FLOW 2015
Portland, Oregon, April 29th, 2015

Solutions to Accommodate Extreme Ranges of Available Flows under a Changing Climate and Competition for a Diminished Water Supply

Dave Rosgen, P.H., Ph.D.
Wildland Hydrology
Fort Collins, Colorado

Conference Theme: "Protecting Rivers and Lakes in the Face of Uncertainty"

With instream flows there *are* some certainties:

- There *will be increased demands* for water with a limited supply
- Population growth and development *will continue*, requiring more water for urban use
- Flow extremes *can be expected* from drought to flood (even in the same year) with changes in climate and land use
- *Increased demands for food* will continue from irrigated agricultural lands

Recommendations

1. Conservation and management of water resources and riparian vegetation

2. Restoration of the river system, which includes channels, floodplains, and the riparian ecosystem

A Watershed Master Plan

A master plan brings together all ownerships, shares common objectives, identifies common problems, and helps develop common solutions (e.g., Blackfoot Challenge, Montana)

The Master Plan must include:

- A set of common *objectives* for the watershed

- A *watershed assessment* to evaluate existing conditions; the source, nature & extent of impairments; fish barriers; land uses; and water yield and distribution

Conservation of Water

- Encourage water conservation for urban, agricultural, and industrial uses
- Urban development needs to follow new “green” infrastructure, retrofitting poor development (the concrete jungle) and encouraging reduced consumptive use of water
- Agricultural irrigation methods can be greatly improved; as well as proportionate sharing - Ruby River Water Users Association, Montana

Land uses that lead to impairment and diminished instream flows and flow stages:

Walla Walla River following the 1964 flood — What is the river telling us?

Traditional trapezoidal, over-wide conveyance channel, US Army Corps of Engineers, 1976, Big Thompson

Straightened, over-wide channel, Big Thompson, 2014

Over-widened, hardened & un-natural Spring Creek “Restoration”…even with the root wads

Traditional, over-wide channel showing automatic time-release bedload capsules

Degradation caused by culvert, shifting B4 → G4 stream type

Floodplain drain culvert design

Floodplain drain culvert design

High flow performance

6’ x 20’ box culvert filled with sediment due to high w/d ratio and high sediment supply; a barrier to fish passage

Restoration of box culvert with a low w/d ratio and floodplain connectivity, Trail Creek, Colorado

Looking upstream showing new channel and floodplain with floodplain drain culverts

Proper grazing management system below fence line: F4→C4→E4

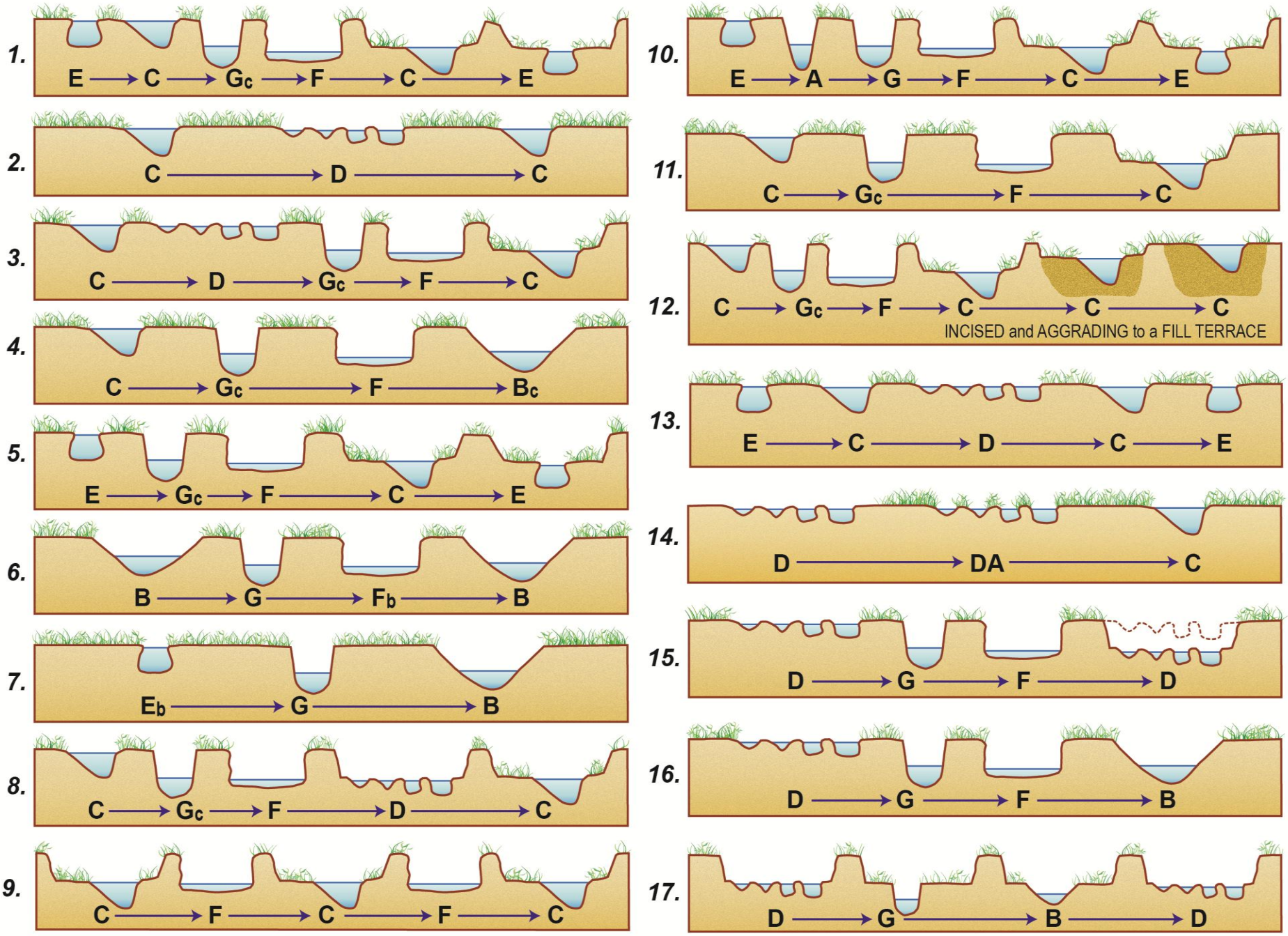
Fence-line contrast showing E4 to C4 stream type conversion

