3 BUILD-OUT ANALYSIS

One of the goals of the RWSMP is to evaluate the potential impacts of future land development on stormwater within the watershed. The first step was to project future land use which was accomplished by analyzing expected watershed land use based on existing zoning.

Existing land use is analyzed in Section 2.10 of Book 1 of this Plan. Existing land use within the watershed was based on the Monmouth County GIS 2006 land use layer. Residential lands occupy 35% of watershed and woodland occupies about 27% with about 10% in commercial and industrial land use. About 55% of the watershed is already developed or is not developable, leaving about 45% of the land area available for future development. Table 9 in Book 1 summarizes existing land use and Table 2, below, (a copy of Table 10 in Book 1), presents general land use, identifying those lands available for future development.

TABLE 2: Use of Developable and Undevelopable Lands

	Acres	**Percent**
Future Developable Lands	**3690.1**	**45.1%**
Agricultural Use	818.5	10.0%
Brush	289.8	3.3%
Unvegetated	311.5	3.8%
Woods	2270.3	27.8%
Developed or Undevelopable Lands	**4483.9**	**54.9%**
Landscaped Open Space	621.8	7.6%
Water	215.9	2.6%
Commercial/Industrial/Institutional	819.2	10.0%
Residential	2827.0	34.6%

This existing land use information was analyzed to generate input data for the hydrologic/hydraulic and watershed water quality models as discussed in Sections 7 and 8 of Book 1 of this Plan. On a sub-watershed basis, land use percents were determined in a GIS database. The landuse categories used in the watershed SWMM model were:

- Agriculture
- Open space
- Commercial/Industrial
- Golf courses
- Residential 17% impervious
- Residential 23% impervious

- Residential 33% impervious
- Residential 65% impervious
- Woodland
- Water.

Because the generation of pollutants in the SWMM model is primarily based on land use, this information served as basic information for model development. These categories were based on review of watershed land use and were limited in the model to ten categories. Further, the availability of pollution generation data for a land use category was considered in selecting these ten categories. Impervious areas were determined using a combination of GIS data files which included roads, buildings and driveways. For the hydrologic/hydraulic model, land use was a factor in developing the CN numbers used to generate watershed flows.

The build-out scenario for the models required projection of future land use conditions, which was conducted as discussed in the following sections.

3.1 Zoning Analysis

Zoning controls future development within each municipality. The specific zoning and development regulations of each municipality control the type and density of land use that can be legally constructed at a site. Thus, analysis of zoning information is essential for evaluating the potential impacts of future development on the quantity and quality of receiving waters.

Each municipality has developed its own zoning categories according to its Municipal Master Plan. The Monmouth County GIS database includes a zoning layer for the watershed which compiles the zoning districts for each municipality into a single data layer. Categories in the zoning layer of the GIS database include zoning class ID and zoning district as defined by the municipality. Table 3 summarizes the zoning districts for the watershed, which include 38 distinct zoning districts in the four municipalities.

The GIS database does not provide detailed descriptions of each class in all cases. In addition, the zoning classes are not always directly comparable across municipalities. For example, Spring Lake has an R-1 zone which requires 15,000 sq. ft. per dwelling unit, while Wall Township designates the same zoning as R-15.

Thus, the first step in analyzing the zoning was to examine the zoning ordinance for each of the four municipalities to define the zones. The definitions in the ordinance were used to standardize the zoning districts for the watershed. Therefore, regardless of the actual zoning district designated by each municipality, a zoning classification was developed for use in this Plan.

Table 3: Zoning Districts		
Municipality	**Zone ID**	**Zoning District**
Sea Girt Boro	1E	District 1 East Single Family
	1W	District 1 West Single Family
	3	District 3 Beach
Spring Lake Boro	GC	General Commercial
	RC	Retail Commercial
	R3	Single family Residential 11,250 sq.ft per Dwelling
	R1	Single family Residential 15,000 sq.ft. per Dwelling
	R2	Single Family Residential 7,500 sq ft per Dwelling
Spring Lake Hts Boro	B-2	Commercial
	R-2	Residential
	R-3	Residential
	R-4	Residential
	R-5	Residential
Wall Twp	OR-2	Office-Research 2
	OR-5	Office-Research 5
	HD-6	
	GS_Prky	GS_Parkway
	A-I	Airport Industrial
	CR-10	Commercial Recreation/10 Acres
	CR-40	Commercial Recreation/40 Acres
	MLCC	Congregate Care/.14 DU Acre
	GI-10	General Industrial/10 Acres
	GI-2	General Industrial/10 Acres
	HD-8	High Density Multi-Family 8 DU/Acre
	HD-12	High Density Multi-Family/12 DU Acre
	HB-120	Highway Business/120,000 Sq. Ft.
	HB-200	Highway Business/200,000 Sq. Ft.
	HB-80	Highway Business/80,000 Sq. Ft
	MHP	Mobile Home Park
	MLC-9	Multi-Family 9 DU/Acre
	MLC-7	Multi-family 7DU/Acre
	ML-8A	Multi-Family 8 DU/Acre
	MCL-3	Multi-Family 3 DU Acre
	ML-3	Multi-Family 3 DU Acre
	MLC-8A	Multi-Family 8 DU Acre
	NB	Neighborhood Business/20,000 sq. Ft
	OB-120	Office Business/120,000 Sq. Ft
	OP-10	Office Park/10 Acres

