UPN7—Unnamed Tributary to the Patuxent River.
This subwatershed is the second subwatershed located above the confluence of the Little Patuxent River. It is located north of Crofton and is completely contained within the Patuxent Research Refuge. One water chemistry and one biological monitoring station were sampled here.

Land Use. Land use within this subwatershed is summarized in the table below:

Table 16. Land Use Summary for UPN1

Land Use	Acres	% of Area
Open Space	220.6	99.8
Utility/Roadway Right-of-Way	0.5	0.2
Total Area	***221.1***	***100***

As illustrated in Figure 11, the land cover in this subwatershed is comprised of nearly 100% forest. A small amount of power line right-of-way crosses the southwestern edge of the subwatershed. In addition, several access roads wind through the subwatershed, but only one of these is paved. Overall, less than 1% of this subwatershed is impervious surface, the lowest of all the subwatersheds assessed in this study.

Natural Resources. This entire subwatershed is under control of the U.S. Fish and Wildlife Service as part of the Patuxent Research Refuge. This area is nearly 100% forested with both deciduous and coniferous forest and likely provides high quality habitat to a variety of species. The National Wetlands Inventory mapped approximately 0.5 acres of palustrine forested wetland in this watershed. This wetland was likely created and is currently maintained by beaver activity at the road crossing that marks the bottom of this subwatershed. Approximately 0.9 miles of stream channel exist in this subwatershed.

Watershed Conditions. The BCS results for this subwatershed are summarized below:

Table 17. BCS summary for UPN7.

Metric Group	Metric Group Score	Condition Rating
Water Quality Conditions	2	Good
Living Resource Conditions	44	Poor
Habitat Conditions	33	Good
Landscape Conditions	13	Good
Hydrologic Conditions	9	Fair
Overall BCS	***101***	***Fair***

While overall conditions in this subwatershed were judged fair, this subwatershed was only one point from achieving a condition rating of "good." No problems were observed during the SCA and very low levels of nitrate and phosphate were observed in this subwatershed during the synoptic sampling. Stream insect populations were judged to be very poor overall, while habitat conditions were judged to be partially supporting. In this case, low water levels and small watershed size can explain poor living resource conditions. Water levels were low, in part, due to the severe drought conditions during the assessment. In addition, this was one of the smallest subwatersheds sampled in the assessment. It is possible that the BCS living resource component does not adequately characterize small streams like this one. For example, fish were not sampled

because the stream was dry during the sample period and anadromous fish usage would be very unlikely due to this stream's small size.

Watershed Improvement Activities. Based on conditions and land use characteristics in this subwatershed, the following general recommendations are made:

- Investigate downstream of assessment area to determine if any natural or manmade fish passage impediments exist and correct as necessary.

There are no specific restoration or enhancement projects recommended for this subwatershed.

