Evolution of Riparian and Floodplain Restoration Design on Several Western Montana Rivers

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Introduction

Topics covered:

- Definition of riparian and floodplain restoration
- Floodplain attributes as a basis for developing criteria for restoration designs
- Evolution of floodplain restoration design approach
- Floodplain restoration planning for the Upper Clark Fork River—example of design criteria

Definitions

Riparian and floodplain restoration – Creating conditions that will sustain *natural processes* and support *floodplain functions*

Floodplain Attributes

The following floodplains attributes reflect how we think about natural processes and floodplain functions to support designing floodplain restoration projects

Floodplain Attributes

- Disturbance regime
- Hydrologic connectivity
- Nutrient transport and storage
- Substrate
- Topographic diversity
- Biological interactions
- Light regime

Disturbance Regime

- Frequent, low-intensity disturbances such as livestock grazing, haying, and weed control prevent plant communities from progressing to later successional stages

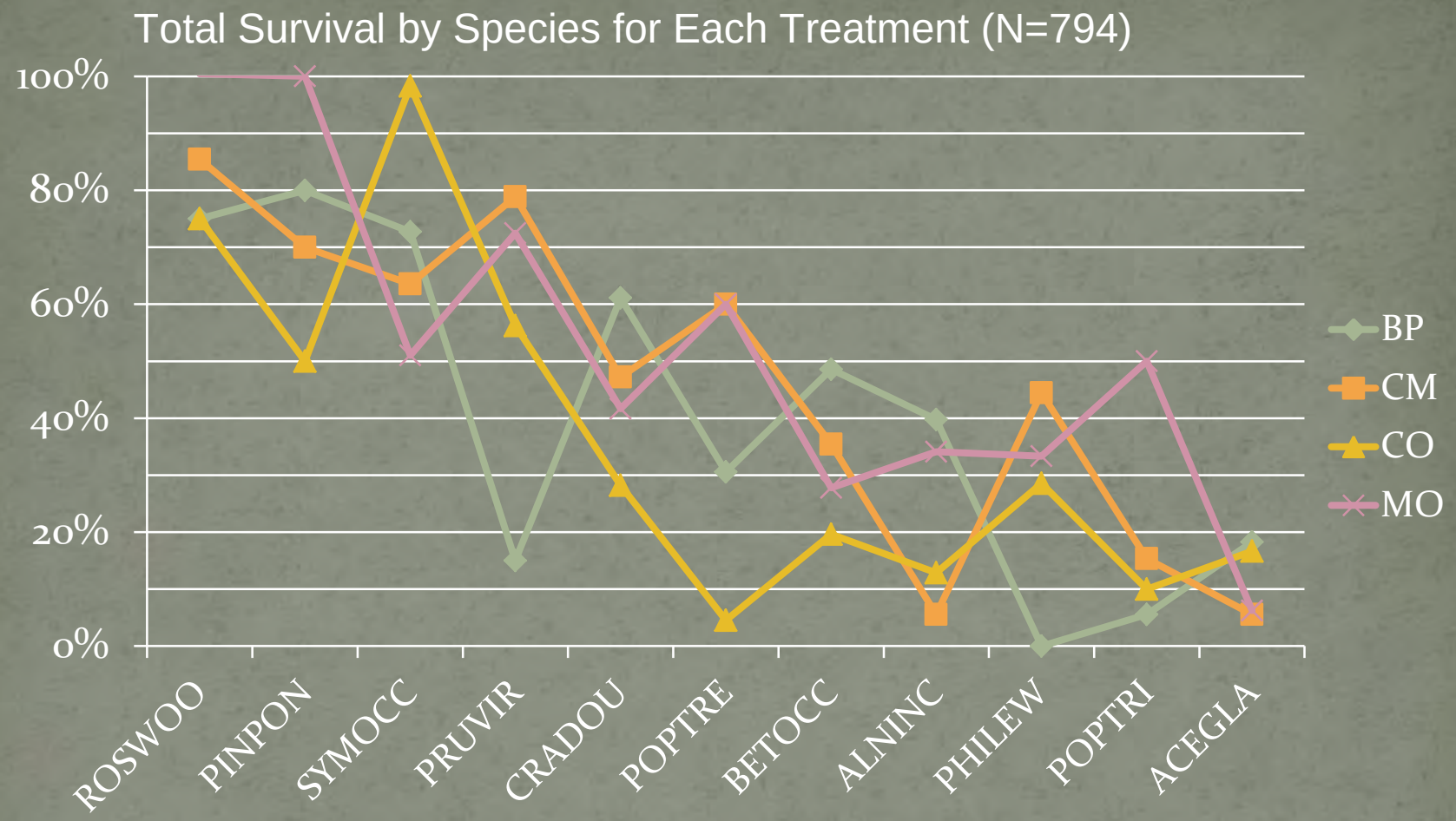
Disturbance Regime

- Initially, we were designing restoration treatments to address the existing static condition based on a modified disturbance regime
- Our response was to address the local symptoms of this modified disturbance regime:
  - restore organic matter,
  - limit weed competition and
  - facilitate establishing native woody riparian vegetation in the floodplain
  - no modification of topography or substrate

