Reconnecting the Floodplain to Restore Flood Storage "Diagnose and Treat" Approach

Case Study: Tedesco Environmental Learning Corridor
Story County Conservation , Ames Iowa

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- ❖Geologist/Professional Wetland Scientist
- ❖20 years+ of experience in wetland science, soils, and geomorphology. She specializes in soil characterization, plant identification, and hydrological studies with an emphasis on hydrology and soil interpretations for land use planning throughout the Midwest.

SPECIALIZATIONS

- ❖Watershed & Nature Resource Planning,
- ❖Stream & Wetland Restoration,
- ❖Soils and Hydrology,
- ❖Geomorphological investigations

Shane Cherry, MS

- ❖Geomorphologist
- ❖20 years+ of experience in stream and river restoration, mitigation, watershed analysis, river process modeling and analysis, and environmental permitting.

SPECIALIZATIONS

- ❖Fluvial Geomorphology
- ❖Ecosystem
- ❖Restoration
- ❖Environmental Permitting
- ❖Mitigation
- ❖Hydrology and Hydraulics
- ❖Sediment Transport
- ❖Watershed Planning

Co-Presenters

Summary

Current Conditions of many Iowa Urban Streams

- Degraded & Entrenched - stream channels have enlarged and eroded downward in response to changes in runoff and peak flows
- Disconnected from their historic floodplains
- Relatively low-valued riparian vegetation dominated by highly invasive species

Restoration CAN

- be used as a strategic component of any basin-wide flood reduction strategy.
- Restore Flood storage
- Have greater benefits and lower cost than alternatives
- Increase Hydraulic roughness reduces downstream flood peaks
- Benefit Water Quality
- Benefit Community Health and Wellness

Stream degradation

- Often occurs in response to changes in land use and runoff volumes.
- Typical channel response includes rapid incision and channel enlargement followed by more gradual bank erosion.
- This channel response is greatest in the smaller order tributaries and contributes to sediment deposition in the larger channels downstream in the drainage network

Pre-settlement

- Infiltration – Upland Prairies and Wetlands and Riparian zone
- Detention – Wetlands in the upper watershed
- Detention – Floodplains
- Water Quality – Wetlands, natural soil and deep rooted plants.

Modern Day Iowa

- Runoff - Crop field, imperious surfaces, turf grass
- Detention – Manmade Ponds
- Water Quality – Manmade soils, filters, treatment facilities.
- Man-made infiltration practices (BMPs)

In Iowa, Restoring Urban Floodplains = Missing Link Flood Storage and Water Quality

