US EPA ARCHIVE DOCUMENT

US EPA ARCHIVE DOCUMENT

Nutrient Trading in the MRB: Possibilities for Improving Gulf Water Quality & Ideas for State Nutrient Reduction Strategies

Michelle Perez, PhD | EPA State Nutrient Reduction Strategies Webinar | May 29, 2013

US EPA ARCHIVE DOCUMENT

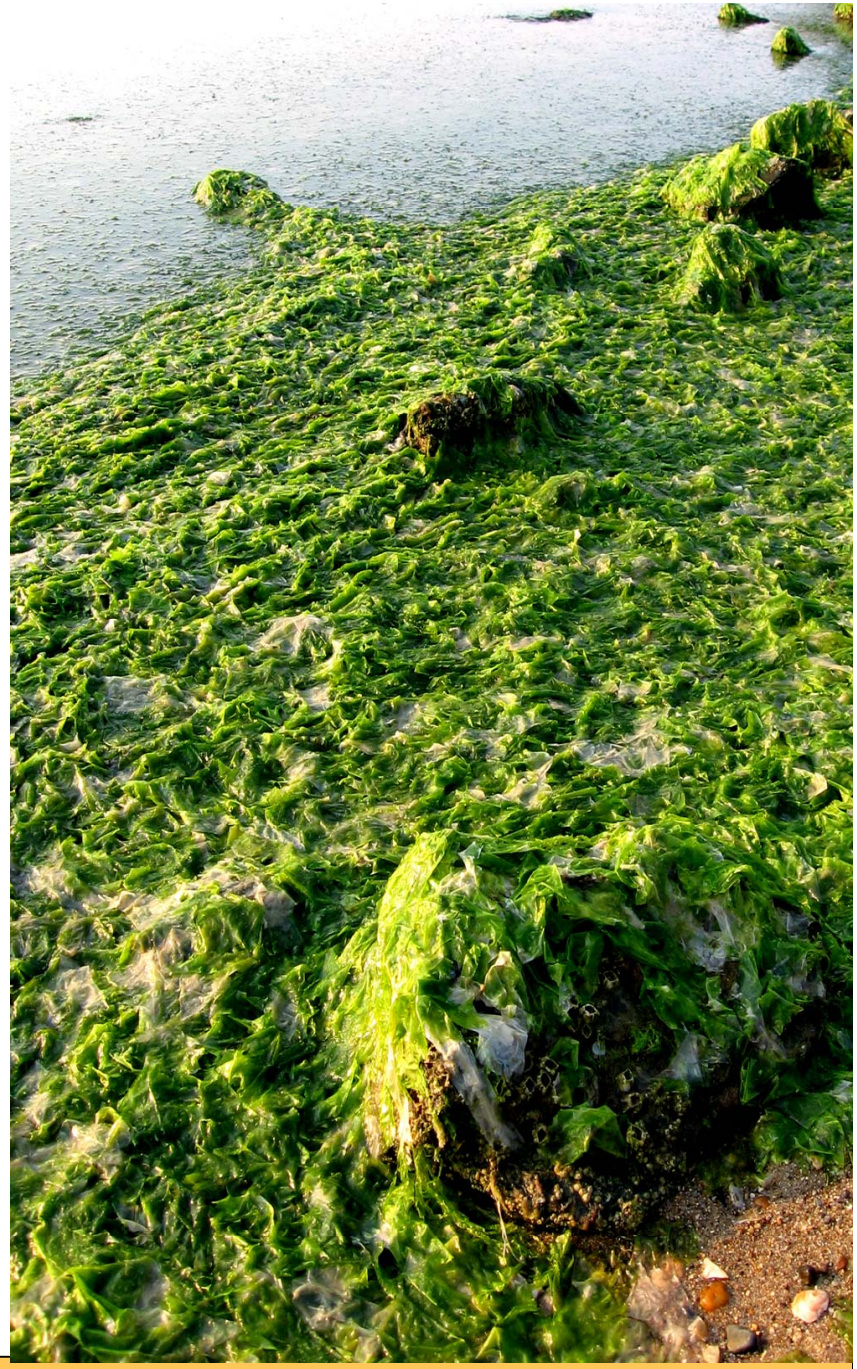


WRI's Nutrient Trading Feasibility Study Team: Michelle Perez, Sara Walker, Cy Jones

US EPA ARCHIVE DOCUMENT

Outline

- Policy methods & assumptions
- Effect of TMDLs & local numeric nutrient criteria on trading for the Gulf
- WWTP upgrade cost analysis
- Agricultural cost analysis
  - Effect of trading policies & prices
  - Conservation's profitability
  - Costs to get majority of project acres to achieve 45% goal
- Trading's economic feasibility for GOM clean-up



US EPA ARCHIVE DOCUMENT

MRB-GOM TRADING FEASIBILITY STUDY

US EPA ARCHIVE DOCUMENT

The Project

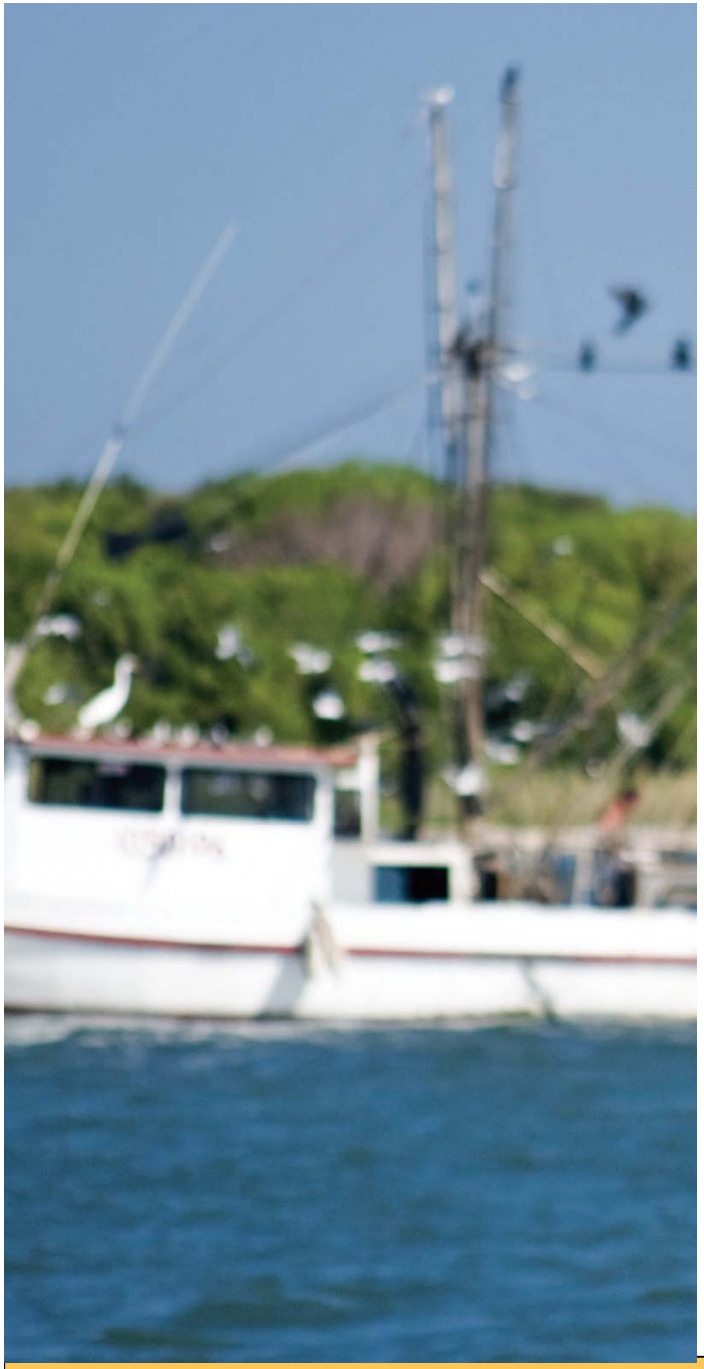
- ***Funding***
  EPA Targeted Watershed Grant & Wells Fargo Foundation

- ***Subcontractors***
  - Symbiont for wastewater utility cost analysis
  - HydroQual for nutrient criteria & delivery factor analysis

- ***Partners***
  - Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) & Sanitation District No. 1 of Kentucky (SD1) utilities shared WWTP Master Plan data
  - USDA NRCS Conservation Effects Assessment Project (CEAP) Team for farm credit supply analysis

- ***Question***
  Is large-scale interstate nutrient trading an economically & environmentally feasible tool to help reduce Gulf of Mexico hypoxia?

US EPA ARCHIVE DOCUMENT



Project Approach

- Case study
- Hypothetical trading framework
- Economic & modeling analysis
- WWTP data: ‘06 – ’09
- Farm & conservation data: ‘03 – ‘06
- Omitted urban & suburban runoff
- No farmers were interviewed; many others were

US EPA ARCHIVE DOCUMENT

Interviewed Stakeholders

- ***WWTP & Regulatory Agencies***

  MWRDGC & SD1

  IL EPA & EPA Region 4,5, & 7

- ***Agricultural Stakeholders***

  AR-FB, MS-FB, & Delta F.A.R.M.

  AR-NRCS & MS-NRCS

  ANRC & MSWCC

  ADEQ & MDEQ

  UAR & MSU

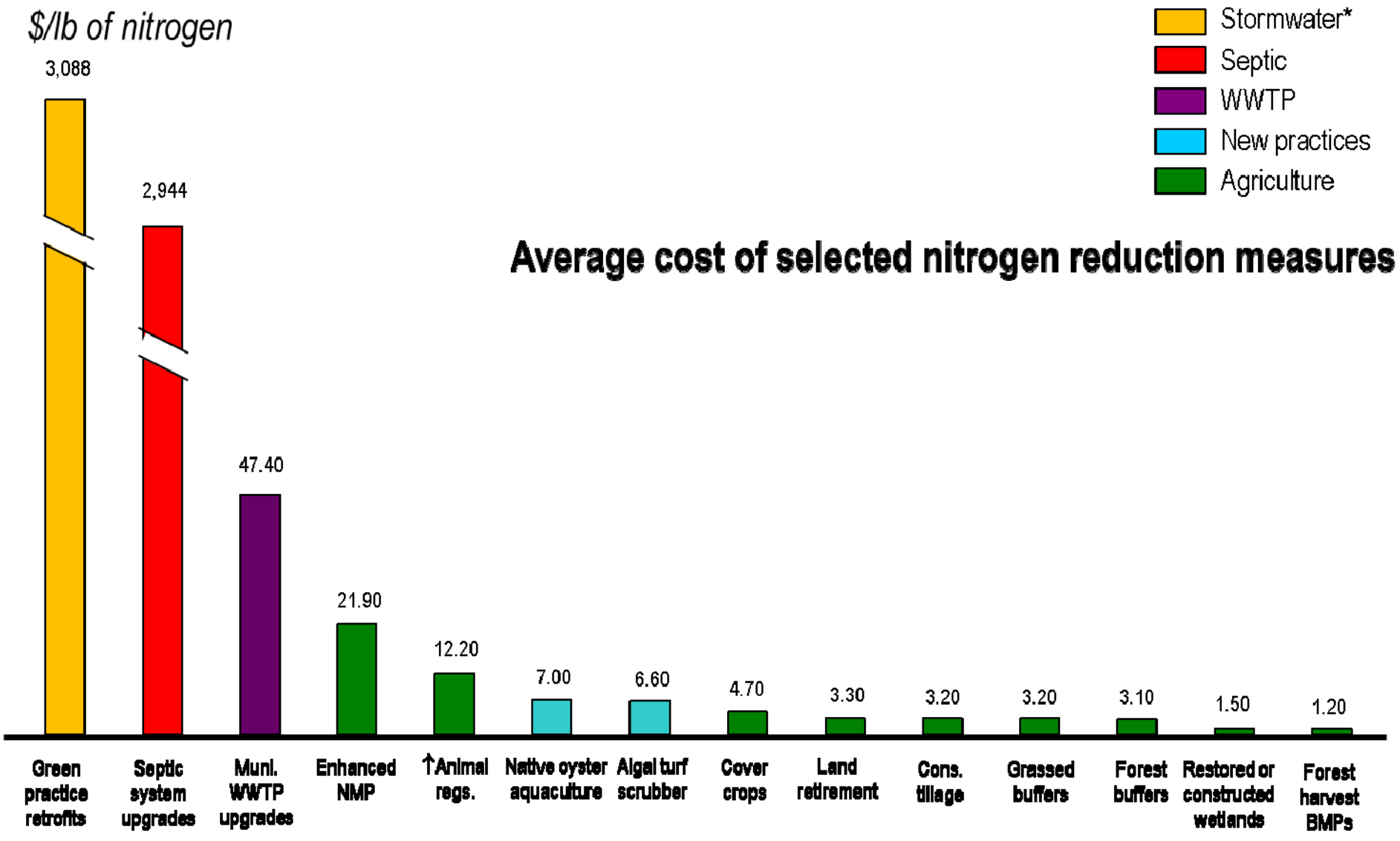
US EPA ARCHIVE DOCUMENT

What is Nutrient Trading?