Table 3: Zoning Districts (continued)		
Municipality	**Zone ID**	**Zoning District**
Wall Twp	OP-2	Office Park/2 Acres
	OR-10	Office Research/10 Acres
	OR-2	Office Research/2 Acres
	OR-5	Office Research/5 Acre
	POS	Public Office Space
	RR	Rural Residential
	RR-5	Rural Residential/5 Acres
	RR-6	Rural Residential/6 Acres
	ML-8B	Senior Citizen & Townhouse 8 DU/Acre
	R-10	Single Family Residential/10,000 Sq. Ft
	R-15	Single Family Residential/15,000 Sq. Ft
	R-20	Single Family Residential/20,000 Sq. Ft
	R-30	Single Family Residential/30.000 Sq. Ft.
	R-40	Single Family Residential/40,000 Sq. Ft
	R-60	Single Family Residential/60,000 Sq. Ft
	R-7.5	Single Family Residential/7,5000 Sq. Ft.

The zoning districts were then assigned to the appropriate general land use class developed in Section 2.10 of Book 1 which are:

- Commercial
- Industrial (includes transportation and GSP)
- Recreation/Park
- Residential-Low Density
- Residential-Medium Density
- Residential - High Density

Table 4 summarizes watershed zoning based on these classifications. Thus, the zoning data indicates that the watershed is zoned as $\pm$67% residential, $\pm$10% open space, $\pm$14% office and commercial and $\pm$9% other zones. The “other” category includes the Garden State Parkway, small industrial zones, and congregate care facilities.

Agricultural zoning is not included in the Master Plan of any of the municipalities within the watershed. However, about 10% of the watershed, approximately 820 acres, is currently in agricultural use. According to the information from the NJDA, none of these areas are currently enrolled as Farmland Preservation areas. According to the zoning, about 25% of the agricultural lands are zoned for recreation/park lands. The remaining lands currently in agricultural use are zoned primarily for residential use (71%). Almost all of the residential zoning (96%) is for low density use.

Table 4: Overall Watershed Zoning - 2006 General Categories		
Zoning District	**Approx Acreage**	**Percent**
Commercial	1366	17%
Industrial (includes transportation and GSP)	507	6%
Recreation/Park	804	10%
Residential-Low Density	3704	45%
Residential-Medium Density	1610	20%
Residential - High Density	180	2%

3.2 Build-Out Land Use

As noted above, future development will not occur on all of the lands as zoned. Thus, the next step was determination of developable lands within the watershed. Undeveloped lands were based on current land use, including lands categorized as agricultural lands, wooded lands, barren lands, extractive mining, and brush. Lands that were already considered developed for residential, commercial or industrial use were not included in this analysis. Although future redevelopment may occur on certain lands, the resulting changes in stormwater generation would not be as significant as those from the development of currently undeveloped lands.

Certain potentially developable lands could be restricted for future development. Currently, there are no farmland preservation lands within the watershed. There are, however, park and open-space lands. In addition, Wall Township includes lands zoned for open space/parks, which are expected to be unavailable for future development. It was assumed that parks, golf courses, athletic fields and municipal open space would not be further developed.

The GIS existing land use (2006) layer was used to determine potentially developable lands including woodland, barren, brush, agriculture or extractive mining uses. The GIS Zoning layer was overlain on these lands. Based on this analysis, Table 5 provides the zoning of the Potentially Developable Lands within the Watershed. The total acreage of potentially developable lands is about 3,600 acres.

These potentially developable lands may be further constrained by environmental conditions. Within the Wreck Pond Brook Watershed, wetlands and associated buffers are the major environmental constraint to development. The NJDEP Freshwater Wetlands Protection Act generally does not permit development within wetlands or fill of wetlands to create upland. Within the watershed about 1,100 acres of wetlands are mapped by NJDEP. Although this mapping is not exact, it provides a generalized picture of the wetlands within the watershed. Buffers of 50 feet are expected to the

watershed wetlands as habitat for endangered or threatened species was not identified within the watershed stream corridors using Version 2 of the Landscape GIS data.

