A Spatially Explicit Framework for Connecting Land Cover Changes to Stream Ecosystems

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Key Questions:

Q1: Did critical areas change?

If so, was change related to CAO implementation?

Q2: To what extent was change due to poor implementation?

How well did people follow the regulations?

Q3: How did the environment respond?

What was the significance of those changes?

Q4: If responses were significant, how might the CAO be modified to reduce future impact?

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Key Questions:

Q1: Did critical areas change?

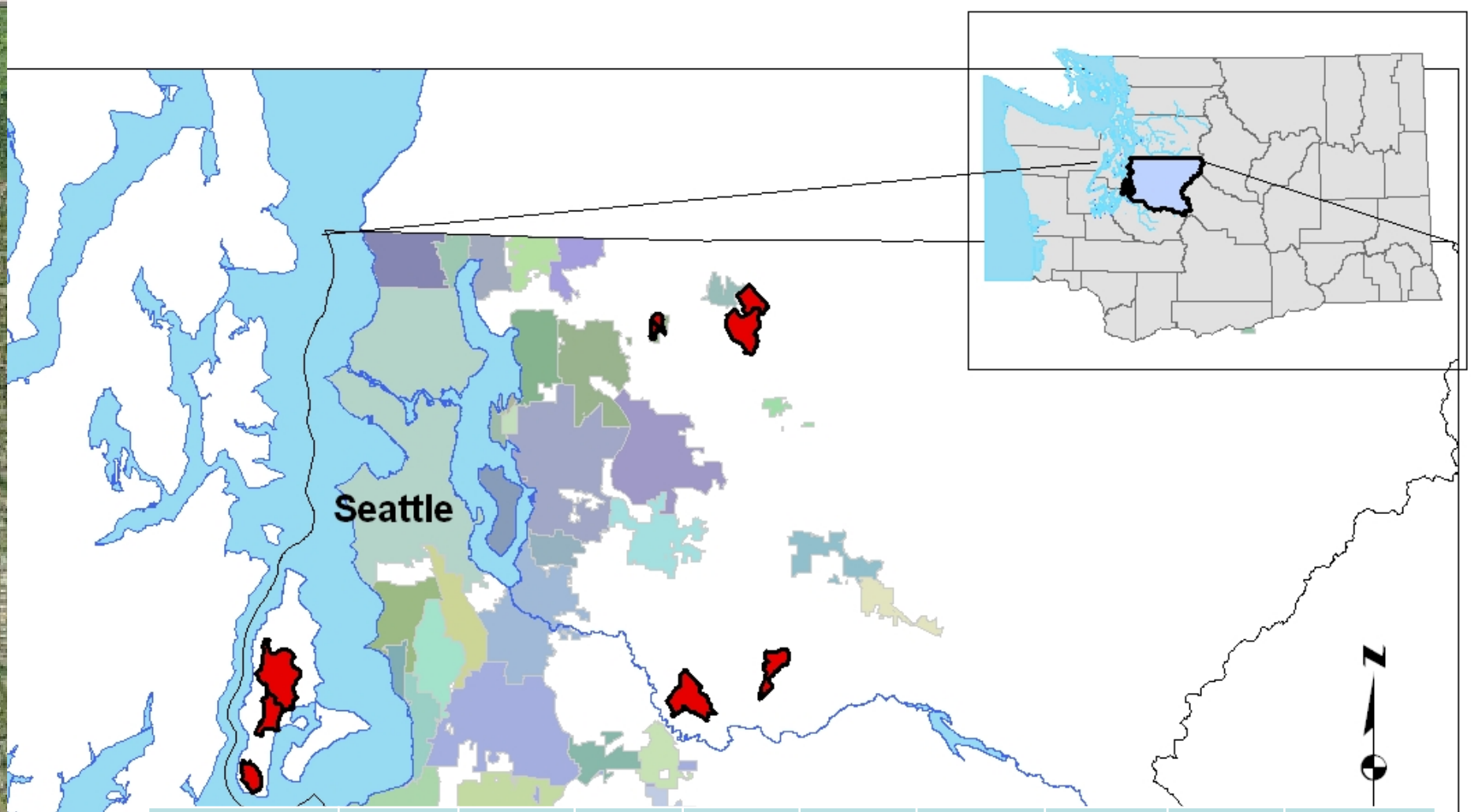
If so, was change related to CAO implementation?

Q3: How did the environment respond?

What was the significance of those changes?

– Corollary Questions –

- **Can we detect a response?**
  - **How will we know?**
  - **Is one method more illuminating than the other?**

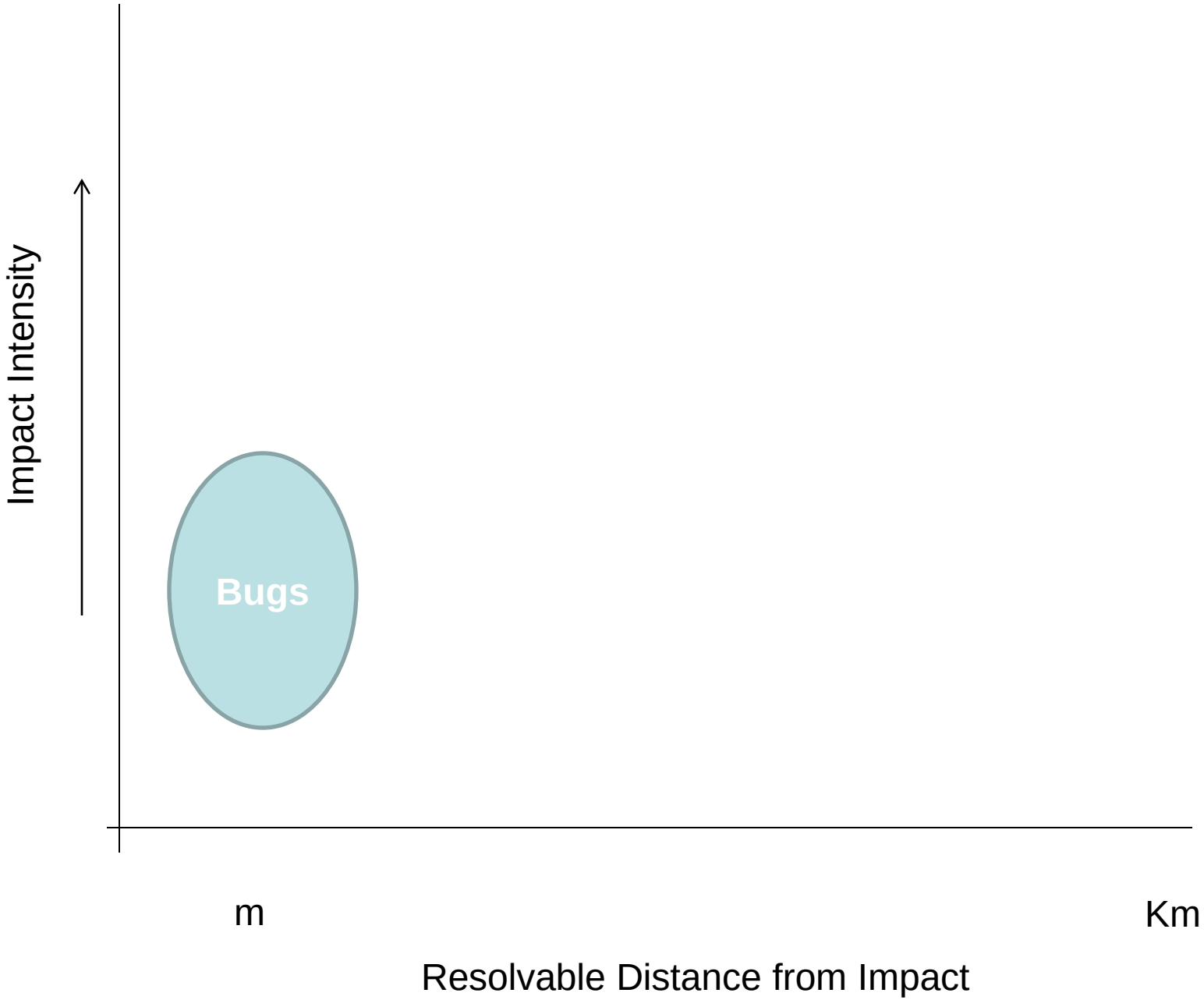


	S. Seidel	E. Seidel	Cherry Trib.	Weiss	Taylor	Webster	Judd	Fisher	Tahlequah
Area (ha)	62	75	300	764	936	397	1262	512	331
Relief (m)	71	74	147	173	114	542	140	131	128
% Developed	0.5	0.08	5	5	15	2	7	5	5
% Forest	98	99.2	78	79	52	98	73	63	86

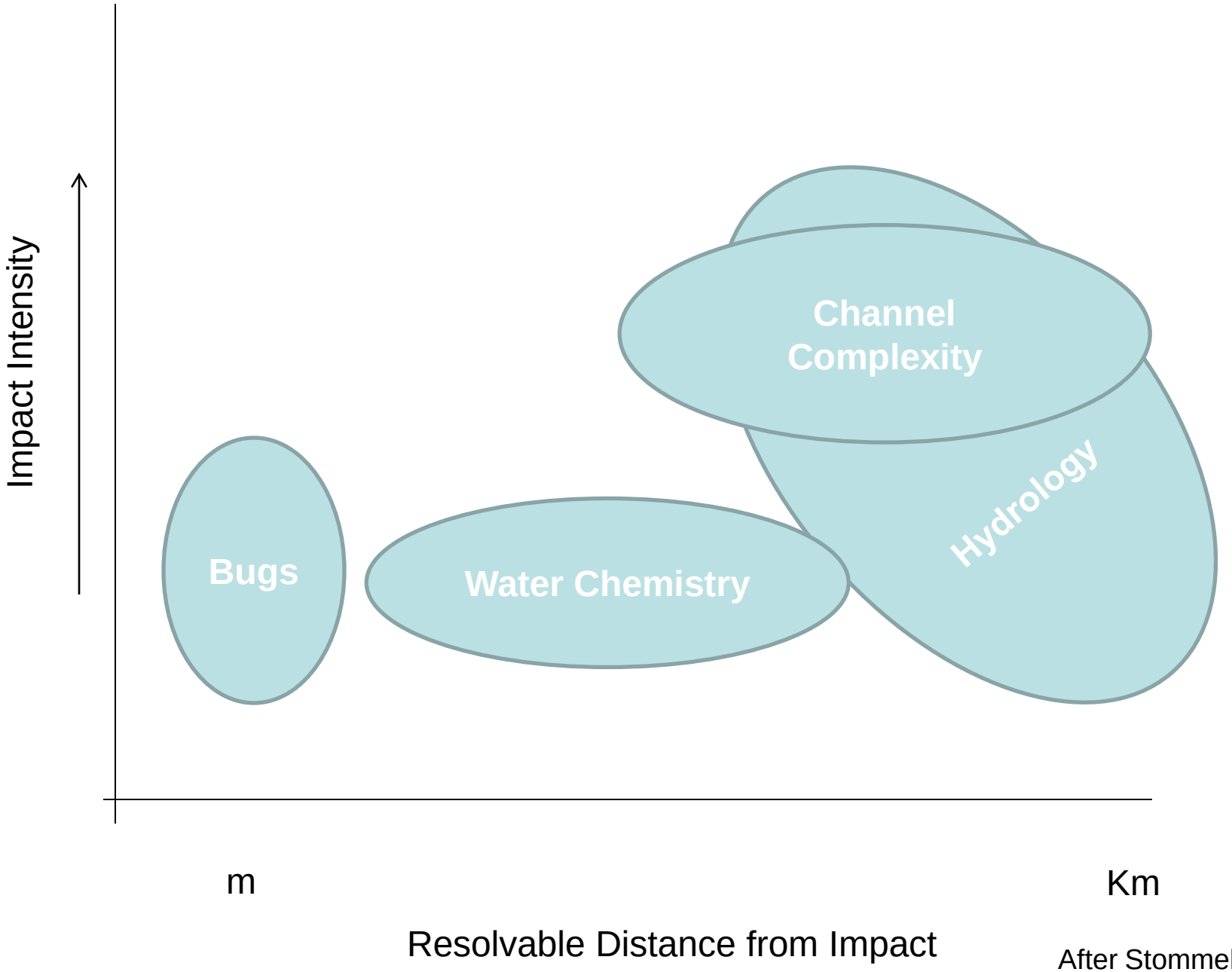
Response variables, metrics, expected response if land cover change is impacting the system.

