VANDERMARK CREEK

PIKE COUNTY

SPECIAL PROTECTION EVALUATION REPORT

WATER QUALITY STANDARDS REVIEW

Segment: Entire Basin

Drainage List: C

QUALITY ASSESSMENT UNIT
DIVISION OF WATER QUALITY
BUREAU OF WATER QUALITY MANAGEMENT
DEPARTMENT OF ENVIRONMENTAL RESOURCES
SEPTEMBER 1989

EXECUTIVE SUMMARY

General

The Pennsylvania Department of Environmental Resources has developed water quality standards for all of the surface waters in the State. These standards, which are designed to safeguard Pennsylvania's streams, rivers, and lakes, consist of both use designations and the criteria necessary to protect those uses.

The Department's Special Protection program is a key element of a national and state program to prevent water pollution. Simply stated, the purpose of the program is to keep clean waters clean and provide Special Protection to exceptionally good quality waters and waters that represent outstanding environmental resources.

Special Protection is provided to streams designated as "High Quality Waters" or "Exceptional Value Waters." These classifications describe streams with excellent existing water quality and environmental features which are deserving of Special Protection. The water quality in a "High Quality Waters" stream can be lowered only if a discharge is the result of necessary social and economic development, the water quality criteria are met, and all existing uses of the stream are protected. "Exceptional Value Waters" are to be protected at existing quality. The water quality in "Exceptional Value Waters" shall not be degraded.

As part of its ongoing review of the water quality standards, the Department conducts evaluations of streams nominated for Special Protection designation. This report contains the results of such an evaluation.

Background

Vandermark Creek is a tributary to the Delaware River located in Pike County (Figure 1). The Vandermark Creek basin is presently classified High Quality - Cold Water Fishes and is currently being considered for redesignation as Exceptional Value Waters at the request of a private citizen, Anthony J. Winters. The stream enters the Delaware River in the Delaware Water Gap National Recreational area near the Borough of Milford.

The Vandermark Creek basin straddles the Glaciated Low-Plateaus section of the Appalachian Plateau's physiographic province and the Appalachin Mountain section of theValley and Ridge physiographic province. The basin is underlain by siltstone, sandstone and conglomerate rock units. Most of the Vandermark watershed is undeveloped and is predominantly wooded. Approximately 13% of the watershed consists of state forest and federal lands while the remainder is in private ownership.

Development in the watershed is primarily concentrated in the areas of Milford and road corridors that parallel the Vandermark mainstem and lower Deep Brook. There are no permitted point-source discharges in the watershed. Nonpoint-source discharges are represented by many scattered single family dwellings, seasonal homes, and at least three housing developments in the southern portion of the watershed that are served by on-lot sewage disposal.

Findings

The Vandermark watershed has excellent water quality, but the absence of limestone or calcareous rock deposits in the underlying geologic units causes the stream to be a very sensitive, poorly buffered soft-water system. The Vandermark basin supports good reproducing brook and brown trout populations near its Delaware confluence. Upstream sections of Vandermark Creek and Deep Brook have well established reproducing brook

trout populations that further indicate excellent water quality conditions. While the salmonid fishery reflects stable, reproducing trout populations, historical data indicates that these populations do not meet Pennsylvania Fish Commission biomass criteria for Class A wild trout waters.

There are several small wetlands scattered throughout the watershed. These blend with upland mixed-oak forest to provide excellent habitat for black bear, deer, turkey, squirrel, and grouse populations. It is possible that populations of furbearers like mink, beaver, and otter, which are known to occur in surrounding watersheds of comparable habitat, inhabit areas of the Vandermark watershed. While a search of the Pennsylvania Natural Diversity Inventory revealed that many Species of Special Concern can be found in nearby watersheds, none were known to occur within the Vandermark watershed.

Most of the soil types found in the Vandermark basin are described as having severe or moderately severe limitations for intensive housing and on-lot sewage development. These soils, which account for 95% of the watershed, are limited primarily by seasonal ground water levels or secondarily by steep slopes or rocky soil conditions.

Natural geologic features and erosional processes caused the formation of impressive waterfalls in Laurel Swamp Brook and Deep Brook sub-basins. These same geologic influences are responsible for a long, narrow canyon-like gorge that forms Deep Brook's upper mainstem. The Vandermark basin's present land uses and natural undisturbed conditions are typical of surrounding areas. However, Deep Brook's waterfall and associated geologic cliff formations ,along with the sub-basin's lower overall land development, makes this stream stand out aesthetically above other areas of the Vandermark Creek watershed.

Recommendations

The foregoing conditions make the Vandermark basin a relatively pristine, undisturbed watershed that is typical of this area of Pike County. However, despite these environmental amenities, the Vandermark basin does not display other significant features that would merit an EV designation. The Department found no conditions that would impart any national historic significance to the watershed. While Species of Special Concern are known to occur in surrounding watersheds, none were documented within the basin. Further, even though the basin supports reproducing trout populations, they do not provide an important public recreational fishery because of limited biomass and the posting of private lands.

The Deep Brook sub-basin shares most of the same overall physical/biological conditions as the rest of the basin. However, in comparison to most other sub-basin areas, the Deep Brook sub-basin proportionally represents the largest expanse of undeveloped lands in the Vandermark Creek watershed. Most of the development within the sub-basin is represented by several permanent and seasonal homes and one small subdivision in the lower 0.5 mile stream segment. Also, of great importance, are the natural topographic features found in the Deep Brook sub-basin. The presence of a picturesque cascading waterfall and a long, narrow, cliff-walled valley that characterizes most of the Deep Brook channel upstream of I-84, creates an outstanding natural aesthetic resource within the Vandermark basin. It is for these reasons, that the Deep Brook sub-basin is recommended for Exceptional Value designation. This recommendation affects approximately 3.8 stream miles and an area of 2.2 square miles. The remainder of the Vandermark Creek watershed is recommended to retain its present HQ-CWF designation.

Location Map

The attached figure shows the location of Vandermark Creek basin and the portion recommended for Exceptional Value status.

GENERAL WATERSHED DESCRIPTION

Vandermark Creek is a tributary to the Delaware River located in Milford and Westfall Townships, Pike County. Vandermark Creek flows in a southerly direction for approximately 4.4 miles from its headwaters in the Delaware State Forest to its confluence with the Delaware River near the Borough of Milford (Figure 1). Vandermark Creek drains an area of approximately 5.72 square miles (3,660 acres). Two smaller tributaries, Deep Brook and Laurel Swamp Brook, contribute flow to Vandermark Creek. There are approximately ten stream miles in the basin.

The Vandermark Creek basin is presently classified for High Quality - Cold Water Fishes (HQ-CWF) in Chapter 93 of the Department's Rules and Regulations. A private citizen, Anthony J. Winters, has petitioned the Environmental Quality Board requesting that Vandermark Creek be reclassified as Exceptional Value (EV) Waters.

NATURAL RESOURCES

Geology

The geology of the area (Figure 2) has been described by Fletcher and Woodrow (1970) and Sevon (in preparation). Sevon's more recent description revises the stratigraphic units discussed in Fletcher and Woodrow's publication. The following geologic discussion follows Sevon's stratigraphic correlations.

