

5 MCOSD OPEN SPACE PRESERVES AND THE ROAD AND TRAIL NETWORK

The Marin County Parks and Open Space District (MCOSD) owns and manages approximately 15,000 acres within 34 open space preserves throughout central and eastern Marin County, including more than 250 miles of unpaved roads and trails that traverse the preserves. Roughly 30 percent of the estimated 640 miles of unpaved roads and trails in Marin County are located within MCOSD preserves (Marin County 2007). Many of the preserves are located adjacent to other large open space and recreational lands, including the Golden Gate National Recreation Area (GGNRA), Point Reyes National Seashore, California State Parks, Marin Municipal Water District (MMWD), and other local city park lands. Terrain within the preserves is varied, ranging from steep, upland hills characterized by “V”-shaped valleys located between narrow ridge crests to low gradient hills and marshes.

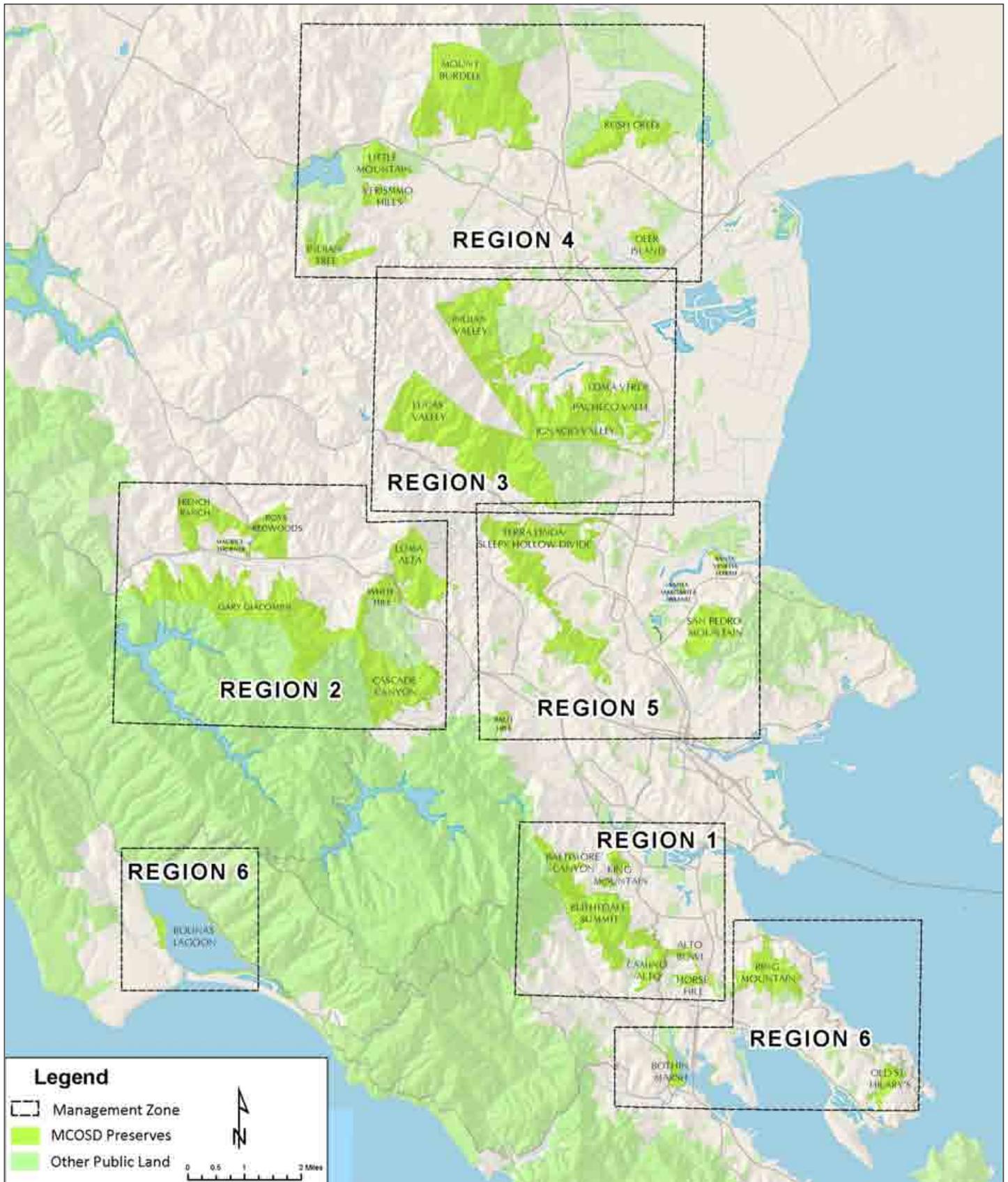
The unpaved roads and trails within preserves consist of former logging and ranch roads, access roads, and both wide and narrow trails. While the MCOSD has developed wide and narrow trails within preserves since they were acquired, many of the logging, ranch, and access roads were constructed prior to MCOSD land acquisition. As a result, some of these roads and trails are well-designed and functioning, while others are inappropriately sited or configured, and may not be sustainable in the long term. These roads and trails presently provide recreational access to a number of different user groups, as well as access for other agencies’ community and emergency services (e.g., Marin County Fire Department, Marin Municipal Water District, telecommunication and utility companies).

5.1 Open Space Preserves – Regions 1 through 6

For planning purposes, the MCOSD’s 34 preserves are divided into six regions as listed below, and as shown in Figure 5-1. The regions are located in different areas of Marin County, have varying adjacent lands uses, and correspond roughly with biomes of the San Francisco Bay area:

- Region 1: Baltimore Canyon, King Mountain, Blithedale Summit, Camino Alto, Horse Hill, Alto Bowl
- Region 2: French Ranch, Maurice Thorner, Roy’s Redwoods, Gary Giacomini, Loma Alta, White Hill, Cascade Canyon
- Region 3: Indian Valley, Lucas Valley, Loma Verde, Pacheco Valle, Ignacio Valley
- Region 4: Mount Burdell, Rush Creek, Little Mountain, Verissimo Hills, Indian Tree, Deer Island
- Region 5: Terra Linda/Sleepy Hollow Divide, Santa Margarita Island, Santa Venetia Marsh, San Pedro Mountain, Bald Hill
- Region 6: Ring Mountain, Old St. Hilary’s, Bothin Marsh, Bolinas Lagoon, Tiburon Ridge

Table 5-1 identifies each preserve, the region within which the preserve is located, its acreage, and its historical setting. The historical setting summarizes information regarding former property owners, land acquisitions, some recreational uses, cultural resources and protected areas, and cattle grazing and ranching use. Figures 5-2 through Figure 5-7 show the preserves located within each region.



SOURCE: Marin County Open Space District, 2012

Marin County Open Space District
Figure 5-1
 Regional Location

Table 5-1 Summary of Preserve Conditions		
Preserve Name	Area	Historical Setting¹
Region 1		
Baltimore Canyon	193.1	<ul style="list-style-type: none"> Redwoods were logged in the mid-1800s, all in less than one decade. West property boundary is shared with MMWD.
King Mountain	107.5	<ul style="list-style-type: none"> Ranching in late 1800. Goats grazing in early to mid-1900s. Parcels acquired in 1988 and 1990.
Blithedale Summit	640.2	<ul style="list-style-type: none"> Shares property boundary with MMWD. Saved from development in 1970s.
Camino Alto	170.3	<ul style="list-style-type: none"> Northridge acquisition from 1970s. City of Mill Valley did most of the vegetation management in this preserve until the late 1990s, when they were fined by the USFWS for ignoring spotted owl protection guidelines. This action caused the district to implement its own spotted owl monitoring program and to take over vegetation management of the preserve, although Mill Valley Fire still provides fiscal support for projects.
Alto Bowl	37.1	<ul style="list-style-type: none"> Former dairy ranches - Tunnel Ranch and Alto Dairy - until 1940. Parcels acquired in 1974, 1985, and 1990.
Horse Hill	50.2	<ul style="list-style-type: none"> Horses have grazed Horse Hill for over 40 years. At least three prehistoric archaeological sites identified. Purchased in 1995. Privately owned horses (maximum of 14) are grazed over 60 acres, including land belonging to Mill Valley Meadows Homeowners' Association. It is assumed that equine use is the dominant use of Horse Hill, and will remain so for the foreseeable future.
Region 1 Total	1,198.4	
Region 2		
Cascade Canyon	497.4	<ul style="list-style-type: none"> Grazing - Bottini Ranch - until 1914. Hunting - "Elliot Nature Preserve" - from mid 1900s to 1970s. Parcels purchased in 1974, 1976, 1978, 1987, 1994, and 1995. Cascade Canyon Bottomlands and Cascade Canyon fire trail are very heavily used. Access and user group conflicts. Gateway to MMWD and other public lands.
French Ranch	402.6	<ul style="list-style-type: none"> Purchased in 1977. Previously combined with Indian Tree.
Gary Giacomini	1,475.9	<ul style="list-style-type: none"> Parcels purchased from developers in 1991 and 1995. MMWD shares the western boundary of preserve; gateway to other public lands. Cortez Fire Road was converted from single-track trail to fire road in 2007 after pressure from local residents to provide an escape route in case of wildland fire.
Loma Alta	508.5	<ul style="list-style-type: none"> History of grazing. Parcels acquired in 1988, 1989, and 1990.
Maurice Thorner	32.8	<ul style="list-style-type: none"> Acquired in 1981. Gold mining in late 1800s on slope south of the preserve.
Roy's Redwoods	293.0	<ul style="list-style-type: none"> Purchased in 1978. Select-cut logging, grazing in mid-1900s. Golf course along southwestern boundary. 463 acres - French Ranch
White Hill	390.0	<ul style="list-style-type: none"> History of grazing, probably until the 1920s. Purchased from Boy Scouts of America in 1994 and 1997-1998. North Shore Railroad built tunnel (now Bothin Tunnel) through ridge north from White Hill. Shares western boundary with MMWD; gateway to other public lands.
Region 2 Total	3,600.2	

Table 5-1 Summary of Preserve Conditions		
Preserve Name	Area	Historical Setting¹
Region 3		
Ignacio Valley	885.3	<ul style="list-style-type: none"> • Purchased in 1975.
Indian Valley	557.6	<ul style="list-style-type: none"> • First parcel purchased in 1975. Previously part of the Back Ranch.
Loma Verde	319.6	<ul style="list-style-type: none"> • History of ranching.
Lucas Valley	1,270.9	<ul style="list-style-type: none"> • History of ranching since 1860. Lucas Valley Dairy. Parcels acquired in 1975, 1986, 1989, 1990, and 1996. • Properties to the west are privately owned ranches, some by George Lucas. County owned parcel to the east, managed by the Lucas Valley Homeowners' Association.
Pacheco Valle	503.9	<ul style="list-style-type: none"> • Parcels acquired in 1975 and 1995.
Region 3 Total	3,537.4	
Region 4		
Deer Island	134.7	<ul style="list-style-type: none"> • Island until late 19th century, diked and drained for pasture land. History of ranching since 1890. Parcels acquired in 1978 and 1983 (nine-acre grazing lease ended). • Property is surrounded by parcels owned by Marin Public Works Department/Flood Control, Novato Sanitary District, California Department of Fish and Game, Marin Audubon Society.
Indian Tree	242.0	<ul style="list-style-type: none"> • Purchased in 1977. Adjacent properties owned by Marin Agricultural Land Trust and North Marin Water District.
Little Mountain	214.1	<ul style="list-style-type: none"> • Previously part of E Ranch. • Purchased in 1995. • Adjacent residential community is essentially surrounded by MCOSD lands. • NMWD lands are adjacent on west boundary.
Mt. Burdell	1,627.3	<ul style="list-style-type: none"> • Previously part of C Ranch. Purchased in 1977. • California Department of Parks and Recreation owns Olompali property to the northeast. Northwest and west slopes are privately owned dairy ranches.
Rush Creek	522.1	<ul style="list-style-type: none"> • Chicken ranch in early 1900s. Received land in late 1990s. • California Department of Fish and Game owns adjacent properties.
Verissimo Hills	114.6	<ul style="list-style-type: none"> • Gift from Sanchez family in 1985. • Adjacent residential community is essentially surrounded by MCOSD lands.
Region 4 Total	2,854.8	
Region 5		
Bald Hill	31.0	<ul style="list-style-type: none"> • Parcels acquired in 1994 and 1995. Shares a boundary with MMWD land.
San Pedro Mountain	357.5	<ul style="list-style-type: none"> • Dairy ranching since mid-1850s. Nike Missile site established in 1954. Parcels purchased in 1974-1977. Additional parcel purchased in 1999. • Adjacent lands owned by City of San Rafael and California Department of Parks and Recreation.
Terra Linda Sleepy Hollow Divide	1,171.8	<ul style="list-style-type: none"> • Numerous parcel acquisitions from 1972 through 1989. • Sheep grazing from 1981-1987 for fuel reduction.
Region 5 Total	1,560.3	

