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## **APPENDIX B: POLLUTANT LOADING ANALYSIS**

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# Appendix B

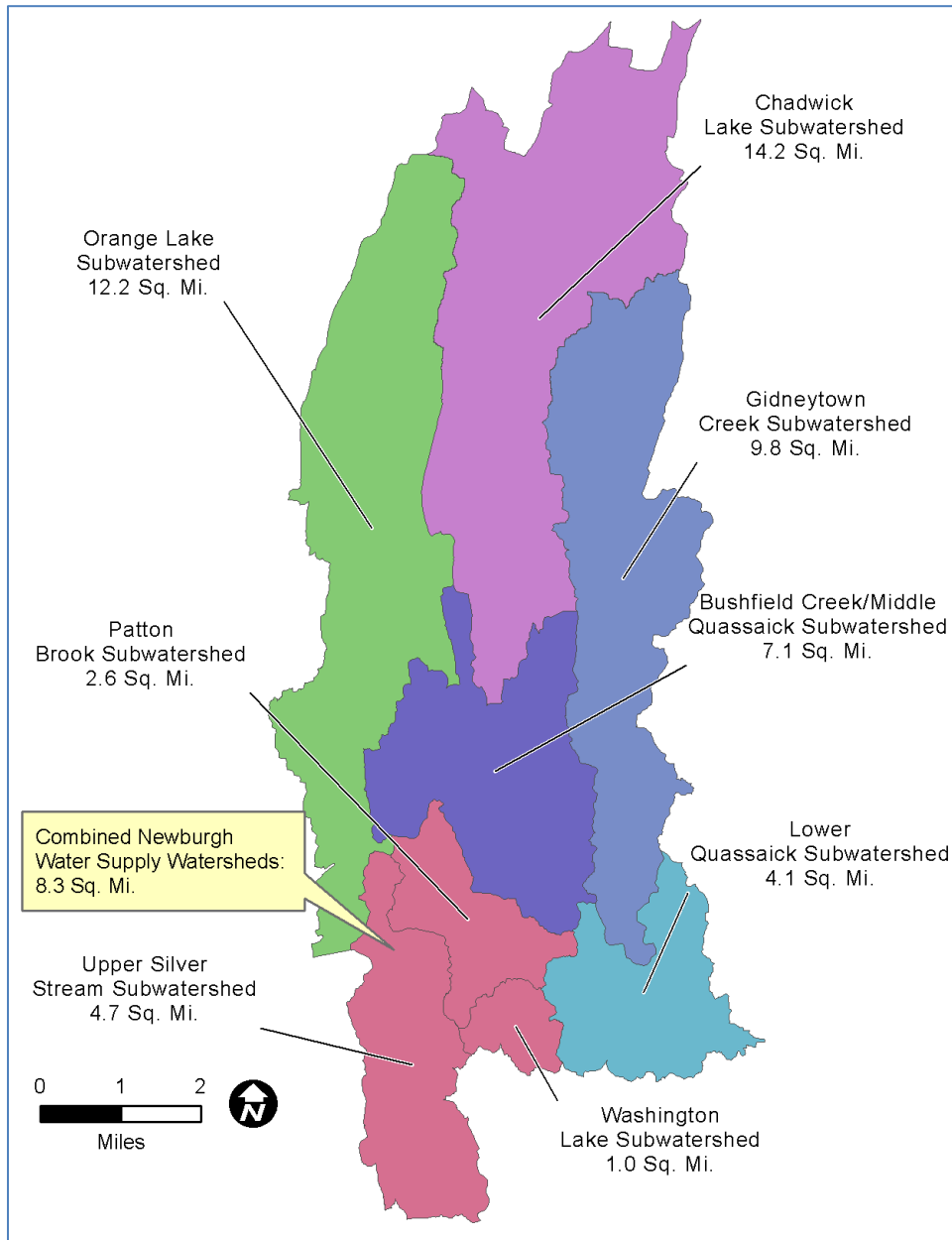
## Pollutant Loading Analysis

### Methodology

- HDR, as primary consultant for the Watershed Plan, developed a pollutant loadings analysis for the Quassaick Creek Watershed using the “Watershed Treatment Model” spreadsheet recommended by the New York State Office of Coastal, Local Government and Community Sustainability in its *Watershed Plans Guidebook*.
- A separate model was developed for each of six subwatersheds:
  - Bushfield Creek/Middle Quassaick Watershed
  - Chadwick Lake Watershed
  - Gidneytown Creek Watershed
  - Lower Quassaick Watershed
  - Orange Lake Watershed, and
  - The “Combined Newburgh Water Supply Watersheds,” a combination of the Upper Silver Stream, Patton Brook and Washington Lake subwatersheds, three adjacent hydrologic areas that together form a region roughly comparable in size to the other five subwatersheds in the list (See Table B-1). The three drainage areas share common characteristics: all exhibit high levels of urban development and disturbance, and the waters of all three are predominantly diverted to reservoirs for the City of Newburgh water supply system.



