Lower Platte Missouri Tributaries Model
Hydrologic Connection Analysis

Lower Platte Basin Tech Committee Meeting
March 4, 2019

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Outline

➢ Lower Platte Missouri Tributaries (LPMT) Model Construction Timeline

➢ LPMT Model Construction Domain and Boundaries

➢ Cycle Well Analysis

➢ Cycle Well Zones

➢ Results – All Zones, Missouri Tributary Zones, and a Single Zone

Why Was the LPMT Model Constructed?

➤ Provide a regional numerical groundwater model to aid in the study of the impact of pumping on streams in the area

➤ Before the development of the LPMT model there was no regional model encompassing the eastern region of Nebraska. The LPMT model covers the northern and central part of that region

➤ Region contains complex hydrogeologic features which range from the High Plains Aquifer in the western side, to alluvial aquifers near the major streams, and local perched and semi-perched aquifers in regions containing glacial till

LPMT Model Construction Timeline

➢ Three HDR reports from 2012, 2013, and 2014 provided the basis for the development of the model

➢ Initial model work started in July of 2014. Model development was contracted out to HDR

➢ First version of the model was finished late 2016 and was reviewed by Olsson Associates. Revisions requested included separating the evapotranspiration from the watershed model to an EVT package, incorporating pilot points, and modify the zonation constraints

➢ Final model incorporating revisions from the review was finished December of 2018

LPMT Model Construction
Domain and Boundaries

➢ Layers
  o Model contains two layers where Layer 1 represents the principle aquifer and Layer 2 represents various bedrock aquifer units

➢ Grid
  o Consists of 350 Rows and 282 Columns of ½ Mile by ½ Mile cells
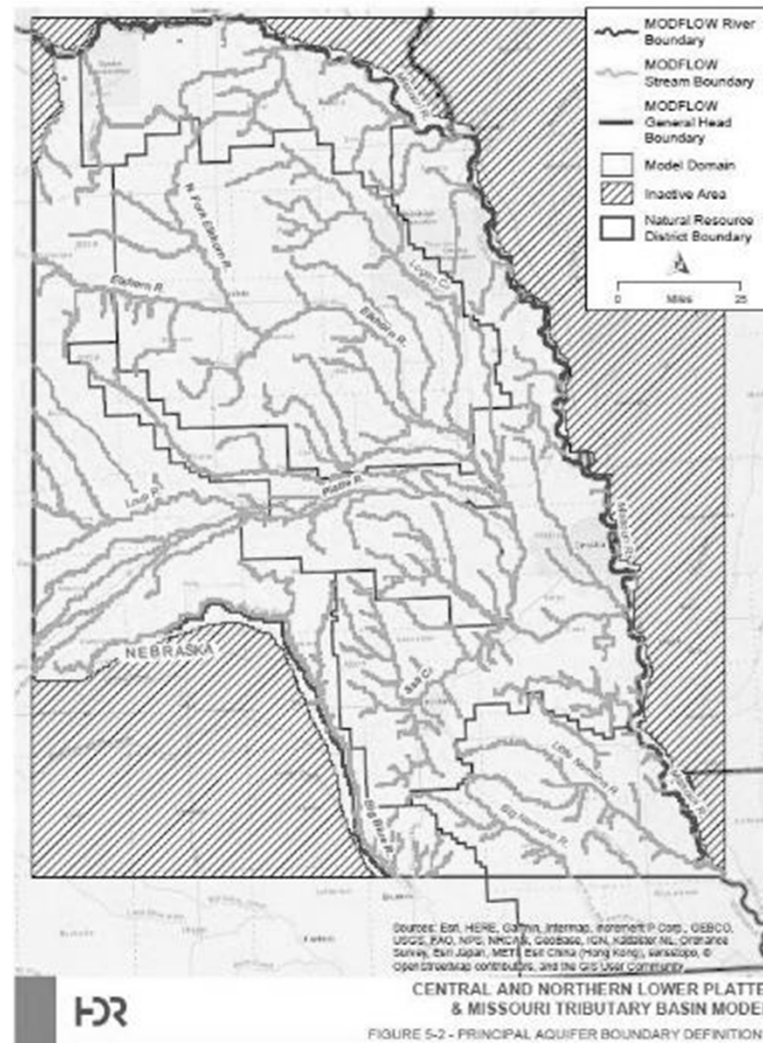 o 64,347 active cells in Layer 1
  o 69,168 active cells in Layer 2

