

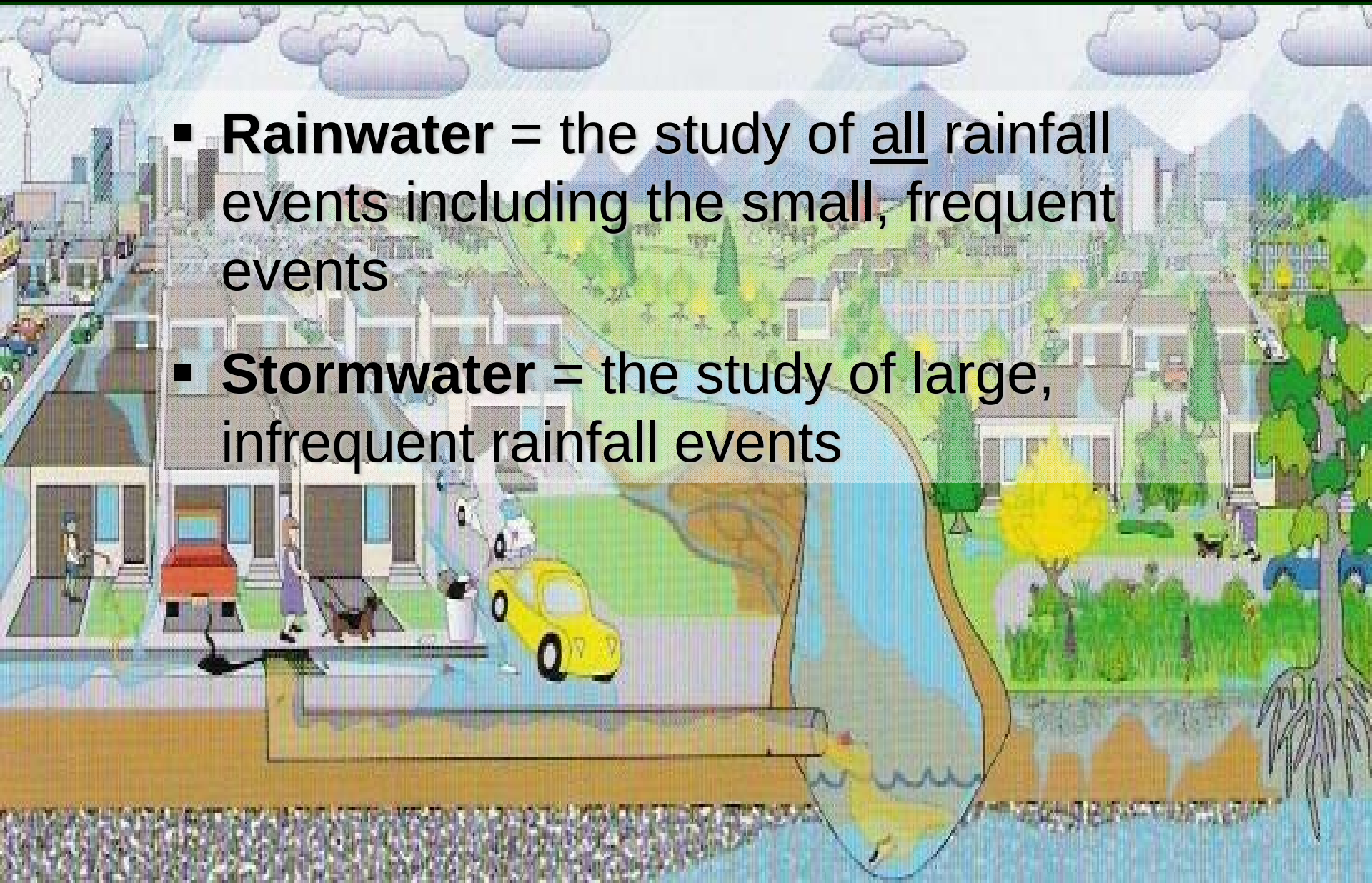
Rainwater Management: Adapting to Climate Change - Water Quality and Quantity Issues in the Okanagan

