# Mapping River Corridors to Inform Flood Resilience Efforts in VT

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- What is a river corridor?
- Why map river corridors?
- How to map river corridors
- Overview of statewide mapping mechanics
- Uses of river corridor maps

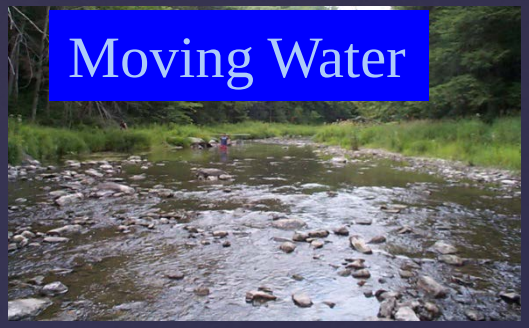
# What is a River Corridor?

## Beltwidth Concept

Minimal area required to accommodate the meander geometry and stable slope of the river's least erosive, equilibrium condition

# Fluvial Geomorphology

Fluvial =




Geo =

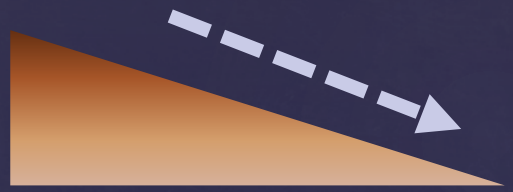
Morphology =

