

USGS Tape Calibration Study

*Bill Cunningham
USGS Office of Groundwater*

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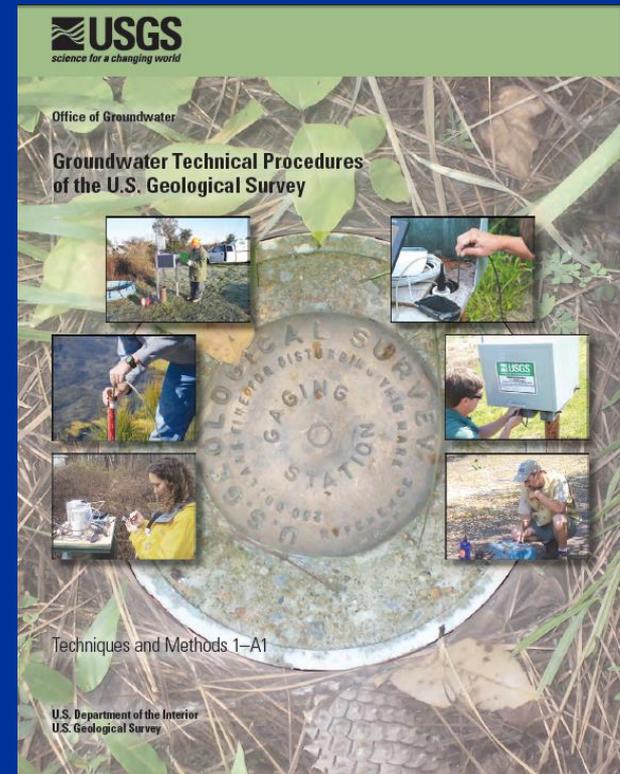
Why Tape calibration?

Drivers for USGS Calibration Program

- USGS GW Procedures require tape calibration, but specific approach was not defined.
- Key aspect: annual tape check
- Some tape issues reported-- difficult to compare because of different calibration approaches



<http://pubs.usgs.gov/tm/1a1/>



USGS Hydrologic Instrumentation Facility

- Stennis Space Center, MS
 - Warehouse and laboratory facilities
 - Provides instruments, equipment, and supplies
 - Tests, evaluates, repairs, calibrates, and develops hydrologic equipment and instruments.
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- **Goal: Evaluate the accuracy of “out of the box” electric tapes used by USGS**

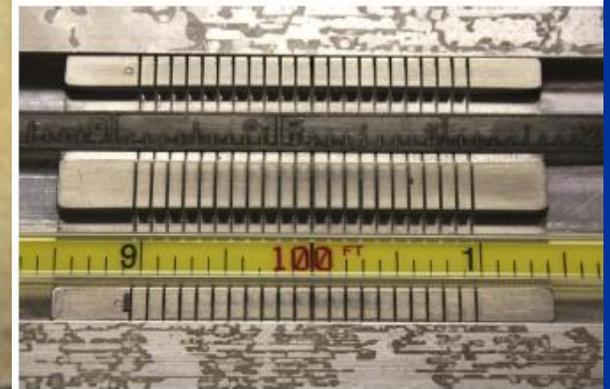
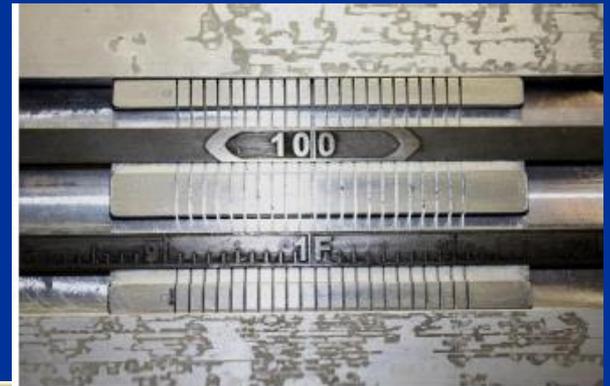


New E-Tapes tested

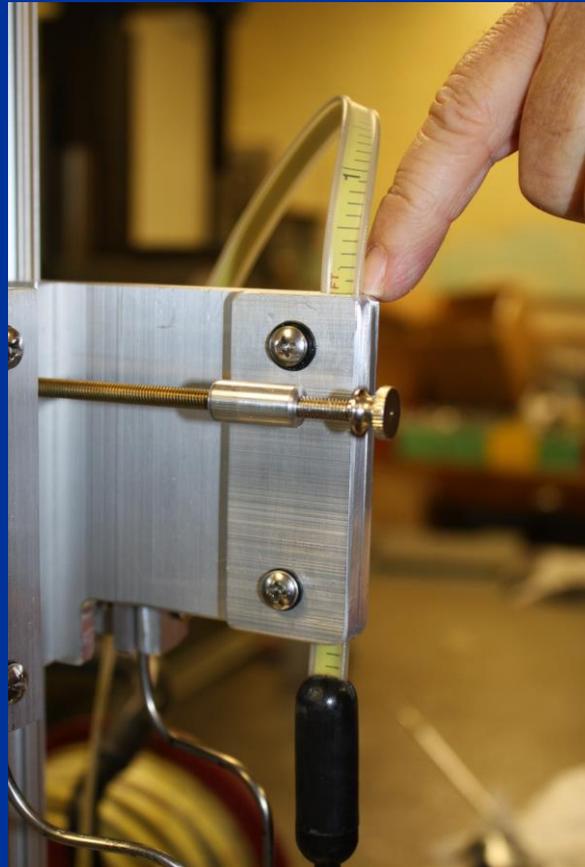
- Slope Indicator, Heron Dipper T, In Situ, Waterline, and Geotech



