

Equestrian-Related Water Quality Best Management Practices



**A Cooperative Effort among Private and Public Entities
in
Orange and San Diego Counties, California
in response to NPDES permits issued by the
Santa Ana and San Diego
Regional Water Quality Control Boards**

It is the hope of the Task Force that the equestrian community will embrace and implement the BMPs contained within this document as reasonable requests to help curtail pollution into local water bodies including San Diego and Orange County creeks, bays, and the Pacific Ocean.

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Regulatory Background

The 1972 Federal Water Pollution Control Act, subsequently known as the Clean Water Act (CWA), established the National Pollutant Discharge Elimination System (NPDES) Program. Throughout the State of California, the State Water Resources Control Board (SWRCB) is the designated agency responsible for the implementation of the Federal Clean Water Act requirements. Implementation is done locally, through permits issued to California counties by the nine (9) Regional Water Quality Control Boards working for the SWRCB. In certain circumstances, the Regional Boards issue special permits to individual facilities. Orange and San Diego Counties are governed by the Santa Ana and San Diego Regional Boards, which have issued NPDES Permits to the County of Orange and the County of San Diego as the “Principle Permittees” in charge of implementing the provisions of the Clean Water Act and the NPDES Permits (“Permits”). The Permits are reviewed annually and updated every five years. For Orange County, the Permits were extensively revised in early 2002, directing the County of Orange, the incorporated cities, and the Orange County Flood Control District (collectively known as the “Permittees”) to examine how pollution from runoff is handled, mitigate the sources of pollution and require substantial fines and legal action for non-compliance.

The Permittees, in their commitment to maintain a clean environment, developed Storm Water Local Implementation Plans (LIPs) (also known as Jurisdictional Urban Runoff Management Plans (JURMPs) in the San Diego Region), which were then submitted to the Regional Boards in 2003. The Local Implementation Plans regulate runoff from all properties in the Permittees respective jurisdictions. The LIPs also contain a list of actions that may be implemented to help reduce or eliminate pollution from specific activities. These activities are referred to as Best Management Practices or BMPs.

The Regional Boards, as part of their duties under the Federal Clean Water Act, are also responsible for identifying “pollutants of concern,” which are those pollutants that cause water bodies to be impaired for identified beneficial uses (“impaired water bodies”). For example, the Santa Ana Regional Board has determined the pollutants of concern for the Newport Bay Watershed in Orange County, California, are fecal coliform (a type of bacteria), sediment, toxics, and nutrients because these pollutants have impaired the use of Newport Bay for identified beneficial uses such as water contact recreation (REC-1), shellfish harvesting (SHELL), and others. For San Diego and Orange Counties, many beaches and lower reaches of creeks have been identified as impaired water bodies with fecal coliform and sediment most commonly listed as the pollutants of concern. The Regional Boards have listed fecal coliform as a pollutant of concern because it is an indicator of potential viruses and pathogens that cause swimmer-associated sickness in water bodies. Therefore, the Permittees have been charged with finding and reducing the amount of fecal coliform and sediment coming from land uses within their jurisdictions in an effort to curtail the impact of human activities on beaches, creeks, and the Pacific Ocean. (For more information on equestrian-related pollutants, please see the next section, “How Can Horse Waste and Equestrian Activities Impair Water Quality?”)

During the process of writing the LIPs, the Permittees worked together to identify water quality related BMPs for activities that might take place within each Permittee's jurisdiction. Among the pollutants of concern the Permittees worked to address were bacteria and sediments as well as other pollutants such as petroleum hydrocarbons, chemicals, nutrients, and other materials that might affect the quality of water bodies. As a result, the Permittees came up with categories of activities and identified the specific BMPs that could be used within each of those categories to curtail the quantity of the pollutants in the impaired water bodies. During the process, the Permittees identified a lack of applicable BMPs that could apply to the equestrian community. Unfortunately, Orange County does not have its own Resource Conservation District, so in an effort to identify appropriate equestrian BMPs for Orange County, some South Orange County cities decided to start the process of researching BMPs by referencing already available documents from other Resource Conservation Districts such as *Stable and Horse Management in the Santa Monica Mountains*, prepared by the Resource Conservation District of the Santa Monica Mountains, *Backyard Ranches: A Horse Management Program for San Diego County*, prepared by the San Diego County Association of Resource Conservation Districts, and *Horse Keeping: A Guide to Land Management for Clean Water*, prepared by the Council of Bay Area Resource Conservation Districts.