The Vandermark Creek basin straddles the Glaciated Low Plateaus Mountain section of the Appalachian Plateaus physiographic province and Appalachian Mountain section of the Valley and Ridge physiographic province. The topography for most of the watershed is characterized by flat-topped hills formed on nearly horizontal coarse-grained sandstone and conglomerate rock units. Maximum relief in the watershed is 1,085 feet where the elevation drops from a northern high point of 1,465 feet to approximately 380 feet at its Delaware River confluence. In the northwestern portion of the basin, hill tops are separated by moderately sloped valleys. In the southern and eastern portions of the basin, the valley areas are steeper with greater stream gradients. At least three localized, abrupt drops in stream bed elevations in this area of the basin form cascading waterfalls. One each of the two larger waterfalls are located in Laurel Swamp Brook and Deep Brook sub-basins. The third smaller falls is located on the Vandermark mainstem, near its mouth. Much of the watershed's steepest topography can be found in localized areas of the Deep Brook sub-basin. Geologic conditions and erosional processes that led to the formation of Deep Brook resulted in the formation of a long, aesthetically impressive, narrow, v-shaped valley flanked in some areas by cliffs with shear vertical drops. The Vandermark Creek basin gained these final topographic features from erosion and depositional processes during Pennsylvania's last glacial period.

The underlying geology of the Vandermark Creek basin is characterized by rock units of the Mahantango, Trimmers Rock, and Catskill (Towamensing Member) Formations. Dark gray siltstones, silty shales, and shales comprise the Mahantango and Trimmers Rock Formations. The Towamensing Member of the Catskill Formation is comprised of fine-to-medium grained gray sandstones and gray and olive silty claystones. These underlying geologic formations are covered by glacial till and outwash gravel deposits.

Mineral Resources. Sandstones were actively quarried from neighboring areas until the 1920's. Catskill sandstones are economically important because of their desirable weathering, ease-of-splitting, and hardness properties. Generally, economic development of the few sand and gravel deposits found in the watershed is limited by the undesirable particle size distribution that characterizes the local glacial deposits. However, one gravel pit was found at the confluence of Laurel Swamp Brook during the field study. It did not appear to be used frequently, nor were there any permit signs posted at the site.

An exploratory well drilled to the north of the watershed indicates that subsurface structure and stratigraphy typifying the Vandermark watershed and surrounding areas was not conducive for the accumulation of petroleum and natural gas reserves in exploitable quantities.

Soils

There are three soil associations that commonly occur in the watershed; Volusia-Tughill-Morris-Norwich (Volusia), Wurtsboro-Mardin-Swartswood (Wurtsboro), and Dekalb-Manlius-Oquaga Associations (DeKalb) (Taylor 1969).

Volusia soils are poorly drained and occur in small valleys and upland depressions. These soils have seasonally high water tables and are either saturated most of the year or have well developed fragipans that impede root growth and penetration. The ground water conditions associated with these soils severely limit septic field and home site development.

Soils of the Wurtsboro Association are stony and are found in upland areas. With the exception of the Wurtsboro subgroup, other soils within this Association are generally well-drained. The Wurtsboro soils have seasonally high water tables caused by a compact fragipan. Although the Swartswood subgroup soils are well-drained, portions are found in areas of steeper slopes. The major factors limiting septic field and home site land uses of this Association are the poor drainage of the Wurtsboro soils, the steepness of some Swartswood soils, and general stoniness.

DeKalb soils are stony, shaly, well-drained, and found in upland areas. Unlike most of the soils from the other Associations, land use limitations of the DeKalb Assocation are not caused by ground water problems. Rather, the limitations of these soils are due to stoniness, depth-to-bedrock (2-4 feet), and steep slopes (>12%).

A fourth soil association, the Chenango-Tunkhannock-Tioga (Chenango), can be found in a few, very small, scattered areas in the watershed. Chenango soils are deep, well-drained and gravelly; developed from glacial outwash. These soils are normally found in lower terraces of larger stream and river valleys. With regard to residential development (septic fields, home sites), slopes of greater than 12% are major limitations. Soils from the Chenango Association comprise a small, insignificant portion of the watershed.

Figure 3 shows the extent of soils in the Vandermark Creek basin where development potential is: 1) moderate-to-severe or severely limited by steep slopes, stony land, and poor drainage characteristics, or 2) has moderate or less-than-moderate limitations. It must be noted that within the areas delineated as severely limited, particularly where limitations are based on slope, gently sloped lands that are suitable for home site construction and on-lot sewage disposal can be found in small isolated areas. However, as can be seen in this figure, about 95% of the watershed area is generally unsuited for intensive development.

Ground Water Conditions

Since private wells serve most of the domestic water demands in the watershed (excluding Milford), ground water yields are critical considerations in the Vandermark Creek basin. The size sorting that occurred when materials were deposited by glacial processes is generally unsuitable for long-term, dependable ground water yields. The yields of any shallow wells developed in these deposits are directly influenced by extended periods of dry weather. Sandstones, siltstones, and shales typically do not yield large volumes of water due to their low porosity and grain size. However, all the stratigraphic units of the geologic formations underlying the watershed comprised of these rock types act as viable aquifers (Fletcher and Woodrow 1970). The sandstones are extensively fractured by prominent joint sets with well-defined bedding partings. These features make the Towamensing Member of the Catskill Formation an excellent water-bearing rock. For similar reasons, the fracture systems of silt and sandstone interbeds of the Trimmers Rock and Mahantango Formations allow good yields from these rock units.

Calculations were made to estimate monthly low flows (Q_{7-10}) based on geologic, precipitation, and areal factors (Flippo 1982). The lowest monthly (Q_{7-10}) at the mouth of Vandermark Creek would typically occur during August and is estimated to be 0.32 cfs. The presence of wetlands scattered throughout the watershed (discussed later in this report) is further indicative of generally adequate ground water storage.

Even though there is no available well water chemistry data from the Vandermark basin, limited departmental file information indicates that nearby ground water quality is good. Analysis of the Milford Water Authority's springs show parameter concentrations are well within public drinking water standards. While the wells that serve Matamoras' public water supply are several miles away, the Department's file records indicate that the groundwater quality of adjacent northeastern areas is generally comparable to that exhibited by Milfords' springs.

Surface Water Conditions

Water Chemistry. Laboratory analysis results of Vandermark basin water samples indicates excellent water quality conditions. The concentrations for most of the parameters of concern (i.e., nutrients, metals, total dissolved solids and hardness) were low or in trace amounts (Table 2). However, concentrations of parameters associated with the stream's natural buffering system are also very low (pH, alkalinity, calcium, magnesium) and indicates that the Vandermark watershed is a naturally infertile, poorly buffered, softwater stream, reflecting the influence of its underlying geologic rock units. These rocks are predominantly sandstones and siltstones that are virtually devoid of any limestone or other carbonaceous rock. The Vandermark's weak buffering system appears to be typical of most Pike County streams (based on Pike County Conservation District annual water quality data). This weak buffering system renders the stream incapable of assimilating any acidic or other pH-altering discharges that may result from commercial or industrial development.

Point Source and Nonpoint Source Discharges. Presently, there are no point-source discharges permitted in the watershed. Nonpoint source discharges consist of on-lot sewage systems serving the housing developments, isolated primary dwellings, and seasonal residences that are located primarily along the Vandermark mainstem, Deep Brook south of I-84, and in Milford. The entire town of Milford is served by subsurface disposal systems.

Aquatic Flora and Fauna

The Pennsylvania Fish Commission (PFC) conducted a survey on the Vandermark in 1979. More recently, Department biologists have conducted surveys during August 1988 and July 1989. During the course of these surveys, water quality and biological conditions were evaluated. Results of the Vandermark surveys are compiled in Tables 2-4. Existing land use conditions were also observed during these surveys.