KERR WOOD LEIDAL associates limited CONSULTING ENGINEERS

Chris Johnston, P.Eng. –

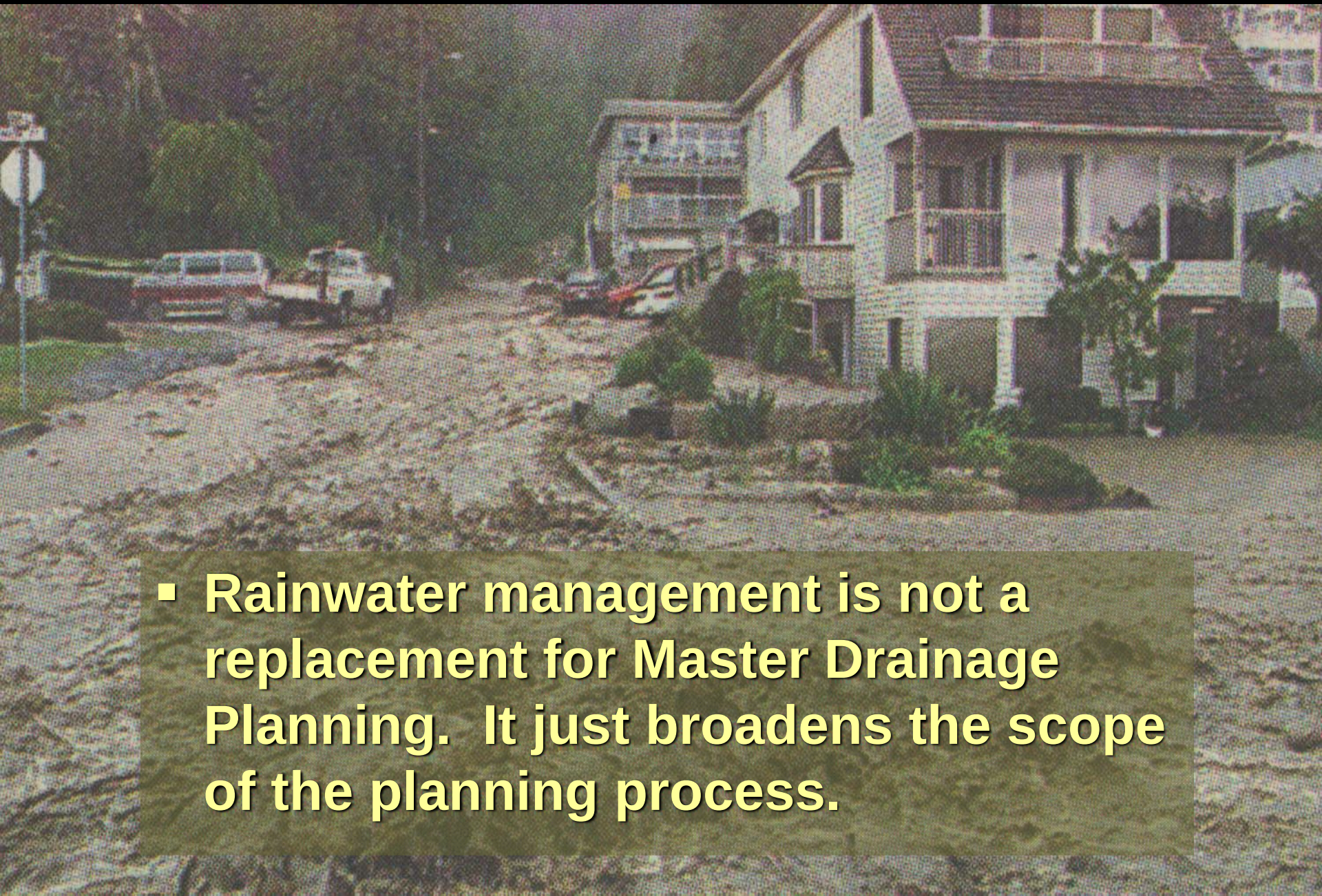
Kerr Wood Leidal Associates

Stormwater versus Rainwater



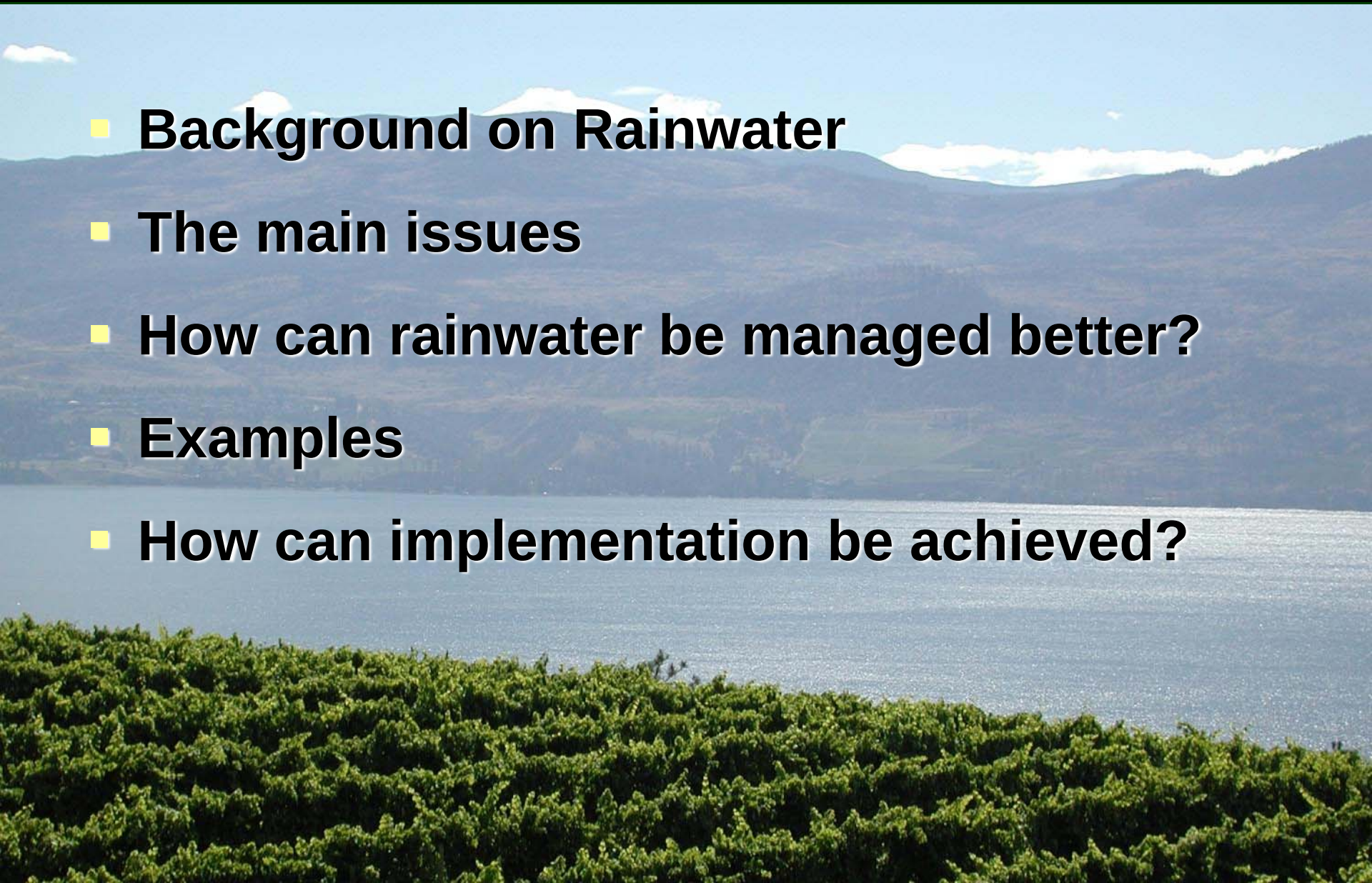
- **Rainwater** = the study of all rainfall events including the small, frequent events
- **Stormwater** = the study of large, infrequent rainfall events

White Rock – June 8, 1999



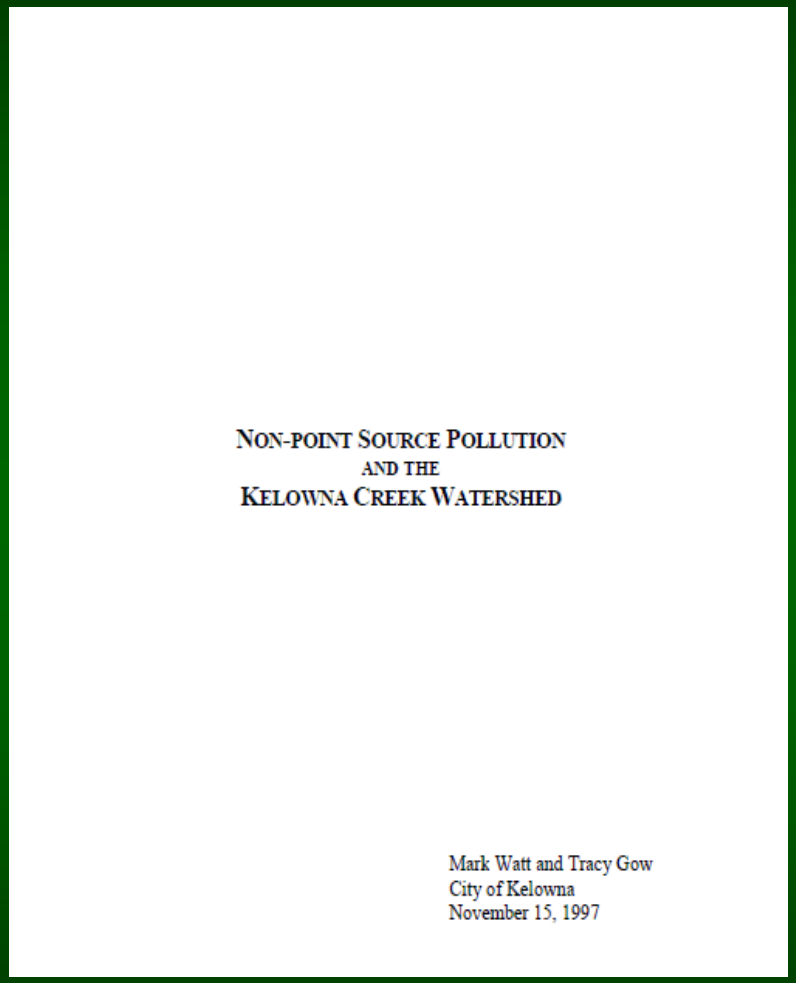
- Rainwater management is not a replacement for Master Drainage Planning. It just broadens the scope of the planning process.

Rainwater Management in the Okanagan



- Background on Rainwater
- The main issues
- How can rainwater be managed better?
- Examples
- How can implementation be achieved?

Okanagan Municipalities



NON-POINT SOURCE POLLUTION
AND THE
KELOWNA CREEK WATERSHED

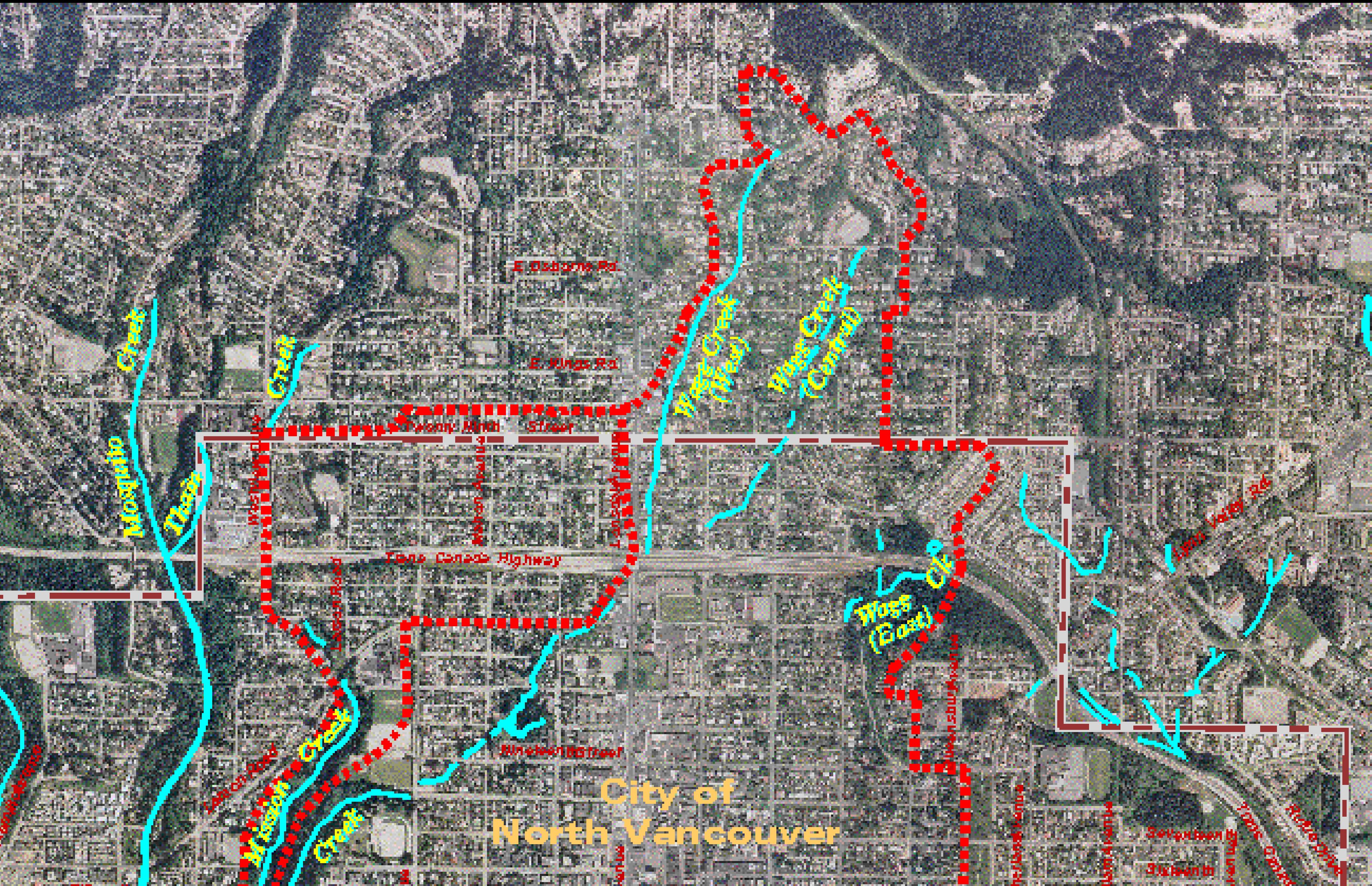
Mark Watt and Tracy Gow
City of Kelowna
November 15, 1997

