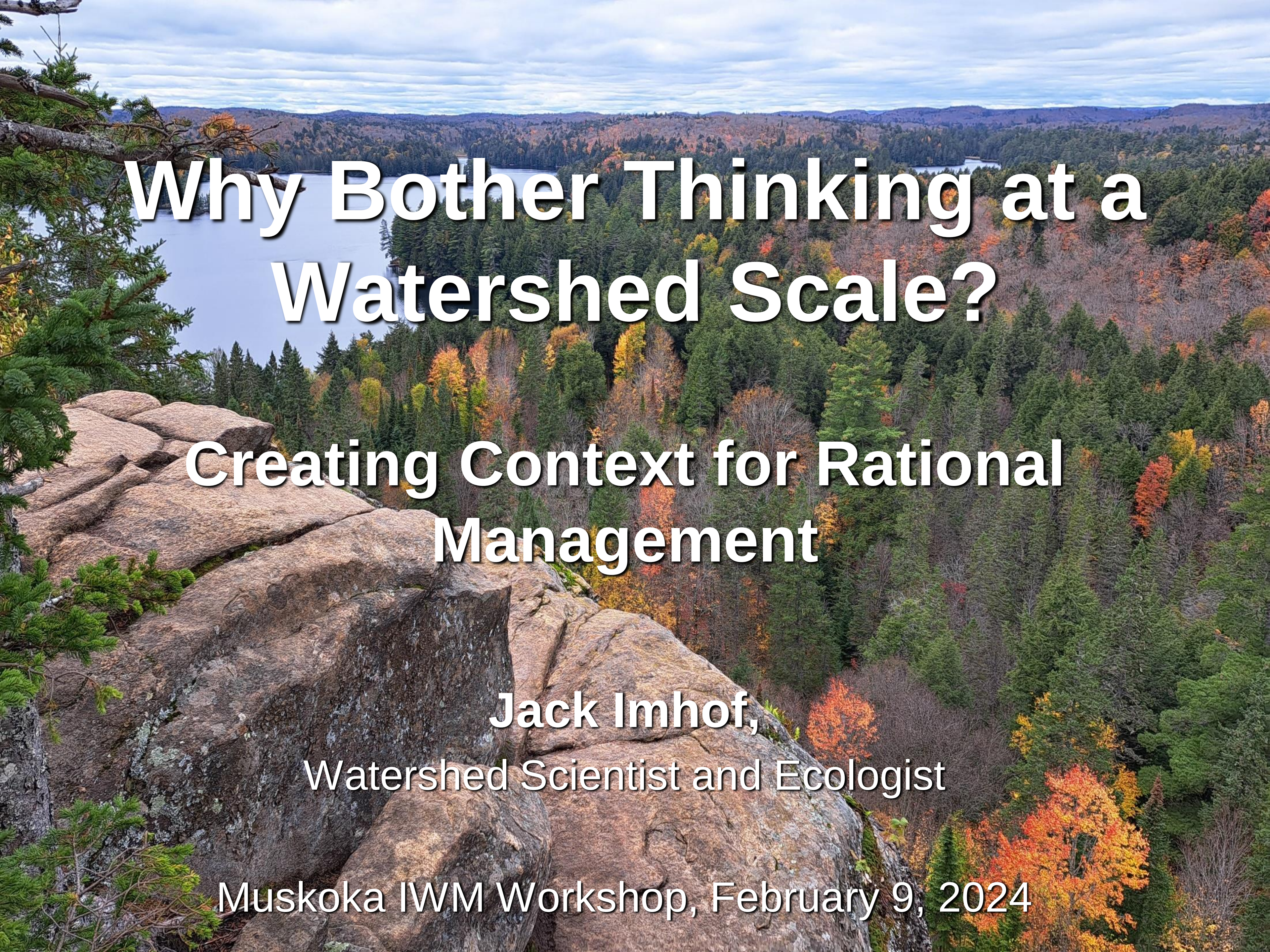

Why Bother Thinking at a Watershed Scale?

Creating Context for Rational Management

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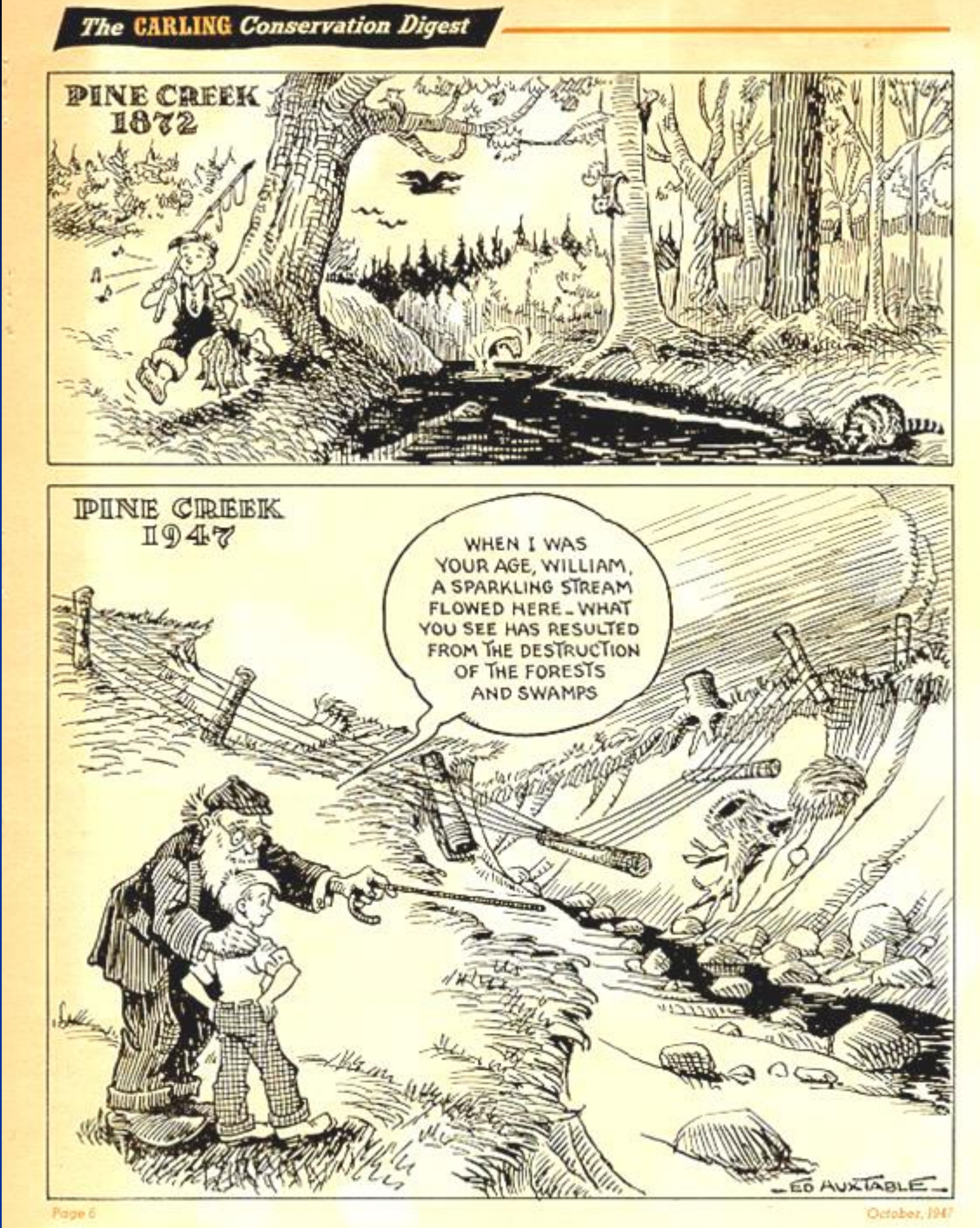
Muskoka IWM Workshop, February 9, 2024

Outline

- Why Manage on a Watershed Basis?
- Watersheds as Ecological Units and more
- Importance of Context
- The importance of Scale and why it matters to you
- Linking the watershed to the Environment
- Summary - Restoring our Natural Infrastructure and ensuring Sustainability for People and Environment

Why do we keep repeating the same mistakes?

