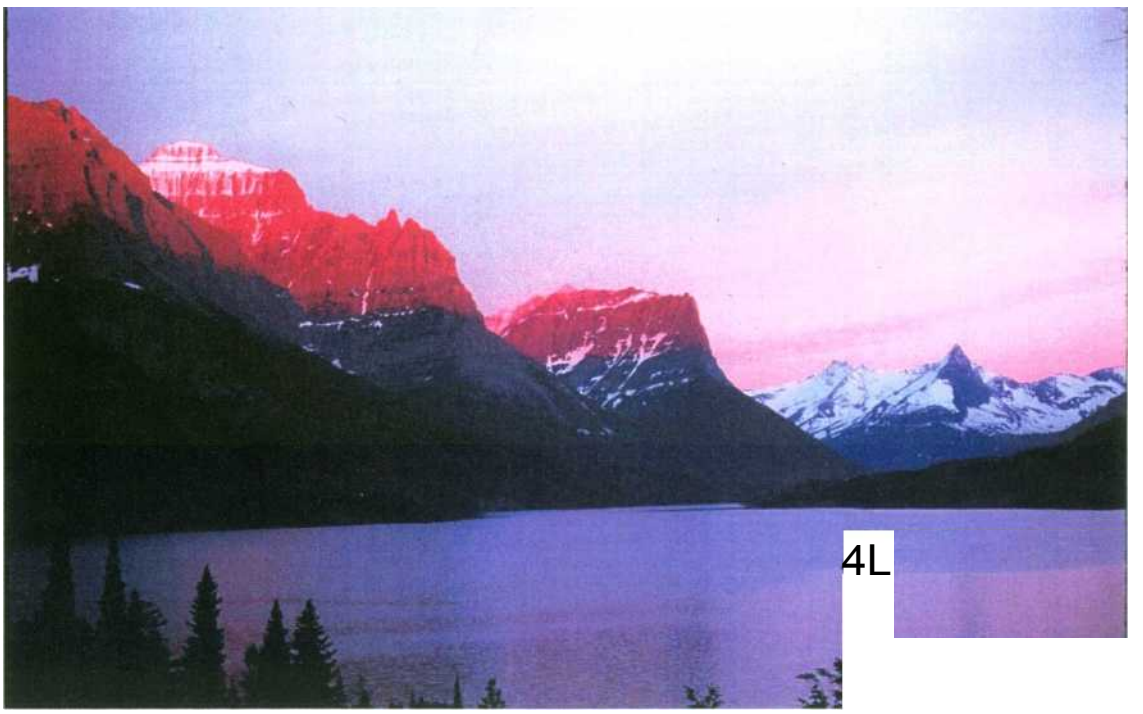
FINAL

2000 AIR EMISSIONS INVENTORY

GLACIER NATIONAL PARK
MONTANA



U.S. NATIONAL PARK SERVICE

AUGUST 2002

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MONTANA

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AUGUST 2002

Cover Photo: Wild Goose Island

CONTENTS

CONTENTS (Continued)

FIGURES

TABLES

1. INTRODUCTION

1.1 BACKGROUND

In August of 1999, the National Park Service (NPS) embarked on the Natural Resource Challenge, a major effort to substantially improve how the NPS manages the natural resources under its care. As part of Natural Resource Challenge, the NPS Air Resources Division (ARD) was tasked with the responsibility of expanding efforts to monitor and understand air quality and related values in the parks. In addition, the NPS Environmental Leadership policy directs the NPS to manage the parks in a manner "that demonstrates sound environmental stewardship by ¡mplementing sustainable practices in all aspects of NPS management...." In order to achieve both of these objectives, it is necessary to gain an understanding of air pollution emissions that result from activities within the park. Development of an in-park air emissions inventory for Glacier National Park (NP) serves three functions in this regard. First, it provides an understanding of the sources and magnitude of in-park emissions and a basis for contrasting them with emissions from the surrounding area. Second, it identifies existing and potential strategies to mitigate in-park air emissions. Finally, it evaluates and ensures the compliance status of the park relative to state and federal air pollution regulations.

1.2 TYPICAL AIR EMISSION SOURCES

Typical air emission sources within NPS units include stationary, area, and mobile sources. Stationary sources can include fossil fuel-fired space and water heating equipment, generators, and fuel storage tanks. Area sources may include prescribed burning, campfires, wastewater treatment plants, highway maintenance, and miscellaneous visitor activities. Mobile sources may include vehicles operated by visitors, tour operators, and NPS and concessioner employees, and nonroard vehicles and equipment.

1.3 INVENTORY METHODOLOGY

The methodology to accomplish the air emissions inventory consisted of preparation of an Air Emissions Preparation Protocol (EA 2001), a site survey in October 2001, interviews with Glacier NP[1] and concessionaire personnel, review of applicable park records, emission calculations, and report preparation. The data were used in conjunction with a number of manual and computer software computational tools to calculate emissions. Computational tools included U.S. Environmental Protection Agency (USEPA) emission factors such as AP-42 and the Factor

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Information Retrieval System (FIRE) database, USEPA *TANKS 4.0* model, U.S. Forest Service *First Order Fire Effects Model (FOFEM) 4.0* model, and USEPA *MOBILE5band PARTS* mobile source emissions model. The year 2000 was selected as the basis for the air emission inventory since data for that year were the most recent available at the park. It should be noted that emissions are expected to vary from year to year due to fluctuations in visitation, prescribed and wildland fires, and other activities. Additional information on emission estimation methodology, including emission factors, are provided in other sections of this report, and emission factors and data on fuel types are provided in Appendix A.

1.4 PARK DESCRIPTION

Glacier NP is located in northwest Montana and shares a 39-mile border with Warterton Lakes National Park in Alberta, Canada (Figure 1). The park was established in 1910, and in *1932,* the U.S. Congress and Canadian Parliament designated Glacier and Waterton Lakes NPs as the Waterton-Glacier International Peace Park as a symbol of the longtime friendship between the two countries. **In** the 1970s, each park was designated as a Biosphere Reserve, and in 1995, the International Peace Park again gained global recognition with its designation as a World Heritage Site.

Glacier NP encompasses approximately 1,014,000 acres or 1,584 square miles of forests, alpine meadows, and lakes in the Rocky Mountains. The landscape includes approximately 50 glaciers and 650 lakes, including Lake McDonald and St. Mary Lake, which are the two largest in the park. There are approximately 700 miles of maintained trails and 135 miles of paved roads. The Going-to-the-Sun road, a 55-mile paved road that was completed in the 1930s, traverses the park from West Glacier to St. Mary and has been designated a National Historic Landmark. Most of the park's roads are closed during the winter season beginning in November and re-opening in May or June. Consequently, the majority of visitation, 60 percent of the 1.7 million visitors, occurs in July and August. Principal summer visitor activities include hiking, wildlife watching, camping, boating, fishing, river rafting, and horseback riding, and winter visitor activities include cross-country skiing, snowshoeing, and winter wildlife watching. Snowmobiles have been prohibited since the mid-1970s.

Information on developed areas in the parks is summarized in Table 1, and site maps of many of these developed areas are provided in Appendix B. Commercial services in the park that are authorized under concession contracts that may generate air emissions include lodging, food services, campstores and other retail establishments, boat tours and small boat rentals, and some transportation tours and services. There are approximately 450 acres of private in-holdings within

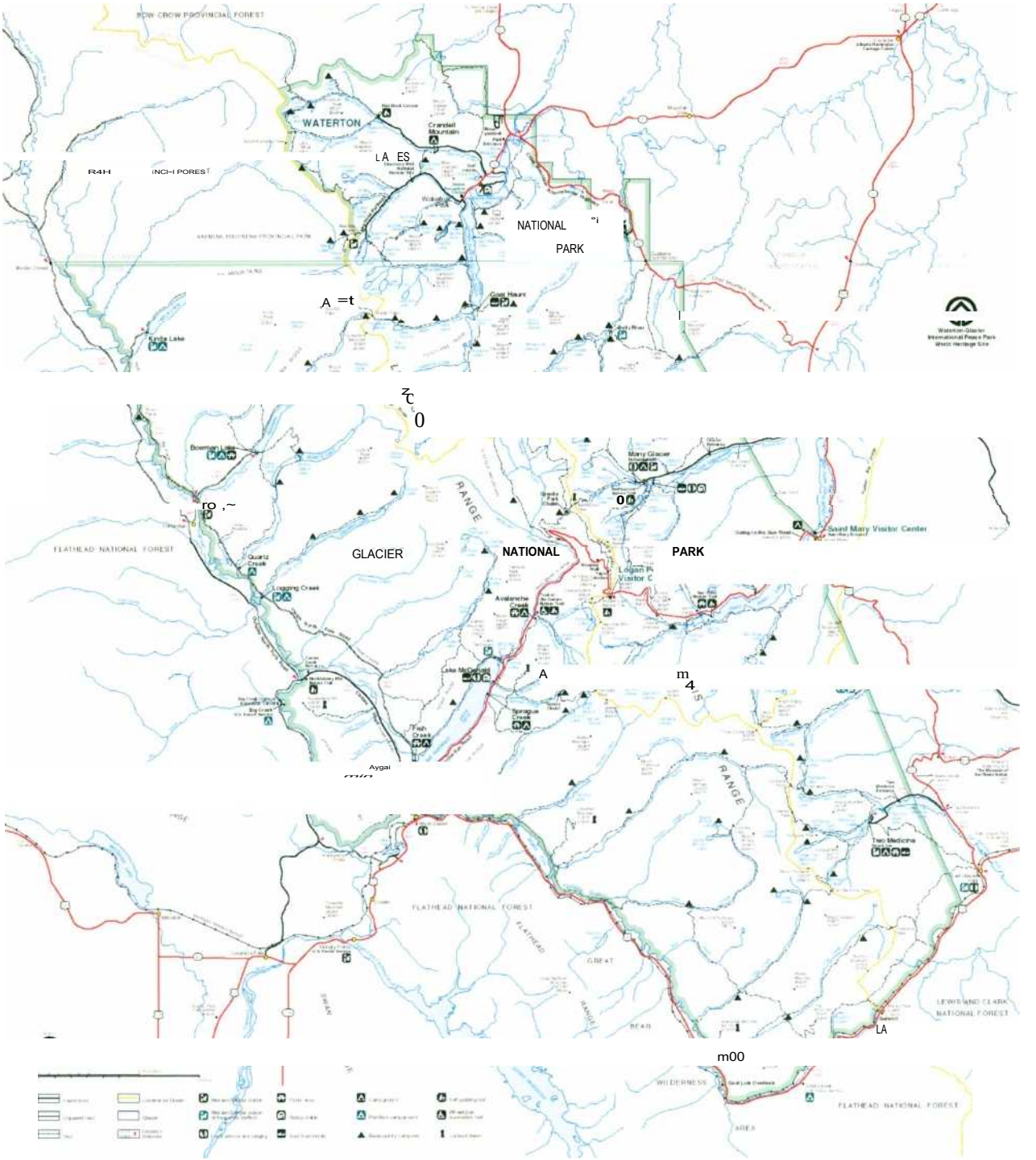

Figure 1 . Glacier National Park

the park boundaries, and the majority of these are summer residences located around Lake McDonald. Site maps of most of these private in-holding areas are provided in Appendix C.

TABLE 1: GLACIER NP DEVELOPED AREAS

Name/Location	Function/Facilities
West Glacier	Park Headquarters, Maintenance Shops, Fire Cache, Employee Housing
Apgar Village	Visitor Center, Gift Shops, Apgar Village Lodge, Village Inn Motel, Restaurant, Environmental Education Center, Public and Rental Boat Docks
Lake McDonald	Lake McDonald Lodge, Restaurant, General Store, Employee Housing,
Rising Sun	Rising Sun Motor Inn and Cottages, Restaurant, Employee Dormitories
Many Glacier/Swiftcurrent	Many Glacier Hotel, Swiftcurrent Motor Inn, Visitor Orientation Center, Camp Store, Restaurant, Employee Dorms and Cabins
Logan Pass	Visitor Center
St. Mary	Visitor Center, Restaurant, Camp Store, Employee Housing
Goat Haunt	Employee Dorm and Apartment, Backcountry Ranger Station, Barn, and Maintenance Buildings
Two Medicine	Ranger Station, General Store
East Glacier	Glacier Park Lodge, Camp Store, Employee Housing

1.5 AIR QUALITY STATUS

Glacier NP is located in Flathead and Glacier Counties, MT, and the Montana Department of Environmental Quality (DEQ) is the governing authority for regulating air pollution from stationary sources in the state. Northwestern Montana is very mountainous and heavily forested, and the valleys have relatively poor atmospheric dispersion characteristics. Historically, particulate concentrations have been problematic, and carbon monoxide (CO) concentrations have had the potential to reach elevated levels, particularly during the winter months. Residential wood combustion is common in the nearby communities due to the relatively easy access to wood from local forests, and older model wood stoves emit relatively high quantities of PM_{10} and CO.

Flathead County is classified as attainment for all the National Ambient Air Quality Standards (NAAQS), except for particulate matter (PM_{10}). Since 1993, portions of Flathead County have been designated as nonattainment for PM10. These areas, which are west of the park, include the towns of Columbia Falls, Kalispell, and Whitefish and vicinity. An ozone monitor is located in Glacier NP just west of the park's west entrance and headquarters, and the maximum ozone measurement recorded at this site since 1996 was 0.065 parts per million (ppm), which compares to the federal 1-hour standard of 0.12 ppm. Glacier County, which includes the east side of the park, is classified as attainment for all the NAAQS. Particulate monitors are located in Babb, Browning, and East Glacier communities in Glacier County, and they have not recorded any exceedences of the particulate NAAQS in the last five years.

Visual quality is often judged by how far one can see on a given day, and how distant or clear the objects being viewed appear compared to how they look on other days. Visibility may be ¡mpaired by both natural and human influences. The most common sources of natural visibility ¡mpairment in the region of Glacier National Park are organic carbon from forest fires, atmospheric moisture (humidity, mist, fog, rain and snow) and wind blown dust. The primary man-made condition affecting the park's visibility quality is organic carbon from agricultural, slash, prescribed and wood stove burning. Other sources of man-made visibility reduction include local industry and road dust.

Glacier NP has been monitoring visibility since 1982 with the objectives of developing a visibility database and determining the impact of existing conditions affecting visibility. The monitoring program at Glacier NP is part of a continuous nationwide monitoring program network called IMPROVE (Interagency Monitoring of Protected Visual Environments). Visibility is monitored in two different ways by two separate instruments at Glacier. These two monitoring instruments, working in concert, demonstrate the connection between particulates in the air and visibility reduction. *A transmissometer* monitors Glacier NP's visibility by measuring visual range, temperature, and relative humidity hourly. The transmissometer emits a chopped beam of light toward a receiver station 5.28 km away. The receiver gathers the light and outputs visual range (distance of visibility). At the receiver station visibility data is sent via satellite for compiling. *A fine particulate sampler* measures the particles in the air that influence visibility.

Since Glacier NP is six miles downwind from Columbia Falls Aluminum Co. (CFAC), gaseous and particulate fluoride emissions (byproducts of aluminum reduction) have been of concern to the park and surrounding areas. Animals and plants that accumulate significant levels of fluoride may exhibit tissue death, inhibited growth or greater susceptibility to disease or insects. Glacier NP began monitoring fluorides in the park in 1970, and at that time, monitoring indicated that high levels of ambient fluoride occurred in the park and accumulated in plants, animals and soil above normal levels. A significant reduction of fluoride levels was detected after the installation, in 1980, of a scrubber system at the plant. Monitoring by Glacier NP and aluminum company personnel from 1980-1998 show fluoride levels within Glacier NP to be significantly reduced.

Glacier NP is one of 49 NPS units that are designated as Class I areas by the Clean Air Act and its Amendments. A Class I area is one that receives the most stringent degree of air quality protection within and around its borders. For example, potential new or modified sources of significant pollution that plan to locate near a Class I area must obtain a permit from the applicable air quality regulatory agency. The NPS has significant input to the peiuiitting process to ensure that potential air emissions do not pose a threat to visibility or other park resources.

2. STATIONARY AND AREA SOURCE EMISSIONS

This section summarizes emissions from stationary sources at Glacier NP for the year 2000. The discussion is divided into sections covering emissions from combustion sources, fuel storage sources, and area sources. The following emissions were calculated for each source: particulate matter (PM10), sulfur dioxide (SO2), nitrogen oxides (NO_X), carbon monoxide (CO), and volatile organic compounds (VOCs). Emission factors and other data used in the calculations are provided in Appendix A.

2.1 STATIONARY SOURCES

2.1.1 Space And Water Heating Equipment

Stationary combustion sources at Glacier NP include approximately 215 NPS-owned and operated natural gas and propane space and water heating units. With one exception, all the space and water heating units are rated as residential furnaces since all but one are rated below 300,000 Btu/hr heat input. Criteria emissions were calculated using the appropriate residential and commercial unit emission factors. For example, PM emissions from a natural gas-fueled boiler at headquarters are calculated as follows:

$$347{,}059\ cubic\ feet/yr \times \frac{7.6\ lb\ PM}{1{,}000{,}000\ cubic\ feet} = 2.64\ lb\ PM/yr$$

Actual criteria pollutant emissions from space and water heating equipment are summarized in Table 2. Potential emissions also were calculated by assuming that the heating units were operated continuously during the year, and these emissions are noted in Table 3. All heating equipment in the lodges operated by the concessionaire, Glacier Park, Inc., are electric units, except for one small propane water heater at the Rising Sun Motor Inn.

2.1.2 Generators

2.1.2.1 Generator Emissions - Actual

Emissions were calculated by multiplying the unit rating (kW) of the generators by an estimated annual run time (hr/yr) to get the kW-hr/yr, and the appropriate emission factors were then applied. For example, PM emissions from three 45 kW diesel generators at Polebridge were calculated as:

$$45\ kW \times 3\ generators \times \frac{2{,}912\ hours}{year} \times \frac{1.34\ hp}{kW} \times \frac{0.00220\ lb\ PM}{hp\text{-}hr} = 1{,}159\ lb\ PM/yr$$

TABLE 2. 2000 ACTUAL AIR EMISSIONS FROM GLACIER NP
SPACE AND WATER HEATING EQUIPMENT

Equipment	Location	No.	Fuel	Fuel Consumption	PM_{10} (lbs/yr)	SO_2 (Ibs/,yr)	NO_X (lbs/yr)	CO (lbs/yr)	VOC (lbs/yr)
Boiler	Headquarters	1	Natural Gas	347,059'	3	0	35	29	2
Boiler	Headquarters	4		292,137'	2	0	27	12	2
Furnace	Headquarters	45		1,314,617'	10	1	124	53	7
Furnace	Housing	52		3,038,226'	23	2	286	122	17
Water Heater	Housing	97		2,096,960'	16	1	197	84	12
	Natural Gas Total	199		7,089,000'	54	4	668	299	39
Emission Factors from AP-42, Tables 1.4-1 and 1.4-2 for residential furnaces and small boilers Formula = Consumption (cf/yr) * Emission Factor (lb/1,000,000 cf)									
Furnace	East Glacier Housing	14	Propane	14,236[2]	6	0	199	27	4
Emission Factors from AP-42, Tables 1.5-1 for commercial boilers, S=.05 Formula = Consumption (gal/yr) * Emission Factor (lb/1,000 gal)									
				Totals	60	4	868	326	43

' cubic feet/year gallons/year

TABLE 3. 2000 POTENTIAL AIR EMISSIONS FROM GLACIER NP
SPACE AND WATER HEATING EQUIPMENT

Equipment	Location	No.	Fuel	Fuel Consumption	PM_{10} (lbs/yr)	SO_2 (Ibs/yr)	NO_X (lbs/yr)	Co (Ibs/yr)	VOC (lbs/yr)
Boiler	Headquarters	1	Natural Gas	4,955,657'	38	3	496	416	27
Boiler	Headquarters	4		4,171,429'	32	3	392	167	23
Furnace	Headquarters	45		18,771,429'	143	11	1,765	751	103
Furnace	Housing	52		43,382,857'	330	26	4,078	1,735	239
Water Heater	Housing	97		29,942,514'	228	18	2,815	1,198	165
	Natural Gas Total	199		101,223,886'	769	61	*9,545*	4,267	557
Emission Factors from AP-42, Tables 1.4-1 and 1.4-2 for residential furnaces and small boilers Formula = Consumption (cf/yr) * Emission Factor (lb/1,000,000 cf)									
Furnace	East Glacier Housing	14	Propane	134,033[2]	54	1	1,876	255	40
Emission Factors from AP-42, Tables 1.5-1 for commercial boilers, S=.05 Formula = Consumption (gal/yr) * Emission Factor (lb/1,000 gal)									
				Totals	823	61	11,421	4,522	597

' cubic feet/year gallons/year

Actual generator emissions are summarized in Table 4.

TABLE 4. **2000** ACTUAL AIR EMISSIONS FROM GLACIER NP GENERATORS

Goat Haunt	2	Propane	45	840					19
Lift Stations	11		35	6,190	492	4,324	11,276	2,747	613
				Subtotal	508	4,461	11,634	2,834	633
Emission Factors from AP-42, Chapter 3.1-1 for natural gas large uncontrolled gas turbines (lb/hp-hr), S=.18 Formula = Emission Factor (lb/hp-hr) * 608 (g/kW-hr / lb/hp-hr) * Output (kW-hr/yr) / 453.6 (g/lb)									
Polebridge	3	Diesel	45	2,912	1,159	54	16,330	3,519	1,322
Emission Factors from AP-42, Chapter 3.4-1 for generators rated less than 448 kW, S =.05 Formula = Output (kW-hr/yr) * 1.34 (hp/kW) * Emission Factor (lb/hp-hr)									
				Total	1,666	4,515	27,964	6,353	1,955

' hours/year

2.1.2.2 **Generator Emissions - Potential**

Potential emissions were also calculated for the generators, and the same emission factors that were used to calculate the actual emissions were used to calculate these potential emissions. To calculate potential emissions, it was assumed that the generators were operated continuously or 8,760 hours per year. These are summarized in Table 5.