**Tape-length calibration system.
Length measurement accurate to
0.0005 ft. Pull force accurate to
0.02 lbs.**

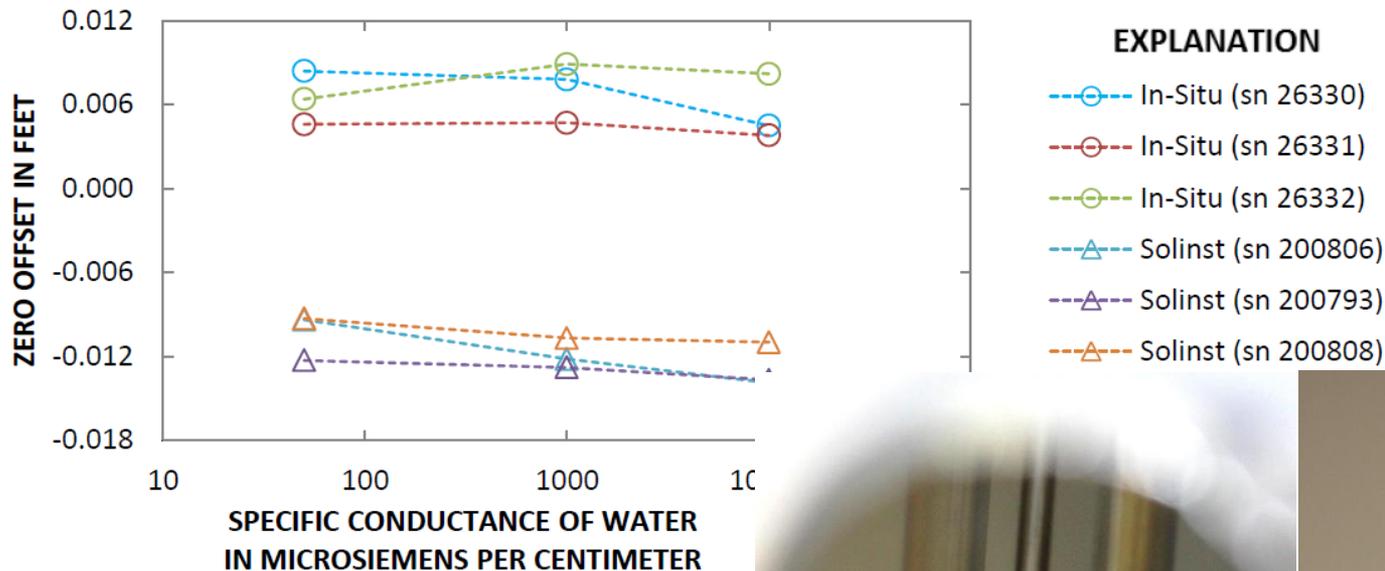


Additional testing done on sensitivity, and errors from the 1-ft mark.



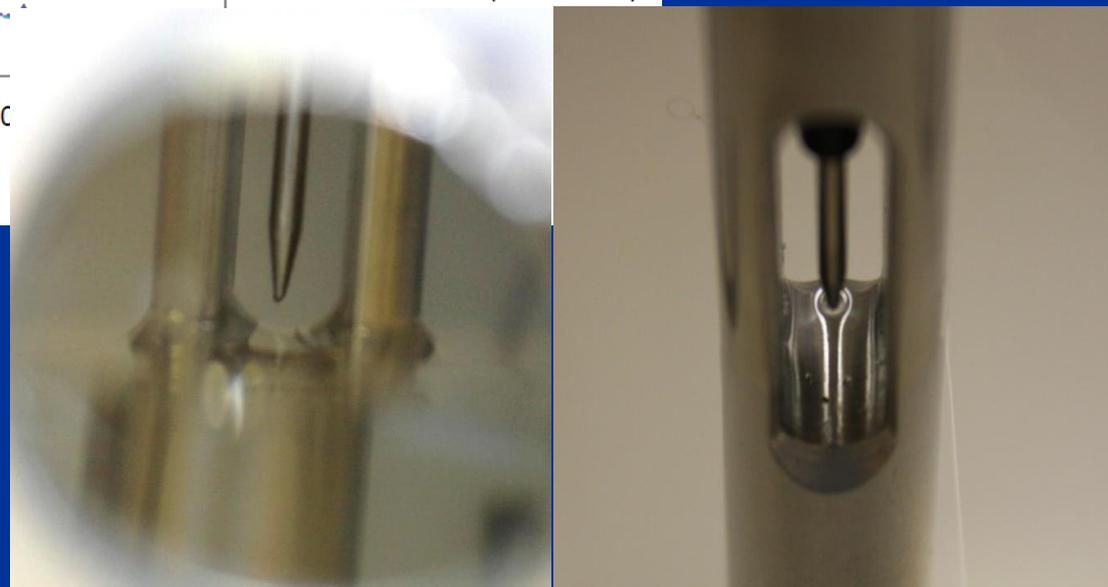
- Testing distance from the water surface to the 1-foot mark on the E-tape.

