

Jun 27th, 11:40 AM - 12:00 PM

Session A1- The Vermont culvert screening tools for aquatic organism passage and geomorphic compatibility

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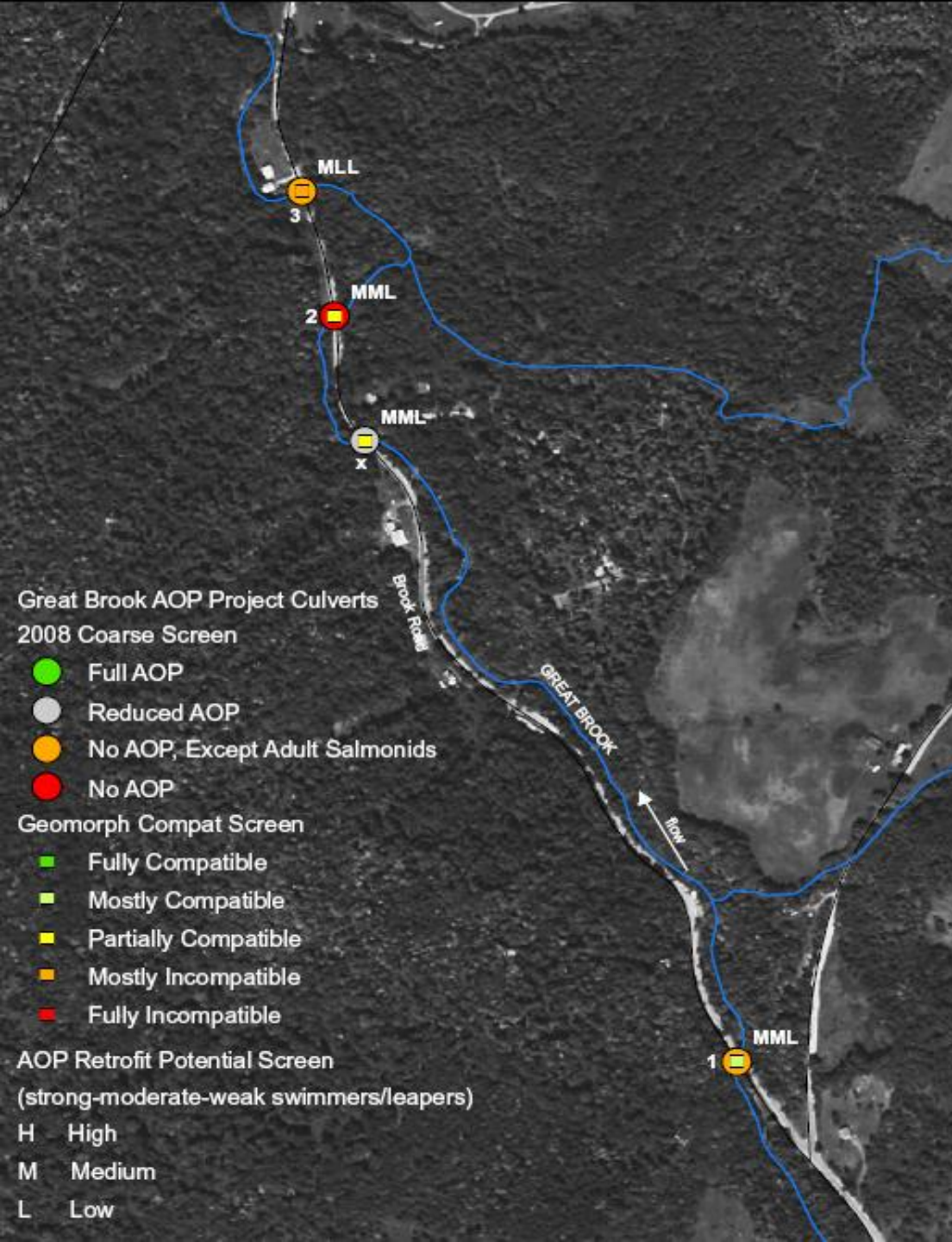
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The Vermont Culvert Screening Tools for Aquatic Organism Passage and Geomorphic Compatibility

National Conference on Engineering &
Ecohydrology for Fish Passage
June 27-29, 2011
University of Massachusetts Amherst

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ACKNOWLEDGEMENTS

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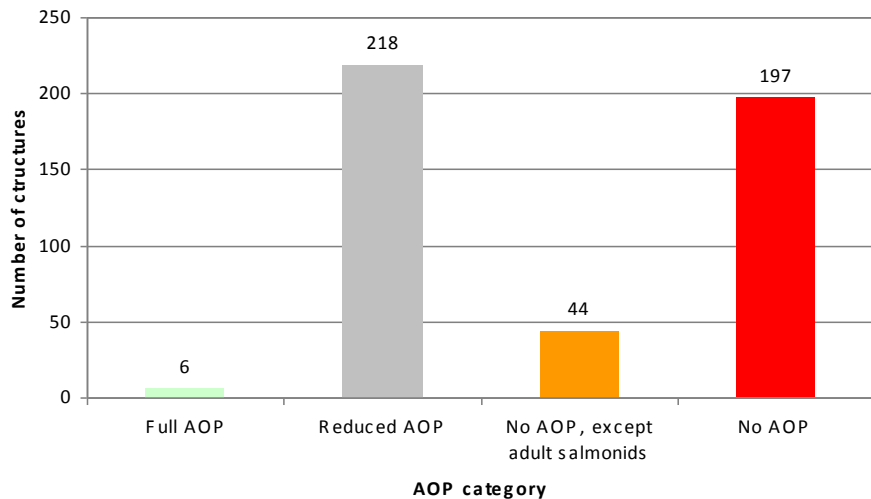
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VT Aquatic Organism Passage Coarse Screen	Full AOP	Reduced AOP	No AOP	
Updated 2/25/2008	for all aquatic organisms	for all aquatic organisms	for all aquatic organisms except adult salmonids	for all aquatic organisms including adult salmonids
AOP Function Variables / Values	Green (if all are true)	Gray (if any are true)	Orange	Red
Culvert outlet invert type	at grade OR backwatered	cascade	free fall AND	free fall AND
Outlet drop (ft)	= 0		> 0 , < 1 ft OR	≥ 1 ft OR
Downstream pool present			= yes (= yes AND	= no OR (= yes AND
Downstream pool entrance depth / outlet drop			n/m ≥ 1)	n/a < 1) OR
Water depth in culvert at outlet (ft)				< 0.3 ft
Number of culverts at crossing	1	> 1		
Structure opening partially obstructed	= none	≠ none		
Sediment throughout structure	yes	no		

