Hickory Creek 319 grant project City of Denton

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PREPARED IN COOPERATION WITH THE

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

AND U.S. ENVIRONMENTAL PROTECTION AGENCY

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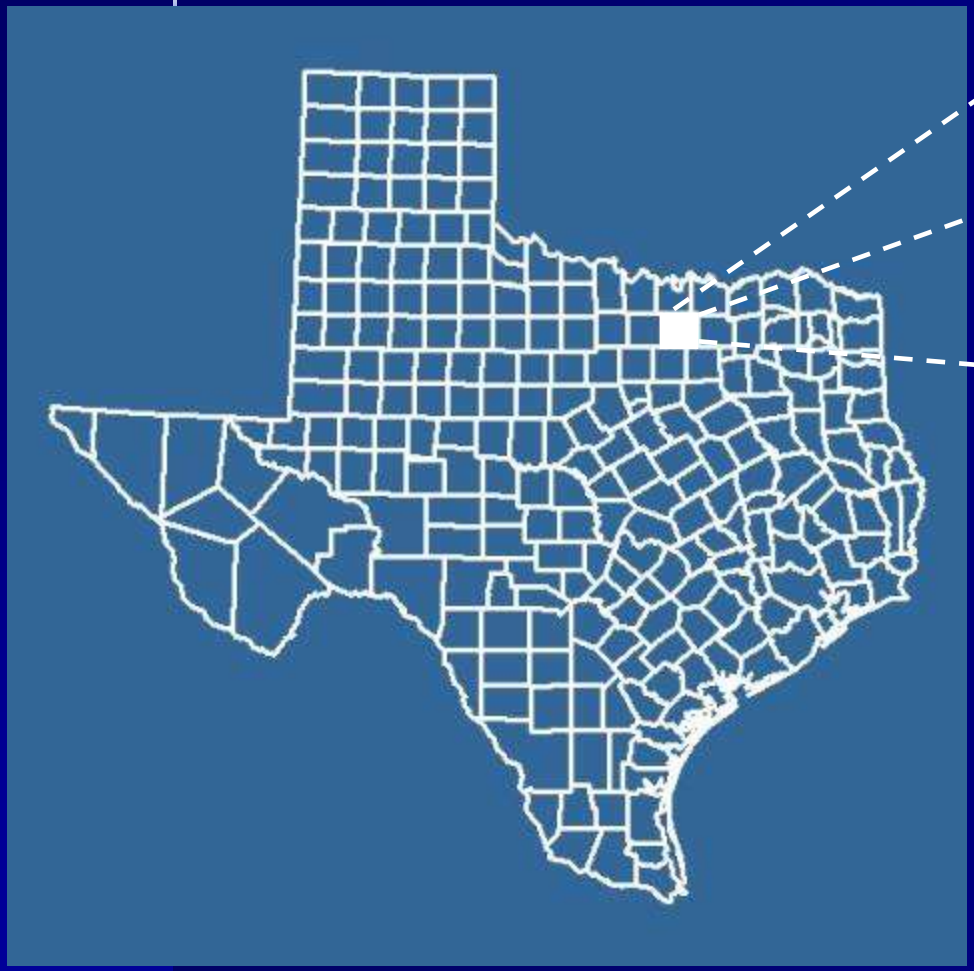
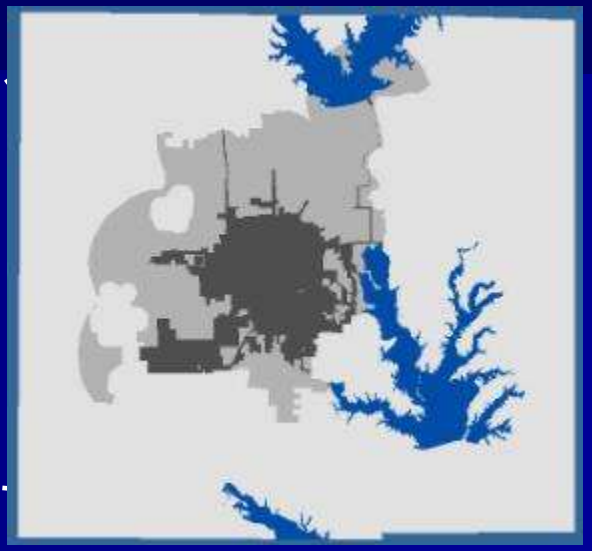
Project background

- 319(h) grant through the TCEQ to examine watershed protection issues for Hickory Creek .
- Grant started in April 2005.
- Initial work centered on modeling, stakeholder group formation, and evaluating pollutant loads on a “unit cost” basis
- Work transition into stakeholder group interaction, demonstration BMP implementation, initial monitoring, and developing a Watershed Protection Plan.
- Grant ended on August 31, 2008.

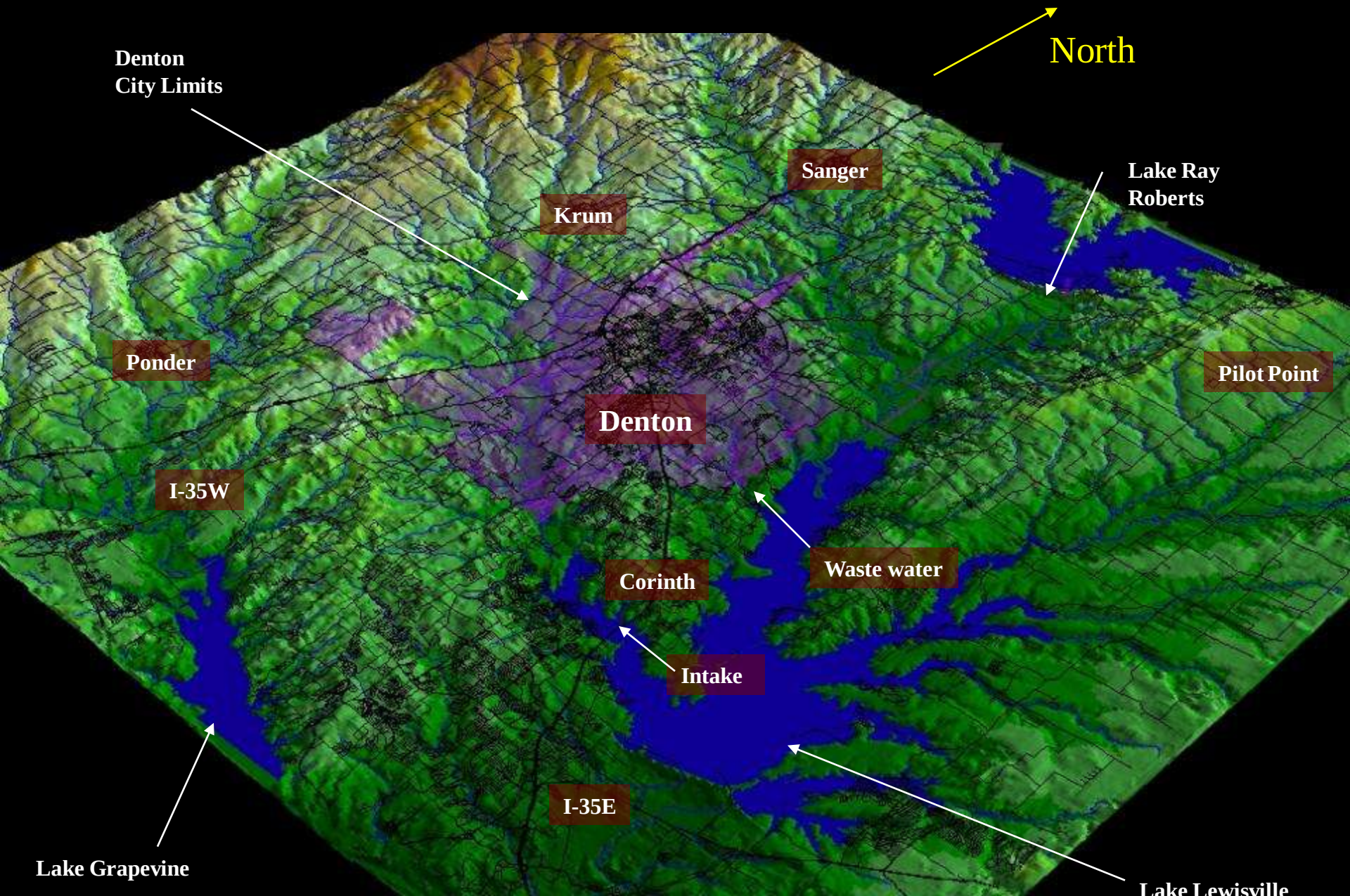
Study Area – Denton, Texas





- Population ~115,000
- Denton City Limits ~160 sq km
- Denton ETJ ~207 sq km
- Rainfall averages 99 cm / yr
- One of the top 10 fastest growing cities in the nation

Denton's Location in Denton County

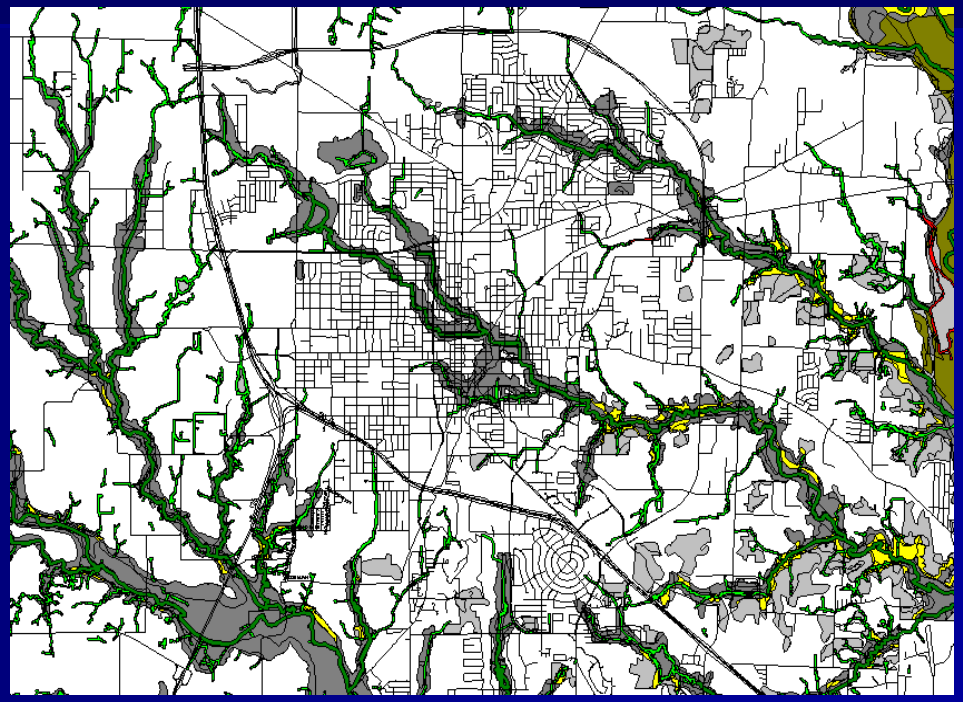


Implications for Hickory Creek

- Significant challenges to face ... this area is developing rapidly, gas wells are being rapidly drilled, etc.
- Hickory Creek still has potential for actively managing development .
- The 319 grant presents an opportunity to explore ways to manage impacts to Hickory Creek through a **Watershed Protection Plan (WPP)**
- **Demonstration BMPs (dBMPs)** are part of the project
- **Water quality based BMP optimization mechanisms** are also a component of the project.

