ENVIRONMENTAL ASSESSMENT
FOR A
SEWAGE TREATMENT PLANT
AND EXPANDED WATER STORAGE FACILITIES

GRANT GROVE
SEQUOIA-KINGS CANYON NATIONAL PARKS
California

U.S. Department of the Interior / National Park Service

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PURPOSE OF AND NEED FOR ACTION

INTRODUCTION

Grant Grove is located in Kings Canyon National Park (see Location map). Kings Canyon National Park was established by the act of March 4, 1940, which provided that the area was "dedicated and set apart as a public park . . . for the benefit and enjoyment of the people." It also provided that the secretary of the interior "in order to insure the permanent preservation of the wilderness character of the park may, in his discretion, limit the character and number of privileges within the park."

A joint resolution dated March 29, 1956, declared the General Grant tree a national shrine in memory of the men and women of the armed forces and directed the secretary of the interior to make appropriate provisions for its perpetual care and maintenance (National Park Service, U.S. Department of the Interior 1971).

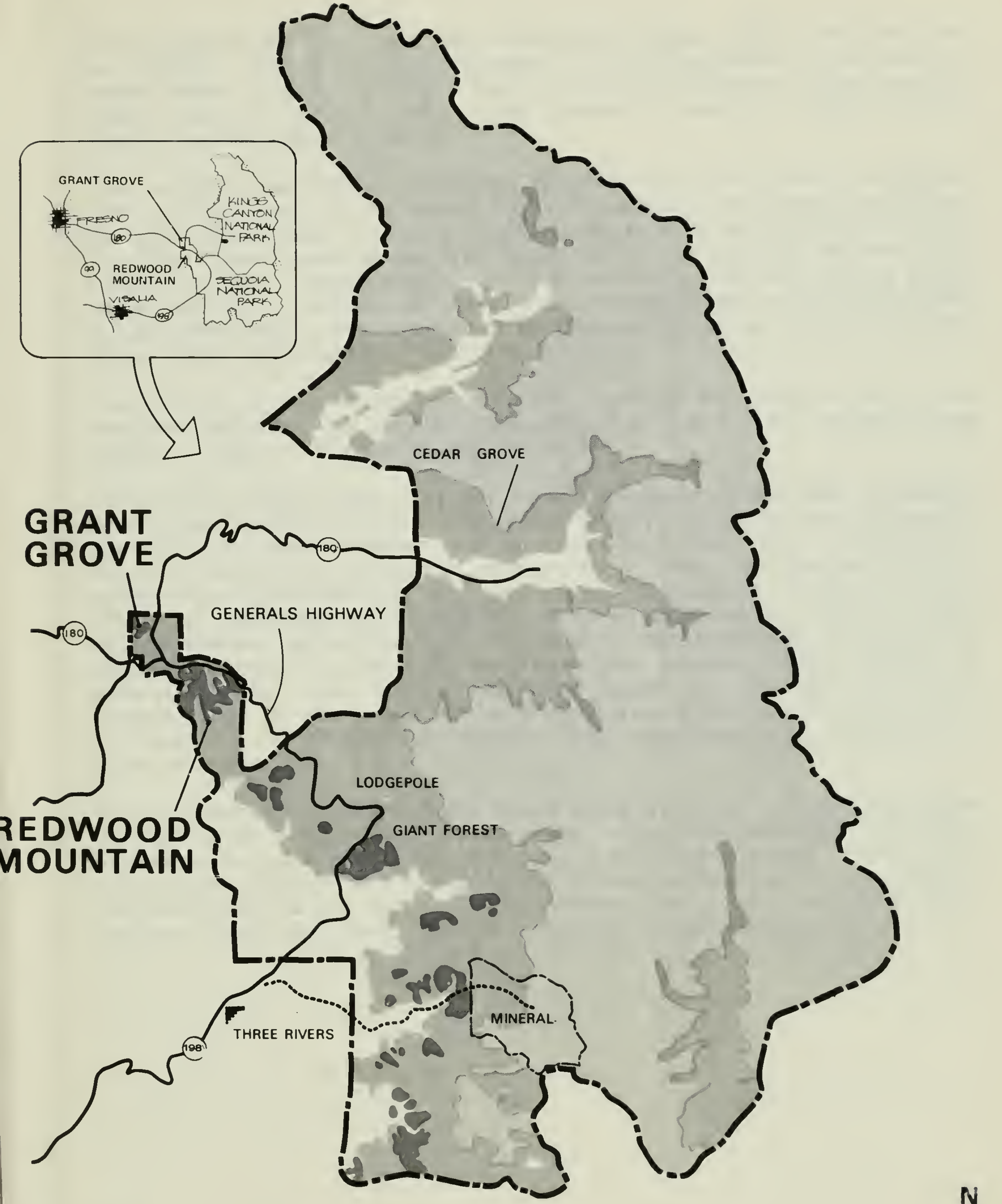
The primary purpose of this environmental assessment is to evaluate the need for improving the wastewater collection, treatment, and disposal system in the Grant Grove development area. The secondary purpose is to investigate the water supply and storage capacity for the proposed expansion of visitor facilities.

PROBLEM STATEMENT

The existing wastewater collection, treatment, and disposal system is inadequate in both the extent of the collection system and the method of wastewater treatment and disposal. The existing collection system includes collector and trunk sewer lines that transmit wastewater to two septic tanks located northwest of the General Grant Grove. Effluent from the septic tanks is discharged through a "spray" system, extending northwesterly around the hillside below the tanks.

The septic tank treatment is basically inadequate for proper spray disposal, and the Grant Grove units are often overloaded. In addition, the discharge system does not spray properly, the disposal area is too steep, and it has insufficient soil depth. Also, downslope from the existing spray field, giant sequoias are growing. Although they do not currently display any obvious effects from the effluent disposal in the area, the possibility does exist. There are indications of adverse impacts on vegetation in the existing spray field area, as several white fir and incense cedar trees have died or are dying. This condition is caused by a higher water table, increased nutrients and salts, and/or the clogging of the soil surface to prevent the exchange of air. There are also obvious understory vegetational changes within the spray field area. This vegetation is denser, and the species composition differs significantly from similar sites in the general vicinity. The location of the disposal site also precludes visitor use of the area.

The Grant Grove area wastewater treatment and disposal facilities were inadequate for 1976 volumes and remain inadequate to date (Osmundson



ALPINE
CONIFER
SEQUOIA GROVE
OAK WOODLAND/CHAPARRAL (BALANCE OF PARK AREA)

LOCATION
GRANT GROVE

SEQUOIA-KINGS CANYON NATIONAL PARKS/CALIFORNIA
UNITED STATES DEPARTMENT OF INTERIOR/ NATIONAL PARK SERVICE

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and Associates 1976). Long and Associates (1973a, 1973b) reported that the disposal system was in violation of the regulations of the Central Valley Water Quality Control Board and the California Department of Public Health. The controlling state agency is now the California Water Quality Control Board (CWQCB).

The existing wastewater treatment is inadequate for forest irrigation. The coliform count of the septic tank effluent has been reported by the California Department of Public Health to be as high as 5,000,000 MPN/ml, and they have observed surface runoff as far as 150 feet downhill from the spray field. Continuing to use the existing system will pose a public health hazard. Also, eutrophication and contamination of Mill Flat Creek are possible due to the location of an intermittent stream--within 100 feet of the spray field--which drains into the creek.

The existing trunk sewer line is buried through the General Grant tree area and degrades the aesthetic atmosphere of the site due to odors from breaks or leaks in the line (Long 1973a, b).

The present water supply has also been inadequate in the past, especially during late summer or fall. The water supply may have been adequate, but leaks in the collection and distribution system have reduced the quantity actually available for consumption. Also, the periods of high water demand coincide with dry hydrological periods, and stored water is needed to make up the difference. The existing water supply is from Round Meadow, located a little less than 1 mile northeast of the visitor center. Water is collected from the lower portion of the meadow in galleries, which flow into a small dam below the meadow and into a collection box at the head of the transmission pipeline. There are also two wells in the meadow--an artesian well being the most significant in terms of water flow.

The transmission pipeline from Round Meadow leads to a 200,000-gallon reservoir with a chlorinator at the inlet. From the reservoir, the water is transmitted down the hill into the distribution system. Along this transmission pipeline is a 50,000-gallon storage facility, which was used in the past for storing water collected from Merritt and Winter springs. This tank leaks profusely, and its value for storage is negligible.

AFFECTED ENVIRONMENT

NATURAL ENVIRONMENT

Climate/Geology/Topography

Climate conditions in the Grant Grove area are typical of the western Sierra Nevada slope. Summers are dominated by warm sunny days, with occasional, but short duration, high intensity afternoon thunderstorms. Summer temperatures are usually in the low 70s. Winter temperatures average in the low 30s and may occasionally fall below 0°F. More than 90 percent of the precipitation occurs as snow during the winter from November through April, which averages a yearly depth of about 200 inches. The mean annual precipitation amounts to 42 inches.

The geological conditions of the Grant Grove area are typical of the Sierra Nevada. This mountain range is composed of overlying metamorphic rock with intrusions of granite. The entire area has been uplifted and tilted to the west through time. Much of the older metamorphic rock has been weathered and eroded away, leaving a largely granitic area exposed.

No faults have been mapped in the area. The closest active fault is the Kern Canyon Fault, approximately 30 miles east of Grant Grove. There is no detailed site-specific information available concerning the consistency of the subsurface bedrock formations in terms of jointing, fracturing, and depths of overburden, but it is assumed these occurrences are widespread.

The highest point in Grant Grove is on Park Ridge, which is nearly 7,800 feet in elevation. The lowest point (5,400 feet) is at Sequoia Creek. The proposed control building site for the new sewage treatment facility is at an elevation of 6,280 feet, and the spray field area ranges from 6,250 to 6,050 feet in elevation.

Nearly half of the Grant Grove area is on slopes of 25 percent or greater. Most of the terrain with slopes of less than 10 percent makes up an area about 1½ miles long and ½ mile wide and includes Wilsonia, Grant Grove Village, and the Sunset, Azalea, and Crystal Springs campgrounds. The proposed spray field site has an average slope of 22 to 23 percent.

The proposed water tank site is located in a relatively flat area at an elevation of 6,750 feet. The water well at Round Meadow is at an elevation of approximately 7,000 feet.

Soils

The soils of the proposed spray field area are classified as a Shaver-Corbett Association. The soils are deep (20 inches to over 50 inches) sandy, and well drained. The soil erosion hazard is rated as high when protective vegetative cover is removed, but these soils are well suited to

spray disposal of sewage effluent. This soil type has the same classification as that of the General Grant tree area, which indicates that the proposed spray field site is a potential giant Sequoia habitat, but no indication of the species growing on this site in the past has been found. The soil moisture regime may not be adequate for sequoia growth at this site, but groundwater modifications in the area could alter the conditions.

Also, a spray field site recommended in the Long reports (1973a, b) is categorized as granitic rockland. This land type consists of large areas of exposed granitic rock intermixed with some random thin soil profiles. The jointing pattern of the bedrock area has hydrologic significance because the joints can be important conduits for transporting subsurface water in the otherwise impervious rock. Similarly, large bedrock joints can transmit inadequately filtered sewage effluent to local water sources.

This land type is excessively drained. Runoff can be very rapid depending on the amount of soil cover. Shallow depths to hard bedrock present major constraints to most types of land uses and, due to the characteristics of this type of land, it should not be used for spray irrigation of effluent.

