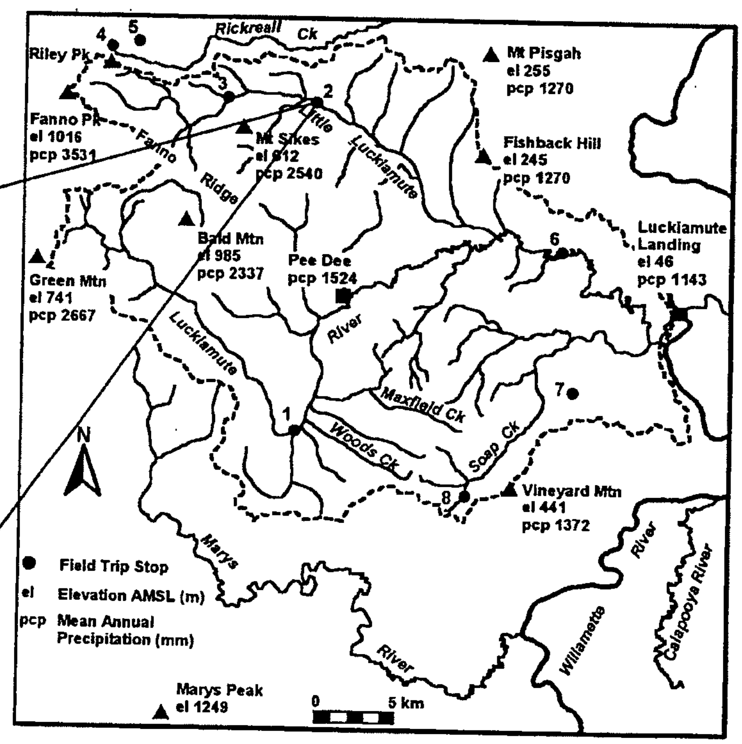
Field Guide to the Luckiamute River Watershed, Upper Willamette Basin



Trip Leaders:

Steve Taylor, Ph.D., Earth and Physical Science Dept., Western Oregon University

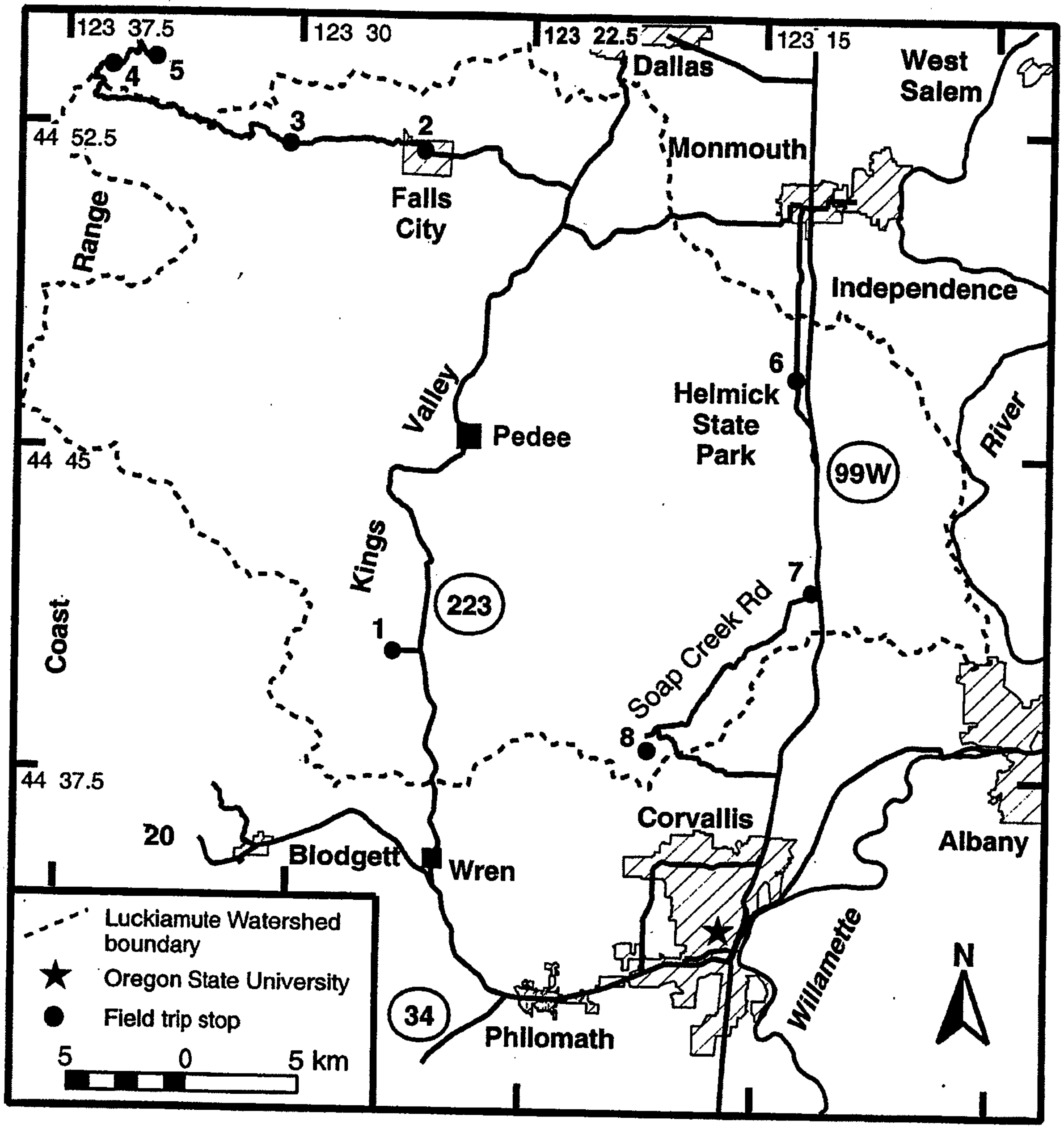


Figure 1. Location map and field trip route for the Luckiamute Watershed.

River to 1016 m (3333 ft) at Fanno Peak. The Luckiamute has an average gradient of 3 m/km, a total stream length of 90.7 km, and an average basin elevation of 277 m (910 ft) (Rhea, 1993; Slack and others, 1993). Fanno Ridge separates the watershed into two tributary subbasins, with the Little Luckiamute to the north and the main stem of the Luckiamute to the south (Kings Valley) (Fig. 2). Lower-order tributaries include Boughey Creek, Waymire Creek, Vincent Creek, Plunkett Creek, Woods Creek, Maxfield Creek, and Soap Creek.

The greater Willamette Valley extends northward 190 km from Eugene to Portland, Oregon. This lowland is up to 60 km wide, separating the Coast Range to the west from the Cascade Range to the east. Valley floor elevations range from 150 m (500 ft) to 3 m (10 ft), with an average gradient of 2 m/km (Slack and others, 1993).

Physiographic Setting of the Luckiamute Watershed

- Boundaries
  - Crest of Coast Range to West (headlands)
  - Willamette River to East

- Drainage Area = 815 km^2

  - Largest Fifth-Field Watershed in central and northern Coast Range

  - Primary Tributaries
    - Little Luckiamute – northern watershed
    - Luckiamute – southern watershed

  - Secondary Tributaries
    - Soap Creek, Maxfield Creek, Woods Creek, Teal Ck

- Elevation Range:
  - Min: 46 m (150 ft) at Willamette
  - Max: 1016 m (3333 ft) at Fanno Peak
  - Avg. Basin Elevation: 277 m (910 ft)

- Basin Morphometry
  - Average Stream Gradient: 3 m /km
  - Total Stream Length: 90.7 km

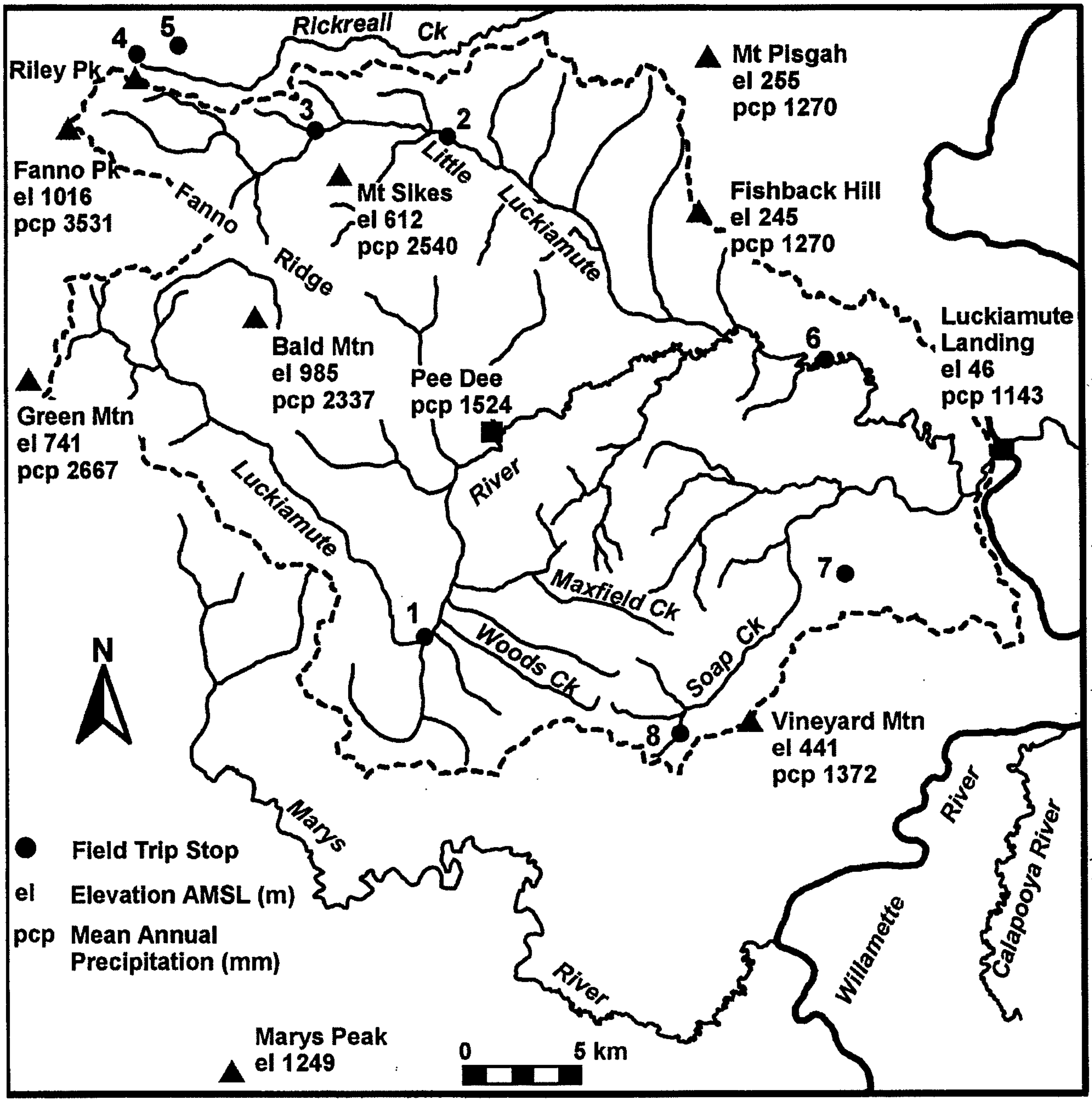


Figure 2. Physiographic map and spot annual precipitation for the Luckiamute Watershed.