- Voluntary approach
- Market-based mechanism
- Find most cost-effective nutrient reductions to help make progress towards a specific water quality goal
- **Credit buyers** – Regulated WWTPs who want to satisfy permits via purchase of credits or a combination of credits & on-site upgrades
- **Credit sellers** – WWTPs & unregulated farmers with cheaper nutrient reduction costs than buyers

US EPA ARCHIVE DOCUMENT

Trading takes advantage of cost differentials



US EPA ARCHIVE DOCUMENT

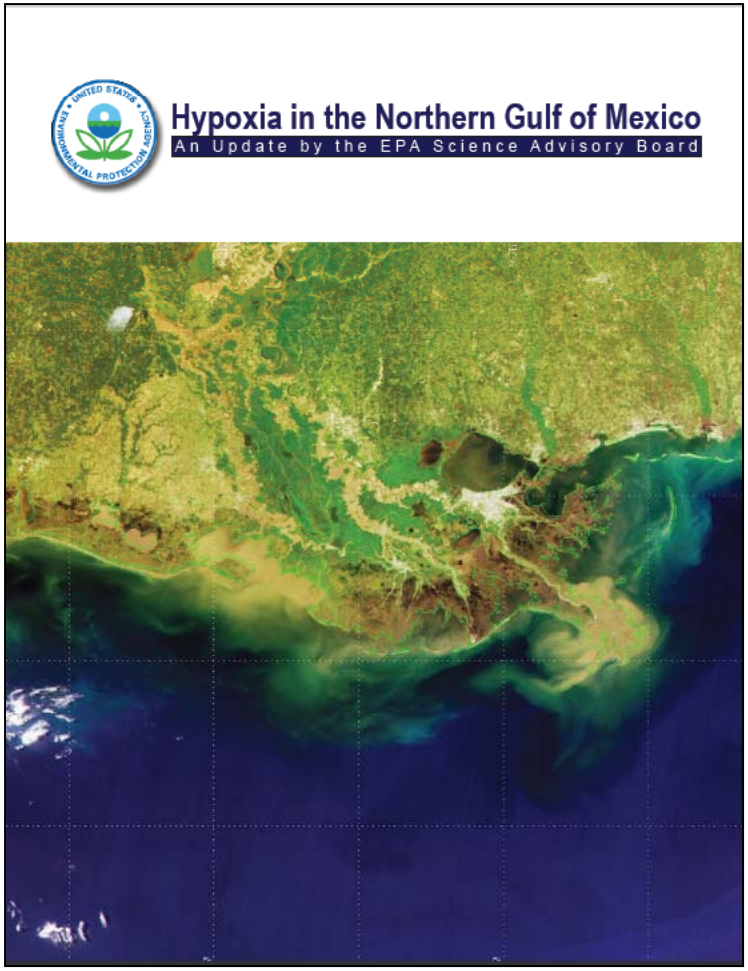
Project Policy Framework

- ***Water body of interest:***

  Gulf of Mexico hypoxic zone

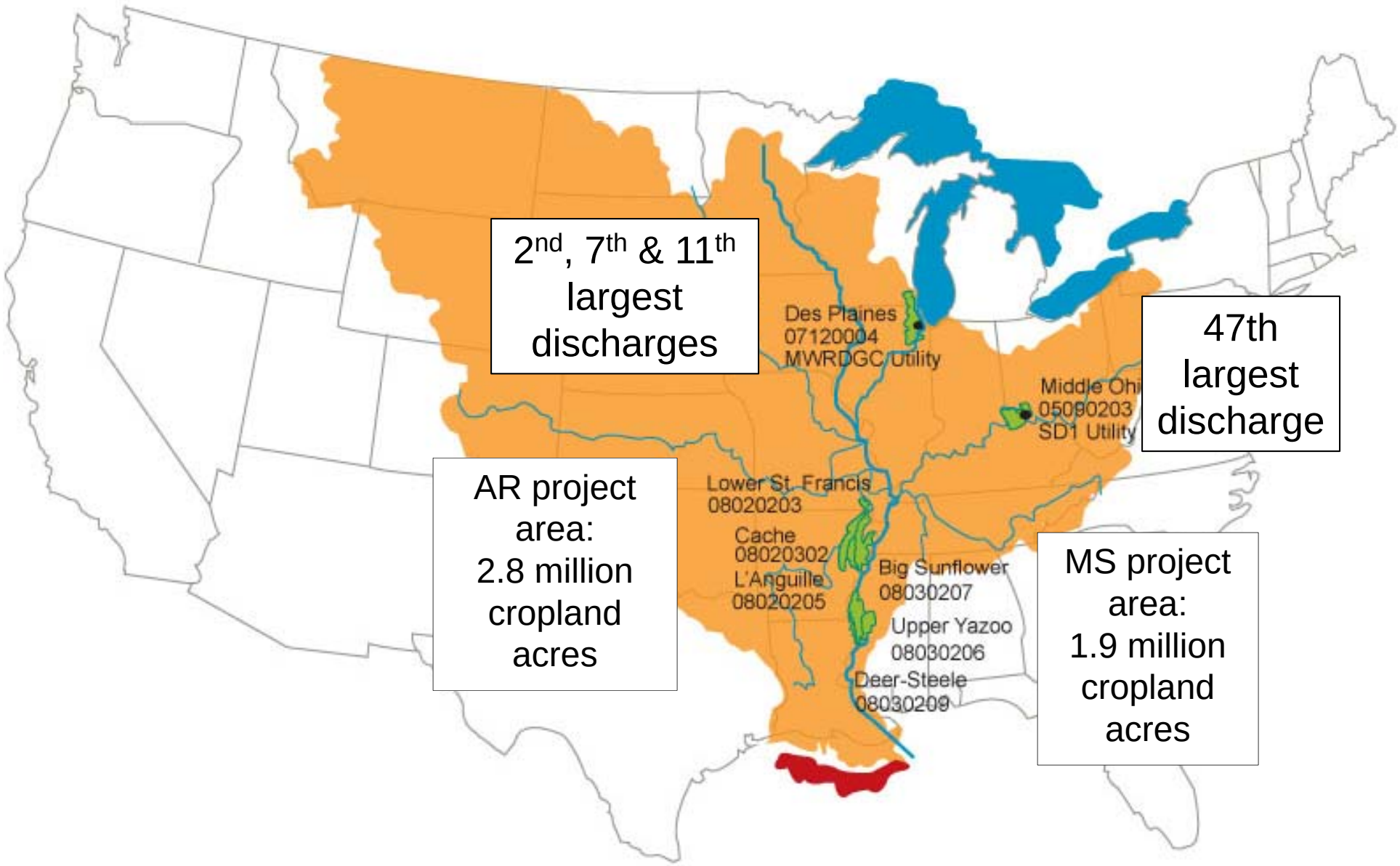
- ***Water quality goal:***

  45% N & P delivered load reduction to the Gulf is needed to achieve smaller, safer hypoxic zone (EPA SAB, '07)



US EPA ARCHIVE DOCUMENT

Demand & Supply Locations



US EPA ARCHIVE DOCUMENT

Project Policy Framework

- **Project assumptions for WWTP credit buyers:**
  - WWTPs need to reduce nutrient discharges by 45% or achieve an equivalent amount of reduction from credit purchases (or a combination)
  - Used design flow capacity & nutrient concentration data (‘06 – ‘08 MWRDGC & ‘06 – ‘09 SD1) & at each plant to estimate needed 45% N & P reduction in delivered load

US EPA ARCHIVE DOCUMENT

Project Policy Framework

- **Project assumptions for farm credit sellers:**

  - Before selling credits, individual suppliers must first achieve their project area's per acre trading eligibility standard (TES)

  e.g. N TES lbs /ac =

  Average baseline N load from project area ('03 – '06) reaching Gulf – 45% reduction

  ÷ cropland acres

US EPA ARCHIVE DOCUMENT

Additional Trading Ratios

- **Reviewed various potential trading ratios:**
  - i.e., uncertainty, retirement, reserve ratios
- **Did not apply any additional trading ratios to our study**
  - Trading ratios are both a political decision & a scientific decision (linked to water quality & watershed models used to develop a Gulf-related TMDL & nutrient trading program)
- **Analyzed the effect of an uncertainty ratio when burden falls on buyer, on seller, or shared by both**

US EPA ARCHIVE DOCUMENT

Unaddressed Costs that Could Affect Trading

- Trading ratios
- Cost-share from farm conservation federal or state programs
- Trading program administrative fees
- Aggregator fees

US EPA ARCHIVE DOCUMENT

EFFECT OF NUTRIENT CRITERIA ON TRADING

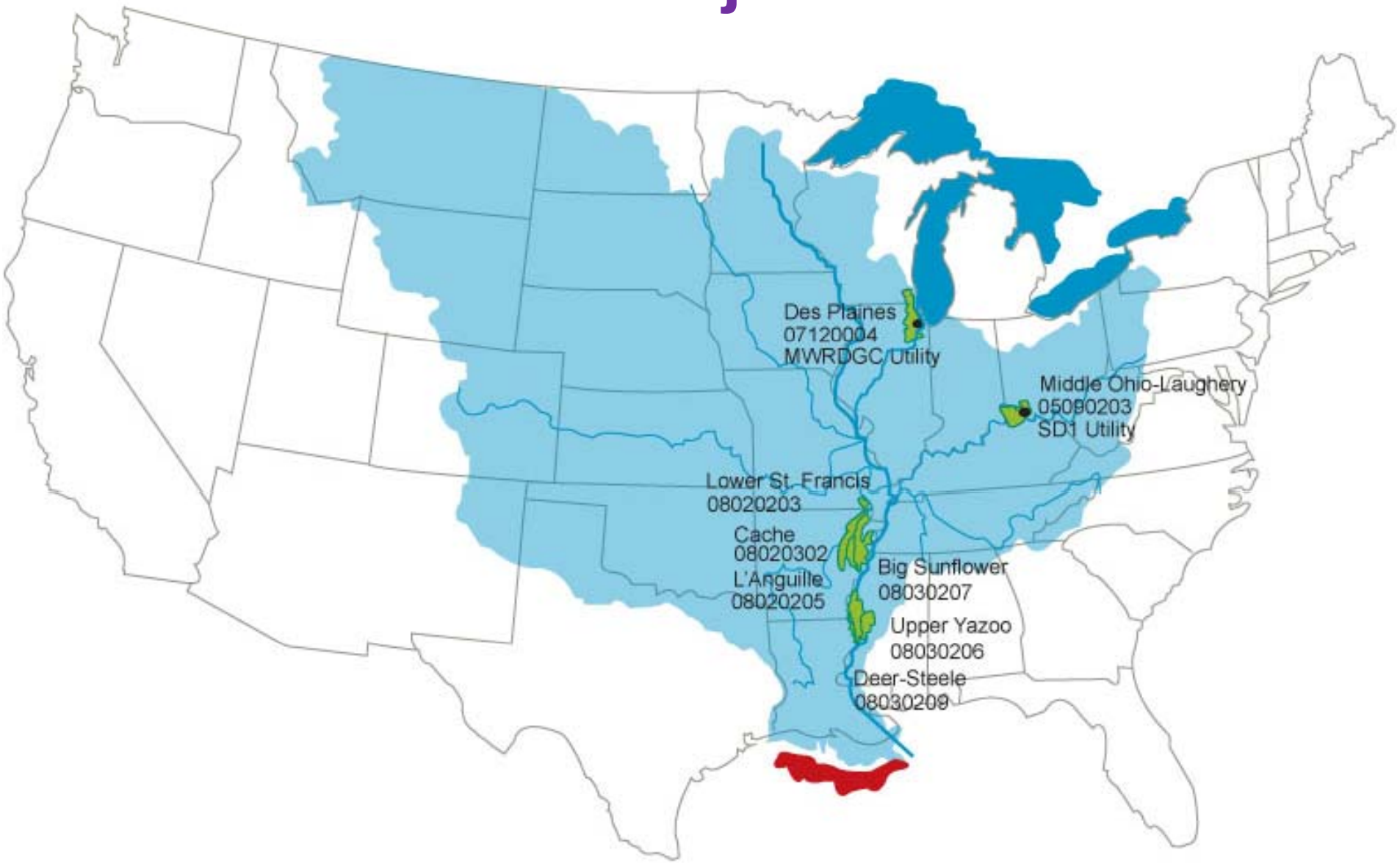
US EPA ARCHIVE DOCUMENT

Effect of Local Numeric Nutrient Criteria & TMDLs on Trading for GOM

- None of project's watersheds have numeric nutrient criteria
- IL EPA prioritizing waterbodies for numeric P criteria
  - Criteria would have to be met before meeting a regional water quality goal if stricter
  - Would shrink trading market for buyers
- Sub-watershed in 1 MS project watershed has a TMDL calling for an 85-95% reduction in N & P from ag
  - TMDL would have to be met before meeting this project's less strict regional water quality goal

