The use of low head weirs to reconnect severely entrenched perennial streams with their floodplains:

An Anne Arundel County TMDL Watershed Implementation Plan Strategy

presented by

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Mid Atlantic Stream Restoration Conference

November 16, 2011
Rocky Gap, Maryland

ANNE ARUNDEL COUNTY MARYLAND

DPW

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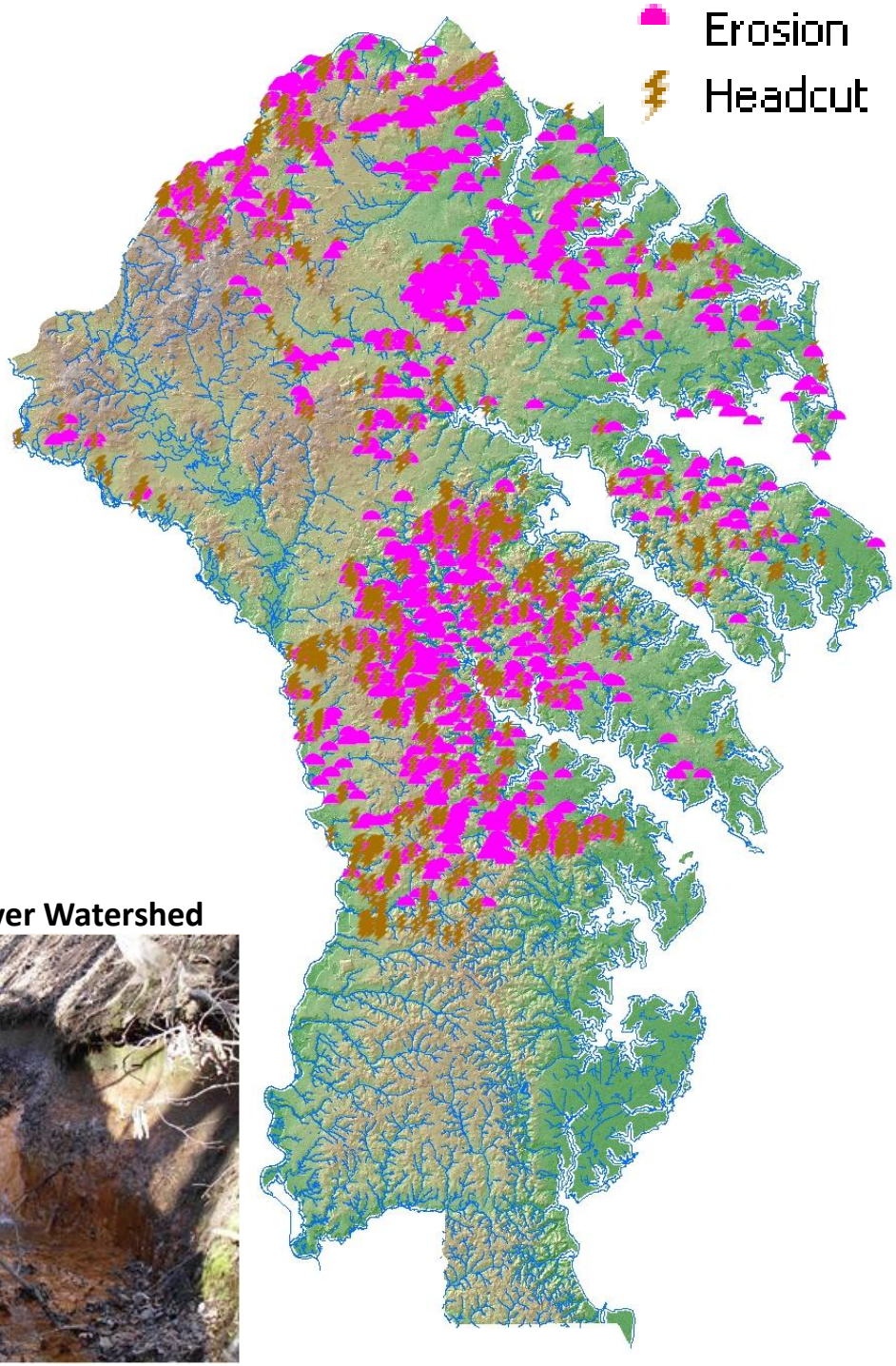
Outline

- *Current Condition Assessment for Streams in Anne Arundel County*
- *Instream weir design*
- *Implementation examples*
- *A water quality strategy for meeting sediment and nutrient TMDLs in Maryland*
- *Conclusion*