Response Variable	Metric	Expected Response	Response Mechanisms
Hydrology	Flashiness	Increase	Elevated surface runoff
	Peak flows	Increase in magnitude, reduced duration, altered timing	Increased drainage density
	Low flows	Reduced magnitude, Increased frequency of intermittency	Decreased infiltration and storage
Water quality	Temperature	Change during critical periods (summer warming, winter cooling)	Shade loss and altered hydrology
	Conductivity	Elevated	Solutes in runoff from developed land
Biology	B-IBI	Decreases	Reduced habitat quality
Stream complexity	Transient storage and travel time	Decreases	Reduced bedform complexity Channel roughness

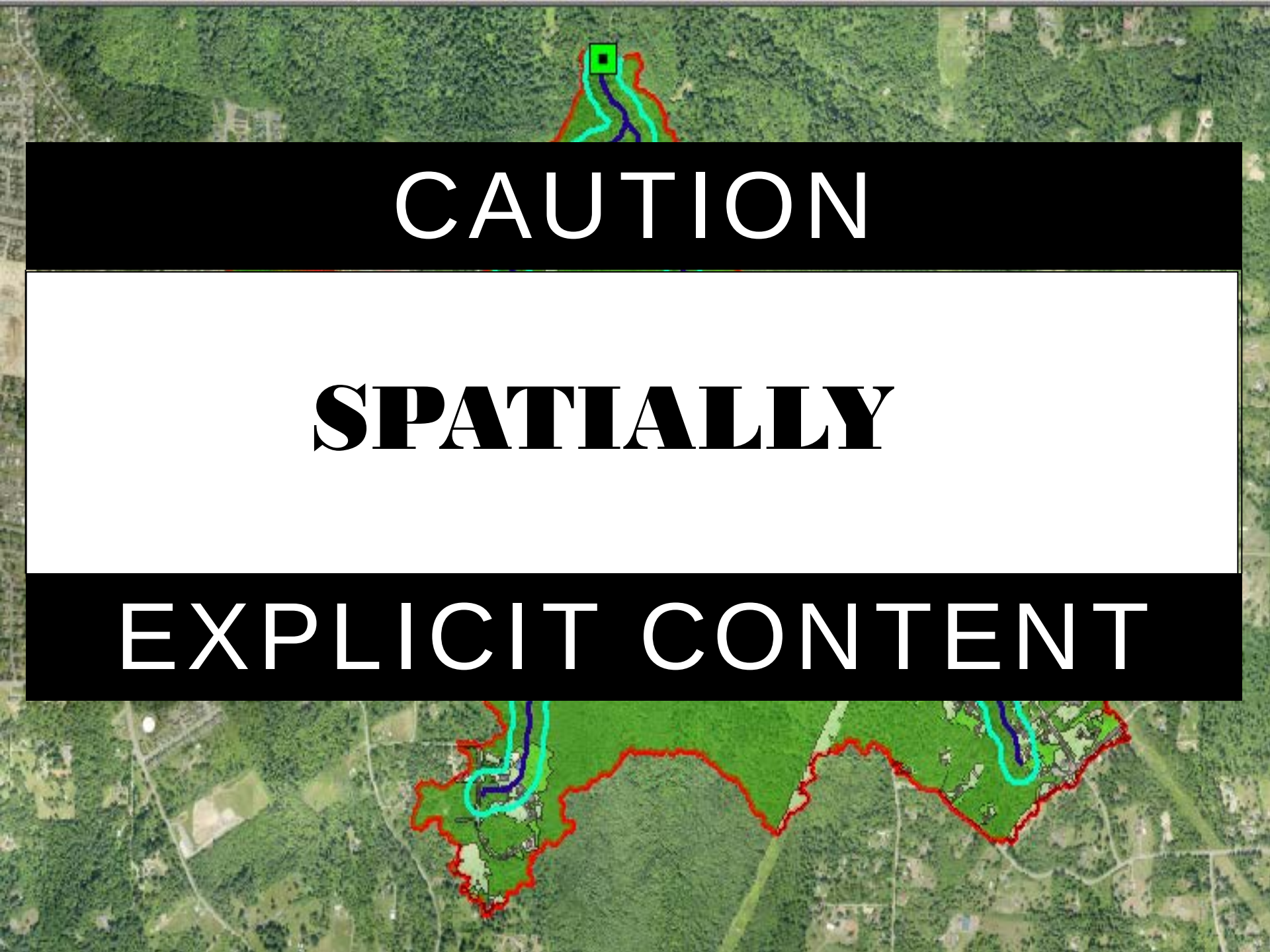
(Meyer et al. 2005, Walsh et al.2005, DeGasperi et al. 2009)

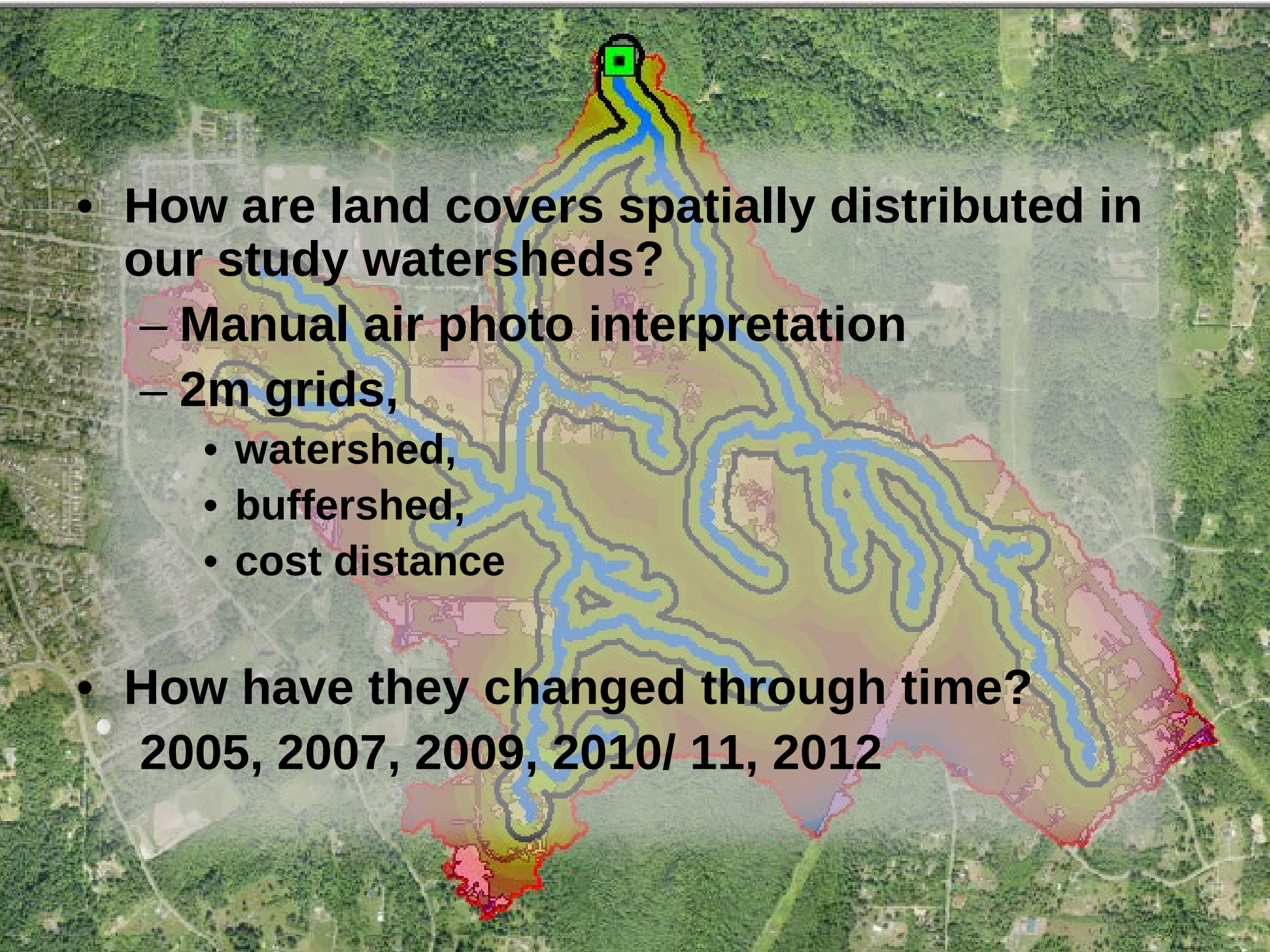

Impact Intensity
Bugs
m
Km
Resolvable Distance from Impact

Impact Intensity
Bugs
Hydrology
m
Km
Resolvable Distance from Impact



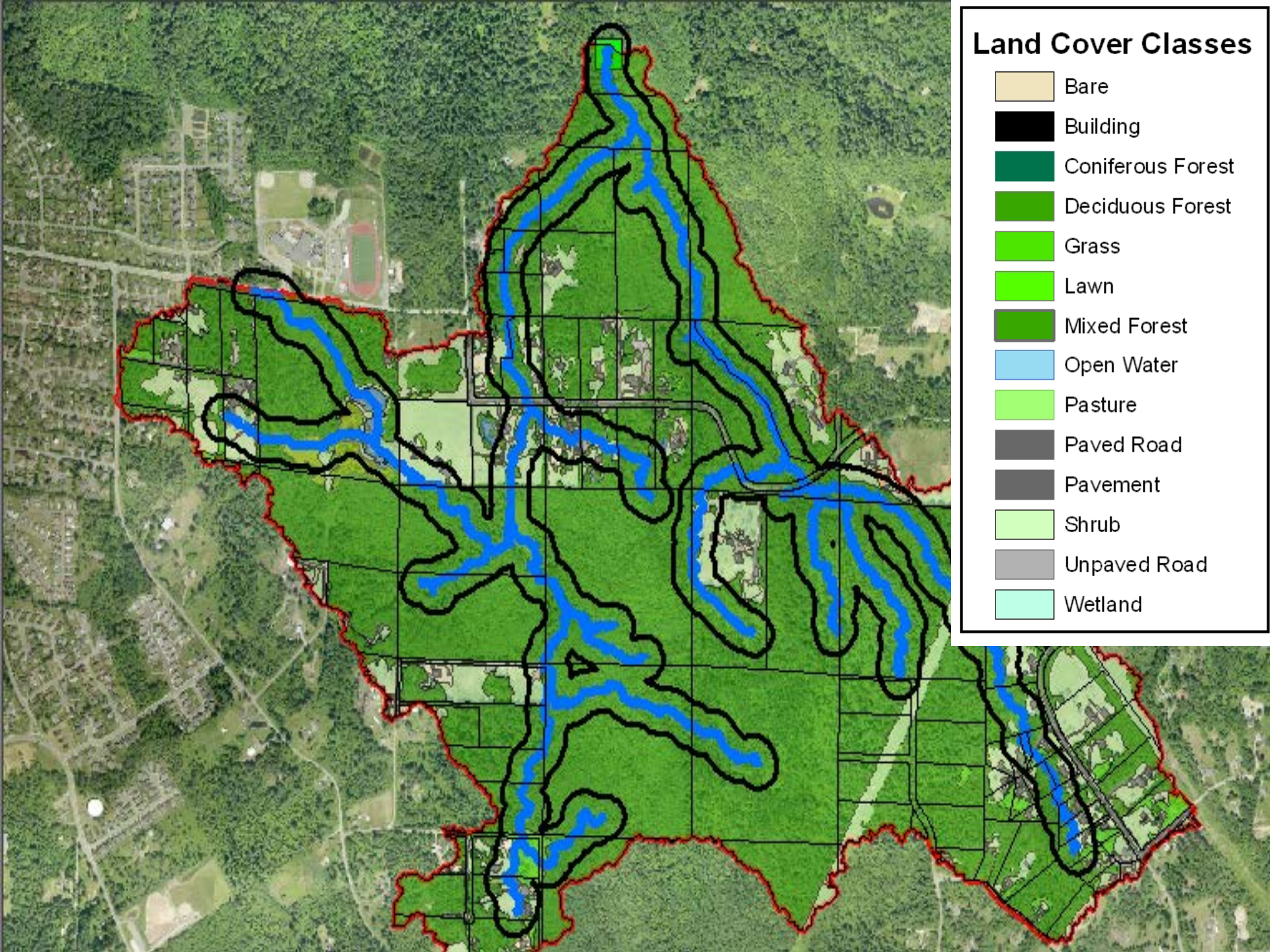
After Stommel (1963)


CAUTION
SPATIALLY
EXPLICIT CONTENT



- How are land covers spatially distributed in our study watersheds?
  - Manual air photo interpretation
  - 2m grids,
    - watershed,
    - buffershed,
    - cost distance
- How have they changed through time?

