TOTAL PHOSPHOROUS LOADING ANALYSIS FOR THE ASHUELOT RIVER TMDL

NEW HAMPSHIRE
DEPARTMENT OF
Environmental
Services

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PURPOSE

The purpose of this analysis is to determine the relative contributions of Total Phosphorous (TP) discharged from point sources (PS) and non point sources (NPS) to the Ashuelot River within the limits of the TMDL study area. The results of this modeling effort will be used as supplemental information only and will not be used in the calculation of permit limits or as input in the QUAL2Ev5 computer model.

NON POINT SOURCE LOADING

The PLOAD computer model was used to determine the NPS loadings from the watershed in the study area. PLOAD is a GIS-based model (extension to ESRI's ArcView GIS 3.x) that can calculate pollutant loads for watersheds based on land use criteria. PLOAD estimates non point source pollution on an average annual basis. The PLOAD model can be used in two ways, either using export coefficients or the EPA's Simple Method approach. For this application, the export coefficient method was applied.

Prior to running PLOAD two required components were created: a watershed area and a landcover area. The watershed area used for this modeling was the portion of the Ashuelot River watershed that drains into the TMDL study area. It was created using HUC12 watershed boundaries with the sample site locations as break points. Where more than one subwatershed drained into the same sample site within the study area, those subwatersheds were merged together on the Phosphorous Loading Results map (Figure II) to more accurately depict the total drainage to that sample site point in the system.

The source of the land cover data was the 2001 Land Cover Assessments provided through the NH GRANIT Database[1]. Those land use assessments were clipped to the study's watershed area and applied in the model. The Land Use Classification map depicts the various land uses within the study area's subwatersheds (Figure I). Table 1 contains a list of the typical land use cover types used for modeling. Each land type has an export coefficient associated with it. Professor Jeff Schloss, Extension Associate Professor at the University of New Hampshire, conducted research and was able to determine actual phosphorous export coefficient values for typical land use types in New Hampshire[2]. So, rather than use literature values for coefficient data, we applied the coefficient data developed specifically in New Hampshire. In his research, Professor Schloss used broad land use descriptions. In order to ensure all of the land use covers identified in the NH GRANIT Database

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[1] Complex Systems Research Center, University of New Hampshire, 1980. NH GRANIT DATABASE, Complex Systems Research Center, University of New Hampshire, Durham, New Hampshire.

[2] Schloss, Jeffery A..2000. Development of Statewide Nutrient Coefficients Through Geographic Information System Aided Analysis, University of New Hampshire Cooperative Extension and Center for Freshwater Biology.

were applied in this modeling application, the code numbers of like land types were combined (see the bottom section of Table 1) and then applied in the model.

The model output file is in Table 3. The column identified as LD_PHOSPHOROUS represents the loading in lbs/acre for each of the subwatersheds. The box below that column represents the sum of the non point source loading from the entire study area.

POINT SOURCE LOADING

There are two point sources within the study area, the Keene and Swanzey Waste Water Treatment Facilities (WWTF's). PS input used in the model can be found in Table 2. In 2001, NHDES conducted three rounds of sampling in the study area. In 2002, NHDES conducted one additional round of sampling. The average TP loading from the composite samples taken from the two WWTF's were used as input to the model. The 2001 and 2002 Discharge Monitoring Reports (DMR's) from the WWTF's were used to estimate current flows. The average flow for 2001 and 2002 were used as input in the model for current conditions. Calculations to determine the TP loading from the WWTF's under future design flow conditions were also made and are shown on Table 2.

RESULTS

Using the PLOAD model results presented in Table 3 and the Point Source loading calculations provided in Table 2, annual TP loadings were computed just downstream of the Keene WWTF (Station 16B-ASH), just downstream of the Swanzey WWTF (Station 14-ASH) and at the downstream end of the study area (Station 12-ASH). Calculations and results are shown below.

Results indicate that under current conditions, at sample station 16B-ASH which is located just downstream of the Keene WWTF, the Keene WWTF represents approximately 72.3% of the annual TP loading and the nonpoint sources represent approximately 27.7% of the annual TP load. Further downstream at sample station 14-ASH, which is located just below the Swanzey WWTF, the combined TP loading from the Keene and Swanzey WWTF's represents approximately 64.6% of the annual TP loading and the nonpoint sources represent approximately 35.4% of the annual TP load. At the furthest point downstream within the study area, at station 12-ASH, the combined total PS loading represents approximately 64% of the annual TP Loading and the nonpoint sources represent approximately 36% of the total load in the river.

