Sediment Traps

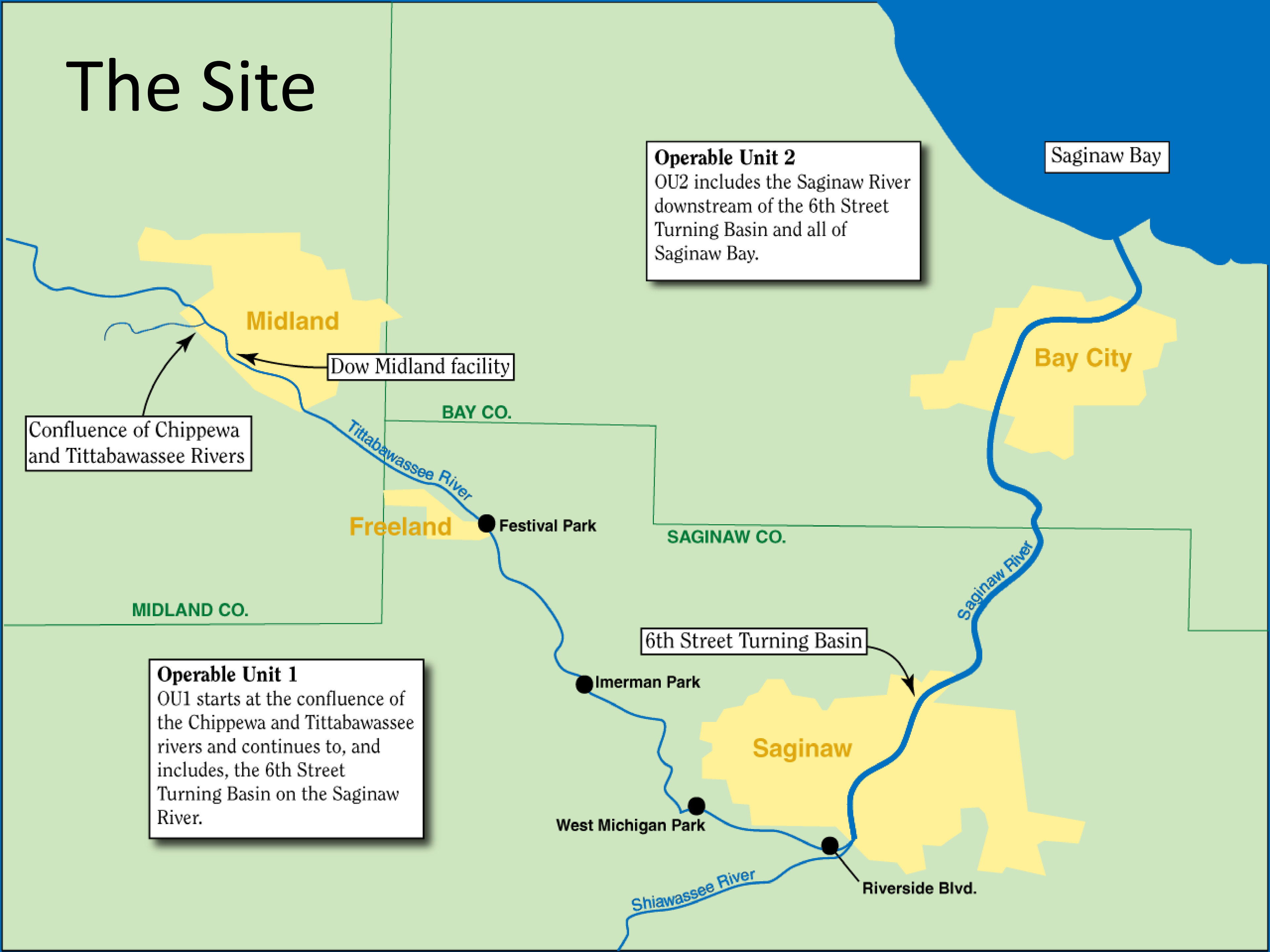
CAG Meeting

May 21, 2012

Agenda

- Background
- Fundamentals of Sediment Transport
- Sediment Trap
- Existing Information
- Next Steps

