Overview

Technical Team Update

- Data collection & analysis to date
- Nature of the technical challenge
- Present early concepts

Overview of Technical Team Update

Data collection & analysis to date:

- Investigated reports on historic presence of trees
  - Drastic temporal variability
  - Observations of trees and no trees are both are right – over time
- ***Unique and complex river/riparian system!***
- But how does this guide viable restoration alternatives…
- H&H, geomorphic, and ecological analyses direct targets
- Remaining data needs & uncertainty:
  - Hydrologic analysis & topographic data pending
  - Uncertainty will remain due to changed/changing system

Overview of Technical Team Update

Nature of the technical challenge:

- Hydromodification – drawdown reduces available water – climate change
- Dam is a major impact on the landscape
- ***Geomorphic effects of these changes mean some desired options are not sustainable***
- Competing water needs – technical solutions cognizant (constraints; localized changes)

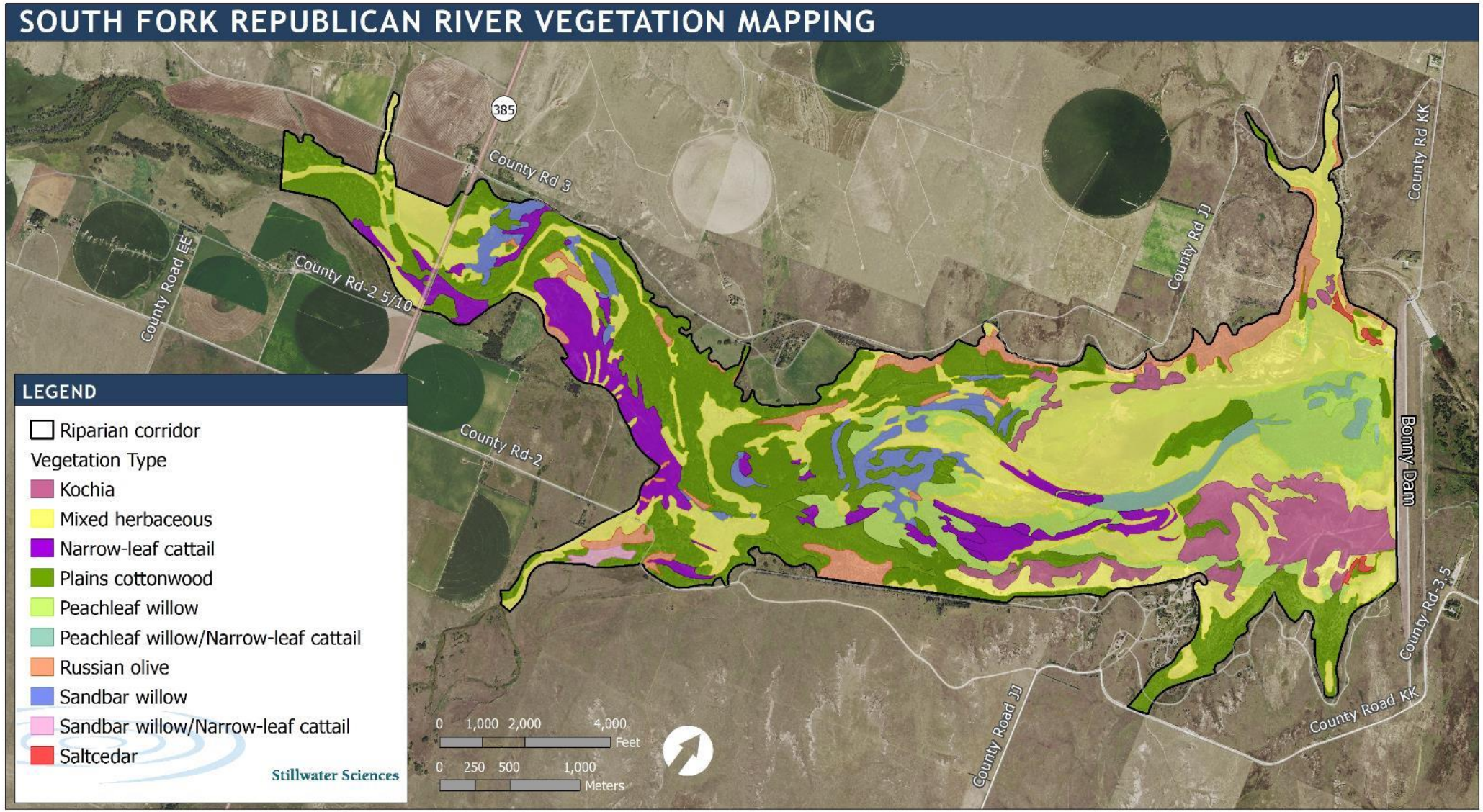
Present early concepts for what is possible:

- Meet restoration goals AND balance all needs

Data Collection and Analysis

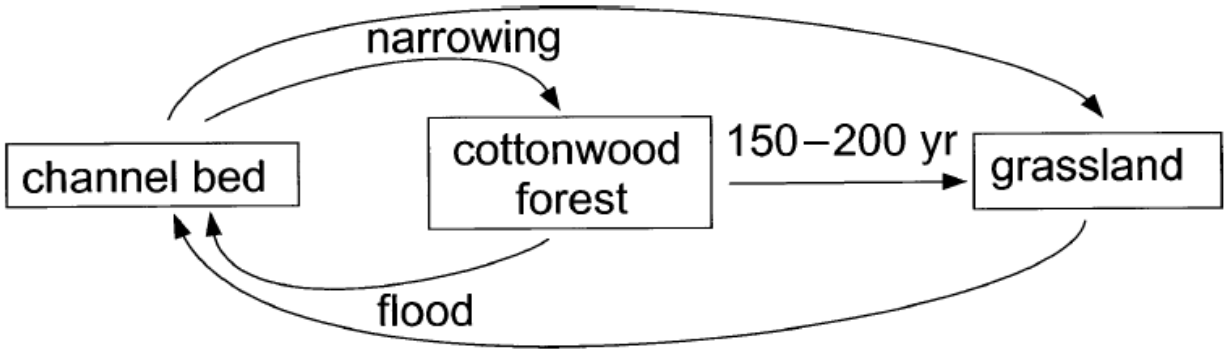
- Vegetation mapping
- Shallow soil sampling
- Historical flooding
- Riparian forest dynamics/history
- Surface and groundwater hydrology
- Species and habitats of concern

SOUTH FORK REPUBLICAN RIVER VEGETATION MAPPING



Riparian Forest Dynamics

- **Great Plains riparian forests are dependent on cycles of physical disturbance**
  - Required for seedling establishment
  - Without recruitment the cottonwood trees die off after 150 – 200 years (Friedman and Lee 2002)



Source: Friedman and Lee 2002

- **Flood events, subsequent channel narrowing, and channel meandering produce cottonwood regeneration sites in the Great Plains (Friedman et al. 1997)**
- **The mature cottonwoods along the SFRR became established during two to three decades of channel narrowing following the 1935 flood (Katz et al. 2005)**
- **Very little cottonwood recruitment was observed upstream of the old reservoir bed.**

Ecological Opportunities and Constraints

Opportunities:

- Restore natural processes (conservation action identified in Colorado State Wildlife Action Plan [CPW 2015])
- Creation of new river channel with connection to upstream channel
- Enhance native riparian forest for wildlife corridor
- Creation of wetland ponds for waterfowl, native amphibians, and other native species (depending on available hydrology).
- Invasive plant species management/removal in old reservoir bed, creating/enhancing habitat value for native wildlife

Constraints:

- Uncertainty regarding current and future (i.e., with restoration) shallow groundwater hydrology
  - Current: shallow groundwater depth unknown, but likely varies seasonally
  - Future: Potential for localized lowering of shallow water table
  - Future: Potential changes to plant communities and extent of wetland area
- Current and future topography – especially relative elevation of floodplain/terrace – controls suitability for native riparian vegetation

Habitat Restoration

Riverine Aquatic:

- Creation/enhancement of river channel in old reservoir bed
- Example fish species that would benefit
  - Brassy minnow (State threatened)
  - Orangethroat darter (State special concern)
  - Stonecat (State special concern)

Native Riparian Forest:

- Targeted invasive species removal
- Creating opportunities for passive recruitment of cottonwoods
- Targeted riparian plantings if necessary to stabilize newly constructed streambanks
- Restore vulnerable and imperiled plant communities

Wetland Pond Habitat:

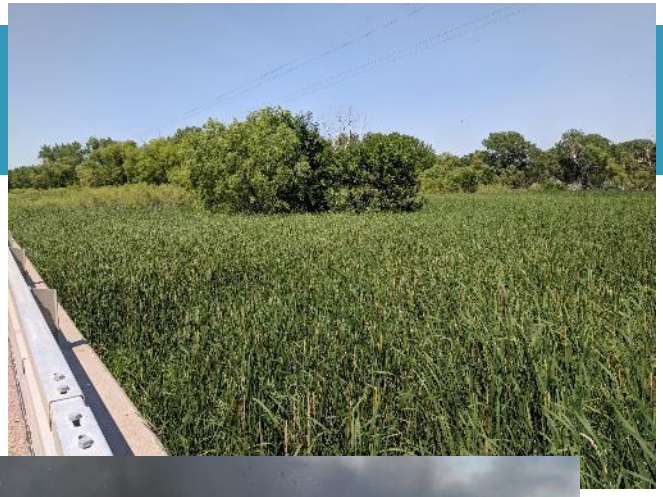
- Construction of aquatic habitat for native wildlife in strategic locations
- Example species that would benefit
  - Waterfowl
  - Northern leopard frog (State special concern)
  - Plains leopard frog (State special concern)
  - Cricket frog (State special concern)
  - Yellow mud turtle (State special concern)

Nuisance Plant Species Management

- **Cattail management** may be necessary to maintain perennial flow in restored channel
  - Cattails are proficient at trapping sediment (UMN 2016)

- **Cattail control techniques**
  - Mechanical removal
  - Cattails can be burned or mowed and subsequently flooded for effective control (submerging the cut plants) (USDA 2006; Washington State NWCB 2019; Motivans and Apfelbaum 1987
  - Without flooding, mowing after heads are well formed, followed by another mowing one month later has been shown to kill 75%
  - Chemical control has limited success, but can be one tool

- **Other nuisance plant species**
  - Russian olive: The Yuma County Pest Control District has been removing Russian olive in the vicinity
  - Tamarisk: removal is warranted while the infestation is still manageable
  - Kochia: large areas of near monoculture exist



