Rub-A-Dub-Dub Explaining Detention with a Tub

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Get to know us

GARVER HYDROLOGY AND HYDRAULICS

- Alan Dennis PE, CFM
  - Oklahoma H&H Team Leader
- Flora Oakley
  - H&H Engineer
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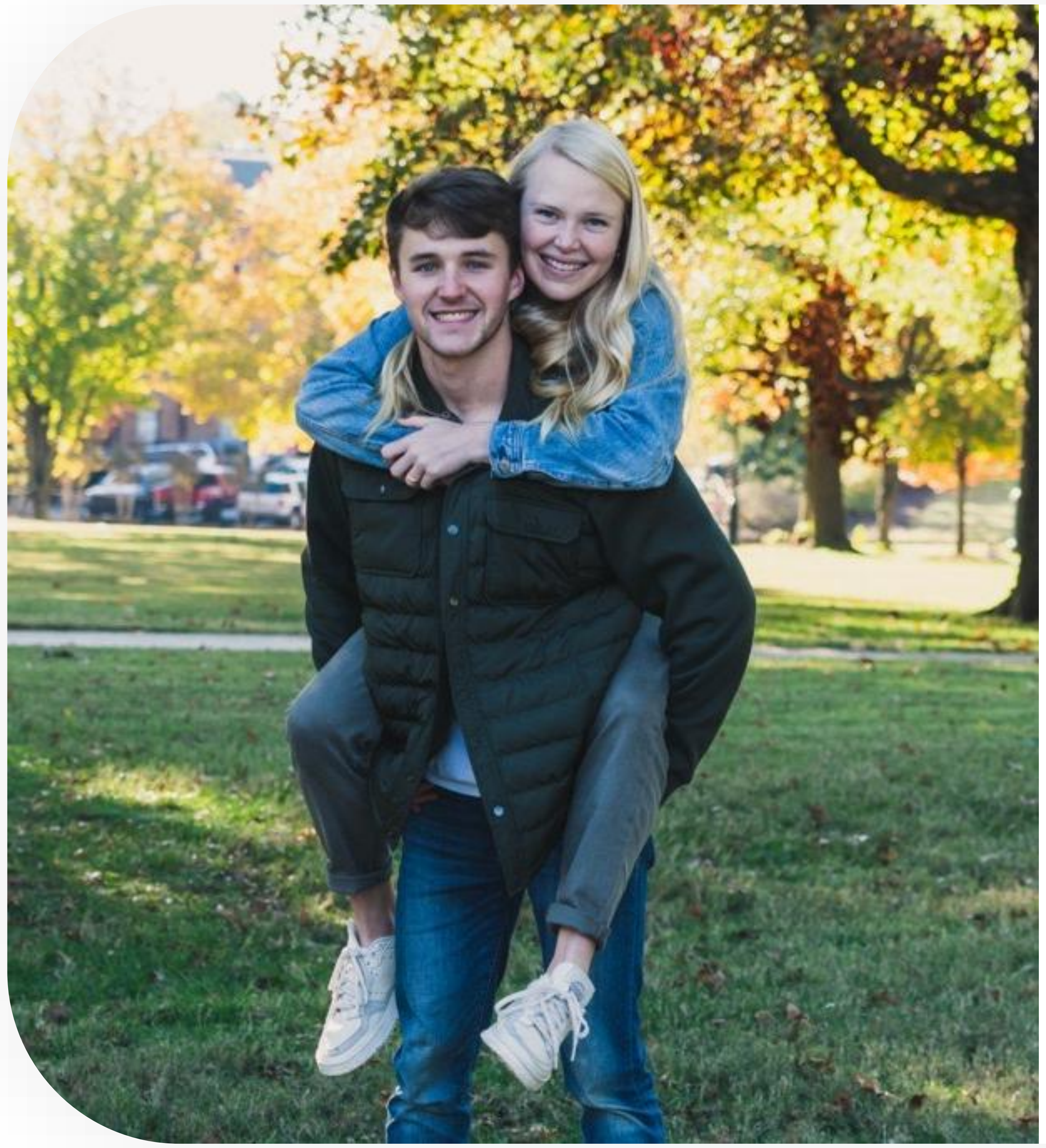

