Mattawoman Creek Watershed Management Plan

Charles County, Maryland

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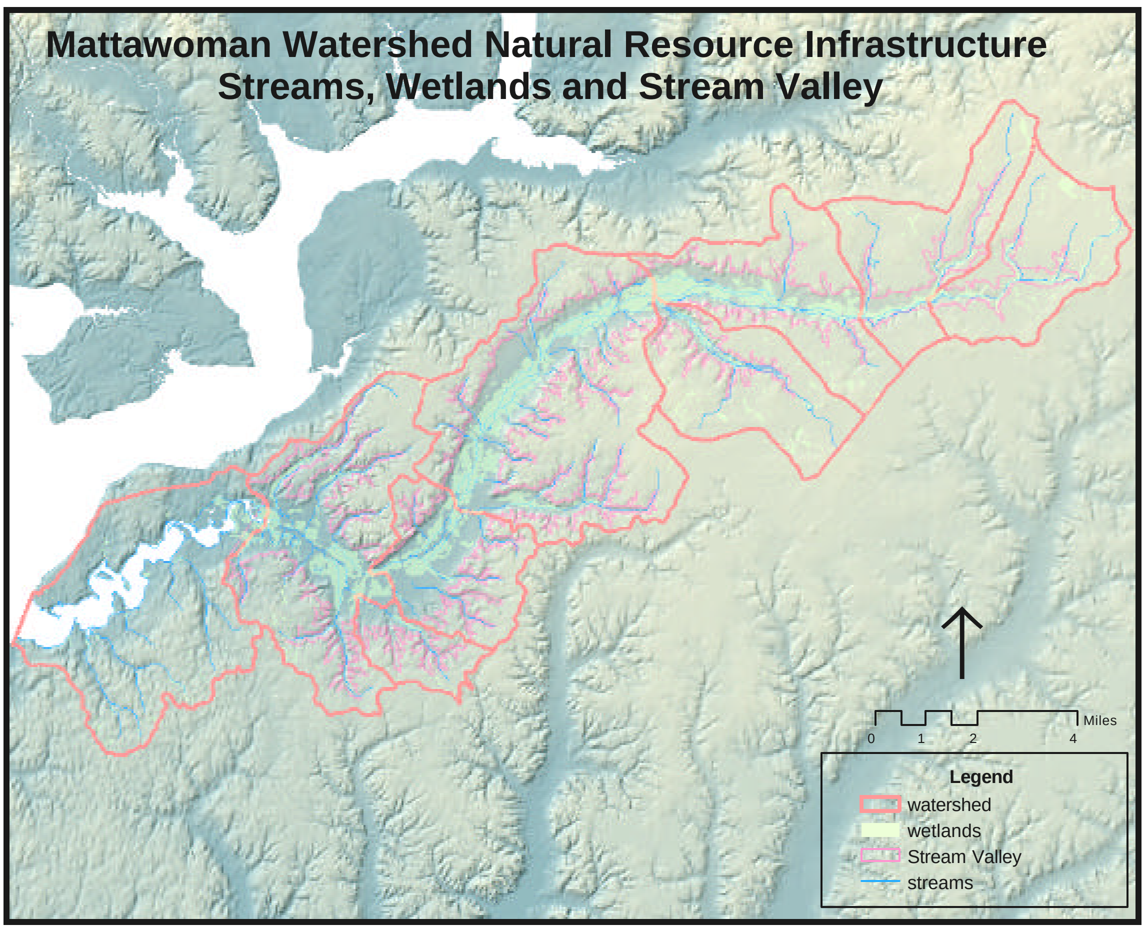
TABLE OF CONTENTS
MATTAWOMAN CREEK WATERSHED MANAGEMENT PLAN

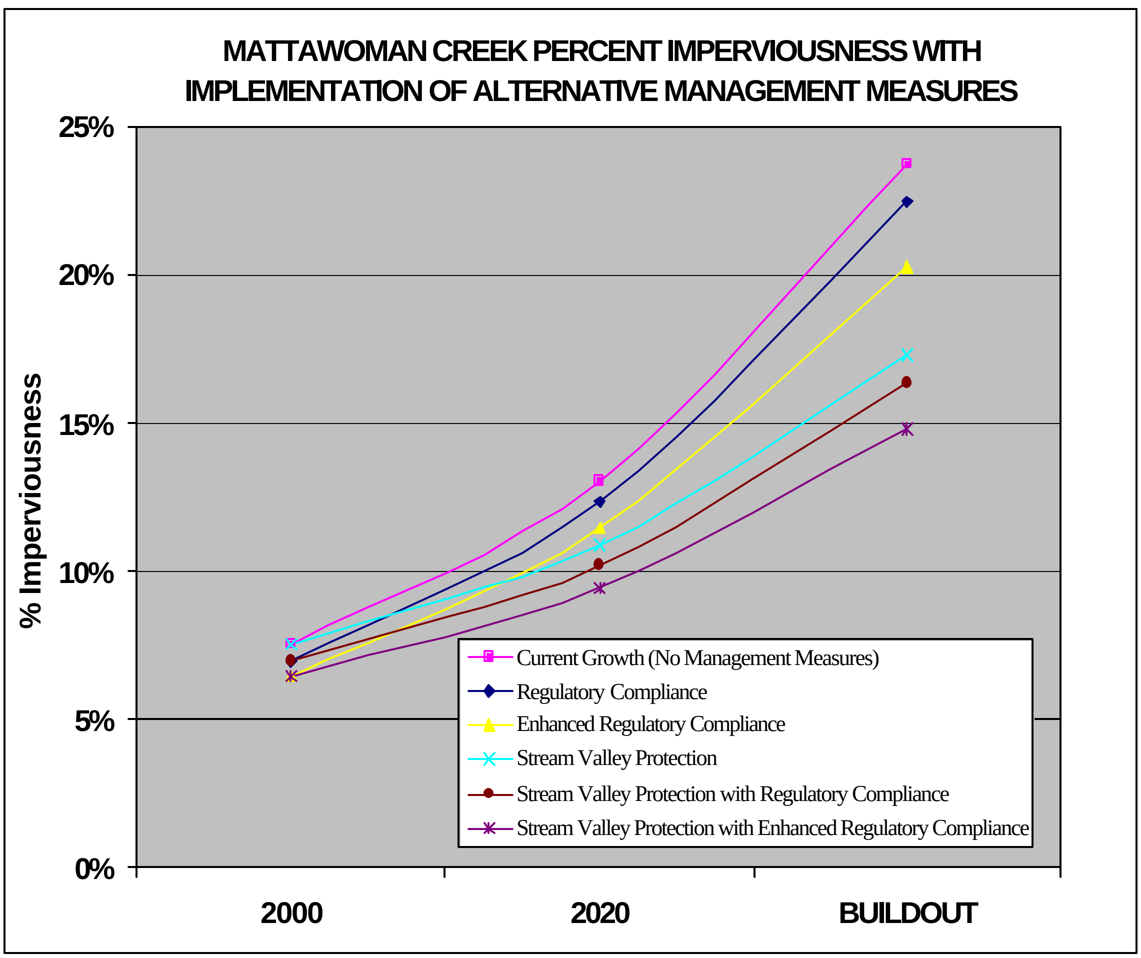
EXECUTIVE SUMMARY

The Mattawoman Creek Watershed represents a significant natural resource for northwestern Charles County, Maryland. Comprised of a mix of forests, wetlands, and agriculture, the stream system supports a high diversity of fish and wildlife. The watershed lies almost wholly within Charles County and much of the watershed is within the County's Development District. Over the last several years there has been significant growth in the watershed and that trend is expected to continue. An analysis of current and projected landuse trends confirm this expectation, demonstrating the potential for a major change in the character of the watershed as existing forest cover and historically agricultural areas are converted into low and medium density housing and business developments. Current development pressures have adverse impacts on habitat value and water quality of the Mattawoman Creek, and the Creek is expected to continue its decline as growth continues over the next 20 years. Hydrologic changes as well as increases in the loading of nitrogen, phosphorus, and suspended solids to the stream can be anticipated. Under current development scenarios, the result will be an overall decline in the ecosystem.



To understand this decline in the Mattawoman Creek watershed, it is important to examine the role of impervious cover. The conversion of natural and open areas (i.e. farmland, wetlands, forests) to parking lots, roads, landscaping, and buildings creates impervious cover or compacted pervious cover. An important indicator of watershed health, current conditions as well as predicted growth of impervious cover can be used to calculate future water quality. When open space is converted to impervious cover, storm events deviate from their natural process of recharging groundwater to increasing surface runoff. Surface runoff increases stream flows and exacerbates erosion rates leading to habitat degradation. Impervious cover also significantly increases the amount of pollutants that flow into the watercourses thereby reducing water quality. In addition, the loss of groundwater can severely impact the amount of clean water flowing into streams during droughts and decrease the amount of available water for deepwater aquifers.

These landuse scenarios reflect changes in development, which have occurred and are currently planned within the watershed and water quality conditions resulting from these changes. The following graph demonstrates a range of impervious cover of 8-13% in year 2020 to 14-24% at buildout, depending on which measures are implemented. It is generally accepted that if impervious cover exceeds 15%, then impacts can be severe.



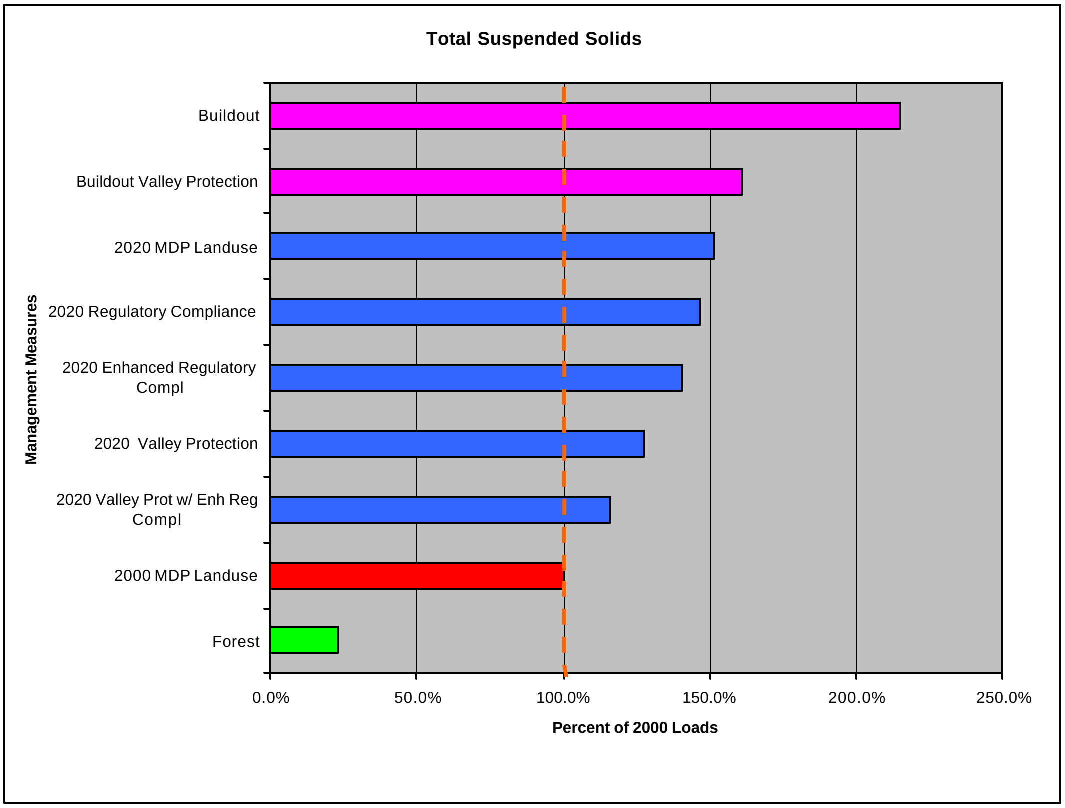
In conjunction with the examination of impervious surfaces, an analysis was done of the projected rate of increase of phosphorus, nitrogen, and sediment loading under the management scenarios. These pollutants directly contribute to the degradation of habitat and water quality within the watershed. A model was developed that assess the future pollutant loads within the Mattawoman Creek in a variety of future landuse conditions. Three times scales were used, 2000—representing existing conditions, 2020—representing the near future, and buildout—a hypothetical time period when landuse equals the maximum zoned density.

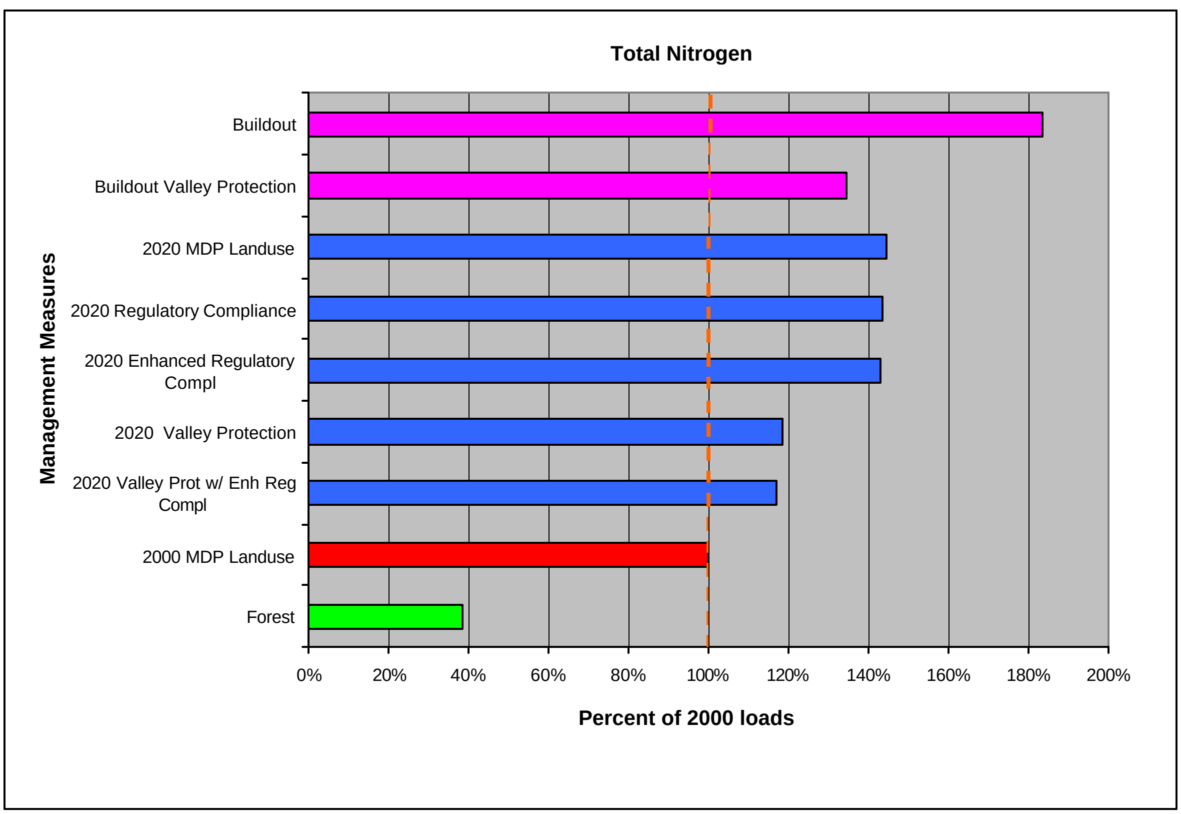
In addition, several management scenarios were modeled, including the continuation of current trends, complete regulatory compliance, enhanced regulatory compliance, and stream valley protection. Forested conditions were included for reference. Together with the time scales, there were 9 scenarios used for the model:

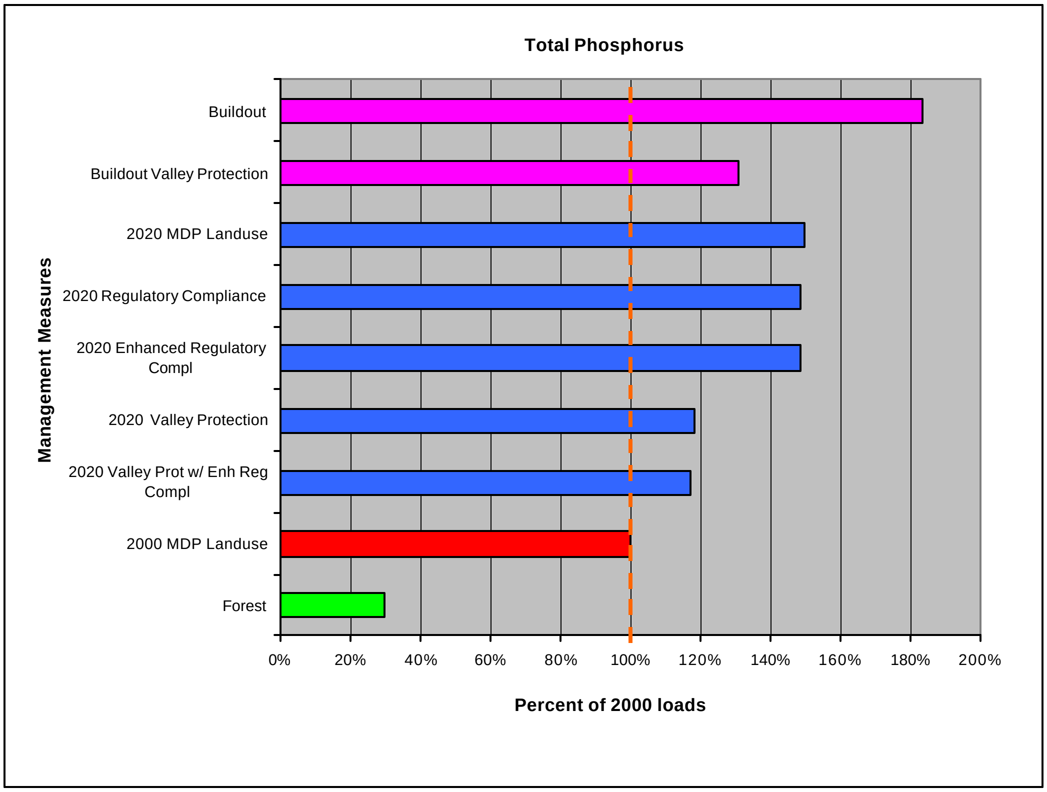
1. The Build-out scenario represents the maximum potential development under current zoning practices.
2. The Build-out stream valley protection scenario represents conditions that would result at buildout if future development were prohibited within the valley.
3. The 2020 scenario represents landuse project to occur within the watershed by the year 2020.
4. The 2020 with regulatory compliance scenario represent conditions that would result in the year 2020 if current regulations required under the County's National Pollution Discharge Elimination System municipal stormwater permit were met.
5. The 2020 with enhanced regulatory compliance scenario represents conditions which could occur in the year 2020 if future planning goes beyond implementing current regulations by retrofitting existing untreated impervious surfaces and implementation of management measures reducing the impacts of impervious surfaces.
6. The 2020 stream valley scenario represents the conditions in 2020 if future development was prohibited within the stream valley. *
7. The 2020 valley protection scenario with enhanced regulatory compliance represents the conditions if future planning goes beyond current regulations and development is prohibited within the stream valley. *
8. The 2000 scenario represents current land development conditions in the watershed.
9. The forest scenario represents pristine conditions prior to development in the watershed. It assumes the entire watershed is forested with no impervious surfaces.

* Scenarios 6 and 7 are based rates established by other model runs, not actual model runs.

Results of the model are shown in the graphs below. Based on the model results and the obvious increase in impervious surfaces, phosphorous, nitrogen, and sediment loads, is expected to increase dramatically. Loads are expected to increase by over 50% in the next 20 years. Even with aggressive regulatory enforcement, there is still a significant increase in the pollutants.


Total Suspended Solids
Buildout
Buildout Valley Protection
2020 MDP Landuse
2020 Regulatory Compliance
2020 Enhanced Regulatory Compl
2020 Valley Protection
2020 Valley Prot w/ Enh Reg Compl
2000 MDP Landuse
Forest
Management Measures
0.0%
50.0%
100.0%
150.0%
200.0%
250.0%
Percent of 2000 Loads


Total Nitrogen
Buildout
Buildout Valley Protection
2020 MDP Landuse
2020 Regulatory Compliance
2020 Enhanced Regulatory Compl
2020 Valley Protection
2020 Valley Prot w/ Enh Reg Compl
2000 MDP Landuse
Forest
Management Measures
0%
20%
40%
60%
80%
100%
120%
140%
160%
180%
200%
Percent of 2000 loads



Protection of the stream valley is the most effective management scenario to minimize pollutant impacts on water quality and should be coordinated with other efforts. These recommendations allow for the continued development of the Mattawoman Creek Watershed, while emphasizing natural resource protection. If implemented, this strategy will help maintain the natural resources of the stream system and promote sound development strategies. Implementation will require a multi-tiered strategy, at the subwatershed scale, neighborhood scale, and individual site scale. In addition effective implementation will require extensive public participation and education.

Based on the analysis, a management plan with three specific recommendations was developed:

1) The stream valley should be delineated and protected, through zoning category changes, acquisition, or ordinance changes. This area could be used to develop a greenway or park system designed to connect the Mattawoman estuary to the Waldorf Central Business District zone (CB).

2) Site planning on future development should implement low impact design techniques, minimizing the amount of impervious surfaces and promoting stormwater disconnects. New housing developments should emphasize many small-scale stormwater management practices, rather than one single stormwater management pond and emphasize tree cover as a main stormwater management component.

3) Existing developments should be examined for stormwater retrofit opportunities, including the retrofitting of existing commercial sites and housing developments in Waldorf. The technology exists to increase the stormwater management within small-scale housing and commercial areas. These techniques should be encouraged through ordinances, public workshops, and re-development projects.

SECTION 1
INTRODUCTION

The Corps of Engineers Planning Division, in conjunction with the Charles County Planning Division and the Charles County Mattawoman Creek Watershed Citizen's Advisory Committee, have prepared this Watershed Management Plan for the Mattawoman Creek Watershed. This watershed represents a majority of the Charles County Development District, and is a focal point for continuing growth within the County. A portion of the watershed is located in Prince George's County, but is significantly less developed. The Mattawoman Creek Watershed is shown in Figure 1.1. The purpose of this watershed plan is to balance the protection of the Mattawoman Creek's natural resources and water quality with the development plans of the County.

The Mattawoman Creek Watershed Management Plan has the following goals:

- Document existing natural resources and characterize the conditions of Mattawoman Creek and its tributaries.
- Document current and projected urbanization and growth, and assess the impacts on the natural resources.
- Document current and predicted future water quality, based on projected growth.
- Develop a planning guide for future development practices.
- Develop the following three management recommendations at the subwatershed level:
  - Regulatory Compliance: Scenario is based upon compliance with all existing regulations and laws.
  - Enhanced Regulatory Compliance: Scenario is based upon compliance with all existing regulations and laws accompanied by an aggressive implementation of laws beyond minimum law requirements.
  - Stream Valley Protection: Scenario is based on removal of the Mattawoman stream valley from the Development District, approximately 28% of total watershed.

In order to accomplish these goals, the watershed management plan has taken a subwatershed approach. The initial characterization will address the overall character and resources of the Mattawoman Creek watershed, emphasizing existing conditions and developing a holistic watershed management plan. In addition, the watershed can be divided into eight non-tidal subwatersheds, which provide a clearer portrait of the watershed's characteristics and management options. These subwatersheds are pictured in Figure 1.2. A subwatershed profile and subwatershed management plan has been developed for each of the subwatersheds. The numeric coding of subwatersheds is based on the Maryland Department of Natural Resources 12 digit subwatershed codes.

Figure 1.1: Location of Mattawoman Creek Watershed

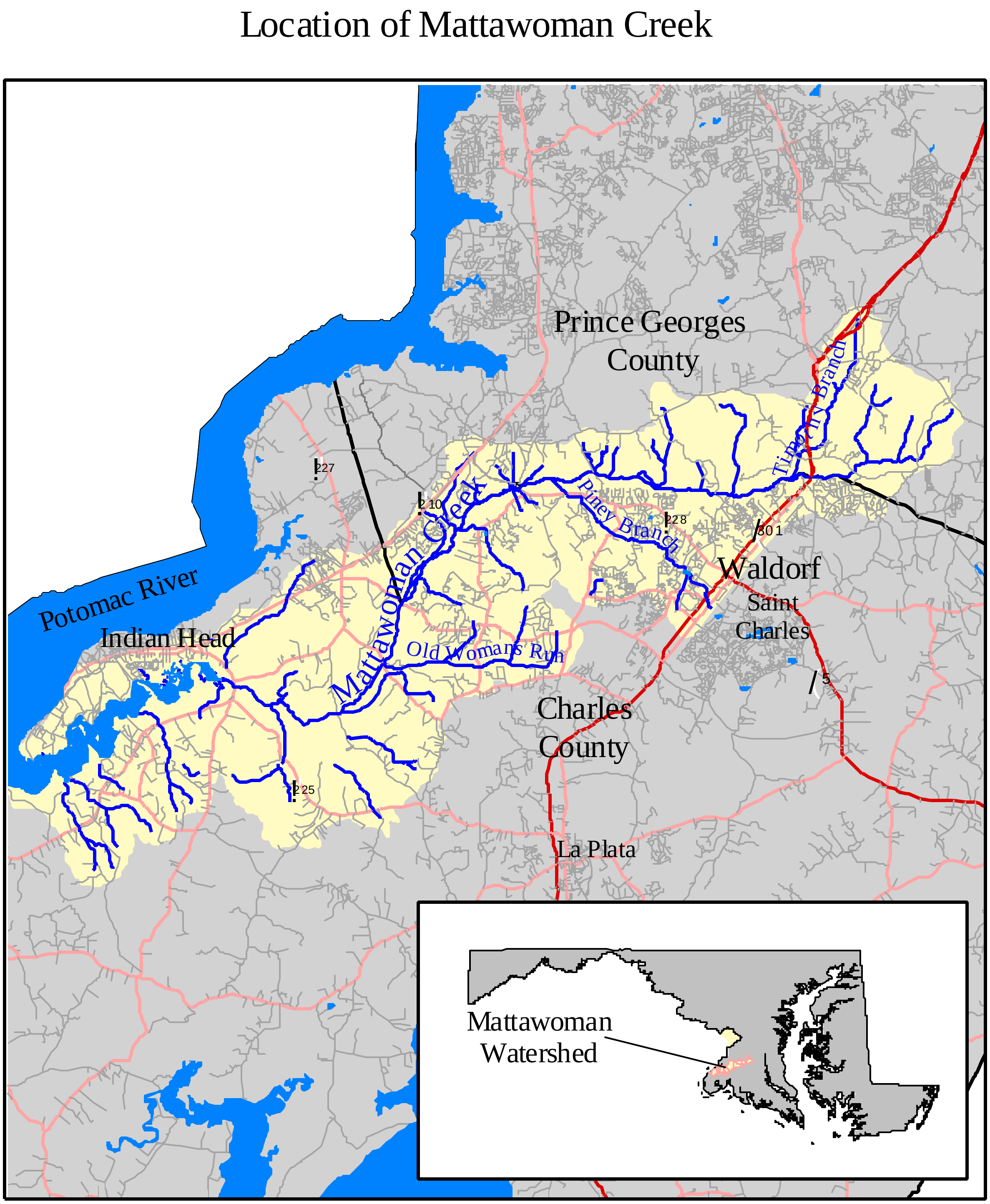
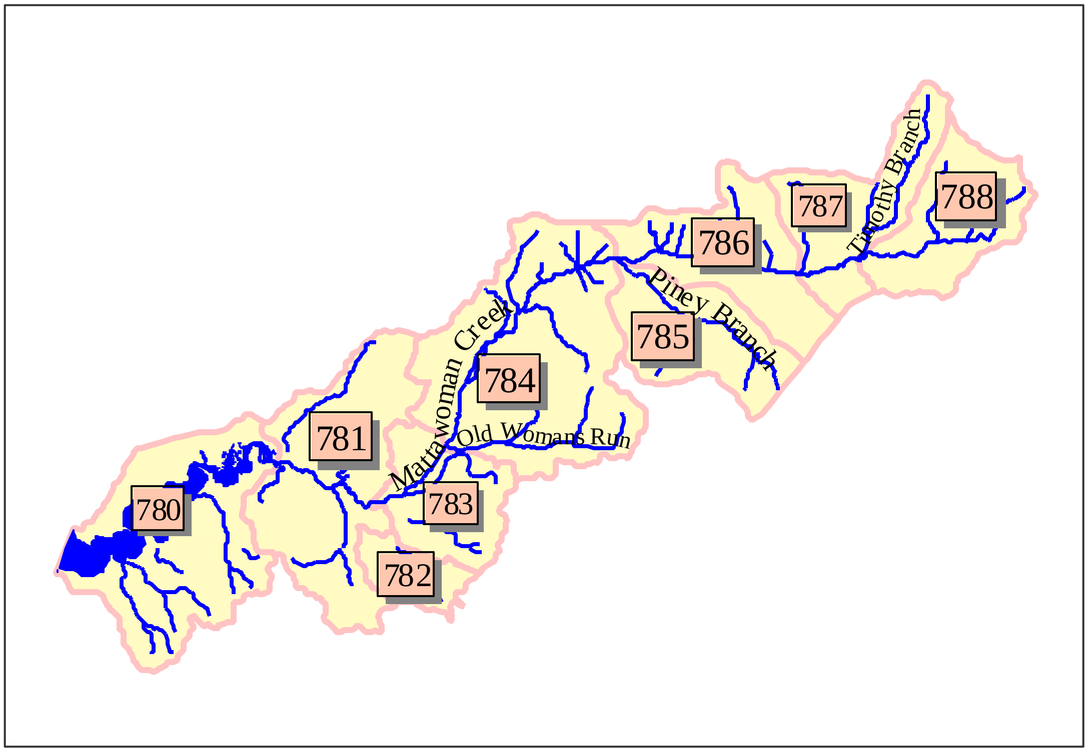


Figure 1.2 Location of Mattawoman Creek Subwatersheds.



1.1 Framework and Analysis

The watershed management plan is designed to be a functional document, providing data on both the watershed and subwatershed scale. This document will examine the watershed in its entirety, identify its physical and biological characteristics, its growth patterns, expected future conditions, and existing and future water quality. Based on these characteristics, a management plan will be developed for the watershed, emphasizing the balancing of economic development and natural resource protection.

In addition to the overall watershed management plan, a subwatershed profile and management plan will be conducted. This will allow for a more accurate assessment and development of recommendations. The subwatershed plans will be site specific and are more effective in developing effective watershed plans.

The watershed characterization used a Geographic Information Systems (GIS) based approach to examine and analyze existing watershed conditions, identify resources, and develop future conditions. This report has created a map-based framework that highlights the spatial component of the resources. GIS data was obtained from a variety of sources discussed in Appendix C. These include federal, state, and county datasets, including elevation, forest cover, topography, roads, wetlands, and protected lands. Additional datasets were generated for this report, including the delineation of the Mattawoman stream valley, steep slopes, and growth rates.

The recommendations in this report will be based on an analysis of existing GIS data and the Hydrologic Simulation Program Fortran (HSPF) model, designed to characterize water quality under different development conditions. By combining the GIS based approach with the model, it is possible to analyze watershed impacts at the landscape scale and assess the impacts to individual streams. At the subwatershed scale, this will create an effective methodology for developing individual subwatershed plans.

1.2 Study Assumptions

In developing the watershed management plan, several key assumptions were made to develop future landuse and growth.

1. Future growth rates were developed in 1998 by Maryland Department of Planning for 2020. These rates were based on an analysis of Charles and Prince George's County current zoning and estimated demand rates for housing units.
2. All modeling was based on best available data, including data collected by the Smithsonian Institute for weekly flow data. This was used for calibration but is not a complete, long-term data set.
3. Build-out is based on 2002 MDP zoning characteristics, with the assumption that 80% of zoned area will be entirely developed according to its zoning density limits. This is implied for the "Build-out" scenario.
4. Towson University bases impervious surface calculations on a review of existing literature and combination of direct measures from Landsat imagery and classification conducted. For current estimates (year 2000), the Towson data is preferred for its accuracy. However, this data cannot be projected to predict future (year 2020) scenarios.
5. Future analysis, such as the MDP 2020 estimate, is based on current zoning. If zoning changes occur, these will have corresponding effects on growth rates and future landuse parameters.

SECTION 2
WATERSHED CHARACTERIZATION

2.1 Physical Characteristics

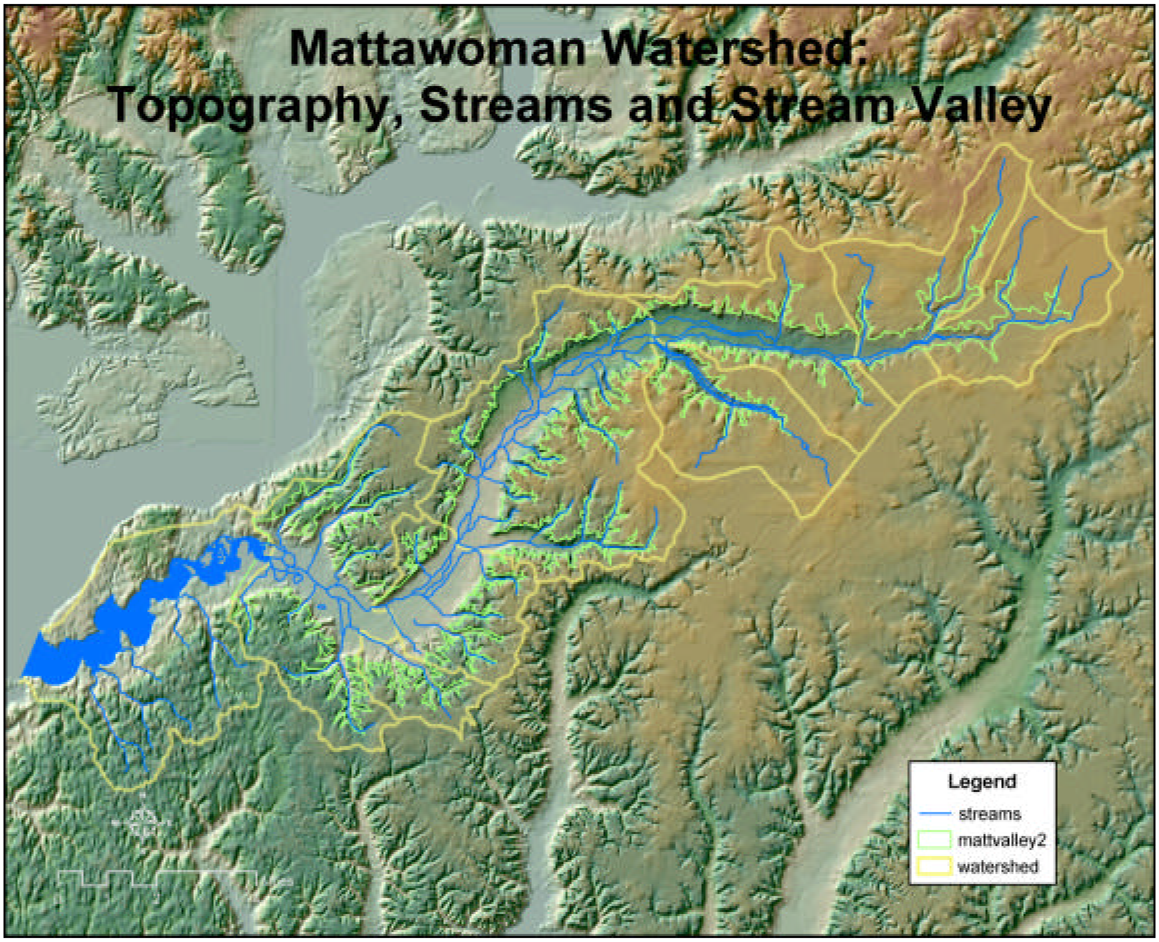
The Mattawoman Creek is an estuary that drains into the Potomac River and is part of the Lower Potomac Watershed. Located approximately 12 miles south of the District of Columbia (figure 1.1), the Mattawoman watershed is a diverse mix of forests, wetlands, and suburban development. Forests and some farmland are slowly converting to suburban development and there has been a sharp increase in urbanization, which has altered the character of the watershed, especially in the headwaters. The stream itself meanders through a broad floodplain within the Maryland coastal plain, and runs southwest into the Mattawoman estuary, a tributary of the Potomac River.

The focus of this study is the non-tidal portion of the creek, which has approximately 276 miles of streams and a watershed area of over 60,000 acres, or 97 square miles. The largest population center within the watershed is Waldorf. Waldorf has grown from a small community into a suburban bedroom community for Washington D.C and continues to experience significant growth. The Mattawoman Creek runs through the Charles County Development District before entering the Potomac River at the Mattawoman Creek Estuary. The estuary is the location of the town of Indian Head and the Indian Head Division of the Naval Surface Warfare Center. A considerable portion of the upstream watershed enters the southern section of Prince George's County.

2.1.1 Topography and Slope

Accurate mapping of the topography and slopes within the Mattawoman watershed are necessary in defining the physical character of the watershed and the biological system that it supports. The topography of the Mattawoman Creek Watershed consists of flat coastal plain topography separated by wide stream valleys. The topographic pattern is shown in Figure 2.1. Figure 2.1 is a Digital Elevation Model (DEM) with the Mattawoman Watershed and sub watersheds delineated. The DEM illustrates geologic features such as stream valleys and elevation features depicted by color schemes. The model shows that over the entire watershed, there is a very gradual slope difference, ranging from roughly 200 ft above sea level in the headwaters, to sea level around the confluence of the Potomac River.

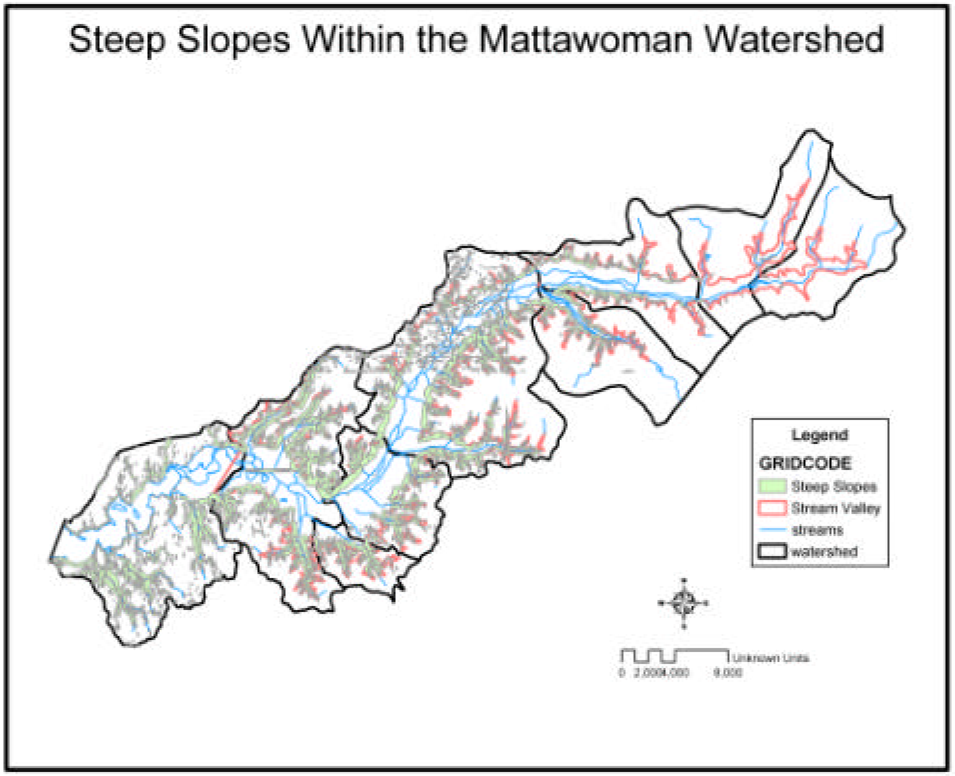
Figure 2.1 Elevation and the Mattawoman Stream Valley



The DEM was also used to delineate the Mattawoman Stream Valley. The valley creates a very clear and broad ridge system depicted by a sharp change in elevation over a short distance, or a steep slope. This map highlights the relatively wide valley, carved by the Mattawoman Creek and its tributaries. The hills and the riparian system are differentiated by a major break in slope.