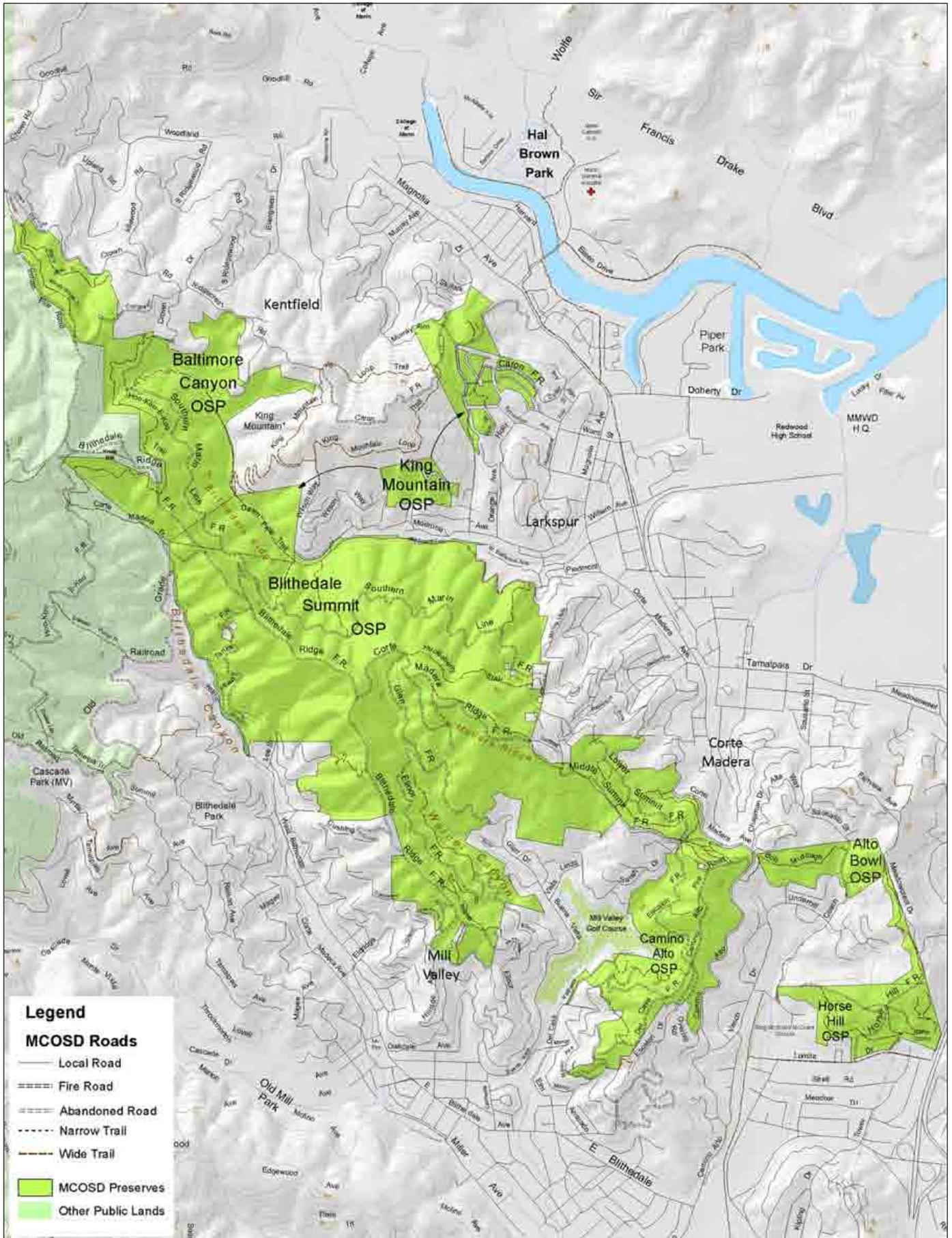
Table 5-1 Summary of Preserve Conditions		
Preserve Name	Area	Historical Setting¹
Region 6		
Bolinas Lagoon	1,076.9	<ul style="list-style-type: none"> Management turned over to MCOSD in 1988 from Marin County Parks Department. Audubon Canyon Ranch owns a portion of Kent Island, and has expressed interest in cooperating with restoration work. Adjacent properties owned by California Department of Parks and Recreation and National Park Service.
Bothin Marsh	105.9	<ul style="list-style-type: none"> North and South Basins are essentially man-made marshes. 1851 map shows tidal marshes extending to base of the hills. Dikes built in 1950s and 1960s. Shell mound in North Basin. Filling and building in 1970s. Acquired in 1976. Pathway (old railroad right of way) acquired in 1981 through Rails to Trails Program.
Old Saint Hilary's	121.8	<ul style="list-style-type: none"> Acquired parcels in 1993 and 1997. MCOSD owns adjacent Tiburon Uplands Nature Preserve.
Ring Mountain	367.2	<ul style="list-style-type: none"> Earliest Miwok village dated to 370 BC. Part of Reed Ranch for 130 years until 1965. Army installed guns on summit in 1950s, deactivated in 1960s. Management turned over to MCOSD in 1995 from Nature Conservancy. Town of Tiburon owns several significant adjacent properties.
Santa Margarita Island	8.8	<ul style="list-style-type: none"> Land used for soil disposal after World War II. Dumping of dredging spoils in 1969 and 1987. Purchased in 1974; marshland filled in and canals built, "thousands of rare and exotic plants brought in." Residents of Las Gallinas contributed to funding of this preserve.
Santa Venetia Marsh	32.8	<ul style="list-style-type: none"> Prehistoric archaeological site (California Archaeological Inventory CA-MRN-124). Residents recall goats on the island in the 1940s and 1950s; the west side of the island burned in 1974. Landfill on the north end of island. Purchased in 1978. Handwritten note: land used for soil disposal, Santa Venetia Land Corp. Sold land to Trust for Public Land in 1973, purchased in 1974; marshland filled in and canals built to sell lots for houses but none were built, "thousands of rare and exotic plants brought in." Residents of Las Gallinas contributed to funding of this preserve.
Tiburon Ridge	15.1	<ul style="list-style-type: none"> Formerly Koch property. Acquired in 1983. The second smallest of the MCOSD preserves. The Northwestern Pacific Railroad once ran freight trains through a tunnel on Tiburon Ridge. The trail that delivered the first prisoners to Alcatraz Island ran through that tunnel.
Region 6 Total²	2,298.6	
County Total	15,049.7	

Notes:

1 MCOSD = Marin County Open Space District, NMWD = North Marin Water District, MMWD = Marin Metropolitan Municipal Water District

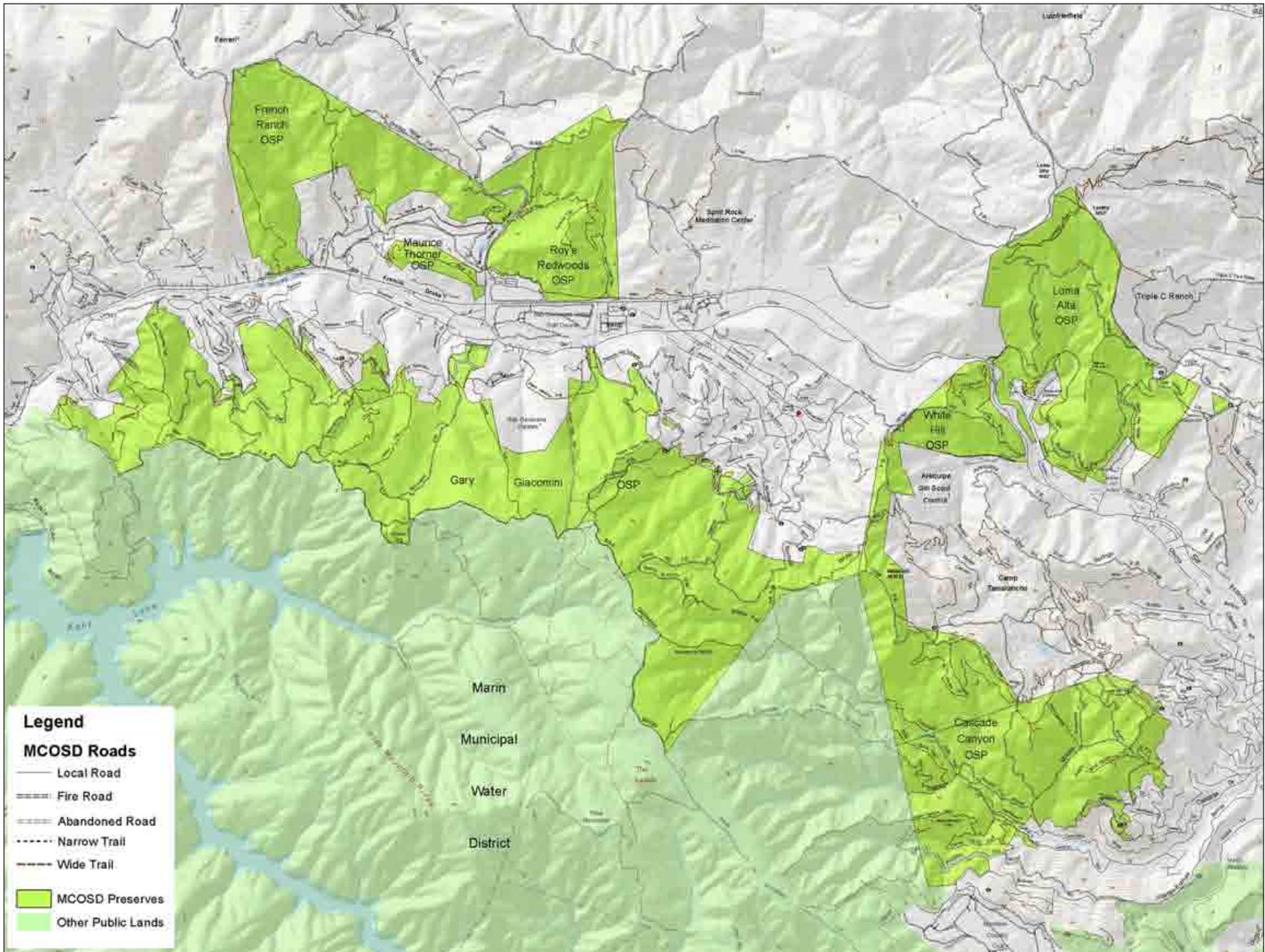
2 Includes Strawberry Point Tidal (19.8) and Water Lots (550.3) not shown in this table.

Source: *Queries from Marin County GIS Database, 2011; Draft Vegetation Management Plan, 2012.*



SOURCE: Marin County Open Space District, 2012

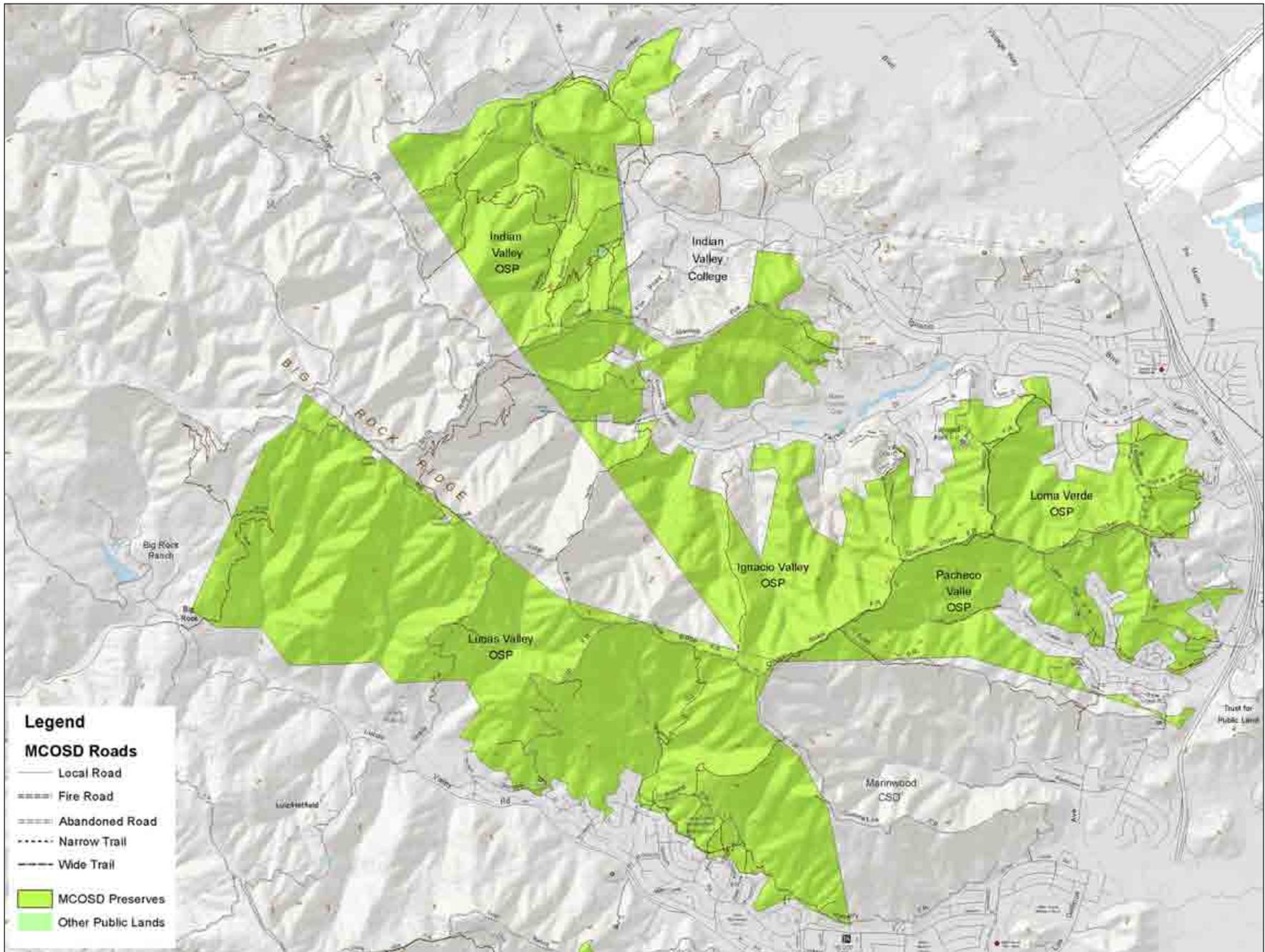
Marin County Open Space District
Figure 5-2
 Region 1