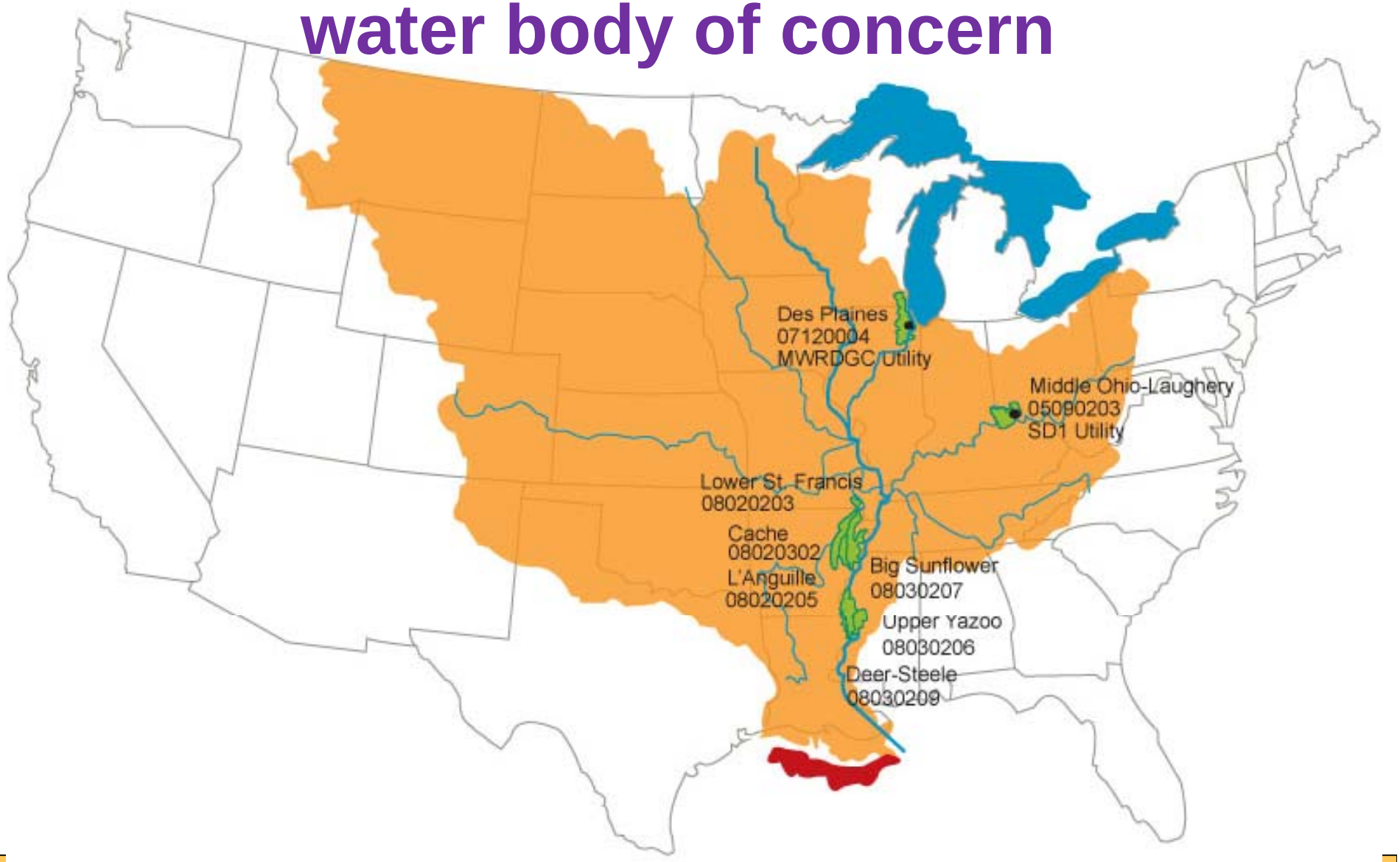
US EPA ARCHIVE DOCUMENT

MRB Basin & Project Watersheds



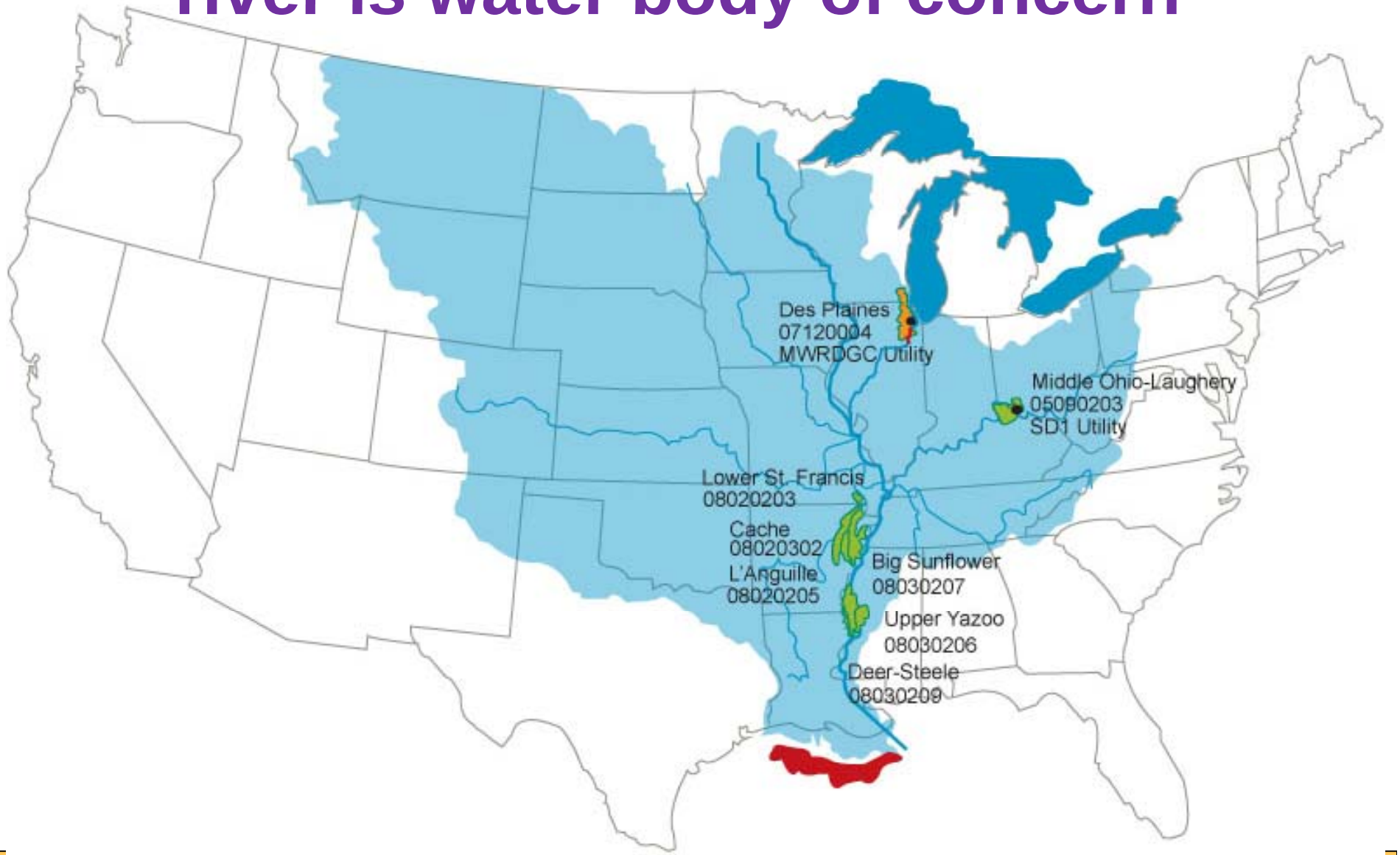
US EPA ARCHIVE DOCUMENT

Trading market (orange) when Gulf is water body of concern



US EPA ARCHIVE DOCUMENT

Trading market (orange) when local river is water body of concern



US EPA ARCHIVE DOCUMENT

WWTP ON-SITE COST & CREDIT DEMAND ANALYSIS

US EPA ARCHIVE DOCUMENT

MWRDGC'S planning levels similar for N but more stringent for P than project's goal

MWRDGC's Calumet & Northside Plants						
	Total Nitrogen			Total Phosphorus		
	Current	Planning Level	Project Policy Goal	Current	Planning Level	Project Policy Goal
Effluent Concentration (mg/L)	10 & 10.3	6-8	5.6	2.4 & 1.4	0.5	1.05
Mass Load (lbs/day)	58,129	34,377	31,971	10,973	2,865	6,035
Percent Load Reduction	---	*20-40%*	*45%*	---	*64-79%*	*45%*

US EPA ARCHIVE DOCUMENT

SD1's planning levels similar for N but more stringent for P than project's goal

SD1's Two Plants						
	Total Nitrogen			Total Phosphorus		
	Current	Planning Level	Project Policy Goal	Current	Planning Level	Project Policy Goal
Effluent Concentration (mg/L)	14 & 7.2	8 & 3	7.4	2.7 & 0.65	1 & 0.3	1.4
Mass Load (lbs/day)	8,005	4,540	4,380	1,519	565	841
% Load Reduction	---	*43-58%*	*45%*	---	*55-63%*	*45%*

US EPA ARCHIVE DOCUMENT

Utility Price Ceiling for Credits

On-Site Achievement of a 45% N and P Load Reduction to the Gulf				
	MWRDGC (Calumet & Northside)		SD1 (All 3 Plants)	
Annual Average (Delivered To Gulf)				
	TN	**TP**	**TN**	**TP**
Annual Average Reduction (lbs)	7,733,613	1,153,517	1,020,365	203,703
Annual Average Cost	$46,782,390	$47,057,332	$16,303,184	$7,139,900
Annual Average Cost/lb	$6.05	$40.79	$15.98	$35.05
20-Year Present Value (Delivered To Gulf)				
	TN	**TP**	**TN**	**TP**
Nutrients Removed Over 20 Years (lbs)	154,672,254	23,070,336	20,407,296	4,074,057
20-Year Present Value (Capital Cost Payments and O&M)	$696,003,835	$700,094,268	$242,550,205	$106,223,682
20-Year Present Value Cost/lb	**$4.50**	**$30.35**	**$11.89**	**$26.07**

US EPA ARCHIVE DOCUMENT

Credit Demand Assumptions

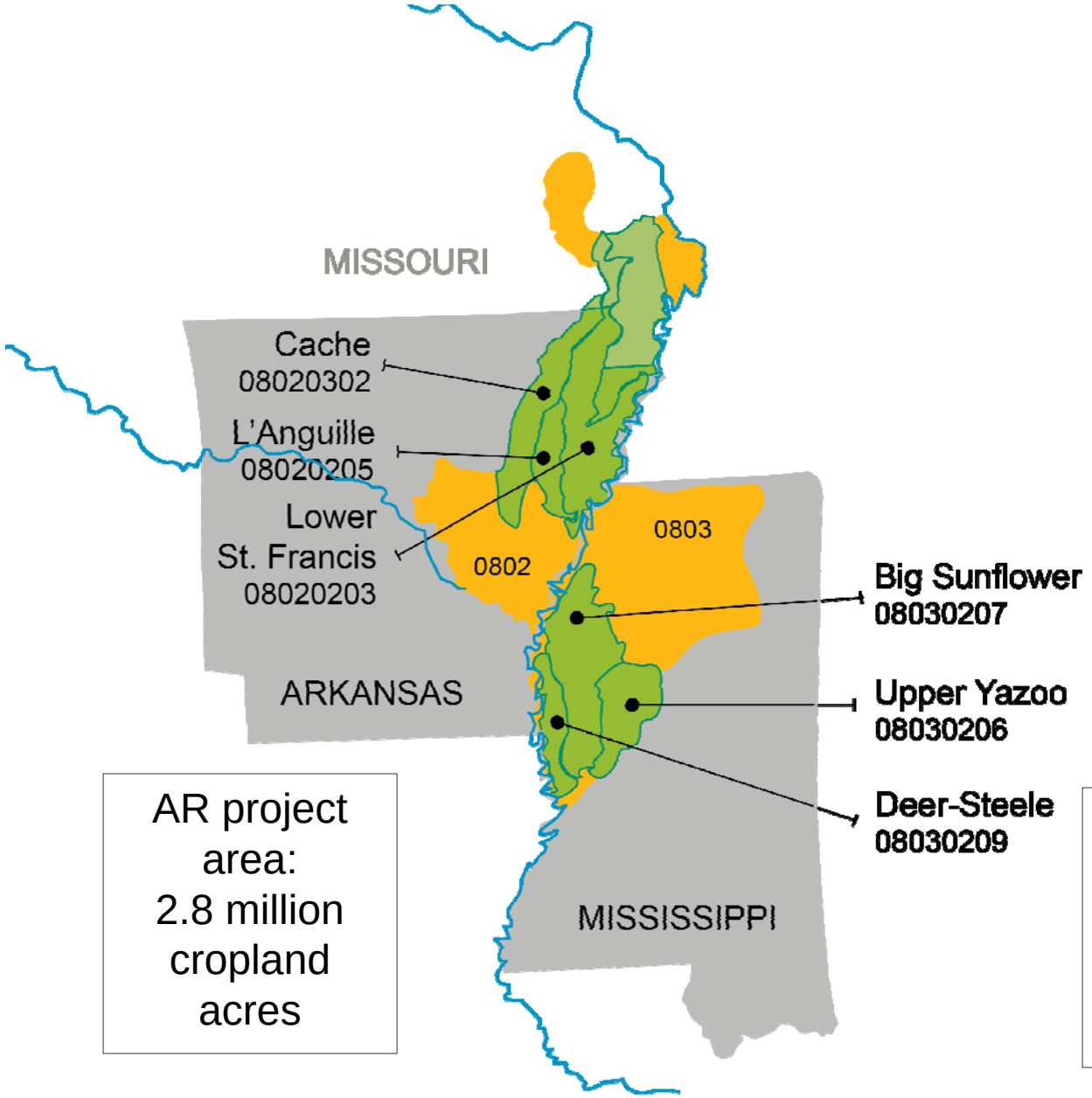
- **If interested in trading to meet their potential future Gulf-related NPDES permits, wastewater utilities may choose to offer credit prices that reflect a percentage of their on-site, technological upgrade costs**
  - WRI examined potential credit demand and willingness to pay at 25%, 50%, or 75% of utility on-site costs