Table 5: Zoning of Potentially Developable Lands							
Zoning	**Existing Land Use**					**Future Zoning**	**% Future Land Use**
	Agriculture	**Barren**	**Brush**	**Mining**	**Woodland**	**TOTAL**	
Commercial	35.6	50.6	84.9	10.8	585.6	767.5	21.3%
Industrial	0.2	67.5	86.0	1.8	128.0	283.6	7.9%
Recreation/Park	202.8	9.0	18.8	1.1	270.9	502.7	13.9%
Residential (17% impervious)	556.0	16.1	51.6	106.8	864.7	1595.2	44.2%
Residential (23% impervious)	24.8	3.6	17.9	0.4	234.4	281.2	7.8%
Residential (33% impervious)	0.2	14.5	14.6	0.0	93.2	122.5	3.4%
Residential (65% impervious)	0.0	0.3	2.1	0.0	53.0	55.5	1.5%
Other							
	819.6	**161.8**	**275.9**	**120.9**	**2229.9**	**3608.1**	

The wetlands and a 50-foot buffer were overlain on the potentially developable lands within the watershed to determine the zoning of the wetlands and buffers. About 890 acres of wetlands, including the fifty-foot buffer, are within the potentially developable lands. Table 6 summarizes the zoning of the wetland/buffer areas within the potentially developable lands.

Table 6: Zoning of Wetlands and Buffers	
Zone	**Area (acres)**
Commercial	224.4
Industrial	15.2
Recreation/Park	0.4
Residential (17% impervious)	457.2
Residential (23% impervious)	98.8
Residential (33% impervious)	50.6
Residential (65% impervious)	43.4

It should be noted that this must be considered a rough approximation of the wetland acreage. For example, this analysis indicates that about 100 acres of the areas

identified as wetlands by NJDEP mapping are mapped as a developed land use within the GIS system. Another approximately 80 acres are zoned as Public Open Space and thus is not developable land in the build-out analyses.

To determine the final developable zoning, the acreage of wetlands within each zoning category was subtracted from the acreage of Potentially Developable Land within that zone. Table 7 summarizes this result. Figure 4 shows the wetlands overlain on the developable zoning.

It should be further noted that the Recreation/Park use may include wooded lands and agricultural lands in addition to those listed. The ±503 acres zoned for recreation and park include about 200 acres of agricultural lands and about 270 acres of woodlands. However, since recreation/park land can be simply open space preserve or athletic fields, it is not known how much of these lands will be preserved as agricultural land or woodland and how much may become fields, parking lots or other park features.

Table 7: Developable Lands Zoning

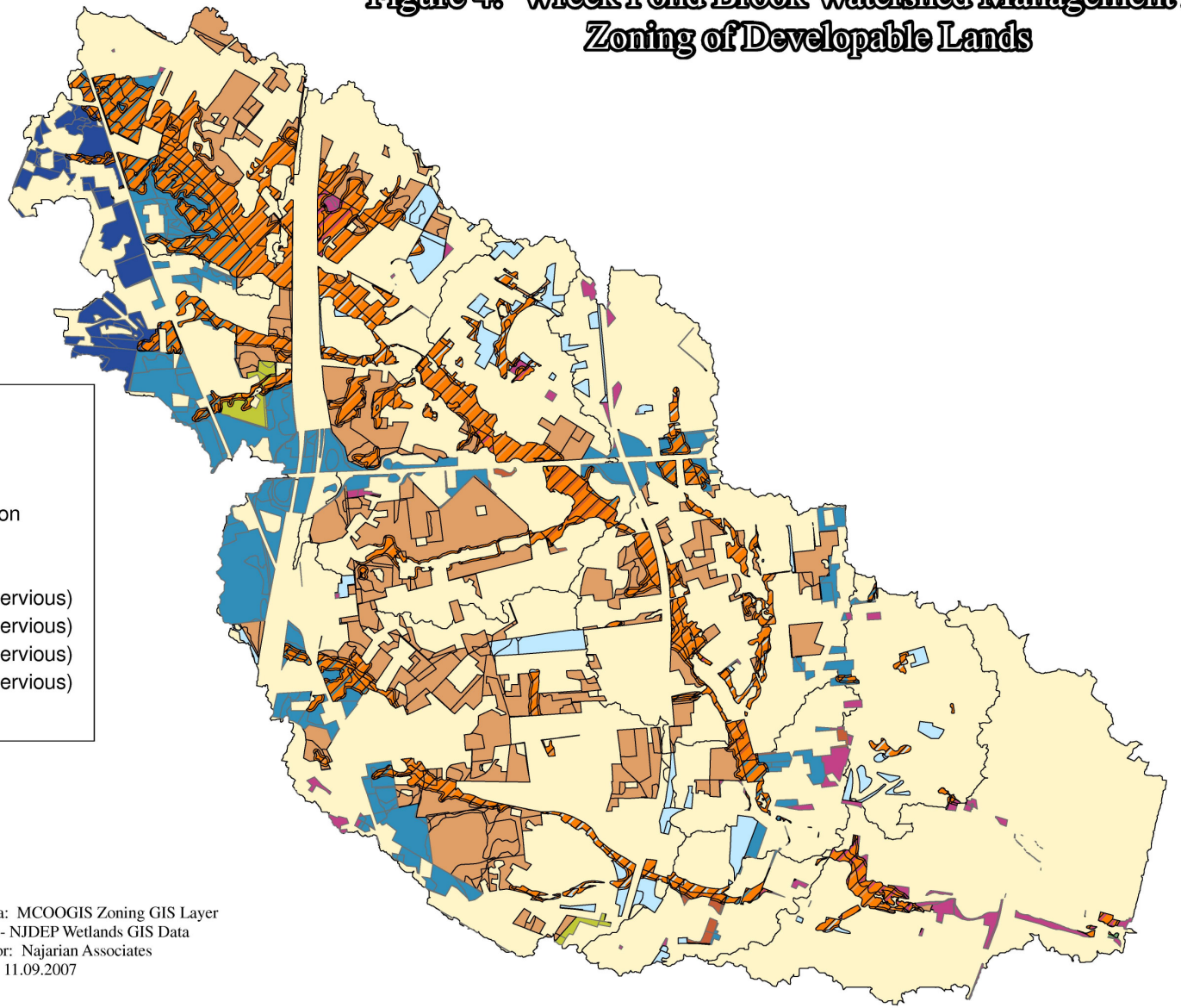
	Zoned	Wetlands	Developable Zoning
Commercial	767.5	224.4	543.0
Industrial (include GSP)	283.6	15.2	268.3
Recreation/Park	502.7	0.4	502.3
Residential (17% impervious)	1595.2	457.2	1138.1
Residential (23% impervious)	281.2	98.8	182.4
Residential (33% impervious)	122.5	50.6	71.9
Residential (65% impervious)	55.5	43.4	12.0
TOTAL	**3608.1**	**890.1**	**2718.0**