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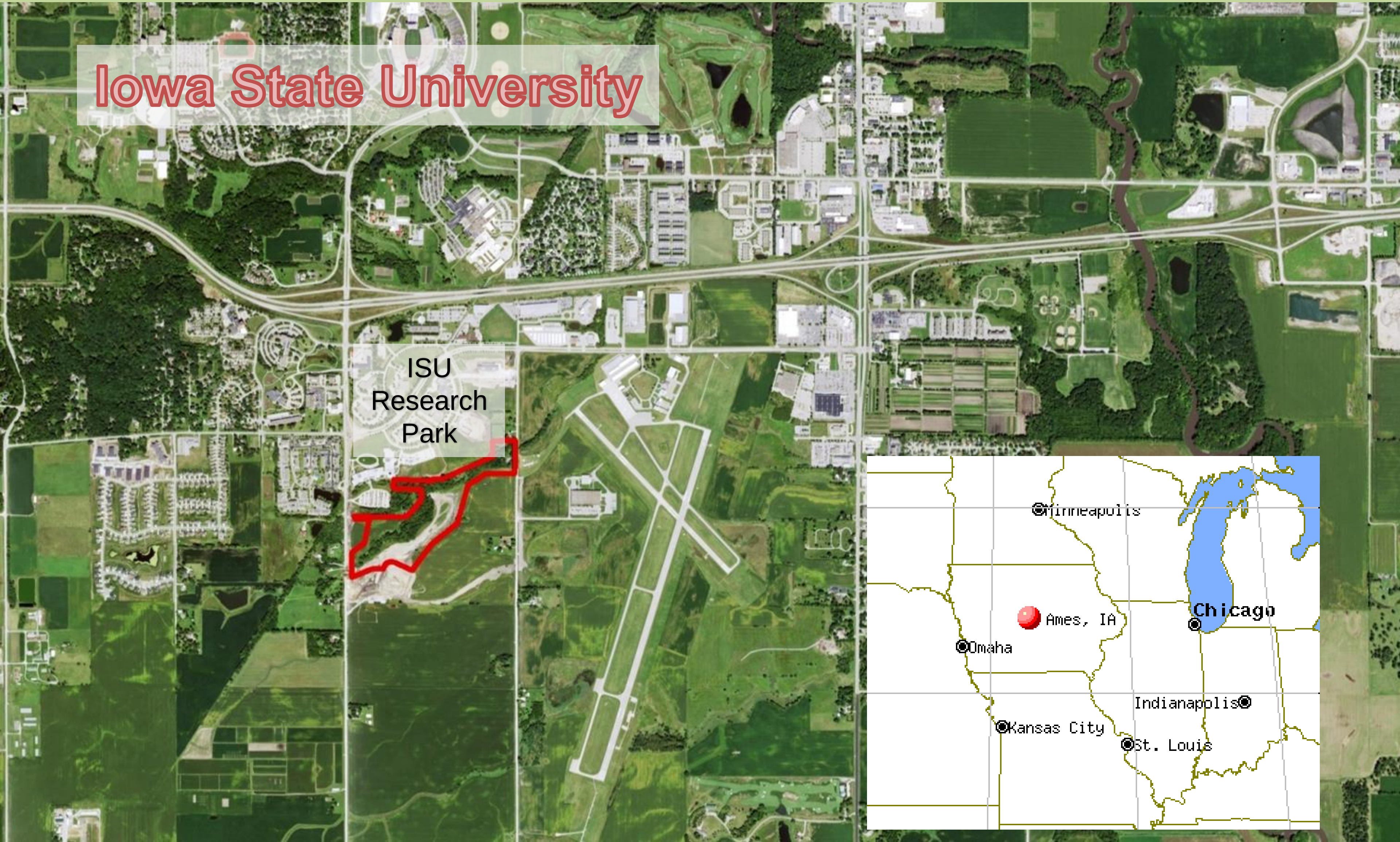
Reconnecting the historic floodplain



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Reconnecting the historic floodplain

- First County Park in City Limits
- Attract businesses
- Connect with Nature – 15 min walk business meeting
- Demonstration Site

