# *Investigation of Sand Resources in North Dakota: Sedimentological Characterization of Surficial Sand Deposits for Potential Use as Proppant*

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*North Dakota Department of Mineral Resources*

*N.D. Oil & Gas Research Council Meeting*
*Tuesday, January 24, 2012*

*North Dakota Geological Survey*

# *Mission of the N.D.Geological Survey*

*The mission of the North Dakota Geological Survey is threefold:*

- ***Investigate*** and report on the geology of North Dakota, emphasizing the state's energy resources and stressing applied research leading to economic benefits or quality of life improvements for residents of the state;

- Provide ***Public Service***, and to collect, create, and disseminate geologic and map-related information, and:

- Administer ***Regulatory Programs*** and act in an advisory capacity to other state, federal, and local agencies.

# NDGS Geological Investigation Overview

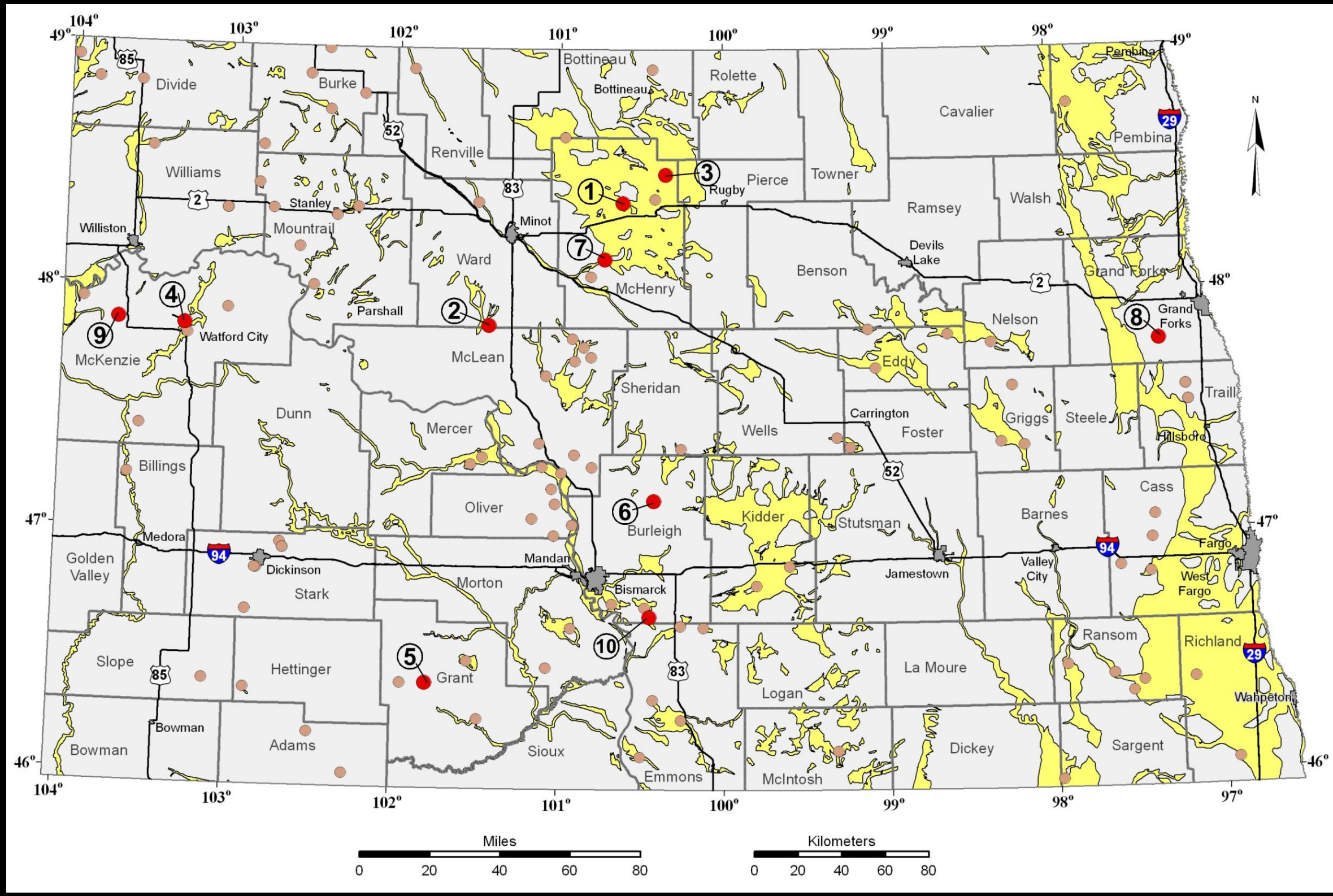
- ***Project Duration:  2009-2011 Biennium***
- ***Over 150+ Sand Samples Evaluated (Still Receiving Samples)***
- ***Samples Collected\Submitted from: Sand and Gravel Producers***

