Phase 6 Chesapeake Bay Watershed Model – Final Calibration

Modeling Workgroup Conference Call – November 2017

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Presentation outline

- Review of final re-calibration
- State-basin summary of loads

Final re-calibration

- A detailed presentation on the updates included in the final re-calibration was made in the October modeling workgroup quarterly meeting [1].

- The updates include:
  - Partnership review comments for both inputs and model.
  - USGS-SPARROW Nitrogen land to water delivery variance factors were excluded.
  - Flow weighted observations were used.
  - Chesapeake floodplain network (CFN) observations (not regressions) were used for estimating stream loads.
  - Organic scour processes were added.

- The post auto-calibration phase included further refinements of the model performance, calibration of time-variable Conowingo infill, and parametrization of ungaged river segments.

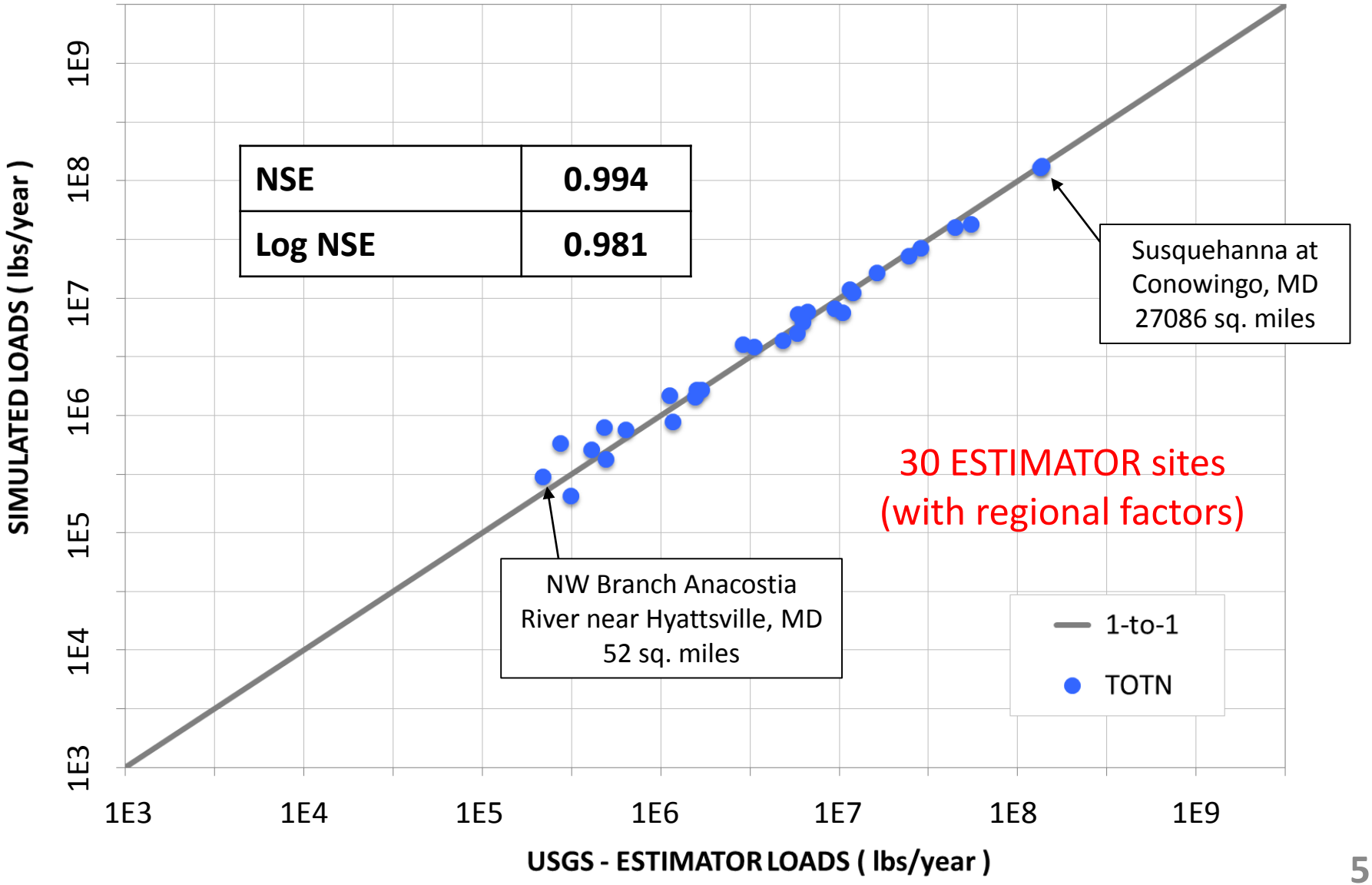
[1] https://www.chesapeakebay.net/channel_files/24721/20171017_-_bhatt_-_cbp_-_october_recalibraion_2.pdf

Model performance across spatial scales

average annual loads at WRTDS sites

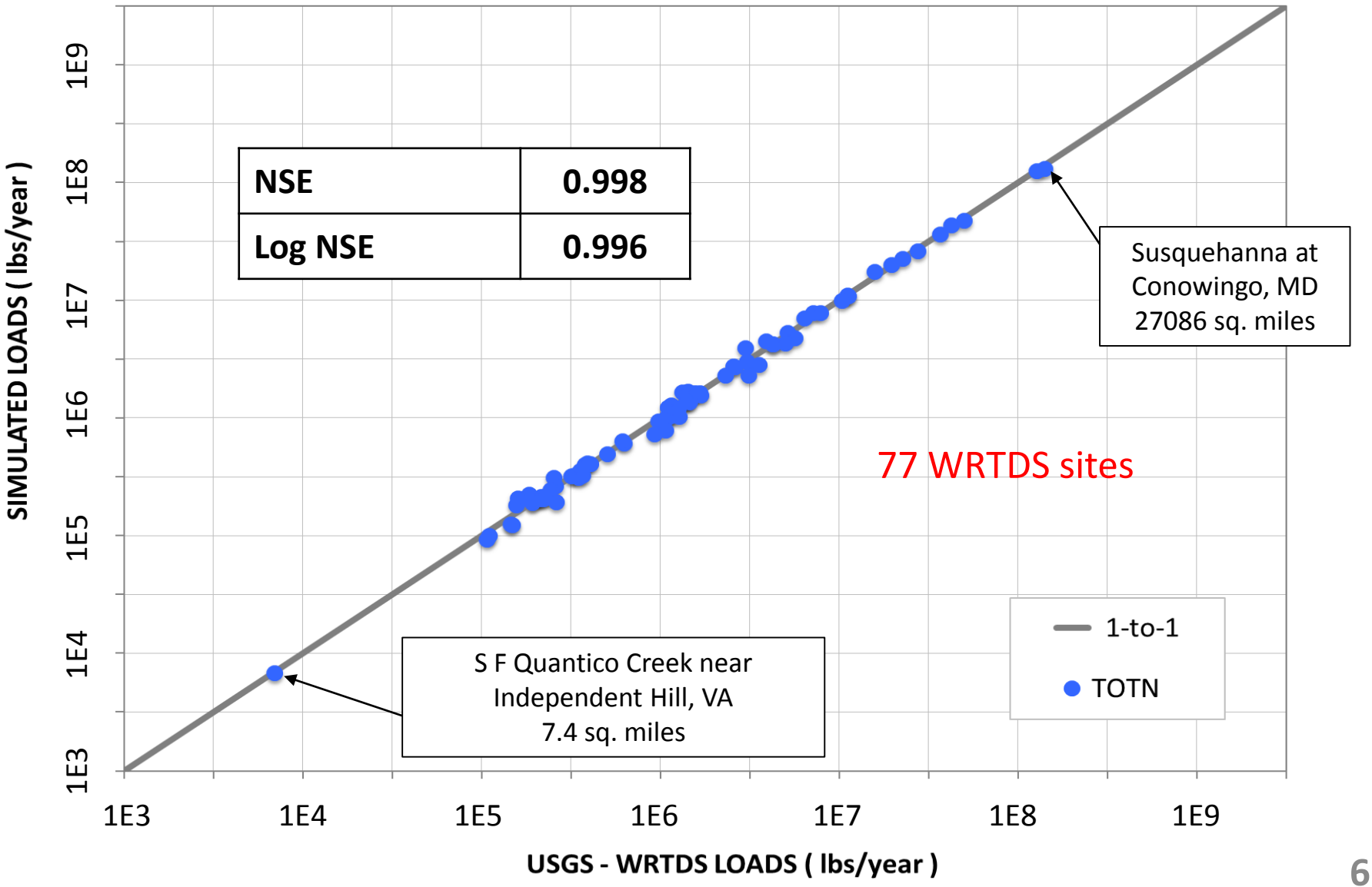
PHASE 5

NITROGEN



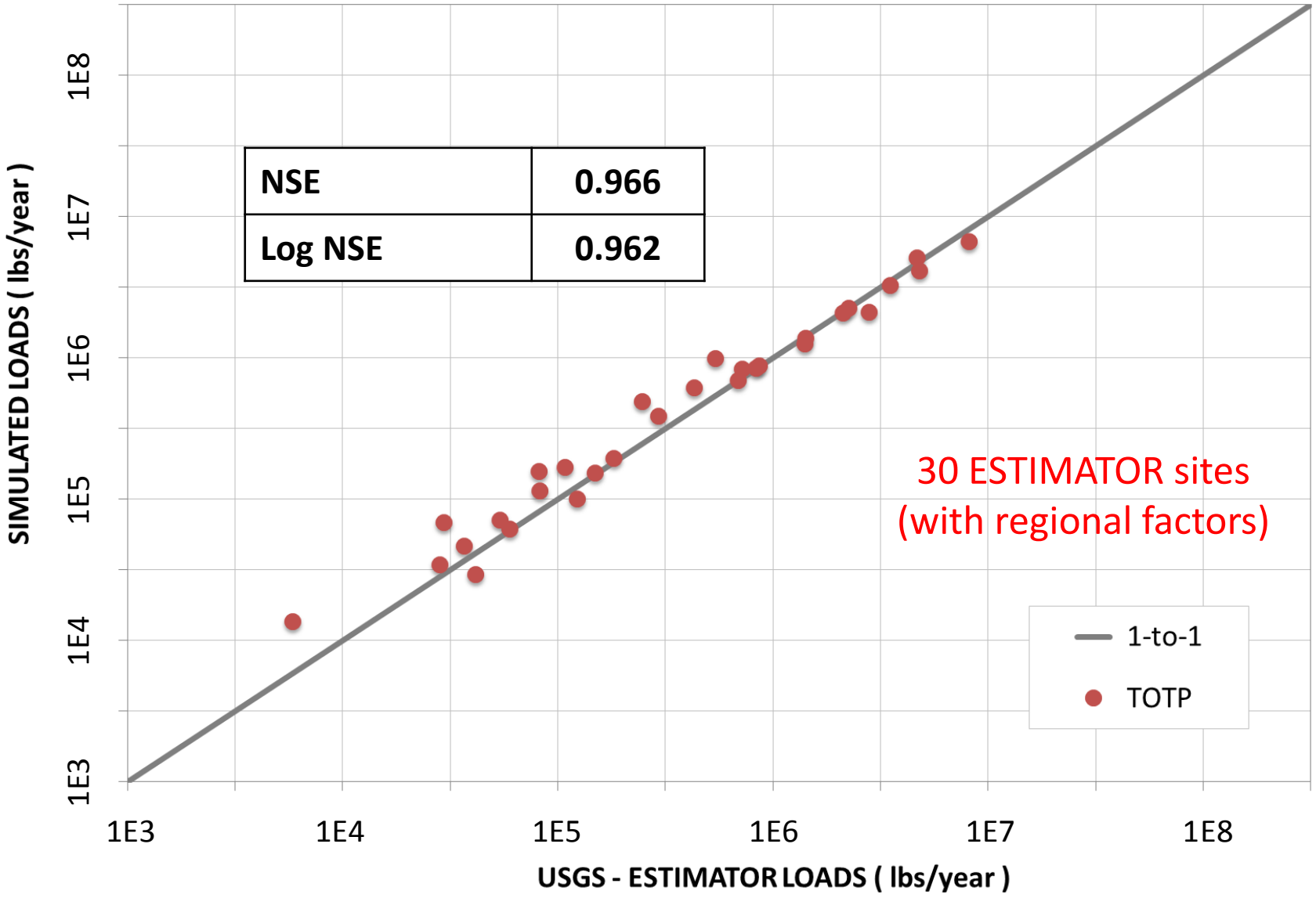
PHASE 6

NITROGEN



PHASE 5

PHOSPHORUS



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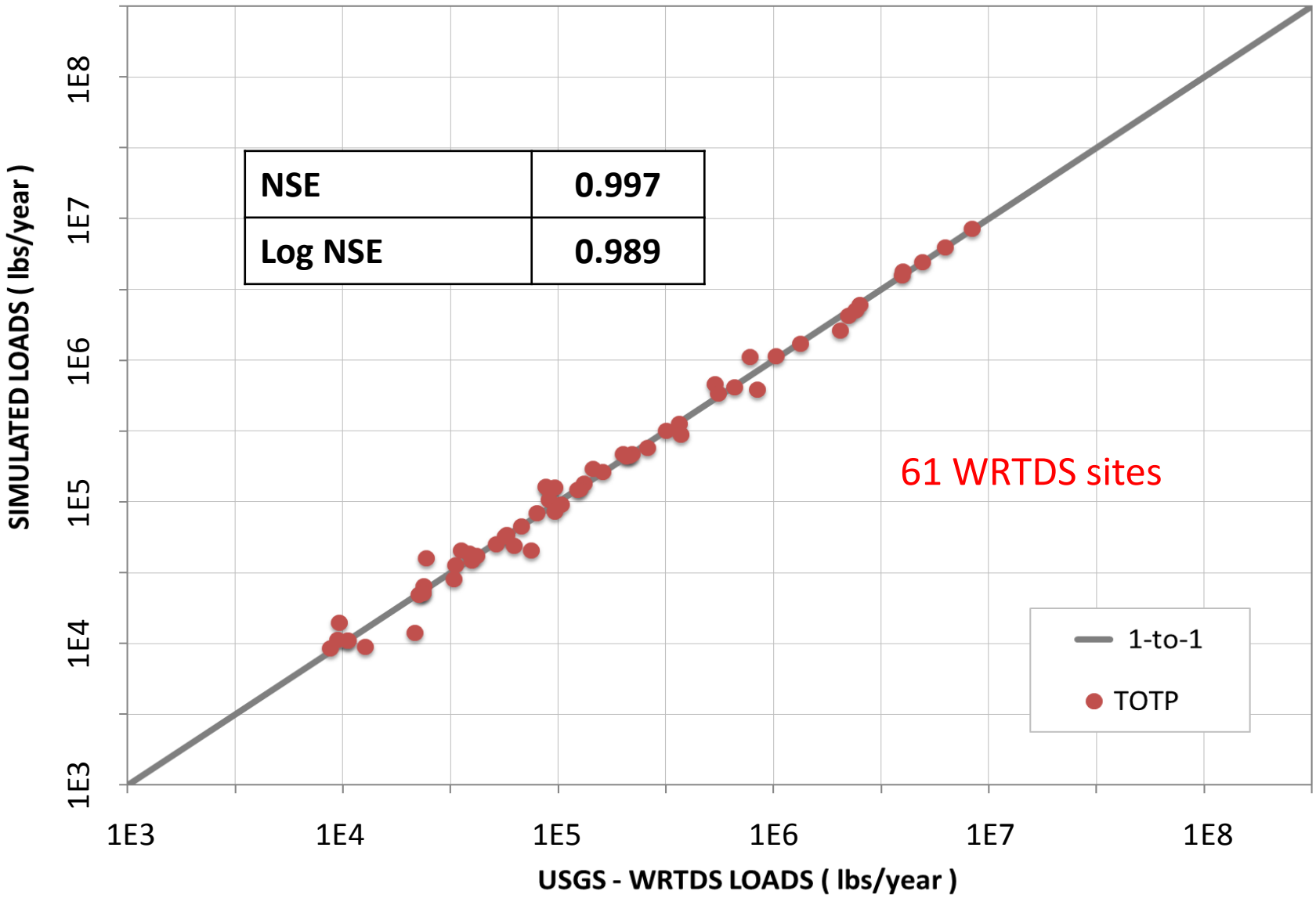
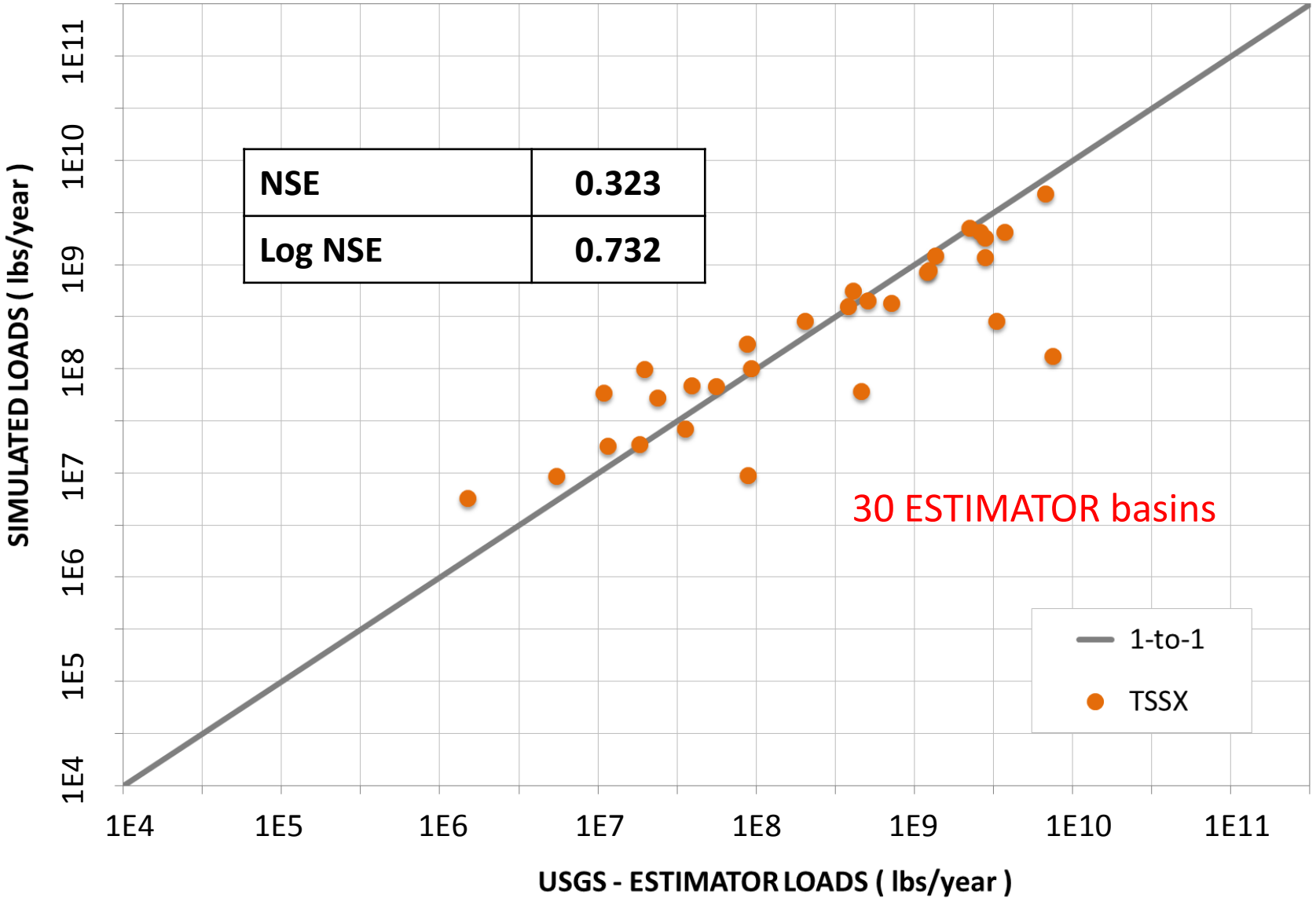


PHASE 5

SEDIMENT



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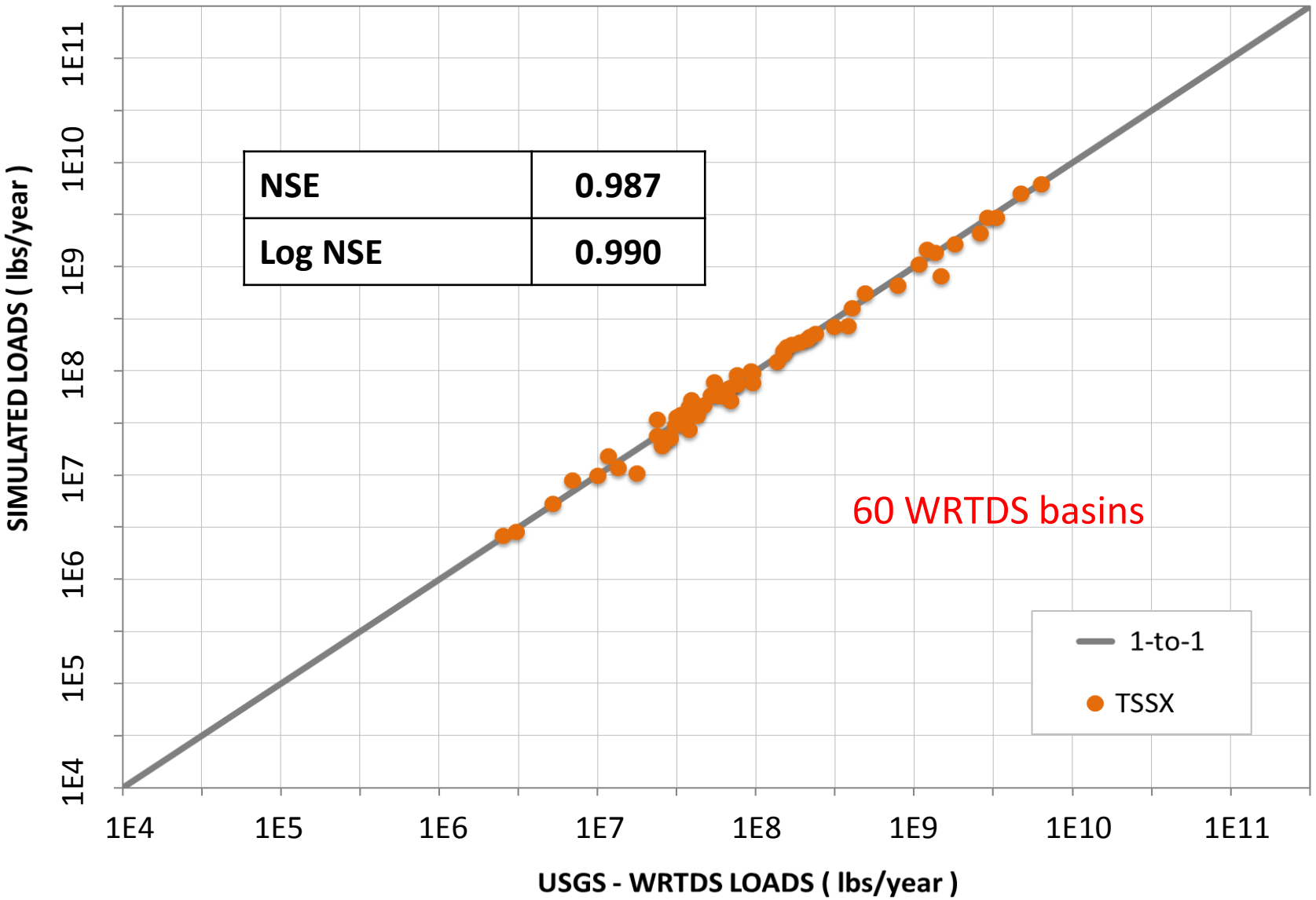
SEDIMENT



Model performance in resolving heterogeneity

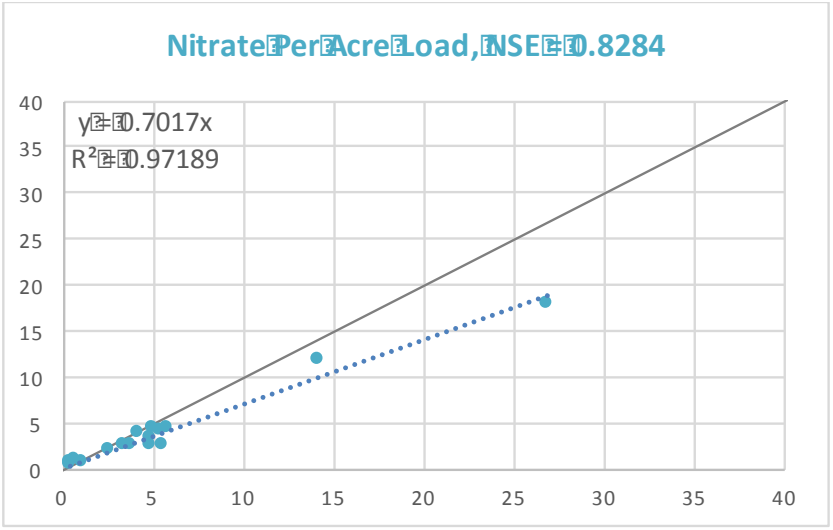
average annual per acre loads at WRTDS sites

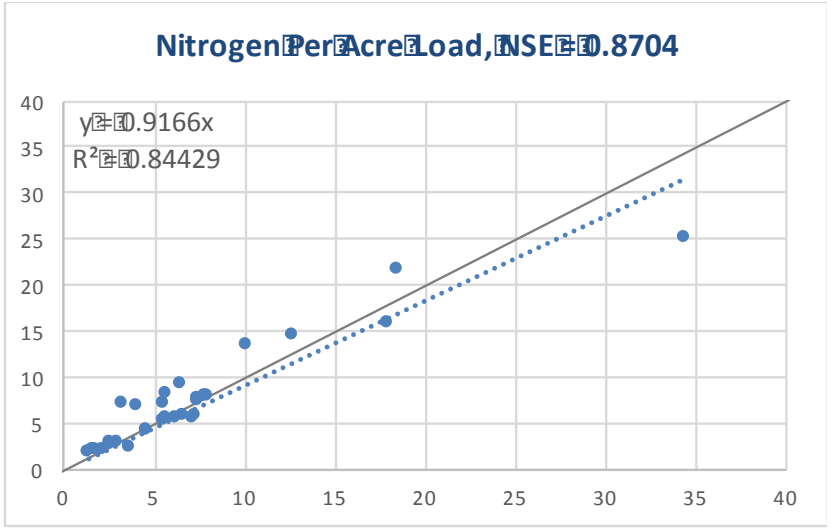
Review of geographic efficiencies

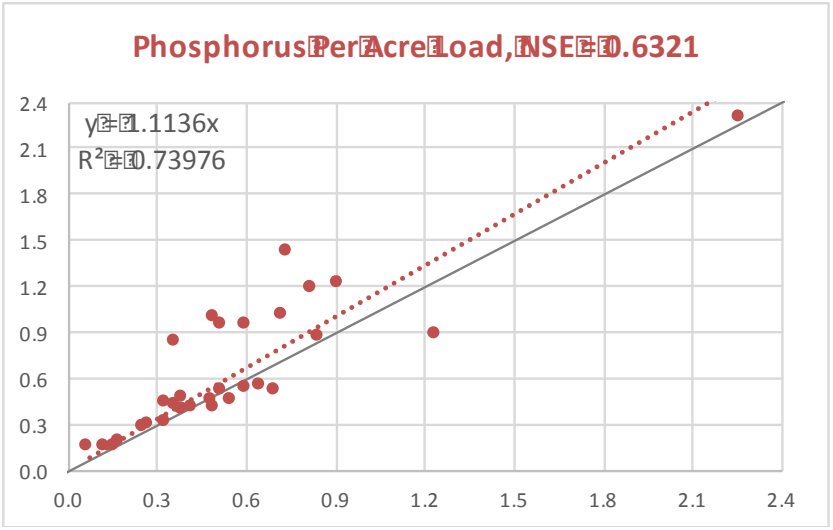
- WRTDS and simulated per acre loads are compared.
- Nash-Sutcliffe model efficiency was used to quantify the predictive power of the model across the watershed.
- An efficiency of 1 would indicate a perfect match in loads for all river basins (where WRTDS estimates are available).

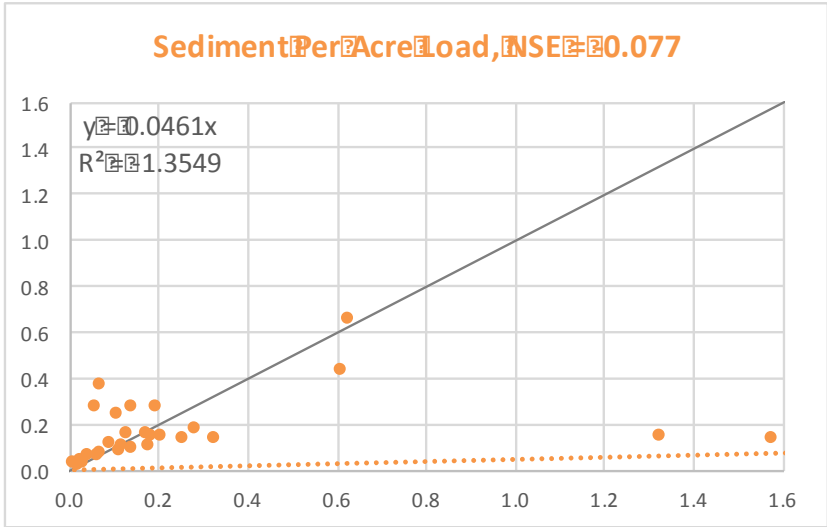
Higher NSE indicates better model performance.

Phase 5 – geographic efficiencies





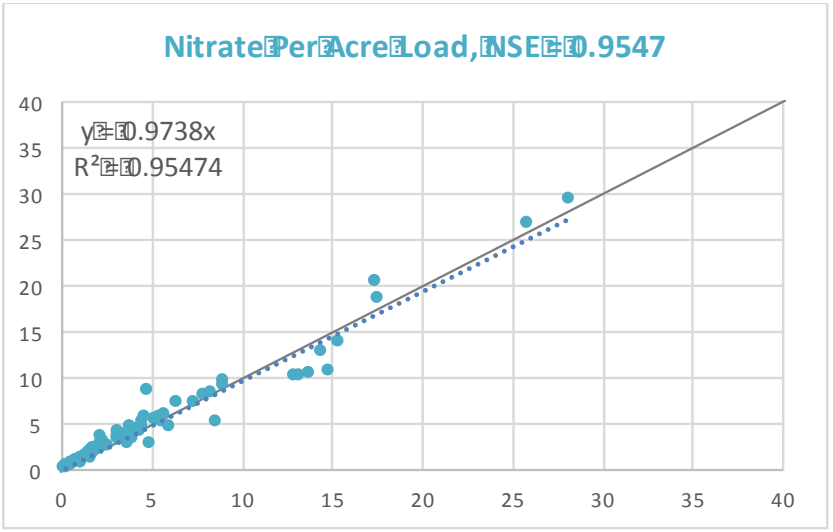


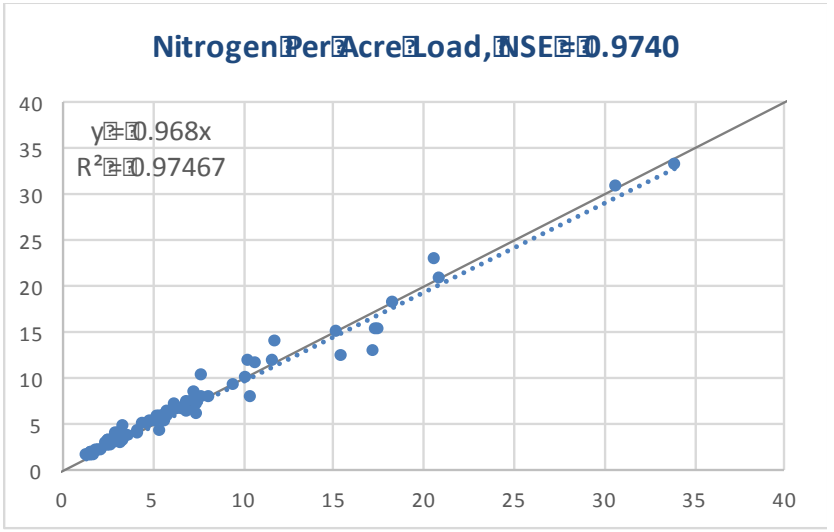


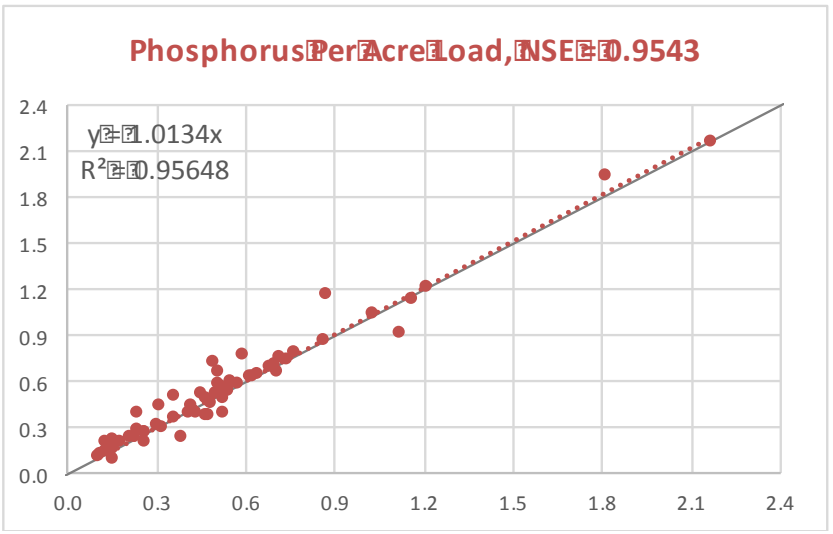
Simulated Per Acre Load

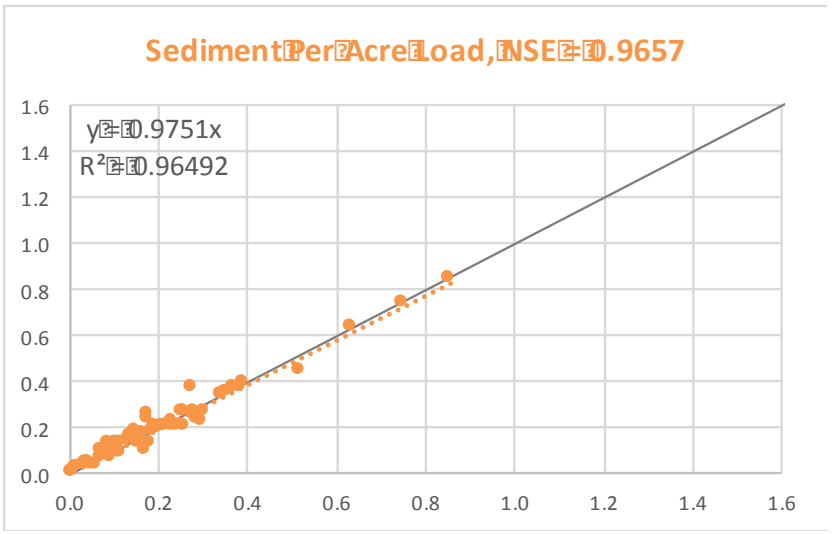
WRTDS Per Acre Load

Phase 6 – geographic efficiencies









Simulated Per Acre Load

WRTDS Per Acre Load

Higher NSE indicates better model performance.