The build-out analysis herein does not consider redevelopment of existing land uses in accordance with the zoning. In many cases, current land uses have uncontrolled stormwater and proposed development would be required to conform to current, more stringent stormwater management requirements. Further, more detailed information would be required as to which uses were non-conforming.

3.3 Build-out Timeframe

Review of past development rate may assist in determining an appropriate build-out horizon. Past rates of development may not predict the future as development may accelerate or slow depending on market condition and available lands. However, in order to investigate the past development rate in the watershed, land use data from 1986 and 2006 were compared.

Figure 4: Wreck Pond Brook Watershed Management Plan
Zoning of Developable Lands



Source: Zoning Data: MCOOGIS Zoning GIS Layer
Wetlands Data - NJDEP Wetlands GIS Data
Map Author: Najarian Associates
11.09.2007

The NJDEP has a Land Use/Land Cover layer from 1986 which is summarized in Table 8. This can be compared to Table 4 for existing development as of 2006.

Table 8: 1986 Land Use

Land Use Category	Acres	Pct of Watershed
Agriculture	1100	13.5%
Barren	213	2.6%
Forest	1693	20.7%
Urban	3996	48.9%
Water	104	1.3%
Wetlands	1066	13.0%

Several factors must be considered when comparing the 1986 and 2006 land use data. First, in 1986 wetlands were categorized as a separate category while in 2006 wetlands were included with the overlying land type, primarily woodland. Second, the land uses were reviewed and some land uses were re-categorized in 1996 and later by Monmouth County and other agencies. For example, the acreage of unvegetated land, also known as barren land, is greater in 2006 at about 311 acres than in 1986, at about 213 acres. A review of a GIS layer that combines these two land use files indicates that areas that are called unvegetated in 2006 included lands that in 1986 were classified in uses including agricultural, urban and water. Thus, the 1986 land use classes may not be directly comparable to the 2006 data and may have more inaccuracies. The later data may be more accurate due, in part, to improved mapping tools. In addition, the land use classifications schemes may differ between the two time periods.

In analyzing the 1986 Land Use data, the wetlands category was split so that the area classified as water was the same in 1986 as in 2006. The remainder of the wetlands were assigned to the woodland category.

With these caveats in mind, the available information shows a transformation of about 5% of the watershed in the period from 1986 to 2006 from agriculture or forested use to urban or barren lands. This represents a decline of about 25% of the lands devoted to agricultural use, with a 5% reduction in forested lands. Given that about 950 acres (38%) of the forest area is wetlands, about 9% of the non-wetland wooded lands were developed. The overall increase in urban land is about 4% of the total watershed area.