➢ Stress Periods – January 1960 through December 2013
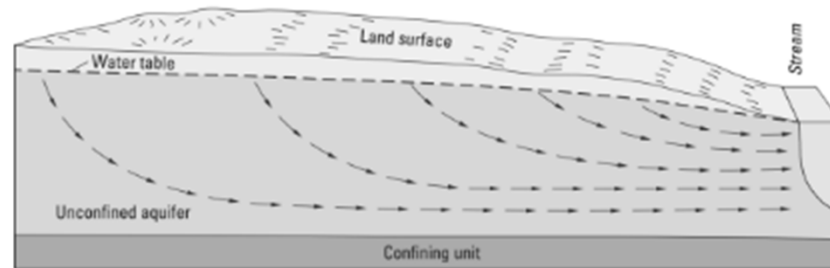 o 1 Steady State, 26 Transient Annual, 336 Transient Monthly

➢ Packages
  o Well, Recharge, Stream Flow Routing, River, and Evapotranspiration

LPMT Model Construction
Domain and Boundaries

FIGURE 5-2 - PRINCIPAL AQUIFER BOUNDARY DEFINITIONS

CENTRAL AND NORTHERN LOWER PLATTE
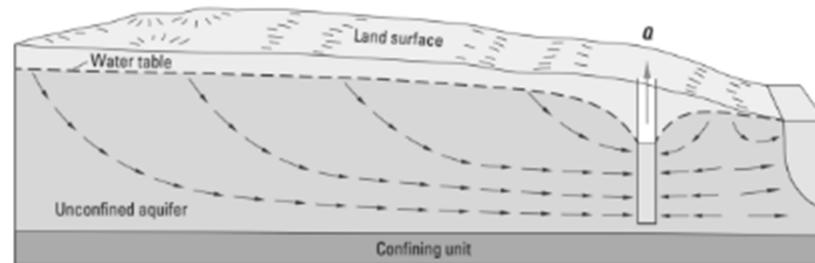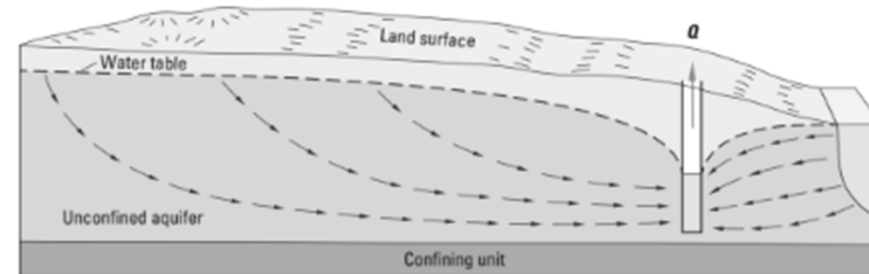& MISSOURI TRIBUTARY BASIN MODEL

Cycle Well Analysis

Natural Condition

Capture

Induced Infiltration

Cycle Well Analysis

➢In order to calculate Stream Depletion Factors a cycle of pumping of a known, fixed quantity for every stress period by a fictional well is needed