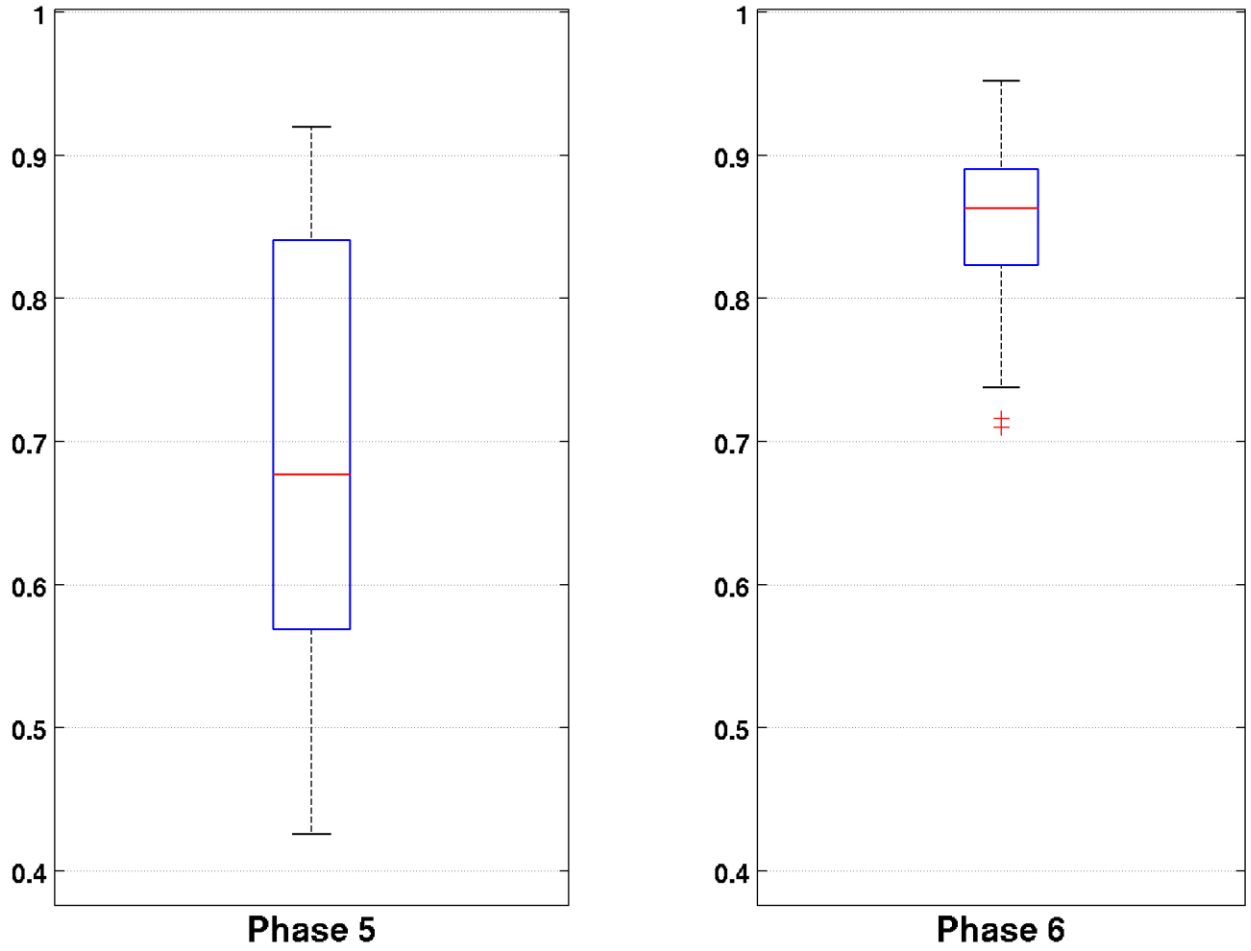
Summary of geographic efficiencies

Constituents	**Phase 5**	**Phase 6**
Nitrate	0.8284	**0.9547**
Nitrogen	0.8704	**0.9747**
Phosphorus	0.6321	**0.9565**
Sediment	-0.0770	**0.9649**

Temporal/seasonal model performance

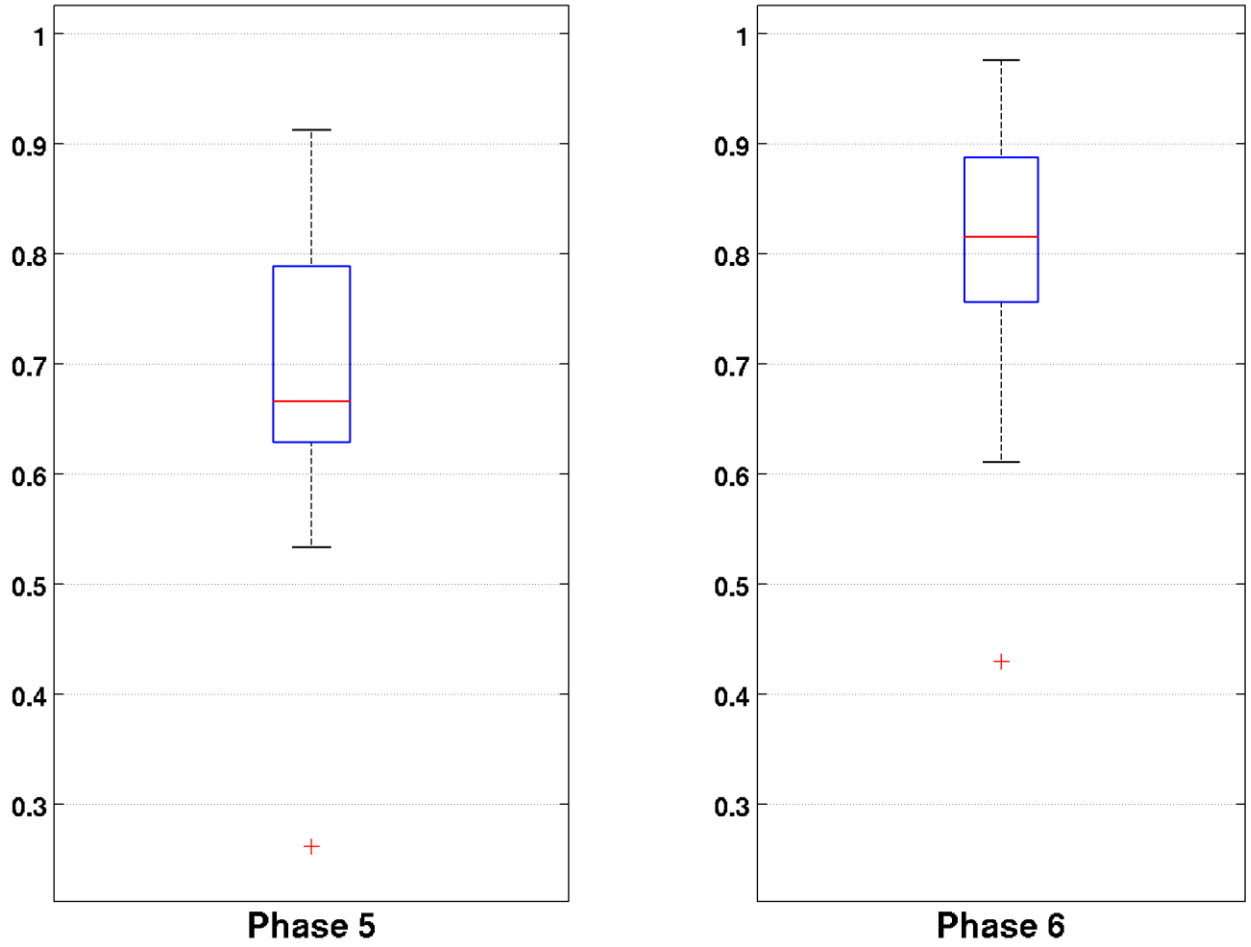
the correlation of simulated and WRTDS monthly loads

Correlation of monthly loads: total nitrogen



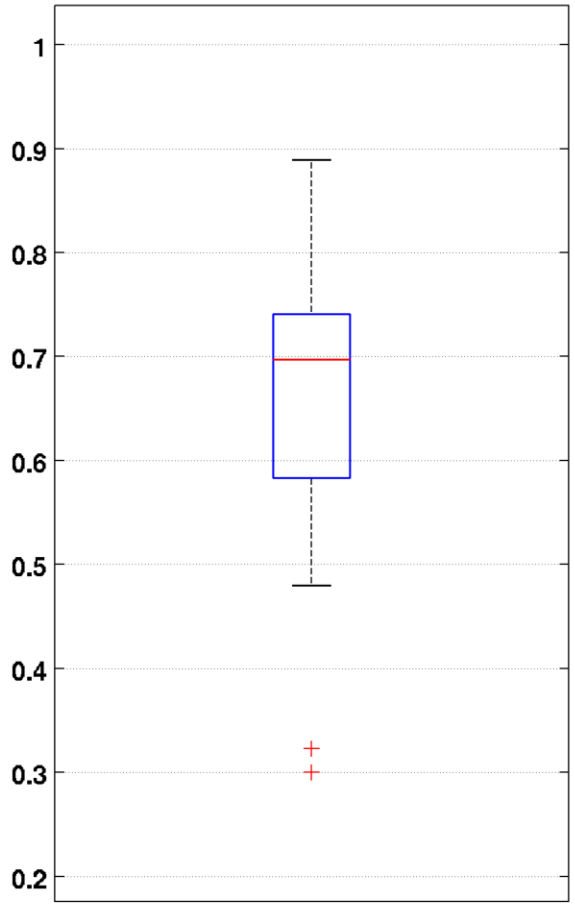
Higher correlation coefficient indicates better model performance.

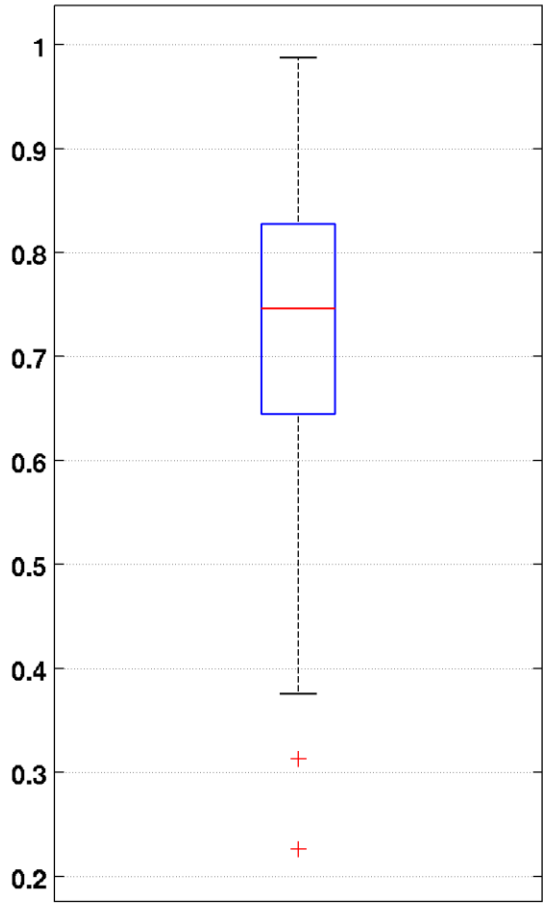
Correlation of monthly loads: total phosphorus



Higher correlation coefficient indicates better model performance.

Correlation of monthly loads: sediment



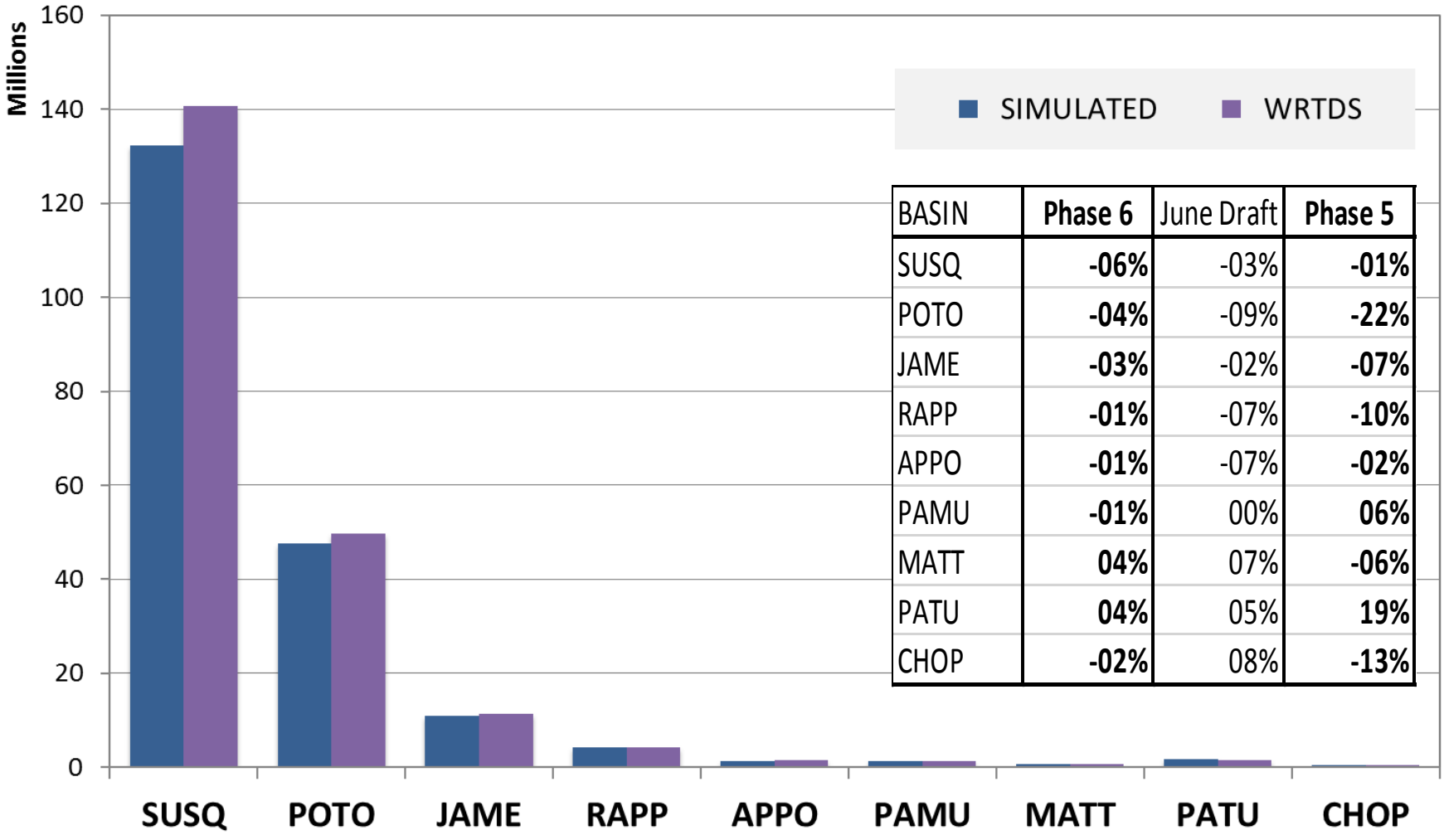


Higher correlation coefficient indicates better model performance.

Model performance in loading estuarine model

average annual loads at RIM sites

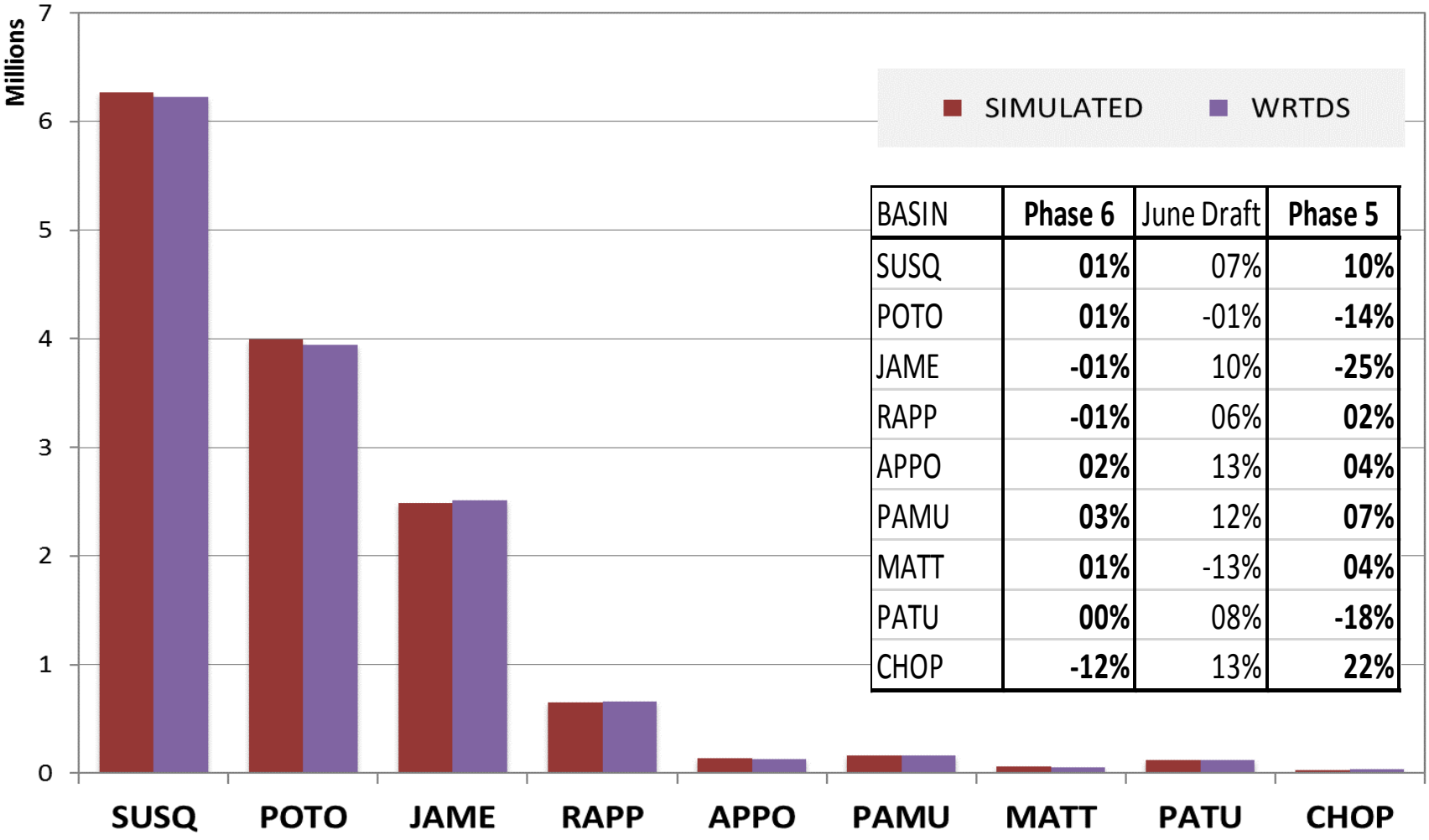
RIM loads: total nitrogen



BASIN	Phase 6	June Draft	Phase 5
SUSQ	**-06%**	-03%	**-01%**
POTO	**-04%**	-09%	**-22%**
JAME	**-03%**	-02%	**-07%**
RAPP	**-01%**	-07%	**-10%**
APPO	**-01%**	-07%	**-02%**
PAMU	**-01%**	00%	**06%**
MATT	**04%**	07%	**-06%**
PATU	**04%**	05%	**19%**
CHOP	**-02%**	08%	**-13%**

assuming +/- 10% uncertainty in WRTDS estimates

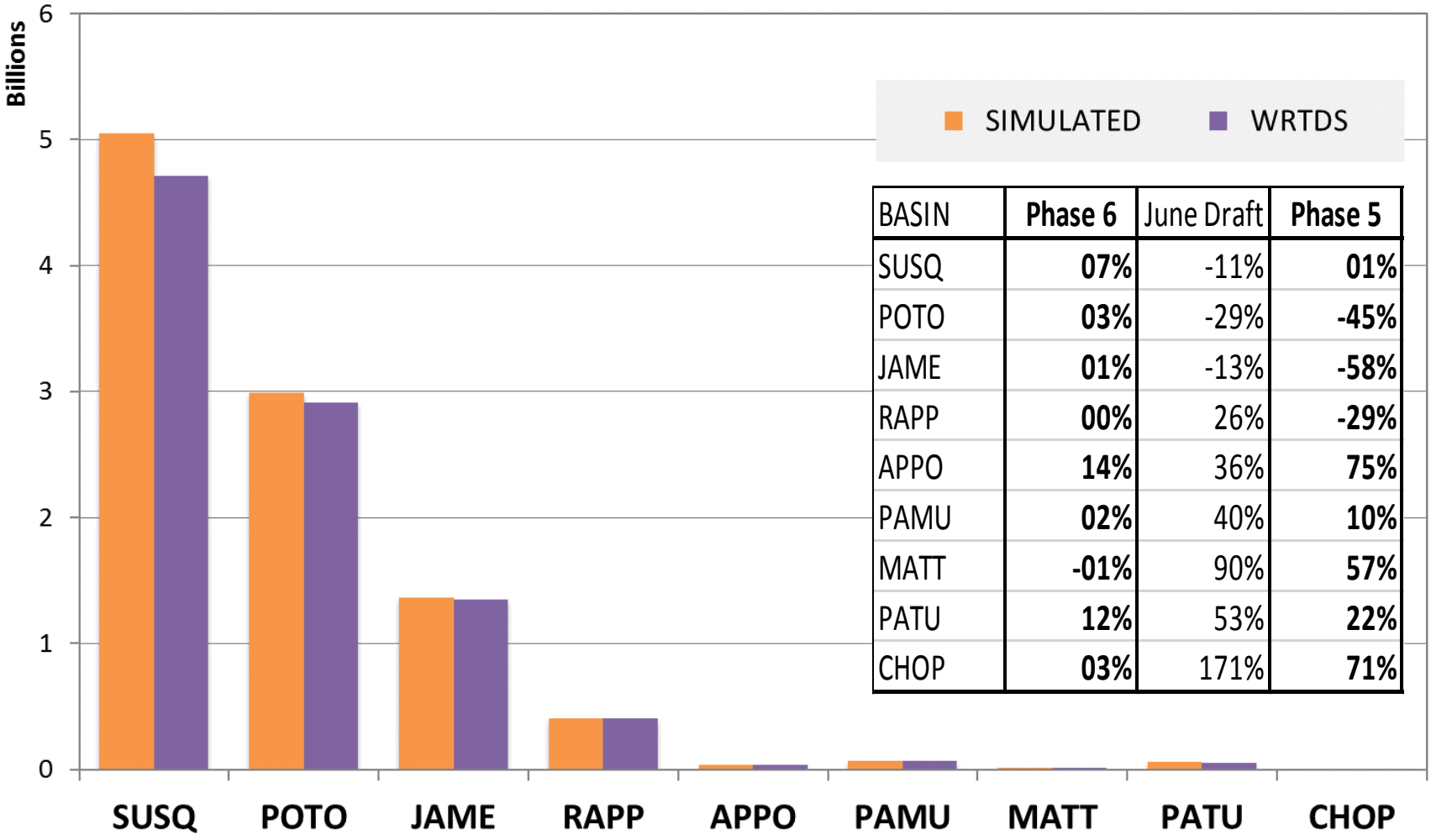
RIM loads: total phosphorus



BASIN	Phase 6	June Draft	Phase 5
SUSQ	**01%**	07%	**10%**
POTO	**01%**	-01%	**-14%**
JAME	**-01%**	10%	**-25%**
RAPP	**-01%**	06%	**02%**
APPO	**02%**	13%	**04%**
PAMU	**03%**	12%	**07%**
MATT	**01%**	-13%	**04%**
PATU	**00%**	08%	**-18%**
CHOP	**-12%**	13%	**22%**

assuming +/- 15% uncertainty in WRTDS estimates

RIM loads: sediment



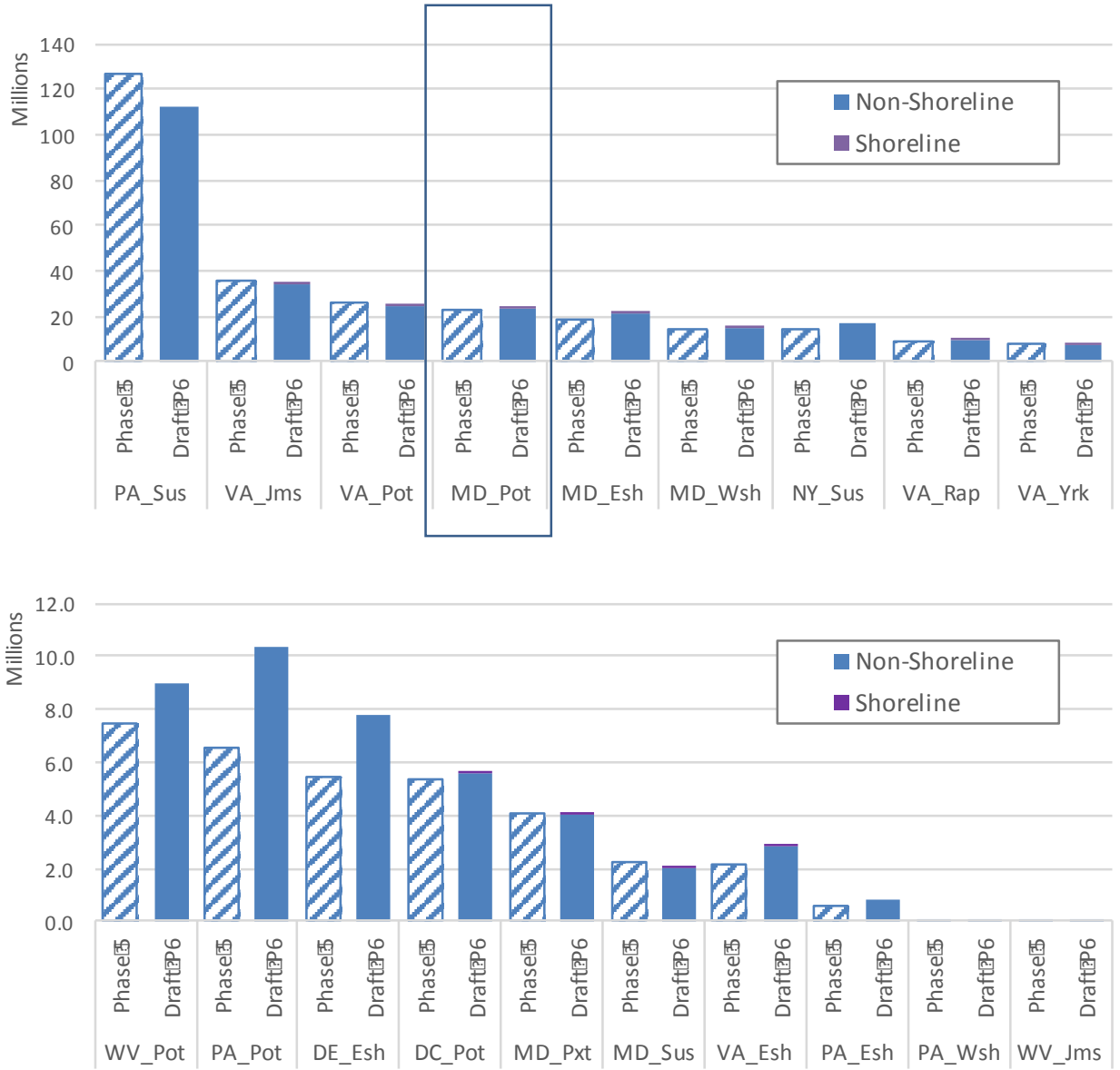
BASIN	Phase 6	June Draft	Phase 5
SUSQ	**07%**	-11%	**01%**
POTO	**03%**	-29%	**-45%**
JAME	**01%**	-13%	**-58%**
RAPP	**00%**	26%	**-29%**
APPO	**14%**	36%	**75%**
PAMU	**02%**	40%	**10%**
MATT	**-01%**	90%	**57%**
PATU	**12%**	53%	**22%**
CHOP	**03%**	171%	**71%**

State-basin loads:

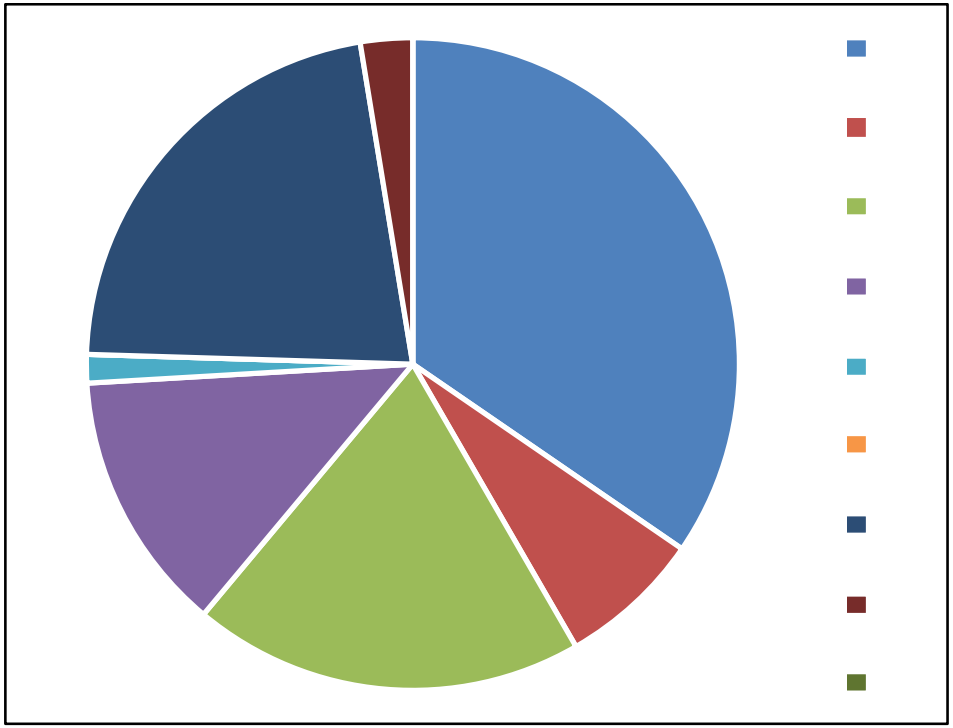
- Continued examination of **Phase 5** and **Phase 6** state-basin loads –

Calibration

NITROGEN

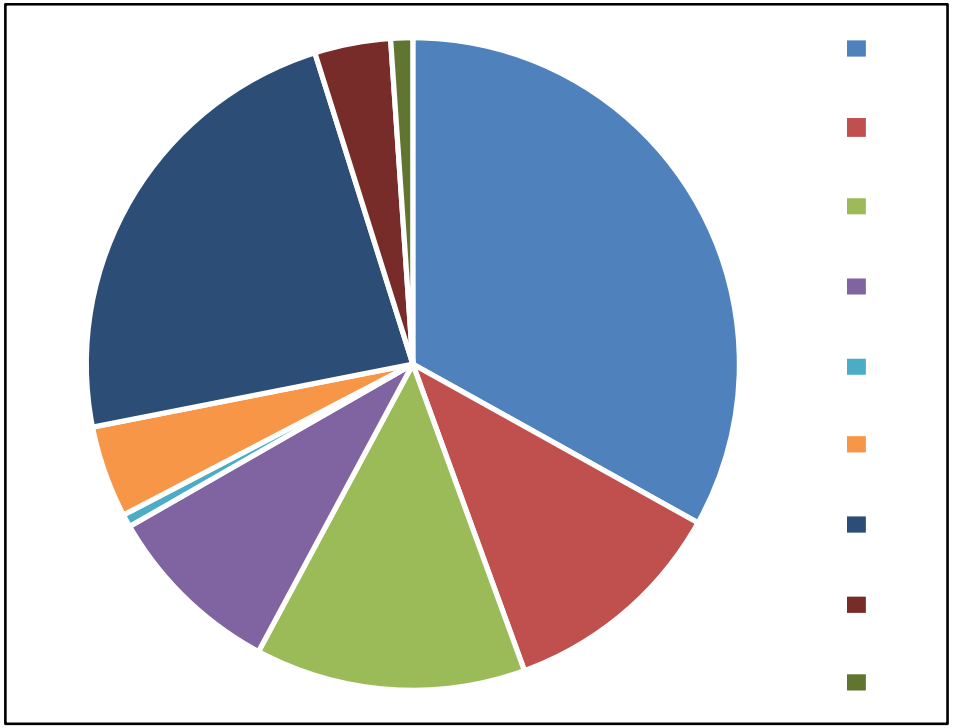


Phase 5: Nitrogen – MD Potomac



Crops	7,891,843	35%
Pasture & Hay	1,617,024	7%
Developed	4,428,629	19%
Natural	2,963,800	13%
Feeding Operations	322,456	1%
Stream Bank & Bed		0%
Wastewater	5,005,291	22%
Septic	690,507	3%
Shoreline		0%

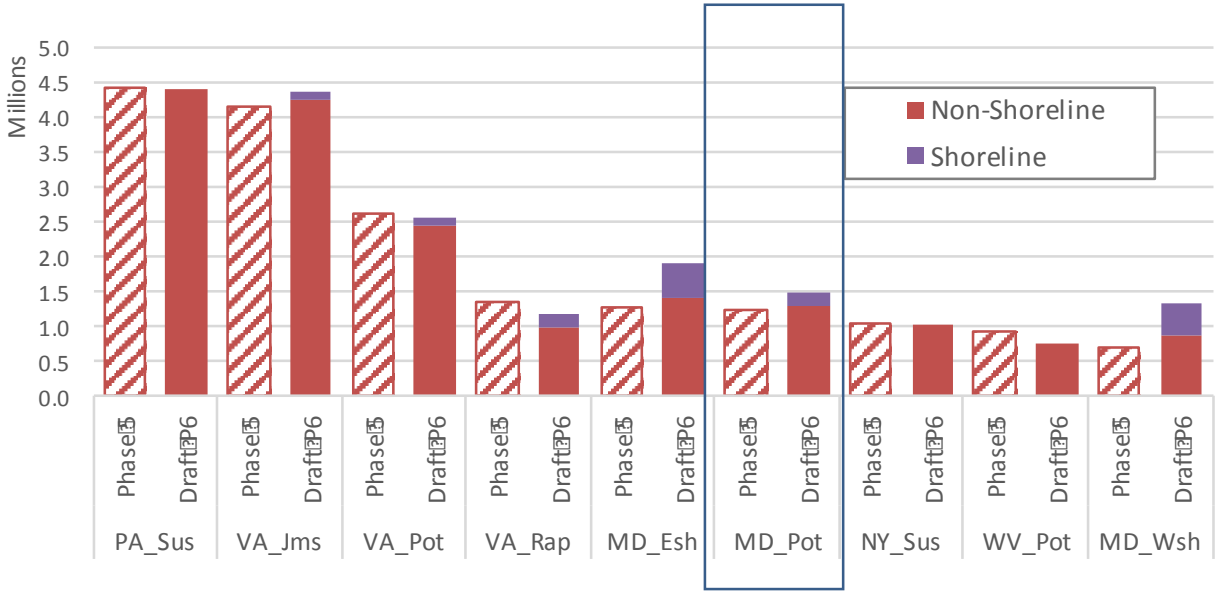
Phase 6: Nitrogen – MD Potomac

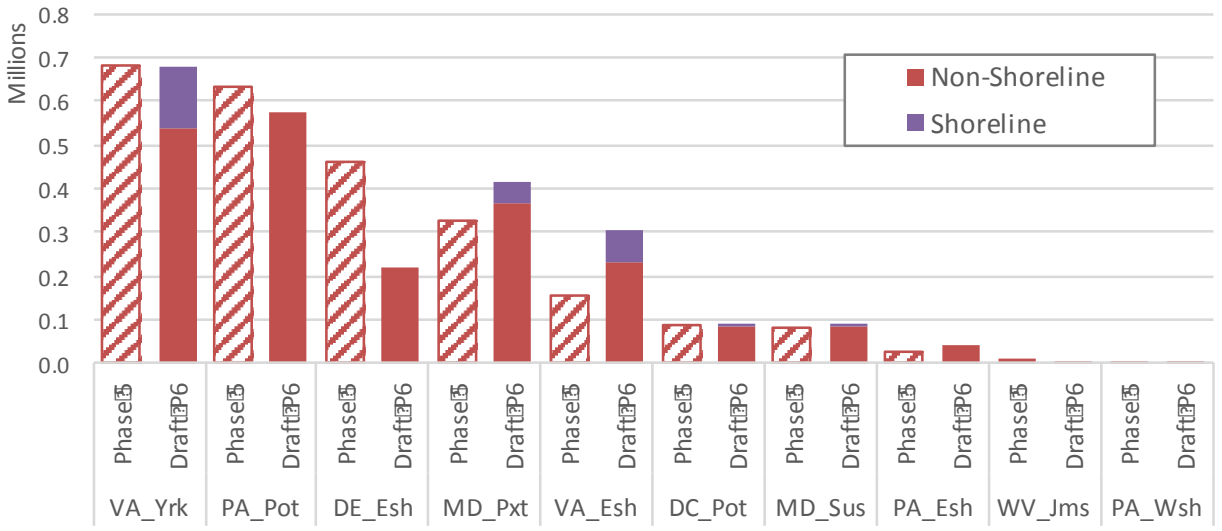


Crops	7,665,706	33%
Pasture & Hay	2,633,240	11%
Developed	3,100,516	13%
Natural	2,055,830	9%
Feeding Operations	147,861	1%
Stream Bank & Bed	1,055,551	5%
Wastewater	5,383,984	23%
Septic	872,502	4%
Shoreline	251,743	1%

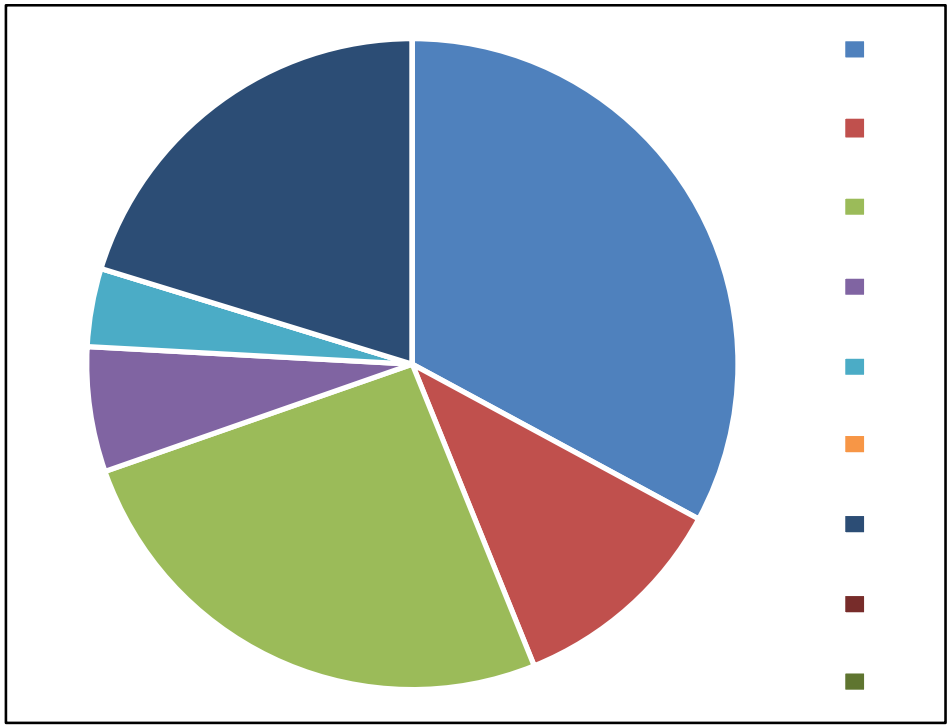
Calibration

PHOSPHORUS



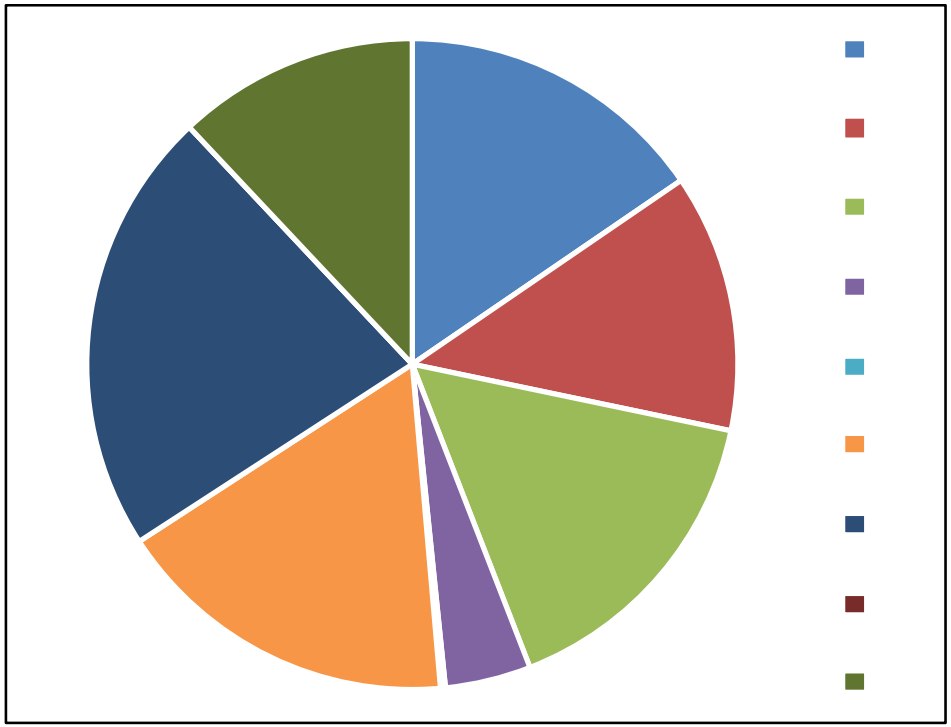


Phase 5: Phosphorus – MD Potomac



Crops	107,395	33%
Pasture & Hay	36,277	11%
Developed	18,930	26%
Natural	6,886	6%
Feeding Operations	8,178	4%
Stream Bank & Bed	2	0%
Wastewater	50,892	20%
Septic	2	0%
Shoreline	2	0%

Phase 6: Phosphorus – MD Potomac



Crops	28,915	15%
Pasture & Hay	89,994	13%
Developed	34,560	16%
Natural	63,084	4%
Feeding Operations	3,611	0%
Stream Bank & Bed	54,839	17%
Wastewater	28,175	22%
Septic		0%
Shoreline	77,957	12%

Summary and Conclusions

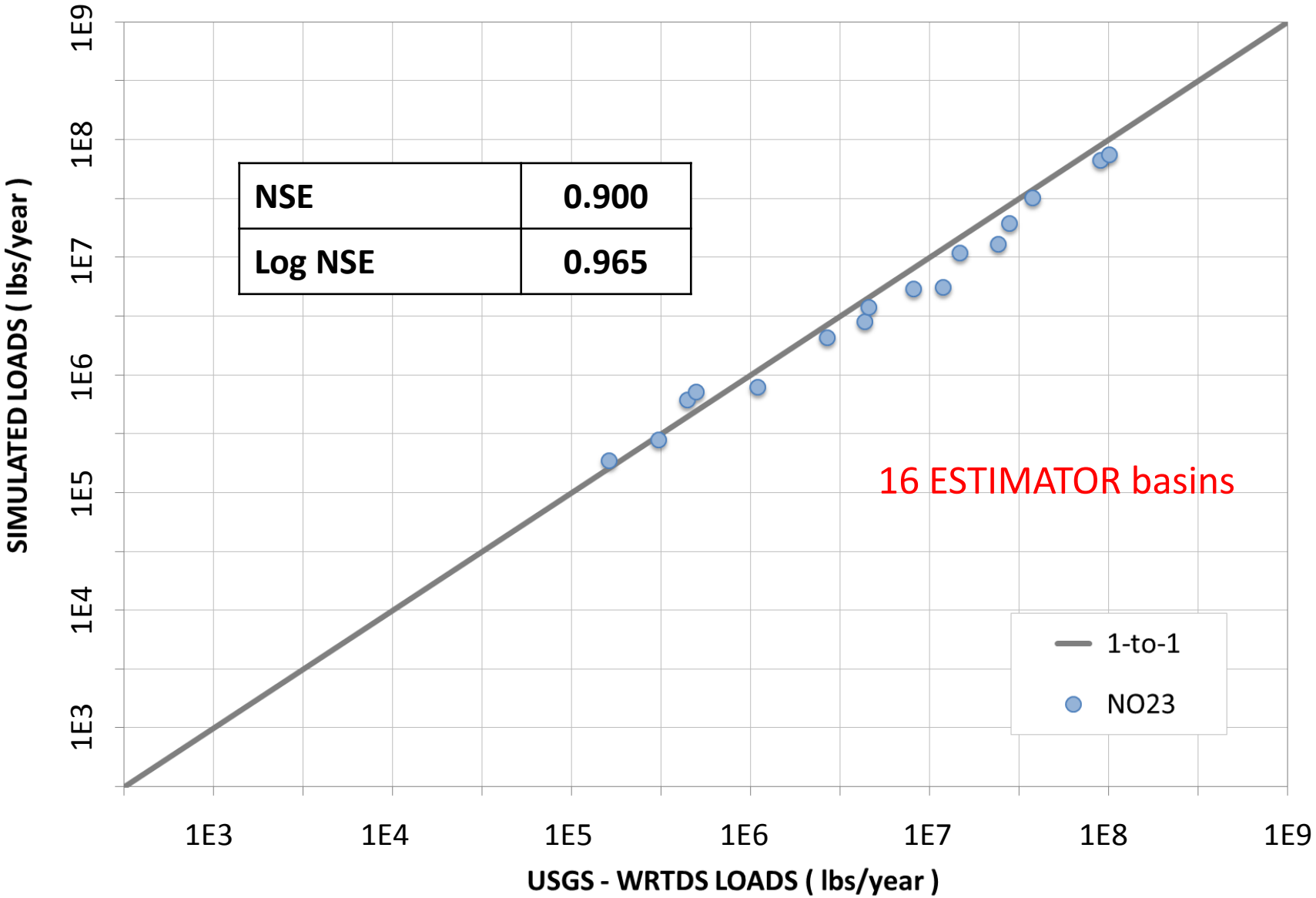
- Phase 6 Watershed Model was re-calibrated to incorporate final partnership inputs and review comments.
- The model performed quite well for several key performance evaluation metrics.
- The corresponding state-basin summary of loads were shown.
- Work is needed to document several aspects of model development, calibration, and its application.