Existing Programs

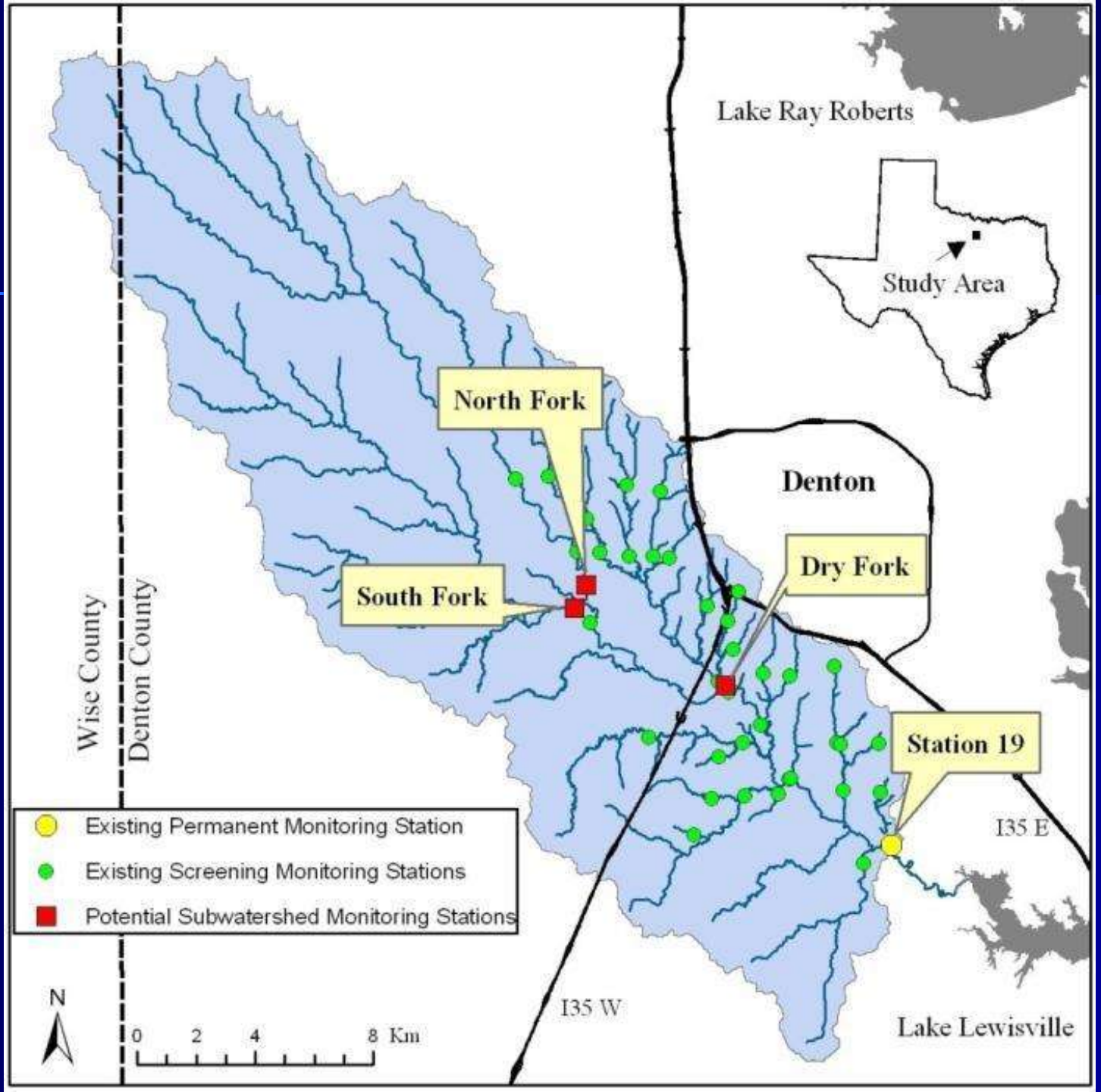
- Classification and protection of ESAs
- SWP3 for construction
- Erosion / Sediment control for gas wells
- Municipal operations (maintenance)
- Local Drainage Design Criteria



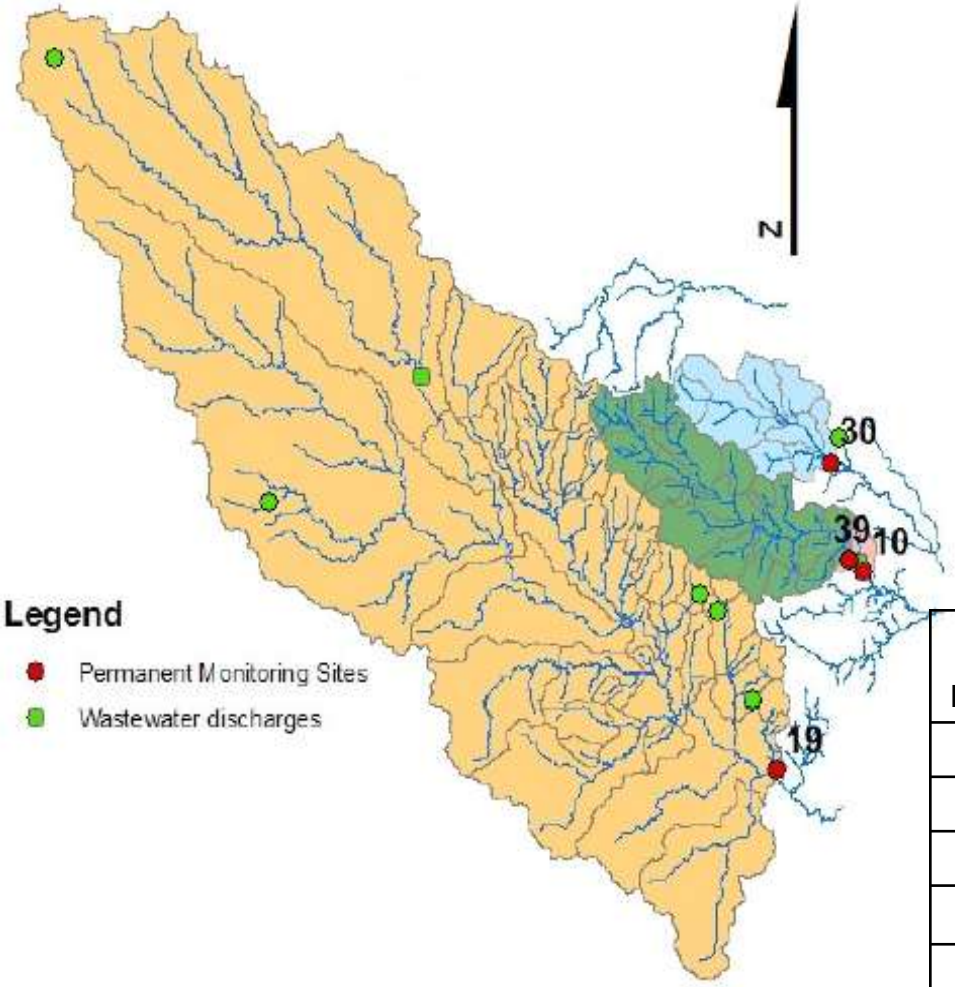
Riparian Buffer, 50 ft.	1,964 ac.
Riparian Buffer, 100ft.	2,950 ac.
Upland Habitat	1,295 ac.
Undeveloped Floodplain	7,522 ac.

Analysis of Pollutant Sources and Annual Loading Rates

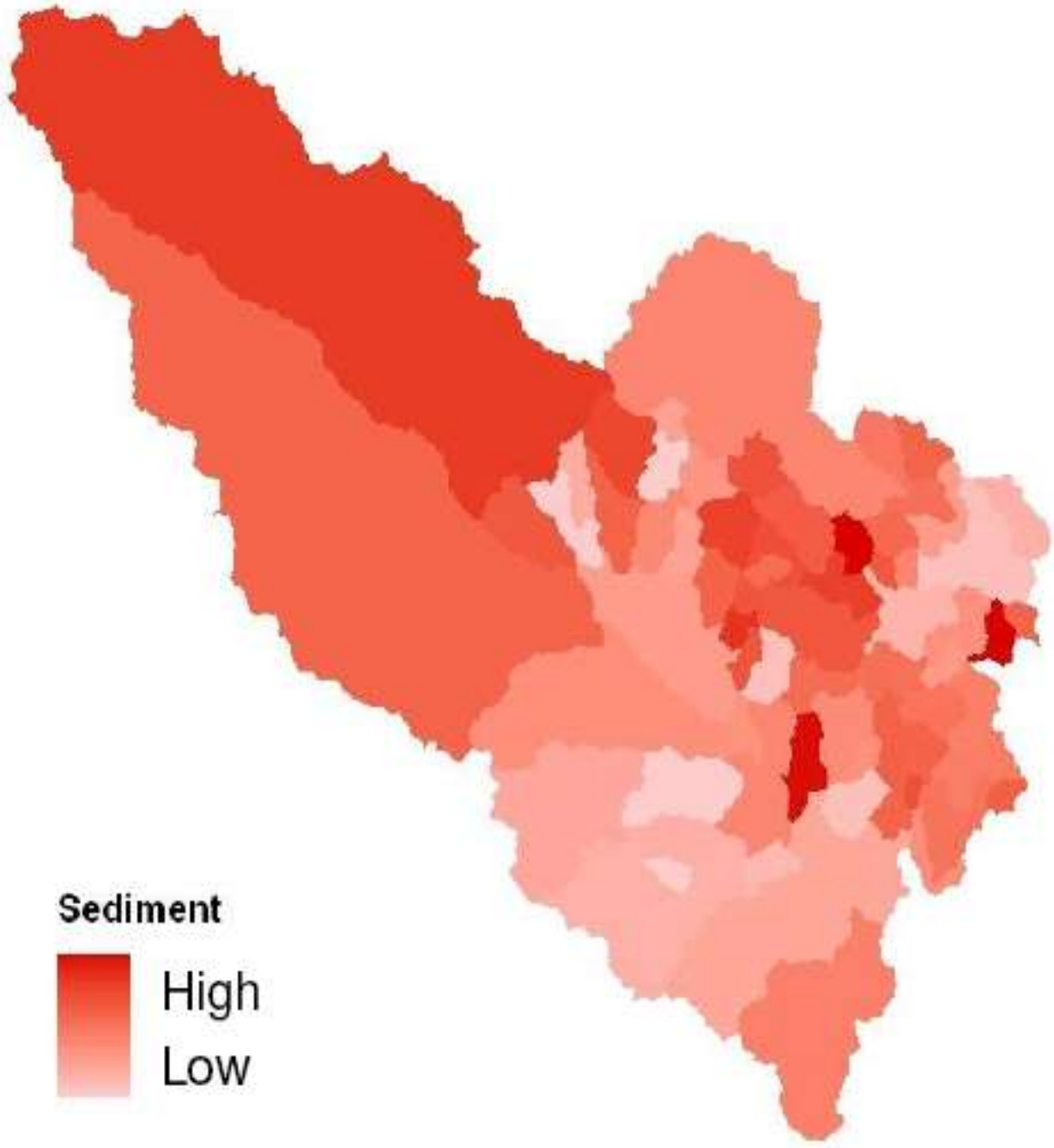
- Hickory Creek Monitoring Program
  - 2001 to 2005 data were used
  - Rainfall events sampled approximately once per quarter, base flow sampling monthly
  - Continuous in-stream monitoring device
- Point Sources:
  - City of Krum, Slidell ISD, Acme Brick Co.
- Nonpoint Sources:
  - Texas A&M SWAT/QUAL-TX Model
  - Calibrated to monitoring data


Lake Ray Roberts
Study Area
North Fork
Denton
Dry Fork
South Fork
Wise County
Denton County
Station 19
I35 E
Existing Permanent Monitoring Station
Existing Screening Monitoring Stations
Potential Subwatershed Monitoring Stations
N
0 2 4 8 Km
I35 W
Lake Lewisville

SWAT/QUAL-TX Model Calibration



Land Use	Area (acres)
Urban	29,447
Agricultural	38,998
Rangeland	45,734
Forest	9,182
Water	1,109
Total:	**124,470**


Sediment
High
Low

Demonstration BMP (dBMPS) component

- Established a group of stakeholders including citizens, developers, Soil Conservation Service, Parks and Wildlife, USACE, a local River Authority, and local Sierra Club.
- Stakeholders were provided with information on potential sites over three meetings.
- **This is part of the cost / benefit approach … What benefits, especially those that are not easily quantified are important to stakeholders?**

Stakeholder group outcomes: "themes and preferences"

- **Land ownership / Access** - Stakeholders expressed a preference for publicly owned lands to avoid potential complications / limited access associated with private property
- **Site Conditions** - Stakeholders preferred undeveloped sites that are expected to develop in the near future instead of retrofits of existing infrastructure

Stakeholder group outcomes: "themes and preferences"

- **BMPs Alternatives** - stakeholders preferred more "natural" BMPs that were incorporated into overall site design as a "usable" component (multiple functions, native plants)
- **BMP Effectiveness** - Stakeholders desired BMPs that provided the greatest long term load reduction for the lowest cost possible, as determined through modeling.

