



**Effects of floods on the  
high energy cobble-boulder  
bedded, urbanized Ellis Creek,  
British Columbia, Canada**

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# Agenda

- Background and History
- Methodology
- Key Findings
- Q/A



# Ellis Creek Master Plan

Identified problems with the function of the creek

## GOALS

**Stabilize** Ellis Creek Channel

**Improve** Ecological Function

**Increase** Flood Resiliency

**Decrease** Infrastructure Risk

**Increase** Aesthetic and Park Values

**ELLIS CREEK: WE HAVE A PLAN**

**Restore balance to improve flood protection AND restore fish habitat.**

Ellis Creek has been an important part of Penticton for generations, but the channel is currently out of balance. The space required for the creek to function properly has been lost resulting in extensive sediment deposits, flooding risks and poor fish habitat. We have a plan that will restore balance to Ellis Creek. There is great economical, environmental and social value in restoring Ellis Creek, including flood protection, increase fish habitat and improved aesthetics.

**OUR PLAN Will Restore Balance By**

- Stabilizing Ellis Creek Channel
- Increasing Flood Resiliency
- Enhancing Ecological Function

**MORE Fish In The Creek.**

The natural structures will improve the production of Salmon and Rainbow Trout in Ellis Creek. Barriers to upstream migration will be removed. Spawning habitat will be constructed. Natural vegetation will be planted along floodplains and channel banks to provide cover and shade. These natural features will benefit birds, amphibians, and other native species.

**PROTECT People and Property**

Ellis Creek requires flood protection. Predictions of flooding show much of the area beside the creek flooding during large flows. As we have seen in neighbouring communities, flooding can be devastating. Increasing the size of the bridge openings, lowering and widening the channel and constructing berms will result in fewer floods.



# Ellis Creek

- **Controlled** for more than 80 years
- Prone to **flooding**, erosion, and deposition
- **Channel excavation** for flood control in 1950 and 1957
- **Urbanization** encroached on the channel through the City
- Diversion structure (1966) permanently **altered sediment transport** characteristics
- **Berms** were hastily constructed during floods





# Ellis Creek

In the City of **Penticton**  
in British Columbia, Canada

## FLOWS

- Westward approximately five km from a reservoir
- Through industrial and urban areas
- to the Okanagan River

Ellis Creek degraded from urbanization and floods





# Major Events ( $\geq$ 10-year event)

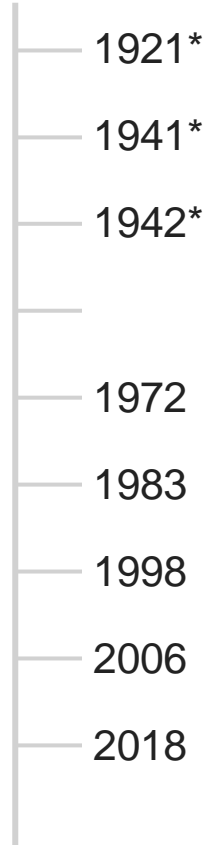


May 1941 – 36 m breach of EC No. 4 Dam

Road damage downstream



May 1942 – Flood damage from of breach of EC No. 4 Deposition of Cobbles, Boulders and LWD



\*Dam Breach / photo Source: Tanant and Skermer 2006. Clear water flood Source: Vasseau Creek Hydrometric station (08NM171) 1971 to 2018. Note: no data from 1942 to 1972



# Historical Changes

## 1938

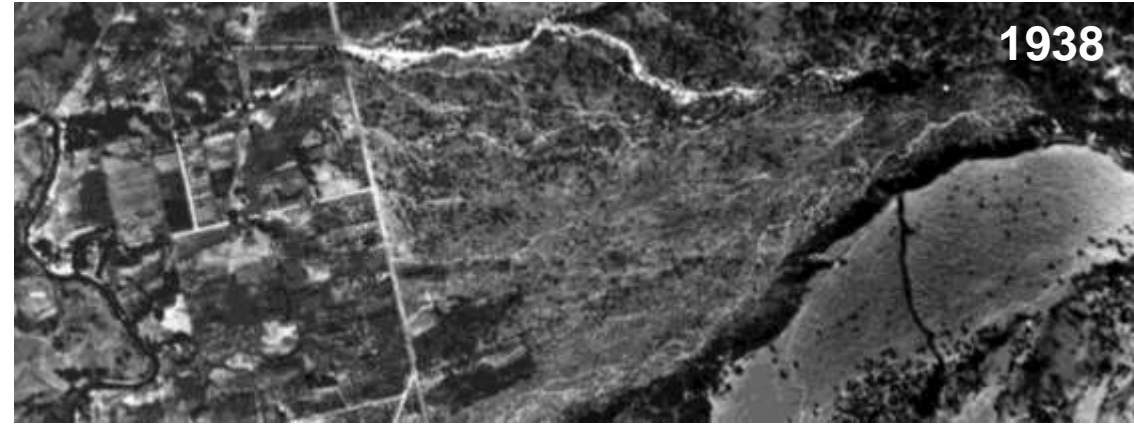
- Extensive braiding and channels from the head of the fan likely caused by 1921 dam breach
- Initial confinement of EC West of Main Street

