Listening to the Noise

What’s in Your Data Besides Data?

Kevin Krogstad | Hydrogeologist
Mining Bureau
Montana Department of Environmental Quality
Introduction

• We all need data to do our jobs, whether we are students, vendors, operators, regulators, or consultants.

• All data is inferred, estimated, extrapolated, and statistically massaged.

• We need data treatments to make collecting, analyzing, and applying information manageable.

• Inaccuracies can result not only from human error, but also from equipment and environmental factors.

• Poor data management can make even the best dataset useless.

• Assumptions are inevitable, but making unwarranted assumptions can be dangerous.

• Careful examination can sometimes reveal useful data even in the shakiest datasets; but always keep it in context.
Data- Facts?

• The data we work with represents natural systems. Natural systems vary.
• Much of our data is not directly measured. Quite often, we are actually measuring tiny changes in electrical current.
• Data is collected, organized, and analyzed by people. People make mistakes.
• Instruments have a margin of error. Calibration is important.
• Variation can come from unexpected sources. It may not be a mistake; you may not be measuring exactly what you think you are.
• Results can be changed or biased by the act of measurement itself.
• Careful statistical processing can remove or control uncertainty in a dataset.
The Human Element

• Well Drillers
Drillers’ Logs

<table>
<thead>
<tr>
<th>WELL LOCATION</th>
<th>DEPT</th>
<th>TRACER</th>
<th>FLOWBACK</th>
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<th>WELL NUMBER</th>
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Drillers’ Logs, Continued

<table>
<thead>
<tr>
<th>SECTION 5: GEOLOGIC LOG OF WELL</th>
<th>DESCRIPTION</th>
<th>FROM</th>
<th>TO</th>
<th>WATER</th>
</tr>
</thead>
<tbody>
<tr>
<td>0'</td>
<td>2'</td>
<td>TOP SOIL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2'</td>
<td>4'</td>
<td>CLAY WITH SAND GRAVEL &amp; BOULDERS</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;/br&gt; WATER @ 491'</td>
</tr>
</tbody>
</table>
## LOG OF WELL

Indicate depth at which water was first encountered, and the depth and thickness of water bearing beds. If water is artesian, indicate depth at which encountered, and depth to which it rises in well.

<table>
<thead>
<tr>
<th>Feet (Feet)</th>
<th>To (Feet)</th>
<th>Description of Formation Material</th>
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</thead>
<tbody>
<tr>
<td>30</td>
<td>60</td>
<td>Sand</td>
</tr>
<tr>
<td>60</td>
<td>100</td>
<td>Gravelly sand</td>
</tr>
<tr>
<td>100</td>
<td>170</td>
<td>Red sand</td>
</tr>
<tr>
<td>170</td>
<td>180</td>
<td>Hard, shell</td>
</tr>
<tr>
<td>180</td>
<td>220</td>
<td>Red sand</td>
</tr>
<tr>
<td>220</td>
<td>250</td>
<td>Light pink sand</td>
</tr>
<tr>
<td>250</td>
<td>300</td>
<td>Gradual</td>
</tr>
<tr>
<td>300</td>
<td>375</td>
<td>Red sand</td>
</tr>
<tr>
<td>375</td>
<td>400</td>
<td>Gravel</td>
</tr>
<tr>
<td>400</td>
<td>500</td>
<td>Gravelly sand</td>
</tr>
<tr>
<td>500</td>
<td>550</td>
<td>Sand</td>
</tr>
<tr>
<td>550</td>
<td>650</td>
<td>Slate and errors</td>
</tr>
<tr>
<td>650</td>
<td>667</td>
<td>Gravel</td>
</tr>
<tr>
<td>667</td>
<td>687</td>
<td>Underground river (100 feet)</td>
</tr>
<tr>
<td>687</td>
<td>690</td>
<td>Hard sand</td>
</tr>
</tbody>
</table>

I hereby certify that this well was drilled by me (or under my supervision), and that each and all of the statements herein contained are true to the best of my knowledge and belief.