- Significant work has already been undertaken in some watersheds
- Strong source controls are in place for some new development areas
- Strong educational programs are in place in some regions

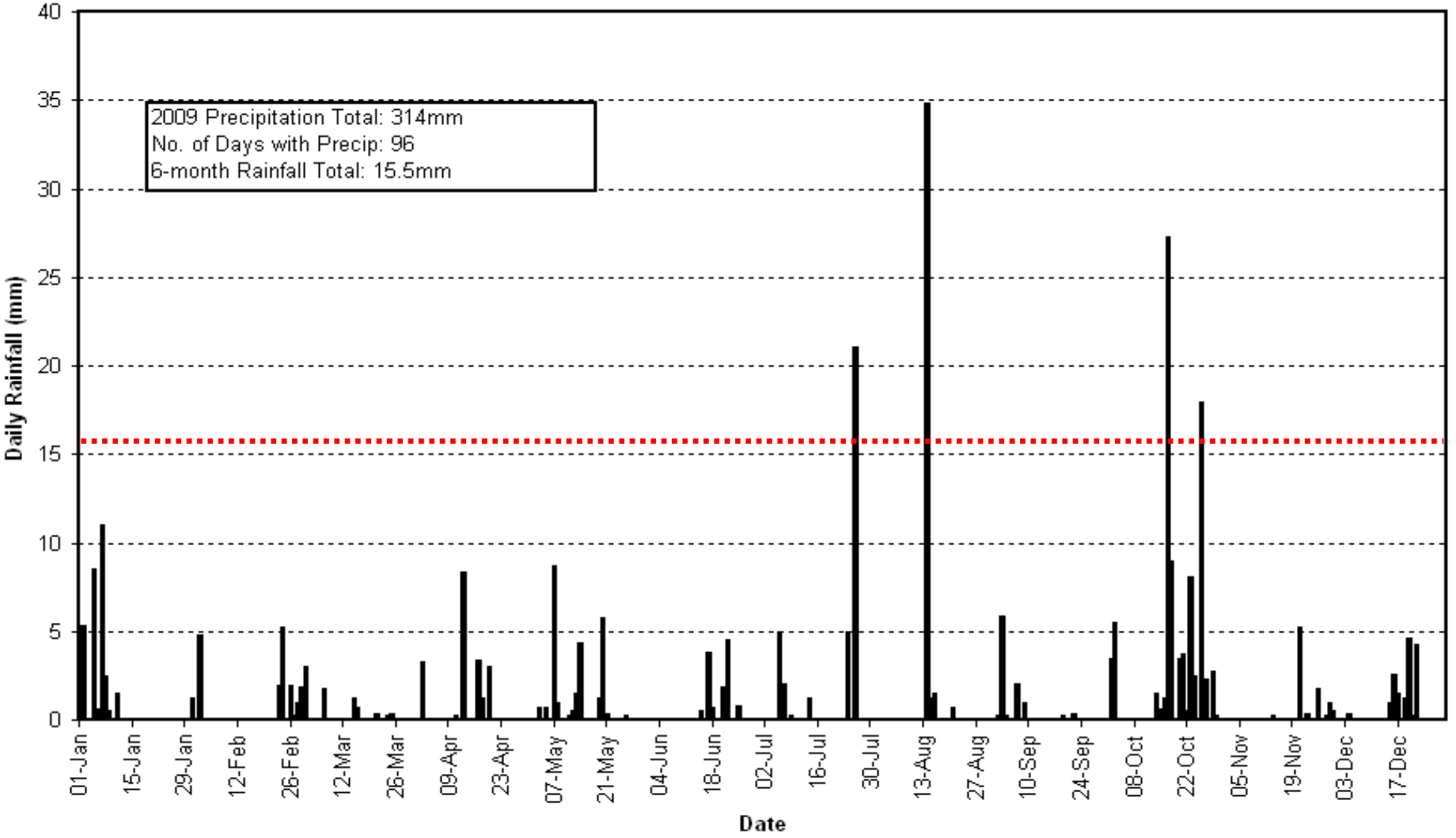
Pollutant	Within City kg/year		Total Watershed kg/year	
	Existing Land Use	*Future Land Use*	*Existing Land Use*	*Future Land Use*
Total P	795	1019	1390	1859
Total N	5643	7293	9167	12618
BOD	21719	26899	30540	41483
Zinc	308	392	419	594
Lead	303	395	397	590
Copper	81	104	108	157
TSS	254000	316000	634000	764000

Table 2: Pollutant Loadings for the Kelowna Creek Watershed

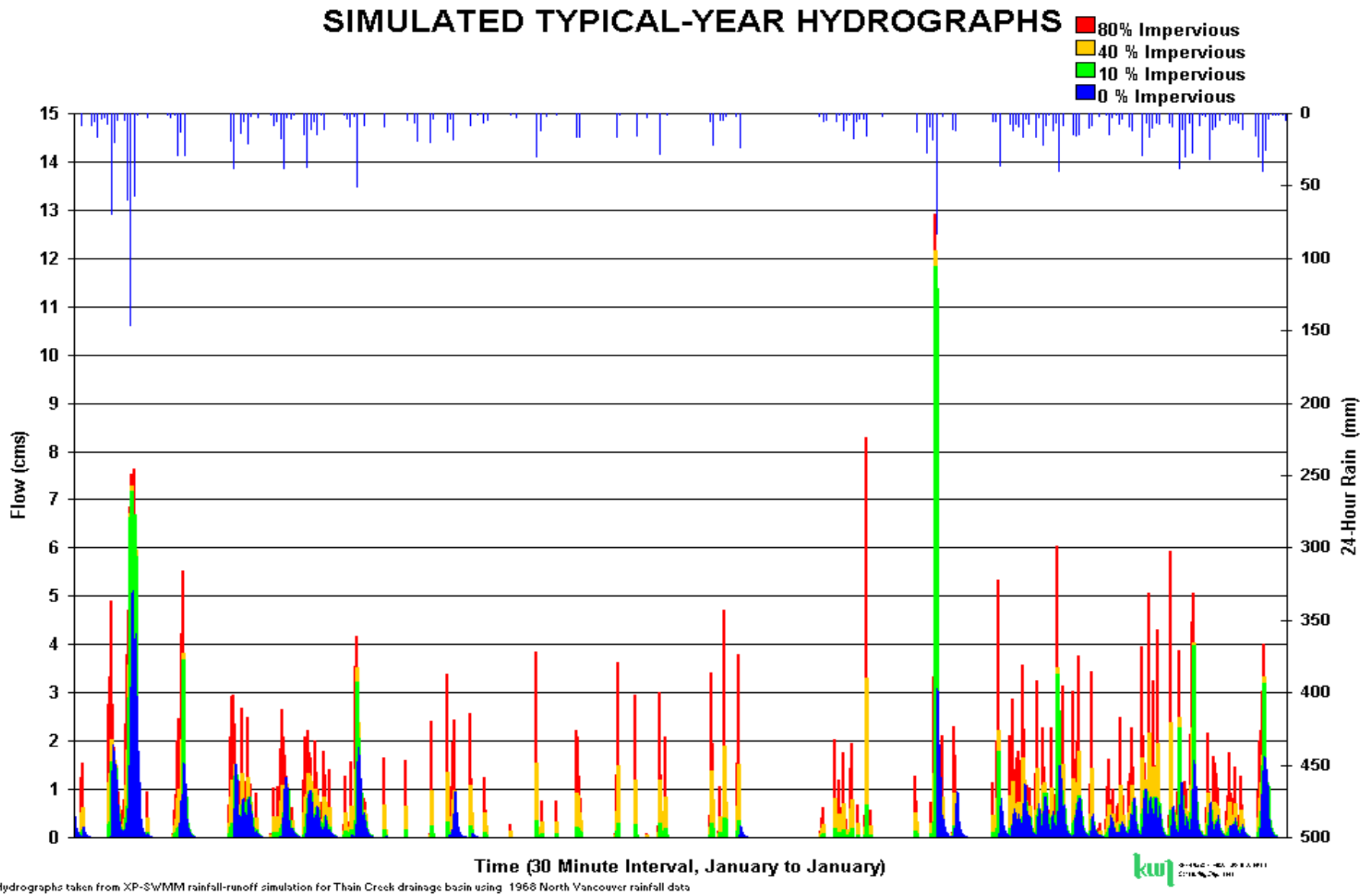
Impervious Surfaces in our Cities



Example of Rainfall: Vernon 2009



Rainfall Generates Runoff



Hydrographs taken from XP-SWMM rainfall-runoff simulation for Thain Creek drainage basin using 1968 North Vancouver rainfall data

The Main Issues

- **Climate Change** – an increase in rainfall intensity over time, leading to a decrease in existing storm sewer service levels
- **Water Quality** – runoff from impervious surfaces carries pollutants to the receiving waters
- **Aquatic Habitat** - runoff damages fish habitat and ecosystems
- **Erosion** – runoff accelerates the erosion process

