

Removal Timescales For Mercury Stored in the Channel of the South River

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Outline

- Objectives
- Review and Summary of Key Processes
 - And our current understanding of them
- Methods – Study Design - Initial Results

Objectives

- Determine timescales required for the South River to mobilize mercury attached to fine sediment stored within the channel of the South River
 - Focusing on 5 cm depth increments
- Quantify rates of downstream migration of fine sediment once it has been mobilized by the South River

Key Processes - Erosion

- Fine sediment in the channel may be mobilized:
 - Through scour of the streambed
 - When gravels are scoured, fine sediment and associated mercury will also be removed
 - Without scour
 - Fine sediment may be mobilized from openings between immobile gravel on the stream bed

Key Processes – Transport and Deposition

- Once mobilized, fine sediment will be mostly transported as suspended load along with the flow
- Fine sediment in transport can be redeposited
 - In open spaces between gravel bed particles
 - In quiescent areas along the margins of the stream channel

Useful Quantitative Methods Can Predict:

- Generalized stream hydraulic processes
 - Water depth, flow velocity, streambed shear forces
- Hydraulic conditions for mobilizing gravel streambed material
 - *But not scour depth*
- Suspended sediment transport
 - *But not fine sediment deposition*
 - *Into gravel pores OR along channel margin areas*

Virtually Unknown....

- Rates of processes of fine sediment removal from pores of immobile gravel stream beds

Approach

- Use field monitoring to quantify and understand:
 - Scour of the streambed
 - Rates of fine sediment erosion and deposition without streambed scour

Develop useful quantitative relations for erosion and deposition that can be combined with models of varying streamflow to assess the long-term fate and transport of fine-sediment and associated mercury currently stored in the channel of the South River

(the emphasis is on physical transport, erosion, deposition, not geochemical processes....)

Monitoring Sites

RRM 2 and 3.5



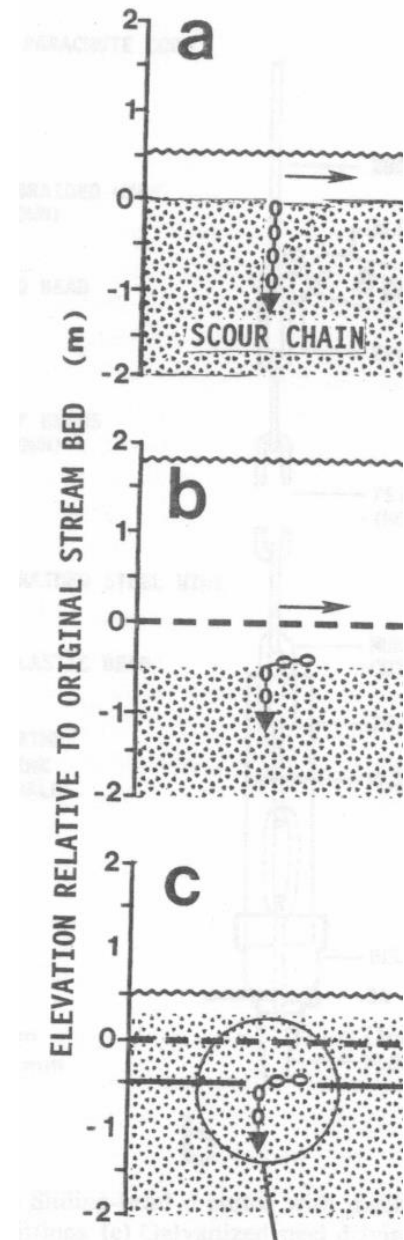
Monitoring Design

- Measure channel morphology and other parameters needed for hydraulic models
- Monitor:
 - Maximum river stages during peak discharges
 - Streambed scour
 - Fine-sediment erosion and deposition

