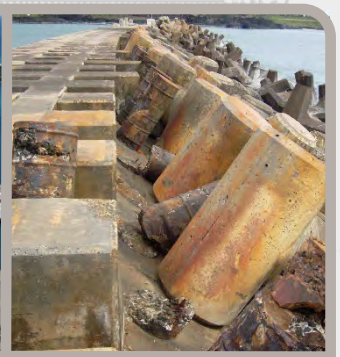
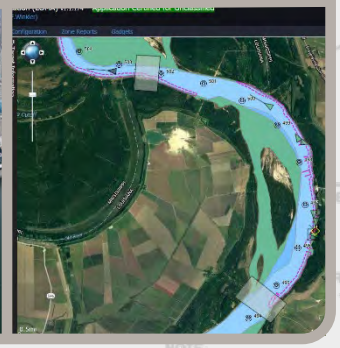
Stream Applications of Natural & Nature Based Features (NNBF) in the Arid SW

May 7, 2025

Chris Haring, PhD, P.G., CFM

Engineering Research & Development Center (ERDC)

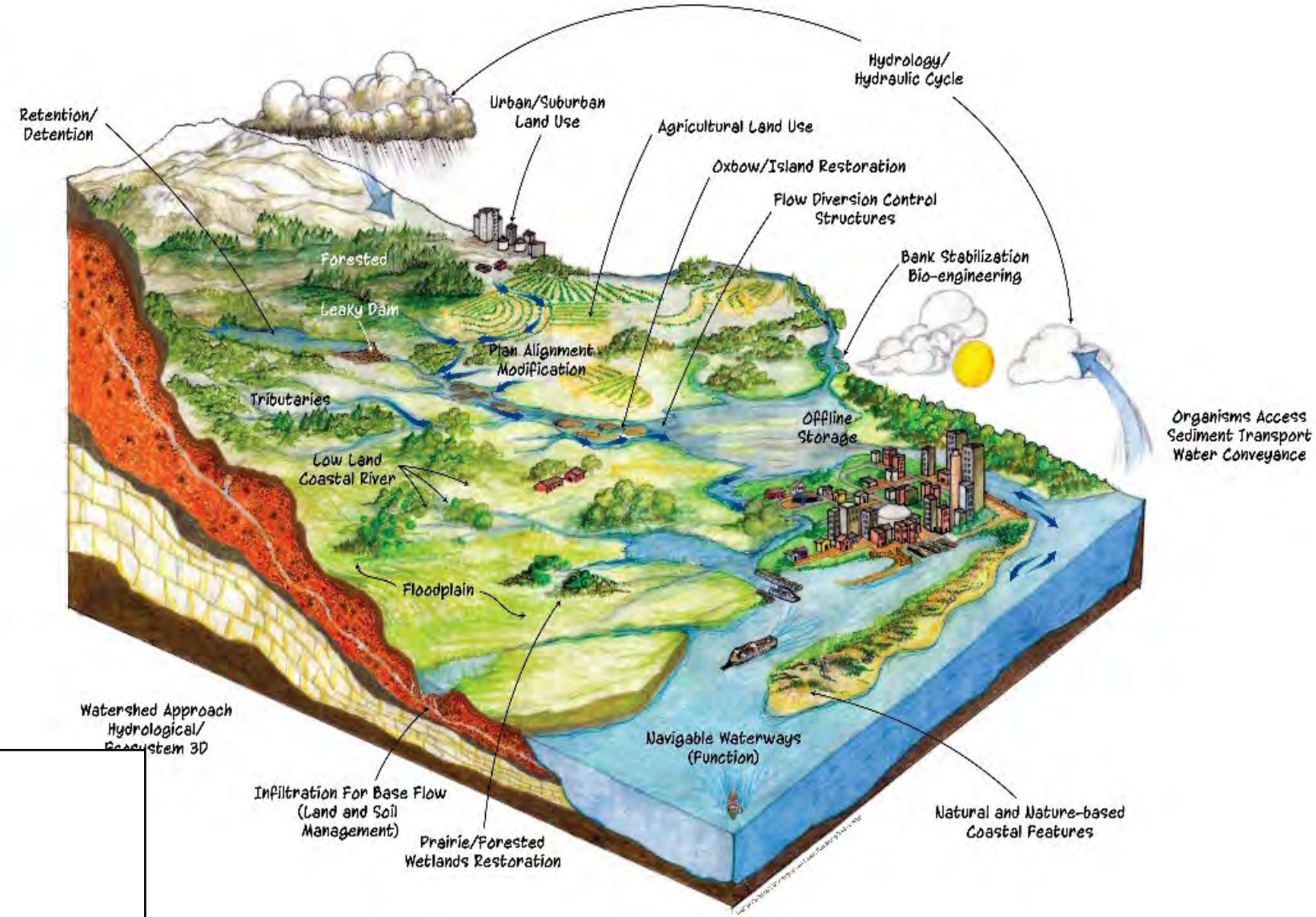
US Army Corps of Engineers

ERDC
Engineer Research and Development Center