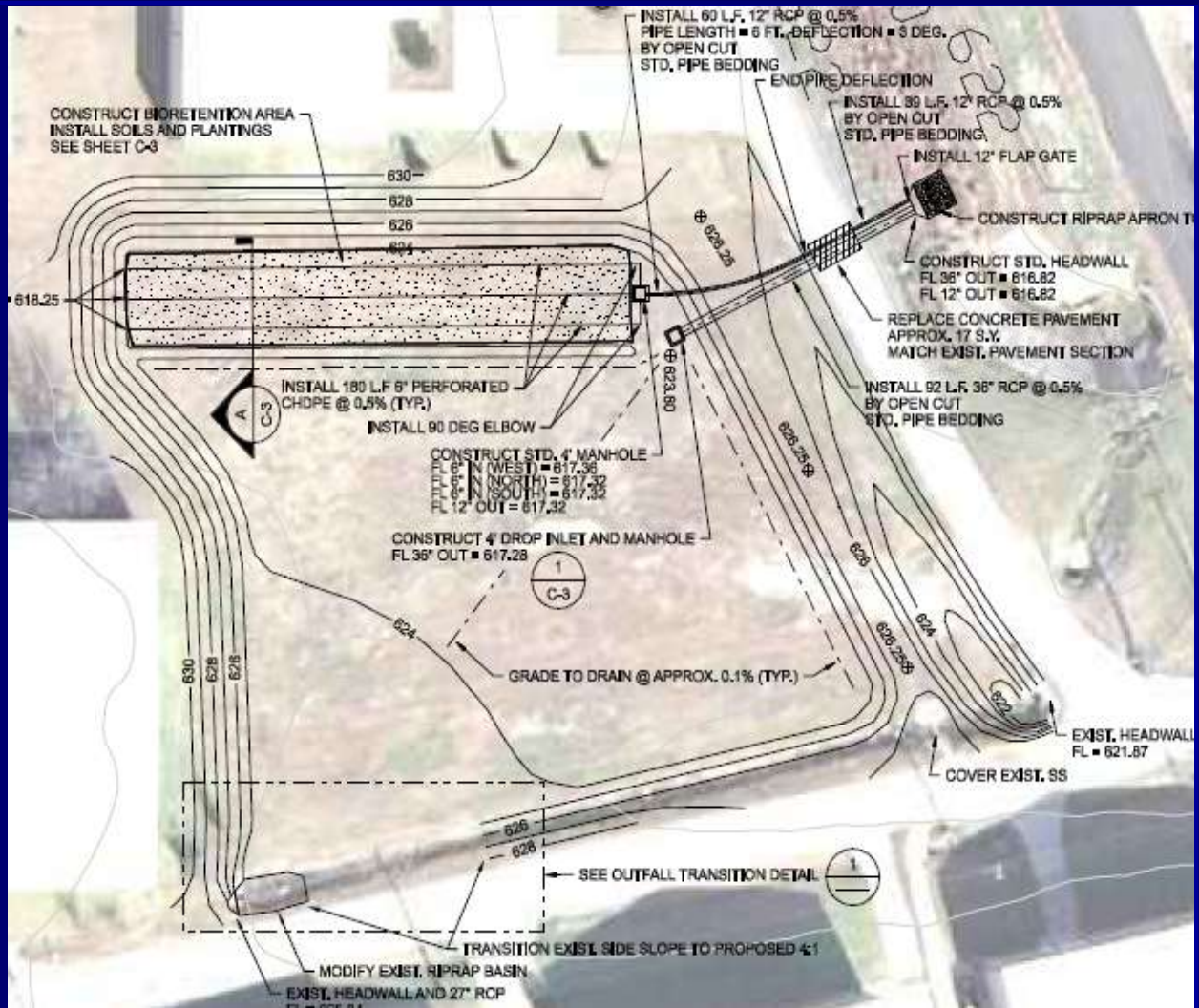
"BMP Implementation" Projects

- A total of 10 candidate sites were evaluated
- Narrowed down to three sites by the stakeholder group, based in part on dollars spent per expected pounds of pollutants reduced (unit cost basis)
- Three sites have been designed and constructed
  - Fire Station, Airport, Lake Forest Dog park

Airport – vegetated channels and “bioretention /rain garden”

- Bioretention / rain garden
- Must drain quickly

Bird Aircraft Strike Hazard (a.k.a. BASH).

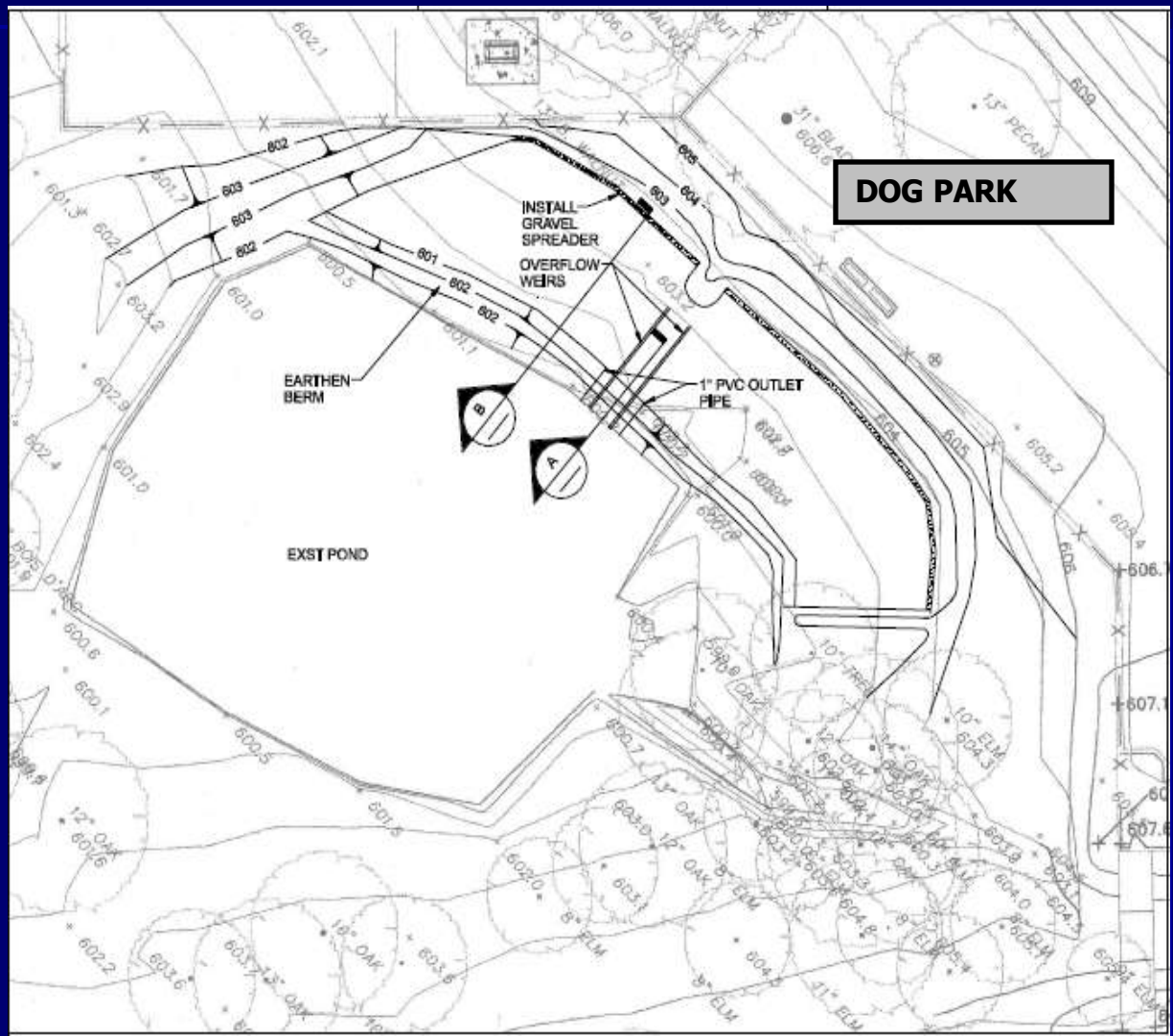


Airport – Bioretention area

Airport – Bioretention area

Dog Park – vegetated filter strip and channel system

- Filter strip is designed to capture small storm flows and slowly release
- Designed to deal with nutrients and sediments, but should also help with bacteria

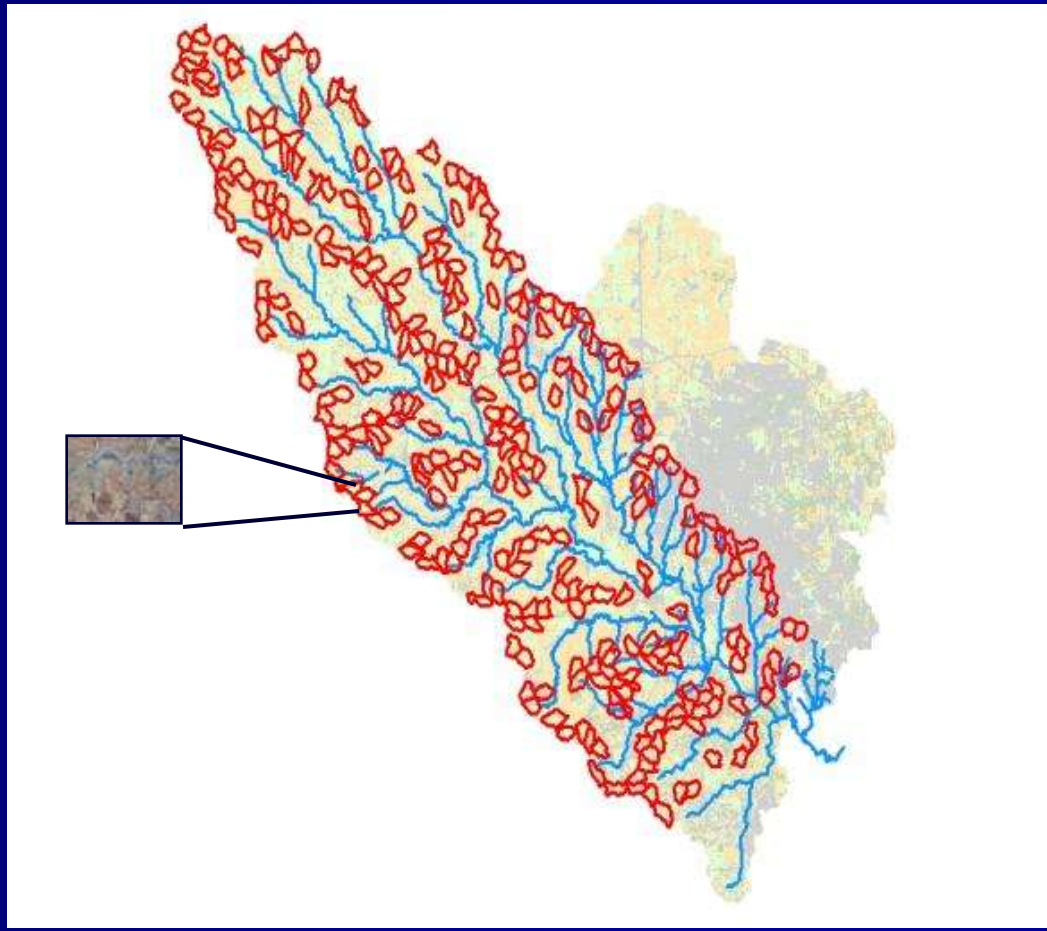


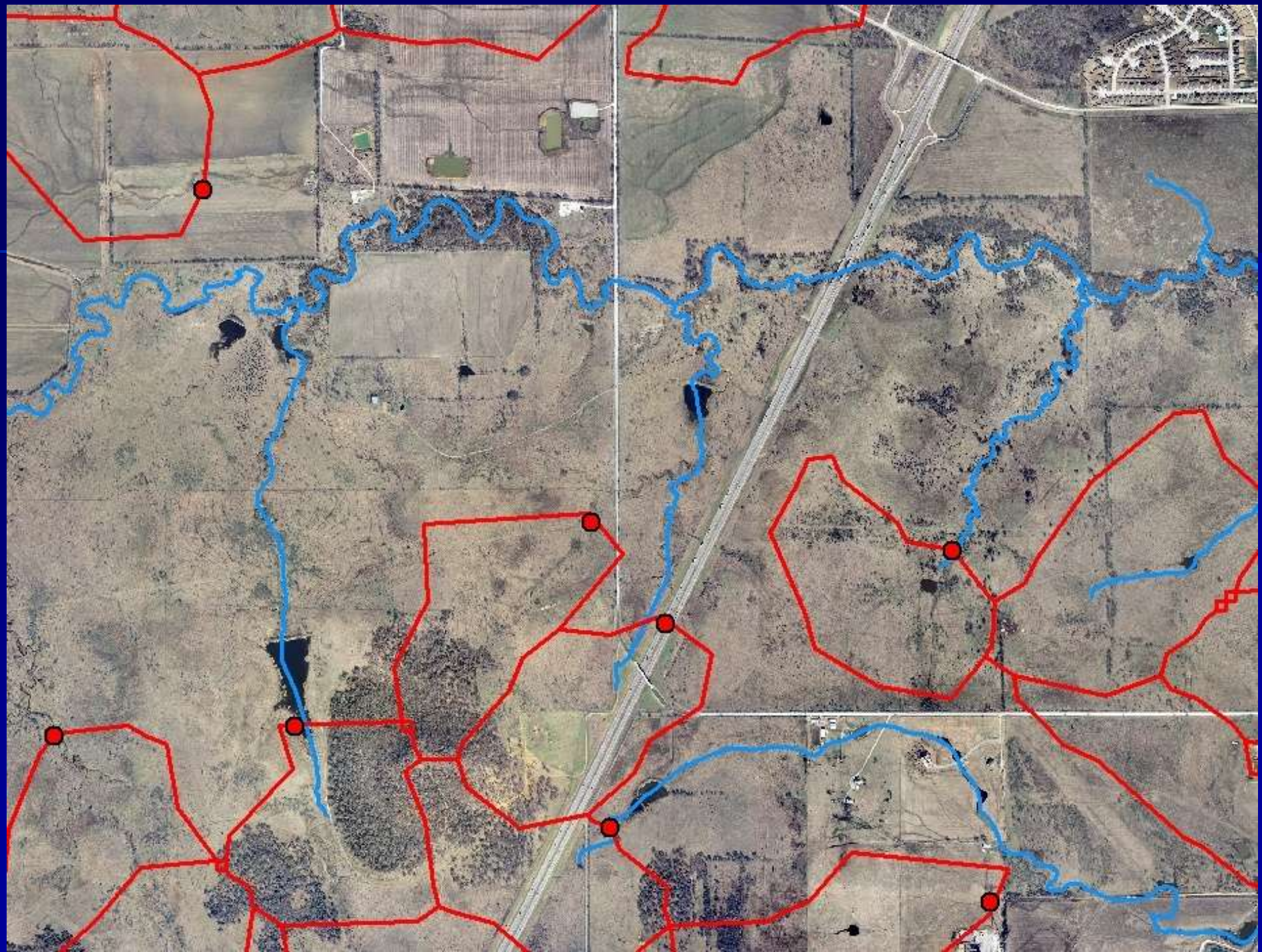
"Next generation" modeling – Sediment, Nitrogen, Phosphorous