The Site



Operable Unit 2
OU2 includes the Saginaw River downstream of the 6th Street Turning Basin and all of Saginaw Bay.
Saginaw Bay
Midland
Dow Midland facility
Confluence of Chippewa and Tittabawassee Rivers
Bay City
BAY CO.
Tittabawassee River
Freeland
Festival Park
SAGINAW CO.
Saginaw River
MIDLAND CO.
6th Street Turning Basin
Operable Unit 1
OU1 starts at the confluence of the Chippewa and Tittabawassee rivers and continues to, and includes, the 6th Street Turning Basin on the Saginaw River.
Imerman Park
Saginaw
West Michigan Park
Riverside Blvd.
Shiawassee River

Saginaw River

- 22 mile river beginning at confluence of Tittabawassee and Shiawassee Rivers
- Drains large watershed
- River serves industries in Saginaw and Bay City
- U.S. Army Corps of Engineers (USACE) conducts maintenance dredging in the lower ~17 miles of the river
  - From 6th Street Turning Basin (SSTB) into Saginaw Bay
- Saginaw River and Bay are a Great Lakes Area of Concern

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Sediment

- Inorganic sediment is weathered rock material
  - Sediment is transported, suspended, and deposited with the flow of water
  - Sediment mixes with organic material during transport
- Sediment particle sizes vary
  - Clay < Silt < Sand < Gravel
  - Tittabawassee River is dominated by sand
  - Saginaw River is dominated by silt and clay
  - Deposited sediment in Saginaw River is mostly sand and silt

Transport Fundamentals

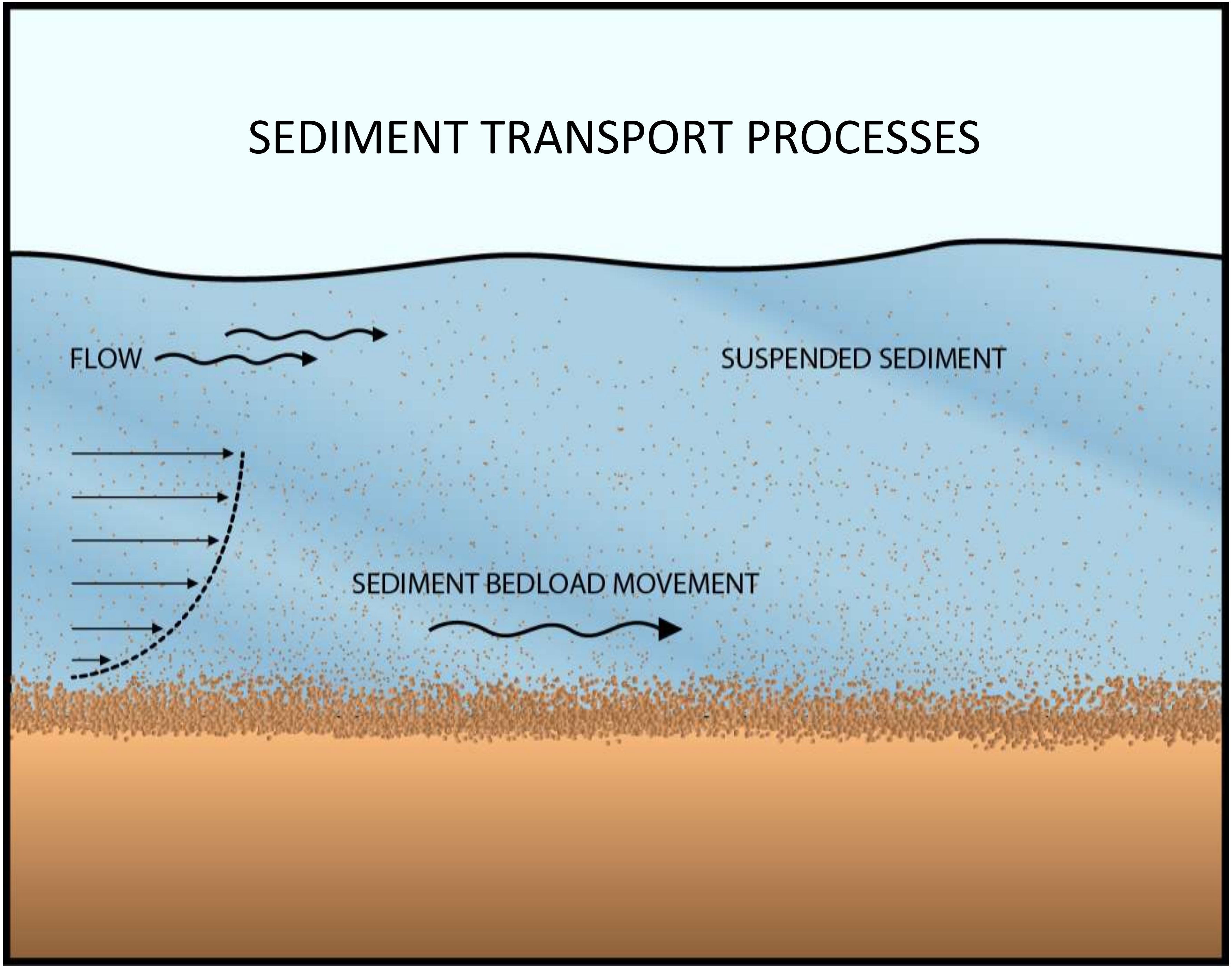
- In rivers, flowing water is the primary driver of sediment transport
  - Flow rates in rivers are variable
  - As the water flow increases and decreases, water velocity increases and decreases
  - As water velocity changes, so does sediment transport
  - A decrease in water velocity results in a decrease in sediment transport, and particles deposit on the sediment bed
- Surface particles in most sediment beds are subject to some degree of movement