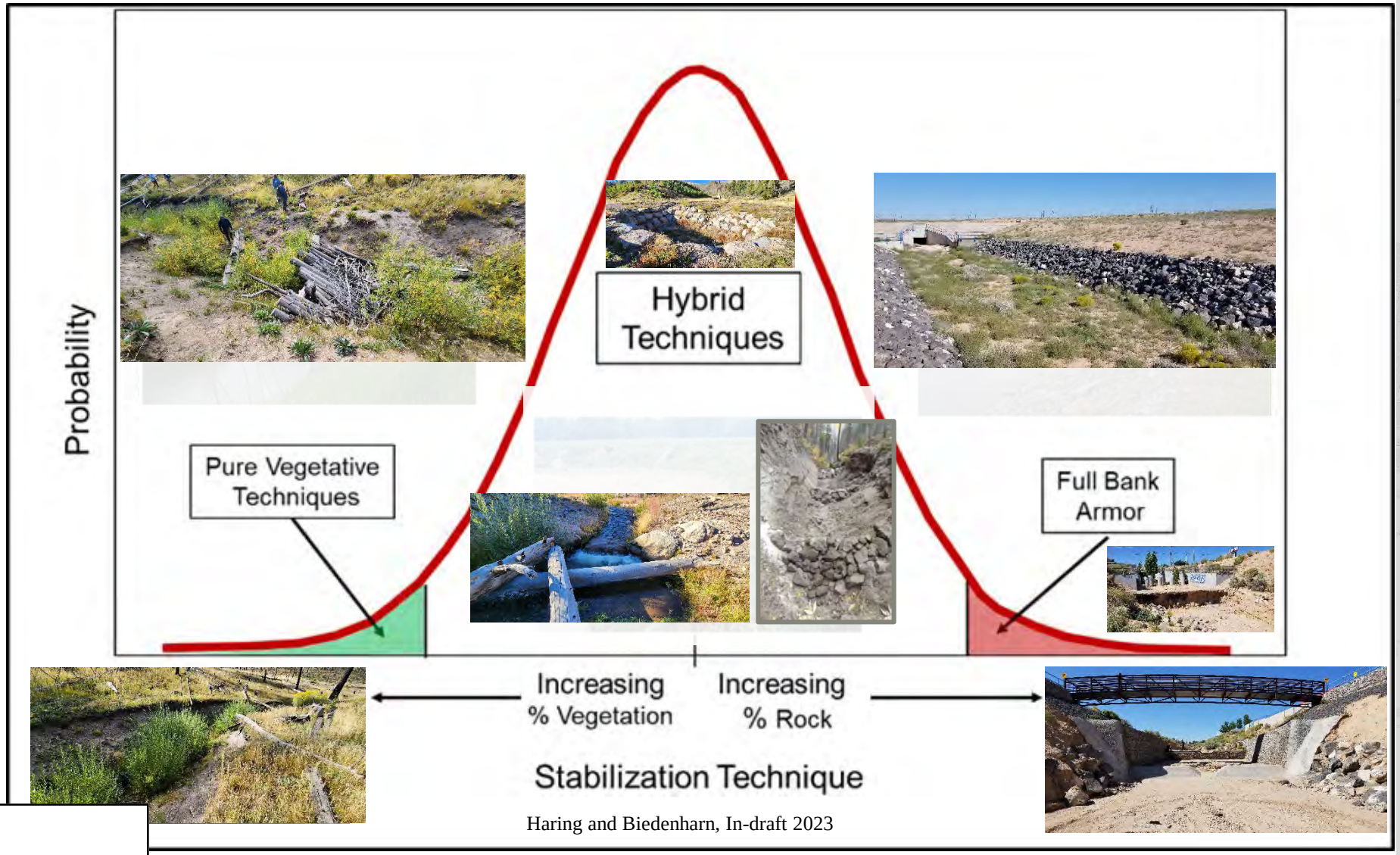
200+ years of Human Activity on the Landscape

- Cleared the Vegetation
- Irrigated and Reduced Groundwater Recharge
- Drained the Wetlands
- Straightened the Streams
- Leveed and Constricted the Floodplains
- Built Cities with Large Areas of Concrete, Asphalt and Rooftops

A SYSTEMS VIEW OF SOLUTIONS



NATURAL & NATURE BASED FEATURES SCALE (NNBF)