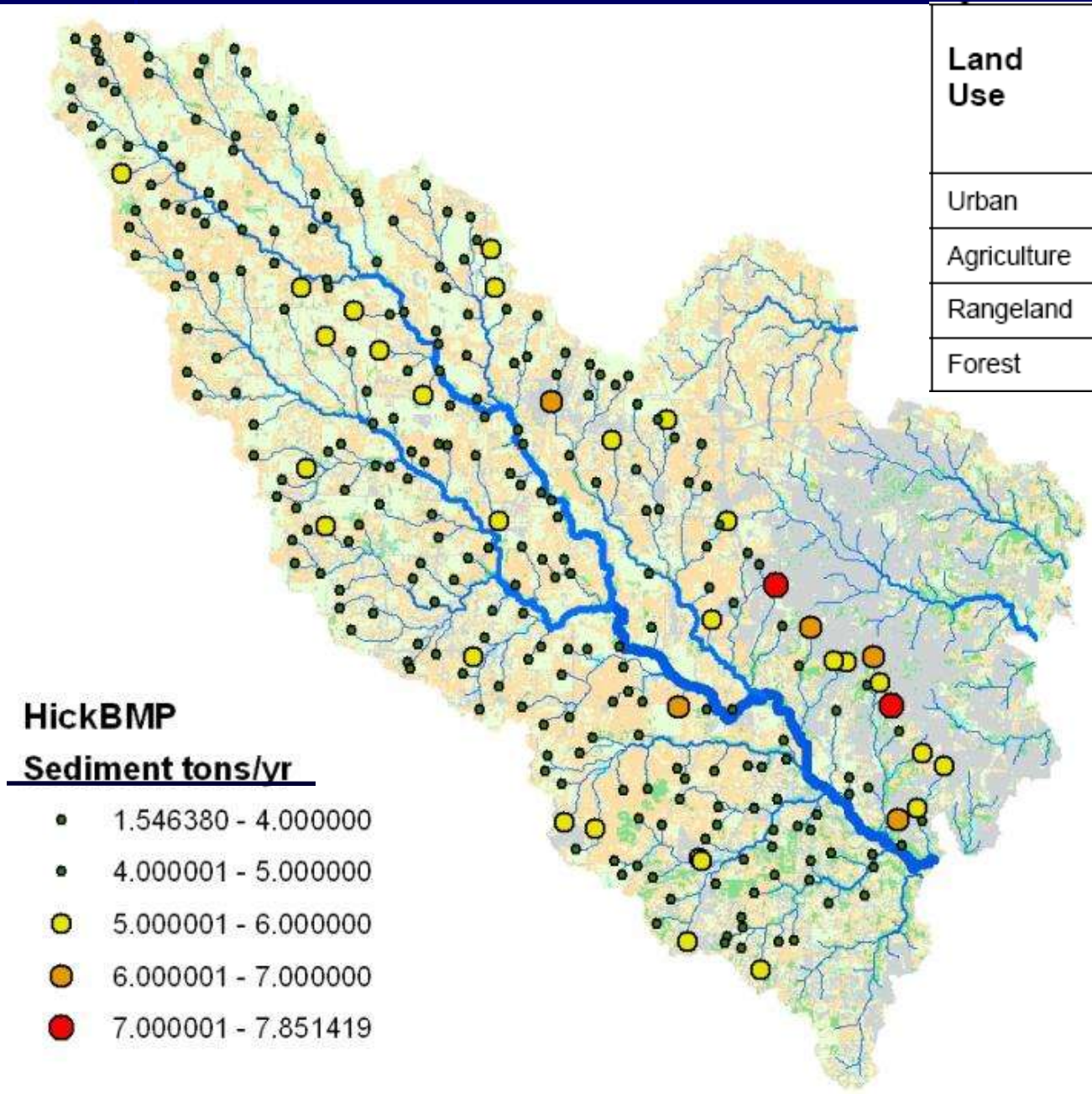
- How do you look at causes and sources for the entire Hickory Creek watershed? **This is an issue of scale – watershed model versus "BMP scale"**
- No TMDL targets, no numerical WQ criteria.
- How can this information applied to the entire watershed, using a "unit/cost" approach?

Prioritizing Sources of Loading

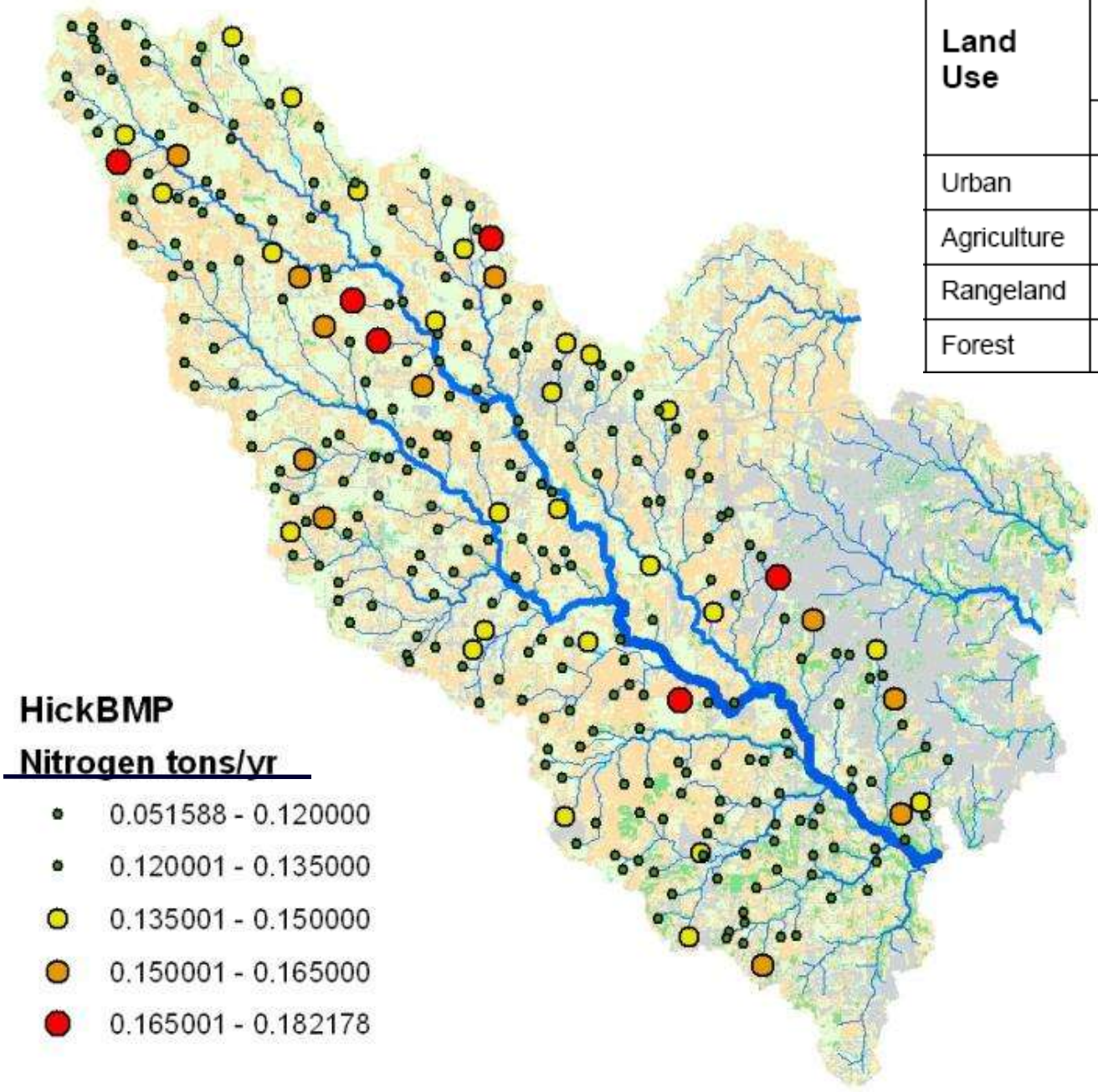
- Identified 282 parcels of 80-120 acre size in watershed
- Best trade-off of fine resolution (BMP scale) and model accuracy
- Determine loads of each sub-watershed using existing model







Land Use	Annual Loads per Unit Area from each Land Use (pounds/acre/yr)		
	Sediment	Phosphorus	Nitrogen
Urban	161.49	1.34	3.66
Agriculture	123.12	1.96	3.75
Rangeland	55.32	0.27	1.87
Forest	21.41	0.09	0.71



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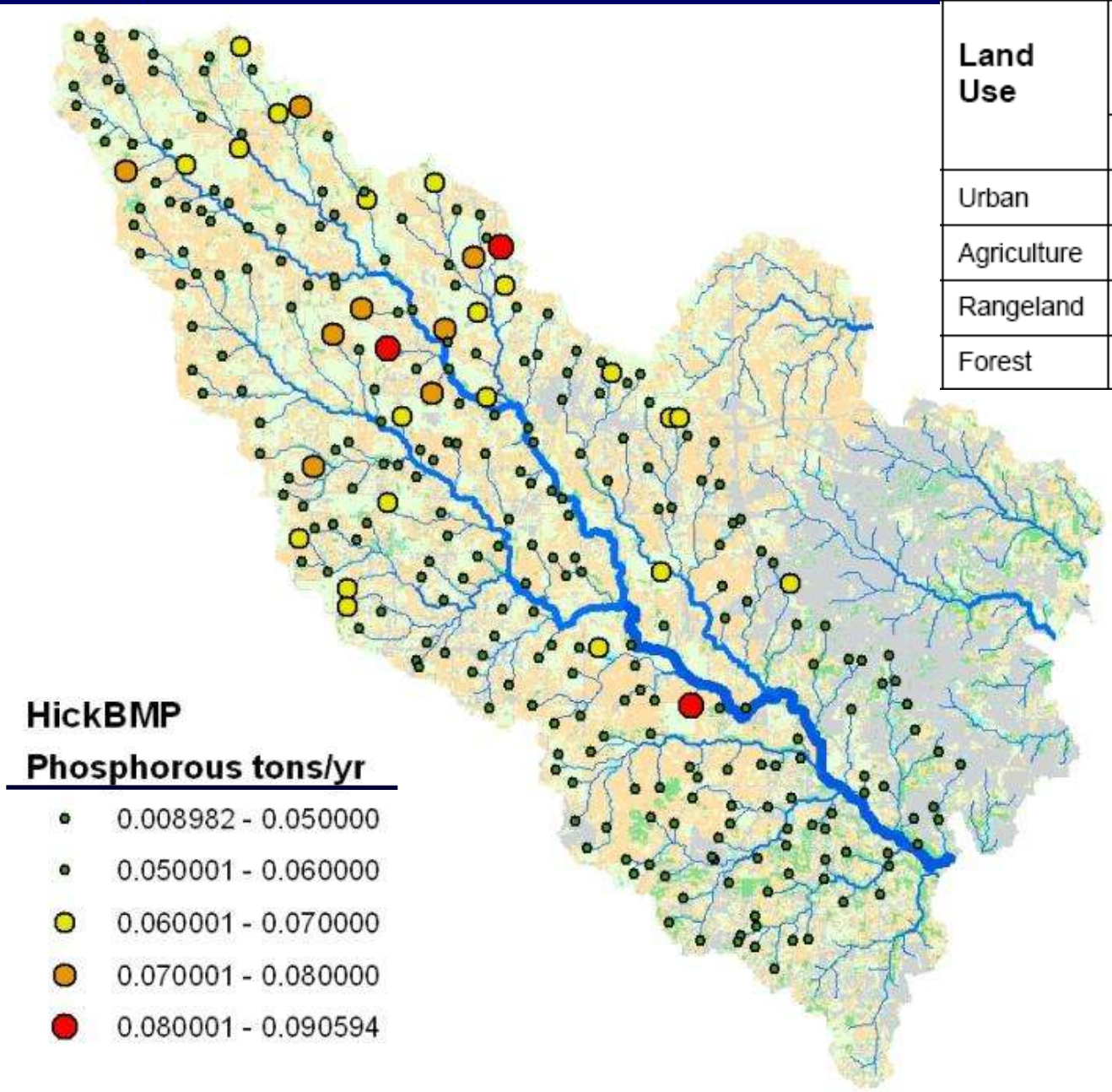

