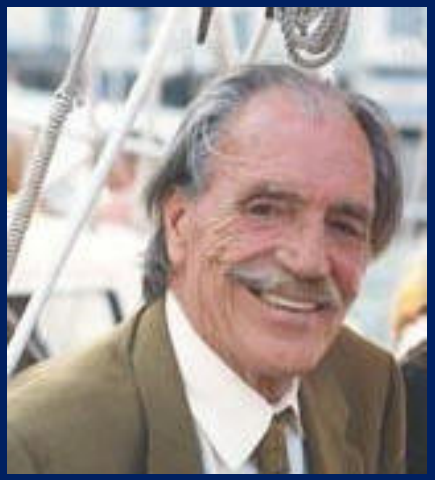
Old Guys Telling Stories

William E. Derry

On behalf of Chris May

BACK TO THE FUTURE: A half-century later, *"Ecosystem Resilience"* is another call to action to "Design With Nature"!



Ian McHarg (1920-2001)

Renowned landscape architect, writer, educator, "father of GIS", founder of environmental planning, and author of Design With Nature

"The shaping of land for human use ought to be based on an understanding of natural process."

"Let us green the earth, restore the earth, heal the earth."

We Need a New Generation of Storytellers

- 1960's 1970's: Environmental and Water Quality Laws
- 1980's, 1990's: Stormwater
  - Camelot
  - 1988: APWA Stormwater Managers Committee
  - We believed we could change and save
  - New Science: Brian Marr, Rich Horner, Derek Booth, Chris May et al

Ecosystems are more complex:
than we know and
more complex than we know how to think
*paraphrased from Jack Ward Thomas

Known with a High Degree of Certainty

- Puget Sound and tributary streams are degraded and declining – populations crashing
- Population growth is unrestrained and will continue
- Puget Sound will continue to decline even without growth
- The majority of lowlands in the Puget Sound Basin has been deforested and converted to other human uses

There is no science and no historic example to support the concept that storm water management practices can sustain hydrologic regimes and water quality to the extent needed to protect, let alone, restore aquatic resources or streams in developed areas.

Well, OK

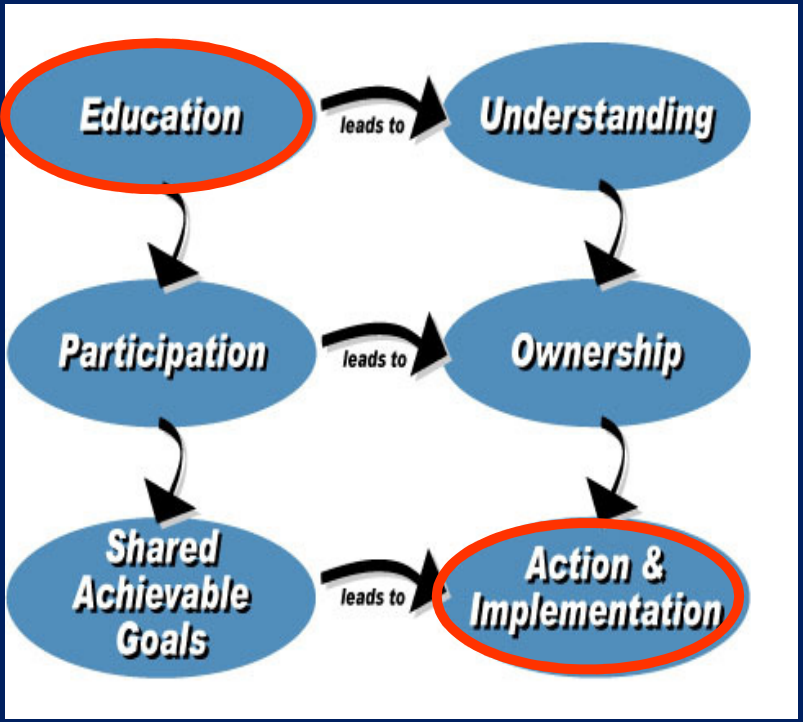
Therefore

- Refinements to current practices won't be enough
- Changes in lifestyles, land use, and regulations are needed
- More public education and funding needed.

Science Is No Longer the Issue!

- This is where NGO's have become critical: governments can't solve the challenges without public pressure
- Water quality and habitat must become a higher priority among the public
- Only NGO's and individuals can make this happen
- Elected officials will jump in to lead the parade only if voters get it started

This is what needs to happen to achieve **integration of perspectives** that leads to **action**



Source: *Stormwater Planning: A Guidebook for British Columbia, 2002*

Critical Success Factors:

- *Commitment to take action & deliver*
- *Champions to provide energy & drive*
- *Accountability to deliver at all levels*
- *Resources to get the job done*

Inform, Educate & Inspire

Glass half-full or half-empty

- It's easy to get discouraged but we have made a lot of progress.
- Things have improved.
- Only because of public pressure and government action

It's Not a Sprint

- You Can Live Through Political and Economic Swings
- Keep On Keepin' On

Land Use
Save the best of the rest
Increase urban densities

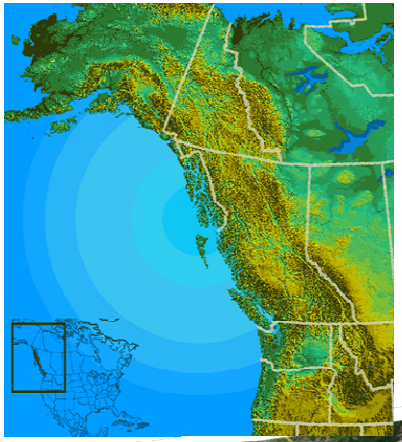
Sustainable Urban Watersheds

Lessons Learned from the Puget Sound & Kitsap County

Using the Whole-System, Water-Balance Approach

Chris May
Stormwater Division Lead
Kitsap County Public Works

Kitsap County Washington

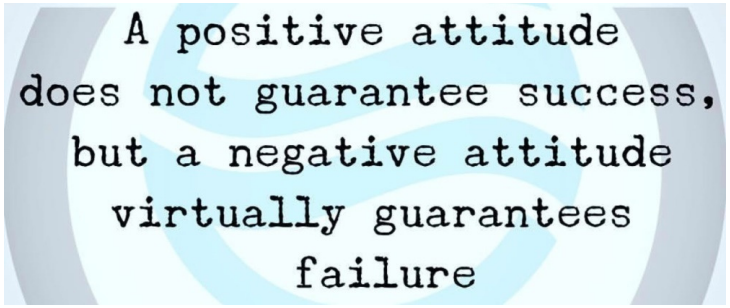


Where in the #@$* is Kitsap County

Presentation Overview

Clean Water Kitsap
Partners in Stormwater Solutions

- **The problems caused by "development"** ***(ironic quotes)***
- **Potential Solutions for Sustainable Living**
  - **Whole-System, Water-Balance Approach**
  - **Green Storm water Infrastructure**
- **Quality of Life Considerations**
  - **Multi-Functional/Benefit Stormwater Systems**