Scour Chains

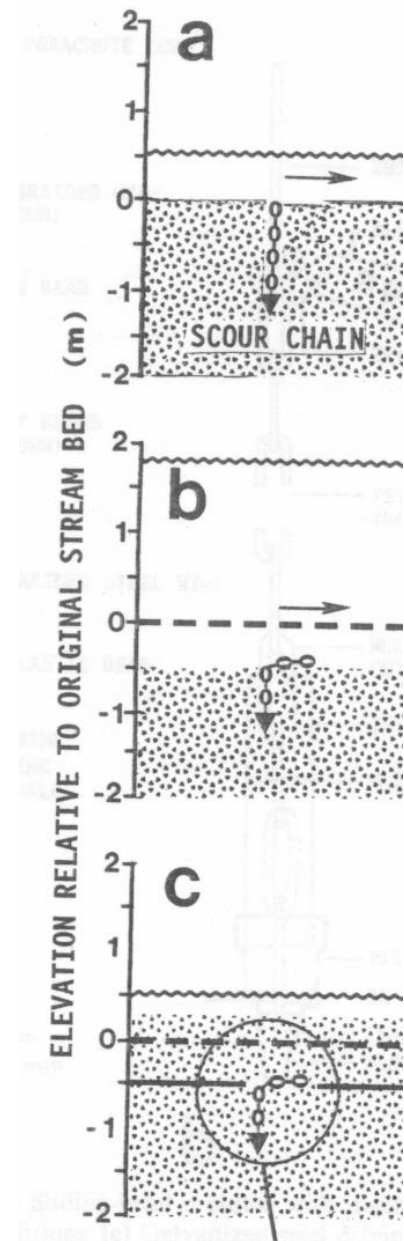


Scour Chains Document Changes in Riverbed Elevation Through Time

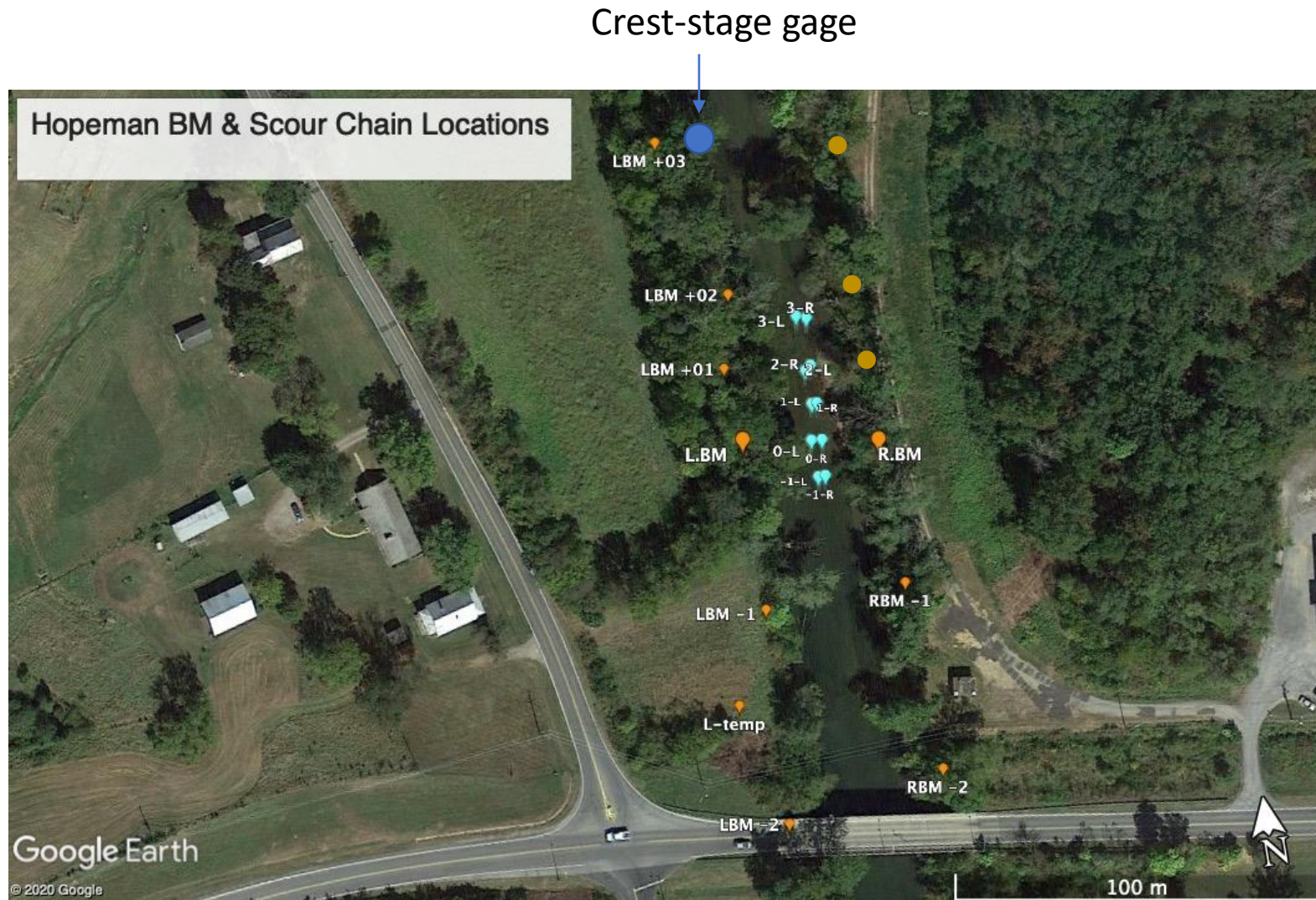


Scour Chains Document Changes in Riverbed Elevation Through Time

Previous monitoring with scour chains suggests that little scour occurs on the South River, even by flows with recurrence intervals of up to 10 years (Pomraning, U. Delaware M.S. thesis, Pizzuto et al., Geological Society of America Bulletin, 2018)