Slopes of greater than 15% are shown in Figure 2.2. These slopes tend to be the transition from the upland coastal plain to the stream valley. Note that the upstream portions of the valley are less steep, and therefore less noticeable on the landscape. Nonetheless, the stream valley represents a physical break from the forests and farmlands of the coastal plain and the wetland systems surrounding the Mattawoman Creek.
The physical character of the watershed is an important component in developing a landscape scale plan for the stream system. In general, the broad valley functions as a floodplain and allows for biological and nutrient cycling from the forest interior to the stream system. The floodplain serves as a filter for pollutants coming from the developed portions of the watershed, allows for habitat connectivity between the forest and stream, and serves as a natural habitat corridor throughout the stream system. The floodplain supports broad wetlands (see section below), allows for periodic overflow of the channels, and maintains a geomorphically stable stream system.

Figure 2.2: Steep Slopes within the Mattawoman Watershed



2.2 Biological Resources

2.2.1 Forest Cover

The stream valley is predominately forested, as shown in Figure 2.3, and characterized by a mixed hardwood coniferous forest. The forest resources are more intact in the western portion of the watershed, as one leaves the Waldorf area. Large unbroken expanses of forest can still be seen in much of the watershed, providing important habitat for a variety of species, including numerous forest interior dwelling bird species. The watershed itself is approximately 50% forested. The percentage is higher in the southwestern areas along the middle portion of the watershed. Significant forest loss can be seen around Indian Head Naval Surface Warfare Center and the Waldorf area. There are relatively few large agricultural areas, and many have reforested over the past century, as local agricultural use has been reduced.

The continuous tract of forest has provided a buffer for the Mattawoman and its tributary network, providing extensive water quality and habitat benefits to the stream system. However, the growing networks of housing developments and road systems have begun to fragment the forest network, especially along the outskirts of Waldorf. Currently, approximately 16% of the watershed have unforested stream buffers, equaling approximately 44.4 miles of stream. This will influence the headwaters of the watershed and may have associated temperature impacts on the relatively small, headwater streams. Headwater streams are typically very sensitive to low levels of pollution, therefore their protection is important. Additionally, headwater streams have been found to have the highest pollutant removal rate of all stream segments. Most of these affected small tributaries within the Mattawoman headwaters are near the developed areas of Waldorf or in previously agricultural areas.

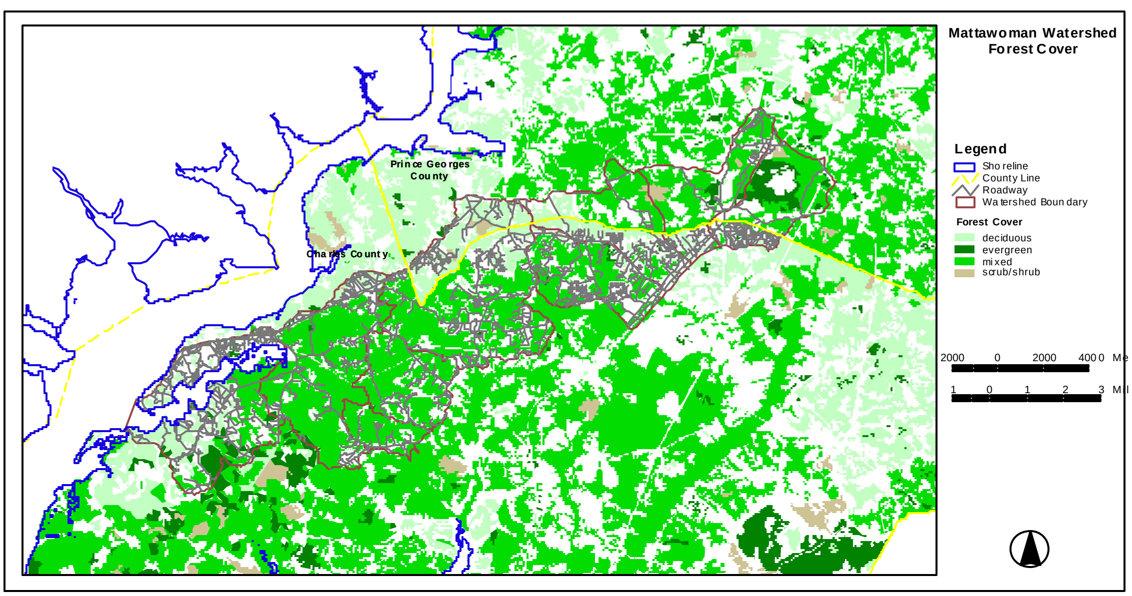
Forest Cover of the stream valley and floodplain is critical to filtering water, however the urban forest canopy also plays and important role. Each year a single mature tree removes 10 pounds of air pollutants before they reach the ground and enter the stream system. The same tree can intercept 760 gallons of rainfall to further reduce run-off.

2.2.2 Wetlands

The Mattawoman Creek has an extensive wetland system surrounding the stream network, especially within the stream valley. A low bottomland forest with non-tidal wetlands surrounds much of the Mattawoman Creek. The wetlands are shown in Figure 2.4. There are approximately 576 acres of wetlands surrounding the stream channel, a majority of which reside within the stream valley.

The wetland complex associated with the Mattawoman Stream Valley provides an effective nutrient and sediment buffer for contaminates, with a relatively high filtering and nutrient removal function. As a result, in order to maintain the quality of the stream, these wetlands should be protected. In the western sections of the watershed, the wetland complexes have been protected by the state as Wildlife Management Areas, reflecting their ecological importance to a variety of aquatic and bird species.

Figure 2.3: Mattawoman Creek Forest Cover, 1995



Non-tidal wetlands are extremely valuable habitat areas and provide extensive water quality benefits. Because of the large amount of intact non-tidal wetlands, the Mattawoman has extensive wildlife usage, with large numbers of blue herons, bald eagles, common egrets, black crowned night herons, wood duck, otter, and mink within the watershed. The tidal wetlands contain the American lotus, *Nelumbo lutea* and wild rice, *Anelema keisak*. Overall, portions of the Mattawoman show similar habitat values associated with larger wetlands surrounded by large forested areas, providing excellent wildlife refuge and the basis for an extensive foodchain. In the Mattawoman watershed, approximately 1,771 acres of hydric soils as shown on the Natural Resources Conservation Service soil maps, which are indicative of existing or previously existing wetlands, have been converted from forest and agriculture to urban and suburban development during the 20th century, according to Maryland Department of Natural Resources (DNR).

2.2.3 Biological Resources

Biological Conditions within the Mattawoman Creek stream system can be measured in numerous ways. Among the most comprehensive is the Maryland Biological Stream Survey (MBSS), Index of Biologic Integrity (IBI) scores. These scores use habitat and biological indicators to develop a measure of overall health. Biological samples of benthic communities and fish communities are analyzed in relation to habitat parameters to develop a measure of overall health. The MBSS data for the Mattawoman Creek from 1996 to 2000 is shown in Figure 2.5.

The biological sampling shows several patterns, including a relatively good match between fish and benthic sampling. Impacts to the biota can be seen within the mainstem of the upper watershed. Headwater streams tend to fall in the fair to poor category, reflecting their proximity to the developed areas. The upper watershed is comprised of poor fish communities with a few pollution tolerant species, indicating that water quality is failing. However, the biological communities near the estuary, in the western edge of the watershed, show a more diverse population with less tolerant species. This situation is similar to that in the tributaries and mainstem of the Mattawoman. In general, the farther west towards the Potomac, the better quality fish and benthic communities, reflecting the relatively pristine conditions in some of these watersheds. The sampling data indicate a clear trend towards deteriorating watershed surrounding the headwater region. Buffering wetlands and forests have been replaced with development resulting in these deteriorating conditions.

Figure 2.4: Wetland Networks within the Mattawoman Watershed

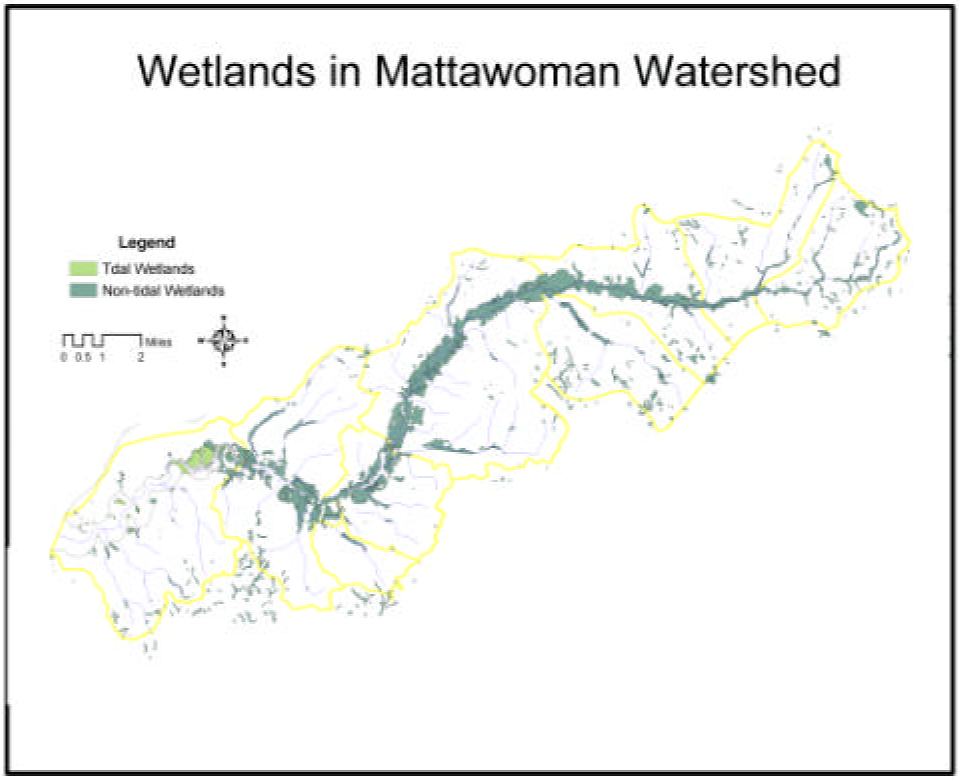
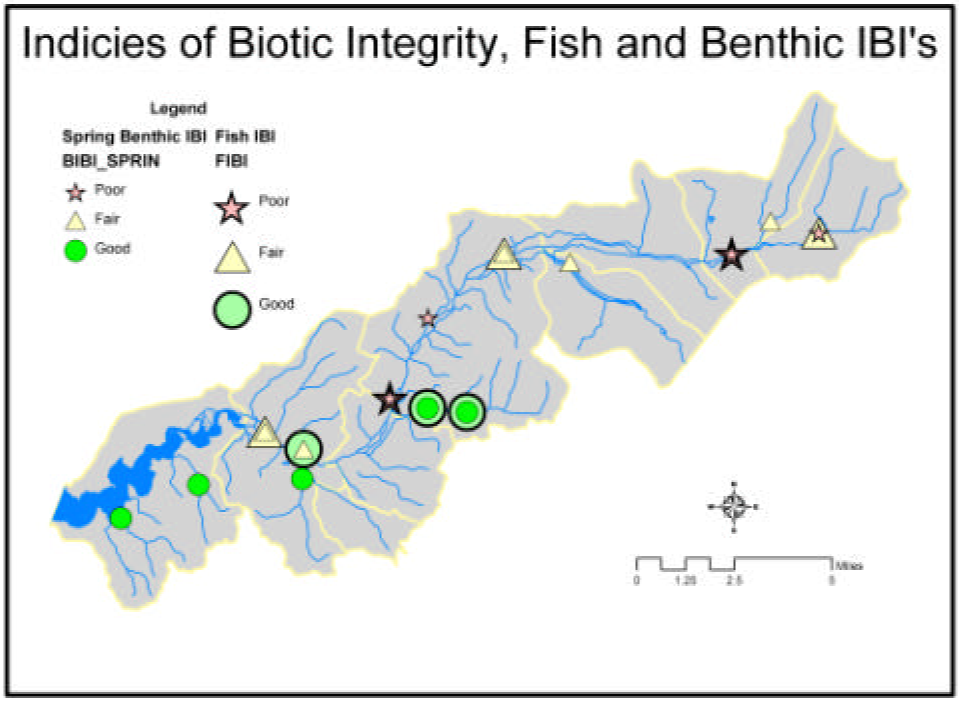


Figure 2.5: Fish and Benthic Indices of Biotic Integrity, MBSS 1996-2000



2.3 Population and Growth

2.3.1 Population

The Mattawoman Creek Watershed, as the Development District for Charles County, has experienced tremendous growth in terms of population and development. The tremendous growth is one of the major factors influencing the character of the watershed. The population change within the watershed is shown in Table 2.1. Note that population is predicted to nearly double in the thirty years form 1990 to 2020, with nearly 10,000 additional residents per decade. This represents a major change from rural to suburban development patterns.

Table 2.1: Population Growth in the Mattawoman Watershed

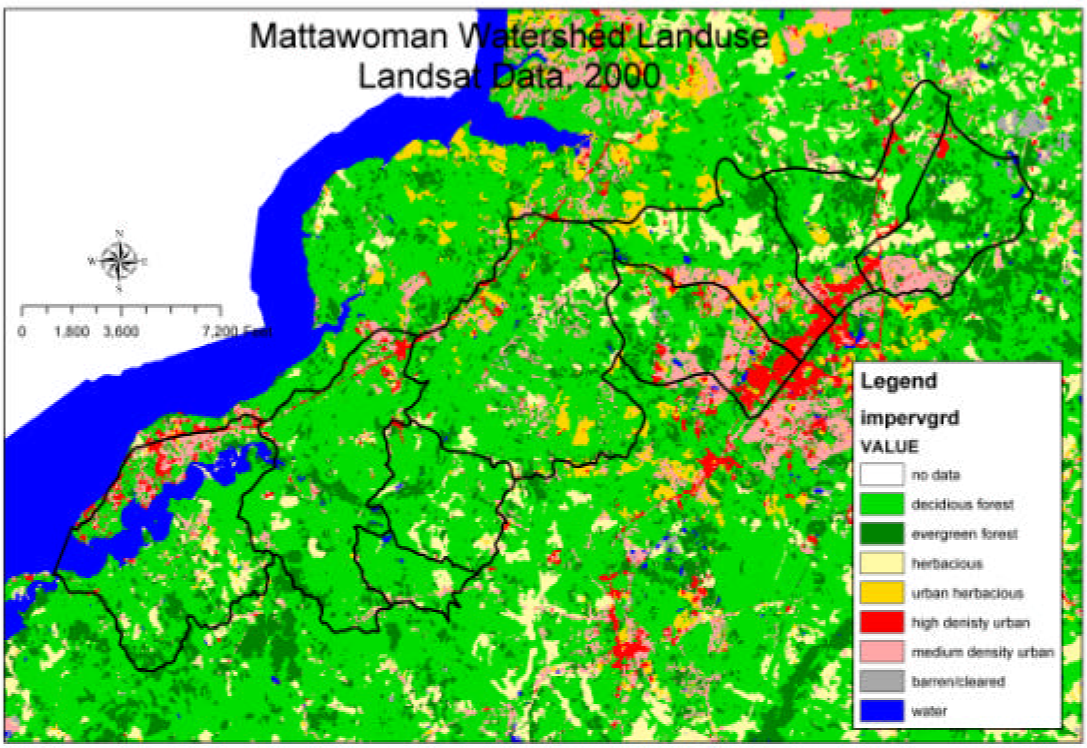
Date	Population
1990	34,978
2000	44,876
2010	51,789
2020	59,708

(Source: US Census data)

2.3.2 Landcover

Landcover within the Mattawoman watershed is a mix of urban, suburban, forest, and agricultural uses (Figure 2.6). The majority of the urban and suburban development is within the upper four subwatersheds, especially within the Charles County portion of the watershed. These are subwatershed numbers 785, 786, 787 and 788. Located near the Potomac River, Indian Head Naval Surface Warfare Center represents a significantly developed portion of the watershed. Most of the other development surrounds the Waldorf area. The vast majority of the watershed remains forested, with a mixed forest surrounding low-density housing and small village centers. The Route 301 corridor is clearly visible, along with the Route 210 corridor from Indian Head and Bryan's Road. These represent development corridors.

Figure 2.6: 2000 Landcover in the Mattawoman Watershed



2.3.3 Impervious Surfaces

Impervious surfaces have been identified as one of the primary factors in influencing the hydrology of stream systems. Impervious surfaces change the rate in which water enters the stream system, prevent infiltration, change the flow regime within the stream system and prevent groundwater recharge, which impacts the dry weather base flow in the streams. Impervious surfaces are the by-product of development. As landuse changes towards more structures and parking lots, more areas are converted to pavement and other types of impervious surfaces. The collective impact from these areas has significant implications on the hydrology of the watershed, and represents one of the major factors in determining overall watershed health.

Because of the profound importance of impervious surfaces in estimating hydrologic changes, an accurate assessment of impervious surfaces is critical. A variety of impervious surface models have been developed to address the changes, including systems developed by Towson University (LANDSAT imagery measurements), the Maryland Department of Planning (MDP), and the Center for Watershed Protection. Two different estimates of impervious surfaces are presented for the year 2000. This report uses the 2000 MDP and 2000Towson University data as the current data since it is the most recent data available. Estimates of future impervious cover are presented for 2020 and buildout scenarios in Table 2.2 below.

Table 2.2: Impervious Surfaces Estimates by Subwatershed

PERCENT (%) IMPERVIOUS				
DNR 12-Digit Watersheds	**Towson 2000**	**MDP 2000**	**MDP 2020**	**Buildout**
021401110788	9.37%	6.60%	7.66%	15.32%
021401110787	10.15%	8.15%	15.41%	34.87%
021401110786	11.84%	9.93%	17.23%	30.82%
021401110785	22.18%	20.27%	35.64%	39.46%
021401110784	5.13%	5.70%	11.81%	17.91%
021401110783	1.83%	2.49%	2.96%	21.03%
021401110782	2.60%	2.01%	4.17%	13.97%
021401110781	4.87%	5.10%	7.75%	19.90%
021401110780*	8.09%	7.35%	15.73%	14.55%
Total (780-788)	8.20%	7.43%	14.16%	22.40%

*subwatershed 780 was not used because the land use and growth rate data was inaccurate for modeling purposes.

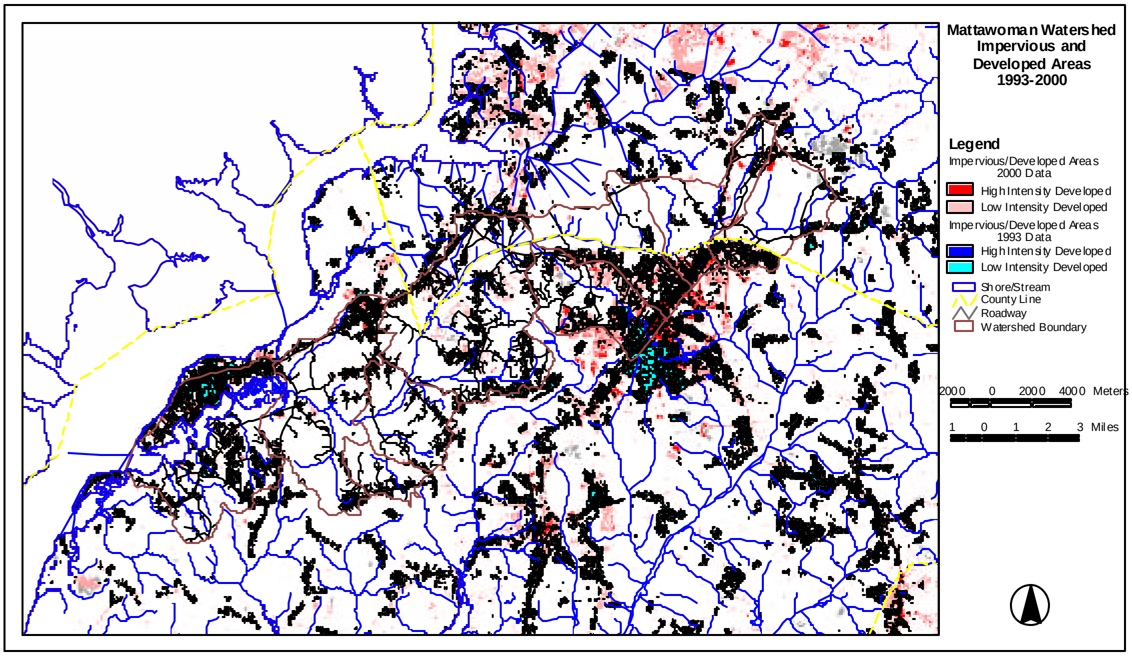
2.3.4 Watershed Development and Growth

The Mattawoman Creek Watershed experienced tremendous growth over the past decade. Figure 2.7 below shows the high and low-density developed areas within the watershed and its development over the previous decade, with landuse changes from 1993 and 2000. This shows the dramatic changes just in the last decade and begins to highlight the potential changes if growth continues in its current trend. Growth has increased dramatically around the Waldorf area, with associated impacts within the headwaters of the watershed. This area is the designated growth area for Charles County through Central Business District (CB) zoning. Most of the development is within the Charles County portion of the watershed, as the Prince George's county portion is outside of their designated growth areas. The growth area is best demonstrated through the current zoning, shown in Figure 2.8. Zoning characteristics are different for both Charles and Prince George's County. (See Appendix A for zoning codes.) The map shows the area of both counties within the watershed. Zoning characteristics were mapped as closely as possible, to highlight growth areas and the areas that are slated for potential development.

Zoning is the by far the most accurate predictor of future landuse, as it determines the range of potential uses for individual parcels. Based on the current zoning plans, the Development District and the Mattawoman watershed overlap extensively. Large sections of the sensitive watershed are zoned to become residential suburbs, especially in the areas surrounding Waldorf. Commercial corridors can be expected to continue to develop along Routes 301 and 210.

Substantial portions (shown in aqua) of the watershed have recently been down-zoned to RC (D), Rural Conservation (deferred). The intent of the deferred classification is to restrict future development in the RC zone. The Charles County code places an expiration date to this deferment classification until all other surrounding areas are built-out. At that time, the zoning returns to the default RC zone. This represents a substantial decrease in the potential impacts from development over the next 20 years. However, under build-out scenarios, these areas are expected to convert to low-density residential housing. As a result, the Deferred Development District provides a reprieve from development pressure for several decades, as development concentrates in the eastern portion of the watershed. Under 2020 growth projections, some areas within the Deferred Development District are expected to begin to be developed, with the deferred restriction lifted. One-third of the 17,000 acres of the stream valley is currently protected from development, leaving an estimated 11,220 acres susceptible to development. Under the Stream Valley Protection Scenario, the entire valley is permanently removed from the Development District. This would significantly reduce the amount of time before build out would occur in the remaining developable zones.

Figure 2.7: Mattawoman Growth from 1993 to 2000



Landuse change will be dramatic over the next 20 years. There will be a large increase in low and medium density housing, with a major corresponding loss of forest resources. Figure 2.9 shows these changes, based on Maryland Department of Planning growth projections. The change in large-lot agriculture reflects a move towards forest clearing for low-density residential development rather than large-scale agricultural development. Overall, the watershed can expect to be transformed from the rural, forested system, to a more suburban environment, with many low and medium density housing developments scattered throughout the watershed.

In general, the development predictions correspond to zoning and demographic trends. As the Waldorf area continues to grow as a bedroom community to the DC suburbs, more housing can be expected. There are small increases in commercial areas and almost no increased industrial activity, reflecting a trend for commuting behavior. As a result, the transition to a suburban bedroom community will be more complete by 2020. Based on the population growth rates and the zoning, most of this growth can be expected in the middle areas of the watershed, along the current outskirts of Waldorf and the Route 210 corridor.

In aggregate, over 10,000 acres of forest are expected to be lost in the next 20 years, replaced with suburban development. This will represent a dramatic change in the landscape and function of the watershed. Traditional pasture and farming activity is expected to be substantially reduced, with almost a total loss of existing pasture lands and a decrease in over 2000 acres of croplands.

Figure 2.8: Current Zoning in the Mattawoman Watershed

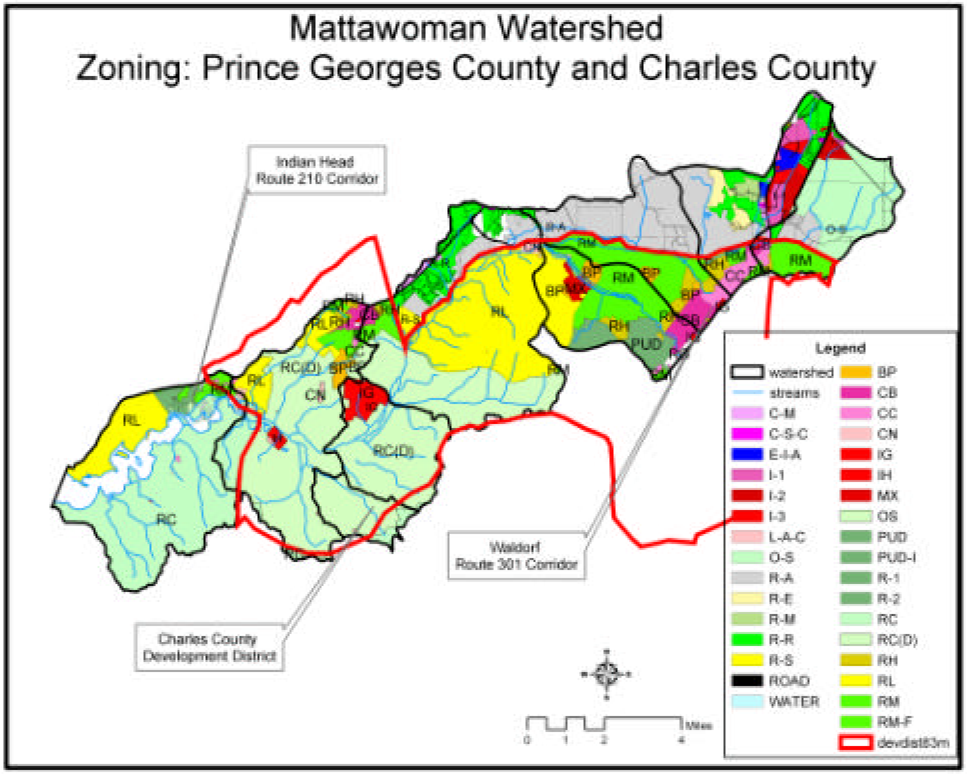
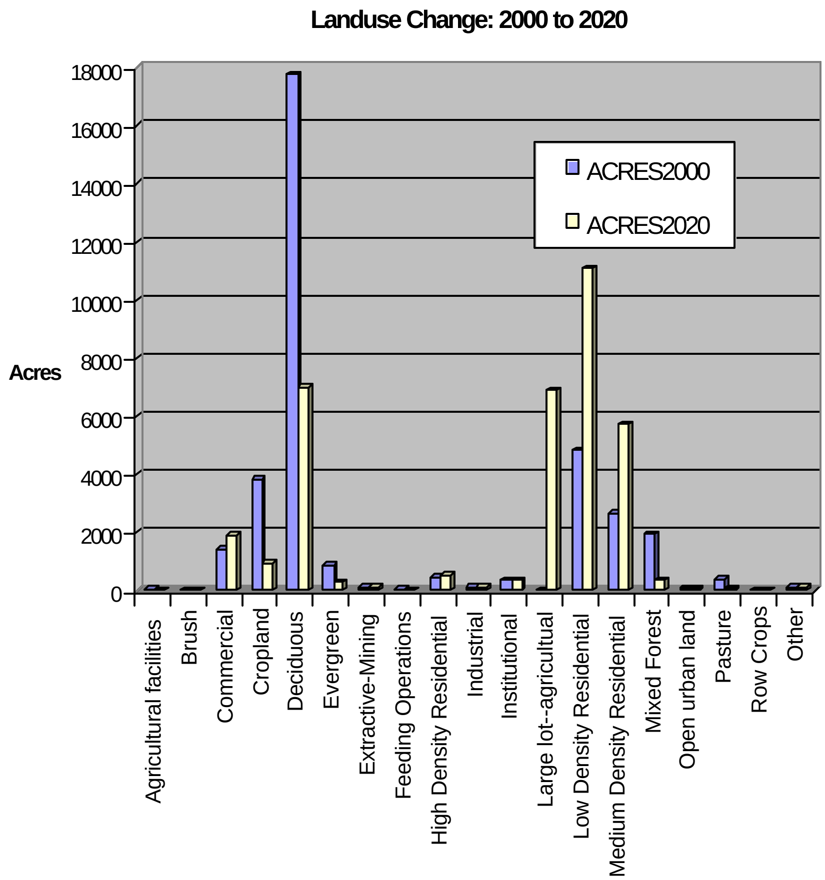


Figure 2.9: Landuse Change within the Mattawoman Watershed, 2000 to 2020



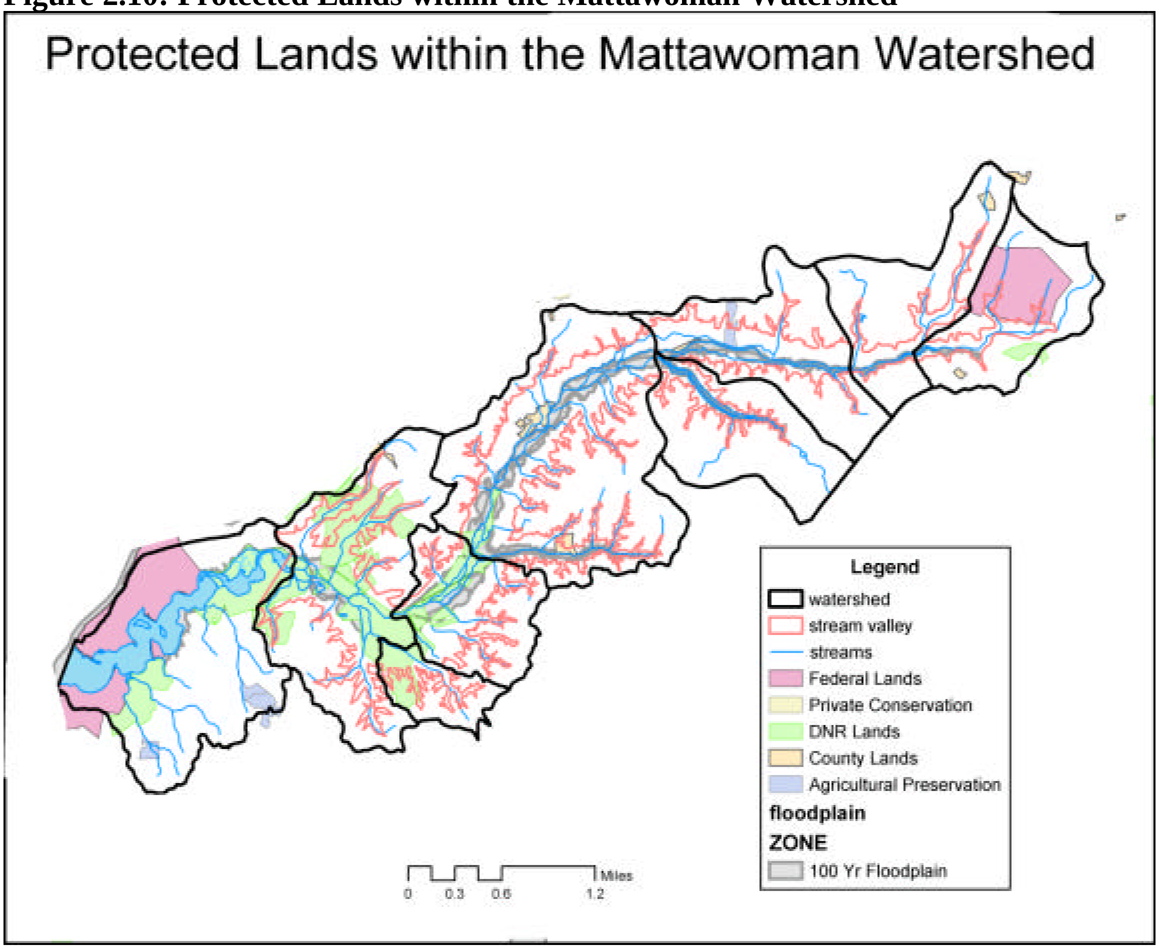
2.4 Protected Lands within Mattawoman Watershed

Despite the severe development pressure, a significant portion of the watershed is protected from development. There are two types of protected lands, those protected directly, through government ownership, and those protected indirectly through ordinances, zoning, or laws.

The directly protected lands take the form of Natural Environment Areas or Wildlife Management Areas, run by the state of Maryland as parks. The largest and most significant protected lands are Mattawoman Natural Environment Area and Myrtle Grove Wildlife Management Area. These two areas protect 8,238 acres within the watershed, including a large amount of the Mattawoman Stream Valley. These areas are shown in Figure 2.10 and are concentrated near the tidal/non-tidal confluence and along the large wetland complexes within the valley. However, as distance from the estuary increase, the proportion of protected land declines significantly.

Lands protected by ordinances and laws include wetlands, steep slopes (over 15% grade and within 100’ of stream banks or flood plain), and forest buffers. These areas are within the Mattawoman stream valley and are particularly sensitive. The protected sensitive lands in the stream valley comprise 40% of the stream valley, or 3,283 acres.

Figure 2.10: Protected Lands within the Mattawoman Watershed



SECTION 3
WATERSHED MODELING

3.1 Water Quality

Existing and future water quality was modeled using an HSPF model, developed by the Corps of Engineers from baseline data collected by the Smithsonian Environmental Research Center (SERC). The development of scenarios that were run in the models are discussed in detail in Appendix B, showing the different scenarios that were developed and the techniques used to integrate these into the model application. Appendix B shows the techniques used to develop and calibrate the model. The data is shown over a three-year modeling period, and is calibrated to a non-tidal discharge point along the Mattawoman Creek. Several parameters were modeled, including flow discharge, total nitrogen, total phosphorous, and total suspended solids. Each of these parameters show several effects associated with changes in the landscape. Modeling results reflect estimated data from this discharge point over varying landuse conditions.

3.2 Management Scenarios

Three alternative scenarios were developed to test different management objectives. These objectives include the reduction in impervious surfaces, an increase in stormwater and water quality treatment, and the protection of critical natural resources compared to current situations. These scenarios were tested through the HSPF model to address their effectiveness in reducing pollutant loadings. After analysis, the data was used to create a management plan that addresses the problems identified in the watershed. For more detail on the development and modeling of the scenarios, see the modeling report in Appendix B.

The following scenarios were modeled at two time periods, 2020 and build-out:

1. **Regulatory Compliance**: This scenario is based upon compliance with all existing regulations and laws. It includes the following parameters:
    - Approximately 25% of existing impervious surfaces do not have adequate stormwater management.
    - Of this 25%, an additional 25% of the watershed will become treated, decreasing the impacts from these sites.
    - In addition, there will be a 5% reduction in impervious surfaces on all new site designs as compared to the buildout and 2020 scenarios.
    - These efforts result in an overall decrease of impervious surfaces by 6.5% as compared to the buildout and 2020 scenarios.

2. **Enhanced Regulatory Compliance**: This scenario is based upon compliance with all existing regulations and laws and aggressive implementation beyond the minimum required by law. It includes the following parameters:
    - Approximately 25% of existing impervious surfaces do not have adequate stormwater management.

- Of this 25%, an additional 25% of the watershed will become treated, decreasing the impacts from these sites.
- Another 10% of existing areas will be treated for water quality management.
- In addition, there will be a 15% reduction in impervious surfaces on all new site designs as compared to the buildout and 2020 scenarios.
- These efforts result in an overall decrease of impervious surfaces by 13.5% as compared to the buildout and 2020 scenarios.

3. **Stream Valley Protection**: This scenario is based on the removal of the Mattawoman stream valley, approximately 28% of the watershed, from the Development District. It effectively maintains the natural integrity of the stream valley and includes the following:
   - The area from the top of the steep slopes to the Mattwoman stream is protected from development. This translates into approximately 17,200 acres, or 28% of the watershed, removed from the Development District.
   - This results in a significant landuse change, with large portions of the watershed maintaining forest cover, rather than the expected suburban development.
   - The stream valley scenario is based on build-out conditions, as 2020 projections do not establish what is within the stream valley, as a result, this scenario shows changes based on build-out conditions.

Three time scales were used in the model, 2000—representing existing conditions, 2020—representing the near future, and buildout—a hypothetical time period when landuse equals the maximum zoned density. In addition to the three management scenarios, baseline conditions of 2000 landuse and forested conditions were included for reference. Together with the time scales, there were 9 scenarios used for the model:

1. The Build-out scenario represents the maximum potential development under current zoning practices.
2. The Build-out stream valley protection scenario represents conditions that would result at buildout if future development were prohibited within the valley.
3. The 2020 scenario represents land use project to occur within the watershed by the year 2020.
4. The 2020 with regulatory compliance scenario represent conditions that would result in the year 2020 if current regulations required under the County's National Pollution Discharge Elimination System municipal stormwater permit were met.
5. The 2020 with enhanced regulatory compliance scenario represents conditions which could occur in the year 2020 if future planning goes beyond implementing current regulations by retrofitting existing untreated impervious surfaces and implementation of management measures reducing the impacts of impervious surfaces.
6. The 2020 stream valley scenario represents the conditions in 2020 if future development was prohibited within the stream valley. *
7. The 2020 valley protection scenario with enhanced regulatory compliance represents the conditions if future planning goes beyond current regulations and development is prohibited within the stream valley. *
8. The 2000 scenario represents current land development conditions in the watershed.

9. The forest scenario represents pristine conditions prior to development in the watershed. It assumes the entire watershed is forested with no impervious surfaces.

* Scenarios are based on rates established by other model runs, not actual model runs.

3.3 Model Analysis

Results of the model are shown in the graphs below. Based on the model results, and the obvious increase in impervious surfaces, phosphorous, nitrogen, and sediment loads, are expected to increase dramatically. Loads are expected to increase by over 50% in the next 20 years. Even with aggressive regulatory enforcement, there is still a significant increase in the pollutants.

Overall, the model results present several key findings concerning existing conditions and potential future impacts to the water quality of the stream. The highest pollutant discharges are associated with the change in stormwater discharge patterns, a result of the flashier system and significant landuse change. In general, current landuse conditions represent a doubling of nitrogen loads from forested conditions, while 2020 and build-out conditions represents a doubling of the current conditions. Most of the impacts occur during storm events. The impacts of nitrogen in stream systems are profound, encouraging algae growth, reducing water clarity and quality, and decreasing biota survivability. Under these conditions, pollution intolerant fish and benthic species are likely to disappear from the stream system, reducing the overall biologic integrity. Because of the major increases in nutrient loading, the nutrient removal functions of wetlands become even more important to the overall health of the stream system.

The nitrogen pollutant loadings show pronounced increases from the forested condtions and extremely pronounced increases over the next twenty years. Nitrogren rates will nearly double in medium and high flow events. Under build-out conditions loadings are expected to increase by another 20%, reflecting a severe change in overall water quality within the stream system. By 2020 and build-out conditions, the nitrogen concentrations will be approximately four times their pre-development concentrations. These concentrations are well beyond natural levels and will impact the stream ecosystem. As the inputs from septic tanks, lawn fertilizers, and wastewater treatment plants increases, it is important to note that much of the present buffering system of wetlands and forests will be depleted.

The high nitrogen loadings will have implications on biota and the biological community, reflecting a major change in the fish and benthic communities. It is likely that pollution intolerant fish and benthic species will disappear from the system, reducing the overall food web and decreasing the ecological function and diversity.

