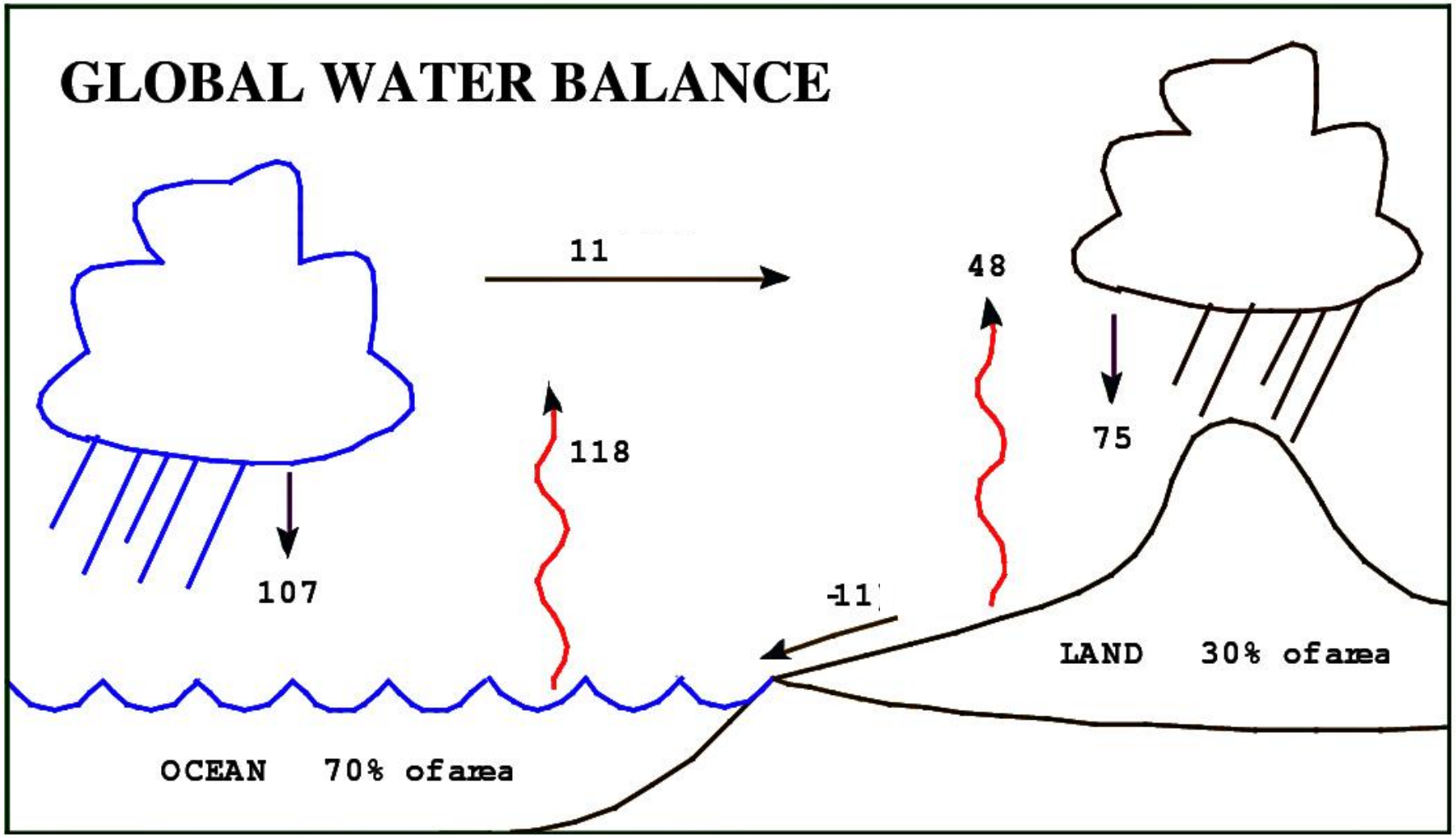
A New Approach

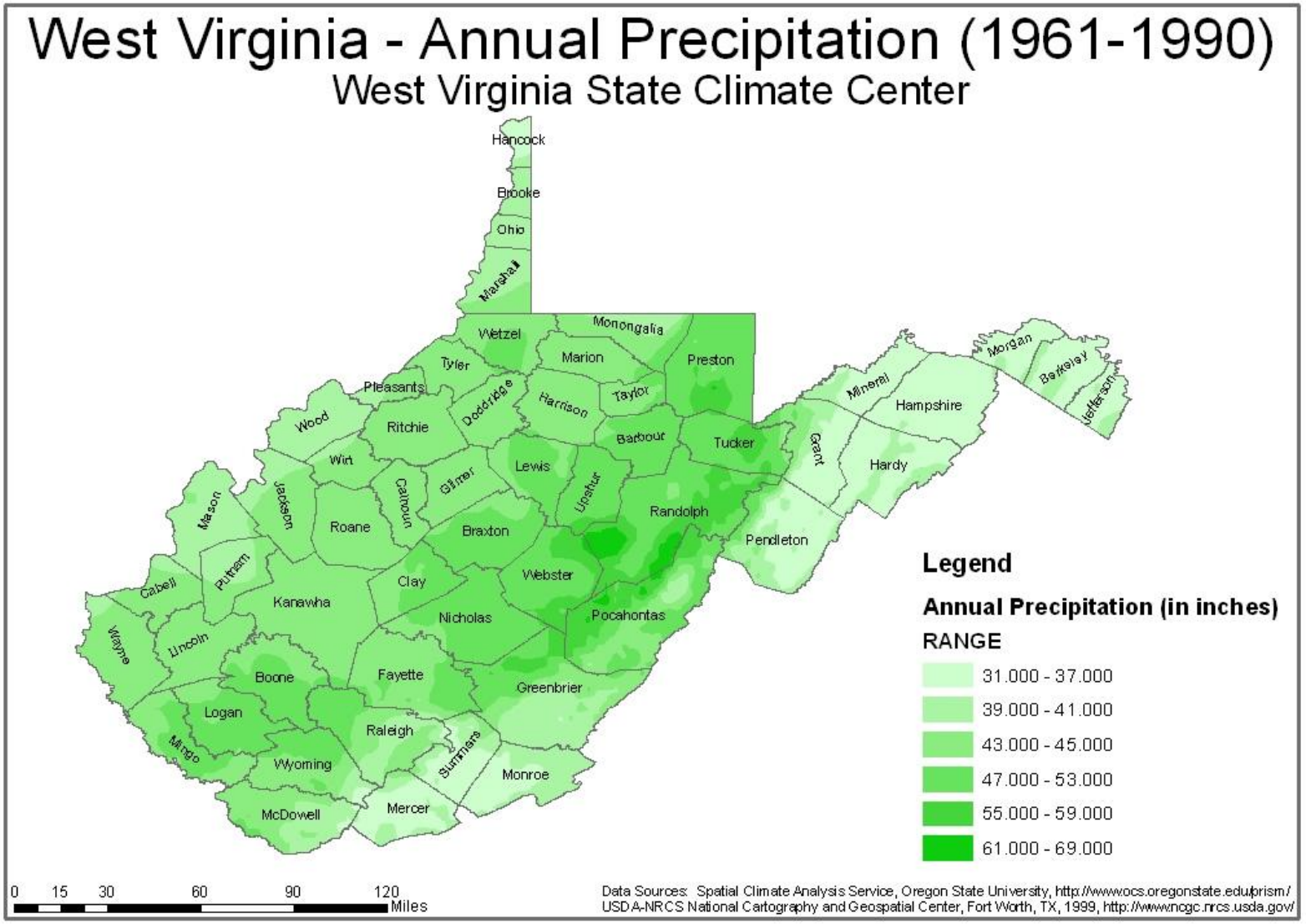
WATERSHED-BASED PLANNING

