DEPARTMENT OF THE ARMY

HEADQUARTERS, 6TH INFANTRY DIVISION (LIGHT)

AND U.S. ARMY GARRISON, ALASKA

FORT RICHARDSON, ALASKA 99505-5500

ENVIRONMENTAL ASSESSMENT FOR RESUMPTION OF FIRING IN THE EAGLE RIVER FLATS IMPACT AREA, FORT RICHARDSON, ALASKA

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ENVIRONMENTAL ASSESSMENT FOR THE RESUMPTION OF FIRING INTO THE EAGLE RIVER FLATS ON FORT RICHARDSON, ALASKA

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1. Purpose and Need for the Proposed Action. The purpose of this action is to provide for the resumption of live-fire training by the 6th Infantry Division (Light) in the Eagle River Flats. The Eagle River Flats is the only impact area on Fort Richardson which can be used for artillery and mortar firing. Artillery and mortar live-fire exercises are an essential component of the 6th Infantry Division (Light) training mission in Alaska.

2. Location of the Eagle River Flats. The Eagle River Flats is located on lower Knik Arm 9 miles northeast of downtown Anchorage, 4 miles north of the Fort Richardson Cantonment Area and 5 miles west of the community of Eagle River. The relationship of the Eagle River Flats to local communities is shown in Figure 1. A large scale map of the Eagle River Flats is at Figure 2. The Eagle River Flats Impact Area showing target and buffer areas is shown in Figure 3.

3. Description of the Proposed Action.

a. Since 1945, the Army has used the Eagle River Flats as an impact area for artillery shells, mortar rounds, rockets, grenades, illumination flares, and Army/Air Force Door Gunnery Exercises. In 1982, hunters discovered large numbers of duck carcasses in the Eagle River Flats. Since this time, the Army and other federal and state agencies have been involved in identifying the cause of the waterfowl mortality problem. On February 8, 1990, the Army temporarily suspended firing into the Eagle River Flats due to the suspected correlation between explosives and duck deaths. A summary in chronological order of the Eagle River Flats waterfowl mortality investigation can be found in the back of this document (Appendix A).

b. Based on the U.S. Army Cold Regions Research and Engineering Laboratory Report (CRREL, 1991) identifying white phosphorus (WP) as the most likely causative agent for the waterfowl mortality in the flats coupled with the observation that lack of firing into the flats apparently had no effect on reducing waterfowl mortality, Major General Samuel Ebbesen, Sixth Infantry Division (Light) and U.S. Army Garrison, Alaska Commander, directed that the necessary environmental documents be prepared to evaluate the resumption of firing into the Eagle River Flats using only non-phosphorus containing munitions. General Ebbesen's decision was made public in a press release by the 6th Infantry Division (Light) on February 21, 1991 (Appendix B). Several local newspaper articles resulted from the press release (Appendix C). An additional Press Release was made public and newspaper articles were written and printed in local newspapers in late September and early October 1991 (Appendix D).

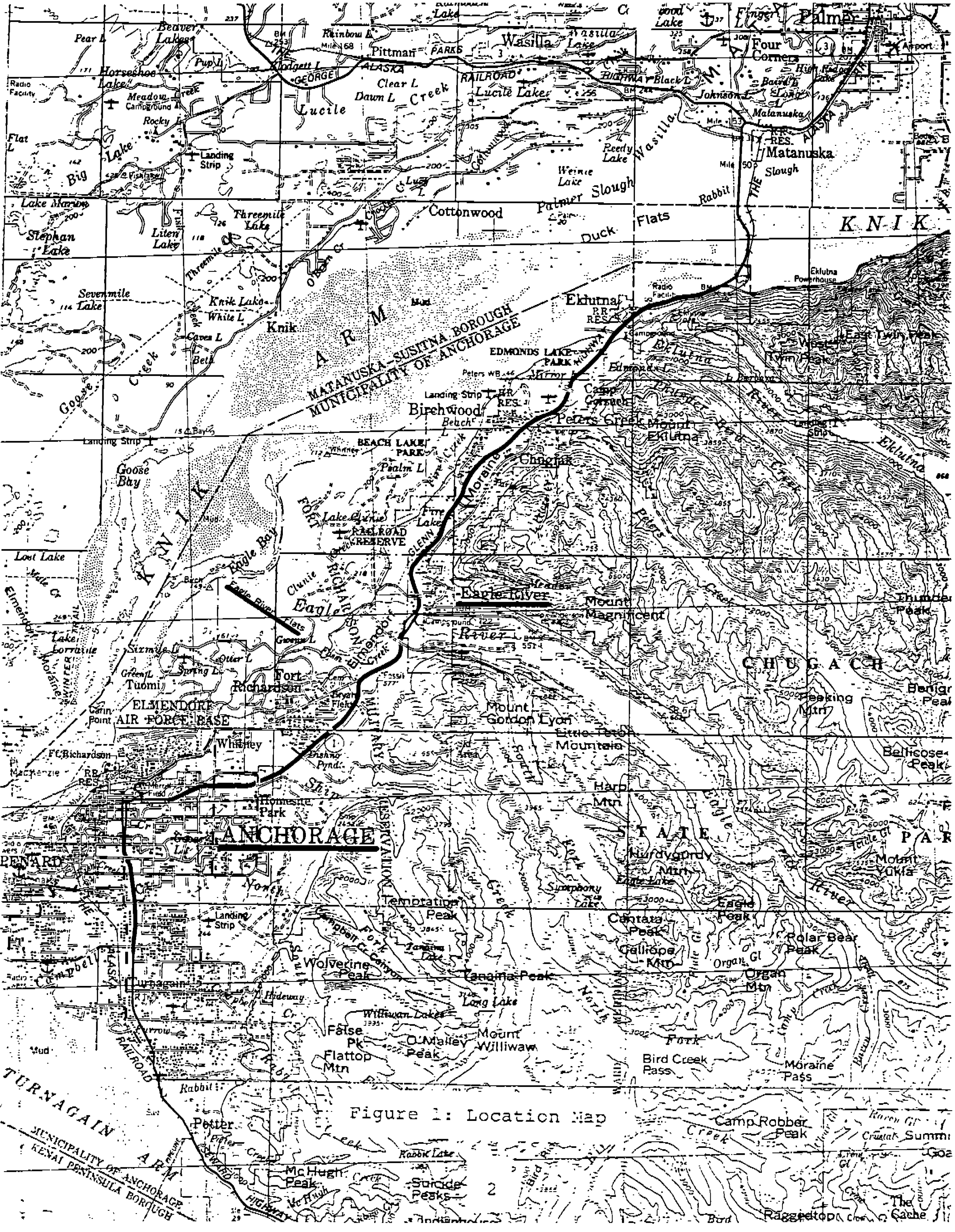

Figure 1: Location Map

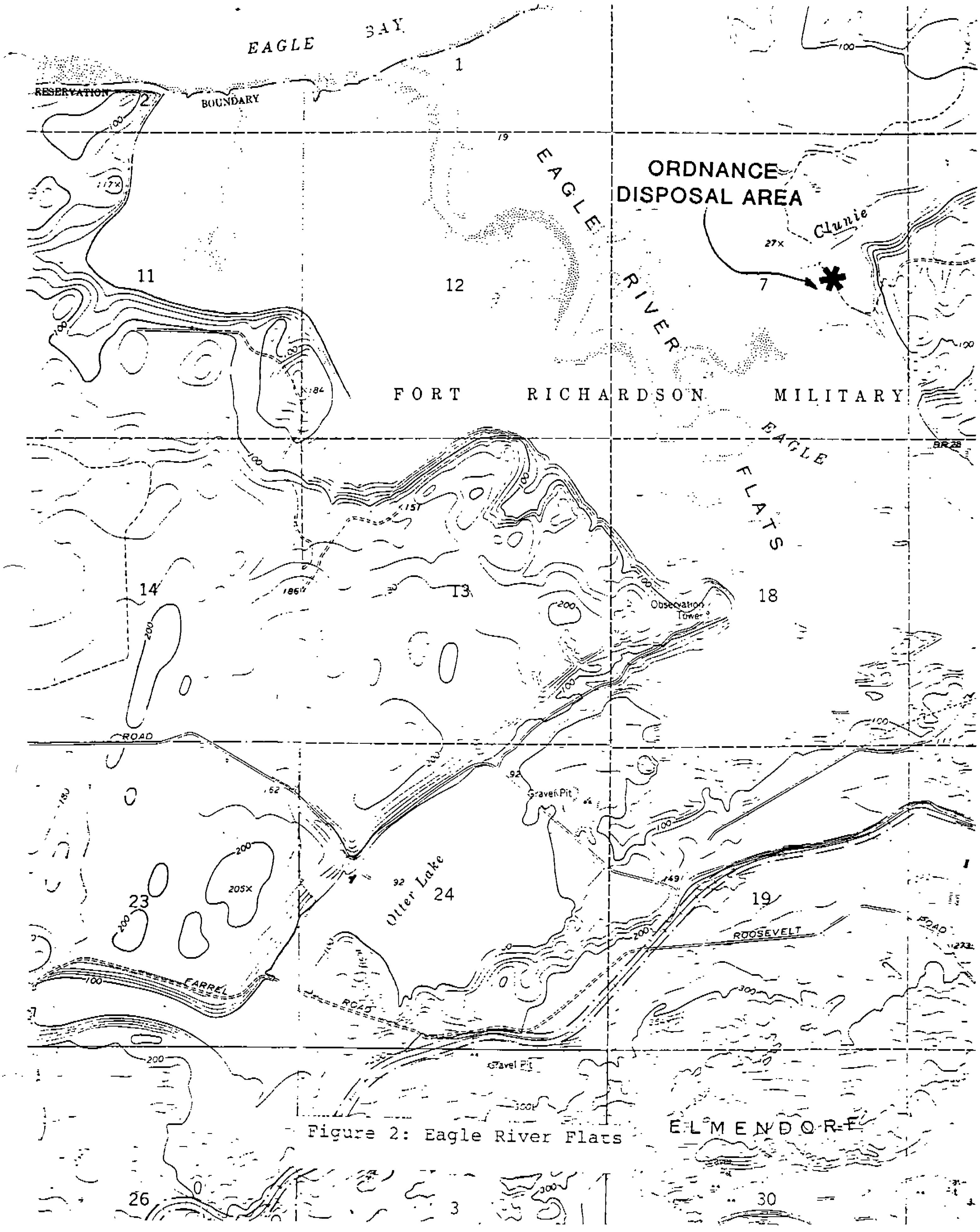

Figure 2: Eagle River Flats

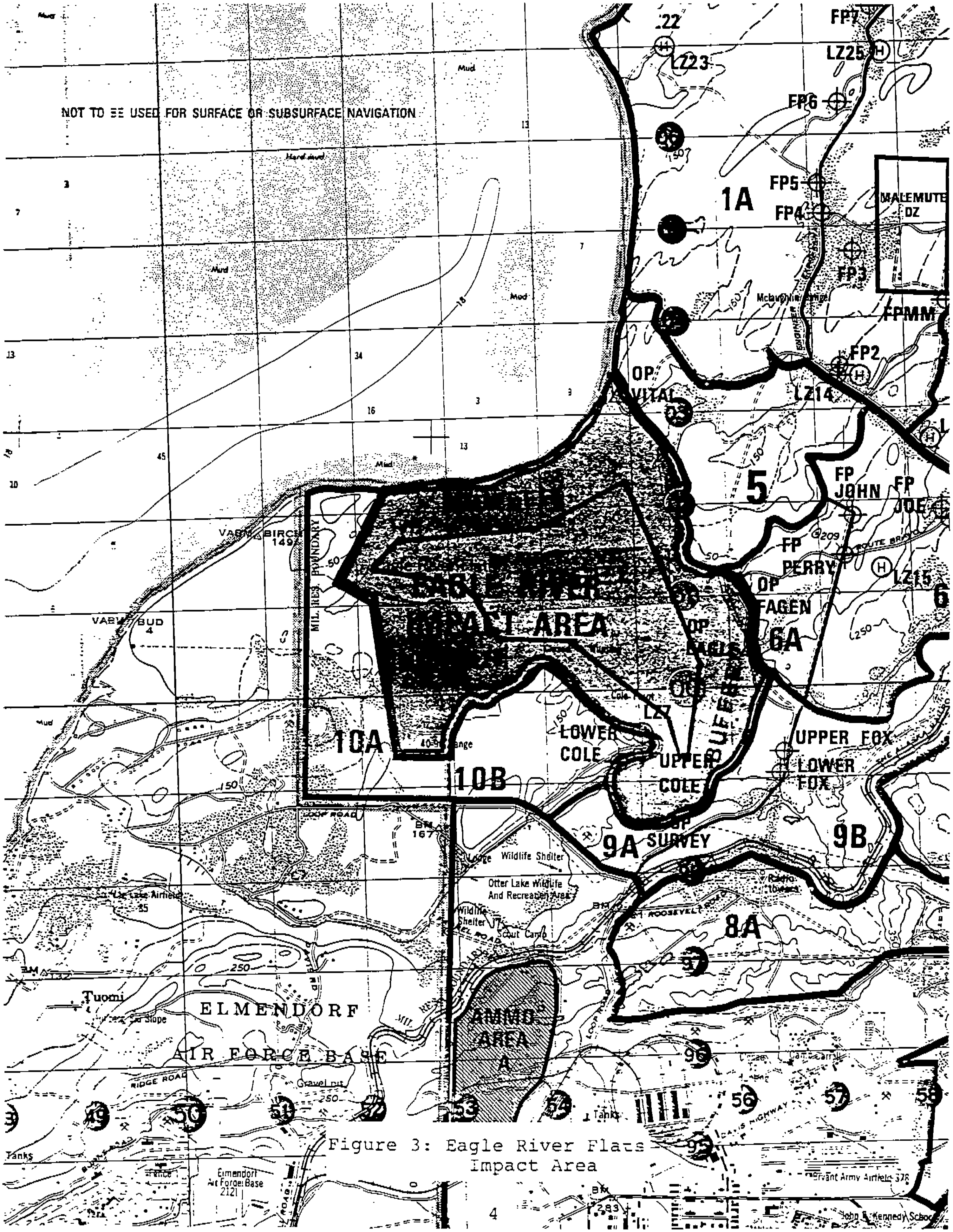

Figure 3: Eagle River Flats Impact Area

c. The 4/11th Field Artillery must conduct live-fire Division Artillery Readiness Tests (DARTS) and a battalion External Evaluation (EXTEV) annually. The Field Artillery units also require live-fire sustainment training during the summer months. These exercises include a minimum of 3 battery live-fire Field Training Exercises (FTXs), a battalion calibration/live-fire synchronization exercise, and a live-fire FTX for the conduct of all battalion and battery Army Training Evaluation Program- Mission Training Plan (ARTEP-MTP) fire missions. The 6th Infantry Division (Light) First and Second Brigade, National Guard, and other visiting units require similar scheduling of live-fire mortar training. Artillery and mortar units must conduct both day and night live-fire in order to sustain proficiency in mission-essential tasks.

d. In summary, the proposed action is the resumption of live-fire training in the Eagle River Flats Impact Area. The intensity of the proposed training activities will be on the order of the same or a slightly increased magnitude than was conducted before the firing was temporarily suspended in February 1990.

4. Alternatives

a. A wide range of alternatives were considered for the resumption of firing into the Eagle River Flats. The proposed action and the preferred alternative will balance training needs with environmental concerns. The most important environmental concerns are further contamination of the soil and water in Eagle River Flats with WP, noise disturbances to resident and migratory waterfowl and other birds using the flats, and the interference with research and remediation actions which could exacerbate the completion of this important work.

b. One alternative eliminated from consideration was that of establishing a new impact area on Fort Richardson. This was determined not to be feasible, as valuable training lands would be lost and another large area would become contaminated. In addition, there are no other lands available on Fort Richardson with ideal terrain features similar to Eagle River Flats (High ground is needed for forward observers and to immediately detect unauthorized entry into the impact area). Also, there are no other lands on Fort Richardson that would be suitable for artillery and mortar firing due to the close proximity to civilian communities in Anchorage, Eagle River, Birchwood, and Chugiak. The Environmental Impact Statement which would need to be prepared would be costly and take at least two years to complete, the task would be arduous, and the final outcome would be uncertain.

c. Alternative A. The "No Action" Alternative.

(1) If this alternative was selected as the preferred alternative for this action, firing of high explosive ordnance into the Eagle River Flats would be prohibited. This would result in permanent closure of the only impact area on Fort Richardson where artillery and mortar rounds could be fired. There would be no environmental impacts on the Eagle River Flats if the "No Action" Alternative was selected. However, environmental and socio-economic impacts could result at a new location if the troops trained elsewhere.