(Carling Conservation Digest – October 1947)



Things are Complicated

Complex problems often have easy to understand….WRONG answers

Ecology isn’t Rocket Science……

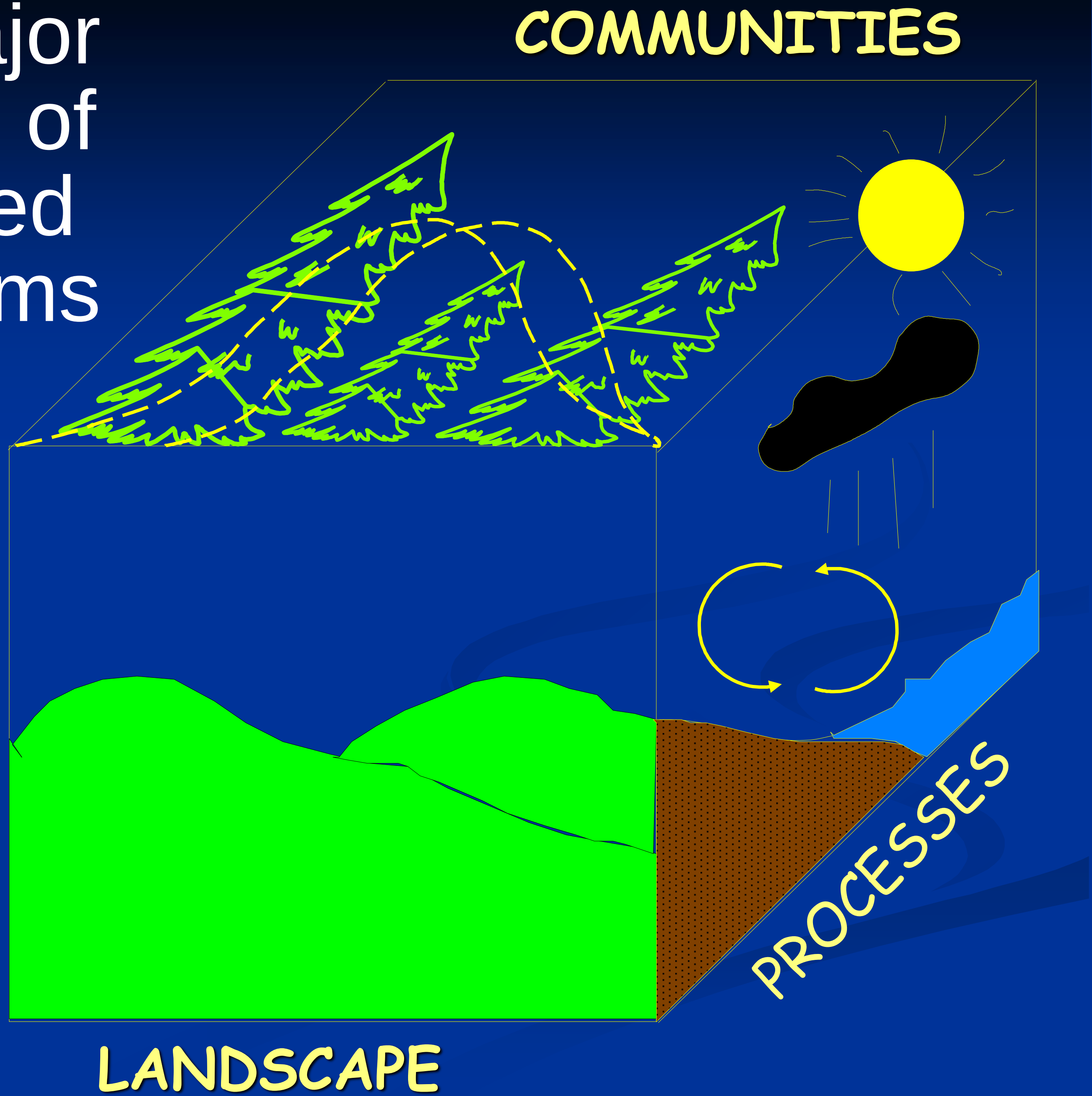
It’s more complicated than that!

And we will need all of us working together at the appropriate scale to sort out managing healthier systems for everyone

Three Major Elements of Watershed Ecosystems

Described by:
- Composition
- Structure
- Function

Understood by the relationship between Pathways and Processes

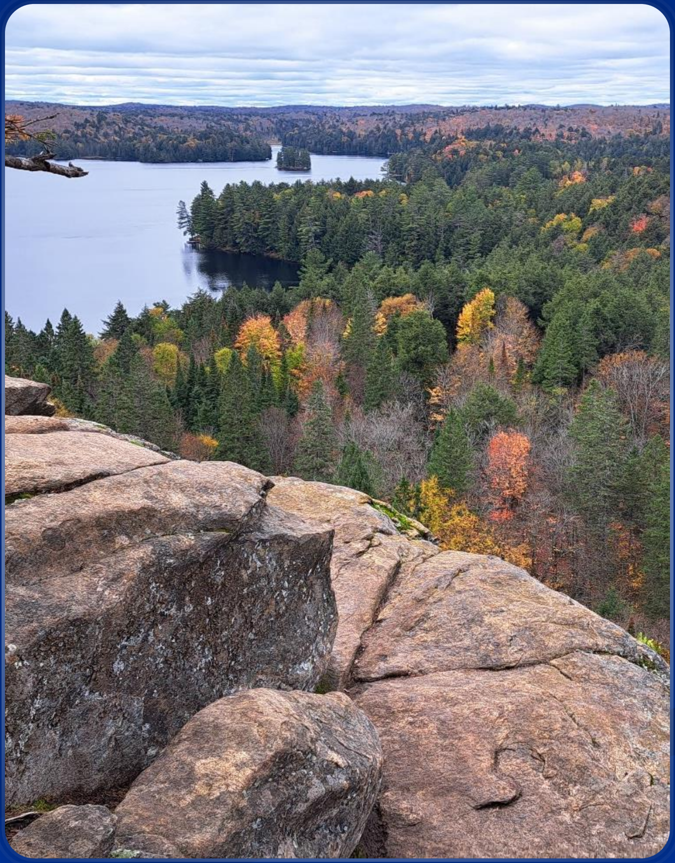


Role of Context in Environmental Management

- Governments currently manage natural systems through policy and programs developed as a result of single issues
- These issues often not connected to other concerns about landscapes
- Therefore to really make a difference…
- Environmental Management and Infrastructure Management MUST Embrace Contextual Thinking since natural systems are inherently inter-connected.