TABLE 5. 2000 POTENTIAL AIR EMISSIONS FROM GLACIER NP GENERATORS

Goat Haunt	2	Propane	45	8,760		1,430	3,730	909	203
Lift Stations	11		35	8,760	696	6,119	15,958	3,888	868
				Subtotal	859	7,549	19,688	4,797	1071
Emission Factors from AP-42, Chapter 3.1-1 for natural gas large uncontrolled gas turbines (lb/hp-hr), S=.18 Formula = Emission Factor (lb/hp-hr) * 608 (g/kW-hr / lb/hp-hr) * Output (kW-hr/yr) / 453.6 (g/lb),									
Polebridge		Diesel	45	8,760	3,486	162	49,125	10,586	3,978
Emission Factors from AP-42, Chapter 3.4-1 for generators rated less than 448 kW, S =.05 Formula = Output (kW-hr/yr) * 1.34 (hp/kW) * Emission Factor (lb/hp-hr)									
				Total	4,345	7,712	68,813	15,382	5,048

2.1.3 Fuel Storage Tanks

Glacier NP has three gasoline and three diesel fuel underground storage tanks (USTs) that service NPS vehicles and other motorized equipment. There are no public automotive service stations in the park, and the principal concessionaire has no fuel tanks.

There are two basic types of VOC emissions from storage tanks: working losses and standing losses. Working losses are composed of both withdrawal and refilling loss emissions. Withdrawal loss emissions result from the vaporization of liquid fuel residue on the inner surface of tank walls as the liquid levels in the tank are decreased and air is drawn into the tank. Refilling losses refer to fuel vapor releases to the air during the process of refilling the tank as the liquid level in the tank increases and pressurizes the vapor space. Standing losses describe those tank emissions from the vaporization of the liquid fuel in storage due to changes in ambient temperatures. VOC losses are also a direct function of the annual product throughput or turnovers. Emissions from diesel tanks are extremely small since the volatility of diesel fuel is extremely low compared to gasoline. VOC emissions from the NPS fuel storage tanks were calculated using the USEPA *TANKS* software program. *TANKS* is based on the emission estimation procedures from Chapter 7 of EPA's Compilation of Air Pollutant Emission Factors (AP-42) and uses chemical, meteorological, and other data to generate emission estimates for different types of storage tanks. Table 6 summarizes the calculated emissions.

TABLE **6: 2000** GLACIER NP FUEL TANK EMISSIONS

Location	Product	Tank Type	Volume (gal)	Throughput (gal/yr)	VOC (Ibs/yr)
West Glacier	Gasoline	UST	12,000	39,000	198
St. Mary	Gasoline	UST	12,000	30,500	155
Polebridge	Gasoline	UST	2,000	6,000	30
				Total	383

2.1.4 Wastewater Treatment Plants

Glacier NP has wastewater treatment plants (WWTP) at three locations: West Glacier, St. Mary, and Many Glacier. Formerly, there was a WWTP at Logan Pass to accommodate the large number of visitors during the summer season; however, this system has been removed, and wastewater is trucked from Logan Pass to the Saint Mary WWTP for treatment during the summer. Data on annual throughputs for the three systems were not readily available. However, the volume of wastewater that is transported from Logan Pass to Saint Mary during the visitation

season was estimated by park personnel to be approximately 1,080,000 gallons per year. Annual throughputs for the plants were estimated based on this throughput volume to plant capacity ratio These throughput estimates and estimated actual VOC emissions are summarized in Table 7. Potential throughputs were based on the assumption that the systems are operated 365 days or 8,700 hours per year.

Table 7: Glacier NP Wastewater Treatment Plant VOC Emissions

Location	Capacity (gal/day)	Throughput (gaUyr)	VOC Emissions (lbs/yr)	
			Actual	Potential
West Glacier	250,000	2,500,000	22	812
Saint Mary	110,000	1,315,000	12	357
Many Glacier	80,000	800,000	7	269
		Total	41	1,438
Emission factor of 8.9 lbs VOC per million gallons of wastewater treated from EPA FIRE database for SCC 50100701				

2.2 AREA SOURCES

2.2.1 Woodstoves

Many employee housing units in West Glacier formerly had woodstoves, but they have been removed due to air quality concerns. A few woodstoves remain in several residences in the east side of the park, but these are rarely used according to park officials. There are fireplaces in the Lake McDonald Lodge and Many Glacier Hotel, and calculated emissions based on annual wood consumption estimates are provided in Table 8.

TABLE 8: **2000** ACTUAL WOODSTOVE CRITERIA AIR EMISSIONS FROM GLACIER NP

Appliance Location	Fuel	Wood Consum , tion	PM_{10} (Ibs/ r)	SO2 (lbs/ r)	NO_X (lbs/ r)	CO (lbs/ r)	VOC (lbs/ r)
Lake McDonald Lodge	Firewood	5 cords/yr	304		23	2,217	2,009
Many Glacier Hotel		10 cords/yr	607	7	46	4,433	4,019
Total		15 cords/yr	911	11	68	6,650	6,028
Emission factors from AP-42, Chapter 1.9, Table 1.9-1 for residential fireplaces. Assumes 3,510 lbs per cord of wood.							

2.2.2 Campfires

There are 13 campgrounds with a total of 1,025 campsites in Glacier NP. Park officials estimate that the average occupancy rate was about 75 percent during the three-month summer season. Assuming that all campsites had one campfire when occupied and that 15 pounds of wood were consumed by each campfire, emissions from these campsites are summarized in Table 9.

TABLE 9: 2000 CAMPFIRE AIR EMISSIONS FROM GLACIER **NP**

Location	**Sites**	**Fires/Yr**	**Tons/Yr**	**PM** (lbs/yr)	SO_2 **(Ibs/yr)**	**NO_X (lbs/yr)**	**CO (lbs/yr)**	VOC (lbs/yr)
Apgar	196	13,230	99	3,433	40	258	25,064	22,723
Avalanche	87	5,873	44	1,524	18	115	11,125	10,086
Bowman Lake	48	3,240	24	841	10	63	6,138	5,565
Cut Bank	19	1,283	10	333	4	25	2,430	2,203
Fish Creek	180	12,150	91	3,153	36	237	23,018	20,868
Kintla Lake	13	**878**	7	228	3	17	1,662	1,507
Logging Creek	8	540	4	140	2	11	1,023	927
Many Glacier	112	7,560	57	1,962	23	147	14,322	12,984
Quartz	7	473	4	123		9	895	812
Rising Sun	83	5,603	42	1,454	17	109	10,614	9,622
Sprague Creek	25	1,688	13	438	5	33	3,197	2,898
St. May	148	9,990	75	2,592	30	195	18,926	17,158
Two Medicine	99	6,683	50	1,734	20	130	12,660	11,477
Total	1,025	69,188	520	17,954	208	1,349	131,076	118,830
				(tons/yr)				
				8.98	0.10	0.67	65.54	59.41

2.2.3 Wildland Fires and Prescribed Burning

Wildland fires are ignited naturally, usually by lightening, or by humans and are typically suppressed, while prescribed fires are ignited intentionally in order to achieve fire management objectives. Prescribed burning is a land treatment process to accomplish natural resource management objectives, including reducing the potential for destructive wildfires, eliminating excessive fuel buildup, controlling insects and disease, improving wildlife habitat and forage production, maintaining natural succession of plant communities, and restoring natural processes. Only prescribed burning emissions are considered as anthropogenic emissions; however, to the extent that prescribed burning is conducted to achieve ecological benefit, the emissions could be considered natural.

Due to NPS restrictions imposed on prescribed fires, none were conducted in the year 2000. However, park data indicate that in a typical year, about 11 fires of all types would occur burning about 190 acres. Assuming that about one-half of these are prescribed fires, then about 95 acres are burned by prescribed burning in a typical year. The First Order Fire Effects Model (FOFEM) was used to estimate emissions. FOFEM is a computer program developed by the Intermountain Fire Sciences Lab, U.S. Forest Service to predict the effects of prescribed fire and wildfire in forests and rangelands throughout the U.S. In particular, it quantifies emissions of CO, PM10, and PM2.5, which are summarized in Table 10.

TABLE 10: PRESCRIBED BURNING AIR EMISSIONS FROM GLACIER NP

Name	**Acres**	PM_{10} (tons/ r)	$PM_{2.5}$ **(tons/ r)**	**CO (tons/ r)**	VOC' **(tons/ r)**
Typical Year	95	43,795	37,145	488,205	22,420

[1] As methane

2.2.4 Miscellaneous Area Sources

Miscellaneous area sources include food preparation, degreasers, paints and other surface coatings, lighter fluid consumption, consumer solvents, propane use by visitors in recreational vehicles, and highway maintenance, such as paving materials. There are several degreasers in the vehicle maintenance shop and a paint spray booth and woodworking dust collection system in the carpentry shops in the west and east areas of the park. However, park officials indicated that the paint spray booths have not been used in some time. The woodworking dust collection systems are ventilated to cyclone dust collectors, and a visual inspection of the units revealed no evidence of wood dust. Finally, park officials estimated that approximately 425 gallons of exterior and interior latex paint were consumed in 2000 throughout the park.

2.3 SUMMARY OF STATIONARY AND AREA SOURCE EMISSIONS

Table 11 summarizes the stationary and area source emissions calculated above in a format that allows comparison between the various sources as well as providing totals for each pollutant or pollutant category under consideration.

TABLE 11: SUMMARY OF 2000 STATIONARY AND AREA SOURCE EMISSIONS AT GLACIER NP

Activity	Particulates		Sulfu Dioxide		Nitro en Oxides		Carbon Monoxide		VOCs	
	lbs/yr	tons/yr	lbs/yr	tons/yr	lbs/yr	tons/yr	lbs/yr	tons/yr	lbs/yr	tons/yr
Stationary Combustion Sources										
Space and Water Heating Units	60	0.03		<0.01	868	0.43	326	0.16	43	0.02
Generators	1,666	0.83	4,515	2.26	27,964	13.98	6,353	3.18	1,955	0.98
Gasoline Storage Tanks	--	--	--	--	--	--	--	--	383	0.19
Wastewater Treatment Plant	--	--	--	--	--	--	--	--	41	0.02
Stationary Sources Subtotal	1,726	0.86	4,519	2.26	28,832	14.42	6,679,	3.34	2,422	1.21
Area Sources										
Woodstoves	911	0.46	**ill**	<0.01	68	0.03	6,650	3.33	6,028	3.01
Campfires	17,950	8.98	210	0.10	1,350	0.67	131,080	65.54	118,830	59.41
Prescribed Burning	43,795	21.90	--	--	--	--	488,205	244.10	22,4201	11.21'
Area Sources Subtotal	62,656	31.33	221	0.11	1,418	0.71	625,935	312.98	147,278	73.64
Totals										
	Particulates		Sulfur Dioxide		Nitrogen Oxides		Carbon Monoxide		VOCs	
	lbs/yr	tons/yr	lbs/yr	tons/yr	lbs/yr	tons/yr	lbs/yr	tons/yr	lbs/yr	tons/ r
Totals without Prescribed Burning	20,587	10.29	4,740	2.37	30,250	15.13	144,410	72.21	127,280	63.64
Totals with Prescribed Burning	64,382	32.19	4,740	2.37	30,250	15.13	632,615	316.31	149,700	74.85

As methane

3. MOBILE SOURCE EMISSIONS

This section summarizes emissions from mobile sources at Glacier NP for 2000. Mobile emission sources include highway and nonroad vehicles. The following emissions were calculated for each source: particulate matter (PM $_{10}$), nitrogen oxides (NO$_x$), carbon monoxide (CO), and volatile organic compounds (VOCs).

3.1 HIGHWAY AND NONROAD VEHICLES

3.1.1 Visitor Vehicles

As auto touring is one of the principal activities enjoyed by visitors to Glacier NP, mobile source emissions are of particular interest in assessing park emissions. The principle road through the park is the Going-to-the-Sun Road that was completed in the 1930s. This National Historic Landmark road is approximately 55 miles in length and traverses the park from the West Glacier area to the St. Mary entrance on the east side of the park. Other paved roads used by the public include the roads to Many Glacier and Two Medicine from the east side of the park and a road from Camas Creek to West Glacier on the west side of the park. There is also an unpaved road on the west side at the Poleridge entrance to Bowman Lake.

The number of visitor vehicles operating in NPS units is often correlated to the number of annual visitors to the park unit, and estimated visitors to Glacier NP in 2000 were approximately 1,730,000. Table 12 summarizes the approximate number of vehicles entering the parks at various entrances and estimated roundtrip distances traveled by these vehicles. There are several additional visitor entry points to the park, such as Waterton and Walton, but these are trailheads only. In addition, public vehicles traverse the northeast corner of the park on Chief Mountain International Highway for a couple miles; however, these vehicles were not considered in estimating park mobile source emissions since they are through-traffic only.

The majority of mobile source emissions can be categorized as either exhaust or evaporative emissions. Exhaust emissions are related to the combustion of fuel in the engine and include VOC, NOx, CO, and PM10. Exhaust emissions are dependent on a number of factors, including engine load, engine design and age, combustion efficiency, emissions equipment such as catalytic converters, and other factors. Evaporative emissions, which can occur while the vehicle is running or at rest, are related to the volatilization of fuel from vapor expansion, leaks and seepage, and fuel tank vapor displacement. Evaporative emissions are primarily dependent on

daily temperature cycles and fuel volatility. In addition to vehicle exhaust, PM_{10} emissions also result from brake and tire wear, as well as the re-entrainment of dust from paved and unpaved roads (referred to as fugitive dust).

TABLE 12: GLACIER NP ANNUAL VISITOR VEHICLE SUMMARY

Entry Point	Visitation	No. Vehicles[1]	Miles/Vehicle[2]	Vehicle Miles Traveled	
				Summer	Winter
West Entrance	807,485	278,443	55	13,400,074	1,914,296
St. Mary Entrance	335,648	115,741	55	5,570,021	795,717
Many Glacier	125,367	43,230	25	945,656	135,094
Two Medicine	50,162	17,297	10	151,351	21,622
Camas	68,985	23,788	22	457,918	65,417
Polebridge	34,629	11,941	12	125,381	17,912
Total	1,422,276	490,440	--	20,650,401	2,950,058

[1] Assumes 2.9 visitors per vehicle

[2] Estimated round-trip driving distance within park boundaries

Emission factors produced by the USEPA MOBILE5b model were used in conjunction with vehicle miles traveled (VMT) data in order to estimate mobile source emissions for VOC (both exhaust and evaporative), NOx, and CO. Similarly, emission factors produced by the PARTS model were used in conjunction with VMT data to estimate PM_{10} emissions. MOBILE5b produces exhaust and evaporative emission factors for the following classes of vehicles: light duty gasoline vehicles (LDGV), light duty gasoline trucks 1 (LDGTI), light duty gasoline trucks 2 (LDGT2), heavy duty gasoline vehicles (HDGV), light duty diesel vehicles (LDDV), light duty diesel trucks (LDDT), heavy duty diesel vehicles (HDDV), and motorcycles. It also produces a composite emission factor for all vehicles based on the vehicle class mix supplied to the model. Inputs to the model include average vehicle speed, vehicle VMT mix, annual mileage accumulation rates and registration distributions by age, inspection and maintenance (I/M) program information, fuel information, ambient temperature data, and others.

Both the MOBILE5b and PARTS models are typically used to support planning and modeling efforts in urban or regional areas, and include default inputs suited for these applications. Therefore it is suitable for applications over large, regional transportation networks. Application of the MOBILE5b model required the utilization of unique inputs that were representative of mobile source activity within the park. In particular, it was necessary to utilize unique inputs for the visitor vehicle class mix and the vehicle age distribution.

The vehicle class mix used in this analysis was taken from data provided in the most recent Glacier NP General Management Plan/Environmental Impact Statement (GMP/EIS) (Glacier,

1999), and these data are summarized in Table 13. Using the VMT data noted earlier in Table 11, the VMT by vehicle class for summer and winter travel also are provided in Table 12. The Center for Environmental Research and Technology within the College of Engineering at the University of California's Riverside Campus (CE-CERT) established park-specific vehicle fleet characterizations in developing air emission inventories for Zion National Park (CE-CERT, 2001). CE-CERT found that the distribution of vehicle ages in the park reflected a larger fraction of newer vehicles than the overall model default vehicle age distribution. The park-specific VMT mix provided in the 1999 Glacier NP GMP/EIS and the vehicle age distribution developed by CE-CERT have been applied in the mobile modeling for Glacier NP.

TABLE 13: VISITOR VEHICLE MIX AND SEASONAL VMT

Vehicle Type	**Vehicle Distribution**	**Summer VMT**	**Winter VMT**
LDGV (<6000 GVW)	0.742	15,322,597	2,188,942
LDGTI (<6000 GVW)	0.156	3,221,463	460,209
LDGT2 (6000-8500 GVW)	0.002	41,301	5,900
HDGV (>6000 GVW)	0.044	908,618	129,803
LDDV (<6000 GVW)	0.000	0	0
LDDT (<8500 GVW)	0.003	61,951	8,850
HDDT (>8501 GVW)	0.009	185,854	26,551
Motorcycles	0.044	908,618	129,803
Total	1.000	20,650,401	2,950,057

In addition to VMT mix and age distribution, CE-CERT also established park-specific modeling inputs for driving pattern characterization. CE-CERT found that park driving patterns differ significantly from the default driving patterns typically used in mobile modeling, such as the Federal Test Procedure (FTP). In particularly, they found that the FTP reflects both higher speeds and a wider range of speeds than observed in the parks. However, since the MOBILE5b model is not designed to readily incorporate unique driving pattern data, the default driving cycle remains the basis for the mobile source emission estimates provided here.

Other important mobile modeling inputs that can significantly affect mobile emission factors are the average speed, fuel characteristics, and I/M program parameters. The average speed input to the mobile models was assumed to be 35 mph, which represents a weighted average of the speed limits on the Going-To-The-Sun Road. The fuel volatility was assumed to be RVP 9, and reformulated gasoline was not assumed to be present. Finally, inspection/maintenance (UM) program inputs were not included since there are no I/M programs in Montana.

In order to account for seasonal differences in mobile emissions, separate MOBILE5b runs were performed to produce emission factors for winter and summer. A composite emission factor for each season, reflecting a park specific VMT mix adapted from the GMP/EIS and CE-CERT data, served as the basis for mobile source emission estimates. Additional particulate emissions (or entrained road dust) from vehicles operating on paved roads in Glacier NP also were calculated based on VMT. A summary of visitor vehicle emissions is provided in Table 17.

3.1.2 GSAINPS/Concessionaire Vehicles

Glacier NP operates a fleet of highway vehicles that are owned by the NPS or leased from the General Services Administration (GSA). The principal concessionaire, Glacier Park, Inc. also operates a fleet of vehicles, including 33 vans that provide tours along the Going-to-the-Sun Road between Lake McDonald and Rising Sun during the summer season. A summary of NPS, GSA, and concessionaire vehicles and their estimated annual mileage is provided in Table 14. A separate MOBILE5b run was executed using the vehicle class mix noted in Table 14 to develop composite emission factors.

The NPS also owns and operates nonroad motorized equipment that is used to maintain roads and grounds and for other purposes. There are records of the Glacier NP equipment inventory, and the larger pieces of equipment are noted in Table 15. Since there are no data regarding its usage, default values for emission factors and annual usage were derived from the USEPA Nonroad emission database (EPA, 1991) and used to calculate annual emissions.

TABLE 14: NPS, GSA, AND CONCESSIONAIRE ROAD VEHICLES AT GLACIER NP

Vehicle Type	Number	Annual Usage (mi/yr)
NPS/GSA		
Light-Duty Gasoline Vehicles	33	267,150
Light Duty Gasoline Trucks (<6000 lbs)	56	212,180
Light Duty Gasoline Trucks (>6000 lbs)	40	300,000
Heavy Duty Gasoline Vehicles (>6000 lbs)	30	132,600
Light Duty Diesel Vehicles (<6000 lbs)	--	--
Light Duty Diesel Trucks (<8500 lbs)	4	30,000
Heavy Duty Diesel Trucks (>8500 lbs)	25	110,500
Total	188	1,052,430
Glacier Park, Inc.		
Light-Duty Gasoline Vehicles	--	--
Light Duty Gasoline Trucks (<6000 lbs)	--	
Light Duty Gasoline Trucks (>6000 lbs)	--	--
Heavy Duty Gasoline Vehicles (>6000 lbs)	33	396,000
Light Duty Diesel Vehicles (<6000 lbs)	--	--
Light Duty Diesel Trucks (<8500 lbs)	25	187,500
Heavy Duty Diesel Trucks (>8500 lbs)	1	4,500
Total	59	588,000

TABLE 15: NPS NONROAD VEHICLES AT GLACIER NP

Vehicle Type	Number	Annual Usage (hrs/yr each)
Utility Cart	7	75
Forklift	5	175
Backhoe	2	660
Front End Loader	8	630
Grader	3	100
Roller/Compactor	3	17
Tractor	4	80
Skid Loader	2	80
Broom Sweeper	1	120
Chipper	1	60
Dozer	2	300
Snowplow	2	130
Crane	1	175

[i] Estimated

3.2 MARINE VESSELS

The NPS operates several marine vessels, including a patrol boat and a barge that operate in the Goat Haunt area, and several other vessels that are used infrequently. Glacier Park Boat Co., a concessionaire, operates a fleet of cruise boats for the public during the summer on five of the

park's lakes. Approximately 13 small, rental boats are available to the general public during the summer for use on Lake McDonald. Finally, the general public may bring in their own small motor boats, and most private in-holding owners have a small recreational motor boat that operates on Lake McDonald. Personal watercraft are prohibited in the park.