Hopeman Parkway Scour Chains and Benchmark Locations



RRM 3_5 Scour Chains and Benchmark Locations

Crest-stage gage ●

RRM 3.5 BM & Scour Chain Locations

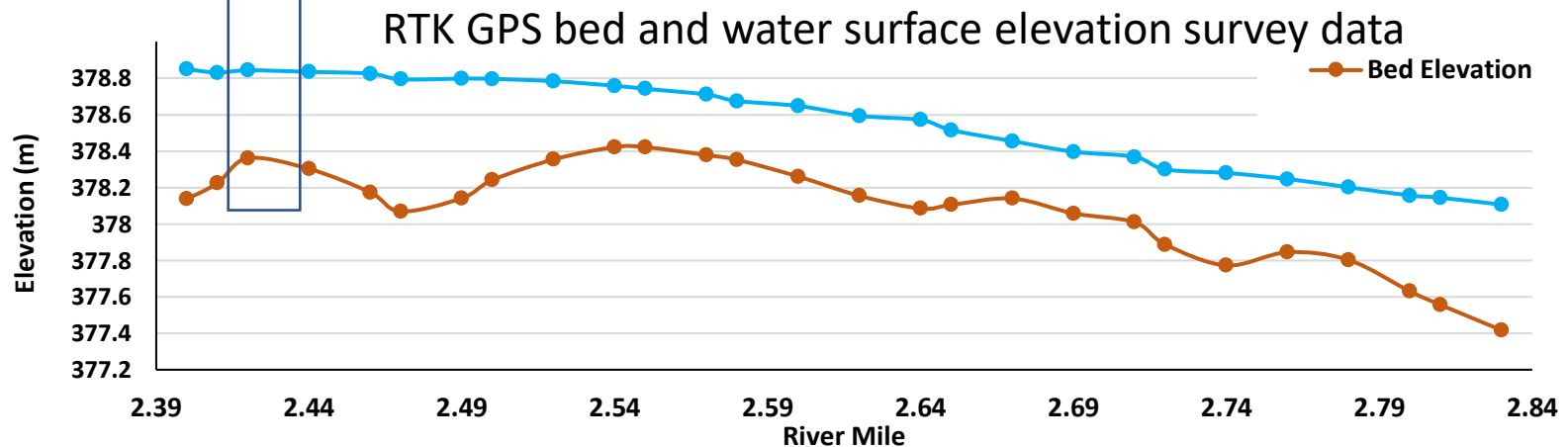
