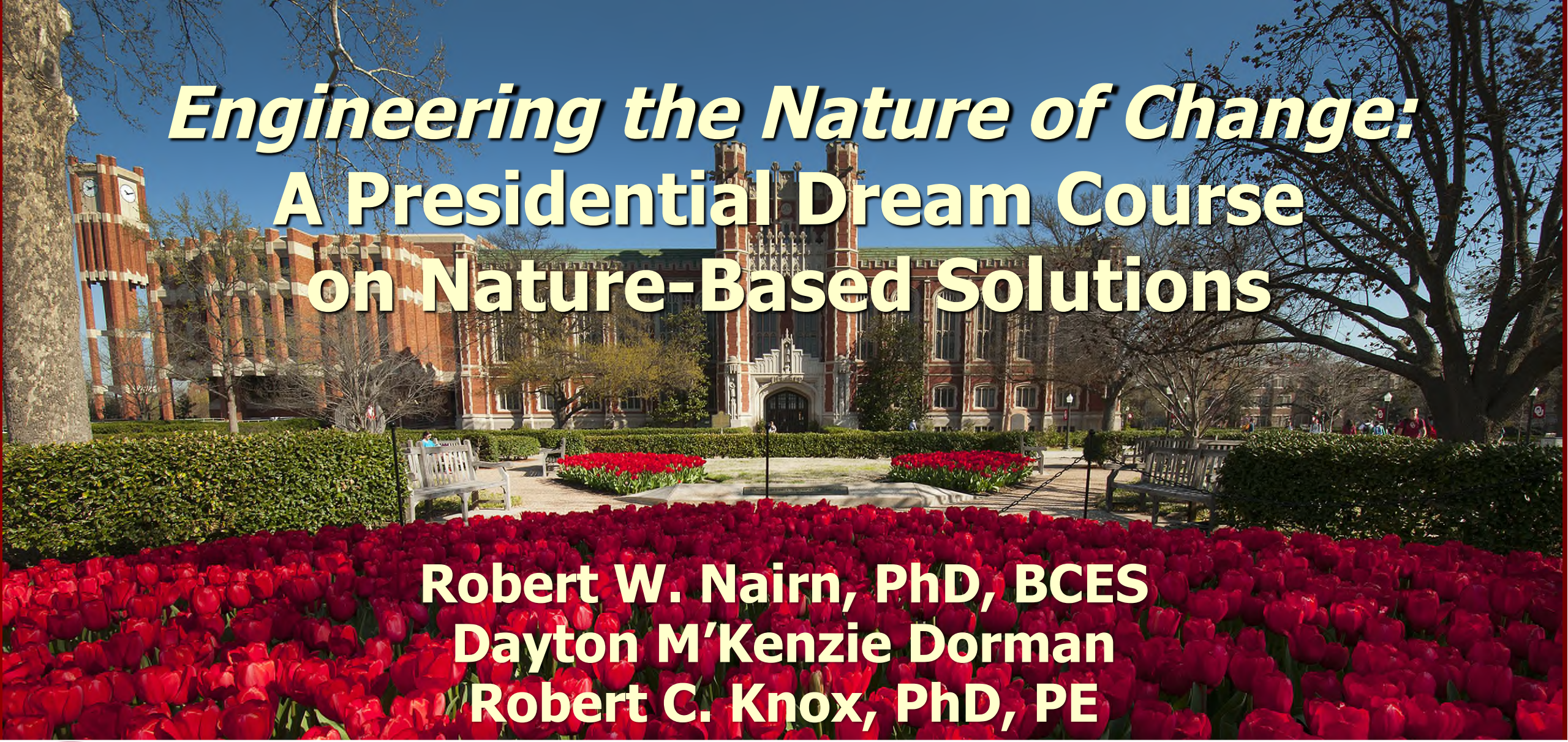


Engineering the Nature of Change: A Presidential Dream Course on Nature-Based Solutions

Robert W. Nairn, PhD, BCES
Dayton M'Kenzie Dorman
Robert C. Knox, PhD, PE

GALLOGLY COLLEGE OF ENGINEERING
SCHOOL OF CIVIL ENGINEERING AND ENVIRONMENTAL SCIENCE
The UNIVERSITY of OKLAHOMA

CREW
Center for Restoration of Ecosystems and Watersheds
The University of Oklahoma