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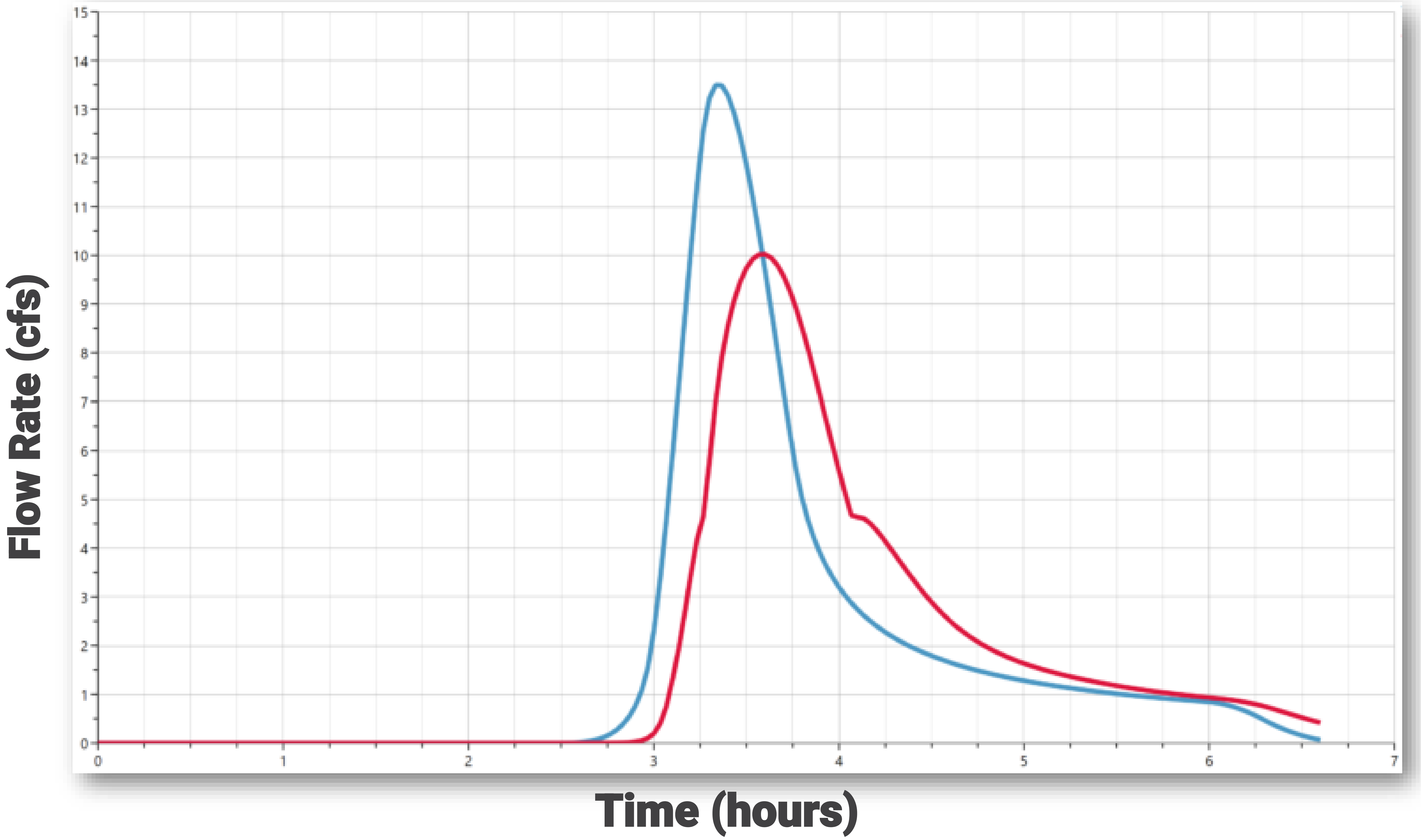
Detention Ponds are Critical to Floodplain Management

- Today's Goals
  - Explain the bathtub analogy
  - Why are they important?
  - Some design pitfalls
  - Examples of detention regulations

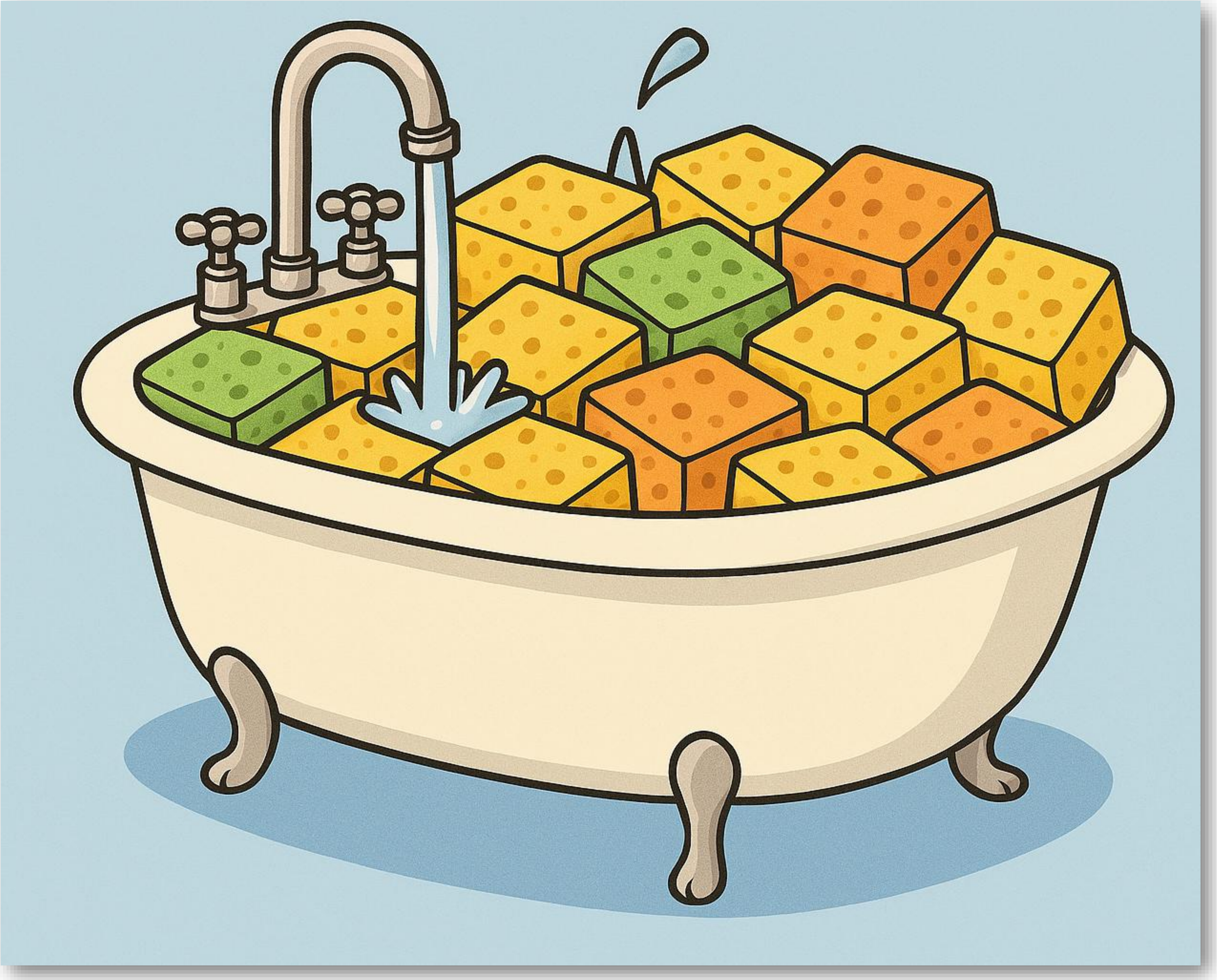
Detention Matters in your Community

- Reduced Peak Flows
- Downstream Flood Mitigation
- Floodplain Dynamics & Community Resilience



Undeveloped land is often like a sponge.

