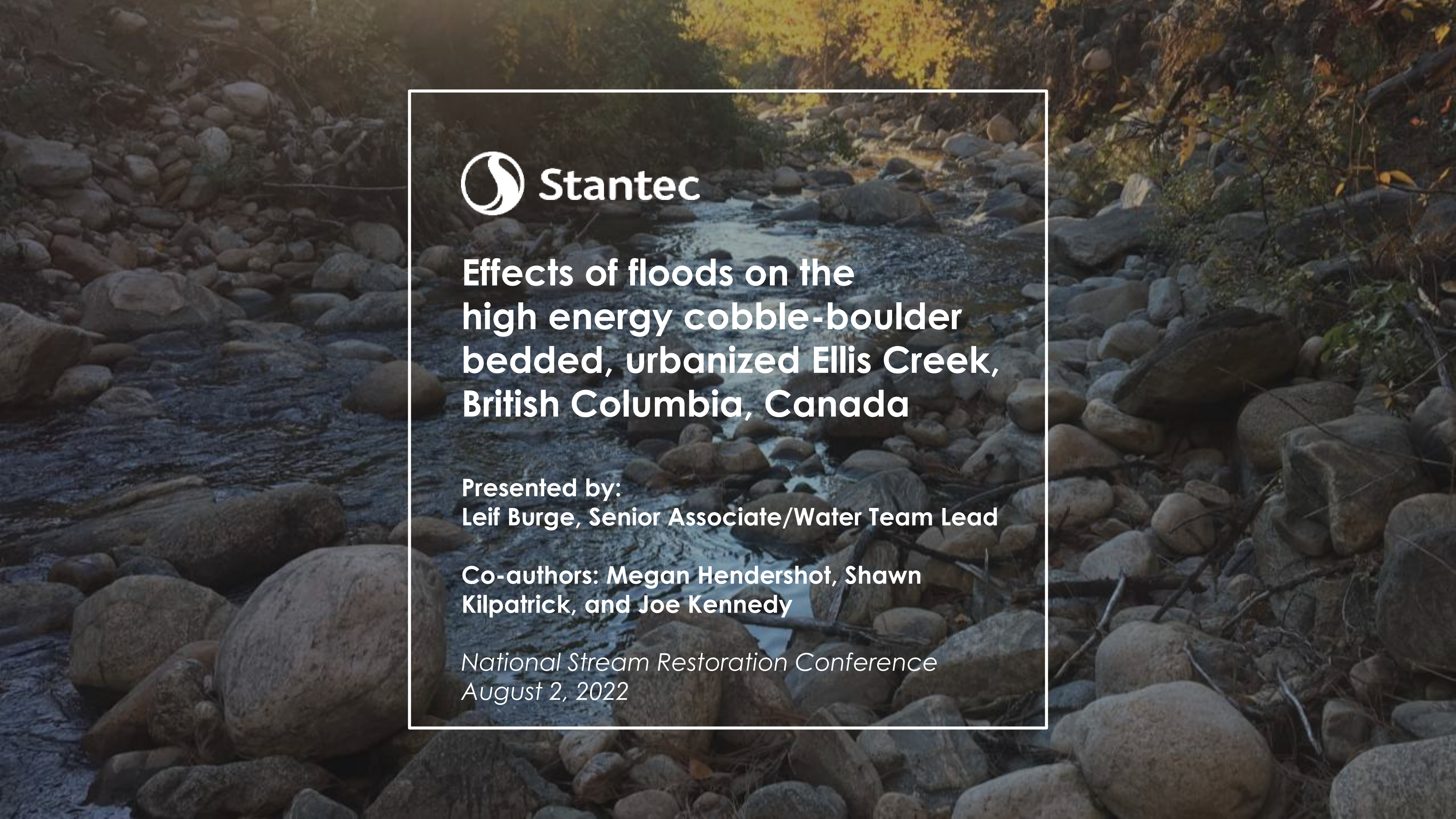

Stantec

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

Presented by:
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Co-authors: Megan Hendershot, Shawn Kilpatrick, and Joe Kennedy

National Stream Restoration Conference
August 2, 2022

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

- **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 (≥ 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

- 1921*
- 1941*
- 1942*
- 1972
- 1983
- 1998
- 2006
- 2018

*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

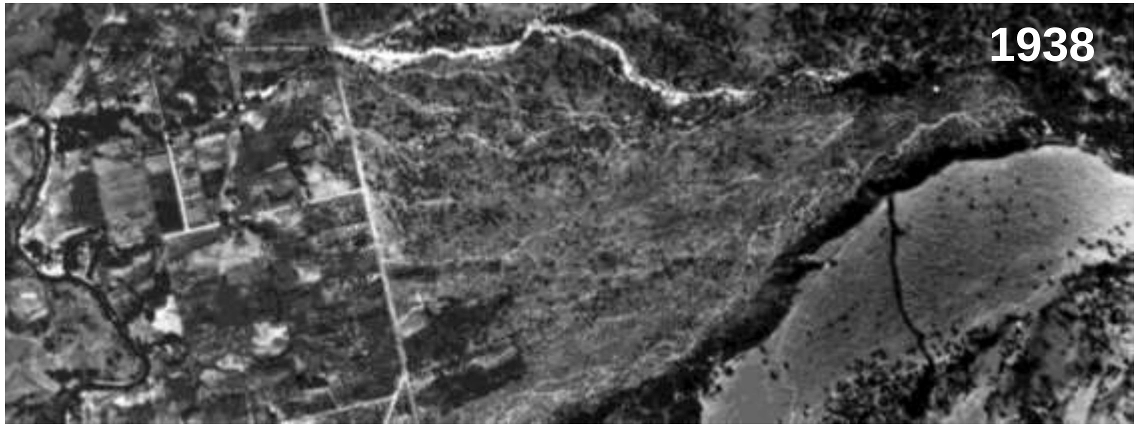
- Extensive braiding and channels from the head of the fan likely caused by 1921 dam breach
- Initial confinement of EC West of Main Street

