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Central Coast Watershed Studies

CCoWS

Road and Trail Resources Inventory (RATRI): Bureau of Land Management Lands

Former Fort Ord, Monterey County, California

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California State University Monterey Bay

Road and Trail Resources Inventory (RATRI): Bureau of Land Management Lands Former Fort Ord, Monterey County, California

26 July 2002

The following report is respectfully submitted to the Fort Ord Office of the Bureau of Land Management (BLM). The work was performed under Agreement No. BAA000016 (Task Order Number 002) with The Foundation of California State University Monterey Bay (CSUMB). Faculty, staff, and students at the Watershed Institute at CSUMB and Moss Landing Marine Laboratories carried out the research and writing between Fall 2001 and Spring 2002 in collaboration with Dr. Nick Mackenzie. The report was presented to the BLM in paper and electronic PDF formats. Laminated posters of the data summary and an ArcView GIS project accompany the report.

Sincerely

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A: Purpose and Scope of Report

Fort Ord, California is the site of a former United States military base in Monterey County, California that was closed pursuant to the Defense Base Closure and Realignment Act of 1990, Public Law 101-510. In 1996, the Bureau of Land Management (BLM) was given 7200 acres of land to manage as a Natural Resource Management Area, and will receive another 7800 acres in coming years (Fig. 1). The landscape is presently riddled with an evolving network of old and new roads and trails and animal paths. Some of these roads and trails will be improved and maintained by the BLM, but a large number of them will be decommissioned and restored to natural habitat (Smith et al, 2002). In order to move forward with Fort Ord land reuse and management of the restoration program, the BLM must have a clear inventory of the existing road and trail network, stratified by width. This inventory allows the BLM to develop a road and trail management strategy that will identify which roads and trails will be open for public and administrative use, and where new roads and trails are needed. The Watershed Institute at California State University Monterey Bay was commissioned to provide a Road and Trail Resources Inventory (RATRI) to help develop this road and trail management strategy and to facilitate the Fort Ord reuse process.

For the 7,200 acres presently managed by BLM (Fig. 1), the inventory includes a combination of aerial photograph and GIS analysis, and is based upon robust field data. We refer to this parcel as "Current BLM Lands" in this report. In this section of the field area, field crews equipped with global positioning system receivers and width estimating equipment indexed every road and trail. For the 7,800 acres of future BLM lands, a less precise estimate of road and trail width was utilized because that area is not open to the public. In the restricted areas we relied upon detailed analysis of georeferenced, June 2000, aerial photography. In this report we refer to the restricted region as "Future BLM Lands."

B: Methods and Results for Current BLM Lands

Before data collection began, data collection interns and managers met with Nick McKenzie, Fort Ord BLM volunteer and experienced orienteering enthusiast. Mr. McKenzie trained data collection interns in the field to identify evidence of current use and provided examples of various road & trail width categories. Data collection for the RATRI took place during the months of October 2001 to February 2002.

1. Definitions and Philosophy

The goal of this project was to divide the roads and trails of the BLM property into width classes and to sum the total lengths of roads and trails falling into each class. As dictated by the BLM, our minimum length unit is 100 feet. In other words, a fieldworker would estimate the dominant width of each 100 ft segment of road or trail. The resulting inventory is tabulated in this report and in provided in electronic and hard-copy maps. There are several working definitions used in the project.

- "Current Use"--The needs of the BLM dictated that the inventory include only roads and trails showing evidence of "current use" by humans, vehicles, or trail horses. This excludes abandoned tracks and animal trails.
- "Tread width"-- For our inventory, the width of a road or trail is the "tread width," which is the portion of the trail or road that is used, or could reasonably be used by humans, human vehicles, or trail horses.

Current use was defined as "evidence of recent human use" (e.g. foot trampling, horse tracks, or tire tracks). Before CSUMB was involved in the inventory, Mr. Mackenzie had collected and compiled a preliminary current use route inventory using a Garmin © GPS Unit. Mr. McKenzie's data set was imported into ArcView Shapefile format (UTM NAD83), which summarized the location and lengths of roads and trails that were previously established as current use. This provided us a framework current use map for field-data collection planning.

Trail "tread' is the visibly constructed surface that is used, or could reasonably be used, on a road or trail. There may be subjectivity in interpreting what is considered "reasonably usable." For example, if shrubby vegetation reduces the width of a road surface, such that the old road is reduced in width by 50%, then the trail "tread" width is the width of the remaining 50% of the road that is currently passable. For another example, where an old Army road that is 10 feet wide is impassable because of gully erosion, but a trail along the rim of the gully shows signs of "current use," then the tread width is not the old road width, but the "currently used" trail width. In that case, we would assume that the old gullied road is not "reasonably usable" (Fig. 2). Figure 3 shows a very common case where the currently-used portion of the trail is 2' - 4', yet the trail lies atop a flat constructed surface that could be reasonably used by a vehicle with a 4'-6' wide tread, so this trail is placed in the 4'-6' class.

Roads and trails were defined as any constructed opening through natural vegetation that meets the following criteria.

a) The road or trail is not primarily a game trail.
b) The road or trail is not a relict feature (no evidence of current use).

