Campbell Creek Geomorphology Assessment

CLEAN WATER LAND & LEGACY AMENDMENT

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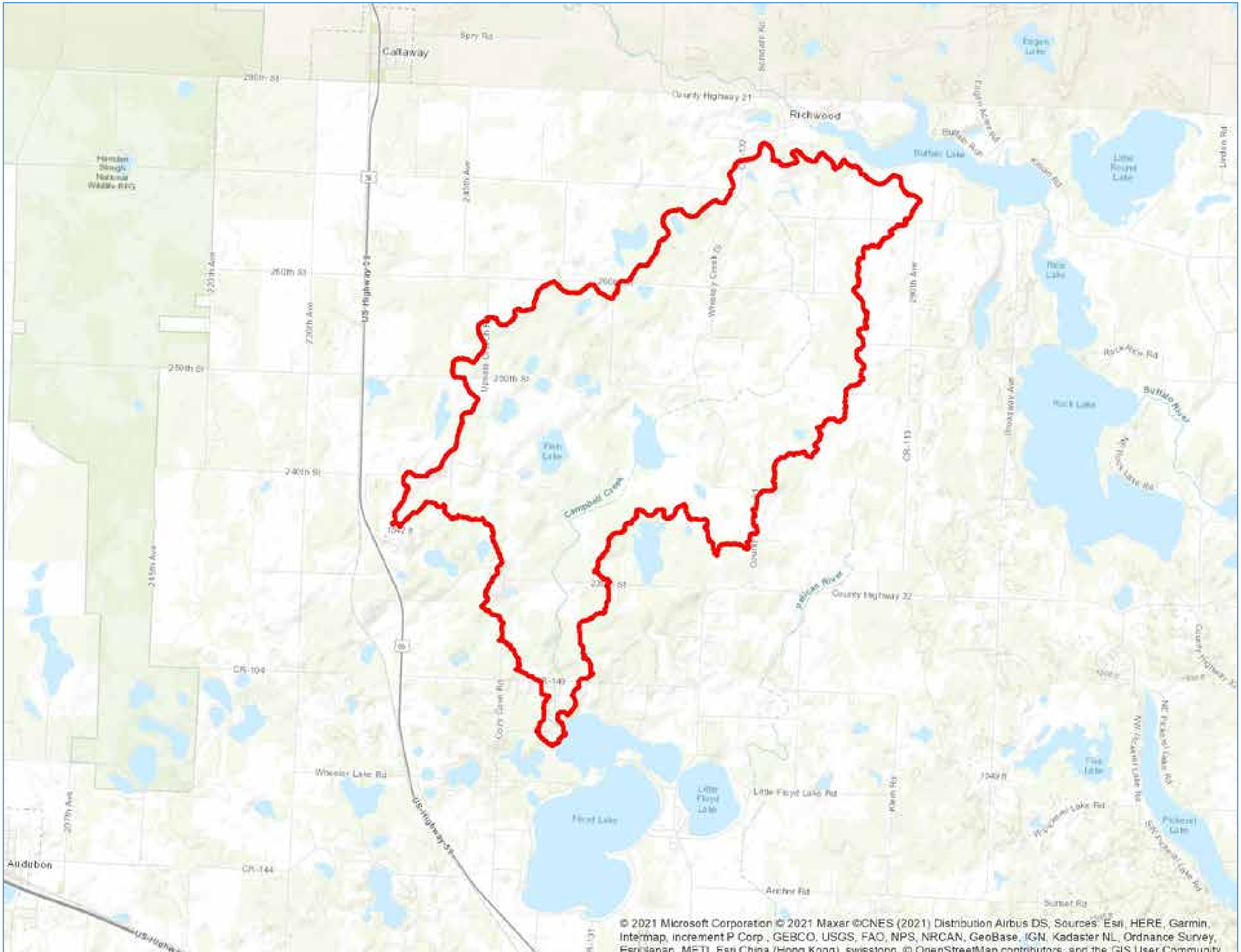
MN DNR Clean Water Specialists

DEPARTMENT OF NATURAL RESOURCES

Campbell Creek Background

- Located within the Upper Pelican River Subwatershed
- Approximately 13 mi^2 drainage area
- Tributary to Mud/Floyd Lakes
- Sediment and nutrient loading concerns to Floyd Lakes


Callaway
Richwood
Buffalo Lake
Little Round Lake
Rice Lake
Rock Lake
Fish Lake
Campbell Creek
Pelican River
Floyd Lake
Little Floyd Lake
Pickerel Lake
Audubon
US-Highway-59
County Highway 21
County Highway 32
260th St
250th St
240th St
CR-104
CR-144
CR-113
Wheeler Lake Rd
Little Floyd Lake Rd
Archer Rd
Sunset Rd
Rock Rice Rd
Buffalo River
Whiskey Creek Rd
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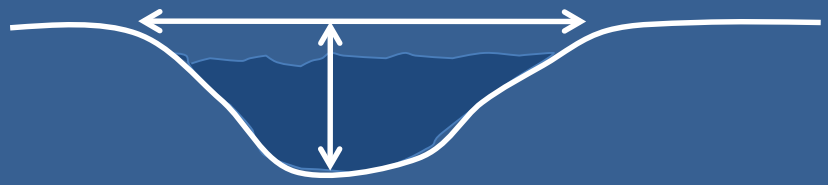
Geomorphology Survey Work

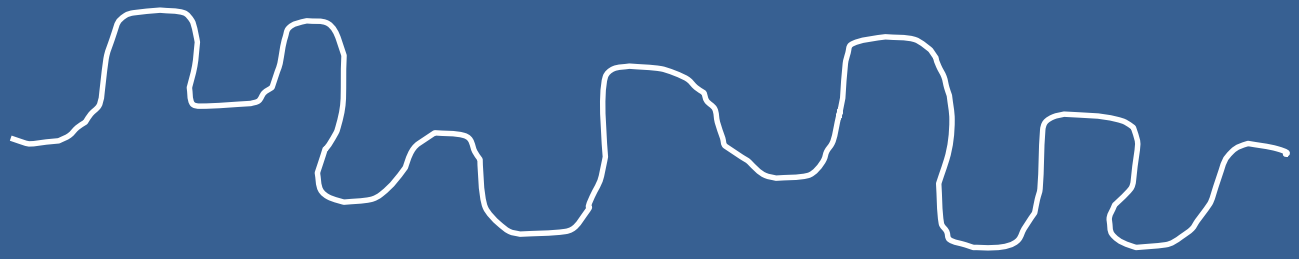
- 2018 field season
  - Bank erosion estimates and limited geomorphology survey (longitudinal profile, cross-sections, pebble counts)
  - Done as part of the Otter Tail River Watershed Restoration and Protection Strategies (WRAPS) assessment

- 2020-2021 field seasons
  - Longitudinal profile
  - Cross-sections (monumented)
  - Stream bed particle (pebble) counts
  - Done as part of an implementation project

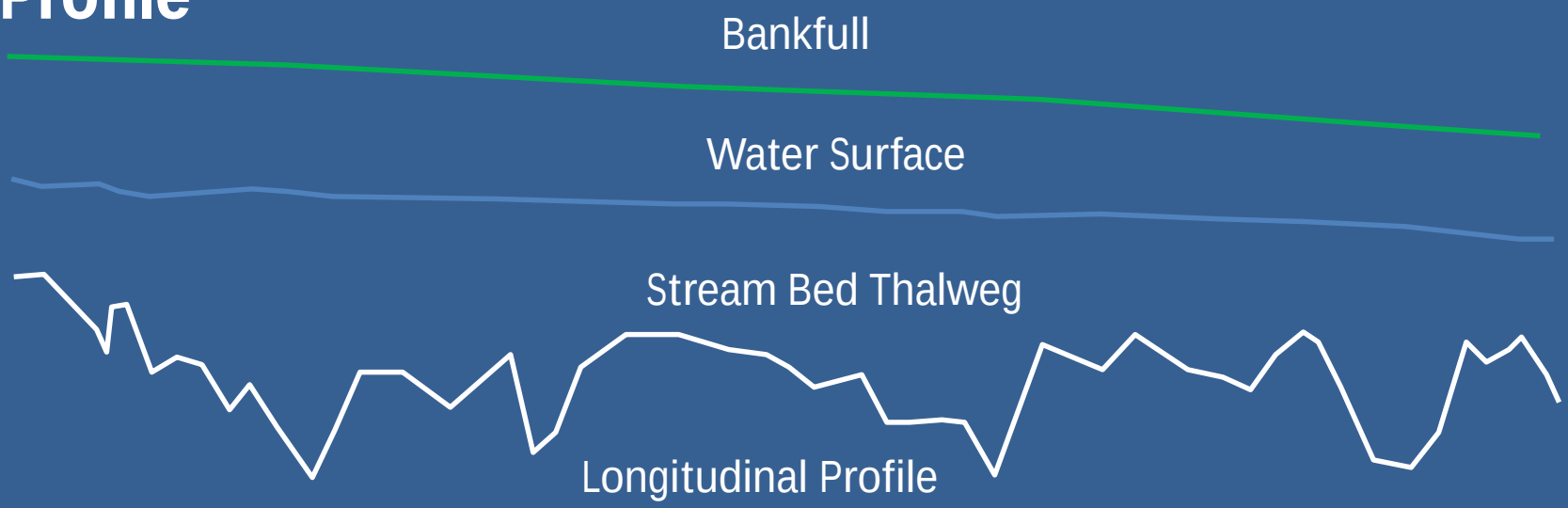
Dimension
(Cross-section)



Pattern
(Top view)



