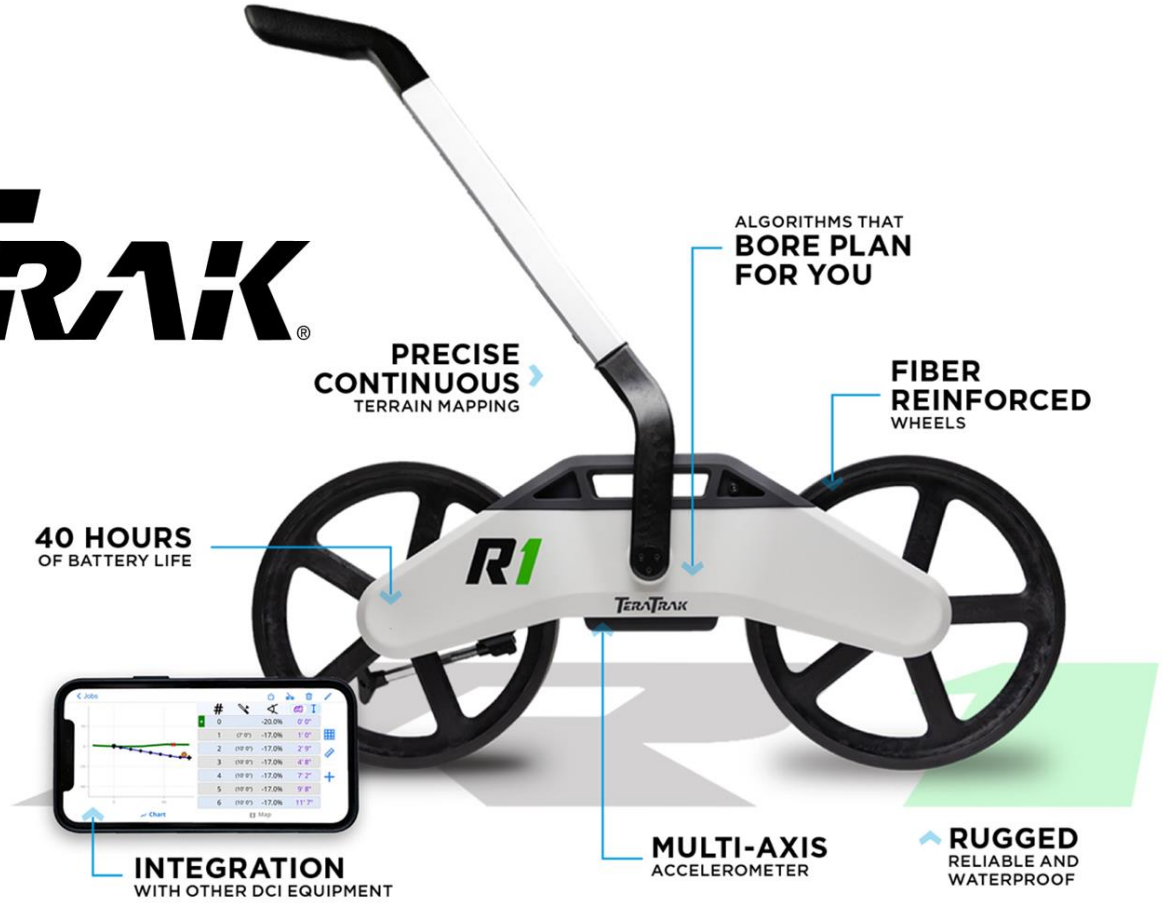


Creating a plan involves..

- Surveying the terrain, identifying the entry and exit points
- Location and depth of utilities being crossed
- Establishing adequate clearance
- Drill parameters such a rod length, bend radius, entry and exit angles
- Location of waypoints
- Math