- Calibration related information, such as calibration figures, comparison with WRTDS loads, are available at https://archive.chesapeakebay.net/Modeling/Phase6/Phase_6_201710/Watershed_Model/

Appendices

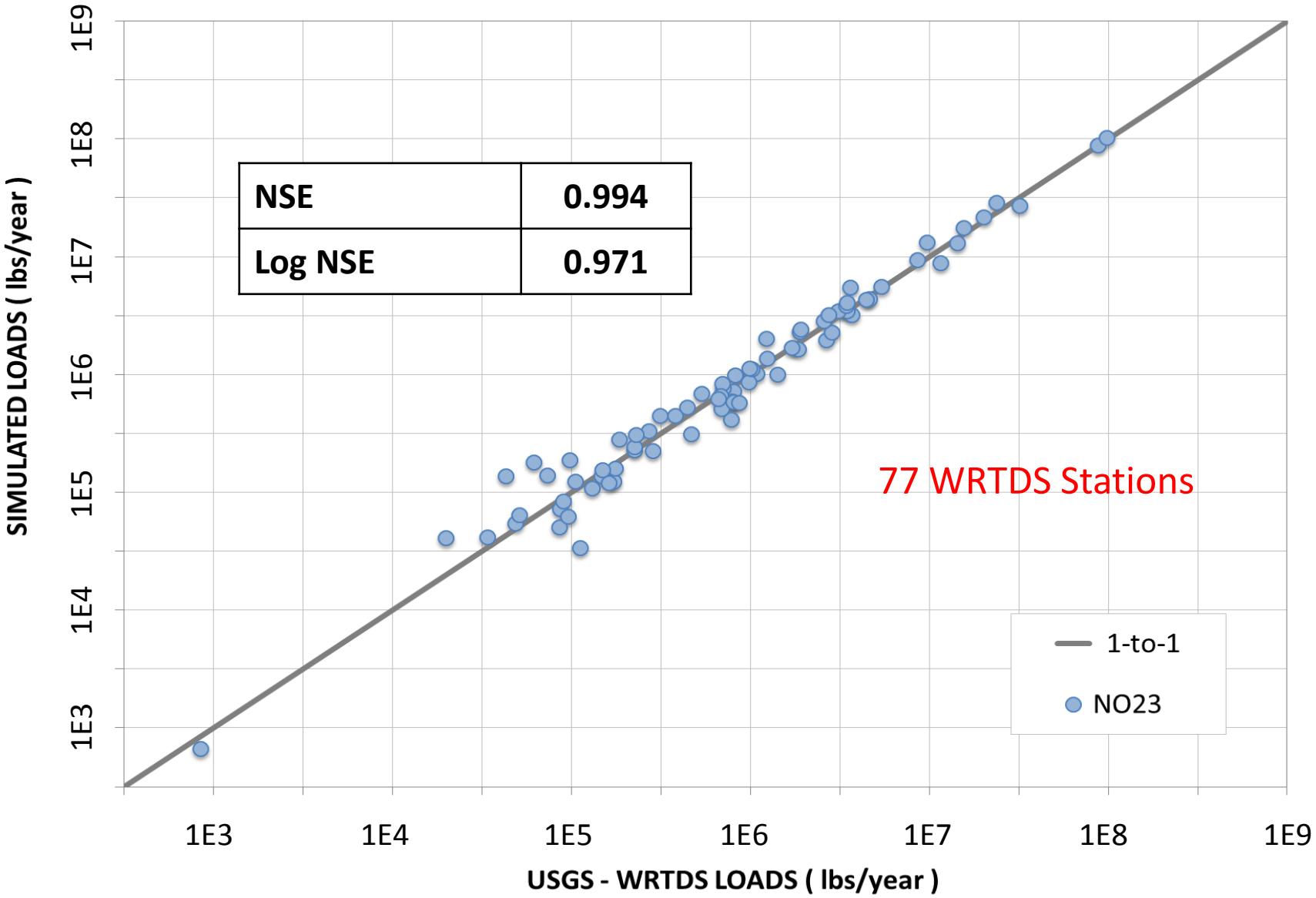
PHASE 5

NITRATE



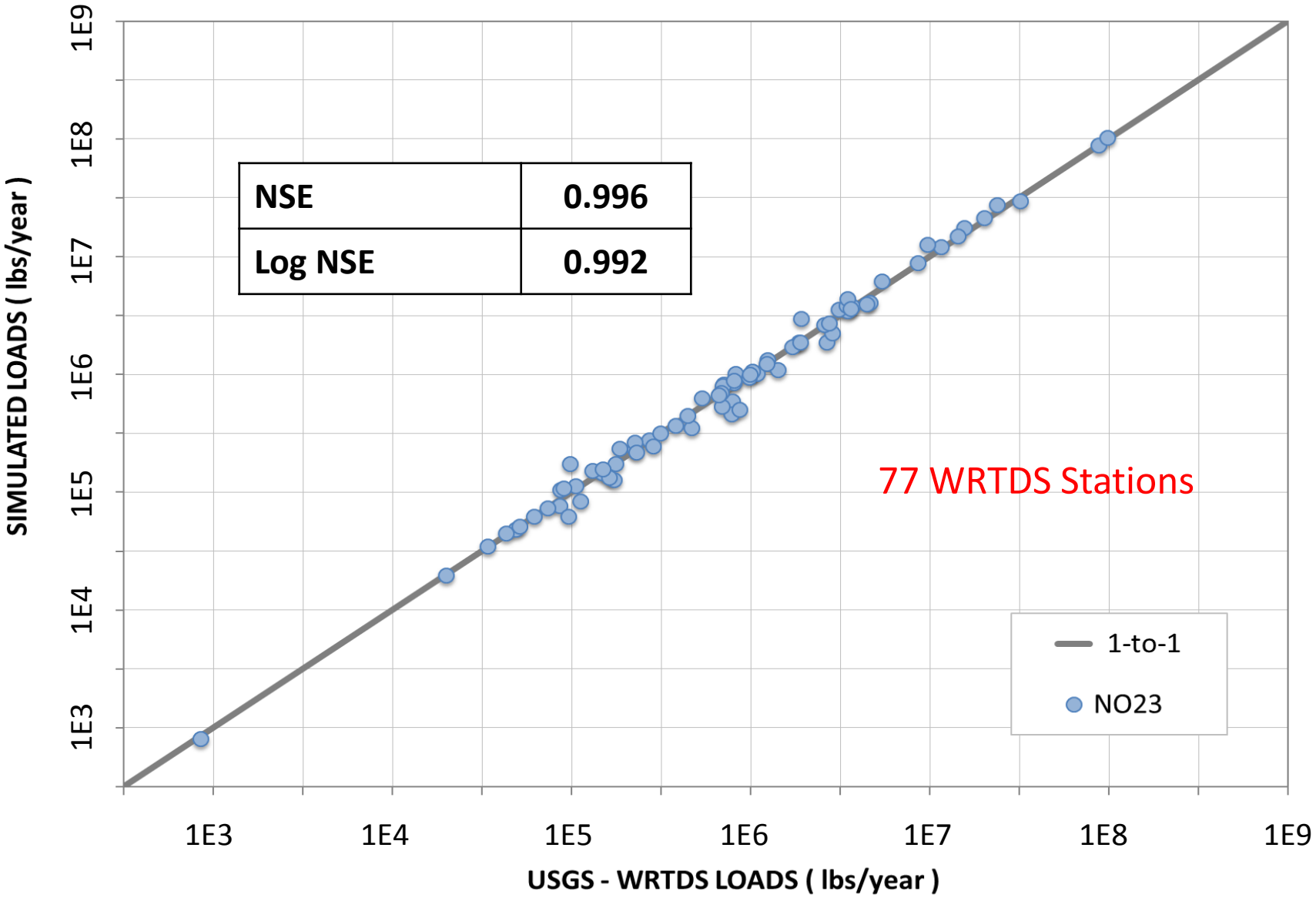
JUNE DRAFT

NITRATE



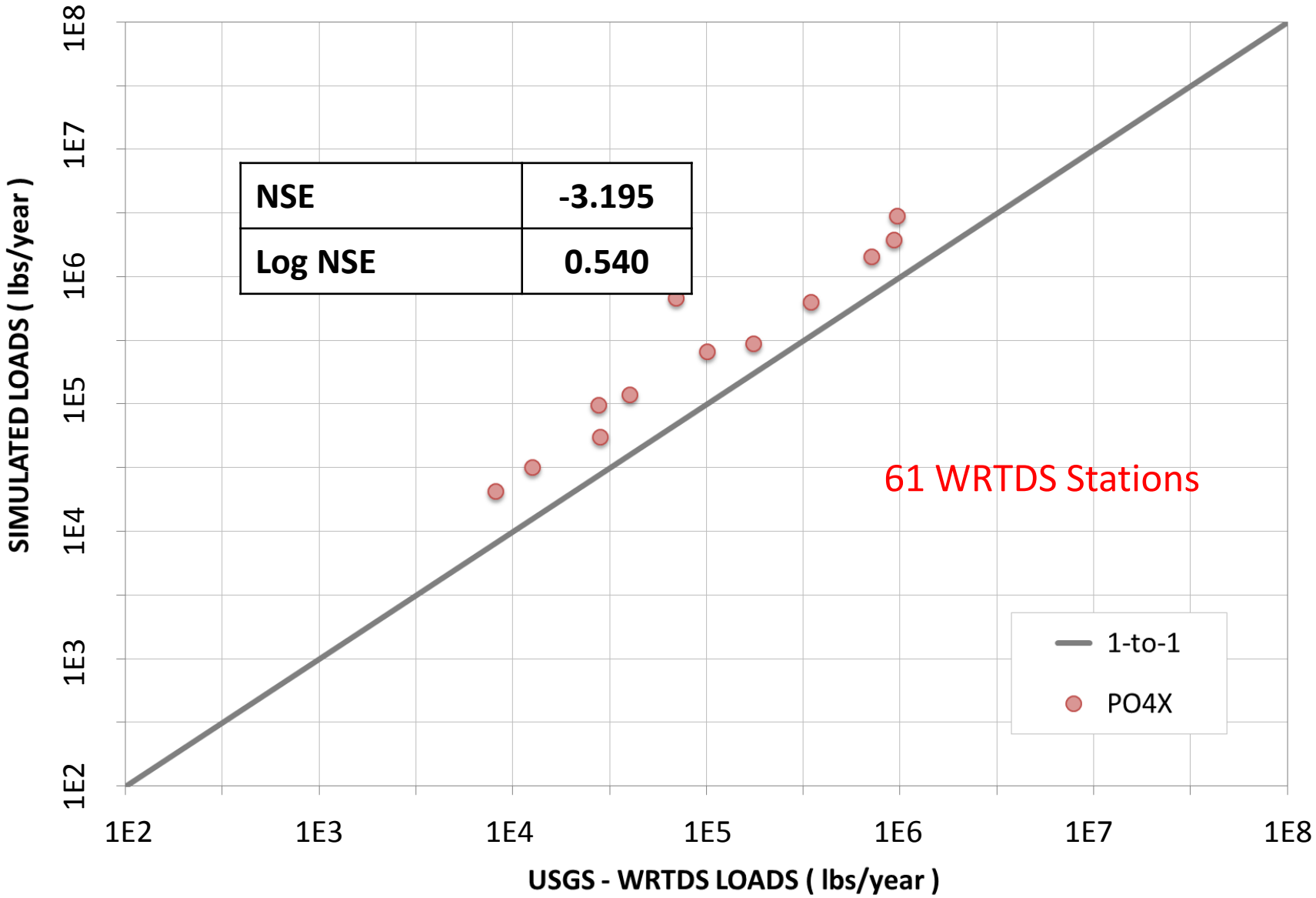
PHASE 6

NITRATE



PHASE 5

DISSOLVED PHOSPHATE



JUNE DRAFT

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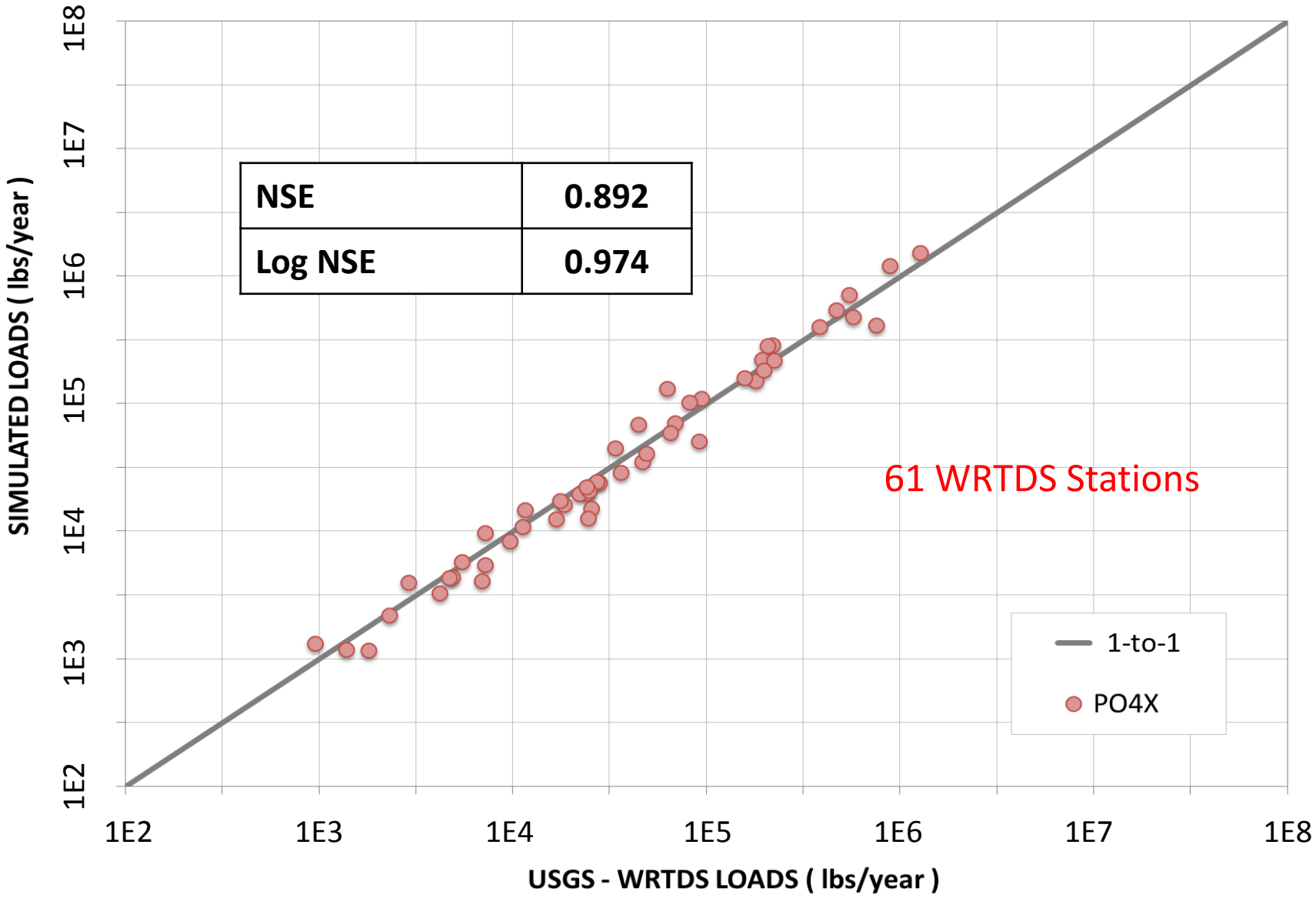

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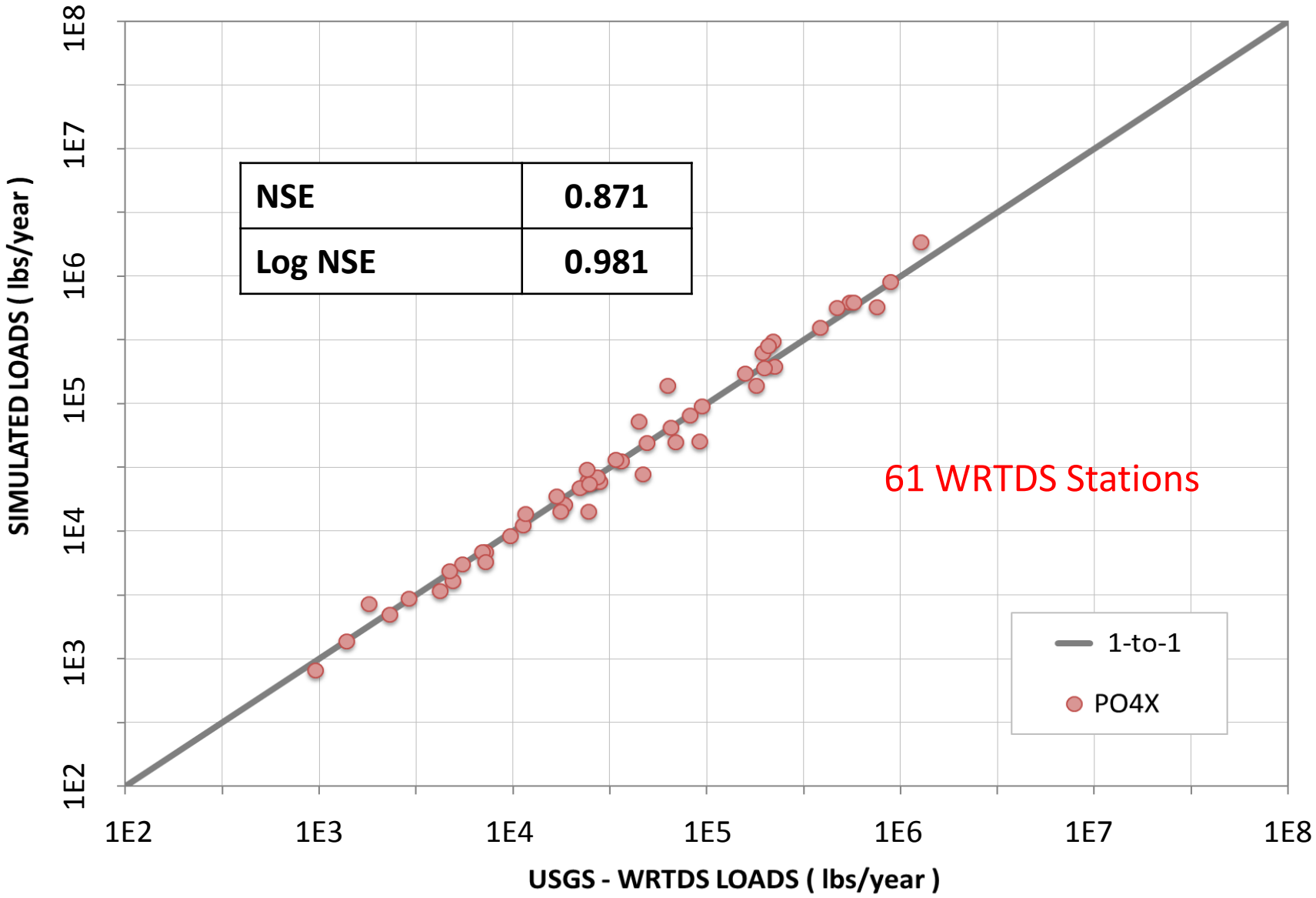
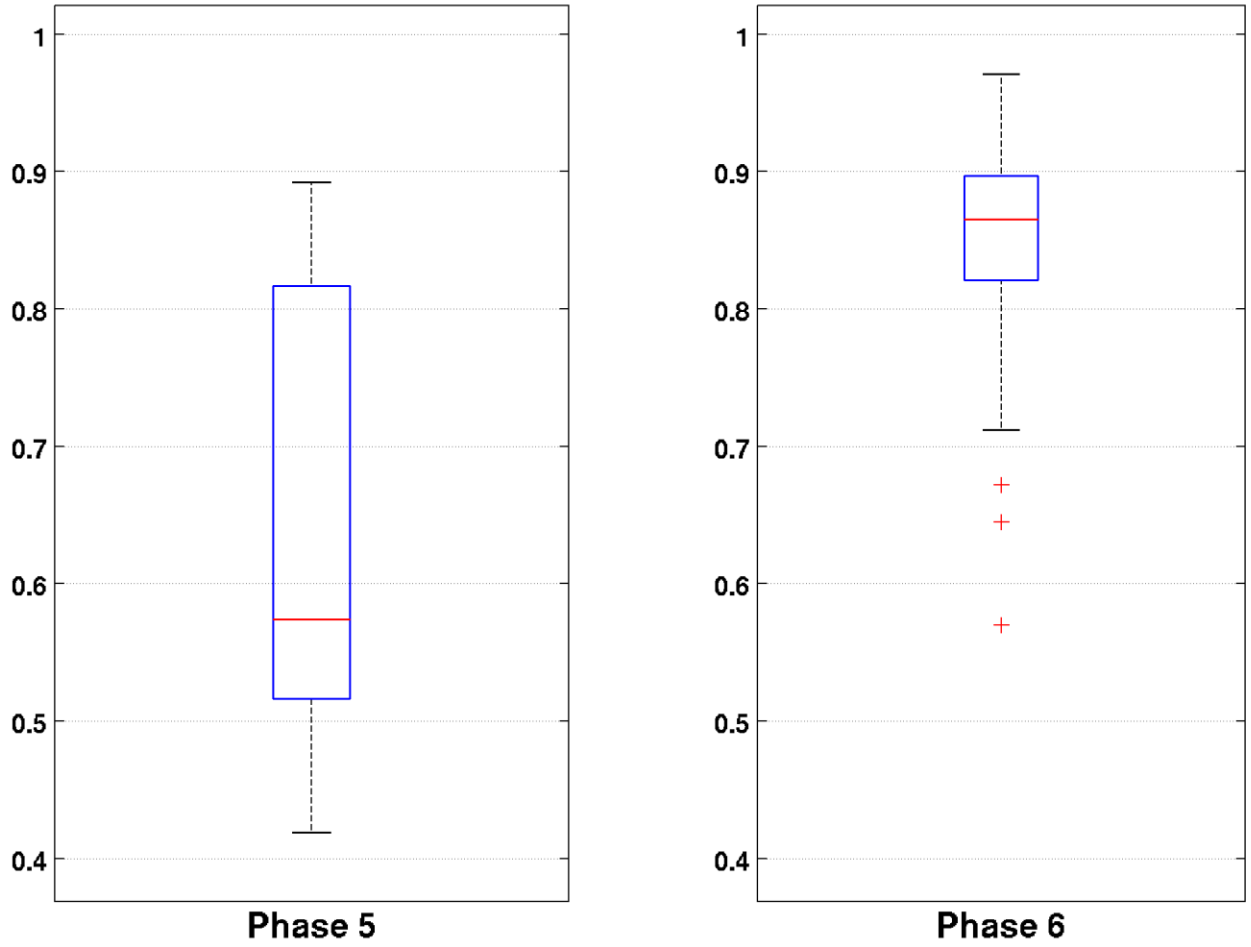
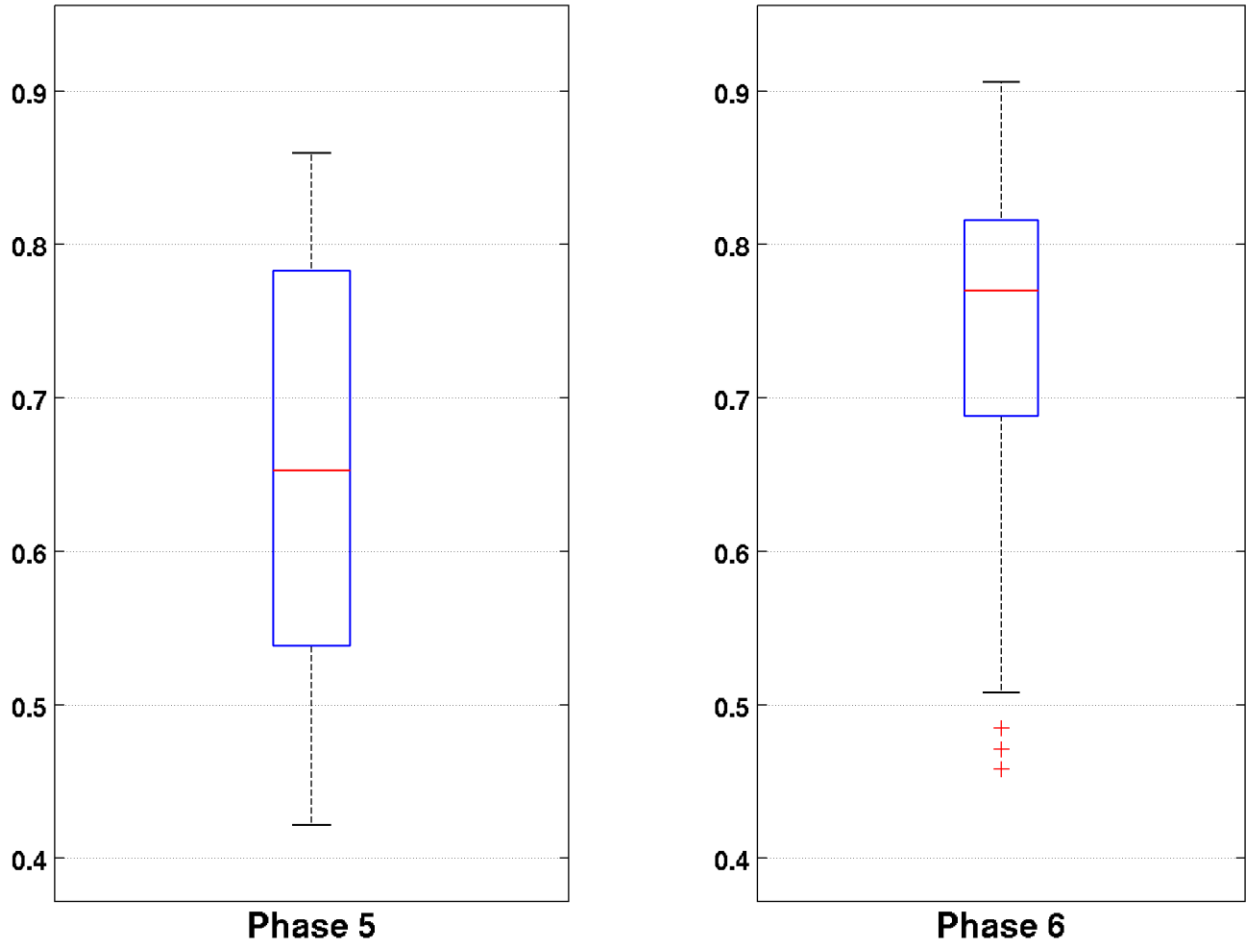


Monthly loads: nitrate

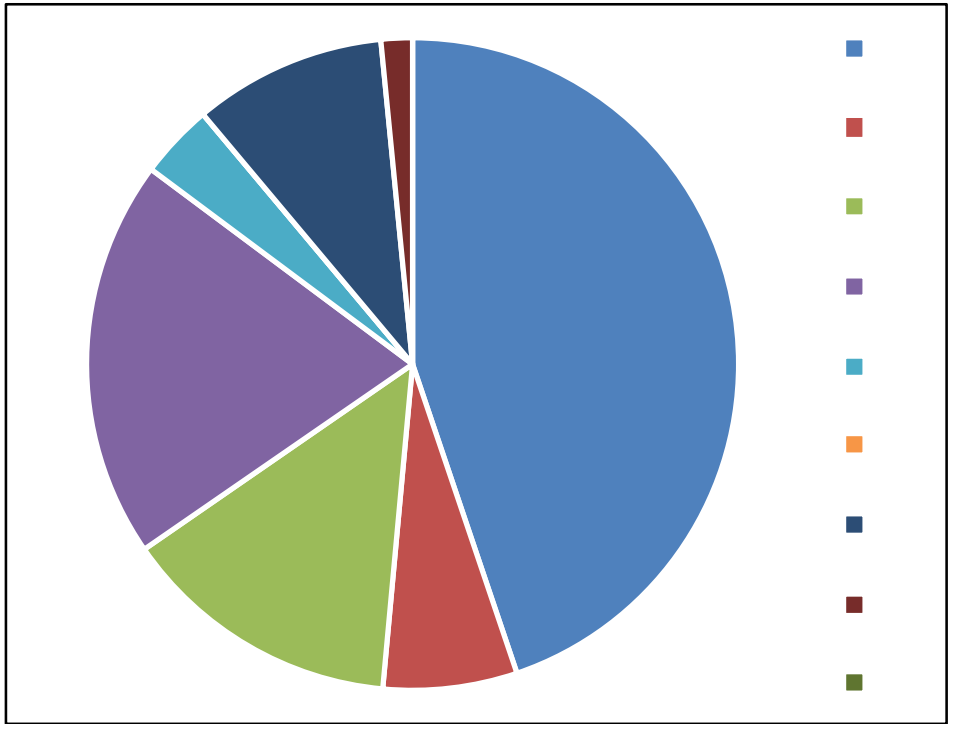


Monthly loads: dissolved phosphate



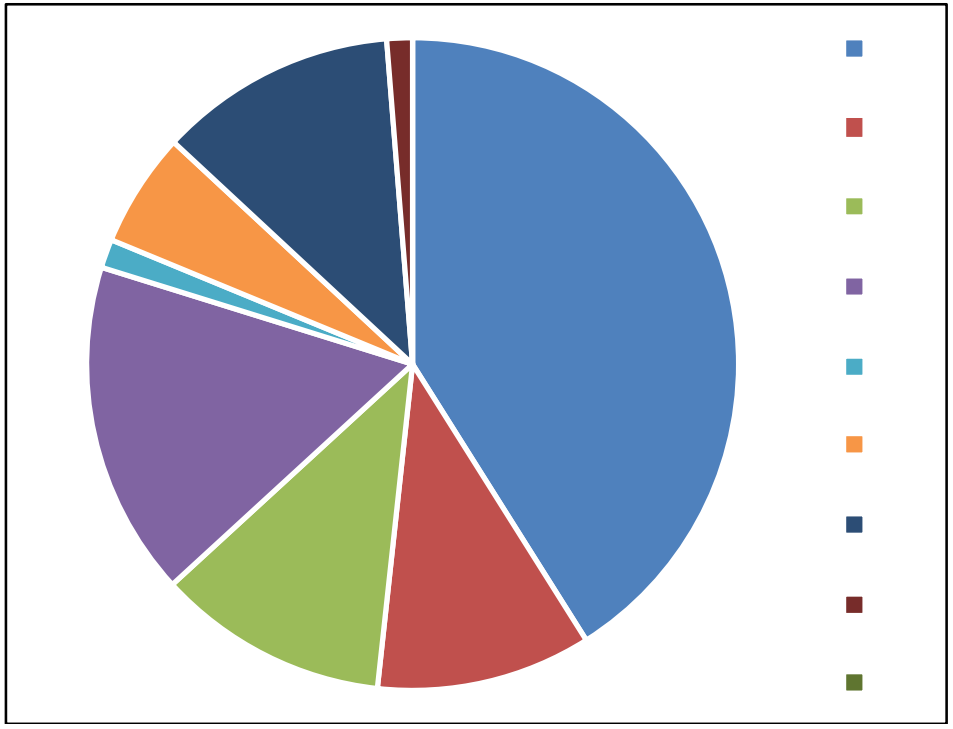
State – basin loads: Nitrogen

Phase 5: Nitrogen PA Susquehanna



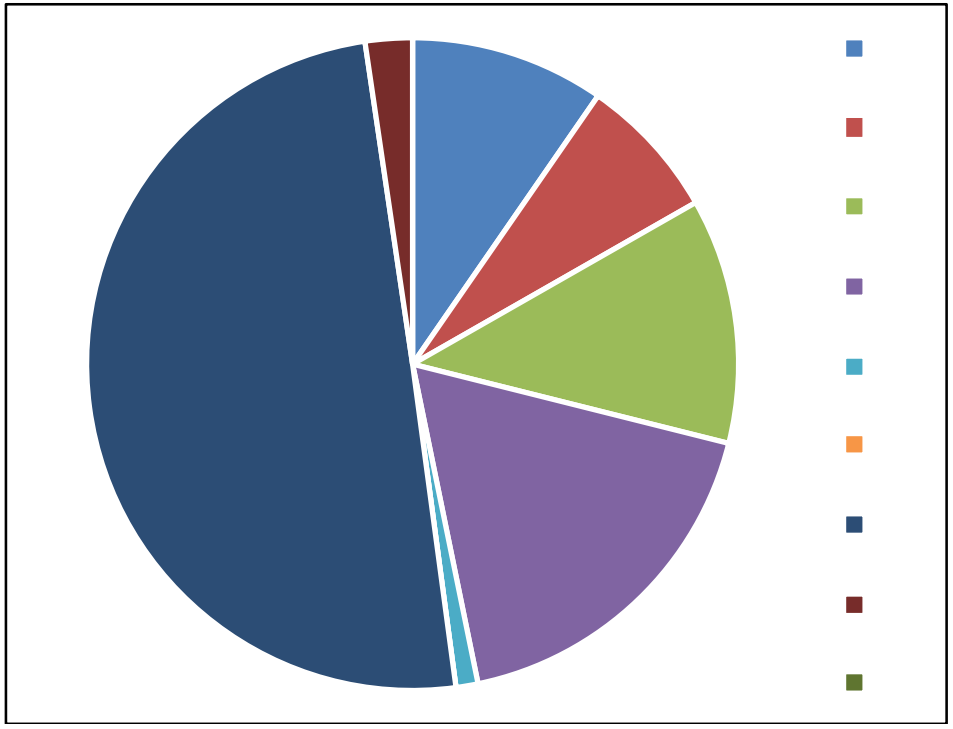
Crops	56,955,708	45%
Pasture & Hay	8,445,931	7%
Developed	17,695,460	14%
Natural	25,160,645	20%
Feeding Operations	4,688,270	4%
Stream Bank & Bed		0%
Wastewater	12,161,160	10%
Septic	1,977,842	2%
Shoreline		0%

