ADJACENT LAND USES

River systems are inextricably linked to the processes that shape and maintain their watersheds. Salmonid habitats within river systems are products of the geology, soils topography, vegetation, climate, and hydrology of a watershed (Meehan 1991). Natural events and land-use activities within a watershed can dramatically affect a river system and its biota. Though not as impressive in scale as major flooding events or other natural processes, land-use activities that result in incremental degradation of river system environments are much more prevalent. Land-use activities have the potential for greater cumulative impacts to fish habitat function and quality by changing streambank and channel morphology, altering streamflow and hydrologic function, altering water temperature, degrading water quality, blocking access to spawning areas, decreasing watershed water retention, and the introduction of competitive nonnative fish species. (CDFG 1996.)

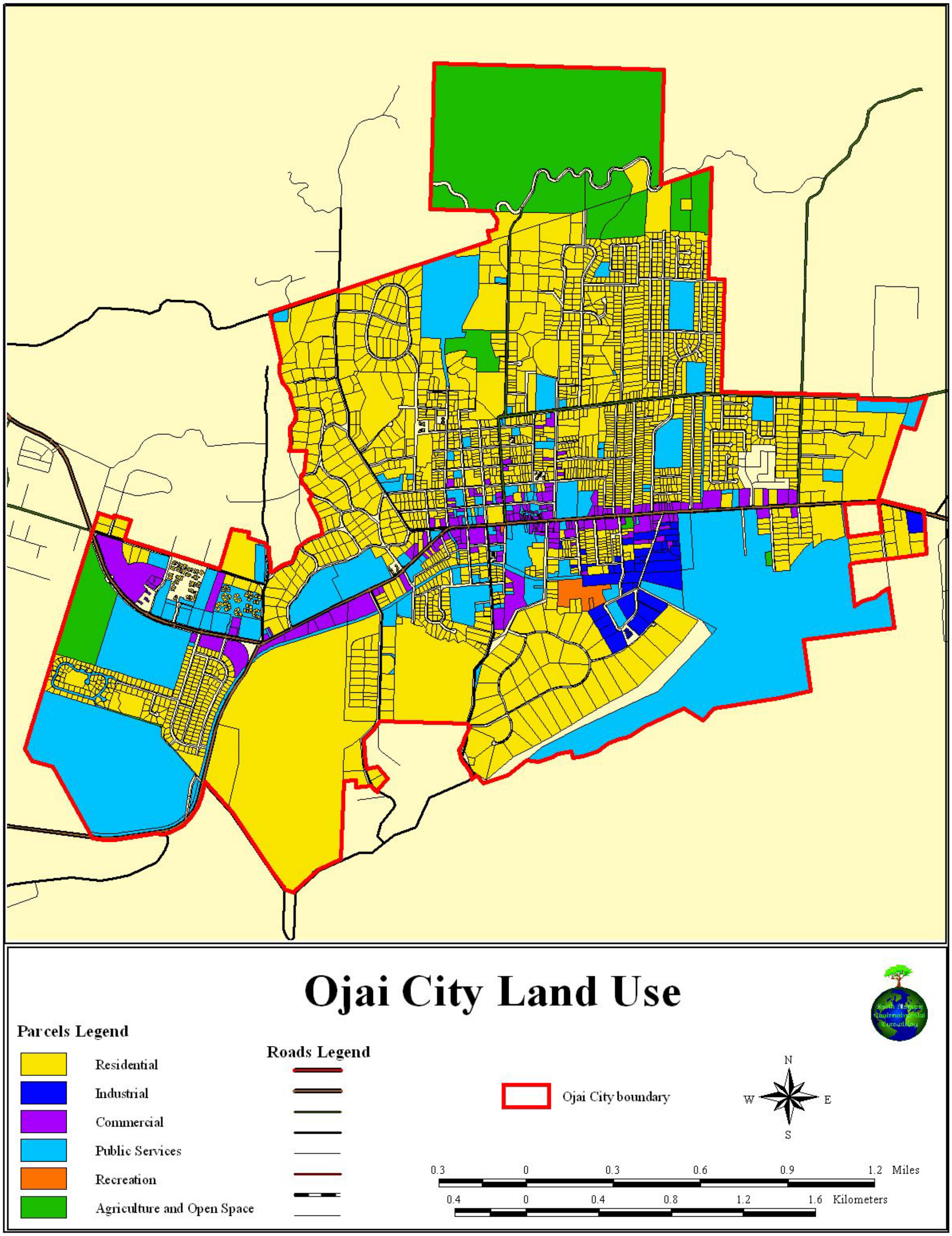
The City of Ojai, occupying an area of 4.5 square miles, is the smallest and slowest growing City in Ventura County. Current land use in the city is predominately residential, but a significant amount of land is reserved for parks and open space. Numerous urban, rural, and private roads cross the streams and creeks at various points. A small commercial area straddles the main road through town, and a 30-acre section of town is occupied by light industry. A zoning map of the City is included, representing current and ultimate planned land use (Figure 14, Map of Current and Planned Land Use).

All of the stream corridors subject to this study are within the jurisdiction of the Ventura County Watershed Protection District (VCWPD), formerly known as the Ventura County Flood Control District. The VCWPD maintains sections of Stewart and Fox Canyons that are concrete lined, but is committed to preserving the natural state of the reaches downstream of these structures. Though the flood carrying capacity of San Antonio Creek is preserved by VCWPD, all maintenance activities are performed in accordance with CDFG regulations.

Land use in the region is primarily open space, agriculture, and urban. Nearly half the coastal watershed (mainly upper elevation areas) is within the boundaries of the Los Padres National Forest. This land is off limits to timber harvesting, but open for recreational use and fuel hazard management. The Forest Service conducts regular monitoring and maintenance of its trail and road system in these watersheds, and is currently reestablishing an old fuel break on Nordhoff Ridge. Higher elevations are usually inhabited by native chaparral with areas of oak woodland, exotic grasses, and riparian woodland corridors. In the foothills many areas have been converted to exotic grass rangeland and avocado and citrus orchards.

Land use activities have decreased aquatic habitat quality throughout the City of Ojai. Most of the stream courses that pass through the City have been slightly to significantly altered, including undergrounding in long pipes and culverts. Many of the drainages flow through small urban residential properties with landowners causing (many unknowingly) direct and indirect adverse impacts to stream habitat and water quality. Many land uses immediately adjacent to "natural" drainages adversely impact stream habitats and water quality, such as placing horse corrals immediately adjacent to a stream. *Escherichia coli* (*E. coli*) bacteria contaminate surface waters and downstream aquatic habitats from surface runoff from such small corrals where buffers and filtering mechanisms are lacking. Numerous such conditions occur throughout the City's drainages.

Figure 14. Map of Current and Planned Land Uses



Photograph 41 *(left). View of horse corral next to creek channel.*
Photograph 42 *(right). View of horse urine and manure within 25 feet of creek.*

Photograph 43 *(left). Lower open portion of Stewart Canyon Creek flood channel.*
Photograph 44 *(middle). Fire-fighting activities that damaged aquatic habitats on San Antonio Creek.*
Photograph 45 *(right). Example of undersized culvert for driveway entrance.*

Recognizing that such land use activities are a national concern, the EPA administers the National Pollutant Discharge Elimination System (NPDES) permit program to control water pollution by regulating point sources that discharge pollutants into waters of the United States. The City of Ojai participates in the local application of this effort through the Ventura Countywide Stormwater Quality Management Program, a countywide effort to identify, monitor, and mitigate land use practices that are potentially harmful to water quality. As part of this program, a number of specific activities and enterprises have been identified as particular concerns for water quality. The activities monitored in this program and deemed to have the most significant impact on water quality in Ojai are:

- Construction Sites – potential source for sediment and construction material waste;
- Corporate Yards – potential source for many pollutants related to the vehicle fleet and storage and handling of chemicals, waste, construction, and other materials;
- Roadways – potential source for automobile related pollutants and miscellaneous solid waste;
- Food Services – potential source of pollutants from solid waste and clean-up wastewater;
- Horse Boarding – potential source of pollution from manure and bedding materials; and
- Industrial Facilities – potential source for manufacturing process waste.

Illicit discharges from a variety of sources are also a concern of the program.

Location, Quantification, and Assessment of Specific Land-Use Activities of Concern

Specific land uses have a higher probability of producing polluted runoff unless specific containment measures are implemented onsite. The land uses that are of particular concern include: construction sites, corporate storage yards, roadways, automobile service businesses, food service businesses, livestock boarding, particularly horses in Ojai, and industrial businesses. Each of these land uses are discussed briefly below.

Construction Sites. New construction is a relatively insignificant activity in the City of Ojai, though the number of vacant lots would indicate that new construction would continue for some time. Figure 15, Map of Vacant Lots in Ojai, shows the location of the 145 vacant lots totaling approximately 161 acres as of September 2004. These parcels represent areas of potential construction activities. More common than new construction is remodeling and landscape alterations. These activities are all temporary in nature but need to be carefully managed to be certain that they do not contribute to water quality degradation.