DEGRADED MORPHOLOGY

Example of F and G channels – Highly Instable



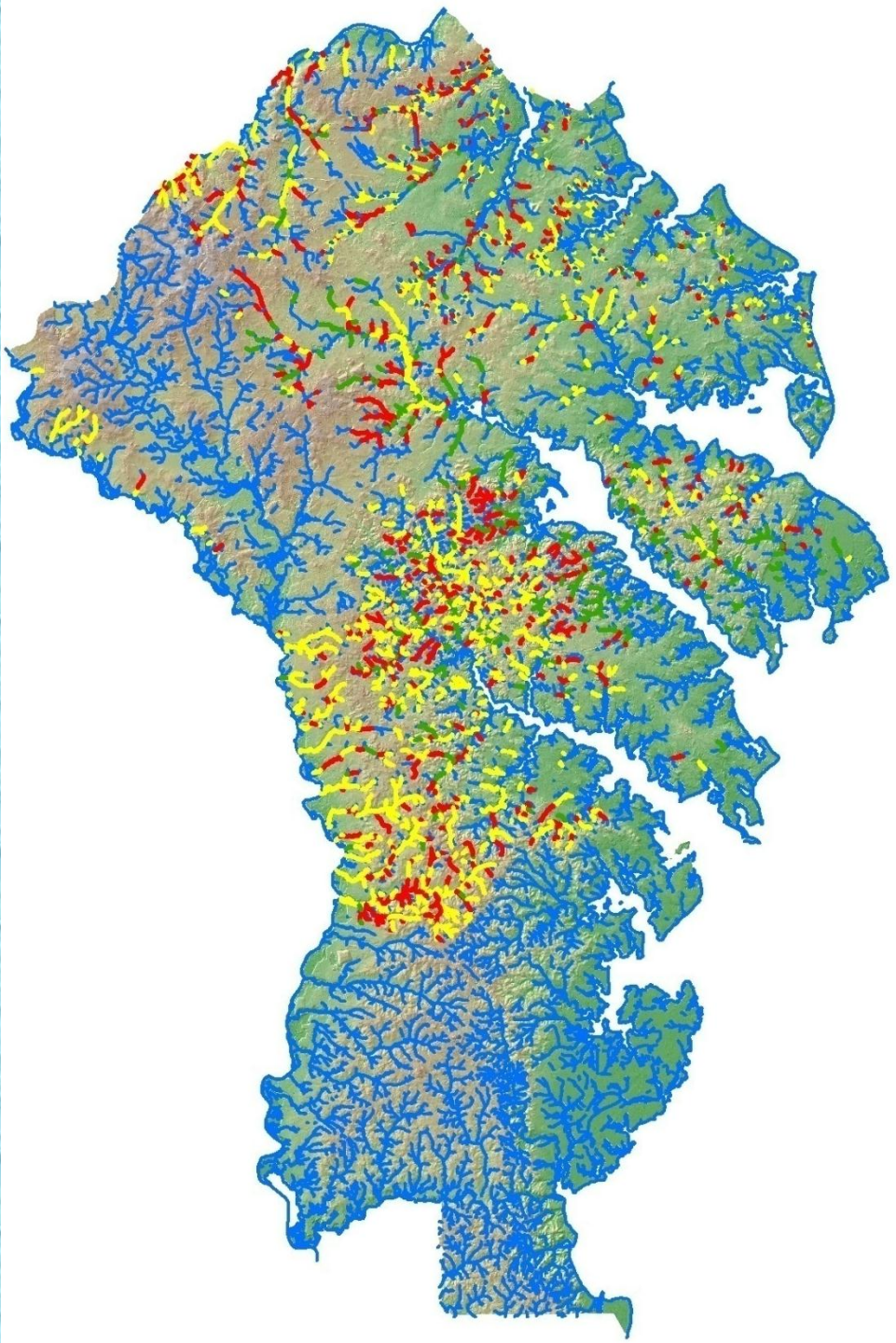
Erosion -- Patuxent River Watershed

Headcut -- South River Watershed

ESTIMATED SEDIMENT YIELD

Perennial Stream Miles Assessed: 406

Sediment Yield	
High	133
Moderate	211
Low	62
Not Assessed	



Conventional upland BMPs do not necessarily correlate with a stable downstream!

Stormwater detention ponds are wet structures that are often used to capture and detain stormwater runoff from residential and commercial areas.