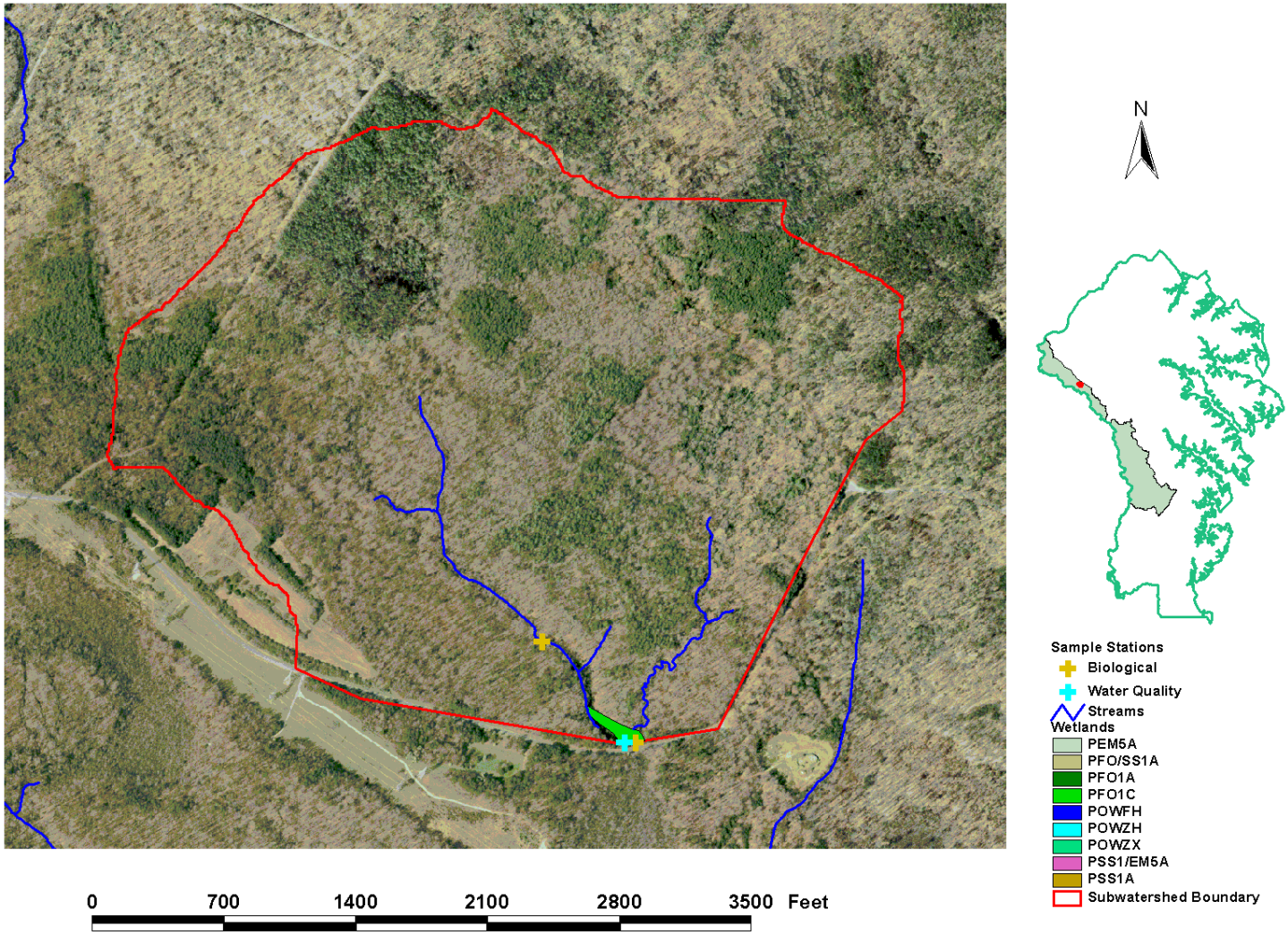

Figure 11. Location of subwatershed UPN7.

UPS1—Cox Branch.
This subwatershed is in the center of the Upper Patuxent River Watershed. It includes parts of the Crofton area and is 1.5 square miles in size. Major roadways crossing the subwatershed include Defense Highway (MD 450), Davidsonville Road (MD 424), and Patuxent River Road. A single fish sampling station, four water chemistry, and four biological monitoring stations were established in the subwatershed for this project. Figure 12 provides an overview of this subwatershed, with sampling locations denoted.

Land Use. Land use in this subwatershed is comprised of low, middle, and high-density residential development, agriculture, and vacant land. A summary of land use is contained in the table below:

Table 18. Land Use Summary for UPS1 (Cox Branch)

Land Use	Acres	% of Area
Agriculture	248.5	25.1
Open Space	12.3	1.2
Single Family Residential	411.6	41.6
Retail	8.7	0.9
Office	0.8	0.1
Industrial	11.7	1.2
Utility/Roadway Right-of-Way	15.4	1.6
School	8.0	0.8
Recreational	58.1	5.9
Vacant Land	213.1	21.6
Total Area	***988.2***	***100.0***