Transport Fundamentals (cont.)

- Larger heavier particles
  - Require more sheer stress (energy) to transport
  - Are first to deposit when velocities decrease
- Smaller, lighter particles (clays and fine silts)
  - Can suspend in water for a long time
  - Require more time and slower velocities to settle from the water

Transport Fundamentals – What Makes Sediment Particles Move

- Water flow/velocity results in energy /shear stress that move sediment particles
- Bed shear stress
  - Describes the hydrodynamic force acting on the sediment bed
  - Bed sediments are transported when the bed shear stress is high enough (greater than critical shear stress)
- Changes in velocity and bed shear stress changes the rate of transport
  - As the river widens or becomes deeper the velocity and bed shear stress reduces


SEDIMENT TRANSPORT PROCESSES
FLOW
SUSPENDED SEDIMENT
SEDIMENT BEDLOAD MOVEMENT

Transport Fundamentals – What Makes Sediment Particles Deposit

- The opposite of what makes sediment particles move makes them deposit in the river
- The ability to effectively capture sediment is influenced by
  - Hydrodynamic conditions (flow rates)
  - Type of sediment particles (gravel, sand, silt, clay)
- Sediments deposit when the kinetic energy (sheer stress) of the water column is reduced
- Making the river wider and/or deeper reduces kinetic energy in the water column
  - Creates a net-depositional area

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What is a sediment trap?