➢This process is repeated for every cell in a model's active domain

$$SDF = \frac{Q'_s - Q_s}{Q_w}$$

Q'_s is the cumulative stream leakage after the new well

Q_s is the cumulative stream leakage of the baseline

Q_w is the total pumping from the new well

Cycle Well Analysis

$$SDF = \frac{Q_s' - Q_s}{Q_w}$$

Q_s' is the cumulative stream leakage after the new well

Q_s is the cumulative stream leakage of the baseline

Q_w is the total pumping from the new well

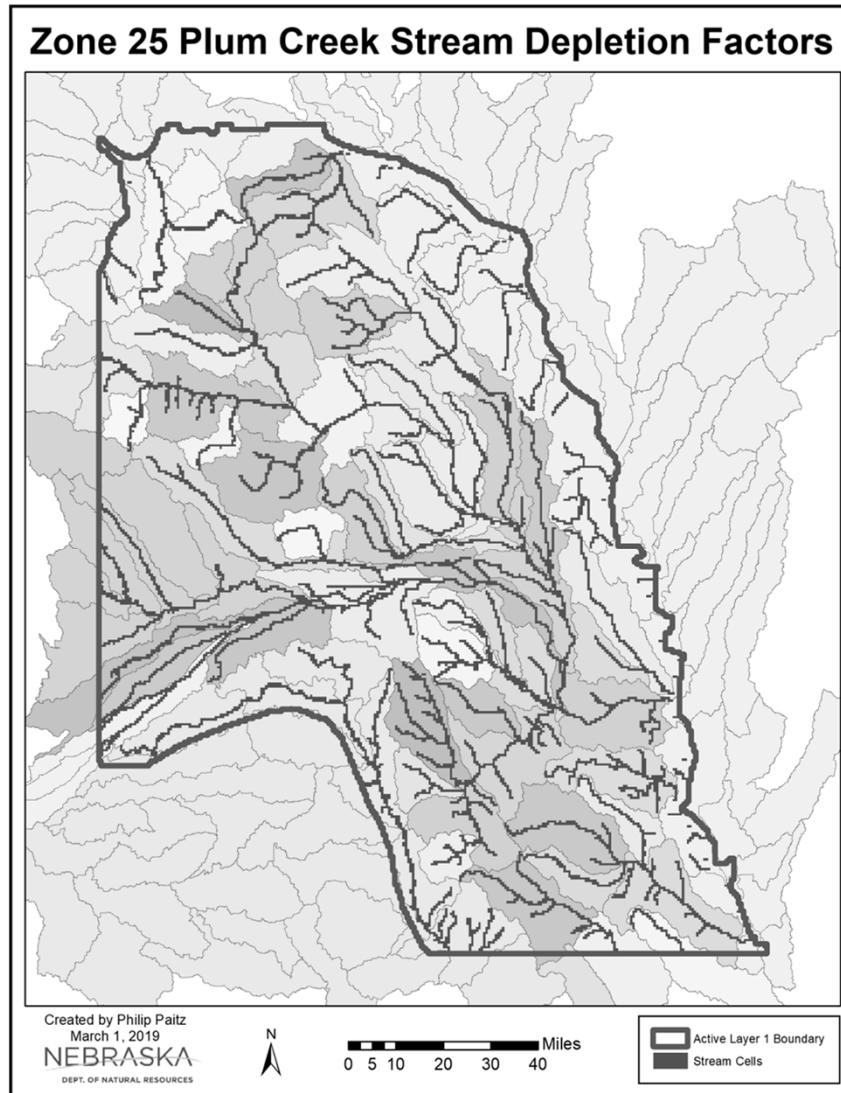| Stress Period	Pumping	Stream Leakage	Cumulative Pumping	Cumulative Stream Leakage	Calculation	Stream Depletion Factor
1	1000	0	1000	0	(0-0)/1000=	0.000
2	1000	5	2000	5	(5-0)/2000=	0.003
3	1000	10	3000	15	(15-0)/3000=	0.005
4	1000	20	4000	35	(35-0)/4000=	0.009
5	1000	40	5000	75	(75-0)/5000=	0.015
6	1000	80	6000	155	(155-0)/6000=	0.026
7	1000	130	7000	285	(285-0)/7000=	0.041
8	1000	190	8000	475	(475-0)/8000=	0.059
9	1000	250	9000	725	(725-0)/9000=	0.081
10	1000	310	10000	1035	(1035-0)/10000=	0.104

LPMT Cycle Well Setup

➢Hydrologic connectivity determined by running a fifty year simulation

➢LPMT cycle well analysis consists of original models 336 transient monthly stress periods plus the last 132 repeated twice