FOR SUSTAINABILITY OF OUR WATER RESOURCES

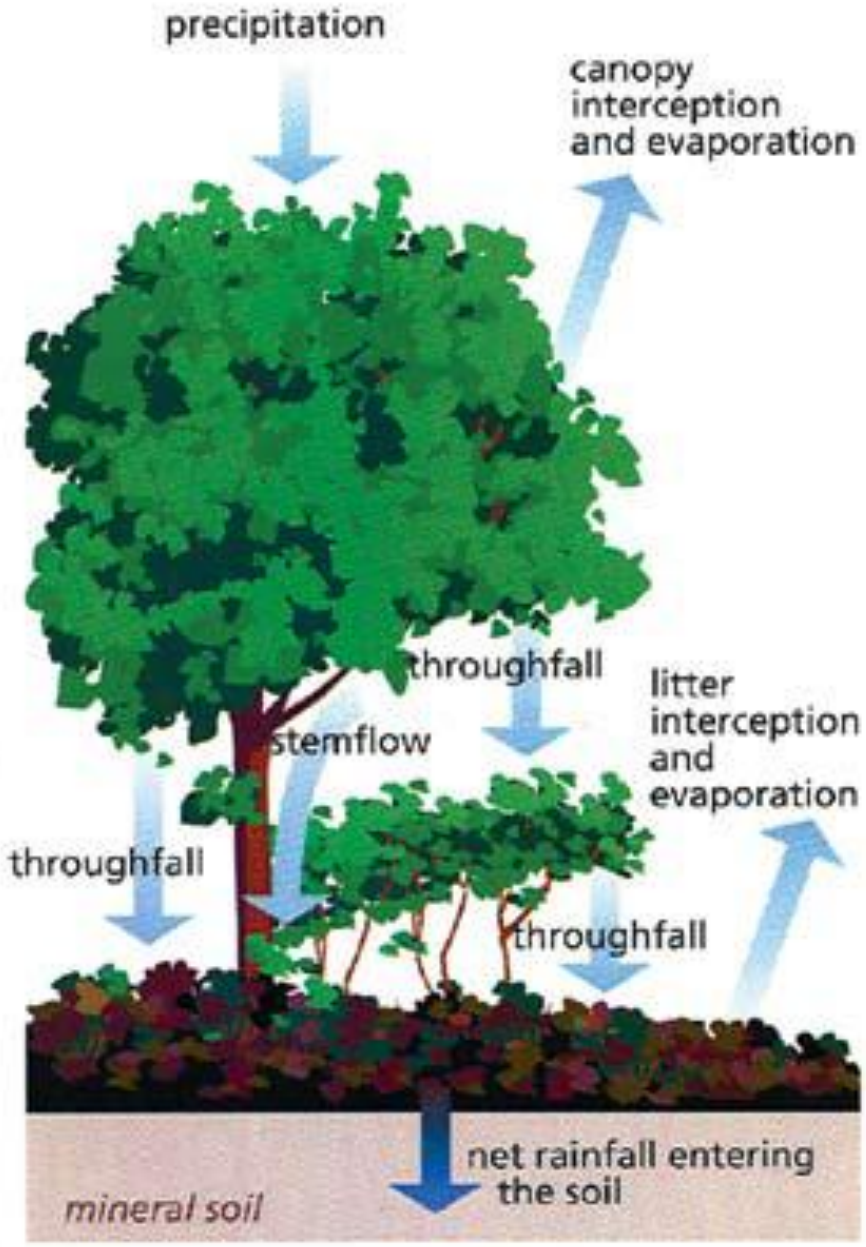


Our Water Is Finite On Our Continents

Units are in centimeters per year. Diagram by Dennis L. Hartmann, Global Physical Climatology, 1994.