In July 2003, the San Diego Regional Water Quality Control Board required the South Orange County Permittees to identify minimum required BMPs when they issued a directive to: "clearly identify which Best Management Practices (BMPs) are the minimum that will be required and how the City will require the specific BMPs for...existing development in accordance with Permit Sections F.2 and F.3." In response to this directive, the same South Orange County cities who had been researching appropriate BMPs for the equestrian community decided to form a Horses and Water Quality Task Force to gain input from the public and formulate a series of minimum BMPs that were agreeable to all parties involved. It was decided early on to recruit members from neighboring counties including San Diego County cities and agencies in the hope of expanding the base of knowledge of the Task Force and to share in the fruits of the labors of the Task Force. The first meeting of the Task Force was held in August 2003 at the San Juan Capistrano Community Center with Ziad Mazboudi from the City of San Juan Capistrano serving as the Chair of the Task Force. The Task Force finished their work in April 2004, and this document is the fruition of the efforts of those people listed in the Acknowledgments section of this document.

It is the hope of the Task Force that the equestrian community will embrace and implement the BMPs contained within this document as reasonable requests to help curtail pollution into local water bodies including San Diego and Orange County creeks, bays, and the Pacific Ocean.

How Do Horse Waste and Equestrian Activities Impair Water Quality?

Although horse wastes (manure, urine and soiled bedding) are organic, biodegradable materials, many of their physical, biological and chemical properties (such as sediment, phosphorous, nutrients, and bacteria) can be detrimental to water quality and can adversely affect human health and aquatic life in water bodies. Many of the nutrients ingested by horses return to the environment in feces and urine. When carried by runoff to streams and lakes, excessive amounts of these same nutrients can stimulate unwanted algae blooms in creeks and streams, causing a decrease in dissolved oxygen in water, which stifles aquatic life.¹

Some activities, such as heavy grazing or pasture use, remove the soil's vegetative cover and can expose the soil surface. Exposed soil is easily transported by runoff to streams and creeks, and excessive sediment can fill pools, smother aquatic habitats, and cover food supplies.¹

Bacteria, such as fecal coliform, are present in horse manure. As previously discussed, the Regional Boards have listed fecal coliform as a pollutant of concern because it is an indicator of potential viruses and pathogens that cause swimmer-associated sickness in water bodies.

Chemicals used during horse grooming and shelter/living area maintenance may cause adverse health effects to humans and are toxic to aquatic life.

¹Paraphrased from *Horse Owners Guide to Water Quality Protection* published by the Council of Bay Area Resource Conservation Districts

Expectations from the Equestrian Community

The Permittees have been charged with the challenging task by the Regional Boards of preventing pollutants to the maximum extent practicable from reaching local water bodies. In response to this challenge, the Permittees worked with equestrian community representatives, the environmental community and the public to develop BMPs that may be implemented while not inhibiting the public's ability to conduct business, curtail recreational use of horses or the enjoyment of land uses. Therefore, the Permittees expect that the equestrian community will implement the suggested minimum BMPs to the maximum extent practicable taking into consideration time, monetary, and other direct and indirect costs associated with improving water quality. Many of the suggested BMPs require little or no monetary expenditures, such as following the directions on horse grooming products to prevent chemicals from reaching waterways, while others will require monetary expenditures, such as drainage control improvements. The Permittees recognize that existing facilities, which have been operating for many years, will require a longer period of time to implement some of the suggested BMPs that require monetary expenditures, compared to newly proposed equestrian facilities that are expected to incorporate necessary and appropriate BMPs into the designs of their facilities.

Therefore, in recognition of the fundamental difference between existing and proposed equestrian facilities in their abilities to implement BMPs to the maximum extent practicable, the Permittees suggest two different paths for evaluating BMPs to be implemented at existing versus newly proposed facilities.

For existing facilities, such as commercial stables, residential properties with a stable, or individuals owning horses on residential properties, owners should perform the following tasks in order to analyze what BMPs should be implemented.

Task 1: Inventory and map your resources. Draw a map of the site and note natural water features (including drainage flow characteristics), property improvements (e.g. corral fences, wash areas, buildings associated with care and stabling, access roads, etc.), vegetation, slopes, bare areas, and other characteristics that affect water drainage and water quality.