Checking water contact vs indicator “activation”



Zero offset range of +/-0.014 ft in test solutions of 50; 1,000; and 10,000 $\mu\text{S}/\text{cm}$.

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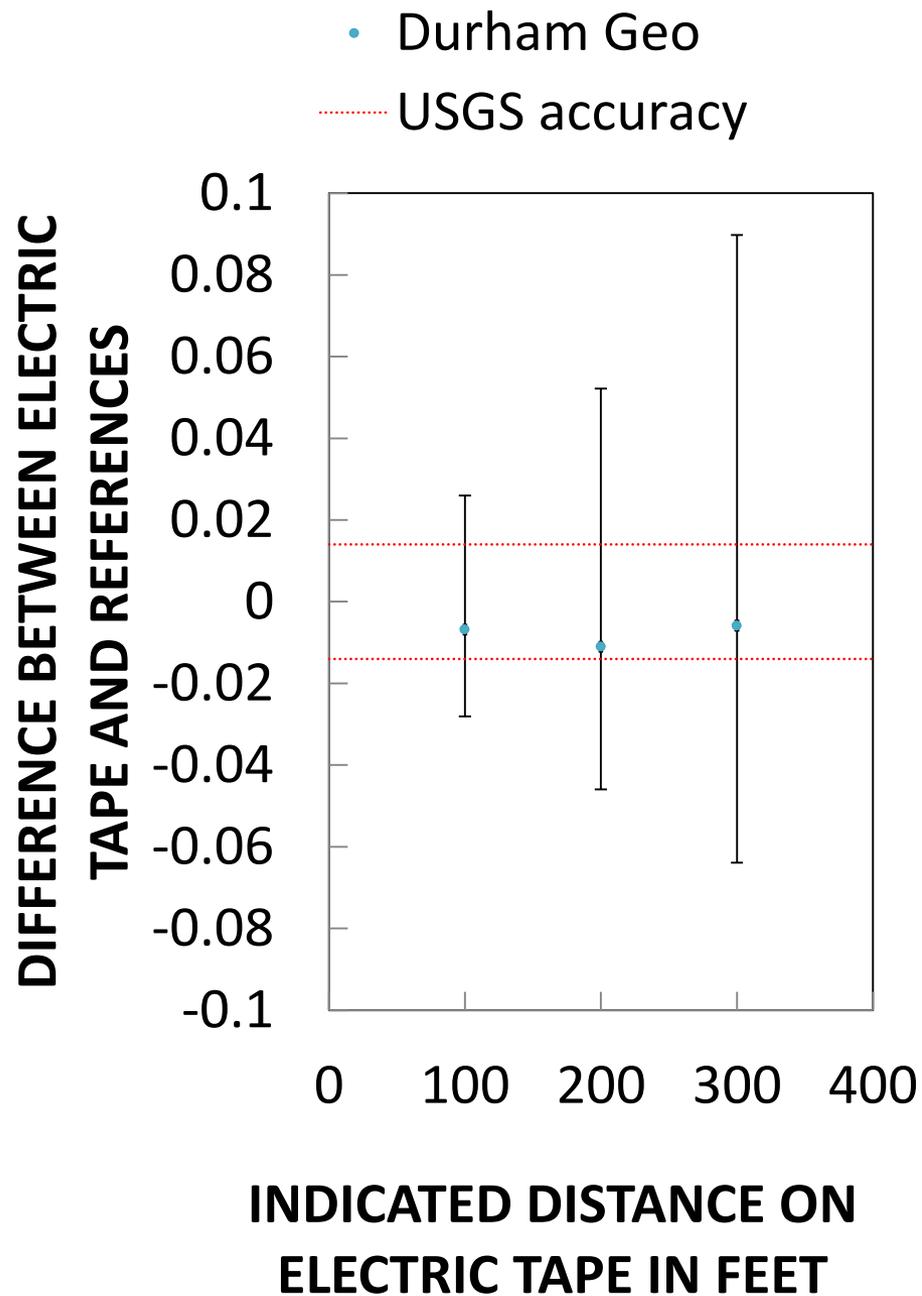


Checking a “Dipper T” reading in 1,000 $\mu\text{S}/\text{cm}$ water.