  2005, 2007, 2009, 2010/ 11, 2012

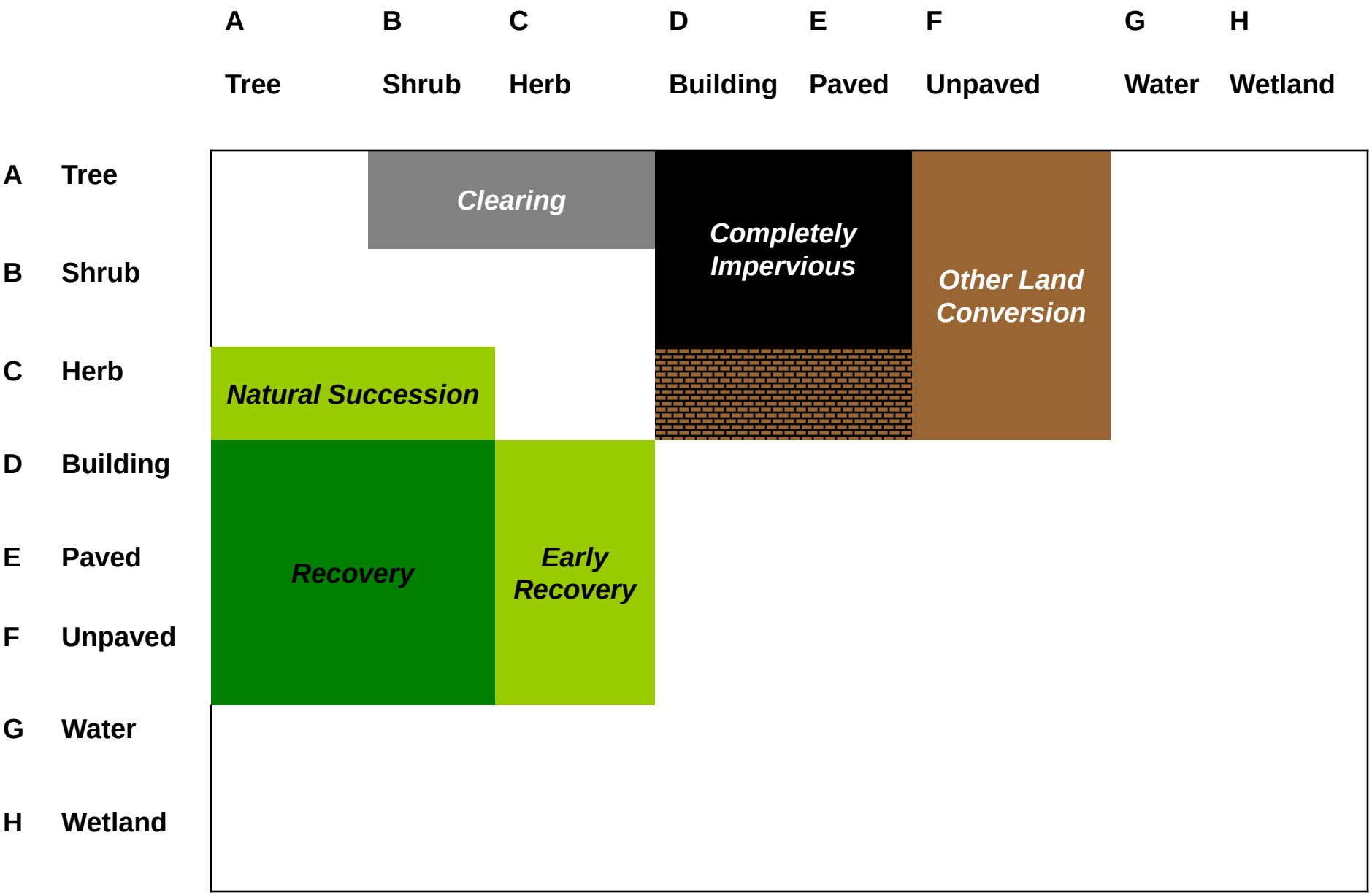

Land Cover Classes
Bare
Building
Coniferous Forest
Deciduous Forest
Grass
Lawn
Mixed Forest
Open Water
Pasture
Paved Road
Pavement
Shrub
Unpaved Road
Wetland

		A Tree	B Shrub	C Herb	D Building	E Paved	F Unpaved	G Water	H Wetland
A	Tree								
B	Shrub								
C	Herb								
D	Building								
E	Paved								
F	Unpaved								
G	Water								
H	Wetland								

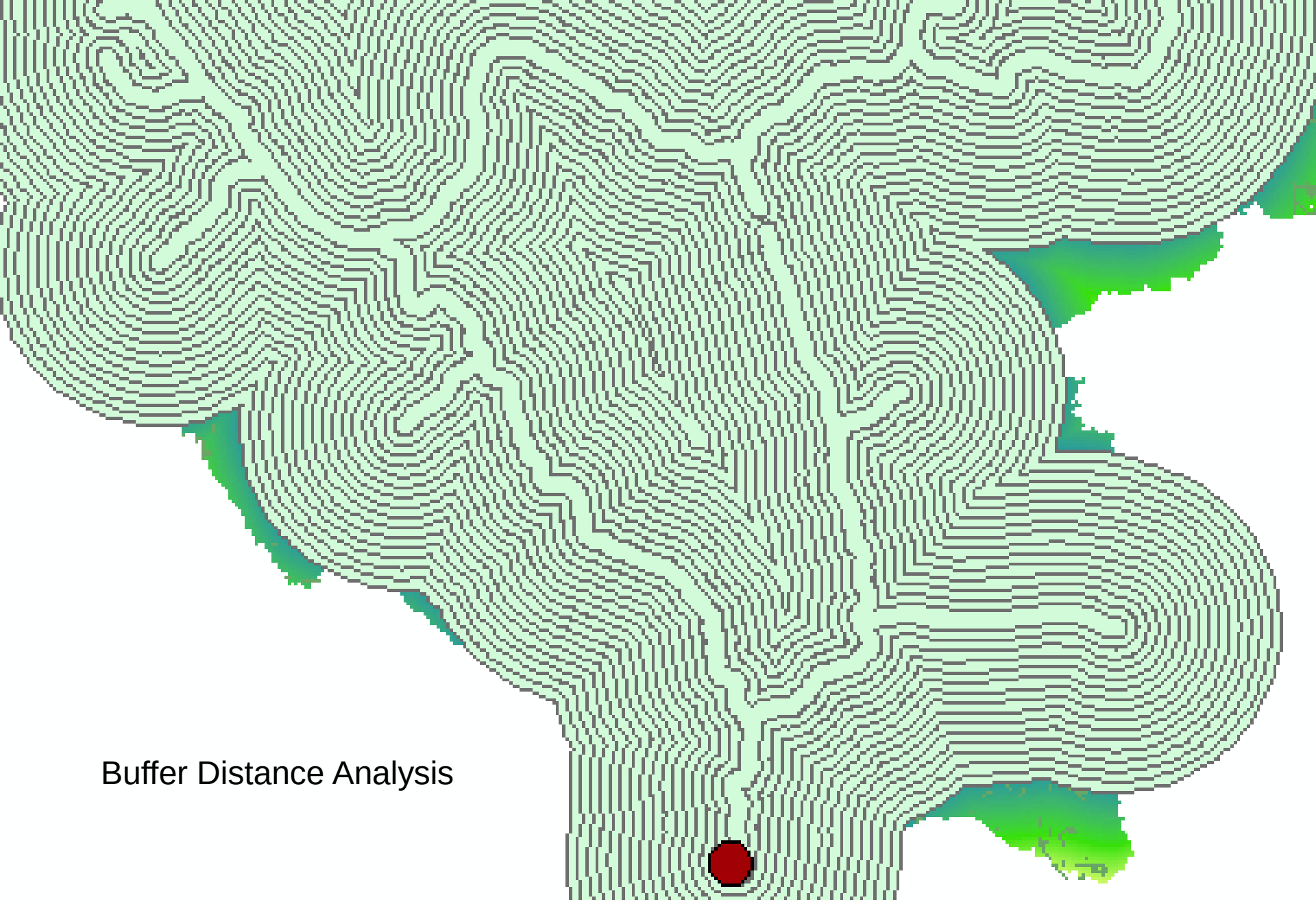
		A Tree	B Shrub	C Herb	D Building	E Paved	F Unpaved	G Water	H Wetland
A	**Tree**		AB	AC	AD	AE	AF	AG	AH
B	**Shrub**	BA		BC	BD	BE	BF	BG	BH
C	**Herb**	CA	CB		CD	CE	CF	CG	CH
D	**Building**	DA	DB	DC		DE	DF	DG	DH
E	**Paved**	EA	EB	EC	ED		EF	EG	EH
F	**Unpaved**	FA	FB	FC	FD	FE		FG	FH
G	**Water**	GA	GB	GC	GD	GE	GF		GH
H	**Wetland**	HA	HB	HC	HD	HE	HF	HG	

		A Tree	B Shrub	C Herb	D Building	E Paved	F Unpaved	G Water	H Wetland
A	**Tree**		AB	AC	AD	AE	AF		
B	**Shrub**	BA		BC	BD	BE	BF		
C	**Herb**	CA			CD	CE	CF		
D	**Building**	DA	DB	DC					
E	**Paved**	EA	EB	EC					
F	**Unpaved**	FA	FB	FC					
G	**Water**								
H	**Wetland**								

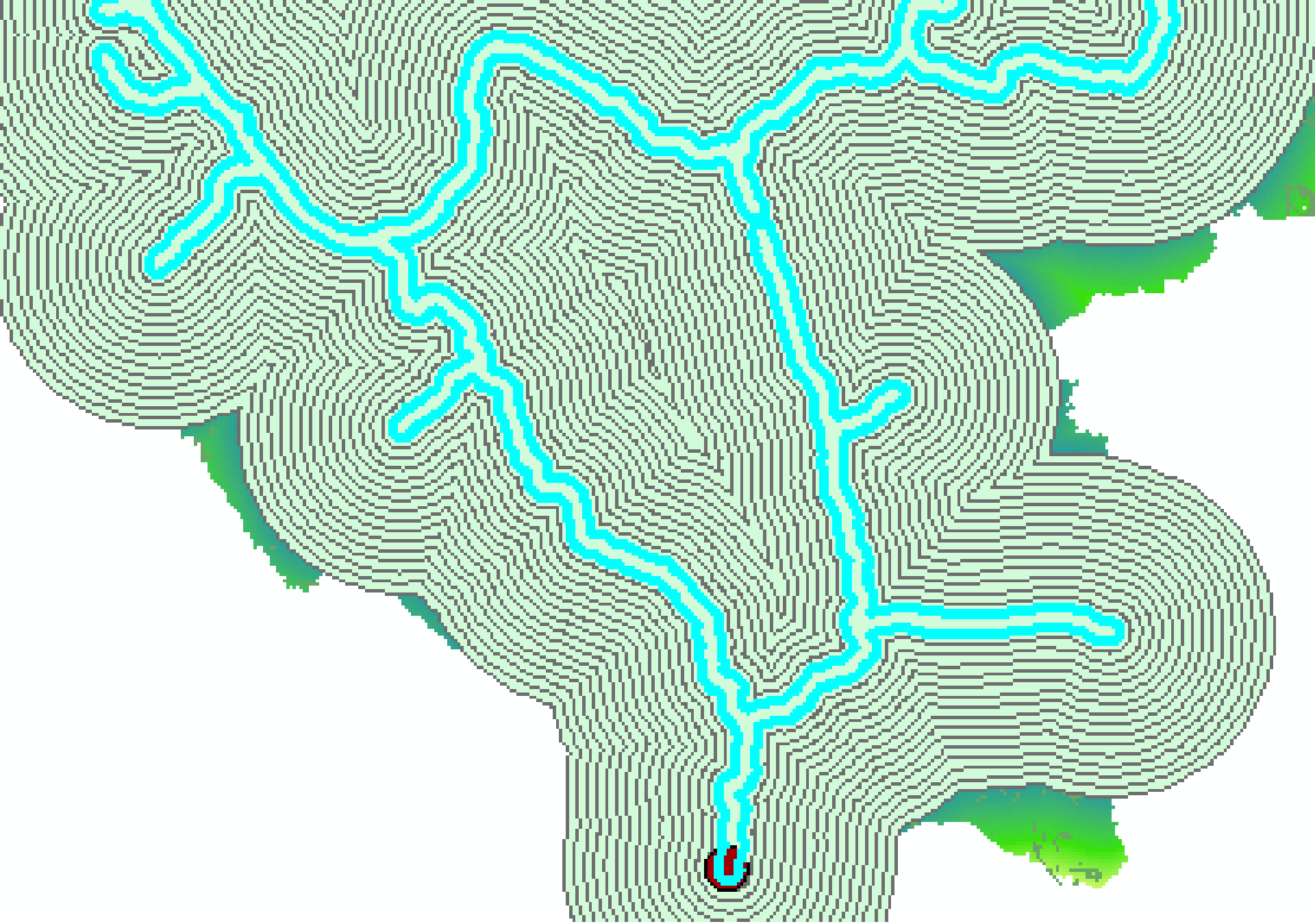
		A Tree	B Shrub	C Herb	D Building	E Paved	F Unpaved	G Water	H Wetland
A	Tree		AB	AC	AD	AE	AF		
B	Shrub				BD	BE	BF		
C	Herb	CA	CB		CD	CE	CF		
D	Building	DA	DB	DC					
E	Paved	EA	EB	EC					
F	Unpaved	FA	FB	FC					
G	Water								
H	Wetland								

