Chapter 9
Hydrologic Hazards at the Earth’s Surface

Drainage Basins
- The fundamental geographic unit or tract of land that contributes water to a stream or stream system
- Drainage basins are separated by divides

Discharge
- The amount of water flowing in a stream channel
- Runoff
- Subsurface flow
- Rainfall/snowfall
- Urbanization
- Vegetation

Erosion
- Erosive power is a function of flow velocity - the greater the velocity, the greater the erosion
- Discharge
- Channel shape
- Gradient

Base Level
- The lowest level to which a stream or stream system can erode
- Sea level
- Temporary base levels, such as lakes, dams, and waterfalls

Graded Stream
- Stream that has reached a balance of erosion, transportation capacity, and the amount of material supplied to the river
Alluvium

- Sediment deposited by a stream, either inside or outside the channel.

Alluvial Fan

- Buildup of alluvial sediment at the foot of a mountain stream in an arid or semiarid region.

Delta

- Deltas are formed where a sediment-laden stream flows into standing water.

Floodplain

- Low area adjacent to a stream that is subject to periodic flooding and sedimentation.
- The area covered by water during flood stage.

Meanders, Oxbow Lakes, and Cutoffs

- Flowing water will assume a series of S-shaped curves known as meanders.
- The river may cut off the neck of a tight meander loop and form an oxbow lake.

Floods

- Highland floods come on suddenly and move rapidly through narrow valleys.
- Lowland floods inundate broad adjacent floodplains and may take weeks to complete the flood cycle.
Hydrograph

- A graph that plots measured water level (stage) or discharge over a period of time.

Recurrence Interval

- The average length of time (T) between flood events of a given magnitude.
- \( T = \frac{n+1}{M} \), where N is the number of years of record and M is the rank of the flood magnitude.

Flood Probability

- The chance that a flood of a particular magnitude will occur in a given year based on historical flood data for a particular location.

Flood Mitigation

- Dams
- Retaining basins
- Artificial levees
- Elevating structures
- Flood Insurance

Urban Development

- Urbanization causes floods to peak sooner during a storm, results in greater peak runoff and total runoff, and increases the probability of flooding.
Meanders in the Smith River south of Great Falls, Montana, nicely illustrate the eroding cut bank on the outside of a meander and the depositional gravelly point bar on the inside of the meander. Flow is toward the lower left.
“Most of the precipitation falls between October and May. The driest months are July and August.”

http://www.crcwater.org/newsltr/news9810.html#75

Chehalis Basin

Length: 115 mi (185 km) [1]
Watershed: 2,660 mi² (6,889 km²) [2]
Discharge at near Satsop, WA:
- average: 6,425 ft³/s (182 m³/s) [3]
- maximum: 47,000 ft³/s (1,331 m³/s)
- minimum: 440 ft³/s (12 m³/s)
Discharge elsewhere:
- mouth (Grays Harbor): 11,208 ft³/s (317 m³/s) [2]
Drainage Patterns

- As seen from above ("map view" or "plan view")
  - Dendritic (most common)
  - Radial
  - Trellis - in tilted or folded layered rock
  - Rectangular

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Mike Salisbury, *The Chronicle*

A Centralia neighborhood near Mellen Street sits flooded Tuesday as a result of severe storms that caused record flood levels on the Chehalis River.

The Chehalis River floods large areas of Chehalis, and also submerges several sections of Interstate 5. The river was almost 10 feet over flood stage. (Steve Bloom/The Olympian)

Private airplanes find safe haven Tuesday from the rising Chehalis River at the Lewis County Airport. (Steve Bloom/The Olympian)
Airplanes were moved to high ground at Chehalis Airport. Officials said it’s the worst flooding in years in and around Chehalis and Centralia including Interstate 5. STEVE RINGMAN / THE SEATTLE TIMES

A Centralia neighborhood is submerged. Flood damage to a segment of the interstate in the Chehalis area will keep the highway closed until Friday at the earliest, a transportation department official said. STEVE RINGMAN / THE SEATTLE TIMES

Flood waters from the Chehalis River inundate a neighborhood in Centralia. STEVE RINGMAN / THE SEATTLE TIMES

The barrier on Interstate 5 between the northbound and southbound lanes is swept away in places as the highway passes through Chehalis. STEVE RINGMAN / THE SEATTLE TIMES

The freeway overpass in Chehalis was underwater, including WalMart on the right. I-5, which runs below, was completely submerged. STEVE RINGMAN / THE SEATTLE TIMES

Looking south, semi trucks sit stranded on high ground above the flooded Interstate 5. STEVE RINGMAN / THE SEATTLE TIMES
A Centralia neighborhood is submerged.  STEVE RINGMAN / THE SEATTLE TIMES

Wal-Mart store in Chehalis.  SkyKING photos

Bridge over Chehalis.  SkyKING photos

You can’t actually see Interstate 5 in this photo; it’s under the flood water.  Notice the exit sign on the bottom of the photo, just a little left of center, and the freeway overpass in the middle of the photo. Dec. 4, 2007.  WA DOT

Two men examine the flow of the Chehalis River that ripped down the Chandler Road Bridge, on the way from Highway 6 to the town of Doty.  STEVE RINGMAN / THE SEATTLE TIMES

SR 6 under a massive mud slide near Pe Ell
Mud up to 3 feet thick sits in fields, around homes and on roads in and around Curtis — and it's starting to dry up. Occupants of this Ceres Hill Road home are burning their furniture and belongings destroyed by the flood. STEVE RINGMAN / THE SEATTLE TIMES

Did development, logging set the stage for disaster?

• By Lynda V. Mapes
Seattle Times staff reporter
• Sunday, December 09, 2007

Flooded Chehalis A new automobile dealership, at bottom of photo, is being built just off Interstate 5 on an island of fill in the Chehalis River floodplain. Some nearby stores, including a Home Depot and a Wal-Mart, were hard hit by last week's high waters. STEVE RINGMAN / THE SEATTLE TIMES

Clear-cuts and mudslides Tons of earth and vegetation washed away from clear-cut hillsides last week and slammed into Stillman Creek, a tributary of the south fork of the Chehalis River. STEVE RINGMAN / THE SEATTLE TIMES

Acres of timber and debris backed up behind this bridge in the Boistfort Valley, which was inundated by the flooding of the south fork of the Chehalis River. STEVE RINGMAN / THE SEATTLE TIMES

Despite being built on a plateau of fill, this Walgreens pharmacy near the Chehalis River suffered water damage from last week's flooding. STEVE RINGMAN / THE SEATTLE TIMES
Ranch House BBQ co-owner Melanie Tapia gets a hug from Ginny Wallace, a friend and DOT worker who stopped by to check on them Monday, Dec. 3, 2007 after a wall of mud from nearby Kennedy Creek destroyed the popular Highway 8 restaurant near Olympia, Wash.