Tectonic Setting of the Luckiamute Watershed

- Convergent Tectonic Margin
  - Subduction of Juan de Fuca Plate Beneath North America
    - Convergent Rates: 3.5-4.0 cm/yr
  - Style of Tectonism
    - Oblique Convergence
    - Tectonic accretion
    - Clockwise Rotation
- Coast Range Orogenesis
  - Accreted Marine Volcanic and Sedimentary Rocks
  - Active Uplift Between 15-10 Ma to Present
  - Neotectonics
    - General Uplift and Eastward Tilting
- Tectonic Influence on Luckiamute
  - Luckiamute drains the eastward tilted flanks of the Coast Range (Rhea, 1993)
  - Luckiamute Watershed located at segment boundary of Juan de Fuca Subduction zone

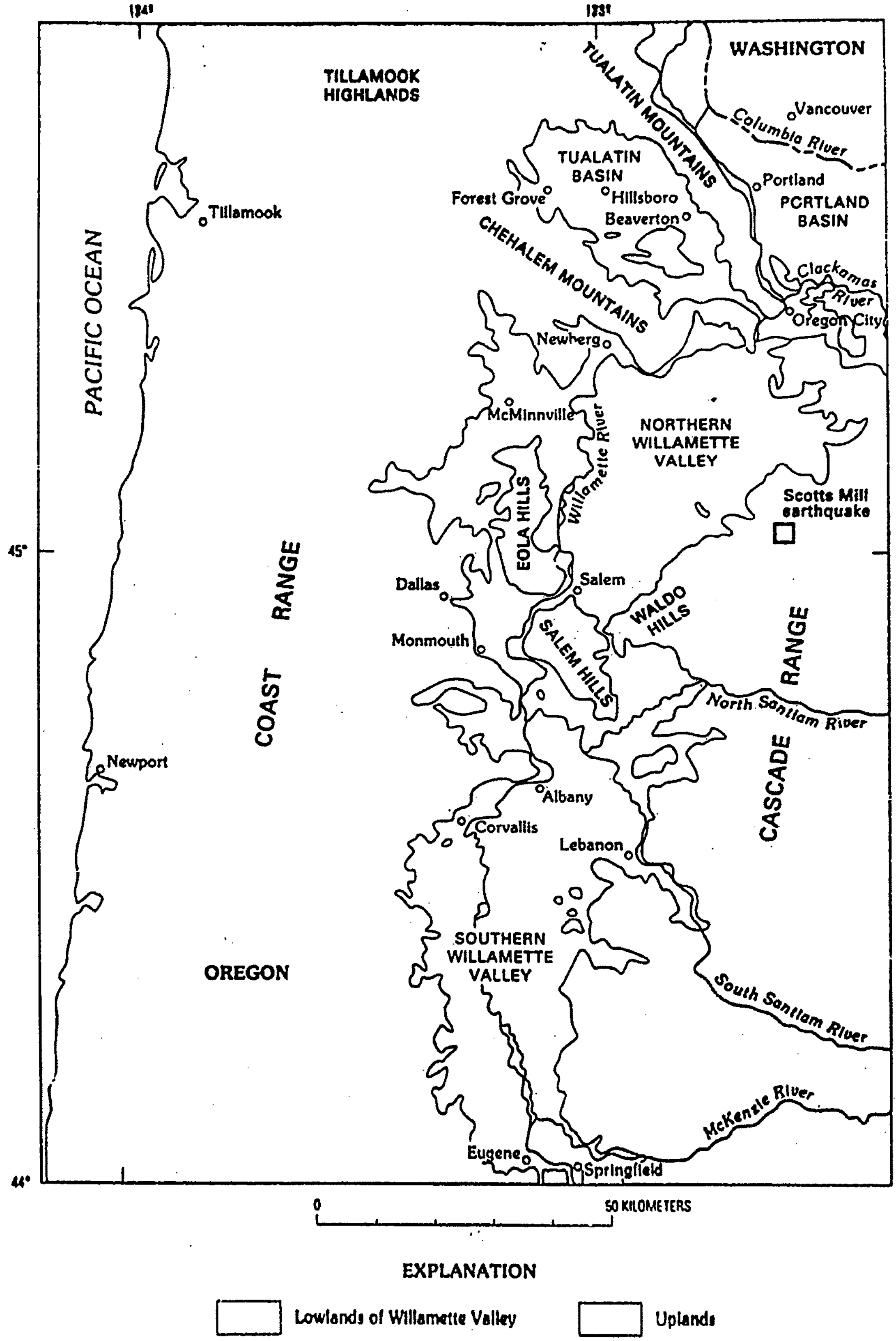


Figure 77. Geographic and physiographic features of the Willamette Valley and Portland and Tualatin basins, northwestern Oregon. The square indicates the epicenter of the March 25, 1993, Scotts Mills earthquake.

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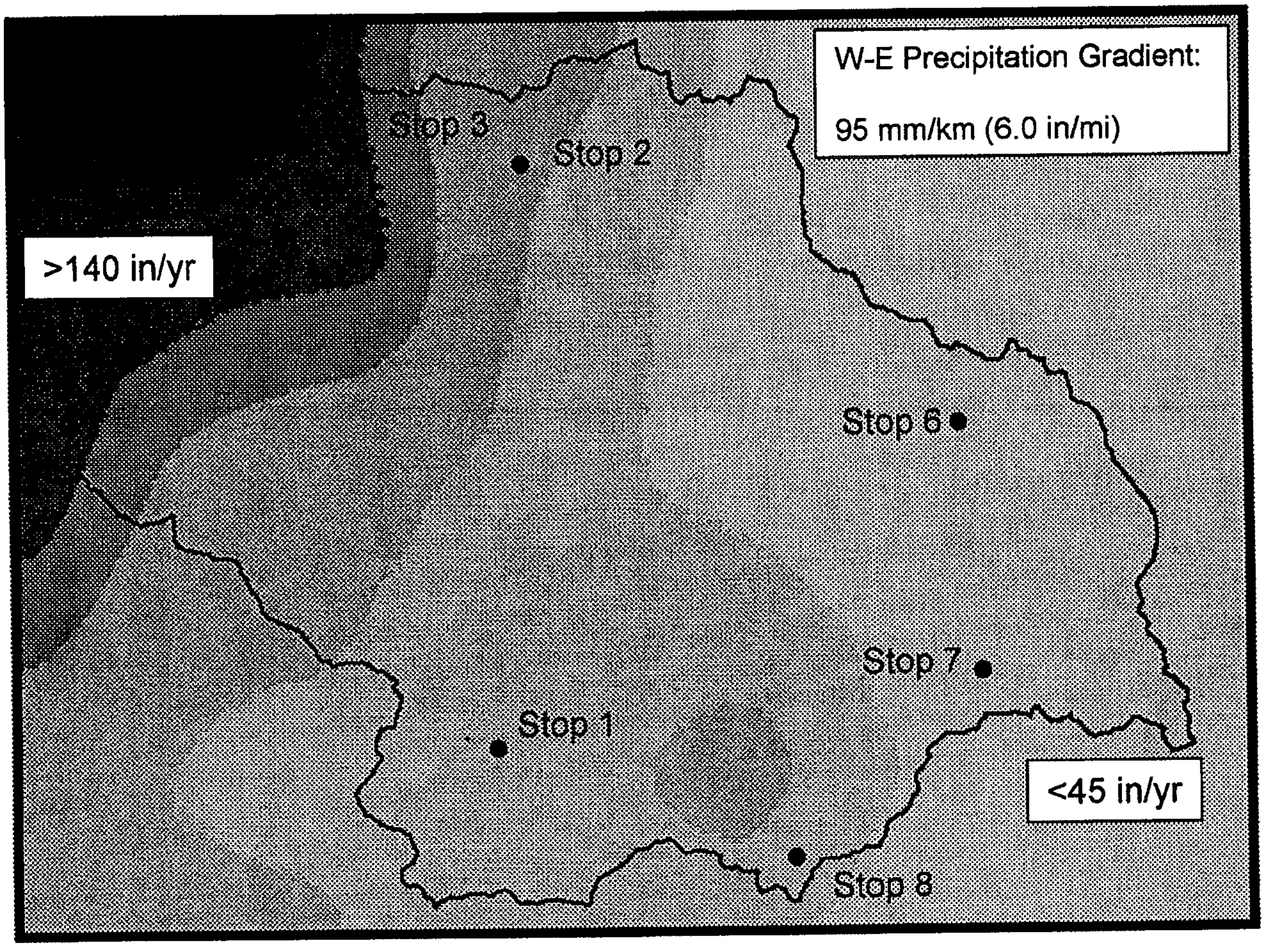


- Tripstop.shp
- Luckbound.shp

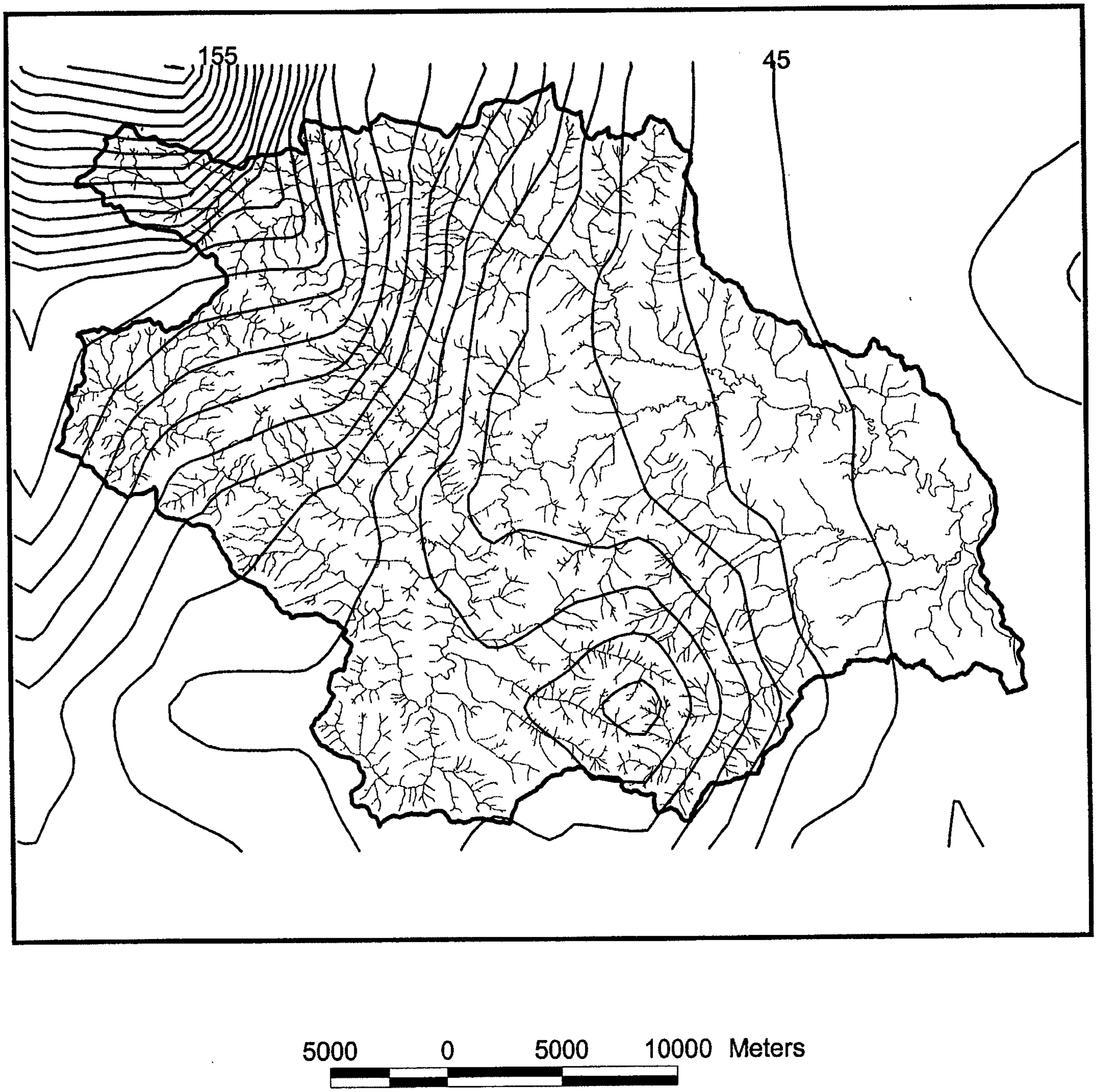
Precip_90 (inches)

- 40 - 55
- 55 - 70
- 70 - 90
- 90 - 100
- 100 - 120
- 120 - 130
- 130 - 150
- 150 - 165
- 165 - 180
- No Data

1990 Average Annual Precipitation for the Luckiamute Watershed (inches) (from the Oregon Climate Service)

Annual Precipitation
- Basin Maximum: 3600 mm (>140 in) – Divide
- Basin Minimum: 1140 mm (~45 in) – Willamette Valley
- Basin-wide Precipitation Average = 1894 mm (~75 in)
- Seasonal Precipitation Cycle (October – March)

Luckiamute Basin Avg. Annual Rainfall (CI = 5 inches /yr)