***Private Landowners***

***NDGS (Geologic Origin)***

- ***Analytical Services Provided by:  StimLab, Inc. (Core Labs) Duncan, OK - $23,600***

# *Locations of Samples Collected and Submitted*



# *Examples of Sands and Proppants*


*Eolian Sand from the Denbigh Dunes*


*Ottawa "White" Sands*

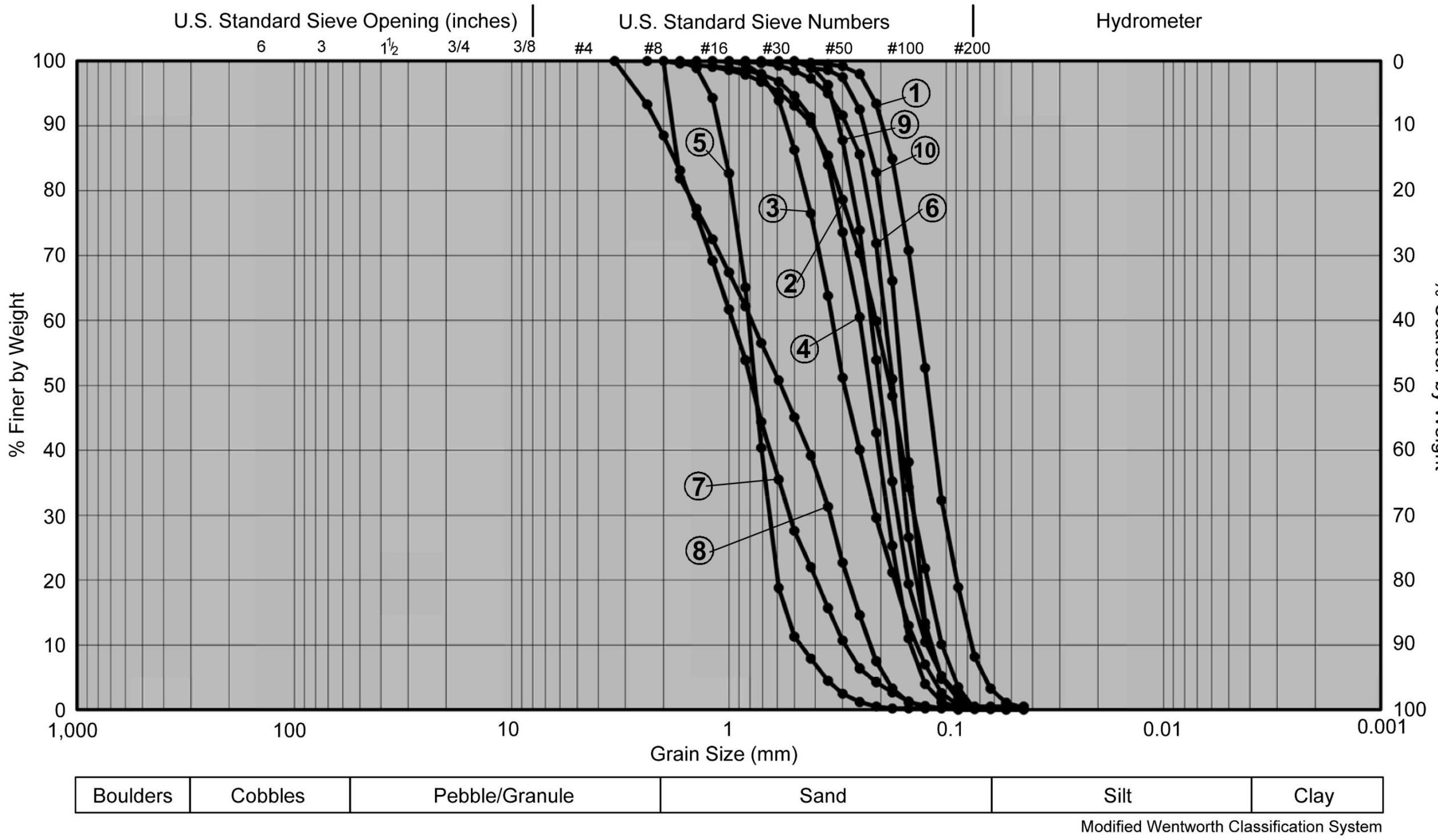

*Ceramic Proppant*

