SPATIAL ERROR IN WELL LOGS FOR GEOLOGICAL MAPPING: ARE THERE CONSEQUENCES TO BEING WRONG?

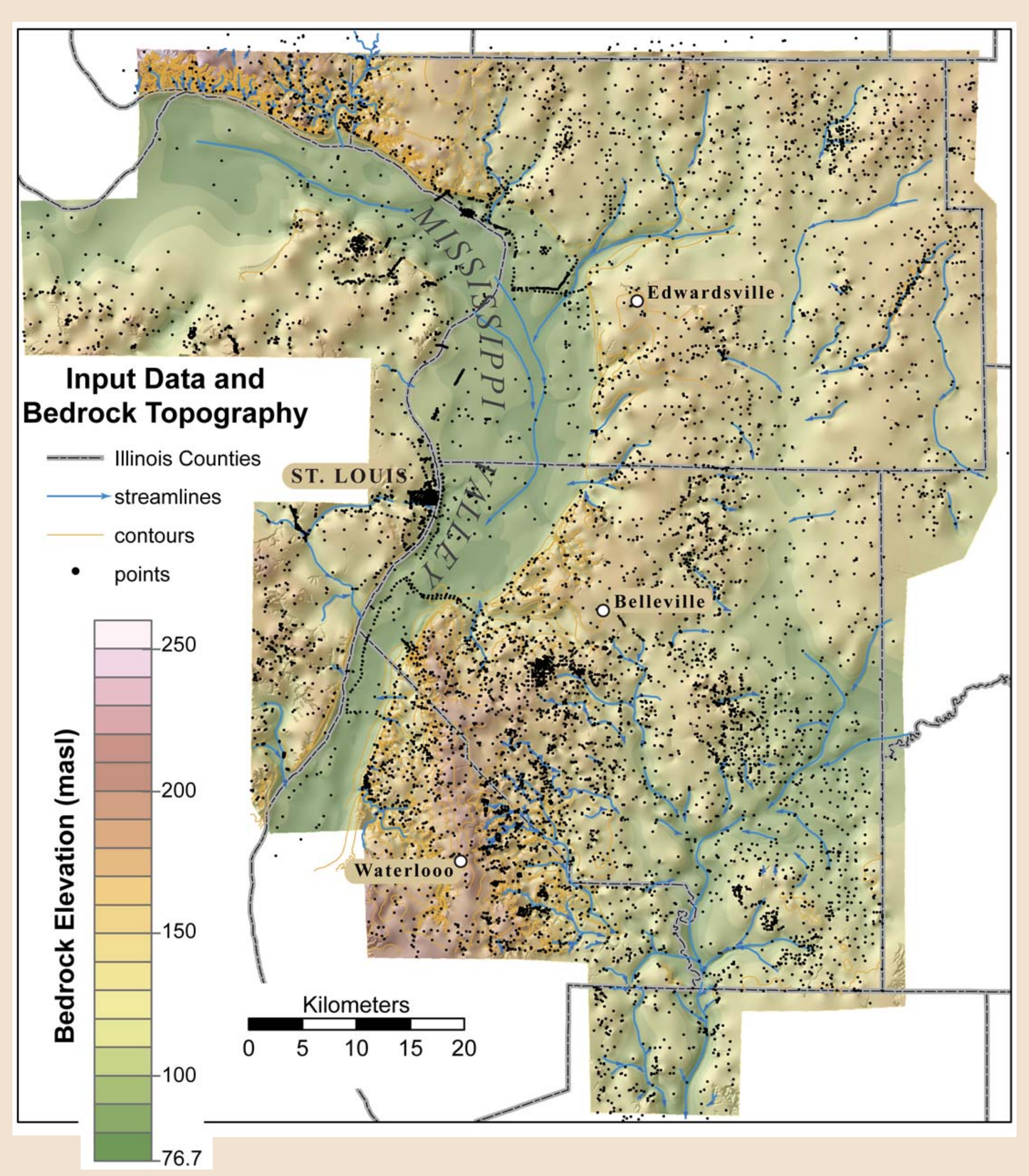
Abstract

- Subsurface data for geologic mapping from varied sources
- Checked for horizontal location
- Unknown elevations assigned based on location
- But if location is uncertain, elevation is uncertain
- Tested sensitivity of bedrock topographic map to uncertainty of input data