- Think of it like a bathtub with no underdrain, and full of sponges.



Undeveloped land is often like a sponge.

- Vegetation
- “Sheet flow” of runoff
- Generally no underground drainage

Development of land is like filling those sponges with cement.

- Natural attenuation of runoff is eliminated.

- Control of runoff is prioritized.

Developed areas typically cause increases in volume *and* intensity of runoff.

- Development projects often required to put the “design storm” underground.
- Higher *volume* of runoff
  - Lower Infiltration and abstraction
- Higher *intensity* of runoff
  - Higher velocity of flow

Detention provides attenuation of concentrated, more intense downstream flow.

- Lack of detention causes
  - Streambank instability
  - Flooding
  - Overtopping of roads
  - Overwhelmed Infrastructure

Detention provides community resilience while continuing to allow responsible development

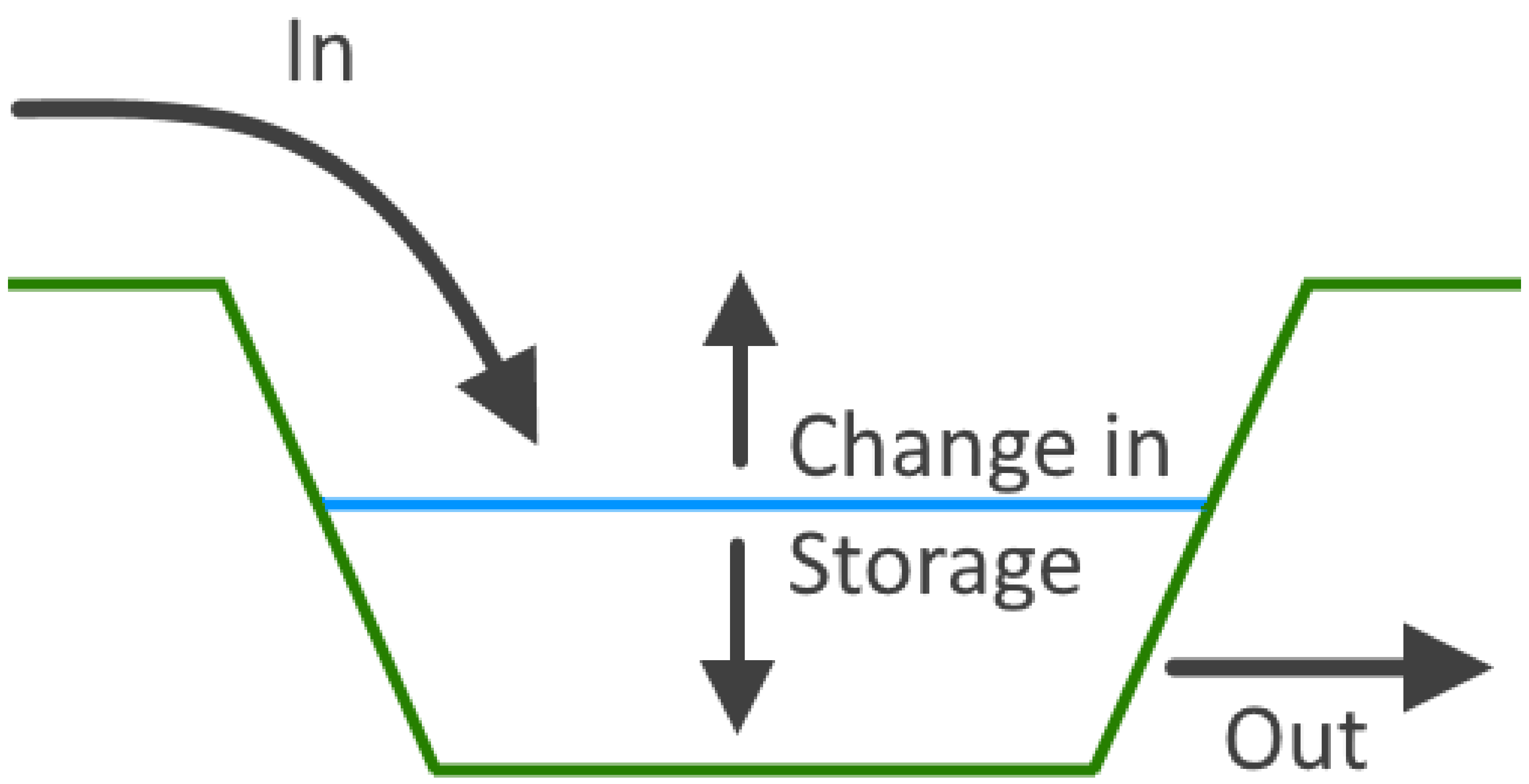
- Downstream property owners are always looking upstream when damages happen.