Under future conditions, when both of the WWTF's are at full design flow capacity, at sample station 16B, the Keene WWTF represents 84.4% of the total loading and the non point sources represent approximately 15.6% of the annual TP load. At sample station 14-ASH, the combined TP loading from the Keene and Swanzey WWTF's represents approximately 79.1% of the annual TP loading and the nonpoint sources represent approximately 20.9% of the annual TP load. At the furthest point downstream within the study area, the combined total PS loading represents approximately 78.6% of the annual TP Loading and the nonpoint sources represent approximately 21.4% of the total load in the river.

RELATIVE CONTRIBUTIONS OF TP LOADINGS

TP LOADING AT CURRENT WWTF'S FLOW CONDITIONS

STATION	NPS (lbs/year)	% Loading	PS (lbs/year)	% Loading	Total Loading (lbs/year)
16B-ASH	11741.2	27.7	30588.6	72.3	42329.8
14-ASH	17397.9	35.4	31681.0	64.6	49078.9
12-ASH	17912.9	36.1	31681.0	63.9	49593.9

TP LOADING AT WWTF'S DESIGN FLOW CONDITIONS

STATION	NPS (lbs/year)	% Loading	PS (lbs/year)	% Loading	Total Loading (lbs/year)
16B-ASH	11741.2	15.6	63286.8	84.4	75028.0
14-ASH	17397.9	20.9	65784.0	79.1	83181.9
12-ASH	17912.9	21.4	65784.0	78.6	83696.9

TABLE 1

NEW HAMPSHIRE LAND USE COVER ASSESMENT USED BY GIS FOR BASINS MODELING

Orginal Code	Original DESCRIPTION	New DESCRIPTION	New Code
0	Residential/Commercial/Industrial	Urban	2
1	Transportation	Urban	2
2	Row Crops	Agriculture	1
3	Hay/Rotation/Permanent Pasture	Agriculture	1
4	Fruit Orchards	Agriculture	1
5	Beech/Oak	Deciduous	4
6	Paper Birch/Aspen	Deciduous	4
7	Other Hardwoods	Deciduous	4
8	White/Red Pine	Non Deciduous	6
9	Spruce/Fir	Non Deciduous	6
10	Hemlock	Non Deciduous	6
11	Pitch Pine	Non Deciduous	6
12	Mixed Forest	Mixed Forest	5
13	Alpine (Krumholz)		
14	Open Water	Wetland	7
15	Forested Wetland	Wetland	7
16	Non-forested Wetland	Wetland	7
17	Tidal Wetland	Wetland	7
18	Disturbed	Urban	2
19	Bedrock/vegetated		
20	Sand Dunes		
21	Cleared/Other Open	Urban/Cleared	3
22	Tundra		

RECLASSIFIED LAND USE COVER CODES AND PHOSPHOROUS COEFFICIENTS SPECIFIC TO NEW HAMPSHIRE FOR PLOAD MODELING

Code	Land Use Description	Phosphorous Coefficients lbs/acre/year
1	Agriculture	2.03392
2	Urban	0.31136
3	Urban/Clear	0.38528
4	Deciduous	0.16576
5	Mixed Forest	0.07728
6	Non Deciduous	0.112
7	Wetlands/Open Water	0.01008

TABLE 2
POINT SOURCE TOTAL PHOSPHOROUS LOADING CALCULATIONS

Keene WWTF, Average Daily Flows

Month	2001 (mgd)	2002 (mgd)
Jan	2.641	2.355
Feb	2.654	2.643
Mar	3.345	2.997
Apr	6.192	3.635
May	3.221	3.63
June	3.133	3.636
July	2.349	2.638
Aug	2.257	2.295
Sept	2.404	2.354
Oct	2.281	2.537
Nov	2.184	3.154
Dec	2.266	3.115
AVG	**2.9106**	**2.9158**
2 YR AVG	**2.9**	