SOURCE: Marin County Open Space District, 2012

Marin County Open Space District

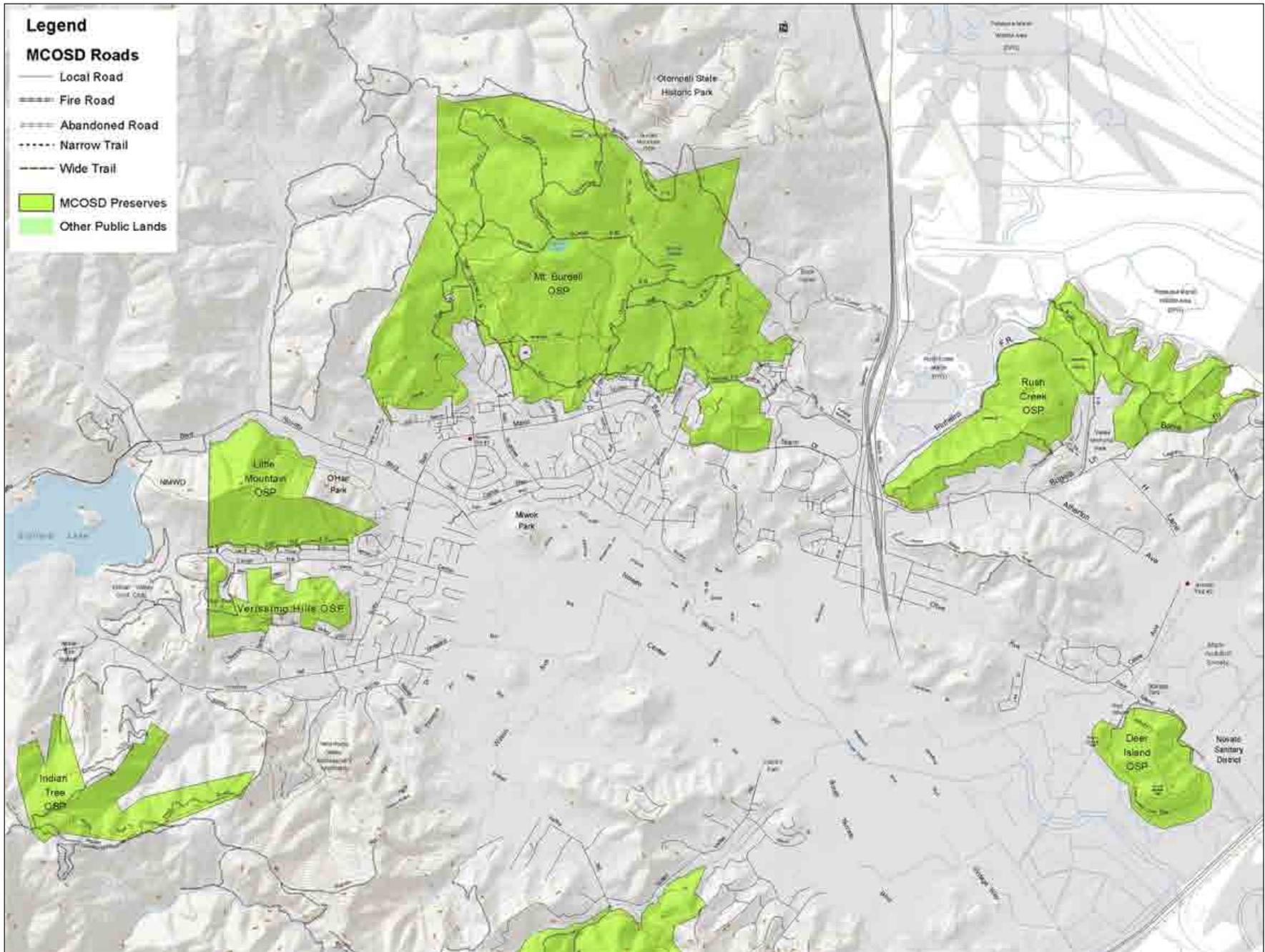
Figure 5-3
Region 2



SOURCE: Marin County Open Space District, 2012

Marin County Open Space District

Figure 5-4
Region 3



SOURCE: Marin County Open Space District, 2012

Marin County Open Space District

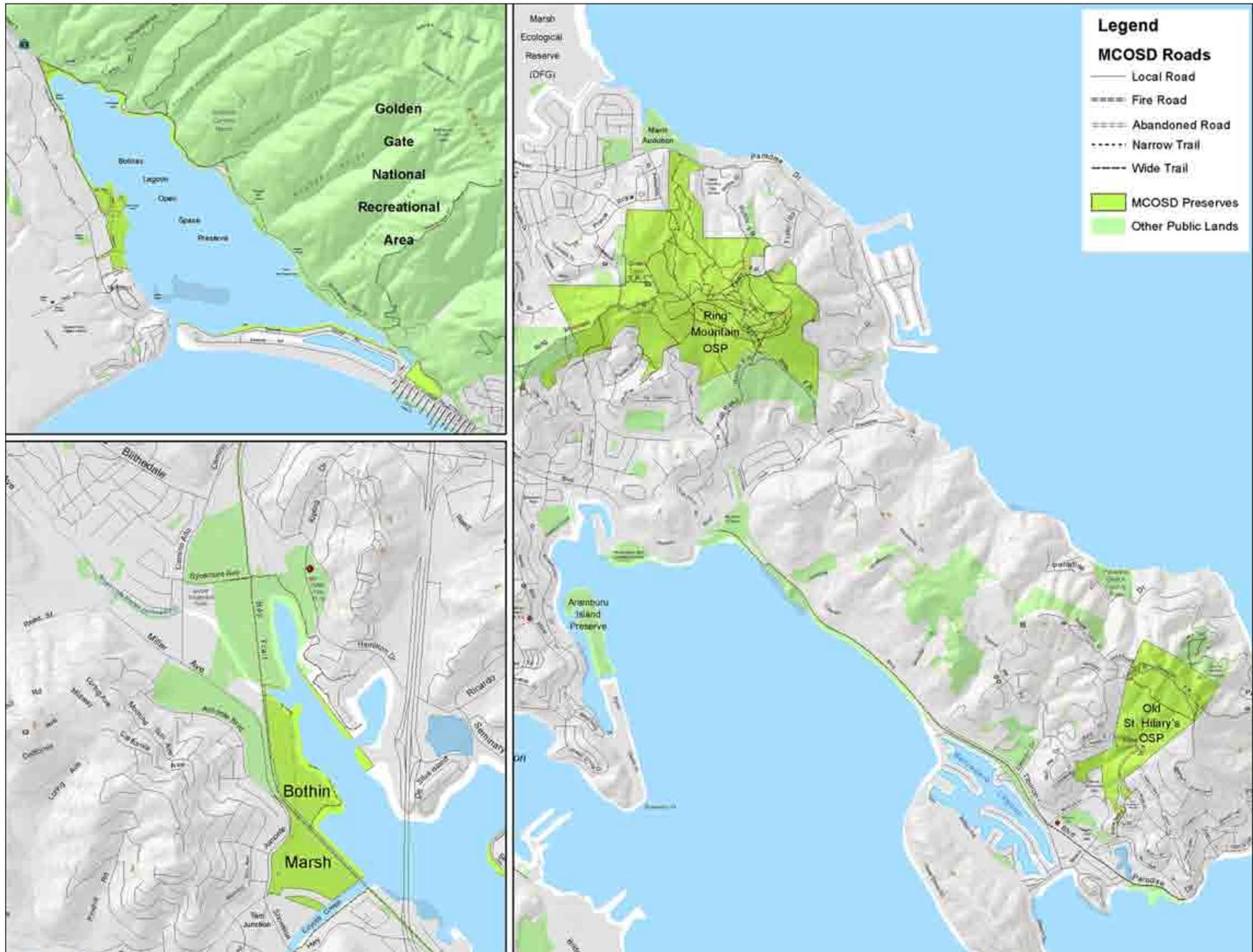
Figure 5-5
Region 4



SOURCE: Marin County Open Space District, 2012

Marin County Open Space District

Figure 5-6
Region 5



SOURCE: Marin County Open Space District, 2012

Marin County Open Space District

Figure 5-7
Region 6

REGION 1

Region 1 is located in the southeastern portion of Marin County. This region consists of six open space preserves totaling approximately 1,198 acres. It includes Baltimore Canyon, King Mountain, Blithedale Summit, Camino Alto, Alto Bowl, and Horse Hill Preserves. The largest preserves include Blithedale Summit Preserve, which contains approximately 640 acres, Baltimore Canyon Preserve, which consists of approximately 193 acres, and Camino Alto Preserve, which contains approximately 170 acres. The perimeter boundaries¹ of all preserves within Region 1 total 16.7 miles, the lowest perimeter mileage of all regions. Region 1 contains approximately 26 miles of road and trails. This region is near Mount Tamalpais State Park, with the public lands of the Golden Gate National Recreation Area to the west. Homestead Valley County Park and private residences are located to the south. Piper Park, U.S. Highway 101, and residential areas are located to the east. Hal Brown Park, the College of Marin, and residences are located to the north.

REGION 2

Region 2 is located in the western portion of Marin County, near the City of Fairfax. This region consists of seven Preserves totaling approximately 3,600 acres. It includes French Ranch, Maurice Thoner, Roy's Redwoods, Gary Giacomini, Loma Alta, White Hill, and Cascade Canyon Preserves. The Gary Giacomini Preserve is the largest preserve in this region, consisting of approximately 1,476 acres, followed by Loma Alta Preserve with 509 acres, and Cascade Canyon Preserve with 497 acres. The perimeter boundaries of Preserves within Region 2 total 50.8 miles, the highest perimeter mileage of any region. Region 2 contains approximately 52 miles of road and trails, the highest mileage of all the regions. The region is located north and east of MMWD lands. The water district's lands abut many of the boundaries of the Gary Giacomini and Cascade Canyon Preserves. Samuel P. Taylor State Park is also located less than one mile west of Gary Giacomini Preserve. Other adjacent land uses include residences along Sir Francis Drake Boulevard. The Gary Giacomini Preserve is located to the south of Sir Francis Drake Boulevard, and the French Ranch, Maurice Thoner, and Roy's Redwoods Preserves are located north of this roadway. The Spirit Rock Meditation Center is located to the east of Roy's Redwood Preserve. Camp Tamarancho, managed by the Marin County Boy Scouts of America, is situated directly north of Cascade Canyon Preserve. Large ranches and scattered residences are located east of the Loma Alta, White Hill, and Cascade Canyon Preserves.

REGION 3

Region 3 is located in the middle of Marin County, west of the Ignacio and Marinwood communities. This region consists of five preserves totaling approximately 3,537 acres. It includes the Lucas Valley, Indian Valley, Ignacio Valley, Pacheco Valle, and Loma Verde Preserves. Lucas Valley is the largest preserve in this region, consisting of approximately 1,271 acres, followed by Indian Valley, which contains approximately 558 acres. Loma Verde is the third largest preserve in this region, consisting of approximately 320 acres. The perimeter boundaries of preserves within Region 3 total 44.5 miles, the second highest perimeter mileage of any region. Region 3 contains approximately 30 miles of road and trails. This region is surrounded by varying land uses, including

¹ Perimeter miles are an indication of how compact a preserve is, and, by proxy, of the possibilities for conflicts with neighboring land uses. For example, a perfectly round preserve would have a smaller perimeter than one of a similar acreage that was long and thin. Similarly, activities within a preserve with a smaller perimeter would have a lower potential for conflict with adjacent uses than would a preserve with a larger perimeter boundary.

large private ranches to the west of the region, and between the Lucas Valley and Indian Valley Preserves. Lands managed by the Marinwood Community Service District (MCSD) are located to the east of Lucas Valley Preserve and to the south of the Ignacio Valley and Pacheco Valle Preserves. Other land uses in the region include Indian Valley College, located to the northeast of Indian Valley Preserve. Residences are located to the north of the Ignacio Valley, Pacheco Valle, and Loma Verde Preserves, and to the south of the Lucas Valley Preserve.

REGION 4

Region 4 is located toward the northern end of Marin County near the City of Novato. It is the northernmost of the six regions. The region consists of six preserves totaling approximately 2,855 acres. It includes the Mount Burdell, Little Mountain, Verissimo Hills, Indian Tree, Rush Creek, and Deer Island Preserves. Mount Burdell is the largest preserve in Region 4, consisting of approximately 1,627 acres. Indian Tree and Little Mountain Preserves are the next two largest preserves, although they are much smaller than Mount Burdell. The perimeter boundaries of preserves within Region 4 total 31.9 miles. Region 4 contains 40 miles of road and trails, the second highest mileage of any region. Olompali State Historic Park is located to the north of Mount Burdell Preserve, and U.S. Highway 101 is located east of Mount Burdell Preserve. The Rush Creek Marsh and Petaluma Marsh Wildlife Refuges, managed by the California Department of Fish and Game (CDFG), are located north of Rush Creek Preserve. The Deer Island Preserve is located southeast of the other preserves, and the Indian Tree Preserve is located to the southwest of the other preserves in the region. The Indian Valley Golf Club is situated west of the Little Mountain, Verissimo Hills, and Indian Tree Preserves.

REGION 5

Region 5 is located north of the City of San Anselmo in the center of Marin County, east of Region 2 and south of Region 3. The region consists of three preserves totaling 1,560 acres including Bald Hill, San Pedro Mountain, and Terra Linda/Sleepy Hollow. The Terra Linda/Sleepy Hollow preserve is the largest in this region, consisting of approximately 1,172 acres, followed by San Pedro with approximately 358 acres and Bald Hill with approximately 31 acres. The perimeter boundaries of preserves within Region 5 total 27.6 miles. Region 5 contains 22 miles of road and trails, the second lowest mileage of any region. The Terra Linda/Sleepy Hollow Preserve is located south of Lucas Valley Road and extends in a southerly direction to Sir Francis Drake Boulevard. Residential areas surround the Terra Linda/Sleepy Hollow Preserve. The Bald Hill Preserve is located southwest of Terra Linda/Sleepy Hollow Preserve and is also surrounded primarily by residences. The San Pedro Mountain Preserve is located just east of the Marin Civic Center, and is adjacent to Harry Barber City Park and China Camp State Park to the east.

REGION 6

Region 6 is the southernmost of the six regions. The region includes remote preserves at the far southwestern and southeastern ends of the county along Bolinas Lagoon, and near Richardson Bay and San Francisco Bay, as well as preserves located on the Tiburon Peninsula. The region consists of nine preserves totaling 2,299 acres. It includes the Bolinas Lagoon, Bothin Marsh, Old Saint Hilary's, Ring Mountain, Santa Margarita Island, Santa Venetia Marsh, Tiburon Ridge and various water lots. Bolinas Lagoon is the largest preserve within the Region, at approximately 1,077 acres, most of which consists of coastal wetlands. Ring Mountain is the next largest with approximately 367 acres,

followed by approximately 122 acres at Old Saint Hillary's Preserve. This region contains just over 550 acres of water parcels that consist of inner coastal wetland and marsh areas. Most of the preserves in this region are near or surrounded by San Francisco Bay or the Pacific Ocean. The perimeter boundaries of preserves within Region 6 total 24.1 miles, the second lowest perimeter mileage of any region. Because of the sensitivity of the coastal environment to disturbance, Region 6 contains only nine miles of road and trails, the lowest mileage of any region. The GGNRA is located to the east of the Bolinas Lagoon Preserve. Ring Mountain Preserve is surrounded by residences and situated near the Corte Madera Ecological Reserve to the north.