OU Dream Courses

Nature-Based Solutions

Course Strategy

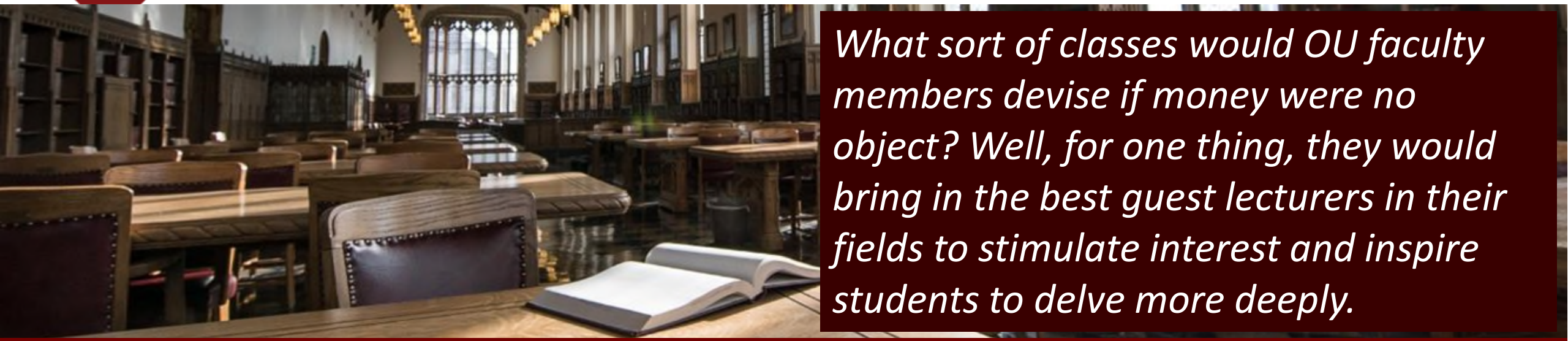
Next Steps

OU Dream Courses

OFFICE OF THE SENIOR VICE PRESIDENT AND PROVOST

PRESIDENTIAL DREAM COURSE

The UNIVERSITY *of* OKLAHOMA



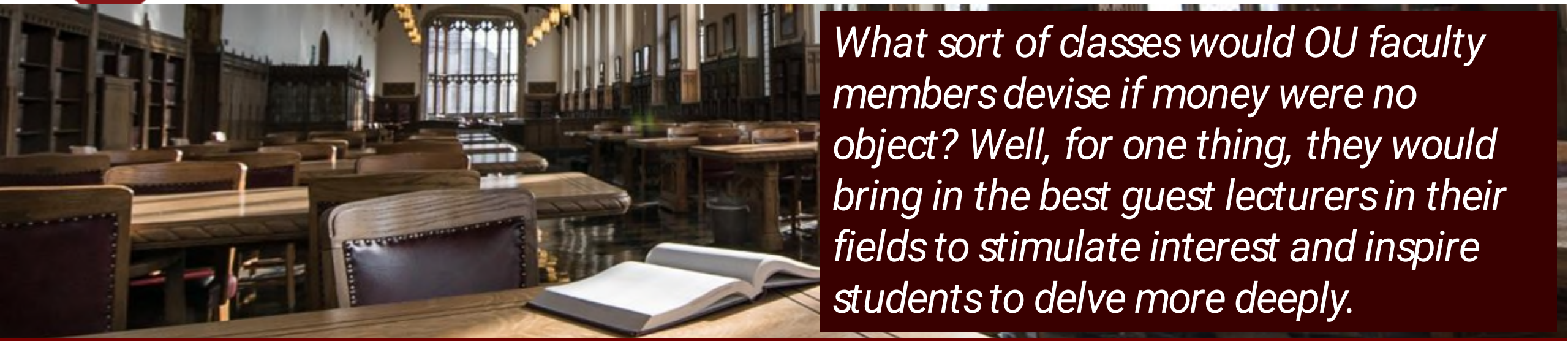
What sort of classes would OU faculty members devise if money were no object? Well, for one thing, they would bring in the best guest lecturers in their fields to stimulate interest and inspire students to delve more deeply.

- Program founded in 2004 by former OU President David L. Boren to enable faculty to "*bring scholars and world-renowned experts to campus to interact with OU students and give public lectures to the local community*".

OFFICE OF THE SENIOR VICE PRESIDENT AND PROVOST

PRESIDENTIAL DREAM COURSE

The UNIVERSITY *of* OKLAHOMA



What sort of classes would OU faculty members devise if money were no object? Well, for one thing, they would bring in the best guest lecturers in their fields to stimulate interest and inspire students to delve more deeply.

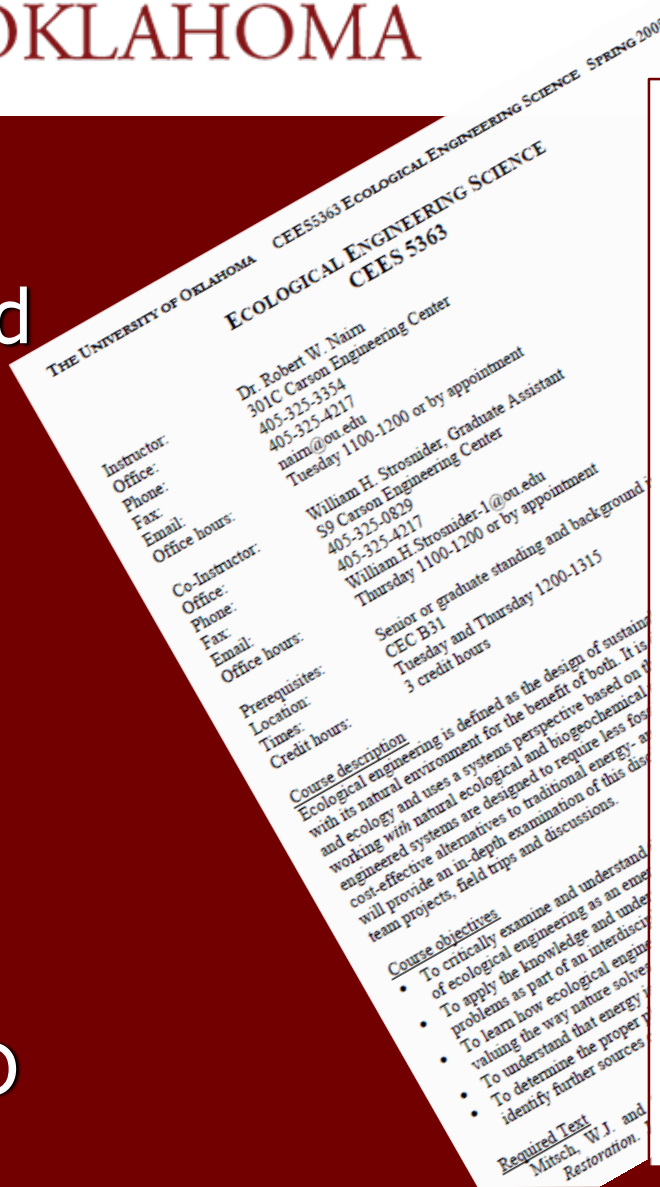
- Courses must be semester-long and regularly scheduled to be eligible for consideration
- Provost's Office provides up to $20,000 in financial support

OFFICE OF THE SENIOR VICE PRESIDENT AND PROVOST

PRESIDENTIAL DREAM COURSE

The UNIVERSITY *of* OKLAHOMA

- Successful proposal to modify Civil Engineering and Environmental Science (CEES) 5363 *Ecological Engineering Science*
- Offered as *Engineering the Nature of Change* as CEES 4970/5970
- Opened enrollment across campus for BS, MS and PhD