Although this analysis does not show a rapid increase in development of the past 20 years, development rates can accelerate if infrastructure becomes available or an owner of a large land area decides to sell. The presence of one development can change the economic viability of development of surrounding parcels. Thus, past rate of development is not a predictor for the future. Therefore, the full build-out scenario is presented herein.

3.4 Hydrologic and Water Quality Impacts of Full Build-out

The main purpose of the build-out analysis was to provide input to model scenarios under build-out land use to predict hydrologic and water quality changes in the watershed. The analysis was conducted using the watershed SWMM model developed by NA. The analysis was conducted based on full build-out conditions outlined in Section 3.2, as a conservative condition. Model input required analysis of the change from one land use to another. Table 9 summarizes this for the watershed. The actual analysis was conducted on the basis of the sub-watersheds used in the modeling.

The SWMM watershed model is discussed in Book 1, Section 8. The calibrated model was run using the full build-out land use, which assumes that all developable lands within the watershed would be converted to developed lands in accordance with zoning. This did not include existing open space areas or wetlands. Thus, the flow and loading information provided is a worst-case scenario for the watershed and Wreck Pond, while realistically excluding wetlands and buffers on which development is prohibited by State regulation.

Table 9: Land Use Changes under Build-out (acres)

	Existing	Change	Buildout
Agriculture	820.3	-794.0	26.3 (wetland/buffer)
Barren	165.5	-149.7	15.8 (wetland/buffer)
Brush	283.7	-251.3	32.4 (wetland/buffer)
Cemetery	38.4	0.1	38.5
Commercial	404.6	544.4	949.0
Extractive Mining	120.9	-119.8	1.1
Industrial	428.1	269.3	697.4
Landscaped Open Space	163.4	0.2	163.6
Recreation/Park	403.4	503.7	907.1
Residential - High Density	239.5	12.4	251.9
Residential - Low Density	1413.4	1141.9	2555.3
Residential - Medium Density	1247.1	256.3	1503.4
Water	215.9	0.3	216.2
Woodland	2229.9	-1414.1	815.8 (wetland/buffer)

Revised land use percentages and percent impervious values were input into the model for each sub-basin and the model was run for the 2-year, wet and dry year simulations. For this analysis the subwatershed areas were:

1. Upper Wreck Pond Brook (west of Route 18)
2. Lower Wreck Pond Brook (east of Route 18)
3. Hannabrand Brook
4. Wreck Pond (below Old Mill Road)
5. Black Creek

Tables 10 through 12, below, provide percent increase information for flow and pollutant loadings for the three simulations. Figure 5 shows these results graphically.

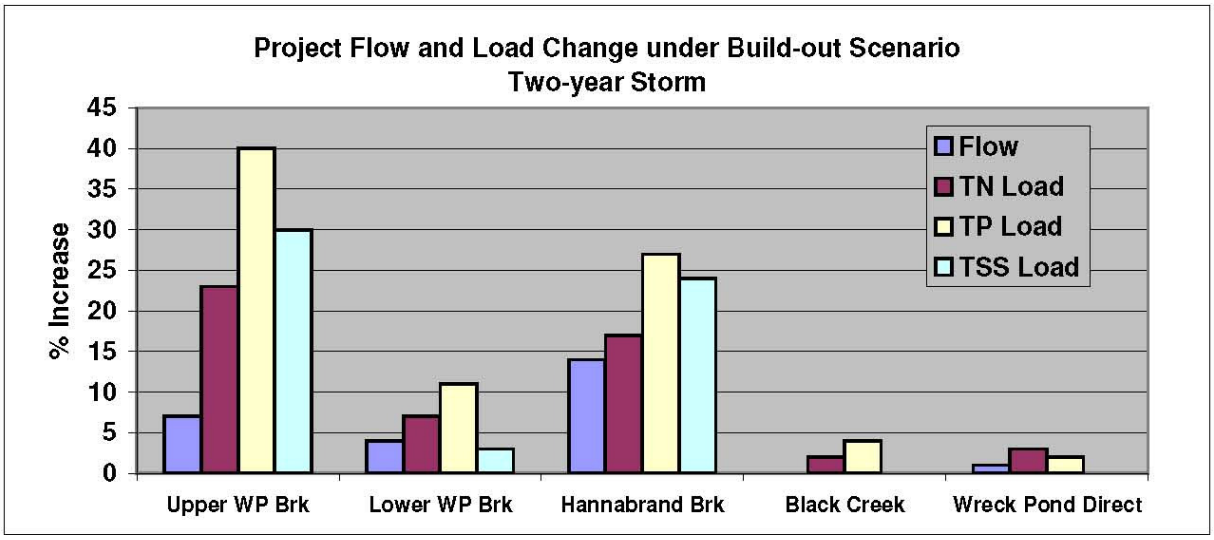
Table 10: Build Out Loading Simulation from SWMM Model
Two-year Storm at Full Build Out – Percent Increase in Load