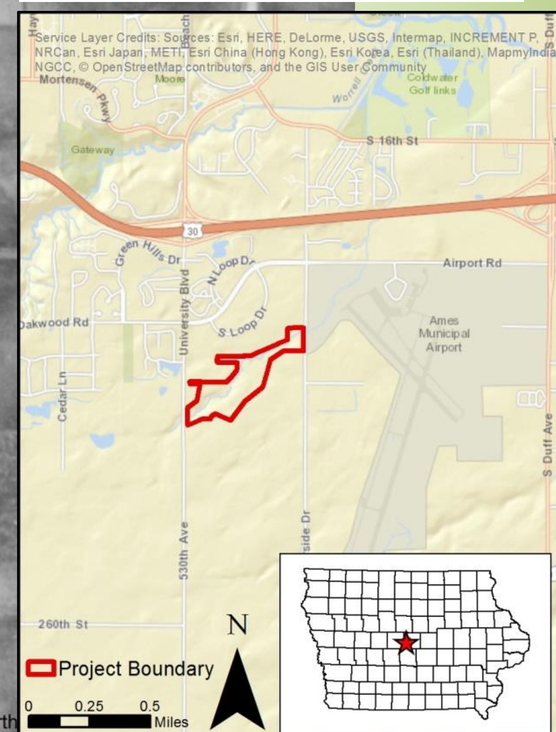
STREAM EVOLUTION

From Swale to Entrenched Stream

1875 Andreas Atlas

Prairie

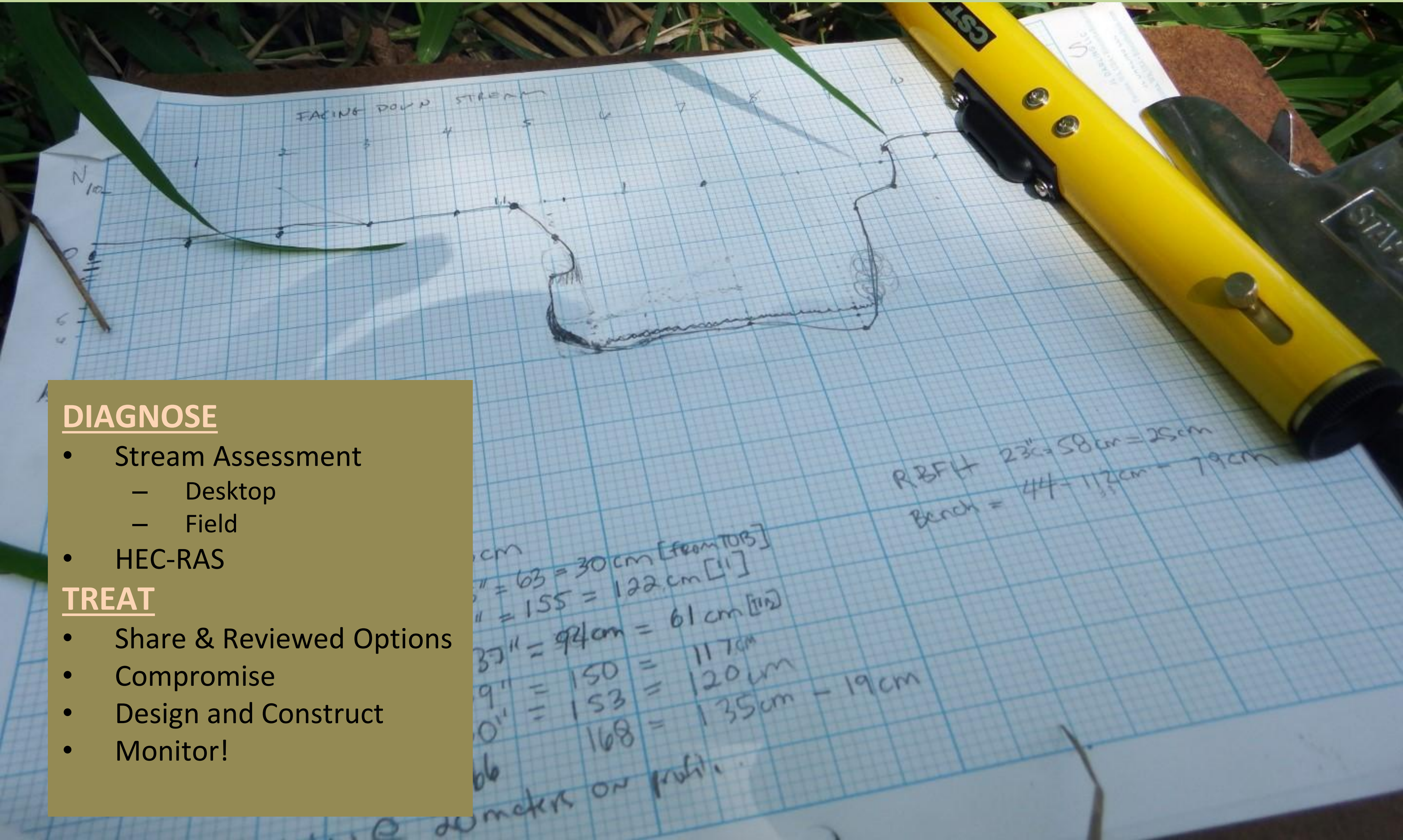
Figure 1: Location Map




2016

“Diagnose and Treat” Approach

Reading the Stream



DIAGNOSE

- Stream Assessment
  - Desktop
  - Field
- HEC-RAS

TREAT

- Share & Reviewed Options
- Compromise
- Design and Construct
- Monitor!