Addressing symptoms of modified disturbance regime—Jocko River

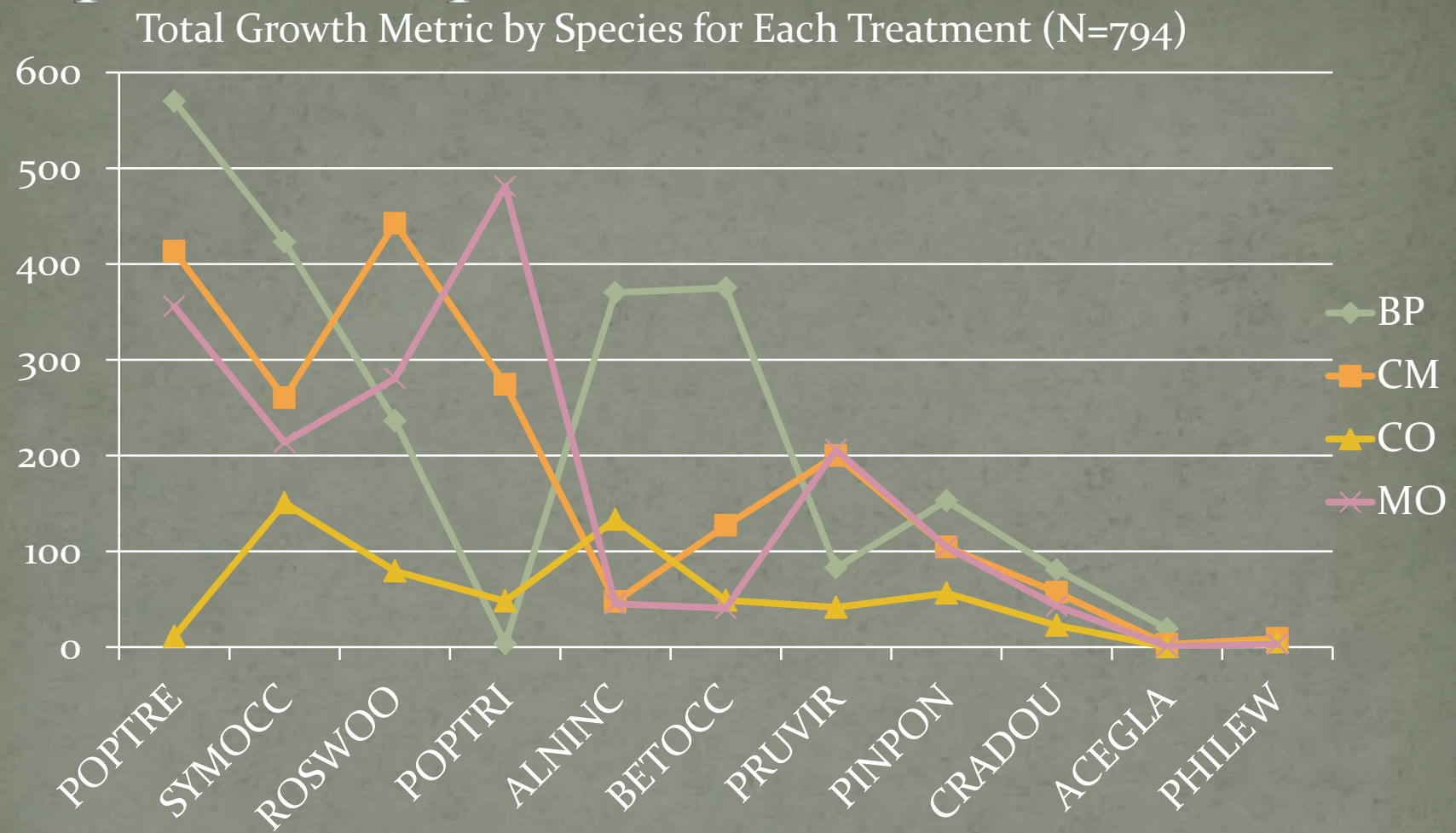
Experimental treatments addressed soil moisture, temperature, and competition from other plants

Species responses to treatments



BP = Black plastic, woven polyethylene fabric
CM = Cardboard with wood mulch
CO = Control, 3 feet square brush blanket
MO = Wood mulch only

Species responses to treatments



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Evolution of Design—Disturbance Related