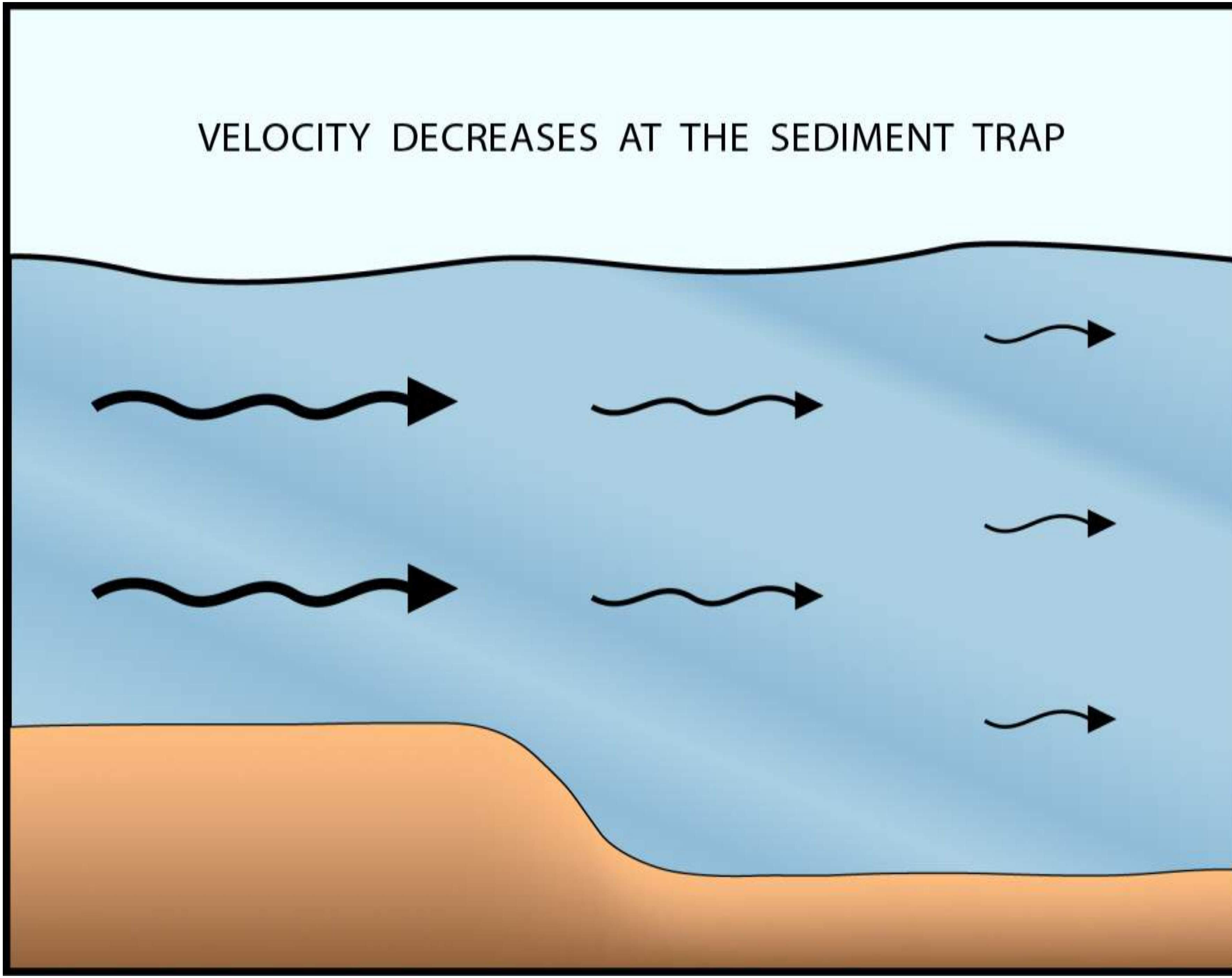
- An area in the river designed to catch and hold sediment transported from upstream
- Effective sediment traps
  - Allow for collection of sediment at a single location
  - Can reduce downstream maintenance dredging requirements in navigation channels

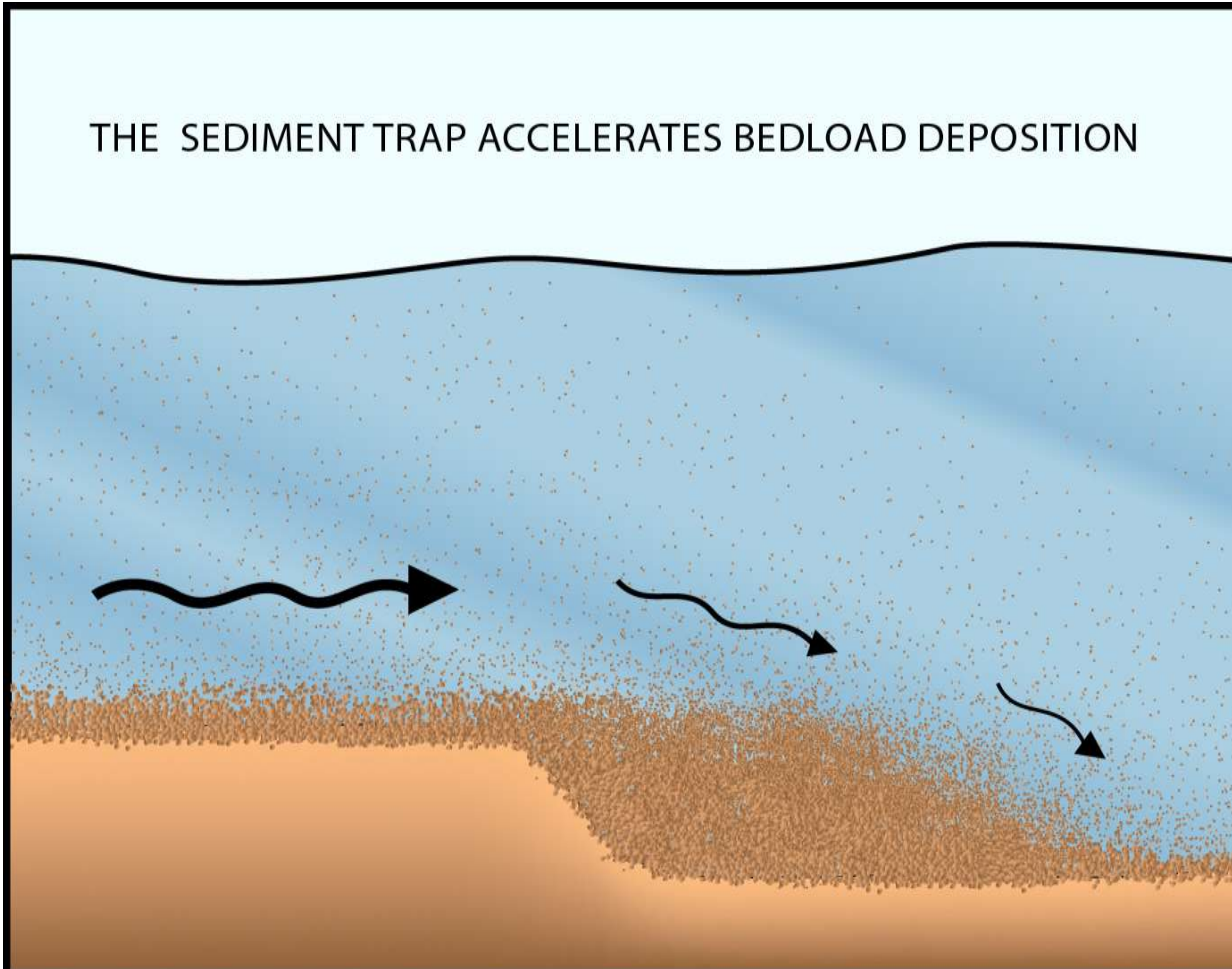
How does a sediment trap work?