Water Resources

Surface and Ground Water. The study area does not contain any major watercourses. Eight small streams radiating from Park Ridge carry perennial or intermittent runoff from the Grant Grove area. Abbott, Mill Flat, and Sequoia creeks are three perennial, but relatively small streams near the project area. These streams would not be adversely affected by the proposed project.

Groundwater is common in the study area wherever decomposed or fractured granitic rock is suitable to form an aquifer and in alluvium deposits in meadow areas. Precipitation is adequate to recharge the groundwater; however, the storage capacity of the aquifers is unpredictable. Meadow areas provide the largest and most predictable groundwater storage units because of numerous springs and seeps. The groundwater storage capacity of all the meadows in the study area is estimated to be 500 acre-feet. Neither storage nor yield can be predicted in the fractured rocks (Long 1973a, b). Groundwater in the proposed spray field area in the preferred alternative was rated as deep, and the soils would provide adequate filtration of effluent to avoid groundwater contamination.

Water Supply and Quality. In the Grant Grove area, the concession and NPS facilities are served by an artesian well in Round Meadow that is used as a year-round water source. Merritt and Winter springs, immediately east of Grant Grove Meadow, are only used late in the summer season or during dry years as a supplemental source of water. Merritt and Winter springs have a flow rate of approximately 9 gallons per minute (gpm) each, and the combined flow rate of the springs at Round Meadow averages 36 to 50 gpm.

Chemical analysis of water supplies at Round Meadow, Winter Spring, and Merritt Spring were provided by Brown and Caldwell, Consulting Engineers, Emeryville, California, and by Environmental Consultants, Inc., Clarksville, Indiana (see appendix A). In all cases, the quality of the water exceeds existing drinking water standards. In general, the springs and wells of the Grant Grove area produce a water supply with a quality typical of waters of a snowmelt origin (Long 1973a, b).

Hydrologic Influences on Giant Sequoias. A study of hydrologic influences on the Giant Forest sequoia grove was conducted during the summer of 1968, a year of unusually dry conditions (Rundel 1972). Both soil moisture stress (indication of water in soil) and plant water stress (indication of water in plant xylem) were determined. The results showed that throughout the summer the soil moisture levels in all parts of the soil profile inside the grove remained well above those outside the grove. The plants outside the grove exhibited a greater water stress (higher stress with less water) that extended to a later date. The conclusion of the study indicated that moisture is a critical factor in the ecology of the giant sequoia ecosystem.

The increased soil moisture during the summer of 1968 can best be explained by an input of moisture by subsurface percolation of groundwater from higher elevations. Precipitation in Giant Forest was too little and scattered to account for the sharp increase in soil moisture. The drainage areas above the study transects were too small for runoff to greatly affect soil moisture. However, hydrologic information on the source and consistency of these hypothesized groundwater supplies does not exist.

It is of ecological importance to the giant sequoia that soil moisture be replenished by groundwater during late summer. More than any other single ecological factor, soil moisture availability determines the physiological limits of giant sequoia survival and maintains present grove boundaries. During drought stress of late summer, sequoia seedlings that have germinated in spring along margins of groves may die, and crown foilage of mature trees may brown. High mortality rates of first-year seedlings can be attributed to desiccation during summer months, even in sequoia groves. Outside grove margins, surface soil moisture levels are too low to allow the survival of seedlings.

Floodplains and Wetlands. The floodplains of the drainage creeks have not been mapped, but because of the small size of the watersheds, overflows would be rare and would not threaten structures or visitors in the area.

The meadows in the Grant Grove area are considered wetlands as defined in Executive Order 11990 (Protection of Wetlands). To comply with this legislation, the meadows must be protected. A detailed description of meadow ecology is included in appendix B. If the wells in Round Meadow are not pumped and only "excess water" is tapped for consumption, then no additional effect on the meadows would occur over the existing conditions.

Air Quality

Sequoia-Kings Canyon National Parks were designated class I under the Clean Air Act as amended (1977). As such, these parks are areas where air quality related values are important attributes. A class I area is subject to the most stringent regulations of any designation. These areas must not exceed the maximum allowable increment over baseline concentrations of sulfur dioxide and particulate matter as specified in section 163 of the act. Air pollutants primarily originate from highly populated areas outside the park, but vehicular traffic on the Generals Highway and to visitor use areas contribute a slight amount of pollutants to the air (hydrocarbons, nitrites, etc.). Campfires in the campgrounds also add carbon monoxide and particulate matter to the air which slightly decreases its quality.

Because of the high altitude of the parks, they receive a large amount of ultraviolet light. The wavelength of this light induces photochemical reactions to yield the more harmful pollutant compounds, nitrates and ozone. The giant sequoias are considered to have good tolerance from high levels of ozone and other oxidants that are the primary pollutants damaging to vegetation. However, the impacts of those pollutants on other components of the ecosystem, of which the giant sequoias are an integral part, are not known (Forest Service, U.S. Department of Agriculture 1972a).

Vegetation and Wildlife

Most of the Grant Grove area contains mixed conifer forest. Species included in this forest type form the major timber belt of the Sierra Nevada. Large conifers, including ponderosa pine, Jeffrey pine, sugar pine, white fir, and incense cedar, are its principal constituents. These species are found in varying degrees of density and dominance depending on elevation (mostly between 4,000 and 8,000 feet) and local microclimatic conditions.

White fir is usually the dominant tree at all elevations in this community. At the lower elevations, ponderosa pine, incense cedar, and black oak are subdominants due to more xeric conditions. At the higher elevations, the distinguishing species are red fir and Jeffrey pine. The mixed conifer zone is bordered by oak woodland forest at lower elevations and by subalpine forest at higher elevations.

In the mixed conifer forest, the upper canopy production of pine seeds and numerous tree-dwelling insects provides food sources for the lodgepole chipmunk, chickaree, gray squirrel, and other small mammals. The forest also provides roosting and nesting habitat for the pygmy owl, spotted owl, great horned owl, and other raptors. In addition, rodent species in the understory provide prey for terrestrial predators, such as fisher, marten, and long-tailed weasel.

In general, a forest of mature trees provides less desirable habitat for most forest-dwelling wildlife. A young forest with interspersed open areas, or glades, is of a much higher value in terms of supporting a more

varied animal community. Additionally, a forest dominated by pines rather than fir will support a higher density and number of species due to a general preference for pine seeds. Within the study area, 23 species of mammals and 15 species of amphibians and reptiles are closely associated with the mixed conifer forest.

The mixed conifer forest community is a rather stable habitat type and can withstand more human intrusion because of the shelter, or buffer, effect of heavy growth on noise and disturbances. Loss of tree cover and understory growth will, however, reduce the diversity of species and the carrying capacity of the forest habitat.

Mountain chaparral occurs in patches in the Grant Grove area. This type of community has a 90 percent brush ground cover. The areas are relatively xeric with rocky and shallow soils. The dominant plant species include manzanita, bush chinquapin, and Ceanothus, which are also found in the understory of the mixed conifer forest.

Wildlife found in this type of habitat include the California ground squirrel, golden-mantled ground squirrel, white-footed mouse, and various reptilian species. The tender shoots of manzanita and various species of Ceanothus that occur within the brush habitat provide excellent browse for mule deer.

This chaparral community provides suitable habitat for at least 32 species of mammals and 12 species of amphibians and reptiles within the study areas. Birds common to these habitats include the spotted towhee, fox sparrow, and white-crowned sparrow. In terms of wildlife habitat, the chaparral community is not particularly sensitive to human disturbance. Reptiles and small rodents within this habitat are relatively tolerant of some nearby human activity or disturbance. Revegetation of these relatively xeric areas may be a long process.

Wet Meadows. The meadows represent a very small but important percentage of the total acreage in the Grant Grove area. Because of the very limited area available and their importance to such a wide variety of wildlife forms, maintaining existing meadow habitat is of critical concern in preserving the biotic associations, the natural balances, and the integrity of the park ecosystems. Grant Grove Meadow is the central aesthetic feature in the immediate village area. A detailed discussion of the wet meadow ecology, dynamics, and associated plant and animal species can be found in appendix B.

Giant Sequoia Groves. The giant sequoia is the best known and largest tree, in terms of volume, in the world. Giant sequoias grow in more or less isolated groves on the western slopes of the Sierra Nevada in central California from Placer County southward to Tulare County. Sequoia ecology and associated plant and animal species are discussed in appendix C.

Endangered or Threatened Species. There are no reported endangered or threatened plant or animal species in the study area. However, the Final Environmental Statement/Development Concept Plan for the Giant Forest/Lodgepole Area of Sequoia-Kings Canyon (NPS, USDI 1979) lists

Muir's raillardella (Raillardella muirii), a clover (Trifolium albopurpureum), and (Phalacroseris bolanderi) as endangered and/or threatened within the park. Of these three plant species, only R. muirii is listed federally as a candidate rare and endangered species (Federal Register 1980) and as rare and endangered by the California Native Plant Society (1980). California pityopus (Pityopus californicus) is not listed as a candidate for federal threatened or endangered status. It is, however, considered rare and is managed in these parks as a sensitive species. There is only a slight chance of finding these species in the study area, but a plant survey would be conducted before any construction was begun.

Also, the giant sequoias (Sequoiadendron giganteum) are of international significance because of their limited range, large size, and life span of over 2,000 years (Harvey, Shellhammer, and Stecker 1980).

CULTURAL ENVIRONMENT

Archeology and Ethnohistory

The Sequoia-Kings Canyon region was prehistorically used by the Western Mono, Yokuts, and Owens Valley Paiute (Steward 1935). Subsistence was based primarily on hunting and gathering, which entailed seasonal migrations from permanent base camps at lower elevations to temporary camps at higher elevations. This area was also used as a trade route by the Owens Valley Paiute.

An archeological survey was conducted in October 1974 in Kings Canyon National Park by Professor L. Kyle Napton and A.D. Albee, California State College. The party surveyed approximately 700 acres north and west of Wilsonia that included the entire Grant Grove development area. No surface evidence of archeological resources was found on any proposed development sites, and clearance to proceed with the concession facility developments on these sites was provided by the Western Archeological Center (143-78-SEKI, October 26, 1978). There are no known archeological sites in the vicinity of this proposed project.

National Register Properties

Pursuant to Executive Order 11593 (Protection and Enhancement of the Cultural Environment), the project area was surveyed for archeological, architectural, and historical resources. Those properties determined to merit nomination to the National Register of Historic Places include the Big Stump historic district, located just inside the entrance to General Grant Grove; the General Grant historic district; and the Gamlin cabin, located in General Grant Grove near Fallen Monarch (also on the National Register). The General Grant historic district includes the chief ranger's old residence and the superintendent's old residence (buildings 108 and 112).

SOCIOECONOMIC ENVIRONMENT

The socioeconomic environment of the region under consideration includes Fresno and Tulare counties in California. In fact, the boundary between these two counties cuts through (east/west) the middle of Grant Grove Meadow.

Land Use

Fresno County extends from the Central Coastal Range across the San Joaquin Valley to the crest of the Sierra Nevada. Fresno County contains some of the state's most productive agricultural land. Approximately 40 percent of the county's lands are federally owned. Tulare County comprises the southeast end of the San Joaquin Valley and also contains very productive agricultural lands. The federal government owns 50 percent of the county's land, with the majority of federal lands being in Sequoia National Park and Sequoia National Forest.