US EPA ARCHIVE DOCUMENT

AGRICULTURAL CREDIT SUPPLY ANALYSIS

US EPA ARCHIVE DOCUMENT

6 Agricultural Credit Supply Project Watersheds



AR project area: 2.8 million cropland acres

MS project area: 1.9 million cropland acres

US EPA ARCHIVE DOCUMENT

Credit Supply Data & Models

- **WRI partnered with USDA Natural Resources Conservation Service (NRCS) Conservation Effects Assessment Project (CEAP) Team**

  – Data came from a CEAP-NRI farmer survey:
    - 400 sample points in 6 watersheds
    - 3 years field-level farm management data (crop years ‘03 to ‘06)
    - Reflect “baseline field conditions for existing crop management & conservation practice adoption
    - Statistically extrapolated to areas with similar crop & hydrologic conditions

  - Used Agricultural Policy Extender (APEX) to model nutrient loads at edge-of-field (EOF) before & after hypothetical conservation treatment

  - Used APEX & USGS SPARROW delivery factors from EOF to Gulf

US EPA ARCHIVE DOCUMENT

Delivery Ratios

- **For WWTP loads**

  Used USGS SPARROW delivery factors to attenuate on-site WWTP reductions delivered to Gulf

2009 SPARROW Watershed Outlet Delivery Factors to the Gulf		
	N Delivery Factor	**P Delivery Factor**
Credit Buyers		
Chicago, IL (MWRDGC) watershed outlet	.81	.64
Licking, KY (SD1) watershed outlet	.78	.81

- **For agricultural loads**

  Used USDA APEX & SPARROW delivery factors to attenuate agricultural edge-of-field reductions to the edge-of-watershed then to the Gulf

US EPA ARCHIVE DOCUMENT

NRCS Delivery Ratios for Nitrogen and Phosphorus						
	Nitrogen			Phosphorus		
8-digit watershed	**Edge of Field to 8-digit**	**8-digit to Gulf**	**Edge of Field to Gulf**	**Edge of Field to 8-digit**	**8-digit to Gulf**	**Edge of Field to Gulf**
8020203	0.93	0.86	0.80	0.68	0.86	0.58
8020205	0.92	0.90	0.83	0.72	0.93	0.67
8020302	0.77	0.81	0.62	0.66	0.85	0.56
0802 average	*0.89*	*0.85*	*0.76*	*0.68*	*0.87*	*0.59*
8030206	0.75	0.96	0.72	0.42	0.97	0.41
8030207	0.94	0.94	0.89	0.52	0.96	0.50
8030209	0.84	0.94	0.79	0.45	0.96	0.43
0803 average	*0.88*	*0.94*	*0.83*	*0.49*	*0.96*	*0.47*
Regional average	*0.89*	*0.89*	*0.79*	*0.60*	*0.91*	*0.54*
Data source	APEX	2009 SPARROW	Product of APEX* SPARROW	APEX	2009 SPARROW	Product of APEX* SPARROW

US EPA ARCHIVE DOCUMENT

Credit Supply Modeling Approach

- **CEAP used two economic models:**
  - "Cost-minimization model" to select least-cost treatment for each sample point to achieve the TES
  - "Profit-maximization model" to select most profitable treatments for each sample point, in response to prices, to generate credits

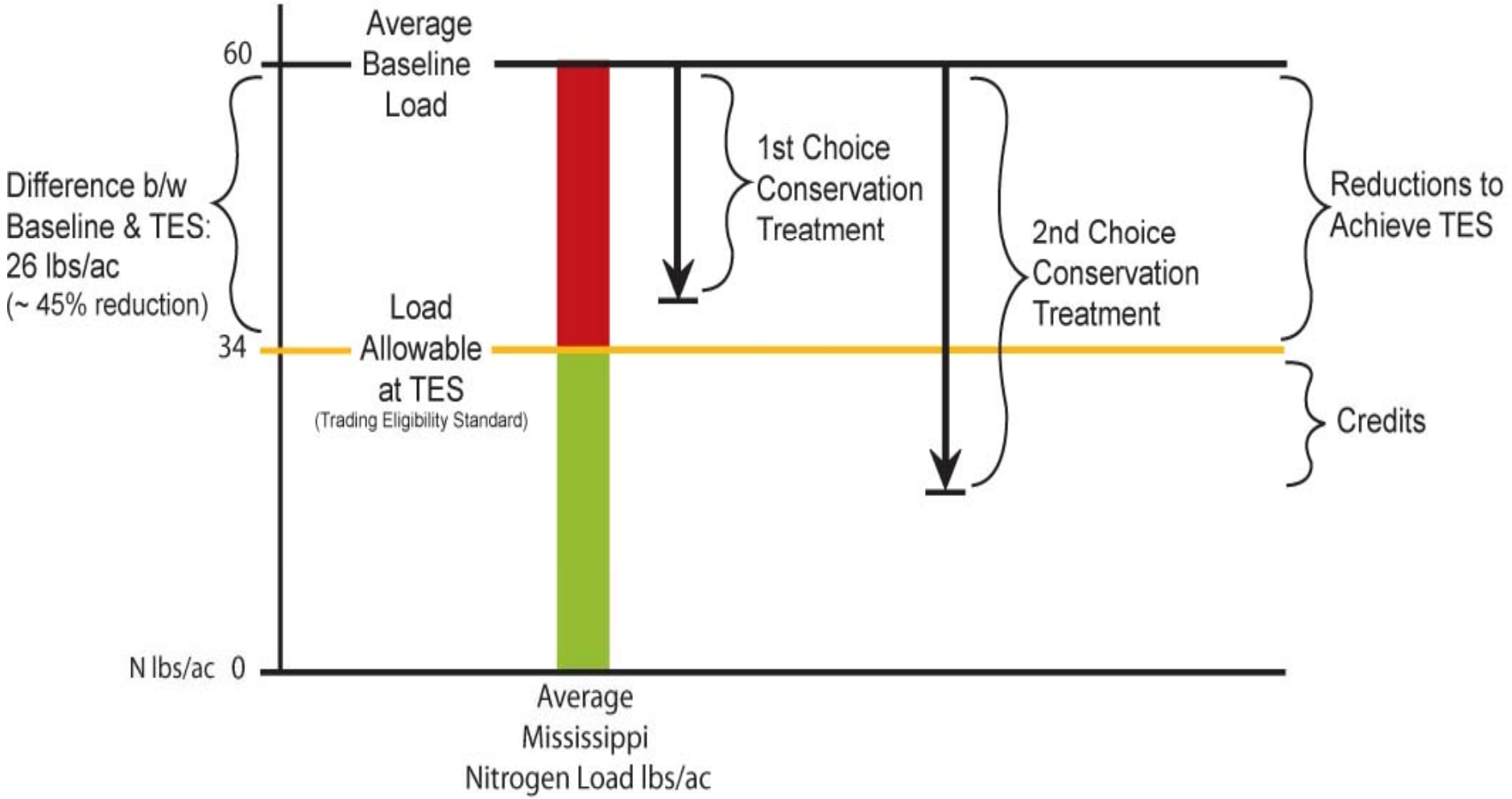
- **Analyzed effect:**
  - Three trading eligibility standards (N-only, P-only, and N&P TES)
  - Two additionality rules (Additionality enforced and not enforced)
  - Three credit prices (N-only, P-only, and N & P credit prices)

N prices: $1, $2, $3, $4, $5, $6, $7, $8, $9, $10, $12.50, $15, $20, & $50

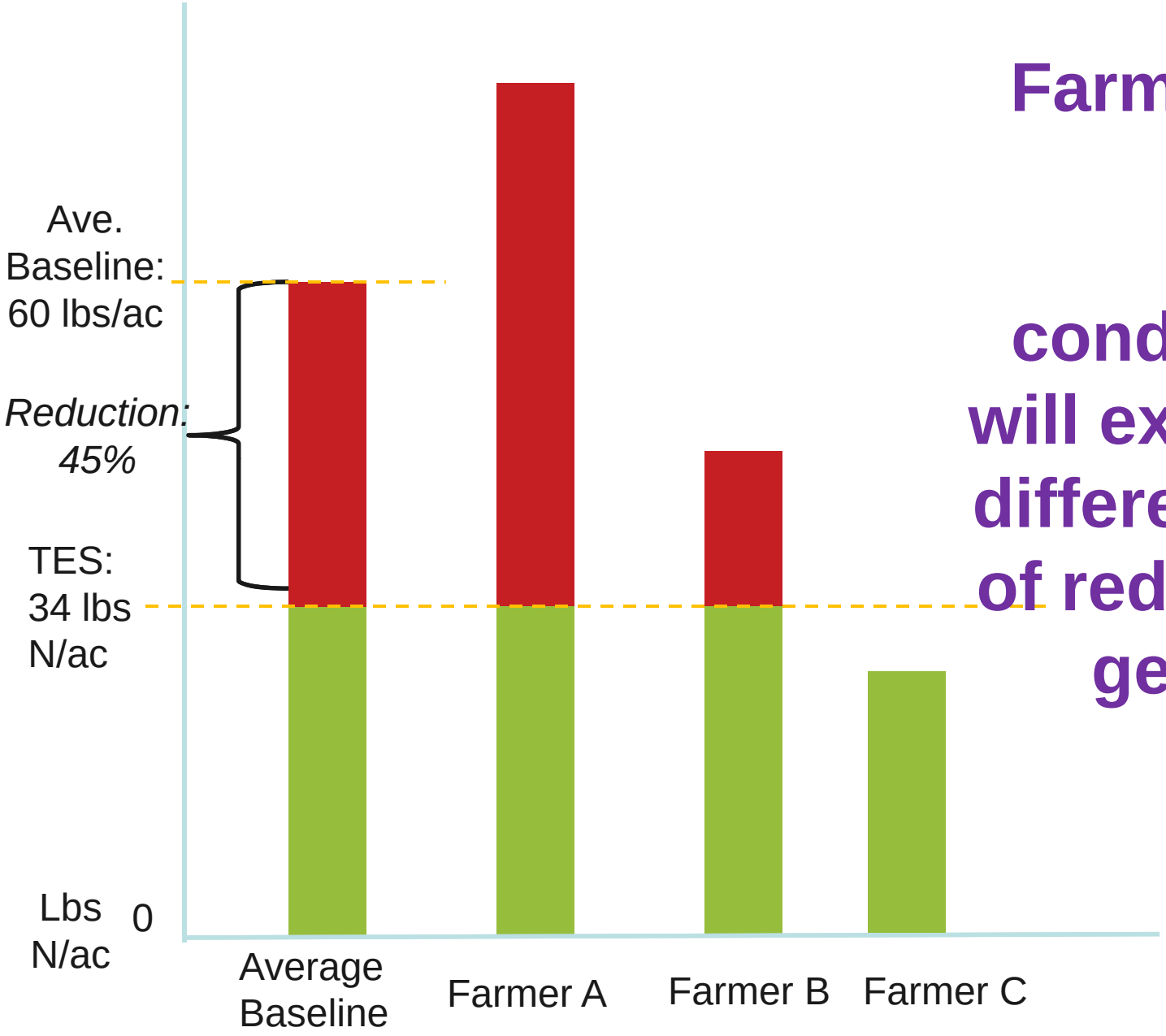
P prices: $5, $10, $15, $20, $25, $30, $35, $40, $45, $50, $75, & $100

US EPA ARCHIVE DOCUMENT

Baseline, TES, Credits, oh my!