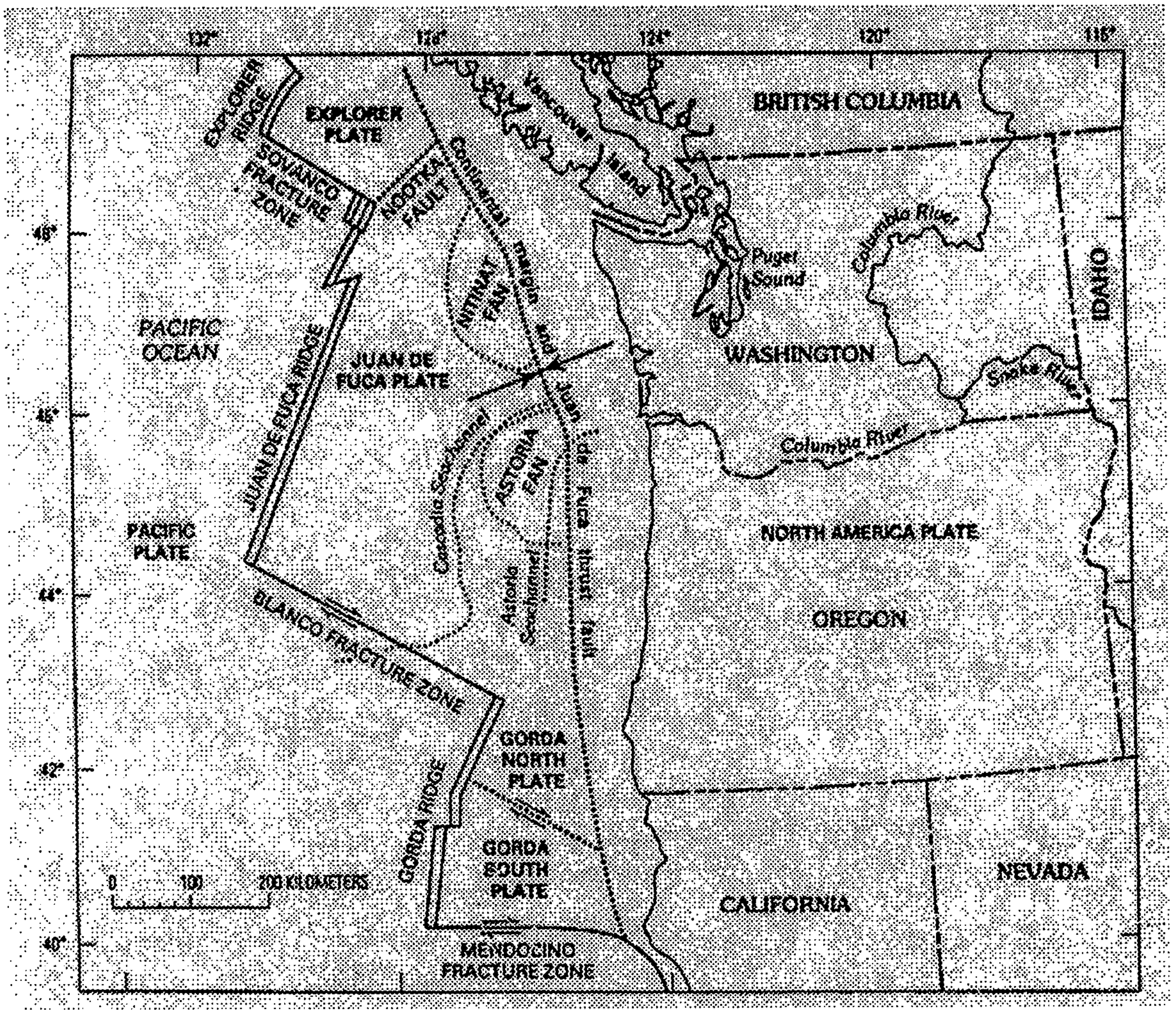
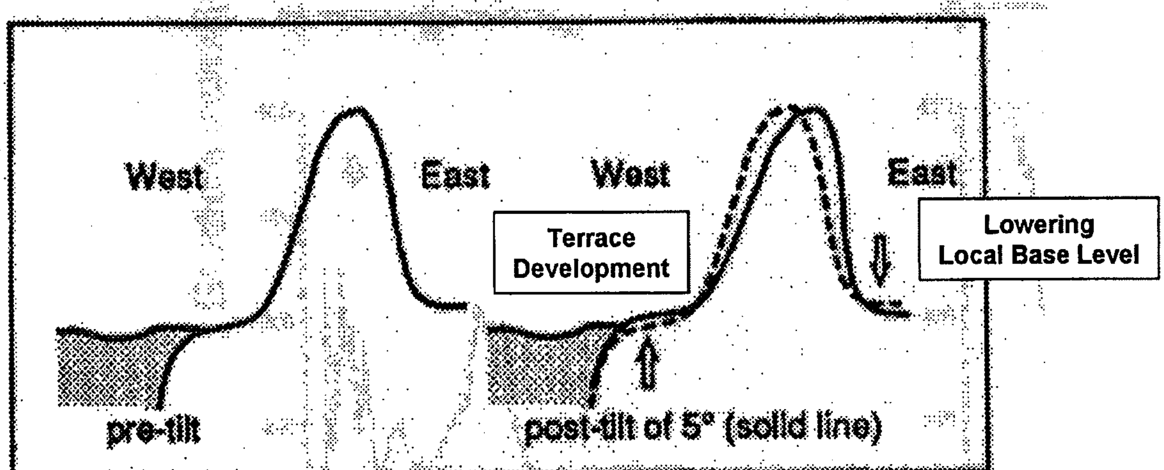


Plate tectonic configuration of the Pacific Northwest.



Cartoon showing effects of Coast Range tilting on watershed gradient (from Rhea, 1993)

Yeats et al., 1996

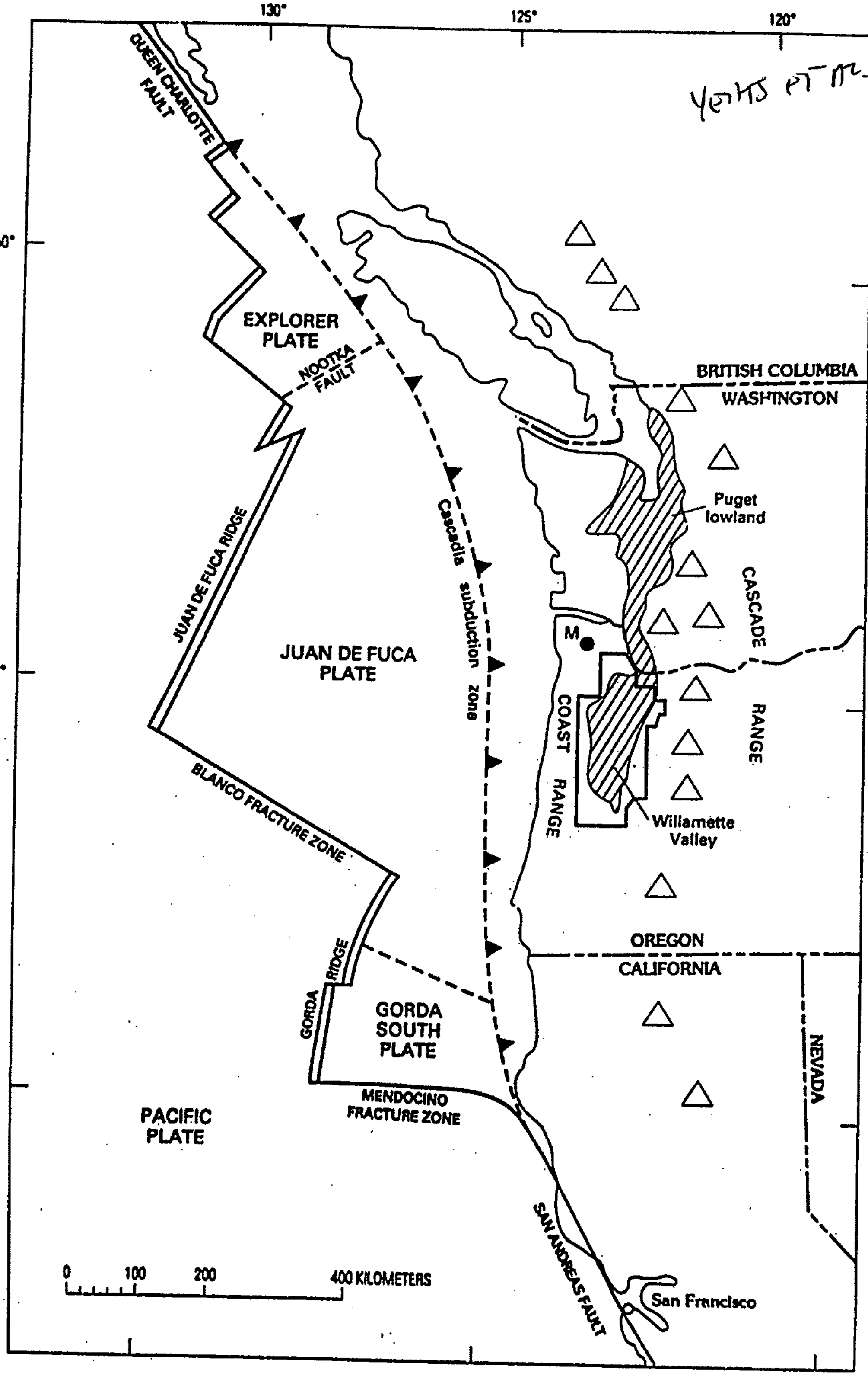


Figure 76. Plate boundaries of the Pacific Northwest showing locations of tectonic features and the Willamette Valley study area. Heavy line, study-area boundary; hatched area, Willamette Valley and Puget lowland; sawteeth denote upper plate of thrust fault. Major stratovolcanoes are shown by open triangles. Dot labeled "M" in northwestern Oregon is the Mist gas field.

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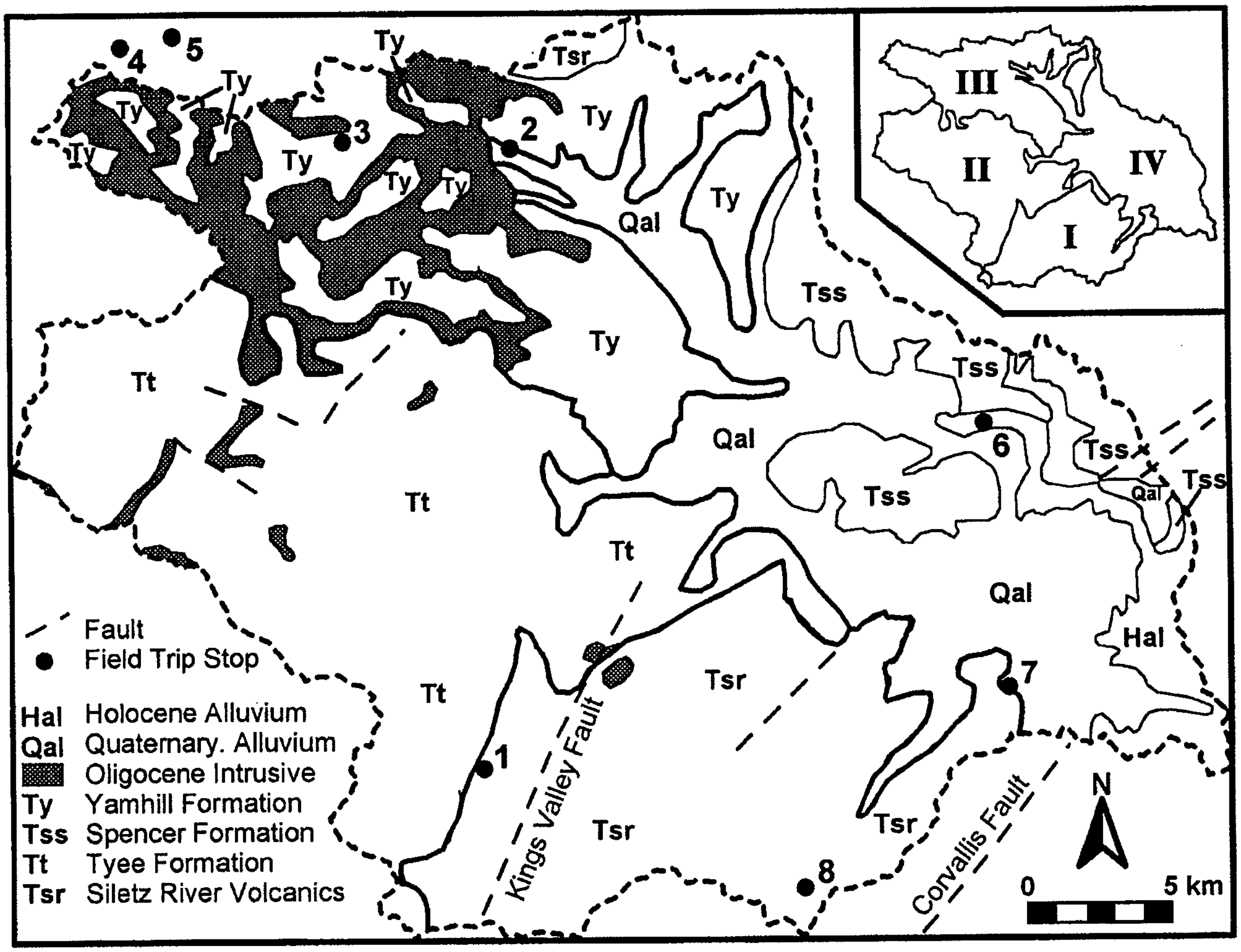

Figure 3. Bedrock geology of the Luckiamute Watershed (after Walker and MacLeod, 1991). Inset map shows grouping of recognized lithospatial domains: I = Siletz River Domain, II = Tyee Domain, III = Yamihill-Ti (Tertiary Intrusive) Domain, IV = Spencer-Valley Fill Domain.