Current total subwatershed imperviousness was estimated at 11%. Future imperviousness is estimated to be 14% assuming no changes in current zoning classifications within the subwatershed. Forest areas, classified mainly as vacant land and open space, cover approximately 25-30% of the subwatershed land area and are mostly located in the central portion of the subwatershed. The Bell Branch Athletic Complex accounts for the most of the 5.9% of recreational land in Cox Branch. Approximately 25% of the subwatershed, primarily in the eastern and southern portions, is used for agriculture. Commercial land uses are concentrated mainly along Defense Highway, in the northern portion of the subwatershed, to its intersection with Davidsonville Road. A large commercial block is partially located within the subwatershed at the extreme northwestern end of the subwatershed. This area is the LID focus area for the WRAS, as described in Section II (Low Impact Development Retrofit Assessments).

Natural Resources. Approximately 6.6 miles of stream channel drain this subwatershed. Cox Branch is a third order stream at its confluence with the Patuxent River. Most of the stream appears well buffered with forest. Approximately 1.2 acres of wetlands are mapped by the NWI at two sites in this subwatershed. These wetlands are classified as excavated open water systems, a classification typically reserved for stormwater or farm ponds.

Approximately 8.5 acres of hydric soil are present in this subwatershed. One parcel approximately four acres in size is located in the extreme northeast corner of the subwatershed and is adjacent of one of the open water wetlands identified by the NWI. Current land use for this area is agriculture. The second is located on both sides of Davidsonville Road along the entrance to Bell Branch Athletic Area. The current land is a mix of agriculture, forest, and roadway.

As described above, a large forest block exists in this subwatershed. However, numerous inclusions of agriculture and residential land uses occur within it. The overall habitat quality of this forested area is unknown.

Watershed Conditions. The BCS results for this subwatershed are summarized in Table 19. Overall conditions in this subwatershed were judged to be poor. In fact, this subwatershed had the most unfavorable BCS rating of all the subwatersheds assessed. Moderate amounts of watershed erosion were observed during the SCA work. Approximately 34% of stream reaches in this subwatershed were judged to be experiencing moderate or greater amounts of erosion.

Table 19. BCS Summary for UPS1 (Cox Branch)

Metric Group	Metric Group Score	Condition Rating
Water Quality Conditions	11	Fair
Living Resource Conditions	71	Very Poor
Habitat Conditions	102	Poor
Landscape Conditions	81	Poor
Hydrologic Conditions	12	Fair
Overall BCS	***277***	***Poor***

Stream insect populations were judged "poor" overall while habitat conditions were rated as "non-supporting." Pavlik and Stribling (2003) describe signs of heavy stormwater flows in this subwatershed. It is likely that uncontrolled or poorly controlled stormwater from the older developed areas located in the northern and eastern portions of the subwatershed could also be impacting biological conditions. Only two fish species were collected from this subwatershed. This could be due to impaired water quality or habitat, or due to an unidentified fish blockage outside the assessment area. Buffer conditions were generally rated as fair with no severe buffer impairments observed during the SCA stream walks.

Watershed Improvement Activities. Based on conditions and land use characteristics in this subwatershed the following general recommendations are made:

- Provide additional stormwater management in unmanaged areas;
- Reduce overall sediment load by repairing unstable stream banks;
- Remove or correct fish passage impediments;
- Investigate the feasibility of wetland restoration on the two hydric soil areas in this subwatershed, and;
- Schedule stream clean-ups.

Specific restoration and enhancement projects for Cox Branch are identified in Table 21 and in Figure 13. In two cases, severe erosion problems may be a result of pipe outfalls or road crossings draining developed areas. Erosion sites UPN25107 and UPN25108 are likely related to the pipe outfall UPN25105. These sites consist of a 500-foot reach with 4-foot high banks leading to an 8-foot headcut. The shallow road crossing (FB UPO24106) is probably causing the erosion described in Table 21 for ES site UPO24106. These projects should be investigated concurrently and solutions should be created that treat the causes (the outfalls) along with the symptoms (the erosion sites).