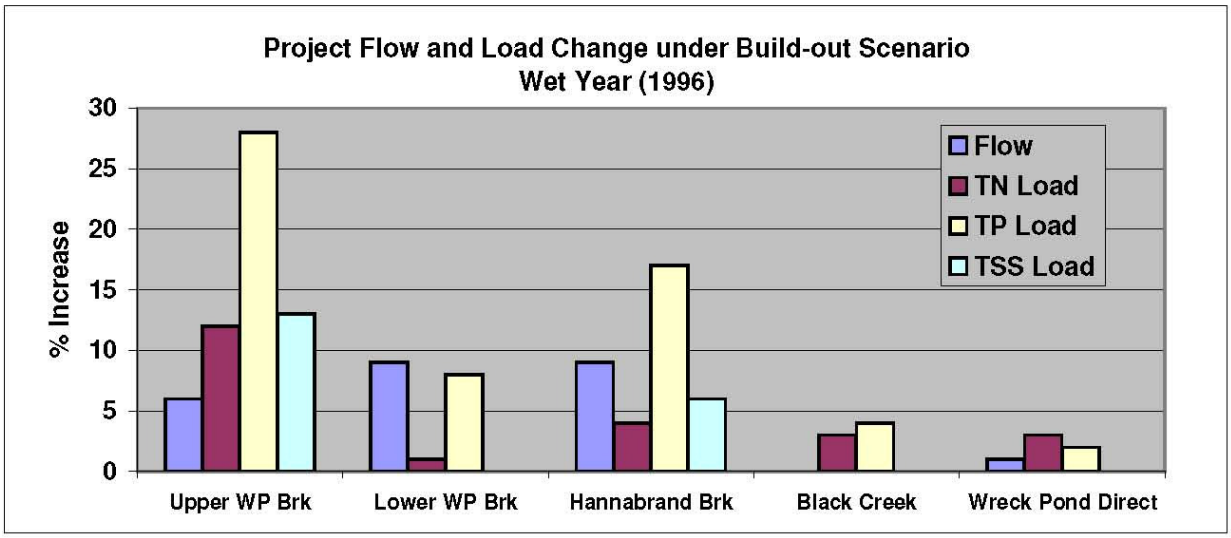
Sub-Basin	Flow Increase (%)	TN Load Increase (%)	TP Load Increase (%)	TSS Load Increase (%)	FC Load Increase (%)
Upper WP Brk	7	23	40	30	87
Lower WP Brk	4	7	11	3	41
Hannabrand Brk	14	17	27	24	107
Black Creek	0	2	4	0	6
Wreck Pond	1	3	2	0	3

Table 11: Build Out Loading Simulation from SWMM Model
1996 Wet Year Simulation at Full Build Out – Percent Increase in Load

Sub-Basin	Flow Increase (%)	TN Load Increase (%)	TP Load Increase (%)	TSS Load Increase (%)	FC Load Increase (%)
Upper WP Brk	6	12	28	13	81
Lower WP Brk	9	1	8	0	70
Hannabrand Brk	9	4	17	6	108
Black Creek	0	3	4	0	9
Wreck Pond	1	3	2	0	4