Corporate Yards. There are a number of locations operated by public entities in and around the City of Ojai that are used for the purpose of parking and servicing a fleet of vehicles. Several are also used for storage and handling of chemicals and other materials that are potential pollutants. Their location is shown on Figure 16, Map of Restaurants, Automotive Facilities, and Corparate Yards. Because of the potential for pollution from a fairly wide variety of sources, corporate yards are one of the focal areas of the countywide stormwater program. Appropriate Best Management Practices (BMPs) have been designed for these yards to prevent pollutants from escaping the premises. Most of the yards implement these BMPs, though compliance is voluntary for certain government entities.

Auto Services. There are 18 auto service facilities, which include service stations, repair shops, new and used car dealers, and car wash facilities. Potential pollutants cover a wide range of automotive related chemicals and materials, including fuel, oil, solvents, cleaning solutions, and solids such as brake dust. The location of most of these facilities is shown on Figure 16.

Food Services. In general, the most troublesome food service facilities are outdoor seating operations because of the tendency for trash and leftover food to be blown or washed into the drainage system if precautions are not taken to minimize this occurrence. Another potential problem is the risk of pollution from wastewater from cleaning operations (such as mopping and outdoor spray cleaning of patios and mats). Greater Ojai has over 40 restaurants and other food service facilities. Those that have been visited as part of the stormwater management program are shown on Figure 16.

Industrial Facilities. Ojai does not have a large number of industrial or manufacturing facilities. Sites that are zoned for manufacturing are indicated on Figure 16.

Horse Boarding. The Ojai Valley has long been a popular place to enjoy horseback riding and other equestrian activities. Many horse owners keep their horses on their own property, while others have their horses boarded at commercial facilities. While horse manure is much less toxic than other pet wastes such as feces from dogs and cats, it is nevertheless a source of coliform bacteria, one of the pollutants found in our stream sampling tests. The presence of coliforms is widely recognized as an indicator of water quality in natural streams.

Figure 15. Map of Vacant Lots in Ojai

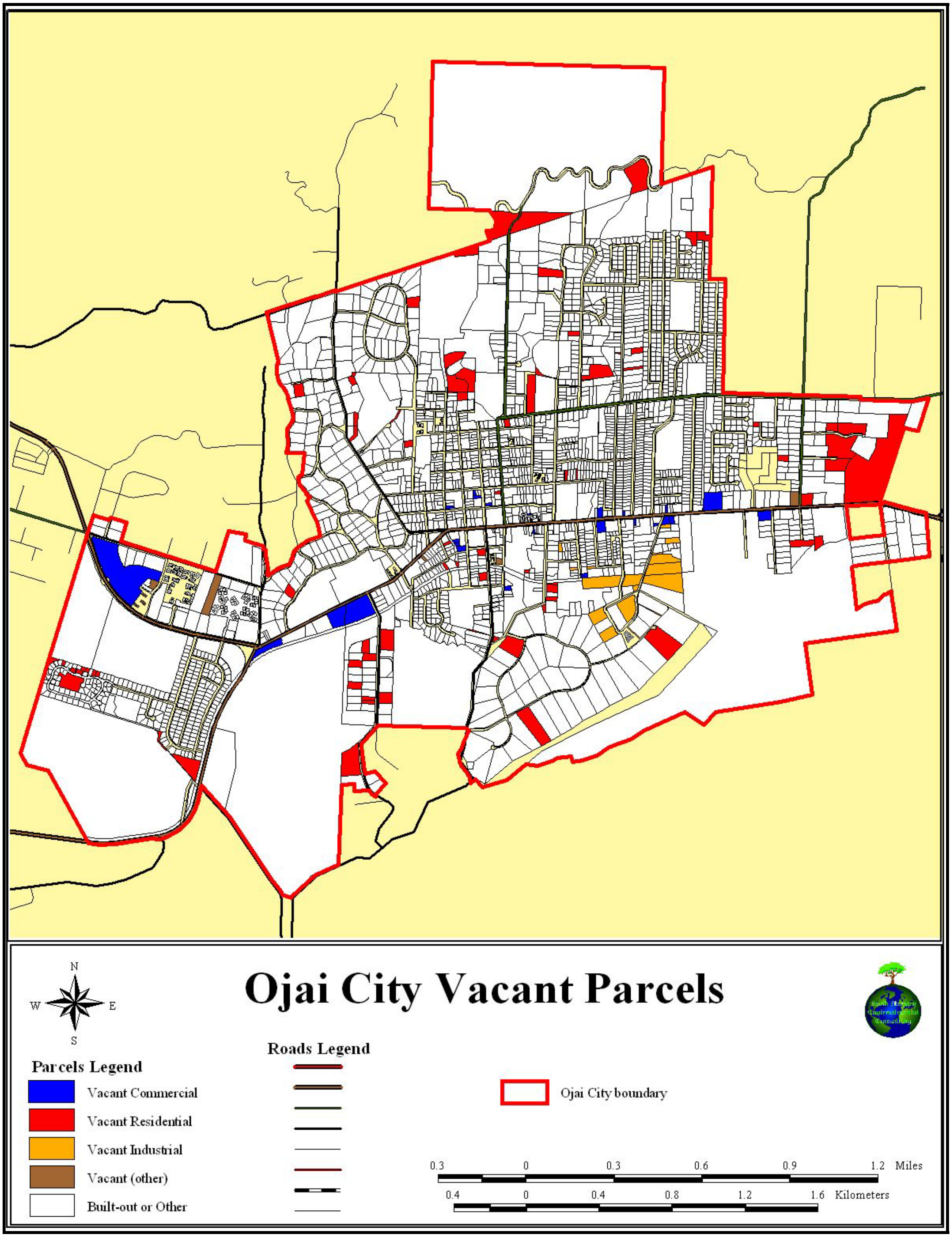
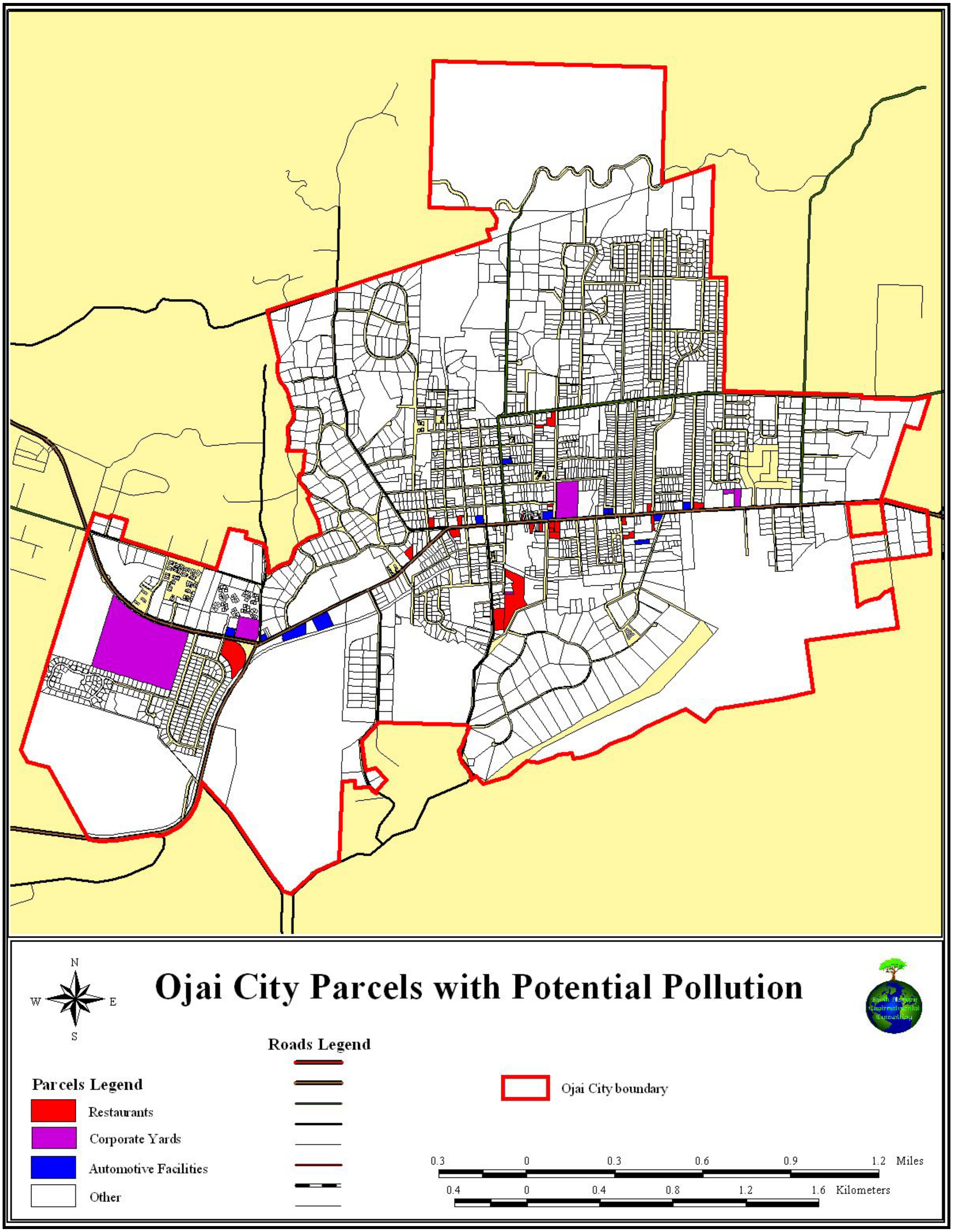


Figure 16. Map of Restaurants, Automotive Facilities, and Corporate Yards



Because individual horse boarding on private land does not require a permit, it was not possible to easily or efficiently locate these parcels on a map or to quantify the number of horses boarded in and around Ojai. However, neighborhoods in Ojai with larger parcels are where horse corals are located within the City, and are generally lacking on parcels less than 1 acre in size. Those neighborhoods in Ojai that are known to contain corals for one or more horses include: Arbolada, Del Oro, north Foothill Road, N. Montgomery, Persimmon Hill, and Gridley Road.