Fluvial Geomorphology = The study of how moving water shapes the land

# Dynamically Stable

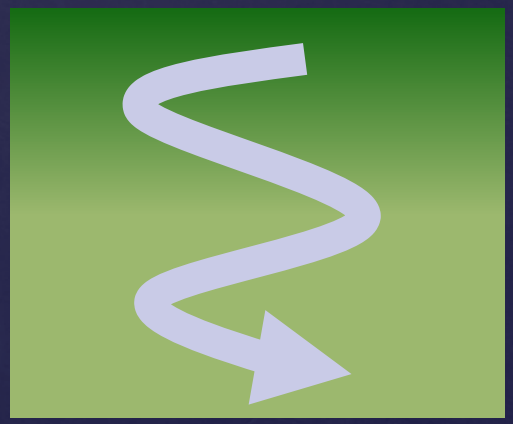
**River Maintains:**

**Slope**



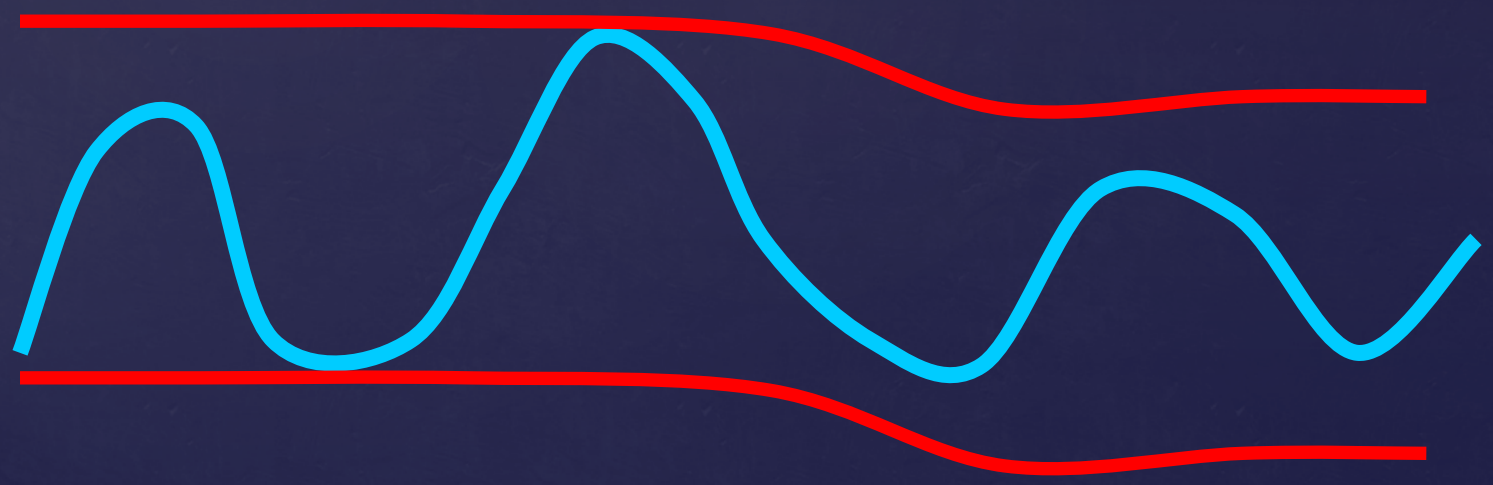
**Depth**

**Pattern**

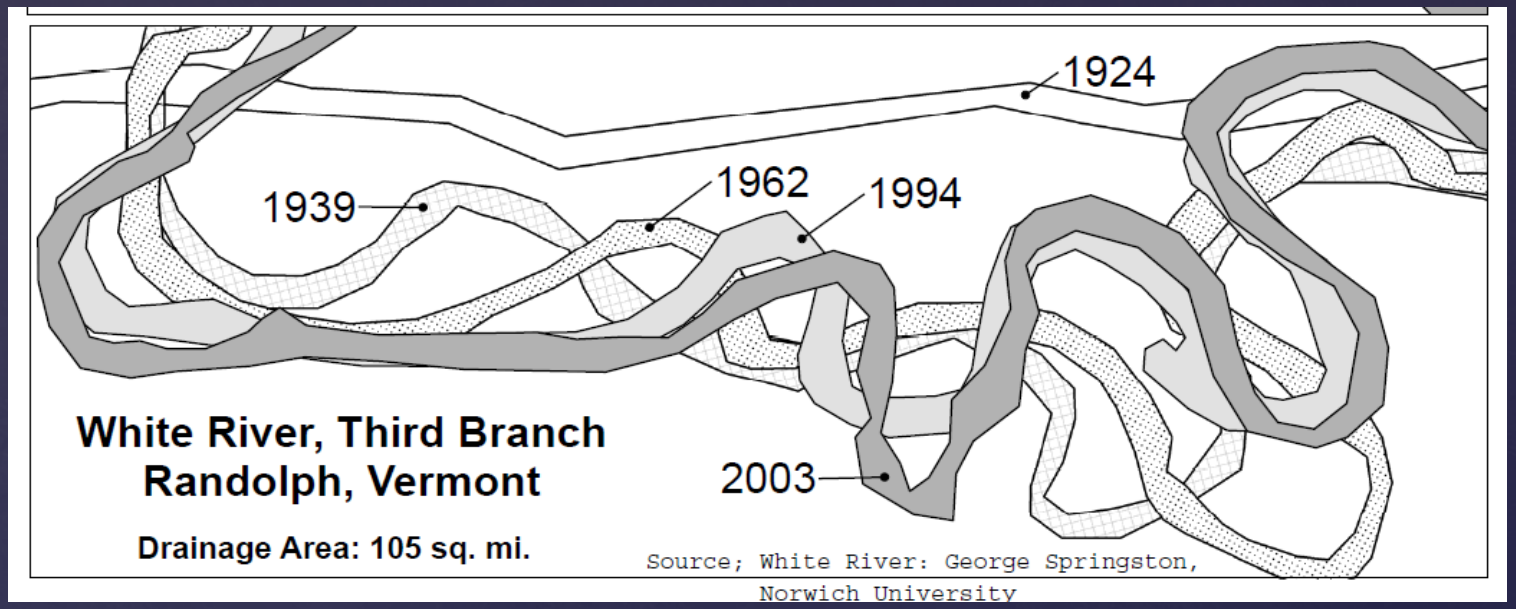


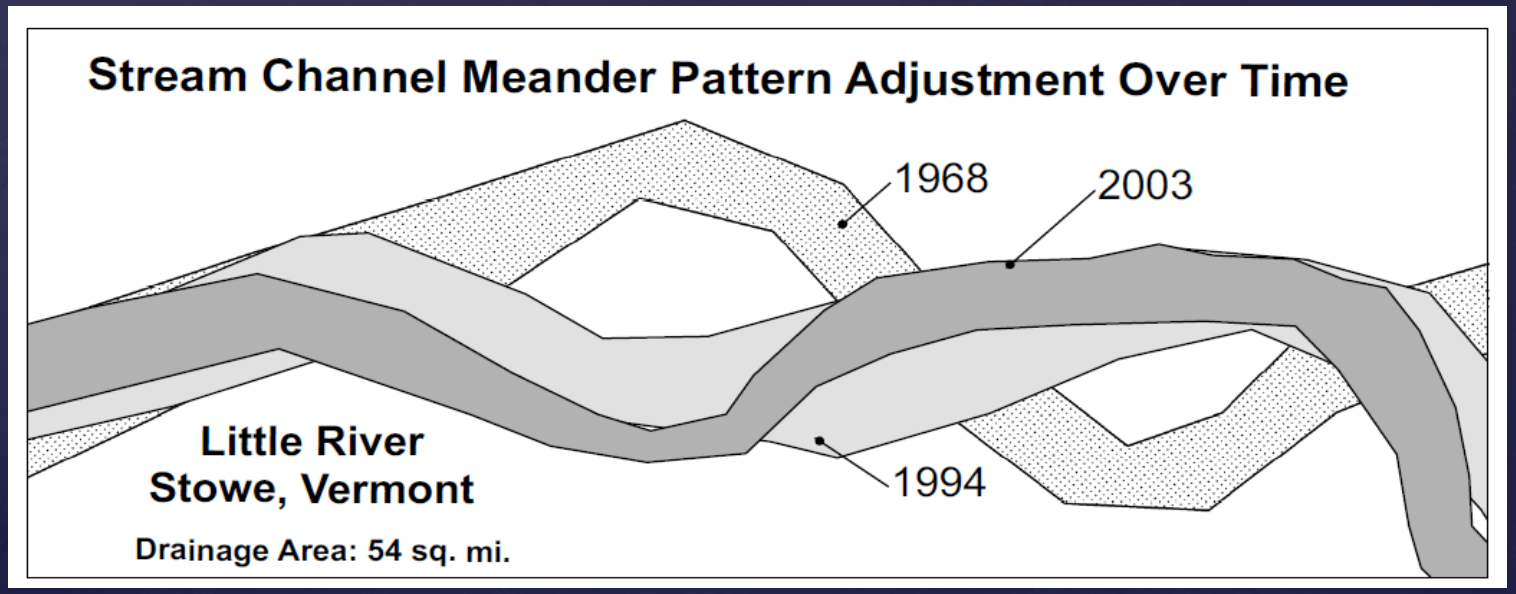
# River Corridor

The lateral area around the river necessary to achieve and maintain a stable condition



# Stable does not mean Static!

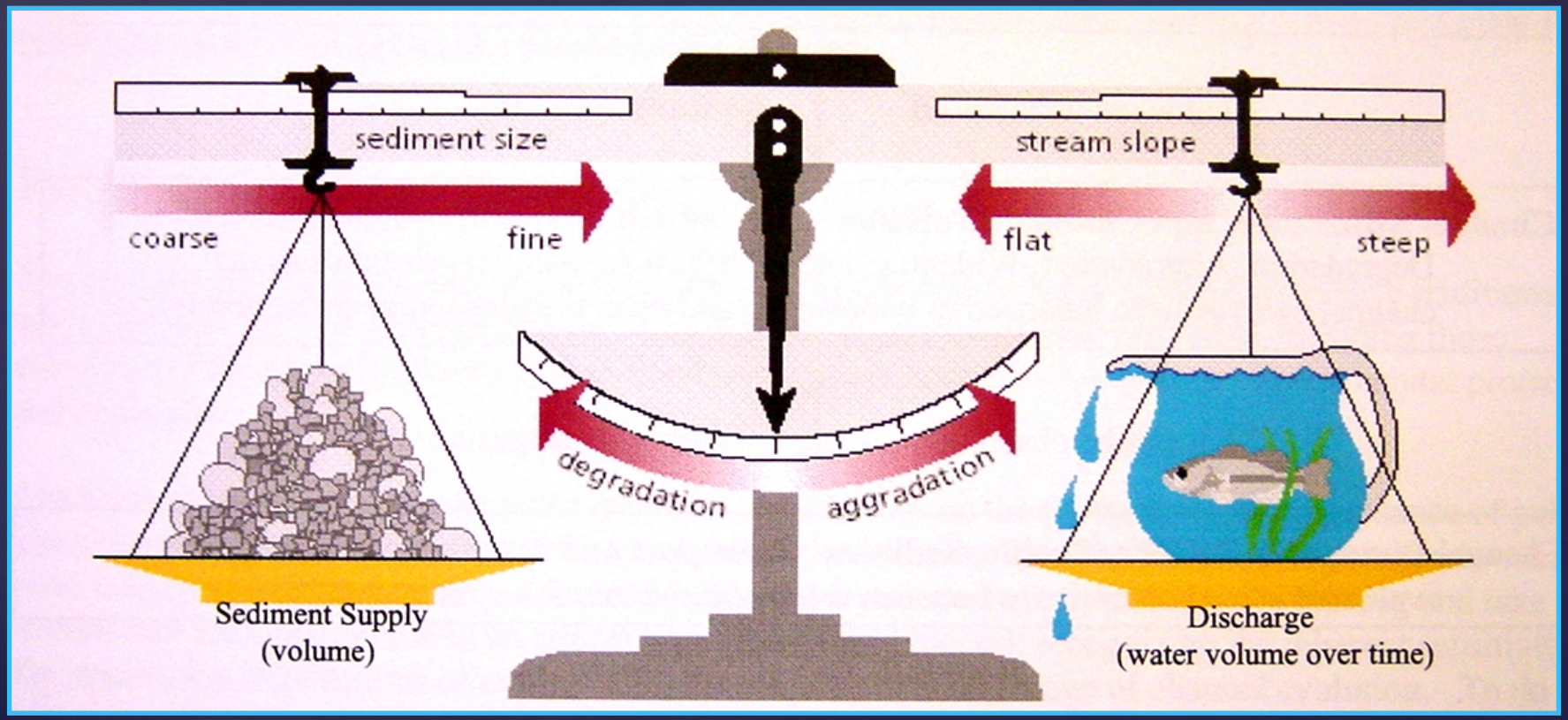


# Channel Equilibrium

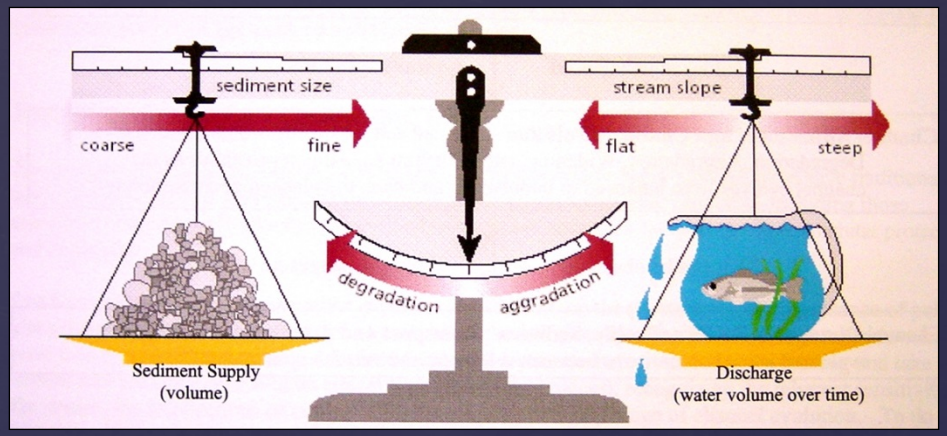
Sediment Load

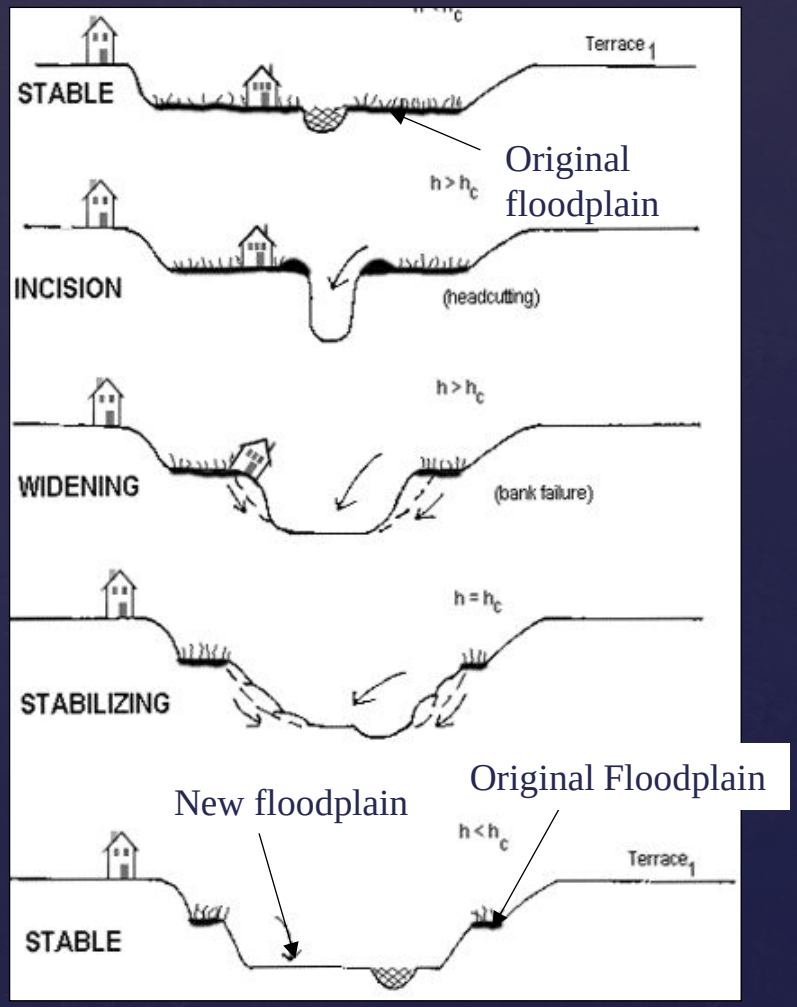
Transport Capacity




Lane (1955)