Restoration of the river system

The restoration of the impaired river system can be very helpful for limited instream flows, including:

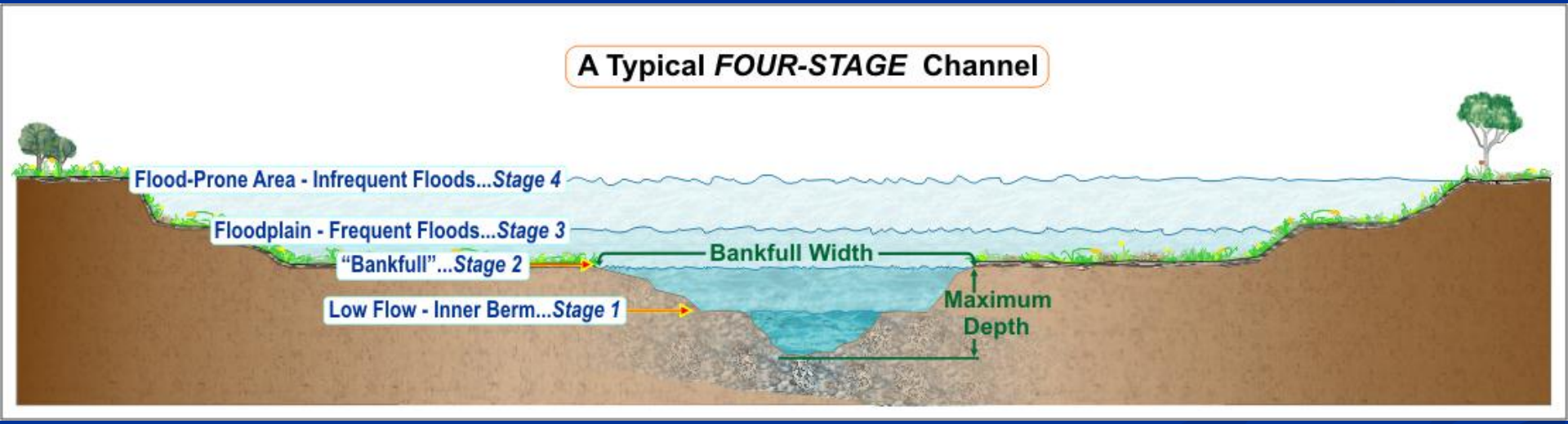
- The incised or entrenched river systems
- Overwide, aggrading river systems
- Channelized, physically-altered systems
- Water depletions due to diversions/reservoirs (Lower Blanco, Colorado River, Nevada Cr.)