Figure 5: SWMM Model Results - Build-out Analysis





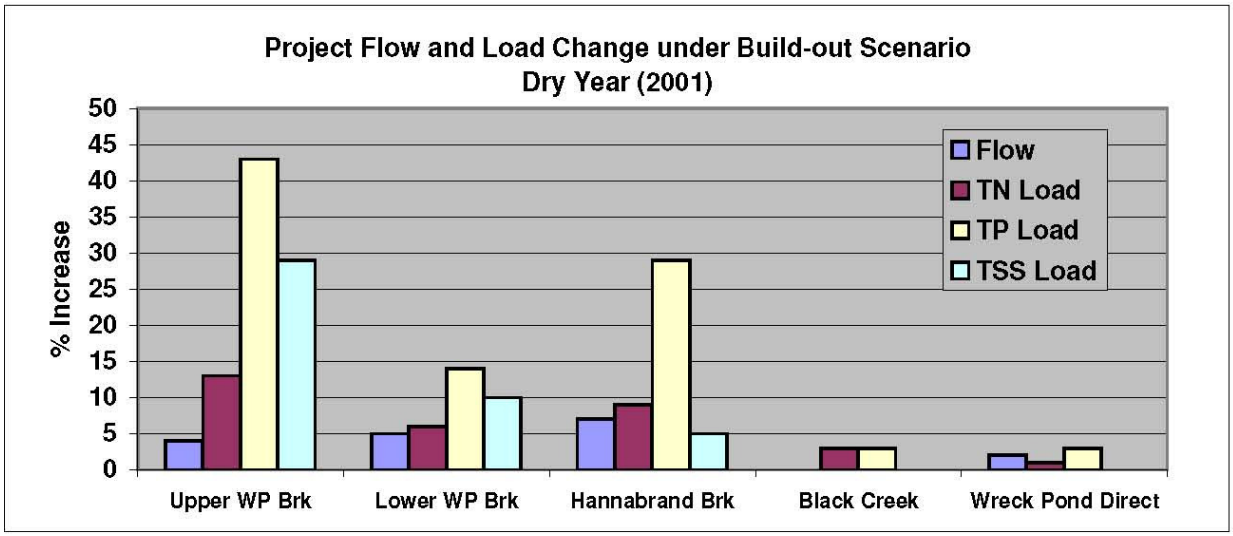


Table 12: Build Out Loading Simulation from SWMM Model 2001 Dry Year Simulation at Full Build Out – Percent Increase in Load					
Sub-Basin	**Flow Increase (%)**	**TN Load Increase (%)**	**TP Load Increase (%)**	**TSS Load Increase (%)**	**FC Load Increase (%)**
Upper WP Brk	4	13	43	29	187
Lower WP Brk	5	6	14	10	117
Hannabrand Brk	7	9	29	5	141
Black Creek	0	3	3	0	17
Wreck Pond	2	1	3	0	3

It should be noted that the bacteria analyses should be considered very preliminary as loading data for bacteria are limited.

These results indicate that the upper portions of the Wreck Pond Brook show the largest percent increases in nutrients and TSS, while lands developed along the Hannabrand Brook produce the highest percent increase in flow and bacteria. These trends can be attributed to the fact that both of these sub-basins contain the highest percentages of developable land. Thus, build-out will increase impervious area to a greater extent here than in other parts of the watershed.

The Black Creek and the Wreck Pond direct drainage sub-basins show the smallest percent increases in all categories for all simulations. This is consistent with the fact that these sub-basins are currently very close to full build out and limited increases in developed land are anticipated. However, redevelopment, including enlargement of existing homes or businesses, is not evaluated in the build-out analysis.

The model used for this build out analysis does not take into account any stormwater management measures that future developments may be required to implement under NJDEP regulations. Current NJDEP regulations require strict control of stormwater runoff from new development including maintenance of existing recharge and control of peak outflow and stormwater quality. Further, this analysis does not take into account development of areas now in open space, such as the golf courses or parks in the watershed.

These worst-case scenario build-out estimates can be used by the Borough and the County as a planning tool with respect to future development, specifically within the upper portions of the watershed. Because Wreck Pond will ultimately receive increased flows and pollutant loadings from development upstream, it is important for future

development to consider potential downstream impacts and appropriate management techniques.

Originally it was planned to include the build-out scenario in the NJDA hydrologic and hydraulic model developed for this study as described in Book 1, Section 7. However, this was beyond the scope of the NJDA modeling effort for the RSWMP. Thus, the analyses herein must be considered estimates and future analysis, particularly related to flooding, with the NJDA model would provide additional information on build-out scenarios.

3.5 Recharge Impacts of Full Build-Out

Section 9 of Book 1 provides an analysis of Recharge Rank based on NJGS methodology using existing land use. This analysis was also conducted using the full build-out land use scenario described above for the developable lands. Figure 6 shows the future recharge rank while Table 13 compares the existing and future recharge.

Within the watershed, about 2,700 acres are available for future development. This excludes already developed lands, wetlands, wetlands buffers, waters, and lands zoned for future open space. Of these, recharge could be calculated for about 1,840 acres. The other acres had soil types that could not be calculated. About half of this is due to soils labeled as hydric in the NJGS methodology, although these are not identified as wetlands on the NJDEP Wetland maps. This is likely due to both areas with wetland that have not yet been identified as well inaccuracies in the soils mapping.

As discussed in Book 1, Wreck Pond Brook is within Watershed Management Area 12. For this area, the NJGS has developed Recharge Rank Categories as follow:

A	>16 Inches per year
B	12-16 in per year
C	9-11 in per yr
D	1-8 in per yr
E	0 in per yr

Clearly, the most recharge occurs in the Rank A areas and the least in Rank E.