Roads (tread width greater than 8ft) were defined using the following criteria.

a) Those constructed openings that have a road name. (i.e. Eucalyptus Rd.)
b) Those un-named constructed openings that fit the width category of a road.
c) Those constructed openings with a width of 8' to 12' and a substrate of asphalt.

Road Width Categories

8' to 12'
12' to 15'
15' to 25'
25' to 30'
30' to 35'
> 35'

Trails (tread width from 1.5 ft to 12 ft) were defined using the following criteria.

a) Those constructed openings that have a BLM designated trail number. (i.e. 2, 41, 56)
b) Those constructed openings that fit the width category of a trail.
c) Those constructed openings with a width of 8' to 12' and a substrate of dirt.

Trail Width Categories

1.5' to 2’
2’ to 4’
4’ to 6’
6’ to 8’
8’ to 12’

2. Field Data Collection and Processing

Field workers were divided into teams and assigned regions to conduct their data collection based on BLM property border vector data provided by the BLM – Fort Ord Project Office and a 1-meter resolution color aerial photograph taken June 2000 by AirPhotoUSA. Interns collected field GPS data on foot, by bicycle, and by automobile using Trimble © GeoExplorer II receivers (Fig. 2). Each road and trail vector segment was collected based on the request that only those width attributes with a minimum 100’ resolution be cataloged. All interns used a designated Pathfinder Office © data dictionary containing the previously mentioned road and trail features, width attributes, and a general point feature for cataloging designated roads and trails.

The resulting GPS data were differentially corrected using Pathfinder Office © and the SIVA – California State University Monterey Bay base station data. Differentially corrected data were exported into ArcView 3.2 © for additional visual data processing and editing. All geo-referenced imagery and corrected vector data were exported to ArcView 3.2 © in UTM NAD83 and converted to English units. ArcView 3.2 © vector editing was conducted to rectify outlier points and better correlate the data to the known trails on the 1-meter air photo and Mr. McKenzie’s vector data set. Questionable results were field verified and resurveyed if required.

3. Current BLM Lands Inventory Results

The sum of road and trail lengths falling into each width class was derived from the length field in each database file associated with the road and trail vector layers (Fig 5). Most (96%) of road width exists between 12 feet and 30 feet with only small proportions of road falling in wider categories (Table 1). The trail system is dominated by trails in the 8' to12' range (39%), with a fairly uniform distribution of trails in the other width classes (Table 2).

Table 1. Current BLM Land Road Statistics

Roads				
Width	Length (ft)	Length (mi)	Length (m)	Length (km)
8' - 12'	4080	0.77	1245	1.25
12' - 15'	61670	11.68	18800	18.80
15' - 25'	71630	13.57	21830	21.83
25' - 30'	17790	3.37	5420	5.42
30' - 35'	2030	0.38	620	0.62
Total	**157200**	**29.77**	**47915.00**	**47.92**

Table 2. Current BLM Land Trail Statistics

All Trails				
Width	Length (ft)	Length (mi)	Length (m)	Length (km)
1.5' - 2'	93930	17.93	28630	28.63
2' - 4'	96900	18.49	29535	29.54
4' - 6'	52150	9.95	15895	15.90
6' - 8'	64820	12.37	19755	19.76
8' - 12'	180700	34.48	55075	55.08
Total	**488500**	**93.23**	**148890**	**148.89**

Active trails within the current BLM lands may be divided into three categories: (1) trails that are open for public use, as shown by signs and maps, (2) trails that are closed to public use as shown by signs and maps, and (3) trails with no designation. Table 2 provides the total length of trail, independent of the use designation. Table 3 summarizes the length data for trails that are designated as open for public use by signs and maps. The BLM-designated trails are dominated (43%) by the 8'-12' width (Table 3). Table 4 summarizes the length data for actively-used trails that are designated as closed or that have no formal designation. Table 4 shows that these undesignated and closed trails fall mainly in the 1.5'-2' width class, suggesting that many new trails are being created by opportunistic pedestrians, equestrians and cyclists.

Table 3. Current BLM Land Designated Trails Statistics

BLM-Designated Trails				
Width	Length (ft)	Length (mi)	Length (m)	Length (km)
1.5' - 2'	29030	5.54	8850	8.85
2' - 4'	51590	9.85	15725	15.73
4' - 6'	40330	7.70	12295	12.30
6' - 8'	37330	7.12	11380	11.38
8' - 12'	120760	23.05	36810	36.81
Total	**279040**	**53.25**	**85060**	**85.06**

Table 4. Current BLM Land Unmarked and closed Trails Statistics

Actively-used Unmarked & Closed Trails				
	Length (ft)	Length (mi)	Length (m)	Length (km)
1.5' - 2'	64900	12.39	19780	19.78
2' - 4'	45310	8.65	13810	13.81
4' - 6'	11820	2.26	3605	3.61
6' - 8'	27490	5.25	8380	8.38
8' - 12'	59940	11.44	18270	18.27
Total	**209460**	**39.97**	**63845**	**63.85**

During the short time frame of this project, the number and position of trails showing evidence of current use have changed, and the official BLM trail numbers have been modified. Likewise, some of the roads and trails are already being decommissioned, fenced off, and returned to natural conditions. Therefore, we emphasize that our inventory results represent a "snapshot" of a rapidly evolving road and trail system. We report here the map-projected lengths of the road and trails. The true road and trail lengths may be different when slope and elevation are considered.