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**Figure B-1. Quassaick Creek Subwatershed Grouping for the Pollutant Loading Analysis.**

- The Watershed Treatment Model (WTM) provides estimates of runoff volume and pollutant loading to waters in each subwatershed based primarily on the land uses found within the drainage area. In general, areas of high residential density, commercial and industrial uses and roadways are computationally ascribed to generate higher rainfall runoff, which depends primarily on impervious surface area, and consequently higher pollutant loading than areas of low residential density, forest and farming.
- For a given pollutant (for example, total phosphorus), the WTM provides an “annual loading rate” for each land use category which, when multiplied by the land area within that category, yields an estimate

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of the quantity of pollutant in pounds estimated to be loaded for that category each year. The sum of the pollutant loading from all of the land use categories is the total estimated pollutant loading for the subwatershed. This annual loading rate is for some categories a constant (e.g., the rate for total phosphorus loading from forest land is always 0.2 lbs/acre), and for some categories, such as the different classes of residential land, is derived by a calculation which takes into account local rainfall and (where data is available) other conditions that cause variations in runoff. The table below tabulates the annual loading rates generally applied by the WTM analysis for phosphorus loading in the Quassaick Creek watershed:

Land Use Type	Total Phosphorus Loading Rate (lb/acre/yr)
Open Water	0.5
Rural	0.7
Forest	0.2
Industrial	1.8
Roadway	2.0
Commercial	1.9
Multifamily	1.7
HDR (>4 du/acre)	1.7
MDR (1-4 du/acre)	1.6
LDR (<1du/acre)	1.5

- It is these rates which, when multiplied by the land areas tabulated in Table B-2 below, produce the Total Phosphorus loading, by subwatershed and by land use category, shown in Table B-3 and Figure B-3 below.
- This application of the WTM considers only separate stormwater drainage and collection systems. A portion of the Lower Quassaick Subwatershed is served by the City of Newburgh's combined sewer system. Combined sewer overflows are not included in the pollutant loading analysis as a separate CSO Characterization Study would be more relevant than the WTM in addressing such pollutant loadings.

### Input Data

- Two major inputs are required for the WTM model: land use, by area, in the ten categories listed in Table B-1, and estimated annual rainfall in inches. For other inputs of lesser impact, including hydrogeologic soil group and depth to groundwater, the default values contained in the model were accepted
- Geographic information system methods and data were used to generate measurements of total land use in each subwatershed in each of these categories. Two primary sources, courtesy of the Ulster County Information Services Office and the Orange County Planning Department, were parcel datasets identifying block, lot and use classification of the tax lots within the Quassaick Watershed, both in Ulster



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and Orange Counties. Working with these parcel polygons, it was possible to classify areas of the watershed into high, medium and low-density and multi-unit residential use, commercial use, and industrial use.

- The National Land Cover Dataset (NLCD) land cover layer was used to identify rural, forest, open water and roadway areas within the Quassaick Watershed. The NLCD is a nationwide 30-meter resolution dataset processed from LANDSAT satellite imagery and sponsored by the U.S. Geological Survey. It provides up to 16 classifications of land cover, including multiple classes of developed land and forest. The most recent version of NLCD, used in this study, was released in 2010 from imagery taken in 2006. In adapting the NLCD 2006 classifications to the Watershed Treatment Model, NLCD's hay/pasture, cultivated crops (e.g., orchards) and grassland/herbaceous classifications were treated as "rural" and NLCD's forest, wetland and shrub/scrub categories were treated as "forest" for purposes of the model. Developed land within the NLCD classification system and falling outside the Ulster and Orange residential, commercial and industrial parcels was treated as roadway; this treatment was checked by map overlay against GIS roadway data and was found to be substantially correct.
- The resulting composite land use dataset for the Quassaick Watershed was divided by subwatershed and used as inputs for the Watershed Treatment Model. Table X below sets out the composite land use inputs, by subwatershed