- Detention ponds can serve community purposes
  - Playgrounds
  - Athletic Fields
  - Disc Golf Courses

Detention Pond Basic Mechanics

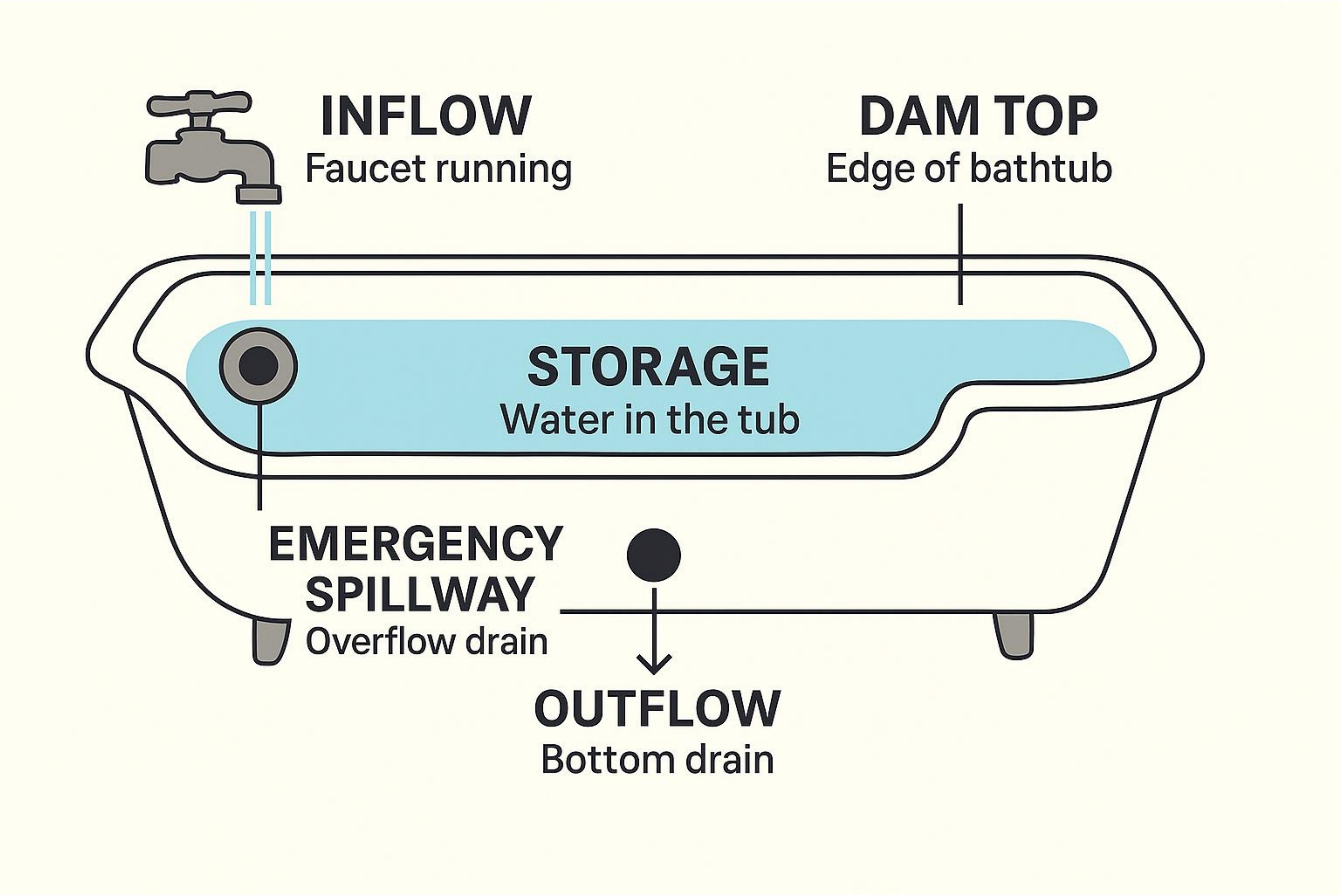
$$I - O = \frac{ds}{dt}$$

Where:
I = inflow volume
O = outflow volume
ds/dt = change in storage volume



Detention slows flow and reduces peak discharge.

