3.0 Summary of Watershed Conditions

This section summarizes the *Lower Occoquan Draft Watershed Workbook* (January 2009). The full Lower Occoquan Draft Watershed Workbook can be found in Appendix A.

3.1 Introduction

Consisting of more than 45 square miles, the Lower Occoquan watershed is one of the larger watershed planning units in the County. Located along the southwestern border of Fairfax County, Lower Occoquan is comprised of eight small watersheds: Old Mill Branch, Wolf Run, Sandy Run, Ryans Dam, Occoquan, Mill Branch, Kane Creek and High Point. Refer to **Map 3.1-1** for the locations of each watershed within Lower Occoquan.

For Fairfax County planning and management purposes, most watersheds are subdivided into watershed management areas (WMAs), which are typically a few square miles of land area. For most of the small watersheds in Lower Occoquan, the entire watersheds themselves are defined as WMAs with the exception of the larger Mill Branch watershed, which has been divided into 3 individual WMAs. Table 3-1 below identifies the 10 WMAs identified within Lower Occoquan. Refer to **Map 3.1-2** for the locations of each WMA within Lower Occoquan. For Fairfax County planning and management purposes, WMAs are further subdivided into smaller subwatersheds. Refer to **Map 3.1-3** for the locations of each of the subwatersheds within Lower Occoquan.

Table 3-1: Lower Occoquan Watershed Management Areas (WMAs)

WMA		Sq. Miles	Acres
1	Giles Run North (Mill Branch)	3.13	2,002
2	Giles Run South (Mill Branch)	3.63	2,328
3	Mill Branch (Mill Branch)	1.98	1,268
4	Sandy Run	8.12	5,198
5	Wolf Run	5.88	3,762
6	High Point	5.55	3,555
7	Kane Creek	4.81	3,076
8	Old Mill Branch	4.26	2,724
9	Ryans Dam	3.53	2,262
10	Occoquan	3.32	2,126
	Total	**44.21**	**28,301**

The Lower Occoquan watershed contains more than 220 miles of stream within the 10 WMAs, and included in the 10 WMAs are 15 separate named tributaries.

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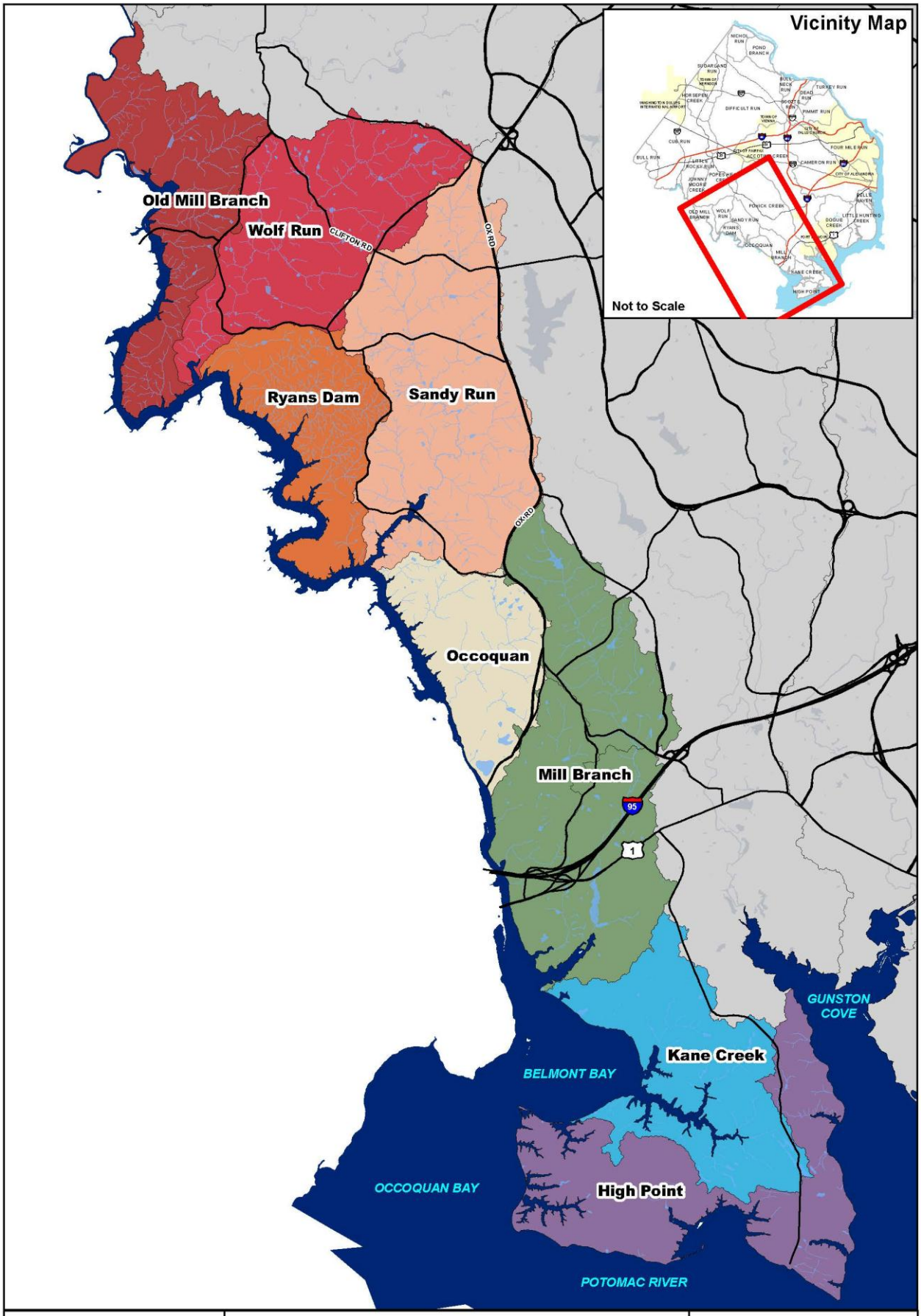
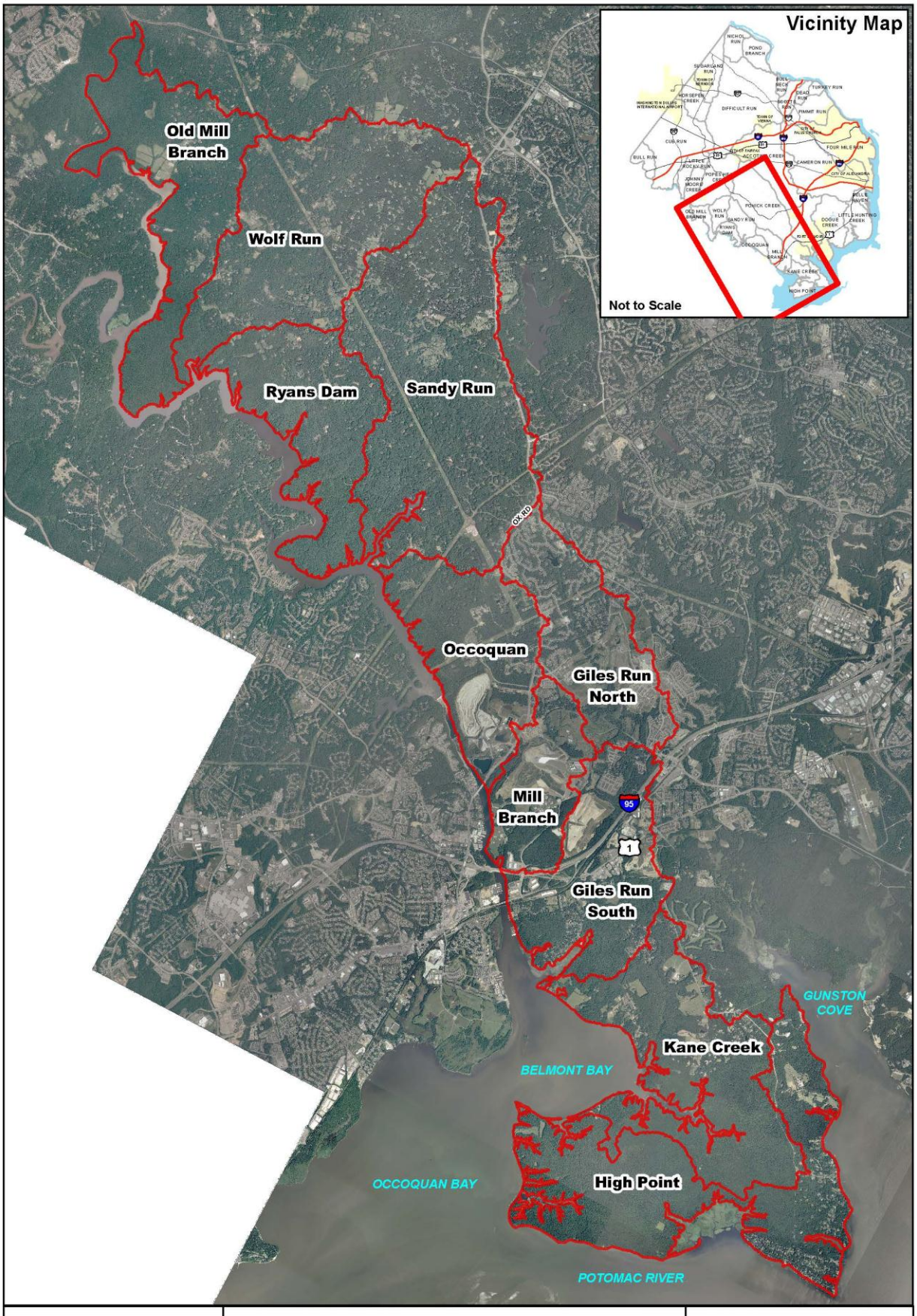