(2) Artillery and mortar live-fire exercises are an essential component of the 6th Infantry Division (Light) training mission. Since there is a compelling need to continue this type of training, other options to complete this training requirement would have to be pursued if the Eagle River Flats were permanently closed. The most likely option for satisfying training needs for artillery and mortar firing without using the Eagle River Flats would be for Fort Richardson units to utilize impact areas North of the Range (NOR) at Forts Wainwright or Greely. The 4/11th Field Artillery trains frequently enough that warrants a Permanent Change of Station (PCS) to Fort Greely. The cost associated with the relocation will be approximately $21.6 million with a recurring annual cost of $1.4 million (Appendix E). This includes the relocation of 453 soldiers, the hiring of 21 additional civilian employees, and the cost of renovation/ construction projects needed to support the unit. With this option, the 1st Brigade could remain at Fort Richardson, however, they would have to travel NOR four times a year (once a quarter) to maintain proficiency in mortar weaponry. Costs associated with this arrangement would be $452,000 per year (Appendix E). Shifting artillery and mortar firing from the Eagle River Flats to NOR including the PCS for the 4/11th Field Artillery to Fort Greely and the 1st Brigade travelling NOR for training four times a year would significantly diminish the importance of Fort Richardson as a prime training installation.

d. Alternative B. The Winter/Summer Firing Alternative.

(1) This alternative would provide for artillery and mortar firing into the Eagle River Flats during the period of November 1 through March 31 when ice thickness is sufficient to protect the underlying sediments and for a maximum of 14 days in July. Artillery and mortar units would conduct both day and night live-fire exercises to sustain proficiency in mission essential tasks. Maps would have to be prepared to locate environmentally sensitive areas (water bodies and other areas with high WP content in the sediments) which would be designated as "no-fire" areas for summer training exercises. Army Environmental Staff will evaluate

the ice cover to determine that the thickness is adequate to protect the underlying sediments prior to firing into the flats. Only variable or mechanical time (air burst) or point detonating super quick fuzes will be employed in the Eagle River Flats. This alternative will satisfy full training requirements for the 4/11th Field Artillery Regiment and the 1/17th Infantry at Fort Richardson.

(2) Firing into the Eagle River Flats in the winter months would result in minimal environmental impacts. Summer firing, in contrast, may result in significant environmental impacts due to WP exposure and redistribution in sediments and disturbance to waterfowl using the Eagle River Flats. Due to potential significant impacts, an Environmental Impact Statement may be required if this alternative is to be pursued.

e. Alternative C. The Winter Firing Alternative.

(1) This alternative would be similar to Alternative B. However, summer firing into the Eagle River Flats would not be authorized. This alternative would provide for the continuation of the remediation studies now being accomplished without interference and would provide for substantial training use of the Eagle River Flats in the winter months. The environmental impacts associated with this alternative would not be significant. Munition rounds containing WP will no longer be used in the Eagle River Flats. The type of munitions used in the Eagle River Flats will be limited to the ones which were previously used prior to the temporary suspension of firing in February 1990. New munitions to be used in the flats will be evaluated and/or tested by the Army prior to employment. Results of the evaluation and tests will be provided to the Eagle River Task Force for their review. Further contamination of the soil and water will not result from firing into the Eagle River Flats during the winter months when sufficient ice cover is present to protect the underlying sediments. Unexploded rounds on the ice will be retrieved and disposed of to the best of the Army's ability. CRREL will study the early winter ice development and conduct firing tests in the Eagle River Flats beginning in mid November 1991. This work will help determine the parameters from which firing can safely resume without disturbance to the underlying sediments. Disturbance to waterfowl will be avoided due to the winter firing schedule (November 1 to March 31). Most waterfowl and other birds would have departed Alaska by this time and would be safely on their wintering grounds.

(2) Live-fire sustainment training during the summer months would have to be arranged for NOR installations. The cost associated with sending the 1/17th Infantry NOR for one mortar firing exercise would be $113,000 (Appendix E). The costs associated with training the 4/11th Field Artillery NOR for 14 days in July would be $178,000. The total cost to provide summer

training which could not be completed at Fort Richardson would be $291,000. This expenditure reflects only those relocation costs that will occur while the units are travelling to and from Forts Wainwright and Greely to perform Artillery and Mortar firing.

f. Alternative D. The Unrestricted Firing Alternative.

(1) This alternative would allow for unrestricted firing into the Eagle River Flats at any time (day or night) the units need to train 365 days a year. This would result in significant environmental impacts in the Eagle River Flats. Prior to the implementation of this alternative, an environmental impact statement (EIS) would be required.

(2) Training use of the Eagle River Flats in past years was, for the most part, of the unrestricted firing nature. Exceptions to this were the restrictions employed in the past few years to cease firing into the flats when large concentrations of swans were present during the Fall migration period (October).

5. The Affected Environment

a. Physical Environment

(1) Description of the Area. Eagle River Flats is a 2,500 acre highly productive estuarine salt marsh located at the lower end of Eagle River and adjacent to Knik Arm in Upper Cook Inlet. The outflow area near the coast (Knik Arm) is about 2 miles wide and narrows gradually inland by a sharp topographic and vegetative boundary of upland spruce and birch forests. Clunie Creek flows into Eagle River Flats from the north and Otter Creek drains into the flats from the south. Many tidal sloughs from the coast on Knik Arm and from the lower terminus of Eagle River reach into the flats. Numerous shallow ponds are found scattered in the flats while other areas are vegetated with water tolerant plants rooted in waterlogged soils.

(2) Land Use. The Eagle River Flats is designated as an Impact Area. It has been used as an artillery and mortar impact area by the Army for more than 40 years and contains thousands of craters, unexploded ordnance, and targets including over 40 junked vehicles. An ordnance disposal area, which is now closed but was used for many years, borders one side of the Eagle River Flats (Figure 2). Due to unexploded ordnance in the flats, the area is potentially dangerous for people to be walking in and even more dangerous to be driving vehicles through the area. The Impact Area is closed to recreation including hunting. Signs are posted around the flats warning individuals not to enter the restricted area.

Contamination of the sediments in the flats from past use as an impact area includes propellent compounds, white phosphorus, and various metals. White Phosphorus (WP) which was in some of the munitions previously used in the Eagle River Flats is highly toxic. It was detected in some of the salt marsh sediment samples and in all waterfowl carcasses analyzed during the 1990 and 1991 waterfowl mortality investigations. Scientists have identified it as the most likely cause of the waterfowl deaths.

(3) Air Quality. Eagle River Flats is located 9 air miles north northeast of downtown Anchorage and 4 miles north northwest of the Fort Richardson Cantonment area. Both urbanized areas contribute to the air quality over Eagle River Flats. Both are located in the Cook Inlet Air Quality Control Region. Industrial expansion of the area as well as natural meteorological conditions conducive to pollutant buildup have resulted in air quality problems. A growing number of automobiles has resulted in high measured levels of carbon monoxide, while summer's period of high construction tends to lead to violations of the Federal standard for particulate levels. The meteorological conditions mentioned refer to temperature inversions combined with low winds.

(4) Airspace. The lands in the northern half of Fort Richardson (including the Eagle River Flats) are in a Special Use Air Space Area controlled by the Federal Aviation Administration (FAA). When artillery or mortar firing into the flats is active, the restricted airspace is termed "hot" and is closed to all civilian aircraft. Only when FAA provides information that the area is "cold" can civilian aircraft enter and use the airspace.

(5) Noise. Exploding munitions in the Eagle River Flats causes loud noises and shock waves. Under certain weather conditions sounds are amplified so that exploding ordnance can disturb civilian residents in Eagle River, Birchwood, Chugiak, and Anchorage. Noise from exploding munitions can also affect wildlife using the Eagle River Flats. Birds react by flying out of the Eagle River Flats or move to quieter environs within the flats. Large mammals usually move out of the flats into adjacent forested areas to escape the noise.

(6) Climate. Climate in the Eagle River Flats area is transitional between continental of interior Alaska and maritime of coastal Alaska (Hartman and Johnson, 1984). Transitional climate has less cloudiness, lower precipitation and humidity, and more pronounced temperature variations throughout the day and year than maritime climate. Annual precipitation averages about 15 inches per year. Snowfall accumulation averages about 66 inches per year. The heaviest precipitation occurs as rain in July and August. Winds

are usually light except when Chinook winds blow over the Chugach Mountains from the southeast. The average daily temperatures in the summer (June-August) range from 48 to 66 degrees F (Selkregg, 1975). During the winter months (October-March) the average daily temperatures range between 4 and 42 degrees F. Highest temperature on record is 86 degrees F in 1969; the lowest is -43 degrees F in 1947. Long term weather records for Fort Richardson are available.

(7) Hydrology of Eagle River. Eagle River flows nearly 40 miles through a narrow valley bordered by high mountains in the Chugach Range and empties into Eagle Bay on Knik Arm. The Eagle River Watershed comprises approximately 192 square miles. Eagle Glacier at the head of Eagle River forms the upper reaches of the watershed at over 5,500 feet above sea level. The glacier covers over 10% of the Eagle River watershed area and contributes large quantities of water and silt to the drainage in summer when the glacier is melting. The average flow rate of Eagle River during the period 1965 to 1981 was 519 cu.ft./second (USGS, 1970-1982). The maximum average discharge occurs in July and August and is associated with glacial melt. The average July and August discharges are greater than 1,500 cu.ft./second with peak discharges averaging greater than 2,300 cu.ft./second. Occasional peak discharges occur where greater than 3,700 cu.ft./second have been recorded. These high peak discharges are usually associated with maximum glacial melt (high ambient temperatures) and large rain storms.

(8) Tidal Influences in the Eagle River Flats.

(a) Cook Inlet and Knik Arm are subject to large semidiurnal tidal fluctuations with high tides ranging from 30 to 36 feet. These large tides have a profound effect on Eagle River Flats. Tidal inundation of the Flats involves both the rise in the tide in Knik Arm and overflow from Eagle River as it meets the rising tide. A high tide of 32.4 feet on May 25, 1990 covered the entire flats before receding (CRREL Report, 1991). Fluctuations in the water levels in the ponds in the Eagle River Flats is greatly influenced by high tide above 30 feet. Most of the water flooding the ponds was fresh water from Eagle River rather than salt water from Knik Arm (CRREL Report, 1991).

(b) In the early winter the ponds and other water bodies in the flats freeze over. Freeze-up usually begins in early October and by March a layer of ice up to 30 inches covers the flats. Snow covers the ice throughout the winter, however, often the ice is bare of snow after periods of warm weather or when water inundates the flats during high tides in Knik Arm.

(9) <u>Geology and soils in the Eagle River Flats</u>. The Eagle River Flats contains large deposits of fine sediments from the glacially fed Eagle River. Each time the high tide from Knik Arm holds up Eagle River from draining into the Arm, the river floods and deposits another layer of glacial fines into the flats. Samples taken in 1990 showed that these deposits were high in silt (52-85%) and clay (13-47%) and predominately low (less than 3%) in sand (CRREL Report, 1991). The pH of these soils ranged from 7 to 8. The reduction and oxidation potentials measured in these soils showed them to be in a highly reduced (waterlogged) state (CRREL Report, 1991).

b. Biological Environment

(1) <u>Vegetation</u>.

(a) The salt marshes of Eagle River Flats are almost completely vegetated with grasses, sedges, bulrushes, sweet gale, and aquatic plants. Exceptions are the mud flats near Knik Arm, the natural levees adjacent to Eagle River and the deeper ponds. Salt marshes contain vegetation zones related to gradients in elevation and the resulting differences in frequency and depth of flooding, salinity, drainage and rates and depths of sediment deposition (CRREL Report, 1991). The zonation types and plant communities have been identified by the CRREL Research Team in 1990 (Appendix F).

(b) Visual observations show that vegetation in the Eagle River Flats is more diverse and lush that what is found in surrounding tidal marshes (CRREL, 1991). This could be the result of increased fertility of the soil due to added nitrates and phosphates from munition residues.

(2) <u>Wildlife</u>.

(a) The intertidal vegetated wetlands (salt marsh) with ponds and other water bodies in the Eagle River Flats is an important spring and fall waterfowl staging area in upper Cook Inlet. The spring waterfowl migration begins in the Eagle River Flats in early to mid April and most migrants or local nesters disperse to nesting grounds by mid to late May. The fall migration through the Flats begins in mid-August and ends at freeze-up time in October. Waterfowl species observed in the flats include both the trumpeter and the tundra swan; three species of geese, including Canada, white-fronted, and snow; and 14 species of ducks, mostly dabblers, including mallard, northern pintail, canvasback, American wigeon, ring-necked, gadwall, redhead, blue-winged teal, green-winged teal, northern shoveler, greater scaup, goldeneye, bufflehead, and merganser. Other waterbirds that use this habitat include the sandhill crane, arctic tern, common snipe, several species of shorebirds (sandpiper, plover, dowitcher, yellow legs, phalaropes), and gulls (Glaucous-winged, Herring, Mew, Bonaparte's). Raptors found in the flats include the bald eagle, red-tailed hawk, goshawk, marsh hawk, merlin and occasionally the peregrine falcon (transient). In addition, ravens are frequently seen in the flats. Although Eagle River Flats is more important as a staging area for waterfowl, some birds nest and rear their young here. These birds include ducks, cranes, gulls, and shorebirds.

(b) Biologists from the U.S. Fish and Wildlife Service and the U.S. Army have conducted aerial waterbird surveys by fixed-wing aircraft in the Eagle River Flats during the past several years. The 1990 surveys were the most comprehensive to date and results have been summarized in a report by the U.S. Fish and Wildlife Service (Appendix G). While the surveys do not provide comprehensive data on the total number of birds that utilize the Eagle River Flats, peak numbers counted during these surveys provide the best information that is available. During 1990, peak surveys showed as many as 1,460 swans (trumpeter and tundra swans can not be distinguished from the air), 2,450 geese, 2,355 ducks, 27 bald eagles, 52 sandhill cranes, 140 common raven, approximately 150 gulls, and several thousand shorebirds using the Eagle River Flats. The fall migration through the flats is more important than is the spring as much greater numbers of waterfowl use the flats at that time of the year.

(c) Mammals also use Eagle River Flats. Moose are commonly observed feeding on the edge of the Eagle River Flats in the summer. Black bear are occasionally observed in the Eagle River Flats in the summer. Smaller mammals which utilize the flats include beaver, muskrat, mink, weasel, wolverine, coyote, red fox, lynx, and numerous rodents. In addition to the land mammals utilizing Eagle River Flats, small pods of Beluga whales have been observed numerous times during the summer months and early Fall immediately off the coast of the Eagle River Flats in Knik Arm and in the river several hundred yards upstream from Knik Arm.

(d) Eagle River has a small natural run of king (300-500) and red salmon which pass through the Eagle River Flats on the way to their spawning grounds in small clear tributaries in the North and South Forks of Eagle River (Roth, 1991). Dolley Varden trout are also found in Eagle River. A king salmon sport fishery has been established on Eagle River. Alaska Department of Fish and Game released 100,000 king salmon fingerlings in Eagle River near the Chugach State Park Visitors Center in summer 1990. In 1992 and 1993 some of these fish will return from salt water. A run of kings consisting of about 3,000 adults would be expected to enter Eagle River in 1994 and each year thereafter. Fingerlings will continue to be planted in Eagle River on a yearly basis to perpetuate the runs. These kings would be used for sport fishing between the bridge on the Glenn Highway and the Eagle River Visitors Center within Chugach State Park.

(e) The lower end of Eagle River as it passes through the Eagle River Flats supports limited rearing activity for salmon and resident Dolley Varden (Roth, 1991). It is primarily a migration corridor through which adult salmon move in (June through September) and juvenile salmon move out (mid April through June).

(f) Endangered Species. Resident threatened or endangered (T/E) species are not known to occur on Fort Richardson (Garrett, 1991). Probability of occurrence of T/E species is low due to the lack of prime habitat, nesting sites, and migration corridors.

c. Historic and Cultural Environment. There are no known archaeological sites or historical structures in the Eagle River Flats.

d. Socioeconomic Environment.

(1) Mission. The Army's presence in Alaska is represented by the 6th Infantry Division (Light) and U.S. Army, Garrison, Alaska. The Division is headquartered at Fort Wainwright, Alaska whereas the Garrison is headquartered at Fort Richardson, Alaska. The Garrison is tasked with performing the operational functions for the Division. The Division is prepared to provide combat ready forces to deploy worldwide in support of the United States national interests and objectives. Additionally, the mission of the Division is to defend the State of Alaska.

(2) Population. The current number of military personnel assigned to Fort Richardson, Alaska is 4,460 (Nakata, 1991). Family members (dependents) associated with military personnel number 5,800. Civilians who work on Fort Richardson number 1,680. The number of personnel including military, family members and civilians living and working on Fort Richardson total 11,940. Fort Richardson also provides support services for a total of 4,182 military retirees in the Anchorage and southcentral Alaska area.

6. Environmental Consequences

a. Probable Effects of Implementing Alternative A, the "No Action" Alternative. The permanent closure of the Eagle River Flats Impact Area for firing would result in no additional environmental impacts on these lands. However, significant socioeconomic impacts on Fort Richardson and Anchorage may arise from training units making a permanent change of station (PCS) to Forts Wainwright or Greely. In addition, if training shifted from the Eagle River Flats to Fort Greely, additional environmental effects on these lands would occur. Although a complete analysis of the impacts on Fort Greely will not be presented in this document, significant impacts to the physical, biological, historic, and socioeconomic environment at Fort Greely would not be expected to occur.

b. Probable Effects of Implementing Alternative B, the Winter/Summer Firing Alternative.

(1) Physical Components

(a) Air.