The Bathtub Analogy: Basic Mechanics



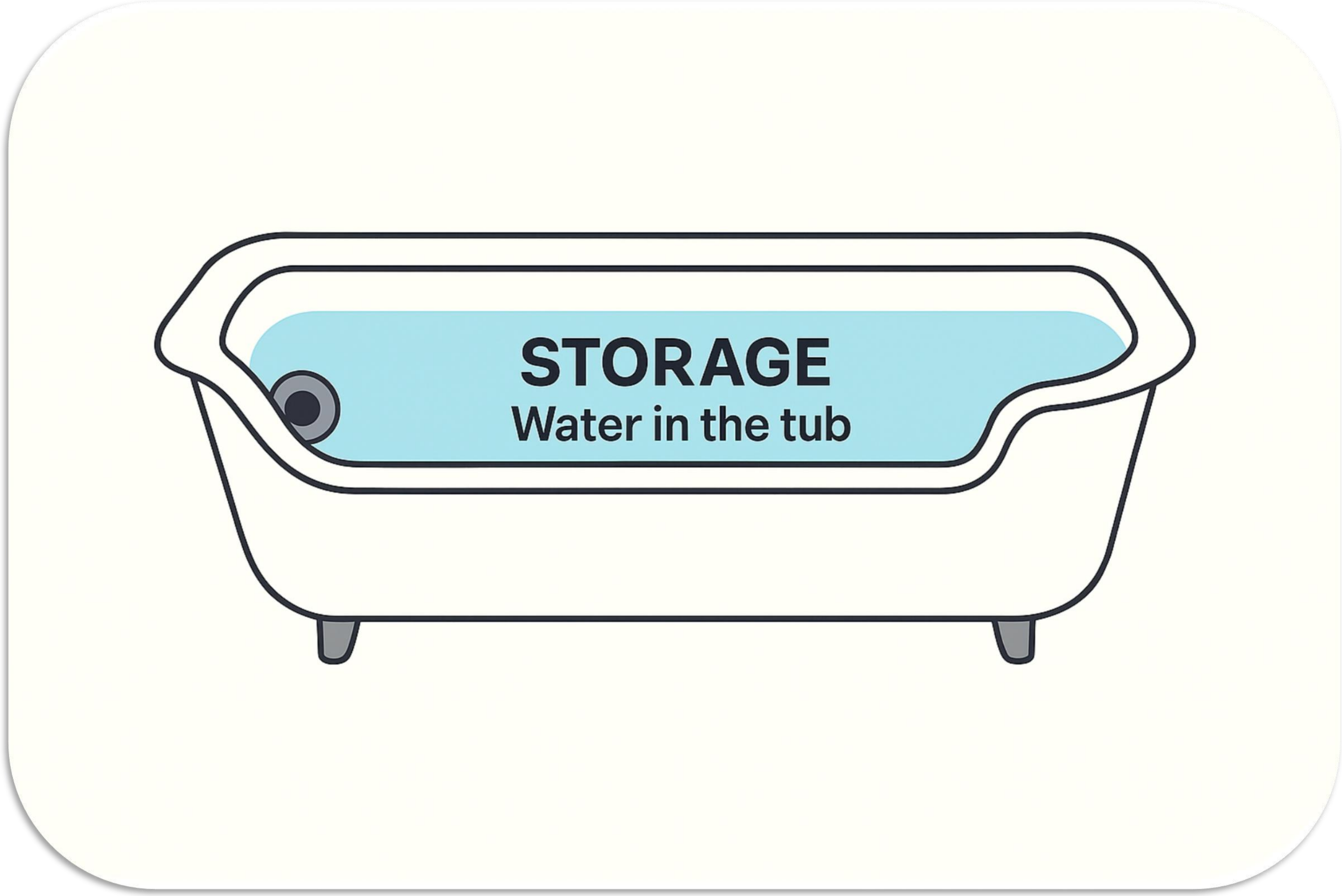
The Bathtub Analogy: Basic Mechanics

INFLOW

Faucet running

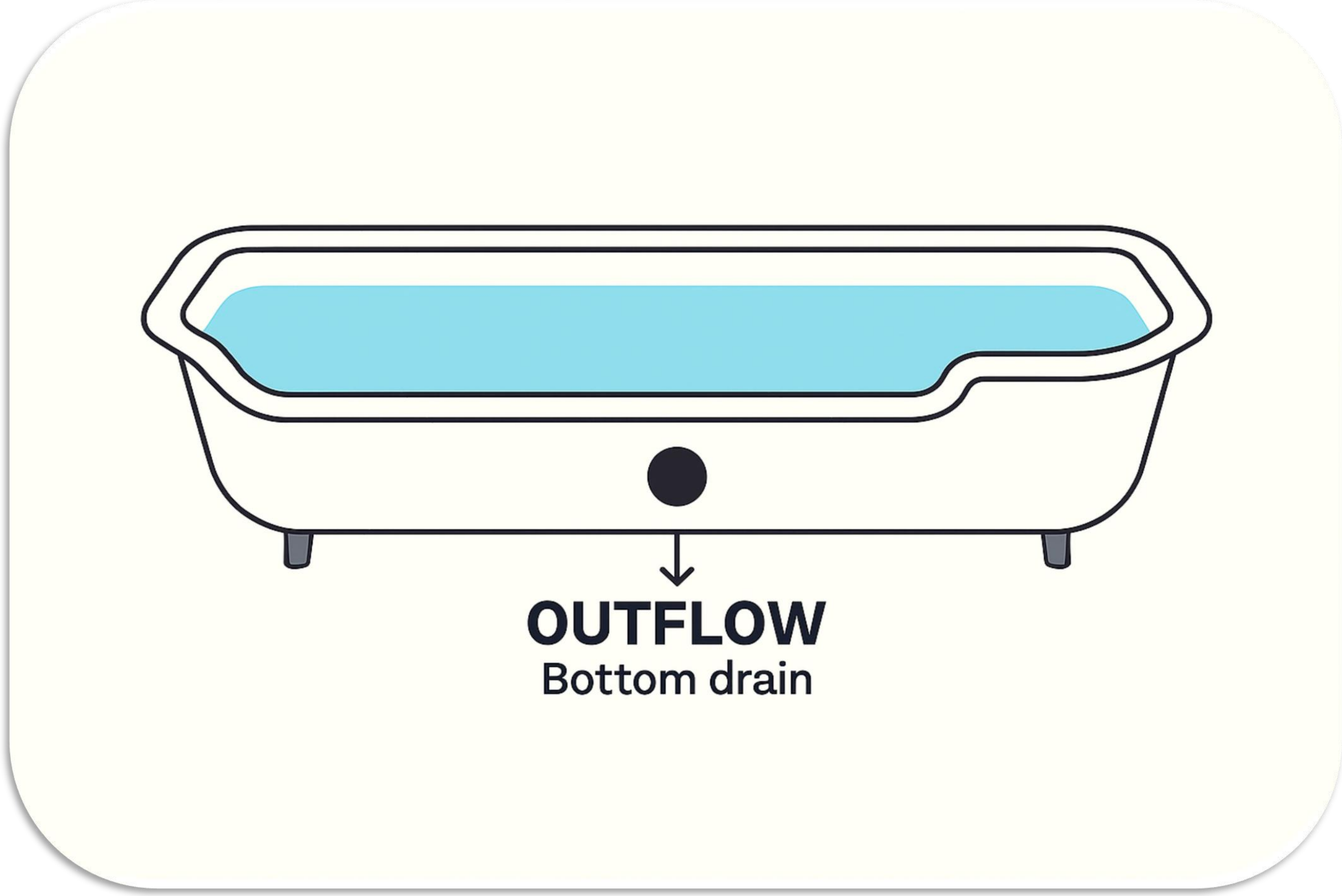
- **Point where stormwater enters the pond.**