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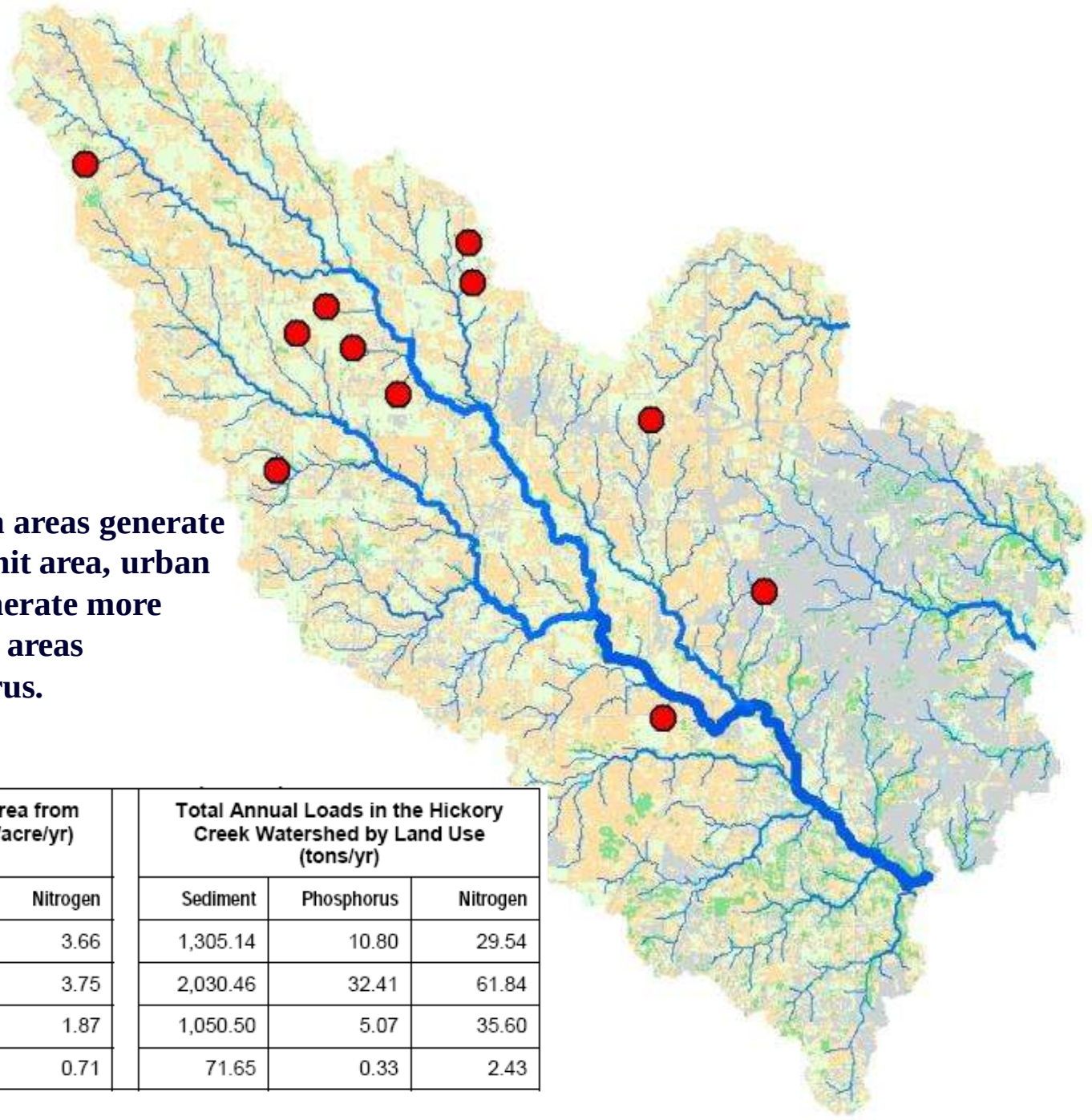


On a relative basis, urban areas generate more sediment load per unit area, urban and agricultural areas generate more nitrogen, and agricultural areas contribute more phosphorus.

Land Use	Annual Loads per Unit Area from each Land Use (pounds/acre/yr)			Total Annual Loads in the Hickory Creek Watershed by Land Use (tons/yr)		
	Sediment	Phosphorus	Nitrogen	Sediment	Phosphorus	Nitrogen
Urban	161.49	1.34	3.66	1,305.14	10.80	29.54
Agriculture	123.12	1.96	3.75	2,030.46	32.41	61.84
Rangeland	55.32	0.27	1.87	1,050.50	5.07	35.60
Forest	21.41	0.09	0.71	71.65	0.33	2.43

Framework for Evaluating Control Strategies in WPP

- This is a **proactive** WPP
- There are currently no "controlling" water quality targets / criteria established for sediments, nitrogen and phosphorous
- In the absence of "controlling" criteria, strategies are implemented based on "levels of investment / levels of resources" using a scalable optimization process
- Local regulatory drivers can be an important component of both incentives and economically based management, as can grants programs.
- Timing and opportunities are integral components of this process

Alternative Strategies for Reducing Nonpoint Source Loads

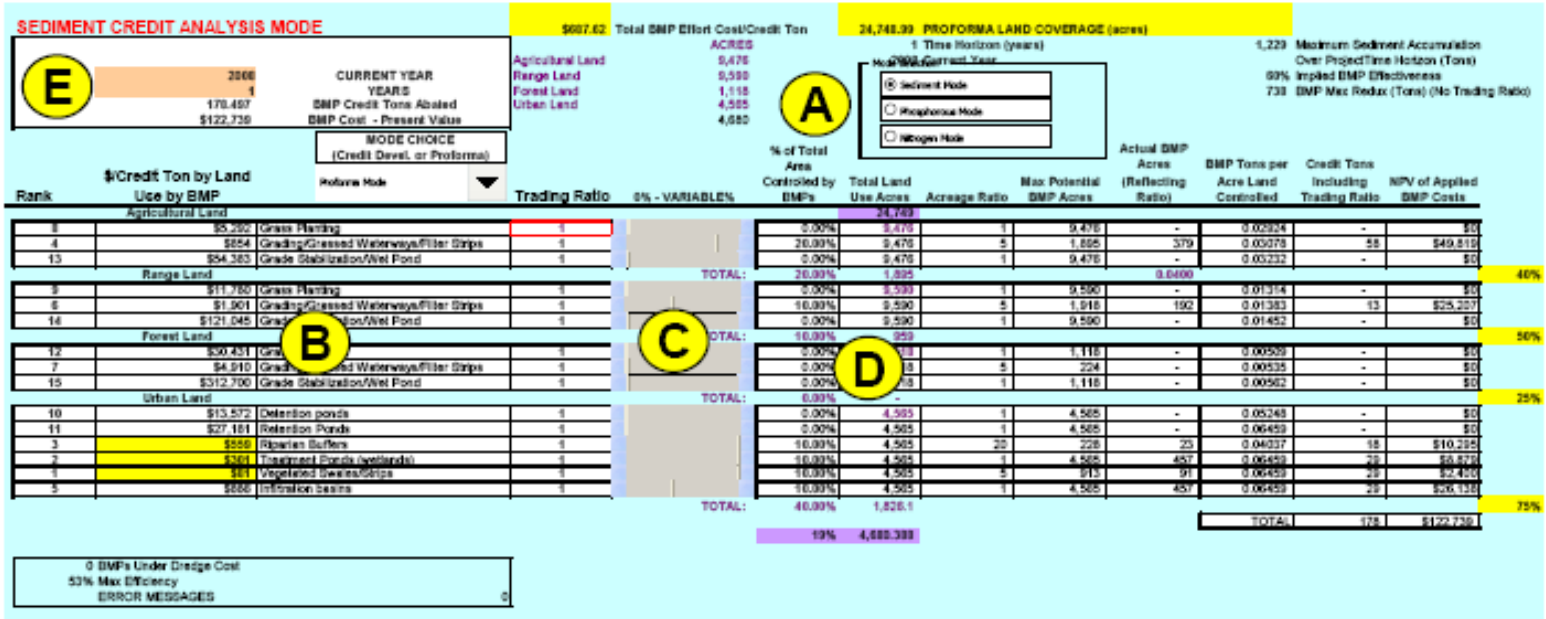
- To create basic planning information, we evaluated BMP implementation at three spatial scales for strategies to optimize public and private investments in BMPs for sediment and nutrient control
  - Hickory Creek Watershed
  - 282 Priority Sites
  - Three Master Planned Communities (MPCs)

Tool Designed to construct and evaluate BMP "portfolios"

- Excel workbook with Visual Basic
- Runs off of acreage inputs:
  - # by land use category
- Calculates total loads for TSS, TP, and TN using the previous loading analyses
- BMP options based on:
  - BMP removal efficiencies for North Texas provided by NTCOG numbers
  - Cost estimates using 2007 $. Includes O&M estimates.
- Allows user to construct BMP portfolio for defined area and calculates portfolio metrics
  - Total cost, load reduction, unit costs

Denton BMP Portfolio Tool
Dashboard

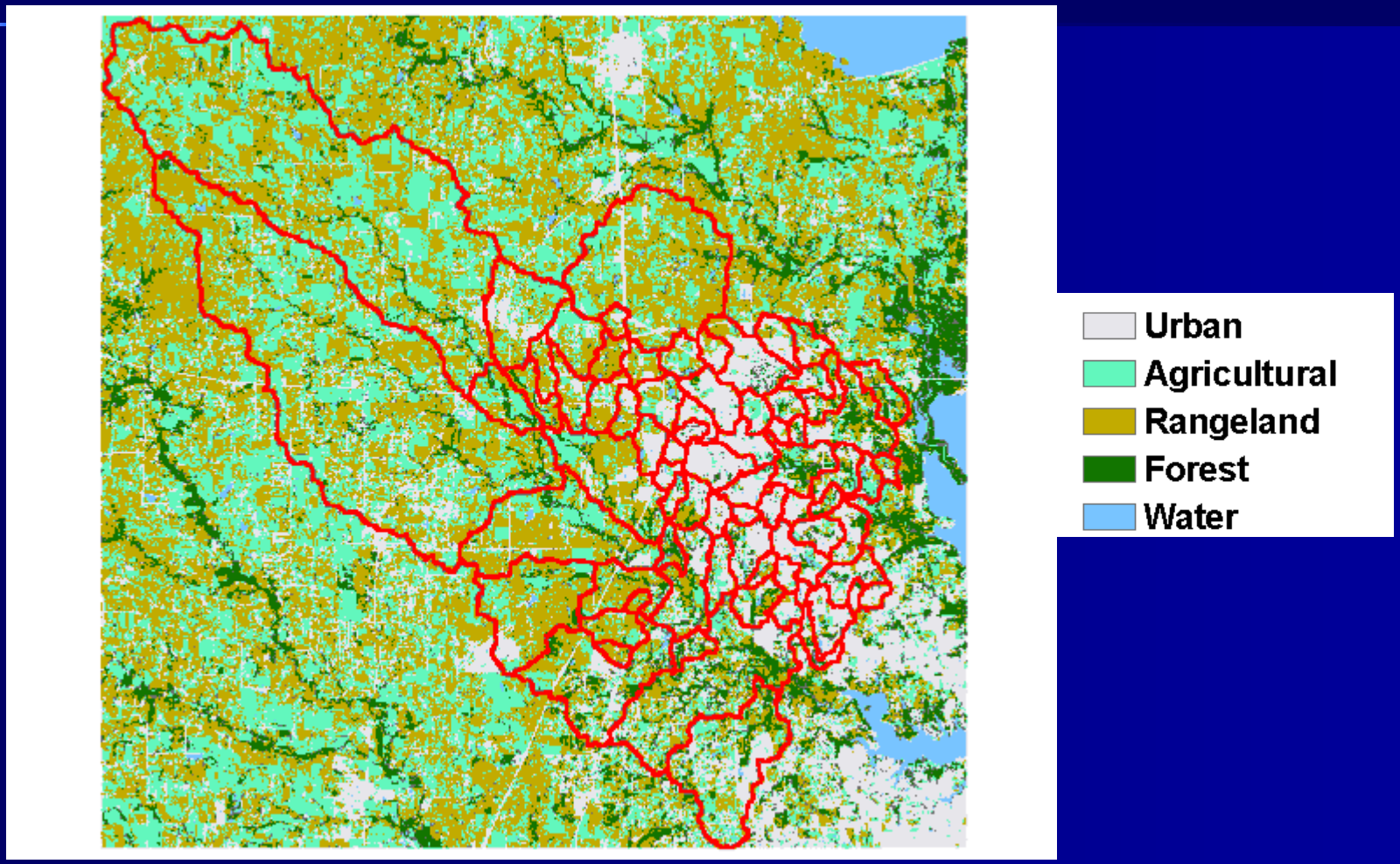
- **A** User selects operating mode: TSS, TP, or TN
- **B** BMP options listed with unit cost and cost-effectiveness rankings
- **C** User selects % of acres in each category to be managed by a given BMP
- **D** % max limits by BPJ
- **E** Summary results



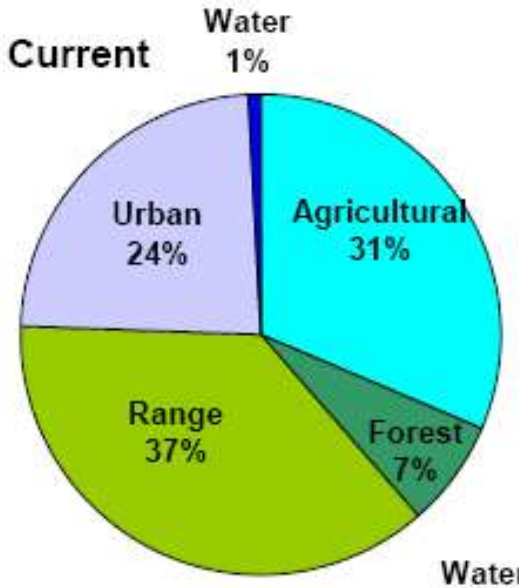
Example: Comparison of land use / BMP type, unit costs, etc