- Making the river wider or deeper
  - Reduces water velocity, thus reducing energy

    Velocity = Flow / Area

    $V\ (m/s) = Q\ (m^3/s) / A\ (m^2)$
  - Allowing particle deposition
- In an effective sediment trap
  - Moving particles can deposit
  - Deposited sediment is difficult to transport


VELOCITY DECREASES AT THE SEDIMENT TRAP


THE SEDIMENT TRAP ACCELERATES BEDLOAD DEPOSITION

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Previous Sediment Trap Studies

- Sediment Trap Assessment, Saginaw River, Michigan, December 2001, USACE/Baird & Associates
- Sediment Trap Pilot Project Feasibility Study for the Saginaw River, Michigan, July 2008, prepared for ADR Technical Workgroup
- Sediment Trap Assessment, Saginaw River, Michigan, February 2012, USACE & Baird/URS

Findings from Sediment Trap Studies

USACE / Baird & Associates (2001)

- Looked at potential traps in the navigation area of the middle and lower Saginaw River
- Depending on the configuration, a Saginaw River sediment trap is expected to collect a large amount of the incoming suspended sand, and some of the incoming suspended silt
- Increasing the trap depth and length will improve the trap efficiency for both sand and silt

Findings from Sediment Trap Studies (cont.)

Sediment Trap Pilot Project Feasibility Study (2008)

