Welcome to the DNR-LGU Forum!

DNR-LGU Forum Goals:

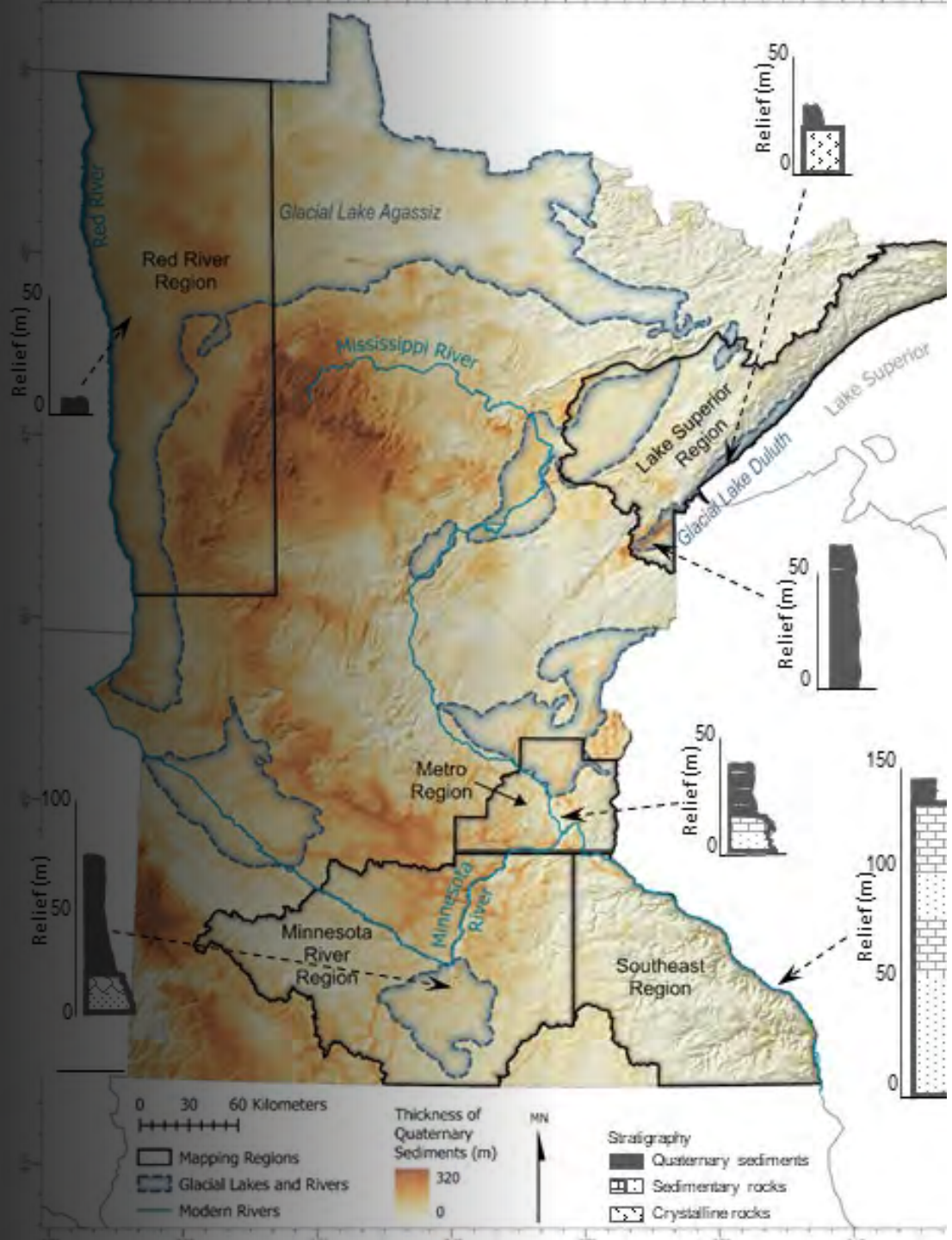
- Strengthen our relationship
- Share challenges and ideas
- Safe space to learn from each other
- Seek solutions together
- Improve SL & FP administration and resource protection

Agenda

- Landslide occurrence and susceptibility– **Carrie Jennings, Freshwater Society**
- State shoreland rules bluff standards– **Dan Petrik, DNR**
- Meander belt higher standard– **Ceil Strauss, DNR**
- Eroding bluff Standards– **Scott Salsbury, Blue Earth County**
- Local higher bluff standards– **Aaron Stubbs, Le Sueur County**
- Bluffland area protection– **Joe Kaltenbach, Wabasha County**
- General Q & A
- Future Forum Topics and Training Updates

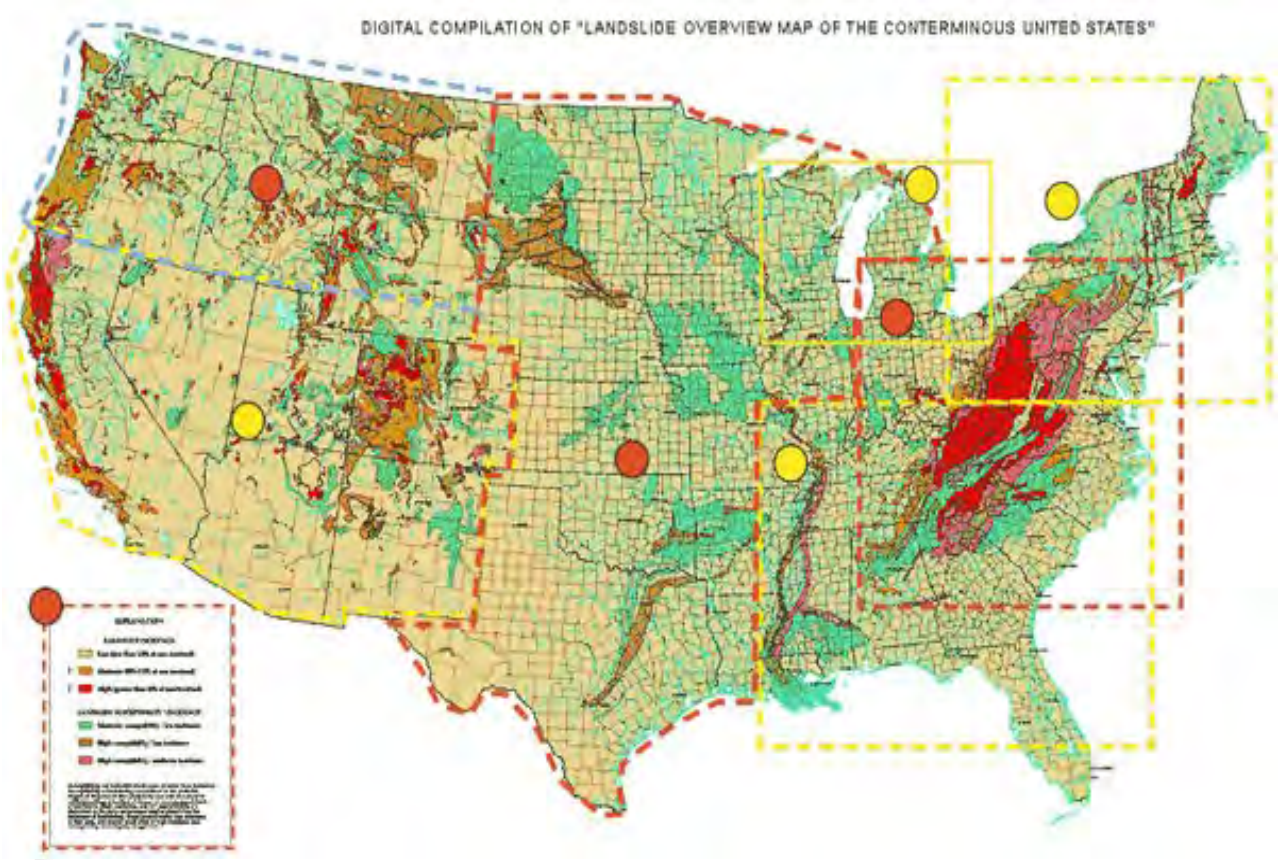
Landslide occurrence and susceptibility in Minnesota, USA

Triplett[1], L.D., DeLong[1], S.B., Hammer[2], M.N., Gran[3], K.B., Jennings[4], C.E., Engle[5], Z.T., Bartley[1], J.K., Blumentritt[6], D.J., Breckenridge[7], A.J., Day[8], S., Larson[9], P.H., McDermott[10], J.A., Richard[2], E.M., Swanson[9], M.A.



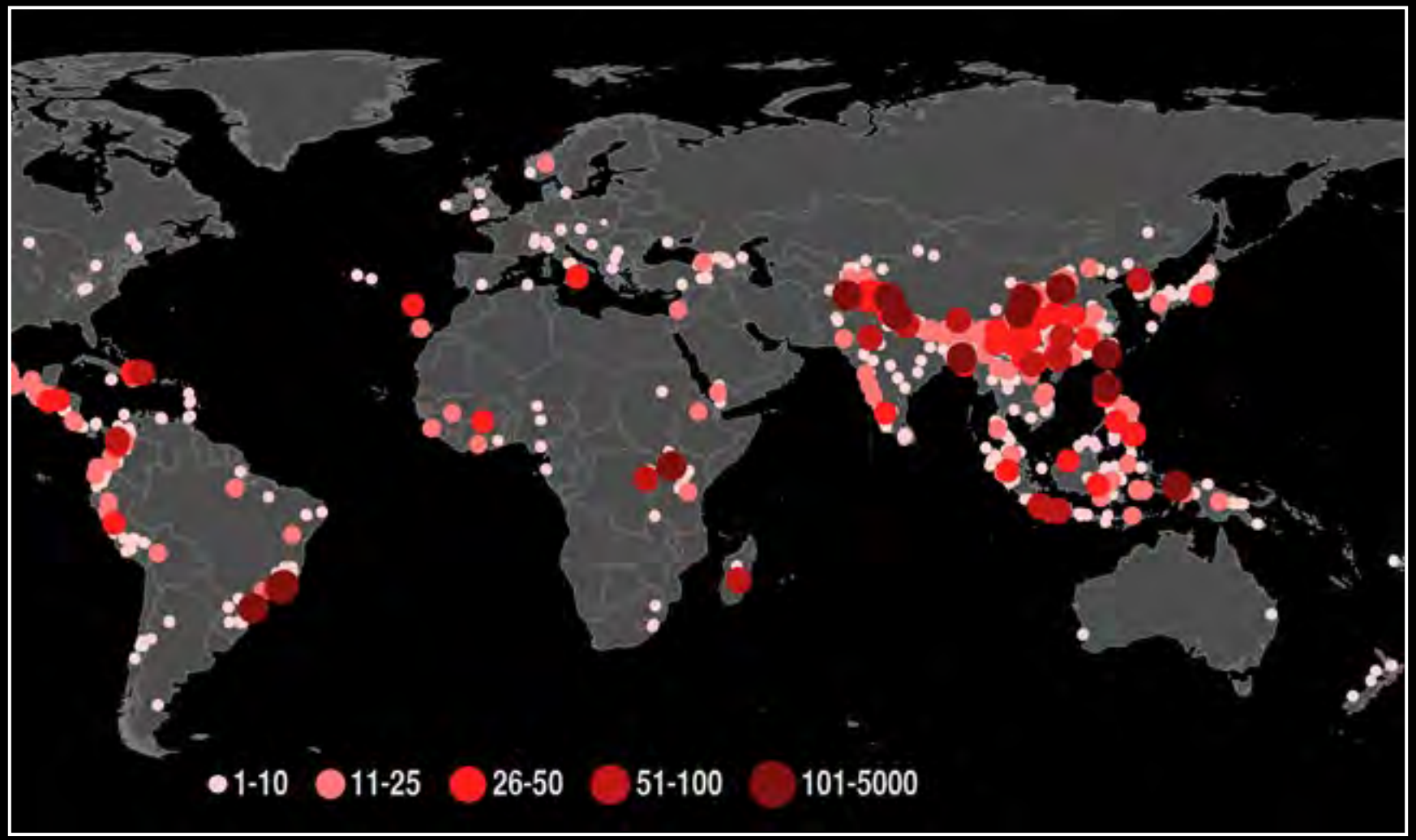
Distribution of landslides in the U.S.

- “Landslides in the United States cause approximately $3.5 billion (year 2001 dollars) in damage, and kill between 25 and 50 people annually.” - https://pubs.usgs.gov/fs/2004/3072/

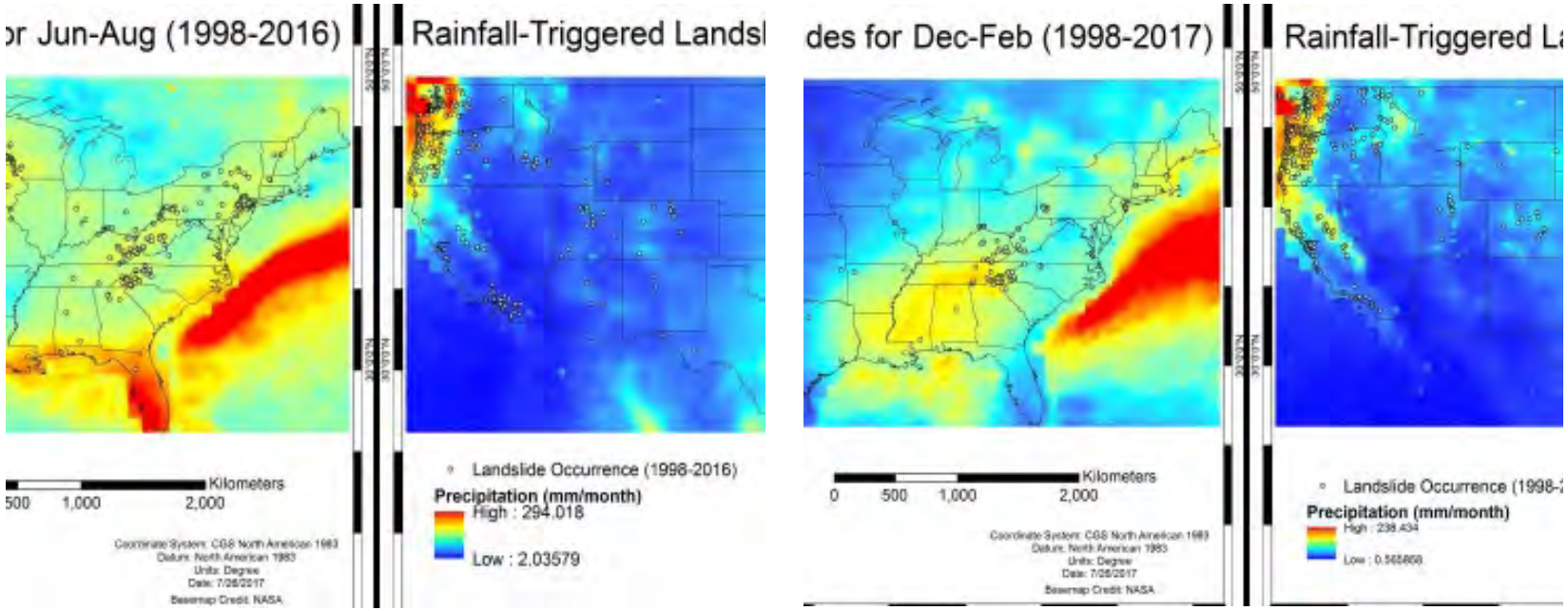


Landslide Overview Map of the Conterminous United States, 1982.

Dorothy H. Radbruch-Hall, Roger B. Colton, William E. Davies, Ivo Lucchitta, Betty A. Skipp, and David J. Varnes



Fatal precipitation-triggered landslides
Dalia Kirschbaum, NASA



Precipitation and landslides

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Blakeley area

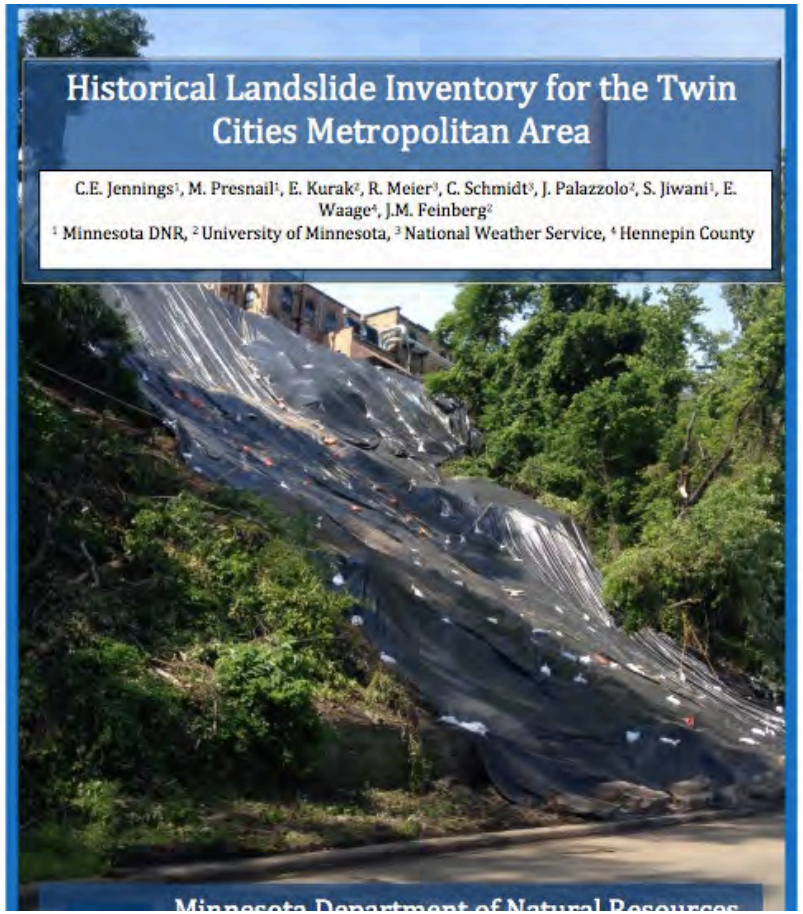

Scott County 60 into Blakely


Scott County Highway 1 into Blakeley


STOP

Sand deposited in ditches and around homes in Blakely

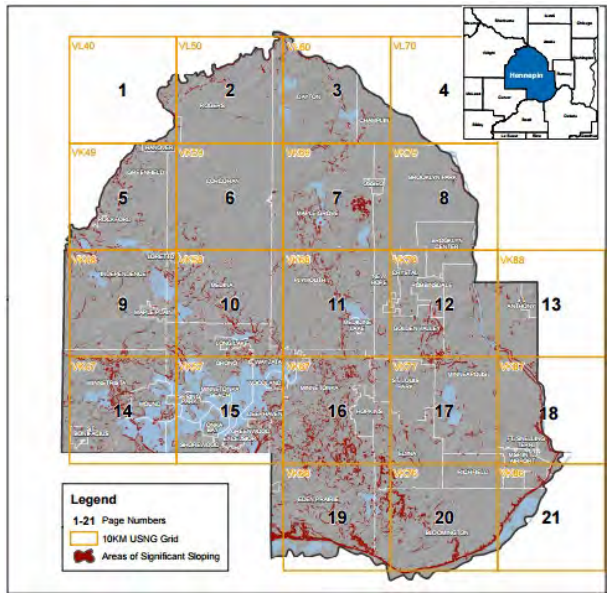
Precipitation driven landslides in Minnesota



Twin Cities' unlikely experience with landslides gets attention in Washington

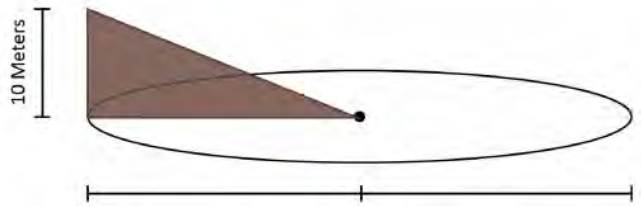
Hennepin County's emergency management director spoke to lawmakers about the area's response after several incidents in recent years.

By David Chanen Star Tribune | JANUARY 13, 2018 — 11:25AM



Slope and Relief Analysis

Slope values contained in these maps are shown only at cells where elevation variation is at least 10 meters within a 30 meter radius of those cells. This distinction was made so that extreme slope values at areas of short slopes were left off of the maps. Landslide risk is positively correlated with landforms having steep slopes and drastic local relief change. Refer to the diagram below for a visual representation of this explanation.



Hennepin County project served as a pilot for state effort

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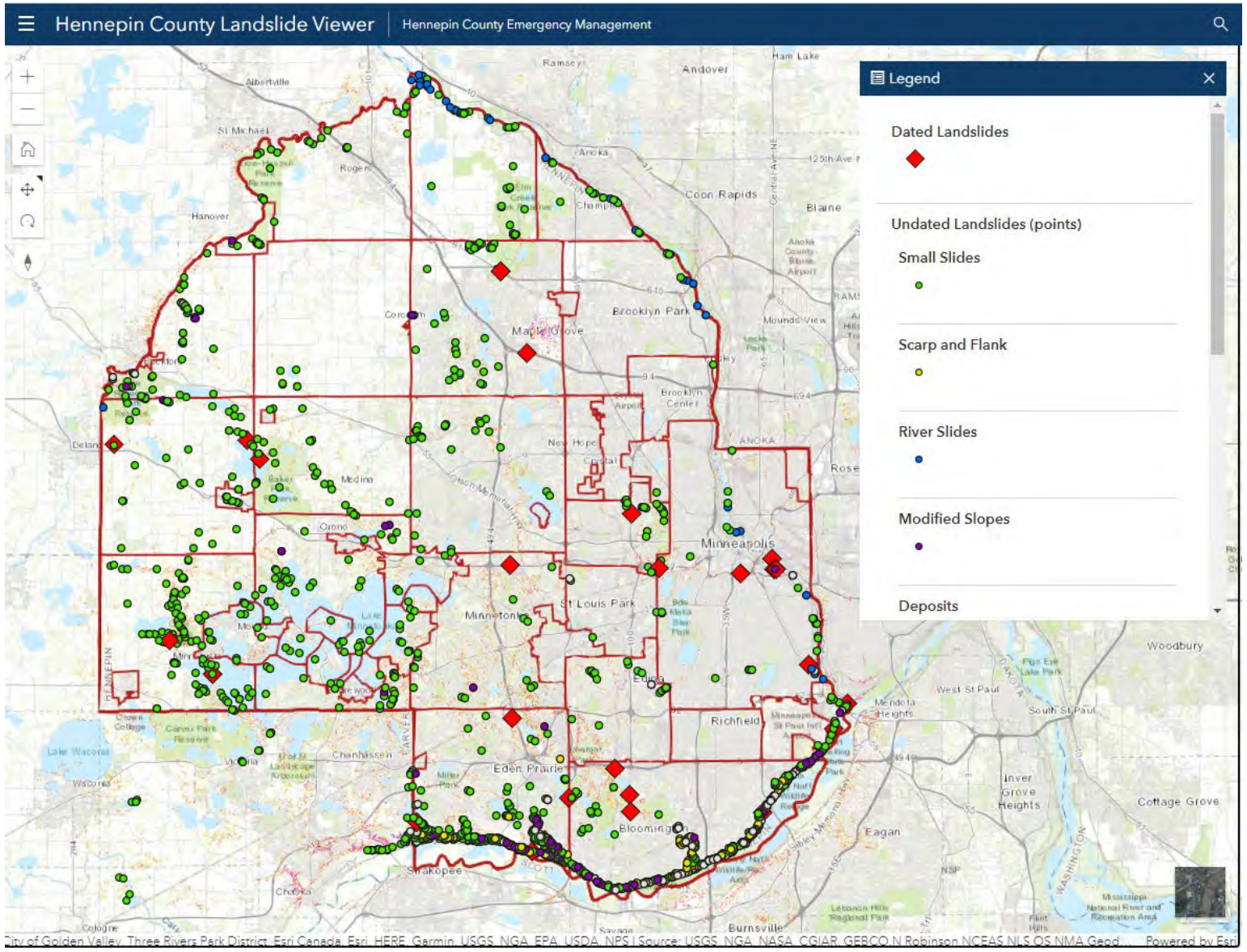
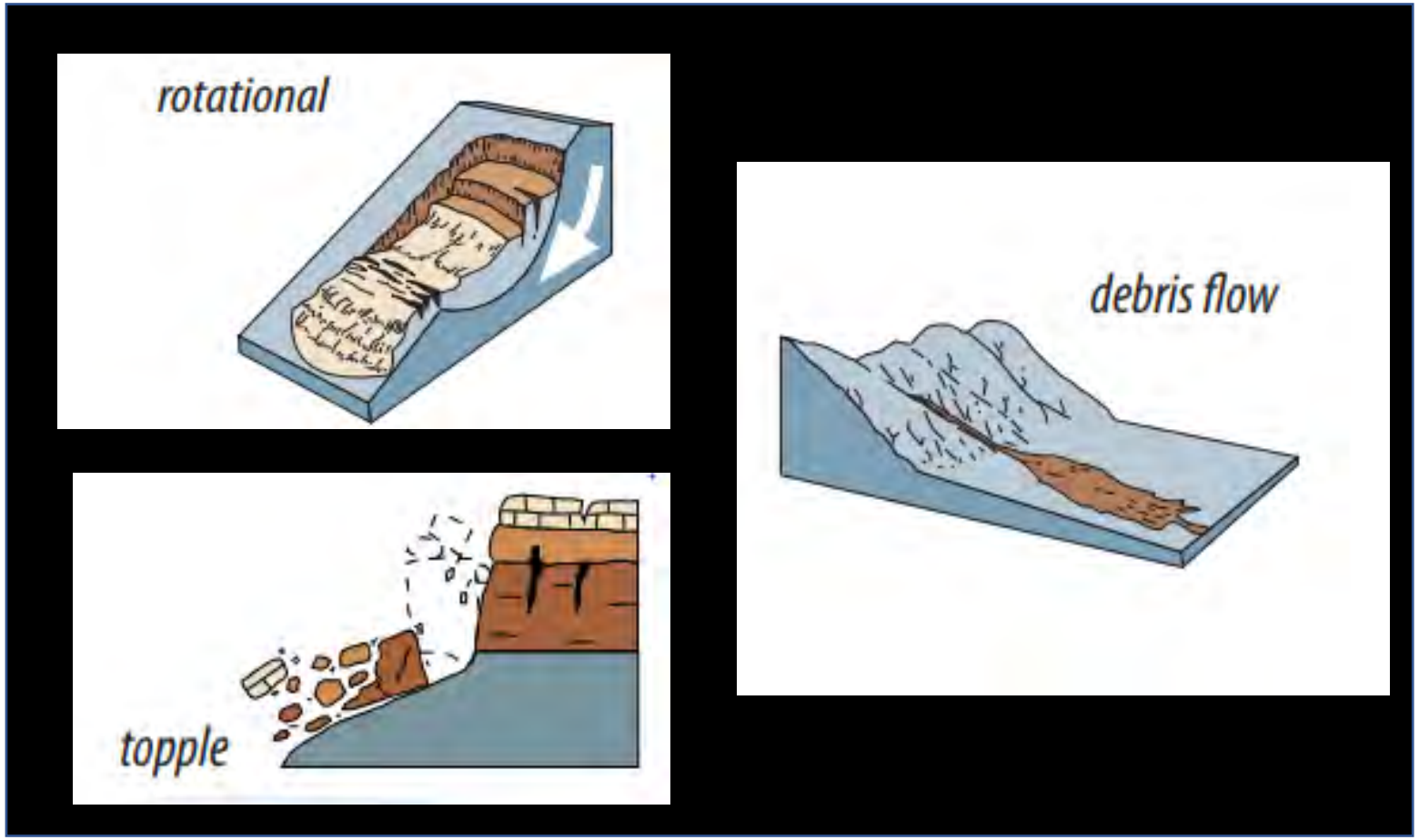
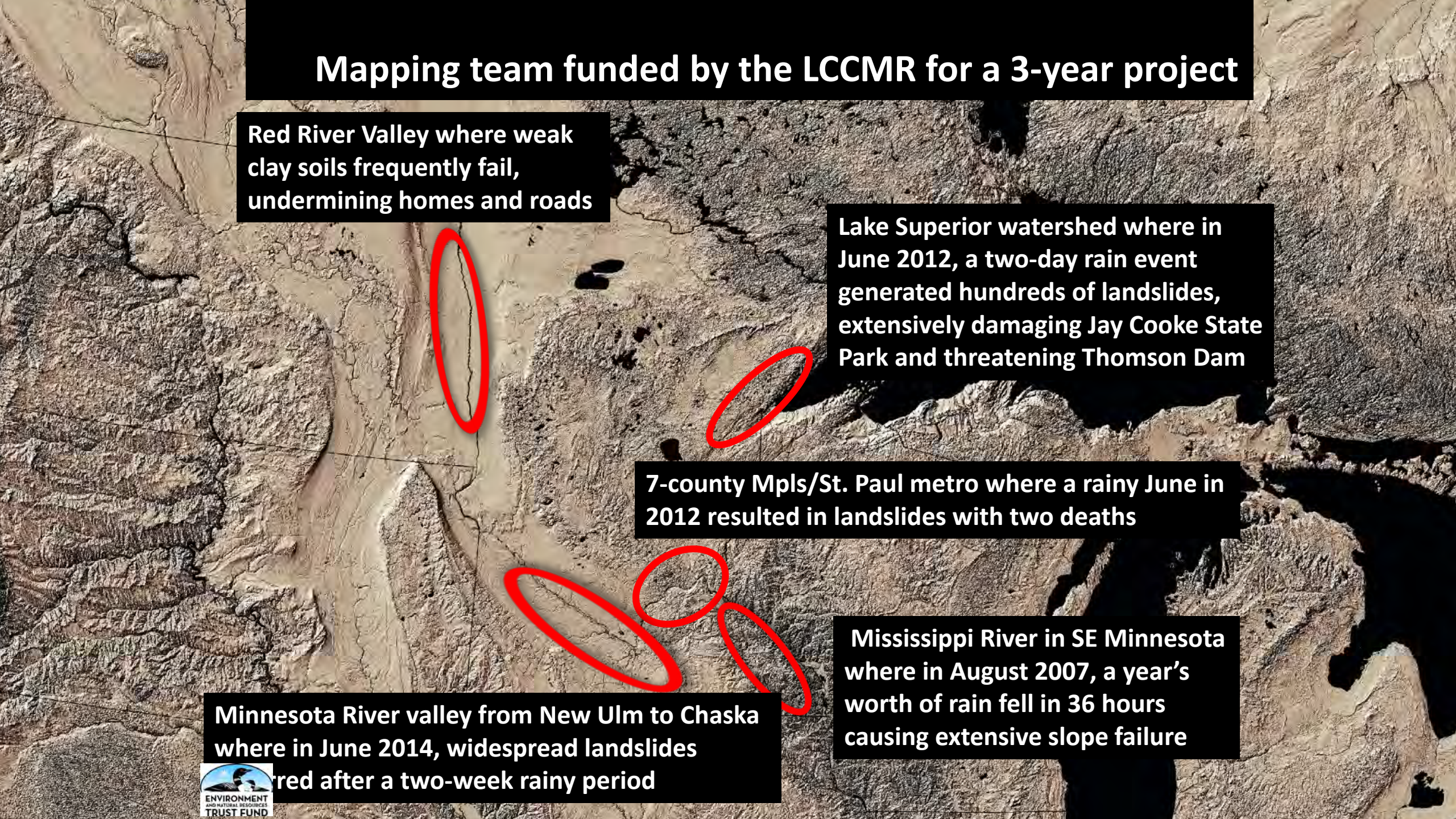

Hennepin County Landslide Viewer
Hennepin County Emergency Management
Legend
Dated Landslides
Undated Landslides (points)
Small Slides
Scarp and Flank
River Slides
Modified Slopes
Deposits
Albertville
St Michael
Rogers
Hanover
Ramsey
Andover
Ham Lake
Anoka
Coon Rapids
Blaine
Champlin
Brooklyn Park
Maple Grove
Mounds View
Brooklyn Center
New Hope
Medina
Minneapolis
St Louis Park
Minnetonka
Richfield
Eden Prairie
Chanhassen
Bloomington
Shakopee
Chaska
Burnsville
Eagan
Inver Grove Heights
Cottage Grove
Woodbury
West St Paul
South St Paul
Mendota Heights
Lake Waconia
Cologne
Savage
City of Golden Valley, Three Rivers Park District, Esri Canada, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS | Source: USGS, NGA, NASA, CGIAR, GEBCO, N Robinson, NCEAS, NLS, OS, NMA, Geod...
Powered by Esri

Common landslide types




Mapping team funded by the LCCMR for a 3-year project
Red River Valley where weak clay soils frequently fail, undermining homes and roads
Lake Superior watershed where in June 2012, a two-day rain event generated hundreds of landslides, extensively damaging Jay Cooke State Park and threatening Thomson Dam
7-county Mpls/St. Paul metro where a rainy June in 2012 resulted in landslides with two deaths
Mississippi River in SE Minnesota where in August 2007, a year's worth of rain fell in 36 hours causing extensive slope failure
Minnesota River valley from New Ulm to Chaska where in June 2014, widespread landslides
rred after a two-week rainy period
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Landslide hazard research objectives

1. Landslide inventory – where have landslides occurred historically?

Evaluate the types of landslides

geologic and topographic settings

and their causes

2. Landslide susceptibility mapping – based on inventory, topography, geology

Communicate hazard to decision makers, stakeholders, citizens through technical and non-technical publications.