Also located in the Grant Grove area on the southeast edge of the village area is a cluster of cabins known as Wilsonia, which contains 166 family dwellings on the 56 acres of privately owned lands. To date, approximately 35 percent of the lands and cabins have been acquired by the National Park Service in the interest of protecting park values. The Wilsonia lodge is located in this section; it provides lodging year-round and includes 16 units, a restaurant, and a market.

Regional Population Characteristics

The population of Fresno and Tulare counties was estimated to be 642,300 persons in 1974, an increase of 7 percent since 1970. The majority of the population of the counties live in urbanized areas. Fresno, the largest city in the region, had a 1970 population of 166,000 persons. Visalia, located along California 198, is the largest city in Tulare County with a 1980 population of slightly less than 50,000 persons.

Visitation

Visitation to Sequoia-Kings Canyon National Parks totaled 1,619,988 persons during 1983. Table 1 shows visitation figures from 1970 through 1983. During this time the numbers remained fairly stable except for 1979, 1980, and 1983. The decline in visitation during those three years can be attributed to gasoline shortages and associated price increases. Seasonally, visitation is heaviest during June through September when over 70 percent of the visits take place.

Table 1: Annual Visitation

Year	Sequoia	Kings Canyon	Total
1983	854,233	765,755	1,619,988
1982	1,020,500	831,044	1,851,544
1981	1,095,000	782,500	1,877,500
1980	862,800	823,800	1,686,600
1979	799,600	804,200	1,603,800
1978	973,400	869,900	1,843,300
1977	978,600	1,046,600	2,025,200
1976	1,040,575	1,127,902	2,168,477
1975	957,386	1,035,294	1,992,680
1974	686,940	1,224,400	1,911,340
1973	846,280	906,770	1,753,050
1972	869,600	1,058,040	1,927,640
1971	882,000	896,690	1,778,690
1970	875,670	1,018,990	1,894,660

Visitors to Grant Grove are primarily attracted by the giant sequoia trees, the mountain environment, and the opportunity to enjoy an overnight stay at campgrounds (376 sites) or in lodging accommodations (52 units) associated with these unique resources. Table 2 shows seasonal campground use in Grant Grove from 1981 through part of 1984. Many visitors opt to come to the Grant Grove area for day visits. A significant number of them take advantage of the interpretive programs available at the visitor center and amphitheater and on walks among the giant trees. Winter brings many valley residents to the area for a day of snow play or cross-country skiing.

Table 2: Seasonal Use in Grant Grove Campgrounds
(Sunset, Azalea, and Crystal Springs)

	1981		1982		1983		1984	
	Monthly Total	Daily Average*	Monthly Total	Daily Average*	Monthly Total	Daily Average*	Monthly Total	Daily Average*
May	5,217	171	6,739	217	3,202	103	8,606	279
June			14,635	488	17,911	597	14,418	481
July	14,029	452	26,347	849	26,520	855		
August	15,327	494	31,035	1,001	25,115	810		
September	7,738**	515	15,360	510	5,085	503		

* The maximum daily capacity is 1,512 campers.
**One-half month total.

ALTERNATIVE A - NO ACTION

This alternative proposes maintaining the sewage facilities at the existing site (see Alternative A - No Action map). No major modifications would be made to the existing potable water or wastewater facilities. Since the Long reports (1973a, b), the sewage spray field area has been expanded, but problems with the system persist. Without major changes to the sewage facilities, the disposal system would remain marginal at best.

The water storage facilities would also remain at a marginal level. There would not be adequate fire protection reserves, and water consumption restrictions would continue during the late summer and early fall. These restrictions would be increasingly severe during low precipitation years.

The wastewater and water supply problems would be significantly amplified if the proposed development described in the Environmental Assessment/ Development Concept Plan for Grant Grove and Redwood Mountain (NPS, USDI 1983) proceeded without upgrading the systems. The proposals that would contribute to increased water consumption and wastewater output include the increase in lodging from 52 to a maximum of 135 overnight units, construction of a laundromat, and installation of shower facilities.

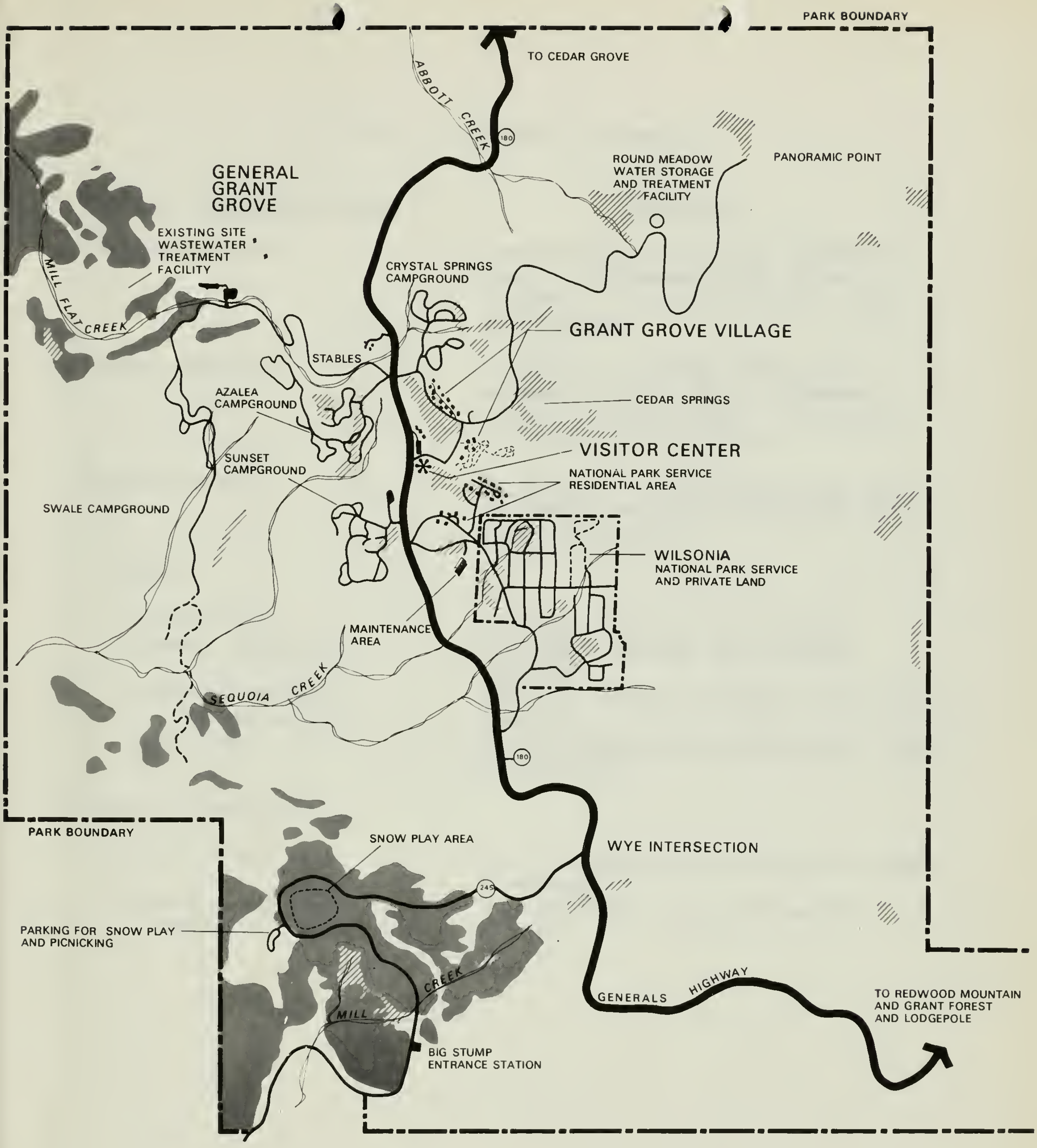
Even without any modifications to the current consumption and wastewater output volumes, an additional water storage facility and a location change for the sewage treatment facilities are urgently needed.

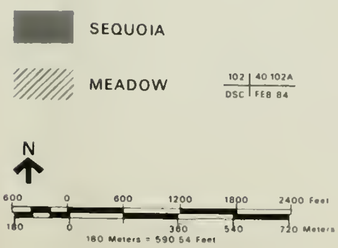
COMMON TO ALL ACTION ALTERNATIVES: THE PREFERRED TREATMENT PROCESS

The extended aeration variation of the biological activated sludge process was selected as the preferred treatment process for the following reasons:

> The process handles variable loads, which are common in the Grant Grove area.
>
> The process is more reliable than other comparable systems.
>
> The system is relatively easy to operate.
>
> The use of this system would be consistent with the systems used in other areas of the park.
>
> The process would comply with CWQCB standards.

Table 3 illustrates the advantages and disadvantages of various treatment processes with respect to this project; table 4 compares the life cycle costs of the preferred process with alternative systems; and table 5 estimates the actual construction cost.





ALTERNATIVE A - NO ACTION

MAINTAIN SEWAGE FACILITIES AT EXISTING SITE

GRANT GROVE

SEQUOIA-KINGS CANYON NATIONAL PARKS/CALIFORNIA

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Table 3: Treatment Processes

Biological Treatment Process	Comments
Stabilization ponds	Requires large land area; effluent is high in suspended solids (algae). Subject to freezing in winter. Low maintenance.
Aerated lagoons	Requires considerable land area; effluent is still high in suspended solids (including algae). Freezing in winter if not covered.
Activated sludge	In general, requires little land, high in energy use, good quality effluent, high maintenance.
Types:	
Conventional	Used for low strength domestic.
Contact stabilization	Process is flexible, but requires attention.
Extended aeration (selected process)	Used for variable hydraulic and organic loading.
High rate	General application, high energy, high operator skill.
Fixed film contactors	
Trickling filter	Low in energy use, high solids content in effluent.
Rotating biological contactor	Low in energy use, good quality effluent.

Table 4: Life Cycle Cost Analysis

	Rotating Biological Contactor	Activated Sludge	Variations of Activated Sludge: Contact Stabilization	Variations of Activated Sludge: Extended Aeration (Preferred Process)
Present value of investment costs	$177,800	$137,544	$138,544	$135,544
Present value of operation costs	208,001	249,874	249,874	217,231
Present value of total life cycle costs	$385,801	$387,418	$388,418	$352,775

Source: Vail and Associates 1983.

Note: This analysis is for comparative purposes only and does not reflect actual costs. The figures do reflect initial cost and maintenance and operation of the plant for the life expectancy of the facility.

Table 5: Wastewater Collection, Treatment, and Disposal Costs

(Summary of Preliminary Estimate - Class B, Based on Summer 1983 Price Levels, ENR 6000)

Item	Construction Cost*
Collection system	$1,209,950
Comfort station at Grant Tree	63,900
Removal of existing treatment facilities	107,900
Treatment facility	3,302,000
Disposal	1,245,000
Water system improvements	1,050,250
Residence	110,000
TOTAL CONSTRUCTION	$7,089,000

Source: Vail and Associates 1983.

*Includes 15 percent contingencies; excludes engineering and administrative costs.

Biological Activated Sludge - Extended Aeration Process

In the biological activated sludge process, air is supplied to an aeration tank in a sufficient quantity to sustain the life of the aerobic organisms digesting contaminants in the sewage. Following the aeration tank is a settling tank where solids settle out. The solids, termed activated sludge, consist mostly of a biomass that is continuously returned to the operation tank to mix with the incoming "food" so that it can be broken down and used for cellular respiration. Activated sludge settles out readily, leaving a fairly clear overflow from the settling tank. Untreated sewage solids don't settle out nearly as well. Although most of the settled sludge is returned to the aeration tank to permit rapid breakdown of the organics, more activated sludge is produced than can be used in the process. The excess sludge is diverted, or "wasted," to the sludge-handling system for treatment and disposal. The treatment process effluent is disinfected with chlorine and detained in a chlorine contact chamber (NPS, USDI 1981).