Value of A WATERSHED'S Natural Infrastructure

- Values:
  - Water storage, supply and management
  - Cleansing of water and health of the land
  - Recreation and food sources
  - Foundation of Biodiversity
  - Resilience to higher environmental variability
  - Spiritual and Physical Well-being
- Conditions to strive for:
  - Better management of land and water in and on the landscape
  - Healthy riparian corridors, shorelines and floodplains
  - Stream competence : move water and sediment while maintaining its form
  - Low maintenance costs and sustainable
  - Safer human environs and infrastructure

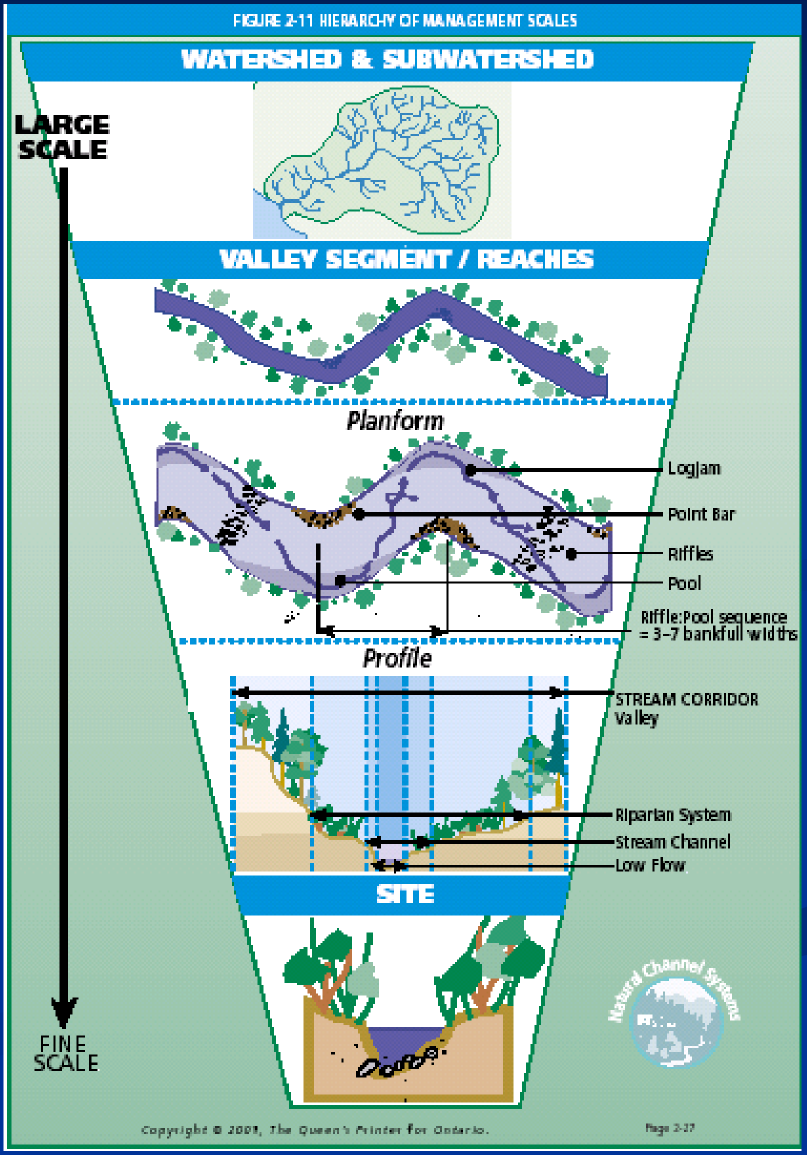


Spatial Scale

Integrated context begins with selecting the spatial scale that helps to integrate the sciences and our understanding.

For watersheds this is often, watershed: valley segment/lake; local site

Implementation will occur at several scales, selected to be the most appropriate to address the issue.



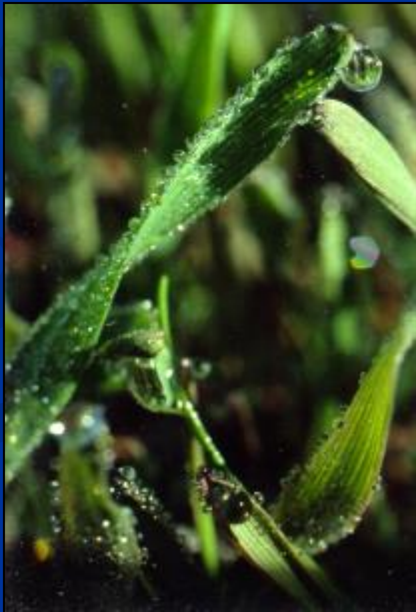
Geology provides the rock and structure

Climate creates the weather and weathering

Vegetation modifies water flow over and through the watershed

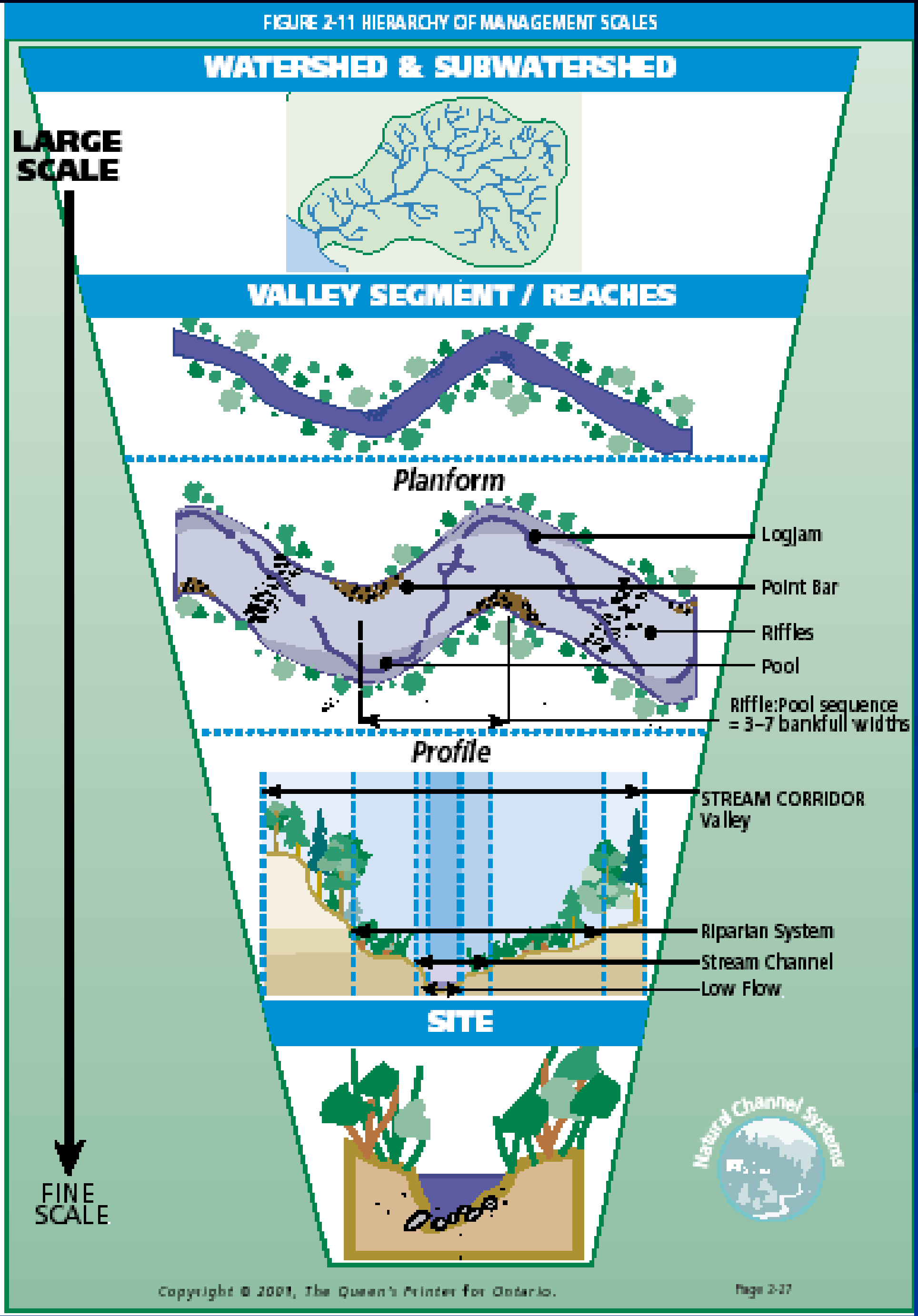
The site creates the channel form or lake shore that provides habitat and stability