Impact of Urban Runoff

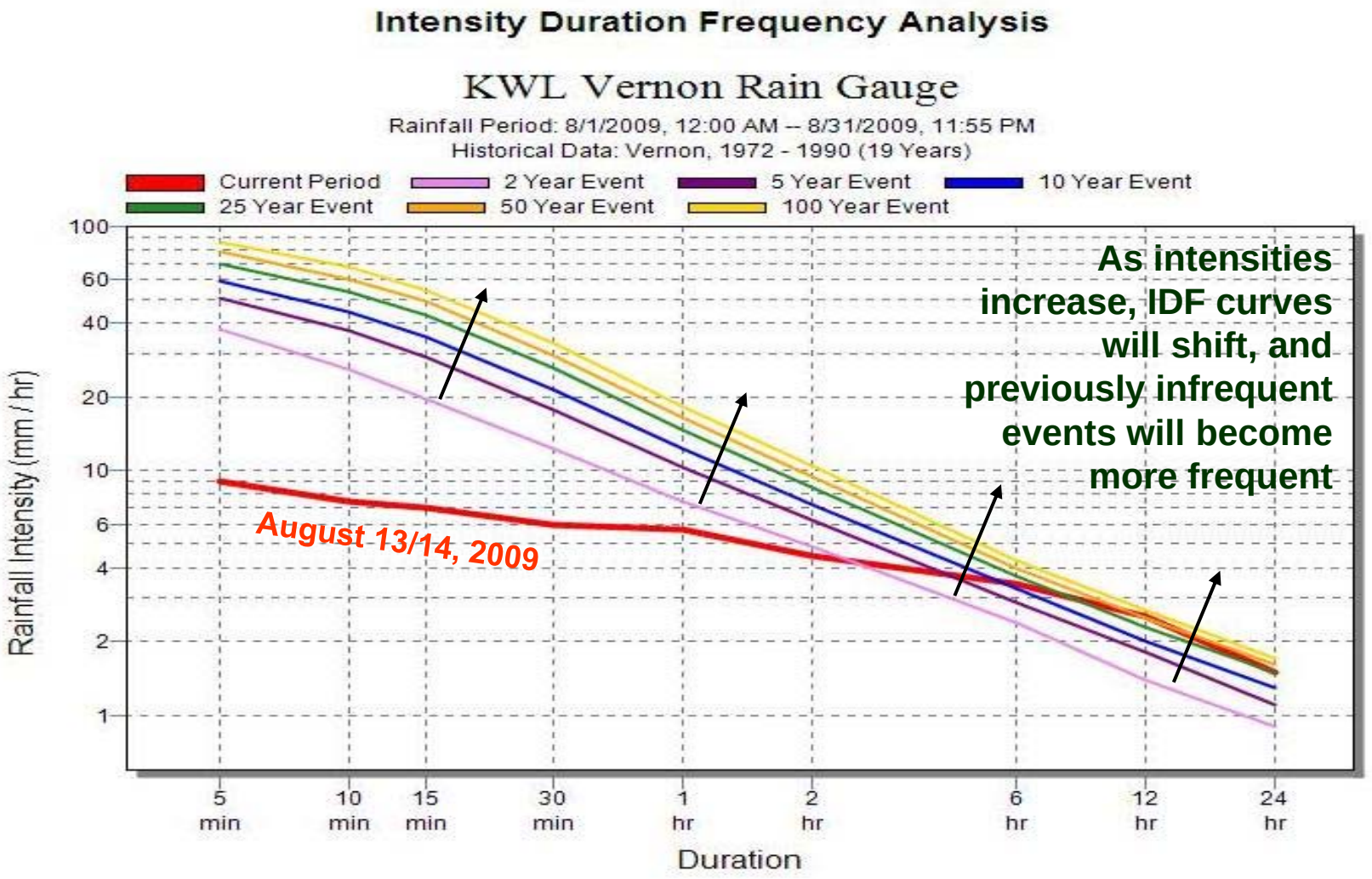
1. Impact of Climate Change

Current Trends in Existing Data Sets	
Rainfall Duration	% increase in intensity
5 min	28
10 min	35
15 min	21
30 min	21
1 hour	43
2 hour	50
6 hour	21
12 hour	14
24 hour	7
Source: Vulnerability to Climate Change Report, Metro Vancouver, March 2008	

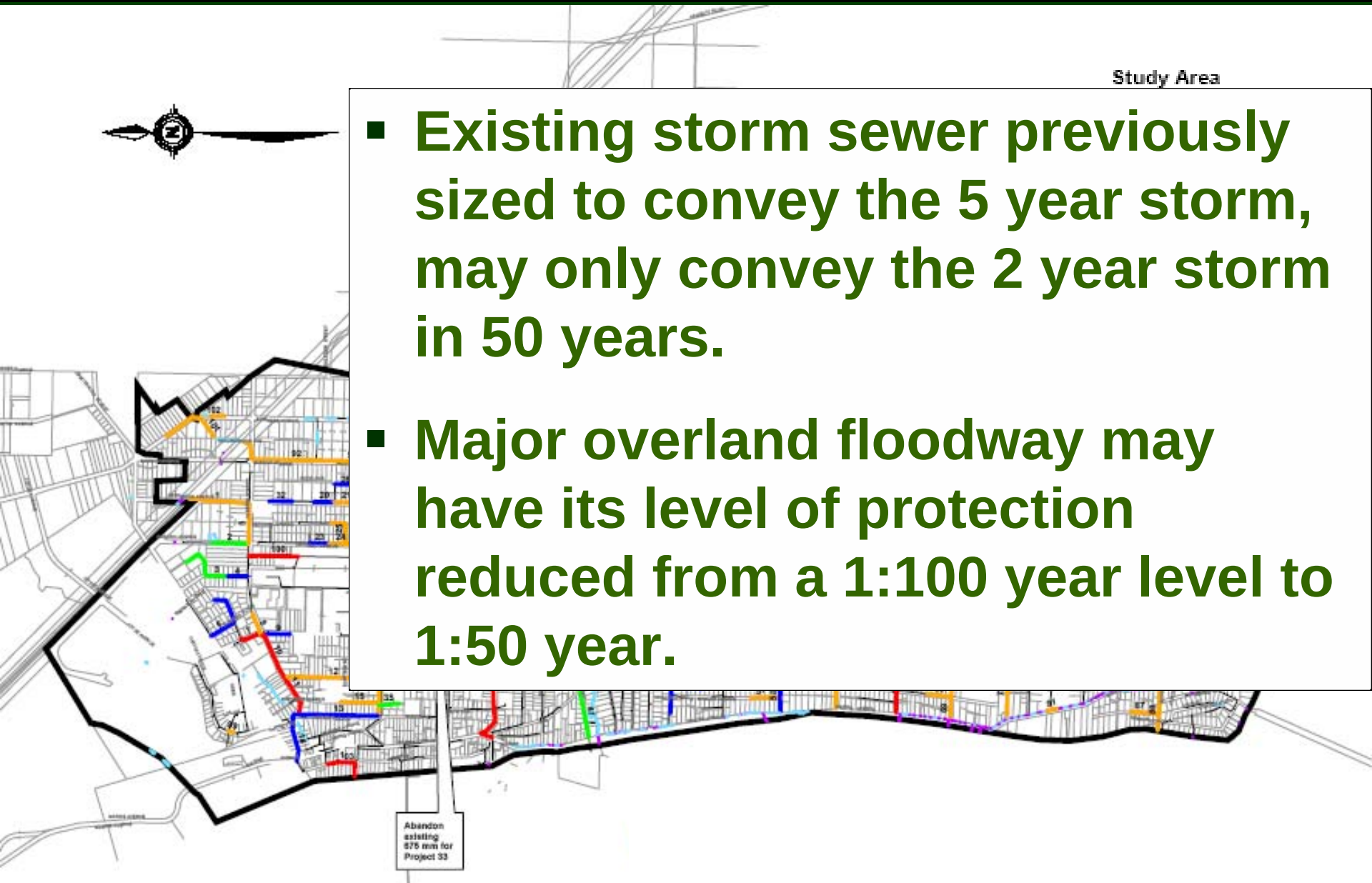
Estimated Change in Precip. From Climate Modelling	
Event	Avg. Change year 2050 (%)
Avg. Ann. 24-hour Precip.	+ 17%
Total Annual Precip.	+ 14%
Source: Vulnerability to Climate Change Report, Metro Vancouver, March 2008	

Based on Datasets and Climate Modelling for Metro Vancouver Region

Impact on Existing Infrastructure



Impact on Existing Infrastructure



- Existing storm sewer previously sized to convey the 5 year storm, may only convey the 2 year storm in 50 years.
- Major overland floodway may have its level of protection reduced from a 1:100 year level to 1:50 year.