THE UNIVERSITY OF OKLAHOMA CEES5363 ECOLOGICAL ENGINEERING SCIENCE SPRING 2008

ECOLOGICAL ENGINEERING SCIENCE
CEES 5363

Instructor: Dr. Robert W. Nairn
Office: 301C Carson Engineering Center
Phone: 405-325-3354
Fax: 405-325-4217
Email: nairn@ou.edu
Office hours: Tuesday 1100-1200 or by appointment

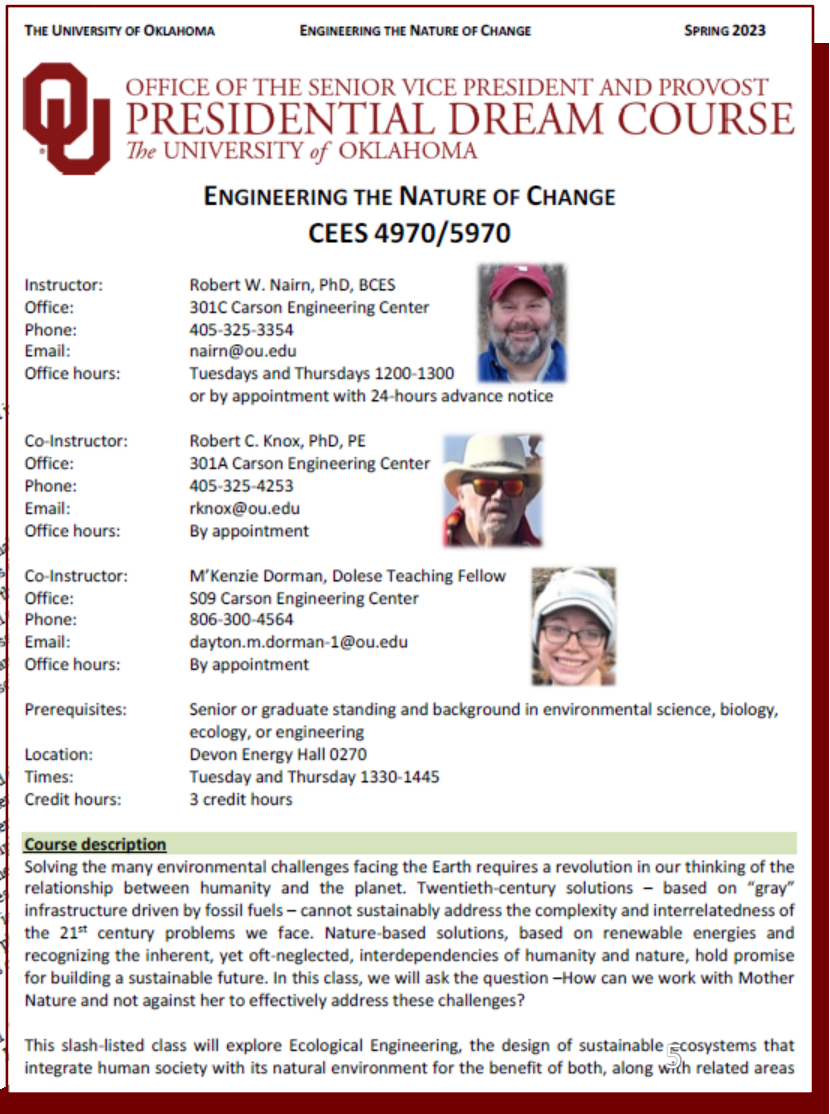
Co-Instructor: William H. Strosnider, Graduate Assistant
Office: S9 Carson Engineering Center
Phone: 405-325-0829
Fax: 405-325-4217
Email: William.H.Strosnider-1@ou.edu
Office hours: Thursday 1100-1200 or by appointment

Prerequisites: Senior or graduate standing and background
Location: CEC B31
Times: Tuesday and Thursday 1200-1315
Credit hours: 3 credit hours

Course description
Ecological engineering is defined as the design of sustain
with its natural environment for the benefit of both. It is
and ecology and uses a systems perspective based on
working with natural ecological and biogeochemical
engineered systems are designed to require less fos
cost-effective alternatives to traditional energy-
will provide an in-depth examination of this dis
team projects, field trips and discussions.

Course objectives
- To critically examine and understand
of ecological engineering as an
- To apply the knowledge and unde
problems as part of an interdisci
- To learn how ecological engin
valuing the way nature solve
- To understand that energy
- To determine the proper
identify further sources

Required Text
Mitsch, W.J. and
Restoration.



THE UNIVERSITY OF OKLAHOMA ENGINEERING THE NATURE OF CHANGE SPRING 2023

OFFICE OF THE SENIOR VICE PRESIDENT AND PROVOST
PRESIDENTIAL DREAM COURSE
The UNIVERSITY *of* OKLAHOMA

ENGINEERING THE NATURE OF CHANGE
CEES 4970/5970

Instructor:	Robert W. Nairn, PhD, BCES
Office:	301C Carson Engineering Center
Phone:	405-325-3354
Email:	nairn@ou.edu
Office hours:	Tuesdays and Thursdays 1200-1300 or by appointment with 24-hours advance notice

Co-Instructor:	Robert C. Knox, PhD, PE
Office:	301A Carson Engineering Center
Phone:	405-325-4253
Email:	rknox@ou.edu
Office hours:	By appointment

Co-Instructor:	M'Kenzie Dorman, Dolese Teaching Fellow
Office:	S09 Carson Engineering Center
Phone:	806-300-4564
Email:	dayton.m.dorman-1@ou.edu
Office hours:	By appointment

Prerequisites:	Senior or graduate standing and background in environmental science, biology, ecology, or engineering
Location:	Devon Energy Hall 0270
Times:	Tuesday and Thursday 1330-1445
Credit hours:	3 credit hours

Course description

Solving the many environmental challenges facing the Earth requires a revolution in our thinking of the relationship between humanity and the planet. Twentieth-century solutions – based on "gray" infrastructure driven by fossil fuels – cannot sustainably address the complexity and interrelatedness of the 21st century problems we face. Nature-based solutions, based on renewable energies and recognizing the inherent, yet oft-neglected, interdependencies of humanity and nature, hold promise for building a sustainable future. In this class, we will ask the question –How can we work with Mother Nature and not against her to effectively address these challenges?