Hydrogeomorphic Considerations Common to all Concepts

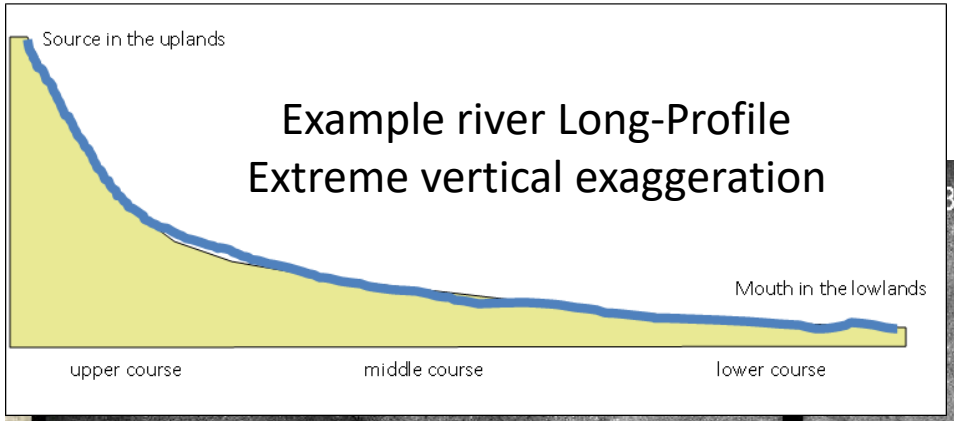
Unique System (very different from mountain/snow melt driven watersheds)

- **Smaller watershed entirely contained within high plains**
- **“Flashy” monsoon/storm driven system – low base flow with large storm peaks**
- **Abundant fine grained material mobilized by every storm event with large sediment supply from tributaries**
- **Hydromodification has resulted in reduced flow compared to pre-dam and 1960s (and beyond) well installation– limiting sediment transport capacity and water availability**
- **Low gradient channel limits shear stress needed for sediment continuity (compounded by reduced flows)**
- **Reservoir basin allows infiltration of surface water and extremely low gradient drives deposition, precluding sediment continuity through focal reach**
- **Dense vegetation within/along channel reduces flow velocity and sediment transport capacity**

A continuous channel would require: increasing channel gradient, reducing channel roughness (cattails, veg, etc.), and limiting sediment supply (or increasing hydrologic discharge)

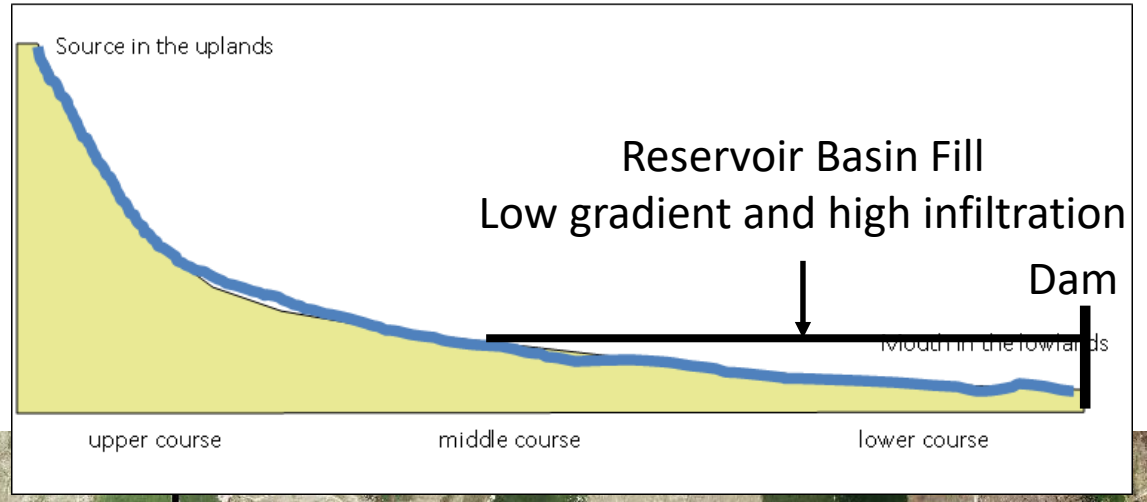
Pre-Dam River System

- Continuous channel
- Steeper gradient
- Higher discharge and volume (base and peak flows)
- Sediment continuity
- “flushing flows” to move sediment and clear channel of vegetation and debris (remove roughness and move sediment)



Existing River Conditions

- Reduced hydrology, ample sediment supply, and low gradients drive depositional problems
- Reservoir basing fill compounds depositional problems due to extremely low gradient and high infiltration (loss of base flow) that *<u>prevents formation of a continuous channel</u>*



Unknowns and Additional Data Needs

- **Hydrology – surface water, shallow ground water, evapotranspiration, water rights and compact needs**
- **Topography**
- **BOR Dam Modification Opportunities**

Reservoir Concept 1

Approach:

