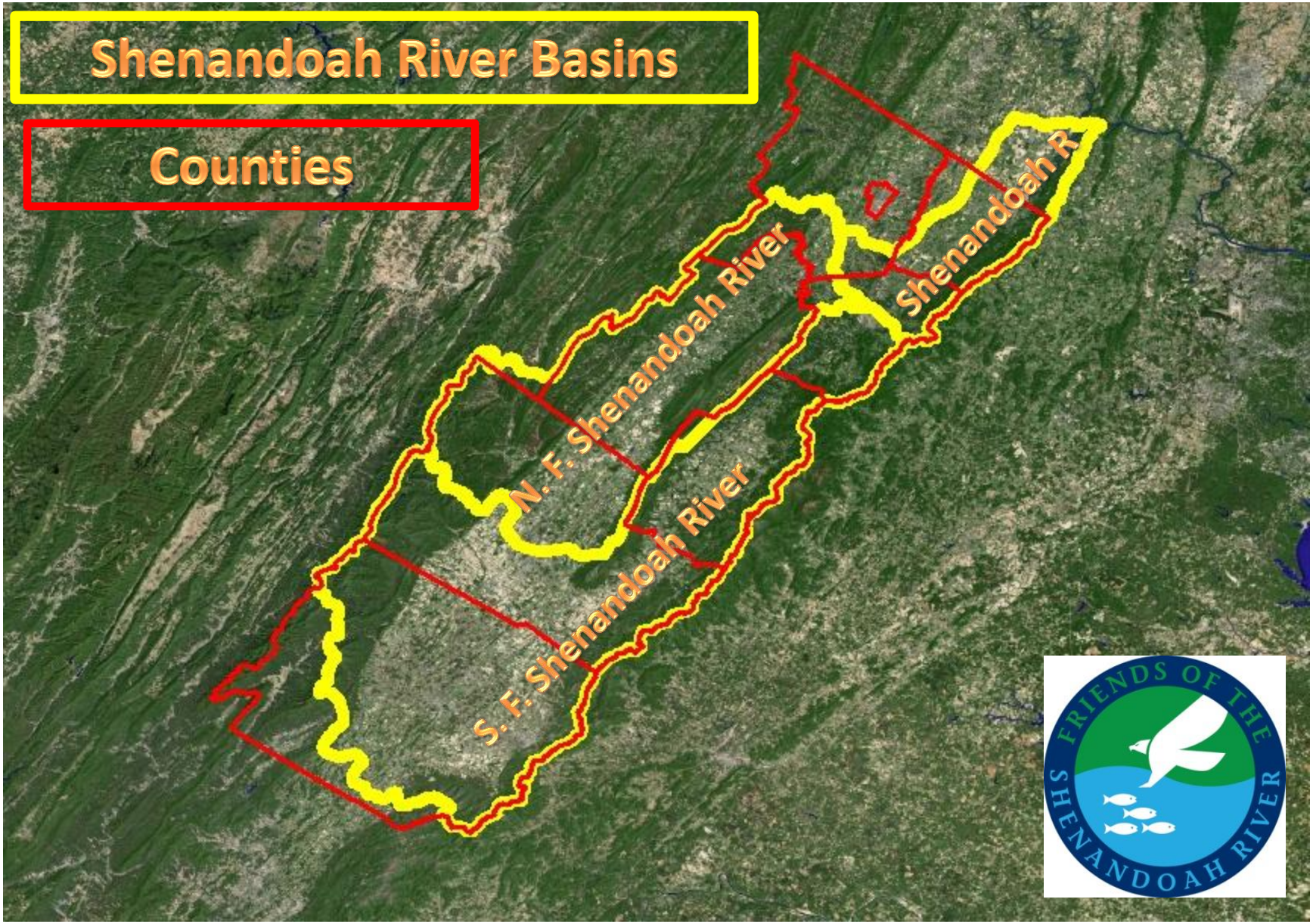
FOSR DATA APPLICATIONS

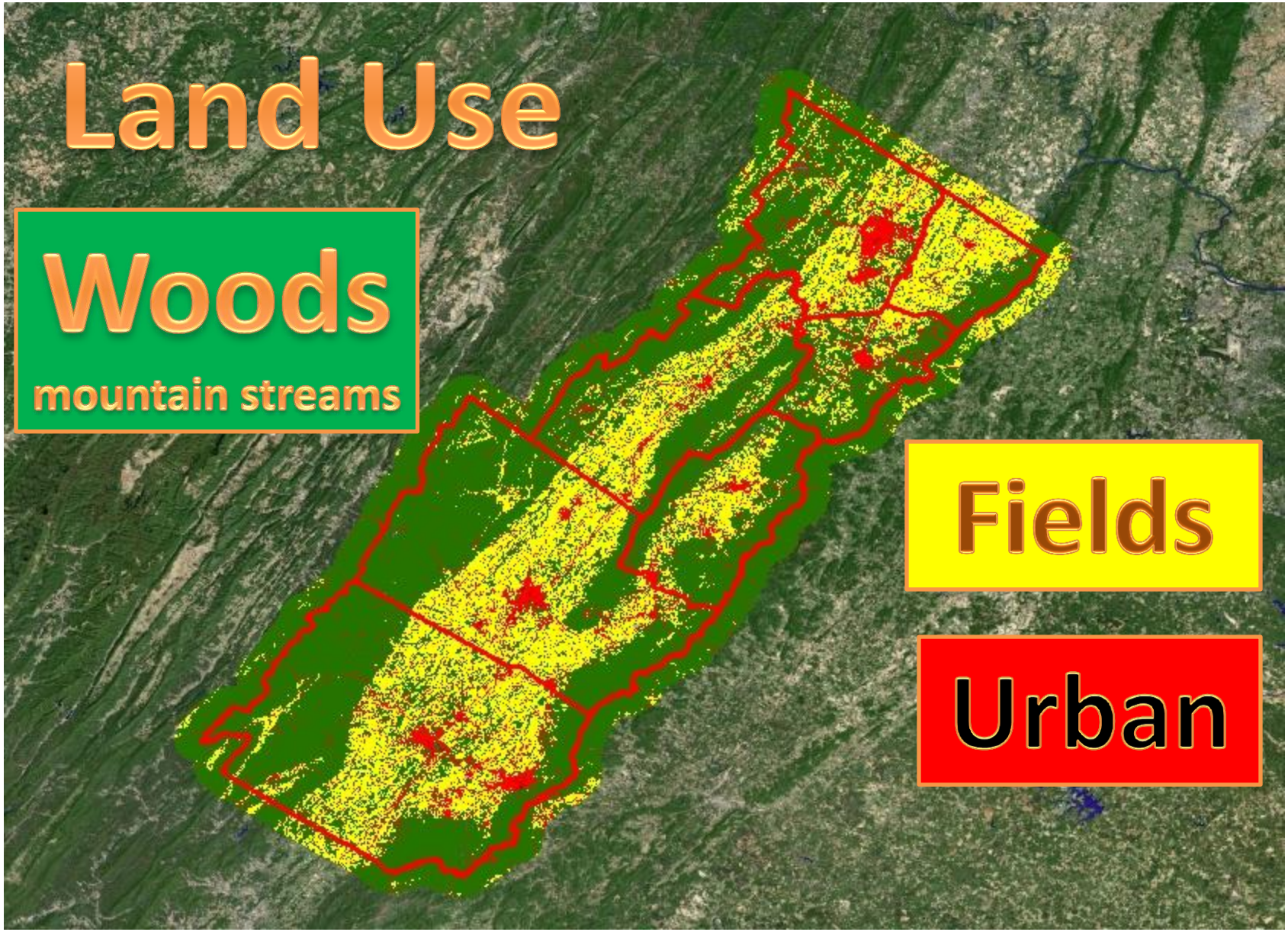
COUNTY LOADS

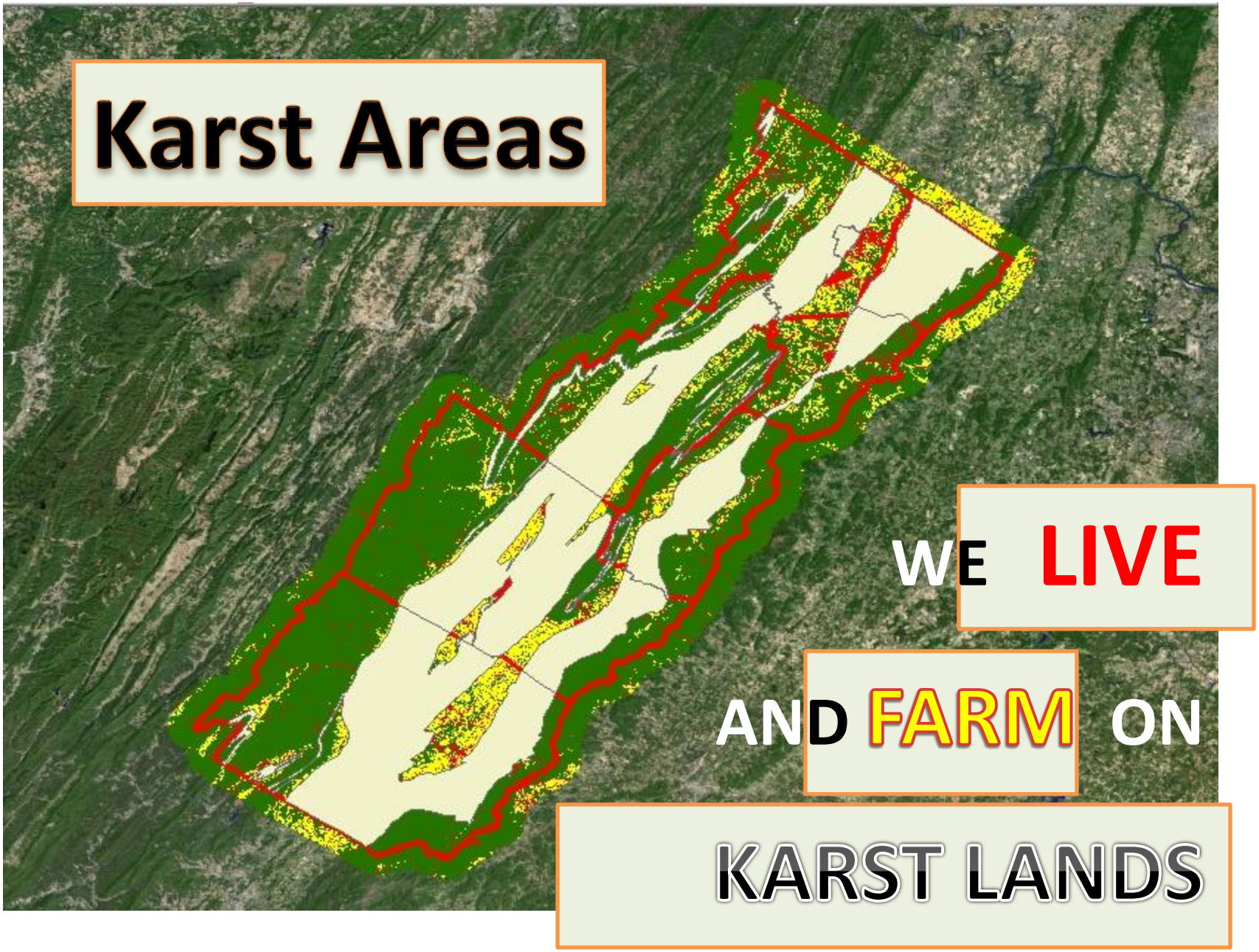
BIOSOLIDS

BAY TMDL

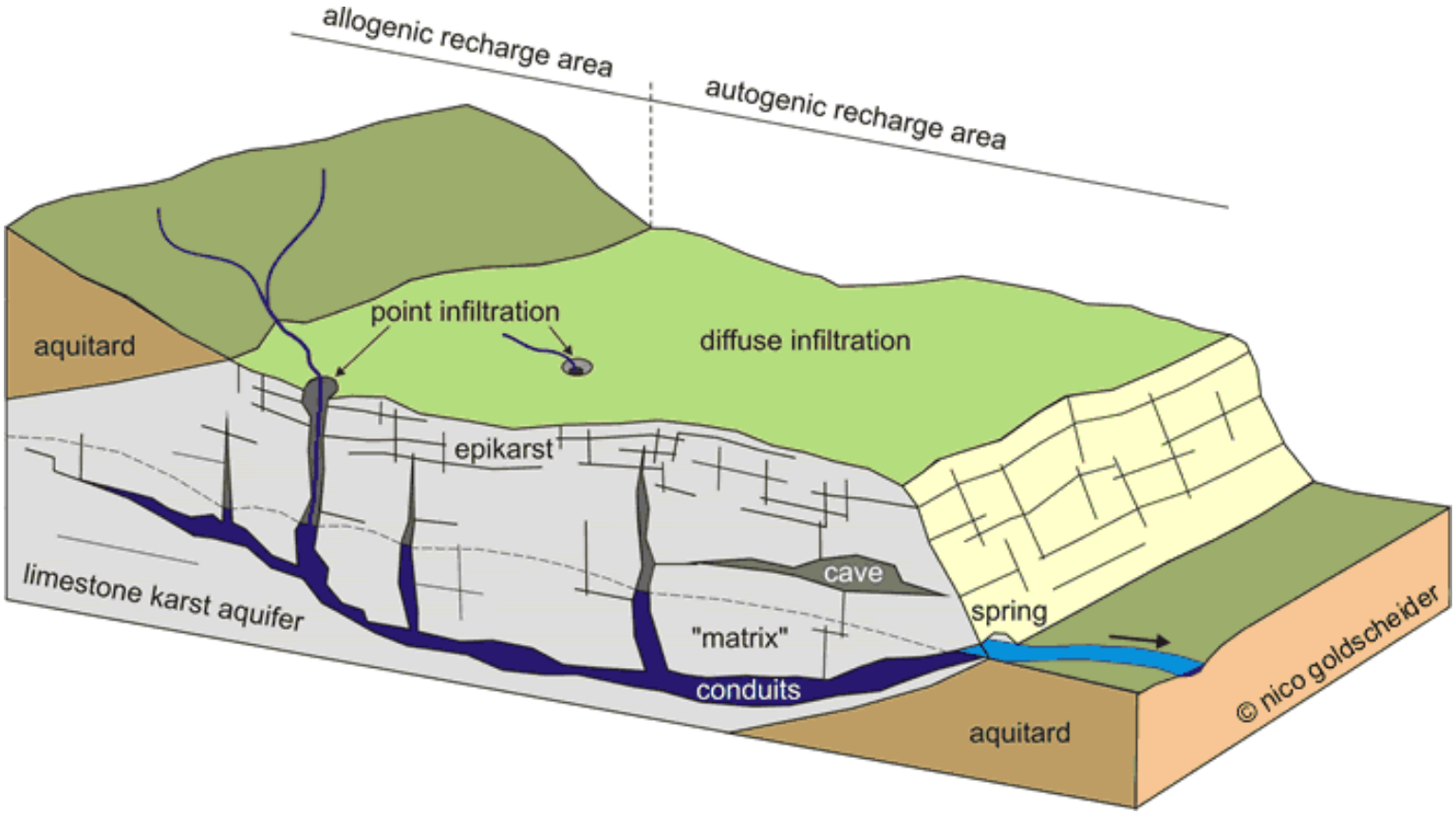
http://www.fosr.org/


Shenandoah River Basins
