# 2026 HydroGeology Symposium Abstract

**447 words / 700 word limit**

***Stream Restoration for Atmospheric Rivers:***
***Rebuilding Watershed Capacity to Stabilize the Water Cycle***


**Abstract :**

The story of water is often told as a reaction to events. Floods in the streets. Drought in the fields. Mud in the river. Algae in the lake. With the ever increasing demand for water and the increase in frequency of severe events, the aim here is to shift the frame from reactive response to proactive design. When it comes to stabilizing our water cycle, finding opportunities for healthy watershed management is important to support atmospheric moisture transport inland.

Groundwater levels across parts of the Nation's heartland are declining, America's biotic pump is stressed and our atmospheric rivers are changing. By "biotic pump," I mean the idea that living vegetation supports the normal water loop of ocean evaporation, atmospheric transport, and precipitation by returning water to the air through evapotranspiration and helping keep moisture moving inland. This presentation proposes a design hypothesis: America's atmospheric water transport and water resource stability can be supported by biotic pump corridors that maintain persistent moisture and vegetative function between coastal zones and our interior basins, especially along gateway terrains such as lower-elevation mountain passes. Restoring hydrologic and ecological continuity increases resilience, fights heat islands, supports local moisture recycling, and reduces the drought–flood whiplash that is destabilizing our Nation and our world.

Capacity is the design variable. It governs storage, infiltration, and the timing of release. Capacity is directly related to the land's ability to buffer against both storms and drought. Water is nature's universal buffer, smoothing extremes across systems: it stores and releases thermal energy, moderates chemical swings through dilution and solution chemistry, and carries and redistributes mechanical energy, so when landscapes lose water storage capacity they do not just lose "water", they lose stability itself. Increasing storage and infiltration will flatten peak flows and release water slowly over weeks to months rather than 24 - 72 hrs. When this capacity is lost, both ecological function and human systems become fragile. Capacity is the difference between a watershed that absorbs disturbance and one that amplifies it. Capacity is not abstract, it is measurable and designable by how long it takes for a drop of water to go from the mountains to the sea. We then ask how and where capacity can be rebuilt to support our water cycle in a world that keeps hardening its surfaces and concentrating its runoff?

With land development, that challenge becomes unavoidable. Modern development concentrates runoff by design. Impervious surfaces accelerate flow, shorten travel time, and export water out of neighborhoods and watersheds as quickly as possible. In doing so, they also increase erosive energy and shift impacts downstream.

The mechanism is lengthening the stormwater flow path from development through a tiered sequence of vegetated practices that detain, infiltrate, and treat runoff in stages. Where conveyance is necessary, outfalls should terminate into ecological buffer zones that function as

an extension of the treatment train, promoting infiltration and slow groundwater release to nearby creeks over time rather than direct, erosive discharge to small receiving streams. In this framework, stormwater is treated as a long-duration ecological resource rather than a short-term liability.

How should these spaces exist within the human landscape? Public Access. Turning water infrastructure into visible, accessible landscapes keeps watershed health in the public eye and creates regular opportunities for people to walk, observe, learn, and care for the land. These spaces also become natural hubs for community cleanup events, restoration workdays, and stewardship activities.

Trail networks emerge as the connective tissue that links these ecological zones into continuous systems. Trails already function as public corridors, and they are frequently aligned with streams, floodplains, and riparian areas. This work proposes that trail corridors be intentionally designed as blue-green infrastructure spines, where stormwater management, habitat continuity, and stream health are planned together rather than treated as separate projects.

Hunnicutt Creek within Clemson University and its surrounding urban watershed is a convenient example where these ideas intersect directly. The New Stream Restoration Creative Inquiry provides an immediate platform to demonstrate how development-scale stormwater planning, ecological capacity design, and trail-based public access can function as one integrated system. The result is a practical, scalable model for our land grant university to lead, and a pathway to restore hydrologic and ecological continuity in service of healthier atmospheric rivers.

Last Year's Presentations:

- Poster Watershed Stewardship (Might Present again)
- Decentralized water management (The Prequil)
- Last Years Abstract:

## Decentralized Runoff Management

**Evans, Andrew,** ace4@clemson.edu, Students for Stewardship, Clemson, SC

The decentralization of water management offers transformative resilience benefits, including enhanced evaporative cooling, transpiration, and ecological restoration. By strategically incorporating ponds that connect to and from streams, we can leverage these water bodies as natural biological filters. This approach significantly improves infiltration, minimizes erosion, and addresses the excessive phosphorus loading—commonly the rate-limiting nutrient for algal blooms in freshwater systems. In contrast to nitrogen-driven limitations in marine environments, phosphorus management through this method directly benefits river and stream ecosystems.

Decentralized water systems also extend the hydrological benefits to aquifer recharge. By increasing the wet surface area along watersheds, infiltration. This process bolsters groundwater reserves, fosters soil percolation, and ensures aquifers, particularly semi-open ones, are recharged sustainably. Beyond ecological benefits, these systems provide long-term solutions for addressing water scarcity, erosion, and stream health, enabling regions to adapt to the challenges of climate variability.

