6 REDUCED SCIENCE OPTIONS

Chapter 6 provides information on the Reduced Science Options. Should NASA decide not to fund the Outrigger Telescopes Project at either the proposed Mauna Kea site, or at the alternative site in the Canary Islands, it may choose to implement a Reduced Science Option.

6.1 BACKGROUND AND PURPOSE AND NEED FOR THE REDUCED SCIENCE OPTIONS

6.1.1 Background

Of the four scientific objectives identified for the Outrigger Telescopes Project, three require the use of an 8 meter (m) (26 foot (ft)) or larger telescope. One objective, precision astrometry of nearby stars to search for planets, can be accomplished using only the Outrigger Telescopes. The astrometry survey is a key part of NASA's Origins Program and would complement the scientific results that other projects, such as the Space Interferometer Mission and the Terrestrial Planet Finder, will provide. NASA has investigated alternative site locations for the Outrigger Telescopes (four Outrigger Telescopes combined) to accomplish the astrometry program. Because location at an alternative site would accomplish only one of four scientific objectives, NASA considers this a *Reduced Science Option*.

6.1.2 Purpose and Need

Astrometry involves measuring the precise position of stars in the sky. A planet orbiting a star exerts a gravitational force on that star, causing it to sway slightly as the planet orbits. This is called the star's reflex motion. By measuring the precise position of the star, the astronomer can infer the presence of the planet from this reflex motion. The actual size of the motion is much smaller than the diameter of the star as seen from Earth. The larger the orbiting planet and the farther it is from the star, the larger the corresponding reflex motion. The period of the motion is equal to the orbital period of the planet.

For planets that are in orbits close to a star and whose orbital period is therefore relatively short (a few months to a few years), scientists can detect motion in a fairly short time. These planets in close orbits cause a relatively small reflex motion, requiring a measurement precision that can be achieved only from space, where the effects of the Earth's atmosphere are eliminated. The Space Interferometer Mission is designed to conduct a five-year astrometric survey of nearby stars for planetary companions, with an emphasis on terrestrial planets in relatively short-period orbits.

For planets with long orbital periods (*e.g.*, Saturn's 29-year orbital period), astronomers require a series of measurements over a long period to detect the corresponding reflex motion. Collecting these data would take longer than a single space mission; therefore, a ground-based observatory is the best location for obtaining data. In addition, if the system contains several planets of different masses and different orbits (as our own solar system), the corresponding motion of the star is very complex and would require additional years of measurement.

NASA needs the Outrigger Telescopes to obtain the data necessary to complete our understanding of the composition of planetary systems around nearby stars. It is envisaged that the Outrigger Telescopes would be required to collect data for at least 20 years to accomplish the survey for long-period planets.

6.2 SCREENING CRITERIA AND ALTERNATIVES

6.2.1 Reduced Science Options Site Screening

Because the astrometry science objective does not require a large telescope and can be accomplished with four Outrigger Telescopes, the combined telescopes can be placed in any location that has acceptable site-observing quality and adequate land. Generally, sites that already host observatories are good candidates, because they have good observing quality.

NASA identified six candidate sites for the Reduced Science Options. Five of the six sites already host or are scheduled to host an interferometer array of some type. The sixth site is home to the National Optical Astronomy Observatory (NOAO). The six reduced science sites are:

- Anderson Mesa, Arizona
- Mount Hopkins, Arizona
- Kitt Peak, Arizona
- Magdalena Ridge, New Mexico
- Palomar Mountain, California
- Mount Wilson, California.

The screening criteria were applied to each site and filtered through two tiers.

Tier 1 criteria address whether the Outrigger Telescopes can be built at a particular site as well as and the site's atmospheric observing quality. Tier 2 criteria address the practical difficulties or challenges of building the Outrigger Telescopes at that site.

6.2.1.1 Tier 1 Screening Criteria

Adequate Land for Four Outrigger Telescopes. The site must have adequate land to locate four Outrigger Telescopes and a beam-combining facility. It must support, at a minimum, two orthogonal (within +/- 15 degrees) baselines, approximately 100 m (328 ft) in length. The site must have unobscured views of the sky from each telescope within a zenith angle of 60 degrees. The beam-combining facility should be within the polygon defined by the locations of the Outrigger Telescopes. Otherwise, an additional building would be required to house a central hub, where a number of relay mirrors would be placed. All buildings, including the combiner facility, should be at the same elevation or altitude above sea level within approximately 6 m (20 ft).

Adequate Site Atmospheric Observing Quality. The site should have adequate atmospheric seeing conditions and good weather most nights, with no season of poor observing conditions. Sites are awarded points for seeing quality and clear nights, as shown in Table 6-1.

The maximum possible score for Tier 1 is 14 points. Sites scoring 6 points or higher in Tier 1 will be evaluated against Tier 2 criteria.

6.2.1.2 Tier 2 Screening Criteria

Technical Considerations. Sites that are deemed relatively straightforward to develop will be awarded an additional 4 points. Sites that are deemed difficult or challenging to develop (*e.g.*, sites with uneven topography), unfavorable local conditions, or other negative factors, will not be awarded additional points.

TABLE 6-1. TIER 1 SCREENING CRITERIA SCORING

Atmospheric Seeing Criterion (arcseconds)	Comments	Point Score Assigned
0.5” seeing	Full astrometric program capability.	10
0.5” – 0.75” seeing	Possible small impact to astrometric program.	8
0.75” – 1.0” seeing	Some degradation to astrometric program.	6
1.0” seeing	Moderate degradation to astrometric program.	4
1.0” – 1.5” seeing	Further degradation to astrometric program.	2
Not possible to predict accurately	Potential for poor seeing.	0
Clear Night Criterion	**Comments**	**Point Score**
Greater than 180 nights/year	Usable more than ½ the year.	4
Less than 180 nights/year	Usable less than ½ the year.	0

Programmatic Considerations. Because the astrometry program would be expected to involve operations every clear night of the year, proximity to the Jet Propulsion Laboratory (JPL) in Pasadena, California (which would develop the interferometer), and the Michelson Science Center at Caltech (which would operate the interferometer) is considered a practical advantage. Sites within 241 kilometers (km) (150 miles (mi)) of JPL will be awarded an additional 2 points.

The maximum possible score for Tier 2 is 6 points.

6.2.2 Reduced Science Site Descriptions and Screening Criteria Evaluations

6.2.2.1 Anderson Mesa, Arizona

Site Description. Anderson Mesa, located on the Colorado Plateau, approximately 16 km (10 mi) from Flagstaff, Arizona, is part of the Lowell Observatory in an area known as the Dark Site. The Dark Site is home to the Navy Prototype Optical Interferometer (NPOI) project, a joint venture between the U.S. Naval Observatory, the Naval Research Laboratory, and the Lowell Observatory.

Screening Criteria Evaluation. Anderson Mesa has adequate land to accommodate the Outrigger Telescopes.

Atmospheric seeing is estimated to fall in the range of 1.0 to 1.5 arcseconds (2 points). The site is reported to have good atmospheric seeing conditions on 60 percent of nights over the year (4 points).

Tier 1 Criteria (score = 6 points)

Anderson Mesa is a straightforward site for development with good access and relatively level terrain.

Tier 2 Criteria (score = 4 points)

6.2.2.2 Mount Hopkins, Arizona

Site Description. Mount Hopkins is in the Santa Rita Mountains within the Coronado National Forest in southeastern Arizona. The Smithsonian Astrophysical Observatory, a research bureau of the Smithsonian Institution, began development of the site in the 1960s. The site is home to several telescopes, including the 6.5-m (21-ft) MMT and the Infrared Optical Telescope Array.

Screening Criteria Evaluation. Mount Hopkins is a rugged mountain site characterized by steep slopes and sheer cliffs. The site could marginally accommodate the Outrigger Telescopes, with the removal of a hard granite knoll to provide level ground.

Atmospheric seeing is estimated to fall in the 1.0 arcseconds category (4 points). This site has acceptable weather and cloud cover (4 points).

Tier 1 Criteria (score = 8 points)

Mount Hopkins would be a relatively difficult site to develop. Road cuts and natural rock outcrops indicate the site has a minimal soil profile and a monolithic, fractured bedrock pattern. Removal or modification would require heavy equipment (*e.g.*, coring, air ram, blasting). A steep unpaved road, portions of which require radio communication between uphill and downhill traffic, provides the only access to the site.

Tier 2 Criteria (score = 0 points)

6.2.2.3 Kitt Peak, Arizona

Site Description. Kitt Peak National Observatory resides on land leased from the Tohono O'odham Tribal Nation. Located about 90-km (56-mi) southwest of Tucson, Arizona, Kitt Peak houses several telescopes, including the 4-m (13-ft) Mayall Telescope and the McMath-Pierce Solar Telescope (1.6 m (5.5 ft)). Kitt Peak also houses the 3.5-m (11-ft) telescope owned and operated by the WIYN Consortium, which consists of the University of Wisconsin, Indiana University, Yale University, and the NOAO.

Screening Criteria Evaluation. The summit area of Kitt Peak is densely developed with structures and access roads. Several possible sites for the Outrigger Telescopes were identified, most of which would require routing the various light paths across roads. Further, given the density of structure in the summit area, location of the Outrigger Telescopes would involve considerable risk of wake-induced turbulence from existing structures, as well as vibration caused by vehicle travel to other facilities. The site most suitable for development is at a slightly lower altitude, to the side of the main developed area, in a local depression. Atmospheric seeing data collected from observatories that occupy premium locations on the mountain could not be relied upon because the data is not likely to be representative of the most amenable site for the Outrigger Telescopes. Considerable risk would be involved in accepting such data without further testing at the site. For this reason this site is being classified with seeing as being "not possible to predict accurately" (0 points).

The average number of nights available for astronomical viewing is estimated at 255 per year (4 points).

Tier 1 Criteria (score = 4 points)

Kitt Peak did not proceed to Tier 2 criteria screening evaluation.

Tier 2 Criteria (no score)

6.2.2.4 Magdalena Ridge, New Mexico

Site Description. Magdalena Ridge, located near Socorro, New Mexico, on land leased by New Mexico Tech, is the site selected for development of the Magdalena Ridge Observatory Interferometer. The site is currently undeveloped except for the Langmuir Lightning Laboratory, an unoccupied balloon hanger, and the Joint Observatory for Comet Research.

Screening Criteria Evaluation. Ample land exists to locate the Outrigger Telescopes at Magdalena Ridge.

Very little atmospheric seeing data exists for this site, and significant risk would be incurred without additional testing. For this reason, the seeing is classified as "not possible to predict accurately" (0 points).

Magdalena Ridge experiences an average of 60 thunderstorms per year. A high percentage of cloud cover at the site means that more than half of the nights during the year would be unsuitable for observing.

Tier 1 Criteria (score = 0 points)

Magdalena Ridge did not proceed to Tier 2 criteria screening evaluation.

Tier 2 Criteria (score = 0 points)

6.2.2.5 Mount Wilson, California

Site Description. Mount Wilson, located in the San Gabriel Mountains overlooking Pasadena, California, is leased from the U.S. Department of Agriculture (USDA) by the Carnegie Institution of Washington and is managed by the Mount Wilson Institute. It houses the 254-centimeter (cm) (100-inch (in)) Hooker Telescope, the 152-cm (60-in) Hale Telescope, the CHARA Interferometer, and the Infrared Spatial Interferometer (ISI), among others. The site has been in use as an astronomical observatory since 1904.

Screening Criteria Evaluation. The observatory is heavily developed, but at least one location has been identified that could accommodate the Outrigger Telescopes.

Atmospheric seeing is estimated to fall in the 1.0 arcsecond category, with periods during the summer better than 1.0 arcseconds. Weather and cloud cover are not issues at this site (4 points).

Tier 1 Criteria (score = 8 points)

Mount Wilson would be reasonably straightforward to develop and is close to Pasadena. Tier 2 Criteria (score = 6 points)

6.2.2.6 Palomar Mountain, California

Site Description. Palomar Mountain, located in northern San Diego County, California, within the Cleveland National Forest, is owned and operated by Caltech and houses the 508-cm (200-in) Hale Telescope, the 102 cm (40-in) Oschin Telescope, and the Palomar Testbed Interferometer. The site has been in use as an astronomical observatory since the mid-1930s.

Screening Criteria Evaluation. Palomar Mountain has ample land to accommodate the Outrigger Telescopes.

Atmospheric seeing is estimated to fall in the range of 1.0 to 1.5 arcseconds (2 points). The site is reported to have 70 percent viewable nights over the year (4 points).

Tier 1 Criteria (score = 6 points)

Palomar Mountain is a straightforward site for implementation. Access is good and two potential locations have been identified for the Outrigger Telescopes. Palomar Mountain is approximately 177 km (110 mi) from JPL.

Tier 2 Criteria (score = 6 points)

6.2.2.7 Summary of Reduced Science Site Scoring

Tables 6-2, 6-3, and 6-4 summarize the final evaluations for the Reduced Science Option sites when filtered through the Tier 1 and 2 criteria.

TABLE 6-2. REDUCED SCIENCE OPTIONS TIER 1 CRITERIA SCORES

Site	Atmospheric Seeing Score	Clear Night Score	Total Tier 1 Criteria Score
Magdalena Ridge	0	0	0
Kitt Peak	0	4	4
Anderson Mesa	2	4	6
Palomar Mountain	2	4	6
Mount Hopkins	4	4	8
Mount Wilson	4	4	8

TABLE 6-3. REDUCED SCIENCE OPTIONS TIER 2 CRITERIA SCORES

Site	Technical Considerations Score	Programmatic Considerations Score	Total Tier 2 Criteria Score
Mount Hopkins	0	0	0
Anderson Mesa	4	0	4
Mount Wilson	4	2	6
Palomar Mountain	4	2	6

TABLE 6-4. REDUCED SCIENCE OPTIONS FINAL SCORES

Site	Tier 1 Criteria Score	Tier 2 Criteria Score	Final Point Score
Kitt Peak	4	---	---
Magdalena Ridge	0	---	---
Mount Hopkins	8	0	8
Anderson Mesa	6	4	10
Palomar Mountain	6	6	12
Mount Wilson	8	6	14

Among the six Reduced Science Options sites evaluated, Mount Wilson is ranked first, followed by Palomar Mountain, Anderson Mesa, and Mount Hopkins. Kitt Peak and Magdalena Ridge were not subjected to Tier 2 criteria because they lacked representative data on atmospheric seeing quality at the site where the Outrigger Telescopes would be placed.

The two sites selected for more detailed study are Mount Wilson and Palomar Mountain, both in California. Sections 6.3 and 6.4 address the on-site construction and installation of the Outrigger Telescopes at Mount Wilson and Palomar Mountain, respectively.

Most of the information in this chapter is extracted from the following documents:

- *Draft Environmental Impact Report for Palomar Mountain Subdivision*
- *A Supplement to the Environmental Impact Report for Palomar Mountain Subdivision*
- *Final Environmental Impact Statement for the Cleveland National Forest*
- *Draft Environmental Assessment for the CHARA Array Mount Wilson California*
- *Draft Southern California Land Management Plan Revisions*
- *Sea West Enterprises, Inc. Alternative Site Assessment Phase 1 and 2 Reports.*

6.3 MOUNT WILSON OBSERVATORY

6.3.1 Mount Wilson, California

The Mount Wilson Observatory (MWO) is located in the Angeles National Forest on top of Mount Wilson, northeast of Los Angeles. The site is approximately 38 hectares (ha) (95 acres (ac)). Carnegie Institute of Washington leases the site from the U.S. Department of Agriculture renewed the lease in 2003 for an additional 100 years. The lease "*provides for the land to be used as an astronomical observatory and authorizes the construction of additional structures consistent with this purpose.*"

Figure 6-1 illustrates the proposed layout for the Outrigger Telescopes on Mount Wilson.

6.3.1.1 Proposed Facilities

Telescope Piers and Light Pipes. See Section 2.1.2 for a detailed description of the Outrigger Telescopes facility. Each proposed telescope would be supported by a telescope instrument room acting as a telescope pier. The telescope room would house the mirrors that inject the starlight beams into the light pipes. These light pipes would bring starlight beams into the interferometer beam-combiner room. Depending on the topography of the site and the locations of the telescopes, the light pipes could be above or below grade. Also, depending on the details of the site, the locations of the telescopes, and the optical requirements for the starlight beams to maintain symmetry, light-beam junction boxes may be required to join multiple light pipes or change the direction the light beams.

6.3.1.2 On-site Construction and Installation of the Outrigger Telescopes at Mount Wilson

Schedule. Construction operations at the 1,737-m (5,700-ft) elevation in the San Gabriel Mountains can occur only nine to ten months of the year. Freezing and/or muddy conditions make the mountain roads impassable to large construction and delivery vehicles and the sites more susceptible to erosion and general degradation. Site grading and earthwork activities would require several months to complete; construction for this project would require about 24 months. As a result of both seasonal and unanticipated weather, this probably would require three building periods (spring, summer, and fall) for three consecutive calendar years.

Estimated Excavation. Construction of the Outrigger Telescopes Project would require building pad earthwork and preparation as well as foundation excavations for each of the four telescopes, each of the enclosures, approximately 40 light beam tube support structures, and the beam-combiner facility.

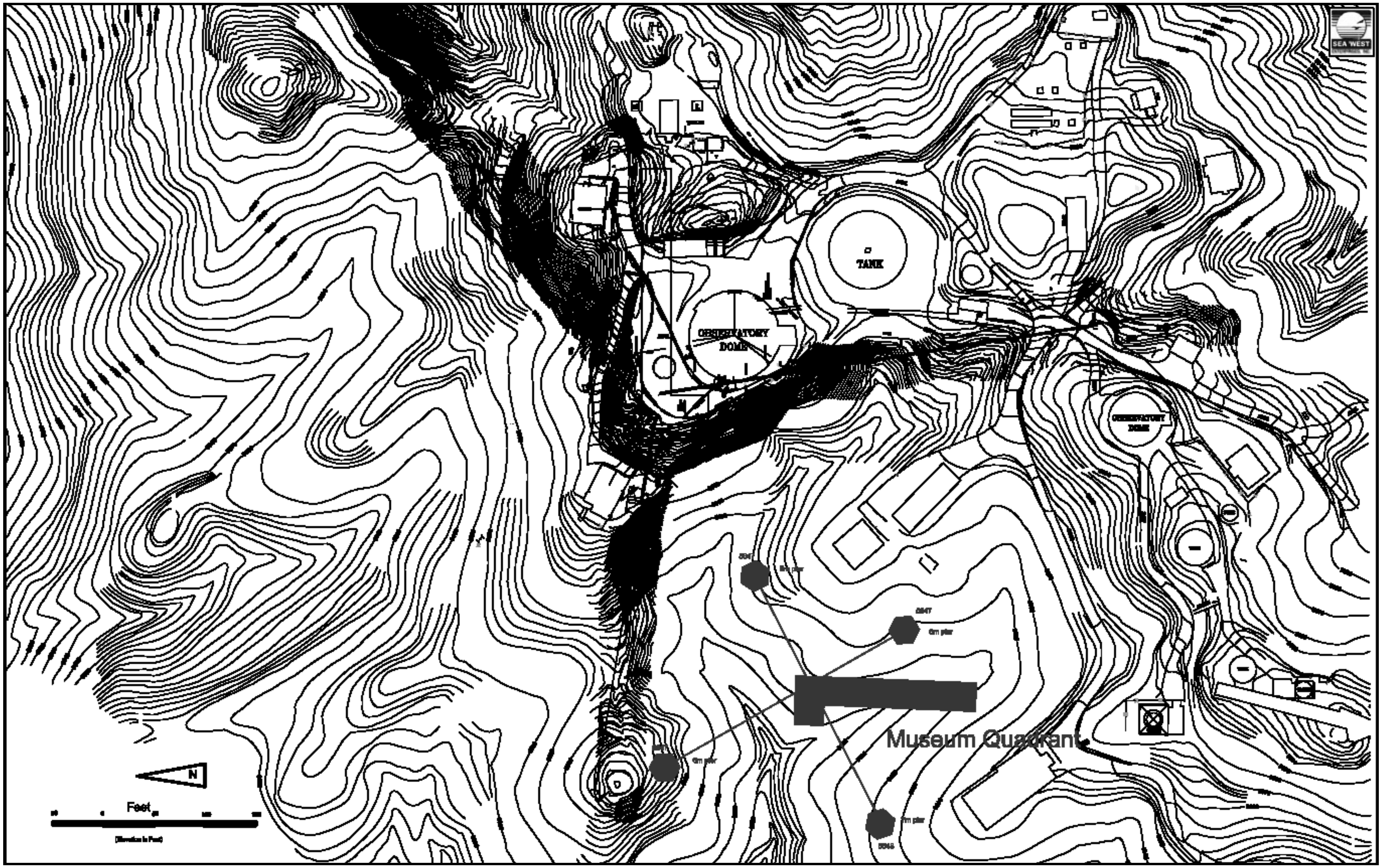


FIGURE 6-1. LAYOUT OF THE OUTRIGGER TELESCOPES AT MOUNT WILSON

The canyon terrain within the Museum Quadrant site would require a cut-and-fill operation involving more earthwork than a project of equal square footage on a level site. The pads for the four telescope buildings—approximately 93 square meters (m^2) (1,000 square feet (ft^2))—and the beam-combiner building—approximately 743 m^2 (8,000 ft^2)—would be about 1, 987 cubic meters (m^3) (2,600 cubic yards (yd^3). The Outrigger Telescopes Project would balance the amount of required cut or excavated material and the amount of required backfill to minimize the need to transport soils or aggregate to and from the site.

The foundation systems include the enclosure and combiner buildings, the large mass piers for the telescopes, inertia pads for the delay lines, optics tables, and combiner instrument stands within the combiner facility. The volume of earth excavated for these elements would be about 2,141 m^3 (2,800 yd^3).

The access trail needed to enter the site for construction activities would remain in use for the life of the Outrigger Telescopes Project. As such it would be designed to handle the traffic and loads anticipated as a part of the operations and maintenance of this facility over an extended period of time. Current designs include an access trail of about 244 m (800 ft) beginning west of the project site at a point of connection to the Observatory Road and diverging downslope to the Museum Quadrant site. Additionally, it would be necessary to implement access to each of the four telescope sites. One or more of these locations might be accessible via existing roads and trails within the observatory. All road cuts and fills would be designed so as to minimize the potential for erosion and concentrated runoff. Based on the current design criteria and configurations, it is estimated that approximately 1,070 m^3 (1,400 yd^3) of material would be involved in the excavation and earthwork operation for these access ways.

Grading Plans. The Outrigger Telescopes foundation would be set as close to the existing grade as possible using a balance cut-and-fill method to achieve an elevation for optimal interferometric measurements.

Each of the four telescope enclosures would sit on Mount Wilson between the 1,713 and 1,716 m (5,620 and 5,630 ft) AMSL contour. From a pad at or near this elevation, the piers would be constructed to allow for adjusting the final telescope mount elevations to create a planer array (at an elevation of about 1,721 m (5,647 ft) AMSL).

Foundations and Footings. Developing a four-aperture array within the museum quadrant at the MWO would require the delivery of up to 600 truckloads of concrete, sufficient for building both foundations/slabs interferometer inertia pads and telescope mounts. Delivery of premixed concrete to the observatory site would minimize the on-site water demand.

Installation of Telescopes and Dome Enclosures. The Outrigger Telescopes constructed within the museum quadrant at the MWO under the current design configuration would consist of four 1.8-m (6-ft) telescopes/enclosures arranged around a central combiner facility. The final collective footprint of the four telescope enclosures, light beam foundations, and combiner building would be approximately 1,300 m^2 (14,000 ft^2). The access trail (suitable for light vehicular traffic) would involve a terrain disturbance of approximately an additional 1,115 to 1,394 m^2 (12 to 15,000 ft^2) from the intersection with the existing observatory access road to the array site. The total project site would require approximately 1 ha (2.5 ac) of land to construct the telescope enclosures, the light-beam paths, access trails, and the beam-combiner building. It is anticipated that the necessary Outrigger Telescopes staging and laydown areas would be located within the 1-ha (2.5-ac) plot. In those cases where deliveries and or staging requirements require off-site holding, it is anticipated that the U.S. Forest Service (USFS) parking area to the west of the observatory could be used as a temporary staging area.

On-Site Construction Facilities/Equipment. The soil and rock types found within the MWO area consist, for the most part, of a range of soils from decomposed granite soils to chemically weathered granites and granodiorites. Excavation of these types of friable soil may be accomplished using conventional equipment. It is anticipated that all excavations would be completed without blasting or using special hardrock equipment. Rubber mounted backhoes, articulated loaders, track mounted excavators and drill rigs would likely be among the earth removal/moving equipment involved in this type for this earth-removal project. During the earthwork, transport vehicles, including 11,793-kilogram (kg) (26,000-gross pound vehicle weight (GVW)) bobtail trucks and 22.7-metric ton (mt) (25-ton) capacity truck and trailer combination rigs, to would be used for the transport, handling, disposal and delivery of soil and aggregate as required.

On-Site Construction Employment and Costs. The work force for the Outrigger Telescopes Project would vary from an average of 25 to 35 workers to up to 60 workers. Fifteen or fewer workers would be on site during the initial phases of work for site preparation and grading. The limited access, terrain, and staging areas require a project schedule that relies on consecutive rather than concurrent execution of activities. Throughout the concrete/foundation portions of the project and into the rough construction of the buildings and enclosures, the crew size will be restricted by the limited space for staging equipment and delivering material. Once the building "shells" are complete, it is possible that additional specialty contractors and technicians would increase the size of the project crew to 50 to 60 individuals for a short time. Final installation of building both facilities and telescope/delay line systems would require a smaller, focused effort and a substantially reduced project crew.

Construction Management. It is assumed that the contractor would follow an approved construction Best Management Practices Plan (BMP) during all on-site construction and installation activities and that the final BMP would be incorporated into the construction contract.

Construction Traffic. During construction of the Outrigger Telescope Project, it is anticipated that the average daily construction related vehicular trips (average daily trips (ADT)) may vary from 50 to 75 (work force size and equipment/material delivery dependent). At peak periods of activity the ADT could reasonably exceed 100 vehicles. This traffic volume would be much lighter than the 730 ADT for Red Box Road (the final 8 km (5 mi) of access way to the site) and the 3,400 ADT for the intersection of Highway 2 and Angeles Forest Highway to the high desert communities to the north.

It is anticipated that most of the construction work would occur during the dry months when road conditions are best. Most of the traffic to the site would occur before 7:00 a.m. during weekdays, before the start of commuter traffic from the Mojave Desert communities into Los Angeles. Traffic leaving the site would likely peak around 3:30 p.m., before the start of return commuter traffic. Commuter traffic along this highway would primarily flow in the opposite direction from construction vehicle traffic.

6.3.1.3 Operations of the Outrigger Telescopes at Mount Wilson

Employment and Economics. The current daily operational workforce level at the MWO averages from 12 to 14 individuals, including technicians, science team members, and facilities staff.

The Outrigger Telescopes would be both locally and remotely operated during its multiyear science mission. The primary on-site activities require a staff of trained individuals—a mechanical engineer, electrical engineer, optics specialist, software specialist, two technicians, and a supervisor. The resident science team would include two or three individuals, depending on the activity and programs underway. Based on current plans, the average workforce would be six staff per day.

Traffic. According to ADT counts conducted by the California Department of Transportation in 2002, current traffic along the Red Box Road access to the MWO is approximately 730 vehicles. The operation of the Outrigger Telescopes at the MWO would be expected to add 6 to 12 vehicular trips from the LA basin to this road and Highway 2.

Infrastructure and Utilities. All utilities, including water, power, communications, and sewage facilities, would be provided from existing Mount Wilson infrastructure.

Southern California Edison (SCE) currently supplies 14,000 kilowatts of electrical power to Mount Wilson, with a considerable portion of that wattage going to the neighboring broadcast antennae group. SCE is *attempting* to implement a three-phase plan beginning in 2004, to improve electrical service on the mountain.

The observatory has a fiber optic network within its boundaries linking many of its facilities; however, the telecommunications network beyond its periphery is limited to copper wire.

Maintenance. The ramp-up phase of the Outrigger Telescopes Project would primarily involve commissioning the interferometer. The staff would focus on calibration and integration activities associated with the telescopes: pointing and tracking tests, encoding enclosure domes, and generally establishing control systems to coordinate the simultaneous operation of the four telescopes, their domes, and the delay line systems. In parallel with these efforts, the staff would align delay line, meteorology, and beam-combiner systems in the main building. These activities require the collaborative participation of engineers and scientists to achieve "first light." Once the staff has completed initial testing and calibration of the interferometer, they would refine the instrumentation with further calibration and troubleshooting, possibly incorporating spectrographs, CCD cameras, and infrared equipment into the Outrigger Telescopes.

These activities would require personnel to move between the control room, combiner facility, and individual telescope locations to conduct necessary installations and testing. These activities would not require the use of heavy equipment or generate noise above normal levels associated with pedestrian traffic at the site and occasional vehicular arrivals and departures from the mountain. Once the ramp-up is completed, the level of activity around each telescope site and within the delay line/beam-combiner facility would decrease sharply because the interferometer would be operated by a high-speed data connection, from a remote site.

During the lifetime of the Outrigger Telescopes, ongoing activities would include scheduled equipment and facility maintenance, re-instrumentation and calibration, periodic optics recoating activities, and system monitoring.

During the operation of the Outrigger Telescopes, lubricants and mirror-care chemicals would be the only frequently used hazardous materials. No airborne pollutants would be associated with the operation of an optical interferometer.

6.3.2 Affected Environment of Mount Wilson

This section describes the existing environment in and around Mount Wilson and serves as a baseline from which to identify and evaluate environmental impacts of activities associated with the Reduced Science Options.