Provide tools for land managers to make informed decisions about mitigation and restoration.

3. Protocols for use of lidar in landslide mapping, event response, and to study landslide process.

Statewide airborne lidar

Some available repeat airborne lidar (Arrowhead region, Minn. River Valley)

Terrestrial lidar, UAV and ground-based structure-from-motion

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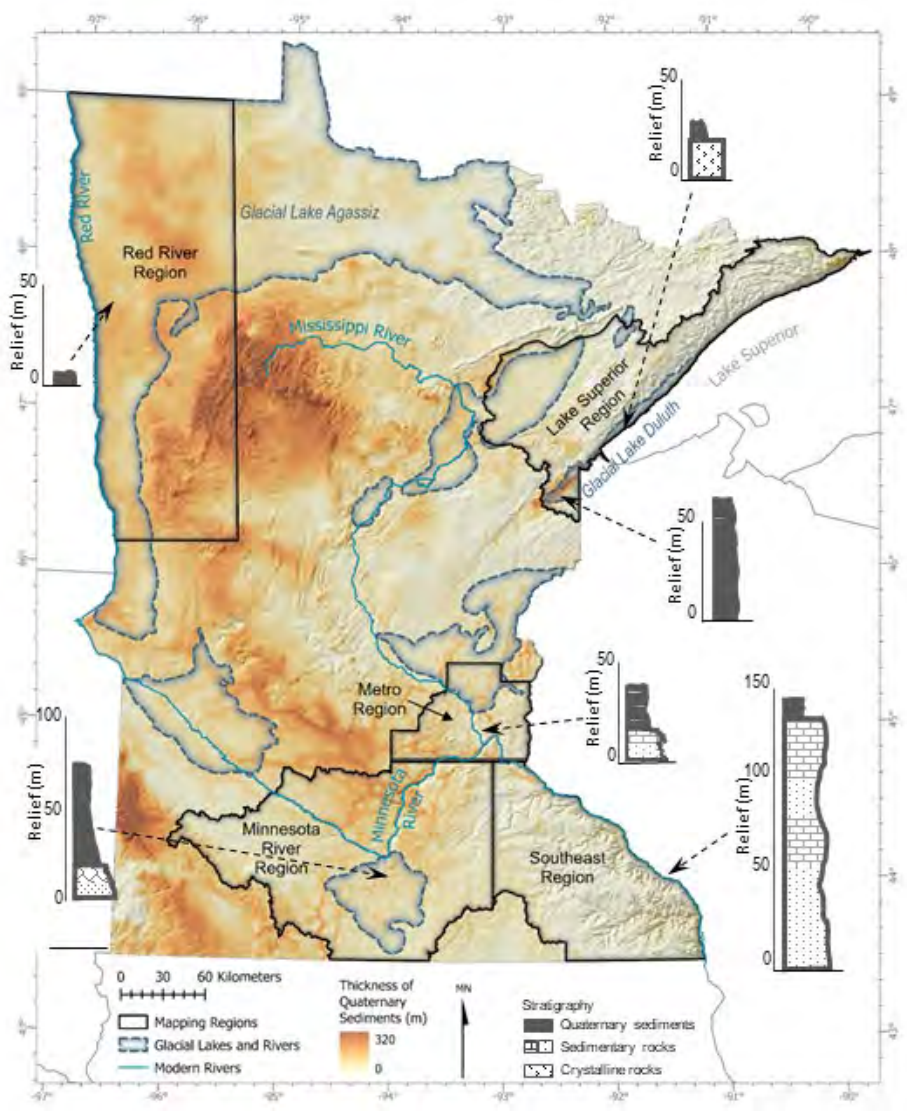
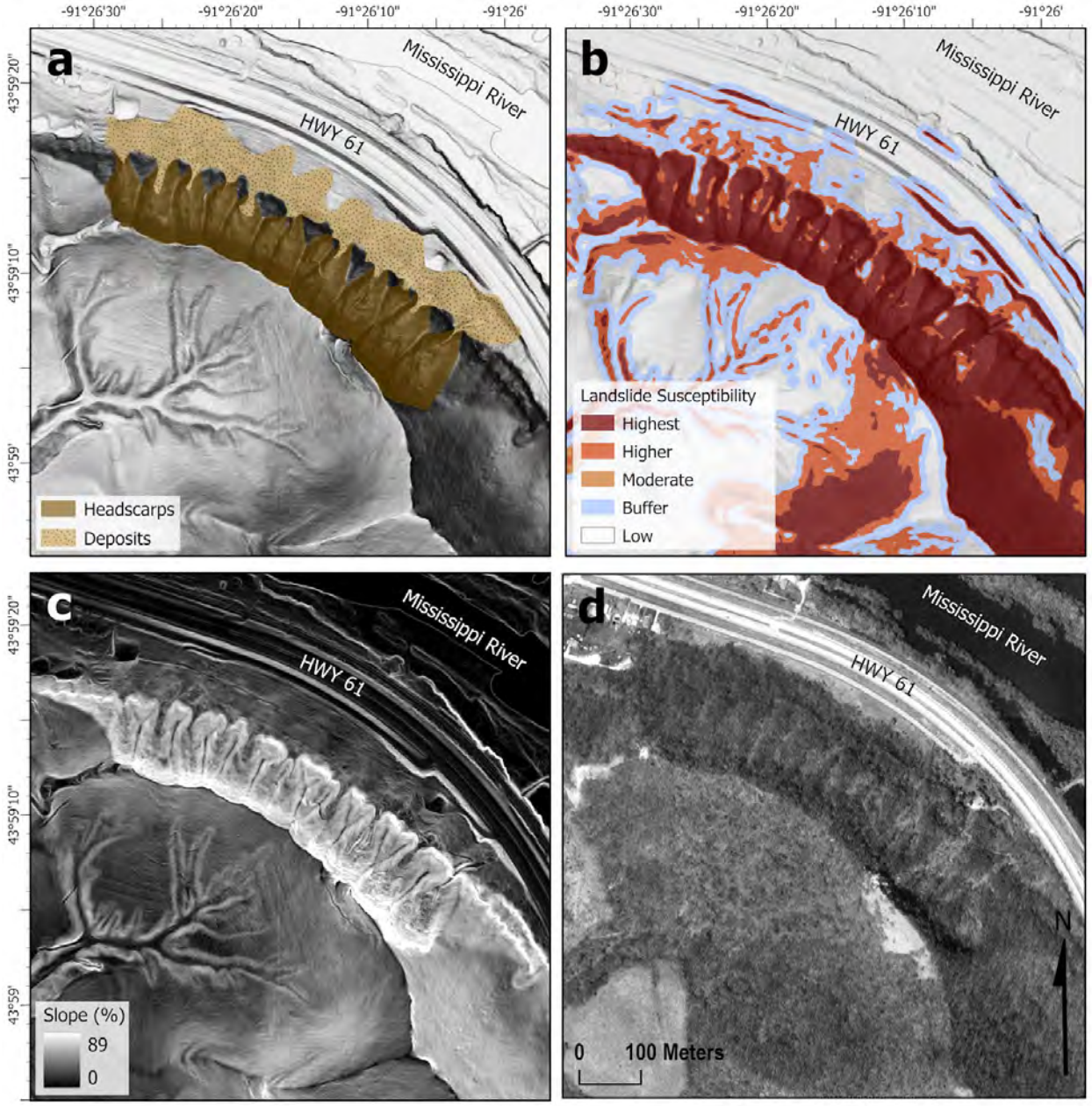
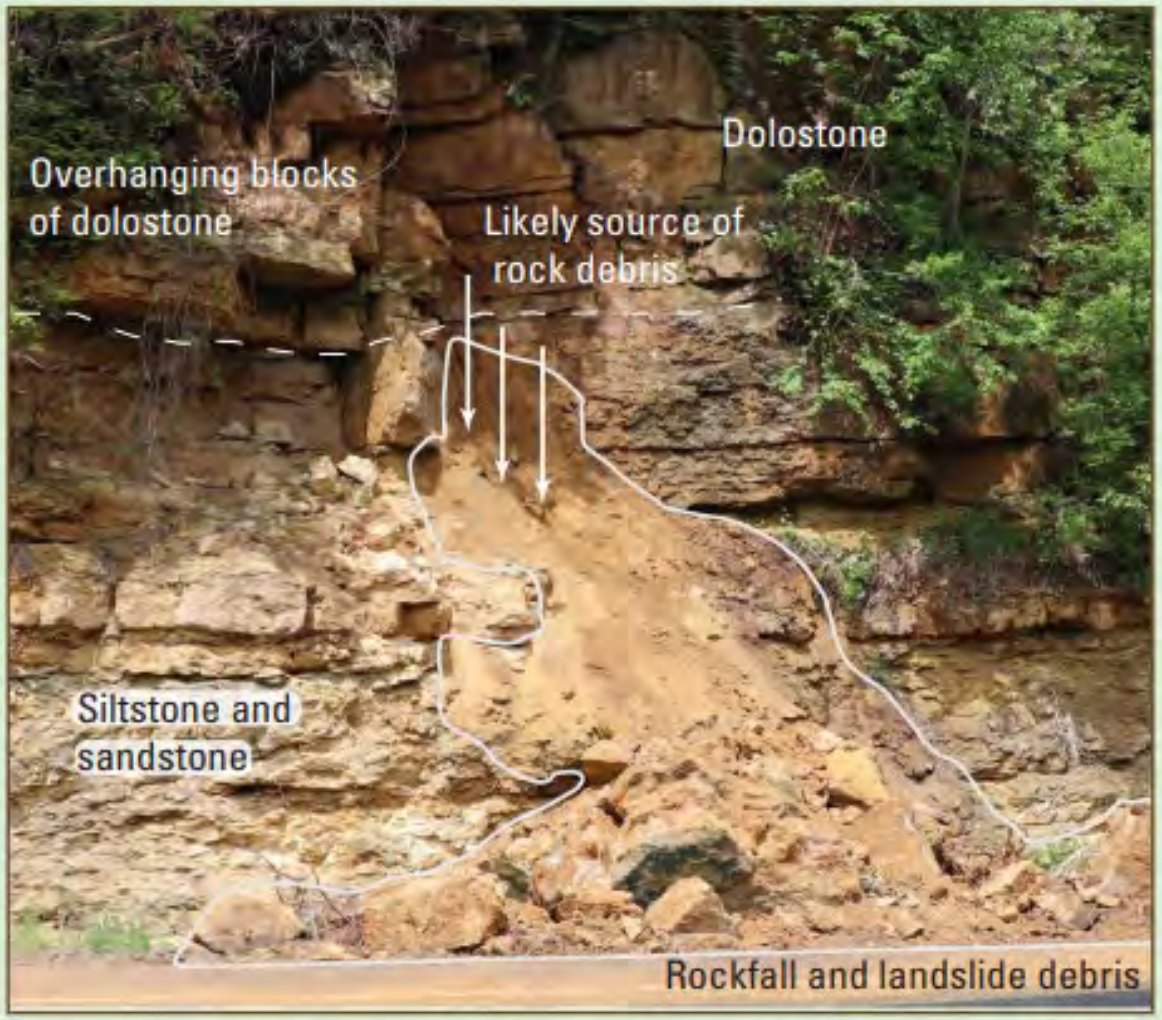

Red River
Glacial Lake Agassiz
Red River Region
Mississippi River
Lake Superior Region
Lake Superior
Glacial Lake Duluth
Metro Region
Minnesota River
Minnesota River Region
Southeast Region
Relief (m)
50
0
100
150
0 30 60 Kilometers
Mapping Regions
Glacial Lakes and Rivers
Modern Rivers
Thickness of Quaternary Sediments (m)
320
0
MN
Stratigraphy
Quaternary sediments
Sedimentary rocks
Crystalline rocks

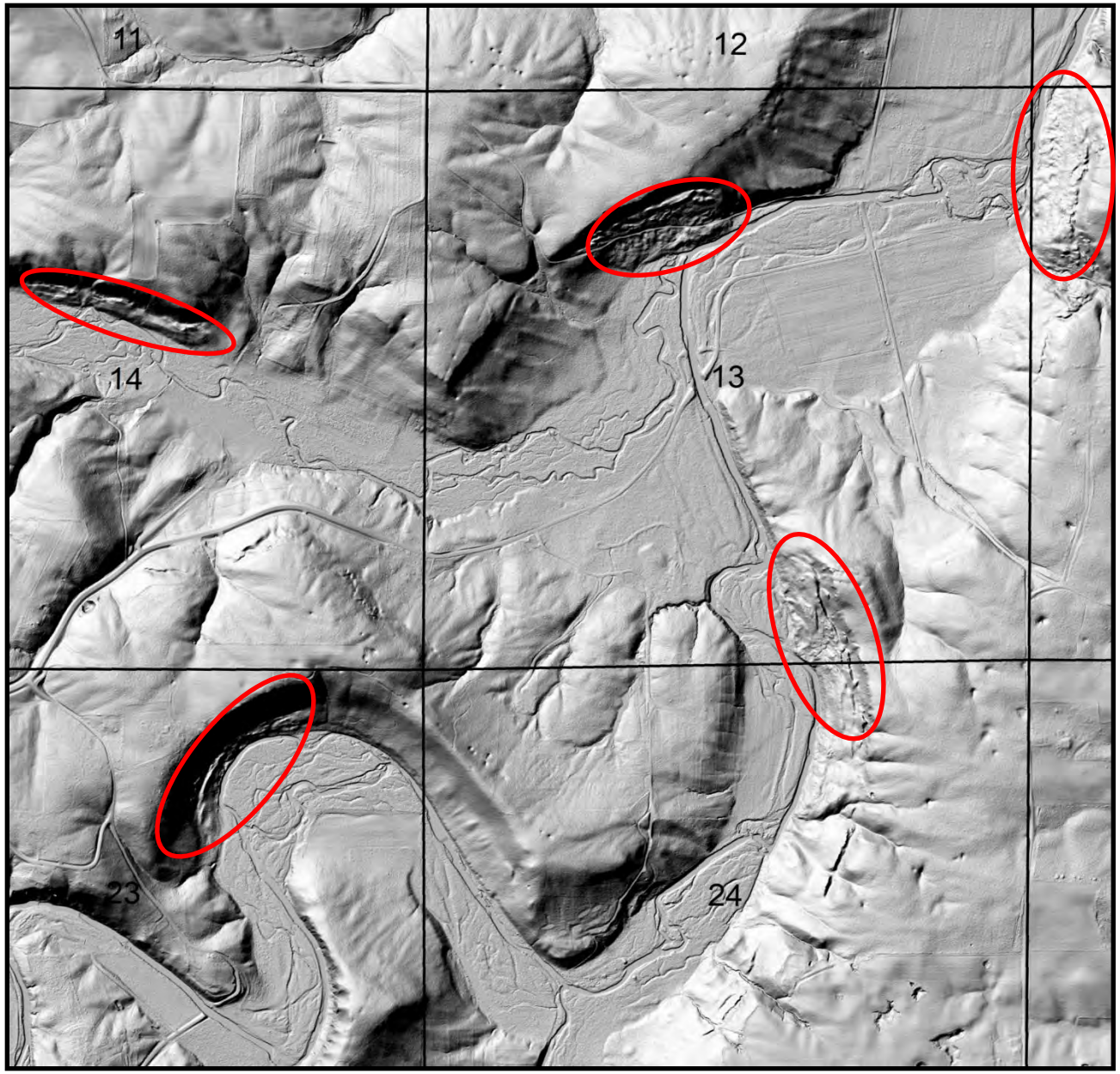
	REGION					
Metric	Southeast	Metro	Minnesota River	Red River	Lake Superior	All Regions
Region area (km^2)	13,000	5,200	22,400	29,300	16,600	86,500
Number of mapped landslides	738	537	3,365	2,648	2,446	9,734
Slide density - slides/km^2	0.06	0.10	0.15	0.09	0.15	0.11
Mean area of each landslide - m^2 (SD)	13,254 (19,480)	4,699 (9,085)	3,577 (8,869)	12,799 (20,808)	2,103 (5,487)	6,505 (14,382)
Mean landslide slope - degrees (SD)	35 (7)	29 (6)	37 (8)	13 (8)	31 (7)	33 (9)



***Example of landslides and topography in Southeast Region**: (a) Mapped headscarps and deposits overlain on lidar-derived shaded relief map, (b) Map of landslide susceptibility overlain on lidar-derived shaded relief map, (c) Topographic slope map, (d) Satellite image, May 4th, 1992 (Google, 1992).*

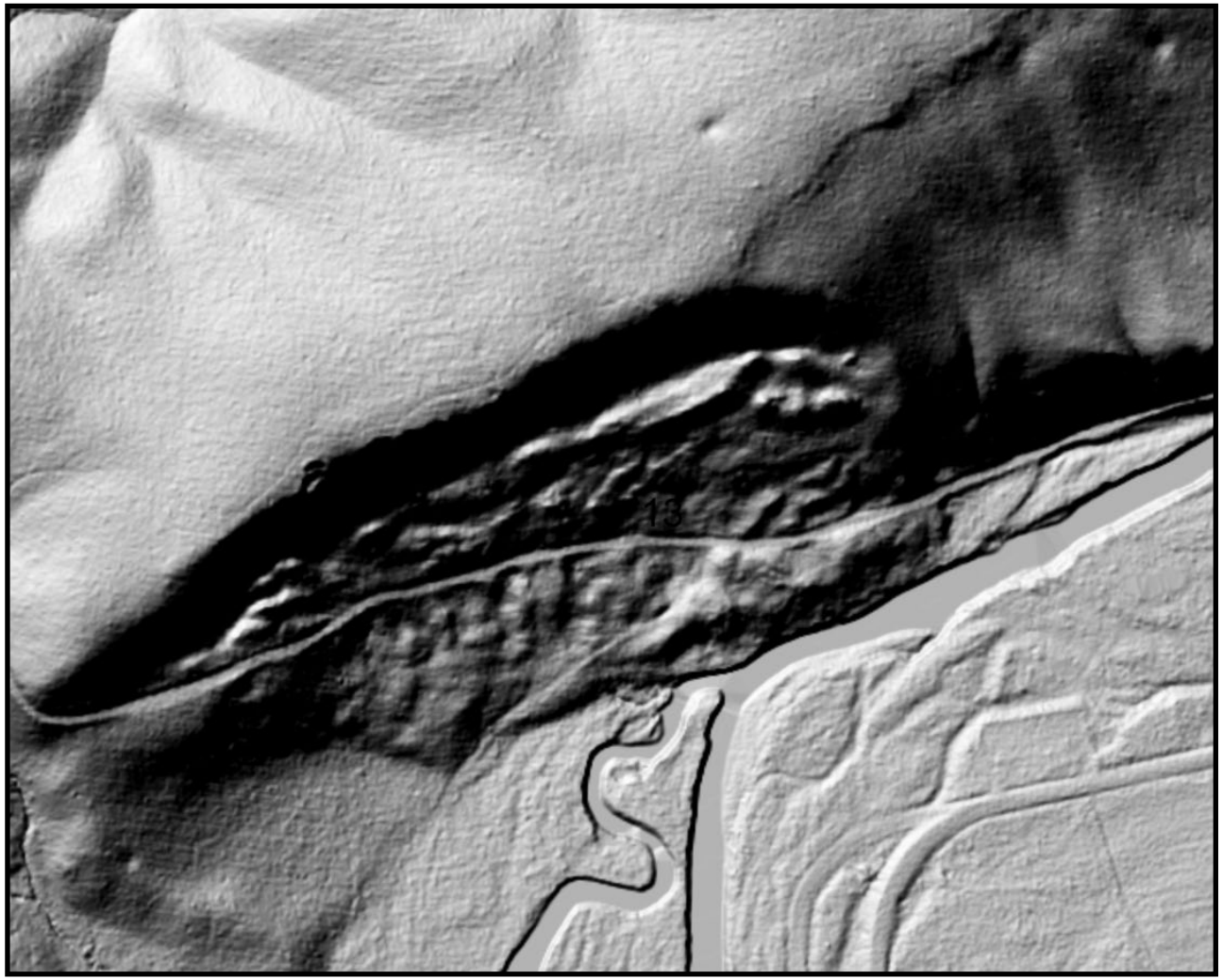


Layered bedrock in southeastern Minnesota and rockfall. In this location, weaker siltstone and sandstone layers are beneath stronger carbonate rock layers. As the siltstone and sandstone are eroded, blocks of the overlying dolostone (above dashed line) are undermined and can fail abruptly. Photograph courtesy of Winona State University.



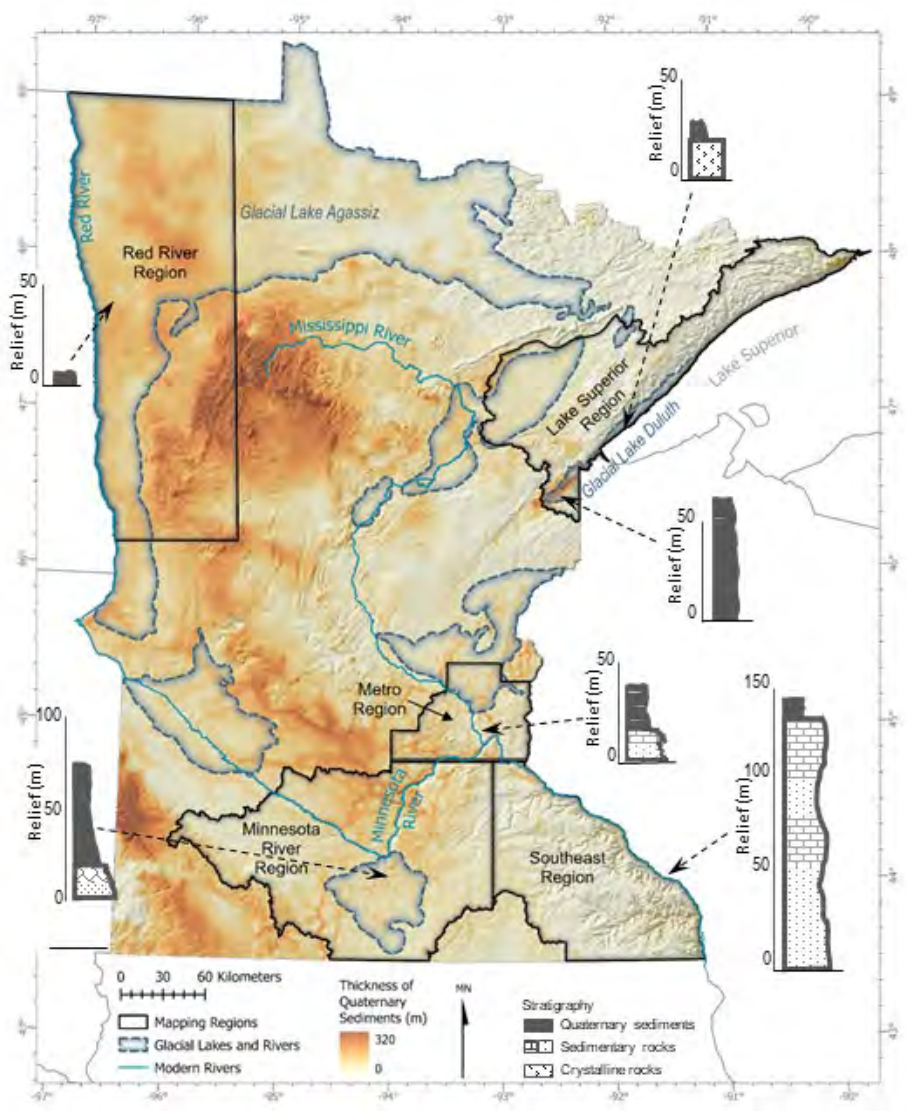
Forestville Mystery Cave State Park Fillmore Co., MN

Forestville Store Slide



- Chaotic slope
- Headwall scarp and trench
- Cross cutting older slide?
- Sinkholes on uplands and on older slopes
- Trail along early settlement wagon road.

Jennings et al., 2020 NCtrlGSA


Red River
Glacial Lake Agassiz
Red River Region
Mississippi River
Lake Superior Region
Lake Superior
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Metro Region
Minnesota River
Minnesota River Region
Southeast Region
Relief (m)
50
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MN
Stratigraphy
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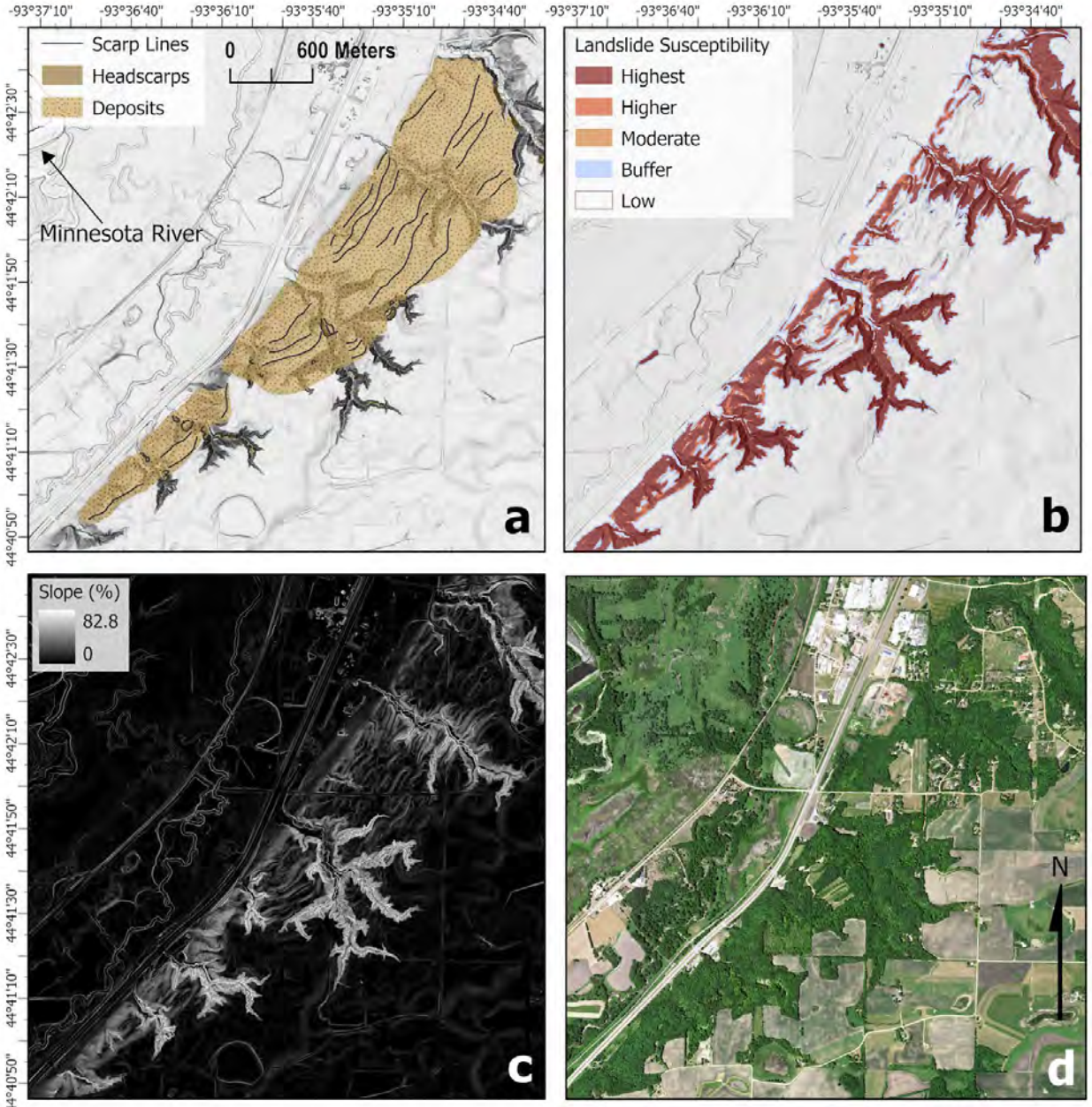
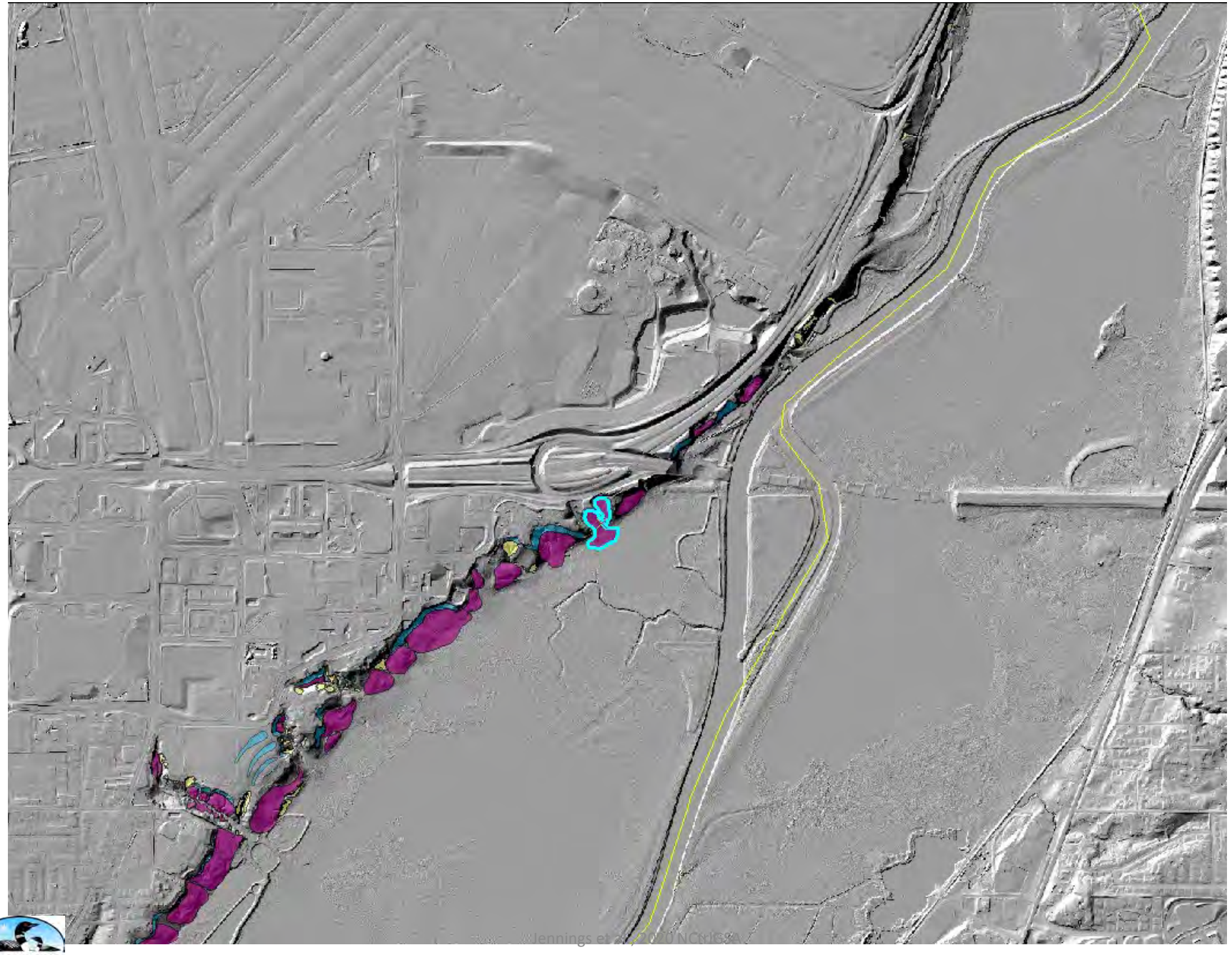


Examples of landslides in Metro Region*: (a) Mapped scarp lines and an extensive, low-slope, perhaps pre-historic deposit overlain on lidar-derived shaded relief map, (b) Map of landslide susceptibility overlain on lidar-derived shaded relief map. Note that much of this deposit has stabilized at a low enough slope that it has low susceptibility for more landsliding other than where it has been locally steepened by gullying, (c) Topographic slope, (d) Aerial image, June 18th, 2021 (USDA a. 2021).*