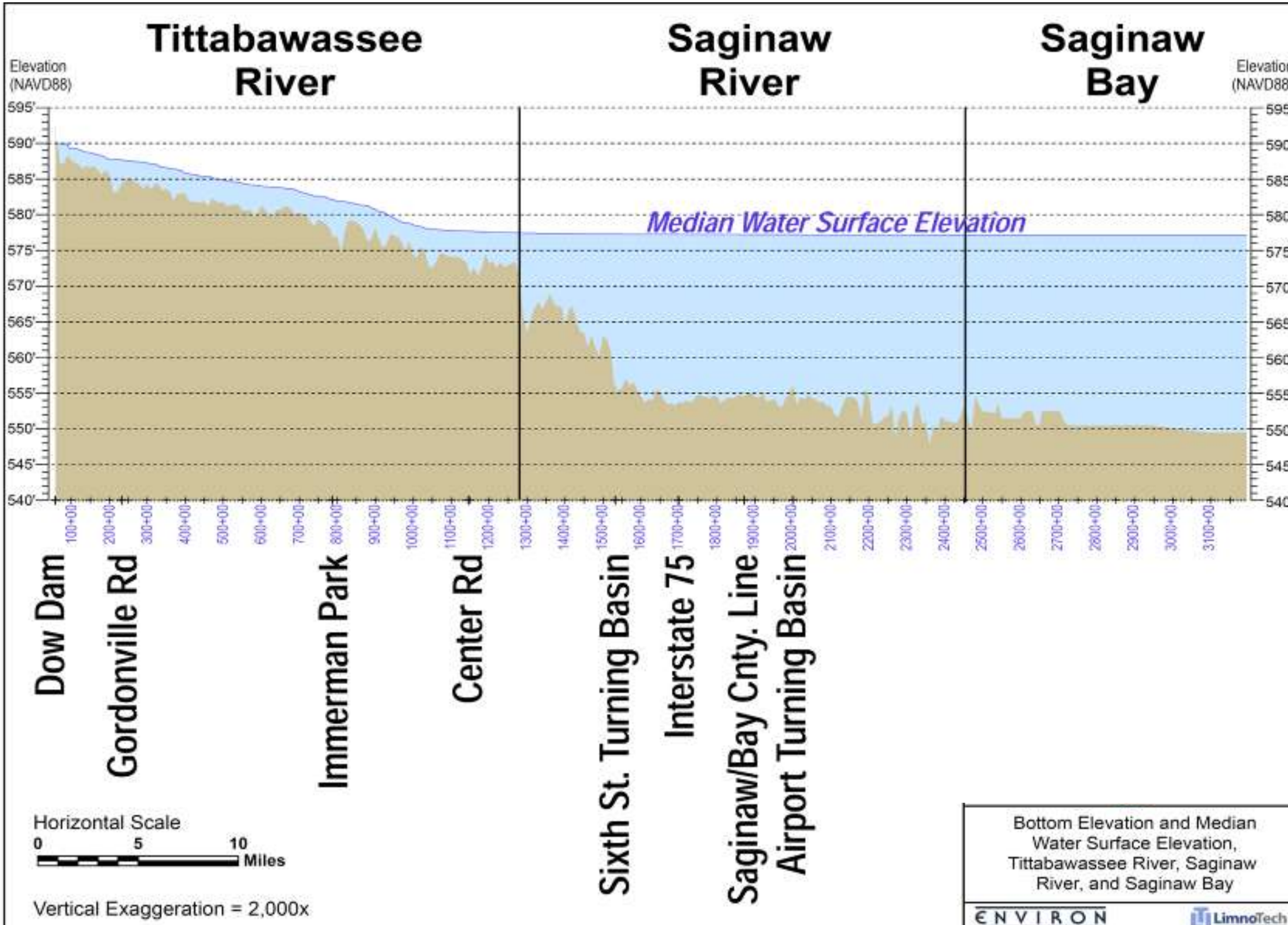
- The SSTB effectively traps bedload material that is transported into the basin across a range of flow conditions
  - Due to its larger grain size and its proximity to the sediment bed, a small reduction in velocity accelerates bedload deposition
  - Most of the site-related dioxins are associated with bedload and larger grain size sediment
- The SSTB has some potential to trap suspended sediment (fine silts and clays), but at a lower capture efficiency compared to bedload

Findings from Sediment Trap Studies (cont.)

USACE / Baird/URS (2012)

- Looked at potential traps in the upper Saginaw River to prevent transport of material into the navigation area and to reduce dredging costs
- Sediment traps can efficiently capture sand, but most clay and fine silt will pass into the Bay
- Increased trap depth increases trapping efficiency and lengthens time needed between maintenance