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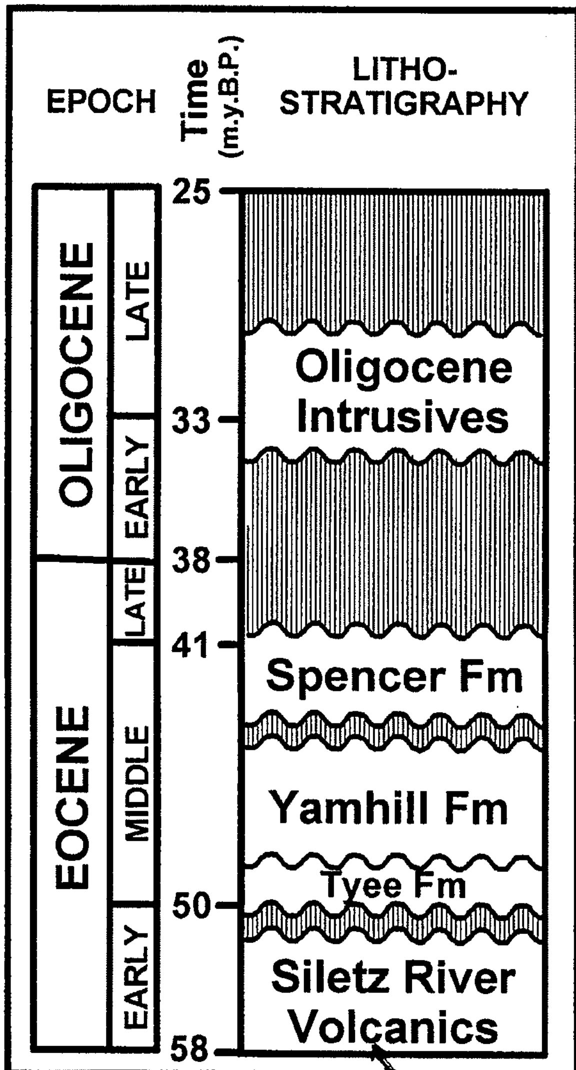
Bedrock Geology of the Luckiamute Watershed



Qal – Quaternary Alluvium

Ti – Oligocene Mafic Intrusives: Sheets, sills, and dikes of massive gabbro.

Tss – Spencer Formation: Thick- to thin-bedded marine tuffaceous sandstone, siltstone, and mudstone.

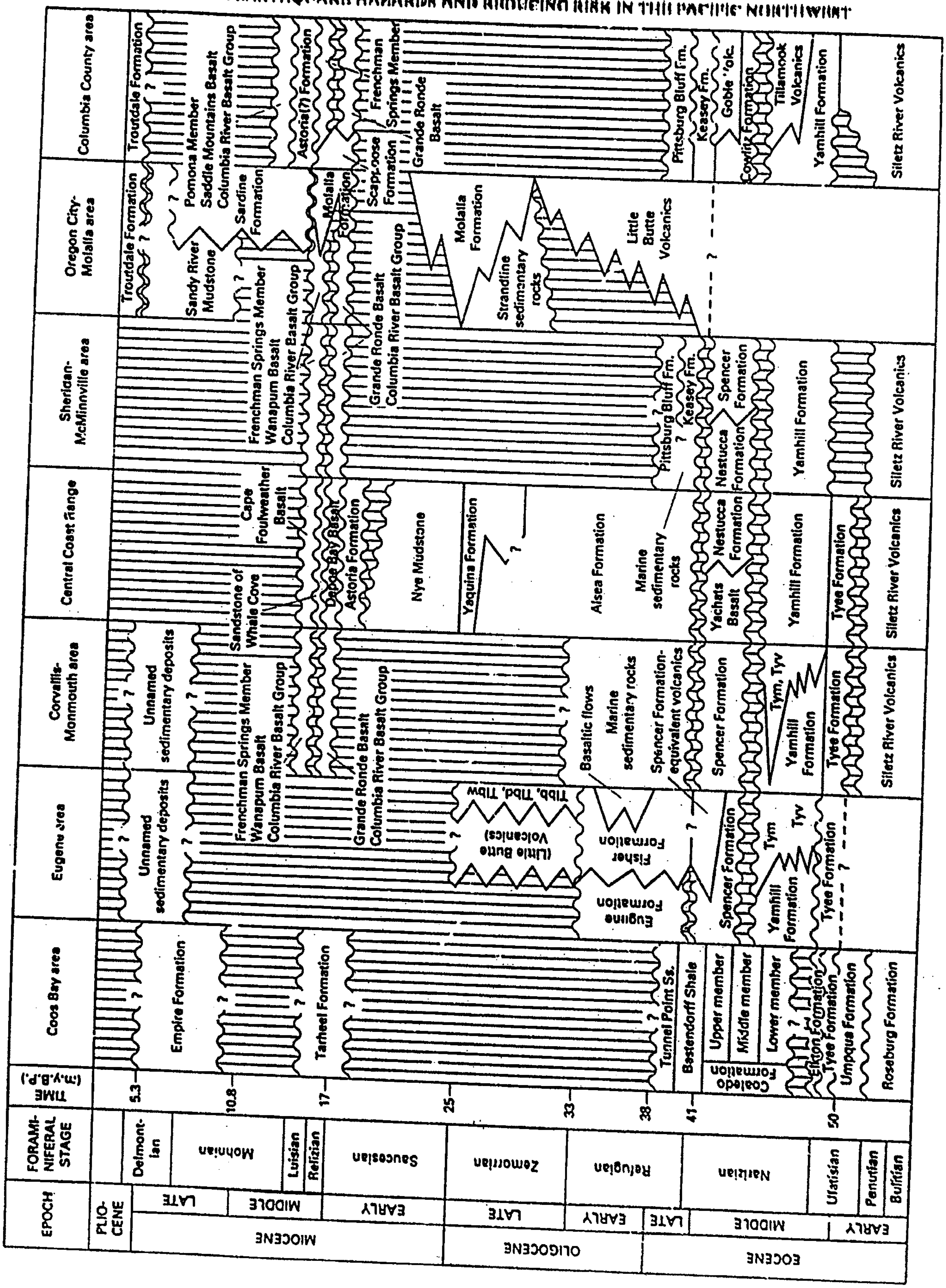
Ty – Yamhill Formation: Massive to thinly bedded marine silstone and sandtone interbeds. Locally includes interlayered basalt lava flows.

Tt – Tyee Formation: Rhythmically bedded, medium-grained feldspathic sandstone and carbonaceous siltstone. Interpreted as deposits of submarine turbidity currents and fans.

Tsr – Siletz River Volcanics: Aphanitic to porphyritic, vesicular pillow flows, tuff breccia, and lava flows. Local interbeds of basaltic siltstone and sandstone. Prevasively zeolitized and veined with calcite. Marine origin interpreted as accreted oceanic crust and seamounts.

Spencer rolling hills, Steep Hills by [illegible]
w/ both @ same elevation
- means [illegible]
uplift [illegible]

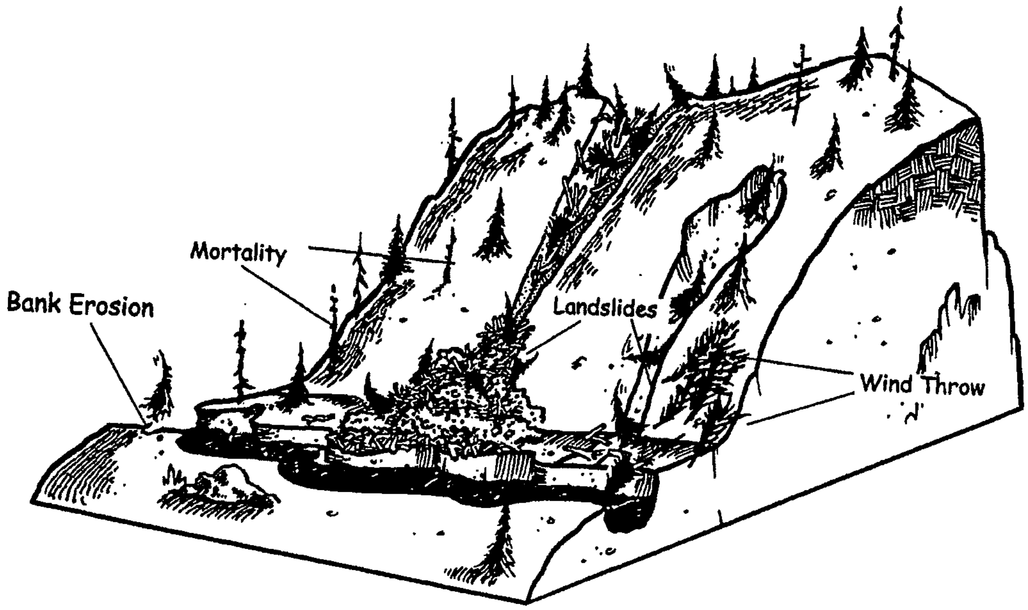
Flat [illegible] [illegible]


EPOCH
FORAMINIFERAL STAGE
TIME (m.y.B.P.)
Coos Bay area
Eugene area
Corvallis-Monmouth area
Central Coast Range
Sheridan-McMinnville area
Oregon City-Molalla area
Columbia County area
PLIOCENE
MIOCENE
OLIGOCENE
EOCENE
LATE
MIDDLE
EARLY
Delmontian
Mohnian
Luisian
Relizian
Saucesian
Zemorrian
Refugian
Narizian
Ulatisian
Penutian
Bulitian
5.3
10.8
17
25
33
38
41
50
Empire Formation
Tarheel Formation
Tunnel Point Ss.
Bastendorff Shale
Coaledo Formation
Upper member
Middle member
Lower member
Elkton Formation
Tyee Formation
Umpqua Formation
Roseburg Formation
Unnamed sedimentary deposits
Frenchman Springs Member
Wanapum Basalt
Columbia River Basalt Group
Grande Ronde Basalt
(Little Butte Volcanics)
Tibb, Tbd, Tbw
Fisher Formation
Eugene Formation
Spencer Formation
Yamhill Formation
Tym
Tyv
Basaltic flows
Marine sedimentary rocks
Spencer Formation-equivalent volcanics
Tym, Tyv
Siletz River Volcanics
Sandstone of Whale Cove
Cape Foulweather Basalt
Depoe Bay Basalt
Astoria Formation
Nye Mudstone
Yaquina Formation
Alsea Formation
Yachats Basalt
Nestucca Formation
Pittsburg Bluff Fm.
Keasey Fm.
Troutdale Formation
Sandy River Mudstone
Pomona Member
Saddle Mountains Basalt
Sardine Formation
Molalla Formation
Scappoose Formation
Strandline sedimentary rocks
Little Butte Volcanics
Astoria(?) Formation
Frenchman Springs Member
Goble Volc.
Cowlitz Formation
Tillamook Volcanics