Conclusions

- Surprisingly precise regional bedrock surfaces can be constructed with mainly office-based location verification methods (Empirically, also largely sufficient for large scale maps, but not yet quantified)
- Not considered here is the quality of the descriptive downhole information (but all data used were the best available)

1. Bedrock topography map constructed of Metro East St. Louis area



METHODS
- Map constructed from 12 years of mapping
- Includes 6500 water wells, geologic, geotechnical, and mineral borings, and outcrops with verified locations (Illinois side)
  2000 geotechnical borings with unverified locations (Missouri side)
- Contours where bedrock is near surface
- Streamlines constrain drainage
- Modeled with ESRI Topo to Raster tool, 50 ft cell, 5 ft vertical standard error

FEATURES
- Broad, low relief Mississippi River Valley
- Steep limestone bluffs in north and south
- Gentler sandstone and shale bluffs in middle
- Rugged incised upland where bedrock near surface
- Upland surface includes buried and modern valleys

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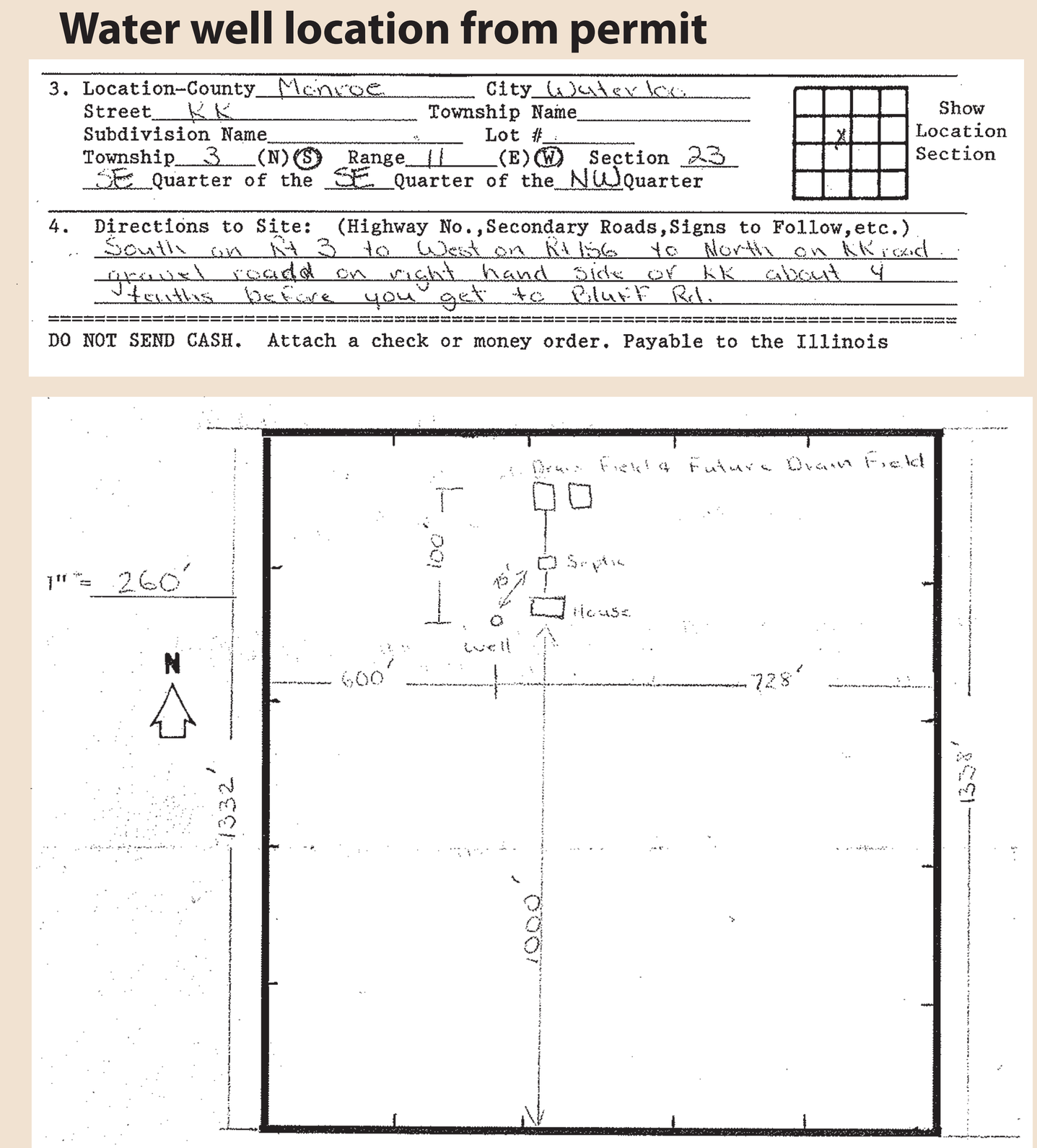
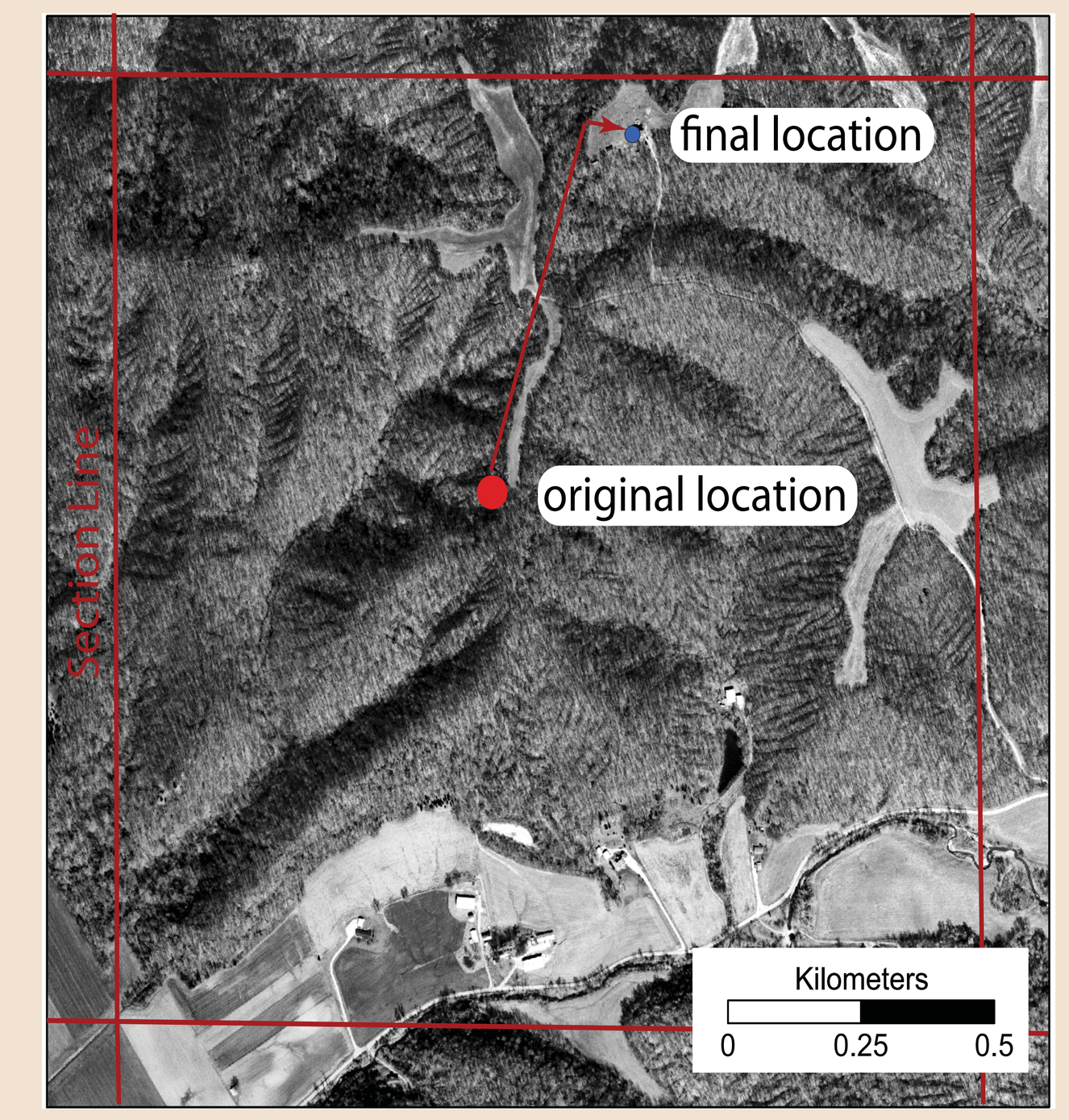
2. Construction Methods