PRECIPITATION is GREATEST on the MOUNTAINS



Mountain FORESTS
***INTERCEPT* RAINFALL**

Allowing Rainfall to
***GENTLY* REACH THE GROUND**

Thus Allowing
LESS SURFACE RUNOFF
and
GREATER GROUNDWATER RECHARGE

MOUNTAIN RIDGE HEADWATER AREAS ARE UNIQUE

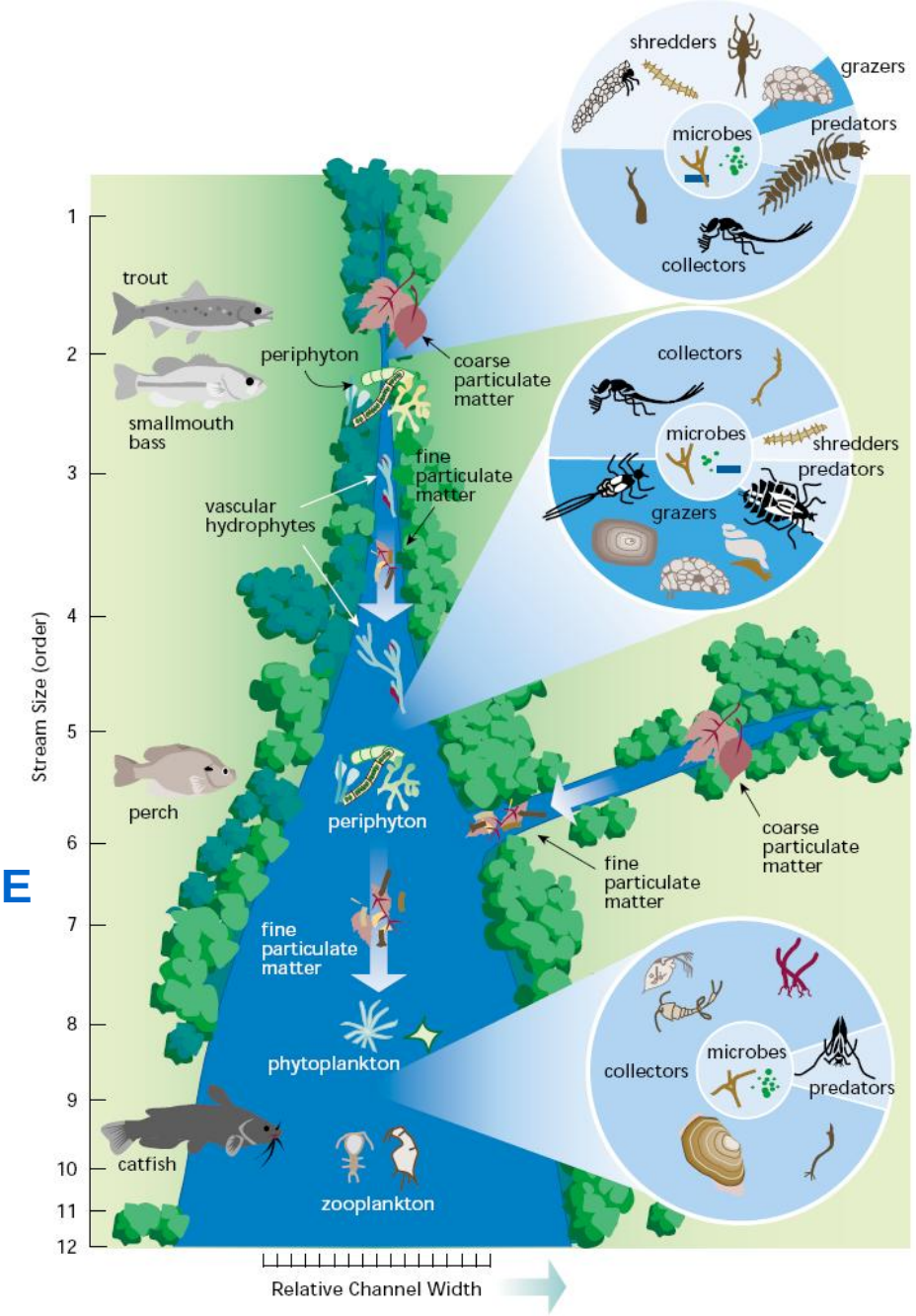
MOUNTAIN RIDGE DEFORESTATION:

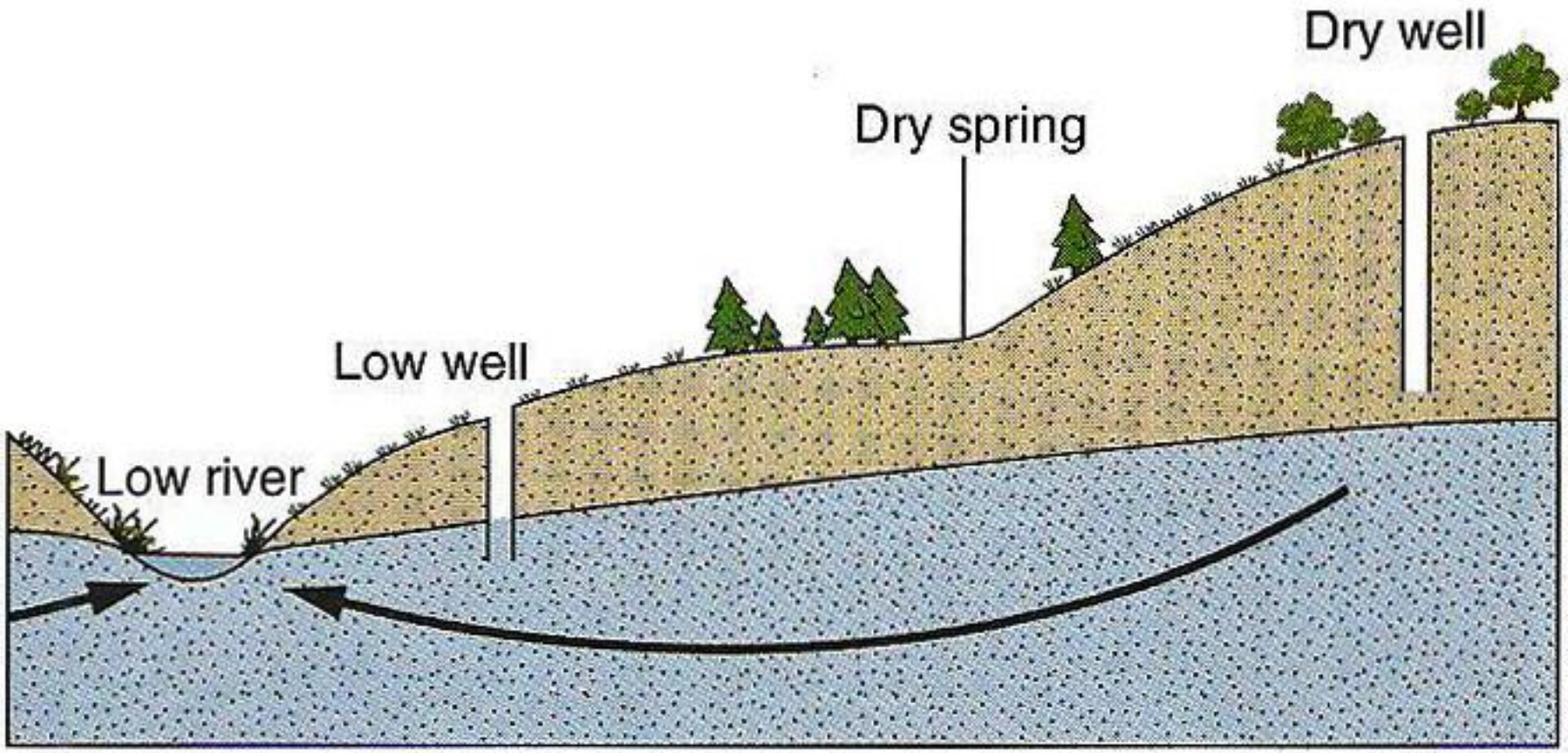
1) INCREASES LIGHT AND WATER TEMPERATURES

2) DESTROYS HEADWATER AREAS

3) INCREASES SURFACE RUNOFF and DECREASES GROUNDWATER RECHARGE

4) INCREASES EROSION AND SEDIMENTATION DOWNSTREAM





STREAMS and GROUNDWATER are INTER-RELATED and INSEPARABLE

GROUNDWATER replenishes stream water during times of low water.