The valley directs and concentrates surface and groundwater



Building Context

- Which end of the telescope should you be using?
- If we only fix what we perceive to be the problem at the site, we may NOT really fix ANYTHING ($$$$$!)
- What is the cause of the problem and at what Scale!?

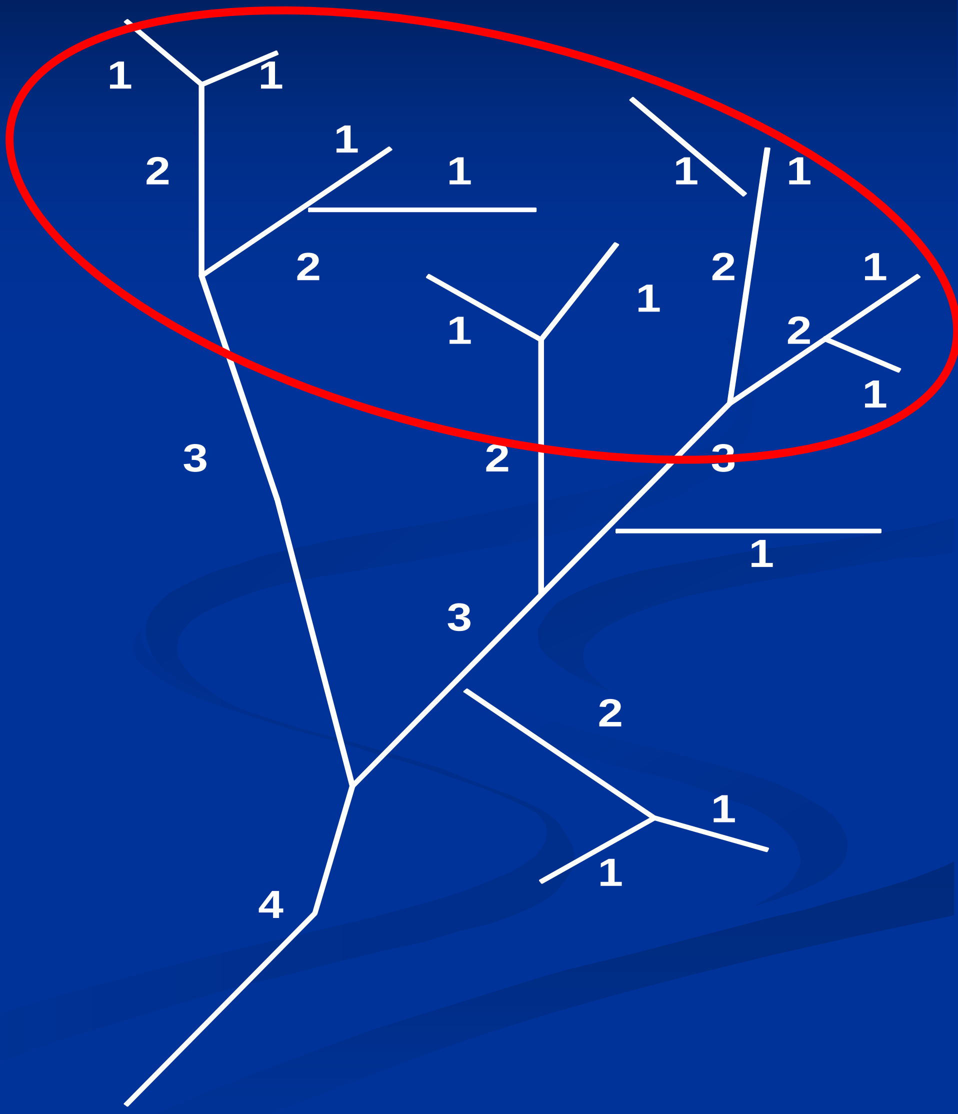


CONTEXT IS EVERYTHING!

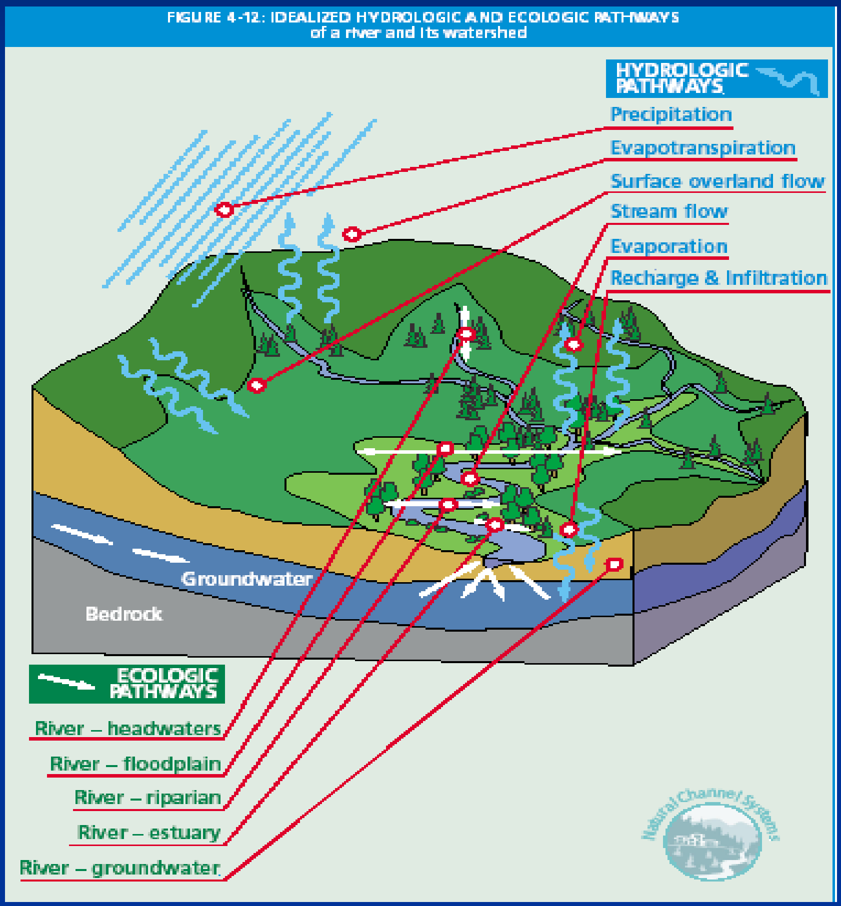
- We all want to stabilize eroding banks…but why is the bank eroding?
- Is it a local issue…cattle or removal of rooted shrubs?
- Is it a result of channelization upstream and the reach is adjusting?
- Is it a large clearcut or subdivision in the headwaters and the entire system is adjusting?