Figure 6: Wreck Pond Brook Watershed
Recharge Rank of Developable Lands under Future Zoning

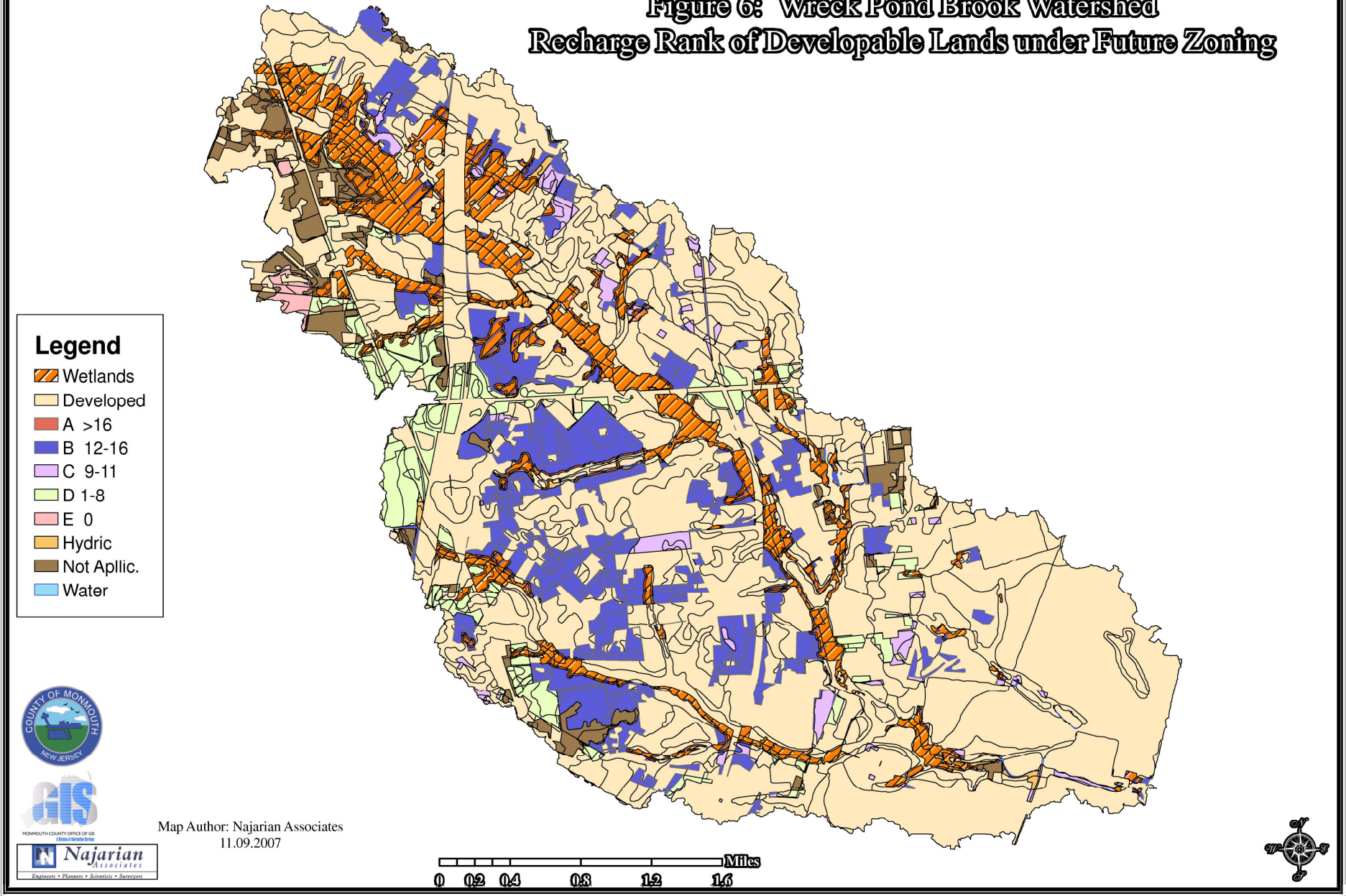


Table 13: Recharge Rankings of Developable Lands Under Future Zoning				
	Existing Developable		Zoned	
	Area (ac)	Percent	Area (ac)	Percent
A	998	54%	0	0%
B	845	46%	1129	61%
C			195	11%
D			487	26%
E			30	2%

As expected, currently undeveloped lands have relatively high recharge rank. After development, the majority of the area will still provide recharge in Rank B, however no Rank A areas will remain. Only limited area will allow no recharge.

Using volumes, the developable area under current conditions represents about 37% of overall watershed recharge. For future, full build-out conditions, without any consideration of mitigation, a 40% reduction in recharge volume is projected. The volume of recharge lost under that scenario is about 14% of the current total calculated recharge volume. That is, with full build-out and no consideration of required stormwater mitigation measures, approximately 86% of the existing recharge will be maintained.

The current NJDEP Stormwater Management Regulations require maintenance of existing recharge rates. These regulations apply to most development projects adding 0.25 acre of impervious area. As most development would fall under those regulations, the required stormwater management techniques would maintain recharge. Thus, this analysis represents a worst-case condition considering full development under existing development and the actual impact is expected to be reduced with implementation of the NJDEP recharge requirements.