STREAMFLOW HAS INCREASED
Due to OVER-DEVELOPMENT

Table 1.2 Average Annual Streamflow for Potomac River @ Hancock Maryland

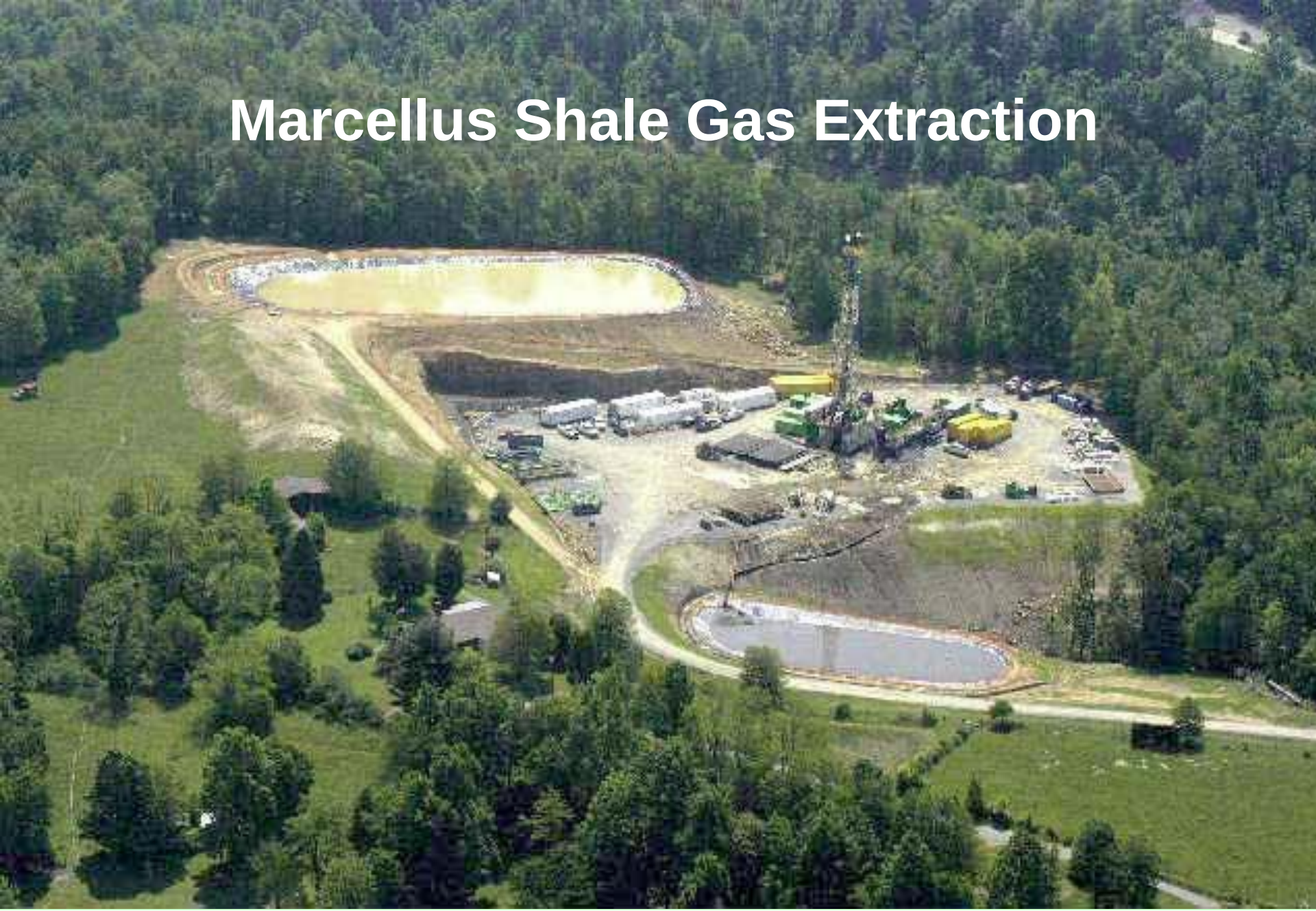
1933-2003							
Year	Annual mean Streamflow, in gal/s	Year	Annual mean Streamflow, in gal/s	Year	Annual mean Streamflow, in gal/s	Year	Annual mean Streamflow, in gal/s
1933	34,991	1951	35,754	1969	13,898	1987	30,219
1934	17,787	1952	35,769	1970	33,488	1988	24,781
1935	32,022	1953	29,643	1971	38,978	1989	34,991
1936	44,611	1954	24,953	1972	56,654	1990	27,661
1937	45,291	1955	32,703	1973	40,242	1991	24,856
1938	18,117	1956	30,339	1974	29,972	1992	23,899
1939	29,583	1957	25,604	1975	42,651	1993	40,414
1940	32,396	1958	28,865	1976	30,907	1994	43,160
1941	18,880	1959	19,426	1977	25,148	1995	24,243
1942	36,667	1960	29,853	1978	38,896	1996	68,075
1943	27,586	1961	33,204	1979	50,550	1997	27,295
1944	28,701	1962	29,434	1980	31,790	1998	41,783
1945	32,149	1963	24,467	1981	22,934	1999	17,024
1946	23,106	1964	26,614	1982	30,930	2000	20,480
1947	16,531	1965	24,706	1983	35,231	2001	21,221
1948	34,827	1966	21,550	1984	40,699	2002	24,101
1949	34,909	1967	32,875	1985	38,821	2003	61,560
1950	35,044	1968	25,649	1986	25,469		