## 1951

- Post-expansive flood events in 1941 and 1942
- Channel braiding and extensive overland flooding at the head of the fan
- Confined channel West of Main Street

## 1974

- Mining operations at head of the fan
- Braided channel pattern
- Confinement of channel East of Main Street
- Urban development through much of the fan





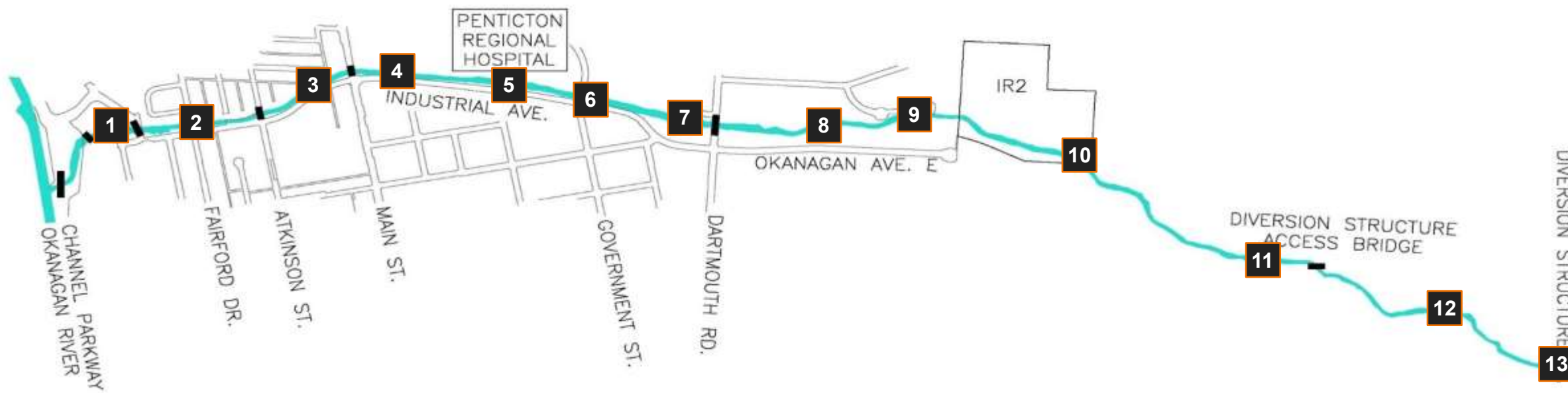
# Methods

## 13 reaches identified

- Hydraulic assessment (HECRAS)
- Geomorphic assessment
- Sediment mobility assessment

## Data Sources

- Topographic survey provided by the City
- LiDAR data set provided by the City
- Bridge inspection reports from 2016 and 2006 were reviewed







# Geomorphic Description

1. Channel walked in October and November of 2018
2. Assessed representative site for each reach
3. Fluvial geomorphology cards used to document channel conditions, such as:
  - Channel form
  - Sediment pattern
  - Vertical and lateral stability
  - Bank material characteristics
4. Measured grain size using Wolman method

**Stantec Fluvial Geomorph**

PROJECT: \_\_\_\_\_

Reach # \_\_\_\_\_ Station # \_\_\_\_\_ Date: \_\_\_\_\_

GPS Location (Indicate L&L, Long or UTM and Datum used)

**River Reach Channel Form**

Straight [ ] Angular [ ] Regular [ ] Barbed [ ] Anastomosing [ ] Braided [ ]

A B C D E F G

**Sediment Pattern**

1 2 3 4 5 6 7

**Channel Stability:**

**Vertical**

Physical Controls (beaver, basal fill, concrete bed, etc...) limiting scour.

Vertically Stable (material transported through at replacement values) over period of interest.

Slow Incision (<20cm/yr) or sustained bed scour.

Rapid Incision (>20cm/yr) or severe sustained aggradation likely result in avulsion, knickpoints and disturbed banks common.

Severe Channel Erosion (>1m/yr) or imminent avulsion.

**Lateral**

Physical Controls (bedrock, vegetation, works, hard points etc...) limiting lateral erosion.

Lateral erosion not evident or not significant over period of interest.

Slow Lateral Erosion (<20cm/yr).

Rapid Lateral Erosion (>20cm/yr) or potential for bank failures to expose 0.2 - 1.0 m in a given year.

Pervasive Lateral Erosion with the potential to expose or erode > 1m of new bank at the crossing in a given year.

**Field Morphology:**

Cascade (no pools - bedrock flow) (vertical erosion req'd)

Step-Pool (vertical erosion req'd)

Cascade-Pool (high flow, pool, cascade)

Plane-Bed (horizontal bed)

Riffle-Pool (bed incision or pool)

Dune-Ripple (shades, dune forms)

Run (trapezoidal shape, banklines)

Run (bed, high flow, some, flatbed)

**Large Woody Debris:**

Controlling Channel

Functioning, not Dominant

Present, not Functioning

None

**Banks:**

**L R Bedrock**

Weak

Strong

**L R Coarse Soils**

Loose

Compact

Dense

Very Dense

**L R Cohesive Soils**

Soft

Firm

Stiff

Hard

**L R Vegetation**

Trees

Shrub or Grass

Not vegetated

**L R Landslides**

> 10 m slope length

Banks in ROW

Banks upstream

Banks downstream

**Y N Exposed Pipeline**

Full Survey?