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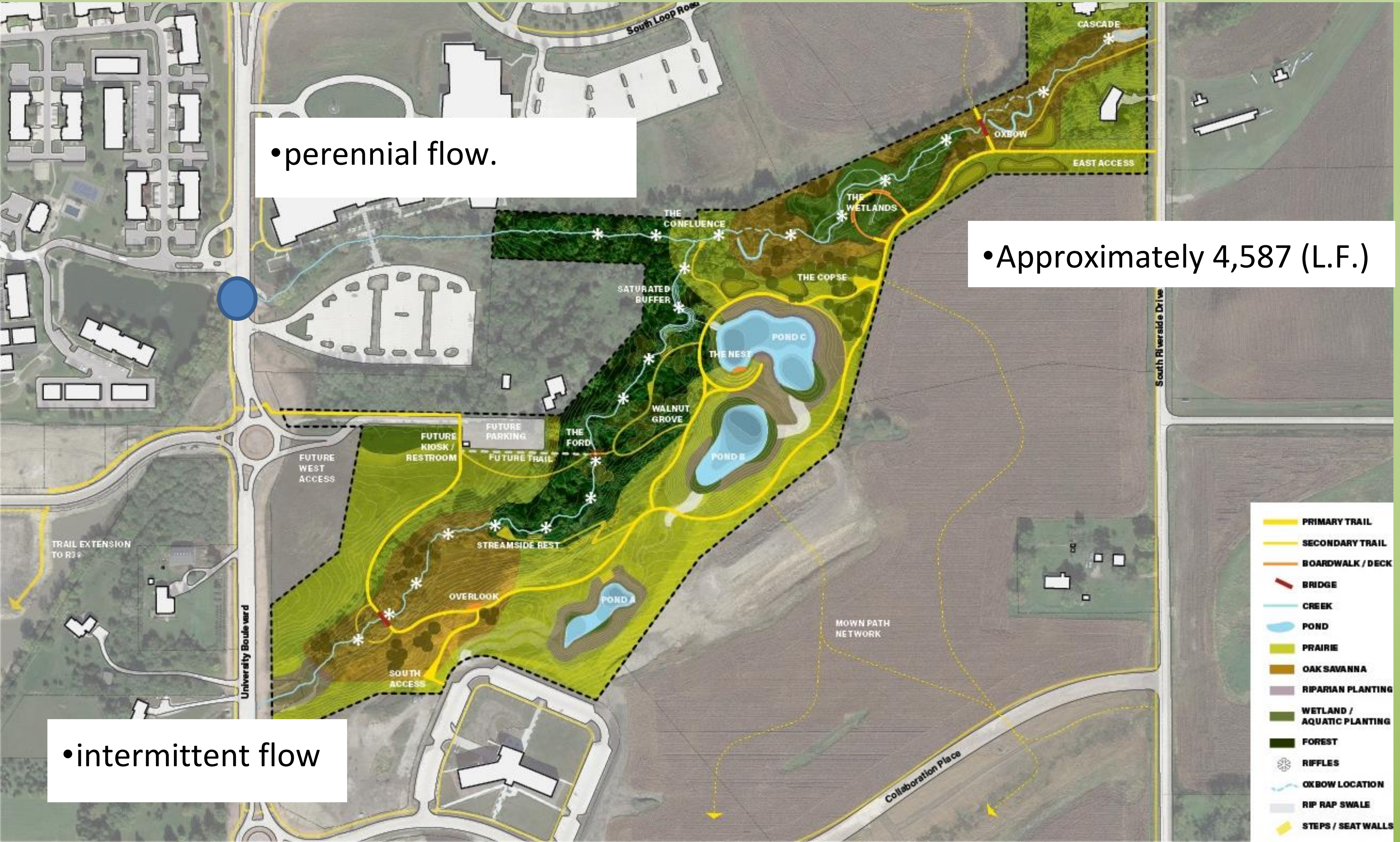
Reconnecting the historic floodplain

- perennial flow.
- Approximately 4,587 (L.F.)
- intermittent flow



Channel Morphology

- Narrow, deeply incised channel
- bank erosion
- floodplain disconnection
- Glacial till exposed in the streambed (*Downcut to Till and Widening)*
- Low gradient meandering channel with riffles and shallow pools
- Streambed composed of sand and fine gravel