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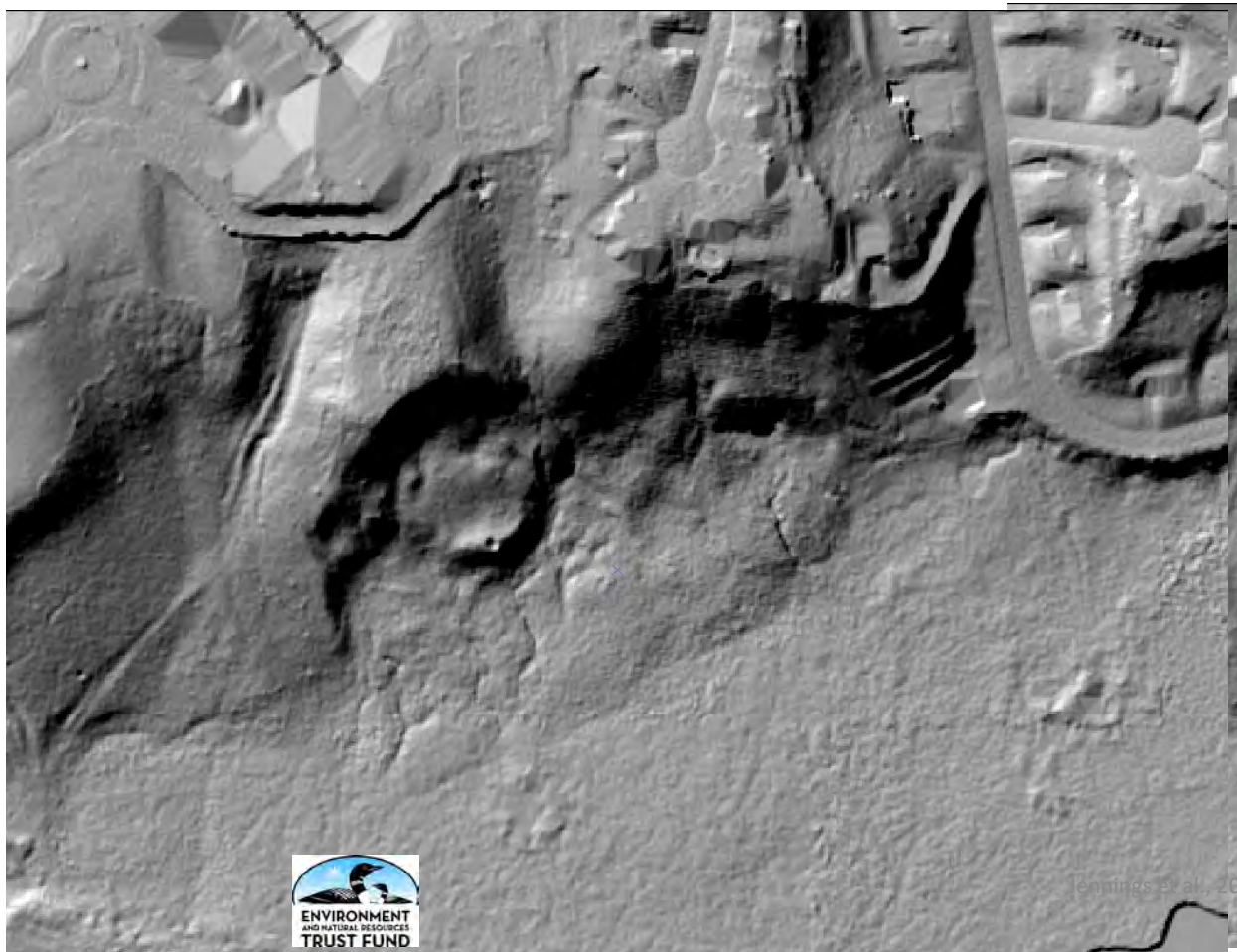
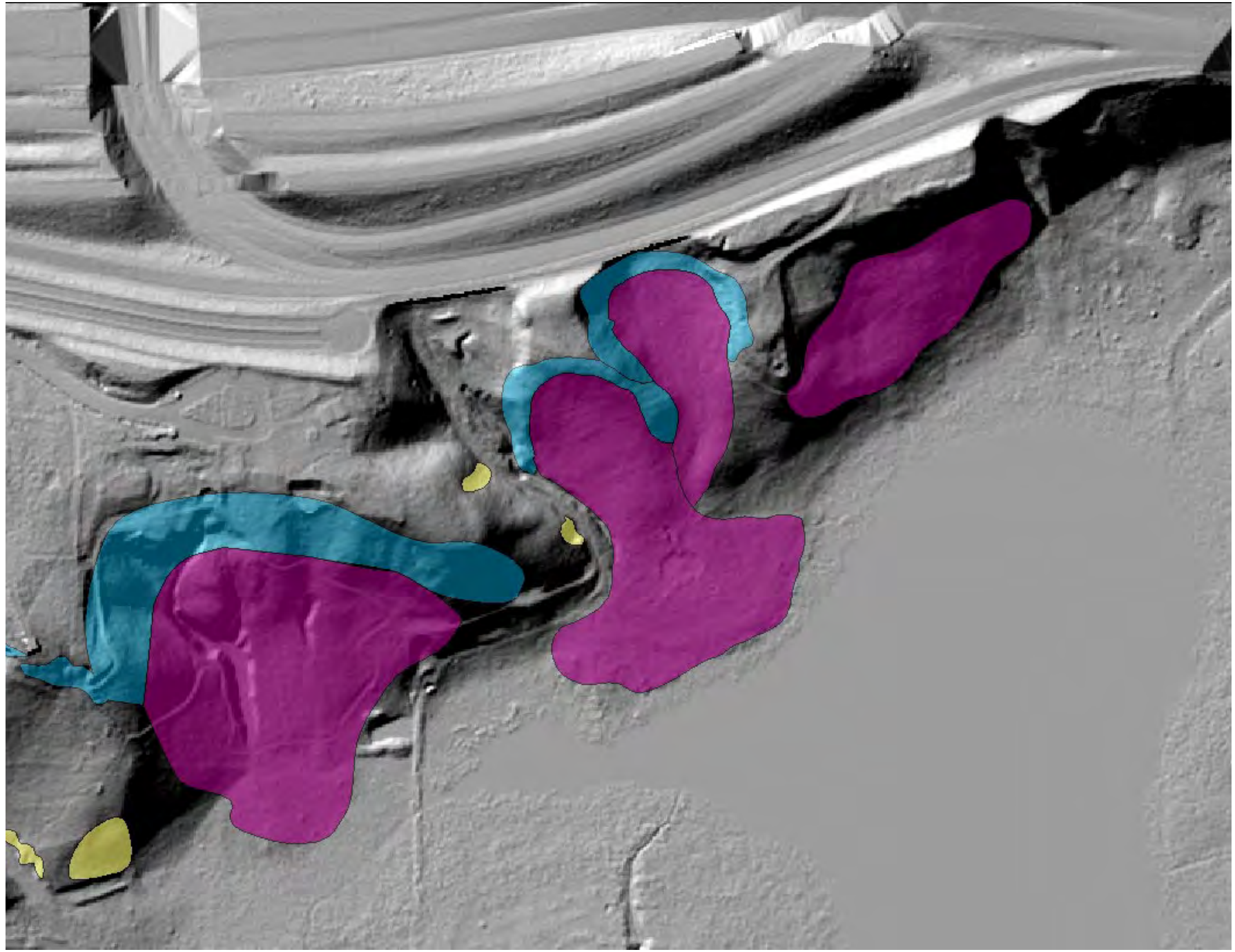
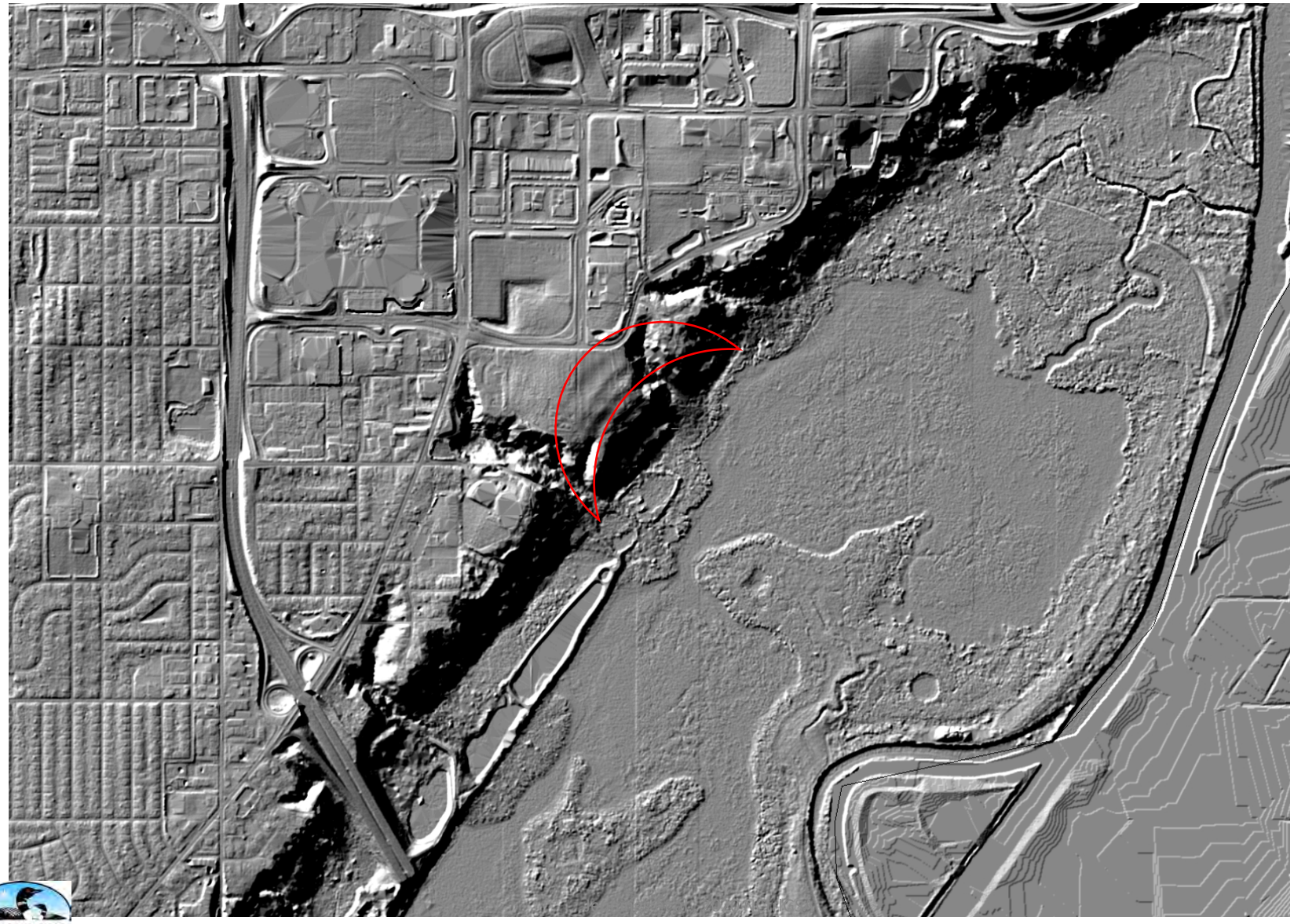
Deposits and scarp and flank





Mall of America



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Spring horizon

Figure 6.5a — Springs in Eroded Traces of Arcuate Depressions

In Bloomington, iron-rich springs emerge where sands overlies lake clay of the Cromwell Formation and where numerous, deep-seated landslides have been mapped.

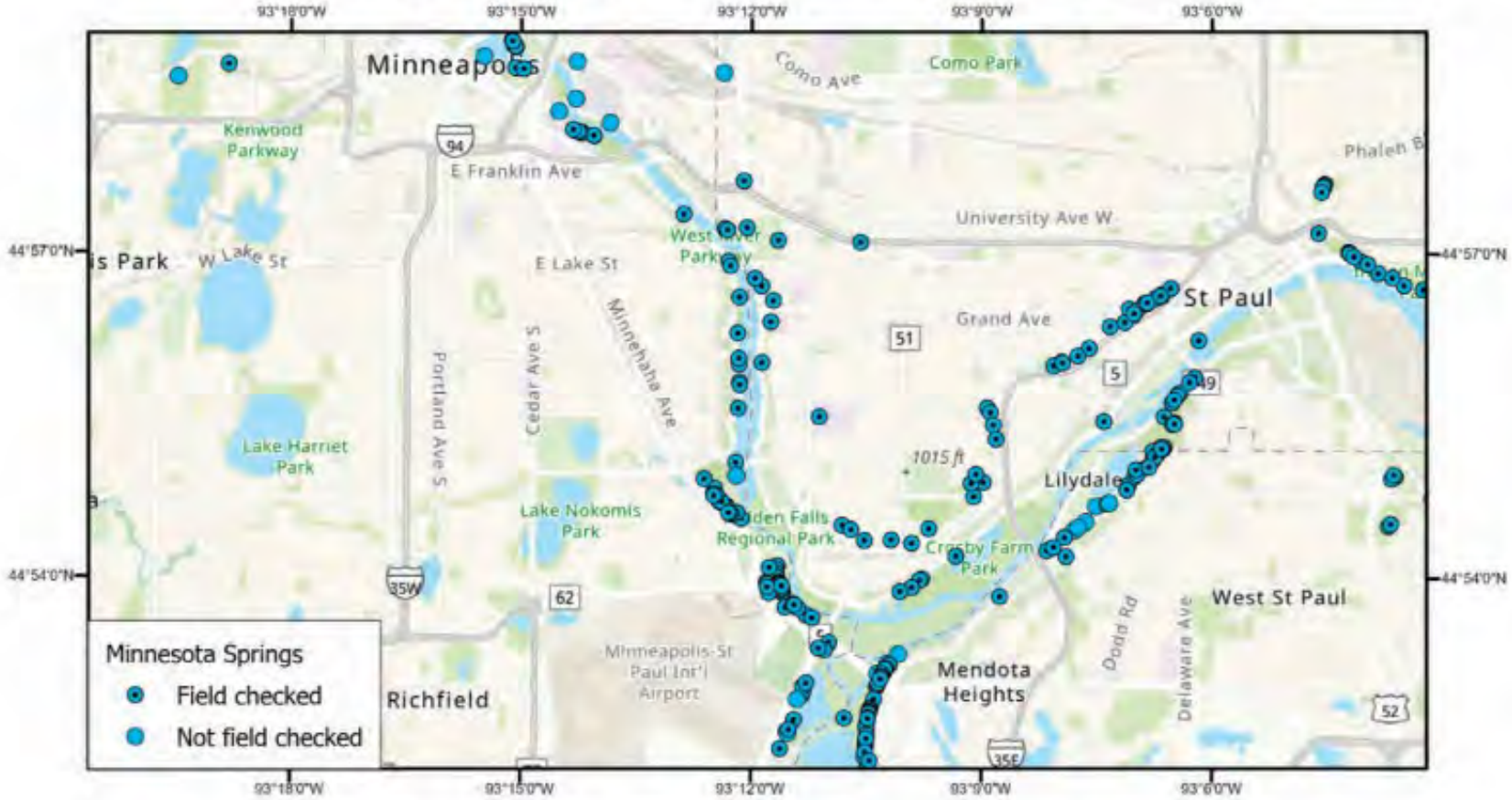
Figure 6.4 — Representative Cross Section

A portion of cross section F-F' from Plate 4, Hennepin County Atlas *(Berthold, 2018)* shows the stratigraphy in the area of large landslides along the Minnesota River in Bloomington in the eastern portion of the section. Unit Qcl appears to be involved in destabilizing the slope.

The role of springs and seeps

Figure 7.3 — Bedrock Sequence The Magnolia Member is 7–10' thick and has a blocky appearance. The Hidden Falls Member is 4–6' thick and has curvilinear fractures. The lowermost Mifflin Member is 11–13' thick and breaks off in large, tabular slabs. Springs emanate predominantly from Magnolia/Hidden Falls contact (48%) and Hidden Falls/ Mifflin contact (25%). Seeps along bedrock layers exposed above the Ford Dam can be identified by ice. *(Runkel et al., 2015)*

Springs along the Mississippi Gorge



0 2 4 Miles

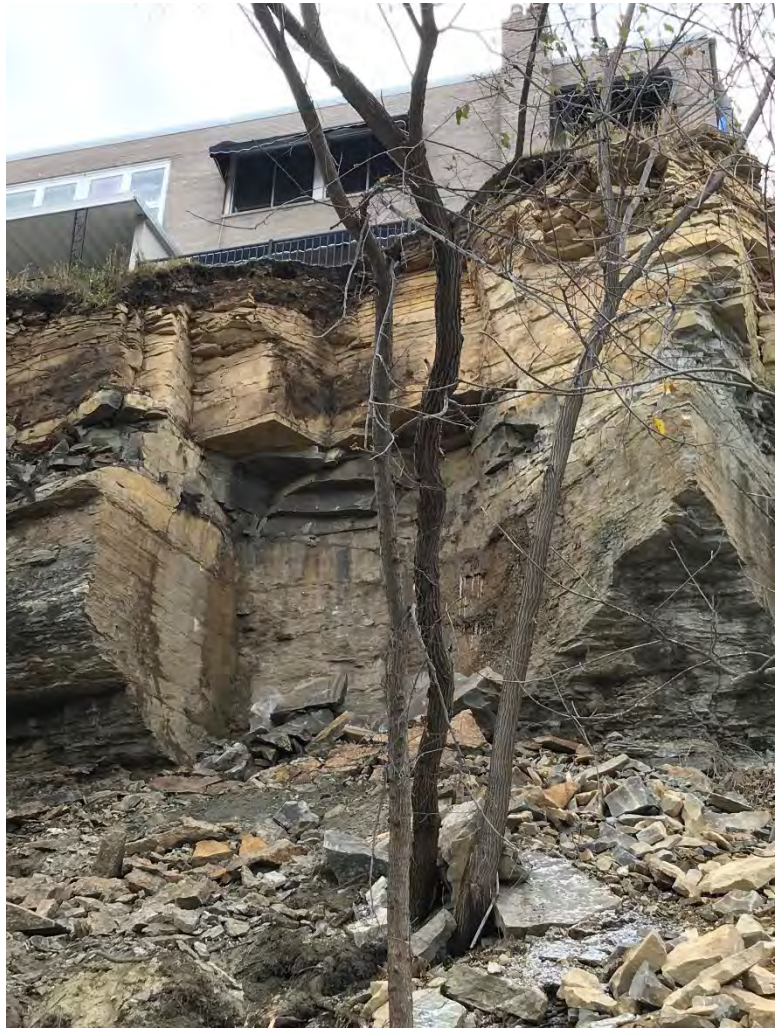
Map Scale 1:118,725

This data (i) is furnished 'AS IS' with no representation as to completeness or accuracy; (ii) is furnished with no warranty of any kind; and (iii) is not suitable for legal, engineering or surveying purposes. Hennepin County shall not be liable for any damage, injury or loss resulting from this data.

Created on 4/10/2020

Data source: MN DNR

Overhanging Mifflin Member of Platteville Formation



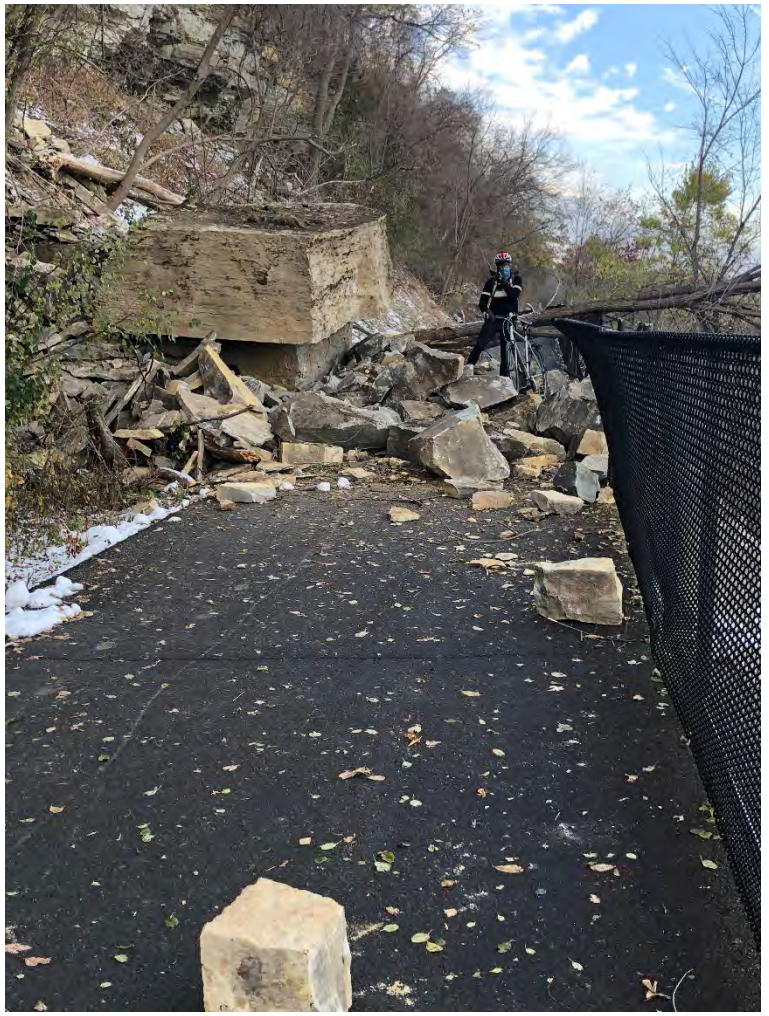
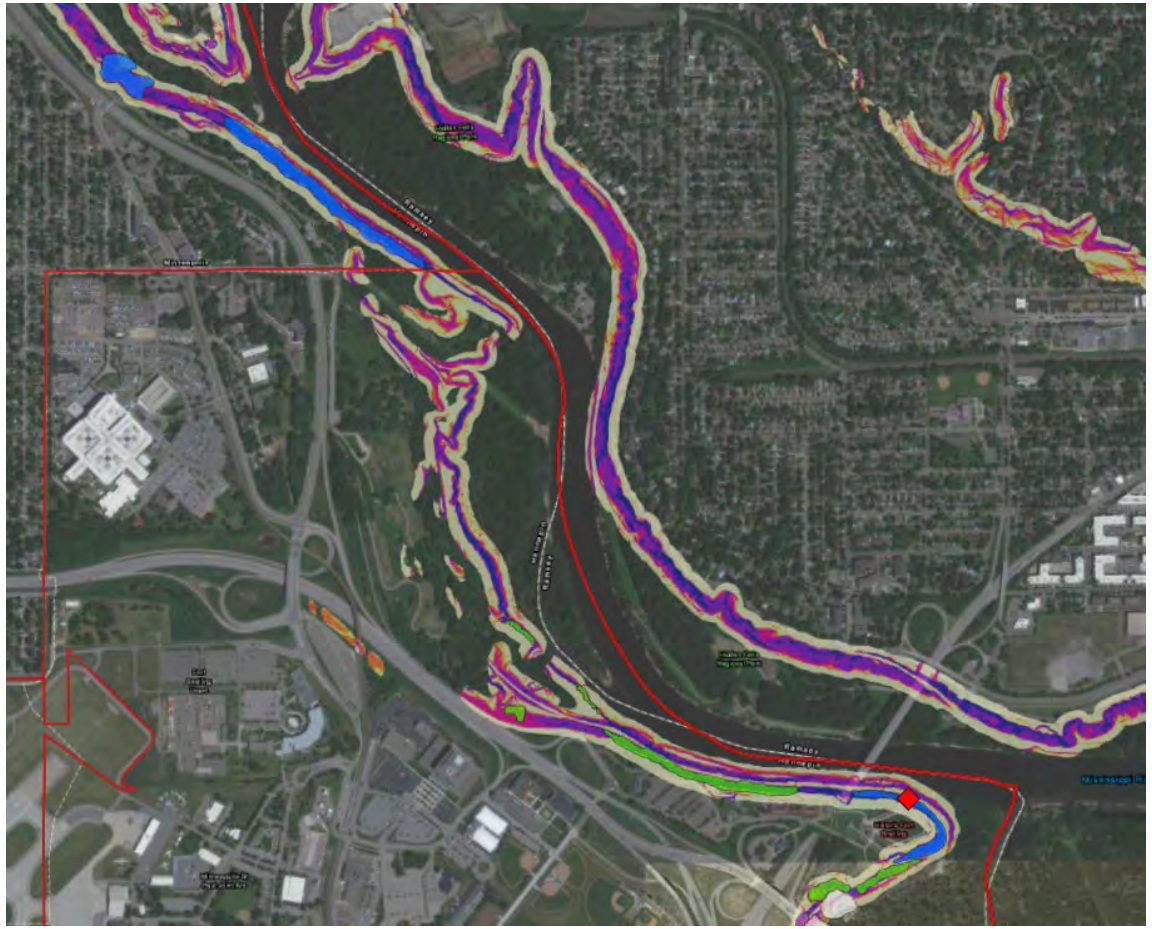
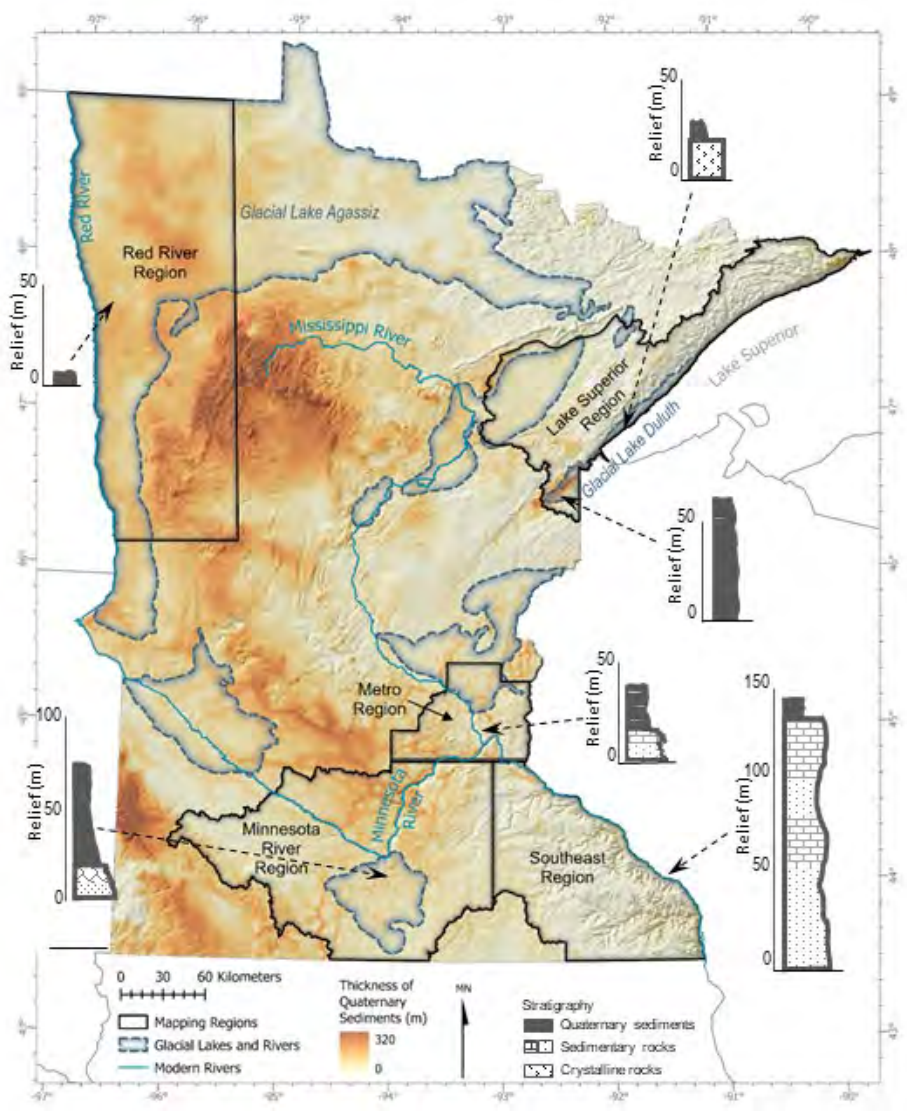


Photo credit, Dylan Strand, Dakota Co.



Rockfall and Trail Use


Red River
Glacial Lake Agassiz
Red River Region
Mississippi River
Lake Superior Region
Lake Superior
Glacial Lake Duluth
Metro Region
Minnesota River
Minnesota River Region
Southeast Region
Relief (m)
50
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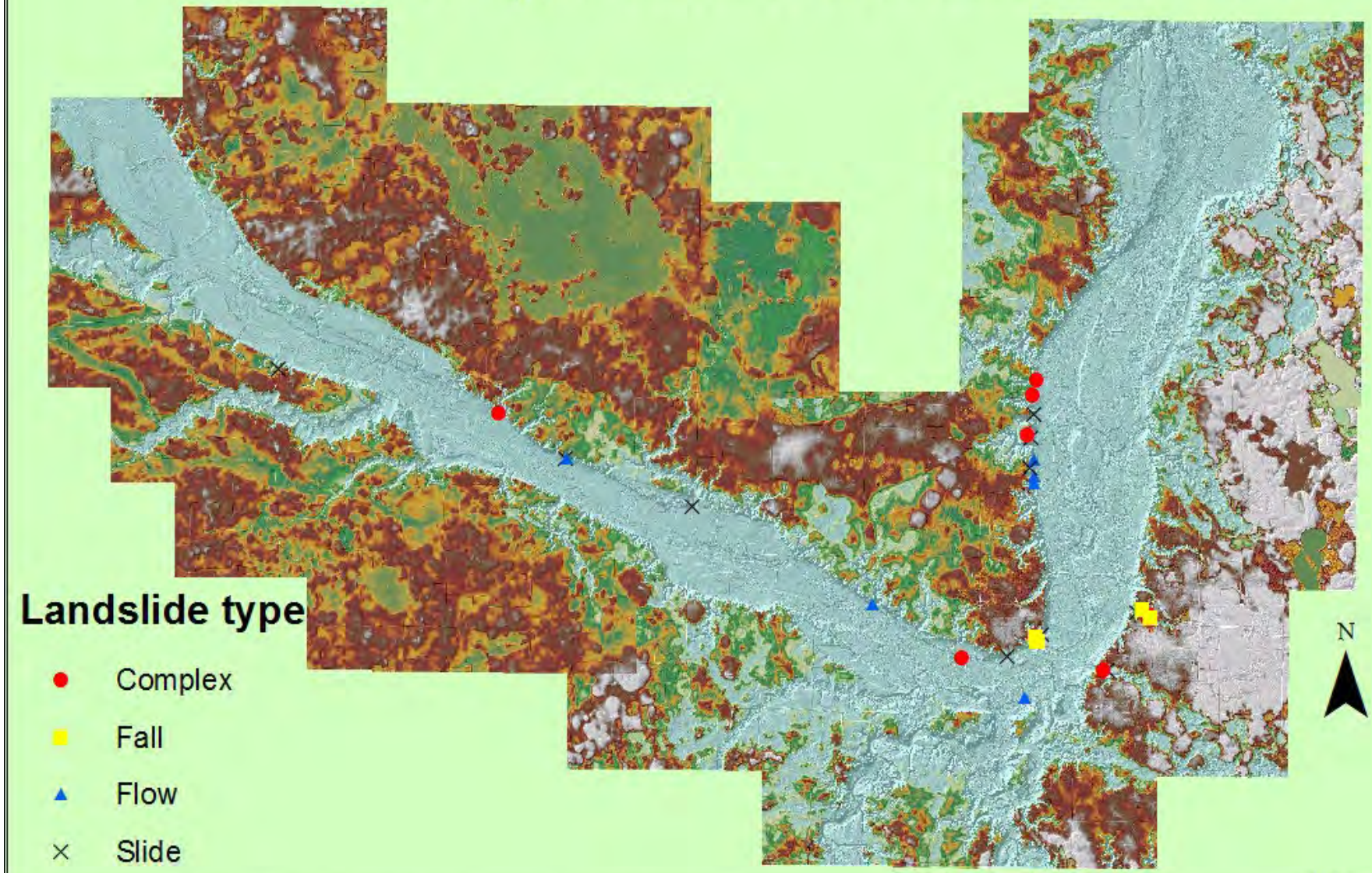
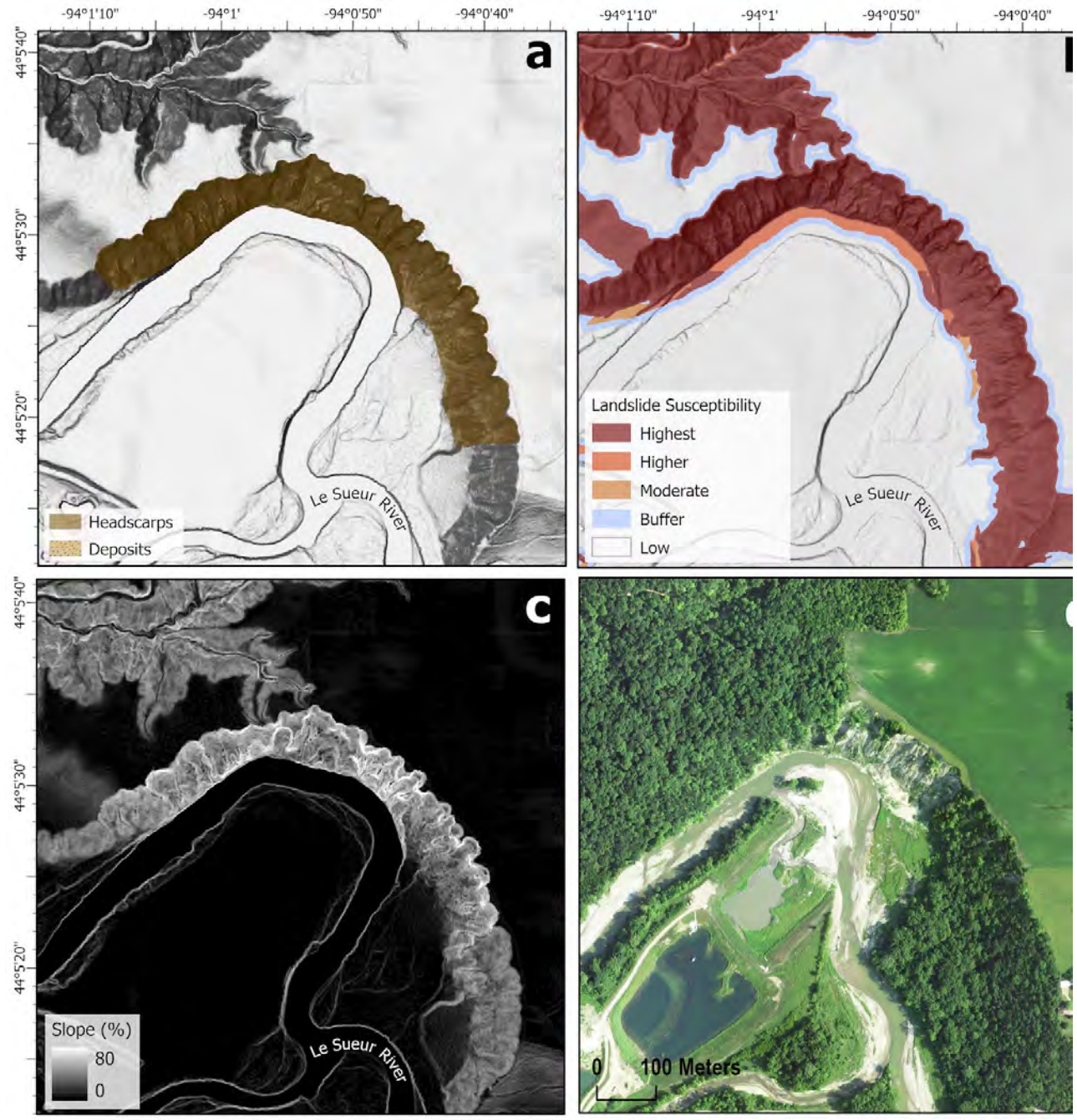
150
0 30 60 Kilometers
Mapping Regions
Glacial Lakes and Rivers
Modern Rivers
Thickness of Quaternary Sediments (m)
320
0
MN
Stratigraphy
Quaternary sediments
Sedimentary rocks
Crystalline rocks