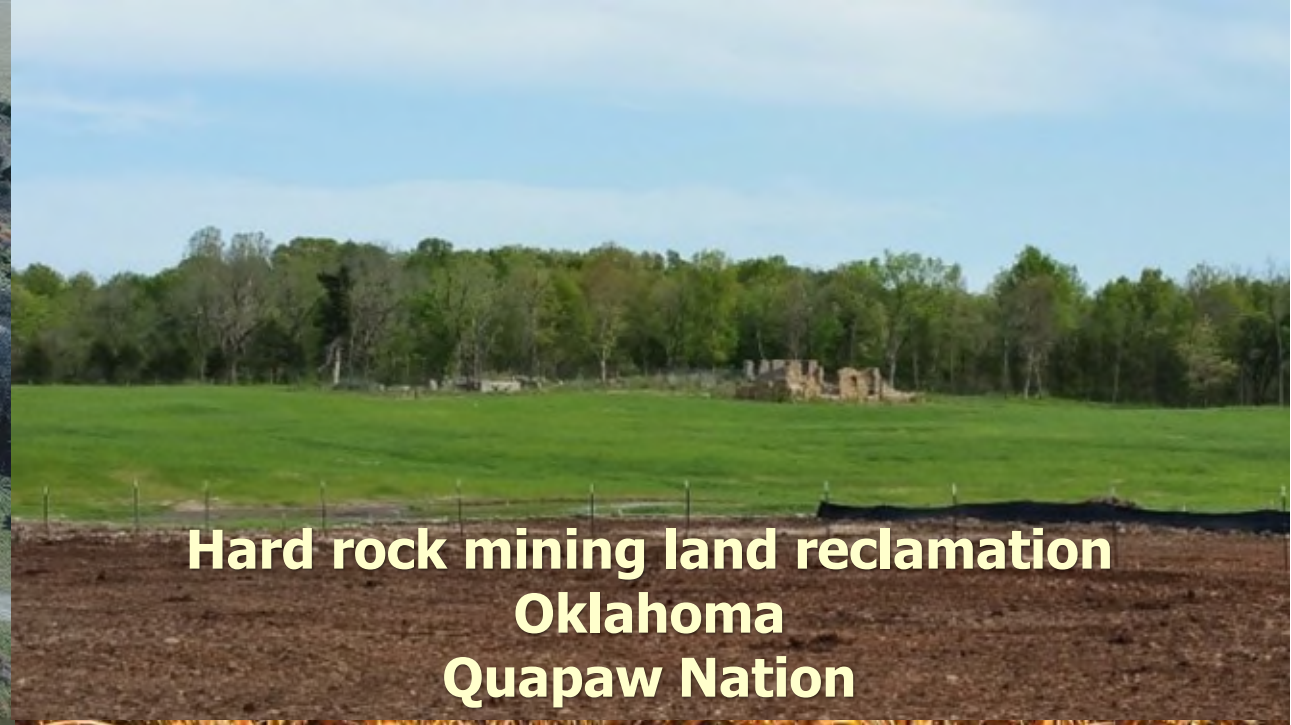
This slash-listed class will explore Ecological Engineering, the design of sustainable ecosystems that integrate human society with its natural environment for the benefit of both, along with related areas

PRESIDENTIAL DREAM COURSE

- Awarded April 2022
- Planning began fall 2022
- Identified ≈ 20 potential Distinguished Guest Speakers
  - Academia
  - Government
  - Private sector
  - Non-profit sector
  - Tribal Nations
  - Authors
- Secured Dolese Teaching Fellowship for GTA support
  - Oklahoma's largest supplier of ready-mix concrete, crushed stone, gravel, and sand
  - Agreement to financially support teaching excellence
- Three instructors!


Nature-Based Solutions

Hard rock mine water passive treatment
Oklahoma
OU CREW



Hard rock mining land reclamation
Oklahoma
Quapaw Nation

Coal mine land and water restoration
Pennsylvania
BioMost Inc.

Biofuel production on reclaimed coal mines
West Virginia
WVU

- Plenary Lecture
- 2017 Joint Conference
  - Appalachian Regional Reforestation Initiative
  - West Virginia Mine Drainage Task Force
  - American Society of Mining and Reclamation

Why Aren't All Reclamationists Considered Ecological Engineers?

Robert W. Nairn and William H.J. Strosnider

Working with Mother Nature, not against her

- Ecological engineering
  - The design of sustainable ecosystems that integrate human society with its natural environment for the benefit of both (Mitsch and Jorgenson 2004)
- Engineering With Nature
  - The intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental, and social benefits through collaboration (Bridges 2018)
- Nature-based solutions
  - Actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously benefiting people and nature (IUCN 2023)

New ideas to address 21st century challenges

- Ecological engineering
- Engineering With Nature
- Nature-based solutions
- Natural infrastructure
- Natural and nature-based features
- Green infrastructure
- Hybrid infrastructure
- Resilient natural engineering

Infrastructure policy should include nature-based solutions to support robust economic development, improve the quality of life in communities and sustain America's lands and waters for future generations.

-The Nature Conservancy, 2020


20th Century Infrastructure I-235/
I-44 Interchange, Oklahoma City

21st Century Natural Infrastructure
North Texas Municipal Water District East Fork Water Reuse Project/ John Bunker Sands Wetland Center, Combine, TX