# Channel Evolution




Caused by changes to:

- Flow regime
- Sediment regime
- Slope
- Cross section
- Boundary condition
- Channel Roughness

# River Corridor

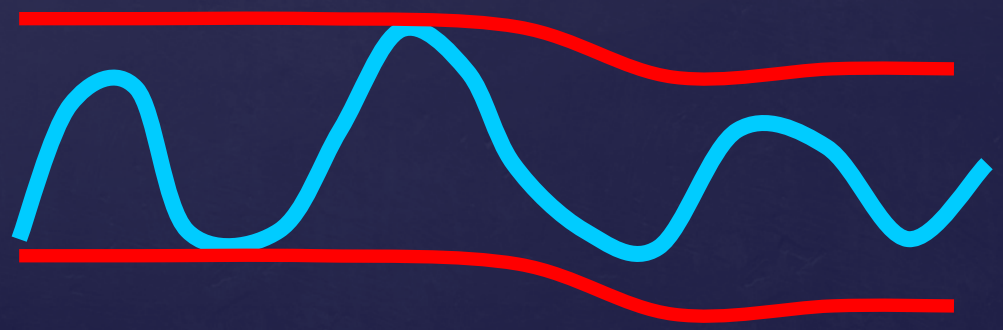
## The lateral area around the river necessary to achieve and maintain a stable condition

- Not necessarily a predictor of future channel location

- Simply identifying an adequate lateral area to accommodate the slope and meander pattern expected under equilibrium conditions

- Can be thought of as a channel management boundary

- A way to factor the dynamic nature of rivers into planning



# Why Map River Corridors?

**In Vermont, most flood damages are caused by Fluvial Erosion**

- VT Geography/Climate
  - Mountainous, Narrow valleys
  - Steep/powerful streams
  - Intense rainstorms/deep snows
  - Destructive Ice jams

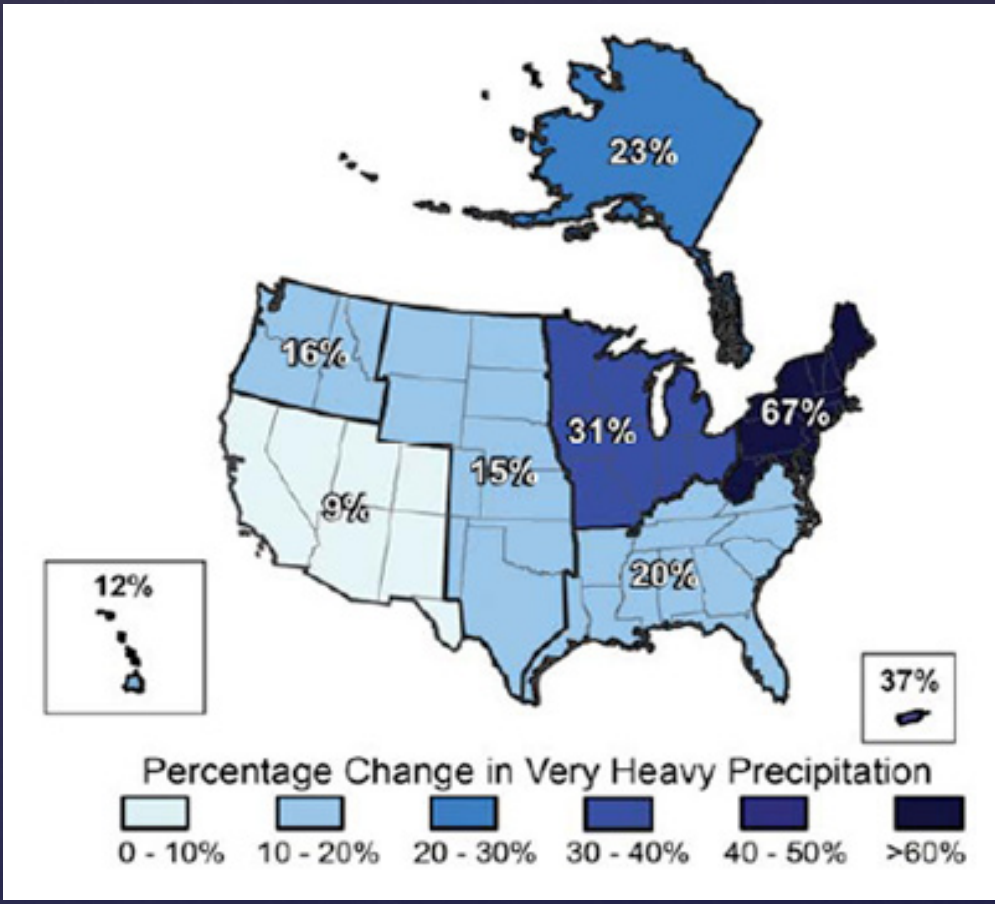
- Historic Patterns of Human Settlement, Stream Alteration

Kate Brook, Hardwick, 1995

# Why Map River Corridors?

## Plan for Flooding

- Historic flooding
- Changing climate




**Map: Progress Report of the Interagency Climate Change Adaptation Task Force: Recommended Actions in Support of a National Climate Change Adaptation Strategy, October 5, 2010.**

Understanding of how rivers function can guide our planning efforts

# Why Map River Corridors?

Enhance some of the key components of flood resilience:

- **Public safety**
- **Economics**
- **Sustainable ecosystems**

# Why Map River Corridors?

- **Public safety**
- Economics
- Sustainable ecosystems

An avoidance strategy

# Encroachment leads to channel management

Channel management leads to floodplain disconnection and increased stream power… which means the next flood of equal flow will be even more destructive

