A large, dynamic splash of water in shades of light blue and white, filling the background of the slide. The water is captured in mid-air, creating a sense of movement and freshness. A horizontal dashed red line is positioned above the title box.

Western Ambient Groundwater Monitoring Program



NORTH DAKOTA
DEPARTMENT OF HEALTH

Michael Cooper



Outline

- ▶ Outline
- ▶ Introduction
- ▶ Description of Study Area
- ▶ Aquifer and Well Selection
- ▶ Data Collection
- ▶ Sampling Methods
- ▶ Preliminary Results
- ▶ Conclusions
- ▶ Future Sampling





Introduction

- ▶ Western Ambient Groundwater Monitoring Program was implemented by the NDDH in November 2013.

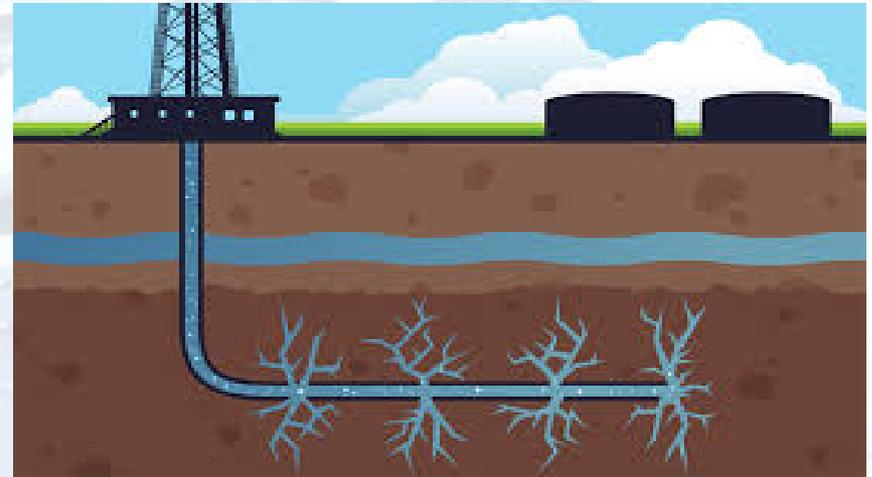
Goal: Provide an assessment of the quality of North Dakota's groundwater resources with regard to potential oilfield contamination.

- ▶ Based on Agricultural Ambient Groundwater Sampling Program implemented in 1992.
 - ▶ Sampling primarily based on susceptibility to pesticide contamination.
 - ▶ Minimal sampling in NW North Dakota



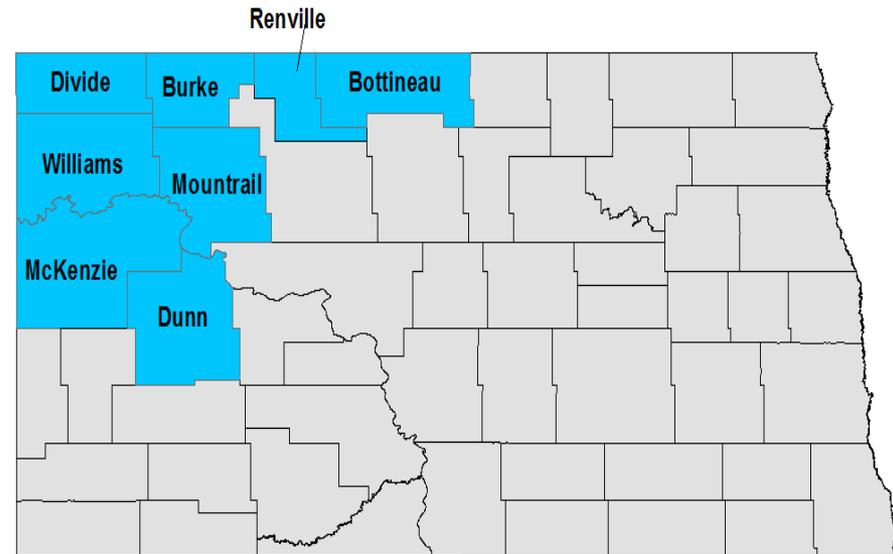
Introduction

- ▶ Increase in Public concern for water resources related to hydraulic fracturing.
- ▶ Reports of water quality issues in private wells after oil well drilling and construction
- ▶ Private well owners and journalists



Description of Study Area

- ▶ Williston Basin Area – Bakken Formation
- ▶ Focused on areas of increased oil production since 2000.
- ▶ Aquifers in 8 counties were selected for further evaluation.
 - ▶ Note: Some aquifer boundaries extend into other counties not listed.