Roadways. There are approximately 35 miles of paved roads in the city, covering 253 acres or 9% of the surface area of the city. The city conducts regular street cleaning activities and has an active catch basin labeling program. A map of Ojai city streets is included as Figure 17, Map of Ojai Roads, illustrating the intensity with which the City is crisscrossed by roads, which are impervious surfaces that serve as vectors for pollutants from vehicles (petroleum hydrocarbons, etc.) and adjacent land uses that then enter the City's drainage system.

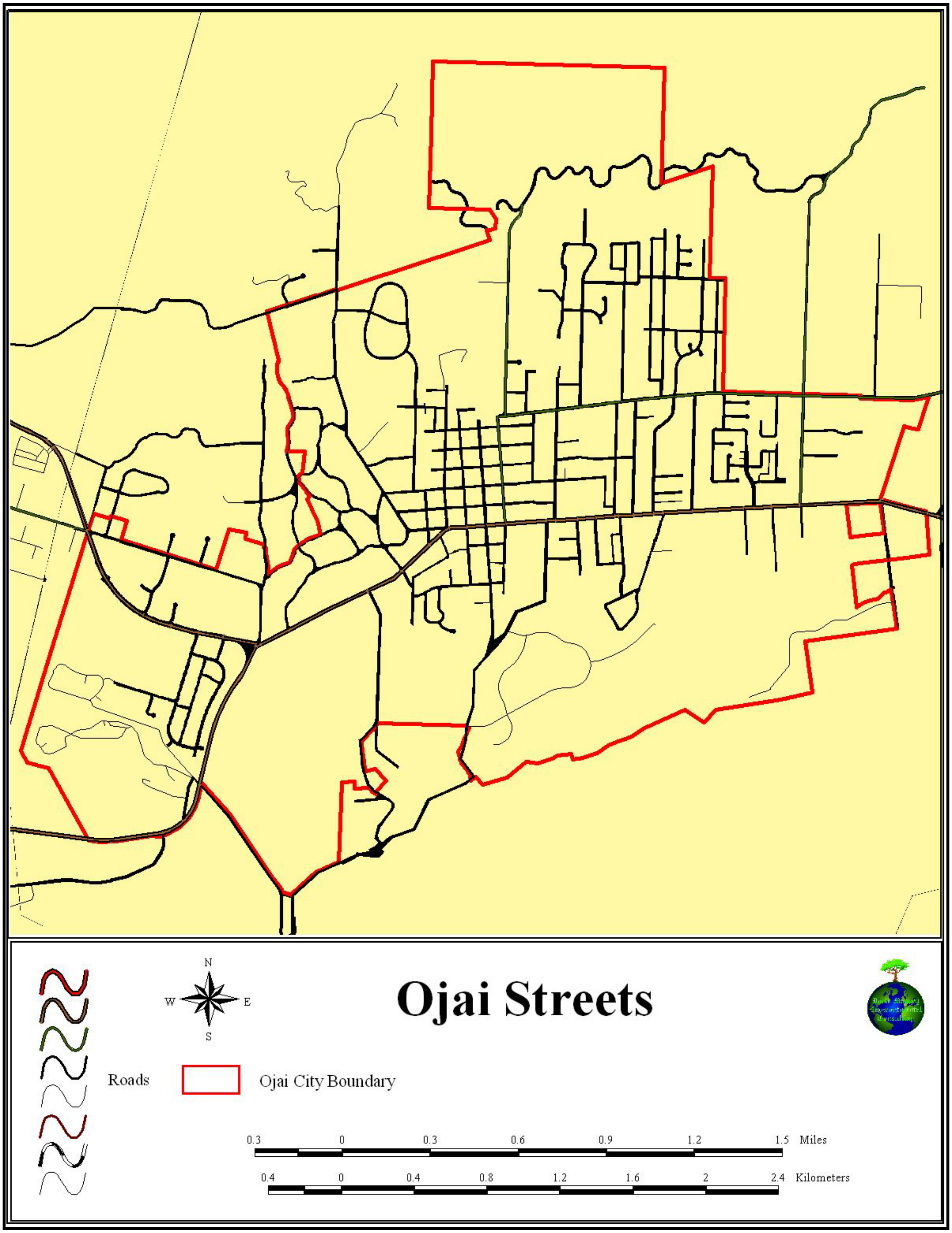
IMPERVIOUS COVER

The conversion of farmland, forests, wetlands, and meadows to rooftops, roads, and parking lots creates a layer of impervious surface in the urban landscape. Impervious cover is a very useful indicator with which to measure the impacts of land development on aquatic systems. The process of urbanization has a profound influence on the hydrology, morphology, water quality, and ecology of surface waters.

Recent research has shown that streams in urban watersheds possess a fundamentally different character than streams in forested, rural, or even agricultural watersheds. The amount of impervious cover in the watershed can be used as an indicator to predict how severe these differences can be. In many regions of the country, as little as 10% watershed impervious cover has been linked to stream degradation, with the degradation becoming more severe as impervious cover increases. (Schueler 1994.)

Impervious cover directly influences urban streams by dramatically increasing surface runoff during storm events. Depending on the degree of impervious cover, the annual volume of stormwater runoff can increase many times its predevelopment rate, with proportional reductions in groundwater recharge. In natural settings, very little annual rainfall is converted to runoff and about half is infiltrated into the underlying soils and the water table. This water is filtered by the soils, supplies deepwater aquifers, and helps support adjacent surface waters with clean water during dry periods. In urbanized areas, less and less annual rainfall is infiltrated, and more and more volume is converted to runoff. Not only is this runoff volume greater, it also occurs more frequently and at higher magnitudes. As a result, less water is available to streams and waterways during dry periods, and more surface flow occurs during storms.

Figure 17. Map of Ojai Roads



Other key changes in urban streams due to increases in impervious cover levels include:

- **Channel enlargement.** The customary response by an urban stream is to increase its cross-sectional area to accommodate the higher flows. Channel enlargement is done by streambed down-cutting, stream bank widening, or a combination of both. Urban stream channels often enlarge their cross-sectional area by a factor of two to five, depending on the degree of impervious cover and the age of development in the upland watershed.
- **Stream channels are highly modified by human activity.** Urban stream channels are extensively modified in an effort to protect adjacent property from streambank erosion or flooding. Headwater streams are frequently enclosed within storm drains, while others are channelized, lined, and or "armored" by heavy stone (riprap).
- **Upstream channel erosion contributes greater sediment load to the stream.** The high rate of channel erosion in urban streams, coupled with sediment erosion from active construction sites, increases sediment discharge to urban streams. Urban streams also tend to have a higher sediment discharge than non-urban streams during the active channel enlargement stage.
- **Dry weather flow in the stream declines.** Since impervious cover prevents rainfall from infiltrating into the soil, less flow is available to recharge groundwater. Consequently, during extended periods without rainfall, baseflow levels are often reduced in urban streams.
- **Instream habitat structure degrades.** Urban streams are routinely scored as having poor instream habitat quality, regardless of the specific method employed. Habitat degradation is often exemplified by a loss of pool and riffle structure, embedding of streambed sediments, shallow depths of flow, eroding and unstable banks, and frequent streambed turnover.
- **Large woody debris is reduced (LWD).** Large woody debris is an important structural component of many streams systems, creating complex habitat structure and generally making the stream less susceptible to erosion. In urban streams, the quantity of LWD found in stream channel declines sharply, due to the loss of riparian forest cover, storm washout, and channel maintenance practices.
- **Stream crossings and potential fish barriers increase.** Many forms of urban development are linear in nature (e.g. roads, sewers, and pipelines) and cross-stream channels. The number of stream crossings increases directly in proportion to impervious cover, and many crossings can become partial or total barriers to upstream fish migration, particularly if the streambed erodes below the fixed elevation of a culvert or a pipeline.
- **Riparian forests become fragmented, narrower, and less diverse.** The important role that riparian forests play in stream ecology is often diminished in urban watersheds, as tree cover is often partially or totally removed along the stream as a consequence of development. Even when stream buffers are reserved, encroachment often reduces their effective width, and native species are supplanted by exotic trees, vines, and ground covers.
- **Water quality declines.** The water quality of urban streams during storm events is consistently poor. Urban stormwater runoff often contains moderate to high concentrations of sediment, carbon, nutrients, trace metals, hydrocarbons, chlorides, and bacteria. While considerable debate exists as to whether stormwater pollutant concentrations are actually toxic to aquatic organisms, researchers agree that pollutants deposited in the streambed exert an undesirable impact on the stream community.