# Why Map River Corridors?

- Public safety
- **Economics**
- Sustainable ecosystems

**Recovering from flood damage is expensive**

**An avoidance strategy is cost effective**

# Channel adjustments during floods can have devastating consequences

Lilliesville Brook, Bethel 1997

Jones Road, Wolcott 1995

Great Brook, Plainfield, 1990

Unnamed Tributary, Braintree, 2007

# Why Map River Corridors?

- Public safety
- Economics
- **Sustainable ecosystems**

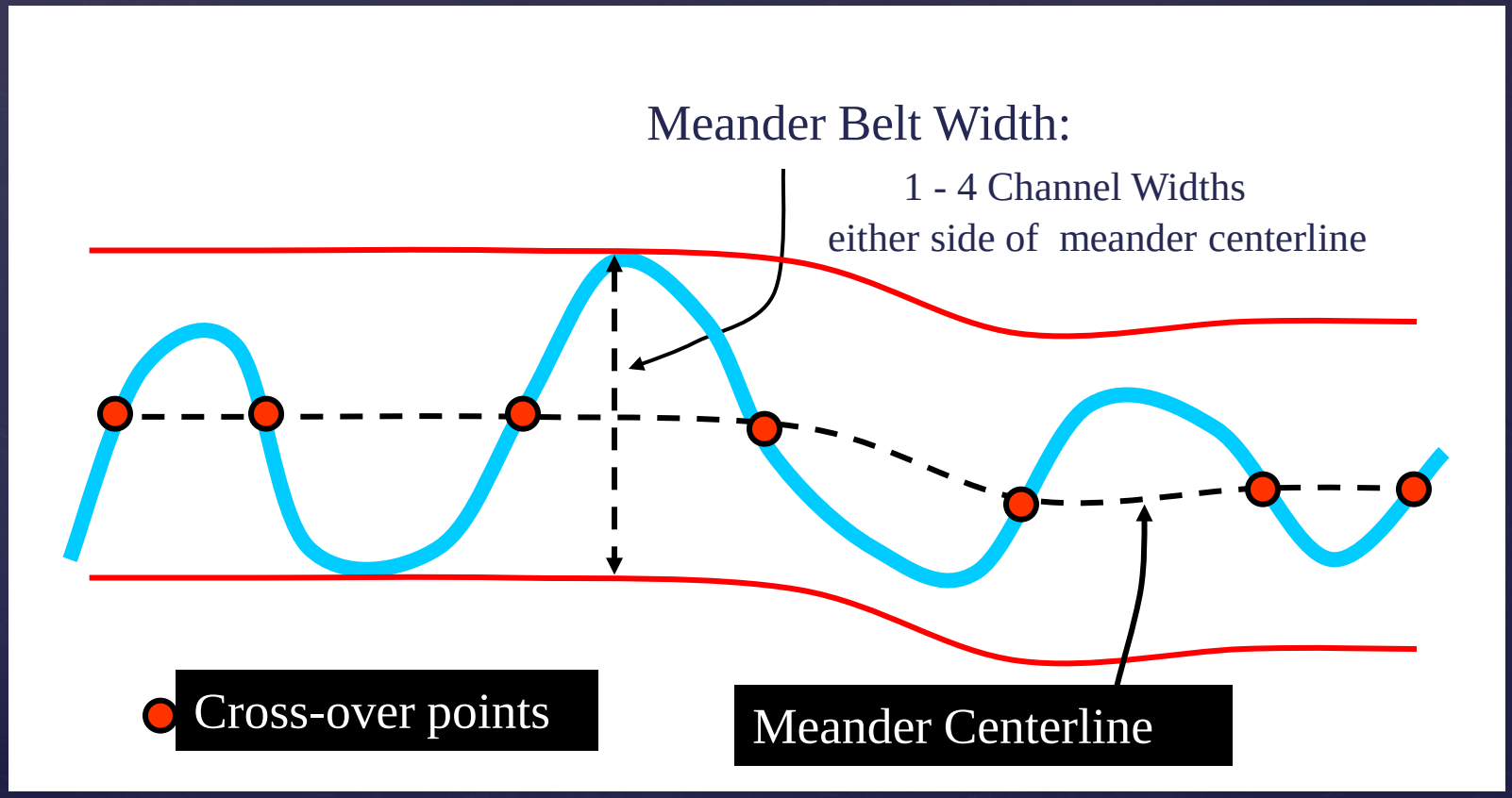
**An avoidance strategy accommodates river processes that:**

- **create and maintain habitat features**
- **create a more stable channel over time**