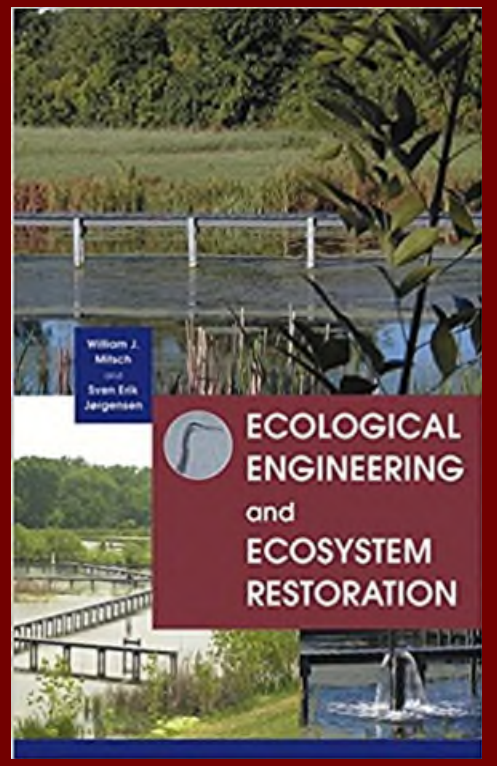
Course Strategy

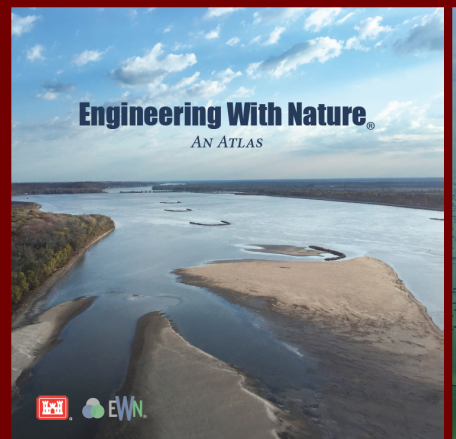
"*Engineering the Nature of Change*" Objectives

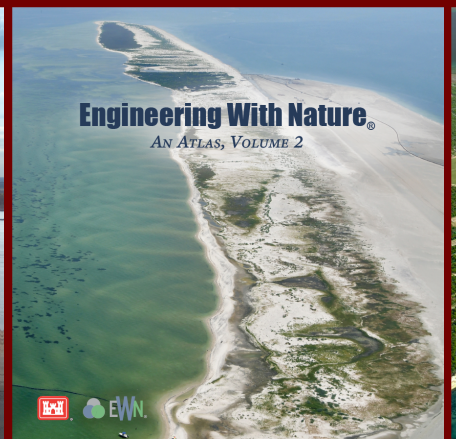
- To critically examine and understand the key concepts, terms, relationships, utility, and acceptability of ecological engineering, Engineering With Nature, nature-based solutions, and related topics.
- To apply the knowledge and understanding gained to design solutions for real-world environmental problems as part of an interdisciplinary team.
- To learn how natural infrastructure can be integrated into traditional engineering approaches by valuing the way nature solves problems.
- To determine the proper placement of these novel concepts in the academic arena and to identify further sources of learning on ecological engineering and related topics.

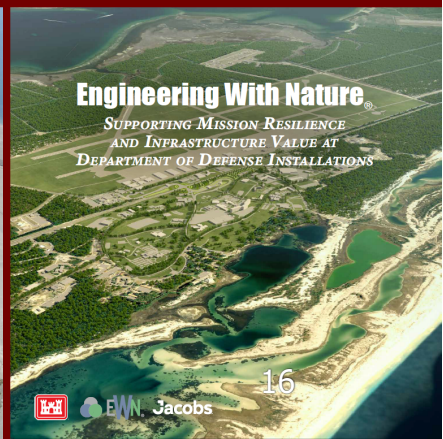
"*Engineering the Nature of Change*" Format

- One primary and three secondary required texts
- Six additional required readings
- Five Journal Article Discussions
- Two 75-minute lecture/discussion per week
  - 15 presentations of new materials
  - 5 Journal Article Discussions
  - 5 Distinguished Speaker class discussions
  - 5 Speaker Reflection discussions
- Five evening Public Lectures



