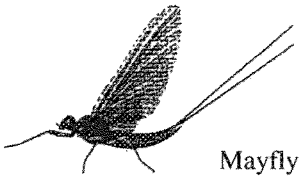
FINAL

Potomac Subregion Environmental Study

May 2000



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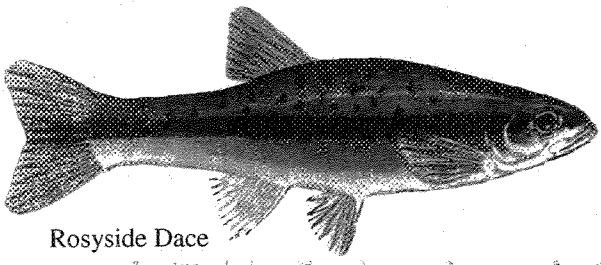

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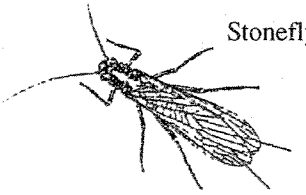

Stonefly

Stoney Creek

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EXECUTIVE SUMMARY

This report presents the results of the Potomac Subregion Environmental Study, which focuses on quantifying and evaluating the environmental effects of alternative development scenarios in the Potomac Planning Area. Three development scenarios were evaluated:

- Scenario 1 – Existing Development Plus Pipeline – which assumes buildout of all approved subdivisions and unbuilt lots in accordance with existing zoning and sewer extension policies. Unbuilt properties (as of 1993-94) in the headwaters outside the planning area are assumed to remain vacant.
- Scenario 2 – Buildout with Current Sewer Policy – which assumes that all approved subdivisions and unbuilt lots are built out as in Scenario 1, plus all remaining vacant property, including the unbuilt properties in Rockville and Gaithersburg areas, are developed (with the exception that the Miller & Smith property is acquired as a park).
- Scenario 3 – Limited Expansion of Sewer Service – which assumes the same development as Scenario 2, except that sewer service would be extended to four areas in Watts Branch and one area in Muddy Branch watersheds and the Miller & Smith property is developed.

The study uses two techniques to evaluate the effects of alternative development scenarios. First, a statistical model (herein referred to as the Potomac Subregion Cumulative Impact Model or PSCI Model) was developed that quantifies the relationship between stream conditions (as measured by the County's biological monitoring data) and various land use related variables. After extensive statistical analysis, the selected PSCI model identified the amount of impervious surfaces, the number of road crossings of streams, and the extent of palustrine emergent wetlands as being the most important variables determining stream conditions at the subwatershed level. The PSCI model was used to predict stream health for each of the three scenarios. Second, the impact assessment quantified the loss of valuable habitats such as priority wetlands; priority forest; rare, threatened, and endangered species habitat, and total forest for each of the three scenarios.

In general, the model predicts that intensive development in the headwaters of Watts and Muddy Branches will degrade much of the mainstems of both streams. This effect is compounded by the susceptibility of long segments of Watts and Muddy Branch mainstems to degradation because of their stream channel geomorphology. The predicted environmental effects of the scenarios on each of the 5 watersheds in the Potomac Subregion are described below.

Watts Branch – Of the 10 subwatersheds in the Watts Branch portion of the Potomac Planning Area, 3 are currently in good condition and 7 are in fair condition. Under Scenario 1, Upper Piney Branch subwatershed is predicted to degrade from good to poor condition. This is of concern in that the Piney Branch has been designated a Special

Protection Area (SPA). It should be noted, however, that the PSCI model does not specifically incorporate the extraordinary stormwater management measures that are required of new development within a SPA. Under Scenario 2, two mainstem subwatersheds (Kilgour Branch and Middle Watts Branch subwatersheds) are also predicted to degrade to poor conditions, primarily due to intense development in the headwaters area. It should be noted, however, that tributaries to the mainstem of Watts Branch would not be affected by this significant development in the headwaters area. The predicted stream conditions in the subwatersheds are indicative of the mainstem rather than the tributaries. Under Scenario 3, West Piney Branch subwatershed is predicted to degrade from good to fair if a potential sewer extension were to occur that would result in a loss of approximately 12 acres of forested riparian buffer. Similarly, Lower Sandy Branch is also predicted to degrade from good to fair conditions under Scenario 3 as a result of the potential Stoney Creek sewer extension. Detailed analyses were also performed on the environmental effects of various sewer and land development options for the Miller & Smith and Lower Greenbriar Properties. Development of these properties would have significant impacts on priority forest and RTE habitat.

Muddy Branch – All 12 of the subwatersheds within the Potomac Planning Area of the Muddy Branch subwatershed are currently in good condition. Under scenario 1, four of the subwatersheds are predicted to degrade to fair conditions, and under Scenario 2, three additional subwatersheds are predicted to degrade to fair or poor conditions. Much of this degradation is attributable to intense development in the headwaters area that adversely affects conditions in the mainstem of Muddy Branch. It should be noted, however, that tributaries to the mainstem of Muddy Branch would not be affected by this significant development in the headwaters area. The predicted stream conditions in the subwatersheds are indicative of the mainstem rather than the tributaries.

Cabin John Creek Watershed – Conditions within the Cabin John Creek watershed vary considerably with subwatersheds in good, fair, and poor condition. The majority of the subwatersheds retain their existing stream condition under all three scenarios, although the Lower Ken Branch subwatershed is predicted to degrade from a borderline good to fair condition under Scenario 1 and the Mainstem subwatershed is predicted to degrade from fair to poor condition under Scenario 2 as impervious surfaces reach 32%.

Rock Run Watershed – Most of Rock Run is currently in poor condition. This is attributed to nutrient enrichment and the lack of adequate stream buffers. Stream health is predicted to remain poor in most of the watershed. There would be little loss of RTE or priority forest habitat.

Lower Great Seneca Creek Watershed – The Lower Great Seneca Creek watershed is currently in good condition. It is predicted to remain good under all three scenarios. There would be little loss of RTE or priority forest habitat.

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POTOMAC SUBREGION ENVIRONMENTAL STUDY

1.0 INTRODUCTION

This summary report presents the major findings of the Potomac Subregion Environmental Study, which is a component of the overall Potomac Subregion master planning process. The Maryland-National Capital Park and Planning Commission (M-NCPPC) initiated the master planning process to update the 1980 Potomac Subregional Master Plan. This study builds on previous efforts such as the *Environmental Inventory for the Potomac Subregion* (January 1998) the *Potomac Subregion Environmental Resources Inventory* (January 1998), and the *Stream Condition Cumulative Impact Models for the Potomac Subregion* (March 2000), but focuses on quantifying and evaluating the environmental effects of alternative development scenarios. The Potomac Planning Area encompasses approximately 66 square miles of Montgomery County, including portions of 5 watersheds: Cabin John Creek, Rock Run, Watts Branch, Muddy Branch, and Lower Great Seneca Creek.

A critical component of this Master Plan update is environmental protection. M-NCPPC has identified several overarching themes, or issues, relating to this update, including Protection of Environmental Resources (M-NCPPC, June 1998). The Potomac Subregion contains many significant environmental resources, as described in the Environmental Resources Inventory (M-NCPPC, January 1998). These include:

- Large blocks of contiguous forest that provide habitat for forest interior dwelling birds;
- A large unique serpentinite rock formation that provides habitat for unusual biological communities;
- Wetlands that provide wildlife and aquatic habitat, flood flow attenuation, ground water discharge and sediment retention/nutrient removal functions; and
- Streams that flow into the Potomac River just upstream of intakes that provide drinking water to millions of people in Maryland, Virginia, and the District of Columbia.

In the *Master Plan Purpose and Outreach Strategy Report* for the Montgomery County Planning Board (June, 1998), M-NCPPC staff identified formulation of a strategy to balance development with the protection of water quality as one of the main challenges facing the Subregion.

This summary briefly describes the following:

- the methodology used for this analysis;
- the three development scenarios that were evaluated; and
- the environmental effects by watershed of each scenario.

2.0 METHODOLOGY

This study uses two techniques to evaluate the effects of alternative development scenarios on the environment of the Potomac Subregion. These techniques include: (1) a statistical model and other statistical analyses to evaluate the cumulative effects of development on stream health, and (2) quantification of the direct impacts of development on several important habitats in the planning area.

2.1 Cumulative Stream Health Impact Assessment

Description of Technical Approach

This analysis uses the extensive database collected by Montgomery County Department of Environmental Protection (DEP) and Maryland-National Capital Park and Planning Commission (M-NCPPC) as part of the *Countywide Stream Protection Strate*gy, or CSPS (February 1998). Traditional stream chemistry monitoring provides a snapshot in time of stream health. By contrast, biological monitoring of fish and aquatic insects living in the stream can be used to identify and track *cumulative effects* of altered stream hydrology, channel erosion, and sedimentation that typically result when a watershed undergoes development. These biological data are compiled into an Index of Biological Integrity (IBI). For the purposes of this study, the IBI has been adjusted to range in value from a minimum score of 20 to a maximum score of 100 (referred to as the stream score). These scores are used to represent stream health, and, based on DEP's and M-NCPPC's monitoring, the *Countywide Stream Protection Strategy* rated the existing health of most streams in Montgomery County as Excellent, Good, Fair, or Poor (referred to as the stream rating).

This study uses a statistical model (multi-variate linear regression) referred to as the Potomac Subregion Cumulative Impact (PSCI) model, to quantify the relationship between stream health (as measured by a stream score or a stream rating) and various land use related variables (impervious surfaces, number of road crossings of streams, wetlands, extent of riparian buffer, etc.). Forty-eight of DEP's monitoring stations were selected for use in the model based on similarity with the Potomac subregion. Appendix A provides a more detailed description of the PSCI model.

The PSCI model identified three variables as being most important in determining stream health:

- the extent of impervious surfaces in the subwatershed;
- the number of road crossings of streams in the subwatershed; and
- the extent of palustrine emergent wetlands[1] in the subwatershed.

Once the PSCI model was developed, it was used as a tool to predict future stream health for several different development scenarios (see Section 3.0 below). This required projections for each of the three variables for each of the three scenarios. With this

[1] Palustrine emergent wetlands are marshes generally characterized by erect non-woody plants found along small streams.

information, the model predicted the expected health of each stream as measured by a PSCI score and a PSCI stream rating.

To test the model, actual existing values for these three variables were used to see how well the model predicted "existing conditions". The predicted values were compared with actual stream ratings from 26 monitoring stations in the *Countywide Stream Protection Strategy* with great success (18 stations (69%) exactly correct and 8 stations (31%) one stream rating high or low). Appendix B provides additional information regarding the 8 stations for which the predicted rating was high or low.

Description of Adjustment Factors

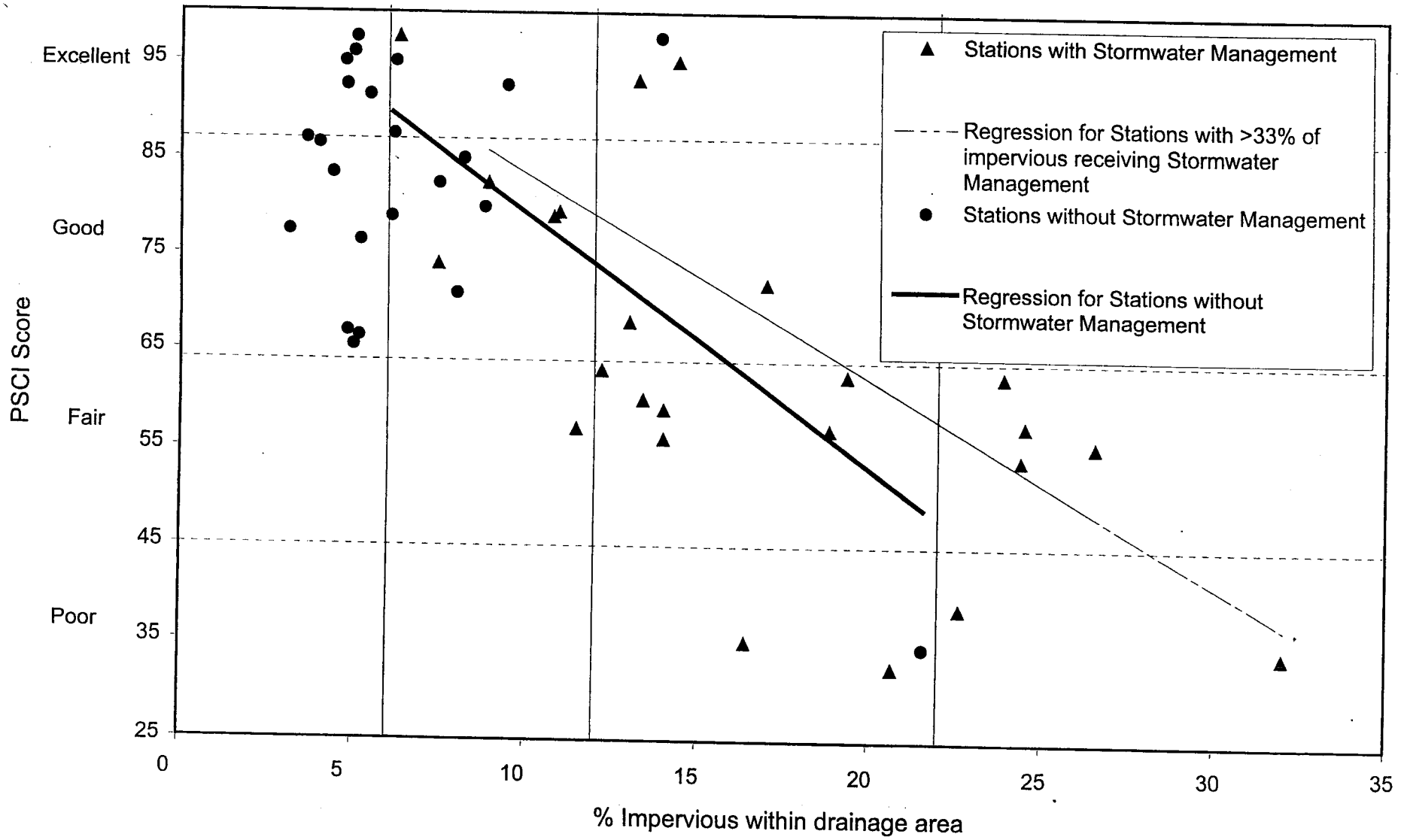
As mentioned above, the model validation process identified several factors that affected the ability of the PSCI model to accurately predict existing stream conditions in some subwatersheds. These, and a few other factors, were used to modify the predicted PSCI scores and resulted in an adjusted predicted stream rating. Two of these factors were used to adjust the predicted scores upwards and five of the factors were used to adjust predicted scores downwards. These adjustment factors are described in more detail below and are identified in Section 4.0 where the results of the model's application to the Potomac Subregion are presented.

Stormwater Management - Numerous studies have linked SWM with stream water quality. Nevertheless, when available SWM data was included in the multivariate regression analysis (expressed as the percent of impervious surface within the drainage area that receives SWM), no significant correlation was found. Further research into the SWM facilities included in the data set revealed a diversity in landscape position (e.g. headwaters, off-stream, in-stream), age (from only a few years to over 25 years old), facility design (from only 10-year storm quantity management to facilities with 2-year storm quality and quantity management with extended detention), and presumably maintenance practices.

Therefore, SWM was not included in the regression analysis, but subjected to a separate statistical analysis, referred to as cluster analysis, to assess the effect of stormwater management on the PSCI model's predicted stream ratings. The analysis indicated that SWM helps streams maintain stream ratings under higher levels of imperviousness. As Figure 1 shows, SWM helps to somewhat mitigate the adverse effects of imperviousness on aquatic communities, but it does not completely offset those effects. It should be noted, however, that this analysis did not include SWM facilities meeting current state design criteria because these data were not available. Once additional SWM performance data becomes available from the County's Special Protection Area (SPA) program, a better statistically valid test can be done and the PSCI model can be refined.

The SWM factor was used to adjust predicted stream ratings upward (e.g. fair to good) in subwatersheds with borderline PSCI scores where a large percentage of existing impervious areas already receive SWM or in areas such as SPAs where extraordinary SWM practices are required. This adjustment was applied to 5 subwatersheds.

Figure 1: Effects of Stormwater Management on PSCI Scores



Bedrock Substrate – Presence of a bedrock channel substrate was the only other adjustment factor that was used to adjust predicted stream ratings upward. The CSPS noted in the Dufief and Quince Orchard subwatersheds that the presence of bedrock outcrops in the streambed reduced stream channel degradation. Streams with a rocky substrate appear to be able to tolerate the hydrologic modifications resulting from increased imperviousness and are able to maintain healthier aquatic communities than other streams with similar levels of imperviousness. This adjustment factor was applied to 2 subwatersheds.

Stream Geomorphology – Several stream reaches were more susceptible to degradation than other reaches because of its geomorphic characteristics. This determination was made based on several field visits to the planning area and review of topographic maps, soil information, and the results of other studies in the area. The results of this screening indicated that several of the subwatersheds were potentially more vulnerable to hydrologic perturbations due to more gentle stream gradients and wide floodplain areas where sediment derived from upstream sources may be deposited and stored. This geomorphic susceptibility to sediment deposition results in lower IBI scores than would otherwise be expected based on watershed characteristics. Nine subwatersheds were identified as being geomorphically susceptible to degradation.

Stream Channelization – Many studies have documented the adverse effects of stream channelization on aquatic communities. None of the streams included in the PSCI model data set were channelized, so the model would not be expected to accurately predict conditions for a stream that has been channelized. Therefore, the predicted score for the one stream within the study area (Beltway Branch) that has been channelized was adjusted downward based on existing conditions.

Water Quality Problems – Known water quality problems (e.g. nutrient enrichment) adversely affect aquatic communities in the Rock Run watershed. For these subwatersheds, the predicted PSCI score was adjusted downward based on existing conditions.

Serpentinite Geology – Nearly all the Greenbriar Branch subwatershed and portions of the Upper Sandy Branch subwatershed are underlain by an unusual serpentinite geologic formation. Soils are generally thin in this area with little water storage capacity. Therefore, many of the streams draining this area dry up during drought periods, which adversely affects the aquatic community. Therefore, the predicted PSCI score was adjusted downward in these two subwatersheds.

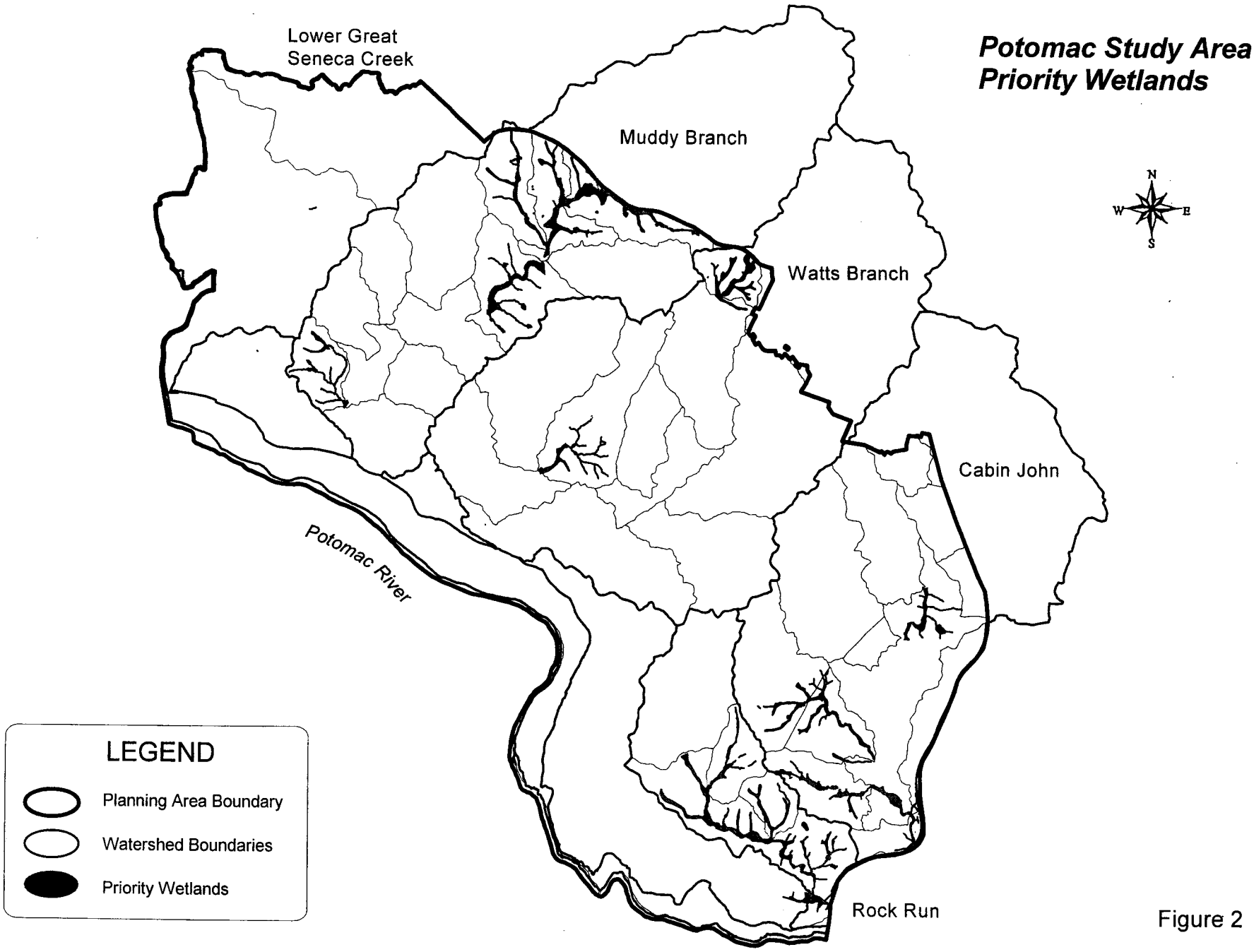
Stream Buffers – The *Stream Condition Cumulative Impact Models for the Potomac Subregion* (ERM, 2000) report identified the importance of riparian buffers in maintaining overall stream health. In most cases, existing riparian buffers will be maintained within the study area because of state and county regulations. In a few cases, however, proposed sewer line construction is evaluated that would occur within a forested riparian buffer area. In cases where the subwatershed has a borderline score

(e.g. within 4 points of the next lower rating), the predicted PSCI score was adjusted downward to reflect this forested riparian buffer impact.