The activated sludge process is versatile and can be tailored to handle a variety of wastewater compositions and to meet various levels of effluent standards. The process will require careful operational control and the energy requirements are relatively high (typically 625 kilowatt-hours per million gallons treated). An activated sludge plant that is properly designed and operated removes essentially all soluble biochemical oxygen demand (BOD). The BOD remaining in the secondary effluent is primarily the oxygen demand exerted by the suspended solids in the effluent. The effluent quality at this stage is typically 20 milligrams per liter (mg/l) BOD and 20 mg/l suspended solids (NPS, USDI 1981).

The proposed system will couple filtration with the above process. Vail and Associates (1983) calculated that the combined process would result in a variable BOD of from 6.2 to 20.0 mg/l with a plant treatment efficiency of 93.3 to 97.9 percent during summer months and 90.8 to 97.1 percent during winter months. Also, with this system additional physical chemical processes could be added to further decrease the effluent BOD.

Sludge Handling Stabilization Process

Aerobic Digestion. Aerobic digestion is a method of sludge stabilization that is carried out in the presence of oxygen. It is accomplished in an open tank by aerating the organic sludges. Microbiological activity beyond cell synthesis is stimulated by aeration, oxidizing both the biodegradable organic matter and some cellular material into carbon dioxide, water, and nitrates. The oxidation of cellular matter, called endogenous respiration, is normally the predominant reaction occurring in aerobic digestion. Stabilization is not complete until there has been an extended period of endogenous respiration (typically 15 to 20 days). Oxygen can be supplied by surface aerators or by diffusers. Aerobic digesters are similar in design to rectangular aeration tanks and use conventional aeration systems. This method of digestion is able to handle high solid loadings (NPS, USDI 1981).

Vail (1983) recommends a 20-day solids retention time for the proposed system. Vacuum-assisted dewatering will also be included in the sludge handling for drying. Following stabilization (if necessary), the dewatered sludge cake would be disposed of at a landfill. The process with options is illustrated in table 6.

The effluent from the above process would be sprayed onto a surface spray field at an application rate of less than 2.3 inches per week during the summer and diverted to percolation trenches during the winter at a rate of less than 1 gal/ft^2/day (Osmundson and Associates 1976 and Vail 1983).

ALTERNATIVE B (PREFERRED) - PROPOSED SEWAGE TREATMENT PLANT SITE FROM OSMUNDSON (1976) AND VAIL (1983)

This alternative is the preferred alternative. It proposes the construction of a new treatment facility in a new location (see Alternative B map) and the installation of a 1.2 million gallon water storage tank(s). The new sewage facility would alleviate the currently inadequate collection, treatment, and disposal system. Also, the increased water storage capacity would provide a storage reserve for fire protection and for late season consumption needs.

The outline below is from Osmundson (1976) and Vail (1983), and the essential elements of this alternative are included.

The design problem is to develop the required facilities in a manner that would most economically meet the required constraints. To satisfy the design constraints, the new facilities would include the following:

Wastewater Collection

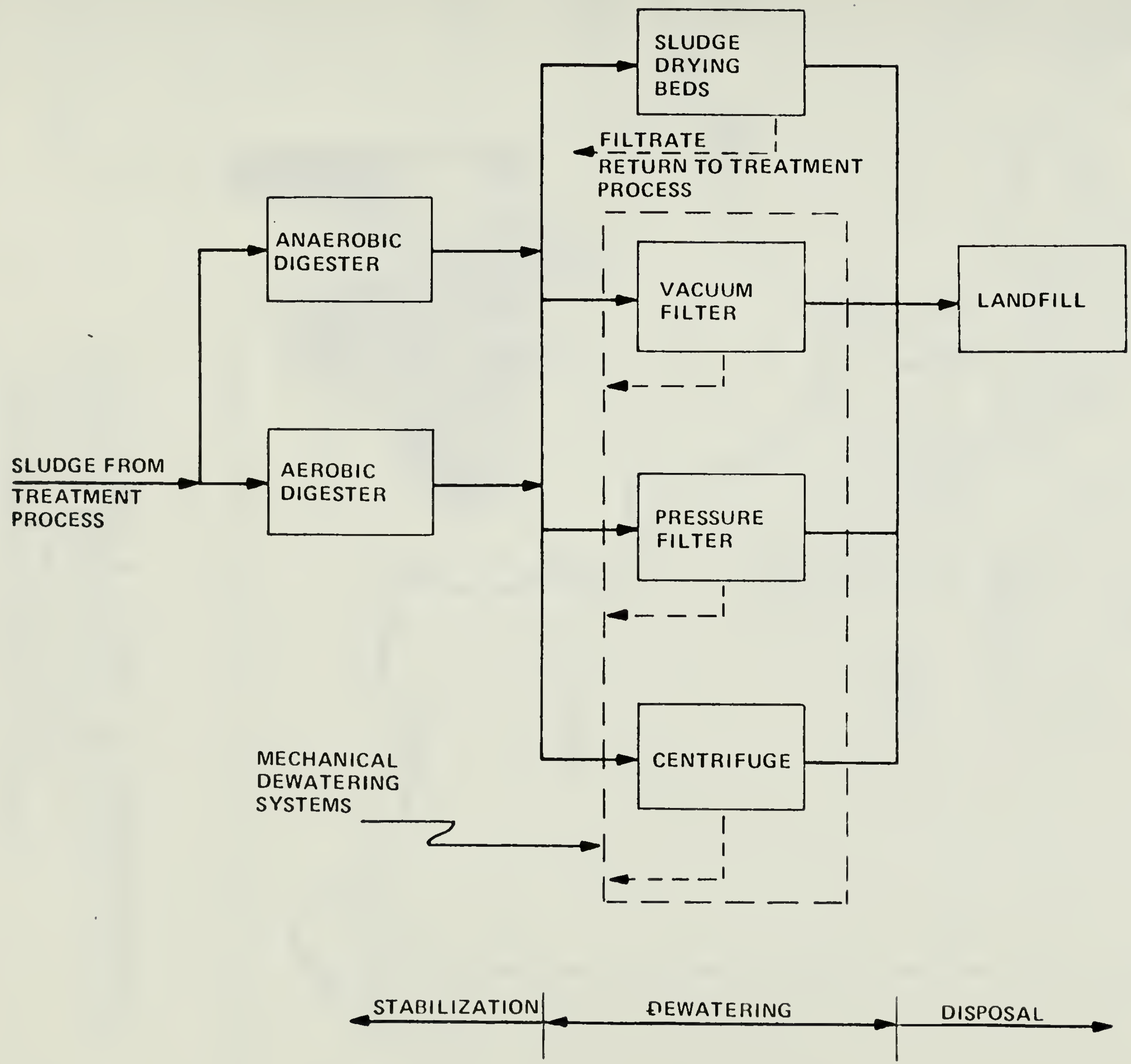
At present there are 11 comfort stations that have individual septic tank/leachfields. These would be collected by either gravity and/or pumped force main and delivered into the existing collection system.

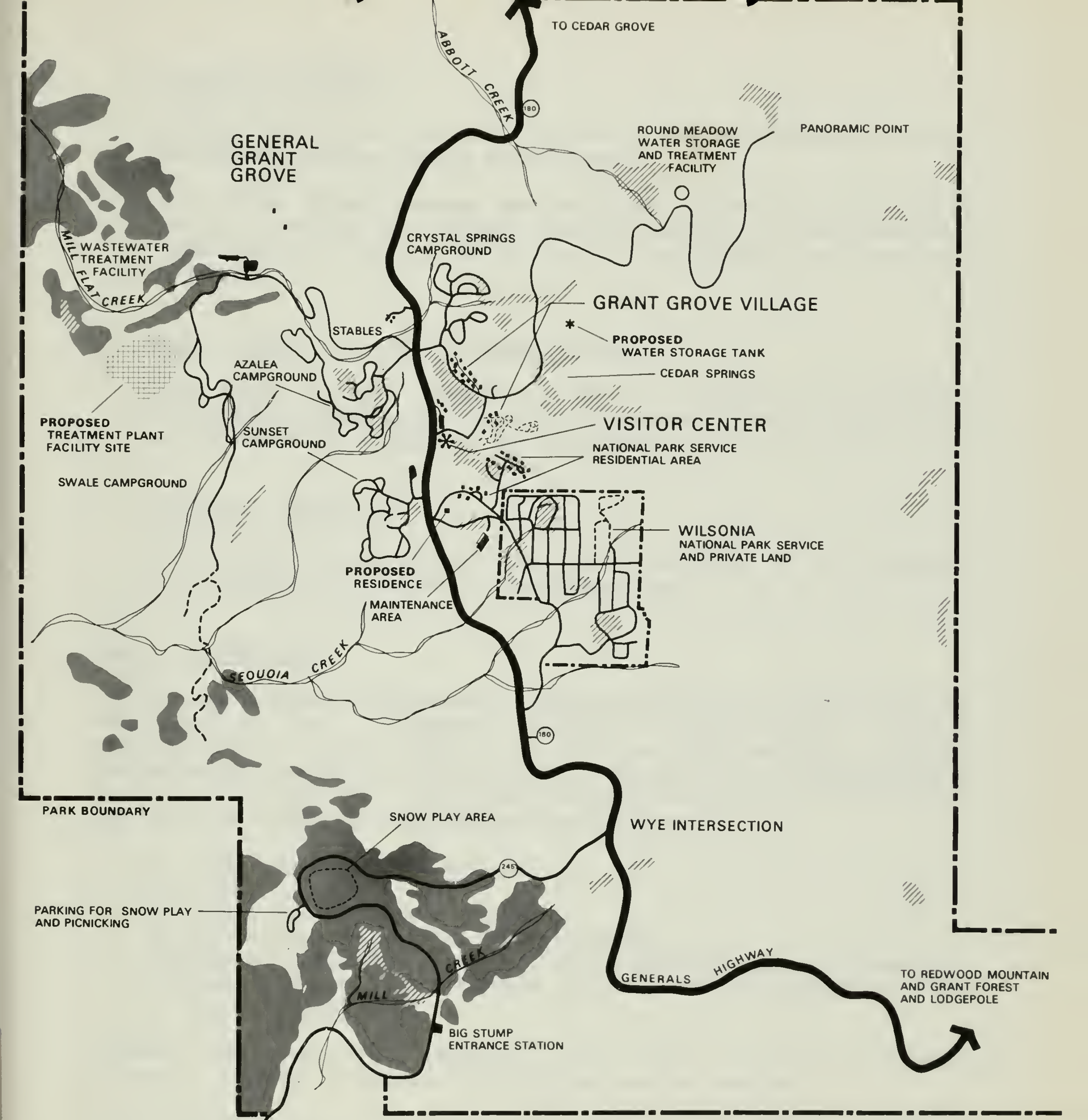
The existing collection system terminates at two large septic tanks located adjacent to Grant Grove. These tanks would be abandoned and removed. A new trunk sewer would intercept upstream and carry the raw sewage to the proposed new treatment site located northwest of the Swale campground.