Stream Channel Succession Scenarios



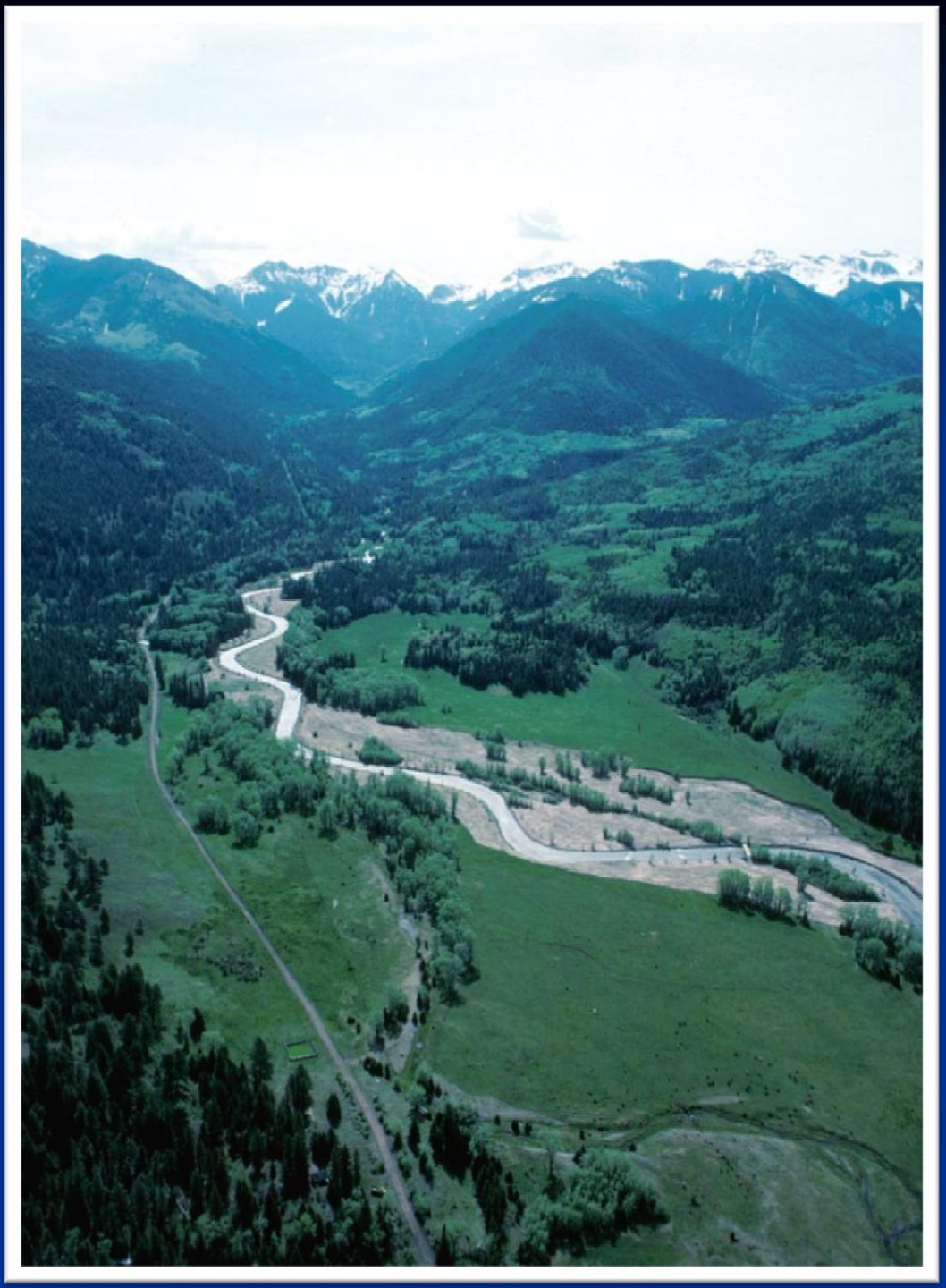
The Multi-Stage Channel Design

1. The Low-Flow or “Inner-Berm” Channel
2. The Bankfull Stage Channel
3. The Active Floodplain at Incipient Point of Flooding
4. The Infrequent but Highest Flood-Level Stage



Typical for C stream types in terraced, alluvial valleys

East Fork San Juan River showing braided condition from clearing willows in the early 1930s



East Fork River meander pattern of the new C4 stream type at bankfull stage – June, 1987

Blanco River (D4 stream type) prior to restoration, 1987, looking upstream

Post runoff restoration – Blanco River, 1990, looking upstream, C4 stream type

Post-restoration reach – Blanco River

Blanco River flood 4x bankfull, 1995

Blanco River floodplain, 24 years after restoration, August, 2011

Trans-basin diversion, F4 stream type, 120 years old…
West Slope Cutthroat Fishery, Poudre Pass Creek, CO

