Phosphorus Forum 2019

April 5, 2019
Barrett and O'Connor Washington Center
at Arizona State University
1800 I Street NW
Washington, DC,

phosphorusalliance.org
#PhosForum19

Made possible by the support of our members:

Founding/Current Members and Strategic Partners

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THE SUSTAINABILITY CONSORTIUM™
RENEWABLE NUTRIENTS
GreenEdge® GreenTechnologies, LLC
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Consultants Associated With Brookside

Strategic Partners

AgSTAR
Water Environment Federation the water quality people
nebra North East Biosolids & Residuals Association

Sustainable Phosphorus Alliance

Agenda

8:30 – 9:00	Welcome from Jim Elser
9:00 – 9:45	Keynote from Bruce Rittmann
9:45 – 10:00	Coffee sponsored by Ostara
10:00 – 10:30	Phosphorus Field-to-Watershed Modeling Task Force Report by Peter Vadas
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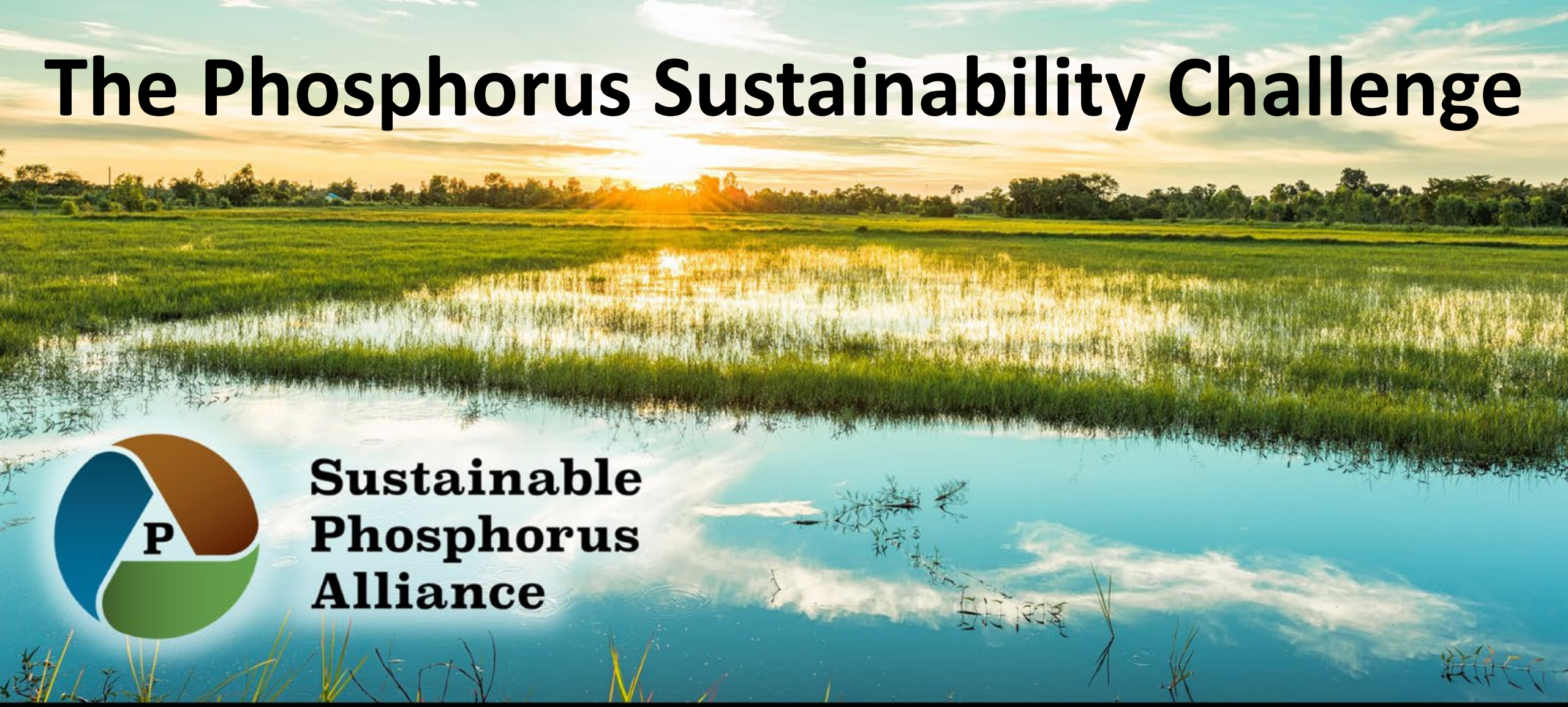
The Phosphorus Sustainability Challenge

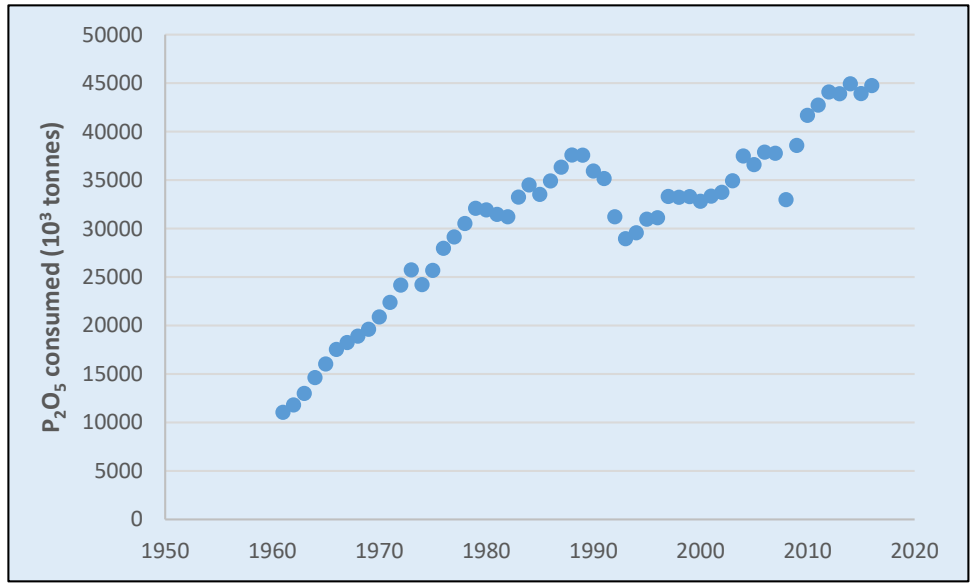


Sustainable Phosphorus Alliance

Green Phosphorus | Blue Water

The Demand Problem

Phosphorus consumption has increased…



and it's wreaking havoc on our waters

40% of lakes were in the "most disturbed" condition for total phosphorus (NLA 2012)

18.2% decline in the percentage of lakes with < 10 ppb P between 2007 and 2012

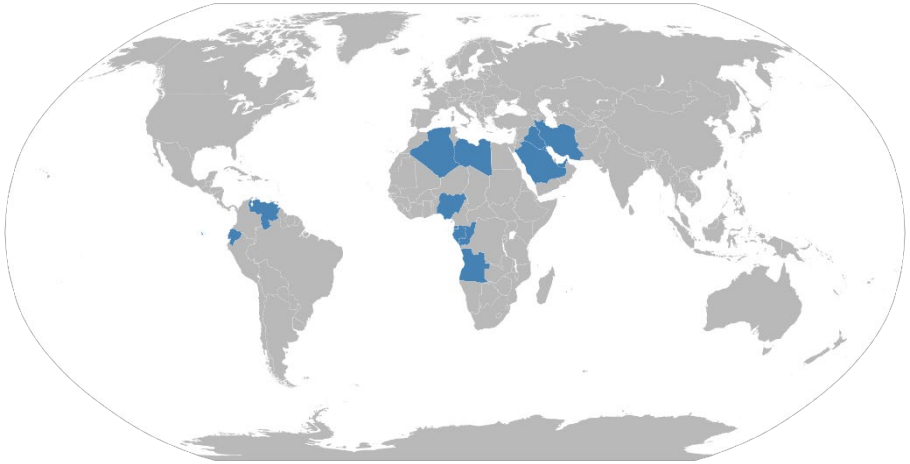
46% of US rivers and streams (by length) had "high" levels of phosphorus (NRSA, 2009)

Phosphorus is the most important pollutant of our most important natural resource and commodity.

The Supply Problem

"World resources of phosphate rock are more than 300 billion tons. There are no imminent shortages of phosphate rock." – USGS, Mineral Commodity Summaries 2018

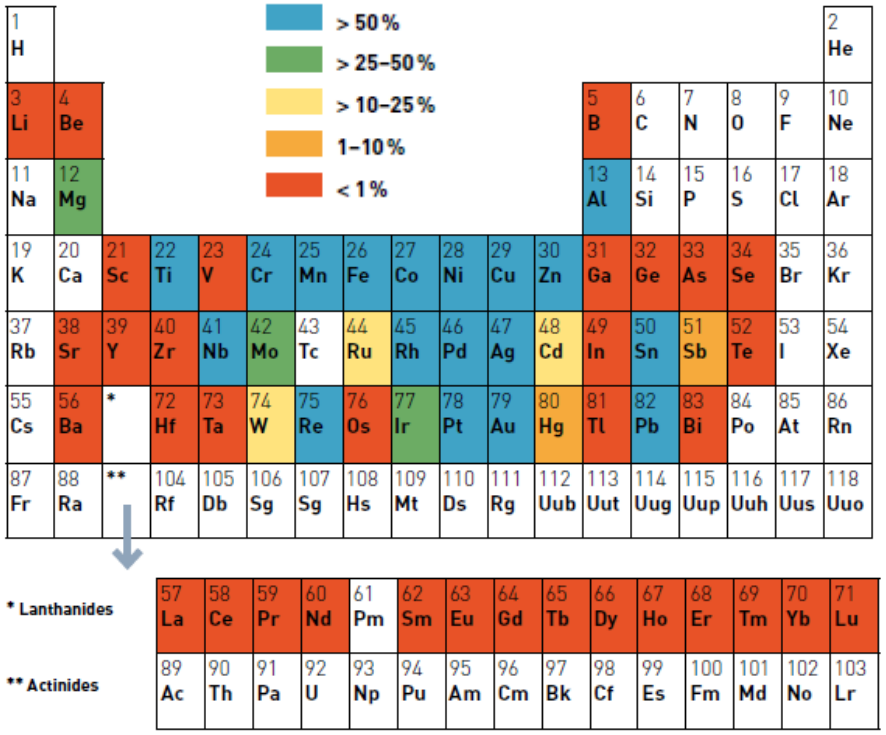
"The reserve/production ratio…is about 266, which is one of the largest among all mineral commodities." – Scholz and Wellmer, 2019



82% of global crude oil reserves here

71% of global phosphate rock reserves here

A Note on Recycling



Post-consumer functional recycling for 60 metals.
UNEP, 2011. Data from 2000-2005.

"rates tend to reflect the degree to which materials are used in large amounts in easily recoverable applications…or where high value is present."

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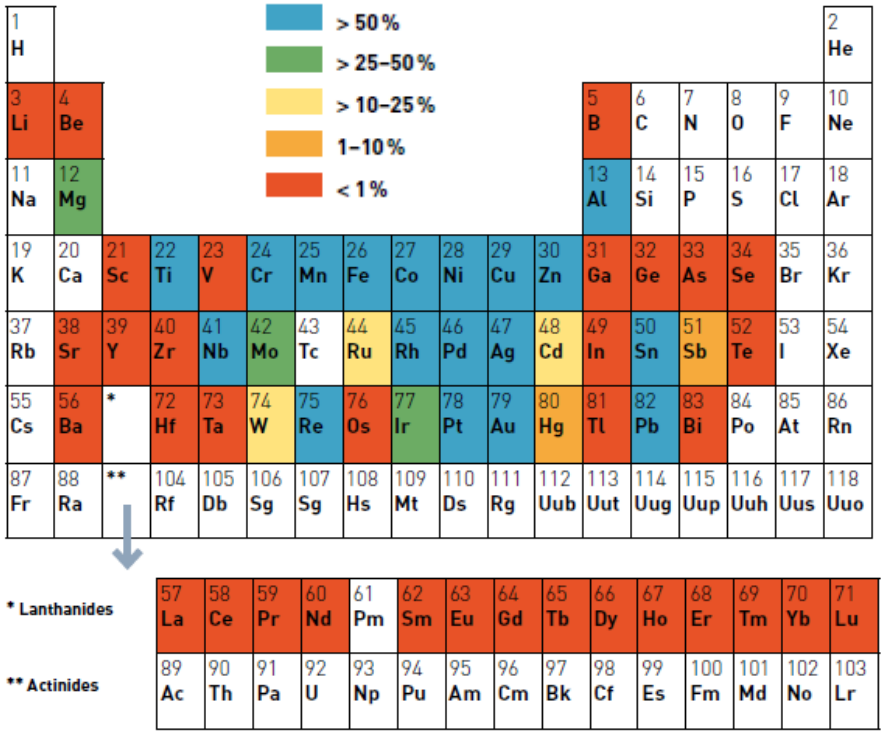

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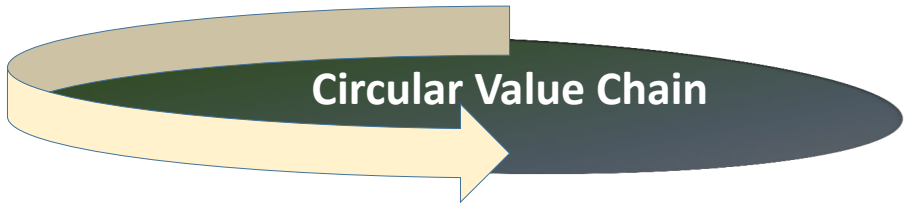
"rates tend to reflect the degree to which materials are used in large amounts in easily recoverable applications…or where high value is present."

Recycling phosphorus is critical, but let's not pin all of our hopes on a circular economy for phosphorus.

The Circular Economy

"A circular economy is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life."

-- UK WRAP



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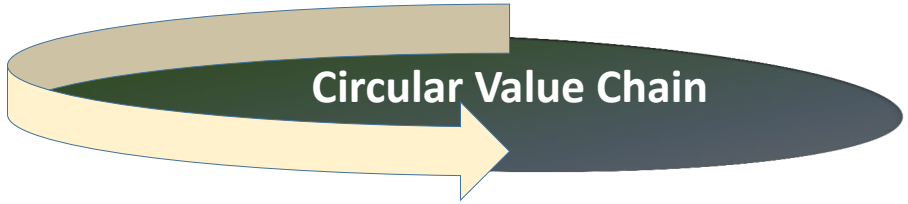

Breaking news! Paper now infinitely recyclable!

The Conical Economy

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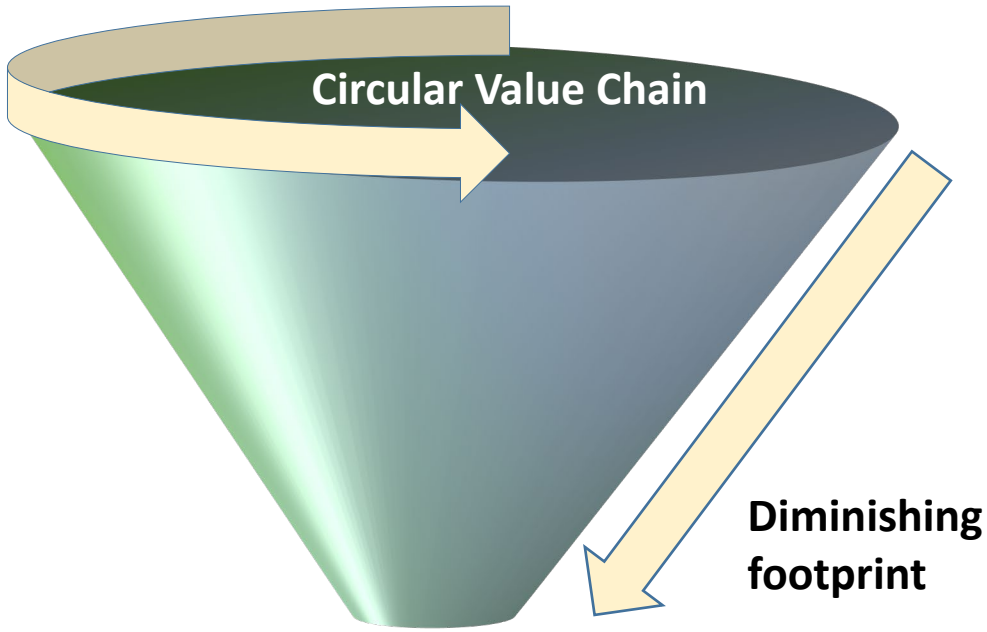
A conical economy is a circular economy that emphasizes reducing the consumptive footprint of the value chain (i.e. sustainable use and *sustainable* recycling).



Conical Approach

The **Sustainable Phosphorus Alliance** is a **members** organization that serves as North America's central forum and advocate for the sustainable use, recovery, and recycling of phosphorus in the food system.

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There Is No P in CSR

Pivot Goals

The sustainability goals of the world's largest and leading companies:
An initiative of Winston Eco-Strategies

Total Number of Goals: 3923

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GHG/Climate/Energy Goals:	1246
Deforestation/Paper Goals:	133
VOC Emission Goals:	28

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Phosphorus is the most important pollutant of our most important natural resource and commodity.

Activities

Company	#CSR P Mentions	#CSR Nutrients Mentions	Notes
Cargill	0	0	Improve water quality through sustainable agriculture (nutrient focus)
ADM	0	0	Waste-to-landfill reduction and sustainable agriculture
PepsiCo	0	0	Sustainable agriculture (nutrient focus) and wastewater management
Nestle	1	0	Wetland restoration, sustainable agriculture, water stewardship
Sysco	0	2	Sustainable agriculture (fertilizer reduction) and recycling vegetative waste
JBS	0	3	

Introducing….

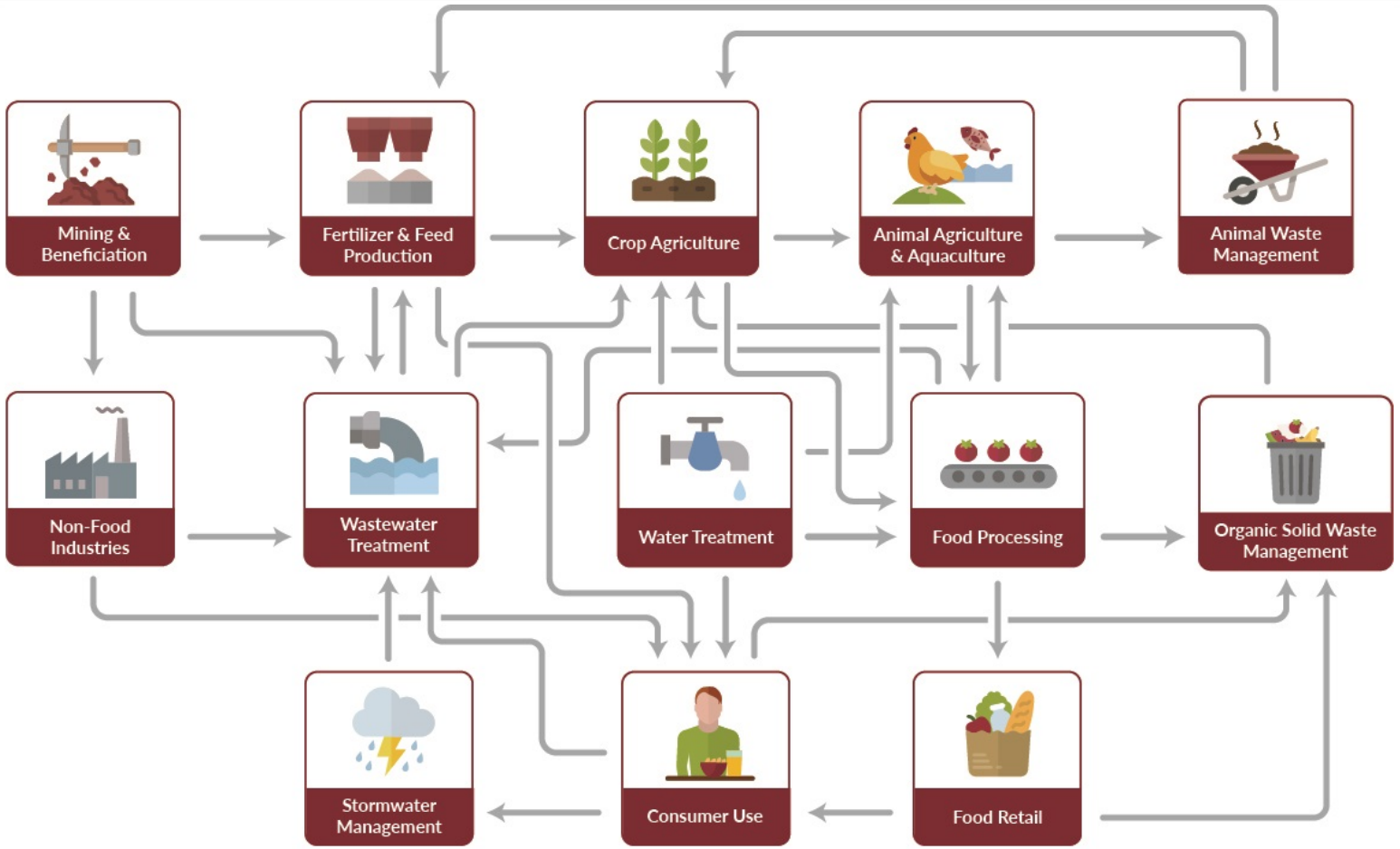
Psustainabilitychallenge.org
#phosphoruschallenge

Raise awareness about the issues and give credit to those addressing them.

Provide a public commitment platform for any organization.

Organize action networks to define sustainability and how to best measure and report it.

Who Needs to Get Involved?



How Does It Work?