1. Air contaminants anticipated are smoke emissions over the Eagle River Flats from exploding munitions, smoke rounds, and illumination flares. Exploding munitions include mortars and artillery fire. Mortars of 60 and 81mm in size leave a negligible smoke emission upon detonation (Explosive Ordnance Disposal Detachment, 1991). Fumes consist principally of carbon dioxide, carbon monoxide, nitrogen oxides, steam, methylene, and pulverized metal. The smoke cloud dissipates in less than 60 seconds depending on local weather conditions. Artillery rounds would produce similar type smoke emissions upon detonation. The size of the cloud would be double the size of the mortar round.

2. About 10% of the artillery rounds fired into the flats would be loaded with canisters of HC smoke (High Concentrate). The canisters contain a mixture of aluminum, zinc oxide, and hexachloroethene. The HC smoke round burns in 40-90 seconds and produces a smoke cloud of approximately 30 cubic yards in size. The smoke cloud persists for up to 1 hour depending on weather conditions. Illumination flares are also used in the Eagle River Flats. They contain a magnesium illumination candle which produces a small smoke cloud of magnesium oxide.

3. These smoke emissions would not be expected to cause significant adverse affects on the overall air quality of the Eagle River Flats area nor would they be expected to cause harm to wildlife in the area.

(b) Land Use. Resumption of firing into the Eagle River Flats when the ground is unfrozen will result in adding hundreds of new craters and unexploded ordnance (UXOs) to the impact area.

(c) Soil and Water. Firing into the Eagle River Flats when the ground is not frozen and the ice cover is not sufficiently thick to prevent the penetration of munition rounds into the soil will result in further contamination of soil and water with WP (Appendix H). The exploding rounds will expose and redistribute buried WP particles on the soil surface and in water bodies. Those exposed WP particles become a new source of poisoning for waterfowl using the Eagle River Flats. Artillery shells fired into the flats also may come into contact with a WP containing UXOs which would explode and release another source of WP contamination into the flats.Treatment to cap or cover contaminated sediments to remediate the WP problem could also be destroyed by firing into the flats when there is no protective layer over the soil surface. Training in the flats could also damage or destroy other remediation test efforts. A mitigation measure for summer firing which may result in limiting contamination in the flats is to fire into areas where the WP concentrations are lowest or absent. The feasibility of spatial placement of munition rounds in the flats will be addressed after the WP concentration contours for the flats become available. Firing into the Eagle River Flats under the above described conditions would result in further contamination of Eagle River Flats with WP and the subsequent increase in waterfowl deaths as a direct result. This additional contamination of the flats would most probably be considered a significant impact.

(d) Noise. The most important noise impacts will be exploding munitions in the Eagle River Flats. Under certain weather conditions, sounds are amplified so that exploding ordnance can be heard in Eagle River and Anchorage civilian communities. Noise from exploding munitions can also affect wildlife using the flats. Birds have been witnessed to leave the area or seek less disturbing places in the flats during firing activities. Larger sized mammals move into the forested areas adjacent to the Eagle River Flats when noise from exploding munitions become too intense. Under certain conditions, noise from artillery and mortar training could cause significant impacts to resident and migratory waterfowl using the Eagle River Flats. Noise impacts on civilian communities near the Eagle River Flats would not be expected to be significant.

(2) Biological Components

(a) Vegetation. Artillery and mortar rounds fired into the flats at the time the soils are unprotected by frozen ground will continue to create craters. The formation of craters results in destruction of vegetation. Winter firing into the flats would protect the dormant vegetation underneath the ice cover.

(b) Waterbird use in the Eagle River Flats. Summer firing could exacerbate the current waterfowl mortality problem and disrupt resident and migratory waterbirds using the Eagle River Flats. Resident waterbirds nest in the Eagle River Flats. Migratory waterfowl and shorebirds use the Eagle River Flats as a staging area on their long journey from their wintering grounds hundreds of miles to the south to their nesting grounds in Alaska and other far northern locations. Resting and feeding at this critical time is necessary so that the birds can continue their migration to their nesting grounds.

(c) Mammals. Studies have not been conducted in the Eagle River Flats to determine the effects of the contaminated environment on mammals. Studies also have not been conducted to determine the effects of firing in the Eagle River Flats on the disturbance to mammals. Observations over the years show that the Eagle River Flats and adjacent areas provide habitat for a wide variety of large and small mammals. At this time, there is no actual or suspected evidence that leads one to surmise that mammals using the Eagle River Flats are adversely affected from contaminants or by disturbance factors.

(d) Fish. Fish surveys have not been conducted in the lower part of Eagle River (Roth, 1991). This area is thought to be primarily a migration corridor through which adults move in (June through September) and juvenile salmon move out (May through June). The runs of natural and planted king salmon stocks in Eagle River have been closely monitored in the past few years and there are no indications that any problems exist (Roth, 1991). This supports the conclusion that adult and juvenile king salmon stocks are little affected by contamination in lower Eagle River.

(3) Historic and Cultural Components. No archaeological or historic structures have been identified or are known to exist in the Eagle River Flats.

(4) Socioeconomic Components.

(a) Training Needs. Resuming the firing into the Eagle River Flats will provide for the critical artillery and mortar training needed on Fort Richardson. Troops will no longer be denied a training area or have to travel North of the Alaska Range (Forts Wainwright of Greely) to obtain live-fire training. This will help to stabilize and establish Fort Richardson once again as a prime training installation.

(b) Human Health Risks. There has been some concern regarding human health risks for consumption of fish and waterfowl which utilize the Eagle River Flats for all or a part of their life cycles. Salmon which use the lower Eagle River as a migration corridor would not likely be affected by contaminants that may be present. It is not considered to be a rearing area and adults do not feed when moving up spawning rivers. Preliminary investigations conducted by the U.S. Army Environmental Hygiene Agency have concluded that potential health risks associated with consuming waterfowl taken in areas near the Eagle River Flats are minimal (Appendix I). Dr. Middaugh, State Epidemiologist, concluded in a letter dated 28, 1991 on this subject that "the potential for any adverse health effect to a hunter or person consuming waterfowl obtained by hunters is extremely low" (Appendix J). Nevertheless, common sense precautions by duck hunters and others consuming ducks in the upper Cook Inlet should be followed-- don't consume sick waterfowl or waterfowl found dead.

c. Probable Effects of Implementing Alternative C, the Winter Firing Alternative.

(1) Physical Components.

(a) Air. The probable affects would be very similar to the impacts discussed in Alternative B, the Winter/Summer Firing Alternative. These effects are minimal and would not be expected to be significant impacts affecting air quality in the Eagle River Flats.

(b) Soil and Water. Firing into the Eagle River Flats in winter when the ground is frozen and a sufficient ice cover is present to protect the underlying sediments would prevent the exposure and redistribution of buried WP in the Eagle River Flats. In addition, it would cause little if any disturbance to any remediation efforts. Artillery shells would not be likely to set off buried UXOs and further contaminate the Eagle River Flats. Firing into the flats in the winter would result in adding UXOs to the impact area. However, these "duds" will be located and disposed of to the best of the Army's ability. The cumulative effects of reducing the ice thickness by bombardment would have little impact on protecting underlying sediments due to frequent flooding and refreezing in the flats and also considering that the sediments, even without an ice cover, remain frozen throughout the winter. Winter firing in the flats under the conditions described above would do little to further contaminate the Eagle River Flats. Therefore, the firing under winter conditions would not result in significant impacts by further WP contamination, destruction to remediation treatments, or by adding numerous UXOs to the Eagle River Flats.

(c) Noise. Noise effects would be similar to those described in Alternative B, the Winter/Summer Firing Alternative. To minimize noise impacts on civilian communities in Anchorage, Eagle River, Chugiak, and Birchwood, the Army will make public service announcements in local newspapers of all artillery live-fire exercises of battalion size or larger prior to the firing taking place. Birds and animals will have to move to quieter areas while the training is taking place. Impacts from noise while firing into the Eagle River Flats will not cause significant impacts on nearby civilian communities or on wildlife using the Eagle River Flats.

(2) Biological Components.

(a) Vegetation. The frozen soils and ice layer over the Eagle River Flats would protect the underlying vegetation. Little if any impact on vegetation would occur.

(b) Waterbird use in the Eagle River Flats. Winter firing would have little effect on bird use in the Eagle River Flats as most birds would have long since migrated out of the area. However, there would be a small number of bald eagles (perhaps less than 10) and ravens using the Eagle River Flats in winter. There also could be a few mallards using the flats in winter. These birds would be expected to temporarily move out of the flats to more quieter environs. Winter firing would not cause significant impacts on bird use in the Eagle River Flats.

(c) Mammals. Studies have not been conducted to evaluate noise disturbances from firing on mammalian use in the Eagle River Flats. However, the large number of mammalian species present and apparent abundance indicate that conditions exist in which they can survive and continue to live in the area. Winter firing would not expect to cause significant impacts on the mammals living in or adjacent to the Eagle River Flats.

(d) Fish. Firing into the Eagle River Flats in winter would have little impact on fish using Eagle River. Adult or juvenile fish would not be expected to be in lower Eagle River during the winter months even though the lower part of the river remains open due to tidal action. Winter firing would not cause significant impacts to adult or juvenile fish in Eagle River.

(3) Historic and Cultural Components. No archaeological or historic structures have been identified or are known to exist in the Eagle River Flats. Therefore, significant impacts would not be anticipated.

(4) Socioeconomic Components.

(a) Artillery and Mortar Training. Using Eagle River Flats in the winter months will provide for the bulk of the artillery and mortar training needed by soldiers at Fort Richardson. This will help to stabilize and establish Fort Richardson once again as a prime training installation.

(b) Human Health Risks. The human health risks of Alternative C, the Winter Firing Alternative, would be less than what was described for Alternative B, the Winter/Summer Firing Alternative. This would be due to less chance of further contamination of the soil and water with WP which could result in increased waterfowl deaths. In addition, there would be less chance of exploding munitions contaminating the soil with chemical residues which could move into Eagle River and contaminate fish. Although winter firing would not be expected to cause significant human health risks, it is recommended that additional monitoring of this potential problem be carried out and that a common sense approach be kept in mind when consuming ducks in upper Cook Inlet.

(c) Socioeconomic Impacts. As discussed above, there would be no significant socioeconomic impacts with implementing the Winter Firing Alternative.

d. Probable Effects of Implementing Alternative D, the Unrestrictive Firing Alternative.

(1) Physical Components.

(a) Air. The probable impacts of unrestrictive firing in the Eagle River Flats would be similar to the impacts described in Alternative B, the Winter/Summer Firing Alternative. These impacts are minimal as the small smoke clouds that form with exploding munitions dissipate in 30-60 seconds. HC smoke rounds would persist longer (up to 60 minutes) but would not be expected to cause harm to birds or other wildlife using the flats.

(b) Soil and Water. Based on past unrestricted artillery and mortar use of the Eagle River Flats, more than half of the firing took place when the soils were unfrozen and in the absence of an ice layer. Impacts of firing under these conditions would further contaminate the soil and water with WP. The exploding rounds will expose and redistribute buried WP particles over the flats and in water bodies. Significant impacts to soil and water contamination would result if unrestrictive firing took place.

(c) Noise. Noise impacts of unrestrictive firing in the Eagle River Flats would be more of a problem than noise impacts from winter firing alone. This is due to a greater number of training exercises which would be held during the summer months when people and wildlife are more active. Noise impacts would increase under the unrestrictive firing alternative and may cause significant impacts on the resident and migratory waterbirds using the flats in the summer months.

(2) Biological Components

(a) Vegetation. Vegetation loss would be primarily to cratering which results from exploding ordnance fired into the flats when the soils are unfrozen. The release of primary plant nutrients (nitrogen and phosphorus) into the Eagle River Flats would be beneficial in increasing biomass and plant species diversity.

(b) Waterbird use in the Eagle River Flats. The impacts on waterbirds to unrestricted firing into the Eagle River flats would be similar to Alternative B, the Winter/Summer Firing Alternative. Due to the critical point in the waterbirds life cycle, significant impacts would likely occur.

(c) Mammals. Unrestrictive firing would impact the mammals using the Eagle River Flats to a greater degree than would Alternative C, the Winter Firing Alternative. This is due to summer firing use of the flats when animals are more active and raising their young. The increased impacts associated with unrestricted firing would not be expected to cause significant impacts on the animals in Eagle River Flats.

(d) Fish. Unrestrictive firing into the Eagle River Flats may cause slightly more impacts on fish using Eagle River than Alternative C, the Winter Firing Alternative. This would be due to the firing in the flats when the ground is unprotected (unfrozen and without ice cover). Possible contamination under these conditions could enter Eagle River and cause harm to fish. However, the monitoring of Eagle River king salmon runs in past years when unrestricted firing in the Eagle River Flats was taking place showed healthy fish and sustained uniform runs. Unrestricted firing in the Eagle River Flats would not be expected to cause significant impacts on fish in Eagle River.

(3) Historic and Cultural Components. No archaeological or historic structures have been identified or are known to exist in the Eagle River Flats.

(4) Socioeconomic Components

(a) Artillery and Mortar Training. Unrestricted use of the Eagle River Flats will provide for artillery and mortar training needed by soldiers at Fort Richardson. This will help stabilize and establish Fort Richardson once again as a prime training installation.

(b) Human Health Risks. The probable human health risks of unrestricted firing into the Eagle River Flats would be very similar to the risks discussed in Alternative B, the Winter/Summer Firing Alternative. Significant human health risks from the unrestricted firing alternative would not be expected to result.

7. Public and Agency Participation

a. A draft copy of the Public Notice, Finding of No Significant Impact (FONSI), and Environmental Assessment (EA) for the resumption of live-fire training in the Eagle River Flats Impact Area on Fort Richardson, Alaska was provided to the Eagle River Flats Task Force on October 18, 1991 (Appendix K). Task Force members presented oral comments to the Army in a special meeting held on October 21, 1991. In the latter part of October, the Army received written comments on the draft environmental documents from all agencies on the Task Force (with the exception of the Environmental Protection Agency), from U.S. Army Cold Regions Research and Engineering Laboratory, and from U.S. Army, Pacific (Appendix L). U.S. Army Toxic and Hazardous Materials Agency presented oral comments. This input was the basis for major changes to the environmental documents. The EA was revised and additional basic information was added to make the documents more comprehensive. This final draft was made available to a host of agencies and the public for their review and comment.

b. Public notices for the availability of the environmental documents were published in the Anchorage Daily News, The Anchorage Times, the Chugiak-Eagle River Star, and the Frontiersman/Valley Sun during the first part of November 1991 (Appendix M). The local news media requested copies of the environmental documents and after reviewing them wrote several newspaper articles (Appendix N). Individuals interested in obtaining further information were directed to the Fort Richardson Media Relations Officer. Written comments on this action were received in the Fort Richardson Public Affair Office during a 30 day period which ended on the 6th of December 1991. Due to delays in printing the draft environmental documents, the public comment period was extended to the 20th of December 1991. More than 60 copies of the documents were mailed or hand carried to potentially affected or interested individuals, organizations, and agencies so that they could have the opportunity to participate in the review and development of the documents prior to implementing the action (Appendix O). A Public Meeting was held on November 26, 1991 at the Chugiak High School Cafeteria to obtain public input (Appendix P).

c. The Fort Richardson Public Affairs Office (PAO) was the Point of Contact for all individuals, organizations and agencies concerning the environmental documents on this subject. Several calls were made to the PAO requesting copies of the documents or asking questions concerning the action. Only one person from the public attended the Public Meeting held at Chugiak High School Cafeteria on Tuesday November 26, 1991 at 7 PM (Appendix P). This person had no prepared questions or comments other than he supported the Army's proposal to resume firing in the Eagle River Flats. The only other input on these documents were three letters from environmental organizations which were faxed to the Fort Richardson Public Affairs Office on December 20, 1991 (Appendix Q).

d. Army response to the letters from the Alaska Center for the Environment, the National Audubon Society, and the Sierra Club Legal Defense Fund, Inc. are found in Appendices R,S,and T, respectively.