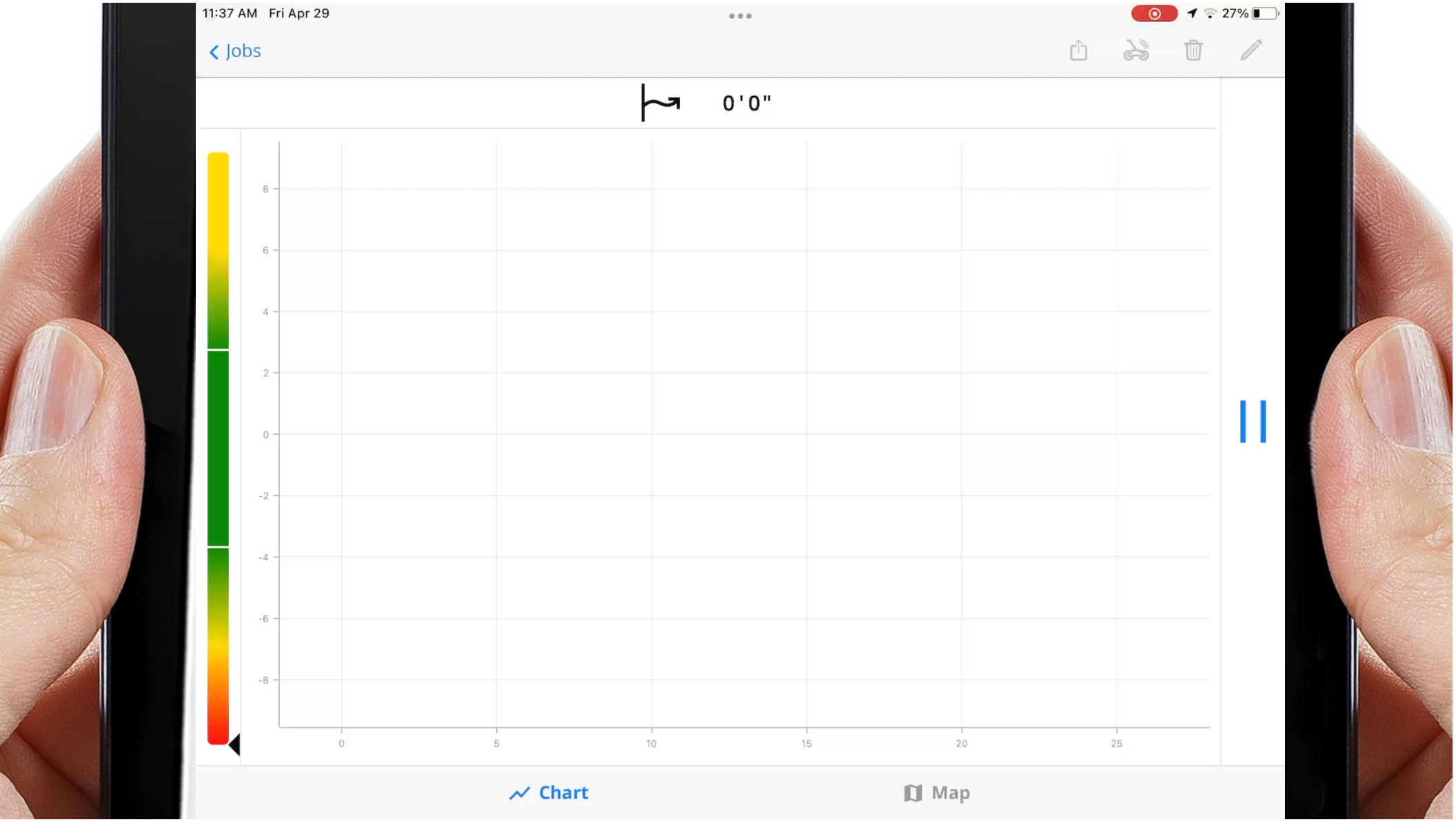
One way to create a plan

TERATRAK®



TeraTrak R1

- Advanced, easy-to-use measuring wheel and bore planning device
- Continuous plot of the elevations and distance in 1-foot increments is created in real-time
- Data is streamed via Bluetooth to an iOS or Android smart device
- +/- 2” elevation accuracy over 500 ft
- Single path used for short (< 125 ft) drill calculations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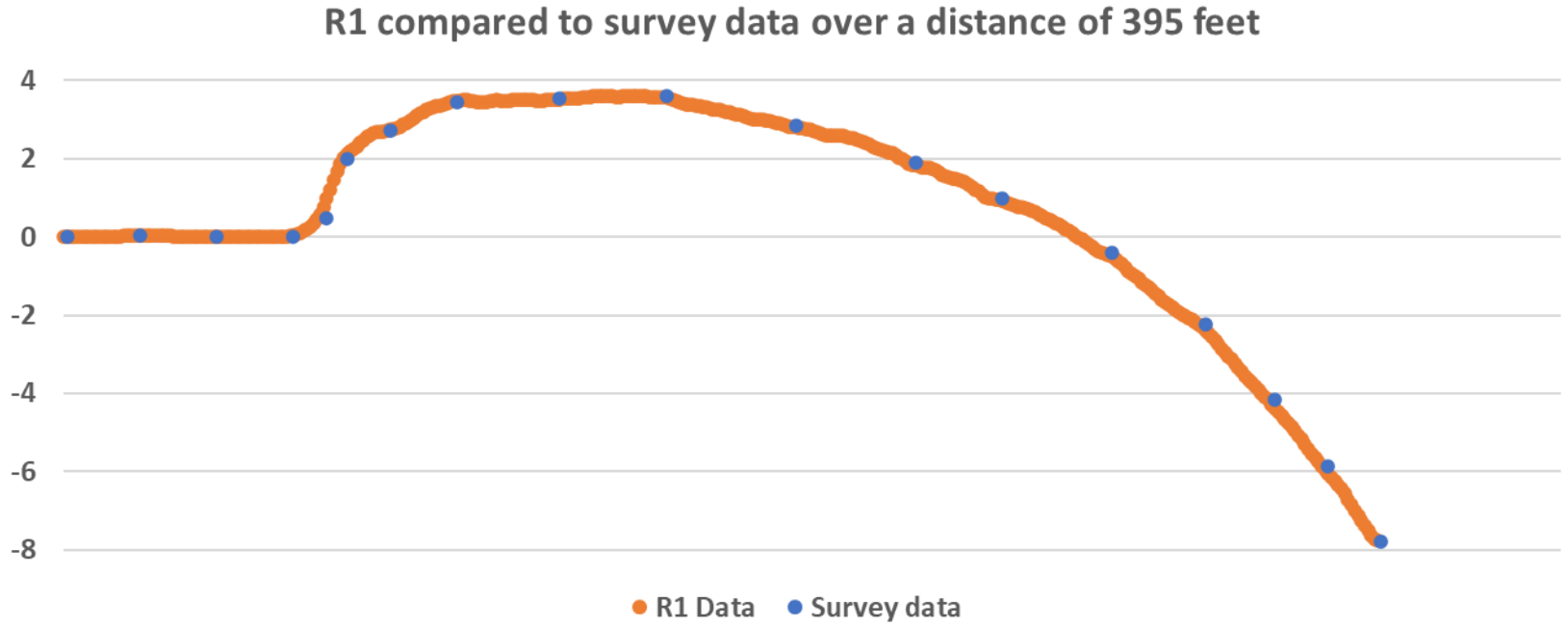
25
Chart
Map

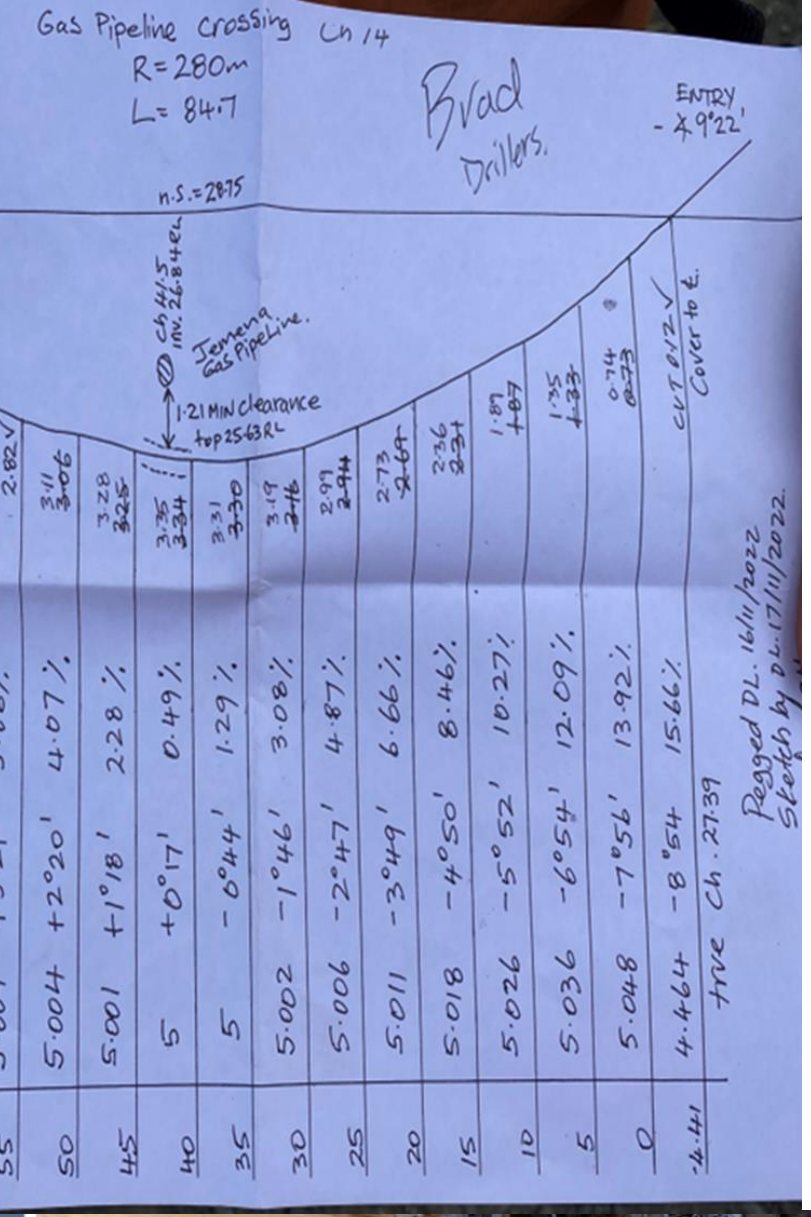
Fieldpoint Surveying, LLC
20271 E CR 163
Altus, OK 73521
Cert of Authorization: 8228

			IGO DATA		
DISTANCE FROM START (FT)	ELEV DIFF FROM START (FT)		ELEV DIFF FROM START (FT)		ELEV DIFF (FT)
0.000	0.000		0.00		0.0000
22.080	0.053		0.04		0.0128
45.240	0.018		0.01		0.0083
68.560	-0.001		0.04		-0.0405
77.820	0.485		0.72		-0.2348
83.880	2.003		2.02		-0.0172
96.580	2.709		2.71		-0.0011
117.000	3.444		3.47		-0.0261
147.950	3.533		3.52		0.0131
179.950	3.616		3.56		0.0560
218.920	2.860		2.82		0.0396
254.890	1.897		1.85		0.0470
281.010	0.997		0.94		0.0569
314.800	-0.413		-0.51		0.0972
341.830	-2.235		-2.30		0.0653
362.590	-4.168		-4.23		0.0623
378.790	-5.856		-5.94		0.0837
395.070	-7.784		-7.76		-0.0243