**Definitions**

Loose: Easily penetrated with rebar pushed by hand, easily excavated with shovel

Compact: Easily penetrated with rebar driven by 5 lb. hammer. Hard to excavate with shovel

Dense: Penetrated 1 ft. with driven rebar, must be loosened with pick to excavate

Very Dense: Penetrated only a few inches with thumb

Soft: Easily penetrated several cm with thumb with effort

Firm: Can be penetrated several cm with thumb with great effort

Stiff: Indented with thumb, but only penetrated with great effort

Hard: Indented with difficulty by thumb nail.

**Condition**

Stable / Maintained

Poor / Failing

Relic / Abandoned

None

**Dam:**

Present

Absent

**Sketch**  **Survey**  **Minimum DOC** \_\_\_\_\_

**Scale** \_\_\_\_\_

**Characteristics**

**Right bank**

**Left bank**

**Undercut (cm)** Left bank \_\_\_\_\_ Right bank \_\_\_\_\_

**Distance to Crossing**

Upstream \_\_\_\_\_ m

Downstream \_\_\_\_\_ m

**Drop Height** \_\_\_\_\_ m



# Degradation

## Estimated based on:

- Narrow channels
- Dencutting seen at toe or banks
- Undercut banks
- Nick points on channel bed
- Exposed utilities
- Increase in bridge openings



# Aggradation

## Estimated based on:

- Wide channel
- Large bars
- Absence of channel banks
- Banks lower than bankfull
- Recently deposited sediment
- Decreases in bridge openings





## Reach 1-3 Key Findings

- Very high flood risk
- Aggraded channel
- Low channel slope
- Channelization

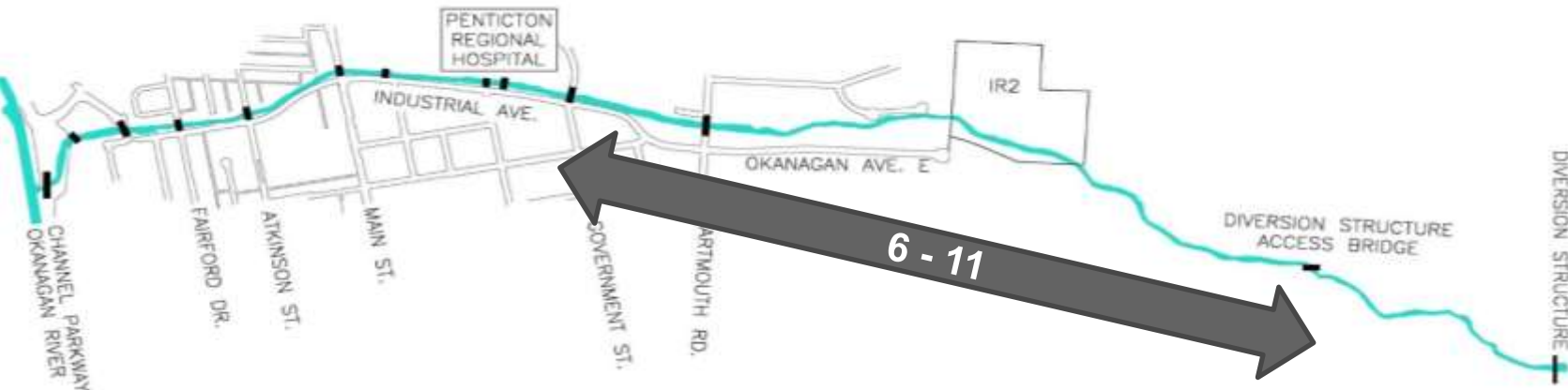




## Reach 4-5 Key Findings

- High to very high flood risk
- Aggraded channel
- Low channel depth





## Reach 6-11 Key Findings

- Deeply incised channel
- Steep bed
- Narrow channel
- Bed degrading





## Reach 12-13 Key Findings

- Natural channel
- Not incised
- Steep
- Step-pools
- Boulder banks





### Supply Sediment

- Reaches 7 to 9

### Deposited in

- Reaches 4 to 5

Reach	Channel Type	Sediment Transport type	Bank Erosion Hazard Index	Aggradation / Degradation Class
1	Aggraded	Deposition	Low	+ 0.75 -1 m
2	Stable	Transfer	Low	+/- 0.25 m
3	Stable	Transfer	Low	+/- 0.25 m
4	Aggraded	Deposition	Low	+ 0.5 - 0.75 m
5	Aggraded	Deposition	Low	+ >1.0 m
6	Transitional	Transfer	Low	± 0.25 m
7	Deeply Incised	Production (Most)	Very high	- >1.0 m
8	Deeply Incised	Production (Most)	Very high	- 0.75 – 1.0 m
9	Deeply Incised	Production (Most)	High	- 0.75 – 1.0 m
10	Incised	Production	Moderate	- 0.25 – 0.5 m
11	Incised	Production	Low	+/- 0.25 m
12	Natural	Transfer	Low	+/- 0.25 m
13	Natural	Transfer	Low	+/- 0.25 m