8. Summary.

a. The environmental effects of resuming artillery and mortar firing into the Eagle River Flats were assessed. Potential significant environmental impacts found in one or more of the alternatives discussed in this assessment include the following: (1) Further contamination of Eagle River Flats by the use of munitions containing WP, (2) Further contamination of soil and water in Eagle River Flats by firing munitions into the impact area when the soil is unprotected by frozen ground and ice cover, (3) Noise disturbances to resident and migratory waterfowl using the Eagle River Flats, and (4) Interference with research and remediation treatments which could exacerbate the completion of the work.

b. Alternatives to the proposed action were thoroughly investigated and Alternative C (the Winter Firing Alternative) was selected as the Army's preferred alternative for implementation. The Winter Firing Alternative, when sufficient ice cover is present to protect the underlying sediments, is the best option and solution to the Army's requirement to train its soldiers. After remedial investigative studies and measures are complete, the potential for resumption of summer firing will be reevaluated in a separate environmental document.

c. Further contamination of soil and water with WP will be eliminated by not using WP in munition rounds fired into the Eagle River Flats. Further contamination of soil and water with WP when the soil is unprotected will be prevented by firing into the flats only in the winter months when the ground is frozen and sufficient ice cover is present. To minimize artillery and mortar rounds from penetrating the ice layer and exposing and redistributing WP, only variable or mechanical time (air burst) or point detonating super quick fuzes will be employed in the Eagle River Flats. The complete moratorium on firing into the Eagle River Flats during the time the soils are thawed (April through October) will reduce the disturbance to migratory and resident waterfowl using the Eagle River Flats to very low and insignificant levels. Winter firing in the flats will allow the waterfowl mortality studies and remediation work to continue uninterrupted in summer. Noise disturbances to waterfowl associated with firing into the Eagle River Flats will be greatly minimized by reducing the maximum number of months each year firing will take place (November through March- 5 months). This is the time of year when most migratory waterfowl and shore birds have migrated out of Alaska and are on their wintering grounds. Research and remediation scientists will closely coordinate work to be accomplished in the Eagle River Flats with the Fort Richardson Range Control Office. The Range Control Office will be responsible to fit the work into the training schedule in such a manner as not to cause unnecessary delays in getting the work completed.

d. U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) has identified White Phosphorus (WP) found in sediments in the ponds in the flats as the most likely cause of the waterfowl mortality problem. CRREL has surmised that WP is stored indefinitely in the sediments of Eagle River Flats and it will continue to be a hazard to waterfowl even without additional inputs of WP. Continuing research by CRREL in 1991 will determine the WP distribution in sediments (both vertical and horizontal), the particle size of the contaminant, and the concentration contours in the flats. The final action will be to remediate WP in the Eagle River Flats so that the waterfowl mortality problem can be greatly reduced or ceases to be a problem. The Army will continue to insure adequate funding to carry out the necessary research to solve the problem.

e. Public comments on the draft EA are discussed in detail in Appendices R, S, and T. The major points raised by all three of the environmental groups were that inadequate treatment was given to the known sediment contamination problem and that significant impacts would result if live-fire training resumed in the Eagle River Flats. The sediment contamination problem is a separate matter being handled by the U.S. Army Toxic and Hazardous Materials Agency. Specific procedures for remediation of the Eagle River flats cannot be determined at this time. Remediation methods are extremely important to all Eagle River Task Force members, including the Army, and are a goal to be accomplished at the end of the on-going investigation. Questions and comments concerning the contamination problem should be addressed to the Eagle River Interagency Task Force. Significant impacts will not occur when firing into the flats resumes due to the Army's selection of the winter firing alternative which includes specific ice and frozen ground parameters that will protect the underlying sediments.

f. In conclusion, the preferred alternative (Alternative C, the "Winter Firing Alternative") with mitigation measures, as discussed in the body of this assessment, will not cause significant direct or indirect impacts on the environment, the wildlife, or the local human population and, therefore, a Finding of No Significant Impact (FONSI) will be prepared.

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APPENDICES

APPENDIX A - A SUMMARY IN CHRONOLOGICAL ORDER OF THE EAGLE RIVER FLATS WATERFOWL MORTALITY INVESTIGATION

APPENDIX B - PRESS RELEASE, EAGLE RIVER FLATS, FEBRUARY 21, 1991, 6TH INFANTRY DIVISION (LIGHT)

APPENDIX C - LOCAL NEWSPAPER ARTICLES ON EAGLE RIVER FLATS

APPENDIX D - PRESS RELEASE AND NEWSPAPER ARTICLES ON THE CONTINUATION OF STUDIES IN THE EAGLE RIVER FLATS, ALASKA; SEPTEMBER 1991

APPENDIX E - COST ANALYSIS FOR FIRING OPTIONS IN THE EAGLE RIVER FLATS

APPENDIX F - VEGETATION ZONES AND PLANT COMMUNITIES; EAGLE RIVER FLATS

APPENDIX G - WATERBIRD SURVEY/REPORT; U.S. FISH AND WILDLIFE SERVICE

APPENDIX H - ARTILLERY TEST FIRING IN RELATIONSHIP TO PROTECTION OF THE UNDERLYING SEDIMENTS IN THE EAGLE RIVER FLATS

APPENDIX I - HUMAN HEALTH RISKS FROM CONSUMING CONTAMINATED WATERFOWL FROM THE EAGLE RIVER FLATS

APPENDIX J - LETTER FROM STATE EPIDEMIOLOGIST WITH CONCLUSIONS ABOUT HUMAN HEALTH HAZARDS RELATED TO POSSIBLE INGESTION OF ELEMENTAL PHOSPHORUS IN DUCK TISSUE

APPENDIX K - LETTER ACCOMPANYING DRAFT ENVIRONMENTAL DOCUMENTS PROVIDED TO THE EAGLE RIVER FLATS TASK FORCE AND A LIST OF TASK FORCE ATTENDEES AT A MEETING HELD ON OCTOBER 21, 1991

APPENDIX L - EAGLE RIVER TASK FORCE AND DEPARTMENT OF DEFENSE COMMENTS ON DRAFT ENVIRONMENTAL DOCUMENTS FOR RESUMPTION OF FIRING IN THE EAGLE RIVER FLATS IMPACT AREA

APPENDIX M - PUBLIC NOTICE ANNOUNCEMENTS FOR THE AVAILABILITY OF ENVIRONMENTAL DOCUMENTS FOR THE RESUMPTION OF LIVE-FIRE TRAINING IN THE EAGLE RIVER FLATS

APPENDIX N - NEWSPAPER ARTICLES ON ENVIRONMENTAL DOCUMENTS FOR THE RESUMPTION OF LIVE-FIRE TRAINING IN THE EAGLE RIVER FLATS, ALASKA

APPENDIX O - MAILING LIST FOR COPIES OF ENVIRONMENTAL DOCUMENTS FOR THE RESUMPTION OF LIVE-FIRE TRAINING IN THE EAGLE RIVER FLATS, ALASKA

APPENDIX P - PUBLIC MEETING DOCUMENTATION FOR THE RESUMPTION OF LIVE-FIRE TRAINING IN THE EAGLE RIVER FLATS; PRESS RELEASE, PUBLIC MEETING NOTICES PUBLISHED IN LOCAL NEWSPAPERS, AND PUBLIC MEETING ATTENDEES

APPENDIX Q - WRITTEN COMMENTS RECEIVED DURING THE 30-DAY PUBLIC COMMENT PERIOD ON ENVIRONMENTAL DOCUMENTS FOR THE RESUMPTION OF LIVE-FIRE IN THE EAGLE RIVER FLATS

APPENDIX R - RESPONSE TO ALASKA CENTER FOR THE ENVIRONMENT LETTER DATED DECEMBER 20, 1991 CONCERNING THE RESUMPTION OF LIVE-FIRE TRAINING IN THE EAGLE RIVER FLATS

APPENDIX S - RESPONSE TO NATIONAL AUDUBON SOCIETY LETTER DATED DECEMBER 20, 1991 CONCERNING THE RESUMPTION OF LIVE-FIRE TRAINING IN THE EAGLE RIVER FLATS

APPENDIX T - RESPONSE TO SIERRA CLUB LEGAL DEFENSE FUND, INCORPORATED LETTER DATED DECEMBER 20, 1991 CONCERNING THE RESUMPTION OF LIVE-FIRE TRAINING IN THE EAGLE RIVER FLATS

APPENDIX A

A SUMMARY IN CHRONOLOGICAL ORDER OF THE EAGLE RIVER FLATS WATERFOWL MORTALITY INVESTIGATION

A SUMMARY IN CHRONOLOGICAL ORDER OF THE EAGLE RIVER FLATS WATERFOWL MORTALITY INVESTIGATION

* Eagle River Flats (ERF) is a 2500 acre salt marsh that serves as Fort Richardson's only impact area for heavy artillery and mortar fire.

* ERF is a highly productive, critical wetland due to its function as a staging area (resting and feeding) for migratory birds in April, May, August, September, and October.

* Excessive mortality was first reported in August 1981 by duck hunters to Fort Richardson biologist Alan Bennett.

* Between 1981 and 1988, investigations concentrated on duck searches, chemical analyses, parasite and disease analyses, and affects of the artillery burst on waterfowl.

* As a result of no conclusive findings for a number of years, an interagency task force was created in February 1988 through a Memorandum of Understanding (Copy Attached).

* In November 1988, Fort Richardson requested U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), Aberdeen Proving Ground, Maryland for technical assistance and expertise in the ERF investigation.

* In April 1989, USATHAMA contractor Environmental Science and Engineering, Inc. (ESE) initiated expanded site investigation.

* February 1990, ESE released final report. Although the actual cause remained unknown, statistical interpretation indicated that explosive compounds and/or their by-products appear to be the cause of the waterfowl mortality on the ERF. The report stated that infectious disease, inhalation of smoke or toxic gases, concussion and algal toxins were not the cause of waterfowl mortality on the ERF.

* Due to the correlation between explosives and duck deaths, the 6th Infantry Division (Light) Commander temporarily suspended firing in the ERF on February 8, 1990.

* March 1990, Cold Regions Research and Engineering Laboratory (CRREL) was contracted by USATHAMA to undertake the follow-on investigation. CRREL was tasked to determine if munition residues were present in the soil and water of the flats and investigate possible relationships to waterfowl mortality.

* Spring 1990, investigation concentrates on identifying explosives on ERF. 2,4-DNT was found but was determined not to be the cause of waterfowl mortality.

* July 1990, a sediment sample collected from ERF smoked when dried in the laboratory. Fall 1990 investigation focused on white phosphorus (WP) as the cause of waterfowl mortality.

* February 1991, CRREL final report identified WP as the cause of waterfowl mortality based on observations, chemical analyses (waterfowl tissues and sediment) and laboratory bassos utilizing WP.

* February 1991, Task Force reviewed USATHAMA Scope of Work and approved the following studies:

a. Waterfowl mortality searches and bird censuses
b. Analytical method validation
c. Sublethal tissue uptake study
d. Predation study
e. WP distribution and fate in ERF sediments
f. Swan mortality study
g. Preliminary remedial feasibility study

* Primary species affected include dabbling ducks and swans, although investigation in the spring of 1991 also found several dead shorebirds and one immature bald eagle. It can not be determined that the eagle died from WP.

* Prior to 1991, all ducks with WP were found in the ERF. During 1991, one duck containing WP was found at Gwen Lake and another duck was found at Clunie Lake. Both lakes are on the Fort Richardson Military Reservation.

* $1.75 million has been spent on the waterfowl mortality investigations to date.

APPENDIX B

PRESS RELEASE, EAGLE RIVER FLATS, FEBRUARY 21, 1991,

6th INFANTRY DIVISION (LIGHT)

PRESS RELEASE
6th INFANTRY DIVISION (LIGHT)

HOLD FOR RELEASE UNTIL 6 p.m., Feb. 21, 1991 Release Number: 91-2-4-12

EAGLE RIVER FLATS REPORT RELEASED

FORT RICHARDSON, Alaska, Feb. 21, 1991 — Army officials here today released a report, prepared by the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), which identifies the ingestion of white phosphorus as the cause of the unusual waterfowl deaths on the post's Eagle River Flats.

The identification was based upon field and laboratory work accomplished last year by CRREL researchers who collected and analyzed the tissues of 14 waterfowl and more than 250 water and sediment samples.

The 80-page report, entitled "Waterfowl Mortality in Eagle River Flats, Alaska: The Role of Munition Compounds," was prepared by CRREL at Hanover, N.H., under a $305,000 study funded by the U.S. Army Toxic and Hazardous Materials Agency at Aberdeen Proving Ground, Md. The report was presented to the 6th Infantry Division (Light) Commander, Maj. Gen. Samuel E. Ebbesen, yesterday, and to the members of the Eagle River Flats Interagency Task Force at a meeting today.

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ERF REPORT RELEASED 2-2-2-2-2

The federal and state agencies of the task force have been working together to determine the cause of the waterfowl mortality since the group's formation in Nov. 1987. Besides the Army, the task force includes the U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, Alaska Department of Fish and Game and the Alaska Department of Environmental Conservation.

In addition to presenting their report on the work completed in 1990, and the conclusion drawn from that work, CRREL scientists have recommended studies continue in 1991. The proposed effort would focus on locating specific areas of high concentrations of white phosphorus contamination as well as evaluating and testing potential remedial solutions.

The Army is pleased by the hard work, scientific approach and spirit of cooperation over the past months which have resulted in a definitive identification of white phosphorous as the cause of the duck mortality. General Ebbesen has directed that white phosphorous will not be fired into the Eagle River Flats impact area in the future.

The 6th Infantry Division (Light) does intend to resume artillery and mortar firing at Eagle River Flats, following completion of an environmental assessment and a firing plan which the commanding general has ordered prepared.

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APPENDIX C

LOCAL NEWSPAPER ARTICLES ON EAGLE RIVER FLATS

Phosphorus causes wildfowl deaths

By DON ALEXANDER
Of The Star Staff

The possibility of an adverse economic impact on Chugiak - Eagle River has been reduced by release of a report last week by the U.S. Army.

The 80-page report identifies white phosphorus as the likely killer of wildfowl in the Eagle River Flats. Because of the death of wild birds in the Flats, which is an Army artillery impact area, firing was suspended in Feb. 1990 until the cause of the deaths could be determined.

The moratorium on firing had forced the move of Fort Richardson soldiers to Fort Wainwright for training on at least one occasion, said Fort Richardson public affairs officer Chuck Canterbury. Additionally, the possibility of permanent relocation of the post's artillery unit loomed if the cause of the wildfowl mortality could not be found. The unit, 4th Bn., 11th Field Artillery, consists of more than 500 soldiers, from junior enlisted to their field grade commander.

The report, entitled "Waterfowl Mortality in Eagle River Flats, Alaska: The Role of Munition Compounds," was prepared by the Cold Regions Research and Engineering Laboratory in Hanover, N.H. It details the investigation into the wildfowl deaths, which were first discovered a decade ago.

(Continued on Page 8)

Army starts environmental assessment

(Continued from Page 1)

Previous studies had eliminated many causes for the bird deaths, including the concussion of falling shells.

Although white phosphorus is seen as the definitive cause of the bird deaths, the Flats has not been re-opened to firing.

"What the Army's intent and wish is that they be able to fire before the end of this calendar year," said Canterbury. "However, it all depends on what the environmental assessment comes up with in conjunction with a firing plan."

About $500,000 has been budgeted for completion of the environmental assessment of the area, he explained. The firing plan will detail when firing can and cannot take place.

Army officials have said that no more shells containing white phosphorus will be fired but considerable deposits of the substance could still be present in the Flats. Part of the job of the environmental assessment will be to determine where heavy concentrations exist, if anywhere, Canterbury said.

In turn, what types of "hot spots" are discovered will determine what type of remediation will take place, Canterbury said.

Several ways of dealing with the white phosphorus have been discussed. Among these is placement of some type of mesh over the hot spots to prevent birds from getting to it. Because the substance burns when exposed to oxygen, the options of digging and injection of oxygen into the soil and pond beds has also been discussed as an option, he said.

In fact, it may be found that there is no way to "fix" the situation, if the white phosphorus is too widely spread out, Canterbury said.

What method or methods of remediation are chosen would determine who would conduct the work. It could be done by specialists with CRREL, by Fort Richardson soldiers, by explosive ordnance personnel, by local civilian contractors or a combination of these, Canterbury said.

"We've lobbed shells into there for 40 years," he explained. "God knows what's under the muck there. To go through there with a Rototiller wouldn't be my idea of a good time."

Contrary to other reports, firing into the Flats will probably not be reduced or eliminated altogether, Canterbury said. The U.S. Fish and Wildlife Service had written the Army a letter suggesting such action several months ago, he said, but no response was given.

"I think that's a dead issue at this point," Canterbury related. Members of the task force of state and federal agencies that had been formed to investigate the bird deaths have not indicated a desire to pursue closure of the Flats, he said.

The Army hopes to have the remediation report by next summer, Canterbury said.

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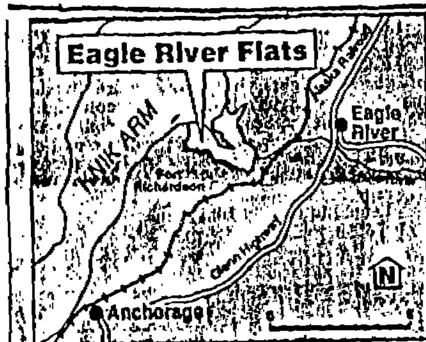
CHUGIAK - EAGLE RIVER STAR
Date 28 Feb 91
Page 1 & 8

DEAD DUCKS: Army says artillery phosphorus killed birds on Eagle River Flats, Metro, C-1



KEVIN POWELL / Anchorage Daily News

Army links phosphorus, bird deaths

By STEVE RINEHART
Daily News reporter

An Army lab has determined that white phosphorus left over from artillery shells has killed thousands of ducks and swans on Eagle River Flats.

The phosphorus — used in incendiary and smoke shells — burns when exposed to air and is very toxic. The study, released late Thursday, found tiny bits of phosphorus preserved in the Knik Arm tidal mud. Ducks and swans scooped it out while feeding. It poisoned them, perhaps scorching their gullets in the process.

The finding — after a nine-month, $305,000 study by the Cold Regions Research and Engineering Laboratory — answers a mystery that has dogged military and civil-

Please see Page C-3, ARMY

ARMY: Studies tie phosphorus, bird deaths on artillery range

Continued from Page C-1

ian scientists for 10 years and has cost at least $1 million. What the latest study termed "catastrophic waterfowl mortality" was first reported by an Army biologist in 1981. Carcasses and feather piles littered the 2,500-acre impact zone, where shells land during Fort Richardson's artillery training.