Swanzey WWTF, Average Daily Flows

Month	2001 (mgd)	2002 (mgd)
Jan	0.067	0.066
Feb	0.0685	0.0721
Mar	0.0805	0.0743
Apr	0.076	0.0738
May	0.098	0.0742
June	0.149	0.0768
July	0.13	0.0555
Aug	0.1085	0.051
Sept	0.092	0.0439
Oct	0.069	0.0461
Nov	0.0914	0.047
Dec	0.082	0.0473
AVG	**0.0927**	**0.0607**
2 YR AVG	**0.07**	

WWTF Effluent TP Sampling Results 2001 and 2002

Date	Keene TP mg/L	Swanzey TP mg/L
8/16/01	**4.65**	**3.44**
8/23/01	**4.65**	**3.40**
8/29/01	**5.69**	**3.25**
8/28/02	**5.517**	**3.77**
2 YEAR AVG	**5.127**	**3.465**

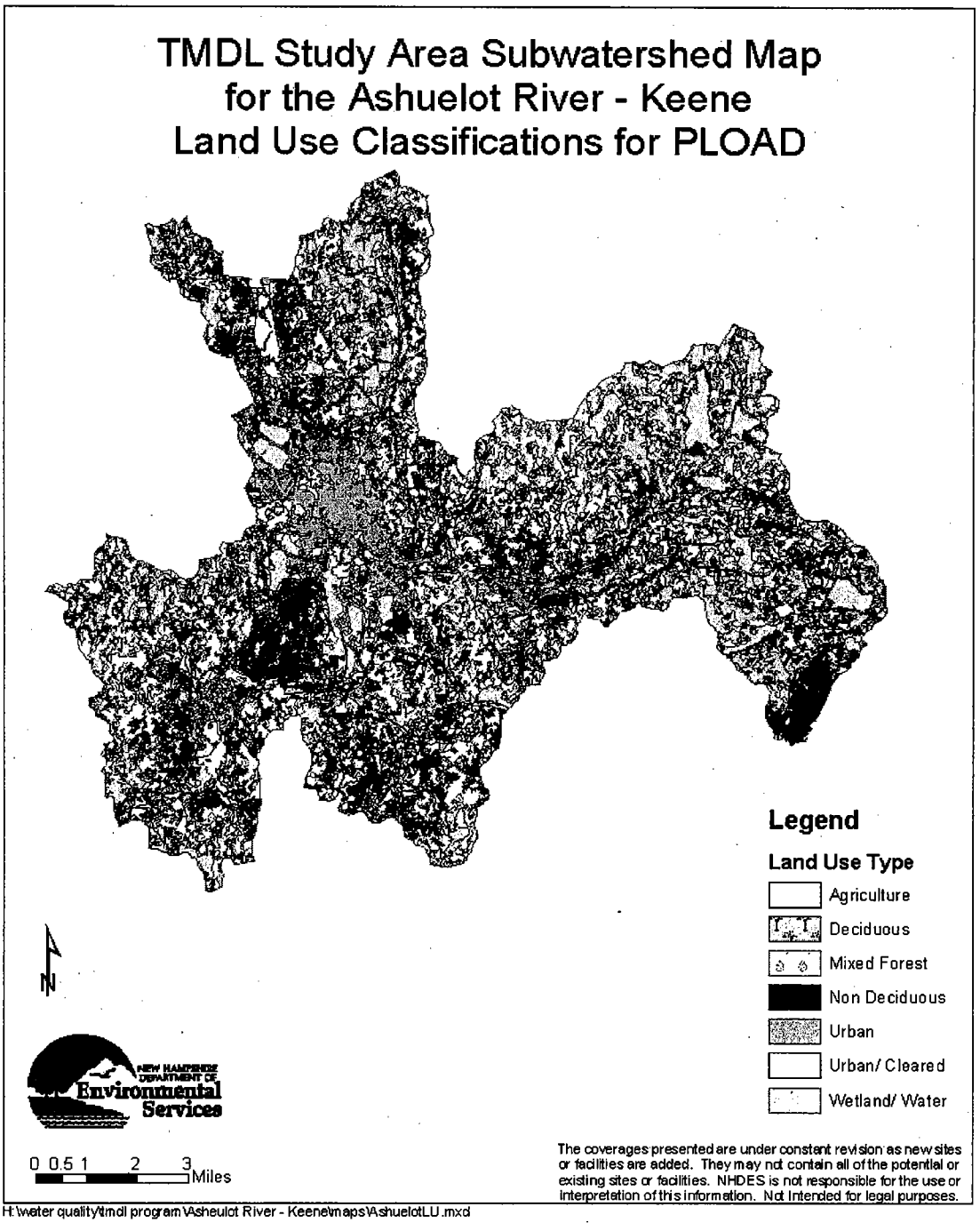
Point Source TP Load Calculations

Location	Daily Avg Flow MGD	Daily AvgTP mg/L	Daily TP Load lbs/day	Annual TP Load lbs/year
Current Conditions				
Keene WWTF	2.90	3.465	83.80	**30588.6**
Swanzey WWTF	0.07	5.127	2.993	**1092.5**
Design Flow Conditions				
Keene WWTF	6.0	3.465	173.389	**63286.8**