6.3.2.1 Land Use and Existing Activities

Land Use. Mount Wilson Institute (MWI) operates the Observatory, under agreement with the Carnegie Institution of Washington, since 1986. MWI's mission *"focuses on scientific research, historic preservation, astronomical education and public outreach"* (Mount Wilson 2003f).

The USFS Dark Sky Observations guidelines, as established in the 1987 Land Management Plan (Forest Plan), require sensitivity to light pollution, and mitigation of new lighting sources and electronic interference around existing observatories; coordination with an affected observatory regarding any planned activity that generates dust or smoke; and preparation of an environmental assessment before adding night skiing activities.

Construction of new facilities and infrastructure are subject to review and inspection by the County of Los Angeles Department of Public Works as part of the USFS-adopted approval process.

Existing Activities. The MWO complex includes the following major facilities for astronomy and astrophysical research: a 254-cm (100-in) telescope; a 152-cm (60-in) telescope; a 46-m (150-ft) solar tower; the Snow solar telescope; a 61-cm (24-in) telescope; a 18-m (60-ft) solar tower; the University of California Berkeley Interferometer; and the U.S. Naval Research Interferometer.

Lodging accommodations and support facilities available within the lease boundary include:

- Astronomical Museum
- Michelson 6-m (20-ft) Stellar Interferometer (display)
- Eleven residences
- The 14-room Monastery dorm
- Galley and restroom
- Vehicular storage and maintenance garage(s)
- Machine shop(s) and woodworking/ storage areas
- 151-kl (40,000-gal) potable water storage tank
- 1,900-kl (500,000-gal) fire suppression water tank.

The current MWO daily operational workforce averages from 12 to 14 individuals, including technicians, science team members, and facilities staff (Sea West Enterprises, Inc. 2004b).

The MWO hosts public tours and attracts tourists during the summer and for special events. The MWO is frequented by hikers, backpackers, and mountain bikers over the network of primitive forest trails that traverse the mountains. This area of the Angeles National Forest is also a popular film/camera location for both amateurs and major film companies. The Angeles National Forest offers additional opportunities for recreational users and tourists, including hiking, camping, fishing, picnicking, hunting and target shooting, and off-highway vehicle use.

The village of Mount Wilson, California, the site of several television and radio antennas that broadcast to the entire Los Angeles Basin, is located near the WMO.

6.3.2.2 Cultural Resources

Resource Definition. See Section 3.1.2.1 for cultural resource definitions.

Cultural Environment. The two cultural resources within an 0.8-km (0.5-mi) radius of the project area are: (1) remnants of the Mount Wilson Toll Road, and (2) remains of the Steil's/Martin's amp (NSF 1996).

"The Mount Wilson Toll Road played a crucial part in the Observatory's construction and early days, functioning as the main connecting road to the Observatory until the completion of the Angeles Crest Highway. Currently, the road is a fairly well maintained dirt road leading from the base of Mount Wilson (in the community of Altadena) to the radio towers at the crest and is still used by hikers and mountain bikers. There are seven sections of retaining wall south of Mount Wilson that appear to date to the road's original construction in 1907" (NSF 1996).

"Steil's/Martin's Camp originally consisted of a number structures and tents to provide accommodations for travelers/campers; however the site has been greatly disturbed and now only consists of several pads where the structures once stood" (NSF 1996).

A reconnaissance survey conducted in 1998 on the observatory grounds found no archaeological sites within the Mount Wilson ridge top system. However, on the basis of the geographical setting, water sources, plant, and animals that exist in the area, this report concluded that it probably contains prehistoric sites. It further stated that historic uses and Observatory construction had greatly altered the mountain surface. Any prehistoric cultural resources would have been destroyed, altered, or buried.

6.3.2.3 Biological Resources and Threatened and Endangered Species

Biological resources include the native and introduced plants and animals within the area potentially affected by the proposed activity.

Biological Resources. Mount Wilson is dominated by canyon live oak and sections of coniferous forest separated by shrubs and small clearings. The coniferous forest evergreens include primarily Coulter pine, Ponderosa pine, and big cone Douglas fir. The forest floor is generally covered with a duff of fallen and decomposing leaves with little or no vegetation except for some small grasses and herbs.

The Observatory area shrubs include scrub oak and Manzanita chaparral, deer brush, California buckwheat, Our Lord's Candle, and Spanish broom. Herbs and grasses in the area include beardtounge, California milkweed, eriastrum, and lupine. Three small flowering plants—the Rock Creek broomrape (*Orobanche valida* ssp. *valida*), Peirson's spring beauty (*Claytonia lanceolata*), and the Laguna Mountains jewel flower (*Streptanthus bernardinus*.)—are listed as sensitive and may potentially be found within the lease parcel, although they have never been documented in the Observatory area.

A variety of wildlife can be found in the Observatory area and throughout the Angeles National Forest, including mountain lion, black bear, mule deer, coyote, western gray squirrel, brush rabbit, lodgepole chipmunk, Merrian's chipmunk, badger, skunk, raccoon, pocket gopher, longtailed gopher, broadfooted mole, and various other rodents.

The Observatory area is also home to the following amphibians and reptiles and can be found in the Angeles National Park include but are not limited to the California newt, Monterey ensatina, black bellied slender salamander, Pacific slender salamander, arboreal salamander, sagebrush lizard, western fence lizard, western whiptail, gilberts and western skinks, and the southern alligator lizard.

Various snakes are also found in the area: common and California king snakes western and speckled rattlesnake, gopher snake, common garter snake, and night snake. The San Diego horned lizard is a Category 2 Federally protected reptile that potentially could inhabit the Observatory area, although there were no sightings of the lizard at or near the Observatory area during the CHARA Environmental Assessment biological survey (NSF 1996).

The northern spotted owl is prevalent throughout mountainous regions of western North America. At Mount Wilson, it potentially may nest in lower elevation canyons and forage in the Observatory area; however, to date, its presence at or near the Observatory has not been documented. The most recent biological survey evaluations for the MWO, including the Biological Evaluation for the Infrared Spatial Interferometer and for the Abbot Solar Tower site, did not identify any Federally listed or endangered species within the boundaries of the MWO (NSF 1996).

Bird species that have been observed or are expected to be present are listed in Table 6-5.

Threatened and Endangered Species. In 2003, Northrop Grumman conducted a biological evaluation/assessment of an area within the MWO complex. Table 6-6 identifies those threatened, endangered, or sensitive species that may occur in Angeles National Forest. A survey completed in 2003 found no threatened, endangered, or sensitive species on or near the MWO complex (Northrop Grumman 2003).

6.3.2.4 Hydrology, Water Quality, and Wastewater

Regulatory Framework. The State Water Resources Control Board (SWRCB) and the Regional Water Quality Control Board (RWQCB) administer the CWA and State water regulations in California. The Los Angeles RWQCB is the local agency responsible for the Mt. Wilson Observatory area. The RWQCB is responsible for management of the NPDES permits process for California. State regulations require a Waste Discharge Requirement for permitting discharge. A Report of Waste Discharge (RWD) is required for actions that would involve discharge of waste to surface and/or groundwater. The California Porter-Cologne Water Quality Act implements the NPDES program for the State (USAF 1998).

TABLE 6-5. BIRD SPECIES OBSERVED OR EXPECTED TO OCCUR ON MOUNT WILSON, CALIFORNIA

Scientific Name [1]	Common Name
Cathartes aura	Turkey Vulture
Haliaeetus leucocephalus	Bald Eagle
Accipiter striatus	Sharp-shinned Hawk
Accipiter cooperii	Cooper's Hawk
Buteo jamaicensis	Red-tailed Hawk
Aquila chrysaetos	Golden Eagle
Falco sparverius	American Kestrel
Falco columbarius	Merlin
Oreortyx pictus	Mountain Quail
Zenaida macroura	Mourning Dove
Columba fasciata	Band-Tailed Pigeon
Bubo virginianus	Great Horned Owl
Strix occidentalis	Spotted Owl
Otus flammeolus	Flammulated Owl
Glaucidum gnoma	Northern Pygmy Owl
Aegolius acadicus	Northern Saw-Whet Owl
Phalaenoptilus nuttallii	Common Poorwhill
Caprimulgus vociferous	Whip-Poor-Will
Chaetura vauxi	Vaux's Swift
Aeronautes saxatalis	White-throated Swift
Cypseloides niger	Black Swift
Calypte anna	Anna's Hummingbird
Selasphorus rufus	Rufous Hummingbird
Melanerpes formicivorus	Acorn Woodpecker
Sphyrapicus rubber	Red-breasted Sapsucker
Sphyrapicus thyroideus	Williamson's Sapsucker
Picoides albolarvatus	White-Headed Woodpecker
Picoides nuttallii	Nuttall's Woodpecker
Colaptes auratus	Northern Flicker
Melanerpes lewis	Lewis Woodpecker
Picoides villosus	Hairy Woodpecker

TABLE 6-5. BIRD SPECIES OBSERVED OR EXPECTED TO OCCUR ON MOUNT WILSON, CALIFORNIA (CONTINUED)

Scientific Name [1]	Common Name
Contopus borealis	Olive-sided Flycatcher
Contopus sordidulus	Western Wood-Pewee
Empidonax hammondii	Hammond’s Flycatcher
Empidonax oberholseri	Dusky Flycatcher
Empidonax wrightii	Gray Flycatcher
Myiarchus cinerascens	Ash-throated Flycatcher
Tachycineta thalassina	Violet-green Swallow
Stelgidopteryx serripennis	Northern Rough-winged Swallow
Hirundo pyrrhonota	Cliff Swallow
Aphelocoma coerulescens	Scrub Jay
Cyanocitta stelleri	Stellar’s Jay
Corvus brachyrhynchos	American Crow
Corvus corax	Common Raven
Parus inornatus	Plain Titmouse
Parus gambeli	Mountain Chickadee
Sitta Canadensis	Red-Breasted Nuthatch
Sitta carolinensis	White-Breasted Nuthatch
Sitta pygmaea	Pygmy Nuthatch
Certhia Americana	Brown Creeper
Regulus satrapa	Golden-Crowned Kinglet
Regulus calendula	Ruby-crowned Kinglet
Myadestes twonsendi	Townsend’s Solitaire
Sialia mexicana	Western Bluebird
Sialia currucoides	Mountain Bluebird
Catharus guttatus	Hermit Thrush
Turdus migratorius	American Robin
Vireo solitarius	Solitary Vireo

TABLE 6-5. BIRD SPECIES OBSERVED OR EXPECTED TO OCCUR ON MOUNT WILSON, CALIFORNIA (CONTINUED)

Scientific Name [1]	Common Name
Vermivora ruficapilla	Nashville Warbler
Dendrocia coronata	Yellow-rumped Warble
Dendrocia occidentalis	Hermit Warbler
Geothylypic tolmiei	MacGillivray's Warbler
Piranga ludoviciana	Western Tanager
Pheucticus melanocephalus	Black-headed Grosbeak
Pipilo chlorurus	Green-tailed Towhee
Spizella passerina	Chipping Sparrow
Chondestes grammacus	Lark Sparrow
Paserella iliaca	Fox Sparrow
Junco hyemalis	Dark-eyed Junco
Molothrus ater	Brown-headed Cowbird
Carduelis pinus	Pine Siskin
Carduelis psaltria	Lesser Goldfinch
Carduelis lawrencei	Lawrence's Goldfinch
Carpodacus purpureus	Purple Finch
Carpodacus purpureus	Cassin's Finch
Loxia curvirostra	Red Crossbill

Source: CHARA Array Mt. Wilson

[1] Nomenclature follows American Ornithologists' Union 1983. Checklist of North American Birds. 6th ed. American Ornithologists' Union, Baltimore, MD and American Ornithologists' Union. 1985. Thirty-fifth supplement to the American Ornithologists' Union Checklist of North American Birds. Auk 102:680-686.

Surface Water. Water runoff in the San Gabriel Mountains is rapid, and most of the streams are dry through the summer.

The Observatory is not located on a 100-year flood plain, nor are there any wild and scenic rivers at or near the Observatory.

Groundwater in the Mount Wilson Area. There are no designated sole-source aquifers at or near the proposed site. The closest sole-source aquifers are the Campo/Cottonwood Creek Aquifer located near the San Diego/Mexico border and the Fresno County Aquifer to the north.

Domestic Wastewater Collection, Treatment, and Disposal. On the mountain wastewater/effluent is treated through septic tank/leach field systems. In this system, waste flows into a septic tank where bacteria break down much of the solid components into a liquid form. The produced liquid is gradually displaced from the septic tank and flows to a leach field where it percolates into the mountain soil. As the liquid percolates, the soil filters out the biological components from the liquid and eventually only water and minor dissolve components remain. This water commingles with other groundwater and is available to wells further down-slope.

TABLE 6-6. FEDERALLY THREATENED, ENDANGERED OR SENSITVE SPECIES KNOWN IN THE ANGELES NATIONAL FOREST

Scientific Name	Common Name	Likelihood of Occurrences
	Plants	
Astragalus brauntonii	Braunton's milk-vetch	Unlikely to occur
Berberis nevinii	Nevin's barberry	Unlikely to occur
Dodecohema leptoceras	Slender-horned spineflower	Unlikely to occur
Rorippa gambellii	Gambel's watercress	Unlikely to occur
	Birds	
Empidonax traillii extimus	Southwestern willow flycatcher	Unlikely to occur
	Amphibians	
Bufo microscaphus californicus	Arroyo southwestern toad	Possible occurence
Federally Listed Threatened Species		
	Plants	
Brodiaea filifolia	Thread-leaved brodiaea	Unlikely to occur
	Birds	
Haliaeetus leucocephalus	Bald Eagle	**Unlikely to occur**
	Amphibians	
Rana aurora draytoni	California red-legged frog	**Unlikely to occur**
U.S. Forest Service Sensitive and Watch List Species		
	Plants	
Arenaria macradenia var. kuschei	Forest Camp sandwort	Unlikely to occur
Astragalus bicristatus	Crested milk-vetch	Unlikely to occur
Astragalus lentiginosus var. antonius	San Antonio milk-vetch	Unlikely to occur
Calochortus striatus	Alkali mariposa lily	Unlikely to occur
Calochortus palmeri var palmeri	Palmer's mariposa lily	Unlikely to occur
Calochortus plummerae	Plummer's mariposa lily	Unlikely to occur
Canbya candida	Pygmy poppy	Unlikely to occur
Castilleja gleasonii	Mount Gleason Indian Paintbrush	Unlikely to occur
Claytonia lanceolata var. peirsonii	Peirson's spring beauty	Unlikely to occur
Eriogonum kennedyi var. alpigenus	Southern alpine buckwheat	Unlikely to occur
Eriogonum microthecum var. johnstonii	Johnston's buckwheat	Unlikely to occur
Frasera neglecta	Pine swertia	Unlikely to occur
Galium grande	San Gabriel bedstraw	Unlikely to occur
Lilium parryi	Lemon lilly	Unlikely to occur
Linanthus concinnus	San Gabriel linanthus	Unlikely to occur

TABLE 6-6. FEDERALLY THREATENED, ENDANGERED OR SENSITVE SPECIES KNOWN IN THE ANGELES NATIONAL FOREST (CONTINUED)

Scientific Name	Common Name	Likelihood of Occurrences
Monardella macrantha ssp. Hallii	Hall's monardella	Unlikely to occur
Monardella viridis ssp. Saxicola	Rock monardella	Unlikely to occur
Opuntia basilaris var. brachyclada	Short-joint beavertail cactus	Unlikely to occur
Oorbanche valida ssp. Valida	Rock Creek broomrape	Unlikely to occur
Birds		
Accipiter gentiles	Northern goshawk	Unlikely to occur
Buteo swainsonii	Swainson's hawk	Unlikely to occur
Strix occidentalis ssp. Occidentalis	California spotted owl	Possible occurence
Reptiles		
Lichanura trivargata ssp. Roseofusca	Coastal rosy boa	Possible occurrence
Phrynosoma coronatus blainvillii	San Diego Horned Lizard	Possible occurrence
Mammals		
Perognathus alticola ssp. inexpectatus	Tehachapi pocket mouse	Unlikely to occur
Perognathus alticola ssp. alticolo	White-eared pocket mouse	Unlikely to occur

Source: Northrop Grumman 2003

Mount Wilson uses about 16.6 kl (4,400 gal) of water per week, and it is assumed that the resulting wastewater is disposed of through the septic system.

6.3.2.5 Solid Waste and Hazardous Materials Management

Potentially hazardous materials stored on the Observatory grounds include:

- Fifteen 1,900-kl (500-gal) propane tanks
- One oxygen/acetylene torch stored in the main observatory
- Carbon dioxide and helium gas canisters stored in the optical path building
- 11 l (3 gal) of paint stored in the machine shop
- Motor oil and hydraulic fluid stored in the machine shop
- Two 19-l (5-gal) gasoline cans stored in the carpenter shop
- Two 160-l (42-gal) liquid nitrogen tanks
- Two 208-l (55-gal) drums (one containing gasoline, one containing diesel fuel) stored in the tractor shed
- About 950-ml (1-qt) hydrochloric acid stored in the machine shop

The MWO recoats telescope optics on site. The facility has the capacity to handle all mirrors up to and including the large 254-cm (100 in) primary mirror for the Hooker Telescope. The process involves the acid etch removal of old reflective coatings and re-application of a molecular aluminum coating in a vacuum chamber. HCl is brought to the Observatory grounds as needed for mirror treatment.

Solid waste (*i.e.*, trash) is stored in two dumpsters that are emptied once a week by a contractor. Waste oil is stored in a 208-l (55-gal) drum on site and is taken down the mountain once a year to be recycled. The acid solution used for mirror coating removal is neutralized with lime or powered calcium carbonate and water prior to disposal.

The Mt. Wilson Observatory has an emergency action plan, which includes contact numbers for emergency situations. The Observatory staff is trained and drilled annually in first aid.

6.3.2.6 Geology, Soils, and Slope Stability

MWO is located in the San Gabriel Mountains within the Transverse Range Province. This range extends from the Santa Monica Mountains and offshore Channel Islands to the west through the San Bernardino Mountains to Yucca Valley in the east. Most of these mountains consist of Mesozoic granitic rock and pre-Cambrian anorthosite with some pre-Cretaceous shist. A majority of the Mount Wilson area consists of metamorphosed and weathered granodiorite.

The primary geomorphic processes are mass wasting and fluvial erosion. The Mount Wilson summit bedrock is overlain with decomposing coarse-sand size granitic soils. The depth of these in-place weathered soils varies from a few inches to several tens of feet. In most locations, contact between the surficial soils and the quartz diorite bedrock is gradational over several feet. Soils are mostly lithic and shallow Typic Xerorthents, shallow Entic Haploxerolls; and Calcic Haploxerolls, most of the soils are leached free of carbonates. The soils are well drained. Soil temperatures are mostly thermic, with some mesic on north-facing slopes at higher elevations. Soil moistures are xeric (Miles and Goudey 1997a).

The flanks of the MWO are steeply sloped; eroding rock faces to the northeast, east, and southeast. Along the northwest and southwest perimeters, the mountain supports substantial growths of live oak and scrub oak on slopes less steeply inclined and able to retain suitable soil profiles. Access to the site is via the roadway to the west that winds up to the mountain along the steep flanks of the north face before crossing to the top of the north-south trending ridge where the observatory sits.

6.3.2.7 Geologic Hazards

Seismic Activity. Earthquakes are a major hazard in California. See Section 3.1.7 for general information about earthquakes.

Although steep terrain and weathered rock outcrops characterize the area, it is stable geologically. The tectonically active San Andreas fault zone is to the north; Mount Wilson is located in Seismic Risk Zone 4, which corresponds to intensity VIII on the Modified Mercalli Scale (MM Scale) (NSF 1996). The Observatory site is not on top of any known fault or located within an Alquist-Priolo Earthquake Fault Zone. The closest mapped fault, the Lowe fault zone, is approximately 2.4 km (1.5 mi) from the site (Tsai and Carnegie 2001).

6.3.2.8 Transportation

Access to the Observatory is via Angeles Crest Highway (State Route-2), designated as a Scenic State Highway, to Mount Wilson Road, which ends on the Mount Wilson plateau and serves the Electronics Site and the MWO. Existing traffic volumes on Mount Wilson Road are very light. Access to the Mount Wilson plateau is controlled; visiting hours are limited. Vehicular traffic from the plateau to the MWO complex is further limited and controlled. Visitor parking is provided on the plateau, about one-half mile west of the

MWO. Parking within the MWO complex is provided only for MWO staff.

The ADT for traffic on the main roads connecting the MWO to the greater Los Angeles area are:

- On Interstate 210 at the East State Route-2 exit, the 2002 ADT was 115,000 vehicles.
  I-210 is a major highway that skirts the southern edge of the San Gabriel Mountains connecting Sylmar (in the northern San Fernando Valley) to I-15 in San Bernardino and carries a large volume of commuter and freight traffic.

- On State Route-2 at the I-210 junction, the 2002 ADT was 15,700 vehicles.

- At the State Route-2 and Angeles Forest Highway junction, the 2002 ADT was 3,400. Many residents of the Palmdale/Lancaster area (approximately 64 km (40 mi)) north of Mount Wilson) use the Angeles Forest Highway and State Route-2 as an alternative to commute to the greater Los Angeles area.

- At the State Route-2 and Mount Wilson Red Box Road junction, the 2002 ADT was 730 vehicles.

6.3.2.9 Utilities and Services

Water Supply. The MWO has its own wells for water supply. Three water tanks are located within the observatory site—1,892-kl (500,000-gal), 625-kl (165,000-gal) and 151-kl (40,000-gal) capacity tanks. The 1,892-kl (500,000-gal) water tank is stored on site for fire suppression and is located southeast of the 254-cm (100-in) telescope (Sea West Enterprises, Inc. 2004a).

Estimated water consumption for the mountain is 4.2 kl (1,100 gal) per day (Sea West Enterprises, Inc. 2004b). The MWO is totally dependent on the limited local groundwater resource for its water supply. The current potable water supply network, including source wells, storage tanks, and distribution systems, need renovation and repair (Sea West Enterprises, Inc. 2004b).

Electrical Power and Communications. SCE supplies the 14,000 kilowatts (kW) of power available on Mount Wilson, much of which is used by the neighboring Electronics site that broadcasts television and radio to the Los Angeles Basin. At this time, the capacity of the existing extended power grid from the foot of the mountain to the MWO, and adjacent broadcast facilities sites, is near, (or over), capacity (Sea West Enterprises, Inc. 2004a).

SCE is attempting to implement a three-phase plan to improve the electrical service on the mountain beginning the first phase this year. However, no schedules, timelines, or project start dates have been set as of this date. The plan would be subject to USFS approval (Sea West Enterprises, Inc. 2004a and 2004b).

Current telecommunication uses copper wire. Fiber optic connectivity is available approximately 1.6-km (1-mi) west of the site within the Electronics site. The MWO has a fiber network within its boundaries that links many of the existing facilities (Sea West Enterprises, Inc. 2004a).

Emergency Services and Fire Suppression

Emergency Services. An updated Emergency Services plan is available at the MWO.

Because Mount Wilson has no emergency medical facilities and the MWO is isolated and many miles from the nearest emergency medical service (EMS), the employees at the Observatory have the primary responsibility for first aid assistance. The plan recommends that each facility maintain a stock of emergency first aid supplies and that all employees have current first aid training and experience using available equipment. In addition, the plan recommends that each facility should establish regular first aid drills and test emergency and safety equipment.

The hospital nearest the Observatory is the Verdugo Hills Hospital in Glendale, approximately 31 km (19.5 mi) away. The Los Angeles County Sheriff's Department provides law enforcement through its Crescenta Valley Station. This station also is responsible for the communities of La Cañada Flintridge, La Crescenta, Montrose, Lake View Terrace, and much of the Angeles National Forest.

Fire Suppression. The MWO fire suppression equipment consists of widely available handheld fire extinguishers, dry chemical (A-B-C) types. Personnel are trained in their use. In addition, a 1,892-kl (500,000-gal) water tank, located southeast of the 254-cm (100-in) telescope, is stored on site for fire suppression (Sea West Enterprises, Inc. 2004a).

In addition, the USFS provides fire protection for the Mount Wilson area and the Angeles National Forest (NSF 1996).

6.3.2.10 Socioeconomics

The total population of Los Angeles County as of 2003 was 10,047,300 in a land area of 10,578 m^2 (4,084 mi^2) (including the Santa Catalina and San Clemente Islands). Demographics from 2000 data show the median household income in the county is $52,100 and the unemployment rate is 5.4 percent.

The closest community to Mount Wilson is the town of La Cañada Flintridge, approximately 31 km (19 mi) to the west/southwest of the Observatory. For the year 2000, La Cañada Flintridge had a population of 20,318, a median household income of $109,989, and an unemployment rate of 1.9 percent. There are no mountain communities in the near vicinity of the MWO. Mount Wilson has no public amenities—restaurants, stores, gas stations, or lodgings.

6.3.2.11 Climate/Meteorology/Air Quality

Climate/Meteorology. The MWO, located at 1,742 m (5,715 ft) above sea level, has a mean annual precipitation (mostly rain) of approximately 51 to 76 cm (20 to 30 in). The mean annual temperature varies between 7° and 16° C (45° and 60° F). The mean freeze-free period is approximately 200 to 275 days. Wind patterns run predominantly from west-southwest, especially in the spring through mid-fall.

Air Quality. Air quality at Mount Wilson is regulated by 40 CFR 50 (National Ambient Air Quality Standards (NAAQS)), 40 CFR 51 (Implementation Plans), 40 CFR 61 and 63 (National Emission Standards for Hazardous Air Pollutants (NESHAP)), and 40 CFR 70 (Operating Permits). Table 6-7 compares Federal and California regulatory standards.

Regulations. See Section 3.1.11.2 for an explanation of air standards. Table 6-8 compares the South Coast Air Basin (SCAB) air quality concentrations to the NAAQS and the California State Ambient Air Quality Standards (CAAQS) (PCR 2002).

Air Quality Monitoring. Air quality in California is assessed on a county and regional basis. The San Gabriel Wilderness Area, a Class I Air Quality area under the

TABLE 6-7. NATIONAL AND CALIFORNIA AMBIENT AIR QUALITY STANDARDS[ab]

Pollutant	Averaging Time	California Standards	NAAQS	
			Primary[a]	Secondary[b]
Ozone	8 Hour	No Standard	157 μg/m³ (0.08 ppm)	No Standard
	1 Hour	180 (0.09 ppm)	235 μg/m³ (0.12 ppm)	No Standard
Carbon Monoxide	8 Hour	10 mg/m³ (9.0 ppm)	10 mg/m³ (9.0 ppm)	No Standard
	1 Hour	23 mg/m³ (5.1 ppm)	40 mg/m³ (35 ppm)	No Standard
Nitrogen Dioxide	Annual (Arithmetic Mean)	No Standard	100 μg/m³ (0.05 ppm)	Same as Primary
Sulfur Dioxide	Annual Average	No Standard	80 μg/m³ (0.03 ppm)	No Standard
	24 Hour	105 μg/m³ (0.04 ppm)	365 μg/m³ (0.14 ppm)	No Standard
	3 Hour	No Standard	No Standard	1,300 μg/m³ (0.5 ppm)
	1 Hour	655 ug/m³ (0.25 ppm)	No Standard	No Standard
Particulate Matter (PM_{10})[c]	Annual (Arithmetic Mean)	30 μg/m³	50 μg/m³	Same as Primary
	24 Hour	50 μg/m³	150 μg/m³	Same as Primary
Particulate Matter ($PM_{2.5}$)[c]	Annual	12 μg/m³	15 μg/m³	No Standard
	24 Hour	No Standard	65 μg/m³	No Standard
Lead	Calendar Quarter	1.5 μg/m³	1.5 μg/m³	Same as Primary
Hydrogen Sulfide	1 Hour	42 μg/m³ (30 ppb)	No Standard	No Standard

a. Designated to protect the public health. Source: 40 CFR Part 50.

b. Designated to protect public welfare.

c. PM_{10} refers to particulate matter sized 10 microns or less. $PM_{2.5}$ refers to particulate matter sized 2.5 microns or less.

d. μg/m³ = micrograms per cubic meters

e. ppm = parts per million

f. ppb = parts per billion

TABLE 6-8. MAXIMUM CRITERIA POLLUTANT CONCENTRATIONS IN LOS ANGELES COUNTY, CALIFORNIA

Pollutant Averaging Time	State Standard	Federal Standard	Maximum Concentrations			
			ppm/µg/m³	% State Standard	% Federal Standard	Location
Ozone						
1-Hour	> 0.09 ppm	> 0.12 ppm	0.06	60%	48%	Several Locations
8-Hour		> 0.08 ppm	0.055		65%	Banning Airport
Carbon Monoxide						
8-Hour	> 9.0 ppm	> 9.0 ppm	8.40	92%	88%	South Central Los Angeles County
Nitrogen Dioxide						
1-Hour	> 0.25 ppm		0.10	38%		Southwest Coastal Los Angeles County
24-Hour			0.069			South San Gabriel Valley
Sulfur Dioxide						
1-Hour	> 0.25 ppm		0.02	8%		South Coastal Los Angeles County
24-Hour	> 0.04 ppm	> 0.14 ppm	0.010	24%	7%	North Coastal Orange County
Particulate (PM10)						
24-Hour	> 50 µg/m³	> 150 µg/m³	95	186%	63%	Metropolitan Riverside County
Particulate (PM 2.5)						
24-Hour		> 65 µg/m³	55.4		85%	South Coastal Los Angeles County
Sulfates						
24-Hour	>=25 µg/m³		4.7	19%		South Central Los Angeles County
Lead[a]						
30-Day			0.03	2%		Central Los Angeles
30-Day[a]	>=1.5 µg/m³		0.19	13%		Several Locations

Source: SCAQMD 2003

a. Maximum monthly average concentration recorded at special monitoring sites in the immediate vicinity of major lead sources.