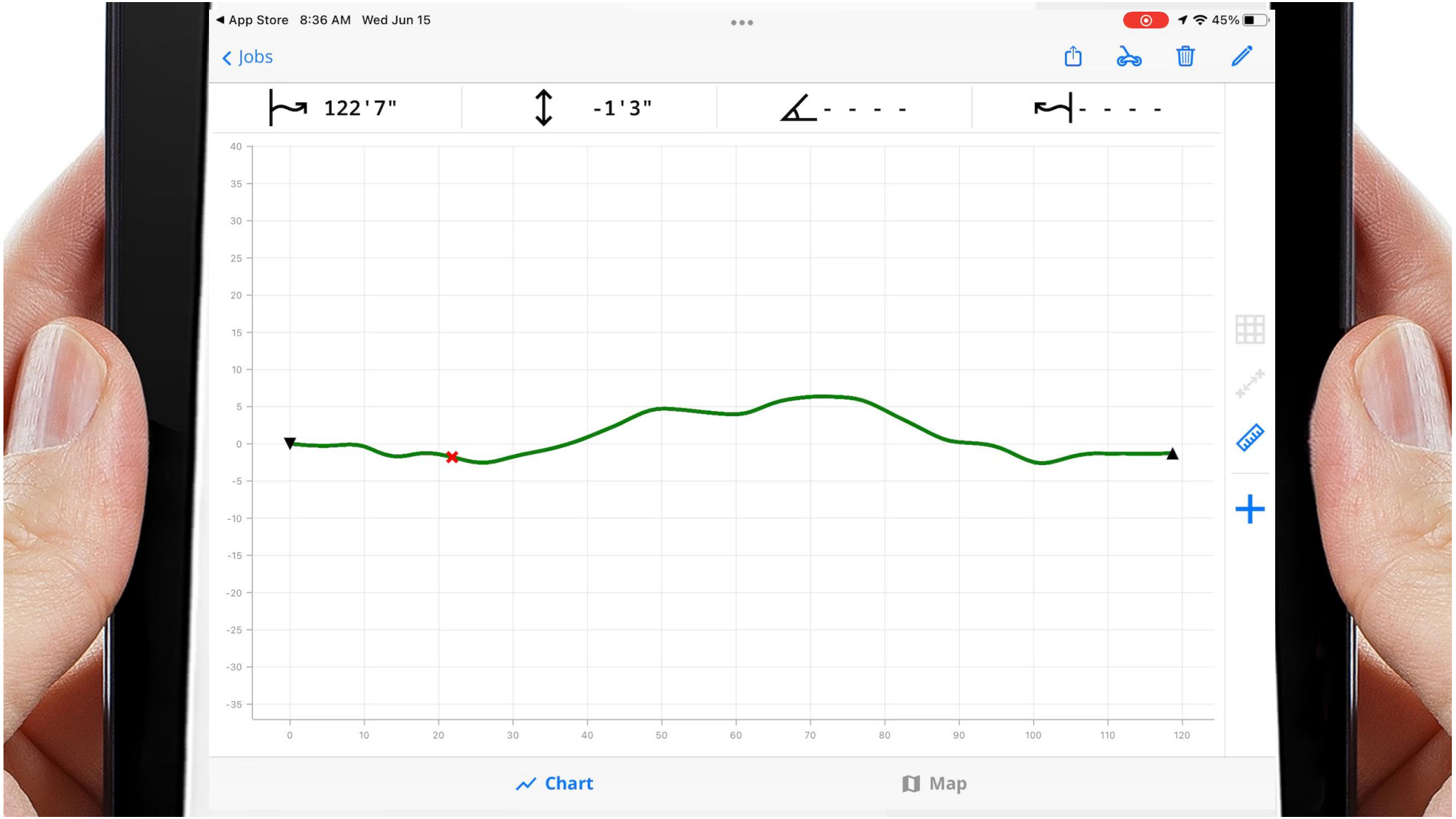
Is the R1 accurate enough?

- Comparison to surveying equipment
- The R1 survey completed in about a ½-time
- The average difference between over 17 data points was 0.05 ft or 0.6 inches
- Largest difference: 0.23 ft
- Smallest difference: 0.001 ft



Pre-bore Safety Aspects of a Bore plan

- Requires all pertinent data for each step
- Holistic view of the terrain and the bore
- What and where are the obstacles
- Preferred path, i.e. above or below a given utility