The phosphorus loads also show a significant increase from forested to current landuse conditions and a major change from 2000 to 2020 landuse conditions. Phosphorous loadings almost double in the twenty-year period. There is a smaller increase under build-out conditions that reflect the fact that landuse at 2020 will approach build-out conditions in many areas of the watershed. High flow events show major increases in the phosphorus loadings, which, coupled with the high nitrogen levels, will dramatically increase the nutrient levels in the stream system, decreasing the overall water quality. The high nutrient levels are likely to remain that way in the system for months or years after the high flow event. These intense development practices would have severe repercussions on the biological community and would decrease the habitat quality within the estuary.

Sediment, especially fine particles, can be expected to move through the system, eventually entering the Mattawoman Estuary. As a result, there may be a decline in the overall substrate and habitat quality within the estuary. Sediment has particular negative impacts on seagrass habitat, and may have implications for striped bass and other game fish species.

The suspended solids data correlates to the patterns seen for nitrogen and phosphorus, with slightly different patterns. In general, forest clearing and the changing of hydrology affects the flow regime in the stream, increasing erosion and channel instability. Under natural watershed conditions (forested) there is a very low amount of suspended sediments within the water column, even during relatively high flow events. As the forest is cleared, there is a corresponding increase in sediment within the stream, and current landuse (2000) reflects a major increase in sediment over deforested conditions. In some cases, the sediment loadings are over five times as great as forested conditions, especially in high flow events. Over the next 20 years, sediment input to the river system will increase by 30%, and double by build-out conditions under current zoning. During high flow events, there will be large sediment loadings associated with runoff, erosion and severe channel change. The severe alterations in hydrology will dramatically increase the rate of sediment input during high flow events. Much of the sediment will be associated with bank erosion, down-cutting, and other examples of stream instability.

3.4 Model Results

Based on an examination of the water quality data, several trends are apparent. These include the following:

1. There has been an increase in peakflow and decrease in baseflow as development in the watershed has occurred. These trends are expected to increase dramatically in the period from 2000 to 2020 and will be even more pronounced under build-out conditions. By 2020, flows are expected to increase by approximately 30% during large storm events.

2. The change in peakflow and baseflow reflects a 'flashy' system, where precipitation flows overland into the stream, rather than enters the groundwater system. The result is more water during storms, and less water during normal and drought conditions. Flashy stream systems are characteristic of urban watersheds and have profound impacts on stream ecology and geomorphology.

3. Under these conditions, the potential for flooding is increased, bank erosion is increased, and biologic conditions are degraded. Sediment and pollutant loads increase, especially during storm events. The problem is compounded as nutrients

linger in the system, causing impacts to the biotic conditions. In general, the flow rates show that the Mattawoman Creek's aquatic habitat will degrade considerably by 2020 and build-out conditions. This is further reflected in the results for pollutant modeling.

4. The results of the pollutant loadings show a major increase in nitrogen, phosphorus, and total suspended solids. As a result, there are likely to be increase in water turbidity, sedimentation, algae growth, and a corresponding decrease in dissolved oxygen, especially during the summer months.

5. As stream hydrology is altered by the development of the watershed, stream instability will increase leading to an increase in all three of the modeled pollutants. Development will also likely result in a decrease in wetlands and a loss of their nutrient consumption and groundwater recharge capabilities. Sediment reducing capabilities decline as riparian areas disappear.

3.5 Development of a Watershed Management Plan

Several tools were used to prepare the watershed management plan, including the watershed profile, HSPF model, and GIS assessment. The water quality data, watershed profile, and overall assessment of the watershed conditions, shows that the Mattawoman will face serious water quality problems and habitat degradation if the stream system is not managed prior to development. Together, these factors were integrated to establish and test several alternative management scenarios.

To create a management plan, several alternative development scenarios were modeled to assess their success in helping reduce pollutant loads within the stream system. After being analyzed for their effectiveness, these scenarios were used to develop management recommendations. The enhanced scenarios were compared to current and expected 2020 pollutant loads.

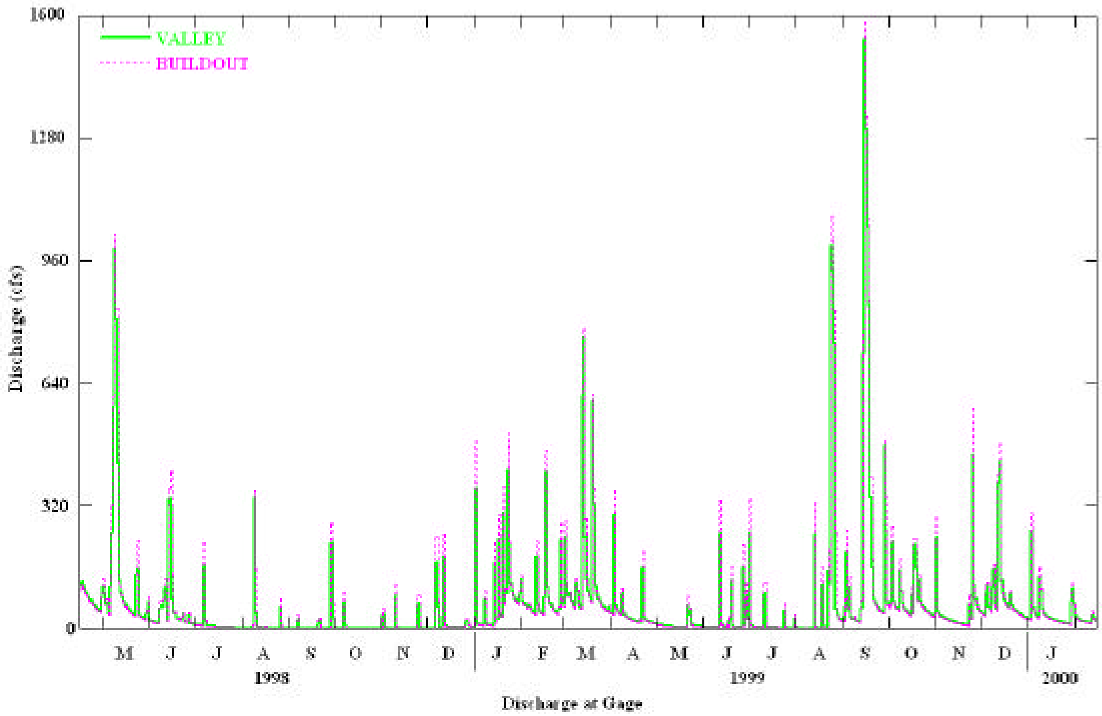
3.6 Scenario Results

3.6.1 Discharge

Discharge was analyzed for two scenarios in Figure 3.1. The significance of discharge in this watershed cannot be understated as discharge is closely correlated with pollutant loading. Discharge tends to be the driver of stream processes that produce nitrogen, phosphorous, and sediments. The stream valley scenario was the only management technique that reduced future discharge in any meaningful way. The stream valley strategy is the only scenario that effectively reduces the 'flashiness' of the system. The stream valley protection technique is successful in reducing peak volume by maintaining wide buffers, extensive forests for infiltration, and maintaining the wetland systems. The reduction in discharge accounts for some of the decreases in pollutant loadings associated with this scenario, and will help maintain higher baseflow levels and fewer high water events.

The model results show that there would be no significant change in drainage based on regulatory compliance or in the enhanced compliance scenarios.

Figure 3.1: Stream Valley Discharge Results

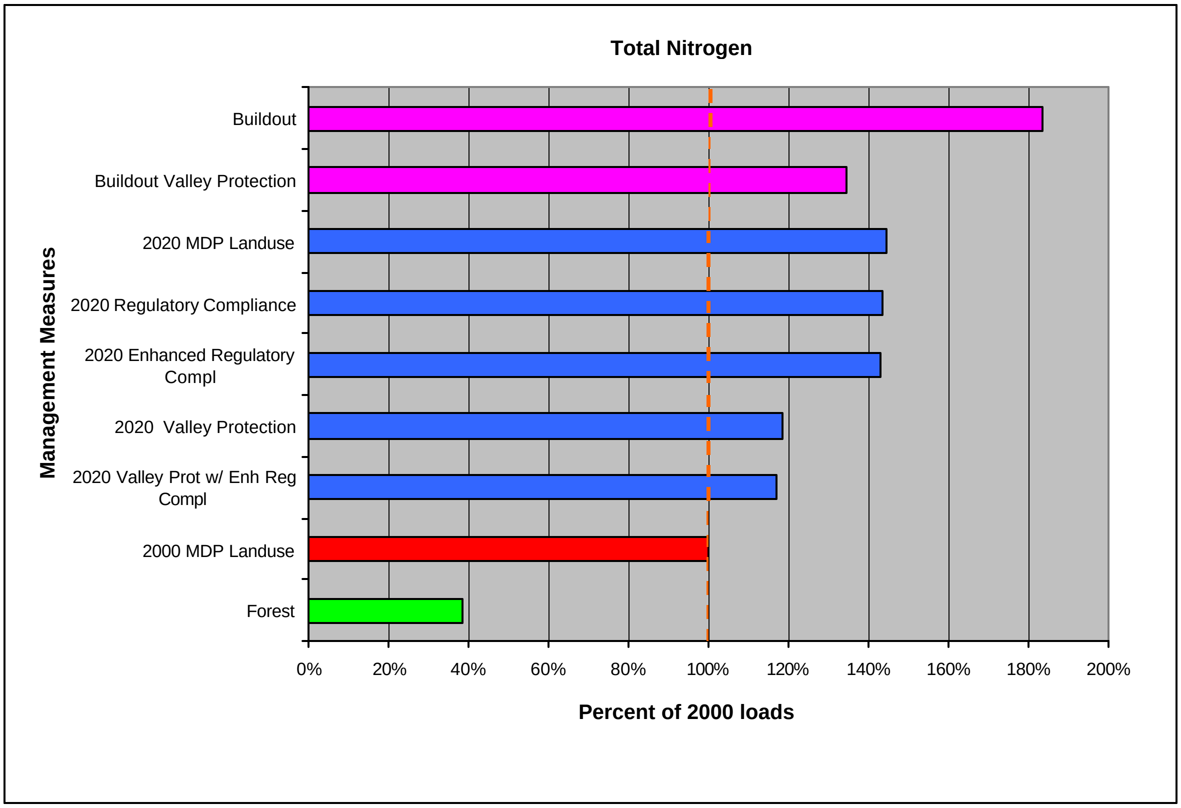


3.6.2 Nitrogen

The following graphs show the nutrient loadings by each of the different water quality parameters. Figure 3.2 shows the loadings for nitrogen. In general, the model shows that conventional and even aggressive regulatory compliance efforts will not have a significant impact on reducing the overall nitrogen load. This assessment concludes that, small decreases in impervious surfaces do not have a major impact on the overall nitrogen load. Possible causes include the fact that much of the nitrogen within the watershed may be from lawn fertilizer and septic systems, rather than direct stormwater runoff. Thus, impacts from the areas associated with suburban development may be just as important as the impervious surfaces themselves. In addition, in dispersed residential patterns, stormwater ponds or other structural techniques to manage stormwater may not be effective.

The stream valley protection scenario, on the other hand, which represents a significant change in the future landuse patterns, has a major effect on the nitrogen loadings. The valley protection scenario decreases nitrogen loading by 10-30%, depending on the size of the storm event. During large events, usually the most damaging, the stream valley reduces nitrogen loading by a significant amount, approximately 30%. In addition, maintaining the wetland systems may help increase the overall reduction beyond the modeling results. It is important to note that this decrease is from build-out conditions, and is not directly comparable to the regulatory compliance scenarios.

Figure 3.2: Total Nitrogen by management scenario



3.6.3 Phosphorous

The graph shown in Figure 3.3 display phosphorous loading rates for each of the development scenarios and indicate similar patterns and results throughout. On average, phosphorus loadings hover in the 400-500 lbs/week rate, as compared to the 4000-6000 lbs/week concentrations of nitrogen. Again, the stream valley protection scenario showed significant nutrient reductions, with decreases on the order of 10 to 20% of build-out conditions. Furthermore, this scenario maintains the extensive riparian buffers and wetland systems, thereby maintaining a functioning floodplain, with its associated pollutant buffering and sediment trapping capacities. Among the most important factors is the decrease in peak concentrations during high flow events.

The regulatory compliance scenarios show almost no effect when compared to the 2020 landuse results, reflecting that these initiatives are inadequate to address water quality problems within the stream. The effects may be associated with the continued sediment problems, since phosphorus binds with suspended sediments as they migrate through the ecosystem.

3.6.4 Total Suspended Solids

Results for total suspended solids are shown in Figure 3.4. These results are significant because sediment is closely correlated with nutrient concentrations. Suspended solid concentrations remain high over all management scenarios, although the most reduction is in the stream valley protection scenario at approximately 10%. This is probably due to providing the maximum amount of forest cover and wetlands to serve as a filter during storm events. This may reduce the amount of entrenchment and instability seen within the channel. In general, the model results indicate that suspended sediments will continue to be a critical issue in the overall health of the stream system and that more direct sediment management techniques are needed throughout the watershed.

The regulatory compliance and enhanced regulatory compliance scenarios do not show significant decreases in sediment loads. This is probably due to the extensive hydrologic and landuse change associated with suburban growth. The corresponding lack of forest cover will have significant impacts on the overall hydrology, creating bank erosion, entrenchment, and stream instability. The relatively small decreases in impervious surfaces are not adequate to overcome the loss of thousands of acres of forest cover.

Figure 3.3: Total phosphorous by management scenario

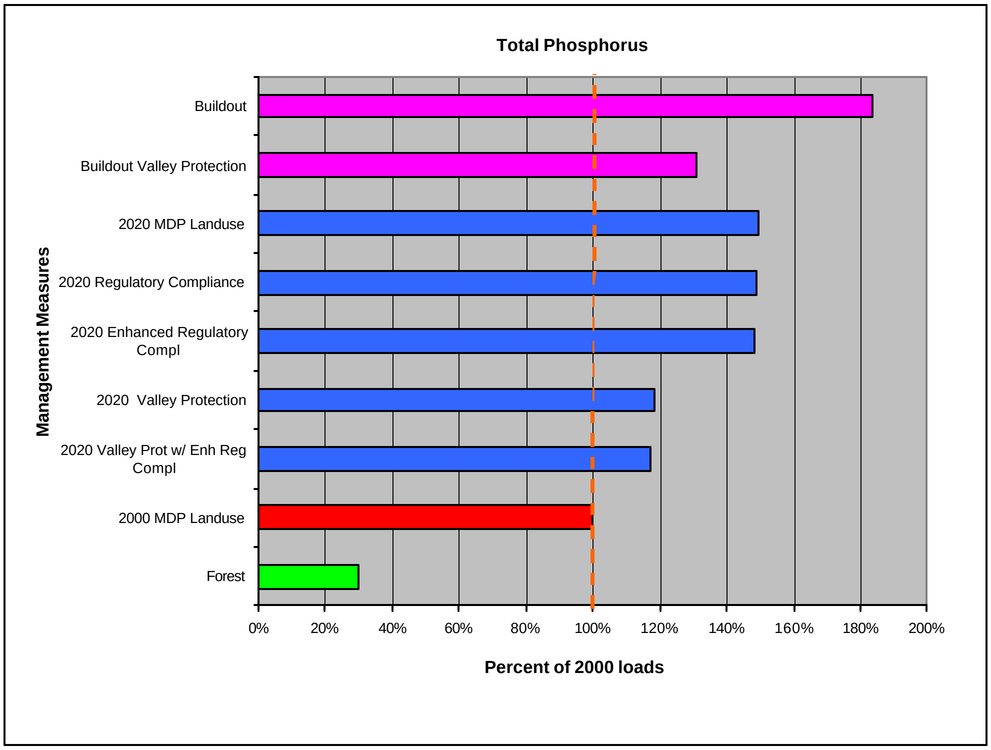
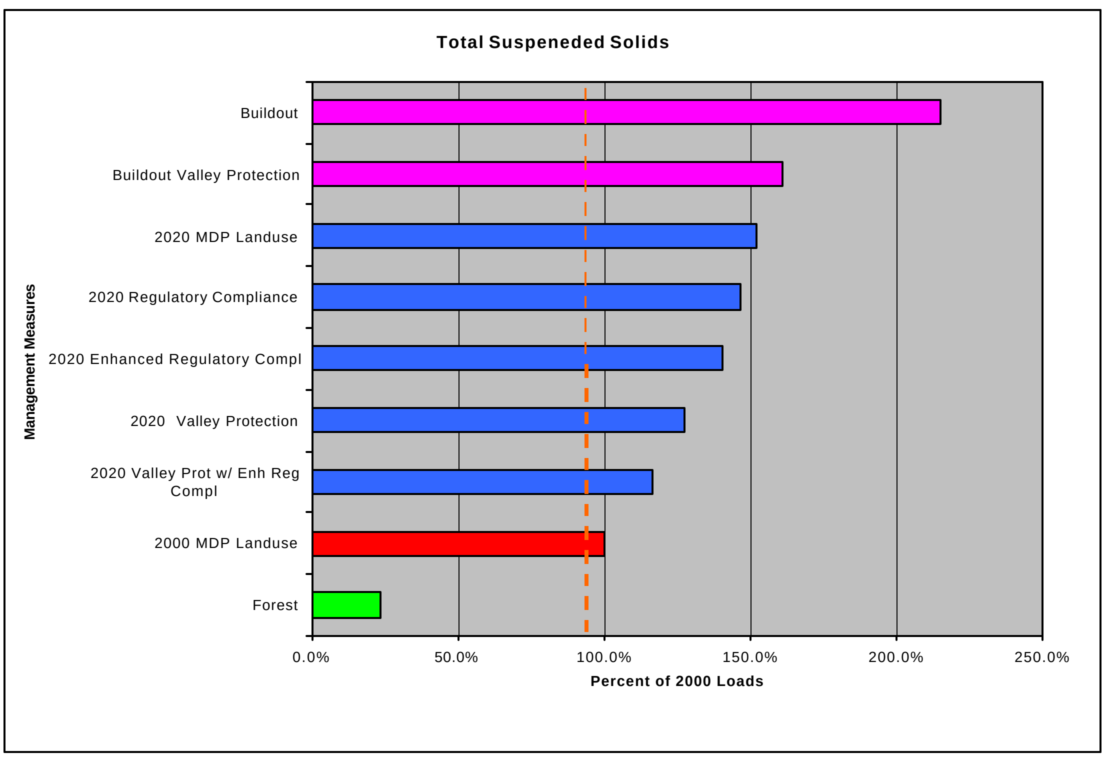


Figure 3.4: Total Suspended Solid Results by Management Scenario



SECTION 4
WATERSHED MANAGEMENT PLAN

4.1 Management Recommendations

Based on a review of the model results and watershed profiles, several management recommendations can be made. The recommendations are based on the goals of maintaining the ecological integrity of the Mattawoman Creek, while maintaining the area as the designated growth area for Charles County.

The management plan reflects the following goals:

1. Protect the natural resources of the Mattawoman Creek while allowing for the maximum amount of economic development.

2. Develop specific recommendations that will help plan the future development of the Mattawoman Creek Watershed.

3. Develop recommendations that can be incorporated into existing zoning and ordinance legislation, as well as help define the future environmental planning initiatives within the watershed.

4.2 Recommended Measures

Based on the overall assessment and analysis of the water quality results, the following measures are recommended:

1. **Stream Valley Protection.** The Mattawoman Stream Valley, defined by the top of slope to the stream, should be protected from future development. This represents a significant portion of the watershed, but is the critical area for the health of the Mattawoman Creek. The stream valley should be defined and delineated, through mapping and field surveys. High-resolution elevation data, such as LIDAR, could be used to map this system. Field surveys should be conducted to ground truth the map results. Once delineated, the following measures can be used to protect the stream valley.

    - Zoning changes. Currently, the area of the stream valley is generally zoned for development. While some of these areas will never be developed because of wetland or buffer requirements, a considerable portion of the valley has development potential. These areas could be downzoned to open space (as in Prince George's County) or another category that protects the stream valley such as the Rural Conservation (deferred) category.

    - Direct Acquisition. Several large portions of the stream valley are protected as State lands. The areas that are not connected could be acquired and turned into a park system, serving as a direct corridor from the Mattawoman Estuary to Waldorf. Acquisition is comparatively expensive, but will allow for the maximum level of protection and potential use. This is compatible with efforts to develop a bike trail and greenway system.

- Ordinance Changes. Development guidelines can be re-written to promote maximum development above the slope, the RPZ overlay zone can be re-defined to extend to the top of the slope, increase buffers between slope, and to protect to the top of slope. Existing developed areas within the stream valley should be required to use extensive best management practices (BMP) and stormwater management. By increasing BMP requirements within the stream valley, this may help encourage growth in other, less sensitive areas.

Protection of the stream valley represents the single most important action that can be taken to protect the natural resources of the Mattawoman Creek. However, there are several obstacles that must be considered for implementation. First, landuse decisions are local and controversial, and this recommendation will effectively remove privately owned land from the Development District. This will have implications for landuse plans, growth plans, and property values. Extensive public education and coordination is necessary. Second, several areas are approaching build-out conditions, and the next areas slated for development are within the stream valley. As a result, development pressure can be expected soon in some of these areas. Finally, several areas of the stream valley are already developed, and these areas should be explored to address their impacts to the stream. Best Management Practices and sound planning should be used in these areas to prevent additional impacts.

2. **Best Management Practices (BMPs) for Future Development.** The extent of current and future development will have impacts on the hydrology and pollutant loading within the stream system. As a result, all state of the art BMP's should be used within the developing areas to minimize as much as possible the impacts on hydrology and pollutant loading. This will require ordinance changes to allow for sound environmental planning within housing developments. Several major BMP's should be incorporated into site review for new developments.

   - *Large-scale site design*. Incorporate better site design, or site plans that minimize the area of impervious cover and promote disconnected stormwater systems. Site designs should attempt to minimize paved areas, decrease the number and width of roads and cul de sacs, avoid curb and gutter systems, and emphasize stormwater infiltration or re-use throughout the site.
   - *Small-scale site design*. Site plans should emphasize many small-scale stormwater management systems, rather than one large pond. This includes small-scale rain-gardens, small-scale infiltration systems, curb cuts, rain barrels, and other similar practices. Above all, these should emphasize disconnected systems and avoid direct discharges into the stream system.
   - *Forest conservation*. Forest cover should be maintained to the maximum extent possible. Clearing should be minimized and reviewers should emphasize forest integrity. Forest preserves should be coordinated to allow

for connectivity between forested areas and maintain effective buffer systems. The County-wide forest conservation plan should emphasize maintaining continuous large tracts of forest, especially within the stream buffers. Large scale clearing before site development should be avoided to the maximum extent practicable. Tree cover minimums for the developed portion of the site are also an important part of reducing pollutant loads to streams and should be emphasized.

3. **Best Management Practices for Existing Development**. Significant portions of the headwaters are already developed, approaching the maximum density allowed by current zoning. In these areas, the sites should be retrofitted with BMP's and redevelopment of existing lots should be encouraged.

- *Commercial areas*. Existing commercial areas, parking lots, and sub-developments can be retrofitted with more effective stormwater management techniques, including curb cuts, infiltration trenches, and other techniques. A survey of the Waldorf area should be conducted to identify potential BMP sites. These sites include parking lots, site landscapes, and other under-utilized areas within the developed areas.
- *Residential areas*. Older sub-divisions should be examined for potential for rain-gardens or other stormwater management opportunities. A retrofit program should be developed to encourage individual landowners to make small-scale changes in their stormwater management. A retrofit program can include pamphlets, public information workshops, and neighborhood planning sessions.
- *Retrofitting*. Regulations should encourage the re-use of developed sites within the Development District to prevent additional sprawl. These include re-development incentives, ordinance changes, or other techniques to promote innovative site re-use.

4.3: Other Planning Recommendations

Coordinated planning, such as the recommendations in this report, will have far reaching implications to the environmental quality and citizen's quality of life in Charles County. The profound influence of Maryland's Smart Growth policy and other wisely planned efforts will coordinate with traffic planning, social planning, and other regional planning practices. Planned development in the Mattawoman Creek watershed should include these local and regional efforts for the purpose of creating an economically developed and environmentally protected area. Balancing these seemingly opposing measures have been considered when developing the management scenarios.

SECTION 5
CONCLUSIONS

The challenge faced by the Mattawoman Creek is the pressure between continued development and natural resource protection. These goals are often at odds and represent a difficult balancing act between competing land use plans. This report evaluated growth patterns and natural resources to develop an overall watershed strategy. Realistically, any development in the watershed will have negative impacts on the watershed. If this development is carefully coordinated and planned within the landscape of the Mattawoman Watershed it will be possible to mitigate these negative impacts and protect the Mattawoman. It cannot, however, be emphasized enough that impacts on hydrology and pollutant loading to stream systems should be minimized to the maximum extent feasible.

The Mattawoman Creek represents an important natural resource, with a diverse network of forests, tributaries, and wetlands, providing tremendous fish and wildlife habitat. The ecological integrity of the Mattawoman is at risk from current and future development pressures within the watershed. Water quality and habitat quality are expected to decline without aggressive implementation of Best Management Practices and Low Impact Development Techniques, combined with the protection of the stream valley. If these recommendations are implemented the natural resources of the Mattawoman have the best chance to maintain their function and integrity.

Implementation of the management recommendations requires a multi-tiered approach, at the subwatershed scale, the neighborhood scale, and the individual site scale. There must be a holistic approach to provide an overall plan that protects the stream valley while encouraging sound site design at the neighborhood and housing development level. At the individual site level, individual homeowners should be educated about stormwater management techniques and site plans should reflect small-scale disconnected stormwater management techniques. Implementation will require an extensive public education and outreach effort, coordinated with site development reviewers, developers, and neighborhood associations.

MATTAWOMAN CREEK

WATERSHED MANAGEMENT PLAN

APPENDIX A

FINAL

WATER QUALITY MODELING

OF LANDUSE AND MANAGEMENT SCENARIOS

August 2003

APPENDIX A
WATER QUALITY MODELING

TABLE OF CONTENTS

List of Figures

In-stream Loadings:

List of Tables

Landuse and Management Scenarios:

In-Stream Loadings:

Edge-of-Stream Loadings:

MATTAWOMAN CREEK
WATERSHED MANAGEMENT PLAN

APPENDIX A

WATER QUALITY MODELING
LANDUSE AND MANAGEMENT SCENARIOS

1.0 Mattawoman Creek Watershed

1.1 Watershed Characteristics. The Mattawoman Creek is a 60,300 acre watershed located in Prince George's and Charles Counties, Maryland, approximately 35 miles southeast of the District of Columbia. Approximately 44,479 acres of the total area is located in Charles County, with the remainder residing in Prince George's County. Mattawoman Creek flows south from its headwaters in Prince Georges County toward Waldorf, where it continues west along the two counties border until it crosses the Maryland Route 228. From this point, it flows southwest about nine miles before entering a seven mile tidal estuary that drains into the Potomac River. The watershed is divided into nine subwatersheds, defined by the Maryland Department of Natural Resources (MDNR) 12-digit Hydrologic Unit Codes (HUC). Some of the major tributaries to Mattawoman Creek include Piney Branch, Old Woman's Run, Laurel Branch, Timothy Branch, and Marbury Run.

1.2 Existing Landuse**.** The developed portion of the Mattawoman Creek watershed is a diverse mix of urban, suburban, industrial, and commercial land uses. The majority of the existing development is within the upper three watersheds, especially within the Charles County portion of the watershed. Indian Head Naval Station, near the Potomac, represents a significantly developed portion of the watershed. Most of the other development centers around the Waldorf area. A substantial amount of undeveloped land, consisting of forest, agriculture, and wetlands, also lies within the watershed. An extensive wetland system occurs adjacent to the stream network, particularly within the mainstem stream valley in the lower portion of the watershed. A low bottomland forest with non-tidal wetlands surrounds much of the Mattawoman Creek. These wetland and forest buffers provide a natural filter to nutrients and pollutants delivered to the creek.

1.3 Existing Water Quality. Water quality in the Mattawoman Creek has been declining in recent years as a result of ongoing development occuring in the watershed. The 1998 Clean Water Action Plan classified the Mattawoman as one of thirteen priority watersheds in the State in need of both restoration (Category I) and protection (Category III). In the water quality category, the per acre loadings of phosphorus and nitrogen for the Mattawoman Creek were in the top 25% of all watersheds in Maryland. The Mattawoman Creek Watershed is also included on MDEs 303(d) list of impaired water bodies for exceeding two federal clean water quality standards: nutrients and sediment.

1.4 Future Development. As a result of it's close proximity to the DC metropolitan area, Charles County is subject to intense pressure for urban development. Approximately 70% of the Counties new growth will be directed to the Development District , which is the principal center of population, services and employment in Charles County. The Development District generally coincides with the Mattawoman Sewer Treatment planned sewer service area, the majority of which lies within the Mattawoman Creek watershed. The continued development of the Mattawoman Creek as currently planned is expected to result in significant impacts to the environment which may affect water quality and habitat within Mattawoman Creek and it's estuary. Protection of this valuable resource from the effects of future development will require changes in the way the watershed is currently managed. These changes may include measures such as implementation of best management practices (stormwater retrofits, low impact development, improved sediment erosion and control, etc.); changes in zoning, development codes, and policies; and protection of environmental resources, such as stream buffers, wetlands, and contiguous forest.

2.0 Study Objective , Modeling Goals, and Limitations

2.1 Study Objective. The primary objective of the feasibility study is to develop a watershed management plan and recommendations that balance future growth and development within Charles County with sustainable ecological functions and habitats of the Mattawoman Creek watershed. In order to evaluate the impacts of existing and future development on water quality in the watershed, the pollutant loads resulting from past, existing, and future land use patterns were analyzed using a water quality model.

2.2 Model Description and Goals. The model selected for this study is the Hydrologic Simulation Program – Fortran (HSPF) water quality model. The HSPF program is a comprehensive watershed and water quality model which integrates the land and soil contaminant runoff processes with instream hydraulic, water temperature, sediment transport, nutrient, and sediment-chemical interactions. The HSPF Model has been applied in the Chesapeake Bay Watershed to develop a nutrient reduction strategies and best management practices for tributaries to achieve the 40 percent reduction in loadings required by the Chesapeake Bay Agreement. The model has also been used by the Environmental Protection Agency to develop Total Maximum Daily Load (TMDL) estimates for state agencies. The model developed in this study could potentially be used as a base model for future TMDL development.

The HSPF model for the Mattawoman Creek watershed was developed by the U.S. Army Engineer Research and Development Center (ERDC) in consultation with Aquaterra Consultants. The calibrated HSPF model for the Mattawoman Creek watershed developed by ERDC was applied by the Baltimore District to evaluate the water quality impacts of various landuse and management practices within the watershed. The landuse and management scenarios modeled for the Mattawoman are described in the Sections 3.0 and 4.0 of this appendix. The results of the all of the HSPF model runs are presented in Section 5.0.

2.3 Model Limitations. Since the HSPF model is a lumped parameter model, as opposed to a distributed model, it does not reflect the spatial distribution of the land cover segments within watershed. For instance, the increased effects of forest and wetland buffers located directly adjacent to the stream on filtering pollutants and attenuating flows is not accounted for. The model results may therefore underestimate the actual effects of management measures on water quality. Additionally, since the model does not account for the direct effects of specific management measures, such as stormwater management, on peak discharge reduction and pollutant removal, specific BMPs may have larger effects than modeled. Additionally, the land cover estimated for future scenarios is based upon MDP future growth projections & current zoning practices as described in the following sections.

3.0 Landuse Scenarios

Landuse scenarios were modeled to reflect changes in development, and the water quality conditions resulting from these changes, which have occurred and are currently planned within the watershed since it's original pristine forested conditions. These scenarios include 2000 existing development, 2020 future planned development, and maximum potential development at buildout. Landcover data used in the HSPF models for all landuse and management scenarios was broken into seven different pervious land segments (PERLND) and two impervious land segments (IMPLND). The pervious land segments included Forest, Agricultural, Grassland, Barren, Wetland, High Density Developed Pervious, Low Density Developed Pervious. The impervious segments included High Density Developed and Low Density Developed. Table A-1 provides the area of each land cover segment in acres within each of the 9 12-diget subbasins in the Mattawoman Creek watershed for all of the landuse and management scenarios. The sources of the landcover data and related assumptions for each scenario modeled is described below. The percentage of impervious surfaces associated with each of the developed land categories is also provided. The name of the model run for use in referencing model results in Section 5.0 is provided in parentheses after each landuse scenario.

***3.1 Pristine Conditions* (FOREST)** – This scenario represents conditions prior to any development in the watershed . It assumes the entire watershed is 100% forested with no impervious surfaces.

3.2 Existing Conditions – Two different scenarios representing current land development in the watershed were modeled to reflect the two different landuse/landcover datasets available. The first dataset is a direct measurement of landcover in 2000 from Landsat remote sensing imagery and classification conducted by Towson University. The other dataset is based on landuse classification of 1997 development conducted by the Maryland Department of Planning (MDP).

- **2000 Towson Landcover Data (MATTA) –** The Towson dataset was considered to be the most up-to date and accurate representation of the land cover available. This data was therefore used for the 2000 baseline model which was calibrated to the Smithsonian water quality and flow data. The Towson dataset classified landcover into ten categories of developed and undeveloped land and provides a direct measure of the watershed's impervious surfaces. This classification system breaks developed land into high density developed (90% impervious) and low density developed (50% impervious).

- **1997 MDP Landuse Data (MDP2000) –** The 1997 MDP landuse dataset was modeled to provide a consistent base reference for comparasin with future planned landuse and management scenarios. Table A-2 provides the impervious percentages applied to each of the MDP landuse categories to estimate the pervious and impervious land cover segments for the HSPF model. These impervious percentages were applied consistantly to the 1997 MDP landuse and all future planned landuse and management scenarios. The percent imperviousness applied in the model were the same as the values used by MDP, with the exception of low density developed which used a lower value recommended by the Center of Watershed Protection thought to better represent development in these areas. These values of imperviousness were found to be the closest match to the Towson direct measure of impervious surfaces for each of the subwatershed.

***3.3 Future Planned Conditions* –** Future scenarios were modeled which represent land development in the watershed in 2020 and at buildout based on current watershed planning guidelines outlined in the 1997 Charles County Comprehensive Plan.

- **2020 MDP Landuse Data** (**MDP2020) –** This scenario represents landuse projected to occur within the Mattawoman watershed by 2020. The MDP 2020 landuse projections for each subwatershed were based upon a growth model which estimated the number of units to be built in each zoned area as a function of population, households, and employment expected in 2020.

- **Build-out (BUILDOUT) –** This scenario represents the maximum development permitted under the current 2000 Charles and Prince Georges' County zoning regulations. It assumes that 100% of the watershed is converted to its' currently zoned landuse at buildout and does not account for future zoning changes or protected lands. This scenario is intended to be used as worst case scenario for water quality in the Mattawoman Creek watershed. Table A-3 provides the MDP landuse categories associated with the County zoning which were used to estimate land cover for the buildout scenario.

4.0 Management Scenarios

Management scenarios were modeled to evaluate the potential reduction in pollutant loadings which could result if best management and watershed protection measures are implemented within the Mattawoman.. Management scenarios were developed to represent both the direct and indirect effects of reducing impervious surfaces on water quality and quantity. These water quality improvements could be achieved through the following measures: (1) changes in landuse, zoning or building ordinances which directly limit the amount of impervious surfaces associated with each landuse or zoned area, (2) implementation of best management protection measures which indirectly reduce the peak discharges and pollutants entering the streams, (3) protection of environmental resources within the watershed, such as critical areas, forest buffers, and wetlands, or (4) combination of these measures.

The water quality modeling results were used to develop a watershed management plan on the subwatershed scale which recommends a variety of federal, state and local actions which could be implemented within each subbasin. Selection of the specific management measures to protect the Mattawoman watershed would be the responsibiliy of Charles and Prince Georges County. The management scenarios analysed using the HSPF water quality model included regulatory compliance, enhanced regulatory compliance, and stream valley protection.

4.1 Scenario 1 - Regulatory Compliance (REGCOMP). The regulatory compliance scenario represents the conditions which would result in the year 2020 if current regulations required under the County's National Pollution Discharge Elimination System (NPDES) permit are met.

- **Retrofit Existing Impervious Surfaces**
  - Assumes 25% are currently not treated for quality and quantity
  - Assumes 25% reduction in existing untreated surfaces by 2020
  - Assumes no reduction in existing treated surfaces

  ➔ Effective 6.25% reduction in existing impervious surfaces or their effects by 2020

- **Reduce Future Impervious Surfaces**
  - Assumes 5% reduction in future impervious surfaces or their effects by 2020

4.2 Scenario 2 - Enhanced Regulatory Compliance (ENREGCOM). The enhanced regulatory compliance scenario represents conditions which could result in year 2020 if future planning goes beyond implementing the current regulations through retrofitting existing untreated impervious surfaces and implementation of management measures which further reduce the impacts of impervious surfaces.

- **Retrofit Existing Impervious Surfaces**

  - Assumes 25% are currently not treated for quality and quantity
  - Assumes 25% reduction in existing untreated surfaces by 2020
  - Assumes 10% reduction in existing treated surfaces

  ➔ Effective 13.75% reduction in existing impervious surfaces or their effects by 2020\

- **Reduce Future Impervious Surfaces**

  - Assumes 15% reduction in future impervious surfaces or their effects by 2020

4.3 Scenario 3 - Stream Valley Protection (VALLEY): This scenario represents conditions which would result at buildout if future development is prohibited within the stream valley. This scenario involves protection of the entire Mattawoman Creek stream valley and buffer to the top of the slope that is not yet developed, including it's tributaries. The stream valley area to be protected was delineated using 2-foot contour interval mapping produced using the 30-meter Digital Elevation Model for the watershed. Land cover for areas not yet developed within the protected stream valley was assumed to be forested and subtracted from the land cover within the stream valley projected at buildout. Future stream valley development had to be referenced to the buildout scenario rather than 2020 because the MDP landuse data was not provided in spatial format.

5.0 Water Quality Modeling Results

The HSPF model was applied to the Mattawoman Creek watershed to simulate the hydrology and non-point source loadings of nutrients and sediment which would be delivered to the streams, and ultimately to the estuary, under the various existing and future landuse and management scenarios. Hydrologic and water quality parameters simulated and calibrated to the Smithsonian data set include discharge, NO3, NH3, Total N, PO4, Total P, and Total Suspended Solids (TSS – comprised of sand, silt and clay fractions). GENSCN, a pre- and post-processor for hydrologic and water quality models, was used to modify the HSPF UCI model input data files, to complete the HSPF model runs, and for analysis and graphical presentation of the HSPF model output data for the various landuse and management scenarios.

The results of the HSPF model simulations of hydrology and in-stream pollutants are presented at three locations along the Mattawoman Creek: (1) the center of the watershed at the outlet of subbasin 786; (2) the calibration point located at the outlet of subbasin 783; and (3) the lower end of the nontidal portion of the creek at the outlet of subbasin 781. The resulting water discharges and weekly in-stream TN, TP, and TSS loadings occurring at these three locations for each of the landuse and management scenarios are shown in Figures A-1 to A-24. The total, average monthly, and average annual loadings of NO3, NH4, TN, PO4, TP, and TSS for each of the landuse and management scenarios are summarized in Tables A-4 to A-6 for the three locations along the Mattawoman. The average annual loadings of TN, TP, and TSS for each of the scenarios are compared in Figures A-25 to A-27 for each location. The monthly loadings of these constituents provided are provided in Tables A-7 to A-9 for each location.

The nutrient and sediment loadings contributed to the Mattawoman Creek by the pervious and impervious land surfaces within each of the nine DNR 12-diget subbasins were computed using a combination of spreadsheets and the LOADSUM program, which produces tables of results from the HSPF model. These "edge-of-stream" loadings reflect the hydrologic and water quality processes which occur on the various land segments within each subbasin and do not account for the "in-stream" transformations which occur as the flow and pollutants are delivered downstream through the stream network. The total, mean monthly, and mean annual edge-of-stream loadings are provided in Table A-10 for the watershed above the calibration point and in Tables A-11 to A-18 for each of the eight subbasins. Total, mean monthly, and mean annual in-stream and edge of stream loadings presented in these tables are based upon the 21 month period from May 1998 to January 2000. The monthly in-stream and edge-of stream loading tables cover the entire simulation period including partial months in April 1998 and February 2000.