As mentioned in Section II, this subwatershed was selected as Anne Arundel County's LID retrofit priority area. Cox Branch was one of the few locations that had concentrated development areas in the Anne Arundel portion of the Upper Patuxent River watershed. As shown in Figure 14, the area for LID implementation consists of an industrial park in the northwestern portion of the subwatershed. The land use here is mixed commercial and light industrial, most of which was developed during the 1980s and 1990s. Development continues today in the southeastern corner of the area.

Once an LID focus area was determined, a way to prioritize project implementation was developed. In brief, two basic approaches were taken. Individual parcels were assessed either for the feasibility of LID implementation or for retrofitting existing facilities if stormwater management was present on the parcels. Parcels corresponded roughly to the legal limits of the commercial property. Within each parcel, individual sites for LID facilities or retrofit areas were identified. Typically, there were several sites for each parcel. Using the physical conditions data collected for each parcel, and individual sites on each parcel, it was possible to rank feasibility and water quality benefits of implementing individual projects (i.e., sites). The overall methods employed are described in Section II. The methodology and the results of this assessment and prioritization exercise are found in Appendix B.

Sites were ranked based on water quality impact considerations. Property owners were contacted to ascertain interest in implementing a project on the priority properties. As LID implementation moves forward, meetings will be held with property owners to determine interest in participating in this demonstration project. A total of 15 parcels were evaluated, with the first five projects identified denoted in Table 20. Projects will be pursued in priority order with willing landowners as funding is available. Implementation is discussed in greater detail in Section IV.

Table 20. Preliminary LID Priority Sites in Cox Branch

Site ID Number	Site Description	Rank	Notes
29	Federal Express	1	Green roof, bioretention sites.
31	2141 Priest Bridge Road	2	Bioretention
37	Crofton Bowling Centre	3	Bioretention
35	2127 Espey Court	4	Bioretention
45	2128 Espey Court	5	Bioretention

Table 21. Description and Ranking of Restoration Projects in UPS1 (Cox Branch

SCA Site Number	Project Type	Project Description	Subwatershed Priority Ranking	Notes
UPN26105	TD	Large trash dump, mixed appliances, recyclables	1	Moderate severity and ease of access, correctability, put this project on top.
UPN25105	PO	Pipe Outfall	2	Likely responsible for erosion problems (UPN25108, UPN25107) downstream.
UPN25104	TD	Yard waste trash dump	2	Moderate severity and easy access, correctability results in high score.
UPO24106	FB	Shallow Road Crossing	2	Only opens minor amount of habitat, which is not accounted for in SCA scoring. Likely causing UPO24106 ES.
UPO24108	EP	Exposed Pipe	5	Appears to instream cistern, possibly for animal watering. Requires additional investigation.
UPO23104	CA	Channel Alteration	6	300-foot long rip rap pond outfall. Pond is likely related to UPO23103.
UPO24106	ES	3 foot high, 2600 foot long eroding bank	6	Likely related to road crossing described above (UPO24106).
UPO24109	ES	8 foot high, 4800 foot long eroding bank	6	Unknown cause. Requires further investigation to determine solution.
UPM25101	UC	Unusual Condition	6	Collapsing road culvert. Unknown cause. Requires further investigation to determine solution.
UPO25103	ES	8 foot high, 5000 foot long eroding bank	10	Unknown cause. Requires further investigation to determine solution.
UPO23103	UC	Cloudy, scummy water	10	Could be water quality problem that requires investigation. Stormwater pond upstream.
UPN25107	ES	4 foot high, 400 foot long eroding bank	12	Likely caused by UPN25105.
UPN25109	ES	4 foot high, 500 foot long eroding bank	12	Unknown cause. Requires further investigation to determine solution.
UPN25108	FB	8 foot high headcut	12	Could be considered erosion site. Likely caused by UPN 25105.
UPN24101	TD	Trash Dumping	15	Difficult access. Volunteer friendly.
UPO24111	TD	Residential trash dump	15	Difficult access. Volunteer friendly.
UPO25104	IC	Construction	17	SCA classified as logging without sediment controls.