Driller: [Signature]

Date: [Date] 1960

[Stamp]
The Human Element

• Well Drillers
• Field Personnel
The Human Element

- Well Drillers
- Field Personnel
- Effort
Effort

• We need to make sure we are always checking units on our field equipment.
• Be careful not to fall into bad habits in field notes. “Ditto” is not data. Significant figures cannot be replaced. “16” is not the same as “16.000”. Once the value is recorded without the trailing zeroes, that precision is gone forever.
• You can never have too many water level readings.
• A water level reading without a date and time is worthless.
• GPS everything, and take lots of photos.
• If you work in the field, it is worth the time to bone up on statistics.
Government of Alberta

Water Well Drilling Report

1. Well Identification and Location

<table>
<thead>
<tr>
<th>Location</th>
<th>SEC</th>
<th>TWP</th>
<th>RGE</th>
<th>W of MNB</th>
<th>Lot</th>
<th>Block</th>
<th>Plan</th>
<th>Additional Description</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

Measured Anticipated Depth to Water:
- From Completion of Well: ______ m
- From Drilled Surface: ______ m

GPS Coordinates in Decimal-Degrees (NAD 83):
- Latitude: 58.936018
- Longitude: -111.486410

Elevation:
- At Completion: ______ m
- At Drilled Surface: ______ m

Additional Information

Distance From Top of Casing to Gravel Layer: ______ m

Filter Control:
- Motor (Yes/No): ______
- N/A

Recommended Pump Rate: ______ L/min

Recommended Pump Intake Depth (From T.O.D): ______ m

Is your well an 'On-Stream' Water? (Yes/No): ______

Geophysical Log Taken:
- Yes
- No

5. Yield Test

<table>
<thead>
<tr>
<th>Date</th>
<th>Start Time</th>
<th>Static Water Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001/05/31</td>
<td>12:20 AM</td>
<td>22.70 m</td>
</tr>
</tbody>
</table>

Method of Water Removal:
- Type: Pump

Removal Rate: ______ L/min

6. Water Diverted for Drilling

<table>
<thead>
<tr>
<th>Water Source</th>
<th>Amount Taken</th>
<th>Date &amp; Time</th>
</tr>
</thead>
</table>

7. Contractor Certification

Name of Contractor:
- [Redacted]

Certification No: 1

Copy of Well Report provided to: [Redacted]

Date approval holder signed: [Redacted]

Printed on 9/14/2012 11:05:17 AM
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The Human Element

- Well Drillers
- Field Personnel
- Effort
- Measurement Errors
Measurement Errors

• Have a working knowledge of what the data ought to look like. You don’t usually need to know whether the pH ought to be 7.2 or 8.1 at a particular well, but -3.5 or 13.7 ought to raise alarm flags anywhere.

• It only takes a few minutes to round up a table of unit conversions, and carry it with you. Or download an app.

• On shift changes, make sure your relief knows where and how you have been measuring, and what units you have been using.
Environmental Factors

- Climate
**Barometric Effects**

\[ \Delta S_b = 0.72 \text{ in. Hg} = 0.816 \text{ feet of water} \]

\[ B_e = \frac{\Delta S_w}{\Delta S_b} \]

\[ B_e = 0.67 / 0.816 \]

\[ B_e = 82\% \]

\[ \Delta S_w = 0.67 \text{ feet after correcting for natural WL rise of 0.075 ft/day} \]
Environmental Factors

• Climate

• Seismic Effects
Seismic Effects
Seismic Effects, Continued.
Environmental Factors

- Climate
- Seismic Effects
- Tidal Forces
Tidal Effects

Figure 9.—Effect of barometric pressure and tidal fluctuation on water level in well 24/4-19H1, October 10-17, 1954.
Environmental Factors

- Climate
- Seismic Effects
- Tidal Forces
- Biologicals
Environmental Factors
Equipment Factors

- Calibration
- Drift
Calibration and Drift

• Always calibrate electronic equipment every day and record the calibration.
• Periodically compare the last several days’ calibration reports to see if there is a trend.
• Read the operator’s manual to check proper handling and storage of instruments.
Equipment Factors

- Calibration
- Drift
- Improper Mounting
Improper Mounting

Water Level Change (feet) vs. Minutes Elapsed

- Logger Data
- Corrected
Equipment Factors

• Calibration
• Drift
• Improper Mounting
• The Truly Weird
It Looks Like Pumping Data...
Shazam! Data Magic!

- Statistical Treatments
- Vetting Shaky Datasets
- Proxy Relationships
- Context Absolutely Must Be Maintained!
Conclusions

• Assumptions are inevitable, and generally are not a problem, provided they are fully understood, conservative, and thoroughly documented.

• Good training and proper equipment maintenance can prevent many issues.

• Be alert for unusual interference and effects.

• Be very careful with statistical treatments, and fully document any data discarded or combined.

• Any proxy or interpolated data must be clearly identified and not combined with observational data.

• Don’t blindly accept data as accurate. All data is wrong, but some of it is close enough to use.
Thank you for your Attention!