Federal Clean Air Act, is approximately 4 km (2.5 mi) northwest of the Observatory. The closest sources of air pollutants are Scenic Highway 2–(Angeles Crest Highway) located approximately 4.8 km (3 mi) north of the Observatory lease land; lower elevation campgrounds located within 3 km (2 mi) of the Observatory lease land; and the greater Los Angeles urban area which starts approximately 6.4 km (4 mi) south of the Observatory lease land. Located in the SCAB, the Los Angeles urban area is a Class II Air Quality area under the Federal Clean Air Act.

Air quality in the SCAB is generally very poor and is one of the most heavily impacted in the nation. However, the Observatory lease land is located in a high-elevation rural area of the SCAB, and air quality at this elevation is generally expected to be better than in the nearby urban areas.

6.3.2.12 Noise

The MWO is located in an isolated, rural area with moderate daytime traffic and very light nighttime traffic. The major noise sources within the Observatory site are occasional motor vehicles traveling at low speeds, human conversations, animal sounds and occasional aircraft ascending out of the Los Angeles Basin on eastbound and northbound flight tracks. On-site mechanical noise includes heating and ventilation equipment, vacuum pumps, and small electric motors used to actuate the astronomy domes and telescopes.

The prevailing noise environment is not pristine due to the current development and level of activity on the Observatory grounds. The presence of a significant number of broadcast facilities within one-half mile of the site creates an environment outside the Observatory area with a significantly higher background noise level than that directly on site. Background noise levels within rural areas such as the Observatory typically range between 35 and 45 A-weighted decibels (dBA).

6.3.2.13 Visual/Aesthetics

MWO sits at an elevation of 1,742 m (5,715 ft) above sea level, along the southern flank of the San Gabriel Mountains. The southern boundary of the Observatory is clearly visible from many locations throughout the Los Angeles Basin and particularly within the San Gabriel Valley, the City of Pasadena, and the surrounding municipalities. The Observatory is also visible along many portions of the 210 freeway. This major southern California artery runs east-west along the southern foothills of the San Gabriel Mountains from San Bernardino County in the east to the northwestern corner of Los Angeles County near the Ventura County line in the west. The State of California has classified the section of this freeway between the Interstate 5 Freeway to the west to Interstate 134 east of La Cañada-Flintridge as an Eligible State Scenic Highway. The Angeles Crest Highway (SR-2), providing access to the Angeles National Forest and Mount Wilson, is classified as a State of California Officially Designated State Scenic Route (see Figure 6-2).

The location and elevation of the Observatory allow views of several of the more prominent structures within the complex by the population in the southern California urban areas.

The 254-cm and 152-cm (100-in and 60-in) telescopes, housed within large white domes set on asphalt pads surrounded by trees, are the most visible structures within the Observatory. These structures can be seen among the trees and their tops can be seen towering over the trees from many viewpoints within the Observatory. These are also the most visible structures from urban areas (NSF 1996).

The north-south-oriented Mount Wilson ridgeline is highly visible from regional viewpoints such as urban areas to the south and Angeles Crest Highway to the north. Individual Observatory facilities are visible from local areas such as Mount Wilson Road and on-site areas such as Skyline Park picnic area.

From a distance, Mount Wilson appears to be a natural landscape with little modification; however, its moderate to substantial modification is obvious onsite (NSF 1996).

6.3.3 Potential Environmental Impacts of the MWO Reduced Science Option

6.3.3.1 Land Use and Existing Activities

ROI for Land Use and Existing Activities. The ROI for assessing land use and existing activities includes the MWO, the Angeles National Forest, and the travel routes used by construction and operation vehicles.

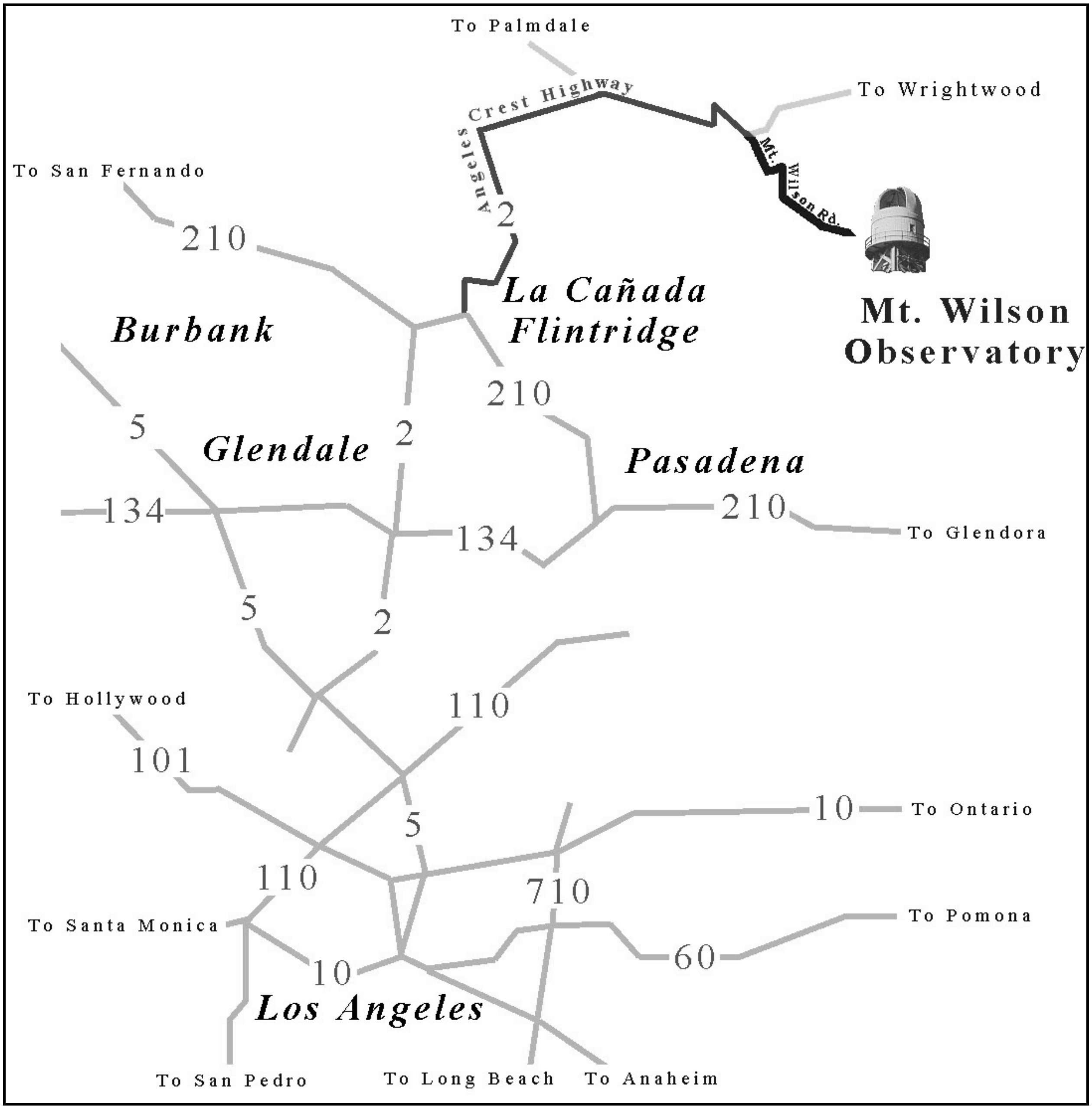


FIGURE 6-2. REGIONAL MAP OF MOUNT WILSON, CALIFORNIA

Land Use. *On-Site Construction and Installation Impacts.* The construction and installation of the Outrigger Telescopes at the MWO is consistent with the land use designation in the current lease that "*provides for the land to be used as an astronomical observatory and authorizes the construction of additional structures consistent with this purpose"* (NSF 1996).

Construction of the telescope enclosures, the light beam paths, access trails, and the beam combiner building would occur within the approximately 1-ha (8.5-ac) site. It is anticipated that the project staging and laydown areas would be located within the project site. If deliveries and/or staging areas must be off site, the USFS parking area to the west of the Observatory could be used as a temporary staging area.

Construction of the Outrigger Telescopes would be subject to review and inspection by the County of Los Angeles Department of Public Works as part of the USFS-adopted approval process. It is anticipated that there would be no land use impact associated with this phase of the Outrigger Telescopes Project.

Operation Impacts. The operation of the Outrigger Telescopes would be consistent with the current designated land use. There would be no land use impact associated with this phase of the Outrigger Telescopes Project.

Existing Activities. *On-Site Construction and Installation Impacts*. Activities associated with the on-site construction and installation of the Outrigger Telescopes Project would occasionally delay traffic along the Angeles Crest Highway (State Route-2) and Mount Wilson Road and temporarily increase noise levels. See sections related to transportation (Section 6.3.3.7) and noise (Section 6.3.3.12) impacts for additional information. It is also anticipated that the viewscape of the proposed site and construction staging areas at the MWO would be temporarily impacted by the presence of large construction equipment, materials, and telescope components. See Section 6.3.3.13 for more information regarding visual impacts.

Although some transportation, noise, and visual impacts would occur, it is anticipated that the Outrigger Telescopes Project would not result in a long-term conflict with or have a substantial impact on existing activities in the ROI. The ability to use the land within the ROI for astronomical and other scientific research, and a variety of recreational activities would remain consistent with the current use. In conclusion, all construction and installation activities on Mount Wilson would be conducted in a manner that would allow the surrounding area to remain accessible for all existing activities.

Operation Impacts. It is anticipated that operation of the Outrigger Telescopes would encompass both on-site and off-site activities. The primary on-site activities would require a crew of trained individuals, including a mechanical engineer, electrical engineer, optic specialist, software specialist, two technicians, and a supervisor. The resident science team would be two or three individuals, depending on the activity and programs underway. Based on current plans, the average daily workforce would be six people.

All telescope and facility operations associated with the Outrigger Telescopes Project would be conducted in a manner that would preserve access to the surrounding area for all existing activities. The only continuing impact of the Outrigger Telescopes operations on existing activities would be the visual presence of the telescope enclosures. Thus, the impacts associated with this project phase would be small.

Mitigation Measures. Refer to the following sections of this chapter for mitigation measures associated with transportation (Section 6.3.3.7), noise (Section 6.3.3.12), and visual impacts (Section 6.3.3.13).

6.3.3.2 Cultural Resources

ROI for Cultural Resources. The ROI for the proposed Outrigger Telescopes Project in the “Museum Quadrant” of Mount

Wilson is defined as the footprint of project facilities and any access roads, trails, and construction staging areas required for on-site construction and installation.

On-Site Construction and Installation Impacts. No previously recorded cultural resources were found within the ROI. Records in the South Central Coastal Information Center, University of California at Los Angeles, Institute of Archaeology, identified the following cultural resources within an 0.8-km (0.5-mi) radius of the project area:

"One multi-component site, CA-LAN-2343/H—Remnants of the Mount Wilson Toll Road, containing no artifacts but having both prehistoric and historic use histories. This site currently consists of a fairly well maintained dirt road leading from the base of Mount Wilson to the radio towers at the crest. In addition to the road, there are seven remaining sections of retaining walls south of Mount Harvard. Some of these are made of sandbagged concrete and appear to date to original road construction in 1907. According to ethnohistorians, the Mount Wilson Road was originally built up over an Old Native Californian trail that also ran to the crest of Mount Wilson" [NSF 1996)].

"One historic site, CA-LAN-2342/H—Remains of Steil's/Martin's camp has been subjected to a great deal of disturbance and currently consists of several pads where former structures and tents once stood. Steil's camp had been outfitted with tents in 1889 and 1890. Martin added a single story, L-shaped, frame dining room at the west side of the camp area, opposite the entrance of the trail from Eaton Canyon. Later its south wing was extended to the west over the edge of a dry masonry terrace wall" (NSF 1996).

An archaeological reconnaissance report conducted in 1998 on Observatory grounds indicated there were no known sites within the Mount Wilson ridge top system. However, on the basis of the geographical setting, water sources, plants, and animals that exist or were known to exist in the area, the report concluded that it was very likely that the area had a high probability of containing prehistoric sites. Further, the mountain surface had been altered greatly by historic uses and construction of the Observatory. Any prehistoric cultural resources would have been destroyed, altered, or buried.

On-site construction and installation are not likely to adversely impact any cultural or archaeological resources within the ROI. A cultural artifacts survey would be required by the USFS, as part of the approval process should the museum quadrant of the MWO be selected as the location for the Outrigger Telescopes Project.

Operation Impacts. Because the proposed site is within yards of the CHARA Array, the comments and conclusions presented in the 1996 Draft Environmental Assessment for the CHARA Array, Mount Wilson, California may also apply to archaeological, historical, and/or cultural resources at the current proposed museum quadrant site:

- The National Register of Historic Places lists no properties within a 0.8-km (0.5-mi) radius of the project area.
- There are no California Historic Landmarks within a 0.8-km (0.5-mi) radius of the project area.
- There are no California points of historic interest within a 0.8-km (0.5-mi) radius of the project area.

Operation of the Outrigger Telescopes at the museum quadrant site would not impact cultural and historic resources within the project area.

6.3.3.3 Biological Resources and Threatened and Endangered Species

ROI for Biological Resources. The ROI for assessing impacts to biological resources would be the Mount Wilson summit and any areas where construction and laydown activities would occur.

On-Site Construction and Installation Impacts. The most recent biological survey evaluations for the MWO, including the biological evaluation for the Infrared Spatial Interferometer and for the Abbot Solar Tower site, did not identify any Federally listed or endangered species within the boundaries of the MWO (Sea West Enterprises, Inc. 2004b). Within the proposed site for the Outrigger Telescopes, no critical habitat exists for any of the species identified in Section 6.3.2.3 (Northrop Grumman 2003).

The northern spotted owl is prevalent throughout mountainous regions of western North America. However, to date there is no documentation of its presence at or near the Observatory.

The Outrigger Telescopes Project would require the removal of trees in the immediate vicinity of the dome enclosures and combiner facility and along the access trail to the site.

Operation Impacts. No substantial biological impacts would occur as a result of operating the Outrigger Telescopes in the proposed project area.

6.3.3.4 Hydrology, Water Quality, and Wastewater

ROI for Hydrology, Water Quality, and Wastewater. The ROI for hydrology, water quality, and wastewater is defined as the Mount Wilson summit and any areas where construction laydown activities would occur.

Water Use and Wastewater Treatment and Disposal for Construction Workers. Separate work crews would be required to prepare the Mount Wilson site for installation and erection and testing of the Outrigger Telescopes and related components. The workforce would vary in size from between 25 and 35 workers to 50 to 60 workers during short-term peaks. The overall term of construction would be approximately 24 months, and it is assumed all workers would commute to the site daily (Sea West Enterprises, Inc. 2004b). Portable facilities would handle water supply and wastewater collection and disposal for construction workers. These portable facilities would be completely self-contained and serviced on a routine basis. As such, they would create no hydrologic or water quality impacts.

The requirement to wash down trucks, tools, forms, and equipment during concrete placement, however, could account for 38 to 76 kl (10,000 to 20,000 gal) of water during the construction period. If the contractor needs to mix concrete on site, the amount of water could substantially increase. Wash down basins and containers would be used to contain the wash water, which would be allowed to evaporate. The remaining solid residues would be disposed of off site (Sea West Enterprises, Inc. 2004b).

Surface Runoff from the MWO. On-site construction and installation of the Outrigger Telescopes would require the contractor to employ approved runoff and erosion controls. Impacts from surface runoff would likely be low and would continue through completion of construction. This small increase in runoff from impervious areas created by the Outrigger Telescopes at the MWO would likely be directed to existing drainage courses and would not result in increased soil erosion.

Subsurface Disposal of Domestic Wastewater. The problem with domestic wastewater that Mount Wilson faces - especially when considering the rapid growth of the broadcast facilities - is that at some point the rate of effluent injection into the mountain may become so great that it will not allow the soil to fully filter the wastewater before it reaches the down-slope wells. Determination of when this imbalance could occur would require extensive research and testing. In the long run, a pipe sewer system would seem to be the best option, but at this time there does not seem to be any set plans of action for upgrades. There is no quantitative analysis available at this time.

To evaluate wastewater increment added by implementing the Outrigger Telescopes, it is assumed that the volume of water trucked to the MWO approximates the volume of domestic wastewater generated. Based on available information, this figure is about 16.6 kl (4,400 gal) per week. It is estimated that operation of the Outrigger Telescopes Project would add about 9.5 kl per month (2,500 gal per month). This is the same amount of wastewater projected for operation of the Outrigger Telescopes on Mauna Kea and is used as an approximation for this evaluation. This would be a 57 percent increase in flow to the existing wastewater system at the MWO. Operation of the Outrigger Telescopes could potentially adversely impact wastewater operations of the MWO.

Mitigation Measures. The existing MWO septic system may need to be upgraded or an additional system installed to manage the additional wastewater generated by the Outrigger Telescopes operation.

6.3.3.5 Solid Waste and Hazardous Materials Management

ROI for Waste and Hazardous Materials. The ROI for waste and hazardous materials is defined as the Mount Wilson summit and any areas where construction laydown activities would occur.

<u>Solid Waste</u>. *On-Site Construction and Installation Impacts*. On-site construction activity would generate debris consisting of wood, scrap insulation, packaging material, concrete, and other construction-related wastes. This construction debris would be disposed of in large roll-off containers sized to accommodate debris generated over several days of construction. No other waste resulting from the construction process would be disposed of in these containers. Occasional high winds potentially could disperse construction debris, unsecured building materials, and equipment about the site and onto the surrounding area. Suitable containment would be used by the contractor to prevent this from occurring. With suitable attention from the construction contractor and enforcement by the Outrigger Telescopes Project construction manager, trash and debris should have little or no impact on the MWO site. The contractor would also be required to provide suitable containers for housekeeping trash (lunch wrappers, etc), and would be required to remove construction debris and trash from the site on a frequent and regular basis throughout

the construction period in accordance with best construction management.

*Operation Impacts***.** Operation of the Outrigger Telescopes would not substantially add to solid waste (trash) currently generated by the MWO.

As an approximation, it is assumed that the amount of trash generated by the additional personnel required to operate the Outrigger Telescopes would increase proportionately with the increase in staff and visitors. It is anticipated that operation of the Outrigger Telescopes would require additional daily average of four staff, an increase of about 7 percent over the current 13 staff and 45 daily visitors. It is assumed there would be no increased traffic to transport this small amount of additional solid waste away from the site for disposal.

Because the Outrigger Telescopes are designed as instruments without any habitable spaces, they would not involve any new trash containment systems. The existing infrastructure at the MWO would be used to collect trash resulting from operation of the Outrigger Telescopes.

*Mitigation Measures***.** It is assumed that the Outrigger Telescopes on-site construction and installation contract(s) would contain provisions regarding the management of solid wastes similar to those provided in Appendix F of this EIS.

Hazardous Materials Management. *On-Site Construction and Installation Impacts*. Diesel fuel and motor oil(s) for construction equipment are anticipated to make up the bulk of on-site hazardous materials during the construction effort for the Outrigger Telescopes. No mercury would be used for the Outrigger Telescopes (CARA 2001d). During the earthwork phase, it is anticipated that up to several hundred gallons of fuel for excavation equipment may be stored within skid-mounted or truck-mounted transfer tanks for short periods of time. Following adopted best management practices, all such fuels and oil would be provided with Material Safety Data Sheet (MSDS) information and warning labels. The storage of all hazardous liquids would be restricted to protected locations within the project site. Spill containment facilities would be provided for all such storage areas to avoid the potential contamination of soils in or around the construction zones. (Typically, such containment systems provide a capacity of 150 percent of all stored liquids). An adopted program of regular inspections of containers and reviews of handling procedures would ensure compliance. A program of spill containment and reporting would be submitted to the site authority prior to the delivery or offloading of any hazardous materials (Sea West Enterprises, Inc. 2004b). The handling guidelines and reporting procedures for other construction-related hazardous materials such as paints, solvents, and lubricants, would also follow best management practices.

Operation Impacts. Operation of the Outrigger Telescopes would require periodic maintenance activities similar to those associated with the MWO telescopes.

The Outrigger Telescopes would have few hazardous materials. The lubricants and cleaning solutions used to service and maintain the interferometer would be purchased and stored in limited quantities. MSDS information, and warning and handling data sheets will be on file at the Observatory, and storage would be in compliance with MWI and Los Angeles County Fire Department policy. The interferometer does not use internal combustion engines or turbines; therefore, the need for fuels and motor oils would be limited (primarily for the personal automobiles of the staff). It is anticipated that existing MWO maintenance equipment and vehicles would service this site. Operation of an optical interferometer does not generate airborne pollutants.

The optics surfaces for the telescopes and the light beam paths are most often composed of a molecular aluminum coating and as such degrade or oxidize over time. Based on historical evidence, it is anticipated that mirror-recoating operations would be necessary on a 1- or 2-year cycle. Hydrochloric acid (HCl) is used to clean the substrate. The quantity of acid required is limited (several gallons, diluted) and is delivered to the site on an as needed basis for scheduled cleaning/coating operations. Waste HCl is neutralized using a calcium carbonate powder. The MWO has conducted optics-coating operations on site and has both the cleaning facilities and vacuum chambers to accomplish these tasks. A small quantity, (typically about 950 ml (1 qt)) of HCl is stored at the observatory machine shop.

Chapter 4 describes other maintenance and operations activities for the Outrigger Telescopes. Table 6-9 compares current hazardous materials use at the MWO with the anticipated requirements of the Outrigger Telescopes Project.

For operation of the Outrigger Telescopes appropriate hazardous waste management and spill control plans would be developed in accordance with Federal and State regulations.

Mitigation Measures. It is assumed that all on-site construction and installation contract(s) would contain provisions regarding the management of hazardous materials similar to those described by Appendix F of this EIS.

6.3.3.6 Geology, Soils, and Slope Stability

ROI for Geology, Soils, and Slope Stability. The ROI for accessing the potential impacts from implementing the Outrigger Telescopes Project on geology, soils, and slope stability would the Mount Wilson summit and at any areas where construction staging and laydown activities would occur.

On-Site Construction and Installation Impacts. Installation of the access trail and pad development for the combiner building and the four telescope enclosures within the Museum Quadrant site would involve terrain modification.

Excavate of the types of friable earth found on the MWO site may be accomplished using conventional equipment. During construction of the CHARA Array on Mount Wilson, all excavations were completed without the aid of blasting or special hardrock equipment (NSF 1996). Rubber-mounted backhoes, articulated loaders, track-mounted excavators, and drill rigs would be used for earth removal in this project. During the earthwork, transport vehicles, including 26,000 GVW bobtail trucks, a 25-ton capacity truck, and trailer combination rigs would be used to transport, handle, dispose of, and deliver soil and aggregate, as required. Similar construction vehicles would be used for on-site construction and installation of the Outrigger Telescopes.

Under the current design configuration, the Outrigger Telescopes would consist of a set of four 1.8-m (6-ft) telescopes/enclosures arranged about a central combiner facility. The final collective footprints of the four telescope enclosures, light beam foundations, and the combiner building would be approximately 1,301 m^2 (14,000 ft^2). The access trail (suitable for light

TABLE 6-9. EFFECT OF OUTRIGGER TELESCOPES ON HAZARDOUS MATERIALS USE AT THE MOUNT WILSON OBSERVATORY

Material Class	Current Use at Mount Wilson Observatory	Anticipated Requirements of Outrigger Telescopes
Cooling	No glycol used	No glycol used
Fuel	Gasoline 208 l (55 gal), Diesel 208 l (55 gal), Propane 28 kl (7,400 gal)	No fuel required; emergency power provided by existing infrastructure
Hydraulic Fluid	In use 19 l (5 gal)	No hydraulic fluids used
Lubricants	Motor oil, in use	Gear oil 66 l (17-gal) for each Outrigger Telescope and grease used; no additional lubricants stored on site
Mercury	In use with 1.5 m (60 in) and 2.5 m (100 in) telescopes	No mercury used
Mirror De-coating & Re-coating	Hydrochloric acid 0.95 l (1 qt)	Up to four mirrors de-coated with hydrochloric acid every two years; no additional chemicals stored on site
Other Compressed Gases	Carbon dioxide, Helium, Nitrogen 160 l (42 gal), Oxygen/Acetylene	Carbon dioxide used for snow cleaning monthly; 8.6-kl (2,272 gal) bottle stored in each Outrigger Telescope
Paints & Related Solvents	Paint 11 l (3 gal)	Used as needed; no additional paint and solvents stored on site

Source: Sea West Enterprises, Inc. 2004b

vehicular traffic) would involve a terrain disturbance of an additional 1,115 to 1,394 m^2 (12,000 to 15,000 ft^2) from the point of connection with the existing Observatory access road to the Outrigger Telescopes site. Overall, the total project site of approximately 1 ha (2.5 ac) of land would include the telescope enclosures, the light beam paths, access trails, and the beam-combiner building locations. It is anticipated that necessary project staging and laydown areas would be located within the 1-ha (2.5-ac) plot. If deliveries and/or staging require off-site holding, it is anticipated that the USFS parking area to the west of the Observatory could be used as a temporary staging area.

It is anticipated that on-site construction and installation of the Outrigger Telescopes would not have a small impact on geology at the site. Site soils in unexcavated areas would be compacted by heavy machinery and other construction activities. This would be relieved at the end of the construction during final site clean-up and contouring.

Operation Impacts. There would be no geology, soils, or slope-stability impacts associated with operation of the Outrigger Telescopes within the Museum Quadrant site.

6.3.3.7 Transportation

ROI for Transportation. Transportation refers to the movement of vehicles along roads. The ROI for assessing transportation impacts includes the MWO and other areas affected by on-site construction, installation, and operations including the Angeles National Forest and vehicle travel routes.

On-Site Construction and Installation Impacts. The daily workforce anticipated for the construction and installation phase of the Outrigger Telescopes Project varies between an average of 25 to 35 workers and a peak of 60 workers (Sea West Enterprises, Inc. 2004b). During construction of the Outrigger Telescopes it is anticipated that the average daily construction related vehicular trips ADT would vary from 50 to 75 depending on the size of the workforce and the amount of equipment and material delivered. At peak periods of activity the ADT might exceed 100 vehicles. This traffic volume would be much lighter than 730 the ADT for Red Box Road —the final 8 km (5 mi) of access to the site— and the 3,400 ADT for the intersection of Highway 2 and the Angeles Forest Highway to the high desert communities to the north (Sea West Enterprises, Inc. 2004b).

Most of the construction work would occur during the dry months when road conditions are best. Most of the traffic to the site would occur before 7:00 a.m. during weekdays, before start of commuter traffic from the Mojave Desert communities into Los Angeles. Traffic leaving the site would likely peak around 3:30 p.m., before the start of return commuter traffic. The primary flow of commuter traffic along this highway would be opposite to the flow of construction vehicles (Sea West Enterprises, Inc. 2004b).

The access trail needed to enter the site for construction activities would remain in use for the life of the Outrigger Telescopes and would be designed to handle the traffic and loads anticipated as a part of the long-term operations and maintenance of this facility. Current design concepts include an access trail of about 244 m (800 ft) beginning west of the project site at a point of intersection to the MWO road and diverging downslope to the museum quadrant site. Additionally, each of the four telescope sites must be accessible. One or more of the four sites might be accessible by existing MWO roads and trails. Based on the current design criteria and configurations, it is estimated that approximately 1,070 m^3 (1,400 yd^3) of material would be excavated and moved for these access ways.

Vehicular traffic associated with construction and installation activities would occasionally delay traffic along the Angeles Crest Highway (State Route-2) and Mount Wilson Road, especially when the telescopes and domes are transported to the mountain. This would occur only intermittently and would not regularly interfere with normal traffic flow. Construction vehicles are slow and difficult to maneuver, but they would not have any long-term impact on the traffic flow.

Construction traffic within the ROI would create minor short-term increases in dust and emissions and temporarily increase noise levels. See Section 6.3.3.11 for impacts associated with air quality and Section 6.3.3.12 for information on noise impacts.

It is also anticipated that the current viewscape of the proposed site and construction staging areas at Mount Wilson would be temporarily impacted by the presence of large construction vehicles. See Section 6.1.13 for more information regarding visual impacts. Overall, short-term minor impacts would occur during this phase of the Outrigger Telescopes Project.

Transportation of minimal quantities of hazardous materials (*e.g.*, diesel fuel, motor oil(s), paints, and solvents) and wastes would be expected throughout the course of constructing, installing, and operating additional facilities on Mount Wilson.

Handling of these materials would be guided by best management practices. No impact is anticipated.

Operation Impacts. Operation of the Outrigger Telescopes at the MWO would add 6 to 12 vehicular trips per day along the Red Box Road access and Highway 2 from the Los Angeles Basin (Sea West Enterprises, Inc. 2004b). This slight increase in traffic associated with this project phase would create a very small impact on transportation.

Mitigation Measures. During the construction and installation phases of the Outrigger Telescopes Project, heavy truck trips will be scheduled during off-peak hours to avoid interfering with normal traffic flow along the Angeles Crest Highway (State Route-2) and Mount Wilson Road.

All road cuts and fills will be designed to minimize the potential for erosion and concentrated runoff.

6.3.3.8 Utilities and Services

ROI for Utilities and Services. The ROI for assessing utilities and services impacts of the Outrigger Telescopes Project includes the MWO, the Angeles National Forest, and vehicle travel routes used by construction and operation vehicles.

This section analyzes potential impacts on water supply, electrical supply and communications, and emergency services and fire suppression.

Water Supply**.** *On-Site Construction and Installation Impacts*. The Outrigger Telescopes Project would result in an increase in the demand for potable water due to the increased number of workers at the site and the implementation of dust controls. The construction contractor(s) would transport this additional water to the summit area. Therefore, there would be no impact on the existing water supply at the MWO.

Operation Impacts. Because of the limited amount of available potable water on site, a new well and storage tank may be required to accommodate the additional Outrigger Telescopes workers and the increased demand on firefighting water systems and supply.