Phase 6: Nitrogen PA Susquehanna



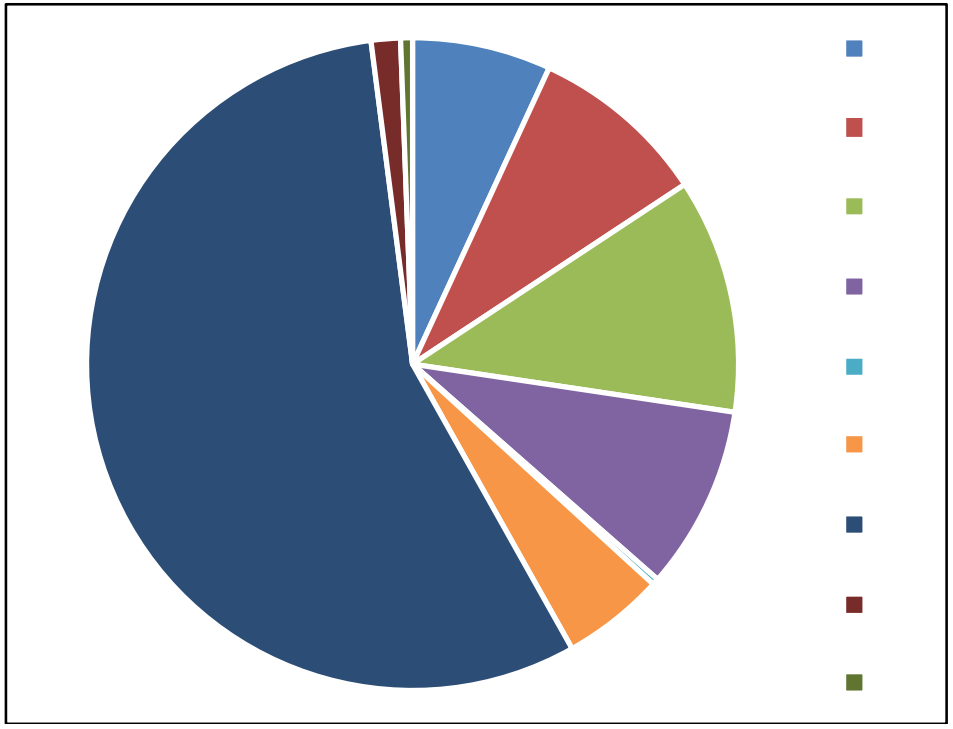
Crops	46,049,006	41%
Pasture & Hay	11,975,173	11%
Developed	12,852,167	11%
Natural	18,626,036	17%
Feeding Operations	1,596,741	1%
Stream Bank & Bed	6,375,636	6%
Wastewater	13,264,379	12%
Septic	1,428,925	1%
Shoreline		0%

Phase 5: Nitrogen – VA James



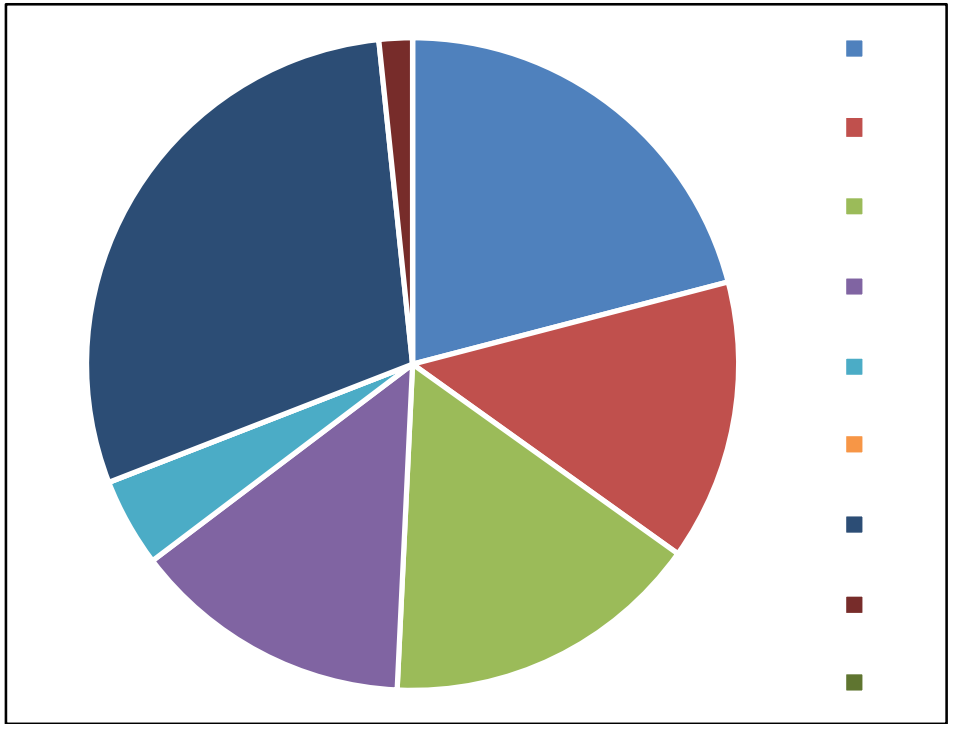
Crops	3,410,187	10%
Pasture & Hay	2,518,138	7%
Developed	4,300,513	12%
Natural	6,326,920	18%
Feeding Operations	384,592	1%
Stream Bank & Bed		0%
Wastewater	17,618,116	50%
Septic	827,637	2%
Shoreline		0%

Phase 6: Nitrogen – VA James



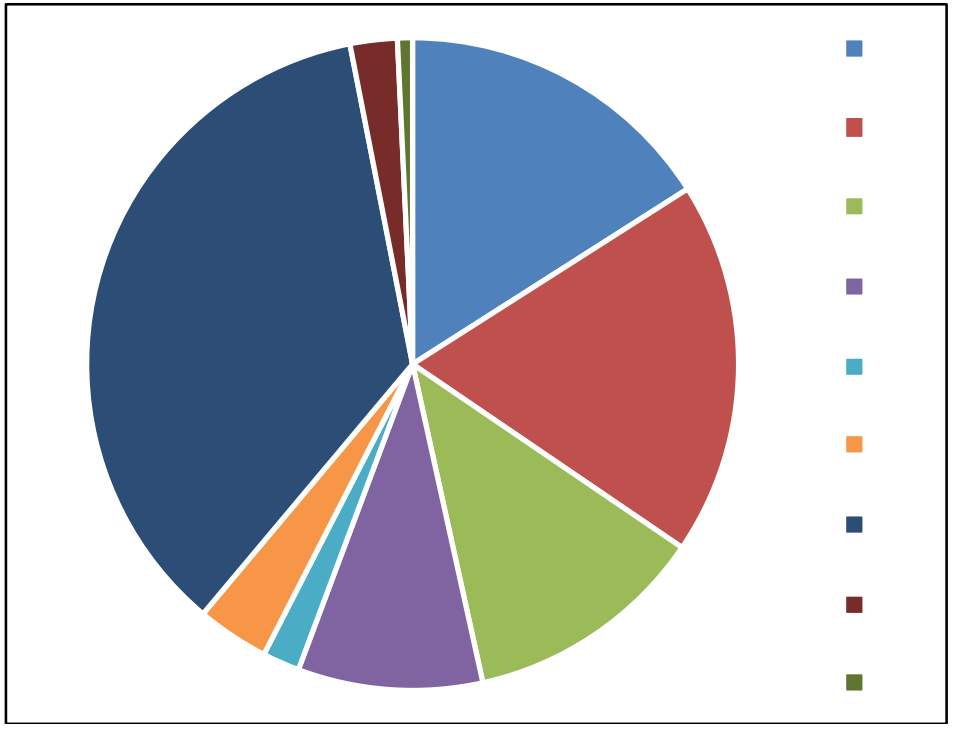
Crops	2,400,910	7%
Pasture & Hay	3,082,281	9%
Developed	4,058,067	12%
Natural	3,175,646	9%
Feeding Operations	11,225	0%
Stream Bank & Bed	1,771,772	5%
Wastewater	19,557,721	56%
Septic	507,997	1%
Shoreline	204,827	1%

Phase 5: Nitrogen in VA Potomac



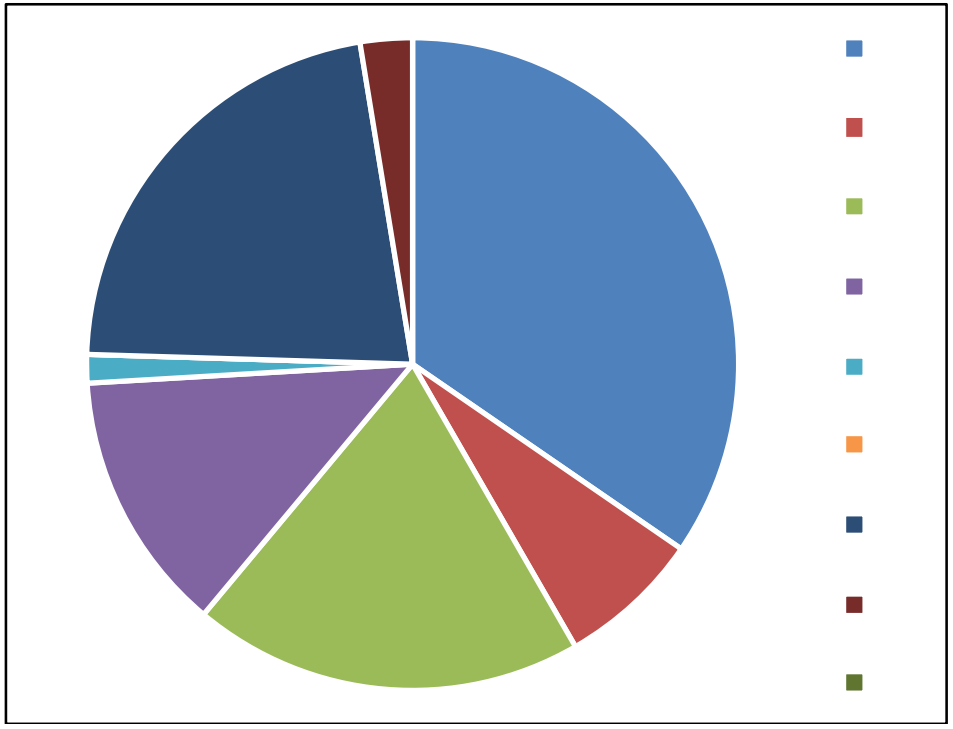
Crops	5,500,133	21%
Pasture & Hay	3,653,902	14%
Developed	4,172,115	16%
Natural	3,662,821	14%
Feeding Operations	1,152,429	4%
Stream Bank & Bed		0%
Wastewater	7,677,184	29%
Septic	435,991	2%
Shoreline		0%

Phase 6: Nitrogen – VA Potomac



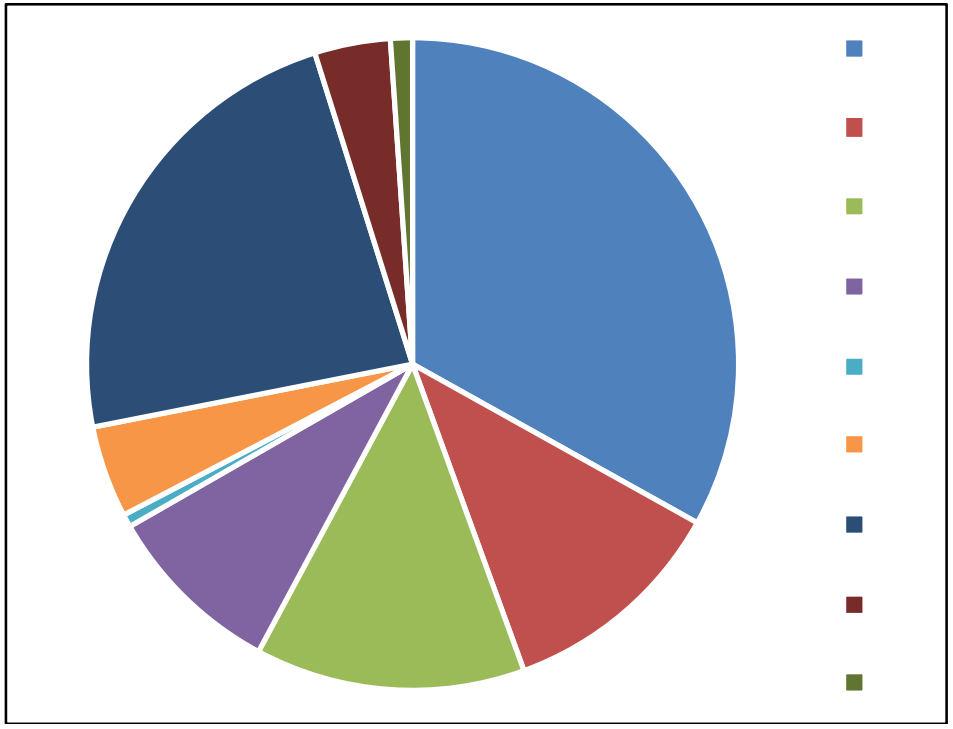
Crops	3,985,982	16%
Pasture & Hay	4,619,360	19%
Developed	3,003,248	12%
Natural	2,283,565	9%
Feeding Operations	457,574	2%
Stream Bank & Bed	893,939	4%
Wastewater	8,927,788	36%
Septic	583,416	2%
Shoreline	185,519	1%

Phase 5: Nitrogen – MD Potomac



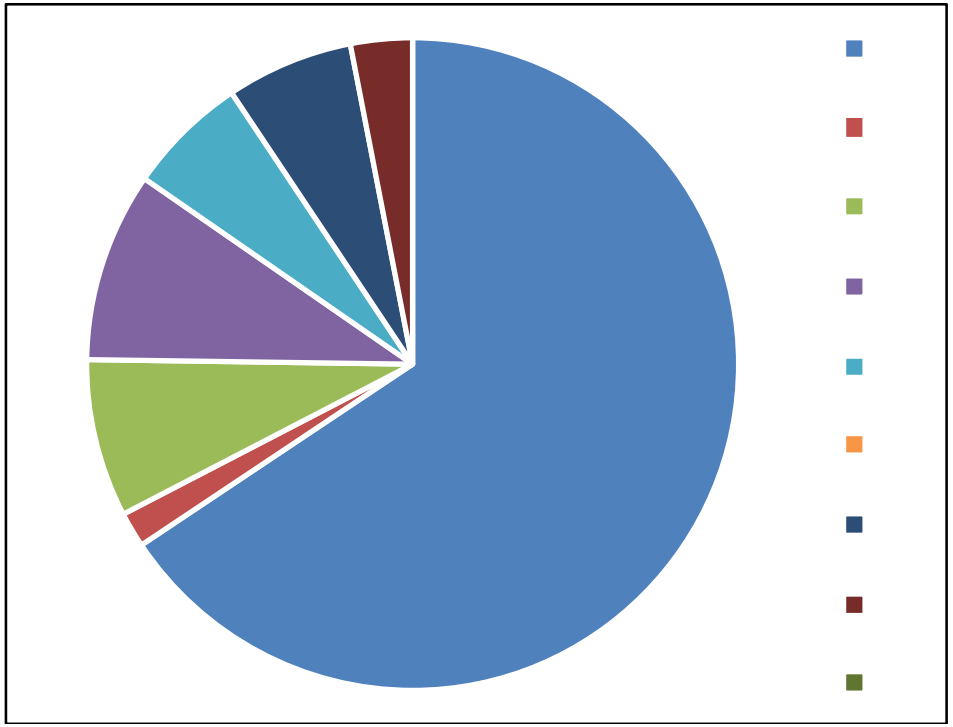
Crops	7,891,843	35%
Pasture & Hay	1,617,024	7%
Developed	4,428,629	19%
Natural	2,963,800	13%
Feeding Operations	322,456	1%
Stream Bank & Bed		0%
Wastewater	5,005,291	22%
Septic	690,507	3%
Shoreline		0%

Phase 6: Nitrogen – MD Potomac



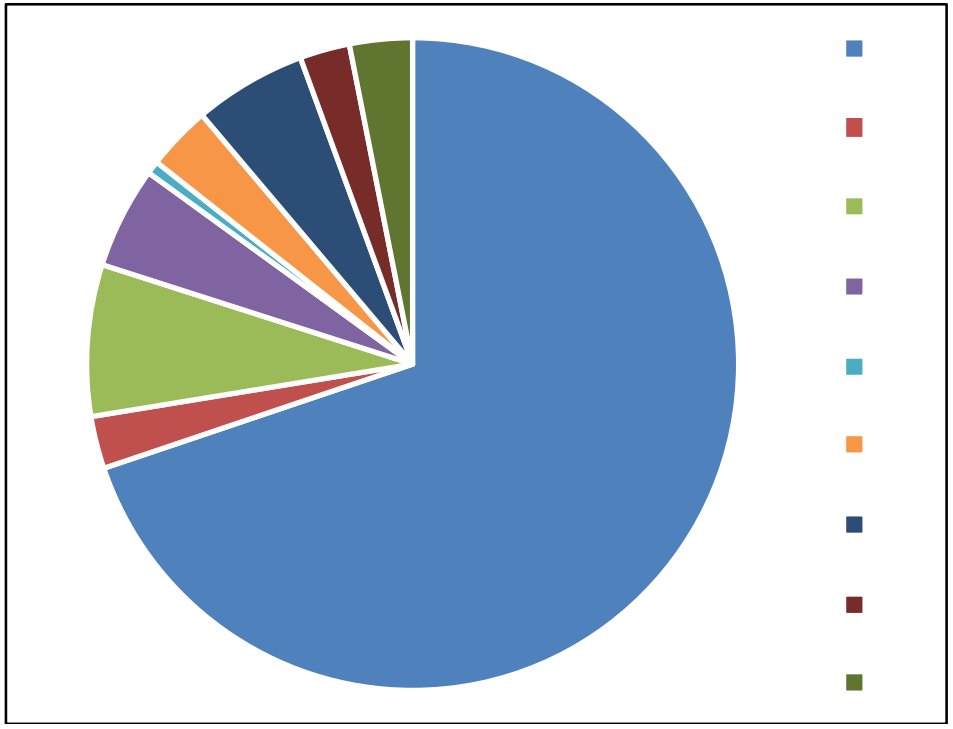
Crops	7,665,706	33%
Pasture & Hay	2,633,240	11%
Developed	3,100,516	13%
Natural	2,055,830	9%
Feeding Operations	147,861	1%
Stream Bank & Bed	1,055,551	5%
Wastewater	5,383,984	23%
Septic	872,502	4%
Shoreline	251,743	1%

Phase 5: Nitrogen – MD Eastern Shore



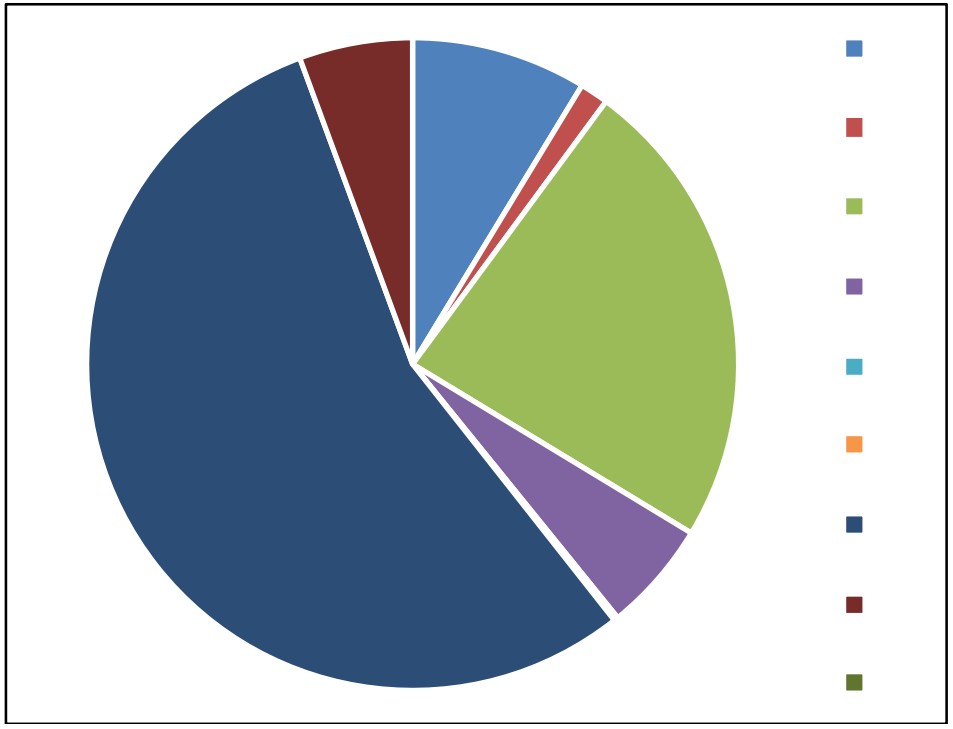
Crops	12,272,689	66%
Pasture & Hay	426,340	2%
Developed	1,463,791	8%
Natural	1,756,498	9%
Feeding Operations	1,124,696	6%
Stream Bank & Bed	0	0%
Wastewater	1,177,886	6%
Septic	573,601	3%
Shoreline	0	0%

Phase 6: Nitrogen – MD Eastern Shore



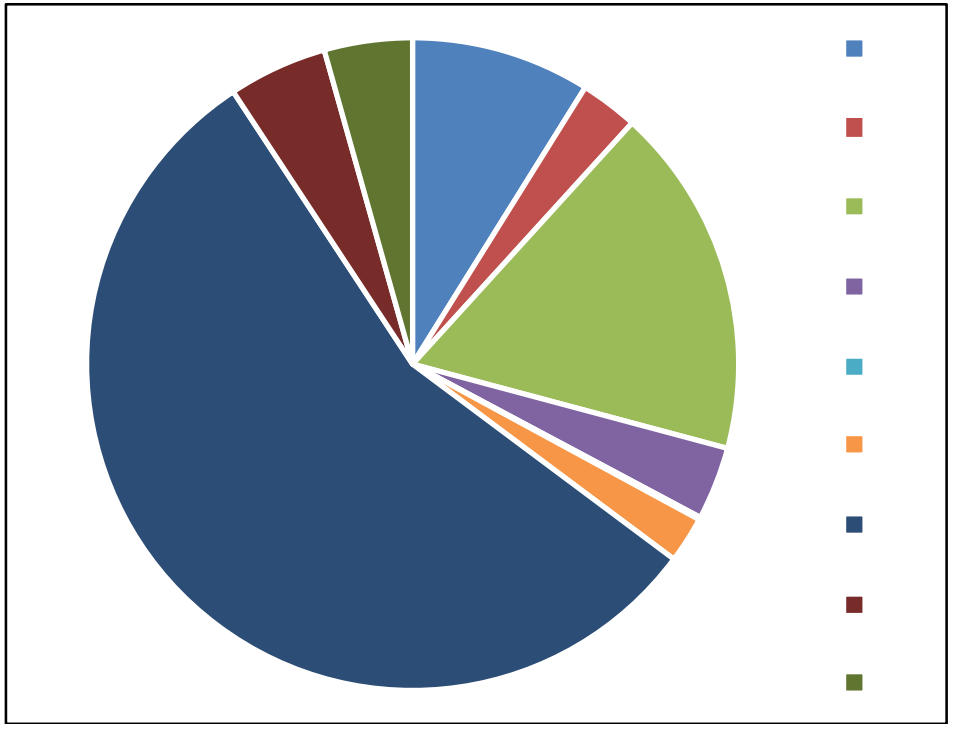
Crops	15,642,298	70%
Pasture & Hay	681,148	3%
Developed	1,681,362	8%
Natural	1,131,087	5%
Feeding Operations	145,136	1%
Stream Bank & Bed	715,357	3%
Wastewater	1,251,956	6%
Septic	455,479	2%
Shoreline	698,156	3%

Phase 5: Nitrogen – MD Western Shore



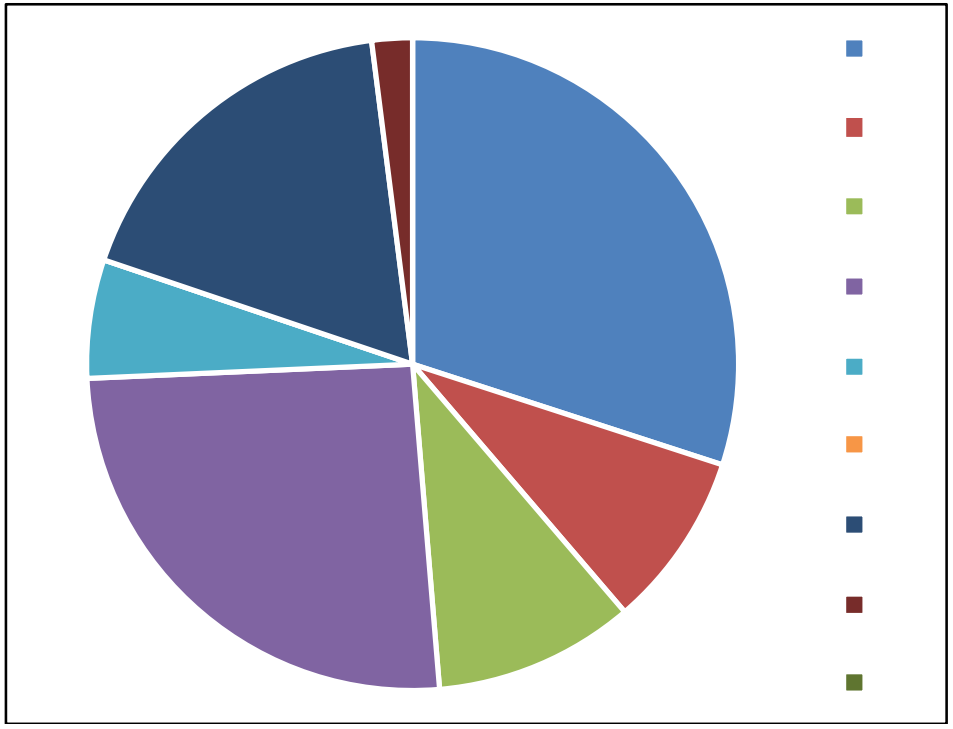
Crops	1,291,014	9%
Pasture & Hay	209,876	1%
Developed	3,495,166	24%
Natural	815,890	5%
Feeding Operations	30,398	0%
Stream Bank & Bed		0%
Wastewater	8,160,191	55%
Septic	835,562	6%
Shoreline		0%

Phase 6: Nitrogen – MD Western Shore



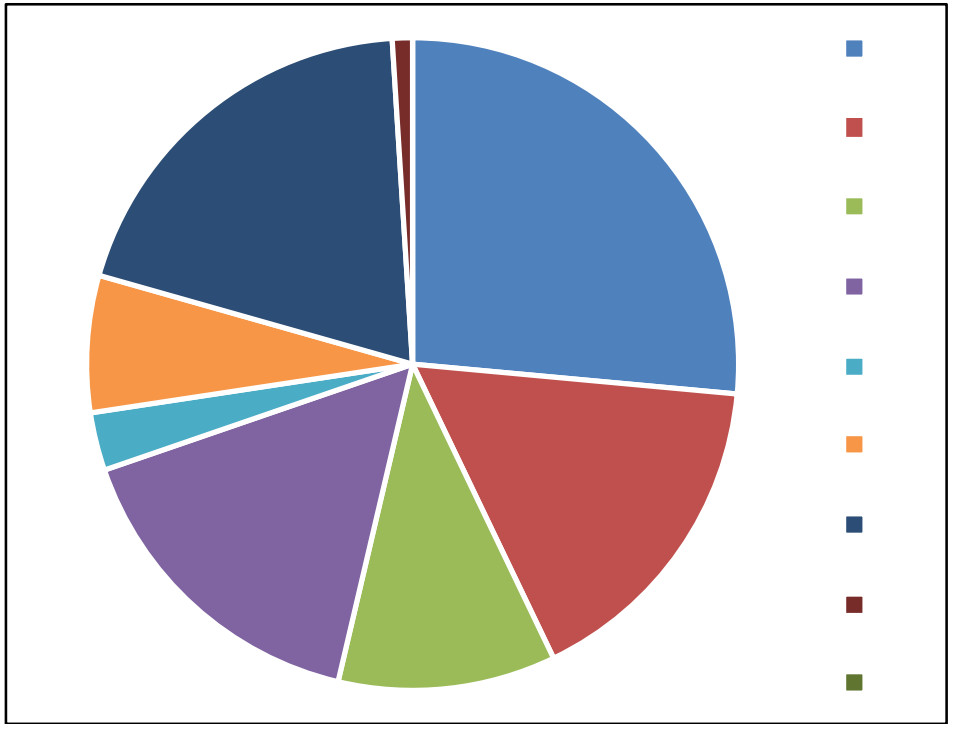
Crops	1,353,787	9%
Pasture & Hay	437,687	3%
Developed	2,651,938	17%
Natural	652,413	4%
Feeding Operations	19,013	0%
Stream Bank & Bed	348,997	2%
Wastewater	8,460,001	56%
Septic	748,331	5%
Shoreline	665,737	4%

Phase 5: Nitrogen – NY Susquehanna



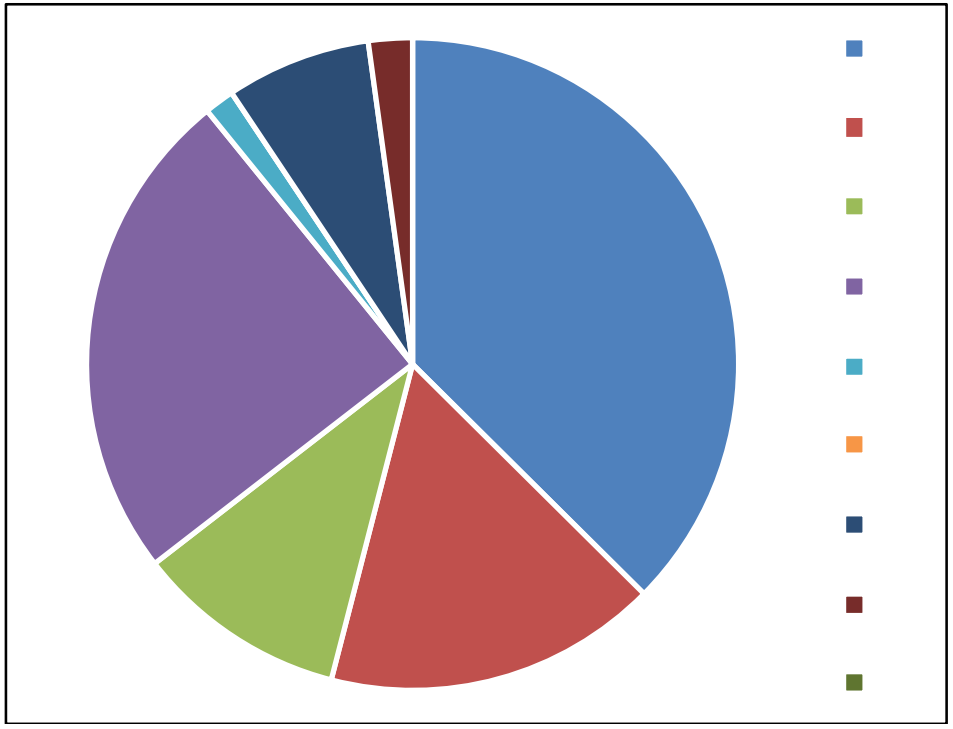
Crops	4,346,975	30%
Pasture & Hay	1,264,811	9%
Developed	1,442,892	10%
Natural	3,712,835	26%
Feeding Operations	851,137	6%
Stream Bank & Bed		0%
Wastewater	2,581,010	18%
Septic	291,983	2%
Shoreline		0%

Phase 6: Nitrogen – NY Susquehanna



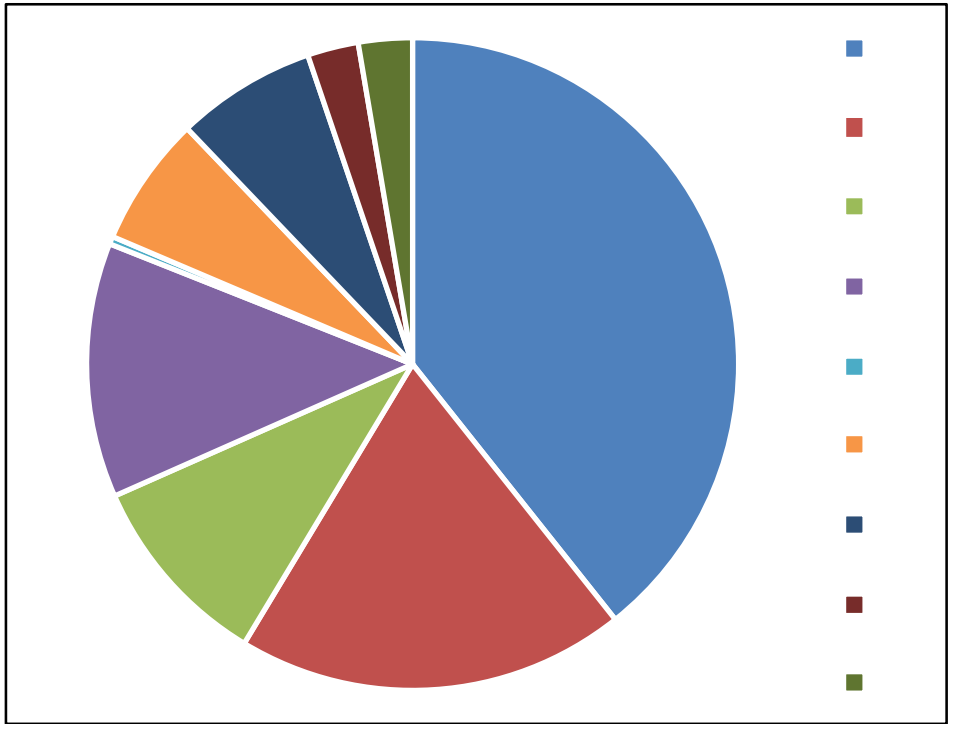
Crops	4,541,569	26%
Pasture & Hay	2,816,741	16%
Developed	1,852,056	11%
Natural	2,755,820	16%
Feeding Operations	493,352	3%
Stream Bank & Bed	1,163,351	7%
Wastewater	3,364,848	20%
Septic	172,049	1%
Shoreline		0%

Phase 5: Nitrogen in VA Rappahannock



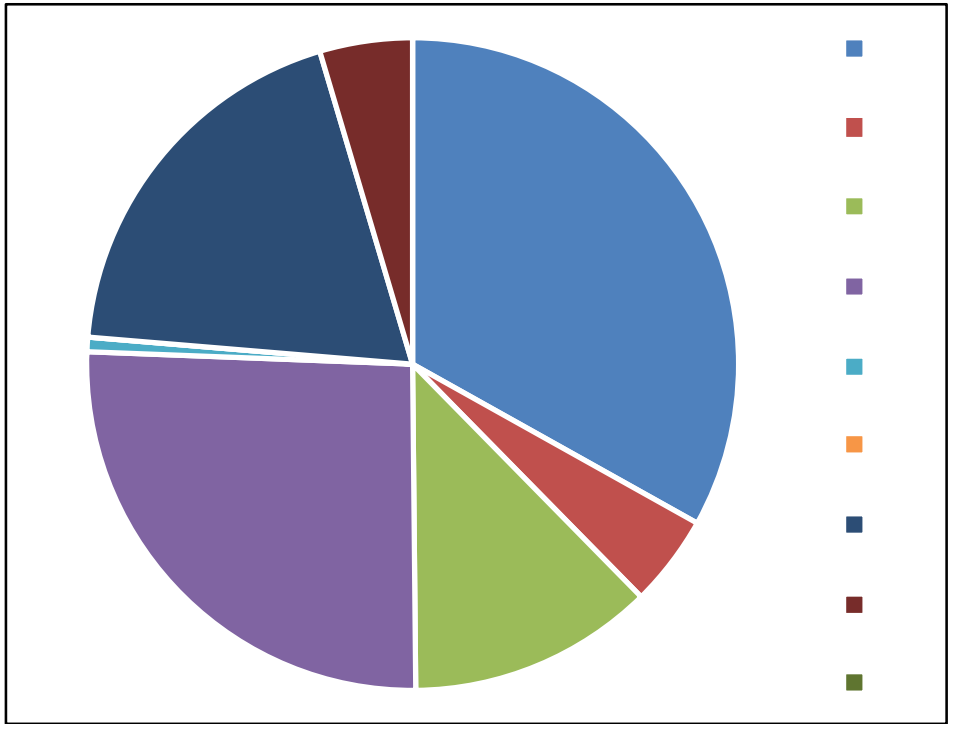
Crops	3,227,240	37%
Pasture & Hay	1,429,430	17%
Developed	905,342	11%
Natural	2,121,876	25%
Feeding Operations	128,115	1%
Stream Bank & Bed		0%
Wastewater	620,050	7%
Septic	187,820	2%
Shoreline		0%