AOP Coarse Screen Results



A) RPS Ranges and Variable Thresholds for Screen

	<i>Strong Swimmers/Leapers</i>	<i>Moderate Swimmers/Leapers</i>	<i>Weak Swimmers/Leapers</i>
Low	%BFW < 30 OR [(L _{NBW} ≥ 200) OR (L ≥ 200 AND D < 1)] OR Od ≥ 2.5 OR 0 ≤ RPS < 5	%BFW < 50 OR [(L _{NBW} ≥ 100) OR (L ≥ 100 AND D < 1)] OR Od ≥ 1.5 OR 0 ≤ RPS < 5	%BFW < 75 OR [(L _{NBW} ≥ 100) OR (L ≥ 100 AND D < 1)] OR Od ≥ 1.0 OR 0 ≤ RPS < 5
Medium	5 ≤ RPS < 9	5 ≤ RPS < 10	5 ≤ RPS < 12
High	%BFW ≥ 75 AND [(L _{NBW} < 100) OR (L < 100)] AND Od < 1.5 AND RPS ≥ 9	%BFW ≥ 75 AND [(L _{NBW} < 100) OR (L < 100)] AND Od < 1.0 AND RPS ≥ 10	%BFW ≥ 100 AND [(L _{NBW} < 100) OR (L < 100)] AND Od < 0.5 AND RPS ≥ 12

B) Aquatic Organism Groups Based on Swimming/Leaping Ability

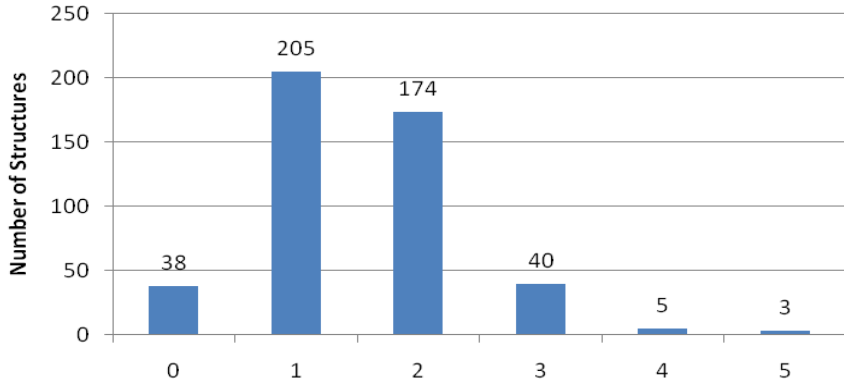
<i>Strong Swimmers/Leapers</i>	<i>Moderate Swimmers/Leapers</i>	<i>Weak Swimmers/Leapers</i>
adult trout adult salmon American eel	juvenile trout suckers shad lamprey	rainbow smelt sculpin minnows bass and sunfish pike, pickerel darters, perch, walleye stickleback aquatic salamanders

C) RPS Variable Scoring

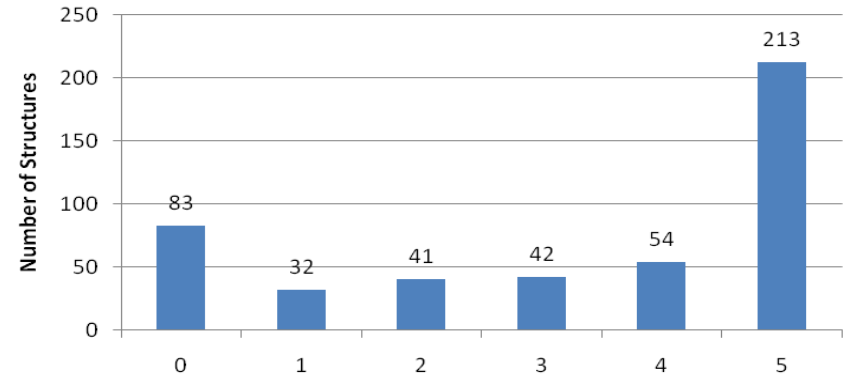
<i>Percent structure width of channel width</i>		<i>Non-backwatered structure length (ft) †</i>		<i>Outlet drop height (ft)</i>	
<i>Score</i>	<i>Values</i>	<i>Score</i>	<i>Values</i>	<i>Score</i>	<i>Values</i>
0	%BFW < 30	0	L _{NBW} ≥ 300	0	Od ≥ 2.5
1	30 ≤ %BFW < 50	1	200 ≤ L _{NBW} < 300	1	2.0 ≤ Od < 2.5
2	50 ≤ %BFW < 75	2	100 ≤ L _{NBW} < 200	2	1.5 ≤ Od < 2.0
3	75 ≤ %BFW < 100	3	40 ≤ L _{NBW} < 100	3	1.0 ≤ Od < 1.5
4	100 ≤ %BFW < 120	4	25 ≤ L _{NBW} < 40	4	0.5 ≤ Od < 1.0
5	%BFW ≥ 120	5	L _{NBW} < 25	5	Od < 0.5

Notes
 %BFW = (culvert width/channel width)*100; L_{NBW} = non-backwatered structure length (ft); L = culvert length (ft); D = water depth in culvert at outlet (ft); Od = outlet drop height (ft); RPS = sum of scores for %BFW, L, and Od.
 †Use culvert length (L) if non-backwatered length (L_{NBW}) not measured.