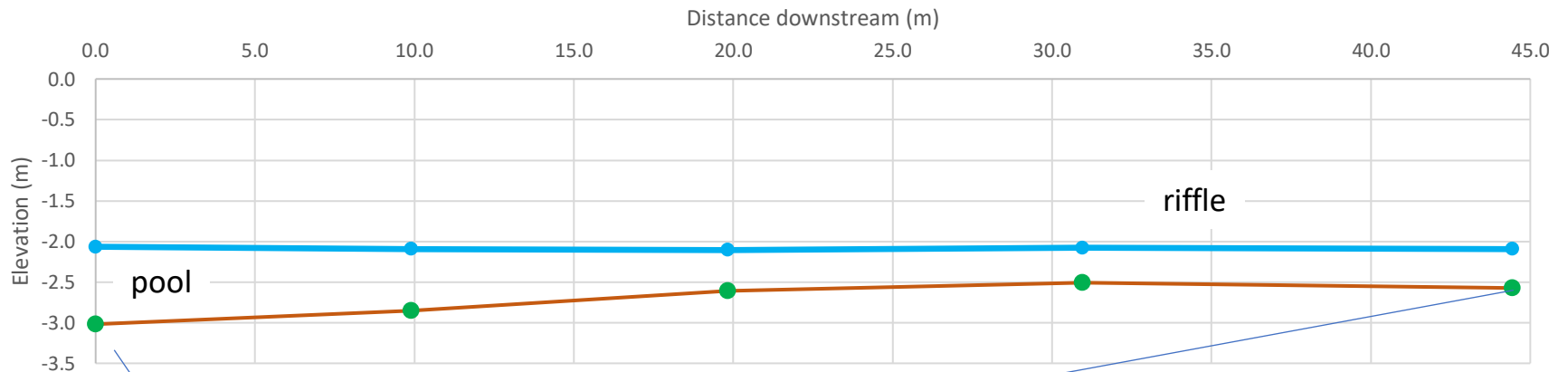


Hopeman Parkway Scour Chains

2 scour chains installed at each surveyed location



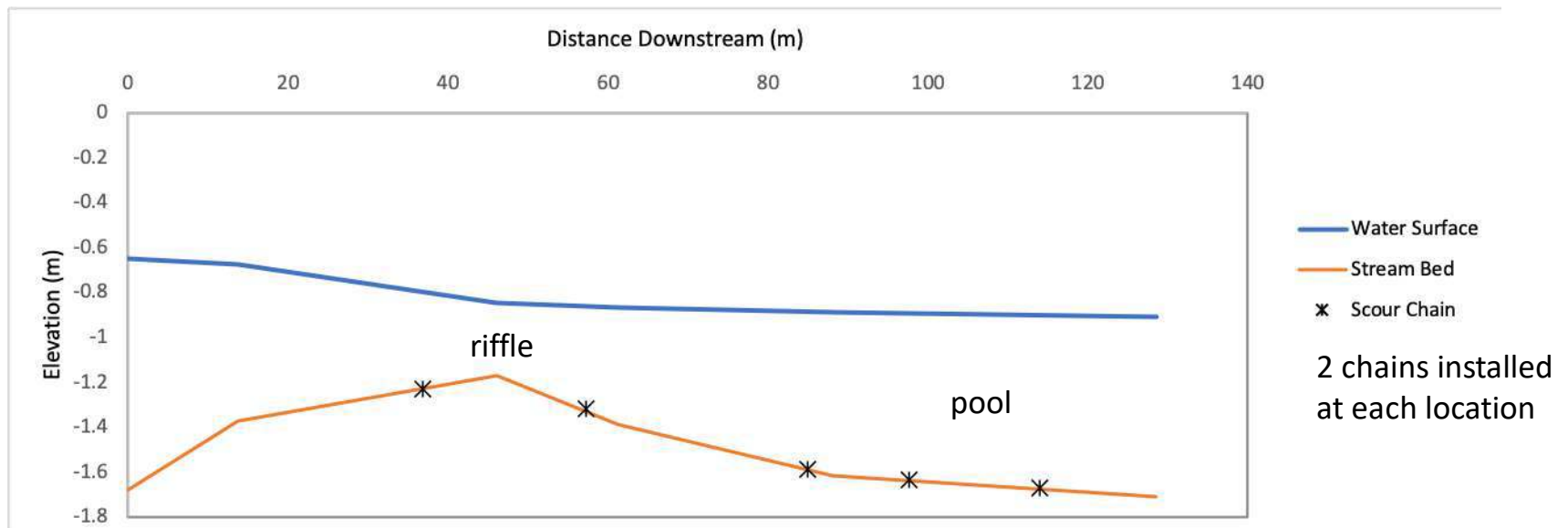
Elevation and Water Level Relative to BM 010-2020