Profile



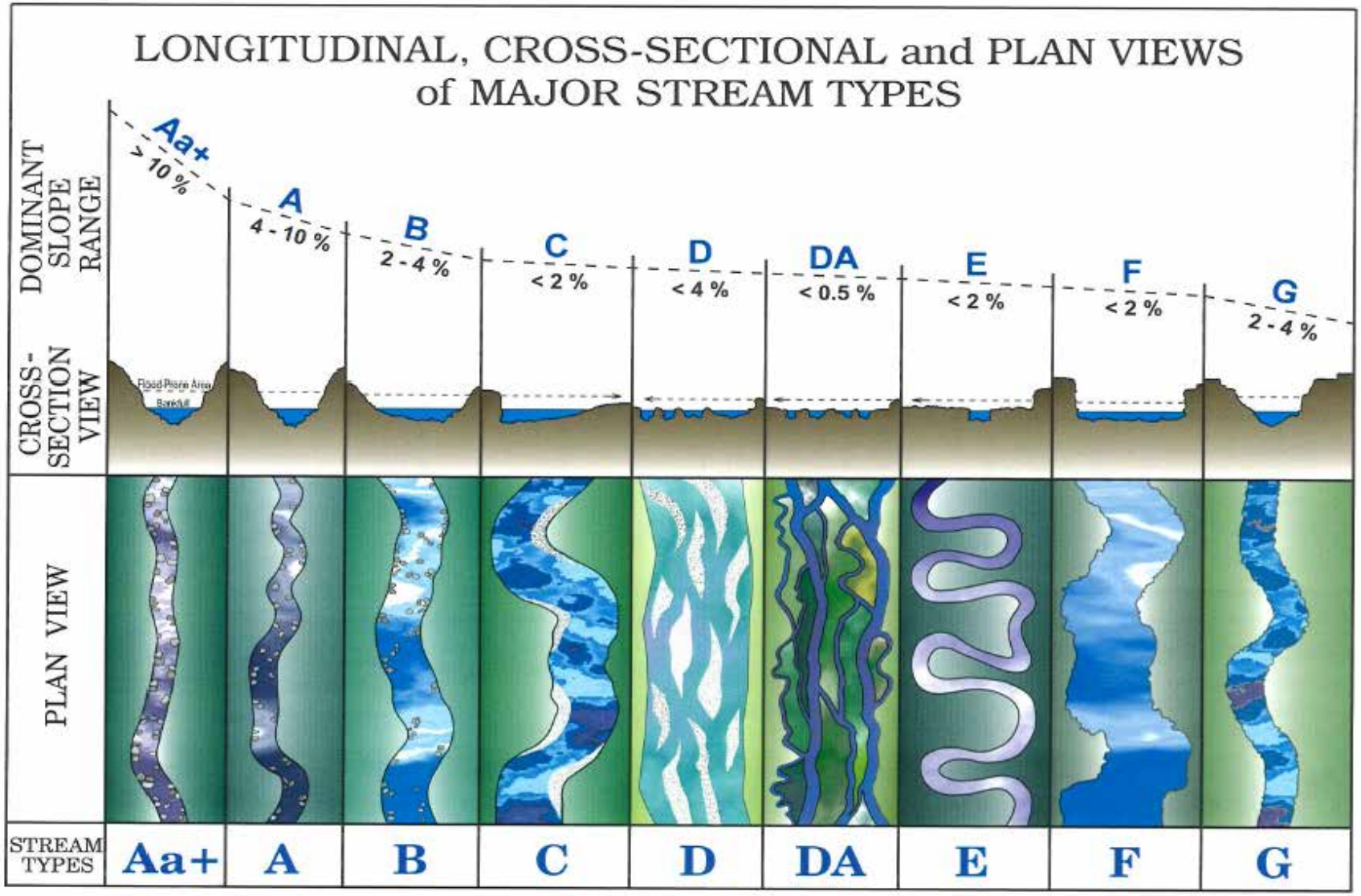
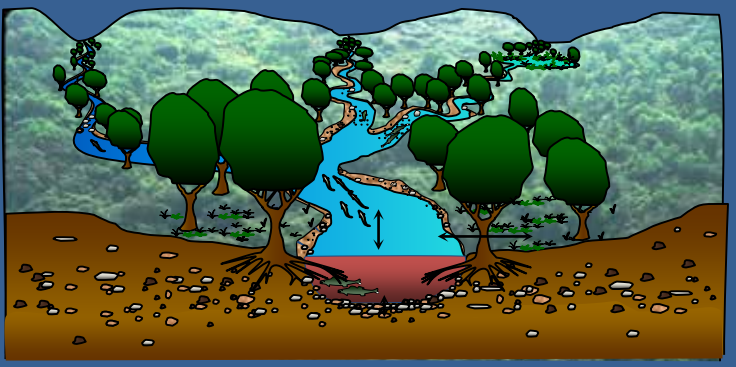


Figure 1-1. Broad-level stream classification delineation showing longitudinal, cross-sectional and plan views of major stream types (Rosgen, 1994, 1996).