Table five shows the area of BLM lands that is occupied by roads and trails. These results were obtained by multiplying the total length of a given trail segment by its nominal median width. For instance a trail in the 2'-4' category was treated as a three-foot wide trail. The data were calculated for each of thirty-six subwatersheds that exist on BLM land (Fig. 6). Many of the roads and trails exist on top of the ridges forming the divide between subwatersheds. In that case, the area of the road or trail was split between the two adjacent subwatersheds.

C: Future BLM Lands Methods and Results

Future BLM lands include 7800 acres of chiefly maritime chaparral that may still contain unexploded ordnance. For this reason, the RATRI process was based upon analysis of a georeferenced, 1m resolution, digital, color aerial photograph taken in June, 2000.

1. Digital Data Collection and Processing

To estimate the total road and trails in the future BLM lands, vector lines denoting all visible trails were rendered into a single vector layer. We found that the resolution of the aerial photograph was insufficient to confidently use more than three size classes in the analysis. Because the same aerial photograph exists for both the present and future BLM lands, we were able to estimate the true road and trail widths in future BLM lands inventory by visual comparison with roads and trails of known width in the present BLM lands. We note that there are inherent inaccuracies in this procedure, but limited field checking did provide some degree of confidence in the results. Our analysis suggests that our three photographic width categories correspond to the following approximate true width dimensions.

Road & Trail Width Categories

< 8'
8'-15'
>15'

Road and trail segment lengths were establish using the vector measuring tool incorporated into the ArcView 3.2 © software. Length data were compiled into a corresponding field associated with the vector data file.

2. Future BLM Lands Inventory Results

The sums of road and trail lengths (Fig. 7) falling into each width class are summarized in Table 6. Most (56% total length) of the roads and trails are less than 8 feet in width. Total road and trail was estimated at 183 miles.

Table 5. Current BLM Land Road and Trail Area

[1]Sub-watershed	[2]Road area (ac)	[3]Road area (ha)	[4]Trail area (ac)	[5]Trail area (ha)	[6]Road & trail (ac)	[7]Road & trail (ha)	[8]Sub-watershed area (ac)	[9]% Area roads	[10]% Area trails	[11]% Area roads & trails
SA01	0.51	0.21	0.05	0.02	0.56	0.23	19.41	2.63	0.25	2.88
SA02	0.35	0.14	0.30	0.12	0.65	0.26	23.76	1.46	1.28	2.74
SA03	0.00	0.00	0.62	0.25	0.62	0.25	24.69	0.00	2.52	2.52
SA04	0.00	0.00	0.79	0.32	0.79	0.32	44.92	0.00	1.77	1.77
SA05	0.90	0.37	1.03	0.42	1.93	0.78	112.97	0.80	0.91	1.71
SA06	2.41	0.98	1.89	0.76	4.30	1.74	148.77	1.62	1.27	2.89
SA07	1.42	0.57	1.66	0.67	3.08	1.24	125.65	1.13	1.32	2.45
SA08	0.00	0.00	0.58	0.24	0.58	0.24	45.59	0.00	1.28	1.28
SA09	0.43	0.17	2.99	1.21	3.42	1.38	194.25	0.22	1.54	1.76
SA10	0.15	0.06	0.62	0.25	0.77	0.31	59.14	0.26	1.05	1.30
SA11	0.96	0.39	2.97	1.20	3.93	1.59	270.46	0.36	1.10	1.45
SA12	6.56	2.65	3.06	1.24	9.62	3.89	1339.57	0.49	0.23	0.72
SA14	0.92	0.37	1.69	0.68	2.61	1.06	207.05	0.44	0.82	1.26
SA15	5.12	2.07	2.65	1.07	7.76	3.14	574.19	0.89	0.46	1.35
SA20	10.39	4.20	5.65	2.29	16.04	6.49	1269.85	0.82	0.45	1.26
SA21	0.00	0.00	0.79	0.32	0.79	0.32	48.31	0.00	1.63	1.63
SA23	1.09	0.44	0.07	0.03	1.16	0.47	125.21	0.87	0.06	0.93
SA25	1.01	0.41	0.34	0.14	1.35	0.55	76.44	1.32	0.45	1.76
SA26	0.00	0.00	1.07	0.43	1.07	0.43	55.74	0.00	1.92	1.92
SA27	0.00	0.00	0.85	0.34	0.85	0.34	32.25	0.00	2.64	2.64
SA28	0.00	0.00	2.42	0.98	2.42	0.98	146.47	0.00	1.65	1.65
SA29	0.00	0.00	0.44	0.18	0.44	0.18	10.22	0.00	4.32	4.32
SE01	0.87	0.35	0.00	0.00	0.87	0.35	43.52	2.01	0.00	2.01
SE03	2.55	1.03	0.47	0.19	3.02	1.22	31.14	8.19	1.51	9.69
SE04	1.19	0.48	2.74	1.11	3.93	1.59	251.08	0.48	1.09	1.57
SE06	1.89	0.76	0.00	0.00	1.89	0.76	56.49	3.34	0.00	3.34
SE10	0.71	0.29	0.00	0.00	0.71	0.29	231.96	0.31	0.00	0.31
TC02	2.99	1.21	3.98	1.61	6.97	2.82	338.42	0.88	1.18	2.06
TC03	4.07	1.65	2.25	0.91	6.32	2.56	482.09	0.84	0.47	1.31
TC04	0.54	0.22	0.49	0.20	1.03	0.42	111.59	0.49	0.44	0.93
TC05	0.00	0.00	0.22	0.09	0.22	0.09	147.07	0.00	0.15	0.15
TC06	3.33	1.35	0.47	0.19	3.80	1.54	463.83	0.72	0.10	0.82
TC07	0.88	0.36	0.00	0.00	0.88	0.36	85.50	1.03	0.00	1.03
TC09	0.69	0.28	0.48	0.19	1.17	0.47	337.07	0.20	0.14	0.35
TC10	0.27	0.11	0.69	0.28	0.96	0.39	104.47	0.26	0.66	0.92
TC11	0.00	0.00	1.87	0.76	1.87	0.76	285.46	0.00	0.66	0.66
Totals	52.20	21.12	46.19	18.69	98.40	39.82	7924.59	0.66	0.58	1.24