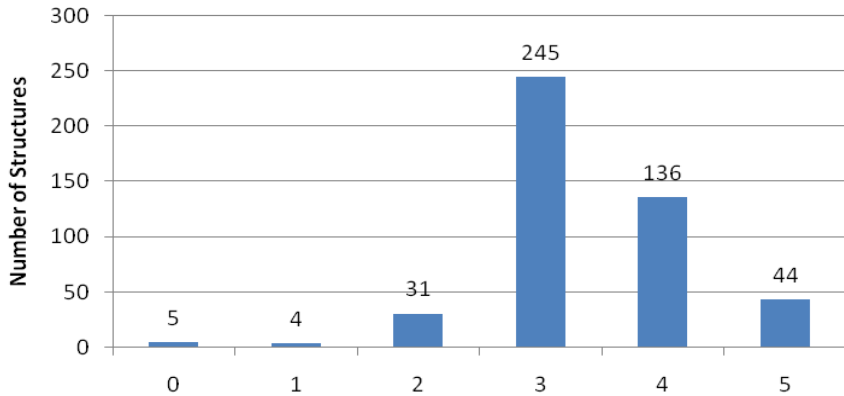
Percent Bankfull Width Scores



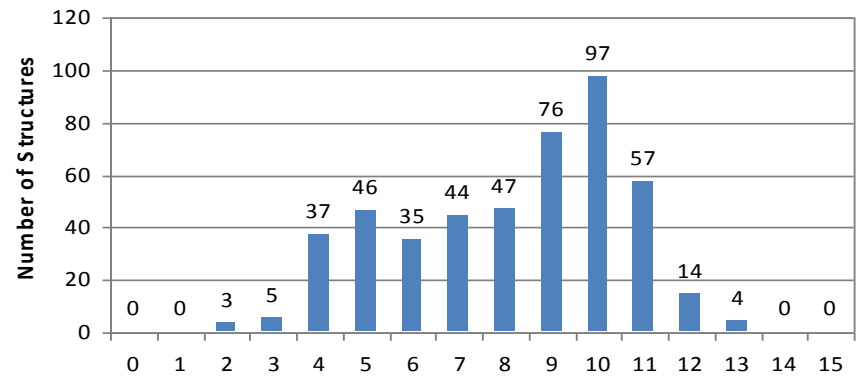
Outlet Drop Scores



Structure Length Scores

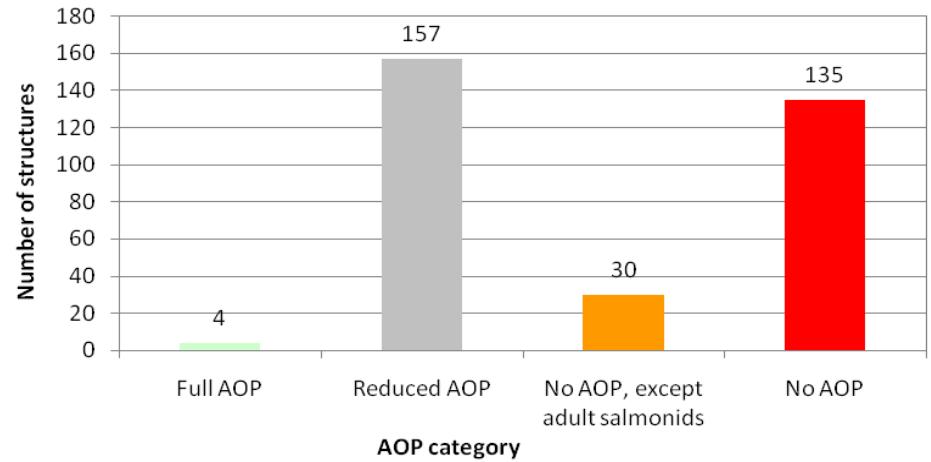


RPS Scores

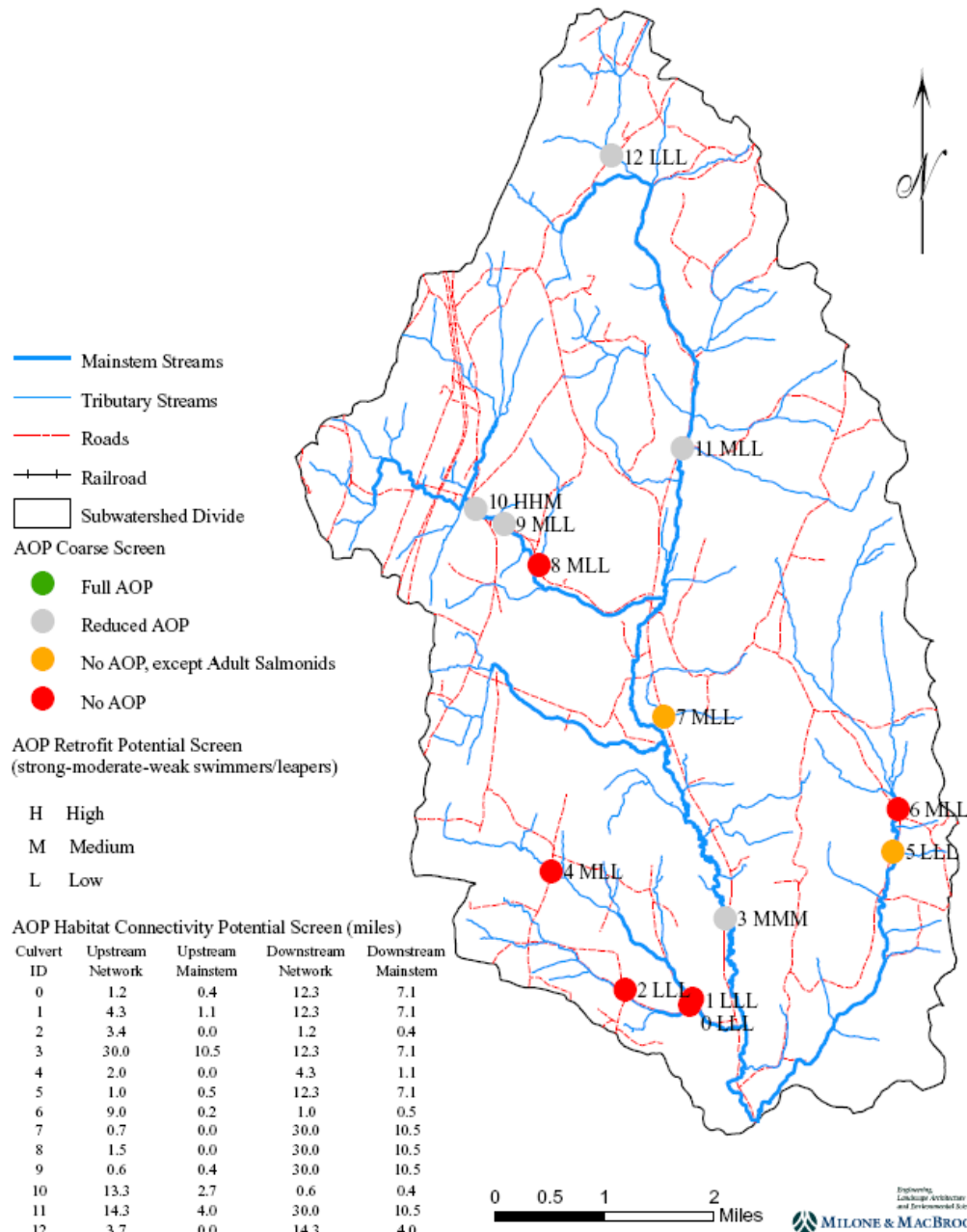


Retrofit Potential	Total	Coarse Screen		
		Gray	Orange	Red
LLL	93	40	4	49
MLL	152	70	15	67
MML	62	35	11	16
MMM	2	2	0	0
HML	1	0	0	1
HHM	12	10	0	2
HHH	0	0	0	0
Total	322	157	30	135

White River AOP Coarse Screen Results



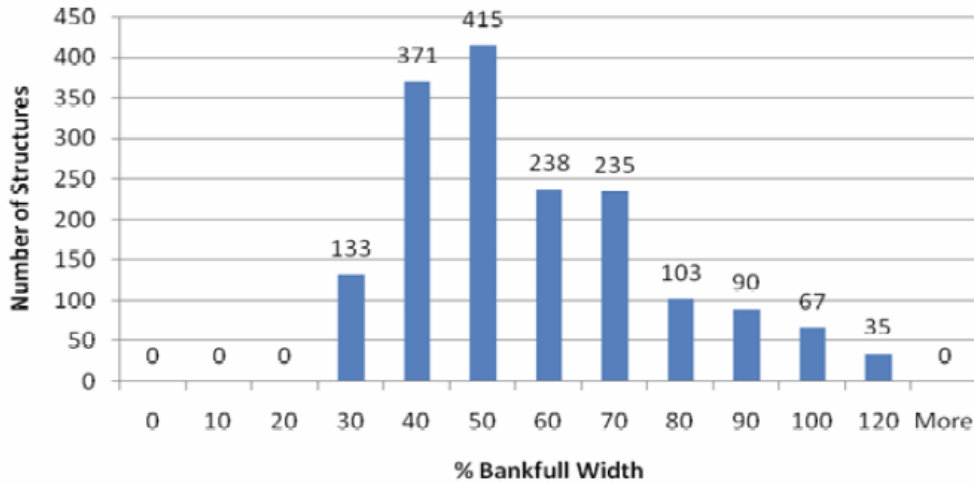
Vermont Culvert Aquatic Organism Passage (AOP) Screening Tool Results Headwaters of the Second Branch Subwatershed White River Watershed