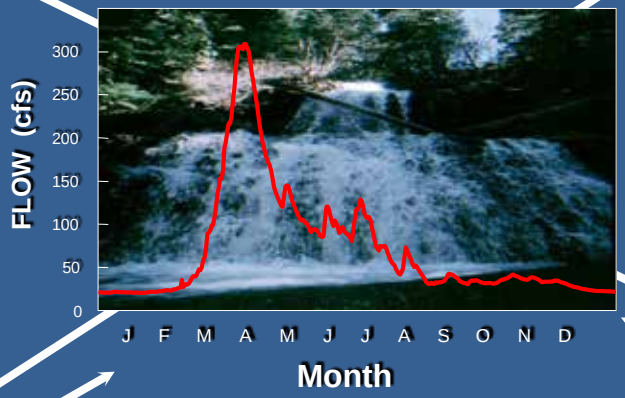
COMPONENTS OF RIVER SYSTEMS

ENERGY PATHWAYS / CONNECTIVITY



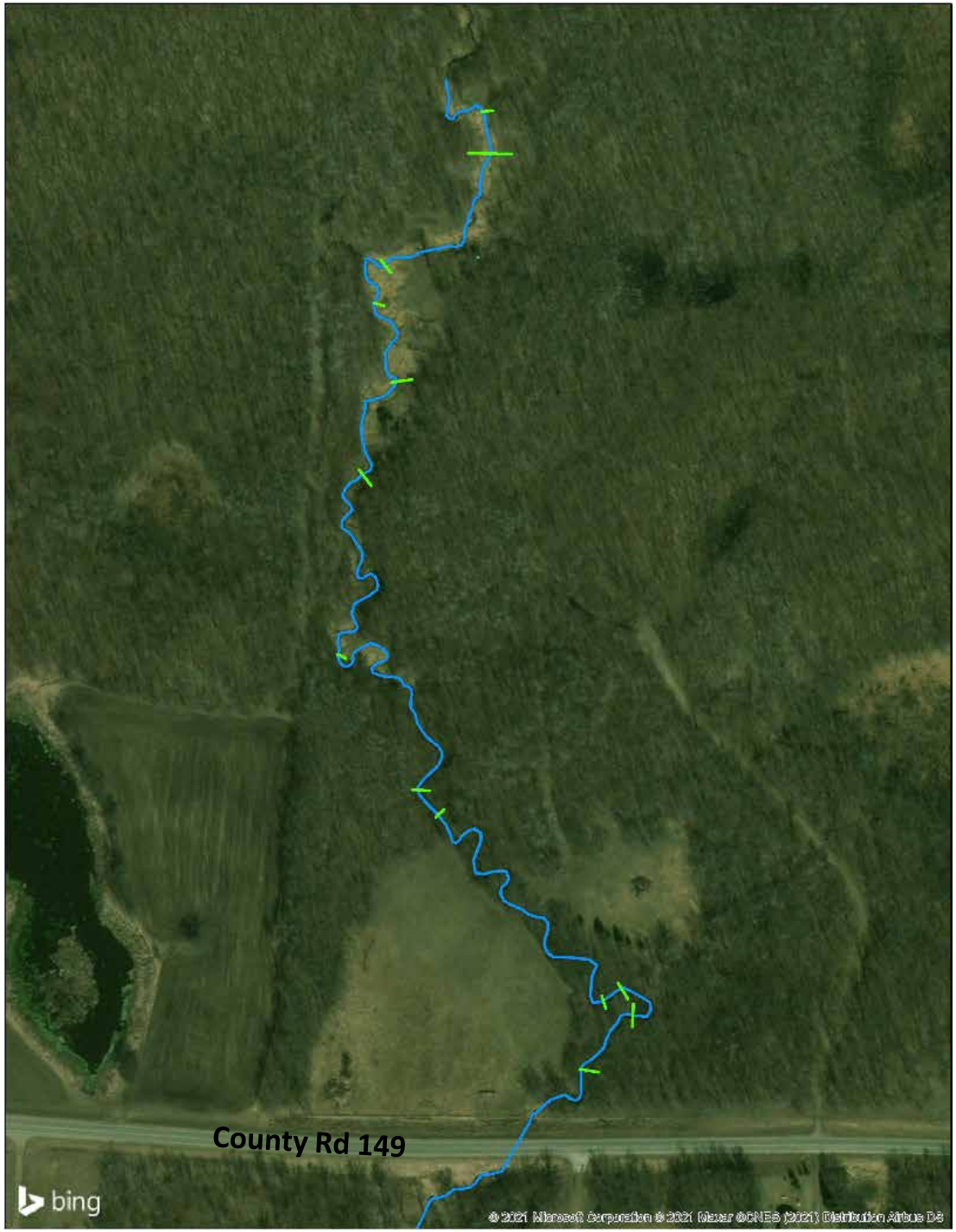
BIOLOGY

HYDROLOGY



GEOMORPHOLOGY

WATER QUALITY


County Rd 149
bing
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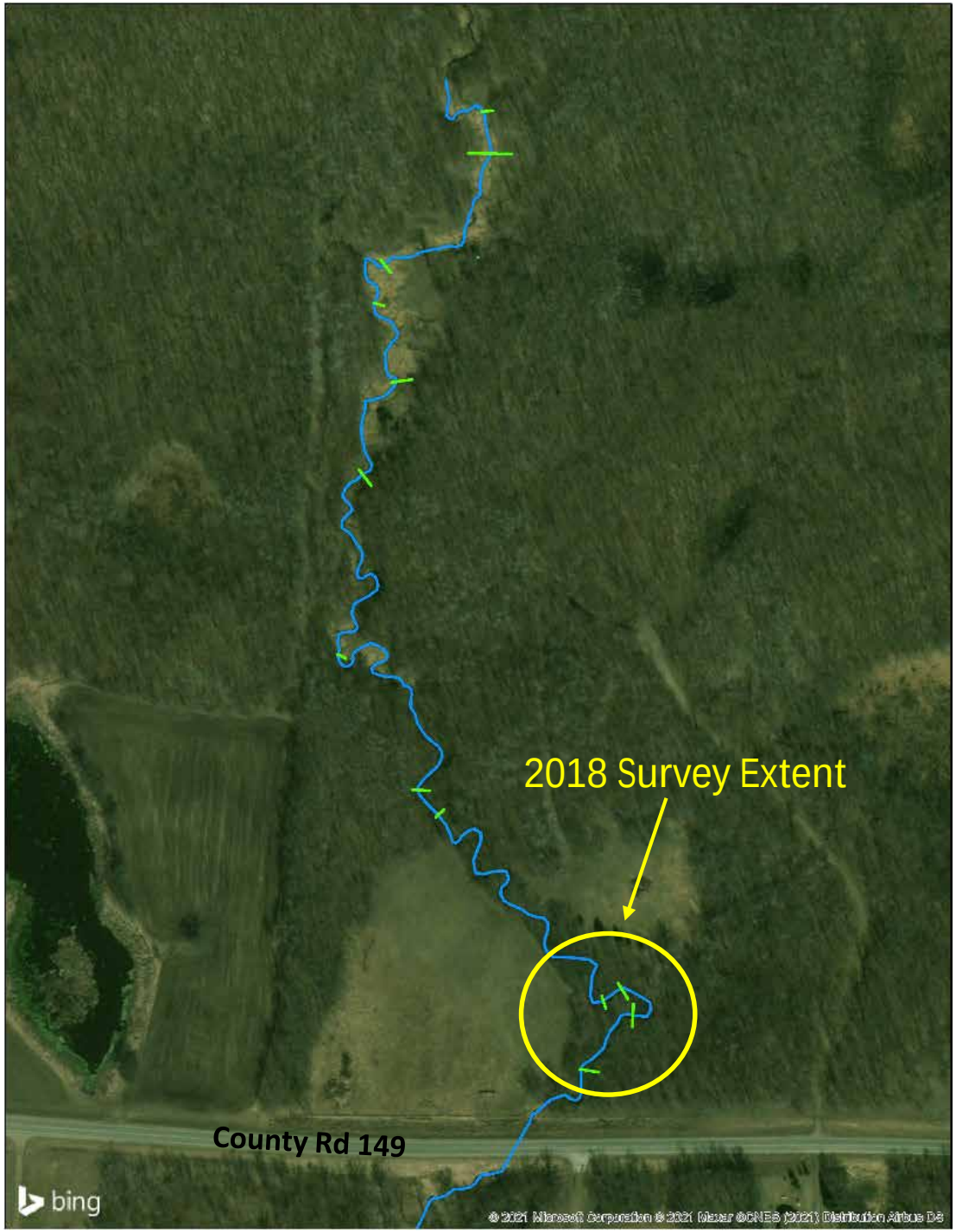
2018 Survey Extent
County Rd 149
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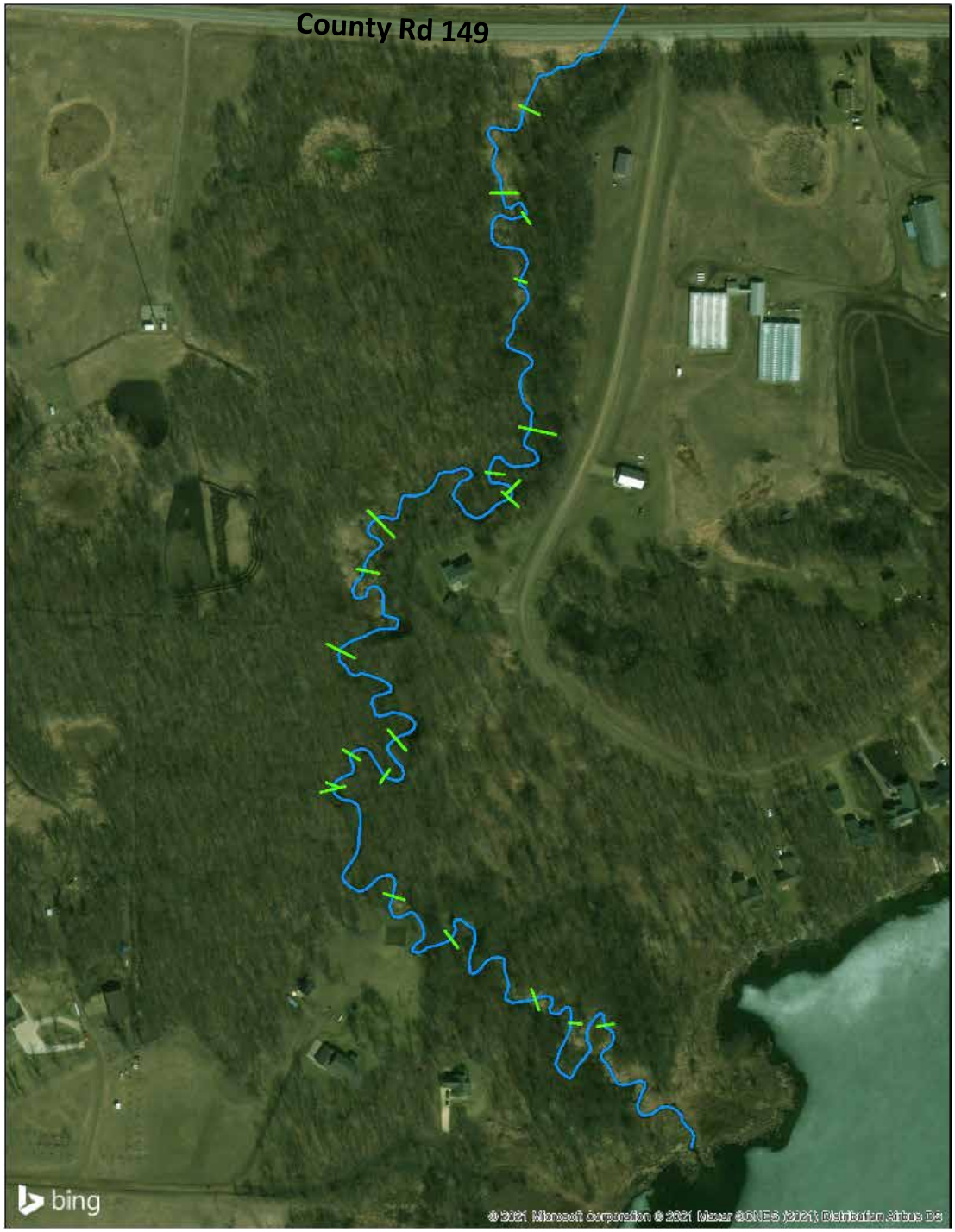
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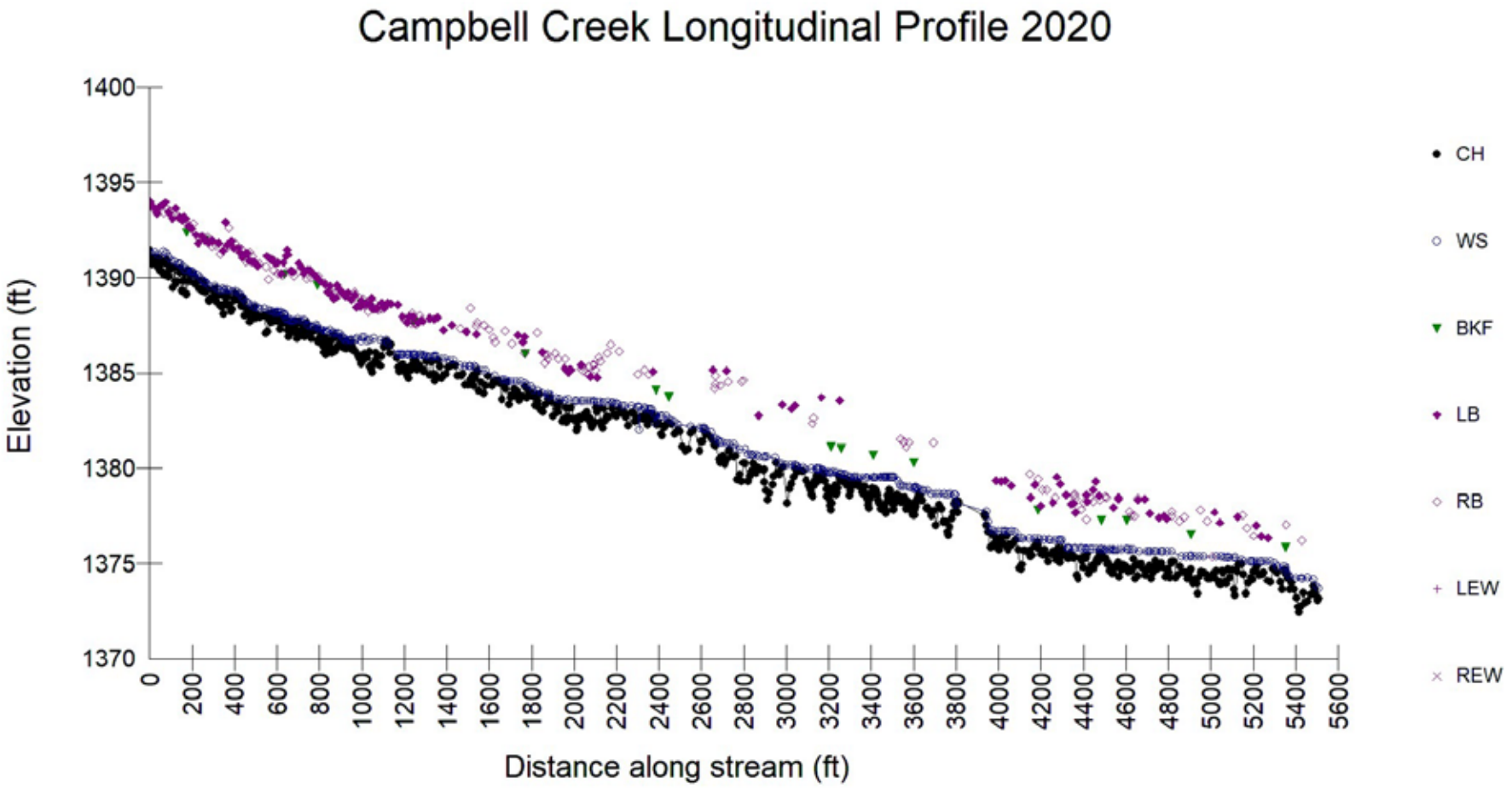
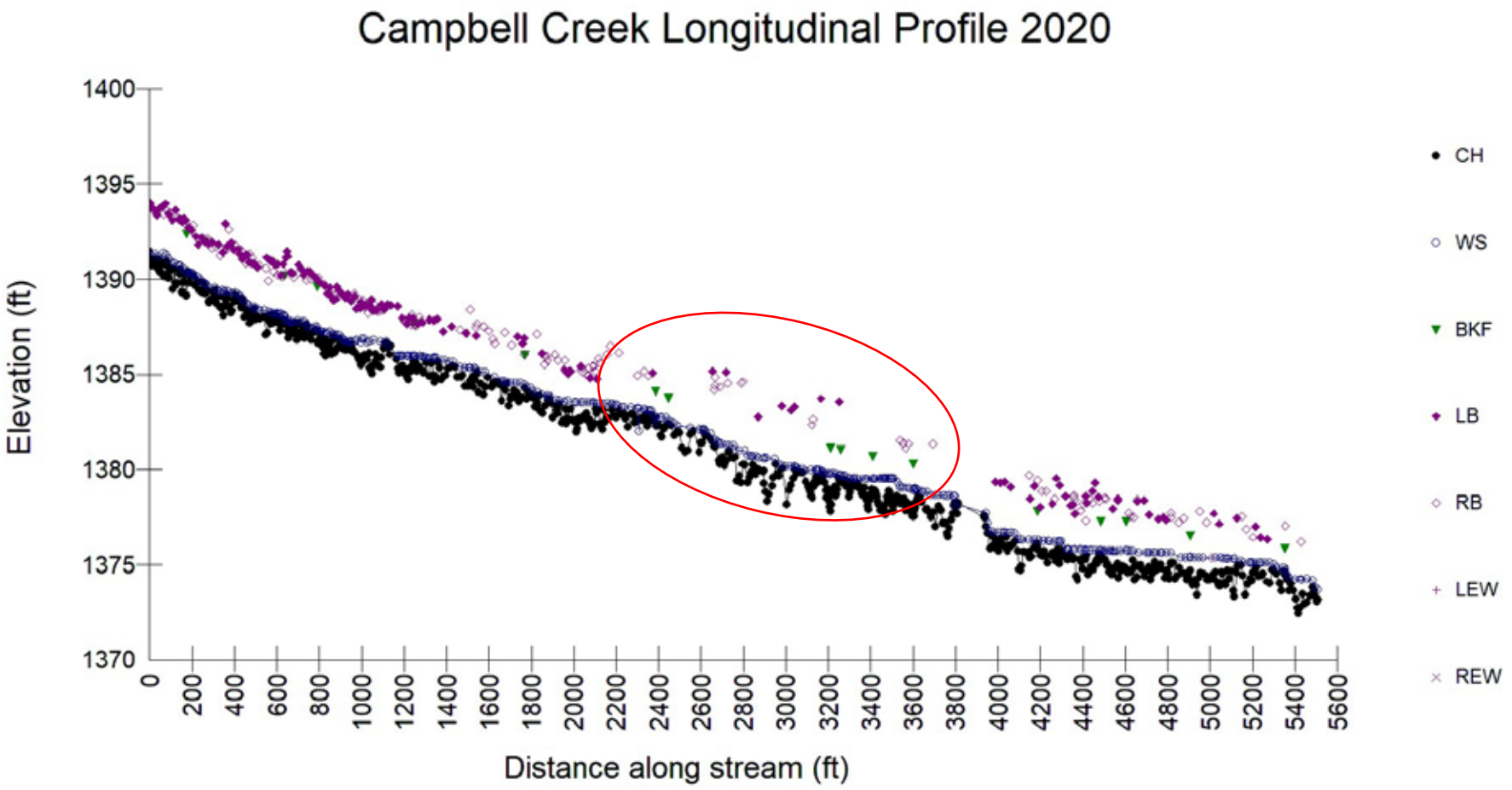

