



LINKING LAND USE DECISION WITH STREAM FLOW AND AQUATIC BIOLOGY MANAGEMENT

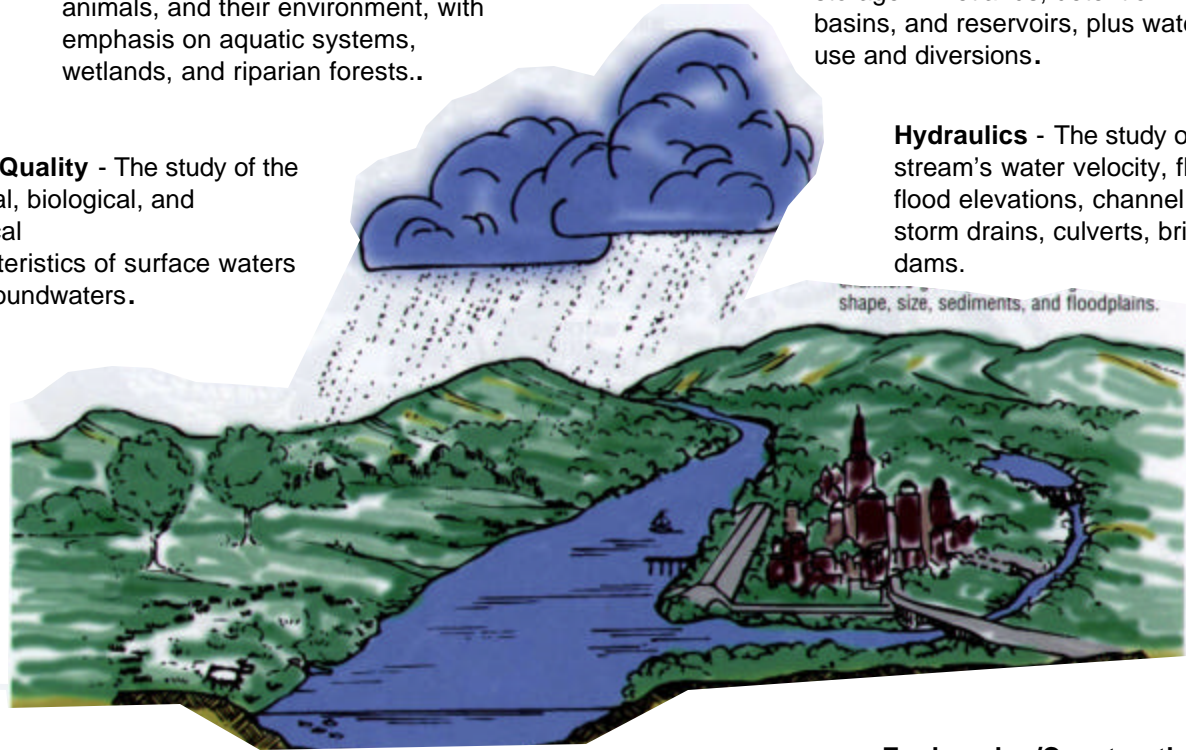
By
Jim MacBroom

CACIWC Annual Meeting
October 2001

OVERVIEW

Ecology - The study of plants, animals, and their environment, with emphasis on aquatic systems, wetlands, and riparian forests..

Water Quality - The study of the physical, biological, and chemical characteristics of surface waters and groundwaters.



Hydrology - The study of precipitation, infiltration, surface runoff, streamflow rates, water storage in wetlands, detention basins, and reservoirs, plus water use and diversions.

Hydraulics - The study of the stream's water velocity, flow depth, flood elevations, channel erosion, storm drains, culverts, bridges, and dams.

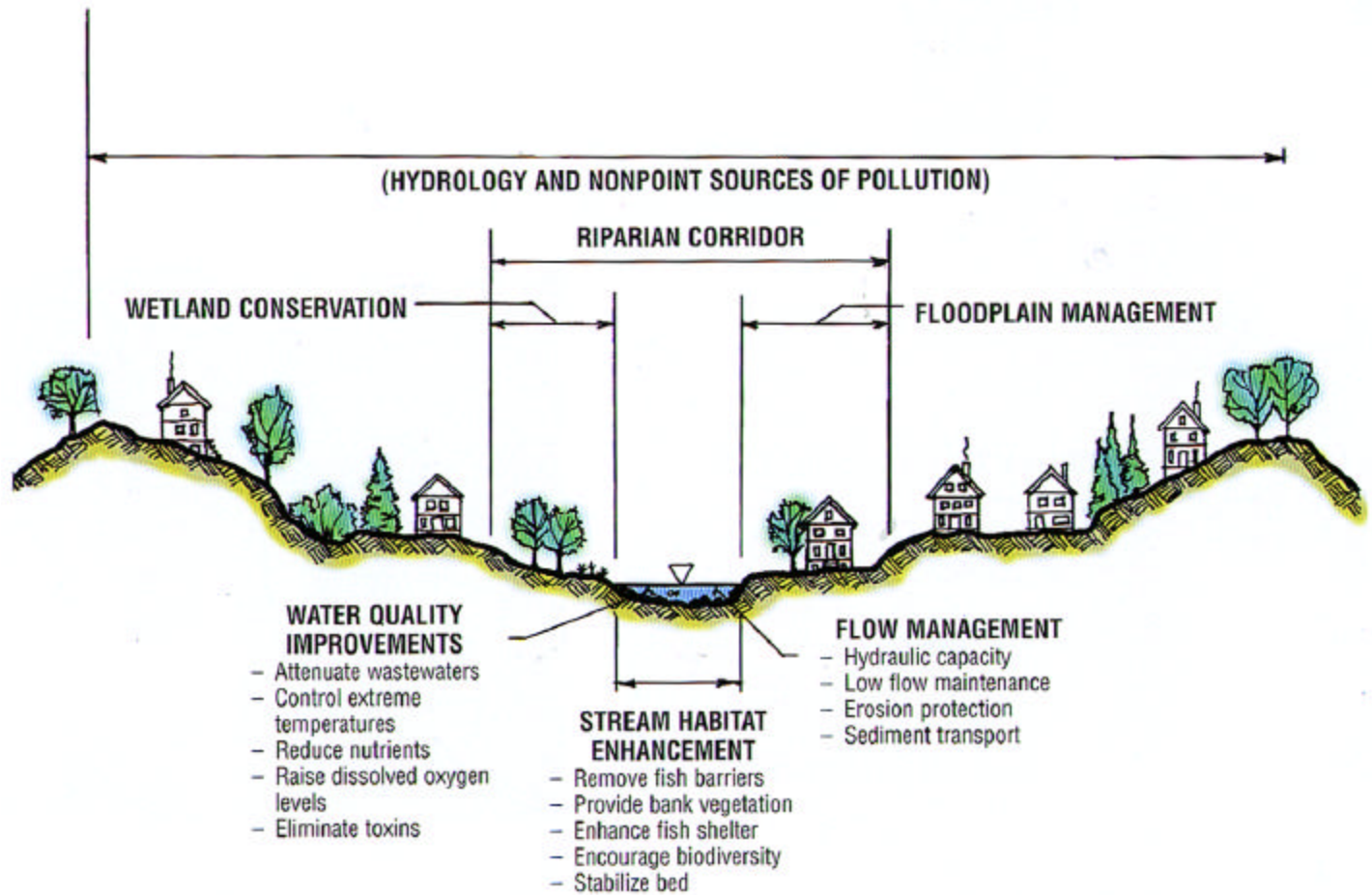
shape, size, sediments, and floodplains.

Fluvial Morphology - The study of the channel's geologic origin, alignment, slope, shape, size, sediments, and floodplains.

Socioeconomic - The study of the sociology, social relationships, economic impacts, and their interconnections.

Engineering/Construction – The application of science and mathematics in analysis, design, permitting, and construction.

WATERSHED MANAGEMENT

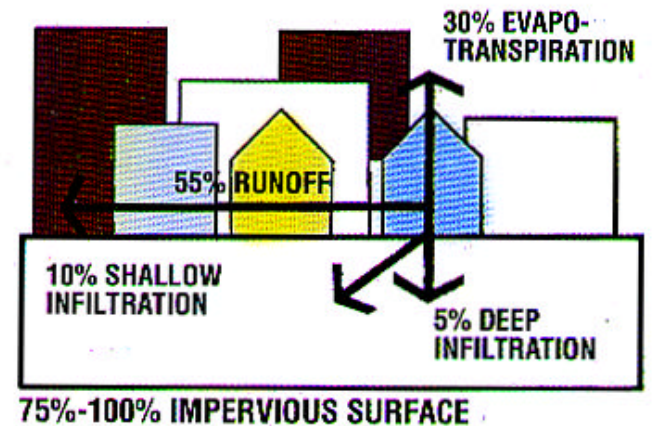
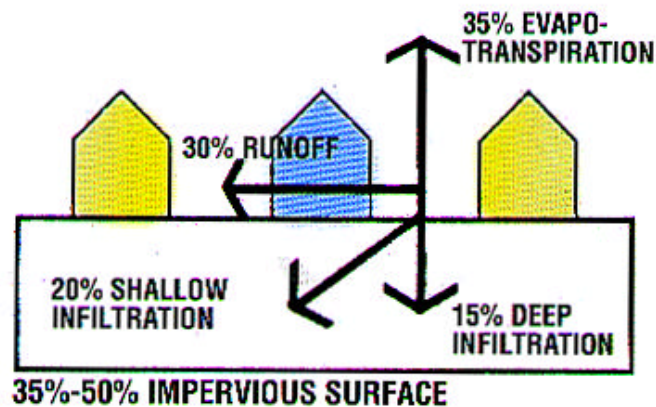
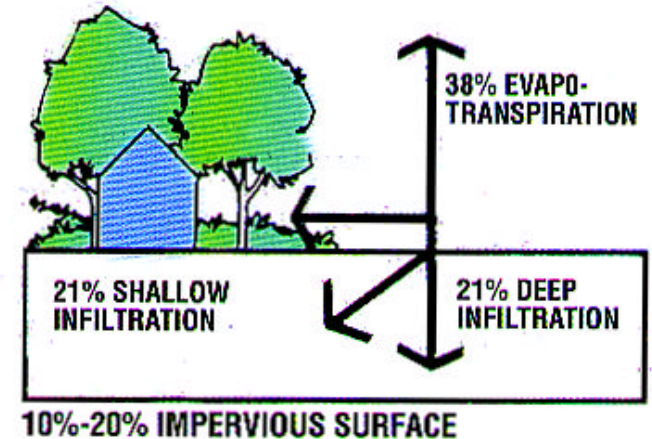
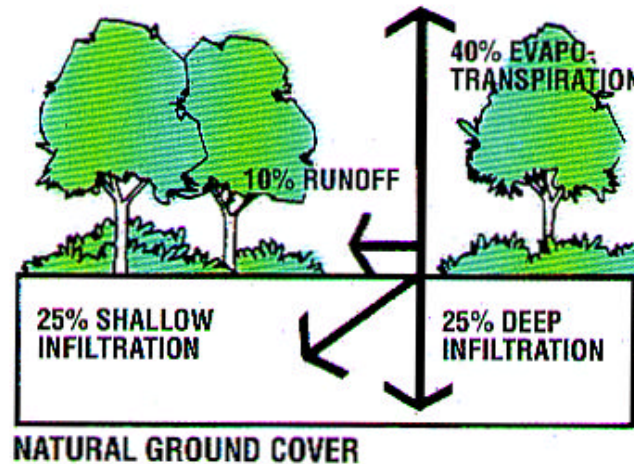




