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Memorandum

To:	Katherine Pekarek-Scott and Bryan Spindler, Minnesota Pollution Control Agency	**Date:**	June 15, 2016
From:	Andrea Plevan	**Subject:**	Upland Loading Rates from the Des Moines River Watershed HSPF Model Application
cc:	Jon Butcher (Tetra Tech), Chuck Regan (MPCA)		

This memorandum is a supplement to the *Des Moines Headwaters, Lower Des Moines, and East Fork Des Moines River Basins Watershed Model Development – Final Report*[1], which details the model development, calibration, and validation of an HSPF model application for the Des Moines River watersheds in Minnesota (8-digit hydrologic unit codes [HUC8] 07100001, 07100002, and 07100003). This memorandum presents pollutant loading rates by land cover and by model subbasin for use by local partners, state agencies, and other interested parties. The ArcGIS shapefile *DesMoinesR_HSPF_subbasins*, which is a spatial layer of the model subbasins, is meant to be distributed with this memorandum.

The loading rates presented here can be used, in conjunction with best management practice (BMP) removal efficiencies, to support grant applications such as for BWSR's Clean Water Fund. The loading rates can be used to calculate the existing watershed load. BMP removal efficiencies can then be applied to the watershed load to estimate the load reduction that will be achieved by the BMP(s).

Please see the *Des Moines Headwaters, Lower Des Moines, and East Fork Des Moines River Basins Watershed Model Development – Final Report* for more information about the model and the derivation of the loading rates presented in this memorandum.

1.1 Loading Rates by Land Cover

Average upland rates for phosphorus, nitrogen, and suspended solids are presented by land cover for the Des Moines River watershed (Table 1). The rates include loading from gully erosion.

[1] Tetra Tech. 2016. Minnesota River Headwaters and Lac qui Parle River Basins Watershed Model Development – Final Report. Prepared for Minnesota Pollution Control Agency by Tetra Tech, Inc., Research Triangle Park, NC.

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Table 1. Average simulated (1994–2004) upland loading rates by land cover in the Des Moines River watershed in Minnesota

Parameter	Upland Unit Area Loading Rate (lb/ac/yr)					
	Cropland	Developed	Forest	Grassland	Pasture	Water and Wetland
Total suspended solids	101	119	16	18	38	0
Total phosphorus	0.77	0.29	0.03	0.12	0.13	0.02
Total nitrogen	26.25	6.42	0.81	0.97	0.99	0.73

1.2 LOADING RATES BY SUBBASIN

Average upland rates for total suspended solids, phosphorus, and nitrogen are presented by model subbasin for the Des Moines River watersheds (Figure 1 through Figure 3, Table 2). The rates represent loads discharged to the Des Moines River from all upland sources, including watershed runoff and gully erosion. Loading rates are variable due to many factors, including differences in slopes, land cover, and soil type. Please reference the ArcGIS shapefile *DesMoinesR_HSPF_subbasins*, which is a spatial layer of the model subbasins.