RRM 3.5 Scour Chain Locations

- Pool sites and riffle sites sample varying hydraulic conditions

Long Profile - RRM 3.5 Showing Scour Chain Locations



Note: two chains across the channel at each location

Preliminary Results – Scour Chain Data

- 3 small events with recurrence intervals of ~ 1-2 months
- Unlikely that any systematic changes in bed elevation have occurred

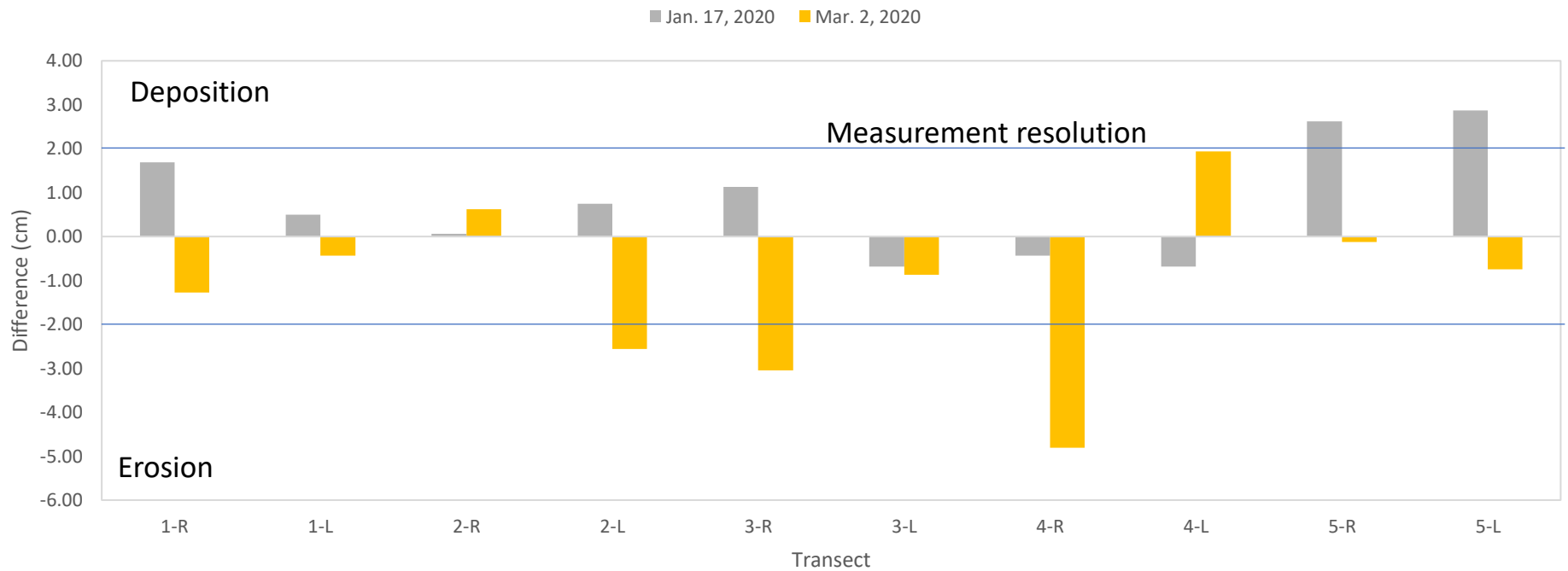
Hopeman Parkway Scour Chain Data

12-Nov-19 17-Jan-20 2-Mar-20



Estimated detection limit ~ +/- 6 cm