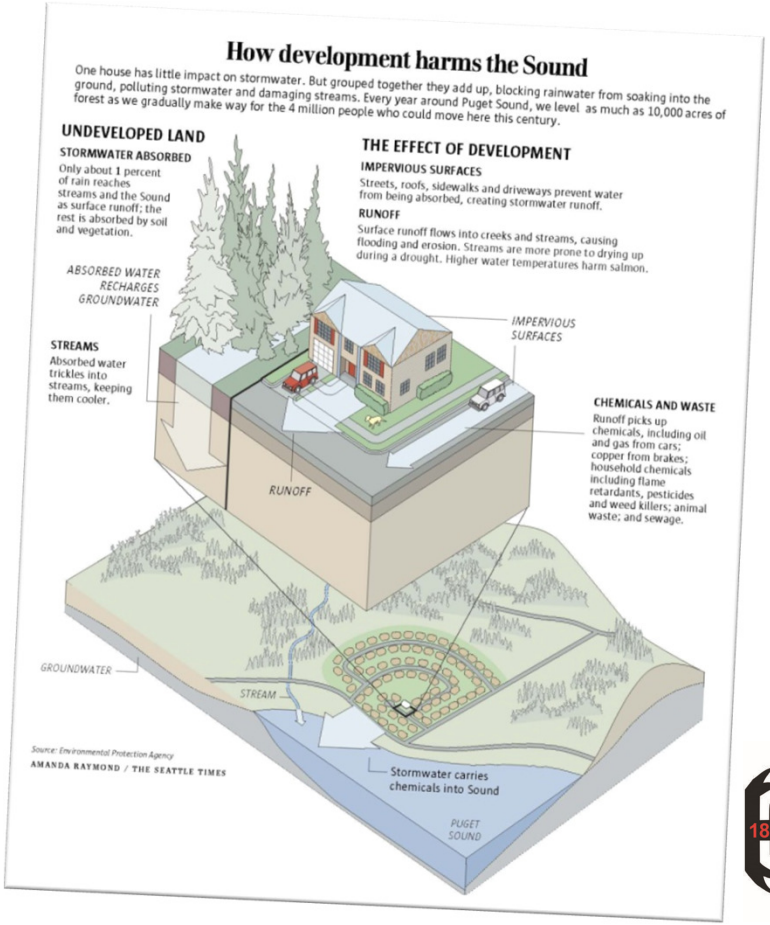


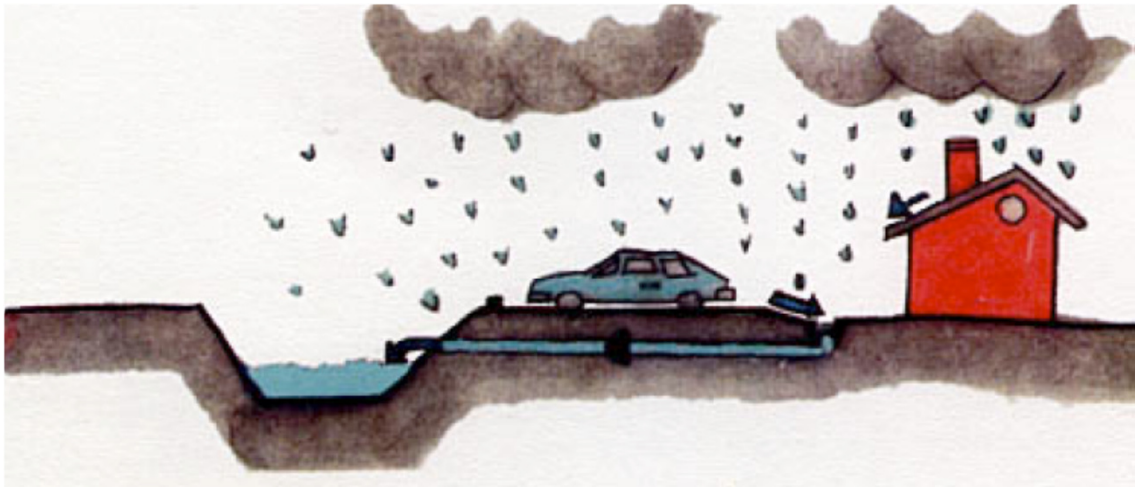
KITSAP COUNTY
18 57
WASHINGTON

Kitsap County Stormwater Problems

Same problems throughout the Puget Sound & Salish Sea

- **Hydrologic Modification due to Stormwater Runoff Volume**
- **Water Quality Degradation due to Stormwater Pollution**
- **Fecal Pollution in Local Inlets, Embayments, and Shorelines**
- **Stream Habitat Degradation due to Frequent and Elevated Stormflows**
- **Localized Flooding of Urban Areas**





How did we get here (literally & figuratively)!?

1972 US Federal Water Pollution Control Act, commonly known as the Clean Water Act (CWA) – Amended in 1977 & 1987

1983 NURP Study
Recognizes Stormwater as a NPS Problem

1988 NPDES Permitting and 1st Stormwater Design Manual in Washington – Flood Control

1995-97 Water Pollution & Flow Control incorporated into Stormwater Management

1995-2001 Research

What's the Big Deal with Urban Runoff?

1

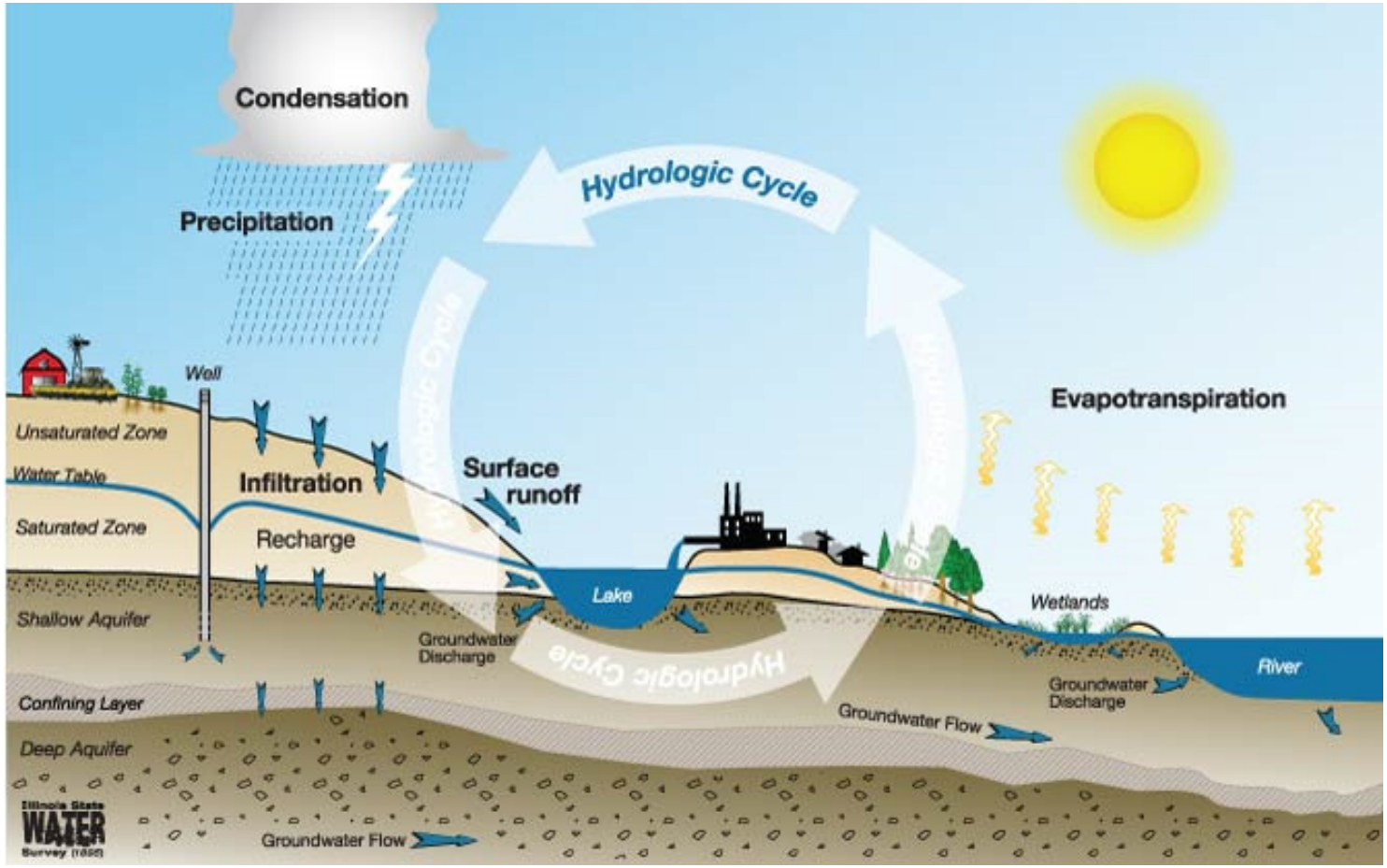
Water Quality & Pollution is usually the first thing that we point to as the biggest impact of Stormwater

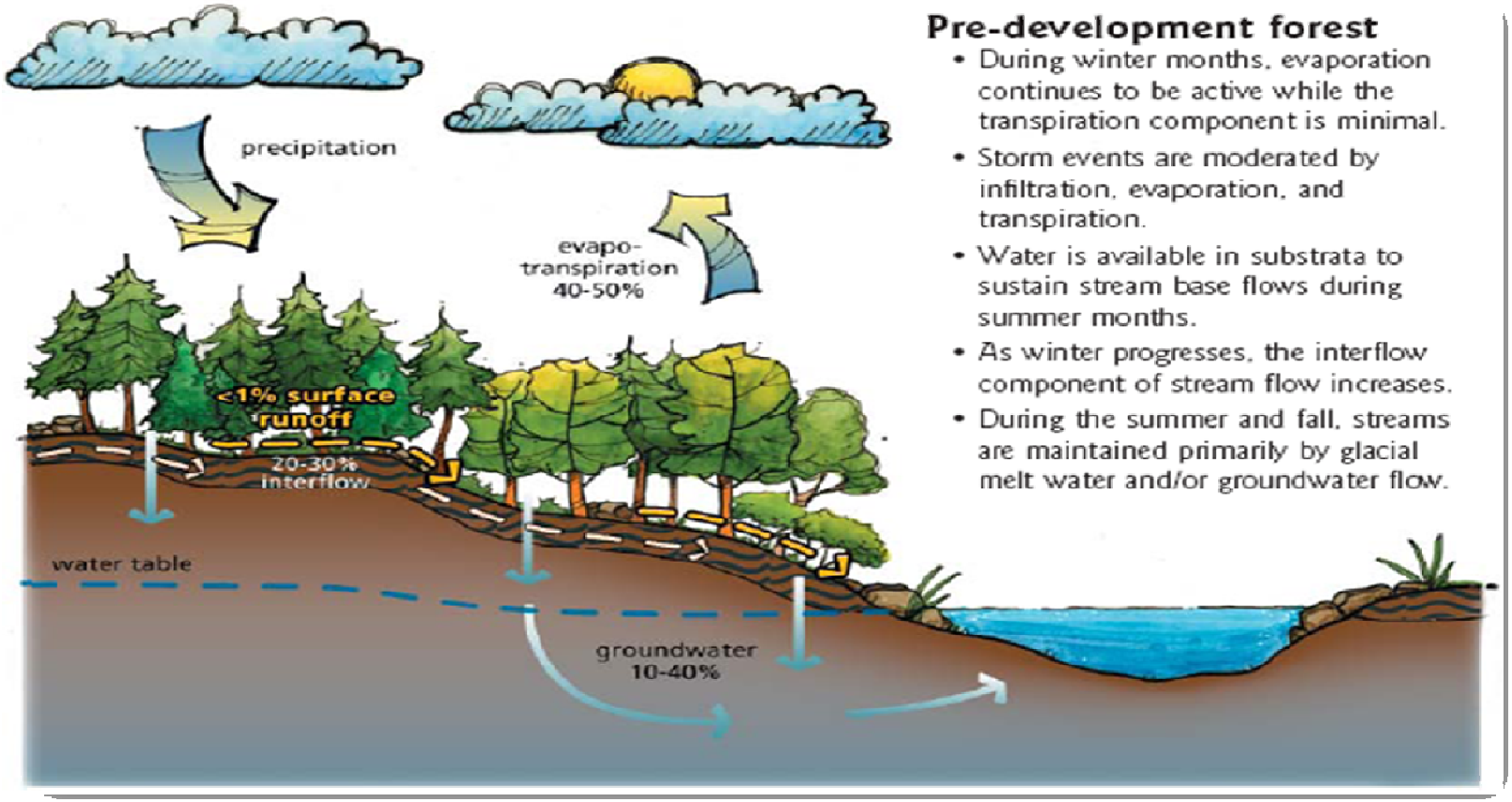
But is it really?