Task 2: Identify, assess, and prioritize potential problem areas. Take a walk around the facility, preferably during or immediately after a heavy rainfall. Use the site map developed and take notes. For example, draw arrows on the site map to show runoff and drainage patterns. Assess situations and prioritize areas in need of attention like manure storage problems such as rain water coming into contact with stockpiled manure and washing downhill into streams or creeks. Prioritize the areas needing attention. Those areas or activities that are directly contributing to pollution must receive the highest priority. As a guidance, the BMPs within this document highlight situations of concern to the Permittees.

Task 3: Develop solutions. Use the BMPs within this document to address problem areas and activities.

Task 4: Schedule and properly install BMPs. Write down a work plan and stick to it. Document current and past practices that help to curtail pollution into creeks and streams.

Task 5: Maintain BMPs. A mismanaged or unmaintained BMP will not work.

Existing facility owners are encouraged to develop a Water Quality Management Plan as a mechanism by which to document to the local jurisdiction that the facility is progressing toward compliance with the applicable local NPDES Program.

For proposed facilities, owners must develop a Water Quality Management Plan (WQMP) for review and approval by the governing Permittee. A WQMP should describe commitments to installation and maintenance of site design, source control and treatment control BMPs listed below that can be readily incorporated for use on the project or other BMPs, which have been demonstrated to work equally well. The WQMP should also reflect language that the above tasks were completed and information from the tasks was taken into account in the WQMP.

For additional information or assistance, contact your City or County NPDES Coordinator.

Runoff Best Management Practices

The goal of runoff management is to prevent the transport of pollutants into receiving waters to the maximum extent practicable by separating “clean water” from “contaminated water” and reducing erosion caused by runoff. Below is a list of examples that could be used to reach these objectives, whenever practical or feasible. Some of these BMPs are more applicable to existing facilities, while others are applicable to new facilities. If a stable operator (commercial or residential) chooses to use other techniques or methods, he/she is required to demonstrate the efficacy of the alternative technique or method to the local jurisdiction in charge of the storm water program.

A. Roof Runoff Related BMPs

Direct roof runoff away from high-use, bare, un-vegetated and manure storage areas. This could include the use of gutters and downspouts, subsurface drains to collect water and divert from buildings, or any other available technology.

B. Facility Runoff Related BMPs

Runoff from areas containing manure, bedding, or feed debris represents the most significant source of pollutants from equestrian facilities. Preventative measures could include some of the below listed examples. Generally these serve to prevent and minimize the runoff that comes into contact with manure, bedding, or feed debris being carried off the facility and into a storm drain.

1. Separate barnyards, paddocks, and manure storage areas from any waterways with buffer strips of vegetation to filter sediments and absorb nutrients in runoff.
2. Divert surface runoff around areas with pollutants by constructing berms, ditches, underground pipelines or other methods.
3. Locate NEW buildings and confinement areas away from creeks, steep slopes, and floodplains. Check with the local jurisdiction regarding zoning or flood plain issues.
4. Maintain vegetation and replant bare areas to reduce erosion.
5. Control potential runoff from water troughs with automatic waterers or other means.
6. Improve infiltration and drainage, in and around arenas, paddocks, turnouts and service roads by using base rock and sand or other appropriate measures.
7. If water basins and waste ponds are used, water should not remain for more than 72 hours because of the likelihood of attracting mosquitoes that may carry the West Nile Virus or other diseases.

The additional benefits of runoff management for water quality include a drier barnyard, a healthier horse environment, and better working conditions.

Erosion Control-Related Best Management Practices

When considering drainage or slope stabilization BMPs, facility operator should seek professional assistance.

A. Horse-Specific Related BMPs

1. Restrict horse access and human activities at horse facilities in wetlands, creeks, creek banks, meadows, and steep hillsides.
2. Keep areas well vegetated and restore bare areas with vegetation.
3. Manage pastures to prevent heavy grazing such as rotating the use of pastures to allow grasses to regrow.
4. Maintain a strip of vegetation downslope of bare areas such as paddocks and turnouts to help trap sediment.