The Bathtub Analogy: Basic Mechanics



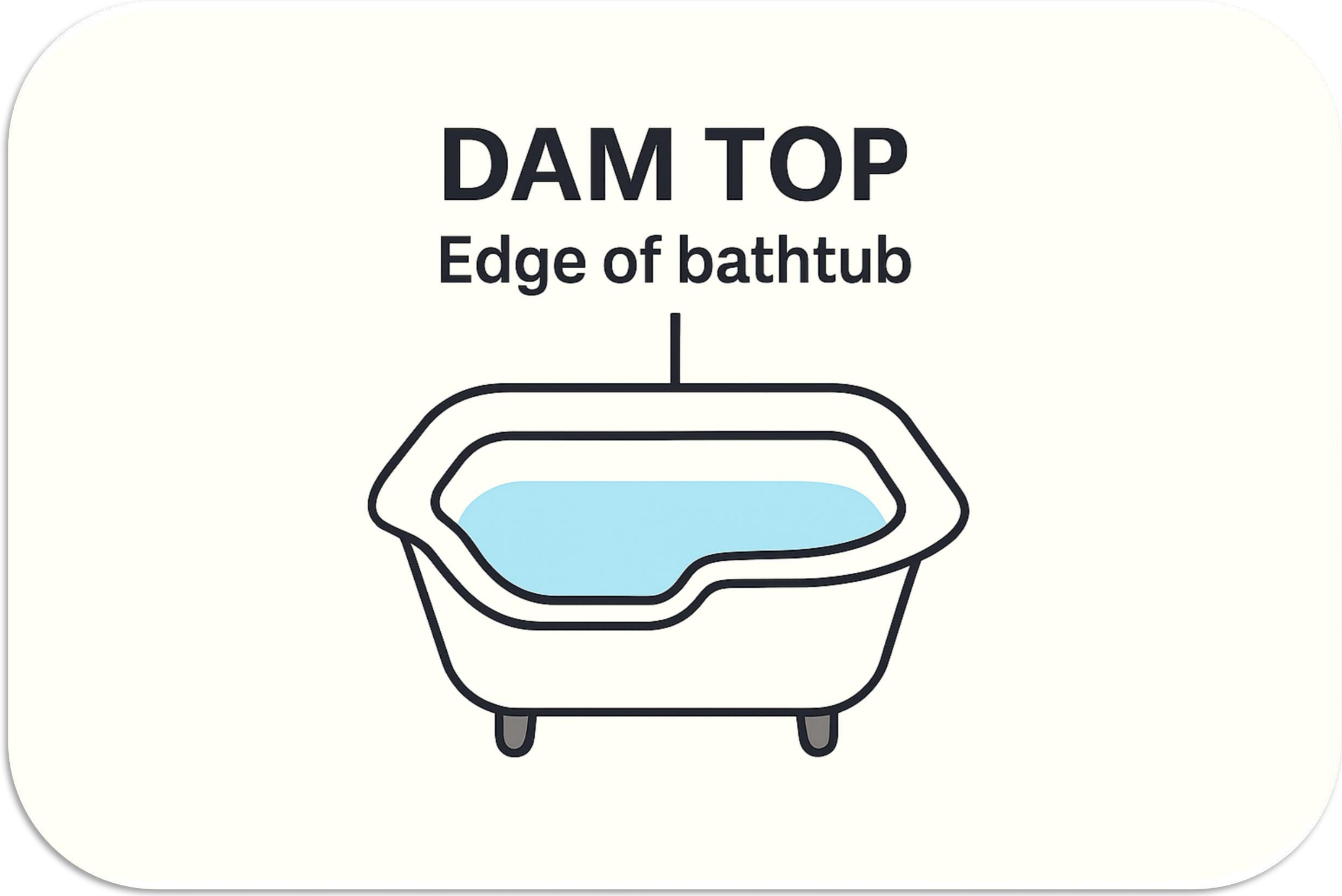
- **Pond's capacity to temporarily hold stormwater.**