5.2 Road and Trail Physical Conditions

An existing conditions assessment, of system and non-system roads and trails on the MCOSD preserves, was undertaken in 2010 and 2011. The physical locations and conditions of those roads and trails are documented in a Road and Trail Assessment (Best, Alta Planning + Design 2011). Additionally, Marin County Geographic Information Systems (GIS) data was incorporated. The results of these studies are reported in the following discussions.

5.2.1 Characteristics of Roads and Trails within Preserves

The Road and Trail Assessment (RTA) provides a reconnaissance-level assessment of system and non-system roads and trails in the preserves. The RTA identifies known problem areas and conditions such as erosion and drainage issues, steep gradients, rough tread, and wet areas. It also provides information that can be used as part of a monitoring program to identify trends in road trail condition or evaluate the effectiveness of management actions.

There are over 200 miles of unpaved roads and trails on the MCOSD's 34 preserves. These routes have many origins and serve various purposes. Few of the MCOSD's roads and trails were formally planned and/or designed as a public trail system.

Most of the roads on the preserves were originally built to serve non-recreational purposes, including logging, ranching, fire and emergency access, and utility access. Route selection was commonly based on ease of construction and/or finding the shortest distance between two points. Natural resource protection objectives were rarely a concern, and many routes were not intended to support the level of year-round recreational and vehicular use they currently receive.

There are also numerous narrow trails used for recreation. Some of these trails are well designed and laid out, while others evolved over time from informal use and are irregularly maintained by staff. Many are associated with resource protection concerns, and were not intended to support the level of recreational use they currently receive.

EFFECTS OF ROADS AND TRAILS – THE PROBLEM

Roads and trails can have a number of undesirable effects on the natural environment. They can contribute sediment to streams, fragment habitat, provide opportunities for the influx or spread of invasive weeds, and create visual scars. The compaction of soils decreases soil pore space and water infiltration, which in turn increases muddiness, water runoff and soil erosion. Erosion and instability can result in increased sediment discharge to streams, adversely impacting water quality and fish habitat. The erosion of soils along trails exposes rocks and plant roots, creating a rutted, uneven tread surface. Poor road drainage can also increase landslide hazards, result in elevated maintenance costs, and degrade user satisfaction.

Steep gradient, wet, and/or degraded trails, and poorly designed trails threaten the quality of visitor experiences by making travel difficult or unsafe, or by diminishing visitors' perceptions of naturalness. Visitors seeking to circumvent muddy or badly eroded sections contribute to tread widening and the creation of parallel secondary treads, which expand vegetation loss and the aggregate area of trampling disturbance.

When existing trail networks fail to provide visitors the access and experiences they desire, visitors frequently venture off-trail to reach locations not accessible by formal trails. These trails are often referred to as “social” trails; they include trails developed by cattle and wildlife, and those informally constructed by various user groups without authorization from the MCOSD. Because social trails are often not professionally designed, constructed, or maintained, they can contribute substantially greater impacts to protected area resources than formal trails (Leung and Marion, 1999; Marion et al., 2006). Undesirable effects of social trails can be linked to trail alignment parallel to the slope (i.e., fall-line orientation), steep grades, multiple trails accessing the same destinations, and routes through fragile vegetation, soils, or sensitive wildlife habitats.

It is important to note that the undesirable effects of roads and trails can be both chronic and episodic. Chronic problems occur every year, such as surface flow running down roads and trails and washing sediments into creeks or reservoirs, or seasonally wet and muddy segments of trail tread. Episodic problems occur infrequently and typically only during large storm events. These problems include slope failures and failures of culverts at stream crossings.

FACTORS AFFECTING TRAIL SUSTAINABILITY

“Sustainability” can mean different things to different people. In the context of the RTMP, the term is used to describe a road or trail that can be maintained for its designated use without off-site impacts and without undue maintenance burdens. Factors influencing road and trail sustainability include trail geometry, design and location; type and extent of use; and maintenance practices. Design and location factors are associated with the layout of the trail, and include trail size, gradient, surfacing, orientation, and geology, soils, and drainage. Use-related factors include type of use, amount of use, and user behavior. One of the most important considerations for sustainable unpaved roads and trails is the maintenance of natural drainage patterns to avoid the concentration of runoff, especially down the trail tread, as this leads to erosion and sediment entering streams. Maintenance practices that affect road and trail condition include surface grading, construction and maintenance of drainage structures, and control of use patterns that impact the trail, such as cutting switchbacks.

Trail Geometry, Design, and Location Related Factors

Principal factors that influence trail sustainability from a location and design standpoint include trail geometry (steepness and orientation), drainage provisions, geology and soils, and use.

Trail Grade

Numerous studies have documented a strong positive relationship between trail grade and degradation (Best 2002, 2010; IMBA 2001; Marion and Olive 2006; Parker 2004). The steeper the grade, the more likely it is to erode. Most erosion problems tend to occur where the road and trail gradients exceed 15 percent.

Grades steeper than 15 percent are difficult to adequately drain (see Photo 5-1) and as a result, runoff tends to concentrate down the road or trail for long distances (see Photo 5-2). Steep gradient trails also impact recreational access, making the trail more difficult to travel and more difficult to use while maintaining control.

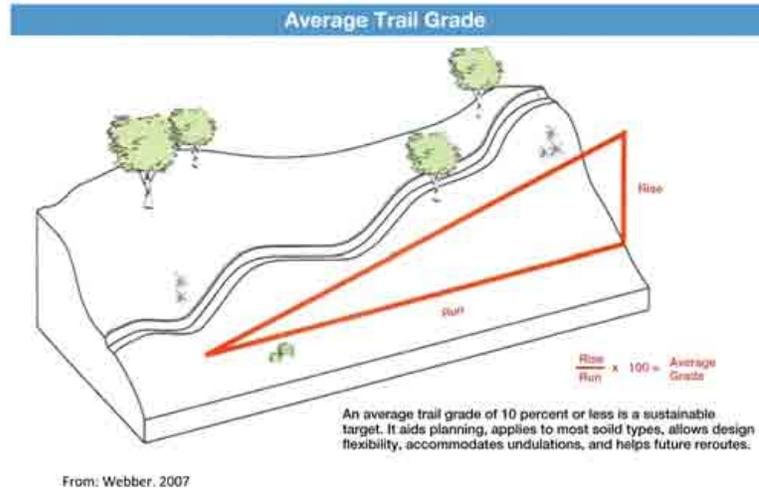


Photo 5-1: Erosion along steep (>15%) gradient trail segment.



Photo 5-2: Steep gradient road and fall line trail. Both are difficult to drain and experience much greater erosional problems compared to lower gradient trails.

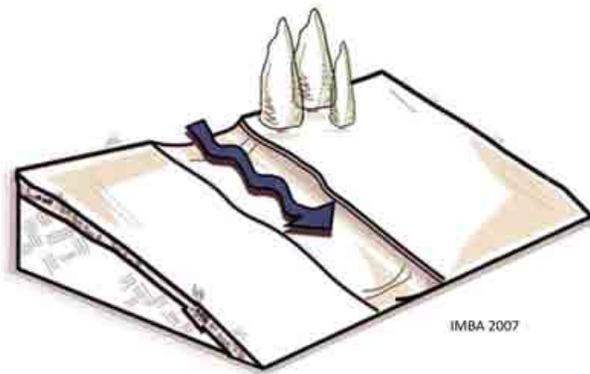
Table 5-2 indicates the road and trail mileage within each preserve by gradient.

Table 5-2 Road and Trail Miles by Preserve and by Gradient							
Preserve	Gentle	Gentle Moderate	Moderate	Moderately Steep	Steep	Unknown	Totals
Region 1							
Baltimore Canyon	1.77	1.65	0.23	0.89	0.17	0	4.71
King Mountain	0.43	0	0.08	0	0.01	0	0.52
Blithedale Summit	3.90	2.76	2.85	1.05	1.65	0.39	12.6
Camino Alto	1.88	0.79	2.03	0.62	0.41	0	5.73
Alto Bowl	0.05	0	0	0	0	0.96	1.01
Horse Hill	0.28	0.41	0.04	0.62	0.31	0	1.66
Region 2							
Cascade Canyon	1.83	2.28	1.83	2.71	0.65	0	9.3
French Ranch	0.33	0.86	0.62	0.23	0.79	0	2.83
Gary Giacomini	3.36	3.49	5.80	2.83	2.23	1.64	19.35
Loma Alta	2.79	1.72	0.37	2.23	1.09	0.44	8.64
Maurice Thorne	0	0	0	0	0	0.83	0.83
Roy's Redwoods	0.75	1.53	0.36	0.74	0.45	0	3.83
White Hill	2.17	1.93	0.26	1.32	1.09	0.79	7.56
Region 3							
Ignacio Valley	0.52	0.001	1.90	0.33	0.90	0.71	4.36
Indian Valley	3.32	1.39	0.86	1.47	1.91	0	8.95
Loma Verde	0.06	0.15	1.39	1.35	0	0	2.95
Lucas Valley	0.89	0.11	2.65	1.7	2.92	1.18	9.45
Pacheco Valle	0.03	0.38	1.87	1.02	0.12	0	3.42
Region 4							
Deer Island	1.92	0.13	0.80	0	0.31	0	3.16
Indian Tree	1.39	0.15	1.23	0.50	0.14	0	3.41
Little Mountain	0.83	0.95	0	0	0.27	0	2.05
Mt. Burdell	7.15	8.28	2.44	4.07	1.66	0.66	24.26
Rush Creek	3.71	1.64	0.52	0	0	0	5.87
Verissimo Hills	0.52	0	0.49	0	0.15	0	1.16
Region 5							
Bald Hill	0	0	0	0	0	0	0.00
San Pedro Mountain	0	0	0.62	0.15	1.65	0	2.42
Santa Margarita Island	0.30	0	0	0	0	0	0.3
Santa Venetia Marsh	1.04	0	0	0.04	0	0	1.08
Terra Linda/Sleepy Hollow	4.41	3.82	1.85	3.70	3.07	1.54	18.39
Region 6							
Bolinas Lagoon	0	0	0	0	0	0	0.00
Bothin Marsh	0	0	0	0	0	0	0.00
Old St. Hillary's	0	0	0	0	0	0	0.00
Ring Mountain	2.78	1.40	1.71	2.47	0.69	0	9.05
Tiburon Ridge	0	0	0	0	0	0	0.00
<p>Note: Not all column values sum to totals due to rounding.</p> <p>Gentle: less than 10% of the reach length is steeper than 15% grade</p> <p>Gentle-moderate: less than 25% of the reach length is steeper than 15% grade</p> <p>Moderate: 25 to 50% of the reach length is steeper than 15% grade</p> <p>Moderate-steep: 50 to 75% of the reach length is steeper than 15% grade</p> <p>Steep: 50 to 100% of the reach length is steeper than 15% grade</p> <p>Source: Planning Partners, 2012; based on information developed by Best et. al., 2011.</p>							

Trail Orientation (Fall-line)

Higher rates of erosion occur on fall line trails (Best 2002, 2010; Marion and Olive 2006). Fall-line roads and trails are routes that drop directly down the hillside. Fall-line trails follow the same path that water flows, thereby focusing water down their length (see Photos 5-3, 5-4, 5-5 and 5-6). These trails are difficult, if not impossible, to drain properly, and often experience ongoing erosion. The repeated grading of these trails can result in shallow through-cuts that further confine flow and run-off to the roadway.

Fall-line routes have been generally laid out to expedite the construction process, often by ranchers or loggers who infrequently used the road, or by recreational users looking for the shortest route. Many of the fall-line roads inventoried within preserves are situated along ridge lines to avoid the need to switchback across steep slopes below the ridge. Some of these roads are problems; others are not.



FALL-LINE TRAIL

Water is not discharged off the trail causing the trail to become eroded and entrenched.

On steep gradient trails with a fall-line orientation, use patterns tend to result in trail widening (see Photo 5-7). This results in greater ground disturbance and higher rates of erosion.



Photo 5-3: Erosion of fall-line segment of Fire Road. Notice that the lower portion of the road is in a thru-cut. Fall-line and thru-cut roads/trail are difficult to adequately drain and should be avoided.



Photo 5-4: Short fall line road segment in seasonally wet and muddy soils. Road segment drains into watercourse and is responsible for chronic fine grained sediment delivery.



Photo 5-5: Example of steep fall line social trail.



Photo 5-6: Gullying on fall-line single track trail.



Photo 5-7: Widening of steep gradient fall line segment of Lower Vogelsang Trail from use. Also note that trail drains to watercourse at base of hillside.

Trail Width

Road and trail width can also play a role in the sustainability of the alignment as well as sediment production. Roads have the potential to erode more than trails due to their greater width of disturbed area. They can also be more difficult to drain where the alignment is steep because the need to have the alignment to be passable by vehicles limits the type of drainage structures that can be installed and maintained. The mileage of roads and trails by size class within each preserve is set forth in Table 5-3.