Official estimates since then have placed waterfowl death on the flats, about 15 miles north of Anchorage, at 1,000 to 2,000 per year. One report said that 1,500 swans massed on the flats during one week in 1988. When they left, nine were dead.

Earlier studies determined the birds were not being blown up or hammered by concussion, and eliminated other possible causes such as lead poisoning. The new report suggests there may have been more than one cause, but that white phosphorus munitions is the main one.

The Army, responding to the report, said Thursday it would resume firing on the range, but will no longer use phosphorus shells. Fort Richardson spokesman Chuck Canterbury said that after an environmental assessment, artillery training would probably start again before the end of the year.

In addition, he said, the Army will "soon" begin looking for a way to find and clean up the remaining phosphorus. Otherwise, it will keep killing for years.

Birds continued to die last summer and fall, even though the Army suspended firing in February last year when it became apparent some kind of munition was at fault.

A task force of state, federal and military agencies formed in 1987 to try to find what was killing the birds. It commissioned a major study by a nationwide consulting firm. But after more than a year, and about $750,000, Environmental Science and Engineering did not have the answer.

Researchers with the firm penned live birds on the flats and in the lab, fed them water, sediment and vegetation from the flats, and cataloged their deaths. Reports say the birds became disoriented, stumbled, walked in circles, then went into convulsions, arched their heads and necks over their backs, then died. But the company was unable to trace the killer chemical in waterfowl tissue; it said its tests weren't good enough.

Local environmental officials gave the new report good marks.

"I am quite satisfied, in my own mind, phosphorus is the culprit," said Bruce Erickson, district manager for the state Department of Environmental Conservation, which is part of the task force.

Erickson said many components of artillery shells will harm wildlife, but phosphorous had seemed a likely villain. It is a well-known shell compound. And it kills rapidly in ways consistent with what has been seen on the flats, he said. It is also fairly easy to trace in tissue, he said.

"It's unbelievable they did not pull it up before now. You can look for it in the gullet," Erickson said.

The Army has been lobbing shells and shooting rockets and grenades into the flats since the 1940s. Fort Richardson officials say they do not know how many of what kind of shells have been used here, because a 1985 fire burned the post's firing range records.

Also unknown is the number of unexploded or dud rounds shot into the mud. Field studies have been limited because biologists have been confined to small areas of the range to reduce the danger posed by those buried bombs.

The U.S. Fish and Wildlife Service is responsible, under federal law, for protecting migratory birds like ducks, swans and geese.

Last summer Fish and Wildlife Regional Director Walter Stieglitz sent a letter to Gen. David Meade, assistant commander of the 6th Infantry Division (Light), recommending that the flats firing range be permanently closed and turned into a conservation area.

The winding river mouth and estuary is a rare and unique saltwater marsh that provides valuable wildlife habitat, Stieglitz wrote. He said "those values are diminished when artillery firing disturbs waterfowl and shorebirds, alters vegetated substrates and destroys food and cover used by waterfowl."

Agency spokesman Bruce Batten said Thursday the Army never replied to Stieglitz's letter.

The next step will be finding specific ways to help the wildlife, Batten said. Those could include proposing a gradual reduction in use of the range, or creating or protecting other waterfowl habitat, he said.

Smoke shells poison ducks

By DANIEL R. SADDLER
TIMES WRITER

Thousands of migrating waterfowl dying on the Eagle River flats artillery range each year are being killed by white phosphorus left from smoke-producing shells, said a U.S. Army report released Thursday.

The yearlong, $305,000 study by the Army's Cold Regions Research and Engineering Laboratory in New Hampshire found birds were dying after eating pinhead-sized fragments of unburned phosphorus buried in the marsh.

"It's been a little bit like solving a mystery, following various clues and leads and solving a pretty complicated mystery," said Charles Racine, an ecologist with CRREL at Fort Greely near Fairbanks.

Biologists in 1980 first reported increasing bird deaths on the mud flats, where migrating waterfowl rest each spring and fall, and where troops have practiced firing artillery shells since the end of World War II. Estimates of bird deaths have ranged up to 2,000 each year.

The deaths have puzzled scientists for years. Previous studies costing nearly $1 million narrowed down the cause of death to compounds contained in the artillery shells, forcing the Army to stop firing on the range a year ago, said Chuck Canterbury, an Army spokesman.

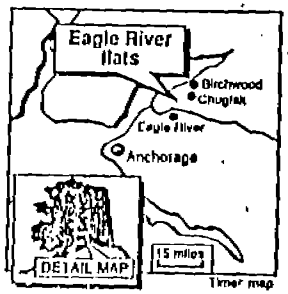
Smoke

Continued from page B1

Starting last spring scientists with CRREL, assisted by other military and civilian researchers, took 250 water and sediment samples, watched birds feed and die on the flats, and analyzed tissues of 14 waterfowl found dead in the shallow waters of the 2,500-acre firing range.

In July, scientists began to consider phosphorus after a sediment sample began smoking when opened in the lab, Racine said. Phosphorus burns with white smoke when exposed to oxygen, and unburned phosphorus may have been driven into the mud and water of the salt marsh by exploding shells, he said.

The researchers had their smoking gun after devising new tests to detect microscopic



Times map

amounts of phosphorus in dead ducks, and finding phosphorus caused the same type of convulsive death in laboratory birds as those observed in the flats, Racine said.

"It's a terrible death, there's no question about it," he said. Birds eating phosphorus become lethargic before entering violent convulsions. Often, they drown or become prey for an eagle before dying by phosphorus poisoning.

The sediment sampling did show high concentrations of DNT, a military shell propellent, near an ordinance disposal dump, the report said. But tests on the duck carcasses discounted theories they were killed by explosives, it said.

"We just took enough time and enough samples that by chance we came up with a sample containing phosphorus," said Racine. "That was the first clue we had something quite unusual."

The U.S. Army has budgeted $500,000 for continued work, which will include letting scientists spend the rest of the year mapping concentrations of phosphorus in the flats, said Canterbury.

The Army has agreed to stop firing all white phosphorus rounds when it resumes using the range, which it hopes to do sometime in the next two years, said Canterbury.

"The next goal is to reduce the waterfowl mortality, now that we have something to remediate," said Marianne Walsh, a physical scientist with CRREL in New Hampshire.

Racine, Walsh, and their colleagues hope to come up with a way to deactivate the compound in 1992. Some possibilities include adding oxygen with chemicals or churning the flats with high explosives or plows. Another plan would place mesh over ponds with too much phosphorus, Racine said.

APPENDIX D

PRESS RELEASE AND NEWSPAPER ARTICLES ON THE CONTINUATION OF STUDIES IN THE EAGLE RIVER FLATS, ALASKA, SEPTEMBER 1991

PRESS RELEASE

6th INFANTRY DIVISION (LIGHT)

FOR IMMEDIATE RELEASE

RELEASE NUMBER: 98-9-2-65

EAGLE RIVER FLATS STUDIES CONTINUE

SEPTEMBER 25, 1991

FORT RICHARDSON, Alaska, Sept. 25, 1991 — With the cause of waterfowl deaths on the Eagle River Flats narrowed earlier this year to white phosphorous from ammunition, Army scientists now are focusing their efforts on defining the scope of the white phosphorous contamination and preventing or lessening exposure of other birds to the chemical.

With Army expenditures at nearly a half million dollars, and about $1.75 million spent on the project since 1989, the Army is diligently working to find immediate and long term resolutions to the problem.

The more than 700 sediment samples taken in the flats from May 1990 to the present indicate that there are certain "hot spots" where white phosphorous pellets are concentrated and where birds die in higher numbers. So far, these areas have been confined to low wet ground. Scientists with the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) are continuing to analyze soil samples in an effort to identify any additional sites of contamination.

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In conjunction with this past summer's soil testing, researchers from Dartmouth College Medical School observed waterfowl mortality, predation of sick and dead waterfowl by other animals and collected tissue samples for laboratory analysis. At the Dartmouth laboratory, studies on domestic ducks exposed to white phosphorous continue, including researching the mechanism by which white phosphorous moves through living tissue and causes death. Since white phosphorous is not a naturally occurring substance, little has been documented or is even known about its effects on birds.

CRREL personnel have begun formulating studies that will focus on the removal, neutralization or covering over of the toxic material.

Since May, Army wildlife biologists have conducted 13 helicopter surveys of Eagle River Flats and wetlands adjacent to the post, looking for indications of sick or dead birds. Although no carcasses or dying birds were found in off-post areas, which included Goose Bay and Fire Creek, just north of the post, waterfowl mortality continues to occur on the Eagle River Flats.

In addition, the biologists have intensively searched the flats for any evidence of predator deaths, and found one juvenile bald eagle in May. Herring gulls, ravens and eagles are the primary predators on the flats.

--more--

Systematic searches of post lakes using canoes have revealed one dead bird, tentatively identified as a grebe, found on Clunie Lake, about two miles east of the Flats. Tissue samples on that bird indicated the presence of white phosphorous. The only other bird ever found to contain white phosphorous outside the flats was a mallard hen at Gwen Lake, also on post, in 1988.

While several herring gull eggs from the flats were found to contain white phosphorous, the eggs from the same nest that were not taken hatched successfully and researchers have not drawn any conclusions from this finding.

Recognizing that the possibility does exist that birds visiting or raised on Eagle River Flats can fly to nearby wetlands, the task force contacted the State of Alaska Department of Health and Social Services for an opinion regarding potential health risks associated with eating those birds.

Following a review of the investigation findings, Dr. John Middaugh, state epidemiologist, concluded that, "While the risk of adverse health effects from potential exposure to elemental waterfowl cannot be said to be zero, based upon evidence from available scientific data and findings of the ongoing investigation, the risk can be said to be so low as to constitute no basis for public health concern.

--more--

EAGLE RIVER FLATS STUDIES CONTINUE 4-4-4-4-4

"Usual common sense precautions by duck hunters are sufficient to assure safety for hunters and their families," Middaugh said. "Hunting was and is banned at the Eagle River Flats. Hunters should not consume sick waterfowl or waterfowl found dead. The findings demonstrate that there is no need for any restrictions on the September 1991 duck hunting season beyond the steps already taken."

As part of ongoing studies, state and federal wildlife officials have collected nearly 300 duck gizzards from upper Cook Inlet waterfowl hunters to be analyzed by Army scientists. These gizzards will be analyzed by CRREL scientists for levels of white phosphorous and lead.

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Army pinpoints hot spots

FT. RICHARDSON–U.S. Army officials here have announced preliminary findings of testing done on more than 700 sediment samples taken from the Eagle River Flats this summer, according to *The Chugiak–Eagle River Star*.

Earlier research done by Army scientists indicated white phosphorus from artillery rounds fired into the Flats was responsible for the high rate of waterfowl deaths in the area.

The soil tests have revealed that there are *hot spots* where white phosphorus pellets are concentrated and where birds die in larger numbers. These areas are confined to low wet ground, researchers from the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) say. The researchers are continuing to focus their concern on defining the scope of the contamination and preventing or lessening exposure of other birds to the chemical.

In conjunciton with the soil testing, researchers from Dartmouth College Medical School observed waterfowl mortality, predation of sick and dead waterfowl by other animals and collected tissue samples for lab analysis.

At the Dartmouth lab, studies on domestic ducks exposed to white phosphorus are proceeding, Army officials report. Because white phosphorus is not a naturally occurring substance, little has been documented or is known about its effects on birds.

CRREL personnel have also begun formulating studies of ways to remove, neutralize, or cover the toxic material.

Since May, Army wildlife biologists have conducted 13 helicopter surveys of the Flats and wetlands adjacent the post, loking for indications of sick or dead birds. Although none were found in off-post areas, including Goose Bay and Fire Creek just north of the post, waterfowl mortality still occurs on the Eagle River Flats.

Additionally, the biologists have intensively searched the Flats for any evidence of predator deaths. So far, the carcass of one juvenile bald eagle has been found. Herring gulls, ravens, and eagles are the primary predators on the Flats.

Systematic searches of lakes on Ft. Richardson have also been conducted with canoes. One dead bird was found at Clunie Lake, two miles east of the Flats. Tissue samples from the bird had white phosphorous in them. The only other bird ever found to contain white phosphorous outside the Flats was a mallard hen discoved in 1988 at Gwen Lake.

Several herring gull eggs from the Flats were found to contain white phosphorous. However, those eggs left in that nest hatched successfully.

In recognition of the possibility that birds visiting or raised on the Flats can fly to nearby wetlands, the task force conducting the study contacted the Alaska Department of Health & Social Services for an opinion regarding health risks associated with eating those birds.

Following a review of the investigation findings, Dr. John Middaugh, state epidemiologist, concluded that the risk from eating affected birds can't be said to not exist. Nonetheess, the risk can be said to be so low as to constitute no basis for public health concern.

As part of the continuing study of the deaths, state and federal wildlife officials have collected nearly 300 duck gizzards from upper Cook Inlet waterfowl hunters. The gizzards will be analyzed for levels of white phosphorous and lead.

ALL - ALASKA WEEKLY
Date 4 Oct 91
Page 4

Army fighting to save birds

The Associated Press

Waterfowl continue to die on a Fort Richardson artillery range, but Army scientists say they believe they've found a lead toward preventing the deaths, which are caused by white phosphorous contamination.

The Army stopped firing white phosphorous shells onto its Eagle Flats range near Anchorage in February 1990 after it was determined that chemical residue from the shells was killing certain kinds of ducks, spokesman Chuck Canterbury said.

"Birds are continuing to die on the flats but not as many," Canterbury said. He wasn't able to provide a total.

The Army uses white phosphorous shells as smoke for camouflage or concealment. They're also deadly anti-personnel weapons, Canterbury said.

"The stuff burns like crazy unless it goes into the water, where it will be extinguished," he said. "That's why the hot spots we've found are in wetter ground.

"The diving ducks pick up the little (phosphorous) pellets as feed. It ends up in their gizzards and kills them."

> *"The diving ducks pick up the little pellets as feed. It ends up in their gizzards and kills them."*
>
> — Chuck Canterbury

The Army has spent about $1.75 million trying to find a long-range cure for the problem, which has killed thousands of waterfowl.

More than 700 soil samples have been taken in the flats since May 1990 in efforts to find the primary "kill zones," Canterbury said.

"When we get the answers back sometime this winter, we'll know how extensive our problem is," he said.

Studies have begun on removing, neutralizing or covering the toxic material, the Army said in a news release.

Nature, however, may have provided a short-term solution.

"One lead, unsubstantiated at this point, came from some boardwalks we'd built in the area," Canterbury said. "We had quite a windstorm recently and it blew some of the boardwalks into the hottest areas.

"We haven't had any die-off there and it's conceivable that the boardwalks are scaring them off — acting like a scarecrow.

"Maybe we need to set up some scarecrows out there."

Meanwhile, the state epidemiologist said there is little health risk from eating some of the contaminated birds.

"While the risk of adverse health effects from potential exposure to elemental waterfowl cannot be said to be zero, based upon evidence from available scientific data and findings of the ongoing investigation, the risk can be said to be so low as to constitute no basis for public health concern," Dr. John Middaugh said.

No additional steps need to be taken so long as hunters follow common-sense rules and pass up sick waterfowl or waterfowl found dead, Middaugh said.

Hunting has been banned in the area.

ANCHORAGE DAILY NEWS
Date 30 Sep 91
Page B-2 Col

Army surveys bird deaths

ANCHORAGE—U.S. Army scientists are trying to determine the scope of white phosperous contamination on a firing range at Fort Richardson in efforts to reduce the number of waterfowl being killed in the area.

The Army announced in February that white phosporous from artillery shells has killed thousands of birds, primarily ducks, in the Eagle River Flats about 12 miles east of Anchorage.

The Army has spent about $1.75 million on the study since 1989 to determine the cause of the bird deaths and to reduce the exposure of other birds to the chemical, officials said.

In a recent letter to the U.S. Fish and Wildlife Service, State Epidemiologist John Middaugh said consumption of waterfowl taken in the Anchorage area poses low health risks.

A hunter would have to eat 3,333 teal before absorbing a fatal dose of white phosphorous, his letter said.

"While the risk of adverse health effects from potential exposure to elemental phosphorous in waterfowl cannot be said to be zero, based upon evidence from available scientific data and findings of the ongoing investigation, the risk can be said to be so low as to constitute no basis for public health concern," Middaugh said in his letter.

"Usual, common sense precautions by duck hunters are sufficient to assure safety for hunters and their families. Hunting was and is banned at ERF (Eagle River Flats). Hunters should not consume sick waterfowl or waterfowl found dead," he said.

FAIRBANKS NEWS-MINER
Date 27-28 Sep 91
Page A-2 Col

Phosphorous-tainted ducks pose low health risk on dinner table

By NANCY PRICE
TIMES WRITER

Nearly 300 duck gizzards were taken from upper Cook Inlet hunters earlier this month for analysis by U.S. Army scientists, who are trying to determine whether the waterfowl were contaminated by white phosphorous at Fort Richardson's Eagle River Flats.

The Army announced in February that white phosphorous from artillery shells has killed thousands of birds, primarily ducks, at the flats since 1981. The Army used the area, located at the mouth of the Eagle River on Knik Arm about four miles west of the Glenn Highway, as an artillery range until 1990.