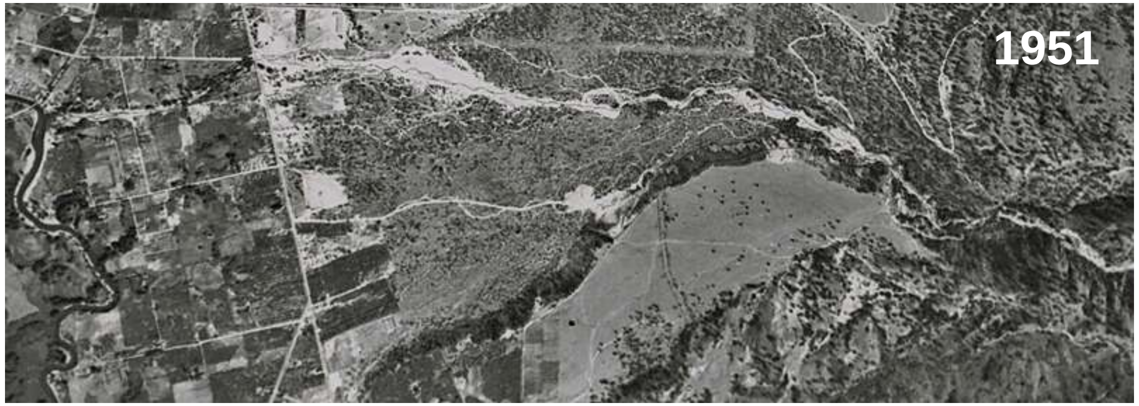
1951

- 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





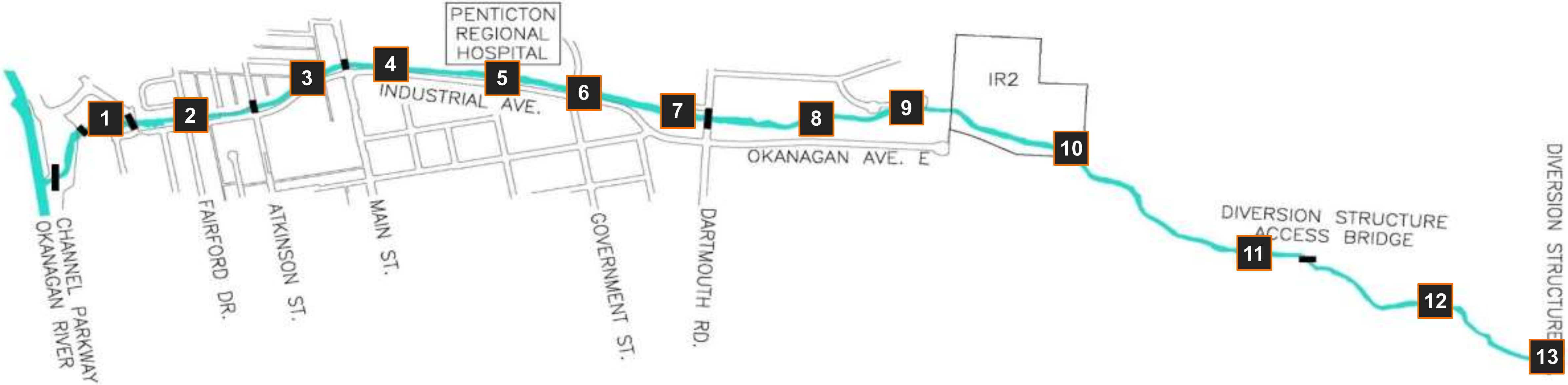
Methods

13 reaches identified

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

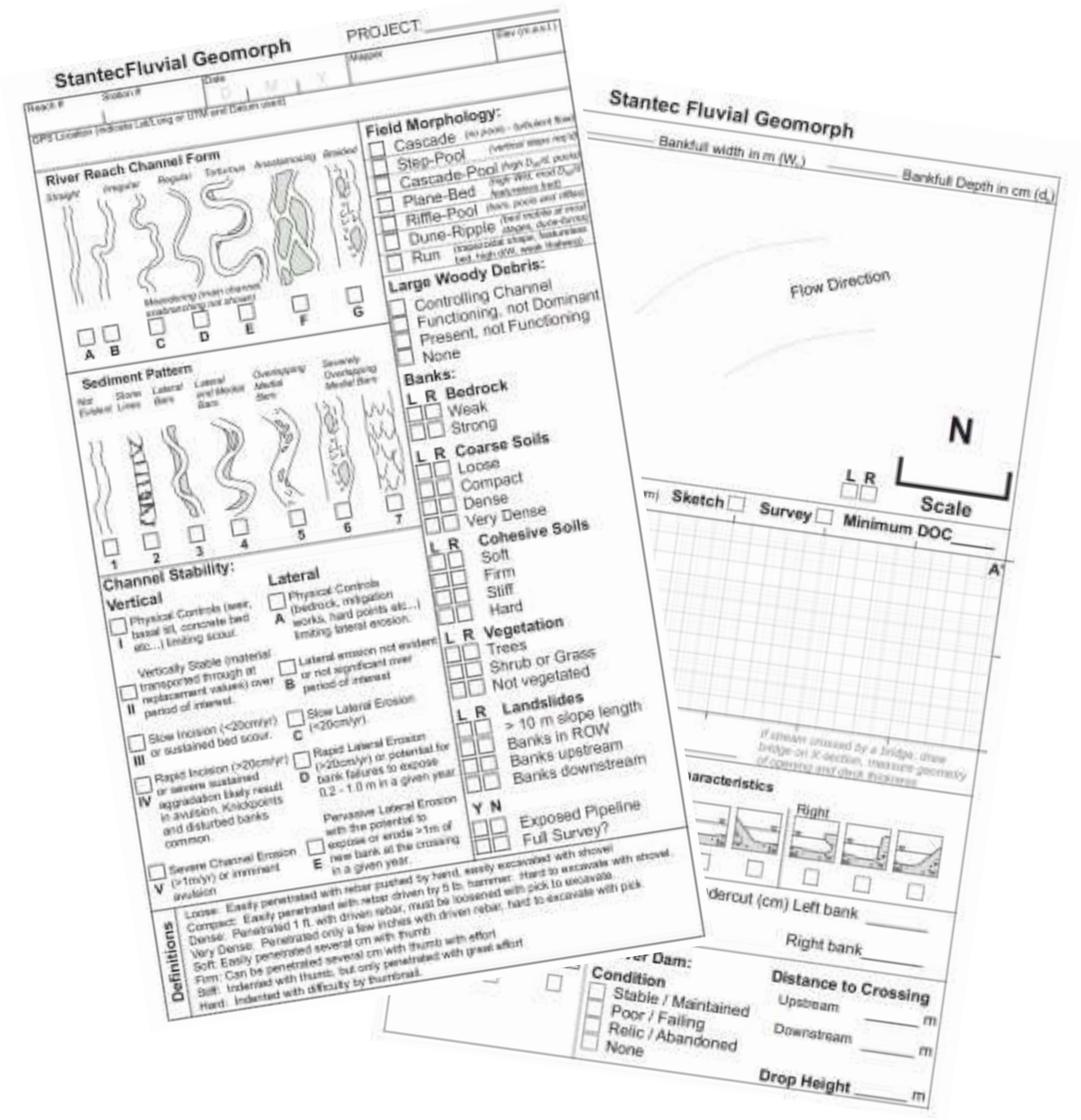
Data Sources

- 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