Mitigation Measures. The Outrigger Telescopes project may need to consider installation of a new walk and storage system, and possibly importing water for at least part of operational needs.

Electrical Power and Communications.

On-Site Construction and Installation Impacts. On-site generators provided by the construction contractor would provide power needs. Only a minor increase in demand for electrical power on the existing distribution system would occur during this period. This increase would have no impact on the existing electrical supply system.

Operation Impacts. The electrical power requirement of each Outrigger Telescope is estimated to be 30 kW (UH IfA 2001a). At this time, the available 14,000 kW of power on Mount Wilson is near, or over, capacity and would not be able to accommodate the additional operation of all four Outrigger Telescopes. In addition, the existing communications system for MWO is limited to copper wire. In conclusion, the Outrigger Telescopes Project could have a substantial impact on the electrical and communications supply systems.

Mitigation Measures. Within the next year, the current electrical supplier, SCE, will attempt to implement a three-phase plan to improve electrical service on the mountain.

It may be possible to connect the fiber optic network that exists within the boundaries of the MWO with the local telecommunications facility at the neighboring antennae farm underground fiber optic connections.

<u>Emergency Services and Fire Suppression</u>

On-Site Construction and Installation Impacts. The need for emergency services is related to the number of personnel at the summit and the types of work or activities they perform. As described in Section 6.3.1.2, the workforce anticipated for this project varies from an average of between 25 to 35 workers and a peak of 60 workers.

The construction contractor would have the primary responsibility for ensuring worker safety. If an injury or accident occurs, the existing emergency service plan that applies to the MWO would be adequate to provide on-site treatment or evacuation off the summit. No additional equipment, personnel, or modification of emergency procedures would be required during on-site construction. There would be no impact associated with this phase of the Outrigger Telescopes Project.

Operation Impacts. As described in Section 6.3.1.3, based on current plans the average daily workforce would be six people. Existing emergency services and procedures would be adequate to accommodate this small increase in personnel. In addition, the Outrigger Telescopes Project would not require additional fire response capabilities by the USFS.

The Outrigger Telescopes would include fire alarm systems and suppression equipment. The additional personnel would follow established procedures and would be included in MWO fire drills and safety training. In conclusion, there would be no impact associated with this phase of the Outrigger Telescopes Project.

6.3.3.9 Socioeconomics

ROI for Socioeconomics. The ROI for assessing impacts to socioeconomics from implementation of the Outrigger Telescopes Project is the area at and near the MWO.

On-Site Construction and Installation Impacts. On-site construction and installation would generate about 25 to 35 construction jobs over the 24 month construction period, possibly peaking at 60 jobs. A number of these workers may come from nearby local communities which would have a moderate but beneficial impact on construction jobs in those areas for the 24 month construction periods. Some highly specialized workers needed to perform highly skilled activities during commissioning of the Outrigger Telescopes may originate from locations for removal from Mount Wilson. The local communities would be likely to benefit temporarily from even these jobs through worker expenditures for lodging and subsistence in those communities.

Operation Impacts. It is anticipated that the construction of the Outrigger Telescopes would not substantially impact the level of activity at the MWO and would have minimal long-term positive impacts on local/regional socioeconomics. Some of the 8 jobs created by operation may be filled locally. Some operation workers may also move into the local area purchasing or renting homes establishing themselves and their immediate families in the local communities.

Mitigation Measures. Given the relatively limited workforce involved in construction and operation, no socioeconomic mitigation measures would be necessary.

6.3.3.10 Air Quality

ROI for Air Quality. During the construction of the CHARA Array on Mount Wilson, all excavations were completed without the aid of blasting or special hardrock equipment. Rubber-mounted backhoes, articulated loaders, track-mounted excavators, and drill rigs would likely be among the earth removal/moving equipment involved in the Outrigger Telescopes Project.

On-Site Construction and Installation Impacts. The proposed project site would be located in a high-elevation rural area where there is no monitoring of air pollutants but the air is substantially better than in adjacent urban areas to the west of the proposed site. No major sources of air pollutants would be located in the vicinity of the proposed site; the closest sources of air pollutants are Angeles Crest Highway, about 4.8 km (3 mi) to the north, the Los Angeles urban area, about 6.4 km (4 mi) to the south, and campgrounds at lower elevations within 3.2 km (2 mi). The proposed site is about 4 km (2.5 mi) to the southwest of the San Gabriel Wilderness Area, the Class I Air Quality area closest to the proposed site.

The project would comply with State and Federal air quality standards and regulations. Truck and worker trips to the site during on-site construction and installation would not add appreciably to the existing traffic levels or to vehicle emissions on Mount Wilson Road.

Excavation for building and pipe support footings and trenching for conduit sections would not exceed particulate standards, because the disturbance would be small, and to suppress dust emissions and control exhaust emission from construction machinery standard best management practices would be used. For example, if high wind conditions are present, best practices could include wetting down the disturbed area to contain fugitive dust.

The workforce anticipated for this project varies from between 25 to 35 workers and a peak of 60 workers (Sea West Enterprises, Inc. 2004b). Additional traffic to the Observatory would add to vehicle emissions, but resulting in little impact on existing air quality. Small impact on ambient air quality would be expected.

Operation Impacts. Air quality at Mount Wilson would return virtually to existing conditions once the Outrigger Telescopes are installed. A slight increase in vehicular traffic and emissions would be associated with scientists traveling to the project site. Overall air quality at Mount Wilson is good; the Outrigger Telescopes operation would not change these conditions.

The project would not include any point sources of air pollutant emissions, and staff and visitors to the facility would generate few additional vehicle trips, so project operations would have no impact on existing air quality.

Mitigation Measures. The construction contractor(s) would be required to institute appropriate dust control measures and abide by applicable vehicular emissions standards.

6.3.3.11 Noise

ROI for Noise Impacts. The ROI for assessing noise impacts from the Outrigger Telescopes Project includes the MWO and other areas affected by on-site construction, installation, and operations including the Angeles National Forest and vehicle travel routes.

On-Site Construction and Installation Impacts. Noise would result from excavation, trenching, grading, installation of sheet piling for utility protection, installation of junction boxes, construction of light and air pipes, construction of telescope dome foundations, and installation of telescopes and domes.

Noise levels would depend on the mix and duration of construction equipment use and construction methods. The vibrating hammer, used to install the sheet piling required for utility protection, would most likely be the loudest piece of equipment used during construction (approximately 95 dBA at 15 m (50 ft)). Use of this equipment likely would be short term, lasting 1 or 2 days. Blasting would not occur during the construction process. Rubber-mounted backhoes, articulated loaders, track-mounted excavators, and drill rigs would likely be the earth removal/moving equipment involved in this type and scale of project.

Transport of materials and equipment and daily construction traffic would also create noise. Increased noise levels would occur intermittently along routes used by construction and operation equipment. Most heavy construction equipment would be stored on site during the construction period. See Section 6.3.3.7 for additional transportation information.

This intermittent and short-term noise could result in minor disturbances to scientists, staff, recreational users, and other visitors within the ROI. However, noise disturbances or interruptions would end once on-site construction and installation ends. Intermittent, short-term noise increases would create a moderate impact.

Operation Impacts. Operation of the Outrigger Telescopes would result in a negligible increase in noise and a minor increase in vehicular traffic noise along the Mount Wilson Road. See Section 6.3.3.7 for additional vehicular traffic information. In conclusion, there would be no impact associated with this phase of the Outrigger Telescopes Project.

Mitigation Measures. Any noise impacts on construction workers would be mitigated by adherence to appropriate Occupational Safety and Health Administration (OSHA) standards.

6.3.3.12 Visual/Aesthetics

ROI for Visuals/Aesthetics Resources. The ROI for visual impacts is primarily Mount Wilson and any other area where the Outrigger Telescopes would be visible.

On-Site Construction and Installation Impacts. Portions of the MWO have been designated for modification (per the USFS's visual quality objective (VQO) designations). The proposed Museum Quadrant site is located within this designated area and would be subject to that objective. A review of the USFS's definition of modification, however, shows that the existing Observatory structures do not comply strictly with VQO because they do not use naturally established form, line, color, and texture that are compatible with the natural surroundings.

The Outrigger Telescopes Project Museum Quadrant site is southwest of the CHARA Array, spanning a small canyon. For best astronomical viewing, the proposed telescopes would sit at a slightly higher elevation than the currently positioned CHARA W1 telescope.

The Outrigger Telescopes situated within the Museum Quadrant site would not be visible from points to the east or south of the Observatory or from any vantage point in the Los Angeles Basin due to adjacent terrain and tree stands. The Outrigger Telescopes enclosures would be visible from the north along sections of State

Route-2 and to the west, within the telecommunication broadcast facility development area.

The transport of construction equipment and machinery to the proposed site and the small amount of additional vehicular traffic necessary for transporting the workforce to the site would cause additional impacts. Construction activities and machinery would be visible from the Mount Wilson site; however, below Mount Wilson, the existing topography of the mountain would preclude view of those construction activities and machinery movement.

Operation Impacts. Operations of the Outrigger Telescopes would have a small incremental impact on visual resources from the view plane on the summit. The Outrigger Telescopes would not be seen below the mountain.

Mitigation Measures. The Outrigger Telescopes facilities would employ color schemes and design criteria established for observatories on the mountain.

6.3.3.13 Environmental Justice

Onsite construction, installation, and operation of the Outrigger Telescopes at the MWO site would not result in disproportionately adverse impacts on minority or low-income populations.

6.3.3.14 Cumulative Impacts

Past and Present Activities on Mount Wilson. Before Spanish arrival, the Gabrielinos (Shoshonean-speaking natives) had a thriving culture in the Los Angeles Basin and San Gabriel Valley, extensively using the resources of the San Gabriel Mountains for food and materials and to trade with tribes across the mountains. With the earliest Spanish explorers—Portola in 1769 and Fages in 1776—Spanish missionaries founded several missions, gathered some of the native peoples into mission communities, taught them Christianity, and had them tend the mission orchards. This missionization resulted in the natives' loss of their own culture and practices, so that by the early 1800s, these native cultures had been assimilated into the Spanish political, economic, and religious systems.

> ***Past Activities***
>
> *Astronomers have been interested in Mount Wilson for more than 100 years. The MWO was preceded by a 33-cm (13-in) refractor telescope located on Mount Harvard, southwest of the present site. That telescope was installed in 1889 and operated for 18 months. In 1904, the Carnegie Institution of Washington established the current Mount Wilson Solar Observatory under a 99-year lease agreement with the U.S. Department of Agriculture Forest Service. Astronomer George Ellery Hale planned to build a 102-cm (40-in) telescope, soon to be replaced by a 152-cm (60-in) and then the 254-cm (100-in) Hooker Telescope. Currently, the site is home to eight prominent observatories operated by universities and research centers throughout the United States.*

The Spanish also relied on the San Gabriel Mountains (calling them the Sierra Madre during the early 1800s) for raw materials and grazing. After the United States took possession of California, the San Gabriel Mountains were used for mining, travel, homesteading, recreation, scientific observatories, and as a timberland preserve. The Angeles National Forest was established in December 1892 by Executive Order.

Benjamin D. Wilson started constructing a pack trail to the mountain summit in 1864 to harvest timber to make wine barrels. However, the timber was found to be unsuitable, and the trail was abandoned.

As the local area population increased, the number of hikers and campers using the trail increased. Often, hikers lit a large bonfire at the summit after sunset to signal their safe arrival to those below.

The Mount Wilson area was first used for astronomical observations in 1889, when the first telescope was installed on the southwestern edge of the summit. The telescope remained for only 18 months before its removal.

In 1904, the Carnegie Institution of Washington entered into a 99-year lease with the National Forest Service to use Mount Wilson for astronomical study of our closest star, the Sun. The Mount Wilson Solar Observatory was founded, and the Snow Solar Telescope was relocated from the Yerkes Observatory to Mount Wilson (the telescope is named after its benefactor, Helen Snow). In 1908, the 8-m (60-ft) Solar Tower was built; the 46-m (150-ft) Solar Tower was built in 1910.

The first reflector deep-sky telescope, the 152-cm (60-in) telescope, was completed in 1908, establishing the basic design for future observatory telescopes. The 254-cm (100-in) Hooker Telescope, completed in 1917, remained the largest telescope in the world until 1948, when the 508-cm (200-in) Hale Telescope was built on Palomar Mountain near San Diego. The Observatory changed its name to MWO after the completion of the Hooker Telescope.

Other astronomic observational equipment added to the Observatory's inventory includes the Berkeley ISI in 1988 and the more recent Georgia State University CHARA Array.

Table 6-10 outlines the history of Mount Wilson.

Reasonably Foreseeable Future Activities. The MWO is administered by the Mount Wilson Institute (MWI), a non-profit corporation. The future uses and growth of the observatory depend on current funding, future funding for new science research projects, and available space on the mountain to support such efforts. MWI Director Dr. Harold McAlister states:

> "Because Mount Wilson is run by a non-profit organization whose major goal is to maintain the status quo, there is no long-range plan of growth at the Observatory. As in the past, MWI will respond to specific requests for new facilities on the site, and we have no idea of what might be proposed to us [or] on what time scale. My own feeling is that from the point of view of available acreage on the present leasehold, there is room for one or two more telescopes in the range of 2 to 4 m (6.6 to13 ft) aperture, placed on high ground that might be expected to enjoy good seeing conditions. Any additional expansion would… require extending the site boundary. That option is highly limited by the mountainous terrain. "

Summary of Cumulative Impacts There are no known plans for construction and operation of any additional telescopes at the MWO site for the foreseeable future.

On-site construction, installation, and operation of the Outrigger Telescopes at the MWO site would have little incremental impact on the whole. Construction would, even at the estimated 24 months, would have little adverse impact on the MWO site and Mount Wilson. Visitors and staff on the mountain would experience minor inconveniences at various times during

TABLE 6-10. MOUNT WILSON HISTORY

Year	Event
1864	Benjamin D. “Don Benito” Wilson hires Mexicans and Indians to transform an old Indian path up Little Santa Anita Canyon into a trail in order to cut down the trees on top of Mount Wilson to build fences and wine barrels. This was the first modern trail in the front range. Wilson builds a Halfway House at what is now called Orchard Camp, consisting of a three-room cabin, a stable, a blacksmith’s shop and a chicken house. When Wilson got to the top, he discovered the remains of two log cabins, whose builders are lost to history. Wilson abandoned logging after a few weeks, perhaps because he didn’t like the wood.
1866	George Islip takes over the Halfway House, and plants fruit trees, giving rise to the name Orchard Camp.
1877	John Muir climbs to a point near Mount Wilson.
About <1880	Islip abandons Orchard Camp.
1880s	Up to 70 hikers and horse-riders climb the trail to camp at Mount Wilson on weekends, building huge bonfires at the peak to signal their safe arrival.
1887	Government surveyors attempt to change the name of Mount Wilson to Mount Kenneyloa. Harrison Gray Otis wrote a scathing editorial in the L.A. Times, and the name wasn’t changed. (The editorial is in SG, p. 115.)
1889	Harvard Professor William Pickering and telescope maker Alvan Clark use a 4" telescope and determine that Mount Wilson would be an excellent site for an astronomical telescope. A 13" telescope from Harvard weighing 3700 pounds is carried up the Mount Wilson Trail by six men and two horses, with the trail being “improved” by dynamite where needed. Within a year, a “star map of the heavens” is completed which included “many objects never heretofore viewed.” Peter Steil opens a tent camp in the Harvard — Wilson Saddle. The Pasadena & Mount Wilson Toll Road Company was incorporated to build a wagon road to Mount Wilson.
1890	The wagon road to Mount Wilson proves too costly, and a 4' wide trail is proposed instead of a 12' roadway. 1,000 people stay at Steil’s camp in the summer. The *Mount Wilson War* begins when A.G. Strain erects a fence across the Mount Wilson Trail, which was ripped down by Steil. The War caused only property damage and a lawsuit.
1891	The Court rules that the Mount Wilson Trail is a “public highway, and cannot be closed against travel.” Strain opens a tent camp near the summit, which also becomes popular, to a capacity of 60 people. Steil sells to Clarence S. Martin, who builds a frame dining room, enough tents for *Camp Wilson*, better known as *Martin’s Camp*, to sleep 40 people, and a water tunnel below Mount Wilson with pipes to bring water to his camp. The 13" telescope is removed, probably in part due to a dispute with USC over land ownership of its site. Pasadena Contractor Thomas Banbury with a crew of 25 men builds the 10 mile “New Mount Wilson Trail,” aka the Toll Road, in five months. It opens in June with a toll of 25 cents round trip for hikers and 50 cents for horseback riders. Its maximum 10 percent grade makes it more popular than the steeper Mount Wilson Trail.
1890s	Both Martin’s and Strain’s camps are full nearly every summer weekend. Hundreds of people use the Toll Road on weekends, stopping at Captain Henninger’s house and George Schneider’s Halfway House near the Idlehour Trail junction.
1892	President Charles W. Eliot of Harvard visits Mount Wilson. Martin offers him 10 acres on the unnamed high point south of the saddle for a 24" telescope, and christens it “Mount Harvard.” Despite that offer and honor, the 24" telescope went to Peru.
1895	Mount Wilson Toll Road Company purchases Henninger Flats.
1896	Mount Wilson Toll Road Company purchases Martin’s and Strain’s camps.
1901	Mount Wilson Toll Road Company purchases 640 acres on the mountaintop for $800 from the U.S. Land Office, eventually expanding its holdings to 1050 acres.

TABLE 6-10. MOUNT WILSON HISTORY (CONTINUED)

Year	Event
1903	Mount Wilson determined to be one of the five best sites in southwestern California for an astronomical telescope by Professor W.J. Hussey of Lick Observatory. George Ellery Hale visits Mount Wilson for the first time on June 25, is "ecstatic" over the excellent observing conditions, and decides to build his observatory at Mount Wilson.
1905	Carnegie Institute granted a 99-year lease for 40 acres for telescopes. Toll Road Company constructs the first Mount Wilson Hotel.
1905	Snow Solar Telescope temporarily relocated from Yerkes Observatory to Mount Wilson
1907	Carnegie Institute widens Toll Road to 10' so that larger telescopes can be transported. The work is done by 200 Japanese laborers using mule-drawn scrapers and plows. Sandbags are used to build retaining walls.
1908	60' Solar Tower Telescope completed. 60" reflector operational and becomes world's largest telescope for almost 10 years until surpassed by the Mount Wilson 100" telescope.
1910	150' Solar Tower Telescope completed.
1913	First Mount Wilson Hotel burns down.
1913	Second, larger, Mount Wilson Hotel built, lasts for 53 years until it is demolished in 1966.
1917	100" Hooker Reflector telescope operational and becomes world's largest telescope for 31 years until surpassed by the 200" Palomar Telescope in 1948. The 200" telescope was built directly as a result of the stunning achievements of the Hooker Telescope.
1912	Toll Road opens to public automobiles until 1936.
1935	Angeles Crest Road/Red Box road to Mount Wilson completed.
1936	Toll Road closed to public travel and given to Forest Service.
1948	First TV/radio antenna installed, followed quickly by many more.
1964	Metromedia purchases the 720 acres of the Mount Wilson Hotel Company.
1966	Mount Wilson Hotel razed for Skyline Park.
1967	Skyline Park opens with the Pavilion, picnic plazas and Children's Zoo.
1976	Skyline Park closes after losing money for 8.5 years. Metromedia deeds its 1,100 acres to The Nature Conservancy, who deeds it to the Forest Service, except for two small parcels of private land.
1984	Carnegie Institute plans to close Mount Wilson observatories to focus its resources on its telescopes in Chile.
1985	Hooker telescope closed. The other telescopes remain operational.
1986	Mount Wilson Institute formed.
1988	UC Berkeley's Infrared Spatial Interferometer, consisting of two 65" telescopes mounted in semi-trailers, begins operation.
1989	Mount Wilson Institute begins operation of the Carnegie Mount Wilson telescopes, and the 100" is opened sometime before 2000.
1996	Construction begins for six 1 m telescopes by the Center for High Angular Resolution Astronomy at Georgia State University. This will be the largest optical interferometric array ever built. Mount Wilson was chosen on the basis of the excellent atmospheric stability, the number of clear nights available, and the infrastructure available here. The Telescopes were installed in 1999. The facility should be operational by the end of 2000.

construction. From an environmental impact perspective, construction of the Outrigger Telescopes would not combine with past and present sources of environmental impact sufficient to result in exceedances of existing environmental standards, either Federal or State.

Operation of the Outrigger Telescopes may incrementally impact the existing wastewater treatment system at MWO and possibly even the current MWO potable water supply capability. These potential adverse impacts, if verified during more detailed planning and design of the Outrigger Telescopes Project, can be avoided by upgrading or supplementing the existing systems.

6.3.4 Adverse Environmental Impacts That Cannot be Avoided for Mount Wilson

Adverse impacts are divided into short- and long-term effects. Short-term effects are generally associated with construction and prevail only for the duration of the construction period. Long-term effects generally follow completion of the improvements and are permanent. Effects that can be considered both adverse and unavoidable are described below for both short- and long-term effects.

6.3.4.1 Unavoidable Adverse Short-Term Effects

- Operation of construction equipment, trucks, and worker vehicles would temporarily increase traffic along the roads serving Mount Wilson during the construction period. This minor impact would be intermittent and temporary and would occur only during construction. The transport of large machinery and large Outrigger Telescope components could temporarily impede traffic flow and result in temporary traffic delays on the Angeles Crest Highway (State Route-2) and Mount Wilson Road. These impacts would be limited to brief periods at the beginning and end of construction.
- Increased vehicular traffic and heavy equipment internal combustion engines would generate air emissions. These emissions would be localized and would not impact the overall air quality on Mount Wilson. Emissions from road construction-related vehicles and equipment would cease once construction is completed.
- Heavy construction equipment operations on site would temporarily generate small dust particles. Although workers would take measures daily to mitigate and reduce these impacts, some soil would occasionally erode during periods of high winds.
- Heavy construction equipment operations on site and the transport of large machinery along the roads serving Mount Wilson would lead to intermittent and temporary increases in noise levels. The transport of large machinery would be limited brief periods at the beginning and end of construction.
- Construction equipment, related materials, and temporary structures, located on site during the construction phase of the project would affect the visual quality of the area for some viewers. Any changes to the visual quality of the area would be temporary, since all equipment and excess materials would be removed at completion of construction.

6.3.4.2 Unavoidable Adverse Long-Term Effects

- The presence of the Outrigger Telescopes would affect the visual quality of the area for some viewers using the area around the Observatory. To minimize this visual impact, the Outrigger Telescopes would be painted to blend into the natural surroundings to the extent possible.
- Workforce traffic associated with the Outrigger Telescopes would result in very minor increases in noise levels along the roads serving Mount Wilson, including the Angeles Crest Highway (State Route-2) and Mount Wilson Road.

6.3.5 Incomplete or Unavailable Information

Sufficient information exists at this stage in development of the Reduced Science Option at Mount Wilson to determine whether or not significant environmental impacts would occur as a result of implementation of the Outrigger Telescopes Project.

Assuming the Reduced Science Option were to move forward at Mount Wilson two areas would require particular attention in facility design and planning: (1) determination of the capability and capacity of the existing MWO wastewater system; and (2) determination of the capability of the existing MWO potable water supply system to meet the needs of an operational Outrigger Telescopes Project. While both areas would need attention, there are no indications at this time that any environmental conditions exist which would preclude assuring adequate wastewater management and potable water needs can be met.

6.3.6 Relationship Between Short-Term Uses of the Human Environment and the Maintenance and Enhancement of Long-Term Productivity

The Outrigger Telescopes Project would be an important addition to California's research and development industry, which can provide broadened employment opportunities for State residents. The productivity of Mount Wilson, however, cannot be measured in purely traditional economic ways. Mount Wilson is a natural and scientific resource that belongs to all State residents and future generations. The use of the mountain as an astronomical observatory need not be incompatible with its use by recreational users and tourists.

Any assessment of Mount Wilson's role as an astronomical observatory versus its role as a natural laboratory for other scientists or an aesthetic and recreational resource, should recognize that astronomy and other activities on Mount Wilson are not mutually exclusive. Upon removal, long-term productivity would not be affected.

6.3.7 Irreversible and Irretrievable Commitment of Resources

The Outrigger Telescopes Project would require a commitment of natural, physical, and human resources causing an irreversible and irretrievable commitment of resources in all these categories. A commitment of resources is irreversible when primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources neither renewable nor recoverable for future use.

Construction of the Outrigger Telescopes would consume energy and building materials. In general, construction equipment would consume natural and propane gas and diesel fuel and these fuels would generate electrical power and heat. The electrical power requirement of each Outrigger Telescope is estimated to be 30 kW (UH IfA 2001a). The electrical utility supplying the observatories would supply additional electrical demand largely through fossil-fuel power. The consumption of petroleum products during operation would be significantly less than during construction. Although construction material such as steel, cement, and aggregate would also be expended, these physical resources are generally in sufficient supply, and their consumption would not have an adverse effect on availability. In some instances, some material resources such as structural steel and copper wiring could be reclaimed, recycled, and reused.

Trade and unskilled laborers would be employed during the development, construction, and operation of the Outrigger Telescopes. Labor is generally not in short supply, and commitment to the project would not have an adverse effect on its continued availability.

6.4 PALOMAR OBSERVATORY

Millions of San Diego and Riverside County residents regard Palomar Mountain as an historic mountain. Home to the Palomar Observatory, the mountain is well known for its star-gazing opportunities and dark-night skies (USDA 2004).

6.4.1 Palomar Mountain, California

6.4.1.1 Proposed Facilities

See Section 2.1.2 for a detailed description of the proposed facilities for the Outrigger Telescopes. Figure 6-3 illustrates the proposed site layout for the Outrigger Telescopes on Palomar Mountain.

6.4.1.2 On-Site Construction and Installation of the Outrigger Telescopes at Palomar Mountain

Schedule. Construction operations at the 1,674-m (5,500-ft) elevation in the area around Palomar Mountain are possible during for most months throughout the year. The mountain roads' southern exposure allows rapid melting during the short-lived snowstorms that occur during the winter months. The relatively gentle site terrain and access road grades allow year-round access for large construction vehicles. The time required for construction of this project would probably be 20 to 24 months. Based on an average annual rainfall of approximately 76 cm (30 in), construction activities would be completed in slightly more than two calendar years.

Estimated Excavation. Construction of the Outrigger Telescopes Project would require building pad earthwork and preparation and foundation excavations for each of the four telescopes, each of the enclosures, the light beam tube support structures, and the beam-combiner facility.

The ridge-top terrain in the Long Canyon site would require a cut-and-fill operation involving more earthwork than a project of equal square footage on a level site. The pads for the four approximately 93-m^2 (1,000-ft^2) telescope buildings and the approximately 743 m^2 (8,000-ft^2) beam-combiner building would be about 1,835 m^3 (2,400 yd^3). This work would be related to creating a level pad on the crest of an existing knoll and establishing the four telescope enclosure pads on equal contour lines around this "center." The Outrigger Telescopes Project would balance the amount of cut or excavated material required with the amount of

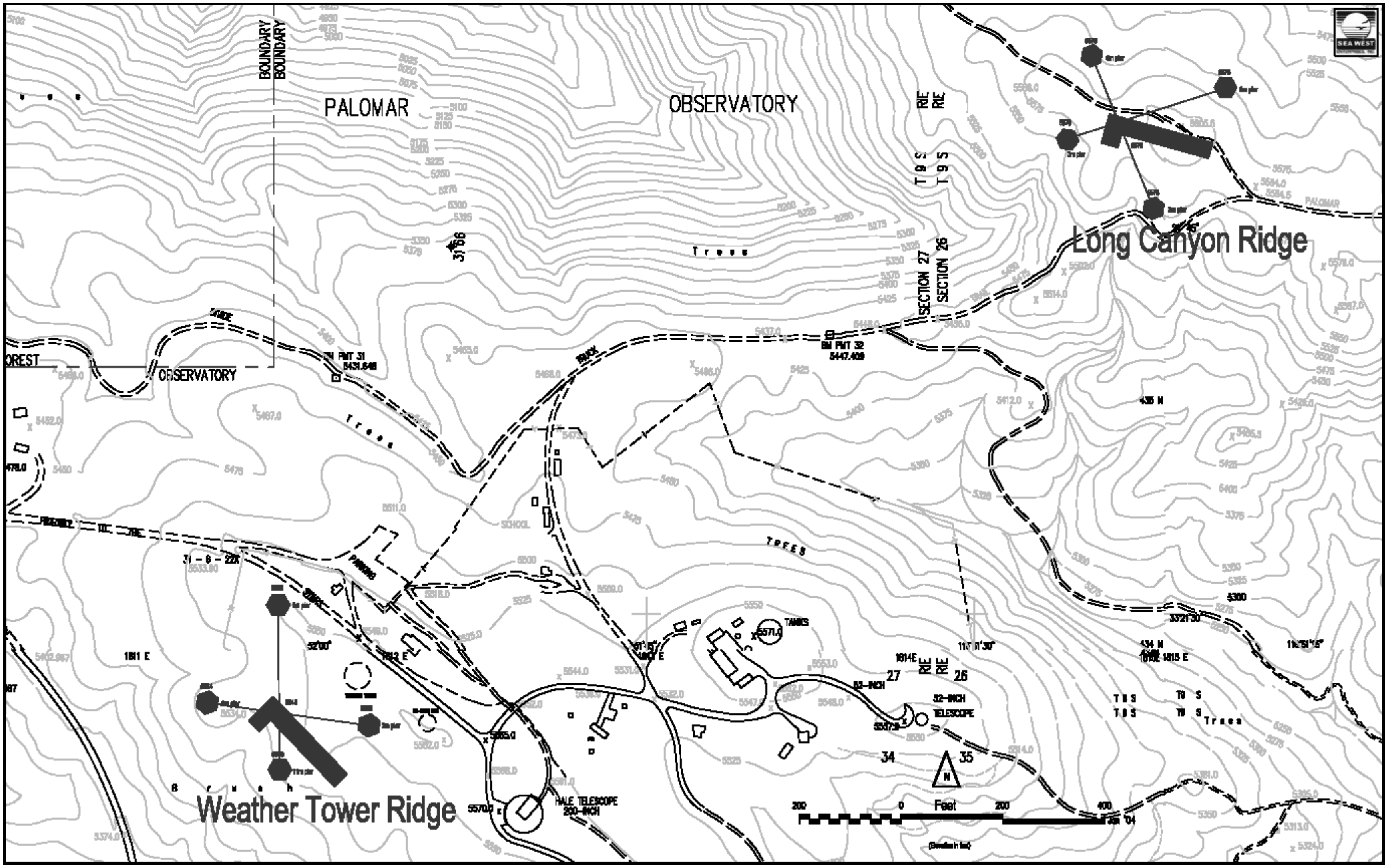


FIGURE 6-3. PROPOSED SITE LAYOUT OF THE OUTRIGGER TELESCOPES ON PALOMAR MOUNTAIN

backfill to minimize the transportation of soils or aggregate to and from the site.