- **Summer stream temperatures increase.** The impervious surfaces, ponds, and poor riparian cover found in urban watersheds can increase mean summer stream temperatures. Since temperature plays a central role in the rate and timing of biotic and abiotic reactions in streams, even moderate increases can have an adverse impact on streams. In some regions, summer stream warming can irreversibly shift a cold-water stream to a cool-water or even warm-water stream, with harmful effects on salmonids and other temperature sensitive organisms.
- **Reduced aquatic diversity.** Urban streams are typified by fair to poor fish and macro invertebrate diversity, even at relatively low levels of watershed impervious cover or population density. The ability to restore pre-development fish assemblages or aquatic diversity is constrained by a host of factors: irreversible changes in carbon supply, temperature, hydrology, lack of instream habitat structure, and barriers that limit natural recolonization. As the level of impervious cover in the watershed increases, the amount of sensitive species declines. (Note: This subsection adapted from "Basic Concepts in Watershed Planning" *in The Practice of Watershed Protection* 2000.)

Quantifying Impervious Cover

An estimation of the percent impervious cover for the watersheds draining to the streams covered in this report is based on a number of sources, including aerial photography, site-use information from the County Assessor's office, and zoning classification from the City's planning office. In addition, to approximate the relationship between land use and impervious cover, reference is made to a recent study conducted in the suburban areas of the Chesapeake Bay (Cappiella and Brown 2001). That study developed the relationship between land use and percent impervious cover as described below in Table 24, Land Use/Impervious Cover Relationships for Suburban Areas of Chesapeake Bay, where IC = impervious cover.

Table 24. Land Use/Impervious Cover Relationships for Suburban Areas of Chesapeake Bay

Land Use Category	Mean IC	Land Use Category	Mean IC
Agriculture	1.9	Institutional	34.4
Open Urban Land	8.6	Light Industry	53.4
2 Acre Lot Residential	10.6	Commercial	72.2
1 Acre Lot Residential	14.3	Churches	39.9
1/2 Acre Lot Residential	21.2	Schools	30.3
1/4 Acre Lot Residential	27.8	Municipals	35.4
1/8 Acre Lot Residential	32.6	Golf Courses	5
Townhome Residential	40.9	Cemeteries	8.3
Multifamily Residential	44.4	Parks	12.5

It is important to note that this method of analysis is only approximate. There are many assumptions that prohibit impervious cover analysis from being a definitive assessment of land use impact on stream quality. For example, runoff from impervious areas that are directly connected to the city drainage system (i.e. roads) has a much greater impact than runoff from impervious areas that must pass over lawns (i.e. most rooftop drainage) or other non-impervious surfaces prior to entering the drainage system. That said, impervious cover analysis serves as a useful indicator of watershed conditions and provides a general frame of reference within which a more detailed analysis may be warranted.

Classifying Urban Stream Quality Potential

This subsection provides the results of the land impervious cover analysis and the instream impervious cover assessment for the Ojai Valley portion of the San Antonio Creek Watershed.

Land Impervious Cover

A general system of classifying stream quality, based on percent impervious cover of the watershed, has been proposed by the Center for Watershed Protection (Schueler, 1994). This stream quality classification divides urban streams into three management categories based on the general relationship between impervious cover and stream quality, and they include the following:

1. **Sensitive Streams (1% to 10% impervious cover).** The resource objective and management strategies in each stream category differ to reflect the potential stream quality that can be achieved. The most protective category is Sensitive Streams in which strict zoning, site impervious restrictions, stream buffers, and stormwater practices are applied to maintain predevelopment stream quality.
2. **Impacted Streams (11% to 25% impervious cover).** Impacted Streams are above the threshold and can be expected to experience some degradation after development (i.e. less stable channels and some loss of diversity). The key resource objective for these streams is to mitigate these impacts to the greatest extent possible, using effective stormwater management practices.
3. **Non-Supporting Streams (26% to 100% impervious cover).** The last category, Non-Supporting Streams, recognizes that predevelopment channel stability and biodiversity cannot be fully maintained, even when stormwater practices or retrofits are fully applied. The primary resource objective shifts to protect downstream water quality by removing urban pollutants. Efforts to protect or restore biological diversity in degraded streams are not abandoned; in some priority subwatersheds, intensive stream restoration techniques are employed to attempt to partially restore some aspects of stream quality. In other subwatersheds, however, new development (and impervious cover) is encouraged to protect other sensitive or impacted streams.

Based on the analysis and classification system described above, the results are presented in Table 25, Results of Impervious Cover Analysis for the Ojai Valley Watershed (below), and in Figure 18, Map of Impervious Cover Levels for the Ojai Valley Subwatersheds.

Table 25. Results of Land Impervious Cover Analysis for the Ojai Valley Watershed

Subwatershed Name	Area (acres)	Hectares	% Impervious Cover	Rating
Happy Valley Drain	725.1	293.5	21.8	Impacted
Villanova Creek	308.8	125.0	21.5	Impacted
Del Norte Creek	417.8	169.1	15.5	Impacted
Lower San Antonio Creek	121.5	31.2	6.7	Sensitive
Stewart Canyon Creek	1816.0	734.9	10.0	Sensitive
Fox Canyon Creek	1042.2	421.8	26.4	Impacted
Ayers Creek	1195.8	483.3	10.2	Impacted
Black Mountain West	238.3	96.4	2.8	Sensitive
Black Mountain	361.2	146.2	2.6	Sensitive
Lower Thacher Creek	1185.2	479.6	6.9	Sensitive
Ladera Ranch	1508.5	610.5	7.4	Sensitive
Gridley Canyon Creek	2848.3	1152.7	2.2	Sensitive

Instream Impervious Cover

Impervious cover has a direct and indirect affect on the earth and its drainage systems. Some natural surfaces are naturally impervious, such as bedrock. Other natural substrates may be relatively impervious to water percolation downwards. Unnatural surfaces are the primary source of impervious cover in the Ojai Valley and City of Ojai. The amount of impervious cover in a watershed is a strong indicator of a watershed's ability to maintain and support high quality aquatic habitats and water quality. Degradation of aquatic habitats and water quality, which are often closely related, directly and indirectly adversely affects aquatic life, such as Southern Steelhead Trout.

Watersheds with as little as 20% impervious cover cannot support high quality aquatic habitats. Or, stated another way, watersheds that have as little as 20% of their surface covered by impervious materials are so degraded and polluted that most aquatic life cannot survive. Only the hardiest species can tolerate such conditions (see Figure 18 above).

Figure 19, Map of Ojai City Streams Imperviousness, shows the impervious, compacted, and natural portions of all creeks within the Ojai City limits. Table 26, Impervious Cover Lengths Summary for Creeks within the City of Ojai, and Table 27, Percent Impervious Cover Summary for Creeks within the City of Ojai, present the results of the impervious cover assessment conducted within the sixteen (16) creeks of the City of Ojai during the streams characterization assessment. Table 26 includes the creek distances for natural, impervious, and compacted surfaces. Table 27 provides the creek percentages for natural, impervious, and compacted surfaces.