Counties
N. F. Shenandoah River
S. F. Shenandoah River
Shenandoah R
FRIENDS OF THE
SHENANDOAH RIVER


Land Use
Woods
mountain streams
Fields
Urban


Karst Areas
WE LIVE
AND FARM ON
KARST LANDS

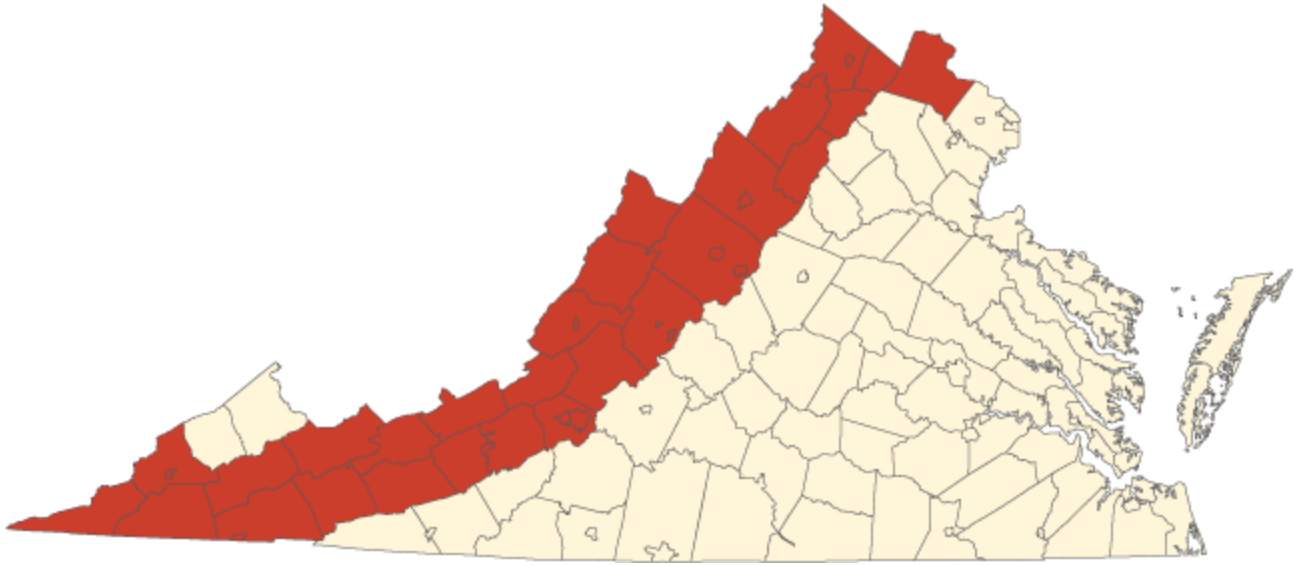
WHAT ARE KARST AREAS ?