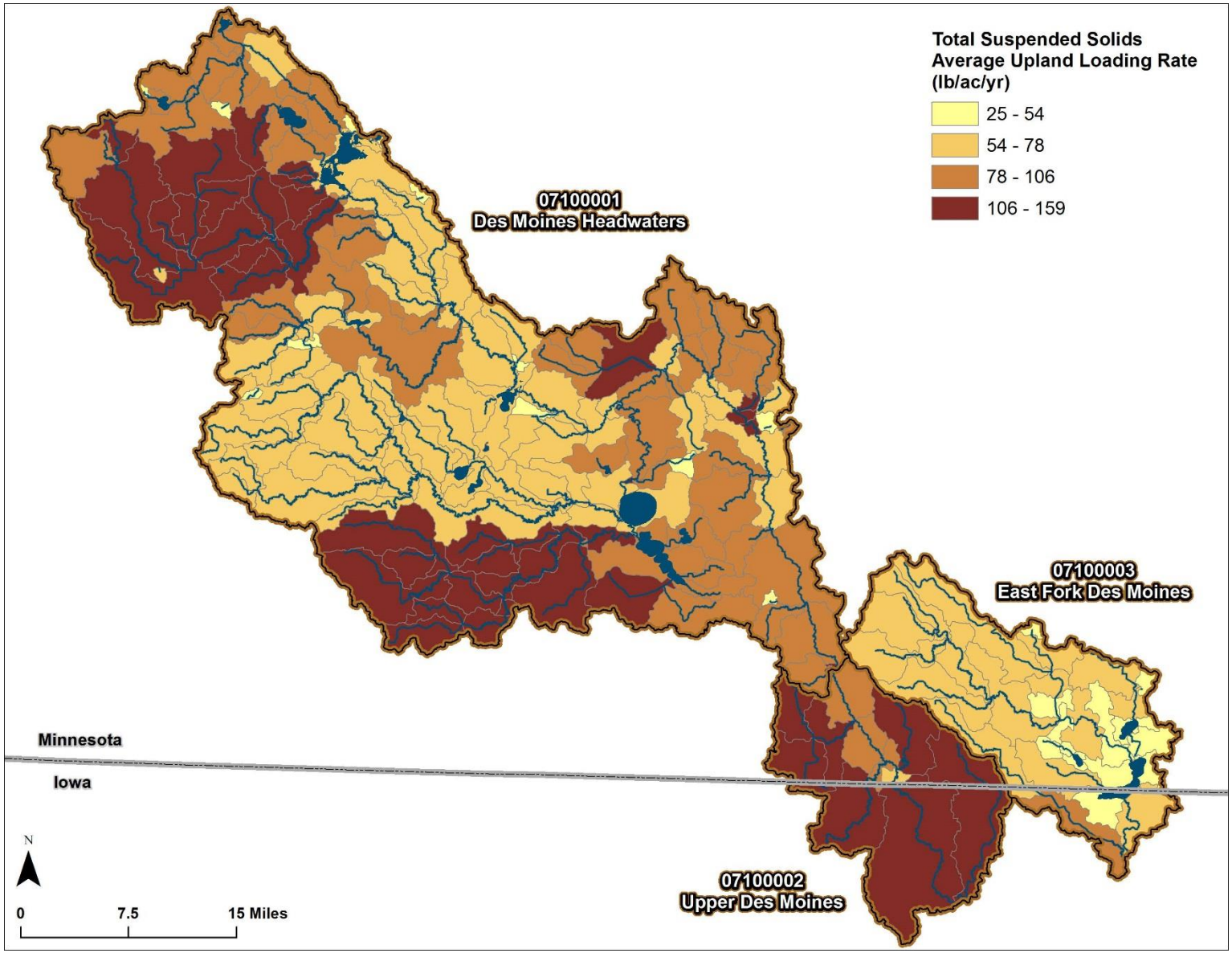

Figure 1. Simulated total suspended solids upland loading rates by model subbasin