Landslide Identification in the Minnesota River Valley, New Ulm to St. Peter

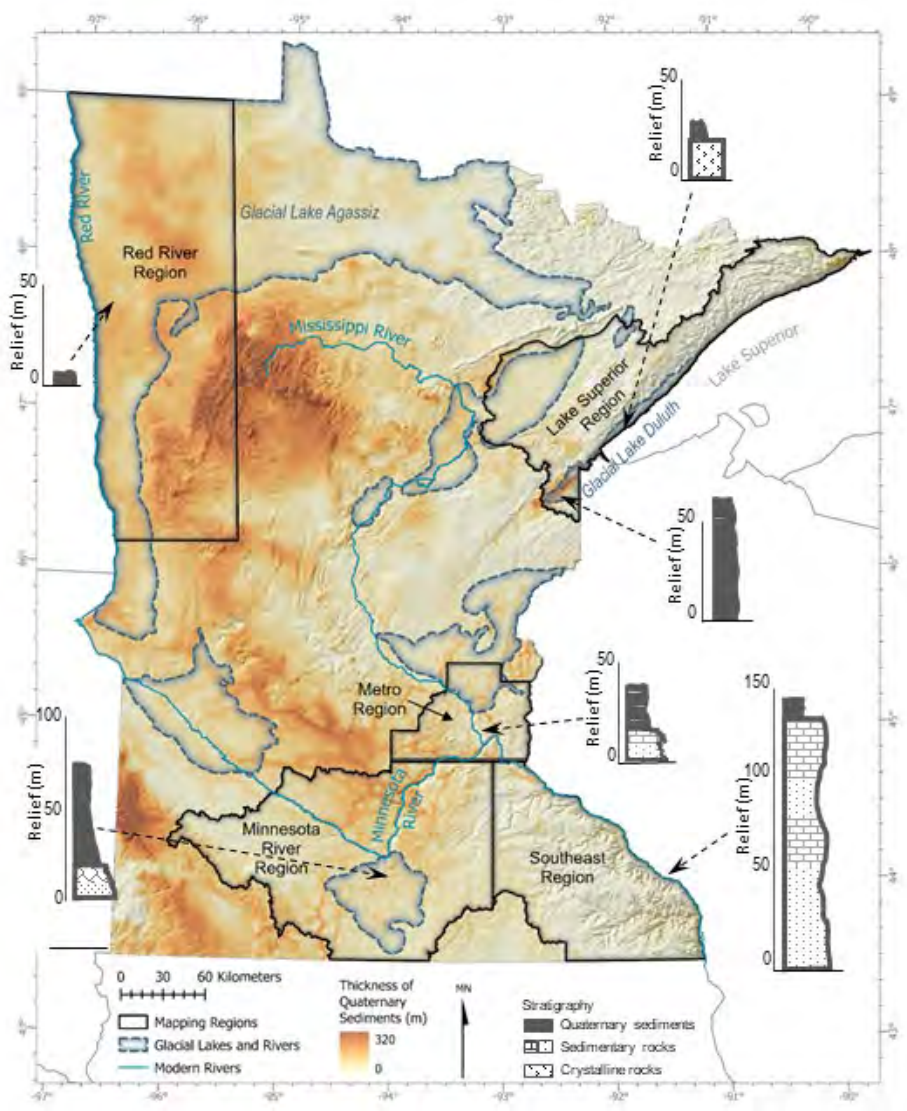


Acknolwedgements: MnTopo, MN DNR, MnGEO, MN.IT services, Minnesota Geospatial Commons



- ***Examples of landslides and topography in Minnesota River Region****: (a) Mapped headscarps overlain on lidar-derived shaded-relief map, (b) Map of landslide susceptibility overlain on lidar-derived shaded-relief map, (c) Topographic slope map, (d) Aerial image, taken August 4th, 2021 (USDA b. 2021).*
-

Located in glacial sediment along a roadcut in the Minnesota River valley, this landslide has been active multiple times. The horizontal bands of vegetation have moved downslope during rainstorms, and the slope has been destabilized as


Red River
Glacial Lake Agassiz
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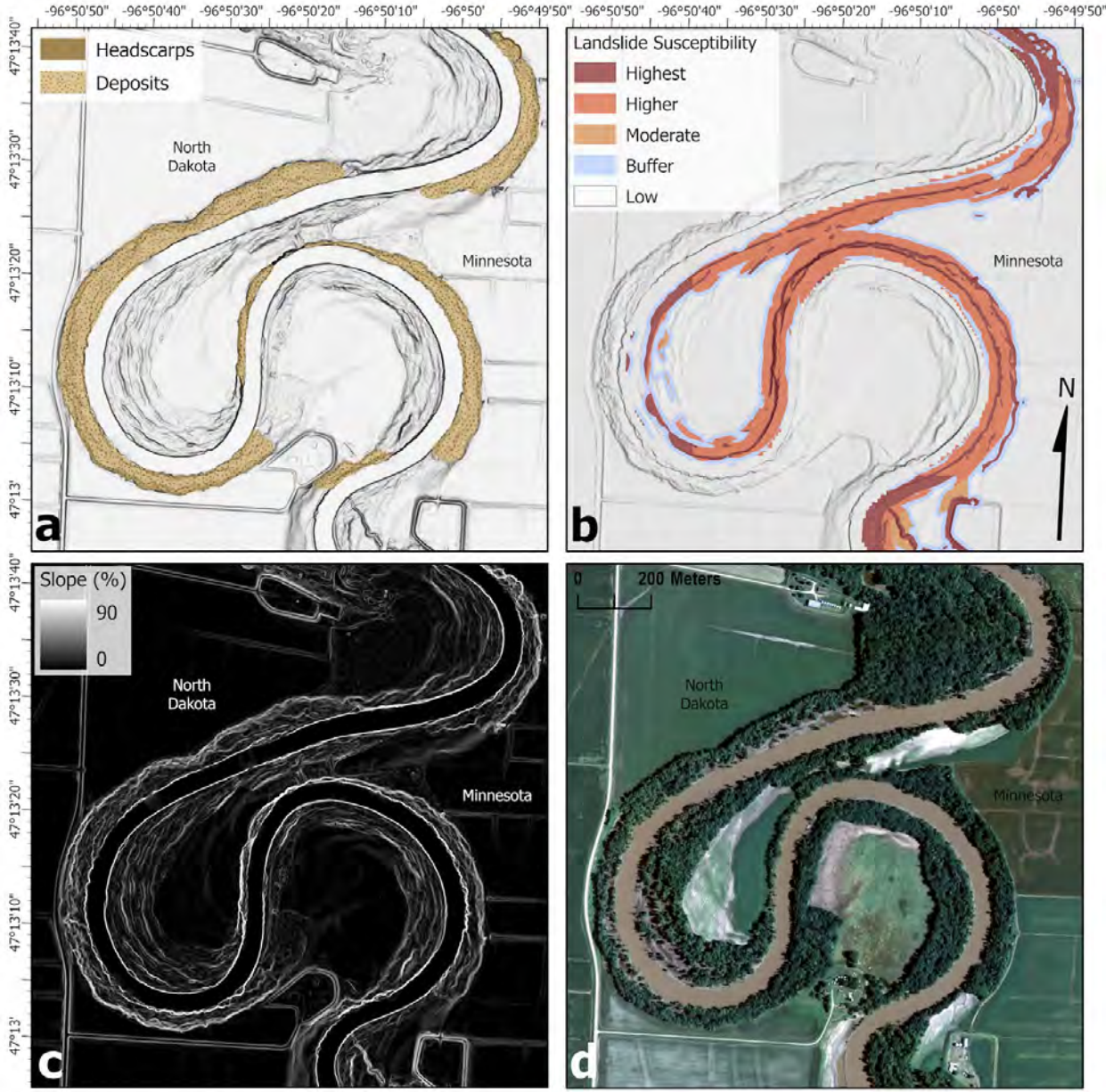
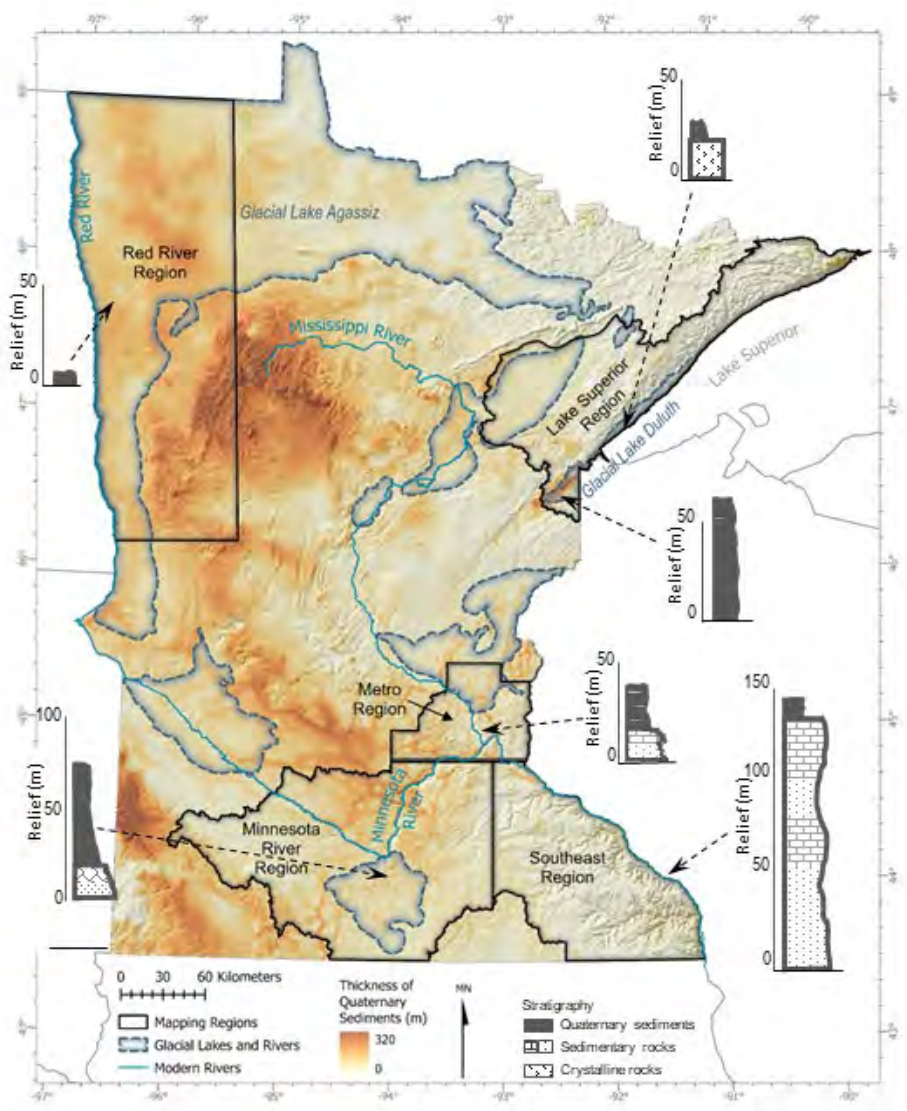


Examples of landslides and topography in Red River Region*: (a) Mapped headscarps and deposits overlain on lidar-derived shaded relief map, (b) Map of landslide susceptibility overlain on lidar-derived shaded relief map. Note that while some landslide mapping was done on the North Dakota side of the river, the susceptibility analysis was limited to the Minnesota side of the river, (c) Topographic slope map, (d) Aerial image taken July 13th, 2005 (USDA, 2005).*

Red River: Cutting the Glacial Lake Plain of Northwestern Minnesota

The Red River valley in northwestern Minnesota was originally the bed of an extensive lake filled by glacial meltwater into which fine sand, silt, and clay were deposited. The Red River and its tributaries have since cut down into the flat lake plain, forming steep slopes adjacent to channels. These slopes, which can be completely covered in water during extensive floods, are prone to landslides.

Landslide formed in glacial lake sediments adjacent to the Red River in 2021. *A*, An overhead view taken from a small unmanned aerial vehicle. Scarps formed in the field and clay-rich sediment that flowed from the base of the streambank are visible in the river channel at the top of image. Note the red vehicle at the right edge of the photograph for scale. *B*, view taken from the ground that shows down-dropped landslide blocks that fell 6 meters (20 feet) from the surface at the top of the photograph. Photographs courtesy of Brad Thoreson (*A*) and North Dakota State University (*B*).


Red River
Glacial Lake Agassiz
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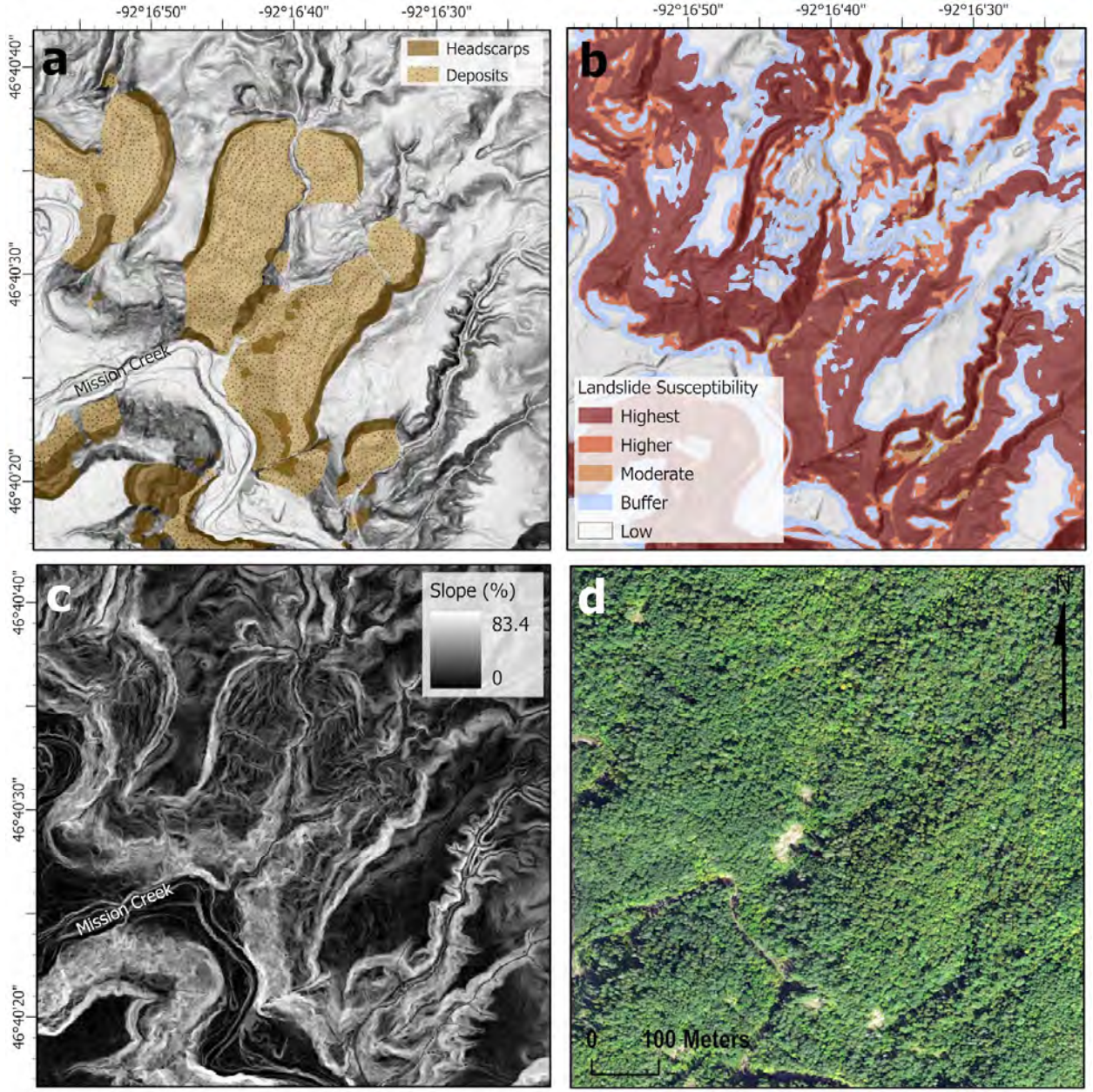
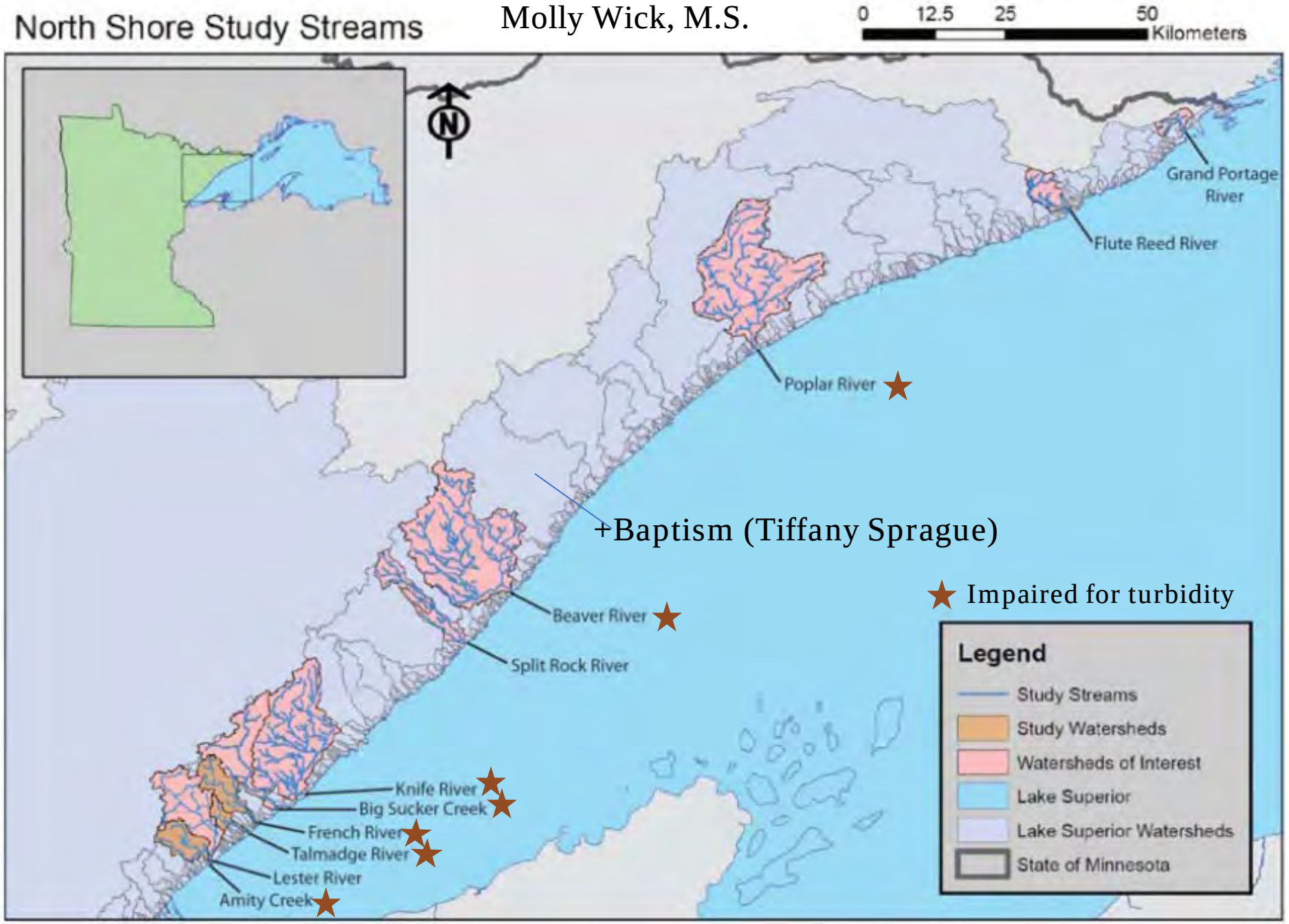
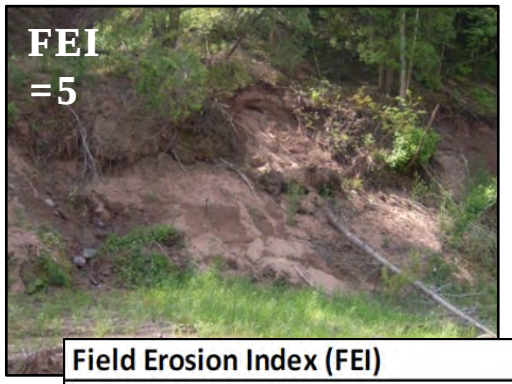


Examples of landslides and topography in Northeast Region: *(a) Mapped headscarps and deposits, (b) Susceptibility model results, (c) Topographic slope map, (d) Black and white aerial photo taken, September 12th, 2017 (USDA, 2017).*


North Shore Study Streams
Molly Wick, M.S.
0 12.5 25 50
Kilometers
N
Grand Portage River
Flute Reed River
Poplar River
+Baptism (Tiffany Sprague)
Impaired for turbidity
Beaver River
Split Rock River
Knife River
Big Sucker Creek
French River
Talmadge River
Lester River
Amity Creek
Legend
Study Streams
Study Watersheds
Watersheds of Interest
Lake Superior
Lake Superior Watersheds
State of Minnesota

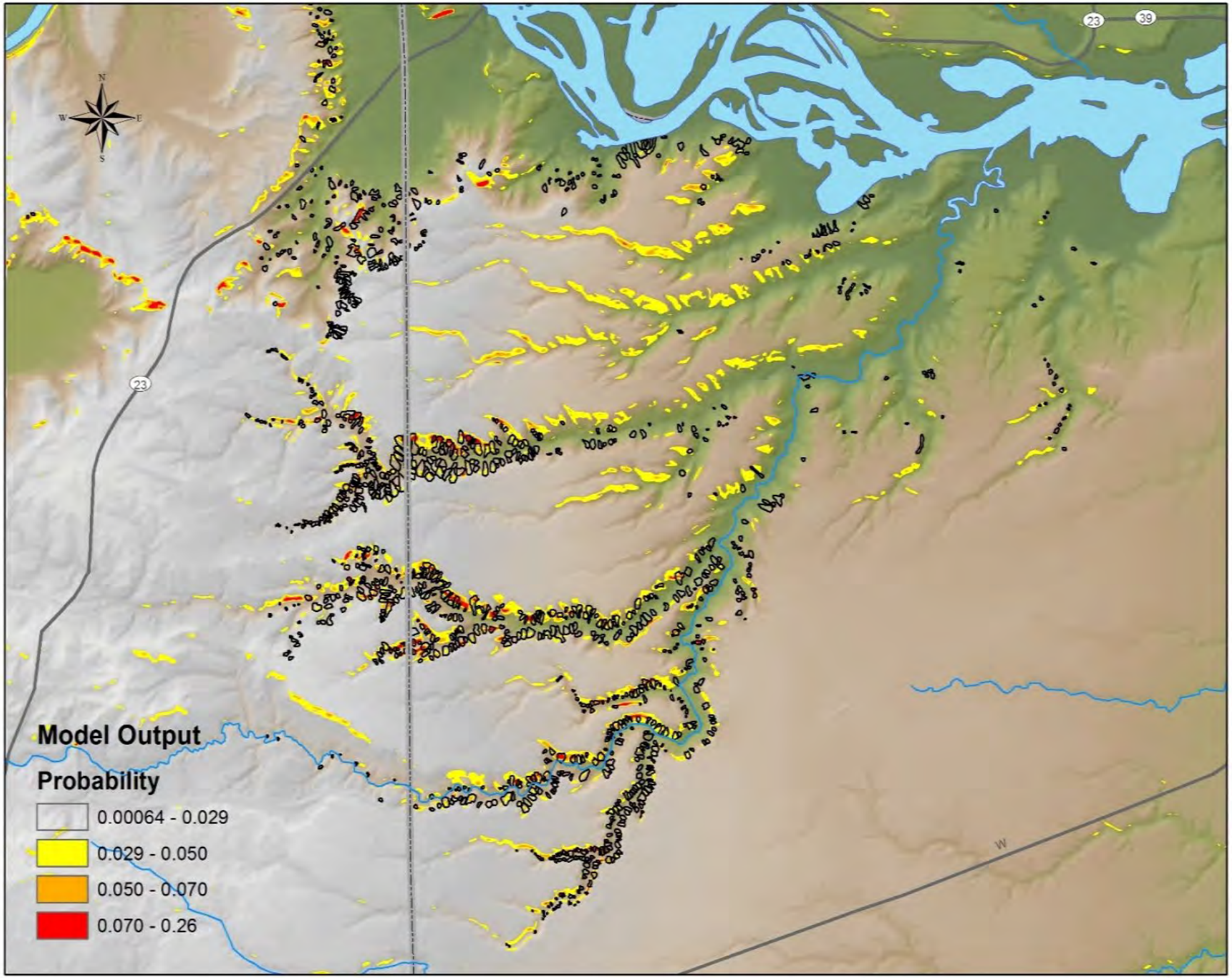
Field Observations

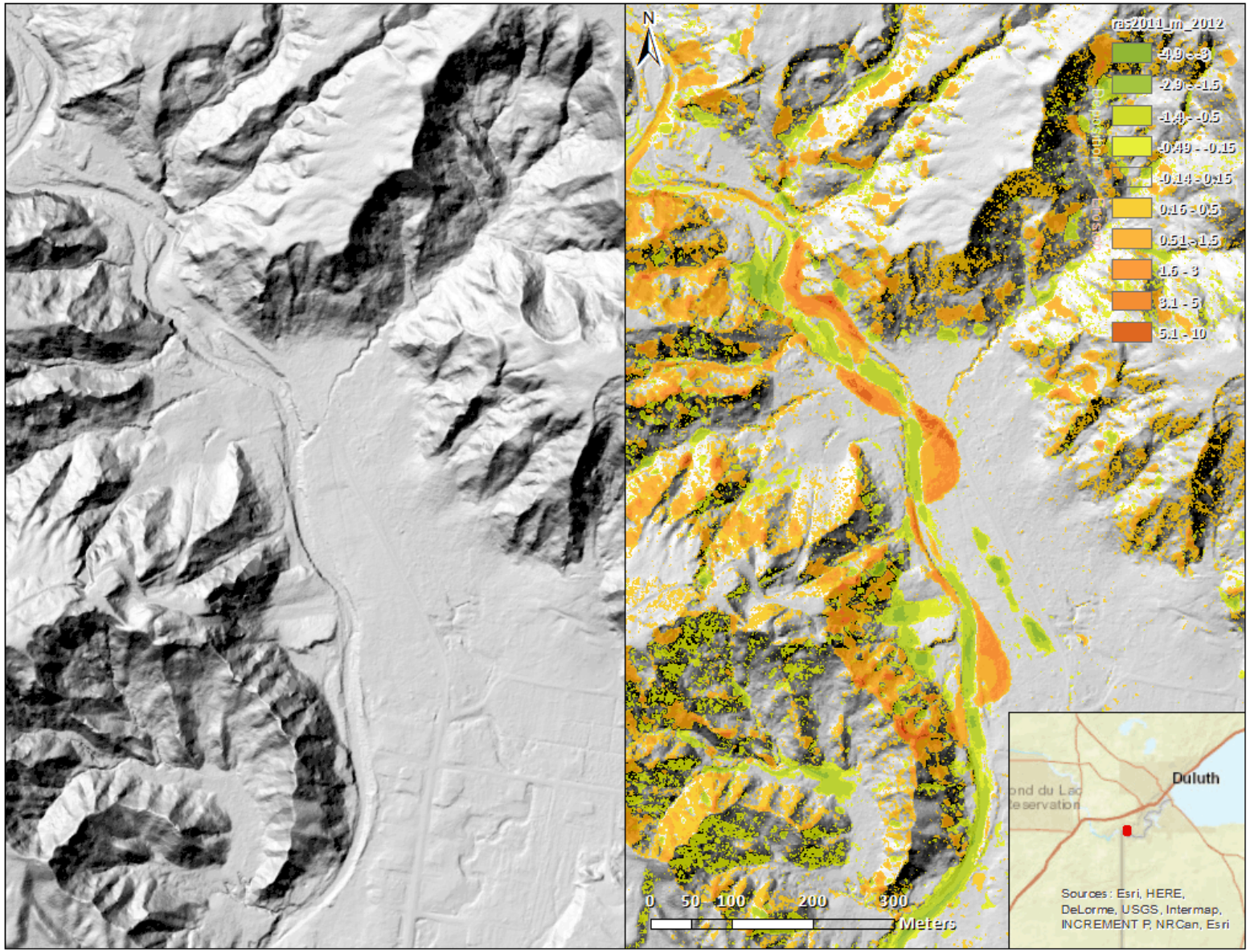


Field Erosion Index (FEI)

Score	Description
0	Bedrock, Little or No Erosion
1	Little or No Erosion
2	Bank Erosion/Undercutting, one bank
3	Bank Erosion/Undercutting, both banks
4	Slump, one bank
5	Slump, both banks, or on bank >4m
6	Complete scour, one bank
7	Complete scour, both banks, or one bank > 4m

- June 2012 flood generated widespread landslides (over 1500) in a small watershed southwest of Duluth.