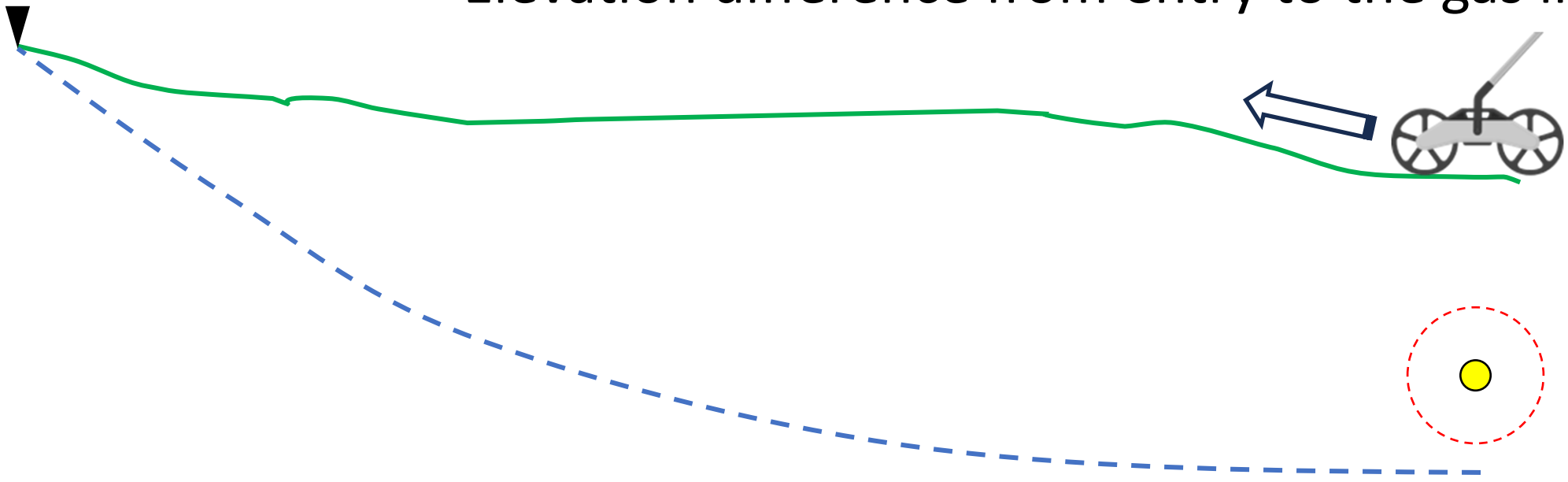


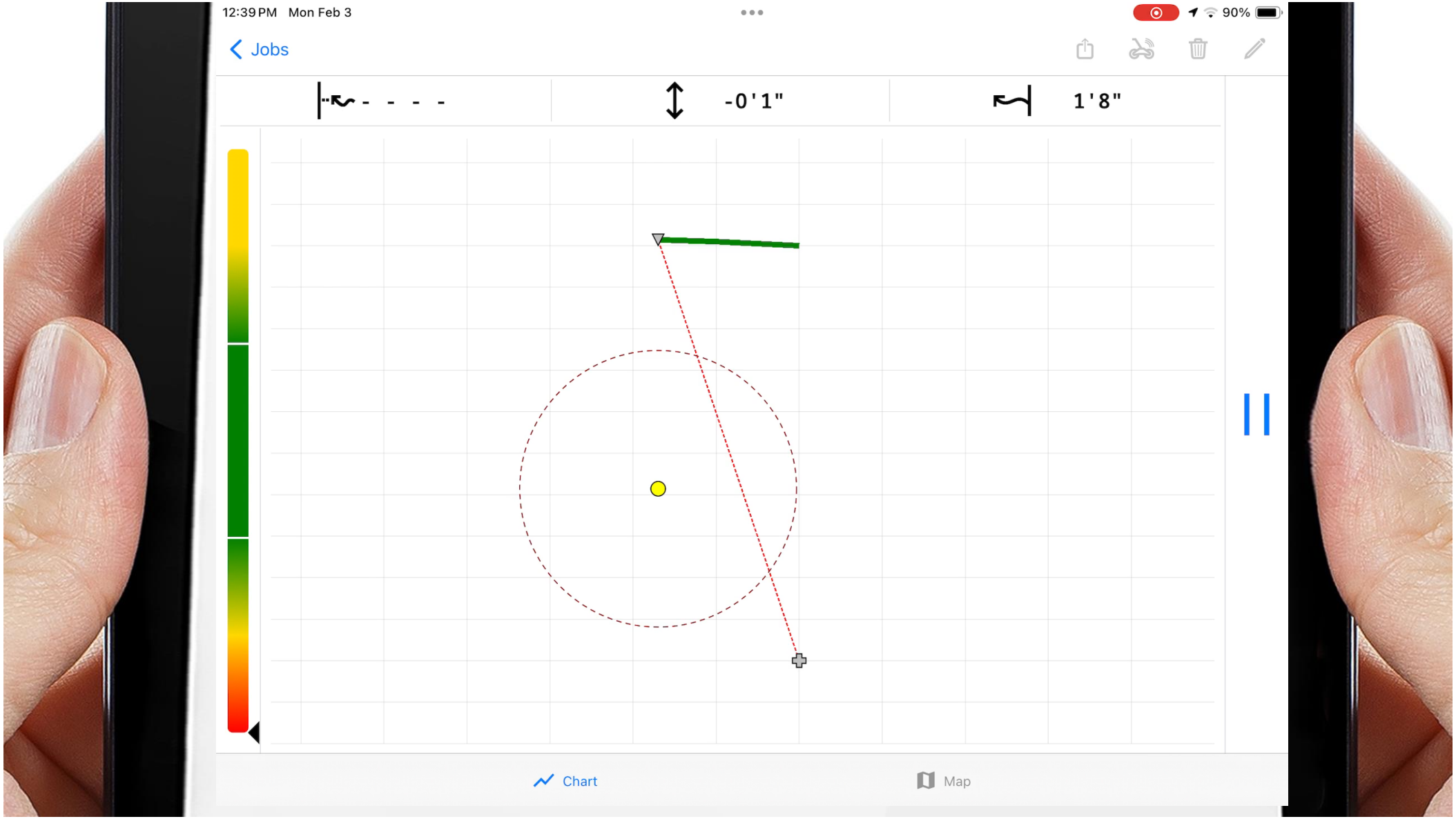
Pre-bore Safety Aspects of a Bore plan

- Setback distance not sufficient, given the machine or bend radius constraints
- Combination of the terrain, setback distance and required depth and pitch may be incompatible
- Can result in the bore ending up being too close to an existing utility

Common case

- Utility needs to be crossed, gas line at 36”
- The required clearance: 18”
- Planned entry is about 40 ft from the gas line,
- Elevation difference from entry to the gas line: unknown





