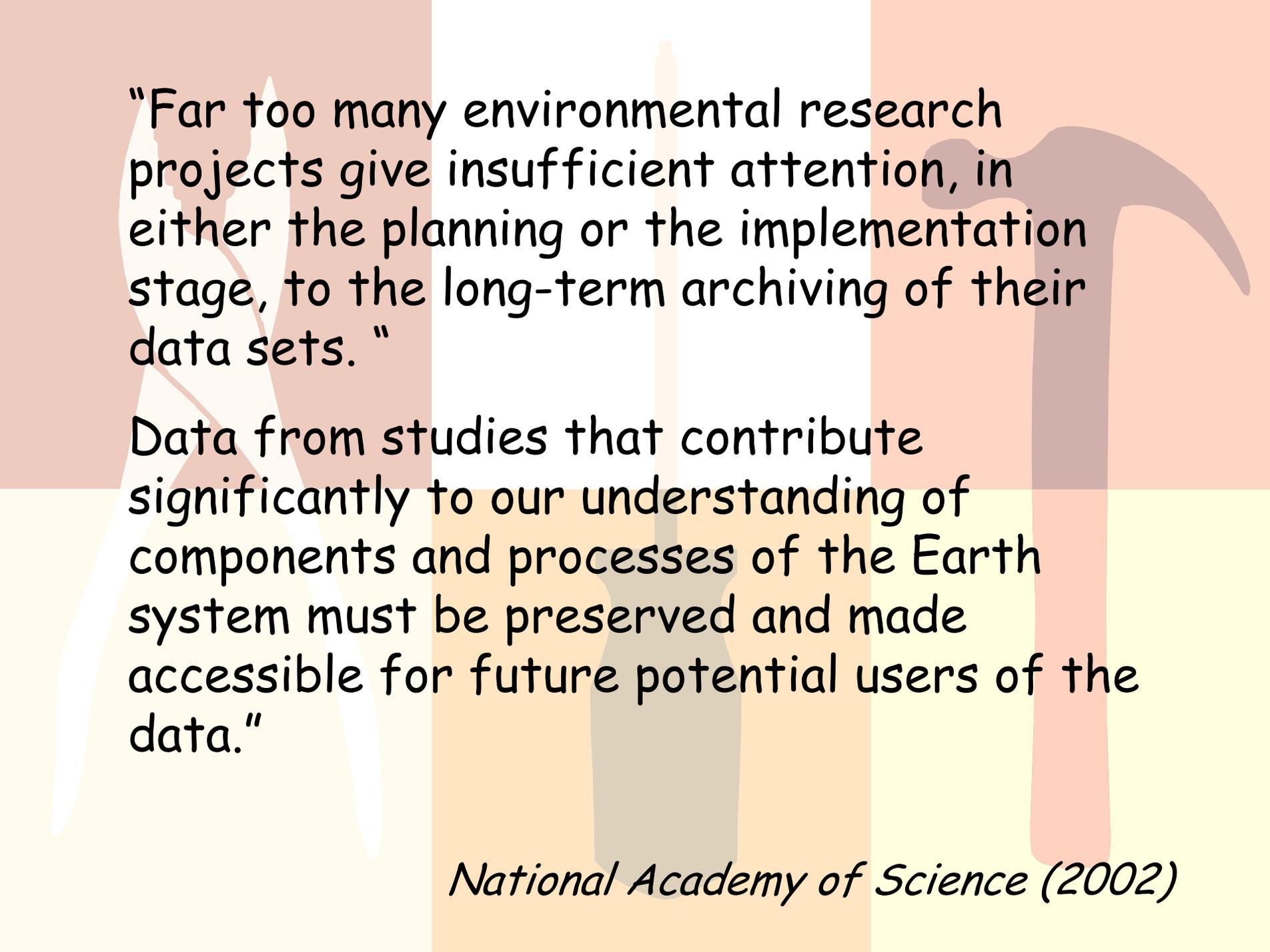


The background features three vertical stripes in shades of brown, white, and light orange. On the left, a white silhouette of a pair of pliers is visible. In the center, a grey silhouette of a pencil is positioned vertically. On the right, a brown silhouette of a hammer is shown. The text is centered over these elements.

