

**IMPORTANCE OF GEOLOGIC
CHARACTERIZATION FOR LEVEE
FOUNDATION AND BORROW MATERIALS AS
STUDIED AT THE INDIAN GRAVES LEVEE
DISTRICT, ADAMS COUNTY, IL**

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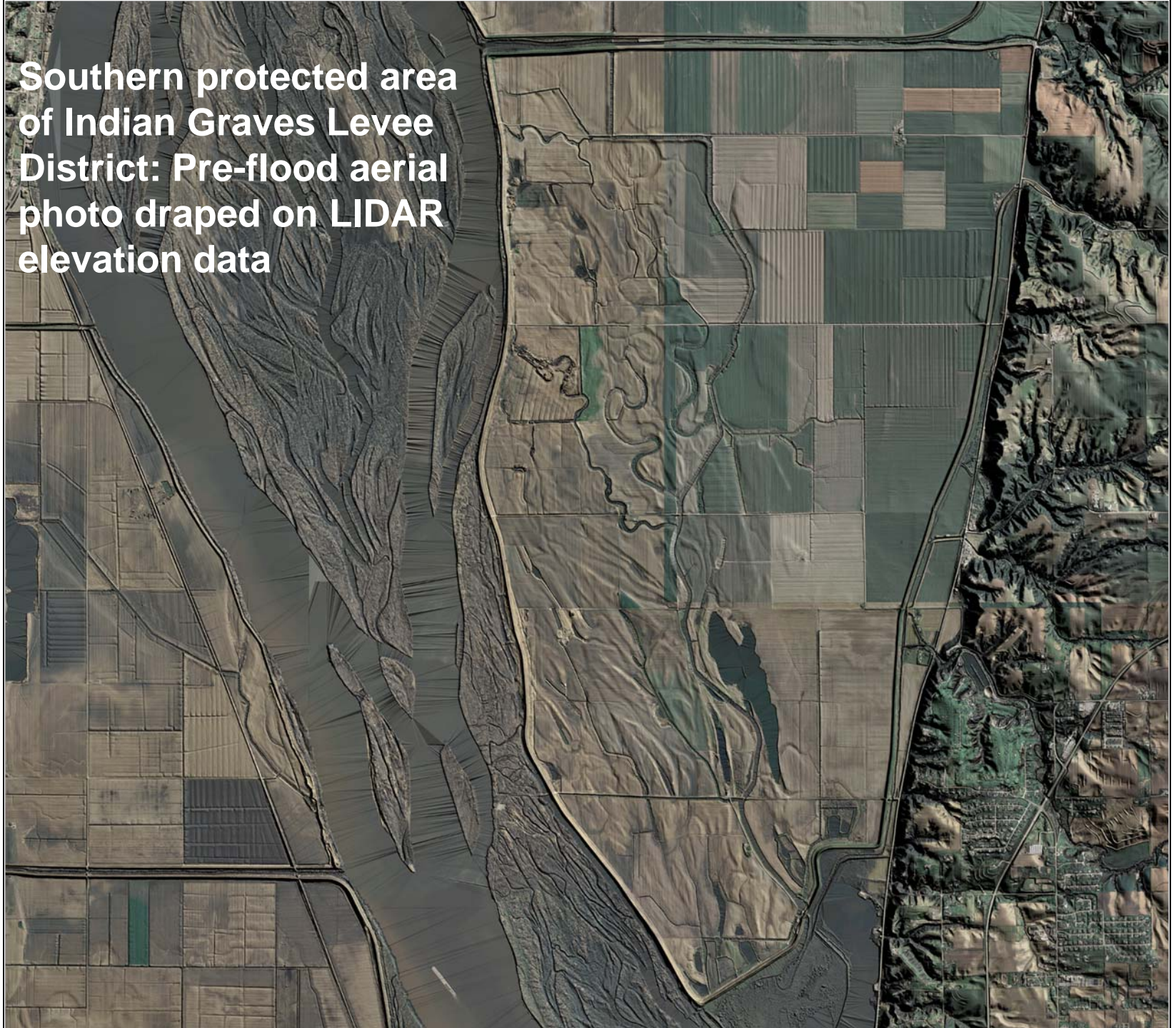
General Overview

- NSF funded Midwest Levee Investigation studied breached levees in Missouri, Illinois, and Iowa after record or near record 2008 summer flooding
- Although other sites were visited throughout 3 states, the Indian Grave Levee District exhibited conditions common through much of the study area and most attention was focused on this site.