The concessionaire's cruise boats were assumed to be twin-engine diesels and the rental boats and general public boats to be 2-stroke gasoline engines. NPS and concessionaire personnel provided information on the vessels and their operating characteristics. Estimated emissions are provided in Table 16, and equipment and operational data and the diesel and gasoline marine engine emission factors are provided in the Appendix D.

TABLE 16: GLACIER NP MARINE VESSEL EMISSIONS

Vessels	No . of	Engine power (hp)	Hours of Operation	HC (lb/yr)	CO (lb/yr)	NO,, (Ib/yr)	PM (lb/yr)	(Ib/yr)
National Park Service								
Patrol Boat		100	250	345	7,841	172		--
Cruise Boats								
Little Chief	2	200	645	75	114	532	34	21
DeSmet2	2	60	550	19	29	136	9	5
Sinopah2	2	60	315	11	17	78	5	3
Morning Eaglet	2	60	280	10	15	70	4	3
Chief Two Guns2	2	60	280	10	15	70	4	3
			Subtotal	125	190	885	56	35
Public Boating								
Rentals - Lake McDonald 2	1	<10	300	21	470	10	0	
General Public - Lake McDonald3	1	≤10	2,200	1,184	2,352	12	78	
Private In-Holders - Lake McDonald3	1	<10	1,200	646	1,283	7	0	
General Public - Bowman Lake3	1	<10	300	161	321	2	0	
			Subtotal	2,012	4,427	31	78	--
			Total	2,481	12,457	1,088	136	35

1 Four-stroke gasoline engines
2 Diesel engines
3 Two-stroke gasoline engines

3.3 SUMMARY OF MOBILE SOURCE EMISSIONS

Table 17 summarizes the mobile source emissions for road and nonroad vehicles and equipment operating in Glacier NP in 2000.

TABLE 17: SUMMARY OF 2000 MOBILE SOURCE EMISSIONS AT GLACIER NP

Activity	Particulates		Sulfur Dioxide		Nitrogen Oxides		Carbon Monoxide		VOCs	
	lbs/yr	tons/yr	lbs/yr	tons/yr	lbs/yr	tons/yr	lbs/yr	tons/yr	lbs/yr	tons/yr
Road Vehicles										
Visitor Vehicles	47,240'	23.62	--	--	48,940	24.47	560,000	280.00	56,600	28.30
GSA/NPS Road Vehicles	2,100'	1.05	--	--	2,260	1.13	27,400	1.13	2,600	1.30
Glacier Park, Inc. Vehicles	1,180'	0.59		--	1,180	0.59	12,540	6.27	1,380	0.69
Vehicle Emissions Subtotal	50,520'	25.26	--	--	52,380	26.19	599,940	300	60,580	30.29
Nonroad Vehicles										
NPS Nonroad Vehicles	1,482	0.74		--	8,945	4.47	7,507	3.75	2,275	1.14
Marine Vessels	136	0.07	35	0.02	1,088	0.54	12,457	6.23	2,481	1.24
Nonroad Vehicle Emissions Subtotal	1,618	0.81	35	0.02	10,033	5.02	19,964	9.98	4,756	2.38
Totals										
Totals	Particulates'		Sulfur Dioxide		Nitrogen Oxides		Carbon Monoxide		VOCs	
	lbs/ r	0							• ,	tons/ r
	52,138	26.07	35	0.02	62,413	31.21	619,904	309.95	62,980	32.67

' Includes exhaust PM_{to} and road dust

4. GLACIER NP AND REGIONALEMISSION SUMMARY

4.1 GLACIER NP SUMMARY

A summary of Glacier NP emissions is provided in Table 18.

TABLE 18: ESTIMATED ANNUAL EMISSIONS FROM GLACIER NP

Source	PM_{10} (tons)	SO_2 (tons)	NO_x (tons)	CO (tons)	VOCs (tons)
Point Sources					
Space and Water Heaters	0.03	<0.01	0.43	0.16	0.02
Generators	0.83	2.26	13.98	3.18	0.98
Gasoline Storage Tanks	--	--	--	--	0.19
Wastewater Treatment Plant	--	--	--	--	0.02
Subtotal	0.86	2.26	14.42	3.34	1.21
Area Sources					
Woodstoves	0.46	<0.01	0.03	3.33	3.01
Campfires	8.98	0.10	0.67	65.54	59.41
Prescribed Burning	21.90	--	--	244.10	11.21 [1]
Subtotal	31.33	0.11	0.71	312.98	73.64
Mobile Sources					
Road Vehicles	25.26	--	26.19	300.00	30.29
Nonroad Vehicles	0.81	0.02	5.02	9.98	2.38
Subtotal	26.07	0.02	31.21	309.95	32.67
Totals	58.26	2.39	46.34	626.27	107.52

[1] As methane

4.2 Regional Air Emissions

Emission estimates for Flathead and Glacier Counties and the state of Montana were obtained from the 1999 National Emission Inventory (NEI) maintained by USEPA. It is important to note that differences may exist between the methodologies used to generate the park emission inventory and those used to generate the NEI. For example, here gasoline storage tanks have been included as stationary sources, while the NEI treats them as area sources. Table 19 provides a comparison of Glacier NP emissions with those from the surrounding counties and the state. For all pollutants, Glacier NP emissions account for less than 1 percent of the surrounding county point source emissions, except for NOx, where the park accounts for approximately 2 percent

TABLE 19: ESTIMATED ANNUAL EMISSIONS FROM GLACIER NP, SURROUNDING COUNTIES, AND THE STATE OF MONTANA

Area	PM_{10} **(tons/,yr)**	SO_2 **(tons/yr)**	NO_X **(tons/yr)**	**CO (tons/yr)**	**VOC (tons/yr)**
Point Sources					
Glacier National Park Total	0.86	2.26	14.42	3.34	1.21
Flathead County	1,076	1,354	550	32,065	1,016
Glacier County	2	<1	172	104	82
Surrounding County Total	1,078	1,354	722	32,169	1,098
Montana Total	13,727	49,362	57,513	46,545	6,069
Area Sources					
Glacier National Park Total	31.33	0.11	0.71	312.98	73.64
Flathead County	594	89	1,492	6,033	1,628
Glacier County	88	17	103	496	897
Surrounding County Total	682	106	1,595	6,529	2.525
Montana Total	6,287	1,069	10,554	47,610	44,743
Mobile Sources					
Glacier National Park Total	26.07	0.02	31.21	309.95	32.67
Flathead County	392	416	5,721	27,787	4,823
Glacier County	91	181	1,837	4,710	701
Surrounding County Total	483	597	7,558	32,497	5.524
Montana Total	4,731	8,178	101,514	336,790	43,553

5. COMPLIANCE AND RECOMMENDATIONS

5.1 COMPLIANCE

The Montana Department of Environmental Quality (DEQ) administers air quality regulations in the State of Montana. Park personnel should continue to coordinate with the agency on permit issues relating to stationary sources, as well as prescribed burning activities. Prior to replacing or adding relatively large heating units, generators, and fuel storage tanks, the Montana DEQ should be consulted regarding the need to obtain a permit to construct or a permit to operate such sources. According to the Administrative Rules of Montana (ARM), Rule 17.8.705, current exemptions to these permits include:

- Residential, institutional, and commercial fuel burning equipment of less than 10 million Btu per hour heat input if burning liquid or gaseous fuels
- Residential and commercial fireplaces and barbecues
- Emergency equipment installed in public buildings.

ARM Rule 17.8.601 allows open burning for small recreational fires.

With respect to ambient air quality standards, the eastern portion of Glacier NP is located in Flathead County, which is designated as nonattainment for the federal particulate matter standard. However, the western portion of Glacier NP is located in Glacier County, which is in attainment for all National Ambient Air Quality Standards.

5.2 RECOMMENDATIONS

Actions to promote sustainable development in the design, retrofit, and construction of park facilities have associated air quality benefits. These include actions that reduce or replace consumption of conventional fossil fuels and/or reduce the consumption of other resources. Reductions in potable and non-potable water consumption also achieve concurrent reductions in energy consumption and associated air emissions. Acquisition of energy efficient appliances whenever possible also is an incremental energy saving measure that has associated air quality benefits.

Opportunities to reduce NOx and VOC emissions, which are the precursors for ozone formation, in Glacier NP are related to the reduction or replacement of conventional fossil fuels. One recent project will replace the propane generator at the Goat Haunt Ranger Station Complex with a non-

polluting micro-hydroelectric power generator that will use Cleveland Creek as the source of water to power the generator (Glacier NP 2001 a). In addition to replacing direct emissions from the propane generator, the new system will obviate the need to transport propane via a barge across Waterton Lake from Alberta, Canada several times a year. This results in reduced transportation emissions, energy consumption, and potential fuel spills.

Another emission reduction opportunity is the replacement of the diesel generators at Polebridge with renewable energy systems. These generators currently account for approximately 60 and 25 percent of stationary source NOx and CO, respectively, from the park.

Logan Pass formerly had a wastewater treatment plant (WWTP) on site to process wastewater generated by visitors during the summer season. This WWTP has been replaced with a holding tank must be emptied approximately three times a day during the visitation season. For approximately 120 days a year, a truck makes three 40-mile round trips a day from the Saint Mary WWTP to service the holding tank. The installation of a new WWTP at Logan Pass would eliminate the emissions and energy consumption associated with this transportation activity.

6. REFERENCES

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APPENDIX A

FUEL DATA, EMISSION FACTORS, AND EMISSION CALCULATIONS

FUEL DATA

Fuel	Heating Value	Sulfur Content
No. 2 Distillate Fuel Oil/Diesel	140,000 Btu/gal	0.05% by weight
Natural Gas	1,050 Btu/ft'	2,000 grains/10^6 ft^3
Propane	91,500 Btu/gal	0.18 grains/100 ft^3

STATIONARY SOURCE EMISSION FACTORS - BOILERS/HEATING UNITS

DISTILLATE OIL (DF-2) - CRITERIA POLLUTANTS

Combustor Type	Emission Factor (lb/1,000 gal fuel burned)				
	PM(a)	SO_2(b)	NO_x(e)	CO	VOC(d)
Residential Furnace(e)	0.4	142S	18	5	0.713
Boilers < 100 Million Btu/hr (Commercial/Institutional Combust.(f))	2	142S	20	5	0.34
Boilers < 100 Million Btu/hr (Industrial Boilers(g))	2	142S	20	5	0.2
Boilers > 100 Million Btu/hr (Utility Boilers(h))	2	157S	24	5	--

Source: AP-42, 5th Edition, Supplements A, B, C, D, and E, Tables 1.3-1 and 1.3-3.

NATURAL GAS - CRITERIA POLLUTANTS

Combustor Type (MMBtu/hr Heat Input)	Emission Factor (lb/10^6 ft^3 fuel burned)				
	pMO)	SO_2	NO_X(e)	CO	VOC
Residential Furnaces (<0.3)					
-Uncontrolled	7.6	0.6	94	40	5.5
Tangential-Fired Boilers (All Sizes)					
-Uncontrolled	7.6	0.6	170	24	5.5
-Controlled-Flue gas recirculation	7.6	0.6	76	98	5.5
Small Boilers (<100)					
-Uncontrolled	7.6	0.6	100	84	5.5
-Controlled-Low NO, burners	7.6	0.6	50	84	5.5
-Controlled-Low NO, burners/Flue gas recirculation	7.6	0.6	32	84	5.5
Large Wall-Fired Boilers (>100)					
-Uncontrolled (Pre-NSPS)l(k)	7.6	0.6	280	84	5.5
-Uncontrolled (Post-NSPS)l(k)	7.6	0.6	190	84	5.5
-Controlled-Low NO, burners	7.6	0.6	140	84	5.5
-Controlled-Flue gas recirculation	7.6	0.6	100	84	5.5

Source: AP-42, 5th Edition, Supplements A, B, C, D, and E, Tables 1.4-1 and 1.4-2.

STATIONARY SOURCE EMISSION FACTORS - BOILERS/HEATING UNITS (Continued)

PROPANE (LPG) - CRITERIA POLLUTANTS					
Combustor Type	Emission Factor (lb/1,000 gal fuel burned)				
	PM[a]	SO_2[b]	NO_X[c]	CO	VOC[d]
Commercial Boilers[f]	0.4	0.10S	14	1.9	0.3
Industrial Boilers (g)	0.6	0.105	19	3.2	0.3
Source: AP-42, 5th Edition, Supplements A, B, C, D, and E, Table 1.5-1.					

STATIONARY SOURCE EMISSION FACTORS - GENERATORS

For generators rated at less than or equal to 448 kW (600 hp):

Fuel T ype	Emission Factor (lb/hp-hr)				
	PM	SO_X	*NO,,*	CO	VOC
DF-2	2.20 E-03	2.05 E-03	0.031	6.68 E-03	2.51 E-03
Gasoline	7.21 E-04	5.91 E-04	0.011	0.439	0.022
Natural Gas/Propane	1.54 E-04	7.52 E-03(S)	3.53 E-03	8.6 E-04	1.92 E-04
Source: AP-42, 5th Edition, Supplements A, B, C, D, and E, Table 3.3-1 and 3.1-1					

For generators rated at greater than 448 kW (600 hp):

Fuel Ty pe	Emission Factor (lb/hp-hr)				
	PM	$SO_{X(b)}$	*NO,.*	CO	VOC
DF-2	0.0007	(8.09 E-03)S	0.024	5.5 E-03	6.4 E-04
Source: AP-42, 5th Edition, Supplements A, B, C, D, and E, Table 3.4-1.					

FIREPLACE EMISSION FACTORS

Fuel Type	Emission Factor (lb/ton)				
	PM°	SO_X	NO.(`)	CO	VOC
Wood	34.6	0.4	2.6	252.6	229.0
Source: AP-42, 5th Edition, Supplements A, B, C, D, and E, Table 1.9-1.					

WOODSTOVE EMISSION FACTORS

Stove Type	Emission Factor (lb/ton)				
	PM°	SO,	NO),(`)	CO	VOC
Conventional	30.6	0.4	2.8	230.8	53
Noncatalytic	19.6	0.4	--	140.8	12
Catalytic	20.4	0.4	2.0	104.4	15
Source: AP-42, 5th Edition, Supplements A, B, C, D, and E, Table 1.10-1.					

STATIONARY SOURCE EMISSION FACTORS - SURFACE COATING OPERATIONS

Surface Coating Type	VOC Emission Factor (lb/gal)
Paint: Solvent Base	5.6
Paint: Water Base	1.3
Enamel: General	3.5
Lacquer: General	6.1
Primer: General	6.6
Varnish/Shellac: General	3.3
Thinner: General	7.36
Adhesive: General	4.4
Source: *Calculation Methods for Criteria Air Pollutant Emission Inventories,* AL/OE-TR-1994-0049, July 1994. Armstrong Laboratory.	

(a) PM = Filterable Particulate Matter.

(b) These factors must be multiplied by the fuel sulfur content (for example, if the sulfur content is 0.05%, then S equals 0.05).

(c) Expressed as NO_2.

(d) Emission factors given in AP-42 are actually for non-methane total organic compounds (NMTOC) which includes all VOCs and all exempted organic compounds (such as ethane, toxics and HAPs, aldehydes and semivolatile compounds) as measured by EPA reference methods.

(e) Unit Rating <300,000 Btufhr.

(f) Unit Rating 3300,000 Btu/hr, but <10,000,000 Btulhr.

(g) Unit Rating 310,000,000 Btu/hr, but <100,000,000 Btu/hr.

(h) Unit Rating 3100,000,000 Btu/hr.

(i) POM = Particulate POM only.

(j) PM = Filterable Particulate Matter + Condensible Particulate Matter.

(k) NSPS = New Source Performance Standard as defined in 40 CFR 60 Subparts D and Db. Post-NSPS units are boilers with greater than 250 MMBtu/hr of heat input that commenced construction, modification, or reconstruction after August 17, 1971, and units with heat input capacities between 100 and 250 MMBtu/hr that commenced construction, modification, or reconstruction after June 19, 1984.

(l) Emission factors are given on a fuel input basis (lb/MMBtu). To convert to a power output basis (lb/hp-hr), use an average brake-specific fuel consumption (BSFC) of 7,000 Btu/hp-hr.

2000 ACTUAL CRITERIA EMISSIONS FROM HEATING UNITS AT GLACIER NATIONAL PARK

Emission Source	Location	Fuel	Number of Sources	Capacity (Btu/hr)		Consumption (cf/yr)	Consumption (gal/yr)	PM (lbs/yr)	S02 (ibs/yr)	NOx (lbs/yr)	CO (lbs/yr)	VOC (lbs/yr)
Boiler	Headquarters	Natural Gas	1	594,000	594,000	347,059		3	0	35	29	2
Boiler	Headquarters	Natural Gas	4	125,000	500,000	292,137		2	0	27	12	2
Furnace	Headquarters - Adm/Housing	Natural Gas	45	50,000	2,250,000	1,314,617		10	1	124	53	7
Furnace	Headquaretrs - Housing	Natural Gas	52	100,000	5,200,000	3,038,226		23	2	286	122	17
Water Heater	Housing	Natural Gas	97	37,000	3,589,000	2,096,960		16	1	197	84	12
		Natural Gas Totals	199		12,133,000	7,089,000		54	4	668	299	39
Emission Factors from AP-42, Tables 1.4-1 and 1.4-2 for residential furnaces								7.6	0.6	94.0	40.0	5.5
Emission Factors from AP-42, Tables 1.4-1 and 1.4-2 for small boilers								7.6	0.6	100.0	84.0	5.5
Formula = Consumption (cf/yr) * Emission Factor (lb/1,000,000 cf)												
Furnace	East Glacier Housing	Propane	14	100,000			14,236	6	0	199	27	4
		Propane Totals	14	100,000			14,236	6	0	199	27	4
Emission Factors from AP-42, Tables 1.5-1 for commercial boilers, S=.05								0.4	0.0	14	2	0.3
Formula = Consumption (gal/yr) * Emission Factor (lb/1,000 gal)												
		Total Heating Units	213			7,089,000	14236	60	4	868	326	43

2000 POTENTIAL CRITERIA EMISSIONS FROM HEATING UNITS AT GLACIER NATIONAL PARK

Emission Source	Location	Fuel	Number of Sources	Capacity (Btu/hr)		Consumption (cf/yr)	(gal/yr)	PM (Ibs/yr)	SO_2 (lbs/yr)	NO, (lbs/yr)	CO (lbs/yr)	VOC (lbs/yr)
Boiler	Headquarter	Natural Gas	1	594,000	594,000	4,955,657		38	3	496	416	27
Boiler	Headquartei	Natural Gas	4	125,000	500,000	4,171,429		32	3	392	167	23
Furnace	Headquarter	Natural Gas	45	50,000	2,250,000	18,771,429		143	11	1,765	751	103
Furnace	Headquareti	Natural Gas	52	100,000	5,200,000	43,382,857		330	26	4,078	1,735	239
Water Heater	Housing	Natural Gas	97	37,000	3,589,000	29,942,514		228	18	2,815	1,198	165
		Natural Gas Totals	199		12,133,000	101,223,886		769	61	9,545	4,267	557
Emission Factors from AP-42, Tables 1.4-1 and 1.4-2 for residential furnaces								7.6	0.6	94.0	40.0	5.5
Emission Factors from AP-42, Tables 1.4-1 and 1.4-2 for small boilers								7.6	0.6	100.0	84.0	5.5
Formula = Consumption (cf/yr) * Emission Factor (lb/1,000,000 cf)												
Furnace	East Glacier	Propane	14	100,000	1,400,000		134,033	54	1	1,876	255	40
		Propane Totals	14	100,000	1,400,000		134,033	54	1	1,876	255	40
Emission Factors from AP-42, Tables 1.5-1 for commercial boilers, S=.05								0.4	0.0	14	2	0.3
Formula = Consumption (gal/yr) * Emission Factor (lb/1,000 gal)												
		Total Heating Units	213			101,223,886	134,033	822.91	61.40	11,421.24	4,521.67	596.941

2000 ACTUAL CRITERIA EMISSIONS FROM GENERATORS AT GLACIER NATIONAL PARK

Emission Source	Location	Fuel	Number of Sources	Rating (kW)	Run Time (hrs/yr)	Output (kW-hr/yr)	PM (lbs/yr)	SO_2 (lbs/yr)	NO, (lbs/yr)	CO (lbs/yr)	VOC (lbs/yr)
Generator	Goat Haunt	Propane	2	45	840	75,600	16	137	358	87	19
Generator	Sewage Lift Stations	Propane	11	35	6,190	2,383,150	492	4,324	11,276	2,747	613
	Propane Generator Totals		13		7,030	2,458,750	508	4,461	11,634	2,834	633
Emission Factors from AP-42, Chapter 3.1-1 for natural gas large uncontrolled gas turbines (lb/hp-hr), S=.18 Formula = Emission Factor (lb/hp-hr) * 608 (g/kW-hr / lb/hp-hr) * Output (kW-hr/yr) / 453.6 (g/lb)							1.54E-04	7.52E-03*S	3.53E-03	8.60E-04	1.92E-04
Generator	Polebridge Complex	Diesel	3	45	2,912	393,120	1,159	54	16,330	3,519	1,322
	Diesel Generator Totals		3		2,912	393,120	1,159	54	16,330	3,519	1,322
Emission Factors from AP-42, Chapter 3.4-1 for generators rated less than 448 kW, S=.05 Formula = Output (kW-hr/yr) * 1.34 (hp/kW) * Emission Factor (lb/hp-hr)							2.20E-03	0.00205*S	3.10E-02	6.68E-03	2.51E-03
	All Generator Totals		16		9,942	2,851,870	1,666	4,515	27,964	6,353	1,9551