Haring and Biedenharn, In-draft 2023

NNBF – TO RESTORE NATURAL PROCESSES REVETMENT & VEGETATIVE APPLICATIONS





Construction: Santa Clara Creek



ject Condition: Copperas Creek



Post Project Stabilization: Copperas Creek

NNBF - RESTORE NATURAL PROCESSES TO DEGRADING CHANNELS

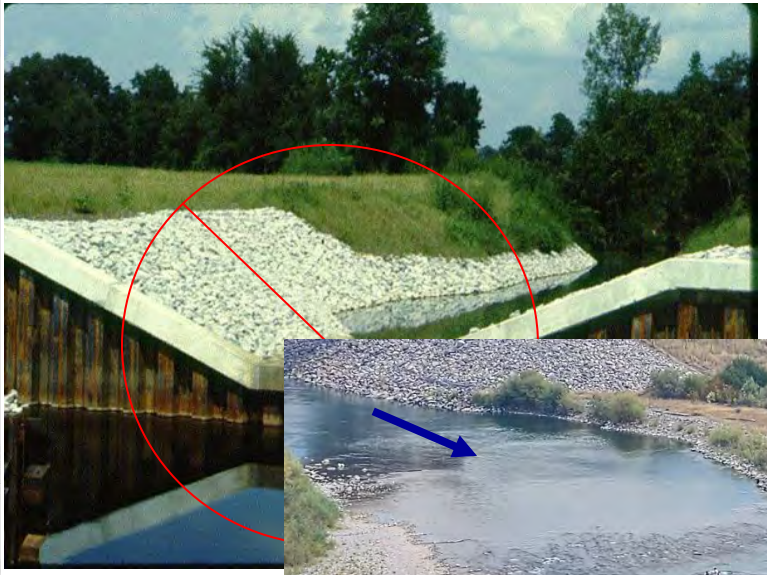








NNBF - RESTORE NATURAL PROCESSES WITH GRADE CONTROL





rt with Grade control









k & Wood GCS & Vegetation

In Situ Rock & Vegetation

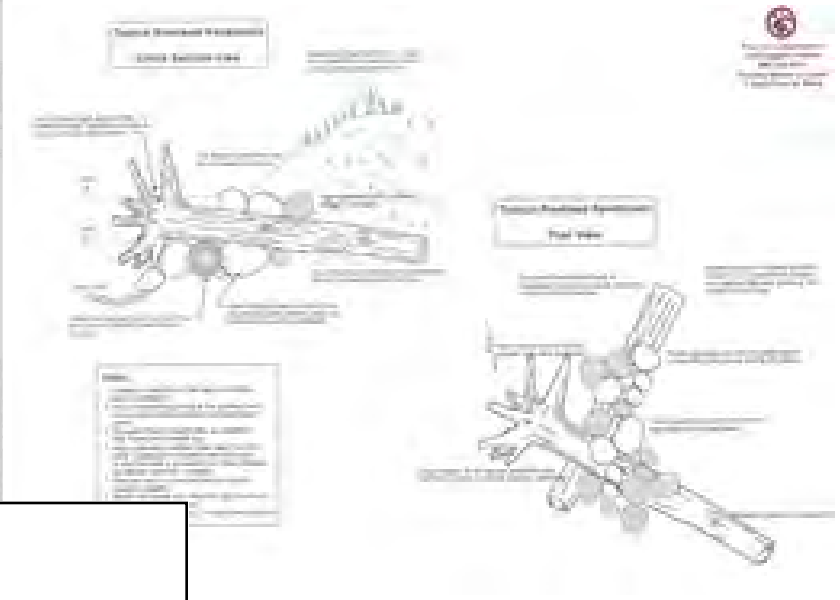
S Army Corps of Engineers • Engineer Research and Development Center

NNBF - RESTORE NATURAL PROCESSES WITH VEGETATION & REVETMENTS



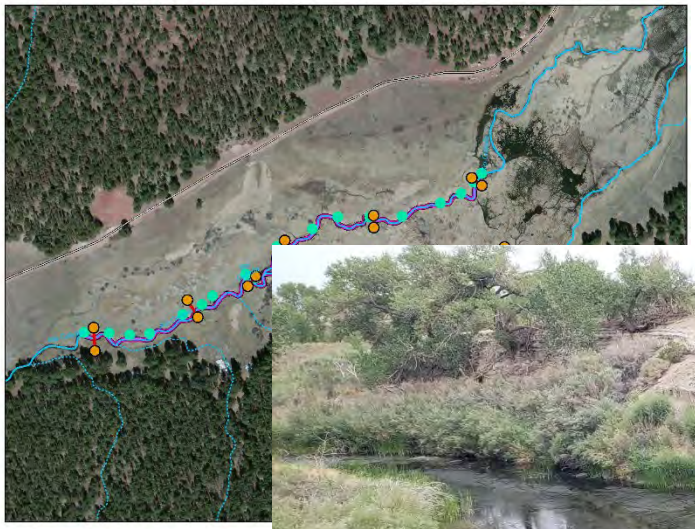


Rootwads + Locked Logs + Vegetation + TP





NNBF - RESTORE NATURAL PROCESSES WITH VEGETATION & REVETMENTS









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UNCLASSIFIED

NNBF - RESTORE NATURAL PROCESSES WITH VEGETATION & REVETMENTS







Rein **erials**





NNBF - RESTORE NATURAL PROCESSES WITH VEGETATION & REVETMENTS





Wetlands Regulatory Assistance Program

ERDC/TN WRAP-23-3
August 2023

Sustainable Bank and Channel Stabilization Techniques in Arid Southwest Streams

by Chris Haring, Autumn Murray, and Forrest Luna

PURPOSE: Channel stabilization and enhancement approaches take many different forms and are implemented using varying construction methods, materials, and techniques. The purpose of this study is to provide a comprehensive evaluation of sustainable streambank stabilization measures that are typically applied in arid southwest (SW) streams. This study was conducted at the request of the US Army Corps of Engineers (USACE), Albuquerque District (SPA), and USACE Headquarters. The document also provides rationale for evaluating bank and bed stabilization measures.