B. Site Drainage Related BMPs

1. Maintain culverts and ditches. Control upslope erosion sources to prevent sediment from filling culverts. Use measures such as fiber rolls to capture sediments upstream of culverts and maintain regularly. Vegetate whenever possible.
2. Keep ditches vegetated with grass to help maintain stability and capture sediments. Longitudinal slopes should not exceed 2.5%. Regularly maintain ditches by clearing sediments and debris. For chronic sediment problems, address the erosion source.
3. Keep inlets clear. Remove debris before the rainy season (October 15 to April 14 each year) and check during and after storms.
4. Properly construct and maintain roads, trails, and parking lots in accordance with local construction requirements. Maintain road and trail surfaces.
5. Regrade roads to smooth the surface and prevent rills from expanding.
6. During construction install and maintain silt fences or straw bale sediment barriers to trap sediment.

C. Slope Stabilization Related BMPs

1. Watch for accelerated erosion on steep slopes, pastures, gullies, and intensively used horse areas.
2. Stabilize slopes with vegetation or other applicable erosion control measures, such as erosion control blankets. Do not plant any invasive species. You may be able to obtain a list of invasive plant species from your local fire department, or your City or County Hazard Reduction Program coordinator.

Bacteria / Nutrient Transportation Prevention Best Management Practices

A. Manure Management

1. Remove manure regularly, daily is best, or keep manure under cover such that runoff does not come into contact with manure stockpiles.
 - a. Stalls, corrals and wash areas should be cleaned and manure removed on a daily basis.
 - b. Paddocks shall be cleaned according to the following schedules:
 - i. During the summer dry season (April 15 to October 14 each year): paddocks shall be cleaned at least once every week.
 - ii. During the winter rainy season (October 15 to April 14 each year): paddocks shall be cleaned at least twice every week.
2. Provide temporary storage for manure that cannot be disposed of daily – about 15 cubic feet of storage per horse per week. Manure shall not be stored for more than a week on site. See #7 below for composting information.
3. Grade the area surrounding the manure storage area to prevent surface water from reaching the storage area.
4. Store horse waste on an impervious surface (a concrete pad or plastic tarp) and under cover (a roof or tarp) during rains to prevent leaching or runoff of pollutants.
5. Locate manure storage areas away from waterways so that floods or runoff will not wash away waste.
6. Do not dump horse waste on the edge of, or directly into waterways.
7. Consider composting if conditions are suitable. Composting might require permits from various agencies, so ensure to check for local requirements. One of the best manure management practices is to compost manure, although the practice requires space, good setup and operation to have good results. For more information, visit the US Composting Council website <http://compostingcouncil.org> or other available resources to determine if composting is a good solution for your stable.

B. Building & Site Design

1. Site layout should ensure that structures are placed where adverse effects are minimized and the natural topography, drainage patterns and vegetation remain undisturbed.
2. If no pastures are on site, filter strips should be used to separate riding rings and manure collection from waterways.
3. Set buildings, covered areas, high-use arenas, horse wash racks, manure storage areas, roads, and trails back away from waterways.
4. It is recommended to place gravel below the sand in corrals to percolate wastes and extra water. If bedding is used in corrals, cleaning it up regularly will help prevent it from being collected in rainwater or surface runoff.
5. It is recommended that paddocks have gravel or sand bottom for percolation of water and pollutants, and not be built in areas with a greater than 10% slope.

6. Keep paddocks and corrals as dry as possible during the winter rainy season.

Prior to building and site design, contact your local agency for setback requirements from property lines and other restrictions.

C. Wash Rack Design

1. Do not allow water from horse wash areas to flow into storm drains, creeks, ponds or seasonal drainages.
2. Connect wash racks to the sanitary sewer system, if permitted and possible. Infiltration of wash rack water, if possible, is an acceptable means of disposal. Verify that soil conditions do allow percolation prior to construction.
3. Elevate the wash area from the surrounding ground.
4. Wash water should drain away from the area to a filter strip or other vegetated area. Check to make sure wash water does not cause drainage problems on neighboring properties.
5. Use a shut-off nozzle or low-flow nozzle at the end of the hose.
6. Use horse grooming and health products properly. Follow instructions and use recommended amounts, and clean up spills. Even biodegradable horse grooming and health care products can have a negative effect on water quality.
7. Use plain water to rinse horses - avoid using soap as much as possible.