6.0 Conclusions

Several conclusions can be drawn from the results of the water quality modeling for the Mattawoman Creek watershed. The first is that watershed planning in the Mattawoman needs to go beyond regulatory compliance for effective pollutant removal and reduction of peak discharges. Secondly, direct reduction in the impervious surfaces associated with developed land uses or implementation of BMPs which indirectly reduce the effect of impervious surfaces alone will not protect the stream ecosystem. Lastly, stream valley protection has greatest effect on reducing water quality impacts to Mattawoman. Protection of the stream valley preserves the natural landscape features including forest buffers and wetlands which serve as a filter for pollutants entering the Mattawoman Creek, thereby reducing the efficiency of the delivery of pollutants to the Mattawoman estuary.

APPENDIX A

WATER QUALITY MODELING

FIGURES

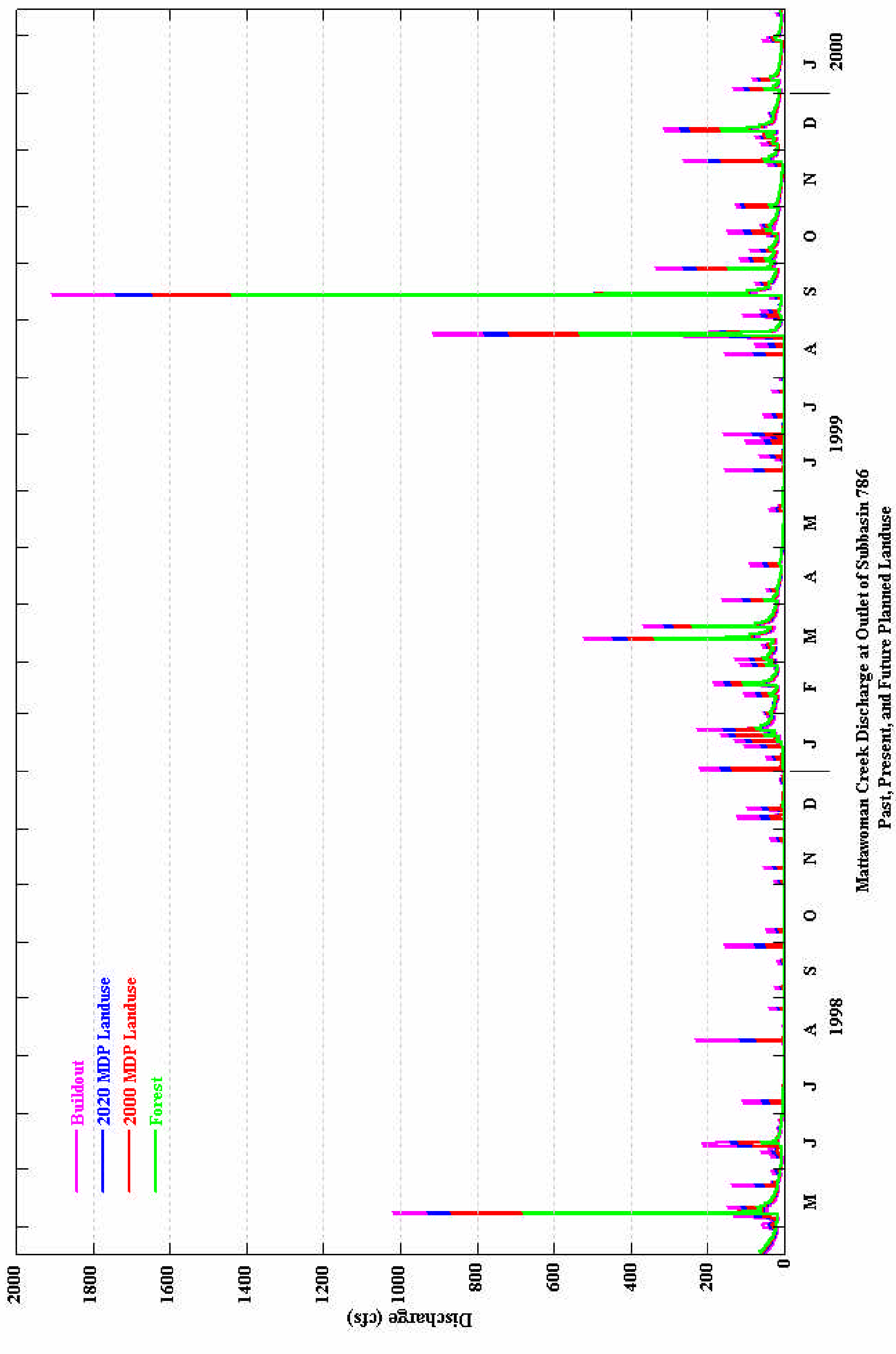
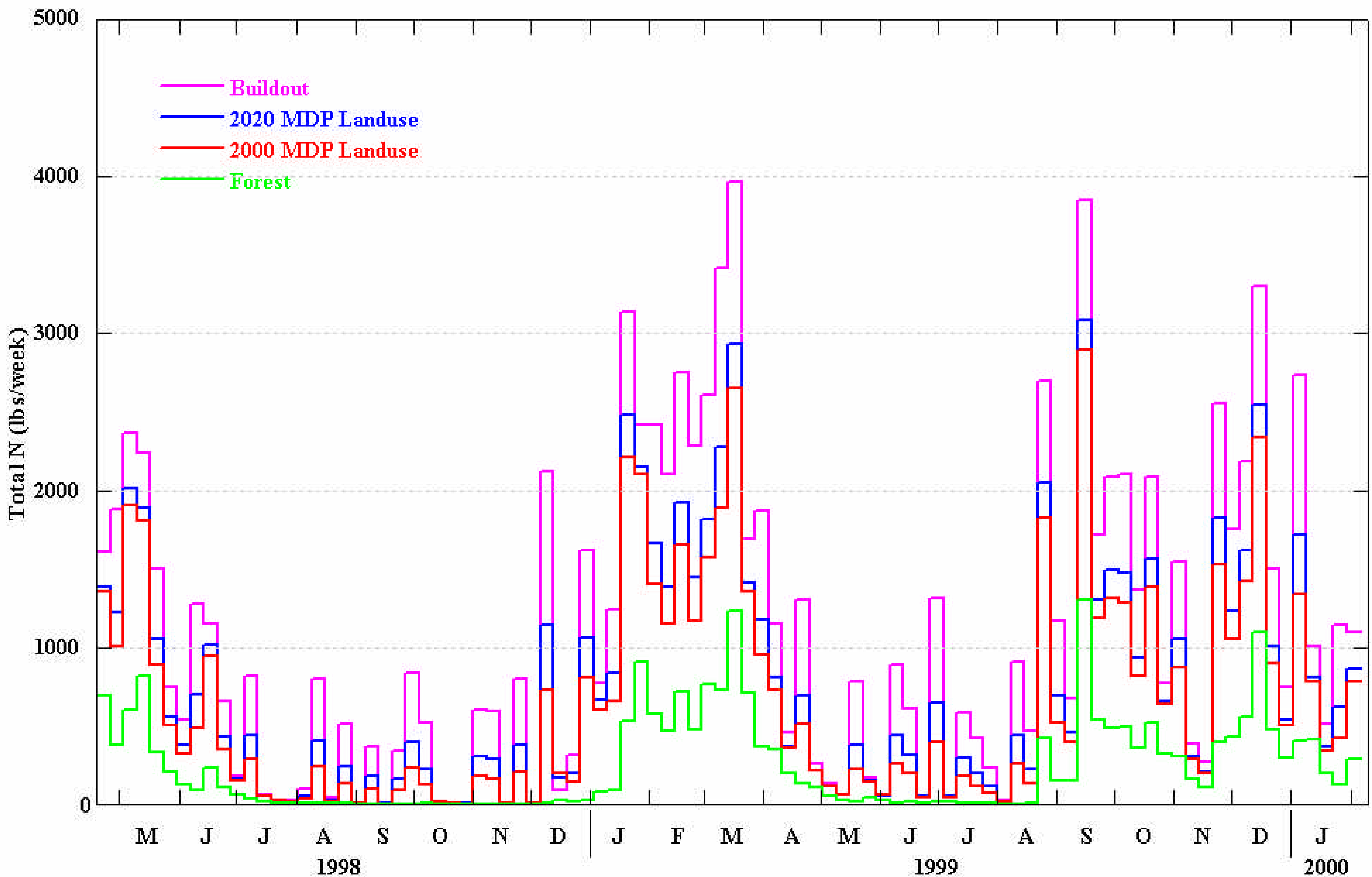

Mattawoman Creek Discharge at Outlet of Subbasin 786
Past, Present, and Future Planned Landuse
Discharge (cfs)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
M
J
J
A
S
O
N
D
J
F
M
A
M
J
J
A
S
O
N
D
J
1998
1999
2000
Buildout
2020 MDP Landuse
2000 MDP Landuse
Forest

Figure A-1



Mattawoman Creek Weekly Total Nitrogen Load at Outlet of Subbasin 786
Past, Present, and Future Planned Landuse

Figure A-2

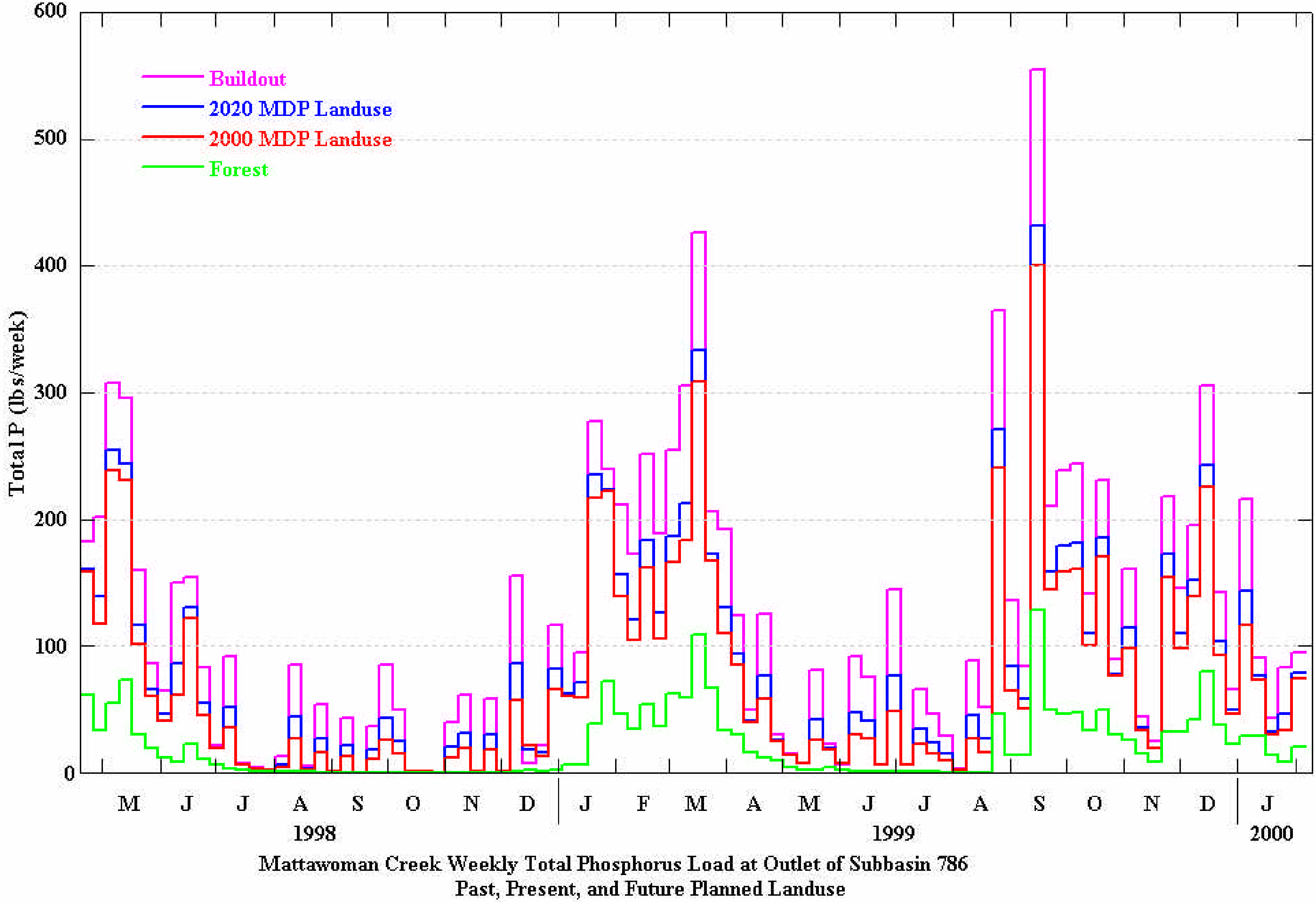
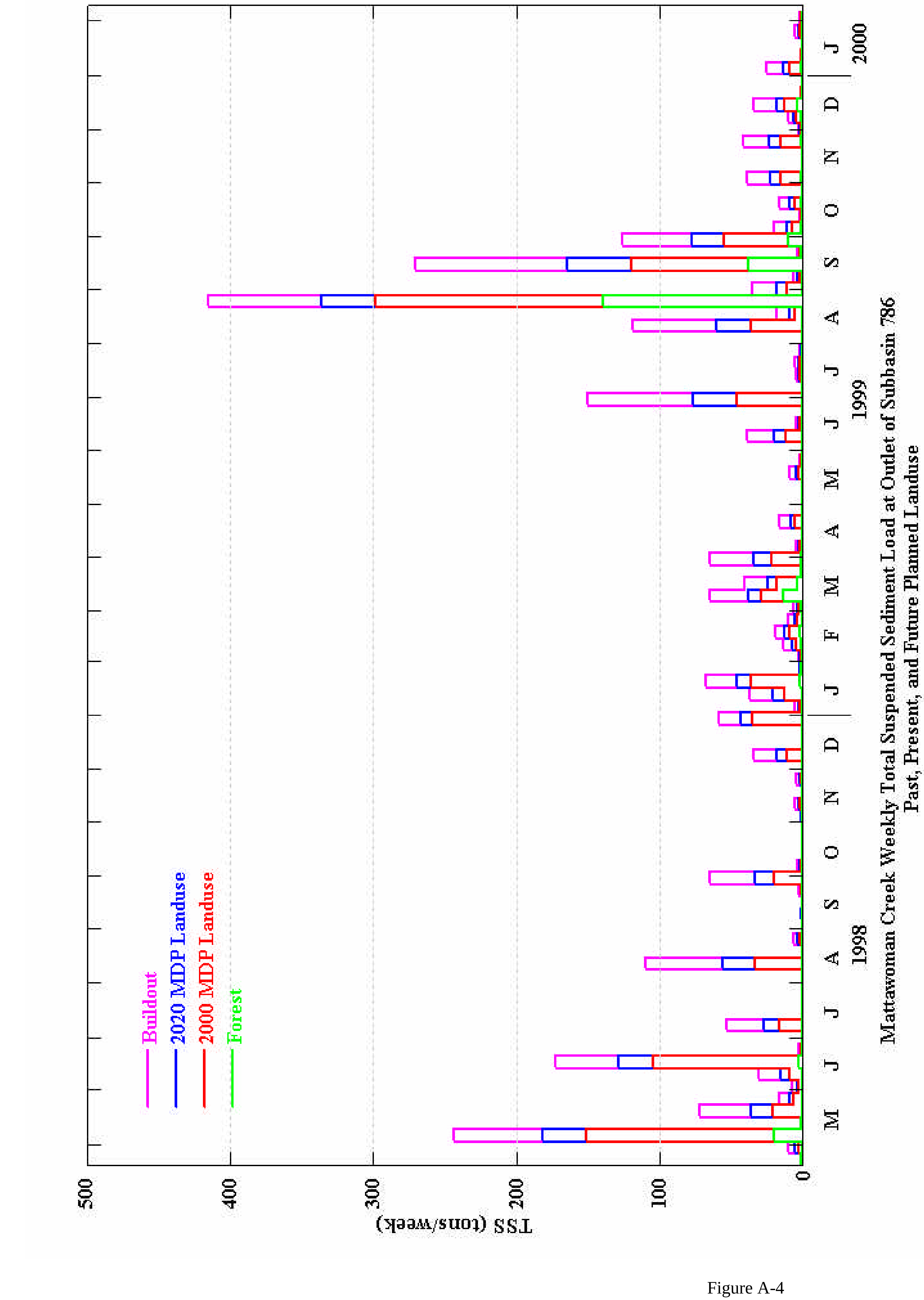

Buildout
2020 MDP Landuse
2000 MDP Landuse
Forest
Total P (lbs/week)
0
100
200
300
400
500
600
M J J A S O N D J F M A M J J A S O N D J
1998
1999
2000
Mattawoman Creek Weekly Total Phosphorus Load at Outlet of Subbasin 786
Past, Present, and Future Planned Landuse

Figure A-3



Mattawoman Creek Weekly Total Suspended Sediment Load at Outlet of Subbasin 786
Past, Present, and Future Planned Landuse
TSS (tons/week)
0
100
200
300
400
500
M
J
J
A
S
O
N
D
J
F
M
A
M
J
J
A
S
O
N
D
J
1998
1999
2000
Buildout
2020 MDP Landuse
2000 MDP Landuse
Forest

Figure A-4

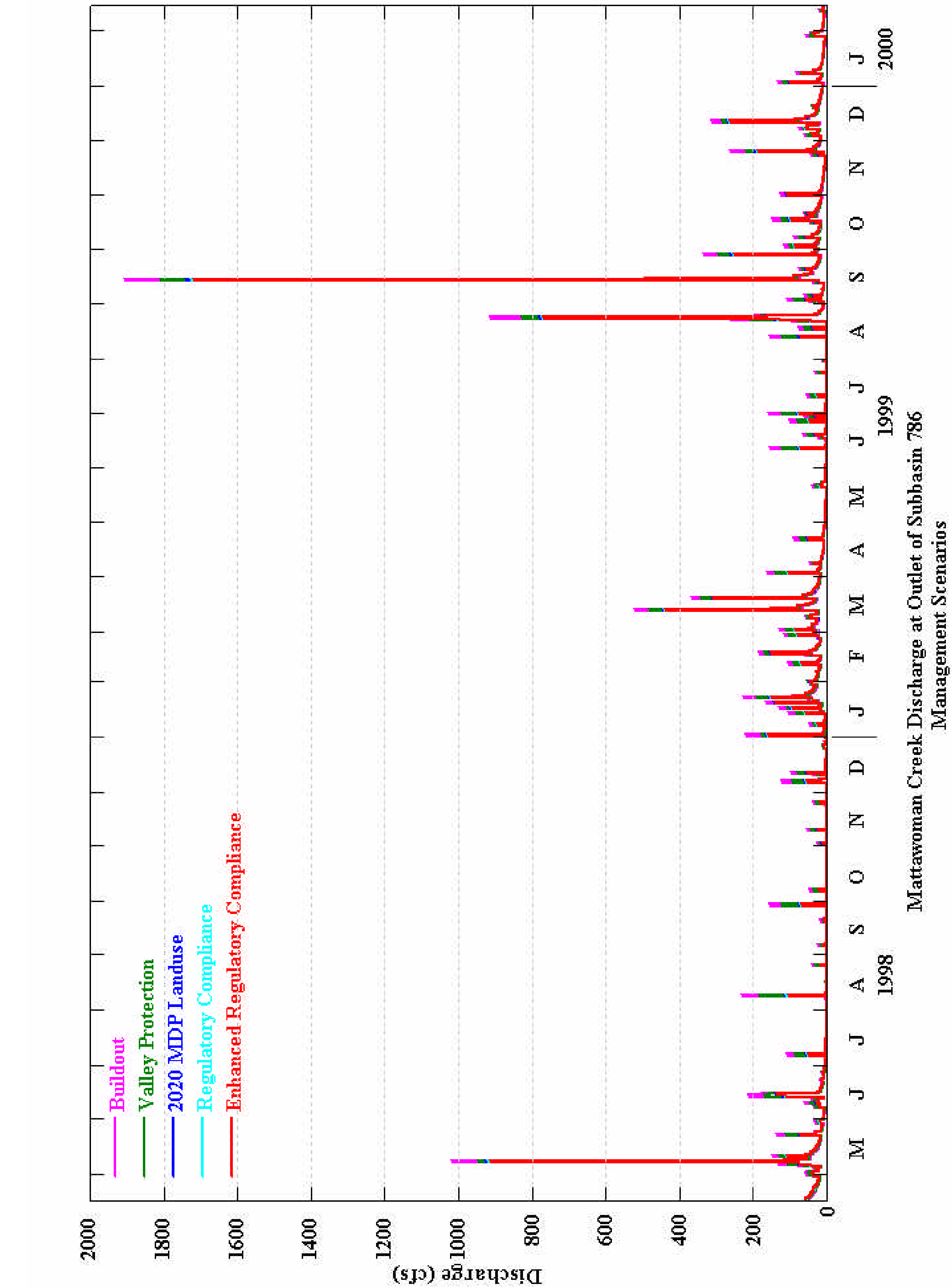
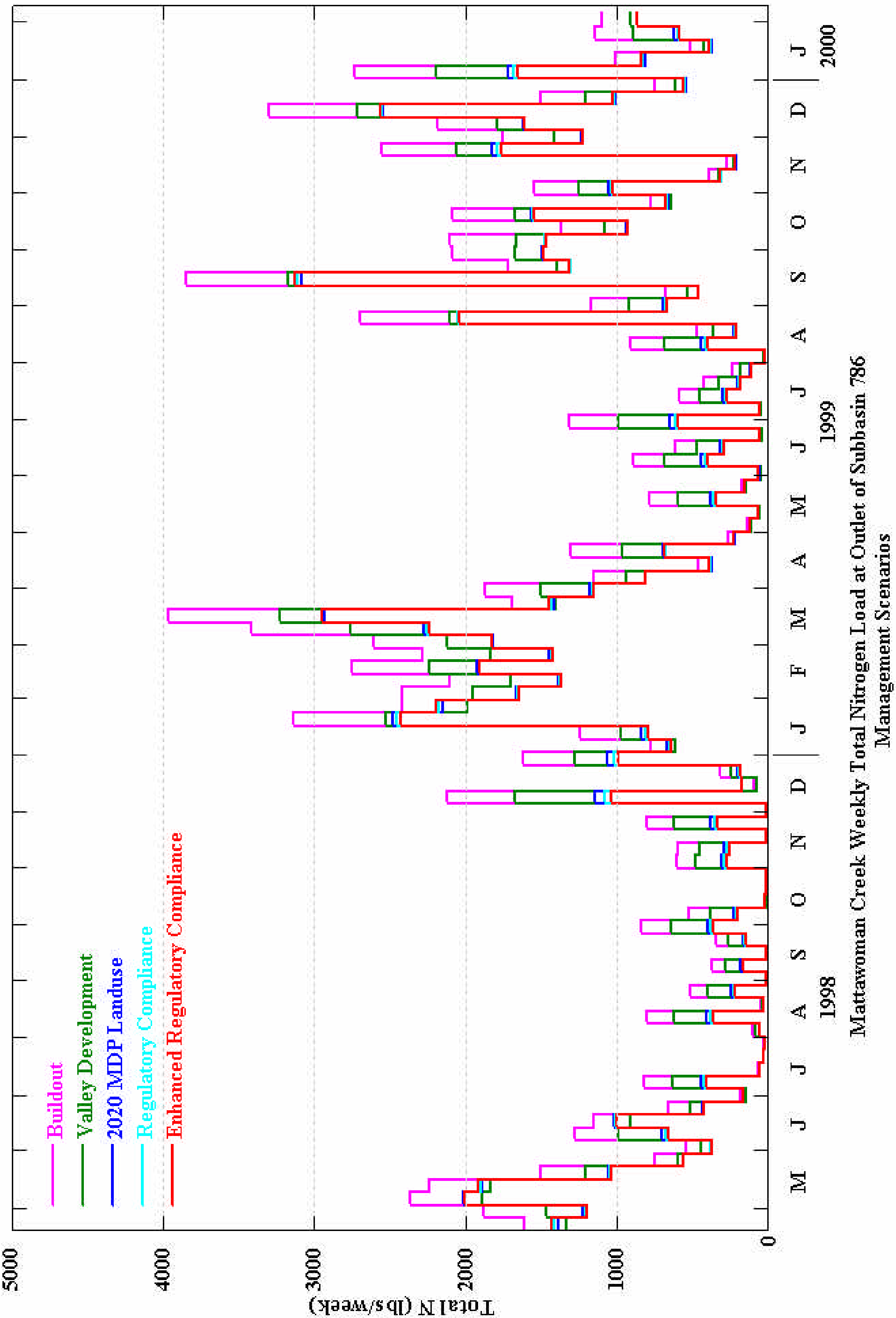
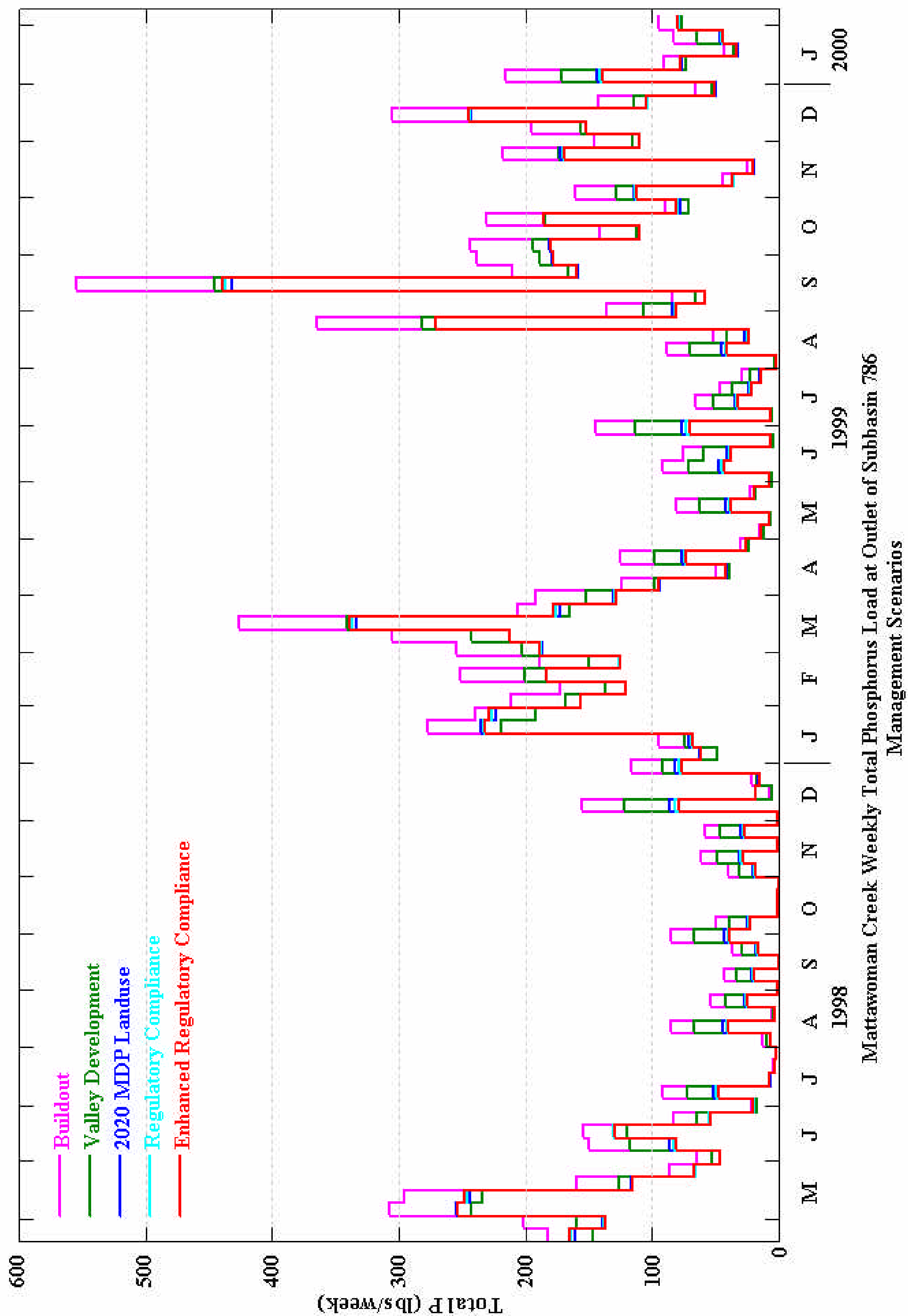

Mattawoman Creek Discharge at Outlet of Subbasin 786
Management Scenarios
Discharge (cfs)
Buildout
Valley Protection
2020 MDP Landuse
Regulatory Compliance
Enhanced Regulatory Compliance
1998
1999
2000
M J J A S O N D J F M A M J J A S O N D J
0
200
400
600
800
1000
1200
1400
1600
1800
2000

Figure A-5



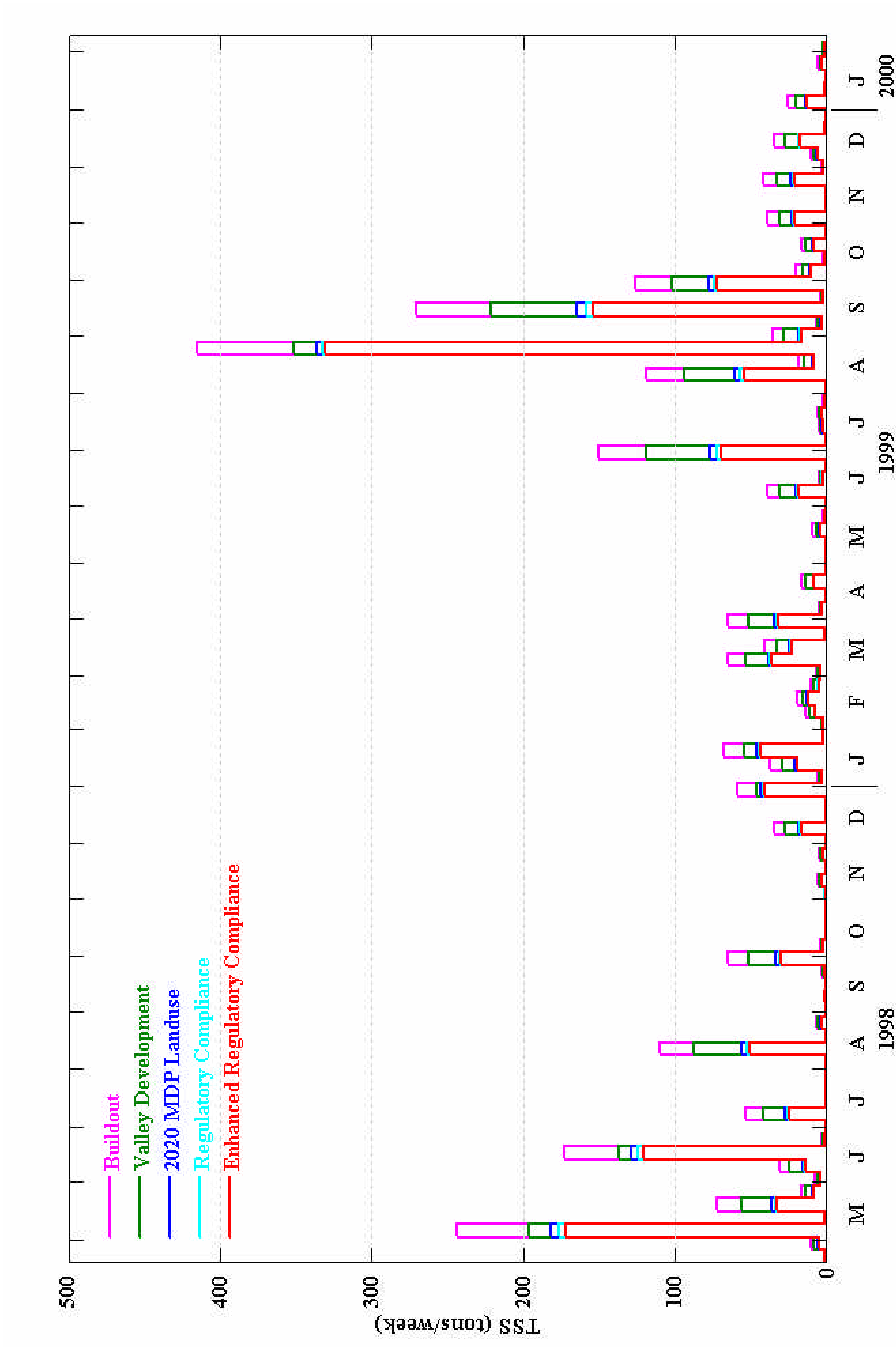
Mattawoman Creek Weekly Total Nitrogen Load at Outlet of Subbasin 786
Management Scenarios
Total N (lbs/week)
0
1000
2000
3000
4000
5000
M J J A S O N D J F M A M J J A S O N D J
1998
1999
2000
Buildout
Valley Development
2020 MDP Landuse
Regulatory Compliance
Enhanced Regulatory Compliance

Figure A-6



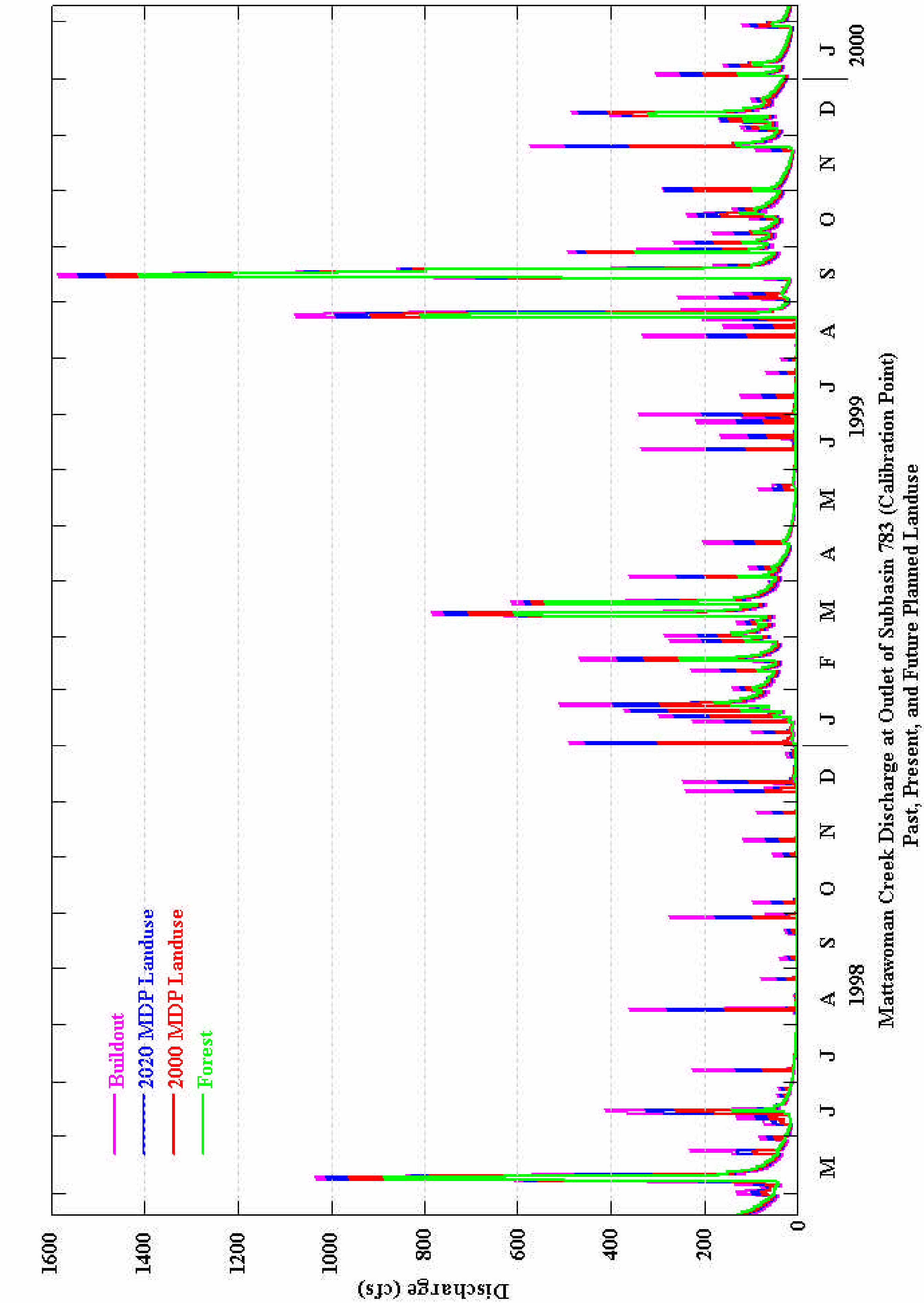
Mattawoman Creek Weekly Total Phosphorus Load at Outlet of Subbasin 786
Management Scenarios
Total P (lbs/week)
0
100
200
300
400
500
600
Buildout
Valley Development
2020 MDP Landuse
Regulatory Compliance
Enhanced Regulatory Compliance
M J J A S O N D J F M A M J J A S O N D J
1998
1999
2000

Figure A-7



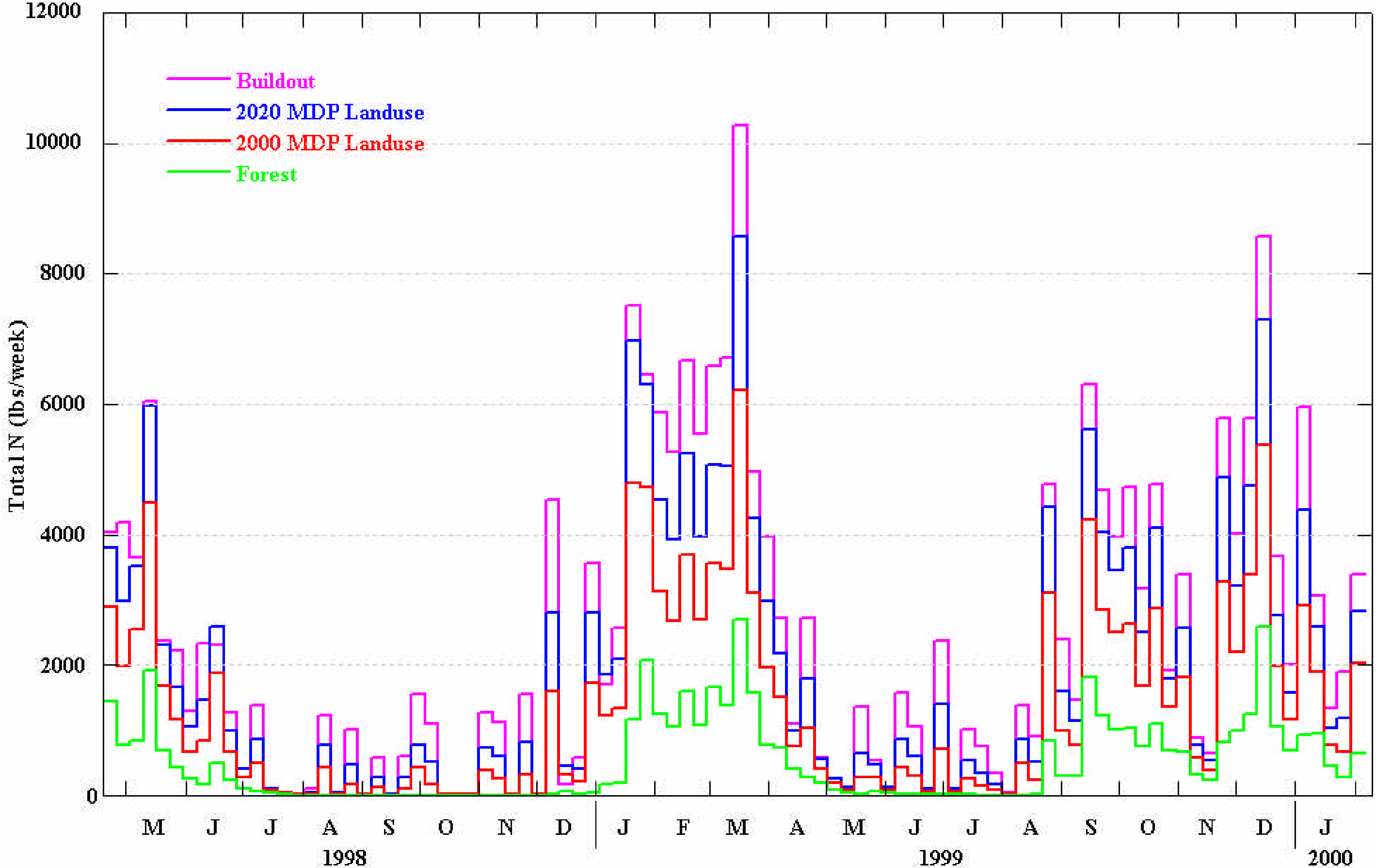
Mattawoman Creek Weekly Total Suspended Sediment Load at Outlet of Subbasin 786
Management Scenarios