Table 5-3 Road and Trail Miles by Trail Width				
Preserve	Narrow	Moderate	Wide	Totals
Region 1				
Baltimore Canyon	2.47	0.44	1.79	4.71
King Mountain	0.22	0.08	0.22	0.52
Blithedale Summit	2.75	3.41	6.44	12.60
Camino Alto	2.19	1.89	1.65	5.73
Alto Bowl	0.96	0	0.05	1.01
Horse Hill	1.07	0	0.60	1.67
Region 2				
Cascade Canyon	2.37	6.17	0.77	9.31
French Ranch	1.08	0.27	1.48	2.83

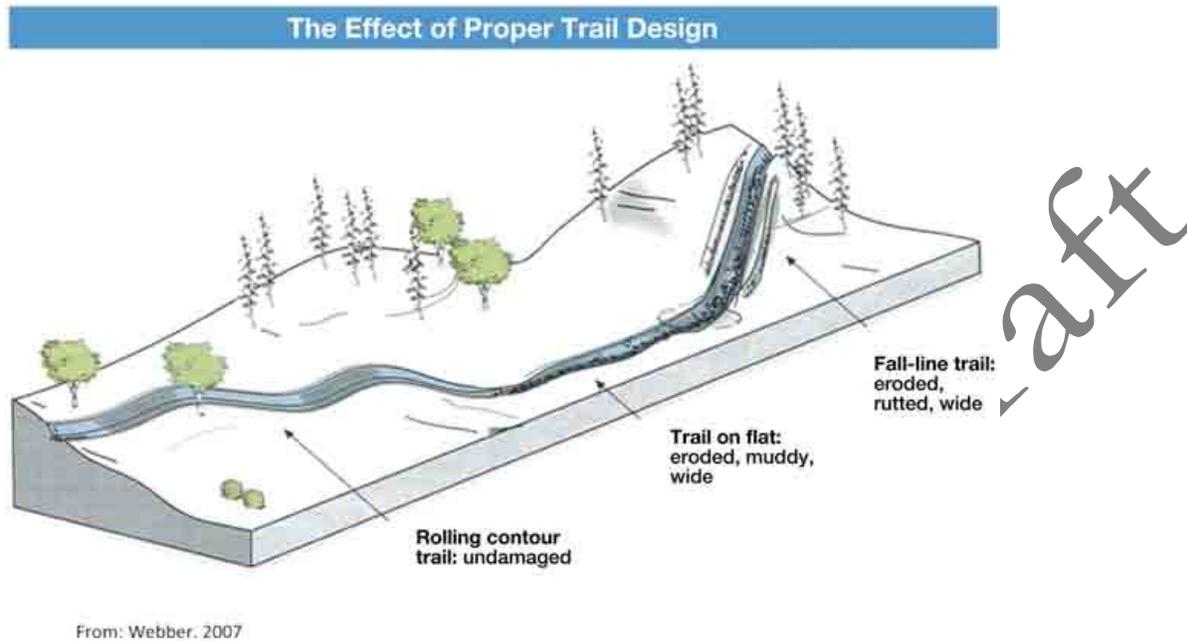
Table 5-3 Road and Trail Miles by Trail Width				
Preserve	Narrow	Moderate	Wide	Totals
Gary Giacomini	6.97	6.22	6.17	19.36
Loma Alta	3.10	0.22	5.32	8.64
Maurice Thorner	0.83	0	0	0.83
Roy's Redwoods	2.65	1.18	0	3.83
White Hill	3.66	0.26	3.65	7.57
Region 3				
Ignacio Valley	2.33	0.08	1.95	4.36
Indian Valley	6.00	1.75	1.19	8.94
Loma Verde	0.85	0	2.10	2.95
Lucas Valley	3.09	2.05	4.33	9.47
Pacheco Valle	0.48	0	2.94	3.42
Region 4				
Deer Island	2.65	0.50	0	3.15
Indian Tree	2.21	0.15	1.04	3.40
Little Mountain	1.24	0.80	0	2.04
Mt. Burdell	12.33	9.57	2.36	24.26
Rush Creek	3.09	2.78	0	5.87
Verissimo Hills	0.85	0.15	0.15	1.16
Region 5				
Bald Hill	0	0	0	0.00
San Pedro Mountain	2.34	0.07	0	2.42
Santa Margarita Island	0	0.30	0	0.30
Santa Venetia Marsh	0.04	1.04	0	1.08
Terre Linda/Sleepy Hollow	9.09	3.53	5.77	18.39
Region 6				
Bolinas Lagoon	0	0	0	0.00
Bothin Marsh	0	0	0	0.00
Old St. Hillary's	0	0	0	0.00
Ring Mountain	6.20	2.77	0.09	9.06
Tiburon Ridge	0	0	0	0.00

Source: Planning Partners, 2012; based on information developed by Best et. al., 2011.

Drainage

One of the most important considerations for sustainable unpaved roads and trails is maintaining natural drainage patterns. Roads and trails should be designed and constructed to minimize the disturbance of natural drainage patterns. This avoids the concentration of runoff down the trail tread, which leads to erosion of the tread and sediment entering streams (Best 2002, 2010; Parker 2004; PWA 1994; Webber 2007). Erosion of the trail tread can result in exposed rocks and plant roots, uneven tread surface and locally muddy conditions (see Photos 5-8 to 5-13). Erosion or instability of the hillslope can also occur where runoff eventually spills over the road embankment. This appears to have been the case along the Luiz Fire Road, where several large gullies have developed on the grass hillside from concentrated runoff, and on the Ponte Fire Road, where a large

fill failure occurred (Best 2010). Erosion can be self-perpetuating when treads erode below the surrounding soil level, forming a shallow through cut and preventing the water from draining off the road or trail.



The most serious problems with drainage tend to occur in areas where the road or trail gradient is steep, typically greater than 15 percent grade. In these areas, constructing effective drainage dips² can be difficult, and therefore they are often undersized or installed at inadequate intervals. Such drains have a short life expectancy since they tend to break down and/or infill easily with trail use.



Photo 5-8: Well drained single track trail incorporating reverse grade dips into design.



Photo 5-9: Shallow gulying along road width trail. There are no cross drains and as a result runoff is concentrated resulting in the observed erosion.

² Drainage dip: A short dip constructed in the road or trail that forces water off the tread and prevents runoff from concentrating. Drainage dips include rolling dips, reverse grade dips, and as a last option, water bars. Frequent dips are essential elements for sustainable trail design.



Photo 5-10: Single track trail constructed without drainage dips. The lack of dips and compaction of the tread has caused the trail to become entrenched.



Photo 5-11: Deeply entrenched and poorly drained trail. Treatment of this trail will be difficult due to the steep grade and high amount of entrenchment.



Photo 5-12: Erosion on rocky road attributed to lack of cross drains. Note that road use has caused shallow rutting along the wheel tracks.



Photo 5-13: Sediment deposited in a natural dip from road bed erosion during the 2009-2010 winter. Frequently placed drainage dips would have minimized this erosion.

The mileage of roads and trails by drainage class within each preserve is set forth in Table 5-4.

Table 5-4 Road and Trail Miles by Drainage							
Preserve	Poor	Fair-Poor	Fair	Good-Fair	Good	Unknown	Totals
Region I							
Baltimore Canyon	0.04	0.17	0.54	2.49	0.68	0.80	4.72
King Mountain	0	0.15	0.08	0	0	0.30	0.52
Blithedale Summit	0.64	2.29	4.86	3.45	0.16	1.20	12.6
Camino Alto	0.97	1.40	2.99	0.29	0.09	0	5.73
Alto Bowl	0	0	0.05	0	0	0.96	1.01

Table 5-4 Road and Trail Miles by Drainage							
Preserve	Poor	Fair-Poor	Fair	Good-Fair	Good	Unknown	Totals
Horse Hill	0.31	0.15	1.20	0	0	0	1.66
Region 2							
Cascade Canyon	0.07	2.43	2.98	3.23	0.59	0	9.3
French Ranch	0	1.45	1.05	0.29	0	0	2.83
Gary Giacomini	2.95	3.38	6.15	0.89	4.09	1.91	19.36
Loma Alta	0.11	2.20	3.49	1.99	0.42	0.44	8.64
Maurice Thorner	0	0	0	0	0	0.83	0.83
Roy's Redwoods	1.77	0.58	1.48	0	0	0	3.83
White Hill	0	1.30	1.81	3.10	0.57	0.79	7.56
Region 3							
Ignacio Valley	0.35	2.17	0.55	0.56	0.02	0.71	4.36
Indian Valley	0.35	1.8	4.07	0	0.84	1.19	8.95
Loma Verde	0	2.20	0.46	0.06	0	0.23	2.95
Lucas Valley	0.99	3.22	3.20	0.54	0.33	1.18	9.45
Pacheco Valle	0.22	2.40	0.42	0.23	0.15	0	3.42
Region 4							
Deer Island	0	0.04	3.11	0	0	0	3.15
Indian Tree	0	0.64	0.20	1.66	0.90	0	3.41
Little Mountain	0	0.54	1.51	0	0	0	2.05
Mt. Burdell	0	5.53	17.13	0.32	0.62	0.66	24.26
Rush Creek	1.12	0.76	3.98	0	0	0	5.87
Verissimo Hills	0	0.15	1.01	0	0	0	1.16
Region 5							
Bald Hill	0	0	0	0	0	0	0.00
San Pedro Mtn	0.40	0	0.61	0	0	1.40	2.42
Santa Margarita Island	0	0	0.30	0	0	0	0.30
Santa Venetia Marsh	0	0	1.08	0	0	0	1.08
Terre Linde/Sleepy Hollow	4.10	2.01	7.15	2.43	0.83	1.87	18.39
Region 6							
Bolinas Lagoon	0	0	0	0	0	0	0.00
Bothin Marsh	0	0	0	0	0	0	0.00
Old St. Hillary's	0	0	0	0	0	0	0.00
Ring Mountain	0.09	0.43	2.07	0	0.68	5.77	9.04
Tiburon Ridge	0	0	0	0	0	0	0.00

Note: Not all column values sum to totals due to rounding.

Poor: road/trail is poorly drained with few effective cross drains in place. Significant concentrated runoff is evident or expected.

Fair-Poor: road/trail is moderately to poorly drained with few cross drains in place. Runoff is locally concentrated (or expected) for long distances.

Erosion of road/trail tread is typically evident. Moderate to severe erosion is expected.

Fair: road/trail is moderately drained with infrequent cross drains. Concentrated runoff is locally evident or expected for short distances. Minor tread erosion may be evident.

Fair-Good: road/trail is well drained. Cross drains may be infrequent but concentrated runoff is not apparent.

Good: road/trail is well drained with frequent cross drains. Concentrated runoff is not evident.

Source: Planning Partners, 2012; based on information developed by Best et. al., 2011.

Geology and Soils

Road and trail stability is also influenced by the underlying geology and soils - how easily they are compacted and eroded, and how stable they are on slopes.

Soft and seasonally wet soils can affect trail impacts and sustainability. Problems exist where bank seeps and springs are present, causing the road or trail to become chronically wet and muddy. This problem is exacerbated on low gradient trails where water collects. Use of wet roads can cause the road surface to rut, resulting in the breakdown of the erosion control structures and drainage dips. These problems may be compounded in soft clayey soils that do not dry out quickly. Additional damage can occur as the trail or roadbed is widened by users skirting the wet areas.

Chronic wet areas are potential sediment sources when they are located in close proximity to a watercourse (see Photo 5-14). When they are located away from drainages they may not be a sediment problem, but they may need to be repaired for access reasons. Other problems occur when relatively weak and soft clayey Franciscan *mélange* soil is encountered, and/or where groundwater emerges towards the base of hillsides (see Photo 5-15).



Photo 5-14. Wet segment of trail dropping into a small ephemeral stream. Erosion of the trail can be a source of fine-grained sediment.



Photo 5-15: Erosion of seasonally wet and relatively weak cohesionless soils along the lower portion of the Luiz Fire Road. Rilling of the road surface begins almost immediately after the dip and is partially attributed to the lack of clay in the soils that would help bind the material.

Many roads and trails are underlain at a shallow depth by relatively competent Franciscan sandstone and shale. When exposed in the road or trail bed, these earth materials are resistant to erosion; significant erosion problems are generally absent. The principal problems with shallow bedrock are twofold. First, the hard rock makes it difficult to install adequate drainage dips, and as a result dips are often infrequently spaced, allowing for runoff to become concentrated. While this may not result in much erosion of the road surface, it can result in problems where runoff is discharged off the road. The second problem is that bedrock, by nature, is often uneven and therefore when rock is exposed, the road and trail can be rough and uneven, which can impact the usability of the trail (see Photo 5-16). Trails routed through serpentinite bedrock are particularly prone to this problem (see Photos 5-17 and 5-18).



Photo 5-16: Competent shallow bedrock, such as what is shown, can minimize the amount of erosion but can also erode to an uneven road/trail surface.



Photo 5-17: Highly irregular tread surface with continuous obstacles along single track trail routed through serpentinite.



Photo 5-18: Irregular tread surface on ridge top fire road routed through serpentinite bedrock.

Stream Crossings

There are a number of stream crossings by roads and trails within the preserves that include bridges, culverts, fords, and puncheons. Examples of these crossings are shown in Photos 5-19 to 5-24. Failures of stream crossings and the associated erosion of crossing fill historically have been a leading source of accelerated sediment delivery to streams, and are often a focus for upgrades.



Photo 5-19: Functional wood foot bridge.



Photo 5-20: Informal puncheon over a small ephemeral watercourse.



Photo 21: Culverted stream crossing. Note the two smaller pipes which were undersized and plugged with sediment.



Photo 5-22: Recently installed plastic pipe. Outlet is "shotgunned" leading to erosion at the outfall.



Photo 5-23: Rock ford on unsurfaced road. Ford constructed using native rock to armor outer road edge.



Photo 5-24: Rock ford on road width trail.

Use Related Factors

For well-designed and constructed trails, post-construction trail impacts would be minimal in the absence of use. This is even the case on some poorly designed trails that are not heavily used, and that are largely covered by vegetation that limits the direct impact of rainfall and runoff. Some specific undesirable conditions, such as trail widening and the creation of parallel treads (trail braiding) or side trails are related to user behavior. However, they are often caused by poor trail physical conditions. For additional information regarding road and trail use, please refer to Section 5.2.3, Road and Trail Visitor Use, below.

Use Intensity

Most forms of trail degradation on otherwise well-designed trails are related to use intensity, with higher use typically resulting in greater ground disturbance. Leung and Marion (1996) found that the majority of post-construction changes occur with initial or low levels of use. Changes tend to diminish, on a per-capita basis, with increasing use. Subsequent degradation on established trails is mostly a function of site durability and other use-related factors, such as type of use and use behavior. The mileage of roads and trails by observed use level within each preserve is set forth in Table 5-5. Road and trails with high use were defined as, “Notable wear of the trail tread. Tread is typically worn and nearly always exposed.” Low use was defined as, “Infrequent use, with tread typically vegetated or covered in duff.” Regions 1, 3, and 4 have the highest recorded levels of use.