- A framework has been built that includes a set of high level goals and specifications for commitment formation (see provided materials)
- Organizations submit commitments via web and we vet for compliance
- Commitments are promoted
- Action networks develop around “hot” issues

How Are Commitments Framed?

Challenge Rules

Applicants must make either a **new commitment** or state **an existing commitment** that has yet to be achieved or publicized.

Commitments **must exceed** regulatory compliance requirements in pertinent jurisdiction(s).

Commitments must address **at least one** of the key phosphorus sustainability goals identified. Organizations may also petition to add **additional goals,** subject to review by Alliance staff.

SMART

Commitments must be **SMART**: Specific in aim, Measurable, Ambitious, Relevant to the Challenge goals, and Time-bound.

Commitments **must include implementation**, that is, commitments to R&D and innovation alone are ineligible. Implementation means that a technology or approach has reached market/rollout after pilot-scale or field trials.

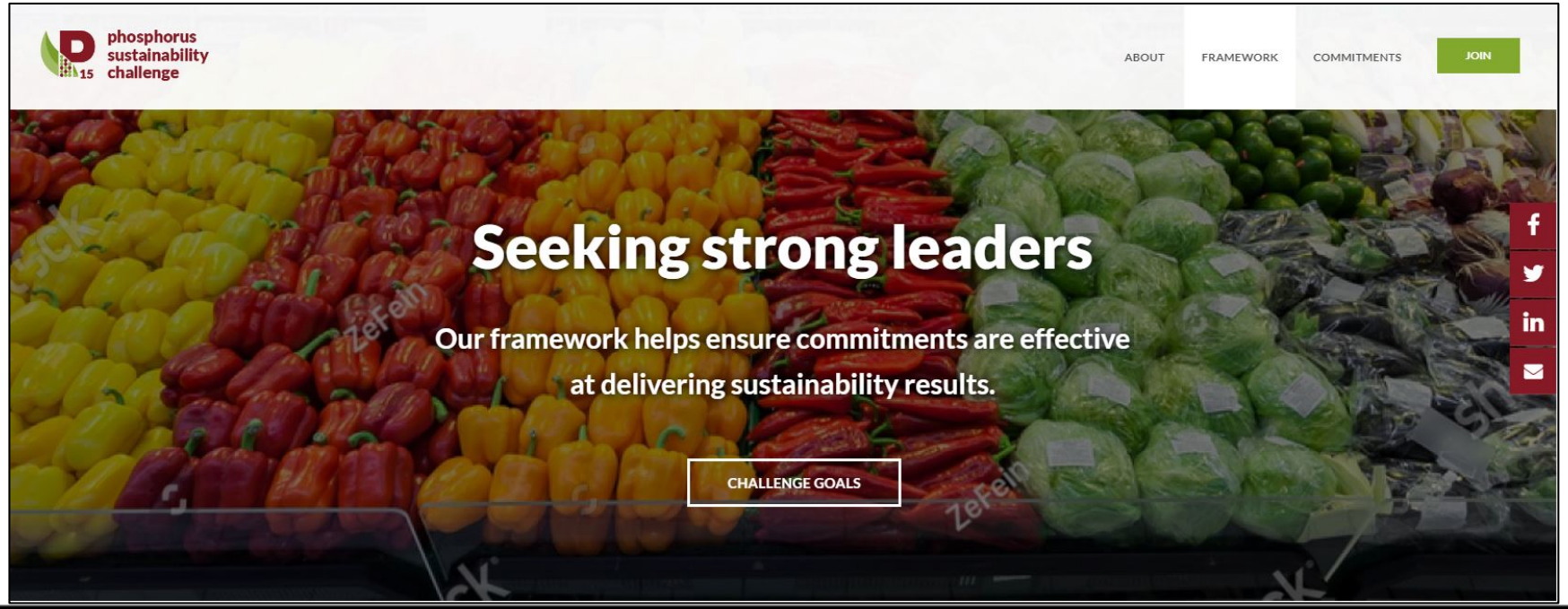
Organizations must enter commitments about which progress can be reported on **annually.**

How Are Commitments Verified?

- Independent verification is acknowledged/encouraged but not mandated
- Commitments are public and misrepresentation will lead to expulsion
- Action networks may agree to a verification framework

How Is News Disseminated?

- Social Media: Twitter, LinkedIn
- Participant promotion: horn tooting via own marketing channels
- YOU! Peer promotion, especially by social media and word of mouth



Endgame: The Conical Economy for Phosphorus

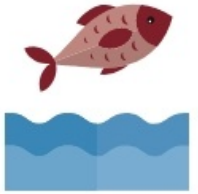
Communities get cleaner water for drinking and recreation

Farms and industries reduce water supply risks

Innovators sell their sustainable products and services

Farms and utilities save on compliance

Taxpayers save on remediation costs



Biodiversity flourishes in healthy waters

Let's get 100 Pivot Goals to address phosphorus pollution

Group Activity

Let’s take 5 minutes to read the Challenge Goals

Activities for each table (20 min)

Write a hypothetical commitment from either a governmental body or corporation that conforms to the specifications and discuss:

1. what challenges someone might face gaining internal buy-in from his/her organization and
2. how we might best help them make the case

Reports to room (20 min)

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1. Use phosphorus on landscapes, including cropland, more judiciously
2. Use phosphorus in animal feeding operations, including aquaculture, more judiciously
3. Sustainably re-use / recycle phosphorus
4. Remove phosphorus from human and animal waste streams
5. Reduce food system waste and recover its phosphorus
6. Recover phosphorus pollution from surface waters
7. Reduce and recover phosphorus wastes from industrial processes
8. Manage landscapes to contain and recover phosphorus
9. Promote human diets with lower phosphorus footprints
10. Improve the efficiency of phosphorus extraction from rock and conversion to products

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Biochar Now

Algae Removal Program

OMRI certified

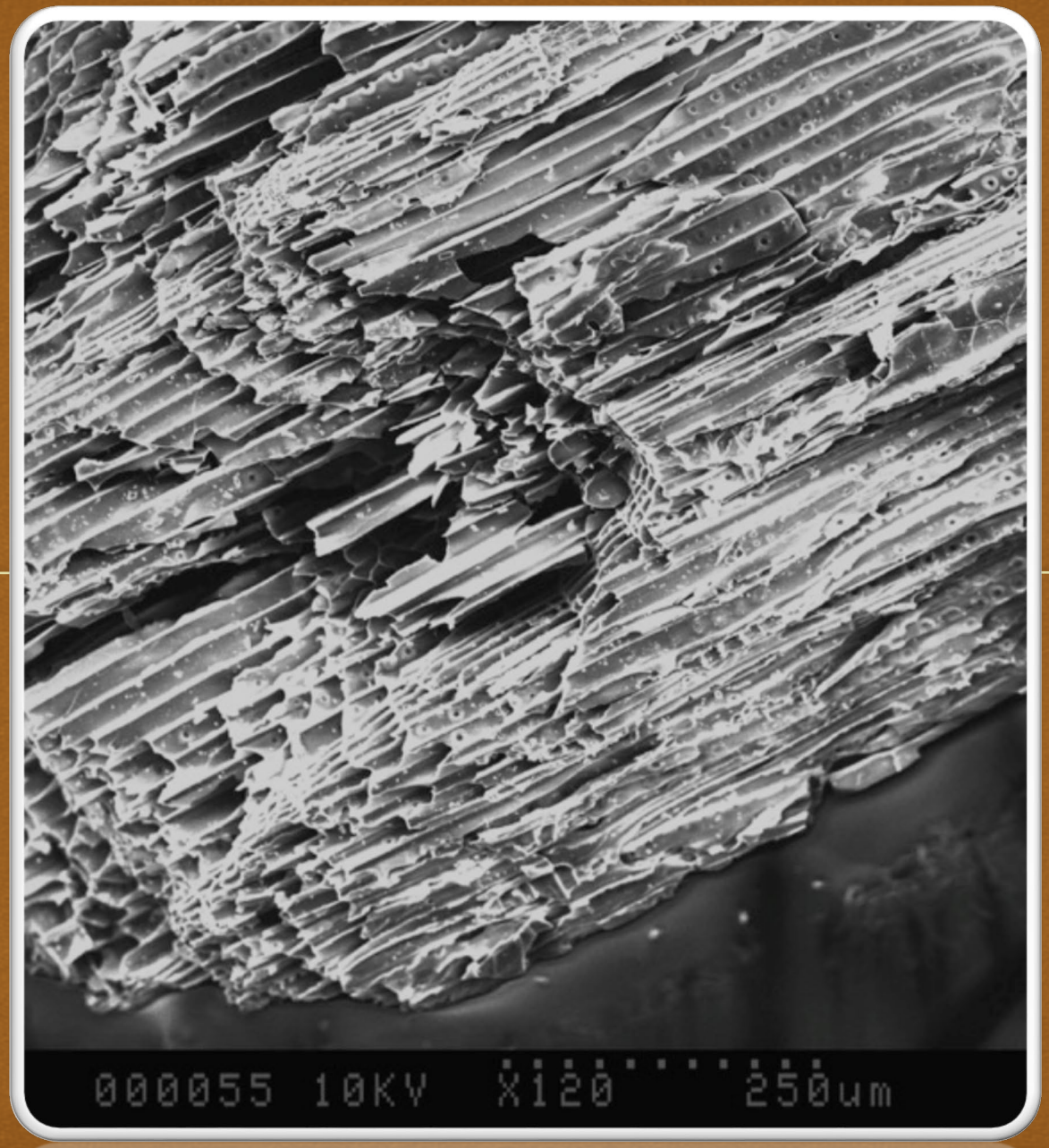
USDA Bio-preferred

TSCA Listed

Biochar – Sized for water application

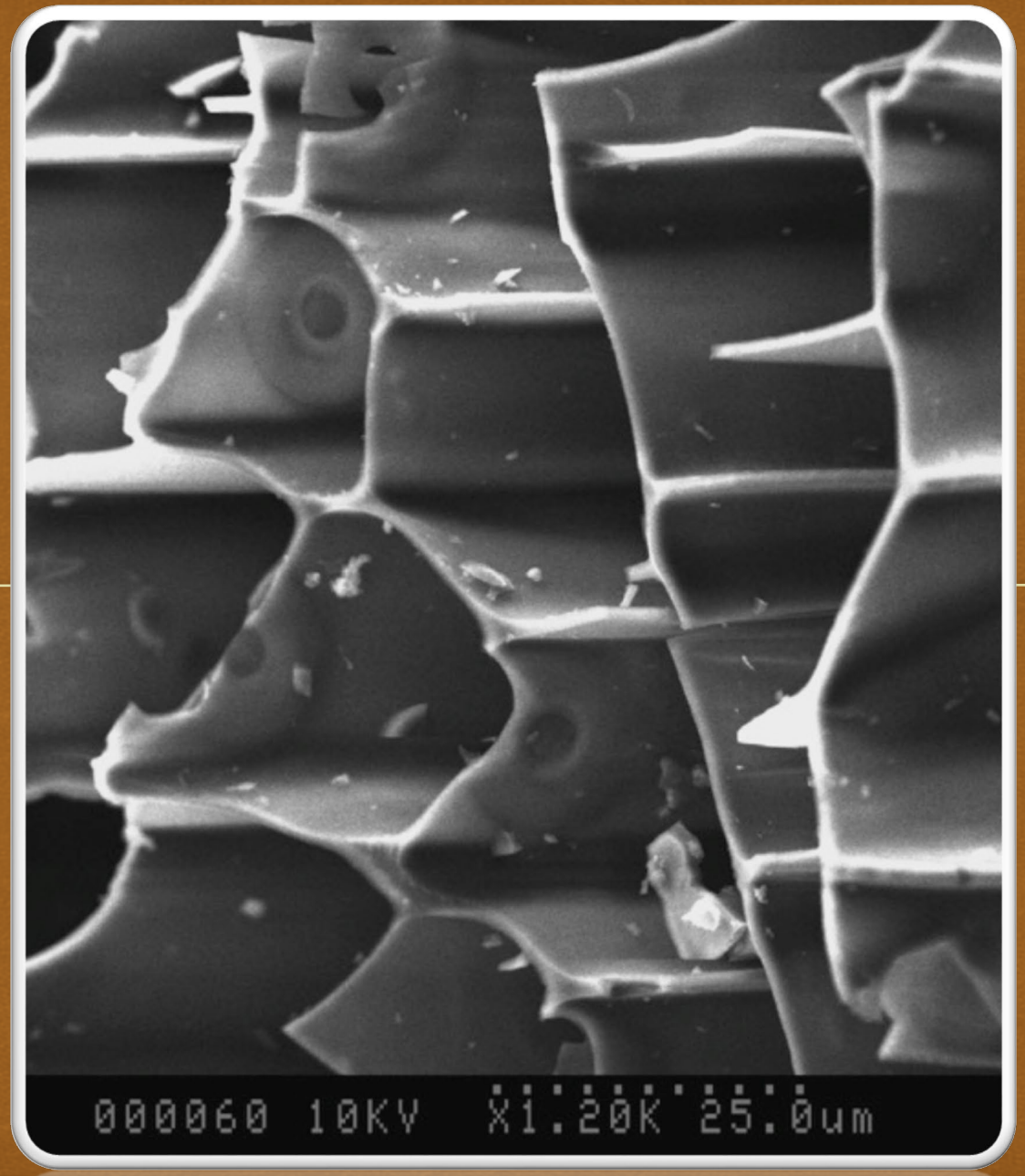
Biochar Now

120X



Biochar Now

1200X



Proven Product

Ag Nutrients Removed from Dirty Water Solutions Using Biochar Now biochar Independent Test Results			
Nutrients		**Starting mg/L**	**% Adsorbed**
Phosphorus	non-soluble P	27	99.9%
Phosphorus	P	27	99.8%
Phosphate	PO4-P	284	86.6%
Ammonia	N	1.1	89.7%
Nitrate	NO3-N	52	64.3%

Solids Removed from a Dirty Water Solutions Using Biochar Now biochar Independent Test Results			
Solids		**Starting mg/L**	**% Removed**
Turbidity	NTU*	68 NTU	99.9%
Phosphorus	Non-soluble P	27	99.9%
Solids	SS	506	80.2%

Water holding capacity = 5.6 x the weight of biochar

Proven Product

Metals and Other Materials Removed from a Dirty Water Solutions Using Biochar Now biochar Independent Test Results			
Metals		**Starting mg/L**	**% Removed**
Aluminum	Al	638	100%
Arsenic	As	203	100%
Barium	Ba	0.17	66.0%
Beryllium	Be	0.16	99.0%
Cadmium	Cd	0.015	100%
Chromium	Cr	166	100%
Cobalt	Co	219	100%
Copper	Cu	1.0	99.7%
Iron	Fe	66	99.6%
Lead	Pb	45	100%
Lithium	Li	0.17	39.0%
Magnesium	Mg	3	69.2%
Molybdenum	Mo	96	100%
Nickel	Ni	211	100%
Selenium	Se	215	100%
Tin	Sn	0.17	100%
Vanadium	V	0.15	75.0%
Zinc	Zn	75	99.7%