Phase 6: Nitrogen – VA Rappahannock



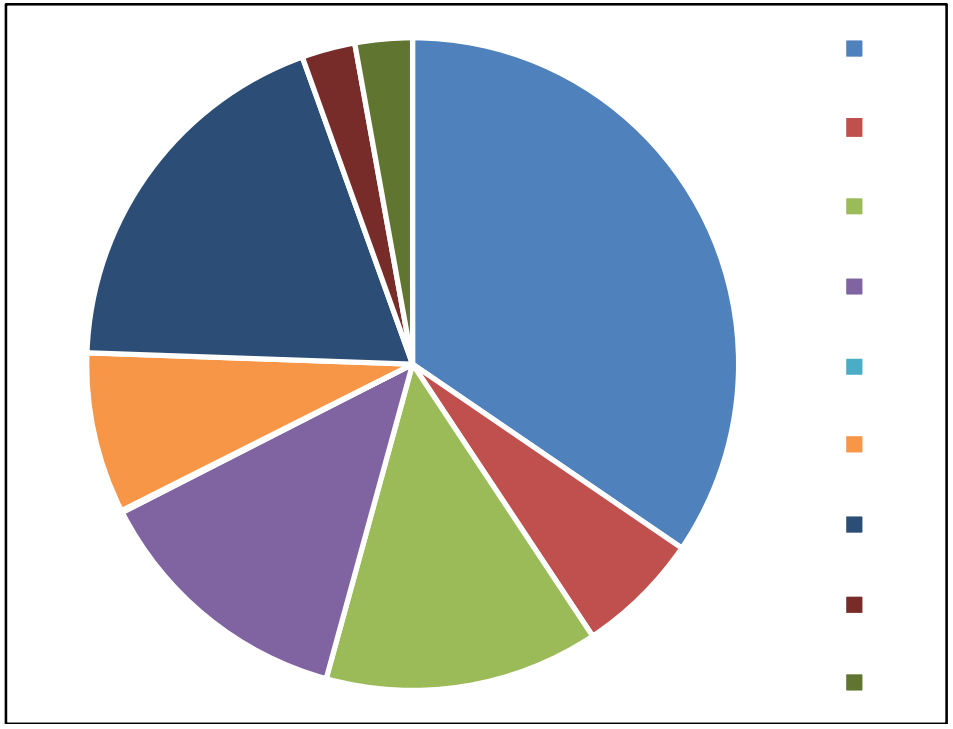
Crops	3,803,808	39%
Pasture & Hay	1,869,708	19%
Developed	941,937	10%
Natural	1,222,821	13%
Feeding Operations	36,682	0%
Stream Bank & Bed	623,944	6%
Wastewater	672,229	7%
Septic	245,800	3%
Shoreline	258,692	3%

Phase 5: Nitrogen – VA York



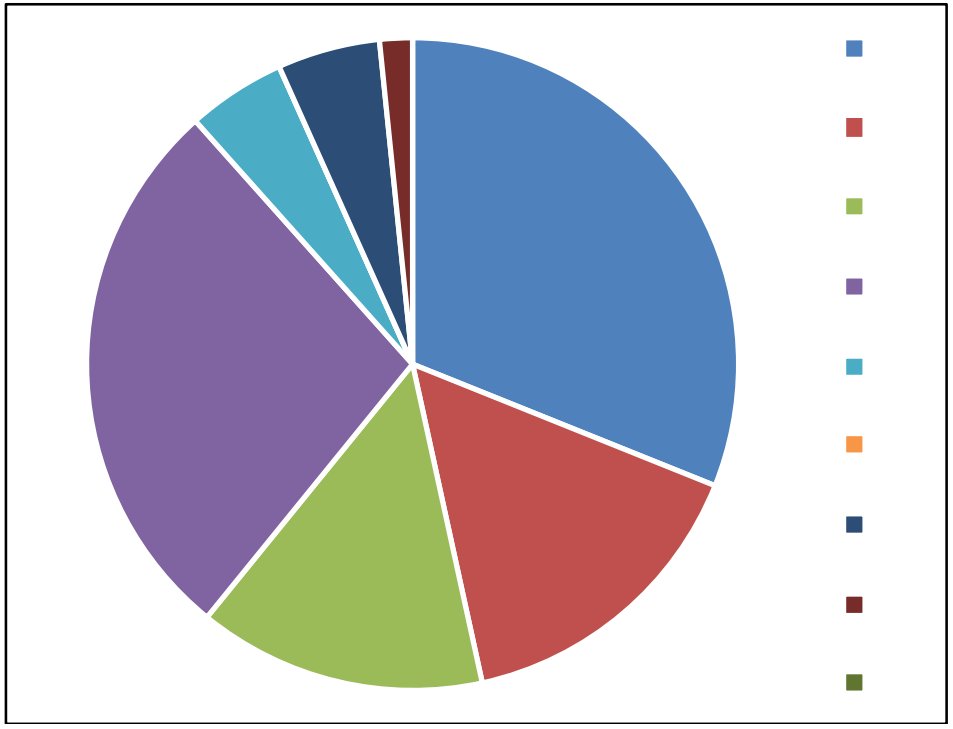
Crops	2,485,053	33%
Pasture & Hay	340,158	5%
Developed	916,507	12%
Natural	1,933,497	26%
Feeding Operations	83,536	1%
Stream Bank & Bed		0%
Wastewater	1,432,420	19%
Septic	345,330	5%
Shoreline		0%

Phase 6: Nitrogen – VA York



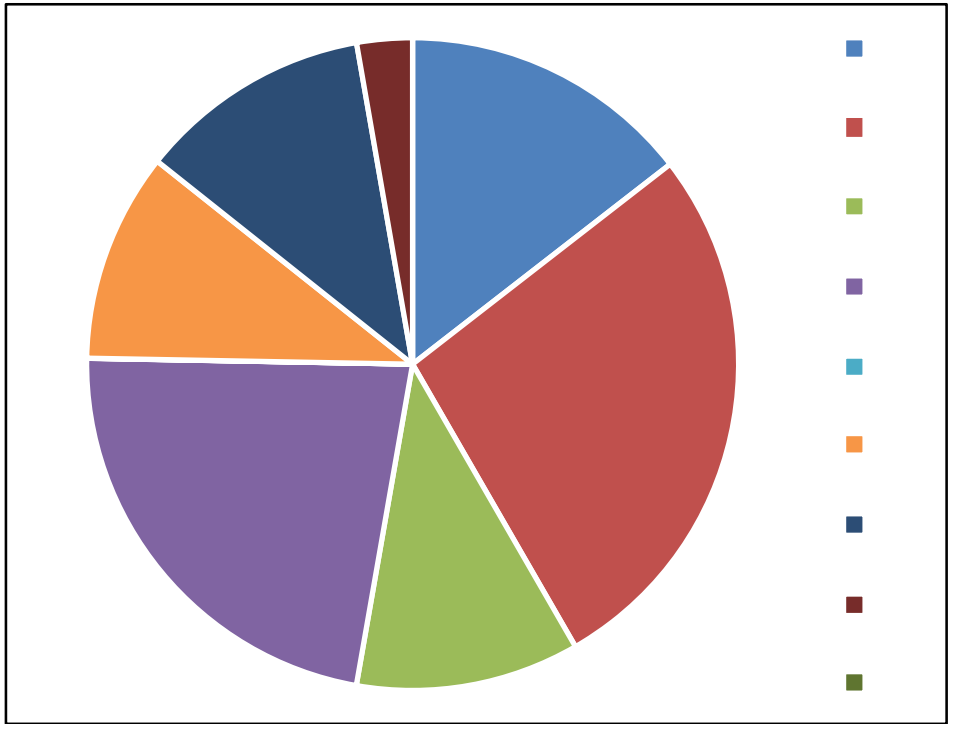
Crops	2,457,807	35%
Pasture & Hay	438,011	6%
Developed	966,801	14%
Natural	940,543	13%
Feeding Operations	6,877	0%
Stream Bank & Bed	566,766	8%
Wastewater	1,348,825	19%
Septic	188,571	3%
Shoreline	202,651	3%

Phase 5: Nitrogen – WV Potomac



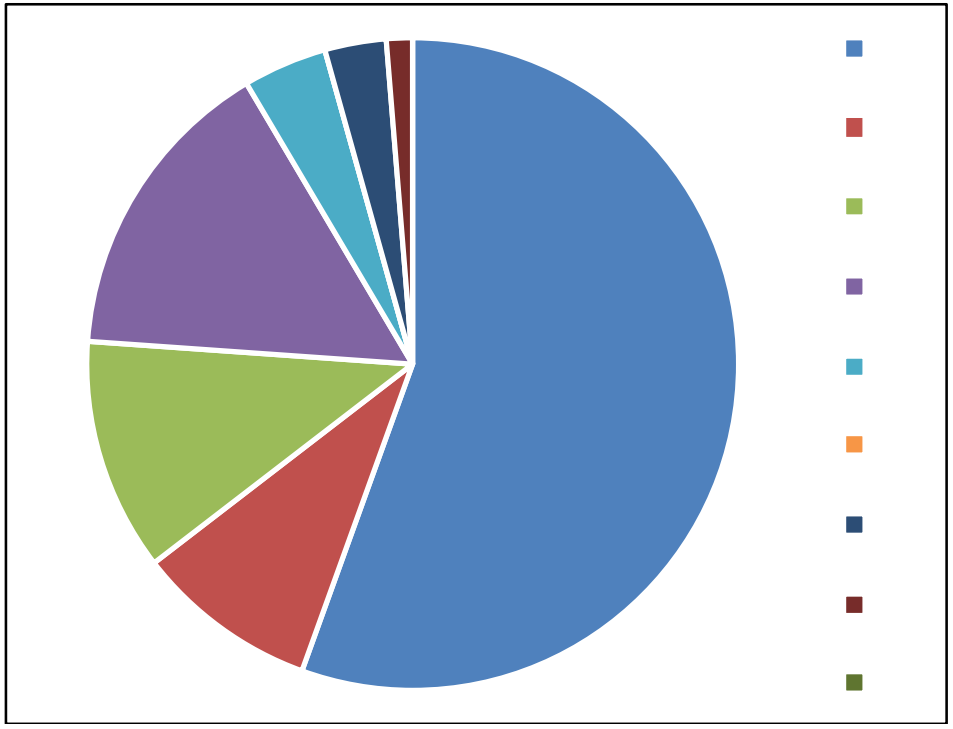
Crops	2,329,143	31%
Pasture & Hay	1,160,577	15%
Developed	1,070,644	14%
Natural	2,062,715	28%
Feeding Operations	366,577	5%
Stream Bank & Bed		0%
Wastewater	381,067	5%
Septic	122,431	2%
Shoreline		0%

Phase 6: Nitrogen – WV Potomac



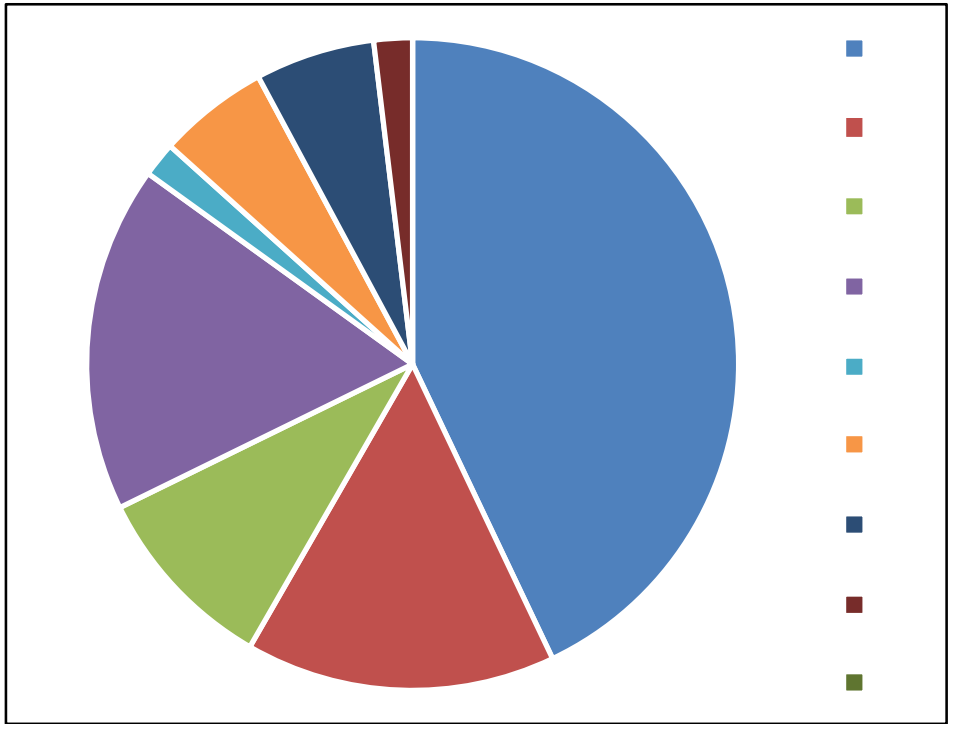
Crops	1,299,408	15%
Pasture & Hay	2,432,774	27%
Developed	993,944	11%
Natural	2,016,603	23%
Feeding Operations	66	0%
Stream Bank & Bed	931,097	10%
Wastewater	1,035,664	12%
Septic	246,914	3%
Shoreline		0%

Phase 5: Nitrogen in PA Potomac



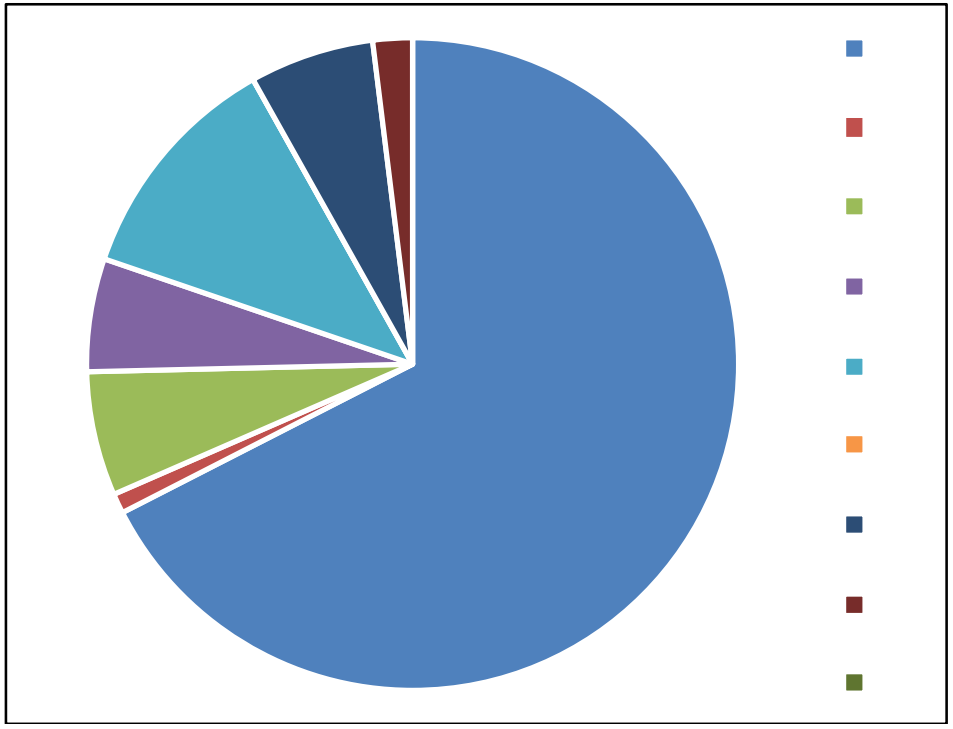
Crops	3,650,487	56%
Pasture & Hay	595,646	9%
Developed	758,976	12%
Natural	1,010,721	15%
Feeding Operations	274,333	4%
Stream Bank & Bed		0%
Wastewater	200,489	3%
Septic	85,068	1%
Shoreline		0%

Phase 6: Nitrogen PA Potomac



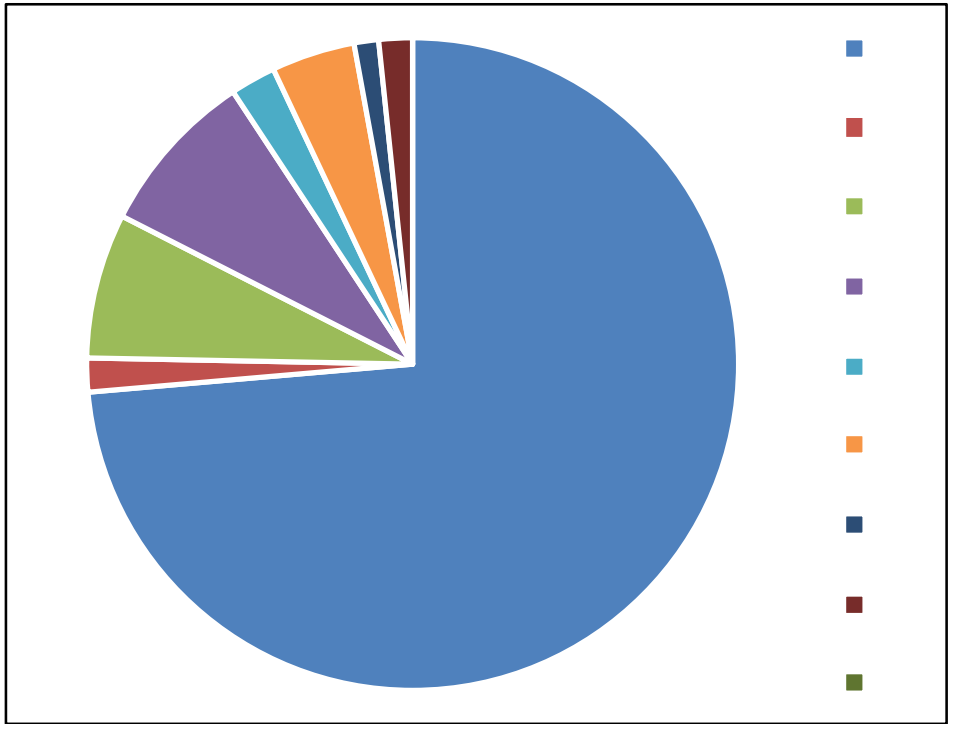
Crops	4,452,324	43%
Pasture & Hay	1,595,760	15%
Developed	978,192	9%
Natural	1,780,979	17%
Feeding Operations	179,081	2%
Stream Bank & Bed	569,886	5%
Wastewater	616,038	6%
Septic	198,210	2%
Shoreline		0%

Phase 5: Nitrogen DE Eastern Shore



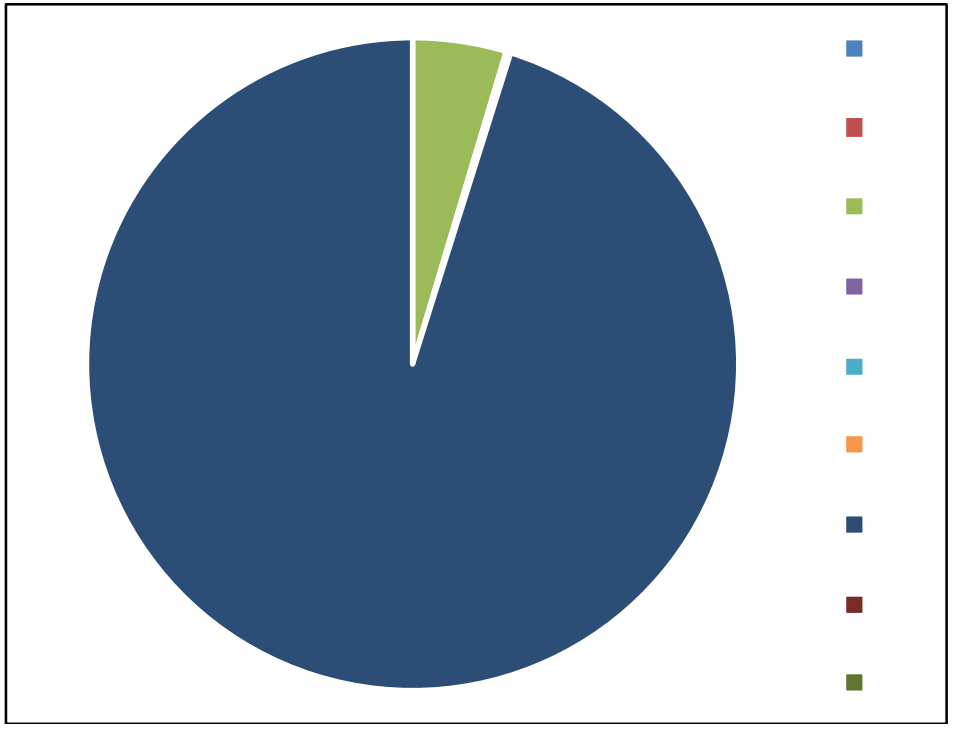
Crops	3,698,450	67%
Pasture & Hay	63,904	1%
Developed	337,414	6%
Natural	307,371	6%
Feeding Operations	637,421	12%
Stream Bank & Bed		0%
Wastewater	338,809	6%
Septic	107,503	2%
Shoreline		0%

Phase 6: Nitrogen – DE Eastern Shore



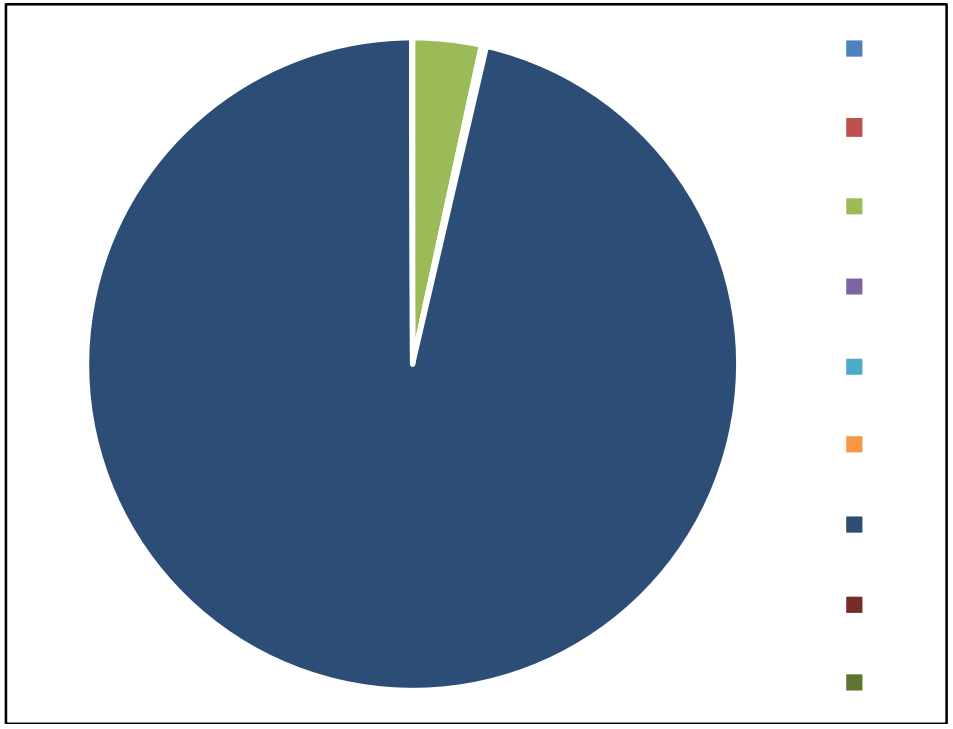
Crops	5,750,407	74%
Pasture & Hay	130,521	2%
Developed	561,912	7%
Natural	642,619	8%
Feeding Operations	176,223	2%
Stream Bank & Bed	323,687	4%
Wastewater	94,977	1%
Septic	130,153	2%
Shoreline		0%

Phase 5: Nitrogen – DC Potomac



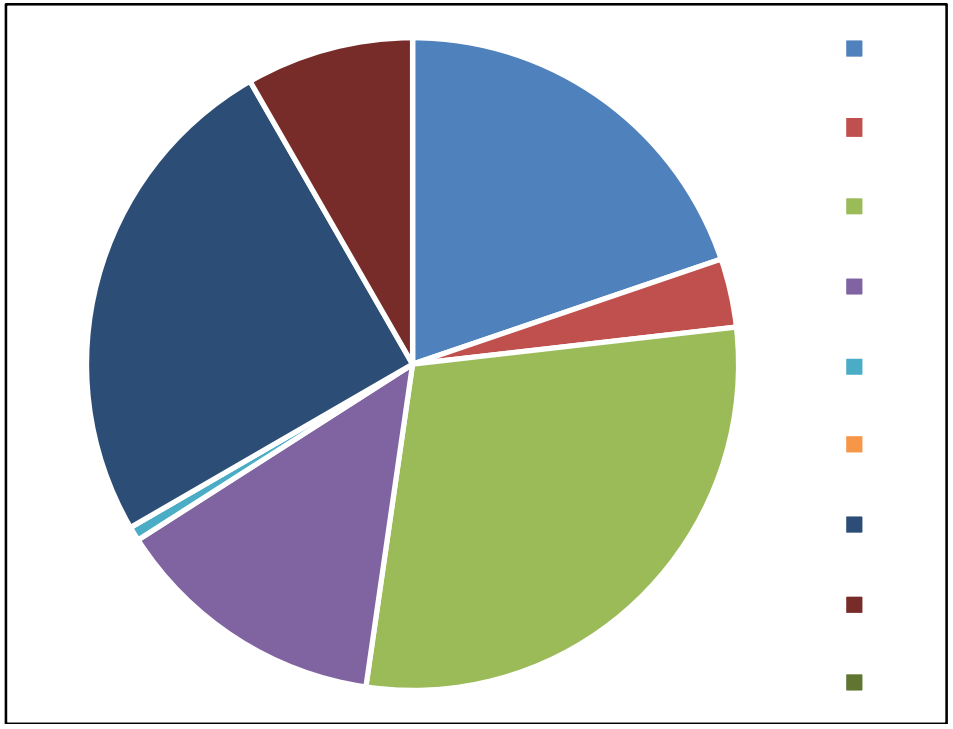
Crops	0	0%
Pasture & Hay	0	0%
Developed	247,936	5%
Natural	2,472	0%
Feeding Operations	0	0%
Stream Bank & Bed	0	0%
Wastewater	5,088,365	95%
Septic	0	0%
Shoreline	0	0%

Phase 6: Nitrogen – DC Potomac



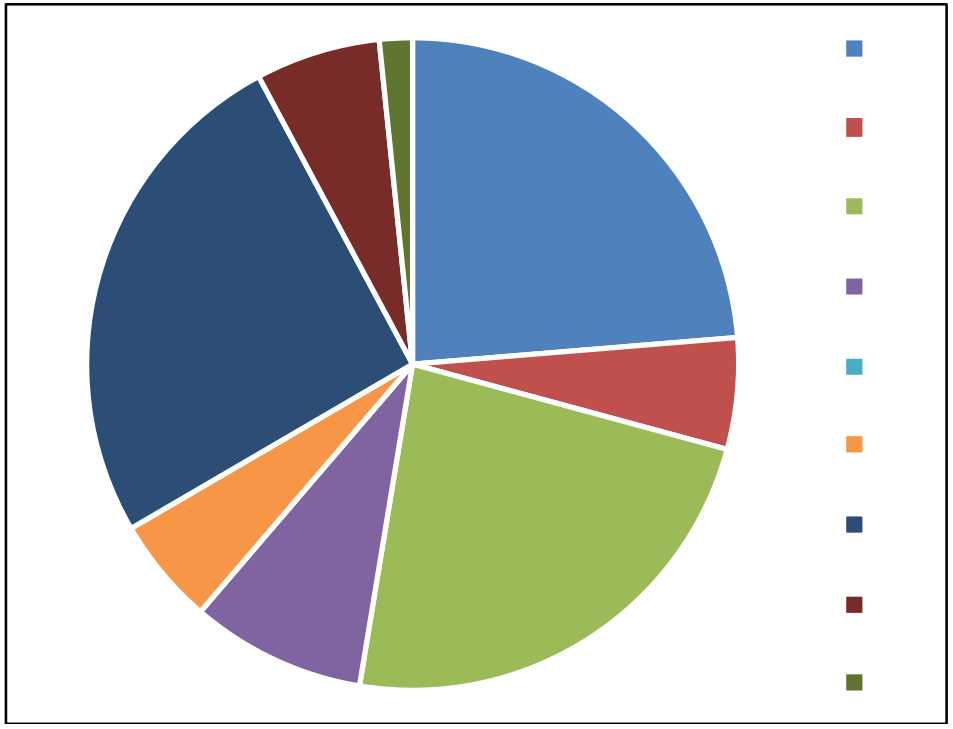
Crops	[illegible]	0%
Pasture & Hay	[illegible]	0%
Developed	[illegible]89,342	3%
Natural	[illegible]8,657	0%
Feeding Operations	[illegible]	0%
Stream Bank & Bed	[illegible]5,176	0%
Wastewater	[illegible]5,377,607	96%
Septic	[illegible]876	0%
Shoreline	[illegible]2,078	0%

Phase 5: Nitrogen – MD Patuxent



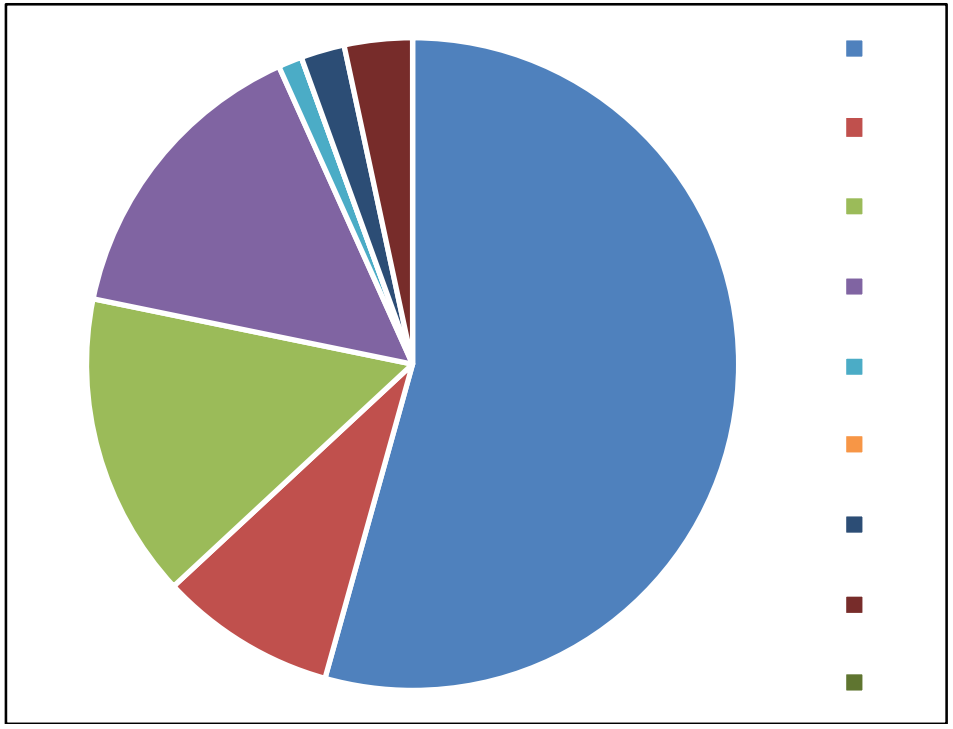
Crops	811,813	20%
Pasture & Hay	139,678	3%
Developed	1,193,667	29%
Natural	560,125	14%
Feeding Operations	29,448	1%
Stream Bank & Bed		0%
Wastewater	1,027,118	25%
Septic	340,936	8%
Shoreline		0%

Phase 6: Nitrogen – MD Patuxent



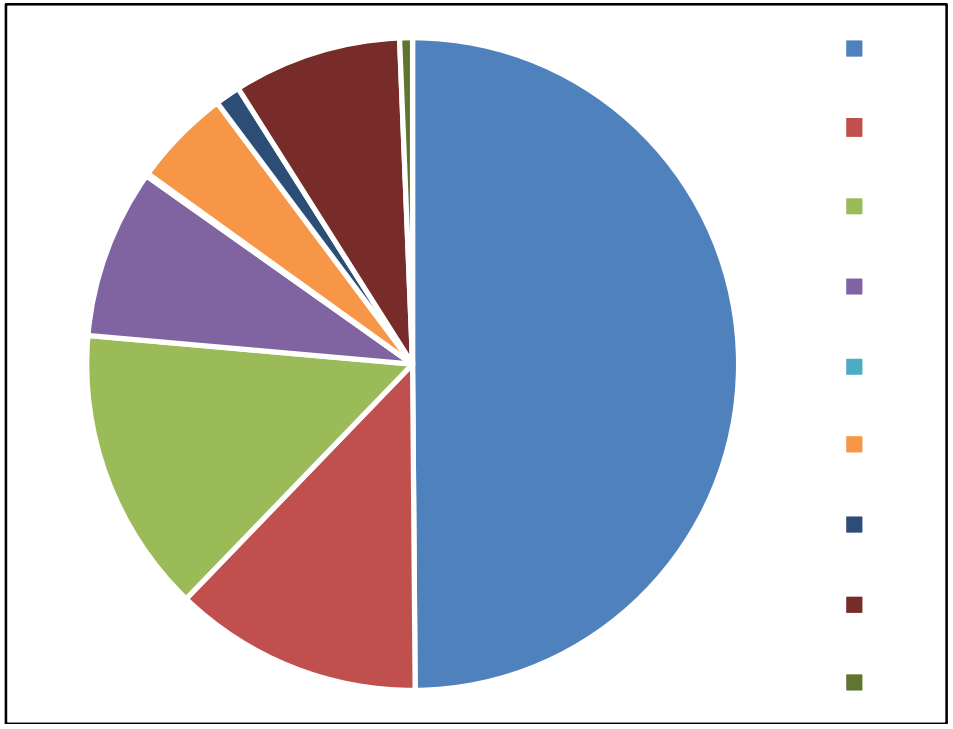
Crops	965,989	24%
Pasture & Hay	224,621	6%
Developed	953,135	23%
Natural	353,923	9%
Feeding Operations		0%
Stream Bank & Bed	216,248	5%
Wastewater	1,042,449	26%
Septic	252,190	6%
Shoreline	66,721	2%

Phase 5: Nitrogen – MD Susquehanna



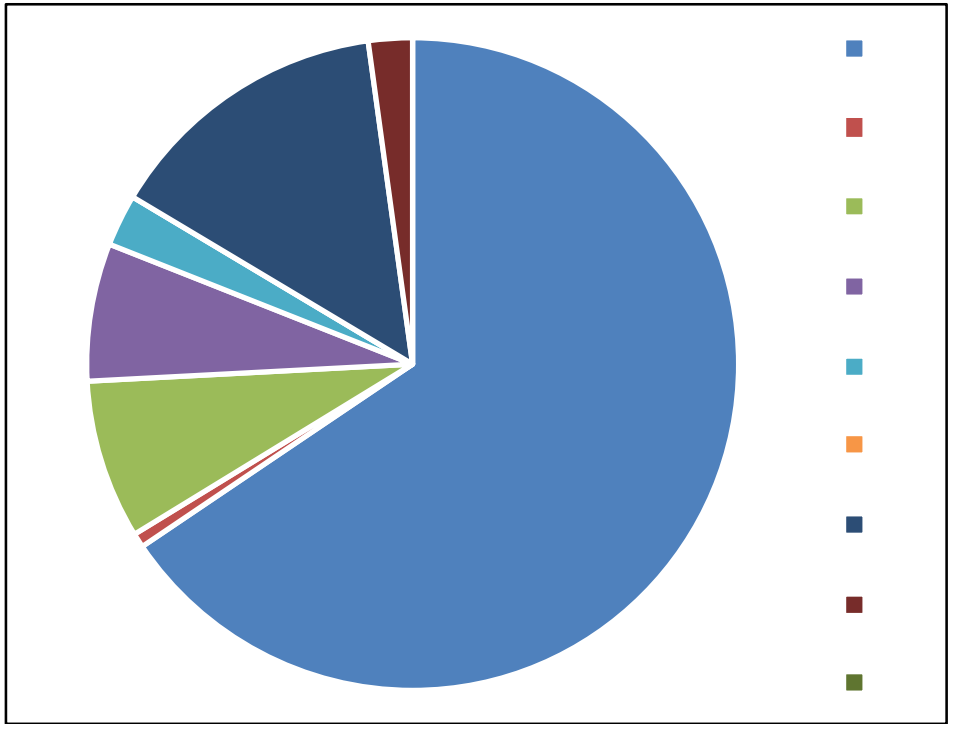
Crops	1,213,451	54%
Pasture & Hay	195,601	9%
Developed	337,662	15%
Natural	336,462	15%
Feeding Operations	26,425	1%
Stream Bank & Bed		0%
Wastewater	48,497	2%
Septic	75,444	3%
Shoreline		0%

Phase 6: Nitrogen – MD Susquehanna



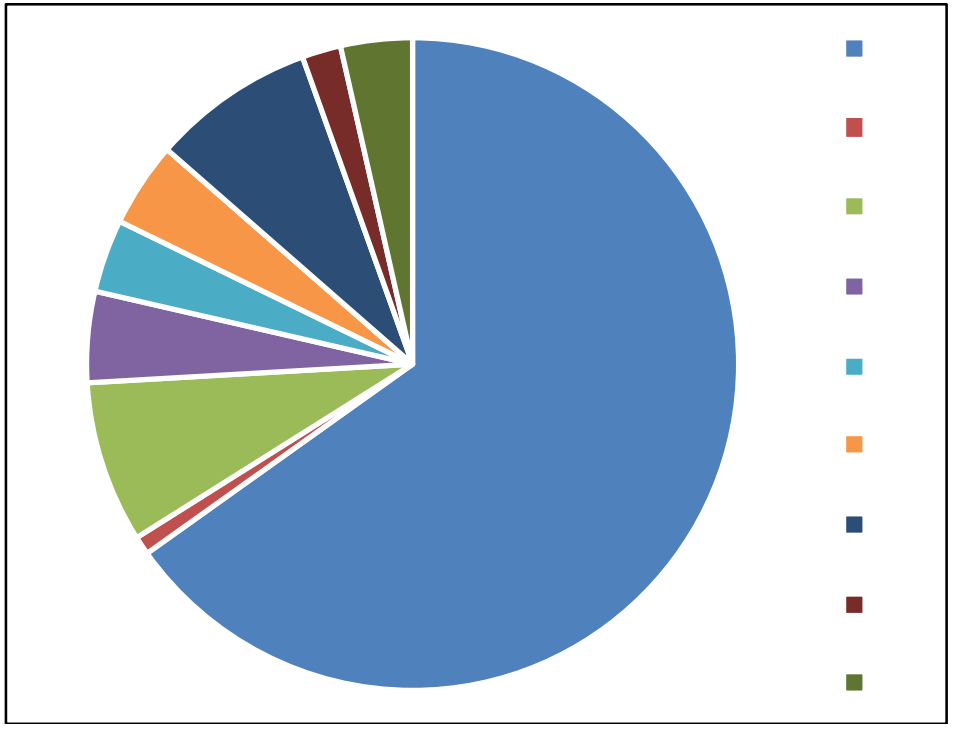
Crops	1,028,621	50%
Pasture & Hay	254,658	12%
Developed	292,276	14%
Natural	173,124	8%
Feeding Operations	2,661	0%
Stream Bank & Bed	100,100	5%
Wastewater	25,646	1%
Septic	172,088	8%
Shoreline	13,267	1%