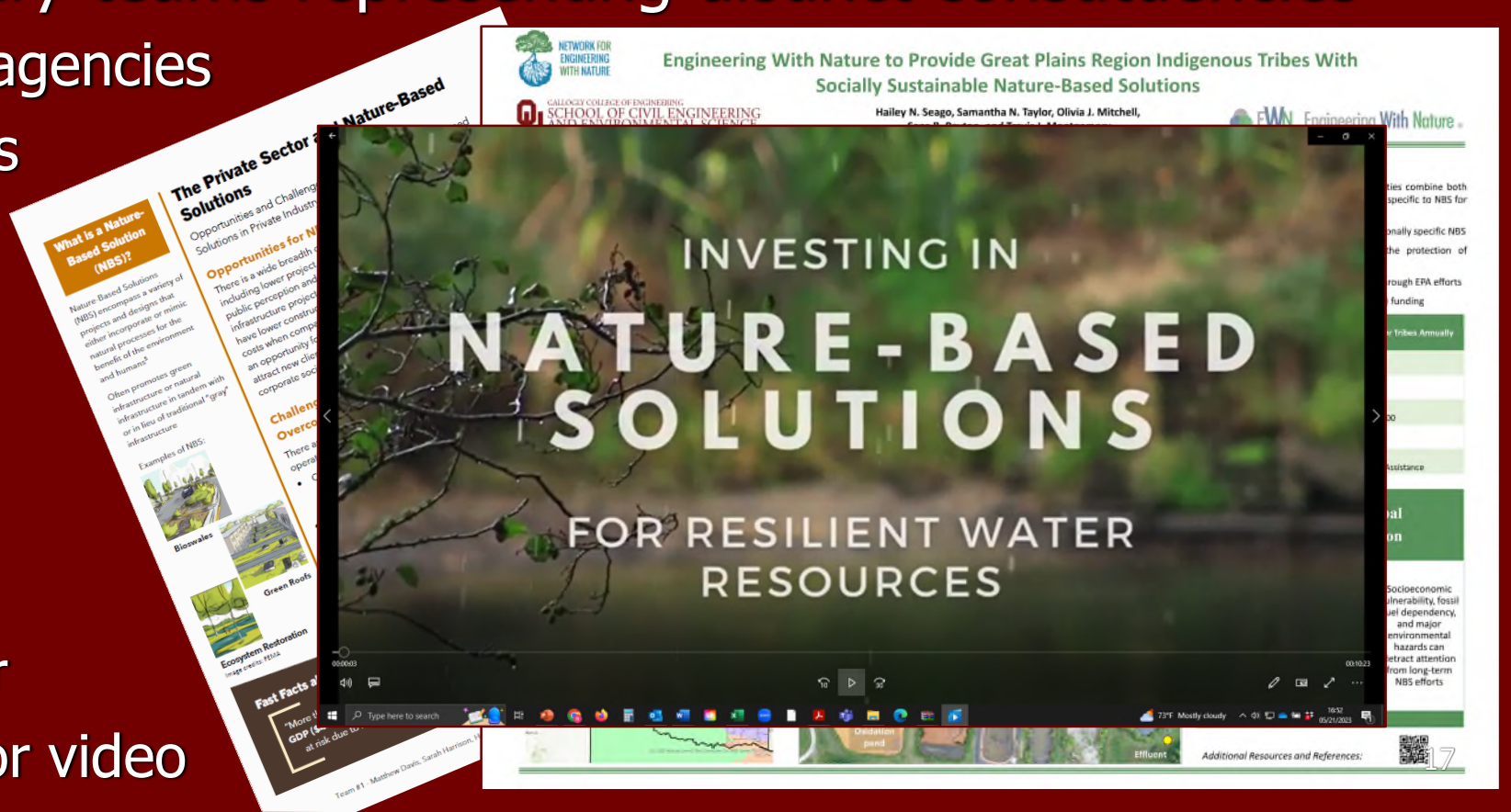






"*Engineering the Nature of Change*" Team Project

- Evaluate risks and rewards of transitioning to nature-based solution approaches, specifically in the Central Great Plains
- Five multidisciplinary teams representing distinct constituencies
  - Federal and state agencies
  - Local municipalities
  - Private sector
  - Non-profit sector
  - Tribal entities
- Three deliverables
  - Fact Sheet
  - Professional Poster
  - Presentation and/or video



"*Engineering the Nature of Change*" Distinguished Speaker Seminar Series

Todd S. Bridges, PhD

- Senior Research Scientist for Environmental Science
- National Lead, USACE Engineering With Nature®
- U.S. Army Corps of Engineers, Engineer Research and Development Center (ERDC), Vicksburg, MS

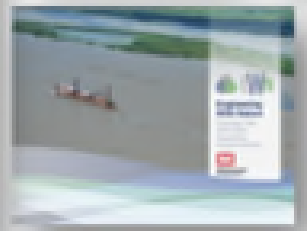
"Engineering With Nature: Innovating for a More Resilient and Sustainable Future"

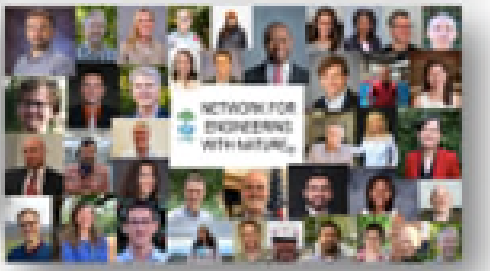
Engineering With Nature®

…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
- Increase and diversify infrastructure value
- Science-based collaboration to organize and focus interests, stakeholders, and partners





"We absolutely want to do more engineering with nature everywhere we work across the Corps, you have my commitment."
— LTG Scott A. Spellmon, 55th Chief of Engineers, to the House Committee on Transportation & Infrastructure, Water Resources & Environment Subcommittee (24 June 2021)

Support Education and Progress: The Network for Engineering With Nature (N-EWN)

- Multi-sector network supporting innovation
  - Types of partners: public and private sector
  - Research – gov't, academic, private
  - Industry practitioners
  - Project owners
- Aligning research with the needs of practice
- Grounding approach in real projects
- EWN education: curricula and training
- Experiential learning for students – systems thinking, cross-disciplinary training
- Freely flowing communication and knowledge sharing
- Accelerate implementation

N-EWN

US Army Corps of Engineers.