2.2 Important Habitat Impact Assessment

The environmental impact assessment also quantified direct adverse impacts to various important habitats from the development scenarios. These included:

- Forested riparian buffer – defined as all forested land within 100 feet of a stream bank.
- Priority wetlands (Figure 2) – as identified in the *Potomac Subregion Wetland Functional Assessment Study* (January 1998). In this study wetlands were rated for a number of factors, including aquatic and wildlife habitat. Priority wetlands are wetlands that received a high composite score for aquatic and wildlife habitat. These wetlands support a diverse community of plants and animals. Priority wetlands located within the riparian buffer were assumed to be protected from all development except for sewer construction. Sewer impacts to wetlands were calculated assuming that sewer construction would disturb a 50-foot wide corridor.
- Priority forests (Figure 3) – as identified by M-NCPPC staff. Forest stands were ranked according to their value and importance for preservation. Based on rankings, forest stands were separated into five preservation categories. This analysis only considers the larger tracts, Priority Forest Preservation Categories 1 through 3. Forest clearing calculations assume that sewer corridors would be 50 feet wide. Aside from clearing in the riparian buffer for sewer lines, all other forest in the riparian buffer was assumed to remain intact. Scenario 1 priority forest clearing calculations underestimate clearing because some development under Scenario 1 occurred after the 1993 baseline, but before priority forests were designated. Total forest loss has also been calculated by subwatershed (see Appendix C).
- Known and potential rare, threatened, and endangered (RTE) species habitat (Figure 4) - as identified in the *Environmental Inventory for the Potomac Subregion* prepared by EA Engineering, Science and Technology (January 1998). RTE habitat impacts were calculated using existing conditions as the baseline (i.e., habitat loss due to parcels developed prior to the 1993 baseline were not included in the cumulative impact calculations). RTE species habitat includes:
    - (i) *Serpentinite rock formations*, which are overlain by shallow, poorly drained, nutrient poor soils that have pockets of high levels of naturally occurring heavy metals due to geology. These globally-rare serpentinite areas support numerous RTE plant and insect species. There is overlap between the serpentinite rock formation and the potential RTE habitat since the serpentinite rock supports RTE species.
    - (ii) *Potential RTE habitat* as identified by the Maryland Natural Heritage Program. These areas have been designated as Sensitive Species Project Review Areas (SSPRAs) and are areas that have the potential to support unique habitat elements most often associated with RTE species.



Potomac Study Area
Priority Wetlands

Figure 2

Map prepared December 1999

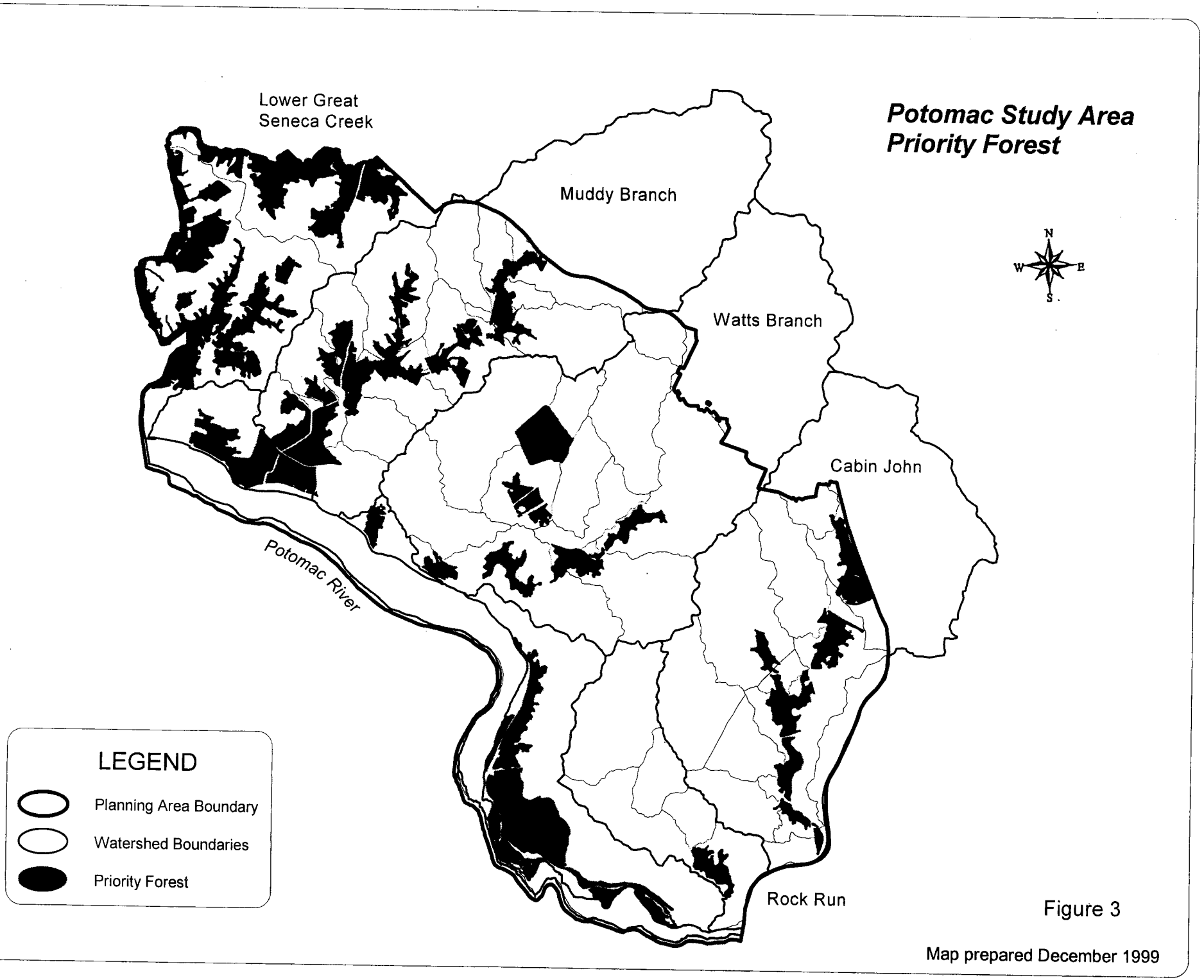
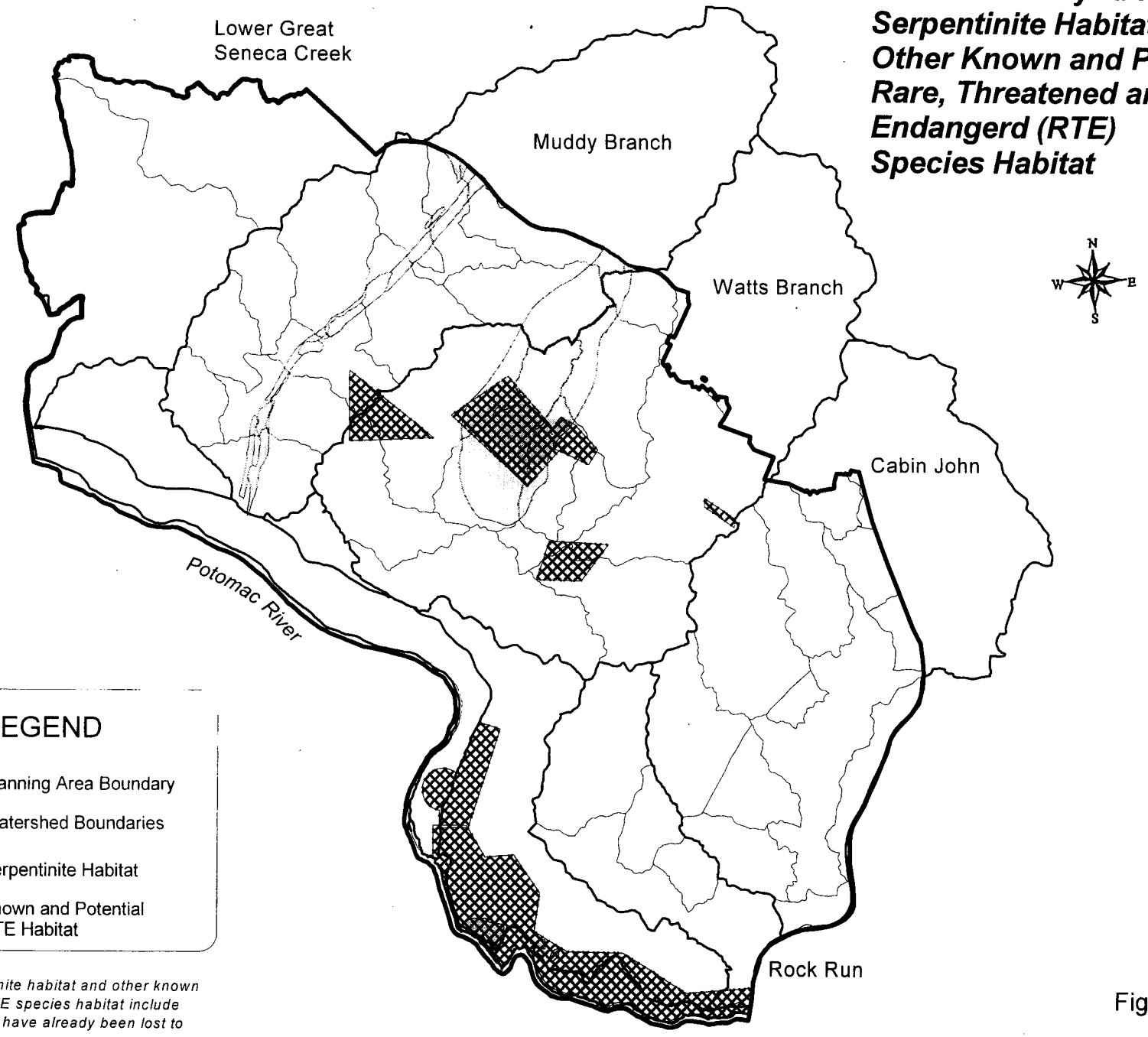


Figure 3

Map prepared December 1999

Potomac Study Area Serpentinite Habitat and Other Known and Potential Rare, Threatened and Endangerd (RTE) Species Habitat



LEGEND

- Planning Area Boundary
- Watershed Boundaries
- Serpentinite Habitat
- Known and Potential RTE Habitat

**Note: Serpentinite habitat and other known and potential RTE species habitat include some areas that have already been lost to development.*

Figure 4

Map prepared December 1999

(iii) *RTE observation points* are sites harboring RTE species as identified by EA Engineering, Science and Technology in a field study. This study was not a complete survey of the entire planning area and only involved verification of records of selected RTE habitat locations.

The direct impacts of land development, road crossings of streams, and sewer line construction on these important habitats was quantified. The study did not attempt to quantify indirect impacts, such as hydrologic changes on wetlands.

3.0 DESCRIPTION OF SCENARIOS

This study evaluates the environmental impacts of three different development scenarios, which are briefly described below. Each of these scenarios was measured against existing conditions. For purposes of this study, we used the most recent planimetric information available (1993 - 1995) regarding land use, and the stream rating from the *Countywide Stream Protection Strategy* (1998) as approximately indicative of existing conditions.

3.1 Scenario 1: Existing Development Plus Pipeline

This scenario describes the environmental conditions associated with buildout of all approved subdivisions and unbuilt lots (*pipeline* projects) in accordance with existing zoning and sewer extension policies (see Figure 5). Therefore, RE-2 and R-200 zoned properties may or may not develop with sewer service. Unbuilt properties within Cabin John, Watts and Muddy Branch watersheds primarily in the I-270 corridor outside the planning area (referred to as the *headwaters area*) remain vacant.[2]

3.2 Scenario 2: Buildout with Current Sewer Policy

This scenario assumes that all approved subdivisions and unbuilt lots are built out as in Scenario 1, plus all remaining vacant property (including unbuilt properties in the headwaters area[2]) in accordance with zoning and sewer service in the 1980 master plan (see Figure 6). The one exception to this is the Miller & Smith property, which is included as parkland. Housing density without community sewer in the serpentinite outcrop area is assumed to be 1 house per 10 or more acres. Finally, the proposed Watts Branch relief sewer is assumed to be constructed within the Middle Watts, Kilgour Branch, and Lower Watts subwatersheds.

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[2] In order to simplify the analysis, unbuilt properties in the headwaters area (outside the Potomac planning area) were considered as a group without distinguishing some as being in the "pipeline." All unbuilt properties in the headwaters area were considered vacant in scenario 1 and built out in scenarios 2 and 3.

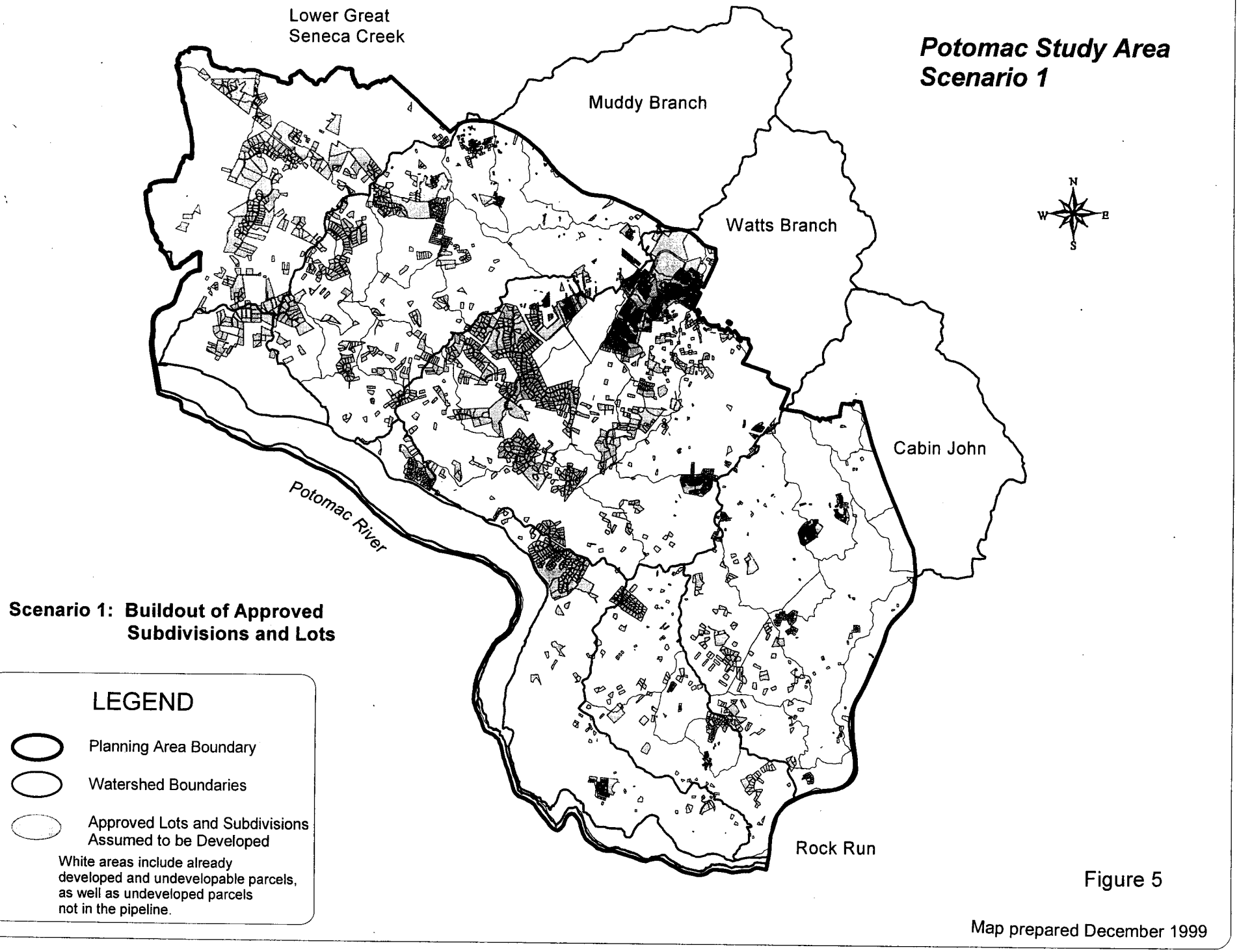


Figure 5

Map prepared December 1999

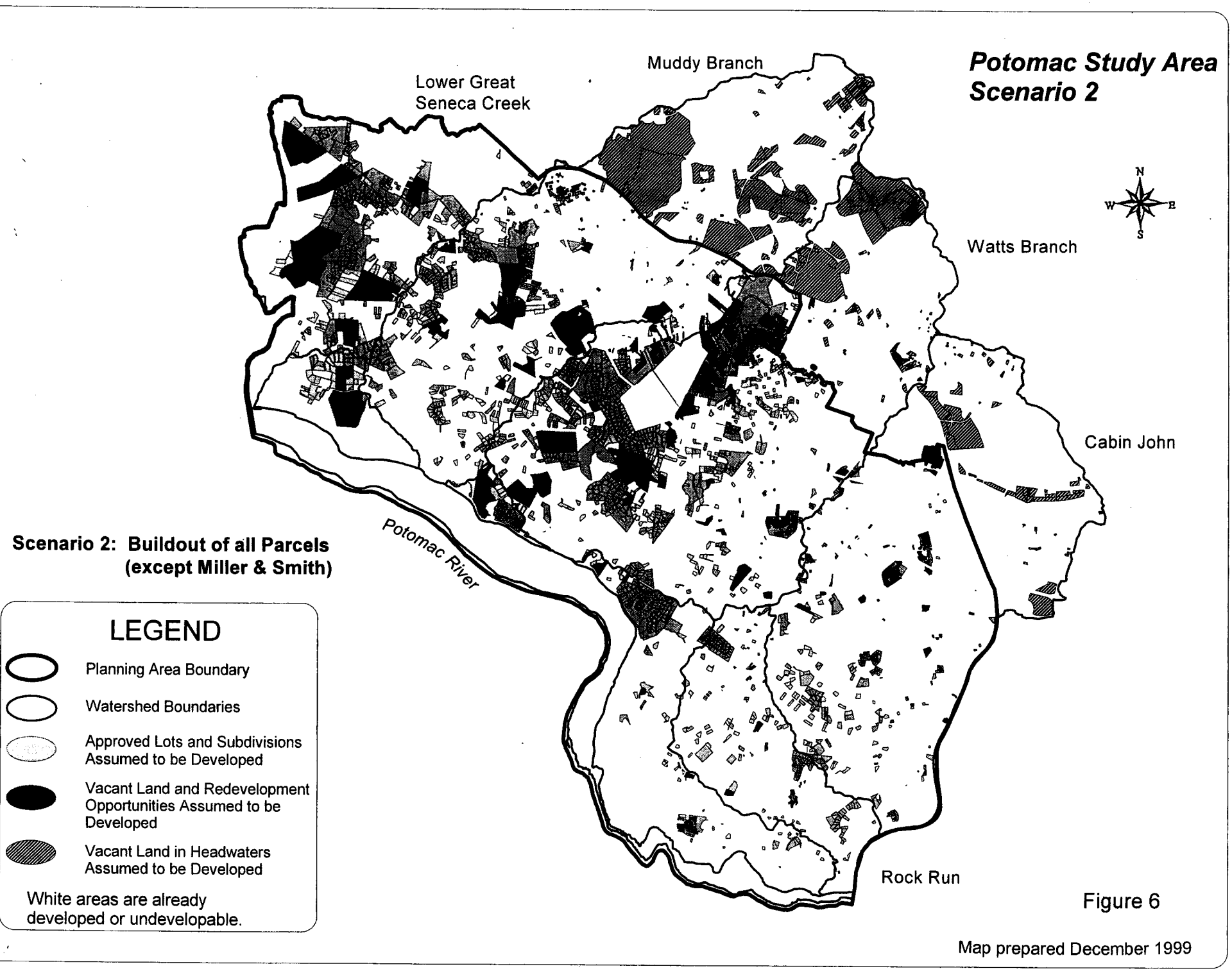


Figure 6

Map prepared December 1999

3.3 Scenario 3: Limited Expansion of Sewer Service

This scenario predicts the potential incremental environmental impacts of providing sewer service and the increased density that would accompany it to four areas in the Watts Branch and one area in the Muddy Branch watersheds, in addition to the development considered in Scenario 2 (see Figures 7 and 8). All other properties outside these five designated areas would develop in accordance with existing zoning and sewer service in the 1980 master plan and have identical environmental impacts as described in Scenario 2. These proposed sewer service alternatives are listed below and described in Section 4.0.