Consumption of waterfowl taken in the Anchorage area poses low health risks, state epidemiologist John Middaugh said in a recent letter to the U.S. Fish and Wildlife Service. The gizzards were collected by state and federal officials.

Middaugh was out of town and could not be reached for comment Thursday.

A hunter would have to eat 3,333 teals to absorb a fatal dose of white phosphorous, Middaugh's letter said.

"While the risk of adverse health effects from potential exposure to elemental phosphorus in waterfowl cannot be said to be zero, based upon evidence from available scientific data and findings of the ongoing investigation, the risk can be said to be so low as to constitute no basis for public health concern," the letter said.

"Usual, common sense precautions by duck hunters are sufficient to assure safety for hunters and their families. Hunting was and is banned at ERF (Eagle River Flats). Hunters should not consume sick waterfowl or waterfowl found dead," the letter said.

Army wildlife biologists have conducted 13 helicopter surveys of the flats and adjacent wetlands since May — the last survey was earlier this week — and found evidence of new bird kills in the flats but not in off-post locations, post spokesman Chuck Canterbury said.

Biologists also paddled canoes around lakes at Fort Richardson this summer and found a dead grebe on Clunie Lake about two miles east of the flats. Tissue samples indicated white phosphorous was present.

Scientists from the Army's Cold Regions Research and Engineering Laboratory in New Hampshire are trying to determine how to remove, neutralize or cover the toxic materials.

After taking more than 700 sediment samples in the flats during the past 16 months, scientists determined that white phosphorous pellets were concentrated in "hot spots."

Surveys showed the chemical is concentrated mostly on low, wet ground, Canterbury said.

"If a shell hit ground that was high and dry, the phosphorous would hit and burn," he said. "But if it went into a pond or swamp, it was extinguished," he said. "That's why the pond areas tend to accumulate more."

The Army has spent about $1.75 million, including $500,000 this year, to determine the cause of the bird deaths and to decrease exposure of other birds to the chemical, Canterbury said.

ANCHORAGE TIMES
Date 27 Sept 91
Page B-5

Army pinpoints chemical hot spots

U.S. Army officials at Fort Richardson announced preliminary findings Wednesday of testing done on more than 700 sediment samples taken from the Eagle River Flats this summer. Earlier research done by Army scientists indicated white phosphorus from artillery rounds fired into the Flats was responsible for the high rate of waterfowl deaths in the area.

The soil tests have revealed that there are "hot spots" where white phosphorus pellets are concentrated and where birds die in larger numbers. These areas are confined to low wet ground, researchers from the U.S. Army Cold Regions Research and Engineering (CRREL) Laboratory say. The researchers are continuing to focus their concern on defining the scope of the white phosphorus contamination and preventing or lessening exposure of other birds to the chemical.

In conjunction with the soil testing, researchers from Dartmouth College Medical School observed waterfowl mortality, predation of sick and dead waterfowl by other animals and collected tissue samples for lab anaylsis. At the Dartmouth lab, studies on domestic ducks exposed to white phosphorus are proceeding, Army officials report. Because white phosphorus is not a naturally occur-

(See Bird Deaths, Page 9)

Bird deaths confined to Flats study findings indicate so far

(Continued from Page 1)

ring substance, little has been documented or is known about its effects on birds.

CRREL personnel have also begun formulating studies of ways to remove, neutralize or cover the toxic material.

Since May, Army wildlife biologists have conducted 13 helicopter surveys of the Flats and wetlands adjacent to the post, looking for indications of sick or dead birds. Although no carcasses or dying birds were found in off-post areas, including Goose Bay and Fire Creek just north of the post, waterfowl mortality still occurs on the Eagle River Flats.

Additionally, the biologists have intensively searched the Flats for any evidence of predator deaths. So far, the carcass of one juvenile bald eagle has been found. Herring gulls, ravens and eagles are the primary predators on the Flats.

Systematic searches of lakes on Fort Richardson have also been conducted via canoe. One dead bird, tentatively identified as a grebe, was found at Clunie Lake, about two miles east of the Flats. Tissue samples from the bird had white phosphorus in them. The only other bird ever found to contain white phosphorus outside the Flats was a mallard hen discovered in 1988 at Gwen Lake, also on the military installation.

Several herring gull eggs from the Flats were found to contain white phosphorus. However, those eggs left in that nest hatched successfully. Researchers have not drawn any conclusions from this finding.

In recognition of the possibility that birds visiting or raised on the Flats can fly to nearby wetlands, the task force conducting the study of the area contacted the Alaska Department of Health and Social Services for an opinion regarding health risks associated with eating those birds.

Following a review of the investigation findings, Dr. John Middaugh, state epidemiologist, concluded that the risk from eating affected birds can't be said to not exist. Nonetheless, the risk can be said to be so low as to constitute no basis for public health concern.

Common sense should rule, Middaugh said. Hunting at the Flats is banned. Moreover, hunters shouldn't eat sick waterfowl or those found dead.

As part of the continuing study of this aspect of the deaths, state and federal wildlife officials have collected nearly 300 duck gizzards from upper Cook Inlet waterfowl hunters. The gizzards will be analyzed by CRREL scientists for levels of white phosphorus and lead.

CHUGIAK - EAGLE RIVER STAR
Date 26 Sep 91
Page 1/9

APPENDIX E

COST ANALYSIS FOR FIRING OPTIONS IN THE EAGLE RIVER FLATS

APVR-RM-BP
21 May 1991

Information Paper

SUBJECT: Cost Analysis for Firing Options in the Eagle River Flats (ERFs)

1. Cost analysis of the various Firing Options are provided below. These Cost Estimates reflect only those relocation costs that will occur while the Units are travelling To and From Ft Wainwright/Ft Greely to perform Artillery or Mortar Firing. It does not include other costs associated with the performance of these Training Exercises. All costs are in FY91 dollars.

2. "No Firing" option. 4/11 FA PCS to Fort Greely. The cost associated with the relocation will be approximately $21.6 Million with a recurring annual cost of $1.4 Million. This includes the relocation of 418 Soldiers from 4/11 FA, 35 Soldiers from DISCOM, the hiring of 21 additional Civilian employees to include the purchase of equipment/supplies, and the cost of Renovation/ Construction Projects at Fort Greely that are necessary if the "No Firing" option is approved.

Funding Appropriations		Recurring Annually
Military Personnel, Army	$3,200,000	
Operation & Maintenance, Army	2,400,000	$1,400,000
Other Procurement, Army	610,000	
Army Family Housing	5,200,000	
Military Construction, Army	10,200,000	
Total	$21,610,000	

3. 1ST Brigade transportation NOR to conduct for one (1) Mortar Firing Training Exercise. Listed below are the estimated costs associated with this Training Event:

Vehicle Operation (CLII,III & IX):	$104,000
44 PAX Bus (1 each):	5,000
Silverside (1 each):	4,000
Total	*$113,000

* This training must be conducted four (4) times a year (once a Quarter) in accordance with the Division Training Guidance and DIV REG 350-13 "Weapons Qualification".

cont'd (21 May 1991)
Subject: Cost Analysis for Firing Options in the Eagle River Flats (ERFs)

4. "Winter Firing" option. 4/11 FA performs Artillery Firing for 14 days in July. Listed below are the estimated costs associated with this Training Event:

Vehicle Operation (CLII, III, & IX) :	$67,000
Vehicle and Equipment Line Haul (48 Trailers):	99,000
44 PAX Buses (8 each):	10,000
Silverside (2 each):	2,000
Total	$178,000

5. "Winter Firing" option, assuming 1st Brigade does not require summer Mortar Training, performs one (1) Mortar Training NOR during the Winter Months will be approximately $28,250.

Twana Jones
Program Analyst/863-8123

APPENDIX F

VEGETATION ZONES AND PLANT COMMUNITIES, EAGLE RIVER FLATS, ALASKA

Vegetation Zones and Plant Communities found in the Eagle River Flats by the Cold Regions Research and Engineering Laboratory Research Team in 1990

Outer Mudflats (Adjacent to Knik Arm):

Bare or sparsely vegetated by alkali grass (Puccinellia sp) or occasional annual species such as Salicornia europea or Atriplex alaskensis.

Salinity in this zone: 15-25 parts per thousand (ppt)

Raised Levees along Banks of Eagle River and other large Distributaries:

These well drained soils are occupied by Elmus sp., commonly called Beacg Grass.

Inner Mudflats:

Vegetation includes alkali grass, annual herbs, Triglochin maritimum and Plantago maritima.

Salinity: 12 to 20 ppt in standing water

Waterfowl use: Geese graze in this zone

Inner Sedge Marsh:

Vegetation is dominmated by the sedge Carex lyngbyei which grows to over 3 feet in height.

Salinity: 2-9 ppt

Waterfowl Use: New shoots of this sedge grow in the Fall and are consumed by migrating waterfowl

APPENDIX G

WATERBIRD SURVEY/REPORT,

U.S. FISH AND WILDLIFE SERVICE

Waterbird Utilization of Eagle River Flats April-October 1990

by

William Dean Eldridge
U.S. Fish and Wildlife Service
1011 E. Tudor Road
Anchorage, Alaska

Key Words: Eagle River Flats, Cook Inlet, aerial survey, ducks, geese, swans, waterbirds, migration

December 9, 1990

Introduction

The U.S. Fish and Wildlife Service (Service) has conducted seasonal aerial waterfowl surveys of Eagle River Flats (ERF) from 1988 through 1990 as part of the ongoing waterfowl mortality studies on ERF. The purpose, history and status of this investigation have been presented elsewhere (Tweeten 1989, ESE 1990) and will not be repeated here. The objective of the 1990 effort was to monitor waterbird utilization of ERF during spring, summer and fall.

Study Area

Eagle River Flats is a salt marsh complex comprising 2,500 acres located along the southern side of upper Cook Inlet, approximately 10 km east of Anchorage (Figure 1). A detailed description of the area is presented elsewhere (ESE 1990).

Methods

Aerial surveys of the study area were flown by the Service and Bill Quirk of the U.S. Army from April through October, 1990. Surveys were flown using fixed-wing aircraft at an airspeed of approximately 70-90 mph and at an altitude of 150 to 300 feet. Parallel transects were flown at intervals which permitted total coverage of ERF. Numbers of waterbirds were counted or estimated and recorded by species or species group with a cassette tape recorder. Tide, snow and ice conditions were also noted. When bald eagles were present, a perimeter survey of the treeline was flown to count perched eagles. Tapes were transcribed in the office.

No attempt was made to stratify ERF by habitat type or classify bird utilization by habitat type. However, the ERF study area has traditionally been divided into four zones; areas A, B, C, and D (Figure 1) (Tweeten 1989, ESE 1990). Boundaries of these zones were expanded for aerial surveys, as indicated in Figure 1, and observations of birds were recorded by area for the majority of surveys.

Results

Moisture Conditions. Although a record amount of snow fell in the upper Cook Inlet region during the winter and spring of 1989/90, timing of breakup in the Inlet appeared about average if not somewhat early. The speed and pattern of breakup may have been influenced by volcanic dust deposits from several eruptions of Mt. Redoubt over the winter, particularly in the lower Inlet (Hupp 1990).

Ice and snow covered 85% of ERF on 13 April, the date of the first aerial survey. Approximately 30% of Eagle River was open from the mouth, and the few birds present were observed along the coast. Snow melt proceeded rapidly, to 50% by 17 April, 30% by 20 April, and by 23 April the west side (Area A) was completely open and meltwater covered ice on ponds in other areas. By 26 April most of ERF had been flooded and opened by high tides. The summer was very dry, and much of Area A dried up and significant portions of Areas C and D lost water. High tides and heavy September rains re-flooded most of ERF. A cold snap in early October resulted in the formation of skim ice over all ponds on 2-3 October, however, swans were able to keep enough water open to permit feeding. High tides helped reopen ERF by 5 October. Ponds remained open until 11 October when they began freezing and by 15 October most of ERF was frozen again. Warmer weather and the open river provided limited habitat for low numbers of waterbirds until late October.

Aerial Surveys. The Service flew 25 aerial surveys of ERF between 13 April and 23 October, 1990. In addition, Bill Quirk of the U.S. Army flew 8 surveys during fall migration. Helicopter mortality surveys also provided some data on live bird abundance, however, results are not directly comparable to the fixed-wing surveys.

Results of the 1990 aerial surveys are presented in Table 1 and Figures 2-4. Data from aerial surveys flown by the Service in 1988 and 1989 are presented in Figure 4 to demonstrate annual variation in numbers of major waterfowl groups utilizing ERF.

Migration Phenology. Generally, spring breakup progresses from east to west in upper Cook Inlet (Butler and Gill 1987, Hupp 1990). Therefore the salt marshes of the western Inlet, including ERF, provide the first open habitat to early arriving migrants, generally by early to mid April. Most migrants or local nesters disperse to nesting grounds by mid to late May, and numbers of waterbirds on coastal marshes, excluding nesters, are relatively low. By mid to late July, migrants and locally produced young return to coastal marshes where migrating populations of various species increase and decline until the salt marshes freeze, generally by mid-October in upper Cook Inlet but occasionally extending into November. A brief description of migration and peak numbers of major waterbird species follows:

Swans. Both tundra (Cygnus columbianus) and trumpeter (C. buccinator) swans use upper Cook Inlet and its salt marshes, including ERF, as a staging area during migration through the Matanuska Valley. During spring, utilization of ERF is relatively low compared to fall, and swans generally do not arrive until late April. Swans are found only in small numbers by late May and do not nest on ERF. By late August or early September swans reappear on ERF and numbers increase gradually, peaking during the first 10 days of October (Figure 4). Up to 1500 swans were counted on ERF in ground or aerial surveys in 1988 and 1990. Annual variations in weather patterns and freeze-up are important factors determining the numbers of swans utilizing ERF and Cook Inlet.

Geese. Three species of geese regularly use ERF, Canada geese (Branta canadensis), greater white-fronted geese (Anser albifrons) and snow geese (Chen caerulescens) (Loranger and Eldridge 1986, Nysewander et al. 1986, Butler and Gill 1987). Of the three, Canada geese are most common throughout the season and may breed on ERF. Snow geese occur in significant numbers only during spring migration, and white-fronted geese occur occasionally in small numbers throughout the season, but generally depart the area by late September. Canada geese are often among the first migrants to upper Cook Inlet, occasionally arriving in late March but generally not until the first week in April. Except for breeders, they generally depart the region by the first week in May. In fall, Canada goose numbers build gradually on ERF in early August then rapidly to a peak of 2000 - 3000 from mid to late September. An abrupt decline usually occurs during the first week of October (Figure 4).

Ducks. A variety of duck species, primarily dabblers, utilized ERF during the season (Table 1). Annual variations in population sizes of various species, as well as weather patterns, affect the numbers of ducks that utilize ERF. More ducks were recorded during fall, 1990 than previous years but fewer were recorded in spring than in 1988. The most common species in 1990 were also the most common recorded in previous surveys (Tweeten 1989, ESE 1990). These include mallards (Anas platyrhynchos), northern pintails (A. acuta), American wigeon (A. americana), green-winged teal (A. crecca) and northern shoveler (A. clypeata). Mallards and northern pintails were the most abundant duck species recorded in 1990.

The timing of spring and fall migration varies with species depicted in Figure 3, where numbers of three common duck species recorded on 1990 aerial surveys are plotted. Northern pintails are generally among the first migrants to upper Cook Inlet, including ERF, arriving as soon as open water and feed is available, usually in early April. Other species of ducks quickly follow and spring numbers generally peak by mid-May as migrants disperse to breed. Sellers (1979) discusses nesting habitat and bird abundance in Cook Inlet refuges, similar to ERF. Numbers are generally low on ERF through breeding and molting, but increase rapidly beginning in early August. Northern pintails are the earliest migrants south, and generally depart the area by late September. As northern pintails are leaving, mallards begin staging with peak numbers occurring in late September through mid October. Generally mallards are the last migrants to leave ERF, often remaining until freeze-up forces their departure. The majority of other duck species depart the area in late September.

Bald Eagles. Generally bald eagles (Haleateetus leucocephalus) are more common in spring than in fall although 27 were observed on a 14 October, 1990 survey (Table 1). Bald eagles prey on waterfowl in ERF, therefore, the abundance of eagles closely parallels the migration of waterfowl. In spring eagles appear in mid April, remain until mid May, and then depart for nesting areas. They appear in lower numbers in late August. In addition to providing a readily available food source of sick or dying waterfowl, ERF also provides ideal habitat for eagles with the nearby bluffs and trees. In spring, there are more bald eagles per mile of treeline in ERF than in any other bay in upper Cook Inlet (Butler, pers. comm).

Shorebirds. Other than the combined species of greater and lesser yellowlegs (Tringa sp.) it is difficult to identify shorebirds to species from the air, particularly in winter plumage. Therefore all shorebirds were combined, which does not demonstrate the difference in timing of migration of various species or identify important species to ERF. However, it is clear that during June and July several thousands of shorebirds utilize ERF and that it is an important staging area, particularly for fall migrants. Common species to ERF probably include least (Calidris minutilla), semipalmated (C. pusilla), western sandpipers (C. mauri), and dowitchers (Limnodromus spp.) in addition to yellowlegs (Gill, pers comm.). Ground counts would be needed to quantify use and to identify species.