Summary – Climate Change

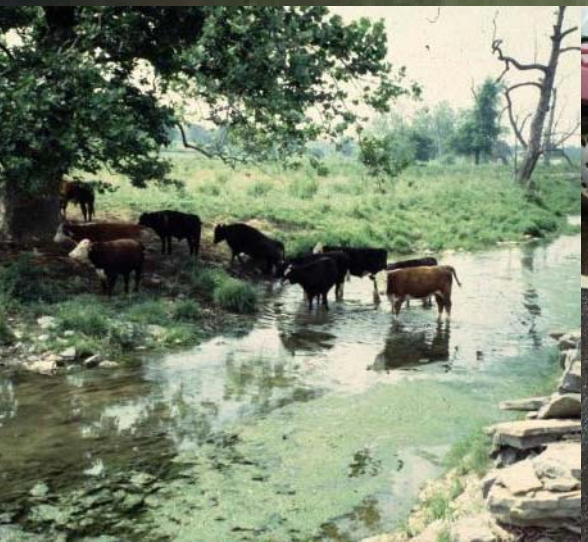
- As rainfall intensities increase over time, previous design criteria may not be sufficient to meet accepted service levels
- The objective is to disconnect impervious surfaces from the storm sewer collection system either at the lot level (preferably), or community level.
- This could provide the additional capacity required to avoid upgrading programs or drop in service levels

2: Impacts of Stormwater Quality

- groundwater contamination
- fish habitat loss
- aquatic life impacts
- drinking water impairment
- recreational impairment
- increased nutrient levels in lakes

Stormwater Pollutants

- Sediment (TSS)
- Phosphorus
- Nitrogen
- Metals/Chemicals
- Hydrocarbons
- Fecal Coliforms



Stormwater Quality Sources

Point Sources

- High Risk Potential Spill Sites
- Construction Sites

Stormwater Quality Sources

Non Point Source

- Roads, parking lots, roofs, lawns, fields, etc

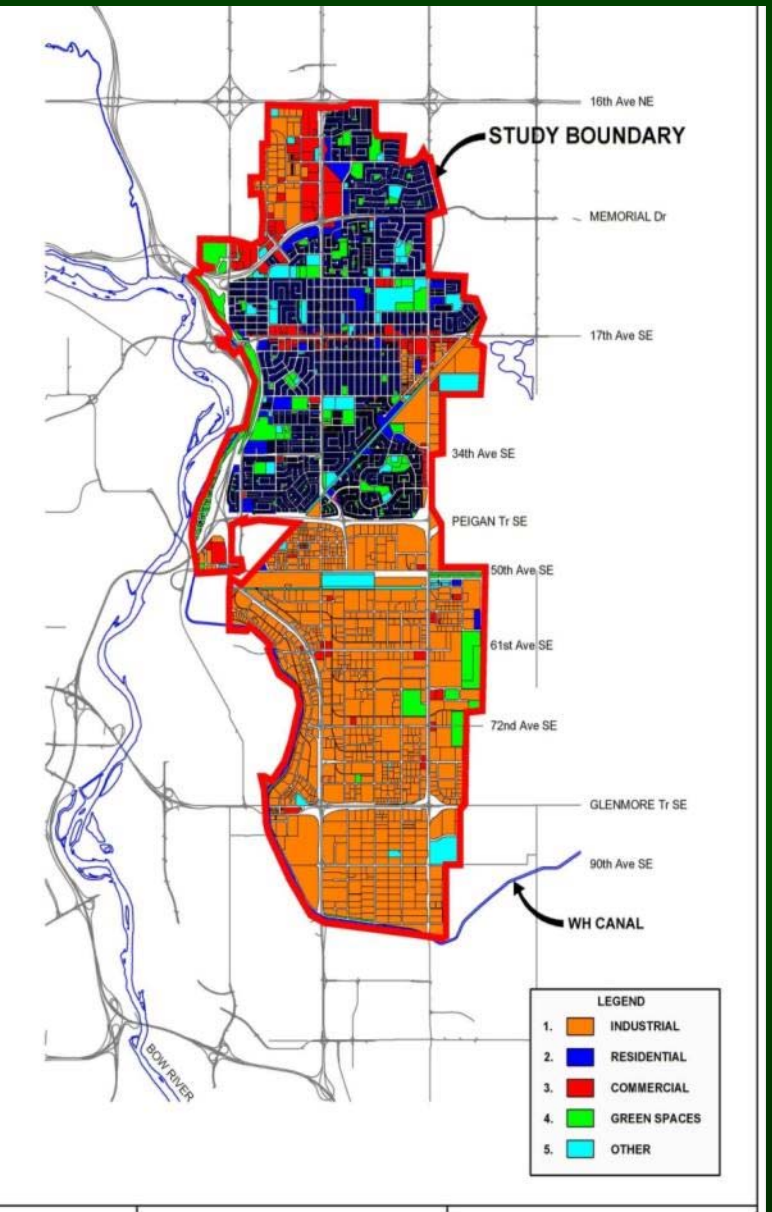
Summary - Water Quality

- Impervious areas act like a funnel for pollutants to move to the receiving waters (and drinking water supplies). For example, a typical road can contribute 1,200 kg/ha/year of solids to the receiving waters
- The smaller “rainwater” events are carrying a majority of the pollutants
- The objective is to disconnect these surfaces from the receiving waters either at the lot level (preferably), or community level.

City of Calgary – Stormwater Quality Program

- Loading to the Bow River for total suspended solids (TSS) and phosphorus has been set at an annual amount for the City.
- Strong land development bylaws are in place for new development to control stormwater pollutants
- Next step is to deal with existing areas.

City of Calgary Retrofit Example



SURFACE TYPE	AREA (% of Catch.)	TSS LOADING (% of Catch.)	LOADING RATIO (kg/ha/yr)
Roads	23 %	34 %	1,215
Paved Parking	4.7 %	12.6 %	1,625
Gravel Parking	2.1 %	18 %	2,585
Roofs	16 %	6 %	315

City of Calgary – Solutions Reviewed

Site Level BMPs

- Rain Garden Areas
- Infiltration Trenches / Systems
- Absorbent Landscaping
- Green Roofs
- Porous Pavement
- Vegetative Porous Pavement
- Oil & Grit Separators
- Street Sweeping (high efficiency)

City of Calgary – Solutions Reviewed

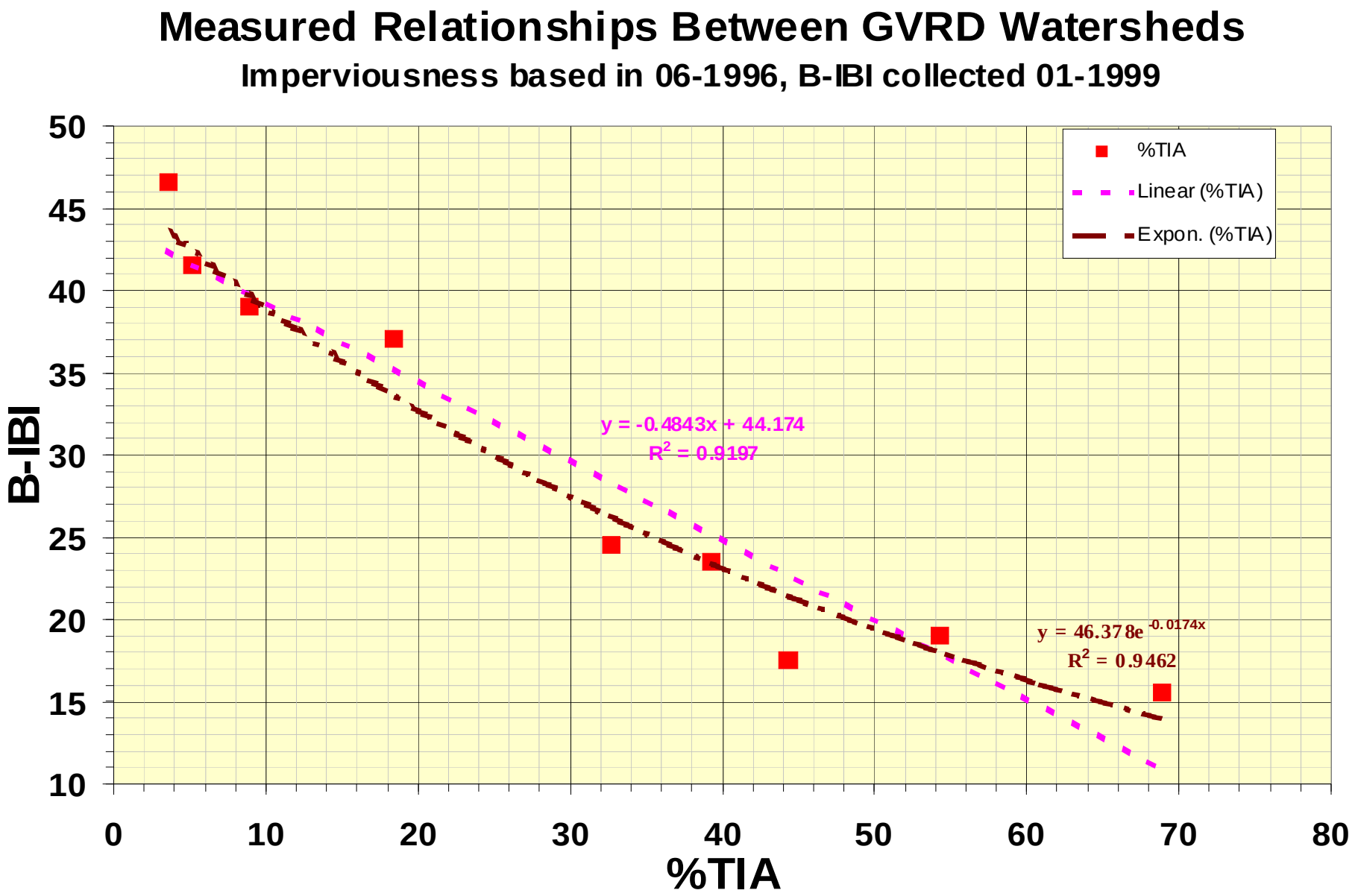
Regional/Community BMPs

- Wet Ponds
- Wetlands
- Sedimentation Basins
- Infiltration Basins
- Sand Filters