Stops Algae Blooms

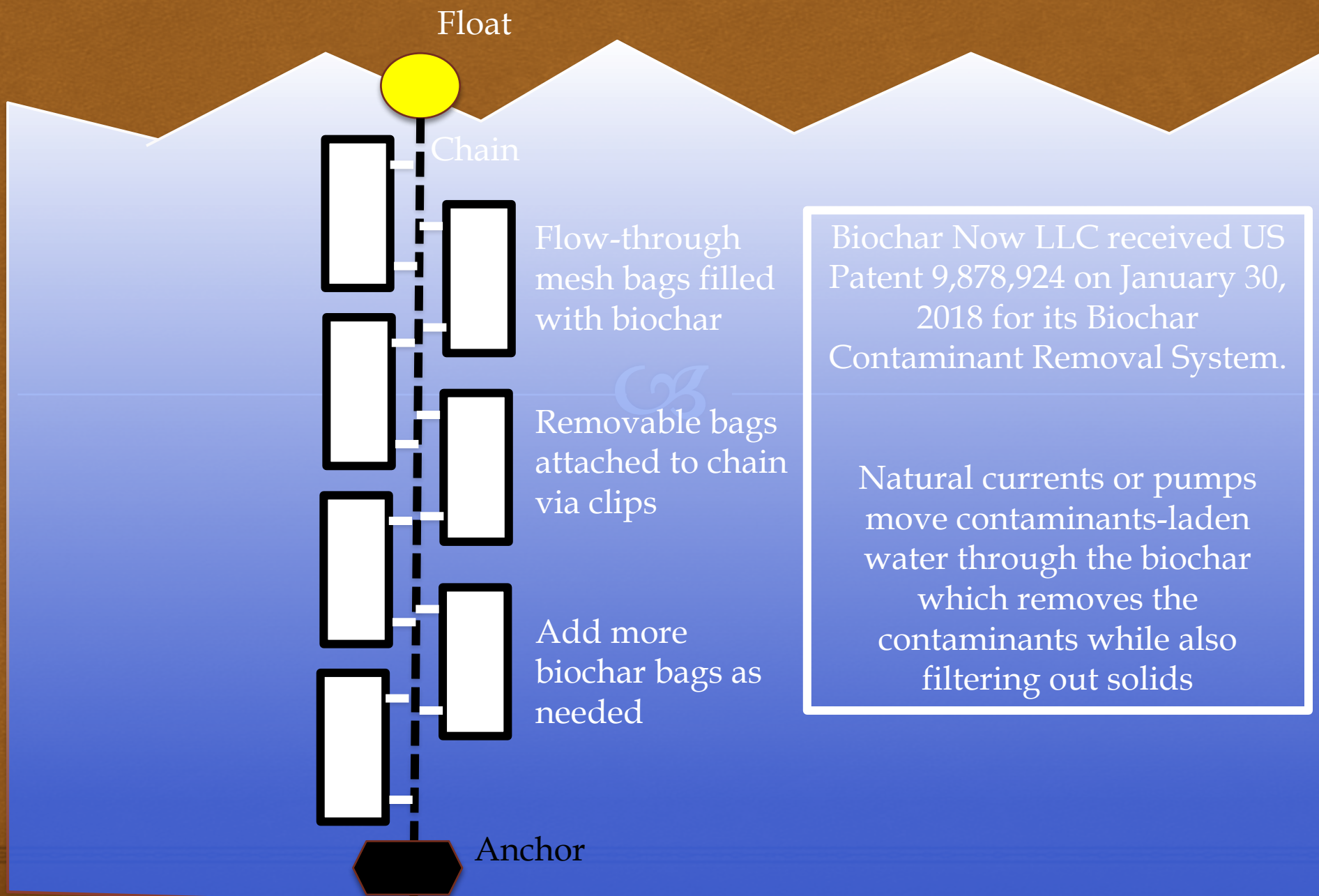
Before

After

Stops Algae Blooms

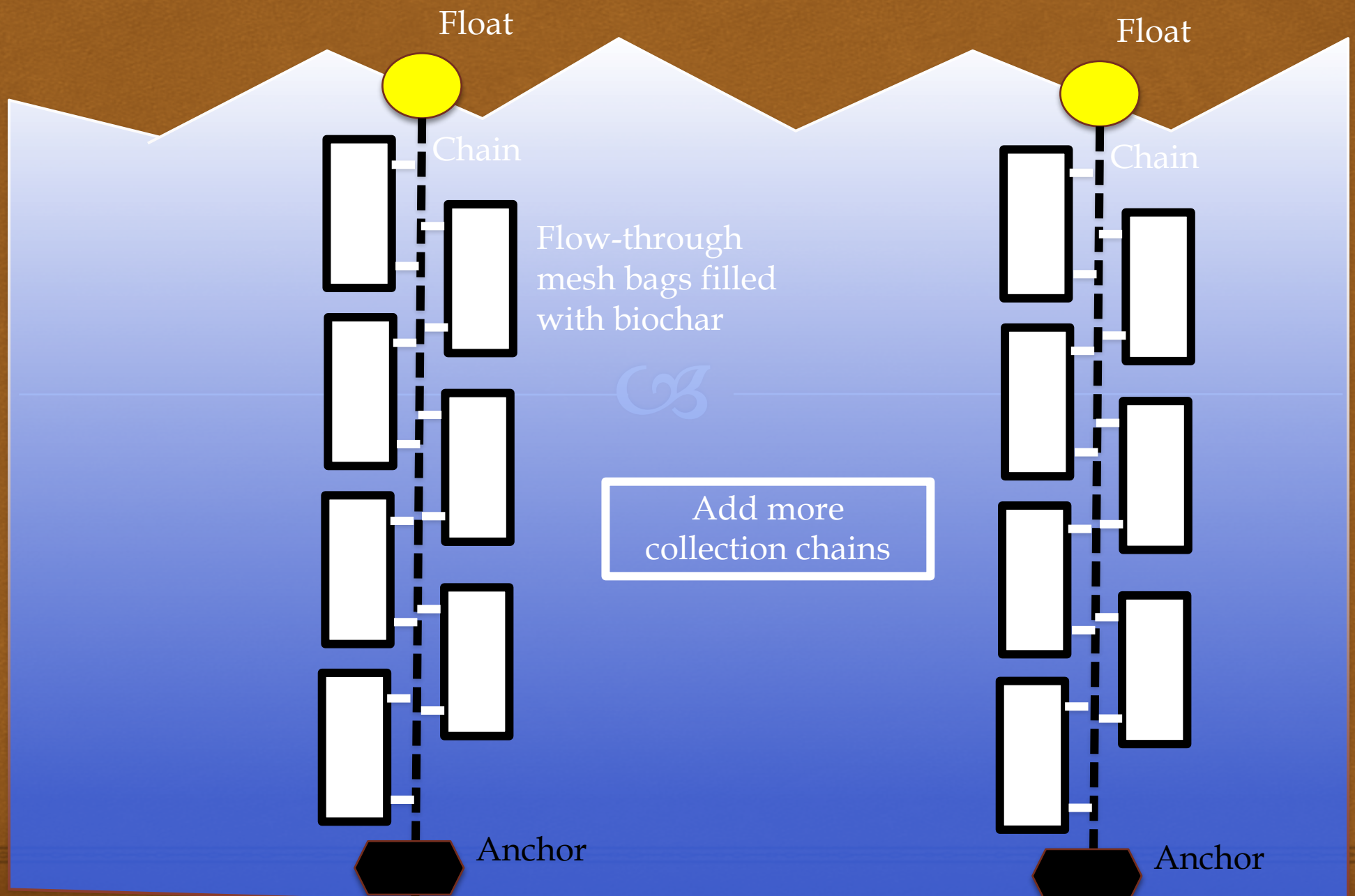
Before

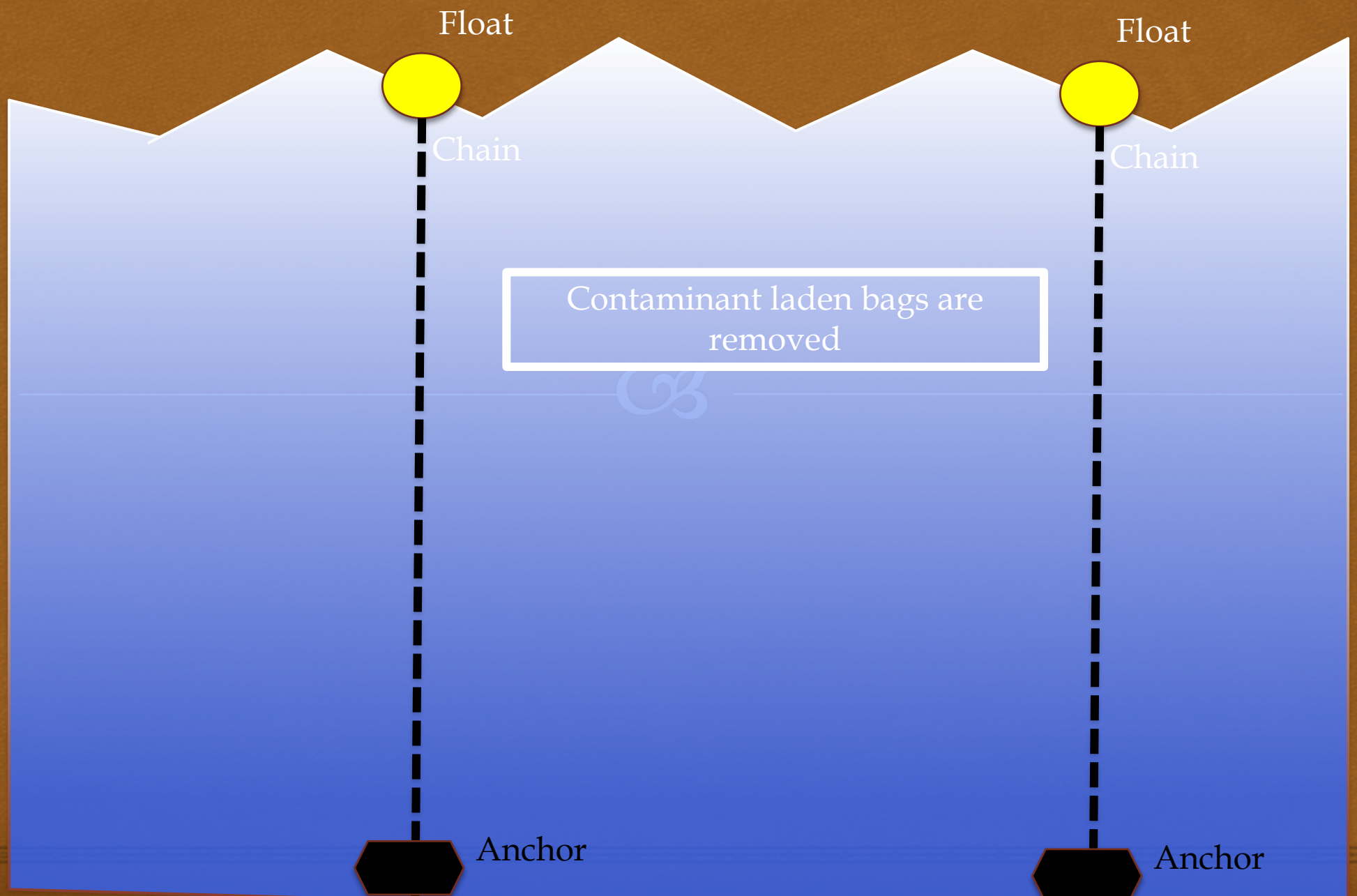
After

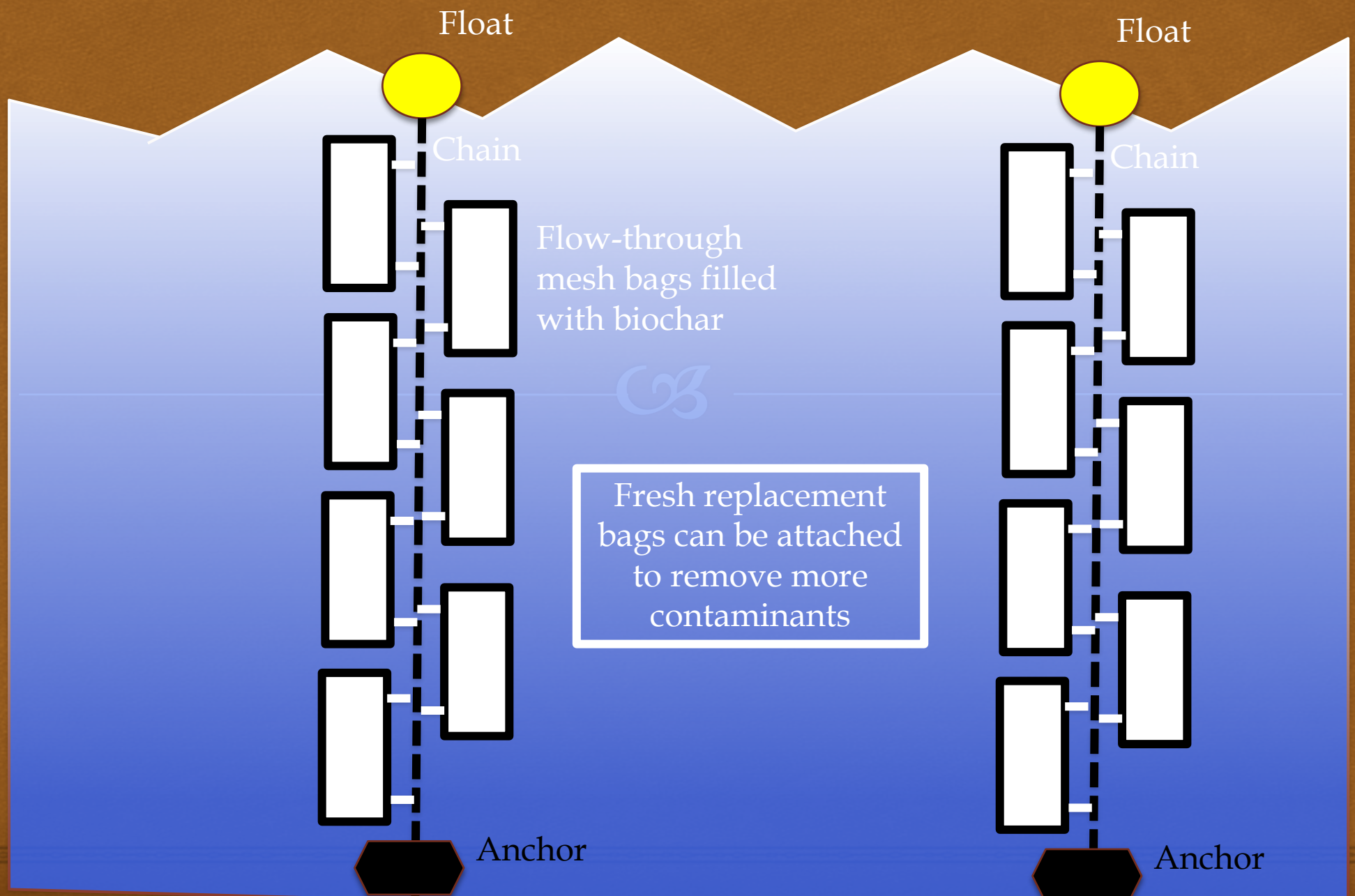


Biochar Now LLC received US Patent 9,878,924 on January 30, 2018 for its Biochar Contaminant Removal System.

Natural currents or pumps move contaminants-laden water through the biochar which removes the contaminants while also filtering out solids

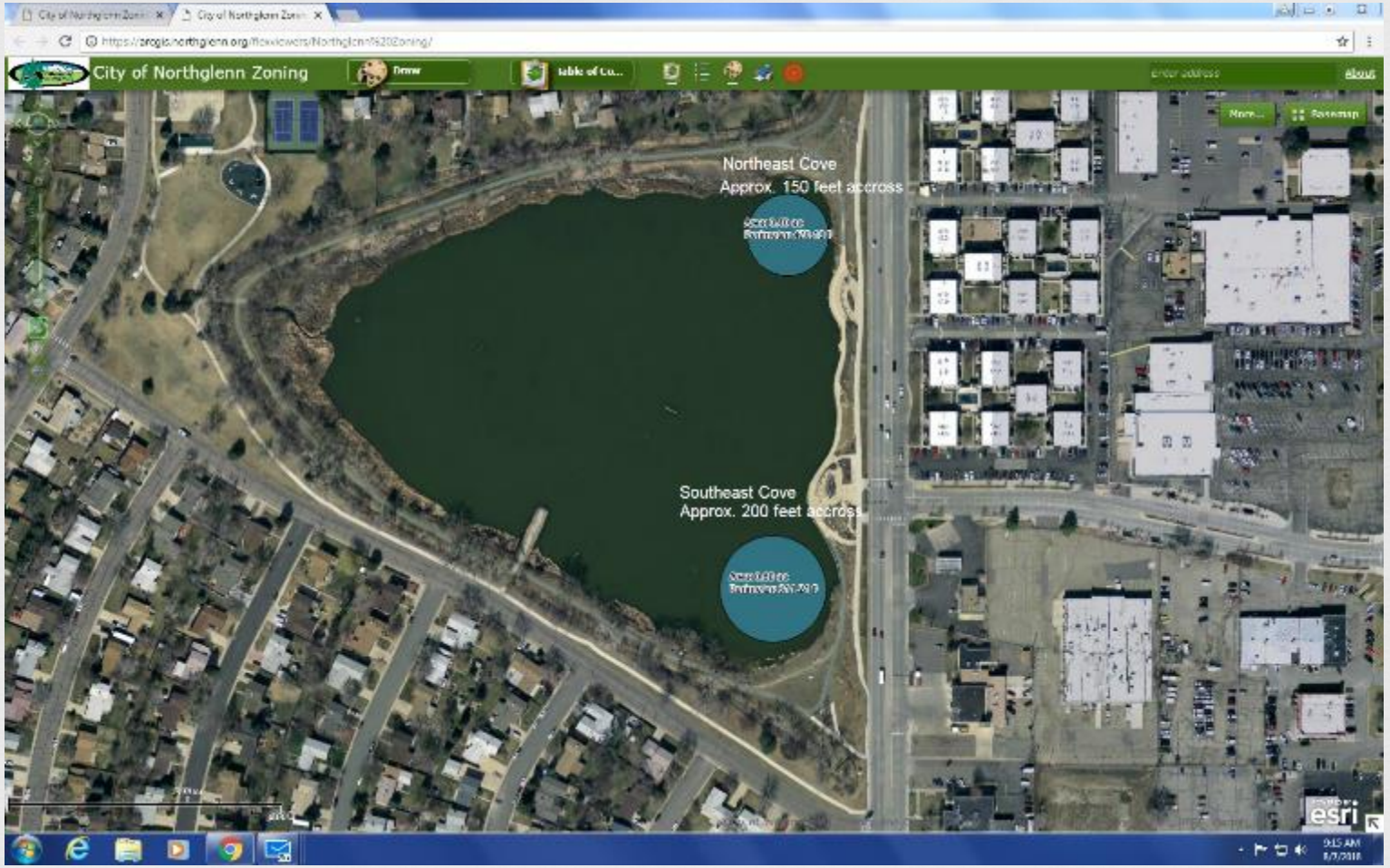

Float
Chain
Flow-through
mesh bags filled
with biochar
Add more
collection chains
Anchor
Float
Chain
Anchor


Float
Float
Chain
Chain
Contaminant laden bags are removed
Anchor
Anchor

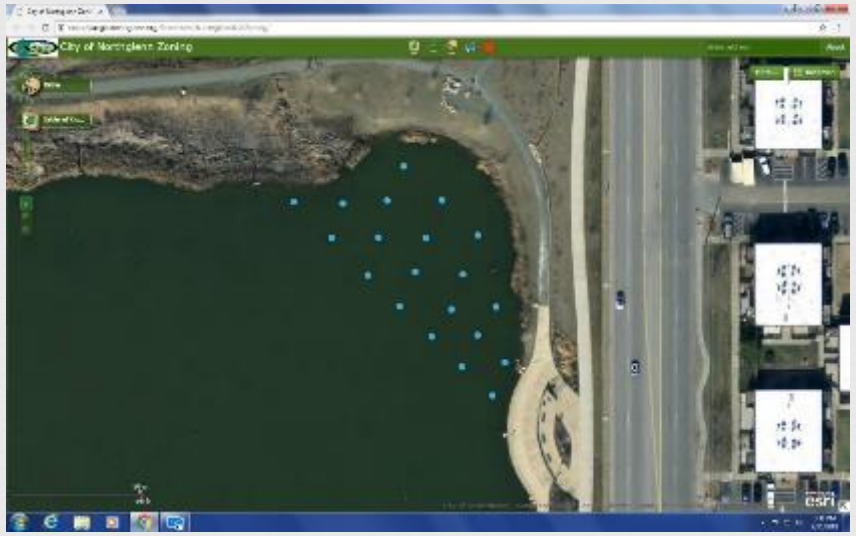

Float
Chain
Flow-through mesh bags filled with biochar
Fresh replacement bags can be attached to remove more contaminants
Anchor
Float
Chain
Anchor

Placing Filter socks in Dairy Lagoon with Floats

Croke Reservoir - Northglenn



Placement of Socks



Placement Day

Can easily configure filters to meet area shape or volume requirements

Remove Biochar Filters and sell into market to recoup costs

- Filters are now nutrient laden and the following slides outline benefits of biochar in agricultural.
- Marketing program is set up with local entities to make public aware of biochar benefits.
- Sell the biochar in local garden centers for home use and directly to large agricultural concerns and lawn care companies.
- Our current sales price in these markets allows for recapture of initial cost of biochar used to adsorb phosphorus and nitrates from water bodies and stop algae blooms.

Cornell Study

Control plot

Amazon River Basin

Native soil, maize corn, no fertilizer, no biochar

Cornell Study

NPK plot

Amazon River Basin

Native soil, maize corn, NPK fertilizer, no biochar

Cornell Study

Biochar with NPK

Amazon River Basin

Native soil, same NPK fertilizer, 10% biochar added

Biochar Increases Tree Root Growth

Root growth of honey locust seedlings growing in compacted soil after 18 months of no treatment (left) and an application of biochar top-dressing (right). Photo: Morton Arboretum Soil Science Laboratory

Lawn & Landscape

Top 20 service companies (2016)

2 of top 4 providers have approved our biochar for national rollout

Top 100 provider market size is $8B

2017 RANK	COMPANY	2016 RANK	2016 REVENUE	HEADQUARTERS	EMPLOYEES	% CHANGE FROM 2015	% CHANGE EXP. FOR 2017
1	BrightView	1	$2,200,000,000	Plymouth Meeting, Pa.	22,000	10%	N/A
2	TruGreen Cos.	2	$1,317,054,000	Memphis, Tenn.	11,444	2%	7%
3	The Davey Tree Expert Company	3	$845,678,000	Kent, Ohio	8,600	3%	5%
4	Bartlett Tree Experts	5	$244,000,000	Stamford, Conn.	1,650	8%	10%
5	U.S. Lawns	7	$168,000,000	Orlando, Fla.	2,000	0%	5%
6 (t)	LandCare	6	$160,000,000	Frederick, Md.	4,000	-10%	0%
6 (t)	Five Seasons Property Management/Asplundh	*	$160,000,000	Philadelphia, Pa.	N/A	N/A	N/A
8	Park West Companies	10	$150,745,000	Rancho Santa Margarita, Calif.	1,615	18%	14%
9	Ruppert Landscape	12	$149,000,000	Laytonsville, Md.	1,275	21%	5%
10	Weed Man	9	$148,826,630	Mississaugua, Ontario	4,050	4%	10%
11	Ferrandino & Son	8	$145,000,000	Farmingdale, N.Y.	350	-3%	7%
12	Yellowstone Landscape	13	$137,500,000	Bunnell, Fla.	1,900	17%	10%
13	Gothic Landscape	11	$130,000,000	Valencia, Calif.	1,500	5%	15%
14	Lawn Doctor	15	$112,000,000	Holmdel, N.J.	1,350	7%	5%
15	Ambius	14	$106,281,790	Reading, Pa.	975	2%	3%
16	Merit Service Solutions	16	$98,000,000	Malvern, Pa.	440	N/A	20%
17	SavATree	17	$89,700,000	Bedford Hills, N.Y.	695	6%	8%
18	Massey Services	19	$74,692,678	Orlando, Fla.	1,892	8%	15%
19	Mainscape	18	$74,019,000	Fishers, Ind.	1,000	4%	0%
20	The Grounds Guys	22	$72,480,000	Waco, Texas	600	25%	20%

Disease Combative Potential

Vinca and Gardenia inoculated with *Phytophthora*

Control

Compost

Biochar

Biochar Retains Toxins and Helps Restore Sterile Soils

END

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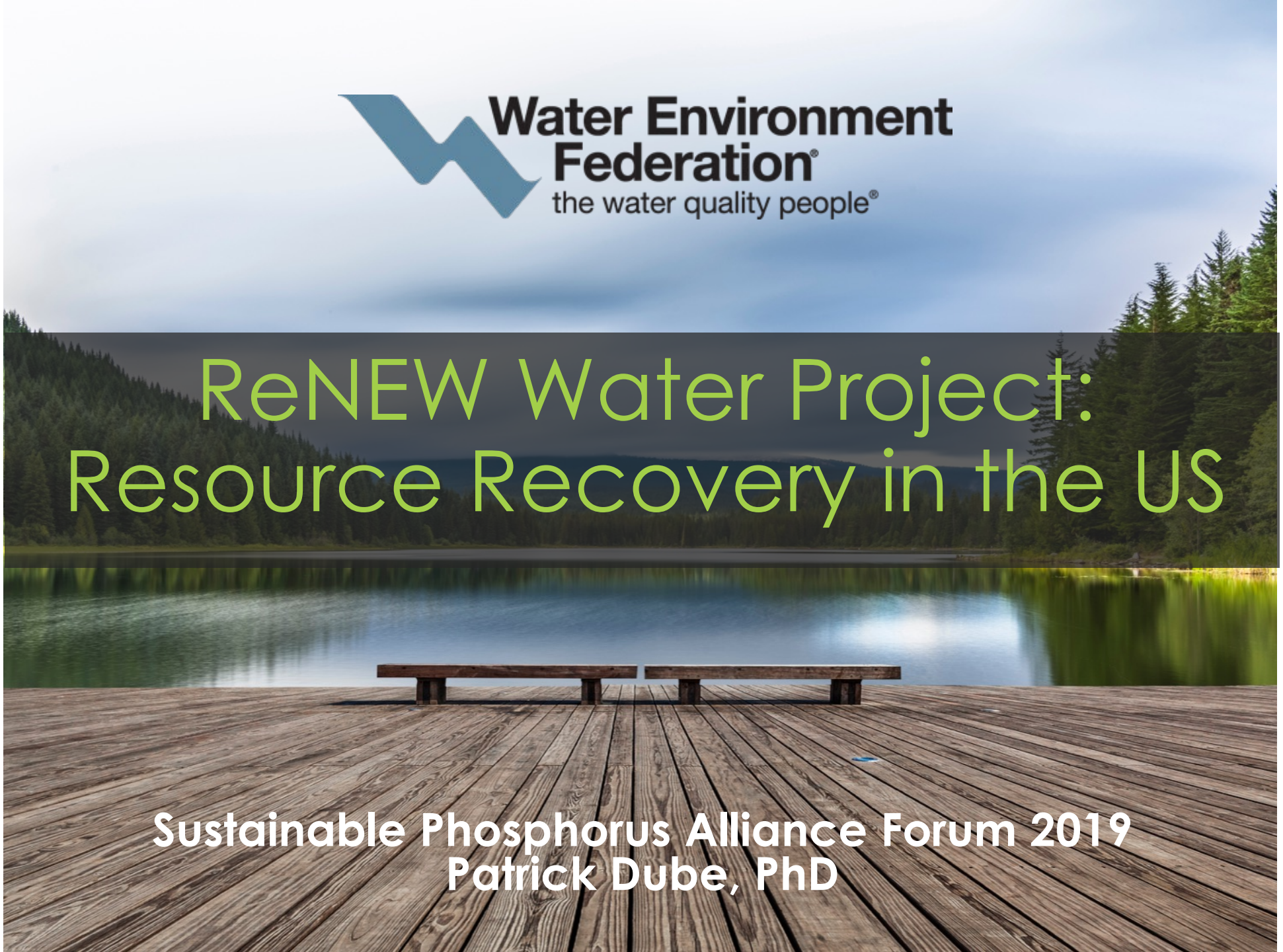