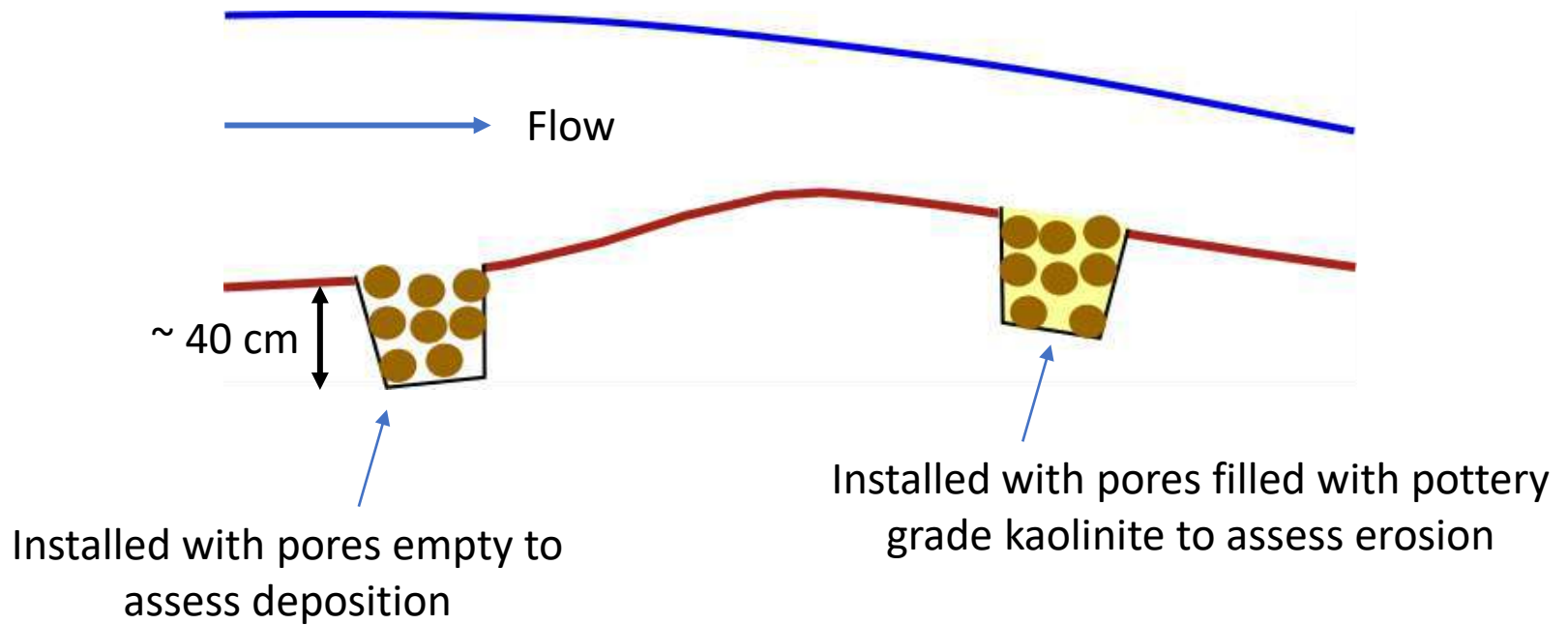
RRM 3.5 Scour Chain Data



Estimated detection limit ~ +/- 6 cm

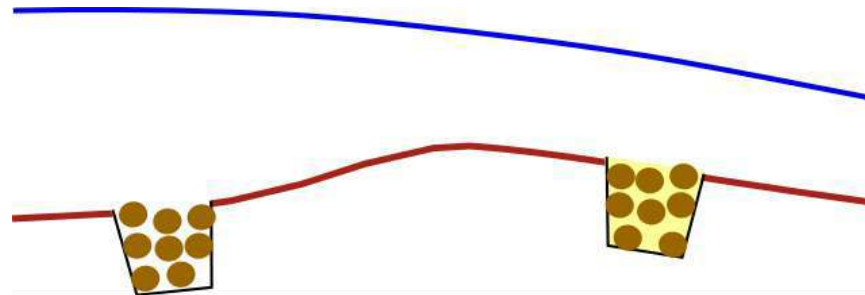
Assess Fine Sediment Erosion/Deposition With Gravel Bed “Mesocosms”

- “Mesocosms” are:
 - Cylinders filled with gravel of varying sizes
 - Installed flush with the stream bed
- “Mesocosms” provide:
 - a means of documenting changes in fine sediment content of streambed gravels
 - Caused by a variety of variables



Variables to Assess

Variable	Treatment