N
W
E
S
23
23
39
Model Output
Probability
0.00064 - 0.029
0.029 - 0.050
0.050 - 0.070
0.070 - 0.26
W
0
0.5
1
2
Kilometers


N
ras2011_m_2012
-4.9 - -3
-2.9 - -1.5
-1.4 - -0.5
-0.49 - -0.15
-0.14 - 0.15
0.16 - 0.5
0.51 - 1.5
1.6 - 3
3.1 - 5
5.1 - 10
0 50 100 200 300
Meters
Duluth
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri

Jennings et al., 2020 NatHazSA

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

Do not encourage people to linger in vulnerable settings

Strategies for Reducing Risk of Slope Failure

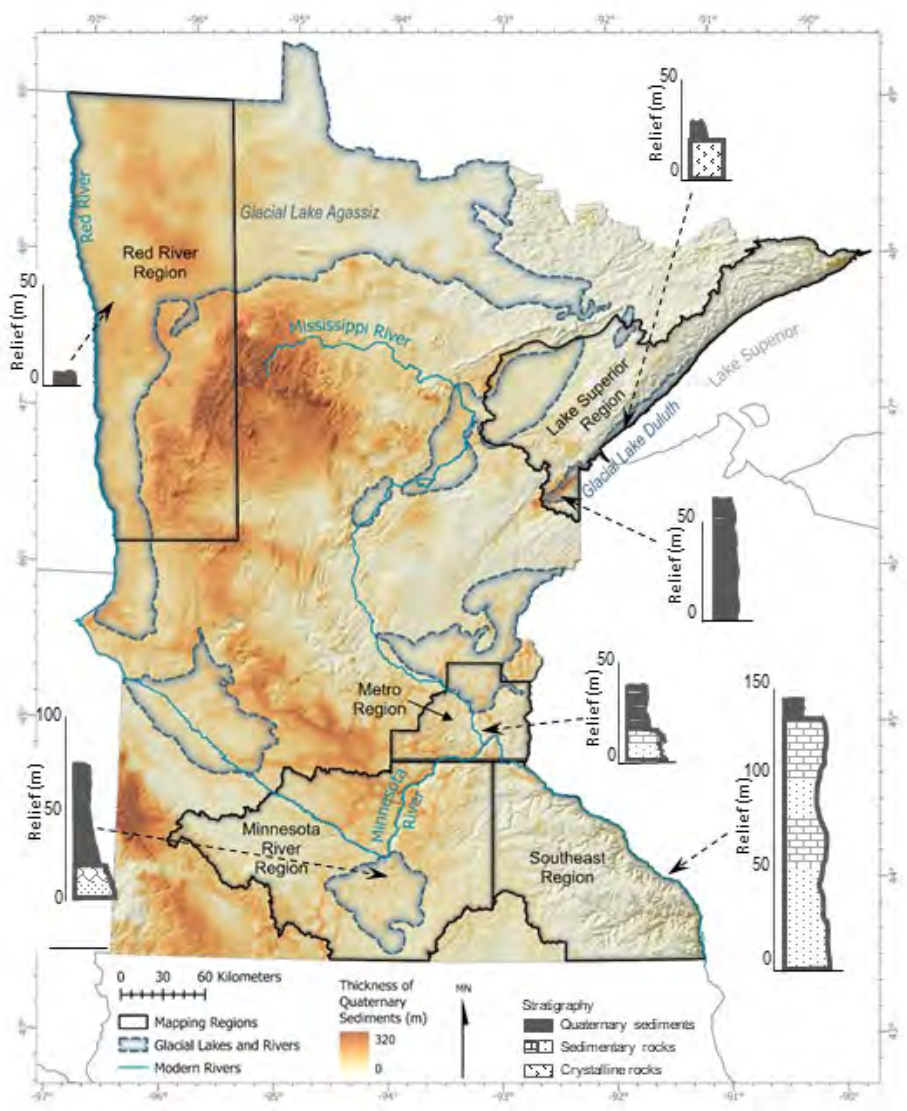
- Avoid land disturbances and placing structures on or near steep slopes
- Establish and maintain vegetation to stabilize slopes
- Use erosion-control measures to minimize erosion during land disturbances
- Avoid placement of stormwater facilities, outfalls, or septic drainfields on slopes or near top of slopes –overland flow should be directed away from slopes when possible

Bluff Protection Standards in Minnesota

- Local zoning controls apply many of these strategies by regulating development around lakes and rivers – consistent with state regulations. These standards are summarized on this page.
- Bluff Protection Standards in Minnesota

Evaluating Slopes for Local Zoning Administration

- Quick Guide to Analyzing Slopes with MnTOPO (PDF)– MnTOPO is an easy-to-use DNR web application for quickly analyzing slopes using LiDAR-derived contour lines. This tool can help determine whether a slope of interest is likely to meet the local zoning definition of a steep slope or bluff. GIS users can also download elevation shapefiles through MNTOPO as well.
- Identifying Bluffs in Shoreland (PDF) - This technical guidance document explains how to understand and apply the shoreland bluff definition using a step-by-step approach and two examples.
- Shoreland Bluff Profile Tool (PDF) – This Excel tool uses elevation data downloaded from a slope profile created in MnTOPO. This tool may be helpful to communicate with property owners where bluffs likely exist, including the locations of bluff impact zones and bluff setbacks for structure placement. This tool takes some time to learn how to use and is best used after the presence of a bluff is determined to likely exist using MnTOPO. The tool does not replace the function of a physical survey.
- Bluffs in Shoreland opens in a new browser tab – This training explains why we have bluff regulations and what those regulations are. Training also works through sample elevation data to determine if a bluff exists using the bluff-related definitions.


Red River
Glacial Lake Agassiz
Red River Region
Mississippi River
Lake Superior Region
Lake Superior
Glacial Lake Duluth
Metro Region
Minnesota River
Minnesota River Region
Southeast Region
Relief (m)
50
0
100
150
0 30 60 Kilometers
Mapping Regions
Glacial Lakes and Rivers
Modern Rivers
Thickness of Quaternary Sediments (m)
320
0
MN
Stratigraphy
Quaternary sediments
Sedimentary rocks
Crystalline rocks

Bluffs in Shoreland

Dan Petrik, Lake & River Shoreland Program Manager

DEPARTMENT OF NATURAL RESOURCES

Purpose of Bluff Protections

To Reduce Risk of Failure

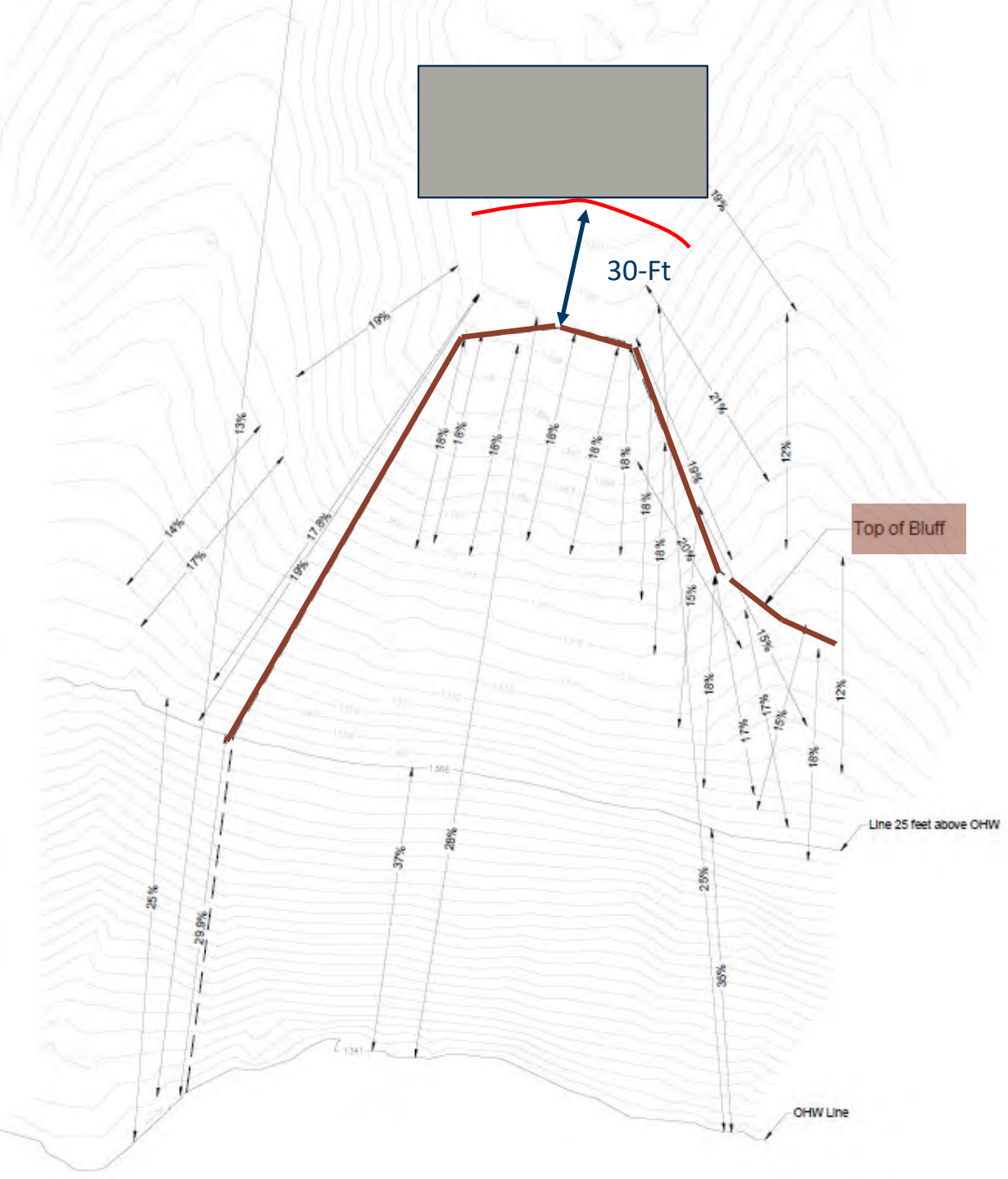
Protect Property Values

Minimize Erosion & Nutrient Flow


Maintain Visual Quality & Habitat

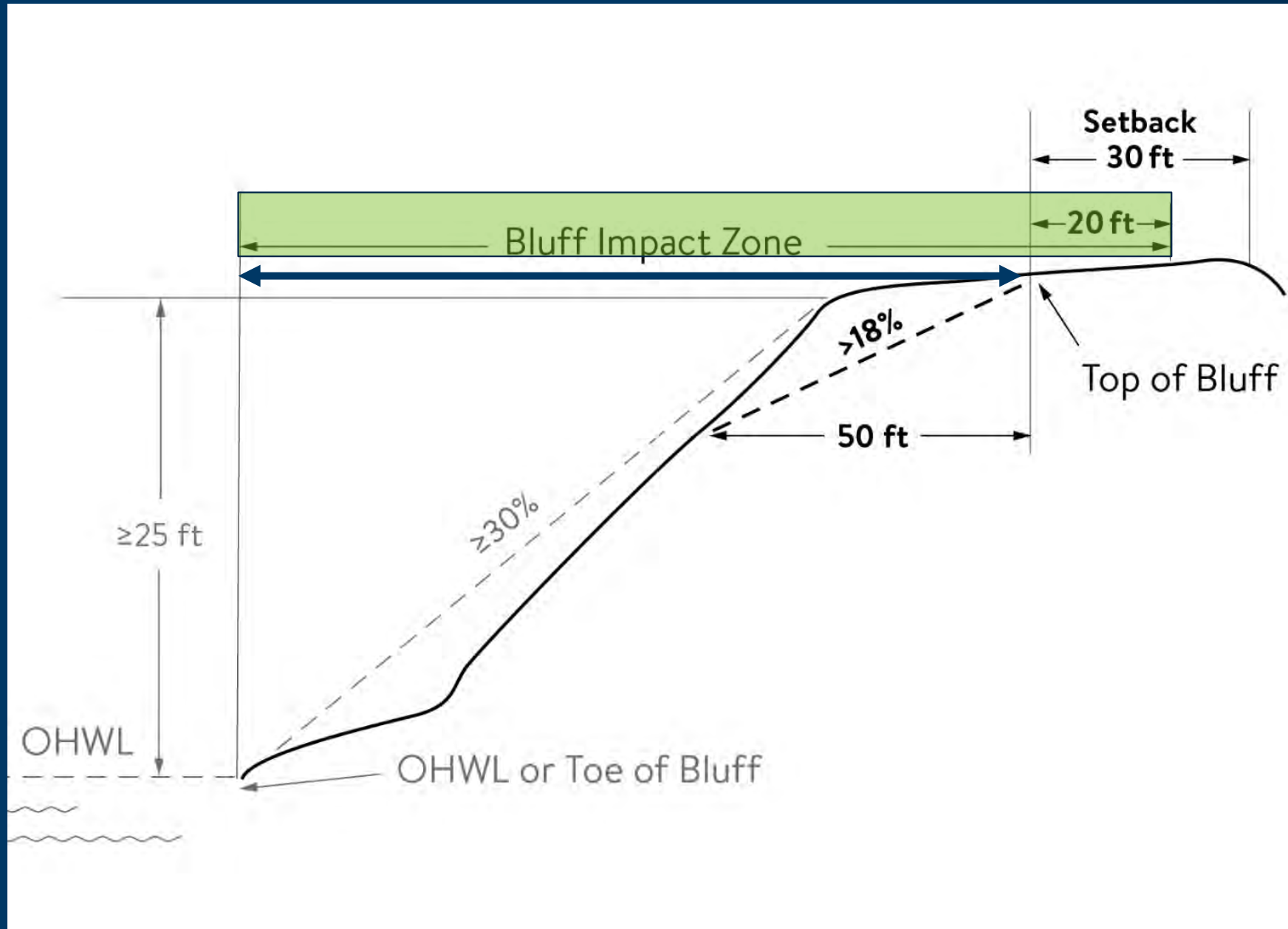
Overview of Bluff Regulations

30-Foot Bluff Setback



Bluff Impact Zone - BIZ

- The bluff, and
- 20 feet from the top of bluff



In Bluff Impact Zone (BIZ), No….

- Structures or accessory facilities (except stairs/lifts)
- Feedlots
- Farming
- Intensive vegetation clearing

Land Alteration in BIZ

- Disturbance over 10 CY requires permit
- No fill placed in BIZ

Identifying Bluffs in Shoreland

Bluff-Related Definitions…

Bluff

A topographic feature with the following characteristics:

1. Part or all of the feature is located in shoreland;
2. The slope drains toward the waterbody;
3. The slope rises at least 25 feet above the ordinary high-water level;
4. The grade of the slope from the toe of the bluff to a point 25 feet or more above the ordinary high water level averages 30 percent or greater

Toe of Bluff

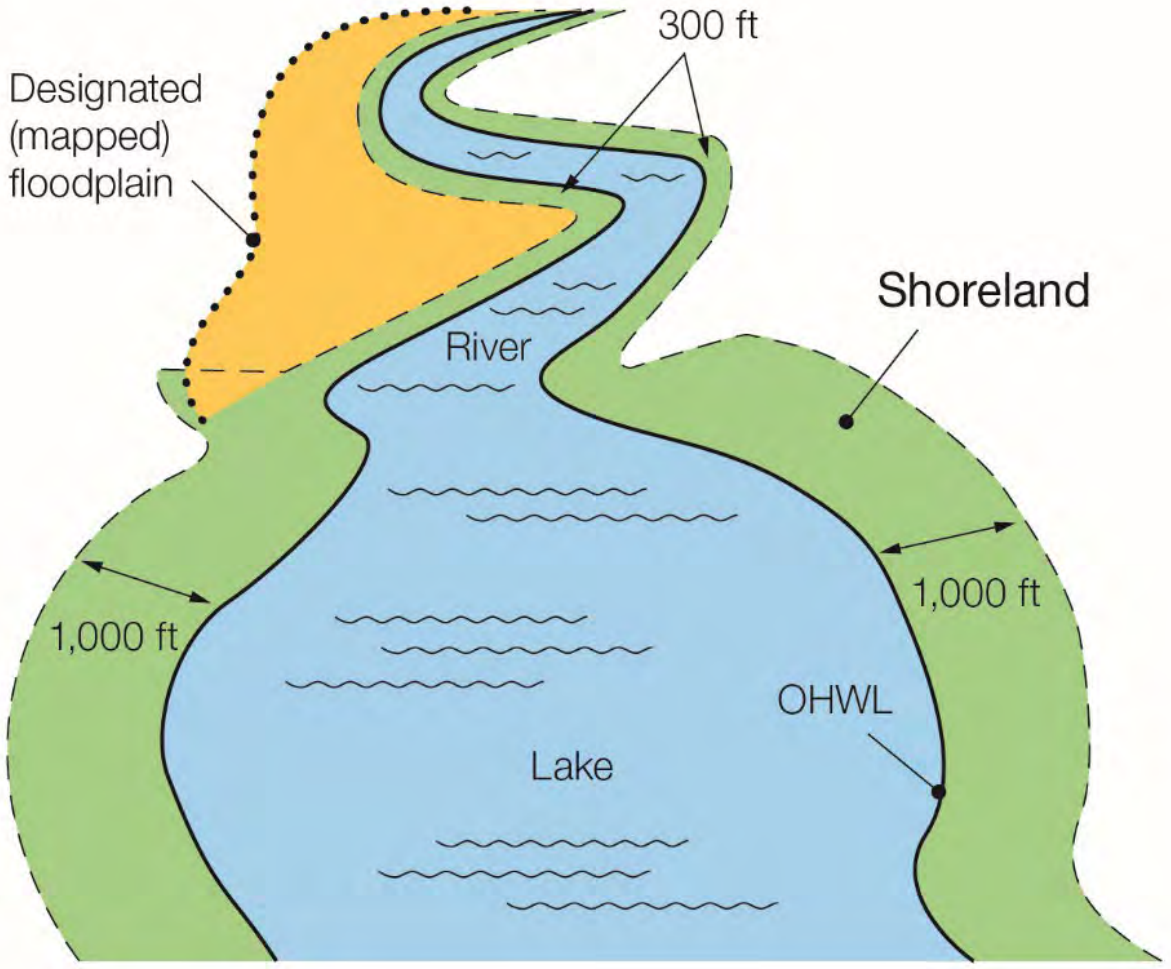
- The lower point of a 50-foot segment with an average slope exceeding 18 percent.

Top of Bluff

- The higher point of a 50-foot segment with an average slope exceeding 18 percent.

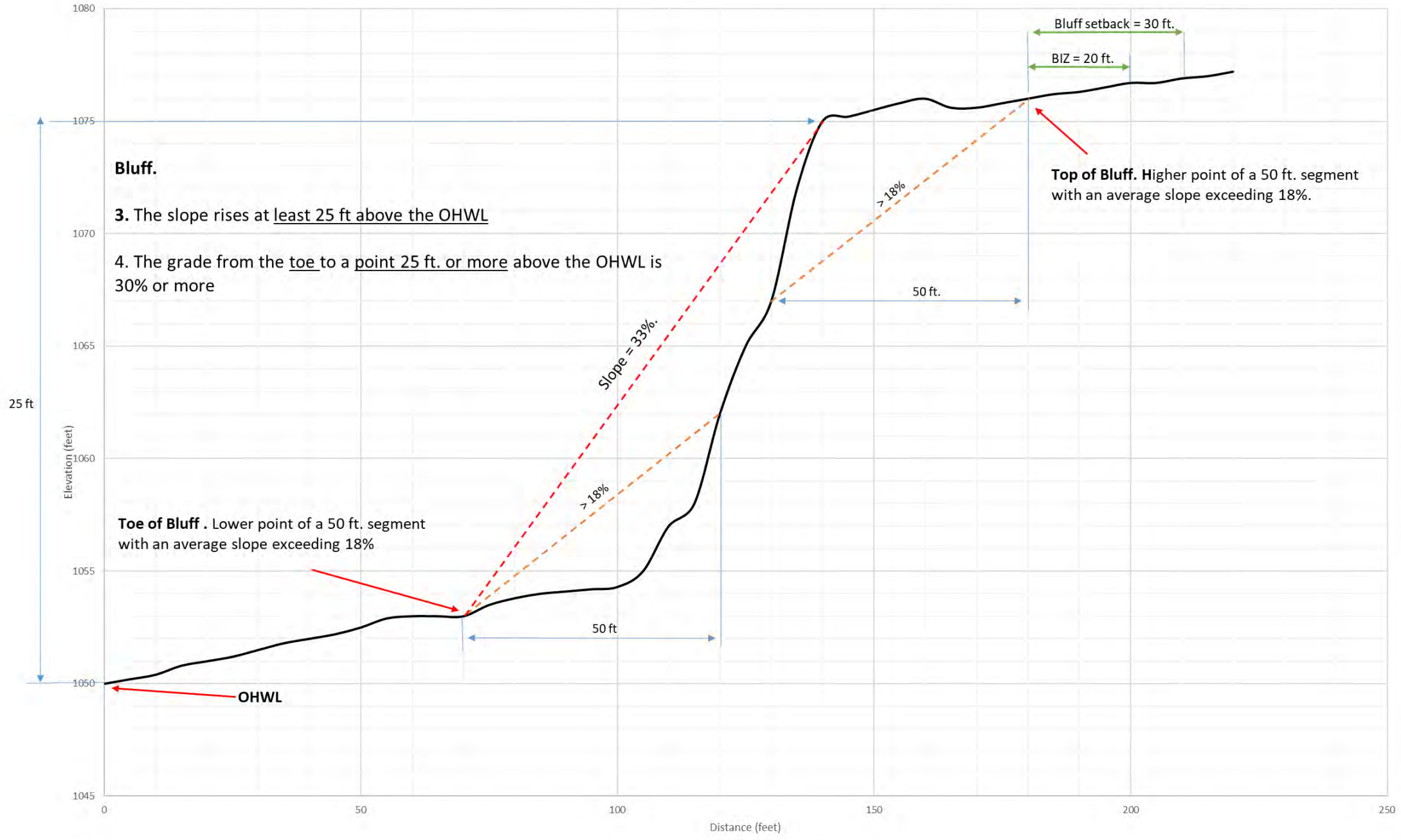
Determine if a Bluff Exists

1. Is part or all of the feature located in shoreland?



Determine if a Bluff Exists

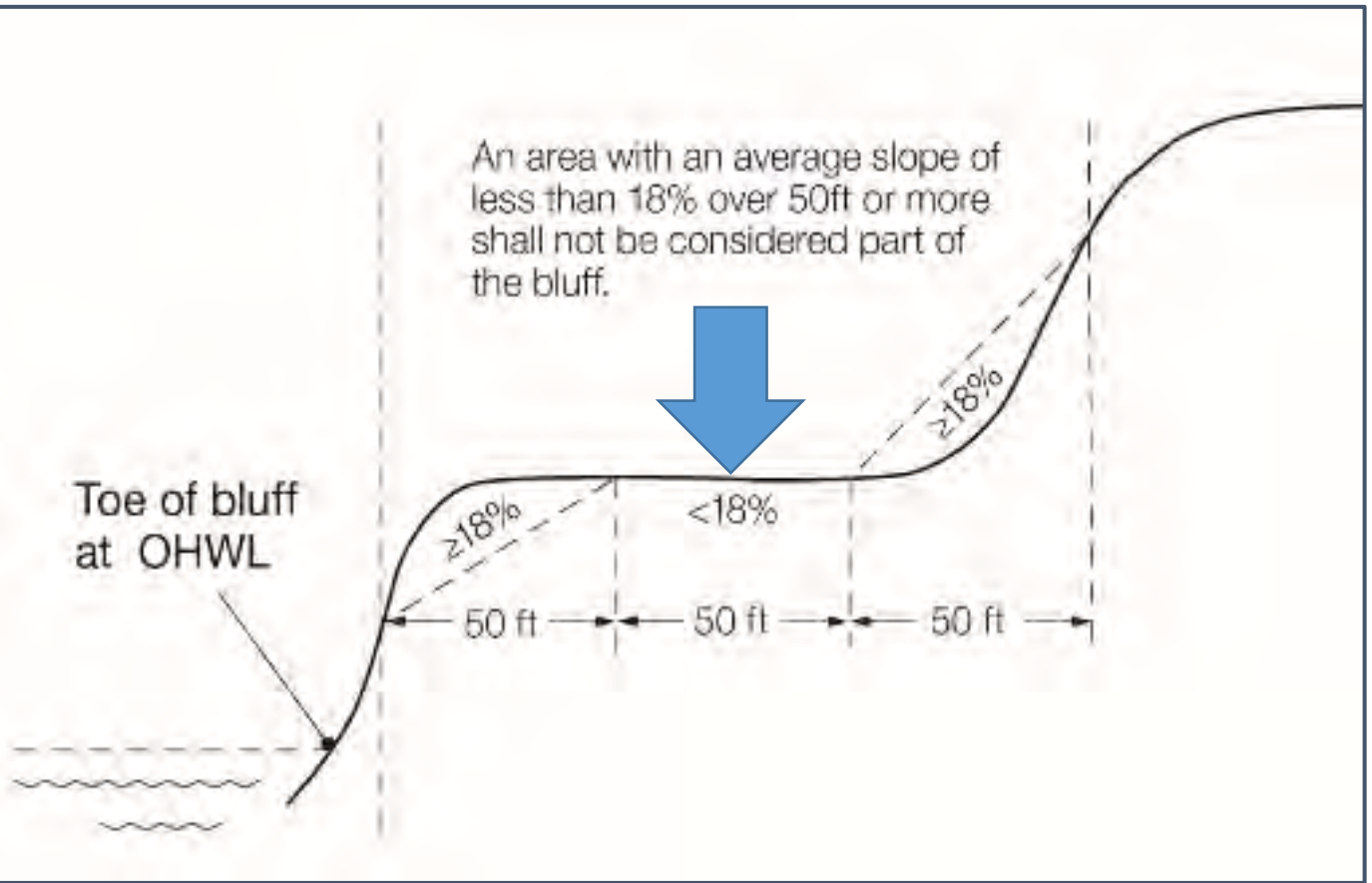
2. Does the slope drain toward the waterbody?

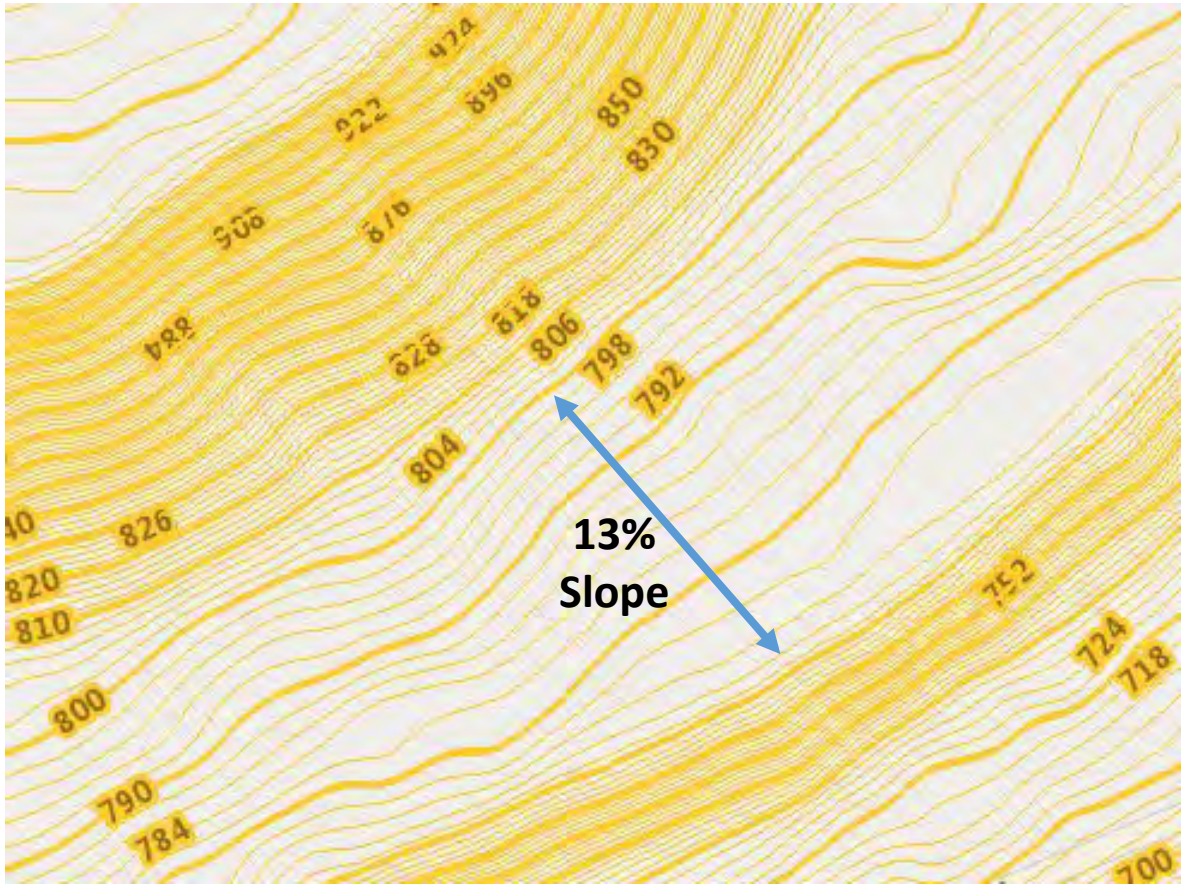

Bluff setback = 30 ft.
BIZ = 20 ft.
Bluff.
3. The slope rises at least 25 ft above the OHWL
4. The grade from the toe to a point 25 ft. or more above the OHWL is 30% or more
Top of Bluff. Higher point of a 50 ft. segment with an average slope exceeding 18%.
> 18%
50 ft.
Slope = 33%.
> 18%
25 ft
Toe of Bluff . Lower point of a 50 ft. segment with an average slope exceeding 18%
50 ft
OHWL
Elevation (feet)
Distance (feet)
1080
1075
1070
1065
1060
1055
1050
1045
0
50
100
150
200
250

Determine if the Bluff Exemption Applies

Common source of confusion

"An area with an average slope of less than 18% over a distance of 50 ft. or more shall not be considered part of the bluff."





Bluff and Slope Protections

Development,vegetation removal, and land disturbances on or near steep slopes commonly leads to slope erosion and failure. Vulnerability to these impacts varies based on geology, soil, hydrology, and slope angle, and hydrologic conditions. Property owners and communities should understand these risks to minimize impacts from existing and future development.

Strategies for Reducing Risk of Slope Failure

Strategies for reducing the risk of slope erosion and failure include:

- Avoid land disturbances and placing structures on or near steep slopes
- Establish and maintain vegetation to stabilize slopes
- Use erosion-control measures to minimize erosion during land disturbances
- Avoid placement of stormwater facilities, outfalls, or septic drainfields on slopes or near top of slopes –

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Identifying Bluffs in Shoreland

Purpose

The purpose of this technical guidance is to help local government staff and property owners determine if a bluff exists on a property and how to find the toe and top of bluff, as defined by the statewide shoreland rules. Identifying bluffs and tops of bluffs is important for applying bluff setback, land alteration, and vegetation management standards in shoreland zoning districts. Always check with the local zoning authority to verify local requirements.

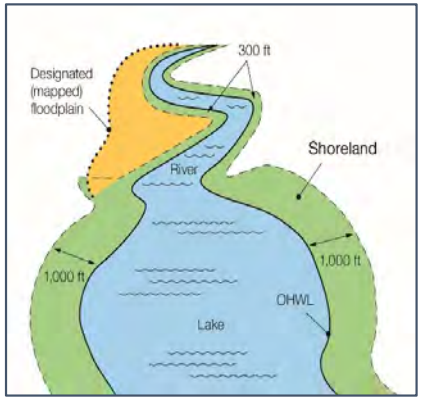
Bluff and Top of Bluff Determination Process

This part explains the three-step process for: 1) determining if a bluff exists, 2) locating the top of bluff, and 3) determining if the bluff exemption provision applies. MnTOPO is a useful website for obtaining data to help determine if a bluff is likely to exist and for identifying the general locations for the top and toe of a bluff. MnTOPO shows LiDAR-derived two-foot contour lines overlaid on a map and contains tools for selecting and measuring slopes. Onsite measurements are still needed to conclusively determine whether a bluff exists and for accurately locating the top and toe of a bluff. This guidance assumes use of MnTOPO data, a site survey, or other mapped representation of slope data. The process described in this document can be used to identify the boundaries of bluffs by using it on different parts of the slope feature.

Step 1 – Determining if a Bluff Exists

Bluffs are determined using an evaluation process based on four criteria in the bluff definition in the shoreland rules (see part 6120.2500, subp. 1b). These criteria build on each other. Each criterion must be met before moving on to the next one. If one criterion is not satisfied, then the evaluation process stops - there is no bluff. Locating the top of bluff is not needed to determine if a bluff exists. The top of bluff is only located after it is determined that a bluff exists. Following is an explanation of each criterion in the four-part evaluation process:

Figure 1. The Shoreland District includes land within 1,000 feet of the ordinary high water level (OHWL) of a lake or 300 feet of a river or the extent of a mapped floodplain, whichever is greater.



Criterion 1: Part or all of the feature is located in the shoreland district.

Determine if any part of the slope feature is located within the shoreland district (Figure 1). Local zoning maps may help in making this determination. If it is, this criterion is met.