General Housekeeping Best Management Practices

A. Integrated Pest Management (IPM) BMPs for Horse Facilities and Surrounding Landscape

Integrated Pest Management is an ecologically based pest control strategy that focuses on long-term prevention and control of pests and their damage. A combination of techniques are used such as inspecting and identifying the pest, learning the pest and host life cycles and biology, removing or reducing the pest habitat when possible, using natural enemies, using resistant plant varieties, using mechanical control for weed removal, monitoring frequently, establishing a threshold for damage, choosing the control tactic and then evaluating the results. Pesticides can be used in an IPM system, but should only be used when all other factors in an IPM strategy are met. Some pesticides are designed to be toxic only to the target pest and will not harm desirable insects.

1. Stabilize bare slopes, use native vegetation whenever possible because native vegetation doesn't require fertilizer.
2. Use IPM techniques to reduce the amount of chemicals, pesticides, fertilizers and herbicides placed on landscaping that may wash away.

Additional information can be found on the University of California, Davis web site at www.ipm.ucdavis.edu

B. Trash / Debris

1. Collect and dispose of trash and debris.
2. Do not allow trash or debris to enter creeks, seasonal streams, storm drains, or ponds.

C. Chemicals

1. Follow directions for all chemical applications.
2. Dispose of unused chemicals at a household hazardous waste (HHW) facility. Call your local jurisdiction for the location of your nearest HHW facility.

Trails and Access to Waterbodies Best Management Practices

- A. Access to Waterbodies
 1. Restrict horse access and human activities in wetlands, creeks, creek banks, meadows, and steep hillsides, if possible.
 2. Provide bridges over waterbodies, if practical.
 3. Designate access points to creeks by using a designated creek crossing point to reduce and control contaminants from entering the creek and to prevent bank erosion.
 4. Select a crossing location that will least impact stream banks and riparian vegetation.

- B. Trail Signage and Design
 1. Use designated trails for horse riding.
 2. The grade on any new trail should not exceed 10 percent and trails should be avoided at all costs on slopes steeper than 20 percent.
 3. If a trail must be built on a steep slope, the trail should switch back and forth down the slope. On steep grades, there is a greater chance that erosion will occur.
 4. Consider drainage patterns when building new trails. To reduce the potential erosion of the trail from rainwater and runoff, trails should be built so that water sheet flows across the trail. Trails parallel to the flow increases erosion of the trail, and the water will create deep treads in the trail that may render it unusable.
 5. Berms should be constructed as appropriate to direct storm water away from the trail.
 6. Whenever possible, provide a buffer area between trails and waterways.

Other Permits Issued by the Environmental Protection Agency and State Water Resources Control Board

In December 2002, the Environmental Protection Agency revised the Clean Water Act regulation for Concentrated Animal Feeding Operations, or CAFOs changing the thresholds at which a horse stable operation becomes a CAFO. CAFO designations are assigned ONLY by the Regional Boards and not by the Permittees. Consequently, the Regional Boards enforce CAFO regulations. The information presented herein is for information only to stable owners. The EPA updates its rules frequently; therefore, contact your Regional Board for the latest CAFO rules and for answers to any questions regarding CAFO regulations.

A horse stable operation can be classified a “Large CAFO,” a “Medium CAFO,” or a “Designated CAFO” if the following requirements are met:

- “Large CAFO”
 - It is an animal feeding operation; and
 - Has at least 500 horses.
- “Medium CAFO”
 - It is an animal feeding operation; and
 - Has at least 150 horses; and
 - Has a manmade ditch or pipe that carries manure or wastewater from your operation, or the horses come into contact with surface water running through the area where they’re confined.

Additionally, any size operation can be a “Designated CAFO” if the Regional Board inspects the operation and determines that it’s adding pollutants to surface waters.

The requirements for all horse CAFO Permits may include:

- Implementing a nutrient management plan;
- Submitting annual reports to the Regional Board;
- Keeping the permit current until the operation is closed and all manure is removed; and
- Keeping records of the nutrient management practices for at least five years.

Nutrient management plans for all horse CAFOs may include provisions for:

- Assuring adequate manure storage capacity;
- Proper handling of dead animals and chemicals;
- Diverting clean water from the production area;
- Keeping animals out of surface water;
- Using site specific conservation practices;
- Developing ways to test manure and soil;
- Assuring appropriate use of nutrients when spreading manure; and
- Keeping records of nutrient management practices.