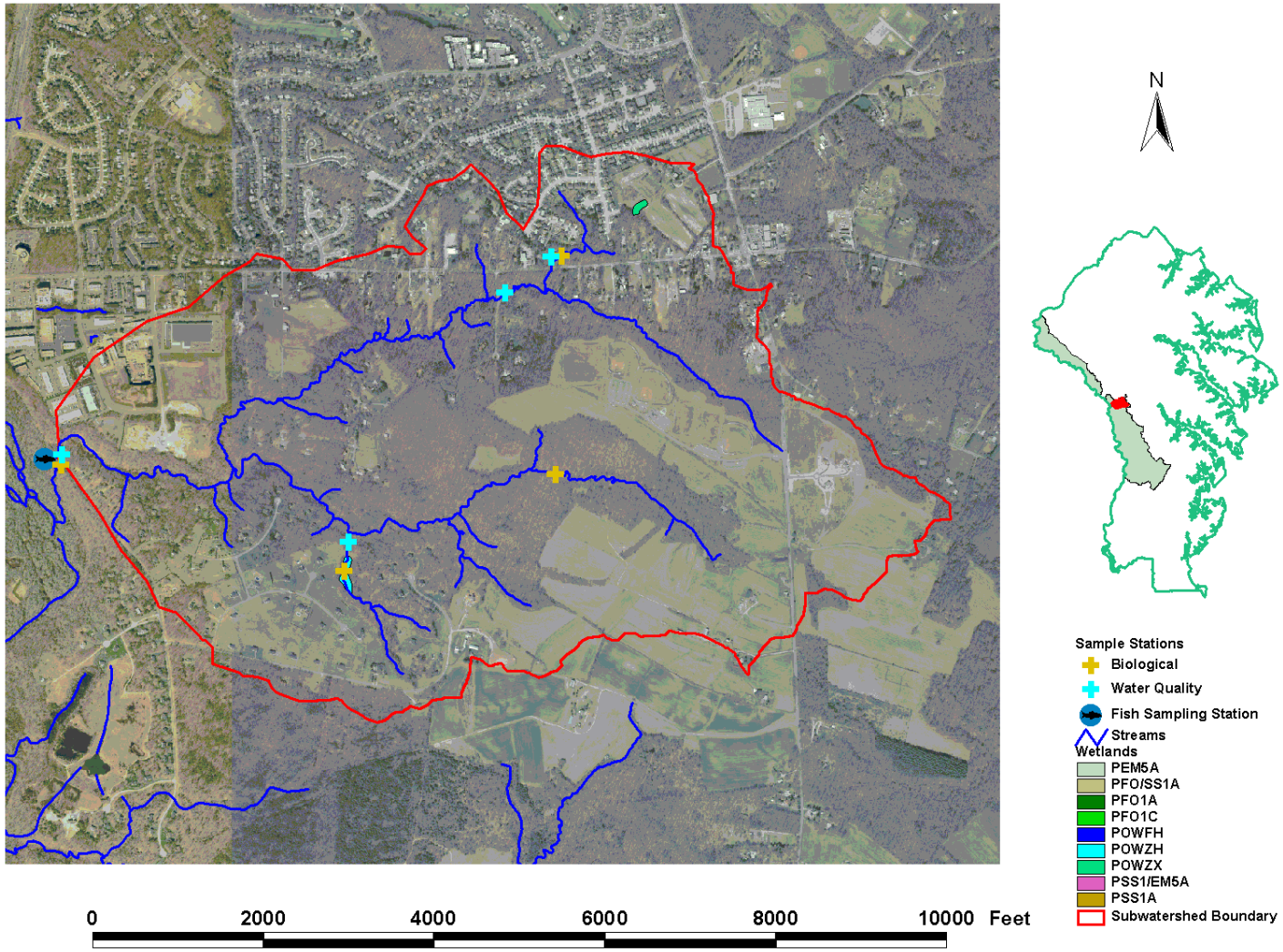

Figure 12. Overview of UPS1 (Cox Branch).