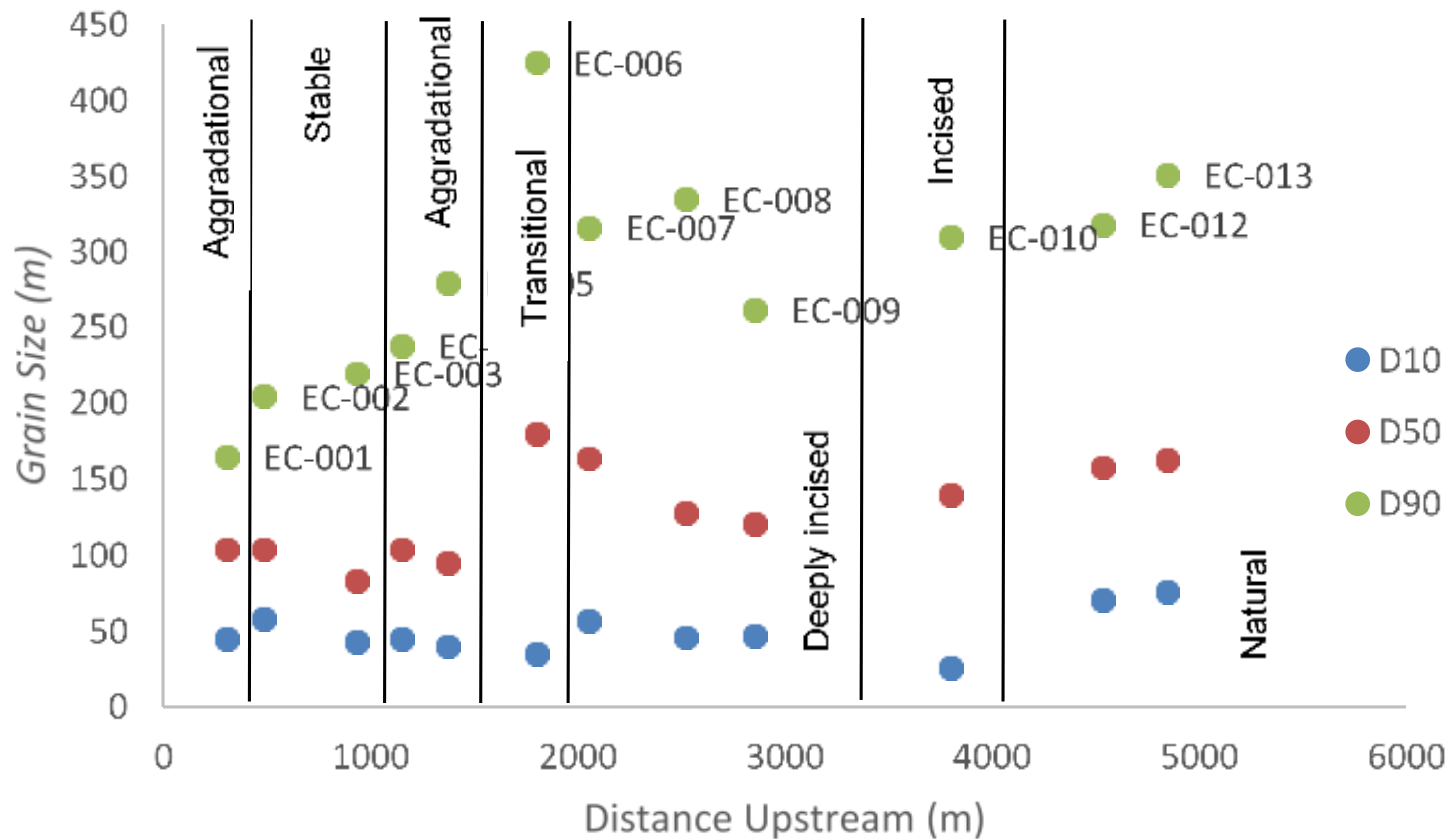


# Grain Size

Generally, decreases from upstream to downstream

## Reaches 9 to 6

- Increasing grain size







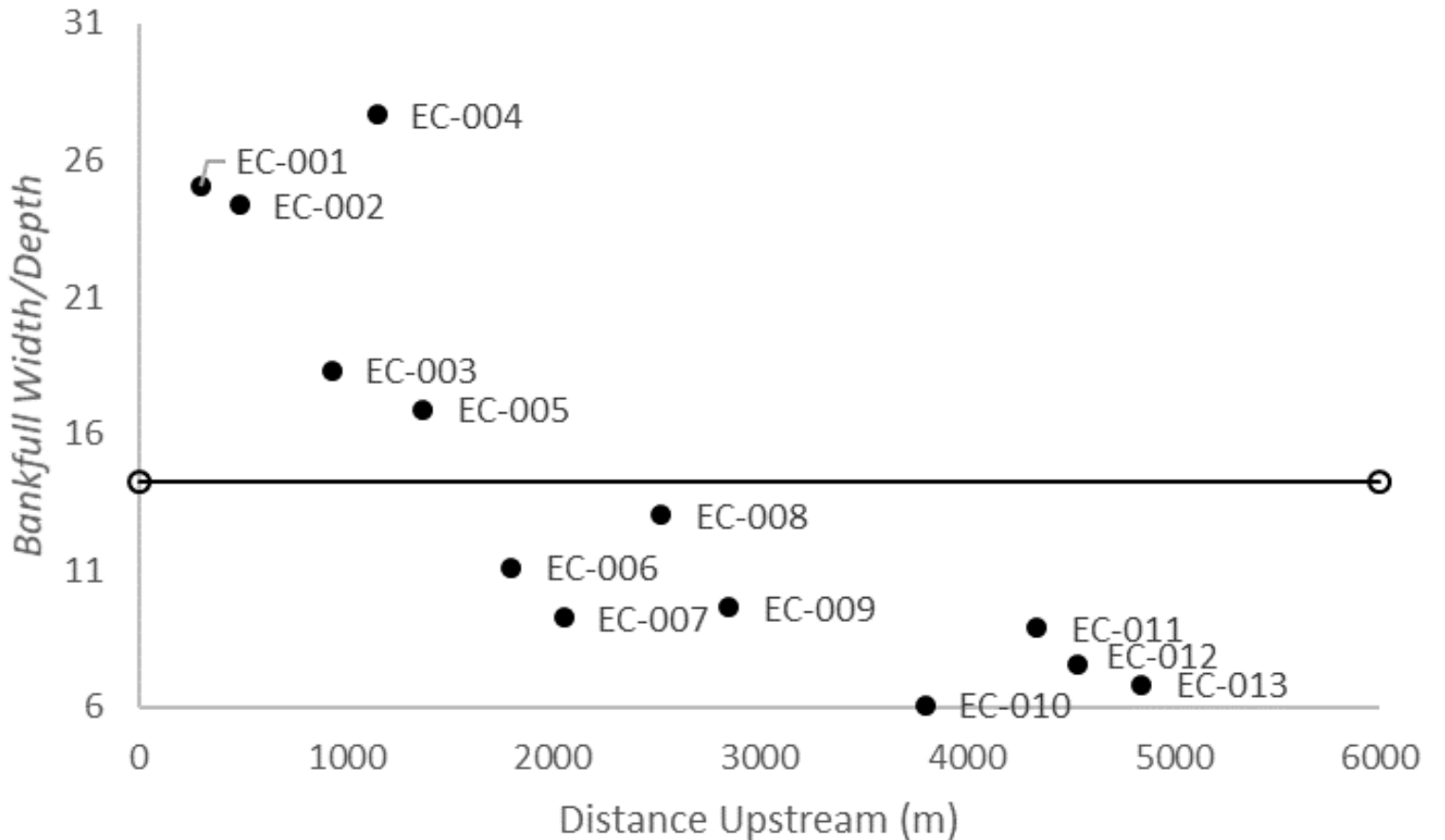
# Hydraulic Geometry

## Reaches 6 to 13