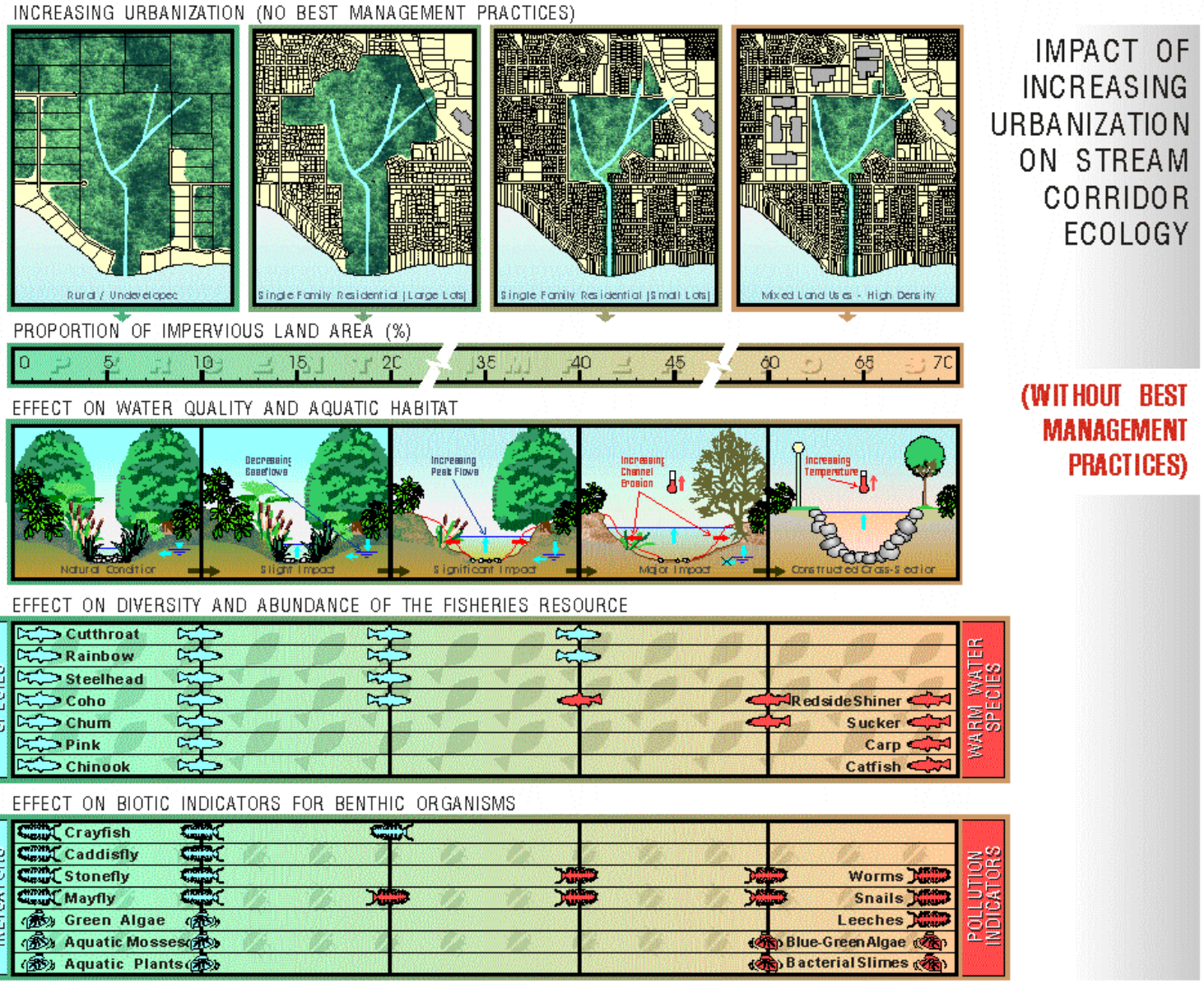
3: Impact on Aquatic Habitat

- As the area of impervious surfaces directly tied to creek systems increases, the quality, diversity, and abundance of aquatic species and habitat will decrease.
- This will be amplified by climate change

Impact of Imperviousness on Bugs



Impact of Imp. Areas on Stream Health



IMPACT OF INCREASING URBANIZATION ON STREAM CORRIDOR ECOLOGY

(WITHOUT BEST MANAGEMENT PRACTICES)

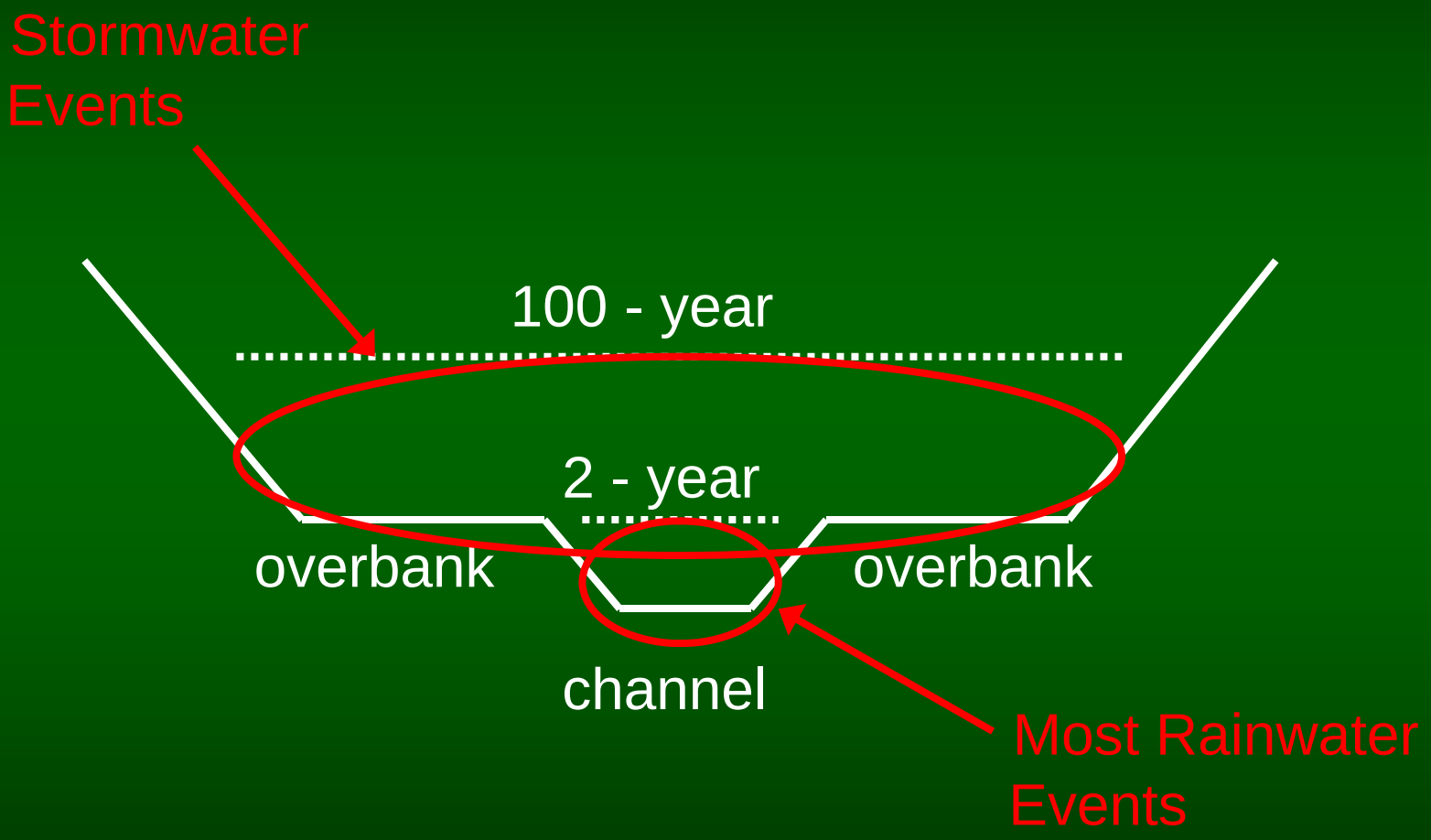
Summary – Aquatic Habitat

- Impervious areas directly tied to creek systems "flush" the bugs from the system. They also reduce the complexity of the creek system and impair water quality reducing the abundance and diversity of aquatic species including fish.
- The smaller "rainwater" events are performing a majority of the un-natural damage
- The objective is to disconnect these surfaces from the creek systems either at the lot level (preferably), or community level.

4. Impact of Erosion

- Erosion is a naturally occurring process in all streams and watercourses.
- However, when the hydrology is changed through increasing impervious surfaces, erosion will accelerate.
- Climate change could amplify this process.