Campbell Creek Longitudinal Profile 2020
Elevation (ft)
1400
1395
1390
1385
1380
1375
1370
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
4200
4400
4600
4800
5000
5200
5400
5600
Distance along stream (ft)
CH
WS
BKF
LB
RB
LEW
REW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1400
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1390
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1380
1375
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400
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2400
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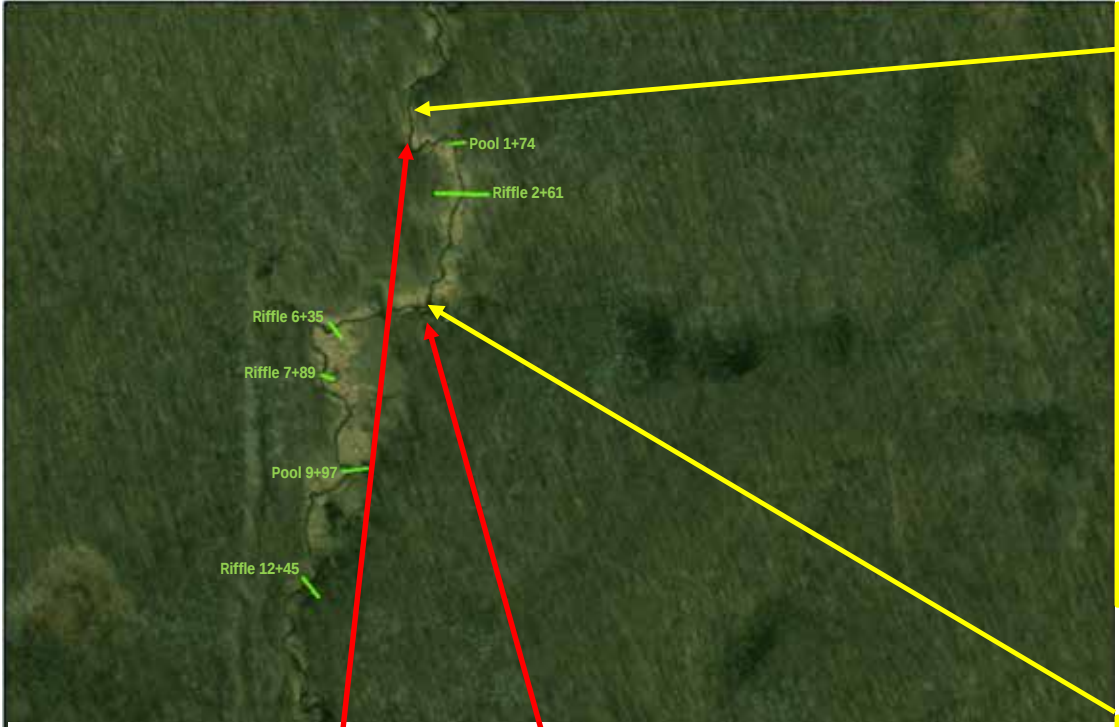
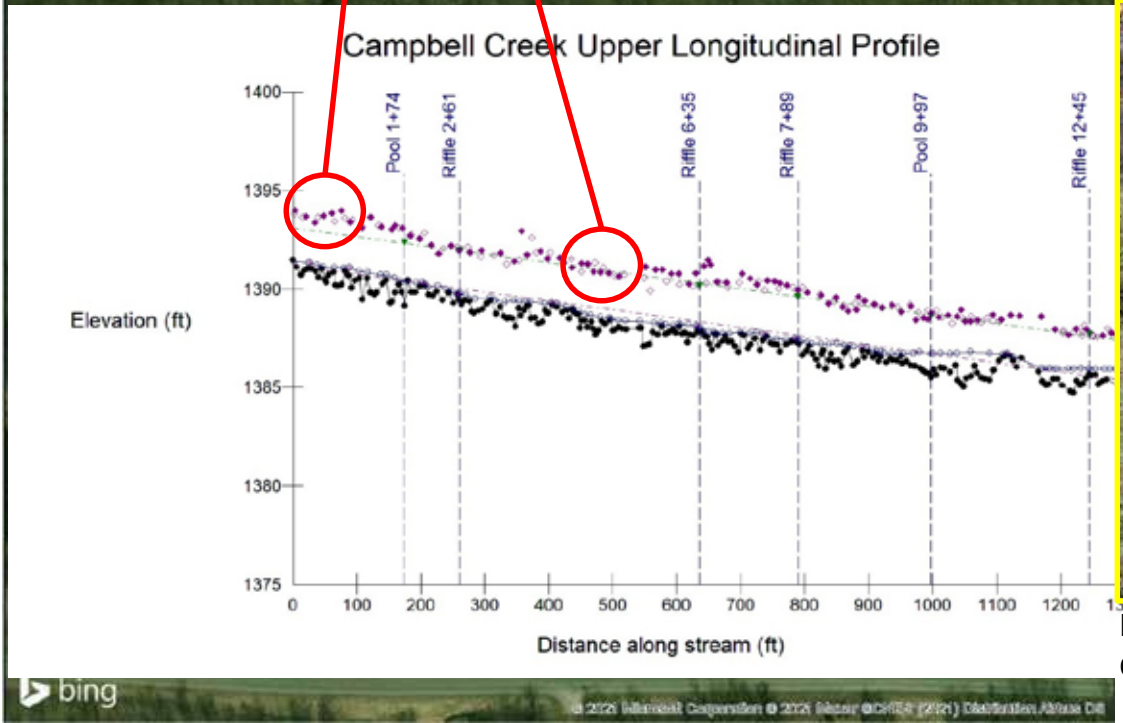
3600
3800
4000
4200
4400
4600
4800
5000
5200
5400
5600
Distance along stream (ft)
CH
WS
BKF
LB
RB
LEW
REW

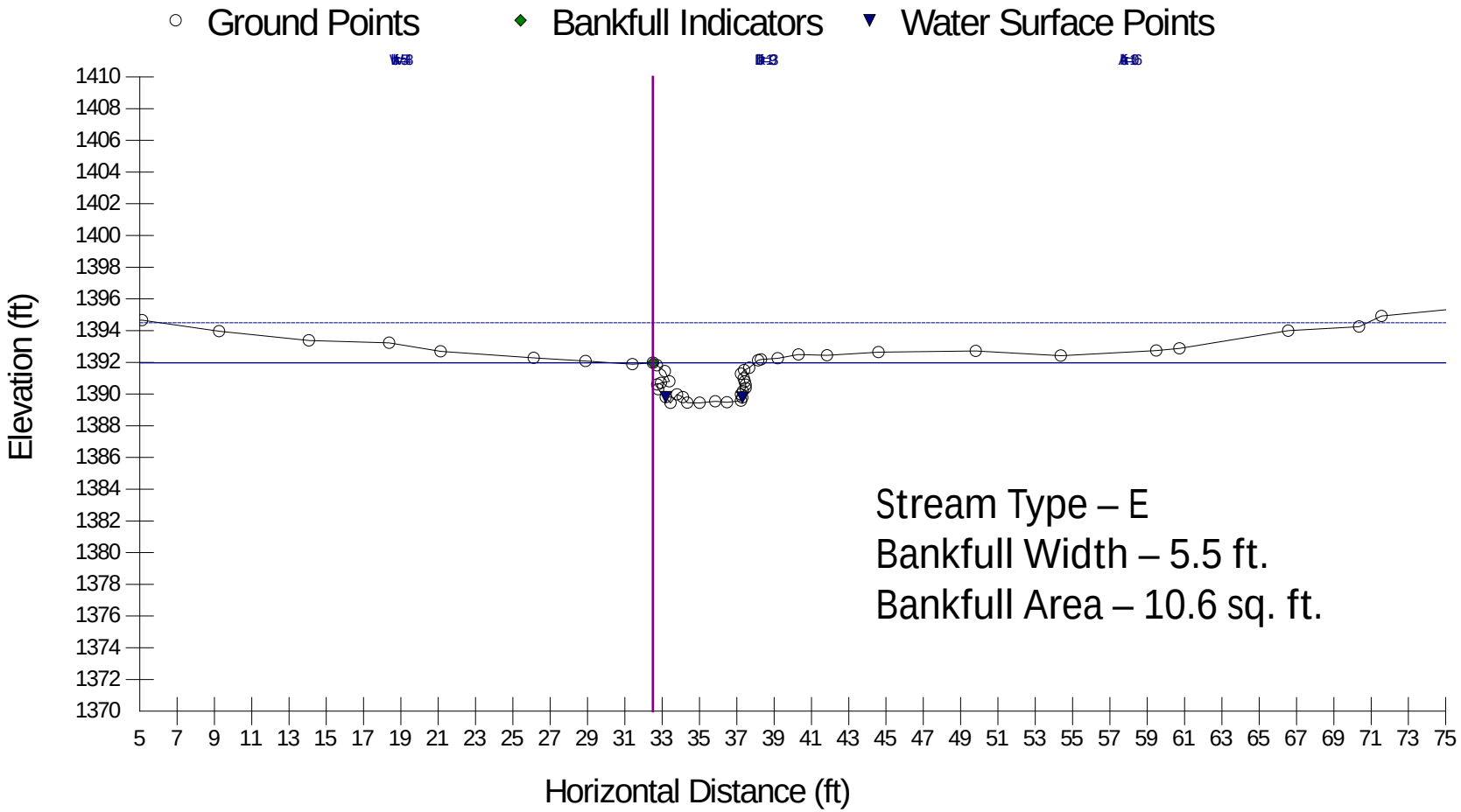


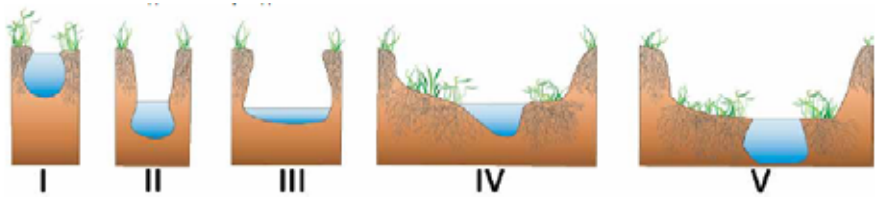
Downstream view from start of longitudinal profile. Some incision but areas with floodplain access at bankfull.



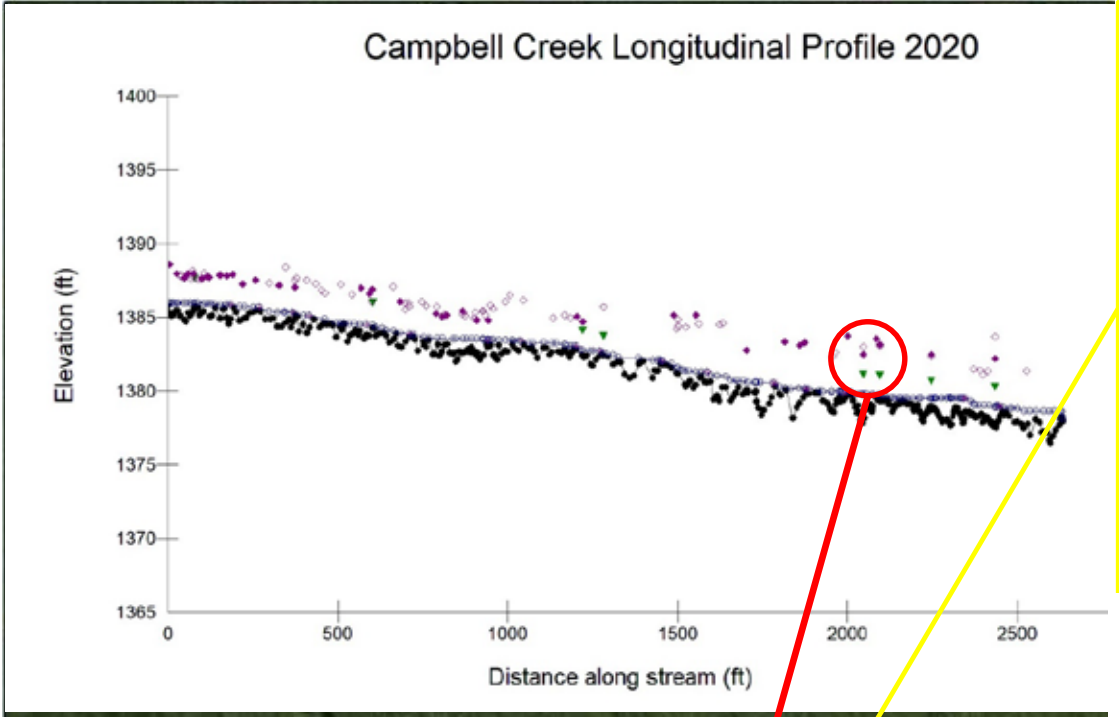
Downstream view from just upstream of culvert crossing. Good floodplain access at bankfull

Campbell Riffle 2+61





I. A properly shaped stream in **equilibrium** and connected to its floodplain prior to disturbance.
II. **Channel incision** from ditching or by a headcut originating in a channelized reach due to increased slope and flow.
III. **Channel widening** as the channel begins to meander again.
IV. A more properly shaped stream as it evolves to re-establish equilibrium and rebuild a new floodplain.
V. A new, properly shaped channel in equilibrium with a lowered floodplain.