- A - Hanson Farm sewer extension (within the Mainstem above Turkey Foot subwatershed in the Muddy Branch watershed)
- B - Stoney Creek sewer extension (within the Lower Sandy Branch subwatershed)
- C - Greenbriar sewer extension (within the Greenbriar and Upper Sandy subwatersheds)
- D - West Piney Branch sewer extension (within the West Piney subwatershed)
- E - Glen Hills sewer extension (within the Middle Watts and Middle Piney Branch subwatersheds)

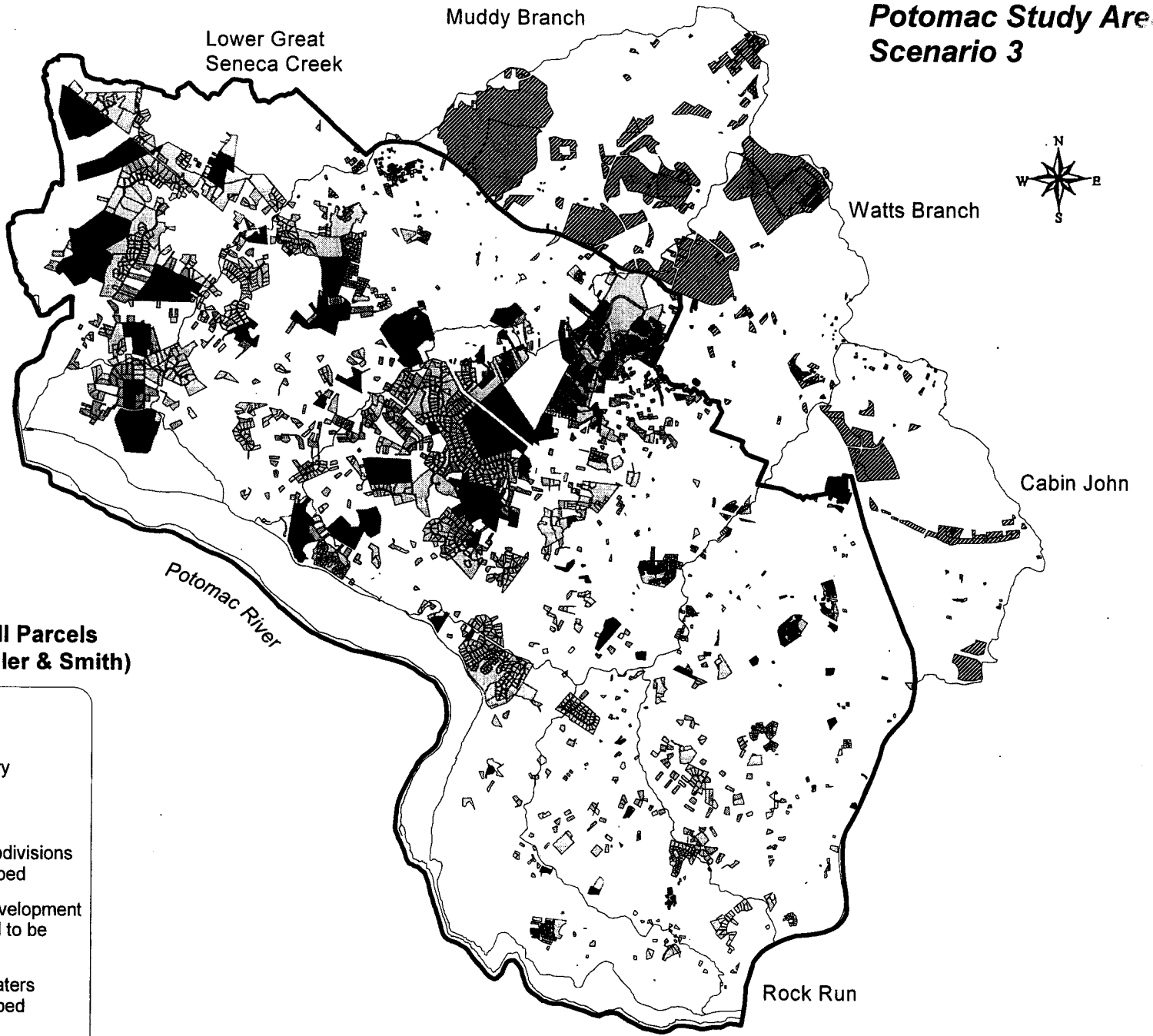
Both the direct and indirect environmental impacts of each of these sewer alternatives are evaluated. The direct environmental impacts of the sewer options result from the actual construction of the sewer line itself and primarily affect priority wetlands, priority forest, and forested riparian buffer. The indirect impacts of extending sewer service result from increased development that provision of sewer service would allow and have been evaluated using the PSCI model.

4.0 ENVIRONMENTAL IMPACTS OF THE SCENARIOS

This section describes the environmental impacts of each scenario by watershed based on the results of the PSCI model and the direct impacts to important habitats. Tables in Appendices C and D summarize the predicted effects of each scenario on stream condition and important habitats, by subwatershed, respectively. Appendix E includes figures showing existing and predicted stream conditions for each subwatershed under each scenario. Figure 9 identifies each of the subwatersheds within the study area.

4.1 Watts Branch Watershed

The Watts Branch watershed drains approximately 22 square miles and includes 10 subwatersheds within the planning area. According to the *Countywide Stream Protection Strategy* (1993 baseline), Upper Piney Branch, West Piney Branch, and Lower Sandy Branch subwatersheds have good stream conditions. The remaining subwatersheds are all in fair condition, including Middle Watts Branch, Middle Piney Branch, Lower Piney Branch, Upper Sandy Branch, Greenbriar Branch, Kilgour Branch, and Lower Watts Branch subwatersheds. The headwaters of the Watts Branch watershed include portions of the city of Rockville.



Scenario 3: Buildout of all Parcels (including Miller & Smith)

LEGEND

- Planning Area Boundary
- Watershed Boundaries
- Approved Lots and Subdivisions Assumed to be Developed
- Vacant Land and Redevelopment Opportunities Assumed to be Developed
- Vacant Land in Headwaters Assumed to be Developed

White areas are already developed or undevelopable.

Figure 7

Map prepared December 1999

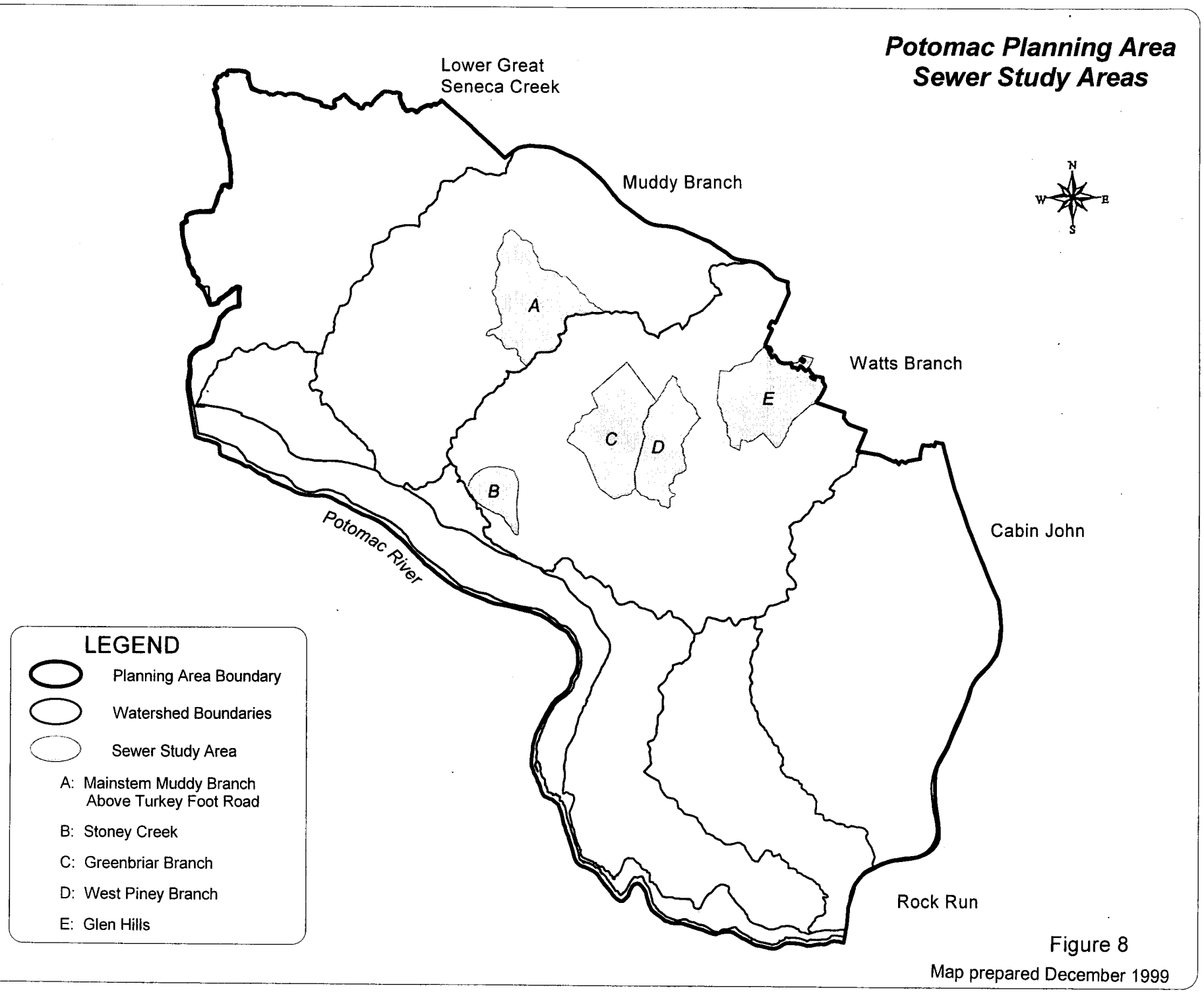
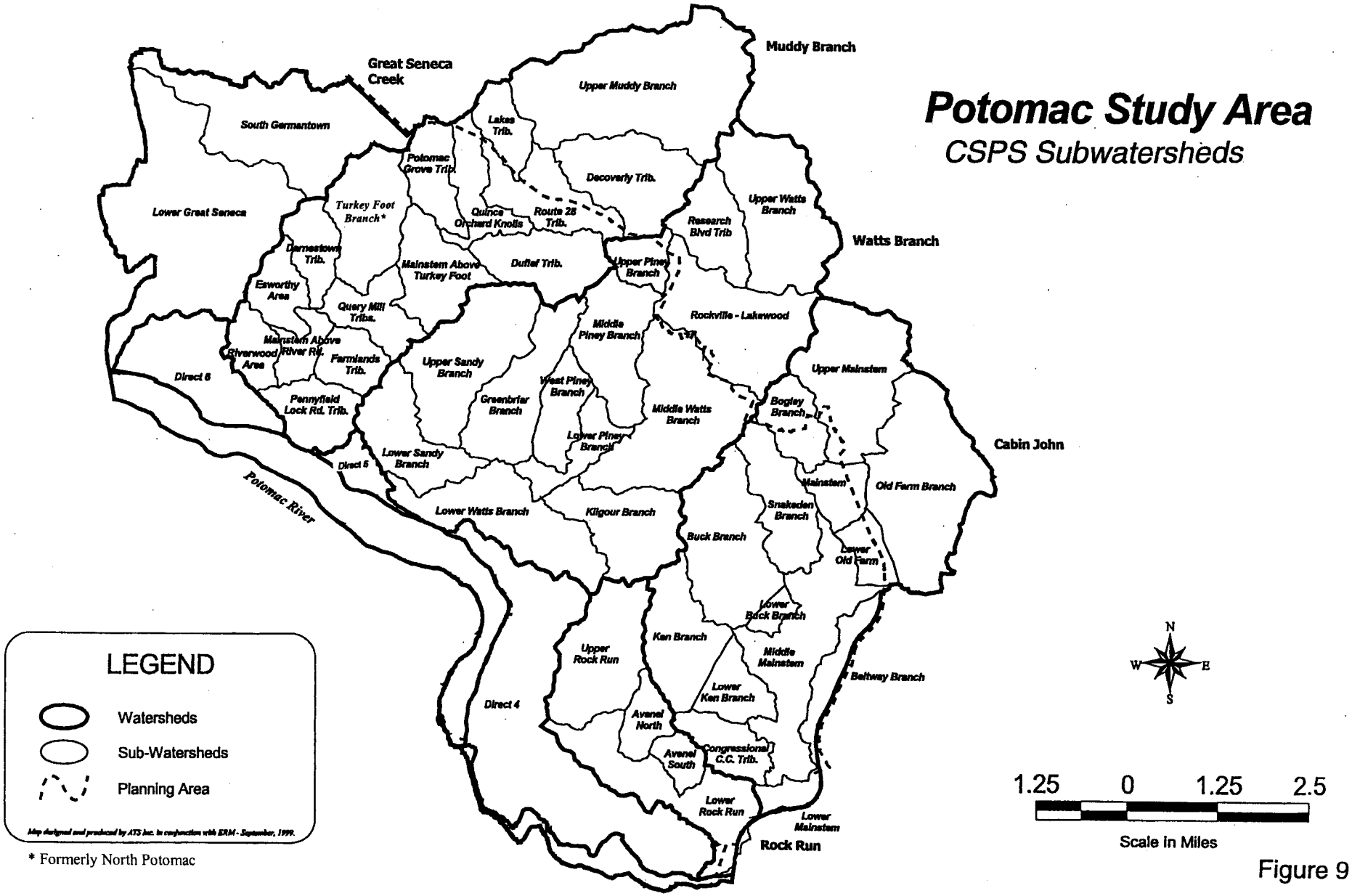


Figure 8

Map prepared December 1999



* Formerly North Potomac

Figure 9

The Watts Branch Watershed is a particularly sensitive watershed for several reasons. First, it includes the vast majority of the unusual serpentine geologic formation that provides habitat for several rare, threatened, and endangered species. Second, there are more areas of forest here than in any of the other watersheds in the study area. Finally, the lower mainstems of Watts Branch (in Lower and Middle Watts Branch subwatershed), Piney Branch (Lower and Middle Piney Branch subwatershed) are geomorphically susceptible to degradation. These areas are generally characterized by more gentle stream gradients and wide floodplain areas where sediment derived from upstream sources is deposited and adversely affects the aquatic community.

In general, the overall condition of the Watts Branch Watershed is predicted to degrade from good/fair condition to fair/poor condition. Much of this degradation is attributable to significant development in the headwaters area that primarily affects the lower mainstem of Watts Branch. That is the area noted above as being geomorphically susceptible to the effects of upstream development. It should be noted, however, that tributaries to the mainstem of Watts Branch would not be affected by this significant development in the headwaters area. The predicted stream conditions in the subwatersheds are indicative of the mainstem rather than the tributaries. Further, especially under Scenarios 2 and 3, there are significant losses in RTE habitat and total forest.

Each of the subwatersheds is discussed below. Figure 10 shows the impacts of each scenario on subwatershed stream health. Figures 11, 12, and 13 display potential RTE habitat lost, serpentinite habitat lost, and priority forest cleared by subwatershed in Watts Branch.

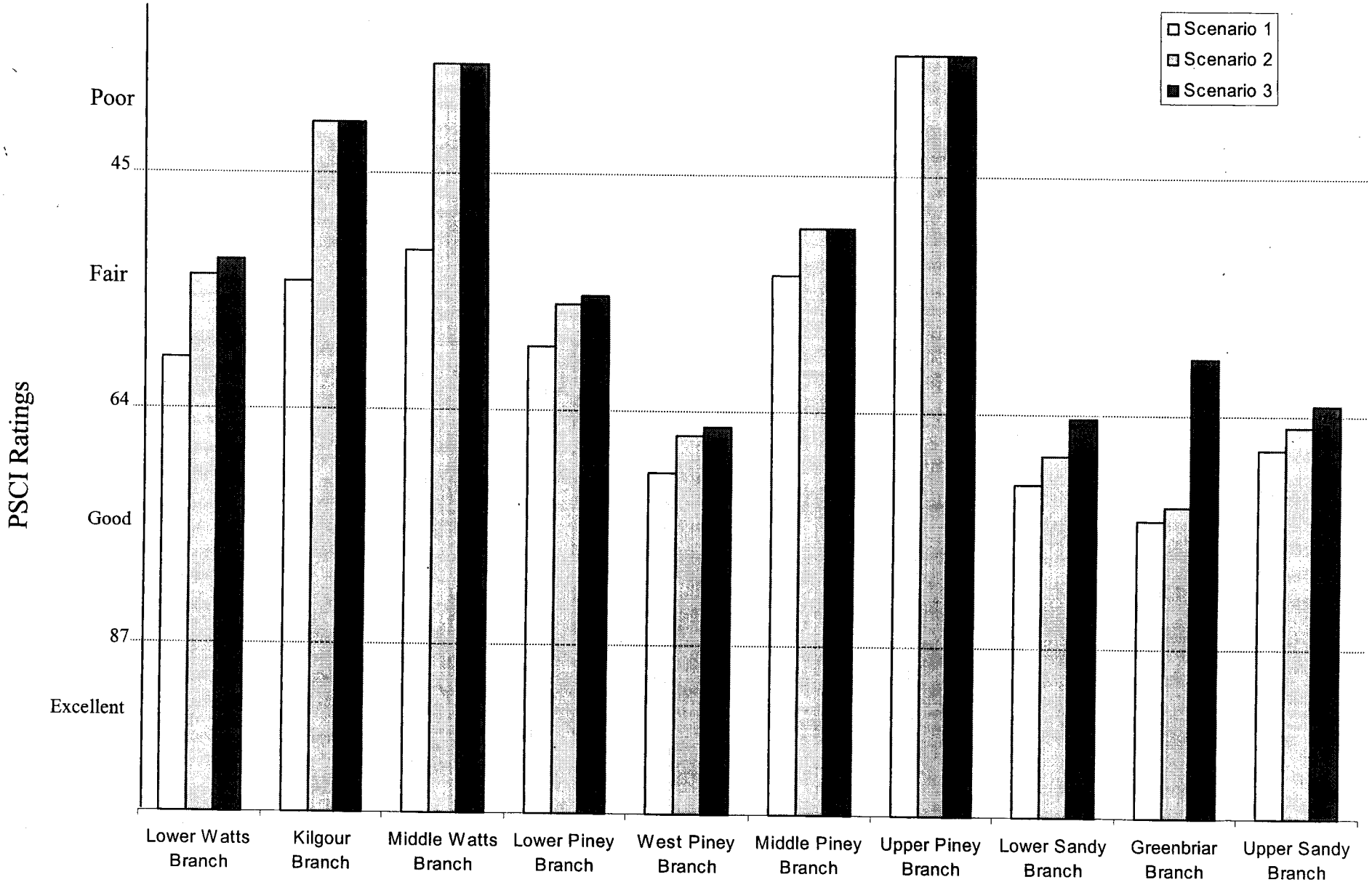
Upper Piney Branch Subwatershed

Given the potential development in the Upper Piney Branch, the Piney Branch tributary to Watts Branch was designated a special protection area in 1995 to help protect the existing high quality stream habitat. The *Countywide Stream Protection Strategy* specifically identifies Upper Piney Branch as containing numerous seeps and springs that are essential to the health of the entire Piney Branch tributary.

Stream Health – The Upper Piney Branch subwatershed is currently in good condition according to the CSPS, with the WBPB201 monitoring station having an observed CSPS score of 80. The PSCI Model predictions correlated very closely with observed conditions in this subwatershed with a PSCI Rating of good and a PSCI Score of 78.