Degradation

Estimated based on:

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

Aggradation

Estimated based on:

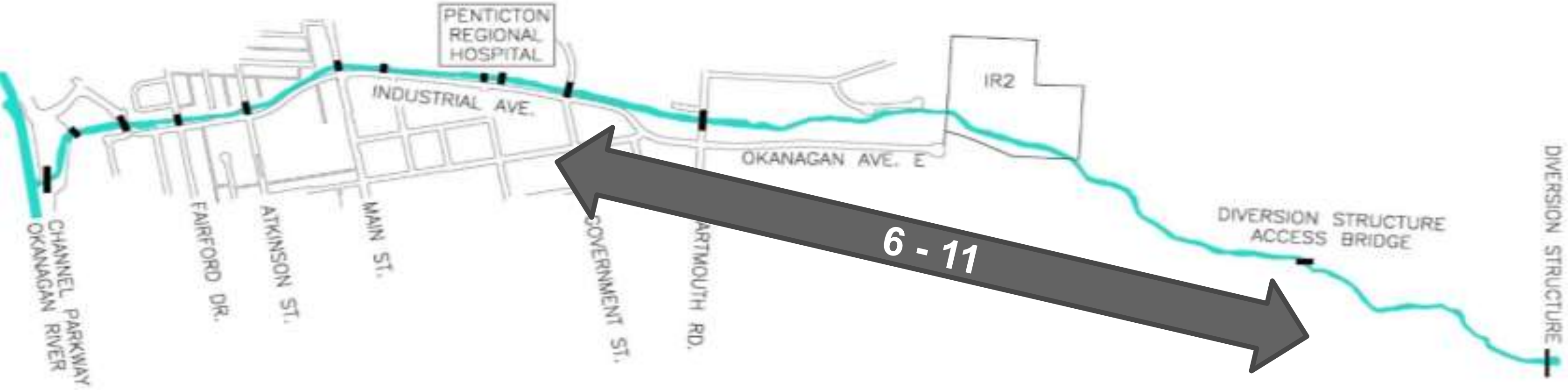
- Wide channel
- Large bars
- Absence of channel banks
- Banks lower than bankfull
- Recently deposited sediment
- Decreases in bridge openings