AREAS WITH LIMESTONE BEDROCK

Block diagram of a heterogeneous karst aquifer illustrating the duality of recharge (allogenic vs. autogenic), infiltration (point vs. diffuse) and porosity/flow (conduits vs. matrix) (Goldscheider & Drew 2007).

WHERE ARE KARST AREAS IN THE VIRGINIA?



*Virginia counties containing karst terrain in **red.***

SHENANDOAH RIVER

HYDROLOGY

RIVER FLOW =

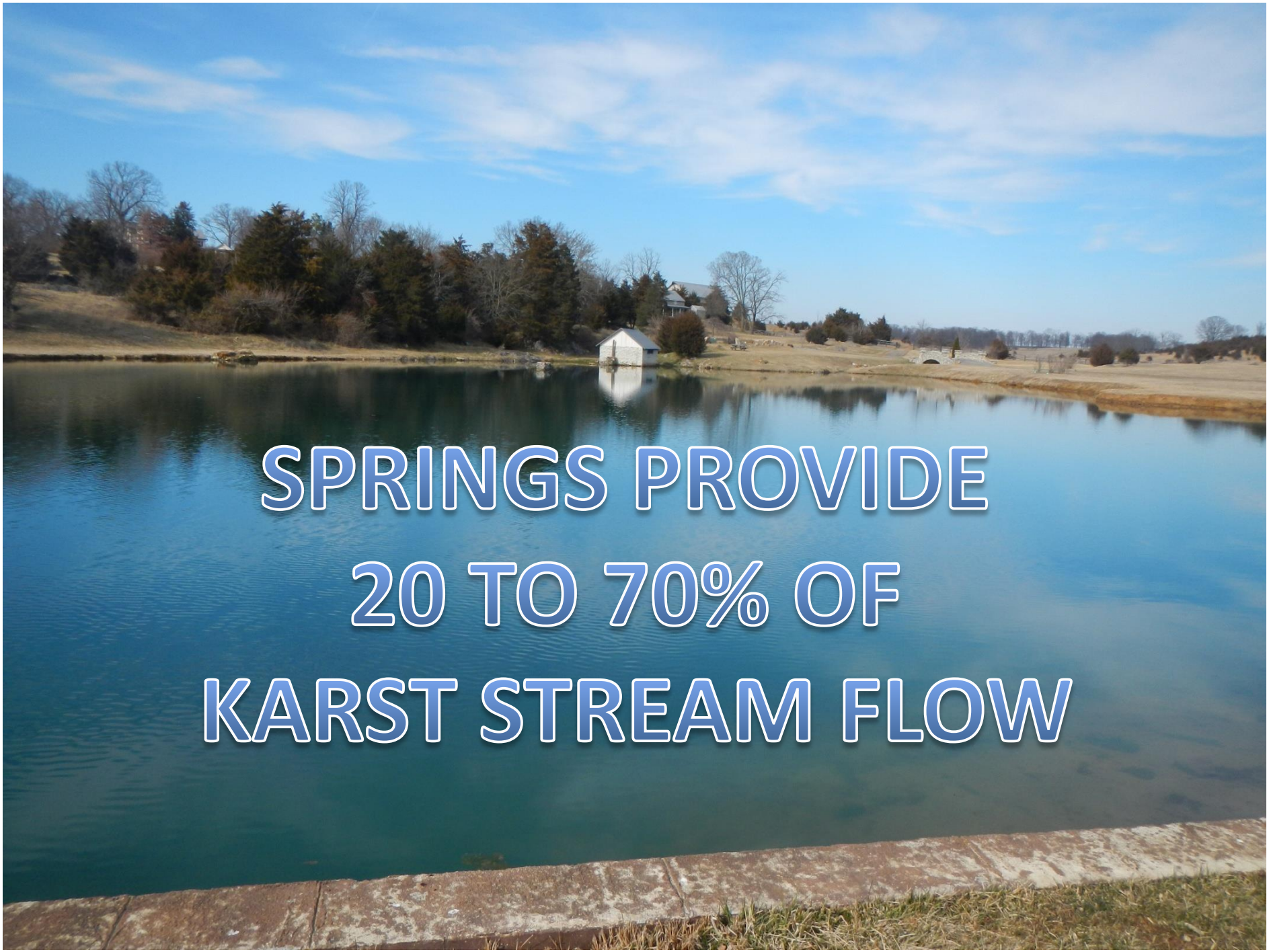
MOUNTAIN STREAMS

LOW NITROGEN CONCENTRATIONS
SUPPLY STORM FLOWS

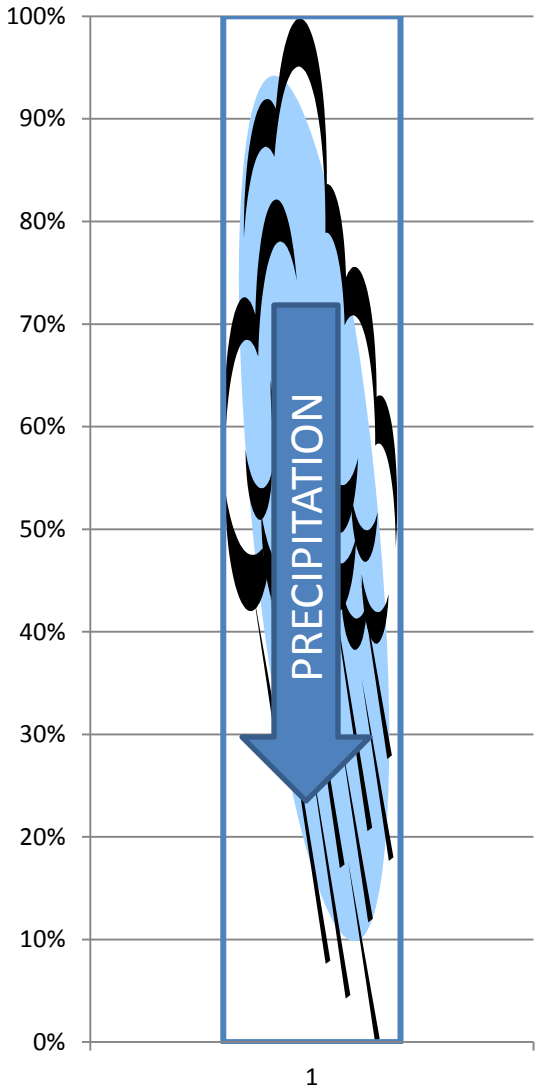
+

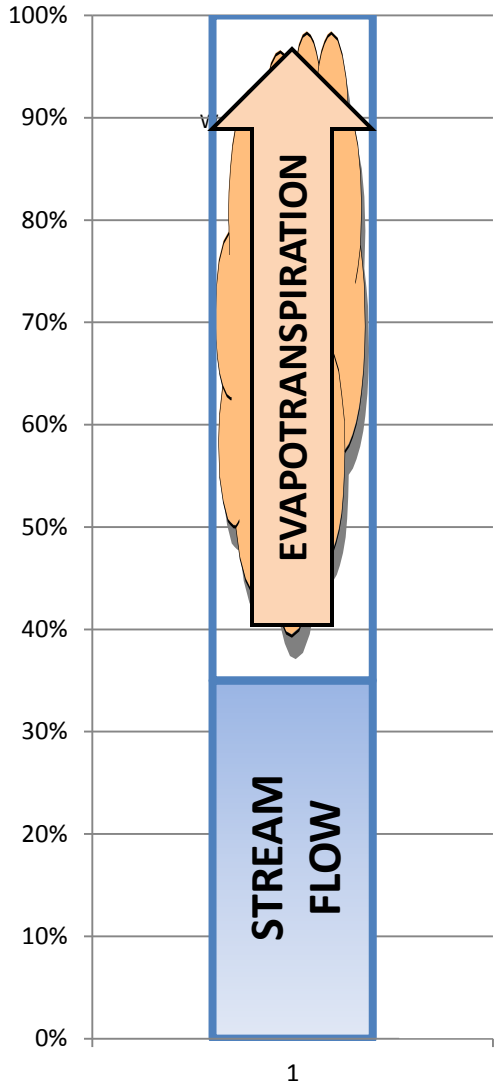
KARST STREAMS

HIGH NITROGEN CONCENTRATIONS