Impact of Rainwater vs. Stormwater Events



Impacts of Urban Erosion

Summary – Erosion

- Impervious areas directly tied to creek systems change the natural hydrology of a watershed
- Erosion can lead to capital-intensive rehabilitation programs and additional TSS loadings in receiving waters
- The smaller “rainwater” events are performing a majority of the un-natural damage
- The objective is to disconnect these surfaces from the creek systems either at the lot level (preferably), or community level.
- Climate change will likely amplify the damage

Re-Occurring Theme

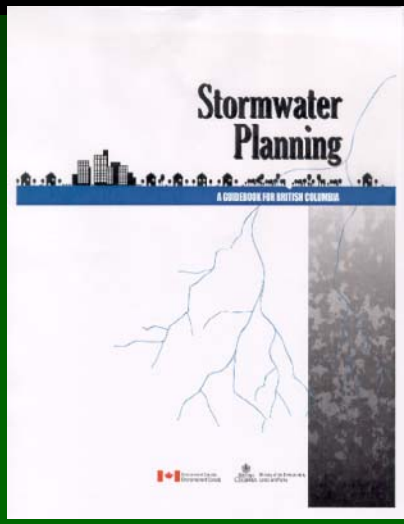
“Disconnect impervious surfaces”

- **This can be done through infiltration, evaporation, or re-use.**
- **It’s important that the disconnection and re-direction is done properly to match specified criteria or new problems can emerge.**

The Benefits

- Allows existing drainage infrastructure to accommodate larger storm events due to climate change
- Improves receiving water quality, fish habitat, and decreases erosive energy.
- Recharges groundwater aquifers
- Reduces risk that these issues will be amplified due to climate change

Process for Change



Watershed Plan

Selection of Criteria

Analysis of Impervious Surfaces

Changes to Development Bylaw

Changes to Standard Drawings

Long Term Retrofit Programs

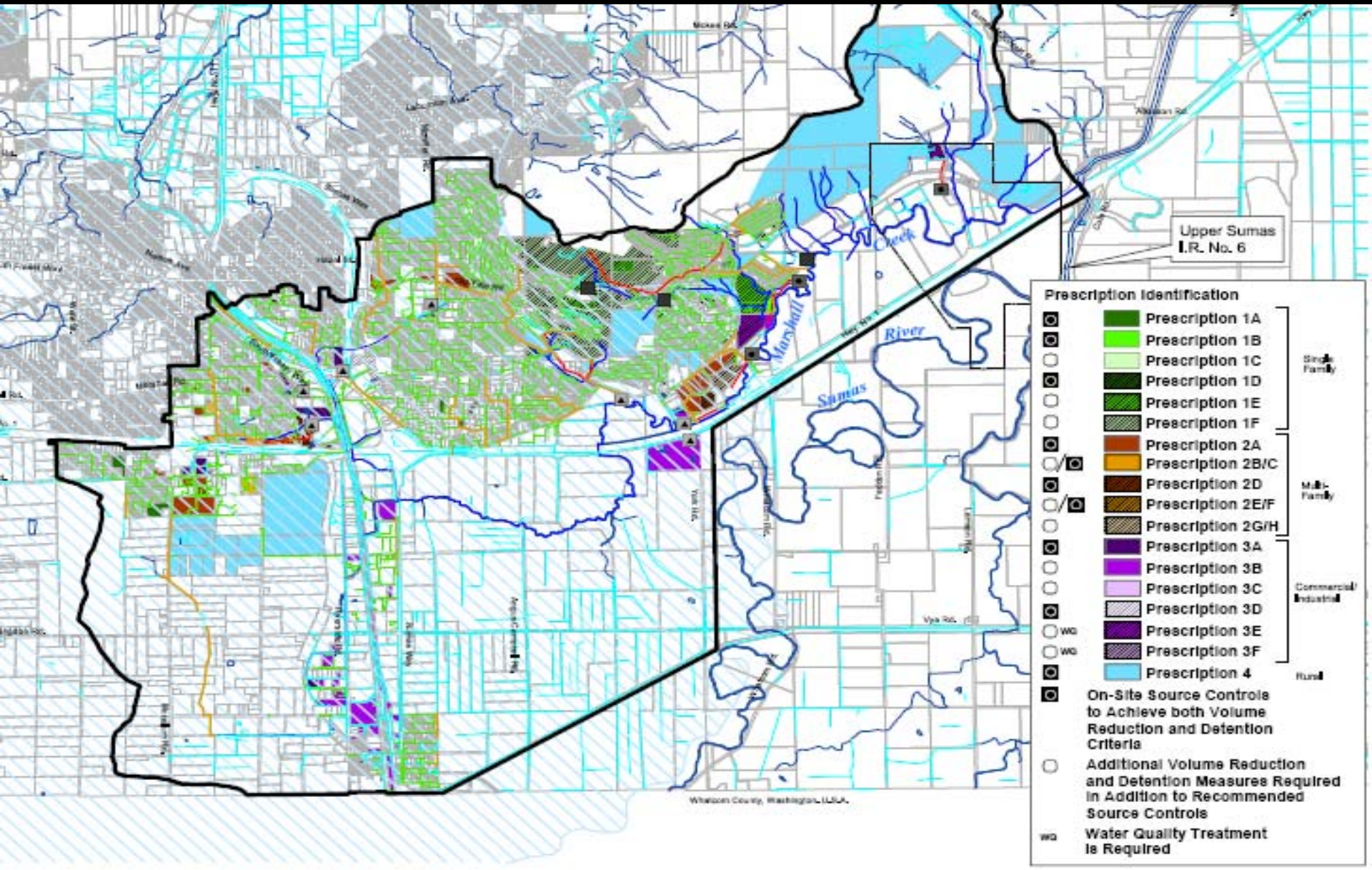
Selection of Rainwater/Stormwater Criteria

Item	Description
Volumetric Reduction	Infiltrate, evaporate, or re-use up to 50% of the 2-year, 24-hour storm (Guidebook), or 72% of the 24-hour storm (DFO)
Rate Control	Detain post development flows to pre-development levels for 2, 5, 10, and 100 year events
Water Quality	Reduce 50 micron and larger TSS by 90% for rainfall events up to the 6-month return period. Or set total TSS loads for the municipality

Criteria example only.

How do you infiltrate rainfall here?

Source Control Initiatives

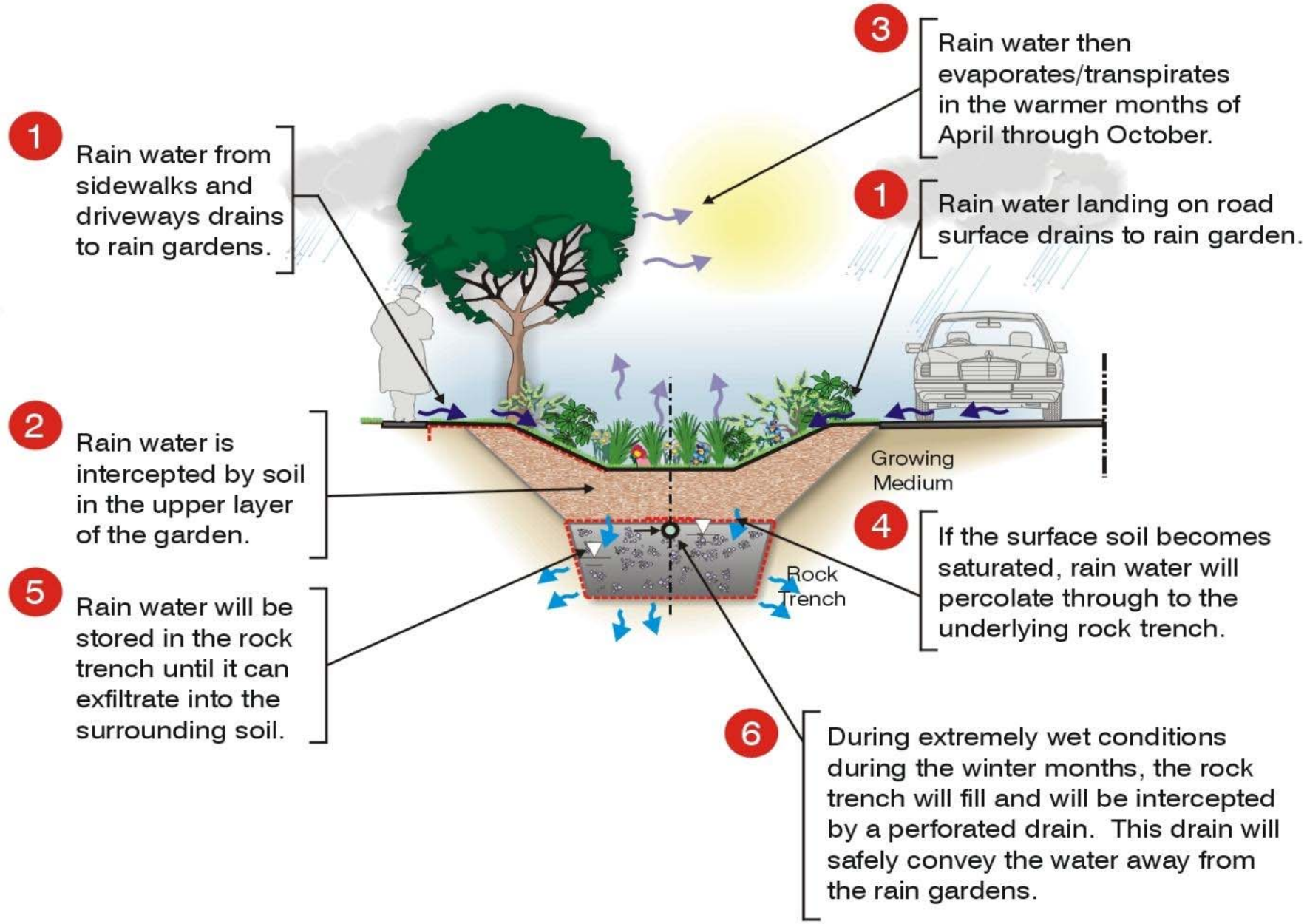


Example of Surfaces

- Roads – flat
- Roads – steep
- Single Family Lots – small
- Single Family Lots – large
- Commercial Areas
- Steep Hillside Development
- Parking Lots

Roads – Flat (<10%)

Silver Ridge, Maple Ridge, B.C.