Watershed and Headwaters

- Stream Ordering helps classify streams within a watershed
- Headwaters are where streams begin
- Often considered 1st and 2nd order
- The Muskoka watershed has over 19,000km of headwaters…..
- THAT is where your floodflows are generated

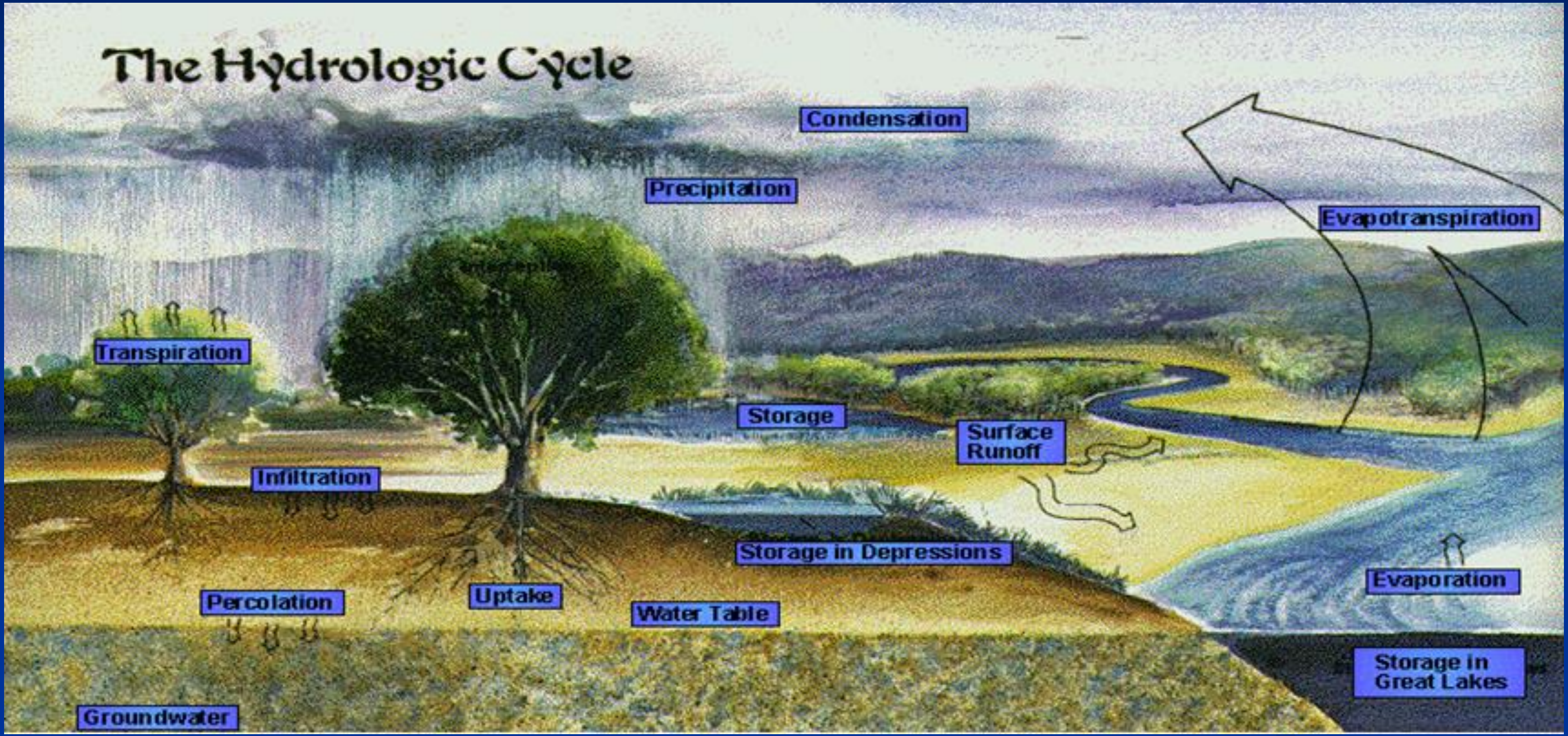


Introduction to Pathways within the watershed



- Two Key Pathways: Hydrologic (water cycle) and Ecologic
- Pathways as a means to understand processes and change
- One way to understand living and non-living interactions
- Water flows over and through the landscape carrying nutrients, materials, organisms, etc.
- These pathways generate various processes that create opportunities for species and for economies