NOTES for Table 5: [1] Subwatershed identification from Smith et al. (2002); See Figure 7; [2] Acres of roads; [3] Hectares of roads; [4] Acres of trails; [5] Hectares of trails; [6] Acres of roads and trails; [7] Hectares of roads and trails; [8] Subwatershed area in acres (Smith et al., 2002); [9] Area of roads as percent of subwatershed area; [10] Area of trails as percent of subwatershed area; [11] Area of roads and trails as percent of subwatershed area.

Table 6. Future BLM Land Road & Trail Statistics

Future BLM Road & Trail				
Width	Length (ft)	Length (mi)	Length (m)	Length (km)
<8'	543590	102.95	165730	165.73
8' - 15'	305420	57.84	93115	93.12
> 15'	115320	21.84	35160	35.16
Total	**964330**	**182.64**	**294000**	**294.00**

3. Future BLM Lands Error Analysis

Several potential errors exist in the determination of width and length using the outlined remote sensing methods. First, only a few of the width estimates were verified on the ground owing to the limited field access. Further, it was difficult to determine the amount of overlap existing between each width category. Lastly, the length estimates for the BLM future lands are based on two-dimensional length measurements. The estimate for true trail length may be different when slope and elevation are considered.

D: Project Personnel

[1]Dr. Douglas Smith (Ph.D.): Project Supervisor
[2]Jon Detka (B.S.): Project Manager
[3]Nicol Mackenzie (M.D.): Field Technology Officer
[4]Zoe Knesl (B.S.): Technician
[5]Matthew Michie: Technician
[6]Wendi Newman (B.S.): Technician
[7]Regina Williams: Technician & Human Resources Manager

E: Acknowledgements

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F: References Cited

Smith, D.P., Curry, R., Kozlowski, D., Williams, R., Watson, F., and Turrini-Smith, L (2002), Watershed and Riparian Assessment Report for Bureau of Land Management Lands: Former Fort Ord, Monterey County, California: Central Coast Watershed Studies Report No. WI-2002-01, Watershed Institute, California State University Monterey Bay, 75 pp., includes Arcview GIS Project, and PDF web document.

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G: Figures

Figure 1: Location of Road & Trail Inventory.