MOUNTAINTOP REMOVAL
DESTROYS FORESTED RIDGES

Typical Transmission Line Deforestation and Excavation

Mountaineer Wind Facility, Tucker County, West Virginia

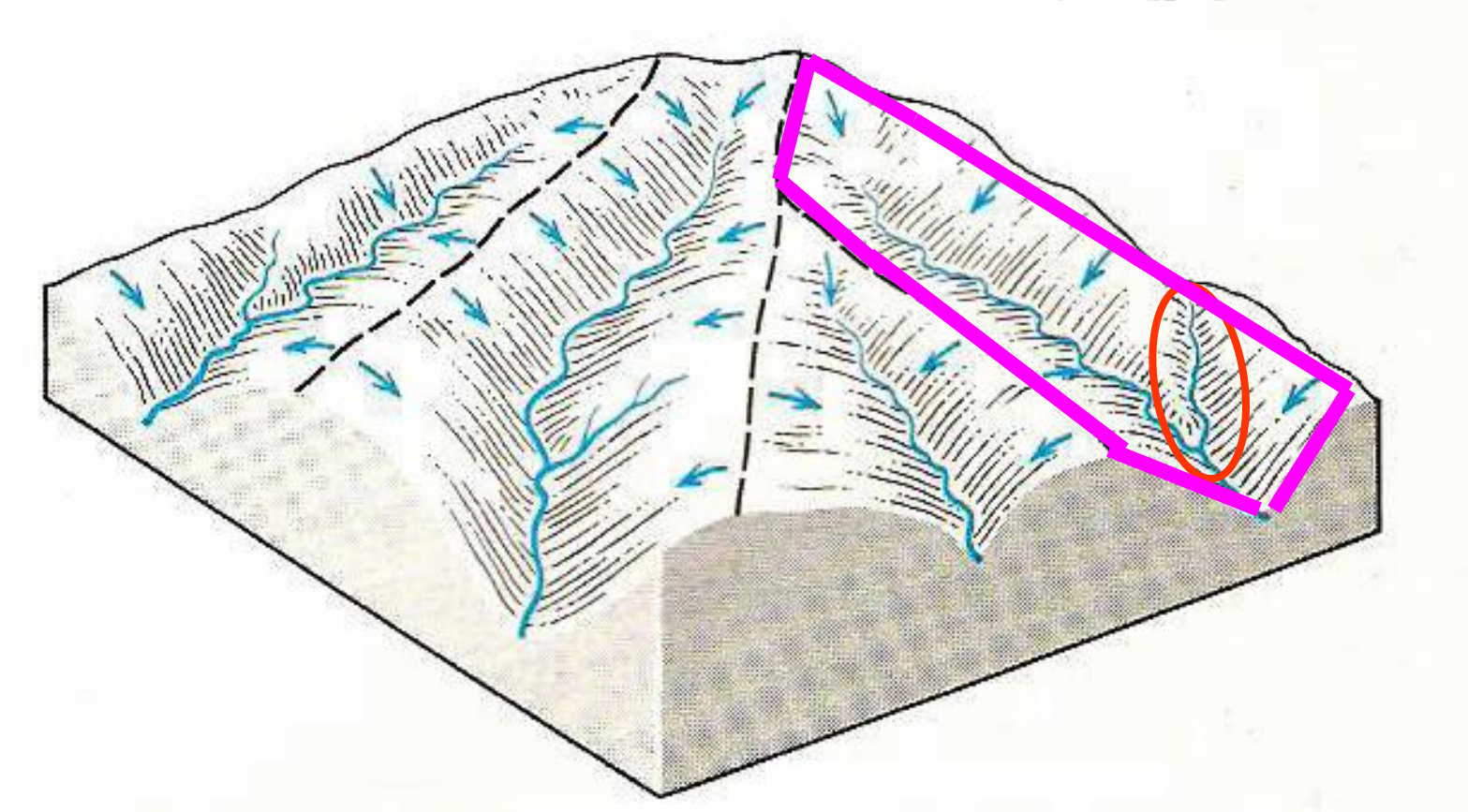
Marcellus Shale Gas Extraction



Uses more than 1 million gallons of water per well


Pipelines

WATERSHED-BASED PLANNING APPROACH



10% Impervious Cover

IMPACTS Watersheds

RATIONAL METHOD:

Oldest and most widely used method of calculating peak runoff rates for urban and rural watersheds that are less than 200 acres

$$Q = CiA$$

“Q” is Discharge
“C” is Runoff Coefficient (e.g. from tables in WVDOH Manual)
“i” is Rainfall Intensity (from NOAA charts)
“A” is Drainage Area (from GIS or Terrain Navigator)

Table 4-4

Recommended Runoff Coefficient (C) Values

Description of Area	Runoff Coefficient (C)		
	Flat areas Slope 0% to 2%	**Moderate areas** Slope 2% to 10%	**Steep areas** Slope Over 10%
Pavement, Roof surfaces, etc.	0.80	0.90	0.95
Earth Shoulder	0.55	0.60	0.70
Gravel or Stone Shoulders	0.45	0.50	0.60
Grass Shoulders	0.30	0.35	0.40
Side Slopes–Earth	0.50	0.60	0.70
Side Slopes–Turf	0.40	0.50	0.65
Median Strips–Turf	0.30	0.35	0.40
Dense Residential Areas	0.60	0.65	0.80
Suburban Areas with Small Yards	0.40	0.50	0.60
Cultivated Land			
Clay and Loam	0.35	0.50	0.60
Sand and Gravel	0.25	0.30	0.35
Woods, Parks, Meadows, and Pasture Land	0.20	0.25	0.35

Source: WVDOH Drainage Manual, 1984

CLAY & LOAM **C=0.60**

WOODS **C=0.35**