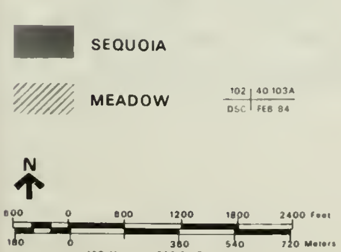
Wastewater Treatment

Most of the plant would be contained in a single building. The new treatment facilities would include headworks/flow measurement/ equalization basin, secondary treatment, filtration, chlorination, sludge handling facilities, and control room(s).

Table 6: Sludge Handling Processes







ALTERNATIVE B-PREFERRED

PROPOSED SEWAGE TREATMENT PLANT SITE RECOMMENDATION FROM OSMUNDSON (1976) AND VAIL (1983)

GRANT GROVE

SEQUOIA-KINGS CANYON NATIONAL PARKS/CALIFORNIA
UNITED STATES DEPARTMENT OF THE INTERIOR/NATIONAL PARK SERVICE

Wastewater Disposal

Disposal would be by spray irrigation in the summer months and by percolation trenches in the winter months.

A 1 million gallon storage tank would be provided to store fall or spring flows that are greater than the capacity of the percolation field, but which cannot be sprayed on the disposal field when snow is present.

Water Supply - 1.2 Million Gallon Tank(s)

The water storage capacity would be increased by providing aboveground storage of a capacity to provide a 30-day supply, plus a fire demand of 1,000 gpm for two hours.

Operator's Residence

This facility would provide year-round residence for the treatment plant operator in the park's residential area.

Design Alternatives

To evaluate treatment alternatives, the desirable effluent quality must be determined. The California Regional Water Quality Control Board - Central Valley Region has not yet published the tentative discharge requirements for this project. However, in conversations and correspondence with Mr. Larry Batty (project coordinator with CRWQCB), the following discharge limitations will be enforced:

No direct discharge into streams.
No odors.
No public health nuisance problems.
No surface discharge while snow is present.
Subsurface discharge must not cause pollution of groundwaters.
Surface irrigation must conform to California Administration Code Title 22 requirements.

Knowing the discharge limitations, the various types of treatment processes available to achieve this limitation can be analyzed.

The proposed system would achieve a discharge limit of 20 mg/l BOD; 20 mg/l suspended solids was tentatively selected as the best representation of the state's requirements. Effluent of this quality is desirable to ensure long-term use of both the spray fields and the percolation trenches. To achieve this effluent quality, most secondary treatment processes coupled with filtration can be used.

ALTERNATIVE C - PROPOSED SEWAGE TREATMENT PLANT SITE FROM LONG (1973a, b)

The same design constraints and requirements as in alternative B would also apply under this alternative. The only significant difference between this alternative and alternative B is the site selection for the sewage treatment facilities (see Alternative C map).

The investigators (Long 1973a, b) chose this location for the following reasons:

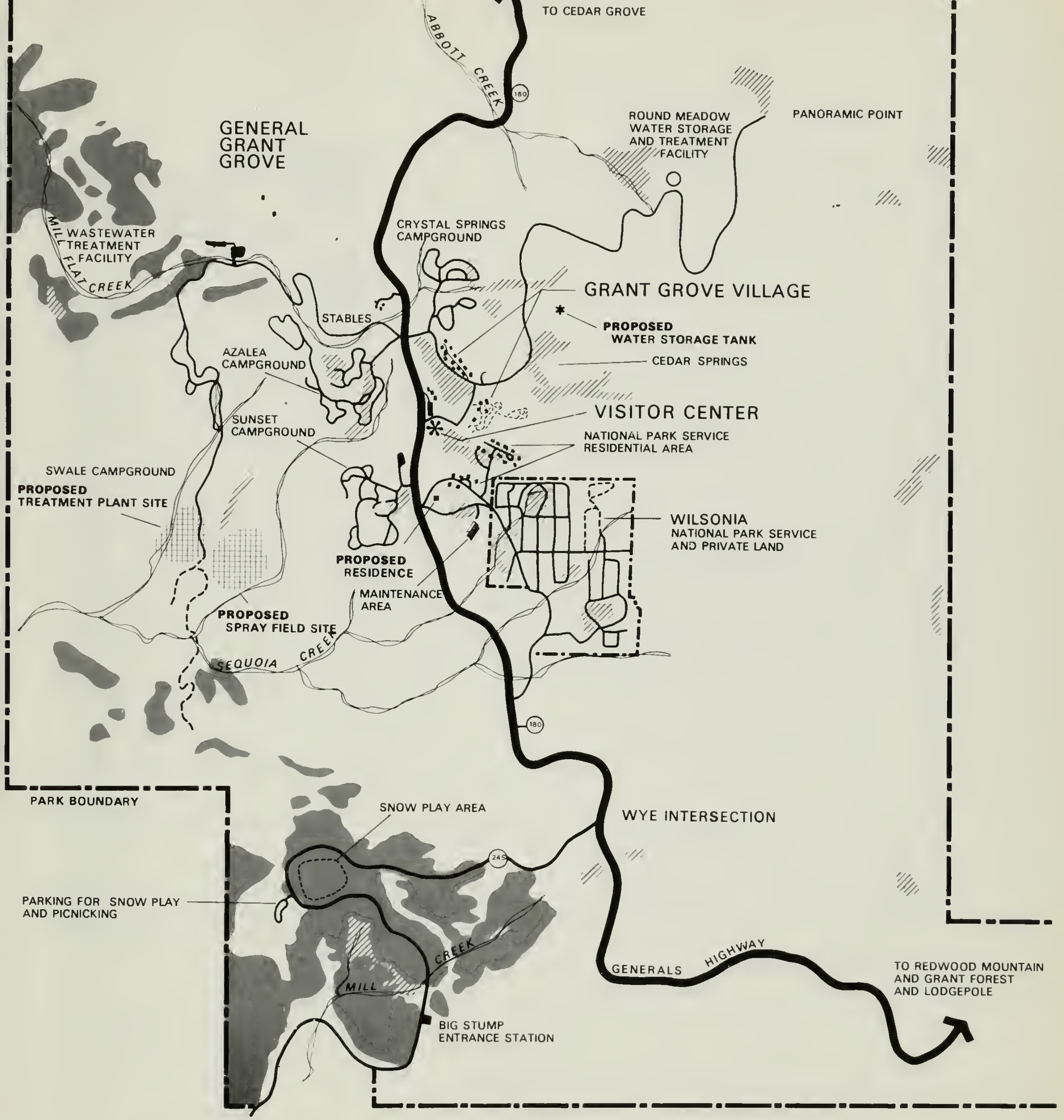
> The terrain and vegetation would make public access difficult.
>
> Drainage facilities for the access road could be used to control and monitor the quality and quantity of runoff, if it did occur.
>
> The area would be clearly visible from the treatment plant site and could, therefore, be closely observed for malfunctions or vandalism.
>
> Cost.

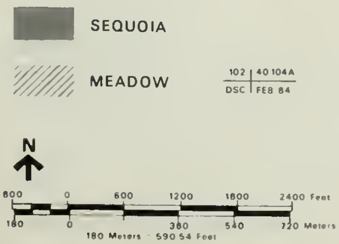
The site proposed under this alternative was rejected because the terrain is too steep, the soils are too shallow, and a small drainage stream is too near the proposed spray field area.

ALTERNATIVE D - SEWAGE PLANT EXPANSION AT OR NEAR EXISTING SITE

This alternative proposes the same design requirements as those outlined in alternative B.

This alternative was also rejected because the site location would remain contrary to the national park's objective of removing facilities from the sequoia grove (see Alternative D map). The proposed secondary treatment facility would yield effluent that would be higher in quality and in conformance with the state of California standards, but the spray field area at the existing site is also too steep and too near the Mill Flat drainage area. The alternate site east of the existing location (suggested by Osmundson in 1976) is also too near the sequoia grove and was rejected.





ALTERNATIVE C

PROPOSED SEWAGE TREATMENT PLANT SITE FROM WALTER LONG (1973b)

GRANT GROVE

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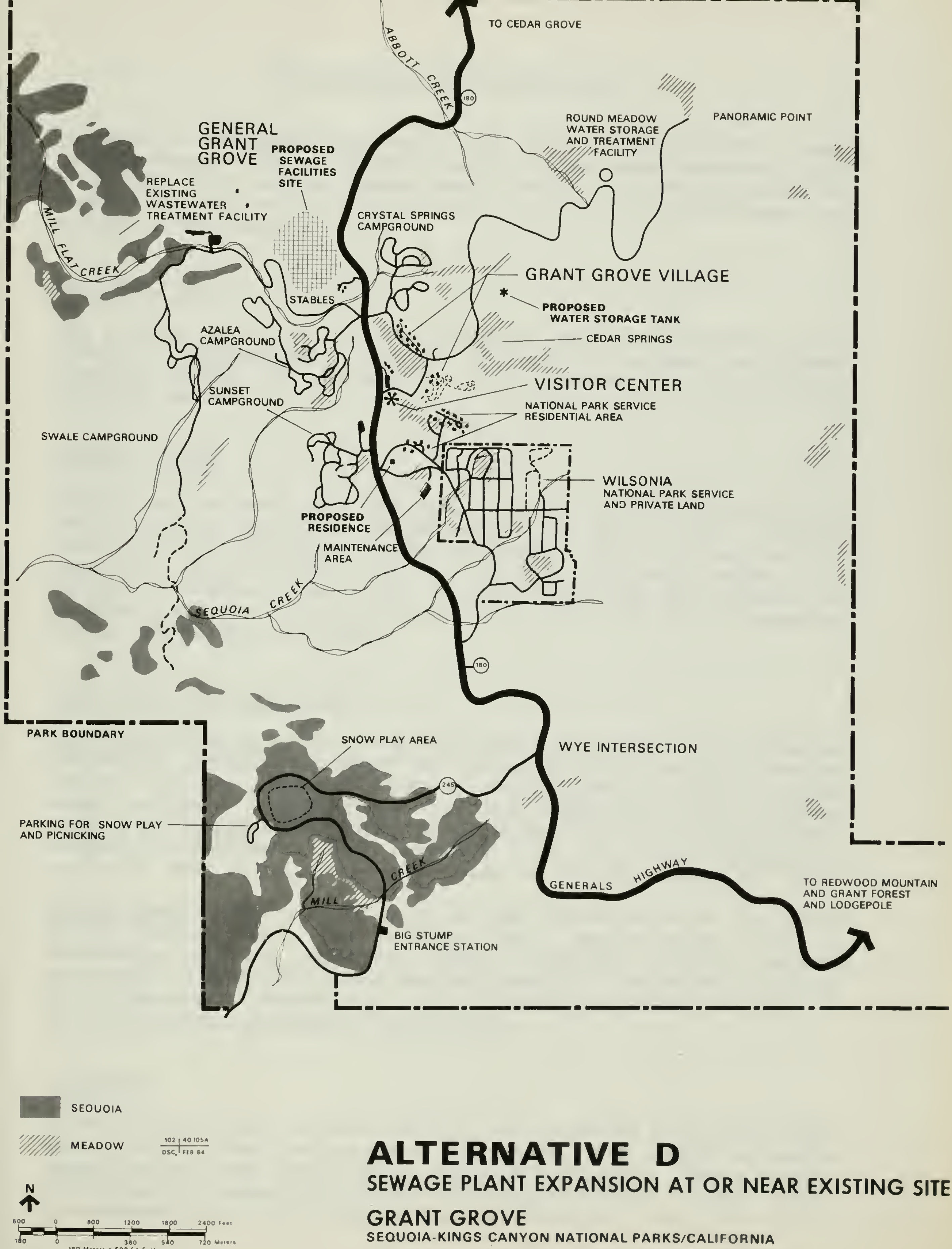
UNITED STATES DEPARTMENT OF THE INTERIOR/NATIONAL PARK SERVICE



ALTERNATIVE D

SEWAGE PLANT EXPANSION AT OR NEAR EXISTING SITE

GRANT GROVE

SEQUOIA-KINGS CANYON NATIONAL PARKS/CALIFORNIA

UNITED STATES DEPARTMENT OF THE INTERIOR/NATIONAL PARK SERVICE

ENVIRONMENTAL CONSEQUENCES

As stated in the Master Plan (NPS, USDI 1971), "No development should be undertaken in the parks which would provide human habitation, until it is shown that adequate water supply and waste disposal systems are available and that such development will not cause undue deterioration of the natural environment."