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

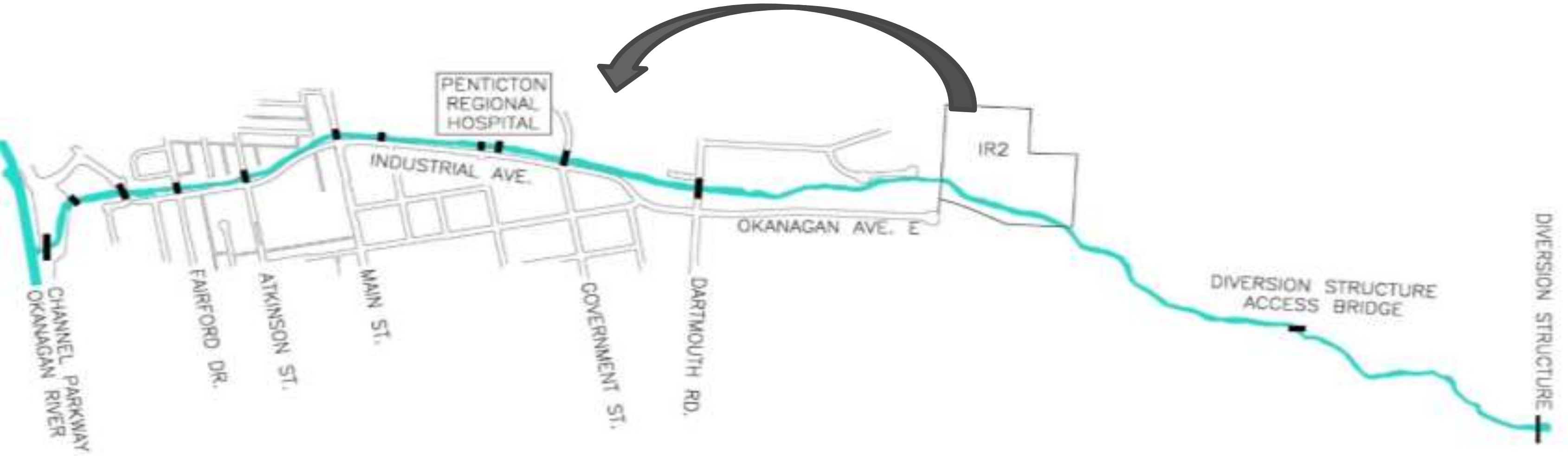


Reach 6-11 Key Findings

- 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

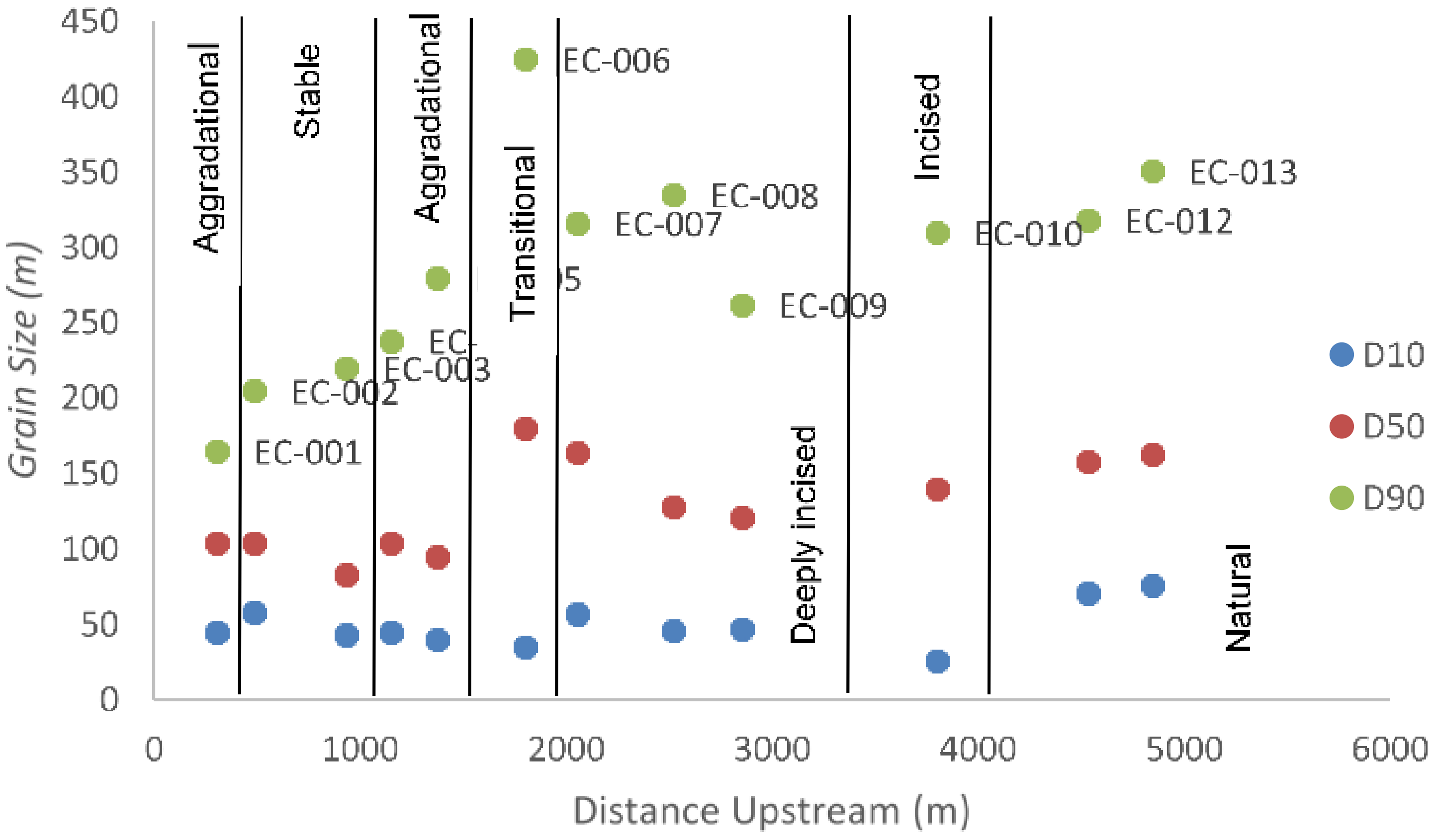
Reach	Channel Type	Sediment Transport type	Bank Erosion Hazard Index	Aggradation / Degradation Class
1	Aggraded	Deposition	Low	+ 0.75 -1 m
2	Stable	Transfer	Low	+/- 0.25 m
3	Stable	Transfer	Low	+/- 0.25 m
4	Aggraded	Deposition	Low	+ 0.5 - 0.75 m
5	Aggraded	Deposition	Low	+ >1.0 m
6	Transitional	Transfer	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