# Sand Testing and Characterization Performed

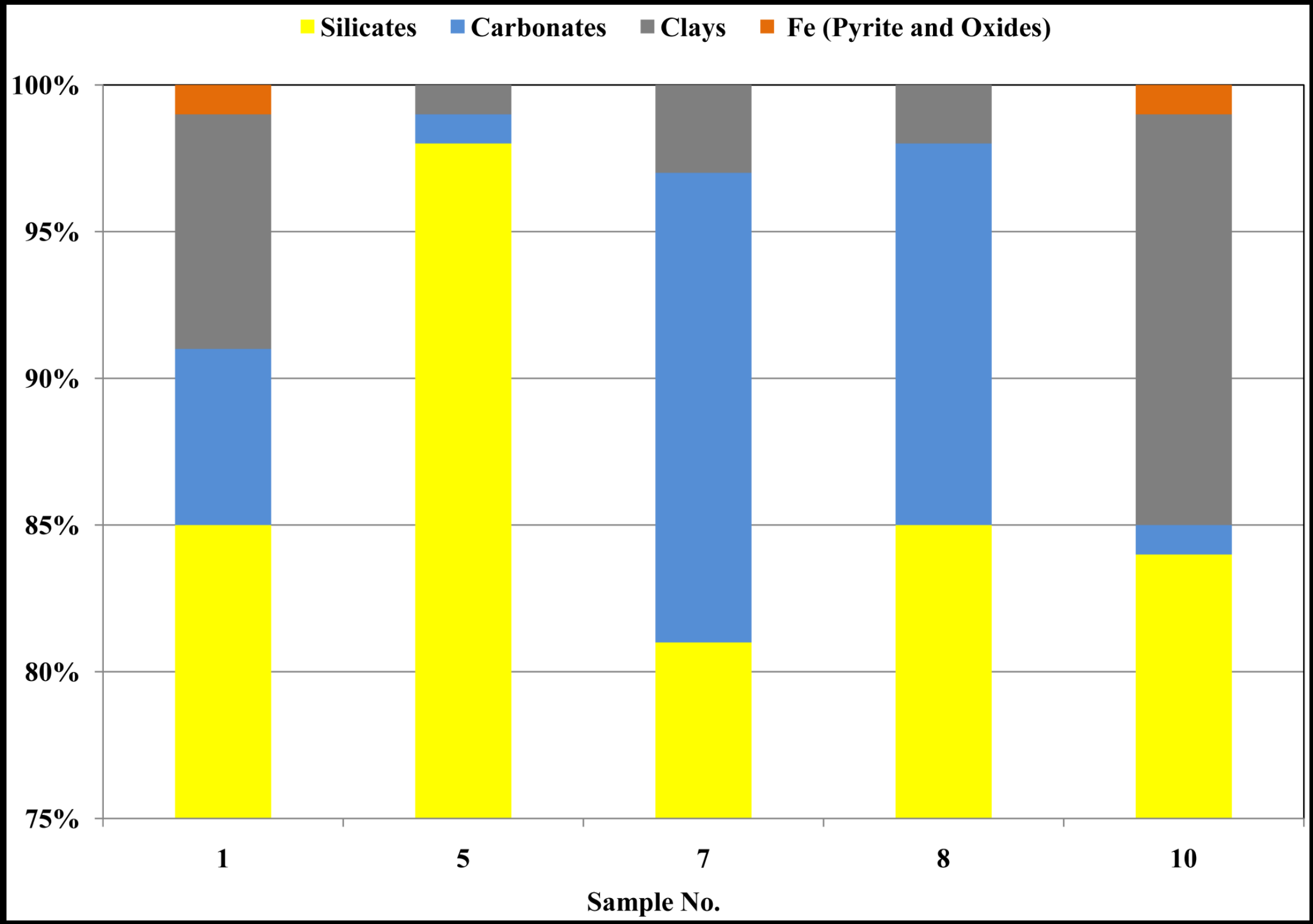
*(in accordance with ANSI/API/ISO specs)*

- Grain-Size Distributions (Bulk and Selected Size Cut)
- Mineralogy (XRD Analyses)
- Crush Resistance Testing
- Acid Solubilities
- Turbidity
- Particle Shape Factors (Sphericity & Roundness)
- % Clusters
- Specific Gravity
- Photomicrography