Durham Geo Slope Indicator

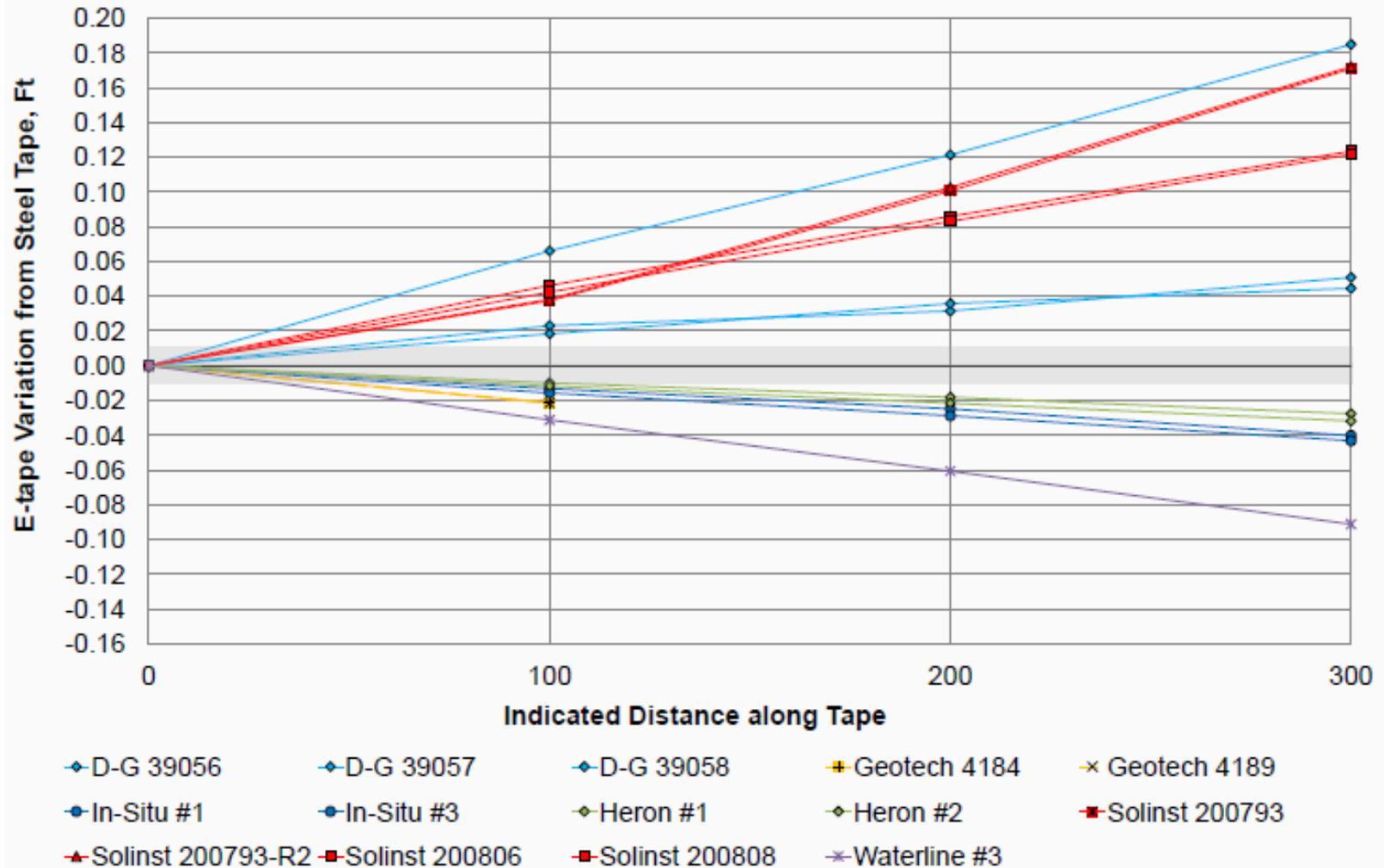




E-Tape Summary

- Calibration Testing Results at 100 ft:
 - Reference Tension
 - 8% had error less than 0.01 ft
 - Maximum error was 0.0704 ft
 - Minimum error was -0.0313 ft
 - "In-Use" Tension
 - 11% had error less than 0.01 ft
 - maximum error was 0.0376 ft
 - minimum error was -0.0514 ft

Cumulative E-tape Error E-tape at Reference Tension



14 Tapes from 6 Vendors measured at **manufacturer's reference tension**. Most tapes do not meet 0.01 ft accuracy at stated pull force.



Accuracy Testing of Electric Groundwater-Level Measurement Tapes

By Jim Jelinski, Christopher S. Clayton, and Janice M. Fulford

Open-File Report 2014–1236

U.S. Department of the Interior
U.S. Geological Survey

- Complete results from the initial testing of selected electric tapes

<http://pubs.usgs.gov/of/2014/1236/>

Suggested citation:

Jelinski, J., Clayton, C.S., and Fulford, J.M., 2015, Accuracy testing of electric groundwater-level measurement tapes: U.S. Geological Survey Open-File Report 2014–1236, 27 p., <http://dx.doi.org/10.3133/ofr20141236>.