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TABLE B-2: LAND USE TYPES BY WATERSHED (ACRES)							
LAND USE TYPE	Bushfield Creek/ Middle Quassaick	Chadwick Lake	Gidneytown Creek	Lower Quassaick	Orange Lake	Combined Water Supply	TOTAL
LDR (<1 du/acre)	775	1,877	918	91	1,893	309	5,863
MDR (1-4 du/acre)	796	311	515	231	334	500	2,686
HDR (>4 du/acre)	66	6	68	265	18	54	477
Multifamily	102	495	144	83	160	17	1,001
Commercial	443	207	206	373	176	1,141	2,545
Roadway	417	196	209	451	257	908	2,437
Industrial	7	0	18	126	99	45	295
Forest	1,678	5,247	3,988	696	3,694	1,363	16,665
Rural	218	467	187	260	722	613	2,467
Open Water	7	259	27	16	414	348	1,070
TOTAL	4,508	9,064	6,278	2,591	7,768	5,297	35,504

- Another relevant input for the Watershed Treatment Model, average annual rainfall, has been derived from StreamStats for New York, a water resources web application made available by the United States Geological Survey in cooperation with New York State agencies ([http://water.usgs.gov/osw/streamstats/new\\_york.html](http://water.usgs.gov/osw/streamstats/new_york.html)). The “Basin Characteristics Report” generated in StreamStats/New York for coordinates 41.4927, -74.0620 indicates a mean annual precipitation of 42.7 inches.
- Although the WTM offers the possibility of entry of inputs for varying hydrogeological soil conditions, the calculation and input of data in this category has not been attempted at this time. The default in the WTM of Soils Group C was used in all subwatersheds. The variation in annual runoff and pollutant loadings produced by different hydrogeological soil conditions is believed to be relatively small. For the Bushfield Creek/Middle Quassaick subwatershed, for example, varying the proportions of the hydrogeologic soil groups produced at most less than a 1% variation in total phosphorus.

## Results

- The WTM includes calculations of pollutant load for total nitrogen, total phosphorus, total suspended solids and fecal coliform. Elevated total phosphorus loading is considered to be a good indicator of the impact of residential, commercial and industrial development on pollutant loads, and water quality of the receiving waterways. Total phosphorus is generally the limiting nutrient for algal growth in freshwater lakes. High algal concentrations can adversely affect drinking water supplies as well as aesthetics in all lakes and impoundments. The following Table B-3 summarizes the predicted quantities of total phosphorus loading, by land use type and subwatershed, for the assumed rainfall of 42.7 inches per year:



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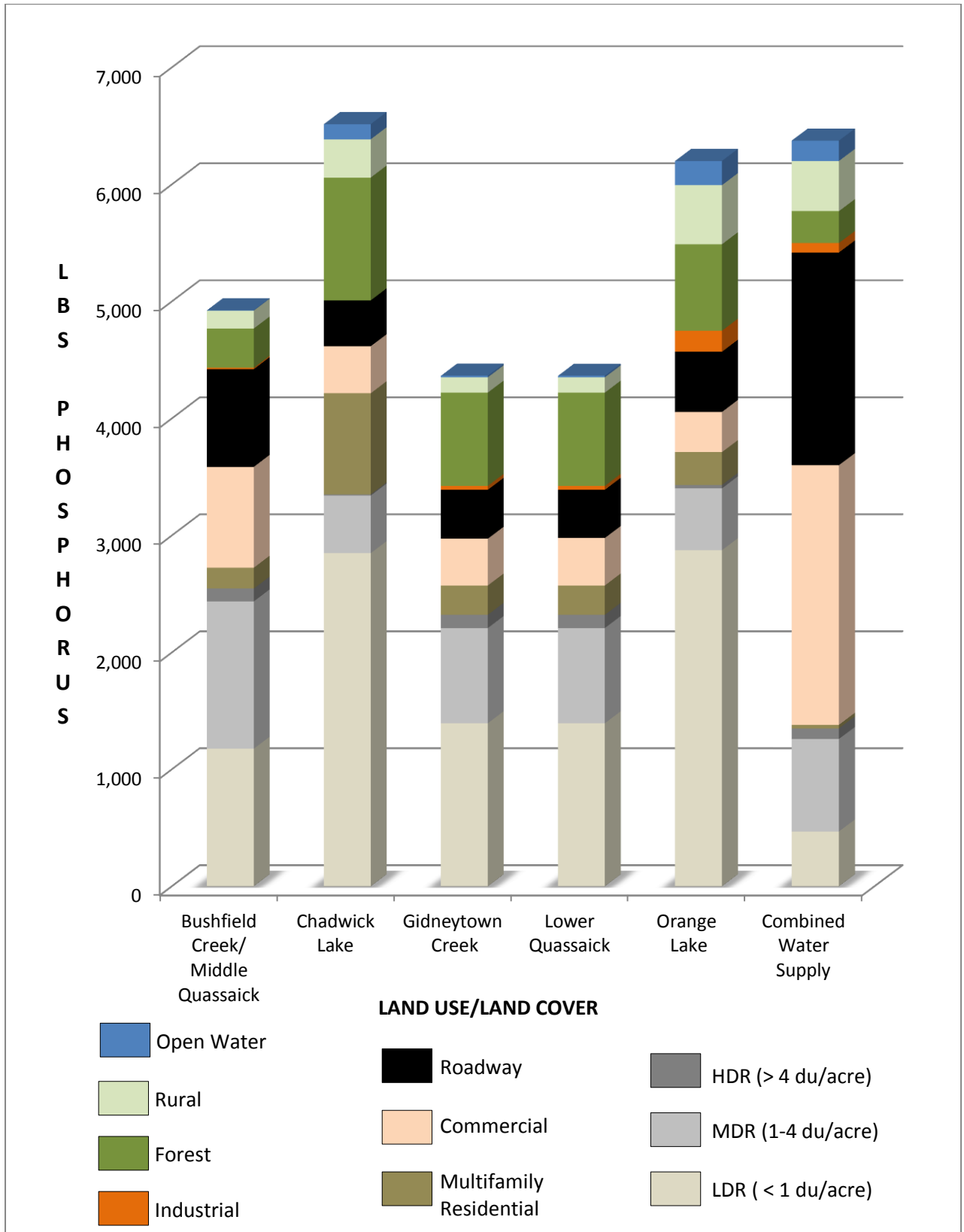
TABLE B-3: PREDICTED ANNUAL TOTAL PHOSPHORUS LOADING BY SOURCE AND SUBWATERSHED (lb/yr)							
LAND USE TYPE	Bushfield Creek/ Middle Quassaick	Chadwick Lake	Gidneytown Creek	Lower Quassaick	Orange Lake	Combined Water Supply	TOTAL
LDR (<1 du/acre)	1,211	2,933	1,395	142	2,958	483	9,121
MDR (1-4 du/acre)	1,325	517	815	384	555	831	4,427
HDR (>4 du/acre)	118	10	113	477	32	98	848
Multifamily	196	951	251	159	308	33	1,898
Commercial	990	462	400	834	394	2,550	5,629
Roadway	969	455	418	1,049	598	2,110	5,598
Industrial	14	0	33	254	200	90	592
Forest	336	1,049	798	139	739	273	3,333
Rural	153	327	131	182	505	429	1,727
Open Water	3	129	13	8	207	174	535
<b>TOTAL</b>	<b>5,313</b>	<b>6,834</b>	<b>4,365</b>	<b>3,628</b>	<b>6,497</b>	<b>7,071</b>	<b>33,707</b>

The following graph presents these results in chart form.





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**Figure B-3. Estimated Pounds of Phosphorus Loading by Land Use and Subwatershed.**

### Conclusions

- Residential land cover, including High Density, Medium Density, Low Density and Multifamily, makes an especially large contribution to pollutant loading, accounting, in the aggregate, for 48% of all total phosphorus loading in the full Quassaick watershed.
- This effect is most marked in the Chadwick Lake and Orange Lake subwatersheds, where low density residential development alone provides approximately one-third of all total phosphorus loading.
- Roadways make a large contribution to phosphorus loading, especially in the more densely developed Lower Quassaick and Combined Water Supply subwatersheds.
- The Combined Water Supply Subwatershed (grouping) has the highest total phosphorus loading of the six subwatersheds. Commercial land use accounts for 36% of the total phosphorus loading in the Combined Water Supply subwatershed.

### Recommendations

The results of the WTM can be used to identify the primary sources of pollutants in the six subwatersheds of the Quassaick Creek watershed for water quality management purposes. For example, the main source of nutrients in LDR, MDR and HDR areas is typically lawn fertilizer (NYS DOS 2009). New York State enacted a ban on fertilizers containing phosphorus that went into effect this year. Although this ban will reduce phosphorus applications it will not eliminate phosphorus because of the exempt applicators and allowed phosphorus use (i.e., gardens; agricultural lands and production; sod farms; phosphorus deficiency; establish new turf). The WTM loading calculation uses a TP concentration of 0.26 mg/l for the runoff from practically all land uses. The WTM can be refined by over-riding this concentration based on site-specific sampling data, if available. Stormwater sampling is recommended to obtain data that can be used to refine the WTM and assess trends in water quality that may result from the recent statewide phosphorus ban as well as local changes in land use.