The access trail to the site for construction activities would remain in use for the life of the Outrigger Telescopes Project. Designed to handle the traffic and loads anticipated as a part of the operations and maintenance of this facility over an extended period of time, it would follow the ridgeline from the existing observatory corridor to the array site, a distance of 37 m (120 ft). The design of the trail would minimize the potential for erosion and concentrated runoff. Based on the current design criteria and configurations, between 229 and 153 m^3 (300 and 500 yd^3) of material would be excavated and moved for this access trail.

Grading Plans. The Outrigger Telescopes foundation would be set as close to the existing grade as possible, using a balance cut-and-fill method to achieve the desired elevation for optimal interferometric measurements. On the Long Canyon Ridge site, a concentricity concept about the knoll would allow the construction of each of the telescope piers between the 1,692- and 1,700-m (5,550- and 5,575-ft) amsl contours. The pier construction might allow each of the telescopes atop its concrete mount to sit at an elevation of 1,700-m (5,576-ft) amsl.

Foundations and Footings. Estimated concrete volumes for development of a four-aperture array on the Long Canyon Ridge site at Palomar Observatory would require the delivery of up to 600 truckloads of concrete both for building foundations/slabs, interferometer inertia pads, and telescope mounts. Premixed concrete could be delivered to the observatory site to minimize the on-site water demand.

Installation of Telescopes and Dome Enclosures. The Outrigger Telescopes Project, constructed within the Long Canyon Ridge site at the Palomar Mountain Observatory, under the current design configuration would consist of four 1.8-m (6-ft) telescopes/enclosures arranged around a central combiner facility. The final collective footprints of the four telescope enclosures, light beam foundations, and the combiner building would be approximately 1,301 m^2 (14,000 ft^2). The access trail, suitable for light vehicular traffic, would disturb approximately 836 m^2 (9,000 ft^2) of additional terrain, most of which would be within the site occupied by the array itself. Overall, the total project site would encompass approximately 5 ha (2 ac) of land in and among the telescope enclosures, the light beam paths, access trails, and the beam-combiner building locations. Necessary project staging and laydown areas would be located within this 5-ha (2-ac) plot. If deliveries and/or staging requirements require off-site holding, Palomar Observatory administration would identify suitable locations with both environmental sensitivities and observatory operations in mind.

On-Site Construction Facilities/ Equipment. The soil and rock types found within the boundaries of the Palomar Observatory appear to be friable and would require the use of conventional earthwork and grading equipment. Rubber-mounted backhoes, articulated loaders, track-mounted excavators and drill rigs would likely be among the earth removal/moving equipment involved in the construction activities for the Outrigger Telescopes Project. During the earthwork, transport vehicles, including 12 metric tons (mt) (26,000 lb GVW) bobtail trucks and 23 mt (25-ton) capacity truck and trailer combinations rigs would be used to transport, handle, dispose of and deliver soil and aggregate, as required.

On-Site Construction Employment and Costs. The workforce anticipated for this project would vary from an average of 25 to 35 workers to a peak of 60 workers. Throughout the concrete/foundation portions of the project and into the rough construction of the buildings and enclosures, the limited space to stage equipment and material deliveries, for the most part, would limit crew size. Once the building shells are completed, additional specialty contractors and technicians might increase the peak crew 50 to 60 individuals for the short term. Final installations for both the building facilities and telescope/delay line systems would once again require a smaller focused effort and result in a substantial reduction in personnel and equipment.

Construction Management. The contractor would be required to follow the approved construction Best Management Practices Plan (BMP) during all on-site construction and installation activities. The final BMP will be incorporated into the construction contract.

Construction Traffic. During construction of the Outrigger Telescopes Project, the ADT may vary between 50 and 75, (depending on the workforce size and equipment/material delivered). At peak periods, the ADT could reasonably exceed 100 vehicles, but is small compared to the ADT for Palomar Mountain Road intersection with CA Highway 76 (the estimated closest monitored site to the CA-76/South Grade Road intersection). The California Highway Patrol recently estimated the ADT at about 10,000 vehicles. The closest regional artery to the Palomar Observatory is Interstate 15. The 2002 ADT volume for I-15 at the point of intersection with CA-76 was 117,000 vehicles. The paved sections along the State routes provide sufficient durability to handle traffic associated with this construction project.

6.4.1.3 Operations of the Outrigger Telescopes Project on Palomar Mountain

Employment and Economics. The current daily operational workforce at the Palomar Observatory is about 24 technicians, science team members, and facilities staff.

The Outrigger Telescopes would be operated both locally and remotely during its multi-year science mission. The primary on-site activities would require a staff of trained individuals; mechanical engineer, electrical engineer, optics specialist, software specialist, two technicians, and a supervisor. The resident science team would be two or three individuals, depending on the ongoing activity and programs underway, with an average daily workforce of six people.

Traffic. Operation of the Outrigger Telescopes at the Observatory would add 6 to 12 vehicular trips daily to Palomar Mountain Road and to South Grade Road that provides vehicular access to the Palomar Observatory.

Infrastructure and Utilities. All utilities—water, power, communications and sewage facilities—would be fully provided from existing infrastructure on Palomar Mountain.

San Diego Gas & Electric provides 12 kW at 480 volts to the Palomar Observatory. The Observatory infrastructure includes an underground power grid and backup generator that is near capacity with about 50 kVA available. If the Outrigger Telescopes were placed here and current electrical supply deemed insufficient, additional power could be made available with the installation of another transformer

The Observatory's telecommunication infrastructure includes an underground fiber optic backbone supported by two T1 lines serviced by Cox Communications and regular telephone service provided by Santa Barbara County, with an Ethernet radio link equivalent to a T3 line.

Maintenance. During the ramp up phase of the Outrigger Telescopes Project, the on-site staff would focus on commissioning the interferometer, specifically on calibrating and integrating the telescopes, pointing and tracking tests, encoding enclosure domes, and generally working out control systems needed to coordinate the simultaneous operation of the four telescopes, their domes, and the delay line systems. Alignment of delay line, meteorology, and beam-combiner systems within the main building would also be underway. These activities require the participation of engineers and scientists in a collaborative effort to achieve first light. After the staff completes initial testing and calibration of the interferometer, they would focus on instrumentation, and further calibration and troubleshooting, possibly incorporating spectrographs, CCD cameras, and infrared equipment into the array.

During these activities personnel would move between the control room, combiner facility, and individual telescope locations to conduct the necessary installations and testing. These activities would probably not require the use of heavy equipment or generate noise above normal operating levels associated with pedestrian traffic at the site and occasional vehicular arrivals and departures from the mountain. Once completed, the level of activity in and around each telescope sites and within the delay line and beam-combiner facility would decrease dramatically. The interferometer is intended to be operated via a high-speed data connection, ultimately from a remote site.

During the lifetime of the Outrigger interferometer, ongoing activities would include scheduled equipment and facility maintenance, re-instrumentation and calibration, periodic optics recoating activities, and system monitoring.

The quantities and use frequency of materials deemed hazardous during the operation of the Outrigger Telescopes are limited to lubricants and mirror-care chemicals. There are no airborne pollutants associated with the operation of an optical interferometer.

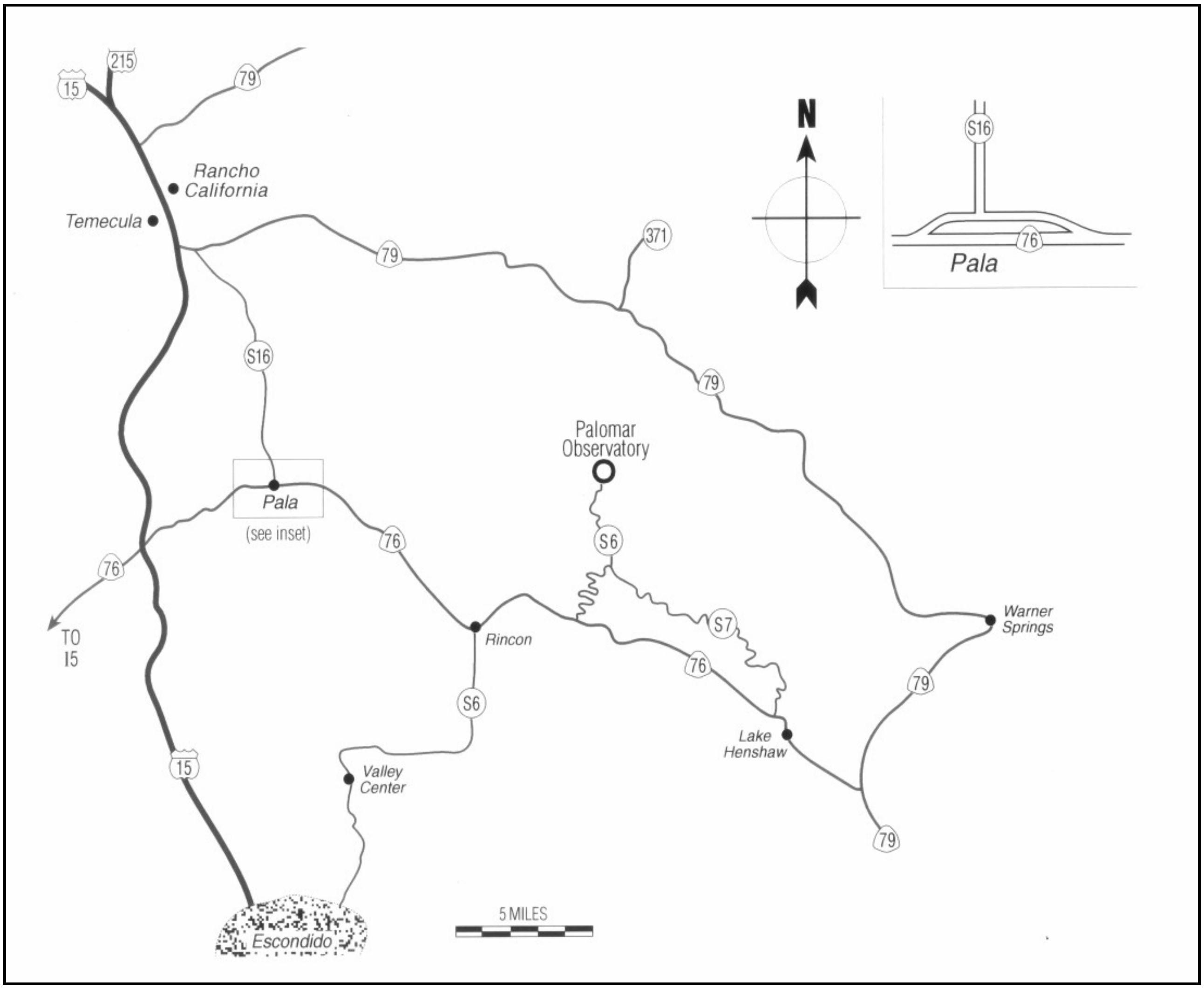
6.4.2 Affected Environment

This section describes the existing environment in and around Palomar Mountain, California, which serves as a baseline from which to measure environmental impacts resulting from activities associated with the reduced science alternative. Figure 6-4 shows a regional map of Palomar Mountain.

6.4.2.1 Land Use and Existing Activities

Land Use. The Palomar Observatory is located in northern San Diego County, approximately 26 km (16 mi) east of Interstate 15 and 8 km (5 mi) north of State Route 76. This region of California's Peninsular Range is characterized by low rolling mountaintops, approximately 1,676 m (5,500 ft) at msl, interlaced with isolated alpine meadows.

The Observatory occupies the summit area of Palomar Mountain and is surrounded by rural and wilderness lands under both private and government ownership.



Source: Sea West Enterprises, Inc. 2004b

FIGURE 6-4. REGIONAL MAP OF PALOMAR MOUNTAIN, CALIFORNIA

Surrounded by more than 23,472 ha (58,000 ac) of the Cleveland National Forest's Palomar Mountain Planning Unit, the 815 ha (2,013 ac) that comprise the Observatory were purchased by the California Institute of Technology (Caltech) beginning in November 1934 (Assessors Parcel Numbers 112-180-14, 112-230-21, 112-110-07, & 112-130-18).

The USFS lands surrounding the Palomar site include more than 6,070 ha (15,000 ac) of the Agua Tibia Wilderness, over 8,095 ha (20,000 ac) of undeveloped and no-road-access land and more than 2,020 ha (5,000 ac) of potentially unique vegetation. There are no classified Special Interest Areas, Research Natural Acres, or Experimental Forests within the immediate vicinity of the site.

To the west of the Palomar Observatory sits the 763-ha (1,886-ac) Palomar State Park. Locally, 3,440 ha (8,500 ac) of wilderness area has been deeded to the Pala and Pauma tribes of the Mission Indians.

Grazing is the primary agricultural land use within the immediate vicinity of the site. Mining operations are ongoing to the northeast and within 4.8 km (3 mi) of the Palomar Observatory.

As privately owned land, the Palomar Observatory is subject to the planning and jurisdictional control of San Diego County under the North Mountain Subregional Plan (Part XVIII of the San Diego County General Plan). As of 1994, the Observatory has operated under a Major Use Permit (MUP # P94-021) granted as part of the approval process for the Palomar Testbed Interferometer Project constructed by the Jet Propulsion Laboratory. The MUP also contains provisions for the operation and maintenance of the multiple observatories built prior to the permit issuance including the:

- 508-cm (200-in) Hale Telescope
- 102-cm (40-in) Oshcin Telescope
- 46-cm (18-in) Schmidt Telescope
- 152-cm (60-in) reflecting telescope.

Additionally, the MUP covers the operations of the various buildings, structures, and roads existing at the time of application:

- Twelve-room lodge/dormitory
- Thirteen employee cottages
- Maintenance facility, including machine shop, auto repair shop, and wood shop
- 190-kl (50,000-gal) high tower water tank
- 38-kl (10,000-gal) propane storage tank
- 7.6-kl (2,000-gal) gasoline storage tank
- 5.7-kl (1,500-gal) liquefied nitrogen tank
- 6.4 km (4 mi) of paved roads and 32 km (20 mi) of unpaved roads
- 3,785-kl (1,000,000-gal) water reservoir.

Existing Activities. The Palomar Mountain region has a number of hiking and recreation trails both on and around the 815-ha (2,013-ac) site, including Doane Valley Nature Trail, Weir Trail, French Valley Trail, Observatory Trail, and Boucher Hill. The Palomar Observatory is a destination for tourists and outdoor enthusiasts, and it hosts facility tours, museum displays, telescope viewing gallery, and gift shop.

6.4.2.2 Cultural Resources

Resource Definition. See Section 3.1.2.1 for cultural resource definitions.

Cultural Environment. A San Diego County staff archaeologist recently investigated the State-maintained archaeology database for the property parcels associated with the Palomar Observatory and concluded that no "archaeology surveys or archaeology sites have been recorded for these parcels. However, there have been archaeology surveys and archaeology sites found on nearby properties" (Stevenson 2004b). (The surveys on nearby properties were not done in connection with San Diego County-issued permits; therefore, the County does not have specific documentation on those particular surveys and sites.)

San Diego County does recognize the archaeological, historical, and cultural significance of Palomar Mountain and recommends in their current County General Plan: Part XVIII North Mountain Subregional Plan that "wherever an environmental analysis is required, archaeological surveys with these areas would aid in protection of the archaeological history" (San Diego County 2002).

6.4.2.3 Biological Resources and Threatened and Endangered Species

Biological Resources. Montane coniferous forest with areas of open grass dominates the landscape of the Palomar Observatory grounds. The forest and the species it supports are unique to southern California and qualify Palomar Mountain as a Resource Conservation Area. Evergreens that populate the forest on and around the site include tall Coulter pines, Jeffrey pines, big cone Douglas fir, white fir, incense cedar and giant Sequoia trees. The giant Sequoias planted by Observatory staff in the 1920s, are not native to the site. Bark-beetle infestation is a current threat primarily to the Coulter pines surrounding the site. Annually, the forest receives 71 to 91 cm (28 to 36 in) of rainfall. Mountain lions, bobcats, and reptiles including the California mountain king snake inhabit the Palomar Mountain region. The spotted owl prevalent throughout mountainous regions of western North America, has an estimated population that ranges from 42 to 60 in the Palomar region (as of 1994). Their habitat elevations range from 800 to 2,600 m (2,625 to 8,530 ft) and occur in forests of mixed conifer canyon live oak, and big cone fir.

The Observatory property has various vegetative climates in addition to the montane coniferous forests: black oak woodlands, mixed evergreen forest, Sierran mixed coniferous forest, and bigcone spruce-canyon oak forest. Five main types of chaparral surround the observatory grounds: granitic northern mixed chaparral, scrub oak chaparral, montane scrub oak chaparral, montane chaparral, and most prevalent, red shank chaparral. Dry Montane Meadows span the areas between the cool upland slopes where the forests are located. The Dry Montane Meadows consist of grasses surrounded by bracken. Graminoid species in the area include Mexican rush, Toad rush, Kentucky bluegrass, and cluster field-sedge, dominated by bracken fern. The San Diego milk vetch *(Astragalus oocarpus*), a Category 2 species endemic to San Diego County, is found in chaparral at the edges of the dry montane meadows. A 1994 survey of the area identified a small population of this plant east of the Palomar Testbed Interferometer building site.

Horkelia clevelandii, the Cleveland horkelia, is also found in the meadows of Palomar Mountain. This plant is host to the Laguna Mountains Skipper butterfly. In 1997, both the Cleveland horkelia and the Laguna Mountains Skipper butterfly were Federally listed as endangered. Both occur on "meadow margins within northwestern points of the Palomar Observatory lands" (Osborne 2003). Cattle grazing in the Palomar Mountains have adversely affected the horkelia population. Studies have shown that the decline of the Laguna Mountain Skipper butterfly may be directly related to the declining population of the Cleveland horkelia. The Laguna Mountains Skipper will also use an additional host plant, *Potentilla glandulosa*, and also lives in small wooded glens and large open meadows, suggesting that the species may occur in many unstudied areas in the Cuyumaca, San Jacinto, Palomar, Laguna, San Gabriel, and the San Bernardino Mountains.

In a more current survey conducted by the USFWS in 2002, Laguna Mountains Skipper was not detected on Observatory lands. However, survey conditions were extremely difficult because of grasshoppers that came into maturity. The grasshoppers flew within a few meters of the surveyor's approach preventing small butterflies such as the Laguna Mountains Skipper from being seen.

Threatened and Endangered Species. The Southern bald eagle (*Haliaeetus leucocephalus leucocephalus*) a Federally listed endangered species. Migrant birds of this species visit the area during the winter season. Roosting areas are located on Palomar Mountain, but no active nests have been identified (Planning Unit 1976).

6.4.2.4 Hydrology, Water Quality, and Wastewater

Regulatory Framework. The SWRCB and the RWQCB administer the CWA and State water regulations in California. The San Diego RWQCB is the local agency responsible for the Palomar Mountain area. The RWQCB manages the California NPDES permits process. State regulations have a waste discharge requirement for permitting discharge. A report of waste discharge (RWD) is required for actions that would involve discharge of waste to surface and/or groundwater. The California Porter-Cologne Water Quality Act implements the NPDES program for the State (USAF 1998).

Surface Water. The variable nature of rainfall, rainfall cycles, and groundwater infiltration-storage-release factors creates highly variable surface water quality. Surface water normally does not contain more than 1,000 mg/l of total dissolved solids (TDS), except near the ocean or estuaries. Imported Colorado River water occasionally exceeds 700 ppm TDS at the westerly portal of the San Jacinto Tunnel. The most significant potential source of degradation to existing water quality would be sedimentation from erosion after a large wildfire (Planning Unit 1976).

Groundwater in the Palomar Mountain Area. The Palomar Observatory is completely dependent on local groundwater for its water supply.

The North Mountain Subregion's water supply is generated from groundwater. Water companies with districts in this area include: (1) Palomar Mountain Mutual Water Company, (2) Bailey Mutual Water Company, and (3) Los Tules Mutual Water Company (San Diego County 2002).

There are no designated sole source aquifers at or near the proposed site. The closest sole source aquifer is the Campo/Cottonwood Creek Aquifer located near the San Diego/Mexico border. Observatory property is not located on a 100-year flood plain. There are no wild and scenic rivers at or near the Observatory.

Stormwater runoff from the Observatory goes into the Santa Margarita River to the north and the San Luis Rey River to the south. A portion of this runoff is collected in the Redec, Tule Creek, Pauma, and Warner sub-basins.

According to County documentation, groundwater recharge is conservatively estimated at 18,500 m^3 (15 acre-feet) per acre per year for the Palomar area.

The groundwater extraction rate is estimated at 620 m^3 (0.5 acre feet) per acre per year per household, assuming a three-member household and includes landscape and domestic water use. This estimate excludes water recycling to groundwater by septic disposal system(s), which would be taken into consideration at the Observatory.

Domestic Wastewater Collection, Treatment, and Disposal. The Observatory uses septic tanks with leach lines to process the effluent/wastewater. Comments from the Observatory Superintendent indicate that reported recent difficulties in obtaining a permit far a septic system upgrade were related to the selection of a wetland location as the installation site. Avoidance of these habitats would be necessary for any proposed projects at the Observatory.

6.4.2.5 Solid Waste and Hazardous Materials Management

Solid Waste. The Palomar Mountain area has three bin-transfer sites, the closest being the Palomar Mountain site. Solid waste is collected at this site and hauled to the nearest landfill in Ramona. However, San Diego County is considering a new, closer landfill area in Gregory Canyon. The Observatory itself has two 4.6 m^3 (6 yd^3) solid waste/trash dumpsters that are emptied weekly by a contractor.

Hazardous Waste. Palomar Observatory currently has on file with the County of San Diego, Department of Environmental Health (DEH), Establishment Permit Number 104071, inventory of hazardous materials (Table 6-11) and hazardous waste materials (Table 6-12) stored on site.

Palomar Observatory recoats telescope optics on site. The facility has the capacity to handle all mirrors up to 190 cm (75 in) in diameter, and with some modification, can service the larger optics within the Observatory. The process involves the acid etch removal of old reflective coatings and re-application of a molecular aluminum coating in a vacuum chamber.

Fewer than 19 l (5 gal) of reflective mirror treatment solution (HCl) are stored on site. The excess waste is neutralized with either calcium carbonate or lime.

Palomar Observatory has and emergency action plan, and employees are responsible for understanding and following its procedures. In the event of a minor spill of a chemical, Observatory personnel alert people in the area of the spill; confine the spill; avoid breathing vapors from the spill; and, during clean-up, wear personal protective equipment, such as safety glasses, gloves, and a lab coat.

For emergency situations, the On-Call Supervisor is responsible for notifying the appropriate regulatory agencies and coordinating personnel evacuation, as needed. Subsequent documentation is provided by the Superintendent and On-Call Supervisor.

6.4.2.6 Geology, Soils, and Slope Stability

Palomar Mountain is located in the central portion of the Peninsular Range batholith. This range extends from the Santa Ana Mountains to the north into Baja California to the south, with rock types consisting of metavolcanics, metasedimentary, and igneous crystalline bedrock. A majority of the mountain consists of granite interlaced with some metamorphic rock.

In this region, the primary geomorphic processes are mass wasting and fluvial erosion. The summit areas of Palomar Mountain are overlain by decomposing granitic soils (mafic plutonics to diorites), ranging from fine sandy loams to loamy coarse sand. These soils vary in depth from exposed bedrock down to several tens of feet, with depth variations a function of both elevation and slope, (typically thinning on the steeper slopes and at higher elevations).

TABLE 6-11. PALOMAR OBSERVATORY HAZARDOUS MATERIALS DISCLOSURE

Chemical Name	1st Hazard Category	2nd Hazard Category
Acetylene	Fire	Acute
Argon	Pressure Release	
Carbon Dioxide	Pressure Release	
Diesel	Fire	Acute
Gasoline	Fire	Acute
Helium	Pressure Release	
Kerosene	Fire	Acute
Liquid Nitrogen	Pressure Release	
Mineral Spirits/Paint Thinner	Fire	Acute
Motor Oil & Hydraulic Fluid	Fire	Acute
Oxygen	Fire	Pressure Release
Paints	Fire	Acute
Propane	Fire	Pressure Release

Source: Sea West Enterprises, Inc. 2004b

TABLE 6-12. PALOMAR OBSERVATORY HAZARDOUS MATERIALS WASTE STREAM

Waste Category	Annual Quantity	Storage Method
Waste Oils	2,700 l (720 gal)	Metal Drum
Waste Latex Paint	1,800 l (470 gal)	Metal Drum
Waste Solvent	9.1 kg (20 lb)	Can
Absorbent Rags	125 kg (275 lb)	Metal Drum
Used Oil Filters	9.1 lb (20 lb)	Metal Drum

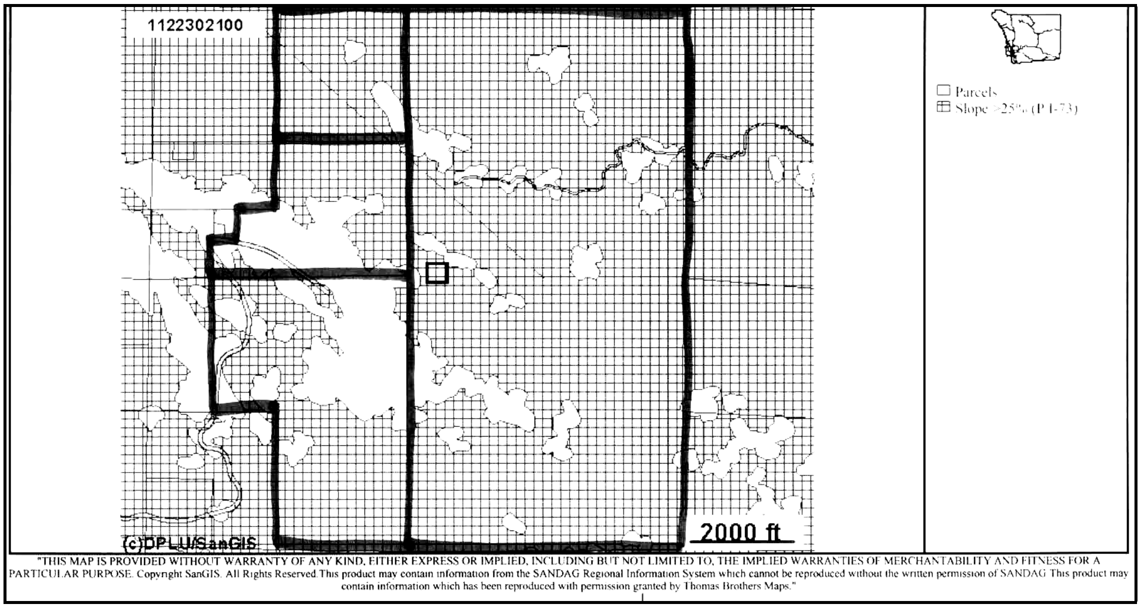
Source: Sea West Enterprises, Inc. 2004b

Figure 6-5 shows the Palomar Observatory site, indicating the terrain in excess of 25 percent slope (Stevenson 2004h). There are no designated floodplains within the Palomar Observatory.

6.4.2.7 Transportation

Palomar Mountain is located within San Diego County. Access to Palomar Mountain is via I-15 to I-76 eastbound and then to County Road S-6, which ends at the Observatory gates. The nearest cities are Escondido and Temecula, approximately 48 km (30 mi) from the Observatory. Approximate travel time from Pasadena to the Observatory is 2 hours. County Road S-6 is a paved and maintained mountain road, the only road maintained by the San Diego County; all others are private and maintained by the Observatory (Sea West Enterprises, Inc. 2004a).

The ADT for traffic on the major traffic arteries that connect the Palomar Mountain community and observatory to the rest of southern California are as follows:



Source: Stevenson 2004h

FIGURE 6-5. PALOMAR OBSERVATORY SITE INDICATING THE TERRAIN IN EXCESS OF A 25 PERCENT SLOPE

- At the Interstate 15 and California CA-76 junction, the 2002 ADT was 117,000 vehicles.

The 2002 ADT on CA-76 at Palomar Mountain Road (the estimated closest monitored site to the CA-76/South Grade Road intersection) was 3,600 vehicles. However, recent California Highway Patrol estimates bring the ADT closer to 10,000 vehicles.

6.4.2.8 Utilities and Services

Water Supply. The Observatory has its own wells for water supply. Two wells and five springs are located on site. The Observatory supports a 3,785-kl (1,000,000-gal) water storage tank on site (Sea West Enterprises, Inc. 2004a).