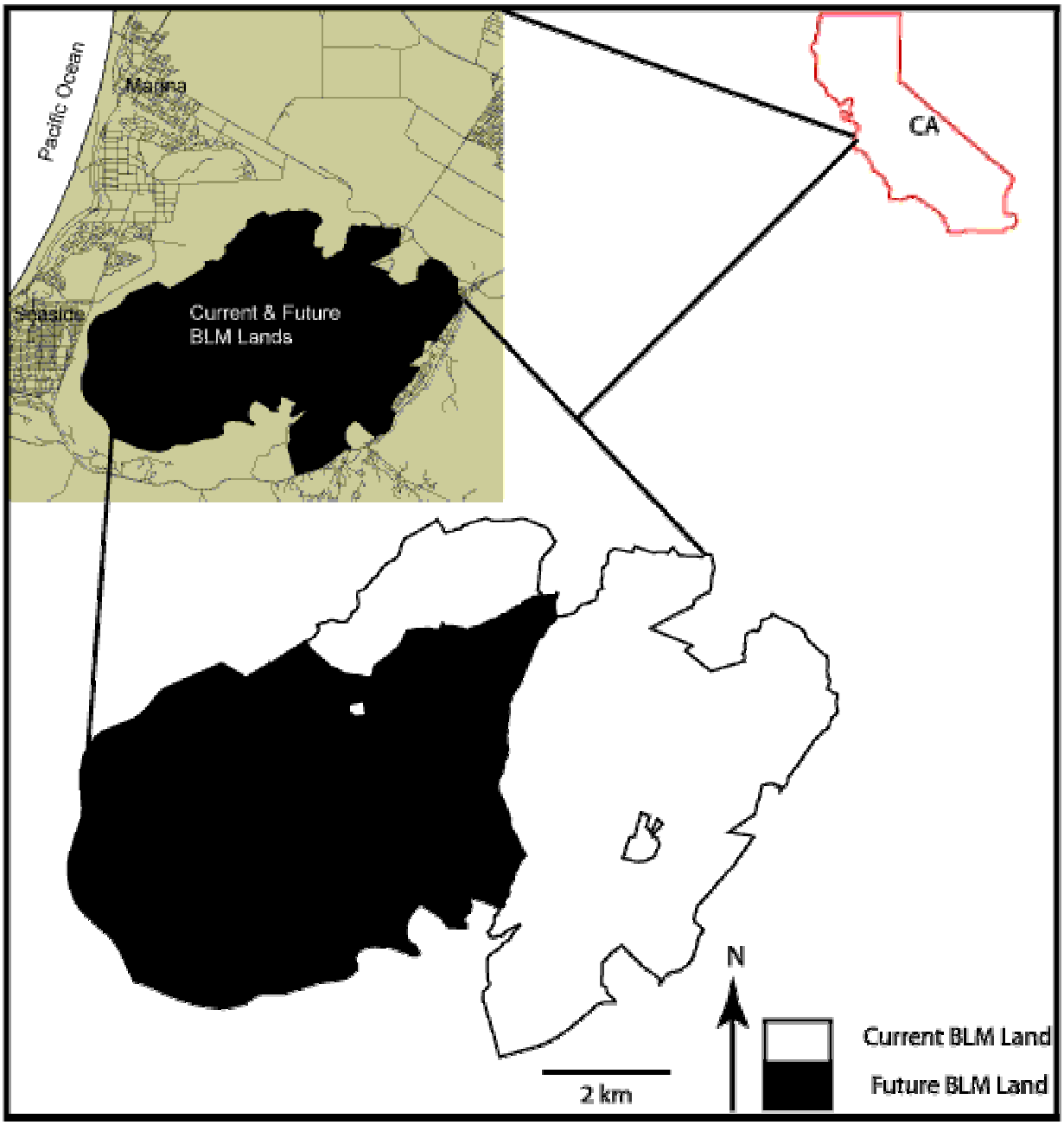


Figure 2: Example of 2'-4' tread width trail next to gullied abandoned road.

Figure 3: Example of data collection along a 4'- 6' trail. Note that the visibly-worn track showing current use is not as wide as the tread width that can be "reasonably used."