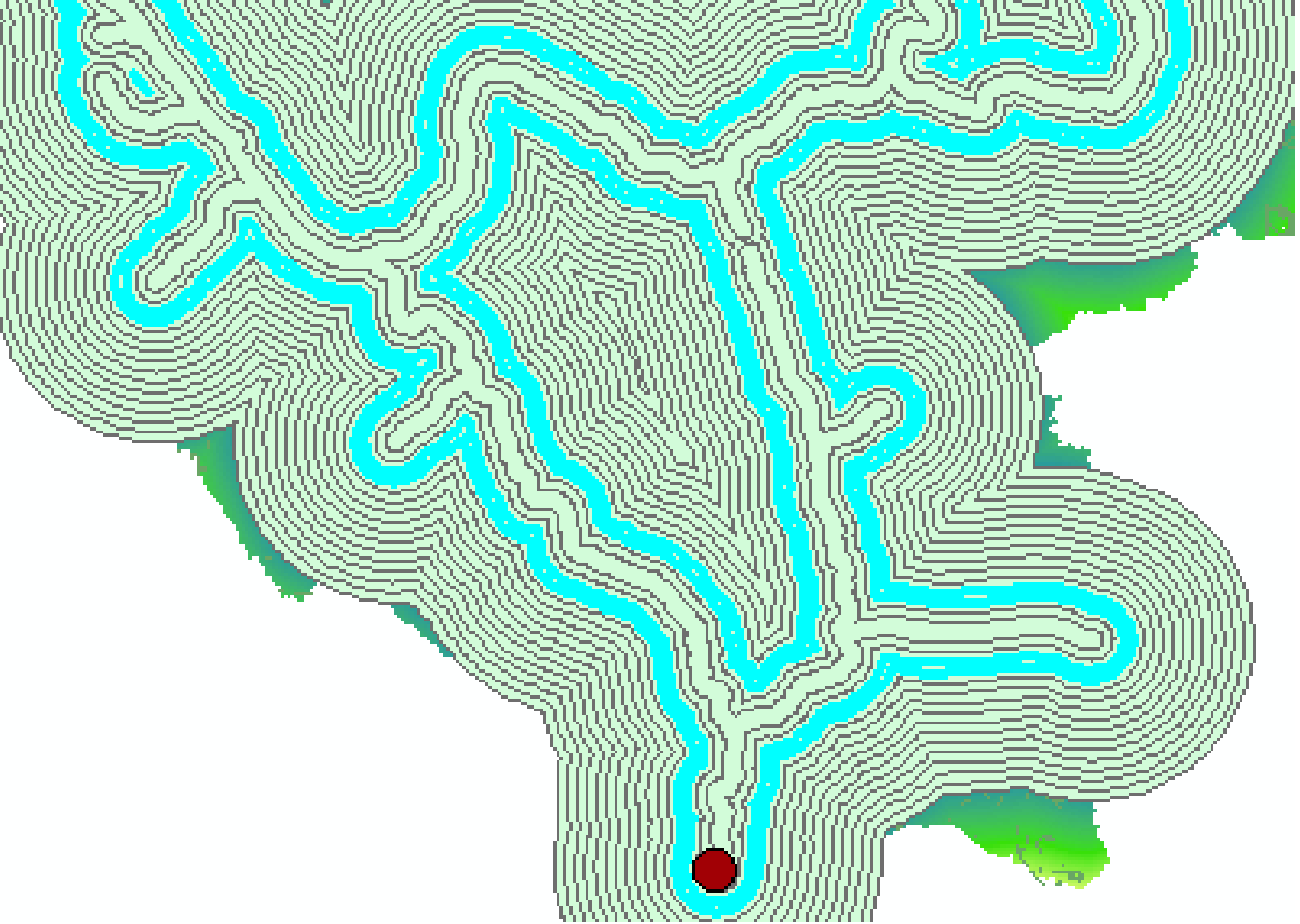

A Tree
B Shrub
C Herb
D Building
E Paved
F Unpaved
G Water
H Wetland
A Tree
B Shrub
C Herb
D Building
E Paved
F Unpaved
G Water
H Wetland
Clearing
Completely Impervious
Other Land Conversion
Natural Succession
Recovery
Early Recovery

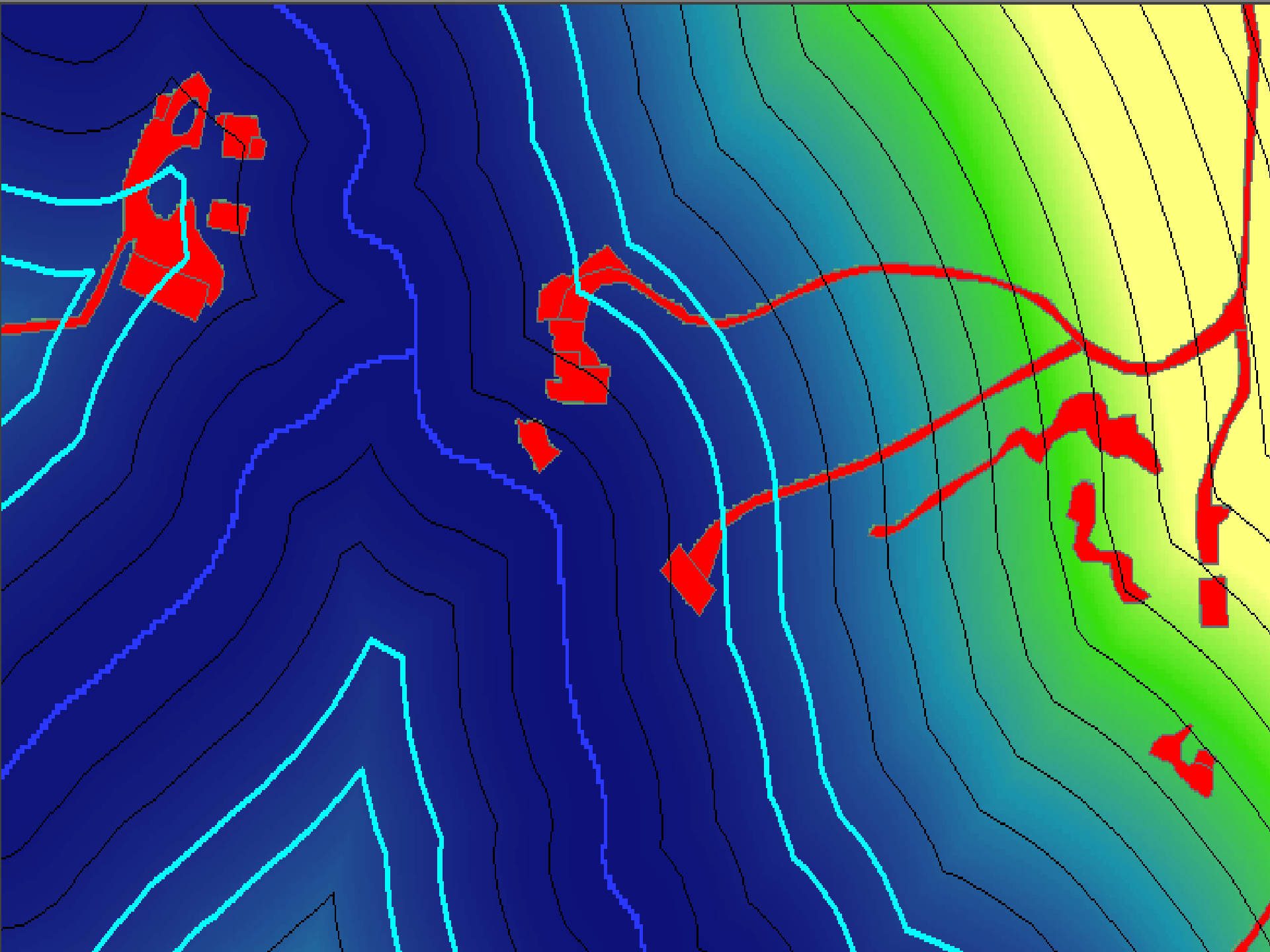
A Tree
B Shrub
C Herb
D Building
E Paved
F Unpaved
G Water
H Wetland
A Tree
B Shrub
C Herb
D Building
E Paved
F Unpaved
G Water
H Wetland
BAD
GOOD