Swanzey WWTF	0.16	5.127	6.841	**2497.1**

Daily Load Formula = Flow (MGD) x TP (mg/L) x 8.34

Annual Load formula = Flow (MGD) x TP (mg/L) x 8.34 (lbs-L/mg -MG) x 365 days/year

Figure I


TMDL Study Area Subwatershed Map
for the Ashuelot River - Keene
Land Use Classifications for PLOAD
Legend
Land Use Type
Agriculture
Deciduous
Mixed Forest
Non Deciduous
Urban
Urban/ Cleared
Wetland/ Water
N
NEW HAMPSHIRE DEPARTMENT OF
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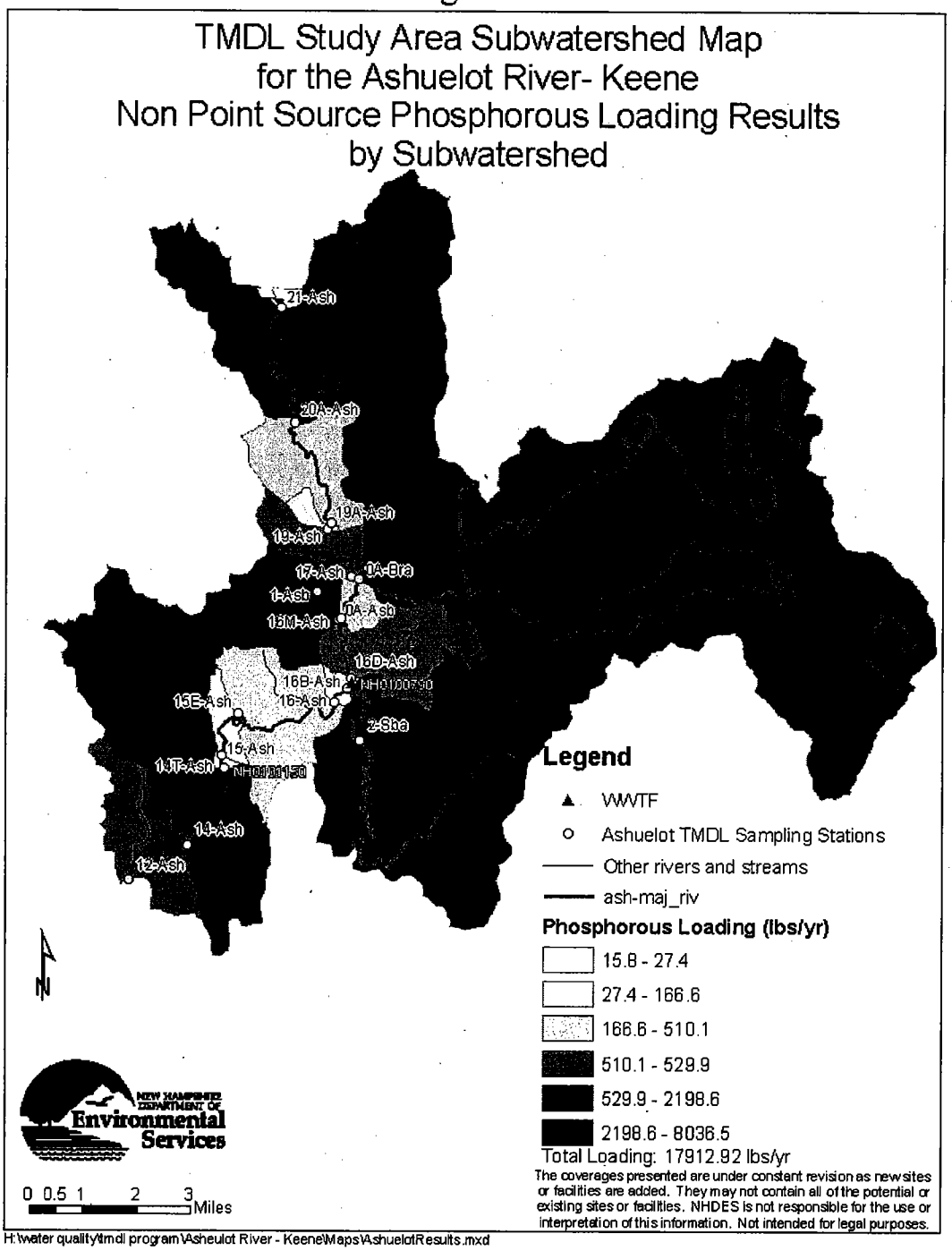
0 0.5 1 2 3 Miles
The coverages presented are under constant revision as new sites or facilities are added. They may not contain all of the potential or existing sites or facilities. NHDES is not responsible for the use or interpretation of this information. Not intended for legal purposes.
H:\water quality\tmdl program\Ashuelot River - Keene\maps\AshuelotLU.mxd