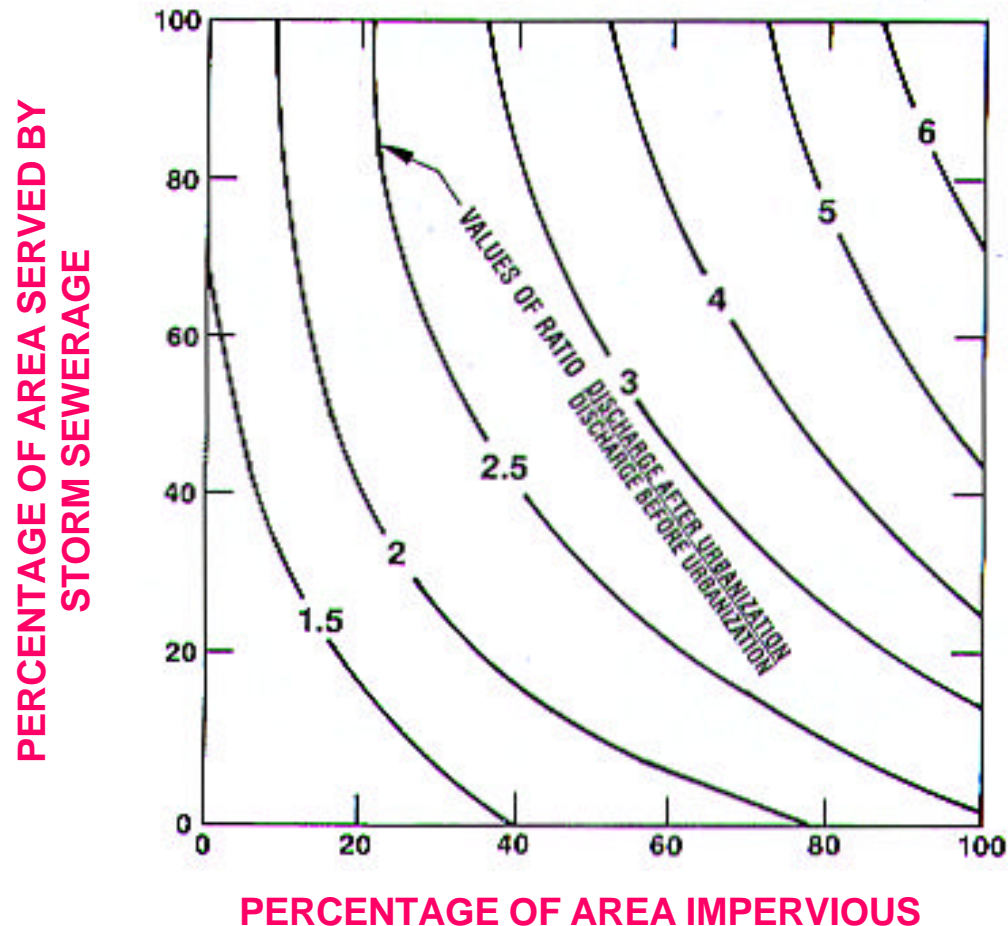
GEOGRAPHIC LEVELS OF RIVERS MANAGEMENT

ISSUE	WATERSHED	CORRIDOR	CHANNEL
HYDROLOGY	X	X	X
WATER QUALITY	X	X	X
NORMAL FLOW HYDRAULICS			X
FLOOD FLOW HYDRAULICS		X	X
AQUATIC HABITAT			X
RIPARIAN ECOSYSTEM		X	X

HYDROLOGIC CHANGES RESULTING FROM URBANIZATION



EFFECT OF URBANIZATION ON MEAN ANNUAL FLOOD FOR A 1-SQUARE MILE DRAINAGE AREA



Reproduced from U.S. Geological Survey Circular 554 "Hydrology for Urban Land Planning," 1968.



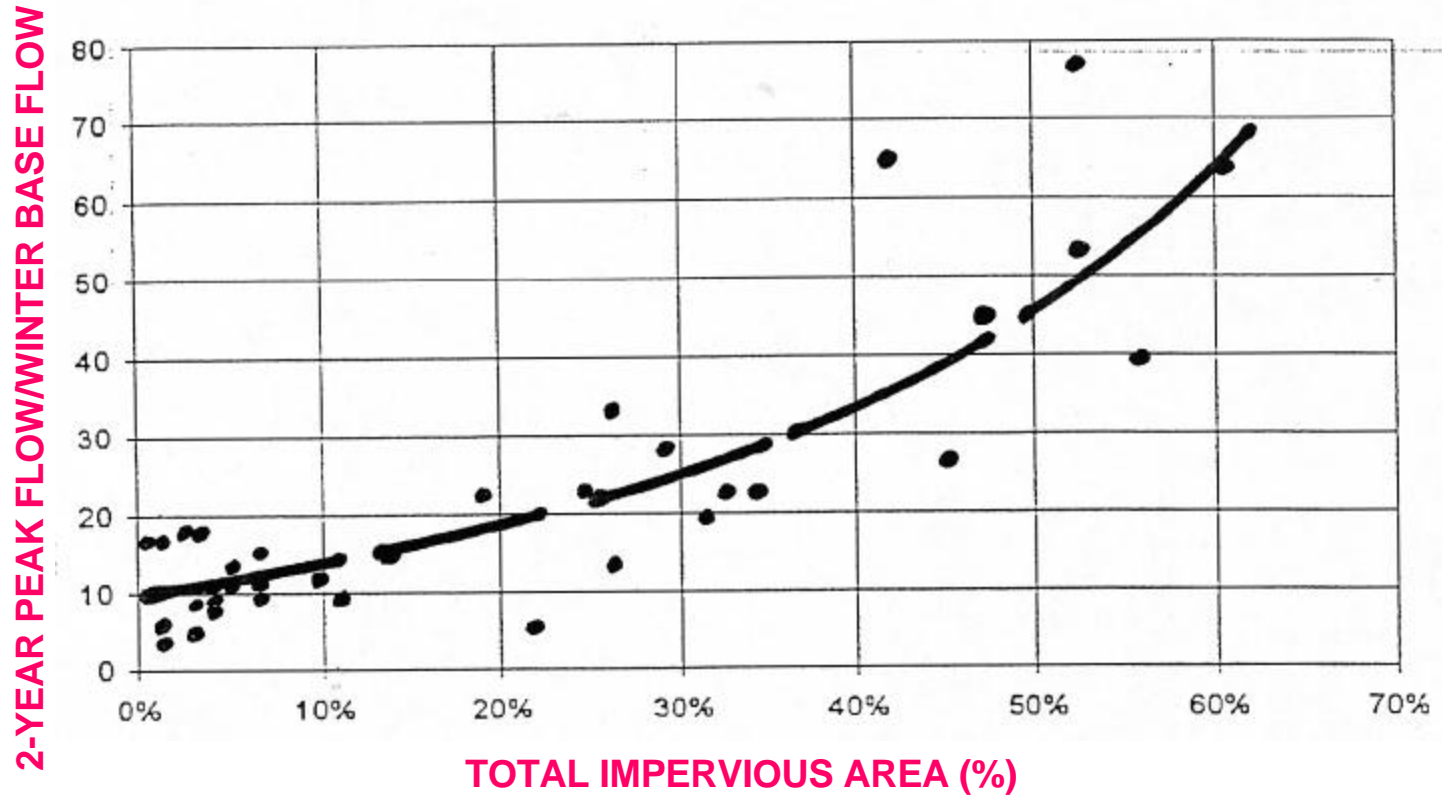
IMPACT OF LAND USE ON RUNOFF SCS CN METHOD WITH STANDARD CNN VALUES

USE TYPE “B” SOIL

USE 10-YEAR FREQUENCY. 24-HOUR PRECIPITATION OF 4.7”