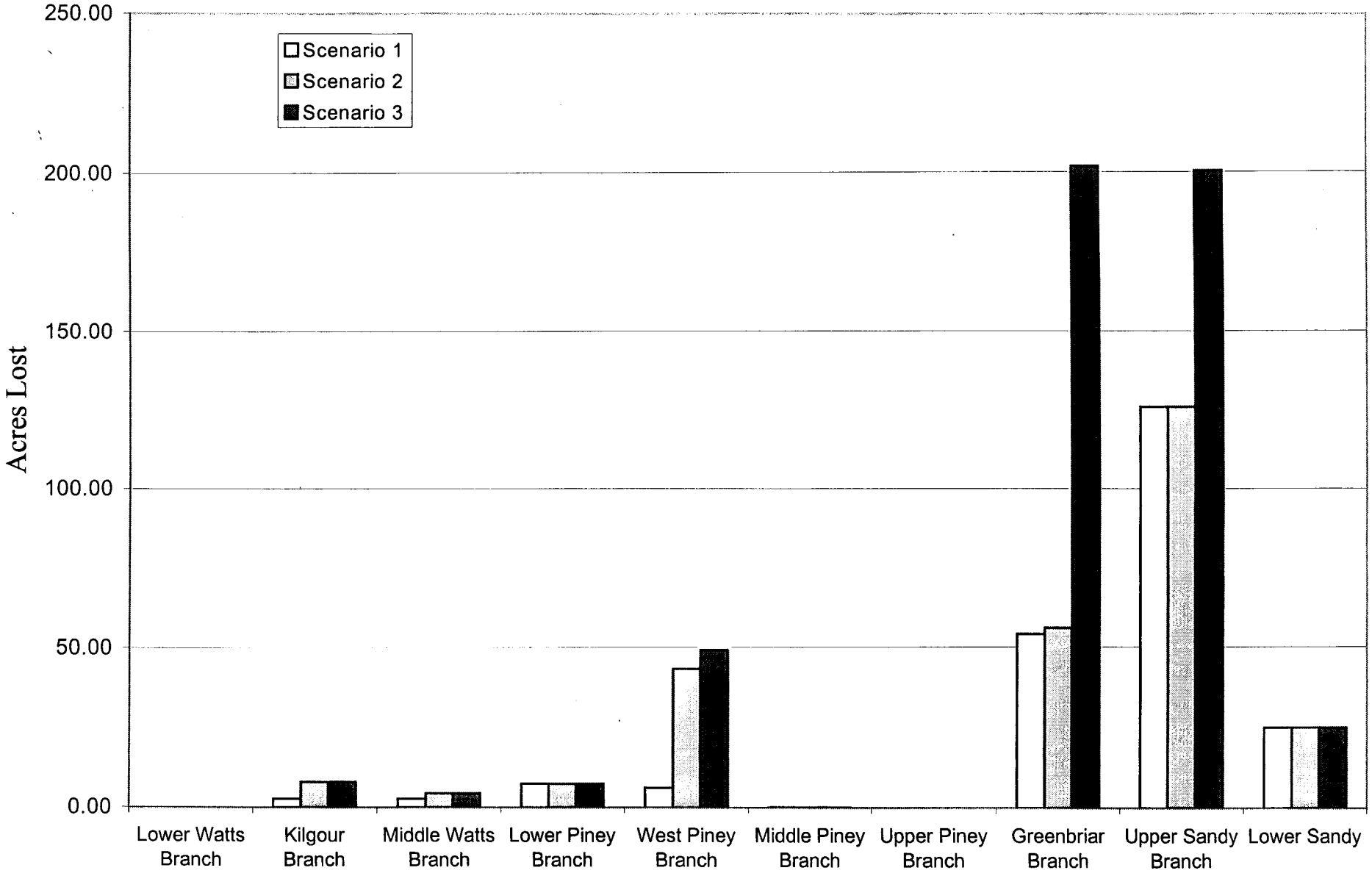
Development (primarily development of Traville, residential properties, and the University of Maryland) under Scenario 1 would increase the amount of impervious surfaces from approximately 10% (1993 baseline) to over 28% and result in a predicted degradation of this stream from good to poor condition. There is little additional development projected for the subwatershed under Scenarios 2 and 3 and the predicted stream condition remains poor. It should be noted, however, that the data set from which

Figure 10: Potomac Subregion Cumulative Impact Model Scores for Watts Branch by Scenario



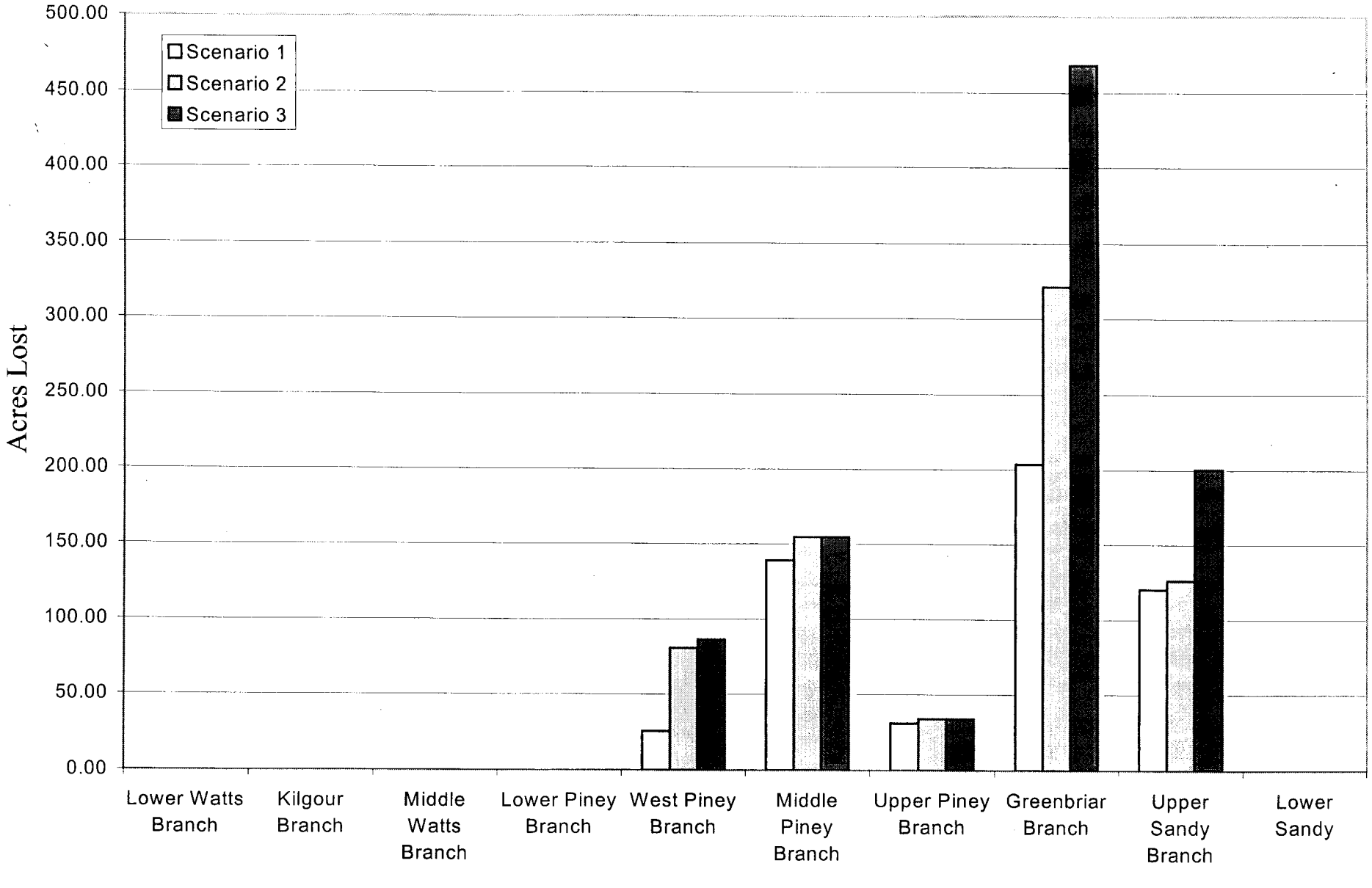
* Values given for the PSCI scores are the unadjusted values, consult text (or Table 2 in Appendix) for predicted CSPS stream ratings.

Figure 11 - Potential RTE Habitat Lost in Watts Branch by Subwatershed



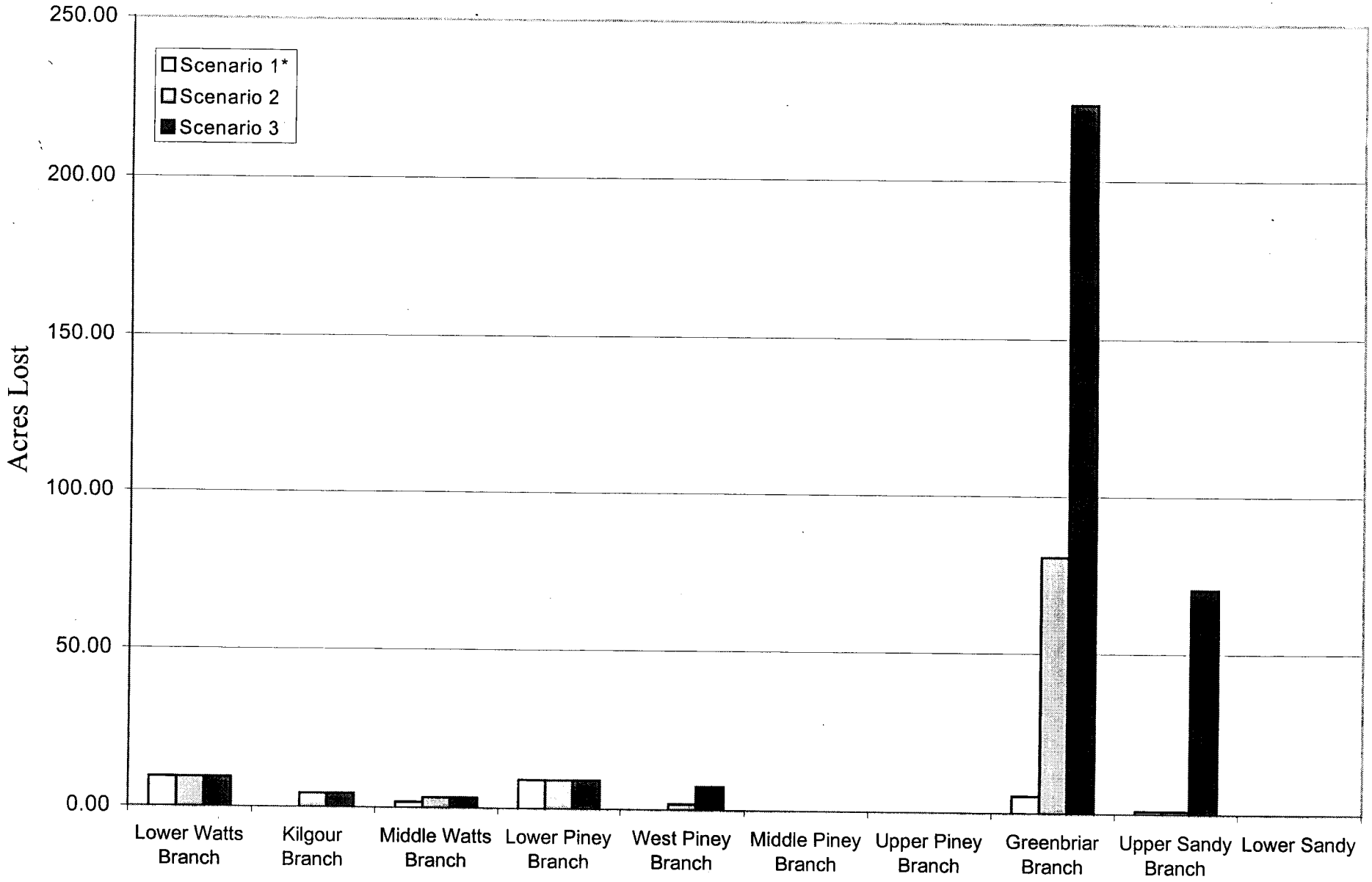
* These estimates of habitat loss include that portion of the serpentinite habitat (see Figure 12) that have been identified as providing potential RTE habitat.

Figure 12 - Serpentinite Habitat Lost in Watts Branch by Subwatershed



* Some of this Serpentinite Habitat Lost is also included in Figure 11, Potential RTE Habitat Lost in Watts Branch by Subwatershed.

Figure 13 - Priority Forest Cleared in Watts Branch by Subwatershed



* Note: Scenario 1 Priority Forest Clearing calculations underestimate losses because some development under Scenario 1 occurred before Priority Forests were designated.

the PSCI Model was developed did not include many examples of current SWM facilities, let alone the extraordinary SWM facilities required by the special protection area regulations. It is difficult, therefore, to quantify the effectiveness of these measures in offsetting the impacts of increasing imperviousness. Once SWM performance data becomes available from the County's SPA program, the PSCI model can be refined. At this time, the model does not specifically incorporate the potential benefits of the additional stormwater management that is required for new development within this subwatershed.

Recognizing this lack of data and the inability to accurately predict stream conditions with SPA controls, there is concern that good, or even fair, conditions may be difficult to maintain in this subwatershed given the proposed development.

RTE Impacts – Serpentinite habitat losses would increase from 31 acres (2.5% of total remaining unbuilt serpentinite habitat in the Watts Branch watershed) under Scenario 1, to 34 acres (2.8%) under Scenarios 2 and 3.

Forest Clearing – There would be no clearing of priority forests under any of the development scenarios.

Middle Piney Branch Subwatershed

Stream Health – The CSPS assigned the Middle Piney Branch subwatershed a fair stream rating. The PSCI model predicted good stream conditions, however, this rating was adjusted down to reflect the geomorphic susceptibility of this subwatershed to stream degradation. Under all three scenarios, stream health in the Middle Piney Branch subwatershed is predicted to remain fair, although closer to the fair/poor borderline given its geomorphic susceptibility.

Under Scenario 3, a proposed alternative would extend gravity sewer to serve a small portion of the Glen Hills area in the Middle Piney Branch subwatershed. This area has experienced failing septic systems and many of these aging septic systems do not meet current requirements for replacement drain fields. It was assumed that this area would continue to develop at one-acre densities. This extension of sewer service would result in a very slight increase in the amount of impervious surface, since the area is already extensively developed and no change in zoning is proposed. However, provision of sewer service would eliminate marginal and potentially failing septic systems and improve water quality.

RTE Impacts – Serpentinite habitat losses will increase from 139 acres (11.5% of the total remaining unbuilt serpentinite habitat in the Watts Branch watershed) under Scenario 1, to 155 acres (12.8%) under Scenarios 2 and 3. There would be minimal impacts (0.05 acres) to potential RTE habitat under all three scenarios.

Forest Clearing – There would be no clearing of priority forests under any of the development scenarios.

West Piney Branch Subwatershed

Stream Health – Under Scenarios 1 and 2, little additional development would occur within the West Piney Branch subwatershed and stream health is predicted to remain good. Under Scenario 3, the West Piney Branch sewer extension alternative would extend gravity sewer service up along the stream to several vacant parcels within the serpentinite outcrop area. This extension of sewer service would result in only a slight increase in overall imperviousness since the area is already extensively developed and no change in zoning is proposed. In order to serve these parcels, however, nearly 8,200 linear feet of sewer would need to be constructed along West Piney Branch, resulting in the loss of approximately 12 acres of forested riparian buffer. This forested buffer is particularly important in West Piney Branch in that the Montgomery County Department of Environmental Protection has identified this stream reach as having the potential to function as an important refuge for fish during times of stress on the Watts Branch mainstem. Further, the *Countywide Stream Protection Strategy* notes that West Piney Branch has marginal bank stability, which could be adversely affected by the proposed sewer construction. Therefore, it is predicted that the West Piney Sewer extension would result in the degradation of stream conditions from good to fair.

RTE Impacts – Serpentinite habitat losses would increase from 25 acres (2.1% of total remaining unbuilt serpentinite habitat in the Watts Branch watershed) under Scenario 1, to 81 acres (6.7% of total) under Scenario 2, and 87 acres (7.2%) under Scenario 3. Loss of potential RTE habitat would also increase under the three scenarios, from 6 acres under Scenario 1, to 43 acres under Scenario 2, to 49 acres under Scenario 3.

Forest Clearing – Minimal acreage of priority forests would be cleared under the three scenarios, with 7 acres (0.8% of remaining total priority forest in the Watts Branch watershed) cleared under Scenario 3.

Lower Piney Branch Subwatershed

Stream Health – The CSPS assigned the Lower Piney Branch subwatershed a fair stream rating. The PSCI model predicted good stream conditions, however, this rating was adjusted down to reflect the geomorphic susceptibility of this subwatershed to stream degradation. Under all three development scenarios this subwatershed is predicted to maintain its current stream rating of fair.

RTE Impacts – There would be no loss of serpentinite habitat under the three development scenarios, and losses of potential RTE habitat would remain constant at 7 acres (1.0% of total remaining potential RTE habitat in the Watts Branch watershed).

Forest Clearing - Approximately 9 acres of priority forests would be cleared under all three scenarios.

Upper Sandy Branch Subwatershed

Stream Health – The CSPS assigned the Upper Sandy Branch subwatershed a fair stream rating. The PSCI model predicted good stream conditions, however, this rating was adjusted down to reflect the influence of the serpentinite geology found in the headwaters of this subwatershed. Upper Sandy Branch is predicted to maintain its stream rating of fair for all three scenarios.

RTE Impacts – There would be significant losses of serpentinite and co-incident RTE habitat under all three scenarios, increasing from 120 acres under Scenario 1, to 126 acres under Scenario 2, and 200 acres (16.6 % of the total remaining unbuilt serpentinite habitat in the Watts Branch watershed) under Scenario 3.

Forest Clearing - Less than 1 acre of priority forests would be cleared under Scenarios 1 and 2, while 70 acres (8.1% of the total remaining priority forest in the Watts Branch watershed) would be cleared under Scenario 3.

Greenbriar Branch Subwatershed

The Greenbriar Branch subwatershed is almost entirely underlain by an unusual serpentinite rock formation. Serpentinite rocks are usually green to yellow in color and the soils derived from this formation tend to create an inhospitable environment for many plants for several reasons. The soils tend to be shallow, stunting the growth of trees. The soils are thin with little capacity for water storage and tend to create xeric conditions during dry seasons and poorly drained conditions when the weather is wet. This also affects the nature of streams. Numerous seeps and springs feed into stream channels that are often shallow and wide as surface drainage works it way along impermeable rock. Braided stream systems exist in several areas of Greenbriar Branch. These wetlands have not been precisely delineated due to the fact that soils on the serpentinite outcrop are difficult to differentiate and are mapped as a single unit. For this reason the only wetlands assumed in Greenbriar Branch are a small stream channel and its 25-foot-wide wetland buffer. This is a gross underestimation, but cannot be corrected without extensive field work. Finally, these soils are nutrient poor and high in many metals, which many plants cannot tolerate. The plants that grow in this serpentinite formation are those that can withstand these harsh conditions. These same plants often cannot compete successfully with other plants on better quality soils, and as a result, the serpentinite formation supports many uncommon, rare, threatened, and endangered plants.

Stream Health - The PSCI model predicts Greenbriar Branch subwatershed to currently have good stream health, given little existing development and good riparian buffer. The *Countywide Stream Protection* Strategy, however, assigned Greenbriar Branch a fair stream health rating. Both, the *Countywide Stream Protection Strategy* and the *Rapid Stream Assessment Technique for the Watts Branch Watershed* (Biohabitats, 1997) characterized the stream habitat as good, but found that the relatively poor biological conditions are caused by low base flows. These low base flows are expected given the

limited water storage capacity of the soils. Under Scenarios 1 and 2, little development is projected because the lack of sewer service limits development to approximately 1 house per 10 or more acres. Also, the Miller & Smith property (formerly the PEPCO property) is assumed to remain undeveloped. As a result, stream health remains fair (stream habitat conditions would remain good).

Under Scenario 3, various *options* for extending sewer service to, and *alternative* development of, the Lower Greenbriar Branch properties and the Miller & Smith property are proposed. This study evaluates both the direct and indirect environmental impacts of these sewer options and development alternatives.

Direct Impacts of Sewer Extension Options

Option 1 would involve serving the Lower Greenbriar properties with approximately 2.5 miles of gravity sewer located in the stream valleys and extending south of Glen Road to connect with an existing sewer interceptor along Watts Branch. This option would adversely affect approximately 5.6 acres of priority wetlands, require clearing of 10.7 acres of forested riparian buffer, and involve several stream crossings along Greenbriar Branch.