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- **New Goal: Design a consistent tape calibration procedure for steel and electric tapes that could be done at a Center, or done at the HIF**
 - Precise, repeatable, cost-effective procedure

Calibration Steps – Electric Tape Offset

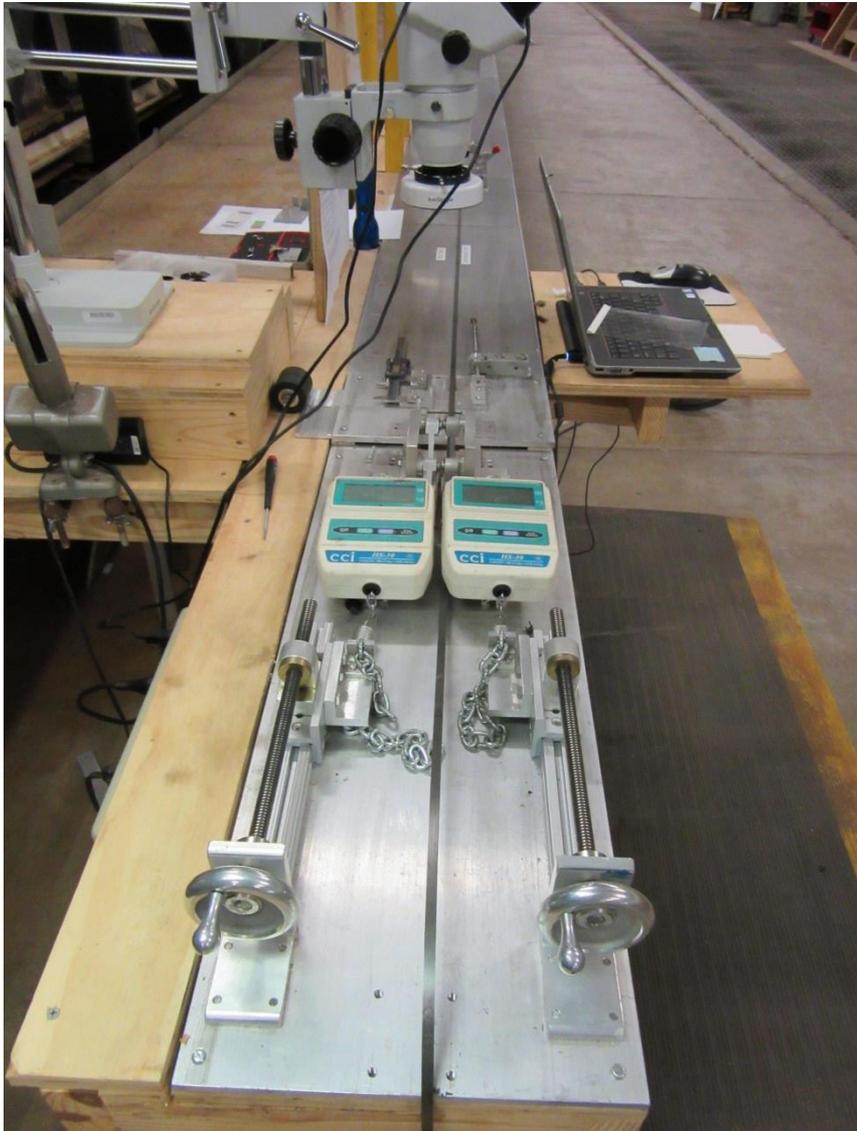


- Fixed to test stand
- Lowered until sensor sounds
- Encoder is zeroed
- Lowered until the 1 ft mark is at the water level.
- Displacement (error) = Encoder Reading – 1 ft



Tape Test Facility – Hydraulic Lab





Tape interval measurement accuracy:

- ± 0.06 in (1.4mm) per 100 ft
- ± 0.2 mm repeats



Table 10. Based on the U.S. Geological Survey Office of Groundwater survey, comparison of quantity and makes of in-service electric groundwater-level tapes with the study numbers and makes of in-service electric tapes.

[%, percent; Durham Geo Slope Indicator, DGSI]

Make	Total in service	Percentage of in-service tapes	Number in study	Percent in study
Solinst	286	47%	5	43%
DGSI	135	22%	4	29%
Heron	21	3.5%	1	7.1%
Waterline	103	17%	0	0%
RST	14	2.3%	1	7.1%
Instruments				
In-Situ	13	2.1%	1	7.1%
GeoTech, (Keck)	34	5.6%	1	7.1%