2

As research shows, Water Quantity & Flows are generally the biggest impact of Stormwater

The Hydrologic (Water) Cycle



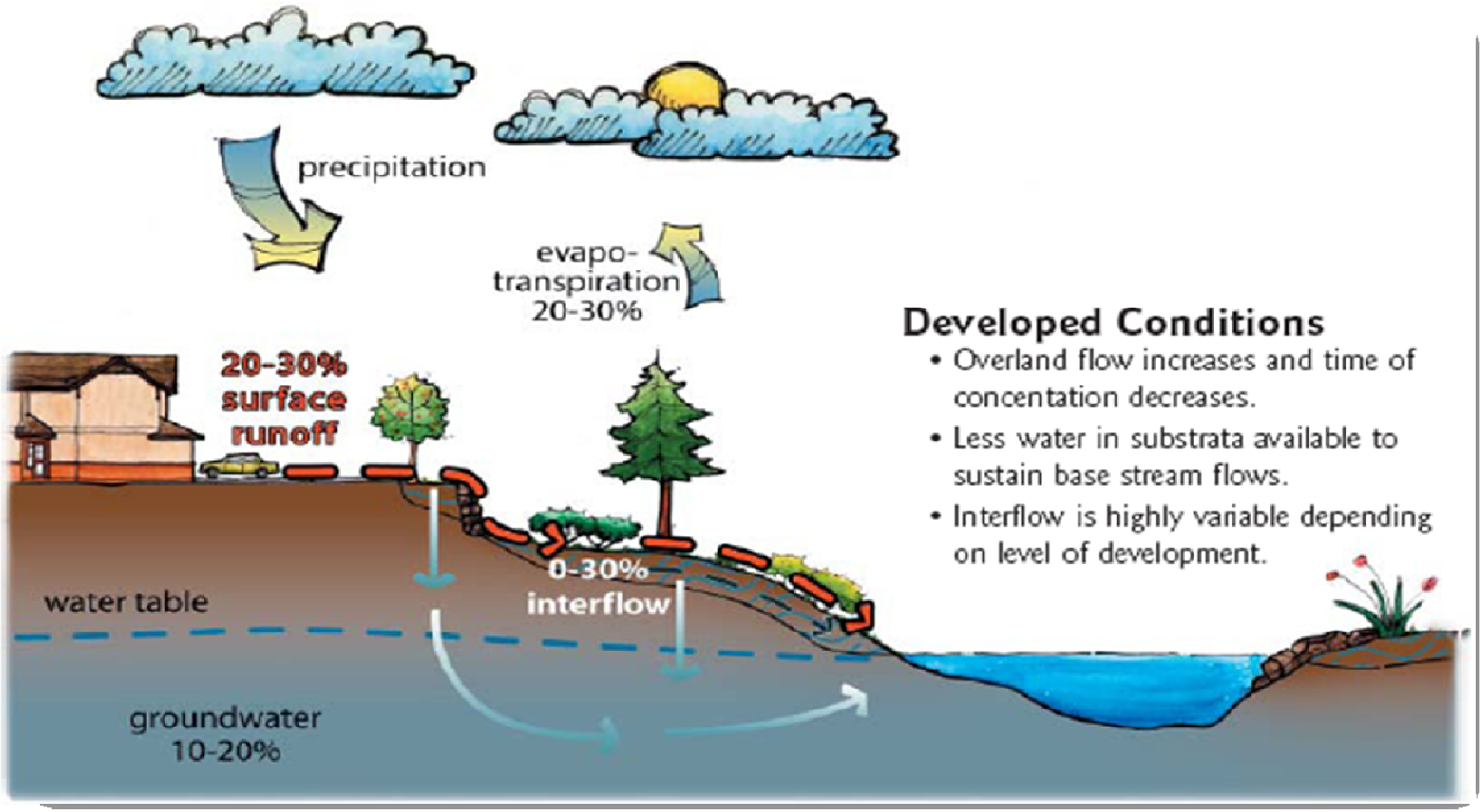


Pre-development forest

- During winter months, evaporation continues to be active while the transpiration component is minimal.
- Storm events are moderated by infiltration, evaporation, and transpiration.
- Water is available in substrata to sustain stream base flows during summer months.
- As winter progresses, the interflow component of stream flow increases.
- During the summer and fall, streams are maintained primarily by glacial melt water and/or groundwater flow.

Urban Landscape Alterations

- Loss of Natural Forest Cover
- Loss of Wetland Storage
- Landscape Fragmentation
- Soil Compaction
- Impervious Surfaces
  - Pavement
  - Rooftops
  - Turf and Landscape



Developed Conditions

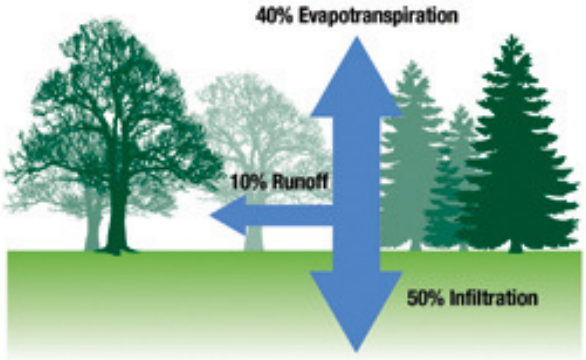
- Overland flow increases and time of concentation decreases.
- Less water in substrata available to sustain base stream flows.
- Interflow is highly variable depending on level of development.

Impact of Urbanization

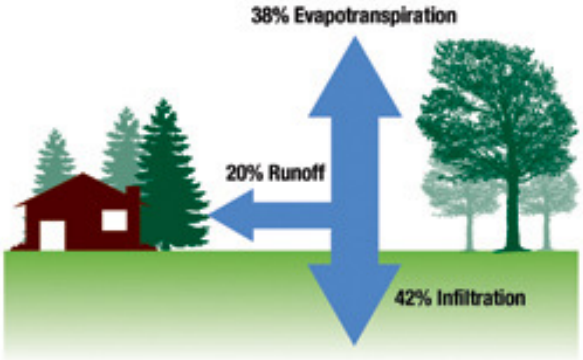
- **Shift in Watershed Hydrology**
  - **Reduced Evapo-Transpiration**
  - **Greater Impervious Surface Generated Runoff**
  - **More Erosive & Longer Duration Instream Flows**
  - **Reduced Infiltration and GW Recharge**
- **Non-Point Source (NPS) Pollution**
- **Stream Habitat Degradation**
  - **Loss of Habitat Complexity and Quality**
  - **Migration Barriers (culverts, dams, etc.)**

KITSAP COUNTY 18 57 WASHINGTON

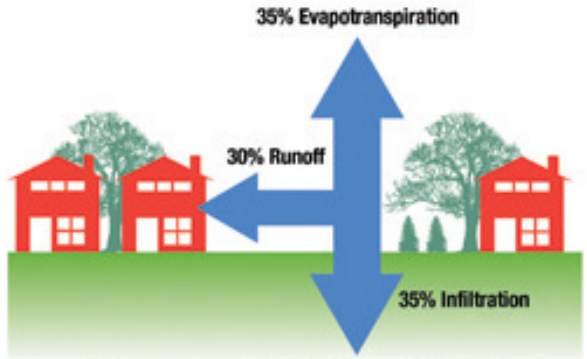
EFFECTS OF IMPERVIOUSNESS ON RUNOFF AND INFILTRATION



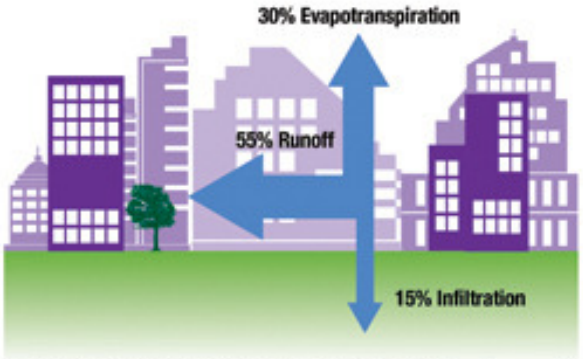
NATURAL GROUND COVER
0% Impervious Surface