2000 POTENTIAL CRITERIA EMISSIONS FROM GENERATORS AT GLACIER NATIONAL PARK

Emission Source	Location	Fuel	Number of Sources	Rating (kW)	Run Time (hrs/yr)	Output (kW-hr/yr)	PM (lbs/yr)	SO_2 (lbs/yr)	NO_x (lbs/yr)	CO (lbs/yr)	VOC (lbs/yr)
Generator	Goat Haunt	Propane	2	45	8,760	788,400	163	1,430	3,730	909	203
Generator	Sewage Lift Stations	Propane	11	35	8,760	3,372,600	696	6,119	15,958	3,888	868
	Propane Generator Totals		13		17,520	4,161,000	859	7,550	19,688	4,797	1,071
Emission Factors from AP-42, Chapter 3.1-1 for Natural Gas Large Uncontrolled Gas Turbines (lb/hp-hr), S=.18 Formula = Emission Factor (lb/hp-hr) * 608 (g/kW-hr / lb/hp-hr) * Output (kW-hr/yr) / 453.6 (g/lb)							1.54E-04	7.52E-03*S	3.53E-03	8.60E-04	1.92E-04
Generator	Polebridge Complex	Diesel	3	45	8,760	1,182,600	3,486	162	49,125	10,586	3,978
	Diesel Generator Totals		3		8,760	1,182,600	3,486	162	49,125	10,586	3,978
Emission Factors from AP-42, Chapter 3.4-1 for generators rated less than 448 kW, S=.05 Formula = Output (kW-hr/yr) * 1.34 (hp/kW) * Emission Factor (lb/hp-hr)							2.20E-03	0.00205*S	3.10E-02	6.68E-03	2.51E-03
	All Generator Totals		16		26,280	5,343,600	4,345	7,712	68,813	15,382	5,048

TANKS 4.0
Emissions Report -,Detail Format
Tank Identification and Physical Characteristics

Identification

User Identification:	West Glacier Gasoline
City:	Kalispell
State:	Montana
Company:	
Type of Tank:	Horizontal Tank
Description:	Gasoline UST

Tank Dimensions

Shell Length (ft):	20.40
Diameter (ft):	10.00
Volume (gallons):	12,000.00
Turnovers:	3.25
Net Throughput (gal/yr):	39,000.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	Y

Paint Characteristics

Shell Color/Shade:	Aluminum/Specular
Shell Condition:	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig):	0.03

Meteorological Data used in Emissions Calculations: Kalispell, Montana (Avg Atmospheric Pressure = 13.22 psia)

TANKS 4.0
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Mixture/Component	Month	Daily Liquid Surf. Temperatures (deg F) Avg.	Min.	Max.	Liquid Bulk Temp. (deg F)	Vapor Pressures (psia) Avg.	Min.	Max.	Vapor Mol. Weight	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Gasoline (RVP 9)	All	41.78	41.78	41.78	41.34	3.1798	3.1798	3.1798	67.0000			92.00	Option 4: RVP=9, ASTM Slope=3

TANKS 4.0
Emissions Report - Detail Format
Detail Calculations (AP-42)

Annual Emission Calculations	
No Standing Losses: Underground Tank	
Working Losses (lb):	197.8263
Vapor Molecular Weight (lb/lb-mole):	67.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.1798
Annual Net Throughput (gal/yr.):	39,000.0000
Annual Turnovers:	3.2500
Turnover Factor:	1.0000
Tank Diameter (ft):	10.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	197.8263

TANKS 4.0
Emissions Report - Detail Format
Individual Tank Emission Totals

Annual Emissions Report

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Gasoline (RVP 9)	197.83	0.00	197.83

TANKS 4.0
Emissions Report - Detail Format
Tank Identification and Physical Characteristics

Identification

User Identification:	West Glacier Diesel
City:	Kalispell
State:	Montana
Company:	
Type of Tank:	Horizontal Tank
Description:	Diesel UST

Tank Dimensions

Shell Length (ft):	8.50
Diameter (ft):	10.00
Volume (gallons):	5,000.00
Turnovers:	4.28
Net Throughput (gal/yr):	21,400.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	Y

Paint Characteristics

Shell Color/Shade:	Aluminum/Specular
Shell Condition:	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig):	0.03

Meteorological Data used in Emissions Calculations: Kalispell, Montana (Avg Atmospheric Pressure = 13.22 psia)

TANKS 4.0
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Mixture/Component	Month	Daily Liquid Surf. Temperatures (deg F) Avg.	Min.	Max.	Liquid Bulk Temp. (deg F)	Vapor Pressures (psia) Avg.	Min.	Max.	Vapor Mol. Weight	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	41.78	41.78	41.78	41.34	0.0035	0.0035	0.0035	130.0000			188.00	Option 5: A=12.101, B=8907

TANKS 4O
Emissions Report - Detail Format
Detail Calculations (AP-42)

Annual Emission Calculations	
No Standing Losses: Underground Tank	
Working Losses (lb):	0.2303
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0035
Annual Net Throughput (gal/yr.):	21,400.0000
Annual Turnovers:	4.2800
Turnover Factor:	1.0000
Tank Diameter (ft):	10.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	0.2303

TANKS 4.0
Emissions Report - Detail Format
Individual Tank Emission Totals

Annual Emissions Report

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	0.23	0.00	0.23

TANKS 4.0
Emissions Report - Detail Format
Tank Identification and Physical Characteristics

Identification

User Identification:	St. Mary Gasoline
City:	Kalispell
State:	Montana
Company:	
Type of Tank:	Horizontal Tank
Description:	Gasoline UST

Tank Dimensions

Shell Length (ft):	20.42
Diameter (ft):	10.00
Volume (gallons):	12,000.00
Turnovers:	2.54
Net Throughput (gal/yr):	30,500.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	Y

Paint Characteristics

Shell Color/Shade:	Red/Primer
Shell Condition:	Good

Breather Vent Settings

Vacuum Settings (psig):	0.00
Pressure Settings (psig):	0.00

Meteorological Data used in Emissions Calculations: Kalispell, Montana (Avg Atmospheric Pressure = 13.22 psia)

TANKS 4.0
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Mixture/Component	Month	Daily Liquid Surf. Temperatures (deg F) Avg.	Min.	Max.	Liquid Bulk Temp. (deg F)	Vapor Pressures (psia) Avg.	Min.	Max.	Vapor Mol. Weight	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Gasoline (RVP 9)	All	41.78	41.78	41.78	41.34	3.1798	3.1798	3.1798	67.0000			92.00	Option 4: RVP=9, ASTM Slope=3

TANKS 4.0
Emissions Report - Detail Format
Detail Calculations (AP-42)

Annual Emission Calculations	
No Standing Losses: Underground Tank	
Working Losses (lb):	154.7103
Vapor Molecular Weight (lb/lb·mole):	67.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.1798
Annual Net Throughput (gal/yr.):	30,500.0000
Annual Turnovers:	2.5417
Turnover Factor:	1.0000
Tank Diameter (ft):	10.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	154.7103

TANKS 4.0
Emissions Report - Detail Format
Individual Tank Emission Totals

Annual Emissions Report

	Losses(lbs)		
Components	Working Loss	Breathing Loss	To al Emissions
Gasoline (RVP 9)	154.71	0.00	154.71

TANKS 4.0
Emissions Report - Detail Format
Tank Identification and Physical Characteristics

Identification

User Identification:	St Mary Diesel
City:	Kalispell
State:	Montana
Company:	
Type of Tank:	Horizontal Tank
Description:	St Mary UST

Tank Dimensions

Shell Length (ft):	6.80
Diameter (ft):	10.00
Volume (gallons):	4,000.00
Turnovers:	4.28
Net Throughput (gal/yr):	15,750.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	Y

Paint Characteristics

Shell Color/Shade:	Aluminum/Specular
Shell Condition:	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig):	0.03

Meteorological Data used in Emissions Calculations: Kalispell, Montana (Avg Atmospheric Pressure = 13.22 psia)

TANKS 4.0
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Mixture/Component	Month	Daily Liquid Surf. Temperatures (deg F) Avg.	Min.	Max.	Liquid Bulk Temp. (deg F)	Vapor Pressures (psia) Avg.	Min.	Max.	Vapor Mol. Weight	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	41.78	41.78	41.78	41.34	0.0035	0.0035	0.0035	130.0000			188.00	Option 5: A=12.101, B=8907

TANKS 4.0
Emissions Report - Detail Format
Detail Calculations (AP-42)

Annual Emission Calculations	
No Standing Losses: Underground Tank	
Working Losses (lb):	0.1695
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0035
Annual Net Throughput (gallyr.):	15,750.0000
Annual Turnovers:	4.2800
Turnover Factor:	1.0000
Tank Diameter (ft):	10.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	0.1695

TANKS 4.0 -- Detail Format
Emissions Report - Individual Tank Emission Totals

Annual Emissions Report

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	0.17	0.00	0.17

TANKS 4.0
Emissions Report - Detail Format
Tank Identification and Physical Characteristics

Identification

User Identification:	Polebridge Gasoline
City:	Kalispell
State:	Montana
Company:	
Type of Tank:	Horizontal Tank
Description:	Gasoline UST

Tank Dimensions

Shell Length (ft):	5.00
Diameter (ft):	10.00
Volume (gallons):	2,000.00
Turnovers:	3.00
Net Throughput (gal/yr):	6,000.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	Y

Paint Characteristics

Shell Color/Shade:	Red/Primer
Shell Condition:	Good

Breather Vent Settings

Vacuum Settings (psig):	0.00
Pressure Settings (psig):	0.00

Meteorological Data used in Emissions Calculations: Kalispell, Montana (Avg Atmospheric Pressure = 13.22 psia)

TANKS 4.0
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Mixture/Component	Month	Daily Liquid Surf. Temperatures (deg F) Avg.	Min.	Max.	Liquid Bulk Temp. (deg F)	Vapor Pressures (psia) Avg.	Min.	Max.	Vapor Mol. Weight	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Gasoline (RVP 9)	All	41.78	41.78	41.78	41.34	3.1798	3.1798	3.1798	67.0000			92.00	Option 4: RVP=9, ASTM Slope=3

TANKS 4.0
Emissions Report - Detail Format
Detail Calculations (AP-42)

Annual Emission Calculations	
No Standing Losses: Underground Tank	
Working Losses (lb):	30.4348
Vapor Molecular Weight (lb/lb-mole):	67.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.1798
Annual Net Throughput (gal/yr.):	6,000.0000
Annual Turnovers:	3.0000
Turnover Factor:	1.0000
Tank Diameter (ft):	10.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	30.4348

TANKS 4.0
Emissions Report - Detail Format
Individual Tank Emission Totals

Annual Emissions Report

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Gasoline (RVP 9)	30.43	0.00	30.43

TANKS 4.0
Emissions Report - Detail Format
Tank Identification and Physical Characteristics

Identification

User Identification:	Polebridge Diesel
City:	Kalispell
State:	Montana
Company:	
Type of Tank:	Horizontal Tank
Description:	Polebridge UST

Tank Dimensions

Shell Length (ft):	3.40
Diameter (ft):	10.00
Volume (gallons):	2,000.00
Turnovers:	3.00
Net Throughput (gal/yr):	6,000.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	Y

Paint Characteristics

Shell Color/Shade:	Aluminum/Specular
Shell Condition:	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig):	0.03

Meteorological Data used in Emissions Calculations: Kalispell, Montana (Avg Atmospheric Pressure = 13.22 psia)

TANKS 4.0
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Mixture/Component	Month	Daily Liquid Surf. Temperatures (deg F) Avg.	Min.	Max.	Liquid Bulk Temp. (deg F)	Vapor Pressures (psia) Avg.	Min.	Max.	Vapor Mol. Weight	Liquid Mass Fract.	Vapor Mass Fract.	Vol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	41.78	41.78	41.78	41.34	0.0035	0.0035	0.0035	130.0000			188.00	Option 5: A=12.101, 8=8907

TANKS 4.0
Emissions Report - Detail Format
Detail Calculations (AP-42)

Annual Emission Calculations
No Standing Losses: Underground Tank

Working Losses (lb):	0.0646
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0035
Annual Net Throughput (gal/yr.):	6,000.0000
Annual Turnovers:	3.0000
Turnover Factor:	1.0000
Tank Diameter (ft):	10.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	0.0646

TANKS 4.0
Emissions Report - Detail Format
Individual Tank Emission Totals

Annual Emissions Report

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	0.06	0.00	0.06

2000 ACTUAL EMISSIONS FROM FIREPLACES AT GLACIER NATIONAL PARK

Appliance	Location	Cords/Yr	Tons/Yr	PM (lbs/yr)	SO_2 (lbs/yr)	NO_x (lbs/yr)	CO (lbs/yr)	VOC (lbs/yr)
Fireplace	Lake McDonald	5	8.78	304	4	23	2,217	2,009
	Many Glacier Hotel	10	17.55	607	7	46	4,433	4,019
			Total	911	11	68	6,650	6,028
	Emission Factors		lbs/ton	**34.6**	0.4	2.6	252.6	**2291**

2000 ACTUAL EMISSIONS FROM CAMPFIRES AT GLACIER NATIONAL PARK

Location	Sites	Fires/Yr	Tons/Yr	PM (lbs/yr)	SO_2 (lbs/yr)	NO_X (lbs/yr)	CO (lbs/yr)	VOC (lbs/yr)
Apgar	196	13,230	99	3,433	40	258	25,064	22,723
Avalanche	87	5,873	44	1,524	18	115	11,125	10,086
Bowman Lake	48	3,240	24	841	10	63	6,138	5,565
Cut Bank	19	1,283	10	333	4	25	2,430	2,203
Fish Creek	180	12,150	91	3,153	36	237	23,018	20,868
Kintla Lake	13	878	7	228	3	17	1,662	1,507
Logging Creek	8	540	4	140	2	11	1,023	927
Many Glacier	112	7,560	57	1,962	23	147	14,322	12,984
Quartz	7	473	4	123	1	9	895	812
Rising Sun	83	5,603	42	1,454	17	109	10,614	9,622
Sprague Creek	25	1,688	13	438	5	33	3,197	2,898
St. Mary	148	9,990	75	2,592	30	195	18,926	17,158
Two Medicine	99	6,683	50	1,734	20	130	12,660	11,477
Total	1,025	69,188	519	17,954	208	1,349	131,076	118,830
			Tons/yr	8.98	0.10	0.67	65.54	59.41
		Emission Factor	lbs/ton	34.6	0.4	2.6	252.6	2291

TITLE: Results of FOFEM model execution on date: 1/3/2002

FUEL CONSUMPTION CALCULATIONS

Region: Interior West
Cover Type: SAF/SRM - SAF 210 - Interior Douglas-fir
Fuel Type: Natural
Fuel Reference: FOFEM 031

FUEL CONSUMPTION TABLE

Fuel Component Name	Preburn Load (t/acre)	Consumed Load (t/acre)	Postburn Load (t/acre)	Percent Reduced (%)	Equation Reference Number	Moisture
Litter	0.60	0.60	0.00	100.0	999	
Wood (0-1/4 inch)	0.23	0.23	0.00	100.0	999	
Wood (1/4-1 inch)	0.67	0.67	0.00	100.0	999	15.0
Wood (1-3 inch)	0.80	0.75	0.05	94.3	999	
Wood (3+ inch) Sound	6.30	1.45	4.85	23.0	999	15.0
3->6	1.57	0.76	0.81	0.5		
6->9	1.57	0.38	1.20	0.2		
9->20	1.57	0.21	1.36	0.1		
20->	1.57	0.09	1.48	0.1		
Wood (3+ inch) Rotten	0.70	0.28	0.42	39.9	999	15.0
3->6	0.17	0.13	0.05	0.7		
6->9	0.17	0.08	0.09	0.5		
9->20	0.17	0.05	0.13	0.3		
20->	0.17	0.02	0.15	0.1		
Duff	10.00	5.18	4.82	51.8	2	75.0
Herbaceous	0.20	0.20	0.00	100.0	22	
Shrubs	0.35	0.21	0.14	60.0	23	
Crown foliage	6.00	0.00	6.00	0.0	37	
Crown branchwood	3.00	0.00	3.00	0.0	38	
Total Fuels	28.85	9.57	19.28	33.2		

FIRE EFFECTS ON FOREST FLOOR COMPONENTS

Forest Floor Component	Preburn Condition	Amount Consumed	Postburn Condition	Percent Reduced	Equation Number
Duff Depth (in)	1.0	0.6	0.4	60.0	6
Min Soil Exp (%)	.0	31.0	31.0	31.0	10

Note:
'Duff' (tons/acre) and 'Duff Depth (in)' burned are computed using different equations, sometimes this may cause an inconsistancy in the 'Percent Reduced' shown on this report.
Duff (tons/acre) consumed is best suited for predicting smoke production, while Duff Depth (in) may be better related to fire severity and soil heating

Emissions -- lbs/acre	flaming	smoldering	total
PM 10	7	454	461
PM 2.5	6	385	391
CH 4	2	234	236
CO	14	5125	5139
CO 2	3823	20860	24683

2000 PRESCRIBED BURNING AIR EMISSIONS AT GLACIER NATIONAL PARK

Fire Name	Acres	PM10 (lbs/yr)	PM2.5 (lbs/yr)	CH4 (lbs/yr)	CO (lbs/yr)	PM10 (tons/yr)	PM2.5 (tons/yr)	CH4 (tons/yr)	CO (tons/yr)
Typical	95	43,795	37,145	**22,420**	488,205	21.90	18.57	11.21	244.10
Totals	95	43,795	37,145	**22,420**	488,205	21.90	18.57	11.21	244.10
Emission Factor	lbs/acre	461	391	236	5,1391				

2000 Glacier NP Visitor Vehicles

Entrance		Visitation	Vehicles	Average VMT	Annual VMT	Summer VMT	Winter VMT
West Entrance		807,485	278,443	55	15,314,371	13,400,074	1,914,296
St. Mary Entrance		335,648	115,741	55	6,365,738	5,570,021	795,717
Chief Mountain		223,970	0		0	0	0
Many Glacier		125,367	43,230	25	1,080,750	945,656	135,094
Two Medicine		50,162	17,297	10	172,972	151,351	21,622
Camas		68,985	23,788	22	523,334	457,918	65,417
Polebridge		34,629	11,941	12	143,292	125,381	17,912
Waterton		36,743	0		0	0	0
Cut Bank			0		0	0	0
Walton		45,644	0		0	0	0
	Totals	1,728,633	490,440		23,600,458	20,650,401	2,950,057

Vehicle Type		Visitor Vehicles Vehicle Distribution	Summer VMT	Winter VMT
LDGV (<6000 GVW)		0.742	15,322,597	2,188,942
LDGT1 (<6000 GVW)		0.156	3,221,463	460,209
LDGT2 (6000-8500 GVW)		0.002	41,301	5,900
HDGV (>6000 GVW)		0.044	908,618	129,803
LDDV (<6000 GVW)		0.000	0	0
LDDT (<8500 GVW)		0.003	61,951	8,850
HDDT (>8501 GVW)		0.009	185,854	26,551
Motorcycles		0.044	908,618	129,803
	Total	1.000	20,650,401	2,950,057

2000 Glacier NP and Concessionaire Vehicles

NPS/GSA Vehicles

Vehicle Type	No.	VMT
LDGV (<6000 GVW)	33	267,150
LDGT1 (<6000 GVW)	56	212,180
LDGT2 (6000-8500 GVW)	40	300,000
HDGV (>6000 GVW)	30	132,600
LDDV (<6000 GVW)		
LDDT (<8500 GVW)	4	30,000
HDDT (>8501 GVW)	25	110,500
	188	1,052,430

Glacier Park, Inc. Vehicles

Vehicle Type	No.	VMT
LDGV (<6000 GVW)		
LDGT1 (<6000 GVW)		
LDGT2 (6000-8500 GVW)		
HDGV (>6000 GVW)	33	396,000
LDDV (<6000 GVW)		
LDDT (<8500 GVW)	25	187,500
HDDT (>8501 GVW)	1	4,500
	59	588,000

Park Vehicles	Summer	789,323
	Winter	263,108
Concessionaire		588,000

NPS Nonroad Equipment

Vehicle Type	No.
Utility Cart	7
Forklift	5
Backhoe	2
Front End Loader	8
Grader	3
Roller/Compactor	3
Tractor	4
Skid Loader	1
Broom Sweeper	1
Chipper	1
Dozer	2
Snowplow	2
Crane	1
Skid Loader	1

GLACIER NATIONAL PARK VISITOR VEHICLE EMISSIONS

Summer VMT	Winter VMT
20,650,401	2,950,057

	Emission Factors (glmi)				Emissions (tonstyr)			
	NOx	CO	VOC	PM10	NOx	CO	VOC	PM10
Summer	0.91	9.70	1.06	0.91	20.67	220.34	24.08	20.67
Winter	1.17	18.24	1.30	0.91	3.80	59.19	4.22	2.95
				Total	24.47	279.53	28.30	23.62

GLACIER NATIONAL PARK-OWNED VEHICLE EMISSIONS

Summer VMT	Winter VMT
789,323	263,108

	Emission Factors (g/mi)				Emissions (tonstyr)			
	NOx	CO	VOC	PM10	NOx	CO	VOC	PM10
Summer	0.91	9.70	1.06	0.91	0.79	8.42	0.92	0.79
Winter	1.17	18.24	1.30	0.91	0.34	5.28	0.38	0.26
				Total	1.13	13.70	1.30	1.05