Figure 18. Map of Impervious Cover Levels for the Ojai Valley Subwatersheds

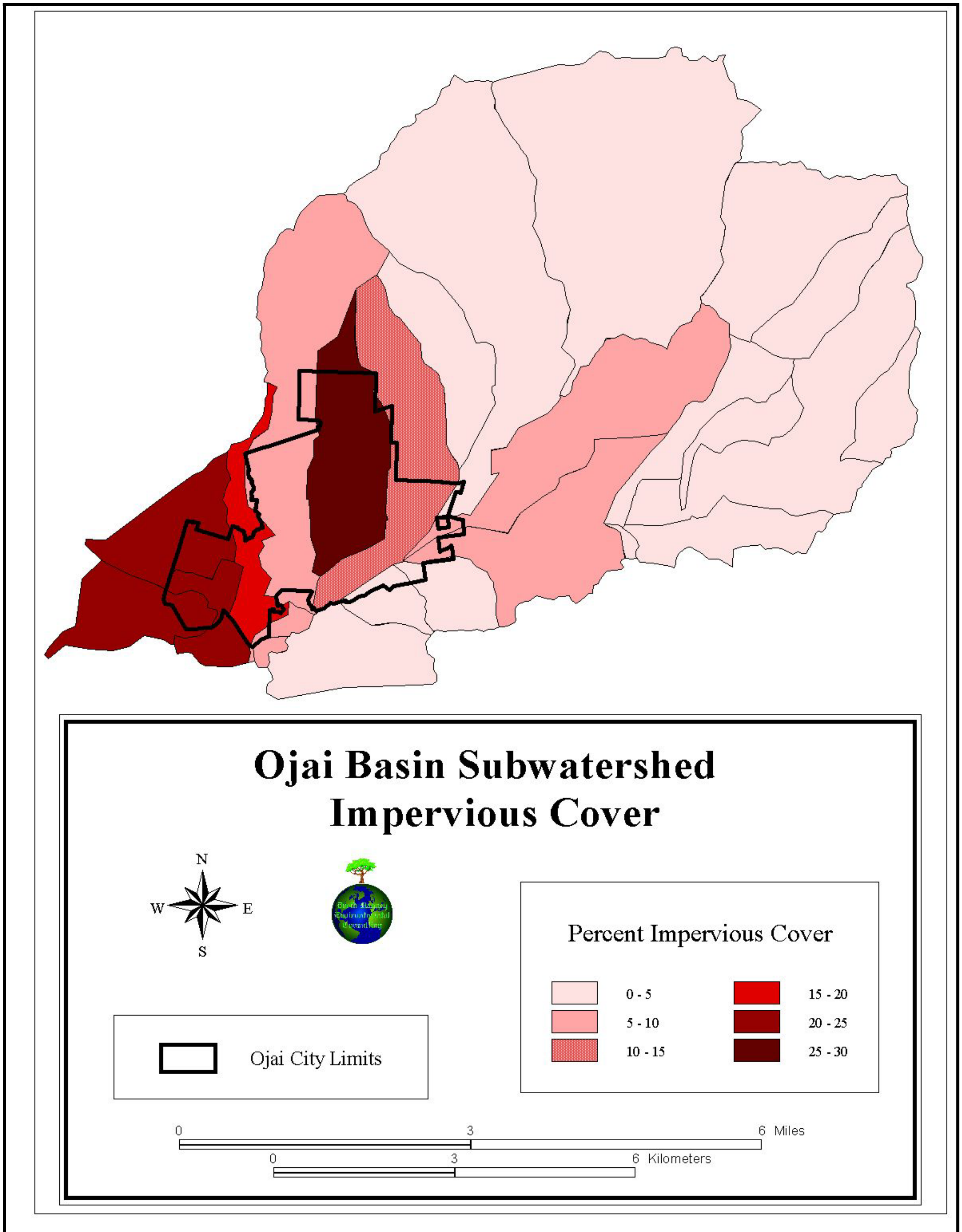


Table 26. Impervious Cover Lengths Summary for Creeks within the City of Ojai

Creek Name	Creek Lengths (feet)			
	Total Length	*Natural*	*Impervious*	*Compacted*
Arbolada Creek	5,759	5,533	225	0
Ayers Creek	10,197	1,022	5,511	3,664
Del Norte Creek	7,928	321	1,349	6,257
East End Creek	339	339	0	0
Fox Canyon Barranca	17,426	8,188	6,620	2,617
Grandview-Park Drain	4,160	0	4,161	0
Nordhoff Drainage	837	837	0	0
Oak Creek	1,720	1,720	0	0
Ojai Creek	8,018	2,681	4,227	1,110
Post Office Creek	1,036	1,036	0	0
San Antonio Creek	12,096	12,096	0	0
Soule Park Creek	1,561	1,561	0	0
West Soule Park Creek	1,305	1,305	0	0
Stewart Canyon Creek	9,003	4,062	4,941	0
Thacher Creek	2,445	2,445	0	0
Villanova Creek	3,078	1,701	50	1,327
Total Lengths	**86,905**	**44,847**	**27,083**	**14,975**

Table 27. Percent Impervious Cover Summary for Creeks within the City of Ojai

Creek Name	Percent of Creek		
	Natural	*Impervious*	*Compacted*
Arbolada Creek	96.1	3.9	0.0
Ayers Creek	10.0	54.0	35.9
Del Norte Creek	4.1	17.0	78.9
East End Creek	100.0	0.0	0.0
Fox Canyon Barranca	47.0	38.0	15.0
Grandview-Park Drain	0.0	100.0	0.0
Nordhoff Drainage	100.0	0.0	0.0
Oak Creek	100.0	0.0	0.0
Ojai Creek	33.4	52.7	13.8
Post Office Creek	100.0	0.0	0.0
San Antonio Creek	100.0	0.0	0.0
Soule Park Creek	100.0	0.0	0.0
West Soule Park Creek	100.0	0.0	0.0
Stewart Canyon Creek	45.1	54.9	0.0
Thacher Creek	100.0	0.0	0.0
Villanova Creek	55.3	1.6	43.1
Results:	**51.6** of the length of all Ojai Creeks consist of natural channel	**31.2** of the length of all Ojai Creeks consist of impervious channel	**17.2** of the length of all Ojai Creeks consist of compacted channel

Of the 16 creeks flowing through the City of Ojai, 51 distinct primary reaches were delineated. Table 28, Summary of Stream Reach Imperviousness for Creeks of the City of Ojai, indicates which creek reaches are above or below ground, and shows the general substrate, imperviousness, and length of each creek reach included in the Ojai city limits.

Table 28. Summary of Stream Reach Imperviousness for Creeks of the City of Ojai

Creek Name	Reach	Above or Below Ground	Most common Substrate	Imperviousness	Length (ft.)	Tributary Drains Into Reach
Arbolada Creek	1	Above	Natural	Natural	987.2	
	2	Below	Concrete pipe	Impervious	225.3	
	3	Above	Natural	Natural	4,546.0	
Ayers Creek	1	Above	Natural	Natural	228.8	
	2	Below	Culvert/pipe	Impervious	4,076.4	
	3	Above	Mixed compacted	Impervious	2,786.1	
	4	Above	Natural	Natural	511.3	
Tributary A	1	Above	Mixed compacted	Compacted	520.9	2
Tributary B	1	Above	Soil compacted	Compacted	2,073.0	3
Del Norte Creek	1	Above	Mixed compacted	Compacted	5,355.6	
	2	Above	Mixed compacted/natural	Compacted	1,034.8	
	3	Below	High-density polyethylene pipe	Impervious	898.9	
	4	Above	Natural	Natural	158.9	
Tributary A	1	Above	Lawn	Compacted	444.8	1
Tributary B	1	Above	Natural	Natural	34.8	1
East End Creek	1	Above	Natural	Natural	339.1	
Fox Canyon Barranca	1	Above	Natural	Natural	2,810.0	
	2	Above	Concrete channel	Impervious	3,407.4	
	3	Below	Concrete	Impervious	3,212.3	
	4	Above	Natural	Natural	4,540.6	
Tributary A	1	Above	Natural/mixed compacted	Compacted	2,470.7	3
Tributary B	1	Above	Natural	Natural	984.6	3
Grandview-Park Drain	1	Below	Reinforced concrete pipe	Impervious	1,180.1	
	2	Above	Concrete channel	Impervious	2,980.4	
Nordhoff Drain	1	Above	Natural	Natural	837.1	
Oak Creek	1	Above	Natural	Natural	1,719.7	
Ojai Creek	1	Above	Natural	Natural	1,955.2	
	2	Below	Reinforced concrete pipe	Impervious	813.0	
	3	Above	Mixed compacted	Compacted	786.4	
	4	Below	Pipe	Impervious	1,067.5	
	5	Above	Masonry channel	Impervious	1,668.4	
Tributary A	1	Above	Mixed compacted	Compacted	323.6	4
Tributary B	1	Below	Corrugated metal pipe	Impervious	204.4	4
	2	Above	Gutter	Impervious	474.0	4
	3	Above	Natural soil	Natural	562.3	4
Tributary A of Tributary B	1	Above	Natural soil	Natural	163.1	4

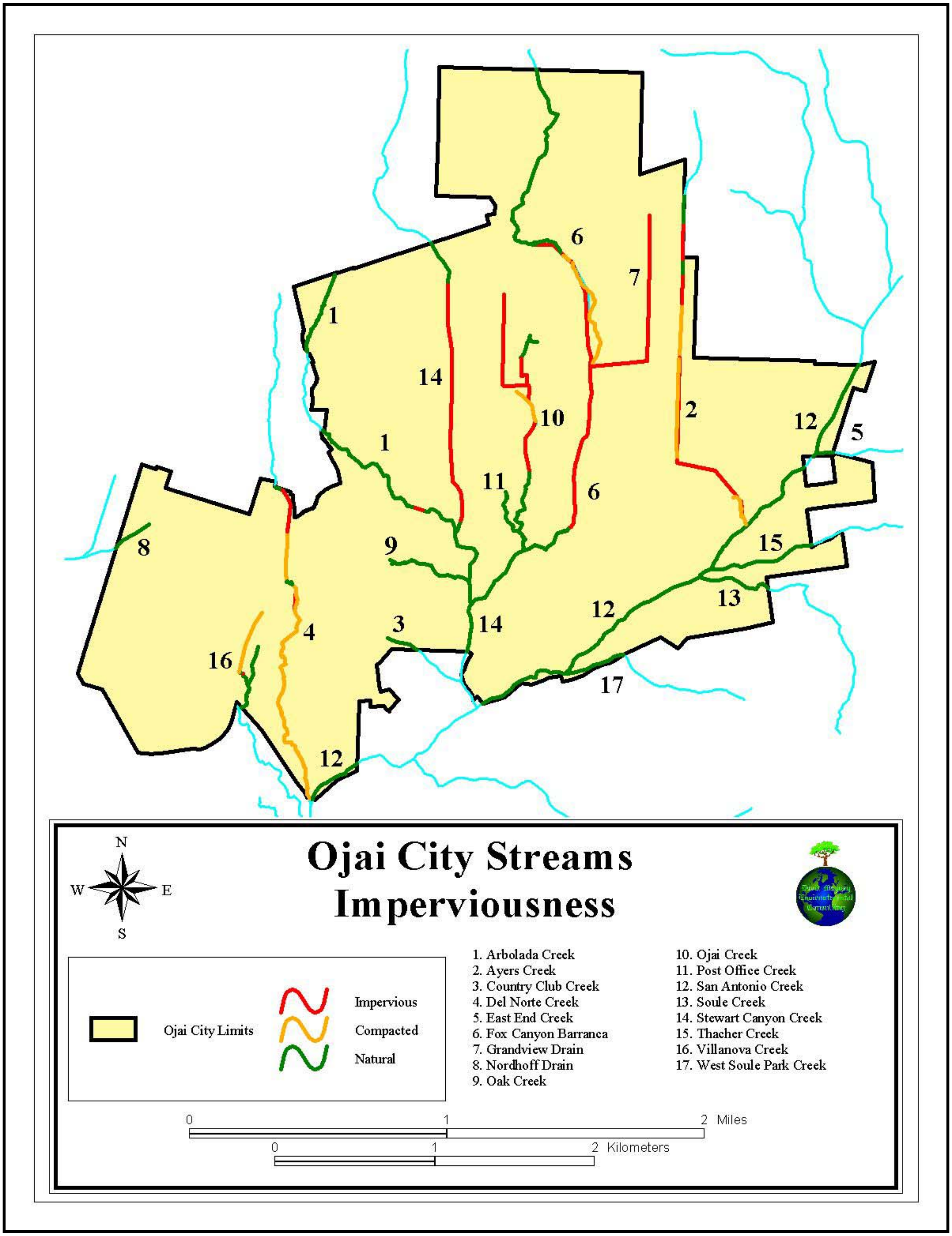
Table 28. Summary of Stream Reach Imperviousness for Creeks of City of Ojai (continued)