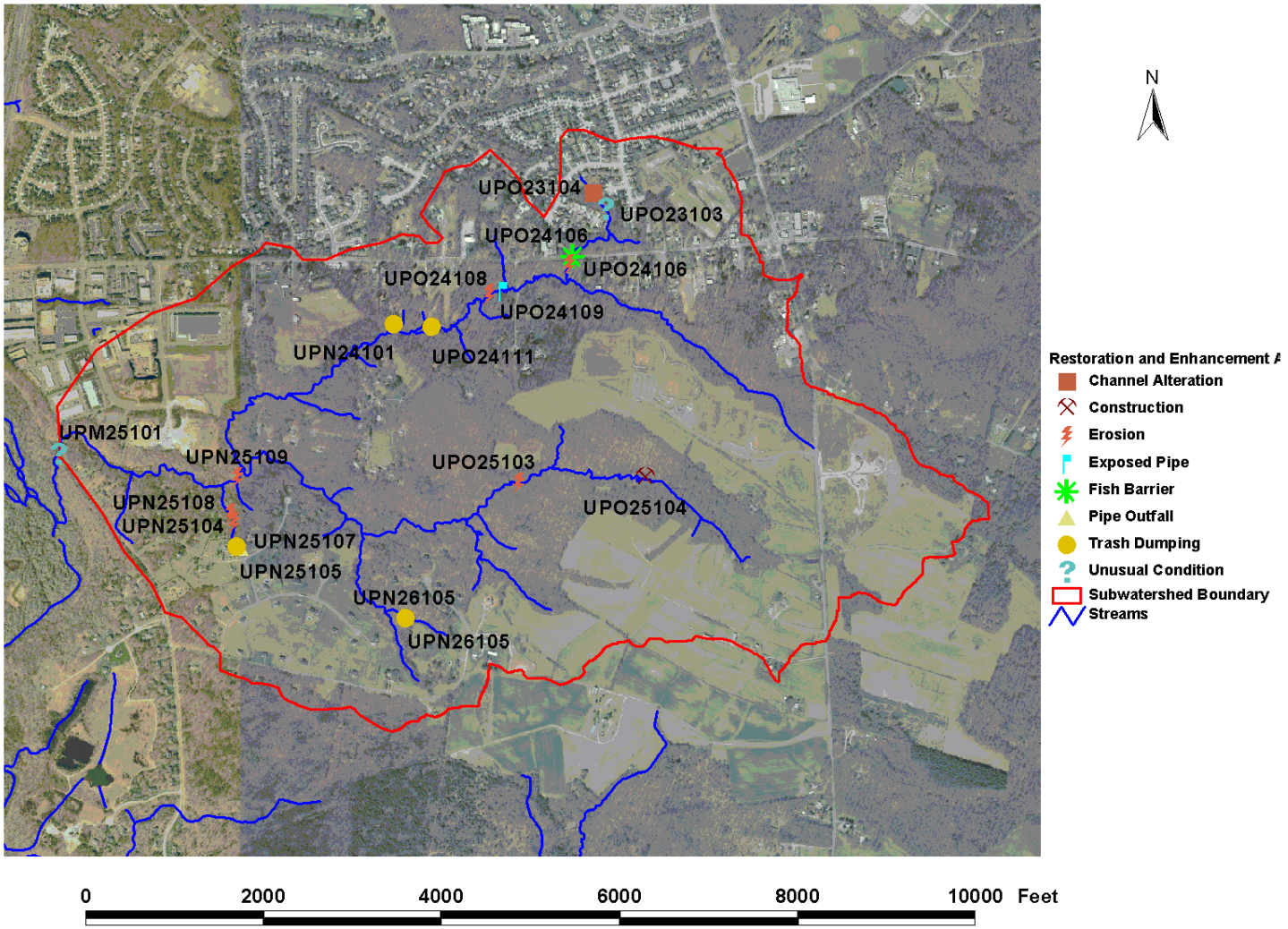

Figure 13. Potential restoration and enhancement sites in UPS1 (Cox Branch).