Palomar Observatory currently utilizes a 26,497-kl (1,000,000-gal) reservoir and a 190-kl (50,000-gal)-high tower pressure tank, licensed small water system. The average weekly water consumption at the Observatory is approximately 265 kl (70,000 gal). The majority of use occurs during the summer months, likely due to the public restrooms (estimated 100,000+ visitors per year) and irrigation systems for lawns within the Observatory. The Palomar Observatory is completely dependent on the limited local groundwater resource for its water supply (Sea West Enterprises, Inc. 2004b).

Electrical Power and Communications. San Diego Gas & Electric providing 12 kW at 480 volts of electricity to the Palomar Observatory. The Observatory infrastructure includes an underground power grid and backup generator. The generator is nearing capacity, with about 50 kVA available.

The Observatory's telecommunication infrastructure consists of an underground fiber optic backbone supported by two T1 lines (serviced by Cox Communications), regular telephone service (provided by Santa Barbara County), and an Ethernet radio link equivalent to a T3 line. Also, Caltech is currently funding the construction of a new microwave antennae communication, projected to be completed by year's end (Sea West Enterprises, Inc. 2004b).

Emergency Services and Fire Suppression.

Emergency Services. An updated Emergency services plan is available for Palmer Observatory.

As a result of the isolated work location of the Palomar Observatory, many miles from the nearest professional EMS, the employees at each observatory facility are the primary source of first aid assistance. There are no emergency medical facilities on Palomar Mountain. The plan recommends that each facility maintain a stock of emergency first aid supplies and that all employees have current first aid training and experience using the available equipment. In addition, the plan recommends that some staff members undergo EMT training and that each facility establish regular first aid drills and test emergency and safety equipment.

The closest hospital facility is Palomar Medical Center in Escondido. Police protection and ambulance services are provided by the County Sheriff, Rural Law Enforcement Division, which serves 6,734 km^2 (2,600 mi^2) – from the Riverside County line to the Mexican border –and is staffed by 19 resident deputies, each serving 389 km^2 (150 mi^2), and by the California Highway Patrol (CHP). Two Sheriff substations are located in Julian and Valley Center, and two offices, in Ranchita and Warner Springs. In September 2003, the CHP opened a satellite office in Pauma Valley to handle the increased traffic on CA-76 and on Valley Center Road. Sheriff's deputies and volunteer fire department personnel, who all have EMT training, also handle medical emergencies.

Fire Suppression. The fire suppression equipment at the Palomar Observatory consists of widely available handheld fire extinguishers, which consist of halon and dry chemical (A-B-C) types. Breathing apparatuses are also available. A 3,785-kl (1,000,000-gal) water storage tanks feeds the water system that is attached to the hydrants.

Fire protection is provided by the USFS during the fire season and by the local Palomar Mountain Volunteer Fire Department (CSA1100) all year, the fire department is located at S-7 and Crestline Road, approximately 9.7 km (6 mi) from the Observatory.

6.4.2.9 Socioeconomics

The total population of San Diego County as of 2003 was 2,951,600 and is forecasted to increase by an average of 1.5 percent per year to approximately 3,885,500 by the year 2020. San Diego County is the fourth most populated county in the nation, with a median household income of $49,649 and 2003 unemployment rate of 4.5 percent.

The closest metropolitan community to Palomar Observatory is Escondido, about 32 km (20 mi) to the southwest. Escondido's total 2003 population was 138,015, with approximately 45,800 housing units (single-family homes, multifamily units (apartments) and mobile homes) with a median household annual income of $45,165.

The current population of the North Mountain Subregion is 2,619, with the County estimating future population growth up to 5,281 by the year 2020. The existing population for Palomar Mountain, based on 2000 census data, is 245.

6.4.2.10 Climate/Meteorology/ Air Quality

Climate/Meteorology. Mean annual precipitation for the Palomar Observatory area is 71 cm (28.07 in). Snowfall accounts for additional 91 cm (36 in) per year, on average. The Palomar climate does not hold snow pack, and the largest average snow depth (occurring in January) is 5 cm (2 in). The mean freeze-free period for the Palomar Mountain region is about 200 to 250 days, and the mean annual temperature for the Observatory area is 13.3° C (55.9° F). Predominant wind direction for San Diego County is from the northwest.

Air Quality

Regulations. See Section 3.1.11.2 for a discussion of Federal regulations. Air quality for the Palomar Mountain area is also regulated under the California Code of Regulations (CCR), Title 17.

The San Diego County Air Pollution Control District (SDCAPCD) also regulates Palomar Mountain, incorporating the Federal regulation for Operating Permits under Title 40 CFR Part 70.

Air Quality Monitoring. Air quality in California is assessed on a county and regional basis. Both the U.S. Environmental Protection Agency (EPA) and California Air Resources Board have designated the SDAB as being in attainment of the NAAQS for SO_X, NO_X, and CO. San Diego County has been designated by the EPA to be unclassified with the Federal PM_{10} standard but has been designated by California Air Resources Board to be in nonattainment with the more stringent California standard for PM_{10}. The EPA has classified San Diego County as being in serious non-attainment for the Federal ozone standard.

> The Palomar Observatory site is within Zone A, an area designated by San Diego County Ordinance No. 6900 as "*…the circular area, fifteen (15) miles in radius centered on the center of Palomar Observatory…*" (SD Ordinance 2000b). Palomar Mountain is essentially free of the smog that is characteristic of southern California. In addition, air quality for Palomar Mountain is generally good to excellent.

6.4.2.11 Noise

According to statements in the USFS Environmental Statement for the Palomar Mountain Planning Unit (1976), "there is no identifiable sound disturbance associated with the lands within or adjacent to the unit….Affected areas can best be described as point source sounds originating from any one of the roads described…. and areas of concentrated use…" The USDA Palomar Mountain Planning Unit encompasses the Palomar Observatory, which has never been named as a source of noise within Federal, County, or State publications.

San Diego County publication, Code of Regulatory Ordinances, February 2000, mandates that for the Palomar Observatory, the maximum noise sources may not exceed the following standards:

- 50 dBA (7:00 a.m. to 10:00 p.m.)
- 45 dBA (10:00 p.m. to 7:00 a.m.) (see Table 6-13).

There are currently no on-site sources that exceed these standards.

TABLE 6-13. SAN DIEGO COUNTY NOISE ORDINANCE EXTERIOR NOISE STANDARDS

Zoning	Noise Metric	Noise Level Not to be Exceeded	
		7 A.M. to 10 P.M. (Daytime)	10 P.M. to 7 A.M. (Nighttime)
R-S, R-D, R-R, R-MH, A-70, A-72, S-80, S-81, S-87, S-88, S-90, S-92, R-V, and R-U Use regulations with a density of less than 11 dwelling units or less per acre.	L_{eq} (1-hour)	50 dBA	45 dBA
R-RO, R-C, R-M, C-30, S-86, R-V, and R-U Use regulations with a density of 11 or more dwelling units per acre.	L_{eq} (1-hour)	55 dBA	50 dBA
S-90 and all other commercial zones	L_{eq} (1-hour)	60 dBA	55 dBA
M-50, M-52, M-54	Anytime	70 dBA	70 dBA
S-82, M-58, and all other industrial zones	Anytime	75 dBA	75 dBA

Source: San Diego County Code, Section 36.404

a. Zoning Designations:
R-C, R-D, R-M, R-MH, R-R, R-RO, R-S, R-U, R-V = residential zones
A-70, A-72 = agriculture zones
M-50, M-52, M-54, M-58 = manufacturing/industrial zones
C-30 = commercial zone
S-80, S-81, S-82, S-86, S-87, S-90, S-92 = special purpose use zones

b. The noise limit shall be raised to the measures ambient noise level, if the ambient noise level is higher. The ambient noise level shall be measured when the alleged noise violation source is not operating.

c. The noise limit on the boundary between two zoning districts shall be the arithmetic mean of the respective noise limits, provided however, that the one-hour average sound level limit applicable to extractive industries (including but not limited to borrow pits and mines), shall be 75 dBA at the property line regardless of the zone where the extractive industry is actually located.

d. L_{eq} = equivalent sound levels

The North Mountain Subregional Plan, part XVIII of the San Diego County General Plan, dated April 2002 …“ that noise generated in rural areas can travel greater distances and is much more noticeable therefore potentially more irritating to residents….”

The Birch Hill and Palomar Mountain Sub-Divisions located south-southeast of the Palomar Observatory are the residential communities nearest to the site. Both communities are documented as approximately 4.8 km (3 mi) from the Observatory site, placing each development approximately 3.2 km (2 mi) from the southern observatory boundary line. There are also sparsely distributed private residences located near Bull Pasture and around the Crestline group, both of which lie within 3.2 to 4.8 km (2 to 3 mi) of the Observatory grounds.

6.4.2.12 Visual/Aesthetics

Palomar Observatory sits at an elevation of 1,676 m (5,500 ft) above sea level surrounded by elements of the Cleveland National Forest. Above the 1,524 m (5,000-ft) elevation the visual aspects of this terrain are described as follows:

> *…plateaus with mixed conifer stands and oak woodlands… large meandering meadowlands… found in protected valleys and occasionally on coastal facing slopes. Weathered rock outcroppings are frequently found in these meadowlands and timber stands, but contrast little with the land due to their low relief.*
>
> USFS-R5 1976

California State Highway 76 and Canfield Road to the south of the Observatory are designated as Eligible State Scenic Highways. Therefore, these local routes fall under the San Diego County General Plan Scenic Highway Element's goals and objectives, including protecting and enhancing scenic resources within both rural and urban scenic highway corridors by establishing and applying design standards to regulate visual quality of development within scenic highway corridors.

San Diego County also addresses their concerns over retaining and enhancing the rural character of the Palomar Mountain community in the North Mountain Subregional Plan (Part XVIII), which preserves existing natural landscape features. *"Natural landscape features include, but are not limited to: drainage courses, streams and other wetlands, ridgelines, rock outcroppings, native and old-growth vegetation and steep slopes greater than 25 percent"* (San Diego County 2002).

6.4.3 Potential Environmental Impacts of the Palomar Mountain Reduced Site Option

6.4.3.1 Land Use and Existing Activities

ROI for Land Use and Existing Activities. The ROI for assessing land use and existing activities includes areas near the Palomar Observatory, the Cleveland National Forest, and the travel routes used by construction and operation vehicles.

Land Use**.** *On-Site Construction and Installation Impacts.* The construction and installation of the Outrigger Telescopes at the Palomar Observatory would be subject to the review and approval processes of the San Diego County Department of Planning.

It is expected that the Outrigger Telescopes would fit within the basic guidelines for future projects at Palomar and would not result in any impact on designated land use at the Observatory.

Operation Impacts. The operation of the Outrigger Telescopes would be consistent with the current designated land use. There would be no impact associated with this phase of the Outrigger Telescopes Project.

Existing Activities. *On-site Construction and Installation Impacts.* Activities associated with the on-site construction and installation of the Outrigger Telescopes Project would occasionally delay traffic along State Route 76 and South Grade Road and temporarily increase noise levels. See sections related to transportation (Section 6.4.3.7) and noise (Section 6.4.3.12) impacts for additional information. The current viewscape of the proposed site and construction staging areas at the Palomar Observatory would be impacted temporarily by the presence of large construction equipment, materials, and telescope components. See Section

6.4.3.13 for more information regarding visual impacts.

Although some transportation, noise, and visual impacts would occur, it is anticipated that the Outrigger Telescopes Project would not result in a long-term conflict with or have a substantial impact on existing activities in the ROI. The ability to use the land within the ROI for astronomical and other scientific research, and a variety of recreational activities would remain consistent with the current use. In conclusion, all construction and installation activities on Palomar Mountain would be conducted in a manner that would allow the surrounding area to remain accessible for all existing activities.

Operation Impacts. It is anticipated that the Outrigger Telescopes would be both locally and remotely operated. The primary on-site activities would require a staff of trained individuals, likely to include mechanical engineer, electrical engineer, optic specialist, software specialist, two technicians and a supervisor. The resident science team would be two or three individuals depending on the activity and programs underway. Based on current plans, the average daily workforce would be six people.

All telescope and facility operations associated with the Outrigger Telescopes Project would be conducted in a manner that would preserve access to the surrounding area for all existing activities. The only continuing impact of the Outrigger Telescopes operations on existing activities would be the visual presence of the telescope enclosures. Thus, the impacts associated with this project phase would be insignificant.

Mitigation Measures. Refer to the following sections of this chapter for mitigation measures associated with transportation (Section 6.4.3.7), noise (Section 6.4.3.12), and visual (Section 6.4.3.13) impacts.

6.4.3.2 Cultural Resources

ROI for Cultural Resources. The ROI for the Outrigger Telescopes Project would be Palomar Mountain and access roads/trails and construction staging areas required for on-site construction and installation.

On-Site Construction and Installation Impacts. As stated in Section 6.3.2.2, no archaeological surveys have been conducted for either of the proposed Outrigger Telescopes locations. While there are currently no recorded sites for these land areas should the Outrigger Telescopes Project be implemented at Palomar Observatory, a cultural resources survey may be conducted.

It is anticipated that no culturally or historically significant sites would be found during construction. Therefore, on-site construction and installation would have no impact on cultural resources.

Operation Impacts. Operations of the Outrigger Telescopes would have minimal impact on cultural resources.

Mitigation Measures. In the absence of more detailed information indicating otherwise, an archaeological and cultural survey should be conducted prior to excavation according to a plan prepared detailing the steps to protect a discovery. If cultural or archaeological resources were to be found either prior to or during construction, appropriate protective measures and mitigation plans would be developed in accordance with applicable Federal and State regulation, and enforced.

6.4.3.3 Biological Resources

ROI for Biological Resources. The ROI for the Outrigger Telescopes Project consists of Palomar Mountain, any access roads/trails, and construction staging areas required for on-site construction and installation.

On-Site Construction and Installation Impacts. The Outrigger Telescopes Project would require the removal of trees in the immediate vicinity of the dome enclosures and combiner facility and along the access trail to the site.

Before any on-site construction, any and all critical habitat in the vicinity of project activities would be identified to ensure protection from disturbance. Signage, fencing, and field crew information sessions would be used to prevent disturbance and/or potential damage to the environment surrounding the project site access roads, and construction staging areas. Periodic inspection by qualified biologists and environmental scientists would ensure that construction site awareness and protection practices are enforced and maintained.

Operation Impacts. No biological impacts would occur as a result of operating the Outrigger Telescopes in the proposed project area.

Mitigation Measures. Within sensitive habitat areas, the removal of trees is often accompanied by a requirement for a one-for-one or two-for-one replacement with like species. If such a project requirement were imposed, the new trees would be planted at a reasonable distance from the facility and other potential project areas. Due to the ongoing efforts to reduce combustible fuels in and around structures, such as those being conducted by the San Diego Forest Area Safety Task Force, it is anticipated that the removal of trees at the Long Canyon Ridge (or Weather Tower Ridge) site for the construction of the Outrigger Telescopes facility probably would not require tree replacement within the immediate vicinity of the Palomar Observatory infrastructure or science facilities.

6.4.3.4 Hydrology, Water Quality, and Wastewater

ROI for Hydrology, Water Quality, and Wastewater. The ROI for hydrology, water quality, and wastewater is defined as the Mount Wilson summit and any areas where construction laydown activities would occur.

Water Use and Wastewater Treatment and Disposal for Construction Workers. Separate work crews would be required to prepare the Palomar Mountain site for installation, erection, and testing of the Outrigger Telescopes and related components. The workforce would vary in size from 25 and 35 workers and short-term peaks of 50 to 60 individuals. The overall construction term would likely be approximately 20 to 24 months, and it is assumed all workers would commute to the site daily. Water supply and wastewater collection and disposal for construction workers would be handled by completely self-contained portable facilities. and serviced on a routine basis. They would create no hydrologic or water quality impacts.

The requirement to wash down trucks, tools, forms, and equipment during concrete placement, however, could account for 38 to 76 kl (10,000 to 20,000 gal) of water during the construction period. If workers must mix concrete on site, the amount of water would increase substantially. Wash-down basins/containers would be used to contain the wash water, which would be allowed to evaporate. The remaining solid residues would be disposed of off site.

Surface Runoff from the Palomar Observatory. Surface runoff from the construction site and laydown areas would be controlled through appropriate erosion and drainage controls as specified in applicable environmental permits and regulations. Impacts would be expected to be small lasting only for the 20–24 month construction period.

Subsurface Disposal of Domestic Wastewater. To evaluate wastewater impacts of Outrigger Telescopes operation, it is assumed that the volume of water currently trucked to Palomar Observatory approximates the volume of domestic wastewater generated. Based on available information, the Palomar Observatory uses about 1,060 kl (280,000 gal) per month (Sea West Enterprises, Inc. 2004a). It is estimated that operation of the Outrigger Telescopes Project would add about 9.5 kl per month (2,500 gal per month), a 1 percent increase to existing wastewater volumes. It is assumed the current septic system could handle this without modification, resulting in no significant impact.

Mitigation Measures. As noted appropriate runoff and erosion controls would be implemented during on-site construction and installation. No mitigation measures would be needed for operation.

6.4.3.5 Solid Waste and Hazardous Materials Management

Solid Waste.

On-Site Construction and Installation Impacts. On-site construction activity would generate debris consisting of wood, scrap insulation, packaging material, excess concrete, and other construction-related wastes. This debris would be disposed of in large roll-off containers sized to accommodate debris generated over several days of construction. No other construction waste process would be disposed of in these containers. It is assumed that all construction debris would be removed from the site by the construction contractor and taken to an authorized disposal facility at least weekly during the construction period in accordance with best construction management practices. Occasional high winds could potentially blow construction debris from the containers and disperse the material about the site and onto the surrounding area. Unsecured building materials and equipment could also be susceptible to wind dispersal.

Operation Impacts. Operation of the Outrigger Telescopes would not generate substantially greater solid waste (trash) than that currently generated by the Palomar Observatory.

As an approximation, it is assumed that the amount of trash generated in operating the Outrigger Telescopes would increase proportionately to the current average number of workers and visitors to the Palomar Observatory. It is anticipated that operation of the Outrigger Telescopes will require an additional four staff per day on average, representing an increase of about 1 percent over the current 24 staff and 278 visitors per day. This small increase would likely have little to no impact on the existing solid waste management system in place at the Palomar Observatory.

Because the Outrigger Telescopes do not have habitable spaces, they would not require trash containment systems. The existing infrastructure at the Palomar Observatory would be used to collect trash stemming from operation of the Outrigger Telescopes.

Mitigation Measures. It is assumed that the Outrigger Telescopes on-site construction and installation contract(s) would contain provisions regarding the management of solid wastes. Those provisions would be enforced.

Hazardous Materials Management.

On-Site Construction and Installation Impacts. The bulk of hazardous materials brought on site during construction of the Outrigger Telescopes likely would be diesel fuel and motor oil(s) for construction equipment. No mercury would be used for the Outrigger Telescopes (CARA 2001d). The earthwork phase it is anticipated that up to several hundred gallons of fuel for excavation equipment may be stored for short periods of time within skid-mounted or truck-mounted transfer tanks. Following adopted best management practices guidelines, all such fuels and oil would display MSDS information and warning labels. The storage of all hazardous liquids would be restricted to protected locations within the project site. Spill containment facilities would be provided for all such storage areas to avoid potential contamination of soils in or around the construction zones (typically, such containment systems provide a capacity of 150 percent of all stored liquids). A program of regular inspections of containers and reviews of handling procedures would ensure compliance. A program of spill containment and reporting would be submitted to the site authority before the delivery or offloading of any hazardous materials (Sea West Enterprises, Inc. 2004b). The handling guidelines and reporting procedures for other construction-related hazardous materials such as paints, solvents, and lubricants, would also follow best management practices. Hazardous materials management activities during on-site construction and installation would be expected to have no environmental impact.

Operation Impacts. Operation of the Outrigger Telescopes would require periodic maintenance parallel to that associated with the Palomar Observatory telescopes.

The quantities and use frequency of hazardous materials during the operation of the Outrigger Telescopes would be limited. MSDS information, and warning and handling data sheets would be on file at the Observatory, and storage would be in compliance with Caltech and San Diego County Department of Environmental Health policy. No internal combustion engines or turbines would be associated with the operation of the interferometer and therefore the need for fuels and motor oils would be limited, primarily for to staff use of the personal automobiles. It is anticipated that the Palomar Observatory maintenance equipment and vehicles already on hand would be able to service this site. There are no airborne pollutants associated with the operation of an optical interferometer.

The optics surfaces for the telescopes and light beam paths are most often comprised of a molecular aluminum coating that degrades over time. Based on historical evidence, mirror-recoating operations for the Outrigger Telescopes probably would be necessary on a 1- or 2-year cycle at this facility. This would probably be performed at the Palomar Observatory facility. The quantity of etching solution HCl used to clean the mirror substrate, is limited (several gallons, diluted) and is delivered to the site on an as-needed basis for scheduled cleaning/coating operations. Waste HCl is neutralized using a calcium carbonate powder. The Palomar Observatory has conducted optics coating operations on site and has both the cleaning facilities and vacuum chambers to accomplish these tasks. A small quantity, (typically less than 19l (5 gallons)) of HCl is stored at the Observatory machine shop.

Chapter 4 describes typical maintenance and operations activities for the Outrigger Telescopes. Table 6-14 compares current hazardous materials use at the Palomar Observatory with the anticipated requirements of the Outrigger Telescopes.

The Outrigger Telescopes facility would develop and maintain hazardous materials management and spill plans as required by applicable Federal and State regulations and permits. Personnel would be trained in the implementation of these plans.

Mitigation Measures. It is assumed that all on-site construction and installation contract(s) would contain provisions regarding hazardous material management similar to those identified in Appendix F of this EIS.

6.4.3.6 Geology, Soils, and Slope Stability

ROI for Geology, Soils, and Slope Stability. The ROI for accessing the potential impacts of implementing the Outrigger Telescopes Project on geology, soils, and slope stability would be Palomar Mountain and areas where construction staging and laydown activities would occur.

On-Site Construction and Installation Impacts. As stated in Section 4.1.2, under the current design configuration, the Outrigger Telescopes would consist of a set of four (4) 1.8-m (6-ft) telescopes and enclosures arranged around a central combiner facility. The final collective footprints of the four telescope enclosures, light beam foundations, and the combiner building would be approximately 1,301 m^2 (14,000 ft^2). The access trail (suitable for light vehicular traffic) would involve a terrain disturbance of approximately an additional 1,115 to 1,394 m^2 (12,000 to 15,000 ft^2) from the point of connection with the existing Observatory Access Road to the Outrigger Telescopes site. The soil and rock types found within the boundary of the Palomar Observatory are mostly friable and would require the use of only conventional earthwork and grading equipment for removal. Rubber-mounted backhoes, articulated loaders, track-mounted excavators, and drill rigs would likely remove and move the earth in this type and scale of project. During the earthwork, transport vehicles, including 26,000 GVW bobtail trucks and 25-ton capacity truck and trailer combination rigs, would transport, handle, dispose of and deliver soil and aggregate, as required.

Disturbed and excavated soils would be stockpiled as required on site(s) selected to minimize the impact on surrounding terrain and potential erosion during inclement weather. All disturbed slopes and construction excavations would be protected from erosion and degradation following accepted best management practices in accordance with applicable permits and regulations. Areas of the site where soils would be compacted by construction activities would be restored during final contouring of the site. It is anticipated that impacts to geology, soils, and slope stability would be small and not significant.

Operation Impacts. There would no geology, soils, or slope stability impacts associated with the operation of the Outrigger Telescopes on Palomar Mountain.

Mitigation Measures. It is anticipated that when the construction activities related to the Outrigger Telescopes Project are completed, areas disturbed by the project including slopes and drainage channels would be restored to a natural condition.

6.4.3.7 Transportation

ROI for Transportation. Transportation refers to the movement of vehicles along

TABLE 6-14. EFFECT OF OUTRIGGER TELESCOPES ON HAZARDOUS MATERIALS USE AT THE PALOMAR OBSERVATORY

Material Class	Current Use at Palomar Observatory	Anticipated Requirements of Outrigger Telescopes
Cooling	378 l (100 gal) Polyethylene glycol	No glycol used
Fuel	Gasoline(7.6 kl (2,000 gal), Propane 38 kl (10,000 gal), Diesel, Kerosene	No fuel required; emergency power provided by existing infrastructure
Hydraulic Fluid	In use 189 l (50 gal)	No hydraulic fluid used
Lubricants	Motor oil, in use	Gear oil 66 l (917 gal) per Outrigger Telescope and grease used; no additional lubricants stored on site
Mercury	No mercury used	No mercury used
Mirror De-coating & Re-coating	Done on site; less than 20 l (5 gal) acid solution stored on site	(Up to six) Mirrors de-coated with hydrochloric acid every two years; no additional chemical stored on site
Motor Oil	In use and storage 946 l (250 gal) total	No motor oil used
Other Compressed Gases	Acetylene, Argon, Carbon dioxide, Helium, Nitrogen 5.7 kl (1500 gal), Oxygen	Carbon dioxide used for snow cleaning monthly; 8.6-kl (2,270 gal) bottle stored in each Outrigger Telescope
Paints & Related Solvents	Paints 570 l (150 gal); solvent 946 l, (250 gal) total	Used as needed; no additional paint and solvents stored on site

Source: Sea West Enterprises, Inc. 2004b

roads. The ROI for assessing transportation impacts includes the Palomar Observatory and other areas affected by on-site construction, installation, and operations including the Cleveland National Forest and vehicle travel routes.

On-Site Construction and Installation Impacts. The daily workforce anticipated for the construction and installation phases of the Outrigger Telescopes Project varies between an average of 25 to 35 workers and a peak of 60 workers (Sea West Enterprises, Inc. 2004b). During construction of the Outrigger Telescopes, it is anticipated that daily construction related vehicular trips, ADT, would vary from 50 to 75 depending on the size of the workforce and the amount of equipment and material delivered. At peak periods of activity the ADT might exceed 100 vehicles per day. This traffic volume would be much lighter than the 730 ADT for Palomar Mountain Road intersection with CA Highway 76 (the estimated closest monitored site to the CA-76/South Grade Road intersection) at 3,000 vehicles. However, recent estimates bring the ADT closer to 10,000 vehicles (Sea West Enterprises, Inc. 2004b). The closest regional arterial to the Palomar Observatory is Interstate 15. The 2002 ADT-volume for the I-15 at the point on intersection with CA-76 was 117,000 vehicles (Sea West Enterprises, Inc. 2004b). It is anticipated that the paved sections along the state routes provide sufficient durability to handle traffic associated with such a construction project at this time.

The access trail needed to enter the site for construction activities would remain in use for the life of the Outrigger Telescopes Project. As such, it would be designed to handle the traffic and loads anticipated as a part of the operations and maintenance of this facility over an extended period of time. The access trail would follow the ridgeline from the existing observatory corridor to the array site, a distance of 37 m (120 ft). Based upon the current design configurations, it is estimated that between 230 and 382 m^3 (300 and 500 yd^3) of material would be involved in the excavation and earthwork operations for this access way.

Vehicular traffic associated with construction and installation activities would occasionally delay traffic along State Route 76 and South Grade Road. The greatest traffic delays would occur when the telescopes and domes are trucked up the mountain. This would only occur intermittently and thus should not regularly interfere with normal traffic flow. While construction vehicles are slow and difficult to maneuver, they would not have any long-term adverse impact on the overall traffic flow.

Construction traffic within the ROI would create minor short-term increases in dust and emissions and temporarily increase noise levels. See Section 6.4.3.11 for impacts associated with air quality and Section 6.4.3.12 for information on noise impacts.

It is also anticipated that the current viewscape of the proposed site and construction staging areas at Palomar Mountain would be temporarily impacted by the presence of large construction vehicles. See Section 6.4.13 for more information regarding visual impacts. Overall, impacts would be expected to be short-term and minor during this phase of the Outrigger Telescopes Project.

Transportation of minimal quantities of hazardous materials (*e.g.*, diesel fuel, motor oil(s), paints, and solvents) and wastes would be expected throughout the course of constructing, installing, and operating the Outrigger Telescopes on Palomar Mountain. Handling of these materials would be guided by best management practices. No impact is anticipated.

Operation Impacts. Operation of the Outrigger Telescopes at the Palomar Observatory would be expected to add 6 to 12 vehicular trips per day along State Route 76 and South Grade Road (Sea West Enterprises, Inc. 2004b). This slight increase in traffic associated with this project phase would create a very small impact on transportation.

Mitigation Measures. During the construction and installation phase of the Outrigger Telescopes Project, heavy truck trips would be scheduled during off-peak hours to avoid interfering with normal traffic flow along State Route 76 and South Grade Road.

All road cuts and fills will be designed to minimize the potential for erosion and concentrated runoff.

6.4.3.8 Utilities and Services

ROI for Utilities and Services. The ROI for assessing utilities and services impacts of the Outrigger Telescopes Project includes the Palomar Observatory, the Cleveland National Forest, and travel routes used by construction and operation vehicles. This section analyzes potential impacts on water supply, electrical supply and communications, and emergency services and fire suppression.

Water Supply. *On-Site Construction and Installation Impacts.* The Outrigger Telescopes Project would result in an increase in the demand for potable water due to the increased number of workers at the site and the implementation of dust controls. The construction contractor(s) would transport this additional water to the summit area. Therefore, there would be no impact on the existing water supply at the Palomar Observatory.

Operation Impacts. Current water consumption at the Palomar Observatory is approximately 265 kl (70,000 gal) per week (Sea West Enterprises, Inc. 2004b). The additional water demand associated with operating the Outrigger Telescopes would not be expected to substantially impact the existing water supply. However, consumption during drought periods may be a significant operations consideration.

Electrical Power and Communications. *On-Site Construction and Installation Impacts.* On-site generators provided by the construction contractor would provide power needs. Only a minor increase in demand for electrical power on the current distribution system would occur during this period. This increase would have no impact on the existing electrical supply system.

Operation Impacts. The electrical power requirements of each Outrigger Telescope are estimated to be 30 kW (UH IfA 2001a). If the Outrigger Telescopes were placed here, the current electrical supply would be insufficient. Additional power could be made available with the installation of another transformer (Sea West Enterprises, Inc. 2004b).