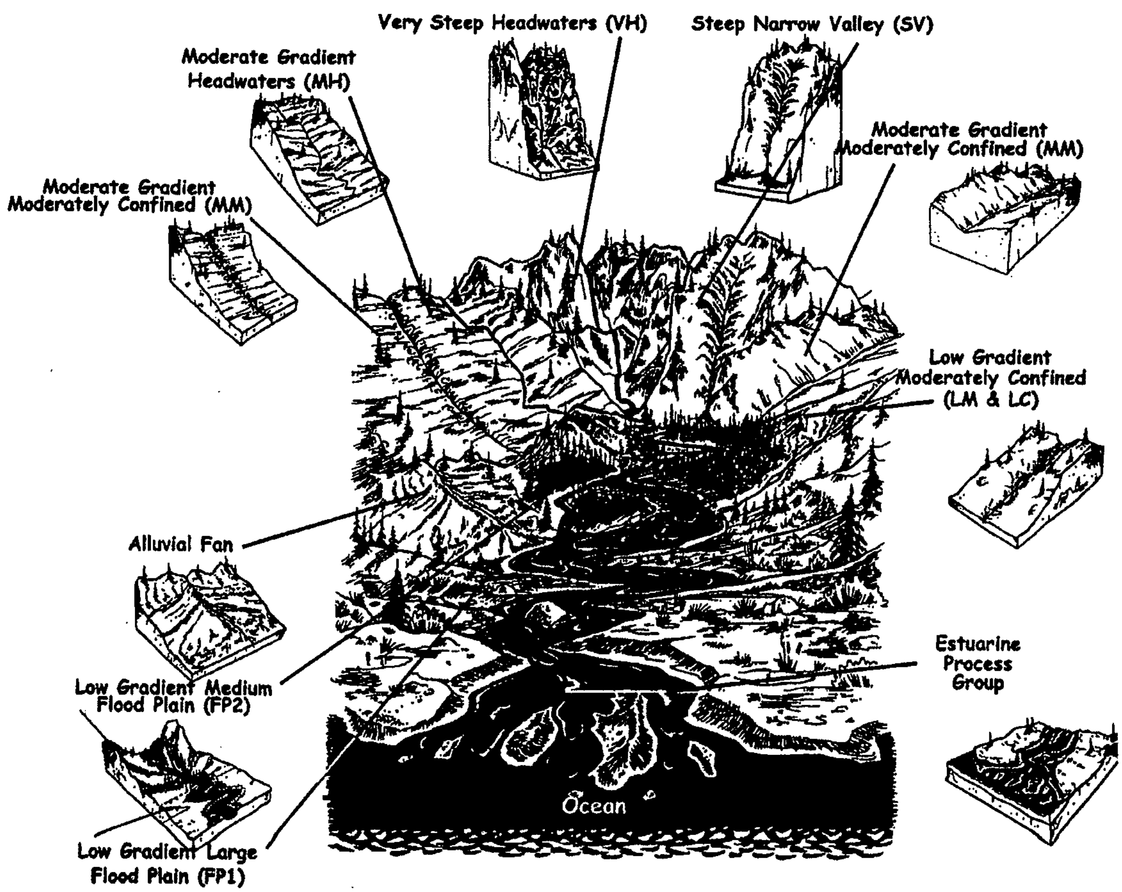
Geomorphology of the Luckiamute Watershed

Valley Floor-Fluvial Regime
- Landforms
  - Channel
  - Floodplain
  - Terrace
  - Small-scale Fans
  - Strath-pediment surfaces
  - Low-relief colluvial hillslopes (Spencer Fm)
- Deposits
  - Alluvial Fill (sorted sand and gravel)
  - Debris Flow Deposits (diamicton)
  - Slackwater Silts and Clay
- Processes
  - Channel Transport
  - Overbank Sedimentation

- Hillslope-Colluvial Regime
  - Landforms
    - Ridge tops
    - Hillslopes-Sideslopes
    - Hollows
    - Pediment Surfaces
  - Deposits
    - Colluvium (gravel diamicton)
    - Residuum (gravel diamicton)
  - Processes
    - Collvial Creep
    - Debris Slide / Flow
    - Tree-throw / Bioturbation



Geomorphic configuration of mountainous watersheds in the Coast Range.



Typical distribution of CHTs in a mountainous watershed.

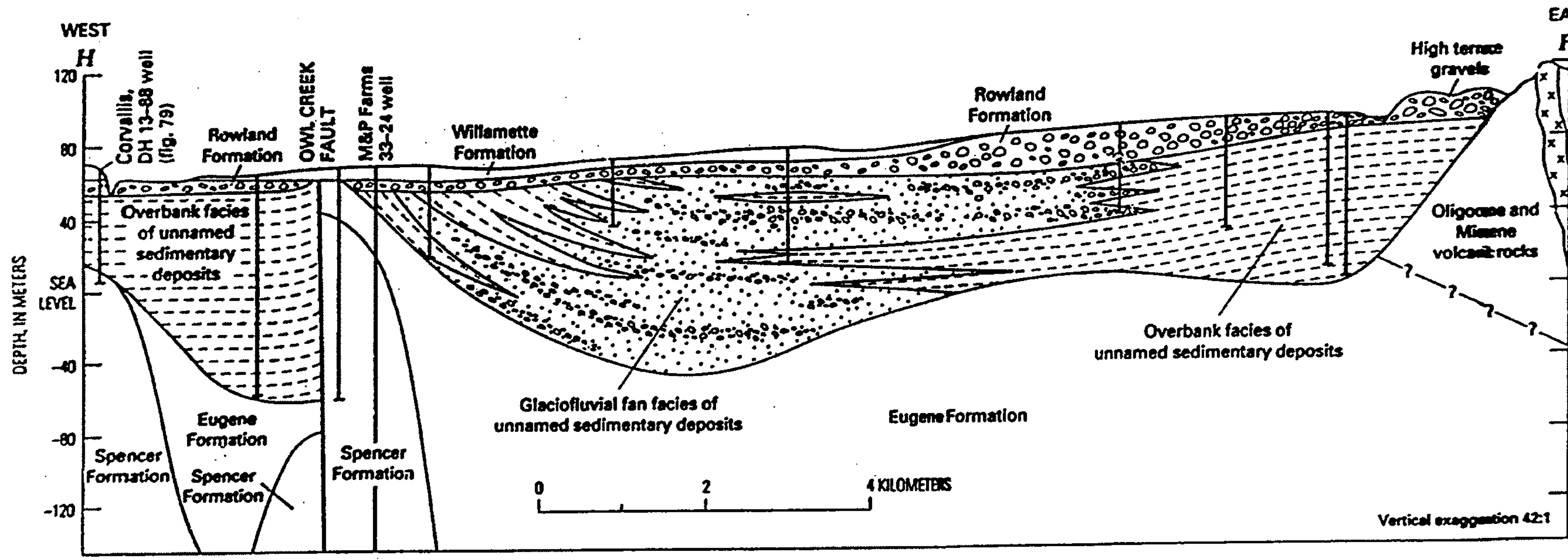


Figure 82. Structural cross section between Corvallis and Lebanon, Oreg., showing channel and overbank facies of unnamed fluvial sedimentary deposits, high-terrace gravels, late Pleistocene outwash deposits of the Rowland Formation, and catastrophic flood deposits of the Willamette Formation. Data are from water wells, engineering bore holes, and petroleum-exploration wells.

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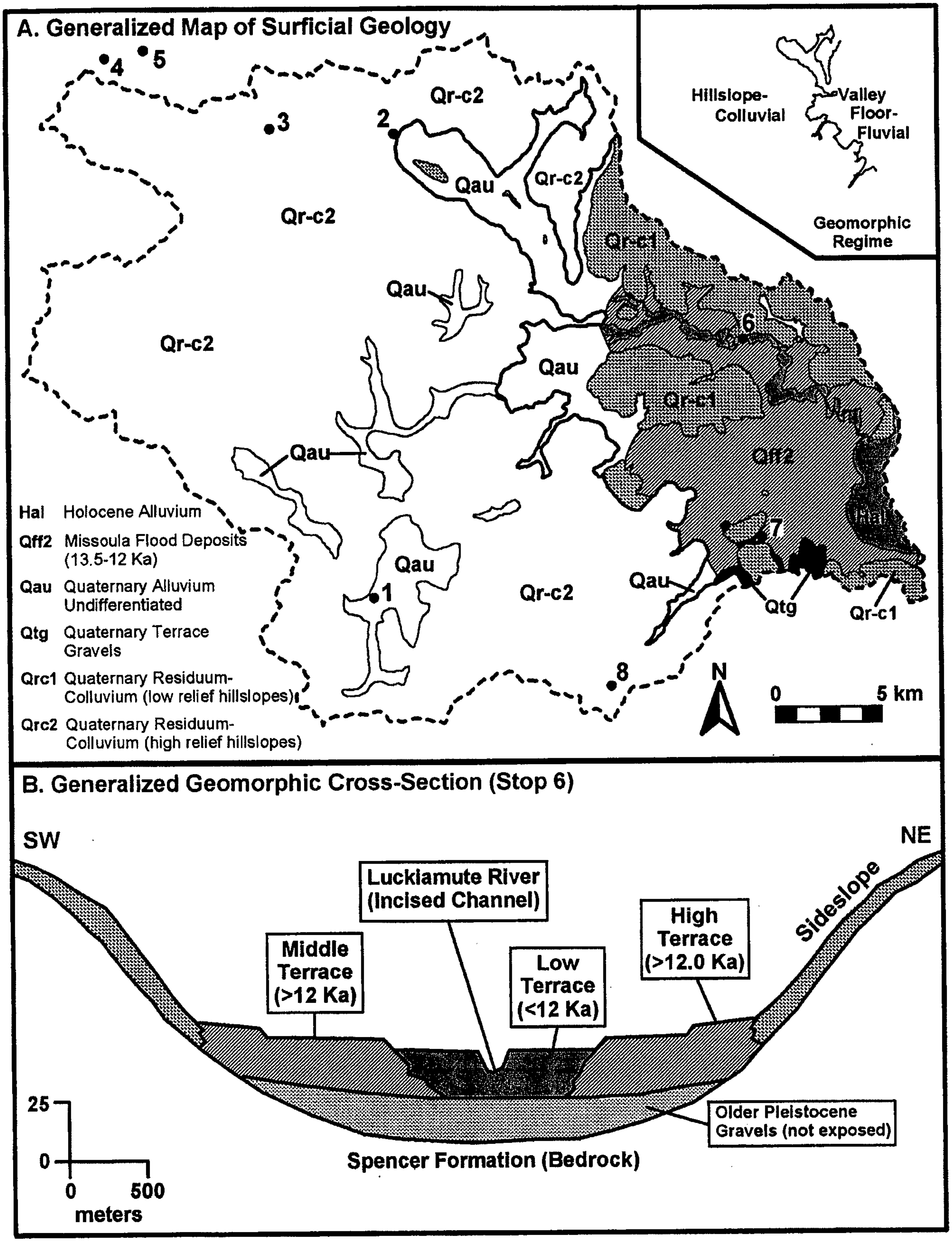

Figure 4. Surficial geology and geomorphology of the Luckiamute River Basin. Surficial map units are modified from O'Connor and others (2001), after Taylor and others (1996). Cross section shown in frame B represents generalized landform elements at Helmick State Park (Stop 6).

Reckendorf, 1993

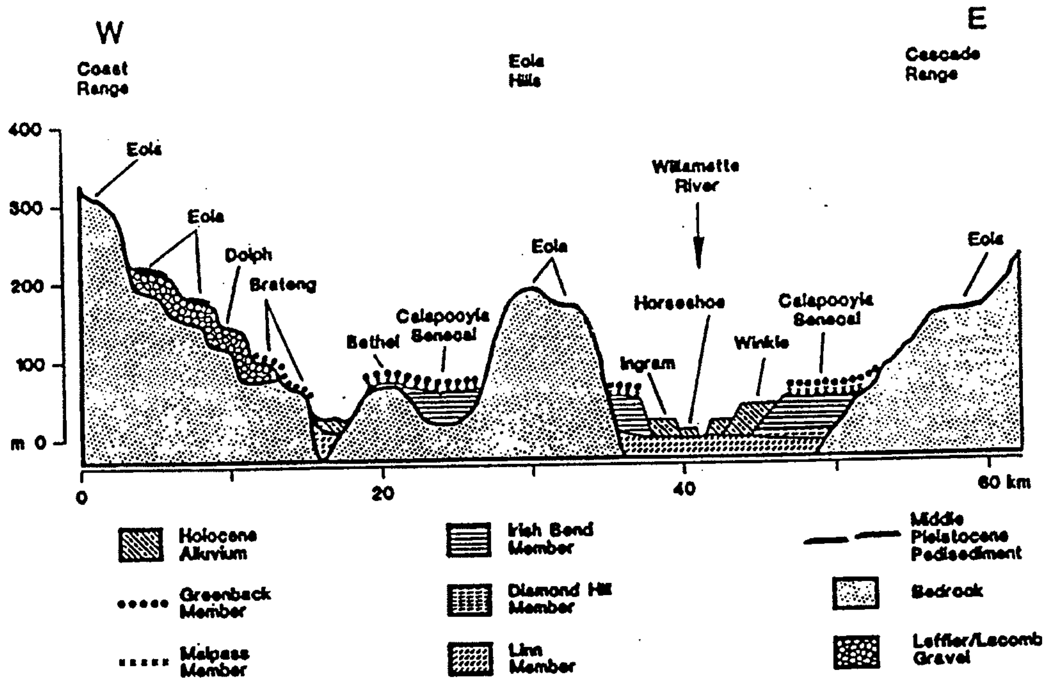

Figure 1. Generalized cross section of geomorphic surfaces at about the 45° latitude of Salem, Oregon. Subsurface distribution of Linn and Leffler/Lacomb Gravels shown here is speculative. Modified from McDowell (1991).

associated Greenback Member as described by Glassman and Kling (1980). Allison's (1935) original work reported no erratics lower than 30 m in the main valley but some as low as 10.5 m in the Portland area. Dozens of erratics locations are shown below 76 m and only rarely are erratics described at the maximum elevation of 122 m.