# *Grain-Size Distributions (Bulk Sample)*

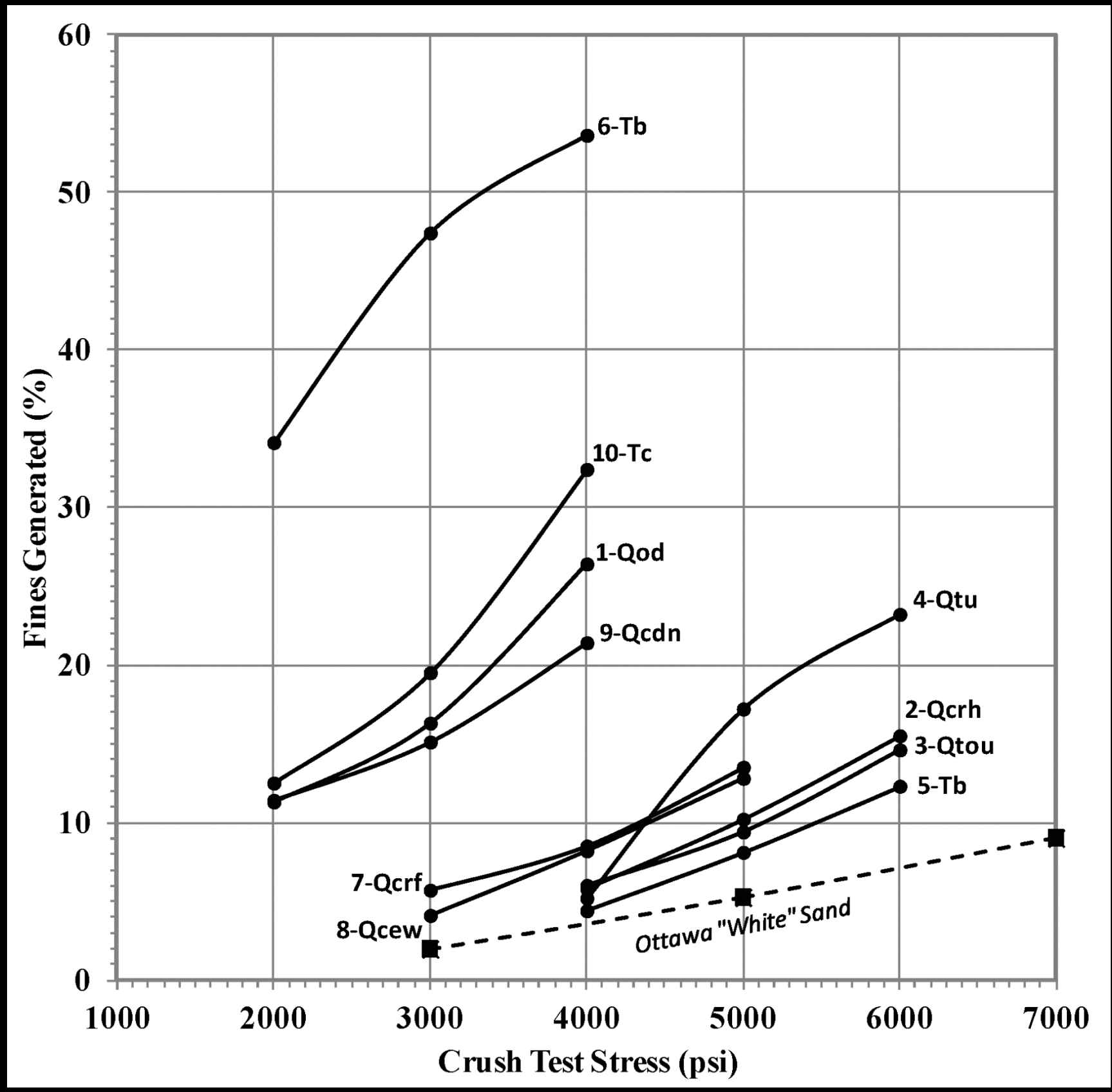


# *Mineralogy (Bulk XRD)*

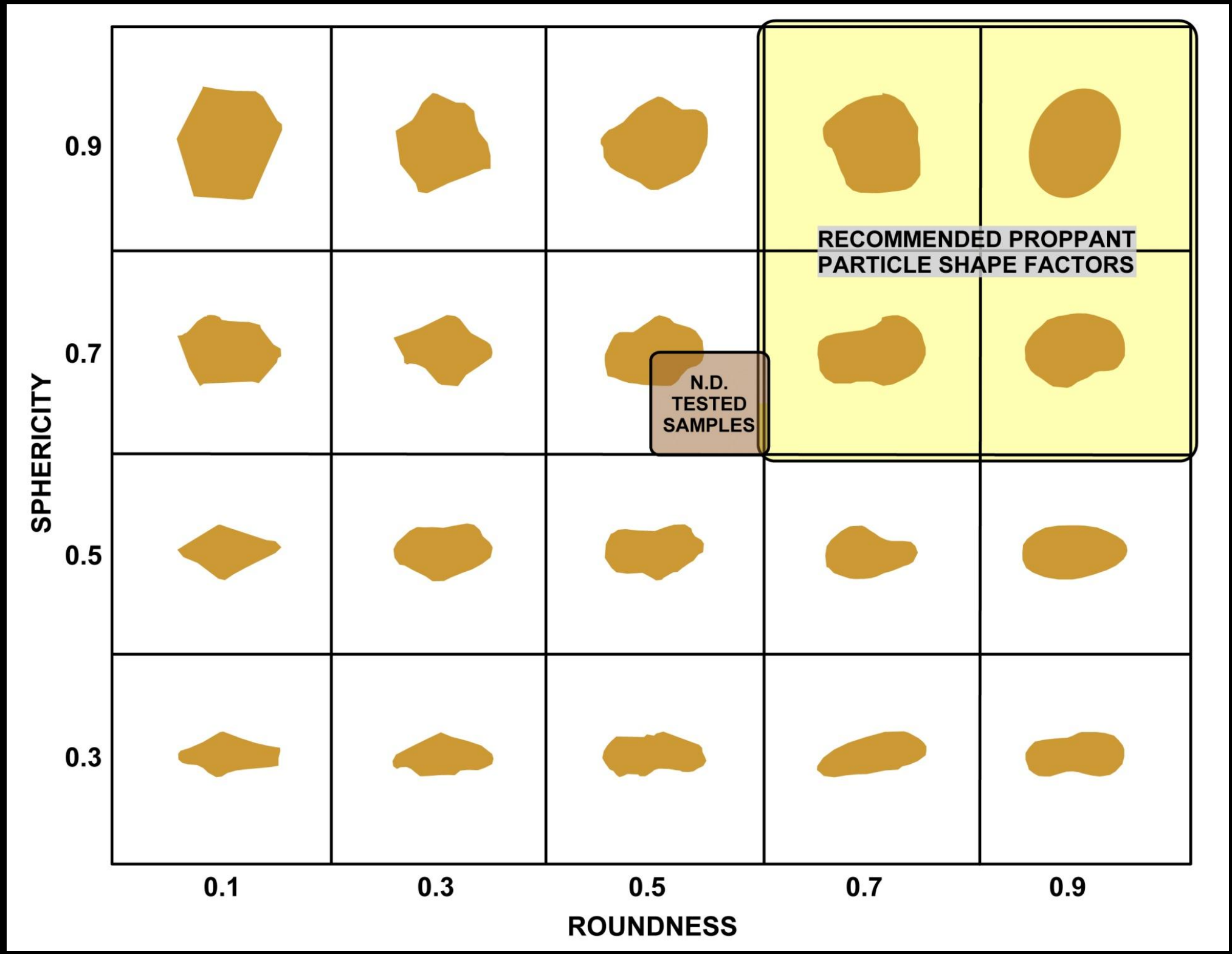


# *Crush Resistance Testing*

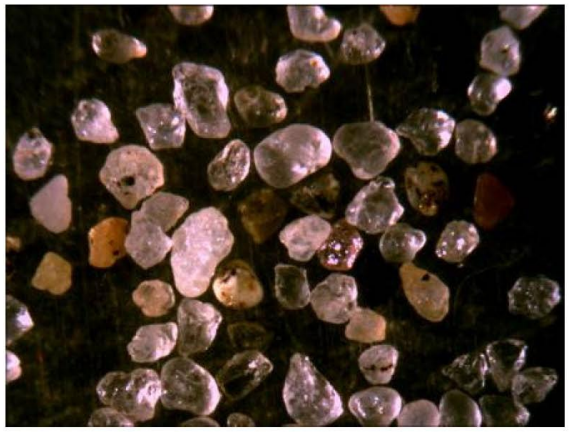
- *Around >9,500 psi common in the Bakken*
- *Ottawa "White" sand typically rated at 7,000 psi (7K Value)*