SUPPORT BASE FLOW
HAVE LIMITED OVERLAND RUNOFF

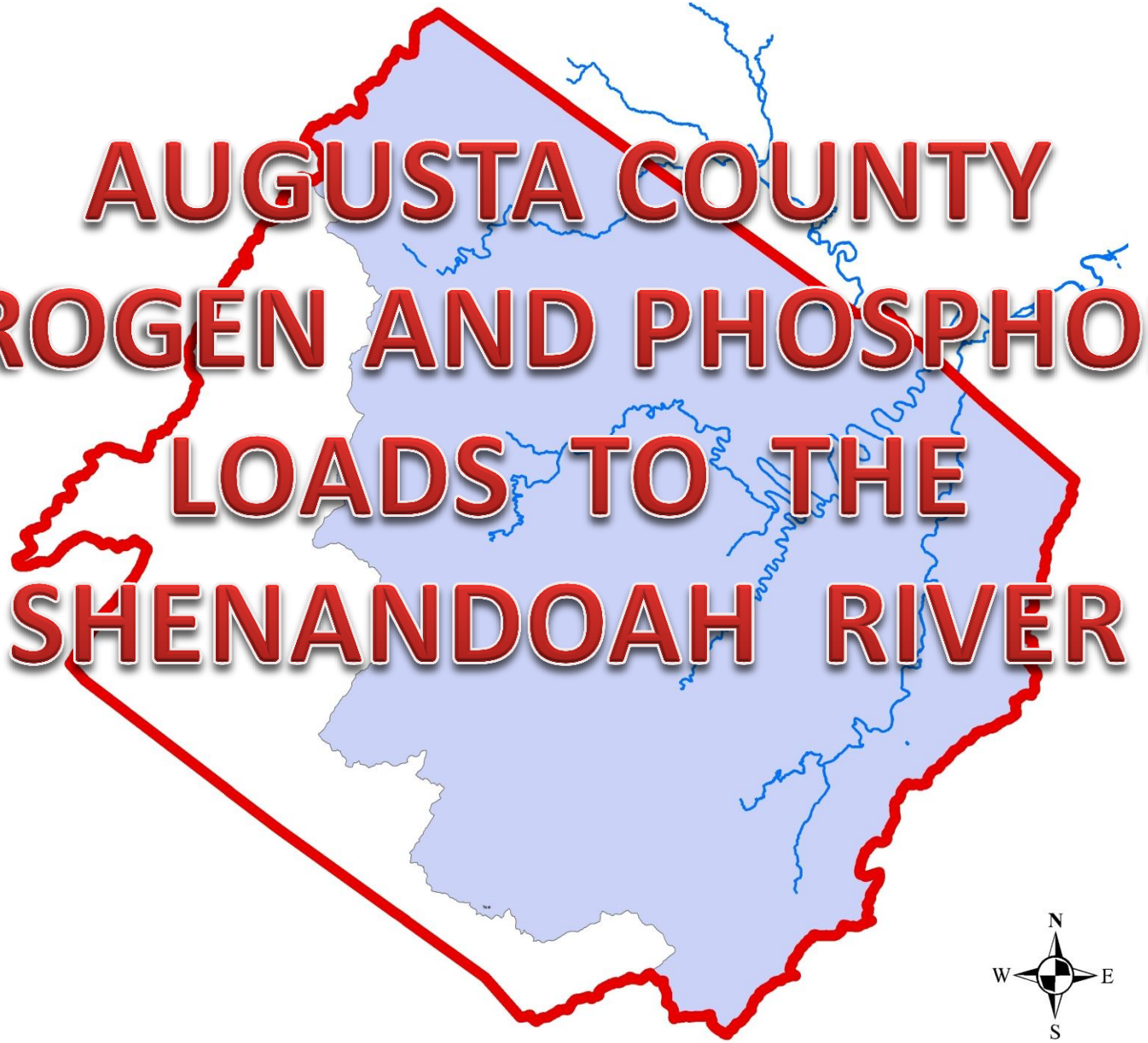

SPRINGS PROVIDE
20 TO 70% OF
KARST STREAM FLOW

KARST WATER BUDGET

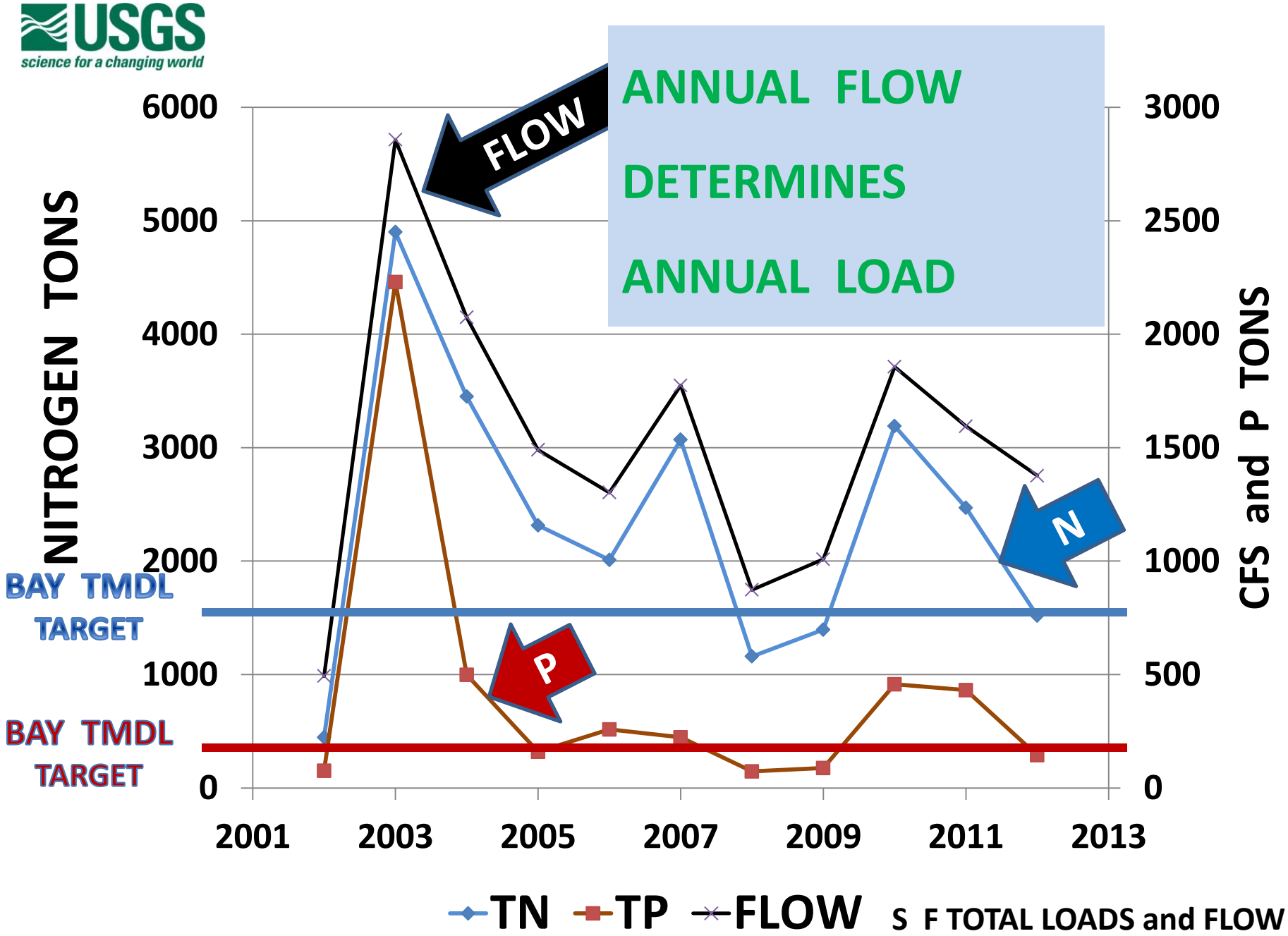




AUGUSTA COUNTY NITROGEN AND PHOSPHORUS LOADS TO THE SHENANDOAH RIVER



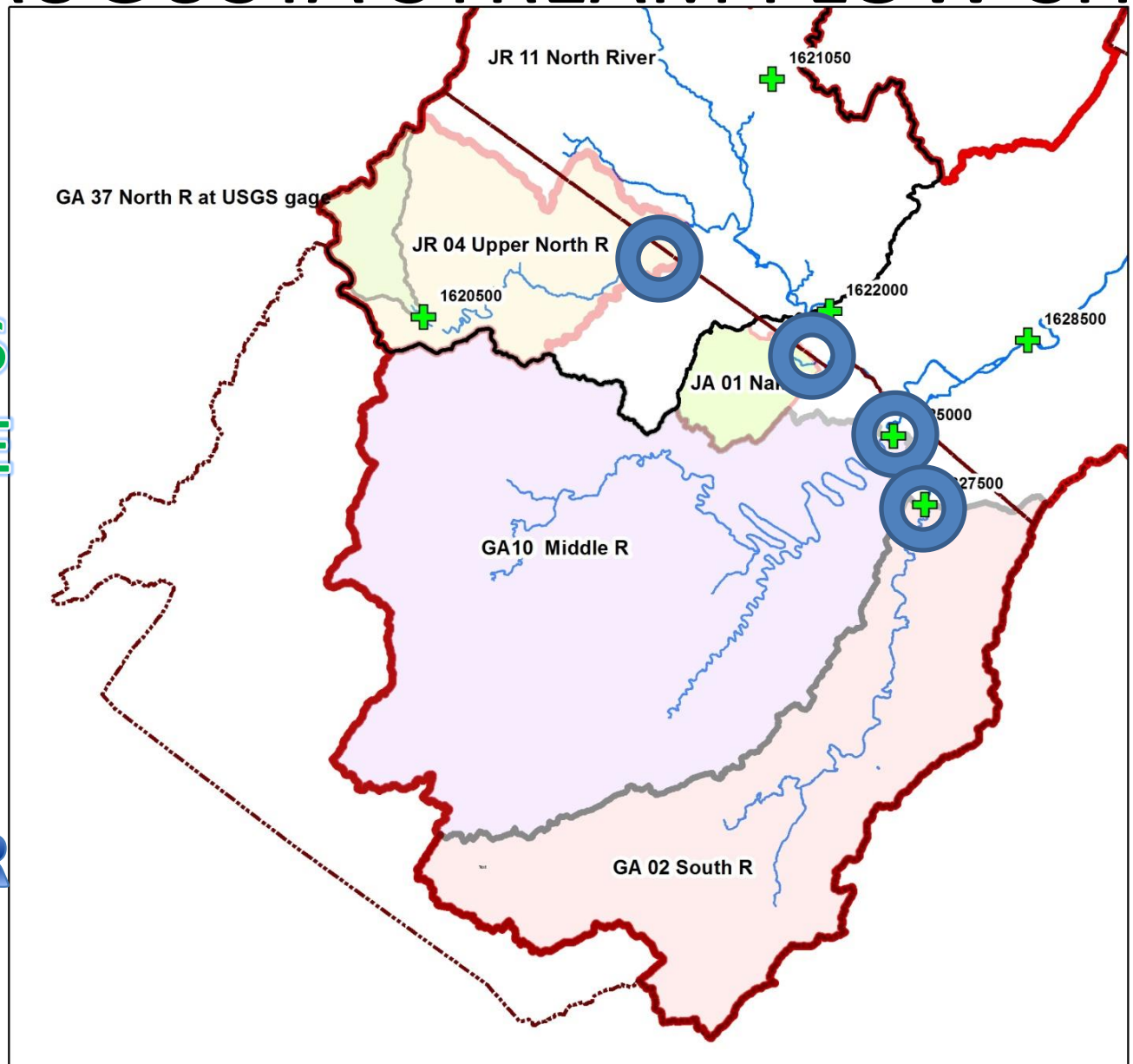
FRIENDS OF THE SHENANDOAH RIVER


USGS
science for a changing world
ANNUAL FLOW
DETERMINES
ANNUAL LOAD
FLOW
N
P
BAY TMDL
TARGET
BAY TMDL
TARGET
NITROGEN TONS
CFS and P TONS
6000
5000
4000
3000
2000
1000
0
3000
2500
2000
1500
1000
500
0
2001
2003
2005
2007
2009
2011
2013
TN
TP
FLOW
S F TOTAL LOADS and FLOW