Benthos. Benthic macroinvertebrates (fish-food organisms) were collected at 5 stations (Table 3) during the Department's surveys. The overall density of benthic macroinvertebrates was quite low. However, this is typical of benthic communities found in infertile streams. The benthic samples collected from most sites revealed healthy, diverse, well-balanced communities despite the basin's naturally low fertility. Pollution intolerant organisms, particularly mayflies and stoneflies were well represented at each station. Many of these benthic taxa require cooler, clean, well oxygenated conditions that characterize the Vandermark basin.

Fish. The PFC surveyed the lower section of Vandermark Creek in 1979 (Billingsley et. al. 1980) and found naturally reproducing brook and brown trout populations near the stream's confluence with the Delaware River (Station 9VC). The Department's survey also sampled the fishery at this lower station along with two additional stations upstream (5VC & 7DB). The Department's results and the PFC's historical data are presented in Table 4. While electrofishing the PFC station (9VC), the Department confirmed the two reproducing trout populations documented in 1979. Naturally reproducing brook trout were also collected at stations 5VC and 7DB. No brown trout were found at these stations. There are no significant water chemistry and/or substrate differences between 5VC , 7DB, and 9VC to explain the absence of brown trout. The apparent reason for this absence is a natural barrier on the Vandermark approximately .5 mile from the mouth; upstream of the U.S. Route 6 bridge. At this point, the Vandermark flows over a rock outcrop creating a cascading waterfall with an almost vertical drop in stream bed elevation of about 10-15 feet.

The Vandermark watershed provides generally good habitat conditions for salmonid production. Young-of-year trout were collected at all electrofishing stations. Except for a few small, scattered patches of open canopy, the Vandermark and its tributary channels are well shaded by riparian vegetation, hardwoods, and/or steep valley slopes. These conditions, along with sufficient groundwater base flow, provide desirable year-round cold water conditions that salmonids require. There are a few ponds and small wetland areas in the watershed that could elevate summer water temperatures, but most of these are not on the mainstem channels to provide direct flow to the streams. Except for 1VC, where the low gradient allows natural siltation and poor riffle development, substrate conditions and gradient were favorable at all stations. The distribution of substrate particle sizes was generally good, providing adequate salmonid spawning sites and benthic habitat. However, there were very few pools (to provide refuge and cover) found at the surveyed stations. Good pool development is an important factor for a stream to provide conditions optional for high biomass salmonid populations. The PFC's 1979 survey provided data that can be used to calculate population estimates by the Peterson mark and recapture method. Analysis of that 1979 data resulted in brown trout population estimates of <30 kg/ha (kilograms/hectare) and brook trout estimates of <3 kg/ha. By comparison, PFC criteria for Class A wild brown or brook trout fisheries requires population biomass estimates to be at least 40 or 30 kg/ha (kilograms/hectare) for each species, respectively (PFC 1987). The Class A criteria for a mixed wild trout

fishery include a combined biomass of 40 kg/ha with neither species accounting for more than 75% of the total. Based on PFCs 1979 data, the Vandermark does not meet the criteria for wild trout Class A waters. Although the Department's electrofishing data does not include the mark and recapture information required for 1989 population biomass estimates, it appears that such estimates would be no better than the PFC's 1979 results. The Department's single pass collection at 9VC collected smaller average sized fish than those captured during the PFC's 1979 survey. The primary factors that appear to limit Vandermark's salmonid fishery are the low benthic invertebrate (fish food organisms) densities and poor pool/riffle ratios.

The potential for Vandermark's salmonid population providing a recreational fishery is quite limited. The population does not appear to support substantial numbers of legal sized fish (>7"). Further, with the exception of the National Park Service holdings near the mouth, almost all the other stream sections as noted by the PFC (1979) are not open to public fishing. It is quite possible that most of the legal sized fish are harvested occasionally by local riparian landowners. The Vandermark is not stocked by the PFC.

In summary, the general water quality conditions of the Vandermark watershed are pristine. The diversity of the benthic populations and presence of a reproducing trout fishery very clearly supports this conclusion.

Terrestrial Flora and Fauna

The Vandermark Creek basin is predominantly forested with limited clearings scattered throughout the watershed. The vegetation is characterized by a northern hardwood forest. The dominant forest type is mixed oak that includes white, red, chestnut, and scarlet varieties. Hemlock, white pine, beech, red maple, aspen, and ash can also be found in the basin. Most of the standing timber is not considered to be of high commercial quality.

Wetlands. The wooded upland areas that dominate the watershed are interspersed with scattered, gentle topographic depressions that are classified as wetlands. These areas are depicted on Figure 4 and represent the wet extremes of the soil types with severe limitations due to poor drainage characteristics. In recent years, the environmental benefits of wetlands have been gaining increased attention and recognition. Wetlands are important in their role in stabilizing stream flow, improving water quality, aquifer recharge, and in providing desirable habitat for much of Pennsylvania's flora and fauna. With the exception of the Riverine wetlands shown on Figure 4, (R30W) Vandermark wetlands are classified as Palustrine systems (<20 acres and <2m in depth of standing waters) and are almost entirely restricted to that portion of the watershed north of I-84. They are also known by such generic names as marshes, swamps, bogs, fens, and ponds. Within the Vandermark watershed, these Palustrine areas are sub-classified as Scrub-Shrub (SS), Forested (FO) or Open Water (OW) wetlands. Table 1 further explains these subclasses and other special wetland modifier definitions. The common feature of the Palustrine wetlands in the Vandermark watershed is that they are normally seasonally flooded or saturated. Figure 4 and Table 1 are based on the National Wetlands Inventory Maps and the classification system developed by Cowardin *et al* (1979).

Wildlife Habitat. The vegetative cover and undisturbed setting of the Vandermark watershed provides excellent wildlife habitat for many game species. Most of the Vandermark basin and surrounding areas are prime black bear habitat that also supports very good populations of deer, turkey, squirrel and grouse. To a lesser extent, woodcock, snowshoe hare, and cottontail rabbit populations can also be found in the watershed. The diverse habitats associated with the wetlands may also support furbearer populations of

mink and beaver. While the river otter is known to occur in the Sawkill watershed and surrounding areas, its occurrence in the Vandermark basin has not been documented. Several factors control the abundance of these popular game and furbearer populations. The basin's (and surrounding environs) general undisturbed condition provides vast expanses of forested valleys and hollows that act as refuges; providing shelter and tree cover for roosting. The mix of wetlands and oak-dominant hardwoods offer a wide variety of food types. Most of the area is privately owned and posted, thus reducing hunting pressure on resident game populations.

Species of Special Concern. The Pennsylvania Natural Diversity Inventory (PNDI) database was searched to identify Species of Special Concern known to occur within the Vandermark Creek watershed. In addition, the Edgemere, Milford, Pond Eddy, and Shohola 7.5' quadrangle areas surrounding the Vandermark were also searched. The PNDI revealed that 17 plant species, 8 animal species, and 3 communities of special concern occur or are known to have occurred within the 4 quadrangle search area (Table 5). However, none of these PNDI elements have been documented to occur in the Vandermark Creek watershed. It is possible that some of the PNDI elements found in surrounding watersheds may eventually be found in the Vandermark basin. However, the probability of their occurrence is uncertain because some of the elements' habitat requirements are not clearly defined in the PNDI data-base. Also, while Vandermark basin habitats are similar to those of surrounding areas where PNDI elements have been identified, the extent or degree of the habitats' natural development is not specifically defined and therefore, the watershed's ability to support viable PNDI populations is unknown.