CONCESSIONAIRE-OWNED VEHICLE EMISSIONS

Summer VMT	Winter VMT
588,000	0

	Emission Factors (g/mi)				Emissions (tonstyr)			
	NOx	CO	VOC	PM10	NOx	CO	VOC	PM10
Summer	0.91	9.70	1.06	0.91	0.59	6.27	0.69	0.59
Winter	1.17	18.24	1.30	0.91	0.00	0.00	0.00	0.00
				Total	0.59	6.27	0.69	0.59
					26.19	299.50	30.28	25.27

2000 GLACIER NP NONROAD VEHICLE EMISSIONS

		Emission Factors (gm/hp-hr)							Emissions (lbs/yr)			
Vehicle	No.	PM	Nox	CO	VOC	hp	load	hrs/yr	PM	Nox	CO	VOC
Utility Cart		2.04	1.03	2.31	2.19	15	0.55	75	2.8	1.4	3.1	3.0
Tractors	2	2.04	1.03	2.31	2.19	42.35	0.68	80	20.7	10.4	23.4	22.2
Backhoe	3	2.04	1.03	2.31	2.19	77	0.55	660	376.3	0.0 190.0	0.0 426.1	404.0
Riding Mower	0	1.11	10.3	4.8	1.3	15	0.55	60	0.0	0.0	0.0	0.0
Brush Mower	0	1.11	10.3	4.8	1.3	15	0.55	40	0.0	0.0	0.0	0.0
Bobcat	0	2.04	1.03	2.31	2.19	15	0.55	300	0.0	0.0	0.0	0.0
Dozer	2	2.04	1.03	2.31	2.19	77	0.55	300	114.0	57.6	129.1	122.4
Grader	3	1.06	9.6	3.8	1.43	172	0.61	100	73.4	664.8	263.1	99.0
Power Pruner	0	3.99	0.9	4.8	1.3	5	0.55	600	0.0	0.0	0.0	0
Stihl Brushcutters	0	3.99	0.9	4.8	1.3	5	0.55	600	0.0	0.0	0.0	0.0
Stihl 14 Quick Cut Saw	0	3.99	0.9	4.8	1.3	5	0.55	100	0.0	0.0	0.0	0.0
Post Hole Digger	0	3.99	0.9	4.8	1.3	5	0.55	400	0.0	0.0	0.0	0.0
Case Plate Tamper	0	3.99	0.9	4.8	1.3	5	0.55	300	0.0	0.0	0.0	0.0
Tamper Rammer	0	3.99	0.9	4.8	1.3	5	0.55	100	0.0	0.0	0.0	0.0
Pionjar	0	3.99	0.9	4.8	1.3	5	0.55	600	0.0	0.0	0.0	0.0
Wacker Trash Pump	0	3.99	0.9	4.8	1.3	5	0.55	100	0.0	0.0	0.0	0.0
Generators	0	3.99	0.9	4.8	1.3	5	0.55	165	0.0	0.0	0.0	0.0
Welder-Arc-Generator	0	3.99	0.9	4.8	1.3	5	0.55	100	0.0	0.0	0.0	0.0
Emglo Air Compressor	0	3.99	0.9	4.8	1.3	5	0.55	400	0.0	0.0	0.0	0.0
Sweeper	1	1.7	14	6.06	1.46	30	0.68	120	9.2	75.4	32.6	7.9
Leaf Blowers	0	3.99	0.9	4.8	1.3	1.2	0.55	15	0.0'	0.0	0.0	0.0
Chainsaws	0	3.6	0.96	4.8	1.3	3	0.55	1600	0.0	0.0	0.0	0.0
Trimmer	0	3.99	0.9	4.8	1.3	1.2	0.55	300	0.0	0.0	0.0	0
Weed Wacker	0	3.99	0.9	4.8	1.3	1.2	0.55	0	0.0	0.0	0.0	0
50 gallon Sprayer	0	1.7	14	6.06	1.46	9	0.55	1000	0.0	0.0	0.0	0
Forklift	5	1.06	9.6	3.8	1.43	172	0.61	175	214.1	1938.9	767.5	288.8
Front End Loader	8	1.11	10.3	4.8	1.3	77	0.55	630	521.2	4836.6	2254.0	76
Roller/Compactor	3	2.04	1.03	2.31	2.19	30	0.55	17	3.8	1.9	4.3	1
Skid Loader	2	1.11	10.3	4.8	1.3	77	0.55	80	16.5	153.5	71.6	19.4
Chipper	1	3.99	0.9	1372	495	30	0.55	60	8.7	2.0	2988.2	1078
Crane	1	1.06	9.6	3.8	1.43	172	0.61	175	42.8	387.8	153.5	57.8
Snowplow	2	1	8	5	1.22	210	0.65	130	78.1	624.6	390.4	95.3
							Totals:	(lbs/yr)	1,482	8,945	7,507	2,275
								(tons/yr)	0.74	4.47	3.75	1.14

8/6/02

GLACIER NP MARINE VESSEL EMISSIONS

Diesel Engine Emission Factors'

Units	HC	CO	NO,	PM	SO_2
(g/hp-hr)	1.26	1.91	8.92	0.563	0.352
(lb/hp-hr)	0.003	0.004	0.020	0.001	0.001

1 g = 0.0022016 lbs
BSFC = 0.367 lb/hp-hr

' Source: Exhaust Emission Factors for Nonroad Engine Modeling -- Compression-Ignition EPA Report No., NR-009A; Table 1

2-Stroke Gasoline Engine Emission Factors [3]

Units	HC	CO	NO,	PM	SO_2
(g/hp-hr)	116.38	231.26	1.19	7.7	0.000
(lb/hp-hr)	0.256	0.509	0.003	0.017	0.000

4-Stroke Gasoline Engine Emission Factors [3]

Units	HC	CO	NO_2	PM	SO_2
(g/hp-hr)	14.92	339.18	7.46	0.06	0.000
(lb/hp-hr)	0.033	0.747	0.016	0.000	0.000

[3] Source: Nonroad Emission Inventory Model, Draft, June 17, 1998

Criteria Pollutant Emissions [3]

Location	NPS Vessels	No. of Engines	Engine Power (hp)	Hours of Operation	Load Factor	HC (lb/yr)	CO (lb/yr)	NO, (lb/yr)	PM (lb/yr)	SO_2 (lb/yr)
Goat Haunt	Patrol Boat	2	100	250	0.21	345	7,841	172	1	0
Location	Public Boating									
Lake McDonald	Rentals	1	10	300	0.21	21	470	10	0	0
	General Public	1	10	2,200	0.21	1,184	2,352	12	78	0
	In-Holders	1	10	1,200	0.21	646	1,283	7	0	0
Bowman Lake	General Public	1	10	300	0.21	161	321	2	0	0
						2,012	4,427	31	78	0
Location	Cruise Boat									
St. Mary Lake	Little Chief	1	200	645	0.21	75	114	532	34	21
Lake McDonald	DeSmet	1	60	550	0.21	19	29	136	9	5
Two Medicine Lake	Sinopah	1	60	315	0.21	11	17	78	5	3
Lake Josephine	Morning Eagle	1	60	281	0.21	10	15	70	4	3
Swiftcurrent Lake	Chief Two Guns	1	60	281	0.21	10	15	70	4	3
						125	190	885	56	35
				Total		2,481	12,457	1,088	136	35
						(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
						1.24	6.23	0.54	0.07	0.02

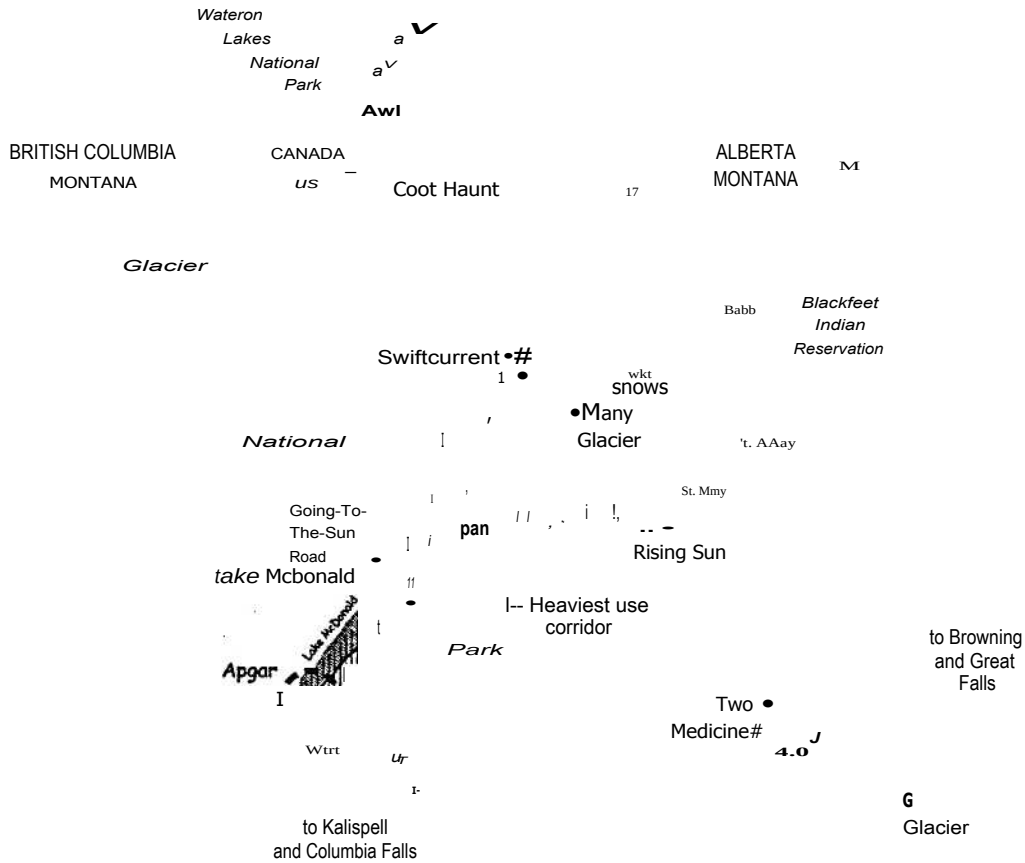
[3] Emissions = Emission Factor' No. of Engines' Engine Power * Hours of Operation

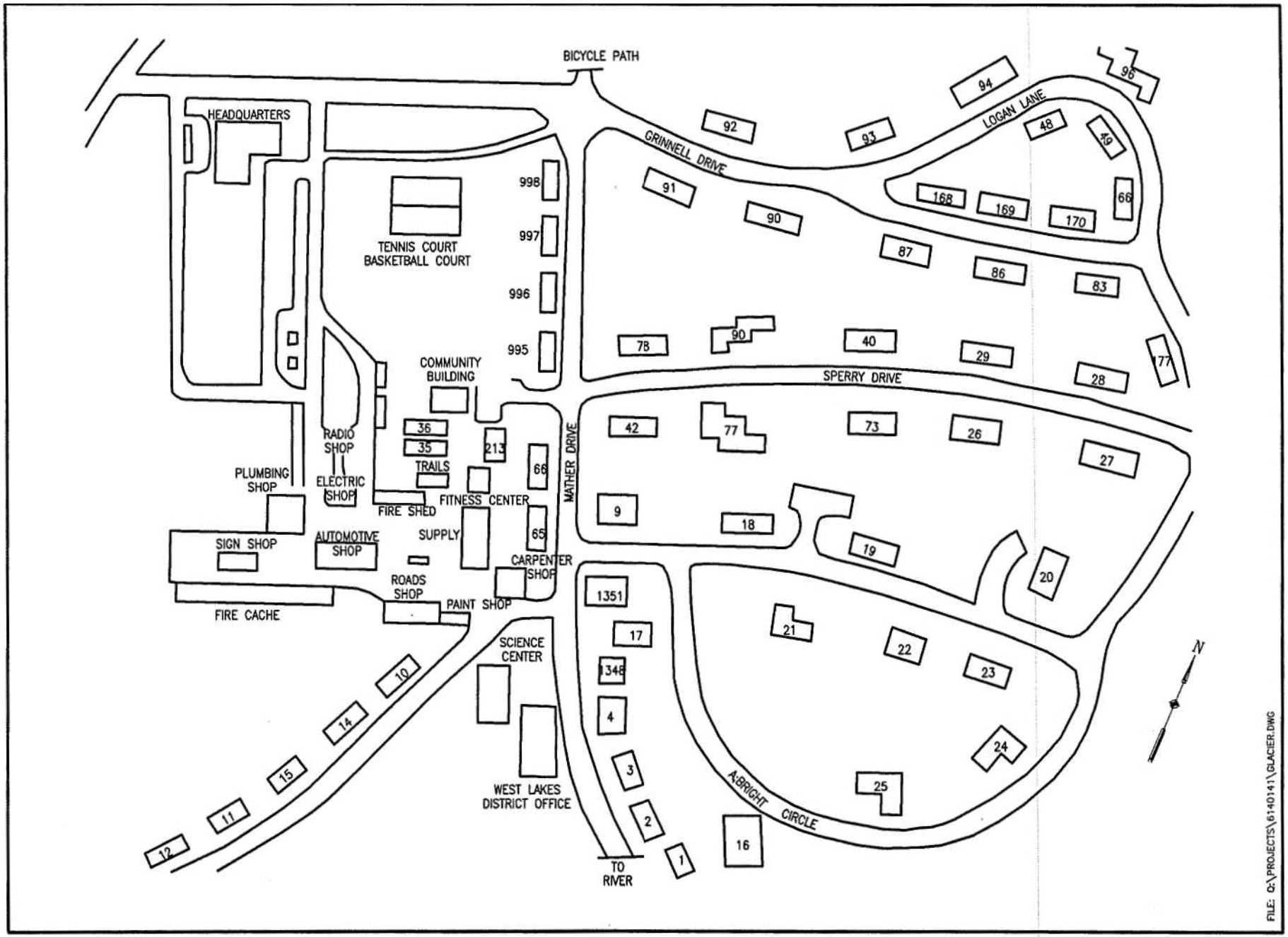
Consessionaire Trips

Glacier Park Boat Co.	Time (Hrs)	Trips/Yr	Hrs/Yr
St. Mary Lake	1.5	430	645
Lake McDonald	1	550	550
Two Medicine Lake	0.75	421	316
Lake Josephine	1.25	225	281
Swiftcurrent Lake	1.25	225	281
	Total	1,851	2,073

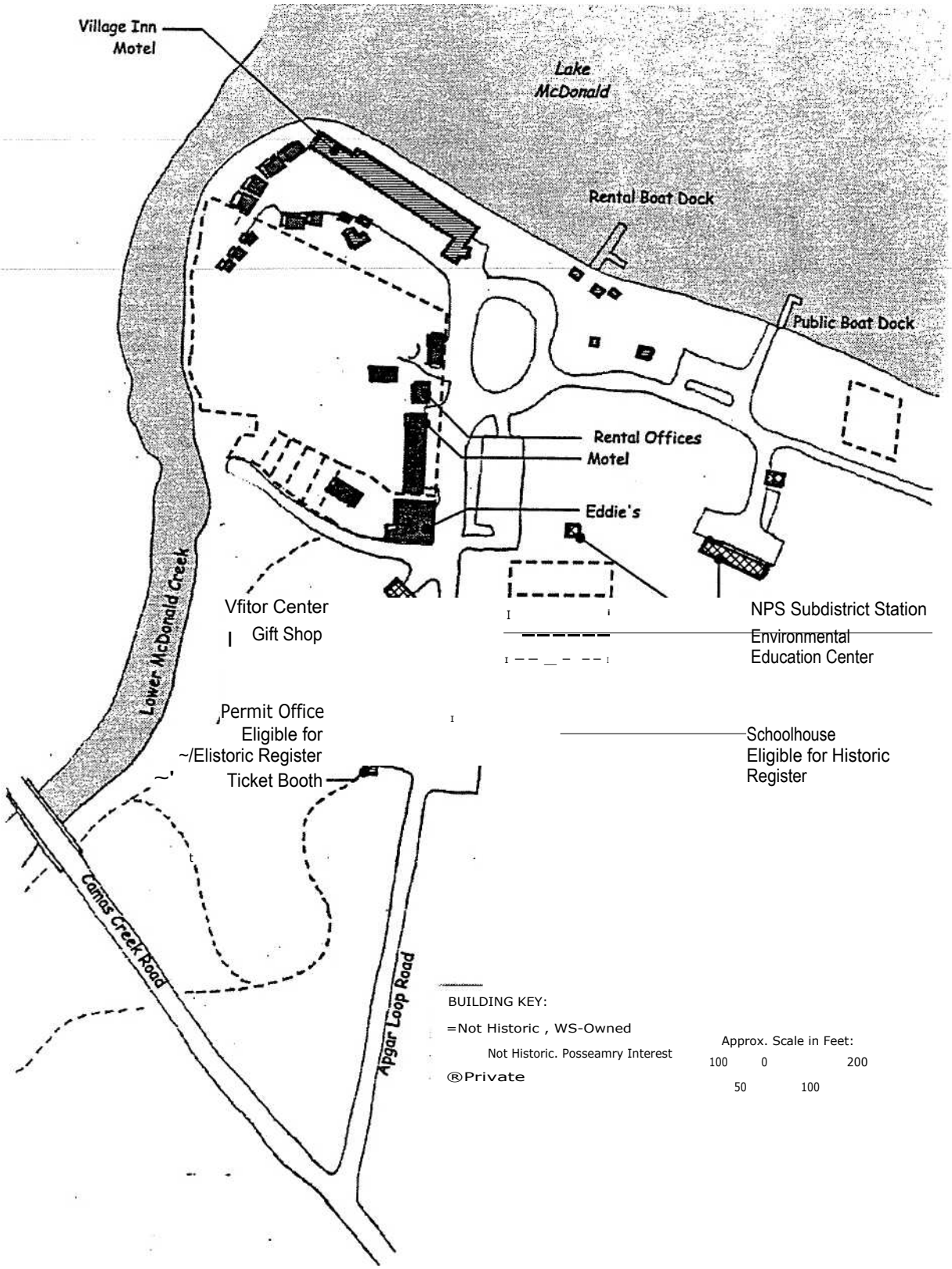
APPENDIX B

DEVELOPED AREAS IN GLACIER NATIONAL PARK, MT

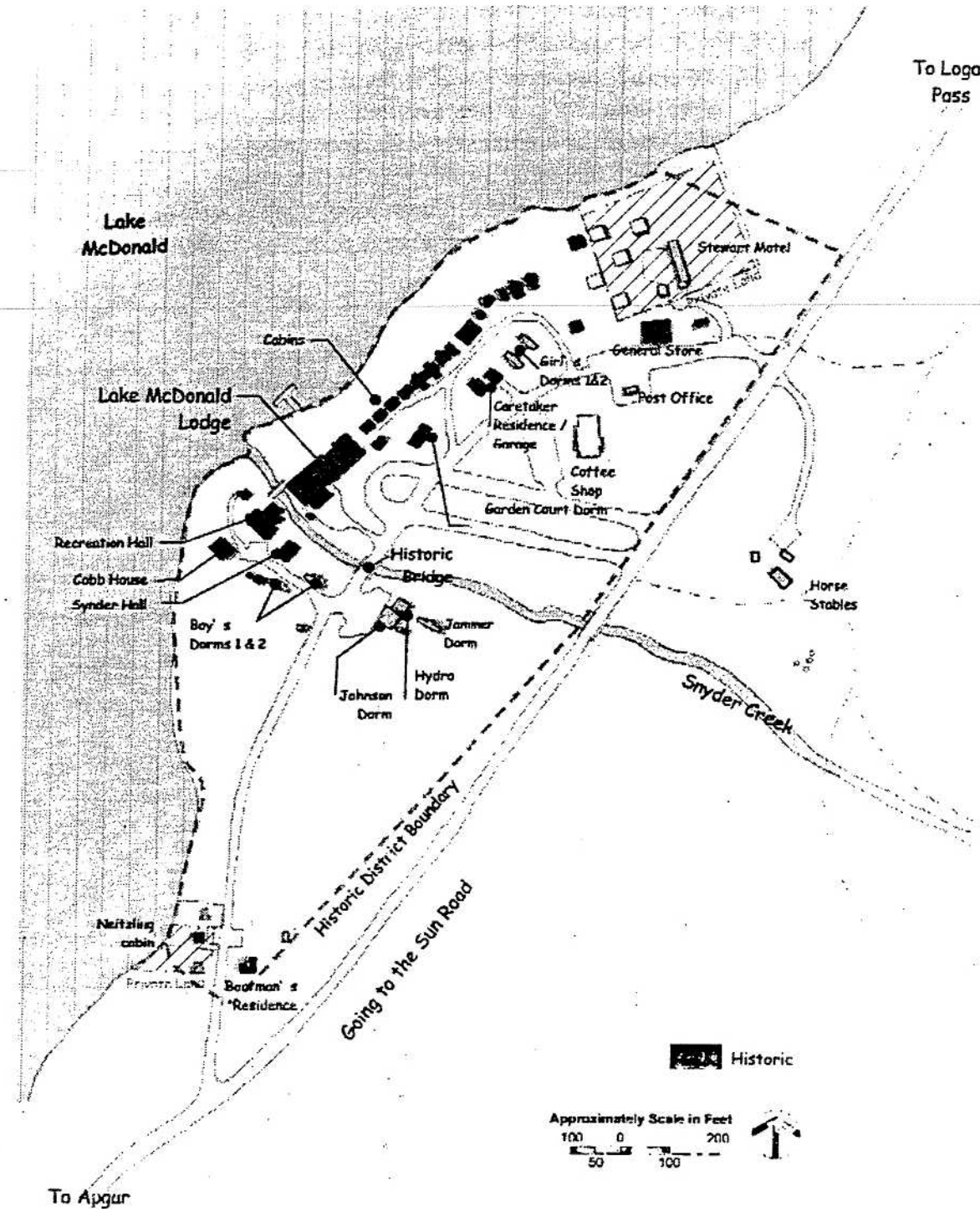

Wateron
Lakes
National
Park
Awl
BRITISH COLUMBIA
MONTANA
CANADA
us
Coot Haunt
17
ALBERTA
MONTANA
M
Glacier
Babb
Blackfeet
Indian
Reservation
Swiftcurrent
wkt
snows
Many
Glacier
National
't. AAay
St. Mmy
Going-To-
The-Sun
Road
pan
Rising Sun
take Mcbonald
Lake McDonald
Apgar
I-- Heaviest use
corridor
Park
to Browning
and Great
Falls
Two
Medicine#
4.0
Wtrt
ur
I-
to Kalispell
and Columbia Falls
G
Glacier