Option 2 would involve serving the Lower Greenbriar properties with gravity sewer located in the stream valleys and connecting to a small pumping station that would be located near Glen Road to pump the wastewater through a force main east along Glen Road. This option would adversely affect approximately 0.8 acres of priority wetlands and clear 4.6 acres of forested riparian buffer. Construction of the pumping station, however, would avoid the need for approximately 2 miles of sewer line through priority wetlands and forested riparian buffer and therefore would have fewer adverse habitat impacts than Option 1.

Option 3 would involve serving the Lower Greenbriar properties with a grinder pump/pressure sewer system (similar to the adjacent Palatine subdivision sewer system) located in the roads and connecting to a gravity sewer system along Piney Meetinghouse Road. Because the sewer lines would be in the roads rather than in the stream valleys, this alternative would have the least habitat impact among the three options for these properties and would result in the clearing of 1.6 acres of forested riparian buffer and 0.7 acres of priority wetlands[3]. WSSC is reconsidering the policy of using pressure sewer systems based, in part, on complaints of odors from the pressure sewer system in the Palatine subdivision.

The *Miller & Smith Property Sewer Option* was proposed by the property owners and involves a combination gravity sewer, pumping station, and force main system that would extend along Piney Meetinghouse Road and eventually connect to the Watts Branch sewer system. This option would clear 14.7 acres of priority forest and 0.2 acres of forested riparian buffer. This option would not serve the Lower Greenbriar properties.

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[3] Measurement based on assumed wetland width of 25 feet. Observations indicate wetlands may be substantially wider, thus greater impacts may result.

Indirect Impacts of Sewer Extensions

Whereas for many of the sewer alternatives considered in this study there is little difference between the amount of development that would likely occur with or without sewer service, in the case of the Greenbriar subwatershed the difference is significant. The reason for this difference is the serpentinite outcrop found throughout the subwatershed that generally limits development density on septic systems to 1 lot per 10 or more acres. Provision of sewer service would increase achievable density five fold or more.

Seven different development alternatives were evaluated including varying levels and combinations of development for the Lower Greenbriar and the Miller & Smith properties. One development alternative assumed no development of either property.

Three levels of development were considered for the **Miller & Smith** property:

- The property remains undeveloped and is acquired as a park (park alternative);
- The property is served with sewer and develops in accordance with current RE-2 zoning (RE-2 alternative);
- The property is served with sewer and develops in accordance with a proposal by the property owner to develop the property as single family housing and one or two private schools preserving approximately 85 acres as a reserve (R-200/TDR alternative).

Three levels of development were considered for the **Lower Greenbriar** properties –

- undeveloped and acquired as park (park alternative),
- limited development on septic systems (septic alternative), or
- full development in accordance with existing RE-2 zoning with the provision of sewer service using one of the sewer options described above (sewer alternative).

Table 1 compares the environmental impacts of each of the seven alternatives. In terms of stream condition, the PSCI Model predicts that the PSCI scores would decline from a 74 (equating to a stream condition of good) when both properties are left undeveloped as parks, to a 59 (equating to a stream condition of fair) when both properties are fully developed with the provision of sewer. As mentioned previously, however, the low base flows associated with the serpentinite geology found throughout the Greenbriar Branch results in only fair stream conditions under existing conditions. Because of serpentinite geology, the PSCI model tends to predict better stream conditions than are actually found. Therefore, the decline in PSCI scores from 74 to 59 (or from good to fair) should only be considered as a qualitative indication of the effects of the development alternatives on stream conditions, and that there is a potential for lower scores[4].

There are significant differences among the development alternatives in terms of effects on serpentinite habitat and priority forest. Both the Lower Greenbriar and Miller &

[4] A score of 45 or less would indicate poor conditions.

Smith properties contain large amounts of serpentinite habitat and priority forests. In fact, the Miller & Smith Property contains the highest ranked priority forest in the planning area. The loss of priority forest ranges from 0 acres under Alternative 1 (i.e. both properties are preserved as parks) to 298 acres under Alternatives 3 and 5 (i.e. both properties are fully developed). Similarly, the loss of serpentinite habitat ranges from 0 acres under Alternative 1 to 298 acres under Alternatives 3 and 5.

RTE Impacts - A significant amount of the serpentinite habitat within the entire Greenbriar Branch would be lost under all the scenarios. Scenario 1 would result in a loss of 204 acres of serpentinite habitat (16.9% of the total remaining unbuilt serpentinite habitat in the Watts Branch watershed). Under Scenario 2, the loss of serpentinite habitat would amount to 321 acres (26.7%), and 468 acres (38.9%) under Scenario 3. Potential RTE habitat losses would range from 54 acres under Scenario 1, to 56 acres under Scenario 2, and 202 acres under Scenario 3. In some areas, potential RTE habitat overlaps with serpentinite habitat. The RTE impacts of alternatives 1 to 7 for the Miller & Smith and Lower Greenbriar properties only are listed in Table 1.

Forest Clearing – Scenario 1 would result in minimal clearing of priority forest (5 acres) in the entire Greenbriar Branch. Priority forest clearing would increase to 81 acres under Scenario 2, and 224 acres under Scenario 3. Significantly, Scenario 3 would involve clearing of the priority forest that is ranked the highest for preservation. The priority forest clearing impacts of alternatives 1 to 7 for the Miller & Smith and Lower Greenbriar properties only are listed in Table 1.

Table 1
Comparison of Environmental Impacts of Alternatives in Greenbriar Branch

Alternatives	Miller & Smith Property	Lower Greenbriar Properties	Predicted PSCI Scores	Serpentinite Habitat Lost (Acres)	Priority Forest Cleared (Acres)
Alternative 1 (Scenario 1)	Park	Park	74	0	0
Alternative 2 (Scenario 2)	Park	Septic	73	89	72
Alternative 3 (Scenario 3)	RE-2 Zoning (Sewer)	Sewer	60	315	298
Alternative 4	Park	Sewer	67	89	72
Alternative 5	RE-2 Zoning (Sewer)	Septic	64	315	298
Alternative 6	R-200/TDR (Sewer)	Septic	63	230	213
Alternative 7	R-200/TDR (Sewer)	Sewer	59	230	213

Lower Sandy Branch Subwatershed

Stream Health – Under Scenarios 1 and 2, Lower Sandy Branch is predicted to retain a good stream rating. Under Scenario 3, the Stoney Creek sewer extension alternative would extend gravity sewer up Stoney Creek to serve a few vacant parcels along River Road and Stoney Creek Road. Steep topography and poor soils limit the suitability of septic systems in this area. The parcels would develop in accordance with existing zoning. This extension of sewer service would result in a minimal increase in impervious surfaces. This increased development, however, when combined with other upstream sewer alternatives and proposed development in Greenbriar Branch, is predicted to degrade stream health in the Lower Sandy Branch from good to fair conditions. In addition, construction of the proposed sewer line through the rugged topography found along Stoney Creek would result in the loss of 4.7 acres of forested riparian buffer and would likely destabilize steep slopes resulting in erosion and sedimentation problems. Less intense development in Greenbriar Branch (e.g., Miller & Smith Property is acquired as a park and/or the Lower Greenbriar Properties develop on septic systems) would enable Lower Sandy Branch to retain a good stream condition.

RTE Impacts – There would be no loss of serpentinite habitat under Scenarios 1, 2 or 3. The loss of other potential RTE habitat would remain constant at 25 acres under all scenarios.

Forest Clearing – There would be no clearing of priority forest under any of the scenarios.

Middle Watts Branch and Kilgour Branch Subwatersheds

Stream Health –With approved development under Scenario 1, Middle Watts Branch and Kilgour Branch subwatersheds are predicted to retain a fair stream rating. Under Scenario 2, however, the stream rating is predicted to degrade from fair to poor stream conditions. Much of this degradation is attributable to significant development in the headwaters area[5] and primarily affects the mainstem of Watts Branch in these subwatersheds. For example, the headwaters area is projected to increase in imperviousness from a 1993 baseline of 26% to 40% under build-out conditions.

Under Scenario 3, a proposed alternative would extend gravity sewer to serve the Glen Hills area in the Middle Watts subwatershed, which has experienced failing septic systems. Many of these aging septic systems date from the 1950's and 1960's and do not meet current requirements for replacement drain fields. It was assumed that this area would redevelop at RE-1 densities and imperviousness. This extension of sewer service would only result in a slight increase in the amount of impervious surface, since the area is already extensively developed and no change in zoning is proposed. Construction of the proposed sewer lines in the stream valleys would result in the loss of approximately 8 acres of forested riparian buffer that would adversely affect stream conditions. Provision

[5] This projection does not take into account any extraordinary BMPs that may be provided as part of development or stormwater retrofit programs being considered in the City of Rockville.

of sewer service, however, would eliminate marginal and failing septic systems and improve water quality. To the extent that sewer construction could primarily occur within the road system, thereby minimizing the loss of forested stream buffers, the proposed extension would improve overall stream health.

RTE Impacts – There would be no loss of serpentinite habitat under any of the scenarios; loss of potential RTE habitat would increase from 3 acres under Scenario 1 to 12 acres under Scenario 3 for the two subwatersheds combined.

Forest Clearing – The three scenarios would not result in significant clearing of priority forests (8 acres under Scenario 3 for the two subwatersheds combined).

Lower Watts Branch Subwatershed.

Stream Health – The CSPS assigned the Lower Watts Branch subwatershed a fair stream rating. The PSCI model predicted good stream conditions, however, this rating was adjusted down to reflect the geomorphic susceptibility of this subwatershed to stream degradation. Under all three scenarios, Lower Watts Branch subwatershed is predicted to retain its current fair stream condition.

RTE Impacts - There would be no loss of serpentinite habitat or potential RTE habitat under the three scenarios.

Forest Clearing - Approximately 10 acres of priority forest would be cleared under each of the scenarios.

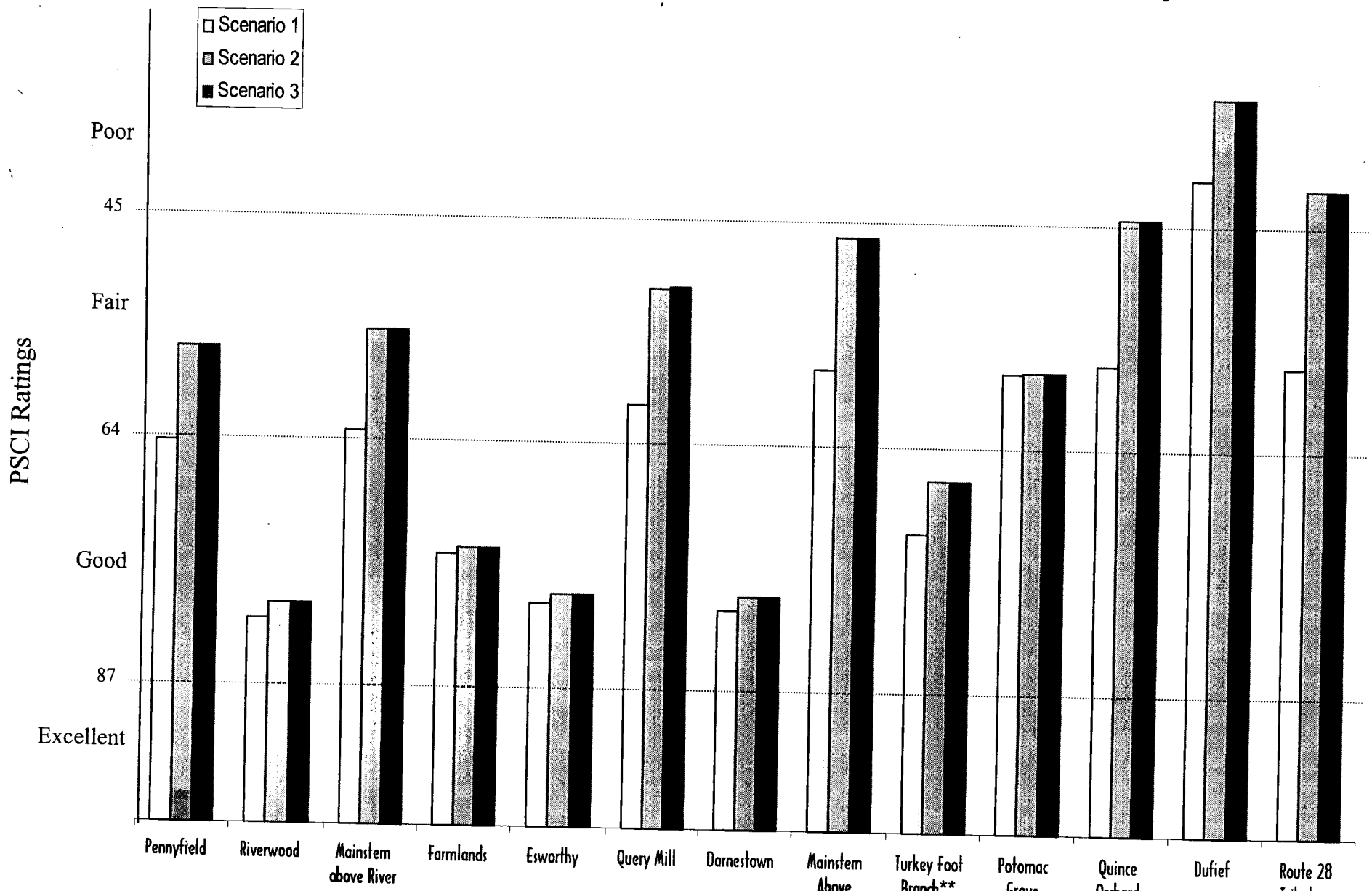
4.2 Muddy Branch Watershed

Muddy Branch consists of 16 subwatersheds, mostly within the planning area. According to the *Countywide Stream Protection Strategy* (1993 baseline), all the subwatersheds entirely inside the planning area are in good condition. Those subwatersheds outside the planning area (Upper Muddy, Lakes Tributary, and Decoverly Tributary) are designated fair, mostly due to the increased development in the headwaters.

The Muddy Branch watershed has many of the same characteristics that makes the Watts Branch watershed sensitive, but generally to a lesser degree. The Muddy Branch watershed does contain some serpentinite geologic areas, but these are limited to portions of a couple subwatersheds. The Muddy Branch watershed contains about 20 percent of the priority forest in the Planning area, but very little identified RTE habitat.

Two of the lower mainstem subwatersheds, Mainstem above River Road and Query Mill, are geomorphically susceptible to degradation. The Muddy Branch mainstem in these areas is generally characterized by gentle stream gradients and wide floodplains where sediment is readily deposited. Conversely, two of the subwatersheds, Quince Orchard

Figure 14: Potomac Subregion Cumulative Impact Model For Muddy Branch by Scenario



* Values given for the PSCI scores are the unadjusted values, consult text (or Table 2 in Appendix) for predicted CSPS stream ratings.

** Formerly North Potomac

and Dufief, have exposed bedrock substrates that generally enable the streams in these areas to better tolerate hydrologic modifications, making them less susceptible to degradation.

Under the three scenarios, several of the subwatersheds would not receive much new development and are predicted to maintain good stream condition. These subwatersheds include Turkey Foot Branch[6], Darnestown, Esworthy, Riverwood, and Farmland Tributaries. The subwatersheds that are predicted to degrade in stream condition are discussed below. Intense development in the headwaters, with imperviousness levels reaching 54% in the Lakes Tributary subwatershed, 32% in Upper Muddy subwatershed, and 31% in Decoverly watershed, adversely affects the downstream Muddy Branch mainstem, including the Route 28, Quince Orchard, Mainstem above Turkey Foot, Query Mill, Mainstem above River, and Pennyfield subwatersheds. Figure 14 shows the effects of each scenario on subwatershed stream condition. Figures 15, 16, and 17 display, respectively, potential RTE habitat lost, serpentinite habitat lost, and priority forest cleared by subwatershed.

Dufief Tributary

Stream Health –According to the *Countywide Stream Protection Strategy,* stream conditions are good in this subwatershed despite extensive development with impervious surfaces exceeding 30%. This is at least partially attributable to a bedrock substrate that limits channel downcutting, thereby minimizing erosion and sediment deposition and maintaining stream condition. Imperviousness is projected to increase to 34% under Scenario 1 and 38% under Scenarios 2 and 3. Even with appropriate stormwater management, this subwatershed is predicted to degrade to fair and then poor condition because of the very high imperviousness levels.

RTE Impacts – Loss of serpentinite habitat would increase from 49 acres (21.1% of the total remaining unbuilt serpentinite habitat in the Muddy Branch watershed) under Scenario 1, to 68 acres (29%) under scenarios 2 and 3.

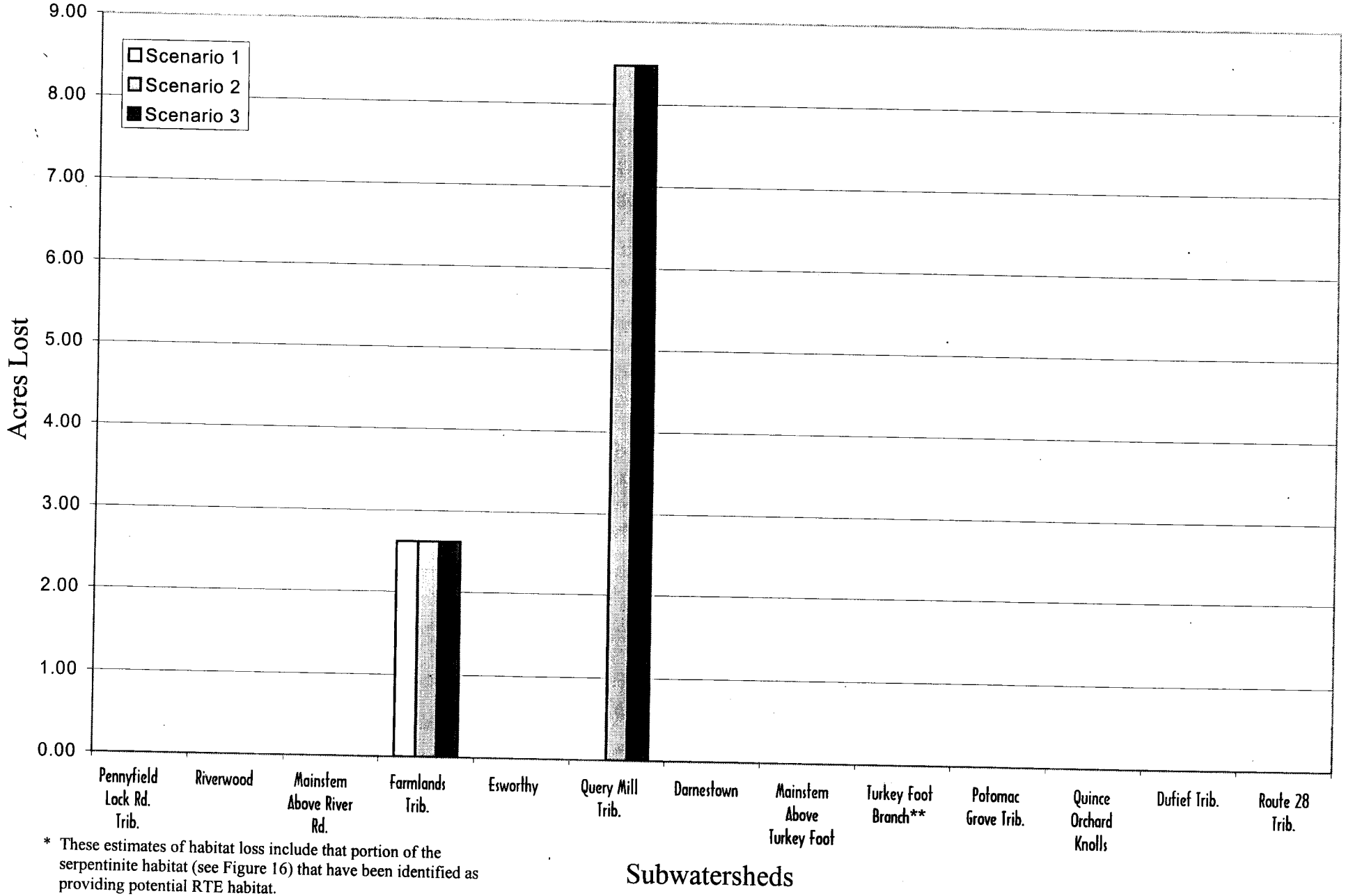
Forest Clearing – Minimal areas of priority forests would be cleared (0.2 acres under Scenarios 2 and 3).

Quince Orchard

Stream Health – According to the *Countywide Stream Protection Strategy,* stream conditions are good in this subwatershed despite extensive development with impervious surfaces approaching 22%. This is at least partially attributable to a bedrock substrate common in this area that limits channel downcutting. Under Scenario 1, the Quince Orchard subwatershed is predicted to retain its good stream rating. Under build-out conditions (Scenario 2), however, impervious surfaces are predicted to reach 30% and the stream is predicted to degrade to fair stream conditions. Much of this degradation is

[6] Formerly North Potomac Subwatershed.