Runoff coefficient values represent an empirical, dimensionless ratio between rainfall and runoff.

$Q = CiA$

"i" is the rainfall intensity for a duration equal to the time of concentration for a selected return period, inches per hour (in/hr)

The time of concentration (Tc) is the time required for water to flow from the hydraulically most remote point of the drainage area to the point of interest. With the Rational Method, the duration of a rainfall event is set equal to the time of concentration and it is used to estimate the average rainfall intensity (i) from the intensity-duration-frequency curves (IDF) for a selected return period.

Q = CiA

Total Area = **154 acres**
Undisturbed Area = **112 acres with C=0.35**
Disturbed Area = **42 acres with C=0.6**

Pre-construction

Q = CiA = 0.35 x 4.6 x 154 = 247.94 cfs

10% Impervious Cover = 15 acres

Weighted C = [(139x0.35)+(15x1.0)]/154 = 0.413
Q = CiA = 0.413 x 4.6 x 154 = 292.56cfs

Post Construction

Weighted C = [(112x0.35)+(42x0.60)]/154 = 0.418
Q = CiA = 0.418 x 4.6 x 154 = 296.11cfs

Conclusion: NEGATIVE IMPACT


C1 & G1
DP-35, 5.1cfs, 1.74ac
G2
C2
G3
C3 and G4
DP-34, 12.4cfs, 11.03ac
DP-33, 9.1cfs, 3.98ac
DP-32, 7.4cfs, 3.20ac
DP-31, 25.2cfs, 11.59ac
C5 &C6
DP-30, 98.3cfs, 48.27ac
BARKER
JEEP TRAIL
PIPELINE
2400
2600
2800
2200
SCALE 1:10000
0 100 200 300 400 500 600 700 YARDS
0 1000 2000 FEET
0 100 200 300 400 500 600 METERS

PROTECT OUR FORESTED MOUNTAIN RIDGES

To SAVE Our WATER