LOW DENSITY RESIDENTIAL(e.g. rural)
10-20% Impervious Surface



MEDIUM DENSITY RESIDENTIAL (e.g. subdivision)
30-50% Impervious Surface

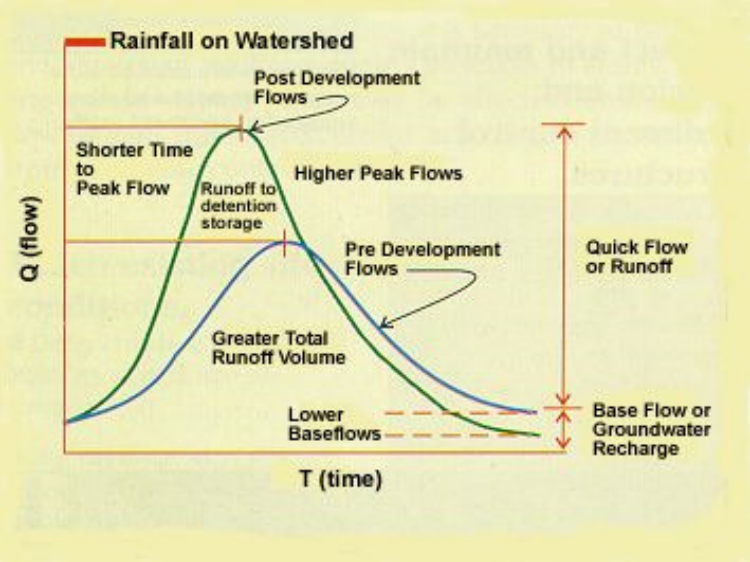


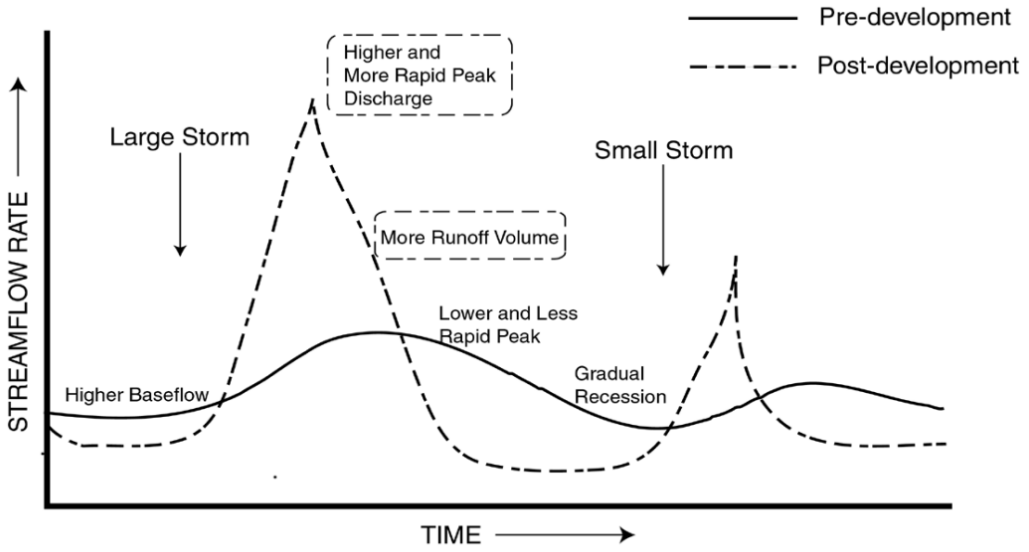
HIGH DENSITY RESIDENTIAL/INDUSTRIAL/COMMERCIAL (e.g. town centre)
75-100% Impervious Surface

Source: Arnold and Gibbons (1996) Impervious Surface Coverage.

KITSAP COUNTY 18 57 WASHINGTON

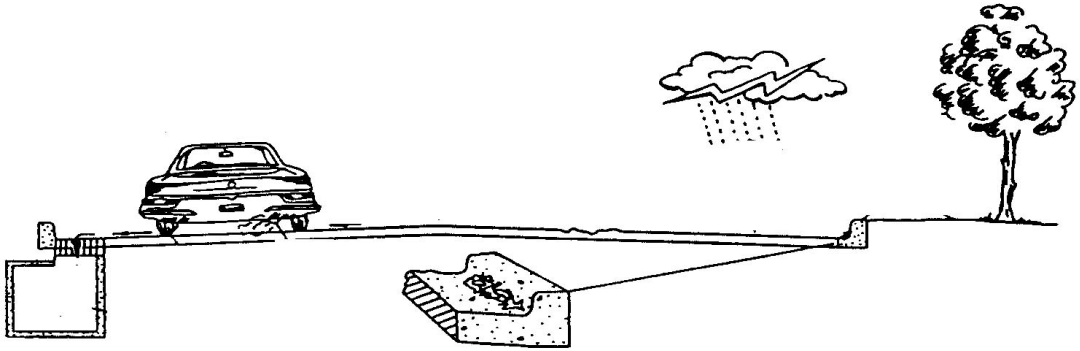
Remember to Focus on the Hydrology!





Changes in stream hydrology as a result of urbanization (Schueler, 1992).

That is NOT to say that Polluted Runoff is not a Problem – It most certainly is!



Stormwater Pollutant Pathways (Schueler, 1995)

Stay Tuned
More on this to come later

Biological Integrity becomes the wholistic measure of Watershed Impact

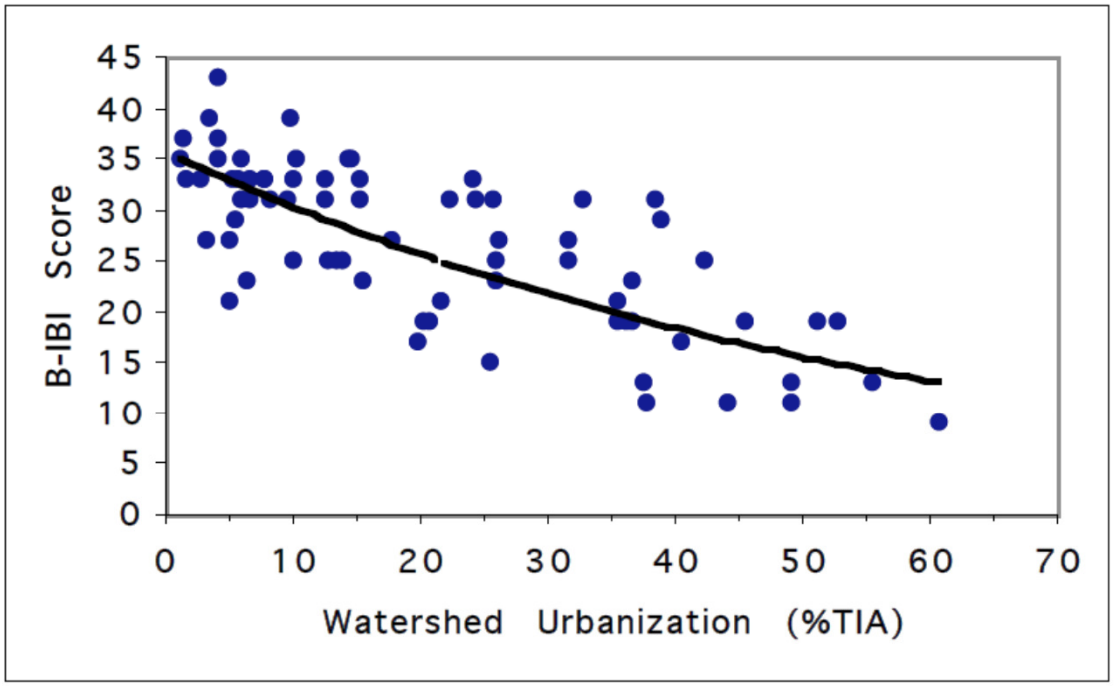
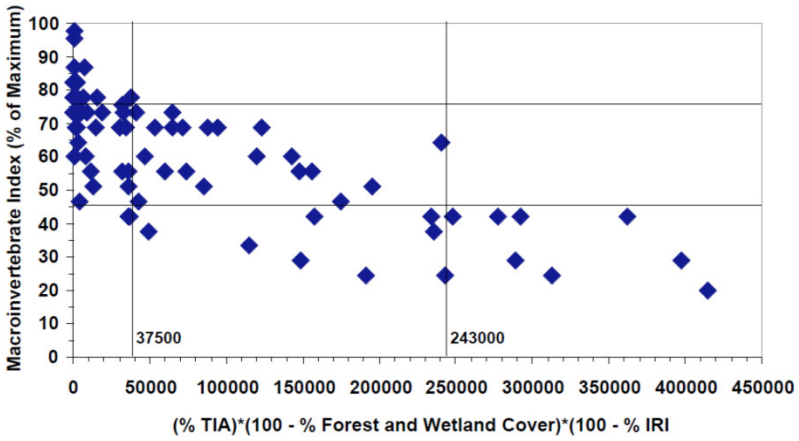
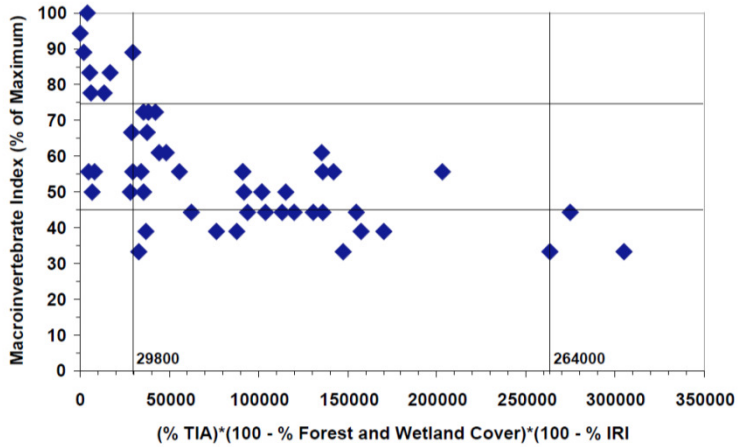


Figure 1: Benthic Index of Biological Integrity (B-IBI) Scores of Puget Sound Lowland



(c) Macroinvertebrate Indices for Puget Sound



(b) Macroinvertebrate Indices for Montgomery County

*Biological Integrity is demonstrated to be applicable throughout the US & World**

** See Similar Results from Maine, Ohio, New Zealand, Australia, and many other places*

Another Shocker!