Erosion and Headcut Inventory

Impervious Area Draining to BMP

- Less than 20%
- 20%< and >50%
- 50%< and >75%
- More than 75%

Anne Arundel County TMDL Restoration Strategy

Core Strategy

Restoration of Severely Degraded Channels

- ***Zero and First Order Streams***
  (Step Pool Storm Conveyances)
  (Wetland Seepage Systems)

- ***Second and Higher Order Streams***
  (Wetland Seepage Systems)
  (Instream Weirs)

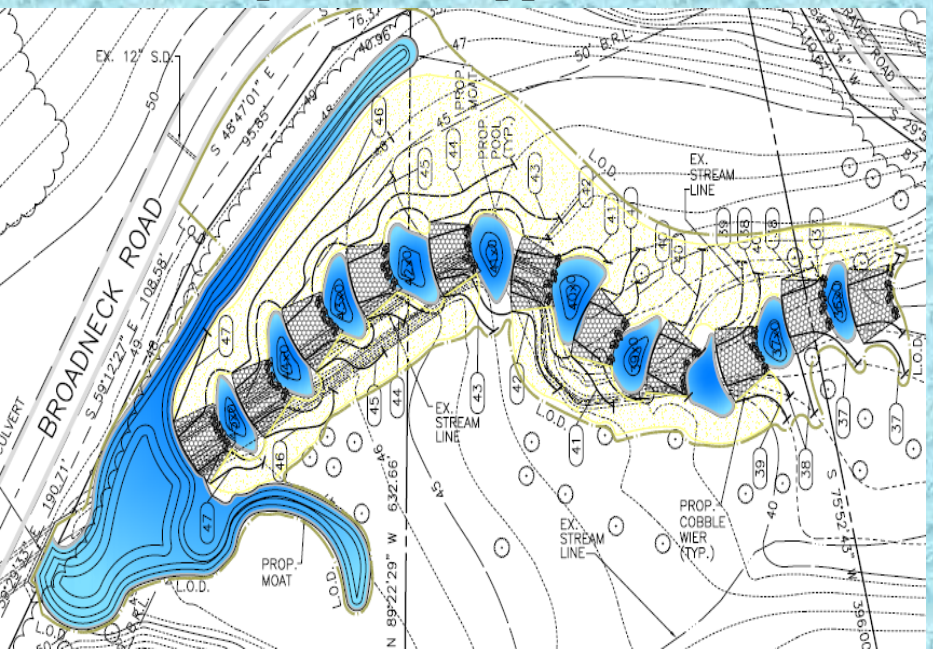
SWM Retrofits

More than 75%

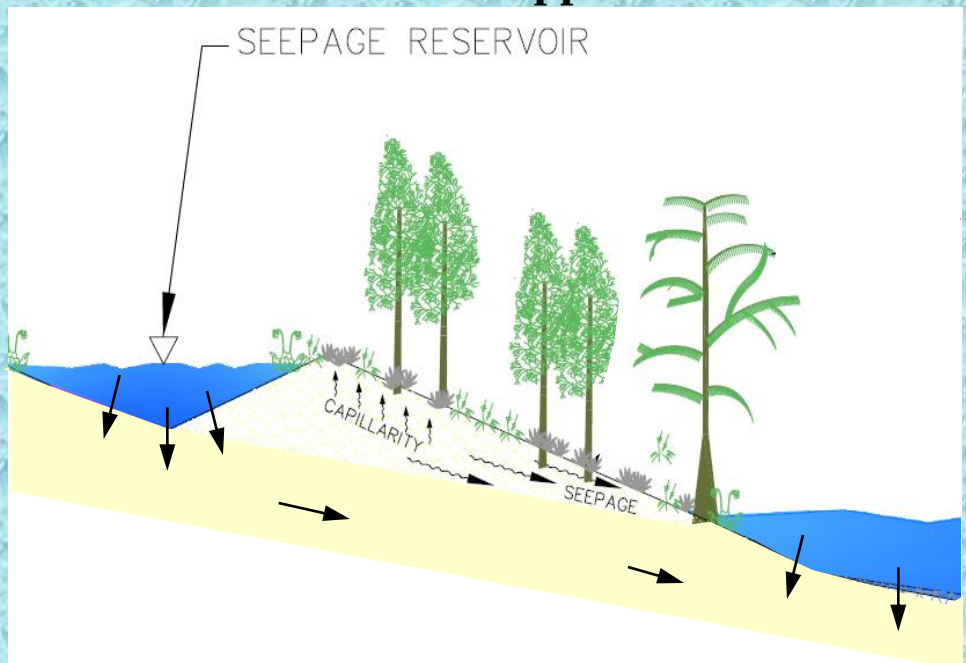
SPSCs – What are they?

SPSCs are open-channel conveyance structures that convert, through attenuation pools and a sand seepage filter, surface storm flow to shallow groundwater flow.