Figure A-8



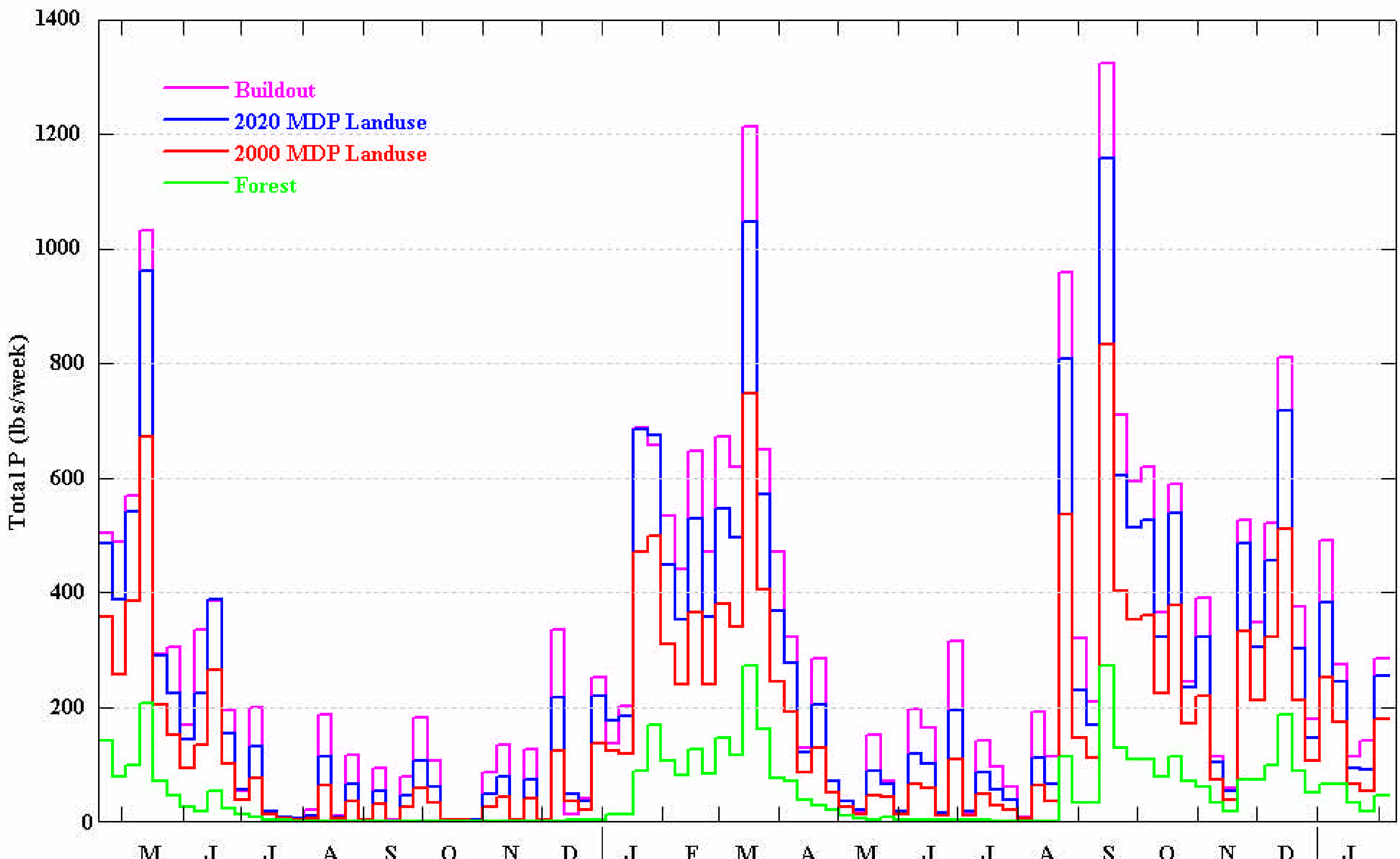
Buildout
2020 MDP Landuse
2000 MDP Landuse
Forest
Discharge (cfs)
0
200
400
600
800
1000
1200
1400
1600
M
J
J
A
S
O
N
D
J
F
M
A
M
J
J
A
S
O
N
D
J
1998
1999
2000
Mattawoman Creek Discharge at Outlet of Subbasin 783 (Calibration Point)
Past, Present, and Future Planned Landuse

Figure A-9



Mattawoman Creek Weekly Total Nitrogen Load at Outlet of Subbasin 783 (Calibration Point)
Past, Present, and Future Planned Landuse

Figure A-10



Mattawoman Creek Weekly Total Phosphorus Load at Outlet of Subbasin 783 (Calibration Point)
Past, Present, and Future Planned Landuse

Figure A-11

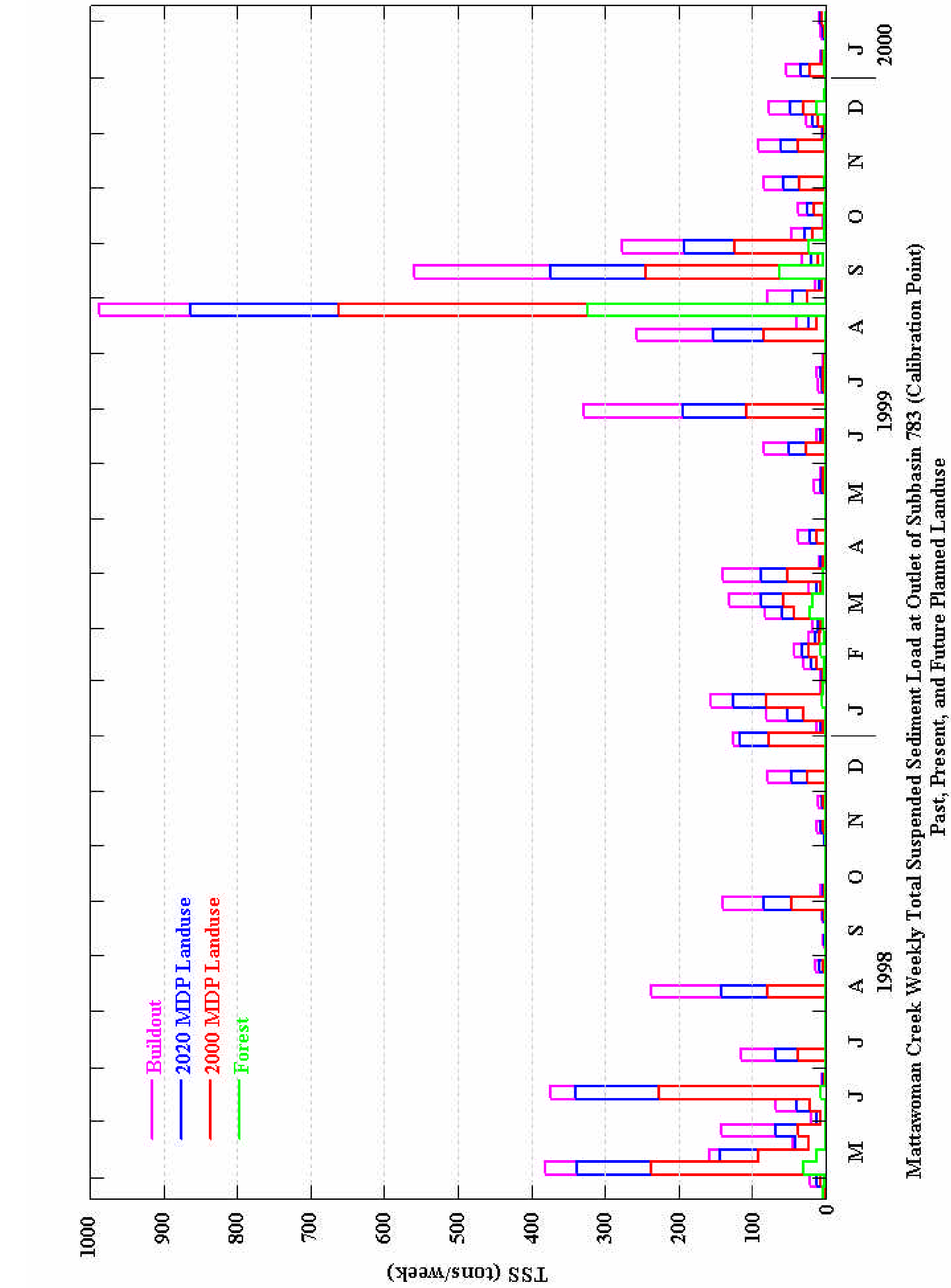

Mattawoman Creek Weekly Total Suspended Sediment Load at Outlet of Subbasin 783 (Calibration Point)
Past, Present, and Future Planned Landuse
TSS (tons/week)
0
100
200
300
400
500
600
700
800
900
1000
Buildout
2020 MDP Landuse
2000 MDP Landuse
Forest
M
J
J
A
S
O
N
D
J
F
M
A
M
J
J
A
S
O
N
D
J
1998
1999
2000

Figure A-12

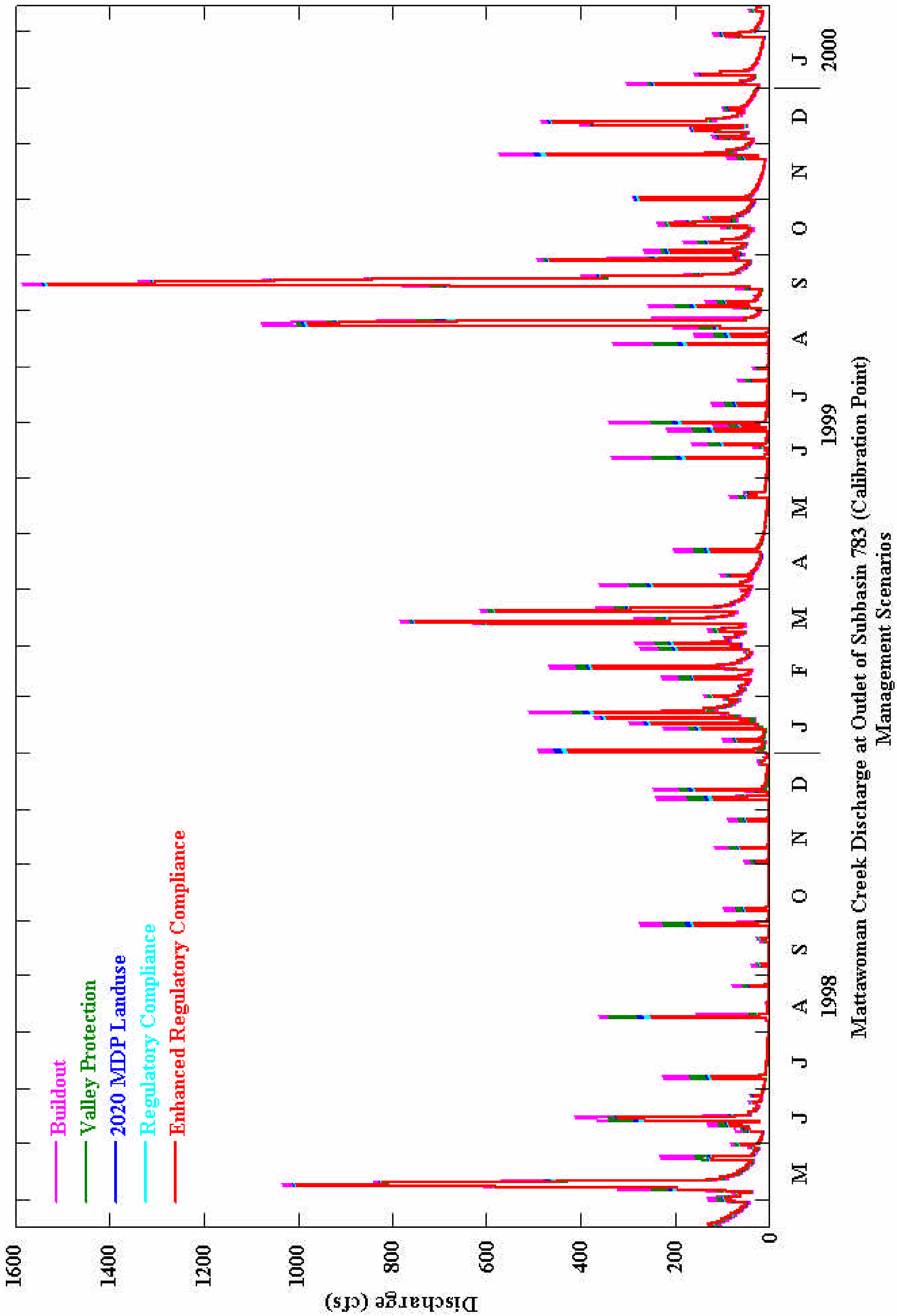

Buildout
Valley Protection
2020 MDP Landuse
Regulatory Compliance
Enhanced Regulatory Compliance
Discharge (cfs)
0
200
400
600
800
1000
1200
1400
1600
M J J A S O N D J F M A M J J A S O N D J
1998
1999
2000
Mattawoman Creek Discharge at Outlet of Subbasin 783 (Calibration Point)
Management Scenarios

Figure A-13

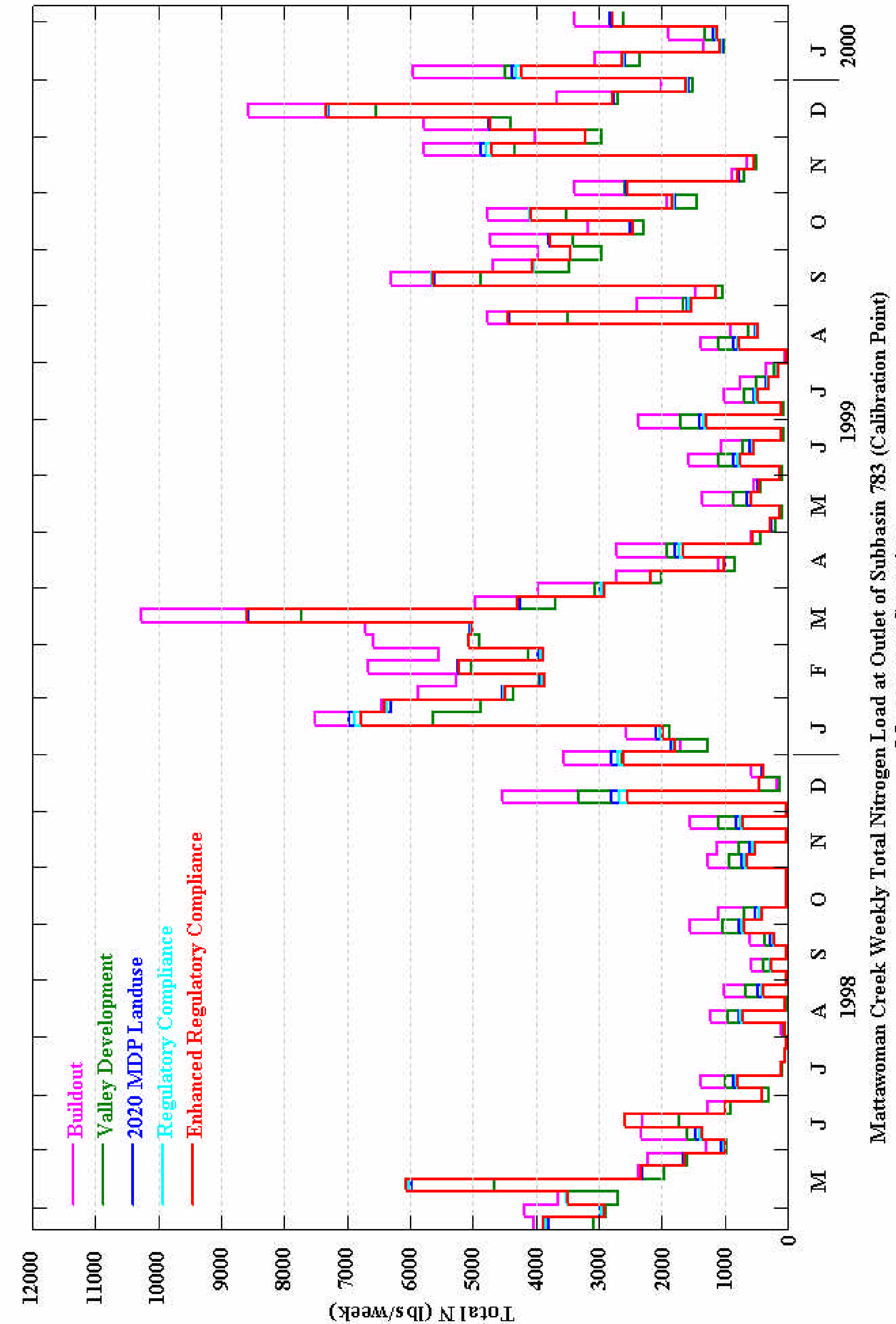

Mattawoman Creek Weekly Total Nitrogen Load at Outlet of Subbasin 783 (Calibration Point)
Management Scenarios
Buildout
Valley Development
2020 MDP Landuse
Regulatory Compliance
Enhanced Regulatory Compliance
Total N (lbs/week)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
M J J A S O N D J F M A M J J A S O N D J
1998
1999
2000

Figure A-14

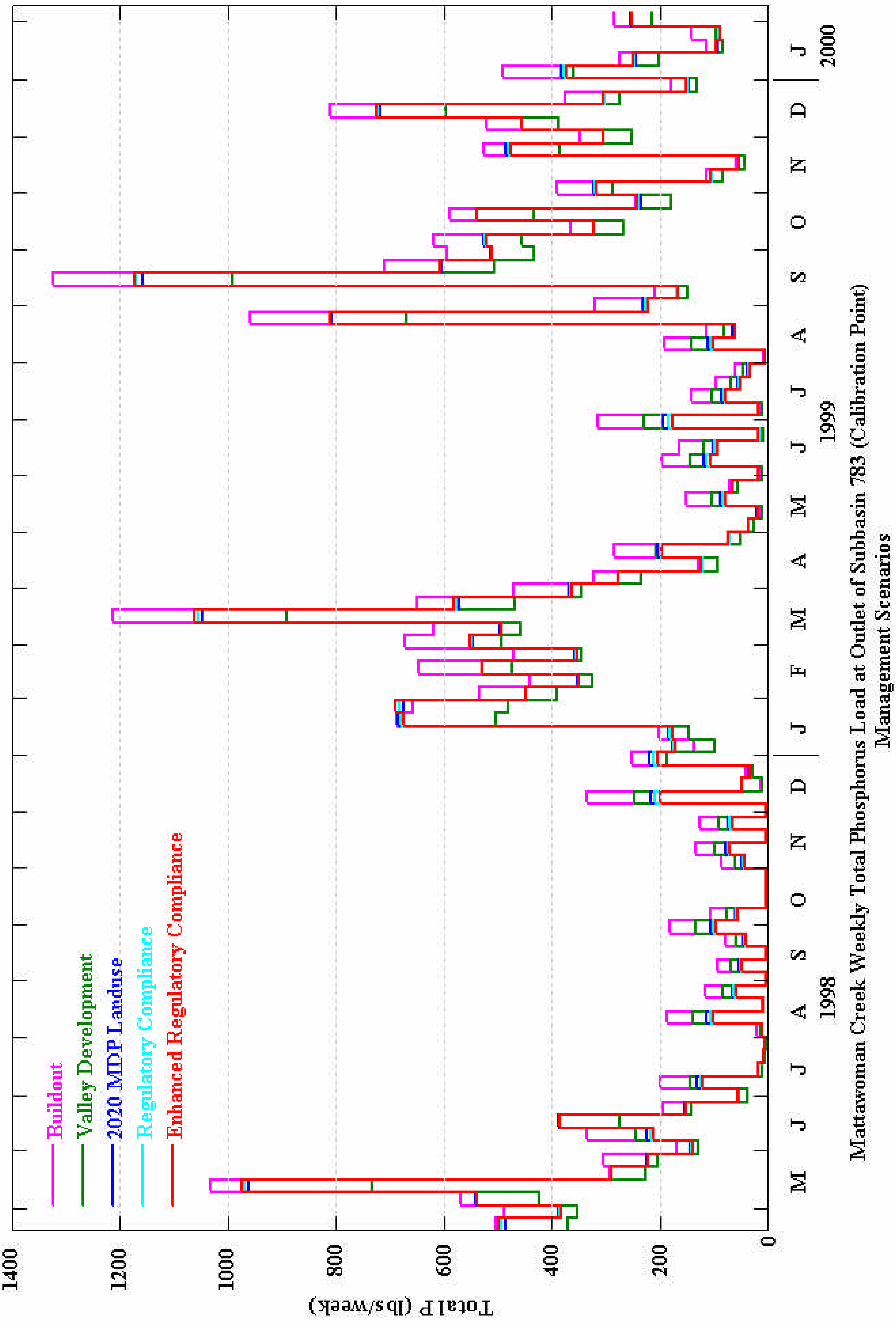
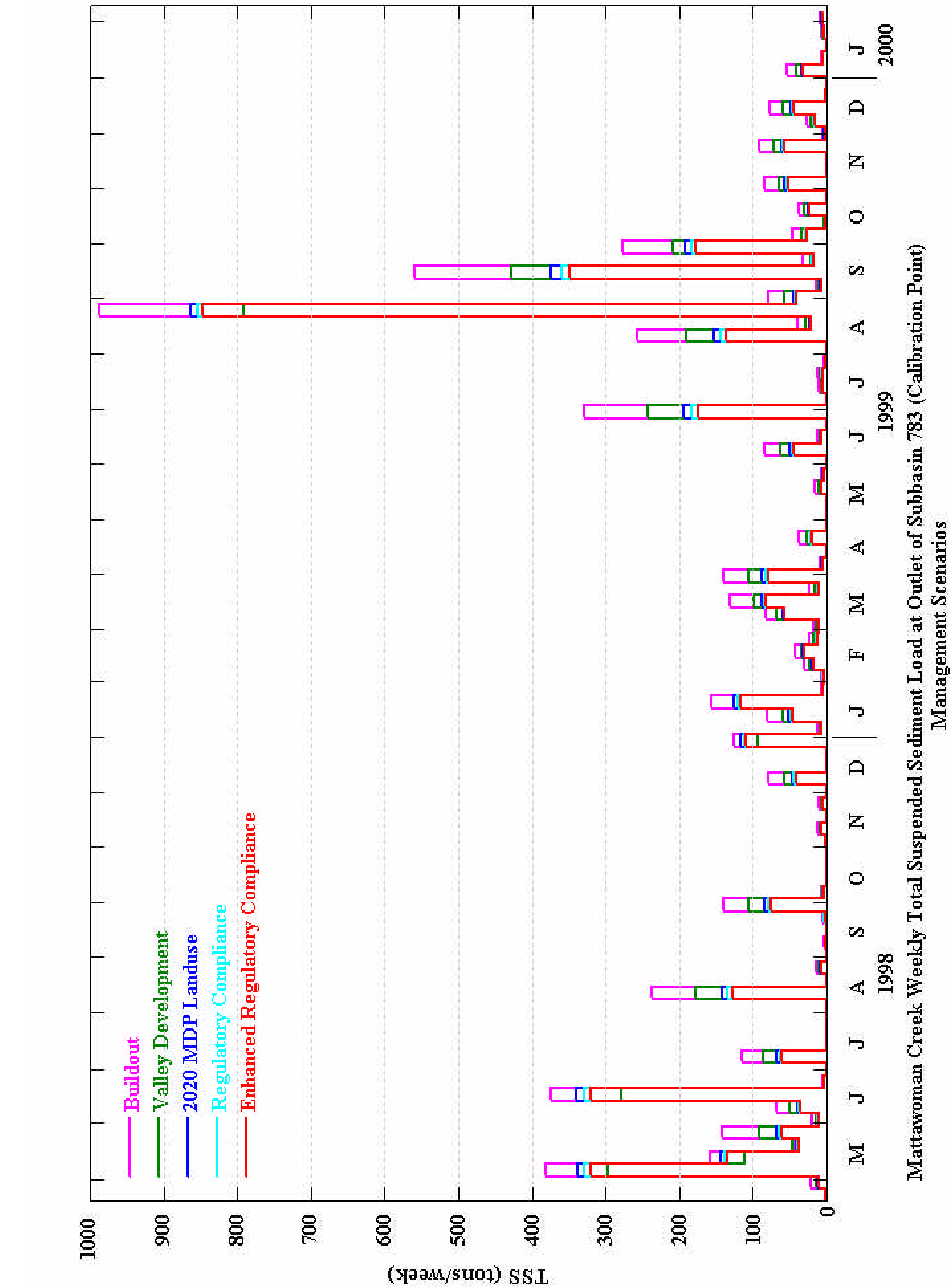
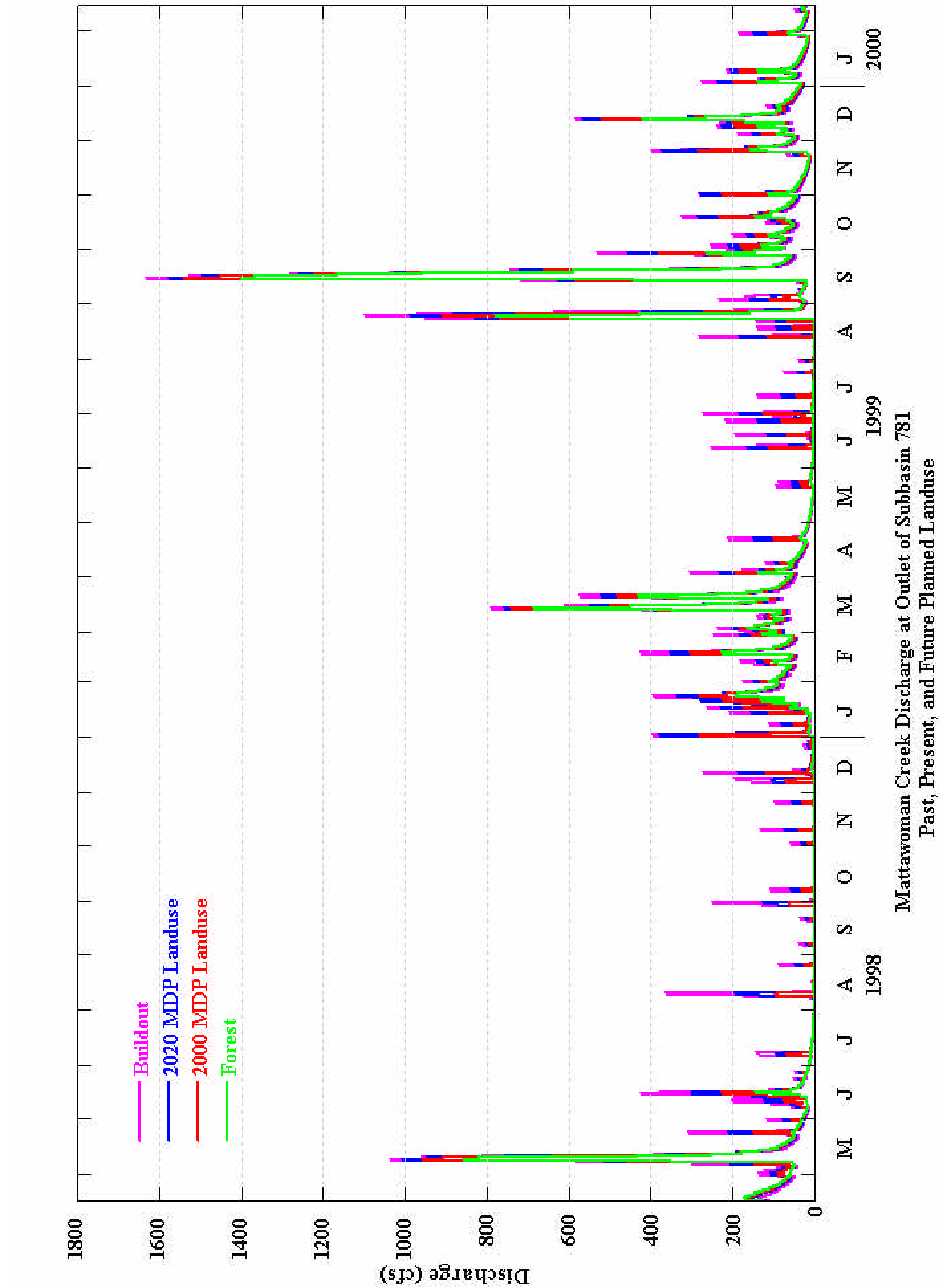

Buildout
Valley Development
2020 MDP Landuse
Regulatory Compliance
Enhanced Regulatory Compliance
Total P (lbs/week)
0
200
400
600
800
1000
1200
1400
M J J A S O N D J F M A M J J A S O N D J
1998
1999
2000
Mattawoman Creek Weekly Total Phosphorus Load at Outlet of Subbasin 783 (Calibration Point)
Management Scenarios

Figure A-15



Buildout
Valley Development
2020 MDP Landuse
Regulatory Compliance
Enhanced Regulatory Compliance
TSS (tons/week)
1000
900
800
700
600
500
400
300
200
100
0
M J J A S O N D J F M A M J J A S O N D J
1998
1999
2000
Mattawoman Creek Weekly Total Suspended Sediment Load at Outlet of Subbasin 783 (Calibration Point)
Management Scenarios

Figure A-16



Buildout
2020 MDP Landuse
2000 MDP Landuse
Forest
Discharge (cfs)
0
200
400
600
800
1000
1200
1400
1600
1800
M J J A S O N D J F M A M J J A S O N D J
1998
1999
2000
Mattawoman Creek Discharge at Outlet of Subbasin 781
Past, Present, and Future Planned Landuse

Figure A-17

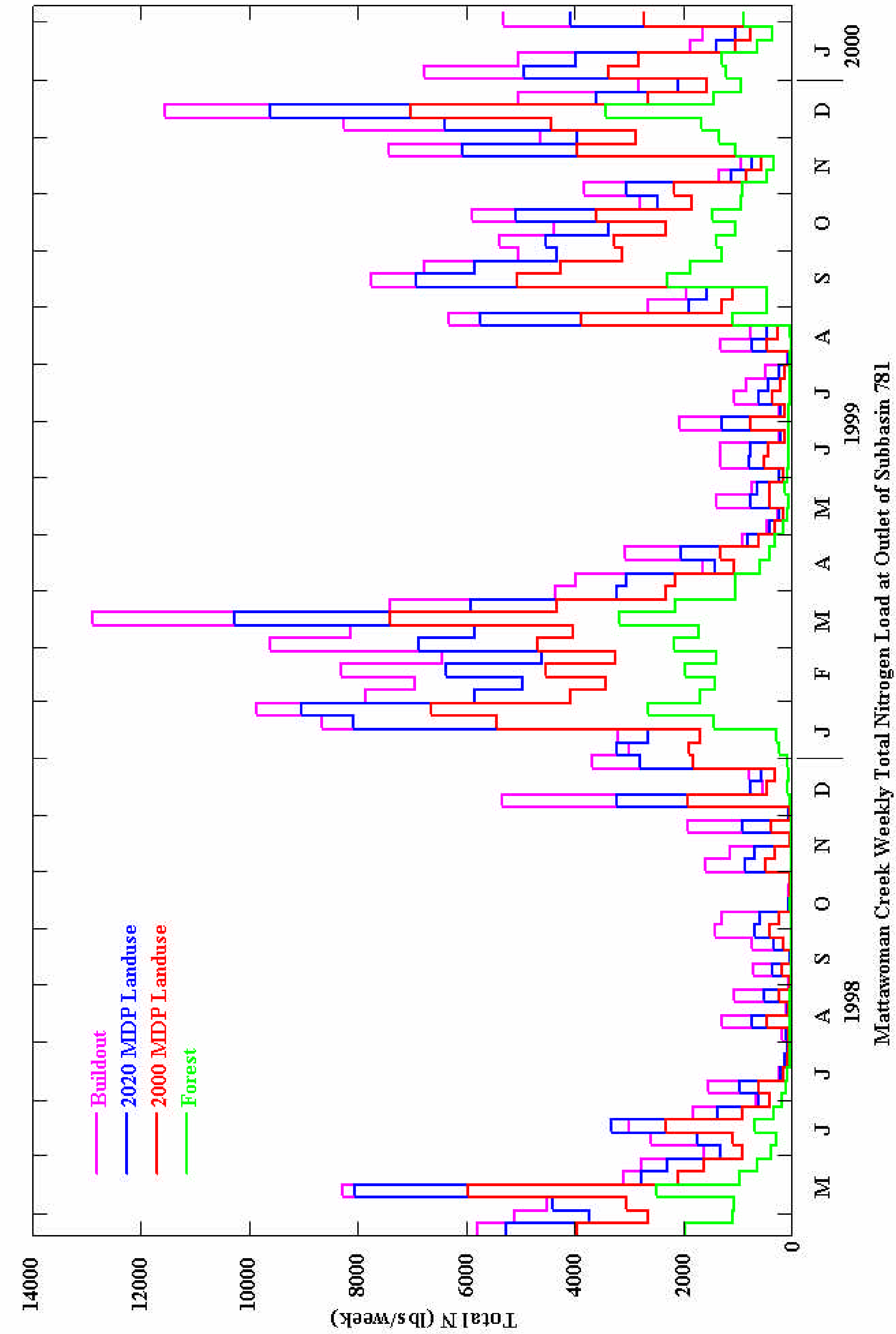
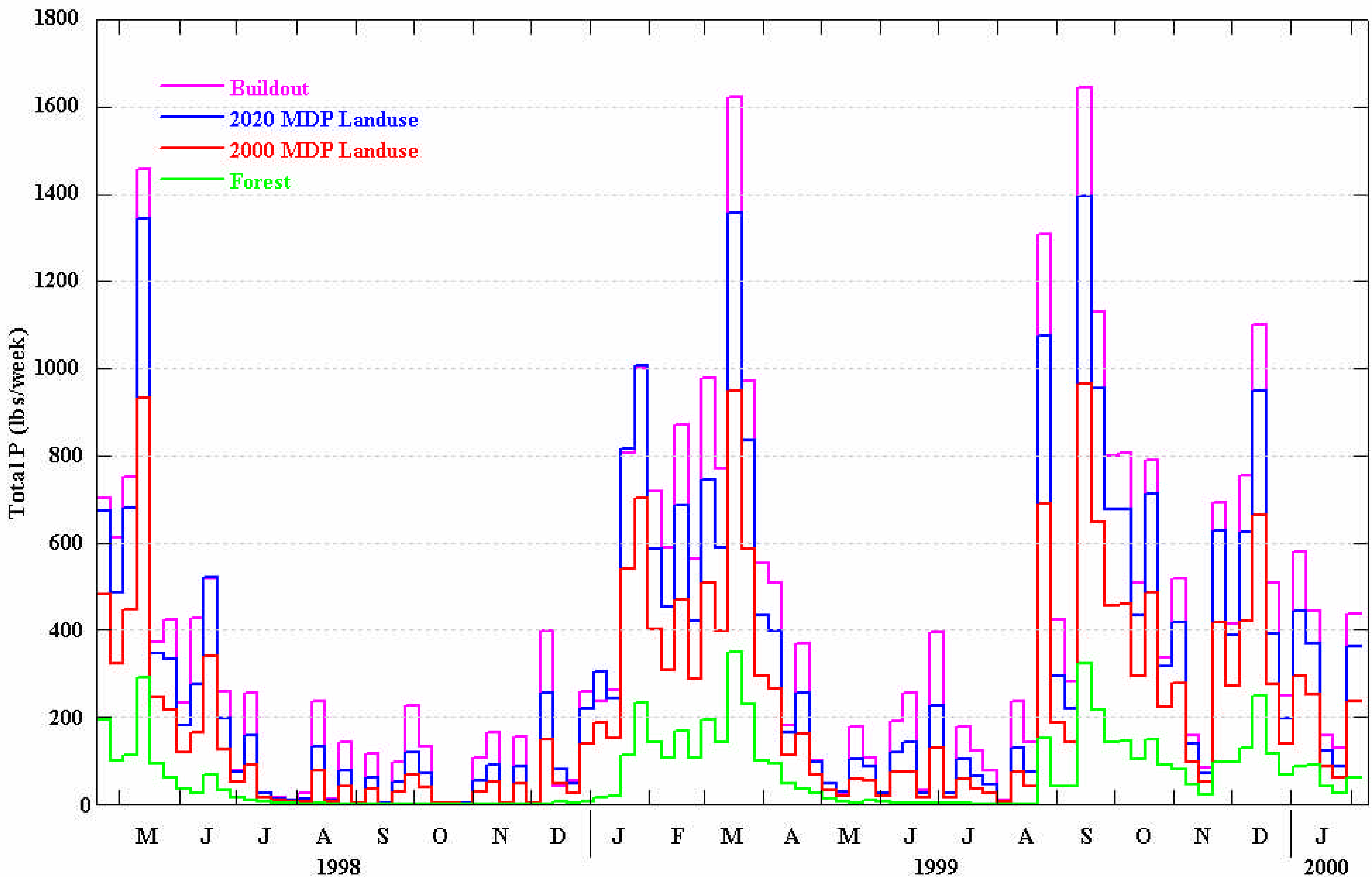
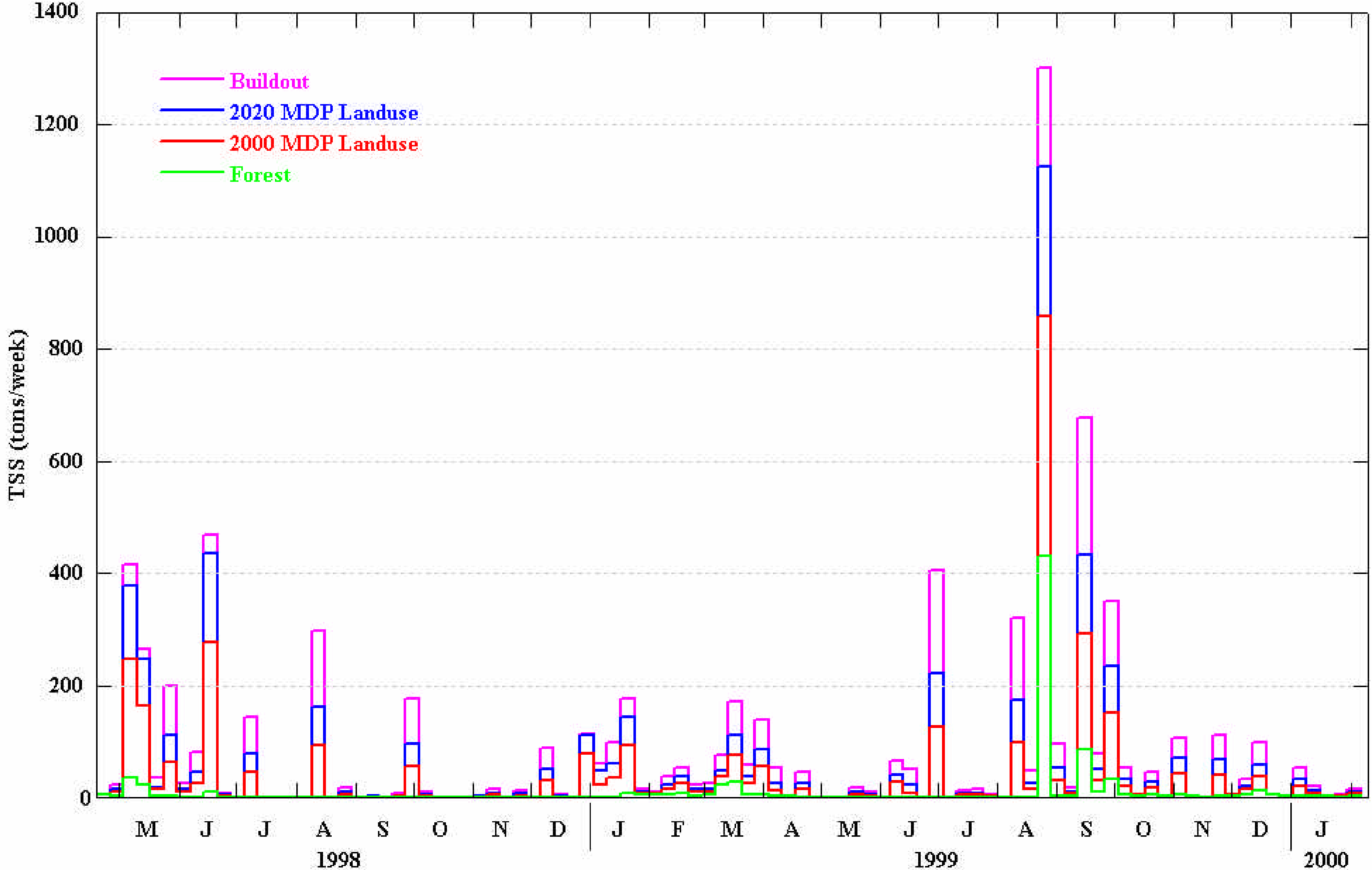