ReNEW Water Project: Resource Recovery in the US

Sustainable Phosphorus Alliance Forum 2019

Patrick Dube, PhD

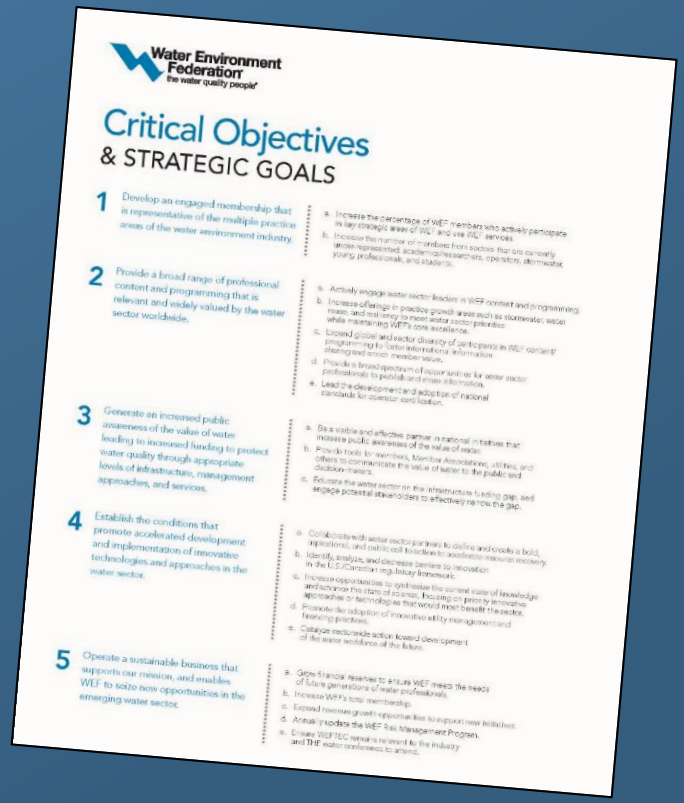
Change our Mind(set)

*Wastewater treatment plants are **NOT waste** disposal facilities, but rather water **resource recovery** facilities that produce **clean water**, **recover nutrients** (such as phosphorus and nitrogen), and have the potential to reduce the nation's dependence upon fossil fuel through the production and use of **renewable energy**.*

WEF's Mission

- Objective 4: Establish the conditions that promote accelerated development and implementation of innovative technologies and approaches in the water sector

- Goal 4a: Drive an increase in resource recovery in the water sector



Water Environment Federation
the water quality people

Critical Objectives
& STRATEGIC GOALS

1 Develop an engaged membership that is representative of the multiple practice areas of the water environment industry.

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ReNEW

WATER PROJECT

Mass Balance Approach

$$\frac{\text{total mass of resource recovered by WRRF}}{\text{total mass of resource that is received and treated at the WRRF}} = \%\ \text{Recovered}$$

Establishing Resource Recovery Baseline

Project Team

carollo

Stantec

University of Colorado Boulder

Supporting Organizations

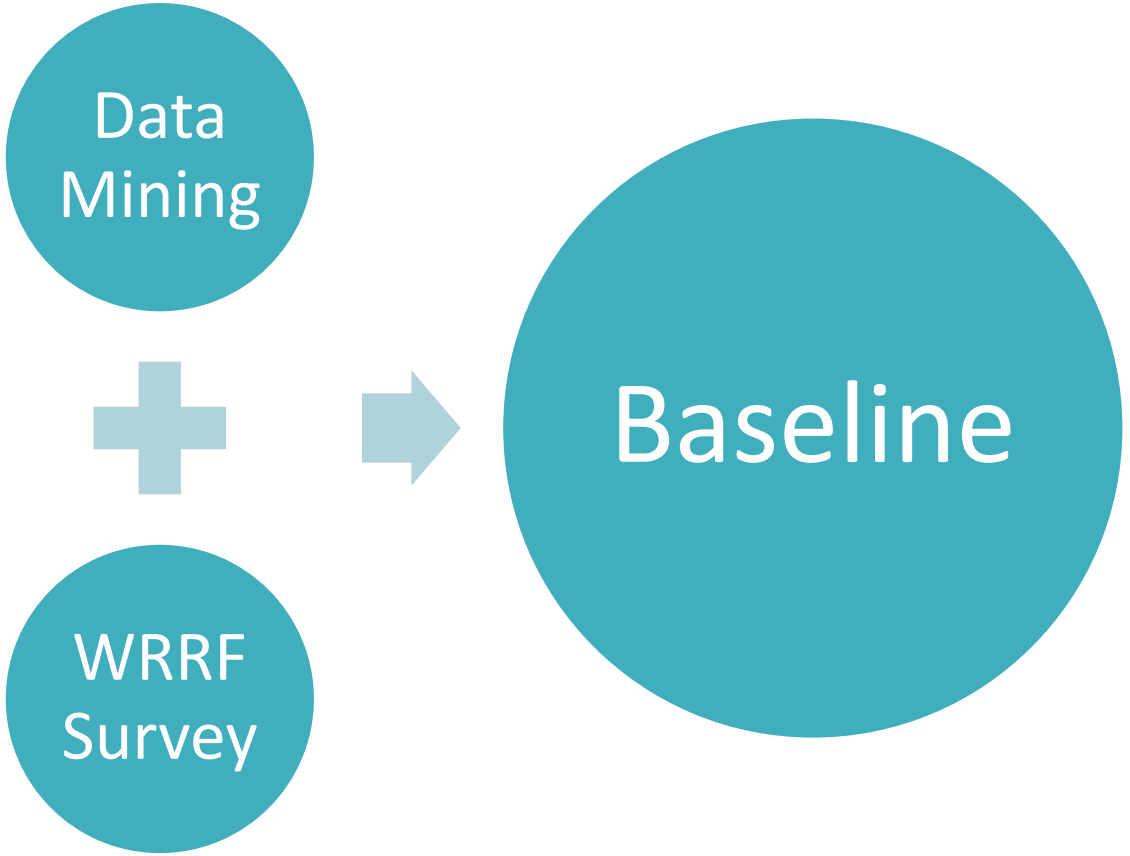
THE Water Research FOUNDATION

WATEREUSE

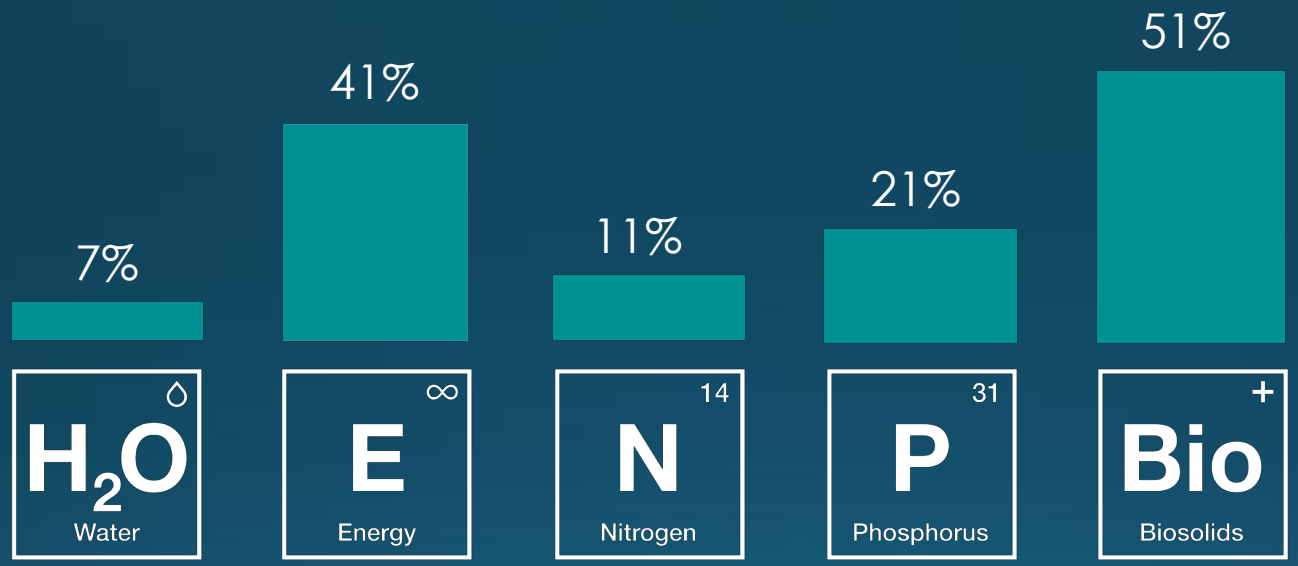
NACWA THE VOICE FOR A CLEAN WATER FUTURE

Association of Clean Water Administrators ACWA The Voice of States & Interstates est. 1961

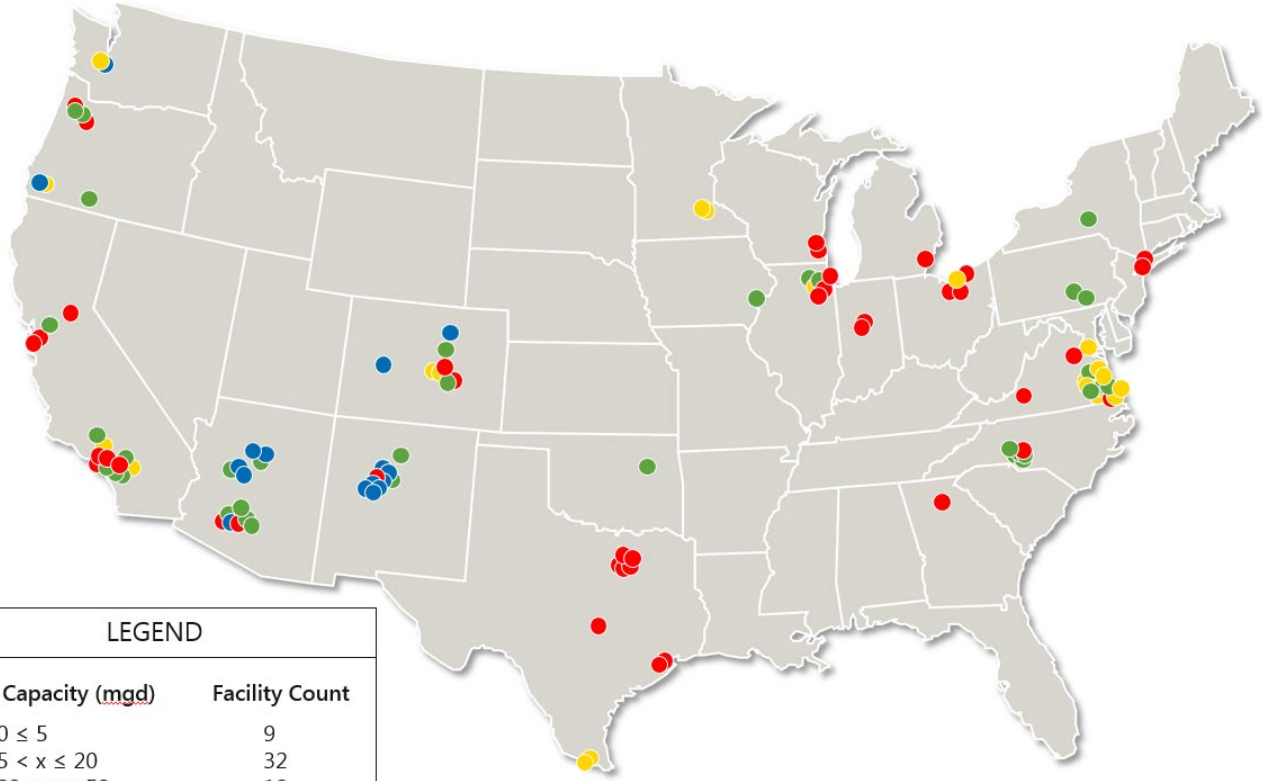
Réseau Environnement


Data Mining
WRRF Survey
Baseline

BASELINE RECOVERY RATES



U.S. Survey Responses



LEGEND	
Flow Capacity (mgd)	**Facility Count**
0 ≤ 5	9
5 < x ≤ 20	32
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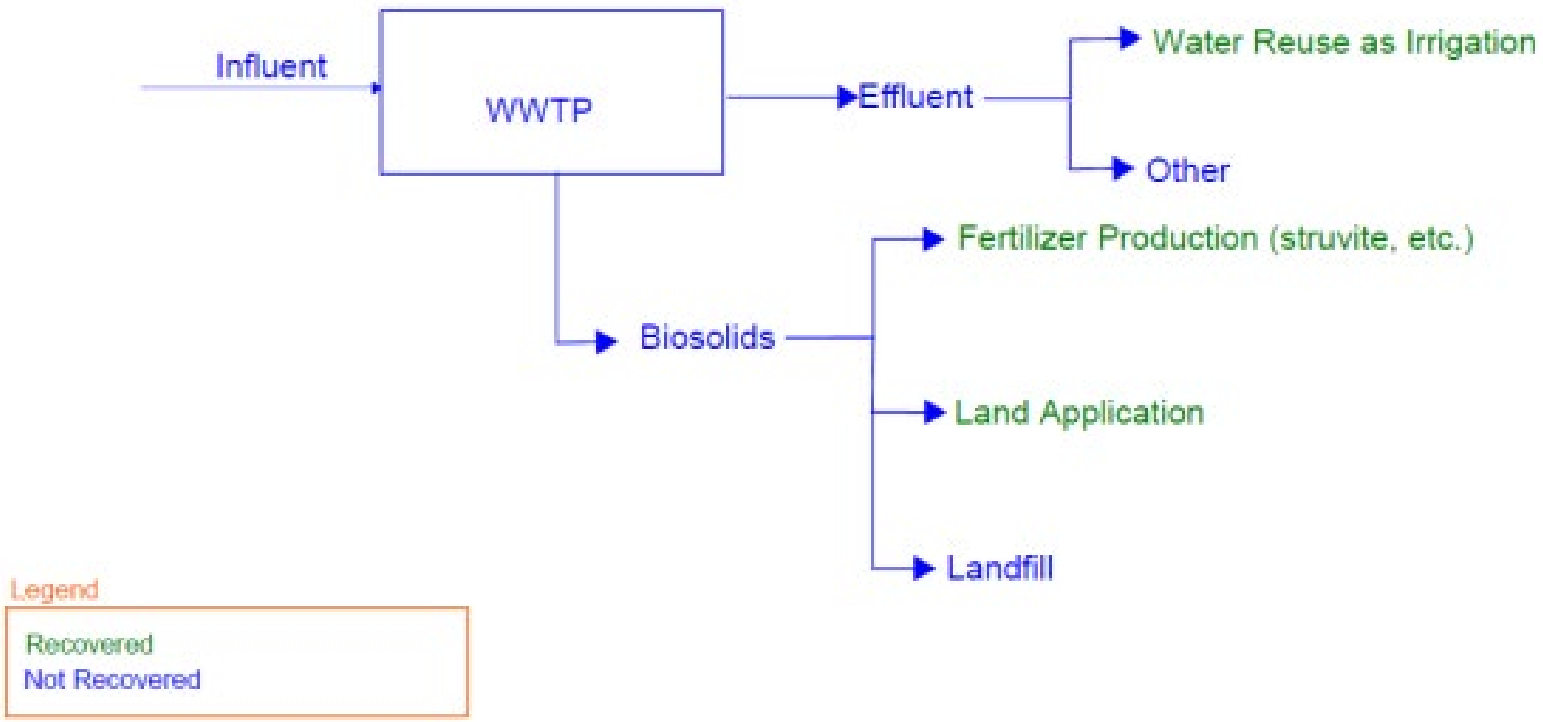
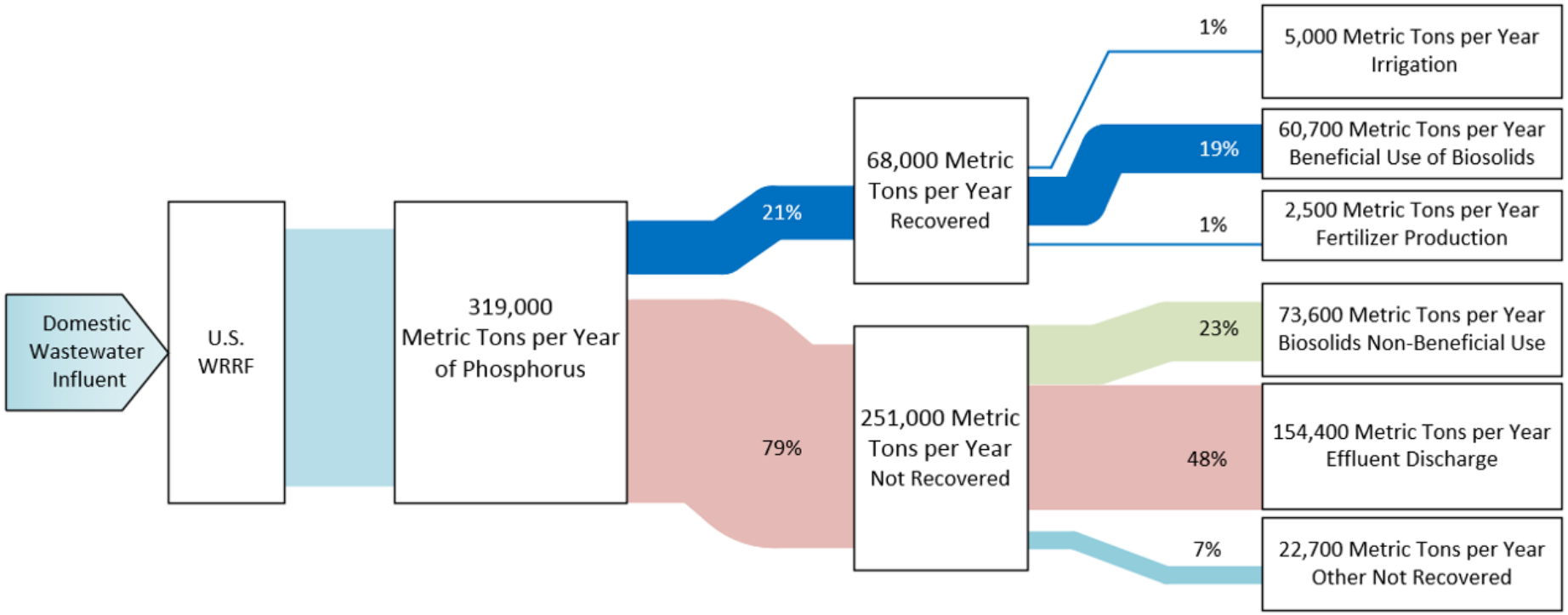


Figure 17 Definition of Recovered and Not Recovered Phosphorus Mass Streams in this Study

Aggregated phosphorus mass flows by end use in the U.S.