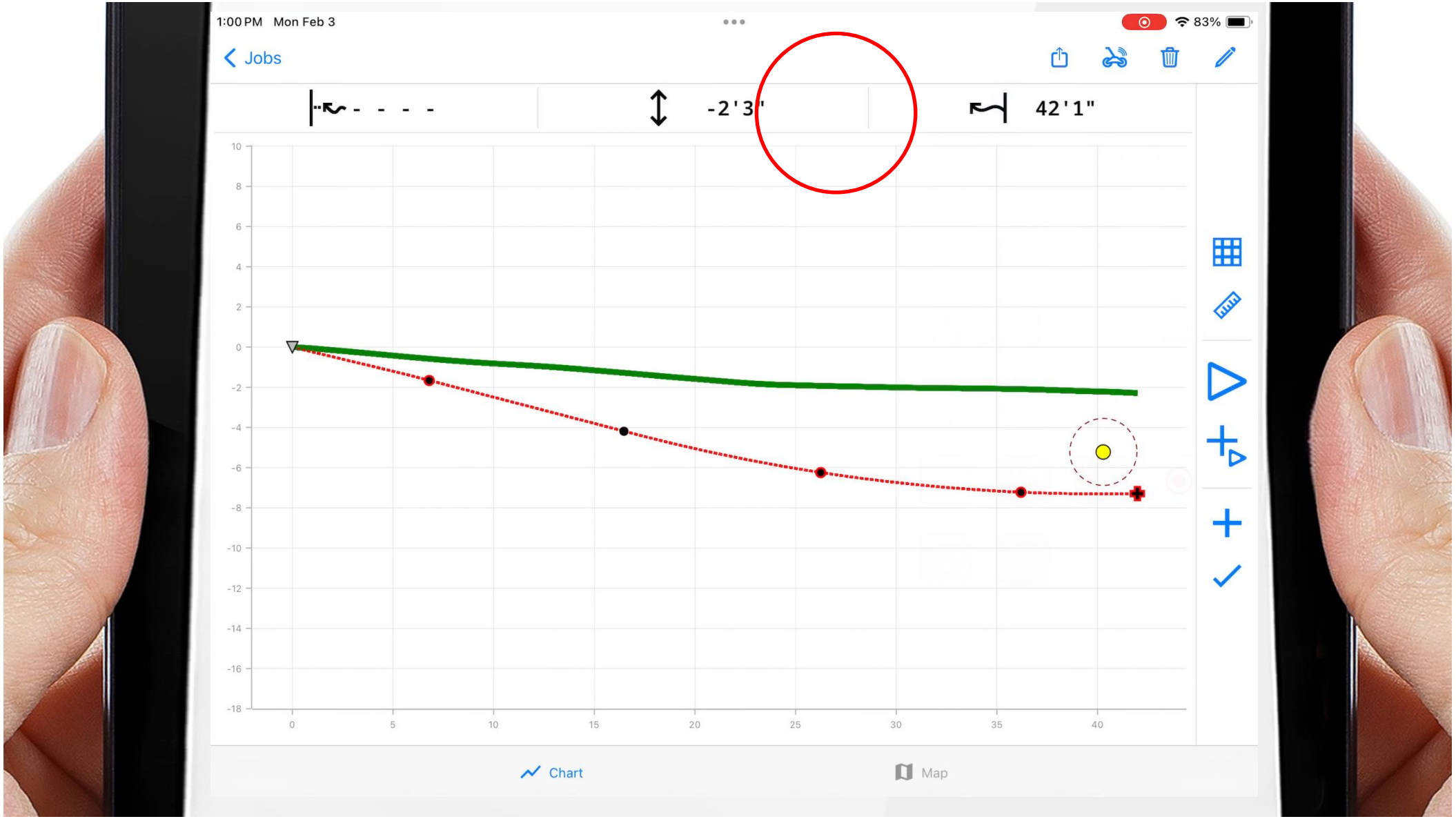

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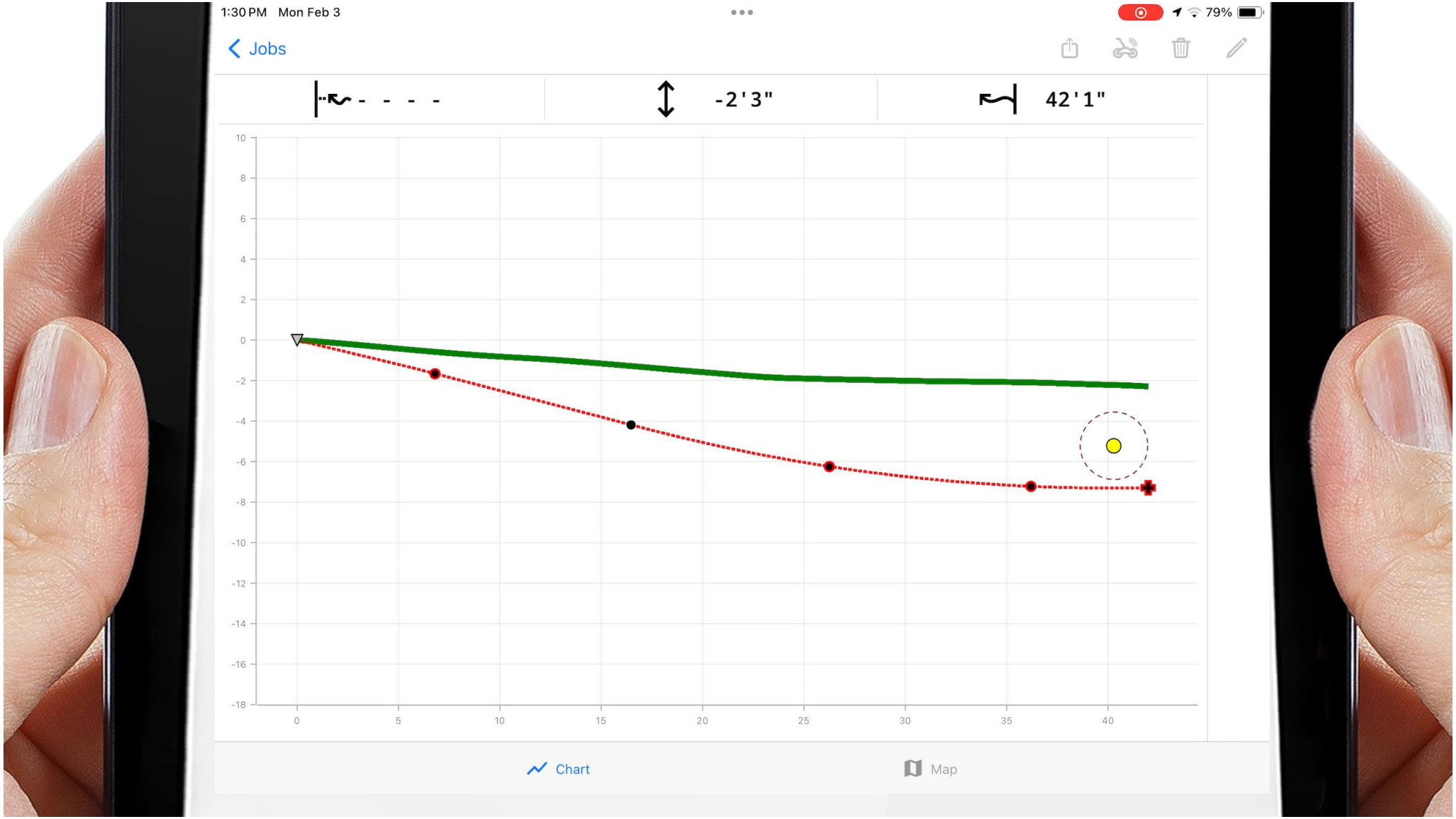
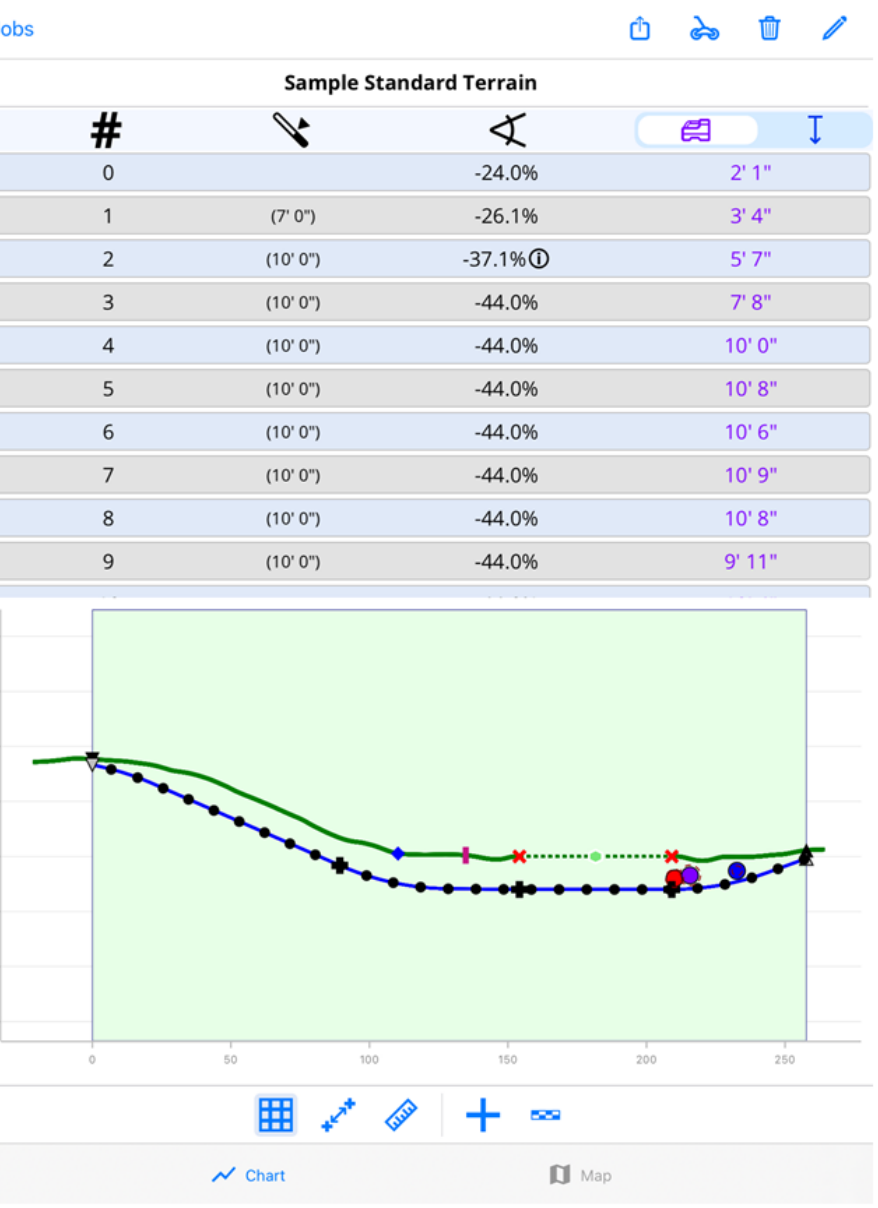
Chart
Map





Pre-bore Safety Aspects of a Bore plan

- What the crew has been asked to do isn't really (or not at all) achievable
- By choosing to go above the first utility it is impossible to go below the second one with adequate clearance
- Might be easier to drill the other direction
- Best tool to review required changes

Safety aspects of a plan during the bore

- Rod-by-rod plan based on an accurate survey of the terrain
- Targeted depth and pitch for each rod are known
- Utilities to be crossed have been daylighted and incorporated into the plan
- Crew has step-by-step instructions for navigation