The status of several other plants and animals has been defined as Tentatively Undetermined (TU). For a plant or animal to receive this designation, it is believed that the species is in danger of population decline but needs further study to determine a more accurate status. According to the PNDI, some of these species, such as the Soft-leaved sedge, Crawford's sedge, Timber Rattlesnake, and Eastern hog-nosed snake have been found in neighboring watersheds.

Other animal Species of Special Concern, their status, and date of last sighting are also listed in Table 5.

LAND USE

Existing Land Uses

Existing land use in the Vandermark watershed is heavily dominated by woodlands and associated wetlands. Secondary uses consist of residential (permanent and seasonal) and recreational areas, and roadways. Residential use is primarily represented by the population center surrounding and including the Borough of Milford. Secondary population centers consist of the much less densely populated rural development located south of I-84 expressway. There are also many single family and second home structures located along State Rt. 2017 and Vandermark and lower Deep Brook mainstems. Public recreational uses are associated with the Delaware State Forest (12.5% of the watershed), a small portion of the Delaware Water Gap National Recreation area, and private summer camps. Malibu Ranch, a private commercial, recreational resort, is located in the headwaters of Vandermark Creek. Figure 6 depicts township boundaries and public land ownership in the Vandermark basin. Other existing land uses affect very small areas of the Vandermark Creek basin.

Land Use Plans

Approximately 63% of the Vandermark basin is located in Westfall Township and 33% in Milford Township. The remainder of the basin is located in Milford Borough and Delaware Water Gap National Recreation Area. Comprehensive land use plans for the watershed have been developed at the township level. Milford and Westfall Townships have enacted zoning, sub-division, and building code ordinances. These township ordinances specify areas within each municipality for certain levels of development. Township zoning classifications found in the watershed include: conservation districts (CD), lower density residential (RU, R-1), and higher density residential and commercial (RD, DD). The townships control the land use pressure from housing development by requiring specific lot-size minimums. For areas designated as conservation or low-density residential districts (CU, CD), lot sizes are generally required to be no less than 2 acres, depending on the township and zoning classification. In areas where higher-density housing is allowed, lot size can be smaller than 2 acres. Figure 6 depicts the different zoning districts in the Vandermark basin and summarizes the types of development allowed in each district.

Milford Township. There are three land development codes set forth by Milford Township's zoning ordinances: Conservation District (CD), Residential District (RD), and Development District (DD). Most of the township north and east of State Route 2017 is zoned as CD, comprising about 54% of the township's area that lies within the Vandermark basin. The remaining portions of Milford Township (southwestern edge of the watershed) are zoned as Residential (RD).

Westfall Township. Westfall Township has lands zoned under three development codes; Conservation (CD), Rural (RU), and low density Residential (R-1) Districts. The low density CD & RU zones comprise over 82% of the Township's lands within the Vandermark basin. The R-1 zone comprises approximately 18% of the basin.

Developments. According to Pike County Planning Commission information (1989), there are at least four subdivisions situated entirely or partially within the Vandermark watershed. Greenwood Hills, Orben, and Moon Valley Falls developments are located in Milford Township and are designed for 89 lots comprising of 42 total acres. As of January 1989, at least 14 dwellings are in place. In Westfall Township, the Laurel Hills subdivision (with a 1969 filing date) is designed for 100 lots totalling 152 acres. Planning Commission records indicate that no dwellings have yet been constructed.

One other subdivision in Westfall Township, Crawford Hills, is located adjacent to the Deep Brook sub-basin. A small portion of this development may be situated within this watershed.

When considering zoned areas within the watershed, lower density development zones (CD, RU) account for 72% of the watershed while higher density development (RD, R-1, DD) account for the remaining 28%. The R-1 zone in Westfall Township is called low-density but since it allows lot sizes <2 acres, it is lumped with Milford Township's RD classification that also allows <2 acre lots.

CONCLUSIONS AND RECOMMENDATIONS

The Vandermark Creek watershed is underlain by geologic formations that are predominantly sandstones, siltstones, and shales. To date, the Vandermark watershed has experienced relatively little land disturbance, thus retaining a naturally wooded or 'wild' character throughout most of the upper basin. The most intensive land use pressures and

population densities are restricted to Milford and road corridors that parallel both the Vandermark and lower Deep Brook mainstem. Much of this area lies south of I-84. The existing housing developments in other parts of the basin rely on individual on-lot sewage disposal and comprise a very small portion of the watershed surface area.

Environmental Attributes. The quality of waters providing baseflow to the Vandermark is excellent. The Vandermark Creek watershed can be generally characterized as a pristine, naturally soft water system with very low buffering capacity. These infertile conditions are able to support low density, but viable, healthy benthic communities and reproducing trout populations that are indicative of the basin's high water quality. The terrestial and scattered wetlands habitat found in the Vandermark basin is typical of surrounding watersheds and provides excellent conditions for desirable game species (bear, deer, turkey, squirel, grouse). Since furbearers, such as mink, beaver, and otter are known to occur in surrounding areas of comparable habitat, it is possible that they may also inhabit portions of the Vandermark basin. Species of Special Concern (i.e., PA rare, endangered, etc.) are known to occur in surrounding areas but have not been documented from the Vandermark study area. Public recreation potential is limited to National Park Service holdings at the mouth of the Vandermark and the Delaware State Forest, most of which lies within the Deep Brook subbasin. The recreational fishery is limited by stream sections closed to public fishing and the scarcity of legal sized trout. There are no features of national historic significance known by the Department to be located within the watershed.

Overall, the Vandermark watershed is aesthetically pleasing because of its natural environmental attributes. However, one portion of the Vandermark study area, the Deep Brook subbasin, stands out above the rest of the watershed. It is the least disturbed subbasin with limited road access and little residential development. The upper portion of the stream is characterized by a picturesque waterfalls and narrow, canyon-like valley with steep, vertical walls.

Recommendations

Because of its excellent water quality and significant additional environmental attributes, the Department recommends that the protected use of the Deep Brook sub-basin be changed from High Quality-Cold Water Fishes to Exceptional Value Waters. The remainder of the Vandermark watershed should remain classified as HQ-CWF. Rationale for this recommendation is as follows:

The Vandermark Creek watershed exhibits excellent, but sensitive water quality conditions. Naturally reproducing brook and brown trout populations are present. The interaction of wetland and upland hardwood habitats provide excellent conditions that support abundant, game species and, possibly populations of beaver, mink, and/or otter. These watershed conditions make the Vandermark basin a pristine, relatively undisturbed watershed that is typical of this area of Pike County. However, despite these environmental amenities, the Vandermark basin does not display other significant features that would merit an EV designation. The Department found no conditions that would impart any national historic significance to the watershed. While Species of Special Concern are known from surrounding watersheds, none were documented to occur with the basin. Further, even though the basin supports reproducing trout populations, they do not provide an important public recreational fishery because of limited biomass and the posting of private lands.

The Deep Brook sub-basin shares most of the same overall physical/biological conditions as the rest of the basin. However, in comparison to most of the other watershed area, the Deep Brook sub-basin proportionally represents the largest expanse of undeveloped

lands in the Vandermark Creek watershed. Most of the development within the sub-basin is represented by several permanent and seasonal homes and one small subdivision in the lower 0.5 mile stream segment. Also, of great importance, are the natural topographic features found in the Deep Brook Sub-basin. The presence of a picturesque cascading waterfall and a long, narrow, cliff-walled valley that characterizes most of the Deep Brook channel upstream of I-84 creates an outstanding natural aesthetic resource within the Vandermark basin. It is for these reasons, that the Deep Brook sub-basin is recommended for Exception Value designation.