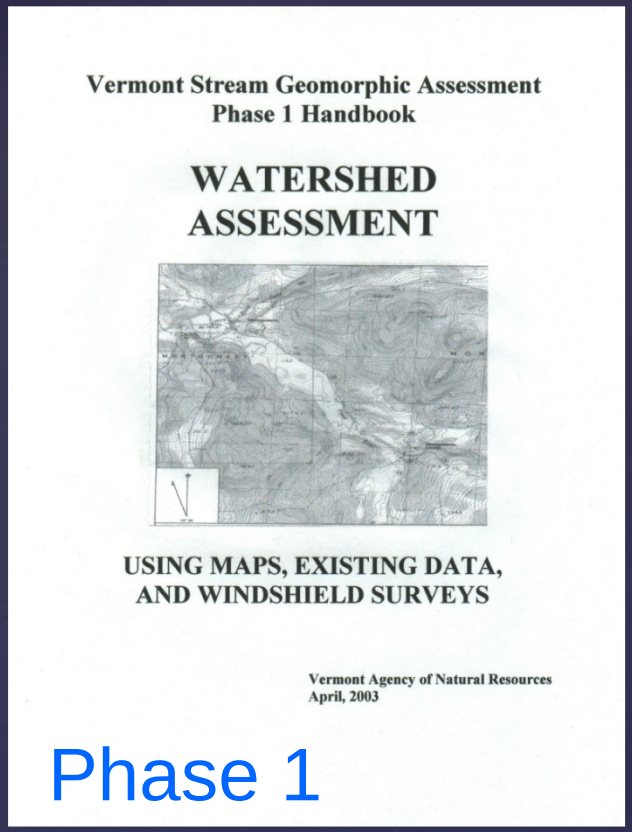
# How to Map River Corridors

1. Detailed River Corridors based on Phase 2 Stream Geomorphic Assessment

2. Statewide River Corridor based on remotely sensed data

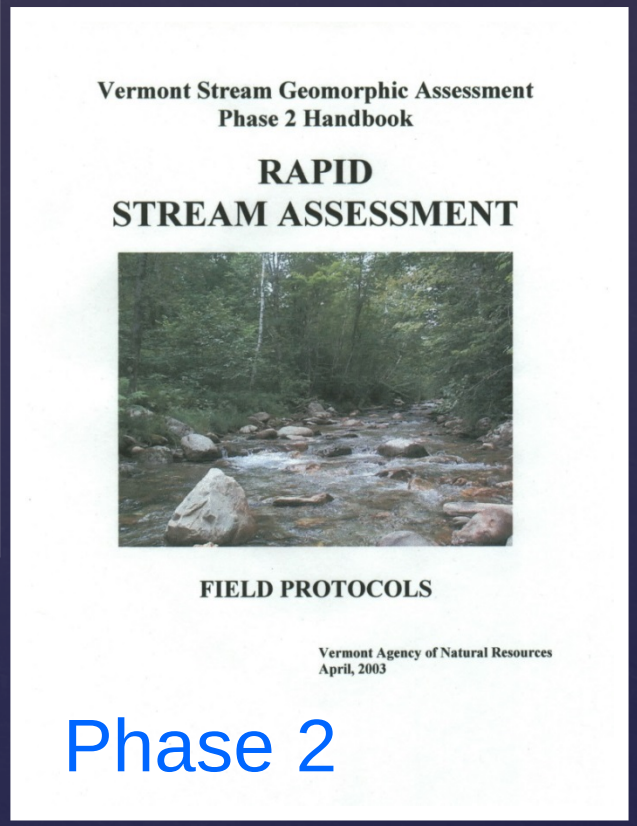


# River Corridor Mapping based on Vermont Stream Geomorphic Assessment Protocols



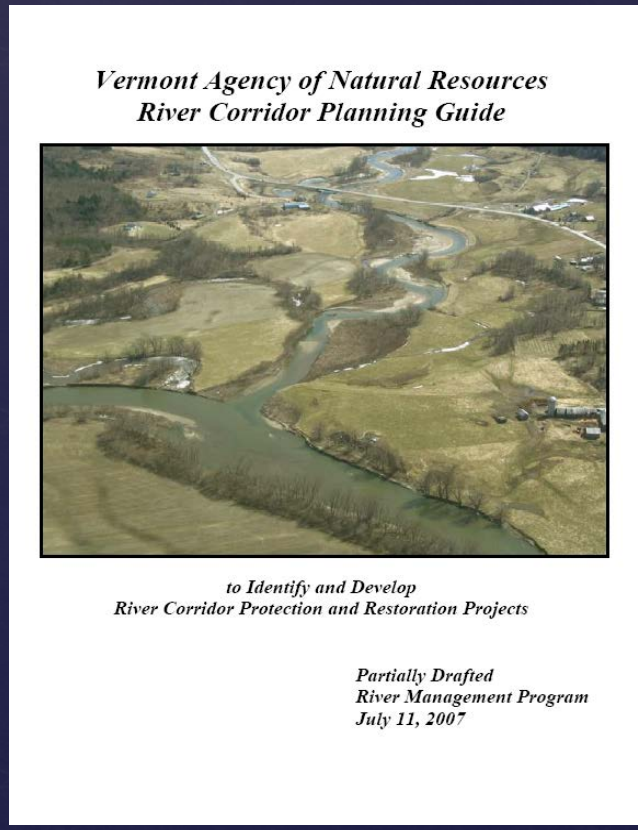

Phase 1

Remote Sensing




Phase 2

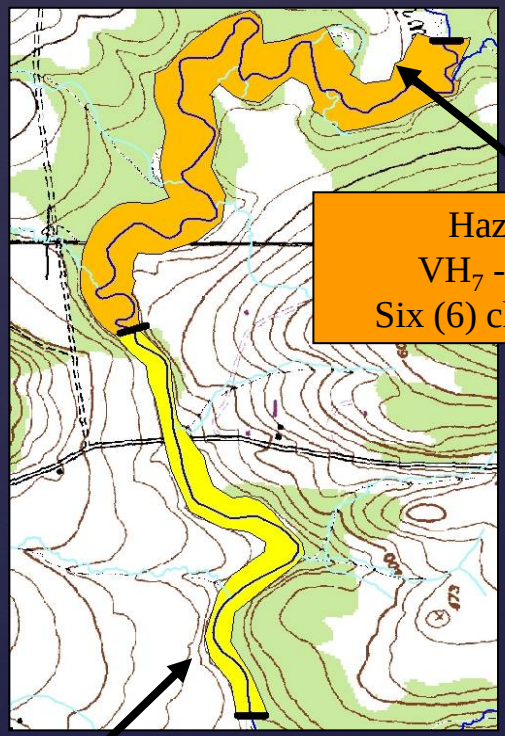
Qualitative & Rapid Field Assessment




River Corridor Planning

# Belt width multiplier based on channel sensitivity

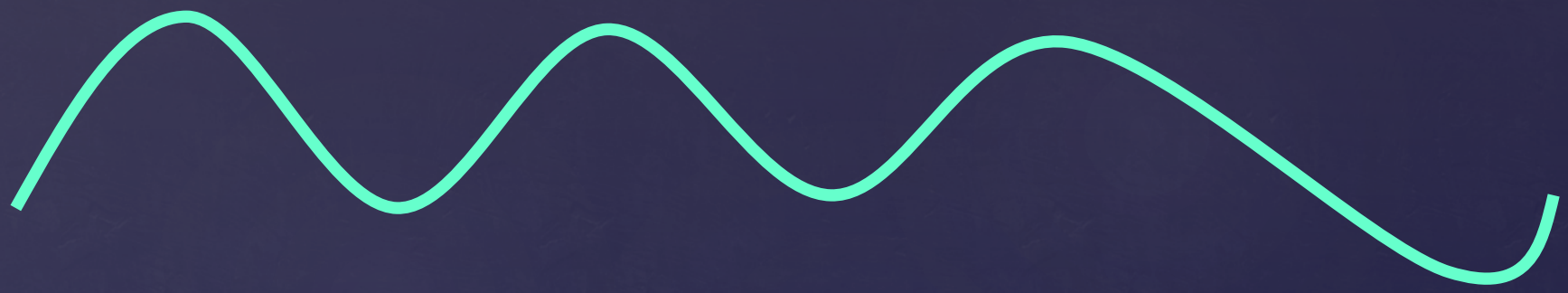
| Sensitivity | Belt Widths |
|---|---|
| Very Low (VL) | Reference channel width |
| Low (LW) | Reference channel width |
| Moderate (MD) | 4 channel widths |
| High (HI) | 6 channel widths |
| Very High (VH) | 6 channel widths<br>8+ channel widths – E streams |
| Extreme (EX) | 6 channel widths<br>8+ channel widths – D&E streams |



Hazard Type
$VH_7$ - Very High
Six (6) channel widths

Hazard Type
$MD_6$ – Moderate
Four (4) Channel Widths

# How River Corridor Map is Made – Example:



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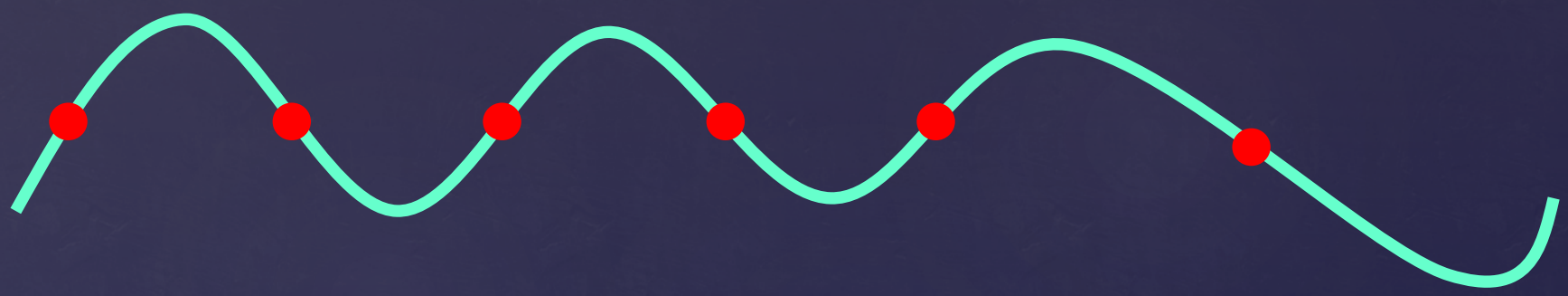
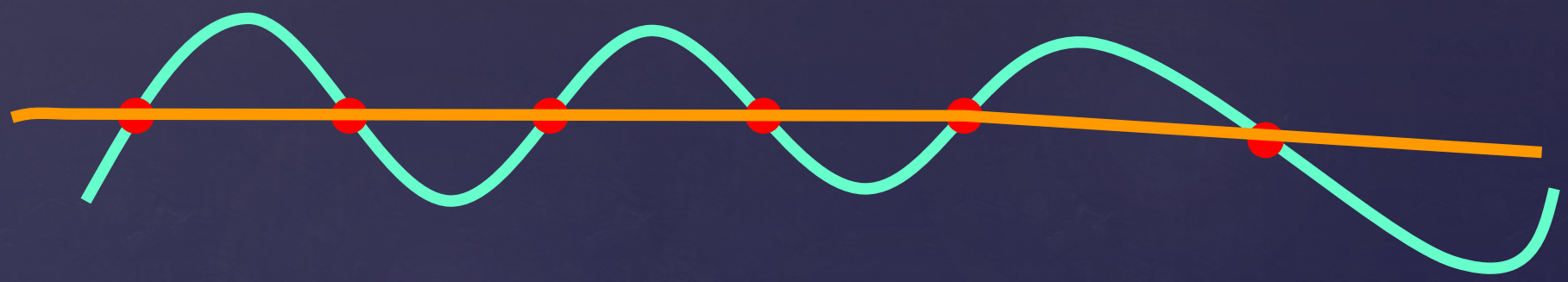


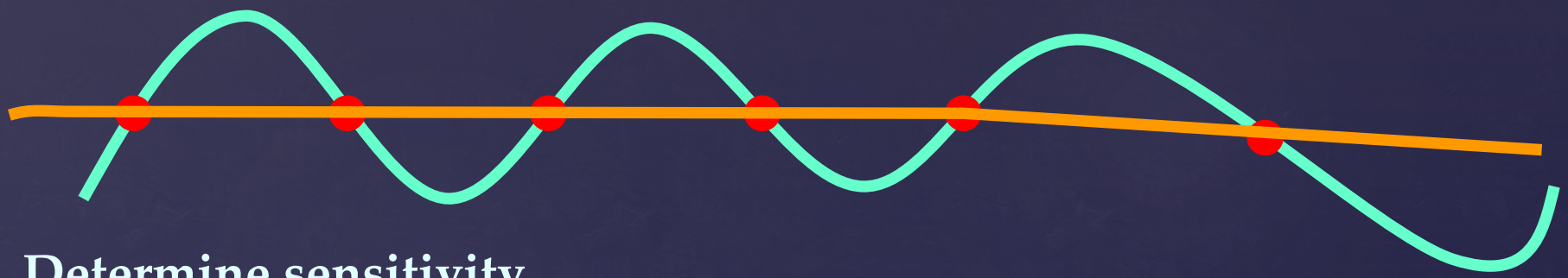
Place nodes at cross over points (riffles)

# How River Corridor Map is Made – Example:



Meander centerline connects nodes

# How River Corridor Map is Made – Example:



## Determine sensitivity

## (function of stream type and condition)

Table 1. Vermont ANR Stream Sensitivity Ratings based on geomorphic stream type and condition.

| Stream Type Group | Existing Geomorphic Stream Type[1] | Sensitivity | | |
|---|---|---|---|---|
| | | Reference or Good Condition | Fair-Poor Condition in Major Adjustment | Poor Condition, Represents a Stream Type Departure |
| 1 | A1, A2, B1, B2 | Very Low | Very Low | Low |
| 2 | C1, C2 | Very Low | Low | Moderate |
| 3 | G1, G2 | Low | Moderate | High |
| 4 | F1, F2 | Low | Moderate | High |
| 5 | B3, B4, B5 | Moderate | High | High |
| 6 | B3c, C3, E3 | Moderate | High | High |
| 7 | C4, C5, B4c, B5c | High | Very High | Very High |
| 8 | A3, A4, A5, G3, F3 | High | Very High | Extreme |
| 9 | G4, G5, F4, F5 | Very High | Very High | Extreme |
| 10 | D3, D4, D5 | Extreme | Extreme | Extreme |
| 11 | C6, E4, E5, E6 | High | Extreme | Extreme |