ALTERNATIVE A - NO ACTION

The existing spray field has been extended since the Osmundson report (1976) as recommended. Although the effluent problems have been alleviated slightly, the incompatibility of the treatment system with spray irrigation remains.

Impacts on Soils

With primary or septic tank effluents, with or without chlorination, there would be slimes present on the spray area (FS, USDI 1972b). The life cycle turnover of these organisms would alter the surface soil composition, which would result in soils high in organic matter. The spraying of these effluents may also clog the soils and establish an anaerobic condition in the subsurface soils, which results in vegetation and soil microorganism changes.

Impacts on Water Resources

Surface and Ground Water. The improved and extended spray disposal system has somewhat decreased the danger of stream pollution through washoff, but the long-term threat to water quality in Mill Flat Creek would continue. This is due to the high probability of soil clogging, creating an impermeable surface that would result in direct effluent runoff without soil filtration. Also associated with soil surface clogging is buildup of salts in the shallow groundwater of the site (Osmundson 1976).

Potable Water. The marginal water storage capacity would be maintained at its present level, and shortages would become more severe if construction of the expanded visitor overnight lodging facilities proceeded. The existing water storage capacity is inadequate to provide fire protection at present and would become even more inadequate to provide increased consumption requirements.

Vegetation

A continuation of the current effects on the vegetation in the spray field would persist under the no-action alternative. The vegetative species composition has been altered due to spray field irrigation. These changes are potentially caused by higher soil nutrient content, higher shallow groundwater salt concentrations, and soil clogging. Any one or a

combination of the preceding factors is sufficient to change the microenvironment, which alters the plant regime by modifying the competitive advantage in favor of more tolerant plant species. This situation is evident in the spray field area as the species composition is different than the surrounding area. Several white fir and incense cedar trees have died, presumably because of microenvironmental changes on the site.

There are also giant sequoias downslope from the spray field, and although they have not shown any adverse effects from spray irrigation in the area, the long-term potential of adverse effects remains.

Impacts on Public Health

Primary or septic tank effluents have a large number of pathogenic organisms present, and there is always the potential that the wind could carry bacteria or virus beyond the spray area, particularly in the fine mists generated by high pressure sprinklers. Measurements taken by the California Department of Public Health indicate that wind may carry bacteria as far as 200 feet beyond the spray area. Also, the presence of pathogenic bacteria in slime growths may cause a health hazard from flies, mosquitos, and other vectors. Chlorination of treated effluents prior to spray field application does help to reduce the public health hazards, but because of the incompatibility of the disposal system with spray irrigation, the potential public health hazards would remain.

ALTERNATIVE B (PREFERRED) - PROPOSED SEWAGE TREATMENT PLANT SITE FROM OSMUNDSON (1976) AND VAIL (1983)

This alternative would locate the proposed new sewage facility at the Osmundson (1976) and Vail (1983) recommended site and would expand the water storage capacity. The selected treatment process, extended aeration coupled with filtration, would comply with the state of California standards for surface irrigation of effluent waters as outlined in the "Alternatives" section.

Impacts on Soils

Treatment Facilities. A total of 2 acres of soils would be disturbed from construction of the proposed treatment facilities: treatment plant (3/4 acre), access road (1/4 acre), and trench field area (1 acre). The soils in these areas would be completely removed from biological productivity. Construction of the treatment plant would require grading and leveling of the site before installation. Construction of the access roadway would require cut-and-fill along the approximately 100 linear feet in length and 20 feet in width. The trench field would require the excavation of 4,100 linear feet of trenches 6 feet wide and 3 feet deep (2,800 cubic yards).

Spray Field. The installation of the 10 spray line extensions with 9 spray heads each would require an access point for construction. This would be accomplished through the use of the previously mentioned plant

structure access road and continuation on to an existing fire trail that leads to the spray field. This access route would be used by construction equipment, which includes equipment for selective tree removal at the spray field site.

The use of the multiple spray line extensions would vary to allow for alternating spray areas and periods of rest for the soils of the spray lines not in use. No effluent spraying would be done on bare or disturbed soil in order to prevent erosion problems. Alternating the spray areas would not only rest the surface area not in use, but would also minimize the hazard of spray field clogging. If clogging occurred, an anaerobic condition in the soils would result and gas-plant root exchanges would be disrupted. This condition would be detrimental to the vegetation, and soil clogging should be monitored and avoided.

The soils have a relatively low nutrient status with the cation exchange capacity and nutrient reservoir concentrated in the upper 2 feet of soil.

Although the nutrient-bonding capacity of the soils can be estimated for the base cations contained in the sewage effluent, an evaluation of the assimilative powers of the soils for anions (particularly nitrates and phosphates) can only be made qualitatively because anion exchange is a nonstoichiometric reaction depending on many dynamic soil variables. In addition, nitrates and phosphates can be converted to relatively insoluble and immobile forms, which are difficult to quantitatively predict.

The spray application rate of 2.3 inches of effluent per week is suggested and is well within the estimated infiltration capacity and subsoil permeability of the Corbett soil group. The potential evapotranspiration rate (as calculated by the Thorthwaite method for areas of similar elevations in the Giant Forest area of Sequoia National Park) would be exceeded in some months at this application rate. However, there is sufficient moisture holding capacity in the soils to store the excess amount of moisture.

Collection System. Upgrading and replacing 6,940 linear feet of the existing collection system would disturb the surface soils along the replacement route. For the most part, the route would follow roadways and would cause minimal environmental impacts. Sections that follow routes other than roadways would require erosion control techniques following installation. These methods would range from minor soil compaction followed by placement of a pine needle mat to more significant soil compaction followed by covering the disturbed soil surface with an approved erosion control matting. The 3,720 linear feet of new lines would follow existing roadways, roadway shoulders, or trails wherever possible, and special care would be taken to avoid sensitive resources (i.e., sequoias and meadows). If lateral roots of sequoias were encountered, hand excavation would be required to prevent major root damage.

Following the installation of the new sewage facilities, the existing septic tank and spray system near the General Grant Grove would be removed and the area restored as is feasible. Also, the comfort station near the Grant tree would be dismantled and removed, and a new one would be reconstructed in the parking lot area.

Water Storage Tank. The proposed 1.2 million gallon storage tank(s) would cover an area of approximately 10,000 square feet. This area would be graded and leveled for installation of the storage tank.

The existing leaking 50,000-gallon storage tank supplied by Merritt and Winter springs would be removed and the site restored to its natural state. The existing 200,000-gallon storage tank would be renovated with insignificant environmental impact.

Park Residence. Because there is not sufficient park housing in the area for an additional employee, a residence is proposed for construction in the Wilsonia park residence area. Construction of this residence would require grading, leveling, and placement of fill material for the foundation and grade requirements. The exact quantity of fill has not been established to date.

Impacts on Water Resources

Surface and Ground Water. The spray field area is separated from the Mill Flat Creek drainage by a ridge parallel to and quite near the creek. Drainage is westerly, with no developed channels in the immediate area, and it is remote from any significant stream course. Effluent sprayed on the area would result in limited groundwater recharge, but the soil type in this area should adequately filter the effluent from the secondary treatment facility to prevent adverse effects on the groundwater aquifer. A standing water table was not encountered in any test excavations, which generally were 7 to 8 feet deep. The soils are deep, generally exceeding 5 feet, are pervious, and do not have any subsoil features restrictive to the movement of water. There were no indications of poor drainage such as gleyed or mottled colors, seeps, or soil slumps.

There were no indications of massive jointing or fracturing patterns in exposed bedrock that could transmit effluent rapidly without adequate filtering. Granitic bedrock crops out over only 10 to 15 percent of the area in mostly smaller individual occurrences. Bedrock is massive with moderate fracturing at the widest joints, all characteristic of exposures in the general park area. No important faulting or other geologic hazards were identified in the field reconnaissance or aerial photoanalysis.

The spray application rate of 2.3 inches of effluent per week is suggested and is well within the estimated infiltration capacity and subsoil permeability of the Corbett soil group. The potential evapotranspiration rate (as calculated by the Thorthwaite method for areas of similar elevations in the Giant Forest area of Sequoia National Park) would be exceeded in some months at this application rate. However, there is sufficient moisture holding capacity in the soils to store the excess amount of moisture.

Nutrients would gradually move out of the immediate spray field site and downslope to be picked up by growing vegetation. At the prescribed application rate, all flow would be subsurface, with the majority of the nutrient release probably occurring by annual flushing during snowmelt. This would also correspond to the period of maximum stream flow.

Considering the great distance the effluent would have to pass through the soil and vegetative systems to enter surface waters, it is doubtful that increased nutrients would be detectible in surface waters, and certainly not in biostimulating amounts. No bacteria or pathogenic organisms would be released to surface waters (Osmundson 1976).

Potable Water. Osmundson (1976) recommended that any additional water supply should be obtained through the better use of existing springs, development of additional springs in the Round Meadow area, and provision of additional water storage capacity. The main source of potable water would be the springs and wells in Round Meadow. Merritt and Winter springs would also continue to be used at the present level and would be connected to the central water supply system. However, pumped wells in the meadows should be avoided because even a slight lowering of the groundwater table would modify the vegetation type of the wet meadows (protected under Executive Order 11990). If the facilities at Round Meadow capture only excess water flows, there should be no disruption of the meadow ecology. Winter flows from the artesian well in Round Meadow would be used initially to fill the new storage facility. Care must also be taken to prevent stagnation and odors that develop from long-term water storage. There should be adequate water flushing to avoid storage problems, and water quality would be monitored regularly.

In direct relationship to the proposed increase in water consumption due to additional overnight facilities, public showers, and a laundromat in the Grant Grove area, all existing and new facilities would be fitted with water conservation type fixtures. These include but are not limited to low-volume flushing toilets and water flow restrictors. The impact of proposed increases in the Grant Grove facilities on the available water and wet meadows will be addressed in detail in the environmental impact statement for Grant Grove.

To cite a worst-case analysis of potable water--using the available recorded data and the EPA's Manual of Individual Water Supply Systems (1982)--the following data have been formulated. The lowest flow yield of Round Meadow was recorded at 17 gallons per minute (gpm) during the 1976 drought year, and the extrapolated yield of Winter and Merritt springs would result in an additional yield of 6 gpm. This would result in a daily yield of 33,120 gallons of water per day.