Modified From Great Ecology, 2017

STREAM RESTORATION

From Entrenched Stream to Restored Floodplain

Opportunities

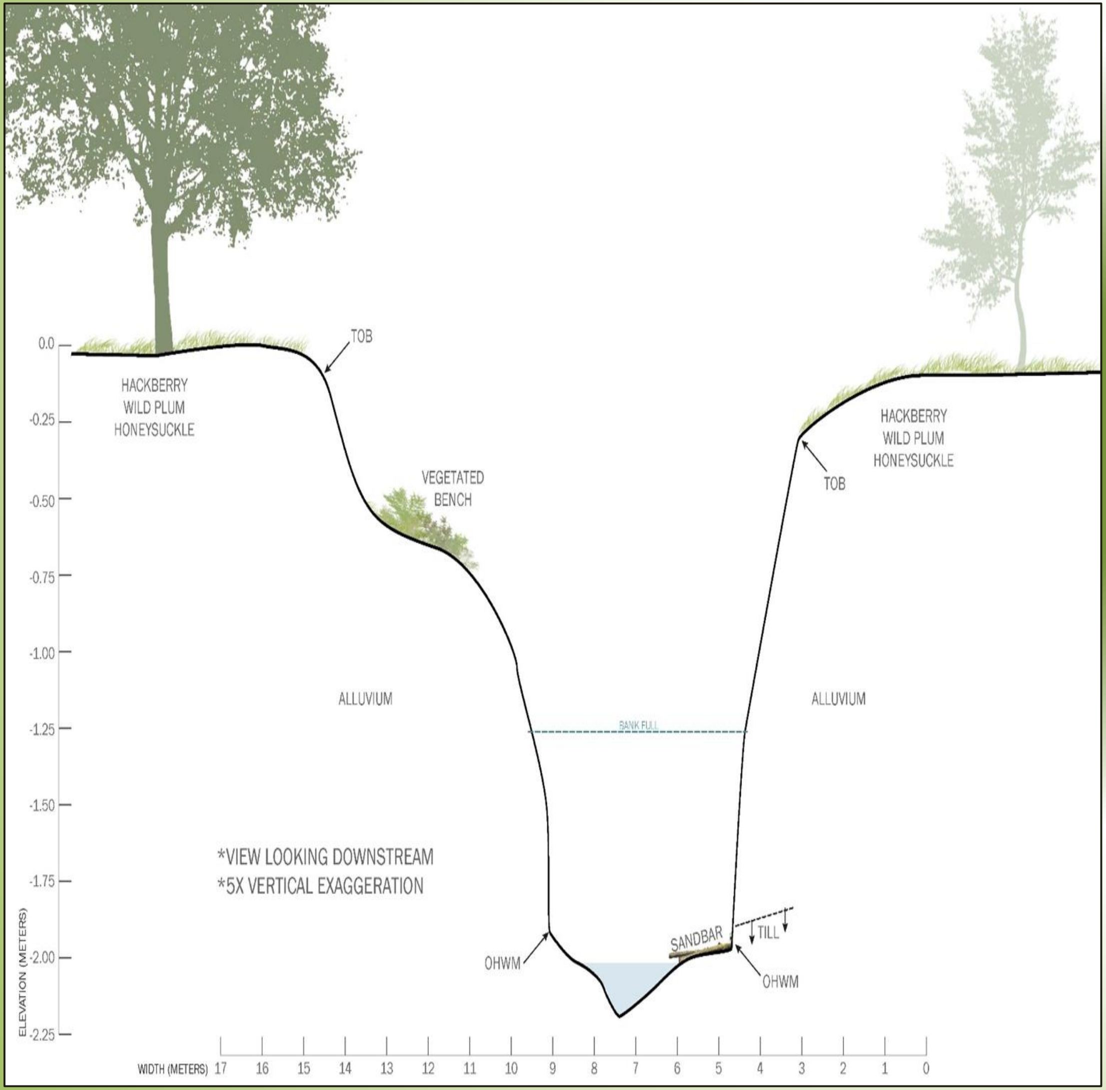
- Alter the stream bed for floodplain reconnection
- Modify existing riffles to control erosion
- Create an oxbow pond-wetland demonstration area
- Re-establish stream to shallow groundwater connection
- Create backwater pools