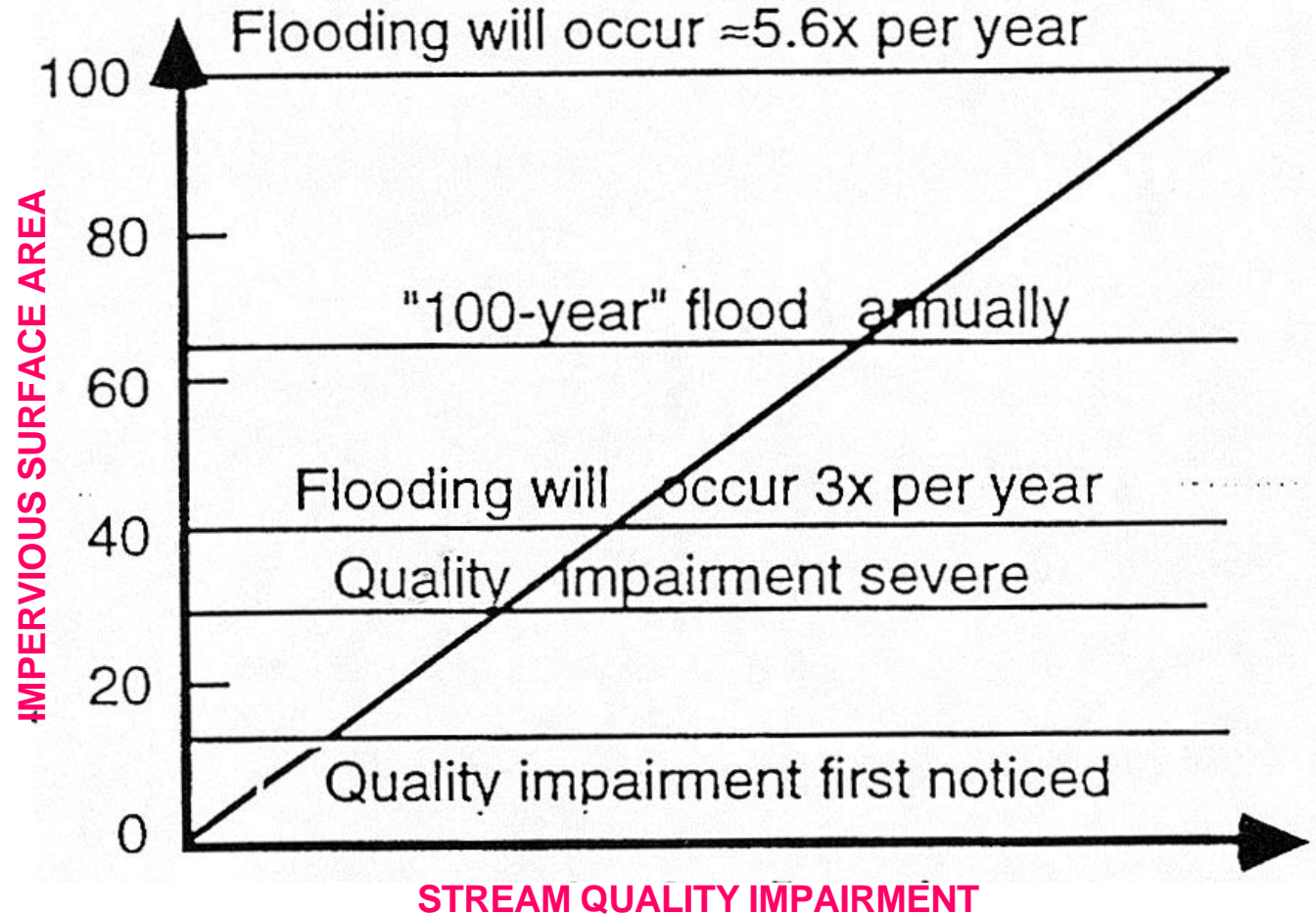
LAND USE	CN	RUNOFF (In.²)	RUNOFF RATIO
WOODS, GOOD	55	0.82	--
OPEN SPACE, GOOD	61	1.2	1.46
2-ACRE RESIDENTIAL	65	1.45	1.77
1-ACRE RESIDENTIAL	68	1.68	2.05
1/2-ACRE RESIDENTIAL	70	1.80	2.20
1/4-ACRE RESIDENTIAL	75	2.20	2.68
1/8-ACRE RESIDENTIAL	85	3.1	3.78
COMMERCIAL	92	3.8	4.63

RATIO OF 2-YEAR PEAK FLOW



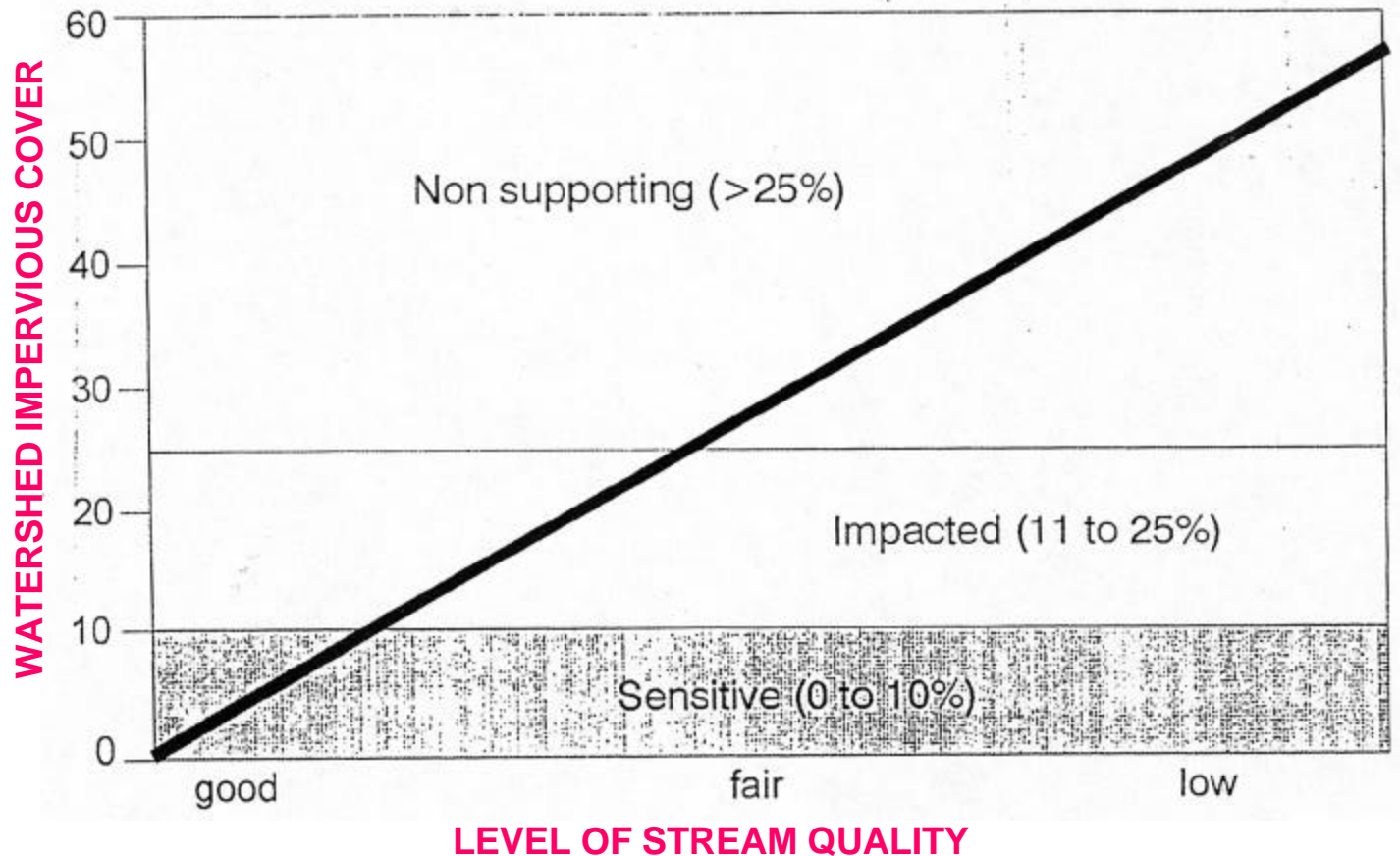
Ratio of 2-Year Peak Flow to Winter Base Flow in Puget Sound Lowland Stream Sediments over a Gradient of Watershed Impervious Land Cover. Horner et al, ASCE 1996

WATERSHED DEVELOPMENT EFFECTS



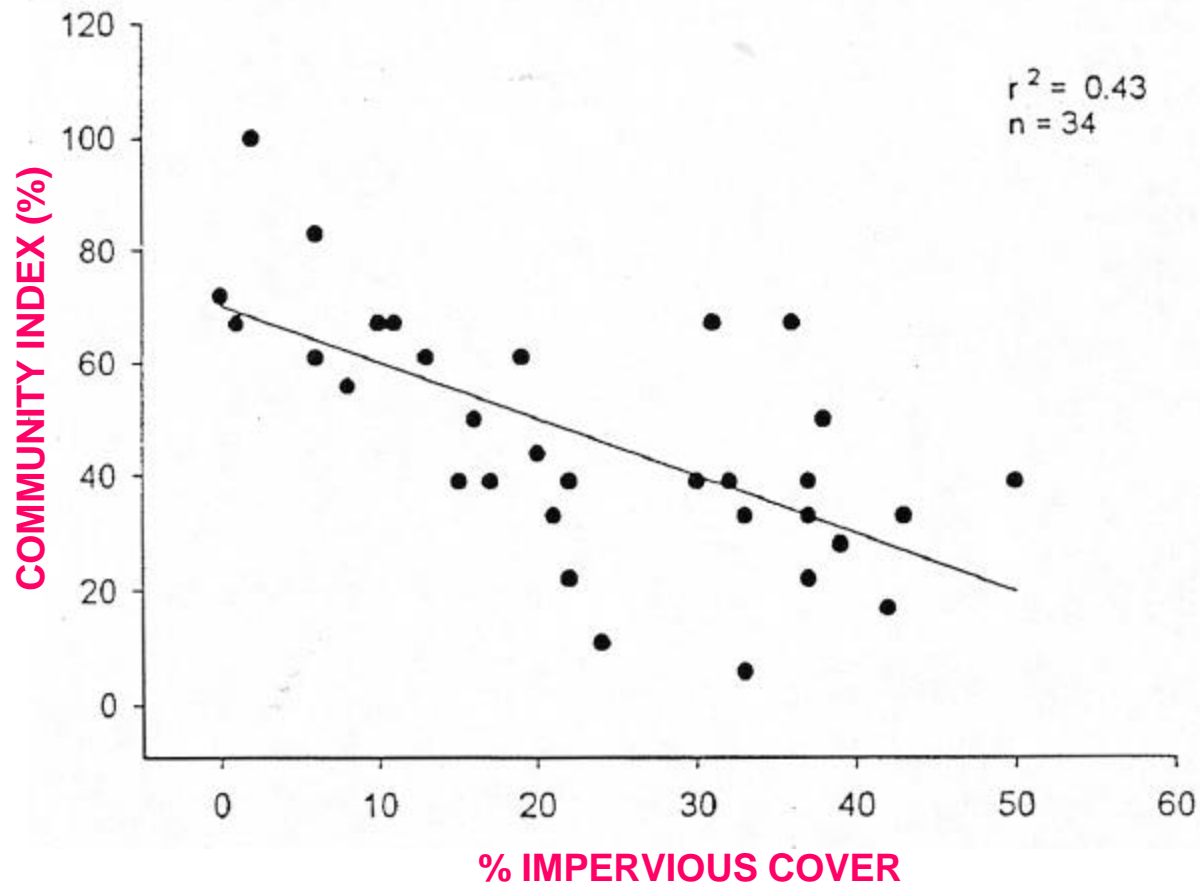
Thresholds for Impervious Surface Impact taken from Klein, 1979

RELATIONSHIP BETWEEN IMPERVIOUS COVER AND STREAM QUALITY



Impervious Cover / Stream Quality Relationship used in the Stream Classification Model. Schueler & Claytor, 1996, ASCE Metro Washington, D.C. area.