Phase 5: Nitrogen in VA Eastern Shore



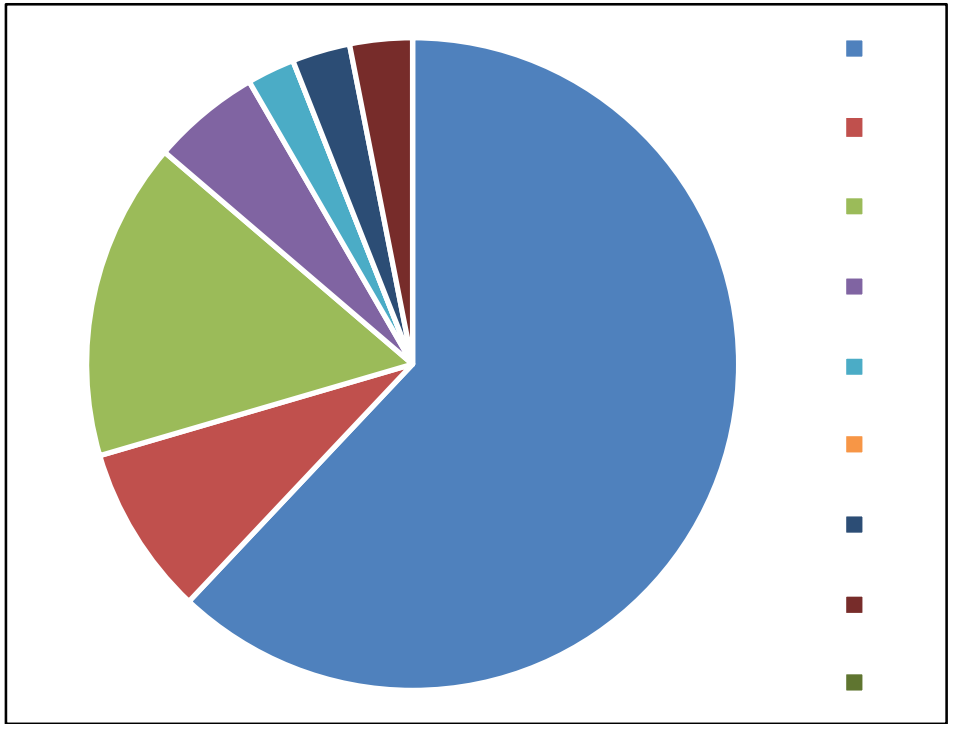
Crops	1,404,082	66%
Pasture & Hay	15,129	1%
Developed	169,017	8%
Natural	146,195	7%
Feeding Operations	65,120	3%
Stream Bank & Bed		0%
Wastewater	305,286	14%
Septic	46,775	2%
Shoreline		0%

Phase 6: Nitrogen in VA Eastern Shore



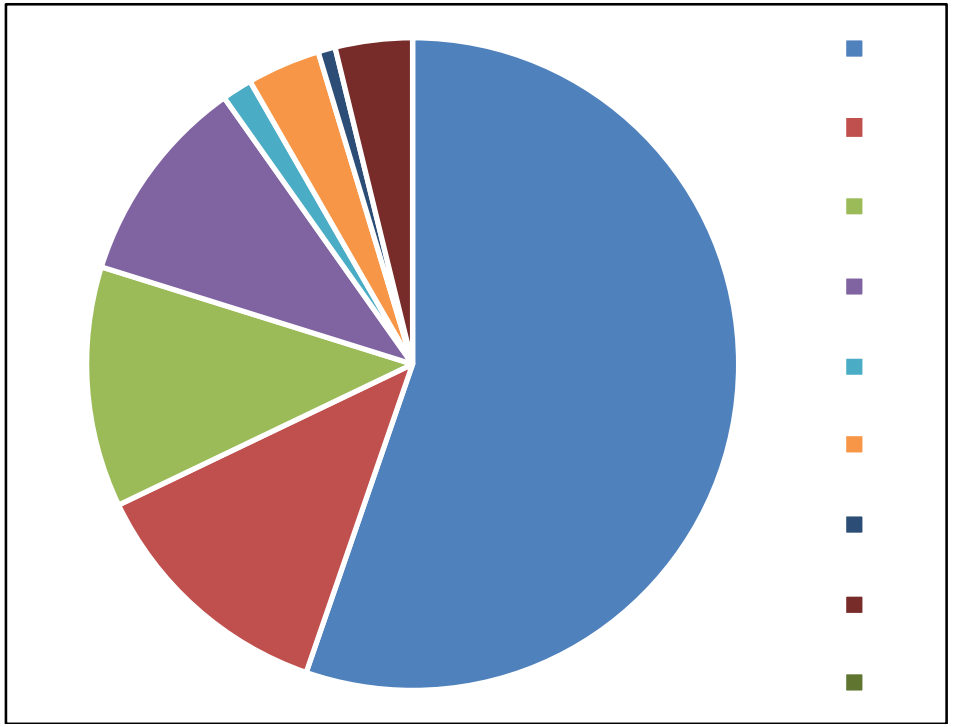
Crops	1,921,007	65%
Pasture & Hay	26,884	1%
Developed	236,261	8%
Natural	132,920	5%
Feeding Operations	106,787	4%
Stream Bank & Bed	124,140	4%
Wastewater	238,625	8%
Septic	56,846	2%
Shoreline	104,892	4%

Phase 5: Nitrogen PA Eastern Shore



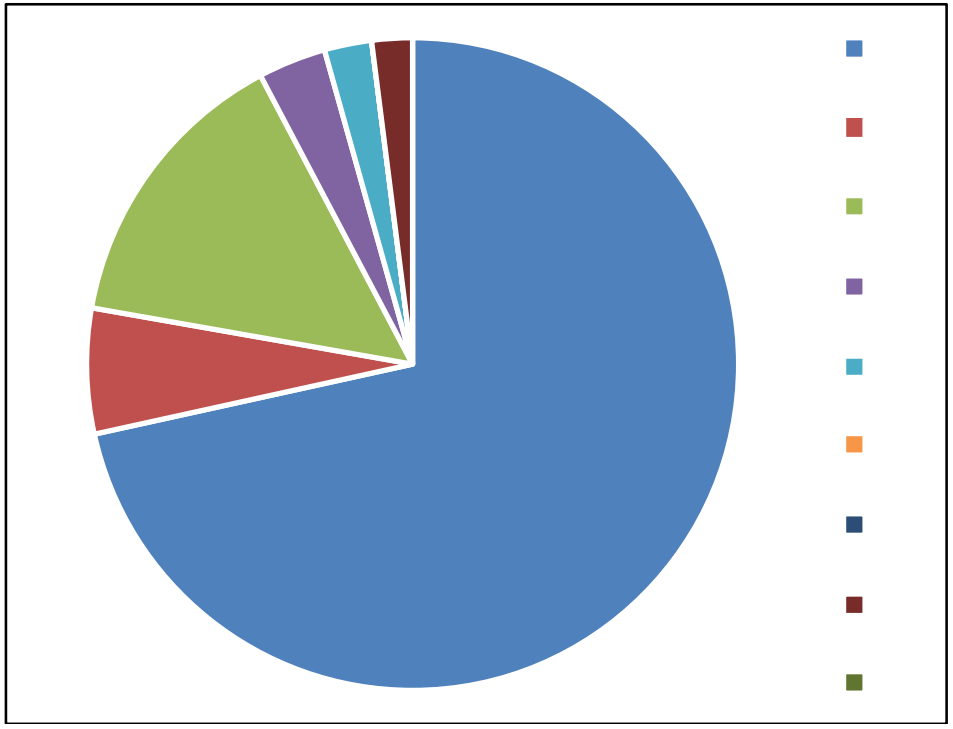
Crops	60,797	62%
Pasture & Hay	9,072	8%
Developed	1,723	16%
Natural	1,404	5%
Feeding Operations	3,747	2%
Stream Bank & Bed		0%
Wastewater	6,754	3%
Septic	8,071	3%
Shoreline		0%

Phase 6: Nitrogen PAL Eastern Shore



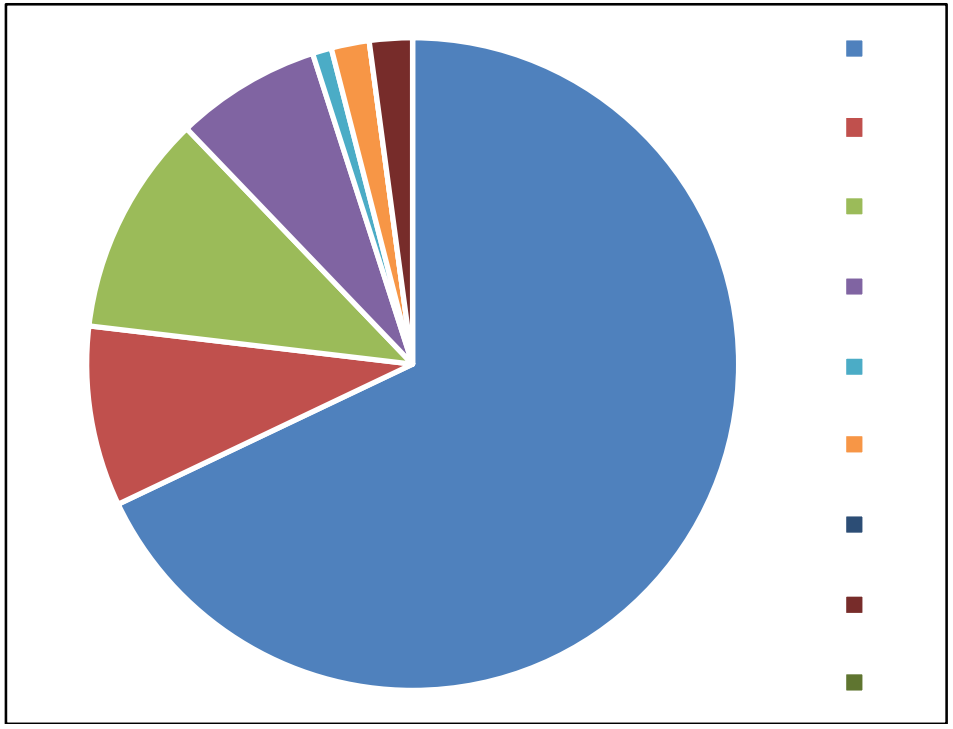
Crops	52,567	55%
Pasture & Hay	103,132	13%
Developed	97,540	12%
Natural	85,025	10%
Feeding Operations	12,190	1%
Stream Bank & Bed	29,738	4%
Wastewater	7,021	1%
Septic	31,291	4%
Shoreline		0%

Phase 5: Nitrogen – PA Western Shore



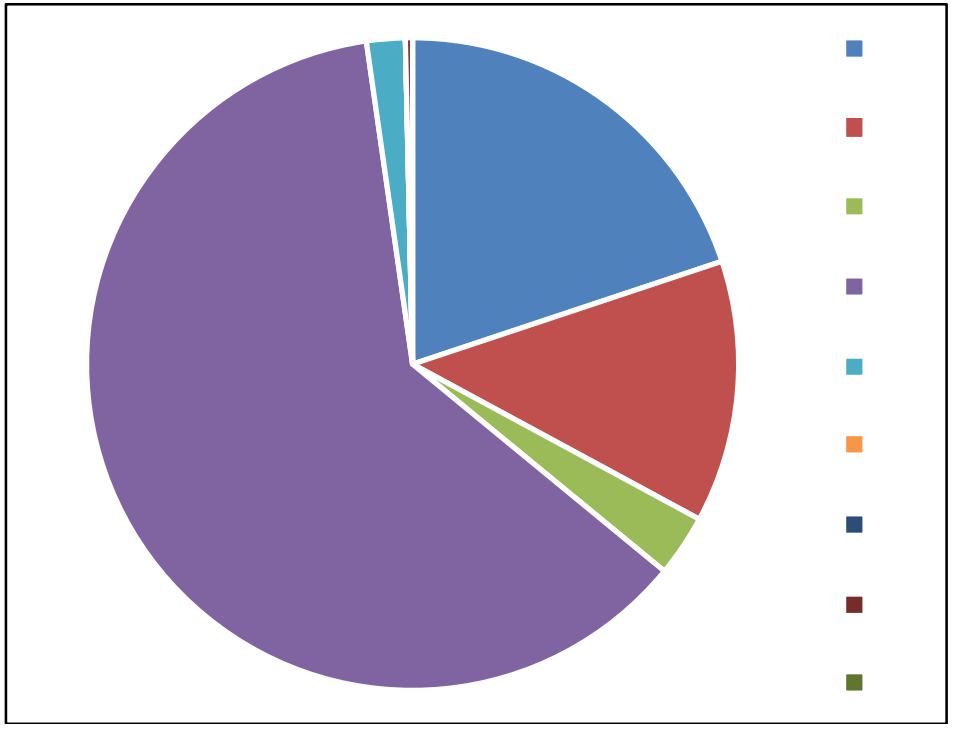
Crops	19,117	72%
Pasture & Hay	1,655	6%
Developed	3,877	15%
Natural	902	3%
Feeding Operations	626	2%
Stream Bank & Bed		0%
Wastewater		0%
Septic	639	2%
Shoreline		0%

Phase 6: Nitrogen – PA Western Shore



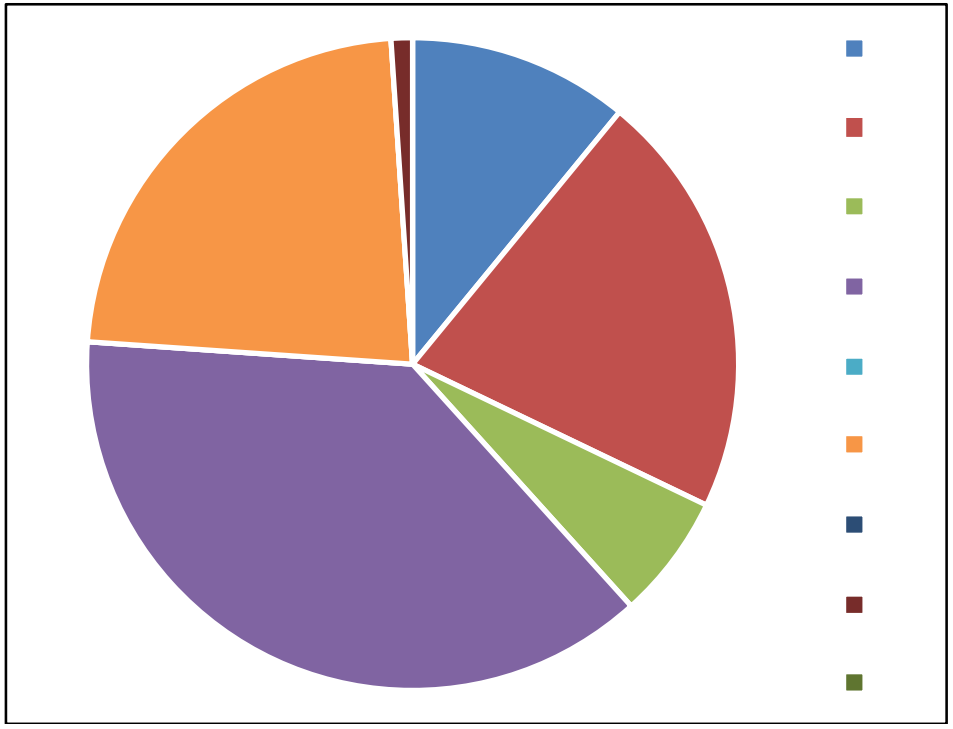
Crops	26,907	68%
Pasture & Hay	3,535	9%
Developed	4,339	11%
Natural	2,857	7%
Feeding Operations	374	1%
Stream Bank & Bed	746	2%
Wastewater	-	0%
Septic	846	2%
Shoreline	-	0%

Phase 5: Nitrogen – WV James



Crops	5,291	20%
Pasture & Hay	3,455	13%
Developed	814	3%
Natural	16,429	62%
Feeding Operations	508	2%
Stream Bank & Bed		0%
Wastewater		0%
Septic	95	0%
Shoreline		0%

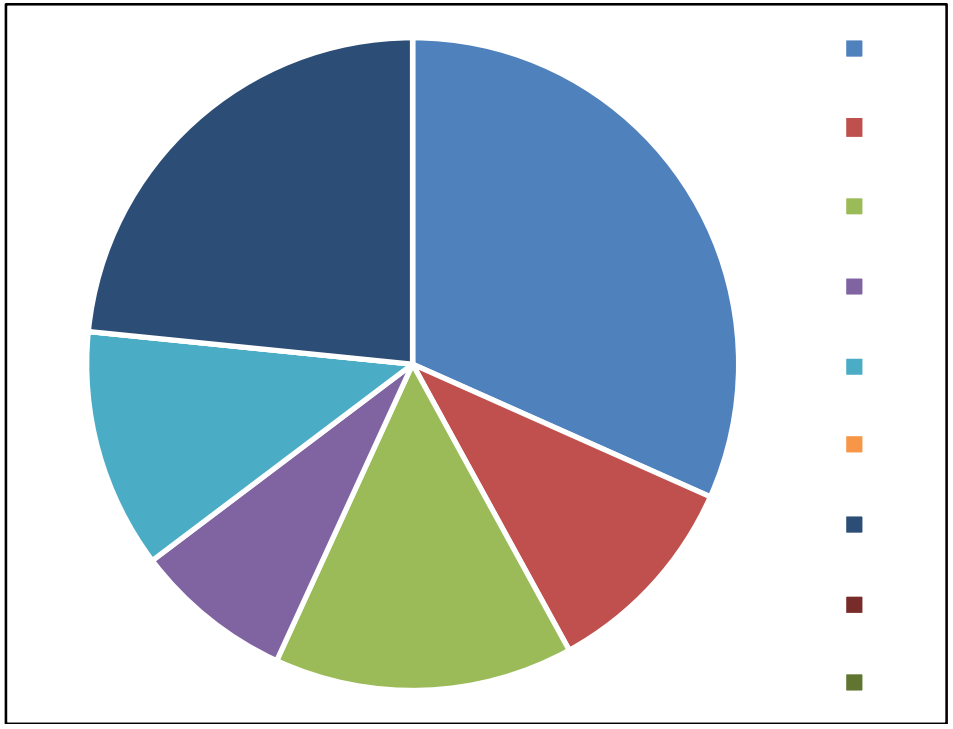
Phase 6: Nitrogen – WV James



Crops	5,762	11%
Pasture & Hay	11,147	21%
Developed	3,256	6%
Natural	19,893	38%
Feeding Operations	-	0%
Stream Bank & Bed	12,028	23%
Wastewater	-	0%
Septic	360	1%
Shoreline	-	0%

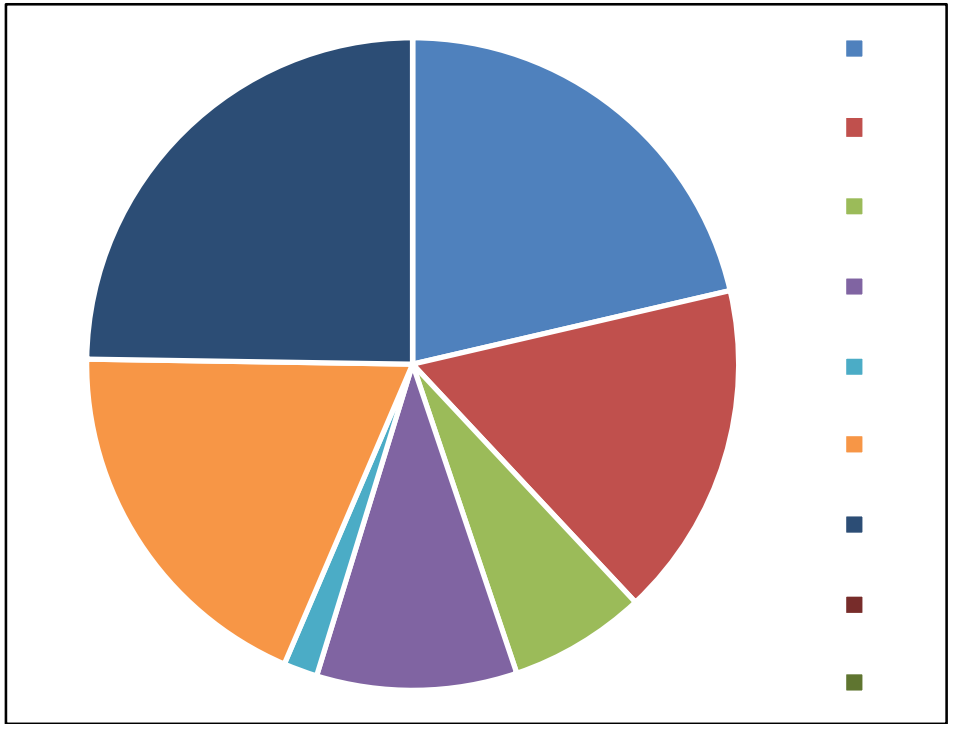
State – basin loads: Phosphorus

Phase 5: Phosphorus in PA Susquehanna



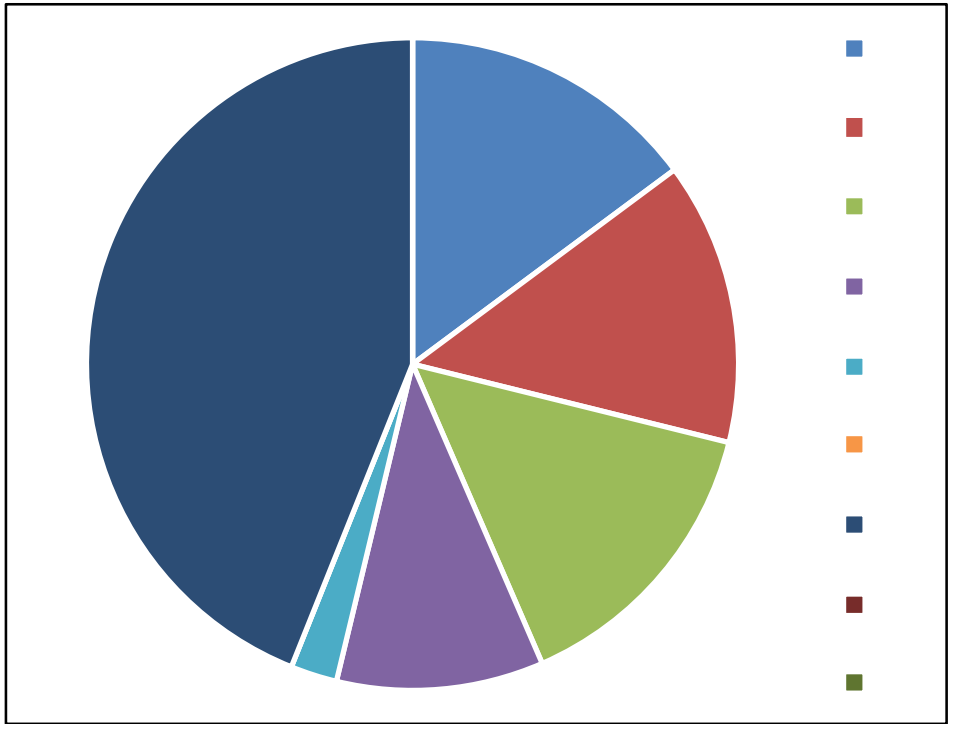
Crops	1,390,551	32%
Pasture & Hay	454,359	10%
Developed	650,792	15%
Natural	345,911	8%
Feeding Operations	521,523	12%
Stream Bank & Bed		0%
Wastewater	1,027,563	23%
Septic		0%
Shoreline		0%

Phase 6: Phosphorus – PA Susquehanna



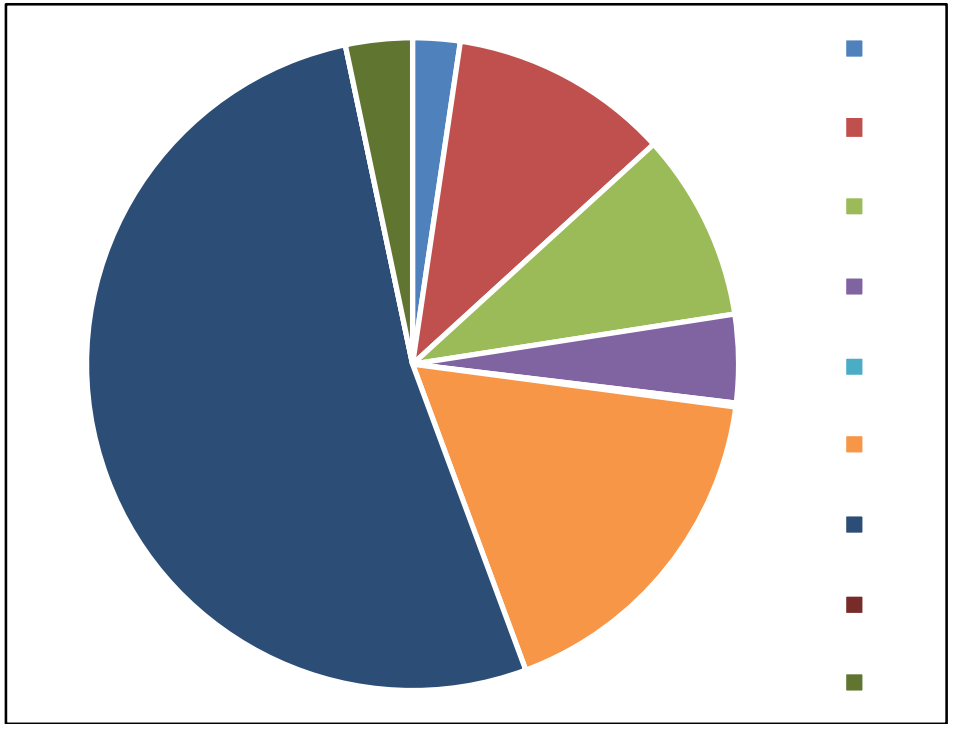
Crops	37,966	21%
Pasture & Hay	30,232	17%
Developed	98,497	7%
Natural	35,800	10%
Feeding Operations	3,817	2%
Stream Bank & Bed	24,837	19%
Wastewater	1,086,345	25%
Septic		0%
Shoreline		0%

Phase 5: Phosphorus WLAs



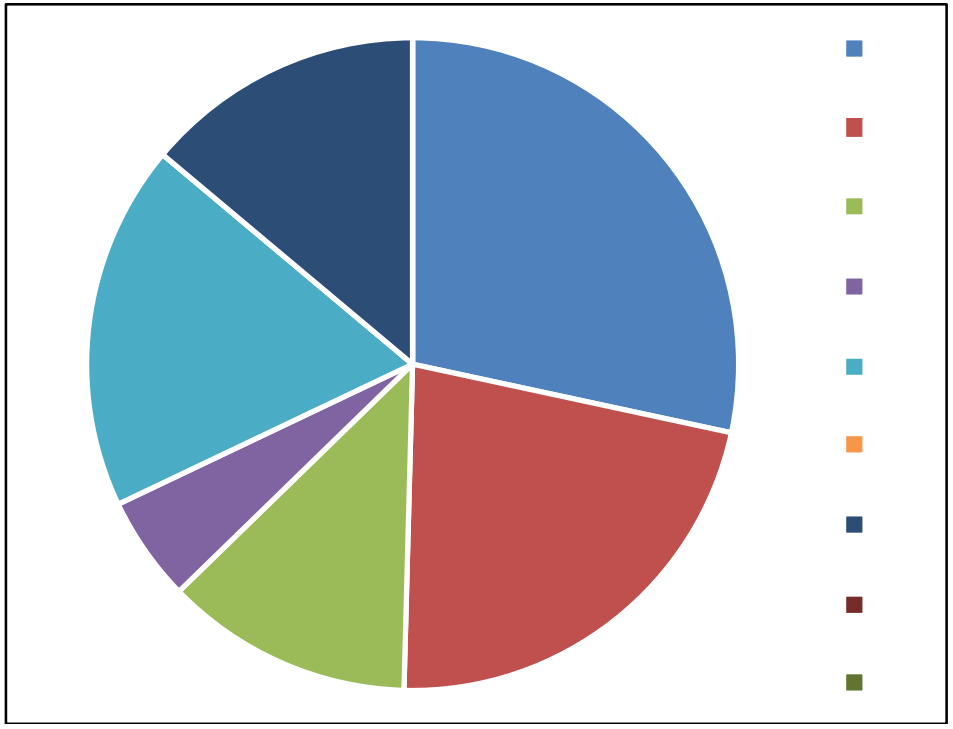
Crops	615,750	15%
Pasture & Hay	581,216	14%
Developed	606,424	15%
Natural	425,431	10%
Feeding Operations	96,020	2%
Stream Bank & Bed		0%
Wastewater	1,821,582	44%
Septic		0%
Shoreline		0%

Phase 6: Phosphorus – VA James



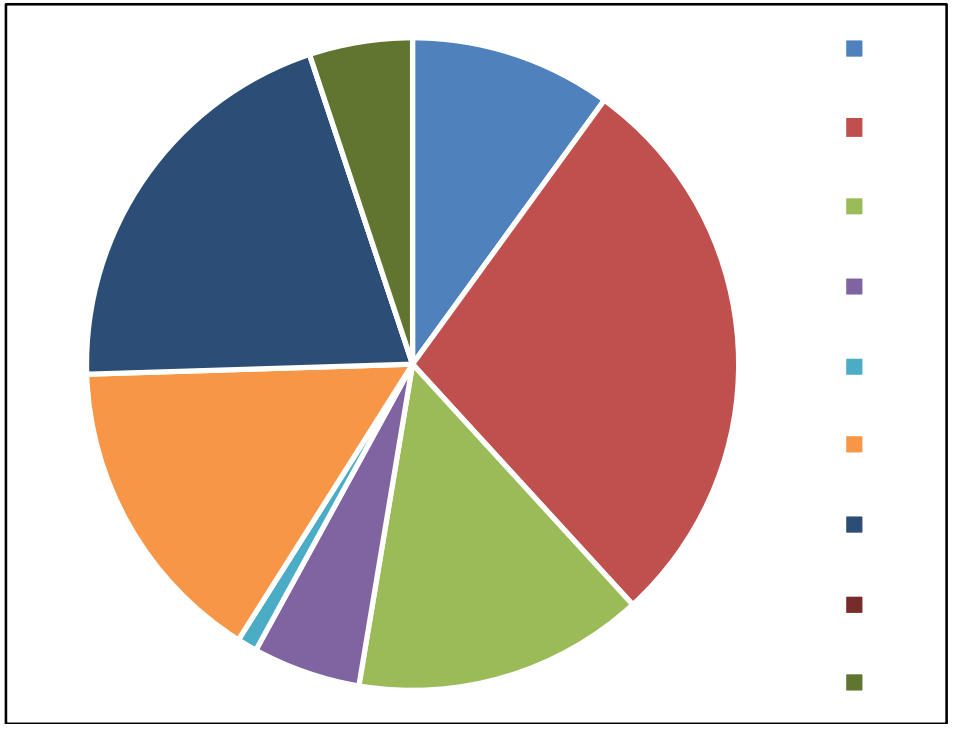
Crops	102,463	2%
Pasture & Hay	476,249	11%
Developed	406,648	9%
Natural	190,154	4%
Feeding Operations	18,506	0%
Stream Bank & Bed	753,795	17%
Wastewater	2,286,331	52%
Septic	-	0%
Shoreline	144,791	3%

Phase 5: Phosphorus – VA Potomac



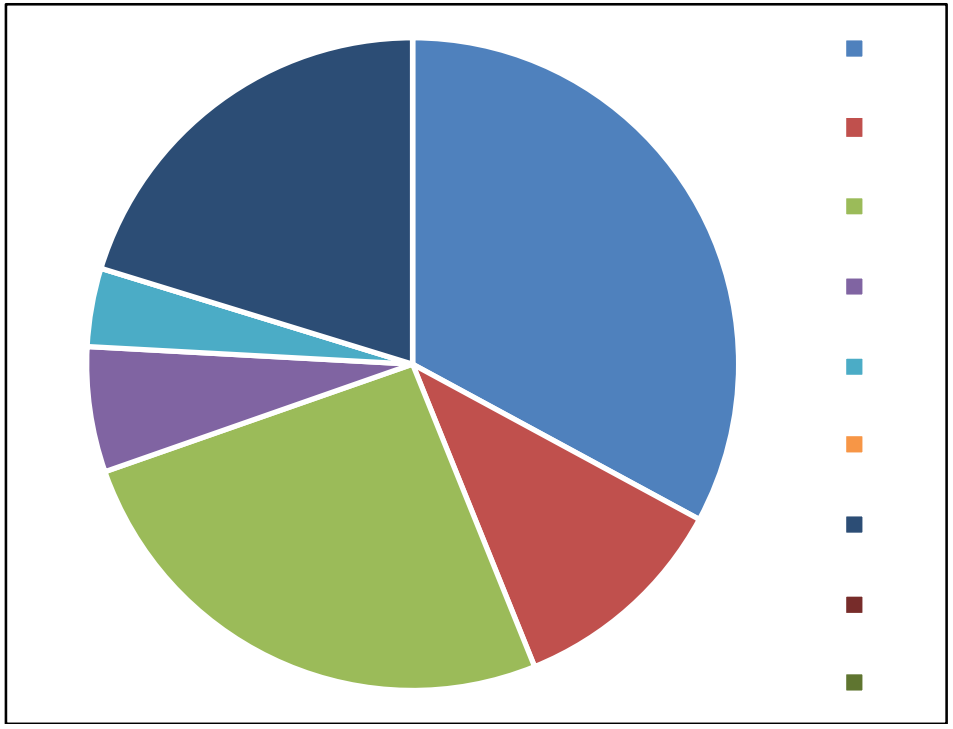
Crops	737,546	28%
Pasture & Hay	573,214	22%
Developed	319,721	12%
Natural	135,375	5%
Feeding Operations	472,217	18%
Stream Bank & Bed		0%
Wastewater	361,356	14%
Septic		0%
Shoreline		0%

Phase 6: Phosphorus – VA Potomac



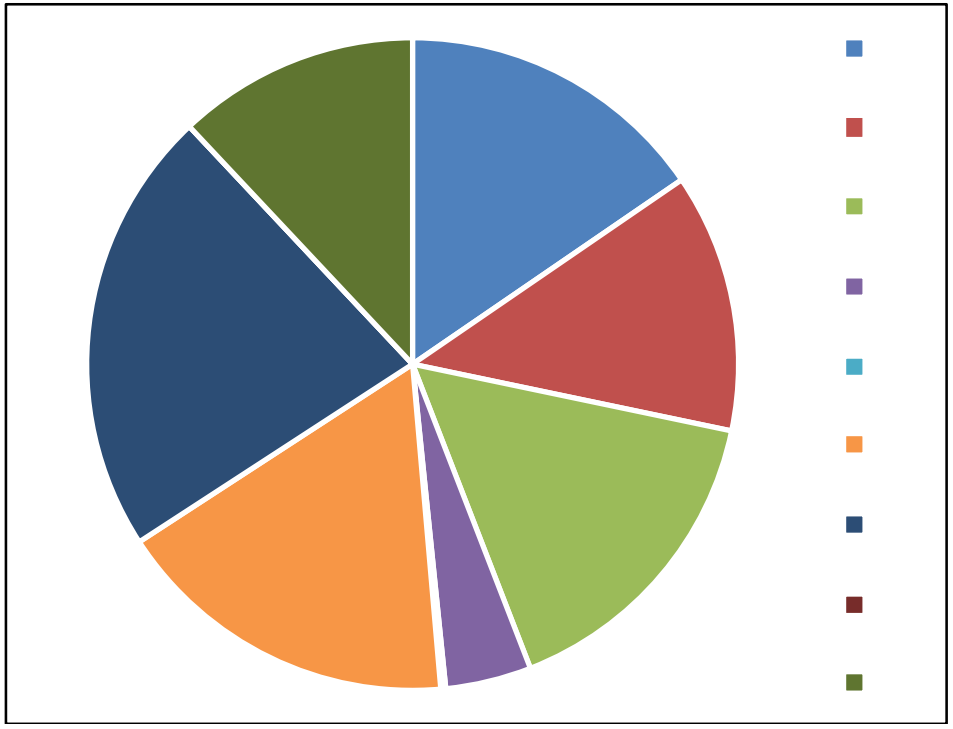
Crops	256,517	10%
Pasture & Hay	722,537	28%
Developed	369,895	14%
Natural	137,106	5%
Feeding Operations	25,391	1%
Stream Bank & Bed	398,016	16%
Wastewater	522,150	20%
Septic		0%
Shoreline	131,143	5%

Phase 5: Phosphorus – MD Potomac



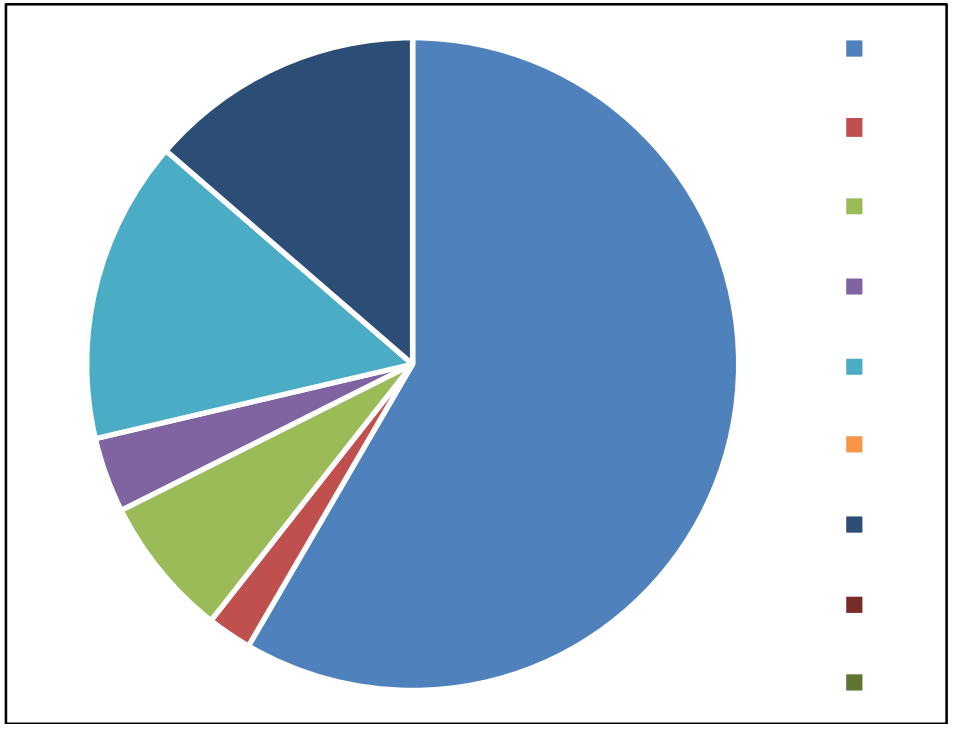
Crops	407,395	33%
Pasture & Hay	136,277	11%
Developed	318,930	26%
Natural	76,886	6%
Feeding Operations	48,178	4%
Stream Bank & Bed	0	0%
Wastewater	250,892	20%
Septic	0	0%
Shoreline	0	0%