Downstream view within incised and moderately entrenched section of reach, just upstream of pool 32+12. Historically, a wide floodplain was accessible here.

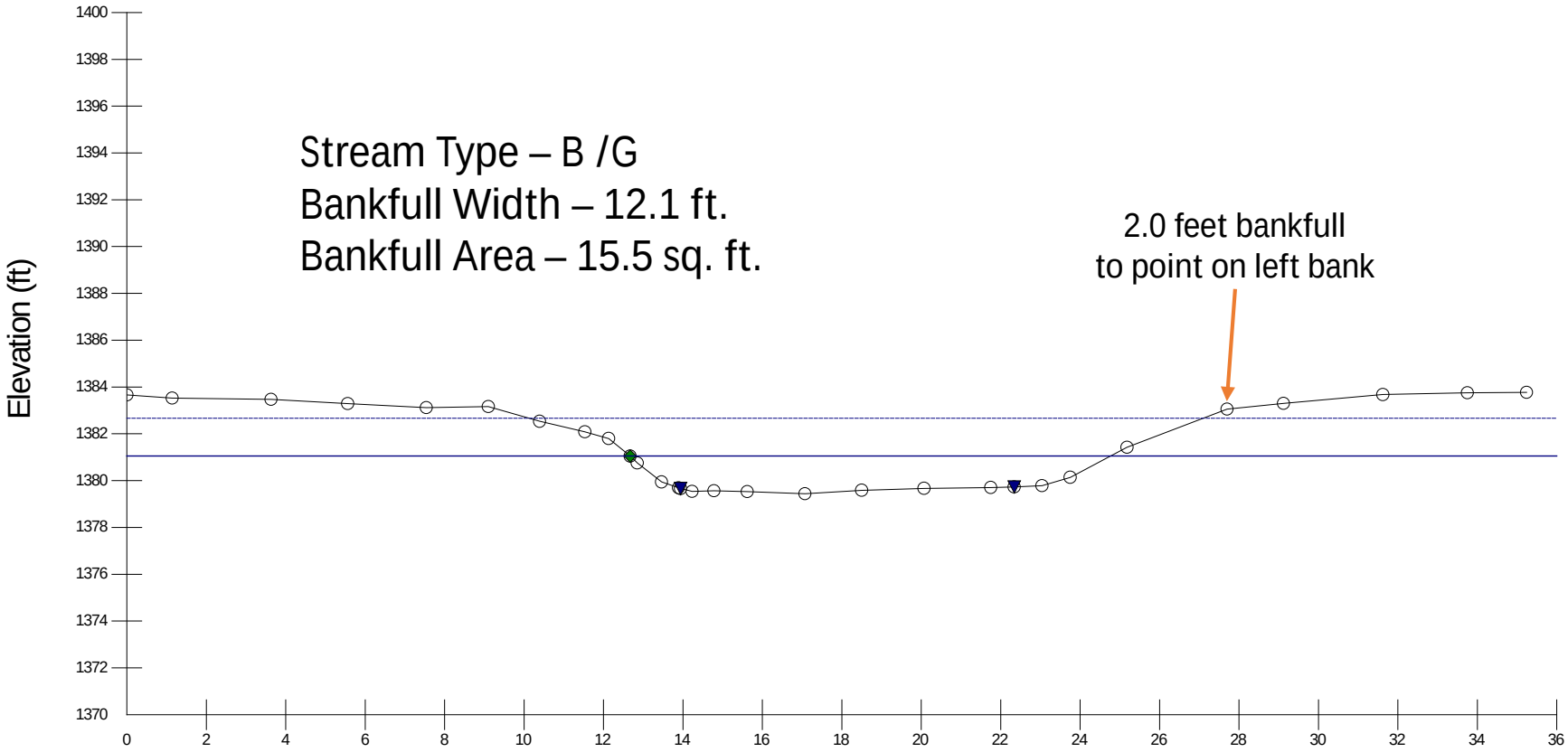
Upstream view within incised and moderately entrenched section of reach, just upstream of CR 149 crossing. Historically, a wide floodplain was accessible here.

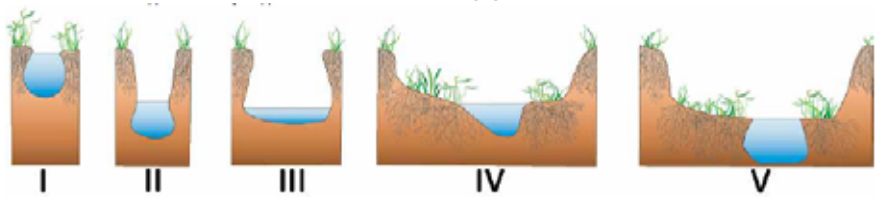
Riffle 32+61

Ground Points Bankfull Indicators Water Surface Points

Stream Type – B /G
Bankfull Width – 12.1 ft.
Bankfull Area – 15.5 sq. ft.