Table 5-5 Road and Trail Miles by Observed Use Levels						
Preserve	Abandoned	Low	Moderate	High	Unknown	Totals
Region 1						
Baltimore Canyon	0	0.04	0.67	4.00	0	4.71
King Mountain	0	0.01	0	0.51	0	0.52
Blithedale Summit	0	1.59	3.45	7.21	0.35	12.6
Camino Alto	0.13	1.31	1.84	0	0	3.28
Alto Bowl	0	0	0.05	0	0.96	1.01
Horse Hill	0	1.03	0.39	0.25	0	1.67
Region 2						
Cascade Canyon	0	1.71	5.12	2.49	0	9.30
French Ranch	0	10.6	1.48	0.29	0	2.83
Gary Giacomini	0.70	1.03	4.68	11.32	1.64	19.37
Loma Alta	0	1.59	2.57	4.04	0.44	8.64
Maurice Thorner	0	0	0	0	0.83	0.83
Roy's Redwoods	0.04	1.03	0.85	1.91	0	3.83
White Hill	0.23	0.82	1.82	3.91	0.79	7.57
Region 3						
Ignacio Valley	0	1.74	0.93	0.98	0.71	4.36
Indian Valley	0	0.14	3.50	5.30	0	8.95
Loma Verde	0.28	0.66	0.96	1.05	0	2.95
Lucas Valley	0	2.51	0.71	5.07	1.18	9.45
Pacheco Valle	0	0.11	0.38	2.93	0	3.42

Table 5-5 Road and Trail Miles by Observed Use Levels						
Preserve	Abandoned	Low	Moderate	High	Unknown	Totals
Region 4						
Deer Island	0	0.55	0.26	2.34	0	3.16
Indian Tree	0	0.33	1.53	1.55	0	3.41
Little Mountain	0	0.10	0.85	1.09	0	2.05
Mt. Burdell	0.58	5.54	6.15	11.34	0.66	24.26
Rush Creek	0	0.11	3.38	2.38	0	5.87
Verissimo Hills	0	0.50	0.29	0.36	0	1.16
Region 5						
Bald Hill	0	0	0	0	0	0.00
San Pedro Mountain	0	0.80	1.62	0	0	2.42
Santa Margarita Island	0	0	0	0.30	0	0.30
Santa Venetia Marsh	0	0	1.08	0	0	1.08
Terre Linda/Sleepy Hollow	0.09	3.01	7.40	6.35	1.54	18.39
Region 6						
Bolinas Lagoon	0	0	0	0	0	0.00
Bothin Marsh	0	0	0	0	0	0.00
Old St. Hillary's	0	0	0	0	0	0.00
Ring Mountain	0.11	1.46	4.57	2.92	0	9.06
Tiburon Ridge	0	0	0	0	0	0.00

Note: Not all column values sum to totals due to rounding.

Source: Planning Partners, 2012; based on information developed by Best et. al., 2011.

Type of Use

Roads and trails on MCOSD preserves receive a wide variety of uses, including patrol and maintenance vehicles, utility maintenance vehicles, and fire trucks, as well as mountain bikes, equestrians, and pedestrians. Type of use has also been shown to be a determinant of the type and extent of trail impacts (Marion and Olive 2006; Marion and Wimpey 2007; Wilson and Seney 1994). Roads with sustained vehicle use have been shown to have greater degradation than trails where vehicles are not used. The RTA did not attempt to characterize or differentiate the impacts of different types of trail uses. It addressed only the observed conditions resulting from general trail use levels.

MAINTENANCE FACTORS

Ideally, roads and trails are located and designed to be very low maintenance, but many MCOSD roads and trails were not designed with this in mind, and even in the best case there is no “zero maintenance” trail. The MCOSD maintenance staff is challenged to keep up with a growing trail system and increasing use at a time when staff resources and maintenance budgets have been reduced. One of the objectives of the RTA in particular, and the RTMP in general, is to prioritize and direct maintenance (staff and resources) to the roads and trails where the cost/benefit ratio, in terms of improvements, upgrades, and reroutes, is positive.

5.2.2 Assessment of Roads and Trails

The RTA was intended to provide information on the location, characteristics, and conditions of all roads and trails on MCOSD preserves. The RTA is based on field observations coupled with observations made from aerial photographs, review of past inventory reports, and discussions with MCOSD staff.

ROAD AND TRAIL CLASSIFICATION

Roads and trails were classified based on simple criteria, including size (width), surfacing, general mode of travel (vehicle or foot), and whether or not the alignment was considered at the time to be part of the MCOSD's designated system (see Table 5-6).

Table 5-6 Road and Trail Classifications	
Road Classifications	Description
Major surfaced road	Double lane (>16'). Major collector road. Typically paved residential thoroughfare.
Minor surfaced road	Double lane (>16'). Minor collector road. Typically paved residential road.
Surfaced single lane road	Paved or rocked single lane (<16') road. Typically fire and utility road.
Unsurfaced single lane road	Unsurfaced dirt single lane road. Typically fire and utility road.
Driveway	Residential driveway.
Unsurfaced Road – other	Unsurfaced dirt road not designated above. Includes tractor and jeep roads.
Abandoned road	Unused road. Typically overgrown and not part of designated road or trail system.
Trail Classifications	Description
Road width trail	Double width trail following old road. Obstacles typically removed. Typically machine built.
Wide trail	Double width (~5 foot) trail. Obstacles typically removed. Typically machine built.
Single track trail	Single width trail (<4'). Part of designated trail system. May or may not have obstacles.
Informal trail	Single width trail (<4'). Typically established over time from informal use. Not part of designated road system and typically does not receive repairs or maintenance.
Trail - other	Other trail not designated above. May include well established cattle or wildlife trails.
Abandoned trail	Abandoned and unused trail. Typically overgrown.

Source: Best, Timothy, CEG, et al. Road and Trail Assessment – Marin County Parks and Open Space Preserves; September 2011.

ROAD AND TRAIL INVENTORY

A key objective of the RTA was to document the location and condition of all roads and trails within MCOSD preserves, and the physical constraints for their continued use. This effort relied primarily on a systematic and comprehensive field-based inventory of pertinent features identified at distinct points (point data) or along reaches (reach data) of roads or trails. (Reaches are linear segments of a road or trail with similar average characteristics, conditions, and constraints.) The primary product of the RTA is a detailed database of the road and trail system and its physical condition and sustainability/suitability regarding continued use, resource impact, and maintenance.

Point Data

Point data are used to record specific information at one or more spots within a road or trail segment. Point features include stream crossings, pertinent erosional features, utilities and facilities, road/trail structures, and photo points. They can also be used to identify localized trail conditions that differ from the average condition of the trail segment. Only significant points, impacts, or obstacles were recorded, rather than every small variation within the trail segment. Data collected for each feature are summarized in Table 5-7.

Table 5-7 Feature Point Categories		
Feature	Feature Description	Measured Values
Stream Crossing	Watercourse crossing	Location, size, condition, and type of constructed facility at crossing
Cross Drain	Features for draining the road/trail surface. Includes waterbars, reverse grade dips, and ditch relief culverts	Location, size, and type of culvert or puncheon
Structure	Feature other than stream crossings and cross drains used to support the road or trail	Location and type of constructed structure
Landslide	Natural or road related	Location, type and volume of slope failure
Erosion	Significant erosional feature along alignment	Type of erosional feature
Facility	Road and trail improvement feature. Includes gates and signs	Location and type of improvements
Utilities	Utility features (water and power) along route. May exclude some underground utilities that are not apparent in the field review	Location and type of utility infrastructure
Water Feature	Springs, streams, swales, lagoons, wet areas	Location of feature

Source: Best, Timothy, CEG, et al. Road and Trail Assessment – Marin County Parks and Open Space Preserves; September 2011.

Road and Trail Segment Reach Data

Although reaches are defined to have similar average characteristics, conditions, and constraints, because roads and trails are not uniform, the recorded data for each reach represents the average condition for that segment. Where substantial changes in reach characteristics and conditions occur, a new reach begins.

Because some attributes can vary significantly in short distances, additional information was collected on shorter sub-segments. This includes information on grade, orientation, tread condition, and wetness. This information was recorded separately and was used to generate the average condition for each reach.

Data collected along each reach and sub-reach are described in Table 5-8.

Table 5-8 Reach Data Categories	
Category	Description and Measured Values
Start and end distance	Road distance (feet) at start and end of reach.
Location	Predominant location of reach (e.g., ridge top, ridge top/fall line, fall line, cross-slope, valley bottom, mixed).
Width	Average width of constructed road/trail bed. This value represents the constructed width of the tread and not necessarily the useable width. For example the full width of an old road would be recorded even though only a portion of the tread may be used. Values range from 1-3 feet for a single track trail to 16+ feet for a double lane road.
Surface Material	Predominant tread surface material in terms of paved, oil-screened, base rock/gravel, or native material.
Grade (sub segment)	Average grade per sub segment expressed in four grade classes from 0% to greater than 35% slope.
Grade (average)	Average trail gradient per reach expressed in five grade classes.
Grade (maximum)	Maximum sustained trail gradient per reach (minimum segment of 50 feet or more).
Fall Line (sub segment)	Fall line alignment per sub segment: yes or no.
Fall Line (average)	Average alignment of each reach of road/trail relative to the fall line. Segments that are not fall line are either cross-slope or flat in terms of five grade classes ranging from less than 10% fall line (good) to greater than 50% fall line with of 25% of the alignment having an average grade of over 25% (poor).
Level of Use	Qualitative measure of the level of use based on observed tread wear, classified into one of three categories from low to high.
Drivability	Measure of whether the road/trail is passable by vehicle. This is useful for MCOSD maintenance staff. Does not reflect managed or accepted use classified into one of seven categories ranging from passable by foot to passable by 4-wheel drive vehicle only with brush removal.
ADA Access Potential	Qualitative determination if the road or trail meets ADA access criteria categorized as yes, possible, or no.
Tread Roughness (sub segment)	Qualitative and relative measure of tread roughness per sub segment in one of five categories ranging from smooth (none) to rough and irregular, gullied or with frequent obstructions (high).
Wet/Muddy (sub segment)	Seasonal wetness or muddiness along a sub segment categorized as yes or no.
Maintenance	Level of maintenance or repair required to conform to typical trail standards as expressed in one of five categories ranging from low to extreme. Facilities classified as extreme may need to be re-routed or decommissioned.

Source: Best, Timothy, CEG, et al. Road and Trail Assessment – Marin County Parks and Open Space Preserves; September 2011.

ROAD AND TRAIL CONDITIONS

Data collected in the Road and Trail Assessment can be analyzed and presented in many ways to evaluate the conditions of roads and trails within the preserves to study management options and make decisions about operating the existing road and trail system, and potentially adding new trails. To provide a basis for establishing road and trail management policies, in addition to those affecting visitor use management, the RTA evaluated the following four categories of information regarding road and trail conditions:

- Tread Condition
- Drainage Condition
- Resource Impact
- Constraints

The four condition categories are summarized in Table 5-9 and discussed below.

Table 5-9 Road and Trail Reach Conditions	
Category	Description and Measured Values
Tread Condition	Qualitative and relative measure of tread condition, roughness and past tread erosion per reach. Measure of size and extent of erosional features, tread wear and obstacles. Includes erosion of the trail tread from surface runoff and irregular tread from natural obstructions. Rated in 5 categories from “good” to “poor”.
Drainage Condition	Qualitative and relative measure of the effectiveness of road and trail drainage structures. It is based on size and spacing of cross drains (dips and ditch relief culverts), road shape and evidence of concentrated road runoff. Rated in 5 categories from “good” to “poor”.
Resource Impact	Qualitative measure of the potential and magnitude for future erosion and its associated impact on aquatic system. It assumes current level of use and maintenance.
Constraints	Record constraints that may affect trail sustainability (such as steep grades and fall line orientation) and constraints that may affect upgrades (such as utility lines, access, downslope properties). Categories may include: Steep grade (>15%), Steep grade (>25%), Fall line orientation, Wet, Eroded tread, Riparian Zone, Stream bank erosion, Underground utilities, Poor access, Uneven bedrock.

Source: Best, Timothy, CEG, et al. Road and Trail Assessment – Marin County Parks and Open Space Preserves; September 2011.

Tread Condition

The tread condition category describes the current condition of the trail tread with respect to roughness, erosion, and obstacles. Trail tread is ranked as “Good to Poor” as outlined in Table 5-5. Treads that are in “Good” condition are typically smooth without significant erosion, obstructions or berms. Trails with “Poor” tread condition have a highly irregular and uneven tread that is often gullied and eroded. Access on these trails is often impeded. On MCOSD lands, tread condition is generally a function of erosion and gullying, but may also include areas where uneven tread condition occurs for other reasons, such as exposed bedrock. Tread condition provides a general measure of where erosion has occurred, but not the rate or timing of erosion. The following photos illustrate examples of different tread conditions.



An example of “good” tread condition.



An example of “fair” tread condition.



An example of “poor” tread condition.

Drainage Condition

Drainage condition describes the relative effectiveness of trail drainage. Drainage is a function of the size and spacing of cross drains (dips and ditch relief culverts), road shape, and evidence of concentrated road runoff. Drainage is ranked as “Good to Poor” as outlined in Table 5-4. Trails with “Good” drainage have frequently spaced cross drains and do not show signs of concentrated runoff. Trails with “Poor” drainage have few effective cross drains and significant concentrated runoff is evident or expected. See Table 5-4 regarding the drainage conditions within each preserve.

Resource Impacts

The resource impact category describes a qualitative and relative classification of the current potential and magnitude for future road and trail erosion, and its associated impact on the aquatic system. Trails ranked as “High” have a significant potential for future erosion and/or chronic sediment delivery to streams or water bodies during average large storm events. Roads and trails ranked as “Low” have a low potential for erosion with sediment delivery. This may include some roads and trails that are at risk for erosion but drain into vegetated areas which act as a filter to trap sediment, and thus are not serious risks to water quality, regardless of their condition.

Constraints/Issues

Constraints that may affect trail sustainability (such as steep grades and fall line orientation), access, or upgrades (such as utility lines, access, downslope properties) were recorded if present. In addition, the constraints that were most significant to trail performance and sustainability were mapped.

These constraints include:

- Steep gradient trails (>15 percent)
- Fall line trails
- Trails with Fair to Poor tread condition
- Seasonally wet and muddy segments

See Table 5-2 regarding the gradients of roads and trails within each preserve.

Overall Condition of Roads and Trails within Preserves

The foregoing four evaluation categories were then combined into an overall conclusion of the condition of roads and trails within the preserves.

The overall condition category describes the overall current physical condition of roads and trails, which are ranked in one of five grades from Good to Poor. The overall condition is based on the various factors outlined above, including tread condition, drainage, resource impact, and constraints, namely grade and fall line orientation. Trails ranked as “Good” are fully functional and sustainable with uniform tread, minimal erosion problems and have low resource impact. Trails ranked as “Poor” are not functional in the long term. They include trails where the tread has deteriorated and is in need of upgrades and trails that are poorly aligned and/or excessively steep and at high risk for erosion with continued use. Some trails that are in a location and/or configuration that puts them at risk for erosion, such as a steep fall-line trail in open grassland, may not show signs of erosion due to low use. These are designated as “Fair” or “Poor” condition depending on the steepness of the fall-line alignment or other factors that that would cause the trail to become unsustainable over the long term if it experienced increased use.