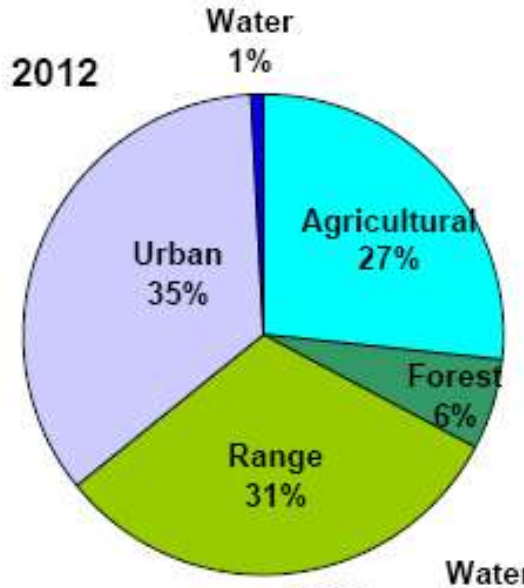
	TSS-LBS			Phosphorus-LBS			Nitrogen-LBS		
LAND USE: BMP	BMP Pounds per Acre Land Controlled	$/Credit Pound by Land Use by BMP	Relative $/lb Rank	BMP Pounds per Acre Land Controlled	$/Credit Pound by Land Use by BMP	Relative $/lb Rank	BMP Pounds per Acre Land Controlled	$/Credit Pound by Land Use by BMP	Relative $/lb Rank
Urban Land									
Detention ponds	104.96	$6.79	**10**	0.67	$1,064	**8**	1.10	$649	**10**
Retention Ponds	129.19	$13.59	**11**	0.67	$2,624	**10**	1.10	$1,600	**12**
Riparian Buffers	80.74	$0.28	**3**	0.27	$84	**5**	0.73	$31	**4**
Treatment Ponds (wetlands)	129.19	$0.15	**2**	0.54	$36	**2**	1.10	$18	**2**
Vegetated Swales/Strips	129.19	$0.04	**1**	0.33	$16	**1**	1.46	$4	**1**
Infiltration basins	129.19	$0.44	**5**	0.80	$71	**4**	2.19	$26	**3**
Agricultural Land									
Grass Planting	58.48	$2.65	**8**	0.37	$415	**6**	0.71	$217	**8**
Grading/Grassed Waterways/Filter Strips	61.56	$0.43	**4**	0.39	$67	**3**	0.75	$35	**5**
Grade Stabilization/Wet Pond	64.64	$27.19	**13**	0.41	$4,264	**12**	0.79	$2,234	**13**
Range Land									
Grass Planting	26.27	$5.89	**9**	0.05	$3,043	**11**	0.36	$435	**9**
Grading/Grassed Waterways/Filter Strips	27.66	$0.95	**6**	0.05	$491	**7**	0.37	$70	**6**
Grade Stabilization/Wet Pond	29.04	$60.52	**14**	0.06	$31,270	**14**	0.39	$4,467	**14**
Forest Land									
Grass Planting	10.17	$15.22	**12**	0.02	$9,129	**13**	0.14	$1,141	**11**
Grading/Grassed Waterways/Filter Strips	10.71	$2.46	**7**	0.02	$1,473	**9**	0.14	$184	**7**
Grade Stabilization/Wet Pond	11.24	$156.35	**15**	0.02	$93,810	**15**	0.15	$11,726	**15**

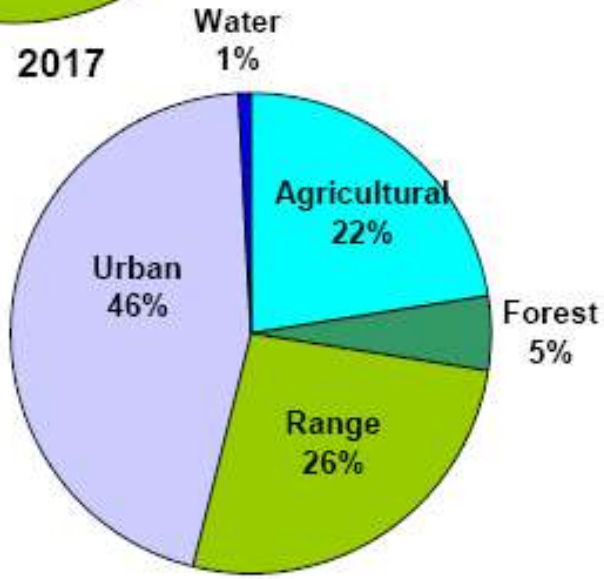
Entire Hickory Creek Analysis: Current Land Use: 123,361 ac

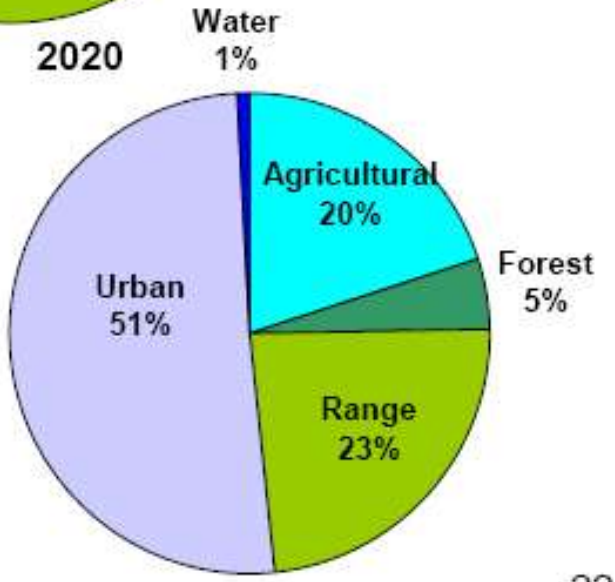


Hickory Creek Analysis: Assumed Land Use Changes



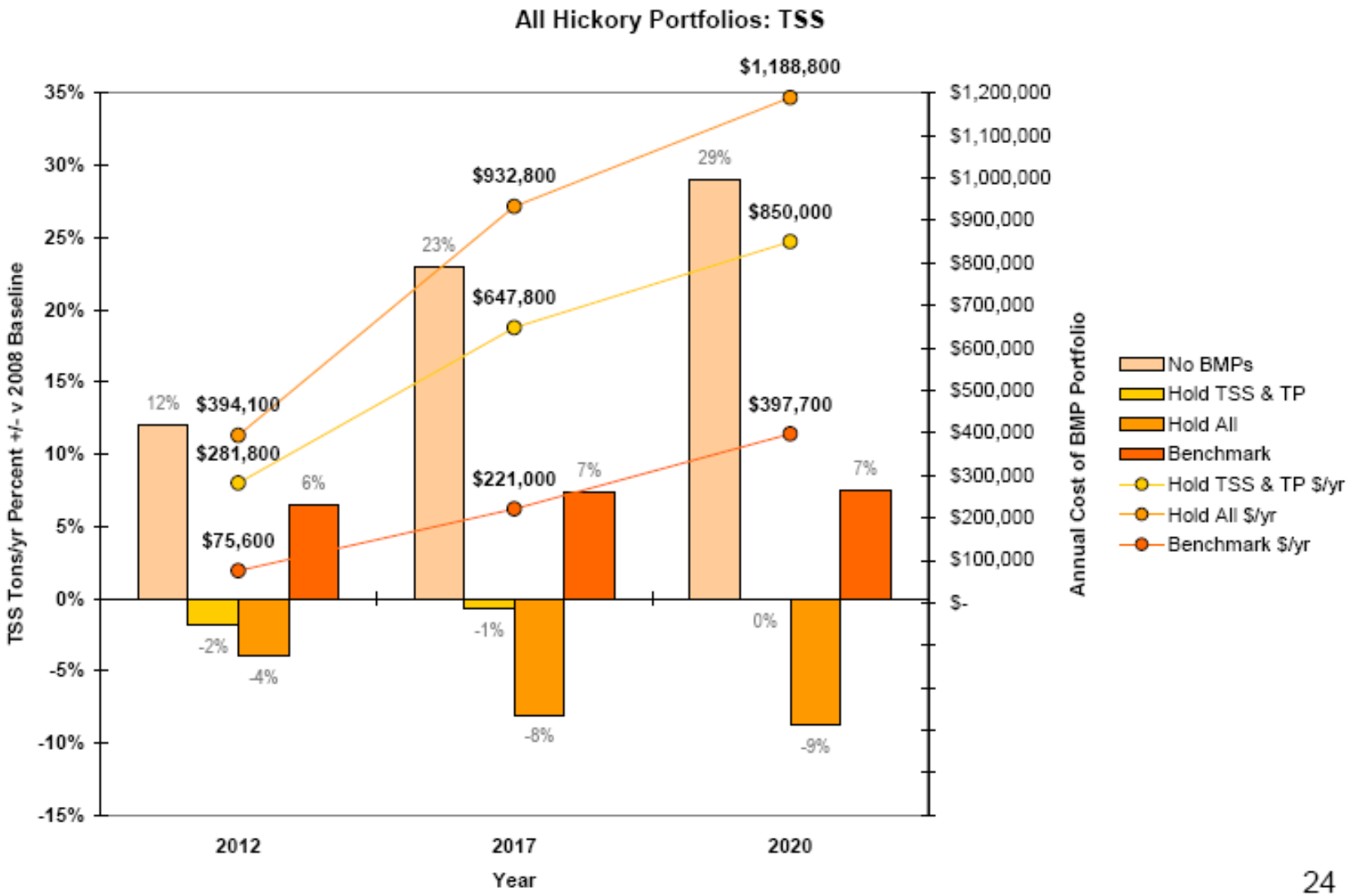




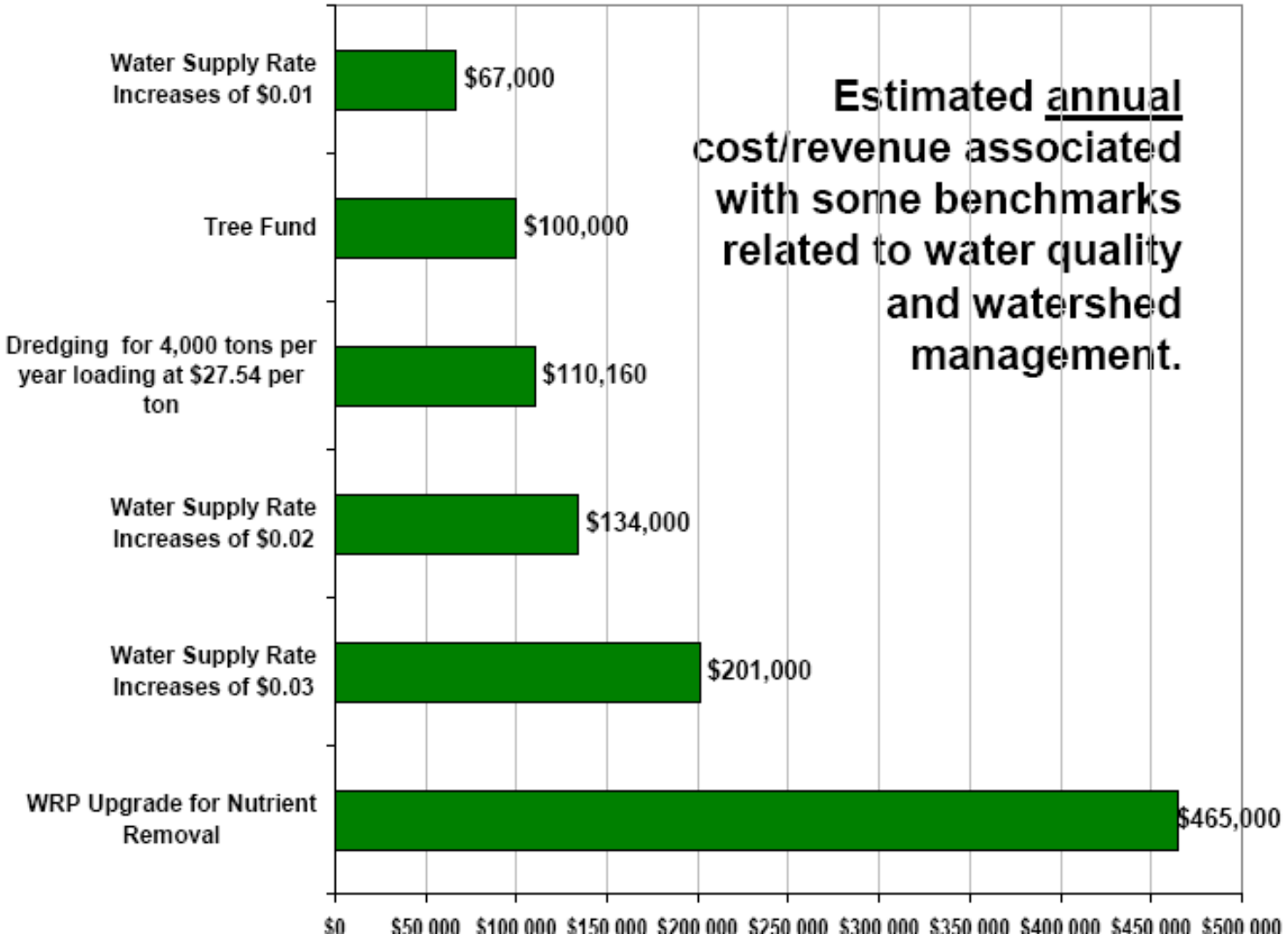


Results for 3 seemingly feasible portfolios: TSS

(A "BMP Max" portfolio cost $15.6-$19.5 M/yr and delivered 35%-29% TSS reduction v. 2008)



Some expenditure benchmarks considered for developing the All Hickory and 282 portfolios



What we learned from Hickory portfolios

- Using relative loading data can be an effective way to select and prioritize sites to achieve the greatest reductions
- Watershed-wide, sufficient acreage exists where very cost-effective BMPs could be installed
- Some BMP-land use combinations are not very cost-effective
- Limitations exist for the practical number/level of BMPs that would realistically be placed on any given parcel
- Data, tools, and simple analyses can help point us to the best opportunities
- Opportunities may exist to influence and incentivize which BMPs are place where
- Incremental opportunities tend to diminish as the list is worked through

What we learned from Hickory portfolios

- Projected land use changes in the watershed will bring significant increases in pollutant loads without BMPs
- It is expensive to hold TP and TSS to 2008 levels through 2020 (portfolio $439,000 / year)
- Modest levels of investment choosing the most cost-effective BMPs could hold increases below 7% between now and 2020 (portfolio $151,000 /yr)
- Implementing the maximum portfolio of BMPs over 123,361 acres is impractical

How can this work support Management practice type and location?