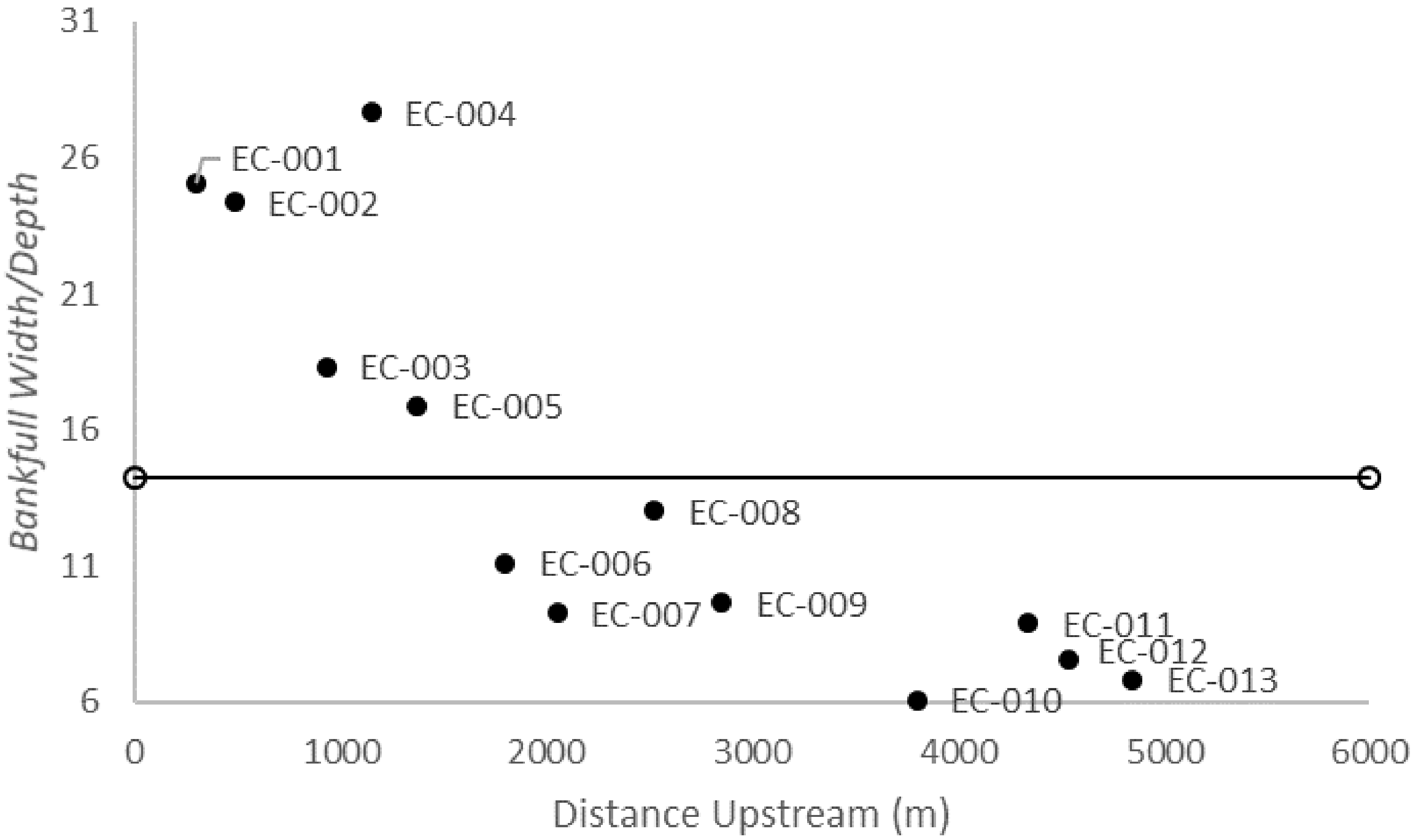
Hydraulic Geometry

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

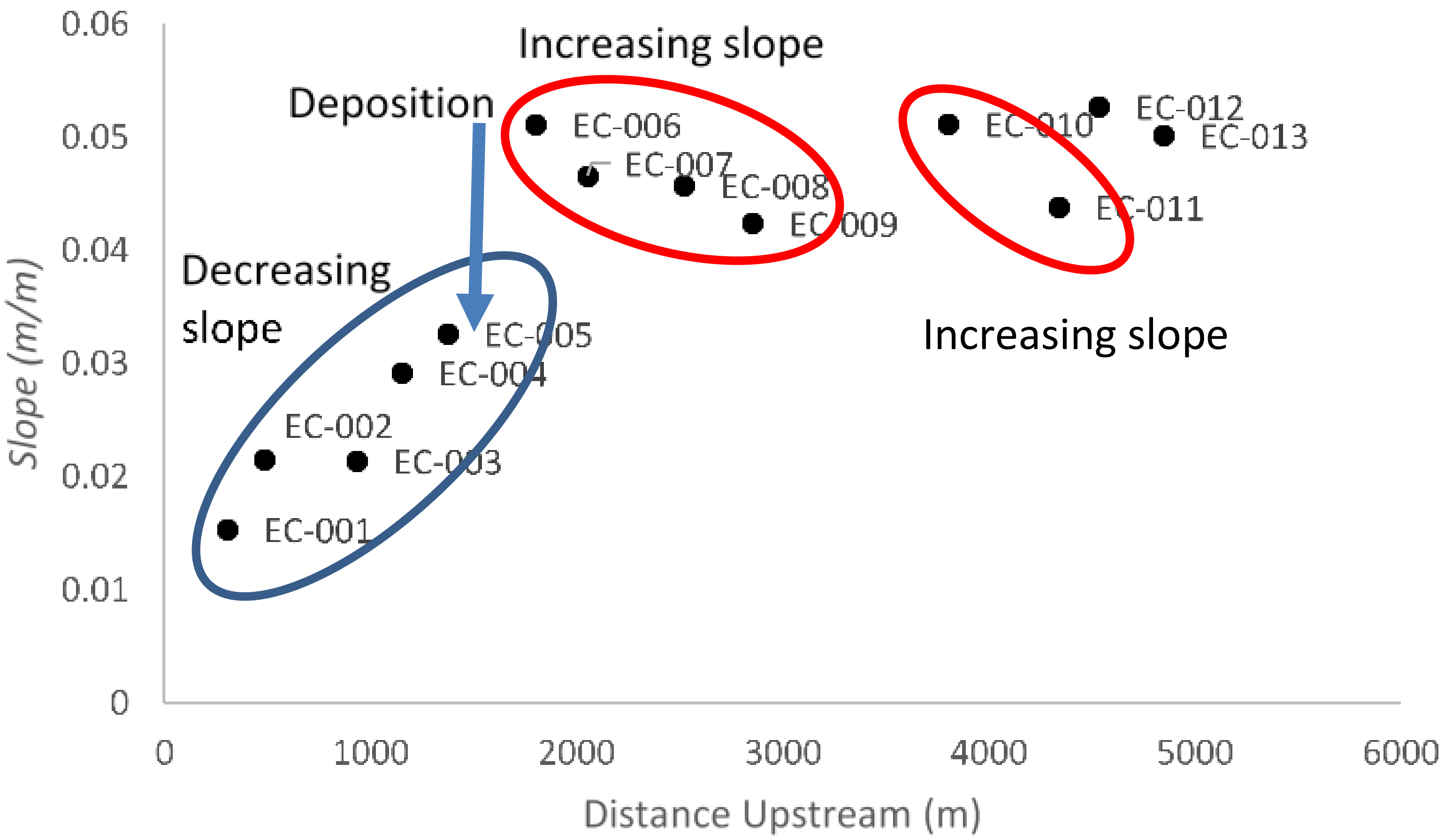
- High slope

Reaches 9 to 6

- Increasing slope

Reaches 5 to 1

- Decreasing slope



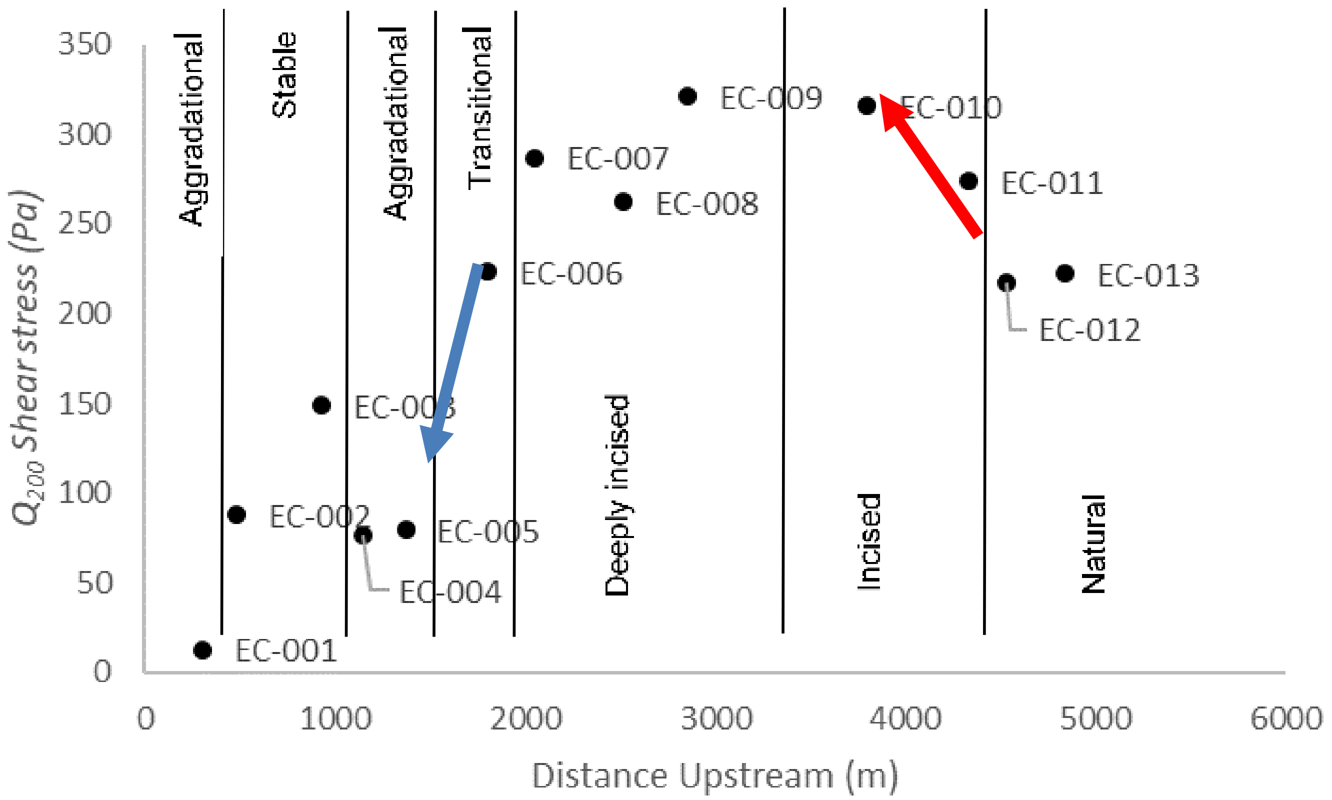
Shear Stress

Reaches 13 to 9