Phase 6: Phosphorus – MD Potomac



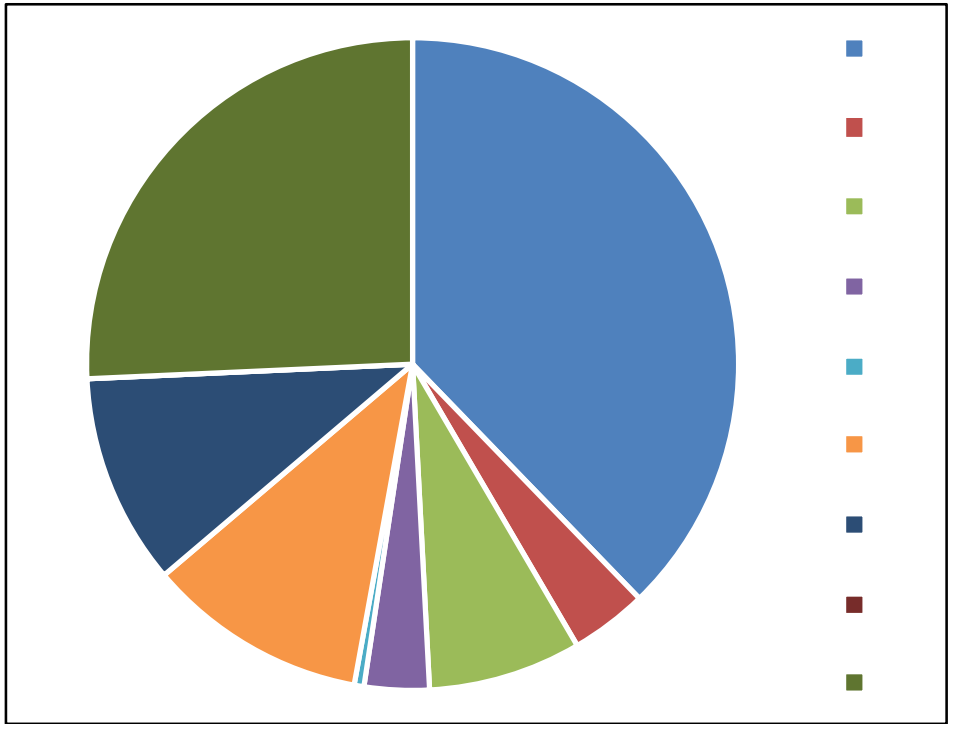
Crops	228,915	15%
Pasture & Hay	189,994	13%
Developed	234,560	16%
Natural	63,084	4%
Feeding Operations	3,611	0%
Stream Bank & Bed	254,839	17%
Wastewater	328,175	22%
Septic		0%
Shoreline	177,957	12%

Phase 5: Phosphorus – MD Eastern Shore



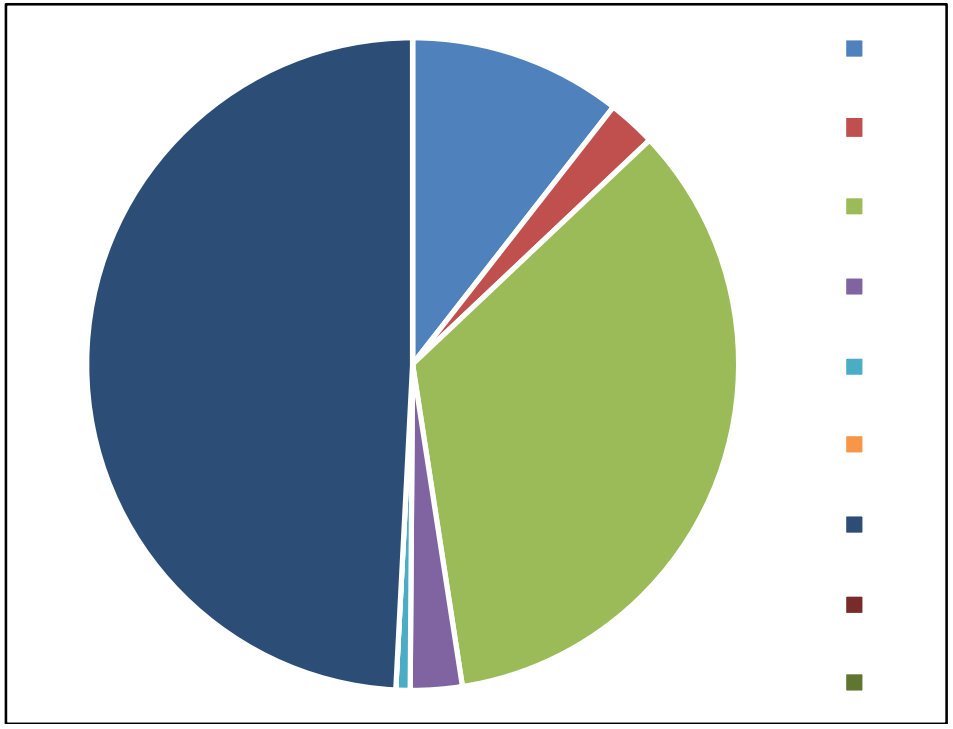
Crops	48,438	58%
Pasture & Hay	8,290	2%
Developed	9,765	7%
Natural	7,643	4%
Feeding Operations	12,370	15%
Stream Bank & Bed		0%
Wastewater	5,012	14%
Septic		0%
Shoreline		0%

Phase 6: Phosphorus – MD Eastern Shore



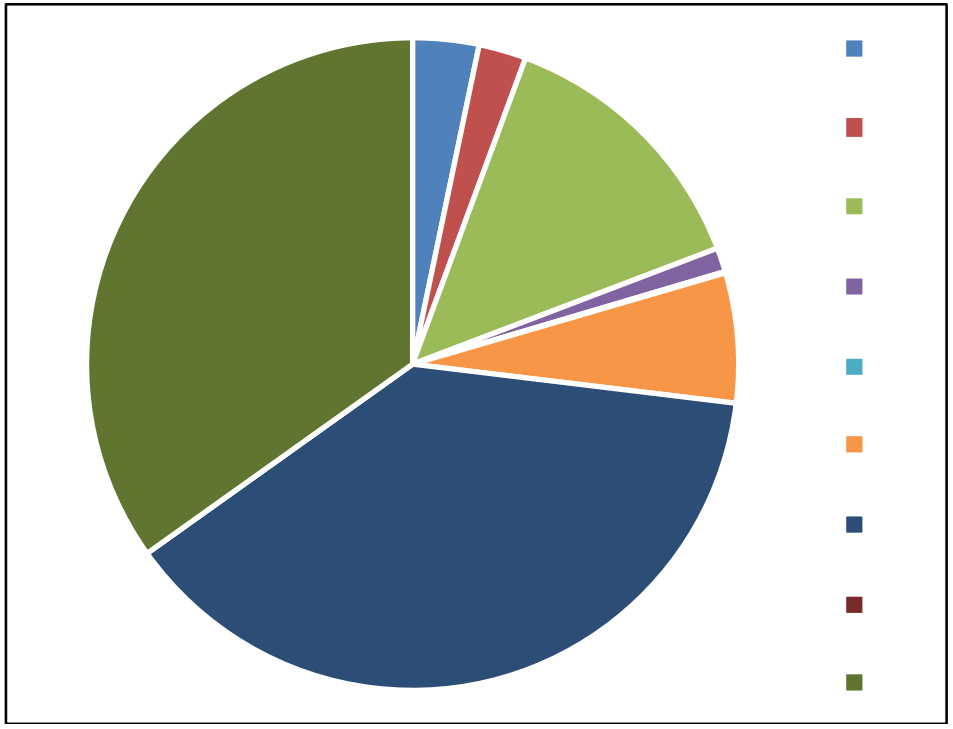
Crops	24,416	38%
Pasture & Hay	3,106	4%
Developed	5,820	8%
Natural	1,848	3%
Feeding Operations	207	0%
Stream Bank & Bed	9,664	11%
Wastewater	0,989	10%
Septic		0%
Shoreline	3,524	26%

Phase 5: Phosphorus – MD Western Shore



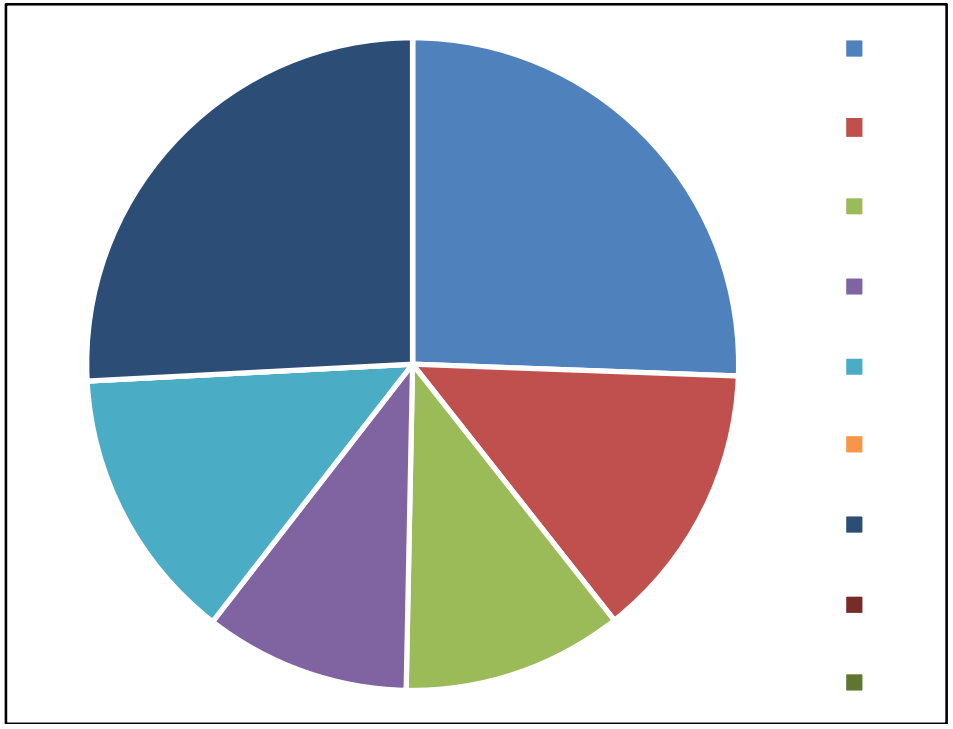
Crops	75,841	11%
Pasture & Hay	17,260	2%
Developed	248,648	35%
Natural	18,405	3%
Feeding Operations	8,043	1%
Stream Bank & Bed	2	0%
Wastewater	353,403	49%
Septic	2	0%
Shoreline	2	0%

Phase 6: Phosphorus – MD Western Shore



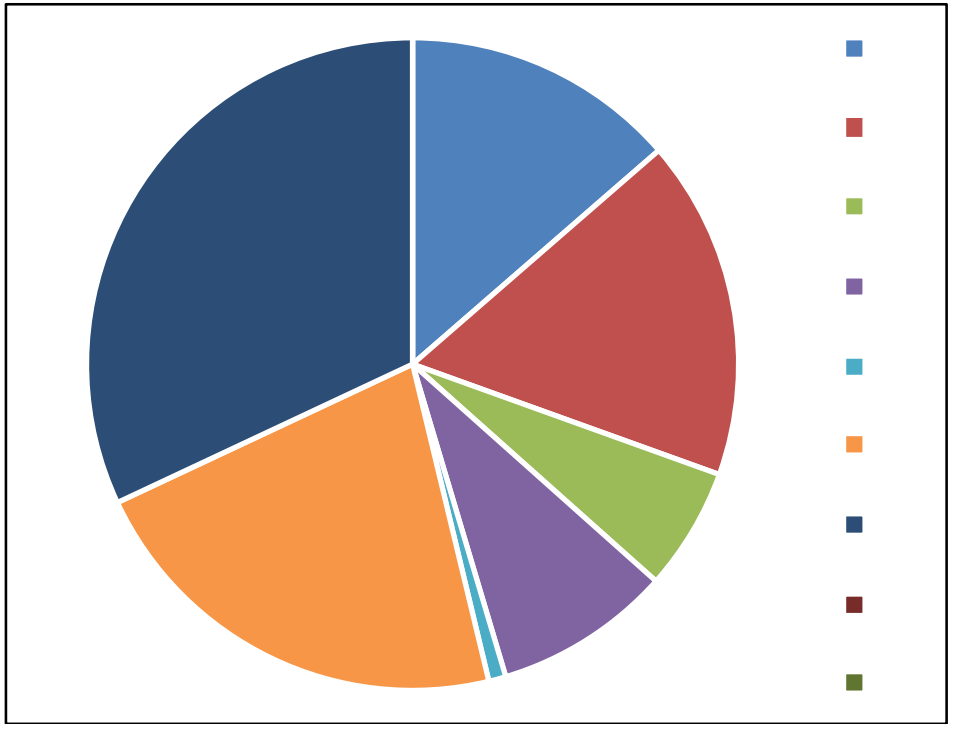
Crops	44,314	3%
Pasture & Hay	31,816	2%
Developed	183,512	14%
Natural	16,151	1%
Feeding Operations	1,040	0%
Stream Bank & Bed	86,648	6%
Wastewater	516,456	38%
Septic		0%
Shoreline	470,607	35%

Phase 5: Phosphorus – NY Susquehanna



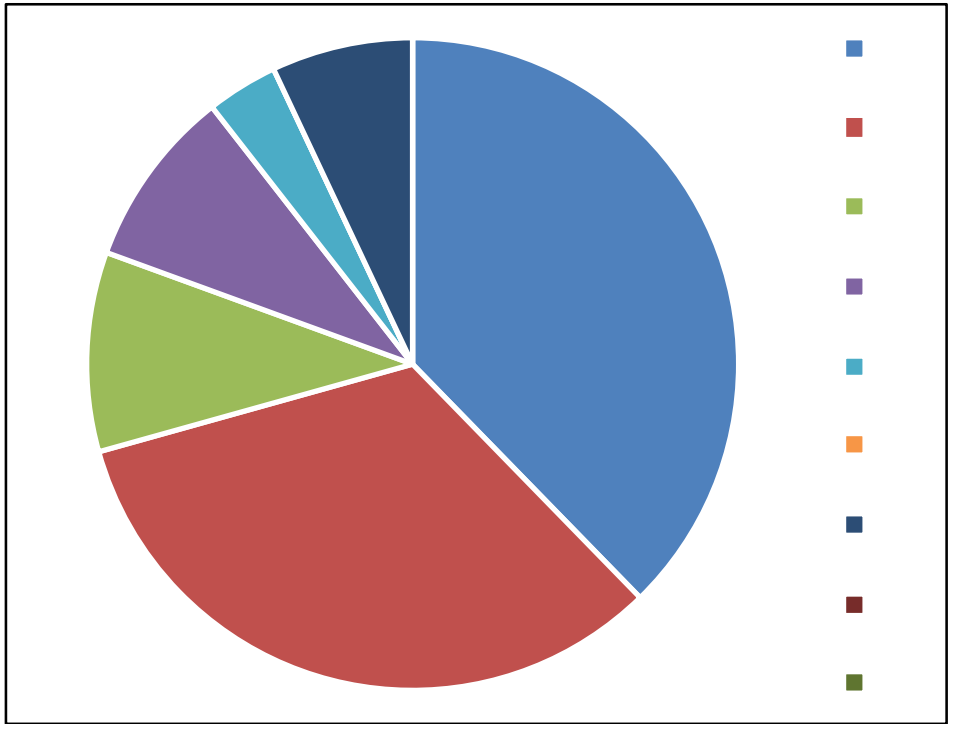
Crops	264,886	26%
Pasture & Hay	142,766	14%
Developed	113,309	11%
Natural	105,522	10%
Feeding Operations	141,464	14%
Stream Bank & Bed		0%
Wastewater	267,395	26%
Septic		0%
Shoreline		0%

Phase 6: Phosphorus – NY Susquehanna



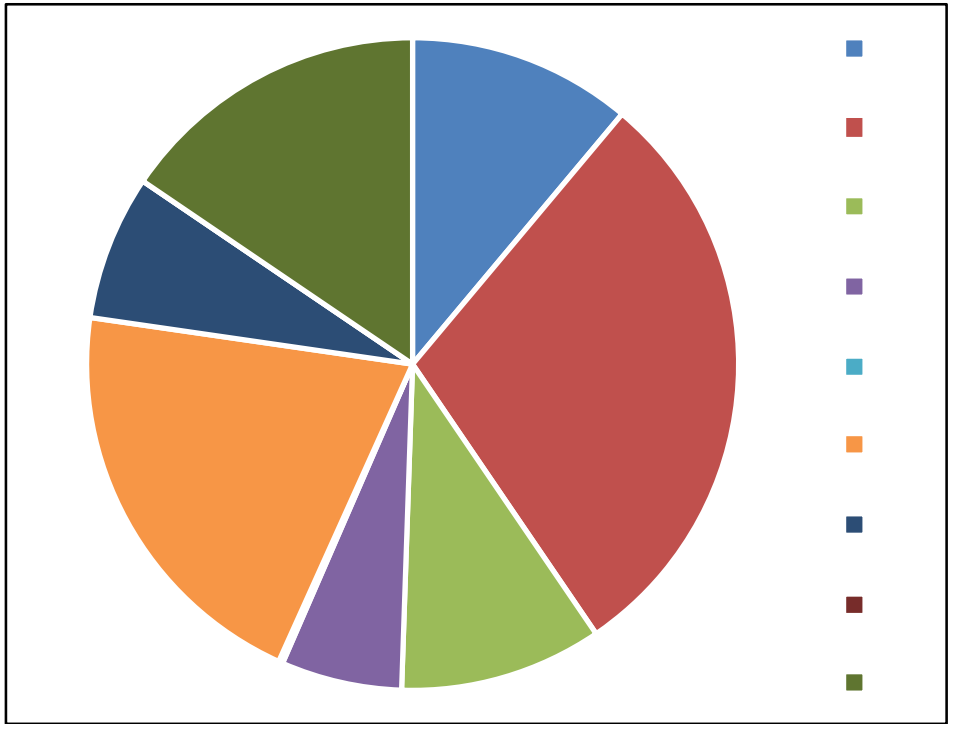
Crops	141,787	14%
Pasture & Hay	175,449	17%
Developed	63,385	6%
Natural	91,603	9%
Feeding Operations	8,837	1%
Stream Bank & Bed	226,633	22%
Wastewater	332,614	32%
Septic	-	0%
Shoreline	-	0%

Phase 5: Phosphorus – VA Rappahannock



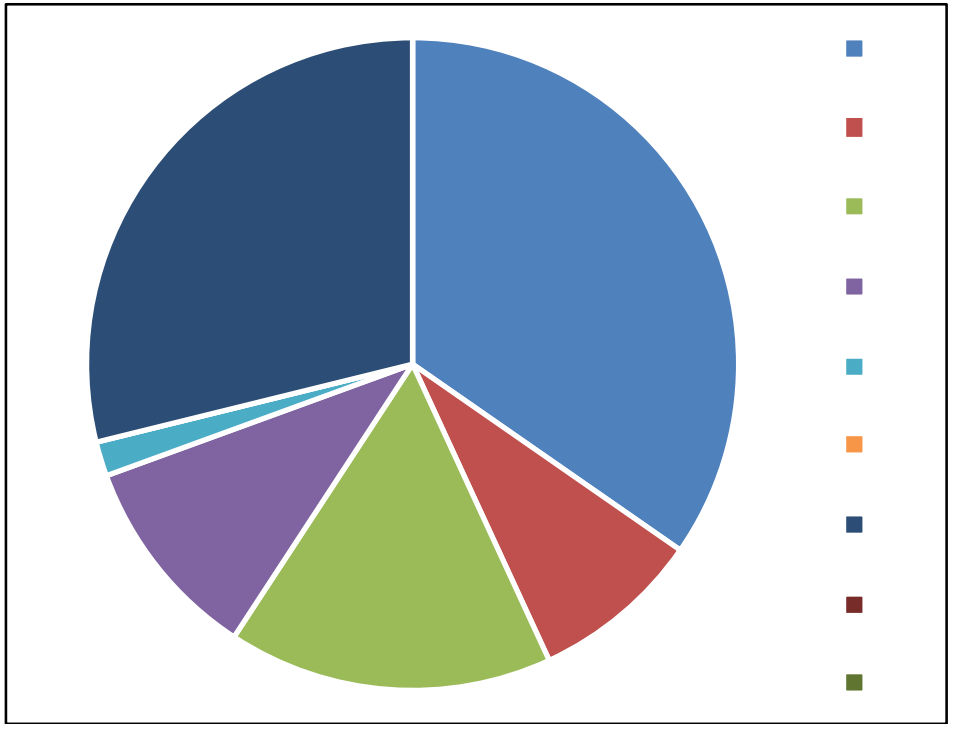
Crops	107,203	38%
Pasture & Hay	93,443	33%
Developed	33,030	10%
Natural	19,566	9%
Feeding Operations	17,585	4%
Stream Bank & Bed	0	0%
Wastewater	14,411	7%
Septic	0	0%
Shoreline	0	0%

Phase 6: Phosphorus – VA Rappahannock



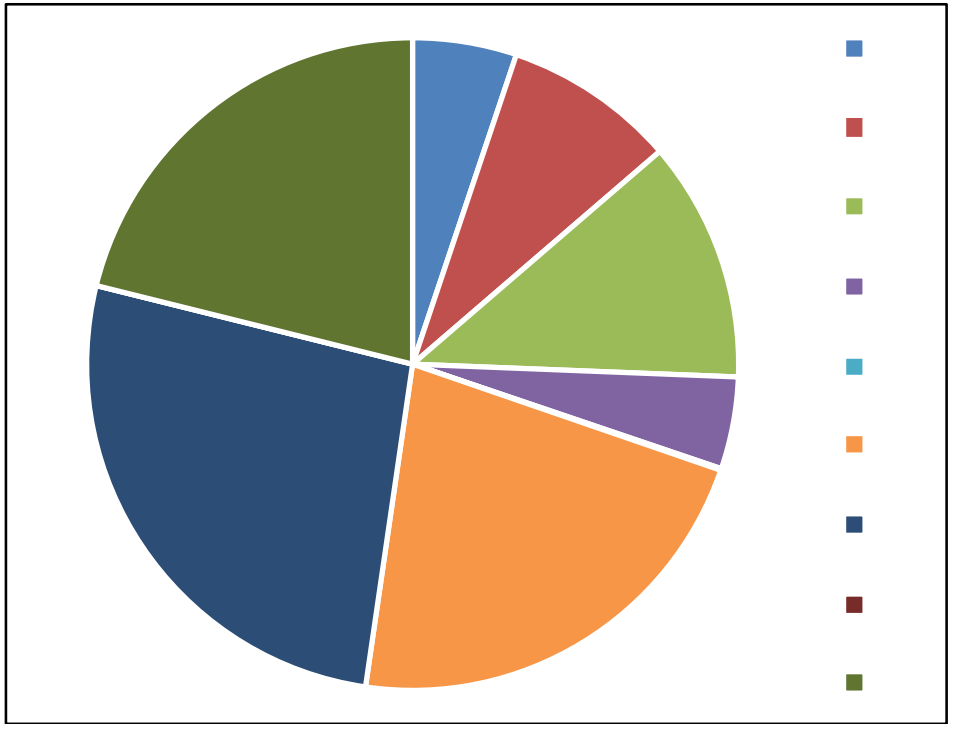
Crops	30,905	11%
Pasture & Hay	46,186	29%
Developed	18,570	10%
Natural	10,604	6%
Feeding Operations	2,454	0%
Stream Bank & Bed	42,073	21%
Wastewater	4,863	7%
Septic		0%
Shoreline	32,869	16%

Phase 5: Phosphorus – VA York



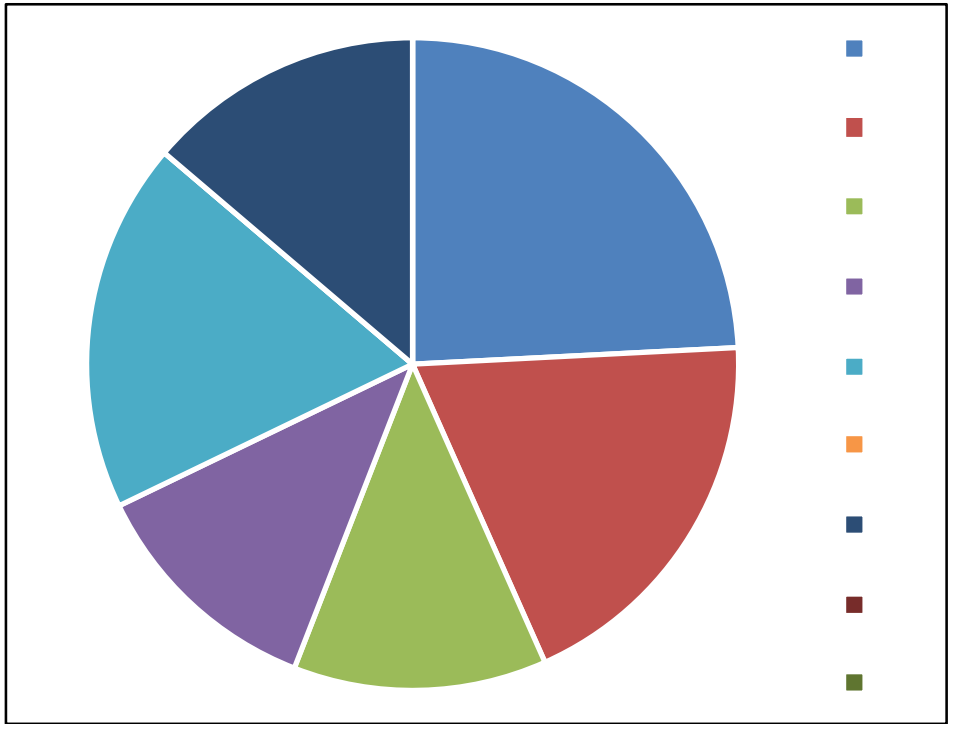
Crops	235,993	35%
Pasture & Hay	57,619	8%
Developed	109,658	16%
Natural	69,559	10%
Feeding Operations	11,644	2%
Stream Bank & Bed	0	0%
Wastewater	196,429	29%
Septic	0	0%
Shoreline	0	0%

Phase 6: Phosphorus – VA York



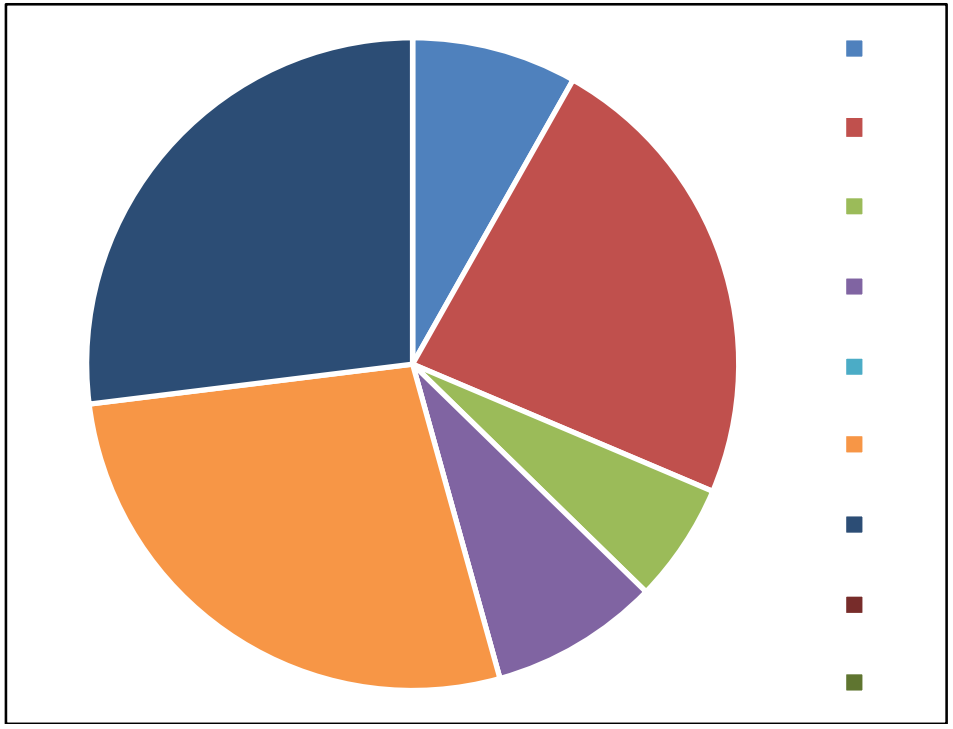
Crops	34,948	5%
Pasture & Hay	57,891	9%
Developed	80,878	12%
Natural	30,985	5%
Feeding Operations	43	0%
Stream Bank & Bed	149,308	22%
Wastewater	180,044	27%
Septic		0%
Shoreline	143,253	21%

Phase 5: Phosphorus – WV Potomac



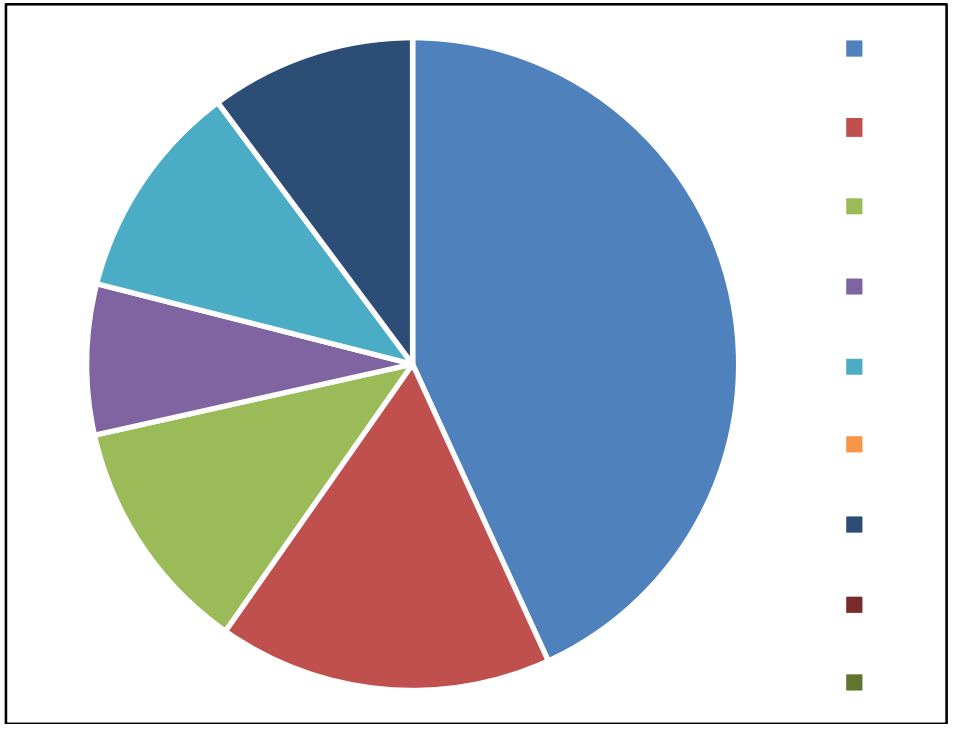
Crops	225,176	24%
Pasture & Hay	178,168	19%
Developed	117,020	13%
Natural	111,052	12%
Feeding Operations	170,955	18%
Stream Bank & Bed		0%
Wastewater	128,257	14%
Septic		0%
Shoreline		0%

Phase 6: Phosphorus – WV Potomac



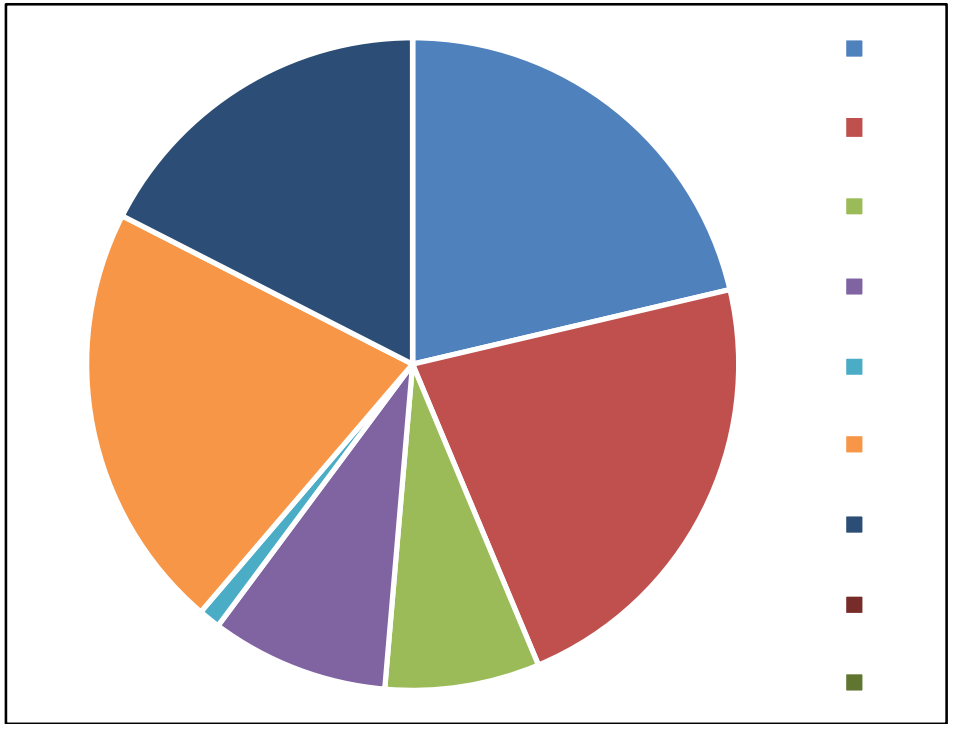
Crops	61,197	8%
Pasture & Hay	173,257	23%
Developed	44,254	6%
Natural	62,718	8%
Feeding Operations	4	0%
Stream Bank & Bed	204,435	27%
Wastewater	201,429	27%
Septic	1	0%
Shoreline	1	0%

Phase 5: Phosphorus – PA Potomac



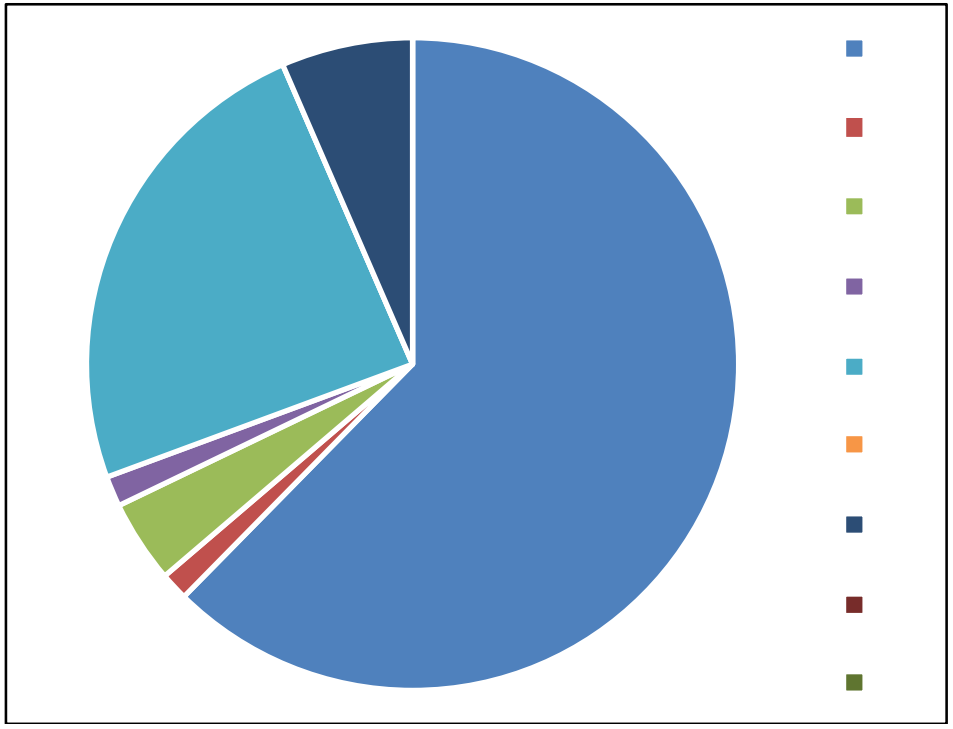
Crops	272,275	43%
Pasture & Hay	104,451	17%
Developed	74,247	12%
Natural	46,988	7%
Feeding Operations	68,404	11%
Stream Bank & Bed		0%
Wastewater	64,324	10%
Septic		0%
Shoreline		0%