Building Monitoring Designs Using the Water Quality Data Elements

The background features a stylized illustration of a person in a white lab coat on the left and a hammer on the right, set against a background of vertical stripes in shades of orange, red, and white.

“Far too many environmental research projects give insufficient attention, in either the planning or the implementation stage, to the long-term archiving of their data sets.”

Data from studies that contribute significantly to our understanding of components and processes of the Earth system must be preserved and made accessible for future potential users of the data.”

National Academy of Science (2002)

Monitoring Components

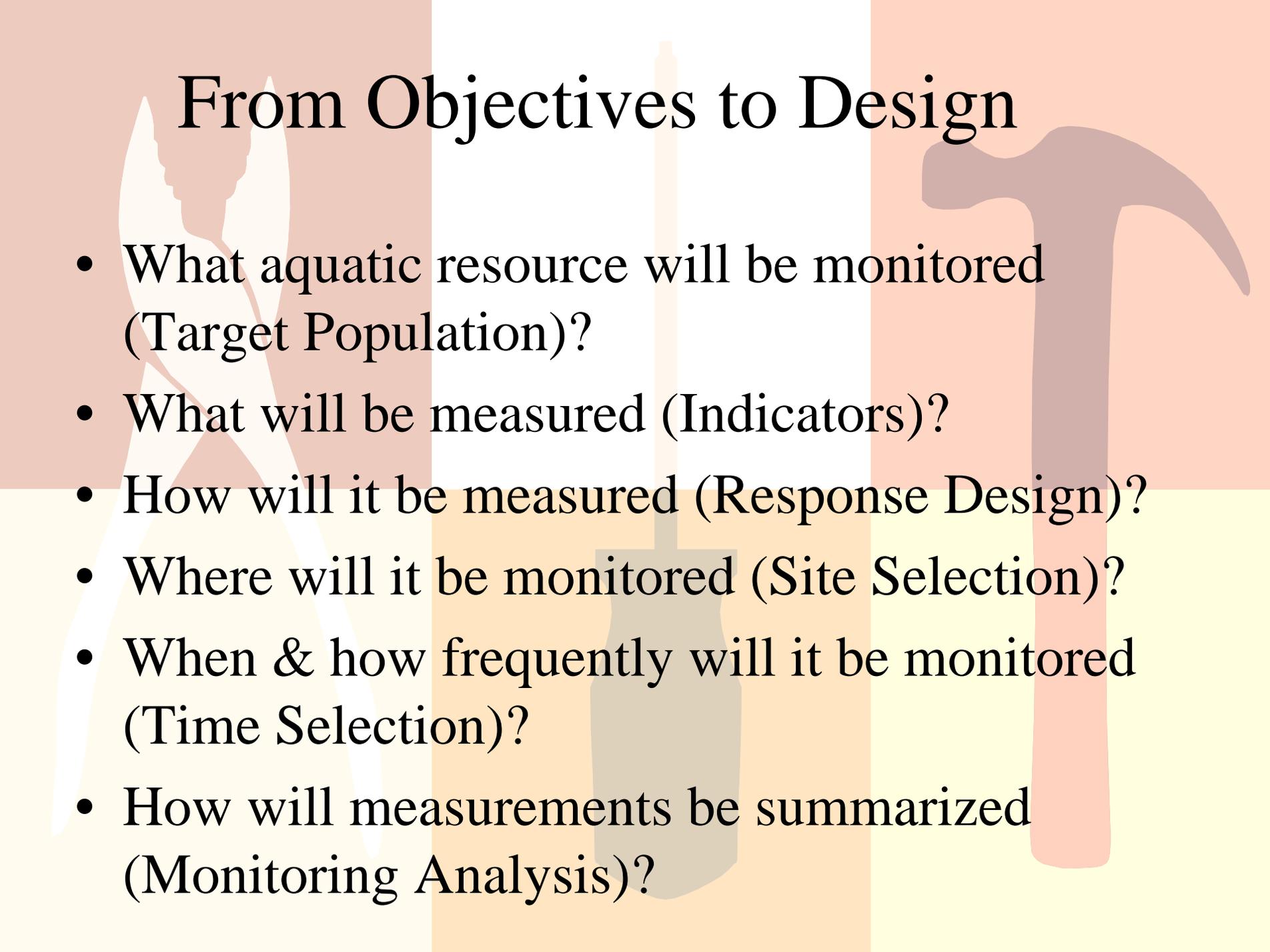
National Wadeable Streams Assessment

- **Monitoring objectives**
- **Institutional constraints**
- **Target population**
- **Sample frame**
- **Indicators and response design**
- **Design requirements**
- **Specification of survey design**
- **Site selection**
- **Site evaluation**
- **Conduct field and lab measurements**
- **Indicator results database**
- **Sample frame summary**
- **Adjust survey weights based on implementation**
- **Target population estimation**
- **Report results**