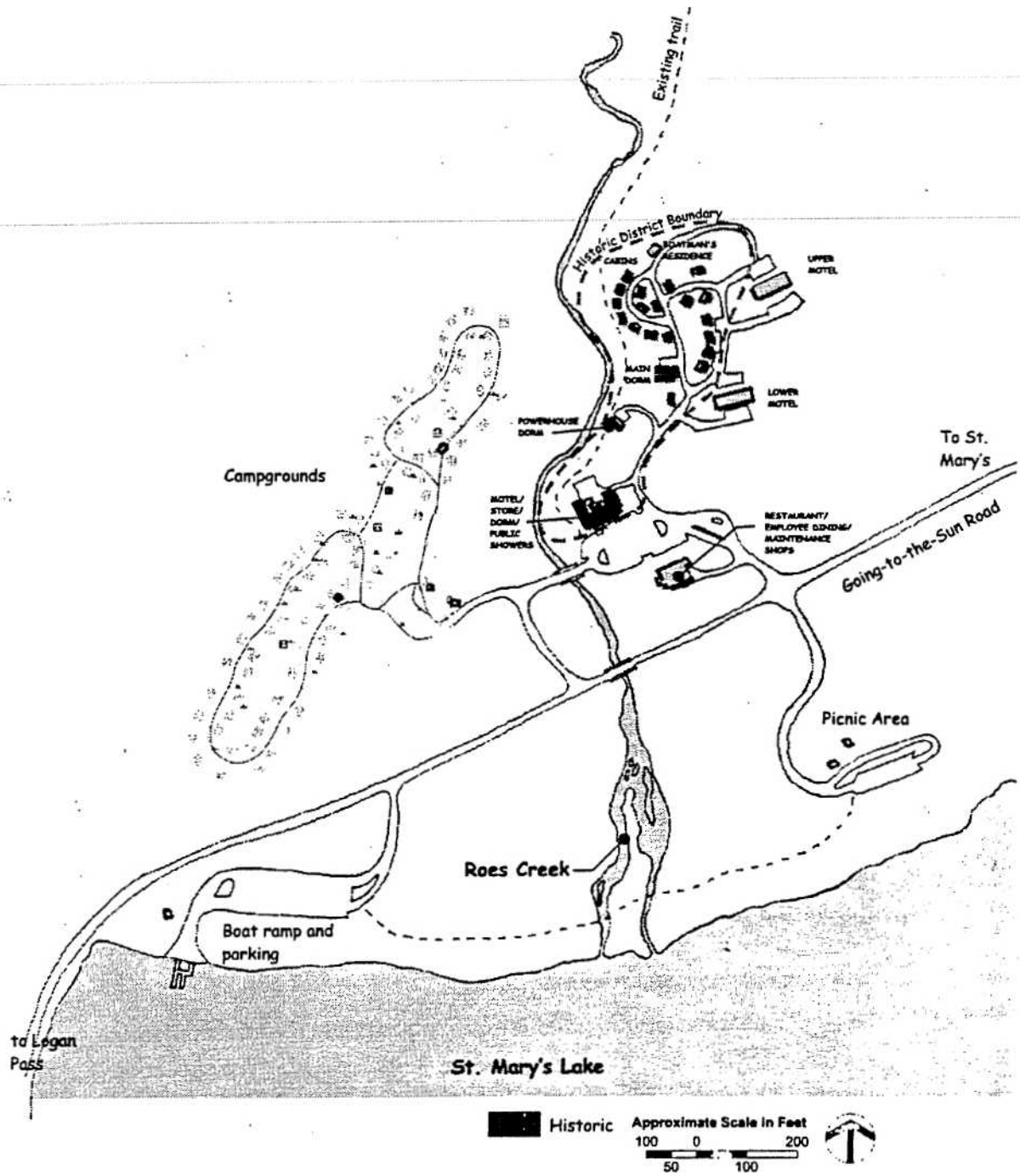


HEADQUARTERS AREA - WEST GLACIER, MONTANA

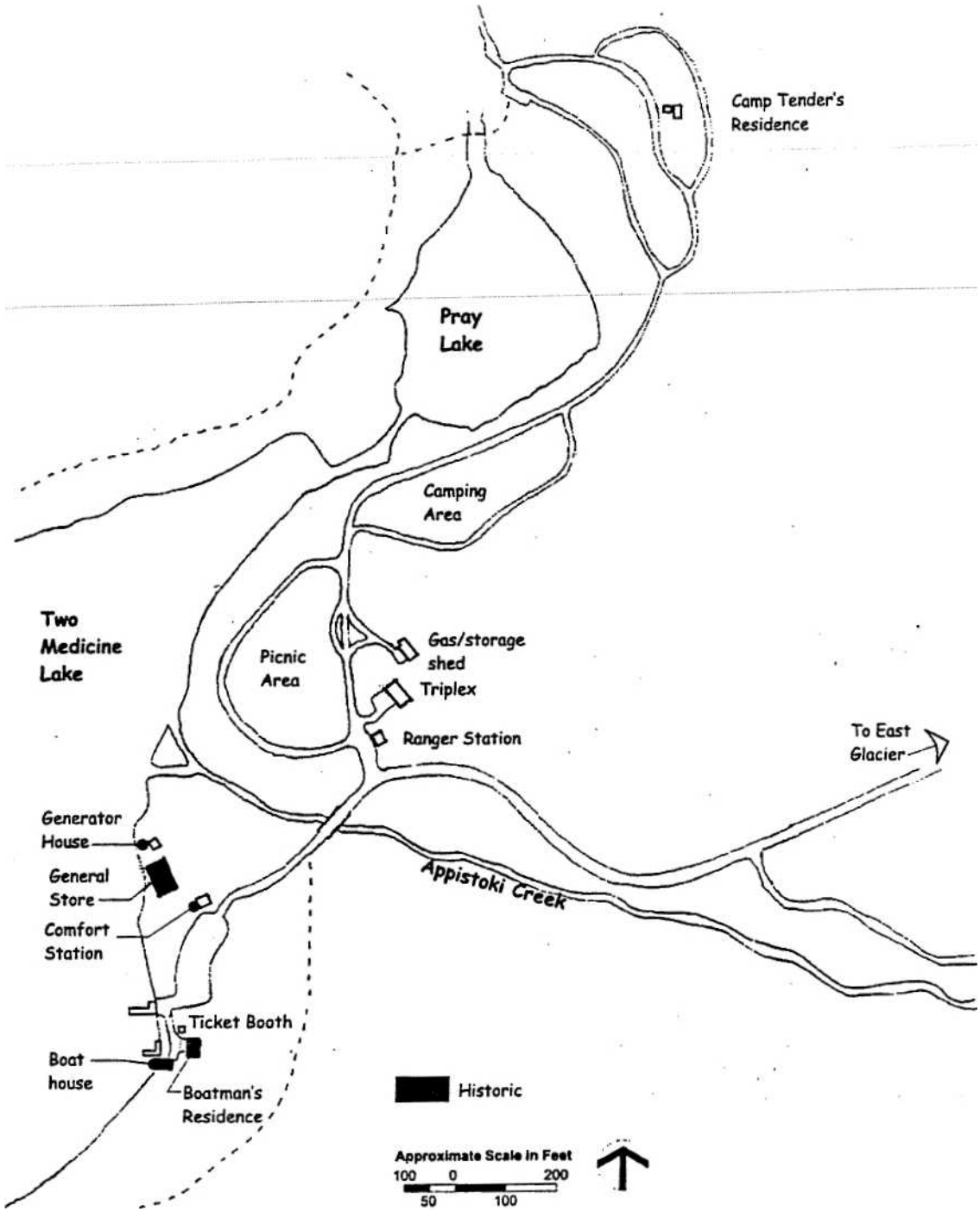


Apgar Village

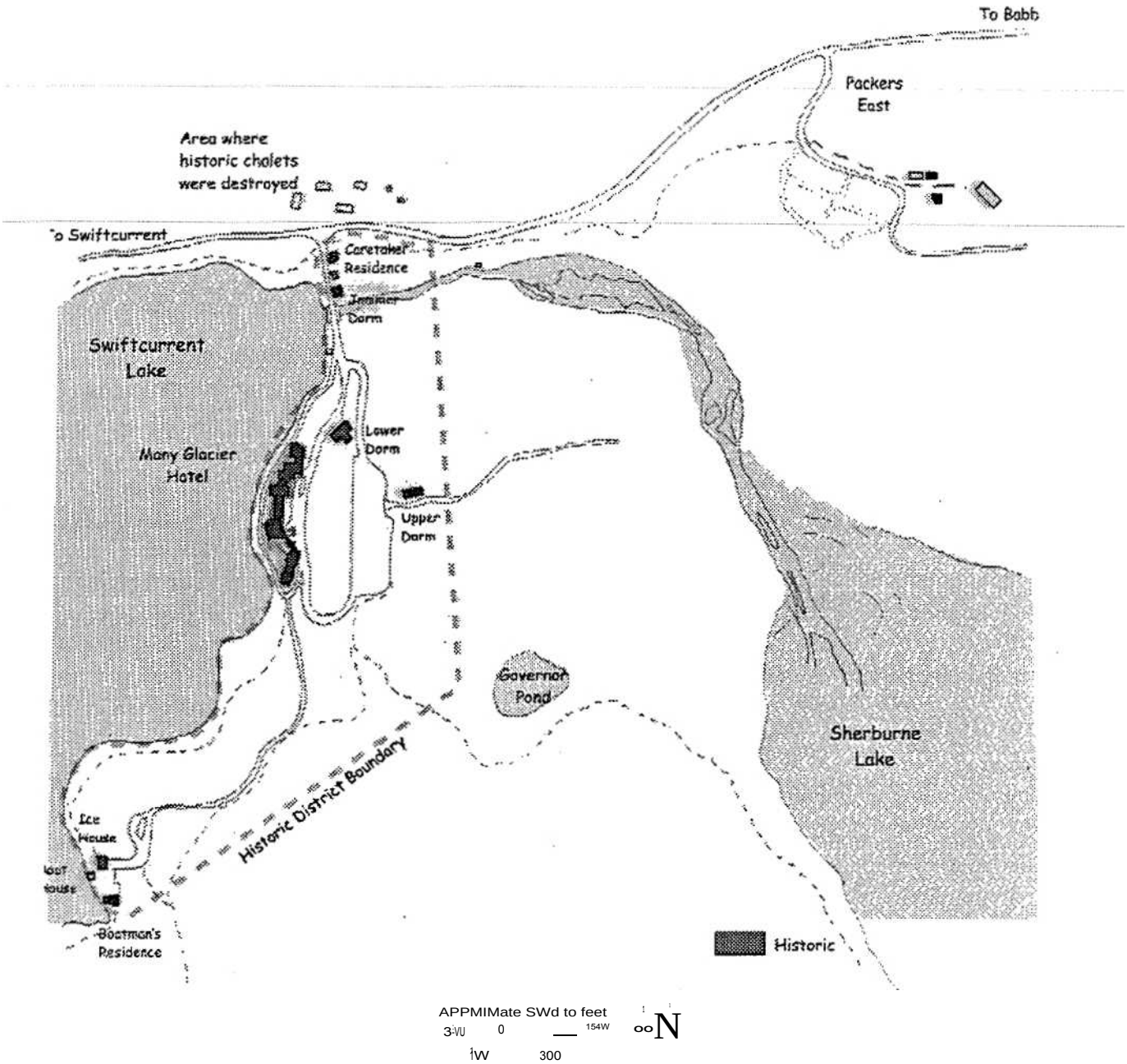

To Logan Pass
Lake McDonald
Stewart Motel
Cabins
General Store
Girl's Dorms 1&2
Lake McDonald Lodge
Post Office
Caretaker Residence / Garage
Coffee Shop
Garden Court Dorm
Recreation Hall
Historic Bridge
Cobb House
Snyder Hall
Horse Stables
Boy's Dorms 1&2
Jammer Dorm
Hydro Dorm
Johnston Dorm
Snyder Creek
Historic District Boundary
Going to the Sun Road
Neitzling cabin
Boatman's Residence
Historic
Approximately Scale in Feet
100 0 200
50 100
To Apgar


Existing trail
Historic District Boundary
CABINS
RANGER'S RESIDENCE
UPPER MOTEL
MAIN DORM
LOWER MOTEL
POWERHOUSE DORM
To St. Mary's
Campgrounds
MOTEL/ STORE/ DORM/ PUBLIC SHOWERS
RESTAURANT/ EMPLOYEE DINING/ MAINTENANCE SHOPS
Going-to-the-Sun Road
Picnic Area
Roes Creek
Boat ramp and parking
to Logan Pass
St. Mary's Lake
Historic
Approximate Scale in Feet
100 0 200
50 100