Native Fish (Salmonids) also Decline as Development spreads in Watersheds

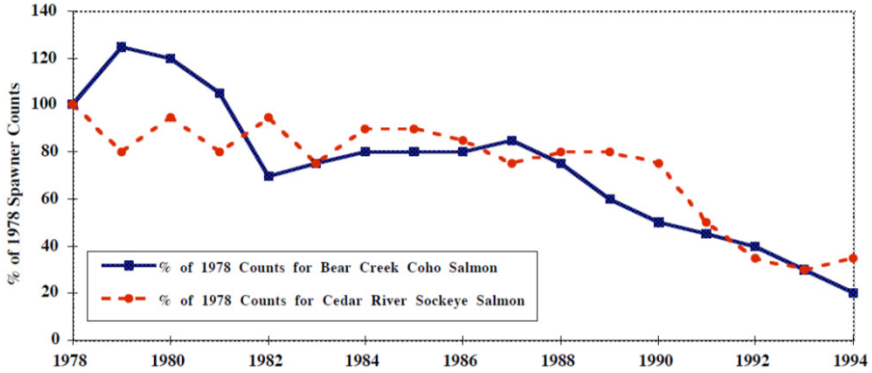


Figure 1. Representative data showing the decline in salmon stocks in the Puget Sound lowland (PSL) region, using 1978 as the base year for spawner counts (Washington State Department of Fisheries data).

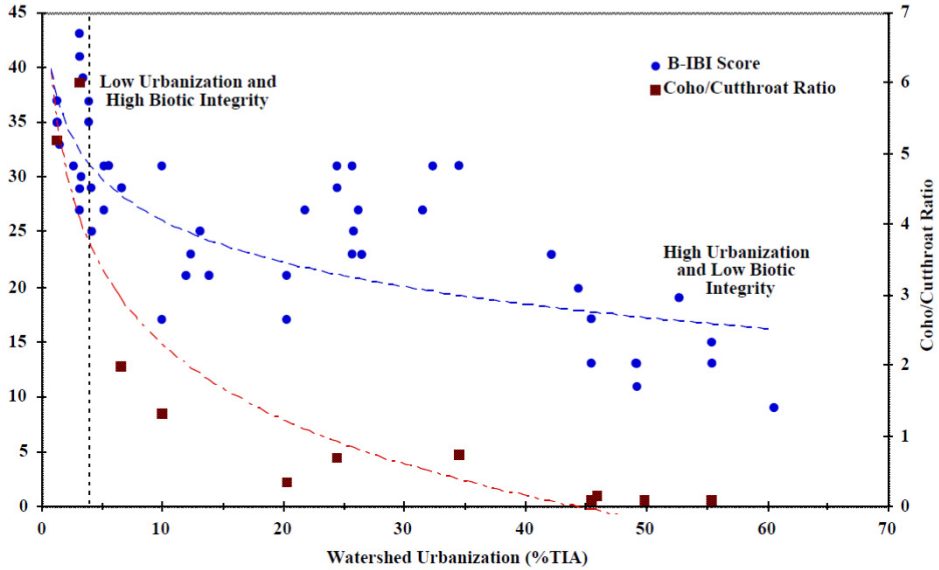
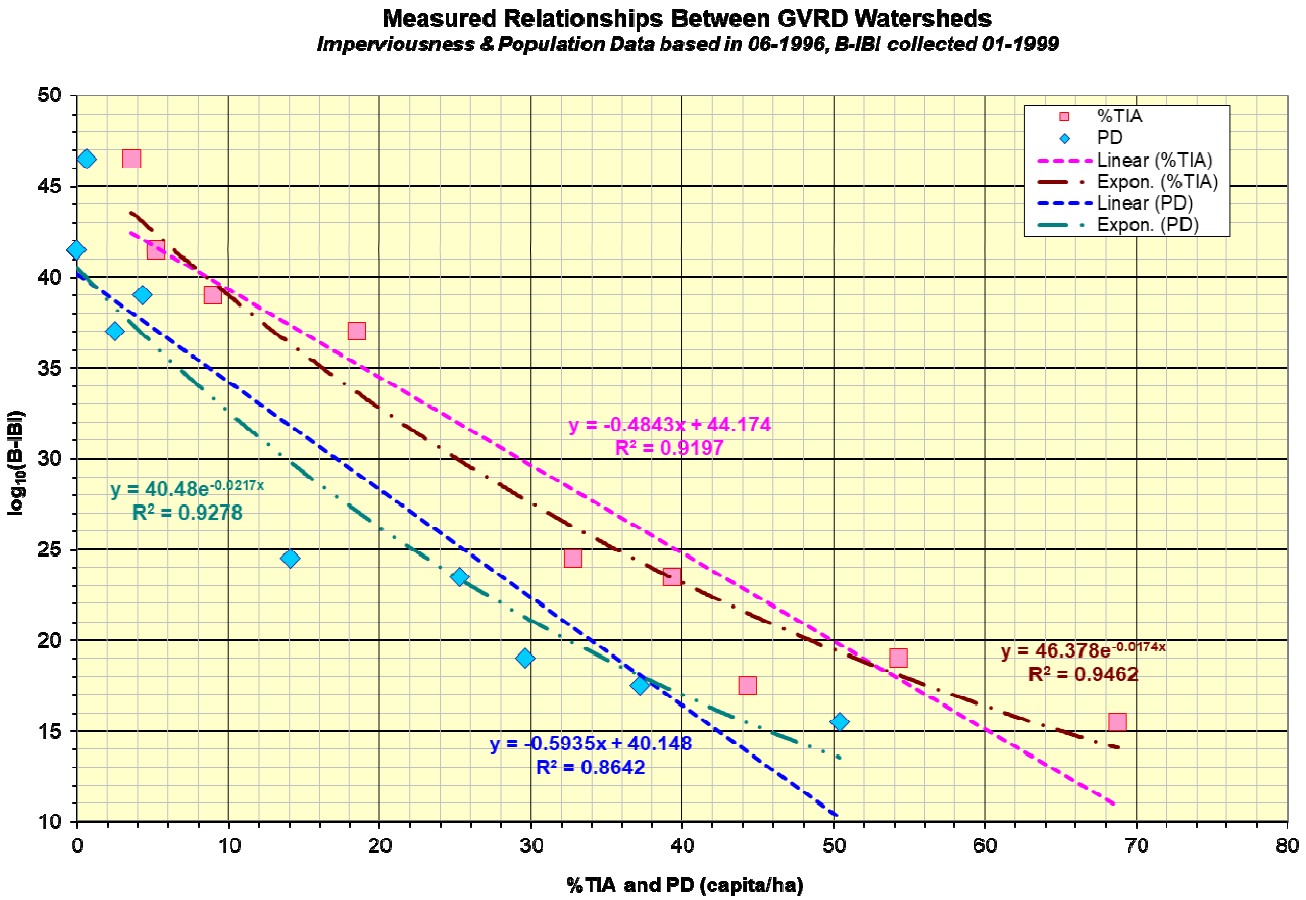


Figure 14. Relationship between watershed urbanization (%TIA) and biological integrity in Puget Sound lowland (PSL) streams. The benthic index of biotic integrity (B-IBI) and the abundance ratio of juvenile coho salmon to cutthroat trout were used as indices of biological integrity.

And, of course, here in Canada (BC)



Imperviousness is just a great indicator, but we are really the cause

KITSAP COUNTY 18 57 WASHINGTON

No Surprise! Natural Land-Cover is sacrificed as Urbanization Progresses

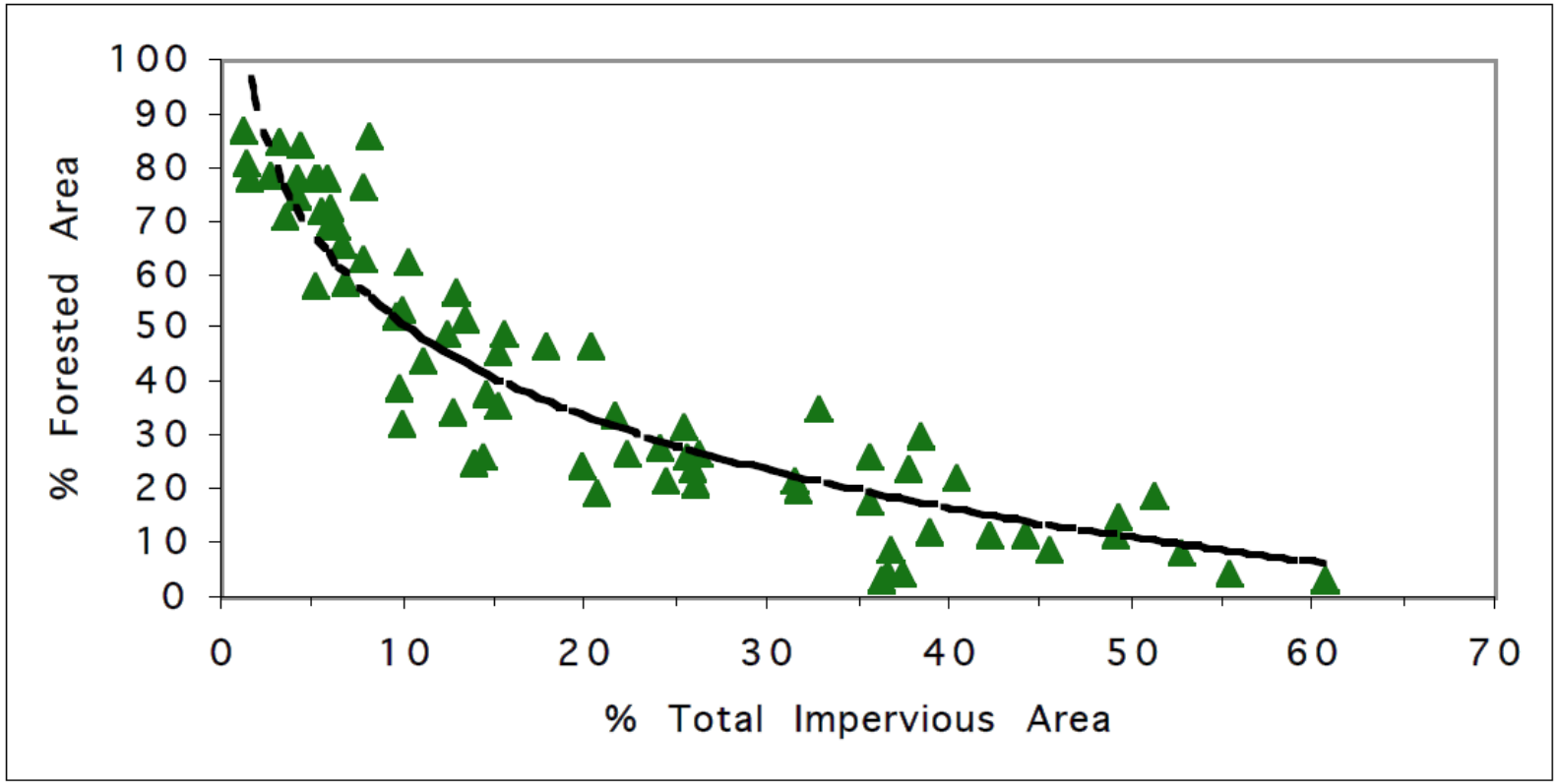
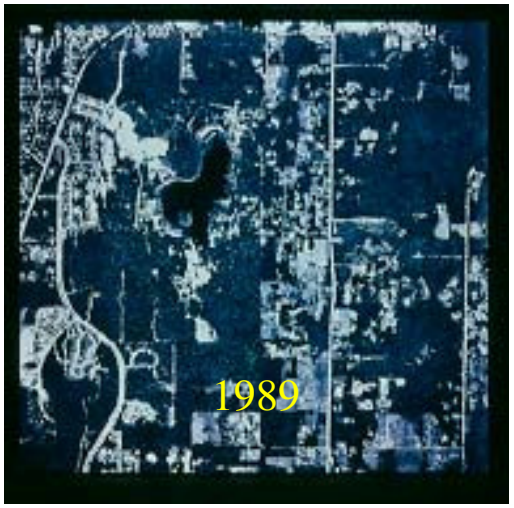