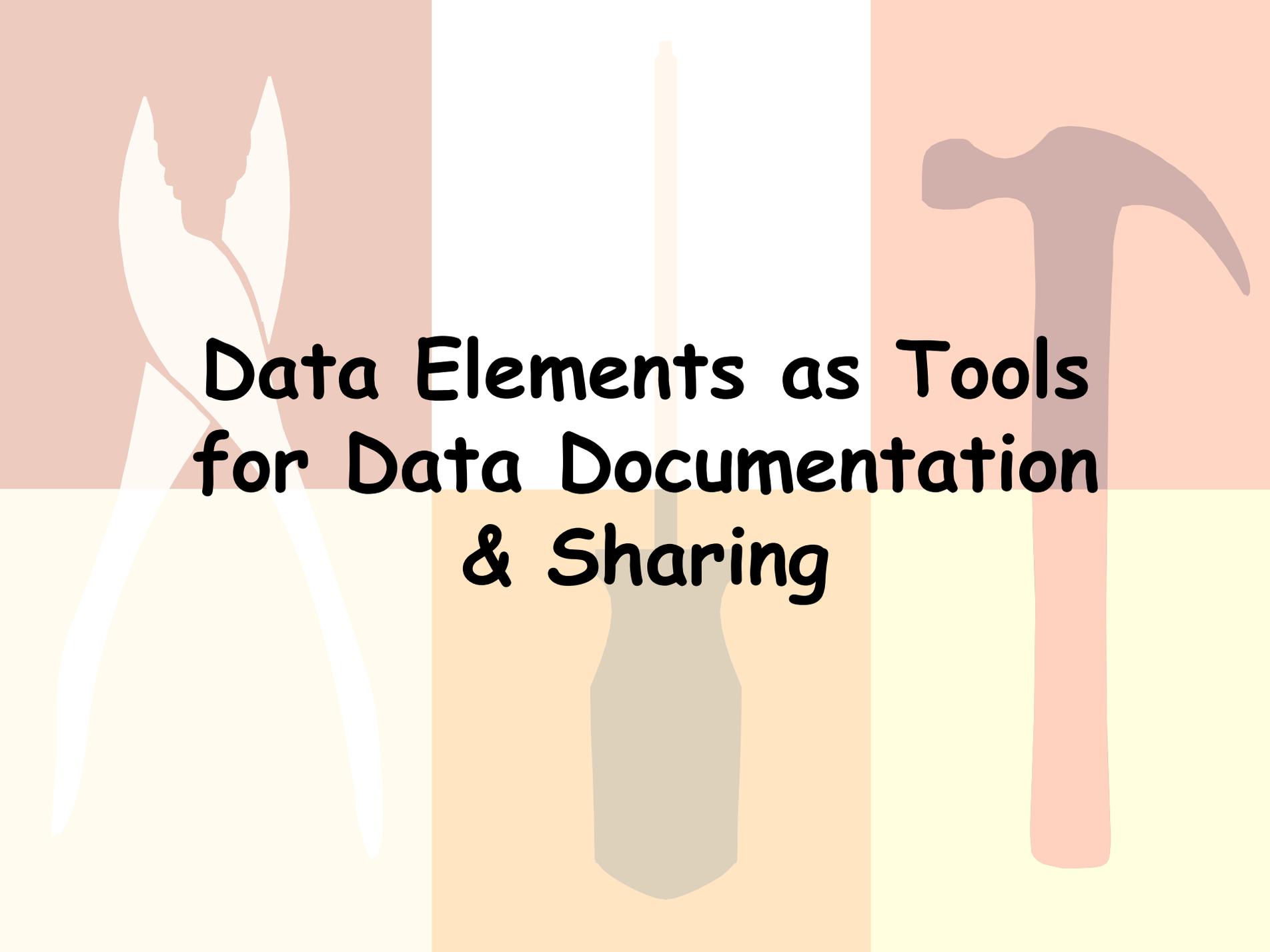
From Questions to Objectives

- What is the overall quality of waters in the state?
- What is the overall quality of streams with flowing water during summer in the state?
- What is the biological quality of streams with flowing water during summer in the state?
- How many km of streams with flowing water during the summer are impaired, non-impaired, and marginally-impaired within the state?
 - How is impairment determined?
 - What is meant by summer?
 - Are constructed channels, canals, effluent-dominated streams included?

From Objectives to Design

The background features several faint, stylized icons: a hammer on the right side, a pencil in the center, and a ruler on the left side. The background is composed of vertical stripes in shades of orange, red, and white.