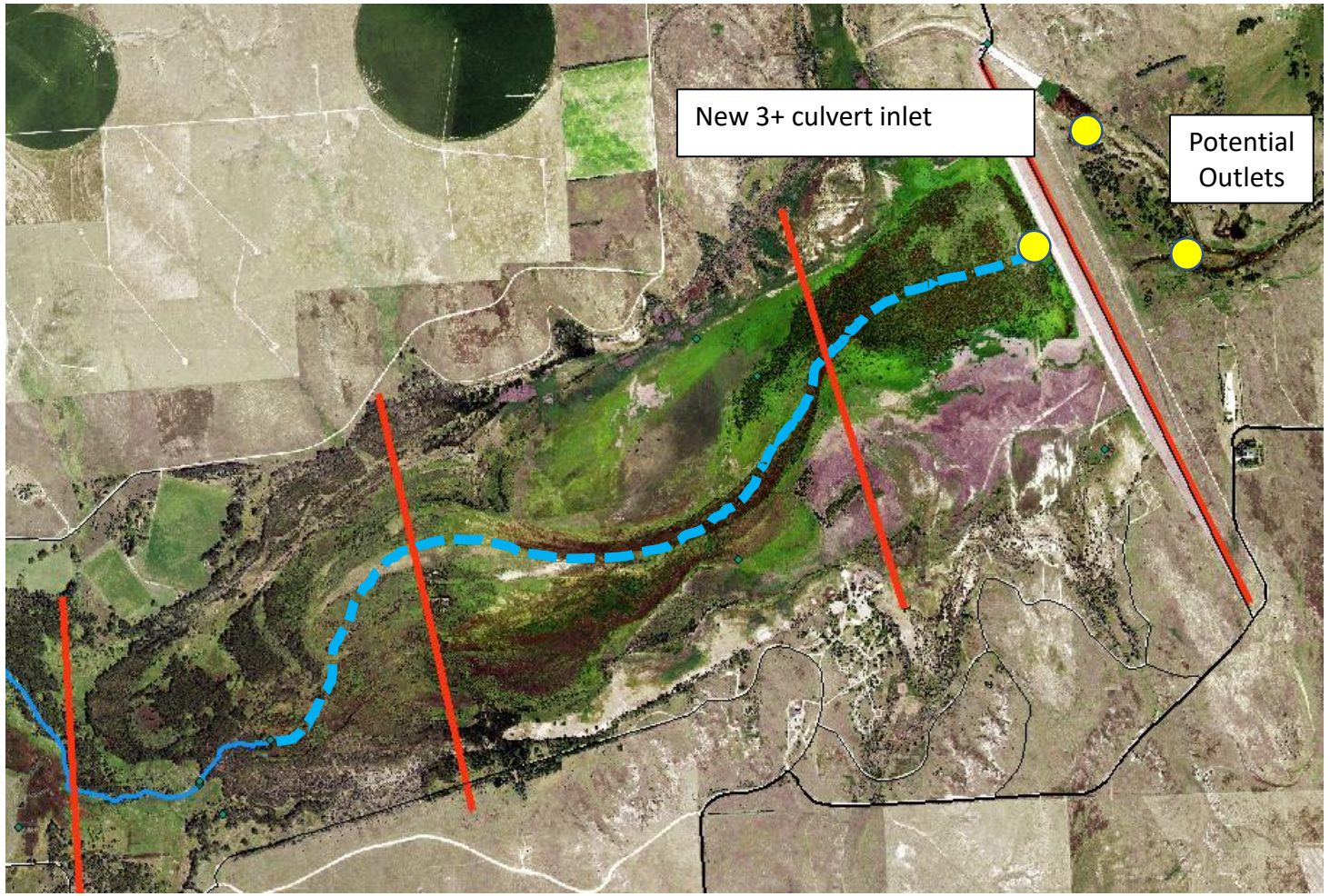
- Add multiple new culverts/pipes through dam to lower inlet/outlet elevations to increase gradient
- Reconnect pre-dam channel to downstream “undisturbed” channel

Opportunities:

- Provides perennial channel
- Hydrologic and sediment continuity
- Conveys high flow and base flow
- Culvert/pipe dimensions dictate hydrologic discharge and volume and flood mitigation
- ***Provides restoration closest to pre-dam conditions – most resilient river and riparian corridor***

Constraints:

- Significant restoration and channel work (high cost)
- Significant modifications to dam (high cost and regulations)
- Will slope and discharge be sufficient to maintain perennial channel?
- Is current/future hydrologic supply sufficient to meet downstream/compact needs?
- Will groundwater levels will drop? – concerns for existing veg/bio and farmers
- Maintenance required after flows that surpass capacity of culverts to remove deposition