- Understanding loadings can help target management, compare efficiencies and optimize BMPs
- Where are the best opportunities?
- Are there ways to manage this watershed that are **economically based**? ($/lb of pollutant removed) and incentivize?
- Could incentives be based in part on local code (ESA, tree preservation, open space, stormwater management)?
- Is a **water quality trading network** possible?
- Are interactions with other grant programs possible?

Denton BMP Portfolio Tool Limitations

- Temporally static: changes over time must be manually entered and results run in separate iterations; 2008, 2012, 2017, 2020
- Can only see one pollutant "mode" at a time: Sediments, Nitrogen or Phosphorus
- Costs and loading rates by land use assumed same across all acreage input for a given analysis …. there can be site differences
- Sufficient for screening and planning only!!

SO WHAT??? HOW DOES all this work on the ground?

- Use planning level document to explore **opportunities** as they become available or as they can be planned.
- Use information to education citizens, garner support, and educate / influence policy makers to implement regulatory change at a local level.
- Never (ever, ever) design and implement for water quantity only. Those days are past for the COD
- Implement at site level using tool recommendations for **planning**, understanding that refined evaluation / design / engineering will be (must be) required at site level.

Opportunities are the key consideration

- We are all faced with a series of great opportunities brilliantly disguised as impossible situations.
  - Charles Swindoll
- I will prepare and some day my chance will come.
  - Abraham Lincoln

As opportunities become available, the approach helps to evaluate which current opportunities are "best" and helps to plan so we can make future needs / opportunities a reality

Here is how developers and policy makers perceived me – "Have I got a deal for you"

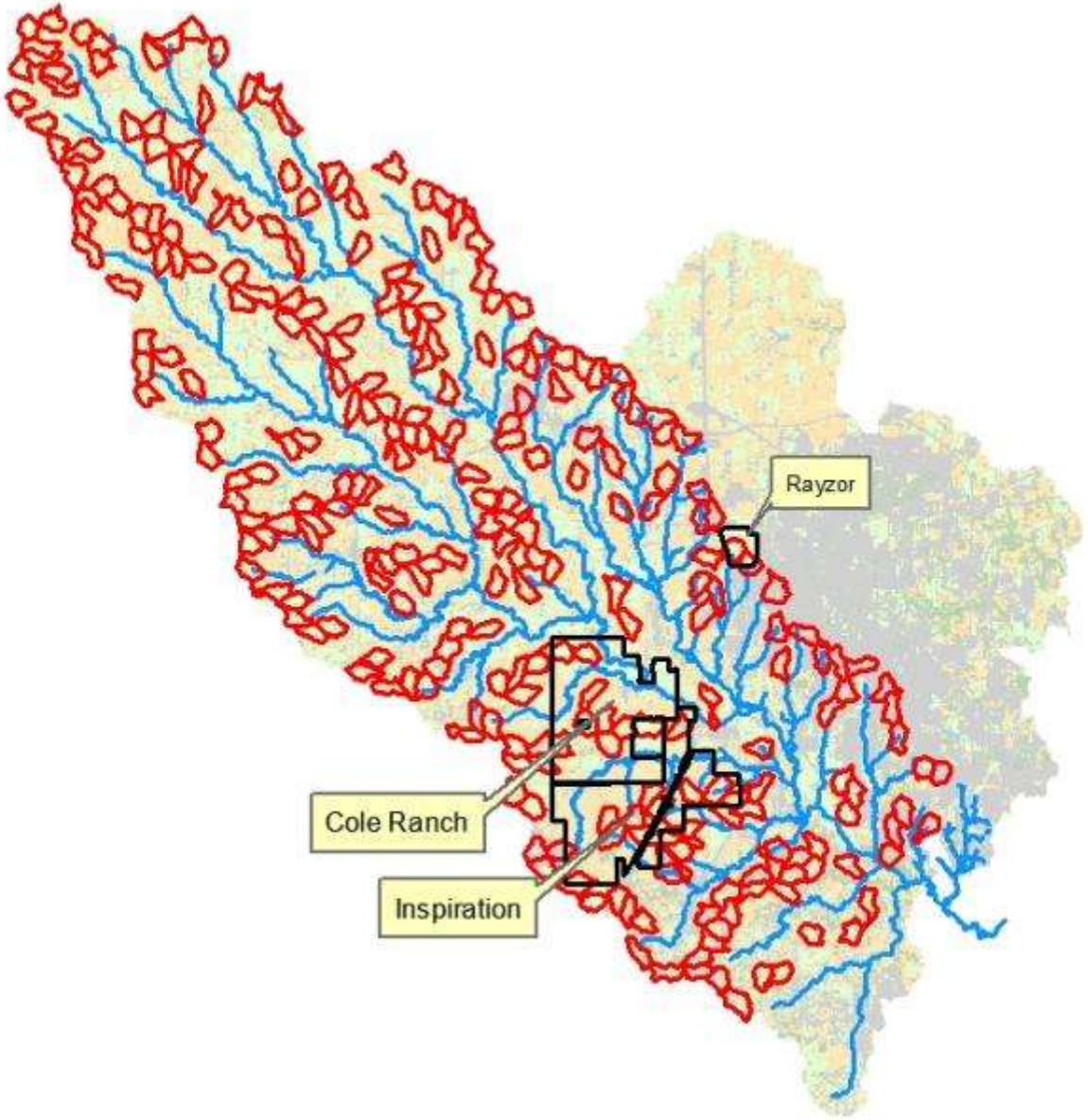
Implementation words of wisdom

- Successful implementation is the intersection between planning, timing, regulatory requirements, and management effectiveness. **These DEFINE opportunities**

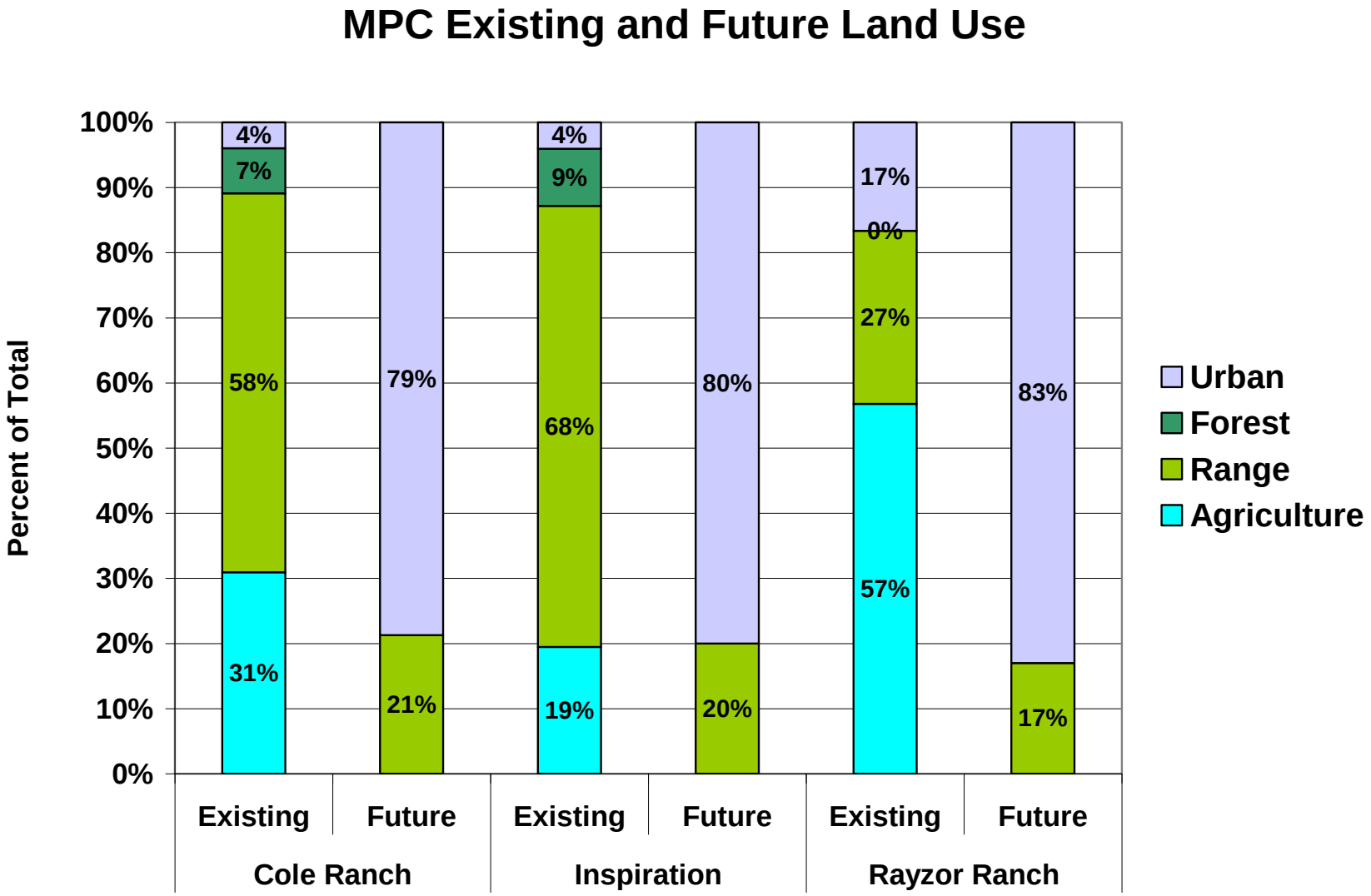
Implementation words of wisdom

- For Denton, many of these opportunities, especially those that are most economically attractive, occur during land use changes at the urban / ag, urban / range interface
- However, this does not mean that other opportunities do not exist, or that these opportunities cannot provide good cost / benefit ratios