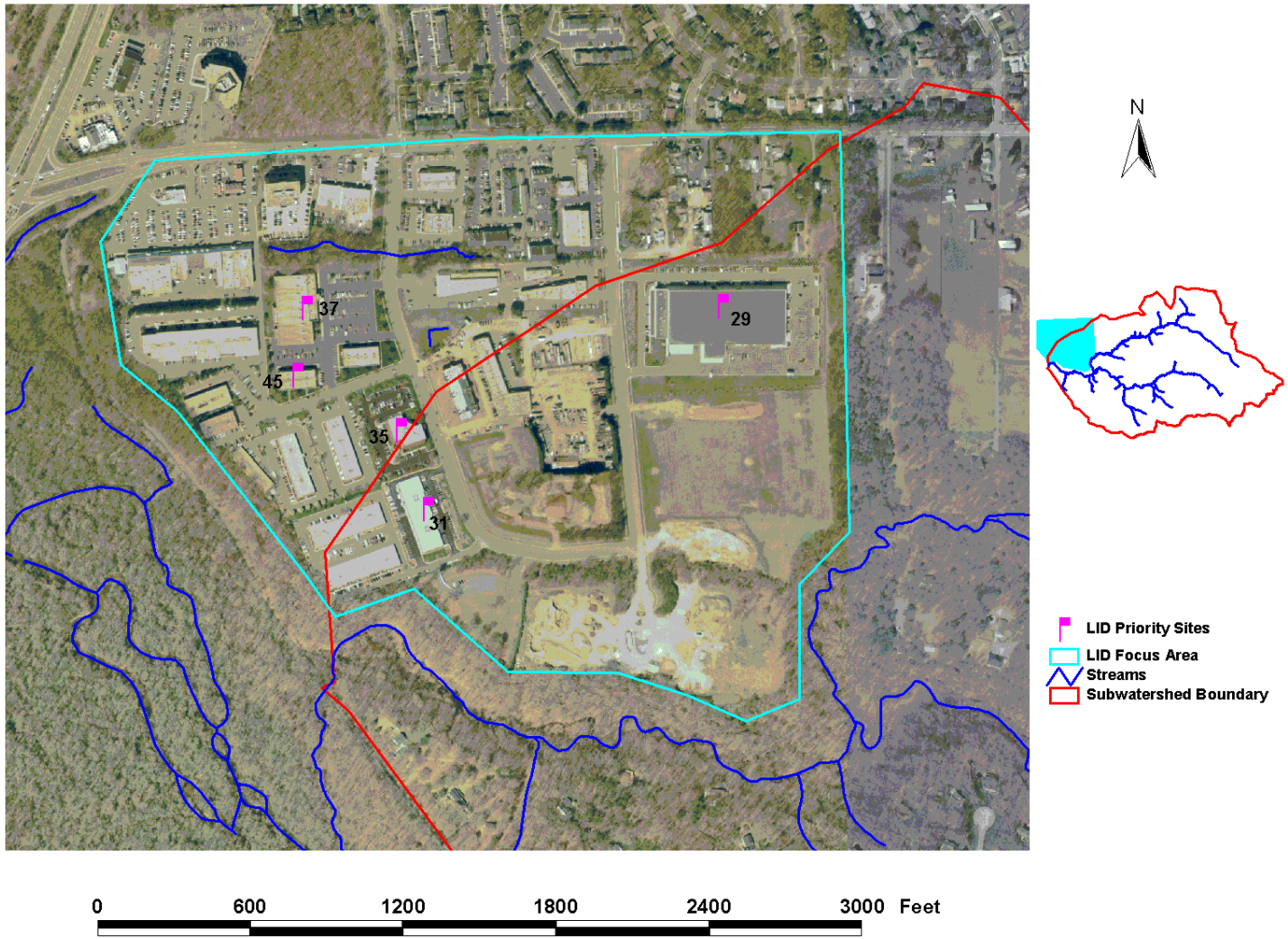

Figure 14. LID focus areas in UPS1 (Cox Branch) — Priority sites denoted with pink flags and site numbers.