Safety aspects of a plan during the bore

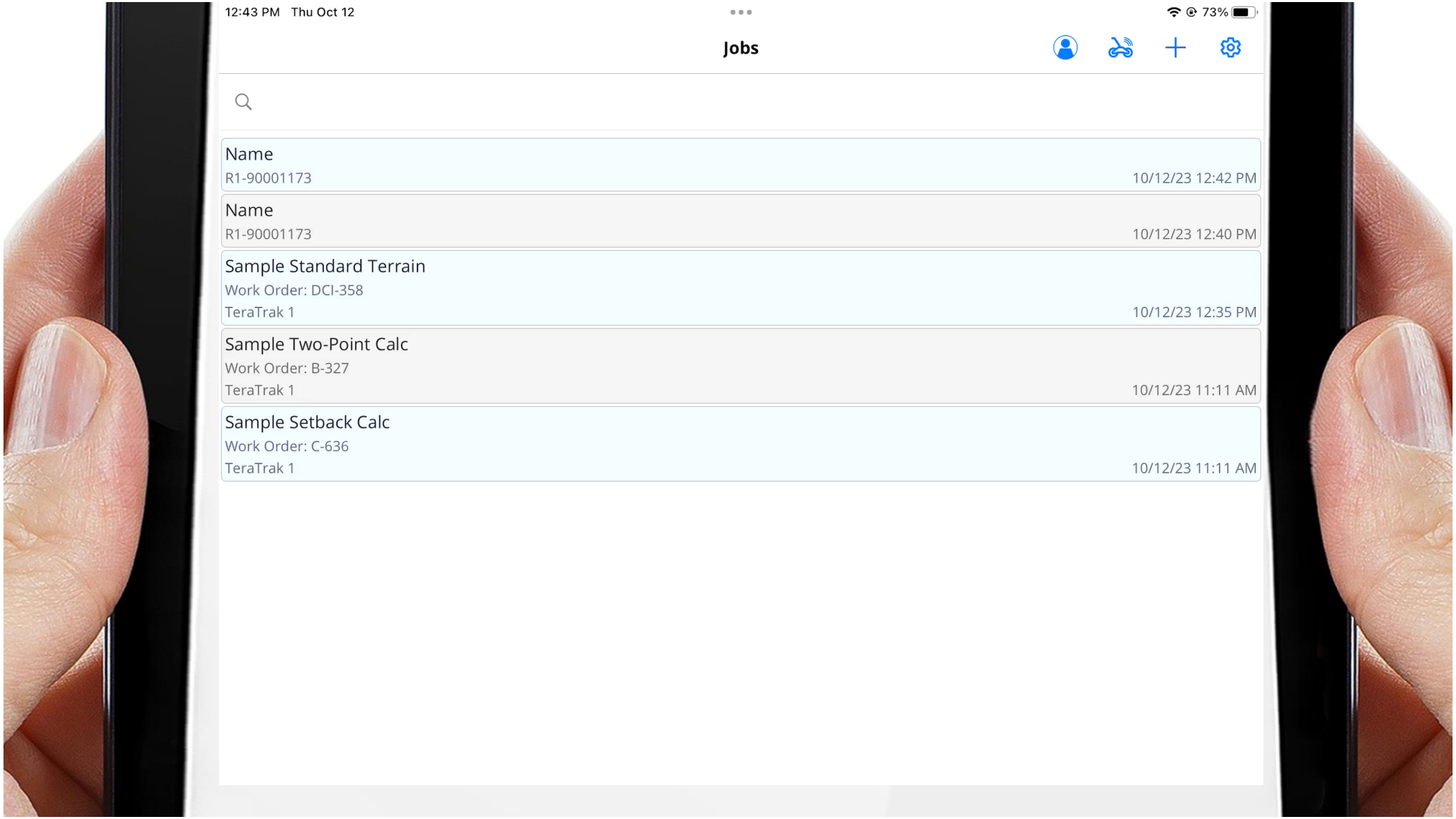
- Proper interference investigation/mitigation
- Optimum frequencies chosen
- Locating system calibration has been verified
- Depth readings above ground have been checked
- Locating system accuracy is paramount

What if the ground doesn’t cooperate?

- Bore plan is the ideal mathematical solution
- Ground conditions do have a vote
- Inevitable deviations are highlighted
- Always a target of a desired depth and pitch for the next rod
- Simplified decision-making!

Larger deviations or unexpected obstacles

- Deviation from plan becomes large enough to take several rods to get back on plan
- The plan could be modified
- Alternately creating a short “few-rod” plan to desired “future” location
- Obstacles often require a plan change
- The plan contains all the necessary data to do so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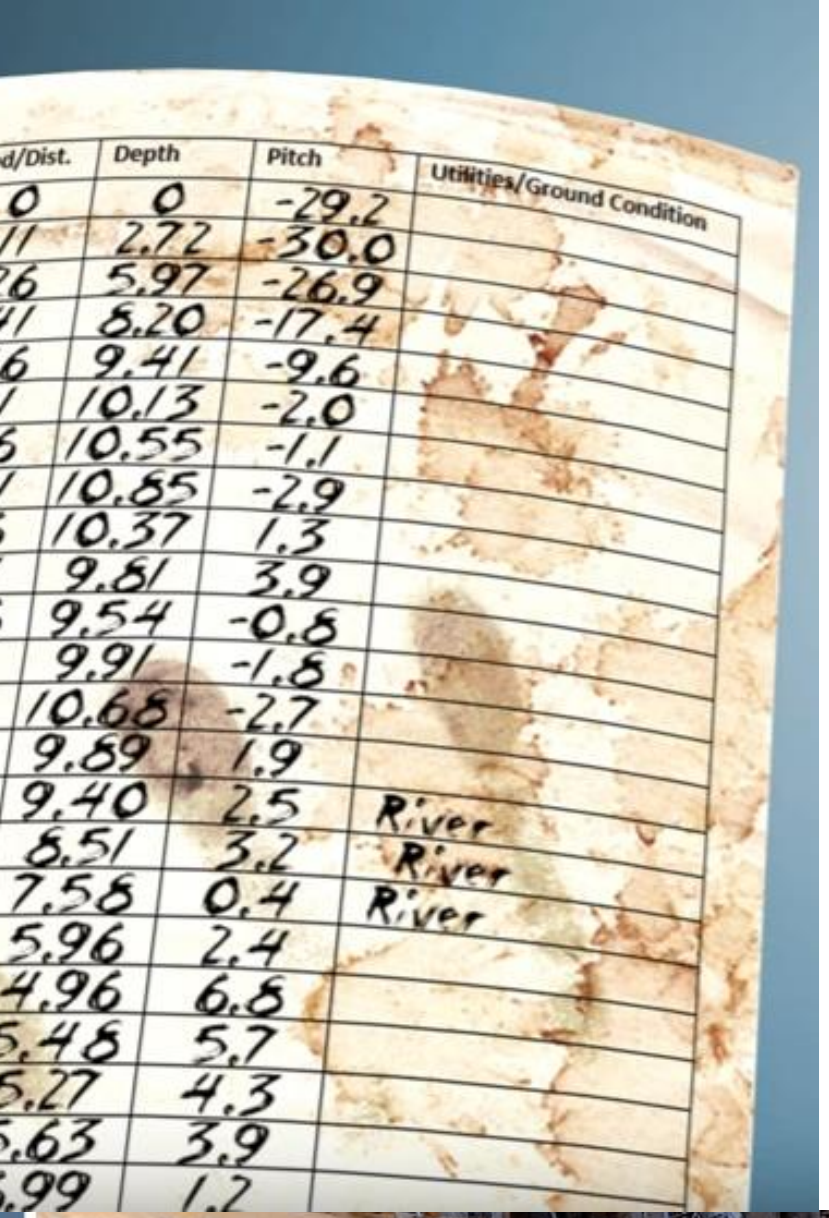
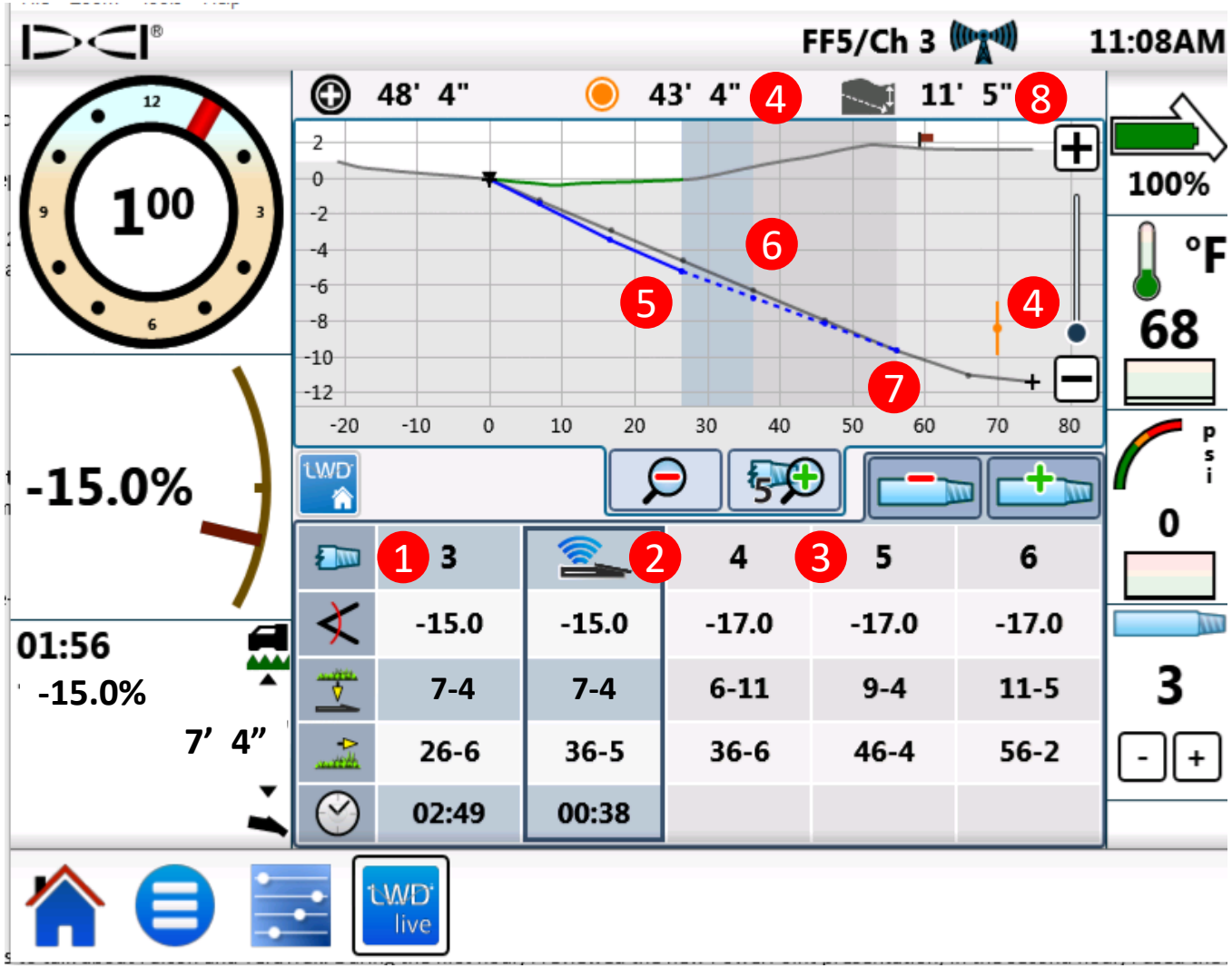