Example: Master Planned Communities

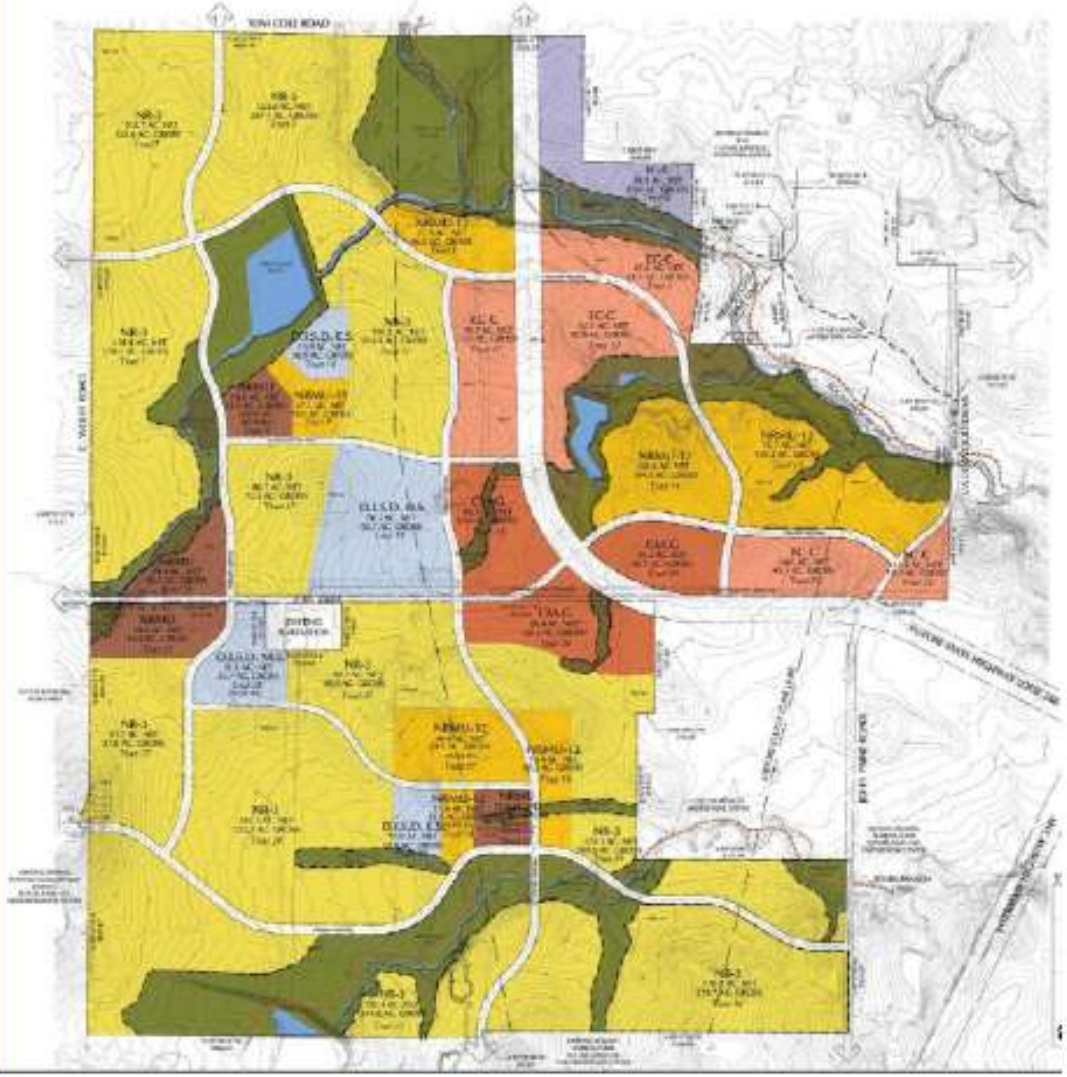


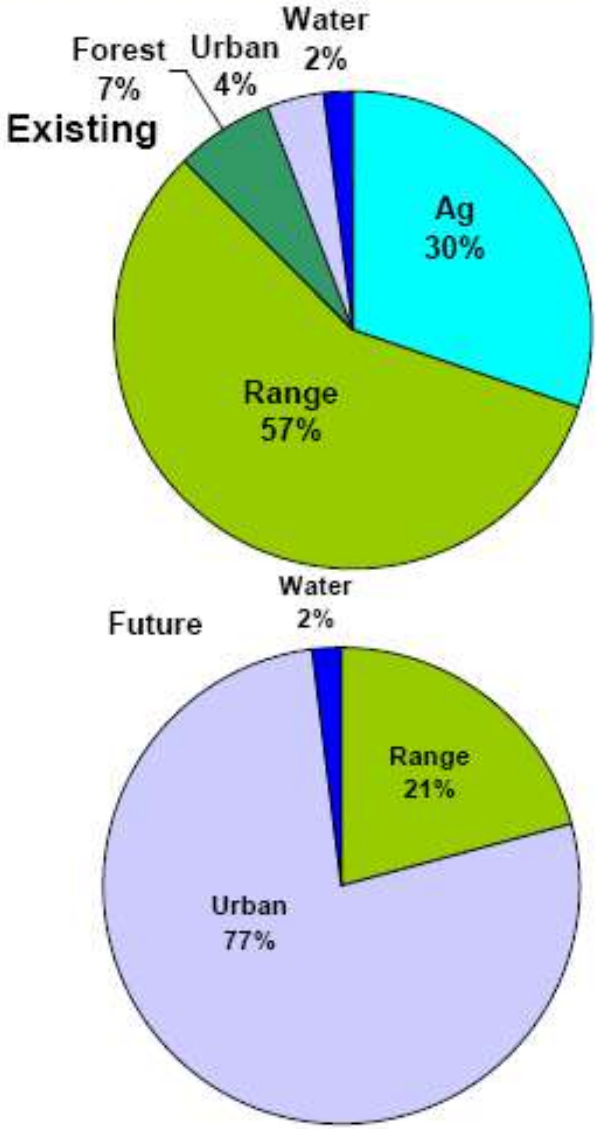
Master Planned Communities:
Different mixes of existing; similar future distribution

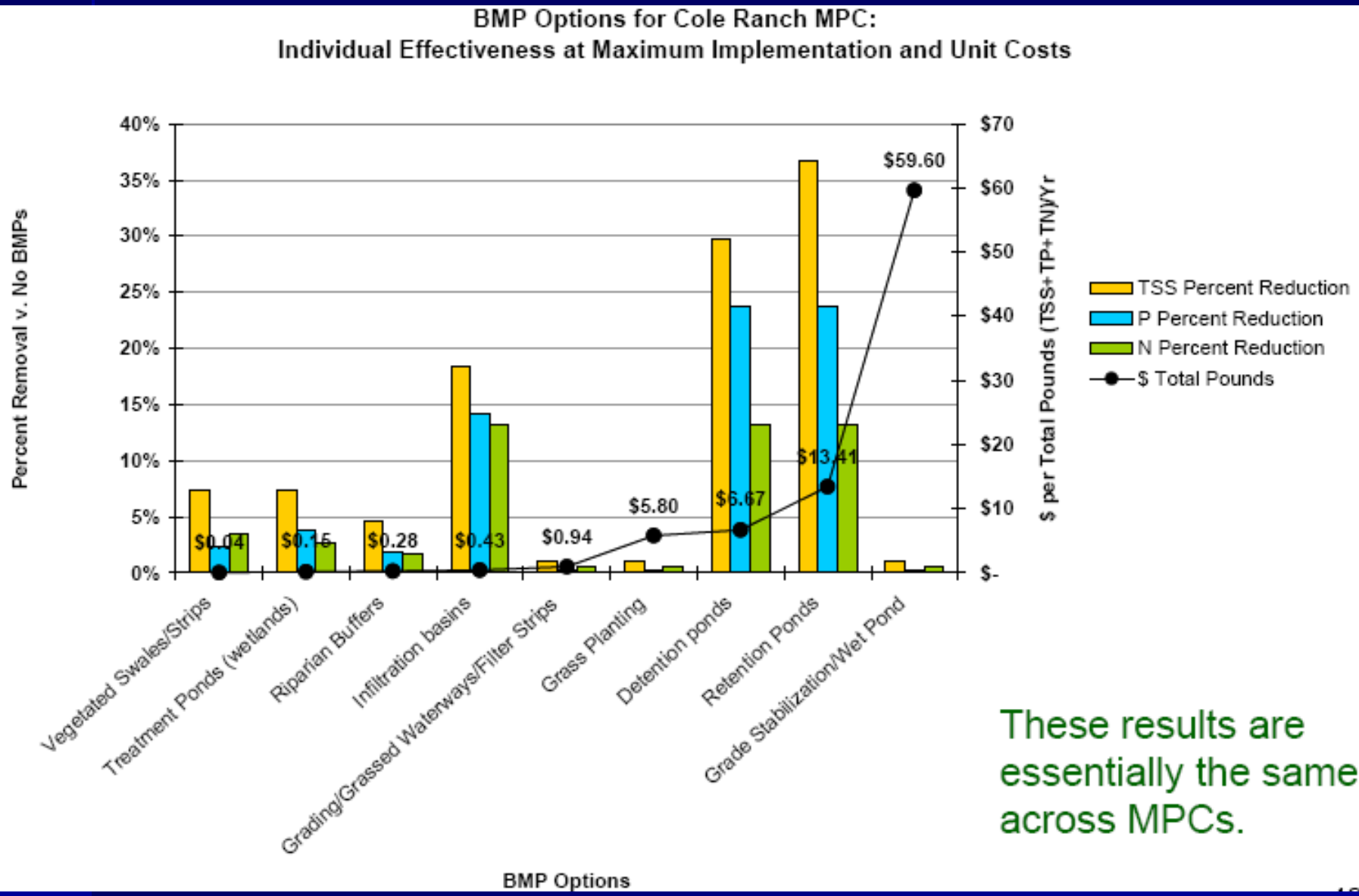


Master Planned Communities:

Cole Ranch Land Use ~ 3300 ac

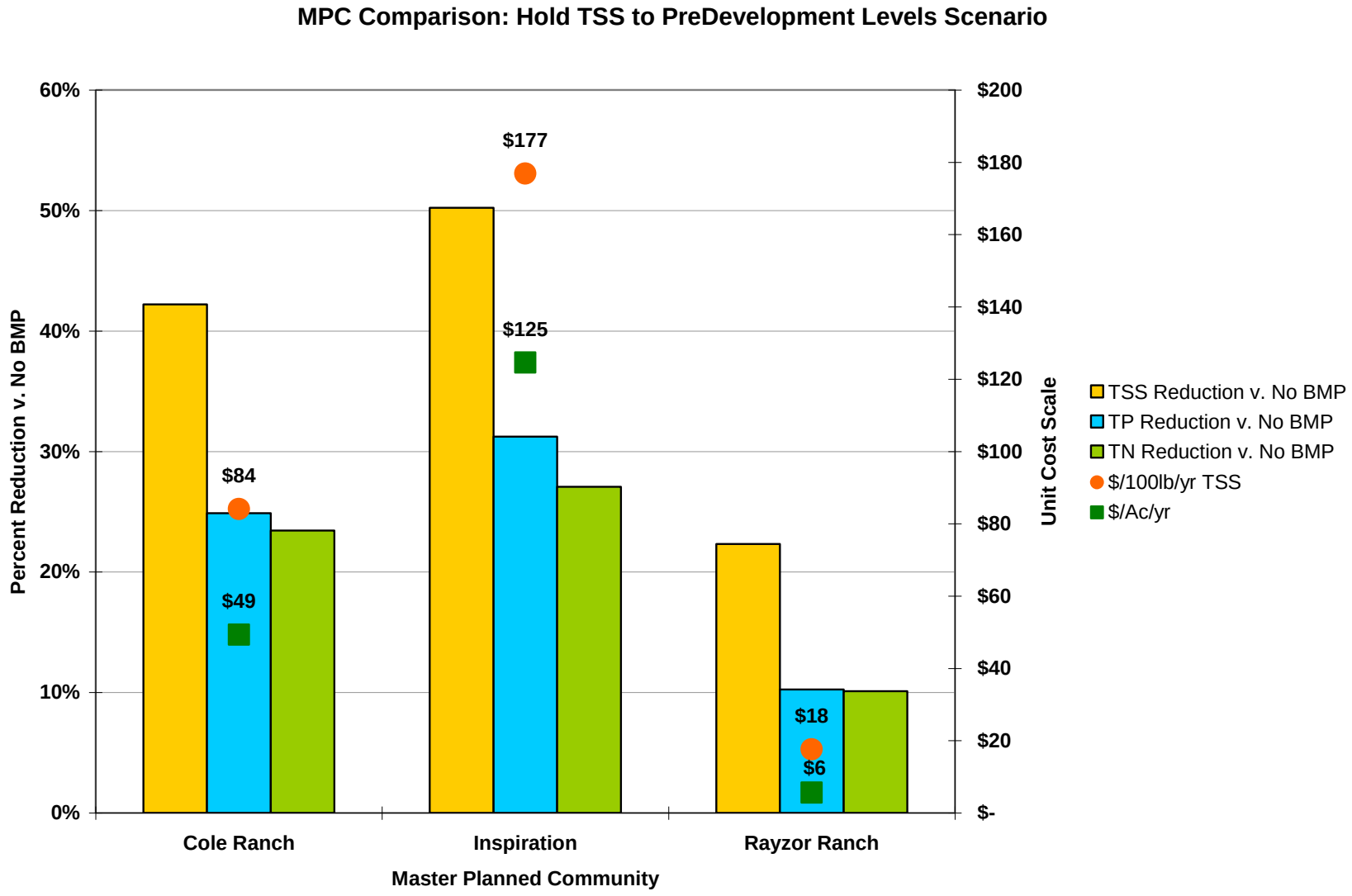






These results are essentially the same across MPCs.

Master Planned Communities: BMP Portfolio Results—Comparison



Future directions: Incentives using Stormwater Credit Program

- Establish performance baselines
- Performance above baselines generates credits that may be sold or banked
- Performance below baselines requires pollutant load reductions from other sources/locations
  - pay in lieu fee to City/County, revenues fund regional BMPs
  - purchase “credits” from other landowner
- The following information is just a brief summary

Summary of preliminary credit trading research

- There are trading-based watershed protection strategies for Hickory Creek that can be very cost-effective.
- Stormwater BMPs for water quality can be effectively integrated into existing drainage design requirements
- Water quality credit trading may present an opportunity to distribute costs and accelerate pollution controls
- We have a **LOT** more work to do "policy-wise" before these strategies can become a reality

Summary of WPP Goals

- Target priority locations through education, technical support, and a pilot credit trading program (MPCs)
- Education and outreach to foster behavior changes that support proactive watershed management

Summary of WPP Goals

- Minimize net increases in loadings despite continued development
- Minimize / mitigate the impact of new development and other land use changes through development code requirements

Conclusions

- The Hickory Creek WPP methodology is flexible on a variety of different spatial scales
- Results are useful for optimizing management strategies and to help bridge the gap between ecosystem services and implementation costs
- Information will be used as a planning tool to shape Denton Comprehensive Plan amendments and Development Code
- Approach has been received by elected officials

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