The Bathtub Analogy: Basic Mechanics



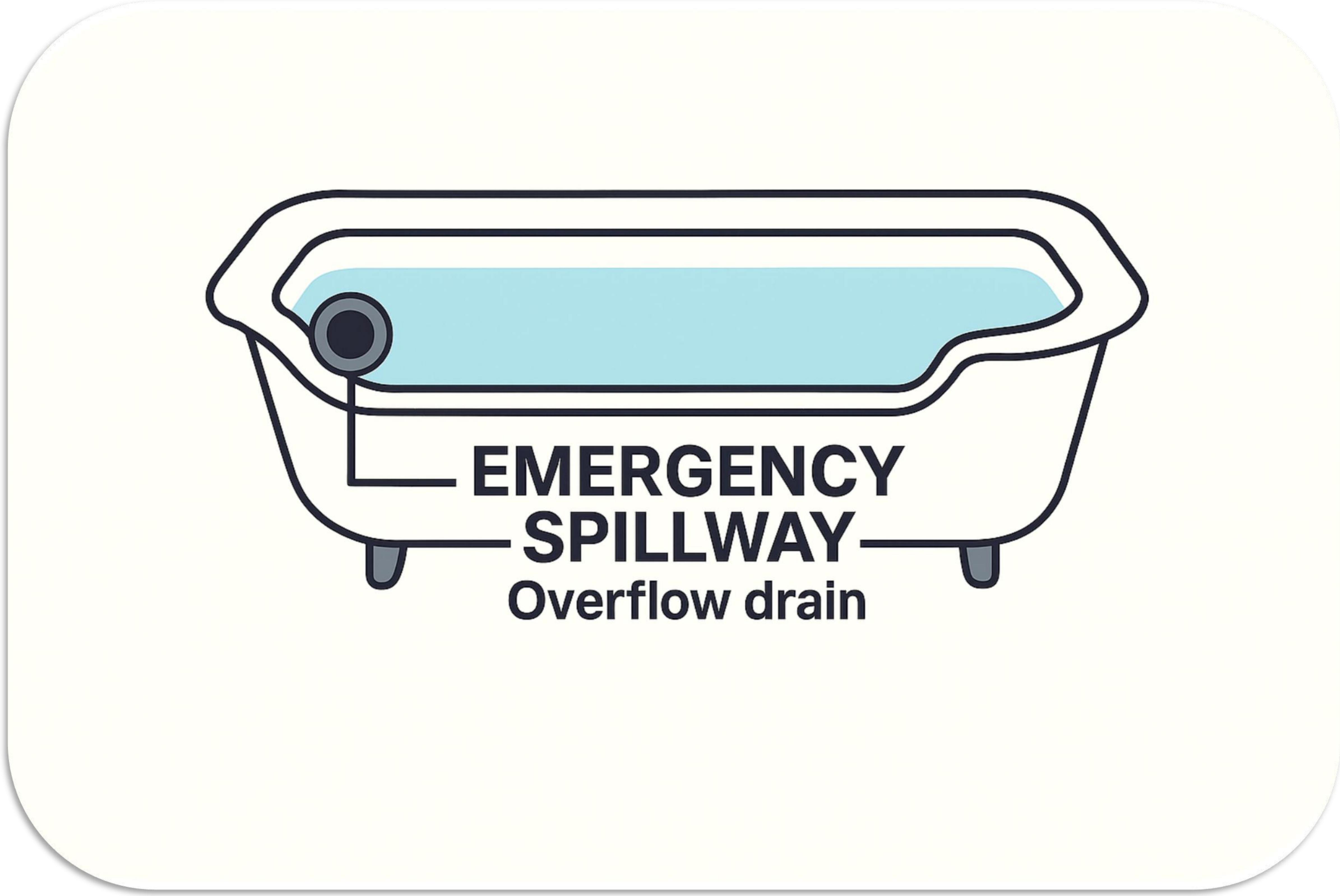
- A pipe, riser, or weir typically.
- Outflow structure is the limiting control on the rate of flow leaving the pond.
- Pipe/Culvert draining the “outflow structure” can also limit discharge rate

The Bathtub Analogy: Basic Mechanics



- **Pond boundary that serves as the barrier holding back water.**

The Bathtub Analogy: Basic Mechanics



- **Secondary outlet located above the normal storage level.**

Real Example: Sutton Wilderness Park

Emergency Spillway

Outlet Structure

Practical Applications for Floodplain Managers

- Things to look out for
- Potential higher standards for design
- FEMA mapping considerations
- Public stormwater and detention pond education

Look out for these common “sinks” when designing detention ponds

- Incorrect downstream boundary conditions
  - Not accounting for culvert flow limitations
- Outlet control structure
  - Not switching from weir to orifice flow
- Retention Ponds
  - Not accounting for “normal” WSEL elevation
    - Reduces available storage

Some communities enforce higher standards of detention pond designs.

Reviewing Development Proposals

Modified Rational Method

- Not accurate for volume calcs
- Unit Hydrograph method recommended

Easements

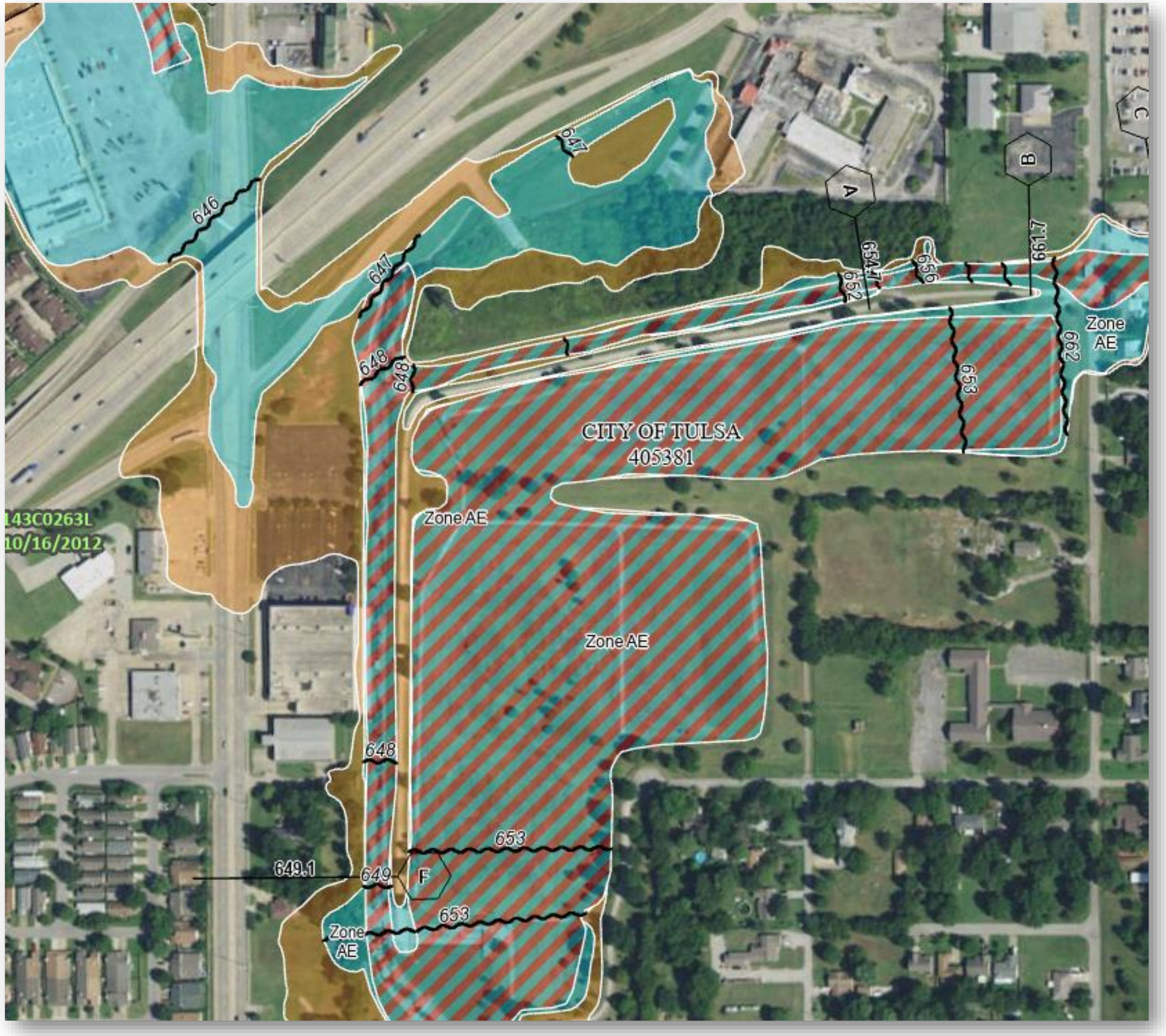
- Spillway protection
- Maintenance access inundation easements