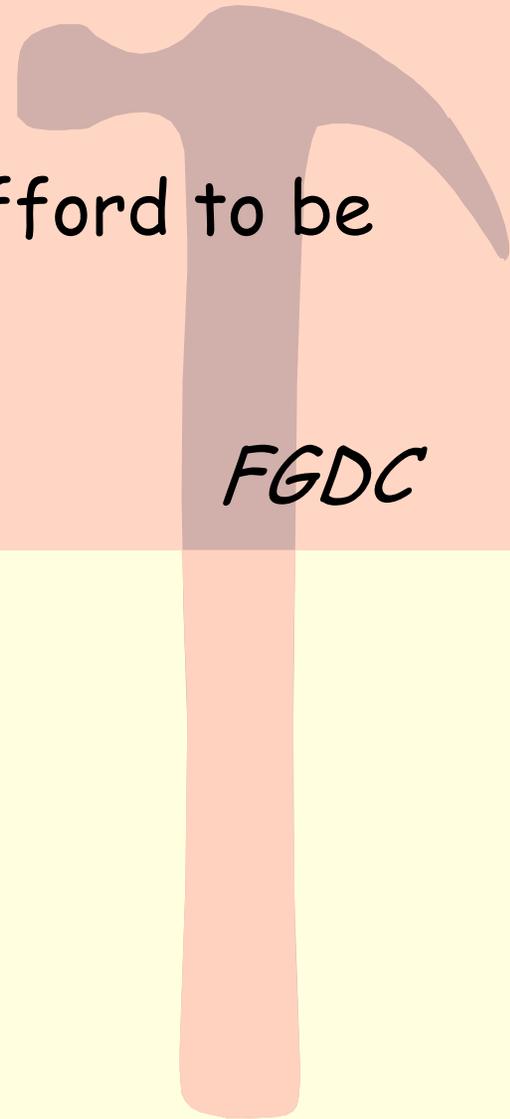
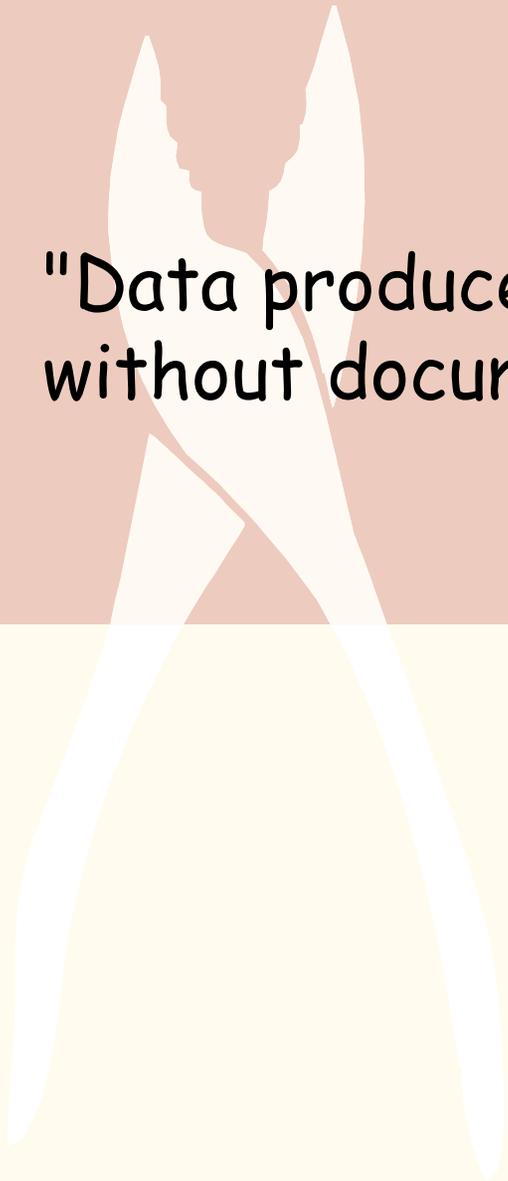
- What aquatic resource will be monitored (Target Population)?
- What will be measured (Indicators)?
- How will it be measured (Response Design)?
- Where will it be monitored (Site Selection)?
- When & how frequently will it be monitored (Time Selection)?
- How will measurements be summarized (Monitoring Analysis)?