According to Allen et al. (1986), one small group of six boulders on Judkins Point east of Eugene occurs at an elevation of 198 m. It is assumed that these particular erratics are on the Eola surfaces rather than on Dolph Surfaces. Allen et al. (1986), attribute these high erratics to Indian transport, but an old Lake Missoula flood origin is also a possibility. Taken collectively, the data shows that erratics occur at various elevations above 30 m in the main valley, and they could be represent several different glacial Lake Missoula floods, rather than just the highest flood.

In general, the erratics range in size from small pebbles to boulders. They are composed of granites, granodiorites, gneisses, quartzites, schist, argillites, and phyllites. Allison (1935, 1936) noted at least 300 occurrences of erratics in the Willamette Valley. According to Allen et al. (1986), probably fewer than 50 of the erratic boulders still exist today.

The erratic rocks all require some outside source. Since the Willamette Valley lacks late Pleistocene continental till and associated outwash, and areas to the north show the definite presence of unmodified (by glaciers) Pleistocene non-glacial soil, it seems unlikely that the erratics were brought in by glaciers from the north. Allison (1935) related the erratics and the Willamette Silts, to be discussed later, to surges of glacial meltwater. This happened when the ice dams at the mouth of the Clark Fork River in Montana failed on different occasions, releasing the flow of Glacial Lake Missoula, to create the "Spokane Floods," between about 15 ka and 12.8 ka years before present (Allen et al., 1986).

The "Spokane Flood" (Bretz, 1919) was later named the "Missoula Flood," when the Montana Lake source for the flood water was discovered. It is commonly published (Allen et al., 1986) that, between 15 ka and 12.8 ka years ago, there were as many as 40 "Missoula Floods", so the term "floods" is

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TABLE 3. GEOMORPHIC SURFACES OF THE WILLAMETTE VALLEY*

Geomorphic Surface	Surface Type	Dominant Surface-forming Process	Final Surface-forming Event	Major Associated Deposits	Approximate Age (B.P.)	Typical Soils
Horseshoe	Depositional	Fluvial lateral accretion	Fluvial lateral accretion	Recent alluvium	<300	Fluventic Haploxeroll
Ingram	Depositional	Fluvial lateral accretion	Fluvial lateral accretion	Recent alluvium	<5,000	Cumulic Ultic Haploxeroll
Winkle	Depositional	Fluvial lateral accretion	Fluvial lateral accretion	Recent alluvium	12,000 to 5,000	Pachic Ultic Argixerol
Champoeg	Depositional	Phase 2 flood proximal facies deposition	Phase 2 flood proximal facies deposition	"Lacustrine deposits"†	13,000	Argiaquic Xeric Argialboll, Aquic Xerocherpt
Senecal	Erosional	Local fluvial incision of Calapooyia surface	Deposition of Greenback Member	Willamette Formation	13,000	Aquultic Argixerol, Pachic Ultic Argixeroll
Calapooyia	Erosional/ depositional	Plantation of Irish Bend Member and older deposits	Deposition of Greenback Member	Willamette Formation	13,000	Typic Albaqualf, Argiaquic Xeric Argialboll
Quad§	Uplifted(?)	Uplift of Willamette Formation deposits	Deposition of Greenback Member	Willamette Formation	13,000	Pacific Ultic Argixeroll
Bethel**	Depositional/ draped on erosional	Willamette Formation deposits draped on low bedrock knolls	Deposition of Greenback Member	Willamette Formation	13,000	Aquultic Argixeroll
Brateng‡	Depositional/ draped on erosional	Greenback Member deposits draped on hillslopes	Deposition of Greenback Member	Greenback Member over Tertiary bedrock	13,000	Ultic Haploxeralf
Dolph	Depositional/ some erosional	Fluvial/glaciofluvial aggradation	Deposition of Greenback Member	Lacomb and Leffler gravels, with Greenback Member in places	Mid-Pleistocene or younger	Ultic Haploxeroll, Ultic Haploxeralf
Eola	Erosional	Pedimentation	Deposition of loess, gravels, or pedisediment	Unnamed pedisediment, Lacomb and Leffler gravels, Helvetia Formation, Portland Hills Silt§§	Early Pleistocene	Xeric Haplohumult
Looney	Erosional	Mass movement	Ongoing mass movement and slope erosion	Colluvium	Time-transgressive	Typic Haplohumult, Typic Haplumbrept

*Based on Balster and Parsons (1968, 1969) and Parsons and others (1970), except as noted.
†Schlicker and Deacon (1967).
§No direct evidence for uplift; probably should be subsumed under the Bethel geomorphic surface.
**Recognized by Gelderman and Parsons (1972) near Amity (Fig. 14).
‡Recognized by Glasmann and others (1980) in a small study site 3 miles south of Monmouth (Fig. 14), but probably widespread.
§§Green (1983), Parsons (1985).

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Luckiamute Basin Debris Flow Hazard Zones (OR Forestry)

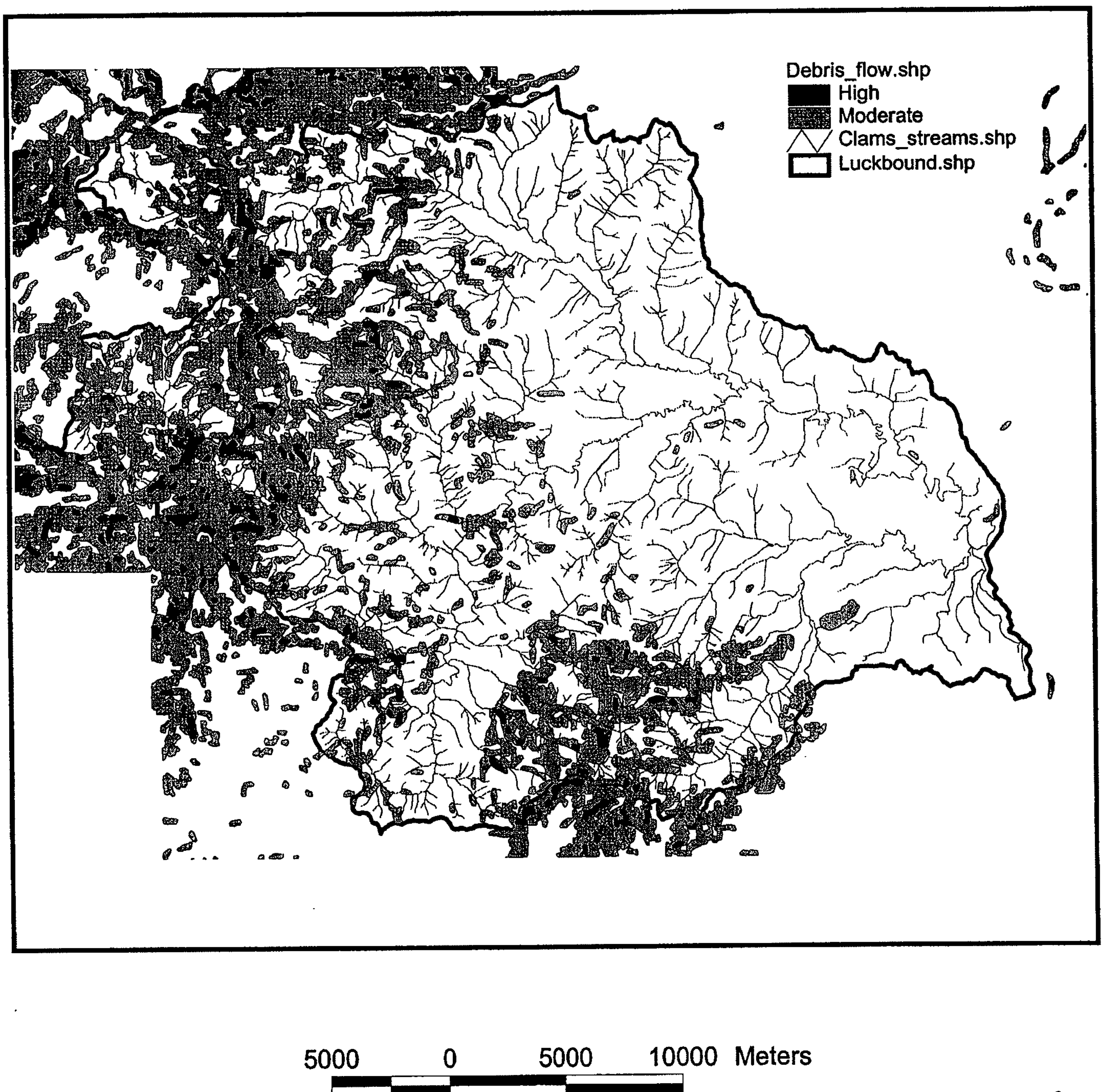


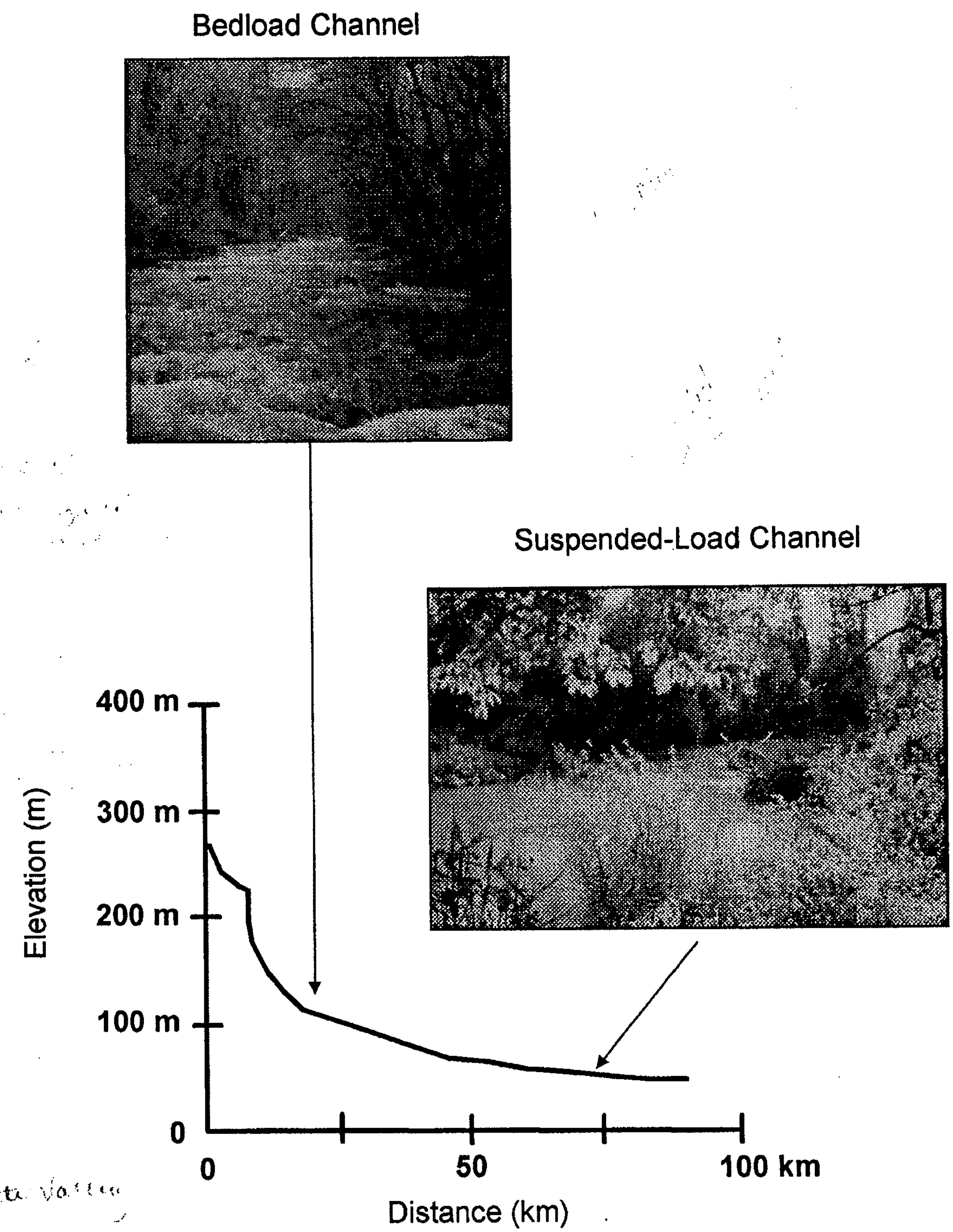
Table 2. Four-fold surficial map protocol for unglaciated mountainous landscapes (after Taylor and others, 1996).