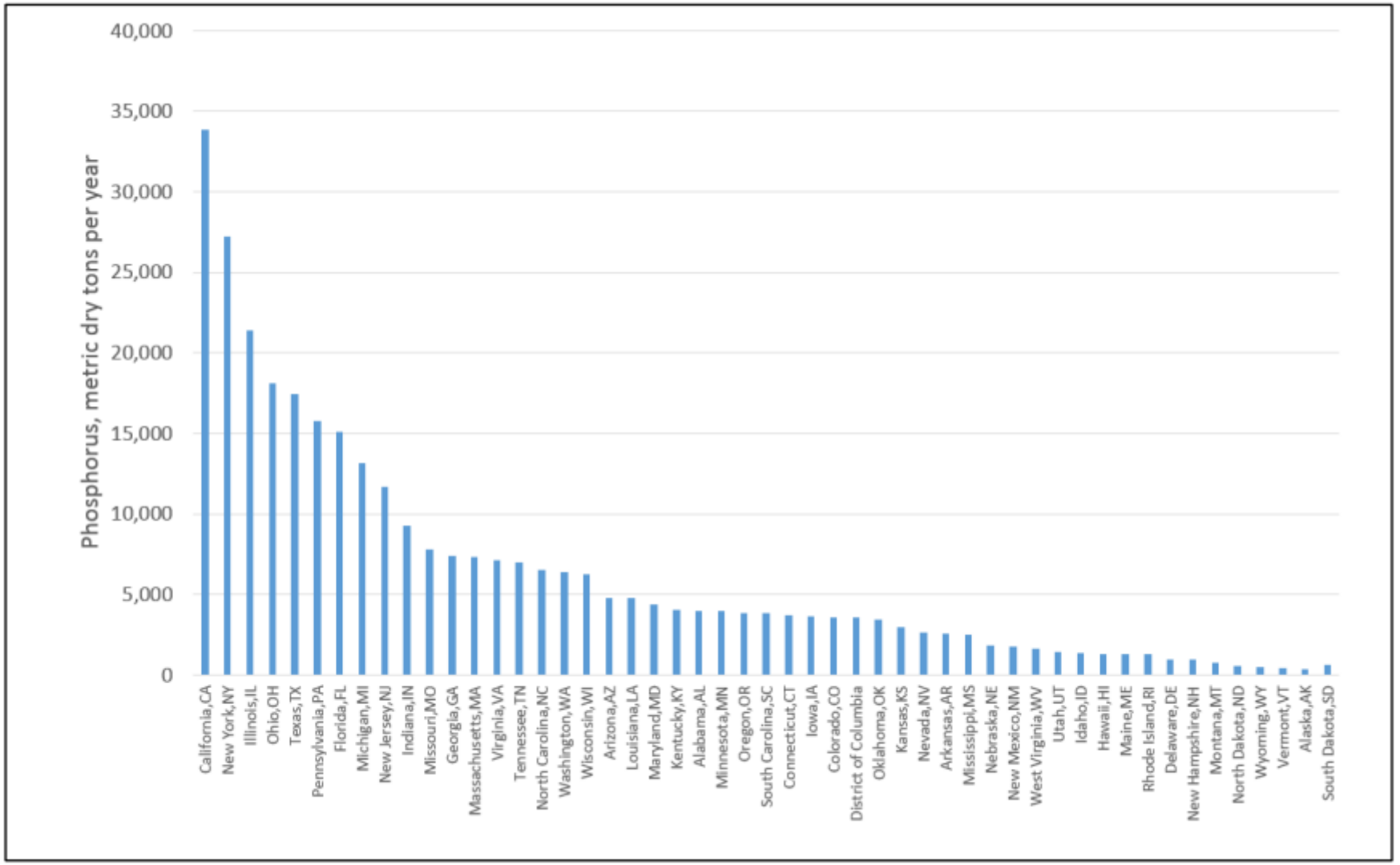


Figure 16 Annual Phosphorus Load in Wastewater Influent by State

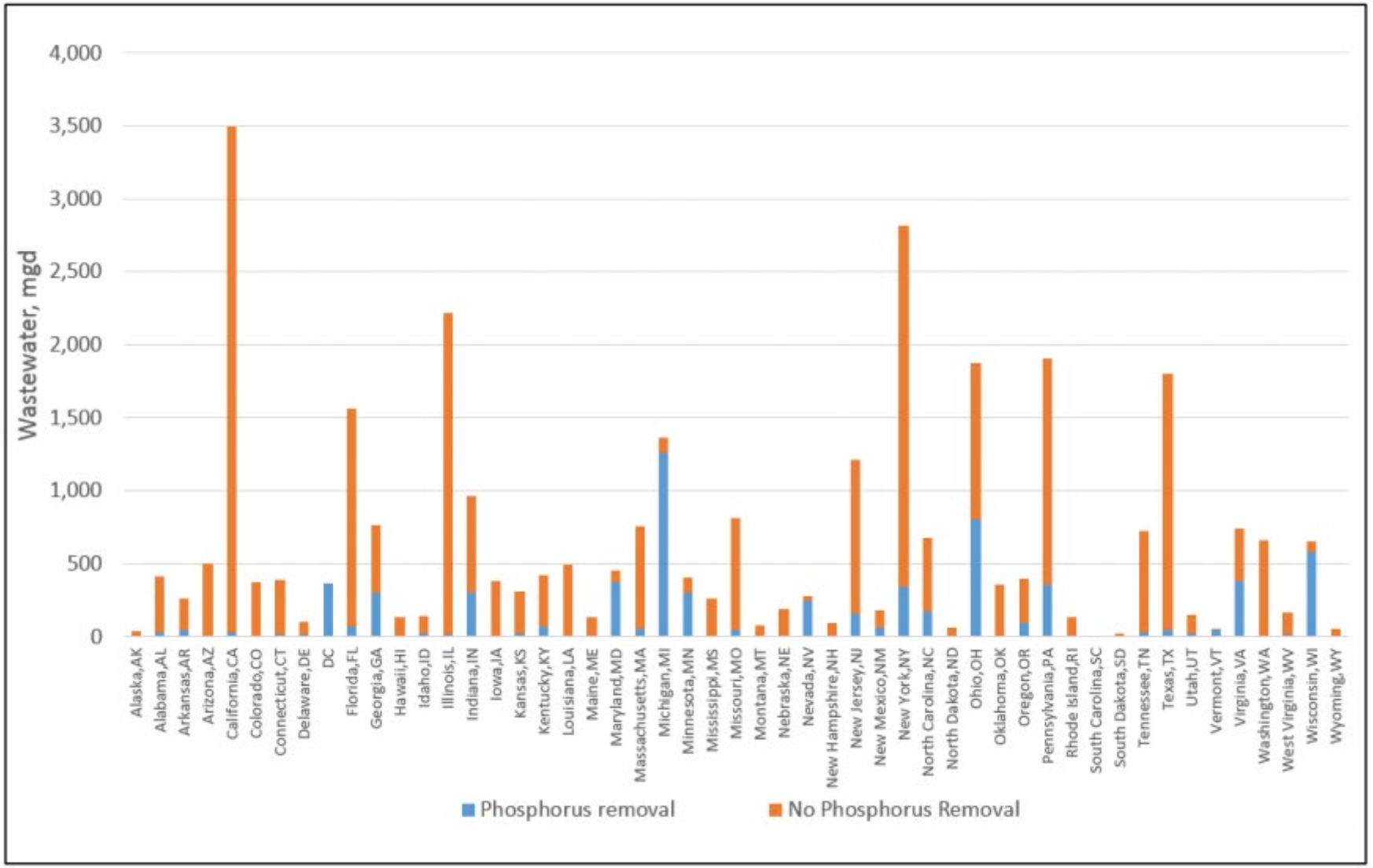


Figure 18 Wastewater Treated with Phosphorus Removal by State

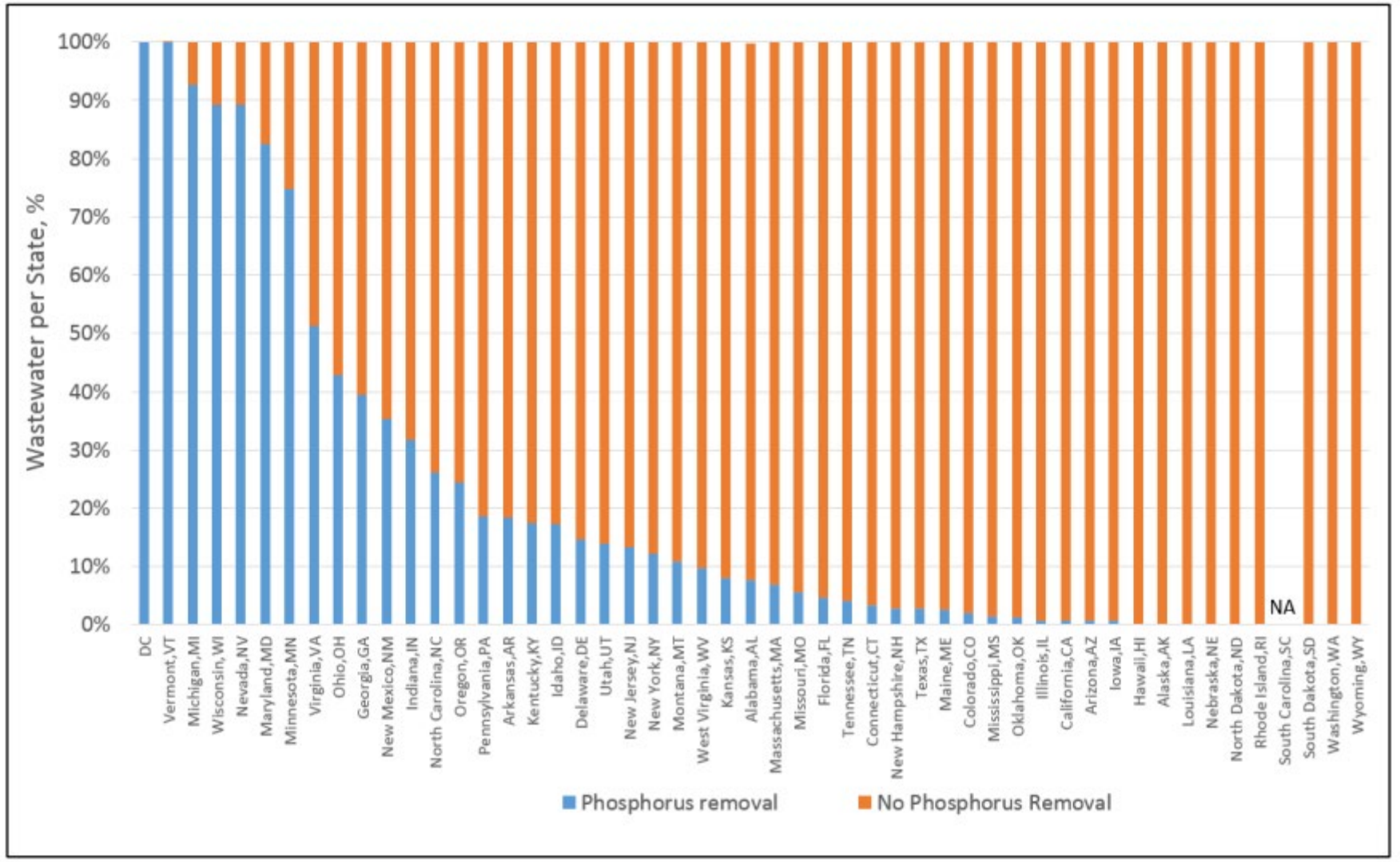


Figure 19 Percent Wastewater by State Treated with and without Phosphorus Removal

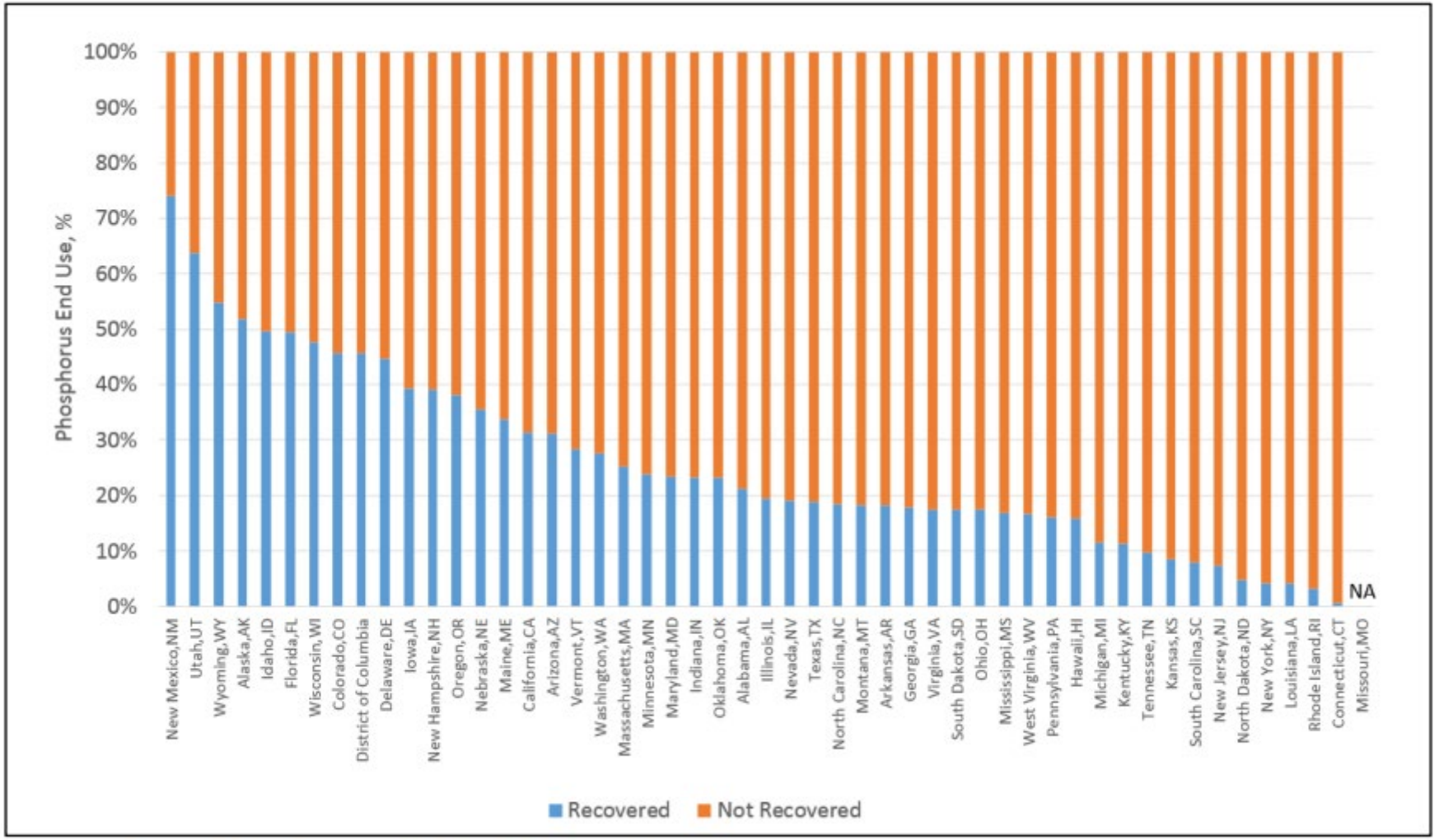


Figure 20 Recovered and Not Recovered Phosphorus by State as a Percentage

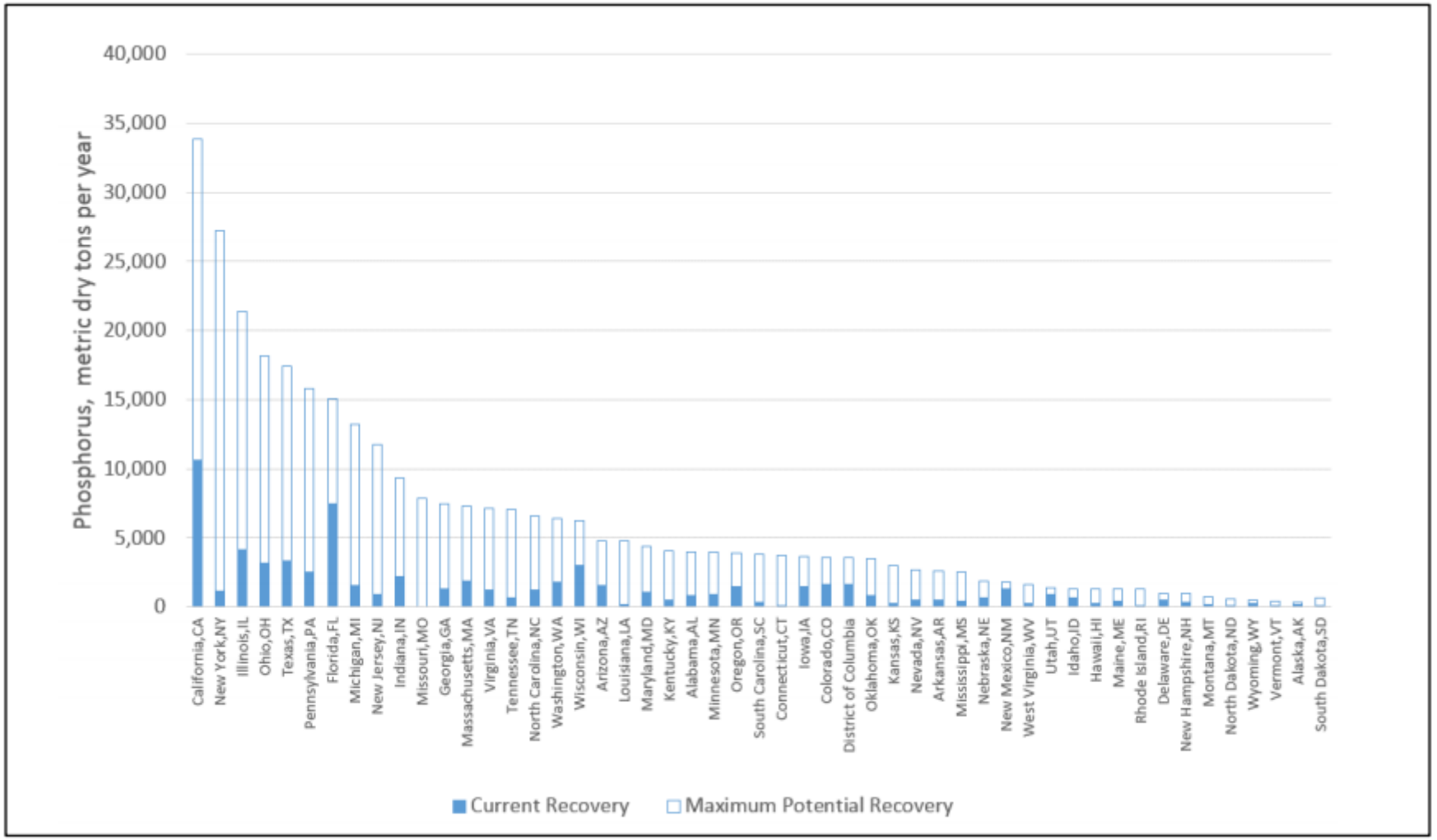


Figure 21 Phosphorus Recovery and Total Recovery Potential by State

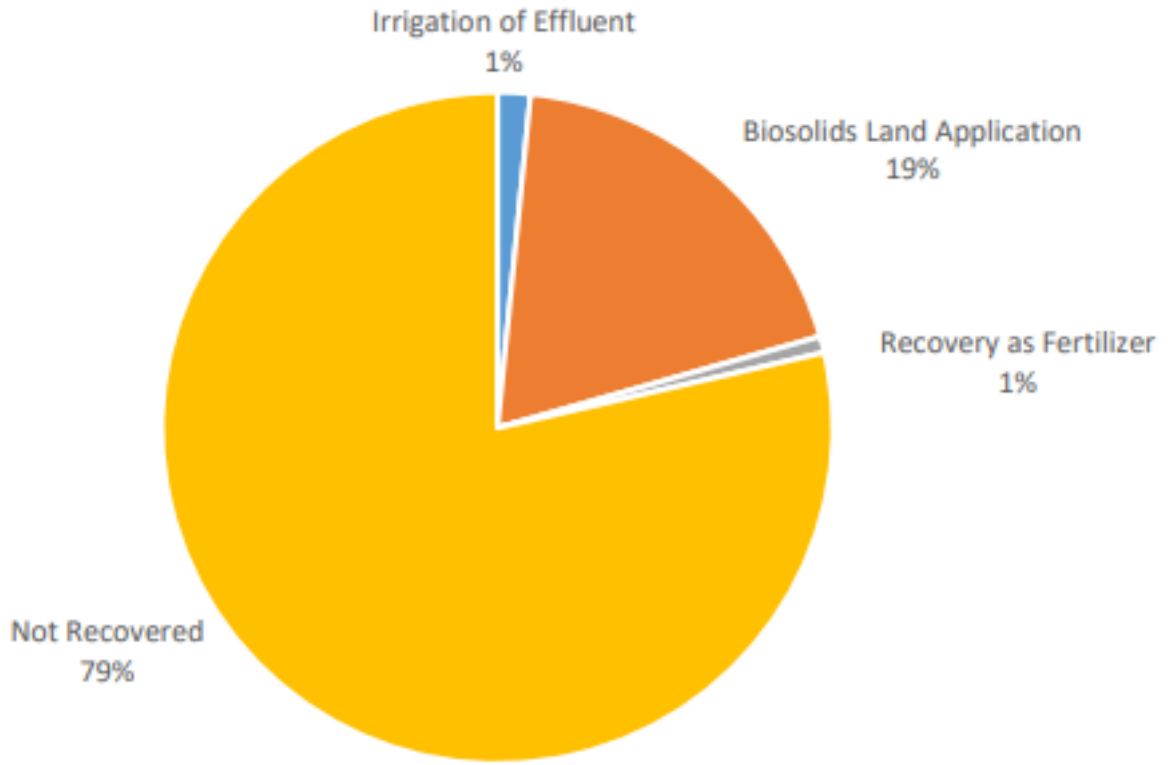


Figure 22 National Distribution of Wastewater Derived Phosphorus

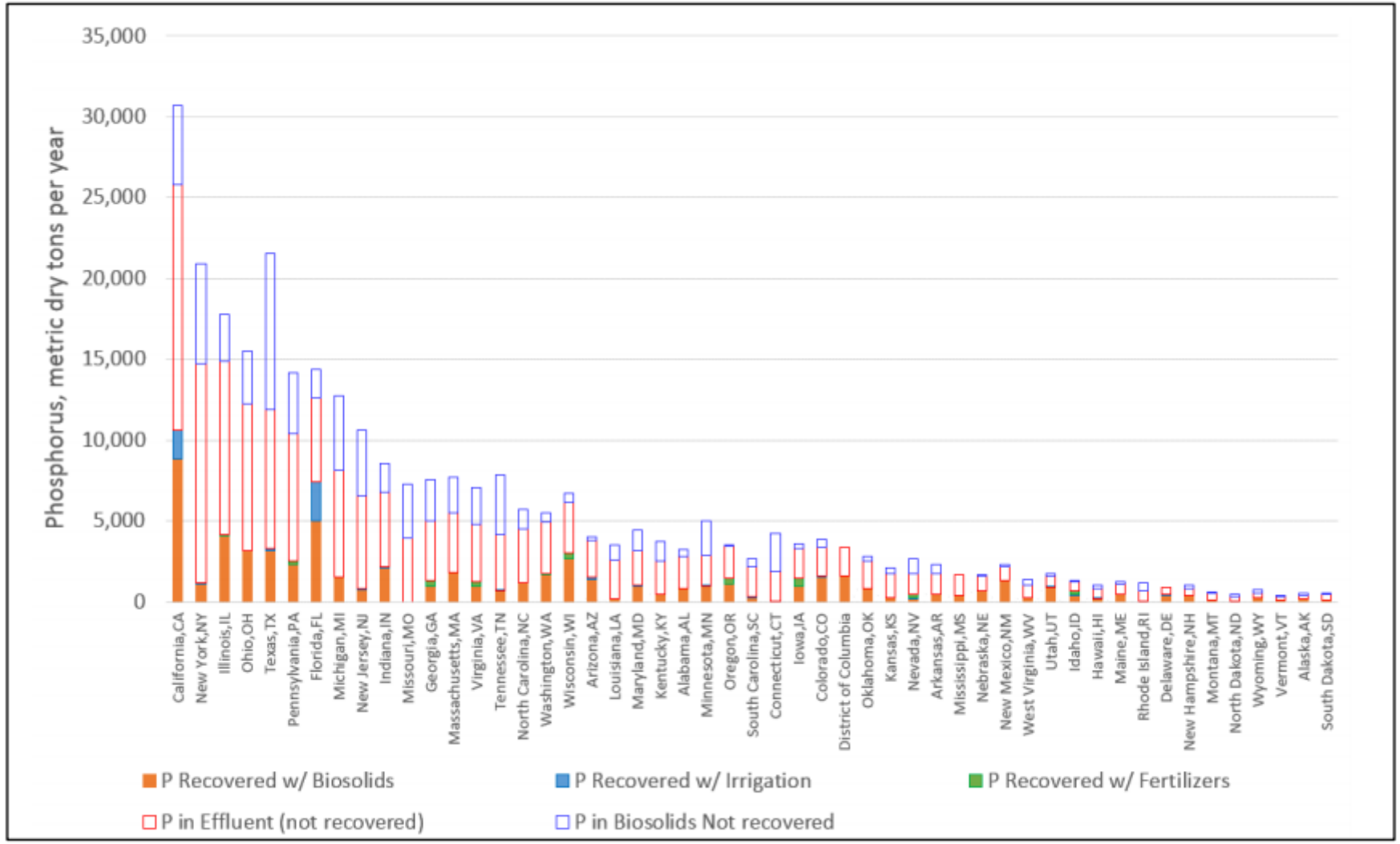


Figure 23 Wastewater Derived Phosphorus End Use by State (Recovered fractions shown as solid bar segments, not-recovered fractions with white fill)