Phase 6: Phosphorus – PA Potomac



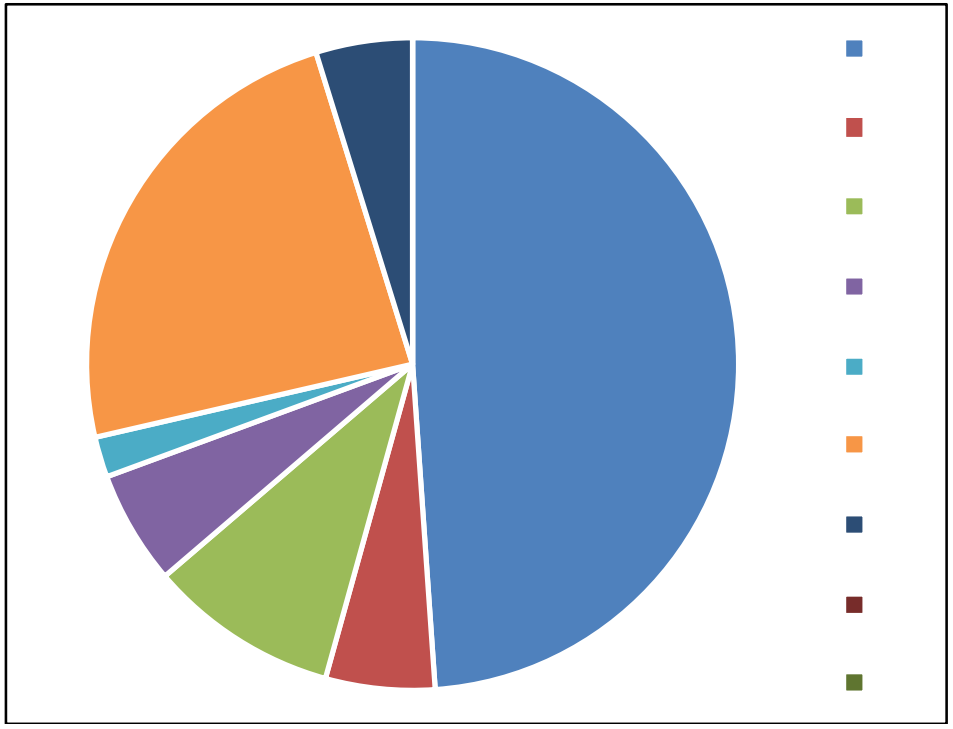
Crops	21,789	21%
Pasture & Hay	27,706	22%
Developed	13,784	8%
Natural	10,387	9%
Feeding Operations	1,182	1%
Stream Bank & Bed	21,257	21%
Wastewater	19,923	17%
Septic		0%
Shoreline		0%

Phase 5: Phosphorus – DE Eastern Shore



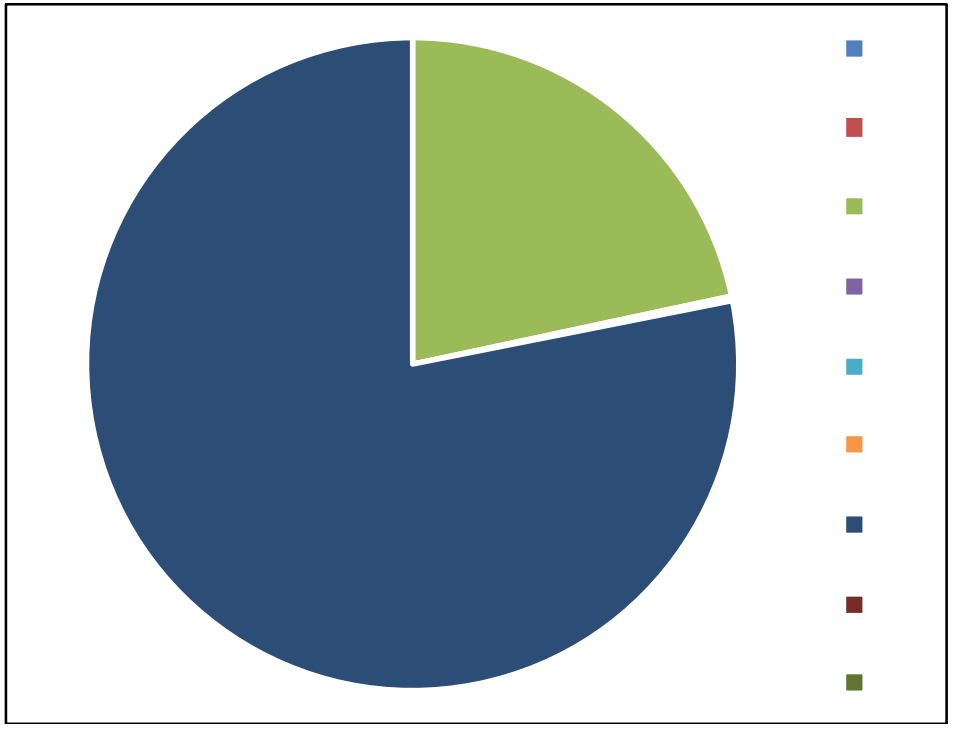
Crops	287,572	62%
Pasture & Hay	6,334	1%
Developed	18,979	4%
Natural	8,956	2%
Feeding Operations	111,135	24%
Stream Bank & Bed		0%
Wastewater	30,062	7%
Septic		0%
Shoreline		0%

Phase 6: Phosphorus – DE Eastern Shore



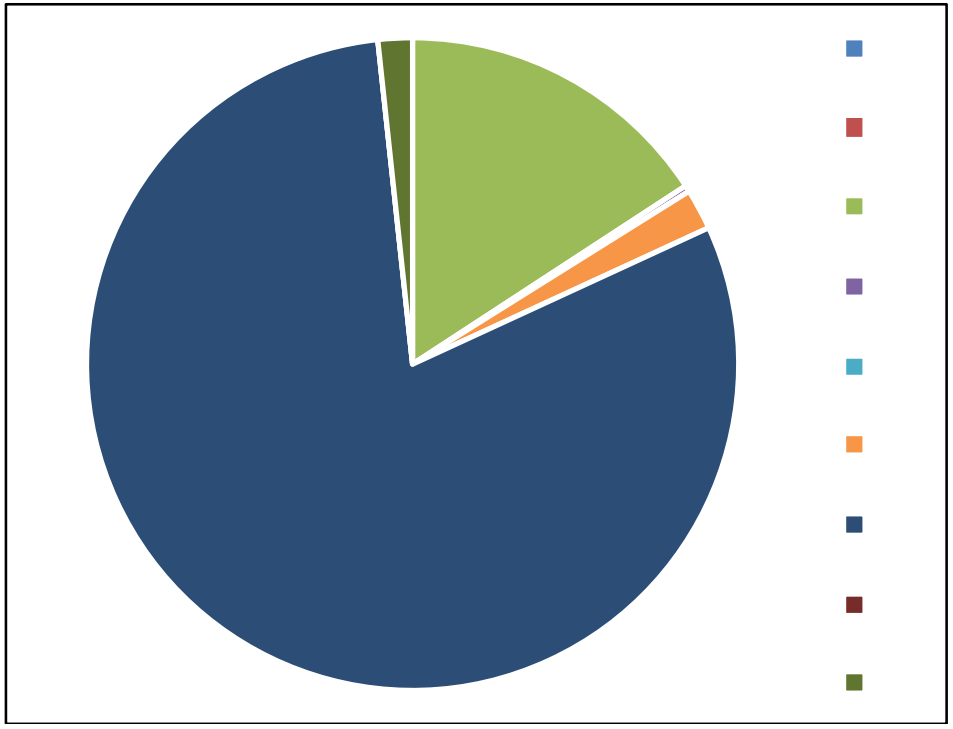
Crops	107,364	49%
Pasture & Hay	11,883	5%
Developed	20,714	9%
Natural	12,392	6%
Feeding Operations	4,406	2%
Stream Bank & Bed	52,294	24%
Wastewater	10,521	5%
Septic		0%
Shoreline		0%

Phase 5: Phosphorus – DC Potomac



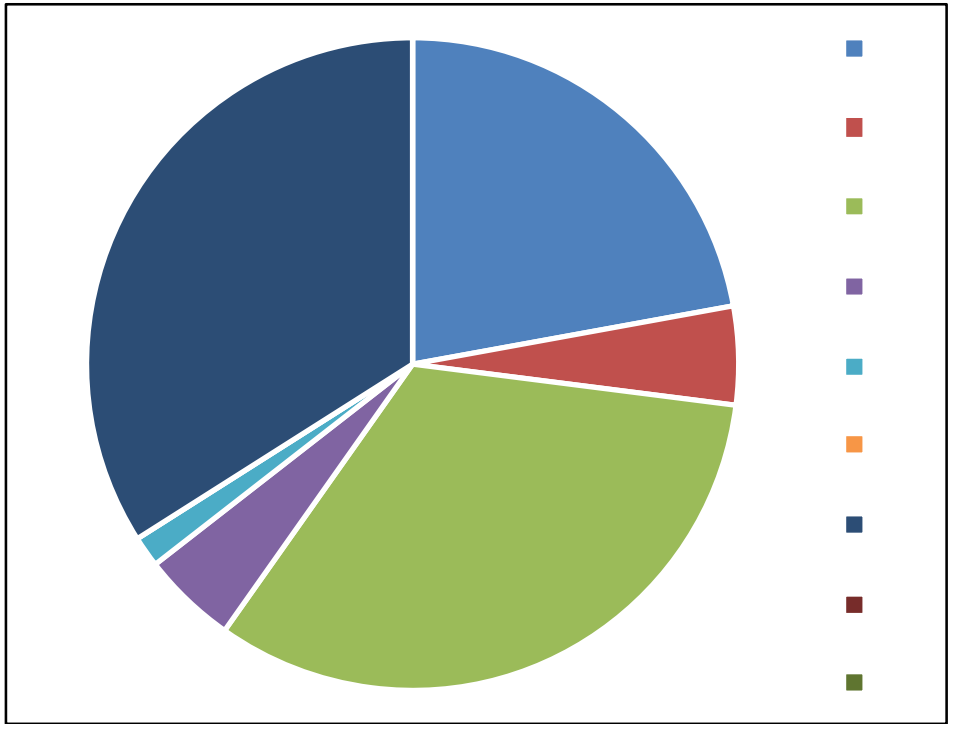
Crops	0	0%
Pasture & Hay	0	0%
Developed	18,443	22%
Natural	204	0%
Feeding Operations	0	0%
Stream Bank & Bed	0	0%
Wastewater	66,532	78%
Septic	0	0%
Shoreline	0	0%

Phase 6: Phosphorus – DC Potomac



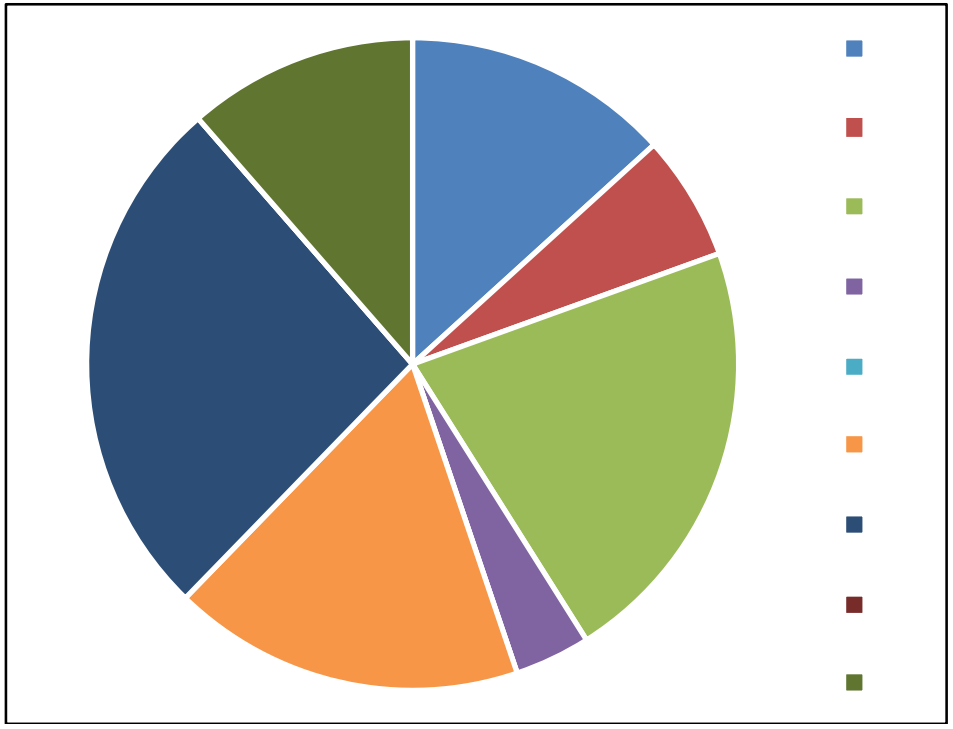
Crops	0	0%
Pasture & Hay	0	0%
Developed	13,582	16%
Natural	269	0%
Feeding Operations	0	0%
Stream Bank & Bed	1,739	2%
Wastewater	68,895	80%
Septic	0	0%
Shoreline	1,469	2%

Phase 5: Phosphorus – MD Patuxent



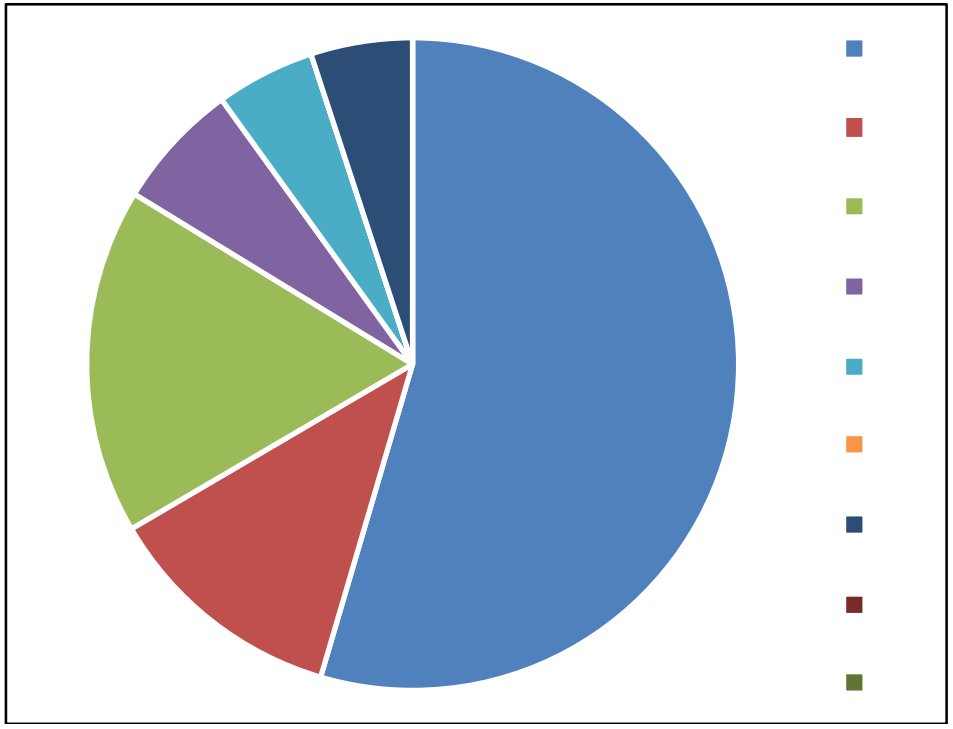
Crops	2,639	22%
Pasture & Hay	6,010	5%
Developed	07,504	33%
Natural	5,421	5%
Feeding Operations	8,024	2%
Stream Bank & Bed		0%
Wastewater	11,505	34%
Septic		0%
Shoreline		0%

Phase 6: Phosphorus – MD Patuxent



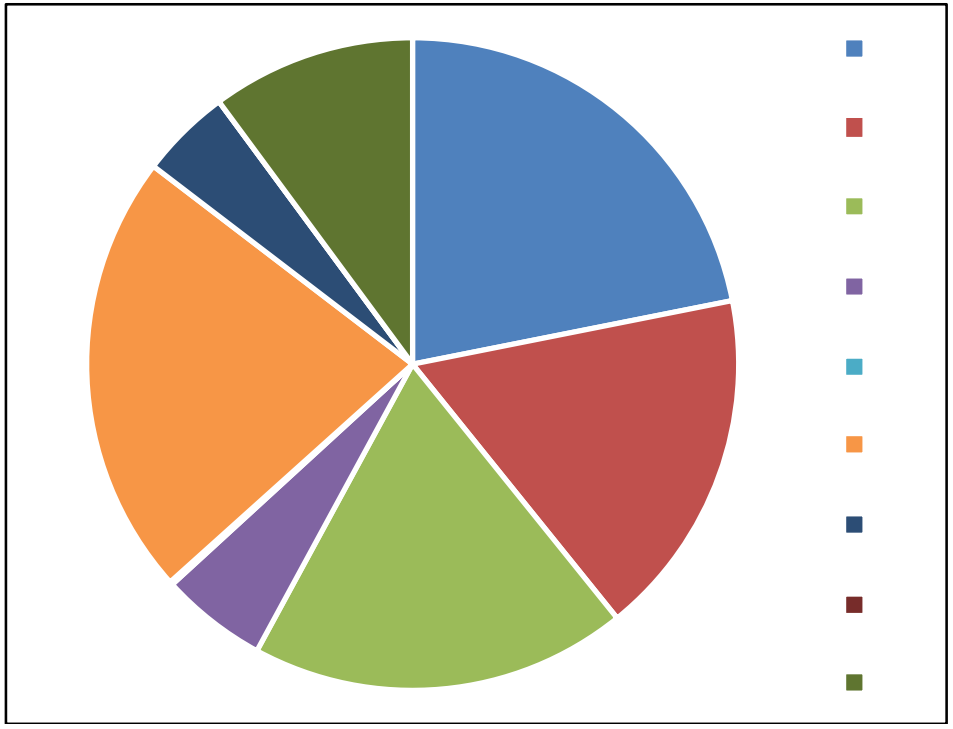
Crops	54,749	13%
Pasture & Hay	25,684	6%
Developed	88,896	22%
Natural	15,502	4%
Feeding Operations	-	0%
Stream Bank & Bed	72,088	17%
Wastewater	108,455	26%
Septic	-	0%
Shoreline	47,165	11%

Phase 5: Phosphorus – MD Susquehanna



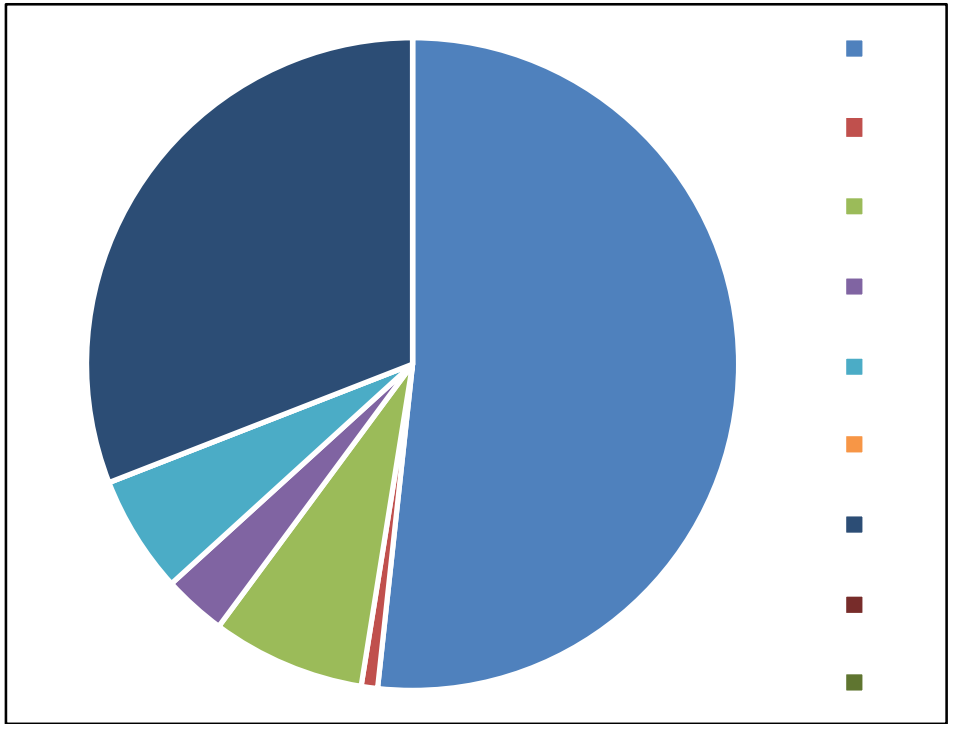
Crops	4,031	55%
Pasture & Hay	9,697	12%
Developed	3,847	17%
Natural	3,093	6%
Feeding Operations	3,965	5%
Stream Bank & Bed		0%
Wastewater	4,077	5%
Septic		0%
Shoreline		0%

Phase 6: Phosphorus – MD Susquehanna



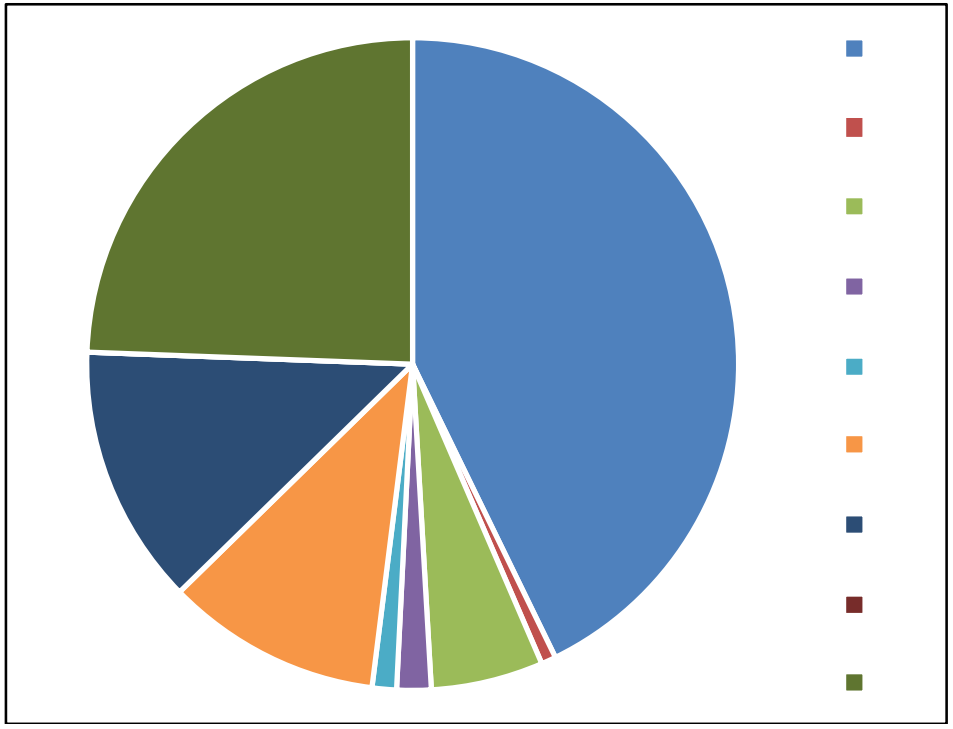
Crops	20,267	22%
Pasture & Hay	16,042	17%
Developed	17,344	19%
Natural	4,883	5%
Feeding Operations	144	0%
Stream Bank & Bed	20,392	22%
Wastewater	4,174	5%
Septic	-	0%
Shoreline	9,378	10%

Phase 5: Phosphorus in VA Eastern Shore



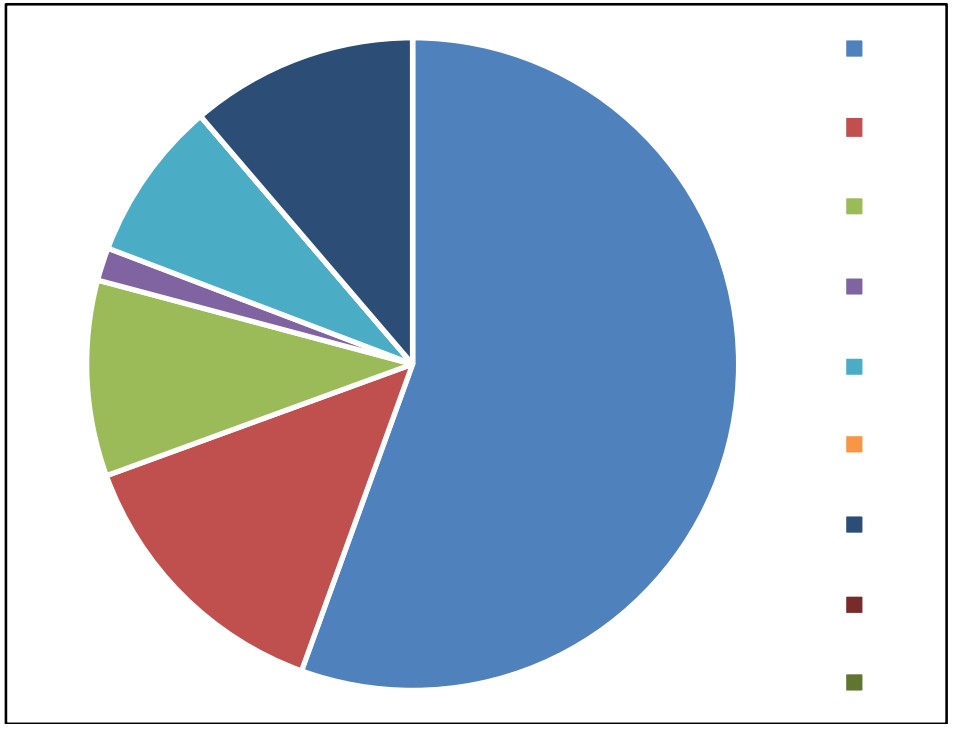
Crops	1,173	52%
Pasture & Hay	1,279	1%
Developed	1,933	8%
Natural	4,889	3%
Feeding Operations	3,167	6%
Stream Bank & Bed		0%
Wastewater	8,520	31%
Septic		0%
Shoreline		0%

Phase 6: Phosphorus – VA Eastern Shore



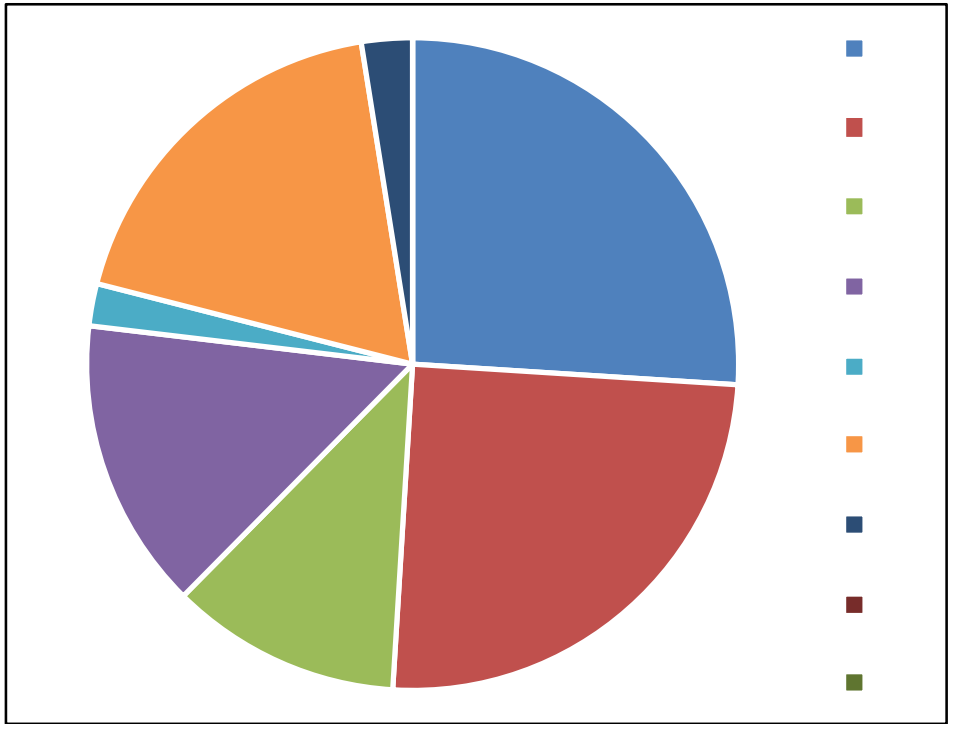
Crops	129,944	43%
Pasture & Hay	2,222	1%
Developed	16,904	6%
Natural	5,173	2%
Feeding Operations	3,661	1%
Stream Bank & Bed	32,479	11%
Wastewater	39,177	13%
Septic		0%
Shoreline	74,148	24%

Phase 5: Phosphorus PA Eastern Shore



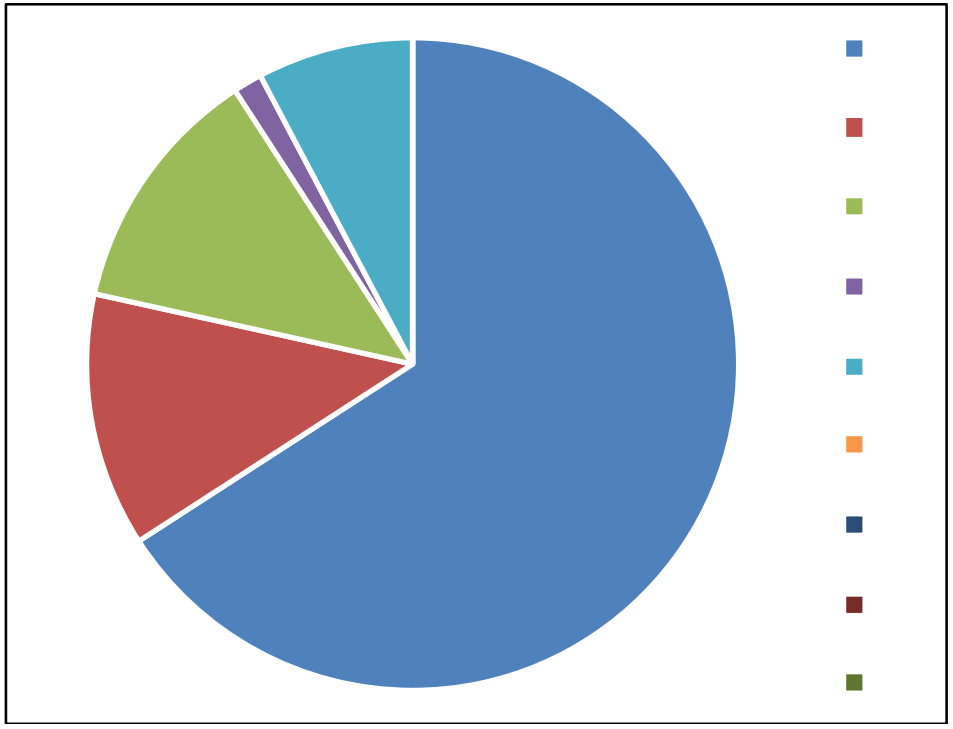
Crops	14,982	56%
Pasture & Hay	3,750	14%
Developed	2,617	10%
Natural	442	2%
Feeding Operations	2,144	8%
Stream Bank & Bed		0%
Wastewater	3,042	11%
Septic		0%
Shoreline		0%

Phase 6: Phosphorus – PA Eastern Shore



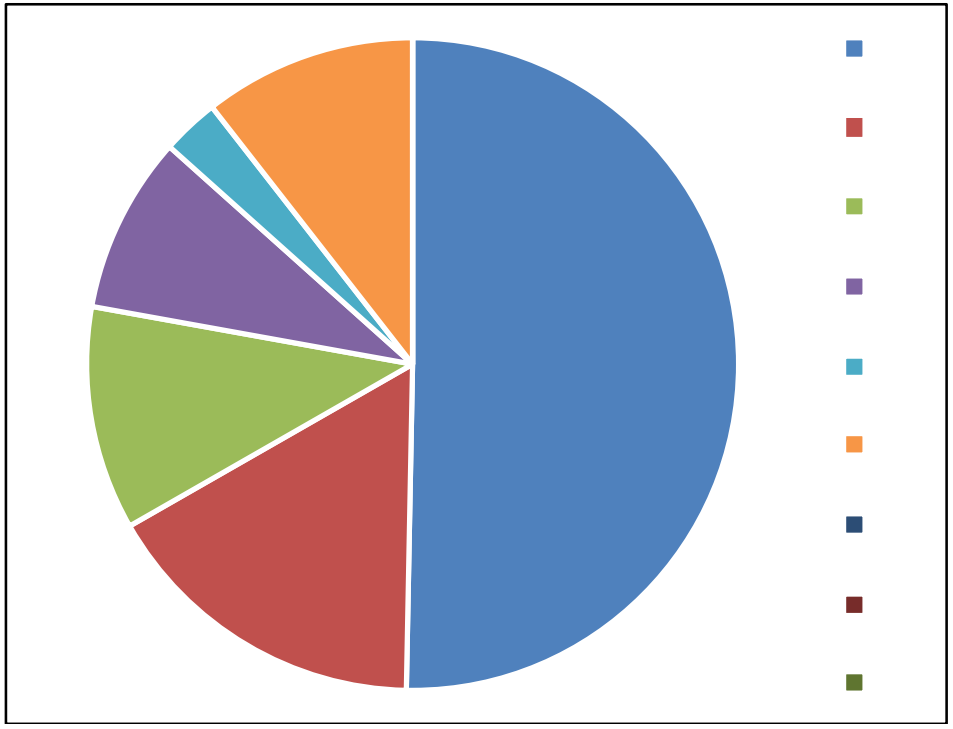
Crops	10,382	26%
Pasture & Hay	9,962	25%
Developed	4,568	11%
Natural	5,769	14%
Feeding Operations	837	2%
Stream Bank & Bed	7,386	19%
Wastewater	1,007	3%
Septic	-	0%
Shoreline	-	0%

Phase 5: Phosphorus in PA Western Shore



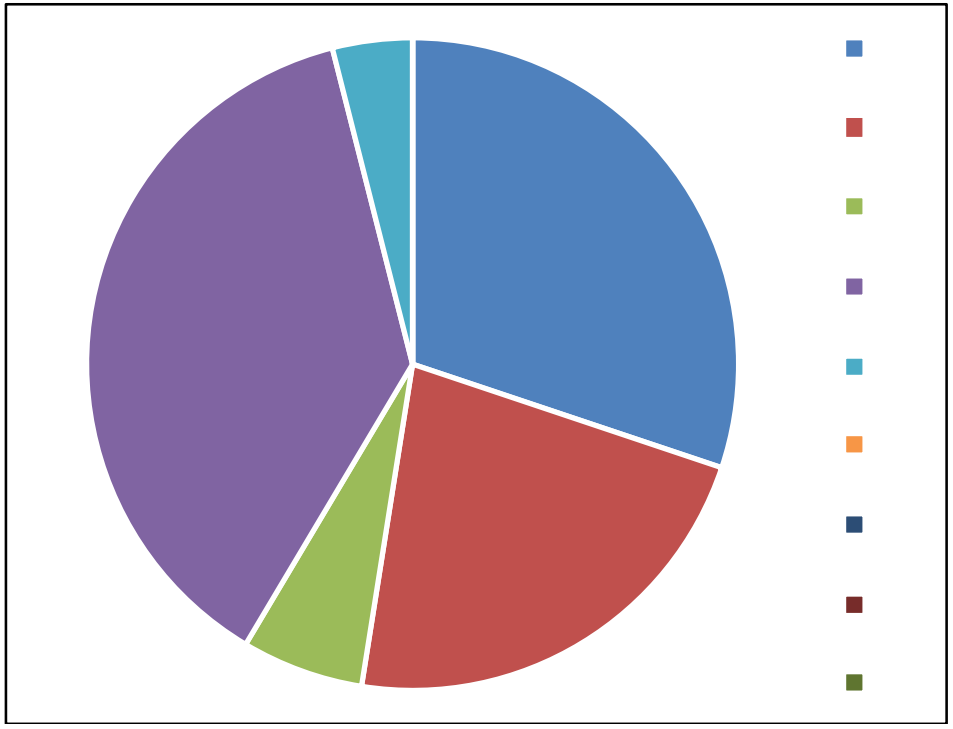
Crops	1,008	66%
Pasture & Hay	192	13%
Developed	189	12%
Natural	22	1%
Feeding Operations	118	8%
Stream Bank & Bed		0%
Wastewater		0%
Septic		0%
Shoreline		0%

Phase 6: Phosphorus PA Western Shore



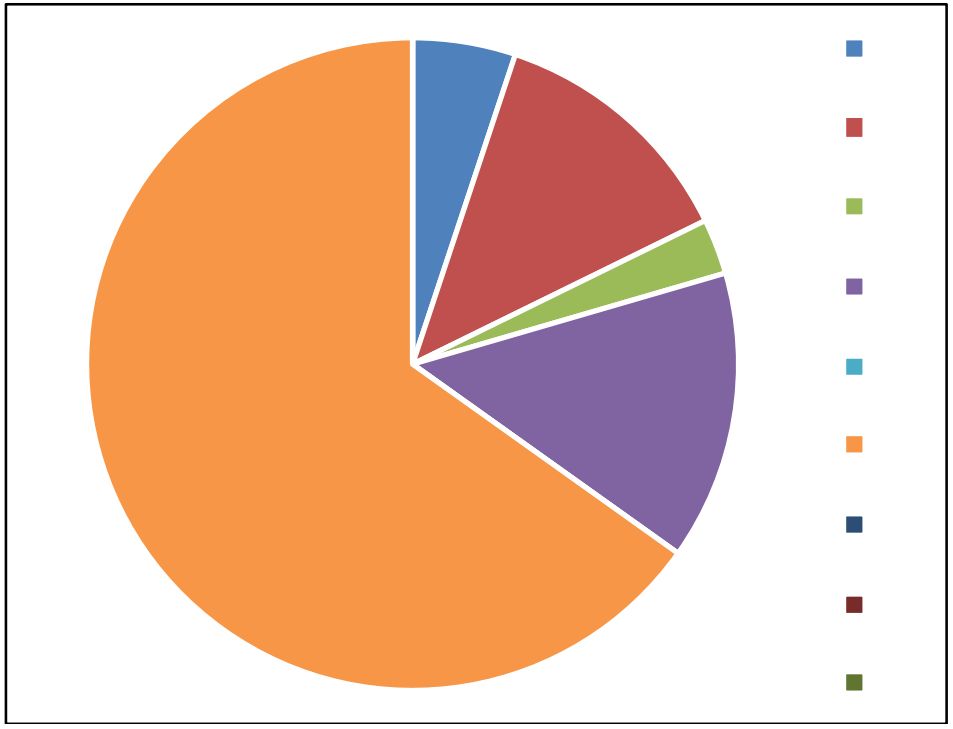
Crops	847	50%
Pasture & Hay	277	16%
Developed	187	11%
Natural	148	9%
Feeding Operations	48	3%
Stream Bank & Bed	178	11%
Wastewater	-	0%
Septic	-	0%
Shoreline	-	0%

Phase 5: Phosphorus – WV James



Crops	3,836	30%
Pasture & Hay	2,847	22%
Developed	770	6%
Natural	4,771	37%
Feeding Operations	504	4%
Stream Bank & Bed		0%
Wastewater		0%
Septic		0%
Shoreline		0%

Phase 6: Phosphorus – WV James



Crops	389	5%
Pasture & Hay	964	13%
Developed	209	3%
Natural	1,094	14%
Feeding Operations	-	0%
Stream Bank & Bed	4,966	65%
Wastewater	-	0%
Septic	-	0%
Shoreline	-	0%