AUGUSTA STREAM FLOW SITES

USGS GAGE

FOSR SITE

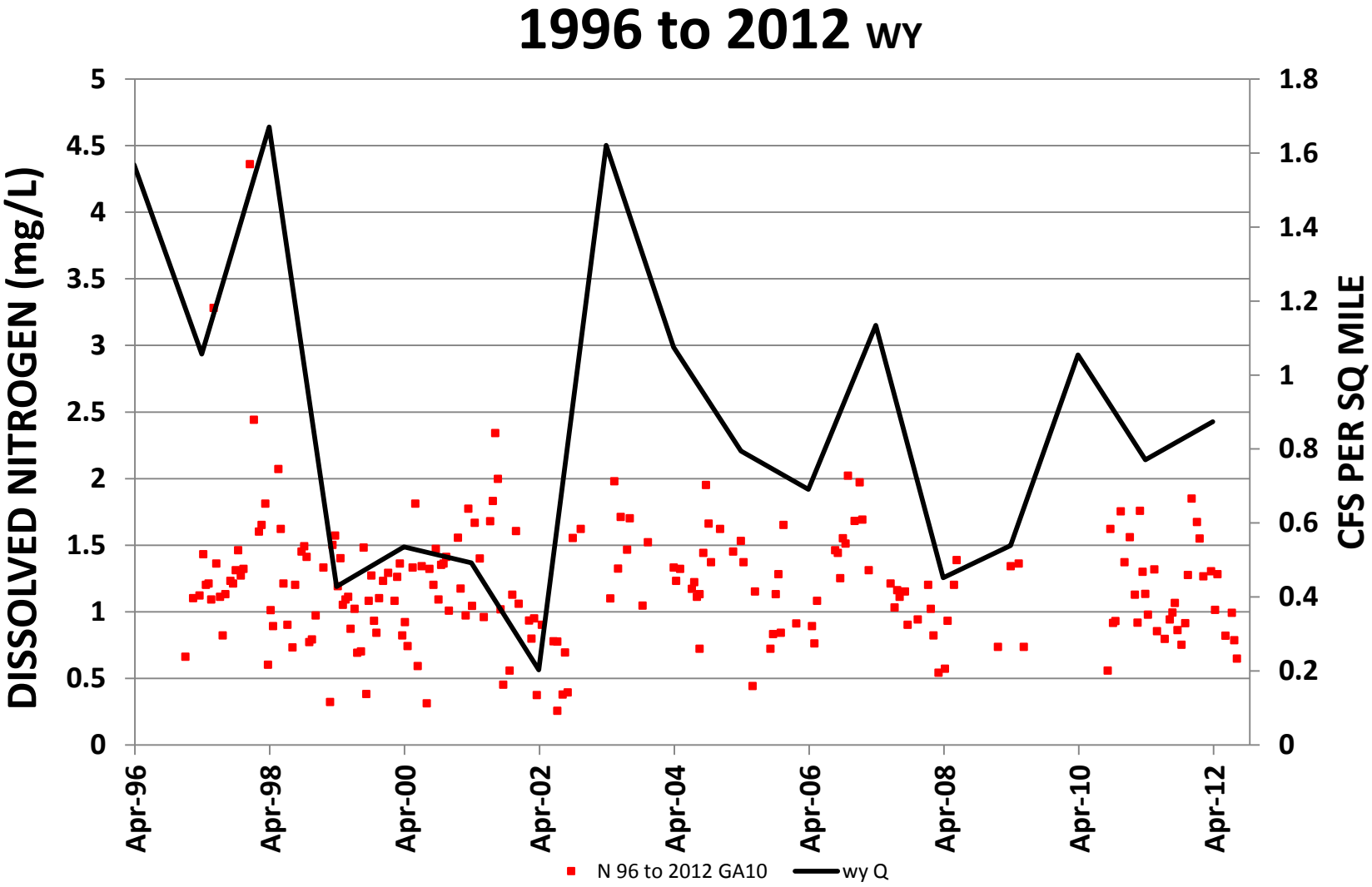


LOAD CALCULATION

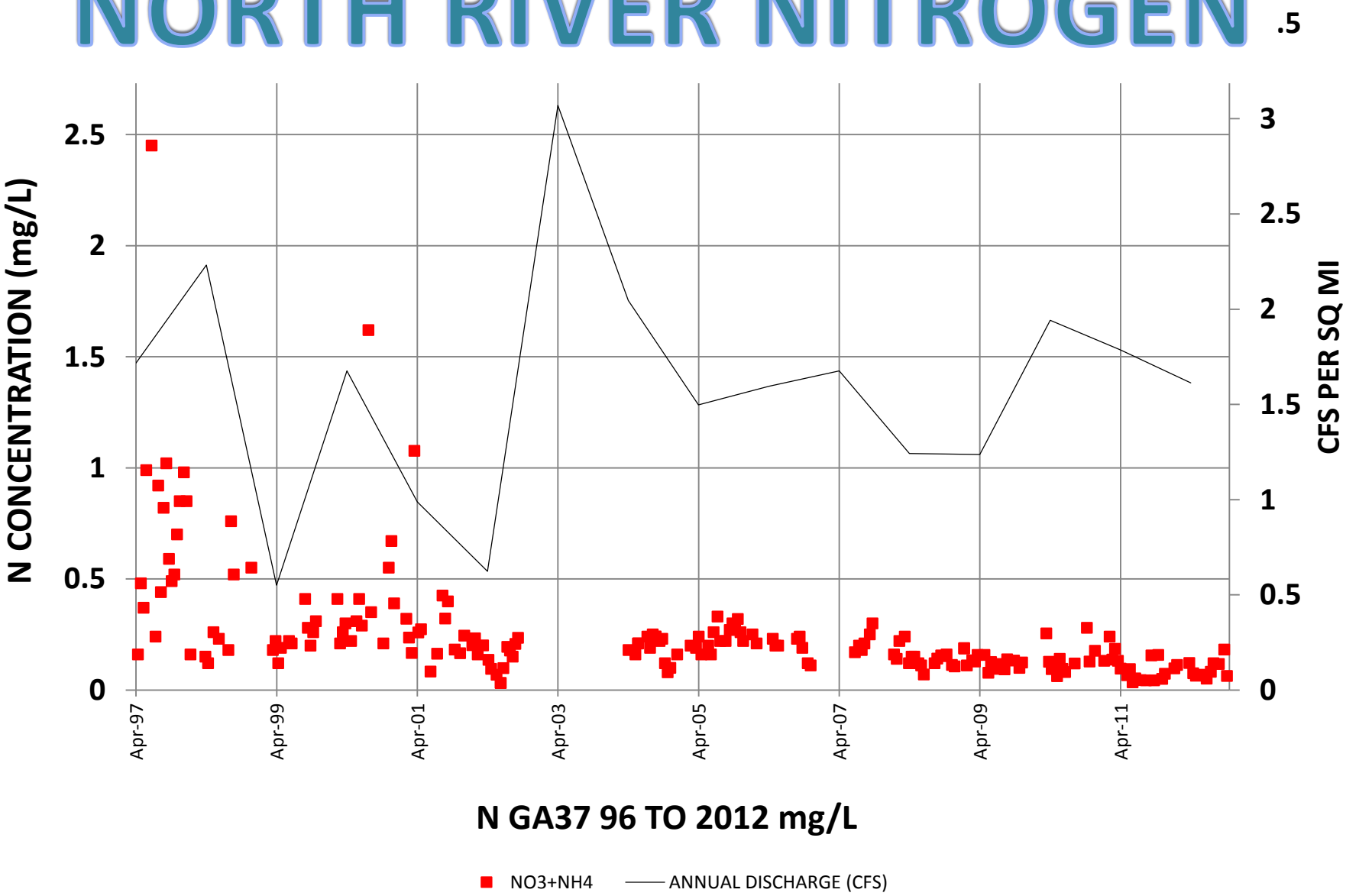
DAILY LOAD =
DAILY FLOW X CONCENTRATION

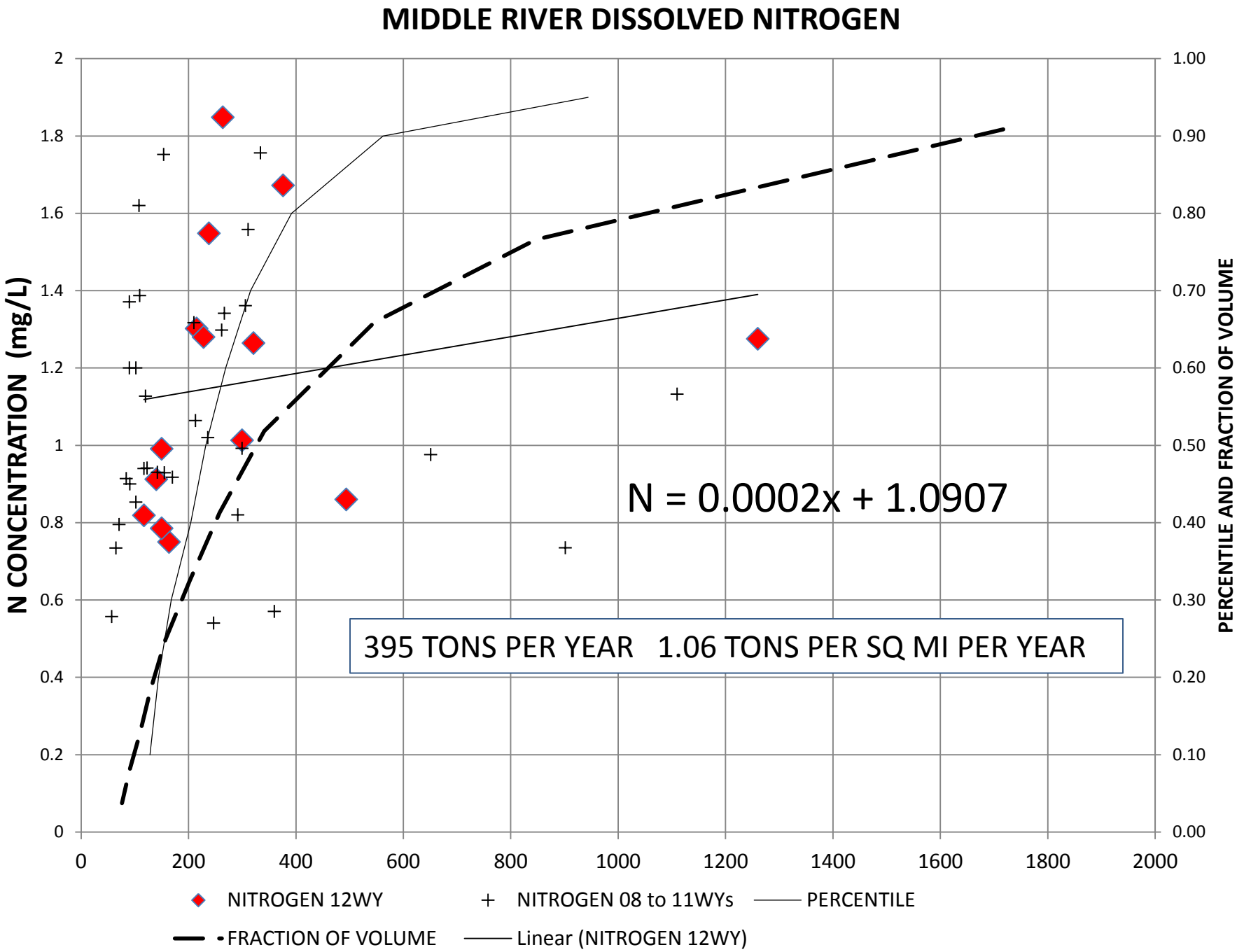
ANNUAL LOAD = ∑ DAILY LOADS

MIDDLE RIVER NITROGEN



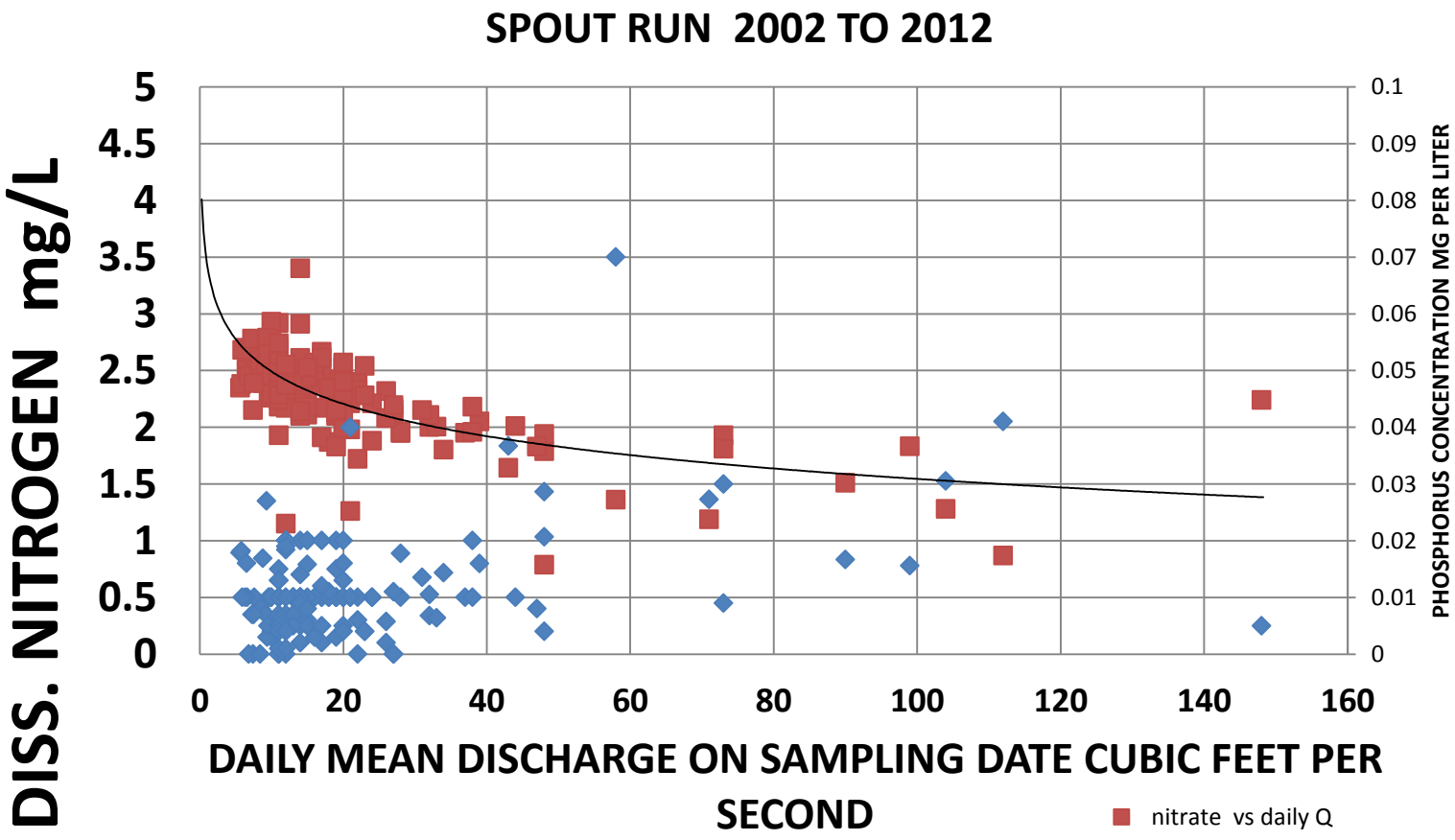
NORTH RIVER NITROGEN



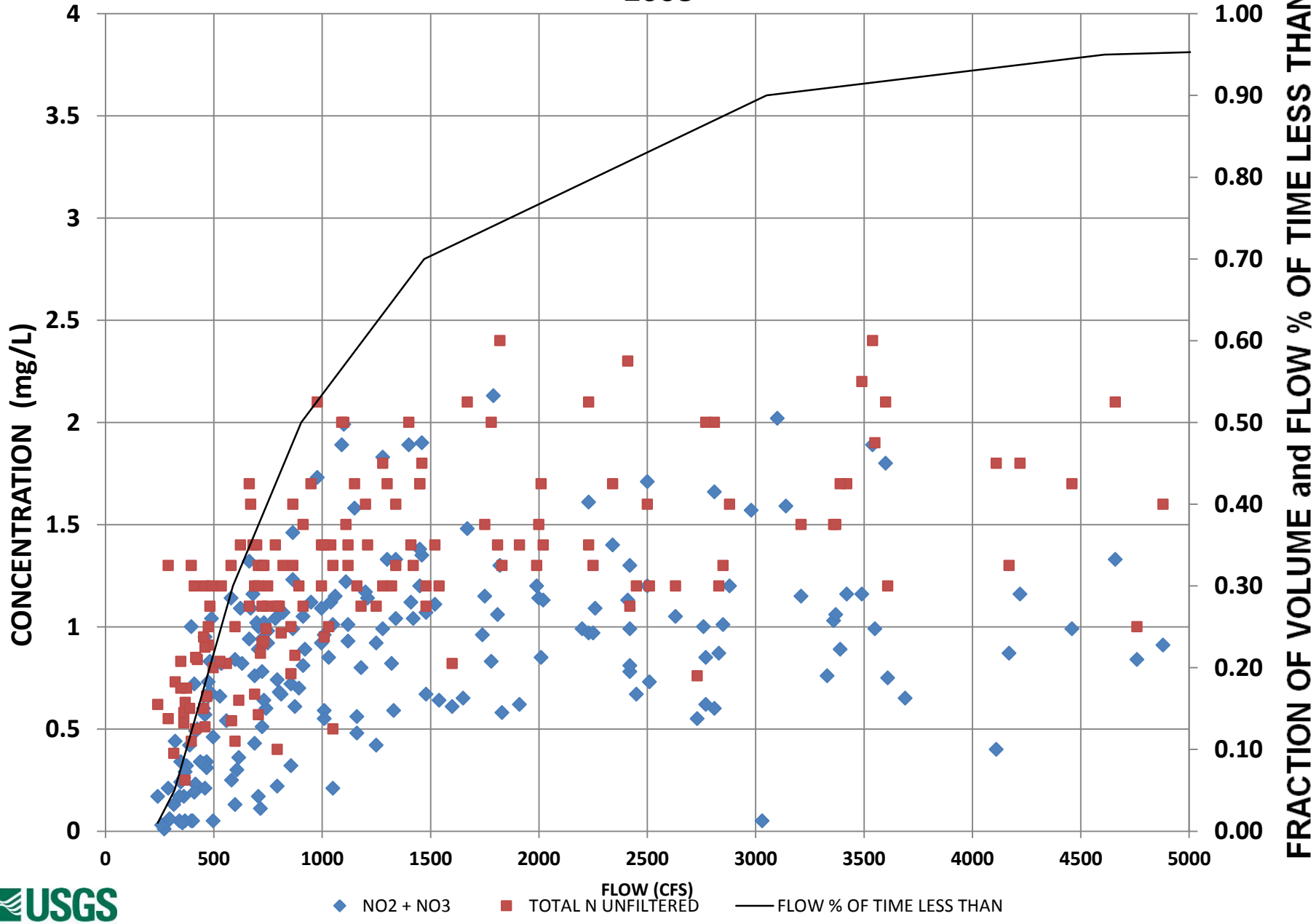