  o Original 336 transient periods – Jan 1986 to Dec 2013

  o Repeated last 127 periods twice - Jan 2002 to Dec 2013

  o Total of 600 stress period representing fifty years

➢All model packages were modified to represent the stress period changes
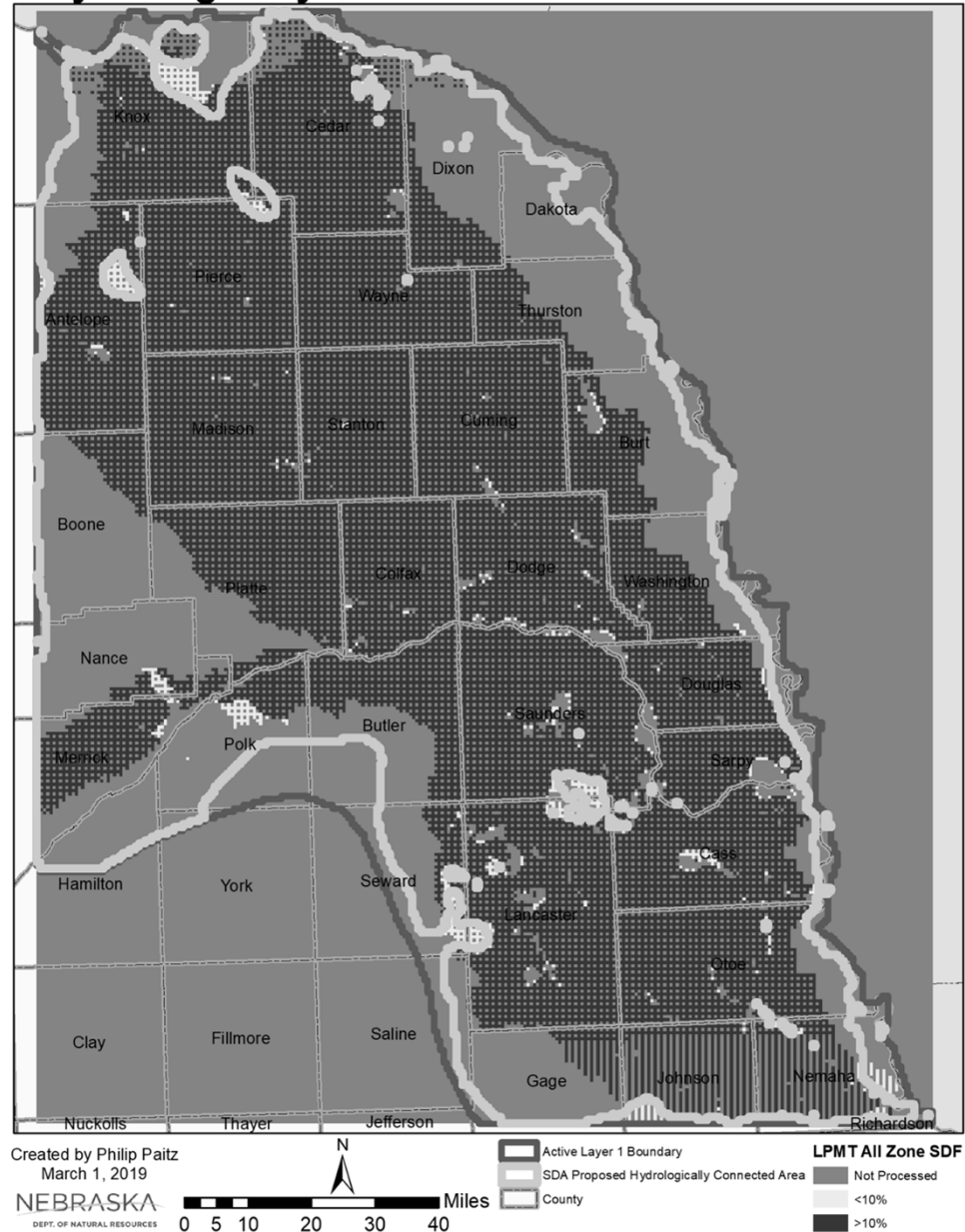
LPMT Cycle Well Zones

➢ Zones were created to aid in the analysis of hydrologically connected areas

➢ The zones are based off of HUC 10 Watershed boundaries and are the same for both layers

➢ Missouri, Blue, Loup, and Platte Tributaries were grouped

➢ Bazille and Elkhorn watersheds without stream cells were grouped

➢ Total of fifty nine zones

LPMT Cycle Well Zones

Zone 25 Plum Creek Stream Depletion Factors

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March 1, 2019
NEBRASKA
DEPT. OF NATURAL RESOURCES