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

Reaches 9 to 1

- Deceasing shear stress
- Deposition



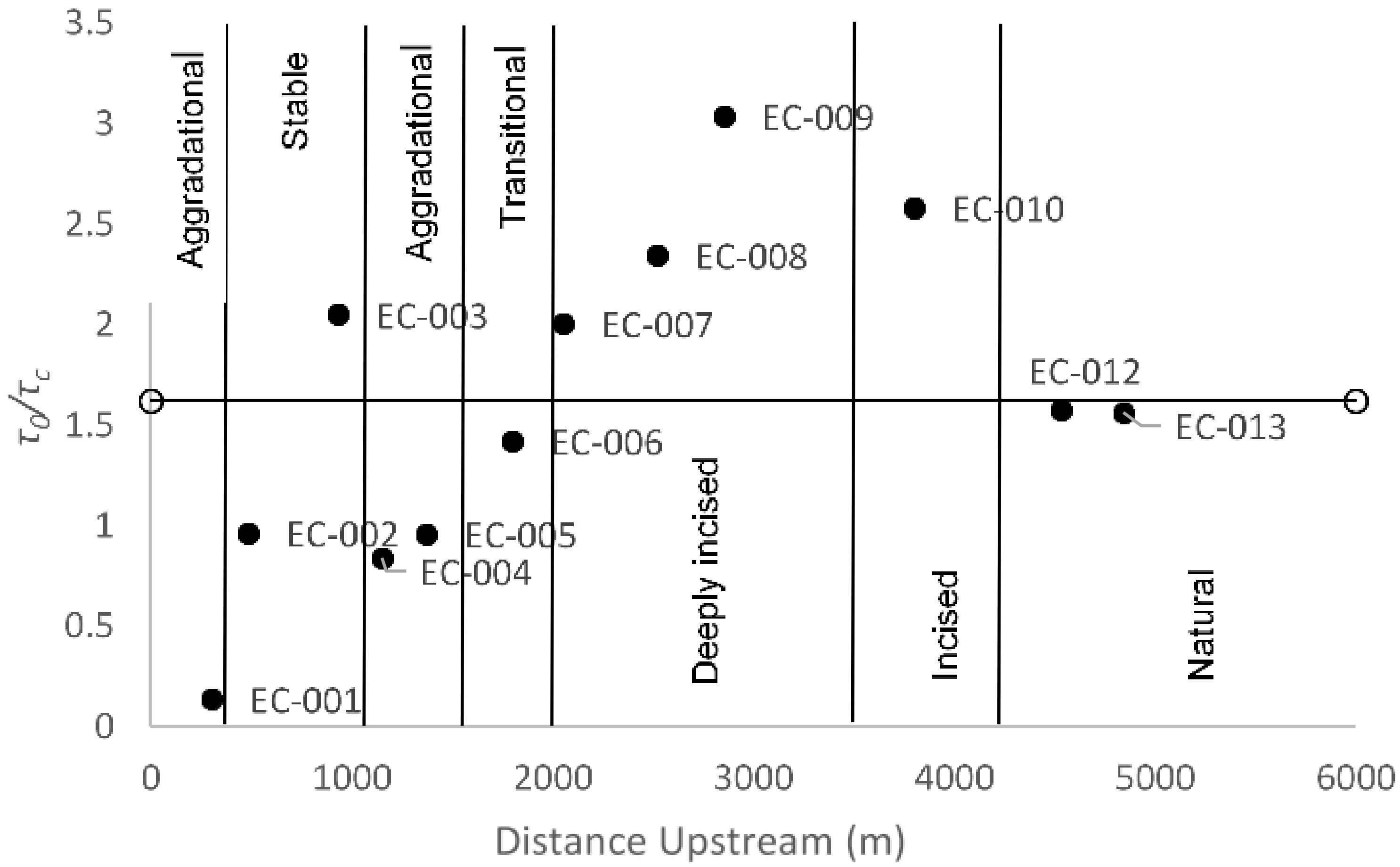
Sediment Mobility

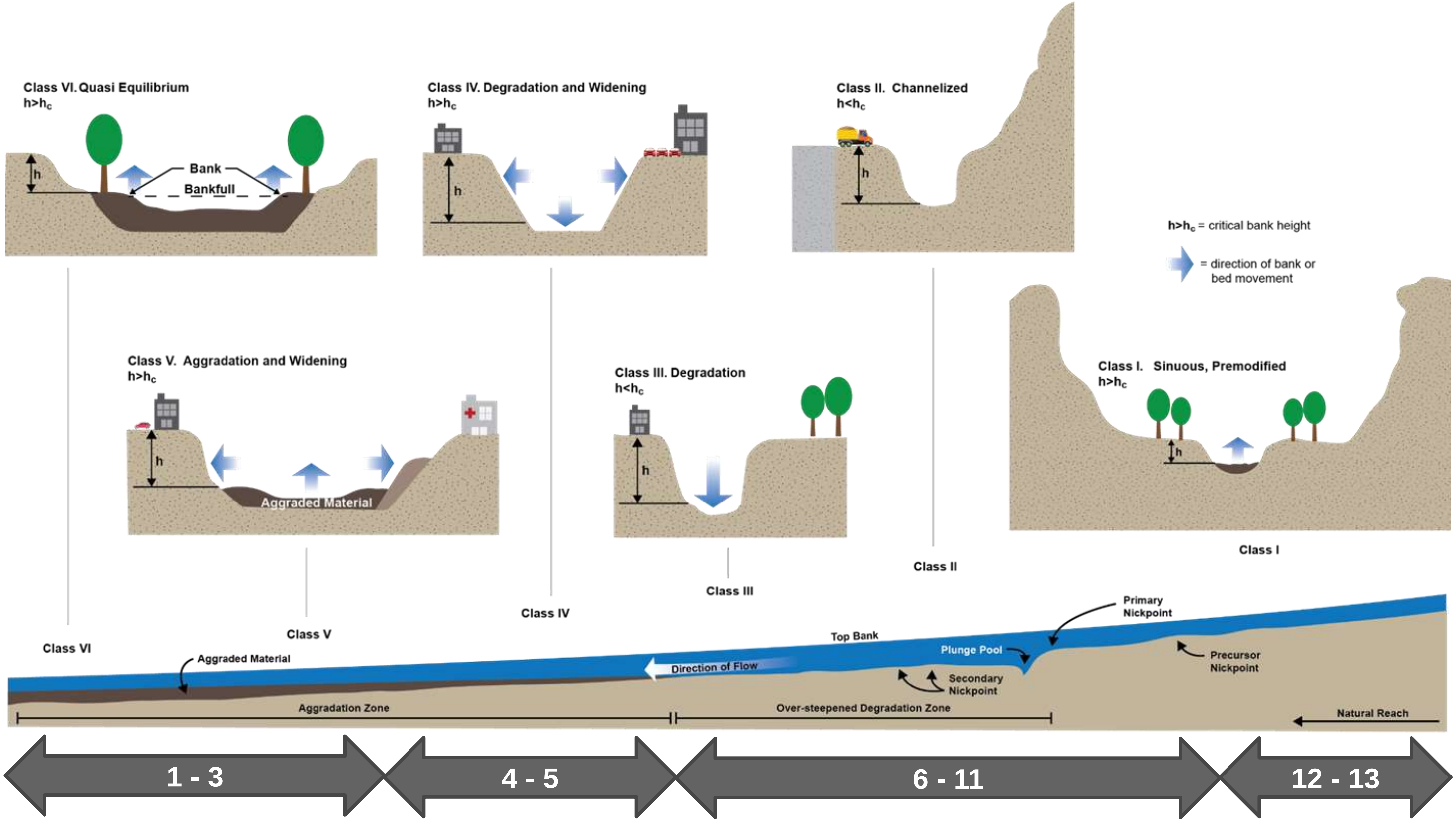
Reaches 12 to 9

- Increasing sediment mobility

Reaches 9 to 5

- Deceasing sediment mobility




Class VI. Quasi Equilibrium
h>hc
Bank
Bankfull
h
Class IV. Degradation and Widening
h>hc
h
Class II. Channelized
h<hc
h
h>hc = critical bank height
= direction of bank or bed movement
Class V. Aggradation and Widening
h>hc
h
Aggraded Material
Class III. Degradation
h<hc
h
Class I. Sinuous, Premodified
h>hc
h
Class VI
Class V
Class IV
Class III
Class II
Class I
Aggraded Material
Direction of Flow
Top Bank
Plunge Pool
Primary Nickpoint
Secondary Nickpoint
Precursor Nickpoint
Aggradation Zone
Over-steepened Degradation Zone
Natural Reach
1 - 3
4 - 5
6 - 11
12 - 13

Questions?

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