Keeping track of deviations

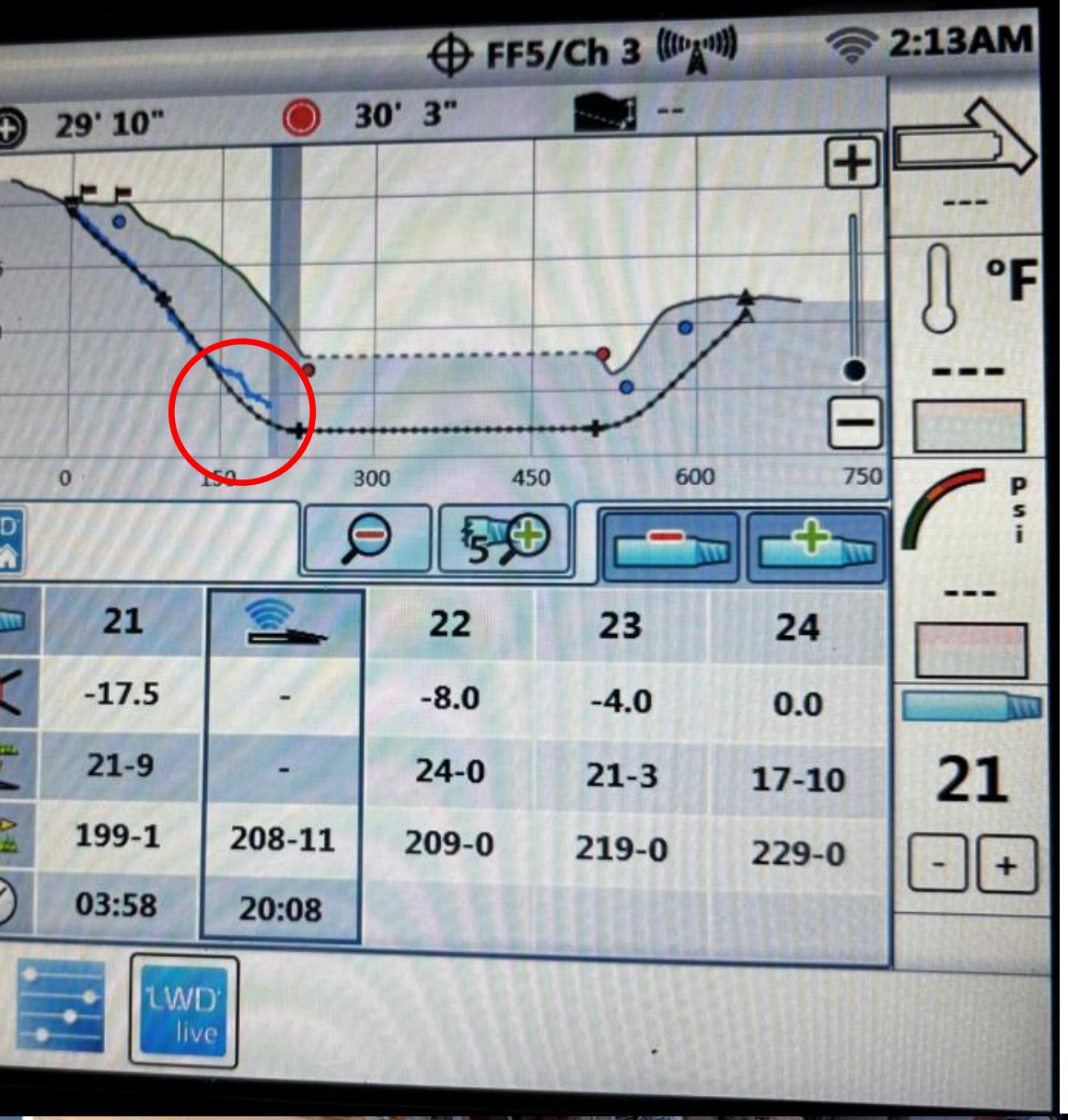
- Locator should verify that the depth change matches change in pitch
- Write down actual values and compare to plan
- If pitch readings generally agree with the plan BUT the depth differs = warning
- Real-time tracking of plan versus actual is key

Remote integration

- Currently, most rig operators rely on the locator for situational awareness
- Transferring the bore plan to the remote display, the operator has a comprehensive view of the bore ahead
- Viewing the rod-by-rod plan, and logging actual values, steering decisions are simplified



1	Logged data for rod 3
2	Current data
3	Next three rods of the plan
4	Distance to closest utility
5	Logged bore path (blue)
6	Planned path (grey)
7	3-rod projection at constant pitch
8	Estimated depth 3 rods out



Real-world application

- 650 ft freeway crossing
- Terrain mapping took 20 minutes
- 15 ft depth required below the road
- Hardpan causes deviation
- 90 ft runway to get on to the plan
- Pilot bore completed in about 7 hrs

Remote Integration in summary

- Improved situational awareness
- Access to the rod-by rod plan
- Chart of planned and drilled paths
- View of obstacles and distances
- Easier to get back on plan