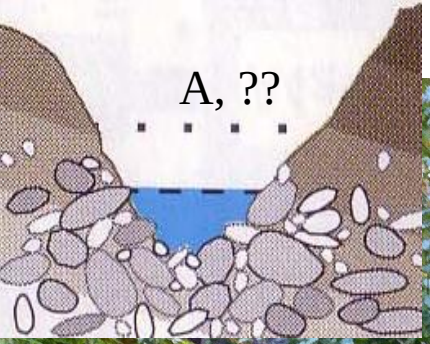
Step Pool Storm Conveyance
Ephemeral Application

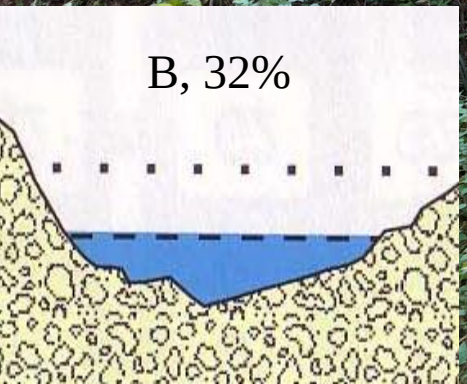


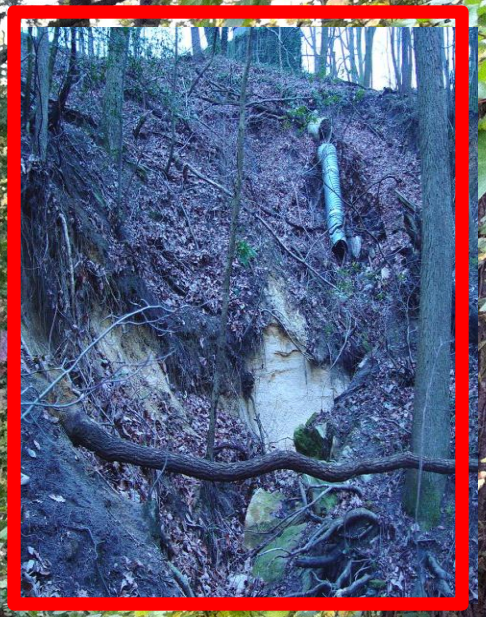
Wetland Seepage System
Perennial Application



STEP POOL STORM CONVEYANCE FOR EPHEMERAL OUTFALLS

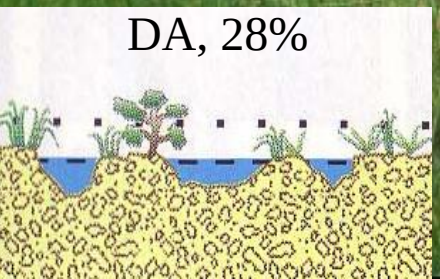






The physical characteristics of the SPSC channel are best characterized by the Rosgen A or B stream classification types, where "bedform occurs as a step/pool, cascading channel which often stores large amounts of sediment in the pools associated with debris dams" (Rosgen, 1996).