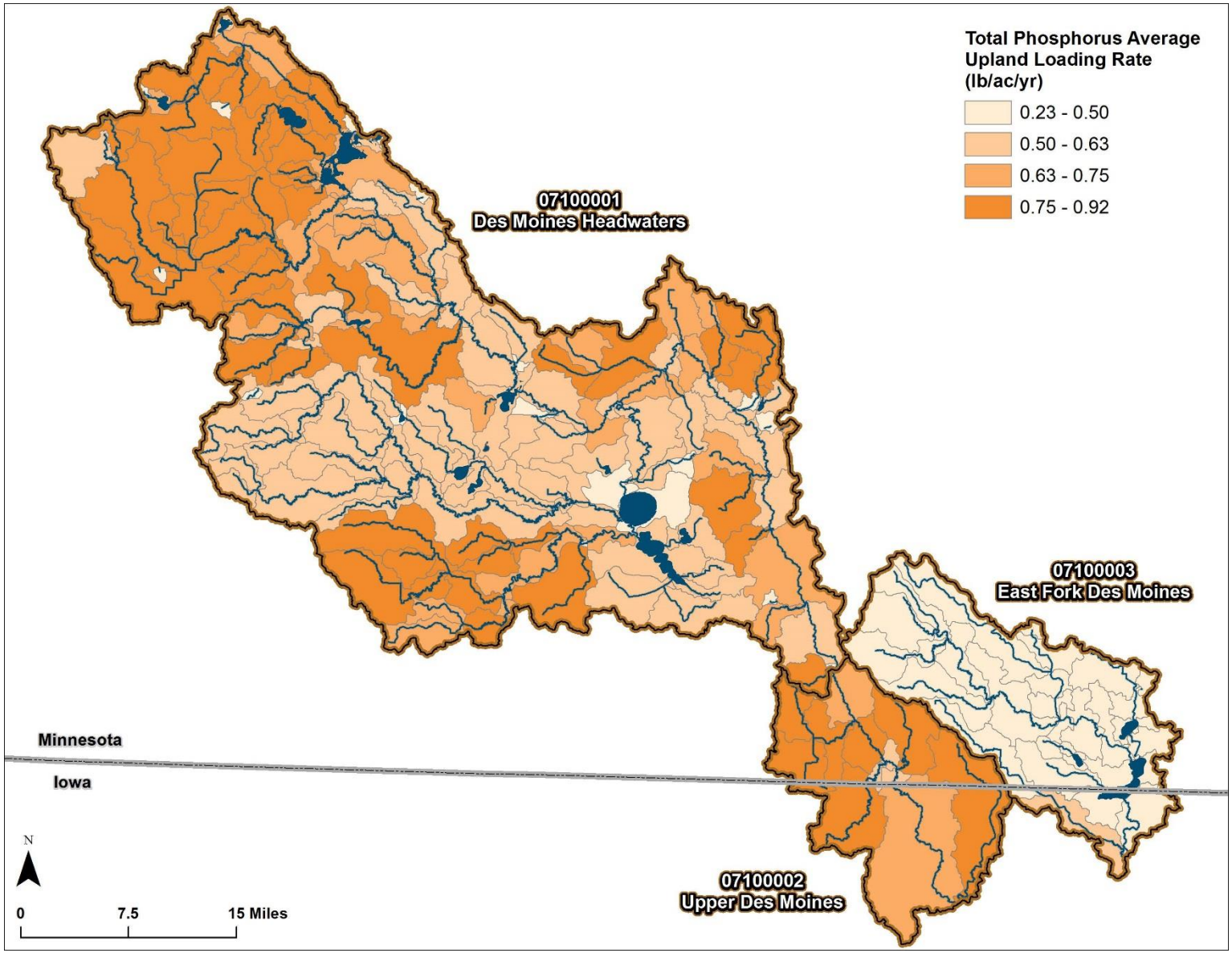

Figure 2. Simulated total phosphorus upland loading rates by model subbasin

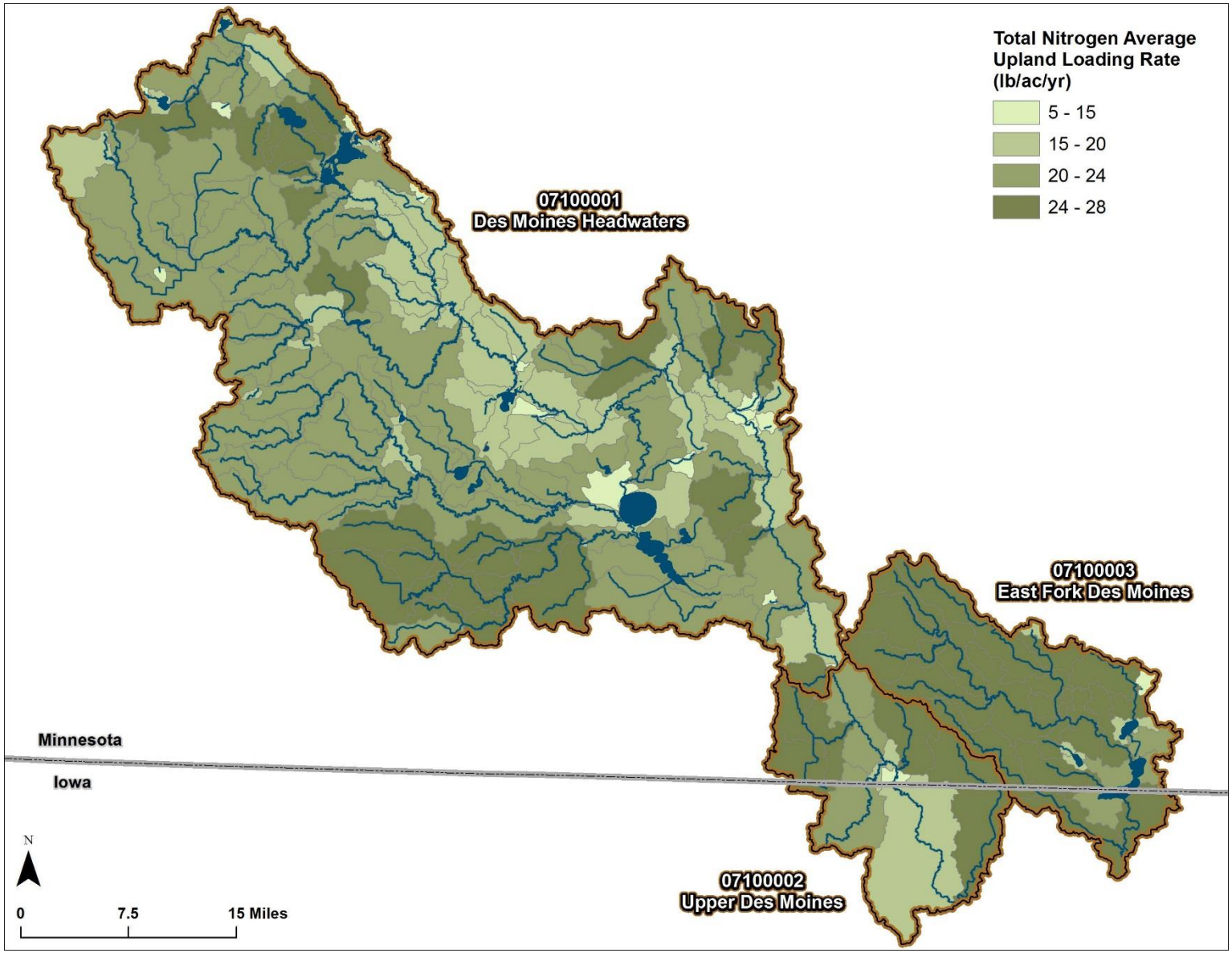

Figure 3. Simulated total nitrogen upland loading rates by model subbasin

Table 2. Simulated upland loading rates by model subbasin

HSPF Model Subbasin	Area (ac)	TSS (lbs/ac/yr)	TP (lbs/ac/yr)	TN (lbs/ac/yr)
1	34,958	140	0.73	19
2	1,130	77	0.52	15
3	1,223	89	0.62	18
4	927	91	0.56	16
5	14,288	159	0.81	21
6	5,474	98	0.77	23
7	5,898	109	0.84	24
8	8,229	121	0.89	25
9	5,729	110	0.88	26
10	7,661	92	0.67	20
11	4,020	94	0.77	24
12	205	120	0.29	5
13	9,706	91	0.59	18
14	3,973	94	0.71	22
15	483	50	0.4	13
16	16,557	87	0.67	21
17	3,644	93	0.77	24
18	6,121	74	0.62	19
19	10,388	87	0.75	24
20	6,370	94	0.73	23
21	6,685	76	0.58	17
22	687	116	0.5	13
23	992	120	0.5	13
24	2,789	74	0.59	18
25	1,362	58	0.53	17
26	3,793	84	0.69	21
27	2,742	66	0.57	17
28	1,018	87	0.66	19
29	4,899	78	0.61	19
30	3,578	89	0.74	23
31	10,687	99	0.59	22
32	2,740	94	0.56	20