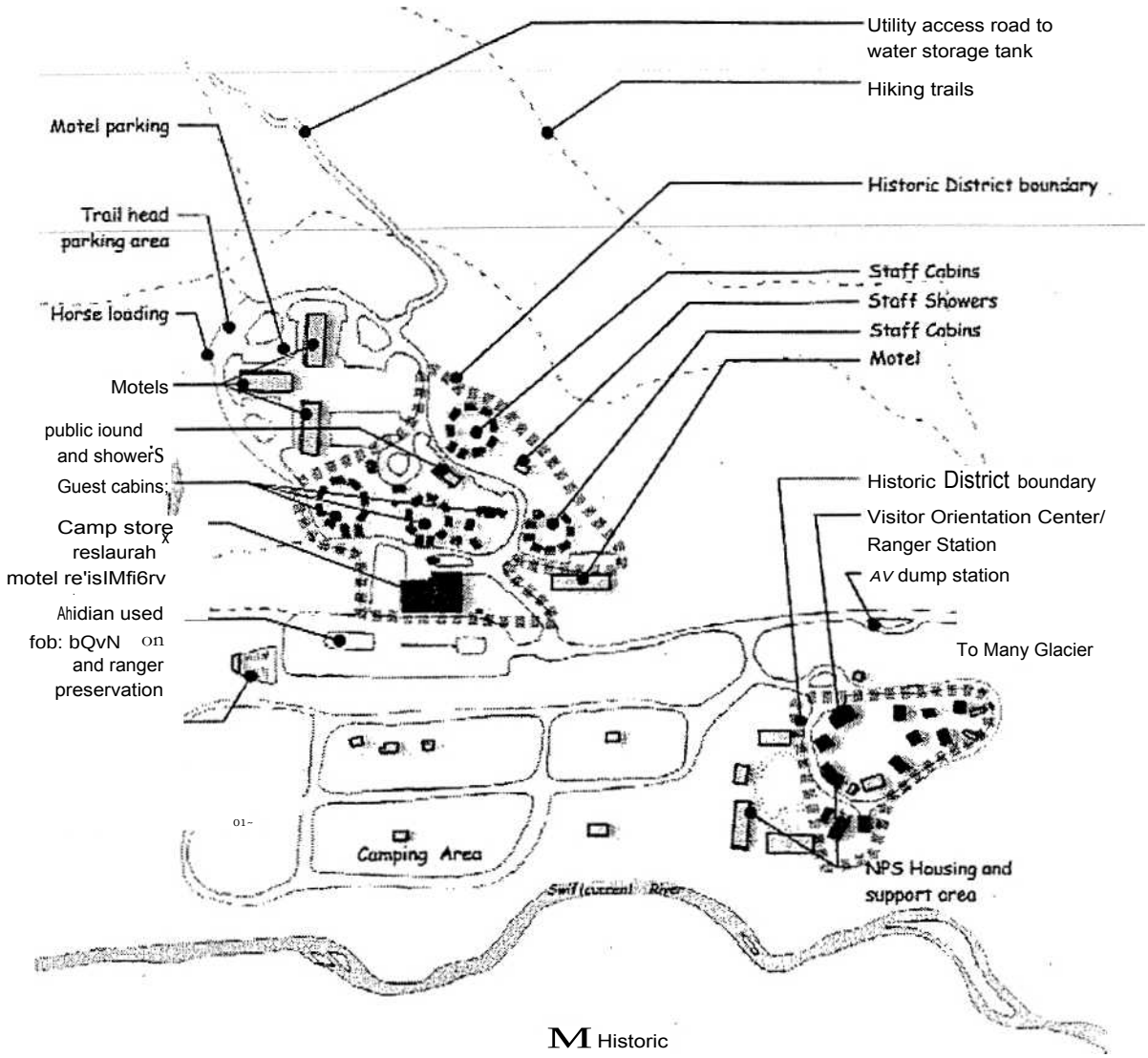
Rising Sun



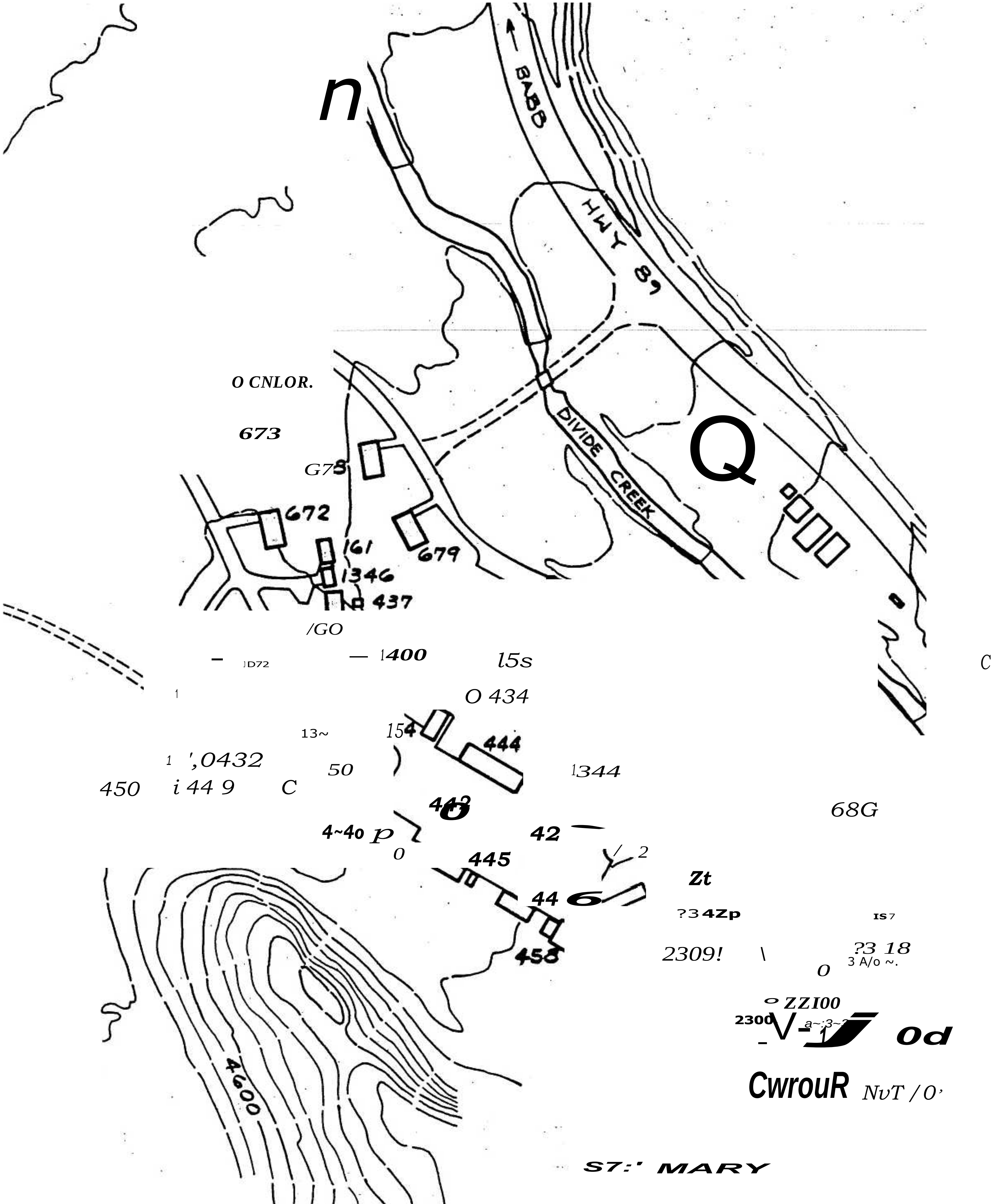
Two Medicine



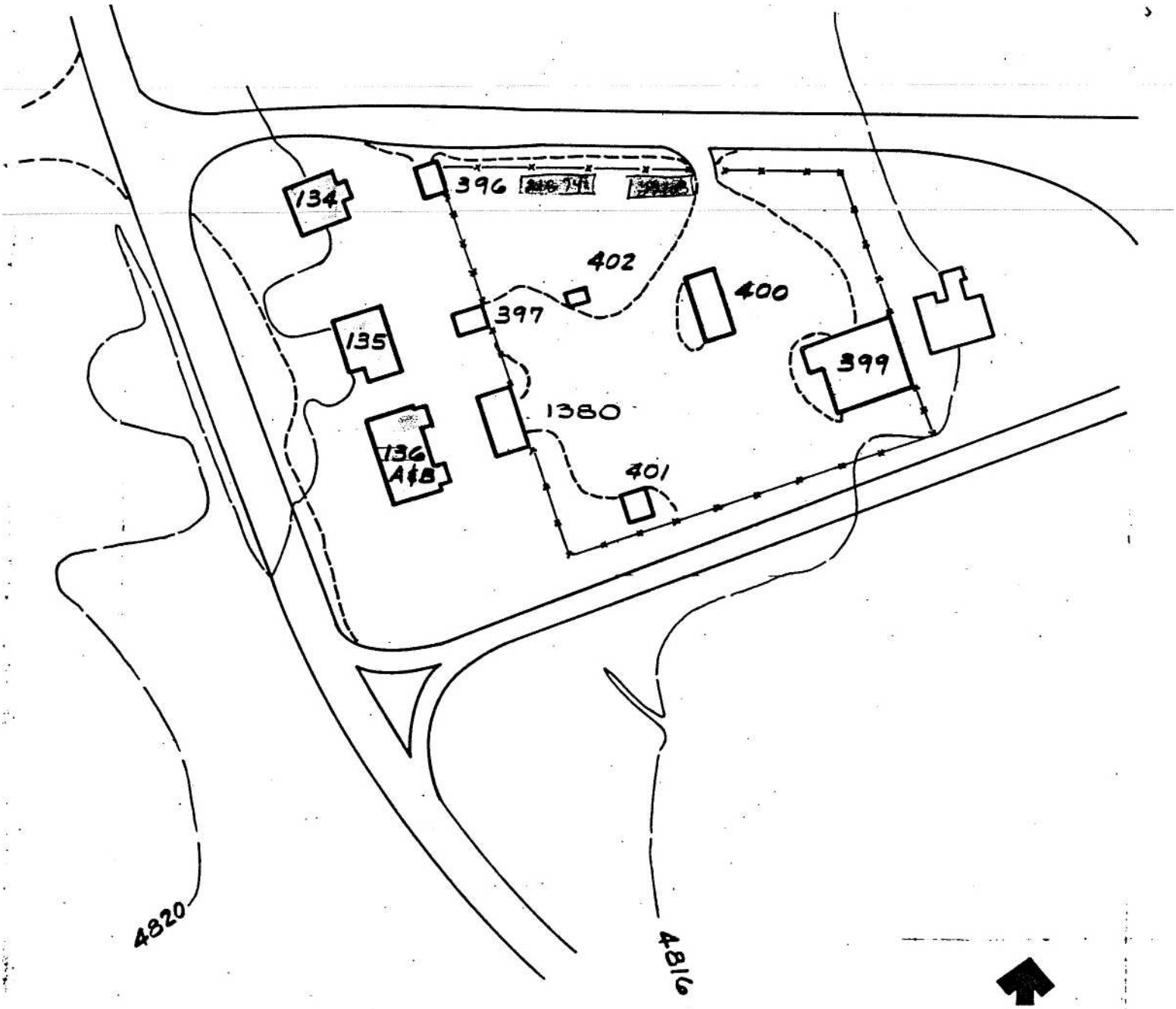
Many Glacier



Swiftcurrent

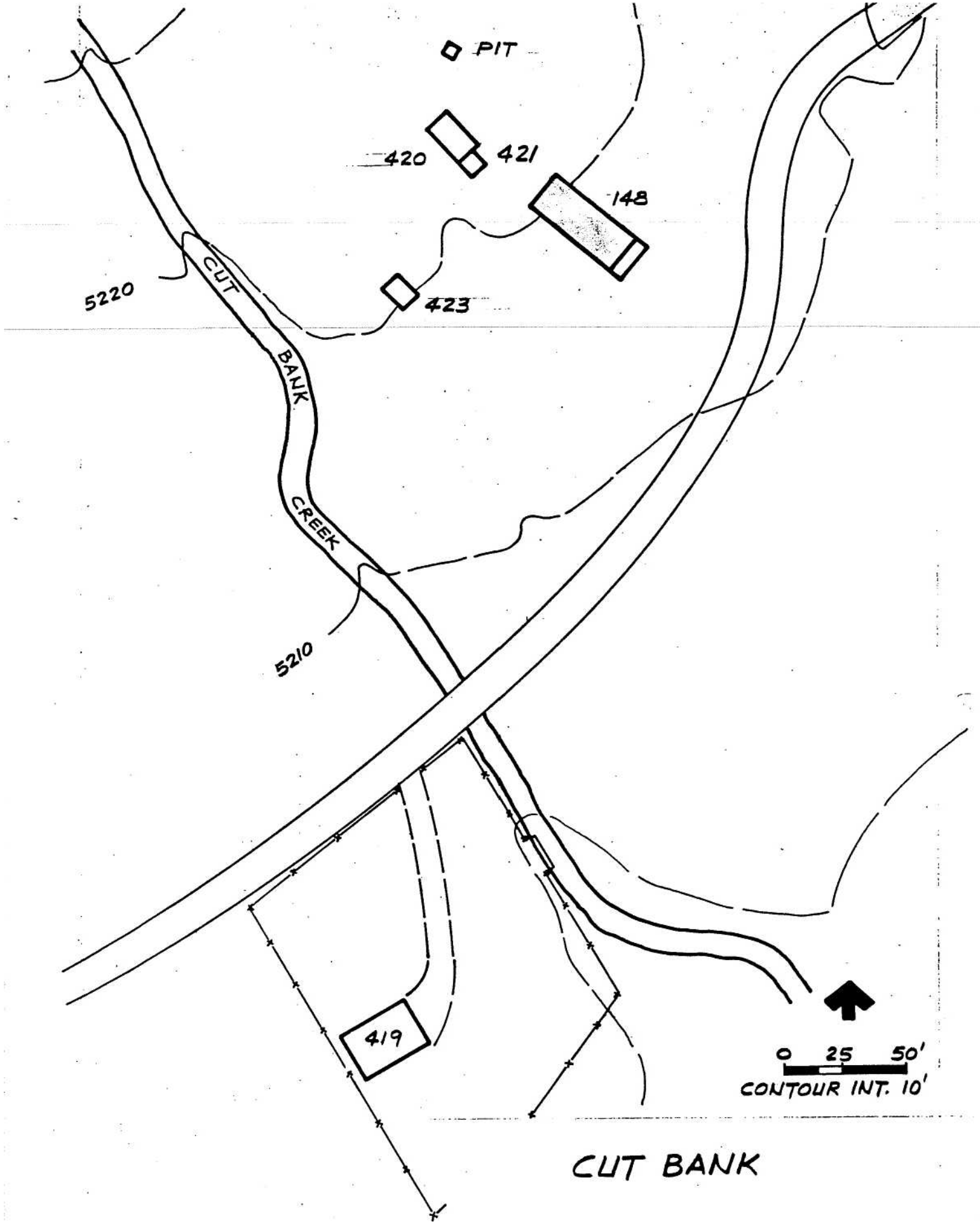


BABB
HWY 89
DIVIDE CREEK
672
161
1346
437
679
444
445
4600



CONTOUR /NT 4'

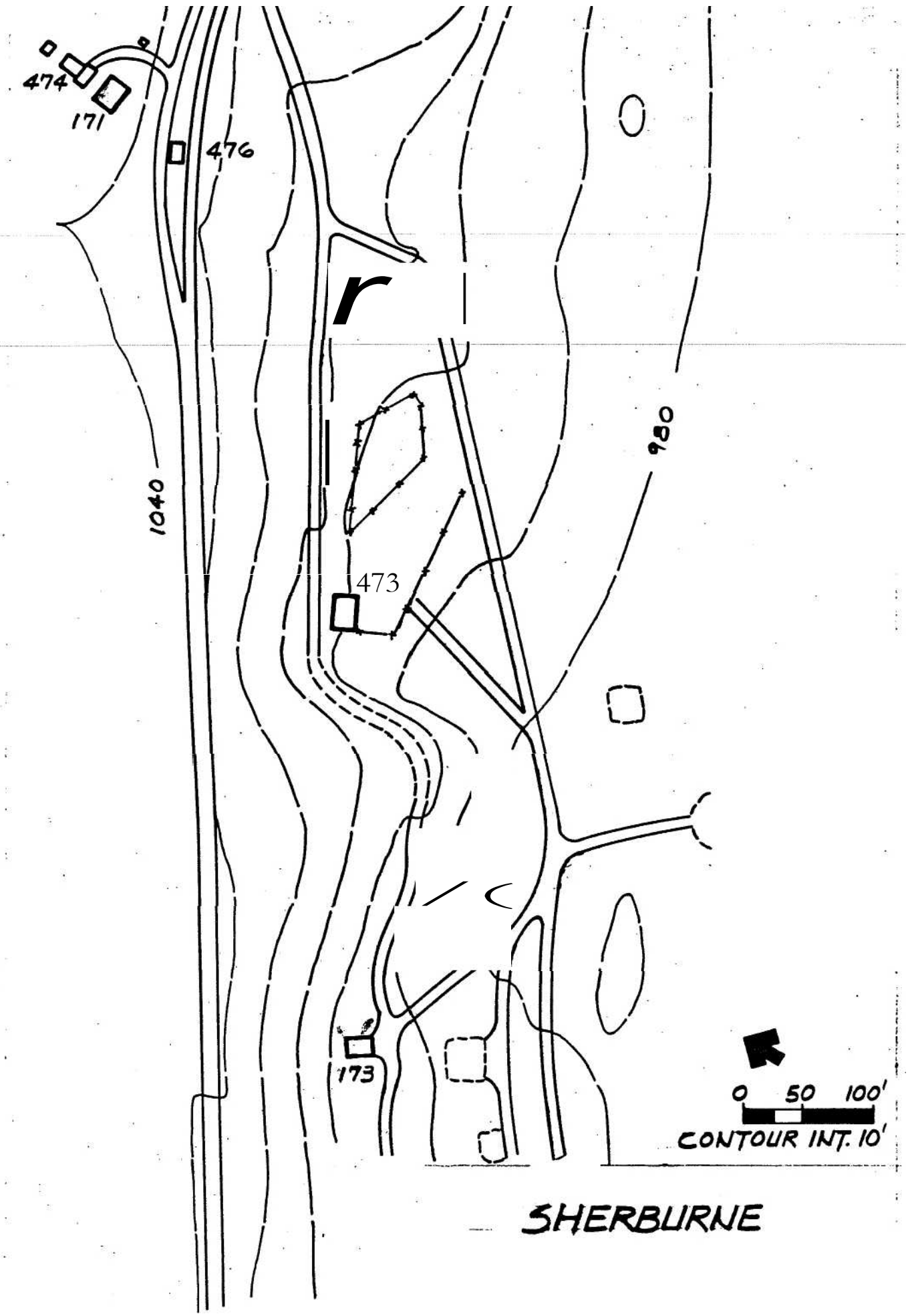
EAST 4LAC/ER

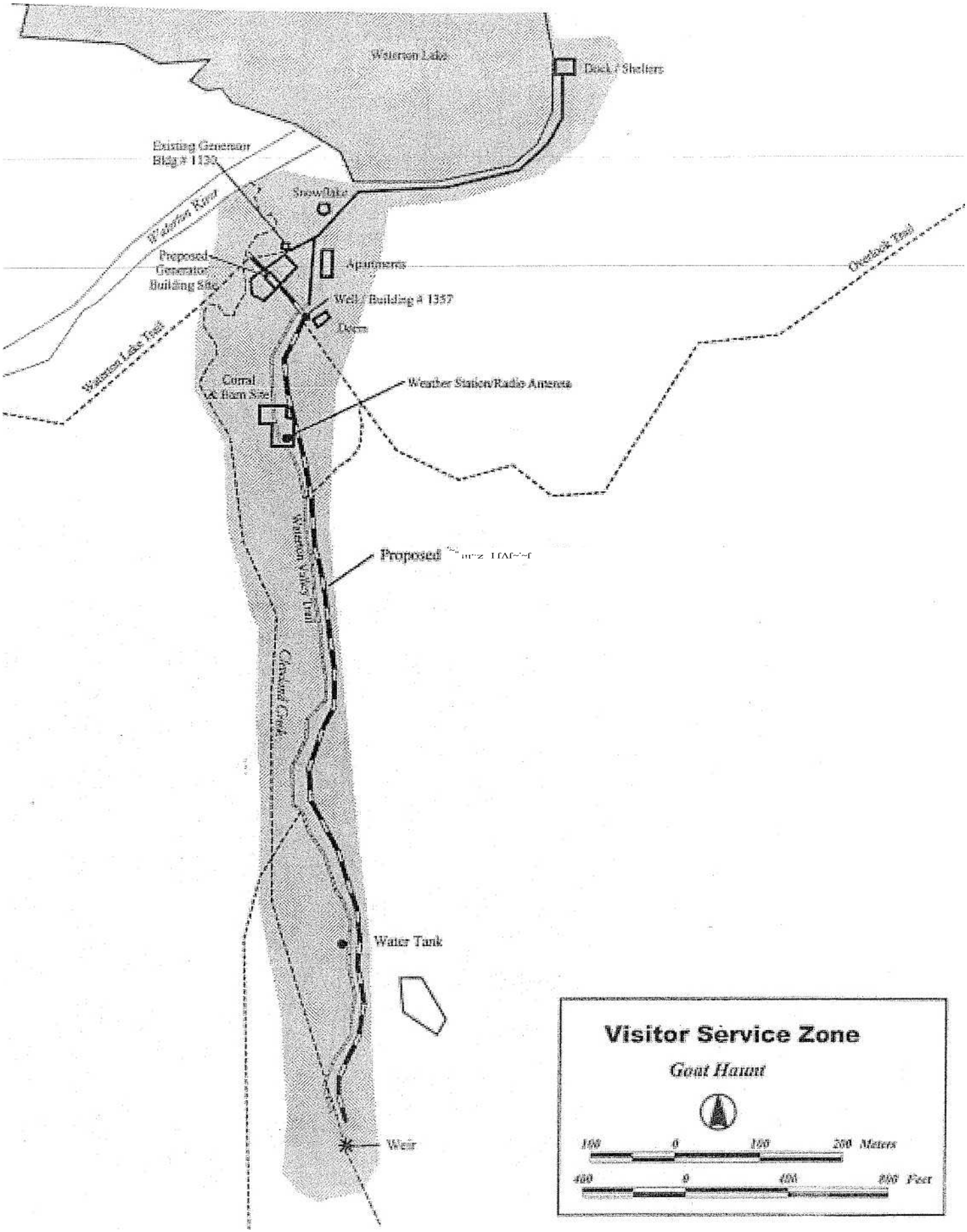

PIT
420
421
148
423
5220
CUT BANK CREEK
5210
419
0 25 50'
CONTOUR INT. 10'

CUT BANK

CoMTbuR INT. 10'

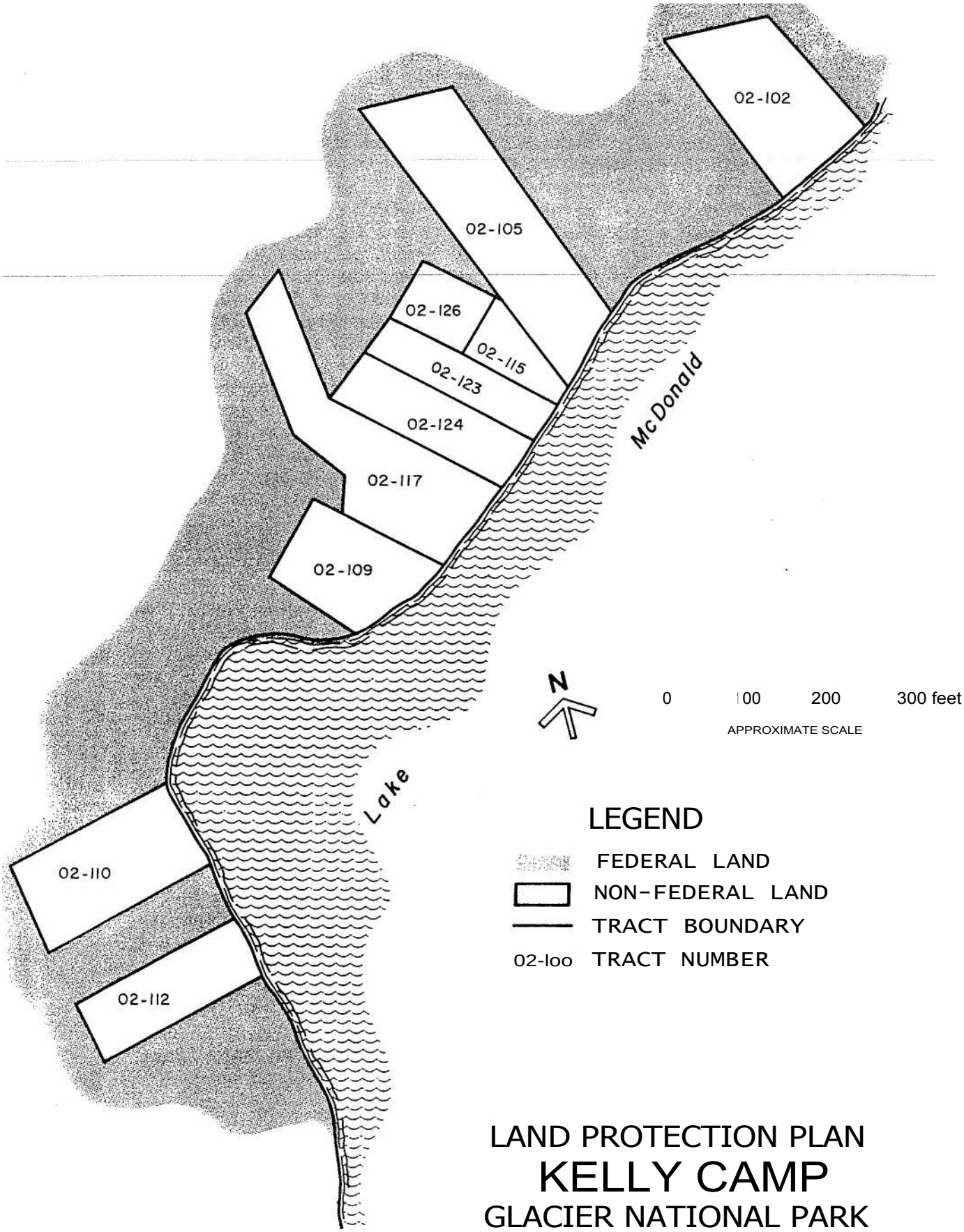
RIVER


474
171
476
1040
980
473
173
0 50 100'
CONTOUR INT. 10'
SHERBURNE


Waterton Lake
Dock / Shelters
Existing Generator
Bldg # 1330
Snow Lake
Waterton River
Proposed
Generator
Building Site
Apartments
Overlook Trail
Well / Building # 1337
Dams
Waterton Lake Trail
Corral
(4 Barn Site)
Weather Station/Radio Antenna
Proposed
Water Tank
Weir
Visitor Service Zone
Goat Haunt
100 0 100 200 Meters
400 0 400 800 Feet