Institute for Resilient Infrastructure Systems
UNIVERSITY OF GEORGIA

DUCKS UNLIMITED

THE WATER INSTITUTE OF THE GULF

NYC Mayor's Office of Climate Resiliency

TRIBAL NATIONS TECHNICAL CENTER OF EXPERTISE

UNIVERSITY OF CALIFORNIA SANTA CRUZ

ASU Arizona State University

NCCOS

UF UNIVERSITY of FLORIDA
CENTER FOR COASTAL SOLUTIONS

The UNIVERSITY of OKLAHOMA

SAN ANTONIO RIVER AUTHORITY

GEORGIA Coastal Resources Division

Stantec

"*Engineering the Nature of Change*" Distinguished Speaker Seminar Series

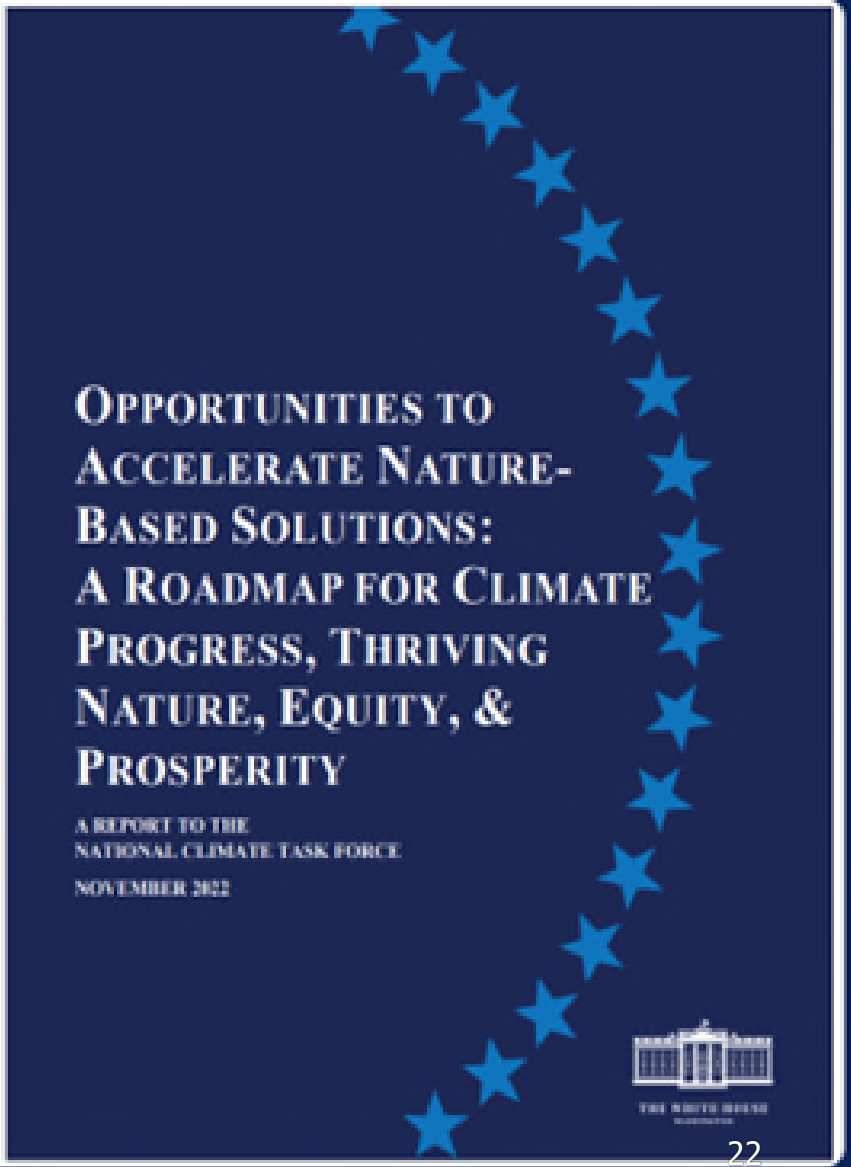
Heather Tallis, PhD

- Assistant Director for Biodiversity and Conservation Sciences
- Acting Director of the National Nature Assessment
- The White House Office of Science and Technology Policy, Washington, DC

"Solving With Nature"

National Nature-Based Solutions Roadmap

- All-of-government recommendations to unlock full potential of nature-based solutions
- **Nature-based solutions should be go-to options** for climate, equity, prosperity—and we know how to get there



Scope of the National Nature Assessment

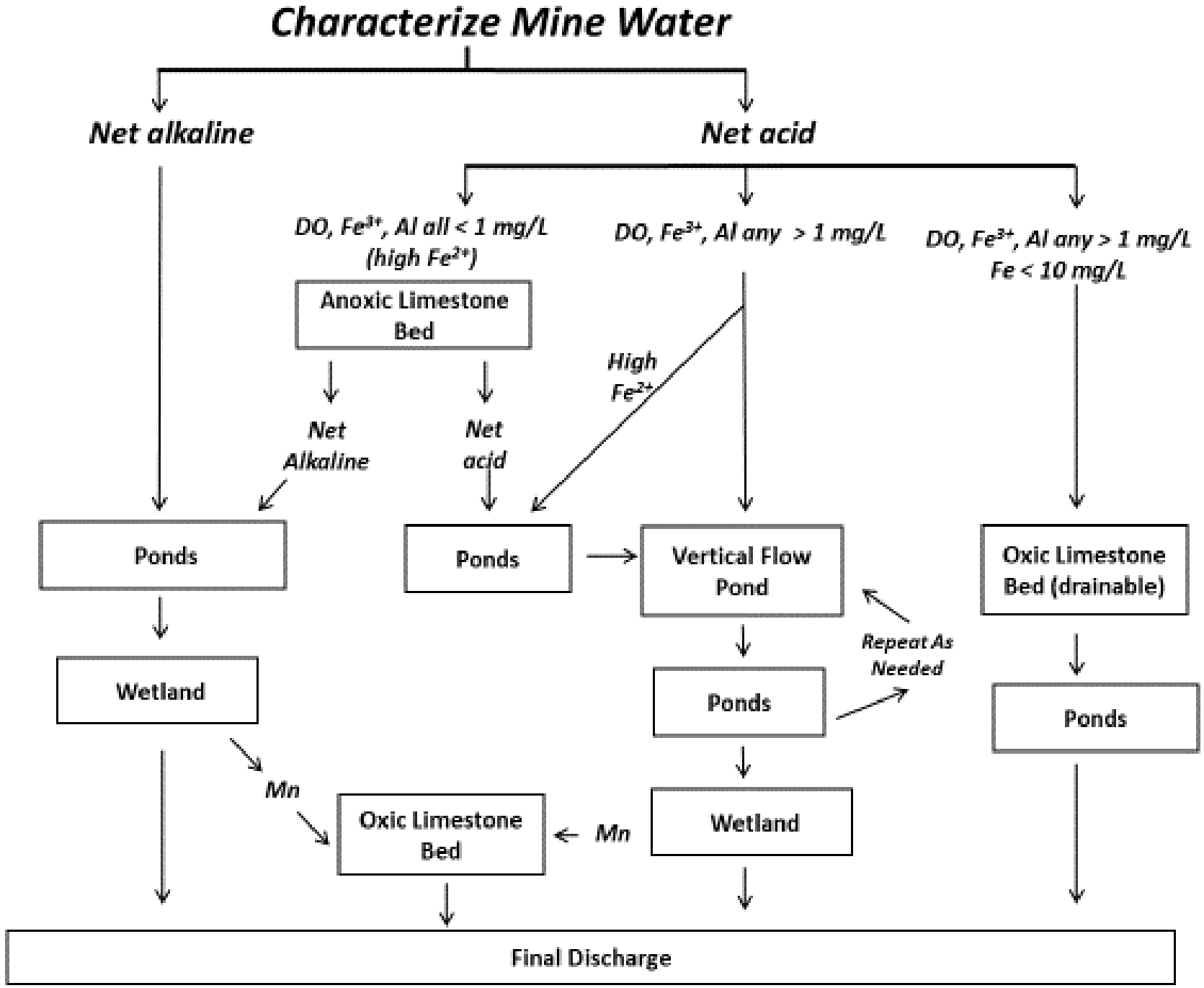
Assess the status, observed trends, and future projections of U.S. lands, waters, wildlife, biodiversity and ecosystems and the benefits they provide, including connections to the economy, public health, equity, climate mitigation and adaptation, and national security.