2.0 feet bankfull
to point on left bank





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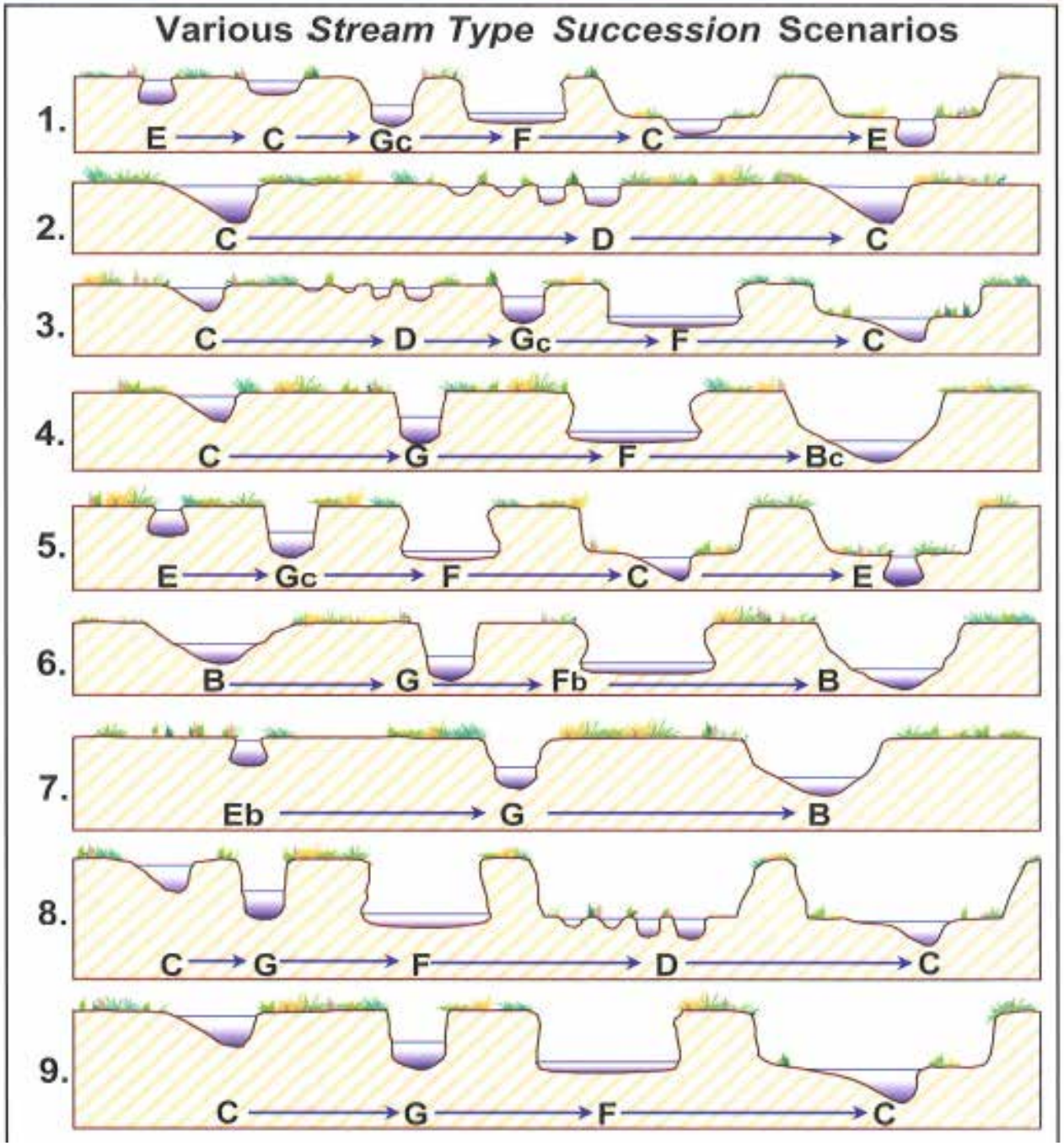
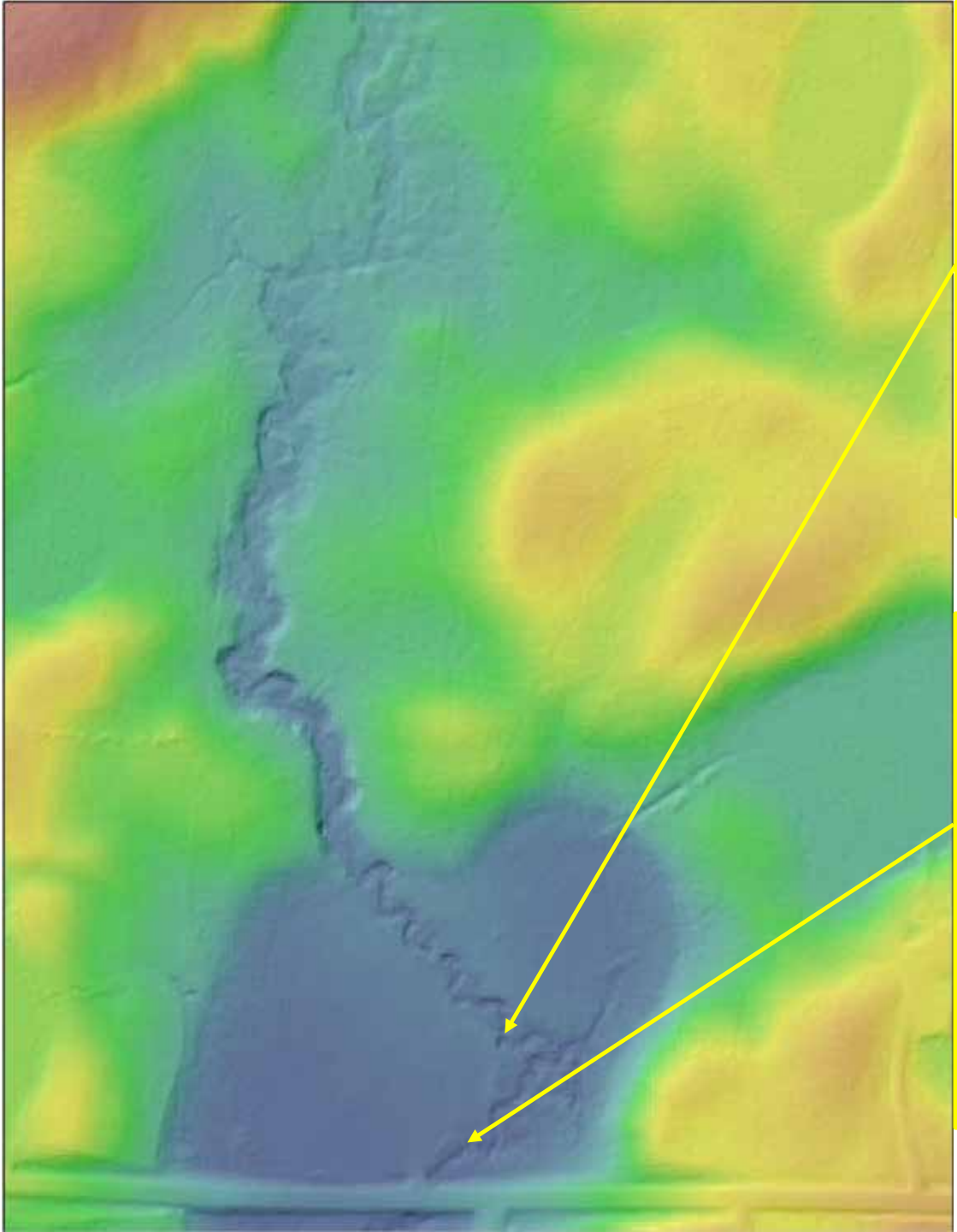
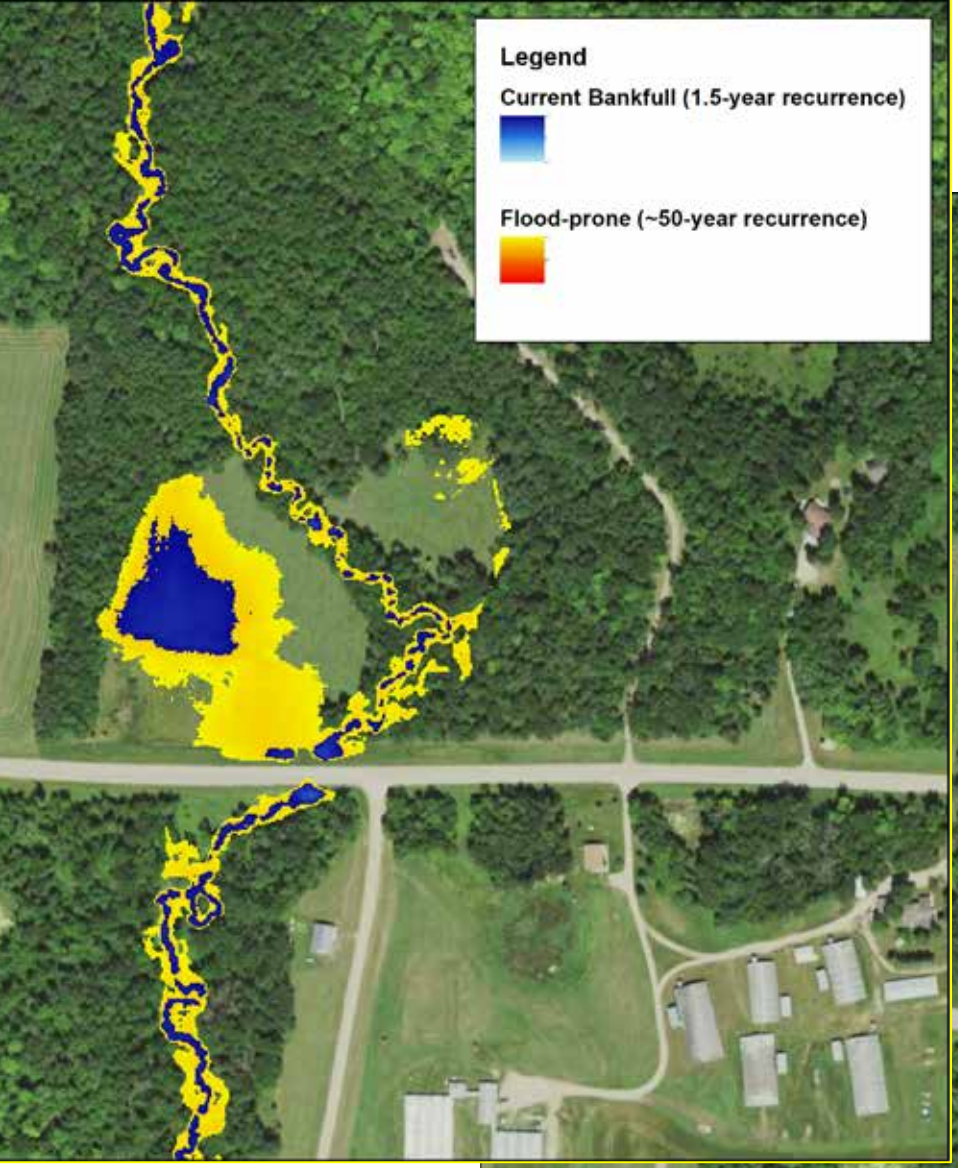
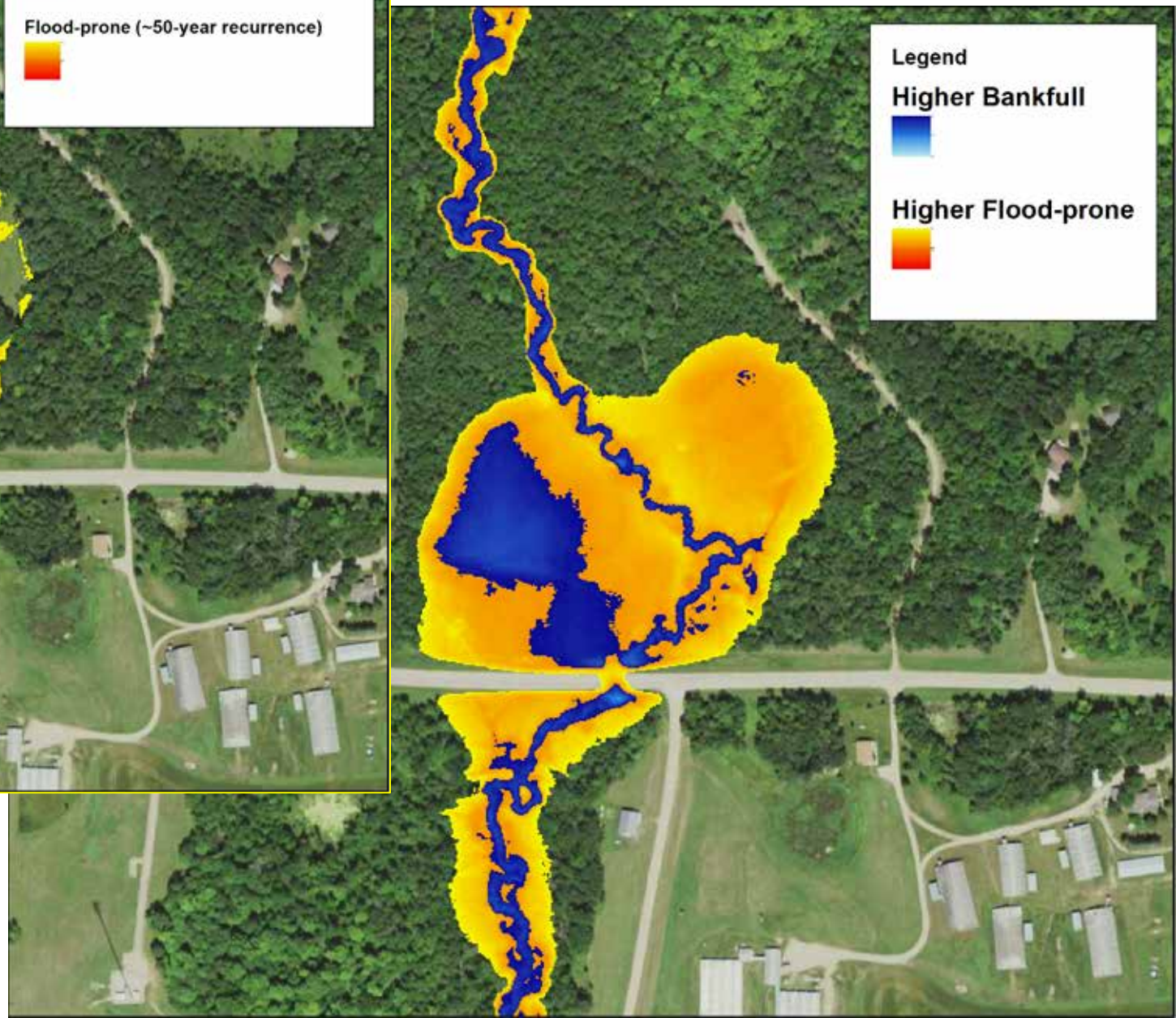

Various Stream Type Succession Scenarios
1.
E → C → Gc → F → C → E
2.
C → D → C
3.
C → D → Gc → F → C
4.
C → G → F → Bc
5.
E → Gc → F → C → E
6.
B → G → Fb → B
7.
Eb → G → B
8.
C → G → F → D → C
9.
C → G → F → C