Additional information can be found by accessing the EPA web site at www.epa.gov/npdes/caforule or the USDA web site at www.usda.gov

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Glossary

Best Management Practices or BMPs. Actions that may be implemented to help reduce or eliminate pollution for specific activities such as horse grooming.

Clean water. Rainfall that has not come into contact with a pollutant such as horse manure, or picked up pollutants.

Concentrated water. Water flow that has increased in volume and velocity due to either natural drainage or human-made diversion of drainage.

Contaminant. The impairment of water quality by waste to a degree that creates a hazard to public health through the spread of disease.

Corral. A fenced area that holds one horse.

Creek. A watercourse smaller than a river. Used in this guide to cover all sizes and types of fresh water bodies such as rivers and streams. May or may not have a year-round surface flow.

Erosion. The wearing away of land surface by wind or water. Occurs naturally from weather or runoff, but can be intensified or accelerated by human activity.

Facility. In this document, the areas used in caring for horses (i.e. barns, paddocks, turnouts, arenas, etc.) whether for a single residential backyard horse or a larger boarding operation.

Horse waste. Manure, urine, bedding material, and feed debris.

Impervious / impermeable surface. Any surface that cannot be easily penetrated by water, such as roofs, compacted soils, and paved areas.

Integrated Pest Management or IPM. An ecologically based pest control strategy that focuses on long-term prevention and control of pests and their damage.

Local Implementation Plan (LIP) or Jurisdictional Urban Runoff Management Plan (JURMP). A document written by an individual Permittee that specifies how the Permittee will comply with Regional Board Permits for water quality.

Manure. In this document, manure includes both the feces and urine from horses.

Non-point source pollution. The diffuse discharge of pollutants that can occur over an extensive area, such as a pasture, as opposed to point source pollution that can be pinpointed to a specific location, such as an outlet at a sewage treatment plant.

Nutrient. The portion of any element or compound that can be readily absorbed and assimilated to nourish plants; examples include nitrogen and phosphorus. Even in small amounts, these same nutrients can have a harmful effect on water quality. Horse manure can degrade water quality because it is rich in nutrients.

Paddock. A fenced area that holds multiple horses. These areas are typically bare because the area is heavily used.

Pasture. A large fenced area that is used for grazing. Usually this area has some grass cover because the number of horses contained within the area does not cause the grass to be trampled from heavy use.

Permittee. The local jurisdiction or district responsible for the implementation of Regional Board Permits or Orders. In Orange and San Diego Counties, these are the County of Orange, the County of San Diego, the Cities of Orange and San Diego Counties, and the flood control districts. In addition, individual facilities could be considered Permittees, based upon meeting a prescribed animal count threshold at a facility (e.g. CAFO permit).

Pollutant. The presence of a substance in such quantities that when it reaches a body of water, soil, or air, it is degrading in effect that it impairs their usefulness or renders them offensive.

Polluted water. Water that has become adversely affected physically, chemically, or biologically by chemicals and other additives, such as manure, sediment, bedding material, and feed debris.

Runoff. Water from rain or other sources (for example, from a hose or horse wash rack not connected to the sewer system) that do not infiltrate into the ground but runs over land surface and into creeks or the MS4.

Sediment. The soil material, both mineral and organic, that is suspended, is being transported, or has been moved from its site of origin by erosion and has come to rest on the land surface or at the bottom of creeks, ditches, or other areas.

Sanitary Sewer (or Sewer system): Carries water from indoor drains to wastewater treatment plants, typically carries sewage.

Storm Drain also known as Municipal Separate Storm Sewer System or MS4: The system that contains catch basins usually located at the edge of a street, which carries and releases untreated water from rain or other runoff sources into channels, rivers and ultimately the ocean.

Turnout. A high-use area where horses are “turned out” for exercise after being confined in stalls. Turnouts can be exercise lots, small paddocks, pens, or corrals. These areas are typically bare and not managed as pastures.

Water quality. Describes the chemical, biological, and physical characteristics of water. The quality of water can limit its specific use or ability to support various beneficial uses such as water supplies for municipalities, recreation, and fish and wildlife habitat.

Watershed. Total land area that drains into a particular creek, river system, or bay. It includes major and minor creeks, seasonal drainages, hillsides, and floodplains. The ridges that separate drainage between watersheds define watershed boundaries.