Though only part of the slope feature needs to be in the shoreland district, the entire feature (those areas that may be outside of the district) is included in determining whether the feature is a bluff using this four-part criteria. If the feature is determined to be a bluff, then only that part of the bluff that is within the shoreland district is subject to shoreland standards. For example:

Essential reading to understand shoreland bluffs

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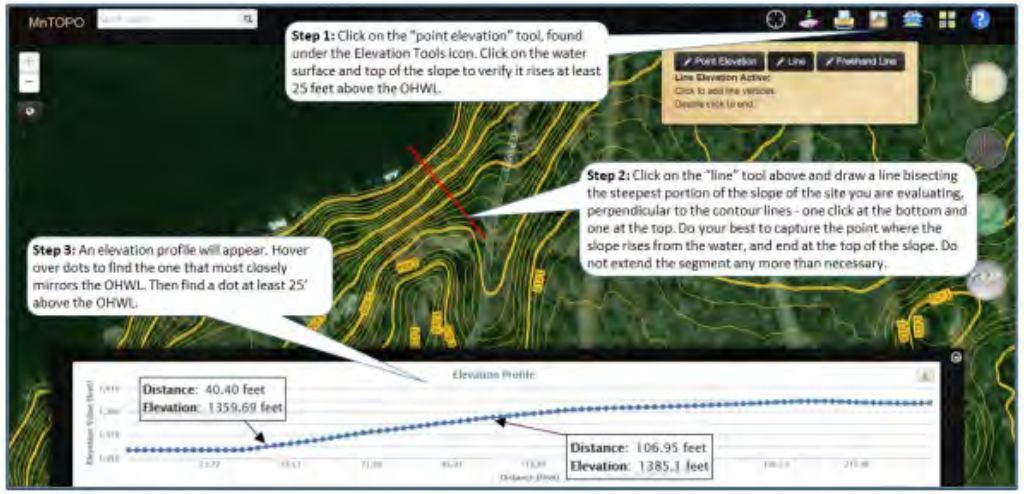
Quick Guide to Analyzing Slopes with MnTOPO

MnTOPO is a handy web-based tool to quickly evaluate slope percentage to help determine if a slope feature meets the bluff or slope definition of local regulations. It uses LiDAR-derived elevation data and is accurate to within ±1 foot. This program gives users the ability to analyze a cross-section of any slope in the state.

The following example uses the bluff definition in the shoreland regulations (Minn. Rule 6120.2100 Subp. 1b) to evaluate whether a bluff likely exists. This same approach can be used with other bluff and slope regulatory definitions. Most permitting situations typically require a deeper level of analysis than what's outlined in this document.

Open MnTOPO, and zoom to your site.



Step 4: Calculate rise ÷ run between your two dots to determine whether the slope exceeds 30%. Since you are looking for a 30% slope at an elevation of 25 feet OR MORE above the OHWL, you may need to evaluate multiple line segments.

$$\frac{1385.1 - 1359.69}{106.95 - 40.40} = \frac{25.41}{66.55} = \mathbf{38.2\%}$$

In this example, a bluff is likely present. There may be some situations where analysis of additional, adjacent cross sections would be needed.

In a shoreland district, this method works best for slopes that rise immediately from the water's edge. Where a detailed analysis is needed, or when the slope starts away from the shore, the Shoreland Bluff Profile Tool may be useful.

A site survey is needed to determine the precise location of the toe and top of bluff, the bluff impact zone (BIZ), and structure setbacks.

GIS users can download shapefiles detailing the 2' contour lines through MnTOPO. Click the "Download Data" icon in the top right corner.

Most shoreland bluff evaluations require a determination of an **Ordinary High Water Level (OHWL)** elevation. The OHWL is the point where natural vegetation changes from aquatic to terrestrial. For many lakes, the OHWL can be found on LakeFinder. For watercourses, the OHWL is the elevation of the top of the bank of the channel. Zoning administrators should contact their DNR Area Hydrologist find out the OHWL elevation where it's unavailable.

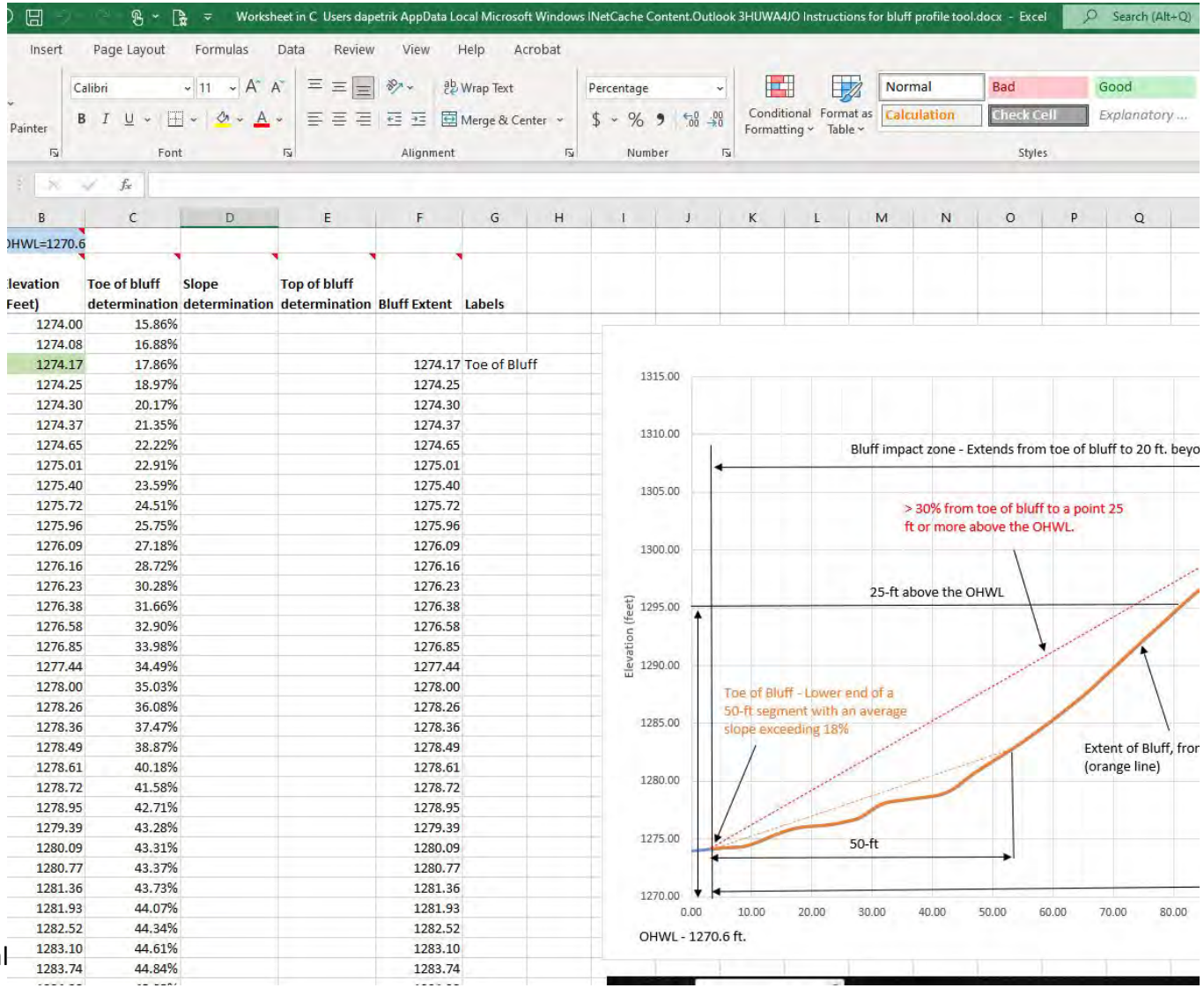
April 2022

Analyze slopes first on MnTOPO to determine if you "LIKELY" have a bluff.

If Bluff likely, they use surveyor and/or bluff profile tool to investigate futher

Bluff Profile Tool

- Excel spreadsheet
- Uses LiDAR elevation data from MnTOPO
- Determines if Bluff exists
- Finds and graphs the toe, slope and top of bluff
- Assumes knowledge of
  - Excel
  - MnTOPO
  - Shoreland bluff definitions



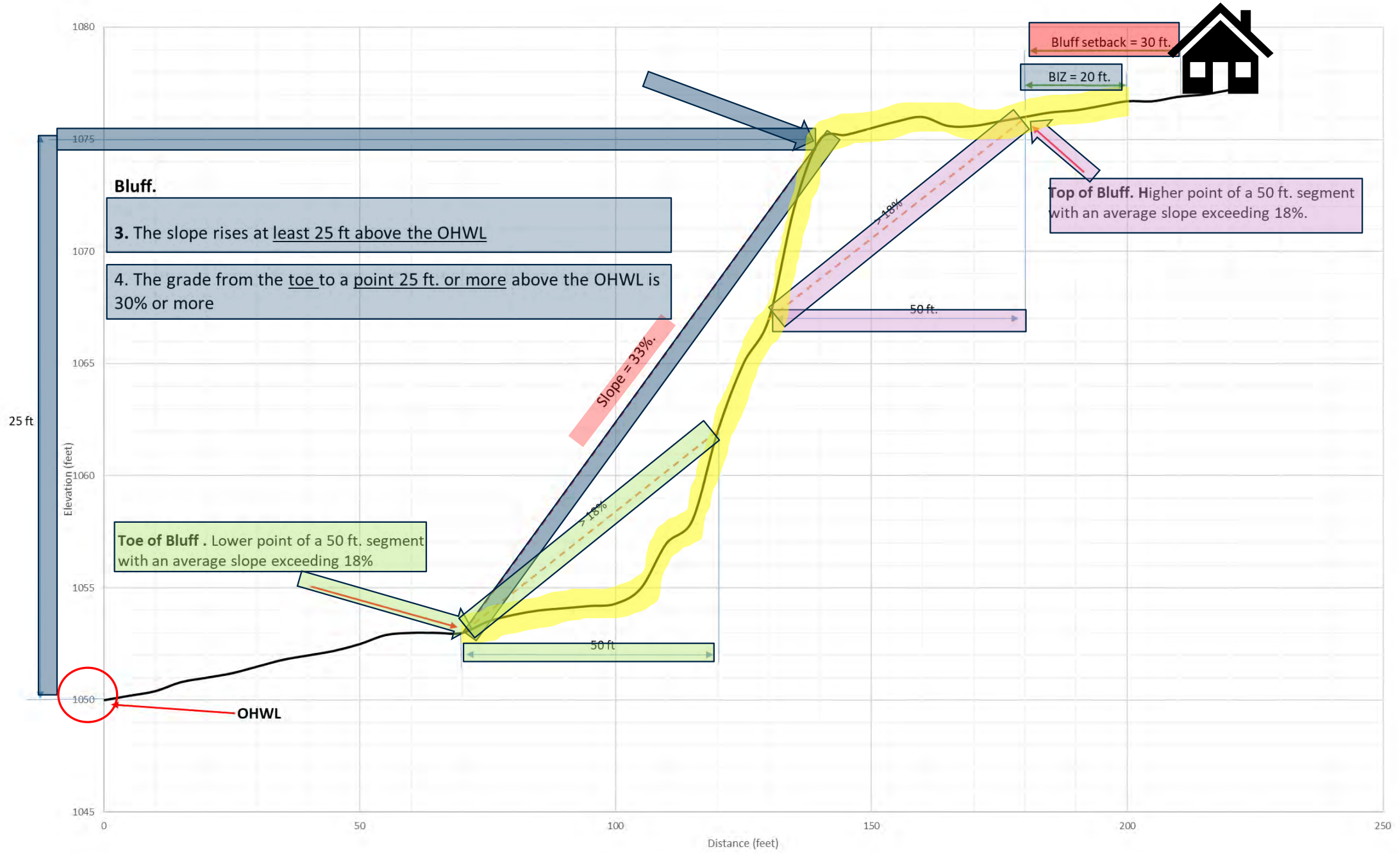
DEPARTMENT OF NATURAL RESOURCES

Thank You

Bluff Definition

A topographic feature with the following characteristics:

1. Part or all of the feature is located in shoreland;
2. The slope drains toward the waterbody;
3. The slope rises at least 25 feet above the ordinary high-water level;
4. The grade of the slope from the toe of the bluff to a point 25 feet or more above the ordinary high water level averages 30 percent or greater


Bluff setback = 30 ft.
BIZ = 20 ft.
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Bluff.
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Slope = 33%.
>18%
50 ft.
25 ft
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>18%
50 ft
OHWL
Elevation (feet)
Distance (feet)
1080
1075
1070
1065
1060
1055
1050
1045
0
50
100
150
200
250

Rivers are Dynamic

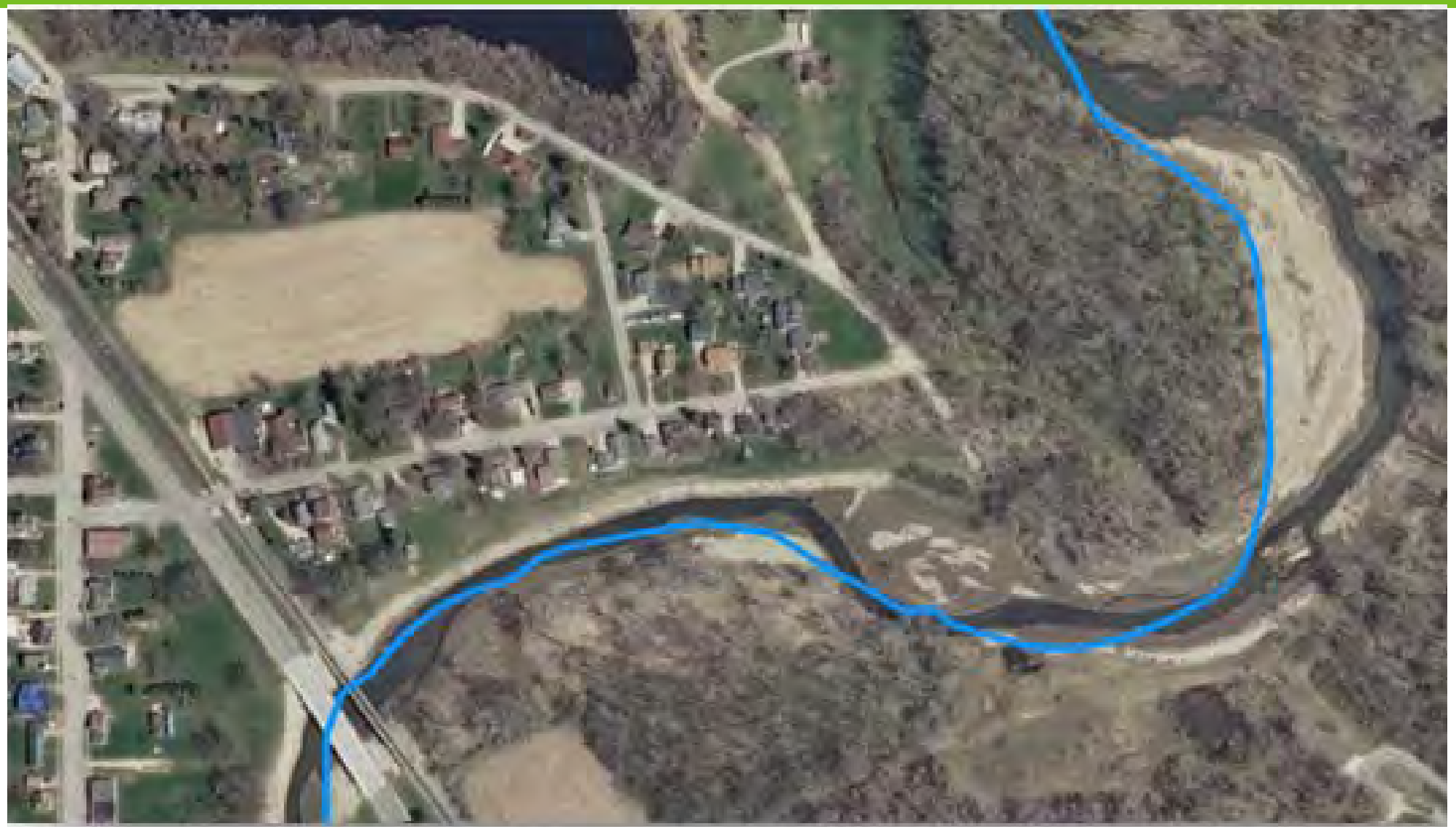
Rivers are Dynamic

Why Consider Meander Zones?

Why Consider Meander Zones?

Garvin Brook - After 2007 Flood

Why Consider Meander Zones?

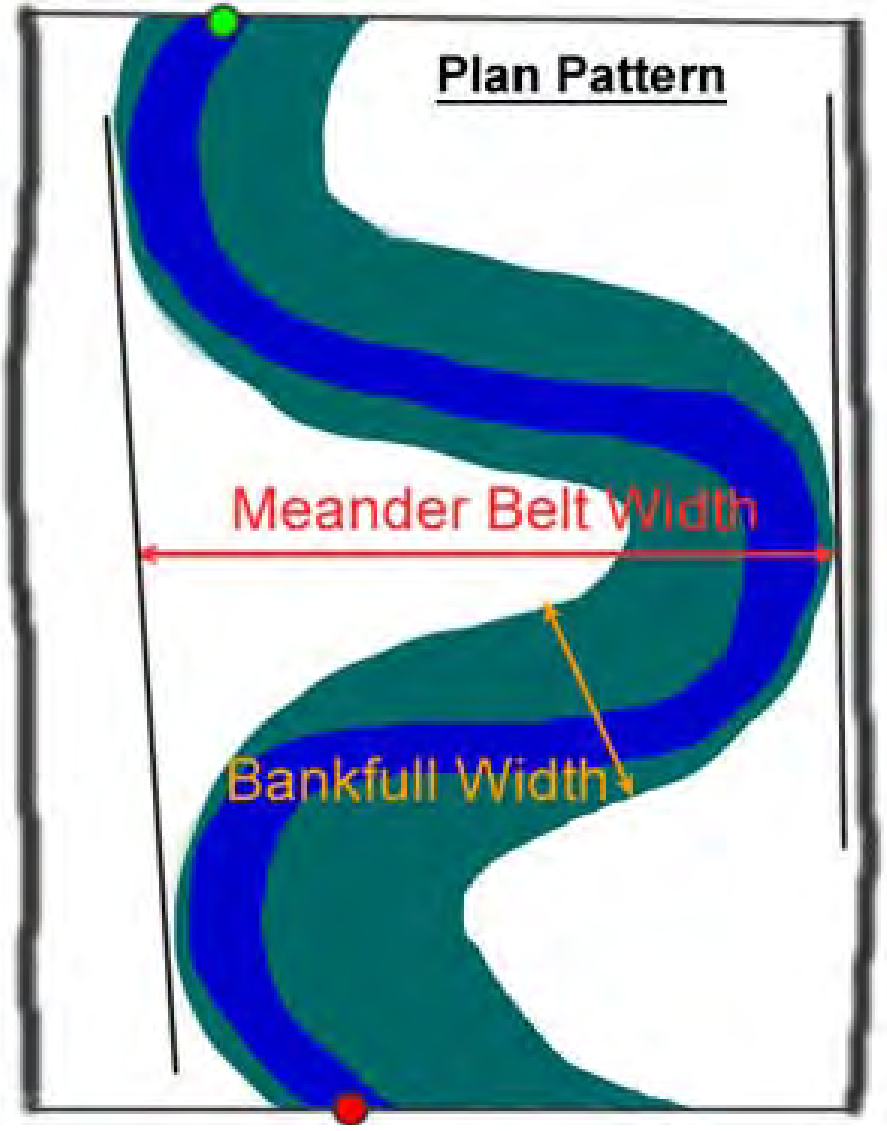


Establish & Protect the Meander Belt

- Rivers and streams and their floodplains are dynamic, not static.
- A meander belt allows river to take its natural course across a valley bottom
- Reduces streambank erosion and sedimentation
- Good examples in Vermont and Washington (state)

Establish & Protect the Meander Belt

Meander Width Ratio of Natural Channels



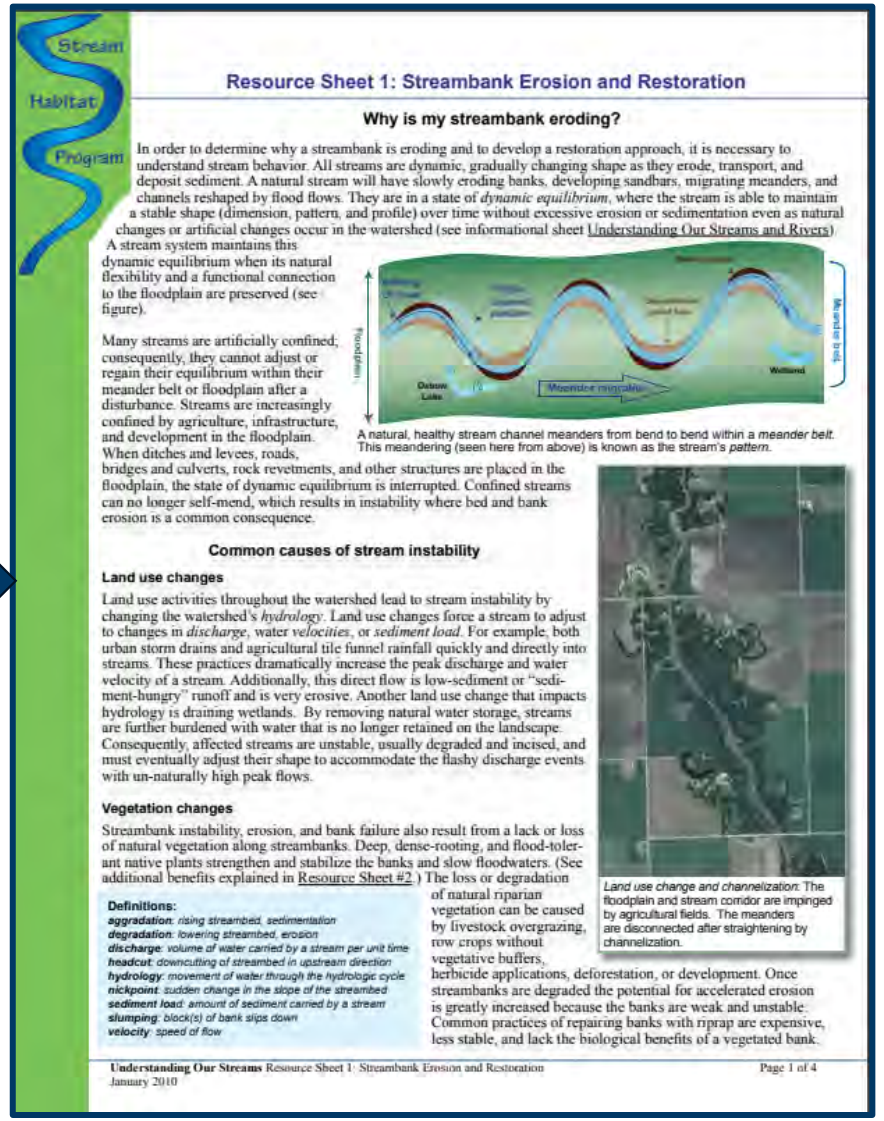
$$\text{Meander Width Ratio} = \frac{\text{Belt Width}}{\text{Bankfull Width}}$$

MN DNR Stream Resources

See resources on River Ecology Unit page

Resources

- Understanding Our Streams and Rivers
  - Are Minnesota Streams Healthy? (PDF) (0.7 Mb)
  - Resource Sheet 1: Streambank Erosion and Restoration (PDF) (4.1 Mb)
  - Resource Sheet 2: The Value and Use of Vegetation (PDF) (5.5 Mb)
  - Stream Restoration: Toe Wood-Sod Mat (PDF) (3.1 Mb)
- Habitat Suitability Criteria for Stream Fishes and Mussels of Minnesota (PDF) .
- Statewide Mussel Survey
- Watershed Health Assessment Framework
- Stream Restoration Priority List
  - Stream Restoration Criteria (PDF) (195 kb)
  - Project Submission Worksheet (DOC) (20 kb)
- Stream Crossings (culverts): Assessment and Ranking Guidelines (PDF)



Stream Habitat Program

Resource Sheet 1: Streambank Erosion and Restoration

Why is my streambank eroding?

In order to determine why a streambank is eroding and to develop a restoration approach, it is necessary to understand stream behavior. All streams are dynamic, gradually changing shape as they erode, transport, and deposit sediment. A natural stream will have slowly eroding banks, developing sandbars, migrating meanders, and channels reshaped by flood flows. They are in a state of *dynamic equilibrium*, where the stream is able to maintain a stable shape (dimension, pattern, and profile) over time without excessive erosion or sedimentation even as natural changes or artificial changes occur in the watershed (see informational sheet Understanding Our Streams and Rivers).

A stream system maintains this dynamic equilibrium when its natural flexibility and a functional connection to the floodplain are preserved (see figure).

Many streams are artificially confined; consequently, they cannot adjust or regain their equilibrium within their meander belt or floodplain after a disturbance. Streams are increasingly confined by agriculture, infrastructure, and development in the floodplain. When ditches and levees, roads, bridges and culverts, rock revetments, and other structures are placed in the floodplain, the state of dynamic equilibrium is interrupted. Confined streams can no longer self-mend, which results in instability where bed and bank erosion is a common consequence.

A natural, healthy stream channel meanders from bend to bend within a *meander belt*. This meandering (seen here from above) is known as the stream's *pattern*.

Common causes of stream instability

Land use changes

Land use activities throughout the watershed lead to stream instability by changing the watershed's *hydrology*. Land use changes force a stream to adjust to changes in *discharge*, water *velocities*, or *sediment load*. For example, both urban storm drains and agricultural tile funnel rainfall quickly and directly into streams. These practices dramatically increase the peak discharge and water velocity of a stream. Additionally, this direct flow is low-sediment or "sediment-hungry" runoff and is very erosive. Another land use change that impacts hydrology is draining wetlands. By removing natural water storage, streams are further burdened with water that is no longer retained on the landscape. Consequently, affected streams are unstable, usually degraded and incised, and must eventually adjust their shape to accommodate the flashy discharge events with un-naturally high peak flows.

Land use change and channelization: The floodplain and stream corridor are impinged by agricultural fields. The meanders are disconnected after straightening by channelization.

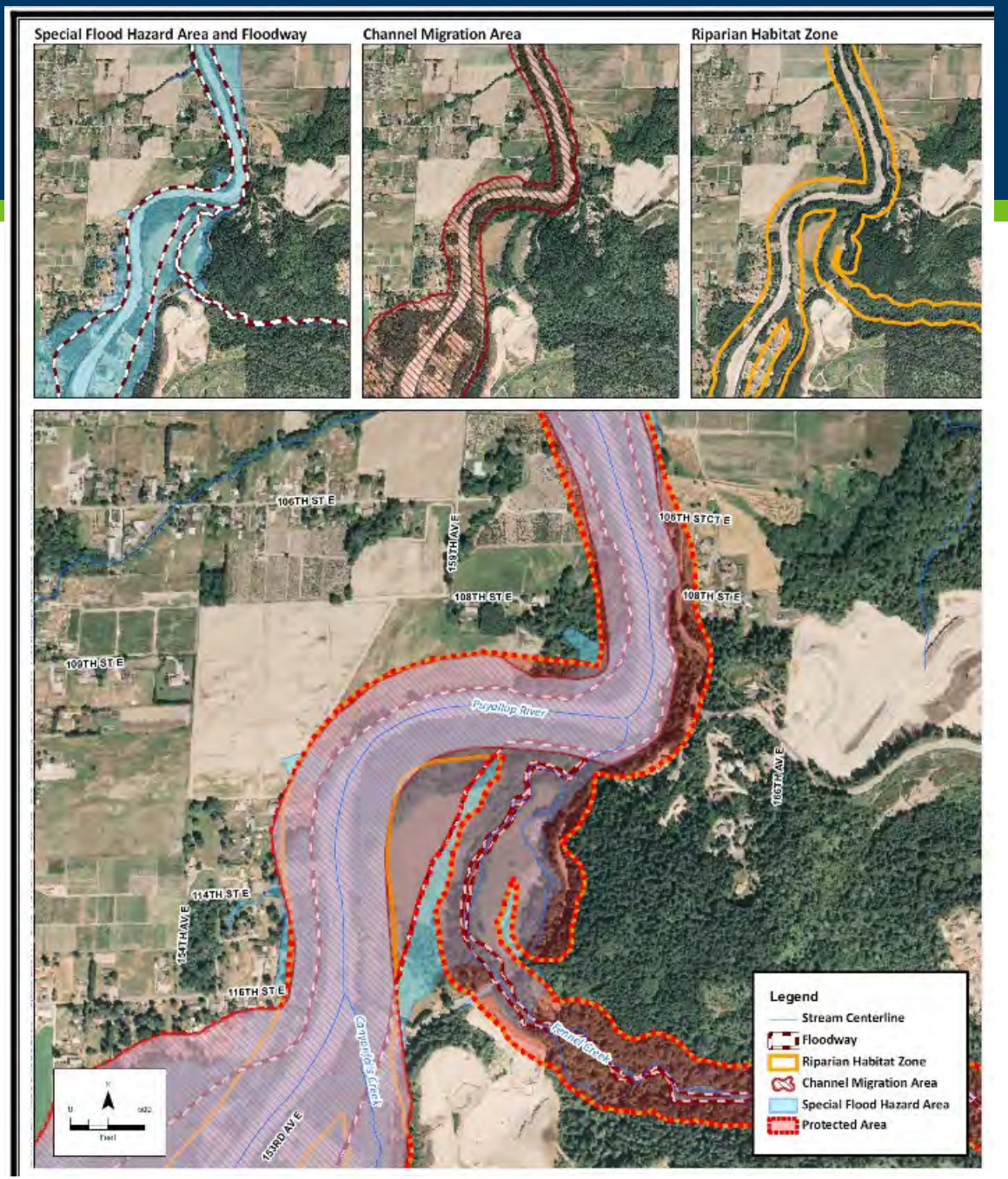
Vegetation changes

Streambank instability, erosion, and bank failure also result from a lack or loss of natural vegetation along streambanks. Deep, dense-rooting, and flood-tolerant native plants strengthen and stabilize the banks and slow floodwaters. (See additional benefits explained in Resource Sheet #2.) The loss or degradation of natural riparian vegetation can be caused by livestock overgrazing, row crops without vegetative buffers, herbicide applications, deforestation, or development. Once streambanks are degraded the potential for accelerated erosion is greatly increased because the banks are weak and unstable. Common practices of repairing banks with riprap are expensive, less stable, and lack the biological benefits of a vegetated bank.

Definitions:
aggradation: *rising streambed, sedimentation*
degradation: *lowering streambed, erosion*
discharge: *volume of water carried by a stream per unit time*
headcut: *downcutting of streambed in upstream direction*
hydrology: *movement of water through the hydrologic cycle*
nickpoint: *sudden change in the slope of the streambed*
sediment load: *amount of sediment carried by a stream*
slumping: *block(s) of bank slips down*
velocity: *speed of flow*

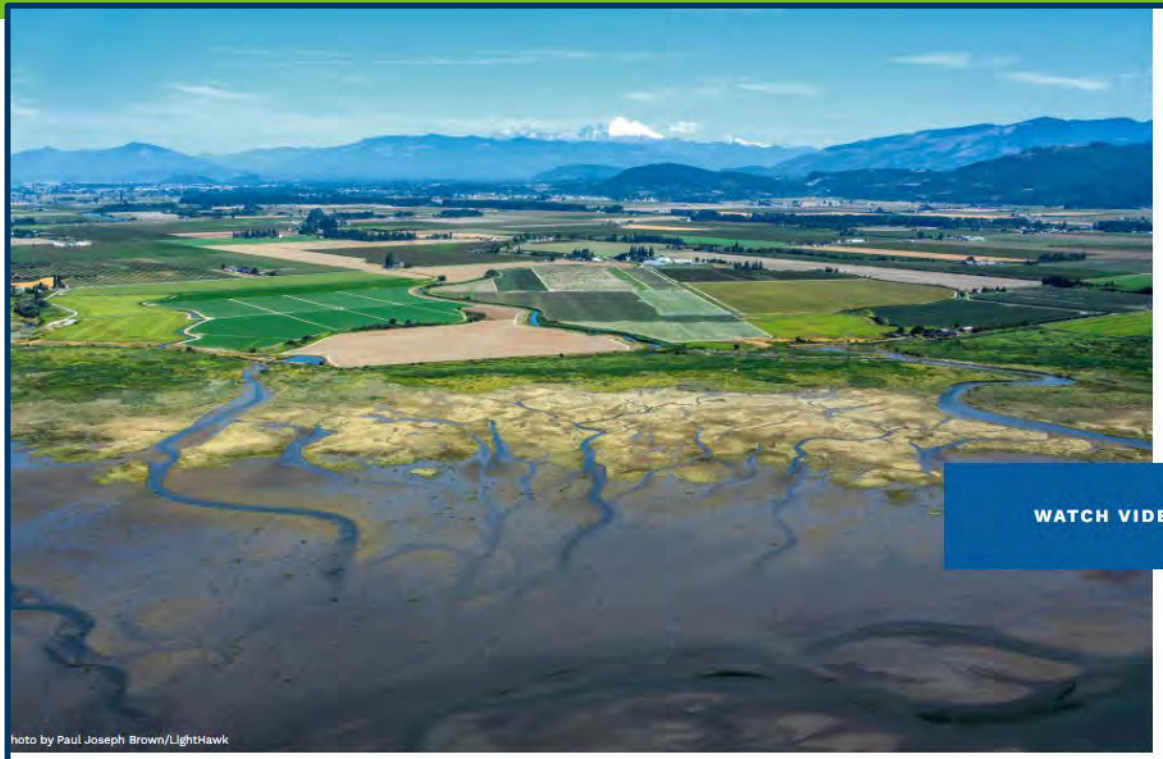
Pierce County, Washington

- riparian habitat zone, 150’ – 250’ salmon habitat, spawning and shelter
- channel migration area (meander protection) – 50’ buffer



See www.floodplainsbydesign.org

Washington's Floodplains by Design



WHAT IS FLOODPLAINS BY DESIGN?