Figure 15- Potential RTE Habitat Lost in Muddy Branch by Subwatershed



* These estimates of habitat loss include that portion of the serpentinite habitat (see Figure 16) that have been identified as providing potential RTE habitat.

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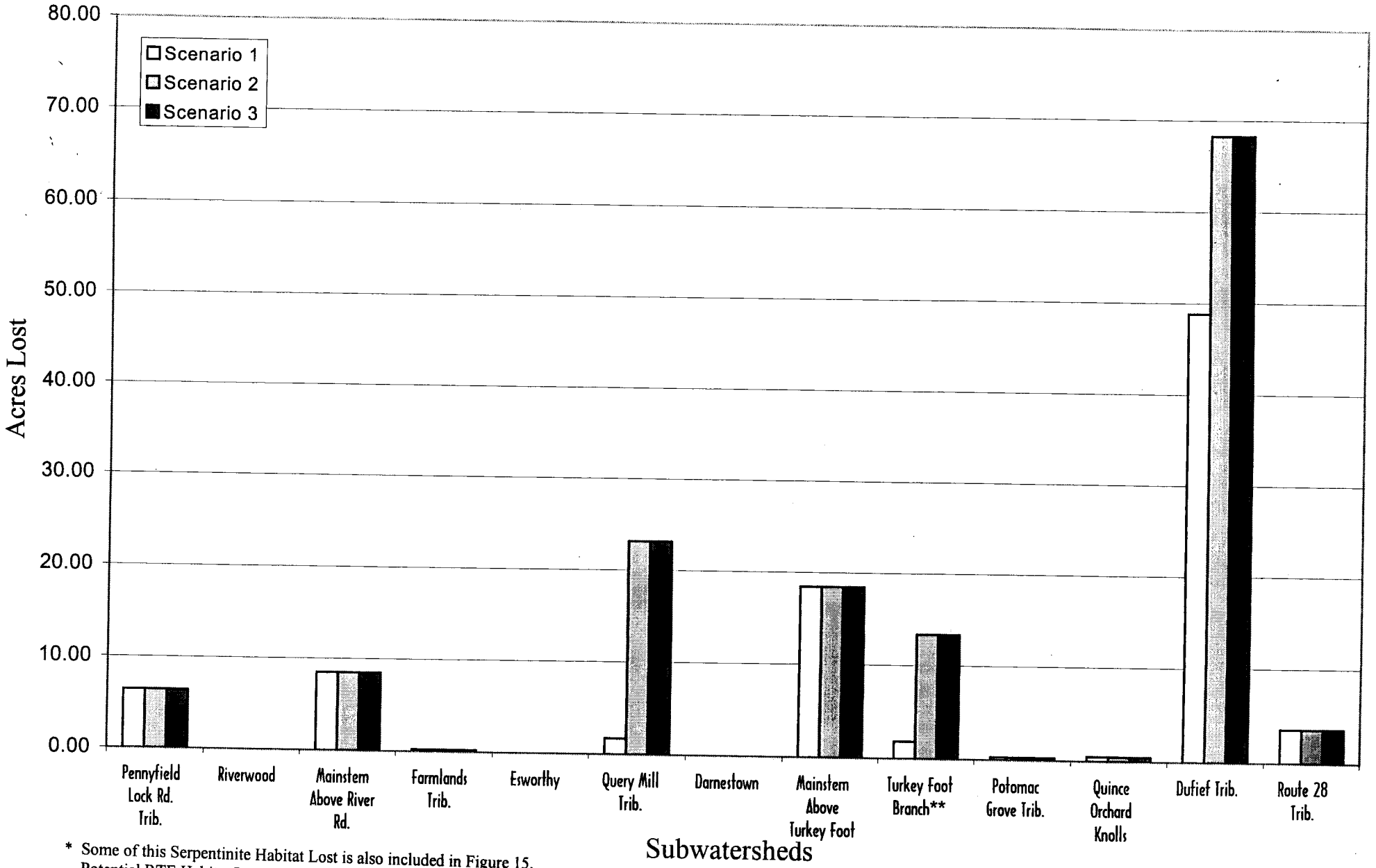
Figure 16 - Serpentinite Habitat Lost in Muddy Branch by Subwatershed



* Some of this Serpentinite Habitat Lost is also included in Figure 15, Potential RTE Habitat Lost in Muddy Branch by Subwatershed.

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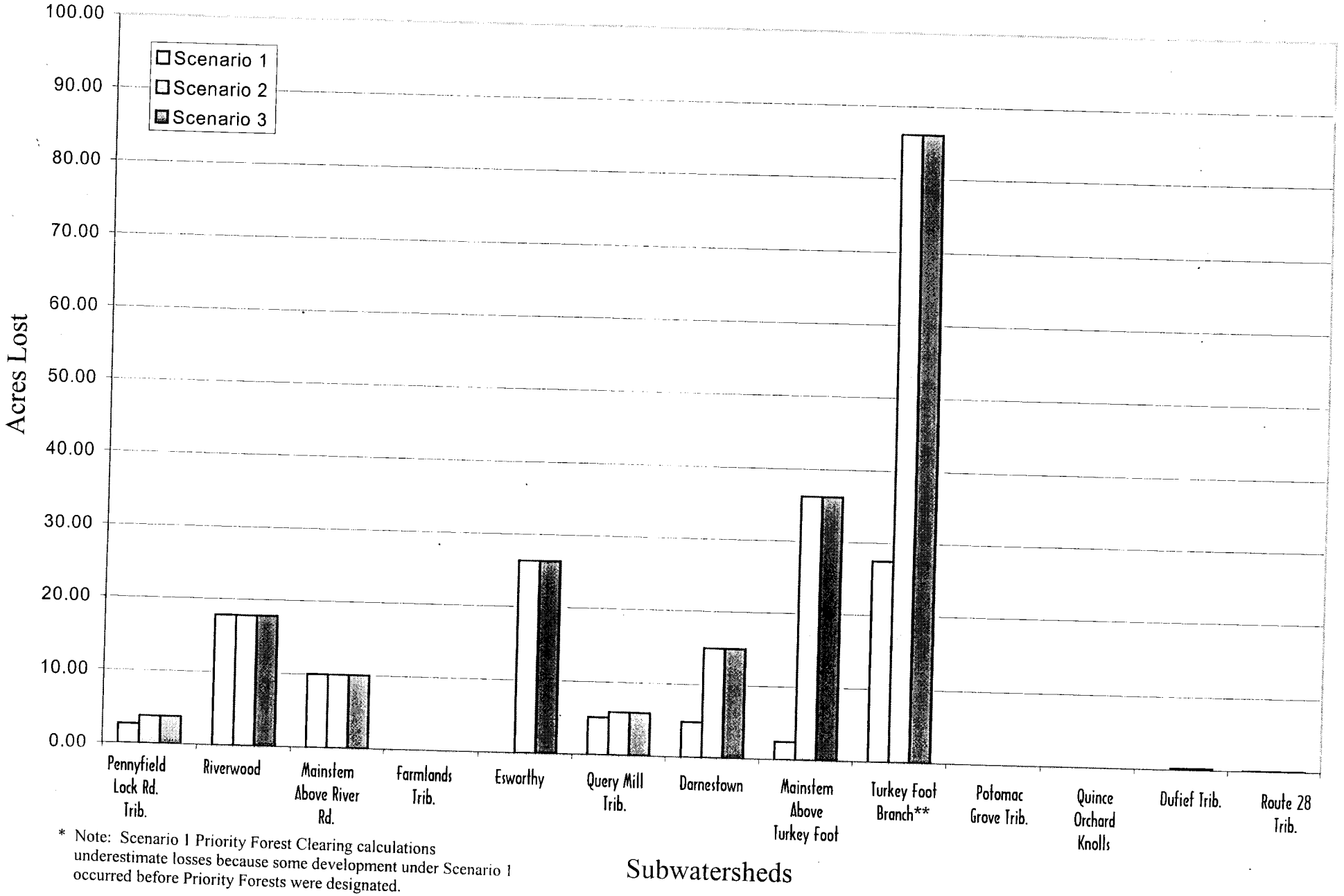
Figure 17 - Priority Forest Cleared in Muddy Branch by Subwatershed



* Note: Scenario 1 Priority Forest Clearing calculations underestimate losses because some development under Scenario 1 occurred before Priority Forests were designated.

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attributable to significant development in the headwaters area. For example, the headwaters area is projected to increase in imperviousness from a 1993 baseline of 22% to 32% under build-out conditions. This increased imperviousness in the headwaters area is predicted to degrade stream health in the downstream subwatersheds of Mainstem Above Turkey Foot and Query Mills Tributaries. This projection does not account for retrofit projects, or any extraordinary BMPs that may be incorporated in development in the headwaters.

RTE Impacts – There would be minimal loss of serpentinite habitat (0.5 acres) and no loss of potential RTE habitat under all three scenarios.

Forest Clearing – There would be no clearing of priority forest under all three scenarios.

Mainstem Above Turkey Foot

Stream Health – The CSPS assigned the Mainstem above Turkey Foot subwatershed a good stream rating. The PSCI model predicted fair stream conditions; however, this rating was adjusted up to reflect the extensive stormwater management that is currently provided within the subwatershed. Under Scenario 1, this subwatershed is predicted to maintain its existing good stream condition despite impervious surfaces that exceed 22% because of extensive stormwater management. With Scenario 2, however, increased impervious surfaces reaching approximately 29% (much of which would occur in the headwater area) are predicted to degrade stream health to fair conditions.

Under Scenario 3, a proposed alternative would extend gravity sewer to serve the Hanson Farm property. The extension of sewer service would result in only a slight increase in impervious surfaces since the provision of sewer was not assumed to result in a significant increase in density. The property does abut a large priority wetland complex along the mainstem of Muddy Branch. Extension of WSSC sewer would adversely affect approximately 1.3 acres of forested priority wetlands, although no stream crossings should be necessary. The Mainstem Above Turkey Foot subwatershed is predicted to degrade from good to fair stream conditions, primarily due to significant development in the headwaters area. The proposed sewer extension would contribute little to this overall degradation of stream health.

RTE Impacts – Serpentinite habitat loss would remain constant at 18 acres (7.9% of the total remaining unbuilt serpentinite habitat in the Muddy Branch watershed) under all three scenarios.

Forest Clearing – Priority forest clearing would increase from 3 acres under Scenario 1, to 36 acres under Scenarios 2 and 3. Under Scenario 3, sewer would allow cluster development, potentially saving more forest area.

Query Mill Tributaries

Stream Health – Under Scenario 1, despite relatively little approved development, this subwatershed is predicted to degrade from good to fair condition. This is attributable to an existing borderline good condition and significant stream reaches that are susceptible to sediment deposition. With Scenario 2, stream condition is predicted to remain fair, because impervious surfaces are projected to only increase slightly (much of which would occur in the headwater area), although it is predicted to be borderline poor.

RTE Impacts – Serpentinite habitat losses would increase from 2 acres under scenario 1, to 23 acres under scenarios 2 and 3. Additionally, 8 acres of potential RTE habitat would be lost under Scenarios 2 and 3.

Forest Clearing – Priority forest clearing would increase from 5 acres under Scenario 1, to 6 acres under Scenarios 2 and 3.

Potomac Grove Tributary

Stream Health – This subwatershed is currently assigned a good stream rating by the CSPS. Stream conditions, however, are borderline fair as reflected by the CSPS score of 63 at monitoring station MBMB107. Approved developments under Scenario 1 are predicted to degrade stream health from a borderline good to fair as the level of imperviousness is projected to increase from 19 to 22%. The Potomac Grove Tributary is predicted to retain a fair stream condition under Scenarios 2 and 3.

RTE Impacts – There would be minimal loss of serpentinite habitat (0.3 acres) under all three Scenarios.

Forest Clearing – There would be no clearing of priority forest under all three scenarios.

Mainstem Above River Road

Stream Health – This subwatershed is predicted to degrade from a borderline good to fair condition under Scenario 1. This is partially attributable to this subwatershed's geomorphic susceptibility to degradation. With Scenarios 2 and 3, it is predicted to retain a fair rating.

RTE Impacts – Loss of serpentinite habitat would remain constant at approximately 8 acres under all three development scenarios.

Forest Clearing –Priority forest clearing would remain constant at approximately 10 acres under all three scenarios.

Pennyfield Lock Road Tributary

Stream Health –The Pennyfield subwatershed is predicted to retain its borderline good stream condition under Scenario 1, but to degrade to fair under Scenarios 2 and 3 as impervious surfaces increase from 16 to 22%.

RTE Impacts – Loss of serpentinite habitat would remain constant at 6 acres under all three scenarios.

Forest Clearing – Priority forest clearing would increase minimally from 3 acres under Scenario 1 to 4 acres under Scenarios 2 and 3.

4.3 Cabin John Creek Watershed

The Cabin John Creek watershed within the Potomac planning area includes 10 subwatersheds. According to the *Countywide Stream Protection Strategy* (1993 baseline), Buck and Lower Buck Branch, Ken and Lower Ken Branch, and Congressional C.C. Tributary are in good condition; Mainstem, Middle Mainstem, and Lower Mainstem are in fair condition; and Snakeden Branch is in poor condition.

The Cabin John watershed has the least forest and the least priority forest of the watersheds within the planning area. It also does not have any known RTE habitat or serpentinite geology. The Snakeden Branch subwatershed is geomorphically susceptible to degradation, which may at least partially explain why this subwatershed is currently in poor condition. Several of the subwatersheds, especially Buck Branch and Lower Buck Branch, have a significant amount of the existing imperviousness receiving stormwater management, which may at least partially explain why these two subwatersheds are currently in good condition despite impervious levels of 18%.

Stream Health - Many of these subwatersheds are already almost fully developed, and, as a result, stream conditions are not predicted to change. Buck and Lower Buck Branch, Ken Branch, and Congressional subwatersheds are predicted to retain good stream conditions under all the scenarios. Similarly, Middle Mainstem and Lower Mainstem subwatersheds are predicted to retain fair stream conditions and Snakeden Branch is predicted to remain in poor condition under all the scenarios. Lower Ken Branch is predicted to degrade from a borderline good condition to fair as a result of increases in imperviousness from 12 to 15% under Scenario 1. The Mainstem subwatershed is predicted to degrade from fair to poor condition under Scenario 2 as impervious surfaces increase from 25 to 32%.

RTE Impacts – There would be no impacts to serpentinite habitat or potential RTE habitat under any of the scenarios

Forest Clearing – Clearing of priority forest would increase from 5 acres under Scenario 1 to 10 acres under Scenarios 2 and 3.

4.4 Rock Run Watershed

The Rock Run watershed is totally encompassed within the Potomac planning area and consists of 5 subwatersheds: Upper Rock Run, Avenel North, Avenel South, Lower Rock Run, and Potomac Direct #4. According to the *Countywide Stream Protection Strategy*, most of the Rock Run Watershed is in poor condition. This is attributed to nutrient enrichment and the lack of adequate stream buffers. For example, only 22% of the riparian buffer is forested in the Avenel North subwatershed, the lowest value for any subwatershed in the planning area. Stream conditions appear to improve slightly in the downstream portion of the watershed, as the Lower Rock Run subwatershed receives a fair rating.

The Rock Run watershed contains approximately 20% of the total forest and 18% of the priority forest within the planning area. It also has the largest amount of RTE habitat, although this is all found on publicly-owned or protected lands.

Stream Health – Stream health is predicted to remain poor in all Rock Run subwatersheds, with the exception of Lower Rock Run, which retains a fair rating and Potomac Direct #4, which retains a good rating.

RTE Impacts – There would be no impacts to RTE habitat under any of the scenarios.

Forest Clearing – Clearing of priority forest would remain constant at 6 acres for each of the scenarios.

4.5 Lower Great Seneca Creek Watershed

The Lower Great Seneca Creek watershed within the Potomac planning area includes portions of three subwatersheds: South Germantown, Lower Great Seneca, and Potomac Direct #6. According to the *Countywide Stream Protection Strategy,* these subwatersheds are currently (1993 baseline) in good condition.

The Lower Great Seneca Creek watershed contains the most priority forest (i.e. 2,659 acres or nearly 38% of the total in the planning area) of any of the watersheds in the planning area. It also has large areas of total forest, although no known RTE habitat or serpentinite geology.

Stream Health – Stream health is predicted to remain good under all three scenarios. This is attributable to the relatively low density development planned (5 to 7% imperviousness at build-out) and excellent riparian buffers (over 70% of the riparian buffer is forested).

RTE Impacts – There are would be no impacts to RTE habitat under any of the scenarios.

Forest Clearing – Clearing of priority forests would increase from 264 acres (9.9% of the total remaining priority forest in Lower Great Seneca watershed) under Scenario 1 to 474 acres (17.8%) under Scenarios 2 and 3.

Appendices

Appendix A
Description of PSCI Model

DESCRIPTION OF THE PSCI MODEL

The Potomac Subregion Cumulative Impact (PSCI) Model is a statistical model that relates various land use variables with stream quality or health. The development of the PSCI model involved three basic steps: selection of stream monitoring stations for inclusion in the data set; selection of the dependent and independent variables to be analyzed in the model; and the statistical analysis. This Appendix describes the steps involved with the development of the PSCI model. For more detail, please refer to the Stream Condition Cumulative Impact Models for the Potomac Subregion report (ERM, 1999).

Selection of Stream Monitoring Stations

As part of the *Countywide Stream Protection Strategy,* stream data was primarily collected by DEP and also used data from a variety of sources including the M-NCPPC, Maryland Department of Natural Resources, Maryland Department of the Environment, Audubon Naturalist Society, and Metropolitan Washington Council of Governments and the Interstate Commission for the Potomac River Basin. For the purposes of this statistical analysis, only stream data collected by DEP and M-NCPPC was included in order to assure consistency in data collection. More detailed information available for selected areas of the County (such as Watts Branch, City of Gaithersburg, City of Rockville) was not included because consistent data was not available for a statistically significant sample.

DEP has collected stream biological and habitat data at over 300 monitoring stations across Montgomery County. The M-NCPPC has also cooperated in this data collection effort. Each monitoring station was assigned a unique four letter watershed/subwatershed designation and a three digit stream code with the first number indicating stream order (i.e. WBPB102 is a monitoring station in the **W**atts **B**ranch watershed and the **P**iney **B**ranch subwatershed on a 1st order stream).

Six basic criteria were used to initially screen this data set:

- *Location within areas with similar underlying soils and geology* – The Potomac Subregion Planning Area is located within two of Montgomery County's three major sub-ecoregions – the Silt Loam and the Channery Silt Loam Sub-ecoregions, which are defined by their underlying soil and geologic characteristics. Any monitoring stations located in the third sub-ecoregion, the Triassic Loam Sub-ecoregion, were excluded from the data set in order to minimize the introduction of natural variability expected with differing sub-ecoregions.
- *Preference for first and second order streams* – Stream size (as indicated by stream order) affects stream flow conditions, which naturally influences stream biological communities. In the CSPS, DEP accounted for this natural variability by developing separate IBIs for stream size – one for 1st and 2nd order streams and another for 3rd and 4th order streams. Most land drains directly to 1st and 2nd order streams and these smaller streams more immediately reflect the influence of land use, whereas larger 3rd and 4th order streams are more strongly influenced by long-term channel adjustment and in-stream processes. In order to reduce the effects from temporal variability, smaller streams were focused on,

while most monitoring stations draining 3rd and all draining 4th order streams were excluded from the data set. Some monitoring stations draining smaller 3rd order streams were retained in order to assure an adequate sample size.

- *Presence of recent development within the monitoring station's drainage area* – The Potomac Subregion planning area is in a developing area and this model is intended to assess the effects of new development on stream health. Therefore, the data set should include monitoring stations that reflect similar active development characteristics. M-NCPPC staff identified census tracts that experienced greater than a 80 percent increase in households between 1980 and 1990 and transportation zones that experienced greater than a 40 percent increase in dwelling units between 1990 and 1996. Monitoring stations that were not located within these census tracts or transportation zones were excluded.

- *Lack of large older urban areas* – Large portions of eastern and southern Montgomery County have urban areas that were developed prior to current environmental controls. These areas were largely developed without any stormwater management and, in many cases long sections of 1st and 2nd order streams were piped. These older urban areas are not representative of the streams or type of new development that would occur in the Potomac Subregion and were therefore excluded from the data set.

- *Availability of data* – Biological sampling and data analysis has not yet been completed for several monitoring stations. In some cases, monitoring data was only available for either fish or aquatic insects, but not both. The combination of fish and aquatic insect data provides a more complete assessment of stream health. There are a few monitoring stations that drain portions of other counties for which accurate land use information was not available. Therefore, monitoring stations for which complete data was not available were excluded from the data set.