The overall condition classes are set forth in Table 5-10, and the mileage and percentage of roads and trails within each of the defined condition classes within each region and preserve is presented in Tables 5-11 and 5-12.

Table 5-10 Overall Road and Trail Condition Classes	
Category	Description
Good	Fully functional: Uniform stable tread. Minimal problems and low resource impact. Trail is sustainable. Standard maintenance required.
Good-Fair	Functional: Generally stable tread with low potential for resource impact. Local minor problems may exist. Trail is sustainable with on-going maintenance. Minor upgrades may be required.
Fair	Marginally functional: Road/trail is typically moderately drained with infrequent cross drains. Tread in fair condition; rilling may be evident but significant erosion problems are generally absent. Portions of the road/trail in need of upgrades to repair damage or minimize resource impact. Portions may not be sustainable w/o high level of maintenance.
Fair-Poor	Not functional: Includes road/trail segments that have deteriorated and in need of upgrades and/or segments that are poorly aligned and/or excessively steep and at high risk for erosion with continued use. Segment is typically moderately to poorly drained with infrequent cross drains. Tread may be deeply rutted and rilled. Also includes segments that are excessively steep and have fall line orientation. Portions of the segment are not sustainable and may be infeasible to upgrade. High level of maintenance required to prevent offsite impacts.
Poor	Not functional: Segment has deteriorated and/or at high risk for erosion. Segment is not sustainable and may be infeasible to upgrade. May present significant offsite impact.

Source: Best, Timothy, CEG, et al. Road and Trail Assessment – Marin County Parks and Open Space Preserves; September 2011.

As shown in Table 5-11, Regions 1, 2, and 4 have a larger mileage of roads and trails within the “Good” or “Good-Fair” categories than is the average for all regions. Conversely, Regions 3 and 5 have a greater proportion of roads and trails within the “Fair-Poor” and “Poor” categories compared with the regional average.

Table 5-12 indicates that Open Space Preserves with a substantially higher than average percentage of Good or Good-Fair roads and trails include: Baltimore Canyon, King Mountain, Blithedale Summit, Horse Hill, Gary Giacomini, Roy’s Redwoods, Deer Island, Indian Tree, Santa Margarita Island, and Santa Venetia Marsh. The Camino Alto, Horse Hill, French Ranch, Loma Alta, Roy’s Redwoods, Indian Valley, Verissimo Hills, and Terra Linda/Sleepy Hollow Divide Preserves have a substantially greater proportion of roads and trails within the Fair-Poor or Poor categories.

Table 5-11 Mileage of Roads and Trails by Road Condition Class within Regions									
Road Condition Class									
Region	Region Acreage	<i>Good</i>	<i>Good-Fair</i>	<i>Fair</i>	<i>Fair-Poor</i>	<i>Poor</i>	<i>Unknown</i>	Total Miles	Density (miles/acre)
Region 1	1198.4	2.2 miles 8.4%	11.83 miles 45.1%	3.4 13.0%	5.28 miles 20.1%	2.17 8.3%	1.36 5.2%	26.24	0.02
Region 2	3600.2	7.91 15.1%	15.75 30.1%	9.69 18.5%	11.69 22.3%	3.38 6.5%	3.96 7.6%	52.38	0.01
Region 3	3537.3	1.82 6.2%	4.91 16.9%	9.85 33.8%	7.14 24.5%	3.53 12.1%	1.89 6.5%	29.14	0.01
Region 4	2584.8	2.85 7.1%	15.5 38.7%	10.59 26.6%	8.41 21.1%	1.34 3.4%	1.24 3.1%	39.89	0.01
Region 5	1601.91	1.94 8.7%	6.17 27.8%	4.71 21.3%	3.51 15.8%	3.51 15.8%	1.81 8.2%	22.18	0.01
Region 6	1686.9	0.42 4.6%	1.95 21.6%	4.71 52.1%	1.22 13.5%	0.75 8.3%	0.00 0.0%	9.05	0.01
Total System	14479.5	17.1 9.6%	56.1 31.3%	42.96 24.0%	37.78 21.1%	14.69 8.2%	10.26 5.7%	178.88	0.01

Source: Planning Partners, 2012; based on information developed by Best et. al., 2011.

Table 5-12 Percentage of Roads and Trails by Road Condition Class Compared to System-Wide Average													
Region	Preserve	Road Condition Class											
		Good		Good-Fair		Fair		Fair-Poor		Poor		Unknown	
		Greater	Fewer	Greater	Fewer	Greater	Fewer	Greater	Fewer	Greater	Fewer	Greater	Fewer
Region 1	Baltimore Canyon	X		X			X		X		X		X
	King Mountain		X	X					X		X		X
	Blithedale Summit		X	X			X						
	Camino Alto		X			X				X			X
	Alto Bowl		X		X		X		X		X	X	
	Horse Hill	X					X		X				X
Region 2	Cascade Canyon		X								X		X
	French Ranch		X					X			X		X
	Gary Giacomini	X							X				
	Loma Alta							X			X		
	Maurice Thorner											X	
	Roy's Redwoods	X			X	X			X	X			X
	White Hill						X				X		
Region 3	Ignacio Valley				X	X							
	Indian Valley									X			X
	Loma Verde		X		X	X					X		X
	Lucas Valley		X		X			X					
	Pacheco Valle		X			X					X		X

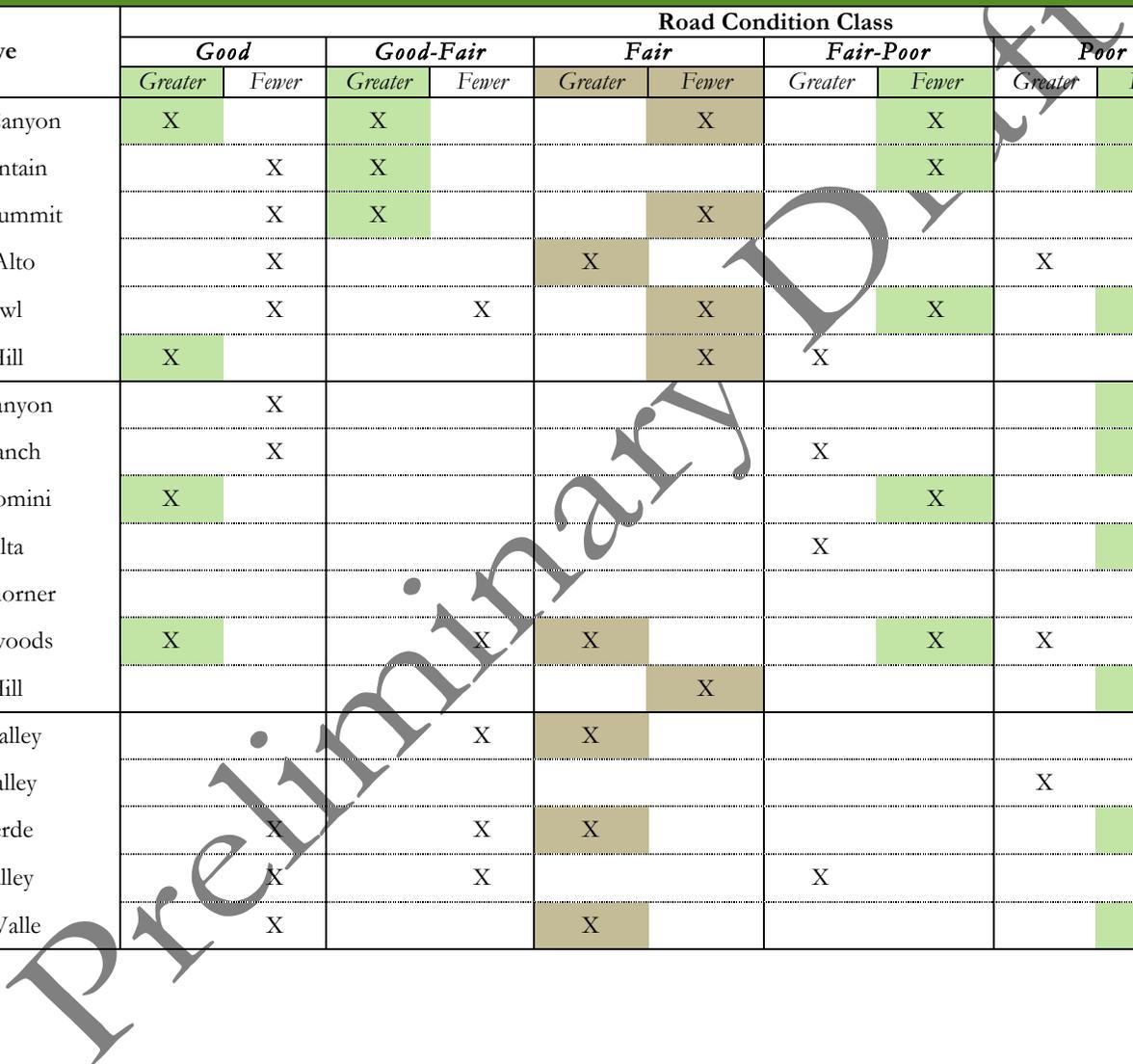


Table 5-12 Percentage of Roads and Trails by Road Condition Class Compared to System-Wide Average

Region	Preserve	Road Condition Class											
		Good		Good-Fair		Fair		Fair-Poor		Poor		Unknown	
		Greater	Fewer	Greater	Fewer	Greater	Fewer	Greater	Fewer	Greater	Fewer	Greater	Fewer
Region 4	Deer Island		X	X			X		X		X		X
	Indian Tree			X			X				X		X
	Little Mountain		X		X	X							X
	Mount Burdell												
	Rush Creek										X		X
	Verissimo Hills		X					X			X		X
Region 5	Bald Hill												
	San Pedro Mountain		X			X							X
	Santa Margarita Island		X	X									X
	Santa Venetia Marsh	X											X
	Terra Linda/Sleepy Hollow Divide									X			
Region 6	Bolinas Lagoon												
	Bothin Marsh												
	Old St. Hillary's												
	Ring Mountain		X										X
	Tiburon Ridge												

Notes: X - Favorable condition
 X - Neutral condition
 X - Unfavorable Condition
 Condition class with no notation = preserve has an average percentage of roads and trails in that condition class, or there are no roads and trails of that condition class within the preserve.

Source: Planning Partners, 2012; based on information developed by Best et. al., 2011.

Road and Trail Redundancy

Trail redundancy occurs when a preserve contains multiple similarly configured roads and trails within the same area that either parallel each other or lead to the same viewpoint or destination. The lengths of redundant trails per region were calculated according to an updated and more recent data set than that set forth in the RTA. Because an updated data set was used, the percentages in this evaluation are based on a total of 237 miles of system and non-system roads and trails rather than the 201 miles inventoried and reported on in the RTA. As set forth in Table 5-13, the preserves having the highest percentage of redundant roads and trails occur in Regions 5 and 6, although the highest mileage of such facilities occurs in Region 2.

Region	Total Miles	Perimeter (miles)	Road and Trail Redundancy	
			Miles	% of total miles
Region 1	28	28.4	10	29%
Region 2	59	50.8	18	26%
Region 3	30	45.0	6	17%
Region 4	50	31.9	14	25%
Region 5	25	27.6	12	44%
Region 6	9	24.1	10	71%
Total	201	162.9	70	30%

Source: Planning Partners, 2012, based on queries from Marin County GIS Database, 2011.

The inventoried results imply there is ample opportunity for potentially combining trails, particularly when one of the trails has an extremely low sustainability rating and great potential for aggravated erosion and or sediment delivery. Removing or decommissioning redundant trails would help reduce road and trail maintenance costs and better meet environmental improvement goals.

5.3 Visitor Use

In fall 2011, the MCOSD surveyed visitor use within selected preserves (Alta Planning + Design 2011), using both a survey and a census. The census and survey were designed to capture a representative sample of visitor use of roads and trails within the 34 Preserves. The objectives of the effort were to determine:

- Who is using the open space preserves (by visitor type and location)?
- When is use occurring (times and patterns of use)?
- What are visitor attitudes, preferences, and experiences?

The data collection methodology was developed to provide unbiased survey protocols and a statistically valid sample of visitors. Data collection included:

- A census of visitor use at 14 preserve locations and over a series of up to three peak time periods that provide a reasonable picture of use activity (see Table 5-14).

- An intercept opinion survey at the same times and locations to determine visitor attitudes and interests.

Visitors were classified as bicyclists, pedestrians, equestrians, and those using motorized devices. Activity was recorded by number of visitors. For example, bicyclists were counted by the number of people riding a bicycle (e.g., a tandem bicycle was counted as two bicyclists). This methodology provides an understanding of the number of visitors by travel choice rather than the number of travel devices. Equestrians were counted by the number of people (e.g., two people on a horse were counted as two equestrians).

The number of dogs was also recorded to gain an understanding of use by visitors with dogs.

Table 5-14 Census and Survey Locations				
Location - Preserve		Weekday Morning	Weekday Afternoon	Weekend Mid-day
1.	Baltimore Canyon	X	X	X
2.	Blithedale Summit	X	X	X
3.	Camino Alto	X	No data	X
4.	Cascade Canyon	No data	X	X
6.	Gary Giacomini	X	X	X
7.	Indian Valley	X	X	X
8.	Mount Burdell	X	X	X
9.	Ring Mountain	X	X	X
10.	Roy Woods	X	X	X
11.	Rush Creek	X	X	No data
12.	San Pedro	X	X	X
13.	Terra Linda/Sleepy Hollow	X	X	X
14.	White Hill	X	X	X

Source: Alta Planning + Design, 2011.

The fourteen locations were selected to be a representative sample of the 34 Preserves and access points.

The summary results of the census and surveys (Alta Planning + Design 2011) are set forth below, followed by detailed results regarding topics most important to the development of road and trail management policies on MCOSD lands.