MIDDLE RIVER DISSOLVED NITROGEN
N CONCENTRATION (mg/L)
PERCENTILE AND FRACTION OF VOLUME
N = 0.0002x + 1.0907
395 TONS PER YEAR 1.06 TONS PER SQ MI PER YEAR
NITROGEN 12WY
NITROGEN 08 to 11WYs
PERCENTILE
FRACTION OF VOLUME
Linear (NITROGEN 12WY)

TOTAL LOAD ESTIMATION

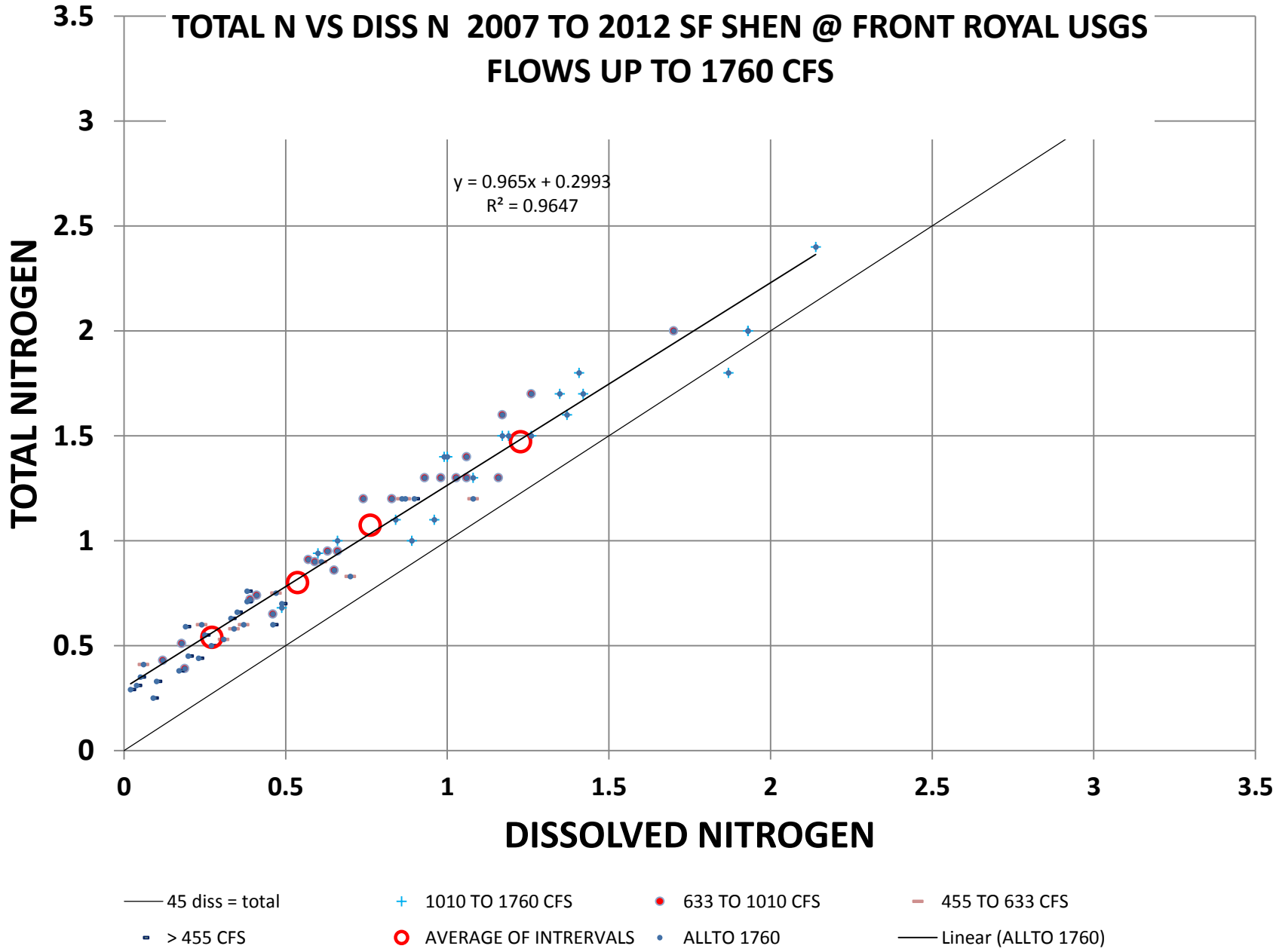
DISSOLVED CONSTITUENTS SHOULD DECREASE WITH INCREASING FLOW



SF SHENANDOAH RIVER AT FRONT ROYAL VA USGS DATA FROM 1997 TO 2008



USGS
science for a changing world


TOTAL N VS DISS N 2007 TO 2012 SF SHEN @ FRONT ROYAL USGS
FLOWS UP TO 1760 CFS
y = 0.965x + 0.2993
R² = 0.9647
TOTAL NITROGEN
DISSOLVED NITROGEN
0
0.5
1
1.5
2
2.5
3
3.5
45 diss = total
1010 TO 1760 CFS
633 TO 1010 CFS
455 TO 633 CFS
> 455 CFS
AVERAGE OF INTRERVALS
ALLTO 1760
Linear (ALLTO 1760)