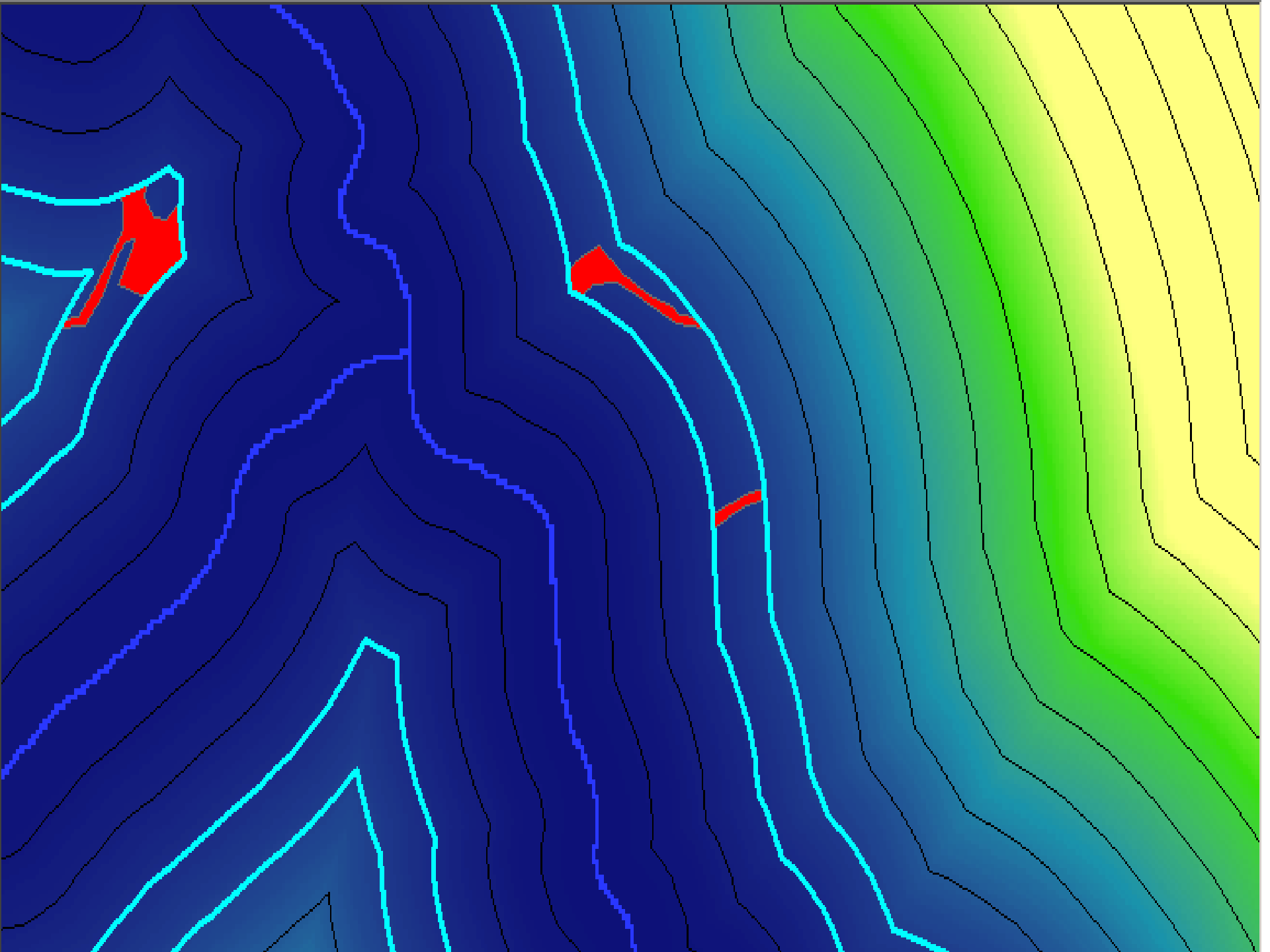


Buffer Distance Analysis

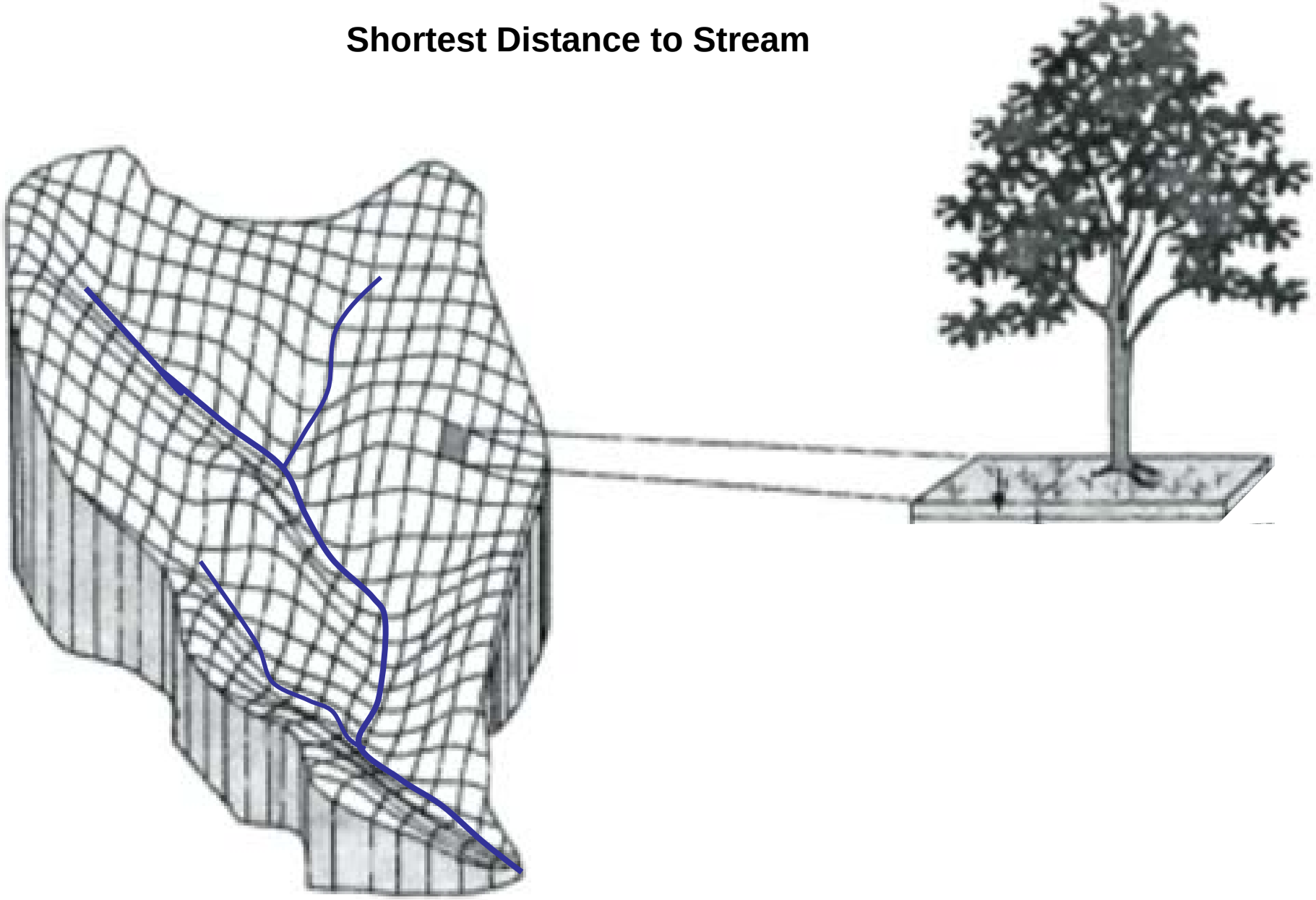






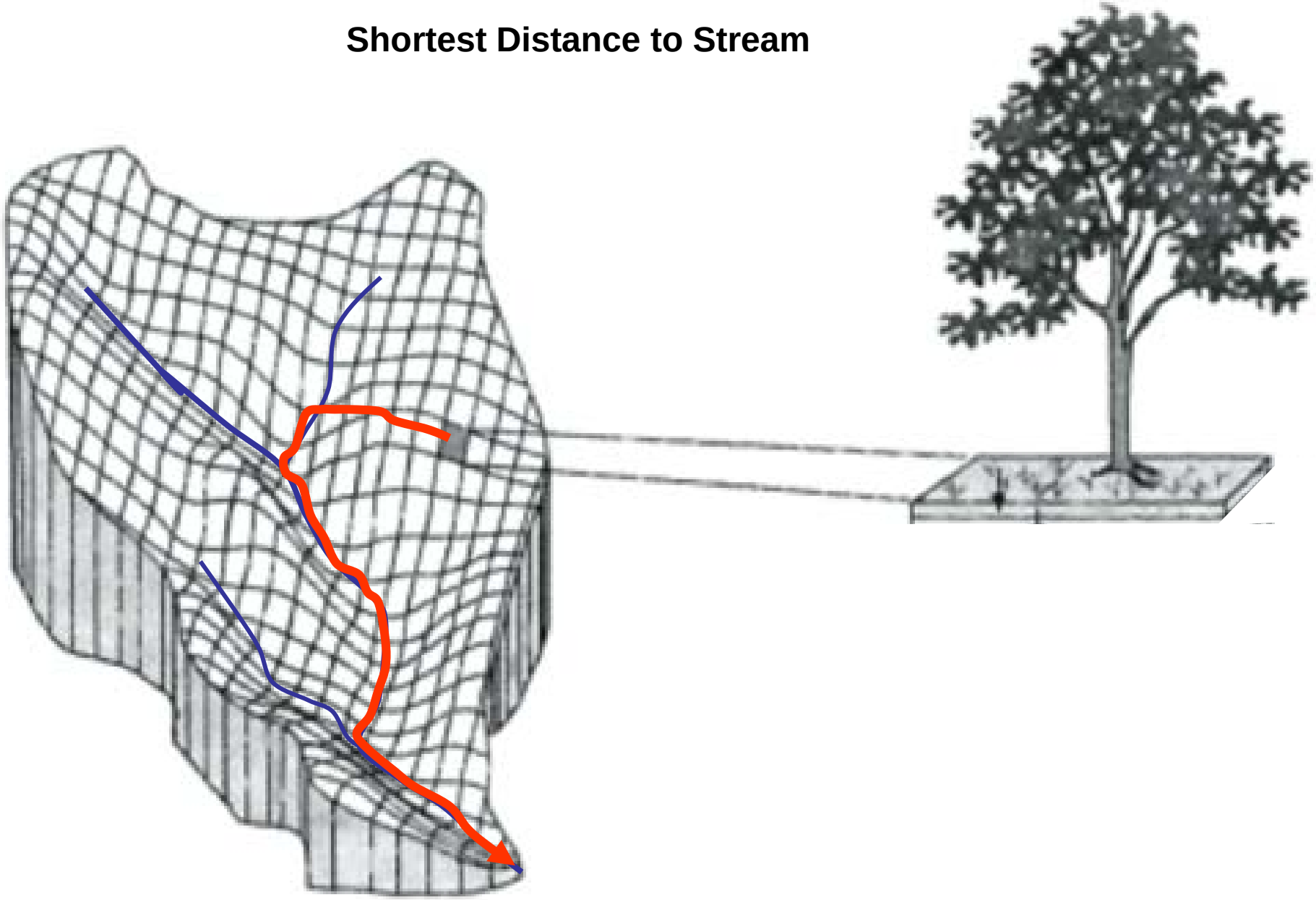


Shortest Distance to Stream



From: Wigmosta et al., (1994)