EFFECT OF IMPERVIOUS COVER



The Effect of Impervious Cover on the Macroinvertebrate Community; Community Index Values Reported as % of Reference based upon 6 Metrics; Taxonomic Richness, EPT Richness, % EPT Abundance, % Chironomidae, % Dominant Taxon, And Hilsenhoff Biotic Index



IMPACTS ON STREAMS FROM IMPERVIOUS COVER

% WATERSHED IMPERVIOUS	STREAM IMPACT	COMMENTS
0-10	MINIMAL	LIMIT FOR PROTECTING SENSITIVE NATIVE TROUT STREAMS.
10-15	LOW	LIMIT FOR PROTECTING AVERAGE STREAMS. DEGRADED HABITAT.
15-25	MEDIUM	LIMIT FOR CONTROLLING SPECIFIC NUTRIENTS AND TOXIC POLLUTANTS.
25-50	HIGH	REDUCE LOW FLOWS, HIGHER PEAK FLOWS. FEW FISH.
50	SEVERE	SEVERE CHANGES IN HYDROLOGY, HYDRAULICS, MORPHOLOGY, WATER QUALITY. THE STREAM WILL HAVE FEW NATURAL ATTRIBUTES.



LOW IMPACT DEVELOPMENT

- Preserve natural vegetation
- Minimize impervious cover
- Disconnect impervious cover
- Provide riparian buffers
- Encourage infiltration
- Avoid direct runoff discharges



LIMIT IMPERVIOUS COVER

- Minimize road widths and lengths
- Combine driveways
- Limit lot coverage
- Use pervious parking lots
- Provide “green” islands and medians
- Cluster development



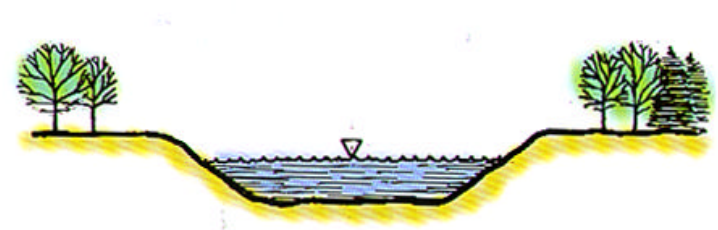
DISCONNECT IMPERVIOUS COVER

- Avoid direct discharges to watercourses
- Use swales instead of pipes
- Encourage overland flow
- Minimize road curbs
- Provide buffer zones

CHANNEL CLEARING



VEGETATED CHANNEL



CLEARED CHANNEL

LOCAL

ADVANTAGES:

- INCREASED FLOW CAPACITY FOR STORMS OF FREQUENT RECURRENCE INTERVALS
- REDUCED FLOODWATER DEPTHS
- REDUCED FLOOD DAMAGE
- REMOVAL OF EXCESS DEBRIS

DISADVANTAGES:

- INCREASED FLOW VELOCITY
- INCREASED EROSION POTENTIAL
- INCREASED WATER TEMPERATURE
- DECREASED WATER TURBULENCE AND AERATION
- DISTURBED HABITAT
- REDUCED INSTREAM COVER AND SHELTER FOR FISH

UPSTREAM

ADVANTAGES:

- LOWER FLOODWATER DEPTHS

DOWNSTREAM

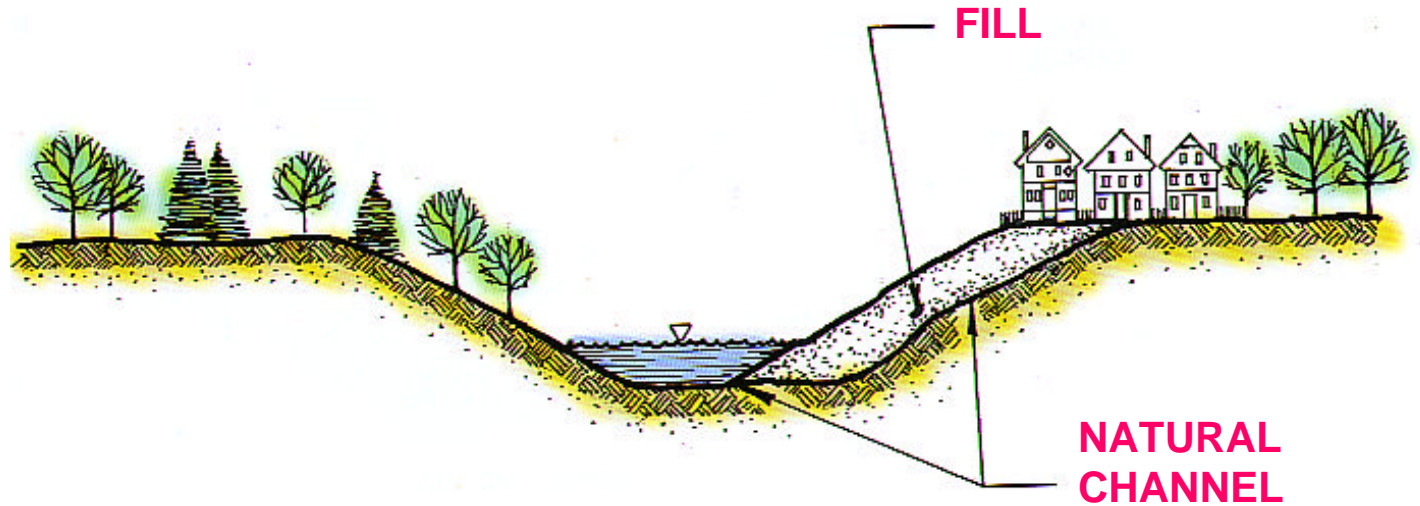
DISADVANTAGES:

- INCREASED SEDIMENT LOAD AND DEPOSITION
- INCREASED WATER TEMPERATURE
- DECREASED DISSOLVED OXYGEN LEVELS
- REDUCED INPUT OF LEAF AND WOODY ORGANIC MATTER

COMMENTS

EXCESS CHANNEL CLEARING ELIMINATES THE NATURAL SHELTER AND ORGANIC DETRITUS THAT CONTRIBUTE TO THE AQUATIC HABITAT. THE NATURAL RIPARIAN VEGETATION AND CHANNEL IRREGULARITIES SHOULD BE PRESERVED.

CHANNEL FILLING



LOCAL

ADVANTAGES:

- INCREASED LAND AREA FOR HUMAN USES

DISADVANTAGES:

- REDUCED CHANNEL SIZE
- INCREASED FLOW VELOCITIES
- INCREASED WATER DEPTH
- INCREASED BED AND BANK SCOUR
- DESTRUCTION OF RIPARIAN HABITAT AND ELIMINATION OF SHADE
- DECREASED FLOODWATER STORAGE AND CONVEYANCE
- ALTERATION OF LATERAL DRAINAGE OF RUNOFF TO RIVER
- PREVENTION OF NATURAL CHANNEL ADJUSTMENTS

UPSTREAM

DISADVANTAGES

- INCREASED WATER DEPTH AND FLOODING
- POSSIBLE REDUCTION IN FLOW VELOCITIES

DOWNSTREAM

ADVANTAGES:

- DECREASED PEAK FLOW RATES

DISADVANTAGES:

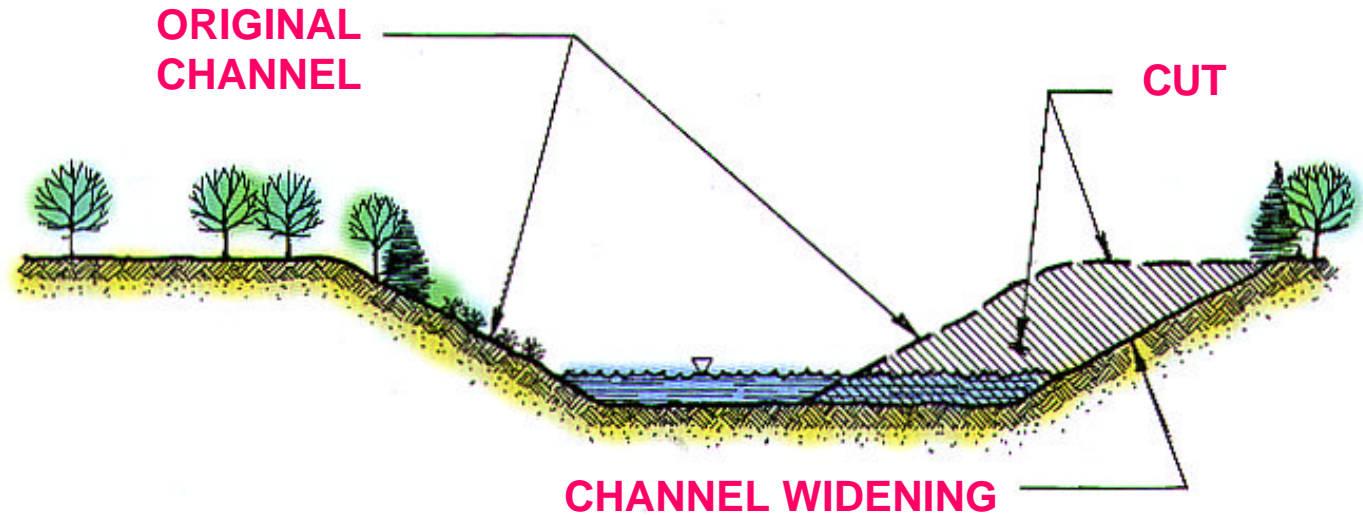
- INCREASED SEDIMENT LOAD LEADING TO REDUCED WATER QUALITY AND POSSIBLE AGGRADATION
- CONCENTRATED FLOW CAUSES SCOUR AT END OF FILL AREA

COMMENTS

PLACING FILL MATERIAL IN RIVER CHANNELS OFTEN CAUSES AN INCREASE IN FLOODWATER LEVELS.



CHANNEL WIDENING



LOCAL

ADVANTAGES:

- INCREASED FLOOD FLOW CAPACITY
- DECREASED FLOOD FLOW DEPTH
- INCREASED CHANNEL STORAGE

DISADVANTAGES:

- DECREASED FLOW VELOCITIES
- INCREASED SEDIMENT DEPOSITION
- DESTRUCTION OF RIPARIAN HABITAT
- INCREASED WATER TEMPERATURE
- POTENTIALLY UNSTABLE BANKS
- REDUCED FLOW DEPTH

COMMENTS

TRY TO SAVE VEGETATION ON ONE OR BOTH BANKS.