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TABLE 1
WETLAND CODES FOR VANDERMARK CREEK
FIGURE 4

Symbol From Figure 4	Wetland Inventory Map Code	Ecological Modifiers			Special Modifiers
		System	Class	Sub-Class	
A	POW	P: Palustrine	OW: Open Water		
C	PFO1	P: Palustrine	FO: Forested	1: Broad-leaved deciduous	
D	PFO1E	P: Palustrine	FO: Forested	1: Broad-leaved deciduous	E: Seasonally saturated
E	PFO 1/4	P: Palustrine	FO: Forested	1/4: 1 + Needle-leaved evergreen	
F[1]	PF04	P: Palustrine	FO: Forested	4: Needle-leaved evergreen	
F	PFO4E	P: Palustrine	FO: Forested	4: Needle-leaved evergreen	E: (see above)
M	PSS1	P: Palustrine	SS: Scrub/Shrub	1: (See 1 above)	
O	PSS3Ba	P: Palustrine	SS: Scrub/Shrub	3: Broad-leaved evergreen	B: Saturated a: acidic
Z	R30W	R: Riverine	30W: Upper Perennial, Open Water		

TABLE 2A.
WATER CHEMISTRY DATA[1]
VANDERMARK CREEK, PIKE COUNTY

Station/ Date	1VC			2VC	3VC	4LSB	5VC		6DB	7DB		8VC	9VC	
	8/8/88	7/5/89	7/6/89	8/8/88	7/5/89	7/5/89	7/5/89	7/6/89	7/5/89	7/5/89	7/6/89	8/8/88	7/5/89	7/6/89
Field Parameters														
Temp (°C)	21.0	-	18	19	-	-	17	-	-	15	-	24.0	15.5	-
pH	-	-	5.4	-	-	-	6.3	-	-	6.3	-	-	6.3	-
Cond (umhos)	30	-	20	80	-	-	40	-	-	40	-	60	60	-
Diss. O_2	-	-	8.6	-	-	-	9.4	-	-	9.8	-	-	9.9	-
Laboratory Parameters														
pH	6.6	6.5	6.6	7.4	6.8	6.7	6.8	6.9	6.4	6.7	6.8	6.7	6.8	6.9
Alkalinity	10	6	6	28	10	8	10	10	4	8	8	12	12	12
Acidity	0	0	0	0	0	0	0	0	4	0	0	0	0	0
Hardness	14	<10	<10	32	12	11	13	12	<10	13	11	19	19	17
T Diss. Sol.	42	28	16	82	50	64	32	31	52	26	32	62	56	50
Susp. Sol.	8	2	<2	18	26	16	22	3	8	6	<2	14	10	<2
NH_3-N	.02	.02	<.02	.05	.02	.02	<.02	<.02	<.02	<.02	<.02	.05	.02	<.02
NO_2-N	<.004	<.004	<.004	.004	<.004	<.004	<.004	<.004	<.004	<.004	<.004	.004	<.004	<.004
NO_3-N	.12	.07	<.04	.62	.33	.09	.29	.26	.07	.15	.154	.56	.55	.64
Total P	.05	.05	.04	.15	.14	.06	.11	.07	.06	.05	.04	.04	.08	.05
Ca	2.78	2.03	2.23	10.42	3.95	3.3	3.46	4.0	2.28	3.32	3.63	5.66	4.78	5.56
Mg	1.13	<1.0	0.80	2.15	1.48	1.27	1.52	1.48	<1	1.43	1.48	2.15	1.83	1.87
Cl	2	2	2	6	4	3	4	4	2	4	4	8	10	8
SO_4	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
As*	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Cd*	<.2	<.2	.28	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
Cr*	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cu*	15	<10	<10	53	<10	<10	<10	<10	<10	<10	<10	13	<10	<10
Fe*	490	352	174	208	970	597	930	295	773	167	110	42	528	141
Pb*	<4	<4	<4	4.4	<4	<4	<4	<4	<4	<4	37.5	<4	<4	<4
Mn*	93	75	19	32	178	80	137	26	151	21	10	<10	40	12
Ni*	<25	<25	<25	<25	37	43	<25	<25	<25	34	<25	29	26	<25
Zn*	18	21	<10	10	35	26	17		25	13	17	15	18	<10
Al*	297	245	<135	520	685	221	638	152	332	139	<135	<135	384	143
Fecal														
colif.N/100ml	220	120	40	120	6700	1200	2700	380	80	280	20	650	4400	240
strep/N/100ml	-	1300	580	-	23000	1400	3600	1200	340	1300	220	-	7000	620
strep/colif	-	10.8	14.5	-	3.43	1.16	1.33	3.16	4.25	4.64	11.0	-	1.59	2.58

[1] Except for pH and conductance and indicated otherwise, all values are total concentrations in mg/l

* Total concentrations in ug/l

TABLE 2B.
WATER CHEMISTRY DATA[1]
VANDERMARK CREEK, PIKE COUNTY,
1987, 1988

Station	Near 5VC PCCD *#83		Upstream of 8VC PCCD *#5		9VC PCCD *#4	
	12-11-87	9-13-88	8-25-87	9-13-88	8-25-87	9-13-88
Temp (°C)	-	15.7	-	15.7	-	14.5
pH	-	9.5	-	8.2	-	8.6
Diss. O_2	-	8.3	-	7.5	-	7.9
Laboratory Parameters						
pH	6.6	7.4	6.0	7.3	6.2	7.4
cond (umhos)	210	89	160	88	73	140
Alkalinity	10	13	15	12	15	13
Acidity	-	3	-	3	-	4
Hardness	-	50.1	-	25.4	-	29.8
Turbidity	2.0	9	3.0	5	<1	5
NH_3-N	<.03	.01	.013	.01	.013	.02
NO_2-N	.004	-	.002	-	.002	-
NO_3-N	2.17	1	2.11	.92	.03	1.15
Total PO_4	.8	.07	.501	.08	.029	.1
Ca	-	15.9	-	6.01	-	7.6
Mg	-	2.5	-	2.53	-	2.62
Cl	19.32	6.1	45.06	5.6	10.22	15.3
BOD-5 day	2.0	.6	1.8	.1	1.5	3.5
fecal colif. col./100ml	3	172	0	148	4	220

1 Except for pH and conductance and indicated otherwise, all values are total concentrations in mg/l

* Pike County Conservation District Stations

TABLE 3
BENTHIC MACROINVERTEBRATE QUALITATIVE[1] RESULTS
VANDERMARK CREEK, PIKE COUNTY.
July 5-6, 1989.