Aquifer and Well Selection

- ▶ 33 glacial drift aquifers identified in study area
- ▶ 536 SWC Observation wells were available for sampling.
- ▶ Developed criteria to reduce well numbers
 - ▶ Well Diameter \geq 2 in.
 - ▶ Well Depth Priority
 1. Well Depth \leq 100 ft
 2. Well Depth 101 to 200 ft
 - ▶ Previous General Water quality data must be available
 - ▶ Wells must be located off reservation land
 - ▶ Select only one well per section, if possible



Aquifer and Well Selection

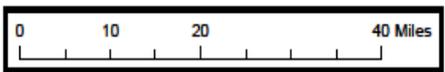
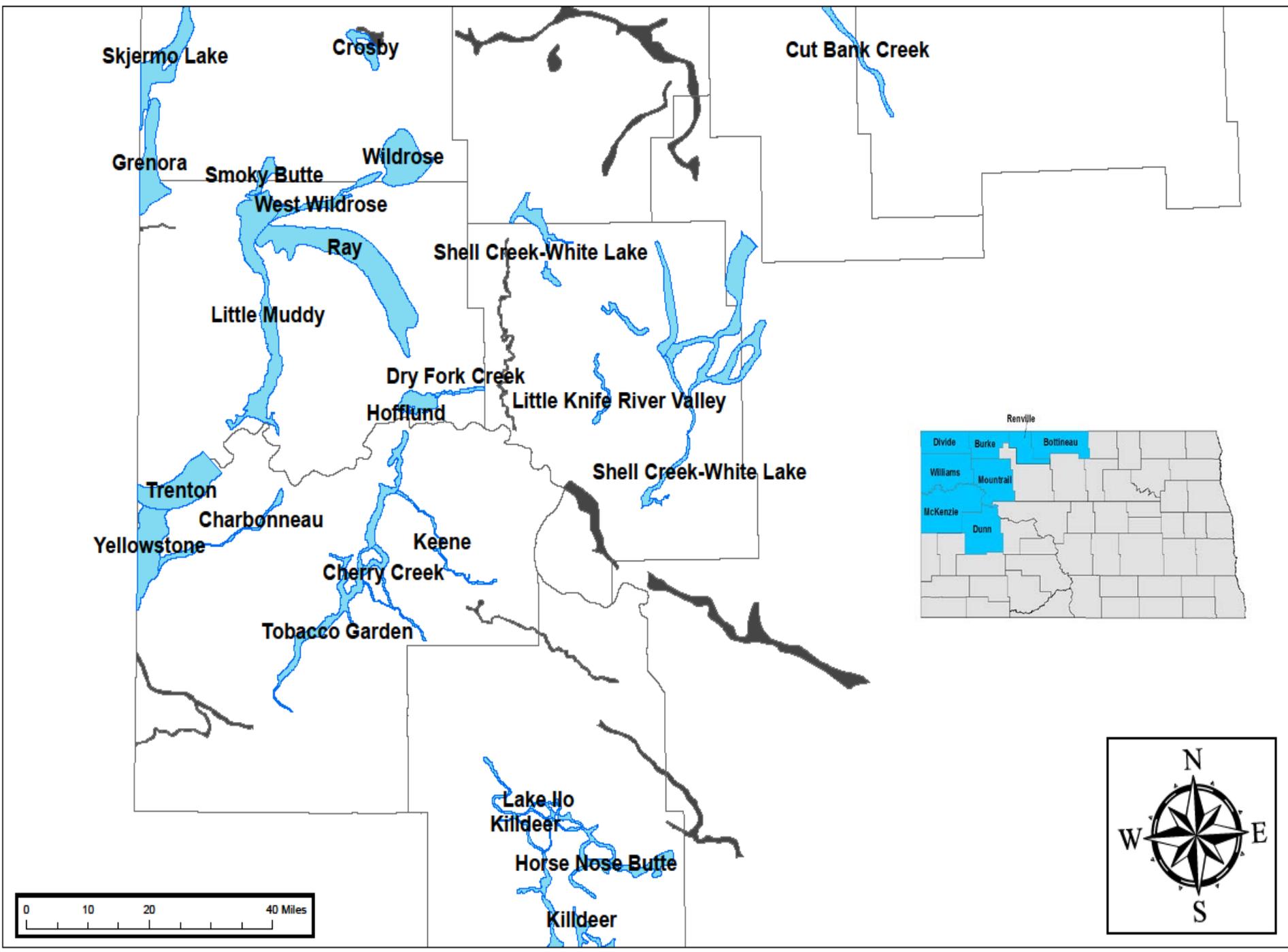
- ▶ Applied Criteria – 153 wells in 21 potential aquifers available for sampling
- ▶ Field observations reduced to 129 wells.