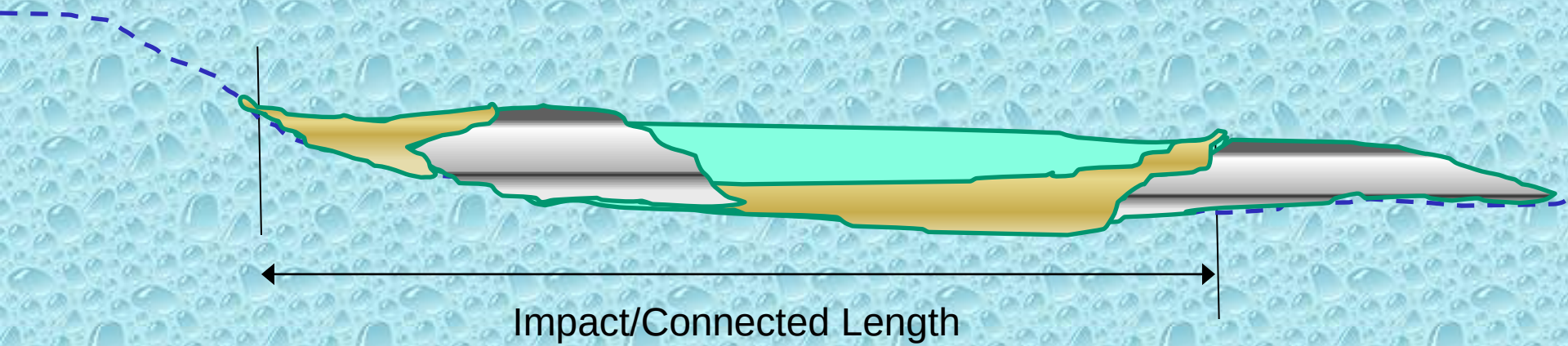
WETLAND SEEPAGE RESTORATION TECHNIQUE FOR PERRENIAL STREAMS



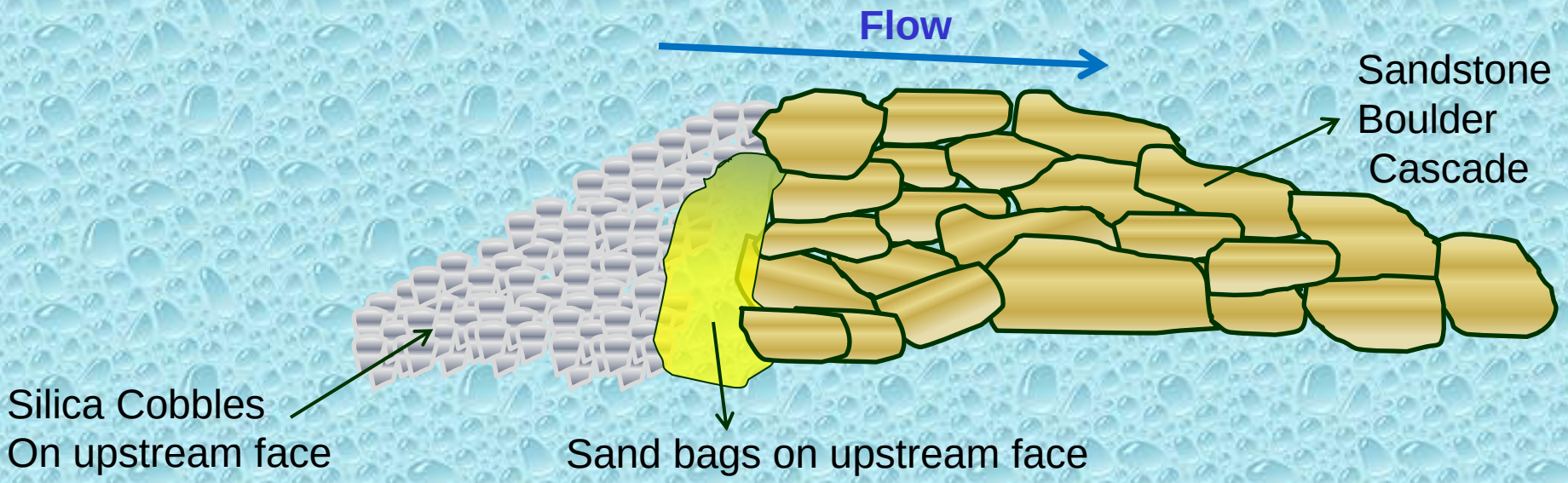
What are In-stream Weirs:

-Sandstone cobble Weirs are used to form 4 ft low head dam lifts to encourage the upstream floodplain to build up to its restored levels

- Maximum slope is 10%
- Maximum Height = 4 ft.