The peak recorded water use figure was 54,500 gallons per day (gpd) during July 1983. If all the 52 lodging units were filled to capacity at 4 persons per unit and the EPA's estimate of 50 gallons of water was used per person, then 10,400 gallons of the total water used per day would be attributed to this function. Also, if the average daily camper volume of 855 persons in July 1983 used the estimated 25 gallons of water per day per camper, then 21,375 gpd would be attributed to this function. The remaining 22,305 gpd is primarily due to use for permanent and seasonal housing, restaurant and lounge, gas station, and day use visitors.

Visitation in 1974 was 60 percent higher for the Kings Canyon District than that recorded for 1983. Assuming that 10,000 gallons of water per day of the 22,305 gpd was due to day visitors and the volume of water

consumption requirements at Grant Grove was directly related to the visitation figure, then an additional 6,000 gallons of water per day would have been used during that year due to increased day visits.

If all the data and assumptions are near the actual situation, then 60,500 gpd would be the peak projected water requirements at the existing level of development, and the lowest yield of available water would be 33,120 gpd during a drought year.

This would result in a deficit of 27,380 gallons of water per day during a drought year similar to 1976, and the water shortfall would be met by using the additional million-gallon storage tank. This level of draw would result in a 36-day supplemental water supply with a 200,000-gallon reserve for fire protection requirements.

During average years of precipitation, the combination of yield for Round Meadow (36 gpm) and for Merritt and Winter springs (9 gpm) would result in 64,800 gpd and would slightly exceed the projected demand.

Table 7 shows water use at Grant Grove since 1981 (data taken from park files, when meter gauge was in operation).

Table 7: Water Use at Grant Grove
(in gallons per day)

Month	1981	1982	1983	1984
January				15,000
February				16,000
March				15,000
April				20,000
May				35,000
June		27,500	27,700	27,400
July*		41,700	54,500	43,700
August*	33,000	46,100	46,100	
September	23,800	24,200	34,400	
October			20,400	
November			18,000	
December			19,000	

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*Peak water consumption months at lowest available water source yield periods.

Impacts on Vegetation

Construction of the Grant Grove sewage facilities, water storage tank, and the additional residence would result in 3 acres of complete vegetation removal and 12½ acres of partial vegetation removal with more precise impacts outlined in following sections.

Treatment Plant and Access Road. Construction of the proposed treatment plant facilities would remove 1½ acres of vegetative cover within the mixed conifer forest/chaparral habitat, including 10 mature sugar pine, 10 mature Jeffrey pine, 5 mature incense cedar, and 5 mature white fir trees, and up to 20 white fir saplings. The area would no longer be biologically productive due to this action.

Spray Field and Trench Areas. According to Vail (1983), a total of 12½ acres would be totally cleared and grubbed for installation of the winter infiltration trenches and the summer spray disposal area. The total acreage affected would be reduced by selective tree removal with limited grubbing. The requirements for the disposal areas would be accomplished and would serve to mitigate the effects of complete "clear cut" tree removal. Even with this mitigating action, approximately 100 mature conifer (primarily) trees and an equal number of saplings would be removed from each of the spray field and winter trench areas.

The 3-acre winter disposal area would include 4,100 linear feet of trenches proposed for three separate bed areas in mixed conifer habitat. Each trench would be 6 feet wide and 3 feet deep. A total of about 1/2 acre would be cleared of vegetation for trench installation. The precise layout has not been established, but in the worst-case analysis, approximately 40 mature white fir, 20 sugar pine, 20 Jeffrey pine, 10 incense cedar, and 10 black oak trees would be removed.

The 9½-acre spray field area would also require selective tree removal (primarily white fir). A total of 10 spray line extensions of nine spray heads each would be installed to allow for alternating spray areas and periods of rest for lines not in use. It might be determined that supplemental plantings of native species would be required for erosion control if the natural ground cover was inadequate. Use of the spray field area would alter the plant species composition of the spray site because of increased moisture and nutrients available locally to plants.

No immediate effect on the vegetation of the site would be expected with the application of 2.3 inches of effluent per week. The vegetation of the site consists predominantly of mature white fir trees with no sequoias in the area. Plants have their greatest fertility requirements during early growth, and thus there would be little stimulation of these older, more mature trees. No alluvial meadows that could be adversely affected were noted in the immediate area. Younger trees, coming up in openings within the stand, would have stimulated growth. In this regard, some stand clearing might be considered to promote rapid growth of younger conifers and to increase the understory cover of grasses and forbs, thereby increasing the assimilation of nutrients applied in the sewage effluent. Tree-harvesting to remove nutrients from recycling in the ecosystem is another long-term management tool. These management options are not recommended until the site has been monitored and evaluated for a few years.

Collection System. Upgrading and replacing 6,940 linear feet of the existing collection system might also require the removal of several mature trees, but in all areas, routes that avoid tree removal or damage would be followed. However, some root pruning would result from replacement

or realignment of the existing lines and installation of new lines. The 3,720 linear feet of new lines would follow existing roadways, roadway shoulders, or trails wherever possible, and special care would be taken to avoid sensitive resources (i.e., sequoias and meadows). If lateral roots of sequoias were encountered, hand excavation would be required to prevent major root damage.

Following the installation of the new sewage facilities, the existing septic tank and spray system near the General Grant Grove would be removed and the area restored as is feasible. Removal of the existing facilities would allow the area to return to a more natural setting and would improve the aesthetic quality of the site.

The comfort station located near the Grant tree would be dismantled and removed and a new one reconstructed in the parking lot area. The existing site would be restored.

Water Storage Tank. The proposed 1 million gallon storage tank(s) would cover an area of approximately 10,000 square feet near Winter Spring Meadow. Installation of this facility would require the removal of a maximum of 30 white fir and 2 incense cedar trees. There are also 3 dead trees near the site that would be removed to minimize potential tree fall hazards on the storage tank. An existing access road to the Winter Spring storage tank would be used for entry to the new tank with no additional impact on vegetation.

The existing leaking 50,000-gallon storage tank on the fringe of Winter Spring Meadow would be removed and the site restored to its natural state. The existing 200,000-gallon storage tank would be renovated with insignificant environmental impact.

Park Residence. Because there is not sufficient park housing in the area for an additional employee, a residence is proposed for construction in the Wilsonia park residence area. Construction of the residence would require the removal of up to 20 mature white fir trees and the placement of fill material for the foundation and grading requirements. Approximately 2,000 square feet of surface area would be removed from biological productivity.

Impacts on Public Health

Minimal danger to the public would occur because the spray field and percolation bed areas would be isolated and fenced. Both areas would be posted to minimize human contact with the effluent, which still contains some disease organisms despite treatment (FS, USDA 1972b). The improved treatment process would also significantly decrease the growth of surface slimes from the sprayed effluent and stagnant surface water pooling would be reduced. These two factors would minimize the potential problems with vectors transmitting disease organisms.

Impacts on Cultural and Archeological Resources

The proposals in this alternative would have no impact on cultural resources. Major facility construction would not take place in the vicinity of historic structures, and minor construction, such as sewage collection, would have no impact on the significant characteristics of any historic structures or historic districts. A site-specific archeological clearance would be obtained prior to construction.

Overall Construction Summary

All of the construction activities outlined would result in the removal of the vegetative cover and the disturbance of the soil surface. A slight, but temporary increase in dust and vehicular emissions would decrease the air quality in the immediate area of construction. Also, an increase in noise and visitor inconveniences would occur, but this would be localized during the construction period. Once all the facilities were in place, a total of 2 acres would have been covered and removed from biological productivity.

A total of 12½ acres of mixed conifer habitat would be altered due to selective tree removal and effluent discharges. Approximately 1 acre would be actively restored, and the existing 10-acre spray field site in the Grant Grove area would return to a natural state through natural selection processes.

ALTERNATIVE C - PROPOSED SEWAGE TREATMENT PLANT SITE FROM LONG (1973a, b)

The proposed site for the new sewage treatment plant (Long 1973a, b) was considered but rejected because of the characteristics of the spray area. Osmundson's evaluation (1976) of the proposed site has been confirmed by field inspection. The spray disposal area contains excessively steep slopes, averaging 40 degrees or more, the majority of which are comprised of massive outcropping granite bedrock. Also, not more than 50 percent of the area is covered by significant weathered rock mantle and soil, and this is thin on the average. A few locations of deeper soil cover are very restricted in extent.

This area is not suitable for land disposal of treated sewage effluent. The soils are too shallow and coarse textured, the slopes are too steep, and there are too many areas of exposed bedrock to consider this site feasible for spray irrigation disposal. High runoff and serious water quality problems could result.

ALTERNATIVE D - SEWAGE PLANT EXPANSION AT OR NEAR EXISTING SITE

Use of either of the proposed locations in this alternative would be contrary to the national park's objective of protecting sequoia groves in their natural state. There is no evidence to prove that sprayed effluent

is harmful to sequoias, but vegetational changes would take place in the spray field area. If modification of the subsurface water flows, which increases nutrient content, does prove harmful to sequoia trees, it may be too late to correct potential adverse effects.

APPENDIXES

A: Water Quality Data

B: Wet Meadow Ecology

C: Giant Sequoia Ecology

APPENDIX A: WATER QUALITY DATA

Grant Grove/Redwood Mountain

Determination (mg/l unless otherwise noted)	Round Meadow Feb. 2, 1980	Winter Spring July 2, 1979	Merritt Spring July 2, 1979	Redwood Mountain Spring March 25, 1976
Chloride	.5	.2	.4	.95
Sulfate (SO_4)	1	.5	.5	.5
(HCO_3)	41	12	9.4	
Carbonate (CO_3)	0	0	0	
Sodium	3.8	2.4	2	
Potassium	.99	.53	.5	
Calcium	8.8	1.6	1.2	
Magnesium	.7	.3	.3	
Hydroxide Alkalinity ($CaCO_3$)	0	0	0	
Carbonate Alkalinity ($CaCO_3$)	0	0	0	
Bicarbonate Alkalinity ($CaCO_3$)	34	10	7.7	
Calcium Hardness ($CaCO_3$)	22	4	2.9	
Magnesium Hardness ($CaCO_3$)	3	1.2	1.1	
Total Hardness ($CaCO_3$)	25	5.2	4	
Iron	.07	.05	.05	.01
Manganese	.01	.01	.01	.008
Copper	.037	.001	.003	.005
Zinc	.01	.02	.05	.003
Flouuride	.05	.05	.05	.1
Arsenic	.0005	.0005	.0005	.002
Barium	.1	.1	.1	.03
Cadmium	.001	.001	.001	.002
Chromium	.01	.01	.01	.008
Lead	.001	.001	.001	.025
Mercury	.0002	.0001	.0001	.001
Selenium	.0005	.0005	.0005	.005
Silver	.001	.001	.001	.002
Cyanide				.003
Nitrate	.16	.21	.13	.04
Nitrite				.001
Phenols				.001
Total Dissolved Solids	79	28	14	64
Turbidity (J.T.U.)				4
Foaming Agents (MBAS)	.02	.025	.025	
Specific Conductance micromhos at 25°C	69	24	19	
Gross Alpha pCi/liter		2.1		
Gross Beta pCi/liter		4.5		
pH	5.8	5		

APPENDIX B: WET MEADOW ECOLOGY

Montane meadow communities in the Sierra Nevada occupy moist sites underlain by shallow water tables. Meadows in the Grant Grove area consist of poorly drained alluvial soils with slopes ranging from 3 to 30 percent. The soil surface is high in organic matter, and the subsoil consists of stratified deposits of sandy material of largely granitic origin. Soil depths commonly exceed 10 feet.