Taxa	Station					
	1VC	2VC	5VC	7DB	8VC*	9VC
Ephemeroptera - mayflies						
Baetidae; Baetis	R	P	-	-	P	P
Ephemerellidae; Drunella	-	P	P	R	-	C
Ephemerella	-	-	P	-	-	-
Serratella	R	R	R	-	P	-
Heptageniidae; Epeorus	-	-	P	P	-	P
Heptagenia	-	-	P	-	P	P
Stenacron	R	-	-	-	-	-
Stenonema	R	R	-	-	P	P
Leptophlebiidae; Paraleptophlebia	-	R	P	P	P	R
Oligoneuriidae; *Isonychia*	P	-	-	-	R	-
Plecoptera - stoneflies						
Chloroperlidae; *Alloperla*	-	-	-	P	R	P
Leuctridae; *Leuctra*	P	P	R	R	R	P
Nemouridae; *Amphinemura*	-	P	R	-	-	-
Peltoperlidae; *Tallaperla*	R	-	-	-	P	-
Perlidae; *Acroneuria*	-	R	P	P	P	P
Agnetina n.r.	-	-	R	-	-	P
Paragnetina	-	P	R	-	-	-
Perlesta n.r.	-	-	R	-	P	P
Perlodidae; *Isoperla holochlora n.r.*	R	P	P	-	-	-
Pteronarcyidae; *Pteronarcys*	-	P	P	P	P	C
Trichoptera - caddisflies						
Glossosomatidae genus	R	-	-	-	-	-
Agapetus	-	-	-	R	-	R
Glossosoma	-	R	C	-	P	P
Hydropsychidae; *Cheumatopsyche*	R	-	-	-	P	-
Diplectrona	-	C	P	C	-	P
Hydropsyche (Hydropsyche)	P	-	-	-	-	-
Hydropsyche (Ceratopsyche)	-	-	-	-	P	P
Hydroptilidae genus	-	-	-	-	P	-
Lepidostomatidae; *Lepidostoma*	R	-	-	R	-	-
Limnephilidae; *Pycnopsyche*	-	P	P	P	-	C
Neophylax	-	-	-	-	-	A
Odontoceridae; *Psilotreta*	-	-	R	-	-	-

TABLE 3
(Continued)

Taxa	Station					
	1VC	2VC	5VC	7DB	8VC*	9VC
Trichoptera (continued)						
Philopotamidae; *Chimarra*	R	-	-	-	-	-
Dolophilodes	R	P	C	P	P	P
Polycentropodidae; *Polycentropus*	-	-	-	-	P	-
Rhyacophilidae; *Rhyacophila fuscula*	-	P	R	R	R	R
R. carolina	-	R	-	R	-	R
Diptera - true flies						
Blephariceridae; *Blepharicera*	-	-	R	-	-	-
Empididae genus	-	-	R	-	-	-
Simuliidae; *Simulium*	-	-	P	-	P	-
Tipulidae; *Tipula*	P	P	P	R	-	P
Hexatoma	-	R	P	R	P	P
Pseudolimnophila	-	R	-	-	-	-
Chironomidae genera	P	P	P	P	P	P
Other Insect Taxa						
Megaloptera - dobson-, alder-, fishflies						
Corydalidae; *Nigronia*	C	P	-	R	R	-
Sialidae; *Sialis*	R	-	-	-	-	-
Odonata - dragon-, damselflies						
Aeshnidae; *Boyeria vinosa*	P	-	-	-	-	-
Cordulegastridae, *Cordulegaster*	P	-	-	-	-	-
Gomphidae genus	-	R	-	-	-	-
Erpetogomphus n.r.	R	-	-	-	-	-
Coleoptera - aquatic beetles						
Elmidae; *Oulimnius*	-	-	-	R	-	-
Promoresia	-	-	-	-	R	-
Stenelmis adult	R	-	-	-	R	-
Non-Insect Taxa						
Oligochaeta, lumbricid type	-	R	-	C	P	P
tubificid type	-	-	-	-	-	R
Decapoda; crayfish						
Cambaridae genus	-	-	P	-	-	-
Pelecypoda; bivalve clams						
Sphaeridae genus	R	-	-	-	-	-
Hydracarina; water mites	R	-	-	-	P	-
Total Number Taxa	24	24	27	19	27*	26

* Station 8VC was sampled 8/18/88

[1] Relative abundances

VA - very abundant C - common R - rare
A - abundant P, X - present

TABLE 4
QUANTITATIVE ELECTROFISHING RESULTS
VANDERMARK CREEK
JULY 5-6, 1989

Fish Species	Stations			
	5VC	7DB	9 VC	
			DER	PFC*
Brook trout, *Salvelinus fontinalis* *(>175 mm)*	0	0	1	1
(<175 mm)	18	14	.8	15
Brown trout, *Salmo trutta* *(>175 mm)*	0	0	0	15
(<175 mm)	0	0	10	35
salmonid total#	18	14	19	67
Longnose dace, *Rhinichthys cataractae*	-	-	X	-
Tessalated darter, *Etheostoma olmstedi*	X	X	X	X
Slimy sculpin, *Cottus cognatus*	X	X	X	X
American eel, *Anguilla rostrata*	-	-	X	-
total species	3	3	6	9*
electrofishing time (min)	10	10	20.5	-
catch/unit effort (# trout/hr.)	108	84	55.6	-

*1979 PFC survey. Other fish collected by PFC include: cutlip minnow, blacknose dace, white sucker, yellow bullhead, margined madtom.

X - Present

TABLE 5
SPECIES OF SPECIAL CONCERN
PENNSYLVANIA NATURAL DIVERSITY INVENTORY
EASTERN PIKE COUNTY

PNDI Common/Element Name	USGS Quad	Township	Watershed	Habitat[1]	State Status[2]	Last Seen
No PNDI elements are presently known to occur in the Vandermark watershed						
Water lobelia *Lobelia dortmanna*	Edgemere Shohola	Delaware Shohola	Dingmans Cr. Twin Lakes Cr.	LA- LAA	PR	1899 1961
Slender water-milfoil *Myriophyllum tennellum tabies*	Edgemere Shohola	Delaware Shohola	L. Bushkill Twin Lakes Cr.	L-- LAA	PR	1986 1961
Floating-heart *Nymphoides cordata*	Edgemere Shohola	Delaware Shohola	L. Bushkill Twin Lakes Cr.	L-- LAA	PR	1986 1982
Spotted pondweed *Potamogeton pulcher*	Edgemere	Delaware	Dingmans Cr.	LA-	PE	1917
Labrador marsh bedstraw *Galium labradoricum*	Milford	Dingman	Raymondskill Cr.	TBC	PE	1983
Rock clubmoss *Lycopodium porophilum*	Milford	Dingman	Raymondskill Cr.	RDA	PE	1983
Prickly-pear cactus *Opuntia humifusa*	Milford	Dingman	Delaware R.	THG	PR	1983
Bicknell's hoary rockrose *Helianthemum bicknellii*	Milford	Delaware	Delaware R.	T--	PT	1936
Roseroot stonecrop *Sedum rosea*	Shohola	Lackawaxen	Lackawaxen R.	TH-	PE	1959
Lupine *Lupinus perennis*	Shohola	Lackawaxen	Shohola Cr.	T--	PR	1974
Slender mtn-ricegrass *Oryzopsys pungens*	Shohola	Blooming Grove	Shohola Cr.	T-	PR	19??
Bog-rosemary *Andromeda polifolia*	Edgemere	Dingman	Saw Kill Cr.	PCA	PR	1985
Yellow cowlily *Nuphar luteum*	Edgemere	Delaware	L. Bushkill	LA-	TU	1899
Soft-leaved sedge *Carex disperma*	Edgemere	Dingman	Gum Brook	PC-	TU	1961
Crawford's sedge *Carex crawfordii*	Shohola	Shohola	Savantine Cr.	T-	TU	1944
White water-crowfoot *Ranunculus trichophyllus*	Milford/ Shohola	Dingman/ Lackawaxen	Delaware R. Lackawaxen R.	R--	TU	1939 1932
Northern hound's-tongue *Cynoglossum boreale*	Shohola	Shohola/ Dingman	Shohola Cr.	T-	TU	1939