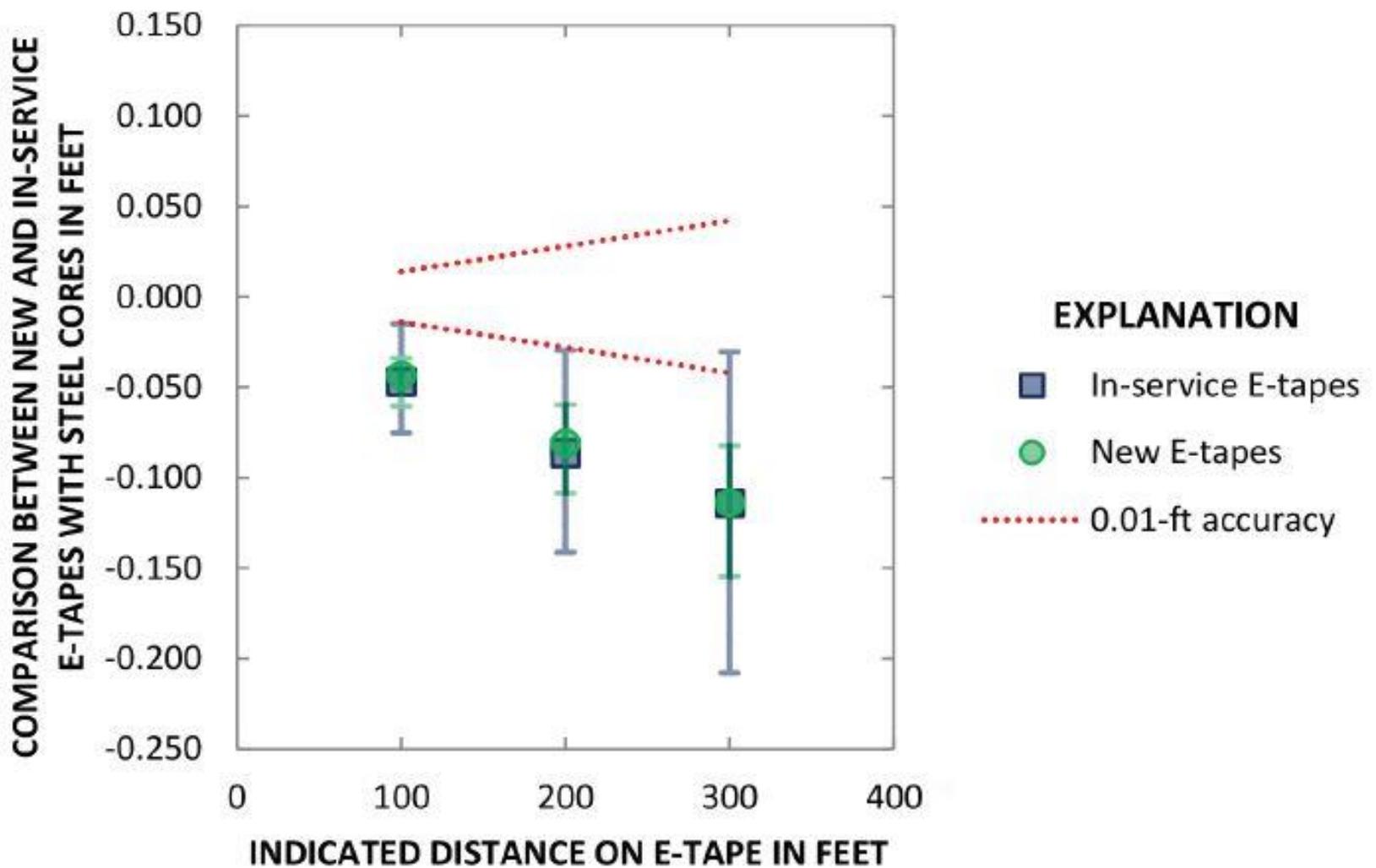


Figure 16. For new and in-service electric test tapes (E-TAPES) with steel tape cores, the cumulative measured displacement between E-TAPES and the steel reference tape plotted with an expected accuracy of 0.01 foot (ft) per 100-ft length. The E-TAPES were tested with in-use tension. Vertical error bars are the maximum and minimum displacement measured.