Figure 3: Percentage of Native Forest Land-Cover for Puget Sound Lowland Streams in relationship to Watershed Total Impervious Area (%TIA).

Urbanization is very hard to see as it is happening



The Problem is more complex than just Imperviousness!

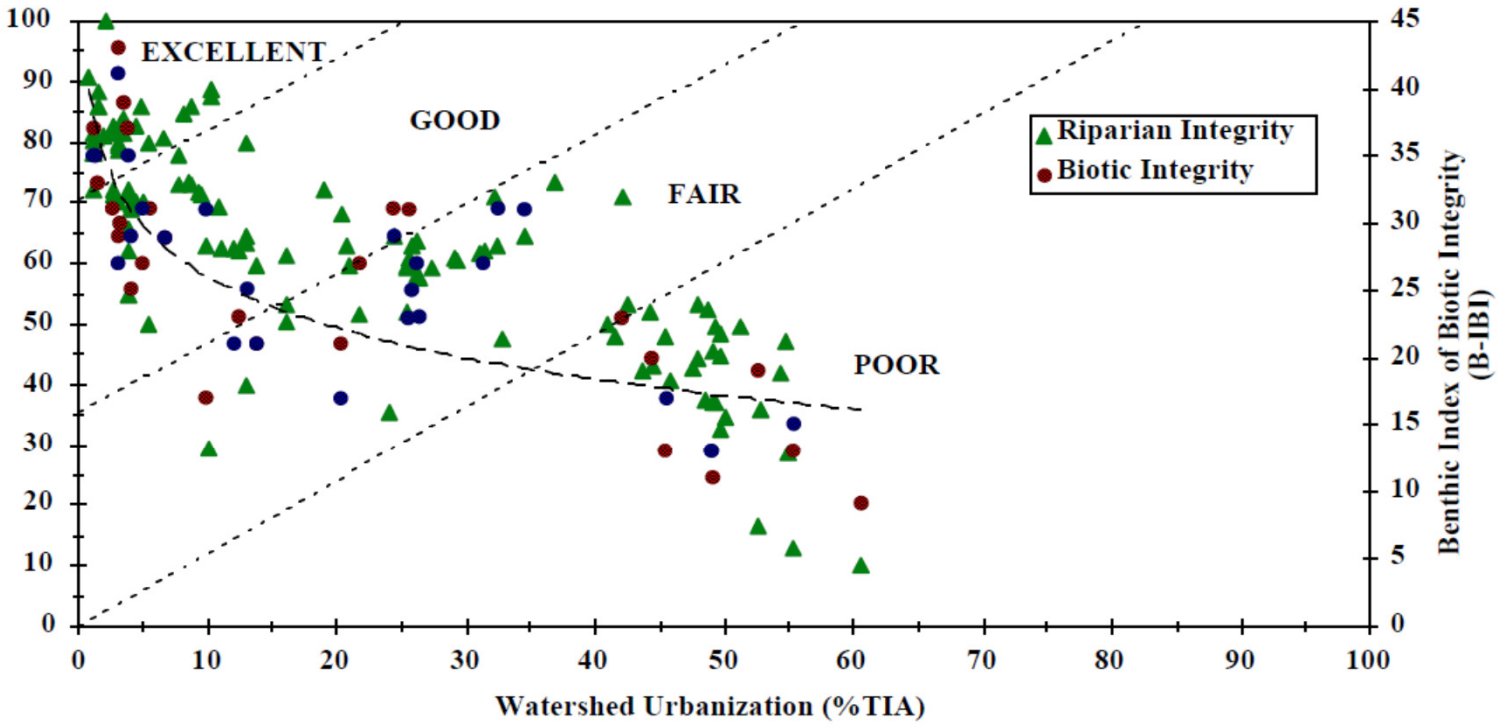
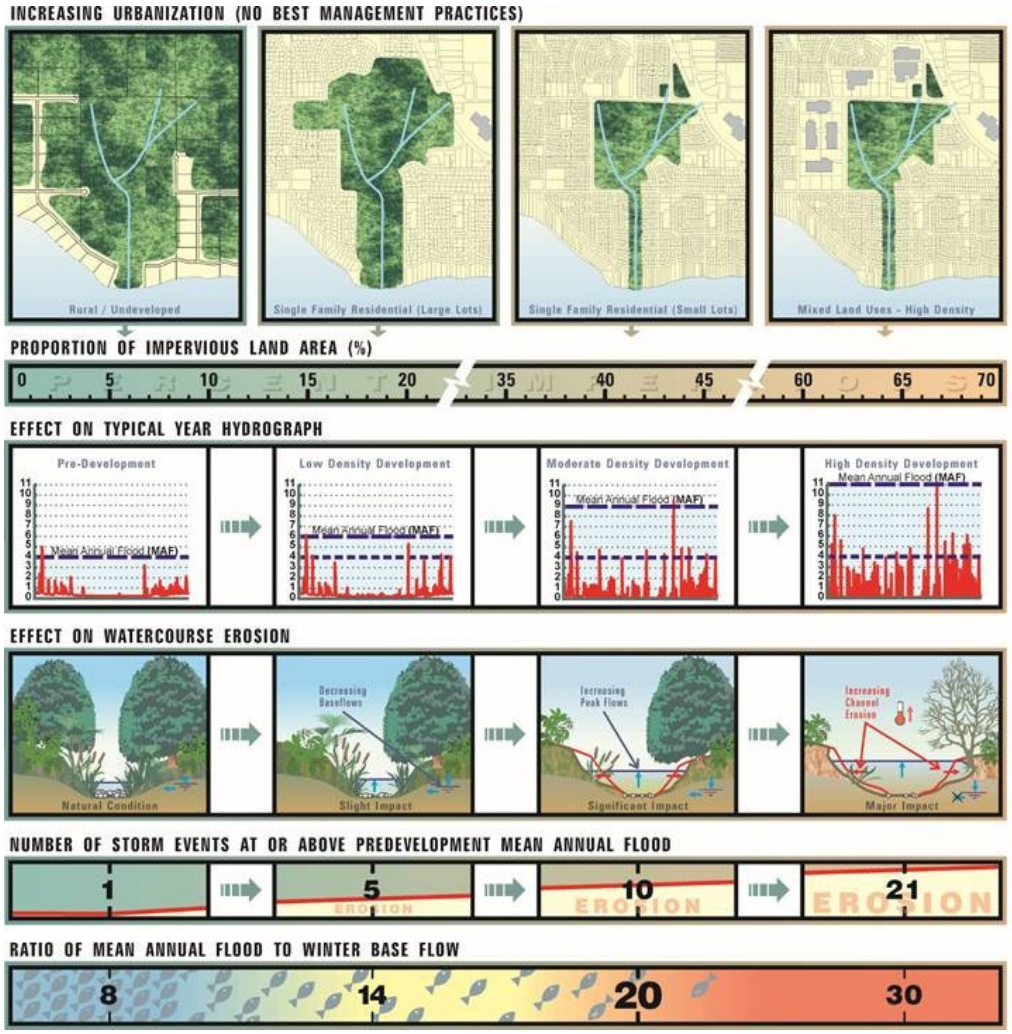


Figure 16. Relationship between basin development, riparian buffer width, and biological integrity in PSL streams.