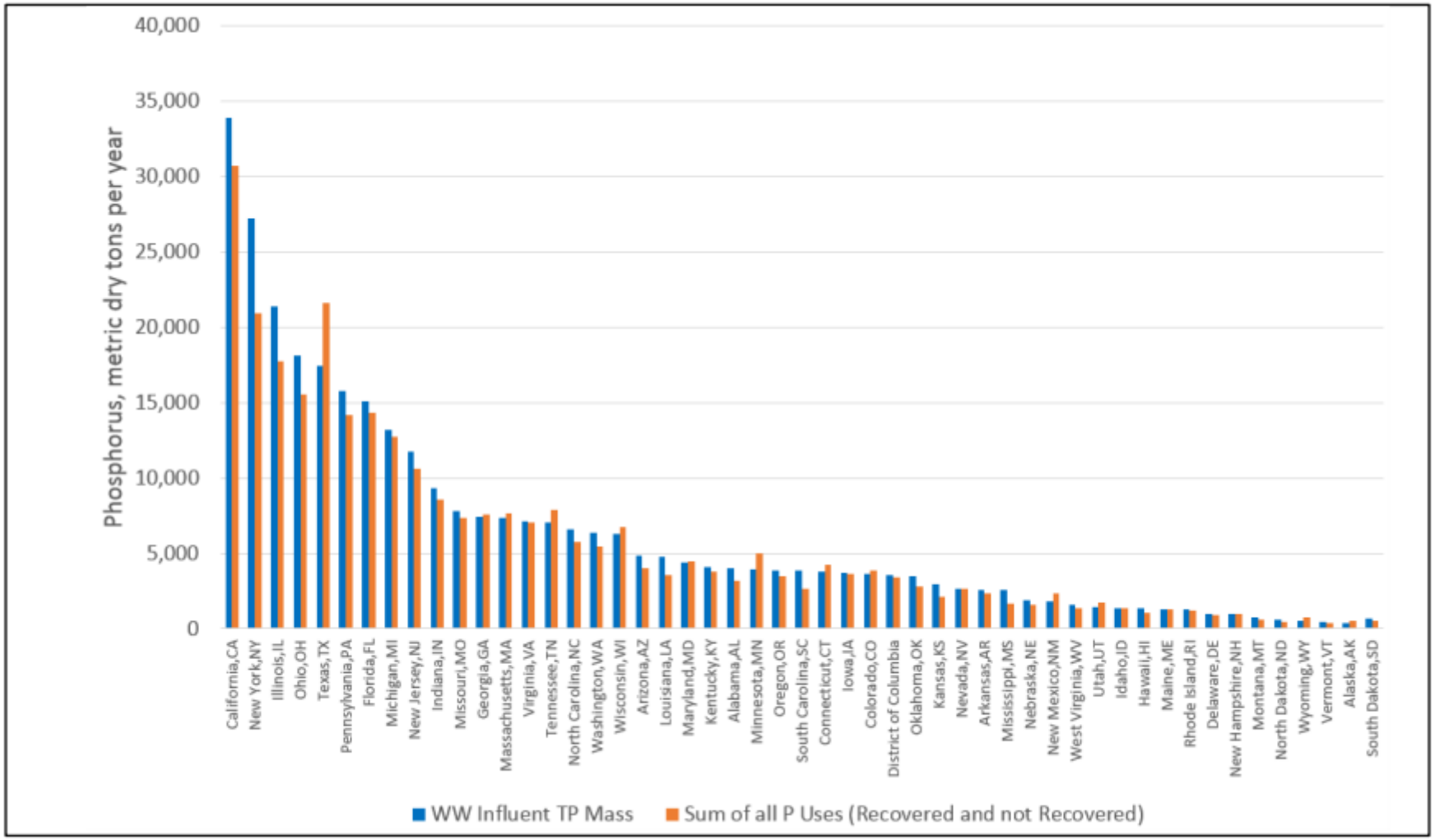


Figure 25 Mass Balance Check between Phosphorus Entering WRRFs and the Sum of all Phosphorus End Uses by State (recovered and not recovered)

Path Forward

- Announce ReNEW Water Goals for 2030 based on established baseline – Fall 2018
- Collection of data for first biannual report – 2018-2020
- Publication of first biannual report WEFTEC 2020
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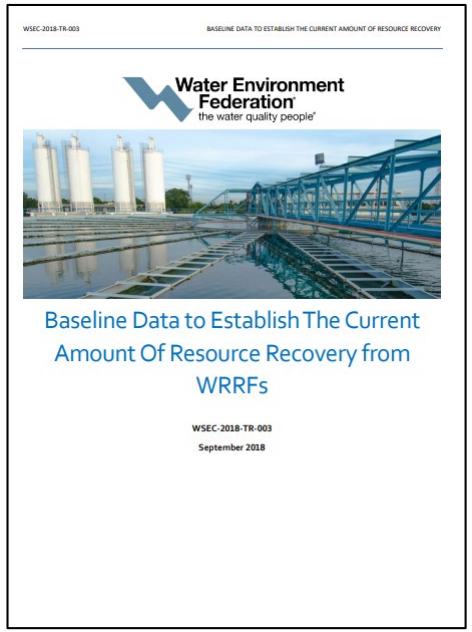
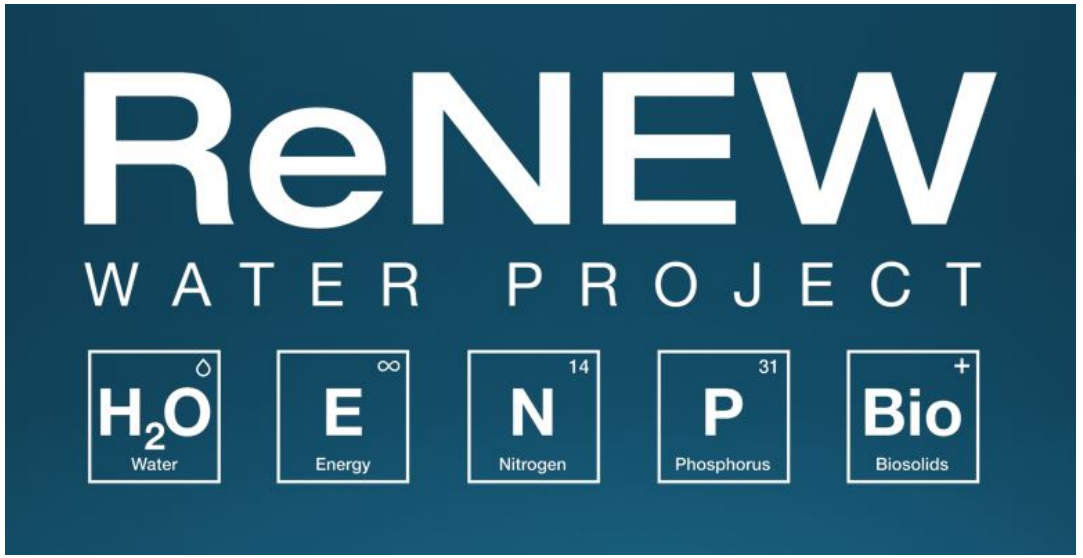
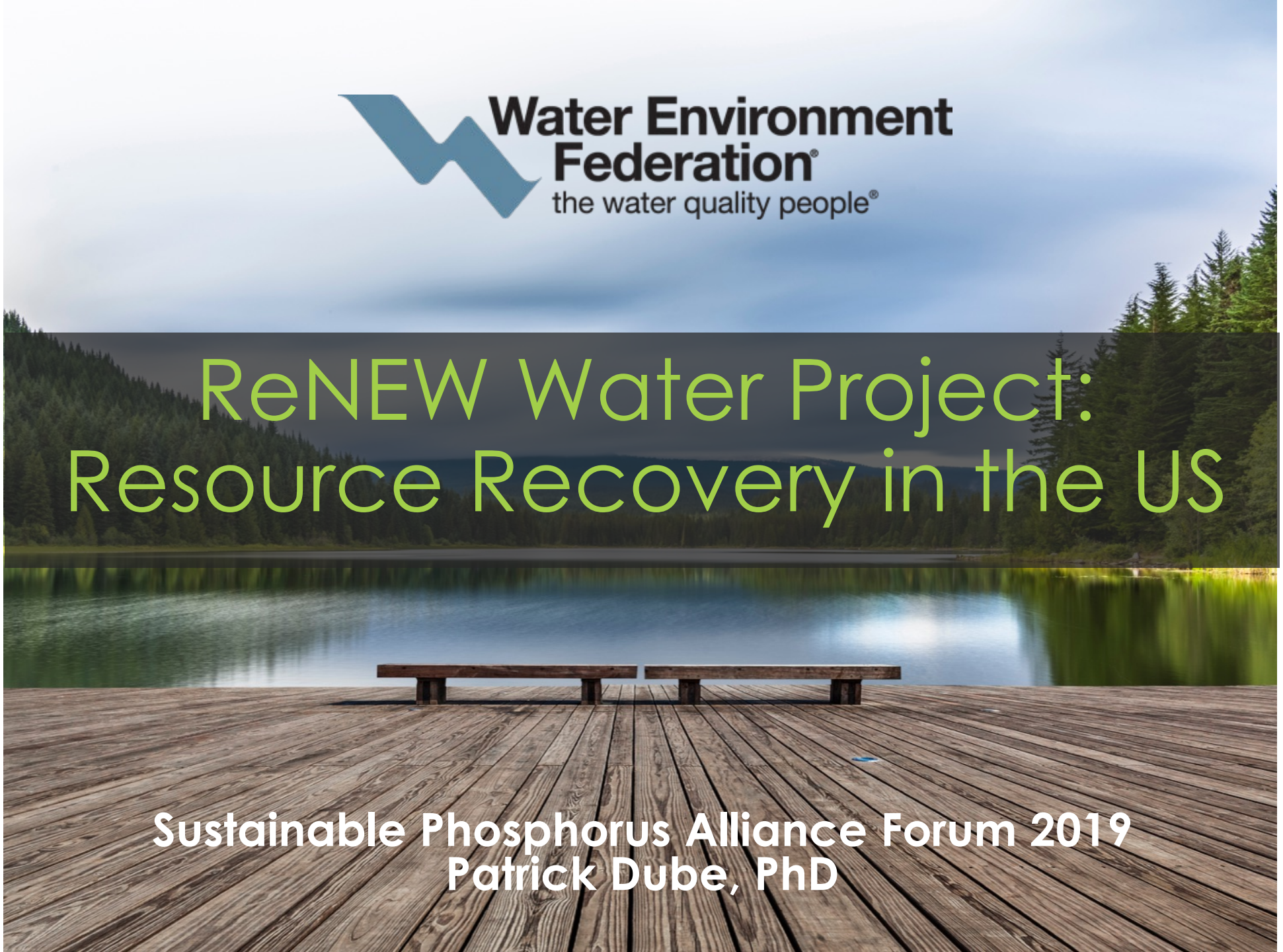




THANK YOU!

pdube@wef.org

www.wef.org www.weftec.org



ReNEW Water Project: Resource Recovery in the US

Sustainable Phosphorus Alliance Forum 2019

Patrick Dube, PhD

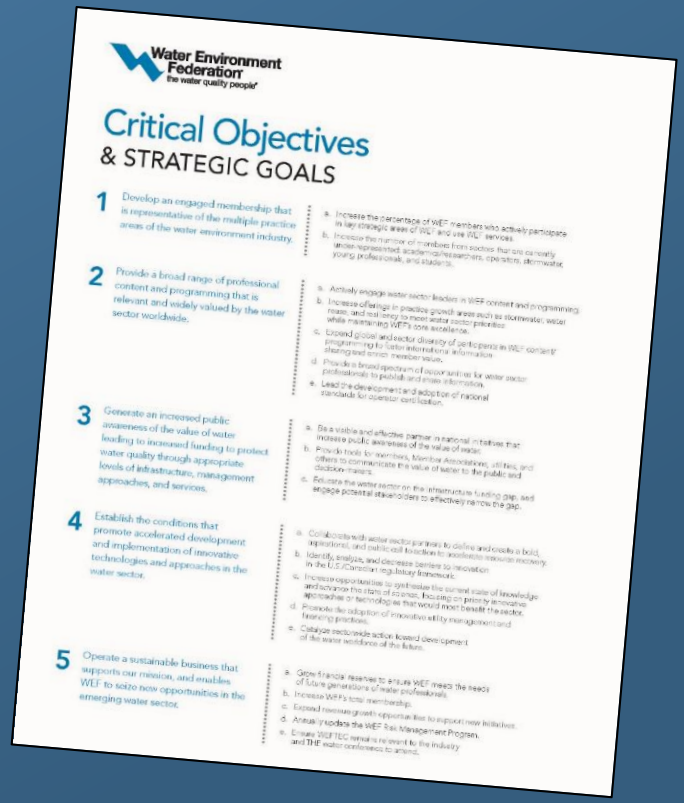
Change our Mind(set)

*Wastewater treatment plants are **NOT waste** disposal facilities, but rather water **resource recovery** facilities that produce **clean water**, **recover nutrients** (such as phosphorus and nitrogen), and have the potential to reduce the nation's dependence upon fossil fuel through the production and use of **renewable energy**.*

WEF's Mission

- Objective 4: Establish the conditions that promote accelerated development and implementation of innovative technologies and approaches in the water sector

- Goal 4a: Drive an increase in resource recovery in the water sector



Water Environment Federation
the water quality people

Critical Objectives
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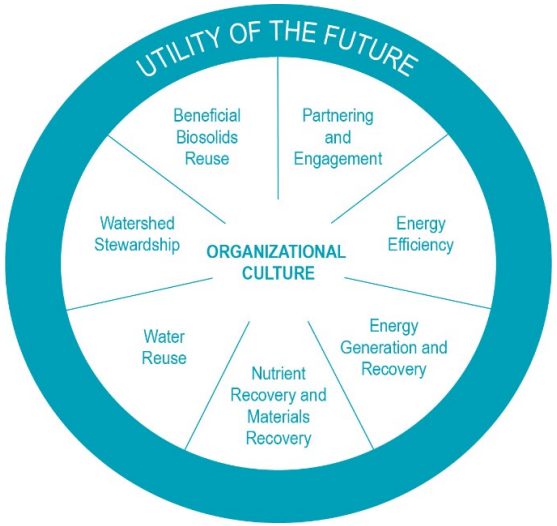
SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

SDG 6: Ensure availability and sustainable management of water and sanitation for all

The Utility of the Future Today

- *The* program launched in 2016
  - Designed by utility partners, with input from staff from the partnering organizations
  - It is a recognition program – not a competition
  - Applicants are evaluated based on program criteria, not against each other
  - The application is compact and streamlined, to limit the burden on applicants



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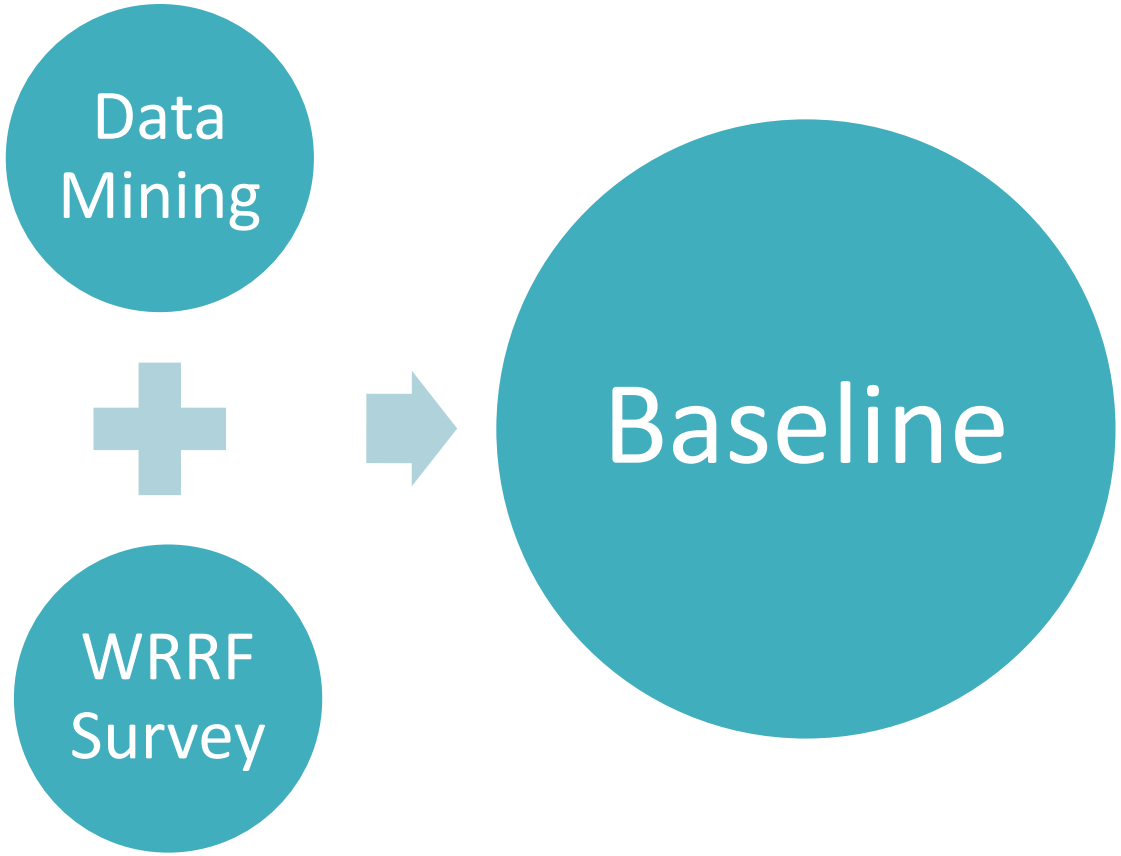
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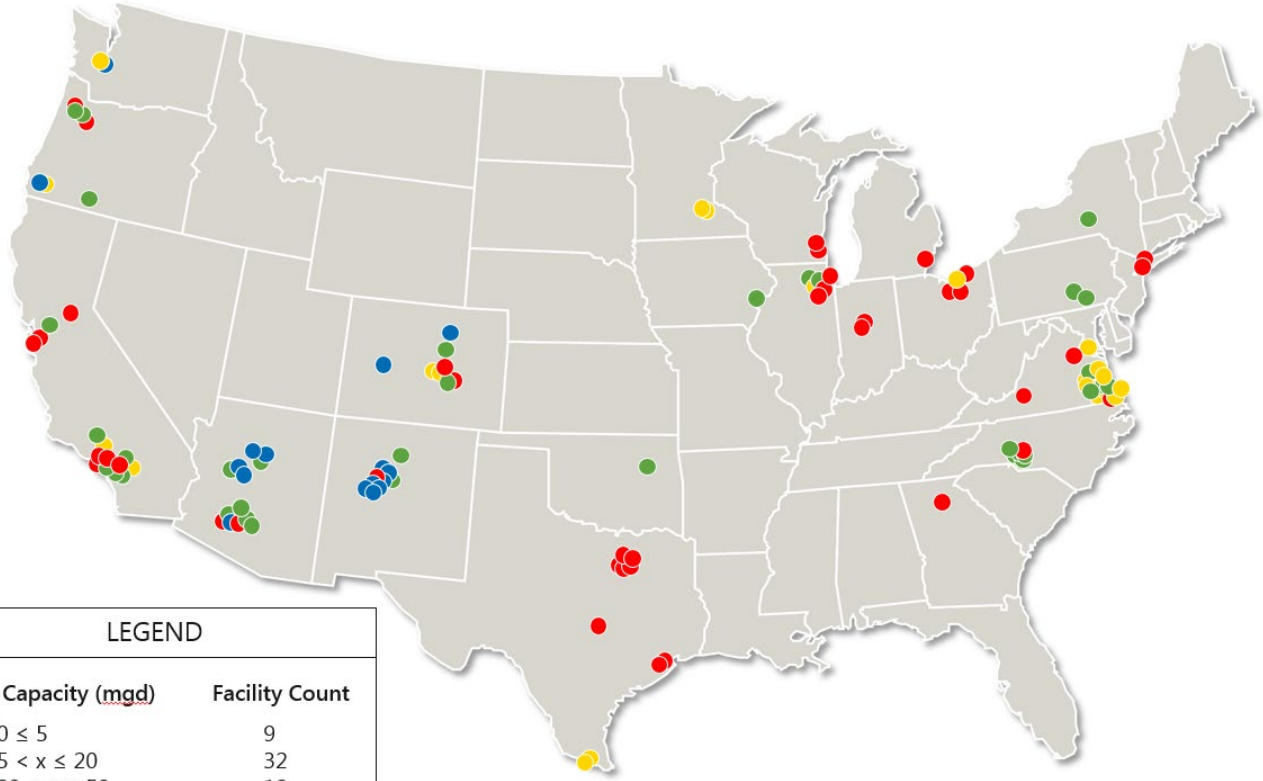