| Sensitivity | Belt Widths |
|---|---|
| Very Low (VL) | Reference channel width |
| Low (LW) | Reference channel width |
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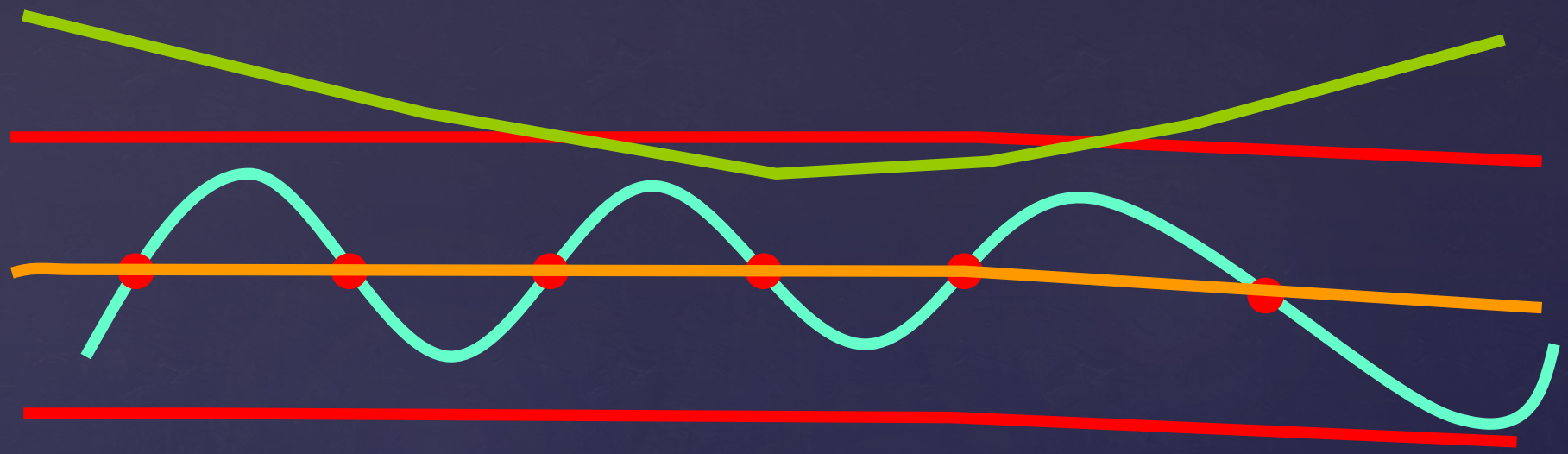
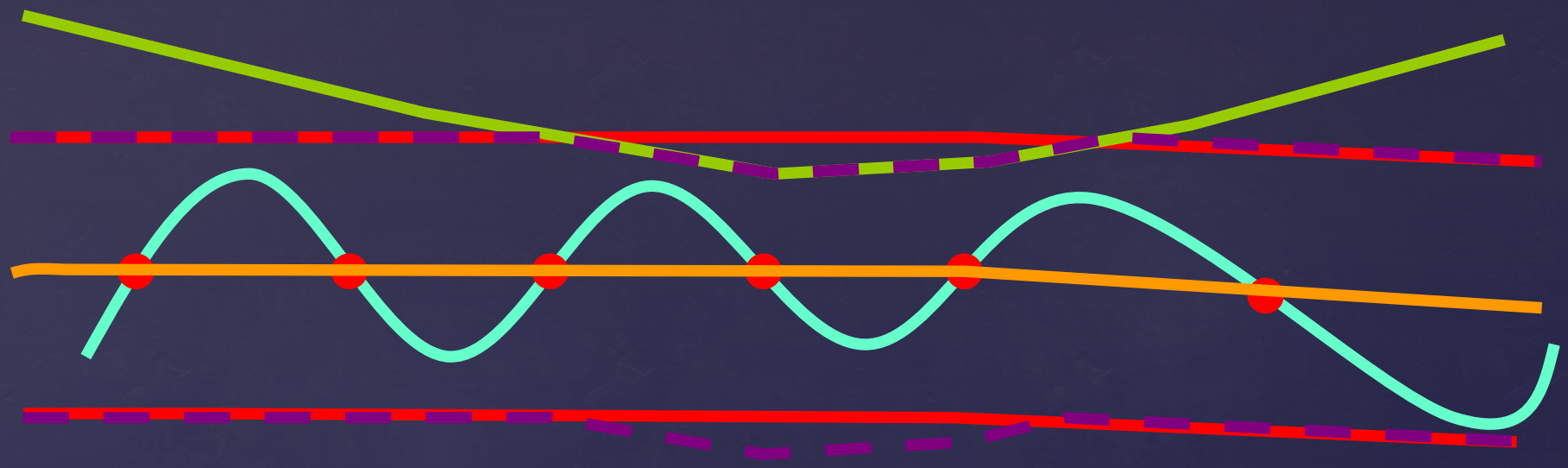


Sometimes valley wall pinches in on river corridor

Where possible, the zone is shifted

# How River Corridor Map is Made – Example:



Sometimes valley wall pinches in on river corridor

Where possible, the zone is shifted

# Statewide River Corridor

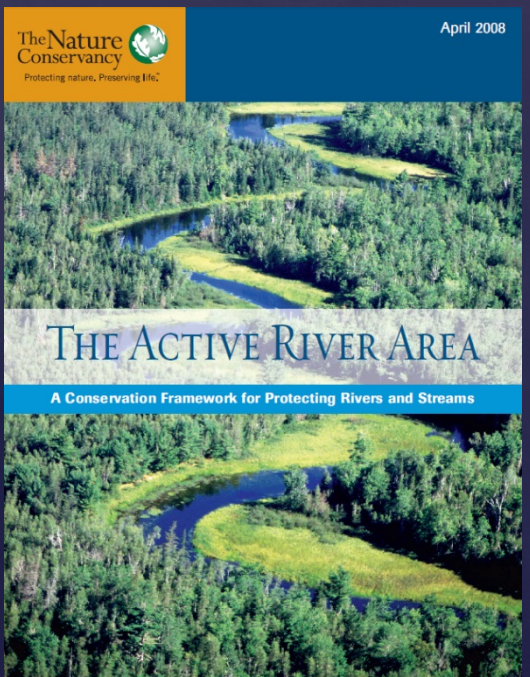
## Data Inputs Differ Slightly

### Phase 2 Corridor

- VHD broken at reaches
- Meander centerline
- Field verified valley wall
- Channel width based on watershed area
- Multiplier based on Phase 2 Sensitivity

### Statewide Corridor

- VHD broken at reaches and VHD breaks
- Meander centerline
- Automated valley wall based on TNC ARA
- Roads and Railroads of specific classes
- Channel width based on watershed area
- Multiplier based on reach slope




PATHDISTANCE modeling

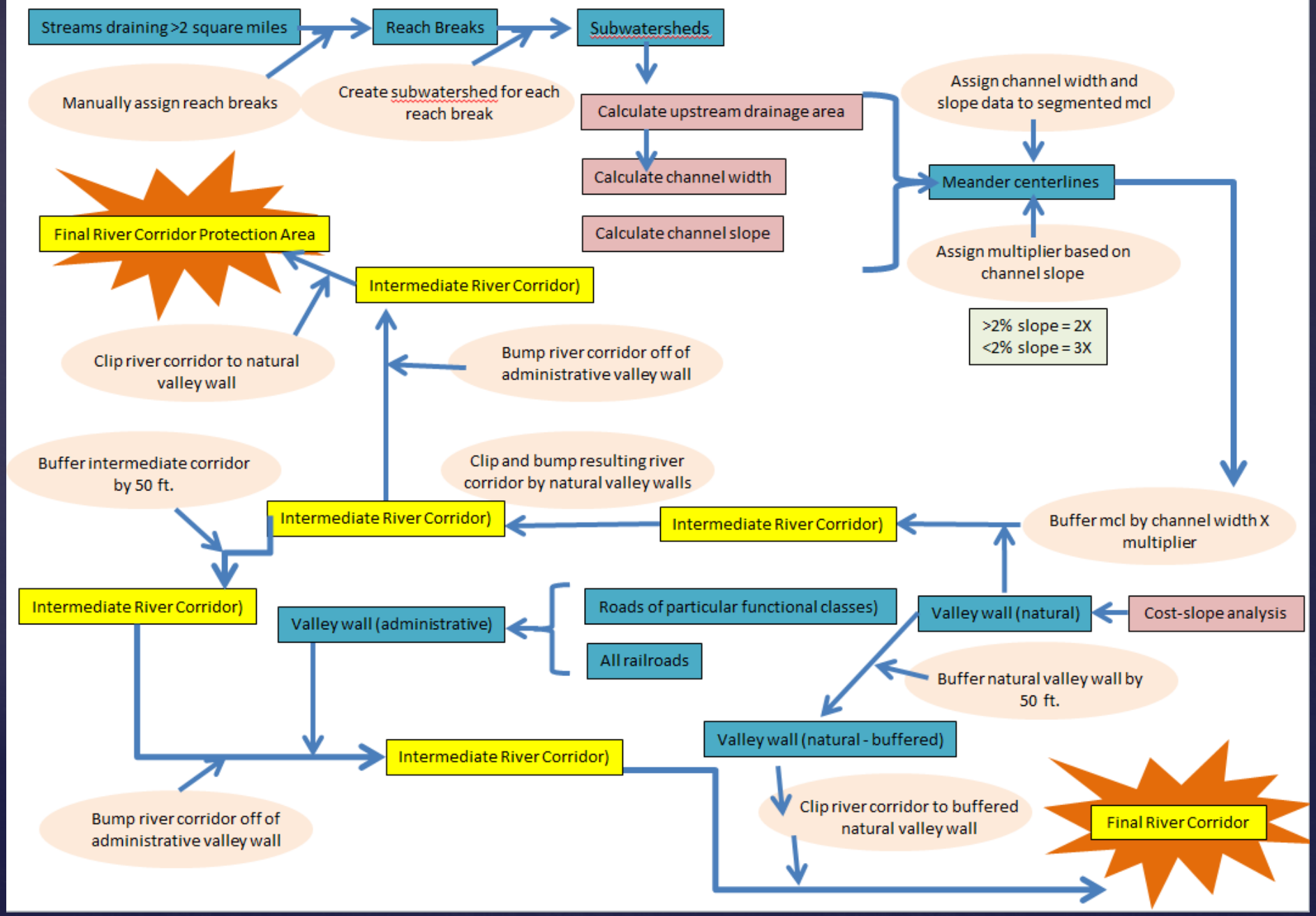
- Uses distance and slope from stream to calculate cost
- Cost of "550" used to define most VT valley walls