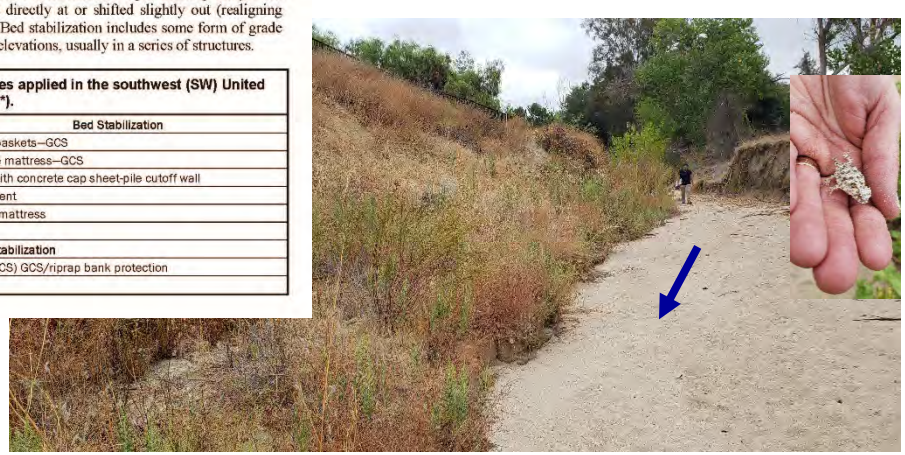
BACKGROUND: The USACE Regulatory Program, particularly in the arid SW, experiences a wide range of challenges associated with reviewing proposed channel stabilization methods on streams, with some projects failing within the first couple of flow events. Many of the stabilization techniques applied in SW streams, such as gabion baskets, are not sustainable due to higher risk of failure from flanking and deep bed scour depths. As a result, the impacts associated with failed bank stabilization projects are not always minimal, yet there are other, less environmentally impactful and potentially lower cost alternatives that may be used in their place.

The US Army Engineer Research and Development Center (ERDC), Coastal and Hydraulics Laboratory (CHL), worked with SPA to analyze and assess some of the most common channel stabilization measures used in SW streams. A list of common stream-stabilization techniques is listed below (Table 1). The table is split into bank- and bed-stabilization categories as well as a section for combined techniques. Some of the bank-stabilization methods are indirect and direct. Indirect methods use flow interception to change channel flow conditions (realigns thalweg away from eroding bank), and direct methods are constructed directly at or shifted slightly out (realigning meander bend for stability) from the eroding bank. Bed stabilization includes some form of grade control structures (GCS) that control channel invert elevations, usually in a series of structures.

Table 1. Common stream stabilization techniques applied in the southwest (SW) United States (indirect methods marked with **).

Bank Stabilization	Bed Stabilization
Gabion baskets	Gabion baskets–GCS
Fence revetments **	Concrete mattress–GCS
Concrete mattress–concrete toe-wall	Riprap with concrete cap sheet-pile cutoff wall
Riprap–whole bank	Soil cement
Riprap–toe protection (bioengineering)	Cement mattress
Riprap–soil filled (bioengineering)	
Bank and Bed Stabilization	
Gabion baskets bank and bed stabilization/cement slurry (CS) GCS/riprap bank protection	
CS GCS with riprap-whole bank protection	





BUILDING PROGRESS

- Expand the “vision” to diversify project benefits
- Increase collaboration and cross-sector partnerships
- Commit to innovation
- Pursue realistic and affordable projects
- Document the value created
- Coordinate communication across partnering organizations for maximum impact





NATURAL AND NATURE-BASED FEATURES (NNBF) STREAMBANK MANUAL

Purpose: Provide engineering guidelines for applications of NNBF to increase function to flood risk management and water resource projects to USACE Districts and partners.