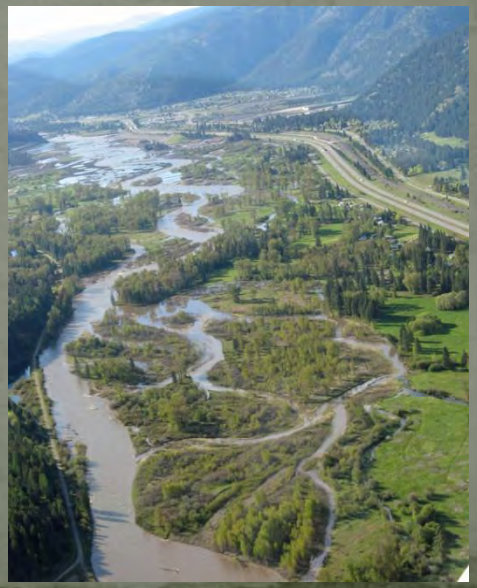
- Cease the unnatural disturbance regime
- Restore a more natural disturbance regime and simulate the conditions that would naturally result until the disturbance processes have time to create a full range of ecological niches

Disturbance Regime

- Natural disturbance creates a set of conditions that can be evaluated and copied as part of restoration designs
- Riparian structure and function rely on natural disturbance regimes – i.e. scour and deposition during floods creates surfaces where cottonwood and willow seedlings can establish

Hydrologic Connectivity

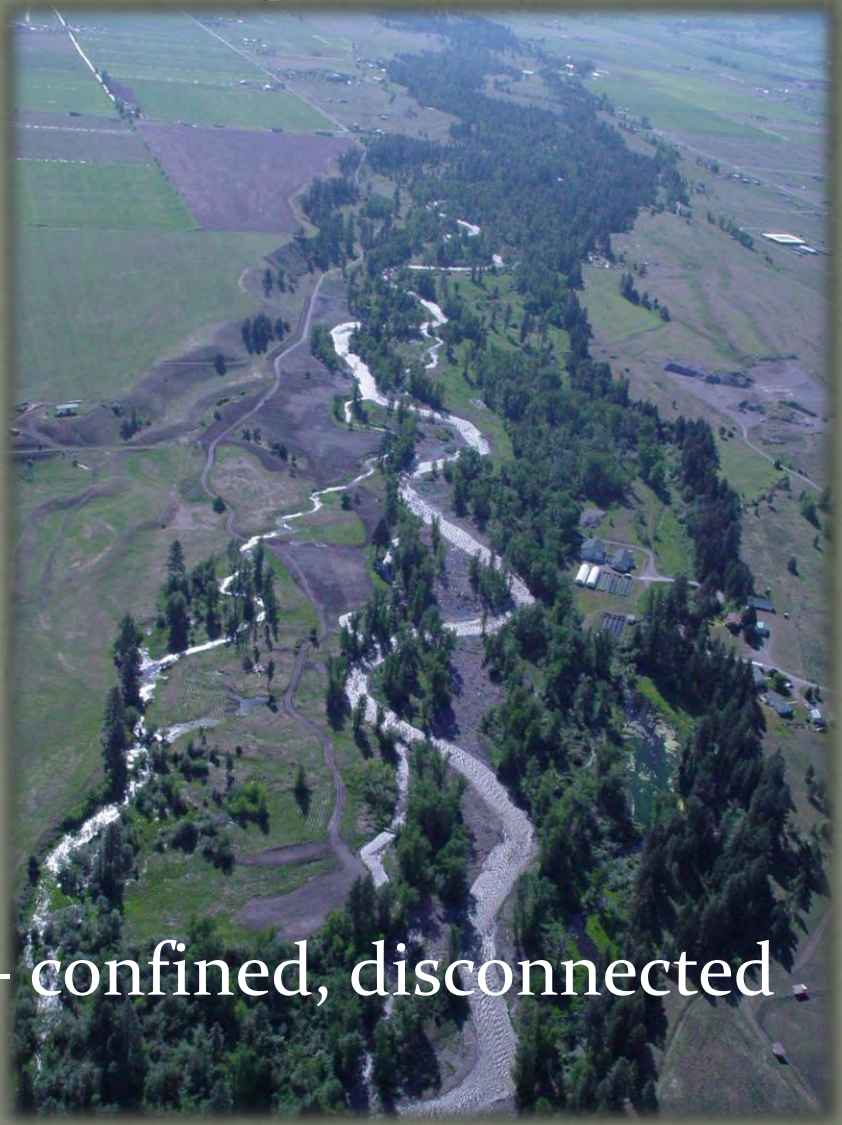
- Floodplain surface connected at frequent flood return intervals—incorporate full range of hydrogeomorphic features (e.g. oxbows, etc.)
- Topographic heterogeneity (uneven surface) to create diverse hydrology
- Timing of hydrology linked to life histories



Hydrologic Connectivity—Jocko River

- Constructed connected floodplain surface in the former channel location
- Used ‘berms’ to maintain stability
- Revised later designs to allow more free flowing connectivity in the floodplain without ‘berms’