Summary Census Findings:

- 23% of visitors were bicyclists
- 76% of visitors were pedestrians
- 0.4% of visitors were equestrians
- 46% of pedestrians walked with dogs
- Baltimore Canyon:
 - ✓ Highest visitor activity
 - ✓ Most dog activity
- Blithedale Summit:
 - ✓ Second most visitor activity
 - ✓ Most bicycle activity
- Camino Alto:
 - ✓ Third most visitor activity
 - ✓ Second most dog activity
- Estimated overall preserve annual activity:
 - ✓ 2,820,000 to 3,760,000 visitors

Summary Survey Findings

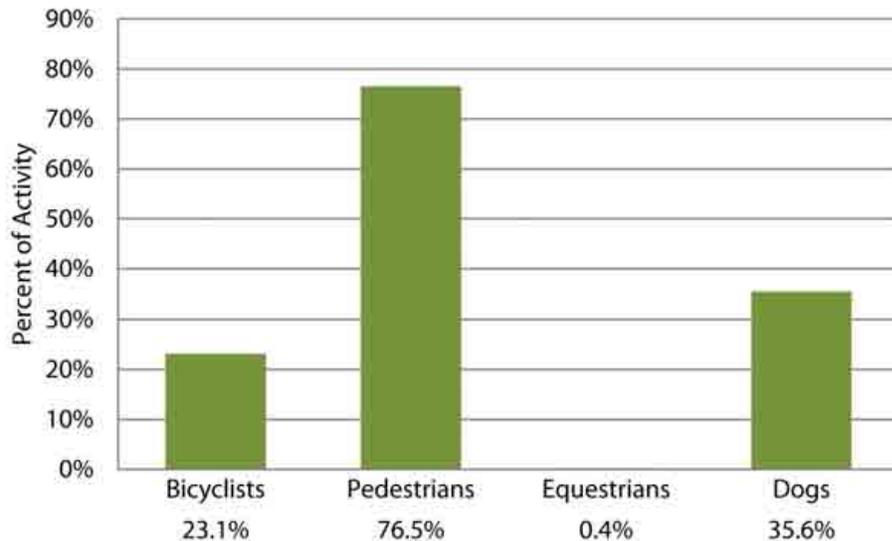
- Number of surveys: 384
- 69% arrived by driving alone or carpooling
- 22% arrived by walking
- Visitor Origin:
 - ✓ 91% from Marin County
 - ✓ 2.4% from Sonoma County
 - ✓ 1.8% each from Alameda & San Francisco Counties
- Common concerns:
 - ✓ Dog and horse waste
- Visitor experience:
 - ✓ 97% good to great trail conditions
 - ✓ 76% good to great maps and signs
 - ✓ 94% good to great interactions

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REGIONAL ACTIVITY BY VISITOR TYPE

Chart 5-1 below presents census results by visitor type. The following section presents a discussion of the census findings.

Chart 5-1 Visitor Census Results by Visitor Type



Source: Alta Planning + Design, 2011.

Bicyclists

Volunteers counted 321 bicyclists, which accounted for 23.1 percent of visitors. The locations with the most bicyclists and respective average count period volumes are listed below. The average counts are presented in parentheses.

- Blithedale (35)
- Baltimore Canyon (12)

China Camp State Park had the highest percentage of bicycles compared to other visitor types (77 percent). Of the locations where 100 or more visitors were counted, Terra Linda/Sleepy Hollow had the lowest percentage of bicycle visitors (2 percent).

Pedestrians

Volunteers counted 1,063 pedestrians, which accounted for 76.5 percent of visitors. The locations with the most pedestrians and respective average count period volumes are listed below.

- Baltimore Canyon (83)
- Camino Alto (71)
- Indian Valley (67)

Ring Mountain had the highest percentage of pedestrians compared to other visitor types (100 percent). Of the locations where 200 or more visitors were counted, Indian Valley had highest percentage of pedestrians (92 percent).

Equestrians

Volunteers counted five equestrians, which accounted for 0.4 percent of visitors. Volunteers counted two equestrians each at the Mount Burdell and Gary Giacomini Preserves, and one at Indian Valley.

The low equestrian activity may suggest equestrian peak activity times differ from pedestrians and bicyclists. Other possible reasons for the low activity may be the count locations are not those used by equestrians or that there may be little equestrian activity system-wide.

Motorized Apparatus Users

Volunteers counted one motorist at Indian Valley traveling eastbound on Indian Valley Fire Road, and no visitors using motorized assistive devices.

Dogs

Volunteers counted 494 dogs. Approximately 46 percent of pedestrians walked with dogs. The locations with the most dogs and respective average count period activity are listed below.

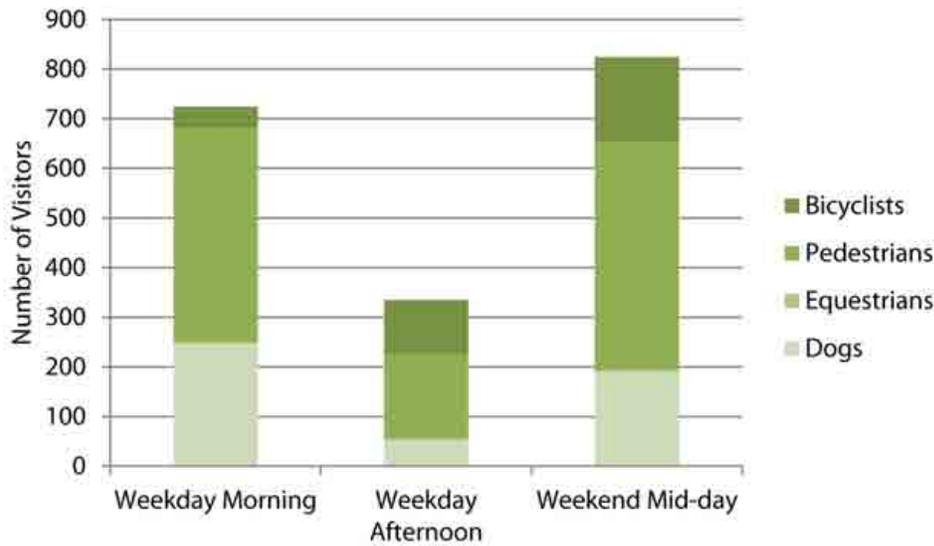
- Baltimore Canyon (165)
- Camino Alto (81)
- Indian Valley (76)

Baltimore Canyon had the highest percentage of pedestrians with dogs (67 percent) of locations where 10 or more dogs were counted.

VISITOR ACTIVITY BY DAY OF WEEK AND TIME OF DAY

Overall, the weekend mid-day count period had the highest visitor activity (633 visitors and 191 dogs) for the two-hour census period. Volunteers counted the most of each visitor type on the weekend while dog activity was highest during the weekday mornings. Chart 5-2 below presents the number of visitors by count time.

Chart 5-2 Visitor Census – Number of Visitors by Count Time



Source: Alta Planning + Design, 2011.

VISITOR ORIGIN, PRESERVE ACCESS, AND TRAVEL AND ACTIVITY WITHIN PRESERVES

Visitor Origin

- The overwhelming majority of visitors (91 percent) lived in Marin County.
- Of those that were from “out of the county,” the majority came from Sonoma County (37 percent).
- The most “out-of-county” visitors (25 surveys or 75 percent) were surveyed on the weekend count period.
- A roughly equal percent of out-of-county visitors reported using the preserves during weekdays (47 percent) and weekends (53 percent) despite count results indicating higher weekend use.
- Most out-of-county visitors (49 percent) reported typically visiting in the morning.

Access Mode to Preserve

- Nearly half of visitors surveyed accessed the preserve by driving alone (48 percent), while about one fifth carpooled (21 percent).
- Many visitors walked to the preserve (22 percent).

Travel in Preserve

- The overwhelming majority of visitors (82 percent) reported walking through the preserve.
- Seventeen percent reported bicycling through the preserve.

- Forty-four percent of visitors surveyed brought at least one dog into the preserve (slightly less than the census count of 46 percent).

The survey travel mode results differ slightly from the census where 76 percent walked and 23 percent bicycled through the preserve.

Visit Purpose

- Exercise (93 percent)
- Recreation (49 percent)
- Experience nature (41 percent)
- Social (29 percent)

Visit Frequency to Marin County Parks

- Daily (47 percent)
- Weekly (39 percent)
- Monthly (9 percent)

Visitor Concerns and Comments

- Requests for more single track trails (5)
- Concerns regarding bicyclists riding too fast, and poor intersections with bicyclists (6)
- Dog waste was the most common concern (16)
- Off-leash dogs (8)
- Conversely, permitting off-leash dogs was appreciated (9)
- Horse waste (8)

Visitor Experience

- The majority of visitors rated trail conditions as great or good (97 percent).
- The majority of visitors felt the usability of maps and signs are great to good (76 percent); however 24 percent rated the maps and signs as fair to poor.
- Interactions with other visitors was rated as great or good (94 percent)

Annual Visitor Use

Using the estimated peak overall weekday morning and peak weekend activity, a range of estimated annual activity was developed for the system. Table 5-15 presents the range of estimated weekly, monthly and annual activity.

Table 5-15 Estimated Annual Activity	
Period	Estimated Activity (Range)
Weekly Activity	38,100 - 70,100
Monthly Activity (September)	169,000 - 301,000
Annual Activity	2,820,000 - 3,760,000

Source: Alta Planning + Design, 2011.

The total estimated annual preserve activity is between 2,820,000-3,760,000 visitors.

5.4 Emergency Access and Infrastructure

Roads and trails serve various functions for MCOSD, county residents and visitors, and other federal, state, and local agencies. For the MCOSD the road and trails provide fire and utility maintenance access, habitat areas, and environmental protection for biological, cultural, geological, and other sensitive resources. For county residents and visitors, the road and trails offer recreational opportunities. For other agencies, such as the Marin County Fire Department and local fire agencies, MMWD, North Marin Water District (NMWD), , the roads provide emergency access in the event of wildland fire, and for access to maintain fire safety, water supply, and other infrastructure. Road and trails also provide access within the preserves for vegetation management, resource protection, and public safety. Infrastructure included the total mileage of fire roads, maintenance roads, and utility assets per region.

FIRE ROADS

More than half of the total road and trail mileage on MCOSD lands, or 113 miles, contains what are considered fire roads. This equates to approximately 19 miles of fire roads per region. Region 2 contains the most fire roads (38 miles), and Region 6 contains the fewest fire roads at only 3 miles. Region 1 contains 18 miles, Region 3 contains 19 miles, Region 4 contains 21 miles, and Region 5 contains 14 miles of fire roads.

MAINTENANCE ROADS & UTILITY ASSETS BY REGION

The MCOSD’s road and trail network includes public service and utility facilities and infrastructure that need regular maintenance and replacement, including storm water facilities, such as culverts, drainage features (e.g. water bars) and other facilities such as water mains, hydrants, telecommunication towers, fences, bridges, gates, locks, signage, and parking areas. Pacific Gas and Electric (PG&E), AT&T, MMWD, and NMWD operate and maintain facilities within MCOSD lands, and require year-round access to MCOSD’s roads. In general, the utilities in Marin County use the majority of the MCOSD’s roads, including all 113 miles of the fire roads, unless access is restricted by the MCOSD. For example, the MMWD uses most of the roads within the Blithedale Summit Preserve to access water tanks and hydrants, or to access watershed lands managed by the MMWD. Utility use within each of the regions is summarized below.

- Within Region 1, the MMWD operates and maintains water mains that parallel 12.2 miles of roads. Along these roads, the MMWD operates and manages 167 water valves, three pump stations, and nine hydrants. The MMWD accesses approximately 18 miles of MCOSD roads within Region 1 to operate and maintain this water utility infrastructure. No road or trails are used within Region 1 by any telecommunication service provider.
- Region 2 contains three miles of roads that contain water mains, including 33 water valves, five corrosion test stations, and two hydrants. The MMWD accesses approximately 30 miles of MCOSD roads within Region 2 to operate and maintain this water utility infrastructure. PG&E uses approximately 38 miles of roads. Telecommunication service providers use approximately four miles of the MCOSD roads within Region 2.
- Within Region 3, the MMWD operates and maintains water mains that parallel three miles of roads. MMWD operates three water valves, one hydrant, using a total of one mile of MCOSD roads for access. The NMWD operates and maintains three water tanks, including other assets, using one mile of MCOSD roads for access. PG&E uses approximately 19 miles of roads. Telecommunication service providers, including AT&T, Verizon, and American Tower, operate communication towers on Big Rock Ridge, and use approximately 19 miles of MCOSD roads for access.
- In Region 4, the MMWD does not operate and maintain any water utility infrastructure. However, the NMWD manages three water tanks, including other related infrastructure, and uses approximately one mile of MCOSD roads for access. PG&E uses approximately 21 miles of MCOSD maintained roads. Telecommunication service providers use approximately 5.5 miles of MCOSD roads in the Mount Burdell Preserve.
- The MMWD manages water mains along 3.5 miles of MCOSD roads in Region 5, in addition to operating 28 water valves, 13 corrosion test stations, four hydrants with access provided by an additional two miles of MCOSD maintained roads. PG&E uses approximately 14 miles of MCOSD roads in Region 5. Telecommunication service providers do not use any roads.
- No utility service providers use any roads within Region 6.

5.5 Shared Boundaries

Many MCOSD preserves share boundaries with either urban or rural residential land uses. These shared boundaries present both opportunities and constraints to the residents and to the MCOSD in the operation of its preserves. Many residents value the aesthetic benefits of preserved open space near their homes and use the preserves regularly for recreation. Conversely, residents can be adversely affected by higher intensity recreational uses within preserves or by management actions undertaken by MCOSD.

To determine the proximity of residences to MCOSD lands, the total mileage of each region's shared boundary with other property owners (e.g. private residences) was calculated. As indicated in Table 5-16, Regions 2 and 3 have the highest mileages of shared property boundaries with private residences, and Region 5 has the highest incidence of shared residential boundaries.

Table 5-16 Shared Preserve/Residential Boundaries				
Region	Total Miles	Perimeter (miles)	Shared Boundary with Residential Areas	
			Miles	Percentage of perimeter
Region 1	28	28.4	14.5	51%
Region 2	59	50.8	23	45%
Region 3	30	45.0	25	55%
Region 4	50	31.9	18	56%
Region 5	25	27.6	19	69%
Region 6	9	24.1	11	45%
Total	201	162.9	108.5	--

Source: Planning Partners, 2012, based on queries from Marin County GIS Database, 2011.

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