Application Of The Water Cycle or Pathway



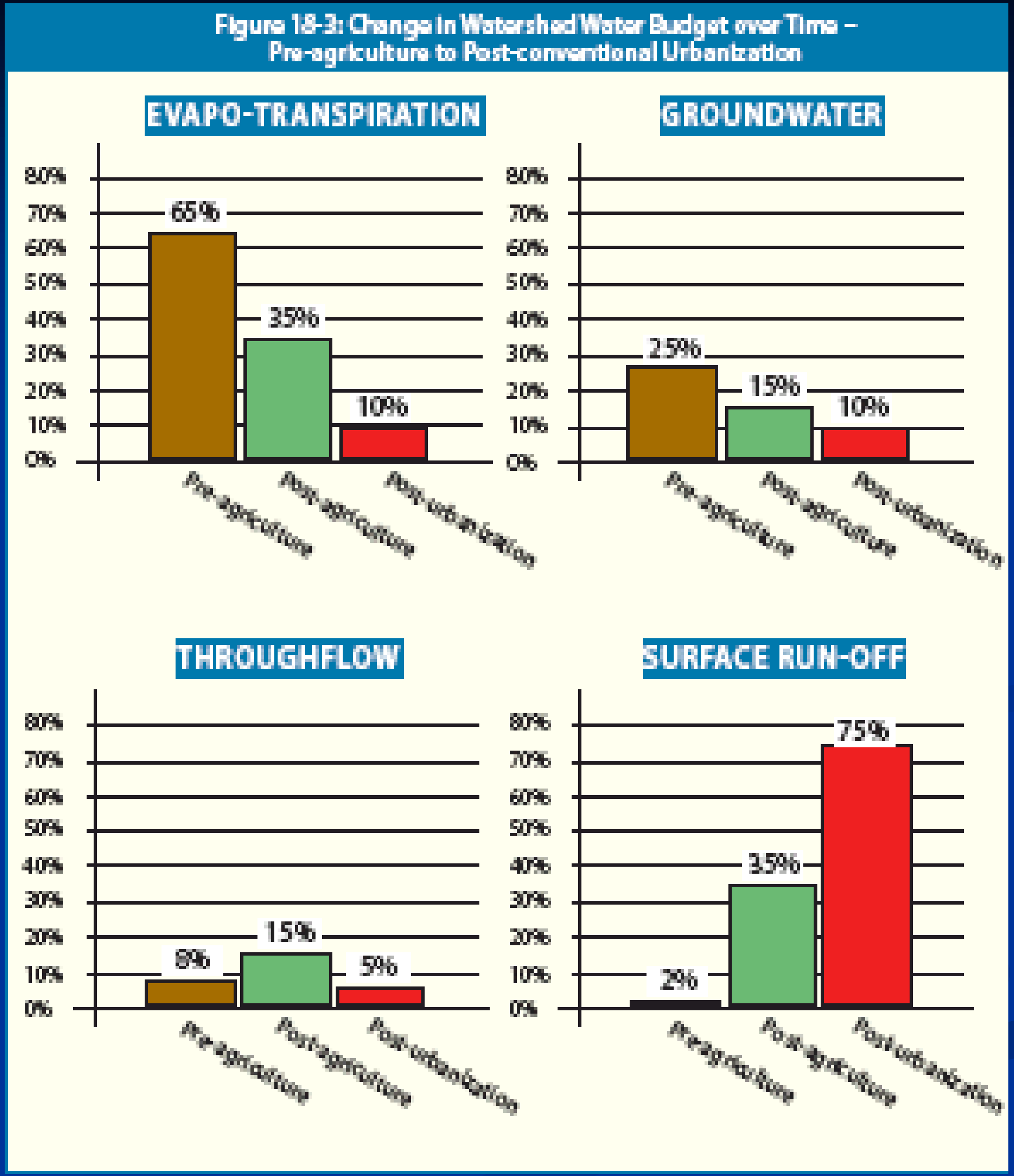
The quality and health of our watershed is controlled by the way that water, nutrients and sediments move over and through the watershed and by life, including our interaction with these pathways <u>and how we have modified them</u>.

Water Cycle Pathways

In our temperate landscape, the water cycle is driven by the geology first and the land cover second.

As we change landcover through landuse, we change the budget.

Pathway drives movement of water, sediment and nutrients



Managing Hydrology is NOT a Site Issue

- Within the Muskoka Watershed, acid rain has depleted Ca in the soils;
- Evapo-transpiration of trees has been reduced by 25% as a result of Ca deficiency in the soils
- Given shallow soils and bedrock…
- This means 25% MORE water entering rivers and lakes during high melt or precipitation
- Causing HIGHER potential floods
- Solutions are not at a municipal level….they are a Watershed issue to be collaborated on from headwaters to mouth

Impacts Of Water Cycle Pathway Disruption

- Changes in water and sediment regime and yields, resulting in:
  - Less infiltration and interflow and concurrent increases in run-off and flooding;
  - Reductions of groundwater contributing to to wetlands and baseflow in streams;
  - High flow changes (magnitude, frequency, duration and rate/timing of change);
  - Changes to geomorphology of valley, lake and stream systems as well as floodplain/riparian and aquatic habitats;
- Impacts on <u>built infrastructure</u>, water quality, properties along lakes and rivers, irrigation and water supply

Impacts Of Ecologic Pathway Disruption

- Flow pattern alterations change migration patterns and routes to and from headwaters;
- Altered in-channel processes (e.g. flow patterns and sediment movement) results in degraded aquatic health, water quality and impacts to built infrastructure
- Alter interactions of river and floodplains (less nutrient and sediment capture and water storage, wetland loss, changes in water quality);
- Loss of riparian zone structure and functions affecting natural system and properties along rivers

The effort to control the health of land has not been very successful. It is now generally understood that when soil loses fertility, or washes away faster than it forms, and when water systems exhibit abnormal floods and shortages, the land is sick.