33	1,313	50	0.29	11
34	129	116	0.57	20
35	4,680	75	0.37	12
36	7,343	66	0.41	16
37	13,243	96	0.57	21

HSPF Model Subbasin	Area (ac)	TSS (lbs/ac/yr)	TP (lbs/ac/yr)	TN (lbs/ac/yr)
38	783	97	0.6	23
39	3,922	80	0.51	20
40	2,490	92	0.58	23
41	10,460	95	0.57	21
42	9,421	108	0.63	22
43	2,925	125	0.65	22
44	117	83	0.48	17
45	13,434	149	0.81	28
46	7,824	132	0.73	26
47	761	118	0.67	24
48	3,772	146	0.77	27
49	6,114	148	0.65	21
50	3,049	136	0.73	26
51	4,718	137	0.76	27
52	15,412	143	0.77	27
53	4,082	139	0.76	27
54	14,960	149	0.8	27
55	3,646	145	0.78	27
56	7,293	143	0.78	28
57	3,187	68	0.56	19
58	3,412	62	0.54	20
59	522	70	0.56	20
60	14,376	70	0.58	21
61	3,330	70	0.58	21
62	4,282	77	0.62	21
63	14,797	71	0.58	21
64	2,774	71	0.59	21
65	3,730	68	0.59	21
66	6,706	65	0.57	21
67	3,048	64	0.53	20
68	9,150	69	0.6	22
69	8,723	64	0.58	22
70	2,674	66	0.59	22
71	3,647	68	0.58	21
72	9,507	63	0.56	21
73	7,673	66	0.59	22
74	488	54	0.45	17
75	4,688	63	0.58	22
76	2,926	63	0.56	21
77	1,276	61	0.52	20