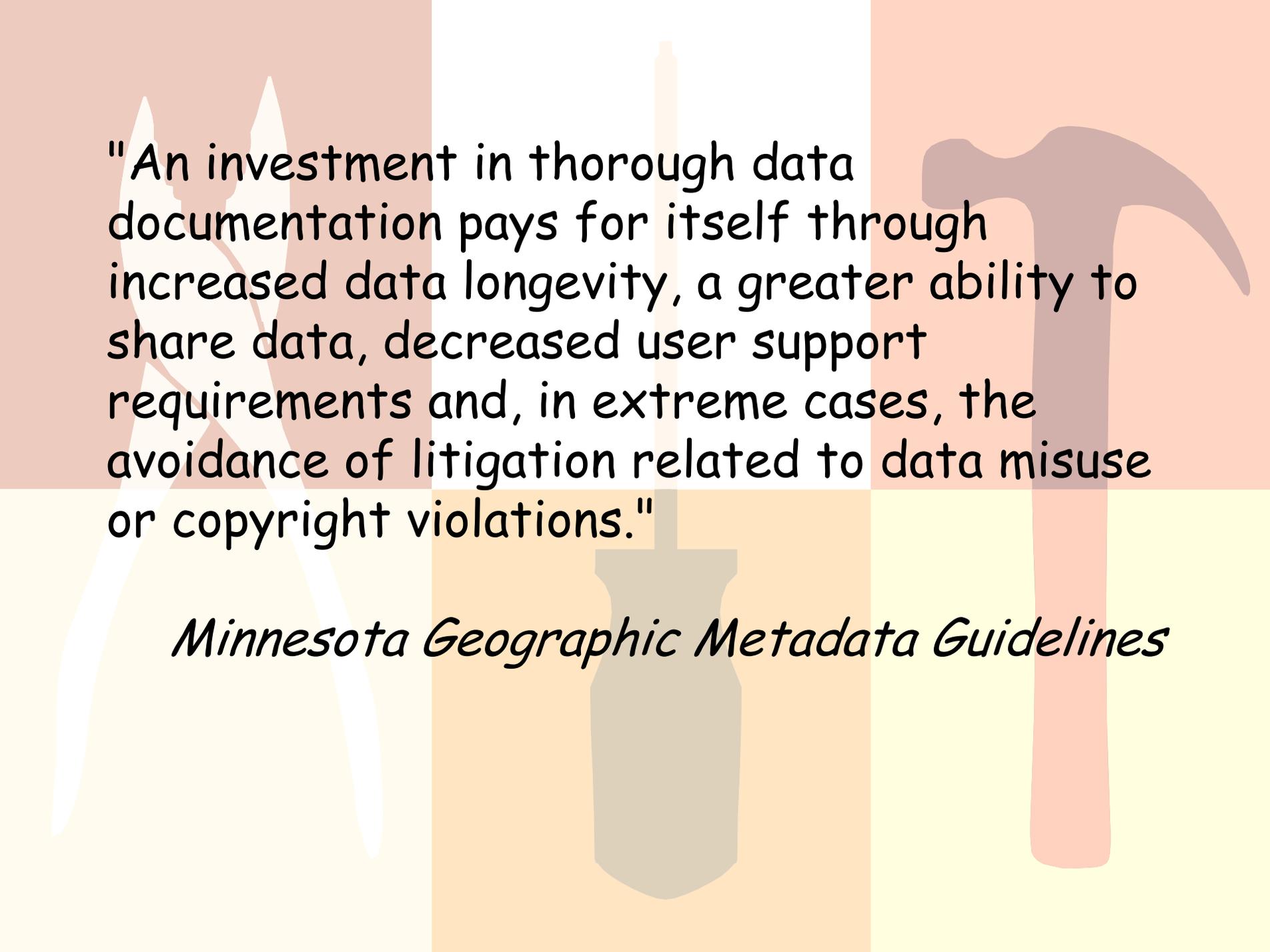
The background features three vertical stripes of different colors: a dark brown stripe on the left, a white stripe in the center, and a light orange stripe on the right. Overlaid on these stripes are three large, semi-transparent silhouettes of tools: a pair of scissors on the left, a pencil in the center, and a hammer on the right. The text is centered over the white stripe.

Data Elements as Tools for Data Documentation & Sharing

"Data producers and users cannot afford to be without documented data."