Opportunities

- Flexible locations for floodplain reconnection will integrate easily with park objectives
- Restore Riparian habitat by restoring floodplain hydrology
- Remove invasive species
- Re-establish prairie landscape

Modified From Great Ecology, 2017

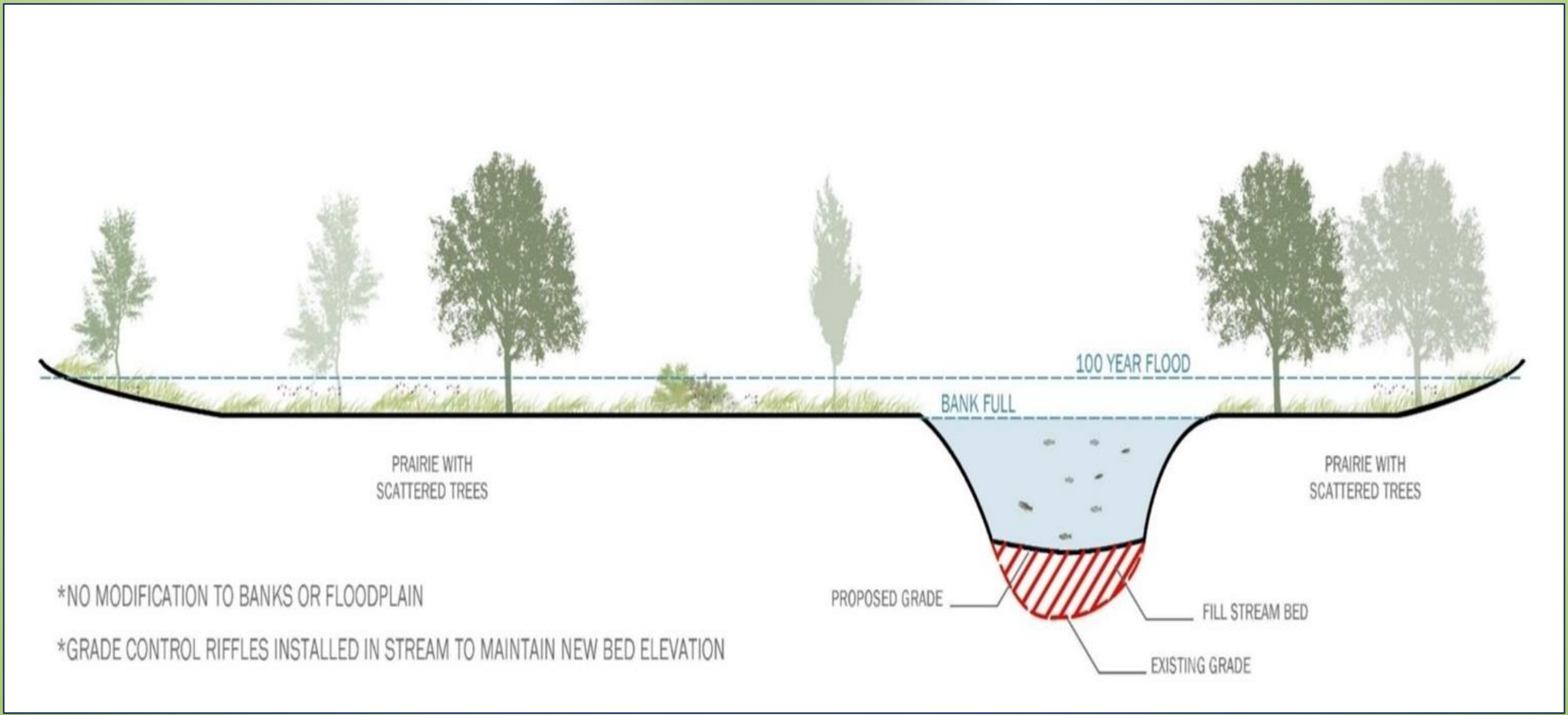
Tedesco Environmental Learning Corridor



- Place fill to raise the stream bed to reengage the existing abandoned floodplain and stabilize the streambed against future scour.