- **Location: Adams County, IL north of Quincy in the Mississippi River Floodplain**
- **In Corps of Engineers Rock Island District**
- **Original levee dates back to 1879**
- **Comprised of clay/silt cored levee heightened with Mississippi River dredge sands in the late 1960's, forming the outer shells**
- **~18 feet tall and rated to withstand 50-year flood event**
- **Non-federal agricultural levee**
- **Southern protected area of levee dist. experienced a breach during June, 2008 flood event**

**Southern protected area
of Indian Graves Levee
District: Pre-flood aerial
photo draped on LIDAR
elevation data**



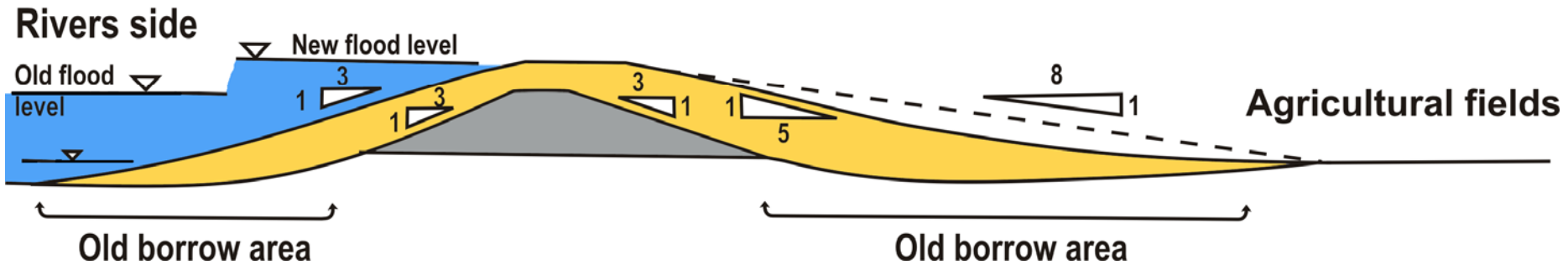
Past History

- **Numerous breaks have occurred throughout the history of the levee district**
- **Repeat breaks and excessive seepage common at sites of prior breaches**
- **2008 break occurred at same location or immediately adjacent to the site of a breach in the 1880's – excessive seepage was noted at site prior to 2008 break**
- **Another location failed in both 1965 and 1993 – this site experienced high rates of seepage but didn't fail in 2008**

Borrow Materials

- **Borrow materials are commonly from local sources. In the case of the Indian Graves Levee District, these are mainly Mississippi River dredge sands/gravels, a byproduct of navigation channel maintenance**
- **The core of the levee is comprised of silt/clays but heightening and repairs since the 1960's have exclusively used permeable dredge sands**

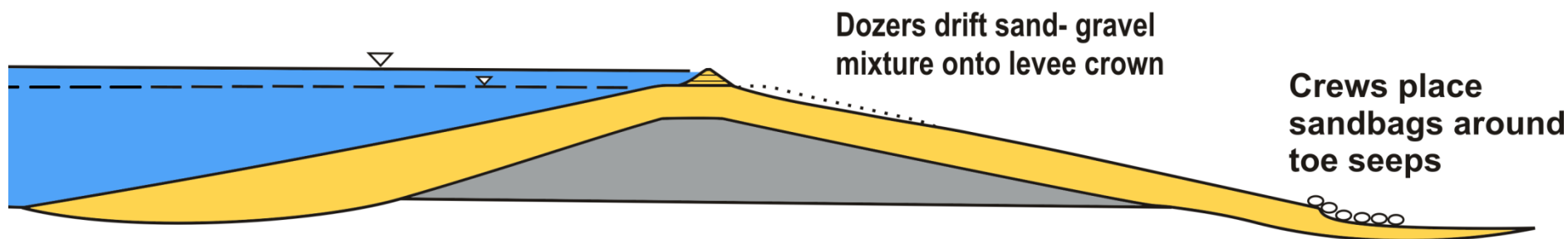
Typical Clay Core Sand Shell Levee



- **Clay core sand shell levees experience a notable increase in through seepage once flood level exceeds level of old buried clay/silt core**