Riparian Streamside Forests are extremely Important as well



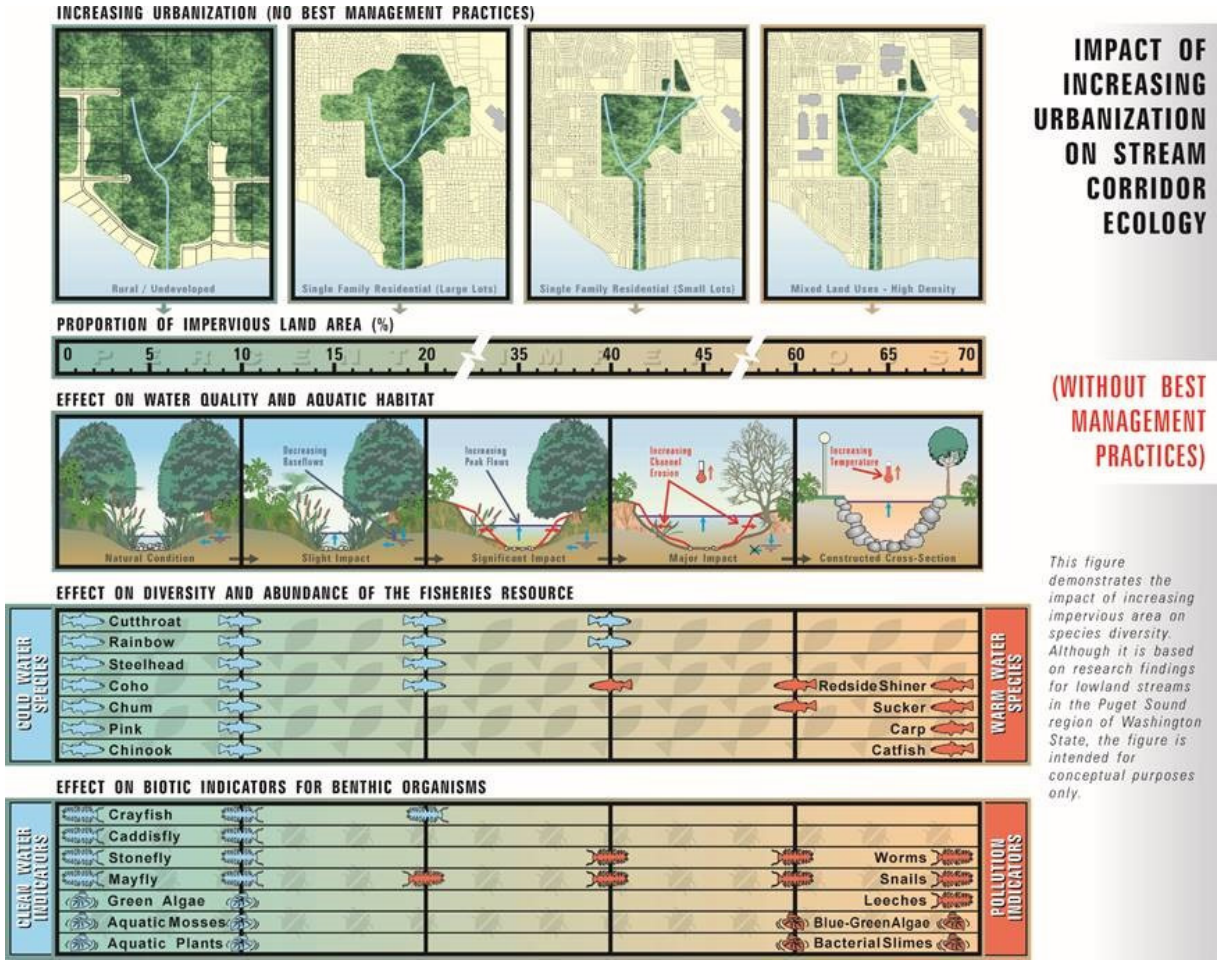
IMPACT OF CHANGES IN HYDROLOGY ON WATERCOURSE EROSION AND BASE FLOW RELATIONSHIPS

(WITHOUT BEST MANAGEMENT PRACTICES)

This figure demonstrates the impact of increasing impervious area on the number of erosion-causing events, and increased peak flow impacts on channel stability. Although it is

Really, everything is really important because everything is connected, as Bill Derry showed so well

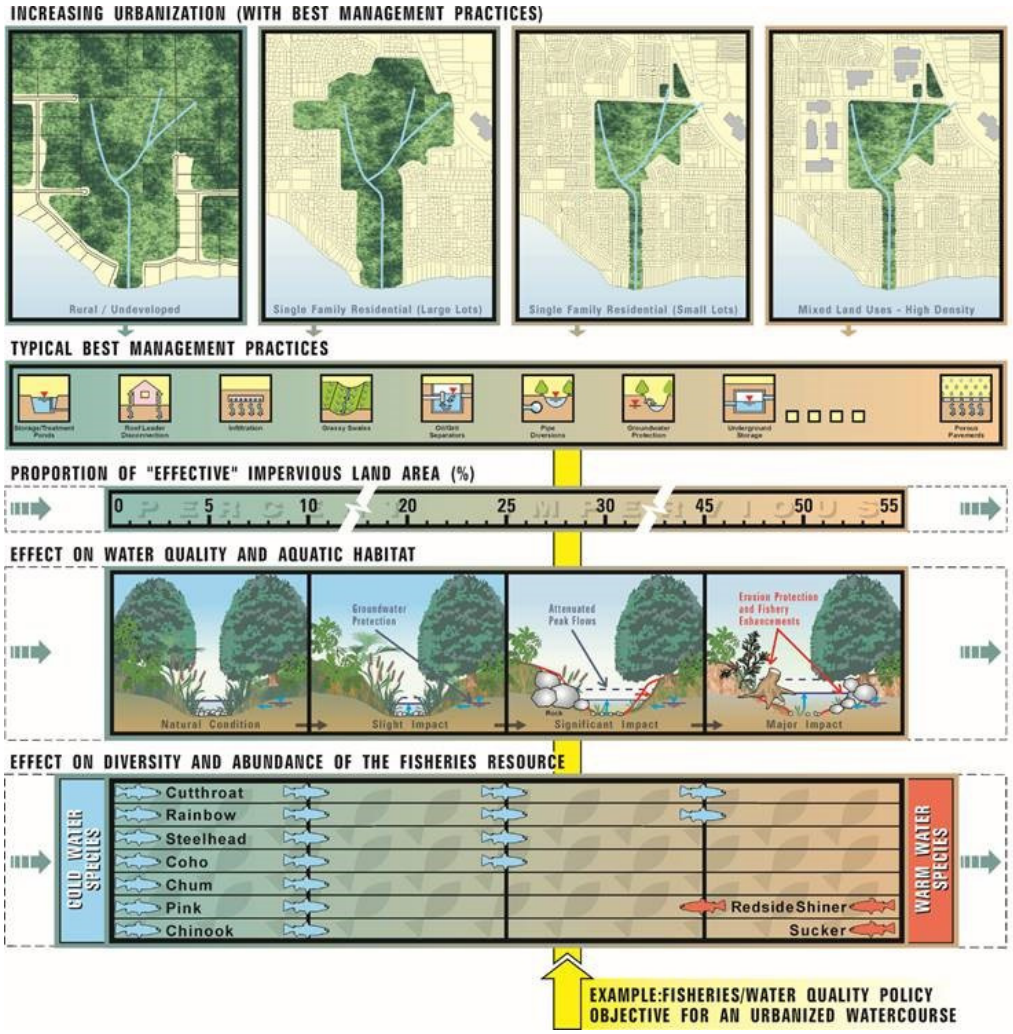
KITSAP COUNTY 18 57 WASHINGTON



IMPACT OF INCREASING URBANIZATION ON STREAM CORRIDOR ECOLOGY

(WITHOUT BEST MANAGEMENT PRACTICES)

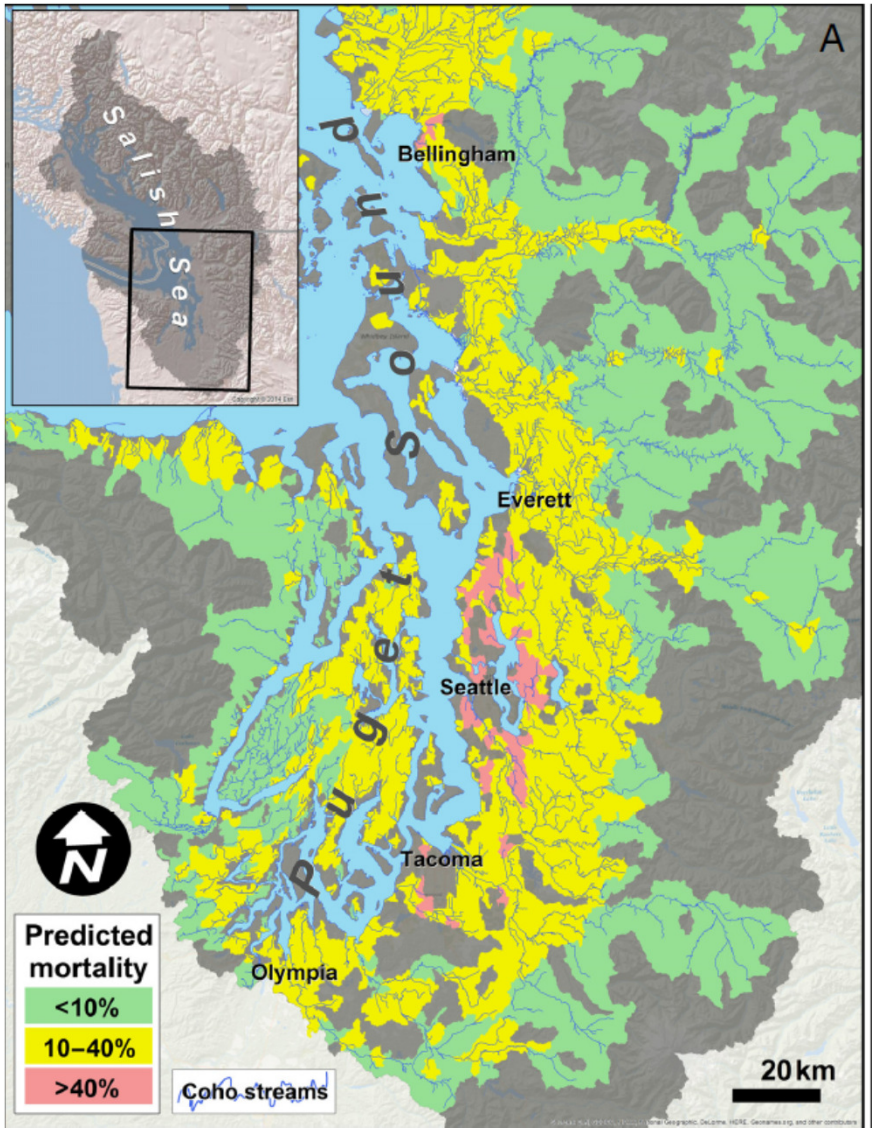
This figure demonstrates the impact of increasing impervious area on species diversity. Although it is based on research findings for lowland streams in the Puget Sound region of Washington State, the figure is intended for conceptual purposes only.