0 4,100 8,200 12,300 Feet

Roads
Streams
WMA Boundary
Water Areas

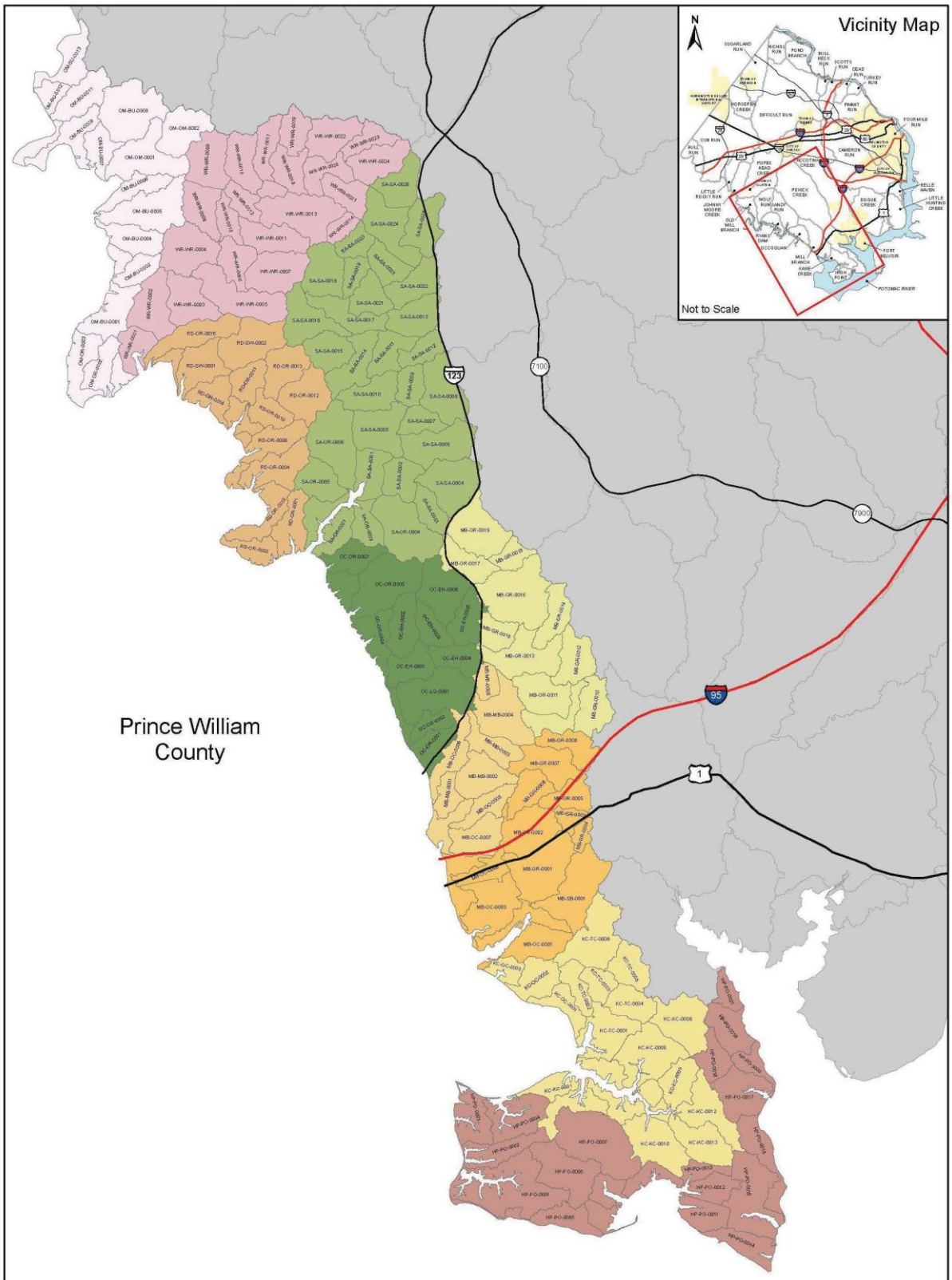
Map 3.1-1

Lower Occoquan Watersheds



Map 3.1-2

Lower Occoquan Watershed Management Areas



0 0.5 1 2 Miles

Legend

- County Highway
- State Highway
- Interstate
- US Highway
- High Point
- Kane Creek
- Mill Branch- Giles Run North
- Mill Branch- Giles Run South
- Mill Branch- Mill Branch
- Occoquan
- Old Mill Branch
- Ryans Dam
- Sandy Run
- Wolf Run
- Watershed Boundaries

Map 3.1-3

Lower Occoquan Subwatersheds

3.2 Current Conditions

Historically, Lower Occoquan has experienced relatively minimal development, which has resulted in a low overall impervious area. A major reason for the minimal development is due to the fact that majority of the northern portion of Lower Occoquan lies in the Residential-Conservation (R-C) district, which was established to protect streams, ecological areas and minimize impervious surfaces to protect water quality. The R-C district restricts development size within the watershed to a minimum of 5 acres per residential dwelling unit. Consequently, the Lower Occoquan is one of the least developed watersheds in the county. Refer to **Map 3.2-1** for the existing land uses and **Map 3.2-2** for the future land uses.

The Lower Occoquan watershed has many unique facets; it is home to local, regional, state and federal parks including Laurel Hill redevelopment area (formerly the District of Columbia Department of Correction Facility, located in Lorton), Fountainhead Regional Park, Mason Neck State Park and the Mason Neck National Wildlife Refuge. In addition, it contains the Occoquan Reservoir that serves as one of the two major drinking water sources for Fairfax County. More than half of the watersheds fall within the Water Supply Protection Overlay District (WSPOD). The WSPOD was established in 1982 to protect water quality in the Occoquan Reservoir. With the exception of Mill Branch, Kane Creek and High Point, the remaining watersheds lie at least partially within the WSPOD.

With the exception of Mill Branch watershed, which contains the Laurel Hill redevelopment, Lower Occoquan watershed is to have very minimal new development. As a result of minimal development, large parks and open space, the overall stream habitat condition of the watershed is considered good to excellent. The Lower Occoquan watershed contains some of the highest stream quality in Fairfax County.

Lower Occoquan also contains a wide variety of additional stormwater infrastructure and best management practices (BMPs) that track with the watershed's development history. Some older developments contain stormwater management (SWM) facilities, consisting primarily of dry detention basins designed to curb peak storm flows (quantity management). For areas developed more recently, SWM facility types are more varied and are more likely to include a water quality component. Facilities found in these areas include wet detention facilities, underground chambers, infiltration devices and wetlands. However, as a direct result of minimal development, more than 95 percent of Lower Occoquan has no stormwater treatment. Go to http://www.fairfaxcounty.gov/dpwes/stormwater/ for more information on stormwater facilities in Fairfax County.

As one of many measures used to protect stream water quality, the County adopted the Chesapeake Bay Preservation Ordinance, which limits development on land that lies within a Resource Protection Area (RPA). RPAs are buffers adjacent to or near the shorelines of streams, rivers and other waterways that protect sensitive areas from the excessive influx of pollutants. The sensitive areas include tidal and non-tidal wetlands, tidal shorelines, certain floodplains and perennial streams (waters flowing year-round). **Map 3.2-3** shows, more than 50 percent (128 of the 228 miles) of the streams within the Lower Occoquan watershed lie within a RPA (County GIS, 2008). Go to http://www.fairfaxcounty.gov/dpwes/environmental/cbay/ for more information on RPAs and the Chesapeake Bay Preservation Ordinance.

The *Lower Occoquan Draft Watershed Workbook,* in Appendix A, includes a description of the findings in each WMA, including field reconnaissance findings, existing and future land use, stream conditions and stormwater infrastructure. Each WMA was examined at the subwatershed level.