The existing communications system for the Palomar Observatory would support the needs of the Outrigger Telescopes Project. In addition, Caltech is currently funding the construction of a new microwave antennae communication network, projected to be completed by the end of 2004 (Sea West Enterprises, Inc. 2004b).

Emergency Services and Fire Suppression. *On-Site Construction and Installation Impacts*. The need for emergency services is related to the number of personnel at the summit and the types of work or activities they perform. As described in Section 6.4.1.2, the workforce anticipated for this project varies from between 25 to 35 workers and a peak of 60 workers.

The construction contractor would have the primary responsibility for ensuring worker safety. In the event of an injury or accident, the existing emergency plan that applies to the Palomar Observatory would be adequate to provide on-site treatment or evacuation off the summit. No additional equipment, personnel, or modification of emergency procedures is anticipated to be required during on-site construction. There would be no impact associated with this phase of the Outrigger Telescopes Project.

Operation Impacts. As described in Section 6.4.1.3, the average daily workforce would be six people. Existing emergency services would be adequate to accommodate this small increase in personnel.

The Outrigger Telescopes would include fire alarm systems and suppression equipment. Operations personnel would be trained in fire emergency procedures.

6.4.3.9 Socioeconomics

ROI for Socioeconomics. The ROI for assessing the potential socioeconomic impacts from implementing the Outrigger Telescopes Project would be Palomar Mountain and at any areas where construction staging and laydown activities would occur.

On-Site Construction and Installation Impacts.

On-site construction and installation would generate about 25 to 35 construction jobs over the 20–24 month construction period, possibly peaking at 60 jobs. A number of these workers may come from nearby local communities which would have a moderate but beneficial impact on construction jobs in those areas for the 20–24 month construction period. Some highly specialized workers needed to perform highly skilled activities during commissioning of the Outrigger Telescopes may originate from locations far removed from Mount Wilson. The local communities would be likely to benefit temporarily from even these jobs through worker expenditures for lodging and subsistence in those communities.

Operation Impacts. It is anticipated that the level of activity at the Palomar Observatory would not be substantially impacted as a result of the construction of the Outrigger Telescopes. Some of the eight jobs created by operation may be filled locally. Some operation workers may also move into the local area purchasing or renting homes establishing themselves and their immediate families in the local communities resulting long-term impacts to local/regional socioeconomics would be minimal.

Mitigation Measures. Given the relatively limited workforces involved in construction and operation, no socioeconomic mitigation measures would be necessary.

6.4.3.10 Air Quality

ROI for Air Quality. The ROI for accessing the potential impacts on air quality would be Palomar Mountain and any areas where construction staging and laydown activities would occur.

On-Site Construction and Installation Impacts. During construction of the Outrigger Telescopes Project, fugitive dust from terrain modification and construction activities would be minimized by approved grading, excavation, and vehicular traffic dust abatement programs, typically by adding moisture to project excavations and traffic corridors. The addition of crushed rock material to the temporary haul roads and staging areas along with dust suppression measures employed by the construction contractor would also minimize dust generated by construction activities. No significant impact to ambient air quality would be expected.

Operation Impacts. Air quality at Palomar Mountain would return to virtually existing conditions once the Outrigger Telescopes are installed. Scientists traveling to the project site would cause slight increase in vehicular traffic and emissions. Overall, air quality at Palomar Mountain is good. The Outrigger Telescopes operation would have no impact on air quality.

Mitigation Measures. The construction contractor(s) would be required to employ appropriate dust control measures, maintain motorized vehicles in good repair, and abide by applicable vehicular emissions standards.

6.4.3.11 Noise

ROI for Noise. The ROI for assessing noise impacts from the Outrigger Telescopes Project includes the Palomar Observatory and other areas affected by on-site construction, installation, and operations including the Cleveland National Forest and vehicle travel routes.

On-Site Construction and Installation Impacts. Noise would result from excavation, trenching, grading, installation of sheet piling for utility protection, installation of junction boxes, construction of light and air pipes, the construction of telescope dome foundations, and the installation of telescopes and domes.

Actual noise levels would be dependent upon the mix and duration of construction equipment usage and the construction methods employed. The vibrating hammer, which would be used to install the sheet piling required for utility protection, would most likely be the loudest piece of equipment used during construction (approximately 95 dBA at 15 m (50 ft)). It is anticipated that the use of this equipment would be short-term, lasting one or two days in duration. There would be no blasting during the construction process.

Transport of materials and equipment and daily construction traffic would also create noise. Increased noise levels would occur intermittently along routes used by construction and operation equipment. Most heavy construction equipment would be stored on site during the construction period. See Section 6.4.3.7 for additional transportation information.

This intermittent and short-term noise could result in minor disturbances to scientists, staff, recreational users, and other visitors within the ROI. However, any noise disturbances or interruptions would end once on-site construction and installation is completed. Therefore, moderate noise impacts would be associated with this project phase.

Operation Impacts. Operation of the Outrigger Telescopes would result in a negligible increase in noise and a minor increase in vehicular traffic noise along State Route 76 and South Grade Road. See Section 6.4.3.7 for additional vehicular traffic information. In conclusion, there would be no impact associated with this phase of the Outrigger Telescopes Project.

Mitigation Measures. Any noise impacts on construction workers would be mitigated by adherence to appropriate OSHA standards.

6.4.3.12 Visual/Aesthetics Resources

ROI for Visuals/Aesthetic Resources. The ROI for visual impacts consists of the Palomar Observatory area and nearby areas from which the Outrigger Telescopes would be visible.

On-Site Construction and Installation Impacts. Visual impacts during construction could be significant to some viewers. These impacts would be largely temporary however, persisting for only the 20–24 month construction period.

Operation Impacts. San Diego County also addresses its concerns over retaining and enhancing the rural character of the Palomar Mountain community in their North Mountain Subregional Plan (Part XVIII) by preserving existing natural landscape features. *"Natural landscape features include, but are not limited to: drainage courses, streams and other wetlands, ridgelines, rock outcroppings, native and old-growth vegetation and steep slopes greater than 25 percent"* (San Diego County 2002).

The Outrigger Telescopes, if constructed on either the Weather Tower Ridge Site or the Long Canyon Ridge site, would not be visible from Canfield Road or State Highway 76.

As a function of its 41 m (135-ft) height and 42 m (137-ft) diameter, the Hale Telescope dome is visible from several regional vantage points at substantial distances from the Observatory. If the Weather Tower Ridge site is selected, potential off-site view planes, (similar to those impacted by the Hale Telescope enclosure), would be examined. It is reasonable to assume that due to both overall reduced height and substantially smaller diameters, the Outrigger Telescope enclosures would not be as prominent visually as the Hale facility.

Should the Long Canyon Ridge site be selected for the Outrigger Telescopes, the potential view plane would include lower elevations to the northwest and to the north, including portions of the communities of Temecula and Aguanga in Riverside County (approximately 32 km and 10 km (20 mi and 6 mi) from the site respectively).

6.4.3.13 Environmental Justice

Onsite construction, installation, and operation of the Outrigger Telescopes at either of the Palomar Observatory sites would not result in disproportionately adverse impacts on minority or low-income populations.

6.4.3.14 Cumulative Impacts

Past and Present Activities. The origins of the Palomar Observatory date to the 1920s, when the astronomical observations from the 254-cm (100-in) Hooker telescope at Mount Wilson demonstrated the need for a larger instrument. After numerous locations were tested for atmospheric quality, Palomar Mountain was selected as the official site in 1934. During that same year, Caltech, the recipient of a grant from the International Education Board (a Rockefeller Foundation), began purchasing property on Palomar Mountain for the Observatory.

Construction for the 508-m (200-in) telescope began in the mid-1930s, but was delayed by World War II. The 508-m (200-in) Hale Telescope was not completed until 1948. Other telescopes have been added to the Observatory and include the 122-m (48-in) Oschin Telescope, the 46-m (18-in) Schmidt Telescope, and the 152-m (60-in) reflecting telescope.

Table 6-15 summarizes the history of Palomar Mountain.

Reasonably Foreseeable Future Activities. A proposed landfill site located approximately 29 km (18 mi) to the west may have a future effect on the air quality at the Observatory. As former Associate Director of the Caltech site commented:

> "San Diego County has announced plans to open a new solid waste landfill in the north county area—with six candidate sites located within 32 km (20 mi) of the observatory. Dust from grading at the landfill (which will be required daily) and pollution from vehicles hauling trash (130 trucks a day, each carrying about 50,000 lbs (25 tons) of material) threaten to increase the amount of airborne particles in the atmosphere over the observatory."
> (Sea West Enterprises, Inc. 2004b)

Summary of Cumulative Impacts. There are no known plans for construction and operation of any additional telescopes at the Palomar Observatory site for the foreseeable future.

On-site construction, installation, and operation of the Outrigger Telescopes at the Palomar Observatory site would have little incremental impact on the whole. Construction would, even at the estimated 20–24 months, have little adverse impact on the observatory site. Visitors and staff on the mountain would experience minor inconveniences at various times during construction. From an environmental impact perspective, construction of the Outrigger Telescopes would not combine with past and present sources of environmental impact sufficient to result in

TABLE 6-15. HISTORY OF PALOMAR OBSERVATORY

Year	Event
1908	Under the supervision of George Hazle, and through grants from the Carnegie Institution of Washington, the Mount Wilson 152-cm (60-in) telescopes is completed and see first light.
1917	Despite challenges, the 254-cm (100-in) telescope is completed in 1917.
1928	Six million dollars was secured for construction of an observatory including the 508-cm (200-in) telescope.
1929	Bernard Schmidt designs a photographic survey telescope.
1930-34	With increasing light pollution at Mount Wilson, Hale selects Palomar Mountain for the home of the 508-cm (200-in) telescope.
1934-36	Combining with Corning Glass Works, a design was made possible for the 508-cm (200-in) mirror using a new glass blend called Pyrex.
1934-36	Overcoming design and engineering concepts, the design of the mirror now includes an oil bearing system, and a mirror support cell.
1936	The construction on the 508-cm (200-in) dome begins; the mirror blank is shipped from New York to Pasadena where it is grinded and polished at Caltech.
1936-47	The 46 cm (18-in) (Schmidt) telescope is in operation.
1937	The 508-cm (200-in) telescope parts are assembled at various sites and are shipped to the Mountain for assembly.
1938	Work on the 122-cm (48-in) Schmidt is started.
1941	Telescope production halts due to World War II.
1947-49	The 508-cm (200-in) mirror is transported from Pasadena to Palomar.
1948	The 508-cm (200-in) telescope is dedicated on June 3rd and named in honor of George Ellery Hale.
1948	First light is achieved on the 122 cm (48–in) Schmidt telescope.
1949	Edwin Hubble takes the first photographic exposure with the 508-cm (200-in) telescope; in October the telescope is made available to astronomers.

exceedances of existing environmental standards, either Federal or State.

Operation of the Outrigger Telescopes may incrementally impact the existing potable water supply system at the Palomar Observatory. These potential advance impacts, if verified during more detailed planning and design of the Outrigger Telescopes Project, can be avoided by upgrading or supplementing the exiting systems.

6.4.4 Adverse Environmental Impacts That Cannot be Avoided for Palomar Observatory

Adverse impacts are divided into short- and long-term effects. Short-term effects are generally associated with construction, and prevail only for the duration of the construction period. Long-term effects generally follow completion of the improvements, and are permanent. Effects that can be considered both adverse and unavoidable are described below for both short- and long-term effects:

6.4.4.1 Unavoidable Adverse Short-Term Effects

- Operation of construction equipment, trucks and worker vehicles would temporarily impede traffic along the roads serving Palomar Mountain during the construction period. This minor impact would be intermittent and temporary and would cease once construction is completed. The transport of large machinery and large Outrigger Telescope components could temporarily impede traffic flow and result in temporary traffic delays on State Route 76 and South Grade Road. These impacts would be limited to a brief period of time at the beginning and end of construction.
- Increased vehicular traffic and internal combustion engines on heavy equipment would result in the generation of air emissions. These emissions would be localized and would not impact the overall air quality on Palomar Mountain. Emissions from road construction-related vehicles and equipment would cease once construction is completed.
- Heavy construction equipment operations on site would lead to the temporary generation of small dust particles. Although daily mitigation measures would be taken to significantly reduce these impacts, some soil would occasionally be subject to erosion during periods of high winds.
- Heavy construction equipment operations on site and the transport of large machinery along the roads serving Palomar Mountain would lead to intermittent and temporary increases in noise levels. The transport of large machinery would be limited to a brief period of time at the beginning and end of construction.
- Construction equipment, related materials, and temporary structures, located on site during the construction phase of the project would affect the visual quality of the area for some viewers. Because all equipment and excess materials would be removed at completion of construction any changes to the visual quality of the area would be temporary.

6.4.4.2 Unavoidable Adverse Long-Term Effects

- The presence of the Outrigger Telescopes would affect the visual quality of the area for some viewers using the area around the

Observatory. To minimize this visual impact, the Outrigger Telescopes would be painted to blend into the natural surroundings to the extent possible.

- Workforce traffic associated with the Outrigger Telescopes would result in minor increases in noise levels along the roads serving Palomar Mountain, including State Route 76 and South Grade Road.

6.4.5 Incomplete or Unavailable Information

Sufficient information exists at this stage in development of the Reduced Science Option at the Palomar Observatory to determine whether or not the potential exists for significant environmental impacts would occur as a result of implementation of the Outrigger Telescopes Project.

Assuming the Reduced Science Option were to move forward at the Palomar Observatory three areas would require particular attention in facility design and planning: (1) a culture resources survey of the project sites may be needed and a suitable protection and mitigation plan developed prior to start of construction; (2) determinations of the capability of the existing Palomar Observatory potable water supply system to meet the needs of an operational Outrigger Telescopes Project; and (3) a pre-construction site survey for threatened or endangered species and critical habitat may be needed and if appropriate, development of protective and mitigation measures to be implemented during construction and/or operation.

6.4.6 Relationship Between Short-Term Uses of the Human Environment and the Maintenance and Enhancement of Long-Term Productivity

The Outrigger Telescopes Project would be an important addition to California's research and development industry, which can provide broadened employment opportunities for State residents. The productivity of Palomar Mountain, however, cannot be measured in purely traditional economic ways. Palomar Mountain is a natural and scientific resource that belongs to all State residents and future generations. The use of the mountain as an astronomical observatory need not be incompatible with its use by recreational users and tourists.

Any assessment of the comparative productivity of Palomar Mountain's role as an astronomical observatory, as compared to its role as a natural laboratory for other scientists or an aesthetic and recreational resource, should take into consideration that astronomy and other activities on Palomar Mountain are not mutually exclusive. Upon removal, long-term productivity would not be affected.

6.4.7 Irreversible and Irretrievable Commitment of Resources

The Outrigger Telescopes Project would require a commitment of natural, physical, and human resources. In all of these categories, an irreversible and irretrievable commitment of resources would occur. A commitment of resources is irreversible when primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources neither renewable nor recoverable for future use. Construction of the Outrigger Telescopes would consume energy and building materials. In general, natural and propane gas and diesel fuel would be used directly by construction equipment and also to generate electrical power and heat. The electrical power requirements of each Outrigger Telescope are estimated to be 30 kW (UH IfA 2001a). The additional electrical demand would be supplied by the electrical utility supplying the observatories largely through fossil-fuel power generation. Petroleum products would continue to be consumed during operation; however, quantities would be significantly less than during construction. Construction material such as steel, cement, and aggregate would also be expended. These physical resources are generally in sufficient supply, and their commitment to the project would not have an adverse effect on their availability. In some instances, at least some material resources such as structural steel and copper wiring could be reclaimed, recycled, and reused.

In terms of human resources, trade and non-skilled laborers would be used during the development, construction, and operation of the Outrigger Telescopes. Labor is generally not considered to be a resource in short supply, and commitment to the project would not have an adverse effect on the continued availability of these resources.

6.5 COMPARISON OF REDUCED SCIENCE OPTIONS

Table 6-16 provides a summary comparison of the Reduced Science Options.

TABLE 6-16. SUMMARY OF MOUNT WILSON OBSERVATORY AND THE PALOMAR OBSERVATORY REDUCED SCIENCE OPTIONS

Impact Area	Mount Wilson Observatory	Palomar Observatory
Cultural Resources	On-site construction, and installation—Not likely to impact any cultural or archaeological resources. Operation—Would not impact cultural or historic resources within the project area.	On-site construction, and installation—Not likely to impact any cultural or archaeological resources. Operation—Would not impact cultural or historic resources within the project area.
Biological Resources	On-site construction and installation—Would require the removal of trees in the immediate vicinity of the dome enclosures. Operation—No substantial impact would occur.	On-site construction and installation—Would require the removal of trees in the immediate vicinity of the dome enclosures. Operation—No substantial impact would occur.
Hydrology, Water Quality, and Wastewater	On-site construction and installation—No water quality impacts anticipated. Operation—Potentially adverse impact on wastewater operations.	On-site construction and installation—Small hydrologic and water quality impact anticipated. Operation— No substantial impact would occur.
Solid Waste and Hazardous Materials Management	On-site construction and installation—No impacts despite temporary increases in solid waste generation and hazardous material use. Operation— Little, if any, impact since increases in solid waste generation and hazardous materials use anticipated to be minor.	On-site construction and installation—No impacts despite temporary increases in solid waste generation and hazardous material use. Operation—Little, if any, impact since increases in solid waste generation and hazardous materials use anticipated to be minor.
Geology, Soils, and Slope Stability	On-site construction and installation—No substantial impact on geology or slopes at the site. Operation—No impact.	On-site construction and installation—Small impact anticipated. Operation—No impact.
Land Use and Existing Activities	On-site construction and installation—Land Use: Expected to be consistent with designated use. Existing Activities: No long-term conflict or substantial impact. Operation—Land use: Consistent with the current designated land use. Existing Activities: The incremental impact would be small.	On-site construction and installation—Land Use: Expected to be consistent with designated use. Existing Activities: No long-term conflict or substantial impact. Operation—Land use: Consistent with the current designated land use. Existing Activities: The incremental impact would be small.
Transportation	On-site construction and installation—Small increases in traffic along the Angeles Crest Highway (State Route-2) and Mount Wilson Road would be expected. Short-term minor impacts. Operation—Slight increase in traffic would create a small impact.	On-site construction and installation—Small increases in traffic along State Route 76 and South Grade Road would be expected. Short-term minor impacts. Operation— Slight increase in traffic would create a small impact.

TABLE 6-16. SUMMARY OF MOUNT WILSON OBSERVATORY AND THE PALOMAR OBSERVATORY REDUCED SCIENCE OPTIONS (CONTINUED)

Impact Area	Mount Wilson Observatory	Palomar Observatory
Utilities and Services	On-site construction and installation—Small increases would be accommodated by existing utilities and services. Operation—Because of the limited amount of water on site, a new well and storage tanks may be required. In addition, the project could have a substantial impact on the electrical and communications supply systems.	On-site construction and installation—Small increases would be accommodated by existing utilities and services. Operation—Except for electrical utilities, increases would be minimal and would be accommodated by existing facilities. Additional power could be made available with upgrades. Water supply could be limited during drought periods.
Socioeconomics	On-site construction and installation—Moderate beneficial impact to the local community. Operation—Mimimal long-term positive impact on local/regional socioeconomics.	On-site construction and installation—Moderate beneficial impact to the local community. Operation—Mimimal long-term positive impact on local/regional socioeconomics.
Air Quality	On-site construction and installation—Small impact on ambient air quality. Operation—No impact.	On-site construction and installation—Small impact on ambient air quality. Operation—No impact.
Noise	On-site construction and installation—Intermittent short-term noise increases would create a moderate impact. Operation—No impact.	On-site construction and installation—Intermittent short-term noise increases would create a moderate impact. Operation—No impact.
Visual/Aesthetics	On-site construction and installation—Temporary visual intrusion to the cultural landscape. Operation—Outrigger Telescopes would not be visible off-mountain, visual impacts would be small.	On-site construction and installation—Visual impacts during construction could be significant to some viewers. Operation—Long-term visual intrusion depending on vantage point.

6.6 CHAPTER 6 REFERENCES

AAA of So. Cal	Automobile Club of Southern California, *California Regional Series: San Diego County Map.*
APCD	County of San Diego Air Pollution Control District (APCD), *Air Quality in 2002.*
APCD 2002	San Diego Air Pollution Control District, *Five Year Air Quality Summary*, Jul. 2002, http://www.sdapcd.co.san-diego.ca.us/air/reports/reports.html.
APCD 2004	County of San Diego Air Pollution Control District (APCD), *County of San Diego Air Pollution Control District: Organization/Contact List*, 2004.
Applicant 1994	*Applicant's Statement of Disclosure of Certain Ownership Interests on Applications for Land Use Amendments and Permits Pursuant to Ordinance No. 4544 (N.S.)*, 2 Sep. 1994.
Brucato 1991	Brucato, R.J., *Site Preservation at Palomar Observatory*, 1991, International Astronomical Union Colloqium, No. 112.
Brucato 1994	Brucato, R.J., *Major Use Permit Application — Palomar Observatory*, 19 Sep. 1994.
CA Dept. of Conservation 2003	California Dept. of Conservation, *Natural Hazards Disclosure: Seismic Hazards Zones*, 2003, http://gmw.consrv.ca.gov/shmp/SHMPrealdis.asp.
Cadman 2004a	Cadman, B., *Waste and Material (Mount Wilson)*, 27 Apr. 2004, Mount Wilson (e-mail).
Cadman 2004b	Cadman, B., *Phone Log with Bob Cadman (Mount Wilson) re: occupancy*, 28 Apr. 2004, (Phone Conversation).
Caltech 2003	California Institute of Technology, *Palomar Observatory Emergency Action Plan*, 19 Jan. 2003.
Caltech 2004	California Institute of Technology, *Caltech Astronomy: History: 1908-1949*, 19 Apr. 2004, http://www.astro.caltech.edu/palomar/history.

Caltech 2004a — California Institute of Technology, *Caltech Astronomy: Palomar Observatory*, 5 Apr. 2004, http://www.astro.caltech.edu/cgi-bin/pf.cgi?fname=/palomar/overview.html.

Caltech 2004b — California Institute of Technology, *Caltech Astronomy: Palomar Observatory — Driving Directions*, 6 Apr. 2004, http://www.astro.caltech.edu/cgi-bin/pf.cgi?fname=/ palomar/driving.html.

CDF 2003 — California Dept. of Forestry & Fire Protection (CDF), *CDF Incident Information: Cedar Fire — FINAL UPDATE*, 5 Nov 2003, http://www.fire.ca.gov/cdf/incidents/Cedar%20Fire_120/incident_info.html.

CDF 2004 — California Dept. of Forestry & Fire Protection (CDF), *CDF Incident Information: Eagle Fire*, 7 May 2004, http://www.fire.ca.gov/cdf/incidents/Eagle%20Fire_132/ incident_info.html.

Chagala 1994 — Chagala, J.C., *Letter of Major Use Permit Approval*, 18 Nov. 1994, County of San Diego Dept. of Planning and Land Use (Letter).

Chester and Strong 2003 — Chester, T. and Strong, J., *Angeles Crest Highway (State Route2)*, 1999-2003, http://tchester.org /sgm/places/sr2.html.

Colavita 2004a — Colavita, M., *Meeting discussing Outrigger Array Phase II status with Jim Fanson (JPL) and Eric Simison (SeaWest)*, 13 Apr. 2004, (Meeting).

Colavita 2004b — Colavita, M., *Phase II Info — Estimated Staff Requirements for Outrigger Array*, 12 Apr. 2004, (e-mail).

Deeds 1934-1936 — California Institute of Technology, *Evidence of Legal Parcel (Deeds)*, 1934-1936.

DEH 2003a — County of San Diego: Dept. of Environmental Health (DEH), *Palomar Observatory Hazardous Materials Disclosure*, 31 Oct. 2003, http://www.co.san-diego.ca.us/deh/ permits/index.html.

DEH 2003b	County of San Diego: Dept. of Environmental Health (DEH), *Palomar Observatory Hazardous Materials Waste Stream*, 31 Oct. 2003, http://www.co.san-diego.ca.us/deh/permits/index.html.
DOT 2002	California Dept. of Transportation, *San Diego County Economic Forecast (2004)*, Dec. 2002.
DOT 2004	California Dept. of Transportation, *2002 All Traffic Volumes on California State Highways*, 2004, http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/index.htm.
DOT 2004a	California Dept. of Transportation, *California Scenic Highway Mapping System: Los Angeles County*, 16 Apr. 2004, http://www.dot.ca.gov/hq/landarch/scenic_highways/ index.htm.
DOT 2004b	California Dept. of Transportation, *California Scenic Highway Mapping System: San Diego County*, 16 Apr. 2004, http://www.dot.ca.gov/hq/landarch/scenic_highways/ sdiego.htm.
DOT 2004c	California Dept. of Transportation, *The California Scenic Highway System*, 16 Apr. 2004, http://www.dot.ca.gov/hq/landarch/scenic/1.htm.
DPLU 1994	County of San Diego Dept. of Planning and Land Use, *Hearing on California Institute of Technology/Palomar Observatory; Major Use Permit P94-021, Palomar Mountain*, 9 Nov. 1994.
DPLU 1994a	County of San Diego Dept. of Planning and Land Use, *Notice of Negative Declaration (Draft)*, 18 Oct. 1994.
DPLU 1994b	County of San Diego Dept. of Planning and Land Use, *Notice of Negative Declaration*, 18 Oct. 1994.
DPLU 2003	County of San Diego Dept. of Planning & Land Use, *County of San Diego Fact Sheet*, Dec. 2003.
DPW 1994	County of San Diego Dept. of Public Works, *Major Use Permit/Canefield Road/Palomar Mountain*, 18 Oct. 1994.

DPW 1999 — San Diego County Dept. of Public Works, *Public Road Standards*, 14 Jul. 1999.

DPW 1999a — San Diego County Dept. of Public Works Mapping Section, *North Mountain Subregional Area Land Use Element Map*, 10 Aug. 1999.

Drieschman 1994 — Drieschman, W.S., *Project Facility Availability (Local Fire Dept.)*, 4 Sep. 1994.

Dykens 2001 — Dykens, M., *Plants that Attract Butterflies: Astragalus oocarpus (San Diego Milk Vetch)*, 2001, San Diego Natural History Museum, http://www.sdnhm.org/valentien/astra-oocarpus.html.

EPA 2001a — United States Environmental Protection Agency, *Campo-Cottonwood Creek Sole Source Aquifer*, Dec. 2001, http://www.epa.gov/safewater/swp/ssa/pdfs/map_ssa_campo _cottonwood.pdf.

EPA 2001b — United States Environmental Protection Agency, *Ocotillo-Coyote Wells Sole Source Aquifer*, Dec. 2001, http://www.epa.gov/safewater/swp/ssa/pdfs/map_ssa_ocotillo _coyote_wells.pdf.

EPA 2002 — United States Environmental Protection Agency, *U.S. Environmental Protection Agency: Technology Transfer Network Ozone Implementation: Wind Roses for Selected Areas*, 30 Jul. 2002, http://www.epa.gov/ttn/naaqs/ozone/areas/wind.htm.

EPA 2003 — United States Environmental Protection Agency, *Designated Sole Source Aquifiers in EPA Region IX*, 29 Oct. 2003, http://www.epa.gov/safewater/swp/ssa/reg9.html.

EPA 2004 — United States Environmental Protection Agency, *Sole Source Aquifer Protection Program*, 29 Mar. 2004, http://www.epa.gov/safewater/ssanp.htm.

Epodunk 2004 — Epodunk.com, *Epodunk — Population Overview-California>All Counties>Los Angeles County>Altadena*, 2004, http://www.epodunk.com/cgi-bin/popInfo.php?locIndex=9785.

Escondido 2004a	City of Escondido, *City of Escondido — Escondido at a Glance: Demographics*, 22 Jan. 2004, http://www.ci.escondido.ca.us/glance/demographics/index.html.
Escondido 2004b	City of Escondido, *City of Escondido Community Profile 2004-2005*, 22 Apr. 2004, http://www.ci.escondido.ca.us/econdev/profile/cover.html.
Essig 2004	Essig Museum of Entomology, *Laguna Mountains Skipper (Lepidoptera: Hesperiidae)*, 1 Apr. 2004, http://essig.berkeley.edu/endins/ruralis.htm.
FAST 2004a	San Diego FAST, *San Diego County Forest Area Safety Taskforce (FAST) Roster*, 22 Apr. 2004.
FAST 2004b	San Diego FAST, *San Diego County Forest Area Safety Taskforce (FAST): 03/25/04 Minutes*, 25 Mar. 2004.
FAST 2004c	San Diego FAST, *San Diego County Forest Area Safety Taskforce (FAST): 04/22/04 Meeting Agenda*, 22 Apr. 2004.
FAST 2004d	San Diego FAST, *San Diego County Forest Area Safety Taskforce (FAST): Outreach & Education Committee: 4/19/04 Minutes*, 19 Apr. 2004.
FAST 2004e	San Diego FAST, *San Diego County Forest Area Safety Taskforce Organization Chart*, 22 Apr. 2004.
Forsythe 2004	Forsythe, B., *Phone Log with Bob Forsythe (San Diego County) re: Gregory Canyon Landfill*, 20 Apr. 2004, (Phone Conversation).
Garstang 2002	Garstang, R.H., *Light Pollution at Mount Wilson and at Palomar in 1931-1932*, Jun. 2002, The Astrophysical Journal, Vol. 510.
Gladson and Tsai 1998	Gladson, R.A. and Tsai, S.S., *Soils and Engineering-Geologic Investigation for Proposed 350-Foot Radio Tower Video Road, Mount Wilson, County of Los Angeles, California*, 29 May 1998, GeoSystems.