- Narrow and deep channels located upstream channel

## Reaches 5 to 1

- Wide and shallow channels located downstream





# Slope

## Reaches 13 to 10

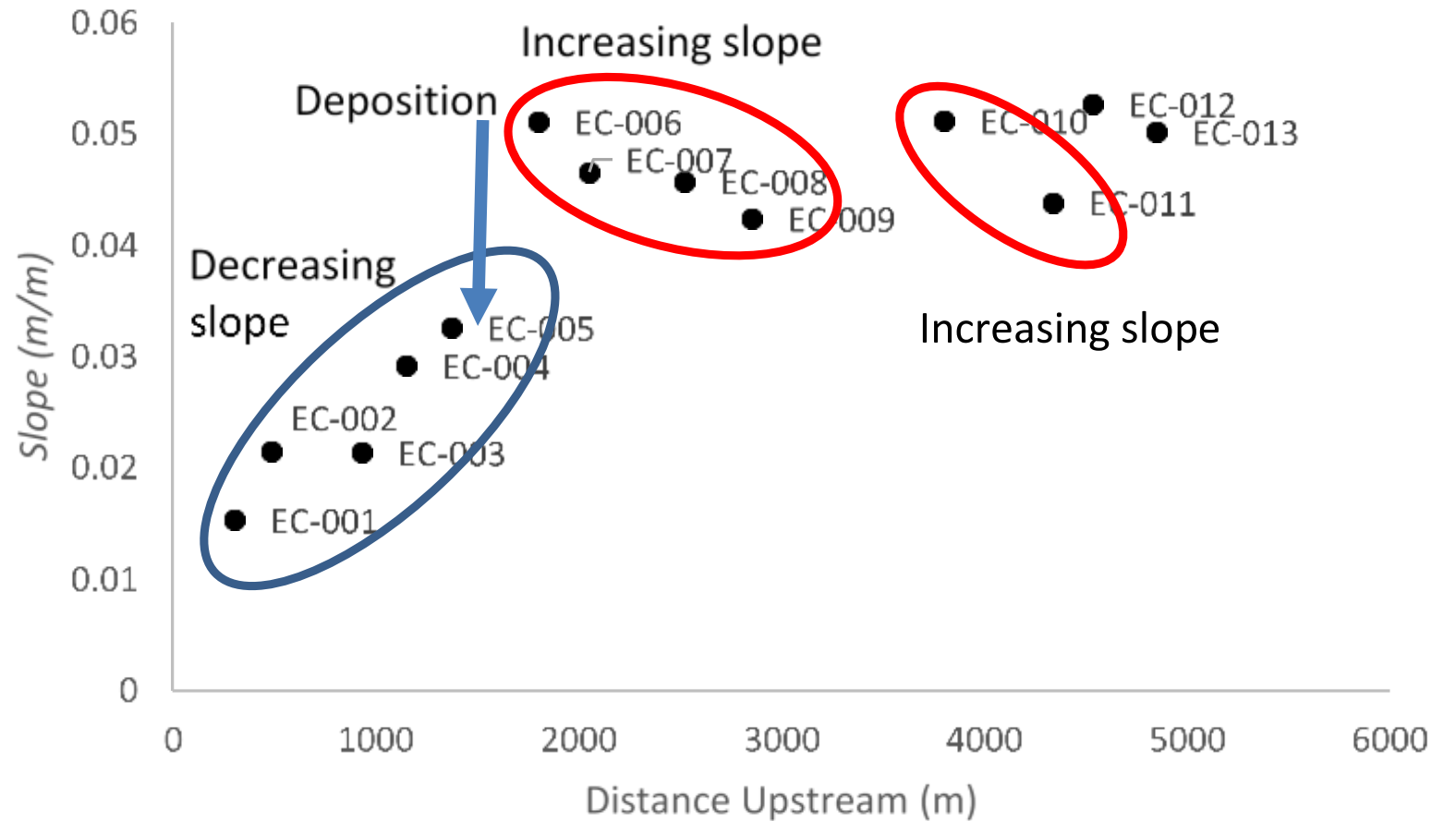
- High slope

## Reaches 9 to 6

- Increasing slope