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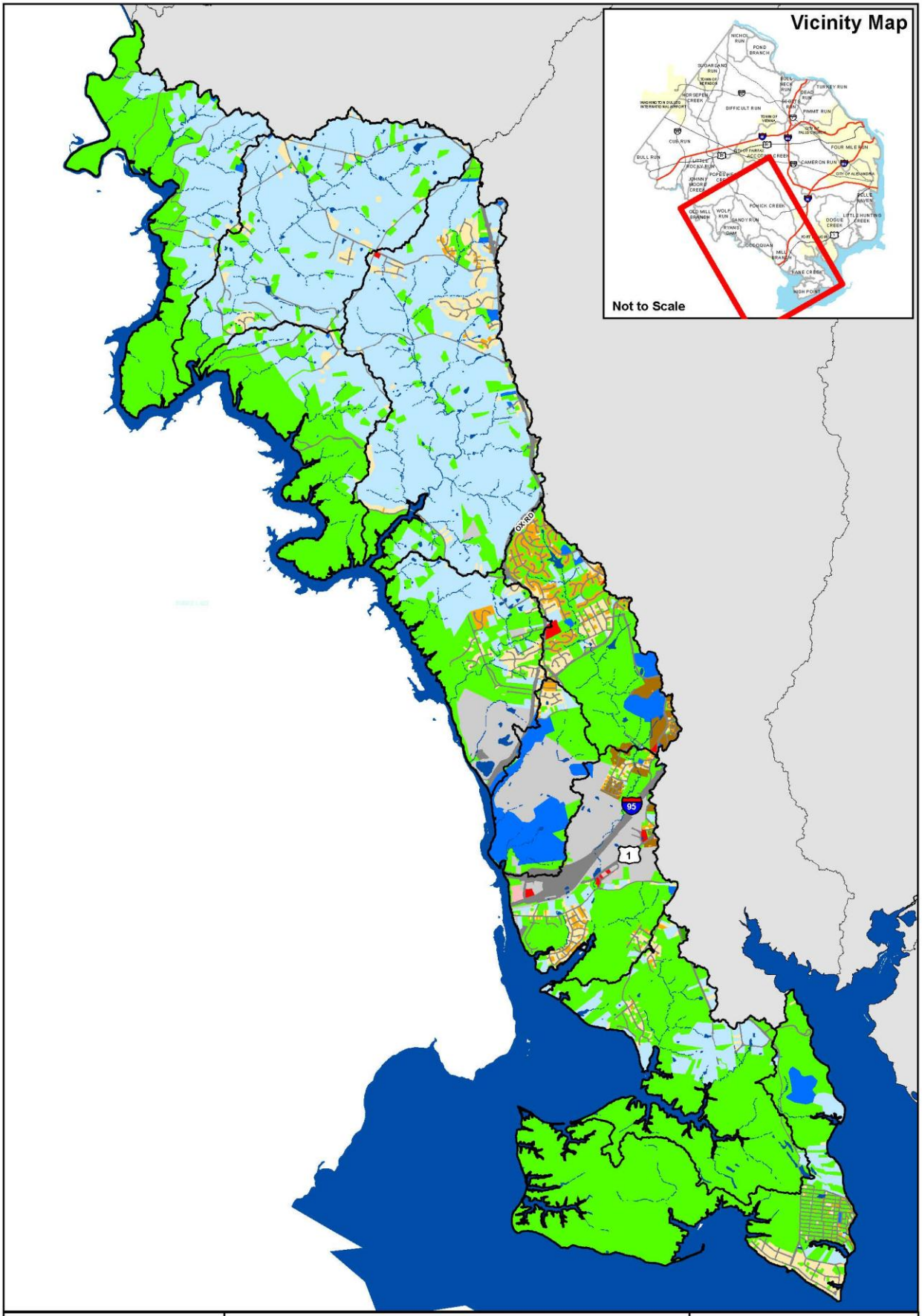
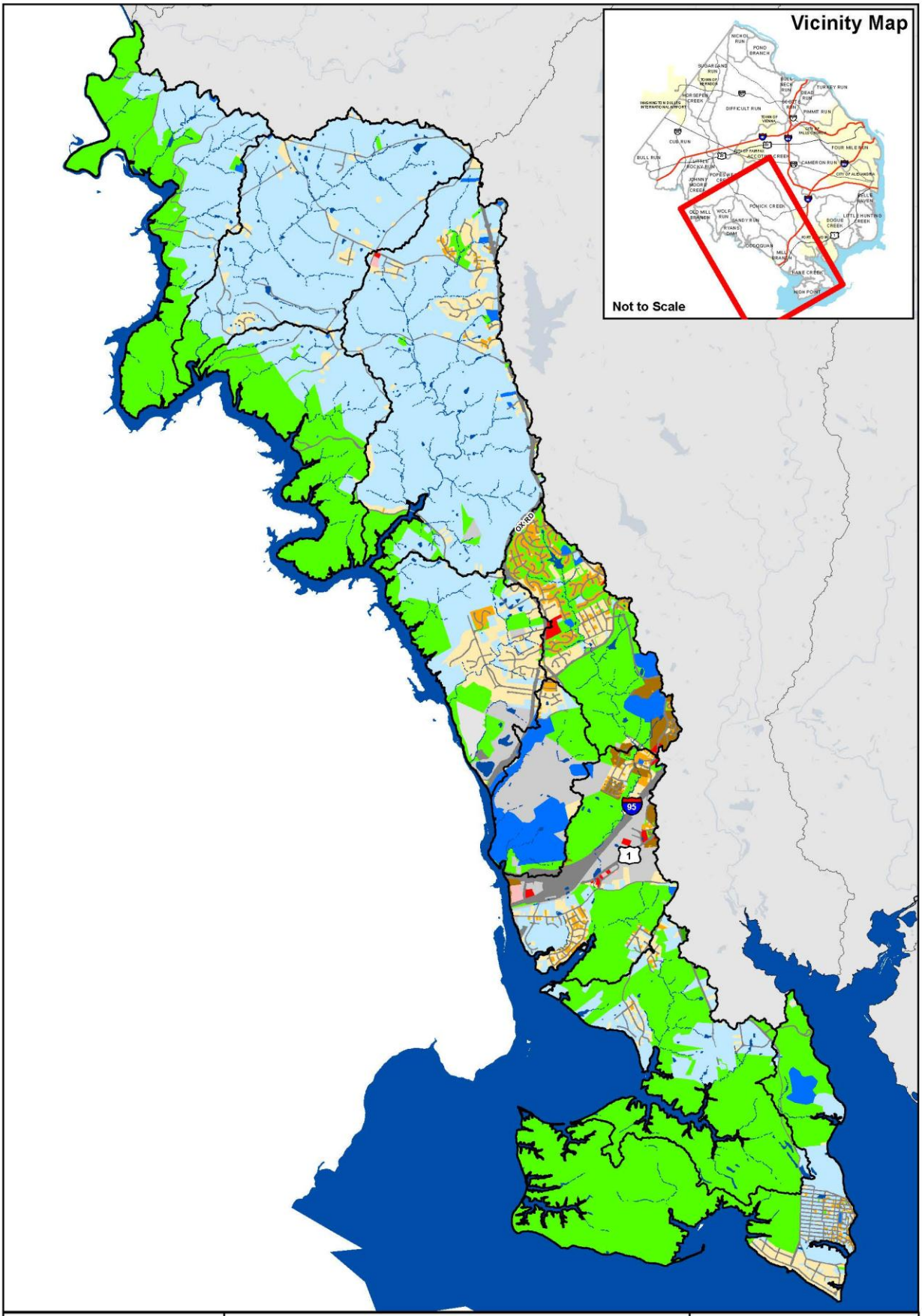