"*Engineering the Nature of Change*"
Distinguished Speaker Seminar Series

Robert S. Hedin, PhD

- President
- Hedin Environmental, Pittsburgh, PA

"Form Follows Function: Lessons from Passive Mine Water Treatment Systems"


Characterize Mine Water
Net alkaline
Net acid
DO, Fe3+, Al all < 1 mg/L
(high Fe2+)
DO, Fe3+, Al any > 1 mg/L
DO, Fe3+, Al any > 1 mg/L
Fe < 10 mg/L
Anoxic Limestone Bed
High Fe2+
Net Alkaline
Net acid
Ponds
Ponds
Vertical Flow Pond
Oxic Limestone Bed (drainable)
Repeat As Needed
Wetland
Ponds
Ponds
Mn
Oxic Limestone Bed
Mn
Wetland
Final Discharge


Pond 1
Pond 2
Pond 3
Pond 4
Pond 5
Wingfield Pines holding ponds
Wetland
Wetland
Wetland
Final effluent

"*Engineering the Nature of Change*"
Distinguished Speaker Seminar Series

Stephanie Lansing, PhD

- Professor and Associate Chair, Department of Environmental Science and Technology, University of Maryland, College Park, MD
- President, American Ecological Engineering Society

"Ecological Engineering and Restoring Our Circular Economy"

Regenerative Food Systems

Create food to meet people's nutritional needs.

- Create healthy soils
- Improve biodiversity
- Mitigate climate change

Benefits to nature & people - the foundations of Ecological Engineering

Anaerobic Digestion – Waste to Energy

Completely Stirred Digester for Dairy Manure, Food Waste, and Maize Silage - Stuttgart, Germany

"*Engineering the Nature of Change*" Distinguished Speaker Seminar Series

William J. Mitsch, PhD

- Distinguished Professor Emeritus and Founding Director, Olentangy River Wetland Research Park, The Ohio State University, Columbus, OH
- Eminent Scholar and Director, Everglades Research Park and Juliet C Sproul Chair for Southwest Florida Habitat Restation, Florida Gulf Coast University, Fort Myers, FL

"Troubled Waters and Troubled Planet: Five Decades Since the First Earth Day"

More than 750 aquatic ecosystems worldwide currently suffer from degraded conditions due to urban and agricultural inflows that cause water quality degradation—often referred to as hypoxic or harmful algal blooms due to nitrogen and phosphorus

Wetlaculture Mesocosms
Buckeye Lake, Central Ohio
Constructed 2016-17

"Engineering the Nature of Change" Distinguished Speaker Seminar Series

- Final Panel Discussion

"What Role Can Universities Play in Advancing Engineering With Nature and Nature-Based Solutions"

- Multidisciplinary panel
- Open conversation
- Over 100 on-ground and online participants

William J. Mitsch, PhD
Professor Emeritus, Florida Gulf Coast University and The Ohio State University

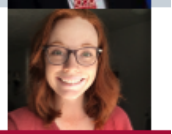
Zev Trachtenberg, PhD
OU Professor, Philosophy and Director of Environmental Studies

Kelly Dixon
Director, Land Protection Division, Oklahoma Department of Environmental Quality

Kendra Dresback, PhD
OU Research Assistant Professor, School of Civil Engineering and Environmental Science

Robert C. Knox, PhD
OU Professor, School of Civil Engineering and Environmental Science

M'Kenzie Dorman
OU Graduate Research Assistant and PhD candidate, Center for Restoration of Ecosystems and Watersheds



For more information or accommodations, please contact Dayton M'Kenzie Dorman (dayton.m.dorman-1@ou.edu)

Next Steps

In the words of our experts…

- "We can not solve our 21st century challenges with 20th century solutions." – *Todd Bridges*
- "Don't settle for part way. Fight to do things right, to make sure that you're confident the treatment system is designed right and is built right. Focus on failure. It's easy to go through that flowchart and say, Okay, we need to build a pond and a wetland. That's the first 10% of the planning. The other 90% is thinking about why is that going to fail?" – *Bob Hedin*
- *What is the one thing we need to move these ideas forward*?

  "Imagination." – *Kelly Dixon*

New Tenure-Track Faculty Position

- Institutional commitment from Gallogly College of Engineering Dean and Senior Vice President and Provost

  "*tenure track faculty position at the Assistant Professor level in Environmental Science, Environmental Engineering, or a related discipline with* ***a focus on Engineering With Nature (EWN), Ecological Engineering, or Natural Infrastructure***"

- Planned fall 2023 start

EWN Graduate Certificate

- 12-hour micro-credential
- Advanced inquiry into defined area of study
- For degree-seeking students
  - indicates area of specialization
- For professionals
  - provides evidence of special expertise
- Addition to existing on-ground and online programs

Possible classes

- *Ecological Engineering Science*
- *Watershed Management and Restoration*
- *River Morphology and Natural Stream Restoration*
- *Wetlands Science and Management*
- *Nature-Based Solutions*

Consideration of full degree

- Undergraduate or graduate level
- Curricular challenges
  - Inherently multidisciplinary
  - Depth vs. breadth
- Proper academic home

- "I never really thought about ideas like these before this class. It really opened my eyes to possibilities for the future of people and our planet."

– CEES 4970 undergraduate student

Thanks!

- CEES/GCoE Staff
  - Molly Smith, Laura Swan, Deanna Amidon
  - Karen Kelly, Lorene Robinson
- Distinguished Speakers
- Public lecture attendees

OFFICE OF THE
SENIOR VICE PRESIDENT *and* PROVOST
The UNIVERSITY *of* OKLAHOMA HEALTH SCIENCES CENTER

OFFICE OF THE SENIOR VICE PRESIDENT AND PROVOST
PRESIDENTIAL DREAM COURSE
The UNIVERSITY *of* OKLAHOMA

GALLOGLY COLLEGE OF ENGINEERING
The UNIVERSITY *of* OKLAHOMA

GALLOGLY COLLEGE OF ENGINEERING
SCHOOL OF CIVIL ENGINEERING AND ENVIRONMENTAL SCIENCE
The UNIVERSITY *of* OKLAHOMA

The "*Engineering the Nature of Change* " students!

CREW
Center for Restoration of Ecosystems and Watersheds
The University of Oklahoma