–Aldo Leopold

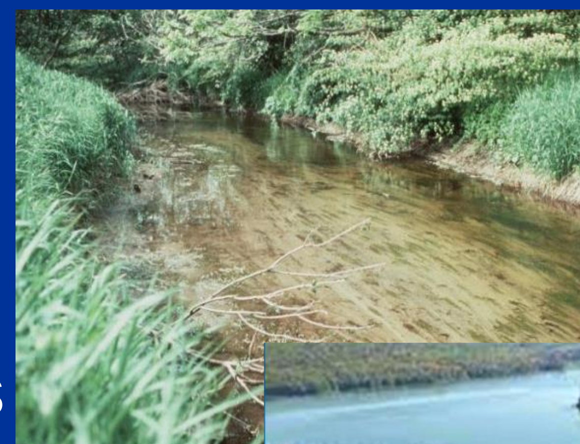
Sand County Almanac

Land **Use Impacts and Scale**

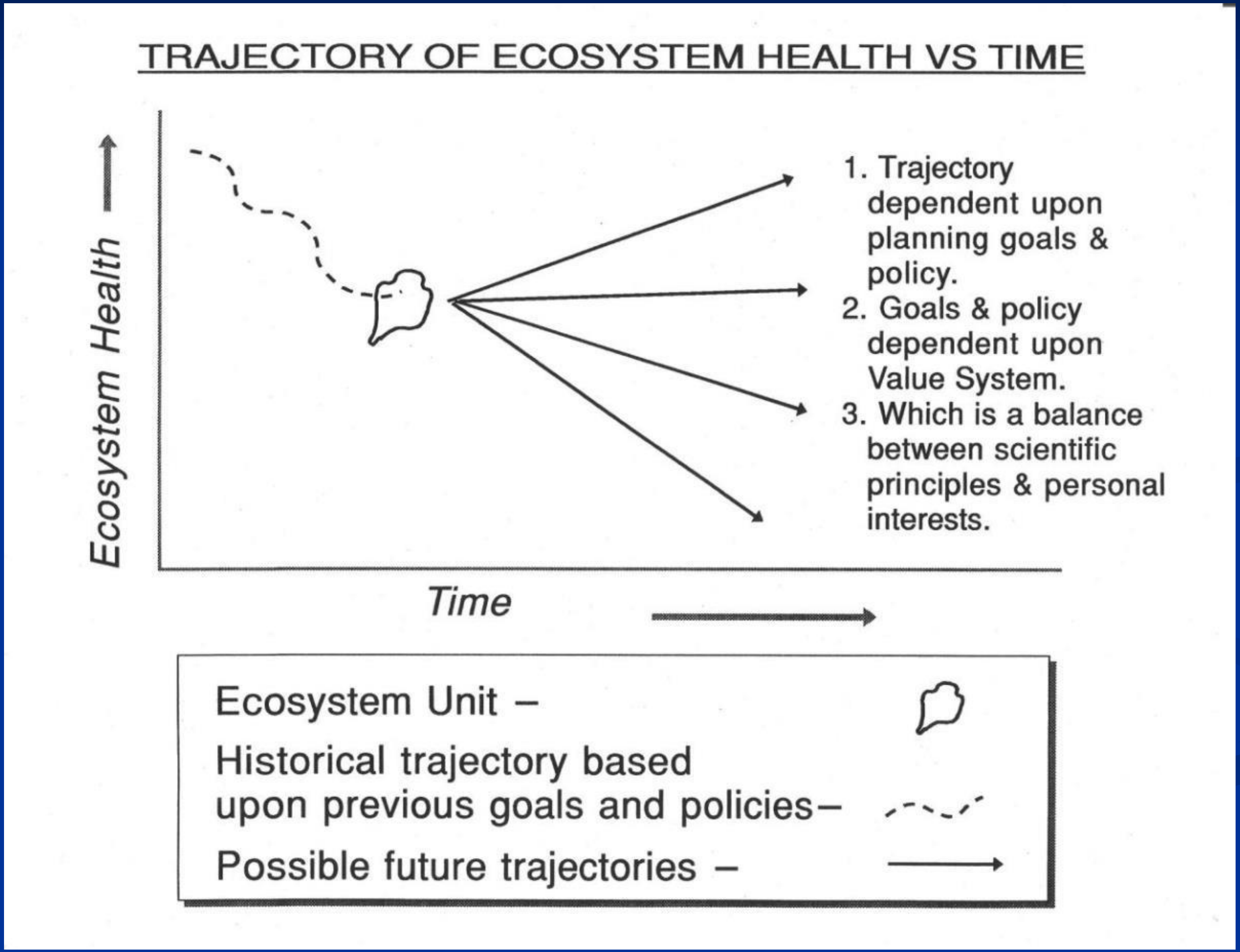
Activity	Watershed/Headwater Tributaries[1]	Valley/Reach[1]	Site[1]
Forest Management - eg. clear cutting	*** ↑ water yield and run-off generation; ↓ infiltration; ↑ sediment discharge	** ↑ sediment loads; destabilization of planform and channel form; ↓ woody inputs	* degradation in riffle:pool sequencing; ↑ bank erosion; changes in substrate sorting; ↓ instream habitat complexity
Agriculture - drainage and crops	*** ↑ surface runoff; ↓ infiltration; ↑ sediment and nutrient loadings	*** ↑ drainage works; ↓ riparian zone and nutrient uptake; bank and riparian compaction; radical ↑ sediments and nutrients; ↓ water quality	* ↓ riffle:pool complexity; ↑ bank erosion; channel degradation; ↑ temperature; infilling of channel by sediments
Agriculture/Rangeland -grazing/pasturage	** ↑ annual peak flows; ↓ baseflows; ↓ saturated zones; ↑ nutrient inputs; ↑ bedload	*** ↓ meander geometry; ↑ channel width and ↓ depth; major reduction or elimination of riparian zone; ↑ bank erosion; ↑ fines in substrate; ↓ substrate sorting; ↓ water quality; impacts on herd health	*** ↓ riffle:pool complexity; wider/shallower cross-sections; ↓ coarse woody debris in channel; ↑ fines in substrate; ↓ habitat complexity and heterogeneity
Aggregate extraction - Gravels and sands adjacent to watercourses (depending upon extent and numbers)	** change in hydraulic gradients of shallow groundwater system; changes in low flow characteristics; changes in stream temperatures; potential ↑ sediments (washing)	*** potential ↓ distributional characteristics of groundwater discharge; potential change in volumes of groundwater discharge; ↓ floodplain storativity (if gravel extraction there); ↑ reach temperature	*** ↓ thermal refugia distributionally and volumetrically; ↓ potential for spawning of some species (eg. brook trout); alteration in distribution of baseflow contributions
Urban Development	*** ↑ impermeability of watershed; changes in water budget and ↑ water yield; change in drainage density; ↑ nutrients; ↑ fine sediment, ↓ coarse sediment inputs; ↓ water quality	*** ↑ surface runoff; ↓ infiltration; ↓ low flow; ↑ fine sediment discharges; ↑ frequency of severe floods; ↓ meander geometry; ↑ channel width; ↓ channel depth; abandonment of floodplain; ↑ water surface slope; ↑ temperatures	* channel armouring; ↓ habitat complexity and heterogeneity; ↓ riffle:pool complexity; wider/shallower cross-sections; ↑ fines in substrate; loss of riparian zone

Landuse Changes Potential Consequences

- These create changes in water quality, water quantity, channel health, lake levels, erosion, flooding, fish communities, etc.
- Results of these transitions on river and lake systems include:
  - Δ Nutrient Cycling
  - Δ Channel Morphology
  - Δ Change in Lake Water Storage
  - Δ In Seasonal Lake Levels
  - Δ Temperature Regime
  - Δ Habitat Conditions
- <u>None of this is solved within any municipal boundary</u>



WHERE DO WE AS A SOCIETY, WANT TO GO?



Putting Integration Into Watershed Management

- **<u>Context is Everything</u>** (eg. Spatial, temporal, policy)
- Helps identify locations and causes of problems
- Integrates understanding of the watershed and helps to prioritize conflicting policy and legislation
- Identifies the SCALE of the problem
- Creates a science-based, transparent process open to scrutiny and discussion
- Ensures implementation projects operate at the right scale AND location as they <u>Treat the Causes of System dysfunction, not their Effects</u>

Desired Outcomes - Restoring Our Natural Infrastructure

- Returning the landscape and its land:water linkages to a healthy, **functional** state for people and environment
- We need an integrative understanding to accomplish this.
- Piece-meal approaches will be either ineffective or actually destructive.
- We have to rebuild resiliency into our watersheds to help mitigate higher climate variability
- Planning is at the watershed level even though implementation may be local

Integrated Watershed Management: Setting Context for linking Agendas and Mandates