UPSTREAM

ADVANTAGES:

- REDUCED FLOOD FLOW DEPTHS

DISADVANTAGES:

- POSSIBLE CHANNEL AGGRADATION
- SCOUR AT TRANSITION

DOWNSTREAM

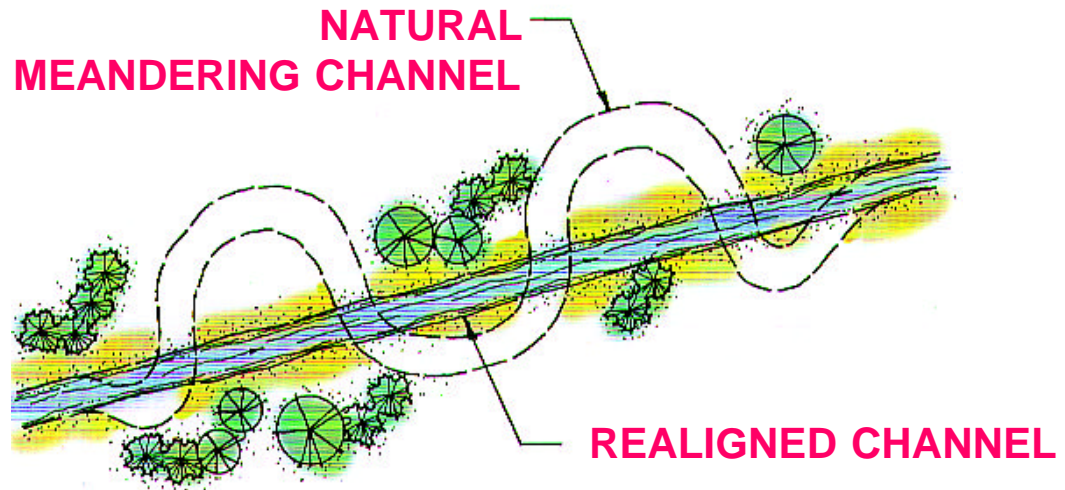
ADVANTAGES:

- COULD DECREASE PEAK FLOWS BY INCREASING STORAGE VOLUMES

DISADVANTAGES:

- COULD INCREASE PEAK FLOWS
- INCREASED SEDIMENT LOAD DURING EXCAVATION
- MAY CAUSE CHANNEL DEGRADATION

CHANNEL STRAIGHTENING



LOCAL

ADVANTAGES:

- INCREASED CONVEYANCE CAPACITY
- RECLAMATION OF LAND
- POSSIBLE REDUCTION OF FLOOD DAMAGE

DISADVANTAGES:

- SHORTER CHANNEL LENGTH, INCREASING SLOPE
- HIGHER FLOW VELOCITIES
- INCREASED SCOUR
- REDUCED FLOODPLAIN STORAGE
- ELIMINATION OF POOLS AND RIFFLES
- REDUCED BANK HABITAT AREA
- REDUCED AQUATIC HABITAT AREA
- CHANNEL SCOUR PROTECTION REQUIRED

UPSTREAM

ADVANTAGES:

- LOWER FLOOD STAGES

DISADVANTAGES:

- POTENTIAL CHANNEL DEGRADATION

DOWNSTREAM

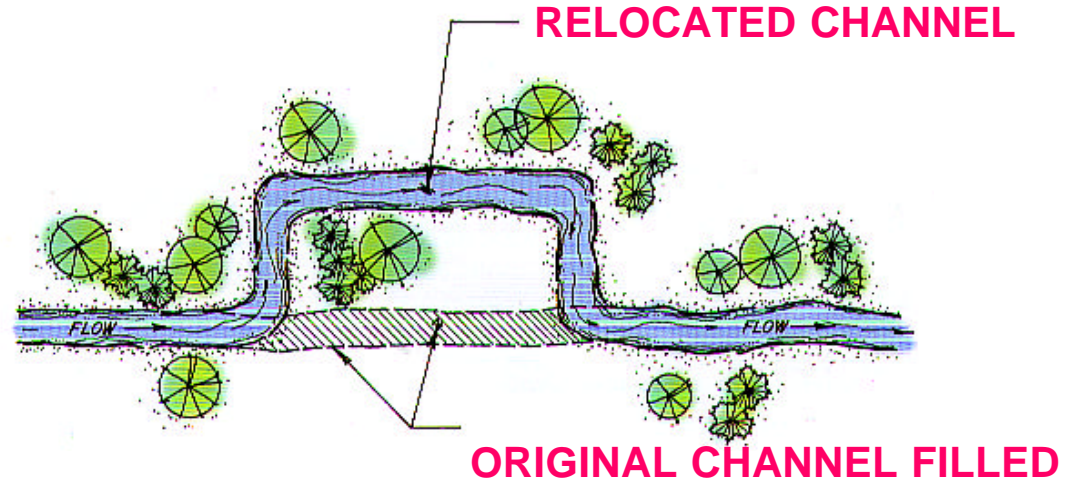
DISADVANTAGES:

- INCREASED FLOOD FLOW RATES AND STAGES
- INCREASED SEDIMENT LOADS
- INCREASED SEDIMENT DEPOSITION; IF EXCAVATED AREA IS NOT ARMORED, MAY BURY BED HABITAT

COMMENTS

THE REALIGNMENT AND RELOCATION OF CHANNELS IS USUALLY ASSOCIATED WITH LAND DEVELOPMENT AND HIGHWAY PROJECTS.

CHANNEL RELOCATION



LOCAL

ADVANTAGES:

- OLD CHANNEL RECLAIMED FOR HUMAN USES
- INCREASED FLOOD STORAGE IF OLD CHANNEL NOT RECLAIMED

DISADVANTAGES:

- INCREASED CHANNEL LENGTH
- DECREASED CHANNEL SLOPE
- DECREASED FLOW VELOCITY
- DECREASED FLOW CAPACITY
- AGGRADATION DUE TO INCREASED SEDIMENT DEPOSITION
- DESTRUCTION OF CHANNEL HABITAT

COMMENTS

CAREFUL DESIGN AND CREATION OF NATURAL CONDITIONS IN NEW CHANNEL CAN MITIGATE NEGATIVE IMPACTS.

UPSTREAM

DISADVANTAGES:

- AGGRADATION
- SCOUR AT TRANSITION
- POSSIBLE INCREASE IN WATER ELEVATION
- POSSIBLE CHANGE IN CHANNEL PATTERN, ALIGNMENT

DOWNSTREAM

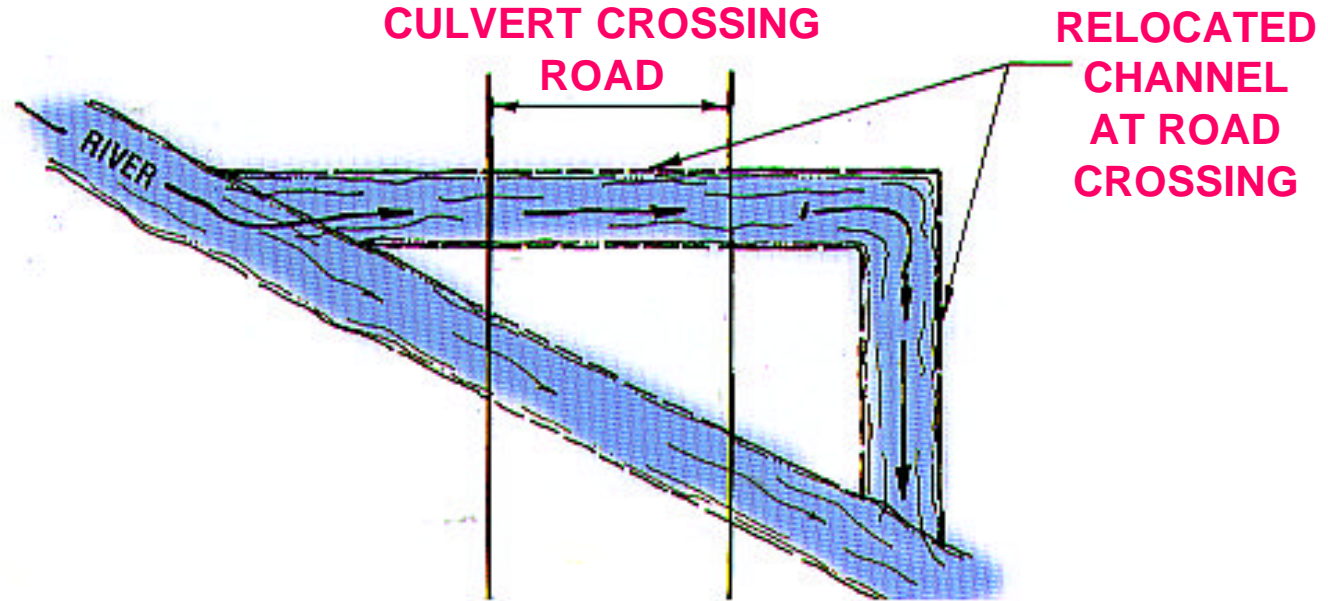
ADVANTAGES:

- DELAY OF PEAK FLOOD FLOWS

DISADVANTAGES:

- DECREASED SEDIMENT LOAD, LEADING TO DEGRADATION

CHANNEL REALIGNMENT



LOCAL

ADVANTAGES:

- ALLOWS CULVERT TO BE SHORTER
- INCREASED CHANNEL LENGTH, LESS SLOPE
- LOWER FLOW VELOCITY

DISADVANTAGES:

- POTENTIAL EROSION IN NEW CHANNEL
- UNNATURAL, ABRUPT BENDS, PRONE TO EROSION
- REDUCED NATURAL HABITAT
- CHANNEL LININGS OFTEN REQUIRED

UPSTREAM

ADVANTAGES:

- REDUCED FLOW VELOCITY

DISADVANTAGES:

- HIGHER WATER ELEVATIONS

DOWNSTREAM

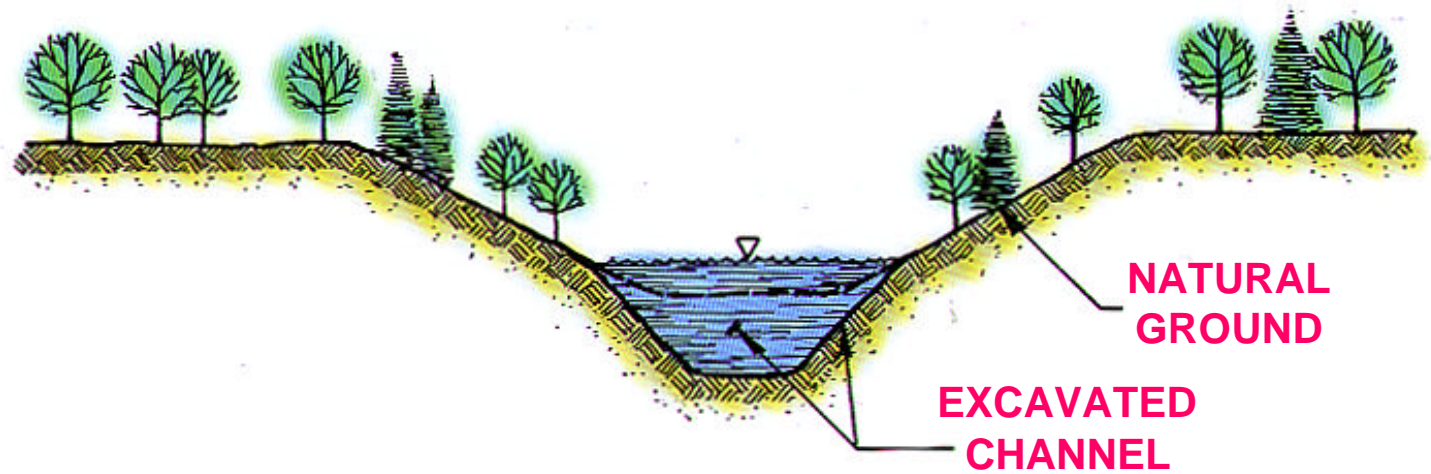
DISADVANTAGES:

- INCREASED SEDIMENT LOAD

COMMENTS

THE NATURAL CHANNEL ALIGNMENT SHOULD BE MAINTAINED WHEREVER POSSIBLE.

CHANNEL DEEPENING



LOCAL

ADVANTAGES:

- INCREASED CHANNEL FLOW CAPACITY
- INCREASED ALLOWABLE FLOW DEPTH
- REDUCED FLOW VELOCITIES
- INCREASED CHANNEL WATER STORAGE
- DECREASED WATER TEMPERATURE
- REDUCED FLOOD DAMAGES

DISADVANTAGES:

- REMOVAL OF NATURAL STREAMBED COBBLES AND ARMOR
- INCREASED EROSION
- POSSIBLE REDUCTION OF BANK STABILITY
- POSSIBLE DEGRADATION OF TRIBUTARIES
- REMOVAL OF VEGETATION
- DISTURBANCE OF SPAWNING AREAS
- POSSIBLE LOWERING OF GROUNDWATER

UPSTREAM

ADVANTAGES:

- LOWER FLOOD ELEVATIONS

DISADVANTAGES:

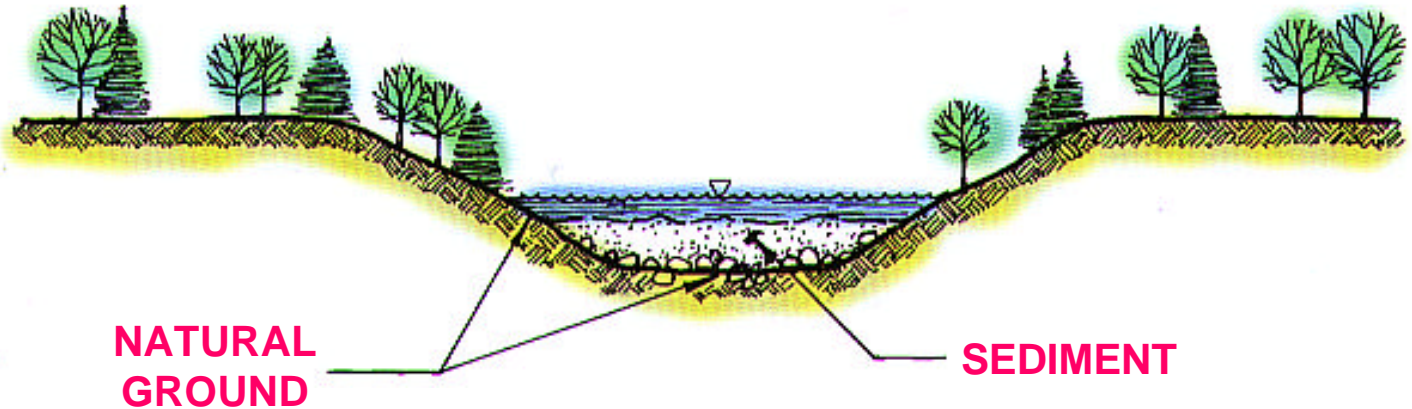
- POSSIBLE STREAMBED DEGRADATION

DOWNSTREAM

DISADVANTAGES:

- INCREASE IN SEDIMENT LOADS AND DECREASE IN WATER QUALITY DURING EXCAVATION
- COULD INCREASE OR DECREASE PEAK FLOW RATES

CHANNEL AGGRADATION



LOCAL

DISADVANTAGES:

- SEDIMENT FILLS CHANNEL BOTTOM
- FILLED POOLS, LEADING TO UNIFORM BED PROFILE
- DESTRUCTION OF FISH HABITAT AND SPAWNING AREAS
- REDUCED FLOW CAPACITY
- HIGHER WATER ELEVATIONS
- DESTROYS LOW FLOW CHANNELS, LEADING TO EVENLY DISTRIBUTED, SHALLOWER LOW FLOWS, HIGHER WATER TEMPERATURE, AND DEGRADED HABITAT

COMMENTS

CHANNEL AGGRADATION IS THE ACCUMULATION OF SEDIMENTS DUE TO EXCESSIVE SEDIMENT LOADS OR INSUFFICIENT SEDIMENT TRANSPORT. IT OFTEN OCCURS DURING LAND DEVELOPMENT WHEN THERE IS INSUFFICIENT EROSION CONTROL.

UPSTREAM

DISADVANTAGES:

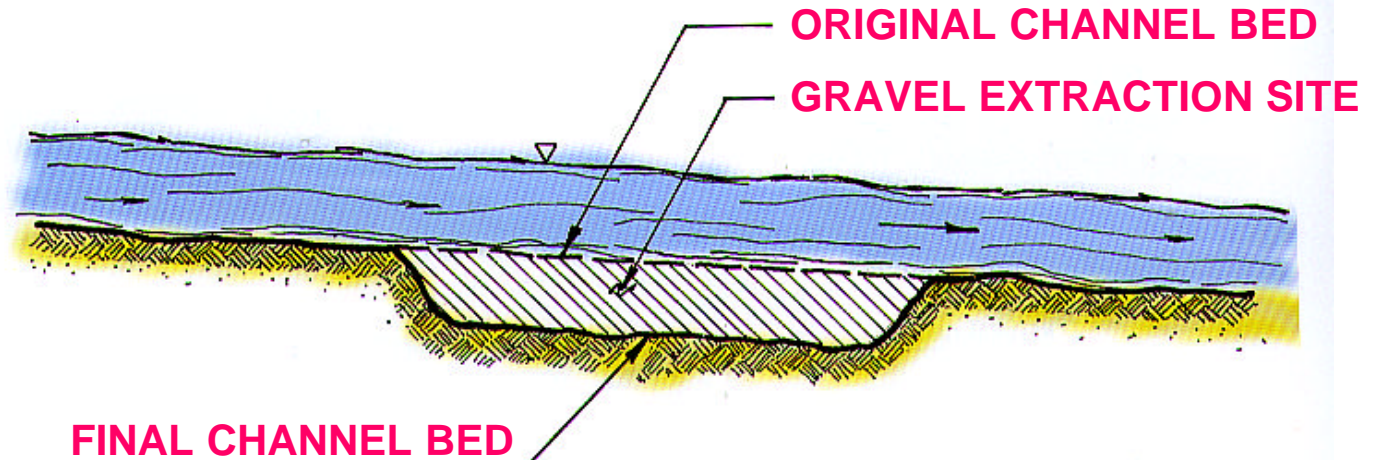
- HIGHER WATER ELEVATIONS
- DECREASED CHANNEL SLOPE
- DECREASED FLOW VELOCITY
- DETERS FISH MIGRATION

DOWNSTREAM

DISADVANTAGES:

- INCREASED INITIAL CHANNEL SLOPE AND EROSION THERE, INCREASING SEDIMENT LOAD

SAND AND/OR GRAVEL EXCAVATION



LOCAL IMPACTS

ADVANTAGES:

- SOURCE OF CONSTRUCTION MATERIALS
- POSSIBLE REDUCTION OF FLOODING DURING STORMS OF FREQUENT RECURRENCE INTERVALS
- MAY PROVIDE PONDS FOR RECREATION

DISADVANTAGES:

- REDUCED FLOW VELOCITY
- INCREASED SEDIMENT DEPOSITION
- DECOMPOSITION OF ORGANIC SEDIMENTS MAY LOWER DISSOLVED OXYGEN LEVELS, LEADING TO FISH KILLS
- STEEPER AND POSSIBLY UNSTABLE BANKS
- REDUCES SUBSTRATE VARIATION

UPSTREAM

DISADVANTAGES:

- POTENTIAL DEGRADATION OF CHANNEL AND TRIBUTARIES

DOWNSTREAM

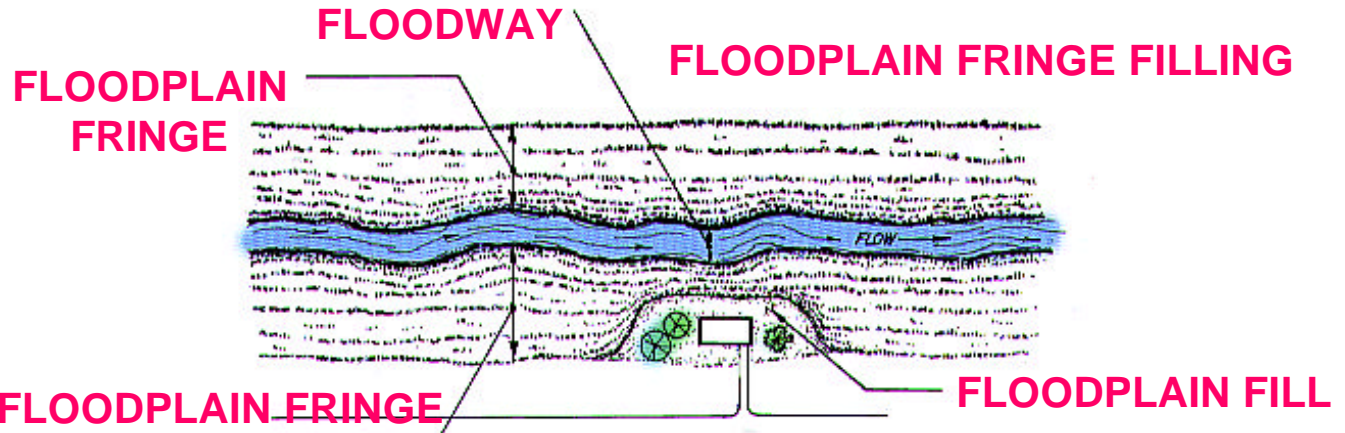
DISADVANTAGES:

- TEMPORARY INCREASE IN SEDIMENT LOAD
- EXCAVATED AREA MAY CAPTURE SEDIMENTS, REDUCING DOWNSTREAM LOAD, CAUSING DEGRADATION
- ALTERS WATER TEMPERATURE, DISSOLVED OXYGEN

COMMENTS

SAND AND GRAVEL, DEPOSITS OF WHICH ARE FORMED THROUGH THE SORTING OF SEDIMENTS BY FLOWING WATER, ARE RESOURCES NEEDED FOR MANY TYPES OF HUMAN ACTIVITIES.