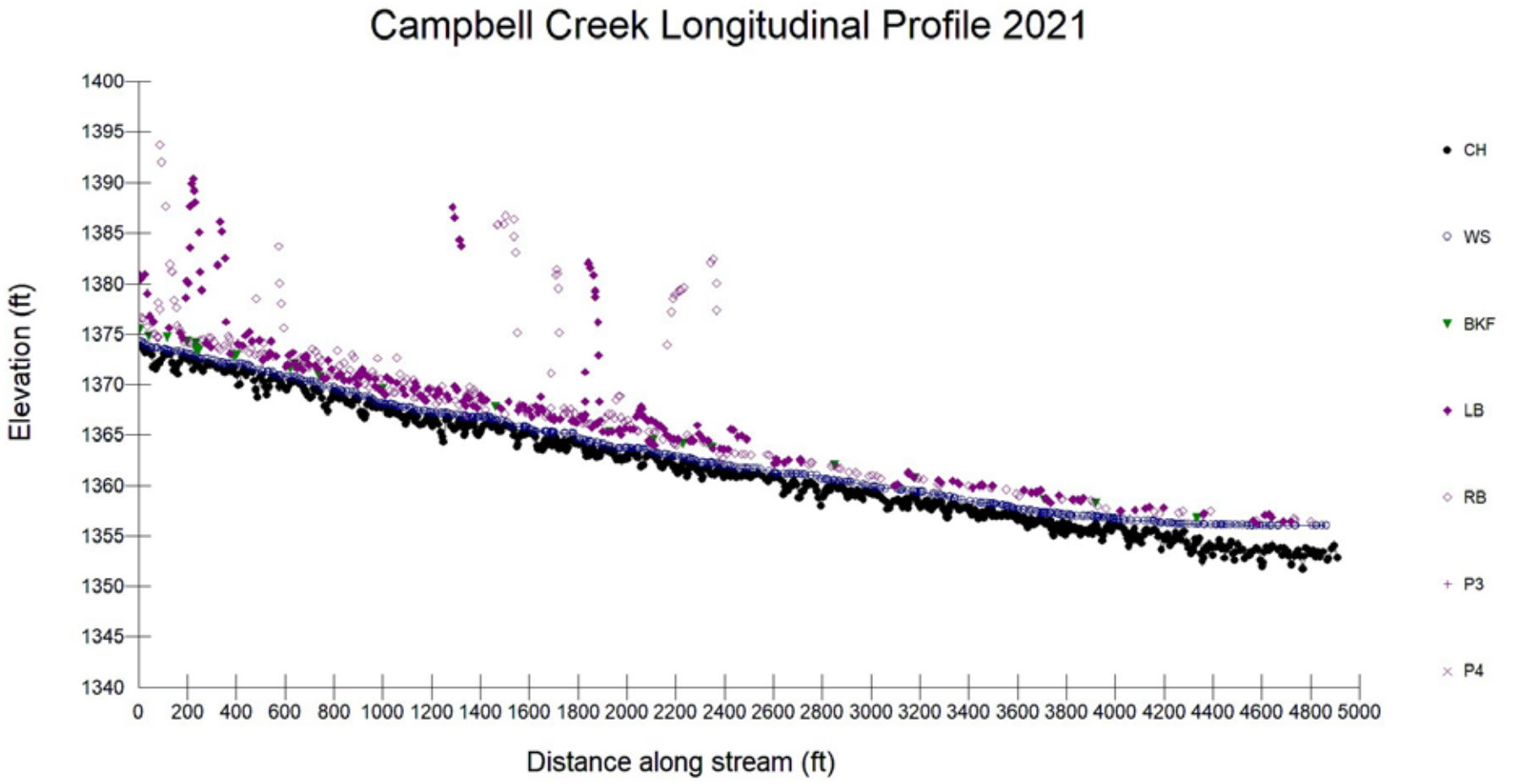


Downstream view within incised and moderately entrenched section of reach, just upstream of pool 32+12. Historically, a wide floodplain was accessible here.

Upstream view within incised and moderately entrenched section of reach, just upstream of CR 149 crossing. Historically, a wide floodplain was accessible here.


Legend
Current Bankfull (1.5-year recurrence)
Flood-prone (~50-year recurrence)


Legend
Higher Bankfull
Higher Flood-prone


Campbell Creek Longitudinal Profile 2021
Elevation (ft)
1400
1395
1390
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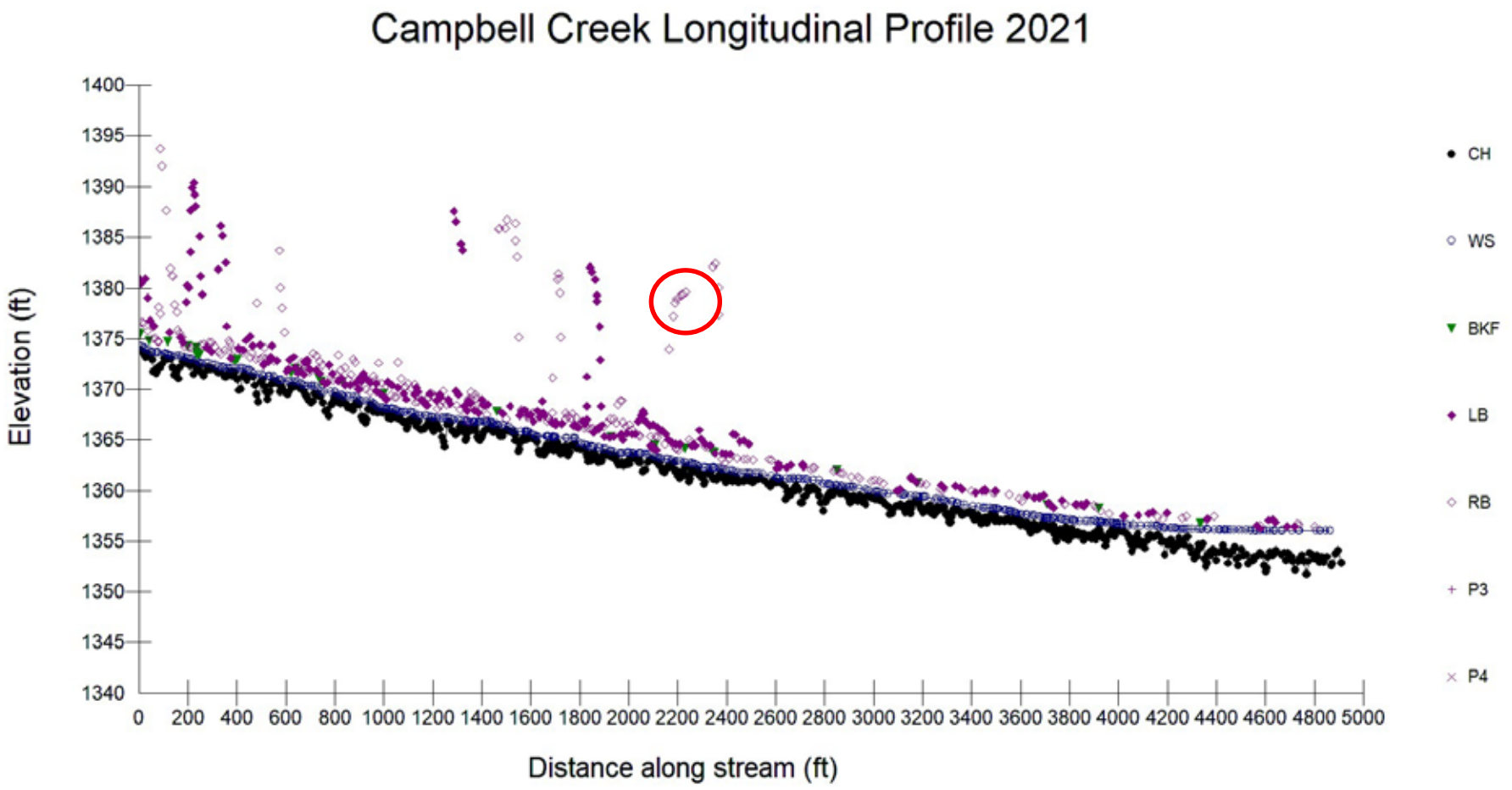
1355
1350
1345
1340
0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600 2800 3000 3200 3400 3600 3800 4000 4200 4400 4600 4800 5000
Distance along stream (ft)
CH
WS
BKF
LB
RB
P3
P4


Campbell Creek Longitudinal Profile 2021
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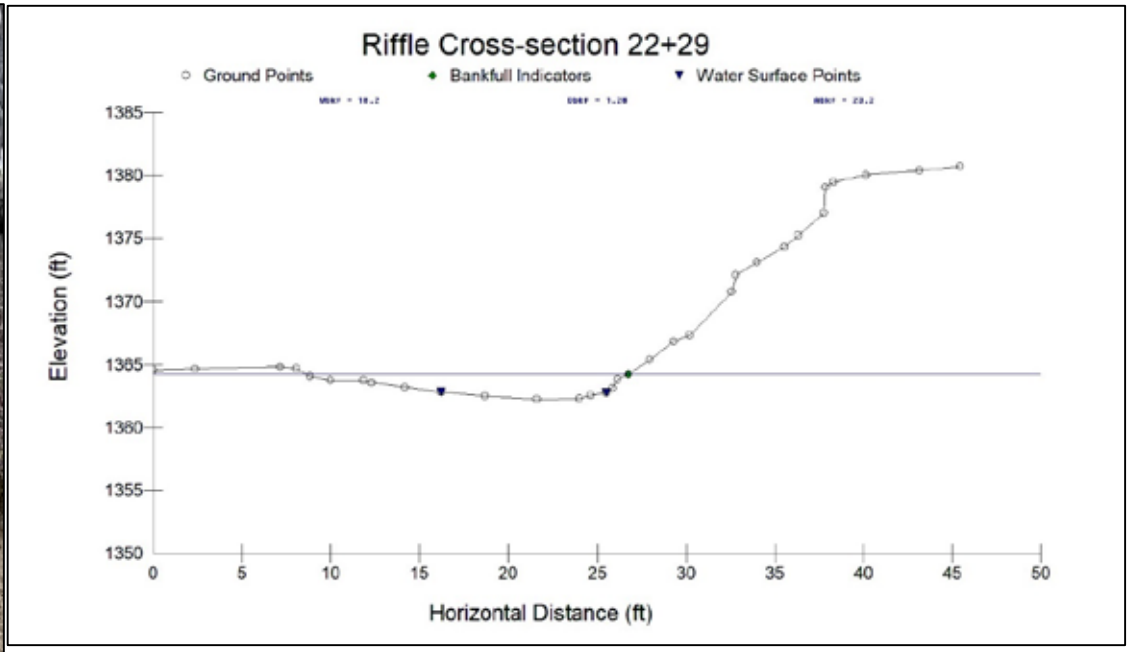
Distance along stream (ft)
CH
WS
BKF
LB
RB
P3
P4

Monumented cut-bank cross-section



Bench forming at base of bank

Preliminary Recommendations

- Where incised, raise stream bed elevation using rock riffle grade control structures
- Remove log/debris jams where causing bed/bank scour or deposition (woody debris is natural and beneficial)
- Encourage growth of deep rooted vegetation in upstream meadow area (does not need to be woody)
- Manage grazing to address bank trampling and overgrazing of riparian vegetation
- Monitor high cut-banks
  - Could pursue installing toe wood sod mats where flood plain is accessible on opposite bank (access might be an issue in some locations)

Photos and other examples in following slides...

Debris jam example

Bank cutting and slumping (vegetation example)

Bank trampling example

Natural Design Approaches

Landscape scale
- Riparian and floodplain vegetation buffers
- Re-establish and protect the floodplain

Streambank stabilization and protection
- Vegetation: deep rooted vegetation on banks
- Biodegradable erosion-control blankets or hydroseeding
- Brush mattresses
- Biologs, wattles, or fiber rolls
- Tree revetments
- Toe wood-sod mats

In-stream bank protection
- Root wad revetments
- Bankfull bench
- J-hooks and rock vanes

MN DNR – Resource Sheet 1: Streambank Erosion and Restoration (2010)

Grazing Management in Woody Draws Associated with Riparian Zones (associated with adjacent upland pasture)

Livestock are attracted to woody draws because they may provide a source of water, a source of forage that is generally greener longer into the grazing season, and shade. Also, livestock tend to loaf in these areas. To offset the attractiveness of these areas to livestock and reduce the amount of time livestock spend in these areas, the manager needs to:

- **Alter livestock distribution patterns through:**
  - Moving salt and mineral away from woody draws
  - Developing fresh stock water on the uplands
  - Installing drift fence to alter cattle trailing
  - Placing or herding animals (low-stress animal handling)

TIP: Off-stream water sources have been shown to reduce time livestock spent in streams by up to 89 percent and in stream areas by 51 percent. Cattle preferred drinking from a fresh water source up to 92 percent of the time, compared with drinking from the stream. Stream bank erosion was reduced by up to 77 percent when off-stream water sources were utilized.
Source: Sheffield. 2003.