Score	% Bankfull Width	Sediment Continuity	Slope	Approach Angle	Erosion and Armoring
5	$\%BFW \geq 120$	No upstream deposition or downstream bed scour	Structure slope equal to channel slope, and no break in valley slope	Naturally straight	No erosion or armoring
4	$100 \leq \%BFW < 120$	Either upstream deposition or downstream bed scour, without upstream deposits taller than 0.5 bankfull height or high downstream banks	n/a	n/a	No erosion and intact armoring, or low upstream or downstream erosion without armoring
3	$75 \leq \%BFW < 100$	Either upstream deposition or downstream bed scour, with either upstream deposits taller than 0.5 bankfull height or high downstream banks	Structure slope equal channel slope, with local break in valley slope	Mild bend	Low upstream or downstream erosion with armoring
2	$50 \leq \%BFW < 75$	Both upstream deposition and downstream bed scour, without upstream deposits taller than 0.5 bankfull height or high downstream banks	Structure slope higher or lower than channel slope, and no break in valley slope	Channelized straight	Low upstream and downstream erosion
1	$30 \leq \%BFW < 50$	Both upstream deposition and downstream bed scour, with upstream deposits taller than 0.5 bankfull height or high downstream banks	n/a	n/a	Severe upstream or downstream erosion
0	$\%BFW < 30$	Both upstream deposition and downstream bed scour, with upstream deposits taller than 0.5 bankfull height and high downstream banks	Structure slope higher or lower than channel slope, with local break in valley slope	Sharp bend	Severe upstream and downstream erosion, or failing armoring upstream or downstream

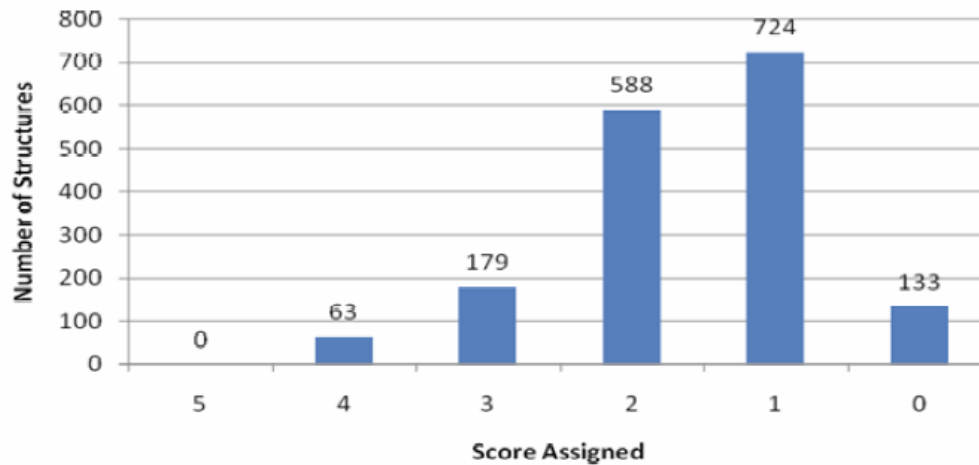


Percent Bankfull Width Data Distribution

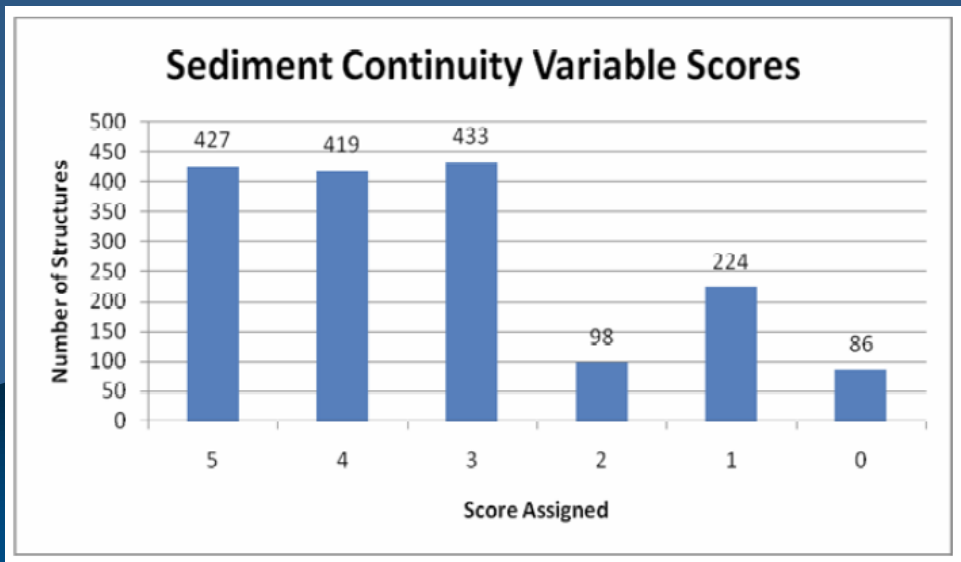


% Bankfull Width	Score
%BFW > 120	5
100 < %BFW < 120	4
75 < %BFW < 100	3
50 < %BFW < 75	2
30 < %BFW < 50	1
%BFW < 30	0

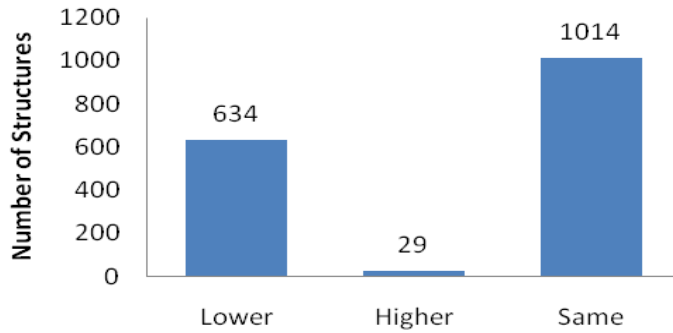
Percent Bankfull Width Variable Scores



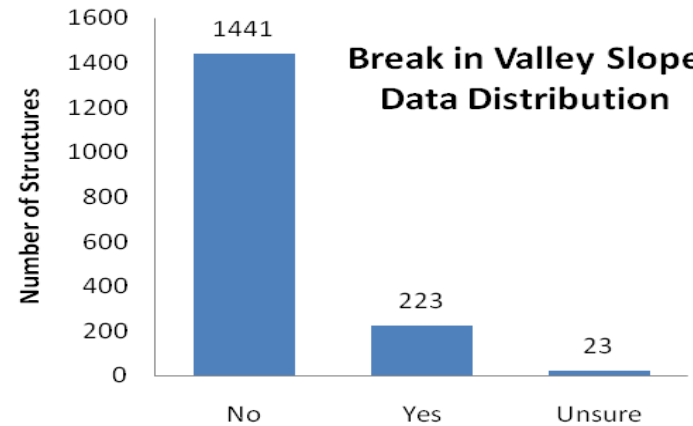
Score	Sediment Continuity Score Description	Sediment Continuity Score Coding
5	neither occur	No upstream deposition or downstream bed scour
4	one occurs, but it is small	Either upstream deposition or downstream bed scour, without upstream deposits taller than 0.5 bankfull height or high downstream banks
3	only one occurs, but it is large	Either upstream deposition or downstream bed scour, with either upstream deposits taller than 0.5 bankfull height or high downstream banks
2	both are small	Both upstream deposition and downstream bed scour, without upstream deposits taller than 0.5 bankfull height or high downstream banks
1	both occur, but one is large and other is small	Both upstream deposition and downstream bed scour, with upstream deposits taller than 0.5 bankfull height or high downstream banks
0	both are large	Both upstream deposition and downstream bed scour, with upstream deposits taller than 0.5 bankfull height and high downstream banks