Hydrologic Connectivity

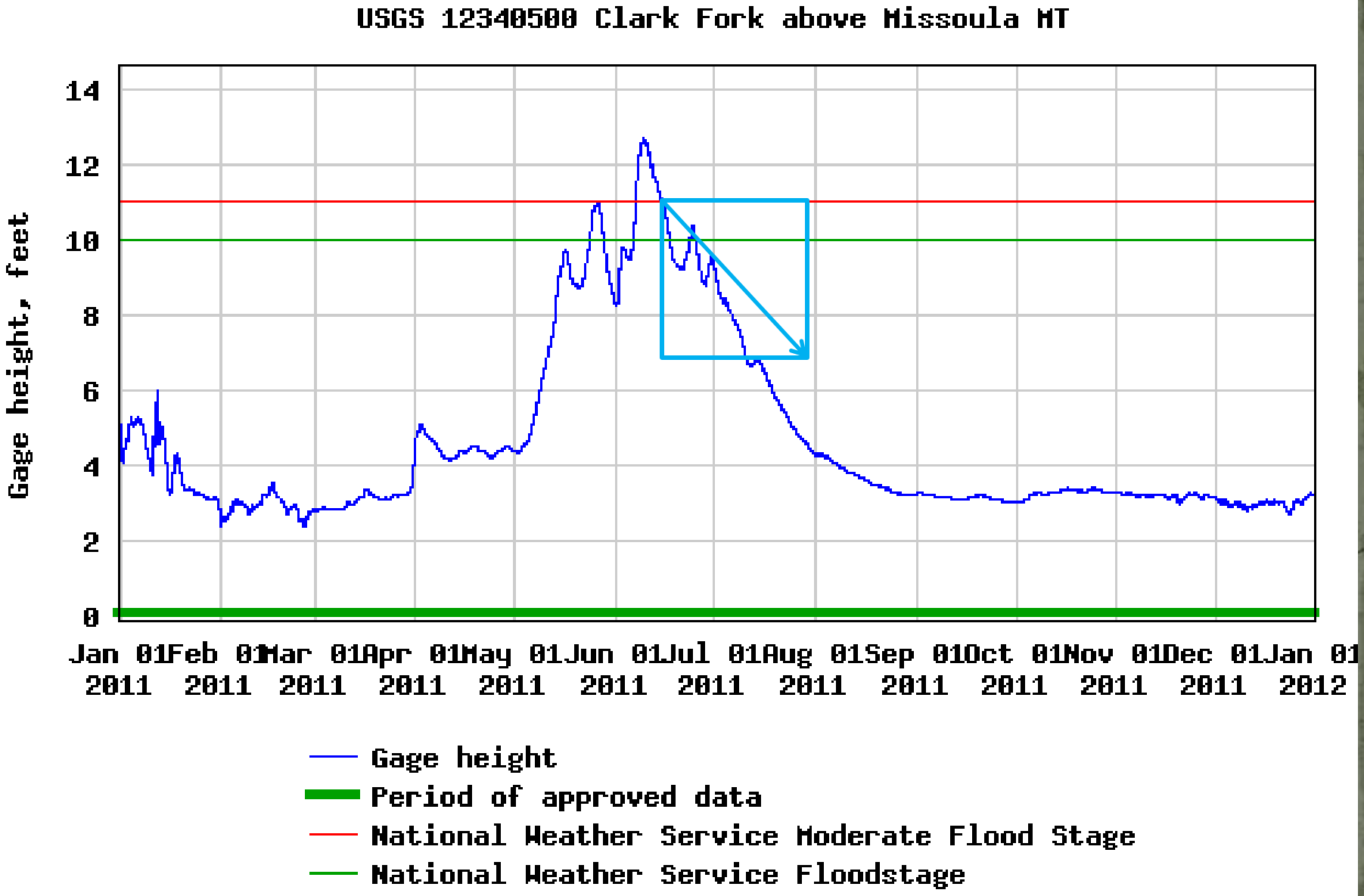


- Pre-construction (left) – confined, disconnected channel
- Post –construction (right) – connected channel and floodplain with floodplain side channels

Hydrologic Connectivity—Timing

Key Components of the Cottonwood Recruitment Box (Stewart Rood):

- Timing of the receding limb of the hydrograph after peak flow corresponds with the release of cottonwood seed (June to end of July)
- Flood flow recession exposes streambanks that are between 60 and 150 cm above base flow elevation at the time of cottonwood seed release (generally within 50 meters of the stream edge)
- Maximum stage decline of approximately 1 inch (2.5 cm) per day
- Capillary fringe of approximately 30 to 60 cm



Hydrograph of the Clark Fork River showing the cottonwood recruitment box described by Rood

Nutrient Transport and Storage

Influenced by:

- Hydrologic connectivity – floods
- Topography – depressions create sinks where organic materials are trapped and decay over time releasing nutrients into the soils
- Denitrification – Anaerobic conditions, bacteria convert nitrate (NO_3) to atmospheric nitrogen (N_2)