This abstract proposes a nationwide initiative to implement decentralized runoff management practices, emphasizing the strategic placement of ponds over critical aquifers. Such systems are crucial for securing groundwater resources for future generations while enhancing ecosystem functionality, biodiversity, and water quality. May bring Regenerative Agriculture practices into this idea so that we can minimize wasteful water usage in Ag.

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References:
The Biotic Pump
Water Cycle Restoration
The Full Water Cycle
The Watershed Death Spiral

# Scott Brame

Andrew

Thanks for the abstract, but I have some questions.  I started editing it for clarity but there are some larger issues to address

1.  You use the term " America's Biotic pump".  This needs a definition, and is it " America's Biotic pump" or " America's biotic pump" or " America's Biotic Pump"?  In other words, is this a formal term, like someone's name?

2. You use the term " This abstract offers a design hypothesis..".  Think in terms of a presentation, not what the abstract will do, this is not a position paper.

3.  This term is unclear and possibly confusing:
" America's humidity and water resource stability can be supported.."
The part about 'humidity' is the problem.  You are making statements that are unsupported and do not logically flow from one sentence to the next.

4.  This part is also suspect in my mind:
" This work proposes a single organizing principle that provides the foundation for system stability & Water cycle balance: Capacity. Capacity is directly related to the land's ability to buffer against both storms and drought."

In order for to accept that as an oral presentation, it will need significant editing that I don't have time or the ability because I cannot follow your flow.

I am willing to accept it as a poster, but not as an oral presentation w/o a clear and logical rewrite.

What are your thoughts?

Scott

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# Andrew Response

Good afternoon Scott,

Thank you for your feedback. I would like to continue to pursue the oral presentation route, and I agree the abstract needs clearer definitions and a cleaner flow. Thank you for working with me on ths as I'm not super well versed in these things.

1. On “biotic pump,” I will treat this as a concept rather than a formal name. I will use “biotic pump” (lowercase) and define it once in plain language as vegetation-supported atmospheric water transport inland through evapotranspiration and related atmospheric dynamics.
2. I will revise “This abstract…” language to presentation language, for example “This presentation proposes” or “This presentation outlines,” to match the oral format.
3. I agree that “humidity” is not the right word. I will replace it with “atmospheric water transport” and make the logic explicit. If we want stronger atmospheric water transport inland, we have to start by stewarding the runoff we already receive, partnering with native biology to keep water cycling through living systems rather than exporting it quickly.
4. I will rewrite the capacity paragraph for a clearer logical sequence, with a simple definition first, then the key mechanisms and measurable indicators, before moving into the development and stormwater framework.

If you are open to it, I will send a revised version shortly that is written specifically for oral delivery and is tighter in definitions and better transitions through the logical story I am trying to write.

Thank you again,
Andrew

# Scott Brame

Andrew
Sounds great.  Try to use plain(er) language that readers can place in context.  Making it shorter would also be helpful – more  concise.

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**Abstract rewrite :**

The story of water is often told as a reaction to events. Catastrophic news dominates the conversation between pollution, drought, and floods. With ever increasing demand for water and more frequent severe events, a shift is being made from reactive response to proactive design. A stable water cycle is built by restoring capacity, the land's holding power on water. When rain is slowed, filtered, and released gradually, streams are sustained and extremes are buffered.

Capacity is the design variable. More capacity means smaller flood peaks and stronger baseflow through dry weeks. Water is nature's buffer in temperature, chemistry, and kinetics, so when land loses water storage capacity it does not just lose "water", it loses stability itself. When capacity is put back into the watershed, life returns and biodiversity is restored. Inland transport of water is then reinforced as surface water is taken up by vegetation and returned to the atmosphere through evapotranspiration, supporting moisture recycling and continuity of transport in a leapfrog pattern across the landscape. This process is referred to here as the biotic pump. Hydrologic and ecological continuity is treated as a form of infrastructure that can be weakened or strengthened. A design hypothesis is proposed: atmospheric water transport inland and water resource stability are supported when persistent moisture and vegetative function are maintained between coastal zones and interior basins, especially along gateway terrains such as lower-elevation mountain passes.

With land development, the loss of capacity is made unavoidable. Runoff is concentrated by impervious surfaces, travel time is shortened, and erosive energy is increased as impacts are shifted downstream. A mechanism is therefore emphasized: the stormwater flow path is lengthened through a tiered sequence of vegetated practices in which runoff is detained, infiltrated, and treated in stages. Drawdown over 24 to 72 hours is used as a first step in stormwater control. That outflow is routed through living filters, first through early successional vegetation, then into wetlands, and only then into streams. In this way, what is already required becomes the starting point for a longer sequence that builds capacity instead of exporting erosive energy. Where conveyance is necessary, outfalls are discharged to ecological buffer zones that function as an extension of this system, promoting infiltration and slow groundwater release to nearby creeks over time rather than direct, erosive discharge to small receiving streams. In settings near protected waters, this sequence is taken further, with higher standards for where and how runoff is received, stored, and released.

By rebuilding capacity in this way, the water cycle can be made more resilient on land, creating conditions that support atmospheric water transport. Stability is then gained against both drought and flood, and aquifer replenishment is supported.