Culvert Slope Compared to Bed Slope Data Distribution

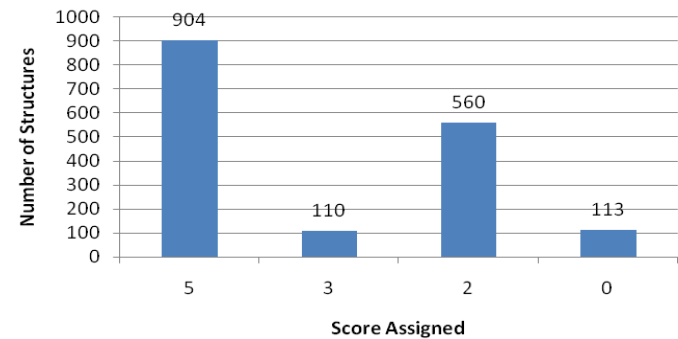


Break in Valley Slope Data Distribution

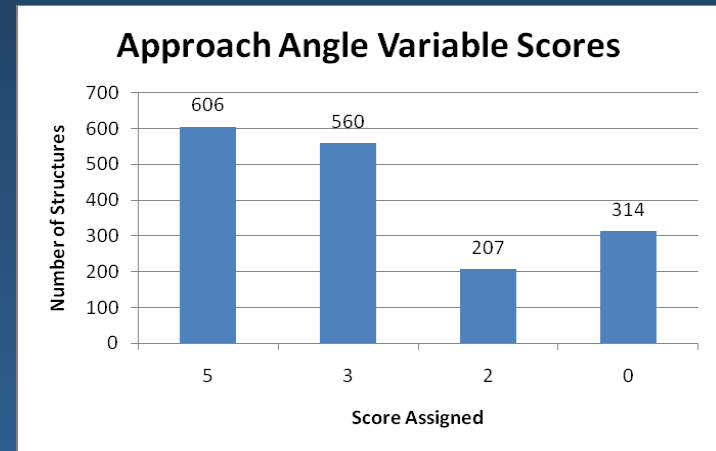
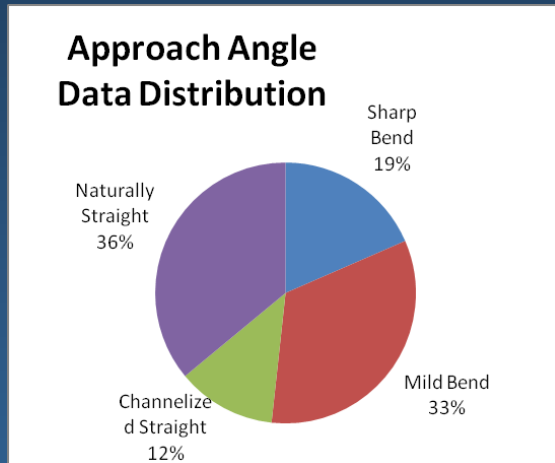


Slope	Score
Structure slope equal to channel slope, and no break in valley slope	5
n/a	4
Structure slope equal to channel slope, with local break in valley slope	3
Structure slope higher or lower than channel slope, and no break in valley slope	2
n/a	1
Structure slope higher or lower than channel slope, with local break in valley slope	0

Slope Variable Scores

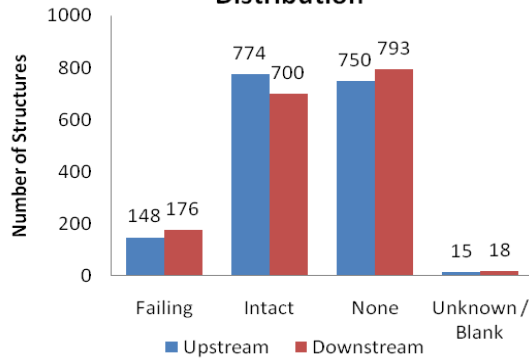


Slope	Score
Naturally straight	5
n/a	4
Mild bend	3
Channelized straight	2
n/a	1
Sharp bend	0

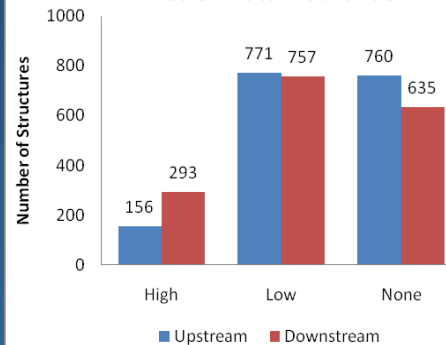


Score	Erosion and Armoring Score Description	Erosion and Armoring Score Coding
5	no erosion AND no armoring	No erosion or armoring
4	no erosion and intact armoring OR low erosion and no armoring	No erosion and intact armoring, or low upstream or downstream erosion without armoring
3	low erosion up OR down, armored	Low upstream or downstream erosion with armoring
2	low erosion up AND down	Low upstream and downstream erosion
1	high erosion up OR down, if armored then intact	Severe upstream or downstream erosion
0	high erosion both up and down OR any failing armoring	Severe upstream and downstream erosion, or failing armoring upstream or downstream

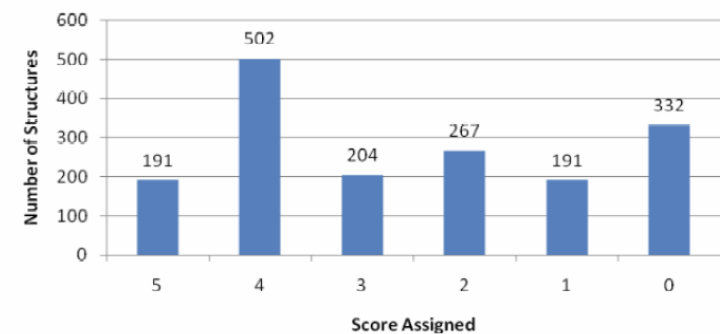
Bank Armoring Condition Data Distribution