“Stabilization” on Poudre Pass Creek diversion channel

100 feet downstream of culvert – G4 stream type due to contraction scour

E4 stream type succession inside of previous F4 stream type, above culvert

Accelerated streambank erosion due to riparian vegetation removal

Post-Installation of Toe Wood: Face Logs, Willows, & Coir-Wrapped Bales

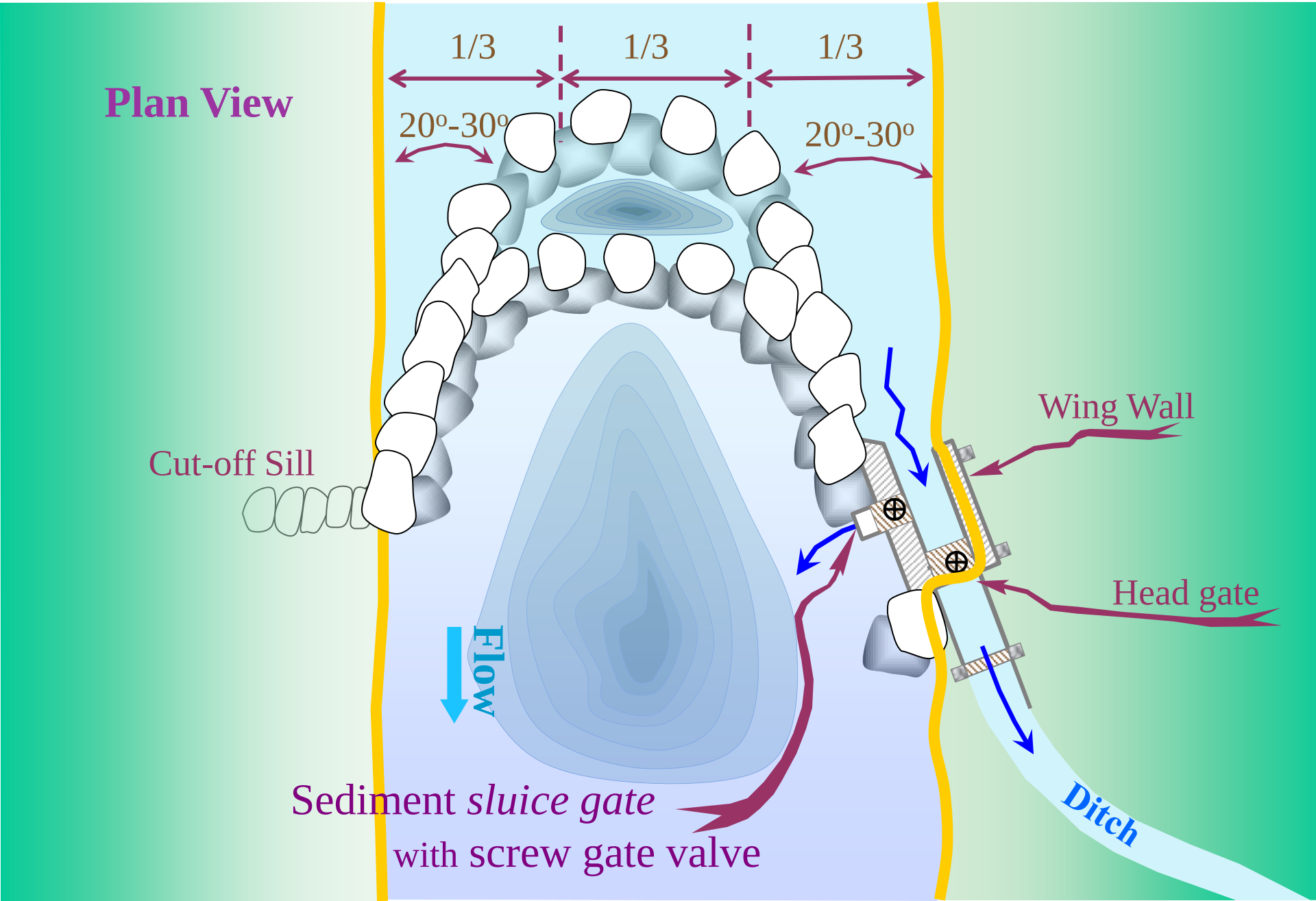
Post-Installation of Toe Wood: Face Logs, Willows, & Coir-Wrapped Bales

Pre-restoration, existing condition, 9/2010

Post-restoration using toe wood with sod mats & willow cuttings on bankfull bench, 11/2010