TABLE 5
(Continued)

PNDI Common/Element Name	USGS Quad	Township	Watershed	Habitat[1]	State Status[2]	Last Seen
Timber rattlesnake *Crotalis horridus*	Edgemere Pond Eddy Shohola	Dingman/ Delaware Shohola/ Westfall	Adams Cr. Savantine Cr. Delaware R.	-- -- --	TU	unk unk 1952
Eastern hognose snake *Heterodon platyrhinos*	Shohola	Shohola	Savantine Cr.	---	TU	1952
Sea lamprey *Petromyzon marinus*	Shohola	Lackawaxen	Delaware R.	---	TU	1969
Bald eagle *Haliaeetus leucocephalus*	Milford	Dingman	Delaware R.	---	LE	1900
Vesper sparrow *Pooecetes gramineus*	Milford	Dingman/ Milford	Sloat Brook	---	LS	1905
River otter *Lutra canadensis*	Edgemere	Delaware	Dingmans Cr.	L--	LS	1980
Cobblestone Tiger beetle *Cicindela marginipennis*	Milford	Milford/ Dingman	Delaware R.	R--	N, C2	1960
Persius Duskywing *Erynnis persus persus*	Milford	Westfall	Dimmick Meadow Brook	---	N	1988
Glacial bog	Edgemere	Dingman	Saw Kill Cr.	PCA	N	1985
Shale cliff community	Milford	Dingman	Delaware R.	THG	N	1983
Pitch Pine/Scrub Oak Barrens	Pond Eddy	Westfall	Dimmick Meadow Brook	-	N	1987

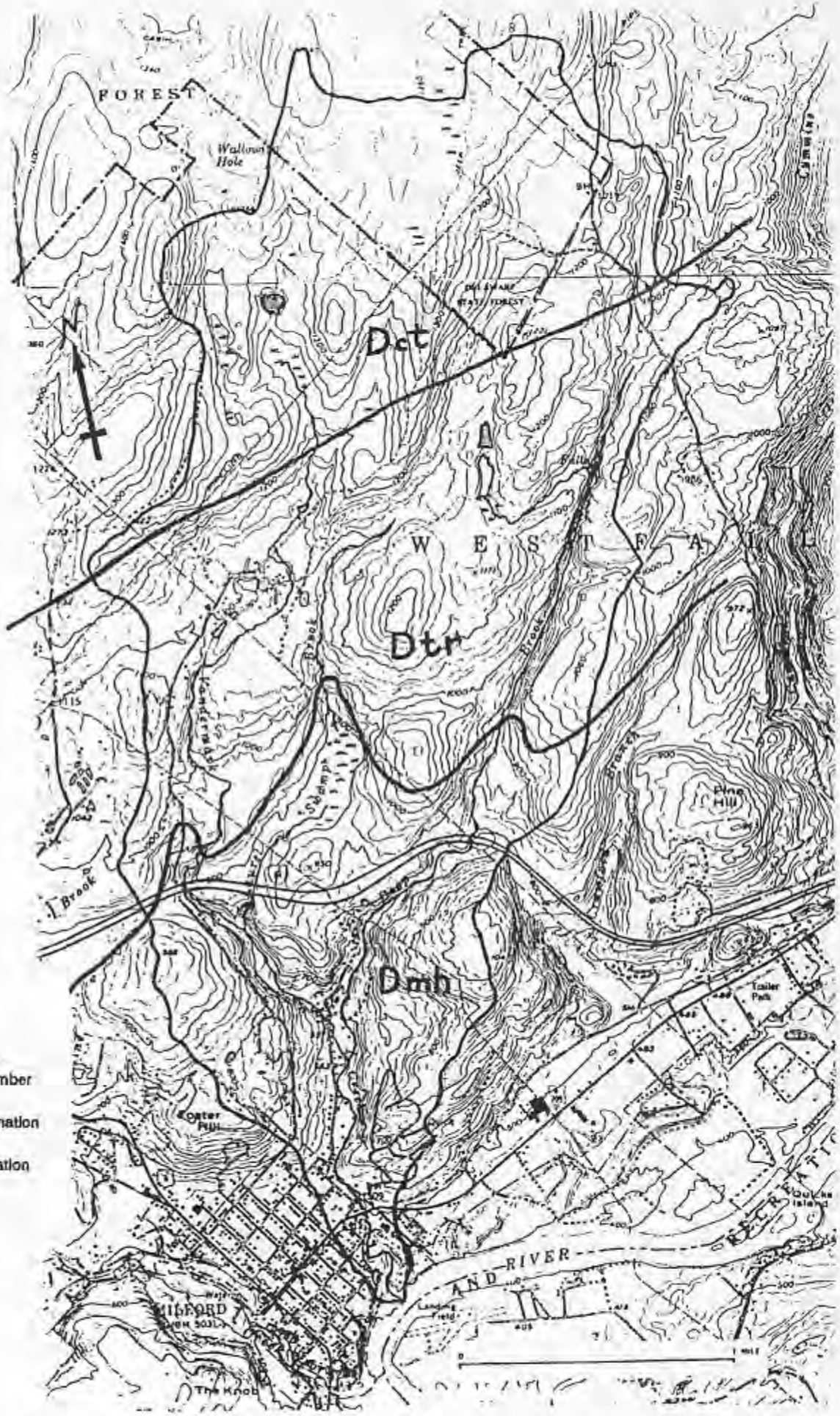
1 - PNDI Habitat codes:

PC-	Palustrine/bog
PCA	Palustrine/glacial bog
L--	Lacustrine
LA-	Lacustrine/lake
LAA	Lacustrine/glacial lake
R--	Riverine/river
RDA	Riverine/waterfall & plunge pool
T--	Terrestrial
TBC	Terrestrial/Northern hardwood - conifers
TH -	Terrestrial/rock exposures
THG	Terrestrial/shale cliff community

2 - Status codes:

PR- Pennsylvania Rare
- PT- Pennsylvania Threatened
- PE- Pennsylvania Endangered
- TU- Tentatively undetermined
- LE- Federal Endangered
- LS- Species of special concern
- N - No status. However, it appears on PNDI because of concern from advisory committee recommending that the element merits special study to determine actual status
- C2 - Federal status: information exists that indicates that listing the elements as threatened or endangered might be appropriate but has too little supportive data.