Miles
0 5 10   20   30   40
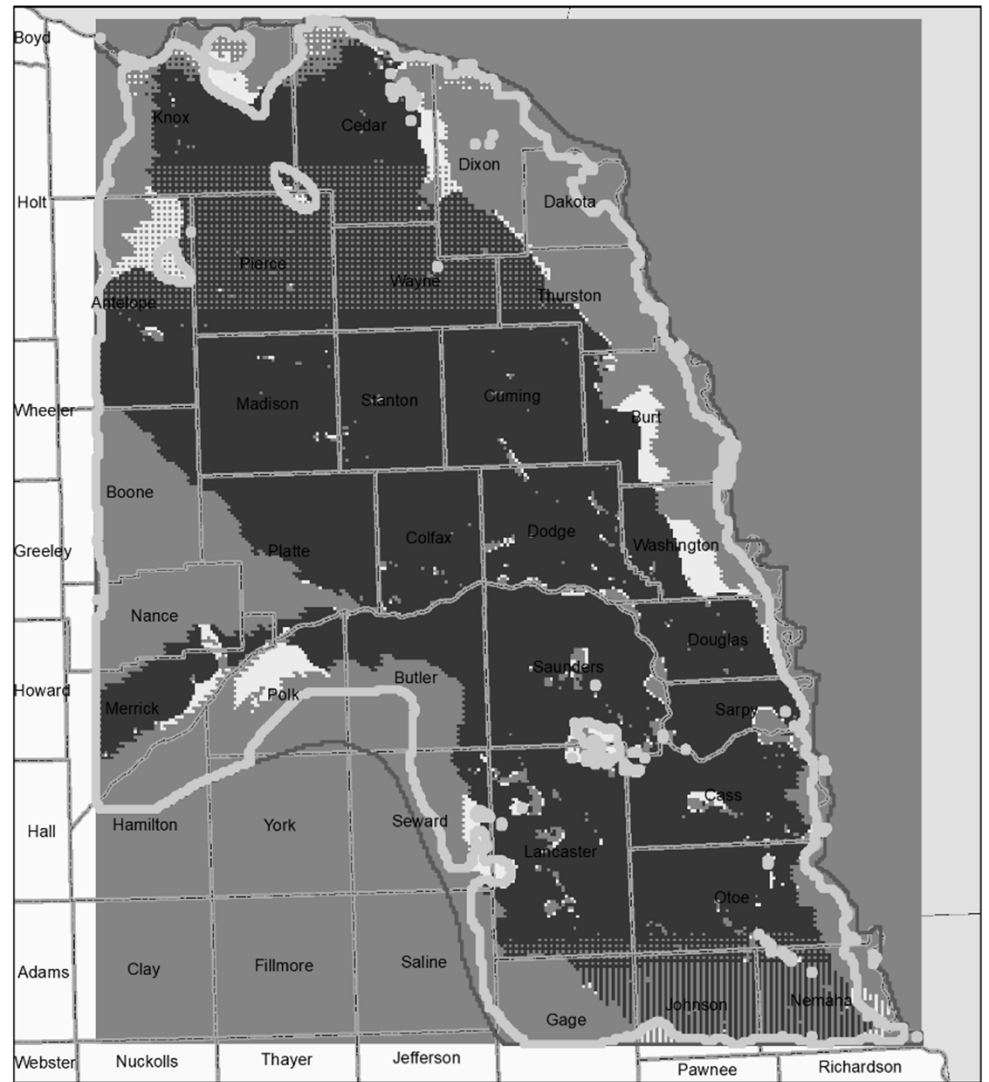
Active Layer 1 Boundary
Stream Cells

LPMT Cycle Well Results 1 All Zones

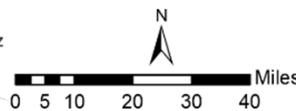Hydrologically Connected Area With All Zones