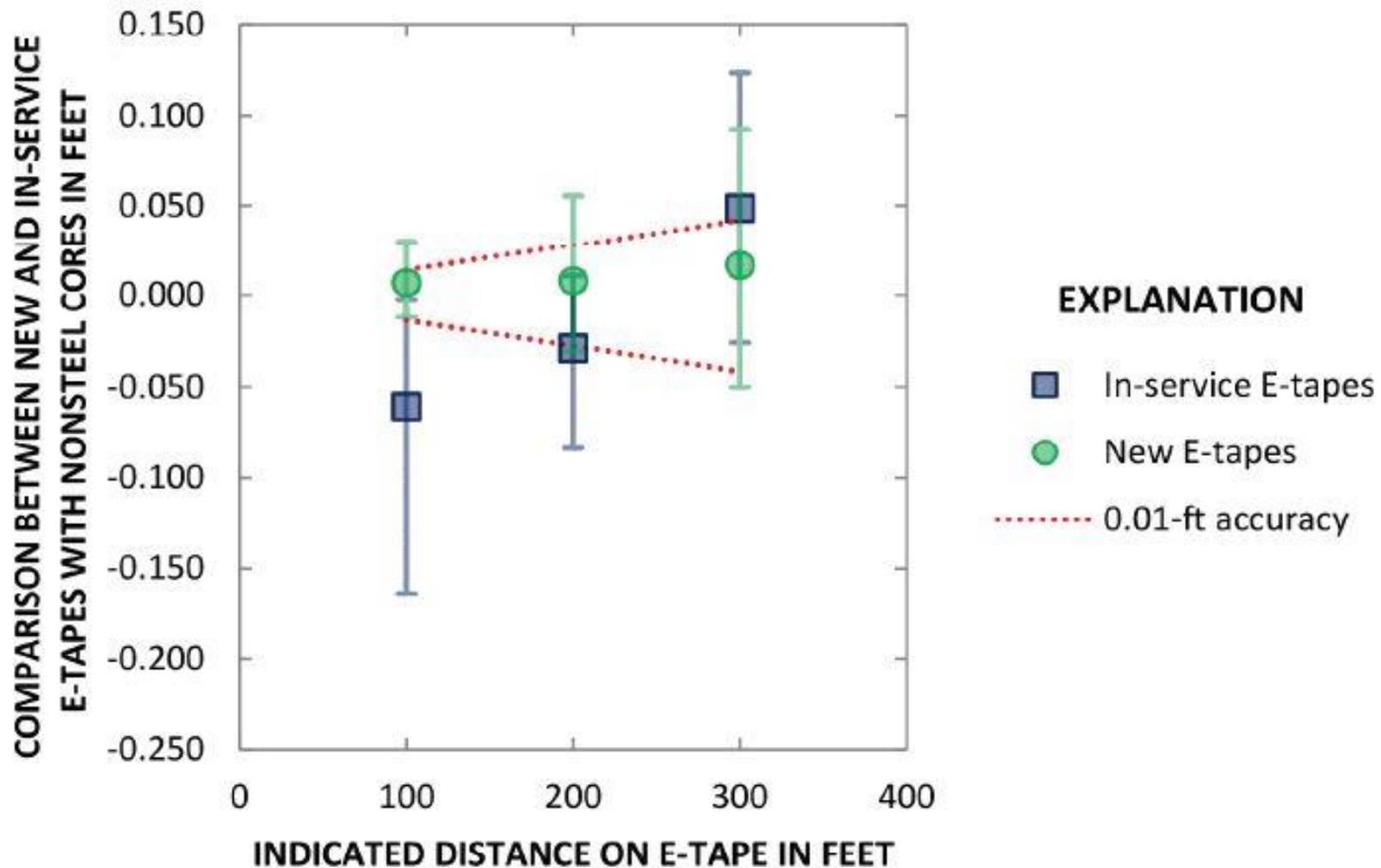
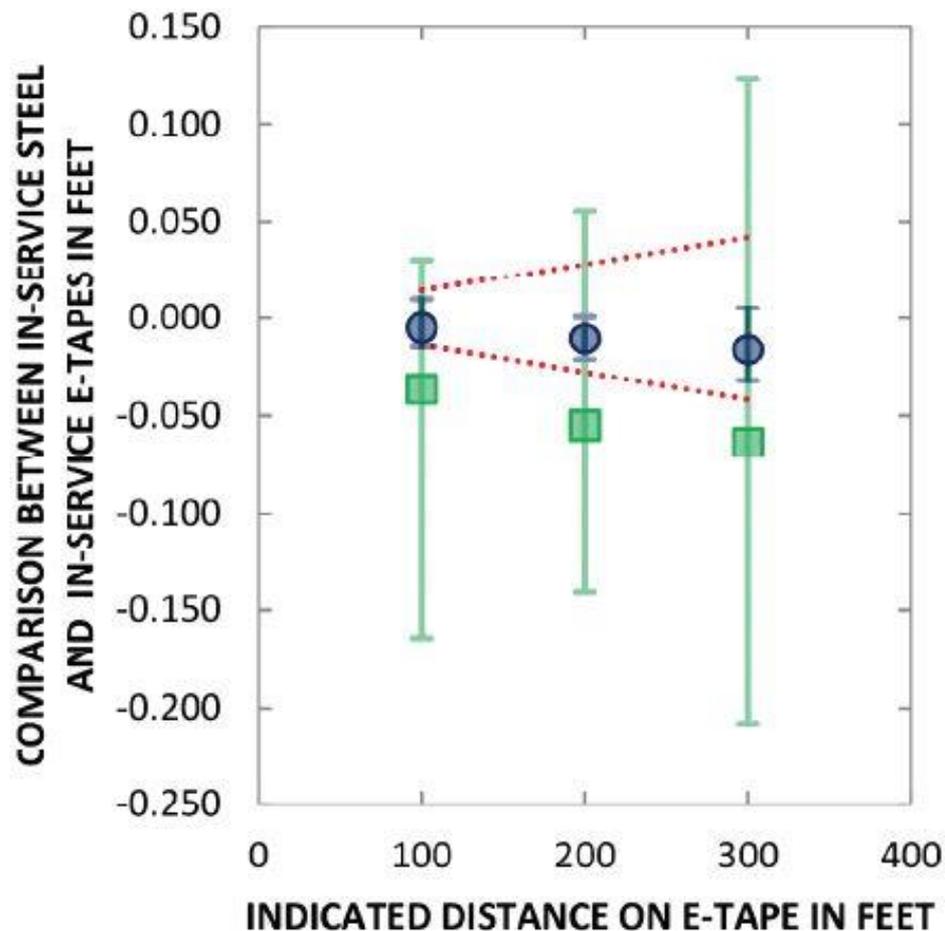