“Push-Ups”: The Last Resort

Increased Flood Storage Using “Push-Ups”



- Technique known as a “push-up” is used to increase the flood capacity of sand shell levees
- This involves using a dozer, tractor, or other equipment to push sand/gravel material onto the levee crown, allowing for ~3-5 extra feet of storage when flood forecasts call for a flood exceeding the height of the levee
- The “push-up” is subsequently covered in plastic sheeting to prevent erosion and through seepage
- Seepage rates are quite high at this point, forming numerous toe-seeps, which must be managed with plastic mesh, sandbags, etc. at the base of the levee

Clay core



Clay core remnant

Clay core



Main 2008 break was over 1000 ft. wide and the resulting scour hole ~35 ft. deep



One of the levee Commissioner's farm was just behind the 2008 break, resulting in loss of farm structures, much of the land being scoured, and sand being deposited on much of the remaining land.





A secondary break resulted when water exited through the southern (downstream) end of the levee district. This location had breached in the past and was repaired with only sand as seen in the exposed levee cross section.



Example “push-up” (plastic sheeting has disintegrated in the sunlight)

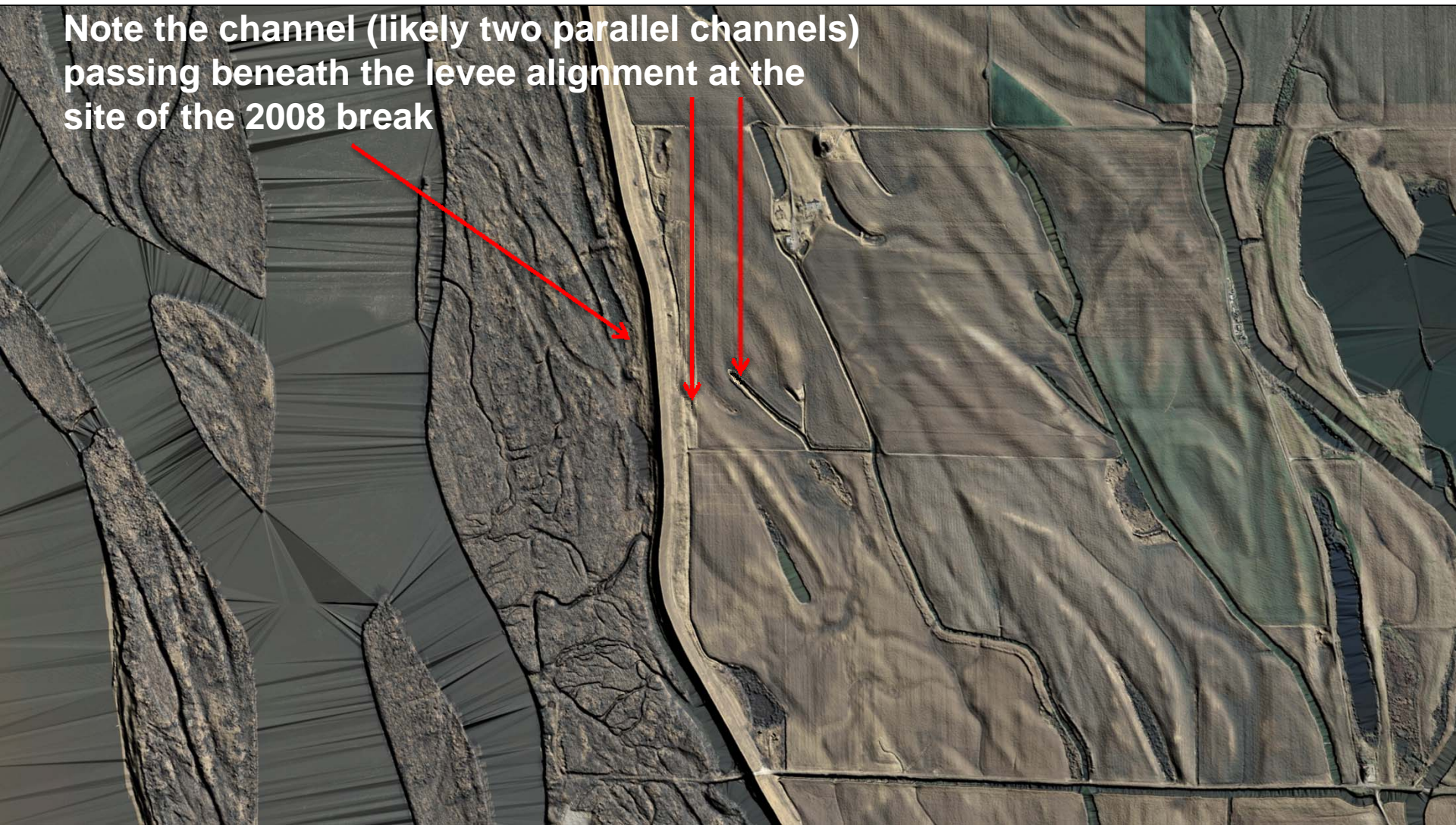
Foundation Conditions

- **Reviews of USDA soil surveys and aerial photography/elevation data reveal that levee breaks at Indian Grave and other levee districts commonly occur where old channels cross beneath the levee alignment**
- **A prominent channel appears to cross beneath the site of the 1965 and 1993 breaks while at least one, likely two, smaller channels pass beneath the site of the 2008 break**



Note the prominent channel passing beneath the levee alignment at the site of the 1965 and 1993 breaks

Note the channel (likely two parallel channels) passing beneath the levee alignment at the site of the 2008 break



Importance of Channels

- **These filled channels likely contain sand and other materials more pervious than the surrounding overbank silts and clays**
- **This leads to more pronounced underseepage in sites where filled channels pass beneath levees due to these preferential seepage paths**
- **Unfortunately the materials were blown out of the scour holes during the failures, precluding material recovery for sampling and testing**