Forest Management

Biodiversity Conservation

Federal Fisheries Act & Fish Habitat Management

Erosion Management

Water Quality/Quantity Management

Agricultural Irrigation and production

Shoreline Management

Water Quality Management

Natural Heritage Systems

Natural Infrastructure

Lake Development

Growth Management

Regional Land Use Planning & Management

Groundwater Surface water Interactions

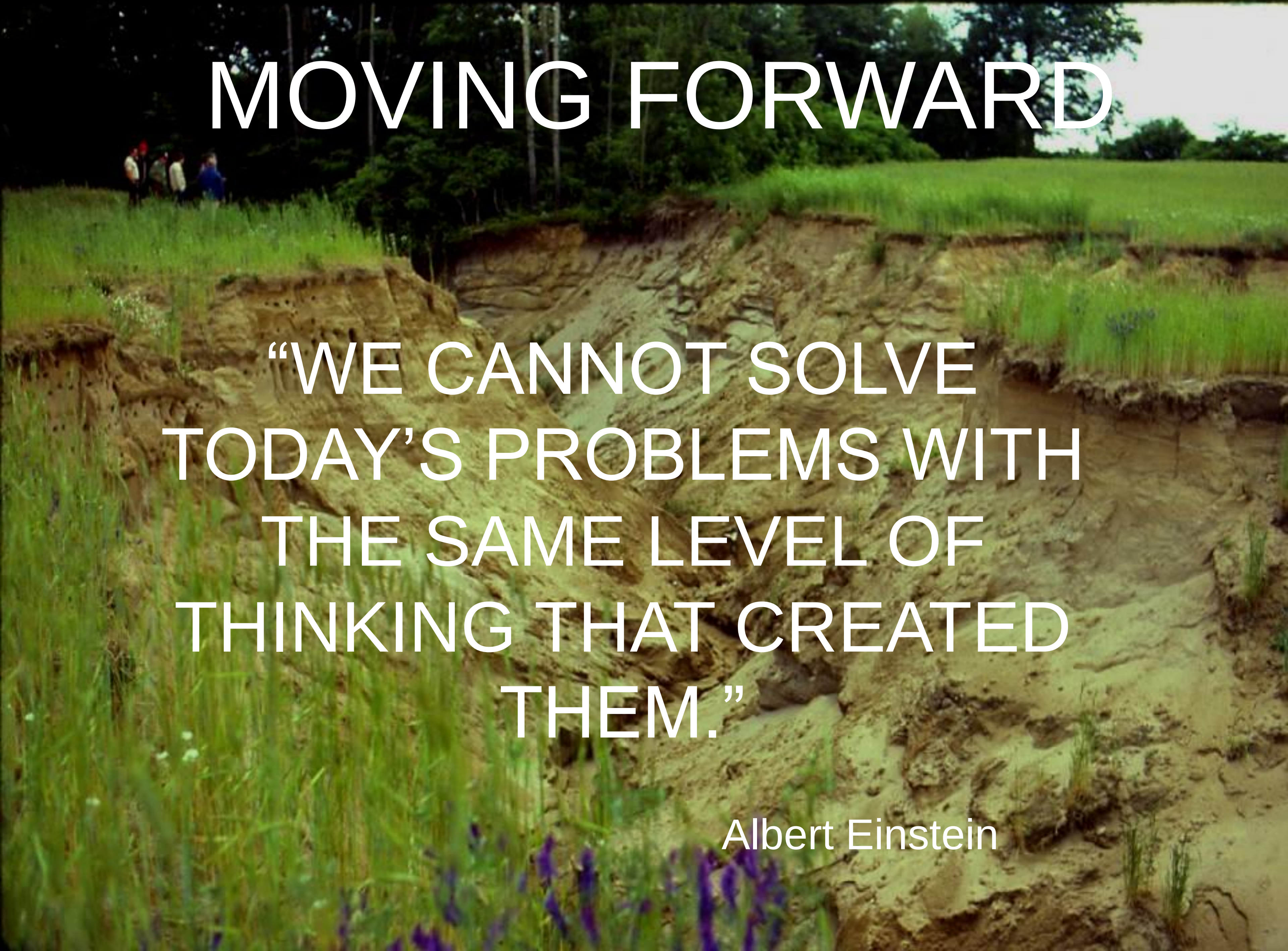
Aquatic Ecosystems Management

Natural Hazards Management

Source Water Protection

SUMMARY
Pay now or Pay Much More Later

- Without a systems context, doomed to fail to address cumulative degradation or effectively adapt to climate change;
- Watersheds are key to linking land/water management and understanding consequences and alternatives;
- Most policies only address one issue therefore to avoid/balance with other policies and desires, we MUST have contextual understanding;
- Site specific regulation primarily slows the slide to degradation, it does not prevent or improve.



MOVING FORWARD

"WE CANNOT SOLVE TODAY'S PROBLEMS WITH THE SAME LEVEL OF THINKING THAT CREATED THEM."

Albert Einstein

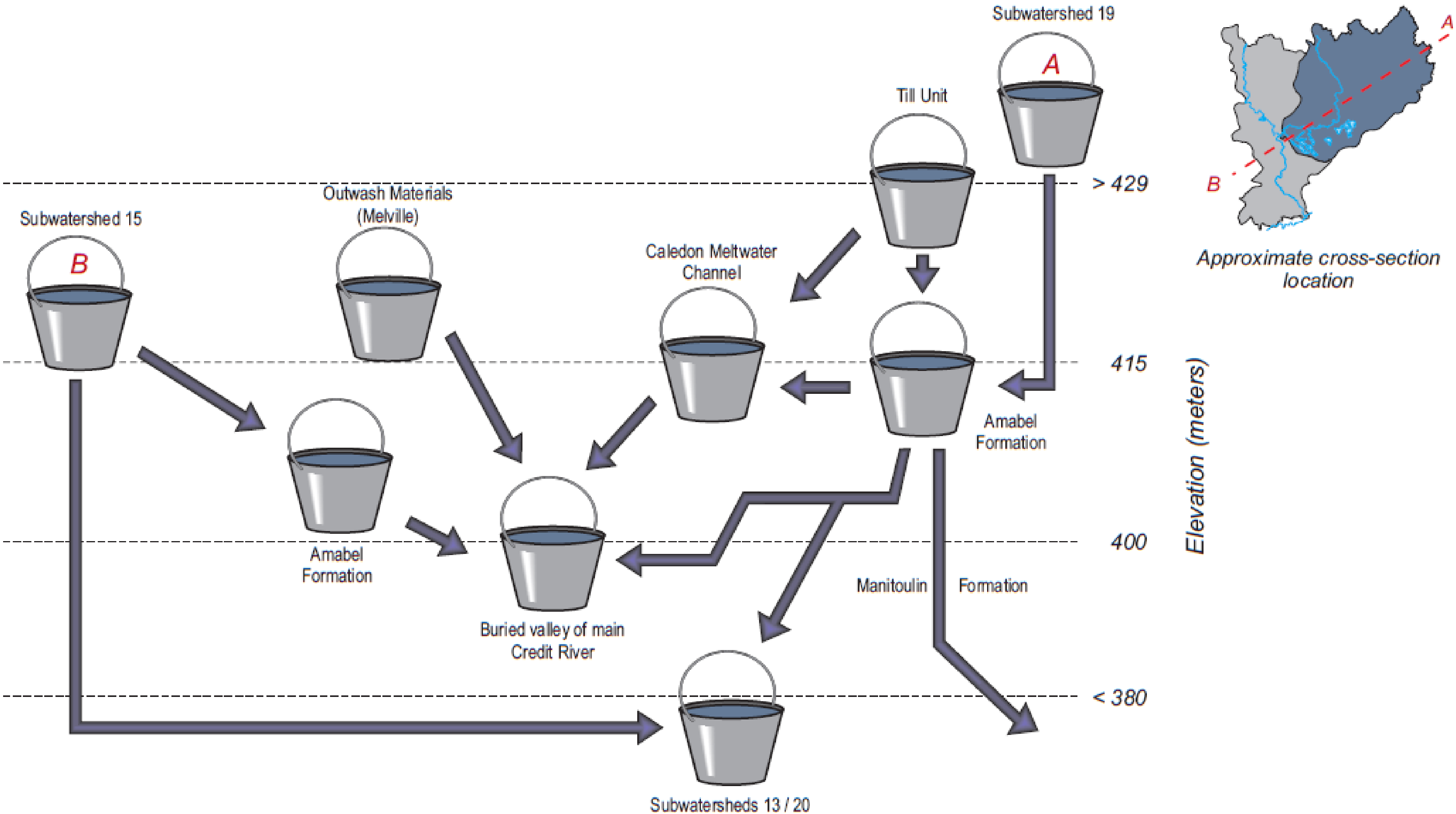


Figure 2.3: Groundwater Linkages

Source: Jack Imhoff and Credit Valley Conservation, 1998