## Reaches 5 to 1

- Decreasing slope





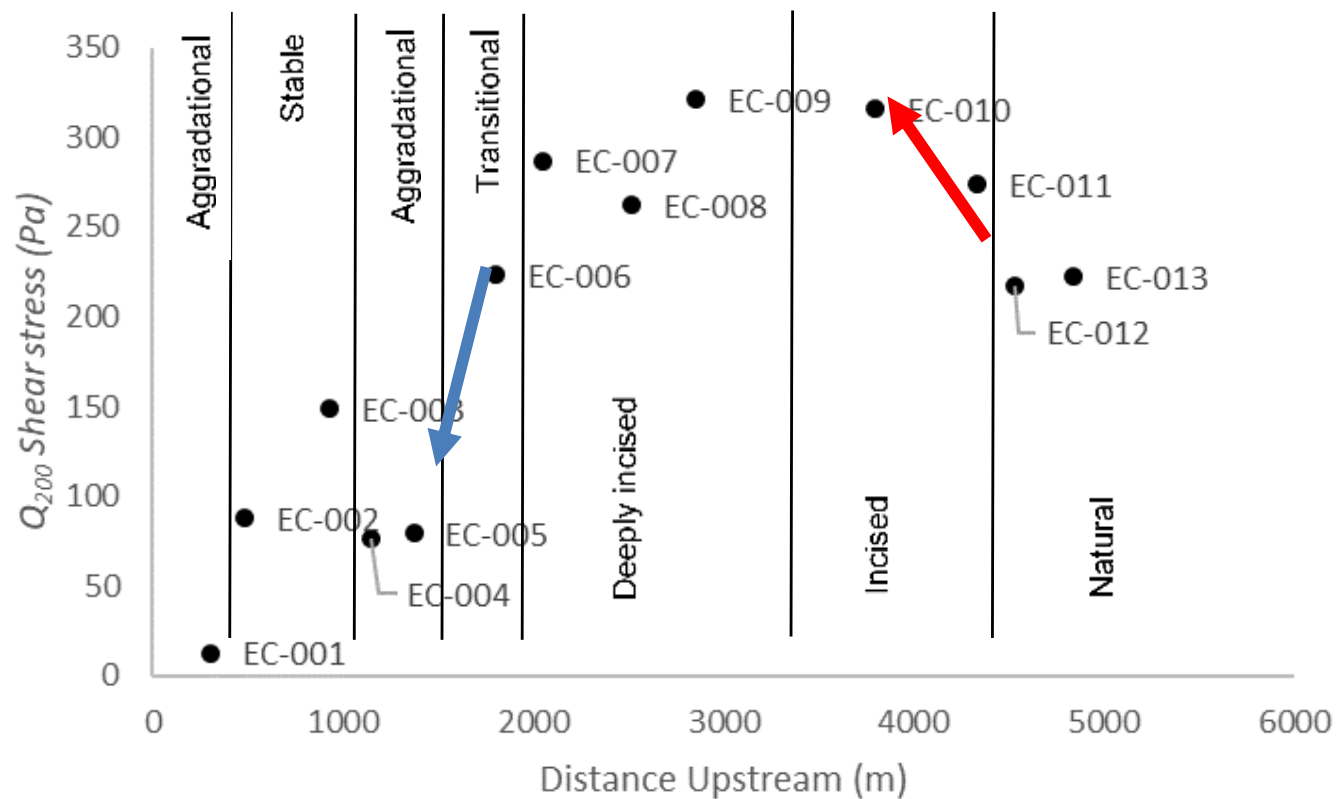
# Shear Stress

## Reaches 13 to 9

- Increasing shear stress
- Highest shear stress in Reaches 9 and 10 indicate future locations of degradation