Creek Name	Reach	Above or Below Ground	Most common Substrate	Imperviousness	Length (ft.)	Tributary Drains Into Reach
Post Office Creek	1	Above	Natural	Natural	1,035.8	
San Antonio Creek	1	Above	Natural	Natural	1,226.7	
	2	Above	Natural	Natural	5,554.3	
	3	Above	Natural	Natural	5,314.5	
Soule Park Creek	1	Above	Natural	Natural	1,560.7	
West Soule Park Creek	1	Above	Natural	Natural	1,304.6	
Stewart Canyon Creek	1	Above	Natural	Natural	3,091.8	
	2	Above	Concrete channel	Impervious	718.7	
	3	Below	RCB	Impervious	2,554.4	
	4	Above	Cement channel	Impervious	1,468.1	
	5	Above	Natural	Natural	970.0	
Thacher Creek	1	Above	Natural	Natural	2,445.1	
Villanova Creek[19]	2	Above	Natural	Natural	816.1	
	3	Above	Compacted soil	Compacted	1,410.0	
Tributary B	1	Above	Natural	Natural	851.8	2

Photograph 46 *(left). Stewart Canyon Creek showing example of natural surface (5 January 2005).*
Photograph 47 *(right). Watershed drainage to Villanova Creek showing example of compacted surface (8 January 2005).*

[19] Villanova Creek Reach 1 and Tributary A are not listed here, since they are both outside of the City limits.

Figure 19. Map of Ojai City Streams Imperviousness



***Photograph 48**. Stewart Canyon Creek showing example of impervious surface (28 January 2005).*

BARRIERS/FACTORS CAUSING HABITAT DEGRADATION

Fish barriers are stream modifications and factors causing impact on fisheries resources and habitat degradation by:

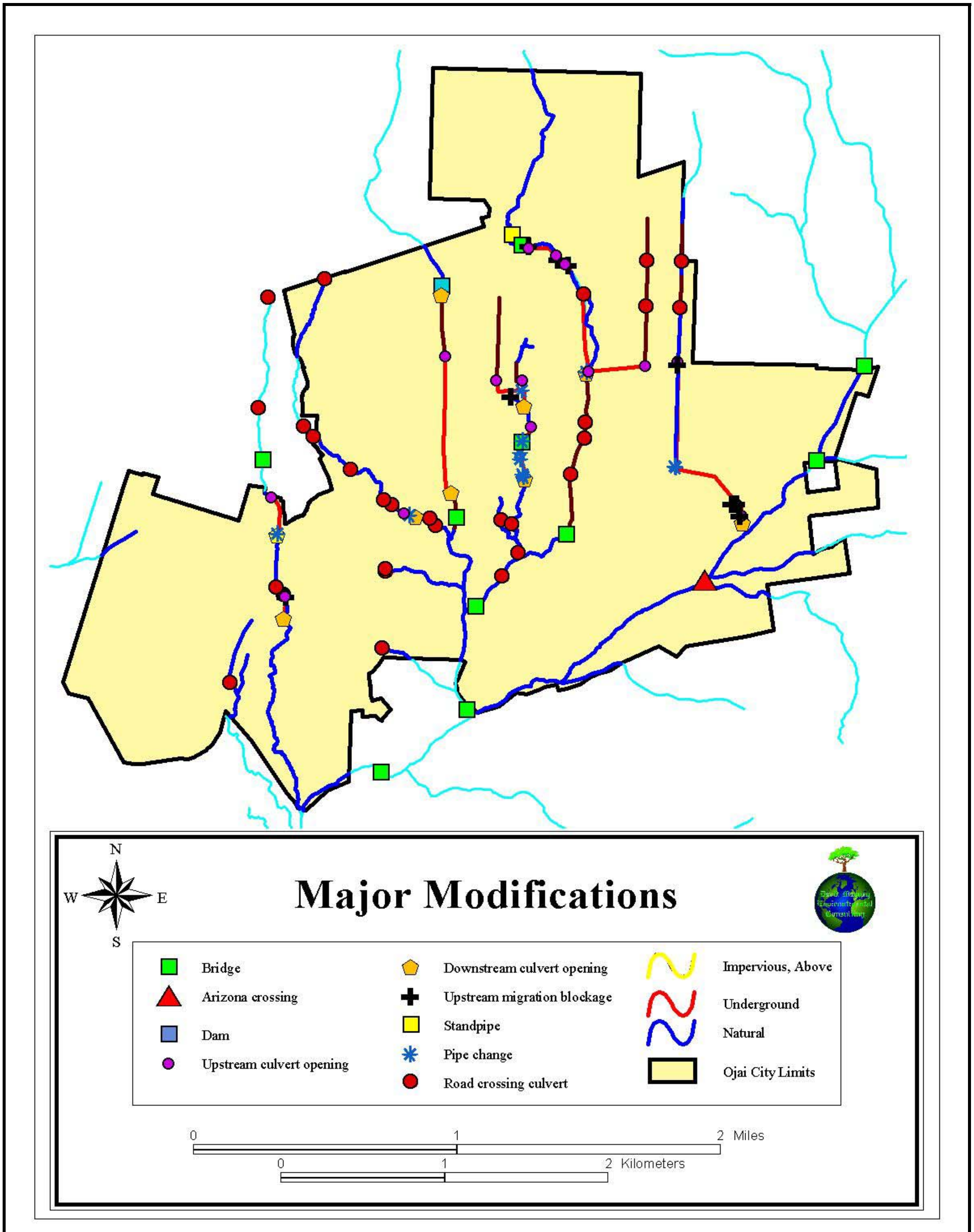
- Reducing the magnitude and duration of peak discharges;
- Reducing the duration and magnitude of between-storm-flows;
- Increasing the extent and duration of desiccation of stream sections; and
- Blocking or inhibiting the passage of adult Steelhead to historically important spawning and rearing habitat in the river's major tributaries. (Moore 1980b.)

Adult Steelhead can maintain a speed of 6.0 feet per second (ft/sec.) for 30 minutes and a burst speed of 10.0 ft/sec. for 5 seconds until they reach exhaustion. The maximum jump speed is stated as 12 ft/sec. and the depth of a pool below an obstruction that requires a jump should be 1.25 times greater than the jump height of the structure from the surface of the water (McEwan 2001, Abramson and Grimmer 2005). Modifications that create conditions that exceed these thresholds are considered barriers or limiting factors to Steelhead that cause habitat degradation.

San Antonio Creek Watershed Modifications

Significant barriers to Steelhead exist on all streams (except San Antonio Creek and Thacher Creek) flowing through Ojai. The major San Antonio Creek Watershed modifications include the barriers to fish passage and factors that cause habitat degradation and inhibit Steelhead spawning and rearing activities. Significant barriers to Steelhead exist on most streams flowing through Ojai, including stream channelization and impervious surfaces, undergrounded streams for significant lengths, road crossings (bridges and culverts), and other steep drops into streams associated with these crossings/channelizations. Figure 20, Major Modifications to the Streams of Ojai, maps out all public service infrastructure modifications, including channelizations, bridges, road-crossing and non-road culverts, pipe diameter changes, upstream migration blockages, and dams.