Reservoir Concept 1

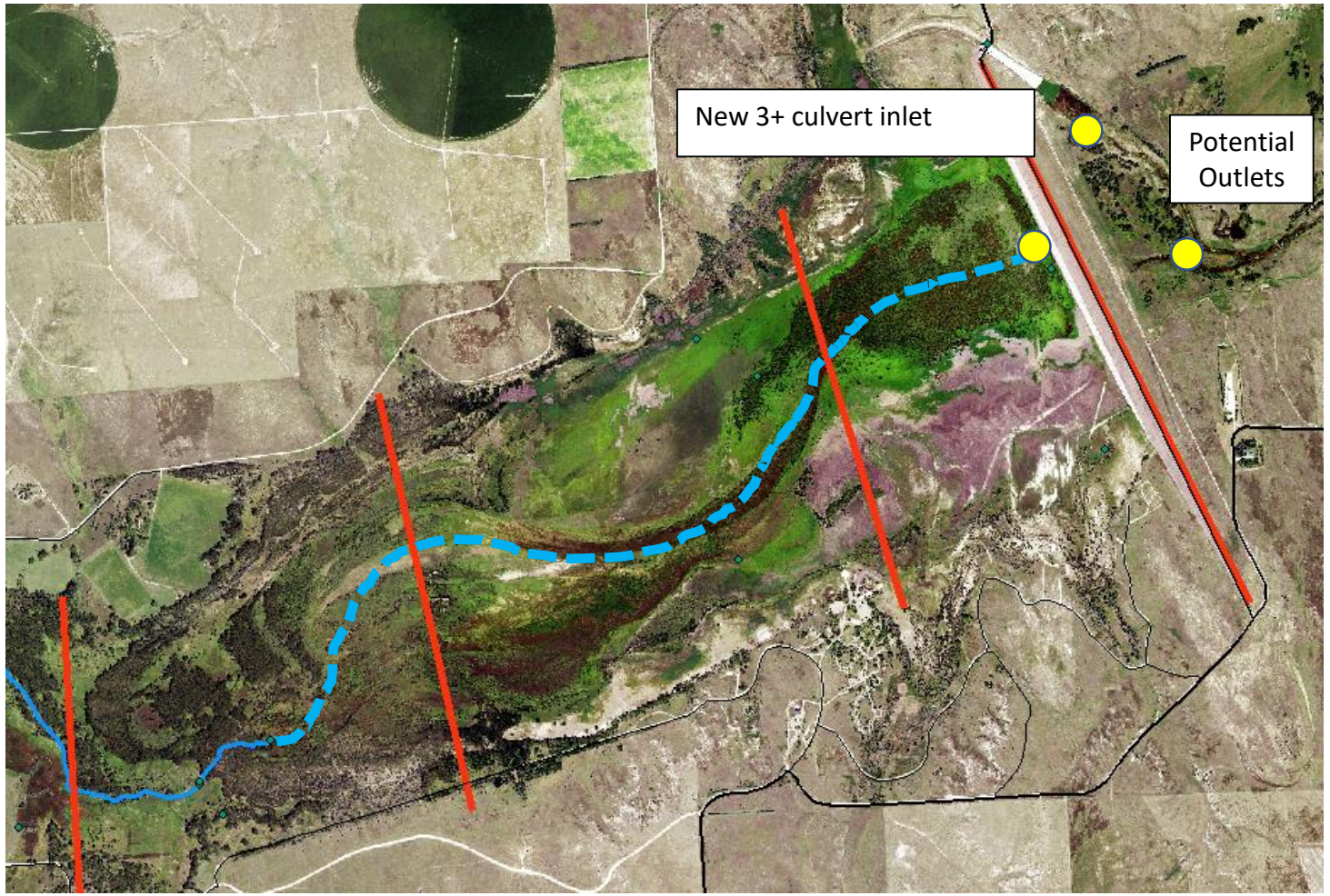
Ecological Considerations:

Opportunities:

- Provides opportunities for riparian and aquatic habitat restoration in restored river corridor
- Provides opportunities for wetland enhancement to mitigate hydrology impacts to existing wetlands
- Restores riverine habitat for native fish
- Perennial flow in restored channel (to be determined)
- Provides the best opportunities to enhance habitat for the fish and wildlife Species of Greatest Conservation Need, including several State Special Concern species
- Restores natural processes to a greater degree than other alternatives (conservation action identified in Colorado State Wildlife Action Plan [CPW 2015])

Constraints:

- Channel restoration could result in lower groundwater table and less surface water
  - Potential loss of wetland area
  - Plant community alterations (drier plant communities)
  - Possible cottonwood die-offs
- Cattail management may be necessary to maintain restored channel



Reservoir Concept 2

Approach:

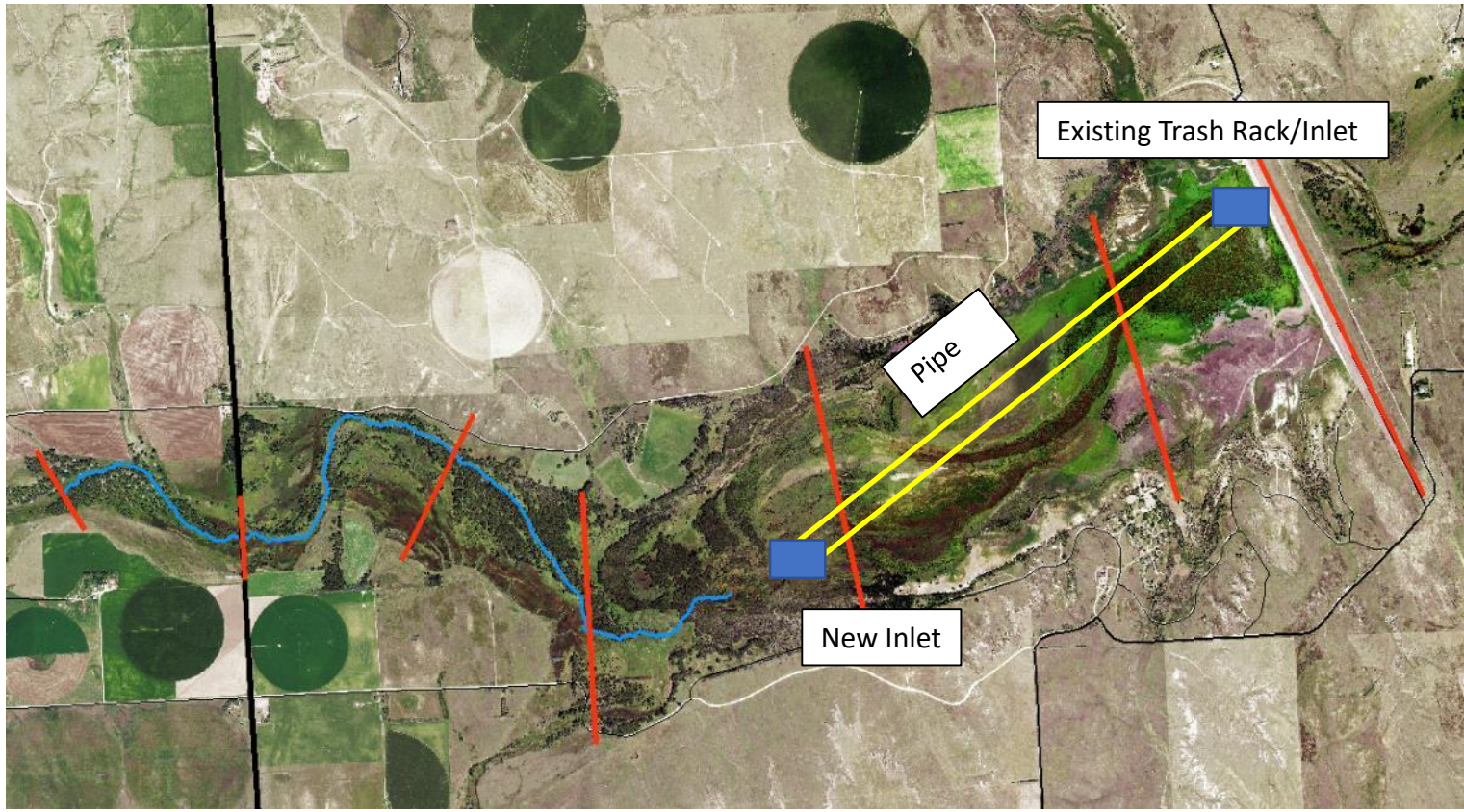
- Add additional trash rack/inlet at upstream of former reservoir where perennial flow can be maintained and pipe base flow to existing 56” pipe
- Lower existing trach rack at dam to capture high flow backwater at dam
- Provides more water downstream, but does not form continuous channel
- Enhance/restore existing perennial channel – reduce roughness and sinuosity wherever possible
- Extend perennial channel downstream