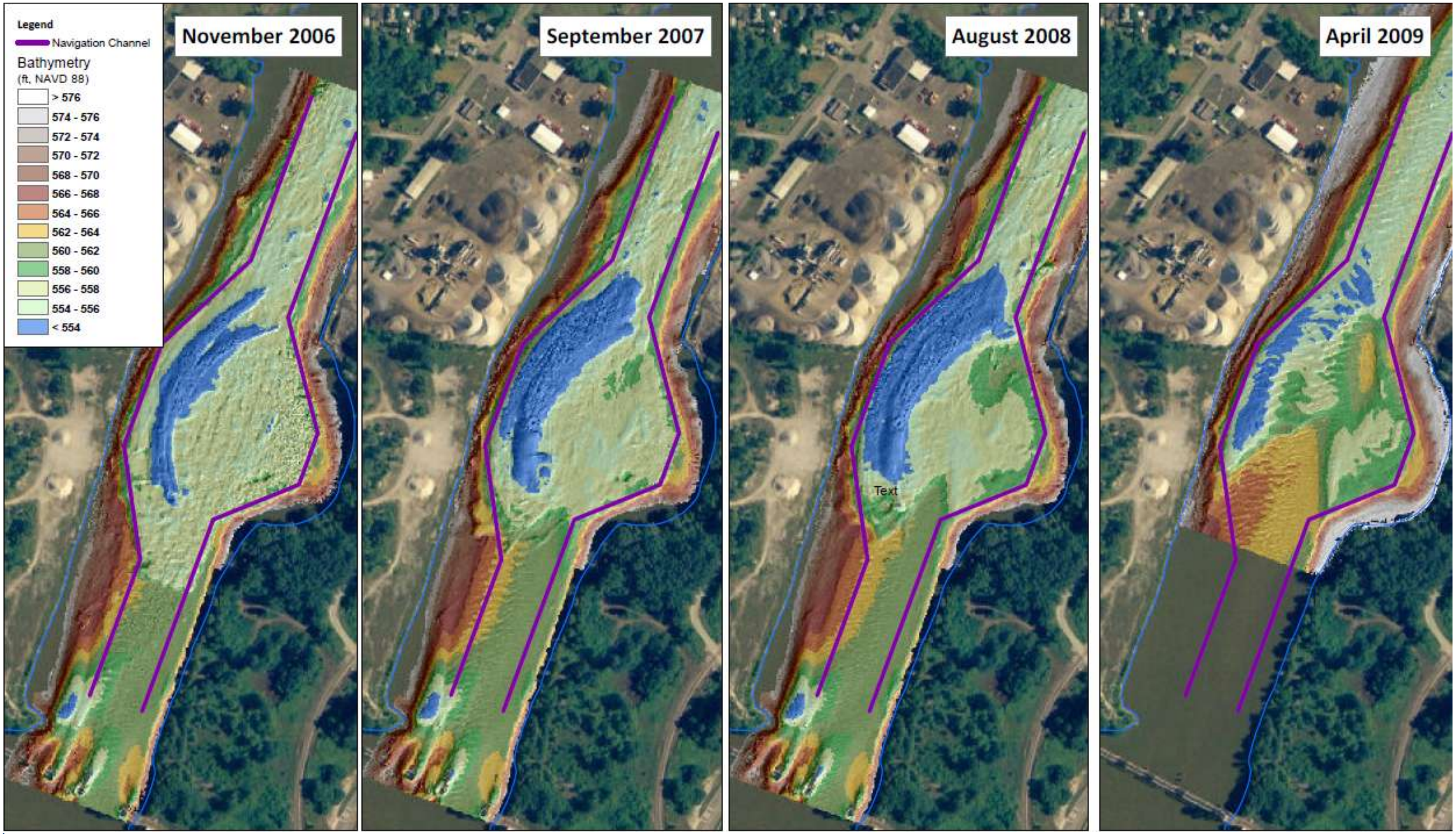
River Bed and Surface Water Elevations



SSTB Bathymetric Surveys

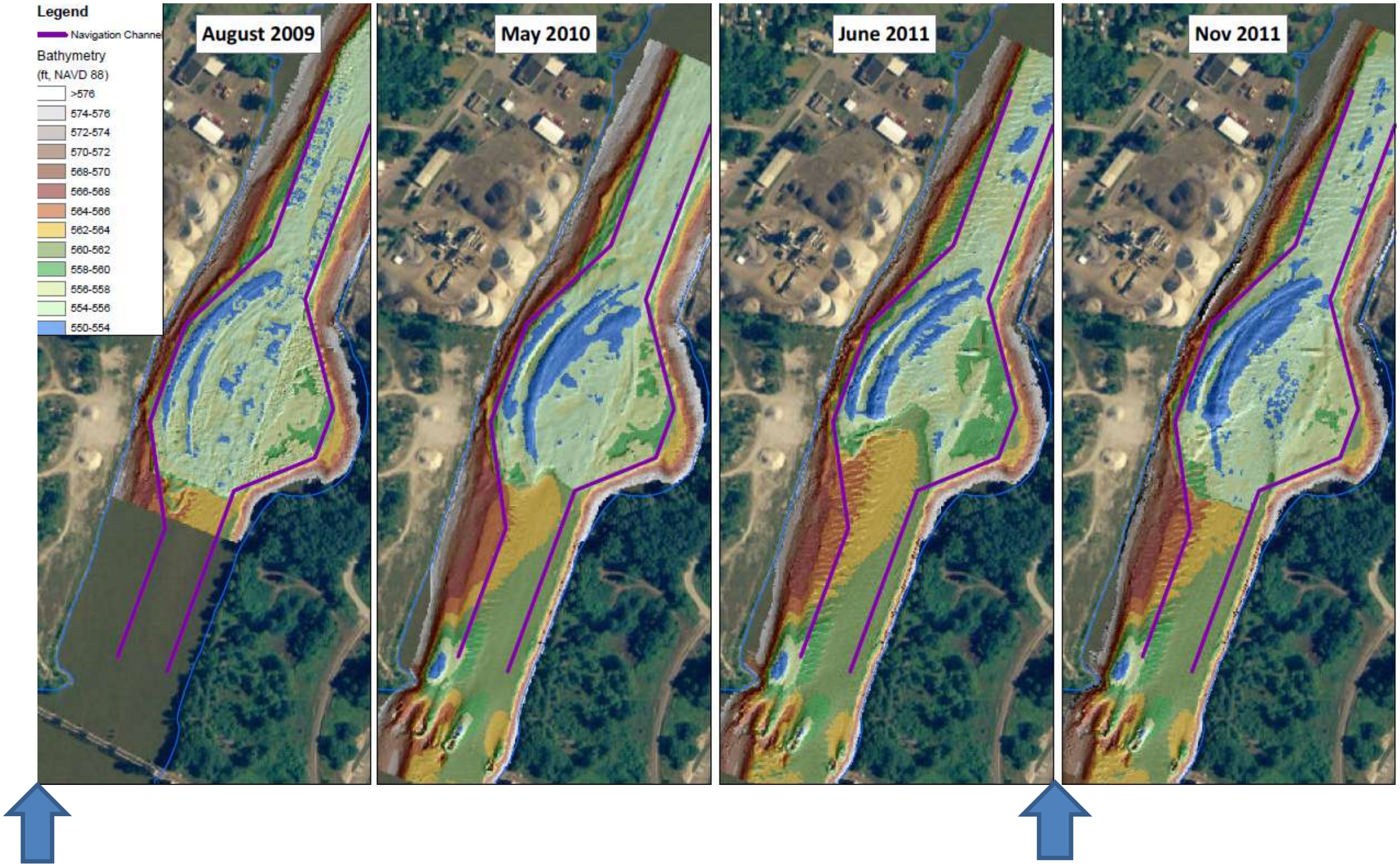
- Multiple bathymetric surveys have been conducted at the SSTB to characterize sediment deposition patterns
  - Fall 2006 Dredging
    - Nov 2006 (post-dredging)
    - Sep 2007
    - Aug 2008
    - April 2009 (pre-dredging)
  - Summer 2009 Dredging
    - Aug 2009 (post-dredging)
    - May 2010
    - Jun 2011 (pre-dredging)
  - Fall 2011 Dredging
    - Nov 2011 (post-dredging)
    - March 2012

Bathymetric Monitoring 2006 to 2009



Dredging occurred Fall 2006

Bathymetric Monitoring 2009 to 2011



Dredging occurred Summer 2009

Dredging occurred Fall 2011

SSTB Annual Deposition Rates

- Net deposition estimated from multibeam bathymetry surveys is variable and influenced by flow conditions
- Average long-term accumulation rate of ~20,000 CY/yr
- Findings demonstrate SSTB currently provides an effective trap for incoming sediment when routinely maintained

Period	Estimated SSTB Volume Dredged by USACE (CY)	Estimated Volume Deposited Within or Upstream of SSTB (CY)
Fall 2006 Dredge Event	~90,000	
Nov. 2006 – Apr. 2009		77,000
Summer 2009 Dredge Event	~60,000	
Aug. 2009– Jun. 2011		26,000
Fall 2011 Dredge Event	~40,000	

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Next Steps

- EPA committed in a letter to the Lone Tree Council to complete an assessment of sediment traps by late 2012

- Any actions would require USACE agreement → we are engaging in discussions with them

QUESTIONS?