## Reaches 9 to 1

- Decreasing shear stress
- Deposition





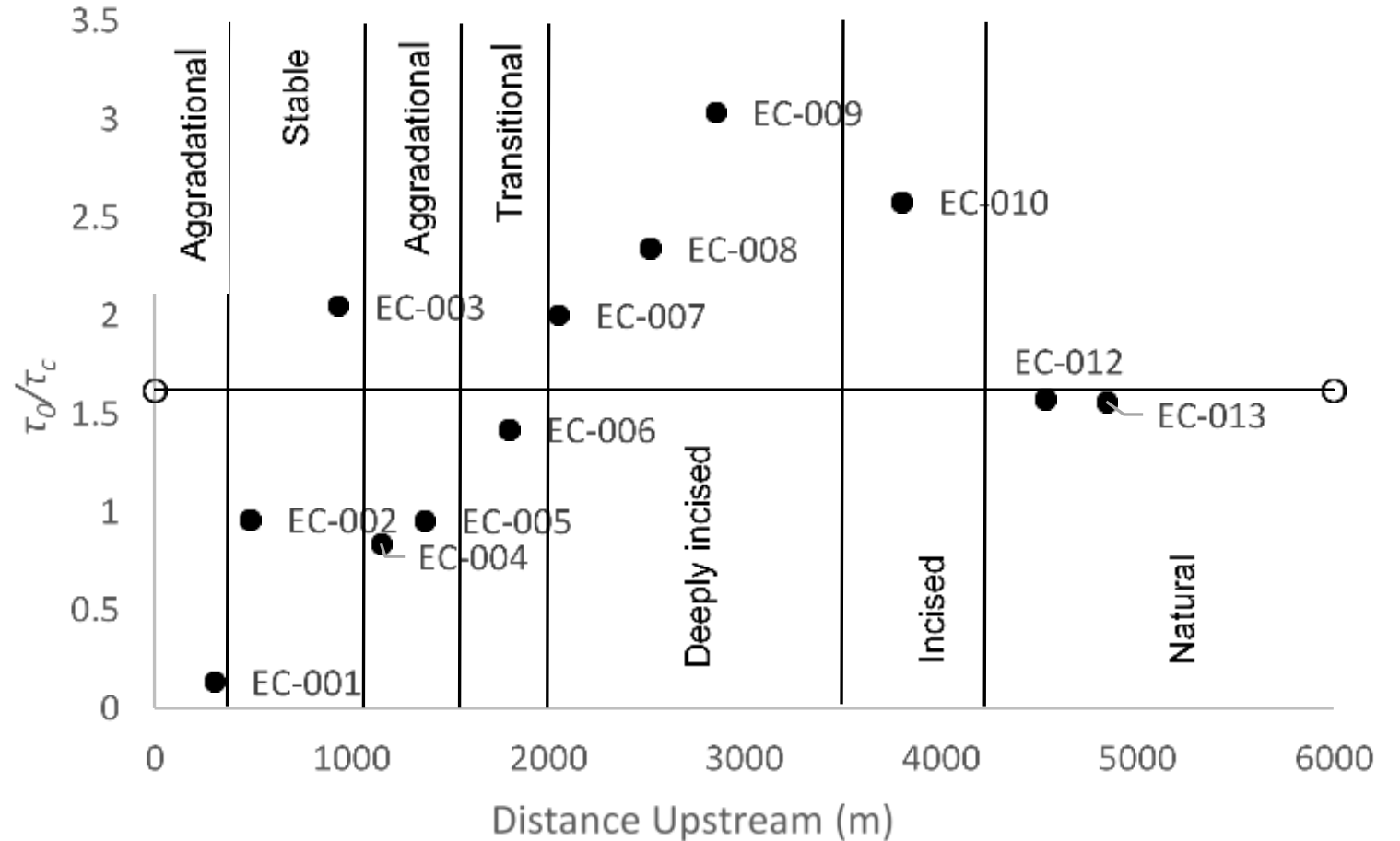
# Sediment Mobility

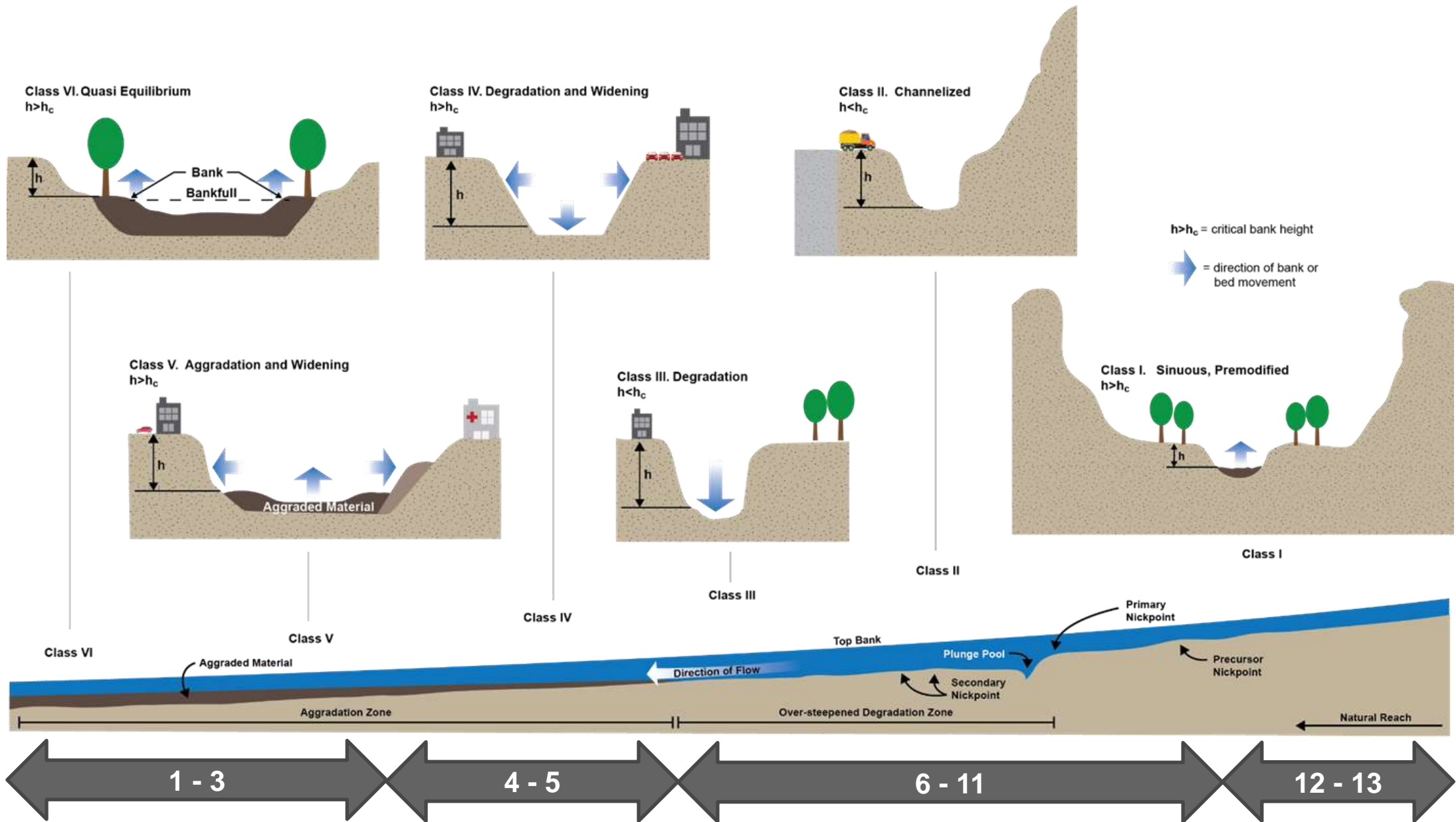