Opportunities:

- Captures base flow before it “disappears” into reservoir
- Allows high flow events to pass to provide hydrology for reservoir eco/bio
- High flow backwater captured by trash rack at dam
- Captures Both high flow and low flow
- Improves and extends existing perennial channel

Constraints:

- Are base flows significant enough to be worth capturing?
- Need to ensure the channel won’t shift away from inlet
- Increased maintenance at two trach rack sites
- Maintenance needed to prevent deposition from overwhelm inlets
- Will existing 56” – 2’ pipe conversion accommodate volume delivered and needed?
- Will not provide perennial channel and will reduce inflow to reservoir



Reservoir Concept 2

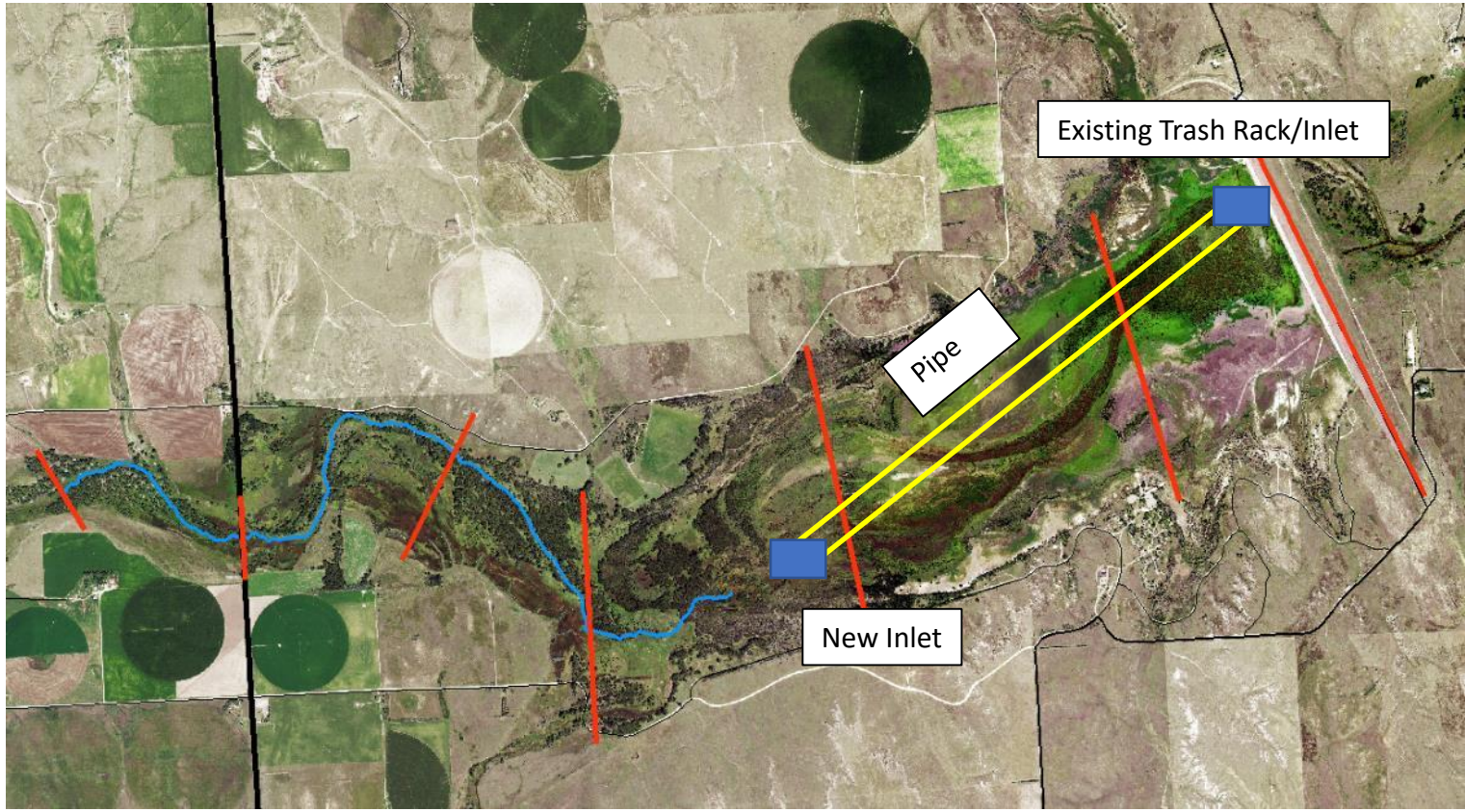
Ecological Considerations

Opportunities:

- Riverine and riparian habitat enhancement/restoration in upstream channel

Constraints:

- No defined, perennial channel
  - Precludes aquatic habitat restoration in the old reservoir bed
  - Precludes riparian habitat restoration in the old reservoir bed
- Larger alterations to groundwater and surface water than other alternatives
  - Loss of wetland area
  - Plant community alterations (drier plant communities)
  - Possible cottonwood die-offs
  - Possibly precludes creation/enhancement of seasonal wetlands or perennial waterfowl ponds



Reservoir Concept 3

Approach:

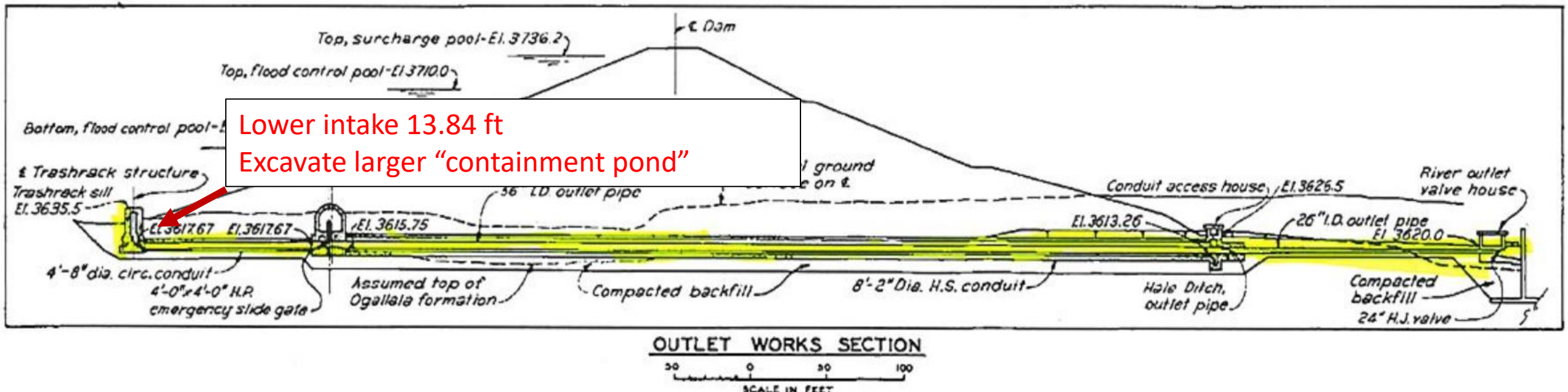
- Lower trach rack to elevation of 56” intake pipe (13.84 ft)
- Excavate surrounding area to lower back water pooling

Opportunities:

- Capture more high flow volume
- Capture back water and reduce evaporative loss
- Minimal modification (cost) to existing infrastructure

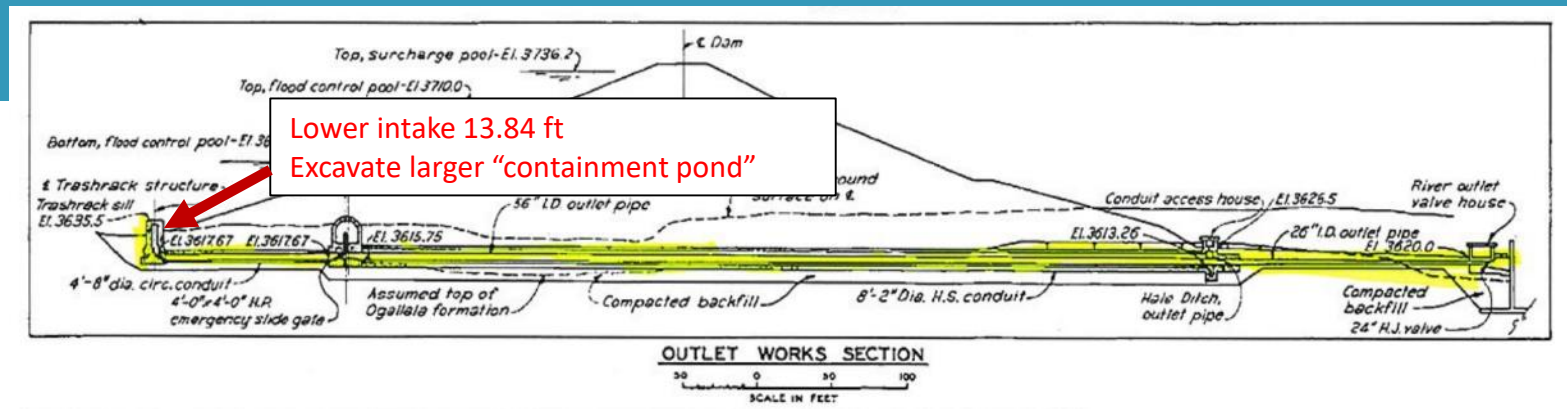
Constraints:

- Will not capture base flows (only high flow events)
- Increased maintenance to remove sedimentation
- Will deposition overwhelm inlet?
- Will existing 56” – 2’ pipe conversion accommodate volume needs?
- Will not provide perennial channel