Floodplains by Design works to reduce flood risk, restore habitat, improve water quality, support agriculture and enhance recreation along Washington's rivers. By transforming how floodplains are managed on a landscape scale, Floodplains by Design supports thriving communities and a healthy environment. The heart of this approach is the idea that the most complex problems are solved by helping people work together. Trust is built through structured conversations that give voice to the values of each interest group, and coordinating investments toward local solutions.

→ ABOUT US

FBD EVENTS

There are a variety of ways to engage with the FbD network to learn, connect, and help shape the direction of the program. From the monthly Lunch & Learn series, to quarterly Action Group meetings, or special topic webinars, take a look at the Events Calendar to learn more

Upcoming Events

JAN 4 12:00 pm - 1:00 pm
Monthly Lunch & Learn Series – Topics Updated Monthly

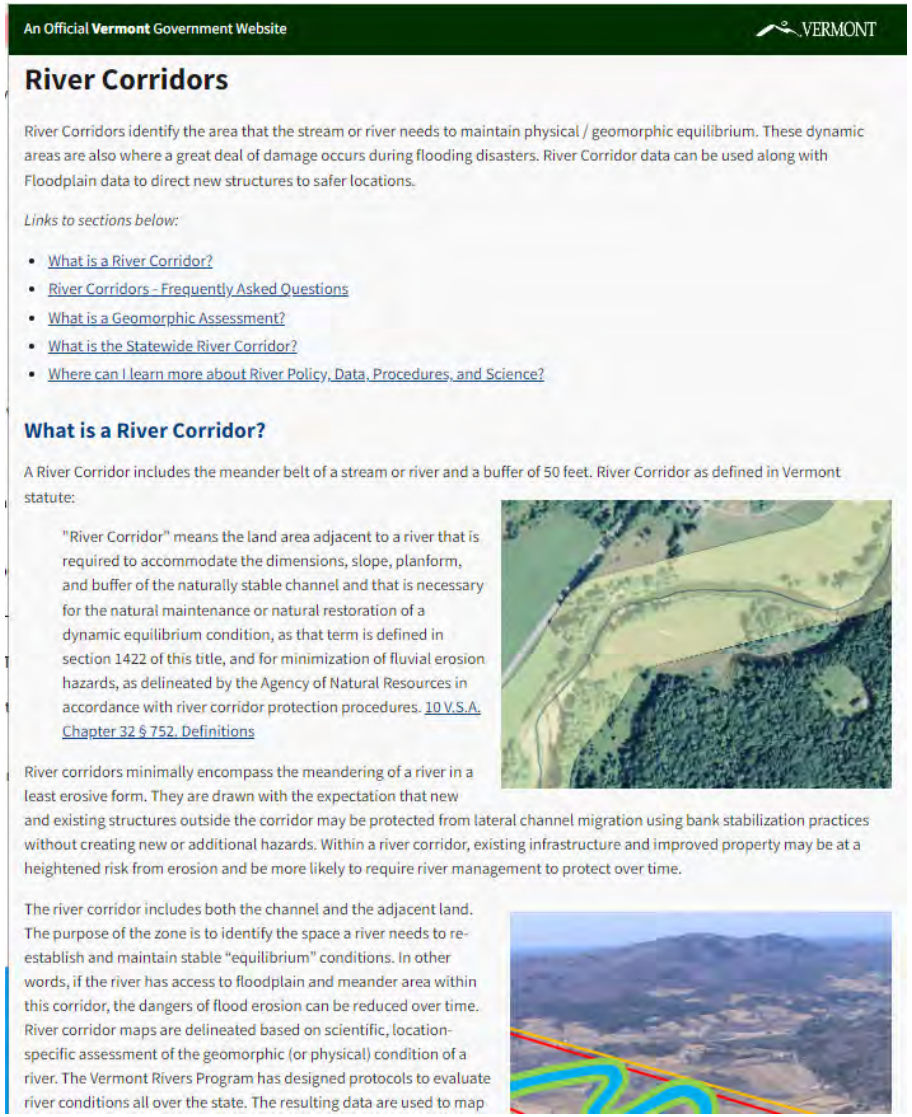
FEB 1 12:00 pm - 1:00 pm
Monthly Lunch & Learn Series – Topics Updated Monthly

MAR

BACK TO TOP ↑

See www.floodplainsbydesign.org - a public-private partnership

Vermont River Corridors



An Official **Vermont** Government Website

VERMONT

River Corridors

River Corridors identify the area that the stream or river needs to maintain physical / geomorphic equilibrium. These dynamic areas are also where a great deal of damage occurs during flooding disasters. River Corridor data can be used along with Floodplain data to direct new structures to safer locations.

Links to sections below:

- What is a River Corridor?
- River Corridors - Frequently Asked Questions
- What is a Geomorphic Assessment?
- What is the Statewide River Corridor?
- Where can I learn more about River Policy, Data, Procedures, and Science?

What is a River Corridor?

A River Corridor includes the meander belt of a stream or river and a buffer of 50 feet. River Corridor as defined in Vermont statute:

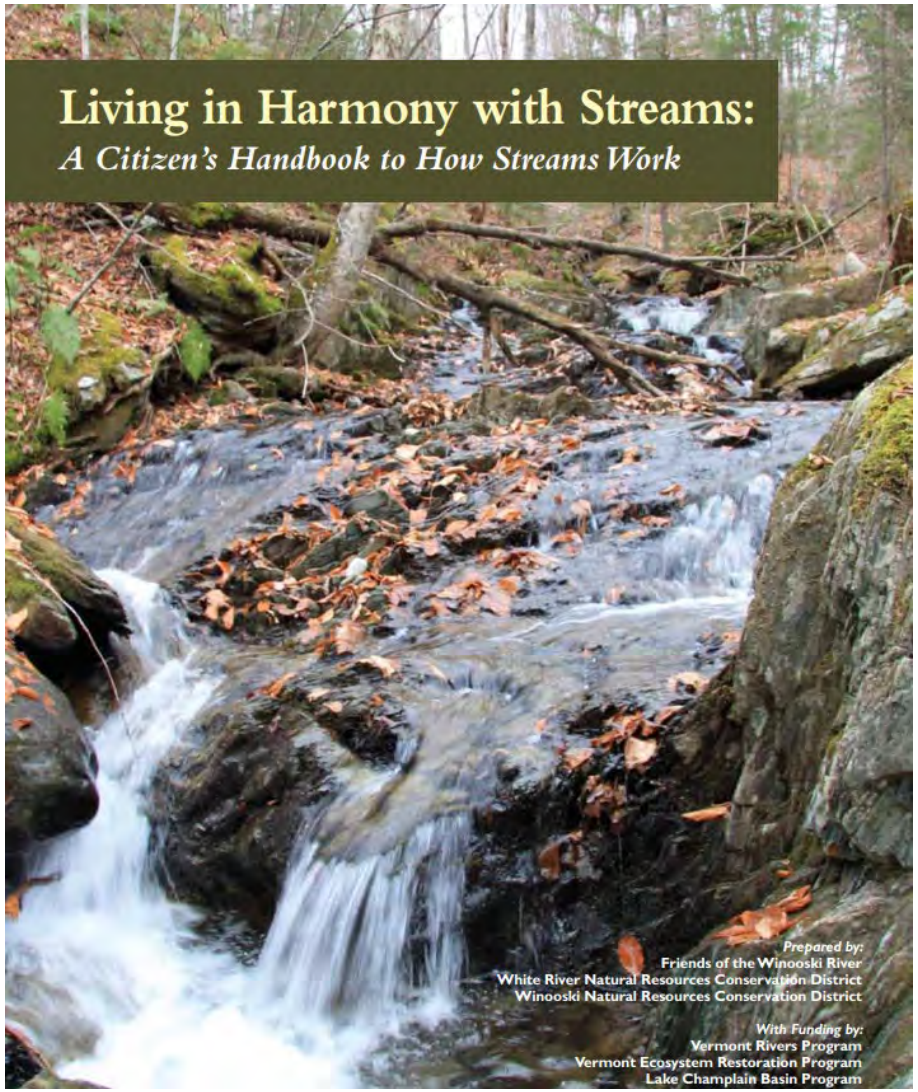
> "River Corridor" means the land area adjacent to a river that is required to accommodate the dimensions, slope, planform, and buffer of the naturally stable channel and that is necessary for the natural maintenance or natural restoration of a dynamic equilibrium condition, as that term is defined in section 1422 of this title, and for minimization of fluvial erosion hazards, as delineated by the Agency of Natural Resources in accordance with river corridor protection procedures. 10 V.S.A. Chapter 32 § 752. Definitions

River corridors minimally encompass the meandering of a river in a least erosive form. They are drawn with the expectation that new and existing structures outside the corridor may be protected from lateral channel migration using bank stabilization practices without creating new or additional hazards. Within a river corridor, existing infrastructure and improved property may be at a heightened risk from erosion and be more likely to require river management to protect over time.

The river corridor includes both the channel and the adjacent land. The purpose of the zone is to identify the space a river needs to re-establish and maintain stable "equilibrium" conditions. In other words, if the river has access to floodplain and meander area within this corridor, the dangers of flood erosion can be reduced over time. River corridor maps are delineated based on scientific, location-specific assessment of the geomorphic (or physical) condition of a river. The Vermont Rivers Program has designed protocols to evaluate river conditions all over the state. The resulting data are used to map

Vermont River Corridors site

Living in Harmony with Streams – by Vermont partnership



Blue Earth County

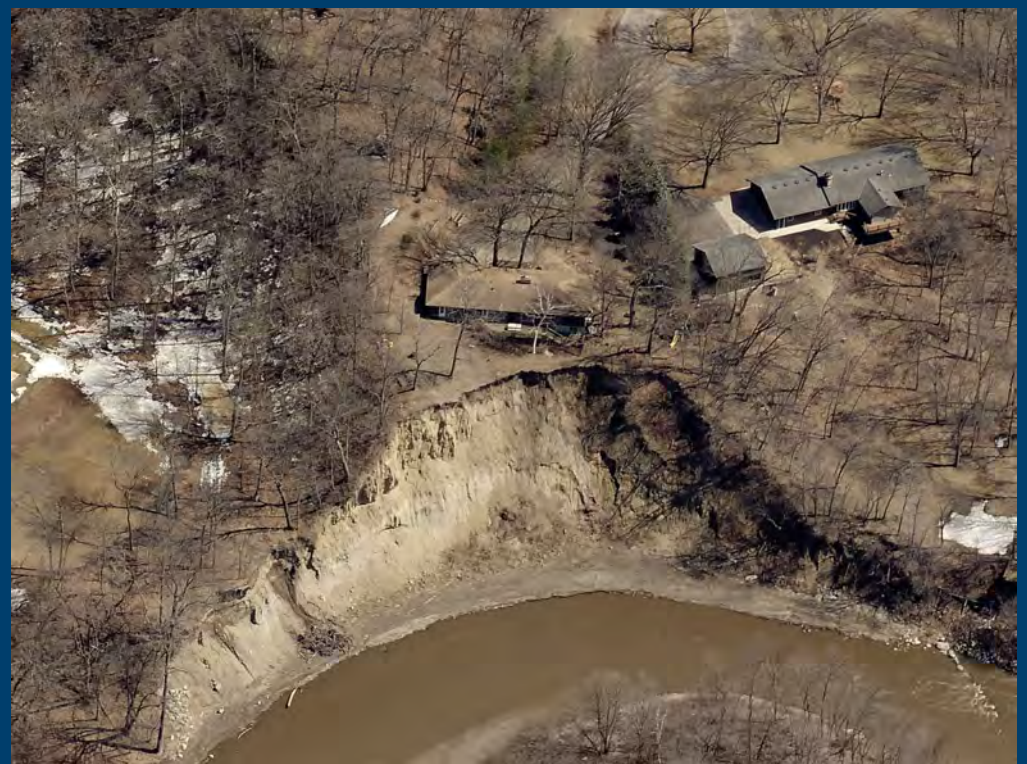
December 20, 2023

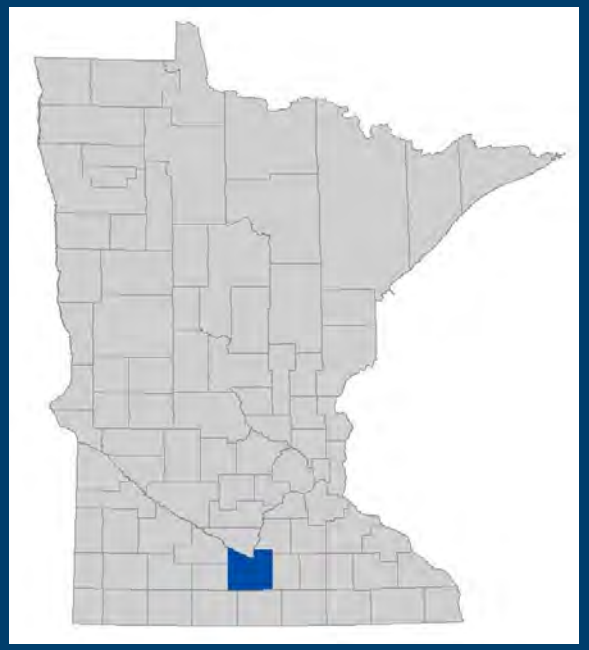
Eroding Bluff Standards

Scott Salsbury – Land Use Planner – Natural Resources

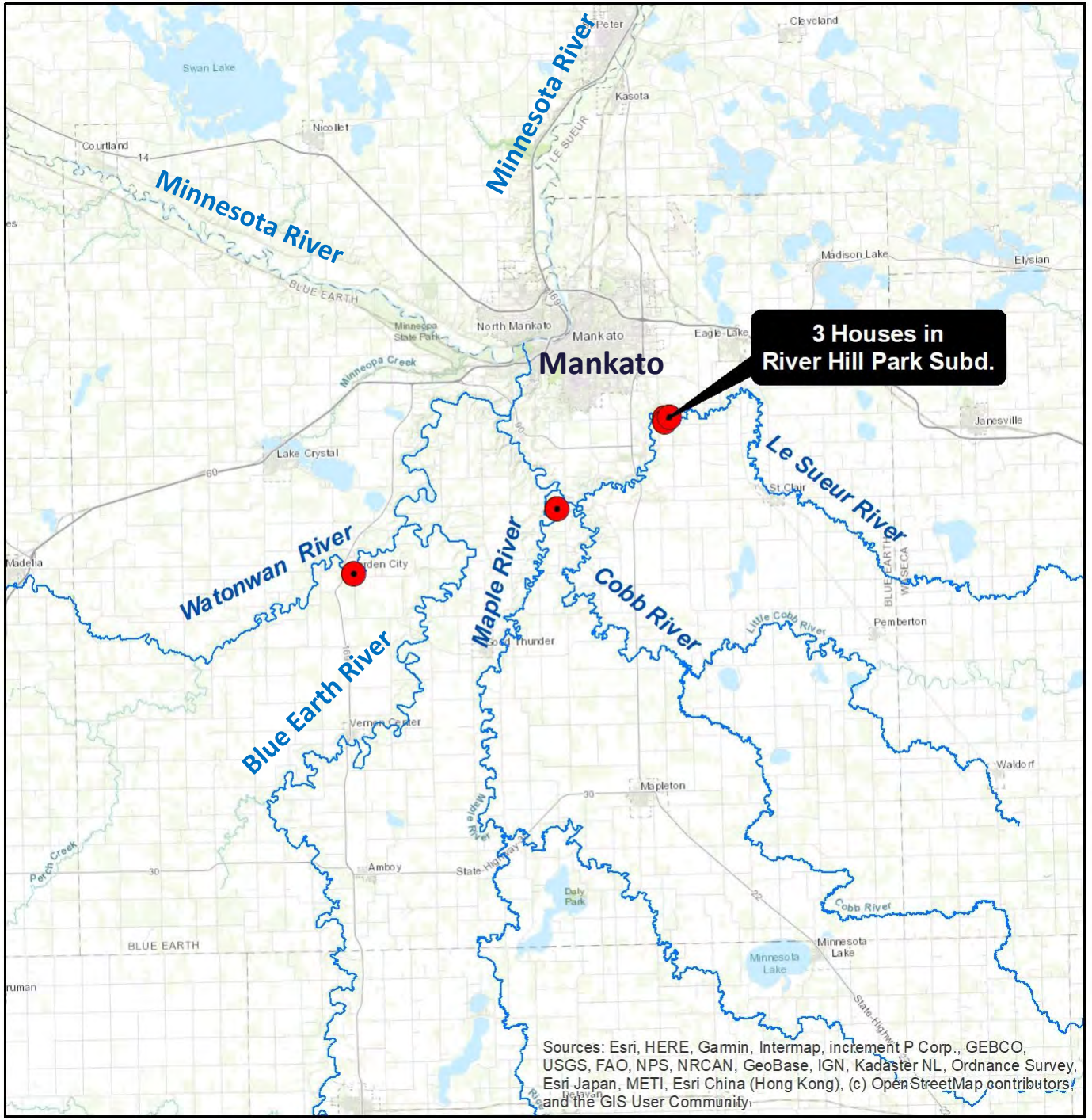
BLUE EARTH COUNTY


04/25/2002





Location of Houses Removed Due to Eroding Bluffs

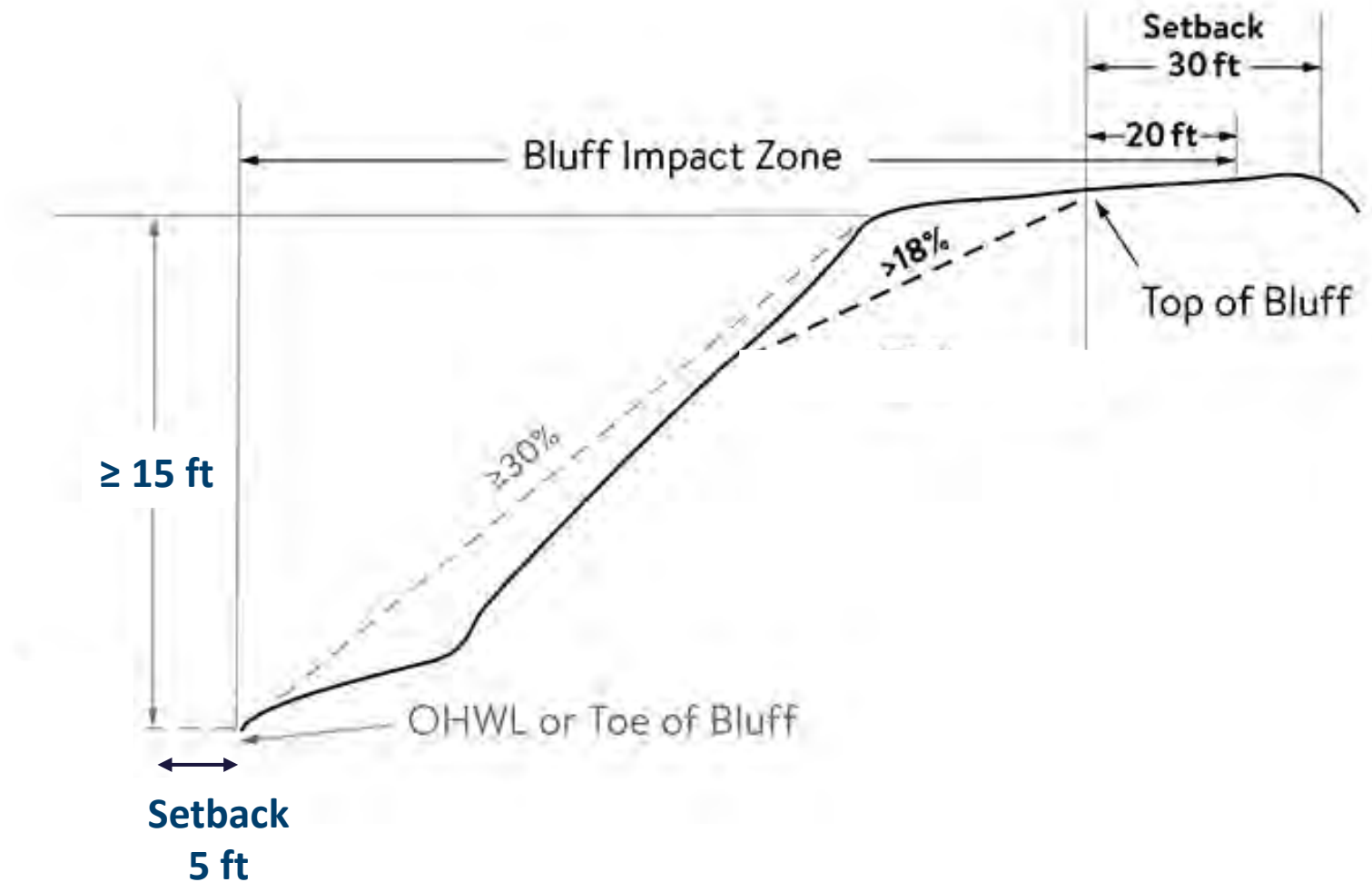


April 2016 – Le Sueur River


September 2016


September 2016

Blue Earth County - Bluff Setback



Pre-2023 Blue Earth County Zoning Standard

Sec. 24-304. Erosion control.

(4) No structure shall be erected within 30 feet of the top of a bluff.

If the adjacent bluff is actively eroding, the zoning administrator may increase the setback requirement.

Plan References

Water Plan and Land Use Plan

Blue Earth County, Mankato Township and other jurisdictions affected by near channel erosion will work together with technical support to develop science-based methods for increasing structure setbacks based on geology, soils and historic trends.

Hazard Mitigation Plan

Increase zoning requirements for dwelling set-backs from bluffs to decrease development impacts and reduce risk of slope failure.

2022 County Actions

- Near Channel Erosion Workshop
  - DNR
  - Townships
  - Local Contractors
  - Planning Commission
- Considered Several Options with Planning Commission
  - Potential Ordinance Revisions
    - Increased Setbacks
    - Eroding River Overlay District
  - Education
  - Waivers

2005

35-Foot-Tall Bluff

2022

35-Foot-Tall Bluff

2023 Amendment

Blue Earth County Zoning Standard Sec. 24-304. - Erosion control.

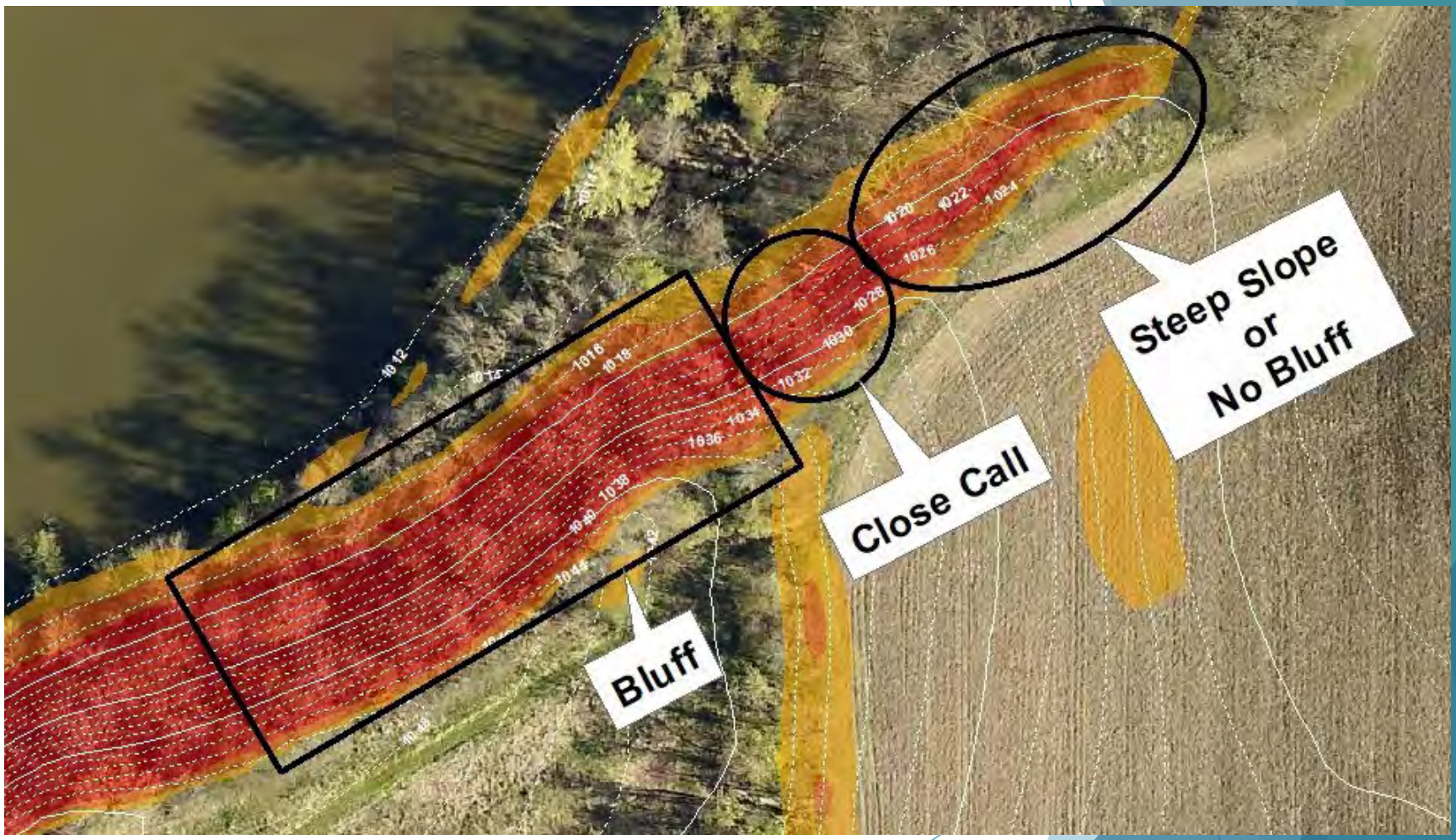
No structure shall be erected within 30 feet of the top of a bluff.

- When the Bluff is Actively Eroding:
  - Requirement for a geotechnical evaluation report from a licensed engineer to evaluate the stability of the bluff and to determine the appropriate setback based on the site and the proposed development


Questions?

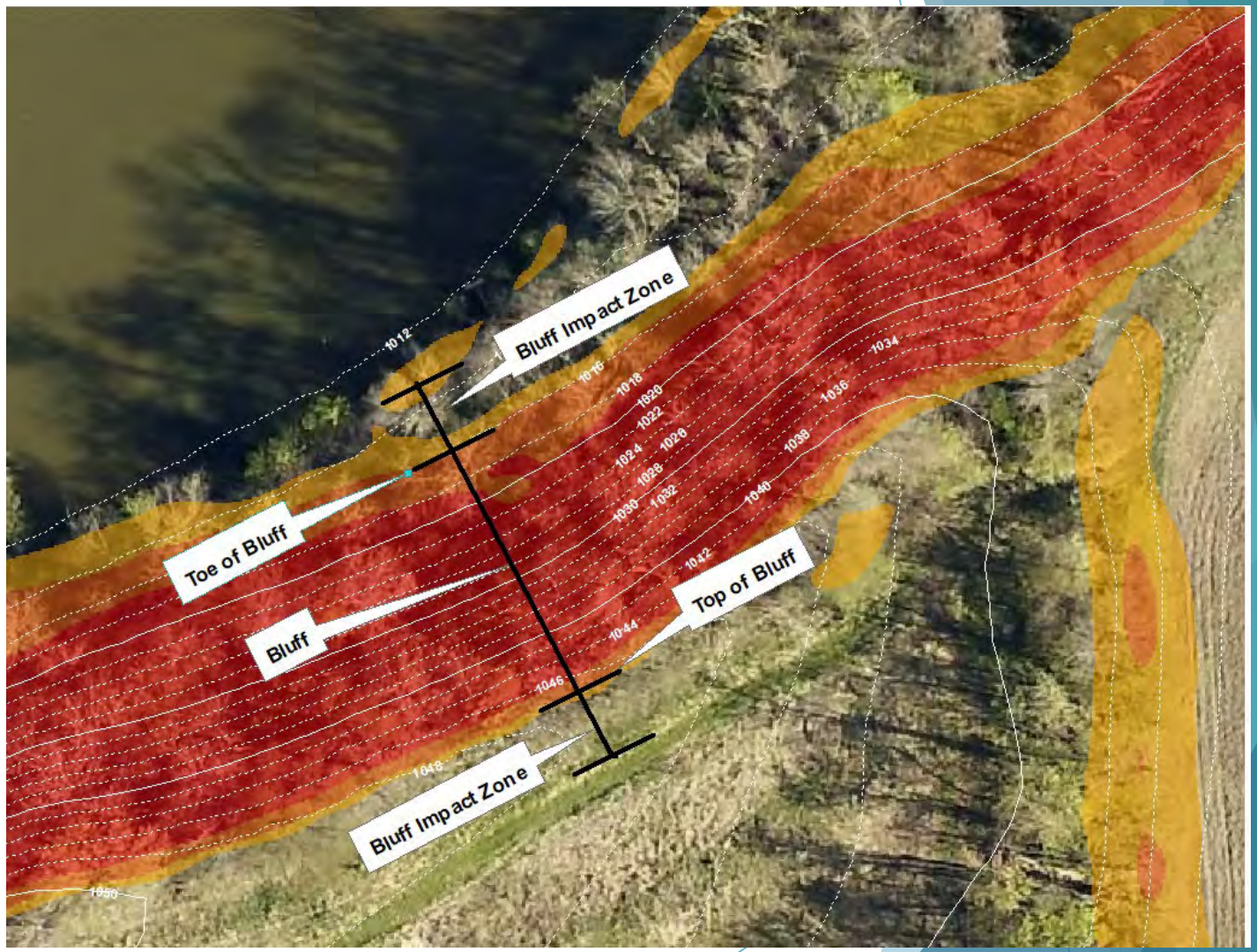
Bluff

- A topographic feature such as a hill, cliff, or embankment in which the slope rises at least 15 feet from the toe of the bluff to the top of the bluff and the grade of the slope from the toe of the bluff to the tope of the bluff averages 18 percent or greater. The percent of the slope is defined as the change in elevation (rise) over a distance (run).



Toe & Top of Bluff

- Toe-the lower end of the lowest 10 foot segment that exceeds 18%
- Top-the upper end of the highest 10 foot segment that exceeds 18%



Bluff Impact Zone

- Land located within 20 feet from the top or toe of a bluff

Standards

- No structures allowed in the Bluff or Bluff Impact Zone
- Setbacks
  - New Construction
    - 30 feet from top and toe of slopes ranging 18-30%
    - 50 feet from top and toe of slopes greater than 30%
  - Existing Building Sites
    - 30 feet from top and toe from any Bluff
  - Septic
    - All components 30 feet from top and toe of any Bluff for new systems
    - Replacement of existing components may be relocated in the Bluff Impact Zone (NOT in the Bluff)

Additional Standards

- No Water-Oriented structures in the Bluff or Bluff Impact Zone
- The creation of a walkout basement is prohibited within the Bluff Impact Zone
- No Rain Gardens within 50 feet from the top or 20 feet from the toe of a Bluff
- Allow stairs, lifts, and landings constructed above ground on posts or pilings, provided they result in less than or equal to three (3) cubic yards of disturbance in the Bluff (with an approved Land Alteration Permit).
- No fencing allowed within a Bluff or Bluff Impact Zone
- Do not allow Access Drives within a Bluff

Wabasha County
Bluffland Area Protection

Wabasha County Comprehensive Plan

General Policy #11: Reduce the environmental and visual impact of development on steep slopes (20% and greater) and blufftops.

In 2015 Wabasha County significantly amended 12 chapters of its Zoning Ordinance.

- Included in these changes were the definition of what constitutes a bluff and the bluff impact zone.

- Although the intention of these changes is unclear, the result was a broader protection of slopes and an increase in setback distances.

What is a Bluff?

Wabasha County Zoning Ordinance Chapter 2.02 (27)

Bluff. A natural topographic feature such as a hill, cliff, or embankment having the following characteristics:

(a) The slope rises at least twenty-five (25) feet above the toe of the bluff; and

(b) The grade of the slope from the toe of the bluff to a point twenty-five (25) feet or more above the toe of the bluff averages thirty (30) percent or greater;

(c) An area with an average slope of less than eighteen (18) percent over a horizontal distance of fifty (50) feet shall not be considered part of the bluff.

Minnesota Statutes 6120.2500 Subp. 1b

Bluff. "Bluff" means a topographic feature such as a hill, cliff, or embankment having all of the following characteristics:

A. part or all of the feature is located in a shoreland area;

B. the slope rises at least 25 feet above the ordinary high water level of the waterbody;

C. the grade of the slope from the toe of the bluff to a point 25 feet or more above the ordinary high water level averages 30 percent or greater; and

D. the slope must drain toward the waterbody.

An area with an average slope of less than 18 percent over a distance for 50 feet or more shall not be considered part of the bluff.