US Army Corps of Engineers®

- NNBF Manual Release scheduled for mid-2026:
  - ► USACE led document with partner inputs.
  - ► Addressing new applications & design concepts
    - Inland Fluvial Applications focused





https://usace.dps.mil/sites/INTRA-CHL/SitePages/NNBS-HOME.aspx

Questions



https://ewn.erdc.dren.mil/

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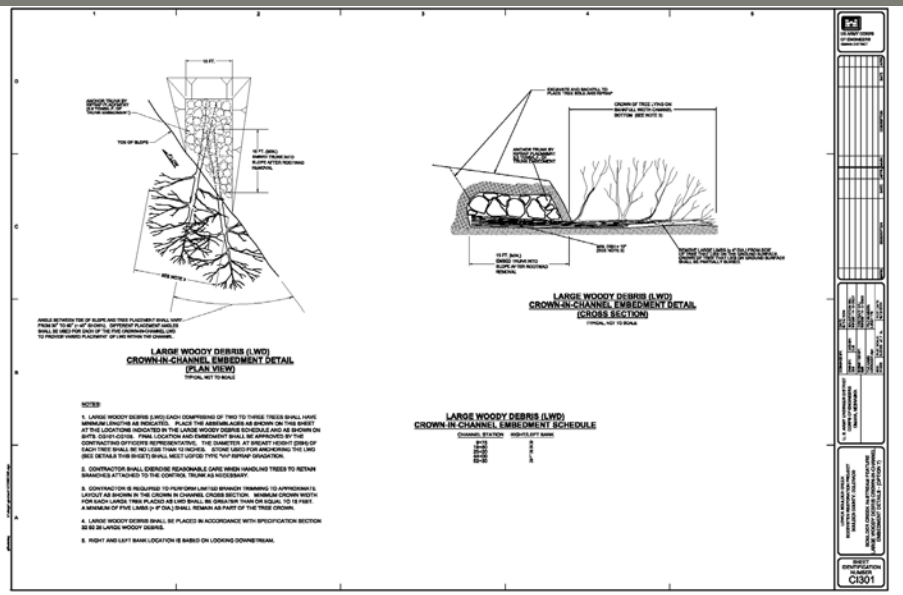
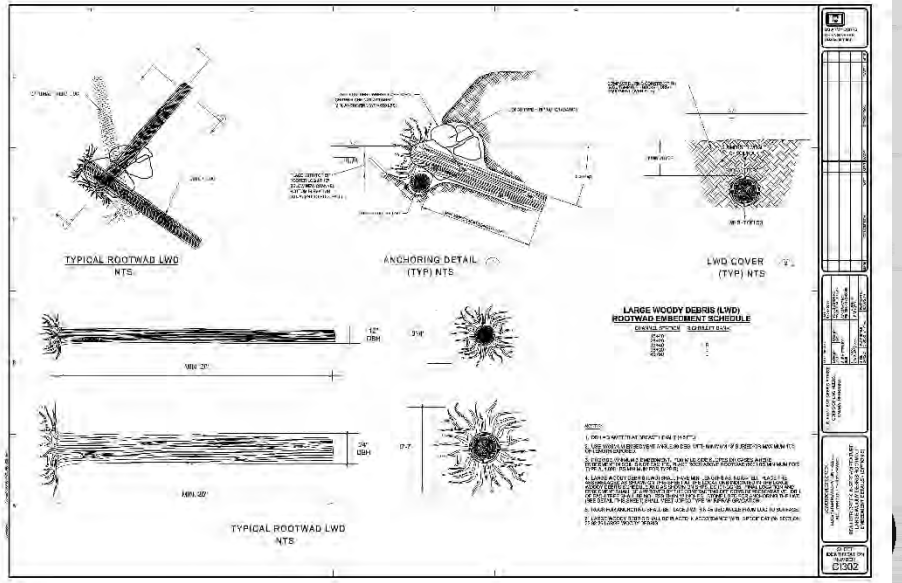
NNBF - FLOODPLAIN RECONNECTION
BOULDER CREEK PROJECT