Gravel Grain Size	Large (cobble-large pebble), small (small pebble), Large + small
Hydraulic Setting	Pools, riffles, channel margins at steep (RRM 3.5) and gently sloping reaches (Hopeman)
Flow Event Magnitude	Sample variety of storms
Season	Sample with and without SAV



Expected Duration

- 2 years.....

Timeline

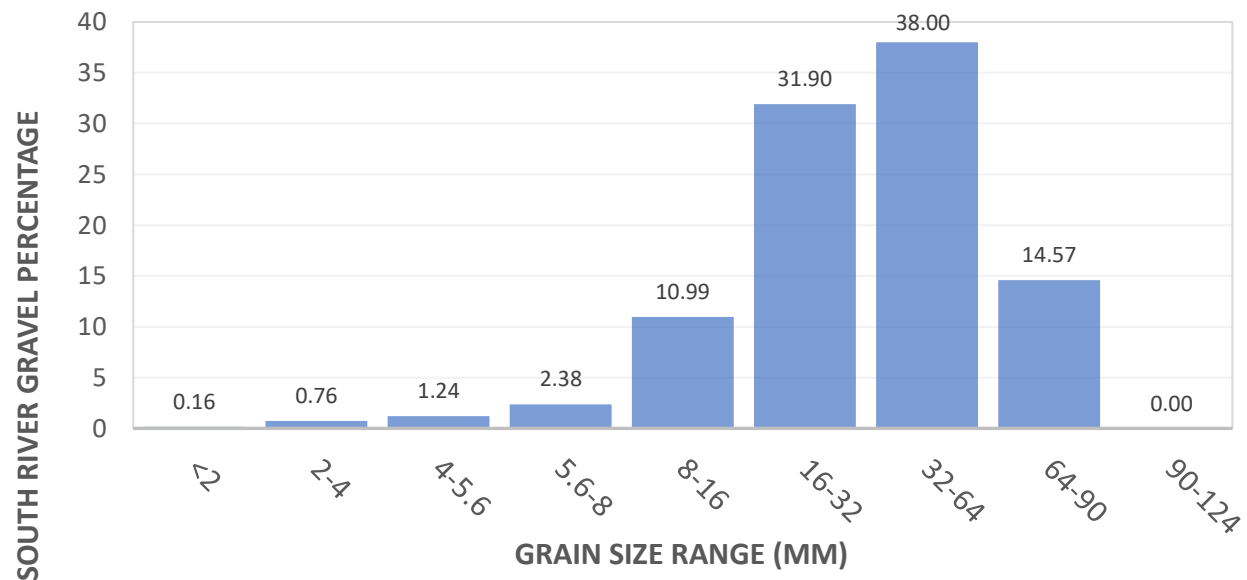
- Under construction.....
- Would be in place now but for the coronavirus

~ 200 kg from the South River



Gravel To Fill Mesocosms

All sand and finer sediment washed away!