Figure 20. Major Modifications to the Streams of Ojai




Photograph 49 *(left)**.** Stewart Canyon Debris Basin empty during spring and summer months (27 May 2004).*
Photograph 50 *(right). Stewart Canyon Debris Basin filled after winter storm event (9 January 2005).*

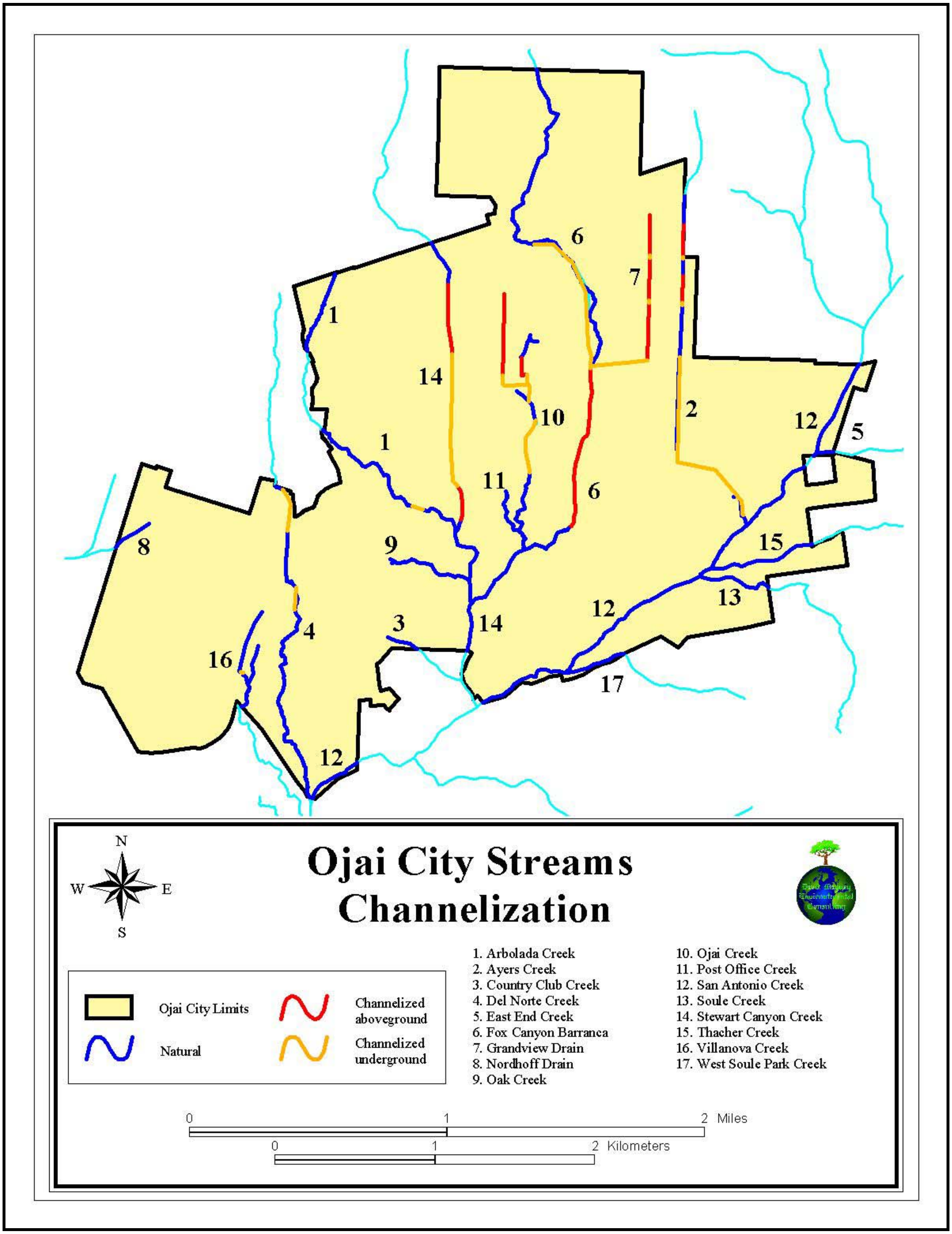

Photograph 51 *(left). San Antonio Creek Arizona Crossing at Soule Park Golf Course creating a major barrier to Steelhead (16 July 2004).* ***Photograph 52*** *(right). San Antonio Creek Arizona Crossing at Soule Park Golf Course was washed out and buried by sediment during significant winter storm (8 February 2005).*

Channelized Streams

Several creeks that flow through the City of Ojai are significantly channelized. Channelized creeks are defined here as modified channels that are now impervious, but are still above ground. Typically, these types of channels are modified into cement box channels that are designed to convey floodwaters. For example, Fox Canyon Barranca is channelized for most of its length through the City. This extensive channelized reach is approximately 3,407 feet long, consisting of vertical and flat concrete walls and bottom. Such a long stretch of channelization creates an effective barrier to fish passage and migration when a low-flow channel and channel roughness are lacking. The channelized portions of Fox Canyon Barranca and Stewart Canyon Creek both have smooth concrete bottoms. The following are creeks with significant channelization within the City (Figure 21, Ojai City Streams Aboveground and Underground Channelization):

Creek Name	Channelized (feet)
Fox Canyon Barranca	3,407
Grandview-Park Drain	2,892
Ojai Creek	2,142
Ayers Creek	1,350
Stewart Canyon Creek	719
Total:	**10,510**

Figure 21. Ojai City Streams Aboveground and Underground Channelization



***Photograph 53** (left). Stewart Canyon Creek showing aboveground flood control concrete channel (27 May 2004).*
***Photograph 54** (right). Fox Canyon Barranca showing meander pattern in concrete channel (9 January 2005).*

Undergrounded Streams

Several major Ojai creek runs have been directed underground as flood control channels due to development and urbanization. Examples of significant undergrounding include the following (Figure 21 above, and Figure 22, Map of Ojai City Non-road Culverts, below):

- Ayers Creek includes two primary undergrounded continuous runs (1,960 feet and 2,140 feet) from the pumping plant to Grandview;
- Del Norte Creek includes an 800-foot undergrounded run at the cemetery;
- Fox Canyon Barranca is undergrounded for 3,210 feet from Grandview up stream;
- Ojai Creek is undergrounded for 1,240 feet from Libbey Park to Aliso Drive, and for 1,070 feet from the Eucalyptus/Lyon intersection to the Grand/Signal intersection; and
- Stewart Canyon Creek includes an underground run for 2,750 feet from Highway 150 upstream.

Fish are not likely to migrate up Ayers, Del Norte, Fox Canyon, and Ojai Creeks since these creeks do not lead to a permanent source of water upstream; however, Stewart Canyon Creek leads to a permanent water source upstream where fish would potentially be able to live year round. Table 29, Undergrounded Streams Summary for Creeks within the City of Ojai, provides the lengths and percentages of above and below ground portions of all Ojai creeks.

***Photograph 55** (left). Undergrounding of Ojai Creek (27 May 2004). **Photograph 56** (right).*
Undergrounding of Stewart Canyon Creek by a flood control channel and box culvert (8 January 2005).

Figure 22. Map of Ojai City Non-road Culverts

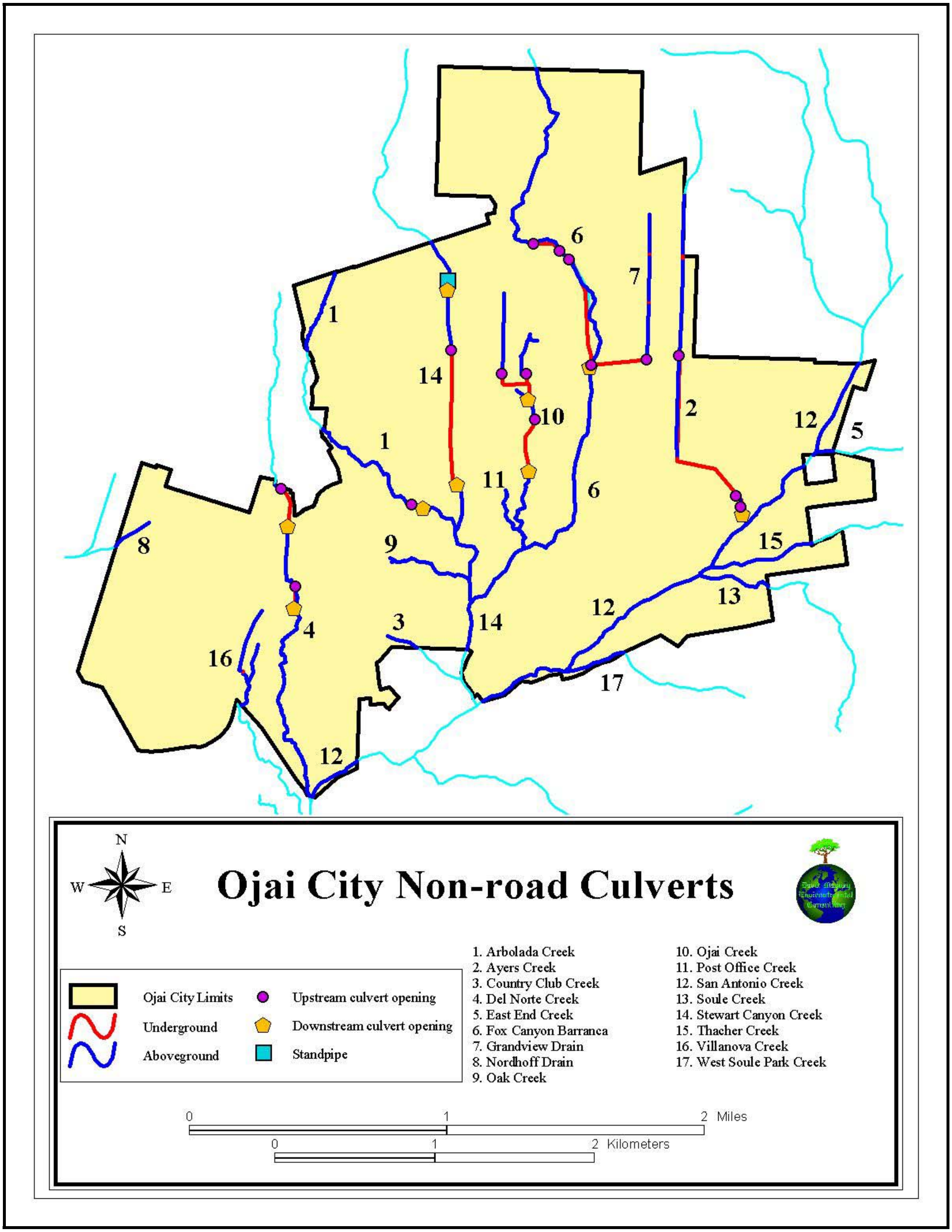
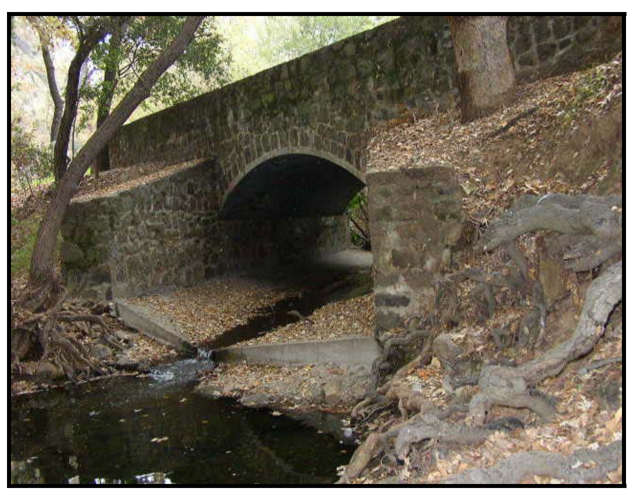