NNBF - FLOODPLAIN RECONNECTION
BOULDER CREEK PROJECT



Existing Condition



Construction

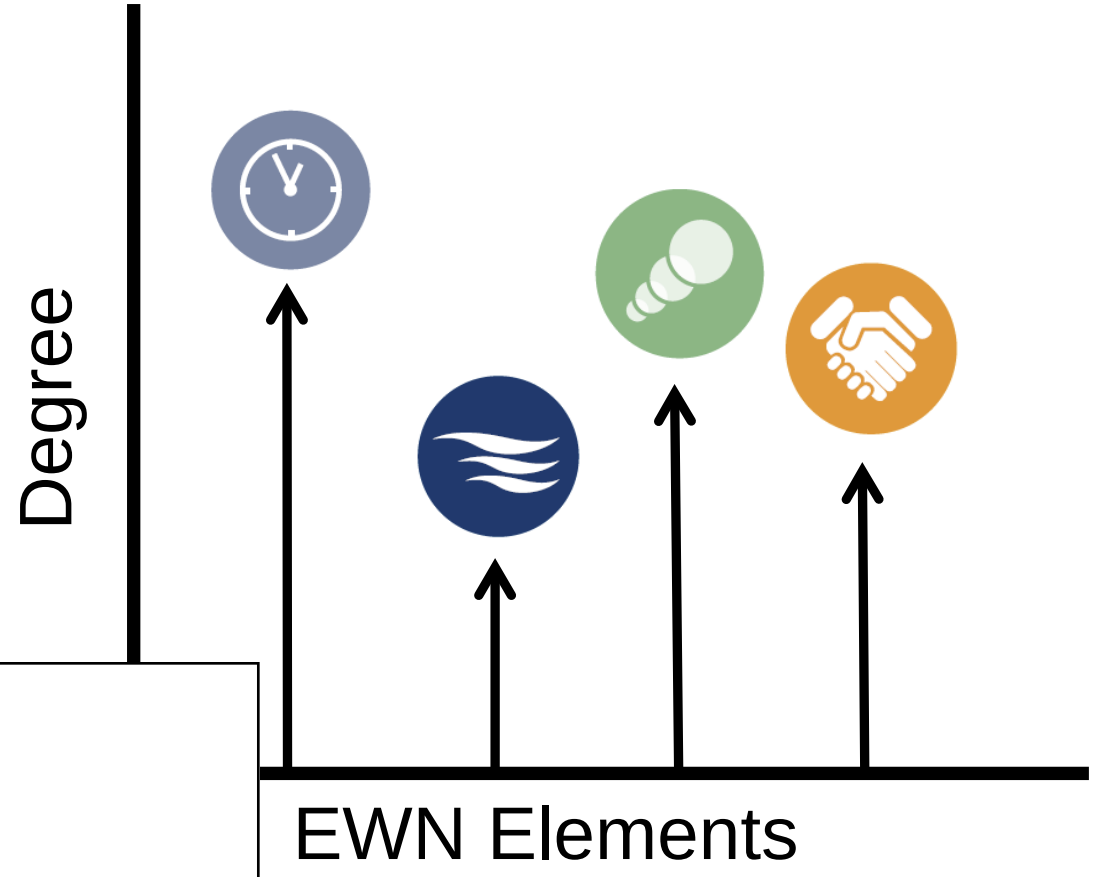


Post Project Stabilization



Post Project Stabilization

NNBF-EWN Key Elements



EWN Elements

Four major elements are involved in applying EWN to develop infrastructure projects:

- Using science and engineering to produce operational efficiencies
- Using natural processes to maximize benefit
- Increasing the value provided by projects to include social, environmental, and economic benefits
- Using collaborative processes to organize, engage, and focus interests, stakeholders, and partners

NNBF ENGINEERING PERFORMANCE



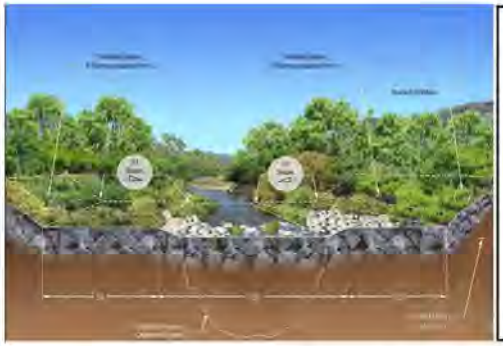
Levee Setbacks

Benefits/Processes

-decreased flood levels and velocities
-reduced frequency of maintenance and repair on levee
-reduced navigational maintenance
-reduction in erosion/scour and O&M costs
-increased recreational, cultural, and educational opportunities

Performance Factors

-amount of new floodplain affects
ding
tions for improved
ion
als of project with
dplain connection
with stakeholders
eral agencies



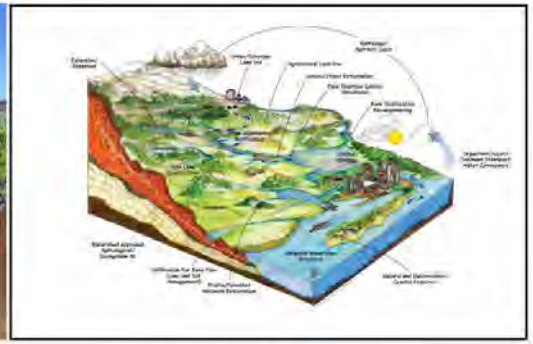
Naturalization of Channel Design

Benefits/Processes

-reduced frequency of maintenance on levee and restoration projects
-naturalization of flow regimes and floodplain reconnection
-ecological benefits to floodplain habitat
-reduction in erosion/scour and O&M costs
-increased recreational, cultural, and educational opportunities

Performance Factors

-type of practice determines hydrologic loading
-practice determines options for improved hazard mitigation, erosion control, and streambed and bank stability
-collaboration with stakeholders and other Federal agencies
-sediment management options



Watershed Treatments

Benefits/Processes

-naturalization of hydrologic watershed regimes
-reduced navigational maintenance
-reduction in O&M costs
-increased recreational, cultural, and educational opportunities
-reduced frequency of maintenance and repair on levee and restoration projects

Performance Factors

-watershed management options determine effects on hydrologic loading
-practice options for improved hazard mitigation, upland erosion control, and groundwater recharge
-sediment management options
-collaboration with stakeholders and other Federal agencies

NNBF & Engineering With Nature®

…the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental and social benefits through collaboration.