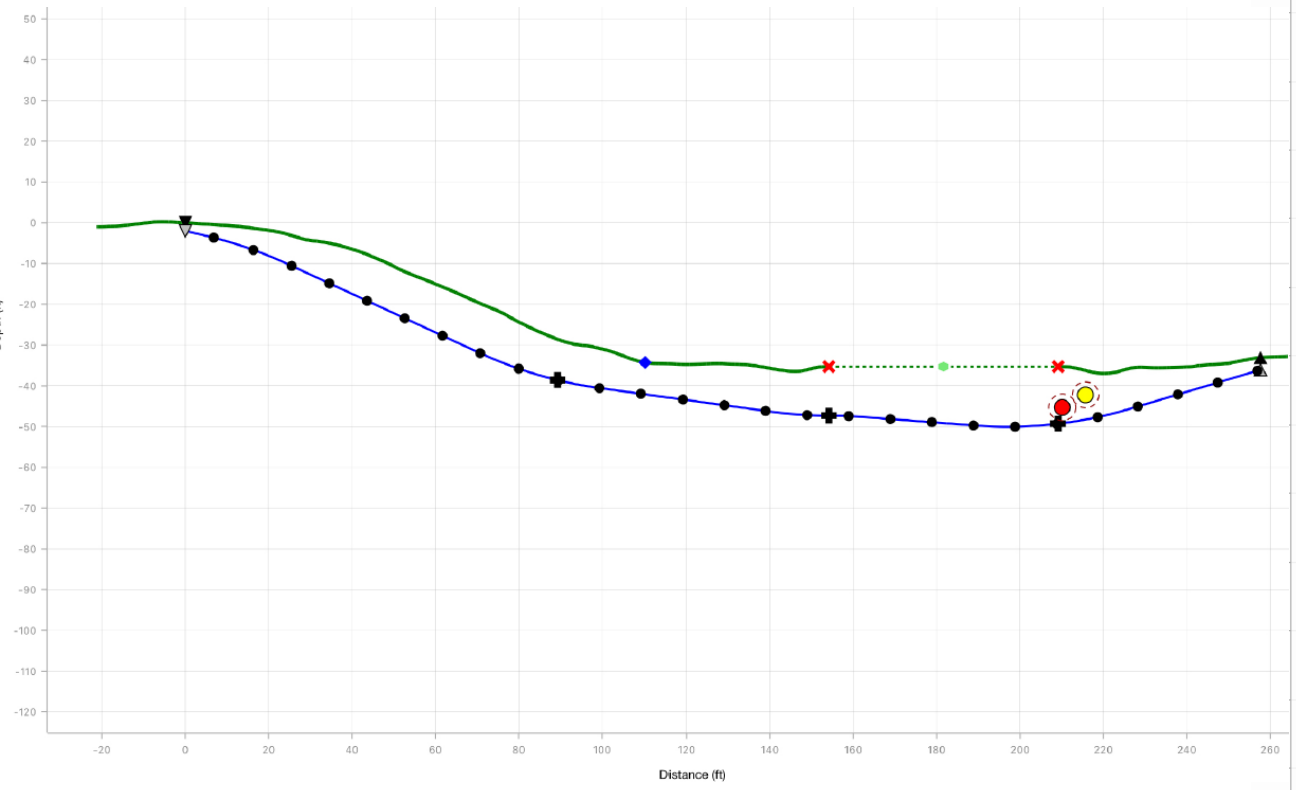
Post-bore Safety Aspects of a Bore plan

- The plan documented the intended solution
- Basis for comparison to the installation
- Installation data can come from drill logs, which can be from field notes, logbooks, or other types of data logging

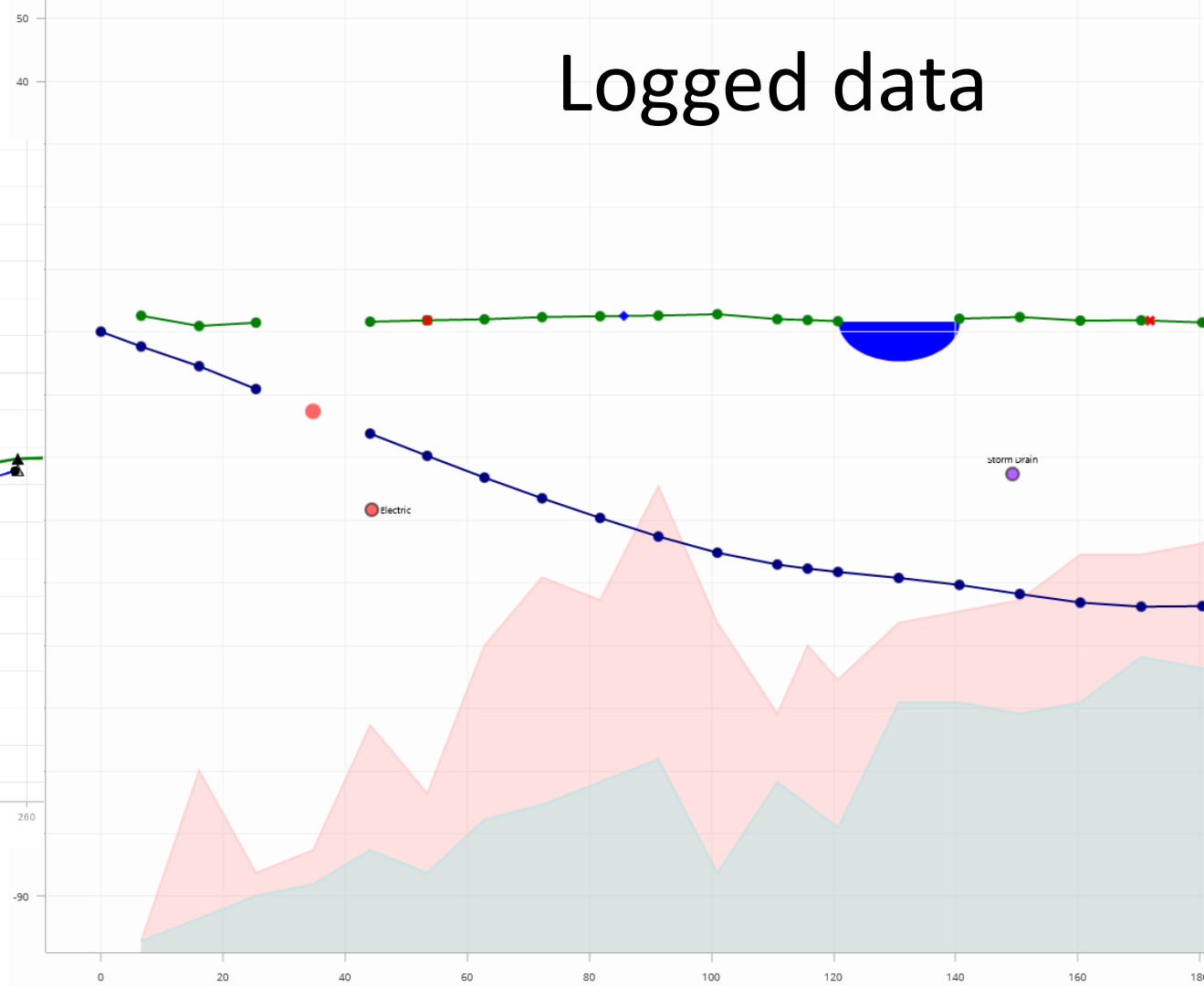
Post-bore Safety Aspects of a Bore plan

- Modern systems support the logging of data
- The system used to navigate the pilot bore is the source of the drill data
- The output is generally in the same format as the plan, rod-by-rod data and a chart
- Allows comparison where “significant deviations” could result in further investigations or clarifications

Plan



Logged data



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	5	(10' 0")	-47.3%	11' 6"
	6	(10' 0")	-47.3%	11' 7"
	7	(10' 0")	-47.3%	12' 1"
	8	(10' 0")	-47.1%	12' 4"
	9	(10' 0")	-35.4%	11' 1"
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5	-38.0%	17' 10" / 44' 1"
6	-38.0%	21' 7" / 53' 5"
7	-36.0%	25' 3" / 62' 10"
8	-34.0%	28' 11" / 72' 3"
9	-32.0%	32' 2" / 81' 9"
10	-30.0%	35' 3" / 91' 4"
11	-23.5%	38' 1" / 101' 0"
12	-15.0%	39' 2" / 110' 9"
12½	-11.0%	39' 8" / 115' 9"
13	-10.5%	40' 0" / 120' 9"

Conclusions

- Plan forces all the pertinent data to be gathered and considered
- “What if” scenarios can be explored, resulting in the best option
- Reduced decision load during installation
- Deviations dealt with more simply
- Safety is at the forefront
- The final product is much better

Questions?

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