Bank Erosion Data Distribution



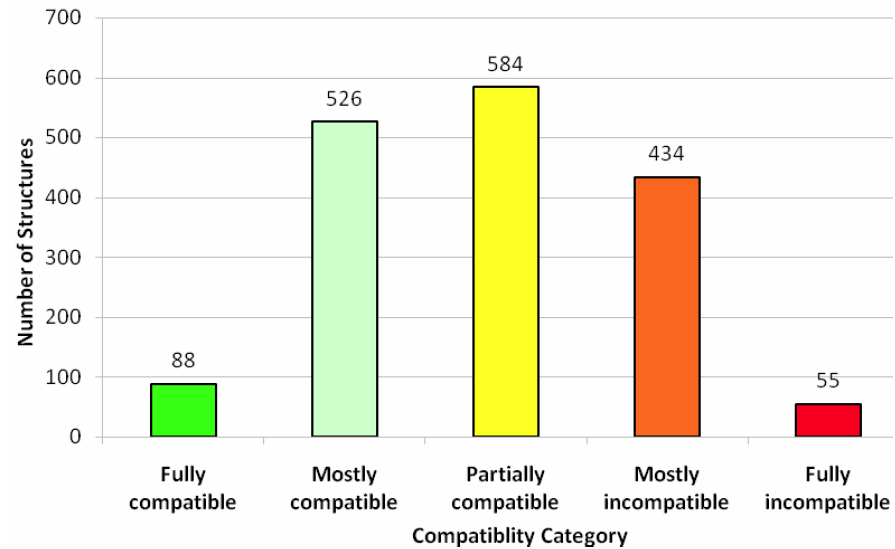
Erosion and Armoring Variable Scores



Category Name	Screen Score	Threshold Conditions	Description of structure-channel geomorphic compatibility
Fully compatible	$20 < GC \leq 25$	n/a	Structure fully compatible with natural channel form and process. There is a low risk of failure. No replacement anticipated over the lifetime of the structure. A similar structure is recommended when replacement is needed.
Mostly compatible	$15 < GC \leq 20$	n/a	Structure mostly compatible with current channel form and process. There is a low risk of failure. No replacement anticipated over the lifetime of the structure. Minor design adjustments recommended when replacement is needed to make fully compatible.
Partially compatible	$10 < GC \leq 15$	n/a	Structure compatible with either current form or process, but not both. Compatibility likely short term. There is a moderate risk of structure failure and replacement may be needed. Re-design suggested to improve geomorphic compatibility.
Mostly incompatible	$5 < GC \leq 10$	% Bankfull Width + Approach Angle scores ≤ 2	Structure mostly incompatible with current form and process, with a moderate to high risk of structure failure. Re-design and replacement planning should be initiated to improve geomorphic compatibility.
Fully incompatible	$0 \leq GC \leq 5$	% Bankfull Width + Approach Angle scores ≤ 2 AND Sediment Continuity + Erosion and Armoring scores ≤ 2	Structure fully incompatible with channel and high risk of failure. Re-design and replacement should be performed as soon as possible to improve geomorphic compatibility.



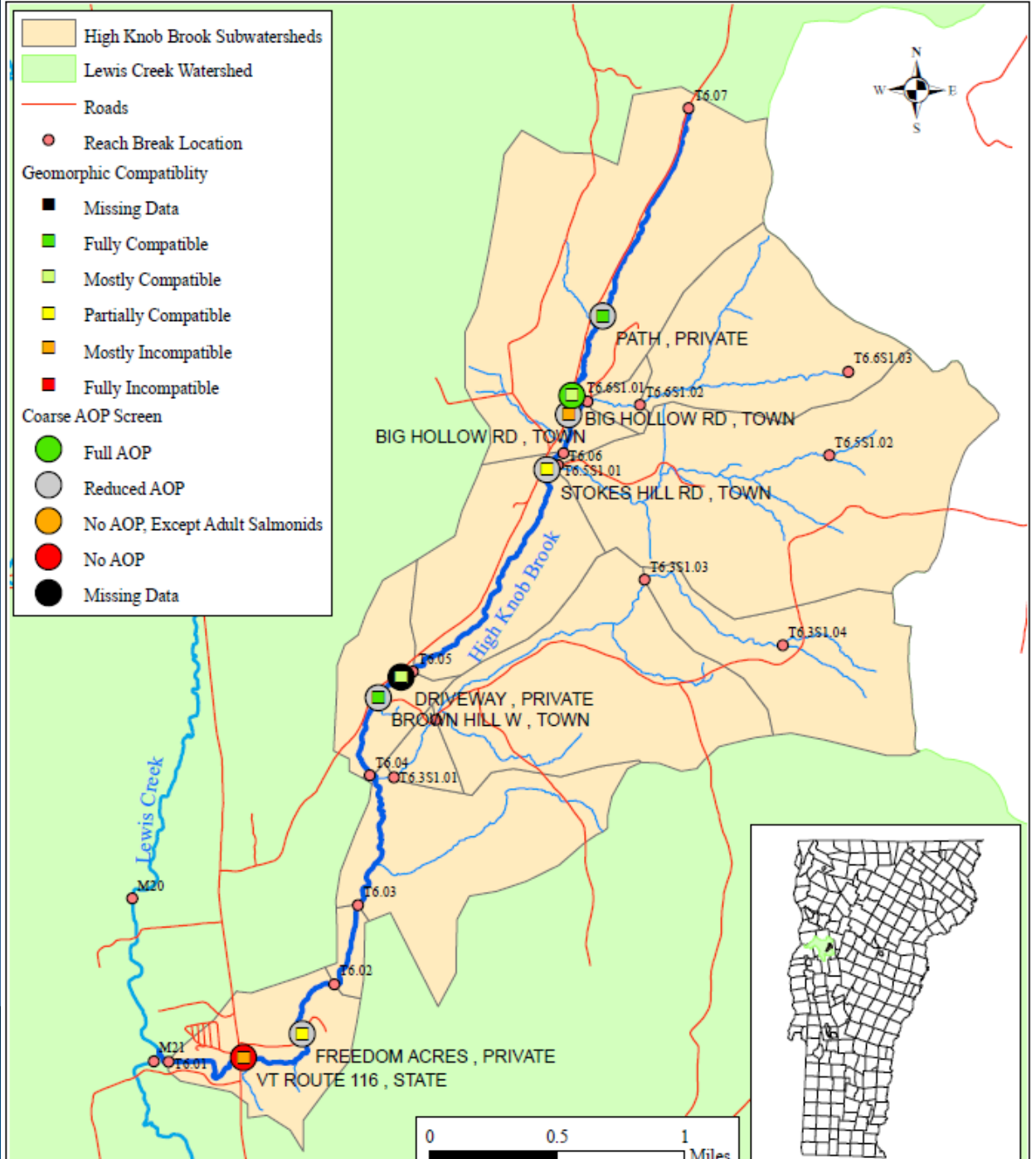
Culvert Geomorphic Compatibility Screen Scores



Pilot Study Results

Category Name	White River Watershed		Ottauquechee River Watershed	
	#	%	#	%
Fully compatible	5	1	0	0
Mostly compatible	93	21	36	18
Partially compatible	165	38	69	35
Mostly incompatible	145	33	78	39
Fully incompatible	26	6	17	9

- High Knob Brook Subwatersheds
- Lewis Creek Watershed
- Roads
- Reach Break Location
- Geomorphic Compatibility**
- Missing Data
- Fully Compatible
- Mostly Compatible
- Partially Compatible
- Mostly Incompatible
- Fully Incompatible
- Coarse AOP Screen**
- Full AOP
- Reduced AOP
- No AOP, Except Adult Salmonids
- No AOP
- Missing Data