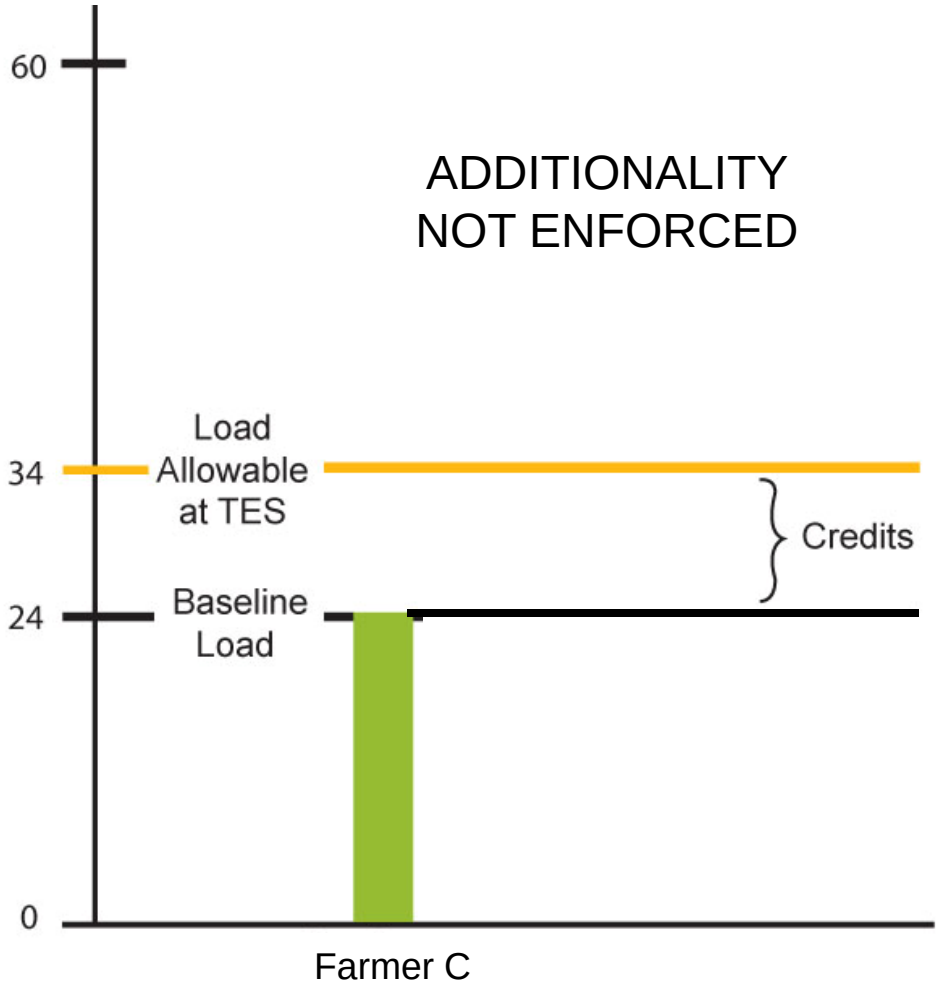
US EPA ARCHIVE DOCUMENT



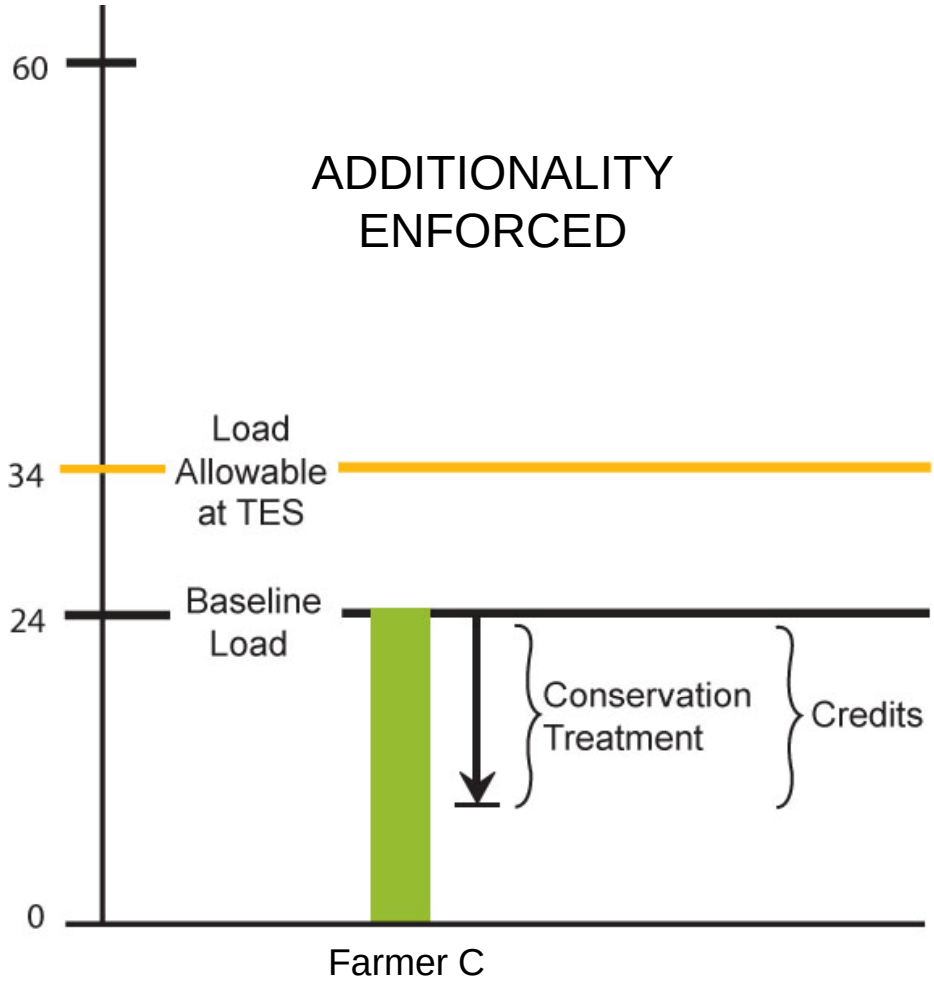
Farmers have different baseline conditions so will experience different levels of reduction to get beyond TES

US EPA ARCHIVE DOCUMENT

Additionality?



ADDITIONALITY
NOT ENFORCED



ADDITIONALITY
ENFORCED

US EPA ARCHIVE DOCUMENT

CEAP modeled six conservation treatments

Six Treatment Scenarios	Practices
Drainage Water Management (DWM)	1 annual practice
Cover Crops (CC)	1 annual practice
Structural Erosion Control (SEC)	Structural practices (1 - 20 yrs)
Erosion & Nutrient Management (ENM)	Structural practices (1 - 20 yrs) + 1 annual practice
ENM & Drainage Water Mgt (E-DWM)	Structural practices (1 - 20 yrs) + 2 annual practices
ENM & Cover Crops (E-CC)	Structural practices (1 - 20 yrs) + 2 annual practices

US EPA ARCHIVE DOCUMENT

CEAP assembled state practice costs

Costs of Conservation Practices					
Practice Name	Practice Life (Years)	Units of Practice per Protected Acre	Amortized "INSTALL" Cost/ Protected Acre	Amortized Technical Assistance Cost/ Protected Acre	Amortized Install + Technical Assistance Cost
Drainage Water Mgt	1	1	$ 9.09	0	$ 9.09
Cover Crop	1	1	$ 71.37	$ 1.52	$ 72.89
Contour Strip Cropping	2	1	$1.26	0	$1.26
Field Border	20	0.02	$3.07	$0.01	$3.08
Riparian Buffer – Grass	20	0.09	$8.97	$0.34	$9.31
Filter Strip	15	0.09	$10.41	$0.43	$10.84
Contouring	1	1	$11.78	0	$11.78
Riparian Buffer – Forest	20	0.16	$15.90	$0.63	$16.53
Terracing	10	215	$49.15	$12.33	$61.48
Nutrient Mgt Planning	1	1	$ 33.95	$ 4.65	$ 38.60

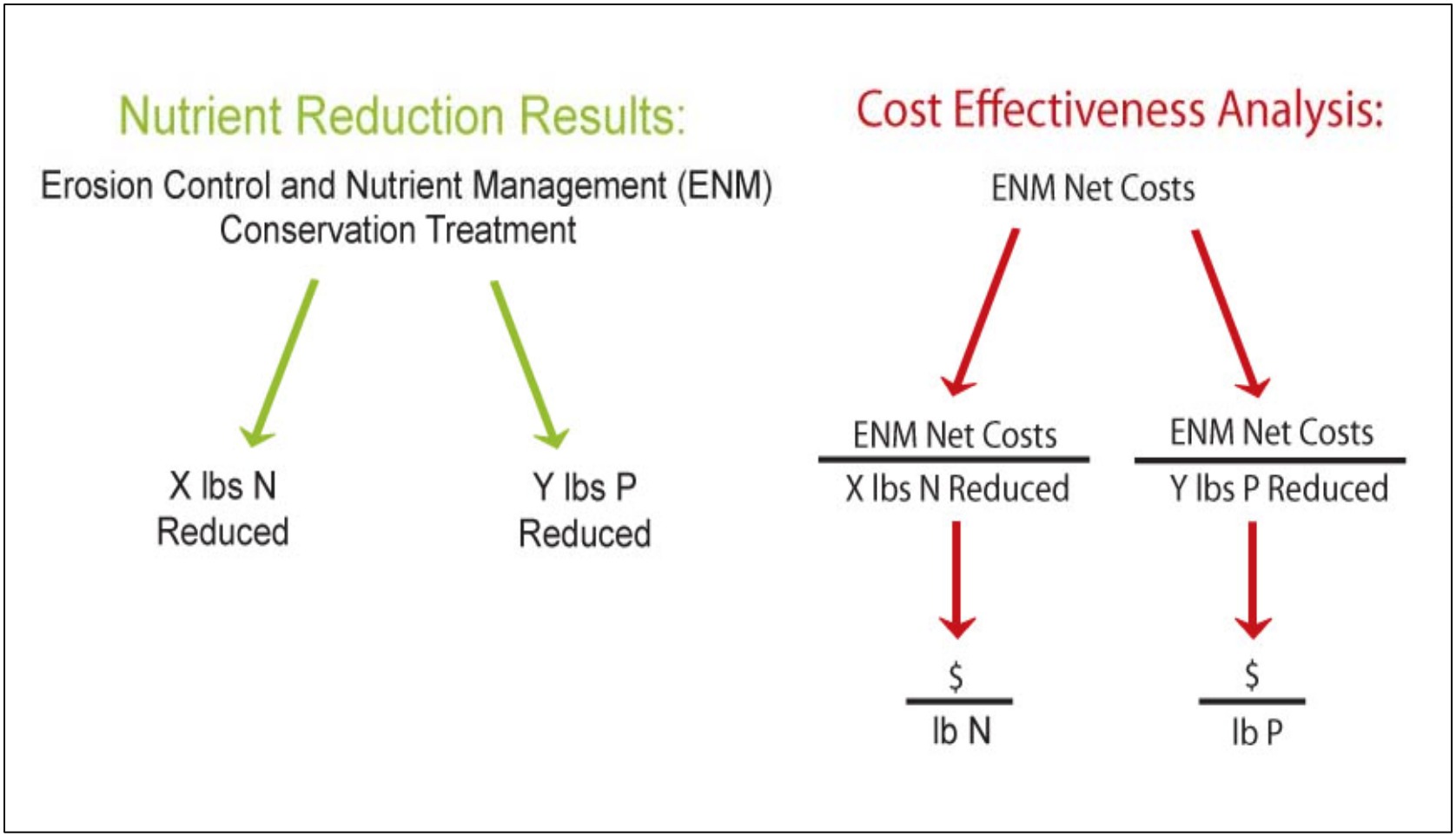
US EPA ARCHIVE DOCUMENT

Focused on net costs

- **Net costs include four elements:**
  - Conservation practice installation, maintenance, & technical assistance costs
  - Changes in fertilizer application cost
  - Changes in crop revenue
  - Changes in diesel fuel use cost
- **Net costs that are negative are *net savings (profits)***

US EPA ARCHIVE DOCUMENT

Apportioning net costs into lbs reduced

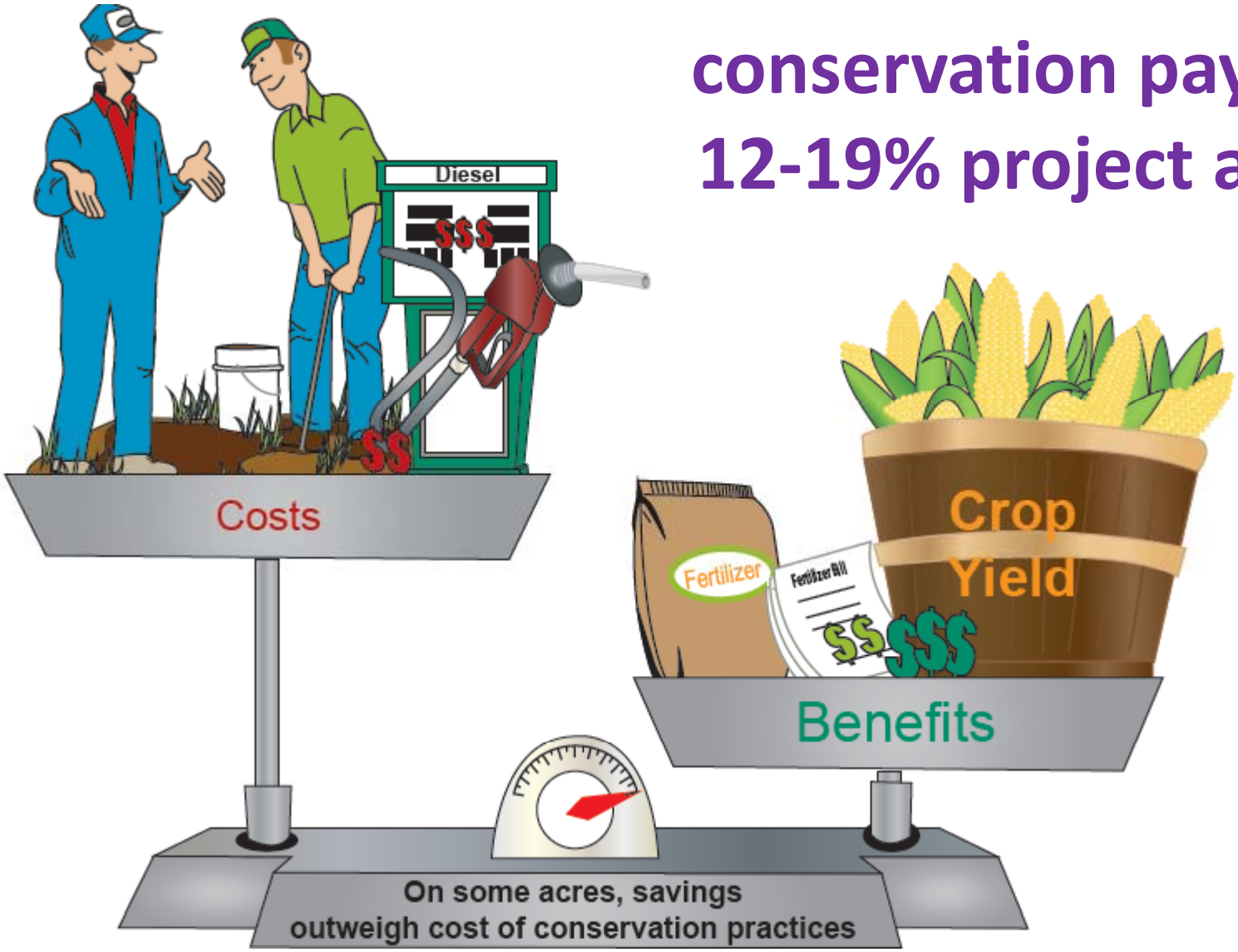


US EPA ARCHIVE DOCUMENT

SURPRISING FINDINGS ABOUT CONSERVATION:

US EPA ARCHIVE DOCUMENT

Even without trading, conservation pays on 12-19% project acres



At low credit prices, it's 38% of acres

US EPA ARCHIVE DOCUMENT

FINDINGS ABOUT AG'S ACHIEVING THE TRADING ELIGIBILITY STANDARD & ABILITY TO PARTICIPATE IN TRADING

US EPA ARCHIVE DOCUMENT

Differences between AR & MS watersheds baseline conditions ('03-'06)

	Arkansas Watersheds	Mississippi Watersheds
Hydrologic and Field Conditions		
Precipitation (inches)	48.5	54.3
Rainfall intensity (USLE R factor)	275.4	349.1
Slope length (in field – feet)	115.8	161.9
Sediment Load (tons/ac)	1.6	6.3
Conservation Practice Implementation		
% in Conventional Tillage	17.9	33.5
% in No Till	22.6	13.9
% w/no Structural Conservation Practices except Drainage	85.7	92.5
% with Control of both Overland & Concentrated Flow	2.6	1.6

US EPA ARCHIVE DOCUMENT

Differences (cont'd)

	Arkansas Watersheds	Mississippi Watersheds
Nutrient Inputs (all crops)		
Applied N (lbs/ac)	68.6	93.6
Legume fixed N (lbs/ac)	76.4	50.9
Crop Yield		
Corn Yield (bu/ac)	169.5	159.5
Winter Wheat Yield (bu/ac)	57.5	48.3
Cotton Yield (bales/ac)	2.2	1.7

US EPA ARCHIVE DOCUMENT

Higher baseline loads & TES in MS areas

	Edge of Field (lbs/ac/yr)	
	Arkansas Project Area	Mississippi Project Area
	Nitrogen	
Baseline load	*23.48*	*60.31*
Uncontrollable load allocation	*0.92*	*1.06*
Baseline + Uncontrollable Load	24.40	61.37
Trading eligibility standard	13.45	33.78
Reductions needed to achieve TES	10.95	27.59
	Phosphorus	
Baseline load	*3.08*	*5.61*
Uncontrollable load allocation	*0.12*	*0.07*
Baseline + Uncontrollable Load	3.20	5.68
Trading eligibility standard	1.76	3.13
Reductions needed to achieve TES	1.44	2.55

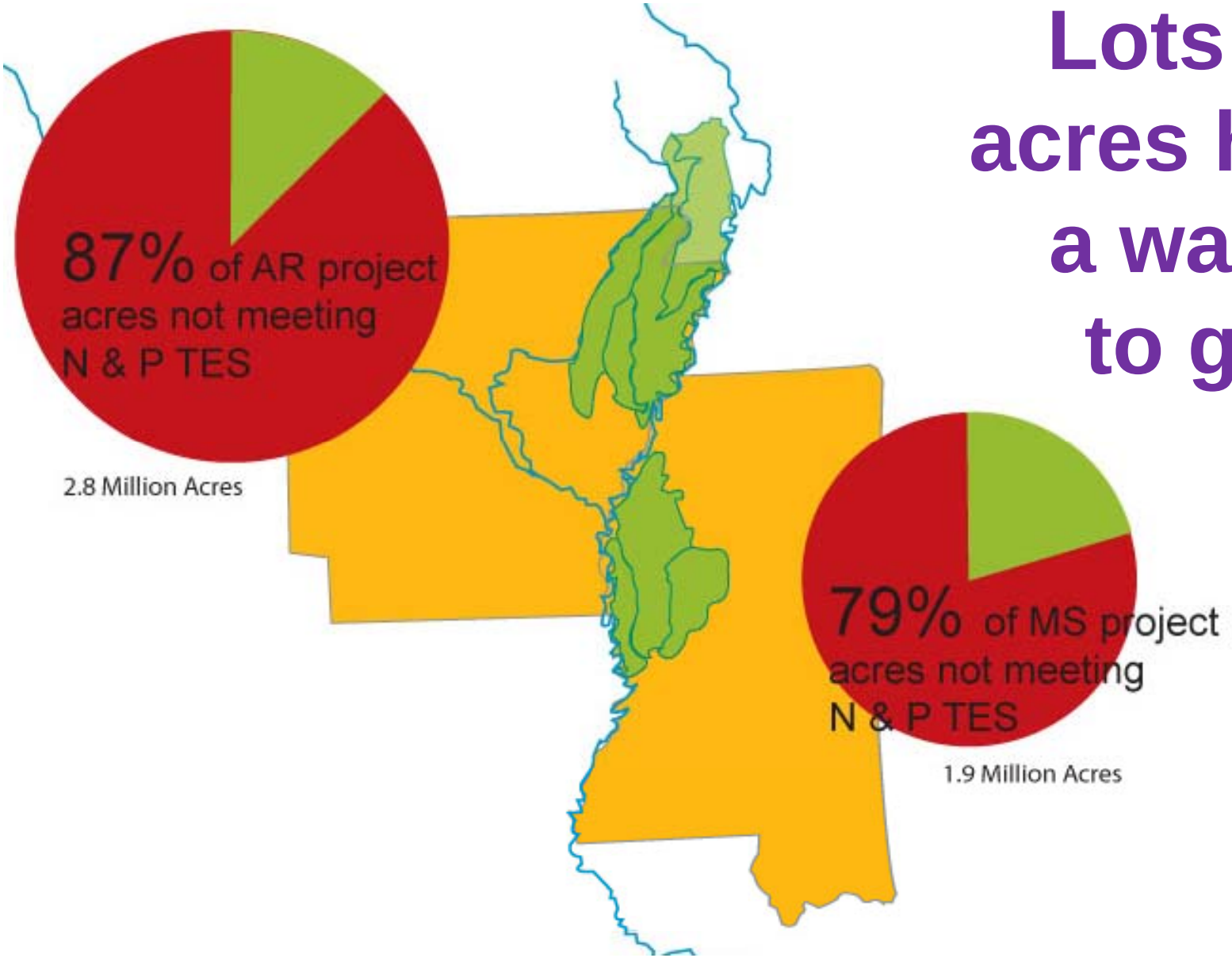
US EPA ARCHIVE DOCUMENT

Higher baseline loads & TES in MS areas

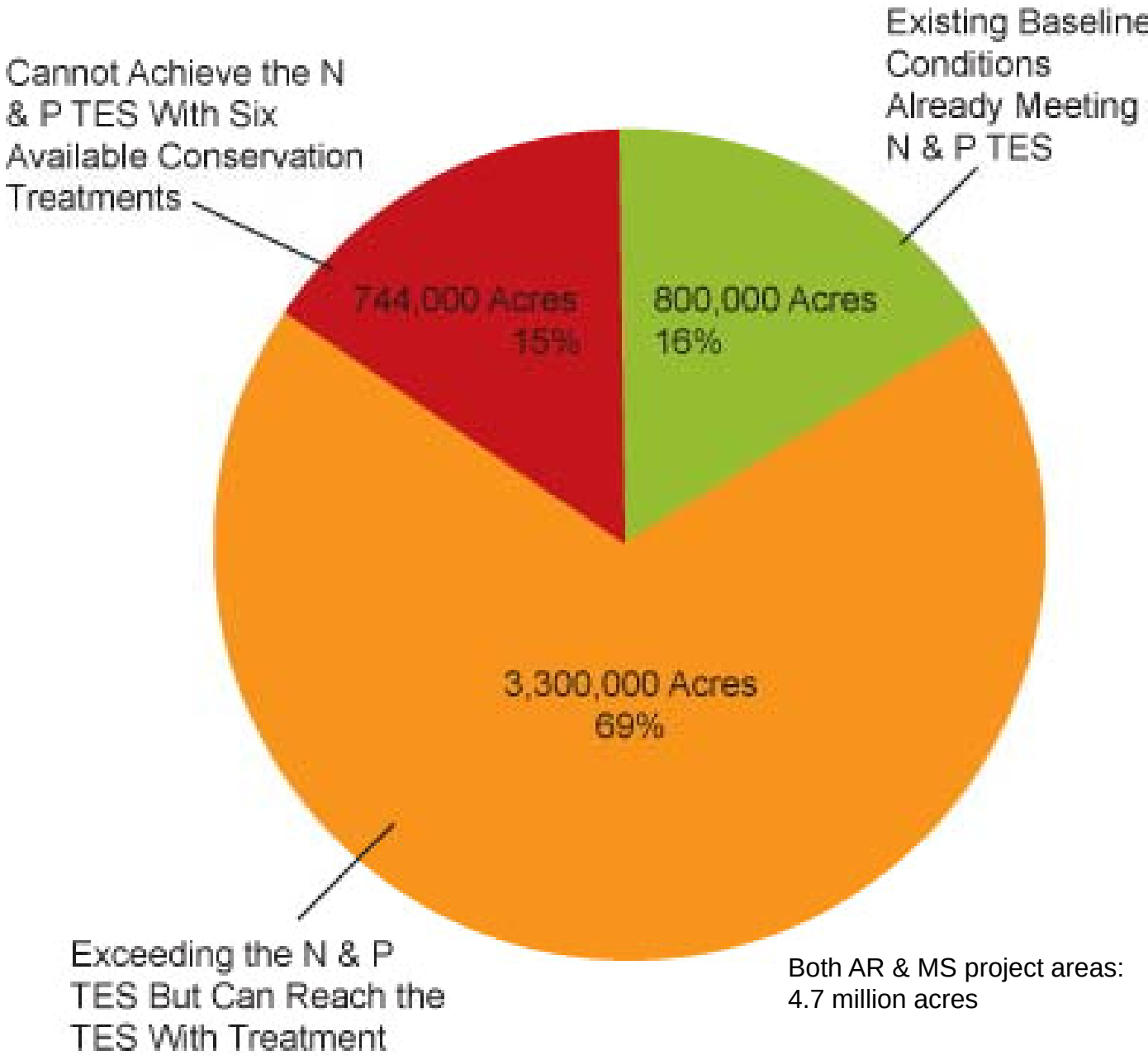
	Delivered to Gulf (lbs/ac/yr)	
	Arkansas Project Area	**Mississippi Project Area**
	Nitrogen	
Baseline load	*18.02*	*48.83*
Uncontrollable load allocation	*0.70*	*0.88*
Baseline + Uncontrollable Load	18.71	49.71
Trading eligibility standard	10.29	27.34
Reductions needed to achieve TES	8.42	22.37
	Phosphorus	
Baseline load	*1.84*	*2.60*
Uncontrollable load allocation	*0.07*	*0.03*
Baseline + Uncontrollable Load	1.91	2.63
Trading eligibility standard	1.05	1.45
Reductions needed to achieve TES	0.86	1.18