Sedimentation Concerns

- Problem for In-line ponds
- Maintenance Required!

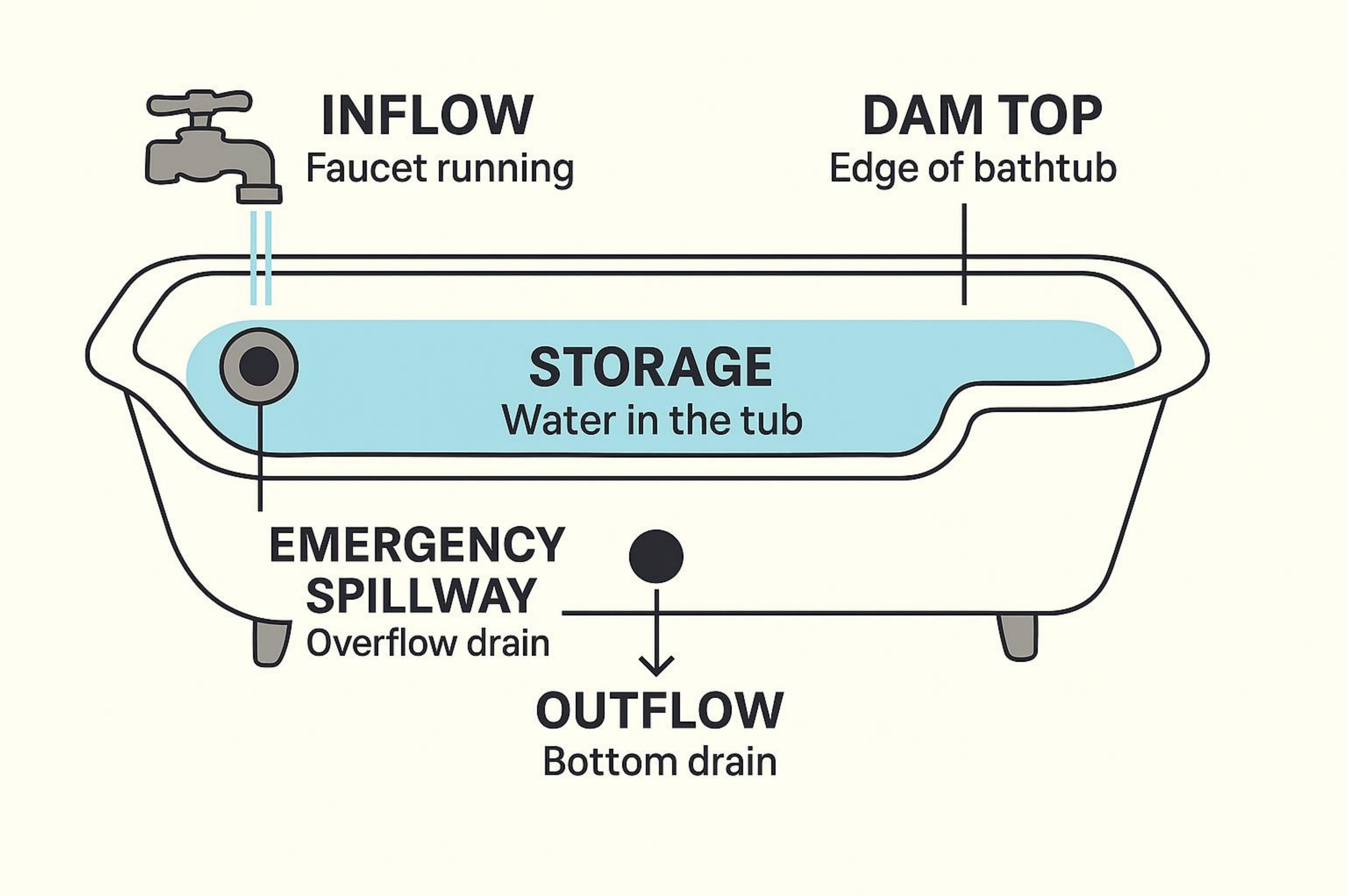
FEMA has certain requirements for floodplain mapping in and around detention ponds

- Area used specifically for attenuation of downstream regulatory flows must be mapped completely as floodway.
- Reservoirs used to reduce downstream regulatory flows must have a record of ownership and regular maintenance



Floodplain Managers can help communicate these concepts in a simple way to the public

Using the bathtub analogy effectively



Conclusion

- **Key Takeaways:**
- Inflow → Storage → Outflow,
- Flood Mitigation
- Community Resilience

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Q&A

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