SOUTH FORK DISSOLVED TO TOTAL N CONVERSION

FLOW % LESS THAN	DISS N	TOT N	
>20	0.27	0.54	
20 TO 40	0.54	0.80	
40 TO 60	0.76	1.07	
60 TO 80	1.23	1.47	
80 TO 90	1.11	1.51	
90 TO 95	1.14	1.55	DISS X 1.4 = TOTAL
95 TO 99	0.97	1.74	DISS X 1.8 = TOTAL
<99	1.15	2.48	DISS X 2.1 = TOTAL

TOT N = 0.9575 x DISS N + 0.3484

MIDDLE RIVER GA10 2012 WY

NITROGEN

TOTAL 597 TONS	1.6 TONS PER SQ MI
DISSOLVED 406 TONS	1.09 TONS PER SQ MI

PHOSPHORUS

TOTAL 33 TONS	0.09 TONS PER SQ MI
DISSOLVED 5.3 TONS	0.014 TONS PER SQ MI

AUGUSTA COUNTY LOADS 2012 WY

NITROGEN

TOTAL 1242 TONS	1.4 TONS PER SQ MI
DISSOLVED 867 TONS	0.99 TONS PER SQ MI

SF TOTAL N	1.38 TONS PER SQ MI
SF DISSOLVED N	1.01 TONS PER SQ MI

PHOSPHORUS

TOTAL 68 TONS	0.08 TONS PER SQ MI
DISSOLVED 11 TONS	0.012 TONS PER SQ MI

SF TOTAL P	0.156 TONS PER SQ MI
SF DISSOLVED P	0.029 TONS PER SQ MI

BIOSOLIDS APPLICATION AND GROUND WATER QUALITY IN SHENANDOAH VALLEY

THE COUNTY OF CLARKE VIRGINIA 1836

FRIENDS OF THE SHENANDOAH RIVER

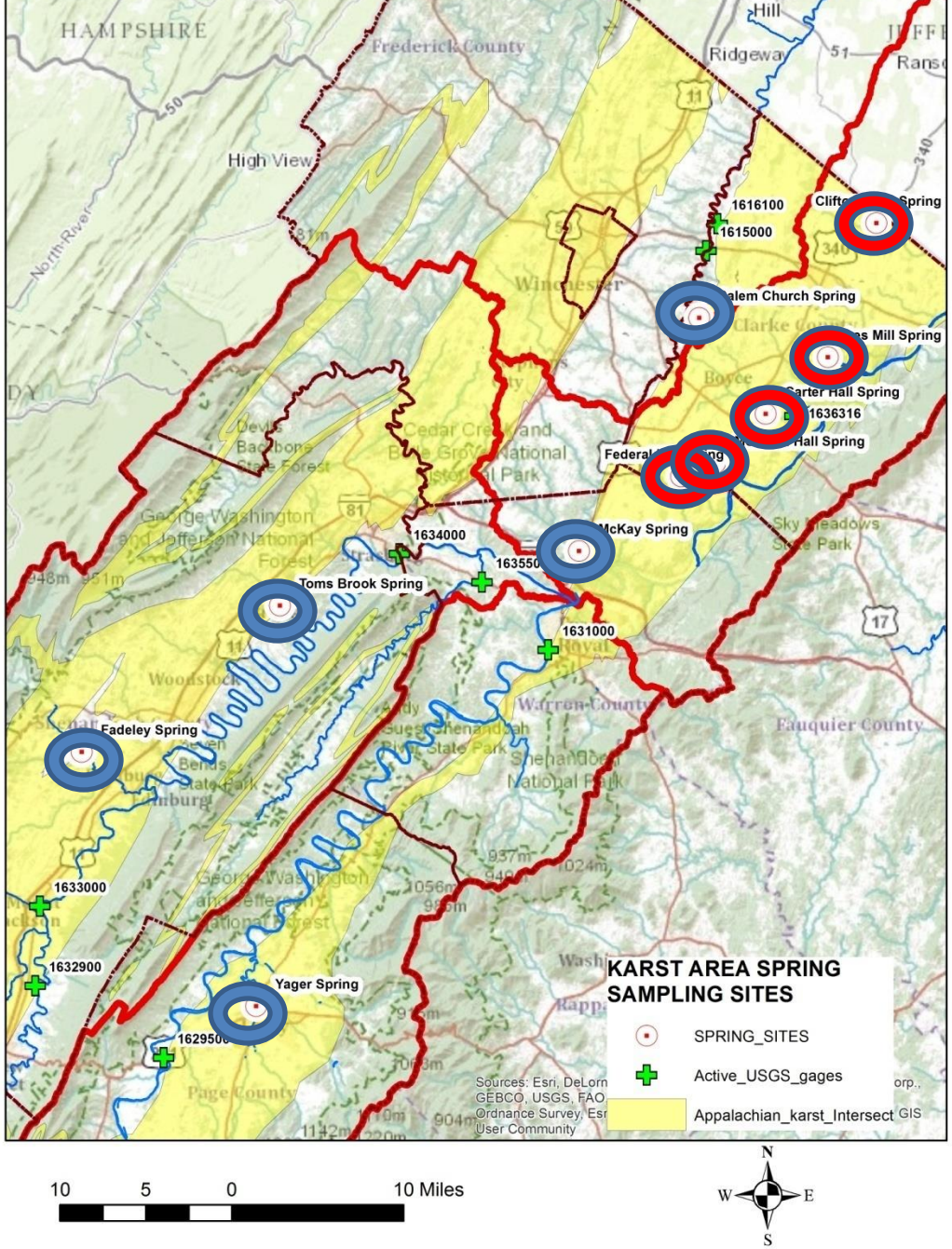
DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

MOST BIOSOLIDS ARE APPLIED ON KARST LAND

Spring sites **NEAR** biosolids application

Spring site **AWAY FROM** biosolids application

Karst land



10 5 0 10 Miles

N W E S

SPRING SAMPLING RESULTS

	Total Phosphorus mg/L			E coli MPN most probable number per 100 mL			Temperature °C		
	25-Feb	22-Apr	24-Jun	25-Feb	22-Apr	24-Jun	25-Feb	22-Apr	24-Jun
Federal Hill Spring	0.13	0.14	<0.05	1.0	<1	3.10	12.6	12.9	12.9
Carter Hall Spring	0.1	<0.05	<0.05	2.0	<1	8.50	12.7	12.9	12.9
Montana Hall Spring	0.07	0.09	<0.05	<1	<1	<1	11.9	12.0	12.9
Clifton Farm Spring	0.11	0.12	<0.05	<1	<1	2.0	12.4	12.5	12.6
Lockes Mill Spring	0.12	0.1	<0.05	<1	<1	12.2	12.2	12.3	12.4
Salem Church	0.11	0.12	<0.05	1.0	1	14.8	12.6	12.6	12.9
Toms Brook Spring	0.07	<0.05	<0.05	6.3	71.1	46.4	12.9	13.1	13.3
Yager Spring	0.09	0.06	<0.05	4.1	4.1	32.7	12.2	11.9	12.4
Fadeley Spring	0.07	<0.05	<0.05	5.2	5.2	12.2	13.1	13.4	13.2
McKay Spring	0.05	0.09	<0.05	5.2	14.1	47.1	13.3	13.2	13.5

	NITRATE mg/L			FLOW cubic feet per second			Nitrogen Yield pounds per day as N		
	25-Feb	22-Apr	24-Jun	25-Feb	22-Apr	24-Jun	25-Feb	22-Apr	24-Jun
Federal Hill Spring	6.57	6.74	6.72	0.85	0.91	1.34	30	33	49
Carter Hall Spring	3.55	3.55	3.42	4.7	6.21	8.4	90	119	155
Montana Hall Spring	10.31	10.96	10.95	0.09	0.04	0.2	5	2	12
Clifton Farm Spring	5.77	5.11	5.58	0.49	0.22	0.36	15	6	11
Lockes Mill Spring	3.05	2.98	2.85	1.83	2.28	2.92	30	37	45
Salem Church	1.89	1.99	1.81	1.29	1.54	1.47	13	17	34
Toms Brook Spring	3.46	3.08	3.29	0.85	1.44	1.32	16	24	23
Yager Spring	1.99	1.58	1.52	8.45	9.74	8.74	90	83	72
Fadeley Spring	3.02	2.99	2.86	2.23	3.96	3.96	36	64	61
McKay Spring	2.89	2.58	2.25	2.71	3.4	3.47	42	47	42

SPRINGS

NEAR BIOSOLIDS

HIGHER IN NITRATE

LOWER IN BACTERIA

LITTLE DIFFERENCE IN P

APPLICATION TO CHESAPEAKE BAY TMDL

YOU CAN HELP

REDUCE NITROGEN

LIMIT NITROGEN APPLICATIONS

MAINTAIN VEGETATIVE COVER

YOU CAN HELP

REDUCE PHOSPHORUS

MAINTAIN VEGETATIVE COVER

LIMIT PHOSPHORUS APPLICATIONS

CONTROLLING OVERLAND RUN OFF IS OF LIMITED VALUE IN STOPPING NITROGEN EXPORT