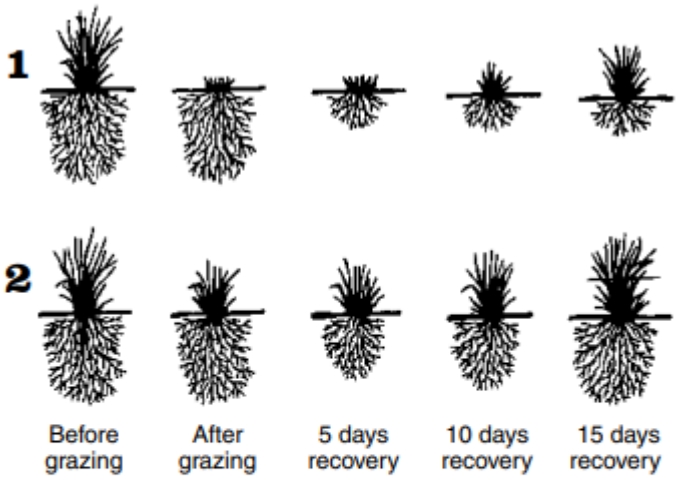
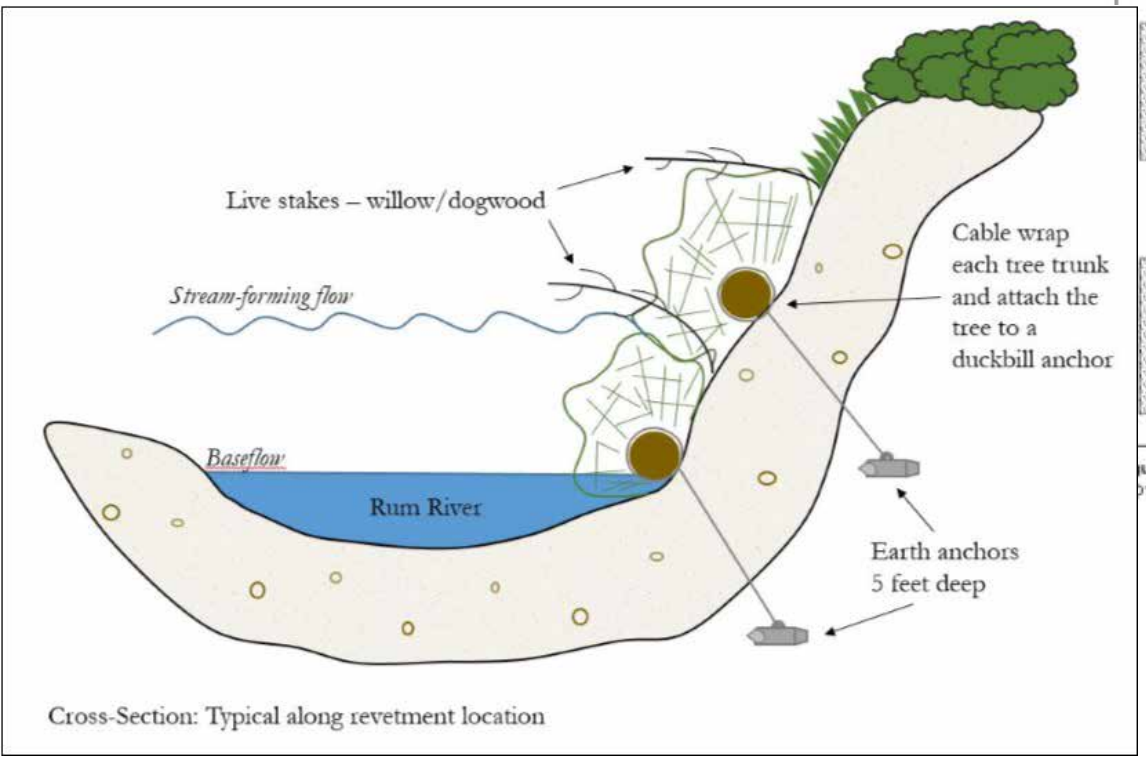
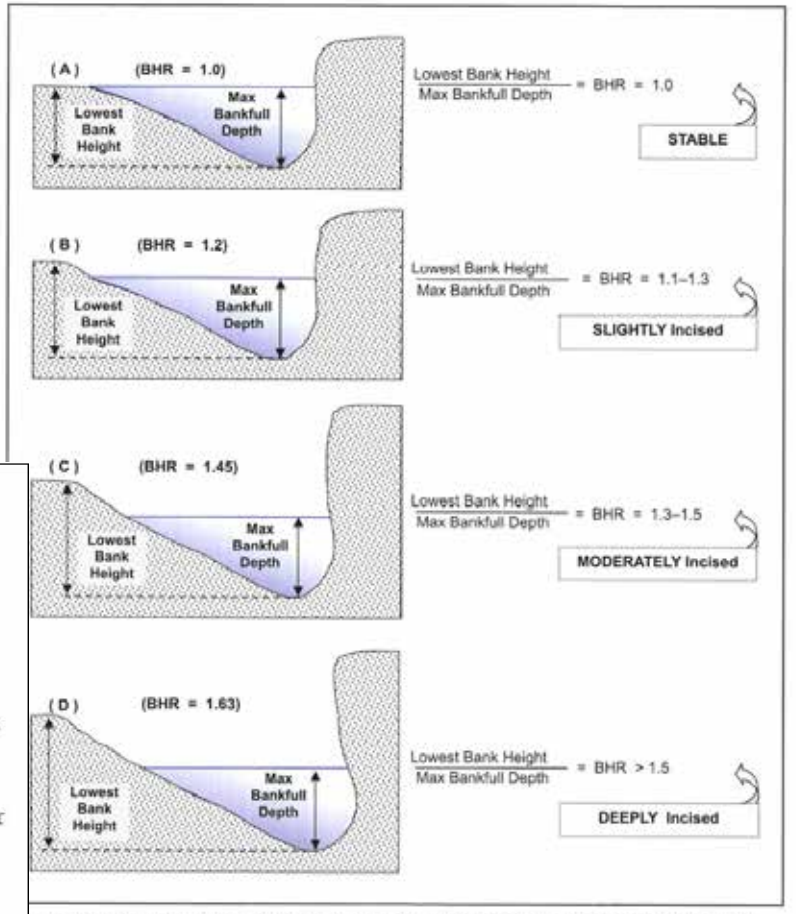


Figure 5. Plant regrowth rates depend on the amount of leaf removed by a grazing event. Plant 2 regrows more quickly because it can fix more energy through photosynthesis than Plant 1, which must draw on its root reserves for energy to regrow. (Reprinted with permission from "Pasture Vegetation – The Monitoring Tool Box" Land Stewardship Project. June 2000.)

TIP: For more information on riparian grazing management, see North Dakota Extension publications "Riparian Ecosystems of North Dakota" (R1539), "Grazing Riparian Ecosystems: Grazing System" (R1540), "Grazing Riparian Ecosystems: Grazing Intensity" (R1541), "Grazing Riparian Ecosystems: Season of Use" (R1542) or "Grazing Riparian Ecosystems: Water Development" (R1543).

Tree Revetments





ure 5-14. Examples of various Bank-Height Ratios (BHR) indicating degree of channel incision (Rosgen, 01b).

Anoka SWCD

Bankfull Bench Examples

I-94 Fergus Falls
Fill

Korby Site
Cut

Hawley Flood Dike
Fill

Toe Wood Sod Mat

- Reduce outside bank erosion
- Maintain scour and thalweg at natural position
- Pass bedload
- Natural appearance and self-repairing (living)
- Re-connected floodplain bench and wood provides habitat
- Vegetation promotes nutrient cycling
- Lease impact alternative with broad benefits

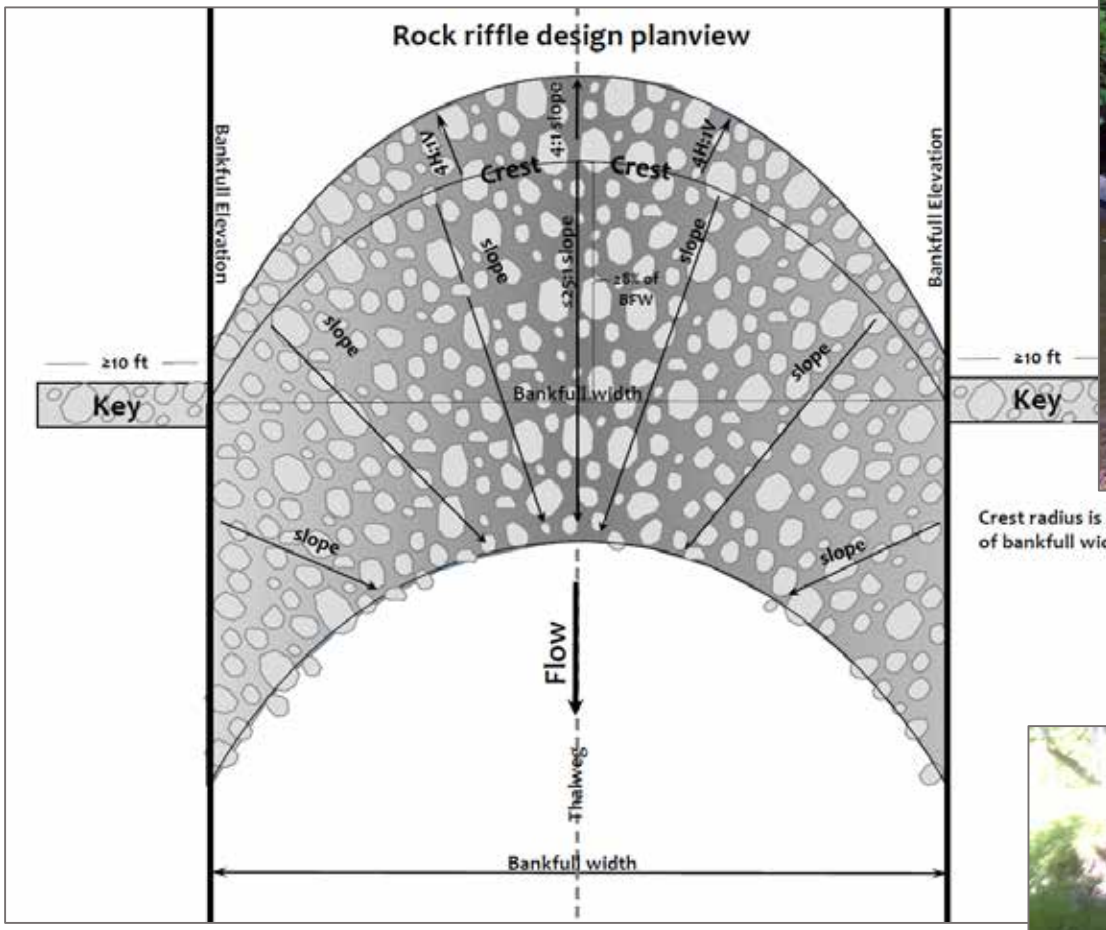
Grade control (decrease slope and reconnect channel to floodplain)

- Riffles and rock weirs

Large-scale restoration

- Re-meander straightened reach
- Remove or modify dams or improperly placed culverts
- Excavate properly shaped channel
- Excavate new floodplain
- Re-establish and protect a functional floodplain with compatible land use practices
- Promote best management practices for runoff including: wetland restoration; minimum tillage; grassed waterways on agricultural land; and rain gardens and pervious pavement in urban areas

MN DNR – Resource Sheet 1: Streambank Erosion and Restoration (2010)



DNR River Ecology Riffle (2017)

Example of how placed rock can adjust flow and sediment deposition (photos are an example of poor placement)