Reservoir Concept 3

Ecological Considerations



Opportunities:

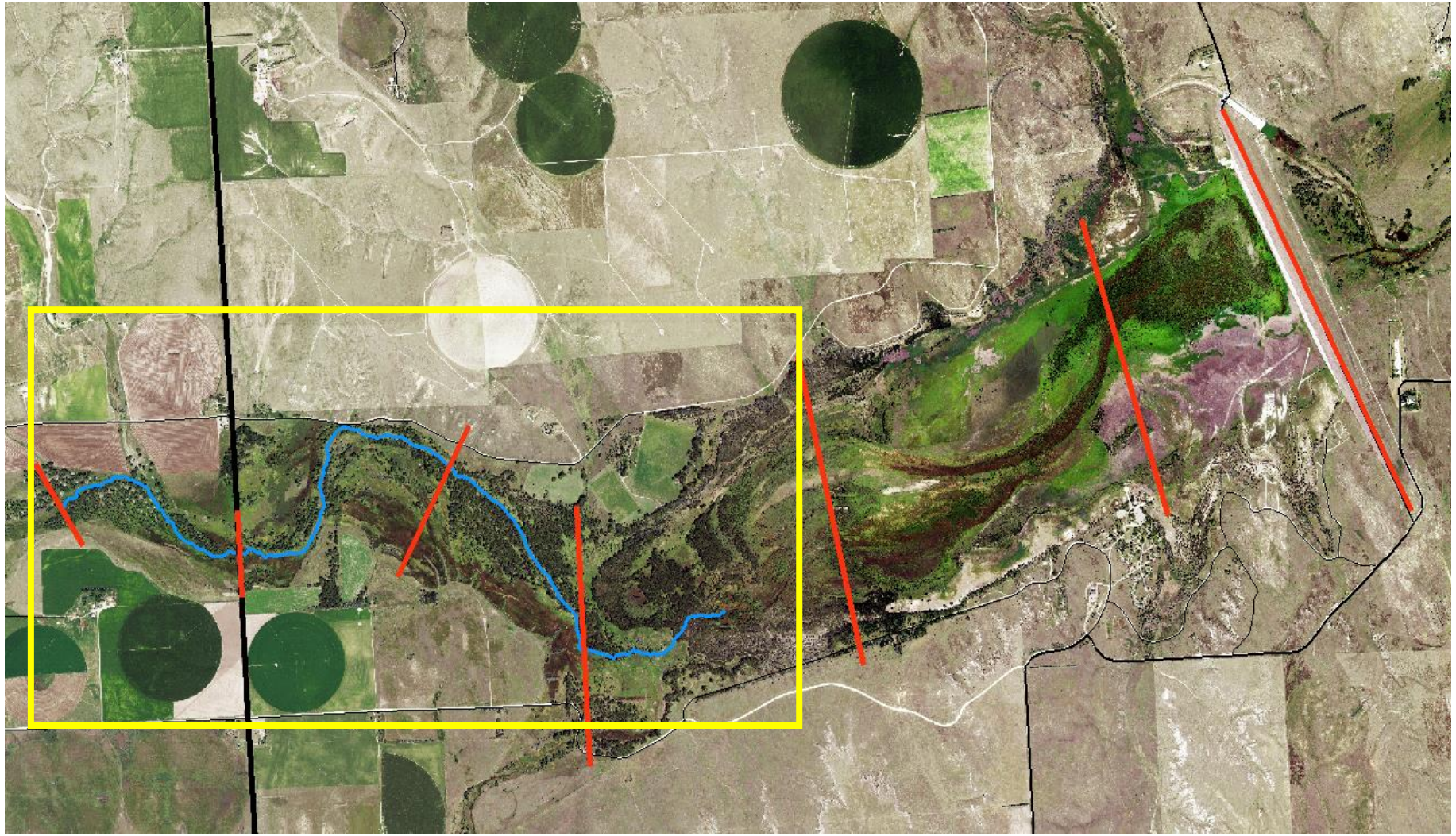
- Does not preclude future restoration/enhancement, potentially including:
  - Channel restoration
  - Aquatic habitat restoration (creating habitat for several native fish species)
  - Riparian habitat restoration (creating/enhancing valuable wildlife habitat)
- Without channel restoration, alterations to groundwater and surface water would be minimal and localized
  - Potentially less hydrology impact to existing seasonal wetlands and native mesic plant communities than other alternatives
- Maintenance of high groundwater table and seasonally ponded surface water provides opportunities for creation of seasonal wetland ponds for waterfowl, native amphibians, and other native species

Constraints:

- Would not provide a defined, perennial channel
  - No immediate creation of aquatic habitat for native fish
  - No immediate active or passive restoration of native riparian habitat (adjacent to river channel)

US 385 Concepts

Concepts focus on enhancing existing perennial channel from US 385 to former reservoir extent



US 385 Concept 1: Cattail and Invasive Species Management/Removal

- Cattail and invasive species in and along the channel increase surface roughness and lowering river velocities, which prevents clearing of vegetation and debris within the channel and adequate sediment transport to prevent excessive deposition

US 385 Concept 2: Cattail Management *and* Bioengineered Sediment Traps

- In addition to cattail and invasive species management/removal…
- Bioengineered sediment traps installed within tributaries allow water to pass while trapping sediment and preventing it from entering the main channel
- A series of offset bioengineered sediment traps located within Sand Draw is a cost effective way to limit sediment input to the main channel system
- Considering the reduced hydrologic regime, minimizing sediment supply is the best opportunity for preventing depositional issues