1. Age of surficial material
- H = Holocene (< 10,000 years old)
- W = Wisconsin (89 to 10 ka)
- I = Illinoian
- P = Pleistocene undifferentiated
- EP = early Pleistocene
- MPl= middle Pleistocene
- LP = late Pleistocene
- Q = Quaternary undifferentiated
- CZ = Cenozoic undifferentiated

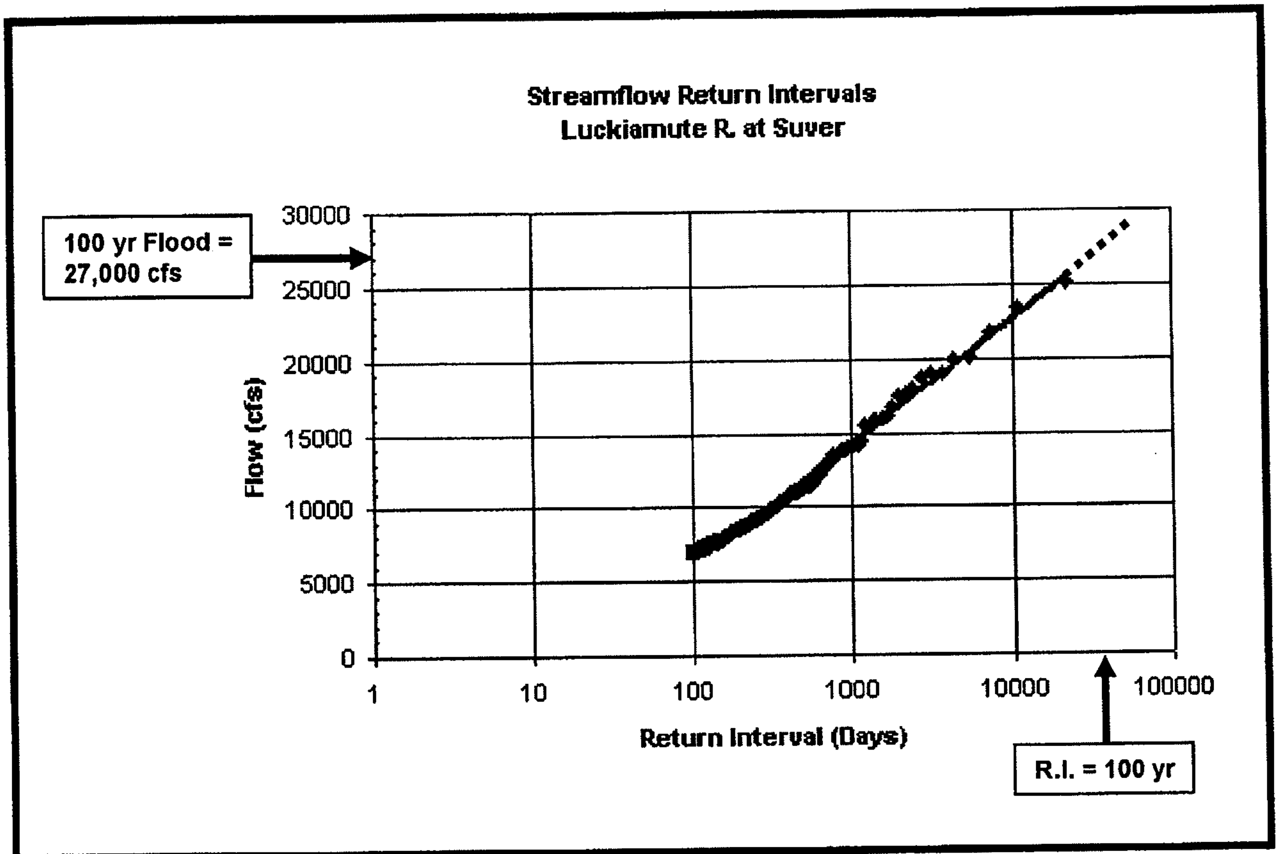
2. Origin of surficial process
- A. Hillslope
  - r = residuum (in situ regolith)
  - c = colluvium (mass wasting)
  - ds = debris slide
  - rf = rock fall or topple
- B. Valley bottom
  - a = stream alluvium (normal flow)
  - hcf = hyperconcentrated flow
  - df = debris flow
  - sw = slackwater deposition
- C. Lacustrine
  - l = lacustrine deposit, undiff.
  - lb = lake-bottom deposit
  - ld = lacustrine deltaic
- D. Other
  - g = glaciofluvial, undifferentiated
  - go = glacial outwash
  - e = eolian
  - cr = cryoturbation
  - x = anthropogenic disturbance
  - f = artificial fill
  - rk = bedrock

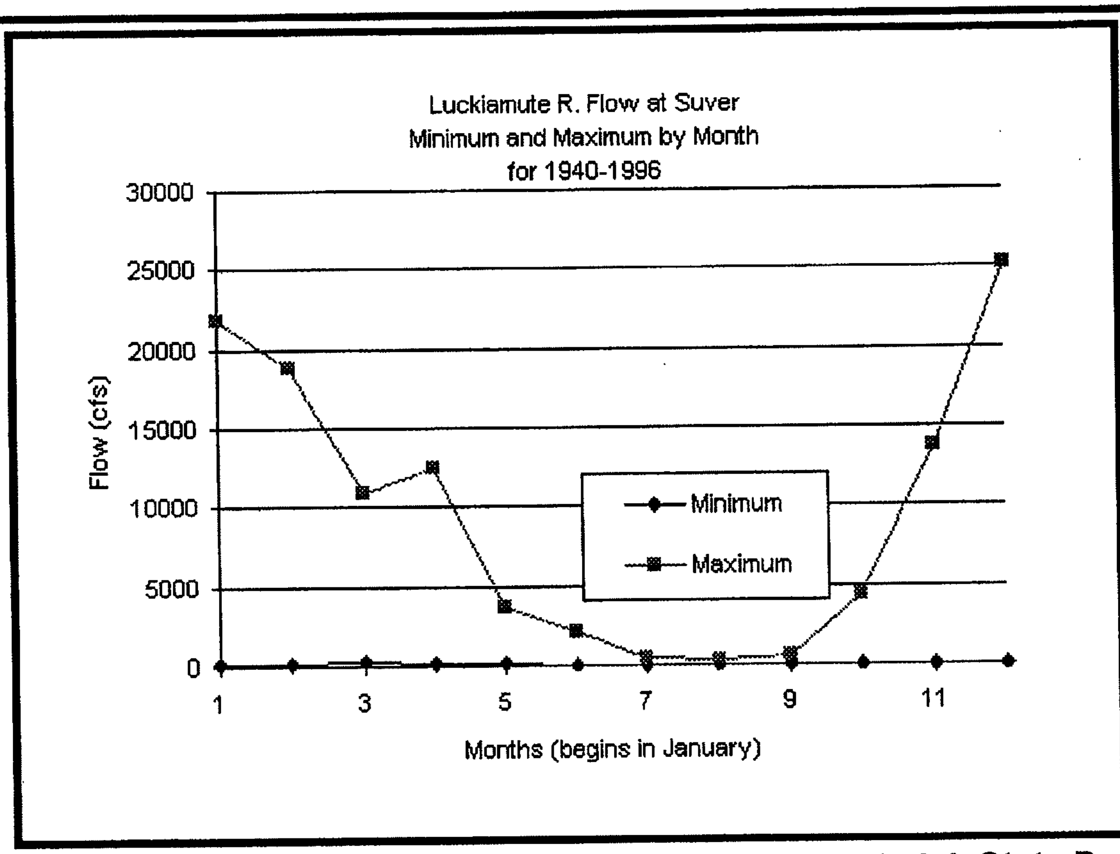
3. Landform Units
- A. Hillslope
  - n = nose
  - sl = side slope
  - h = hollow
  - veneer = < 2 m of regolith
  - blanket = > 2 m of regolith
  - bf = boulder field
  - bs = boulder stream
  - pg = patterned ground
  - tls = talus
- B. Valley bottom
  - ch = channel
  - fp = floodplain (R.I. </= 2-3 yr)
  - t = terrace (t1, t2 ...tn; height above river)
  - f = fan
  - f-t = fan terrace (f1, f2 ...fn; height above river)
  - a = apron (footslope deposit)
  - lo = lobe
  - lv = levee
  - ox = oxbow, abandoned channel
- C. Other
  - ft = flow track (debris flow)
  - hm = hummocky topography
  - rb = rock block-slide deposit
  - x = excavated, fill, disturbed ground
  - d = delta

4. Material (composition and texture)
- b = boulders (>256 mm clast supported)
- c = cobbles (64-256 mm clast supported)
- p = pebbles (4-64 mm clast supported)
- g = gravel (>2 mm clast supported)
- sg = mixed sand and gravel
- s = sand (0.05-2.0 mm)
- st = silt (0.002-0.05 mm)
- cy = clay (<0.002 mm)
- l = loam (mix of sand, silt, clay)
- d = diamicton undifferentiated
- bbd = very bouldery diamicton
- bd = bouldery diamicton
- cd = cobbly diamicton
- pd = pebbly diamicton
- ds = sandy matrix diamicton
- dt = silty matrix diamicton
- dy = clayey-matrix diamicton
- rk = bedrock (modify by lithology)
- rs = rotten stone, saprolite
- tr = travertine
- tu = tufa
- ma = marl
- og = organic-rich sediment
- w = water
- u = unkown

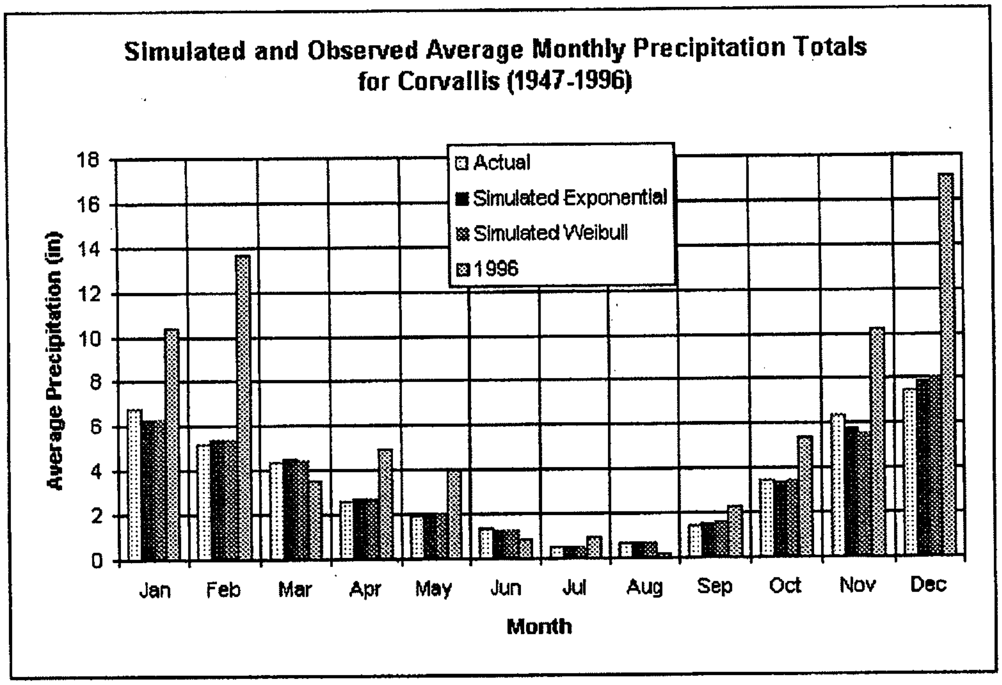


Longitudinal profile along the Luckiamute River (from Rhea, 1993).
Photos from Waichler and others (1997).