# Sand Grain Particle Shape Factors



Sample No. 1 Qod 40/70

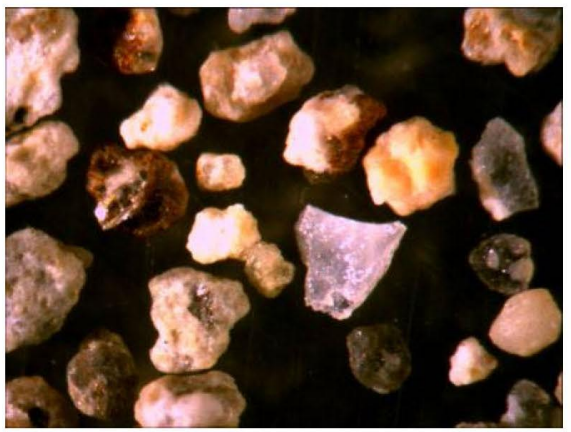


Sample No. 2 Qcrh 30/50

Sample No. 3 Qtou 30/50

Sample No. 4 Qtu 30/50

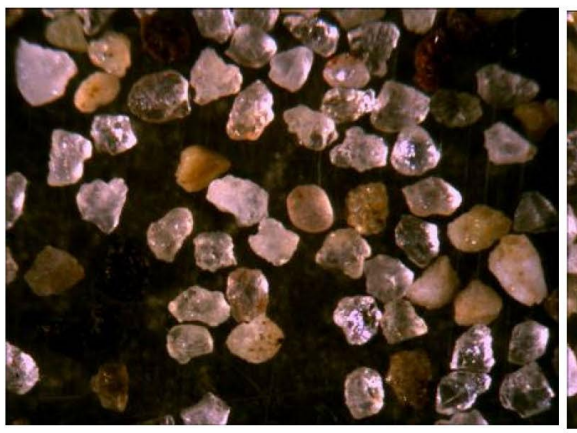
Sample No. 5 Tb 30/50



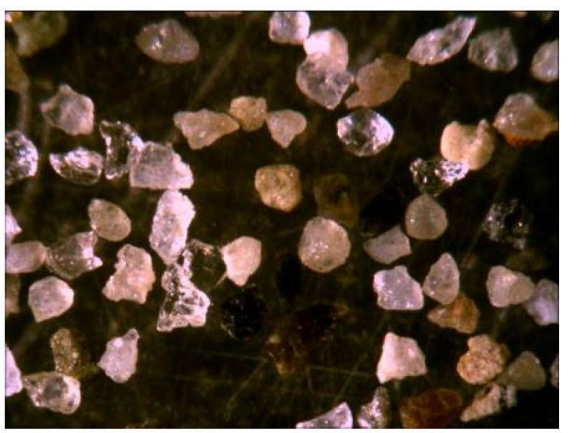
Sample No. 6 Tb 30/50

Sample No. 7 Qcrf 30/50

Sample No. 8 Qcew 30/50



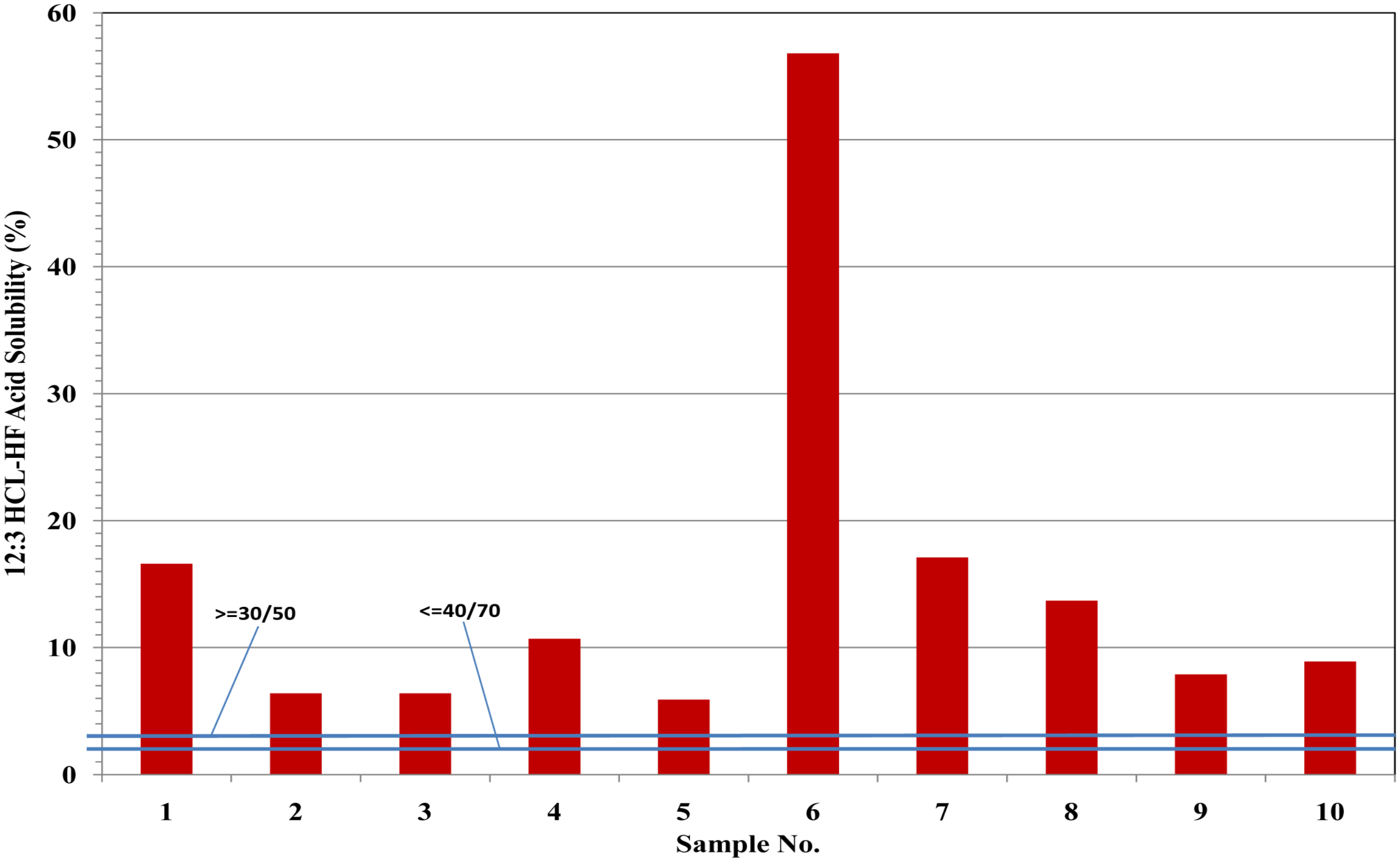
Sample No. 9 Qcdn 30/50



Sample No. 10 Tc 40/70

**Figure 24. Standard (40x) photomicrographs of individual selected sand samples in North Dakota tested for use as proppants for hydraulic fracturing of oil & gas wells.**

# *Acid Solubility Test Results*



# *Sand Testing and Characterization Results Summary*

| Sample No. | Tested Size Cut | Crush Resistance (K-Value) | Acid Solubility (%) | Sphericity | Roundness | ISO Mean Particle Dia. (mm) | Median Particle Dia. (mm) | Turbidity (FTU) | % Clusters | Bulk Density ($g/cm^3$) | Bulk Density (pcf) | Specific Gravity ($g/cm^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 40/70 | <2K | 16.6 | 0.6 | 0.5 | 0.239 | 0.236 | 85 | ~1/100 | 1.23 | 76.8 | 2.58 |
| 2 | 30/50 | 4K | 6.4 | 0.7 | 0.6 | 0.394 | 0.386 | 8 | NIFC | 1.44 | 89.9 | 2.63 |
| 3 | 30/50 | 5K | 6.4 | 0.6 | 0.5 | 0.428 | 0.418 | 18 | NIFC | 1.44 | 89.9 | 2.65 |
| 4 | 30/50 | 2K | 10.7 | 0.6 | 0.6 | 0.388 | 0.38 | 20 | NIFC | 1.33 | 83.0 | 2.63 |
| 5 | 30/50 | 5K | 5.9 | 0.6 | 0.6 | 0.465 | 0.455 | 16 | NIFC | 1.47 | 91.7 | 2.62 |
| 6 | 30/50 | <2K | 56.8 | 0.6 | 0.6 | 0.383 | 0.374 | 36 | ~1/100 | 1.07 | 66.8 | 2.68 |
| 7 | 30/50 | 4K | 17.1 | 0.6 | 0.6 | 0.443 | 0.433 | 25 | ~1/100 | 1.41 | 88.0 | 2.67 |
| 8 | 30/50 | 4K | 13.7 | 0.6 | 0.6 | 0.421 | 0.411 | 28 | ~1/100 | 1.41 | 88.0 | 2.64 |
| 9 | 30/50 | <2K | 7.9 | 0.6 | 0.5 | 0.367 | 0.362 | 10 | NIFC | 1.32 | 82.4 | 2.62 |
| 10 | 40/70 | <2K | 8.9 | 0.6 | 0.5 | 0.245 | 0.243 | 72 | NIFC | 1.21 | 75.5 | 2.61 |