Nutrient Transport and Storage

Floodplain wetlands act as sinks to hold nutrients and organic inputs

Overbank flows deposit organic material

Nutrient transport with sediment deposition

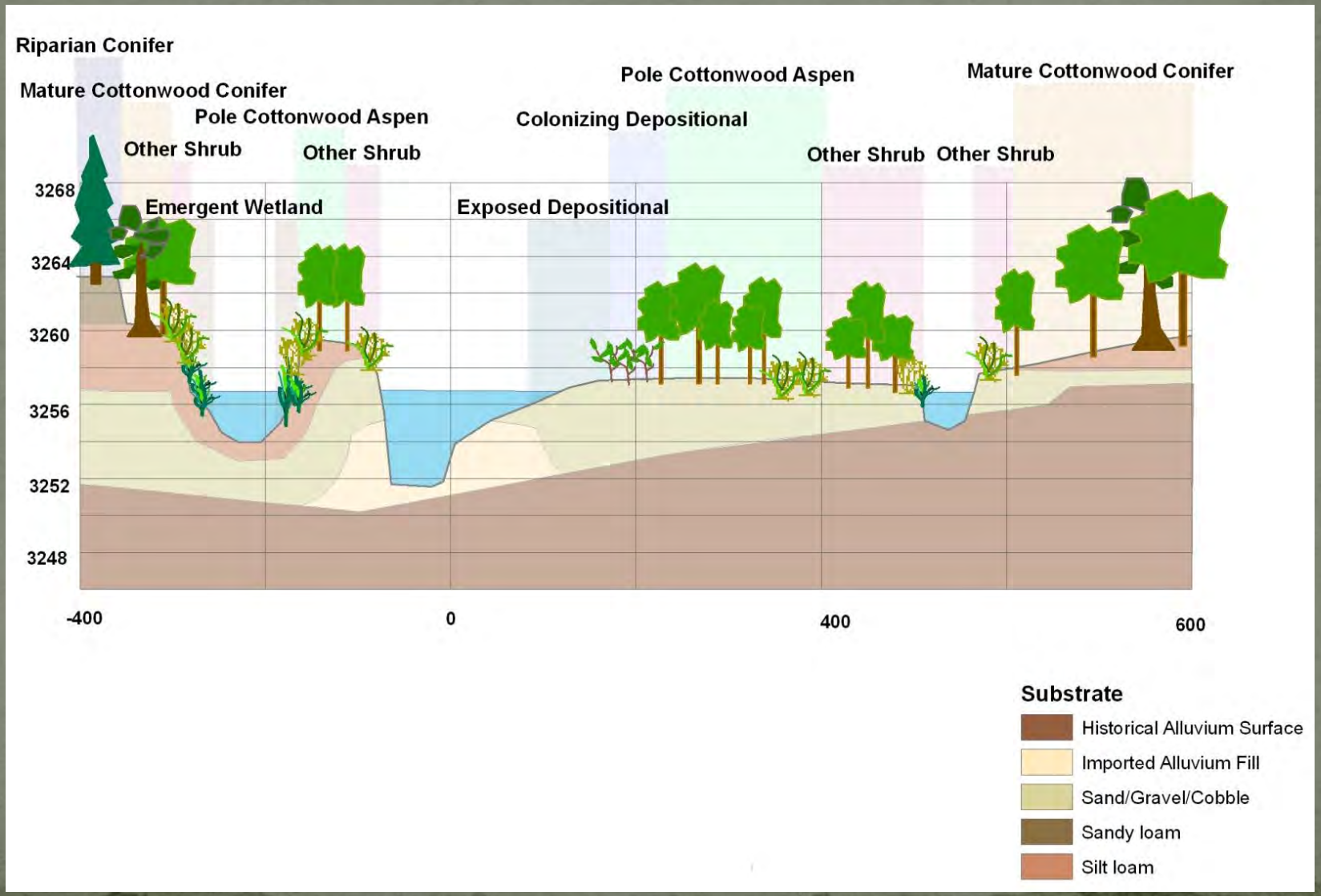
Substrate

Influenced by:

- Sediment transport (scour and deposition)
- Beaver dams—trap fine textured sediments
- Wetlands—accumulate organic matter and support peat development
- Geomorphic position, hydraulic force, and surface roughness are correlated with substrate size and distribution throughout the floodplain

Substrate

Typical floodplain substrate distribution



Substrate

Variable substrate throughout floodplain

Fine textured soil in protected floodplain swales

Coarse alluvium (cobble/gravel) on depositional features

Substrate

Revegetation Plan – substrate depth and texture

Topographic Heterogeneity

Low

Flat constructed floodplain surface planted with a large number of small size container stock

High

Constructed floodplain swales provide microsites and moisture retention for larger sized planted container stock