Figure II


TMDL Study Area Subwatershed Map
for the Ashuelot River- Keene
Non Point Source Phosphorous Loading Results
by Subwatershed
21-Ash
20A-Ash
19A-Ash
19-Ash
17-Ash
1A-Bra
1-Ash
1A-Ash
16M-Ash
16D-Ash
16B-Ash
NH0100750
15E-Ash
16-Ash
2-Sba
15-Ash
14T-Ash
NH0100150
14-Ash
12-Ash
N
Legend
WWTF
Ashuelot TMDL Sampling Stations
Other rivers and streams
ash-maj_riv
Phosphorous Loading (lbs/yr)
15.8 - 27.4
27.4 - 166.6
166.6 - 510.1
510.1 - 529.9
529.9 - 2198.6
2198.6 - 8036.5
Total Loading: 17912.92 lbs/yr
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NEW HAMPSHIRE DEPARTMENT OF
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0 0.5 1 2 3 Miles
H:\water quality\tmdl program\Asheulot River - Keene\Maps\AshuelotResults.mxd

TABLE 3

PLOAD OUTPUT FILE FOR THE ASHUELOT RIVER

STATION ID	Incremental LD_PHOSPHOROUS (LBS/YEAR)	Cumulative LD_PHOS (LBS/YEAR)	ACRES	AR_PHOSPHOROUS(LBS/ACRE/YEAR)
12-Ash	515.07	515.07	2049.31	0.25134
14-Ash	2198.62	2713.69	7925.09	0.27743
14T-Ash	27.41	2741.11	62.78	0.43666
15-Ash	166.62	2907.73	448.58	0.37144
15E-Ash	510.08	3417.81	2557.14	0.19947
16-ASh	18.34	3436.15	126.00	0.14559
2-Sba	2735.61	6171.77	9345.41	0.29272
16B-Ash	39.40	6211.16	52.41	0.75163
16D-Ash	527.48	6738.64	2125.23	0.24820
OA-Asb	256.30	6994.94	384.50	0.66657
16M-Ash	675.97	7670.91	2317.43	0.29169
0A-Bra	8036.49	15707.40	33462.85	0.24016
17-Ash	529.95	16237.35	962.27	0.55073
19-Ash	63.73	16301.09	198.85	0.32052
19A-Ash	452.64	16753.72	1886.40	0.23995
20A-Ash	1143.40	17897.13	5607.06	0.20392
21-Ash	15.79	17912.92	116.15	0.13596

SUM LOADING (lbs/year)		SUM ACRES
17912.92		69627.48

Ashuelot River TMDL Study Area and Sampling Extent