Locations of source data checked against documents

Water well location from permit



Geologic, geotechnical, and exploration borings can often be located quite precisely, but, more important, can be judged to have highly accurate elevations



Confidence in location rated on 0-5 scale (Table I)

Finally, elevation assigned from topographic map or dem

Table I. Location Quality Rating

Rating	Supporting Data	Approximate Precision (m)
5	Best. Differential GPS, map, or diagram supported by DOQ	≤ 10 m
4	Street address or parcel number plus DOQ	10 - 30 m
3	Platbook, DOQ, or driller's description	30 - 100 m
2	In quarter Section or large plat	200 - 400 m
1	In section	600 - 1000 m
0	Worst. Conflicting information, probable bad location.	indeterminate

Table II. Test Data Set

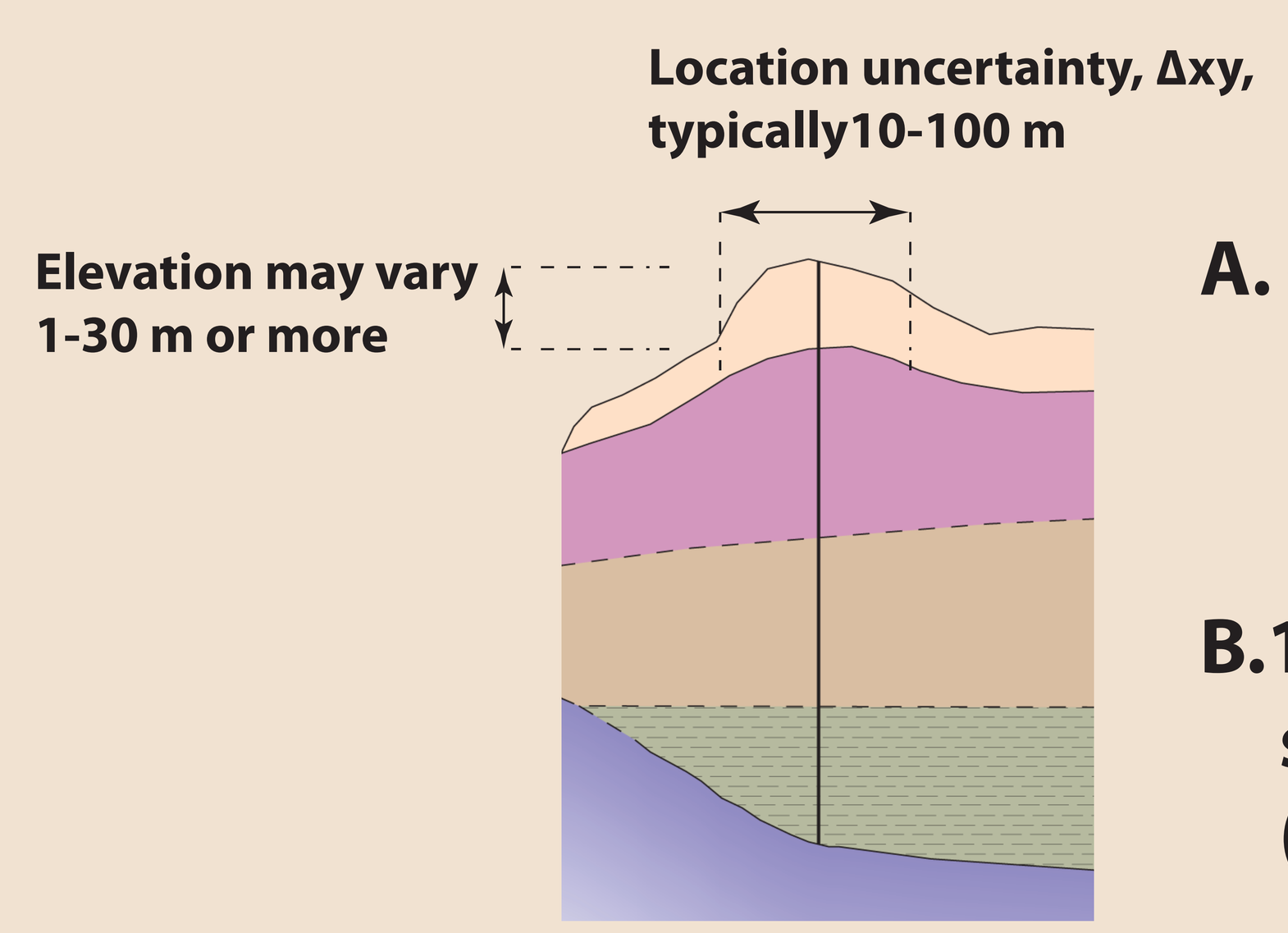
Precision Class (m)	Frequency*
10	2265
100	6290
200	262
1000	86

*test data are a subset of final data set

3. Plagued by Doubt

But even final locations are uncertain (0 to >1000 m) and thus assigned elevations are uncertain (local relief <1 to >30 m)
- address incorrect
- large or small plat
- most permits do not have construction sketch, so are assumed to be near house. This assumption is known to be violated.
- Sketch is prior to construction; final location may be quite different
- Some wells are poorly constrained, but data are sparse....

4. Test by allowing elevation to vary with local topography



A. 6 Confidence classes reduced to 4 precision classes (Table II)
   High precision ("high quality") mainly outcrops, geologic, geotechnical, and exploration borings
   Low precision mainly water wells

B. 10 m grids of elevation range within 10, 100, 200, and 1000 m search radii were interpolated from a 30 m pixel DEM (Abert, 1995)