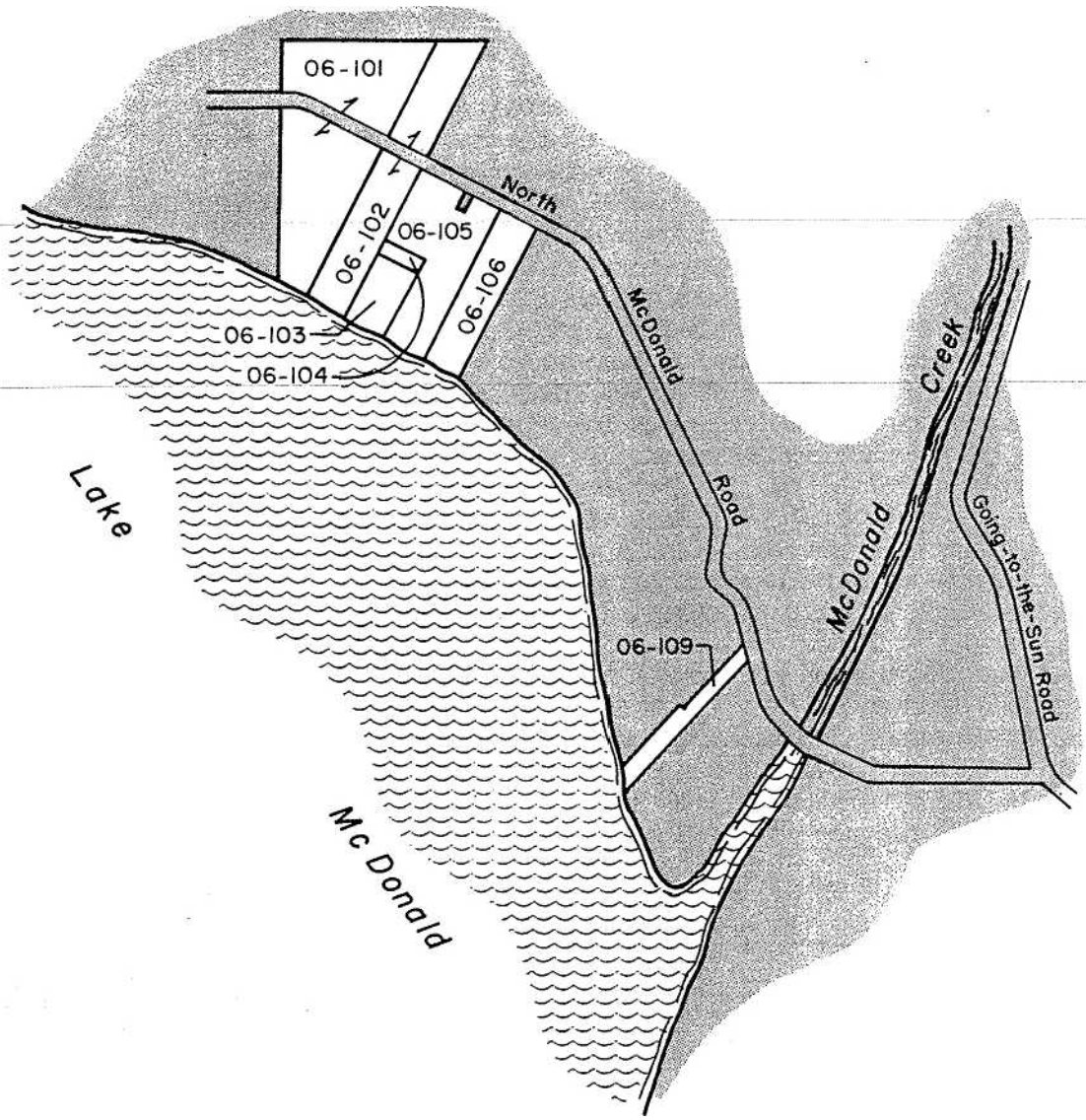
APPENDIX C

PRIVATE IN-HOLDING AREAS AROUND LAKE McDONALD IN GLACIER NATIONAL PARK, MT



LAND PROTECTION PLAN
KELLY CAMP
GLACIER NATIONAL PARK

NATIONAL PARK SERVICE - U.S. DEPT. OF THE INTERIOR



LEGEND

FEDERAL LAND

NON-FEDERAL LAND

TRACT BOUNDARY

02-100 TRACT NUMBER

N

400 800 1200 feet

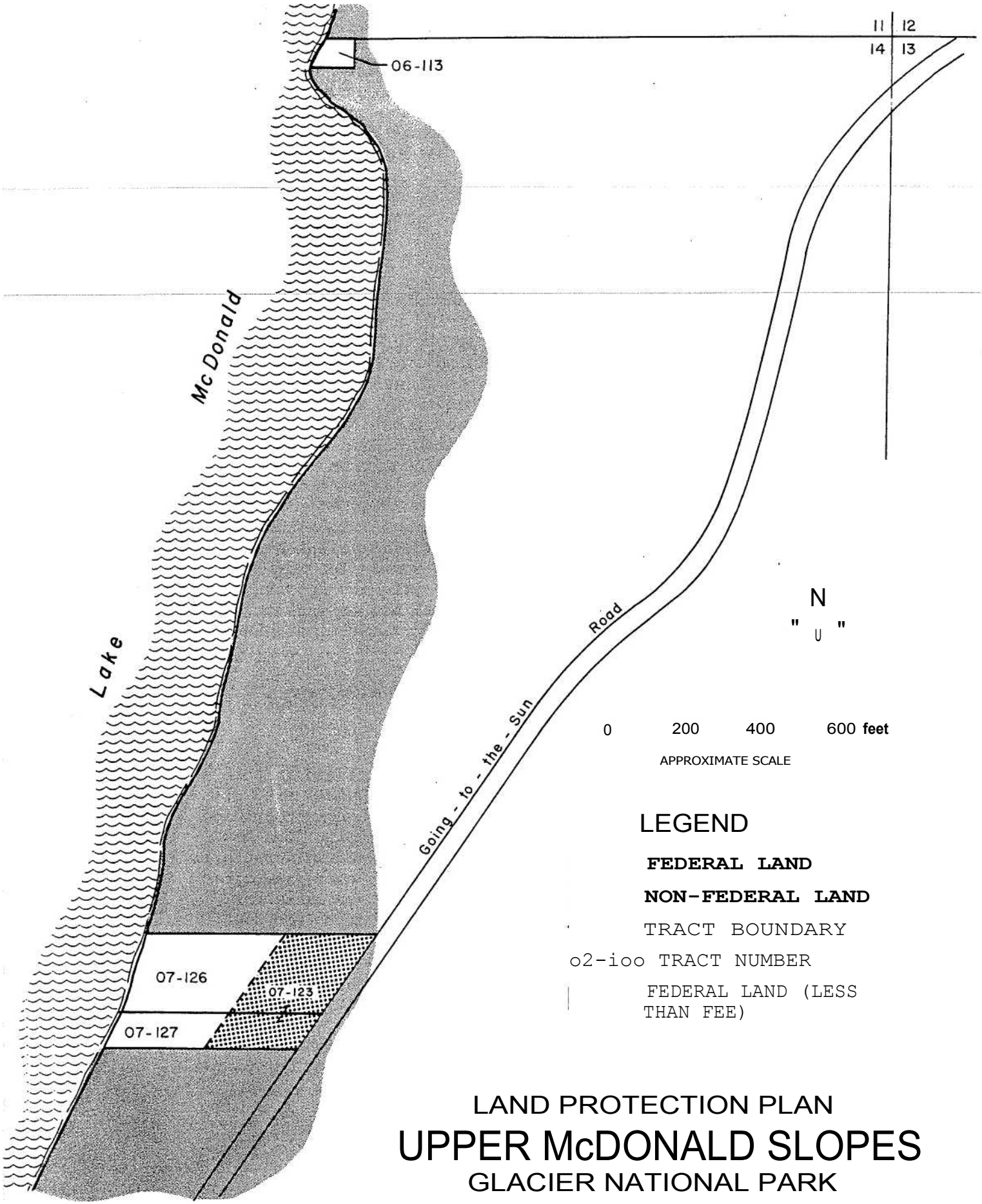
APPROXIMATE SCALE

LAND PROTECTION PLAN

UPPER McDONALD FLATS

GLACIER NATIONAL PARK

NATIONAL PARK SERVICE - U.S. DEPT. OF THE INTERIOR

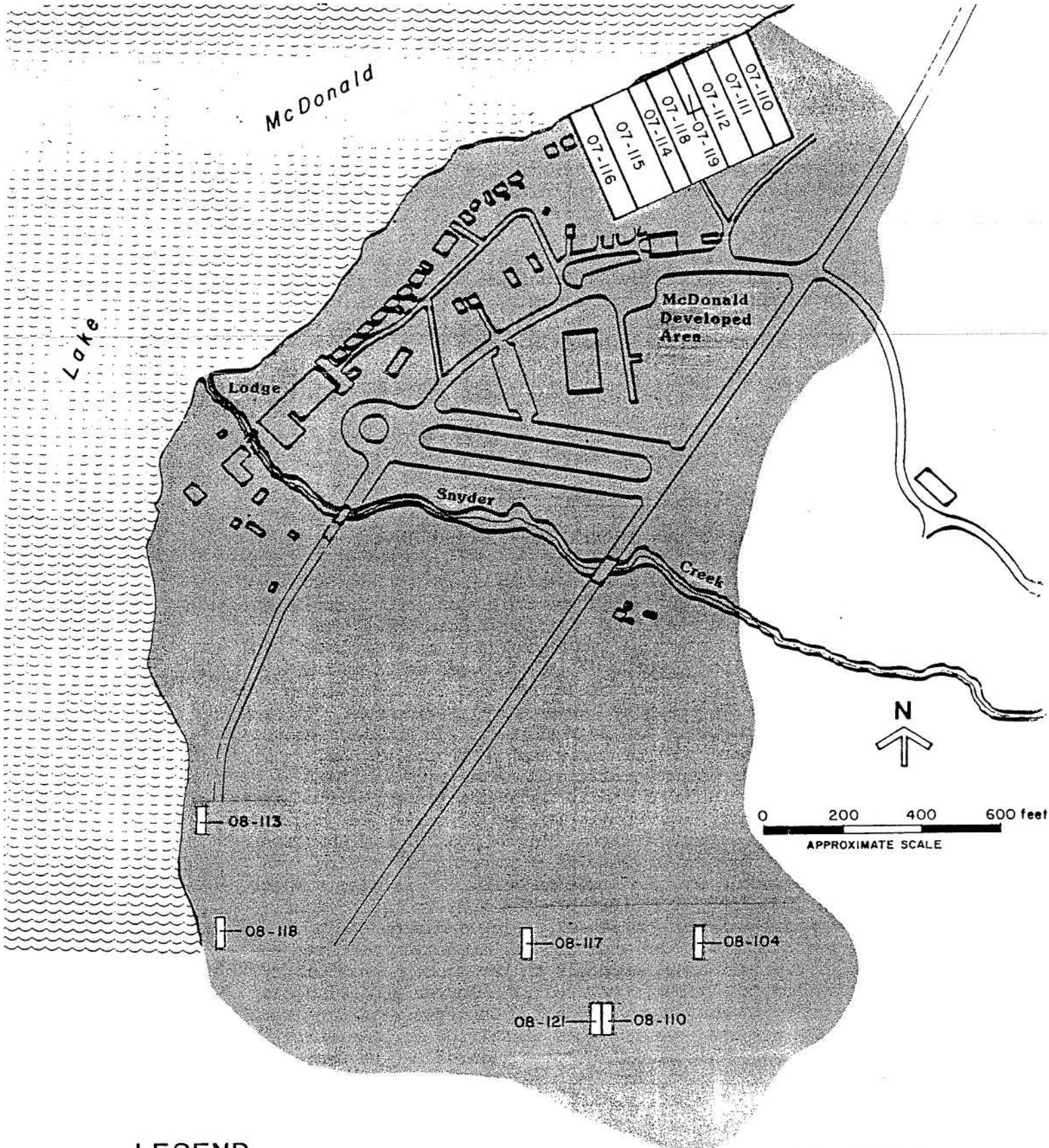


LAND PROTECTION PLAN

UPPER McDONALD SLOPES

GLACIER NATIONAL PARK

NATIONAL PARK SERVICE - U.S. DEPT. OF THE INTERIOR



LEGEND

FEDERAL LAND

NON-FEDERAL LAND

TRACT BOUNDARY

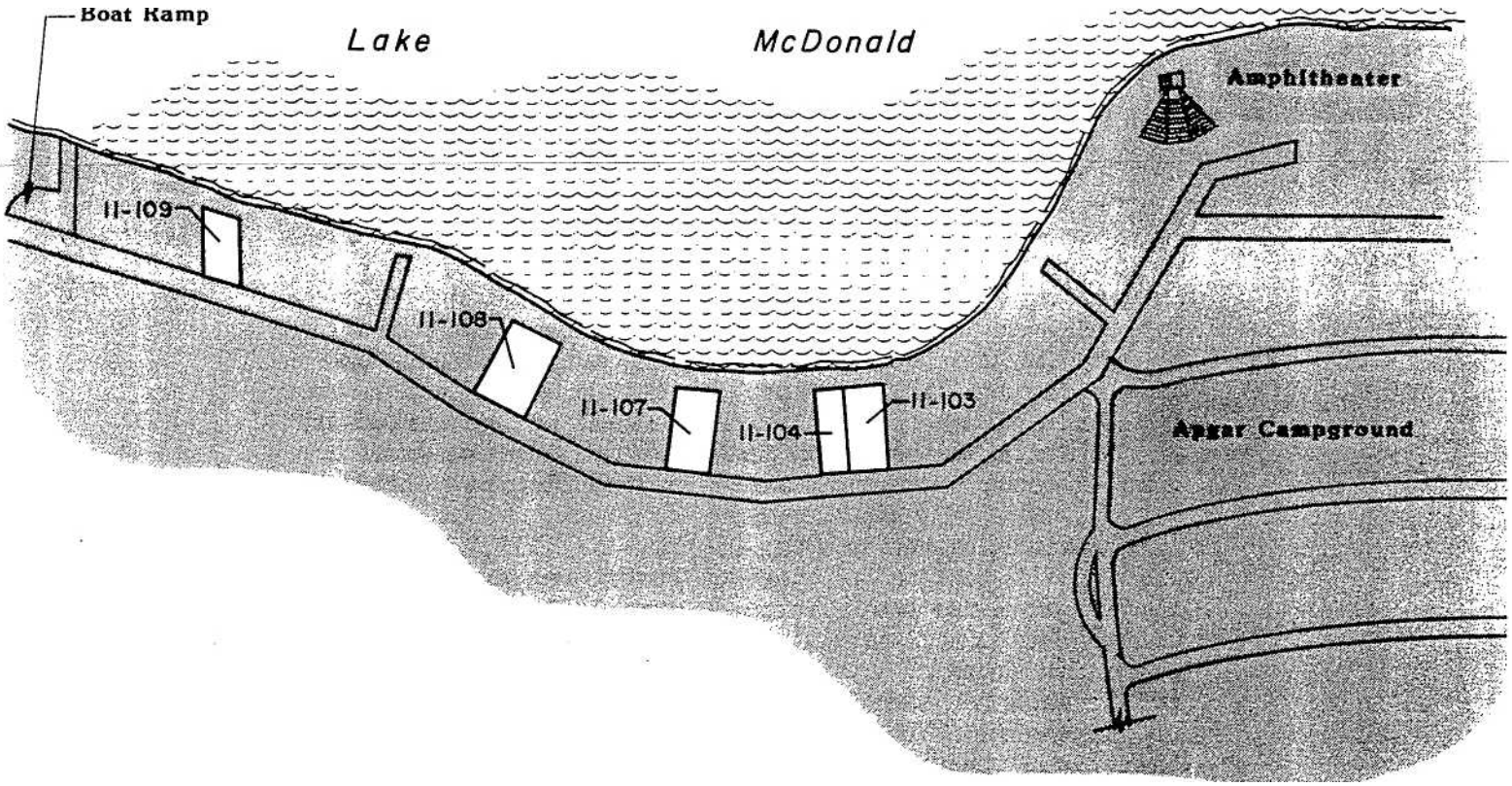
02-loo TRACT NUMBER

LAND PROTECTION PLAN

McDONALD LODGE

GLACIER NATIONAL PARK

NATIONAL PARK SERVICE - U.S. DEPT. OF THE INTERIOR



N

LEGEND

FEDERAL LAND

NON-FEDERAL LAND

TRACT BOUNDARY

02-100 TRACT NUMBER

0 200 400 600 feet

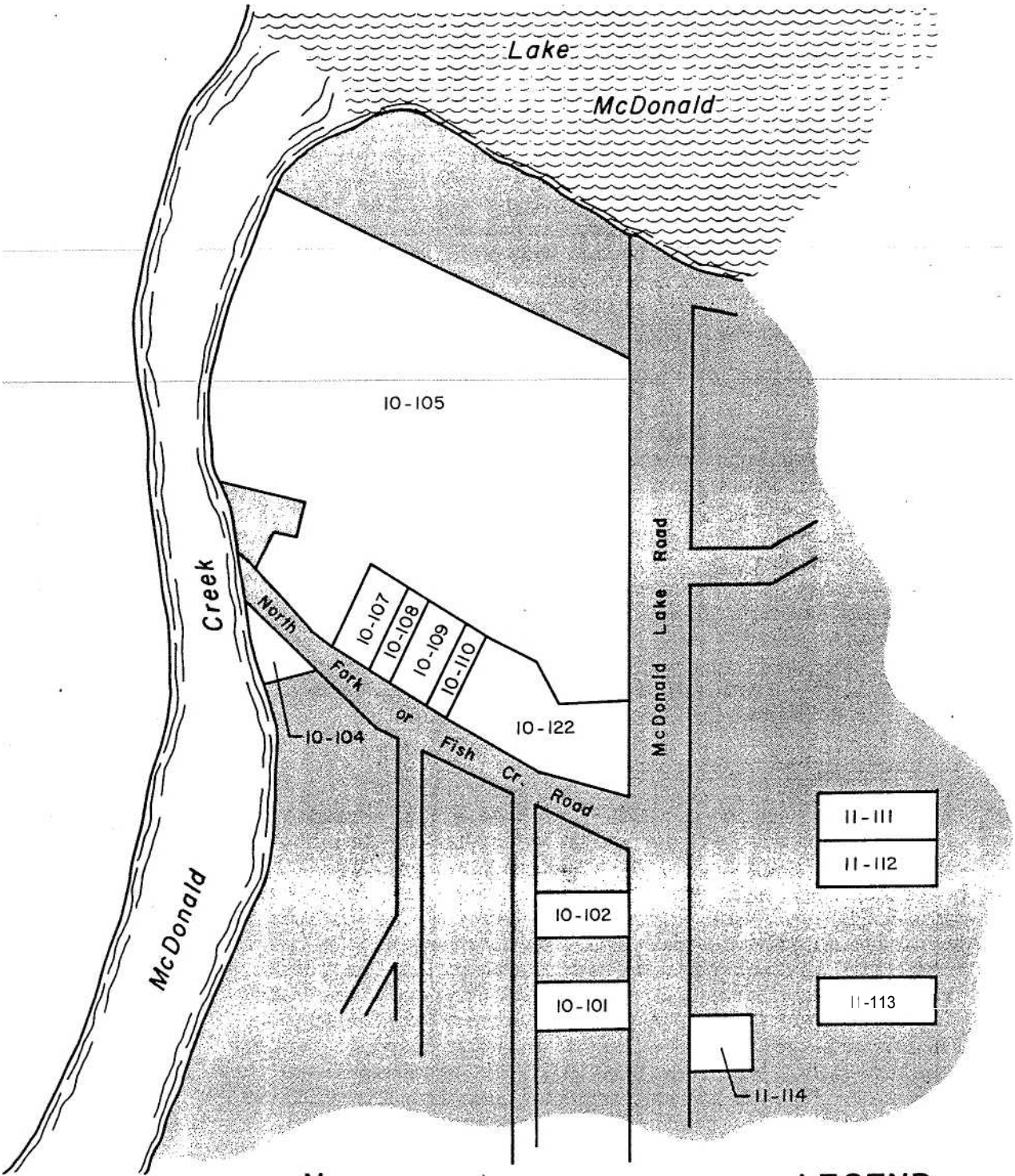
APPROXIMATE SCALE

LAND PROTECTION PLAN

APGAR FLATS

GLACIER NATIONAL PARK

NATIONAL PARK SERVICE - U.S. DEPT. OF THE INTERIOR



N

0 100 200 300 feet

APPROXIMATE SCALE

LEGEND

FEDERAL LAND

NON-FEDERAL LAND

TRACT BOUNDARY

02-100 TRACT NUMBER

LAND PROTECTION PLAN

APGAR VILLAGE

GLACIER NATIONAL PARK

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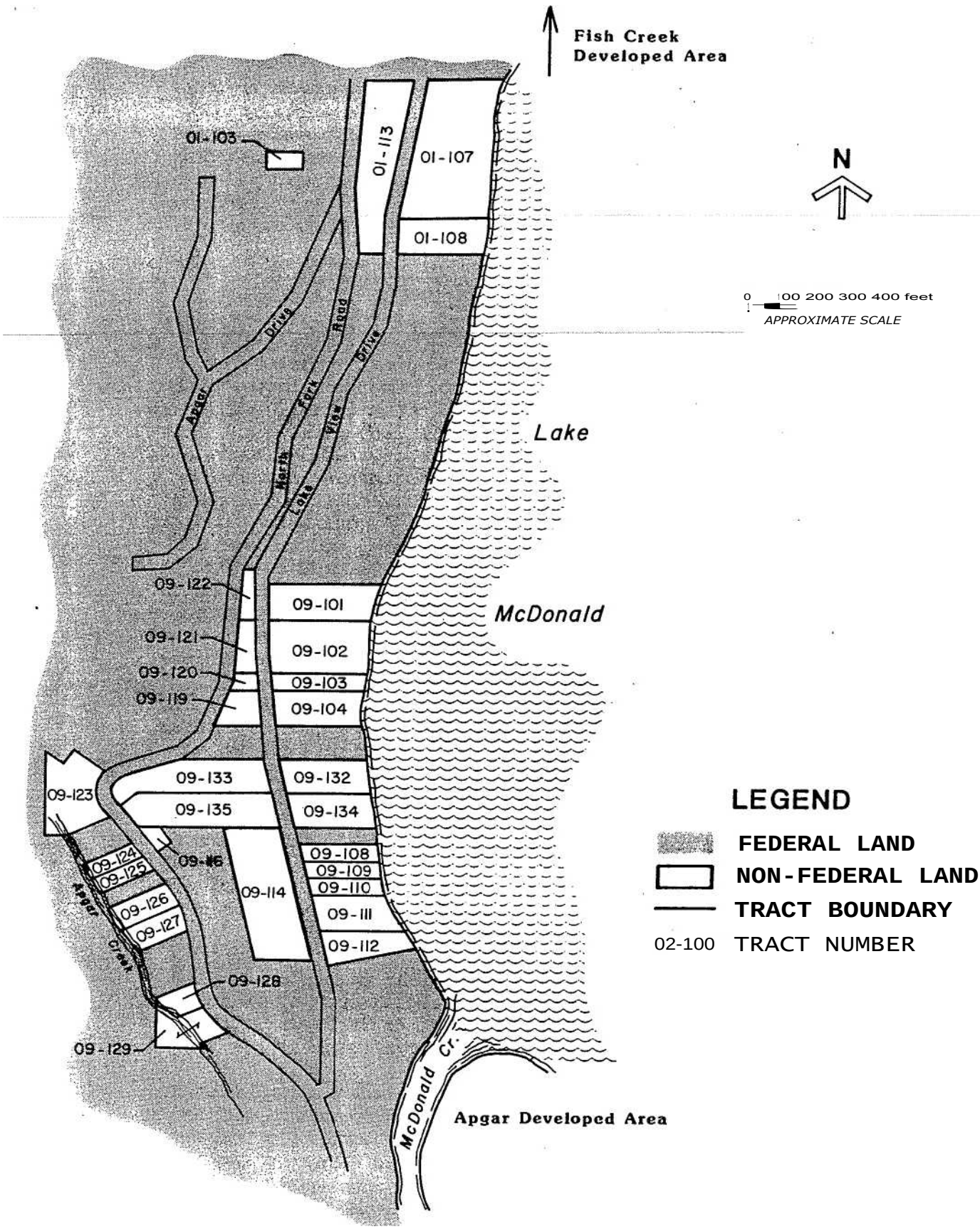

LAND PROTECTION PLAN
APGAR COTTAGE SITES
GLACIER NATIONAL PARK
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