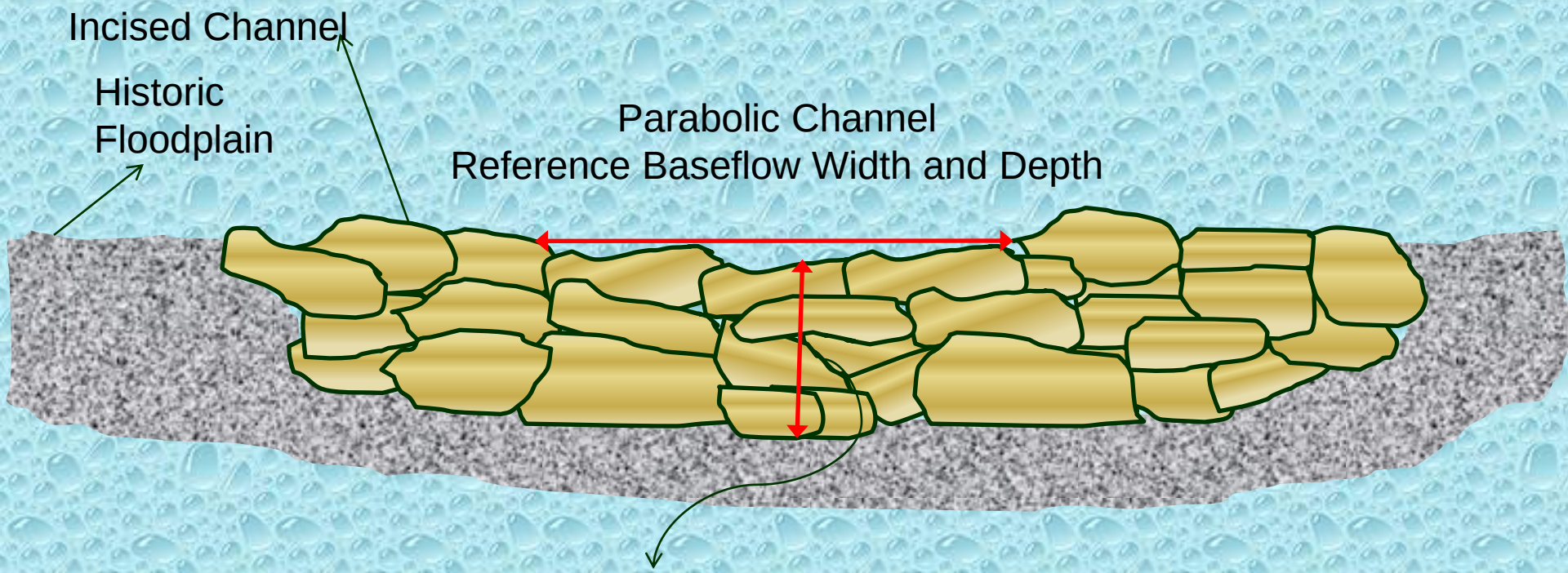


In-stream Weir Typical Detail:



Profile along channel Centerline

In-stream Weir Typical Detail:



Instream Weir/Cascade Cross-Section

In-stream Weir Implementation Scenarios:

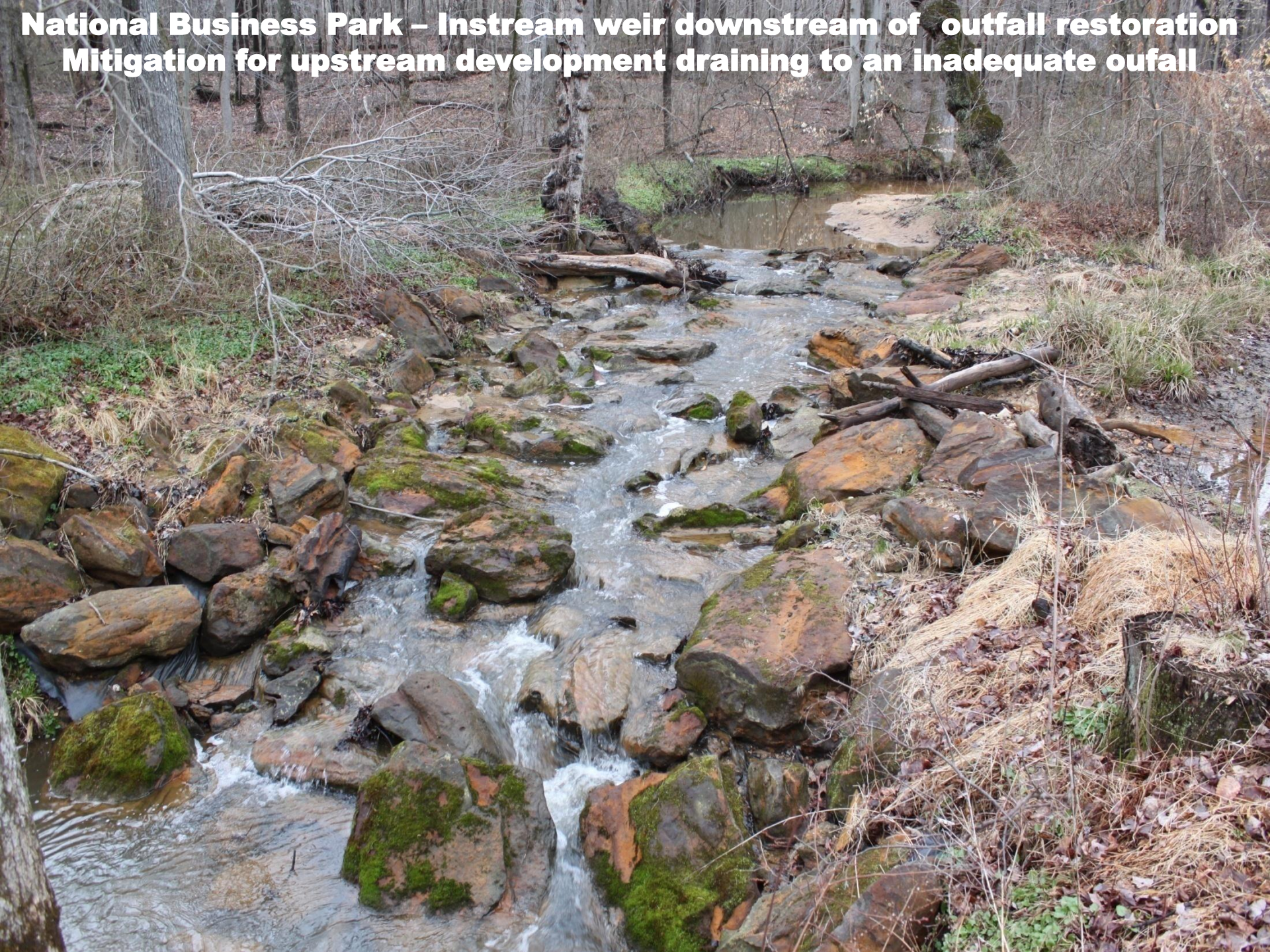
- Restoring incised perennial channels

- Connecting perennial streams to floodplain

- Arresting Headcut

- Protecting public infrastructure


National Business Park – Instream weir downstream of outfall restoration
Mitigation for upstream development draining to an inadequate oufall


National Business Park – Instream weir downstream of outfall restoration
Mitigation for upstream development draining to an inadequate oufall


Severn Run Mainstem – Before Instream Weir – Temporary Fix
Stream incision exposed sewer line crossing

Severn Run Mainstem – directly after construction – Sewer Crossing

Severn Run Mainstem – After Tropical Storm Lee – Sewer line crossing

Severn Run Mainstem – Upstream Channel Clarity

Aurora Hills - Tributary to Wells Branch Restoration
Protect upstream tributary restoration

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Protect upstream tributary restoration

Wells Branch – Upstream of Instream Weir – 2010

Wells Branch – Upstream of Instream Weir - 2011

Gambrills Road Culvert Replacement
Arrest downstream headcut

A breakdown of the cost of Stream Restoration per MDE standards

Baseline Credit (TN = 0.02 lb/LF, TP = 0.0035 lb/LF, TSS = 2.55 lb/LF)

MDE Criteria:

Stream stabilization and restoration projects that connect incised and degraded streams to their Floodplain.
AACO uses **Instream Weir** technology at incised Sections to connect a stream segment to the floodplain.

MDE specifies Impervious acreage treated =
1 acre/100 linear feet of stream connected/restored

Historic Cost Records for In-stream Weir projects in AA County:

Project Name	Restoration Length (Ft)	Contributary DA (Acres)	Nested Impervious DA Treated (Acres)	Total Cost	($/LF)	$/Acre "Nested Impervious DA Treated"
Wells Branch @ Gambrills Road in-stream weir	170	510	1.7	$ 15,000	88	$ 4,412
Wells Branch @ Aurora Hills in-stream weir	150	733	1.5	$ 15,000	100	$ 5,000
Science Drive in-stream weirs	650	109	6.5	$ 75,000	115	$ 5,769
Picture Spring Branch in-stream weir	500	1559	5.0	$ 60,000	120	$ 6,000
Severn Run in-stream weir	150	2811	1.5	$ 30,000	200	$10,000
Weighted Average (By Impervious DA Treated)					$	6,019