Figure 4: Bicycle-mounted data collection apparatus

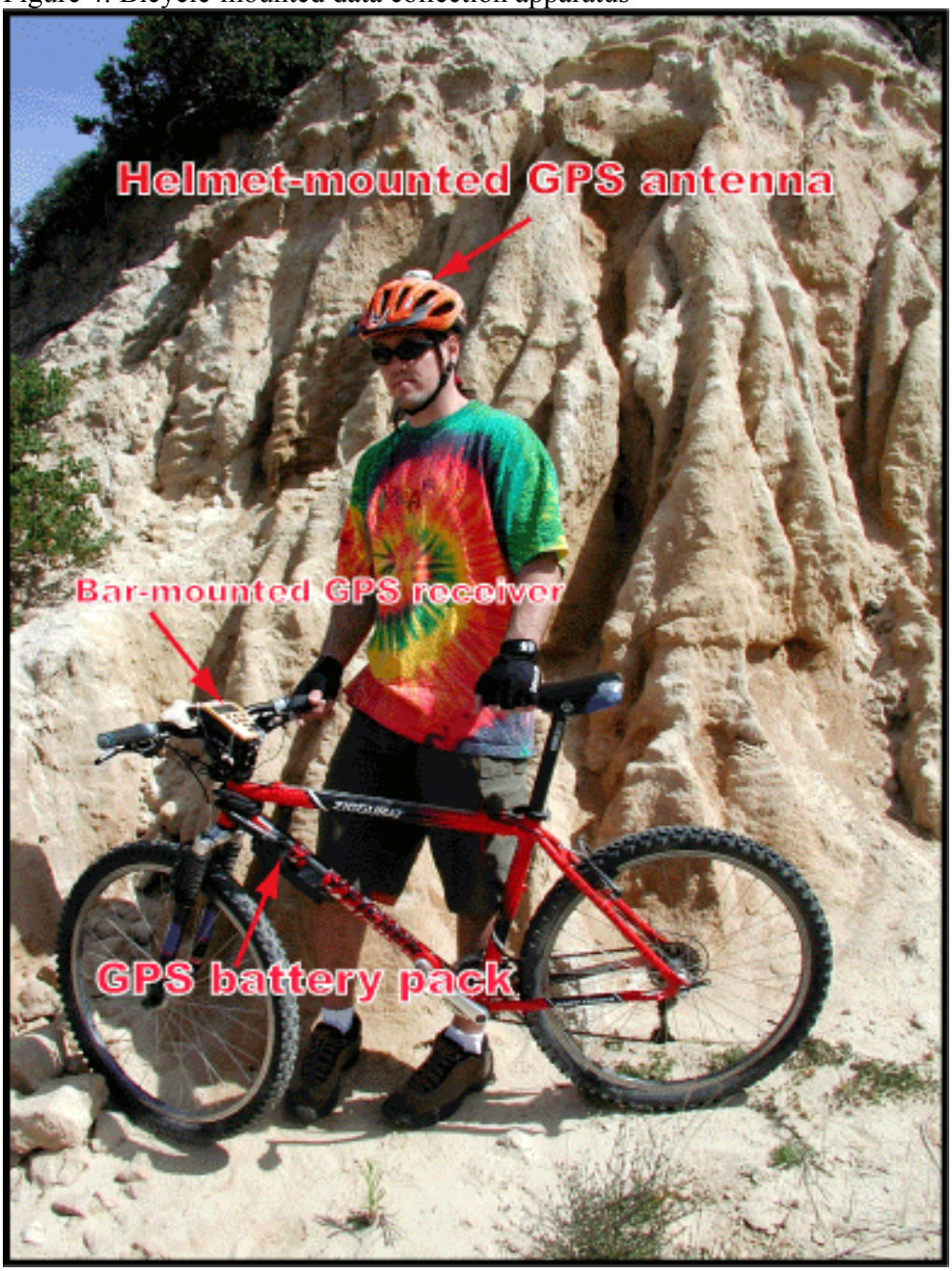
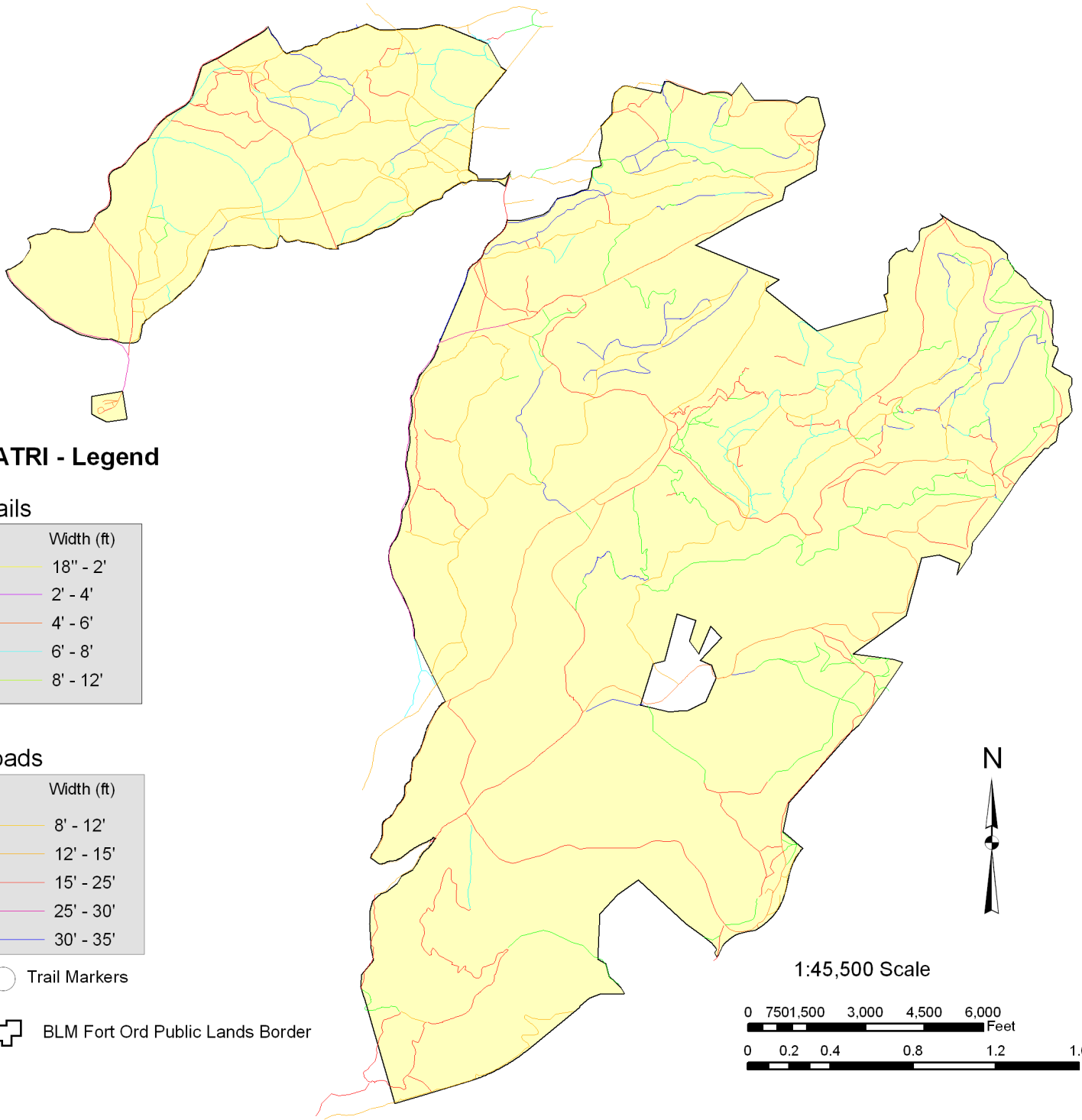