Table 29. Undergrounded Streams Summary for Creeks within the City of Ojai

Creek Name	*Total Length (in feet)*	*Above Ground*		*Below Ground*	
		Length (feet)	*Percent*	*Length (feet)*	*Percent*
Arbolada Creek	5,759	5,533	96.1	225	3.9
Ayers Creek	10,197	6,036	59.2	4,160	40.8
Del Norte Creek	7,928	6,579	83.0	1,349	17.0
East End Creek	339	340	100.0	0	0.0
Fox Canyon Barranca	17,426	14,213	81.6	3,212	18.4
Grandview-Park Drain	4,160	2,892	69.5	1,269	30.5
Nordhoff Drainage	837	837	100.0	0	0.0
Oak Creek	1,720	1,720	100.0	0	0.0
Ojai Creek	8,018	5,933	74.0	2,085	26.0
Post Office Creek	1,036	1,036	100.0	0	0.0
San Antonio Creek	12,096	12,096	100.0	0	0.0
Soule Park Creek	1,561	1,561	100.0	0	0.0
West Soule Park Creek	1,305	1,305	100.0	0	0.0
Stewart Canyon Creek	9,003	6,248	69.4	2,755	30.6
Thacher Creek	2,445	2,445	100.0	0	0.0
Villanova Creek	3,078	3,028	98.4	50	1.6
Results	**86,905**	**71,800**	**82.6** of the length of all Ojai Creeks	**15,105**	**17.4** of the length of all Ojai Creeks

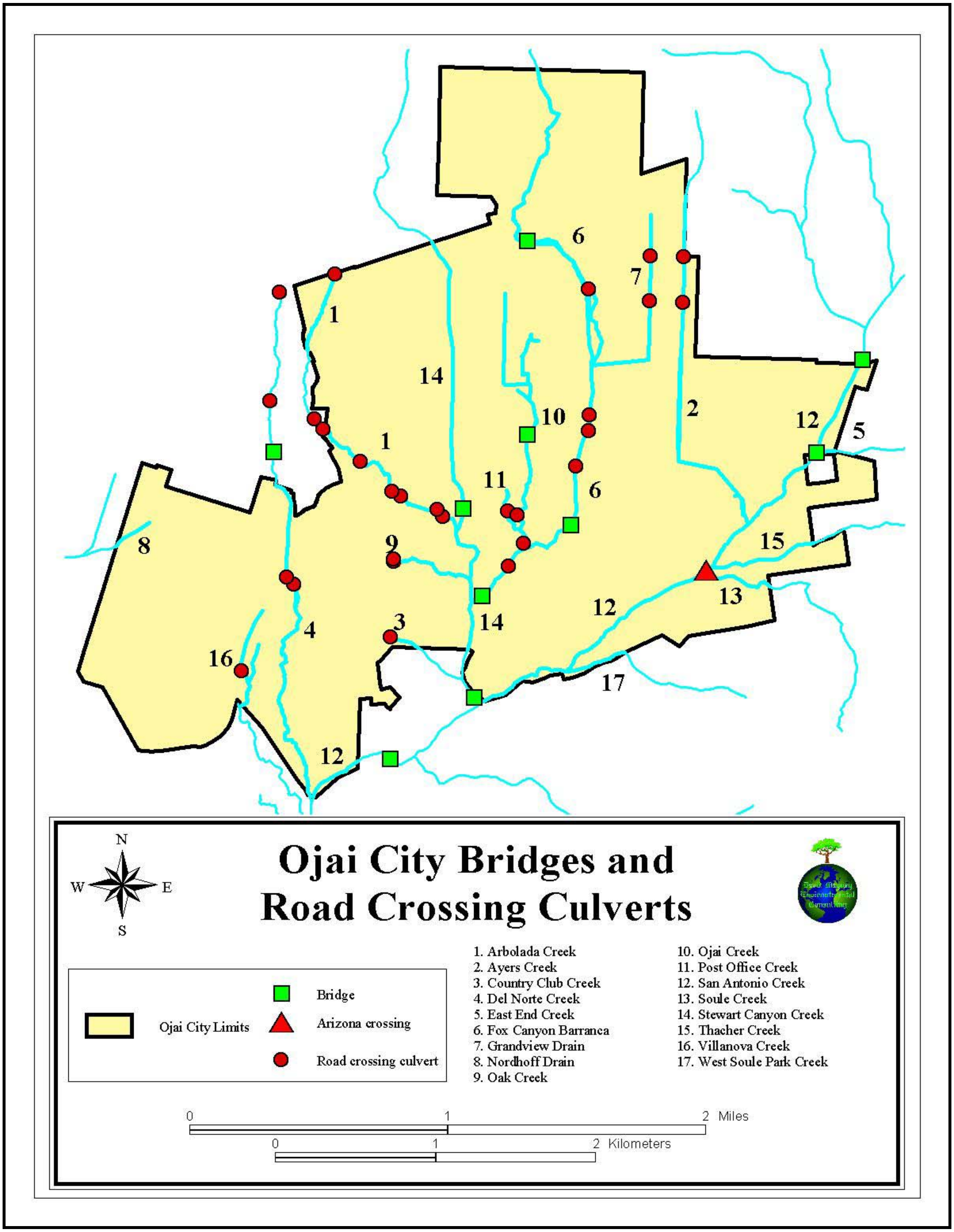
Bridges, Culverts, and Other Barriers

Based on the 1996 Existing Storm Drain System Drawing for the City of Ojai, the creeks within the City limits include six major bridge crossings with a mean length of approximately 93.33 feet and a total of approximately 560 feet of bridge crossings. Figure 23, Map of Ojai City Bridges and Road Crossing Culverts, shows the bridge locations in the City.



Photograph 57 *(left). Fox Canyon Barranca bridge with box culvert above N. Montgomery St. (27 May 2004).*
Photograph 58 *(right). Fox Canyon Barranca bridge with cement floor at North Ventura St. (27 November 2004).*

Figure 23. Map of Ojai City Bridges and Road Crossing Culverts



Based on the 1996 Existing Storm Drain System Drawing for the City of Ojai, the creeks within the City limits include 41 culvert crossings. Twenty-seven (27) of those culverts are road crossings with a mean length of 77.4 feet and totaling 14,440 feet of road crossing culverts (see Appendix C, Summary Table of Creek Obstructions). The remaining 14 culverts are underground runs with a mean length of 1,031.4 feet and a total of approximately 14,440 feet. Figure 22, Map of Ojai City Non-road Culverts, and Figure 23, Map of Ojai City Bridges and Road Crossing Culverts, show all culverts within the City.

Photograph 59 *(left). Fox Canyon Barranca underground intake (non-road) culvert, view downstream (27 May 2004).*
Photograph 60 *(right). Grandview-Park Drain road culvert (27 May 04).*

Some other barriers found throughout the City of Ojai include pipe diameter changes, upstream mitigation blockages, the Fox Canyon Barranca Debris Dam (Photograph 61), and Stewart Canyon Creek Debris Basin Standpipe (Photograph 62). These barriers are shown below in Figure 24, Map of Other Barriers in the City of Ojai.

Photograph 61 *(left). Fox Canyon Barranca Debris Dam (27 May 2004).*
Photograph 62 *(right). Stewart Canyon Creek Debris Basin Standpipe (27 May 2004).*

Figure 24. Map of Other Barriers in the City of Ojai