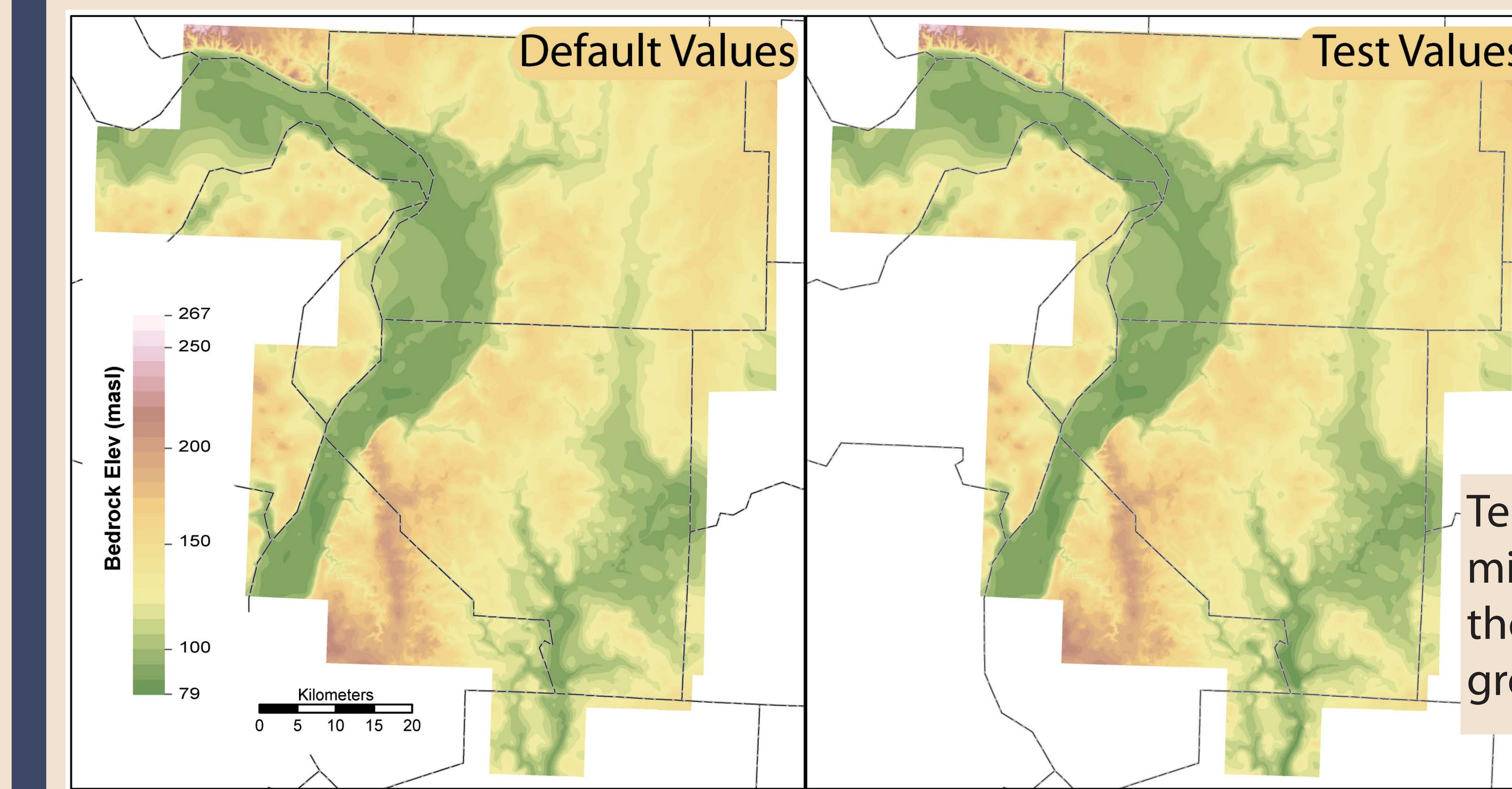
C. Elevation ranges were extracted to each boring