Slope multipliers – surrogate for channel sensitivity

<2% slope = 3 X channel width off mcl

>2% slope = 2 X channel width off mcl

# Flowchart for Statewide River Corridor Creation



# River Corridor Protection Area

- same thing as belt width or fluvial erosion hazard area (FEH)
- minimum area necessary to achieve equilibrium

# River Corridor

- RCPA plus 50 ft.
- Allows space to establish stable boundary conditions (trees)

**River Corridor**

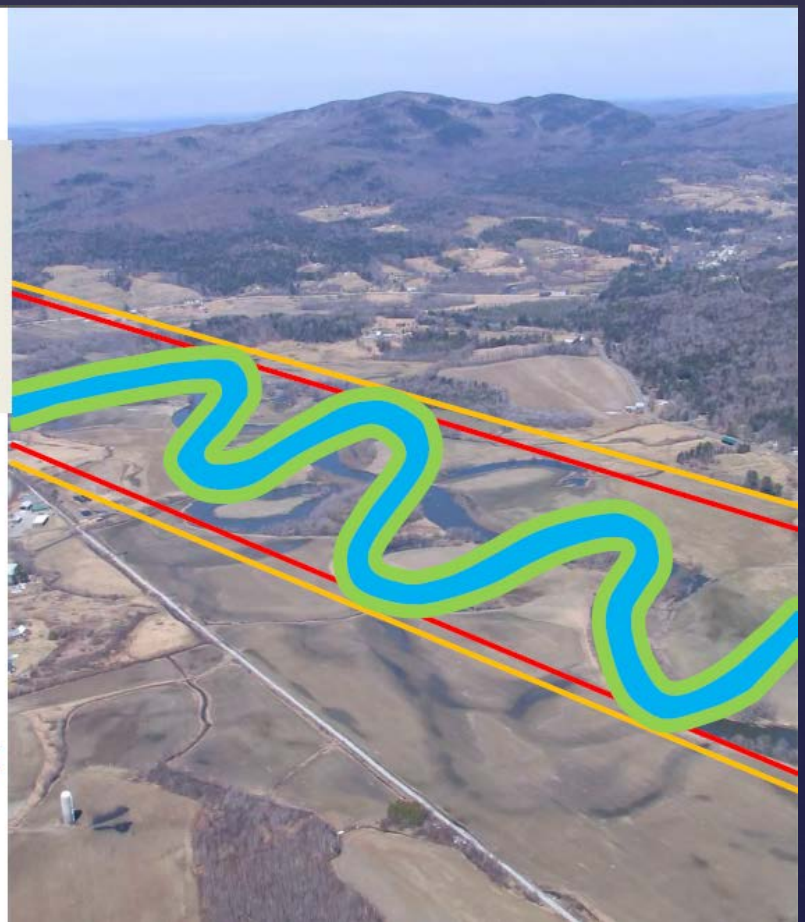
Boundary of the River Corridor

Boundary of the River Corridor Protection Area (RCPA=FEH)

Future Lamoille River at Equilibrium Slope + 50 ft Buffer

Act 110 requires the ANR to create River Corridors that include riparian buffers.

River Corridors provide a set-back area that includes the 50′ buffer when the equilibrium slope is achieved and the meanders have become fully extended.



# Why create two maps?

- Title 24, Chapter 117: Municipal and Regional Planning and Development - Authorizes towns to adopt river corridor protection areas (the minimum beltwidth)
- Act 110 requires ANR to create river corridor maps that include riparian buffers

In order to meet both requirements, we must make two different maps.

# Overview of Statewide Mapping

**Amassing data inputs**

**Base and Created Data**

Meander Centerlines (MCLs)

Reach Break points

VT Hydrography streams

VT HydroDEM

HUC 8 Basins

VT Roads, RRs

**Derived Data**

Cost-Distance river area raster
→ vector Valley Walls

Basin catchments per reach break, attributed with beltwidth formula

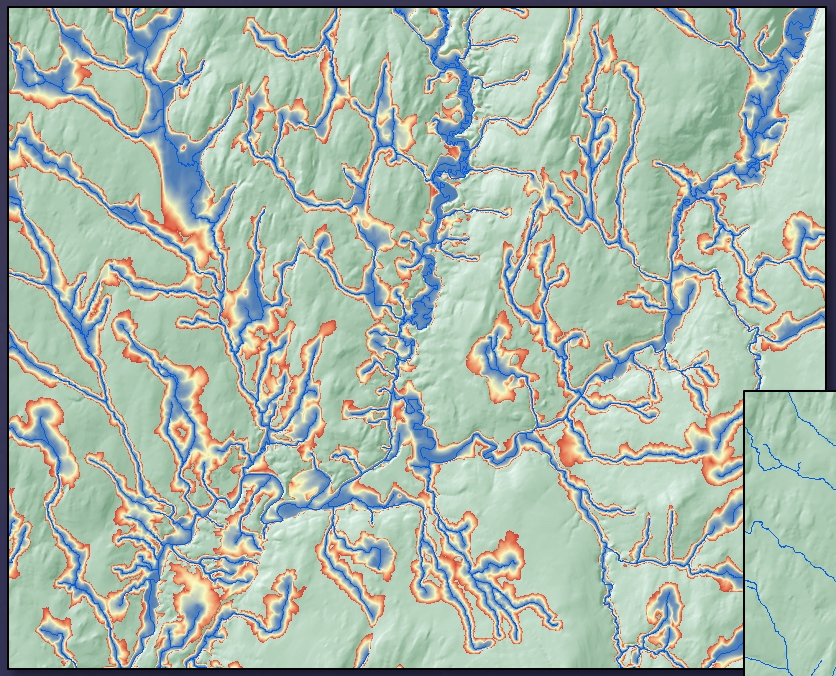
MCL buffers

MCLbuffs bumped and clipped by Valley Walls

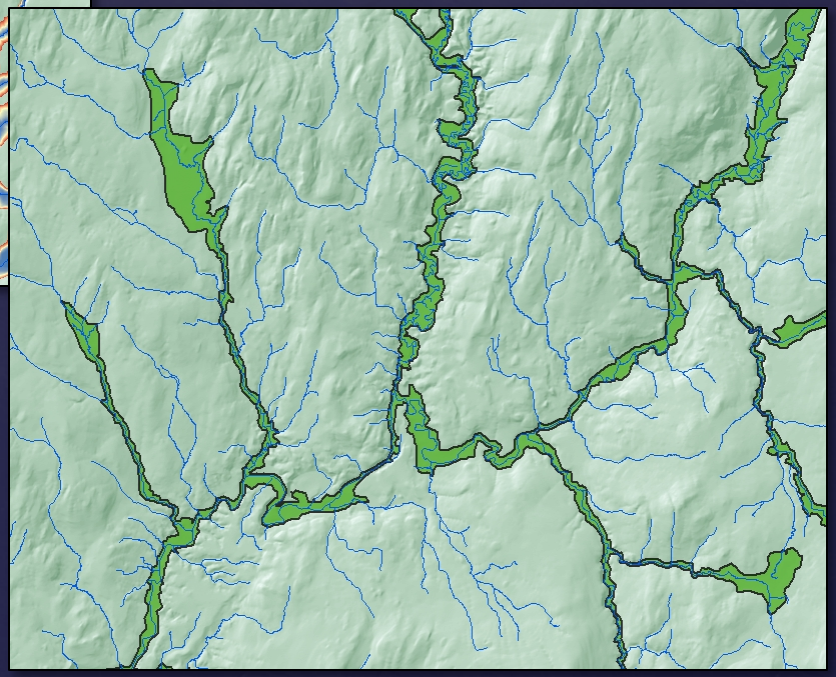
MCLbuffs bumped and clipped by Roads and RRs