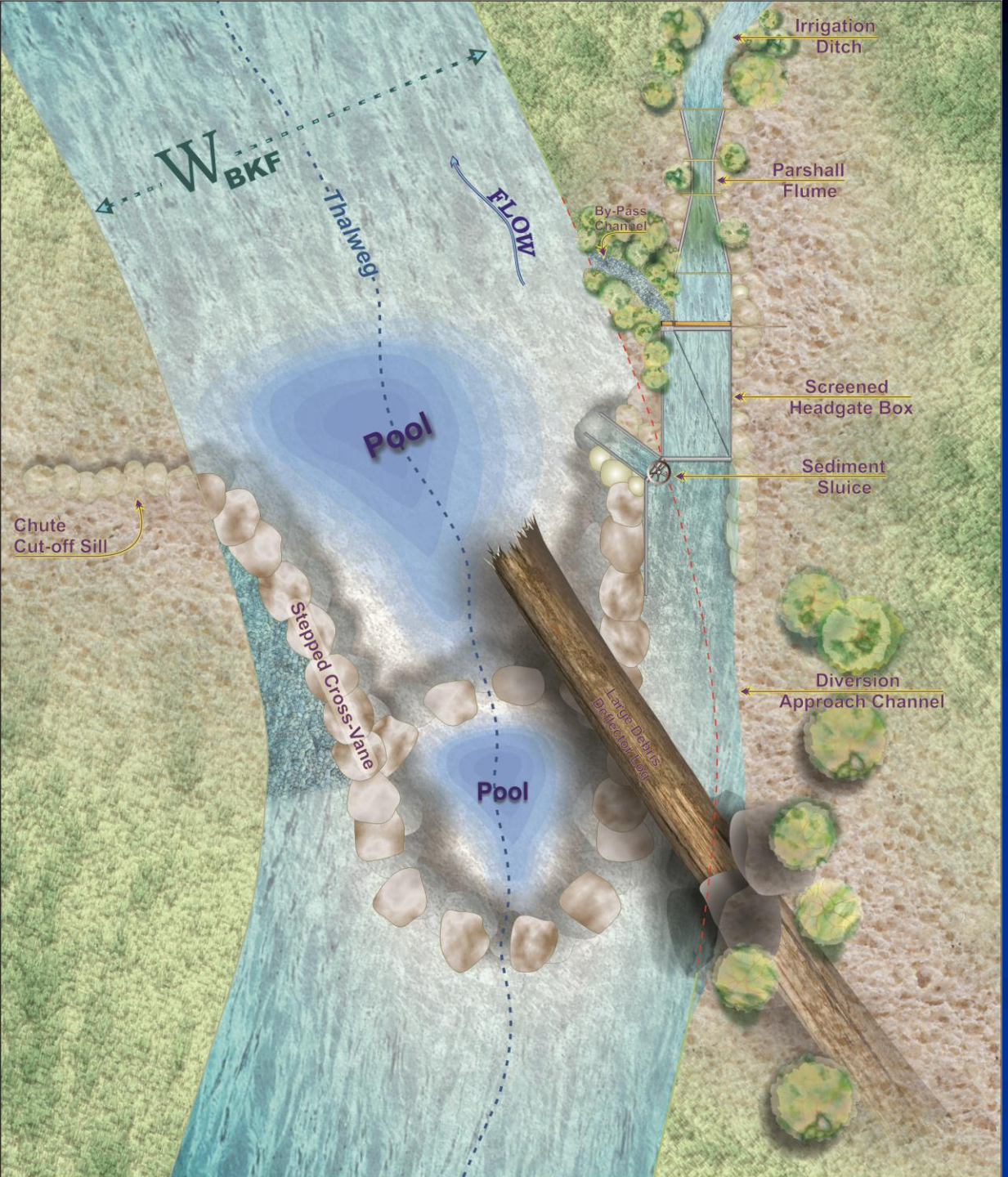
Diversion structure washed out, but same design rebuilt, St. Vrain River, 2013

Cross-Vane and Head Gate with Sediment Sluice



Cross-Vane Diversion

Sediment sluice screwgate valve & headgate valve



Cross-Vane with By-Pass Diversion Box

Step/pool Cross-Vane with a fish screen diversion box

Big Thompson in 1976 at Drake, Colorado

Big Thompson at Drake 35 years later

Little damage occurred to this restored reach in the 2013 flood due to proximity away from road and debris flows

Altered incised channels and flood irrigation gates, Heartrock Ranch, Idaho, 2010

Cross-Vane & By-Pass Diversion Box

New channel constructed on top of floodplain

Multiple oxbows and new channels that raised the water table during summer drought with no flood irrigation

Constructed waterfowl habitat, emergent wetland, rearing & food plot area from previous incised channel… post-construction, 7/20/11