APPLICATION OF BEST MANAGEMENT PRACTICES (BMPs) TO MITIGATE THE IMPACTS OF URBANIZATION ON STREAM CORRIDOR ECOLOGY

(WITH BEST MANAGEMENT PRACTICES)

This figure shows how BMPs could make a difference, but would not reverse a pattern. The figure is intended for conceptual purposes only.



Coho Pre-Spawn Mortality (PSM) is related to high ADT roads such as highways, arterials, and urban collector streets

Sources of Road Runoff Pollution = Vehicles

- Galvanized Metals (Zn)
- Engine Oil or Fuel Leaks (Petrogenic PAH's)
- Exhaust (Pyrogenic PAH's)
- Engine Coolant
- Brake & Transmission Fluid
- Brake Pads (Cu)
- Tire Wear

WQ begins to really matter at higher levels of urbanization, especially where there are highways and high road density

Where Do We Go From Here?

- **Potential Solutions for Sustainable Living**
  - **Whole-System, Water-Balance Approach**
  - **Green Stormwater Infrastructure**
- **Quality of Life Considerations**
  - **Water as a Resource Policy (Kitsap)**
  - **Multi-Functional/Benefit Stormwater Systems**

KITSAP COUNTY 18 57 WASHINGTON

Science-Based Stormwater Design Guidance

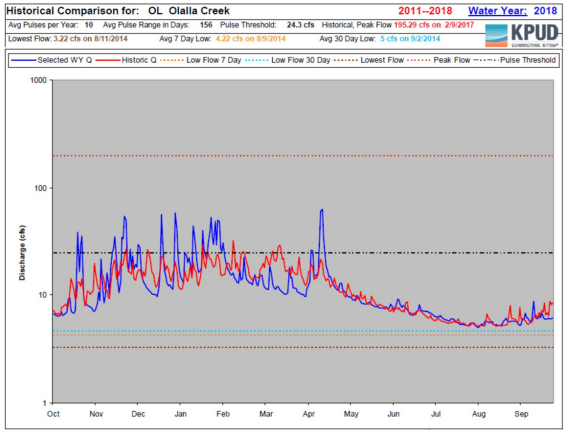
Table 2-1: Summary of Current Stormwater Discharge Criteria

Component	Target Rainfall Amount	Criteria/Guidelines
Typical Municipal Criteria		
Flood Protection	5 or 10-year storm	Minor drainage system – 5- or 10-year return period design event
	100-year storm	Major drainage system - 100-year return period design event
Provincial Stormwater Guidebook		
Volumetric Reduction	0 to 50 percent MAR[1] (Tier A/B rainfall events)	Capture 90 percent of the rainfall in a typical year and either infiltrate or evaporate it at the source (runoff volume reduction and water quality control).
Runoff Control for Large Storms	50 to 100 percent MAR[1] (Tier C storms)	Store runoff from infrequent large storms, and release at a rate that approximates the natural forested condition to decrease the erosive impact. (runoff rate reduction). On-site disposal features to retain 50 percent of the Mean Annual Rainfall (MAR) volume[3]
Flood Risk Management for the Extreme Storms	Greater than MAR[1] up to 100-year return period (Tier D storms)	Ensure that the drainage system is able to convey the extreme storm events with only minimal damage to public and private property. (peak flow conveyance)
Fisheries and Oceans Canada (DFO)[2]		
Water Quality	Treat 90 percent of annual rainfall[3]	Provide treatment for 90 percent of rainfall events falling on impervious areas where source controls are not achievable
Volumetric Reduction	6-month[4]	Infiltrate, evaporate, transpirate, or re-use all rainfall up to the 6-month storm - Only applicable to fish bearing creeks
Rate Control – Erosion	6-month[4], 2-year and 5-year events	Control post-development flows to pre-development levels for 6-month, 2-year and 5-year events

[1] MAR is Mean Annual Rain Event (e.g. a two-year storm event).
[2] Fisheries and Oceans Canada, 2001.
[3] It is generally assumed that by treating the 6-month storm, 90% of all rainfall events will also be treated
[4] Calculated by multiplying the 2-year, 24-hour rainfall amount on the IDF curve by 72% (see GVRD Source Control Design Guidelines 2005 http://www.gvrd.bc.ca/sewerage/stormwater_reports.htm)

- **Watershed & Community Based Planning**

- **Flooding Reduction**
- **Flow-Control Standards**
- **Flow-Duration Analysis**
- **Instream Flow Mitigation**
- **WQ Treatment Standards**
- **Continuous Hydrologic Simulation Model**



KITSAP COUNTY 18 57 WASHINGTON

Green Stormwater Solutions

- Low Impact Development
- Green Stormwater Infrastructure
- Stormwater Parks

A stormwater management strategy that uses the integration of site design and planning techniques emphasizing conservation and use of on-site systems and practices to closely mimic pre-development hydrologic processes of infiltration, filtration, storage, evaporation and transpiration.

We must work at multiple scales within the Watershed for this to be effective!

KITSAP COUNTY 18 57 WASHINGTON

- Manage rain where it falls

Make this…

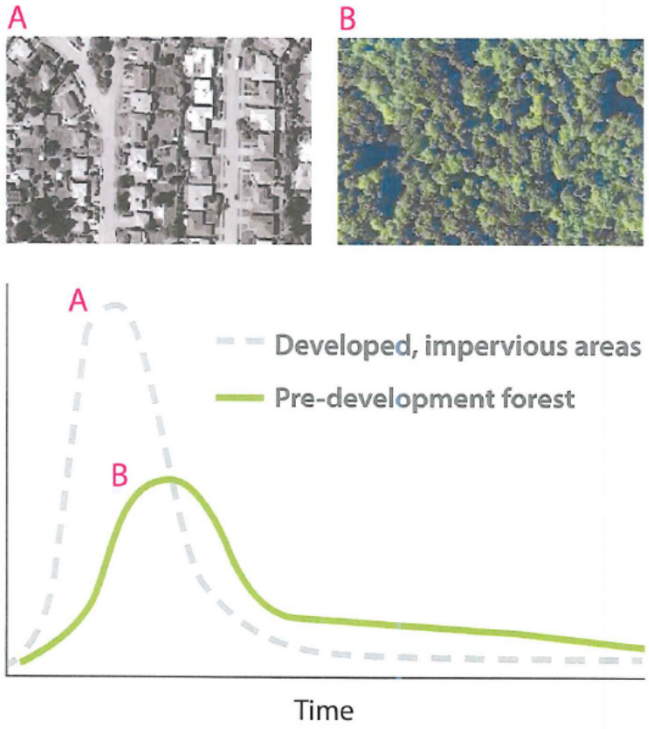
- Closely mimic natural hydrologic processes

Function more like this…

Our Green Infrastructure Design Goals

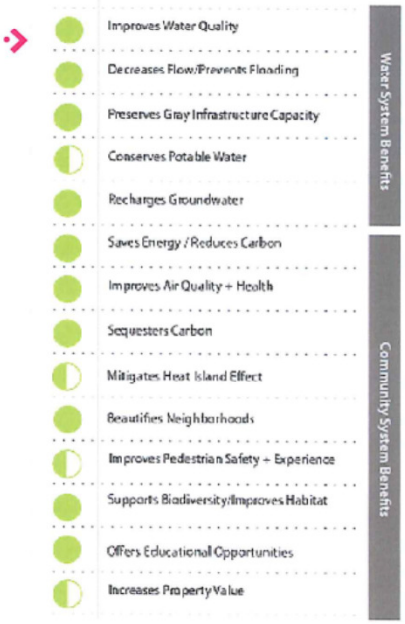
1 Make A function more like B.

(Mimic native systems)



2 Make neighborhoods better

(Get more value for a comparable cost)



Think Multi-Functional and always try to include multiple benefits in your stormwater infrastructure projects

There are a lot of aesthetic and community benefits to Green Infrastructure

No More Stormwater Prisons!

Make runoff a Contributing Member of Society!

Benefits of Green Stormwater Solutions

- **Remove Pollutants**
- **Reduce Runoff Flows and Volume**
- **Replenish Groundwater**
- **Control Local Flooding**
- **Aesthetically Pleasing**

Types of Green Stormwater Solutions

- Bioretention (Rain Gardens)
- Street-Tree Box Filters
- Permeable Pavement
- Green (Eco) Roofs
- Treatment Wetlands
- Infiltration Systems

- Infiltration
- Filtration
- Storage
- Evaporation
- Transpiration

Utilize Natural Hydrologic Functions

- Soil
- Vegetation
- Fungi
- Micro-Organisms

Public Education & Outreach

- **Data is fine, but you must be able to show decision-makers and the public that we are making a difference and being cost-effective with funding**
- **Story Maps and Videos can be very effective tools** (see example below)

https://arcg.is/1WePrT

Clean Water Kitsap
Partners in Stormwater Solutions

KITSAP COUNTY
18 57
WASHINGTON