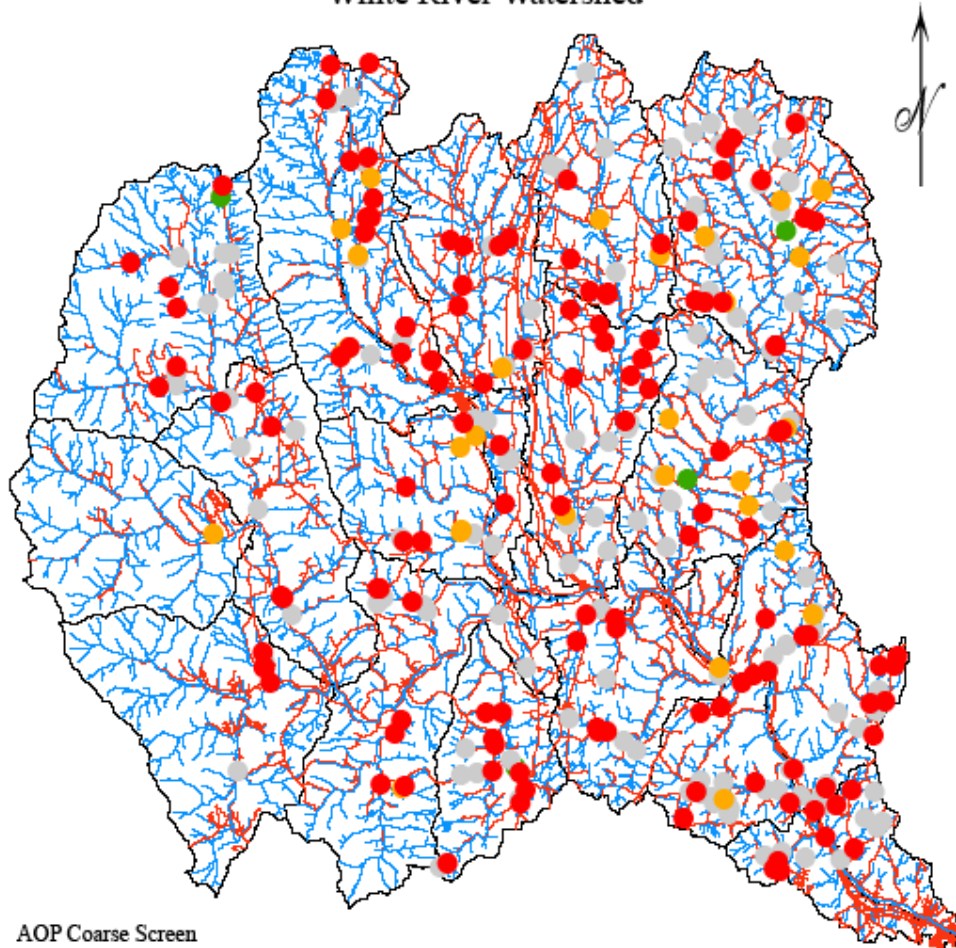


Thank you

http://www.anr.state.vt.us/dec/waterq/rivers/html/rv_geoassess.htm



Culvert Aquatic Organism Passage (AOP) Screening Tool White River Watershed



AOP Coarse Screen

- Full AOP
- Reduced AOP
- No AOP, except adult salmonids
- No AOP

— Roads

— Streams

++ Railroad

□ Subwatershed Divides

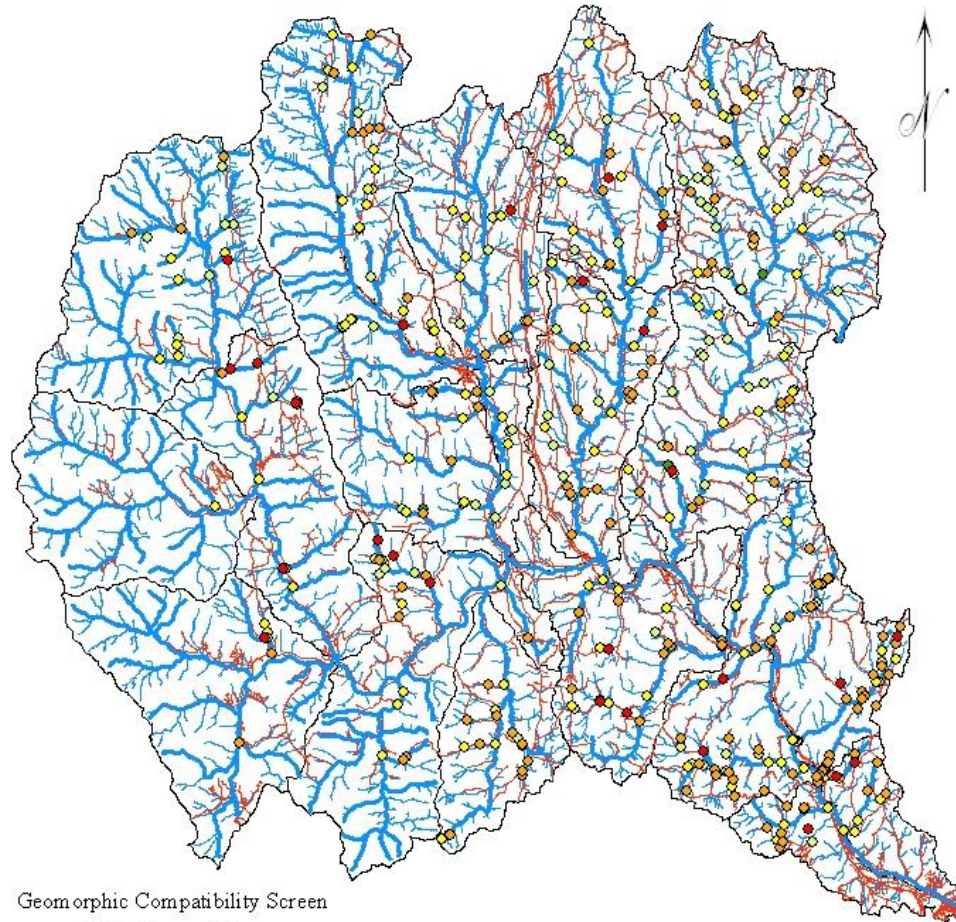
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Culvert Geomorphic Compatibility Screening White River Watershed



Geomorphic Compatibility Screen

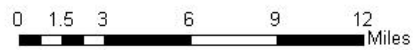
- Fully Compatible
- Mostly Compatible
- Partially Compatible
- Mostly Incompatible
- Fully Incompatible