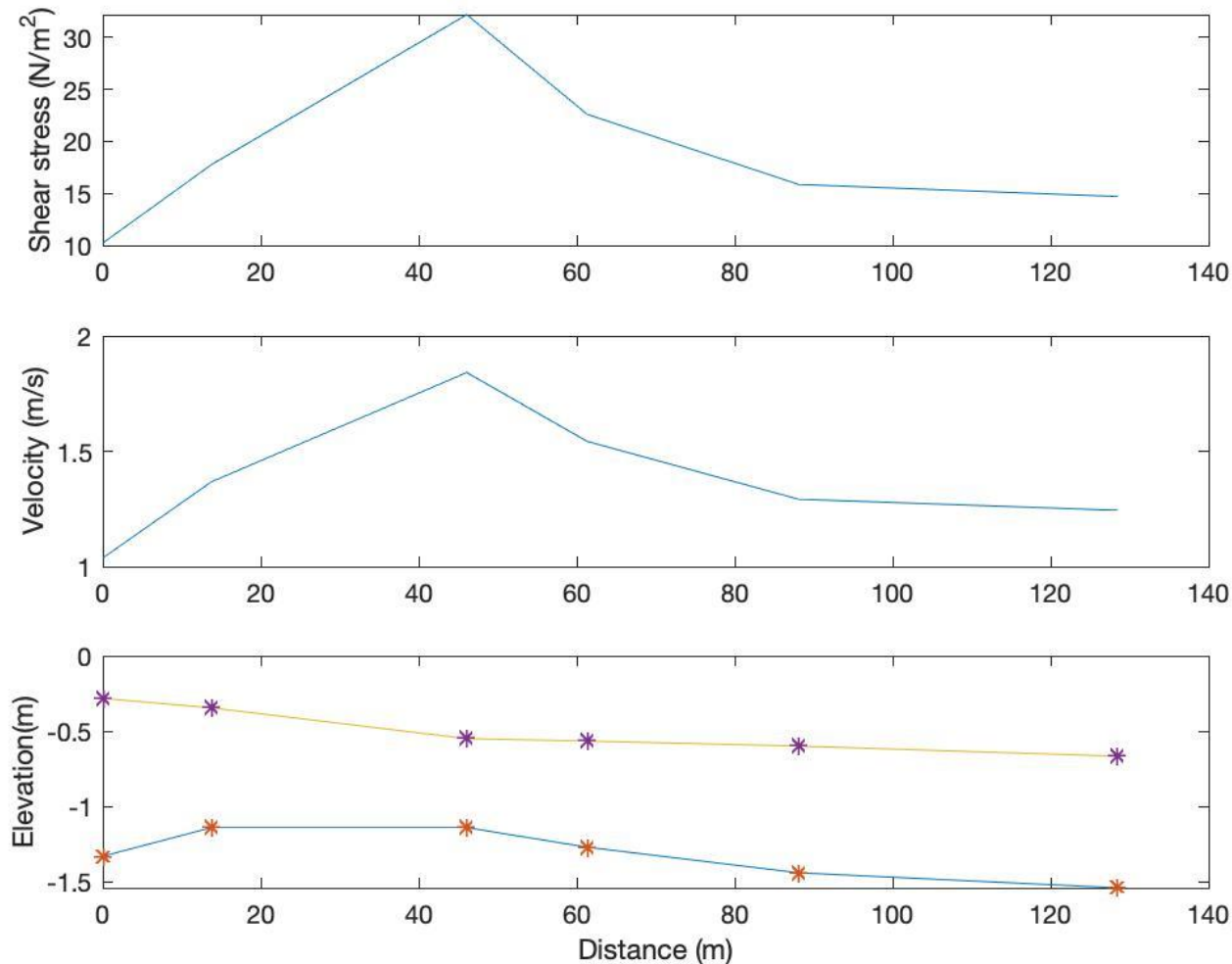


Other Study Components (to be further developed once the monitoring is underway)

- Isotopic analyses of stored fine sediment to assess residence time
 - Be7, Cs137, Pb210
- Development of fine sediment routing models
 - To predict timescales of downstream transport

1-d Hydraulic Computation – RRM3.5

Water Discharge = 25 m³/s



Questions?