- *Extent of development between dates of planimetrics and biological sampling* – Much of the data used in this analysis was drawn from M-NCPPC's planimetric GIS file and from DEP's biological sampling. These data were collected over a number of years, with generally the planimetric data being several years older. The lag between the dates of the planimetrics and the biological sampling is important in understanding and interpreting the results. The greater the time between these dates, the greater the chance that additional development occurred that is not reflected in the planimetrics, but may be expressed in the results of the biological sampling. All subwatersheds with two or more years between planimetrics and biological monitoring were checked and stations with a significant amount of development during the intervening period were dropped from the data set.

Using these six criteria, the data set was narrowed to 50 monitoring stations. A final review of the data set resulted in two additional monitoring stations being eliminated, both of which related to the Travilah quarry in the Watts Branch watershed. Although the quarry historically drained to Greenbriar Branch, water is now discharged from the quarry to Upper Sandy Branch. This artificial hydrologic modification, combined with the unusual serpentinite geologic formation found in this area, justified the exclusion of these two monitoring stations.

The final result of this screening process resulted in the selection of 48 monitoring stations for use in the statistical analysis. The screening process assured that complete information was available for the monitoring stations and that the stations are representative of the environmental and developmental characteristics of the Potomac Subregion.

Selection of Dependent and Independent Variables

Since the statistical model is intended to predict future stream conditions based on biological monitoring data, the dependent variable should be a measure of stream biological conditions. Therefore, the dependent variable selected was the *PSCI Score,* which is a combination of the fish and benthic IBI scores. In order that both fish and benthic IBI scores were weighted equally, the benthic IBI scores were adjusted to have the identical range as the fish IBI scores (10 to 50) for a combined range of 20 to 100. The table below shows the relationship between the PSCI score and the PSCI stream rating.

PSCI Stream Rating	PSCI Score
Excellent	Greater than 87
Good	64 – 86
Fair	45 – 63
Poor	Less than 45

The *independent variables* help quantify, or explain, the dependent variable. The selection of independent variables for analysis was primarily based on the technical literature that identified factors that affect stream health, and are listed below:

- Impervious surfaces
- Cropland
- Road crossings
- Forested riparian buffers
- Wetlands
- Forest cover
- Pasture land
- Soil associations
- Septic systems
- Stormwater management
- Physical Habitat Variables – DEP requested that three physical habitat variables be evaluated: canopy coverage, channel width-to-depth ratio, and stream entrenchment.

Impervious surface is a critical independent variable. This study used a broader definition of imperviousness, reflecting each land use's relative hydrologic contribution to the stream system as established in the *Countywide Stream Protection Strategy*. DEP calculated the percent imperviousness using M-NCPPC's planimetric coverage, which grouped land uses into the following categories: open land (lawns, golf courses, cemeteries, etc.), woodlands, pasture, cropland, parking, roads, buildings, and sidewalks. DEP assigned each of these land use categories an imperviousness factor (see Table below). The sum of multiplying each of these impervious factors against the acreage of that particular land use in the drainage area

equaled the total impervious area. This total impervious area variable was expressed as a percent of the drainage area to each monitoring station.

Impervious Factors (Source: DEP)	
Land Use Category	Impervious Factor
Buildings	1.00
Parking	1.00
Roads	1.00
Sidewalks	1.00
Cropland	0.03
Pasture	0.03
Open Land	0.03
Woodland	0.01

Statistical Analysis

The dataset was analyzed using a statistical method called linear regression. Both step-wise and multivariate linear regression analyses and analysis of variance were performed to determine which independent variables listed above best explain the variability associated with the PSCI Scores.

Recommended PSCI Models

The regression analyses identified several regressions that can serve as models for predicting the effects of development on stream health in the Potomac study area. The four models listed below, in particular, are recommended:

Model Name	**Regression Equation**	**r^2**
BENTHIC IBI 1st Order Streams	BENTHIC IBI = -12.0273(ln impervious) – 0.4822(√drainage area) – 46.9174(%cropland) -+ 1156.120(%palustrine wetlands) + 35.1294(septic systems/acre) + 7.1593	0.88
BENTHIC IBI 2nd/3rd Order Streams	BENTHIC IBI = -111.560(%impervious) – 0.4569(√drainage area) + 725.386(road crossings/acre) + 52.0990	0.81
CSPS Score All Streams	CSPS Score = -159.9462(%impervious) – 598.1195(road crossings/acre) + 512.4691(%palustrine wetlands) + 92.8020	0.59
BENTHIC IBI All Streams	BENTHIC IBI = 4.3746(Z1) – 88.5798(%impervious) – 0.4079(√drainage area) + 46.3757	0.71

These 4 models all have very high correlation coefficients, high confidence levels, and are applicable to a wide range of stream sizes. Although strong correlations were also obtained with the Stream Rating dependent variable, the CSPS dependent variable is preferred because it produced equally strong correlations and uses the more robust semi-continuous variable

(with a range of 20 to 100), versus the 4 ordinal values of the Stream Rating (Excellent, Good, Fair, and Poor).

The following factors were considered in selecting which PSCI model to use for this analysis:

(1) The selected model must be able to predict stream health for the 1st through 3rd order streams found within the Potomac Subregion. Therefore, neither the 1st order nor the 2nd/3rd order stream models alone could be used for the entire study area. Since it is preferred that a single model be used in the planning process for consistency reasons, either the Benthic IBI – All Streams or the CSPS Score – All Streams model should be used.

(2) The Benthic IBI – All Streams model yielded a stronger coefficient of determination ($r^2 = 0.71$) than the CSPS Score – All Streams model ($r^2 = 0.59$) and would be preferable. The Benthic IBI – All Streams model included 3 variables – percent imperviousness, square root of the drainage area, and stream order. In testing this model with the Potomac Subregion stream data set, however, it became obvious that the drainage area variable was problematic. Some of the drainage areas within the Potomac Subregion are as large as 14,000 acres, whereas the largest drainage area in the data set used to develop the regression equations is only approximately 2,600 acres. Therefore, results from the model for large drainage areas were skewed.

(3) The CSPS Score – All Streams model does not include drainage area as a variable in the regression. The variables in this model include percent imperviousness, road crossings per acre, and percent palustrine emergent wetlands. This model was tested with the Potomac Subregion stream data set and performed very well.

As a result of this systematic screening process, the CSPS Score – All Streams regression model is recommended for use in the Potomac Subregion master planning process. All variables and models were checked through this process for co-linearity and other distribution-related characteristics that affect the validity of a variable or combination of variables in a multivariate model. The selected model yielded a correlation coefficient (r^2) of 59% at the 99.9% confidence level. This high confidence level indicates that the observed correlation does not occur by chance, and that the statistical model describes actual relationships between variables.

The multivariate model regression equation is:

PSCI rating = –(159.9462 * %impervious) – (598.1195 * road crossings per acre) + (512.4691 * %palustrine emergent) + 92.8020

The relative contribution to the correlation coefficient by variable is shown below.

Variable	Cumulative r^2	Δr^2
Percent impervious	56.4%	56.4%
Road crossings per acre of watershed	57.7%	1.3%
Percent palustrine emergent wetlands	59.0%	1.3%

The regression model was then used to predict future stream health, as measured by the PSCI Score (possible range of 20-100 points), in each of the watersheds in the planning area. At the 95% confidence level, the percent impervious variable alone predicts the PSCI score with a confidence interval of plus or minus four PSCI points.

Appendix B
Model Validation

MODEL VALIDATION

In terms of the 8 subwatersheds where the model was off by one stream rating, the following information should be noted:

- For one of the subwatersheds (Lower Watts Branch), the model was only off by 1 PSCI point from predicting the stream rating accurately within the confidence interval (approximately 4 PSCI points) of the model.
- For four of the subwatersheds (Lower Piney Branch, Middle Piney Branch, Upper Sandy Branch, and Mainstem above Turkey), the Predicted PSCI Stream Rating is consistent with the Observed CSPS Score, but not the Observed CSPS Stream Rating. For example, Lower Piney Branch subwatershed was assigned a CSPS Stream Rating of fair, despite an Observed CSPS Score of 85, which would normally indicate good stream conditions. The model predicted a PSCI Score of 78 and was therefore assigned a PSCI Stream Rating of good, which was consistent with the Observed CSPS Score, but technically inconsistent with the CSPS Stream Rating of fair. This apparent inconsistency is reflective of a slight difference between the CSPS Stream Ratings and the PSCI Stream Ratings. DEP assigned CSPS Stream Ratings based on overall stream health in the subwatershed as measured at all monitoring stations within the subwatershed. The PSCI Stream Ratings also reflect overall stream health, but is measured at the most downstream point of the subwatershed.
- For three of the subwatersheds, there are known unusual factors other than land use that are affecting stream health (Greenbriar Branch – serpentinite geology, Beltway Branch – stream channelization, and Upper Rock Run – water quality problems).

Appendix C
Results of the PSCI Model

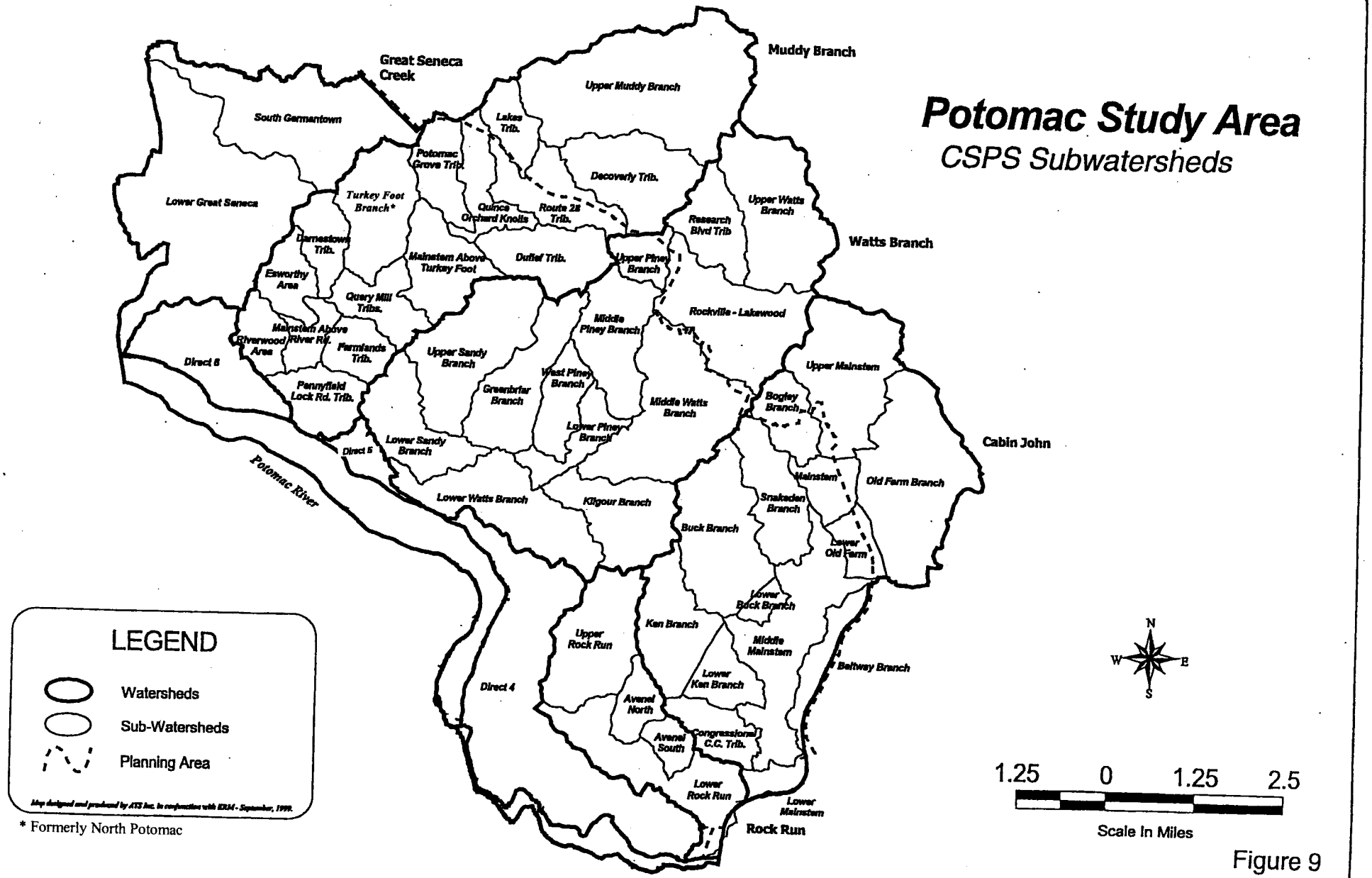
Table 2: Summary of Environmental Impacts of Scenarios on Stream Health

Subwatershed	EXISTING		SCENARIO 1				SCENARIO 2				SCENARIO 3					
	% Impervious	Observed Rating	% Impervious	Predicted PSCI Score	Predicted Rating	Adjusted Rating	% Impervious	Predicted PSCI Score	Predicted Rating	Adjusted Rating	% Impervious	Predicted PSCI Score	Predicted Rating	Adjusted Rating	Adjustments	
															-	+
Watts Branch																
Lower Watts Branch	14	F	18	61	F-G	F	22	53	F	F	23	52	F	F	GM	
Kilgour Branch	21	F	21	54	F	F	29	40	P	P	29	40	P	P	GM	
Middle Watts Branch	22	F	23	51	F	F	32	35	P	P	32	35	P	P	GM	
Lower Piney Branch	7	F	17	59	F	F	18	56	F	F	18	55	F	F	GM	
West Piney Branch	8	G	10	70	G	G	11	67	F-G	G	12	66	F-G	F	B	
Middle Piney Branch	7	F	22	53	F	F	23	49	F	F	23	49	F	F	GM	
Upper Piney Branch	10	G	29	34	P	P	29	34	P	P	29	34	P	P		SWM
Greenbriar Branch	4	F	10	74	G	F	11	73	G	F	17	60	F-G	F	S	
Upper Sandy Branch	8	F	15	68	F-G	F	15	66	F-G	F	16	64	F-G	F		
Rockville	26	F	26	47	P-F	F	40	23	P	P	40	23	P	P		
Research Boulevard	33	F	33	36	P	P	47	20	P	P	47	20	P	P		
Upper Watts	26	F	26	48	F	F	52	20	P	P	52	20	P	P		
Lower Sandy Branch	7	G	12	71	G	G	14	69	G	G	15	65	F-G	F	B	
Muddy Branch																
Pennyfield	16	G	17	63	F-G	G	22	54	F	F	22	54	F	F		
Riverwood	5	G	7	80	G	G	7	79	G	G	7	79	G	G		
Mainstem above River	17	G	18	62	F-G	F	24	52	F	F	24	52	F	F	GM	
Farmlands	9	G	11	74	G	G	11	73	G	G	11	73	G	G		
Esworthy	7	G	9	79	G	G	10	78	G	G	10	78	G	G		
Query Mill	19	G	20	59	F	F	26	48	F	F	26	48	F	F	GM	
Darnestown	6	G	9	79	G	G	10	78	G	G	10	78	G	G		
Mainstem Above Turkey	21	G	22	56	F	G	29	43	P-F	F	29	43	P-F	F		SWM
Turkey Foot Branch*	8	G	13	71	G	G	15	66	F-G	G	15	66	F-G	G		
Potomac Grove	19	G	22	56	F	F	22	56	F	F	22	56	F	F		
Quince Orchard	22	G	22	55	F	G	30	41	P-F	F	30	41	P-F	F		R
Dufief	30	G	34	37	P	F	38	29	P	P	38	29	P	P		R
Upper Muddy	26	F	26	50	F	F	32	39	P	P	32	39	P	P		
Lakes Trib	15	F	15	68	G	F	54	20	P	P	54	20	P	P		
Decoverly Trib	18	F	18	60	F-G	F	31	39	P	F	31	39	P	F		SWM
Route 28 Tributary	22	F	22	55	F	F	32	38	P	P	32	38	P	P		
Cabin John																
Middle Mainstem	21	F	22	53	F	F	24	50	F	F	24	50	F	F		
Congressional	10	G	12	70	G	G	12	70	G	G	12	70	G	G		
Lower Ken Branch	12	G	15	61	F-G	F	15	60	F-G	F	15	60	F-G	F		
Ken	12	G	12	63	F-G	G	15	63	F-G	G	15	63	F-G	G		
Lower Buck Branch	18	G	18	59	F	G	18	58	F	G	18	58	F	G		SWM
Buck Branch	18	G	18	59	F	G	19	59	F	G	19	59	F	G		SWM
Snakeden Branch	21	P	22	51	F	P	22	50	F	P	22	50	F	P	GM	
Bogley Branch	25	F	25	50	F	F	25	50	F	F	25	50	F	F		
Mainstem	25	F	25	50	F	F	32	36	P	P	32	36	P	P		
Upper Mainstem	26	F	26	47	P-F	F	38	25	P	P	38	25	P	P		
Old Farm Branch	33	F	33	37	P	P	36	32	P	P	36	32	P	P		
Lower Old Farm	32	P	32	39	P	P	34	34	P	P	34	34	P	P		
Beltway Branch (In Area)	21	P	21	55	F	P	21	55	F	P	21	55	F	P	C	
Lower Mainstem (In Area)	21	F	22	54	F	F	23	50	F	F	23	50	F	F		
Rock Run																
Upper Rock Run	15	P	17	59	F	P	17	59	F	P	17	59	F	P	WQ	
Avenel North	12	P	14	66	F-G	P	14	64	F-G	P	14	64	F-G	P	WQ	
Avenel South	14	P	18	59	F	P	18	59	F	P	18	59	F	P	WQ	
Lower Rock Run	13	F	14	65	F-G	F	15	65	F-G	F	15	65	F-G	F	WQ	
Direct 4	9	NA	11	73	G	G	11	72	G	G	11	72	G	G		
Lower Great Seneca Creek																
Direct 6	4	NA	4	86	G	G	5	84	G	G	5	84	G	G		
Lower Great Seneca (In Area)	4	G	5	84	G	G	6	82	G	G	6	82	G	G		
S. Germantown (In Area)	5	G	6	90	G-E	G	7	89	G-E	G	7	89	G-E	G		

E= Excellent >87
G= Good= 64-86
F= Fair =45-63
P = Poor= <45

* Formerly North Potomac

Adjustments: GM= Geomorphology makes subwatershed more suceptible to hydrologic changes reducing PSCI score
C= Stream has been channelized reducing expected PSCI score
S= Unique serpentenite geology reduces expected PSCI score
SWM= Extensive stormwater management improves PSCI some
R= Bedrock substrate makes subwatershed more tolerant of hydrologic changes improving PSCI score
B=Significant impacts to forested riparian buffer from sewer construction reduces expected PSCI score
WQ= Water quality problems reduce PSCI score



* Formerly North Potomac

Figure 9

Appendix D
Estimates of Impacts to Important Habitats

Table 3: RTE Habitat Loss and Forest Cleared by Watershed

	Lower Great Seneca Creek			Muddy Branch			Watts Branch			Cabin John			Rock Run		
	Habitat Lost (Acres)	*Habitat* Remaining (Acres)*	*Percent Habitat Lost (%)*	*Habitat Lost (Acres)*	*Habitat* Remaining (Acres)*	*Percent Habitat Lost (%)*	*Habitat Lost (Acres)*	*Habitat* Remaining (Acres)*	*Percent Habitat Lost (%)*	*Habitat Lost (Acres)*	*Habitat* Remaining (Acres)*	*Percent Habitat Lost (%)*	*Habitat Lost (Acres)*	*Habitat* Remaining (Acres)*	*Percent Habitat Lost (%)*
Serpentinite Habitat Lost															
Existing Baseline (1993)		0			232			1204			0			0	
Scenario 1	0	0	0%	90	142	39%	519	685	43%	0	0	0%	0	0	0%
Scenario 2	0	0	0%	143	89	62%	717	487	60%	0	0	0%	0	0	0%
Scenario 3	0	0	0%	143	89	62%	943	261	78%	0	0	0%	0	0	0%
Potential RTE Habitat Lost															
Existing Baseline (1993)		0			14			767			0			1256	
Scenario 1	0	0	0%	3	11	19%	224	543	29%	0	0	0%	0	1256	0%
Scenario 2	0	0	0%	11	3	81%	270	497	35%	0	0	0%	0	1256	0%
Scenario 3	0	0	0%	11	3	81%	496	271	65%	0	0	0%	0	1256	0%
Priority Forest Cleared															
Existing Baseline (1993)		2659			1423			870			804			1284	
Scenario 1	235	2424	9%	82	1341	6%	27	843	3%	5	799	1%	6	1279	0%
Scenario 2	423	2236	16%	201	1222	14%	109	760	13%	10	795	1%	6	1279	0%
Scenario 3	423	2236	16%	201	1222	14%	328	541	38%	10	795	1%	6	1279	0%
Total Forest Cleared															
Existing Baseline (1993)		3198			2763			3325			1647			2820	
Scenario 1	444	2754	14%	445	2319	16%	970	2355	29%	155	1491	9%	167	2653	6%
Scenario 2	668	2530	21%	636	2128	23%	1141	2184	34%	204	1443	12%	204	2616	7%
Scenario 3	668	2530	21%	636	2128	23%	1361	1964	41%	204	1443	12%	204	2616	7%

*Note: For example, in Muddy Branch there were 232 acres of serpentinite habitat under baseline conditions (1993). Under development Scenario 1, 90 of the 232 acres of serpentinite habitat would be lost, with 142 acres remaining. In some cases, the number of total acres may vary slightly due to rounding.