Glass and Elliot 1972	Glass, I.S. and Elliot, J.L., *An Interferometric Seeing Test on Mount Wilson*, Aug. 1972, The Astronomical Journal, Vol. 77, No. 6.
Hazard 1994	*Hazardous Waste and/or Substance Site Verification*, 26 Aug. 1994.
Hinshaw 1994	Hinshaw, P., *Application for Major Use Permit — California Institute of Technology*, 30 Aug. 1994.
Jastrow 1994	Jastrow, B., *Seeing on Mount Wilson (Memo)*, 5 Dec. 1994, Georgia State University (memo).
Koltz 1994	Koltz, A., *Botanical Survey of Cal Tech Palomar Observatory*, 12 Sep. 1994, Pacific Southwest Biological Services, Inc..
La Canada Flintridge 2004	La Canada Flintridge, *About La Canada Flintridge: City Facts: Statistics*, 14 Apr. 2004, http://www.lacanadaflintridge.com/about/stats1.htm & stats2.htm.
La Canada Flintridge 2004a	La Canada Flintridge, *La Canada Flintridge: City Resources*, 14 Apr. 2004, http://www.lacanadaflintridge.com/city/cityserv.htm.
Lahaye et al. 1994	Lahaye, W.S., Gutierrez, R.J., Akcakaya, H.R., *Spotted Owl Metapopulation Dynamics in Southern California*, Oct. 1994, Journal of Animal Ecology, Vol. 63, No. 4.
LASD 2004	Los Angeles County Sheriff's Dept., *Los Angeles County Sheriff's Dept. — Crescenta Valley Station*, 23 Apr. 2004, http://lasd.org/stations/for1/cresenta-valley/index.html.
Lassaline 1999	Lassaline, D., *PIA Waiver*, 1 Aug. 1999.
Laverty and Hartzell 2000	Laverty, L. and Hartzell, T., *A Report to the President in Response to the Wildfires of 2000*, 8 Sep. 2000, National Fire Plan, http://www.fireplan.gov/reports/8-20-en.pdf.
Lawrence Consulting 1987	Lawrence Consulting Group, *Draft Environmental Impact Report for Palomar Mountain Subdivision*, 24 Mar. 1987.
Lawrence Consulting 1988	Lawrence Consulting Group, *A Supplement to the Environmental Impact Report for Palomar Mountain Subdivision*, 29 Feb. 1988.

LEA 2004 — Solid Waste Local Enforcement Agency (LEA), *Solid Waste Local Enforcement Agency: Proposed Gregory Canyon Landfill*, 12 Apr. 2004, County of San Diego.

Legal 2004a — Legal Information Institute, *Safety of Public Water Systems — Definitions (Title 42, Chapter 6A, Subchapter XII, Part A, Sec. 300f)*, 30 Mar. 2004, http://www4.law.cornell.edu/uscode/42/300f.html.

Legal 2004b — Legal Information Institute, *Safety of Public Water Systems — Sole Source Aquifer Demonstration Program (Title 42, Chapter 6A, Subchapter XII, Part C, Sec. 300h-6)*, 30 Mar. 2004, http://www4.law.cornell.edu/uscode/42/300h-6.html.

Locke 2004 — Locke, D., *North Mountain Subregion Population*, 12 Apr. 2004, County of San Diego Dept. of Planning & Land Use (e-mail).

Los Angeles County 2000 — Los Angeles County Dept. of Regional Planning, *2000 Los Angeles County Demographic Profile*, 4 Oct. 2000, http://planning.co.la.ca.us/rsrch_LACountyProfile.pdf.

Los Angeles County 2004 — Los Angeles County, *Los Angeles County: Statistical Data*, 23 Apr. 2004, http://lacounty.info/statistical_information.htm.

MainTour 2003 — MainTour.com, *Tour Palomar Mountain – Palomar Observatory*, 2003, http://www.maintour.com/socal/palomar.htm.

MapQuest 2004a — MapQuest.com, *"Hospitals" within 25 miles of Palomar Mountain, CA*, 14 Apr. 2004, http://www.mapquest.com.

MapQuest 2004b — MapQuest.com, *Driving Directions from JPL to Mount Wilson Observatory*, 5 Apr. 2004, http://www.mapquest.com.

MapQuest 2004c — MapQuest.com, *Driving Directions from JPL to Palomar Observatory*, 6 Apr. 2004, http://www.mapquest.com.

MapQuest 2004d — MapQuest.com, *Driving Directions from Mount Wilson to La Canada Flintridge*, 23 Apr. 2004, http://www.mapquest.com.

MapQuest 2004e — MapQuest.com, *Driving Directions from Mount Wilson to Verdugo Hills Hospital*, 15 Apr. 2004, http://www.mapquest.com.

McAlister 1995 — McAlister, H.A., *Site Selection for the CHARA Array*, 31 Mar. 1995, Georgia State University.

McAlister 2004 — McAlister, H.A., *Mount Wilson Forecast*, 19 Apr. 2004, Georgia State University (correspondence).

McAlister and Simison 2004 — McAlister, H.A. and Simison, E., *Phone Log with Hal McAlister (GSU CHARA)*, 29 Mar. 2004, (Phone Conversation).

McIntyre 1998 — McIntyre, M.J., *Archaeological Reconnaissance Report (Townes Interferometer Project)*, 28 Sep. 1998, USDA Forest Service Angeles National Forest Supervisor's Office.

Miles and Goudey 1997a — Miles, S.R. & Goudey, C.B., *Ecological Subregions of California: Subsection M262Bd: San Gabriel Mountains*, Sep. 1997, USDA Forest Service Pacific Southwest Region, San Francisco.

Miles and Goudey 1997b — Miles, S.R. & Goudey, C.B., *Ecological Subregions of California: Subsection M262Bo: Palomar — Cuyamaca Peak*, Sep. 1997, USDA Forest Service Pacific Southwest Region, San Francisco.

Moreland 2004 — Moreland, J., *CHP Ups Traffic Patrols in Valley Center*, 6 Mar. 2004, North County Times, http://www.nctimes.com.

Moriarty 2004 — Moriarty, J., *Palomar Mountain Road Classification Map*, 12 Apr., County of San Diego Dept. of Planning & Land Use.

MSN 2004 — www.mapblast.com, *MSN Maps & Directions*, 2004, MSN Maps & Directions, http://www.mapblast.com.

Mount Wilson 2003a — Mount Wilson Observatory, *Online Tour of Mount Wilson — 150-Foot Solar Tower Telescope*, 3 Dec. 2003, http://www.mtwilson.edu/vir/150/150.htm.

Mount Wilson 2003b — Mount Wilson Observatory, *Online Tour of Mount Wilson — 60-Foot Solar Tower Telescope*, 3 Dec. 2003, http://www.mtwilson.edu/vir/60/60.htm.

Mount Wilson 2003c	Mount Wilson Observatory, *Online Tour of Mount Wilson — Monastery*, 3 Dec. 2003, http://www.mtwilson.edu/vir/mon/mon.htm.
Mount Wilson 2003d	Mount Wilson Observatory, *Online Tour of Mount Wilson — Museum*, 3 Dec. 2003, http://www.mtwilson.edu/vir/mus/mus.htm.
Mount Wilson 2003e	Mount Wilson Observatory, *Online Tour of Mount Wilson — The Snow Solar Telescope*, 3 Dec. 2003, http://www.mtwilson.edu/vir/snow/snow.htm.
Mount Wilson 2003f	Mount Wilson Observatory, *Mount Wilson Observatory*, 3 Dec. 2003, http://www.mtwilson.edu/main.htm.
Mount Wilson 2003g	Mount Wilson Observatory, *Mount Wilson Observatory Virtual Tour — 100-Inch Hooker Telescope*, 3 Dec. 2003, http://www.mtwilson.edu/vir/100/100.htm.
Mount Wilson 2003h	Mount Wilson Observatory, *Mount Wilson Observatory Virtual Tour — 24-Inch TIE Telescope*, 3 Dec. 2003, http://www.mtwilson.edu/vir/24/24.htm.
Mount Wilson 2003i	Mount Wilson Observatory, *Mount Wilson Observatory Virtual Tour — 60-Inch Telescope*, 3 Dec. 2003, http://www.mtwilson.edu/vir/60i/60i.htm.
Mount Wilson 2003j	Mount Wilson Observatory, *Mount Wilson Observatory Virtual Tour — CHARA Interferometer Array*, 3 Dec. 2003, http://www.mtwilson.edu/vir/chara/chara.htm.
Mount Wilson 2003k	Mount Wilson Observatory, *Mount Wilson Observatory Virtual Tour — Front Gate*, 3 Dec. 2003, http://www.mtwilson.edu/vir/frontgate/gate.htm.
Mount Wilson 2003l	Mount Wilson Observatory, *Mount Wilson Observatory Virtual Tour — ISI Interferometer*, 3 Dec. 2003, http://www.mtwilson.edu/vir/isi/isi.htm.
Mount Wilson 2003m	Mount Wilson Observatory, *Mount Wilson Observatory Virtual Tour — Parking Lot*, 3 Dec. 2003, http://www.mtwilson.edu/vir/lot/lot.htm.

Mount Wilson 2003n	Mount Wilson Observatory, *Mount Wilson Observatory Virtual Tour — Pavilion*, 3 Dec. 2003, http://www.mtwilson.edu/vir/pav/pavilion.htm.
Mount Wilson 2003o	Mount Wilson Observatory, *Science Projects*, 3 Dec. 2003, http://www.mtwilson.edu/sci/science.htm.
Mount Wilson 2004	Mount Wilson Observatory, *Mount Wilson Observatory — Visiting Information*, 5 Apr. 2004, http://www.mtwilson.edu/vis/visit.htm.
Mount Wilson Procedure 2004	*Emergency Procedures (Mount Wilson)*, 19 Apr. 2004.
Murphy 2004a	Murphy, S., *Canfield Rd. & Hwy 76 as Eligible Scenic Hwys*, 16 Apr. 2004, County of San Diego Dept. of Planning & Land Use (e-mail).
Murphy 2004b	Murphy, S., *South Grade Road is not a Scenic Hwy*, 19 Apr. 2004, County of San Diego Dept. of Planning & Land Use (e-mail).
Murphy 2004c	Murphy, S., *Palomar Major Use Permit*, 16 Apr. 2004, County of San Diego Dept. of Planning & Land Use (e-mail).
MWOA 2004	Mount Wilson Observatory Association, *Mount Wilson Observatory Association*, 31 Mar. 2004, http://www.mwoa.org.
NICC 2004	National Interagency Coordination Center (NICC), *Incident Management Situation Report*, 7 May 2004, National Interagency Fire Center, http://www.nifc.gov/news/sitreprt.pdf.
Nickerman 2003	Nickerman, J., *Abbot Solar Tower Site, Mt Wilson: Mobile Lab Installation: Biological Evaluation/Assessment and Botany Technical Report for Northrop Grumman Electronic Systems*, 28 Jan. 2003, Barden Environmental.
Niesenson et al. 1984	Niesenson, P., Noyes, R., and Shao, M., *Is Mount Wilson the Best Interferometric Site in the World*, 1984, BAAS, Vol. 16, No. 4.
Notice 1994a	*Notice to Applicants re: California Building Standards Codes*, 1 Sep. 1994.
Notice 1994b	*Notice to Pala-Pauma Subregion Sponsor Group*, Sep. 1994.

NPS 2004 — National Park Service, *Wild & Scenic Rivers by State — California*, 2 Feb. 2004, http://www.nps.gov/rivers/wildriverslist.html.

NRCS — USDA Natural Resources Conservation Service, *NRCS National Water & Climate Center: Climate Products: Climate Data: Wind Rose Data*, http://www.wcc.nrcs.usda.gov/climate/windrose.html.

NSF 1996 — National Science Foundations, *Draft Environmental Assessment — The CHARA Array, Mt. Wilson, California*, , Prepared by Woodward-Clyde Consultants, Apr. 1996.

OES 2004 — San Diego County Office of Emergency Services (OES), *San Diego County Emergency Services: Community Protection/Evacuation Planning Committee: 04/27/04 Meeting Agenda*, 22 Apr. 2004.

Osborne 2003 — Osborne, K.H., *Adult Survey for Laguna Mountain Skipper (Pyrgus ruralis lagunae) on the Laguna Mountains, Palomar Mountains, and San Jacinto Mountains, Riverside and San Diego Counties*, 3 Jun. 2003, U.S. Dept. of the Interior: Fish & Wildlife Service.

Pala 2000 — Pala Band of Mission Indians, *Pala Band of Mission Indians: Legislation: Save Gregory Canyon*, 9 Oct. 2000, http://www.palaindians.com/legislation.htm.

Pala 2000a — Pala Band of Mission Indians, *Pala History*, 3 Jan. 2001, http://www.palaindians.com/history.

Palomar Mtn. Lodge 2004 — Palomar Mountain Lodge, *Palomar Mountain Lodge Bed and Breakfast*, 14 Apr. 2004, http://www.palomarmountainlodge.com.

Pasadena 2003 — City of Pasadena, *Pasadena Demographics*, 11 Nov. 2003, http://www.ci.pasadena.ca.us/statistics.asp.

PCR 2002 — PCR Services Corporation, *Gregory Canyon Environmental Impact Report*, Dec. 2002, San Diego County Dept. of Health, http://www.sdcounty.ca.gov/deh/chd/gc_feir.html.

Pedersen 2004	Pedersen, B., *Phone Log with Ben Pedersen (Southern California Edison)*, 27 Apr. 2004, (Phone Conversation).
Pickles 2004	Pickles, A., *Outrigger Phase II — Future Plans*, 20 Apr. 2004, California Institute of Technology (e-mail).
Pickles 2004a	Pickles, A., *Phone Log with Andrew Pickles (Palomar) re: socioeconomic/operating costs*, 28 Apr. 2004, (Phone Conversation).
Pique 2004	Pique, M., *Palomar Mountain, San Diego County, California*, 9 Apr. 2004, http://www.palomarmountain.com.
Pratt 1999	Pratt, G.F., *Laguna Mountains Skipper in the Cleveland National Forest 1999 Survey*, 10 Dec. 1999, University of California Riverside.
Preliminary 1994	*Preliminary Floodplain Evalutation*, 26 Aug. 1994.
Pryor 2002	Pryor, G.L., *Biological Resource Mapping Requirements*, 4 Jun. 2002, County of San Diego Dept. of Planning & Land Use.
Public Notice 1994	*Public Notice Certification*, 1 Sep. 1994.
Reiser 1994	Reiser, C.H., *Cleveland horkelia [horkelia clevlandii (E. Greene) Rydb.]*, May 1994, Sierra Club, http://sandiego.sierraclub.org/rareplants/122.html.
SAIC 2003	Science Applications International Corporaiton (SAIC), *Proposed Magdalena Ridge Observatory Environmental Impact Statement — Draft*, Sep. 2003.
San Diego County 2001	County of San Diego, *Applicant's Guide Preparation of Public Notice Package*, Jul. 2001.
San Diego County 2001a	County of San Diego, *Public Notice Procedure*, Jul. 2001.
San Diego County 2002	County of San Diego, *San Diego County General Plan: Part XVIII North Mountain Subregional Plan*, 17 Apr. 2002.
San Diego County 2003a	County of San Diego, *Applicant's Guide to Major Use Permits/Modifications/Minor Deviations*, Oct. 2003.

San Diego County 2003b — County of San Diego, *Application for an Environmental Initial Study (AEIS) (for Applications NOT Covered by a Previously Completed CEQA Document)*, Apr. 2003.

San Diego County 2003c — County of San Diego, *County of San Diego 2004-09 Strategic Plan Summary*, 23 Jan. 2003.

San Diego County 2003d — County of San Diego, *Environmental Review Update Application (for Applications Covered by a Previously Completed CEQA Document)*, Apr. 2003.

San Diego County 2003e — County of San Diego, *Instructions for Completing Environmental Initial Study (AEIS) Application Form*, Apr. 2003.

San Diego County 2003f — County of San Diego, *Resource Protection Study*, Apr. 2003.

San Diego County 2004 — County of San Diego, *Population Summary (December 2002)*, 12 Apr. 2004, http://www.sdcounty.ca.gov/cnty/cntydepts/landuse/planning/GP2020/pubs/popsummary.htm.

SCAQMD 2003 — South Coast Air Quality Management District, *Air Quality Standards Compliance Report — 2002*, Sep. 2003.

SCAQMD 2004 — South Coast Air Quality Management District, *Current Readings at Air Monitoring Subregions: Source/Receptor Area List*, 16 Apr. 2004, http://www.aqmd.gov/telemweb/ reading.html.

SCE 2000 — Southern California Edison, *SCE Launches Major Bark Beetle Tree Removal Effort*, 2000, http://www.sce.com/sc3/003_safety_first/003m_bark_beetle/default.htm.

SCTCA 2004 — Southern California Tribal Chairman's Association, *La Jolla Band of Luiseno Indians*, 8 Apr. 2004, http://www.sctca.net/tribalsite/lajolla.html.

SD County Road 2004 — *San Diego County Route S6*, 6 Apr. 2004, http://www.pacificnet.net/~faigin/CA-HWYS/Countys.html.

SD Ordinance 2000a	County of San Diego, *San Diego County Code of Regulatory Ordinances: Title 3 Public Safety, Morals and Welfare: Division 6 Disorderly Conduct, Places and Publications: Chapter 4 Noise Abatement and Control*, Feb. 2000, American Legal Publishing Corporation, http://www.amlegal.com.
SD Ordinance 2000b	County of San Diego, *San Diego County Code of Regulatory Ordinances: Title 5 Building and Building Regulations: Division 9 Light Pollution Code*, Feb. 2000, American Legal Publishing Corporation, http://www.amlegal.com.
SD Planning 1994	San Diego County Planning Commission, *Decision of the Planning Commission on the Application of California Institute of Technology/Palomar Observatory Application Number P94-021*, 18 Nov. 1994.
SDAPCD App 2004	*San Diego Air Pollution Control District Permit/Registration Application*, 24 Feb. 2004.
SDC Assessor	County of San Diego, *San Diego County Assessor's Maps — Palomar Observatory.*
SDC GP VI	County of San Diego, *San Diego County General Plan: Part VI Scenic Highway Element*, 10 Dec. 1986.
SDC GP VIII	County of San Diego, *San Diego County General Plan: Part VIII Noise Element*, 17 Dec. 1980.
SDC GP X	County of San Diego, *San Diego County General Plan: Part X Conservation Element*, 17 Apr. 2002.
SDHS 2004	San Diego Historical Society, *Timeline of San Diego History*, 27 Apr. 2004, http://www.sandiegohistory.org/timeline/timeline.htm.
Sea West Enterprises, Inc. 2004a	Alternative Site Assessment Outrigger Array of the Outrigger Telescopes Project December 1, 2003.
Sea West Enterprises, Inc. 2004b	Alternative Site Assessment: Phase 2. Outrigger Array of the Outrigger Telescopes Project. April 29, 2004.

Servin 2003	Servin, T., *Meteorological Wind Roses: Data for the ISCST3 Air Quality Model*, 8 Jul. 2003, California Air Resources Board Planning & Technical Support Division.
SFSU 2004	San Francisco State University: California Studies Program, *Luiseno/Cahuilla Group*, 27 Apr. 2004, San Francisco State University, http://bss.sfsu.edu/calstudies/native webpages/luiseno.html.
Smartpages 2004	Smartpages.com, *Smartpages.com: Ambulance Service near La Canada Flintridge, CA*, 23 Apr. 2004, http://www.smartpages.com.
Smartpages 2004a	Smartpages.com, *Smartpages.com: A.D. Hinshaw Associates*, 6 Apr. 2004, http://www.smartpages.com.
Stevenson 2004a	Stevenson, C., *Campo-Cottonwood Creek Sole Source Aquifer (with comment)*, Apr. 2004, County of San Diego Dept. of Planning & Land Use.
Stevenson 2004b	Stevenson, C., *Palomar Mountain Archaeology*, 16 Apr. 2004, County of San Diego Dept. of Planning & Land Use (e-mail).
Stevenson 2004c	Stevenson, C., *Palomar Mountain Observatory: Rainfall*, County of San Diego Dept. of Planning & Land Use.
Stevenson 2004d	Stevenson, C., *Palomar Observatory Parcel Map: Annual Rainfall*, 7 Apr. 2004, County of San Diego Dept. of Planning & Land Use.
Stevenson 2004e	Stevenson, C., *Palomar Observatory Parcel Map: Noise Requirements*, 7 Apr. 2004, County of San Diego Dept. of Planning & Land Use.
Stevenson 2004f	Stevenson, C., *Palomar Observatory Parcel Map: Paleontology*, 7 Apr. 2004, County of San Diego Dept. of Planning & Land Use.
Stevenson 2004g	Stevenson, C., *Palomar Observatory Parcel Map: Prime Agriculture*, 7 Apr. 2004, County of San Diego Dept. of Planning & Land Use.
Stevenson 2004h	Stevenson, C., *Palomar Observatory Parcel Map: Slopes (greater than 25%)*, 7 Apr. 2004, County of San Diego Dept. of Planning & Land Use.

Stevenson 2004i	Stevenson, C., *Palomar Observatory Parcel Map: Soils*, 7 Apr. 2004, County of San Diego Dept. of Planning & Land Use.
Stevenson 2004j	Stevenson, C., *Palomar Observatory Parcel Map: Sub-Basins*, 7 Apr. 2004, County of San Diego Dept. of Planning & Land Use.
Stevenson 2004k	Stevenson, C., *Palomar Observatory Parcel Map: Vegetation*, 7 Apr. 2004, County of San Diego Dept. of Planning & Land Use.
Stevenson 2004l	Stevenson, C., *Palomar Observatory Parcel Map: Watershed*, 7 Apr. 2004, County of San Diego Dept. of Planning & Land Use.
Stevenson 2004m	Stevenson, C., *Palomar Observatory Parcel Map: Wetlands*, 7 Apr. 2004, County of San Diego Dept. of Planning & Land Use.
Stevenson 2004n	Stevenson, C., *Pre-application Conference Worksheet*, 12 Apr. 2004, County of San Diego Dept. of Planning & Land Use.
Stevenson 2004o	Stevenson, C., *Preliminary Review of Resources for IS/EA Preparation*, 7 Apr. 2004, County of San Diego Dept. of Planning & Land Use.
Stevenson 2004p	Stevenson, C., *Road Map w/Road Standards to Palomar Observatory*, 12 Apr. 2004, County of San Diego Dept. of Public Works.
Stevenson 2004q	Stevenson, C., *Summary of County of San Diego Public Road Standards*, 1992, County of San Diego Dept. of Public Works.
Teare and Thompson 2002	Teare, S.W. and Thompson, L.A., *Long-Term Periodic Behavior in the Subarcsecond Seeing at Mount Wilson Observatory*, Jan. 2002, Publications of the Astronomical Society of the Pacific, Vol. 114.
Teare et al. 2000	Teare, S.W., Thompson, L.A., Gino, M.C. and Palmer, K.A., *Eight Decades of Astronomical Seeing Measuremenets at Mount Wilson Observatory*, Nov. 2000, Publications of the Astronomical Society of the Pacific, Vol. 112.
Thicksten 2004	Thicksten, R., *Palomar Facility Rehabilitation Needs*, 19 Apr. 2004, California Institute of Technology (e-mail).

Thicksten 2004a	Thicksten, R., *Palomar Site Names & Septic System*, 6 Apr. 2004, California Institute of Technology (e-mail).
Thicksten 2004b	Thicksten, R., *Outrigger Alternate Site Considerations Phase II*, 6 Apr. 2004, California Institute of Technology (e-mail).
Thicksten 2004c	Thicksten, R., *Palomar Wind Roses, Electricity, Communication, Solid Waste, Future Plans*, 19 Apr. 2004, California Institute of Technology (e-mail).
Thicksten 2004d	Thicksten, R., *Palomar Observatory Organizational Charts*, 6 Apr. 2004, California Institute of Technology.
Thicksten 2004e	Thicksten, R., *Phone Log with Robert Thicksten (Cal Tech) re: Palomar Observatory Water Consumption*, 30 Apr. 2004, (Phone Conversation).
Thicksten 2004f	Thicksten, R., *Phone Log with Robert Thicksten (Cal Tech) re: Palomar Mountain HAZ MAT*, 27 Apr. 2004, (Phone Conversation).
Tsai and Carnegie 2000	Tsai, Steve S. and Carnegie, Vincent J., *Updated Soils & Engineering-Geologic Investigation… 400-Foot Radio Tower and a Transmitter Building… Mount Wilson, County of Los Angeles, California*, 27 Jul. 2000, GeoSystems.
Tsai and Carnegie 2001	Tsai, Steve S. and Carnegie, Vincent J., *Response to the County of Los Angeles… 400-Foot Radio Tower and a Transmitter Building… Mount Wilson, County of Los Angeles, California*, 27 Jun. 2001, GeoSystems.
U.S. Census 2003	U.S. Census Bureau American Community Survey Office, *2002 American Community Survey Profile — Population and Housing Profile: San Diego County, California*, Sep. 2003.
U.S. Congress 2003	108th Congress of the United States of America, *Healthy Forest Restoration Act of 2003 (H.R. 1904)*, 7 Jan. 2003.
U.S. Indian Affairs 2004	United States Dept. of Interior: Bureau of Indian Affairs: Southern California Agency, *Mailing Addresses for Tribal Leaders for Reservations under Southern California Agency*, 20 Apr. 2004.

U.S. Labor Statistics 2004	United States Bureau of Labor Statistics, *2002 Metropolitan Area Occupational Employment and Wage Estimates — San Diego, CA MSA*, 2 Dec. 2004, http://www.bls.gov/oes/2002/oes_7320.htm.
USD 2000	University of San Diego, *Indian Reservations in San Diego County*, Oct. 2000, http://www.sandiego.edu/nativeamerican/reservations.html.
USFS 1987	USDA Forest Service, *Angeles National Forest Land Management Plan*, 1987, USDA Forest Service Pacific Southwest Region, San Francisco.
USFS 2001	USDA Forest Service, *Revised Land and Resources Management Plans for Angeles, Cleveland, Los Padres, and San Bernardino National Forests, CA*, 24 Sep. 2001, Federal Register, Vol. 66, No. 185.
USFS 2004	USDA Forest Service, *USDA Forest Service Directory Entry*, 23 Apr. 2004, USDA Forest Service, http://www.fs.fed.us/cgi-bin/address_detail_net?voc4n2pCgNgyYaI4.
USFS 2004a	USDA Forest Service Region 5, *Angeles National Forest: About Us*, 26 Apr. 2004, USDA Forest Service Pacific Southwest Region, San Francisco, http://www.fs.fed.us/ r5/angeles/about/.
USFS 2004b	USDA Forest Service, *Angeles National Forest: Recreational Activities*, 23 Apr. 2004, USDA Forest Service Pacific Southwest Region, San Francisco, http://www.fs.fed.us/r5/angeles/recreation/.
USFS 2004c	USDA Forest Service Region 5, *History of Cleveland National Forest*, 27 Apr. 2004, USDA Forest Service Pacific Southwest Region, San Francisco, http://www.fs.fed.us/r5/cleveland/about/cnf.history.htm.

USFS 2004d	USDA Forest Service, *Draft Environmental Impact Statement for Revised Land Management Plans: Angeles National Forest, Cleveland National Forest; Los Padres National Forest; San Bernardiino National Forest*, May 2004, USDA Forest Service Pacific Southwest Region, San Francisco, http://www.fs.fed.us/r5/scfpr/documents/deis1.pdf
USFS 2004e	USDA Forest Service, *Draft Land Management Plan Part 2: Angeles National Forest Strategy*, May 2004, USDA Forest Service Pacific Southwest Region, San Francisco, http://www.fs.fed.us/r5/scfpc/documents/part2-anf.pdf.
USFS 2004f	USDA Forest Service, *Draft Land Management Plan Part 2: Cleveland National Forest Strategy*, May 2004, USDA Forest Service Pacific Southwest Region, San Francisco, http://www.fs.fed.us/r5/scfpc/documents/part2-cnf.pdf.
USFS 2004g	USDA Forest Service, *Executive Summary of the Draft Environmental Impact Statement for Revised Land Management Plans: Angeles National Forest; Cleveland National Forest; Los Padres National Forest; San Bernardino National Forest*, May 2004, USDA Forest Service Pacific Southwest Region, San Francisco, http://www.fs.fed.us/r5/scfpr/documents/exec-summary.pdf.
USFS-R5 1976	USDA Forest Service Region 5, *USDA Forest Service Environmental Statement: Palomar Mountain Planning Unit: Final*, 1976, USDA Forest Service Pacific Southwest Region, San Francisco.
USFW 1997	United States Fish and Wildlife Services, *Two Butterflies, Hanging on in Southern California, to be Added to Endangered Species List*, 16 Jan. 1997, http://pacific.fws.gov/news/1997/9702nr.htm.

Van Horn 1996	Van Horn, H.M., *Finding of No Significant Impact (FONSI) — Construction and Operation of the Center for High Angular Resolution Astronomy (CHARA) Array — Mount Wilson,California*, 16 May 1996, National Science Foundation.
W&S 2003	W & S Consultants, *Phase I Archaeological Survey/Class III Inventory of a One Acre Project Site on Mount Wilson, Los Angeles County, California*, 27 May 2003.
White 2004	White, P.M., *The Indians of San Diego County*, 9 Feb. 2004, San Diego State University, http://infodome.sdsu.edu/research/guides/calindians/insdcnty.shtml.
WRCC 2004	Western Regional Climate Center, *Palomar Mountain Observatory, California: Period of Record Monthly Climate Summary*, 12 Apr. 2004, http://www.wrcc.dri.edu.
Yuen 2004	Yuen, A.R., *Laguna Mountains Skipper at Palomar Observatory*, 13 Feb. 2004, U.S. Dept. of the Interior: Fish & Wildlife Service: Ecological Service: Carlsbad Fish & Wildlife Office.

This page intentionally left blank.