Gulls and Terns. Gull species were combined for aerial surveys, however, mew gulls (Larus canus), glaucaus-winged gulls (L. glaucescens) and Herring gulls (L. argentatus) were most common. A small colony of nesting mew gulls is located in Area D. Nesters arrived by late April and migrants peaked in early May. Gulls were common through summer, but were rarely observed after late September. Arctic terns (Sterna paradisaea) and possibly the less common Aleutian tern (S. aleutica), which can not be distinguished from the air, were late migrants, arriving near 1 May, with peak numbers recorded in late June, when they depart coastal marshes.

Spatial Utilization of Eagle River Flats by Waterbirds. Although general in nature, the objective of classifying numbers of birds by Areas A, B, C and D on ERF was to relate bird numbers to the four areas so that they might be compared to ongoing and previous studies regarding mortality on ERF (Tweeten 1989, ESE 1990). Results of this classification are presented in Table 2.

Habitat use by waterbirds on ERF, with the exceptions of geese and cranes, is directly related to the amount and type of water resources available. A series of permanent or semi-permanent ponds in ERF as well as the Cook Inlet coastline and Eagle River itself provide a variety of habitat.

Swans used the driest most shallow area, Area A, the least in spring and fall (Table 2). Area D appeared to be preferred by swans in fall.

Geese utilized Area A more than elsewhere both in spring and fall (Table 2).

Since Canada geese are primarily dry land grazers, preference for drier habitat is understandable. Observations of flocks were usually along the banks of Eagle River or the coastline near the mouth, generally the driest locations on ERF.

Ducks in general were most common on Areas A (well flooded) and C in the spring, Area D in the summer (Area A was essentially dry in summer), but evenly distributed in the fall when rains and tides had re-flooded most of ERF. Some species specific differences were apparent in fall (Table 2). Green-winged teal were most common in Area A, mallards and northern pintails were evenly distributed, and American wigeon were most common in Area D.

Discussion

Concern over the mortality of waterbirds on ERF has often led to the question: "How many birds utilize ERF that could potentially be exposed to the contaminant causing mortality?" The numbers of birds that die on the area or leave and die elsewhere after contamination is related to the numbers that use the area. Through aerial and ground surveys we have attempted to address this question. However, there are several factors that complicate the determination of the numbers of birds utilizing ERF. These include: 1) natural annual variation due to changes in weather and habitat conditions and population fluctuations, 2) daily fluctuations in migrating bird populations that make it difficult to count birds at peak abundance 3) difficulty in detecting all birds due to visibility problems and 4) daily turnover or "roll-through" of the birds on ERF (are the 10 mallards we observed today the same 10 we observed yesterday or replacements?).

The annual variation in numbers of birds utilizing ERF is evident in the three years of aerial surveys as well as various ground counts. Swan numbers in the fall have varied considerably, as have geese numbers throughout the season. Butler and Gill (1987) counted over 100,000 geese in upper Cook Inlet in the spring of 1985, but only 51,000 in 1986. Similar variations can be expected on ERF for most species. Therefore, a determination of peak numbers must be based on counts conducted over several years, rather than any one.

Daily fluctuations in bird numbers on ERF, whether from natural movements or man-made disturbances, are significant. An examination of data presented in Table 1 during October, where counts were conducted on nearly a daily basis for short periods, illustrates this point. Counts can also vary dramatically on the same day, depending on tide conditions, feeding activity and disturbances. The only way to assure that peak numbers of birds have been counted for a particular time period, such as fall migration, is to conduct numerous surveys. Although the 33 surveys conducted in 1990 were considerably more than previous years, we can still not assure that peak numbers were counted for any species.

The numbers of birds observed that are presented in this report can only be considered minimum counts. It is well recognized that aerial surveys for most species of birds (except swans) represent only a fraction of those that are actually present due to various visibility factors. These factors include weather conditions, type and speed of aircraft, observer capability, size of bird, flock size, habitat type, and season. For example, a group of 100 drake mallards is much easier to see in spring, when they are in full breeding plumage and vegetation cover is low, than two or three drakes molting together in late summer when they are in eclipse (brown) plumage and the vegetation is tall. However, it is more difficult to obtain an accurate count of large flock sizes (they are generally underestimated) than small ones.

To determine how many birds are present but not counted by the aerial survey generally requires a ground count (or photograph) that is conducted at or near the same time as the aerial survey. For a variety of reasons this was not feasible on ERF. We can utilize ground/air ratios, referred to as visibility indices, from other, similar areas to estimate what actual numbers might approach on ERF, assuming that the visibility indices are appropriate. Unfortunately, most visibility indices were established for spring breeding pairs on large areas, which likely makes birds more difficult to see than the flocks that usually occur on ERF. However, based on other studies (Conant et al. 1989) and previous experience, I have adjusted published visibility indices so that they may better reflect conditions on ERF. It should be clearly understood that this is only an approximation to demonstrate the fact that aerial counts are not actual counts, and that actual visibility indices could only be determined from ground work on ERF. Peak counts of various species or species groups from an aerial survey conducted on 28 September 1990 with estimated visibility indices are presented in Table 3.

Regardless of peak numbers of birds, we have no useful method for determining the numbers of total birds of any species that move through ERF during the year or any season. Without marking birds, it is impossible to determine how many individuals remain on ERF from day to day or how many are replaced. Peak numbers recorded on aerial or ground surveys, whether expanded with visibility indices or not, will not approximate the actual total number of birds that utilize the area. It is clear that ERF is an important staging area for various species during spring and fall, particularly considering its relatively small size compared to other Cook Inlet marshes. Cessation of shelling by the U.S. Army and the termination of sport hunting on ERF will likely contribute to increased use of the area by waterbirds over time. The implications of increased bird utilization and potential for proportional increased mortality should be evaluated.

Habitat utilization on ERF by waterbirds depends largely on the availability and quantity/quality of water present. However, some species specific preference for certain areas may occur which may influence management decisions on ERF.

ACKNOWLEDGEMENTS

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Table 1. Numbers of birds by species and/or species group observed during aerial surveys of Eagle River Flats in 1990 (not corrected for visibility factors.

	4/13	4/20	4/23	4/26	5/3	5/8	5/13	5/24	5/30	6/22	6/29	7/16	7/24	7/30	8/7
Swans (*Cygnus sp.*)				14	8	11	3	1	5						
Geese															
Greater White-fronted Goose (*Anser albifrons*)															
Snow Goose (*Chen caerulescens*)			25	600					2						
Canada Goose (*Branta canadensis*)	42	380	300	249					2	17	25			100	152
Subtotal Geese	42	380	325	863	8	11	3	1	4	17	25			100	152
Ducks															
Green-winged Teal (*Anas crecca*)				10	48	228	130	32	7	63	20	20	50	100	2
Mallard (*Anas platyrhynchos*)		2	58	180	72	27		9	32	60	11		57	60	334
Northern Pintail (*Anas acuta*)		3	45	228	64	64		37	2	32	3		45	56	557
Northern Shoveler (*Anas clypeata*)					21	40		4	4						
American Wigeon (*Anas americana*)			5	5	57	89		42	50	116	110	8	50	40	14
Canvasback (*Aythya valisineria*)															
Redhead (*Aythya americana*)															
Greater Scaup (*Aythya marila*)															
Goldeneye (*Bucephala sp.*)					2										
Bufflehead (*Bucephala albeola*)															
Merganser (*Mergus sp.*)															
Subtotal Ducks		5	108	423	262	448	130	124	95	251	144	28	202	266	907
Other															
Bald Eagle (*Haliaeetus leucocephalus*)				18	14	20						1			
Sandhill Crane (*Grus canadensis*)		2			21			2	2	2					2
Shorebird sp.		1	15	2	24	143		52	102	439	1026	995	531	925	
Gull (*Larus sp.*)	2	40	35	177	163	71	40	70		65		25	3	20	9
Arctic Tern (*Arctic tern*)					25	31		10		80	77				
Common Raven (*Corvus corax*)						1									

Table 1. Continued.

	8/13	8/25	9/5	9/8*	9/11	9/15*	9/17	9/24	9/28	9/29*	10/3*	10/4	10/5*	10/8*	10/9	10/11
Swans (*Cygnus sp.*)			1	60	13	60	123	243	561	500	1460	650	620	269	125	48
Geese																
Greater White-fronted Goose (*Anser albifrons*)	25	50														
Snow Goose (*Chen caerulescens*)																
Canada Goose (*Branta canadensis*)	135	300	412		355	2450	1040	815	425	180	930	360	720	240	1000	100
Subtotal Geese	160	350	412	2250	355	2450	1040	815	425	180	930	360	720	240	1000	100
Ducks																
Green-winged Teal (*Anas crecca*)	2	30	27		20		112	295	175			220			200	45
Mallard (*Anas platyrhynchos*)	136	200	250		127		309	609	1366			772			1500	473
Northern Pintail (*Anas acuta*)	767	800	174		732		790	407	571			30			300	2
Northern Shoveler (*Anas clypeata*)		20	30				42	167	82			5			50	41
American Wigeon (*Anas americana*)		50														
Canvasback (*Aythya valisineria*)																
Redhead (*Aythya americana*)																
Greater Scaup (*Aythya marila*)																
Goldeneye (*Bucephala sp.*)																
Bufflehead (*Bucephala albeola*)																
Merganser (*Mergus sp.*)																
Subtotal Ducks	905	1100	919	1403	969	1470	1528	1858	2355	1130	1515	1122	1120	1860	2100	561
Other																
Bald Eagle (*Haliaeetus leucocephalus*)			2				2	2	4			6		18	7	7
Sandhill Crane (*Grus canadensis*)			4		52		16	10								
Shorebird sp.			2				8	20	6							
Gull (*Larus sp.*)							2									
Arctic Tern (*Arctic tern*)																
Common Raven (*Corvus corax*)									12			10		140		

Table 1. Continued.

	10/14*	10/15	10/20*	10/23
Swans (Cygnus sp.)	96	55	3	
Geese				
Greater White-fronted Goose (Anser albifrons)				
Snow Goose (Chen caerulescens)				
Canada Goose (Branta canadensis)				
Subtotal Geese				
Ducks				
Green-winged Teal (Anas crecca)		100		
Mallard (Anas platyrhynchos)		850	12	34
Northern Pintail (Anas acuta)				
Northern Shoveler (Anas clypeata)				
American Wigeon (Anas americana)				
Canvasback (Aythya valisineria)				
Redhead (Aythya americana)				
Greater Scaup (Aythya marila)				
Goldeneye (Bucephala sp.)				1
Bufflehead (Bucephala albeola)				1
Merganser (Mergus sp.)				2
Subtotal Ducks	1218	950	12	38
Other				
Bald Eagle (Haliaeetus leucocephalus)	27	16	8	
Sandhill Crane (Grus canadensis)				
Shorebird sp.				
Gull (Larus sp.)				
Arctic Tern (Arctic tern)				
Common Raven (Corvus corax)			40	

* Conducted by Bill Quirk, U.S. Army

Table 2. Percent of total observations* recorded in areas A, B, C, D of Eagle River Flats (Fig. 1) during spring, summer and fall for major waterfowl groups and species.

	Spring					Summer					Fall				
	A	B	C	D	(n)	A	B	C	D	(n)	A	B	C	D	(n)
Swans	12	30	35	23	(42)	0	0	0	0		19	17	21	43	(4,560)
Geese	51	0	0	49	(1,220)	0	0	0	100	(117)	48	11	23	18	(3,717)
Ducks	35	13	43	9	(1,100)	5	3	46	45	(733)	28	24	24	25	(13,974)
Green-winged teal											54	13	14	19	(2,235)
Mallard											25	24	25	26	(6,600)
Northern pintail											25	34	22	18	(3,513)
American wigeon											5	10	36	49	(1,350)

* Represents only observations classified by area

Table 3. Number of waterfowl observed on Eagle River Flats on September 28, 1990, expanded by estimated visibility factors.

Species	Observed Total	Visibility Index(*)	Expanded Total
Swans	561	1.0 (1.0)	561
Canada Geese	465	1.3 (2.7)	553
Ducks			
Green-winged Teal	175	4.5 (12.7)	787
Mallard	1,366	2.0 (4.2)	2,732
Northern Pintail	571	2.5 (3.7)	1,427
Northern Shoveler	82	2.5 (4.4)	205
American Wigeon	141	2.5 (5.9)	353
	3,321		5,504

* Actual visibility indices calculated for waterfowl breeding population surveys on the Yukon Delta, Alaska.

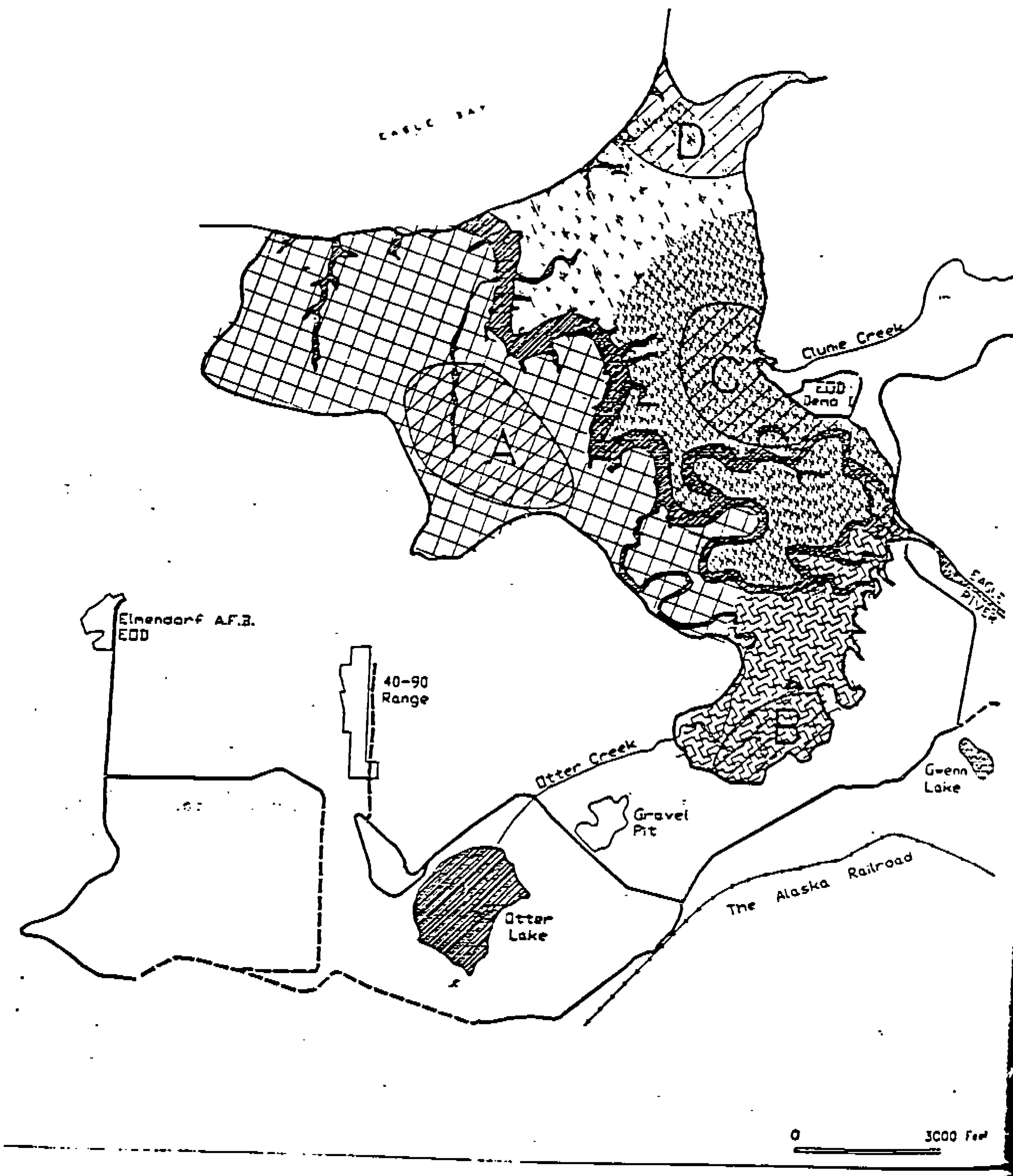
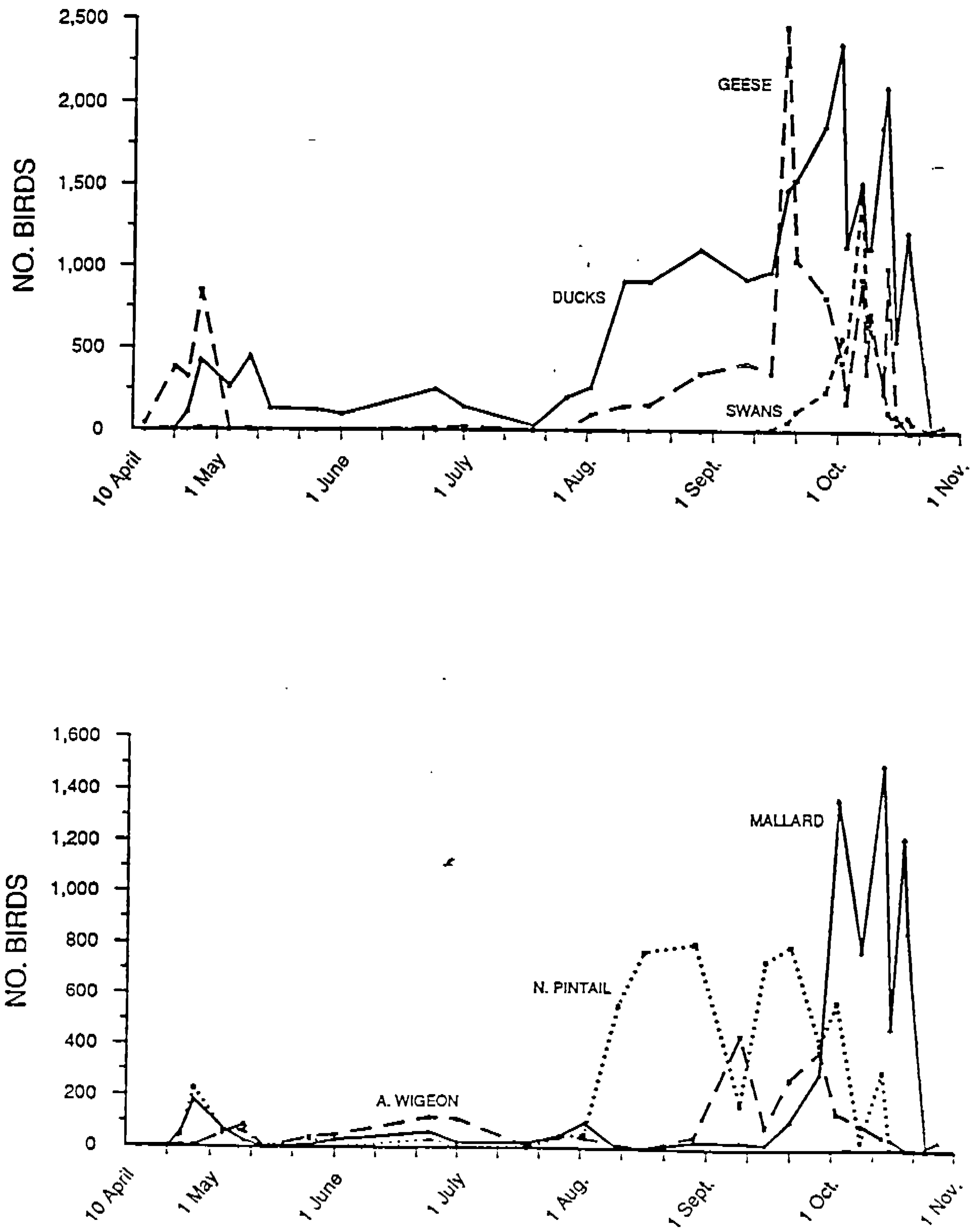