0 3,900 7,800 11,700 Feet

- Estate Residential
- Golf Course
- High Density Residential
- High Intensity Commercial
- Industrial
- Institutional
- Low Density Residential
- Low Intensity Commercial
- Medium Density Residential
- Open Space
- Transportation
- Water

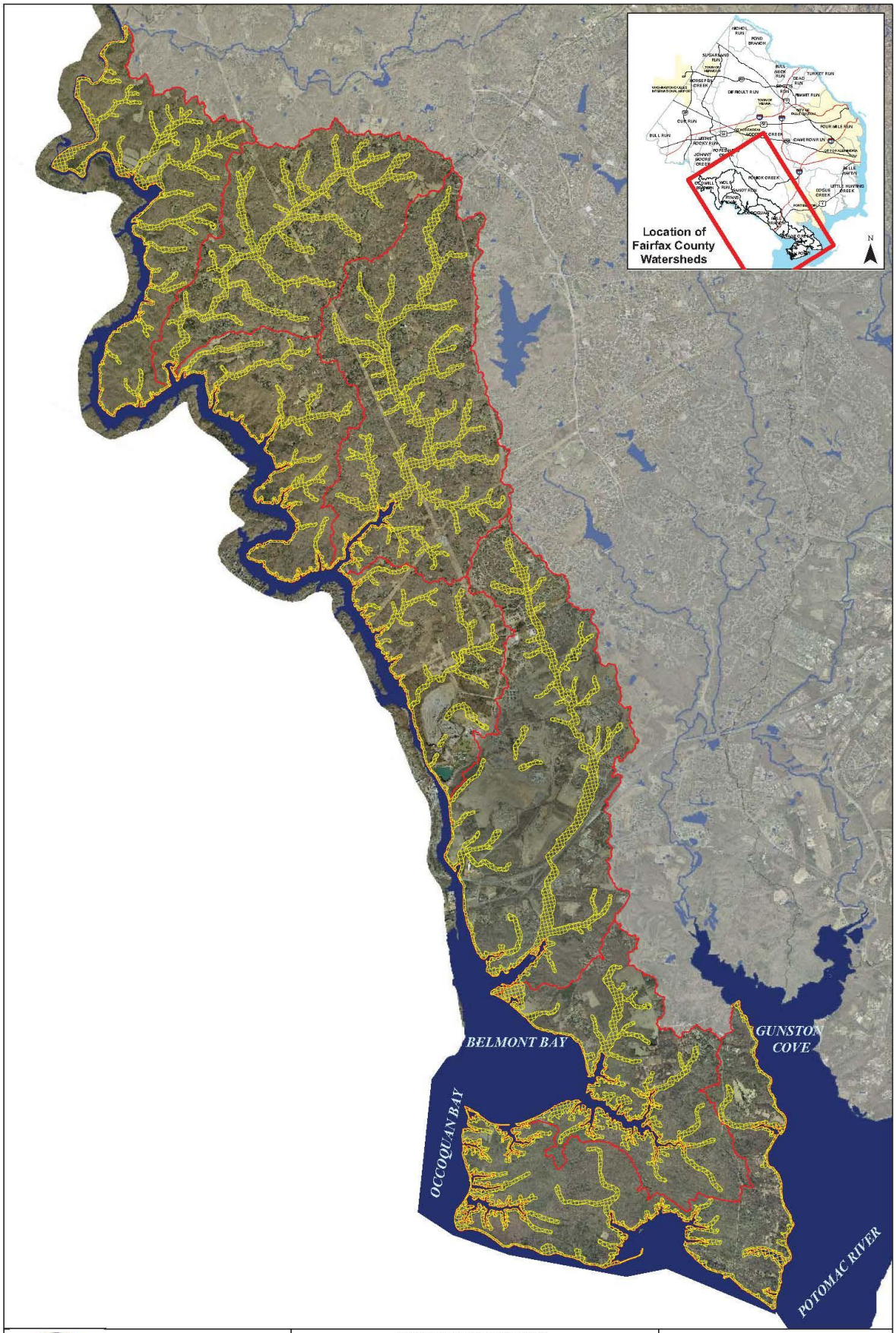
Map 3.2-1

Lower Occoquan Existing Land Use



Map 3.2-2

Lower Occoquan
Future Land Use



3,500 7,000 10,500 Feet

Resource Protection Areas

RPA Limits

Watersheds

Water

Map 3.2-3
Lower Occoquan
Resource Protection Areas

Hydrology and Water Quantity and Quality Modeling

Modeling is a mathematical way to predict and represent spatially what will occur with a given rainfall event. The following modeling software was used in the watershed management plan:

1. The Environmental Protection Agency (EPA) Storm Water Management Model (SWMM) is a dynamic rainfall-runoff simulation model. It is used to track the quantity and quality of runoff generated within each subwatershed, and the flow rate, flow depth and quality of water in each pipe and channel during a simulation period comprised of multiple time steps.
2. The Spreadsheet Tool for Estimating Pollutant Load (STEPL) was used to determine pollutant loads for Lower Occoquan watershed. Also developed by the EPA, the STEPL worksheet calculates nutrient and sediment loads from various land uses and also calculates the load reductions that would result from the implementation of various BMPs.
3. The U.S. Army Corps of Engineers' (USACE's) Hydrologic Engineering Centers River Analysis System (HEC-RAS) hydraulic model simulates the hydraulics of water flow through natural and/or manmade channels and rivers with the objective of computing water surface profiles.