Discharge characteristics for Luckiamute River, Helmick State Park (from Waichler and others, 1997).



(Waichler and others, 1997)

Water Balance of Luckiamute Watershed

Period (1961-1990)	Mean Precipitation (mm)	Precip. (Input) (m^3)	Observed Mean Discharge (cfs)	Observed Total Discharge (m^3)	Difference (Precip-Discharge) (m^3)	Difference as % of Precip. ("%LOSS")
Annual	1894	1.23E+09		7.55E+08	4.77E+08	39%
Jan	335	2.18E+08	2232.146	1.69E+08	4.86E+07	22%
Feb	258	1.68E+08	1853.276	1.27E+08	4.09E+07	24%
Mar	216	1.41E+08	1472.097	1.12E+08	2.89E+07	21%
Apr	101	6.57E+07	795.9956	5.84E+07	7.27E+06	11%
May	51.9	3.38E+07	396.072	3.00E+07	3.72E+06	11%
Jun	41.7	2.71E+07	188.61	1.38E+07	1.33E+07	49%
Jul	11.3	7.35E+06	71.32473	5.41E+06	1.94E+06	26%
Aug	23.8	1.55E+07	37.25441	2.83E+06	1.27E+07	82%
Sep	50.3	3.27E+07	49.19311	3.61E+06	2.91E+07	89%
Oct	143	9.30E+07	124.4226	9.44E+06	8.36E+07	90%
Nov	284	1.85E+08	904.1411	6.64E+07	1.18E+08	64%
Dec	378	2.46E+08	2069.228	1.57E+08	8.89E+07	36%

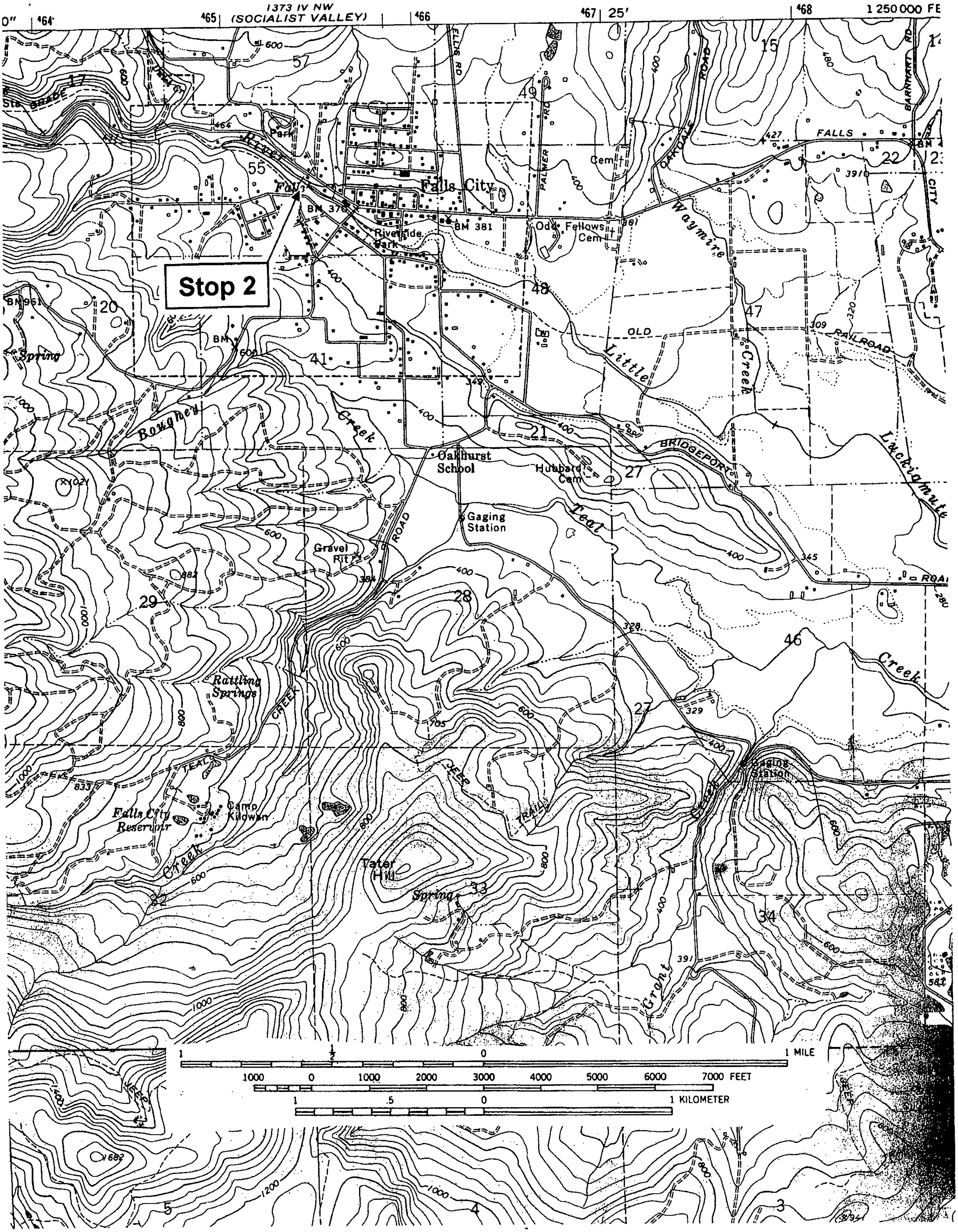
Water budget for Luckiamute Watershed (Waichler and others, 1997)

Stop 2. Falls at Falls City

- Physiographic Location
  - Little Luckiamute River (northern watershed)

- Bedrock and Surficial Geology
  - Stop is located at prominent knick point of Little Luckiamute
  - Stop is located in the Yamhill-Intrusive lithospatial domain (Figure 3, p. 10)

- Content Piece – Fluvial Erosion Dynamics
  - Knickpoint = hydraulic step in gradient
  - Falls are fracture and bedrock controlled
  - Headward erosion, block plucking, and wall-rock undercutting
  - Stream Stream Power = (Discharge) x (Gradient) x (Specific Wt.)
    - Stream Power > Load = Erosion
    - Stream Power < Load = Deposition
  - Little Luckiamute Channel Condition at Stop 2
    - Channel under capacity with respect to sediment load
    - Power > sediment load


1373 IV NW
(SOCIALIST VALLEY)
Stop 2
Falls City
Park
Falls
BM 378
Riverside Park
BM 381
Odd Fellows Cem
Cem
OAKDALE
FALLS
CITY
BARNHART RD
PALMER RD
ELLIS RD
Waymire Creek
Little
OLD RAILROAD
BRIDGEPORT
Luckiamute
Creek
Boughey Creek
Oakhurst School
Hubbard Cem
Teal
Gaging Station
Gravel Pit
ROAD
Rattling Springs
CREEK
TEAL
Camp Kilowan
Falls City Reservoir
Creek
JEEP TRAIL
Tater Hill
Spring
Grant
Spring
1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER

En Route to Stop 6

•Drive from Falls City, out of Yamhill-Intrusive Domain, into Spencer Fm-Valley Fill Domain (refer to Figure 3, p. 10)

•Note change in land use from forestry to agriculture

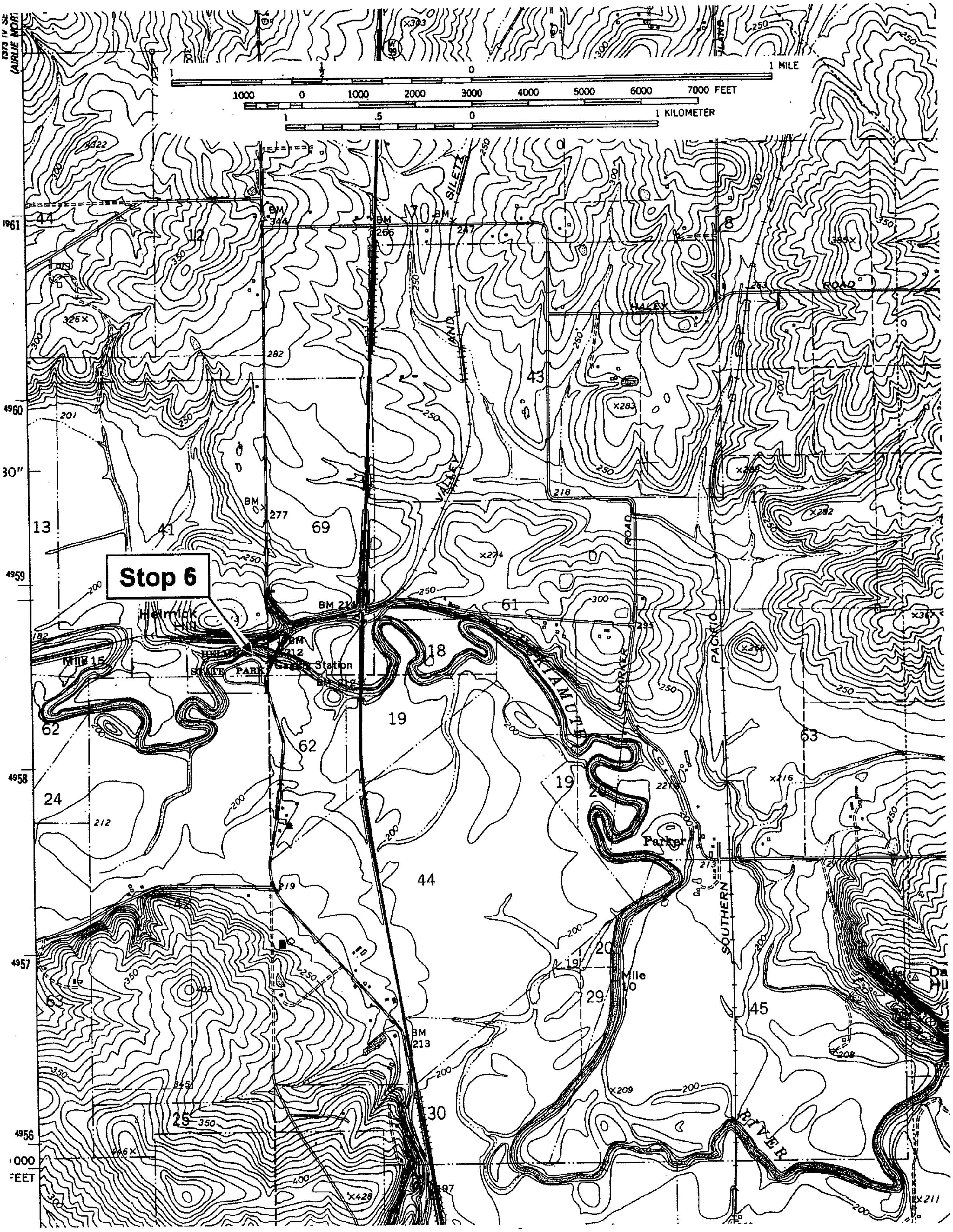
•Stop at Western Oregon University, Natural Sciences Building, for brief slide show discussion of the Polk County Flora Project and Interactive Flora Identification Key

Stop 6. Helmick State Park

- Physiographic Location
  - Lower Luckiamute River, 18 km upstream from watershed outlet into the Willamette River

- Bedrock and Surficial Geology
  - Stop is located in the Spencer Fm-Valley Fill lithospatial domain (Figure 3, p. 10)
  - Note incised channel characteristics and low terraces

- Content Piece – Field Botany and Flood Hydrology
  - Field Botany
    - Participants are provided an opportunity to use Dutton's interactive flora identification key
  - Flood Hydrology
    - USGS Suver Gaging Station
    - Recurrence intervals and seasonal discharge patterns (p. 32)
    - Paleoflood hydrology


1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 KILOMETER
Stop 6
Helmick Hill
HELMICK STATE PARK
Graber Station
Mile 15
SILETZ
VALLEY AND
LUCKIAMUTE
RIVER
HALEY ROAD
PARKER ROAD
PACIFIC SOUTHERN
Parker
Mile 10
BM 344
BM 266
BM 247
BM 277
BM 214
BM 212
BM 213