The meadows occur from 4,500 to 8,000 feet in elevation interspersed in the mixed conifer forest. Perennial sedges, grasses, and rushes dominate the meadows. These include the Nebraska sedge, oval-head sedge, wire rush, wheatgrass, brome, tufted hairgrass, rye grass, fescue, melicgrass, muhly, squirreltail, needlegrass, redtop, mannagrass, timothy, bluegrass, and trisetum.

Wildflowers characteristic of these meadows are shootingstar, elephanthead, spiked mallow, rein orchid, corn-lily, cowparsnip, Bigelow's sneezeweed, California coneflower, red columbine, leopard lily, aster, meadow lotus, owl-clover, wild onion, yarrow, and pearly everlasting. There are no known threatened or endangered plant species in the meadows.

Representative data of species composition are hard to obtain because the meadow is an intricate complex of many small assemblages of organisms associated with slightly differing soil moisture regimes in different areas. Willows are abundant along stream courses, and ponderosa pine may encroach on drier areas.

The meadow environment provides suitable habitat for an abundance of wildlife. Mammals commonly found include several species of shrew, meadow mouse, mole, long-tailed weasel, and deer.

The rodent species provide prey for raptors that include the great-horned owl, red-tailed hawk, and American kestrel. Salamanders and frogs are also common (Osmundson 1976).

The southern extent of the known range of mountain beaver (Aplondontia rufa californica) is within 10 miles of Grant Grove Meadow; however, recent sightings have occurred in nearby meadows. Aplodontia, while neither officially threatened nor endangered, is quite rare to the park.

No officially listed threatened or endangered wildlife species are known to inhabit the meadow (correspondence, December 6, 1978; updated January 1980).

The ecotone between meadows and adjacent forest communities is an important unit aspect of wildlife ecology in the area. Meadows are the major sources of food for many species that seek cover in the adjacent forest. The ecotone often contains denser populations and greater numbers of species than the communities flanking it. The meadow/forest edge is important to the more secretive species, such as the long-tailed weasel and mule deer, that feed on rodents and vegetation, respectively,

in the meadow, but require the security of a nearby forest for a quick retreat to shelter.

The acreage of natural meadow/forest edge has shown a decline in the Grant Grove and Redwood Mountain areas, as well as in other regions of the park, through development of campgrounds and other visitor facilities. Development of visitor facilities within the meadow perimeter has been a common practice for many years. This type of development upsets the balance of the forest ecosystem by eliminating habitats that are crucial to both secretive predators and to escaping prey (NPS, USDI 1978). The integrity of meadows for fawning grounds for deer or nesting sites for birds is sensitive to the concentrated activities of man. Although deer are moderately compatible with man, use of meadows as fawning habitat probably will not occur if there is human activity nearby. Grant Grove Meadow is a significant attraction and serves as a valuable interpretive resource. The vegetation, plants, and wildlife of the meadow are subjects of campfire programs and interpretive walks. Additionally, many people walk to the meadow's edge or wander about its perimeter on their own initiative.

Several meadows in the area have significant springs and seeps issuing a fairly continuous water supply. Meadow areas provide large and predictable groundwater storage units, but the rate of dependable yield during the critical late summer and fall periods will be highly variable. During the period of snow cover and snowmelt, meadow soils are water saturated, and the water table is at the ground surface until the end of June. By early July, direct runoff and seepage from melting snow has ceased, and at this time meadow areas are totally dependent on groundwater for moisture. From early July until September, the water table may decline to a depth of 2 to 4 feet due to evapotranspiration by the plant community. At this time, plants obtain water through root capillary action in the soil. The water table begins to rise in late September and is at the surface again at the end of October.

As defined in Executive Order 11990, the wet meadows in the Grant Grove area are designated as follows: "those areas that are inundated by surface or groundwater with a frequency sufficient to support, and under normal circumstances does or would support, a prevalence of vegetative or aquatic life that requires moist soil conditions for growth and reproduction. Wetlands generally include . . . wet meadows."

The vegetation of the meadow is highly dependent on the local drainage pattern. Any substantial change in moisture availability could radically affect species composition and the integrity of the meadow. Water table depths control the position of the ecotone between meadow and forest. Alteration of local drainage patterns by increased drawdown of the water table would cause the meadow margin to be drier than the meadow proper. This would allow encroachment of species tolerating more xeric conditions in the meadow, reducing the total wetland area.

With establishment of the parks in 1890, a period of active fire suppression was begun. No natural fire has occurred in any meadow since 1920, and no definite record exists of any fire occurring since establishment of the parks. Grant Grove Meadow was prescription burned

(12/80 and 12/81). The frequency of naturally ignited fires entering the meadow is probably less than 80 or 90 years; therefore, fire appears to have been excluded from playing a role in the modern ecology of meadows in the Grant Grove area. Plants that reproduce vegetatively have probably been favored with the absence of fire. Woody plants, such as willow, might be expected to increase in stature and become less available and palatable to wildlife. This has occurred at Grant Grove Meadow but is not attributable solely to fire suppression. Cover quality increases as the willows become larger and more abundant, increasing the attractiveness of the meadow for fawning grounds. Conifers and woody species might be expected to become established at a greater rate along the meadow periphery with the absence of fire. Although few young conifers are present along the meadow's edge, several clumps of woody plants (especially azaleas) are present. Fire is involved in nutrient cycling in the meadow ecosystem on a macrolevel.

Development adjacent to Grant Grove Meadow is extensive. Roads or pavement completely surround the meadow and are rarely more than 100 feet from it. Structures ranging from concession service facilities to small rental cabins circumscribe all but the northwest one-third of the meadow perimeter. Water is drawn from the drainage that feeds the meadow. Sewer and water lines are buried along a portion of the meadow's edge.

If gasoline were to leak from the gas station's storage tanks, it could enter the meadow drainage; however, no evidence of leaks have been observed at the meadow surface.

Aside from the meadow's sensitivity to human activity, the meadow is also highly sensitive to any alteration of surface or subsurface water flow. Poor drainage conditions and flooding hazards during snowmelt periods present major constraints to intensive use of most meadow areas. Meadows are also significant recharge areas for groundwater that travels to lower elevations and may feed other meadows and possibly sequoia groves as well. Meadow vegetation may be adversely affected by activities that raise or lower the water table. The maintenance of the natural vegetation associated with meadow soils creates a major constraint to any activity near the meadow that generates increased traffic in or through the meadow. Meadow soils are subject to compaction under foot traffic and to deterioration of soil structure.

APPENDIX C: GIANT SEQUOIA ECOLOGY

The giant sequoia is restricted to about 75 disjunct groves along the western slope of the central and southern Sierra Nevada. Although at one time more extensively distributed, the giant sequoia's range has been largely reduced by changing climatic conditions. Although present grove boundaries seem stable, a majority of areas are undergoing a gradual decrease in density of giant sequoias because of low levels of regeneration. This decline in density began long before the influence of man on the groves. However, at this time Grant Grove seems to be a mature, stable grove.

An interaction of factors within the ecosystem controls giant sequoia grove boundaries. Availability of soil moisture at the seedling stage is the single most critical factor for maintenance of groves (Rundel 1972). Other environmental conditions, such as temperature and physiographic factors, are of secondary importance. Giant sequoias are associated with conifers, such as white fir, sugar pine, and incense cedar. The white fir is especially tolerant of shade, and unless white fir reproduction is controlled by fire, there is a tendency for it to eliminate reproduction while mature sequoias linger as successional relicts.

Fire is an important component of the giant sequoia ecosystem. In addition to controlling ground cover and understory to provide room for germination of sequoia seeds, hot fires cause the serotinous sequoia cones to open and release their seeds in tremendous numbers (Harvey, Shellhammer, and Stecker 1980). Larger sequoias are insulated from the effects of fires by their thick, relatively fire-resistant bark. Lower branches are sloughed off early in the life cycle, reducing the probability of crown fires. As a result, the giant sequoias are well adapted to withstand fire, and in fact they require it for long-term survival (Harvey, Shellhammer, and Stecker 1980).

Reproduction of giant sequoias is not restricted to conditions produced by fire, although an altered substrate and open forest floor enable more seedlings to survive. Root pits of fallen trees, river terraces, small streams and creeks, and other minor disturbances provide a receptive seedbed for sequoias. Seeds for these intermittent and randomly occurring seedbeds come mainly from the activities of two animals, a minute beetle and the chickaree. The most significant seed release is due to the cone-mining activity of the beetle, which mainly attacks green cones five to eight years old. The chickaree feeds on two- to five-year-old cones, and the fleshy green cone scales appear to be its major food source in sequoia groves.

Giant sequoia seeds will germinate in almost any natural medium in the forest if there is sufficient moisture. However, the primary survival factor of seedlings depends on whether or not the rooting medium remains moist and allows for rapid root penetration. Nearly 90 percent of the mortality rate reported was attributed to lack of soil moisture. Seedlings with adequate moisture availability levels, including seedlings adjacent to rocks, limbs, and other objects that help retain soil moisture show a high survival rate (Rundel 1972). Few insects attack young seedlings, but

heat canker may kill exposed seedlings, and pathogens and falling debris also take their toll on the seeds (Harvey, Shellhammer, and Stecker 1980).

Although relatively brief in the life cycle, the seedling stage of giant sequoias is critical, and the mortality of seedlings in their first year of growth is high. Harvey, Shellhammer, and Stecker (1980) found a mortality rate of nearly 75 percent between July 15 and October 30, 1966, in a study of over 2,000 seedlings in fire-manipulated plots in the Redwood Mountain Grove.

Once seedlings have a majority of their roots located in a zone of relatively permanent soil moisture, growth is extremely rapid. They may reach over 10 feet in height in 10 years, and a few may grow 2 feet vertically per year. This rapid growth, including development of bark and quick loss of lower branches, enables the sequoia to better withstand fire.

Giant sequoia seedlings are better adapted to full sunlight and moderate shade than white fir seedlings. Sequoia seedlings grow best with a litter cover that reduces heat damage to the stem and lowers soil temperatures; they also survive or endure in areas of dense shade but grow poorly. Sequoia seedlings are better able to endure drought than white fir, apparently because of their extensive root system. The presence of dry, dense litter layers adjacent to groves may inhibit seed germination and establishment in many areas.

In large mature groves, such as Grant Grove, the mortality rate remains high until the trees are about 4 feet in diameter, which generally means they are about 400 years old. Beyond this age, there are only slight distinctions in mortality rates between age classes. Factors seemingly involved in the deaths of older trees include toppling of trees from fungus-weakened roots, undercutting by streams, excessive strain due to snow or wind, and waterlogged soils. However, many trees live to be over 2,000 years old (Harvey, Shellhammer, and Stecker 1980).

Mature sequoia trees have extensive root systems that may extend outward from the trunk up to 200 feet. The system consists of large roots up to 3 feet in diameter and tiny threadlike feeders that spread out from larger roots near the base of the tree. The entire root system is within 4 to 5 feet of the soil surface (Engbeck 1976).

In groves where visitation is heavy, both direct effects and alteration of key environmental conditions appear to affect the vigor of mature trees and regeneration of the species. Giant sequoias are subject to direct injury from construction and use of existing facilities. Buildings, parking areas, and compacted soils alter the soil moisture regime. Fire suppression maintained in developed areas increases competition against the giant sequoia and reduces reproduction.

With development sites located in a sequoia grove, management techniques for the best protection of the prime resource are not possible, and the ability of the grove to perpetuate itself is hampered.

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