US EPA ARCHIVE DOCUMENT

Lots of acres have a ways to go



US EPA ARCHIVE DOCUMENT



Lots of acres can get there

Both AR & MS project areas:
4.7 million acres

US EPA ARCHIVE DOCUMENT

Least-cost solution to achieve TES is different for each state

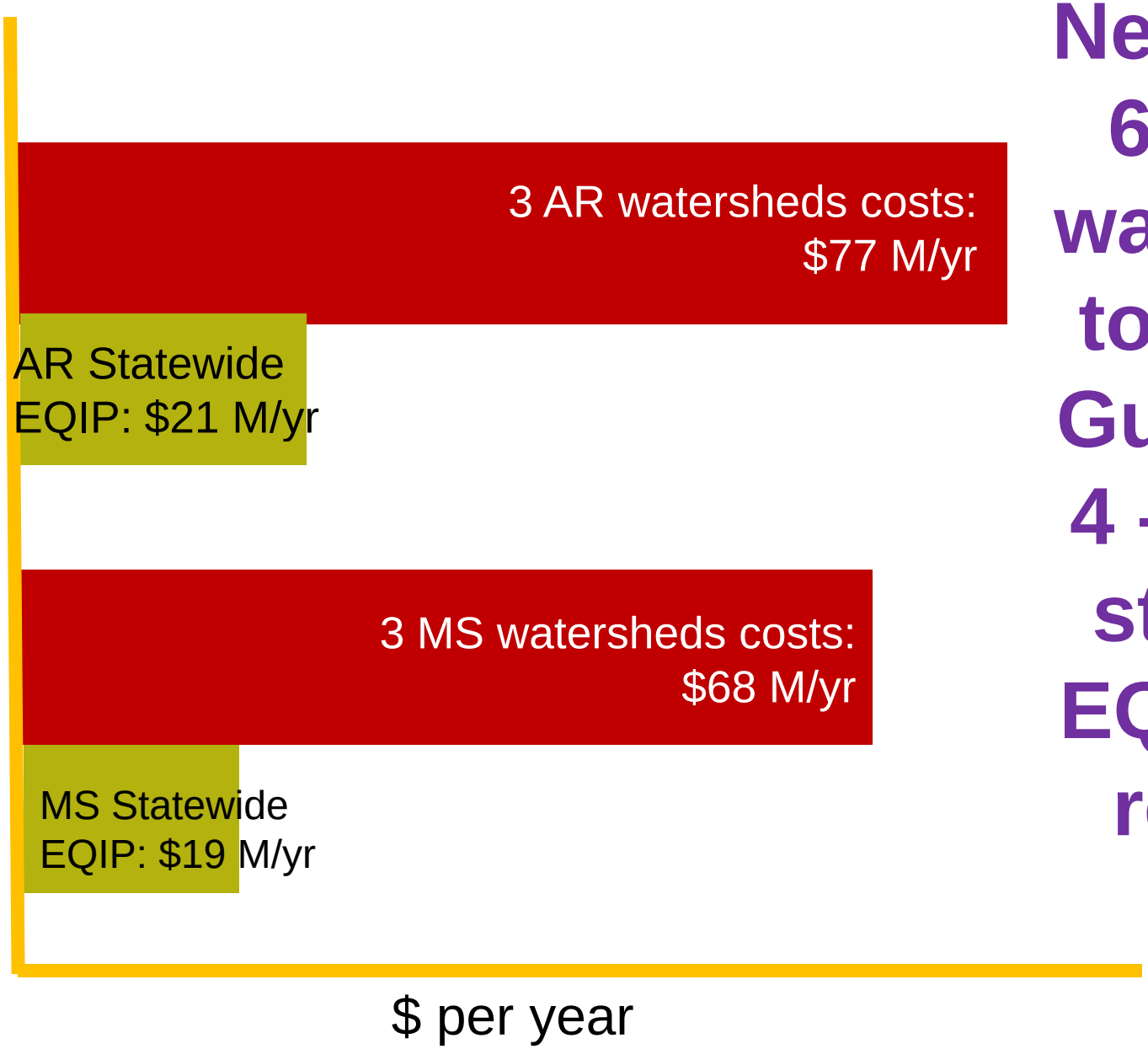
Conservation Treatments	Arkansas Watersheds	Mississippi Watersheds	Total
	(1000 acres)		
Drainage Water Management (DWM)	22	0	22
Cover Crops (CC)	476	287	762.9
Structural Erosion Control (SEC)	**691**	311.7	**1,002.7**
SEC + Nutrient Management (ENM)	358.2	156.2	514.4
ENM + DWM	60.7	38.8	99.5
ENM + CC	218.5	**658.5**	877
Total Treated	1,826.3	1,452.2	3,278.5

US EPA ARCHIVE DOCUMENT

Net costs still large for all project acres to achieve the N & P TES

	Arkansas Project Watersheds	Mississippi Project Watersheds
Total Net Cost	$77 M	$68 M
Conservation Practice Cost	$90 M	$113 M
Fertilizer Cost	-$31 M	-$41 M
Crop Revenue Change	-$18 M	$5 M
Fuel Cost	$0.360 M	$0.433 M

US EPA ARCHIVE DOCUMENT



Net cost for 6 project watersheds to achieve Gulf goal is 4 – 5 times statewide EQIP funds received

US EPA ARCHIVE DOCUMENT

When getting all able acres to achieve TES, net costs per lb are cheaper in Mississippi

	Arkansas Watersheds	Mississippi Watersheds
Net Cost/lb N	$3.18	$0.90
Net Cost/lb P	$21.76	$9.55
Net Cost/acre	$42.29	$46.65

US EPA ARCHIVE DOCUMENT

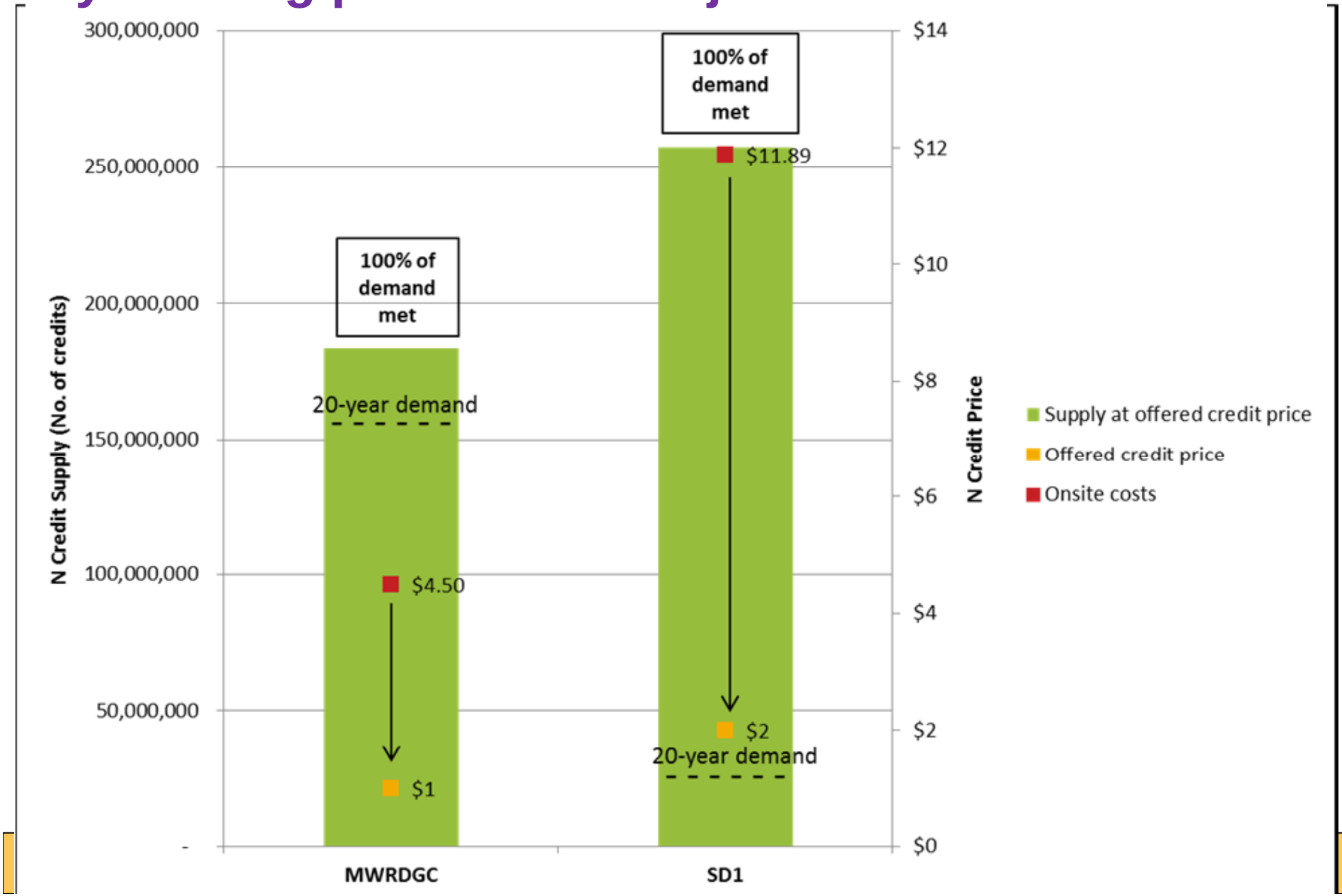
FINDINGS ABOUT TRADING'S ECONOMIC FEASIBILITY

US EPA ARCHIVE DOCUMENT

Nutrient trading in the MRB is an economically feasible approach to help restore Gulf of Mexico water quality

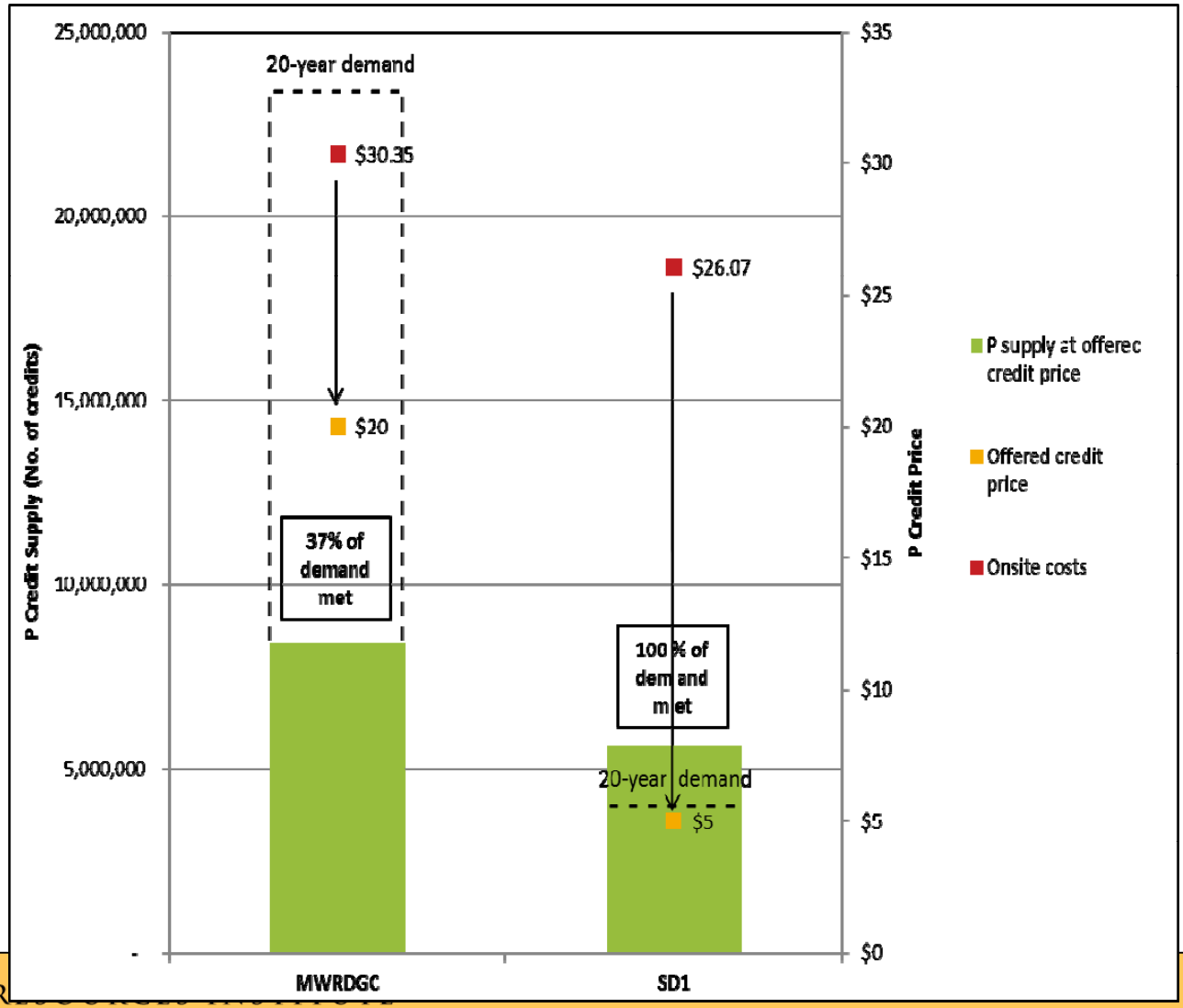
US EPA ARCHIVE DOCUMENT

Both utilities could satisfy all N credit needs by offering prices that are just 25% of onsite costs