Figure 17. For new and in-service electric test tapes (E-TAPES) without steel tape cores, the cumulative measured displacement between E-TAPES and the steel reference tape plotted with an expected accuracy of 0.01 foot (ft) per 100-ft length. The E-TAPES were tested with in-use tension. Vertical error bars are the maximum and minimum displacement measured.

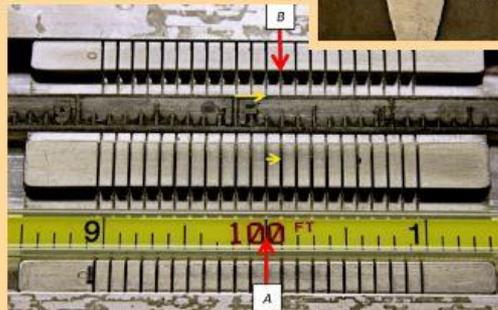
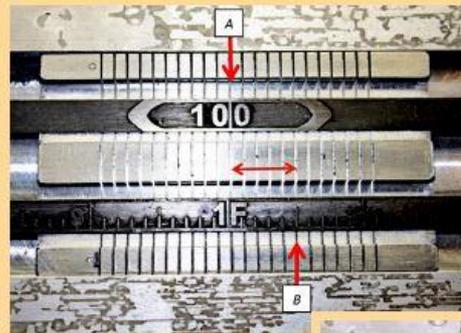
EXPLANATION

- In-service E-tapes
- In-service steel tapes
- 0.01-ft accuracy

Figure 18. For steel and in-service electric test tapes (E-TAPES), the cumulative measured displacement between in-service E-TAPES and the steel reference tape plotted with an expected accuracy of 0.01 foot (ft) per 100-ft length. The E-TAPES were tested with in-use tension. Vertical error bars are the maximum and minimum displacement measured.



Accuracy Testing of Steel and Electric Groundwater-Level Measuring Tapes: Test Method and In-Service Tape Accuracy



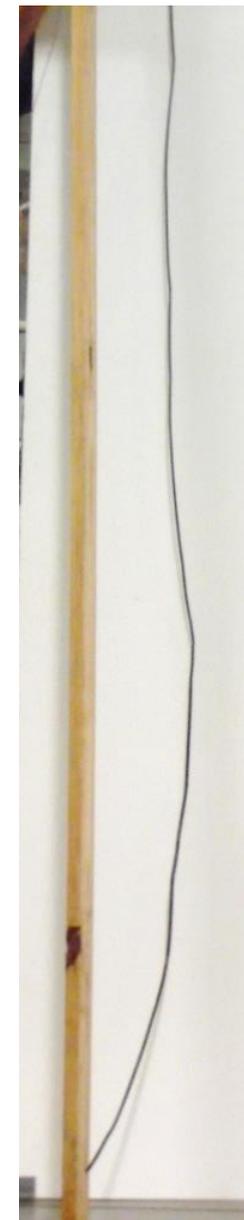
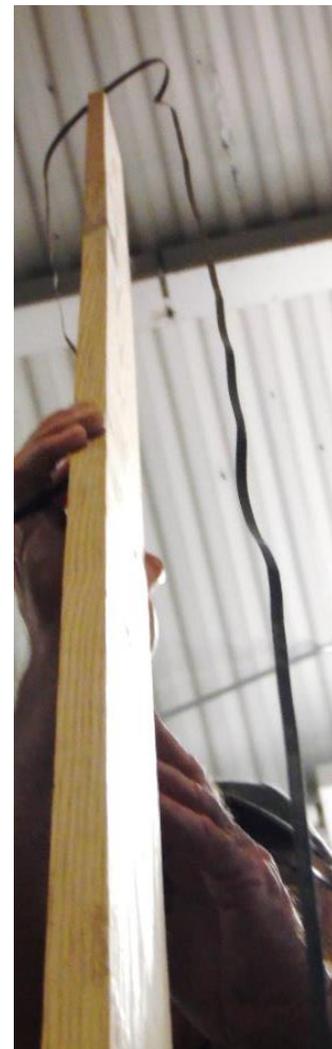
Open-File Report 2015-1137

U.S. Department of the Interior
U.S. Geological Survey

Suggested citation:

Fulford, J.M., and Clayton, C.S., 2015, Accuracy testing of steel and electric groundwater-level measuring tapes—Test method and in-service tape accuracy: U.S. Geological Survey Open-File Report 2015-1137, 31 p., <http://dx.doi.org/10.3133/ofr20151137>.

Kinked Steel Tape



Questions/ Discussion