UPS3—Unnamed Tributary to the Patuxent River.
This subwatershed is located in the southern portion of the Upper Patuxent River watershed area. It has a drainage area of approximately 1.2 square miles. As illustrated in Figure X, US Route 50 runs along the southern edge of the watershed. Other major roads crossing the subwatershed include MD 424, Patuxent River Road, and Governor Bridge Road. Three water chemistry, three biological monitoring stations, and one fish sampling station were established in the subwatershed for this study (Figure 15).

Land Use. Land use within this subwatershed is summarized in the table below:

Table 22. Land Use Summary for UPS3

Land Use	Acres	% of Area
Agriculture	164.8	20.9
Open Space	3.1	0.4
Single Family Residential	171.4	21.7
Utility/Roadway Right-of-Way	29.4	3.7
Public Land	372.0	47.2
Vacant Land	48.2	6.1
Total Area	788.9	100.0

As illustrated in Figure 15, this subwatershed is a mix of forest and pasture with scattered pockets of large lot residential development. The major landowner in the subwatershed is the United States Military, which operates a transmission facility in the central portion of the subwatershed, occupying approximately 47% of the subwatershed area. The current level of watershed impervious surface is estimated at 5% and is predicted to remain at that level once full build-out conditions are reached. An assumption is made that no changes in zoning will occur during build out.

Natural Resources. Approximately 10 acres of wetlands have been mapped in this watershed, and are concentrated in the forested riparian area. Nearly 4 miles of stream channel drain this subwatershed. Two major forks, located in the northern and southern portions of the upper third of the subwatershed, converge to form the mainstem approximately 1000 feet south of Bottner Road. At the lowest point in the subwatershed, this stream is a third order system.

Watershed Conditions. The BCS results for this subwatershed are summarized below:

Table 23. BCS Summary for UPS3

Metric Group	Metric Group Score	Condition Rating
Water Quality Conditions	5	Fair
Living Resource Conditions	33	Fair
Habitat Conditions	42	Fair
Landscape Conditions	40	Fair
Hydrologic Conditions	6	Good
Overall BCS	***126***	***Fair***

In general, this subwatershed is in fair condition but shows some degradation. As described in Pavlik and Stribling (2003), biological conditions were judged to be fair based on aquatic invertebrate sampling results. With the exception of the most upstream sample station, habitat conditions were found to be partially supporting in the lower two-thirds of the subwatershed.

The single station located in the south fork was judged as non-supporting. Fish sampling found only 4 species, most of which are considered pollution tolerant. The dearth of fish species could be related to potential fish blockages that lie beyond the limits of the SCA. In general, habitat conditions and the community of fish and invertebrates are in balance with each other.

While the SCA determined that there were no impaired buffers in this subwatershed, an examination of Figure 16 shows that the forest buffer becomes narrow in some places, particularly along the right bank (downstream) of the south fork. Some of the small, first order systems also appear to have impacted headwater areas.

As described in DNR (2002b), nutrient concentrations were very low in this subwatershed. Dissolved oxygen, conductivity, temperature, and pH measurements collected during sampling showed no anomalous readings. Results of the synoptic water quality sampling indicated good water quality conditions.

Watershed Improvement Activities. Based on conditions and land use characteristics in this subwatershed, the following general recommendations are made:

- Investigate downstream of the assessment area for any natural or manmade fish passage impediments and correct as necessary;
- Improve buffer widths as needed throughout this subwatershed;
- Coordinate with the US Military to determine feasibility of implementing large-scale reforestation of its property; and
- Determine if drainage areas for selected first order headwaters should be retrofitted with best management practices to treat uncontrolled stormwater.

Only two potential restoration projects were identified during the SCA work. These are shown in Figure 16. Both sites are erosion areas consisting of moderately eroding banks between 4 and 6 feet high and 1000 to 1400 feet long. Site UPO29203 is located below the confluence of the north and south forks UPS3 while UPO29201is located in the south fork near the crossing at Bottner Road. Because of the overall fair quality of the subwatershed, restoration activities here would be a secondary priority compared to other subwatersheds.