Figure 18 - Total Forest Cleared in Watts Branch by Subwatershed

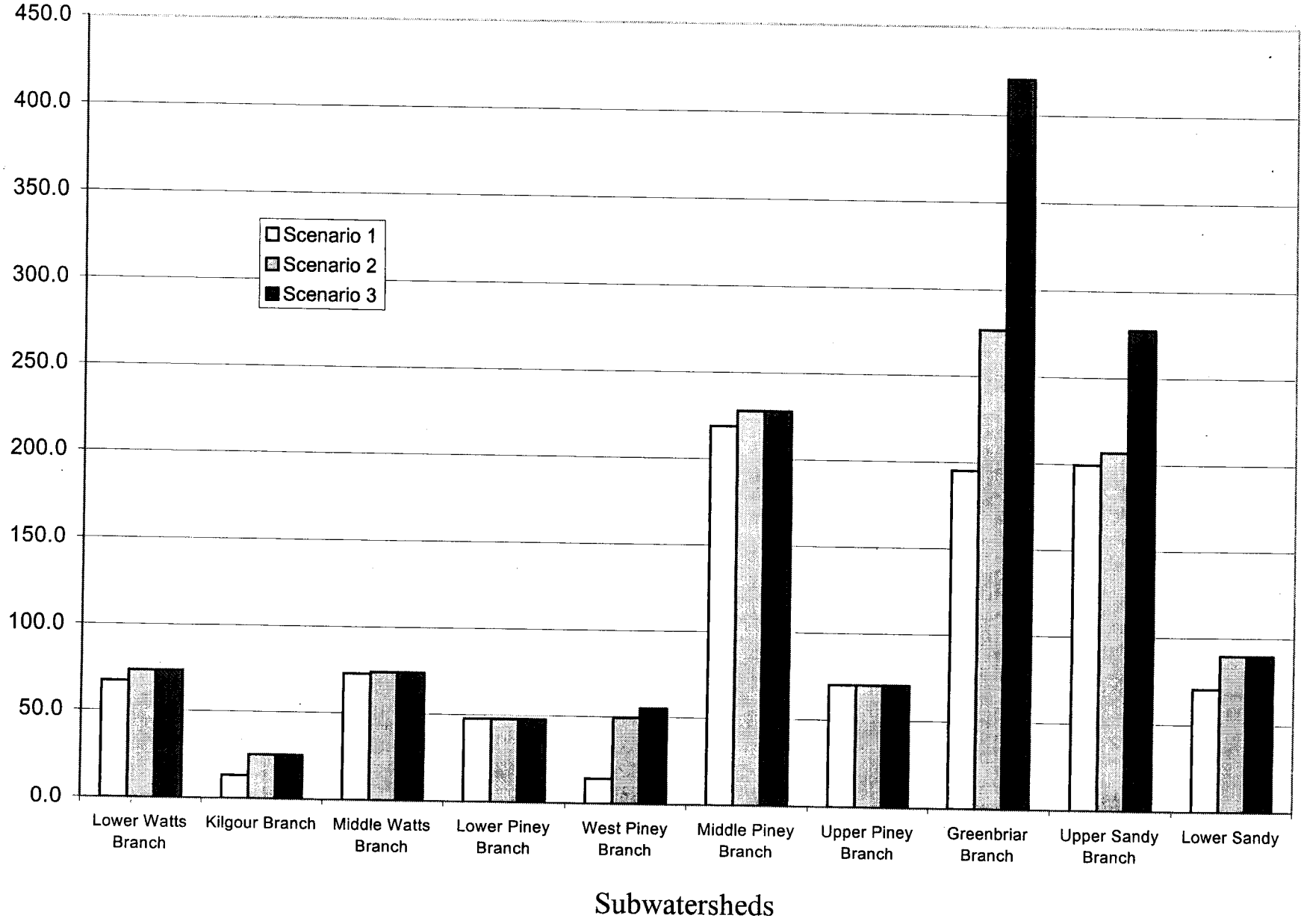
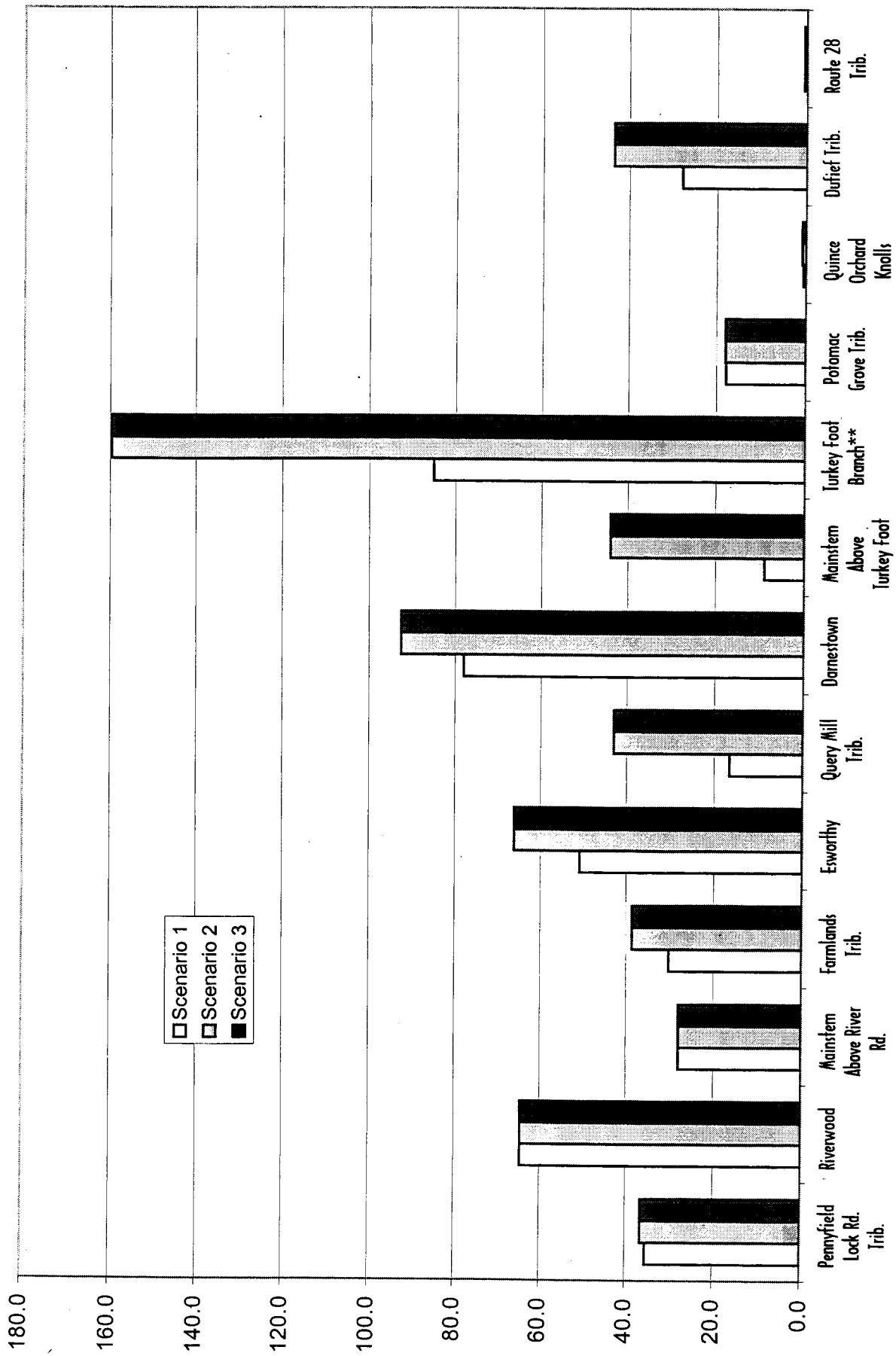
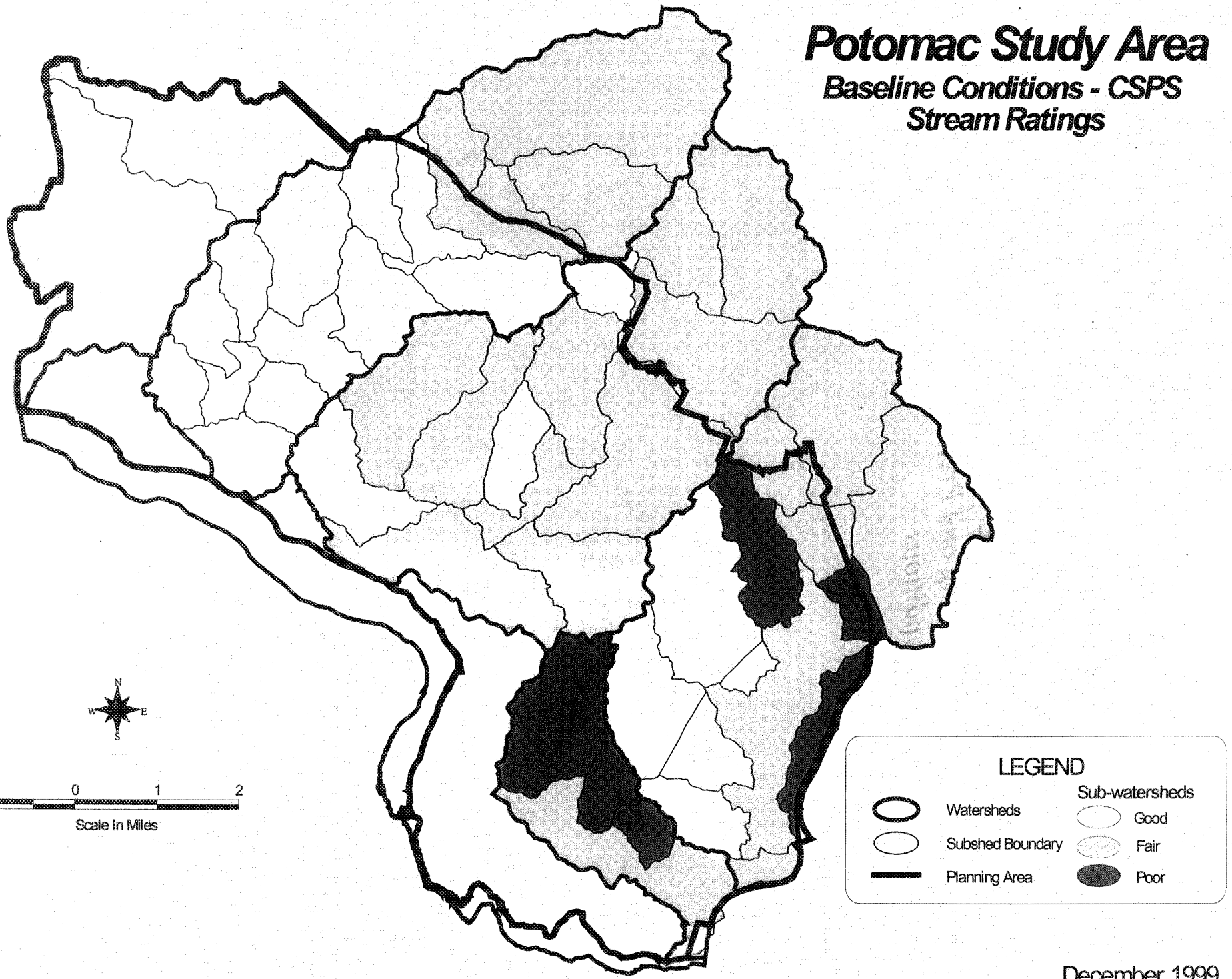


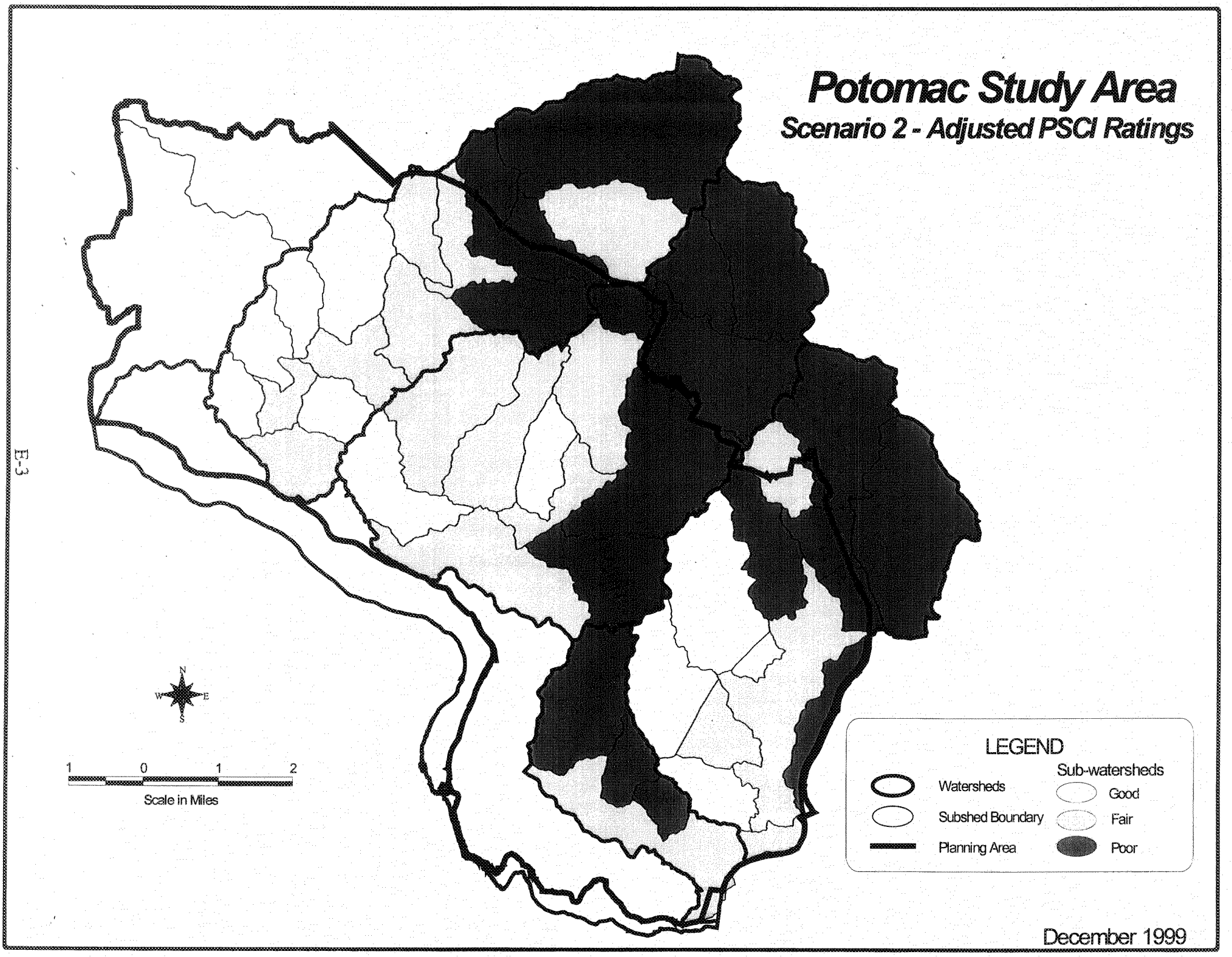
Figure 19 - Total Forest Cleared in Muddy Branch by Subwatershed

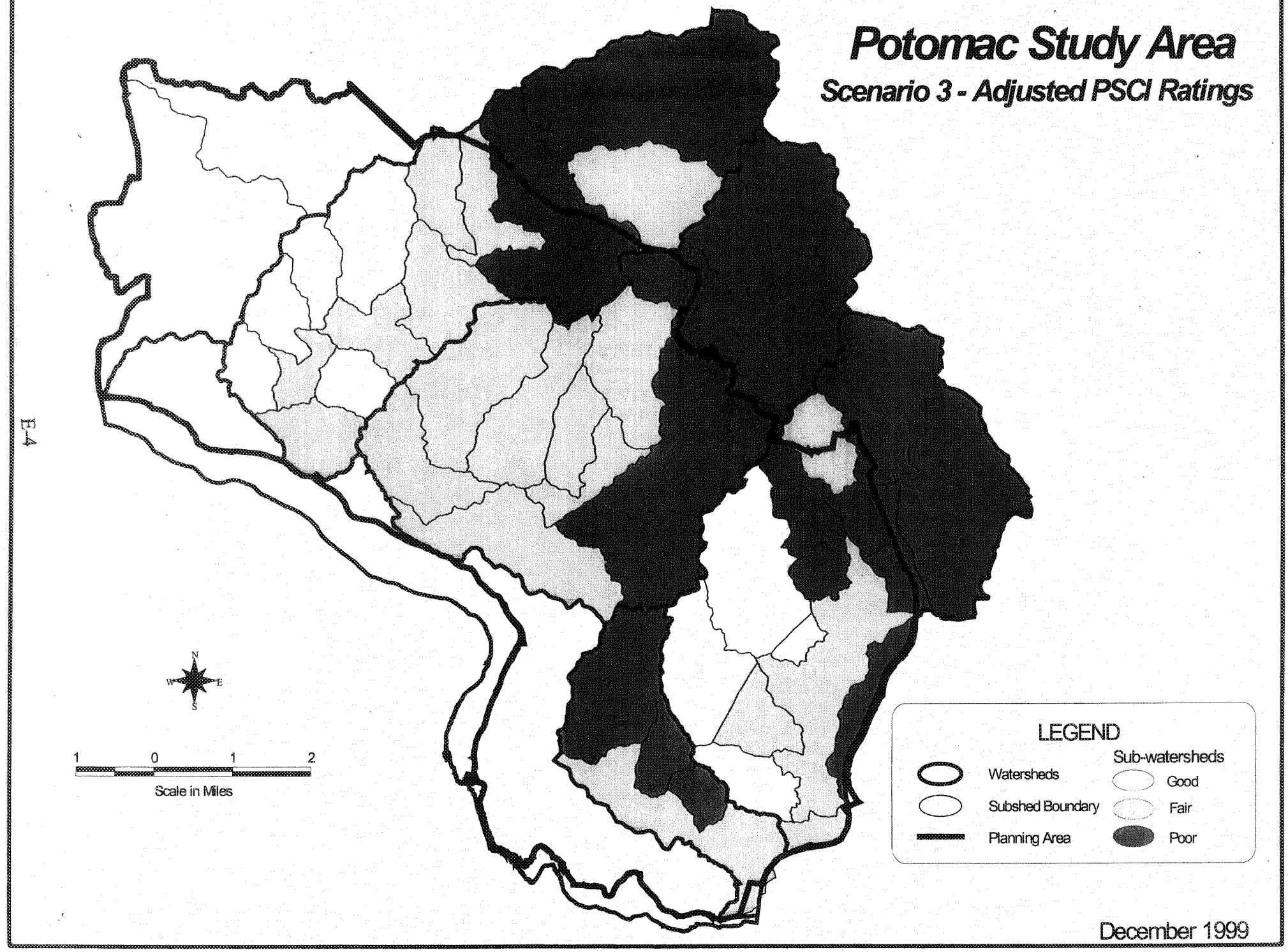


** Formerly North Potomac

Appendix E
Existing and Predicted Stream Conditions


Potomac Study Area
Baseline Conditions - CSPS
Stream Ratings
N
W
E
S
1 0 1 2
Scale in Miles
LEGEND
Watersheds
Subshed Boundary
Planning Area
Sub-watersheds
Good
Fair
Poor
December 1999


Potomac Study Area
Scenario 2 - Adjusted PSCI Ratings
N
W
E
S
1 0 1 2
Scale in Miles
LEGEND
Watersheds
Subshed Boundary
Planning Area
Sub-watersheds
Good
Fair
Poor
December 1999


Potomac Study Area
Scenario 3 - Adjusted PSCI Ratings
N
W
E
S
1 0 1 2
Scale in Miles
LEGEND
Watersheds
Subshed Boundary
Planning Area
Sub-watersheds
Good
Fair
Poor
December 1999