Aquifers Included in the Study

1. Carbonneau
2. Cherry Creek
3. Crosby
4. Cut Bank Creek
5. Dry Fork Creek
6. Hofflund
7. Horse Nose Butte
8. Keene
9. Killdeer
10. Lake Ilo
11. Little Muddy
12. Ray
13. Shell Creek
14. Skjermo Lake
15. Smokey Butte
16. Tobacco Garden
17. Trenton
18. West Wildrose
19. Wildrose
20. Yellowstone
21. Little Knife River





Data Collection

Field Measurements/Data

- ▶ Electrical Conductivity
- ▶ pH
- ▶ Temperature
- ▶ Depth to Water
- ▶ Total well depth

Laboratory Analysis

- ▶ Group 194
 - ▶ General Chemistry
 - ▶ Bromide
 - ▶ Trace Metals
 - ▶ VOC and SVOC
 - ▶ TPH (GRO & DRO)





Sampling Methods



Purge Methods

▶ Low-Flow

- ▶ Solinst Double Valve Pump
- ▶ Pump set in screen interval
- ▶ Pump rate to maintain steady water level
- ▶ Sampled after stabilization criteria are met

▶ Well Volume

- ▶ Bailers, Solinst Pump, Peristaltic Pump
- ▶ 3 well volumes
- ▶ Sampled after stabilization criteria are met.

▶ Stabilization criteria

- ▶ pH (+/-) 0.1 pH units
- ▶ Conductivity (+/-) 10% of previous reading
- ▶ Temperature (+/-) 1.0 degree Celsius.



Preliminary Results

Diesel Range Organics - DRO

- ▶ 129 wells sampled
- ▶ 45 wells had DRO detections
- ▶ 10 of 21 aquifers had DRO detections
 - ▶ Majority found in Little Muddy Aquifer
- ▶ Range: 39.2 µg/L – 1700 µg/L
- ▶ Chromatogram Review
 - ▶ 37 detections - attributable to natural organic matter in aquifer
 - ▶ 3 detections - inconclusive
 - ▶ 5 detections appear to have hydrocarbon signature
 - ▶ Range: 84 µg/L – 1700 µg/L – Oil well under 1/2 mile away – No spills recorded
 - ▶ More sampling will be conducted to confirm DRO detection.



Preliminary Results

Gasoline Range Organics - GRO

- ▶ 129 wells sampled
- ▶ 4 wells had GRO Detections
- ▶ 3 of 21 aquifers had GRO Detections.
- ▶ GRO Concentrations ranged from 1.11 $\mu\text{g/L}$ – 41.6 $\mu\text{g/L}$
- ▶ Chromatogram Review:
 - ▶ All detections appear attributable to natural organic matter in aquifer





Preliminary Results

Volatile Organic Compounds - VOC

- ▶ 129 wells sampled
- ▶ 4 wells had VOC Detections
- ▶ Toluene (1 well) 298 $\mu\text{g}/\text{L}$ and 111 $\mu\text{g}/\text{L}$ – Resample
 - ▶ MCL - 1000 $\mu\text{g}/\text{L}$
- ▶ 2-butanone (MEK) (1 well) 104 $\mu\text{g}/\text{L}$ (R) 110 $\mu\text{g}/\text{L}$ (D)
- ▶ Acetone 38.2 $\mu\text{g}/\text{L}$ – 69.8 $\mu\text{g}/\text{L}$ – 2 wells