Mattawoman Creek Weekly Total Nitrogen Load at Outlet of Subbasin 781
Past, Present, and Future Planned Landuse
Total N (lbs/week)
0
2000
4000
6000
8000
10000
12000
14000
M
J
J
A
S
O
N
D
J
F
M
A
M
J
J
A
S
O
N
D
J
1998
1999
2000
Buildout
2020 MDP Landuse
2000 MDP Landuse
Forest

Figure A-18



Mattawoman Creek Weekly Total Phosphorus Load at Outlet of Subbasin 781
Past, Present, and Future Planned Landuse

Figure A-19



Mattawoman Creek Weekly Total Suspended Sediment Load at Outlet of Subbasin 781
Past, Present, and Future Planned Landuse

Figure A-20

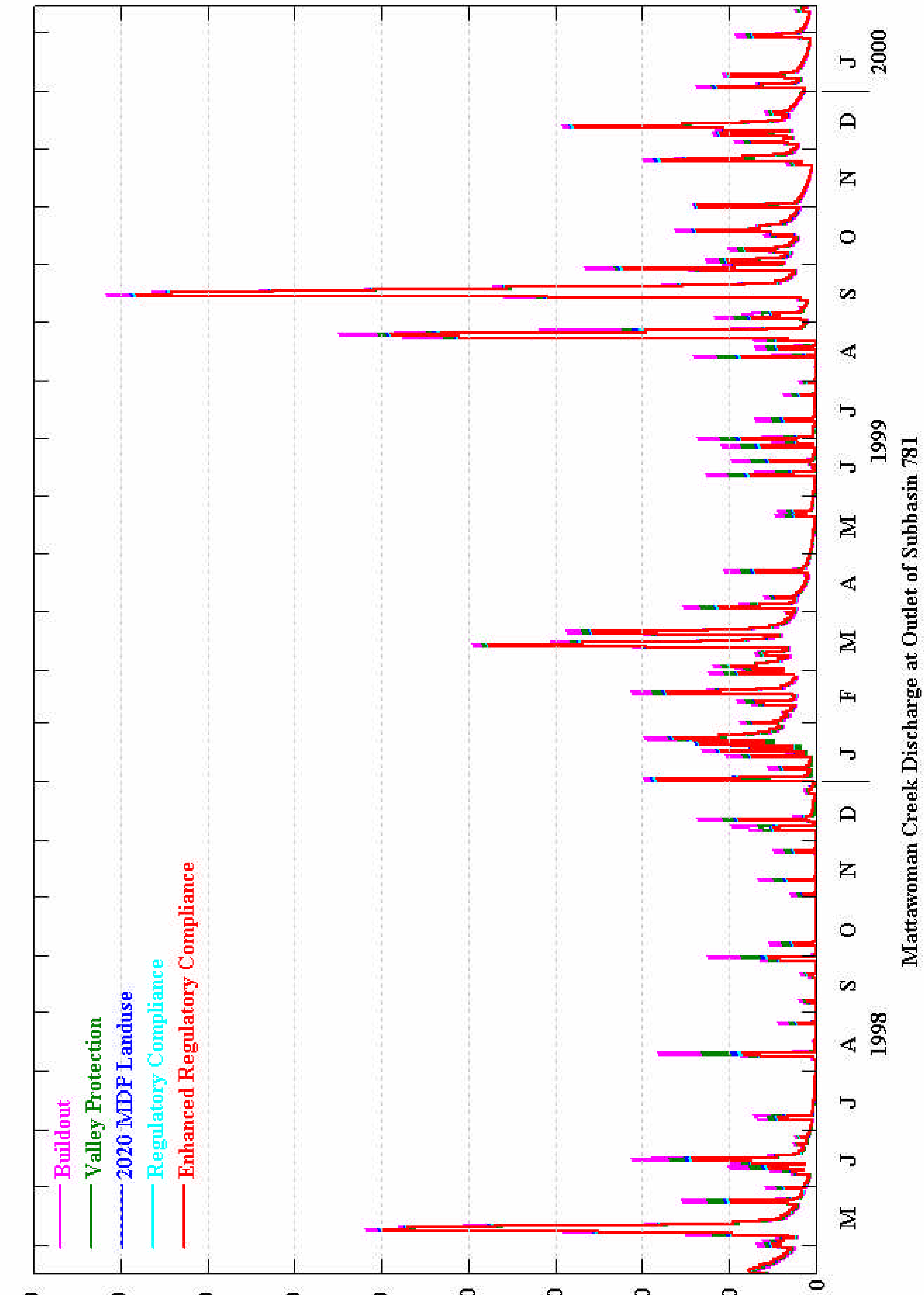
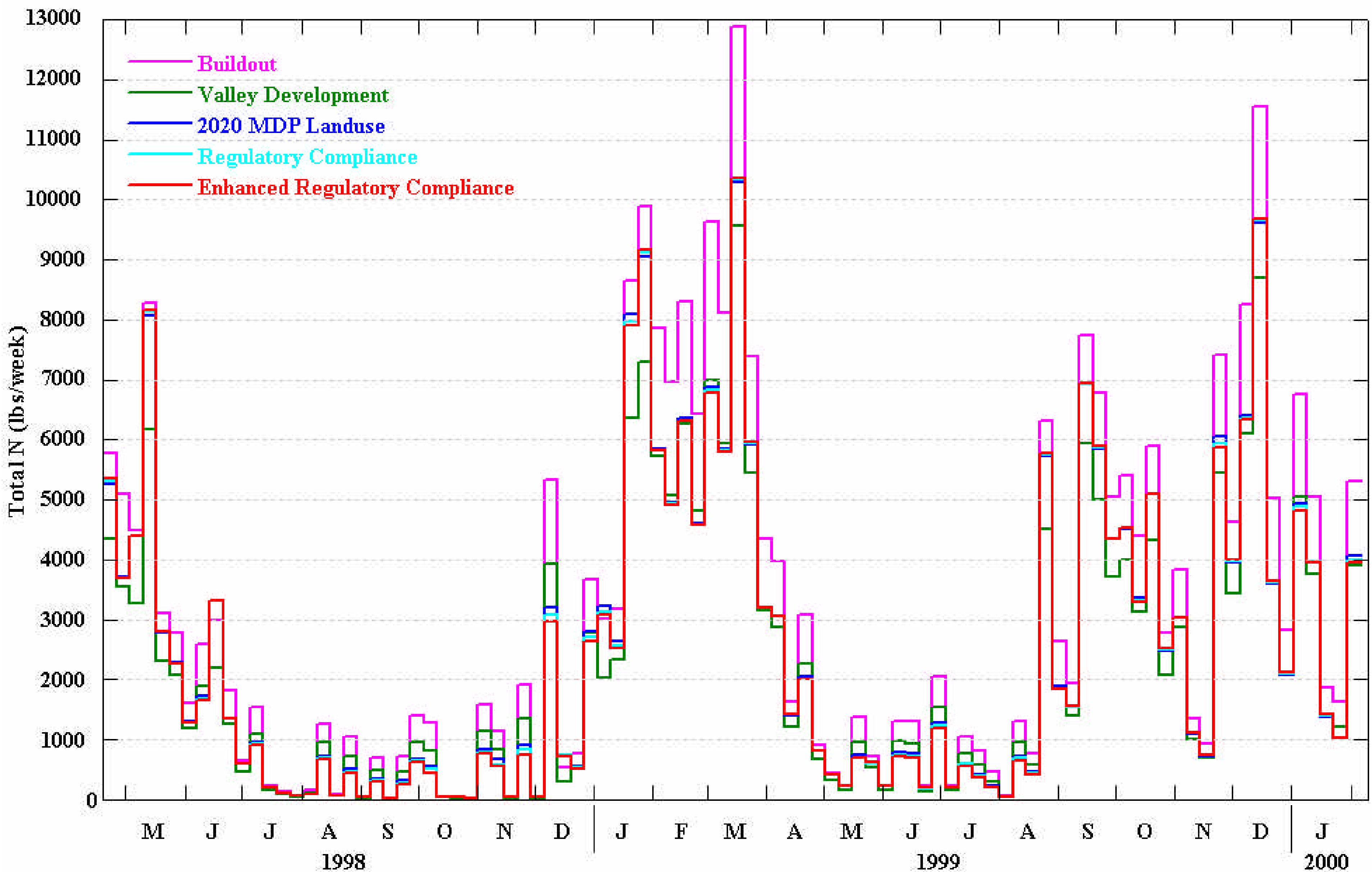

Buildout
Valley Protection
2020 MDP Landuse
Regulatory Compliance
Enhanced Regulatory Compliance
Discharge (cfs)
0
200
400
600
800
1000
1200
1400
1600
1800
M
J
J
A
S
O
N
D
J
F
M
A
M
J
J
A
S
O
N
D
J
1998
1999
2000
Mattawoman Creek Discharge at Outlet of Subbasin 781
Management Scenarios

Figure A-21



Mattawoman Creek Weekly Total Nitrogen Load at Outlet of Subbasin 781
Management Scenarios

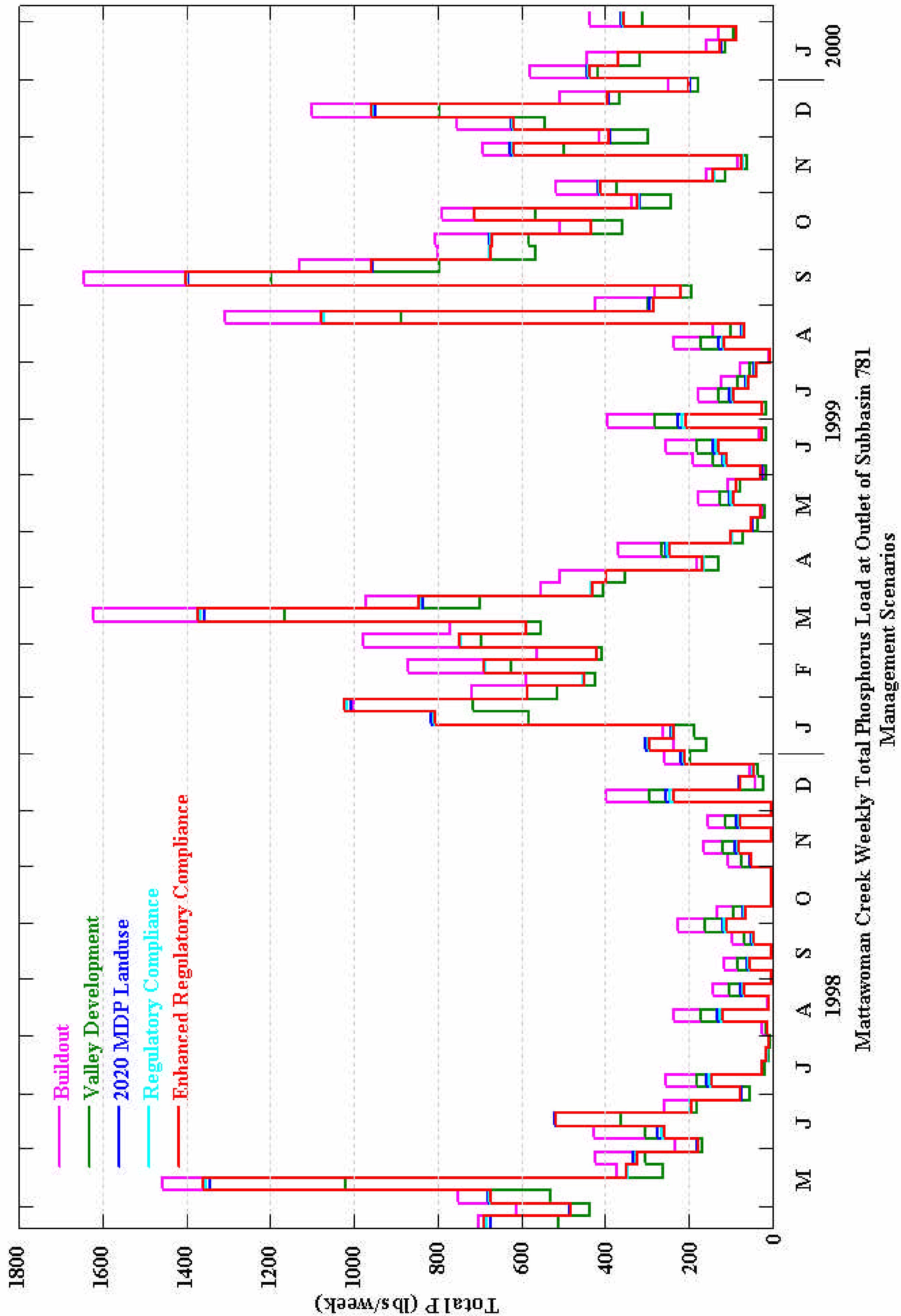
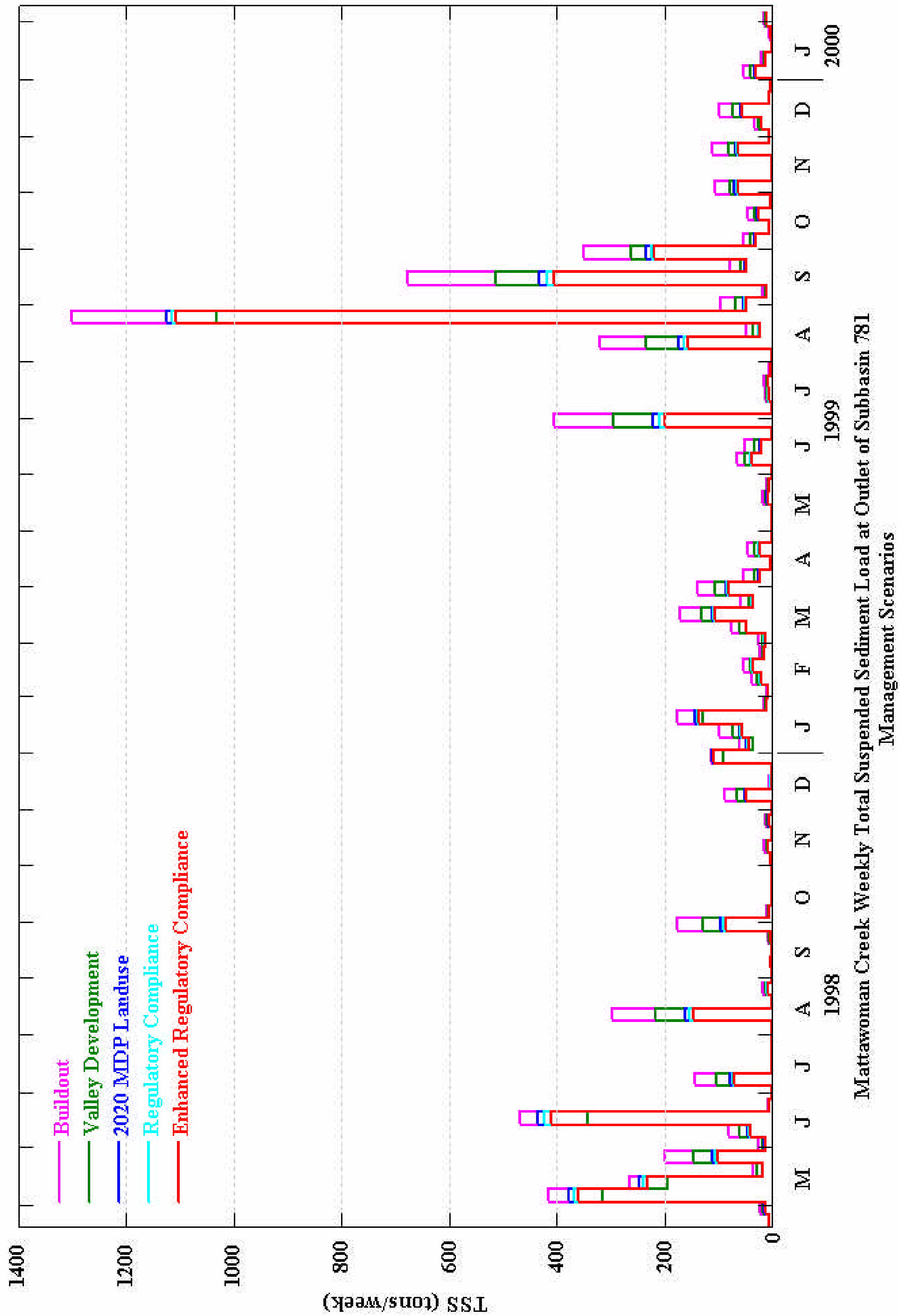

Buildout
Valley Development
2020 MDP Landuse
Regulatory Compliance
Enhanced Regulatory Compliance
Total P (lbs/week)
0
200
400
600
800
1000
1200
1400
1600
1800
M J J A S O N D J F M A M J J A S O N D J
1998
1999
2000
Mattawoman Creek Weekly Total Phosphorus Load at Outlet of Subbasin 781
Management Scenarios

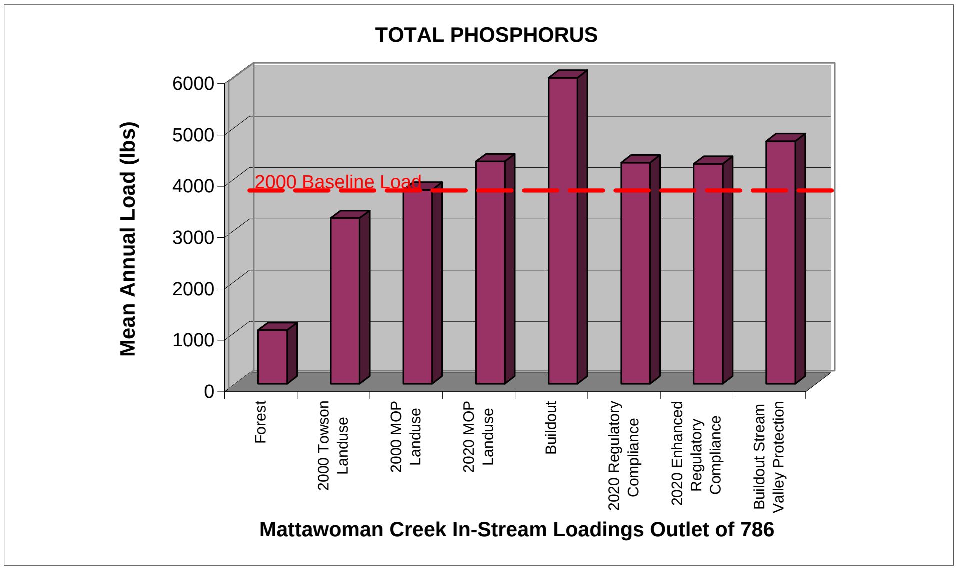
Figure A-23

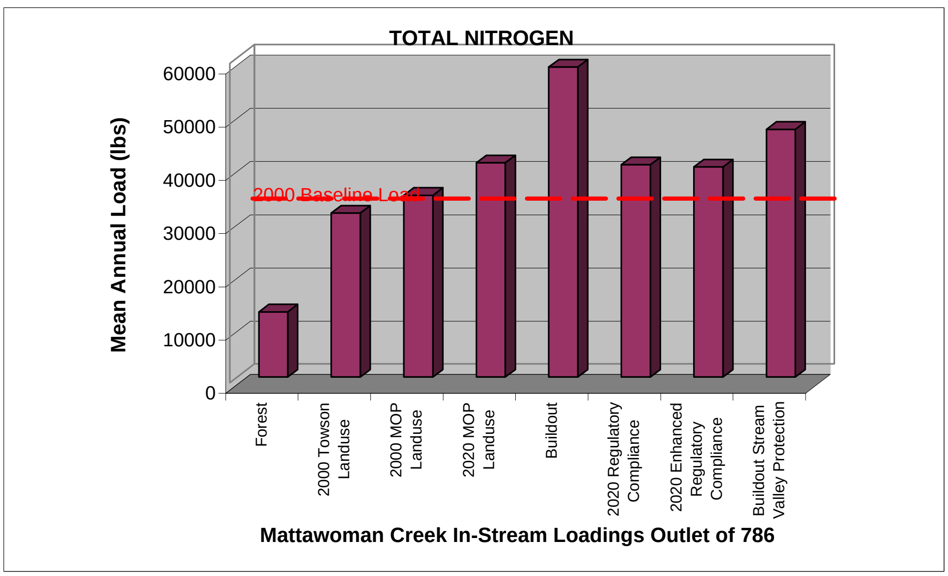


Buildout
Valley Development
2020 MDP Landuse
Regulatory Compliance
Enhanced Regulatory Compliance
TSS (tons/week)
0
200
400
600
800
1000
1200
1400
M
J
J
A
S
O
N
D
J
F
M
A
M
J
J
A
S
O
N
D
J
1998
1999
2000
Mattawoman Creek Weekly Total Suspended Sediment Load at Outlet of Subbasin 781
Management Scenarios

Figure A-24

Figure A-25. Mean Annual In-Stream Total P, Total N, and TSS at Outlet of Subbasin 786.





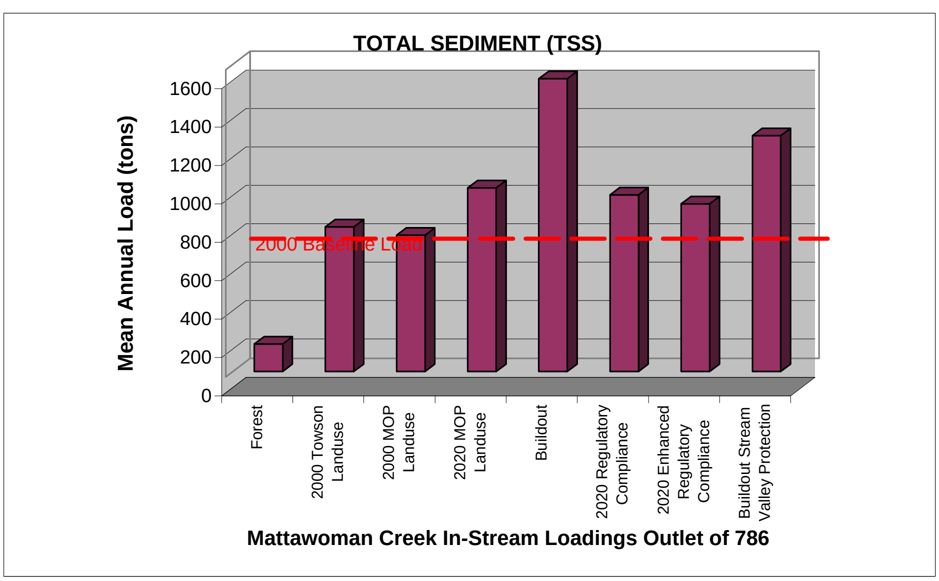
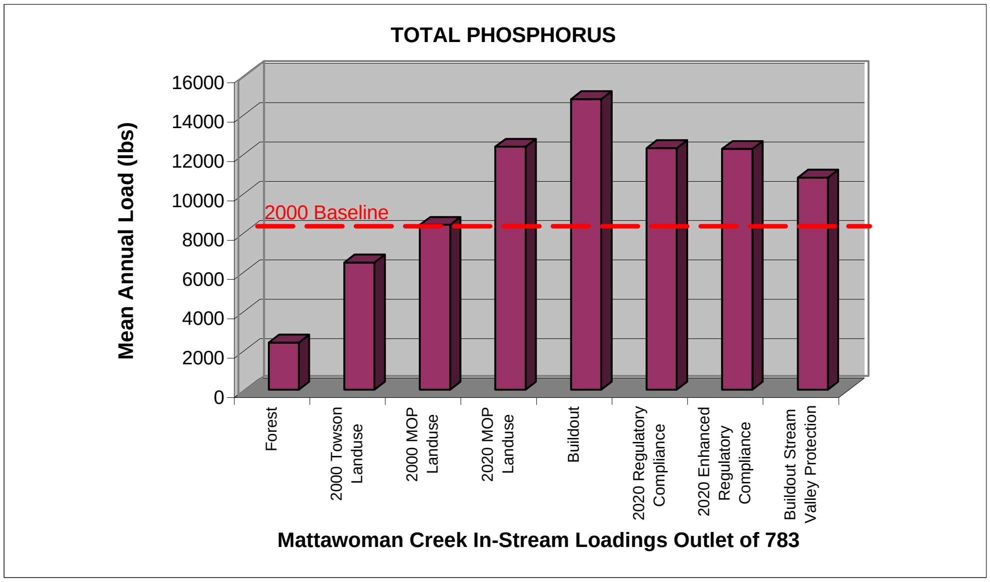
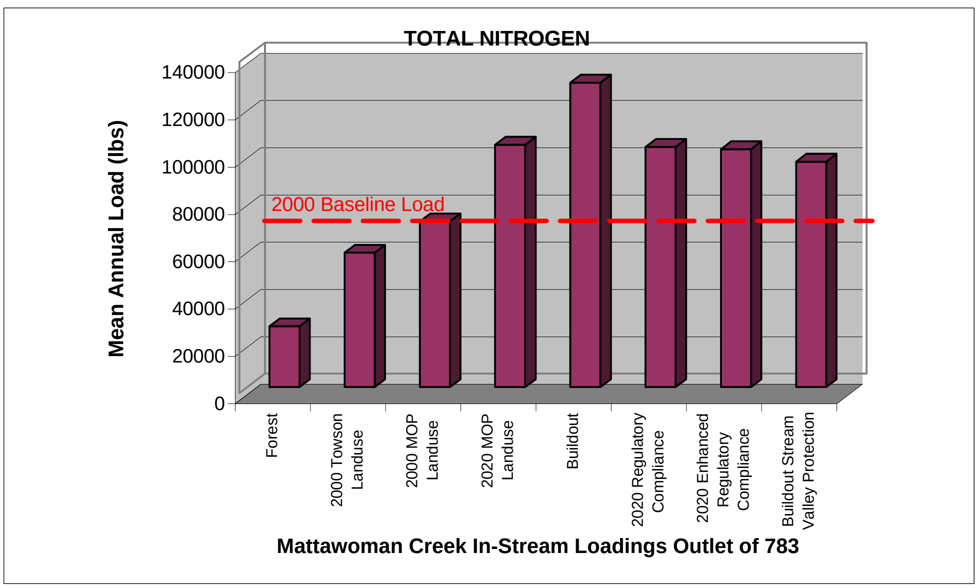


Figure A-26. Mean Annual In-Stream Total P, Total N, and TSS at Outlet of Subbasin 783





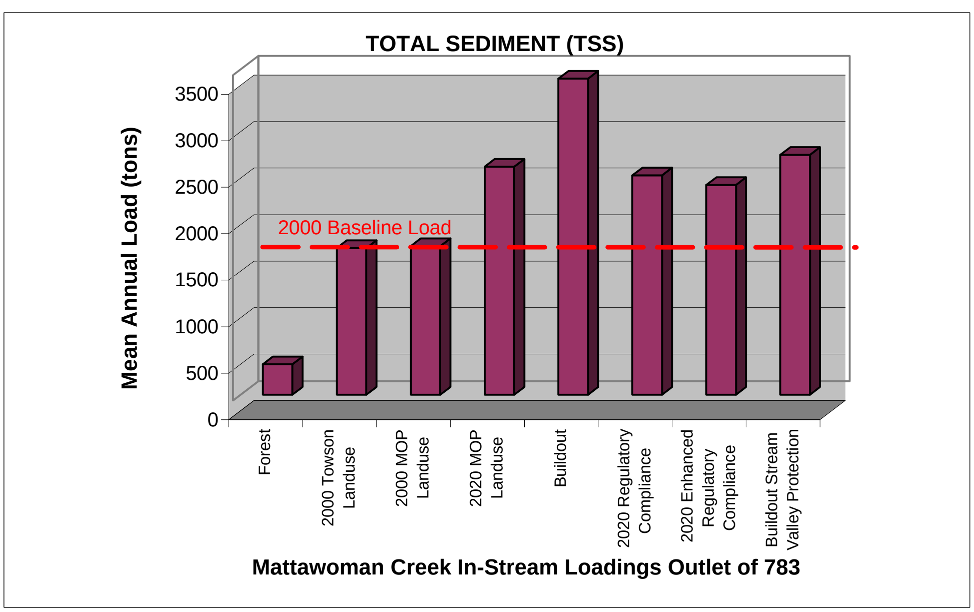
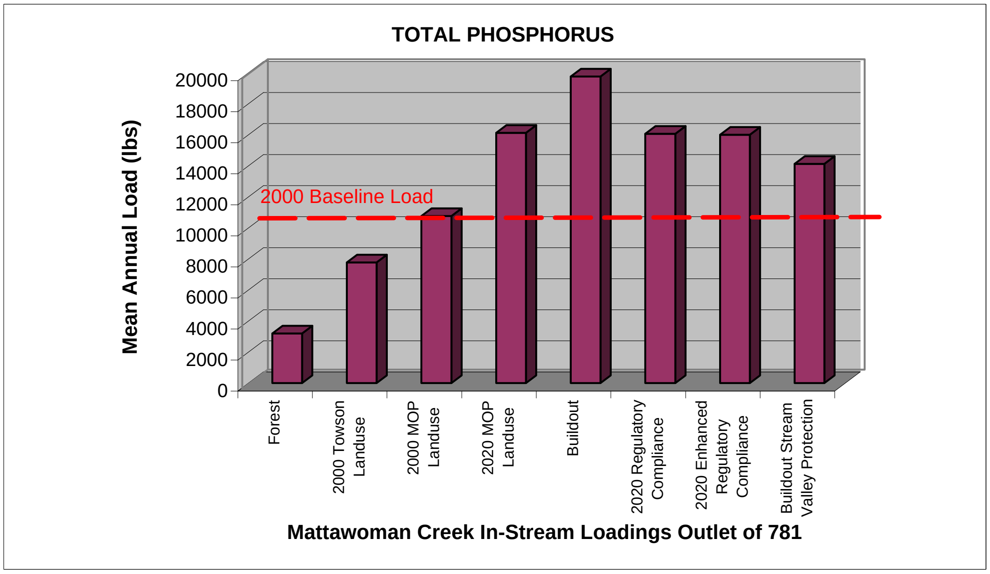
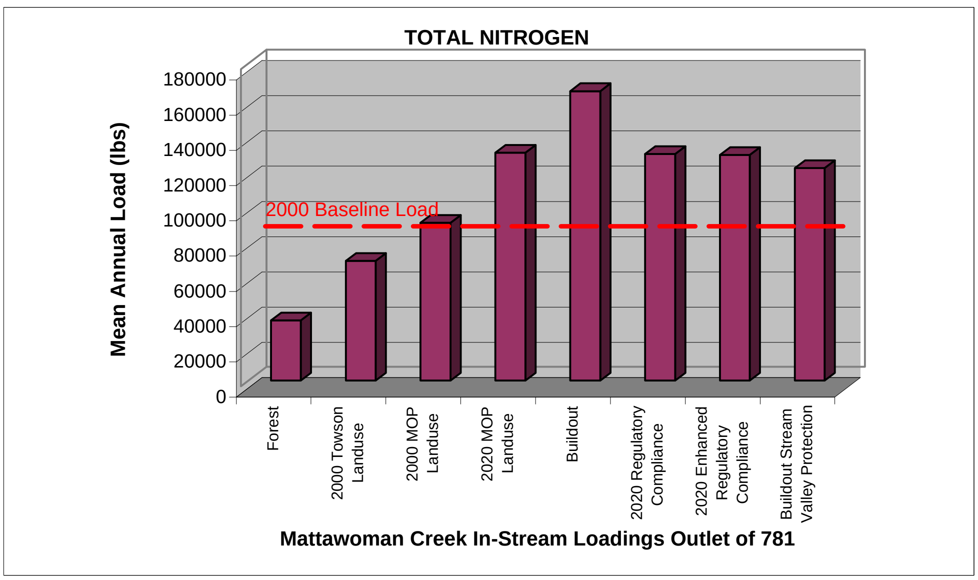


Figure A-27. Mean Annual In-Stream Total P, Total N, and TSS at Outlet of Subbasin 781.





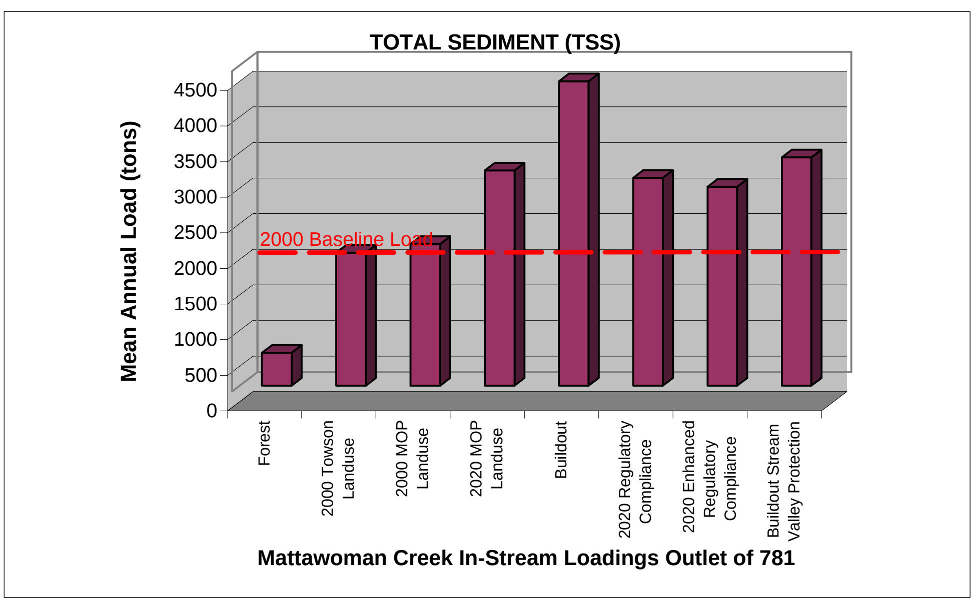
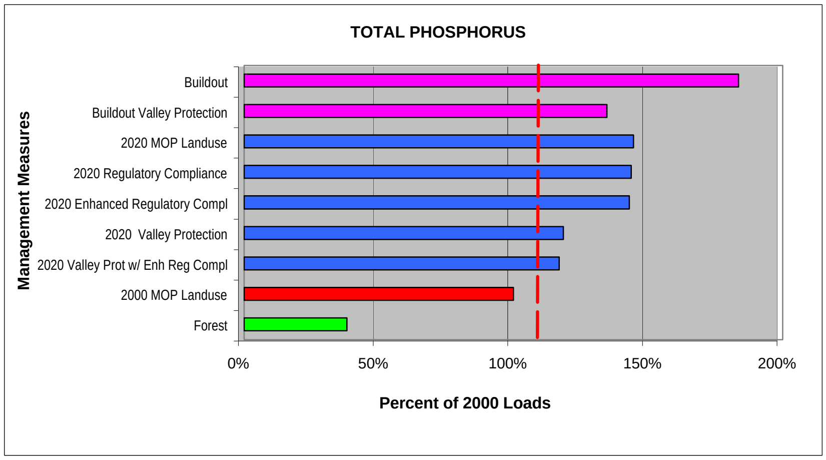
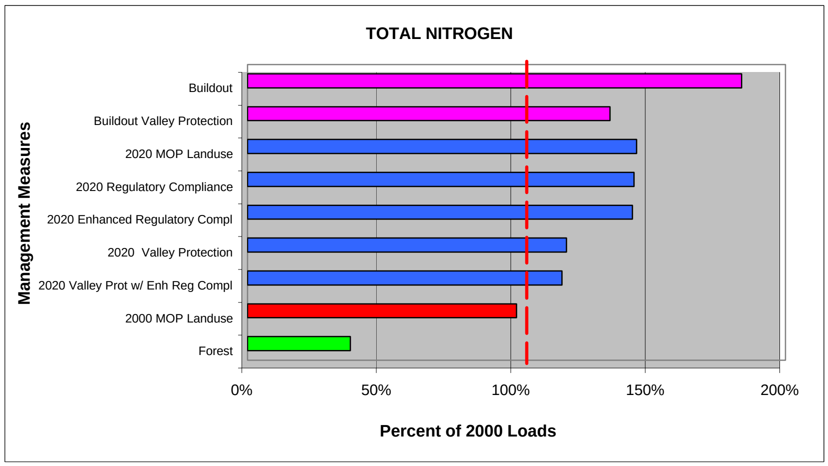
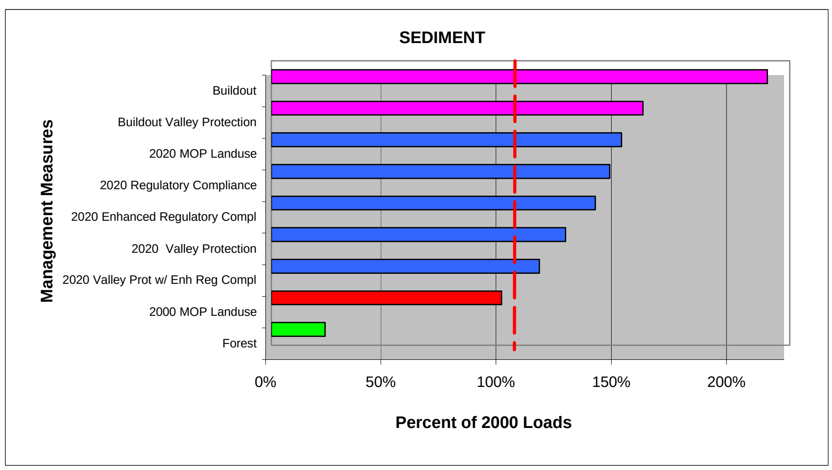
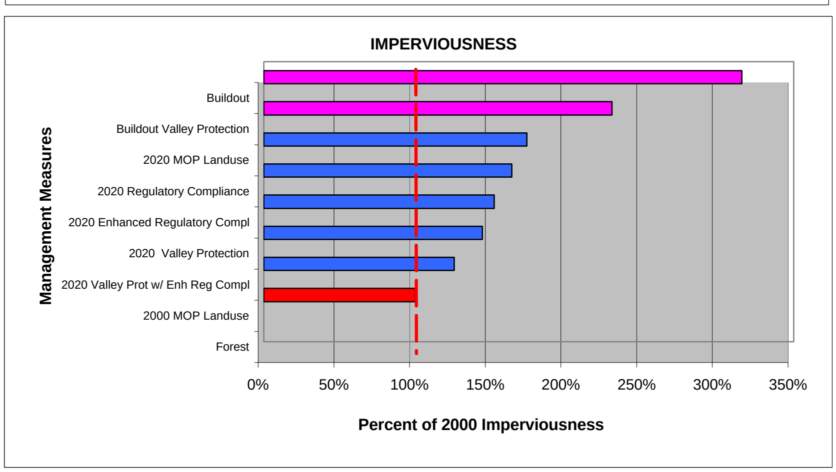


Figure A-28. Percent of 2000 Mean Annual In-Stream Loads at Outlet of Subbasin 781.