HSPF Model Subbasin	Area (ac)	TSS (lbs/ac/yr)	TP (lbs/ac/yr)	TN (lbs/ac/yr)
78	5,996	66	0.56	20
79	415	73	0.47	16
80	3,403	76	0.62	22
81	8,023	66	0.58	22
82	3,806	65	0.59	22
83	5,035	88	0.54	21
84	1,306	64	0.57	16
85	4,395	73	0.64	18
86	6,277	63	0.63	18
87	3,287	66	0.58	16
88	7,174	65	0.62	18
89	1,371	43	0.45	13
90	6,309	62	0.56	16
91	4,503	77	0.66	18
92	9,885	56	0.55	16
93	1,586	66	0.63	19
94	24,804	80	0.8	23
95	1,587	72	0.68	20
96	4,557	57	0.58	17
97	658	62	0.68	20
98	968	52	0.6	18
99	4,764	75	0.76	22
100	7,747	71	0.75	22
101	4,008	80	0.74	21
102	5,921	84	0.78	22
103	7,182	87	0.85	24
104	5,025	66	0.6	18
105	2,356	80	0.69	19
106	5,086	64	0.6	17
107	9,541	67	0.64	19
108	6,285	80	0.7	20
109	2,634	81	0.7	20
110	3,791	64	0.57	17
111	341	96	0.73	20
112	8,291	115	0.73	20
113	7,062	120	0.8	22
114	3,310	120	0.81	22
115	8,351	118	0.83	22
116	21,249	126	0.77	20
117	20,766	113	0.76	21

HSPF Model Subbasin	Area (ac)	TSS (lbs/ac/yr)	TP (lbs/ac/yr)	TN (lbs/ac/yr)
118	451	75	0.39	10
119	9,627	94	0.58	15
120	3,373	110	0.76	20
121	3,521	116	0.86	23
122	4,273	110	0.84	23
123	12,782	116	0.84	23
124	5,003	110	0.8	21
125	5,301	118	0.82	23
126	7,255	78	0.7	21
127	3,529	109	0.84	24
128	1,435	110	0.79	23
129	1,564	126	0.87	24
130	5,441	104	0.87	25
131	3,360	99	0.82	24
132	2,709	83	0.75	23
133	5,392	113	0.89	26
134	4,795	89	0.82	24
135	2,623	88	0.77	23
136	5,958	67	0.64	19
137	469	95	0.78	23
138	3,780	83	0.78	23
139	700	33	0.39	12
140	5,985	100	0.81	24
141	10,612	100	0.88	25
142	4,313	96	0.76	22
143	1,115	87	0.66	19
144	370	43	0.32	9
145	2,457	94	0.69	20
146	784	83	0.63	19
147	659	52	0.47	14
148	529	57	0.61	19
149	576	28	0.34	10
150	8,349	59	0.55	16
151	855	25	0.27	7
152	393	39	0.37	11
153	5,465	69	0.62	18
154	10,737	106	0.81	24
155	4,792	104	0.79	23
156	5,165	81	0.66	20
157	8,127	91	0.73	23

HSPF Model Subbasin	Area (ac)	TSS (lbs/ac/yr)	TP (lbs/ac/yr)	TN (lbs/ac/yr)
158	4,107	96	0.78	24
159	2,153	88	0.7	22
160	873	119	0.48	12
161	4,091	102	0.78	23
162	9,171	106	0.81	25
163	2,567	77	0.6	19
164	1,119	37	0.31	9
165	690	91	0.69	20
166	10,927	109	0.84	25
167	22,440	145	0.92	24
168	8,325	83	0.51	28
169	10,210	65	0.48	28
170	7,486	75	0.47	25
171	10,254	52	0.36	21
172	7,678	58	0.45	28
173	894	42	0.28	17
174	530	47	0.3	17
175	1,327	49	0.39	25
176	4,888	53	0.4	24
177	5,576	56	0.42	26
178	1,353	54	0.43	26
179	11,115	58	0.45	28
180	10,008	59	0.47	28
181	6,189	59	0.44	26
182	9,048	60	0.47	28
183	5,344	57	0.46	28
184	8,611	60	0.47	27
185	2,608	50	0.39	24
186	2,657	60	0.46	28
187	15,674	61	0.47	27
188	4,127	65	0.45	26
189	990	54	0.3	17
190	3,747	46	0.34	21
191	2,282	39	0.29	18
192	2,651	57	0.42	25
193	6,786	59	0.45	27
194	1,250	32	0.23	14