Shortest Distance to Stream



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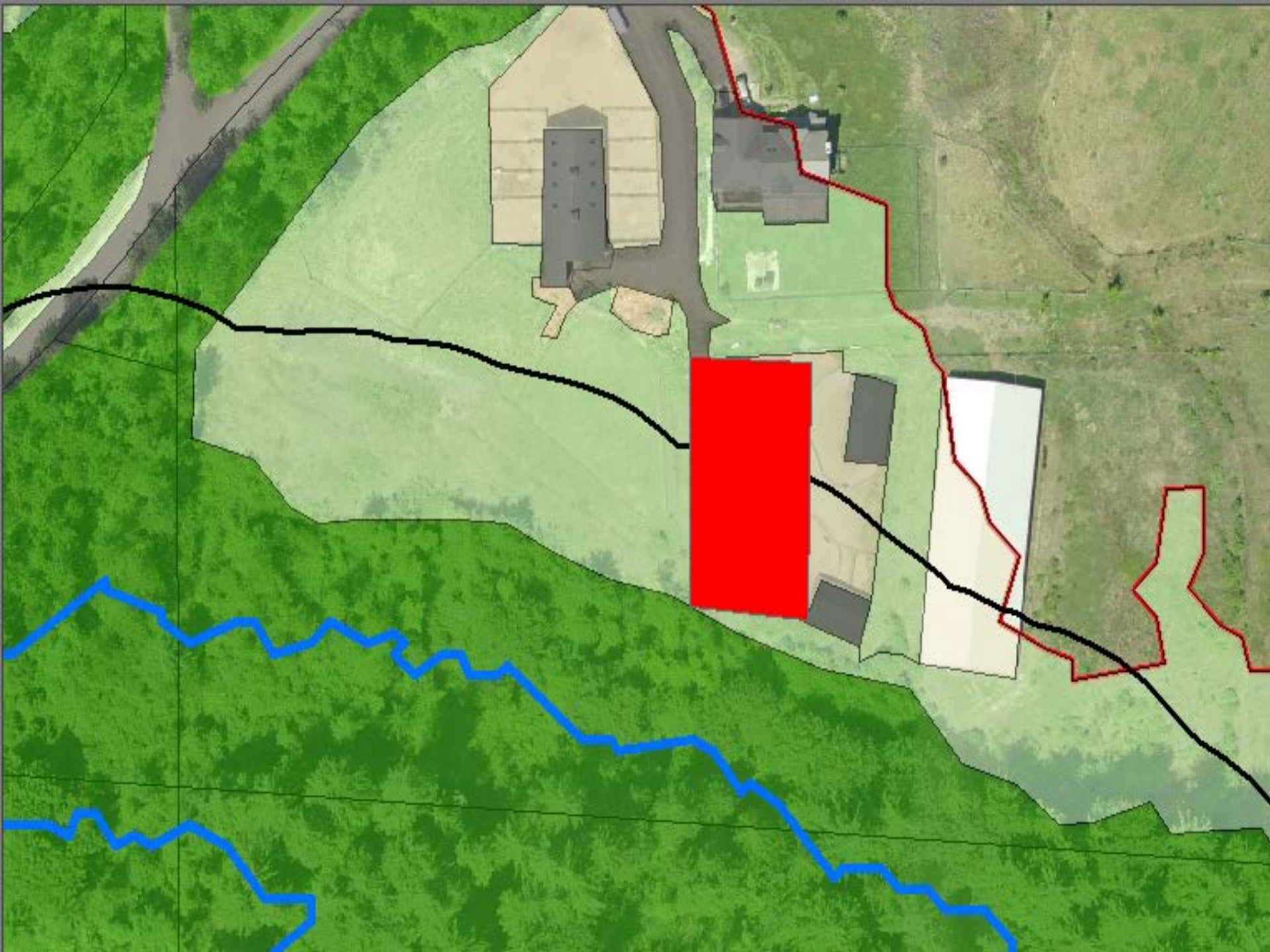
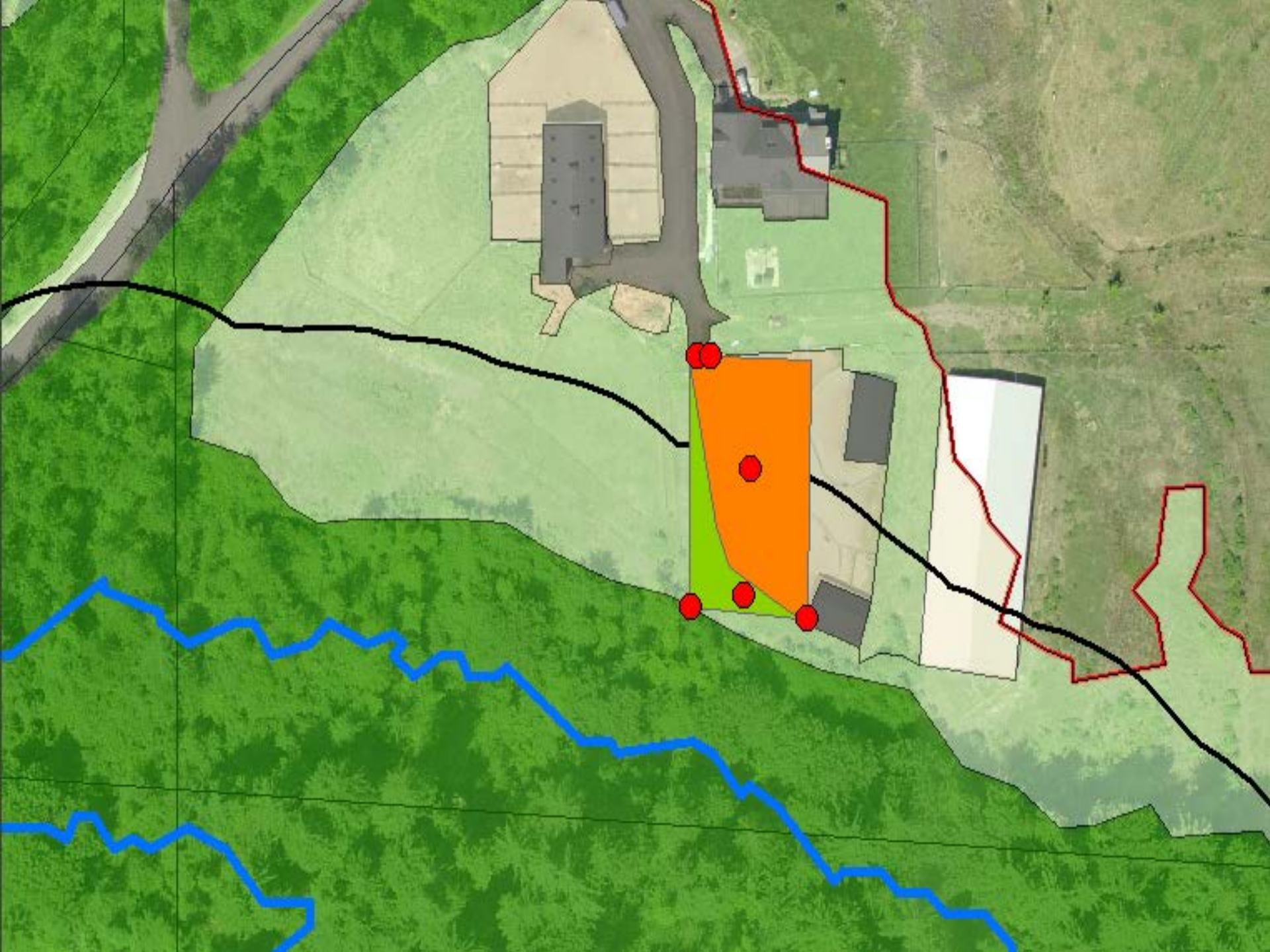
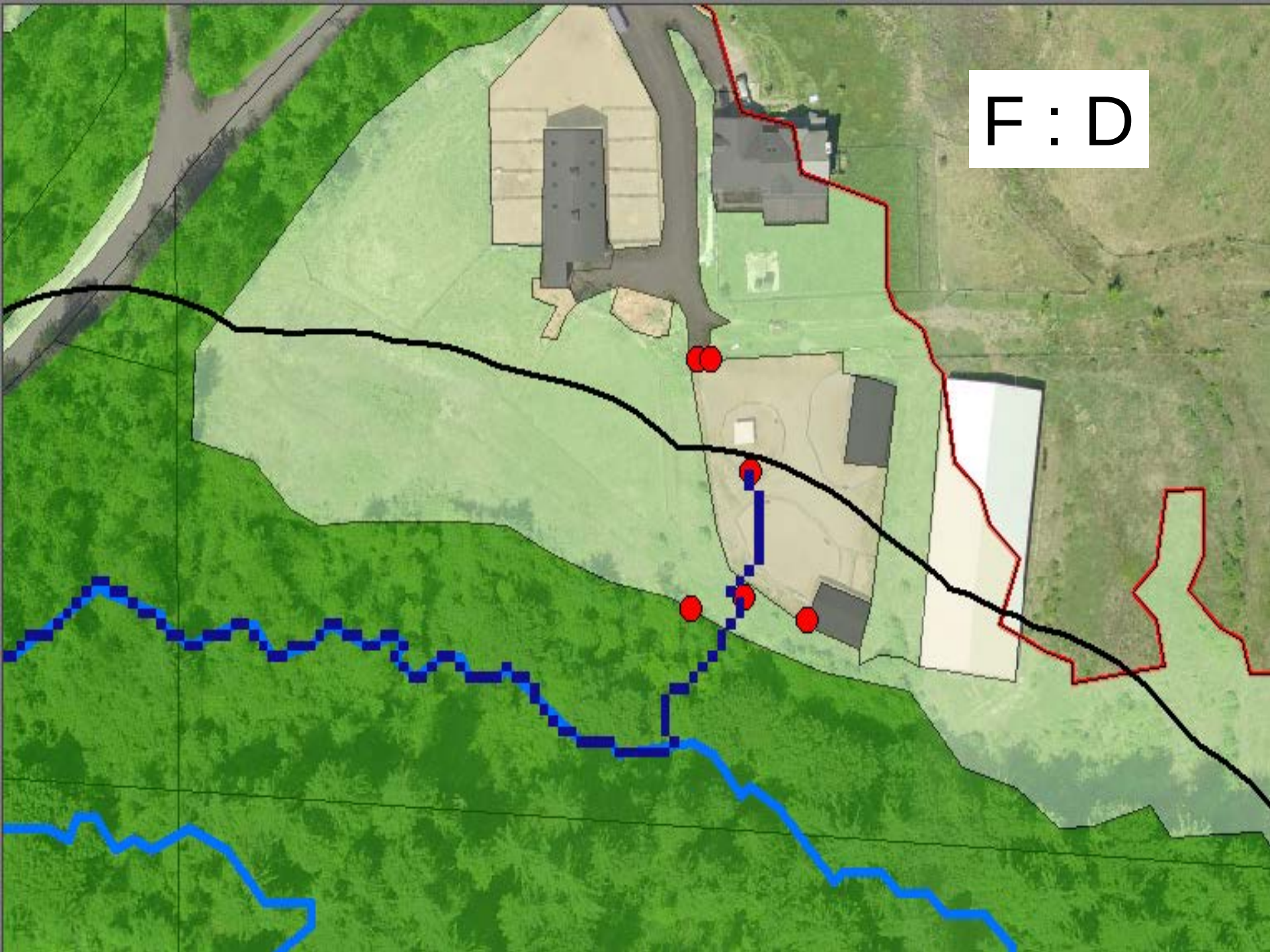
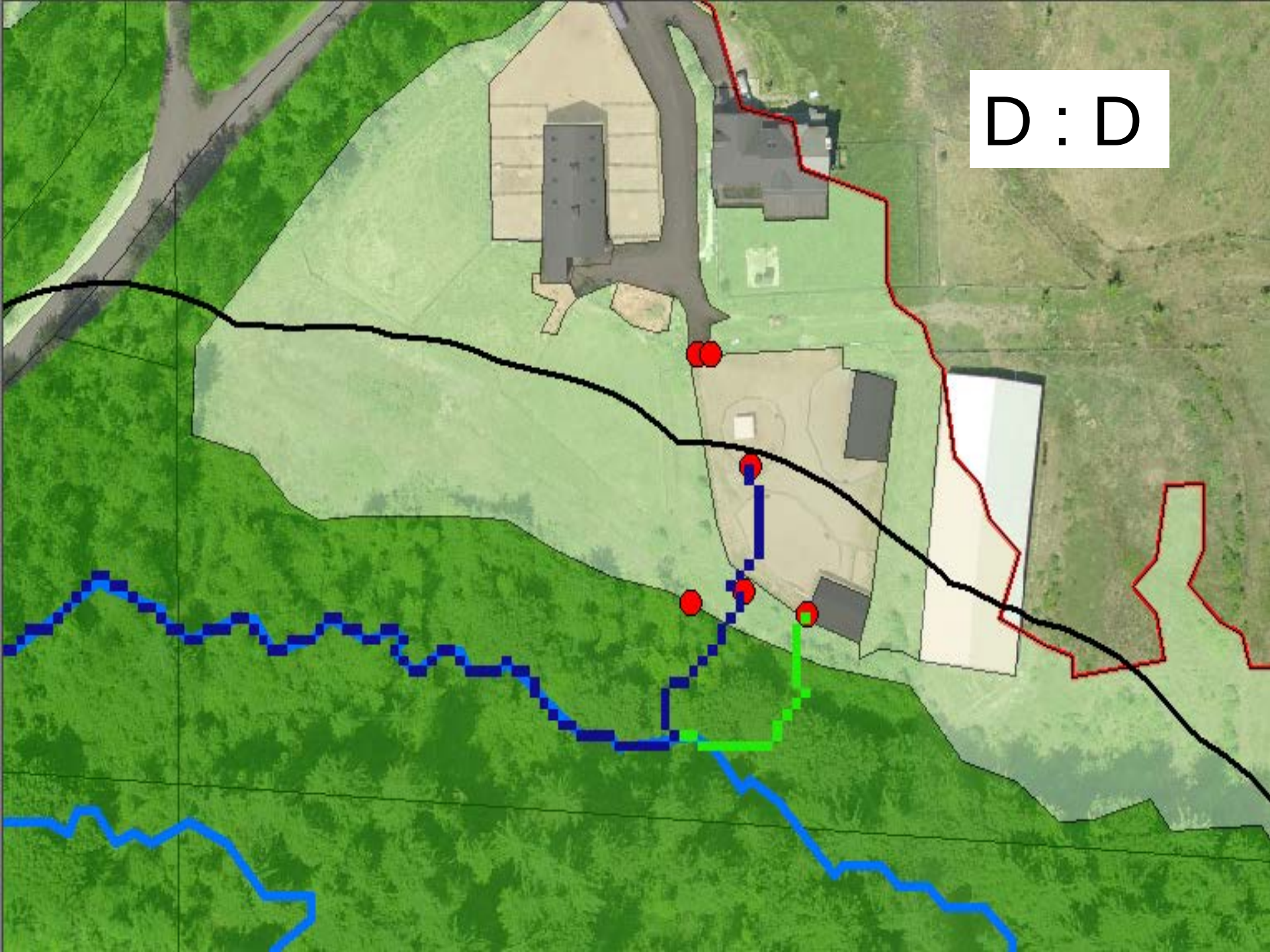