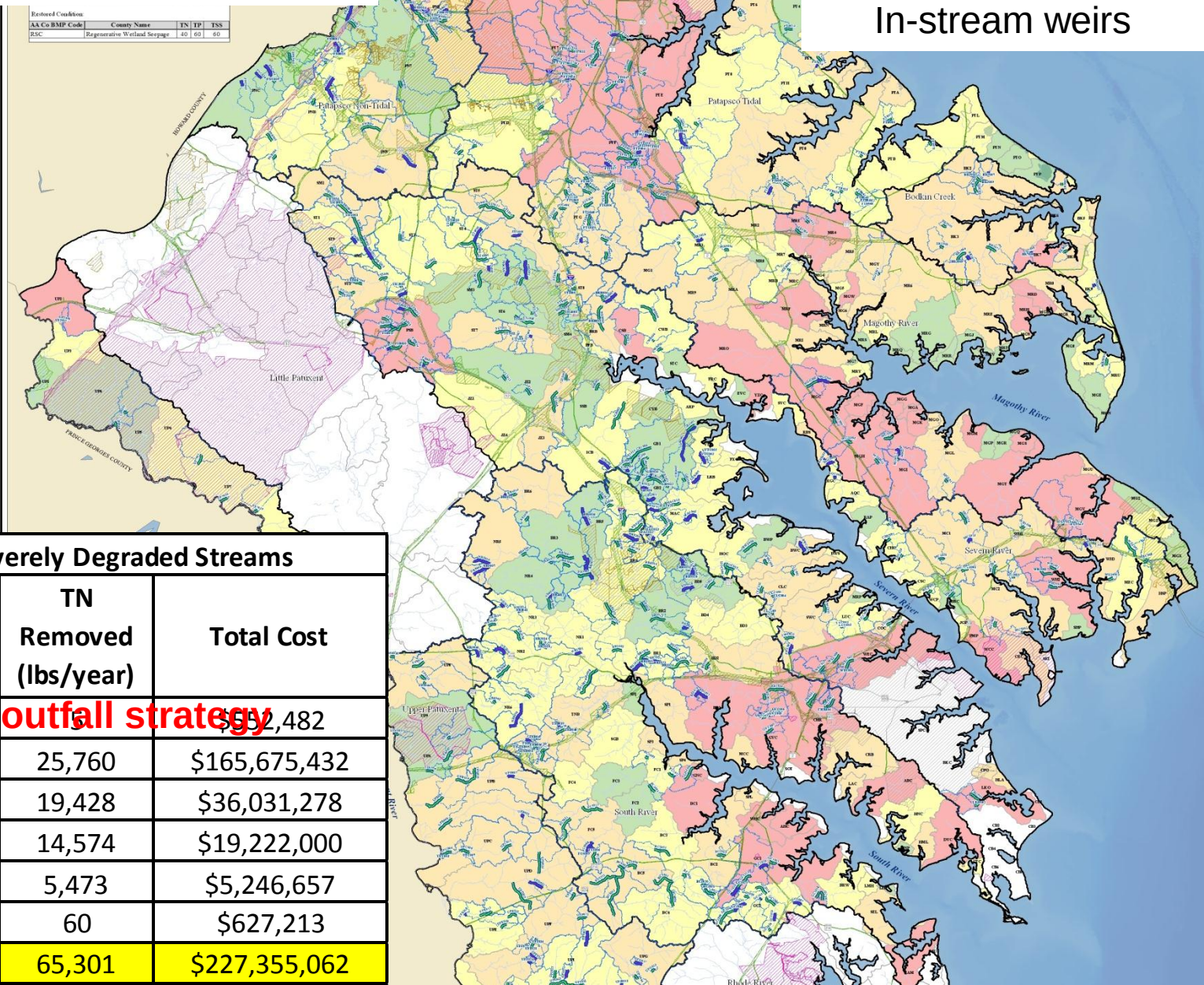
Severn Run Mainstem, 3 feet high 30 ft long instream weir was used to connect 150 feet of stream to the floodplain.

Unit Cost Comparison for TMDL Implementation Strategies

BMP Strategy	TN Removed		
	($/lb)	(lbs/year)	Status
Core Strategy			
Perennial Stream Restoration (Instream Weir)	$3,009	5,433	Limited to 1st two priority restoration tiers
Ephemeral Stream/Pipe Outfall Retrofits with regenerative SPSC Systems	$6,496	41,877	Limited to impaired outfalls
Perennial Stream Restoration (regenerative Wetland Seepage)	$7,751	25,765	Limited to 1st two priority restoration tiers
Pond Retrofits	$8,065	7,915	Limited to ponds with DA>10 acres built prior to 2002
Supplemental Strategy			
Street Sweeping	$721	13,879	Full Plan
Inlet Cleaning	$3,782	34,699	Full Plan
Rain Gardens (Bioretention)	$51,581	2,838	Limited to County Parks and Schools
Forestation	$59,125	196	Limited to public open space
Rain Barrels	$104,544	TBD	All rooftops that can not be disconnected
Other ESD options	TBD	TBD	ESD options for roads, residential, and commericial communities.
Total		**132,602**	**(TMDL Compliance : +200,000 lbs/year)**

Anne Arundel County Government
TMDL Watershed Implementation Plan
Stream Restoration

Stream Order < 2 and severely incised are restored with In-stream weirs



Degraded and Severely Degraded Streams			
Stream Order	**Miles to be restored**	**TN Removed (lbs/year)**	**Total Cost**
0	0.2	5	$552,482
1	57	25,760	$165,675,432
2	30	19,428	$36,031,278
3	16	14,574	$19,222,000
4	4	5,473	$5,246,657
5	1	60	$627,213
Total	109	65,301	$227,355,062

See pipe outfall strategy

Conclusion

- *In-stream low head weirs are designed as stable systems*
- *Instream weirs can be designed to provide fish passage*
- *Instream weirs connect the upstream channel to the floodplain.*
- *Instream weirs encourage upstream building of incised channel by changing the hydraulic gradient/power trapping transported material.*
- *Instream weirs are a cost effective strategy for stream restoration.*