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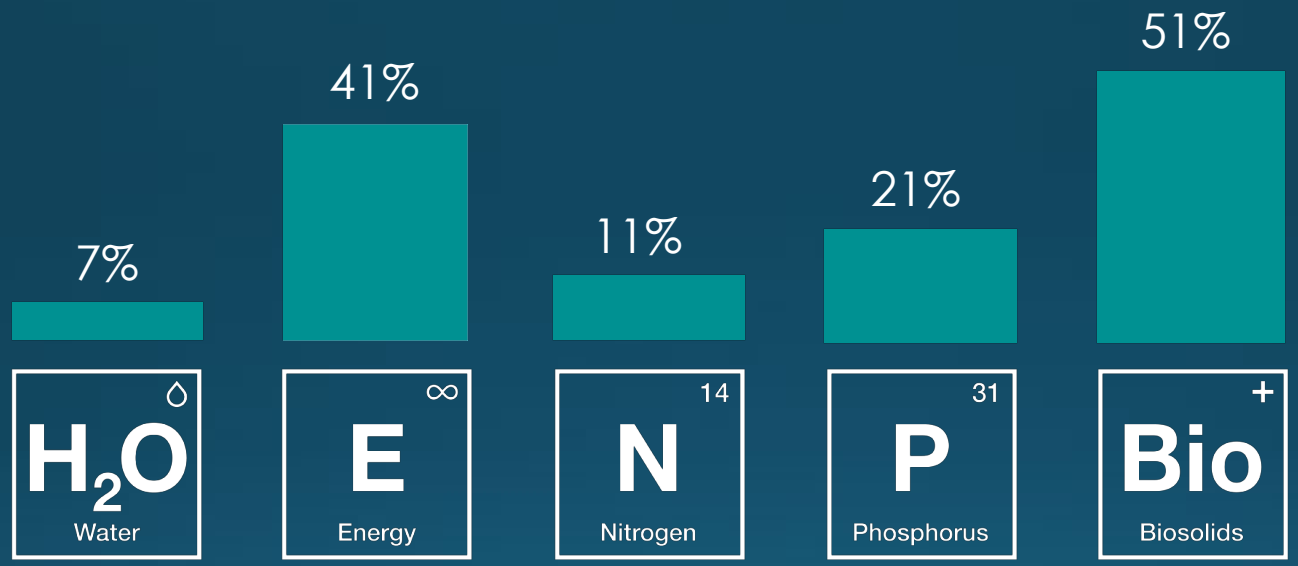
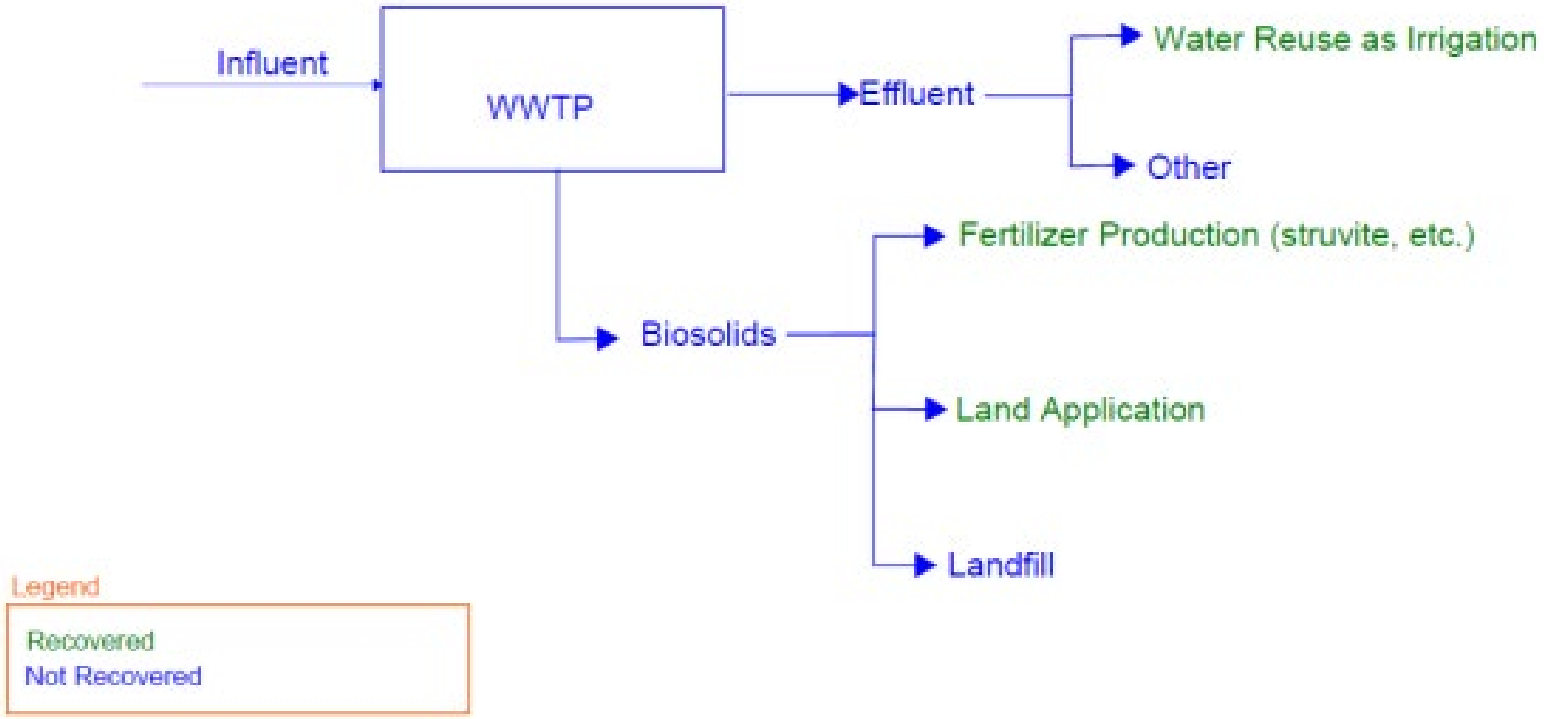
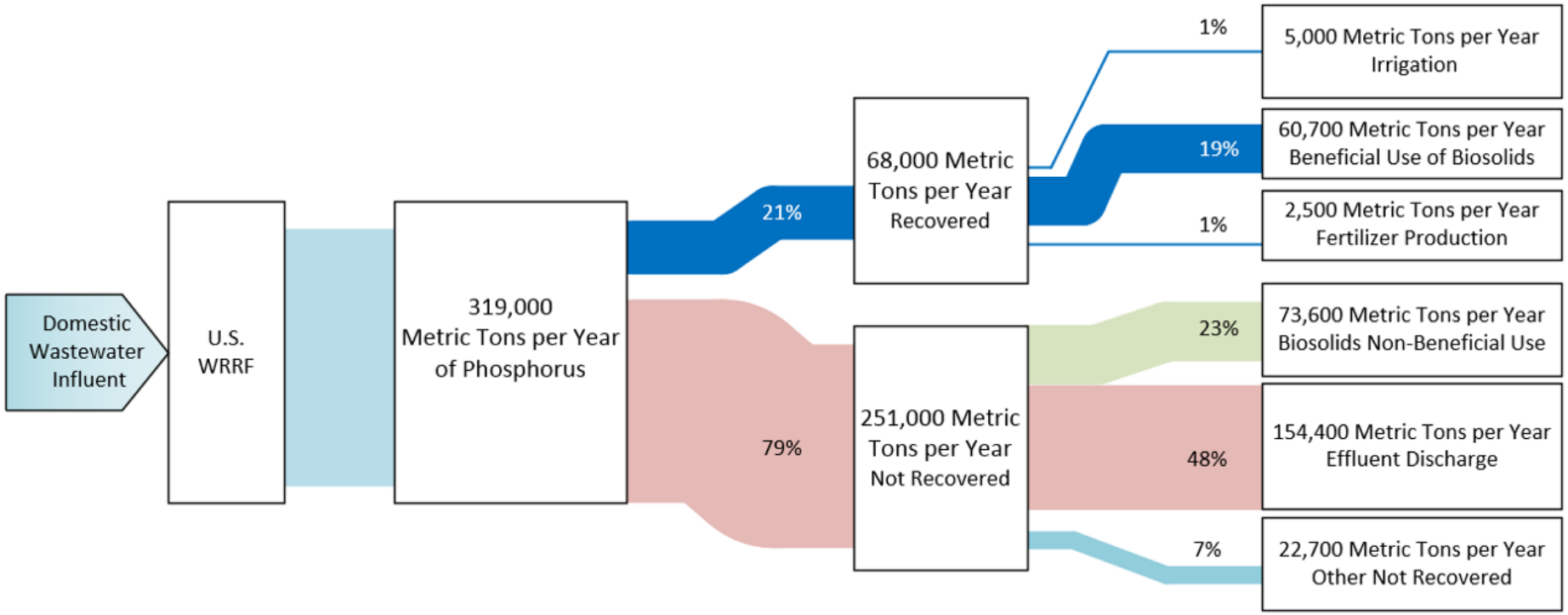


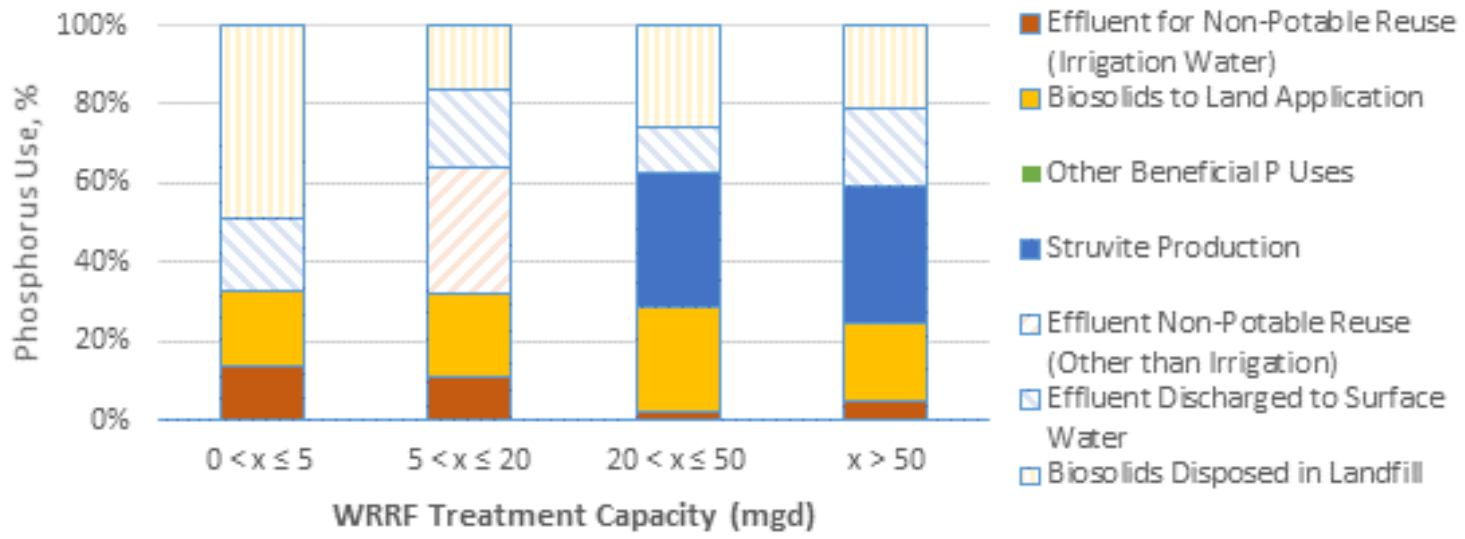
Definition of Recovered and Not Recovered Phosphorus Mass Streams in this Study



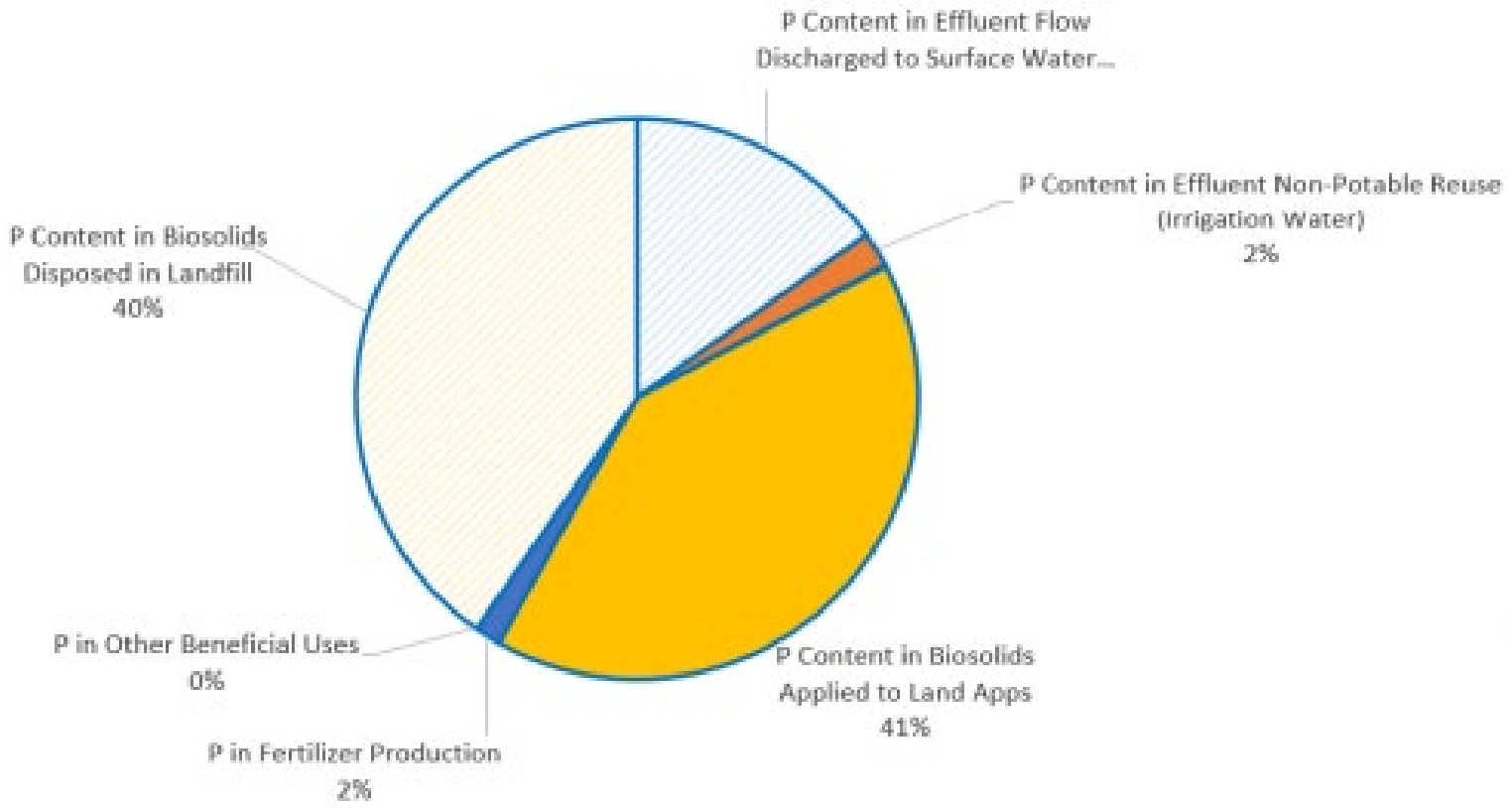
Aggregated phosphorus mass flows by end use in the U.S.



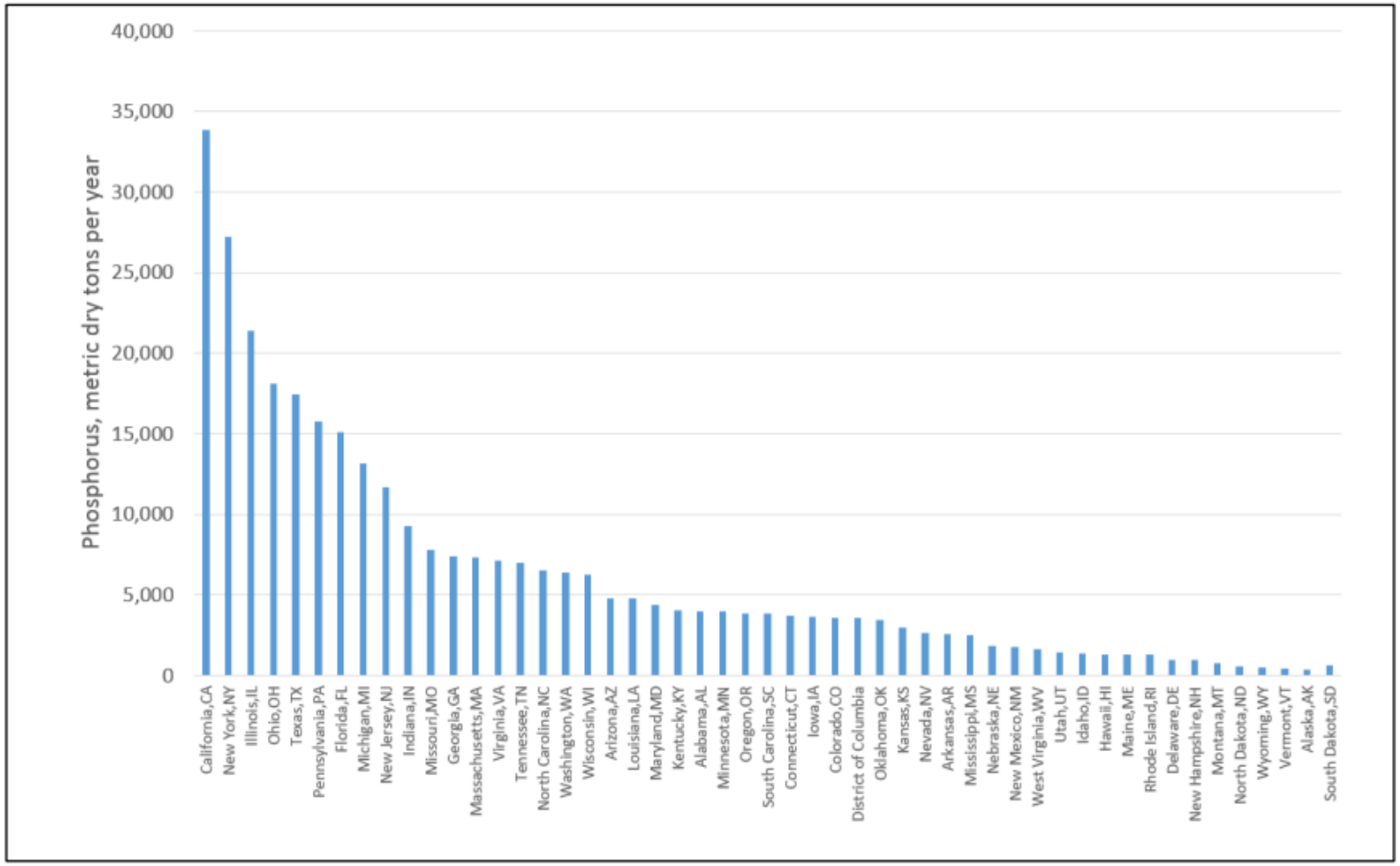
Distribution of Phosphorus End Uses by Facility Size for Survey Participants



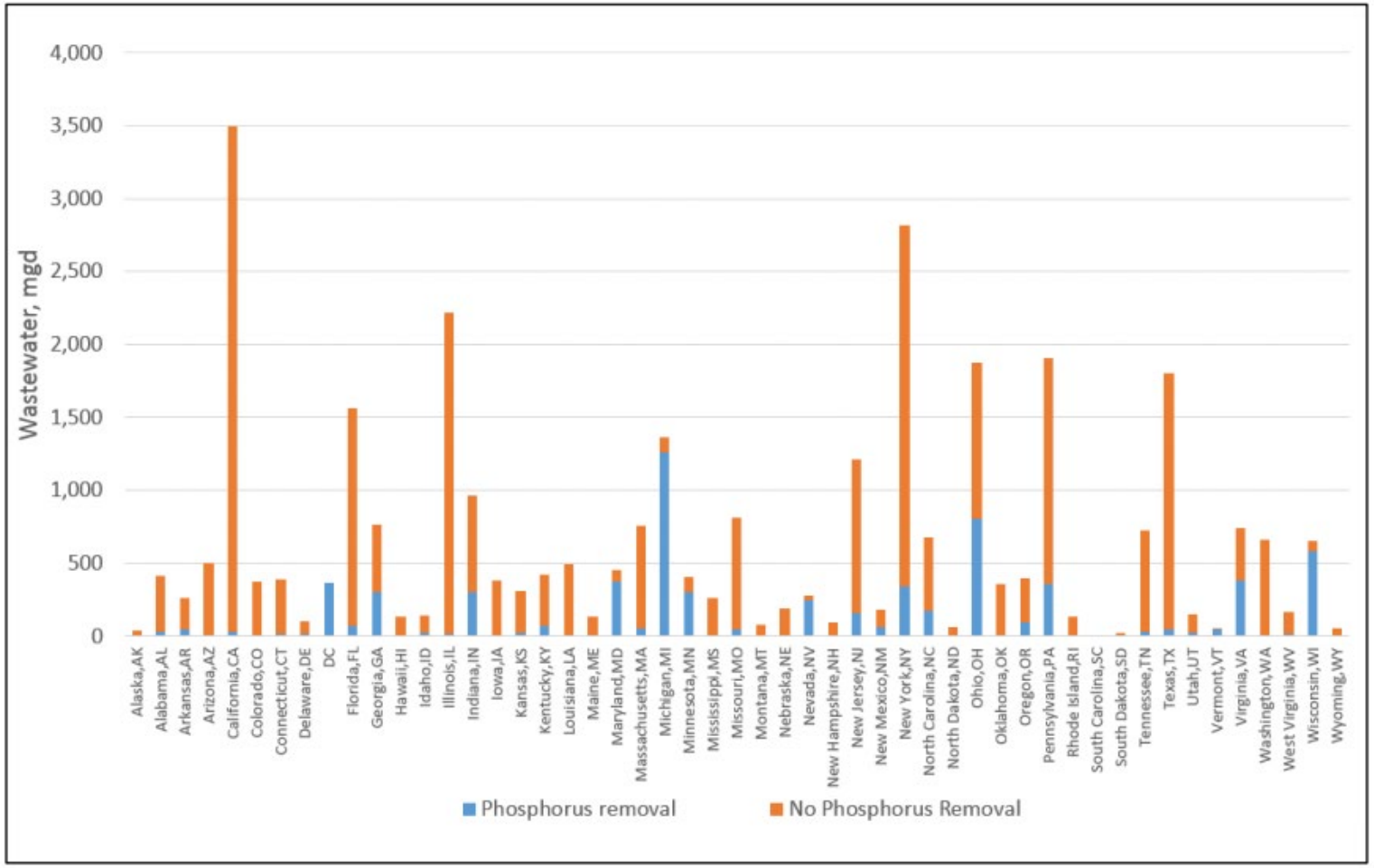
Distribution of Phosphorus End Uses for all Survey Participants