Bluff Impact Zone

Wabasha County Zoning Ordinance

Chapter 2.02 (28):

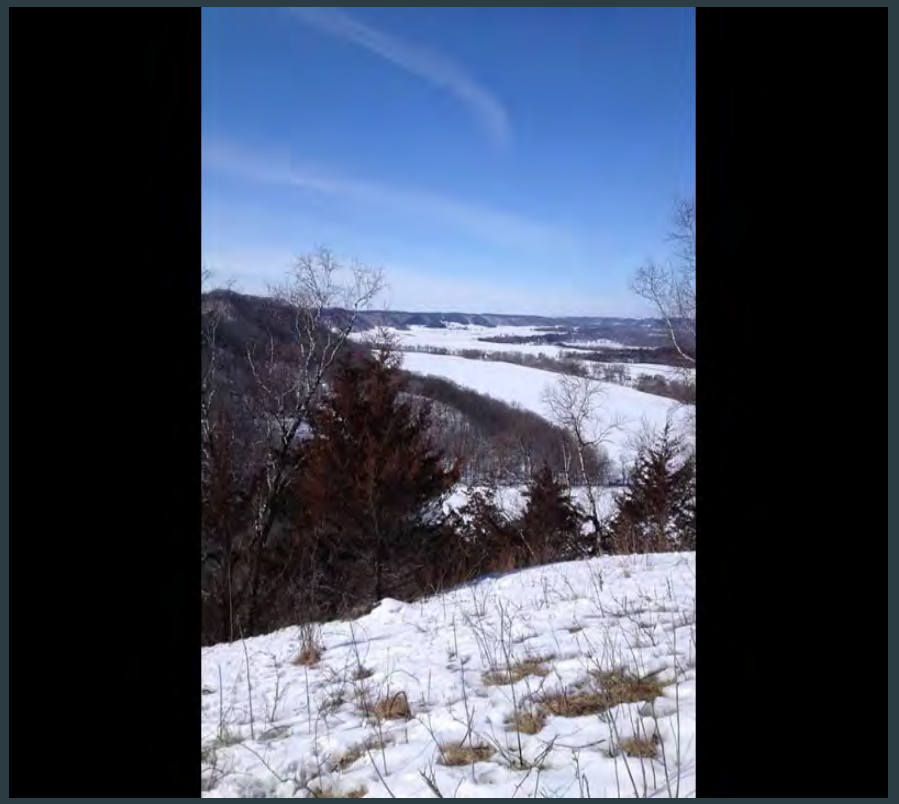
- A bluff and land located within 30 feet from the top and toe of a bluff.

Minnesota Statutes

6120.2500 Subpart 1c:

- "Bluff impact zone" means a bluff and land located within 20 feet from the top of a bluff.

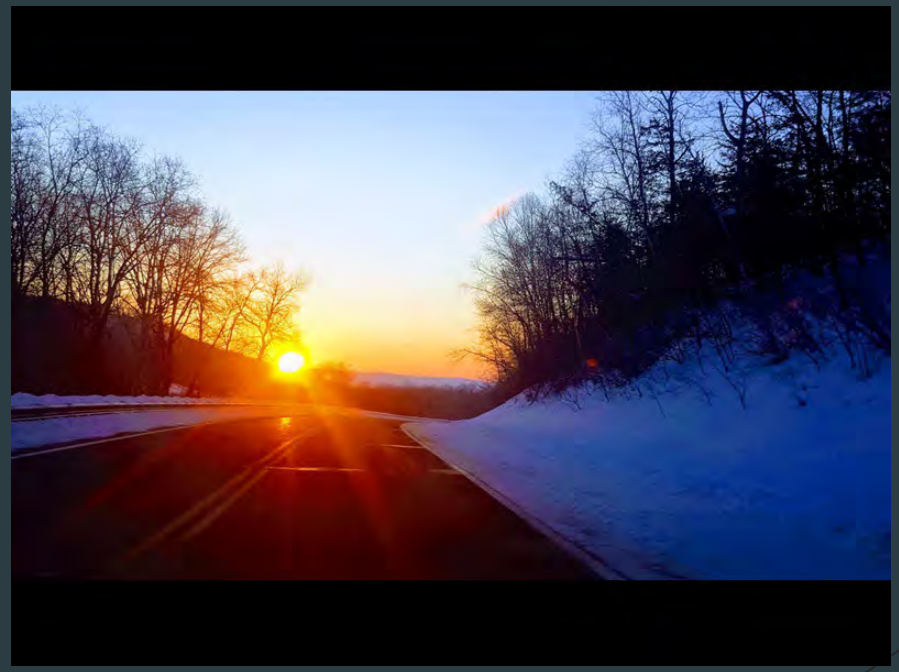
Performance Standards



- Except for stairways, lifts or landings, new structures and accessory facilities shall not be placed within a bluff impact zone.
- Legal pre-existing structures may be continued through repair, replacement, restoration, maintenance, or improvement as per state statue.
- Any expansion of a nonconforming structure in a bluff impact zone shall only be allowed by way of a variance

Performance Standards

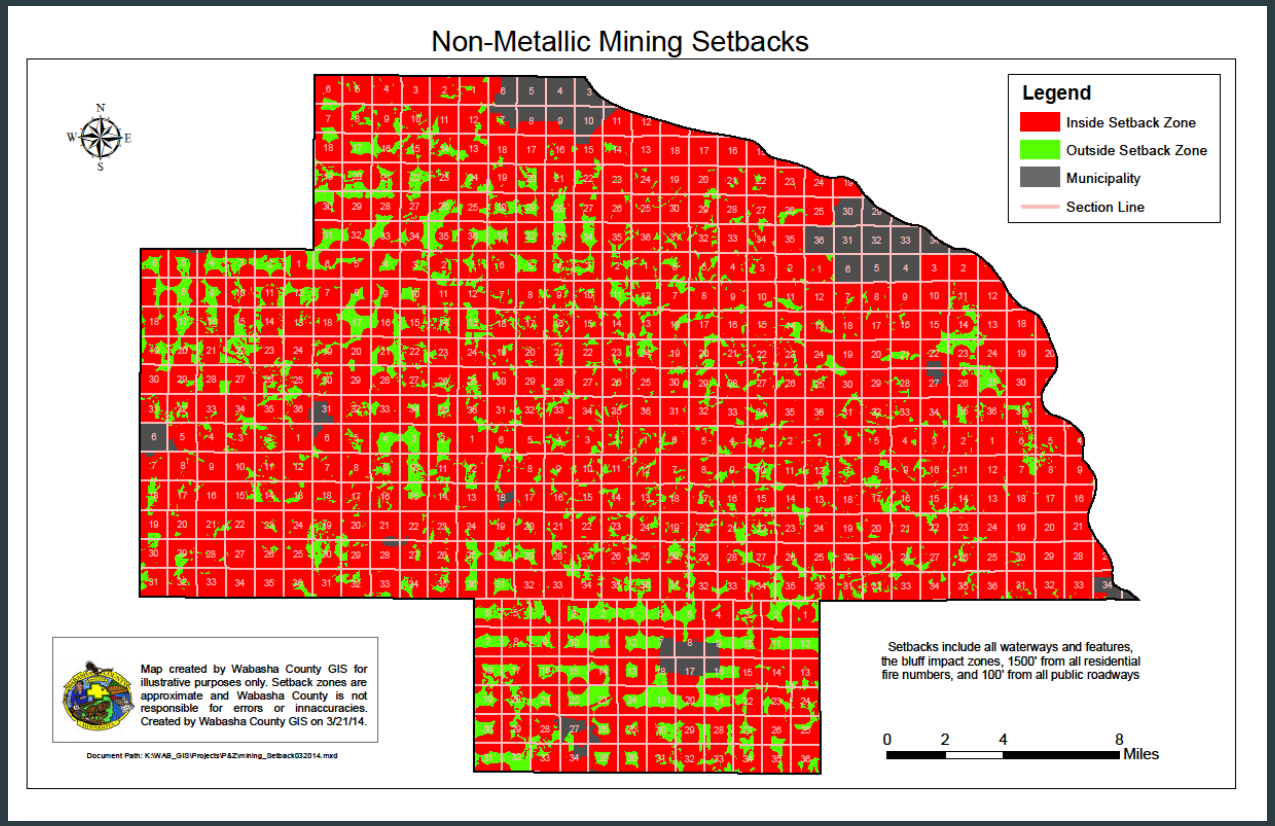
- Roads, driveways, and parking areas must not be placed within bluff impact zones when other reasonable and feasible placement alternatives exist.
- May be placed within these areas through the issuance of a conditional/interim use permit.
- An application for a CUP/IUP permit for a road, driveway, or parking area in a bluff impact zone shall include a design from a MN licensed engineer that minimizes failure and erosion potential. No road, driveway, or parking area allowed on any slope greater than thirty (30) percent.



Bluffs and Non-Metallic Mining

- Nonmetallic mines and/or processing facilities shall not be located on a bluff or within 300 feet of the toe or top of a bluff
- Other limiting factors:
  - Only allowed in the Agricultural Protect District (A-1)
  - Cannot exceed 50 acres
  - Activities must remain at least 15 feet above the established groundwater table
  - 1500 feet from residential dwellings

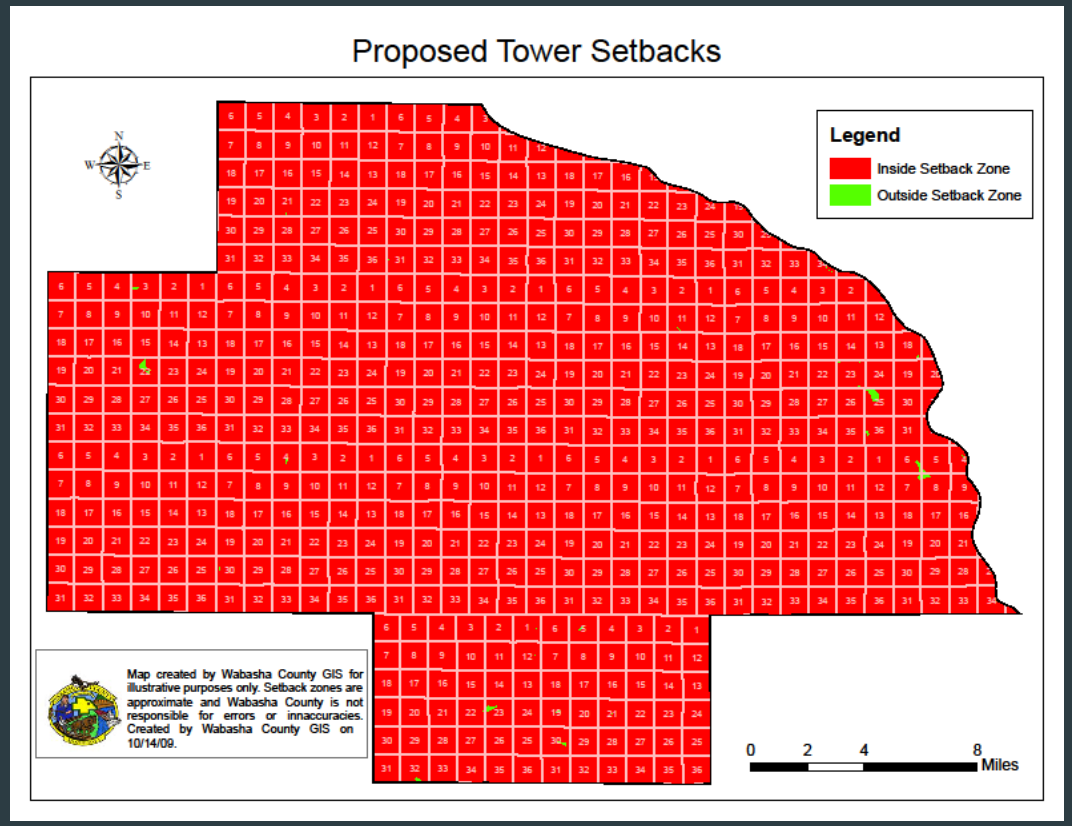
Bluffs and Non-Metallic Mining



Bluffs and Towers

- No communication towers, with the exception of emergency towers, shall be located within ¼ mile of the bluff impact zone.
- Other contributing factors:
  - Towers must co-locate if other available towers are within ½ mile
  - Any new tower must be able to accommodate at least 2 other antennas
  - Must be setback 1,000 feet from dwellings or schools
  - Towers must be setback at least ¼ mile from other towers.

Bluffs and Towers



Challenges

A driveway created into a bluff along the Zumbro River without an access permit to the County Road. The highway department reported the unpermitted driveway to zoning. The slope was later determined to be in excess of 60% in some areas.

Many homes throughout the county were historically placed in flattened out areas of the bluff and now cannot expand without a variance

04/09/2023

04/09/2023

Questions?

Joe Kaltenbach, Wabasha County Zoning Administrator

jkaltenbach@co.wabasha.mn.us 651-565-3062

Upcoming LGU Forum Topics

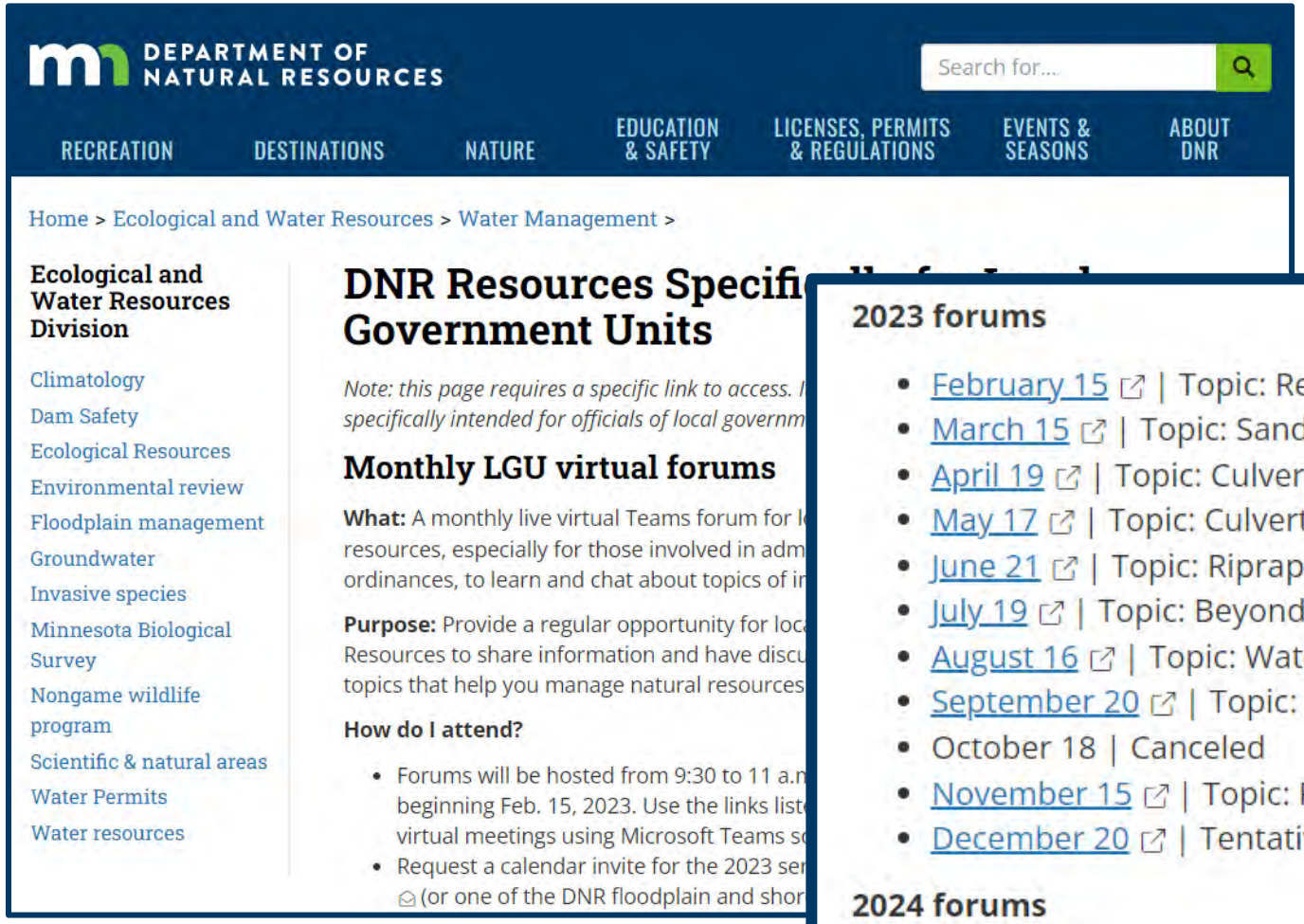
Confirmed:

- 01/17/2024 Stormwater BMPs (Part 2) – Shoreland focus

Future dates:

- 02/21/2024 Mooring and Marina Standards (tentative)
- 03/21/2024 Dealing with Floodplain & Shoreland violations (tentative)

2023 - New LGU Page



"Secret" LGU page only through direct link.

2023 forums

- February 15 | Topic: Retaining walls - Agenda (PDF)
- March 15 | Topic: Sand Blankets and Aquatic Plant Management (APM) - Agenda (PDF)
- April 19 | Topic: Culverts and Crossings - Agenda (PDF)
- May 17 | Topic: Culverts and Crossings - Higher Standards and Approaches - Agenda (PDF)
- June 21 | Topic: Riprap - Agenda (PDF)
- July 19 | Topic: Beyond Riprap: Bioengineering - Agenda (PDF)
- August 16 | Topic: Water Surface Use Impacts and Regulations - Agenda (PDF)
- September 20 | Topic: Stormwater Basics for Zoning Administrators - Agenda (PDF)
- October 18 | Canceled
- November 15 | Topic: Flood Risk Reduction - Agenda (PDF) | Presentations (PDF)
- December 20 | Tentative topic: Bluffs and Landslides - Agenda (PDF)

2024 forums

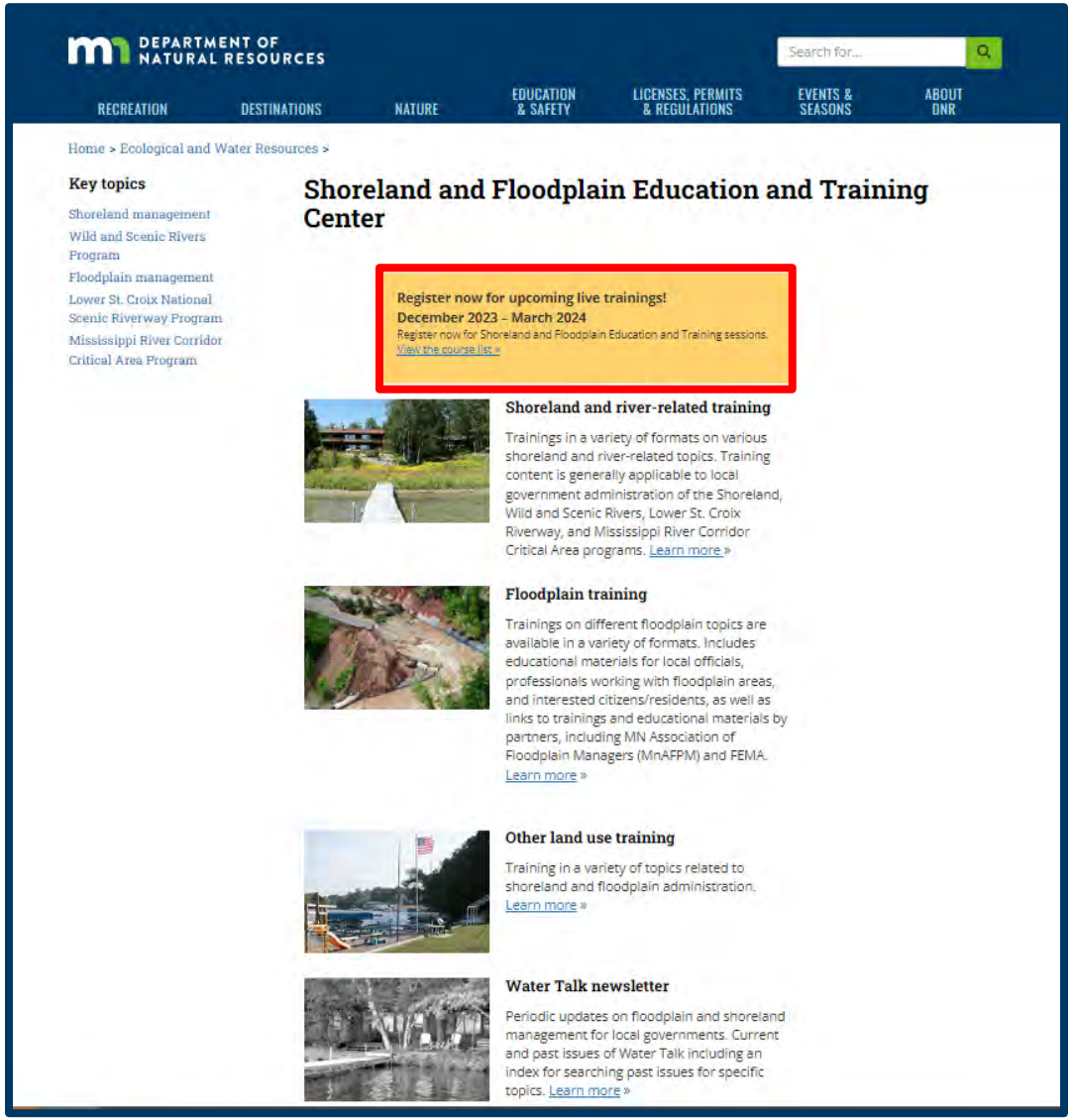
- January 17 | Tentative topic: Stormwater Higher Standards: BMPs in Shoreland
- February 21 | Tentative topic: Mooring and Marina Standards

Trainings & Education Web Updates

Separate pages for:

- Shoreland Training
- Floodplain Training
- Other Land Use Training
- Water Talk Newsletter
  - Past issues
  - *Future – by topics*

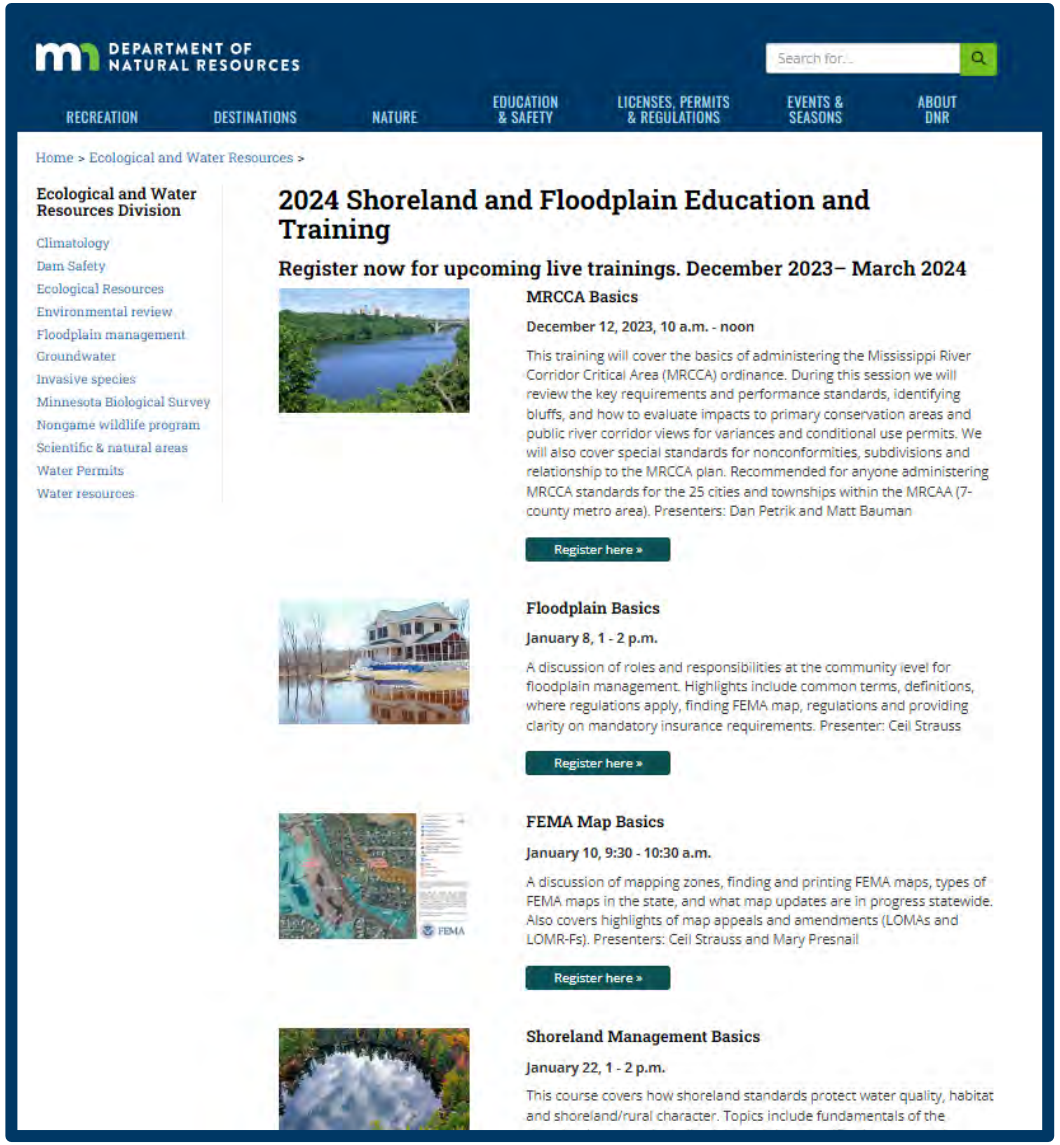
[Link to Shoreland & Floodplain Educations and Training page]



Topics & Registration Links for Upcoming Virtual Trainings Page

- ✓ 12/12/23 MRCCA Basics
- ✓ 01/08/24 Floodplain Basics
- ✓ 01/10/24 FEMA Map Basics
- ✓ 01/22/24 Shoreland Management Basics
- ✓ 01/24/24 Floodplain grading & Non-structural Development*
- ✓ 01/29/24 Better Culverts & Crossings*
- ✓ 01/31/24 Flood Insurance Basics
- ✓ 03/06/24 Dealing with A Zones
- ✓ 03/11/24 Floodplain & Watershed Higher Standards
- ✓ 03/13/24 Shoreland Higher Standards
- ✓ 03/18/24 Floodplain Violations and Enforcement*
- ✓ 03/27/24 Substantial Damage & Post Flood Responsibilities

***New topic**



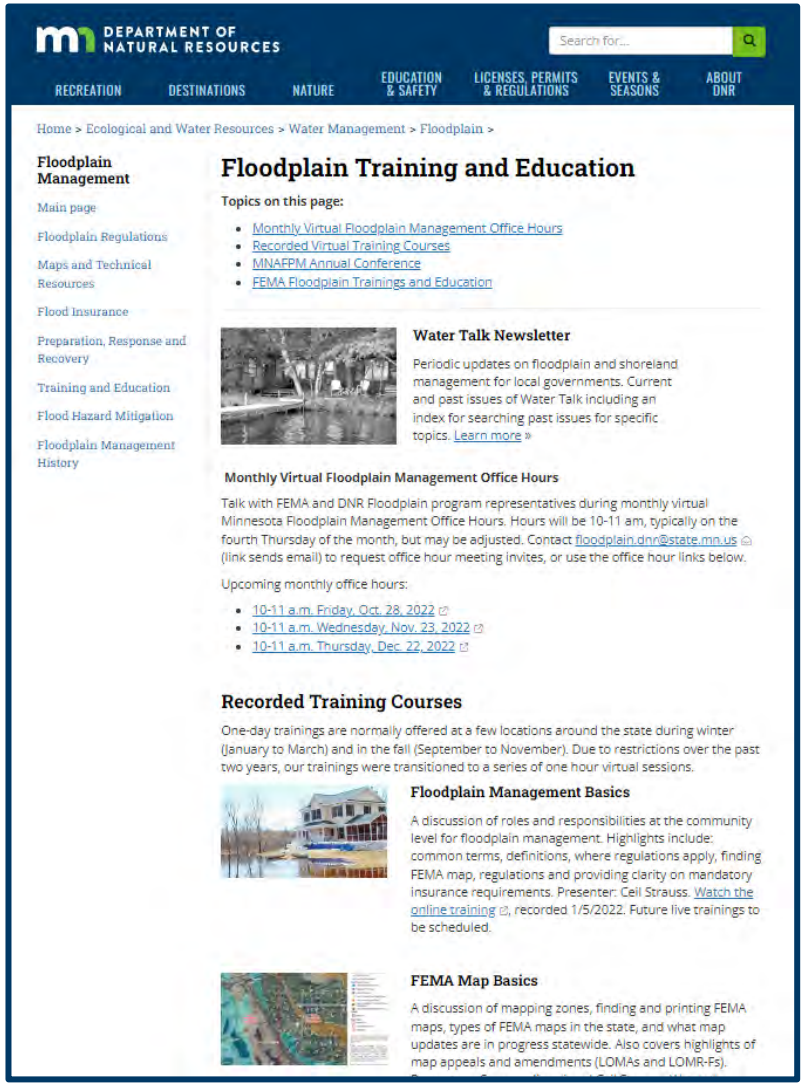
Floodplain Trainings Page

Virtual trainings:

- 11 one-hour trainings Jan to March 2023 (9 updates, new H&H for Non-Engineers & new Floodplain Culverts); Recordings now available on Floodplain Training & Education page (plus several from early 2022)

Monthly Office Hours:

- DNR/FEMA 10-11 am – 4th Thu
  - Dec. 28, 2023
  - Jan. 25, 2024
  - Feb. 22, 2024
  - Mar. 28, 2024

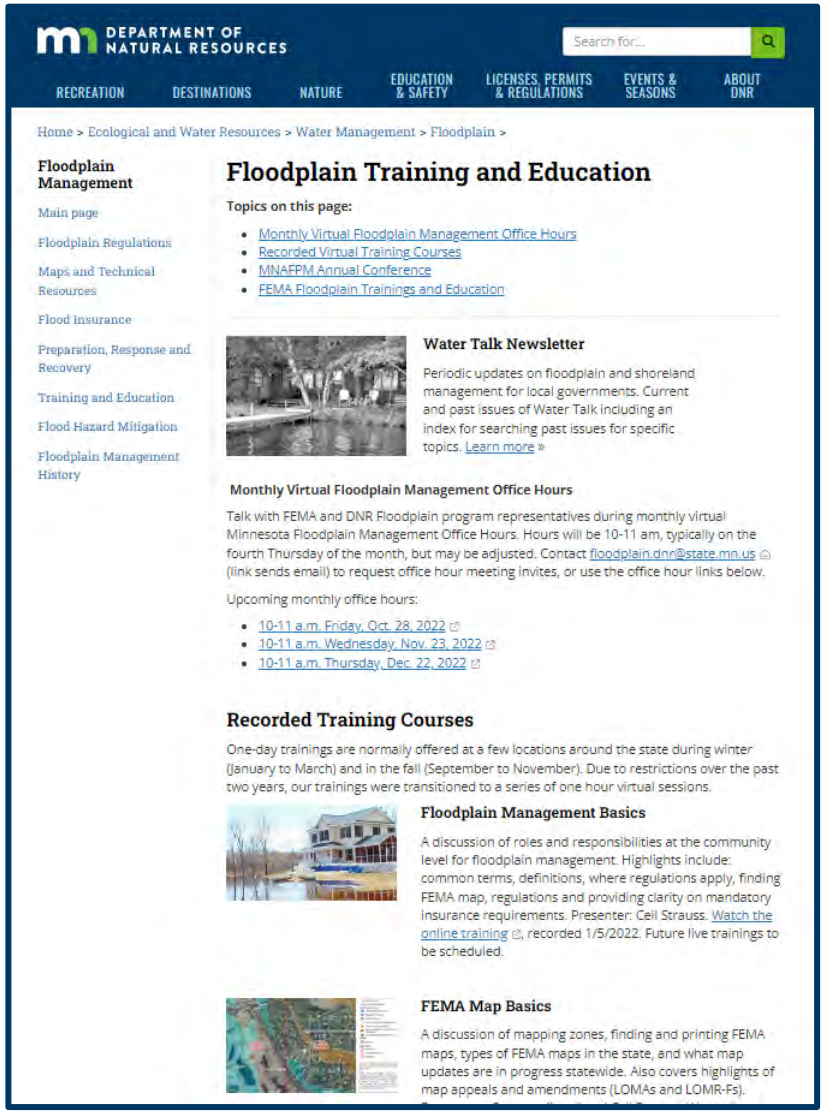


Upcoming Trainings/Office Hours (all FREE)

FEMA monthly topics: 2nd Wed of month

- **9-10 a.m. Dec. 20:** Community Rating System (CRS) | Register
- **9-10 a.m. Jan. 31:** NFIP Fundamentals for Floodplain Managers |Register
- **9-10 a.m. Feb. 28:** Development Permitting| Register
- **9-10 a.m. Mar. 27:** NFIP Compliance| Register

DNR In Person Workshops: One day workshops in Brainerd/Little Falls, Rochester & Metro in March/April?



Thanks for Attending!

See you Jan. 17 for Stormwater Higher Standards: BMPs in Shoreland