APPENDIX A

WATER QUALITY MODELING

TABLES

Table A-1. Mattawoman Creek Watershed Landuse and Management Scenarios.

2000 TOWSON LANDUSE (acres)

DNR 12-Diget Watersheds	Undeveloped Land					Developed Land				TOTAL AREA	Total Impervious	Percent Impervious
	Forest	Agriculture	Grassland	Barren	Water/ Wetland	Low Density Pervious	Low Density Impervious	High Density Pervious	High Density Impervious			
021401110788	3473.88	707.85	51.58	42.46	73.14	315.46	315.46	18.76	168.87	5167.47	484.33	9.37%
021401110787	3848.48	741.20	132.72	10.45	18.90	174.41	174.41	43.02	387.16	5530.73	561.57	10.15%
021401110786	3746.66	752.09	517.77	5.78	33.57	312.13	312.13	46.11	414.97	6141.20	727.10	11.84%
021401110785	2893.64	241.88	263.22	64.03	46.24	519.21	519.21	72.16	649.47	5269.07	1168.68	22.18%
021401110784	10626.83	786.77	662.27	45.57	28.01	506.88	506.88	19.92	179.27	13362.41	686.15	5.13%
021401110783	3743.55	546.45	27.57	3.33	9.78	51.58	51.58	3.33	30.01	4467.18	81.59	1.83%
021401110782	1560.87	139.84	11.78	2.89	22.45	44.35	44.35	0.36	3.20	1830.09	47.55	2.60%
021401110781	8310.10	371.49	71.81	2.89	46.02	240.21	240.21	24.92	224.29	9531.94	464.50	4.87%
Total (781-788)	38204.00	4287.55	1738.72	177.41	278.11	2164.23	2164.23	228.58	2057.25	51300.08	4221.48	8.23%
Gage (783-788)	28333.04	3776.23	1655.13	171.63	209.64	1879.67	1879.67	203.31	1829.76	39938.05	3709.42	9.29%

2000 MOP LANDUSE (acres)

DNR 12-Diget Watersheds	Undeveloped Land					Developed Land				TOTAL AREA	Total Impervious	Percent Impervious
	Forest	Agriculture	Grassland	Barren	Water/ Wetland	Low Density Pervious	Low Density Impervious	High Density Pervious	High Density Impervious			
021401110788	2377.25	435.59	1657.56	124.86	0.00	433.03	248.47	47.10	110.05	5433.91	358.52	6.60%
021401110787	3445.38	1087.55	36.17	88.32	0.00	284.99	99.39	133.84	351.01	5526.65	450.40	8.15%
021401110786	2949.94	1336.27	500.67	0.00	12.52	596.32	284.36	93.01	320.61	6093.70	604.97	9.93%
021401110785	2282.85	593.93	67.94	125.86	41.08	719.80	319.09	285.18	727.45	5163.18	1046.53	20.27%
021401110784	7502.02	1427.08	295.51	0.00	0.00	2945.32	664.09	26.31	73.40	12933.73	737.49	5.70%
021401110783	3143.07	883.31	15.94	0.00	0.00	289.11	47.06	27.45	64.47	4470.41	111.53	2.49%
021401110782	1335.99	240.97	12.17	0.00	4.47	202.56	32.97	3.97	3.97	1837.07	36.94	2.01%
021401110781	7076.14	403.97	141.06	0.00	31.99	1238.33	255.36	104.36	228.26	9479.47	483.62	5.10%
Total (781-788)	30112.64	6408.67	2727.03	339.04	90.06	6709.46	1950.80	721.22	1879.21	50938.11	3830.01	7.52%
Gage (783-788)	21700.51	5763.73	2573.80	339.04	53.60	5268.57	1662.46	612.89	1646.98	39621.58	3309.45	8.35%

MDP 2020 LAI (acres)

DNR 12-Diget Watersheds	Undeveloped Land					Developed Land				TOTAL AREA	Total Impervious	Percent Impervious
	Forest	Agriculture	Grassland	Barren	Water/ Wetland	Low Density Pervious	Low Density Impervious	High Density Pervious	High Density Impervious			
021401110788	2305.77	381.70	1657.56	175.60	0.00	477.99	268.13	64.09	151.57	5482.41	419.70	7.66%
021401110787	2646.63	790.53	34.24	230.37	0.00	746.90	246.58	254.08	609.98	5559.31	856.56	15.41%
021401110786	2204.06	1039.45	509.32	0.00	12.53	1228.13	641.10	115.64	422.75	6172.98	1063.85	17.23%
021401110785	248.77	101.21	30.12	125.86	41.08	2520.43	983.91	331.48	898.04	5280.91	1881.95	35.64%
021401110784	2498.59	2195.46	103.54	0.00	0.00	6683.94	1424.40	37.86	117.95	13061.74	1542.35	11.81%
021401110783	1393.48	2513.63	10.29	0.00	0.00	392.60	64.90	28.12	67.38	4470.40	132.28	2.96%
021401110782	818.44	482.27	8.23	0.00	4.47	442.77	72.18	4.24	4.47	1837.07	76.65	4.17%
021401110781	4043.05	2473.99	50.08	0.00	31.99	2088.68	451.85	117.80	288.07	9545.51	739.92	7.75%
Total (781-788)	16158.79	9978.24	2403.39	531.83	90.06	14581.43	4153.05	953.31	2560.21	51410.31	6713.26	13.06%
Gage (783-788)	11297.29	7021.99	2345.08	531.83	53.61	12049.98	3629.02	831.27	2267.67	40027.73	5896.69	14.73%

FOREST (acres)

DNR 12-Diget Watersheds	Undeveloped Land					Developed Land				TOTAL AREA	Total Impervious	Percent Impervious
	Forest	Agriculture	Grassland	Barren	Water/ Wetland	Low Density Pervious	Low Density Impervious	High Density Pervious	High Density Impervious			
021401110788	5174.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5174.08	0.00	0.00%
021401110787	5545.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5545.17	0.00	0.00%
021401110786	6153.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6153.25	0.00	0.00%
021401110785	5279.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5279.56	0.00	0.00%
021401110784	13383.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13383.32	0.00	0.00%
021401110783	4471.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4471.55	0.00	0.00%
021401110782	1837.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1837.52	0.00	0.00%
021401110781	9555.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9555.81	0.00	0.00%
Total (781-788)	51400.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	51400.26	0.00	0.00%
Gage (783-788)	40006.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40006.92	0.00	0.00%

Table A-1. Mattawoman Creek Watershed Landuse and Management Scenarios.

100% BUILDOUT (acres)

DNR 12-Diget Watersheds	Undeveloped Land					Developed Land				TOTAL AREA	Total Impervious	Percent Impervious
	Forest	Agriculture	Grassland	Barren	Water/ Wetland	Low Density Pervious	Low Density Impervious	High Density Pervious	High Density Impervious			
021401110788	2630.02	0.00	648.71	0.00	10.16	955.48	369.34	137.01	423.27	5174.00	792.61	15.32%
021401110787	11.39	0.00	2.85	0.00	0.00	3029.55	608.87	567.80	1324.54	5545.00	1933.41	34.87%
021401110786	0.00	0.00	0.00	0.00	12.08	4016.01	1133.38	227.60	762.22	6151.29	1895.60	30.82%
021401110785	0.00	0.00	0.00	0.00	41.08	2884.68	1338.68	270.23	744.74	5279.41	2083.42	39.46%
021401110784	71.74	0.00	17.94	0.00	20.16	10741.45	1861.42	137.25	535.71	13385.67	2397.13	17.91%
021401110783	0.00	0.00	0.00	0.00	0.00	3366.23	547.99	167.21	392.78	4474.20	940.77	21.03%
021401110782	0.00	0.00	0.00	0.00	4.47	1576.07	256.57	0.00	0.00	1837.12	256.57	13.97%
021401110781	0.00	0.00	0.00	0.00	31.99	7444.83	1324.56	168.12	575.14	9544.64	1899.70	19.90%
Total (781-788)	2713.16	0.00	669.50	0.00	119.94	34014.30	7440.81	1675.22	4758.40	51391.32	12199.21	23.74%
Gage (783-788)	2713.16	0.00	669.50	0.00	83.48	24993.40	5859.68	1507.10	4183.26	40009.57	10042.94	25.10%

SCENARIO 1 - 2020 MOP LANDUSE WITH REGULATORY COMPLI (acres)

DNR 12-Diget Watersheds	Undeveloped Land					Developed Land				TOTAL AREA	Total Impervious	Percent Impervious
	Forest	Agriculture	Grassland	Barren	Water/ Wetland	Low Density Pervious	Low Density Impervious	High Density Pervious	High Density Impervious			
021401110788	2305.77	381.70	1657.56	175.60	0.00	494.50	251.62	73.04	142.61	5482.41	394.24	7.19%
021401110787	2646.63	790.53	34.24	230.37	0.00	760.47	233.01	288.97	575.10	5559.31	808.10	14.54%
021401110786	2204.06	1039.45	509.32	0.00	12.53	1263.73	605.49	140.79	397.60	6172.98	1003.09	16.25%
021401110785	248.77	101.21	30.12	125.86	41.08	2573.61	930.72	385.48	844.05	5280.91	1774.77	33.61%
021401110784	2498.59	2195.46	103.54	0.00	0.00	6763.46	1344.88	44.67	111.13	13061.74	1456.01	11.15%
021401110783	1393.48	2513.63	10.29	0.00	0.00	396.43	61.07	32.29	63.21	4470.40	124.27	2.78%
021401110782	818.44	482.27	8.23	0.00	4.47	446.79	68.16	4.51	4.20	1837.07	72.36	3.94%
021401110781	4043.05	2473.99	50.08	0.00	31.99	2114.46	426.07	135.06	270.81	9545.51	696.88	7.30%
Total (781-788)	16158.79	9978.24	2403.39	531.83	90.06	14813.47	3921.01	1104.81	2408.71	51410.31	6329.72	12.31%
Gage (783-788)	11297.29	7021.99	2345.08	531.83	53.61	12252.22	3426.79	965.24	2133.70	40027.73	5560.49	13.89%

40027.73

SCENARIO 2- 2020 MOP LANDUSE WITH ENHANCED REGULATORY COMPI (acres)

DNR 12-Diget Watersheds	Undeveloped Land					Developed Land				TOTAL AREA	Total Impervious	Percent Impervious
	Forest	Agriculture	Grassland	Barren	Water/ Wetland	Low Density Pervious	Low Density Impervious	High Density Pervious	High Density Impervious			
021401110788	2305.77	381.70	1657.56	175.60	0.00	515.10	85.45	231.02	130.21	5482.41	361.23	6.59%
021401110787	2646.63	790.53	34.24	230.37	0.00	782.65	341.19	218.29	522.87	5559.31	741.16	13.31%
021401110786	2204.06	1039.45	509.32	0.00	12.53	1320.74	175.05	569.82	363.34	6172.98	933.16	15.06%
021401110785	248.77	101.21	30.12	125.86	41.08	2664.03	457.10	864.24	772.43	5280.91	1636.67	30.85%
021401110784	2498.59	2195.46	103.54	0.00	0.00	6889.30	54.63	1268.85	101.17	13061.74	1370.02	10.45%
021401110783	1393.48	2513.63	10.29	0.00	0.00	401.74	37.42	59.28	58.08	4470.40	117.36	2.62%
021401110782	818.44	482.27	8.23	0.00	4.47	453.19	4.86	64.24	3.85	1837.07	68.09	3.70%
021401110781	4043.05	2473.99	50.08	0.00	31.99	2153.26	158.16	406.42	247.71	9545.51	654.13	6.84%
Total (781-788)	16158.79	9978.24	2403.39	531.83	90.06	15180.01	1313.85	3682.15	2199.67	51410.31	5881.82	11.41%
Gage (783-788)	11297.29	7021.99	2345.08	531.83	53.61	12573.56	1150.83	3211.50	1948.11	40027.73	5301.77	13.25%

SCENARIO 3 - STREAM VALLEY PROTECTION

(acres)

DNR 12-Diget Watersheds	Undeveloped Land					Developed Land				TOTAL AREA	Total Impervious	Percent Impervious
	Forest	Agriculture	Grassland	Barren	Water/ Wetland	Low Density Pervious	Low Density Impervious	High Density Pervious	High Density Impervious			
021401110788	2969.95	0.00	648.71	0.00	10.16	728.30	317.38	123.04	376.45	5174.00	693.84	13.41%
021401110787	930.32	0.00	2.85	0.00	0.00	2573.29	519.83	458.15	1060.55	5545.00	1580.39	28.50%
021401110786	2226.53	0.00	0.00	0.00	12.08	2316.44	632.62	220.06	743.55	6151.29	1376.18	22.37%
021401110785	749.68	0.00	0.00	0.00	41.08	2488.48	1172.97	215.30	611.90	5279.41	1784.87	33.81%
021401110784	5338.76	0.00	17.94	0.00	20.16	6408.83	1081.16	108.54	410.28	13385.67	1491.44	11.14%
021401110783	2325.82	0.00	0.00	0.00	0.00	1549.48	252.24	103.21	243.44	4474.20	495.68	11.08%
021401110782	664.84	0.00	0.00	0.00	4.47	1004.31	163.49	0.00	0.00	1837.12	163.49	8.90%
021401110781	3656.22	0.00	0.00	0.00	31.99	4415.46	829.06	137.77	474.13	9544.64	1303.19	13.65%
Total (781-788)	18862.13	0.00	669.50	0.00	119.94	21484.60	4968.76	1366.08	3920.32	51391.32	8889.07	17.30%
Gage (783-788)	14541.06	0.00	669.50	0.00	83.48	16064.83	3976.21	1228.31	3446.18	40009.57	7422.39	18.55%

Table A-2. Percent Imperviousness for Landuse Categories.

	Mattawoman HSPF Model Landuse Categories	MDP Landuse Categories	MDP Landuse Code	Mattawoman HSPF Model			
				Density (du/acre)	% Imp[1]	Liturature Source[2]	Drainage Connection[3]
Developed Land	Low Density Developed	Low Density Residential	11	1	14.3	CWP	con
		medium density resid	12	4-<8	38	MDP	con
	High Density Developed	high-density residential	13	8+	65	MDP	con
		commercial	14	----	82	MDP	con
		industrial	15	----	70	MDP	con
		institutional	16	----	50	MDP	con
		Transportation	80	----	none	MDP	con
Undeveloped Land	Barren	extractive	17	----	11	MDP	uc
		Barren Land	70	----	none	----	----
		Beaches	71	----	none	----	----
		Bare Exposed Rock	72	----	none	----	----
		Bare Ground	73	----	none	----	----
	Grass	open urban land	18	----	11	MDP	uc
		Pasture	22	----	0	----	----
	Agriculture	large lot agric	191	----	8	MDP	uc
		large lot forest	192	----	none	----	----
		cropland	21	----	0	----	----
		Orchards	23	----	0	----	----
		Feeding Operations	241	----	10	MDP	cu
		Agricultural facilities	242	----	10	MDP	cu
		Row Crops	25	----	0	----	----
	Forest	Deciduous	41				
		Evergreen	42				
		Mixed Forest	43				
		Brush	44				
		Wetlands	60	----	0	----	----
	Water	Water	50	----	0	----	----

Notes:

1 % imp — percent imperviousness for each of the MDP landuse categories was applied to determine the amount of impervious surfaces (IMPLND) and pervious surfaces (PERLND) in the low and high density developed landuse categories used in the HSPF model. MDP landuse categories which wer not

2 CWP — Center for Watershed Protection's report on "Impervious Cover and Land Use in the Chesapeake Bay Watershed" dated January 2001.

MDP — Maryland Department of Planning

3 con — connected impervious surfaces - runoff from connected impervous surfaces is directly connected hydraulically to the drainage system and streams via driveways, streets, stormdrains, etc. All impervious surfaces on developed land were assumed to be connected and included in the HSPF model.

uc — unconnected impervious surfaces - runoff from unconnected surfaces is directed to adjacent pervious surfaces where it infiltrates into the soil substrate. Impervious surfaces on undeveloped land were assumed to be unconnected and were not included in the HSPF model.

Table A-3. Landuse categories associated with Prince George's and Charles County Zoning used for the bulidout scenario.

PG ZONING	Landuse Category
C-M COMMERCIAL COMMUNITY	commercial
C-O COMMERCIAL OFFICE	commercial
C-S-C COMMERCIAL SHOPPING	commercial
ROAD	commercial
E-1-A INST/EMPLOYMENT AREA	institutional
M-X-T MIXED USE	50% high density residential/50% commercial
I-1 LIGHT INDUSTRIAL	industrial
I-2 HEAVY INDUSTRIAL	industrial
I-3 PLANNED INDUSTRIAL	industrial
L-A-C ACTIVITY CENTER	high density residential
O-S OPEN	80%forest/20%grass
R-A RESIDENTIAL AGR	low density residential
R-E RESIDENTIAL ESTATE	low density residential
R-R RESIDENTIAL RURAL	low density residential
R-L RESIDENTIAL LOW	low density residential
R-M RESIDENTIAL MEDIUM	medium density residential
R-S RESIDENTIAL SUBURBAN	medium density residential
V-M VILLAGE	medium density residential

CHARLES ZONING	Landuse Category
CB CENTRAL BUSINESS	commercial
CC COMMUNITY COMMERCIAL	commercial
BP BUSINESS PARK	commercial
CN NEIGHBORHOOD COMMERCIAL	commercial
IG LIGHT NIDUSTRIAL	industrial
IH HEAVY INDUSTRIAL	industrial
RR RESIDENTIAL RURAL	low density residential
RA RESIDENTIAL AGRICULTURAL	low density residential
RL LOW DENSITY RESIDENTIAL	low density residential
RC RURAL CONSERVATION	agriculture/low density residential
RC(D) RURAL CONSERVATION/DEVELOPED	low density residential
PUD PLANNED UNIT DEVELOPMENT	75%commercial/25% medium density residential
RV RESIDENTIAL VILLAGE	low density residential
RO RESIDENTIAL OFFICE	medium density residential
RM RESIDENTIAL MEDIUM	medium density residential
MX MIX USE	high density residential
OUT	forest
PMH PLANNED MOBILE HOME PARK	high density residential
PARK	open urban land /grass

Table A-4. Mattawoman Creek In-Stream Pollutant Loadings at Outlet of 786 (center of watershed).

Total Loads (May 98 - Feb 01)

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Buildout	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	5899	19550	19324	26146	45552	25446	24655	35507
NH3	1625	3760	3547	4930	8716	4780	4605	6901
TN	21459	53930	59786	70481	101944	69793	69112	81457
PO4	524	5427	6941	11143	14543	11017	10848	10189
TP	1831	5650	6612	7581	10431	7539	7500	8270
SED	249	1317	1242	1672	2666	1607	1527	2148

Mean Monthly Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Buildout	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	281	931	920	1245	2169	1212	1174	1691
NH3	77	179	169	235	415	228	219	329
TN	1022	2568	2847	3356	4854	3323	3291	3879
PO4	25	258	331	531	693	525	517	485
TP	87	269	315	361	497	359	357	394
SED	12	63	59	80	127	77	73	102

Mean Annual Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Buildout	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	3371	11171	11042	14941	26030	14541	14089	20290
NH3	928	2149	2027	2817	4981	2731	2631	3943
TN	12262	30817	34163	40275	58254	39882	39493	46547
PO4	299	3101	3966	6368	8310	6295	6199	5822
TP	1046	3229	3778	4332	5960	4308	4286	4726
SED	142	753	710	955	1523	919	873	1228

Percent Reduction in Loadings for Scenarios

	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	2.7%	5.7%	22.1%
NH3	3.0%	6.6%	20.8%
TN	1.0%	1.9%	20.1%
PO4	1.1%	2.6%	29.9%
TP	0.5%	1.1%	20.7%
SED	3.9%	8.7%	19.4%

Note: Scenarios 1 and 2 are reductions in loadings occuring in 2020 with regulatory and enhanced regulatory compliance, while scenario 3 is the reduction in loading occuring at buildout with stream valley protection.

Table A-5. Mattawoman Creek In-Stream Pollutant Loadings at Outlet of 783 (Calibration Point).

Total Loads (May 98 - Feb 01)

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Buildout	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	10061	30503	34019	56770	87173	55209	53215	62220
NH3	3229	6499	6777	10915	17205	10616	10360	12491
TN	44981	99598	122730	179456	225410	177840	176189	166904
PO4	1221	5427	6941	11143	14543	11017	10848	10189
TP	4188	11312	14648	21601	25833	21483	21408	18853
SED	572	2759	2799	4293	5950	4132	3946	4517
DO	6602	6931	6978	7049	7104	7048	7038	7053

Mean Monthly Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Buildout	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	479	1453	1620	2703	4151	2629	2534	2963
NH3	154	309	323	520	819	506	493	595
TN	2142	4743	5844	8546	10734	8469	8390	7948
PO4	58	258	331	531	693	525	517	485
TP	199	539	698	1029	1230	1023	1019	898
SED	27	131	133	204	283	197	188	215
DO	314	330	332	336	338	336	335	336

Mean Annual Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Buildout	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	5749	17430	19439	32440	49813	31548	30409	35554
NH3	1845	3714	3873	6237	9831	6066	5920	7138
TN	25703	56913	70131	102546	128806	101623	100679	95374
PO4	698	3101	3966	6368	8310	6295	6199	5822
TP	2393	6464	8370	12343	14762	12276	12233	10773
SED	327	1577	1599	2453	3400	2361	2255	2581
DO	3773	3961	3987	4028	4059	4027	4022	4030

Percent Reduction in Loadings for Scenarios

	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	2.7%	6.3%	28.6%
NH3	2.7%	5.1%	27.4%
TN	0.9%	1.8%	26.0%
PO4	1.1%	2.6%	29.9%
TP	0.5%	0.9%	27.0%
SED	3.8%	8.1%	24.1%

Note: Scenarios 1 and 2 are reductions in loadings occuring in 2020 with regulatory and enhanced regulatory compliance, while scenario 3 is the reduction in loading occuring at buildout with stream valley protection.

Table A- 6. Mattawoman Creek In-Stream Pollutant Loadings at Outlet 781 (edge of non-tidal watershed)

Total Loads (May 98 - Feb 01)

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Buildout	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	13604	34689	41507	65364	103617	63753	62140	73638
NH3	4379	7175	8071	11993	19400	11695	11407	13985
TN	59722	118855	156433	226248	287270	224868	223790	210770
PO4	1693	6347	8782	14277	19229	14094	13957	13097
TP	5590	13618	18840	28208	34567	28102	27991	24699
SED	813	3272	3478	5286	7485	5106	4890	5611

Mean Monthly Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Buildout	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	648	1652	1977	3113	4934	3036	2959	3507
NH3	209	342	384	571	924	557	543	666
TN	2844	5660	7449	10774	13680	10708	10657	10037
PO4	81	302	418	680	916	671	665	624
TP	266	648	897	1343	1646	1338	1333	1176
SED	39	156	166	252	356	243	233	267

Mean Annual Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Buildout	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	7773	19822	23718	37351	59210	36430	35509	42079
NH3	2502	4100	4612	6853	11086	6683	6518	7991
TN	34127	67917	89390	129285	164154	128496	127880	120440
PO4	967	3627	5018	8158	10988	8053	7976	7484
TP	3194	7782	10766	16119	19753	16058	15995	14114
SED	464	1870	1987	3021	4277	2918	2794	3206

Percent Reduction in Loadings for Scenarios

	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	2.5%	4.9%	28.9%
NH3	2.5%	4.9%	27.9%
TN	0.6%	1.1%	26.6%
PO4	1.3%	2.2%	31.9%
TP	0.4%	0.8%	28.5%
SED	3.4%	7.5%	25.0%

Note: Scenarios 1 and 2 are reductions in loadings occuring in 2020 with regulatory and enhanced regulatory compliance, while scenario 3 is the reduction in loading occuring at buildout with stream valley protection.

Table A-7. Mattawoman Creek Monthly In-Stream Pollutant Loadings at Outlet of 786.

Scenario	FOREST	MATTA	MOP2000	MOP2020	BUILDOUT	REGCOMP	ENREGCOM	VALLEY
Location	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786
Constituent	NO3L	NO3L	NO3L	NO3L	NO3L	NO3L	NO3L	NO3L
1998/04	292	339	404	426	561	435	442	463
1998/05	456	1230	1260	1630	2690	1590	1540	2040
1998/06	82.1	511	440	685	1320	652	612	993
1998/07	12.6	129	107	186	385	176	163	290
1998/08	11.9	243	185	333	717	311	285	552
1998/09	3.3	290	204	374	825	350	321	614
1998/10	5.4	93.9	70.8	127	330	120	111	231
1998/11	2	449	337	600	1280	563	517	987
1998/12	25.4	820	698	1070	1980	1020	952	1560
1999/01	562	2440	2560	3190	4800	3110	3030	3820
1999/02	742	2090	2140	2850	4860	2790	2730	3880
1999/03	959	2140	2270	2910	4850	2880	2830	3860
1999/04	216	669	582	859	1850	831	818	1390
1999/05	27.3	167	131	221	458	209	194	343
1999/06	7	411	313	578	1240	540	493	933
1999/07	8.7	242	181	332	777	310	288	554
1999/08	102	688	652	961	1800	924	881	1330
1999/09	589	1400	1440	1830	3050	1790	1760	2370
1999/10	325	907	913	1250	2330	1220	1180	1750
1999/11	327	1140	1140	1500	2450	1460	1420	1960
1999/12	946	2030	2220	2710	4260	2690	2670	3410
2000/01	489	1460	1480	1950	3300	1910	1860	2640
2000/02	136	326	352	439	696	435	430	557
Total	5898.7	19549.9	19323.8	26146.0	45552.0	25446.0	24655.0	35507.0
Mean Monthly	280.9	930.9	920.2	1245.0	2169.1	1211.7	1174.0	1690.8
Mean Annual	3370.7	11171.4	11042.2	14940.6	26029.7	14540.6	14088.6	20289.7
Percent Buildou	12.9%	42.9%	42.4%	57.4%	100.0%	55.9%	54.1%	77.9%

Scenario	FOREST	MATTA	MOP2000	MOP2020	BUILDOUT	REGCOMP	ENREGCOM	VALLEY
Location	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786
Constituent	NH4L	NH4L	NH4L	NH4L	NH4L	NH4L	NH4L	NH4L
1998/04	138	142	174	188	262	192	195	212
1998/05	152	321	326	430	728	420	408	565
1998/06	44.4	189	172	246	437	236	224	341
1998/07	10.4	44.8	39.8	61.3	116	58.6	55.4	90.3
1998/08	3.6	65.4	51.5	89.8	187	84.2	77.7	145
1998/09	0.8	79.8	62.4	107	217	101	92.9	169
1998/10	1.9	24	18.9	33.1	68.9	31.1	28.8	52.6
1998/11	0.7	78.7	60.8	105	216	98.8	90.8	167
1998/12	5.6	109	88.9	146	287	138	128	223
1999/01	120	321	306	421	724	409	393	578
1999/02	174	303	292	395	688	386	376	553
1999/03	255	326	330	421	709	415	410	571
1999/04	81.8	183	175	241	433	234	226	340
1999/05	15.1	51.5	46.3	69.5	131	66.5	63.1	102
1999/06	5.5	129	102	176	357	165	152	276
1999/07	4.9	74.9	59.8	102	207	95.7	88.4	160
1999/08	22.8	197	185	262	448	251	238	350
1999/09	169	340	329	434	734	425	414	579
1999/10	183	266	265	345	581	338	332	467
1999/11	90.2	186	177	240	414	234	226	334
1999/12	195	281	282	359	594	354	350	486
2000/01	88.8	190	178	246	439	239	231	352
2000/02	31.1	42.4	43.1	54.7	91.4	54.1	53.3	74.1
Total	1624.5	3760.1	3547.4	4929.7	8715.9	4779.9	4605.1	6900.9
Mean Monthly	77.4	179.1	168.9	234.7	415.0	227.6	219.3	328.6
Mean Annual	928.3	2148.6	2027.1	2817.0	4980.5	2731.4	2631.5	3943.4
Percent Buildou	18.6%	43.1%	40.7%	56.6%	100.0%	54.8%	52.8%	79.2%

Table A-7. Mattawoman Creek Monthly In-Stream Pollutant Loadings at Outlet of 786.

Scenario	FOREST	MATTA	MOP2000	MOP2020	BUILDOUT	REGCOMP	ENREGCOM	VALLEY
Location	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786
Constituent	TNLD	TNLD	TNLD	TNLD	TNLD	TNLD	TNLD	TNLD
1998/04	1390	2150	2700	2760	3200	2810	2840	2660
1998/05	2100	4870	5650	6260	8170	6230	6220	6520
1998/06	587	1990	2160	2580	3680	2540	2490	2900
1998/07	118	466	481	640	1040	624	605	813
1998/08	34	542	443	732	1470	691	641	1150
1998/09	7.6	563	421	737	1550	692	637	1180
1998/10	15.8	193	163	260	564	247	232	415
1998/11	5.8	732	568	975	2010	917	845	1550
1998/12	66.9	1340	1230	1730	2910	1650	1560	2290
1999/01	1630	5490	6230	6980	8810	6900	6810	7080
1999/02	2230	4820	5370	6420	9560	6360	6330	7730
1999/03	3600	6630	7760	8740	12100	8770	8810	9830
1999/04	978	2240	2420	2910	4600	2890	2880	3630
1999/05	173	592	607	777	1220	759	738	959
1999/06	62.2	941	810	1290	2480	1230	1150	1910
1999/07	51.4	561	493	770	1520	733	694	1140
1999/08	489	2140	2400	2950	4450	2900	2850	3430
1999/09	2400	5000	5760	6470	8810	6470	6470	7120
1999/10	1880	3910	4560	5090	6880	5080	5090	5500
1999/11	1140	2930	3250	3750	5170	3720	3680	4190
1999/12	2620	4950	5730	6450	8910	6460	6500	7250
2000/01	1270	3030	3280	3970	6040	3930	3880	4870
2000/02	404	814	943	1070	1480	1070	1070	1200
Total	21458.7	53930.0	59786.0	70481.0	101944.0	69793.0	69112.0	81457.0
Mean Monthly	1021.8	2568.1	2847.0	3356.2	4854.5	3323.5	3291.0	3878.9
Mean Annual	12262.1	30817.1	34163.4	40274.9	58253.7	39881.7	39492.6	46546.9
Percent Buildou	21.0%	52.9%	58.6%	69.1%	100.0%	68.5%	67.8%	79.9%

Scenario	FOREST	MATTA	MOP2000	MOP2020	BUILDOUT	REGCOMP	ENREGCOM	VALLEY
Location	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786
Constituent	PO4L	PO4L	PO4L	PO4L	PO4L	PO4L	PO4L	PO4L
1998/04	33	83.4	116	118	139	120	122	106
1998/05	50.8	259	311	368	540	365	362	410
1998/06	12.4	125	128	169	277	164	158	213
1998/07	2.3	28.3	27.6	38.9	68.1	37.4	35.7	52.6
1998/08	0.8	39.4	31.9	52.8	105	49.8	46.1	82.6
1998/09	0.2	44.6	35.6	59.4	118	56	51.7	92.6
1998/10	0.4	14.7	12.3	19.8	38.4	18.7	17.4	29.9
1998/11	0.1	44.3	35.5	58.3	115	55	50.8	90.1
1998/12	1.2	69.2	63.1	89.5	152	85.3	80.1	119
1999/01	36.6	260	301	347	458	342	336	356
1999/02	49.2	205	237	291	453	288	285	350
1999/03	91	295	379	438	631	439	442	484
1999/04	20.8	110	120	155	253	152	148	194
1999/05	3.2	31.9	31.9	43.6	74.1	42.1	40.3	57.1
1999/06	1.1	75.7	62.9	102	196	96	89	153
1999/07	1	44.9	38.4	60.5	115	57.4	53.5	90
1999/08	18.2	147	161	211	348	207	202	267
1999/09	70.8	306	369	439	663	438	437	508
1999/10	51.8	204	246	285	403	283	282	310
1999/11	27.1	139	160	190	271	187	185	210
1999/12	59.4	209	256	297	427	297	297	331
2000/01	25.6	124	138	173	275	171	168	212
2000/02	8.4	31.5	38.9	45	64.9	45	44.9	49.7
Total	524.0	2776.0	3145.2	3887.8	5980.6	3830.7	3766.6	4611.9
Mean Monthly	25.0	132.2	149.8	185.1	284.8	182.4	179.4	219.6
Mean Annual	299.4	1586.3	1797.3	2221.6	3417.5	2189.0	2152.3	2635.4
Percent Buildou	8.8%	46.4%	52.6%	65.0%	100.0%	64.1%	63.0%	77.1%

Table A-7. Mattawoman Creek Monthly In-Stream Pollutant Loadings at Outlet of 786.

Scenario	FOREST	MATTA	MOP2000	MOP2020	BUILDOUT	REGCOMP	ENREGCOM	VALLEY
Location	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786
Constituent	TPLD	TPLD	TPLD	TPLD	TPLD	TPLD	TPLD	TPLD
1998/04	124	242	316	321	363	326	330	293
1998/05	190	572	695	764	989	763	764	780
1998/06	56.4	248	276	326	460	321	315	362
1998/07	11.4	56.3	59.6	76.3	119	74.6	72.6	93.7
1998/08	2.5	61.4	51.5	81.8	158	77.5	72.2	124
1998/09	0.5	62.4	49.8	82.8	164	78.1	72.2	129
1998/10	1.2	21.9	19.3	29.2	53.8	27.9	26.2	42.3
1998/11	0.4	63.1	51.2	83.2	161	78.5	72.6	127
1998/12	4.6	108	104	137	211	132	125	166
1999/01	125	513	613	659	762	655	650	605
1999/02	172	431	511	587	824	586	587	657
1999/03	313	684	861	943	1240	950	962	988
1999/04	85.1	242	278	326	470	324	322	372
1999/05	15.9	67.7	73.2	90	134	88.3	86.3	106
1999/06	5.9	114	101	153	279	146	137	219
1999/07	4.7	68.1	62.6	92.4	166	88.5	83.6	130
1999/08	52.1	264	306	371	552	367	362	430
1999/09	229	618	751	841	1140	843	846	905
1999/10	180	461	563	612	774	614	617	617
1999/11	94.4	288	340	377	485	375	374	387
1999/12	197	454	556	611	802	614	619	643
2000/01	90.2	252	290	338	487	336	334	387
2000/02	30.7	73.6	90.5	99.1	129	99.5	100	103
Total	1831.3	5649.9	6612.2	7580.7	10430.8	7539.4	7499.7	8270.0
Mean Monthly	87.2	269.0	314.9	361.0	496.7	359.0	357.1	393.8
Mean Annual	1046.5	3228.5	3778.4	4331.8	5960.5	4308.2	4285.5	4725.7
Percent Buildou	17.6%	54.2%	63.4%	72.7%	100.0%	72.3%	71.9%	79.3%

Scenario	FOREST	MATTA	MOP2000	MOP2020	BUILDOUT	REGCOMP	ENREGCOM	VALLEY
Location	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786	SEG_786
Constituent	SEDL	SEDL	SEDL	SEDL	SEDL	SEDL	SEDL	SEDL
1998/04	1.8	1.5	1.6	1.5	1.2	1.5	1.6	1.3
1998/05	21.1	189	182	233	343	224	212	274
1998/06	2.9	119	117	149	212	143	135	168
1998/07	0.1	20.2	16.1	26.7	52.7	25.1	23.2	41.6
1998/08	0	44.7	35.6	59	117	55.6	51.3	92.3
1998/09	0	25.7	20.2	34	68.1	32	29.5	53.5
1998/10	0	1.8	1.7	2.4	4.2	2.3	2.1	3.4
1998/11	0	4.3	3.4	5.6	11.4	5.3	4.9	8.9
1998/12	0	13.8	11.2	18.1	35	17	15.7	27.6
1999/01	2.9	90.6	86.9	114	170	109	103	135
1999/02	3.8	20.7	18.8	26.8	45.7	25.7	24.2	36.8
1999/03	19.1	53.8	49.5	66.9	112	64.7	62	91.7
1999/04	1.5	34.5	28.9	45.6	85.4	43.2	40.1	67.7
1999/05	0.1	3.9	3.1	5.1	10.1	4.8	4.4	7.9
1999/06	0	46.7	36.9	61.8	123	58.2	53.6	97
1999/07	0	31.5	25.5	42.1	81.6	39.7	36.7	64.5
1999/08	139	324	341	407	554	399	390	461
1999/09	47.7	207	189	264	441	253	240	358
1999/10	2.2	16.3	13.9	21	38	19.9	18.6	30.5
1999/11	1.5	35.4	30.9	45.6	80.2	43.4	40.5	63.7
1999/12	5.4	20.5	18.1	26.3	48	25.3	24.1	38.7
2000/01	1.2	14	12	18.1	33.2	17.2	16.1	26.4
2000/02	0.2	0.5	0.5	0.6	1	0.6	0.6	0.9
Total	248.5	1317.4	1241.7	1672.1	2665.6	1607.4	1527.0	2148.2
Mean Monthly	11.8	62.7	59.1	79.6	126.9	76.5	72.7	102.3
Mean Annual	142.0	752.8	709.5	955.5	1523.2	918.5	872.6	1227.5
Percent Buildou	9.3%	49.4%	46.6%	62.7%	100.0%	60.3%	57.3%	80.6%

Table A-8. Mattawoman Creek Monthly In-Stream Pollutant Loadings at Outlet of 783 (Calibration Point).