F : D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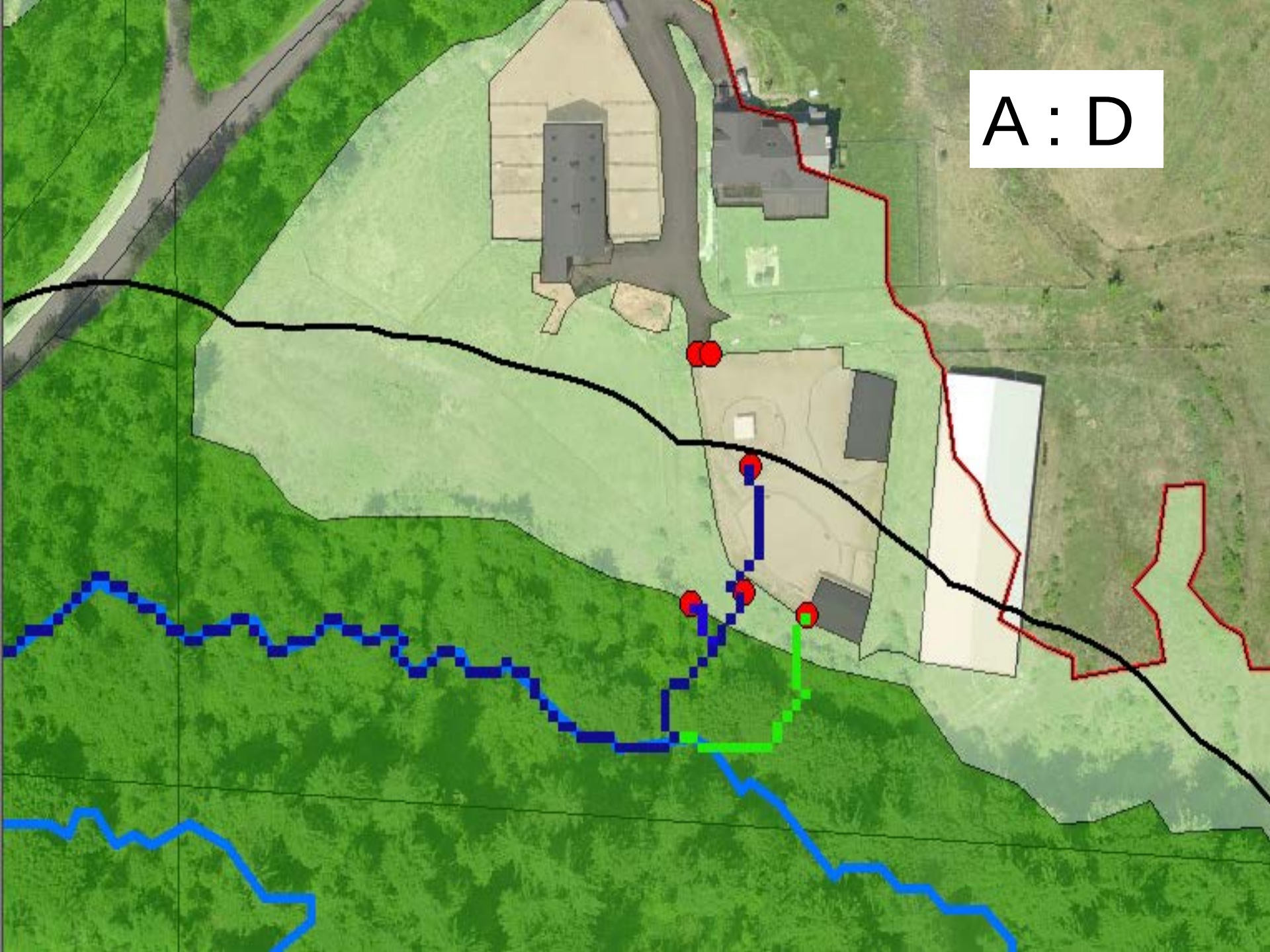
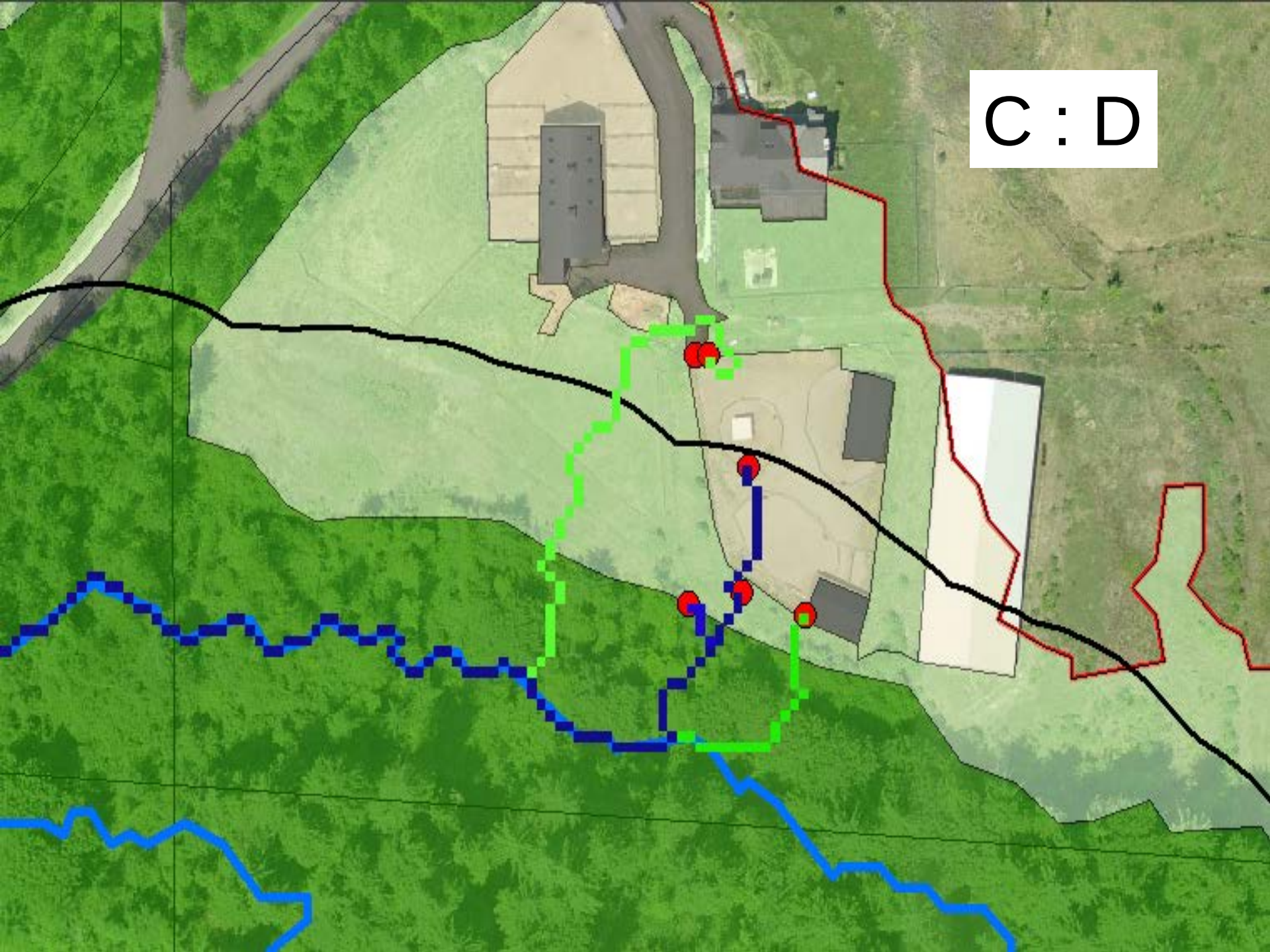