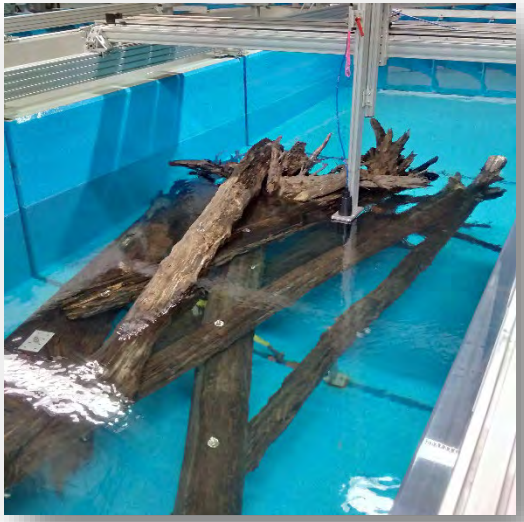
Key Elements:

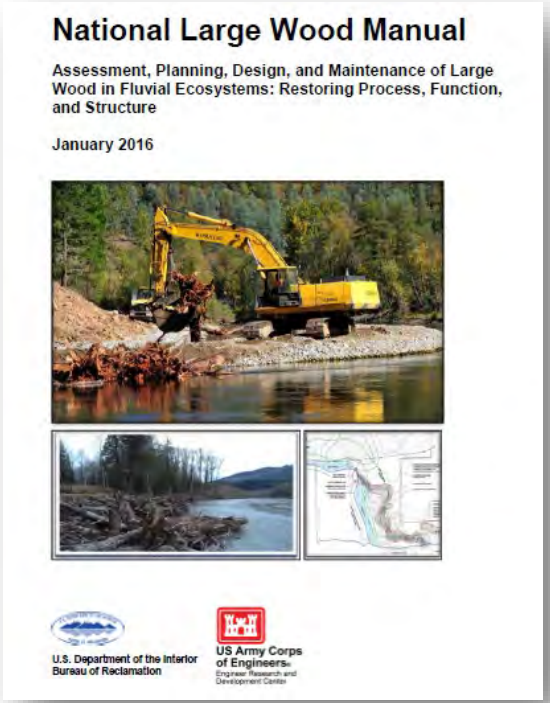
- Science and engineering that produces operational efficiencies
- Using natural process to maximum benefit
- Broaden and extend the benefits provided by projects
- Science-based collaborative processes to organize and focus s, stakeholders, and partners

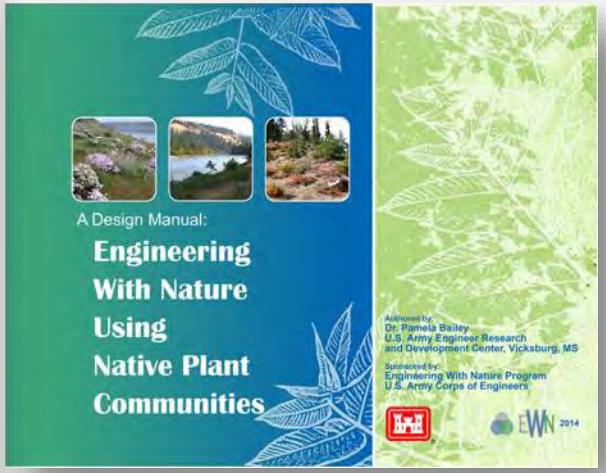


www.engineeringwithnature.org

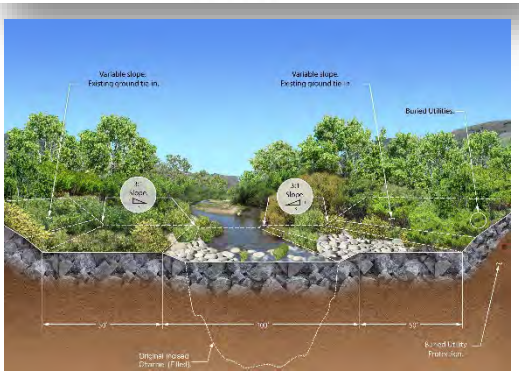
NNBF AND NATURAL MATERIALS















NNBF WILDFIRE RECOVERY: USACE ALBUQUERQUE DISTRICT SANTA CLARA PUEBLO WATERSHED





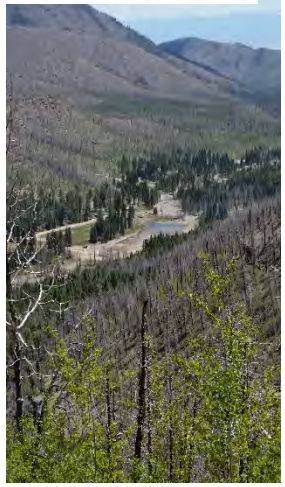
Producing Efficiencies

Working with natural processes using local materials to stabilize the watershed and stream channels; reduced time and cost of importing materials, ecological and aesthetics benefits.