3.2.1 SWMM Results

Table 3-2 shows the peak flows from the WMAs. The 2-year storm event is defined as the storm that has a 50 percent chance of occurring in any one year. The 10-year storm event has a 10 percent chance of occurring in any one year.

Table 3-2: SWMM Results

WMA Outlet Point	Stormwater Runoff Peak Flow Values	
	2-Year Storm (cubic ft/sec)	10-Year Storm (cubic ft/sec)
High Point	577	1,466
Kane Creek	601	1,697
Mill Branch - Giles Run North	483	1,154
Mill Branch - Giles Run South	593	1,471
Mill Branch	400	981
Occoquan	540	1,570
Old Mill Branch	594	1,763
Ryans Dam	429	1,356
Sandy Run	740	2,260
Wolf Run	552	1,646
Lower Occoquan Totals	**5,508**	**15,364**

3.2.2 STEPL Results

A major cause for many streams' poor water quality is increased levels of two particular nutrients—nitrogen and phosphorous—as well as high levels of suspended sediments. Increased nutrient levels can cause eutrophication and high levels of suspended sediments can kill underwater plants. While nitrogen and phosphorus occur naturally in soil, animal waste, plant

material and even the atmosphere, the increase of nitrogen and phosphorus from manmade sources can be detrimental to the overall health of receiving waters. Increased phosphorus and nitrogen pollutants in urbanized areas primarily come from chemical lawn fertilizers, vehicle emissions and discharges from municipal wastewater treatment plants. High levels of suspended sediments are due to land and streambank erosion.

The data provided in Table 3-3 represents the results by WMA from the existing conditions STEPL model (land-based loads) as well as pollutant loads from stream erosion. The STEPL pollutant loads are heavily dependent on land-use distribution within the WMAs. The stream erosion loads were calculated separately and were estimated from available stream survey and soils information.

Table 3-3: Pollutant Loads – STEPL and Streambank Erosion

WMA	Area	Pollutant Loading STEPL Results			Streambank Erosion Pollutant Loading		
		TSS (tons/ ac/yr)	TN (lb/ ac/yr)	TP (lb/ ac/yr)	TSS (tons/ ac/yr)	TN (lb/ ac/yr)	TP (lb/ ac/yr)
High Point	2,346	0.091	1.764	0.323	0.049	0.072	0.028
Kane Creek	1,948	0.086	1.740	0.311	0.123	0.171	0.066
Mill Branch - Giles Run North	3,015	0.119	4.237	0.677	0.185	0.278	0.108
Mill Branch - Giles Run South	2,540	0.188	6.678	0.958	0.168	0.248	0.096
Mill Branch	1,889	0.164	6.282	0.869	0.145	0.220	0.085
Occoquan	1,532	0.110	3.356	0.491	0.135	0.197	0.076
Old Mill Branch	2,525	0.070	1.345	0.239	0.092	0.139	0.054
Ryans Dam	2,308	0.080	1.308	0.245	0.140	0.192	0.074
Sandy Run	3,105	0.054	2.488	0.380	0.142	0.223	0.086
Wolf Run	2,041	0.045	2.135	0.326	0.364	0.575	0.223

3.2.3 HEC-RAS Results

Hydraulic models were created for the major channels in the watershed. These major channels extend from the basin outlet to the most upstream sub-basins in the watershed. Cross sections were aligned based on representative channel sections, and upstream and downstream of bridges. Structures along these streams were identified based on the County's GIS road shapefiles and the most recent aerial photos provided by the County, and surveyed using GIS equipment. Flow data was entered from the SWMM model.

Three flood events were modeled in HEC-RAS: the 100-year, 10-year and 2-year events. These are the events that have a 1 percent, 10 percent or 50 percent chance, respectively, of occurring in any given year. The 100- and 10-year floodplains were mapped to determine the extent of the flooding. The impact of the flooding on the watershed was determined by examining roads that are overtopped or buildings that are located within the floodplain.

3.3 Ranking of Subwatershed Areas

The County has developed goals and objectives to be applied to all watersheds during the workbook development process. The countywide goals and objectives allow recommendations to be linked to the countywide watershed assessment. The goals are:

1. Improve and maintain watershed functions in Fairfax County, including water quality, habitat and hydrology.
2. Protect human health, safety and property by reducing stormwater impacts.
3. Involve stakeholders in the protection, maintenance and restoration of county watersheds.

The list of objectives allows for a countywide evaluation that addresses stakeholder concerns while providing an efficient and effective means of assessment.

Table 3-4: Fairfax County Watershed Planning Final Objectives

Objective		Linked to Goal(s)
CATEGORY 1. HYDROLOGY		
1A.	Minimize impacts of stormwater runoff on stream hydrology to promote stable stream morphology, protect habitat and support biota.	1
1B.	Minimize flooding to protect property and human health and safety.	2
CATEGORY 2. HABITAT		
2A.	Provide for healthy habitat through protecting, restoring and maintaining riparian buffers, wetlands and instream habitat.	1
2B.	Improve and maintain diversity of native plants and animals in the county.	1
CATEGORY 3. STREAM WATER QUALITY		
3A.	Minimize impacts to stream water quality from pollutants in stormwater runoff.	1, 2
CATEGORY 4. DRINKING WATER QUALITY		
4A.	Minimize impacts to drinking water sources from pathogens, nutrients and toxics in stormwater runoff.	2
4B.	Minimize impacts to drinking water storage capacity from sediment in stormwater runoff.	2
CATEGORY 5 STEWARDSHIP		
5A.	Encourage the public to participate in watershed stewardship.	3
5B.	Coordinate with regional jurisdictions on watershed management and restoration efforts such as Chesapeake Bay initiatives.	3
5C.	Improve watershed aesthetics in Fairfax County.	1, 3

The purpose of the subwatershed ranking approach is to provide a systematic means of compiling available water quality and natural resources information. Ranking subwatersheds based on watershed characterization and modeling results provides a tool for planners and managers to aid in the project selection, types of projects and prioritization processes. The ranking was updated based on issues and problem areas identified during the introductory and issues scoping forum and advisory group meetings. The resultant data is then used to identify key issues and proceed with projects that will achieve the County's watershed management goals and objectives.