FLOODPLAIN ENCROACHMENTS



LOCAL

ADVANTAGES:

- RECLAMATION OF LAND FOR HUMAN USES
- REDUCED FLOOD DAMAGES ON FILLED AREAS

DISADVANTAGES:

- INCREASED FLOOD VELOCITIES IN REST OF FLOODPLAIN
- INCREASED SCOUR
- POTENTIALLY IRREGULAR CURRENTS AND FLOW PATTERNS
- DESTRUCTION OF FLOODPLAIN HABITAT
- DECREASED AQUIFER RECHARGE
- POSSIBLE OBSTRUCTION OF TRIBUTARY FLOW TO MAIN CHANNEL
- BLOCKAGE OF NATURAL CHANNEL MEANDER MIGRATION
- ENCOURAGES OTHERS TO PLACE FILL
- REDUCED FLOODWATER STORAGE

COMMENTS

FLOODPLAIN ZONING USUALLY ALLOWS FILLING FRINGE AREAS. RAISING THE UPSTREAM FLOODWATER PROFILE BY THE 1 FOOT ALLOWED BY NATIONAL FLOOD INSURANCE PROGRAM REGULATIONS MAY CAUSE FLOOD DAMAGE TO EXISTING BUILDINGS.

UPSTREAM

DISADVANTAGES:

- INCREASED FLOODWATER ELEVATIONS AND FLOOD DAMAGES
- ALTERED FLOW PATTERNS
- ENCOURAGES SEDIMENT DEPOSITION

DOWNSTREAM

ADVANTAGES:

- POSSIBLE DECREASE IN PEAK FLOOD FLOWS

DISADVANTAGES:

- CHANGE IN FLOW PATTERNS
- HIGHER FLOW VELOCITIES
- INCREASED SEDIMENT LOAD

ROAD CULVERT CROSSINGS

ROAD EMBANKMENT

WSP*

CULVERT

STREAM PROFILE

SCOUR

LOCAL

ADVANTAGES:

- ACCESS ACROSS RIVER
- LOWER COST THAN BRIDGES

DISADVANTAGES:

- FILL CONSTRICTS CHANNEL, REDUCING HABITAT AREA
- NARROWS RIVER, FLOODPLAIN
- INCREASED FLOW VELOCITIES
- INCREASED ROAD RUNOFF AND DEBRIS FLOW INTO CHANNEL
- POSSIBLE OBSTRUCTION BY DEBRIS
- OBSTRUCTION OF FISH PASSAGE
- OBSTRUCTION TO BOATING AND FISHING

COMMENTS

ELIMINATES STREAM HABITAT

UPSTREAM

DISADVANTAGES:

- RAISES FLOODWATER LEVELS
- POSSIBLE REDUCTION OF FLOW VELOCITIES
- POSSIBLE INCREASE IN SEDIMENT DEPOSITION
- POTENTIAL BARRIER TO FISH MIGRATION
- CULVERT BOTTOM PREVENTS NATURAL BED DEGRADATION
- EMBANKMENTS MAY ACT AS DAM IN MAJOR FLOODS

DOWNSTREAM

ADVANTAGES:

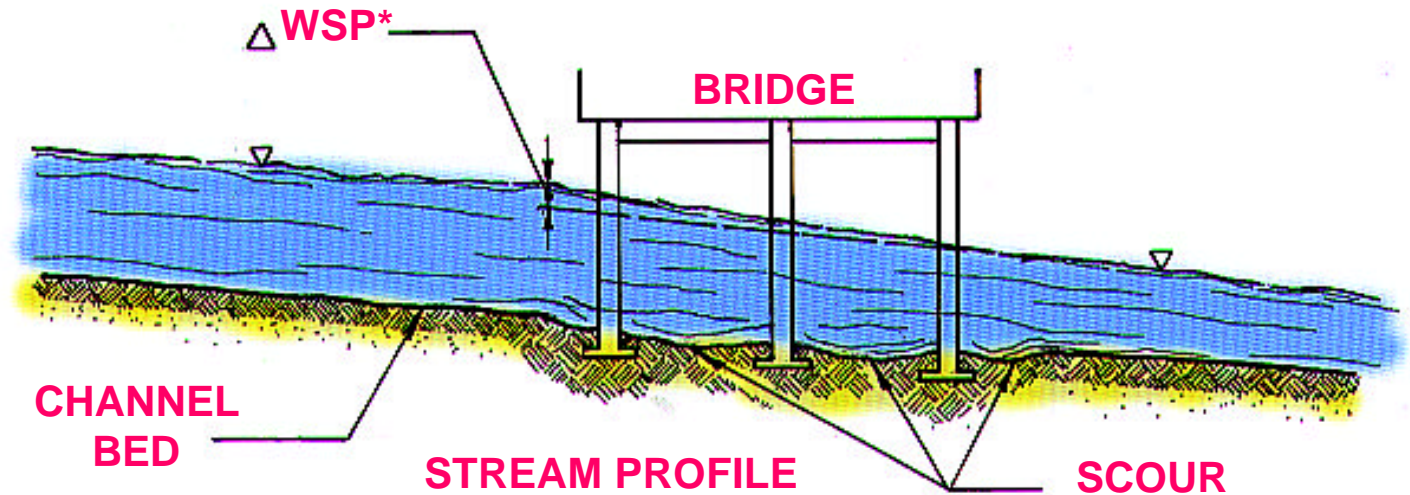
- PONDING UPSTREAM OF CULVERT MAY REDUCE PEAK FLOOD FLOWS DOWNSTREAM

DISADVANTAGES:

- SCOUR DUE TO CONCENTRATED FLOW
- DESTABILIZATION OF BANKS

* CHANGE IN WATER SURFACE PROFILE DUE TO CULVERT

BRIDGES



LOCAL

ADVANTAGES:

- ACCESS ACROSS RIVER
- LESS HABITAT DAMAGE THAN FROM CULVERTS

DISADVANTAGES:

- GENERALLY HIGHER COST THAN CULVERTS
- USUALLY NARROWS CHANNEL, INCREASING FLOW VELOCITIES AND CHANNEL SCOUR
- OBSTRUCTION TO BOATING, FISHING, WILDLIFE
- POSSIBLE ACCUMULATION POINT FOR DEBRIS

UPSTREAM

ADVANTAGES:

- USUALLY NO BARRIER TO FISH MIGRATION
- GENERALLY, LESS DAMAGE THAN FROM CULVERTS, DUE TO GREATER FLOW CAPACITY

DISADVANTAGES:

- POTENTIALLY HIGHER FLOODWATER LEVELS
- EMBANKMENT CAN ACT AS DAMS DURING FLOODS

DOWNSTREAM

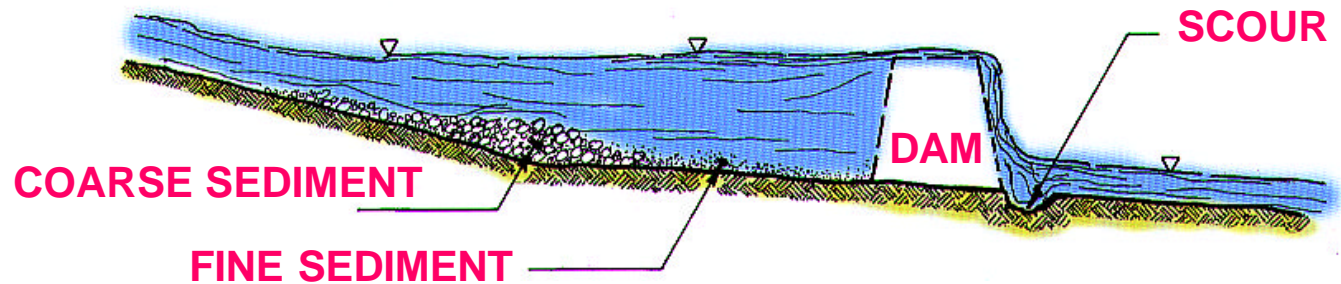
DISADVANTAGES:

- INCREASED SCOUR

* CHANGE IN WATER SURFACE PROFILE DUE TO BRIDGE



DAMS



LOCAL

ADVANTAGES:

- CREATION OF LAKE OR POND HABITAT
- RECREATIONAL SITE
- POTENTIAL POWER-GENERATION SITE
- LOWERS WATER TEMPERATURE
- MAY STORE RUNOFF
- STORES WATER FOR HUMAN USES

DISADVANTAGES:

- DECREASED TURBULENCE AND INCREASED ORGANIC SEDIMENTS LEAD TO LESS DISSOLVED OXYGEN
- INCREASED FLOOD STAGE
- FLOODS NATURAL RIVER BANKS
- POSSIBLE FLOODING OF TRIBUTARIES
- HIGHER GROUNDWATER LEVELS
- ELIMINATES SHALLOW HABITATS
- BLOCKS FISH PASSAGE, SEGMENTS RIVER

UPSTREAM

ADVANTAGES:

- MAY PROVIDE AREAS FOR BOATING, FISHING, SWIMMING

DISADVANTAGES:

- BED AGGRADATION
- HIGHER WATER LEVELS
- BARRIER TO FISH MIGRATION
- FLUCTUATING WATER LEVEL CAUSES BANK SLOUGHING

DOWNSTREAM

ADVANTAGES:

- MAY DECREASE PEAK FLOWS, INCREASE LOW FLOWS

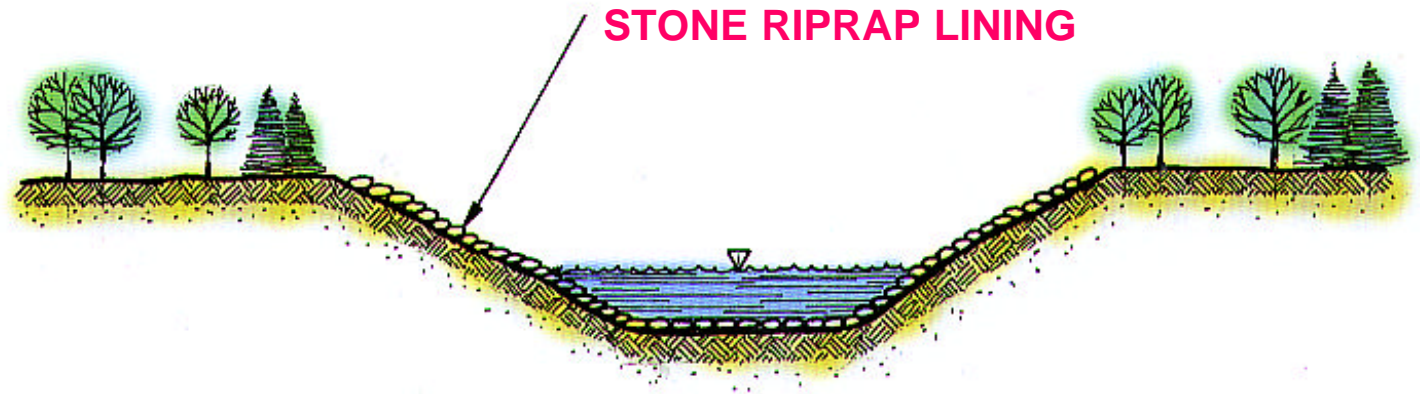
DISADVANTAGES:

- DECREASED SEDIMENT LOAD
- INCREASED SCOUR
- DAM FAILURES WOULD CAUSE DOWNSTREAM FLOOD WITH CATASTROPHIC FLOW AND SCOUR

COMMENTS

LARGE DAMS MAY PROVIDE RECREATION, FLOOD CONTROL AND WATER SUPPLY STORAGE. LARGE IMPOUNDMENTS MAY BE USED TO REGULATE DOWNSTREAM FLOW RATES.

RIPRAP CHANNEL LININGS



LOCAL

ADVANTAGES:

- MINIMAL EROSION
- INCREASED FLOW CONVEYANCE
- ALLOWS FOR STEEPER BANKS AND BED SLOPES

DISADVANTAGES:

- PREVENTION OF NATURAL CHANNEL ADJUSTMENTS
- POLLUTION FROM LEACHING MINERALS
- DESTRUCTION OF NATURAL VEGETATION, WILDLIFE HABITAT AND FISH SPAWNING SITES
- POOR AESTHETIC VALUE

UPSTREAM

DISADVANTAGES:

- SCOUR POTENTIAL AT TRANSITION
- IMPEDIMENT TO FISH MIGRATION

DOWNSTREAM

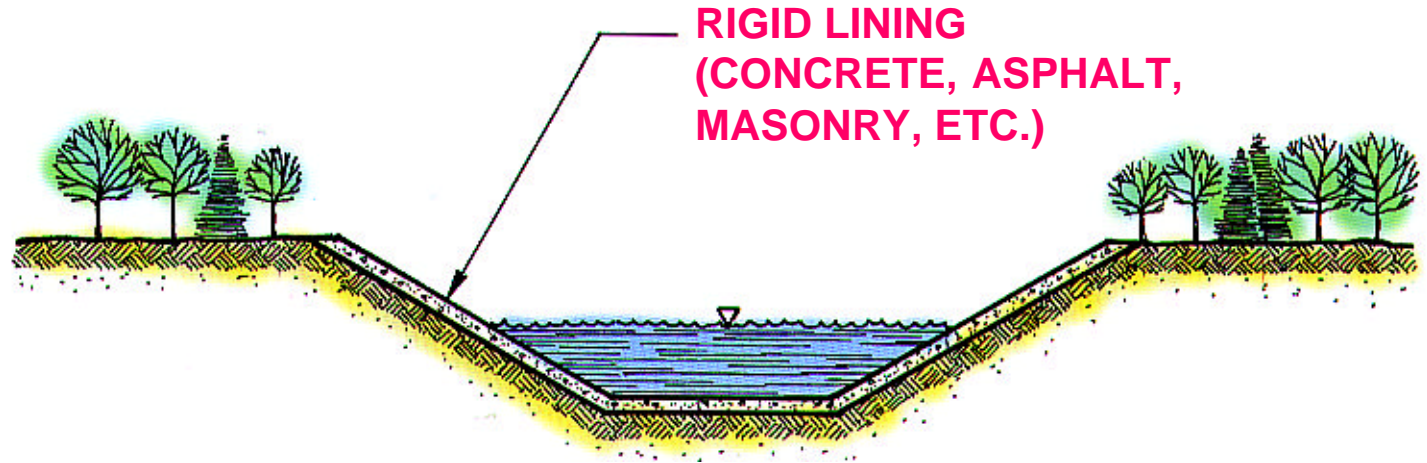
DISADVANTAGES:

- INCREASED FLOW VELOCITIES
- POTENTIAL FOR SCOUR
- HIGHER WATER TEMPERATURE

COMMENTS

IN AREAS WITH LOW VELOCITIES, TOPSOIL CAN BE PLACED OVER THE RIPRAP AND PLANTED WITH RIPARIAN SPECIES TO MITIGATE VEGETATION LOSSES.

RIGID CHANNEL LININGS



LOCAL

ADVANTAGES:

- PREVENTS EROSION
- LOW MAINTENANCE COST AT OUTSET
- INCREASED FLOW CAPACITY
- ALLOWS FOR STEEPER BANKS AND BED SLOPES

DISADVANTAGES:

- INCREASED SEDIMENT TRANSPORT CAPACITY
- DESTRUCTION OF RIPARIAN HABITAT
- HIGHER WATER TEMPERATURE
- POOR AESTHETIC APPEAL
- LACK OF HABITAT DIVERSITY
- DECREASED CHANNEL STORAGE
- DECREASED STREAM-GROUNDWATER INTERACTION
- DESTRUCTION OF FISH SPAWNING SITES
- PREVENTION OF NATURAL CHANNEL ADJUSTMENTS
- REDUCES RUNOFF RENOVATION, QUALITY

UPSTREAM

ADVANTAGES:

- MAY LOWER FLOODWATER ELEVATIONS

DISADVANTAGES:

- MAY HAVE HIGH VELOCITIES AND SCOUR AT TRANSITIONS

DOWNSTREAM

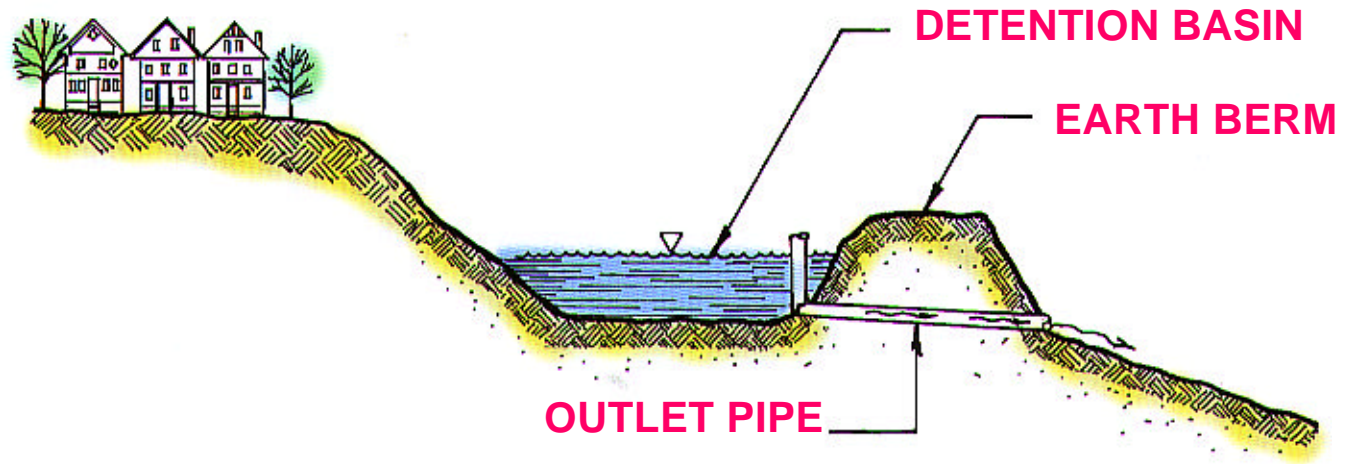
DISADVANTAGES:

- SCOUR AT TRANSITION
- DIMINISHED WATER QUALITY
- CAUSES MORE CONCENTRATED PEAK FLOW RATES
- HIGHER WATER TEMPERATURE

COMMENTS

CAN CREATE A STERILE RIVER WITH NO LIFE.

DETENTION BASINS



LOCAL

ADVANTAGES:

- TEMPORARY STORAGE OF EXCESS RUNOFF
- TRAP FOR SEDIMENTS AND URBAN RUNOFF CONTAMINANTS, IMPROVING WATER QUALITY
- POSSIBLE CREATION OF WETLANDS

DISADVANTAGES:

- ALTERED ECOLOGY IF CONSTRUCTED IN NATURAL WETLANDS
- LIMITED EFFECTIVENESS IF LOCATED IN FLOODPLAINS
- MAINTENANCE REQUIRED

UPSTREAM

DISADVANTAGES:

- DETERRED FISH MOVEMENT

DOWNSTREAM

ADVANTAGES:

- REDUCTION AND DELAY OF PEAK FLOWS
- POSSIBLE IMPROVEMENT OF WATER QUALITY

DISADVANTAGES:

- POTENTIAL FOR FLOODING IF DAM FAILS

COMMENTS

DETENTION BASINS AND THEIR DAMS REQUIRE CAREFUL SITING, DESIGN AND CONSTRUCTION. THE USE OF OFFSTREAM DETENTION BASINS MINIMIZES HABITAT DISTURBANCE. TRY TO AVOID SITING THEM IN NATURAL WETLANDS. DETENTION BASIN DISCHARGE RATES AND TIMING SHOULD BE COORDINATED WITH THOSE OF THE RECEIVING WATERCOURSE.