— Streams

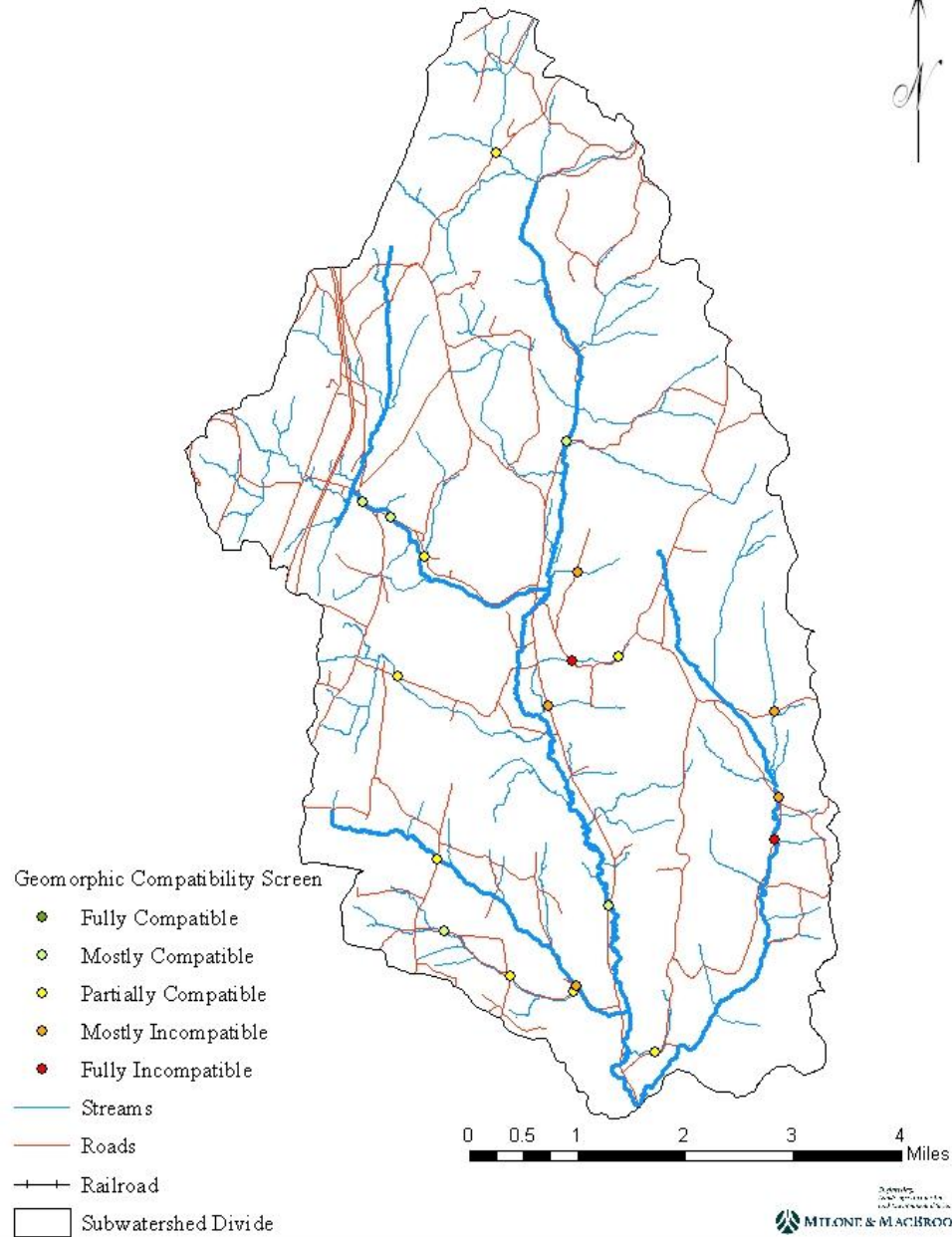
— Roads

—+— Railroad

□ Subwatershed Divides



Culvert Geomorphic Compatibility Screening Headwaters of the Second Branch White River Watershed



Culvert Assessment Field Form - Geomorphic & Habitat Parameters Field Map # _____

SGA Structure ID		Struct_Num		
Observer(s) / Organization(s)		Date		
Town		Phase 1 Project		
Location		Longitude (E/W)		
Reach VTID		Latitude (N/S)		
Road Name		Road Type	paved gravel trail railroad	
Stream Name		High Flow Stage	yes no	
Channel Width curve measured	(ft.)	Culvert Material concrete plastic corrugated plastic smooth tank steel corrugated stone aluminum corrugated other mixed	Structure skewed to roadway	yes no
Culvert Length	(ft.)		Culvert Height	(ft.)
Culvert Width	(ft.)		# of culverts at crossing	
			Overflow pipe(s)	yes no

Geomorphic and Fish Passage Data

General				
Floodplain filled by roadway approaches:	entirely	partially	not significant	
Structure located at a significant break in valley slope:	yes	no	unsure	
Culvert slope as compared with the channel slope is:	higher	lower	same	
Upstream				
Is structure opening partially obstructed by (circle all that apply):	wood debris	sediment	deformation	none
Steep riffle present immediately upstream of structure:	yes	no		
If channel avulses, stream will:	cross road	follow road	unsure	
Estimated distance avulsion would follow road: _____	(feet)			
Angle of stream flow approaching structure:	sharp bend	mild bend	naturally straight	channelized straight
Downstream				
Water depth in culvert (at outlet): _____	(0.0 feet)			
Culvert outlet invert:	partially backwatered or at grade	cascade	free fall	
Backwater Length (measured from outlet): _____	(0.0 feet)			
Outlet drop (invert to water surface): _____	(0.0 feet)			
Pool present immediately downstream of structure:	yes	no		
Pool depth at point of streamflow entry: _____	(0.0 feet)			
Maximum pool depth: _____	(0.0 feet or >4feet)			
Downstream bank heights are substantially higher than upstream bank heights:	yes	no		



Geomorphic and Fish Passage Data	UPSTREAM					DOWNSTREAM					IN STRUCTURE								
	1	2	3	4	5	UK	1	2	3	4	5	UK	0	1	2	3	4	5	UK
Dominant bed material at structure	bedrock present: yes no					bedrock present: yes no					material throughout: yes no								
Sediment deposit types	none	delta	side			none	delta	side			none	delta	side			point	mid-channel		
Elevation of sediment deposits is greater than or equal to ½ bankfull elevation:	yes	no				yes	no				yes	no							
Bank erosion	high	low	none			high	low	none			Bed Material Codes 0-none 1-bedrock 2-boulder 3-cobble 4-gravel 5-sand UK-unknown								
Hard bank armoring	intact	failing				intact	failing												
Streambed scour causing undermining around/under structure (circle all that apply)	none	culvert				none	culvert												
Beaver dam near structure Distance from structure to dam	yes	no				yes	no												
Wildlife Data (left/right bank determined facing downstream)		LEFT	RIGHT			LEFT	RIGHT			Vegetation Type Codes C-coniferous forest D-deciduous forest M-mixed forest S-shrub/sapling H-herbaceous/grass B-bare R-road embankment									
Dominant vegetation type																			
Does a band of shrub/forest vegetation that is at least 50' wide start within 25' of structure and extend 500' or more up/downstream?		yes	no	yes	no	yes	no	yes	no										
Road-killed wildlife within ¼ mile of structure? (circle none or list species)	species: none																		
Wildlife sign and species observed near (up/downstream) and inside structure (circle none or list species and sign types)	Outside Structure					Inside Structure													
	species (none)					sign													
Spatial data collected w/GPS: yes no		Comments:																	
Photos taken: yes no Please fill out photo log below																			
Roll and Frame #	Photo View	Description of Features in Photo																	