Three basic indicator categories were used to rank subwatershed conditions, as identified in Table 3-5.

Table 3-5: Subwatershed Ranking Indicators

Indicator Type	Description
Watershed Impact	Diagnostic measures of environmental conditions (e.g., water quality, habitat health biotic integrity) that are linked to the County's goals and objectives
Programmatic	Reports the existence, location or benefits of stormwater management facilities or programs
Source	Quantifies the presence of stressors and/or pollutant sources

These scores were weighted and combined into composite scores that are used in the subwatershed ranking and project prioritization process.

3.4 Lower Occoquan Results

The Lower Occoquan Watershed Impact Composite Score is shown in **Map 3.5-1**. This map displays an overall composite score that itself is a weighted average of composite scores of the individual impact indicators for each subwatershed. The scale on the map ranks the subwatersheds from high (green) to low (red) quality.

In the Lower Occoquan watershed, various portions differ considerably in quality as measured by the overall watershed impact indicator composite score. The watershed's western and northern portions, (including Old Mill Branch, Wolf Run, Ryans Dam and Sandy Run WMAs), all of which discharge directly into the Occoquan River and Reservoir, show generally good watershed quality. These subwatersheds include a wide area that was downzoned by Fairfax County in 1982 to protect the water quality of the Occoquan Reservoir. Several of the subwatersheds in the I-95 corridor of the southern grouping of subwatersheds, including Giles Run North and Giles Run South, show poorer overall watershed quality. The eastern portion of the watershed (including the majority of the Kane Creek and High Point WMAs) also shows generally good watershed quality, as much of this land is either Federally protected or a state park. The more developed central portion of the watershed (Mill Branch, Giles Run North and Giles Run South WMAs) shows a generally average watershed quality, but also a great deal of variation between individual subwatersheds. The older, more heavily developed headwaters of the Mill Branch watershed (Mill Branch, Giles Run North and Giles Run South WMAs) show the poorest watershed quality in general. The Mill Branch WMA is experiencing significant redevelopment as a result of the Laurel Hill project. Pockets of better water quality still exist where undeveloped lands remain intact.

The source composite score rankings are shown in **Map 3.5-2**. Unlike the watershed impact score, the source composite score was computed as a simple average of approximately a

dozen individual source indicator scores. The scale establishes the bounds on the gradation from generally good quality (green) to comparatively poor quality (red) on the map. Since the source composite score was computed with a distinct set of indicators from the overall watershed impact score, the subwatersheds with good quality or poor quality may be significantly different than for the overall watershed impact map.

Fairfax County's 1982 downzoning of much of the County's Occoquan River watershed has preserved higher source quality in the watershed. The subwatersheds to the west of the Laurel Hill redevelopment project and Interstate 95 (Old Mill Branch, Wolf Run, Ryans Dam, Sandy Run, and Occoquan) each have generally high source quality. The more densely developed subwatersheds that include Laurel Hill and the I-95 corridor (Mill Branch, Giles Run North and Giles Run South), however, have generally poor source quality, as noted by the orange and red regions on the map. The eastern reaches of the Lower Occoquan subwatersheds, including Kane Creek and High Point, are characterized by above-average to good source quality, with zones of average quality around the Mason Neck marina area just downstream of the I-95 Bridge.