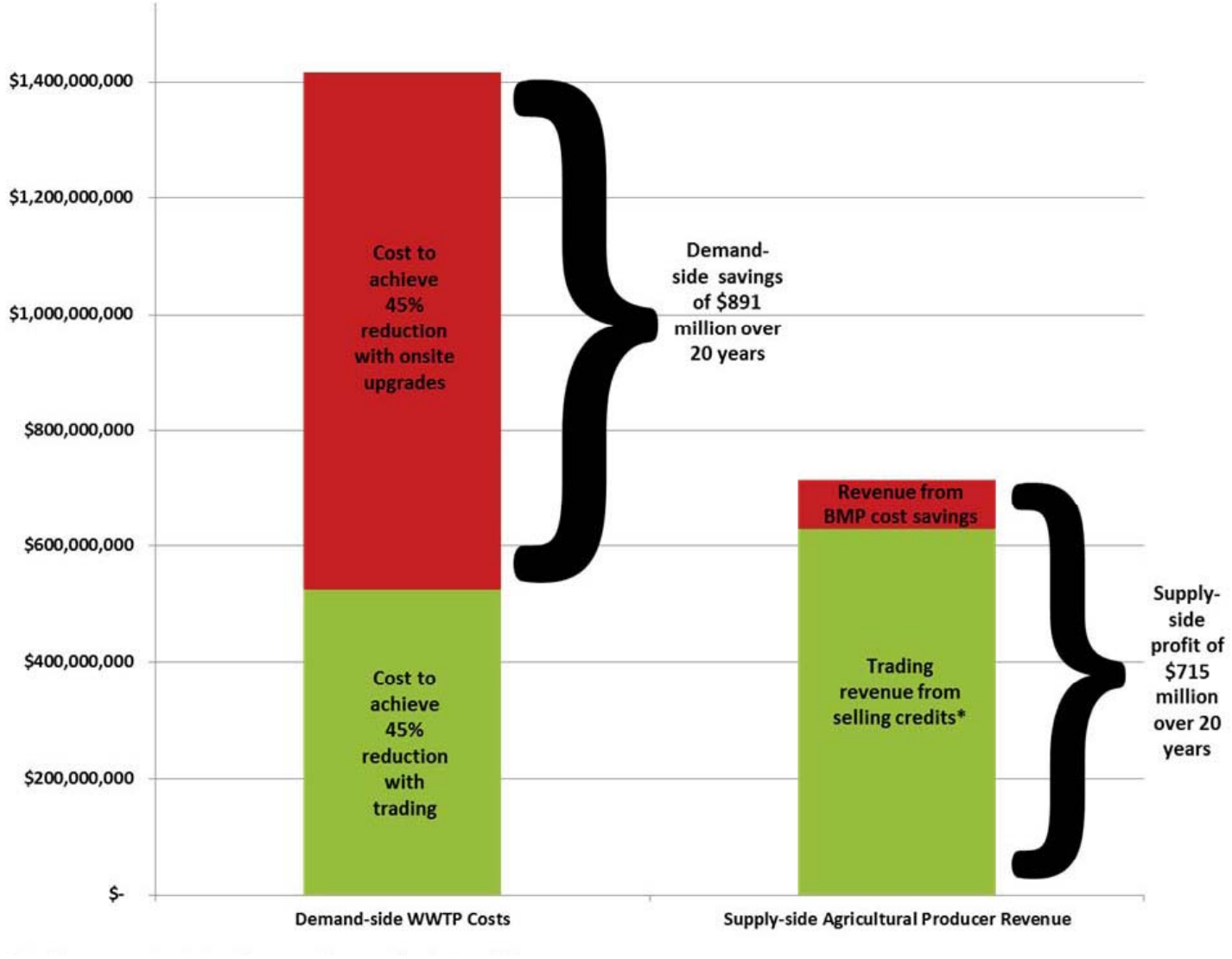
US EPA ARCHIVE DOCUMENT

SD1 could satisfy all P credit needs from project watersheds at 25% of its onsite costs but MWRDGC can't (even if offered 75% onsite costs)

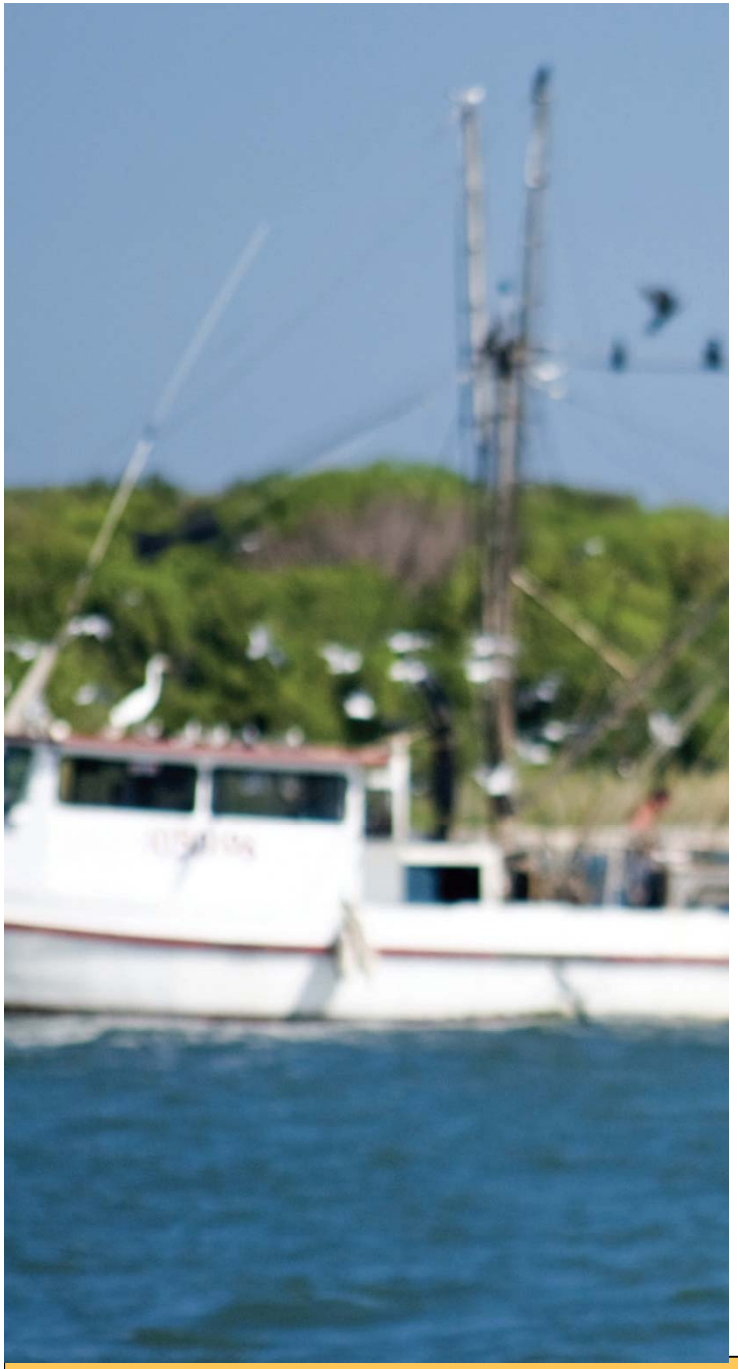


US EPA ARCHIVE DOCUMENT

N trading could save utilities $900M to meet N Gulf goal & earn $700M in producers net profits



US EPA ARCHIVE DOCUMENT



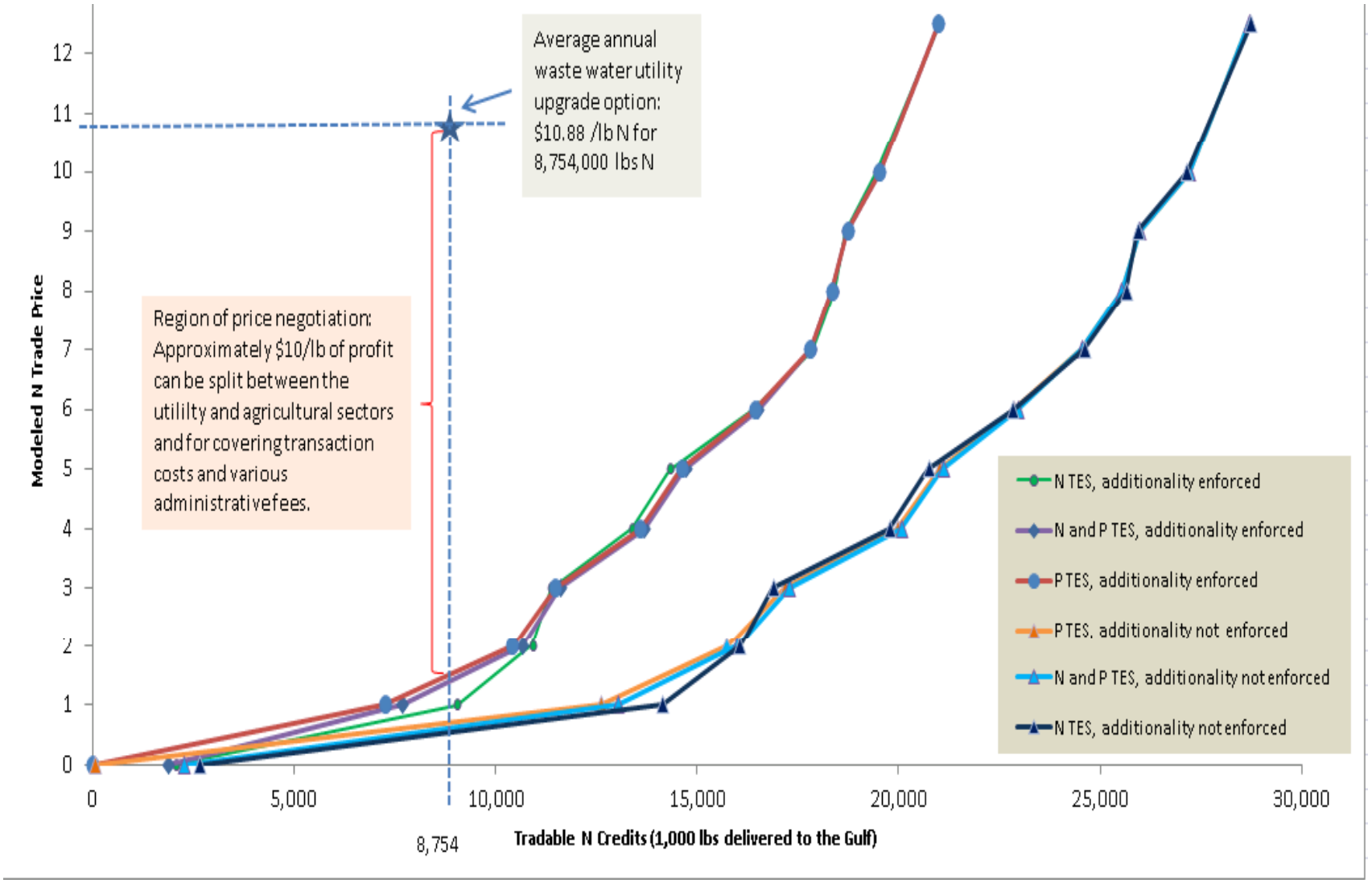
Producer profits from trading sufficient

"You'll get some takers"

- In response to N credit prices, profits ranged from $25 to $60 per acre
- In response to P credit prices, profits ranged from $18 to $42 per acre
- Farmer participation could occur on 12 to 40% of the project crop acres

US EPA ARCHIVE DOCUMENT

Sufficient cost differential between buyers and sellers to cover transaction costs & program fees



US EPA ARCHIVE DOCUMENT

FINDINGS ABOUT TRADING POLICIES & CREDIT PRICES:

US EPA ARCHIVE DOCUMENT

Impact of trading scenarios on credit supply

- **TES findings**
  - Having both N & P TES yield more credits than just 1 TES
- **Additionality findings**
  - Volume of credits is larger if additionality is not enforced than if it is (though water quality goal may be compromised)
- **Market price findings**
  - Presence of both N & P prices stimulates more acres to trade, larger volume of credits, & higher profits than when only 1 price
  - N price stimulates more credits than a P price
  - Higher the price, larger volume of credits offered

US EPA ARCHIVE DOCUMENT

Outcomes

- Large-scale, interstate trading in the MRB is a cost-effective option for helping to achieve potential future Gulf hypoxia clean-up goals
- Potential credit prices offered by utilities likely to stimulate sufficient credit supply
- Utilities can save money by purchasing credits; agricultural credit suppliers can generate money by selling credits

US EPA ARCHIVE DOCUMENT

Next Steps & Ideas for State Nutrient Reduction Strategies

1. Identify local watersheds where trading could help achieve local water quality goals

2. Gather wastewater, industrial, environmental & agricultural stakeholders to define & design trading program & agree to trade to achieve specific goal

3. Develop needed datasets, models, & tools for quantifying agricultural baseline, nutrient reductions, & cost

US EPA ARCHIVE DOCUMENT

Interview Highlights

WWTPs

- Trading an option but no policy signal
- Uncertain about legal authority to trade
- Political challenge to convince ratepayers & policy makers to allow credit purchases outside of jurisdiction
- Concerned about fairness of CWA's lack of NPS regulation & effect for trading

Regulatory agencies

- Interested but due to shrinking budgets, administrative capacity to assist in trading program development & implementation is constrained

US EPA ARCHIVE DOCUMENT

Interview Highlights

Agricultural community

- Trading an option but no policy signal
- Interested in anything that achieves more conservation & brings funding to farmers
- Need field-level credit calculation tools & watershed-level planning tools
- Need both tools to be calibrated to current farm & conservation practices
- Need to buy-in to tools & to trading
- Concerned about fairness issues, i.e. shouldering burden for others

US EPA ARCHIVE DOCUMENT

Thank you!

Michelle Perez, PhD
Senior Associate
mperez@wri.org
202-729-7908

Insights.wri.org: Can Nutrient Trading Shrink the Gulf of Mexico's Dead Zone?