Preliminary Results

Semi-Volatile Organic Compounds

- ▶ 129 wells sampled
- ▶ 1 well had an SVOC detection
 - ▶ 4-Methylphenol – 62.3 $\mu\text{g/L}$ (R) and 24.6 $\mu\text{g/L}$ (D)
 - ▶ No MCL exists
 - ▶ Will Re-sample to verify detection



Preliminary Results

Bromide Analysis

- ▶ 98 wells had bromide detections
- ▶ Range: 0.050 mg/L – 2.68 mg/L
- ▶ Based on preliminary bromide analyses, according to the North Dakota Dept. of Health Spill Response program criteria, most bromide hits were below levels that would indicate an impact to the aquifers due to oil field activity.
 - ▶ The contamination potential for the single detection of 2.68 mg/L is undetermined at this time and should be sampled again to determine possible impacts.
 - ▶ More sampling is needed to determine representative conditions within the aquifers.



Preliminary Results

▶ ICP/Trace Metals

▶ Arsenic (MCL = 10 µg/L)

- ▶ 16 of 21 aquifers had at least one well with arsenic concentration over the MCL
- ▶ 68 of 129 wells had arsenic present at level greater than MCL
- ▶ Concentrations over MCL ranged from 10 to 379 µg/L

▶ Chromium (MCL = 100 µg/L)

- ▶ 2 wells had concentrations of chromium above MCL
- ▶ 112 µg/L and 2040 µg/L*

*Other Metals also elevated in this well (Lead, Nickel, Zinc) compared to other wells.

- ▶ Will Re-sample well to confirm previous result



Preliminary Results

▶ General Chemistry

▶ Based on preliminary data, the general chemistry within the study area has remained consistent, in all aquifers, with past sampling events done by the NDSWC.

▶ i.e. anions, cations, pH, conductivity, SAR, TDS, etc

▶ TDS - 122 of 129 wells exceeded the MCL (500 mg/L)

▶ Cl – 1 well exceeded the MCL (250 mg/L)

▶ Nitrates – 4 wells exceeded the MCL (10 mg/L)

▶ Pb – 22 of 129 wells exceeded the MCL (15 µg/L)

▶ Trends will be established with future sampling events.



Conclusions

- ▶ At this time, it does not appear that the aquifers sampled have been significantly impacted by oil development activities in Northwestern North Dakota.



Proposed Sampling Schedule

- ▶ 45 - 50 well rotation every Spring and Fall
- ▶ 1.5 year rotation
- ▶ Allows us to evaluate seasonal trends (Spring/Fall)
- ▶ 1st round: Fall 2013 – Spring 2015
- ▶ 2nd round: Fall 2015 – Spring 2017
- ▶ 3rd Round: Fall 2017 – Spring 2019



Moving Forward

- ▶ Continue Sampling Program
- ▶ Evaluate data and prepare report.
- ▶ Consider modifications to sampling program.
- ▶ Utilize Low-Flow sampling method
- ▶ Drop SVOC and VOC analyses and Add BTEX analyses.
- ▶ Program Modification
 - ▶ Add/delete wells and/or aquifers



Public Disclosure of Monitoring Data

- ▶ In 1991, the Legislature enacted a program to protect groundwater sources from contamination, but chose to protect landowners and operators by restricting the Department from disclosing the results of the monitoring.
- ▶ N.D.C.C. §23-33-08 provides that “The names and addresses of landowners and operators who participate in a monitoring program may not be linked, in any public disclosure, to the findings of the program unless it is determined by rule that a compelling public interest justified disclosure”.



Public Disclosure of Monitoring Data

- ▶ Without a determination of a compelling public interest, disclosing the information is a class C felony. The Department has not promulgated a rule under which a compelling public interest can be determined.
- ▶ Department is currently developing a policy that will allow the public disclosure of monitoring data in a manner that is consistent with N.D.C.C. §23-33-08.
 - ▶ i.e. Fictitious well names with no location data or all location data tied to the center of the aquifer.



QUESTIONS?

The world is a dangerous place, not because of those who do evil, but because of those who look on and do nothing.

- Albert Einstein



Thank You

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