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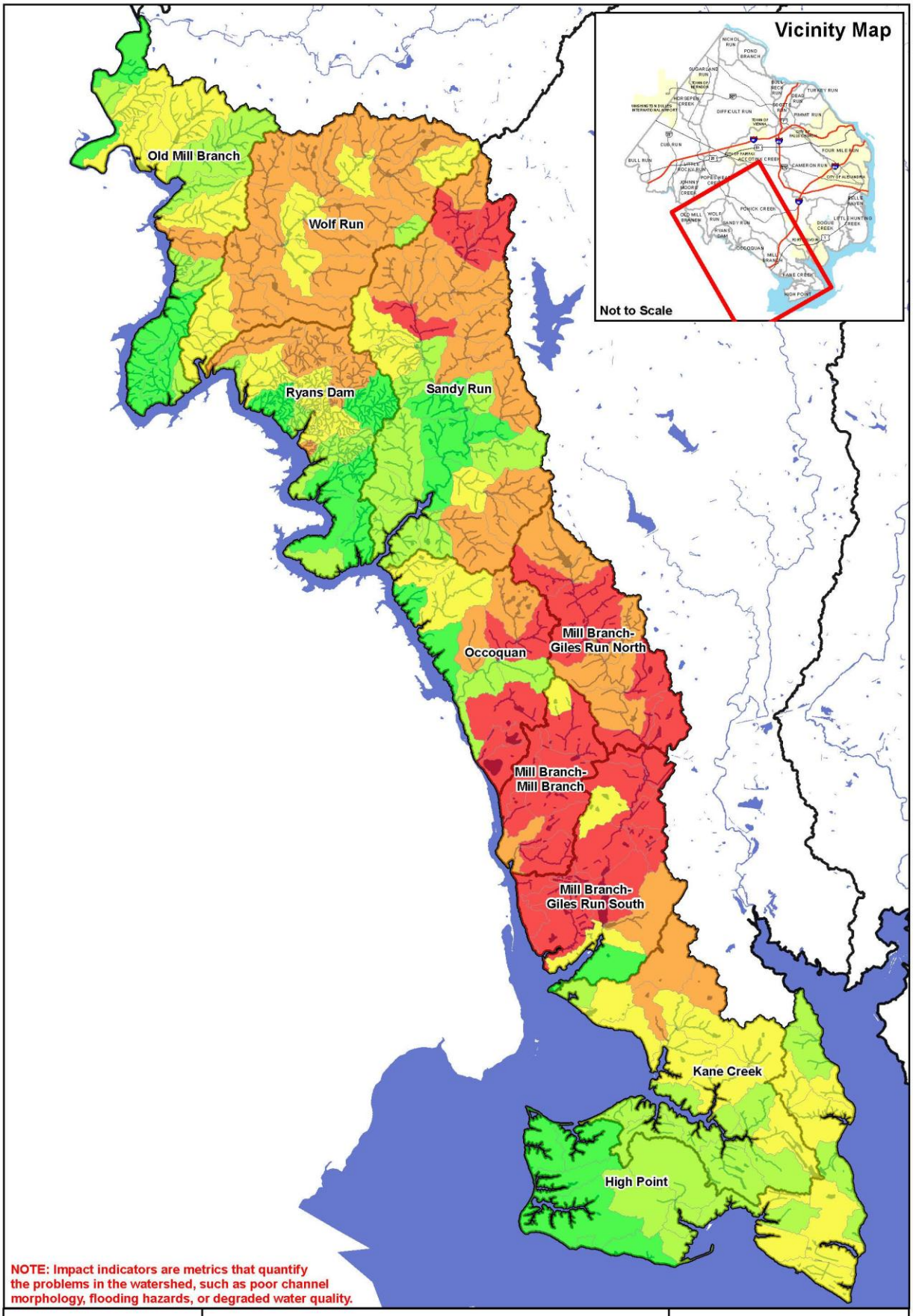
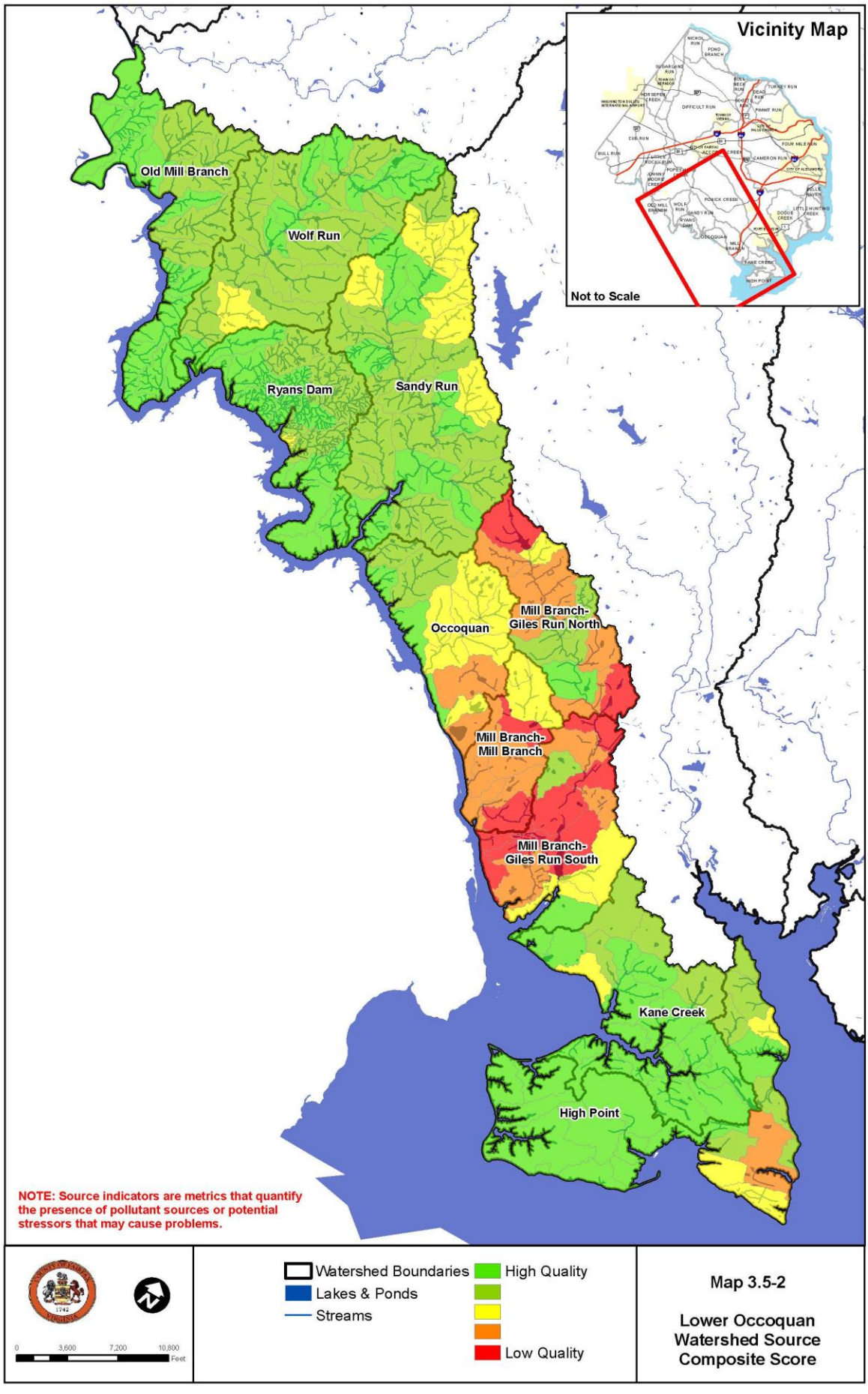

Vicinity Map
Not to Scale
Old Mill Branch
Wolf Run
Ryans Dam
Sandy Run
Occoquan
Mill Branch-
Giles Run North
Mill Branch-
Mill Branch
Mill Branch-
Giles Run South
Kane Creek
High Point
NOTE: Impact indicators are metrics that quantify the problems in the watershed, such as poor channel morphology, flooding hazards, or degraded water quality.
0
3,500
7,000
10,500
Feet
Watershed Boundaries
Lakes & Ponds
Streams
hydro_line_lower_lo
High Quality
Low Quality
Map 3.5-1
Lower Occoquan
Watershed Impact
Composite Score


Vicinity Map
Not to Scale
Old Mill Branch
Wolf Run
Ryans Dam
Sandy Run
Occoquan
Mill Branch-
Giles Run North
Mill Branch-
Mill Branch
Mill Branch-
Giles Run South
Kane Creek
High Point
NOTE: Source indicators are metrics that quantify the presence of pollutant sources or potential stressors that may cause problems.
0 3,600 7,200 10,800
Feet
Watershed Boundaries
Lakes & Ponds
Streams
High Quality
Low Quality
Map 3.5-2
Lower Occoquan
Watershed Source
Composite Score