D. Random number [0,1] and random sign were assigned to each boring

Then,

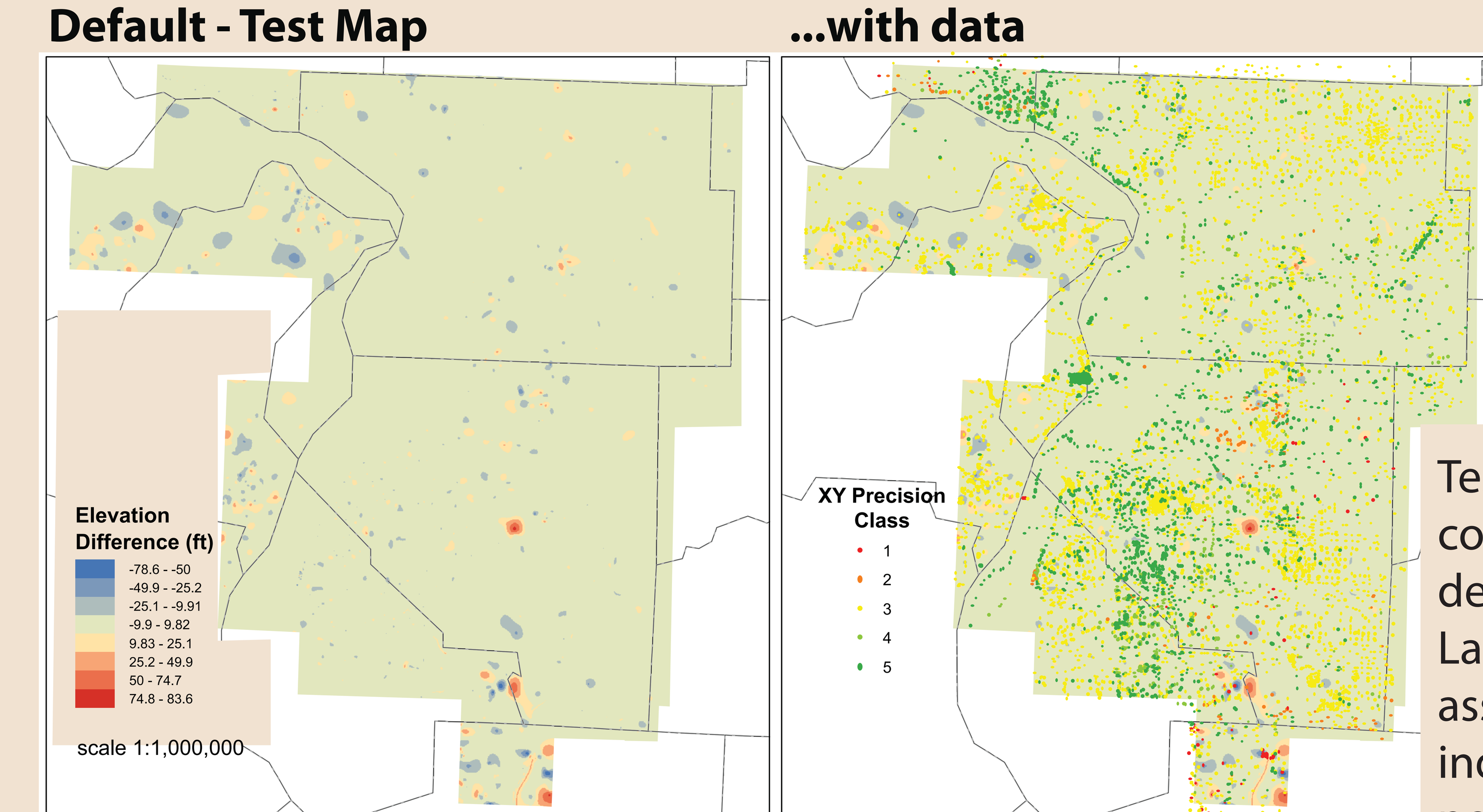
TEST ELEVATION = ELEVATION + ELEV. RANGE x RANDOM NUMBER x RANDOM SIGN

5. Analysis



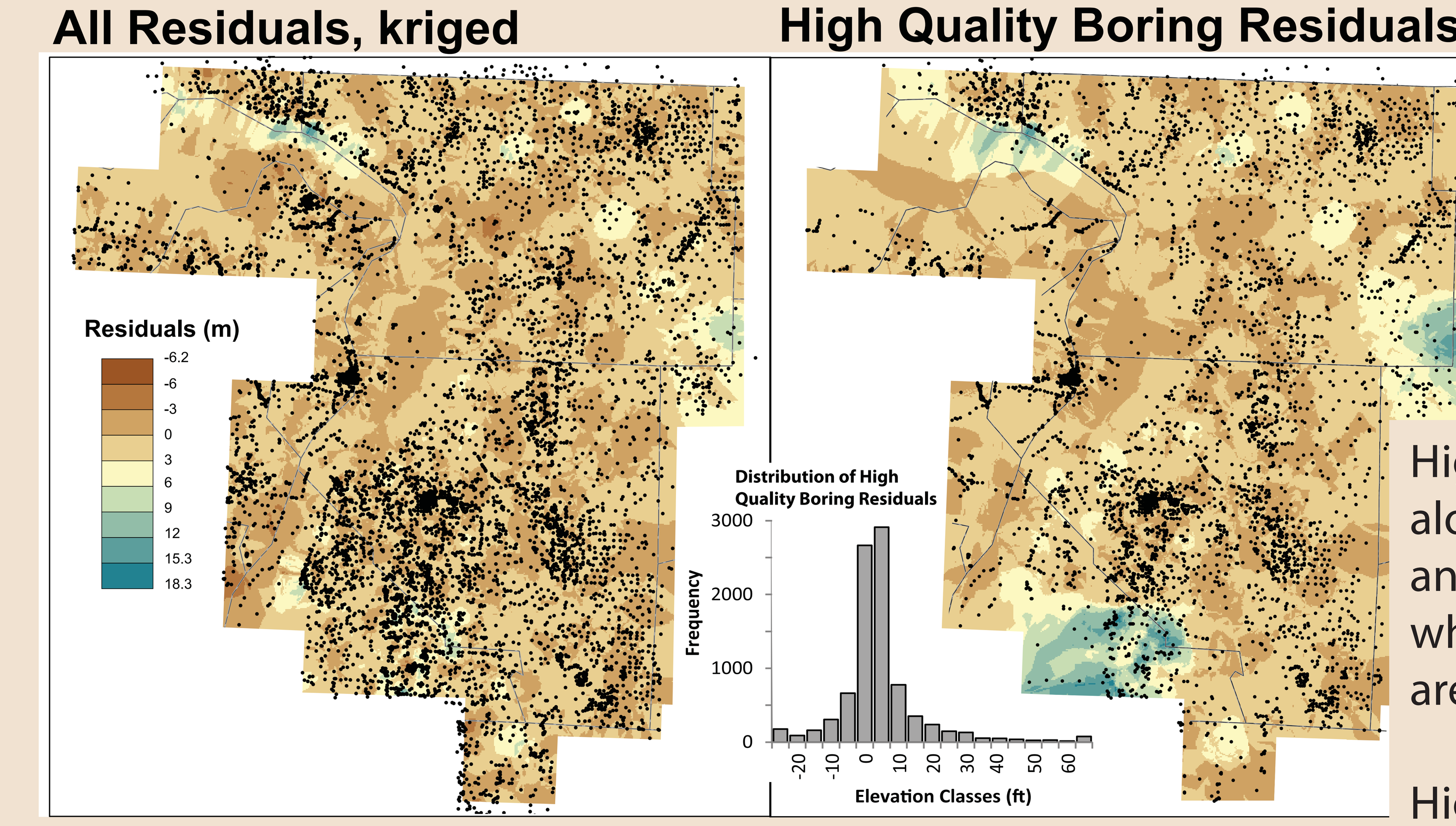
Test largely mimics default, though with greater variability

Default - Test Map ...with data



Test largely conforms to default. Larger variations associated with individual data points

All Residuals, kriged High Quality Boring Residuals



Highest residuals along rocky bluffs and incised streams where point data are few

High Q points track features that are swamped by clustered lower Q points

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