FIGURE 1 - VANDERMARK CREEK BASIN, PIKE COUNTY



LEGEND:

Dct - Catskill Formation - Towamensing Member

Dtr - Trimmers Rock Formation

Dmh - Mahantango Formation

- Gravel Pit

FIGURE 2 - GEOLOGIC FEATURES OF VANDERMARK CREEK BASIN

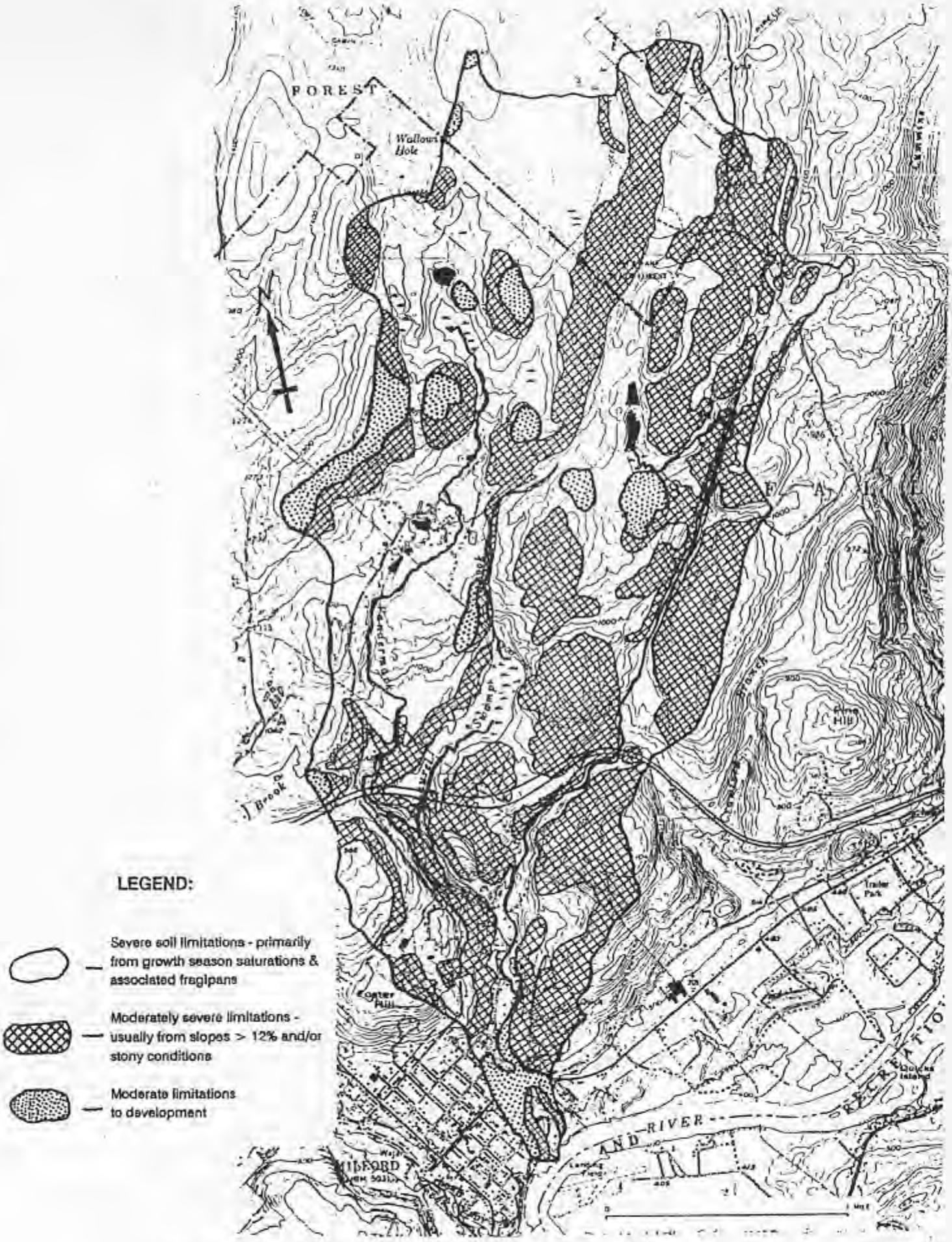


FIGURE 3 - VANDERMARK CREEK BASIN DEVELOPMENT LIMITATIONS

(BASED ON SOIL CONDITIONS)

FIGURE 4 - WETLAND AREAS OF VANDERMARK CREEK WATERSHED

(SEE TABLE 1 FOR DEFINITIONS)

FIGURE 5 - VANDERMARK CREEK SAMPLE STATION LOCATIONS

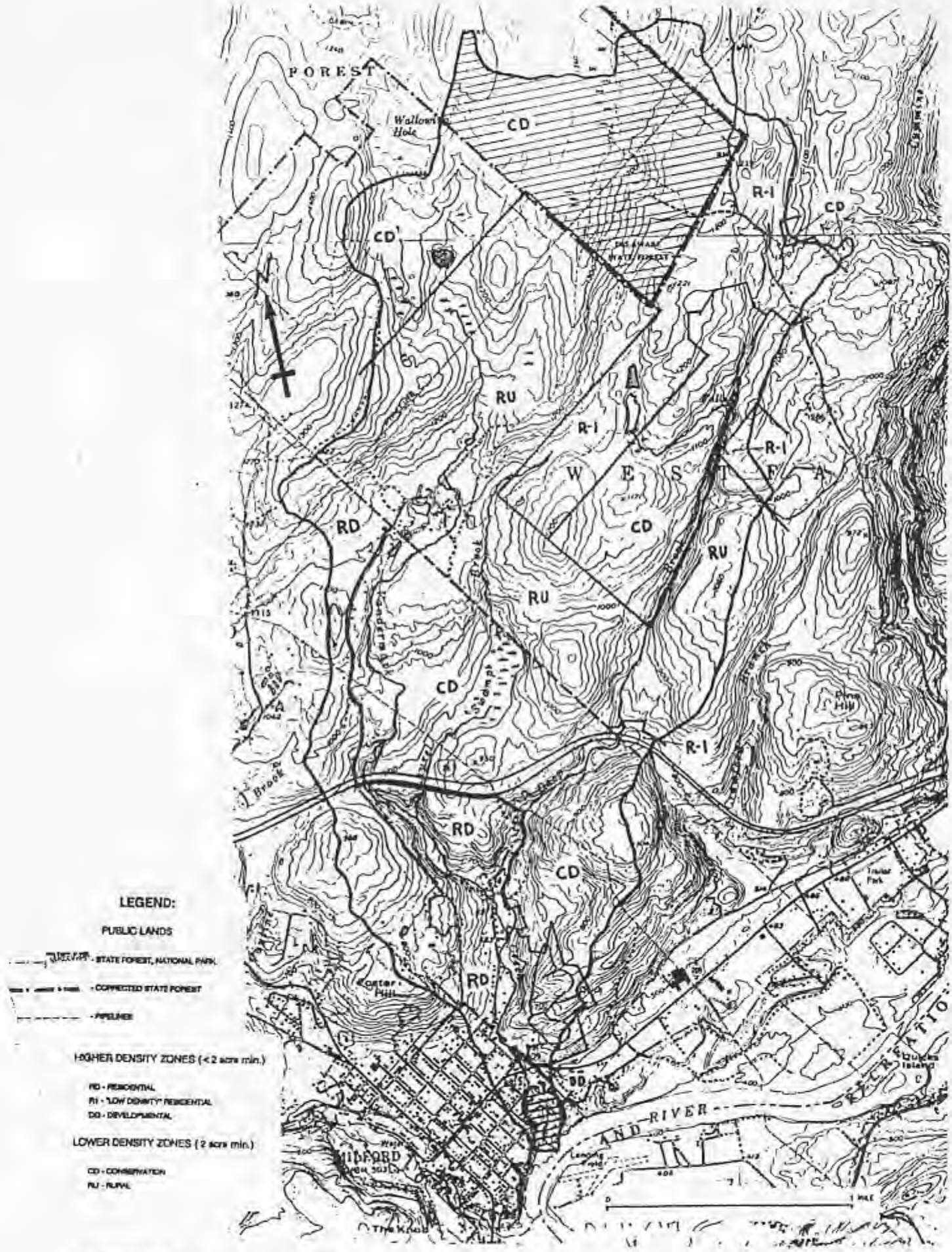


FIGURE 6 - VANDERMARK CREEK BASIN LAND USES & ZONING CLASSIFICATIONS