LPMT Cycle Well Results 2 Missouri Tributary Zones
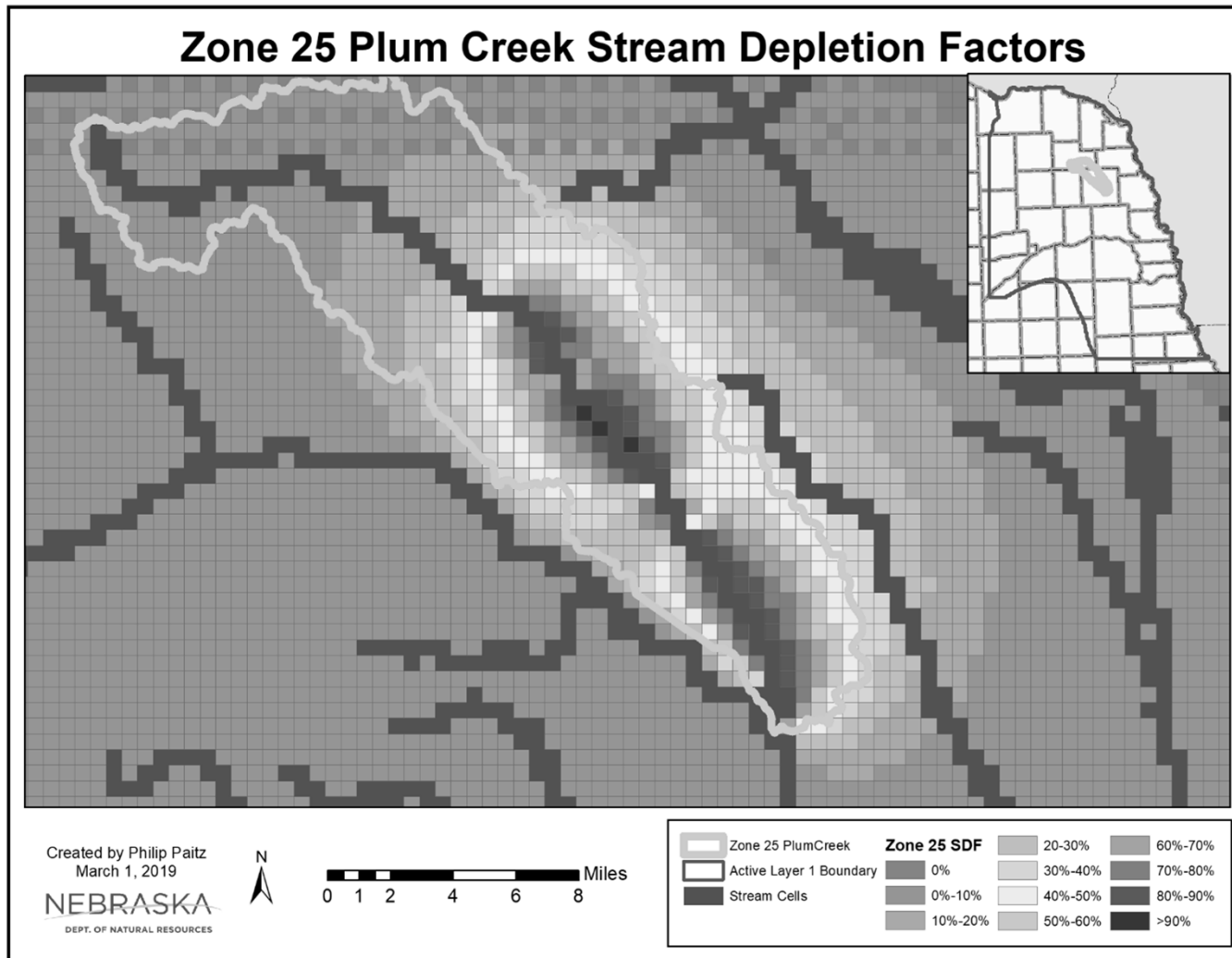

Hydrologically Connected Areas Without Outside Zones

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DEPT. OF NATURAL RESOURCES

N

Miles
0 5 10   20   30   40

Active Layer 1 Boundary
SDA Proposed Hydrologically Connected Area
County

LPMT Missouri SDF Only
Not Processed
<10%
>10%

LPMT Cycle Well Results 3 Single Tributary Zone

Zone 25 Plum Creek Stream Depletion Factors

What's Left to Do?

➢ Finish post-processing the cycle well results

➢ QAQC the process, post-processing, and results

➢ Export results to shapefiles and create final csv files for each zone

➢ Finalize documentation and write metadata for shapefiles

➢ Distribute results to public

➢ Also ahead with the NRD's help

   o Examine and incorporate AEM data into the LPMT Model
   o Develop local sub-models

Summary

➢ LPMT Model was constructed to aid in the study of impact to streams within the region with an emphasis on hydrologic connectivity

➢ Cycle well analysis was conducted using the LPMT Model expanded to fifty years

➢ Zones allow for hydrologic connectivity to analyzed at watershed level

➢ Post-processing and QAQC need to be completed

THANK YOU

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