FGDC



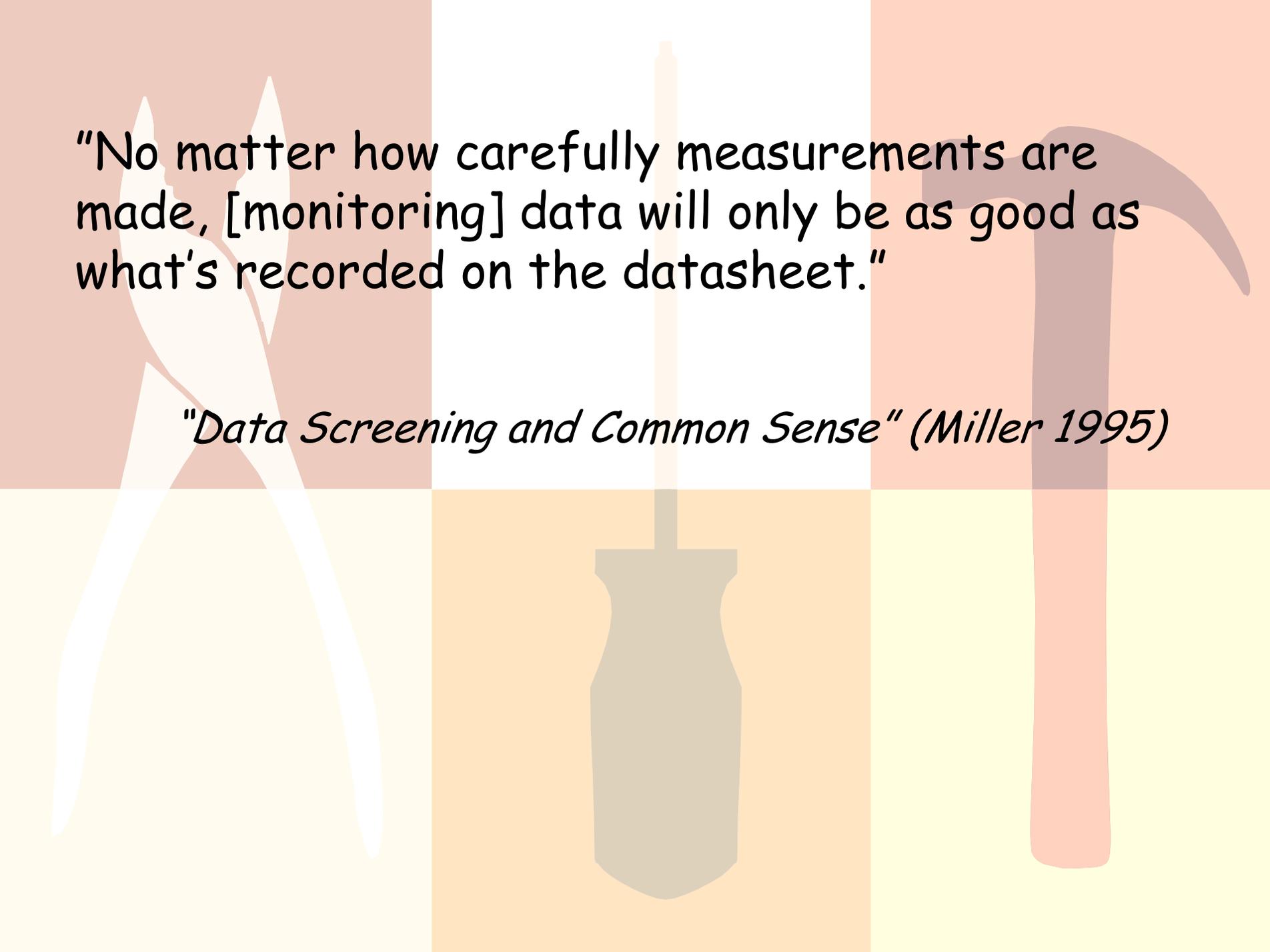
The background features three vertical stripes in shades of brown, orange, and yellow. Overlaid on these stripes are faint, semi-transparent silhouettes of tools: a white pickaxe on the left, a grey wrench in the center, and a brown hammer on the right.

"An investment in thorough data documentation pays for itself through increased data longevity, a greater ability to share data, decreased user support requirements and, in extreme cases, the avoidance of litigation related to data misuse or copyright violations."

Minnesota Geographic Metadata Guidelines

The background features three vertical stripes in shades of brown, orange, and yellow. Overlaid on these stripes are three large, semi-transparent silhouettes of tools: a pair of pliers on the left, a screwdriver in the center, and a hammer on the right.

Real-World Tools for Implementing Water Quality Data Elements

The background features three vertical stripes in shades of brown, white, and orange. Overlaid on these stripes are faint, semi-transparent silhouettes of tools: a pair of pliers on the left, a screwdriver in the center, and a hammer on the right.

"No matter how carefully measurements are made, [monitoring] data will only be as good as what's recorded on the datasheet."

"Data Screening and Common Sense" (Miller 1995)