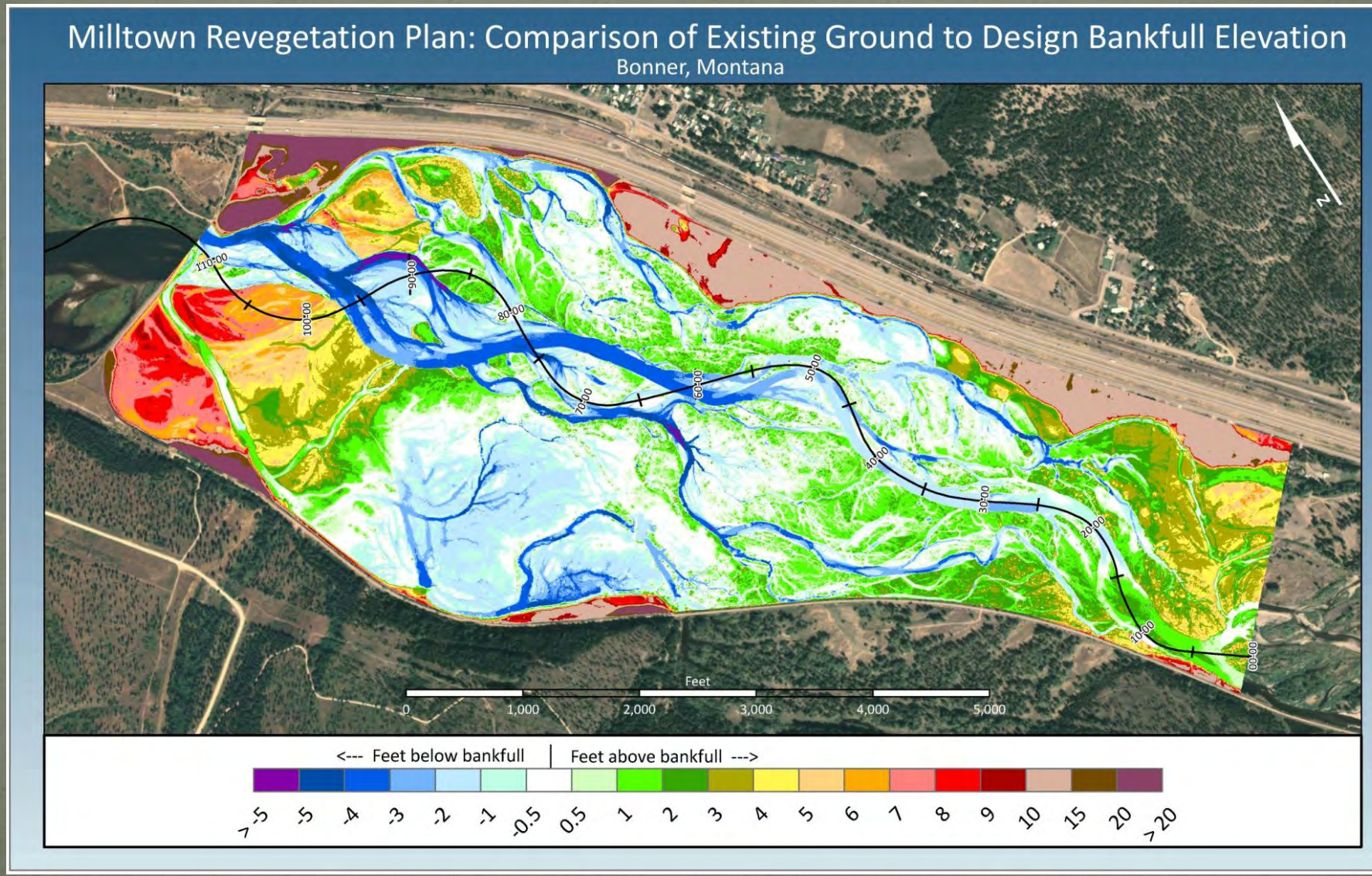
Topographic Heterogeneity

Constructed floodplain swales increase topographic diversity

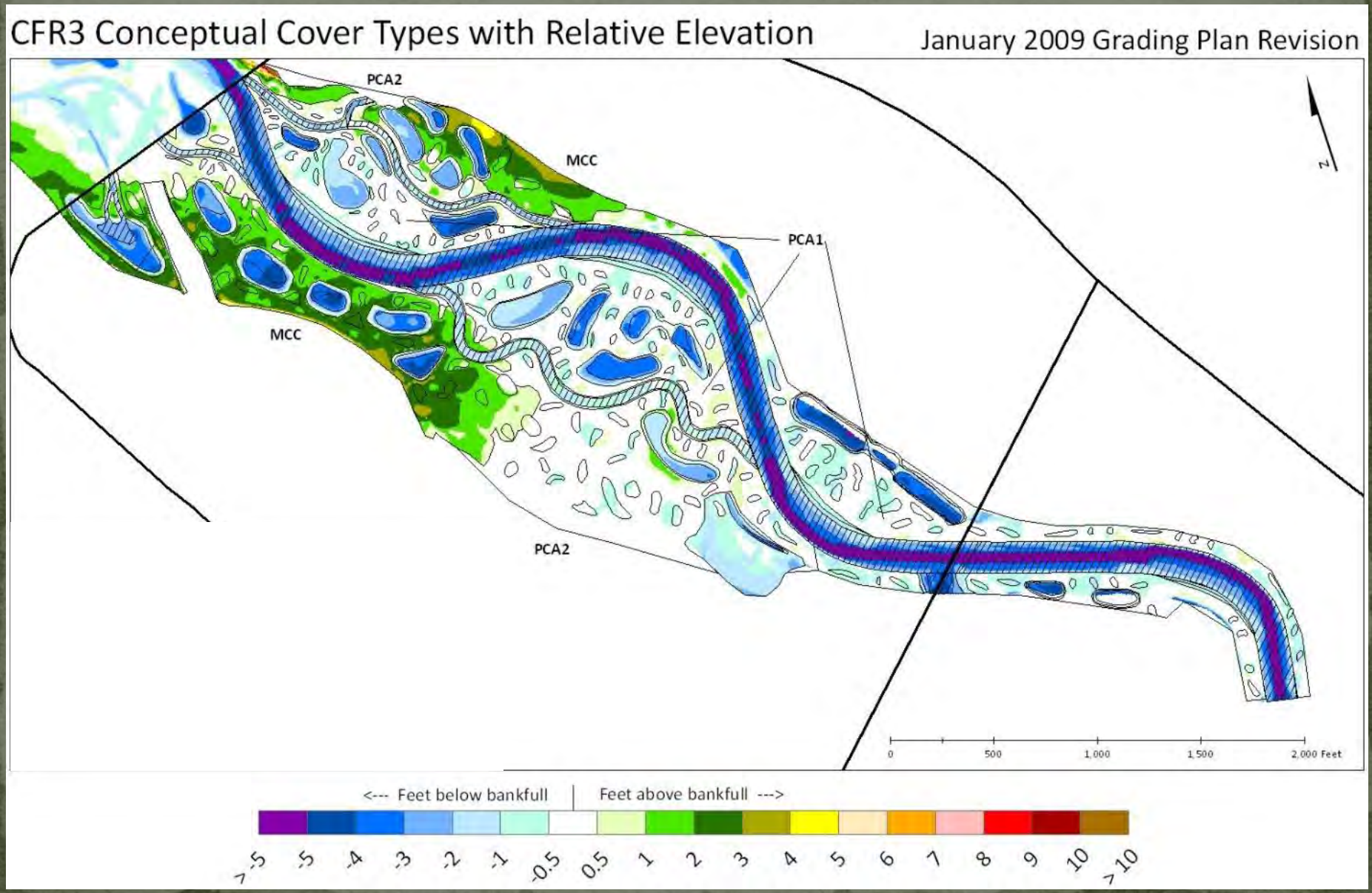
Topographic Heterogeneity

- Micro-topography promotes natural recruitment by trapping seed and protecting seedlings
- Placed large woody debris augments organic content and creates protected microsites

Topographic Heterogeneity



Topography + Substrate + Hydrology



Biological Interactions

Influenced by:

- Herbivory
- Competition from weeds and invasive plants
- Plant communities' ability to moderate their environment
- Presence and quality of seed bank

Biological Interactions

Beaver herbivory

Wildlife browse (herbivory) and competition from noxious weed species

Light Regime

Influenced by:

- Shade – woody vegetation canopy cover
- Patches – openings in the woody vegetation canopy structure (trees and shrubs)

Light Regime

Shrubs growing in shade near mature forest

Weedy species common in open floodplain further from mature forest

Attributes of Floodplains

- Disturbance regime
- Hydrologic connectivity
- Nutrient transport and storage
- Substrate
- Topographic diversity
- Biological interactions
- Light regime

Revegetation Treatments

Hydrologically connected floodplain

Microtopography and woody debris placement

Mature shrub salvage and transplant

Browse protection

Upper Clark Fork River Phase 1 Riparian Revegetation Design

Purpose—Reconnect floodplain to support self-sustaining, dynamic mosaic of native riparian plant communities.

Design components include:

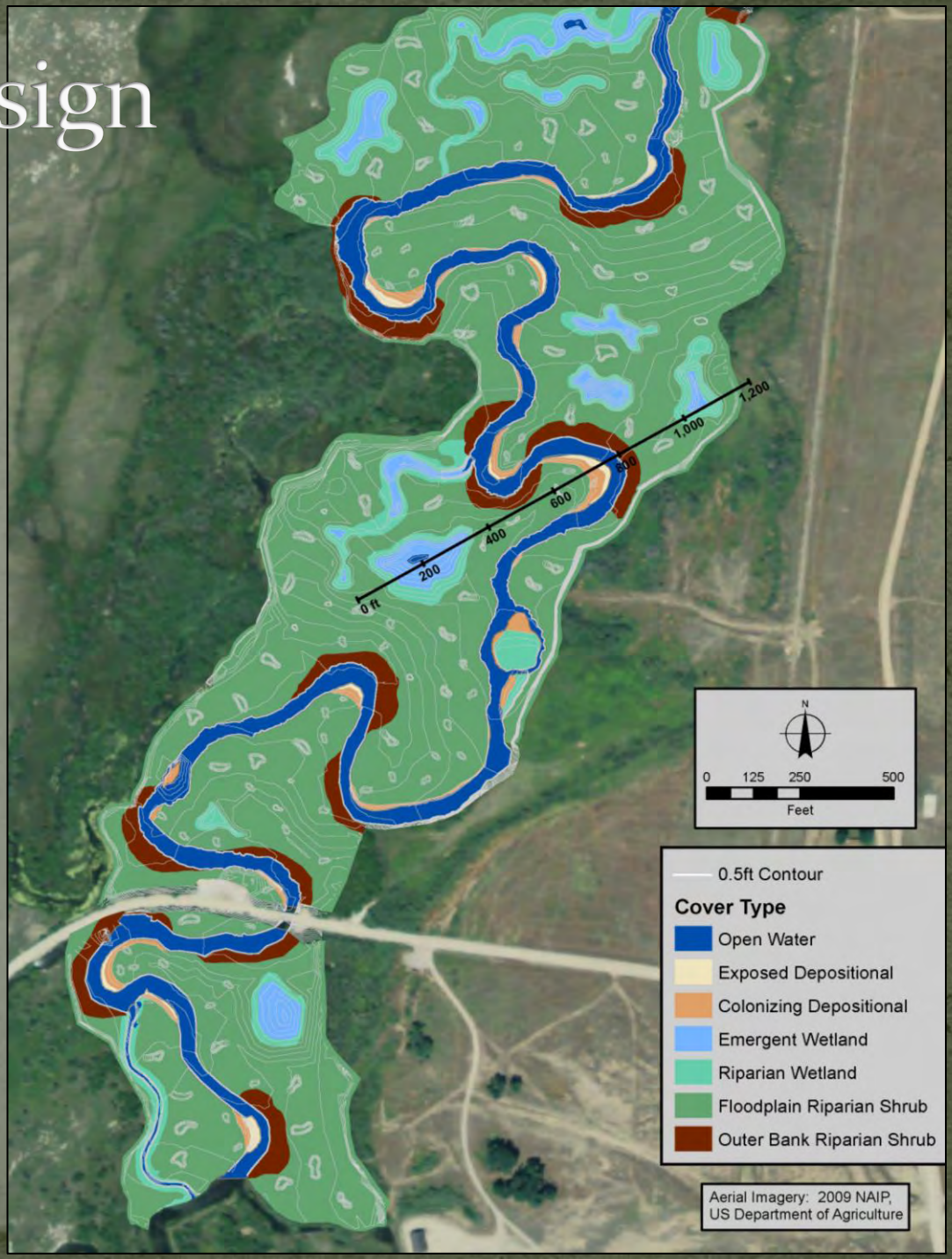
- Remove tailings that have raised and disconnected the floodplain from Clark Fork River hydrology
- Reconstruct the floodplain including diverse geomorphic features with varied elevations, wetlands, plant communities, side channels, oxbows, and micro-topography

Design Revegetation Cover Types

- Exposed depositional
- Colonizing depositional
- Riparian wetland
- Floodplain riparian shrub
- Outer bank riparian shrub
- Emergent wetland

Revegetation Design

Design plan view of revegetation cover type layout in the floodplain



Revegetation Design Criteria

For each Cover Type identify the following criteria:

- Geomorphic feature: location of the cover type within the floodplain
- Flood dynamic: anticipated return interval for overbank flooding
- Distance to groundwater
- Elevation: relative to the two-year flood return interval
- Soil texture: range of textures that can support desired plant communities
- Soil depth: over alluvium
- Target ecological types: reference plant communities

Revegetation Design Criteria

Colonizing Depositional Cover Type	
Geomorphic feature	bankfull channel
Flood dynamic	1 to 2 year return flow
Distance to groundwater	0 to 3 ft
Elevation	At or 1 ft below 2 yr flow stage
Soil texture	Sandy loam to coarse gravel/cobble
Soil depth	0 inches over alluvium
Target ecological type	Sandbar willow community type

Revegetation Design Criteria

Riparian Wetland Cover Type	
Geomorphic feature	bankfull floodplain, connected wetlands, oxbows, side channels
Flood dynamic	1 to 3 year return flow
Distance to groundwater	0 to 3 ft
Elevation	At or 2.5 ft below 2 yr flow stage
Soil texture	Silt to sandy loam overlaying alluvium
Soil depth	12 inches over alluvium
Target ecological type	Willow/herbaceous habitat types

Floodplain Design

Design cross-section of revegetation cover type layout in the floodplain