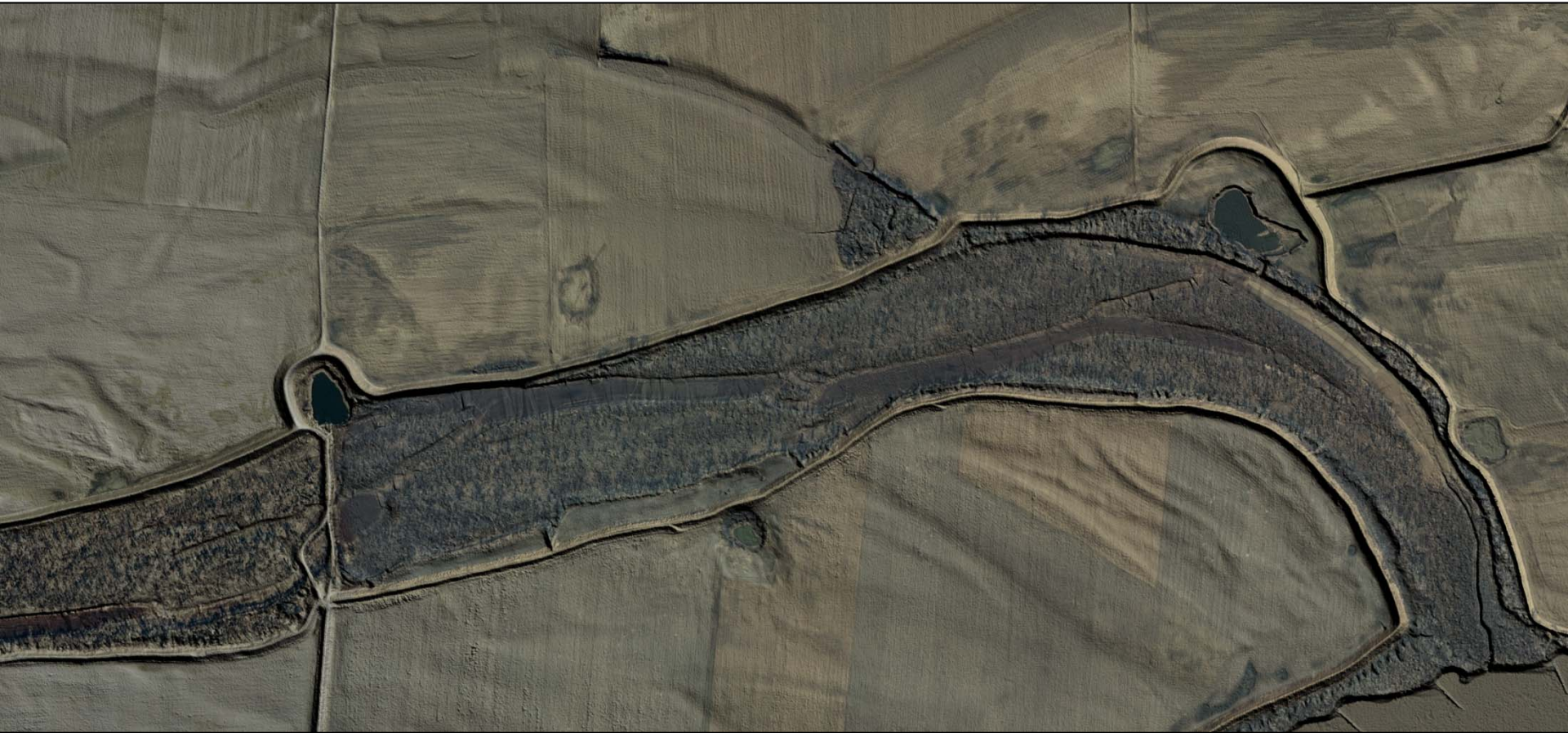
Importance of Repair Method

- **Water-filled scour holes at the Indian Grave Levee District, among others, have been filled with dredge sands from the Mississippi River channel**
- **The repaired levee cross section is constructed entirely of sand and the pre-existing clay core is not replaced**
- **This type of repair leaves the levee just as likely to fail as prior to failure, as shown by the repeated failures**
- **Some levee repairs have been performed by constructing “ring levees”, which curve around the old scour hole, forming a semi-circle in the levee alignment while avoiding scour hole repair to avoid the necessity of filling in these holes in the wet**



Previously repaired section of Indian Grave Levee that experienced a repeat failure in 2008; note that clay core had not been replaced at this location

“Ring Levees”



Example of repairs conducted using “ring levees” at the Consolidated North County and Kuhs Point Levee Districts along the Missouri River in St. Charles County, MO

“Ring levees” along the eastern side (Mississippi River) of the Kuhs Point Levee



Third Time's The Charm?



Levee showing at least two generations of repairs using “ring levees” at the Consolidated North County Levee District in St. Charles County, MO on the Missouri River – Note that the third levee constructed has a much wider cross section than the previous two attempts

Conclusions

- **Levees are constructed of locally sourced materials to reduce costs, although these materials are not always the best suited for levee construction**
- **Old channels running under levee alignments are not usually accounted for in levee design and construction; levees tend to use a “one size fits all” approach, often ignoring the underlying geology**
- **Levee construction should account for the geology of both the foundation and the borrow materials; agricultural levees are non-engineered**
- **For example, wider cross sections or uplift relief wells could be used where old channels pass beneath levees, or where past breaches have been repaired, using dredge sand. This would lengthen seepage paths and improve levee reliability**

INDIAN GRAVE

DRAINAGE



DISTRICT

••• **QUINCY, IL** •••