Figure 5

BLM Fort Ord Public Lands - Road & Trail Inventory - Current Use



RATRI - Legend

Trails

Width (ft)
18" - 2'
2' - 4'
4' - 6'
6' - 8'
8' - 12'

Roads

Width (ft)
8' - 12'
12' - 15'
15' - 25'
25' - 30'
30' - 35'

Trail Markers

BLM Fort Ord Public Lands Border

N

1:45,500 Scale

0 750 1,500 3,000 4,500 6,000 Feet

0 0.2 0.4 0.8 1.2 1.6 Miles

Trail Statistics

Width (ft)	Length (ft)	Length (mi)
18" - 2'	93930	17.93
2' - 4'	96900	18.49
4' - 6'	52150	9.95
6' - 8'	64820	12.37
8' - 12'	180700	34.48
	Total (mi)	**93.23**

Road Statistics

Width (ft)	Length (ft)	Length (mi)
8' - 12'	4080	0.77
12' - 15'	61670	11.68
15' - 25'	71630	13.57
25' - 30'	17790	3.37
30' - 35'	2030	0.38
	Total (mi)	**29.77**

Figure 6
Subwatersheds of BLM Land
(modified from Smith et al., 2002)

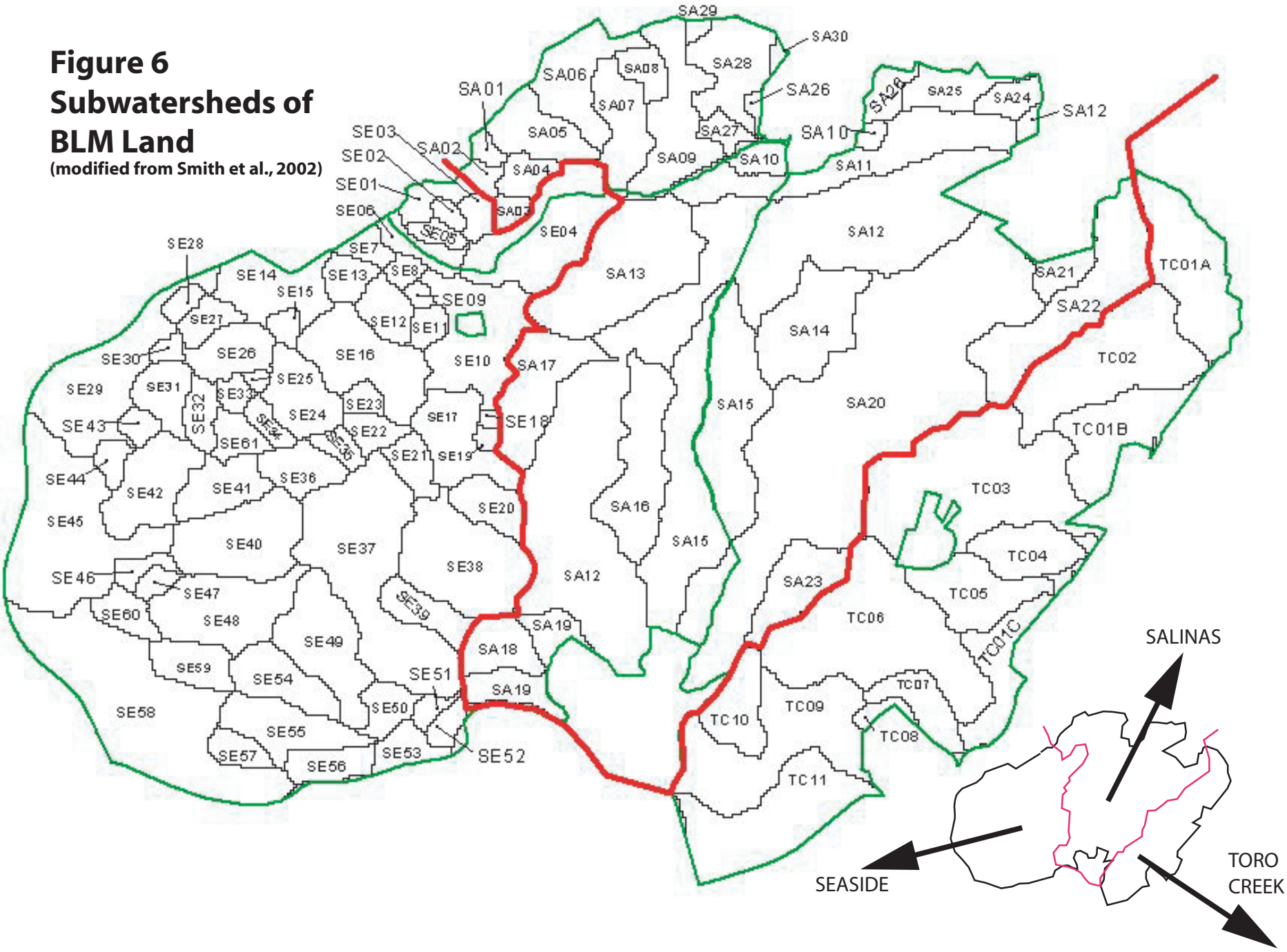
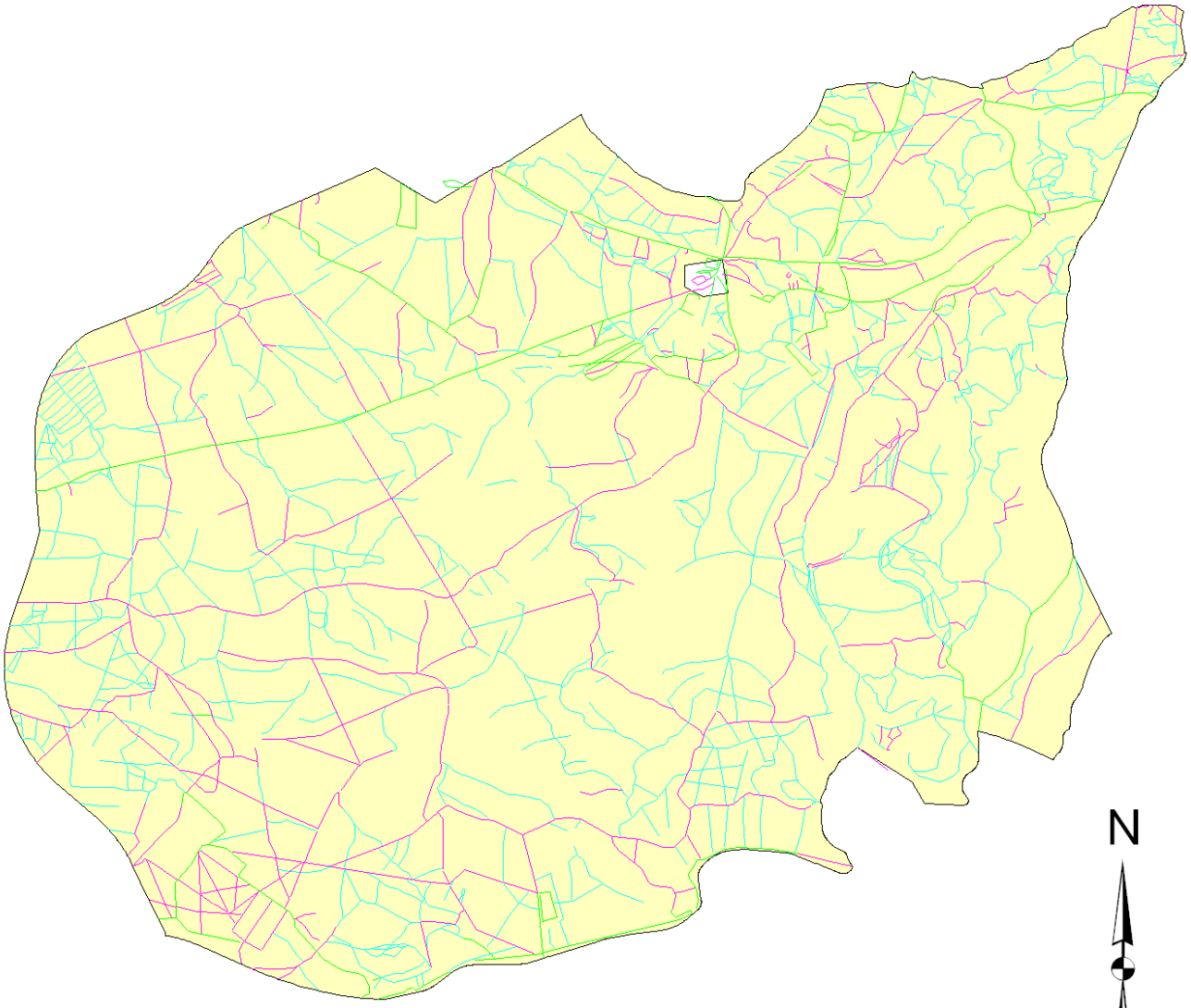


Figure 7
Roads & Trails Inventory
Future Fort Ord BLM Public Lands



Legend

Road & Trail Width Series

- <8'
- 8' - 15'
- >15'
- Future Use Public Lands

Future Use - Road & Trail Statistics

Width	Feet	Meters	Miles
< 8'	543590	165690	103.90
8' - 15'	305420	93090	57.80
>15'	115320	35150	21.80
Total Length	964330	293930	182.60