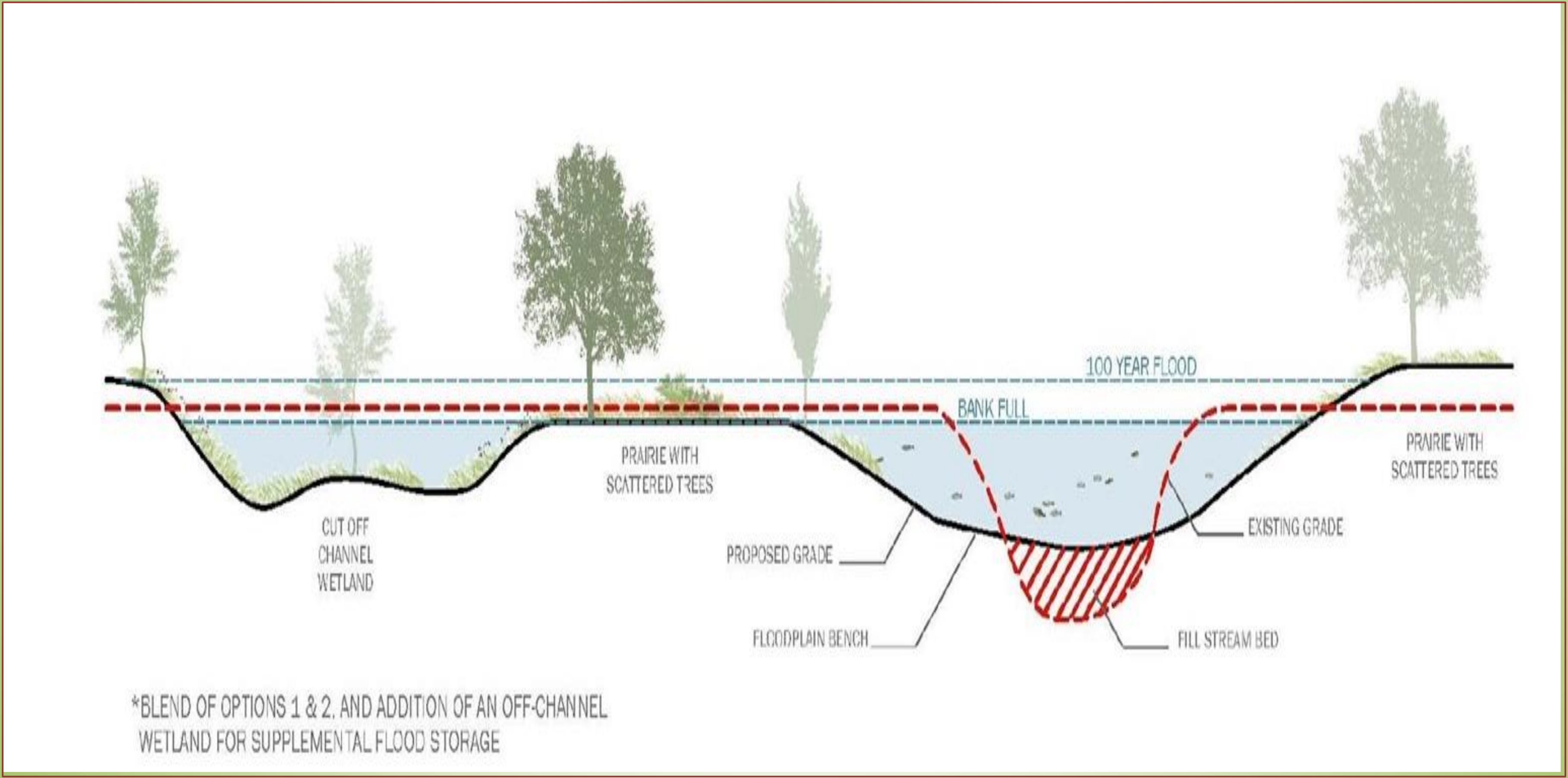
- Excavate a new floodplain to match the new lower streambed elevation