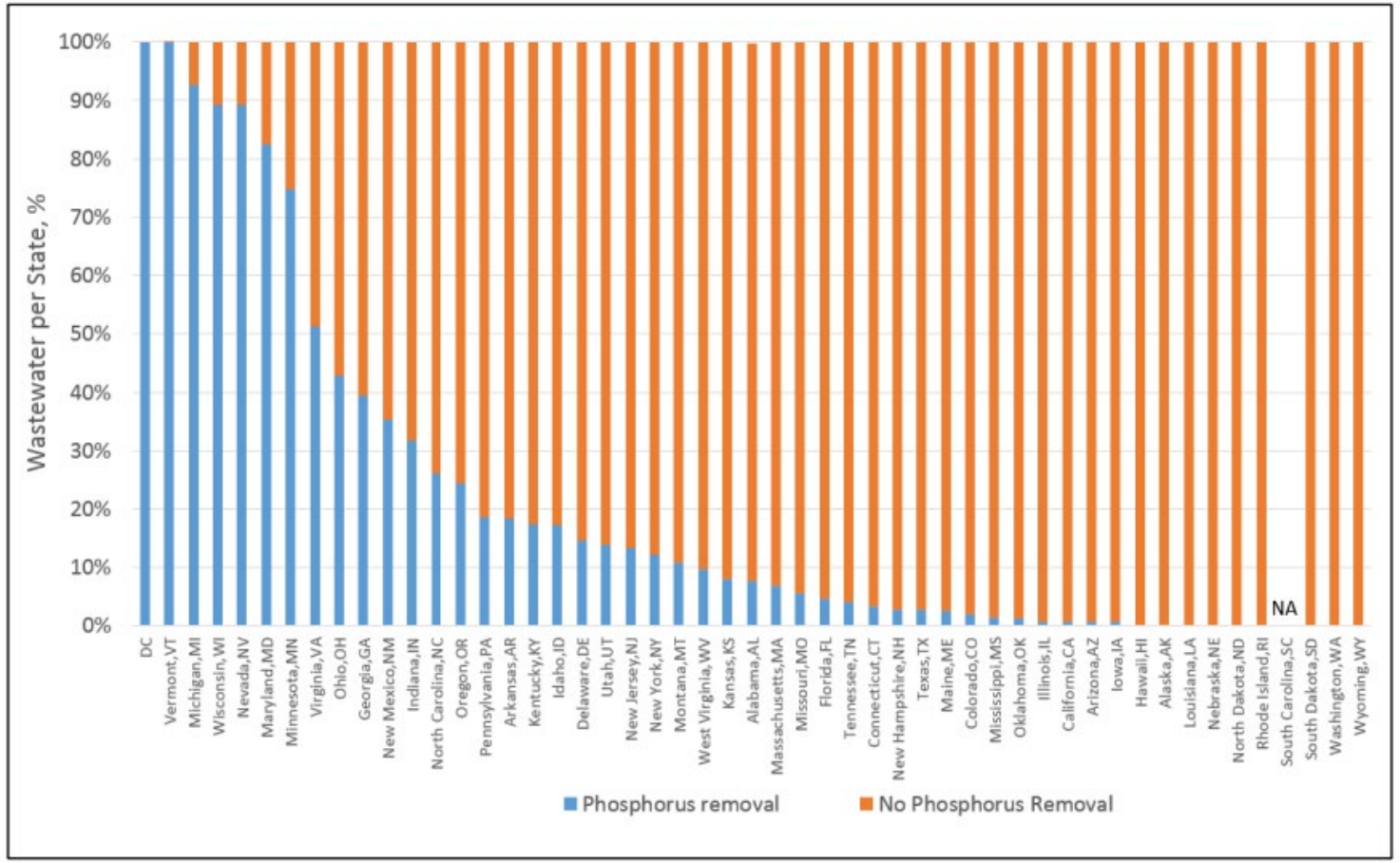
Annual Phosphorus Load in Wastewater Influent by State



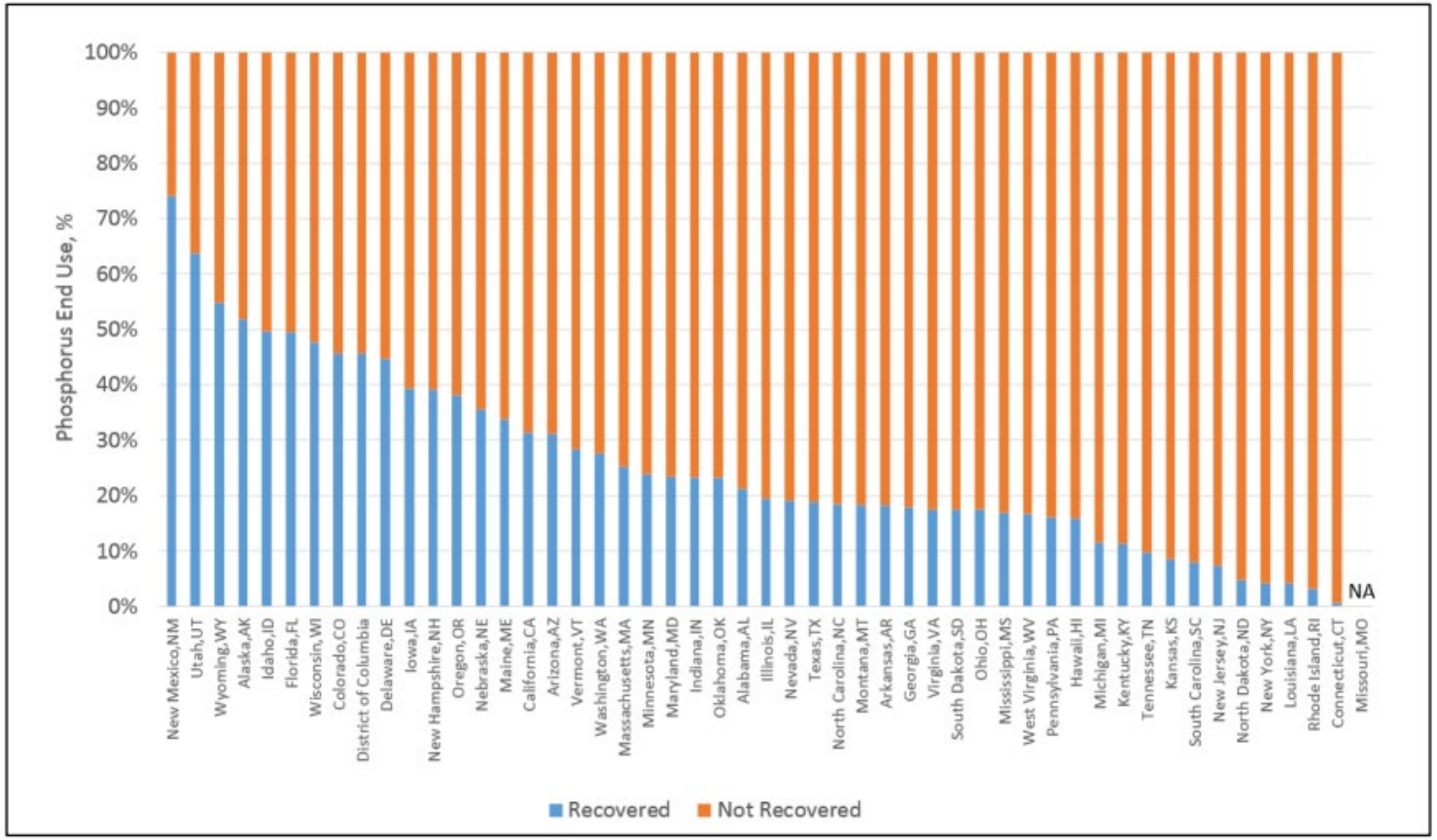
Wastewater Treated with Phosphorus Removal by State



Percent Wastewater by State Treated with and without Phosphorus Removal



Recovered and Not Recovered Phosphorus by State as a Percentage



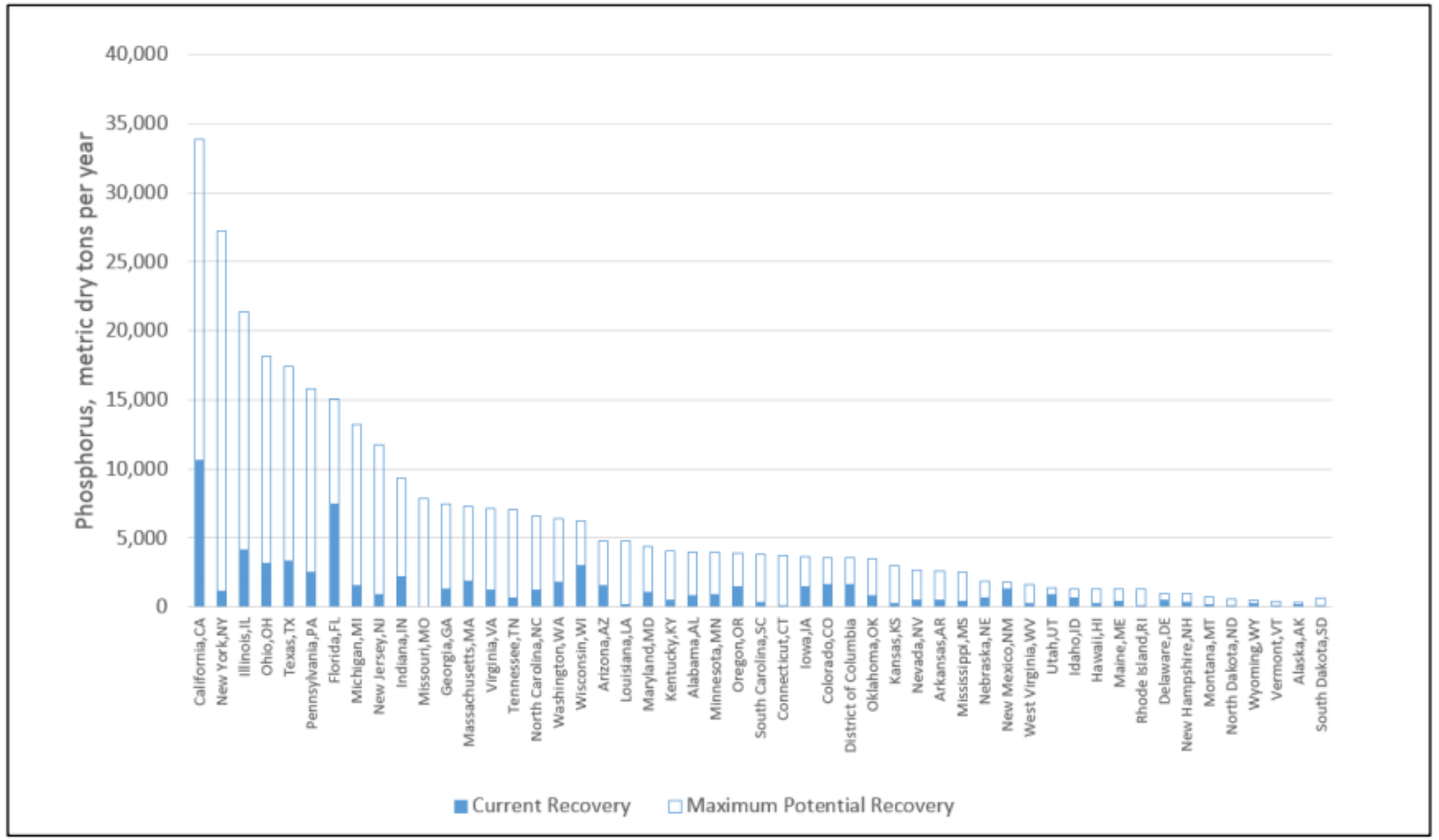
Recovered:

- Urine source separation
- Water reused for irrigation
- Biosolids applied to land application
- Fertilizer production (struvite, etc.) from biosolids

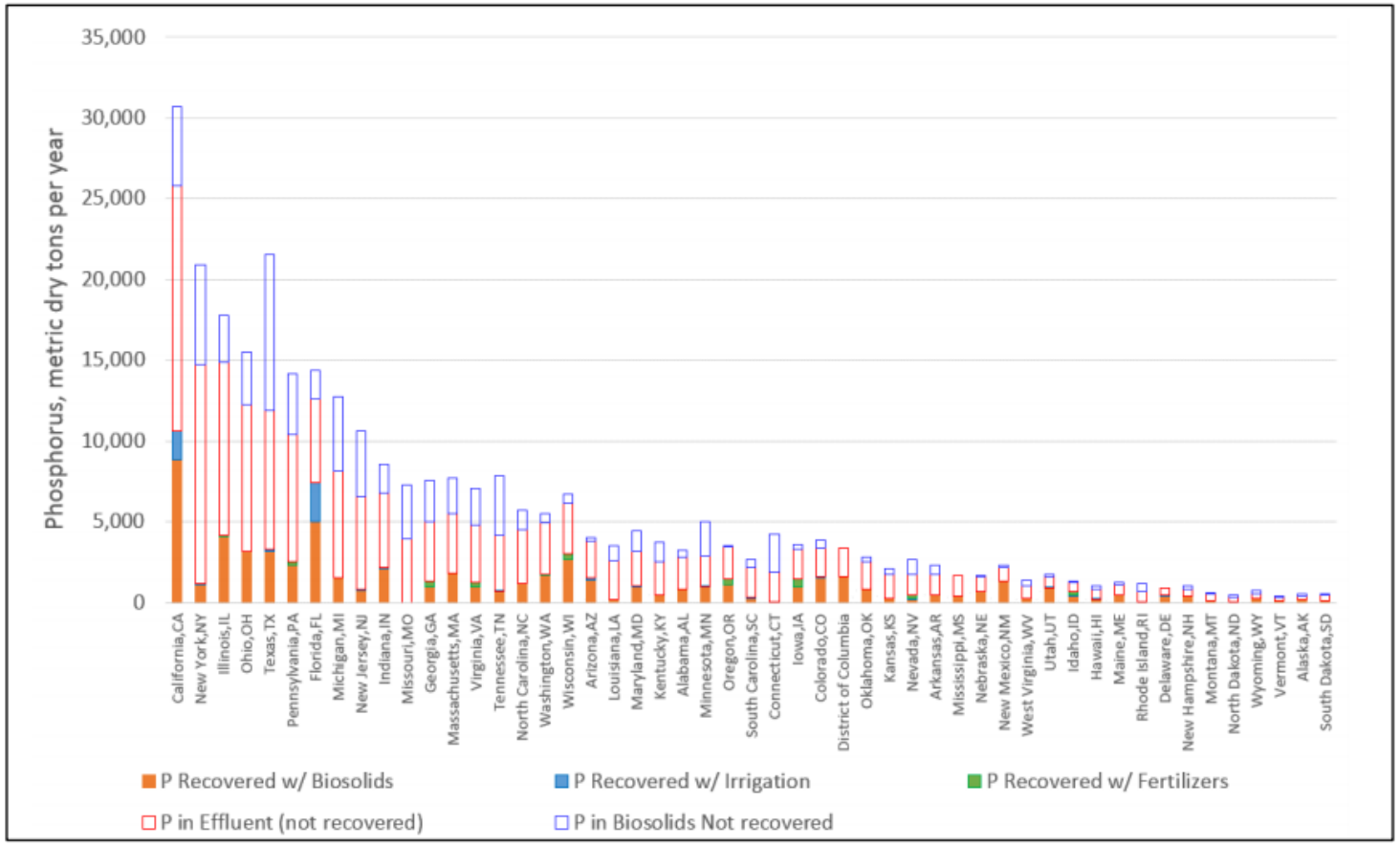
Not recovered:

- Effluent discharged to surface or groundwater
- Potable reuse

Phosphorus Recovery and Total Recovery Potential by State



Wastewater Derived Phosphorus End Use by State



(Recovered fractions shown as solid bar segments, not-recovered fractions with white fill)

Current Status of Struvite Recovery by U.S. State

Vendor	Installation Country	Installation Location	ADAF Current, mgd	lbs P recovered as fertilizer per year	Reference
AirPrex	USA	Medina County, OH	Not yet online	-	
AirPrex	USA	Howard County, MD	Not yet online	-	
Multiform Harvest	USA	Boise, ID	26	425,531	Estimate
Multiform Harvest	USA	City of Yakima , WA	10	163,666	Estimate
Multiform Harvest	USA	Green Bay . WI	No long-term data yet.	-	
Ostara	USA	Rock Creek, Portland, OR	29	296,000	WEF 2018 RR Survey
Ostara	USA	Madison, WI	42	687,396	Estimate
Ostara	USA	Suffolk Nansemond River Treatment Plant, VI	18.24	400,000	WEF 2018 RR Survey
Ostara	USA	City of York, PA	26	425,531	Estimate
Ostara	USA	Durham Facility, Portland OR	27	458,000	WEF 2018 RR Survey
Ostara	USA	TMWRF, Reno NV	30	490,997	Estimate
Ostara	USA	Gwinnett, GA	34	732,000	WEF 2018 RR Survey
Ostara	USA	Chicago, IL	689	232,000	WEF 2018 RR Survey
Ostara	USA	Opequon Water Reclamation Facility, Winchester, VA	12.6	206,219	Estimate
Ostara	USA	Des Moines Wastewater Reclamation Authority, IA	60	981,994	Estimate
			Total	**5,499,332**	

0.8% of the total recoverable P available!

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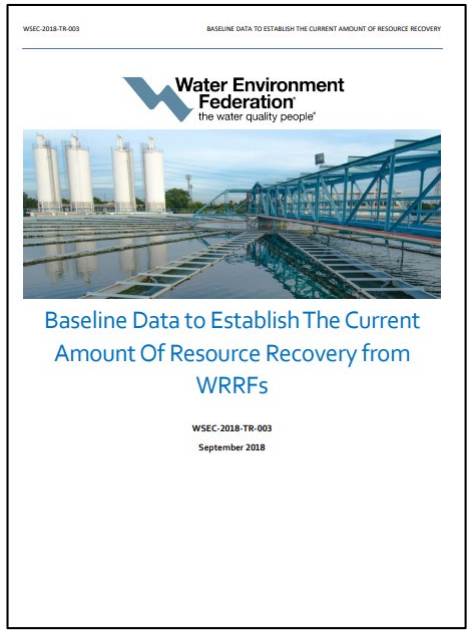

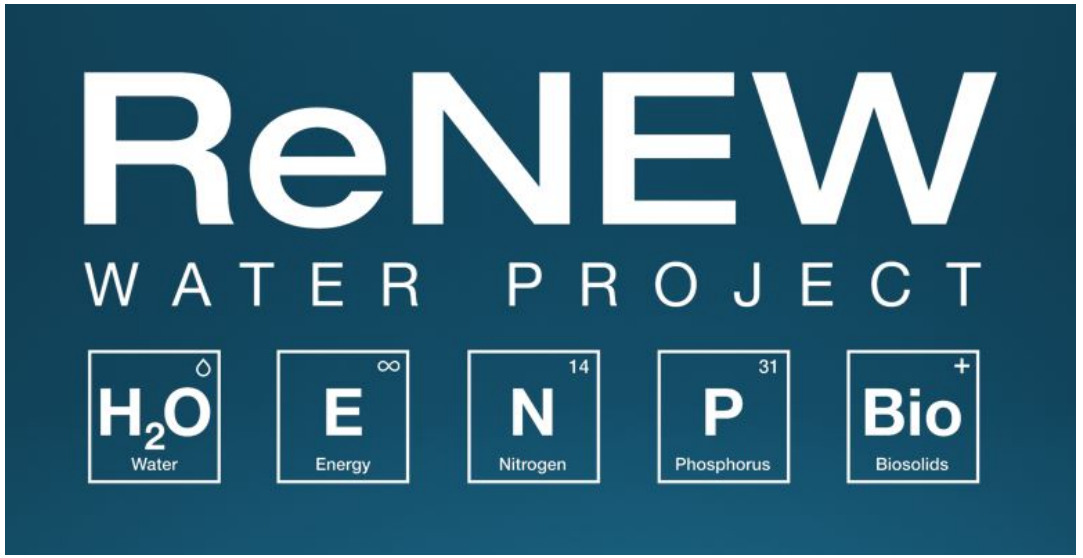

THANK YOU!

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www.wef.org www.weftec.org

Thanks for coming!

Sustainable Phosphorus Alliance

PhosphorusAlliance.org

YouTube