## Reaches 12 to 9

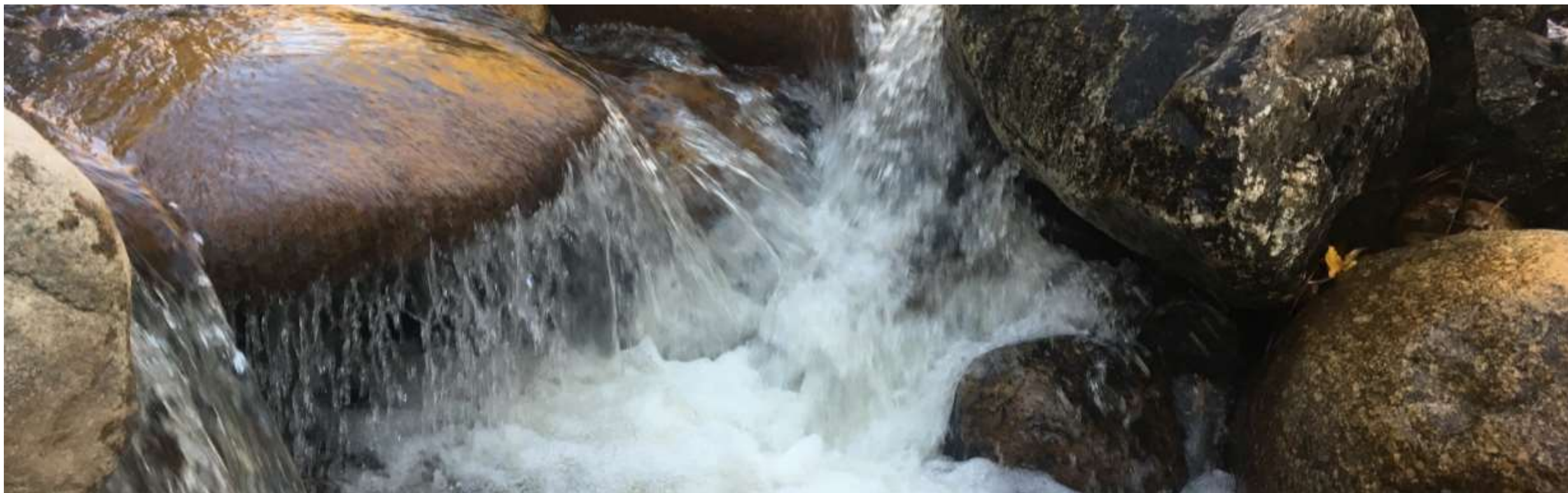
- Increasing sediment mobility

## Reaches 9 to 5

- Decreasing sediment mobility







# Questions?

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