Raise Stream Bend
Increase Flood Storage Capacity



From Great Ecology, 2017

Raise Stream Bend, Cut Floodplain Bench Increase Flood Storage Capacity



From Great Ecology, 2017


CAT
Raise Bed

Cut Floodplain

No Connection=Compromises

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- Total Storage ≈ 8 acre-feet of
  - ≈ 5.5 acre-feet excavated floodplain over the lower 1,200 feet of channel
  - ≈ 2.5 acre-feet cutting back the banks to a 3H:1V along north and south forks over about 3,500 feet of stream length.
- Bid Cost : $6/CY
  - *Bid unit cost $6 – 9/CY*

Floodplain Storage

Floodplain Restoration Vs. Basins

Floodplain Storage

- Keep costly infrastructure out of floodplain
- Eliminates future concerns about damage – back yard loss
- Multi-use for recreation, open space, trails, other
- Environmental Lift – Habitat Restoration
- Water Quality benefits!
- Lower Cost per acre-ft.
- Lower Cost per lb. of treatment

Detention Basin

- Land is expensive – often installed in land suitable for other developable use.
- To make recreational (fish pond) requires more excavation (15 feet)
- “Green Pond” issues
- Sedimentation – Long term maintenance cost
- Geese!

EXAMPLE
Cost of 36 ac-ft. of Flood Storage:

Floodplain Restoration

- 1 mile stream length with 100 ft. floodplain width and 3 ft. incision depth.
- Cost :$350,000 – 500,000
  - Plus cost of stream restoration *(above is only the incremental cost of floodplain excavation)*

Detention Basin

- 9 Acres and 4 feet Depth
- Spillway Structure
- Cost: $400,000-750,000
  - Plus Cost for Amenities
    - Deepen “pond” for fish
    - Hardscape edging
    - Fountain

The total cost and total benefit will vary from site to site with changes in floodplain width and depth of channel incision. The cost per acre-ft. would remain the same.

Do Floodplain Storage and Detention Basin Storage have an Equivalent Effect on Peak Flows?

Floodplain Storage

- Overbank flow fills the floodplain
- Water surface elevation and storage volume are variable with flow.
- Flows are not metered as they return to the channel – return rate depends on topography and distance from channel bank

Detention Basin Storage

- Flows are delivered by stormwater collection system
- Flows are released via metered outlet engineered to meet specified discharge rate(s)
- Delayed release of stormwater will generally have a larger effect per unit volume compared to same volume of floodplain storage

How to Maximize Effectiveness of Floodplain Storage

- Slow the return rate of water moving from the floodplain back into the channel by strategically contouring the floodplain
- Grade floodplain storage areas to include large shallow depressions that hold water after the flood peak has passed
- Mimic the low profile natural levees that form on floodplains along channel margins
- Contour the floodplain so that flows return to the channel at limited locations downstream of where water spills overbank
- Use vegetation to make the floodplain hydraulically rough
- Make the channel hydraulically rough and include log jams to force overbank flow into the contoured depressions on the floodplain

Stream Restoration – Stormwater and Flood Water Management

- Flood control and surface water management (Iowa Watershed Approach) programs could apply this strategy to **significantly improve the cost benefit relation for flood storage.**
- One approach would be to **partner with other agencies** and programs to develop **multi-objective stream** restoration projects that address ecological improvement, sediment load reduction, nutrient load reduction, and flood storage.
- Cost sharing a portfolio of such projects would reduce the unit cost for all participants.

Conclusions:

- The cost of floodplain excavation is comparable or less expensive than conventional capital projects for stormwater and flood control that provide the same amount of flood storage.

Conclusions:

- Stream restoration that uses a floodplain reconnection strategy simultaneously improves ecology, reduces sediment load, lowers nutrient loading, and increases flood storage. These can all be described as "ecological services" provided by the stream and floodplain.

Follow your bliss and the universe will open doors where there were only walls

–Joseph Campbell

Questions?

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