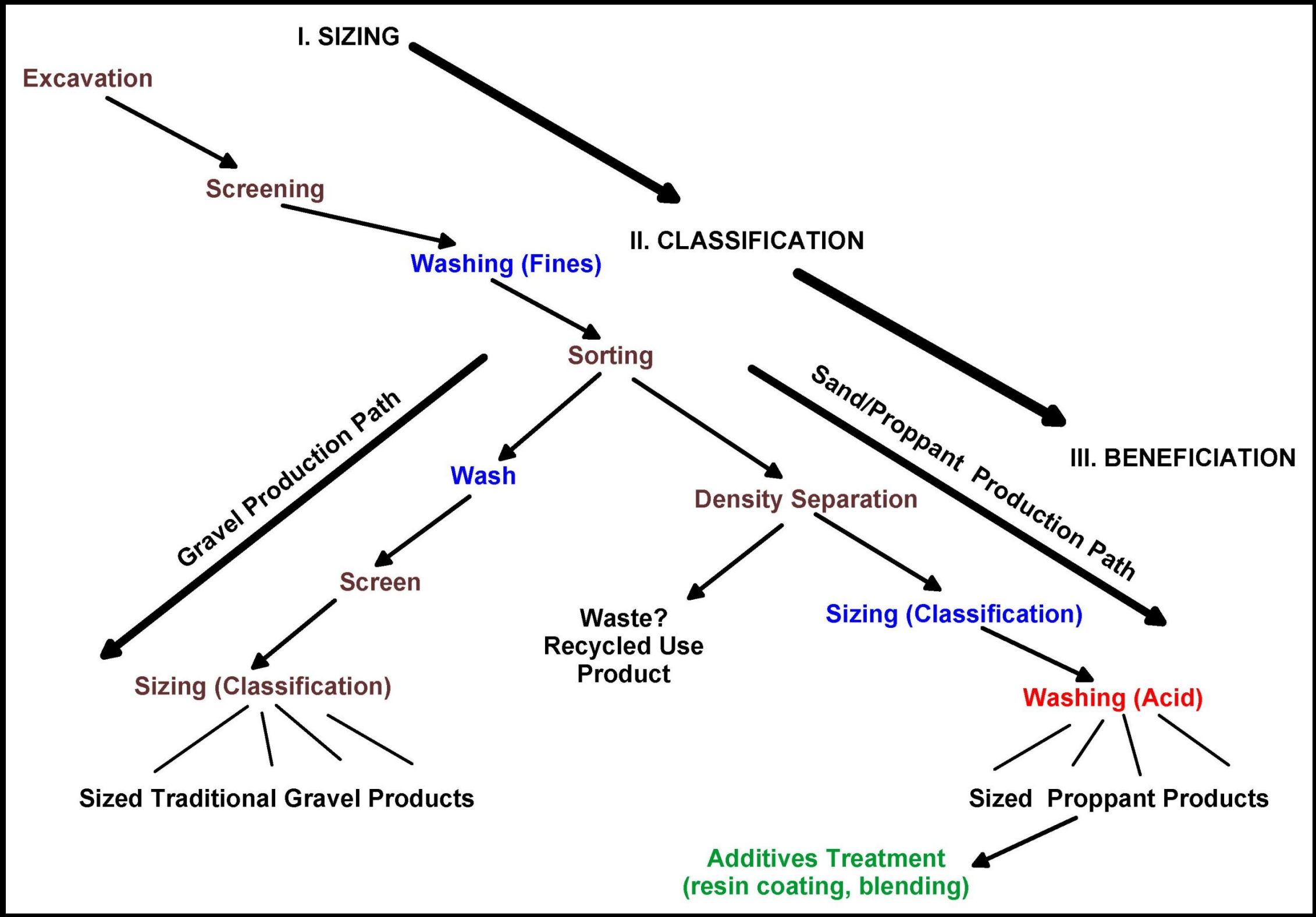
*K-Value is defined as the highest stress level which proppant generates no more than 10% crushed material, rounded down to the nearest 1,000 psi.*

*FTU = Formazin Turbidity Unit.*

*NIFC = No clusters observed in field of count.*

*pcf = pounds per cubic foot.*

# *Possible Proppant Sand Process Model*



# *Conclusions & Recommendations*

- Selected North Dakota sand deposits were sampled and tested for potential use as natural sand proppants in the hydraulic fracturing of oil and gas wells in the Williston Basin during the 2009 to 2011 biennium. Testing and sediment characterization indicate that North Dakota's sand resources are of a condition and quality that approach current industry standards, specifications, and recommendations for the use of natural sands as proppants.

- However, they are of a lesser overall quality in direct comparison with other domestic sand sources currently being utilized as proppant in the U.S., such as Ottawa "white" and Brady "brown" type sands.

- Significant processing and material refinement would likely be required to bring deposits of marginal quality up to applicable standards and specifications. Creativity in proppant design formulations and manufacture may render North Dakota's sand deposits viable.

- That may be made possible through the deposit refinement process during production, material enhancement (such as resin coating or blending with ceramic proppants), reduction in standards of quality and use based on overall sand resource availability, or enhancements in other areas of the hydraulic fracturing design formula.

- The information collected during this investigation will also find use in the continued characterization of North Dakota's sand (and gravel) resources for use in other industrial applications.

*(Anderson, 2011)*

# *N.D. Geological Survey Report of Investigation No. 110*

# *(RI-110)*

*https://www.dmr.nd.gov/ndgs/Publication_List/pdf/RI%20SERIES/RI-110.pdf*

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By

Fred J. Anderson


**REPORT OF INVESTIGATION NO. 110**
**NORTH DAKOTA GEOLOGICAL SURVEY**
**Edward C. Murphy, State Geologist**
**Lynn D. Helms, Director Dept. of Mineral Resources**
**2011**

# NORTH DAKOTA GEOLOGICAL SURVEY

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