Final River Corridor/RCPA

# Cost-distance river area raster and Valley Walls

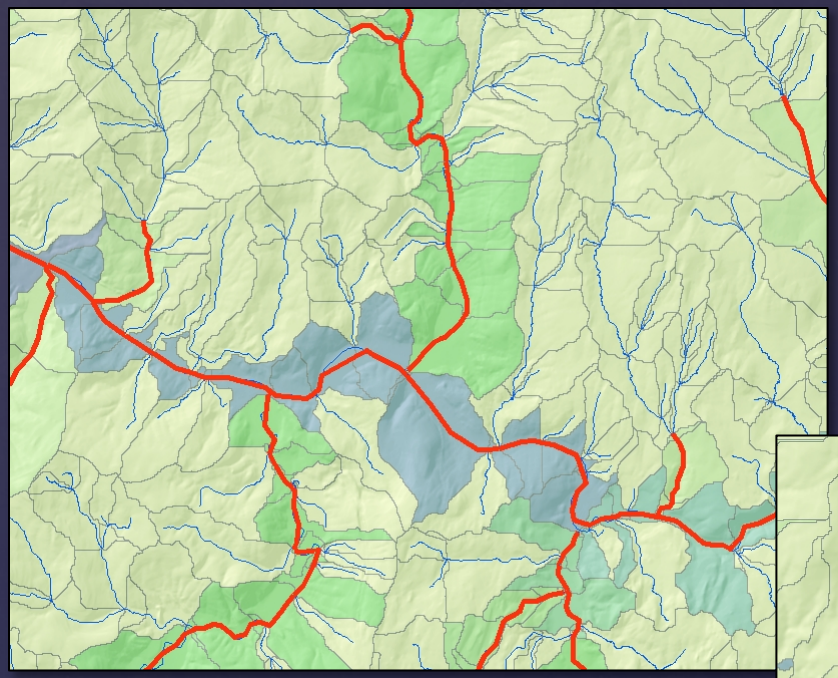


Spatial Analyst
PathDistance command
(cost = 1000)

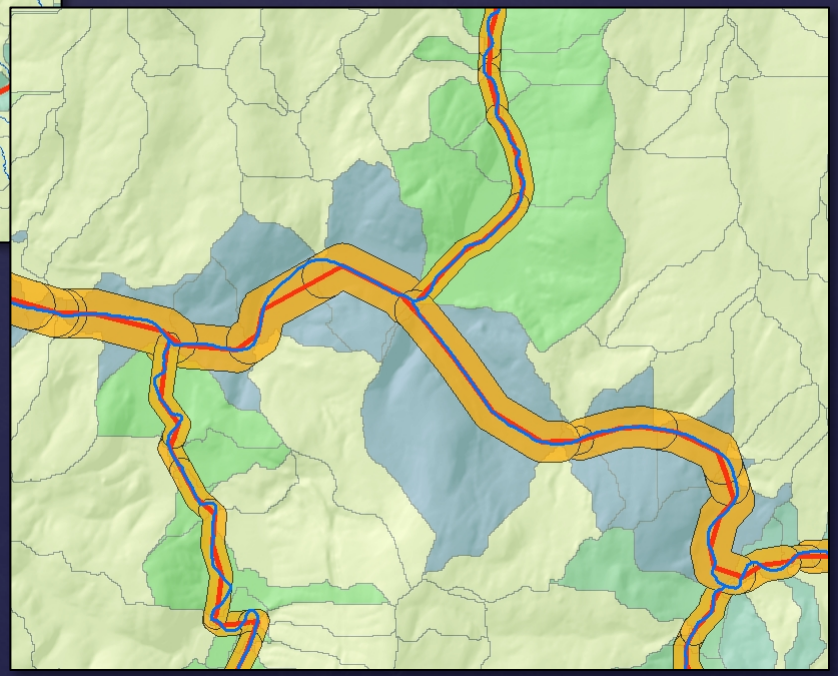


Toe of VW ~ 550 cost
➡ Vector polygon

# Buffering MCLS



Arc Hydro Tools extension used to make catchments; MCLs assigned catchment attributes



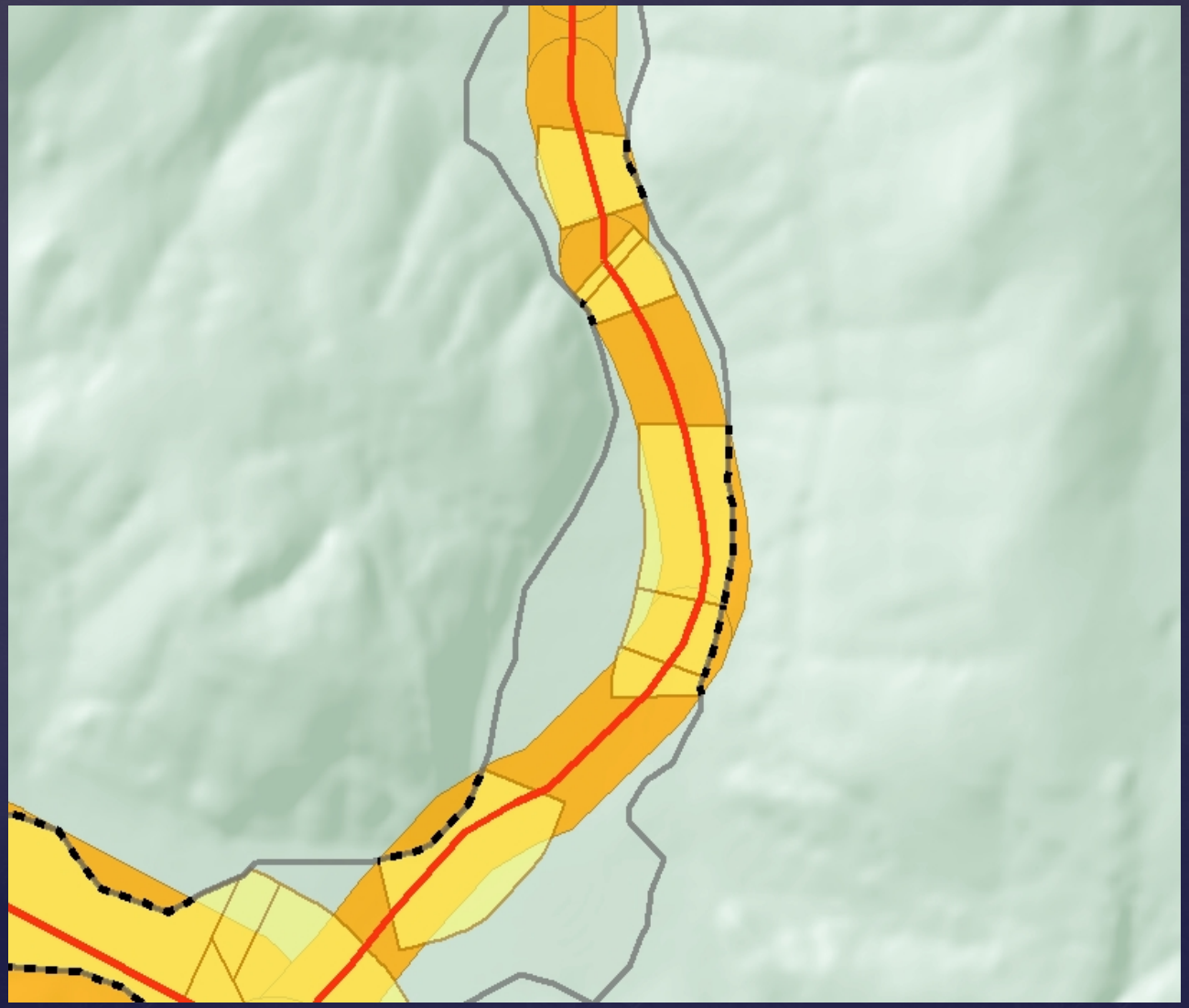
MCLs buffered based on cumulative drainage area and channel multiplier

# Clip and Bump Procedures

Valley Wall
pinching
RC beltwidth

Where possible,
RC should be shifted
over within VW
to accommodate
full beltwidth

## Clip and Bump Procedures



Where VW and RC intersect, polylines are created.

The polylines are buffered by double the RC beltwidth, then those buffers are clipped by the VW.

## Clip and Bump Procedures

Buffers are merged, clipped, and dissolved to make the final River Corridor polygon.

# Next Steps

- Iterative QA Process
- Completion goal by end of 2014
- River Corridor to be published on ANR Atlas
- Defining process for map maintenance and updates

# Uses of River Corridor Maps

- Municipal adoption and ERAF
- Act 250 / Sect. 248 regulation
- State Floodplain Rule
- Stream Alteration Rules

# Questions?

**VT Agency of Natural Resources Rivers Program**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