1
Rain water from sidewalks and driveways drains to rain gardens.
2
Rain water is intercepted by soil in the upper layer of the garden.
5
Rain water will be stored in the rock trench until it can exfiltrate into the surrounding soil.
3
Rain water then evaporates/transpirates in the warmer months of April through October.
1
Rain water landing on road surface drains to rain garden.
Growing Medium
4
If the surface soil becomes saturated, rain water will percolate through to the underlying rock trench.
Rock Trench
6
During extremely wet conditions during the winter months, the rock trench will fill and will be intercepted by a perforated drain. This drain will safely convey the water away from the rain gardens.

Single Family Residential Lots - Large

Disconnected Roof Leaders

Rain Barrels / Re-Use

Single Family Residential Lots - Small

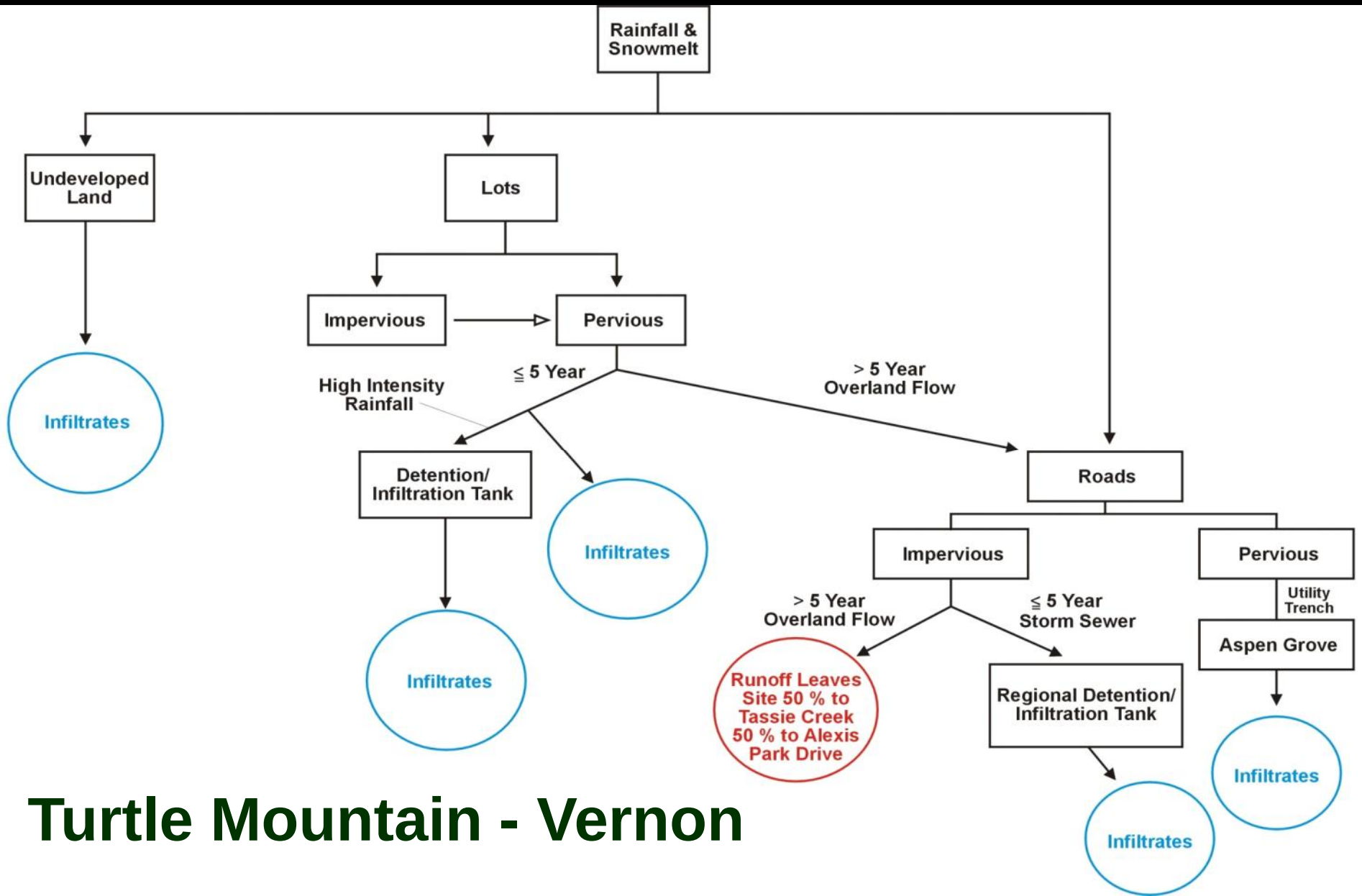
Disconnected Roof Leaders

Rock Pits or Infil. Vaults

Rain Barrels /Re-Use

Parking Lots

Steep Hillside Development

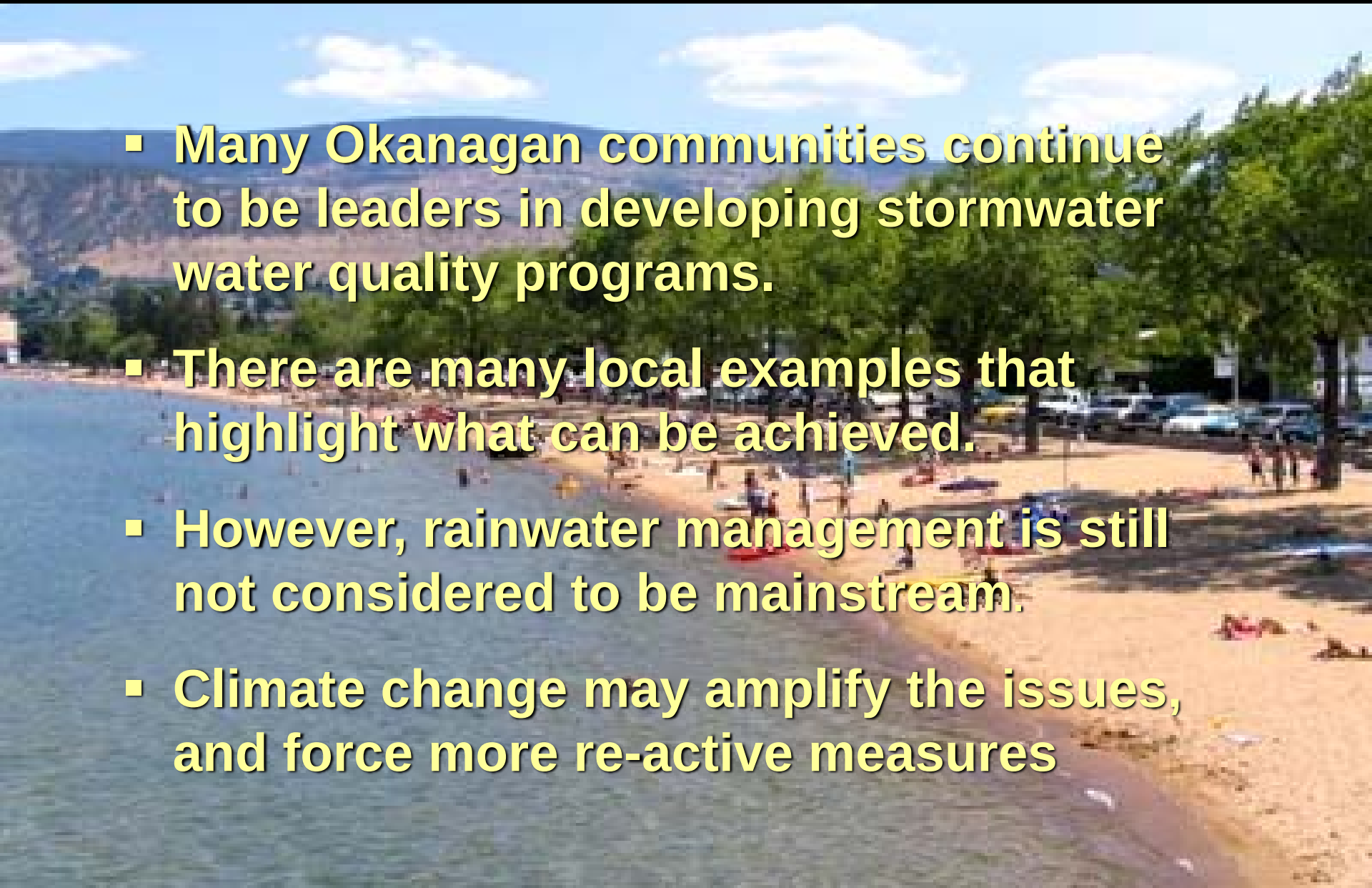


Turtle Mountain - Vernon


Grey Canal Trail

Community Exfiltration Facility

Concluding Remarks



- Many Okanagan communities continue to be leaders in developing stormwater water quality programs.
- There are many local examples that highlight what can be achieved.
- However, rainwater management is still not considered to be mainstream.
- Climate change may amplify the issues, and force more re-active measures

Questions ?

Chris Johnston

Kerr Wood Leidal Associates Ltd.

cjohnston@kwl.ca

604 209 5070