Using Natural Processes

Uses local material in system vs. introducing riprap; placement of materials in situ with native vegetation to re-establish natural channel tendencies.





Broadening Benefits

New options to place existing materials; habitat created; restoration of channel and reduction of sediment delivered to channels and reservoirs.



Promoting Collaboration

Partnering with Santa Clara Pueblo, USGS, USFS, BIA, NMDOT, and NRCS

Structures



R&D: Implement, study and long-term performance of NNBF; Offers opportunities to determine appropriate performance metrics aligned with ecosystem and engineering services.

*Initial Funding from 2017 Dredging Operations Tech Support (DOTS)

NNBF – TO RESTORE NATURAL PROCESSES (TEK)

- Traditional Ecological Knowledge
- Wetland & Erosion Control
- Bottomless Culvert



Post Wildfire Watershed Restoration for Flood Risk Management (FRM)



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Received: 6 January 2021 | Returned for Revision: 18 March 2021 | Accepted: 12 May 2021

Special Series

Using Engineering With Nature® (EWN®) principles to manage erosion of watersheds damaged by large-scale wildfires

Christopher P. Haring,[1] Garrett L. Altmann,[2] Burton C. Suedel,[3] and Stephen W. Brown[4]
[1]US Army Engineer Research and Development Center, Rock Island, Illinois, USA
[2]Santa Clara Pueblo, Forestry Department, Española, New Mexico, USA
[3]US Army Engineer Research and Development Center, Vicksburg, Mississippi, USA
[4]US Army Corps of Engineers-Albuquerque District, Albuquerque, New Mexico, USA

EDITOR'S NOTE:
This article is part of the special series "Ecological consequences of wildfires." The series documents the impacts of large-scale wildfires in many areas of the globe on biodiversity and ecosystem condition in both terrestrial and aquatic ecosystems, the capacity for systems to recover, and management practices needed to prevent such destruction in the future.

Abstract
The US Army Corps of Engineers (USACE) manages hundreds of reservoirs and thousands of miles of navigation channels that provide invaluable flood control, commercial transport of materials, water supply, recreation, and stream flow regulation. This capability is being threatened by the continued occurrence of large-scale wildfires across the western United States. The wildfires damage watersheds in part by denuding landscapes, reducing infiltration rates, and increasing runoff rates, thereby dramatically increasing the potential for the erosion of denuded slopes, destabilizing stream channels, increasing the infilling potential of reservoirs and, hence, reducing their capacity. The increased erosion rates highlight the need to develop innovative solutions to reduce erosion of watersheds laid bare after wildfires engulf the area. The Santa Clara Pueblo in northern New Mexico extends from the top of the eastern Jemez Mountains to the floodplains of the Rio Grande River. The Pueblo designed and constructed thousands of structures built from natural materials, consistent with Engineering With Nature (EWN) principles for erosion control incorporating low-cost and readily available materials such as logs, mulch, vegetation, and local rock to stabilize highly erodible parts of the watershed. The watersheds where these natural structures were constructed were monitored after construction to assess their effectiveness, guiding a series of recommendations for broader implementation. As part of a continued emphasis on updating USACE engineering guidance, research, and development, funding has been focused on developing sustainable and resilient project designs using natural materials like those implemented by the Santa Clara Pueblo. This paper focuses on the innovative EWN-based watershed stabilization practices that were implemented in the upper section of this wildfire affected canyon and tributary streams. Recommendations for future implementation based on lessons learned from this project are also provided. *Integr Environ Assess Manag* 2021;00:1–9. Published 2021. This article is a US Government work and is in the public domain in the USA.

KEYWORDS: Equity, Las Conchas Wildfire, Nature-based solutions, Reservoir, Santa Clara Pueblo

INTRODUCTION
The US Army Corps of Engineers (USACE) manages hundreds of reservoirs and thousands of miles of navigation channels that provide invaluable flood control, commercial transport of materials, water supply, recreation, and stream flow regulation. This capability is being threatened by the continued occurrence of large-scale wildfires across the western United States. The wildfires damage watersheds in part by denuding landscapes and destabilizing stream networks, thereby dramatically increasing the potential for erosion of denuded slopes, hence increasing the infilling potential of reservoirs and reducing their capacity. The reduced reservoir capacity decreases the availability of drinking water and increases the management costs of having to dredge the reservoirs to restore that capacity. The increased erosion rates highlight the need to develop innovative solutions to reduce erosion of watersheds, laid bare after wildfires engulfed the area, and to reduce threats to mission capability.

This article contains online-only Supporting Information.
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Email: burton.suedel@usace.army.mil
Published 18 May 2021 on wileyonlinelibrary.com/journal/ieam.

NNBF TO RESTORE NATURAL PROCESSES

- ❑ Wood structures
- ❑ Rock onsite
- ❑ Combination