A : D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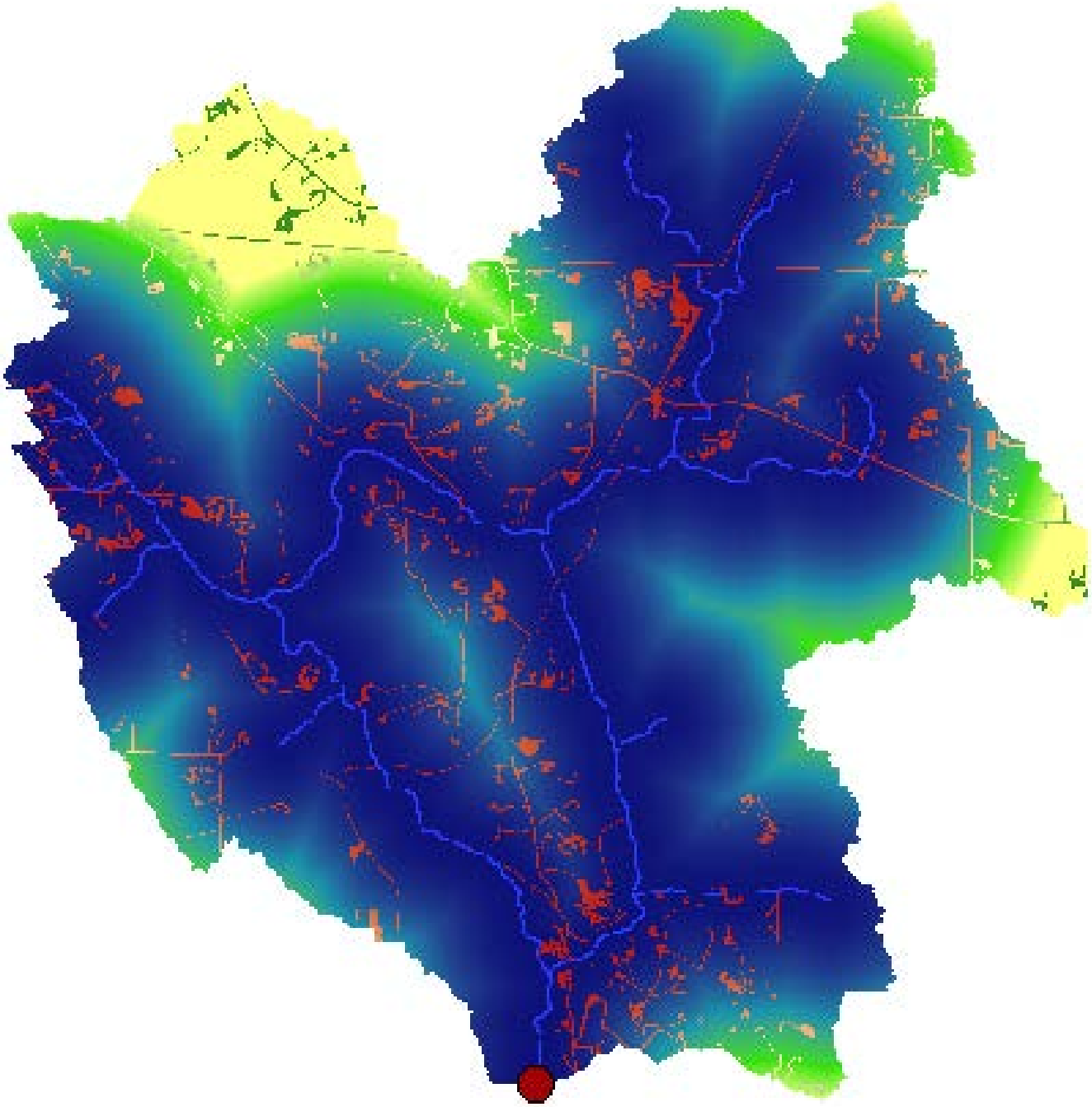
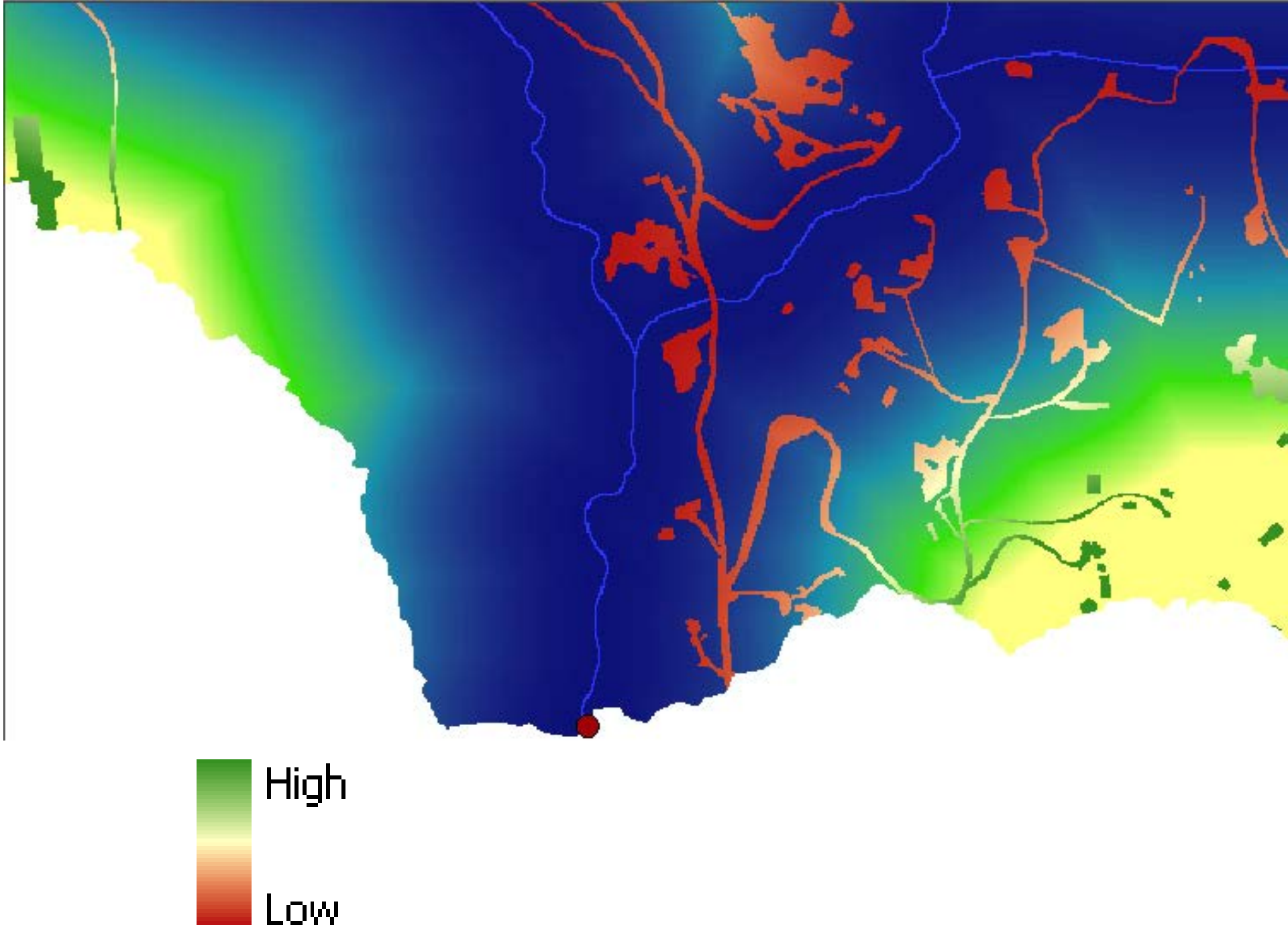
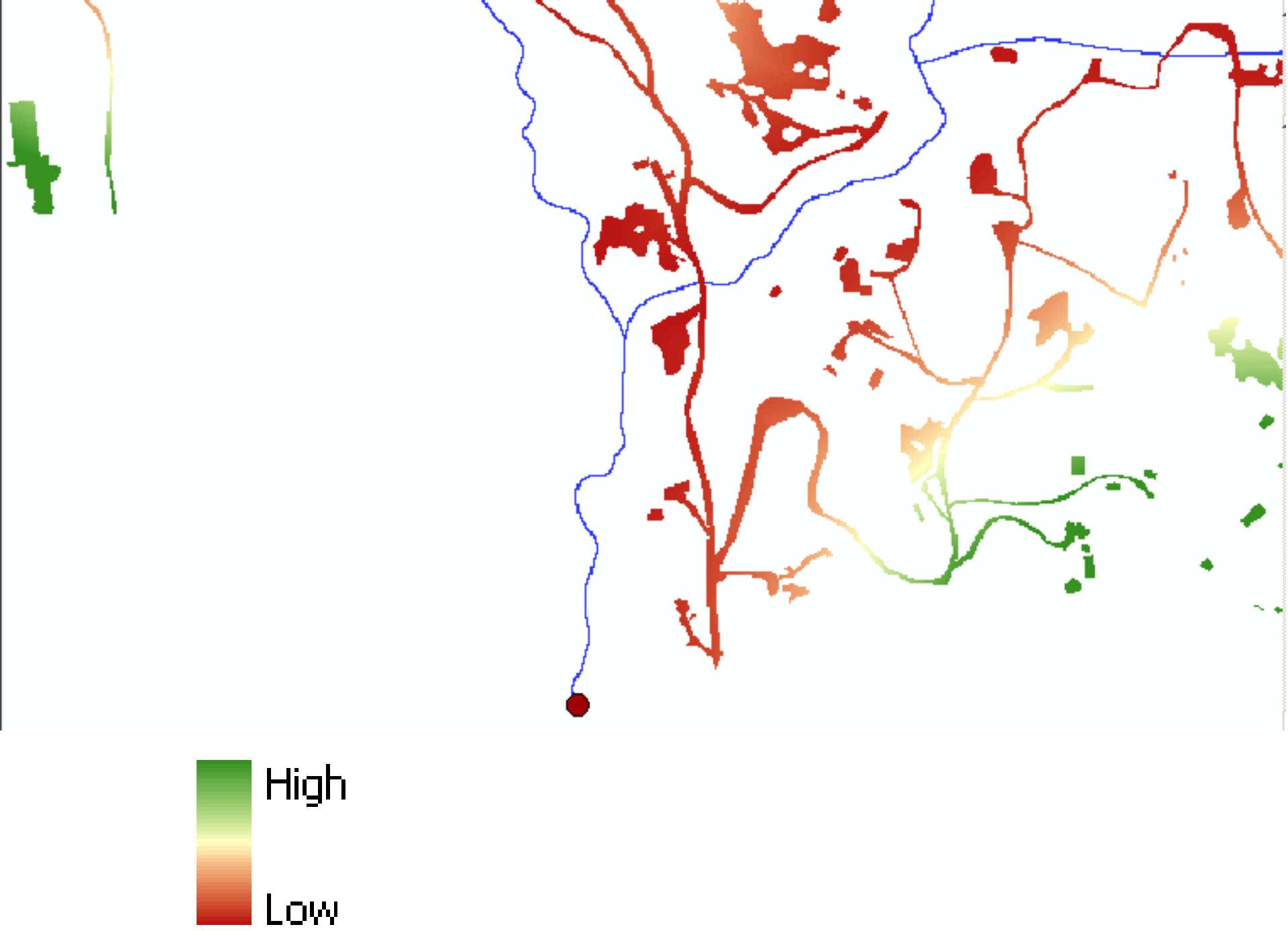
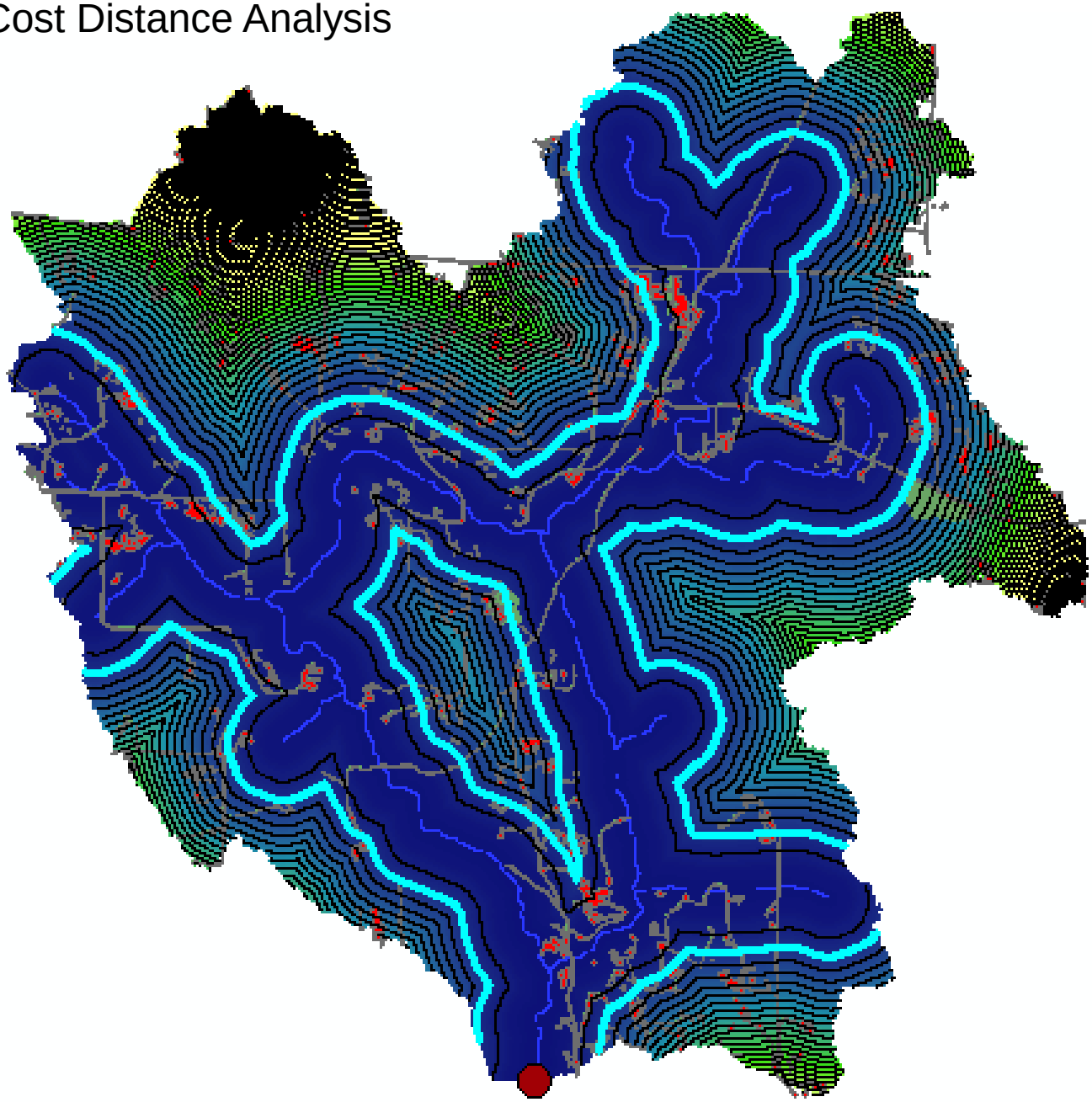


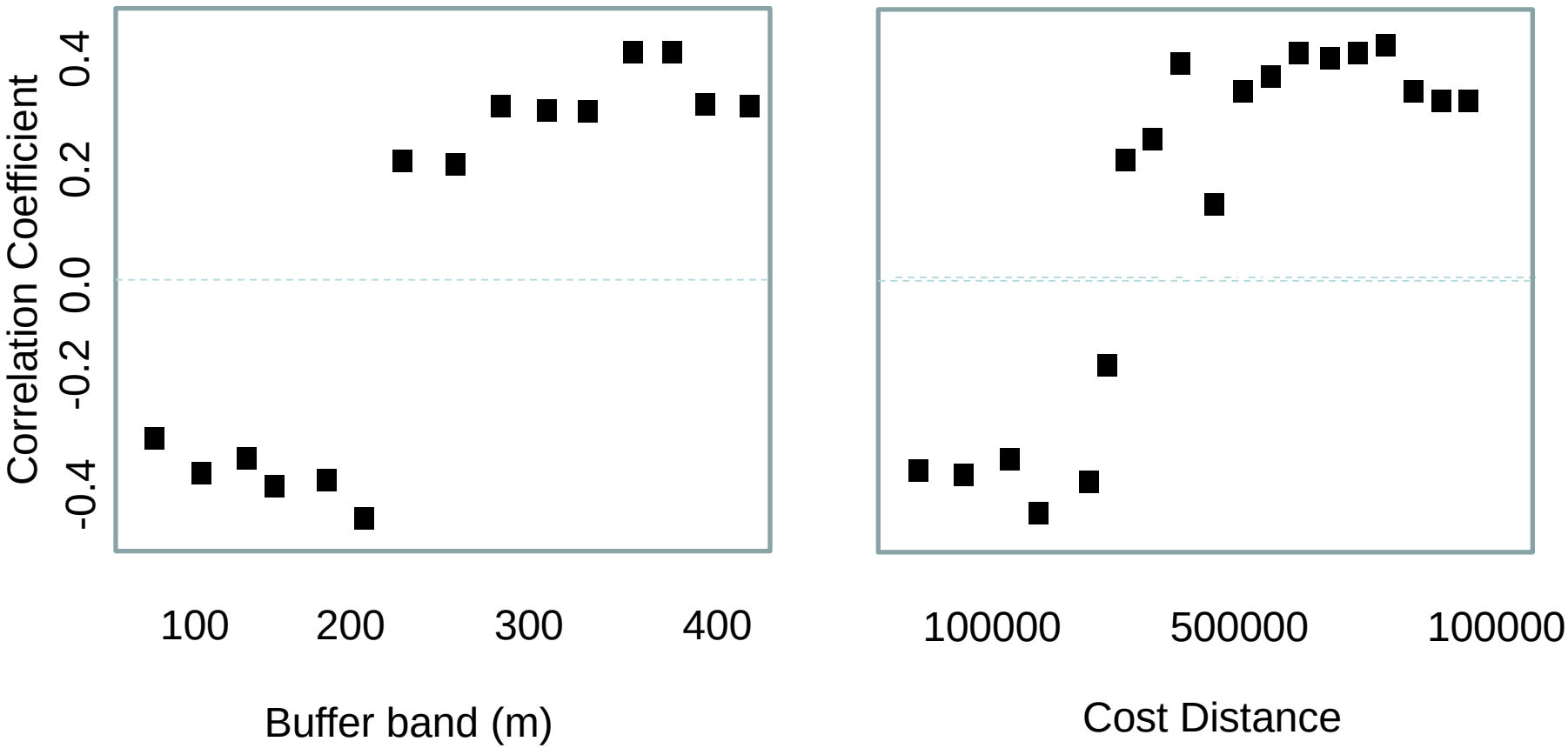

High
Low


High
Low

Cost Distance Analysis



Ephemeroptera Richness



So … What do we know so far?

- We have an approach that is showing promise
- Even low levels of impact and change may be resolvable in our response variables -

  IF we examine the spatial relationships
- Not all responses are resolvable at each extent
- Not sure yet if it is worth the extra effort to calculate cost distance

Acknowledgements

- U.S. Environmental Protection Agency
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- King County
- Angie Hugeback