Scenario	FOREST	MATTA	MOP2000	MOP2020	BUILDOUT	REGCOMP	ENREGCOM	VALLEY
Location	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5
Constituent	NO3L	NO3L	NO3L	NO3L	NO3L	NO3L	NO3L	NO3L
1998/04	396	408	509	707	847	718	726	623
1998/05	414	1010	1140	2030	3310	1970	1880	2300
1998/06	77.1	414	442	951	1650	873	818	1050
1998/07	6	112	108	232	439	217	207	301
1998/08	6.3	189	181	465	910	413	376	644
1998/09	8.2	248	250	532	1230	484	431	748
1998/10	10.5	78.5	71	290	786	251	210	411
1998/11	4.6	664	548	1300	2460	1210	1100	1730
1998/12	53.6	1610	1540	2680	4270	2560	2380	3130
1999/01	1230	4840	5600	8650	11100	8450	8210	8170
1999/02	1590	4330	4860	7630	11400	7490	7340	8390
1999/03	1550	3730	4360	6990	10500	6910	6740	7440
1999/04	268	820	824	1800	3250	1720	1540	2330
1999/05	18.1	104	99.7	345	798	295	245	493
1999/06	2.5	385	355	876	1810	817	738	1180
1999/07	2.9	213	207	539	1190	501	434	763
1999/08	82.9	512	537	1010	1660	978	956	1220
1999/09	358	863	956	1720	3040	1660	1540	1970
1999/10	437	1080	1230	2400	4080	2300	2210	2630
1999/11	631	2060	2290	3590	5180	3510	3420	3860
1999/12	2170	4200	5040	7500	10400	7460	7420	7720
2000/01	1140	3040	3380	5240	7710	5140	5020	5740
2000/02	305	719	824	1260	1760	1240	1230	1300
Total	10060.7	30502.5	34018.7	56770.0	87173.0	55209.0	53215.0	62220.0
Mean Monthly	479.1	1452.5	1619.9	2703.3	4151.1	2629.0	2534.0	2962.9
Mean Annual	5749.0	17430.0	19439.3	32440.0	49813.1	31548.0	30408.6	35554.3
Percent Buildout	11.5%	35.0%	39.0%	65.1%	100.0%	63.3%	61.0%	71.4%

Scenario	FOREST	MATTA	MOP2000	MOP2020	BUILDOUT	REGCOMP	ENREGCOM	VALLEY
Location	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5
Constituent	NH4L	NH4L	NH4L	NH4L	NH4L	NH4L	NH4L	NH4L
1998/04	278	256	328	462	590	470	477	427
1998/05	295	535	601	969	1430	949	933	1000
1998/06	75.6	286	302	531	813	508	490	573
1998/07	13.8	63.1	64.6	118	203	110	105	140
1998/08	3.6	97.7	87.1	172	310	161	153	221
1998/09	1.9	127	104	211	376	199	189	281
1998/10	4	42.4	36.9	71.1	158	71.6	67.4	95.3
1998/11	1.6	127	112	218	412	213	201	286
1998/12	6.1	178	164	313	549	300	286	388
1999/01	245	591	614	971	1480	943	922	1100
1999/02	359	566	591	905	1440	884	868	1060
1999/03	531	597	661	959	1460	949	941	1080
1999/04	152	301	321	531	827	516	504	597
1999/05	21.3	67.2	64.9	137	233	131	118	160
1999/06	6.6	197	184	363	666	348	325	468
1999/07	5	110	98.8	210	384	191	186	263
1999/08	53.9	295	310	527	813	509	500	568
1999/09	328	612	669	1030	1470	1010	991	1100
1999/10	374	490	522	783	1200	768	756	888
1999/11	174	342	352	530	826	516	506	623
1999/12	406	531	569	823	1280	812	804	951
2000/01	172	344	349	543	875	527	515	649
2000/02	56.5	75.1	78.8	117	180	115	113	134
Total	3229.4	6499.4	6777.3	10915.1	17205.0	10615.6	10360.4	12491.3
Mean Monthly	153.8	309.5	322.7	519.8	819.3	505.5	493.4	594.8
Mean Annual	1845.4	3713.9	3872.7	6237.2	9831.4	6066.1	5920.2	7137.9
Percent Buildout	18.8%	37.8%	39.4%	63.4%	100.0%	61.7%	60.2%	72.6%

Table A-8. Mattawoman Creek Monthly In-Stream Pollutant Loadings at Outlet of 783 (Calibration Point).

Scenario	FOREST	MATTA	MOP2000	MOP2020	BUILDOUT	REGCOMP	ENREGCOM	VALLEY
Location	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5
Constituent	TNLD	TNLD	TNLD	TNLD	TNLD	TNLD	TNLD	TNLD
1998/04	2900	4200	5680	7470	7910	7570	7650	6050
1998/05	4190	8390	10900	15100	17100	15100	15100	12800
1998/06	1190	3300	4150	6250	7340	6140	6070	5300
1998/07	194	683	796	1310	1820	1280	1250	1310
1998/08	38	723	677	1360	2400	1260	1170	1740
1998/09	18.8	718	676	1340	2590	1250	1140	1770
1998/10	32.3	265	260	616	1390	560	499	794
1998/11	13.6	1170	1010	2170	3970	2030	1860	2810
1998/12	119	2490	2520	4290	6170	4110	3880	4520
1999/01	3640	10800	13500	19400	20900	19200	19000	15600
1999/02	4990	10100	12200	17700	23400	17600	17500	17500
1999/03	7670	13300	17000	23800	29500	23800	23900	22000
1999/04	1980	4030	4930	7520	10000	7440	7280	7440
1999/05	284	820	973	1670	2420	1600	1540	1680
1999/06	87.3	1330	1300	2550	4370	2410	2260	3040
1999/07	65.6	779	798	1560	2730	1480	1370	1880
1999/08	978	3220	4130	6260	7710	6200	6160	5680
1999/09	4140	7990	10200	14400	17200	14400	14300	12800
1999/10	3970	7320	9450	13400	15800	13400	13400	11600
1999/11	2450	5650	6910	9860	11800	9780	9710	8940
1999/12	6030	10300	13000	18200	22500	18200	18300	16900
2000/01	2900	6220	7350	10700	14300	10600	10500	10800
2000/02	904	1720	2130	3010	3700	3010	3010	2790
Total	44980.6	99598.0	122730.0	179456.0	225410.0	177840.0	176189.0	166904.0
Mean Monthly	2141.9	4742.8	5844.3	8545.5	10733.8	8468.6	8390.0	7947.8
Mean Annual	25703.2	56913.1	70131.4	102546.3	128805.7	101622.9	100679.4	95373.7
Percent Buildout	20.0%	44.2%	54.4%	79.6%	100.0%	78.9%	78.2%	74.0%

Scenario	FOREST	MATTA	MOP2020	MOP2000	BUILDOUT	REGCOMP	ENREGCOM	VALLEY
Location	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5
Constituent	PO4L	PO4L	PO4L	PO4L	PO4L	PO4L	PO4L	PO4L
1998/04	73.7	154	243	364	376	369	373	253
1998/05	119	494	681	1100	1340	1090	1080	912
1998/06	24.8	236	280	471	634	458	444	447
1998/07	3.8	52.4	59.1	101	149	96.5	95.6	104
1998/08	0.8	77.8	70.9	130	222	122	112	160
1998/09	0.4	90.4	77.9	143	234	135	128	182
1998/10	0.8	33.4	30.9	53.2	104	52.2	47.8	65.5
1998/11	0.3	88.6	79.5	141	244	137	123	177
1998/12	1.4	126	129	222	322	215	200	233
1999/01	82.5	495	643	989	1090	976	962	777
1999/02	111	403	520	833	1120	826	819	783
1999/03	209	578	831	1290	1640	1300	1300	1130
1999/04	43	202	248	421	581	413	406	402
1999/05	5	55.2	61.1	111	155	108	99.7	109
1999/06	1.6	143	137	249	415	238	220	299
1999/07	1.4	91.1	87.1	157	255	147	140	183
1999/08	48.4	304	384	635	901	625	617	611
1999/09	197	650	887	1380	1750	1380	1370	1240
1999/10	121	391	527	830	1000	825	822	694
1999/11	58.9	267	344	535	647	529	523	457
1999/12	136	414	567	873	1090	871	872	767
2000/01	54.6	235	296	479	650	473	467	456
2000/02	17.1	60.5	81.2	130	161	129	129	111
Total	1220.7	5426.9	6940.5	11143.2	14543.0	11016.7	10848.1	10188.5
Mean Monthly	58.1	258.4	330.5	530.6	692.5	524.6	516.6	485.2
Mean Annual	697.5	3101.1	3966.0	6367.5	8310.3	6295.3	6198.9	5822.0
Percent Buildout	8.4%	37.3%	47.7%	76.6%	100.0%	75.8%	74.6%	70.1%

Table A-8. Mattawoman Creek Monthly In-Stream Pollutant Loadings at Outlet of 783 (Calibration Point).

Scenario	FOREST	MATTA	MOP2000	MOP2020	BUILDOUT	REGCOMP	ENREGCOM	VALLEY
Location	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5
Constituent	TPLD	TPLD	TPLD	TPLD	TPLD	TPLD	TPLD	TPLD
1998/04	285	491	703	960	988	972	982	729
1998/05	447	1140	1550	2240	2510	2240	2240	1810
1998/06	124	487	608	928	1100	914	901	801
1998/07	20.8	102	119	193	262	188	185	188
1998/08	3.6	120	110	198	332	187	174	242
1998/09	1.2	122	108	197	323	187	175	249
1998/10	2.5	47.1	45.5	77.5	146	74.7	69.2	92.9
1998/11	1	124	112	203	345	193	177	251
1998/12	7.4	193	207	345	450	333	315	327
1999/01	286	995	1320	1900	1870	1890	1880	1370
1999/02	395	887	1150	1690	2090	1680	1690	1530
1999/03	728	1420	1950	2770	3270	2790	2820	2400
1999/04	192	480	611	914	1140	908	905	832
1999/05	29.1	119	140	225	289	221	215	209
1999/06	9.4	215	209	373	593	356	335	431
1999/07	7.1	135	135	234	363	223	212	264
1999/08	127	525	683	1060	1370	1050	1040	967
1999/09	517	1260	1700	2460	2930	2470	2470	2150
1999/10	414	933	1250	1790	1990	1790	1800	1460
1999/11	214	571	742	1070	1190	1060	1060	874
1999/12	458	935	1260	1790	2090	1790	1810	1540
2000/01	204	502	638	943	1180	938	935	865
2000/02	68.9	149	198	284	327	285	287	240
Total	4188.1	11312.1	14647.5	21600.5	25833.0	21482.7	21408.2	18852.9
Mean Monthly	199.4	538.7	697.5	1028.6	1230.1	1023.0	1019.4	897.8
Mean Annual	2393.2	6464.1	8370.0	12343.1	14761.7	12275.8	12233.3	10773.1
Percent Buildout	16.2%	43.8%	56.7%	83.6%	100.0%	83.2%	82.9%	73.0%

Scenario	FOREST	MATTA	MOP2000	MOP2020	BUILDOUT	REGCOMP	ENREGCOM	VALLEY
Location	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5	LMATTA5
Constituent	SEDL	SEDL	SEDL	SEDL	SEDL	SEDL	SEDL	SEDL
1998/04	6.6	5.6	5.6	5.1	4.1	5.2	5.2	4.7
1998/05	44.2	377	397	604	745	582	556	561
1998/06	7.6	241	258	396	467	381	363	348
1998/07	0	42.1	37.5	67.7	116	63.8	59.1	85.6
1998/08	0	94.6	84.1	150	253	142	132	188
1998/09	0	48.4	42	78.3	111	73.9	68.9	98.6
1998/10	0	8.9	8.8	14.5	45.5	13.5	12	18.3
1998/11	0	8.6	7.5	14.3	25.4	13.4	12.3	18.3
1998/12	0	28.9	26.2	47.6	80.8	44.8	41.5	58.5
1999/01	9.6	190	198	306	383	294	280	285
1999/02	12.2	49.2	47.3	70.9	106	68	64.6	81.4
1999/03	47.9	118	117	172	254	167	161	197
1999/04	3.9	74.1	68	117	188	110	103	141
1999/05	0.1	7.8	6.9	12.7	22.3	12	11.1	16.2
1999/06	0	92.4	81.8	153	265	144	133	195
1999/07	0	71.4	64	112	184	106	98.2	138
1999/08	324	694	760	1040	1290	1020	1000	1010
1999/09	90.5	418	408	639	959	612	581	727
1999/10	7.2	38.9	36.3	57.8	89.4	55.2	52.1	69.3
1999/11	4.5	77.9	75.3	120	177	114	108	137
1999/12	16.5	46.6	45.3	70.3	112	67.8	64.9	85.2
2000/01	3.6	31.6	30.1	49.4	76.4	47.1	44.4	58.2
2000/02	0.4	1.3	1.2	1.8	2.7	1.7	1.6	2.1
Total	571.8	2759.4	2799.1	4292.5	5949.8	4131.5	3946.1	4516.6
Mean Monthly	27.2	131.4	133.3	204.4	283.3	196.7	187.9	215.1
Mean Annual	326.7	1576.8	1599.5	2452.9	3399.9	2360.9	2254.9	2580.9
Percent Buildout	9.6%	46.4%	47.0%	72.1%	100.0%	69.4%	66.3%	75.9%

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Table A-9. Mattawoman Creek Monthly In-Stream Pollutant Loadings at Outlet of 781 (non-tidal watershed).

Scenario	FOREST	MATTA	MOP2000	MOP2020	BUILDOUT	REGCOMP	ENREGCOM	VALLEY
Location	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781
Constituent	NO3L	NO3L	NO3L	NO3L	NO3L	NO3L	NO3L	NO3L
1998/04	480	516	688	929	1400	932	934	962
1998/05	620	981	1290	1850	3240	1820	1790	2100
1998/06	225	499	611	1010	1740	975	941	1200
1998/07	62.9	156	196	296	511	288	284	366
1998/08	22	174	194	381	790	348	325	563
1998/09	10.8	212	227	430	1050	394	360	671
1998/10	14.7	103	110	339	874	296	223	512
1998/11	6.2	718	652	1460	2860	1320	1180	2070
1998/12	76.5	1860	1870	3190	5410	3060	2870	3890
1999/01	1430	5660	6850	10700	14300	10400	10200	10300
1999/02	2020	4970	5870	8940	14000	8780	8600	10200
1999/03	1650	3820	4690	7710	13400	7560	7360	9300
1999/04	502	921	1050	1750	3350	1690	1650	2290
1999/05	93.8	198	243	477	837	449	422	577
1999/06	48.7	382	435	683	1250	672	642	919
1999/07	35.9	244	271	519	925	494	453	700
1999/08	120	441	538	859	1430	827	810	1020
1999/09	625	1000	1310	1900	2950	1830	1830	2020
1999/10	712	1140	1500	2480	4460	2410	2320	2930
1999/11	828	2310	2690	4240	6240	4150	4060	4520
1999/12	2960	5230	6610	9600	14000	9560	9520	10100
2000/01	1540	3670	4300	6550	10000	6430	6300	7390
2000/02	418	875	1060	1600	2470	1580	1560	1730
Total	13603.5	34689.0	41507.0	65364.0	103617.0	63753.0	62140.0	73638.0
Mean Monthly	647.8	1651.9	1976.5	3112.6	4934.1	3035.9	2959.0	3506.6
Mean Annual	7773.4	19822.3	23718.3	37350.9	59209.7	36430.3	35508.6	42078.9
Percent Buildout	13.1%	33.5%	40.1%	63.1%	100.0%	61.5%	60.0%	71.1%

Scenario	FOREST	MATTA	MOP2000	MOP2020	BUILDOUT	REGCOMP	ENREGCOM	VALLEY
Location	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781
Constituent	NH4L	NH4L	NH4L	NH4L	NH4L	NH4L	NH4L	NH4L
1998/04	342	316	420	576	816	584	589	568
1998/05	405	569	715	1010	1530	991	976	1060
1998/06	116	315	359	598	932	577	556	661
1998/07	26.9	76.6	86.8	142	245	136	134	172
1998/08	7.2	96.2	92	170	323	160	147	231
1998/09	2.5	104	96.5	184	370	173	162	263
1998/10	5.4	64.3	57.7	109	219	108	98.9	151
1998/11	2.2	137	127	236	457	231	205	325
1998/12	13.7	192	191	332	592	321	296	423
1999/01	328	630	696	1040	1630	1020	992	1200
1999/02	499	635	705	996	1650	979	963	1210
1999/03	656	678	792	1080	1730	1070	1060	1250
1999/04	208	334	392	594	968	582	570	689
1999/05	37.8	88.2	96.8	179	297	172	160	212
1999/06	17.4	201	206	341	621	330	308	448
1999/07	12.9	120	118	236	440	219	207	310
1999/08	70.1	298	344	562	846	537	536	593
1999/09	411	661	792	1130	1590	1080	1070	1120
1999/10	523	579	652	896	1420	884	875	1040
1999/11	234	380	419	589	950	578	566	713
1999/12	548	629	714	969	1570	960	953	1160
2000/01	255	388	419	600	1020	587	572	754
2000/02	78.3	97.6	109	152	257	149	147	185
Total	4379.1	7175.3	8070.8	11993.0	19400.0	11695.0	11406.9	13985.0
Mean Monthly	208.5	341.7	384.3	571.1	923.8	556.9	543.2	666.0
Mean Annual	2502.3	4100.2	4611.9	6853.1	11085.7	6682.9	6518.2	7991.4
Percent Buildout	22.6%	37.0%	41.6%	61.8%	100.0%	60.3%	58.8%	72.1%

Table A-9. Mattawoman Creek Monthly In-Stream Pollutant Loadings at Outlet of 781 (non-tidal watershed).

Scenario	FOREST	MATTA	MOP2000	MOP2020	BUILDOUT	REGCOMP	ENREGCOM	VALLEY
Location	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781
Constituent	TNLD	TNLD	TNLD	TNLD	TNLD	TNLD	TNLD	TNLD
1998/04	3750	5260	7480	10000	11100	10100	10200	8310
1998/05	5550	10000	14000	19400	21800	19500	19600	15900
1998/06	1710	3950	5370	7950	9270	7890	7840	6720
1998/07	340	862	1120	1720	2390	1700	1670	1720
1998/08	74.3	780	799	1420	2610	1340	1260	1890
1998/09	24.8	634	640	1160	2400	1090	1000	1650
1998/10	44.5	415	424	908	1890	838	730	1220
1998/11	18.2	1290	1200	2470	4670	2270	2070	3360
1998/12	186	2890	3130	5280	7770	5090	4840	5600
1999/01	4620	12800	17000	25100	27300	24800	24600	20000
1999/02	6470	11900	15300	21800	29600	21700	21600	21900
1999/03	9650	15800	21300	30100	39400	30100	30200	29000
1999/04	2790	4850	6400	9200	12400	9150	9140	9000
1999/05	477	1090	1420	2250	3040	2210	2170	2190
1999/06	194	1470	1630	2660	4260	2580	2480	3110
1999/07	143	934	1050	1850	3020	1780	1690	2200
1999/08	1270	3570	5020	7580	9350	7530	7500	6710
1999/09	5550	9610	13100	18200	21500	18200	18300	16000
1999/10	5440	8960	12400	17400	20600	17400	17400	15100
1999/11	3250	6680	8660	12500	15100	12400	12400	11200
1999/12	8040	12800	17000	23600	30200	23700	23800	22300
2000/01	3880	7570	9470	13700	18700	13600	13500	14000
2000/02	1220	2130	2790	3950	5200	3940	3940	3750
Total	59721.8	118855.0	156433.0	226248.0	287270.0	224868.0	223790.0	210770.0
Mean Monthly	2843.9	5659.8	7449.2	10773.7	13679.5	10708.0	10656.7	10036.7
Mean Annual	34126.7	67917.1	89390.3	129284.6	164154.3	128496.0	127880.0	120440.0
Percent Buildout	20.8%	41.4%	54.5%	78.8%	100.0%	78.3%	77.9%	73.4%

Scenario	FOREST	MATTA	MOP2000	MOP2020	BUILDOUT	REGCOMP	ENREGCOM	VALLEY
Location	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781
Constituent	PO4L	PO4L	PO4L	PO4L	PO4L	PO4L	PO4L	PO4L
1998/04	97	184	315	490	522	496	500	342
1998/05	172	575	868	1390	1760	1380	1380	1160
1998/06	35.6	272	349	598	830	583	567	568
1998/07	6.3	61.9	75.2	130	198	125	123	136
1998/08	1.6	88.8	84.7	153	281	145	133	199
1998/09	0.5	82.6	75.8	131	238	124	117	175
1998/10	1.2	55.6	51.5	96.1	183	92.6	85.3	126
1998/11	0.5	99.3	92.9	164	303	158	143	217
1998/12	3	143	157	277	408	268	250	289
1999/01	115	572	811	1300	1440	1280	1270	998
1999/02	155	465	648	1040	1450	1030	1030	991
1999/03	280	686	1060	1680	2240	1680	1690	1500
1999/04	57	232	311	530	765	521	512	514
1999/05	8.2	64.8	78.6	144	207	140	132	143
1999/06	3.9	159	163	282	494	271	253	350
1999/07	3.1	107	107	200	353	187	177	246
1999/08	68.7	361	492	822	1190	804	802	794
1999/09	269	769	1130	1780	2310	1760	1770	1570
1999/10	168	473	690	1110	1380	1110	1100	925
1999/11	78.1	312	437	698	862	691	685	594
1999/12	187	492	725	1140	1480	1140	1140	1010
2000/01	78.9	276	375	612	857	604	598	592
2000/02	22.8	70.7	104	170	225	169	169	147
Total	1692.6	6347.0	8781.7	14277.1	19229.0	14093.6	13957.3	13097.0
Mean Monthly	80.6	302.2	418.2	679.9	915.7	671.1	664.6	623.7
Mean Annual	967.2	3626.9	5018.1	8158.3	10988.0	8053.5	7975.6	7484.0
Percent Buildout	8.8%	33.0%	45.7%	74.2%	100.0%	73.3%	72.6%	68.1%

Table A-9. Mattawoman Creek Monthly In-Stream Pollutant Loadings at Outlet of 781 (non-tidal watershed).

Scenario	FOREST	MATTA	MOP2000	MOP2020	BUILDOUT	REGCOMP	ENREGCOM	VALLEY
Location	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781
Constituent	TPLD	TPLD	TPLD	TPLD	TPLD	TPLD	TPLD	TPLD
1998/04	375	606	922	1290	1370	1310	1320	986
1998/05	596	1380	2010	2960	3380	2960	2970	2390
1998/06	167	574	770	1200	1460	1190	1170	1040
1998/07	30.5	123	155	253	353	247	243	249
1998/08	5.9	138	134	235	421	223	208	302
1998/09	1.6	112	105	181	328	172	161	240
1998/10	3.4	79.1	76.1	140	257	134	124	179
1998/11	1.4	140	133	237	428	225	207	307
1998/12	12.3	223	259	443	573	429	408	410
1999/01	382	1180	1690	2540	2490	2530	2520	1790
1999/02	522	1060	1470	2150	2740	2150	2150	1970
1999/03	961	1750	2550	3670	4510	3690	3720	3230
1999/04	256	577	785	1180	1530	1180	1170	1090
1999/05	42	143	183	297	390	292	285	277
1999/06	16.3	245	257	438	718	420	399	515
1999/07	12.2	162	171	304	509	290	276	360
1999/08	168	619	866	1380	1830	1360	1360	1260
1999/09	687	1520	2160	3190	3890	3190	3190	2790
1999/10	558	1160	1660	2430	2770	2430	2440	1980
1999/11	284	686	955	1410	1590	1410	1410	1150
1999/12	609	1140	1630	2350	2830	2360	2370	2040
2000/01	274	607	821	1220	1570	1220	1210	1130
2000/02	92.1	182	258	378	459	378	380	322
Total	5589.6	13618.1	18840.1	28208.0	34567.0	28102.0	27991.0	24699.0
Mean Monthly	266.2	648.5	897.1	1343.2	1646.0	1338.2	1332.9	1176.1
Mean Annual	3194.1	7781.8	10765.8	16118.9	19752.6	16058.3	15994.9	14113.7
Percent Buildout	16.2%	39.4%	54.5%	81.6%	100.0%	81.3%	81.0%	71.5%

Scenario	FOREST	MATTA	MOP2000	MOP2020	BUILDOUT	REGCOMP	ENREGCOM	VALLEY
Location	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781	SEG_781
Constituent	SEDL	SEDL	SEDL	SEDL	SEDL	SEDL	SEDL	SEDL
1998/04	9	9	9	9.2	9.3	9.2	9.2	9.2
1998/05	65.6	444	496	767	936	742	712	696
1998/06	12.6	276	315	501	584	484	463	428
1998/07	0.8	48.6	44.8	78.2	143	73.8	68.6	104
1998/08	0	106	98	172	315	162	151	230
1998/09	0	28.2	27	38.7	61.7	37.1	35.3	50.8
1998/10	0	37	32.7	67.3	134	62.7	57.3	90.9
1998/11	0	10.2	9.3	16.7	30.6	15.7	14.6	22.3
1998/12	0.1	33.2	31.6	53.8	93.6	50.9	47.5	68.1
1999/01	12.7	210	234	374	462	361	345	339
1999/02	21.5	58.2	58.3	83.5	125	80.5	77	96.7
1999/03	61.9	144	149	214	330	208	200	252
1999/04	10.6	88.4	84.5	138	235	131	123	174
1999/05	1.2	10.3	9.6	15.9	27.7	15.1	14.2	20.6
1999/06	0.1	102	95	162	294	153	143	215
1999/07	0.1	84.6	76.9	140	258	131	121	186
1999/08	432	855	975	1330	1680	1310	1280	1300
1999/09	129	493	500	757	1170	728	695	888
1999/10	19.9	59.4	57.8	91.5	151	87.1	82.1	109
1999/11	9.7	87	86.6	141	219	134	127	162
1999/12	25.3	59.2	59.7	87	143	84.2	81.1	109
2000/01	9.5	37.8	37.2	57.6	92.6	55.1	52.3	69.7
2000/02	2.9	3.8	3.8	4.3	5.4	4.3	4.2	4.7
Total	812.6	3272.1	3478.0	5286.2	7485.2	5106.2	4890.0	5611.1
Mean Monthly	38.7	155.8	165.6	251.7	356.4	243.2	232.9	267.2
Mean Annual	464.3	1869.8	1987.4	3020.7	4277.3	2917.8	2794.3	3206.3
Percent Buildout	10.9%	43.7%	46.5%	70.6%	100.0%	68.2%	65.3%	75.0%

Table A-10. Mattawoman Creek Edge of Stream Pollutant Loadings from Watershed above Calibration Point

Total Loads (May 98 - Feb 00)

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	29837	76614	87251	128369	126304	124713	175638	132504
NH3	6133	13100	14225	20543	20302	19893	29302	22519
TN	71557	158535	191892	271238	269376	267716	337832	255846
PO4	1674	6815	8683	13114	12979	12876	16537	12009
TP	4911	11346	16907	24240	24146	24074	28624	21179
SED	491	2740	2788	4321	4158	4033	6021	4541

Mean Monthly Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	1421	3648	4155	6113	6014	5939	8364	6310
NH3	292	624	677	978	967	947	1395	1072
TN	3407	7549	9138	12916	12827	12748	16087	12183
PO4	80	325	413	624	618	613	787	572
TP	234	540	805	1154	1150	1146	1363	1009
SED	23	130	133	206	198	192	287	216

Mean Annual Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	17050	43779	49858	73354	72174	71265	100364	75717
NH3	3505	7486	8129	11739	11601	11368	16744	12868
TN	40890	90592	109652	154993	153929	152981	193047	146198
PO4	957	3894	4962	7493	7417	7358	9449	6862
TP	2806	6483	9661	13852	13798	13757	16357	12103
SED	280	1566	1593	2469	2376	2304	3441	2595

Percent Reduction in Loadings for Scenarios

	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	1.6%	2.8%	24.6%
NH3	1.2%	3.2%	23.2%
TN	0.7%	1.3%	24.3%
PO4	1.0%	1.8%	27.4%
TP	0.4%	0.7%	26.0%
SED	3.8%	6.7%	24.6%

Table A-11. Mattawoman Creek Watershed Edge of Stream Pollutant Loadings from Subbasin 781

Total Loads (May 98 - Feb 00)

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	7127	12640	15347	24642	24378	24220	40543	28527
NH3	1465	2323	2685	3748	3738	3673	6693	4830
TN	17092	26941	33476	57120	56903	56714	81774	57706
PO4	400	978	1330	2693	2676	2666	3957	2643
TP	1173	2068	2735	5307	5295	5287	7099	4858
SED	117	387	419	733	712	700	1207	853

Mean Monthly Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	339	602	731	1173	1161	1153	1931	1358
NH3	70	111	128	178	178	175	319	230
TN	814	1283	1594	2720	2710	2701	3894	2748
PO4	19	47	63	128	127	127	188	126
TP	56	98	130	253	252	252	338	231
SED	6	18	20	35	34	33	57	41

Mean Annual Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	4072	7223	8770	14081	13930	13840	23168	16301
NH3	837	1327	1534	2142	2136	2099	3825	2760
TN	9767	15395	19129	32640	32516	32408	46728	32975
PO4	228	559	760	1539	1529	1523	2261	1511
TP	670	1182	1563	3032	3025	3021	4056	2776
SED	67	221	240	419	407	400	690	487

Percent Reduction in Loadings for Scenarios

	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	1.1%	1.7%	29.6%
NH3	0.3%	2.0%	27.8%
TN	0.4%	0.7%	29.4%
PO4	0.6%	1.0%	33.2%
TP	0.2%	0.4%	31.6%
SED	2.8%	4.5%	29.3%

Table A-12. Mattawoman Creek Watershed Edge of Stream Pollutant Loadings from Subbasin 782

Total Loads (May 98 - Feb 00)

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	1370	2239	2767	4251	4225	4201	7134	5044
NH3	282	403	452	636	630	627	1169	847
TN	3287	5187	6747	10401	10374	10352	15098	10813
PO4	77	188	274	482	480	478	718	486
TP	226	420	595	983	982	981	1336	933
SED	23	59	65	109	107	105	179	122

Mean Monthly Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	65	107	132	202	201	200	340	240
NH3	13	19	22	30	30	30	56	40
TN	157	247	321	495	494	493	719	515
PO4	4	9	13	23	23	23	34	23
TP	11	20	28	47	47	47	64	44
SED	1	3	3	5	5	5	9	6

Mean Annual Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	783	1279	1581	2429	2414	2400	4076	2882
NH3	161	230	258	363	360	358	668	484
TN	1878	2964	3856	5944	5928	5915	8627	6179
PO4	44	107	157	275	274	273	410	277
TP	129	240	340	562	561	561	764	533
SED	13	34	37	62	61	60	103	70

Percent Reduction in Loadings for Scenarios

	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	0.6%	1.2%	29.3%
NH3	0.9%	1.4%	27.5%
TN	0.3%	0.5%	28.4%
PO4	0.4%	0.7%	32.4%
TP	0.1%	0.2%	30.2%
SED	1.9%	3.7%	31.7%

Table A-13. Mattawoman Creek Watershed Edge of Stream Pollutant Loadings from Subbasin 783

Total Loads (May 98 - Feb 00)

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	3335	5538	7219	11705	11656	11644	19344	11295
NH3	686	959	1127	1514	1512	1503	3197	1940
TN	7998	13525	17878	31210	31169	31150	38720	23016
PO4	187	512	761	1546	1543	1542	1880	1018
TP	549	1151	1628	3183	3180	3180	3352	1907
SED	55	142	190	336	332	331	590	333

Mean Monthly Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	159	264	344	557	555	554	921	538
NH3	33	46	54	72	72	72	152	92
TN	381	644	851	1486	1484	1483	1844	1096
PO4	9	24	36	74	73	73	90	48
TP	26	55	78	152	151	151	160	91
SED	3	7	9	16	16	16	28	16

Mean Annual Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	1906	3164	4125	6689	6661	6653	11054	6454
NH3	392	548	644	865	864	859	1827	1108
TN	4570	7728	10216	17834	17811	17800	22126	13152
PO4	107	293	435	884	882	881	1074	582
TP	314	658	930	1819	1817	1817	1915	1090
SED	31	81	108	192	190	189	337	190

Percent Reduction in Loadings for Scenarios

	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	0.4%	0.5%	41.6%
NH3	0.1%	0.7%	39.3%
TN	0.1%	0.2%	40.6%
PO4	0.2%	0.3%	45.9%
TP	0.1%	0.1%	43.1%
SED	1.2%	1.5%	43.5%

Table A-14. Mattawoman Creek Watershed Edge of Stream Pollutant Loadings from Subbasin 784

Total Loads (May 98 - Feb 00)

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	9981	19423	26433	43661	43130	42634	55063	37467
NH3	2052	3483	4335	6874	6867	6692	9074	6339
TN	23938	42237	59880	95980	95554	94989	112753	77806
PO4	560	1641	2615	4605	4571	4538	5426	3515
TP	1643	3400	5263	8739	8714	8692	9848	6607
SED	164	597	705	1237	1195	1156	1562	1030

Mean Monthly Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	475	925	1259	2079	2054	2030	2622	1784
NH3	98	166	206	327	327	319	432	302
TN	1140	2011	2851	4570	4550	4523	5369	3705
PO4	27	78	125	219	218	216	258	167
TP	78	162	251	416	415	414	469	315
SED	8	28	34	59	57	55	74	49

Mean Annual Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	5704	11099	15104	24949	24646	24363	31464	21410
NH3	1172	1990	2477	3928	3924	3824	5185	3622
TN	13679	24135	34217	54846	54602	54279	64430	44460
PO4	320	938	1494	2632	2612	2593	3100	2008
TP	939	1943	3008	4994	4980	4967	5627	3775
SED	94	341	403	707	683	661	893	588

Percent Reduction in Loadings for Scenarios

	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	1.2%	2.4%	32.0%
NH3	0.1%	2.7%	30.1%
TN	0.4%	1.0%	31.0%
PO4	0.8%	1.5%	35.2%
TP	0.3%	0.5%	32.9%
SED	3.4%	6.5%	34.1%

Table A-15. Mattawoman Creek Watershed Edge of Stream Pollutant Loadings from Subbasin 785

Total Loads (May 98 - Feb 00)

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	3938	15970	16555	26649	25991	25477	28749	25199
NH3	809	2711	2761	4479	4307	4271	4825	4250
TN	9443	28665	31830	48208	47519	47079	51260	45273
PO4	221	1357	1530	2429	2386	2353	2597	2257
TP	648	2266	2668	3983	3953	3929	4205	3696
SED	65	689	660	1073	1021	981	1168	1010

Mean Monthly Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	188	760	788	1269	1238	1213	1369	1200
NH3	39	129	131	213	205	203	230	202
TN	450	1365	1516	2296	2263	2242	2441	2156
PO4	11	65	73	116	114	112	124	107
TP	31	108	127	190	188	187	200	176
SED	3	33	31	51	49	47	56	48

Mean Annual Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	2250	9125	9460	15228	14852	14558	16428	14399
NH3	463	1549	1578	2560	2461	2441	2757	2429
TN	5396	16380	18189	27547	27154	26903	29291	25870
PO4	126	776	874	1388	1364	1345	1484	1289
TP	370	1295	1525	2276	2259	2245	2403	2112
SED	37	394	377	613	583	560	667	577

Percent Reduction in Loadings for Scenarios

	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	2.5%	4.4%	12.4%
NH3	3.9%	4.6%	11.9%
TN	1.4%	2.3%	11.7%
PO4	1.8%	3.1%	13.1%
TP	0.7%	1.3%	12.1%
SED	4.8%	8.6%	13.5%

Table A-16. Mattawoman Creek Watershed Edge of Stream Pollutant Loadings from Subbasin 786

Total Loads (May 98 - Feb 00)

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	4589	13807	14935	19625	19252	18969	30282	22003
NH3	943	2303	2347	3172	3103	3056	5050	3745
TN	11006	28211	33021	39879	39518	39248	56750	41164
PO4	257	1279	1553	1934	1909	1891	2823	1960
TP	755	2380	2984	3488	3471	3458	4771	3362
SED	75	520	511	730	701	679	1103	812

Mean Monthly Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	219	657	711	935	917	903	1442	1048
NH3	45	110	112	151	148	146	240	178
TN	524	1343	1572	1899	1882	1869	2702	1960
PO4	12	61	74	92	91	90	134	93
TP	36	113	142	166	165	165	227	160
SED	4	25	24	35	33	32	53	39

Mean Annual Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	2622	7890	8534	11214	11001	10840	17304	12573
NO3	539	1316	1341	1813	1773	1746	2886	2140
ORGN	6289	16120	18869	22788	22582	22428	32428	23523
TN	147	731	887	1105	1091	1081	1613	1120
ORGN	432	1360	1705	1993	1983	1976	2726	1921
SED	43	297	292	417	400	388	631	464

Percent Reduction in Loadings for Scenarios

	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	1.9%	3.3%	27.3%
NH3	2.2%	3.7%	25.8%
TN	0.9%	1.6%	27.5%
PO4	1.3%	2.2%	30.6%
TP	0.5%	0.9%	29.5%
SED	4.0%	7.1%	26.4%

Table A-17. Mattawoman Creek Watershed Edge of Stream Pollutant Loadings from Subbasin 787.

Total Loads (May 98 - Feb 00)

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	4136	11322	11638	15693	15396	15147	28682	24408
NH3	850	1887	1861	2598	2542	2501	4798	4107
TN	9918	23577	25968	31863	31575	31339	52506	45241
PO4	232	1041	1175	1507	1488	1472	2636	2223
TP	681	1984	2309	2741	2728	2717	4366	3745
SED	68	418	394	588	564	544	1104	916

Mean Monthly Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	197	539	554	747	733	721	1366	1162
NH3	40	90	89	124	121	119	228	196
TN	472	1123	1237	1517	1504	1492	2500	2154
PO4	11	50	56	72	71	70	126	106
TP	32	94	110	131	130	129	208	178
SED	3	20	19	28	27	26	53	44

Mean Annual Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	2363	6470	6651	8968	8798	8655	16390	13947
NH3	486	1078	1063	1484	1453	1429	2742	2347
TN	5668	13473	14839	18208	18043	17908	30004	25852
PO4	133	595	671	861	850	841	1506	1271
TP	389	1134	1319	1567	1559	1552	2495	2140
SED	39	239	225	336	322	311	631	523

Percent Reduction in Loadings for Scenarios

	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	1.9%	3.5%	14.9%
NH3	2.1%	3.7%	14.4%
TN	0.9%	1.6%	13.8%
PO4	1.3%	2.4%	15.6%
TP	0.5%	0.9%	14.2%
SED	4.0%	7.4%	17.0%

Table A-18. Mattawoman Creek Watershed Edge of Stream Pollutant Loadings from Subbasin 788

Total Loads (May 98 - Feb 00)

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	3859	10555	10471	11035	10879	10841	13518	12133
NH3	793	1757	1794	1905	1899	1871	2358	2138
TN	9254	22321	23315	24098	23968	23911	25843	23346
PO4	216	983	1050	1092	1082	1080	1176	1037
TP	635	1894	2055	2107	2100	2098	2083	1862
SED	63	373	328	357	345	342	494	440

Mean Monthly Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	184	503	499	525	518	516	644	578
NH3	38	84	85	91	90	89	112	102
TN	441	1063	1110	1148	1141	1139	1231	1112
PO4	10	47	50	52	52	51	56	49
TP	30	90	98	100	100	100	99	89
SED	3	18	16	17	16	16	24	21

Mean Annual Loads

	Forest	2000 Towson Landuse	2000 MOP Landuse	2020 MOP Landuse	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Buildout	Scenario 3 Buildout Stream Valley Protection
NO3	2205	6031	5983	6306	6217	6195	7724	6933
NH3	453	1004	1025	1089	1085	1069	1348	1222
TN	5288	12755	13323	13770	13696	13663	14767	13341
PO4	124	562	600	624	618	617	672	592
TP	363	1082	1174	1204	1200	1199	1190	1064
SED	36	213	187	204	197	195	283	252

Percent Reduction in Loadings for Scenarios

	Scenario 1 2020 Regulatory Compliance	Scenario 2 2020 Enhanced Regulatory Compliance	Scenario 3 Buildout Stream Valley Protection
NO3	1.4%	1.8%	10.2%
NH3	0.3%	1.8%	9.4%
TN	0.5%	0.8%	9.7%
PO4	0.9%	1.2%	11.9%
TP	0.3%	0.4%	10.6%
SED	3.5%	4.3%	10.9%

Definitions

Biota—the animal and plant life for a specific region

Deciduous—plants that shed foliage at the end of the growing season

Estuary—the wide lower course of a river where its current is met by the tides; an arm of the sea that extends inland to meet the mouth of a river

Geomorphic—the lands shape or surface configuration

Greenway—corridor of open land that provides one or more of the following benefits: (1) protection and management of natural and cultural resources; (2) provision of recreational opportunities; and (3) enhancement of the quality of life and the aesthetic appeal of neighborhoods and communities

***Headwater*—**the water from which a river rises

Hydrology—the scientific study of the properties, distribution, and effects of water in the atmosphere, on the earth's surface, and in soil and rocks.

Impervious—incapable of being penetrated

Non-tidal—an area that is inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions

***Retrofit*—**addition of a pollution control device on an existing facility without making major changes to the generating plant. Also called backfit.

***Riparian System*—**zone situated on the bank of a watercourse such as a river or stream

***Stream Valley*—**a long depression in the surface of the land that contains a river

***Sub Watershed*—**topographic perimeter of the catchment area of a stream tributary

***Tributary*—**a river or stream flowing into a larger river or stream

Watershed—a region draining into a river, river system, or body of water