Figure 1. The Eagle River Flats study area, with zones A, B, C, and D.

Figure 2. The numbers of swans, geese, and ducks observed on Eagle River Flats during aerial surveys conducted in 1990.



APPENDIX H

ARTILLERY TEST FIRING IN RELATIONSHIP TO PROTECTION OF THE UNDERLYING SEDIMENTS IN THE EAGLE RIVER FLATS

ARTILLERY TEST FIRING IN THE EAGLE RIVER FLATS

1. There exists a continuing need to conduct artillery and mortar training in the Eagle River Flats Impact Area on Fort Richardson. Since the cause of the waterfowl mortality in the Eagle River Flats has been identified, ways to conduct firing into the flats without exacerbating the current white phosphorus (WP) problem must be determined. Winter only firing has been proposed as a solution to the problem. The seasonally frozen ground and the ice layer which forms over the flats during winter may provide protection for the buried WP particles and prevent them from being disturbed and redistributed. To test this hypothesis, Cold Regions Research and Engineering Laboratory (CRREL) conducted a series of live-fire tests in the Eagle River Flats with 105mm howitzers and 60mm and 81mm mortars in March 1991. Preliminary results of this research showed that disturbance to soil sediments below a 1 to 2 foot ice layer over the flats was minimal when point detonated (exploding on contact) fuse rounds were employed (CRREL Report Attached). The howitzers created 8-10 foot diameter craters in the ice with only one round penetrating the ice and exposing the soil sediments below (virtually all frozen soil sediments remained undisturbed). Effect from the mortars was even less severe, creating shallow craters with slight depressions in the center. Additional research will be needed in the early winter to determine ice formation rates and thicknesses.

2. CRREL has conducted further testing of the impacts of artillery firing into WP contaminated sediments in summer 1991. CRREL used a six (6) pound explosive charge (similar to the charge in a 105mm howitzer) placed 10cm deep in sediments of a shallow pond where WP is known to be present. Plastic sheets to catch ejecta were placed over the water surface. Sampling and testing of sediments for WP in the vicinity of the buried charge were conducted prior to detonation. Following the explosion, the material displaced and collected on the plastic sheets was analyzed for WP. Preliminary results show that the concentrations of WP in the displaced material was on the order of several times the magnitude of the initial sampled sediment material. The explosive charge also exposed WP along the crater walls in larger concentrations than were detected in the initial sediment samples.

3. The results of the March 1991 live-fire test clearly showed that seasonally frozen ground and an ice layer can provide protection for the buried WP particles in the frozen sediments in the Eagle River Flats. The simulated test firing in summer 1991 strongly indicated that firing munition rounds into the Eagle River Flats without some type of sediment protection would cause further contamination of soil and water with WP. The exploding rounds will expose and redistribute buried WP particles on the soil surface and in the ponds.

DRAFT REPORT

PRELIMINARY ANALYSIS OF ARTILLERY TEST FIRING INTO EAGLE RIVER FLATS DURING THE WINTER OF 1991

Charles M. Collins

June 1991

This is an unofficial, unedited draft, for limited distribution only

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ARTILLERY TEST FIRING INTO EAGLE RIVER FLATS DURING THE WINTER

INTRODUCTION

The Eagle River Flats (ERF) is an estuarine salt marsh in upper Cook Inlet on Fort Richardson. The2500-acre salt marsh has been used as an U.S. Army artillery impact range into which artillery shells, mortars, rockets and illumination flares have been fired over the past 40 years. Hundreds of waterfowl have been found dead annually during fall and spring migrations for the past 10 years in Eagle River Flats. The cause of this unusual mortality has remained a mystery despite numerous investigations over the past five years by federal and state agencies. Analysis of waterfowl carcasses recovered from Eagle River Flats by various wildlife laboratories ruled out avian diseases and lead poisoning, and analysis of sediment and water samples did not show significant levels of any poisonous compounds or heavy metals. A report by USATHAMA (ESE 1989) concluded that chemicals from explosive ordnance were a probable cause of waterfowl mortality in ERF. Because of the conclusions stated in the ESE report, firing into the impact area was suspended by the Commanding General in February 1990. Despite closure, large numbers of waterfowl continued to die during the 1990 spring and fall migrations.

Because of CRREL's expertise in chemical analyses for munition residues in soil and water and CRREL's expertise in Alaskan wetlands ecology, we were requested by USATHAMA to test the hypothesis that munition compounds are the cause of mortality in ERF. Over 250 sediment samples, as well as tissue from waterfowl observed to die or found dead in the salt marsh, were collected and analyzed during the spring and fall 1990. White phosphorus was found in sediment from the bottom of shallow ponds used extensively by waterfowl. In addition we found white phosphorus in the gizzards of all 19 waterfowl carcasses collected in Eagle River Flats (Racine, et al., 1991)

Since the highly toxic white phosphorus or elemental phosphorus (P_4) does not occur in nature and is extremely reactive and quickly oxidized or burned in the presence of oxygen, the mechanism by which unburned white phosphorus entered and was stored in the salt marsh sediments is important to understand. Eagle River Flats was contaminated by the firing of white phosphorus containing smoke projectiles. When a smoke projectile bursts, particles of white phosphorus ignite, producing a dense white cloud of smoke. Burning particles are extinguished when they fall into the water of the shallow ponds in ERF. Because white phosphorus has a high density and a low water solubility, particles would sink through the water column into the bottom sediments where periodic tidal flooding of the ponds with silt-laden waters would cover the particles. Bottom sediments in these ponds are very anaerobic, providing a suitable environment for white phosphorus storage. Oxidation in these anaerobic conditions will be extremely slow (Davidson et al. 1987, Sullivan et al. 1979). Thus white phosphorus in the sediments of ERF could be stored indefinitely and will continue to be a hazard to waterfowl even without additional inputs.

WHY STUDY WINTER ARTILLERY FIRING ?

Because of the white phosphorus in the sediments of the ponds, there is some concern that renewed firing of HE artillery projectiles into the flats would possibly cause redistribution of bottom sediments with additional white phosphorus particles made accessible to feeding waterfowl. When a projectile explodes in a shallow pond, bottom sediments would be thrown up and out from the crater, falling back down into the water and settling to the bottom of the pond. White phosphorus particles in these bottom sediments also would be thrown up and out, landing in the pond and settling to the bottom of the pond, on top of bottom sediments already there. Theoretically some of these white phosphorus particles could be oxidized and disappear when they are blown out of the pond and up into the air during the explosion. However the chances of much oxidation occurring are probably low. When the white phosphorus projectile was originally fired into the flats the white phosphorus was being oxidized under near ideal conditions prior to falling into the ponds. That is the white phosphorus shell burst above the ground surface in an airburst, the white phosphorus charge inside the projectile was blown apart, and particles of white phosphorus ignited at well above 30 ^{o}C (white phosphorus ignition point) and were burning when they fell into the pond. In the case of a HE projectile exploding in a shallow pond, the white phosphorus particles would be thrown up into the air along with wet mud and water from the pond. The probability that a large percentage of the white phosphorus particles would be oxidized under these less than ideal conditions is probably very low although no tests have been undertaken as of yet to confirm this hypothesis.

To avoid disturbing buried white phosphorus, winter firing into the flats has been proposed. The seasonally frozen ground and the ice that form over extensive areas of the flats during the winter might provide protection for the white phosphorus and prevent it from being disturbed by firing. To test this hypothesis a series of test firings was undertaken in March 1991 using

105 mm howitzers and 60 mm and 81 mm mortars, the weapons most commonly fired into the impact area by the 6th Infantry Division.

When and if remediation is undertaken the particular remediation technique used will depend in part on whether firing is conducted year round or confined to the winter.

METHODS

Site Characterization

Prior to the artillery tests, we made measurements in the impact area to characterize site conditions. The proposed impact area for the test was an approximately 500 m by 500 m area located on the east side of Eagle River, about 500 m southwest of the EOD gravel pad (Figure 1). We measured ice thicknesses and snow depths in the proposed impact areas and six cores of ice and underlying frozen soil were taken by hand using a 3" SIPRE core barrel. Ice thicknesses varied from 30 to 60 cm. In each core, frozen sediment was encountered below the ice. Sediment cores up to 25 cm were obtained at some of the sites. Total frozen sediment below the ice is unknown but greater than 25 cm. Snow depth averaged about 20 cm throughout the test impact area. After the test firing, we photographed the craters formed by the explosion of the HE projectiles and measured the diameters and apparent depths of the craters. Samples of snow around the craters were collected for later analysis of explosive residuals.

Seasonally Frozen Ground

In areas of the Flats without standing water, such as the slightly higher ground along either side of the river and the sedge marsh area adjacent to the EOD pad, the ground freezes seasonally each winter. The depth of seasonal freezing is dependent upon the depth of the overlying snow cover, frequency of tidal flooding, and average winter temperatures. Sediments underlying shallow ponds such as in Area C, may or may not freeze depending upon the depth of water and whether the water freezes completely to the bottom of the pond during the winter. During March 1991 the ground was frozen as deep as 40 cm.

Ice Cover Formation

An extensive ice sheet builds up during the winter in Eagle River Flats because of periodic tidal flooding and aufeis buildup. The Flats are subjected to periodic inundations with a thin layer of water during high tides that then freezes. Subsequent high tides add additional thin layers of ice. Aufeis builds up in the Flats as water from tributary streams along the sides of the Flats and groundwater continues to drain into the Flats throughout the winter. The wicking of water up into the overlying snow cover seem to inhance the buildup of ice, allow inundations of areas that normally would be higher than could be reached by tidal action alone. Exactly what percentage of the ice buildup is due to freshwater aufeis and what percentage is due to tidal flooding is not known at this time. We are undertaking chemical and petrograpic studies of the ice cores to try to determine the origins of the ice.

Areas of bare ground during summer build up a 30 to 60 cm layer of ice cover during the winter. Areas of standing water, such as the ponds along the margins have increased ice thicknesses of 40 to 50 cm. Part of the growth of the thickness of the ice cover is due to freezing downward of the water but much is due to the repeated thin flooding over the surface by aufeis and tides. Elevation of ice surfacees in ponds is 40 to 50 cm above summer water surface elevations. Ice covered the shorelines around ponds in Area C that were dry during the summer.

Artillery Test

The artillery test firing onto the ice of Eagle River Flats took place on 20 March 1991. The first part of the test consisted of firing a series of 105 mm howitzer high explosive (HE) projectiles with point detonating fuses, the configuration normally fired into the Flats for training, This was followed by a series of HE projectiles with time delay fuses. The objective of the time delay fuses was to see if the slight delay before detonation allowed the projectile to penetrate through the ice cover before exploding. The HE projectiles were fired from M101A1 105 mm howitzers of the 4th Battalion, 11th Field Artillery. The howitzers were set up at FP ____ ___ km to the eat of the Flats. Firing information for the weapons used in the test is presented in Table I.

Table I. Firing information for weapons used in test.

Weapon	Round	Barrel Angle
105 mm Howitzer M101A1	105 mm HE M1	350-354 mils = 19.7° - 19.9°
81 mm Mortar M252	M374-A-3-81mm	1217-1289 mils = 68.5° - 72.5°
60 mm Mortar M224	M49-A-4-60mm	1166 mils = 65.6°

The second round of tests consisted of firing 81 mm mortar projectiles, first point detonating and then time delay fused, into an area just to the north-of the impact area. Because of initial problems by the mortar crew on getting the projectiles on target, not all the craters were accessible for later measurement. Several hit in the river and on the far side of the river. The third round of tests consisted of point detonating fused 60 mm mortar projectiles fired into an area west of the 105 mm impact area. Firing information on both these weapons is presented in Table I.

RESULTS

105 mm Howitzer

Point detonating fused projectiles were fired first into the designated impact area. The projectiles detonated on contact with the ice sheet (Figure 2) [Photo 91-021,023 or 024] One projectile was a dud, creating a white plume when it hit the ice (Figure 3)[91-022]

Seven craters formed by exploding PD fused projectiles were measured. All of the craters were somewhat oblong in shape, possibly due to the low firing angle used. Maximum diameters ranged between 2.26 and 3.54 m and minimum diameters between 1.89 and 3.05 m. The average for maximum and minimum diameters was 3.17 and 2.44 m. Craters were shallow with most of the apparent depth being the snow cover blown off the ice sheet. Some ice was broken up within the crater (Figure 4)[91-059]. Two craters had frozen ground exposed within the crater where the ice in the center had been broken and tossed out (Figure 5)[91-054]. There was no cratering of the frozen ground beneath the ice. The one dud projectile, shown hitting the ice in Figure 3, produced a small crater estimated to be one meter in diameter although we did not measure this crater directly for safety reasons.

Delay fused projectiles were very erratic in their performance. Several ricochetted off the ice before exploding. Figure 6 [91-027] shows a ricochetting projectile exploding in the air after hitting the ice. The next projectile ricochetted and exploded at or near the surface (Figure 7)[91-028]. In the photograph one can see the white plume of ice where the projectile initially hit and then the explosion just beyond it. This explosion produced a shallow elongated crater (Figure 8)[91-068], approximately 2.5 m wide at the near end, narrowing down to 0.6 m wide at the far end and 9 m long.

A third delay fused projectile appeared to detonate normally (Figure 9)[91-029]. producing a crater similar to those of the PD fused projectiles (Figure 10) [91-72,73, or 74]. This crater measured 3.0 x 2.4 m.

A fourth delay fused projectile ricochetted high into the air (50 m ?) before exploding. Figure 11[Photo 91-030] shows the white plume of ice & snow where the projectile first hit and the dark explosion cloud high in the air, right against the skyline of the tree-covered hills in the background. The small crater caused by the ricochetting projectile is shown in Figure 12[91-066]. This crater measured 1.07 x 0.6 m.

81 mm Mortars

Both point detonating and delayed fused projectiles were fired. Point detonating craters averaged 2.2 x 2.1 m in diameter. These craters were more nearly circular than the howitzer craters, most probably because of the higher trajectory of the mortar projectile. Most of the apparent depth of craters were cause by removal of snow cover by the explosion. A shallow depression was blown in the underlying ice cover but the ice was not penetrated in any of the craters formed by point detonating projectiles. (Figures 13, 14, and 15)[91-105, 107, 112]

Three projectiles of delayed fused 81 mm projectiles landed in close proximity. Figure 16 [91-034] shows the first of these projectiles exploding.

The craters produced by two of the projectiles was similar to the point detonating fused projectiles (Figure 17)[91-077].

The third delayed fused projectile produced a camauflet, or a hidden crater. The projectile penetrated the ice cover and the underlying frozen and unfrozen sediment for some unknown depth before exploding. The confining strength of the ice, the upper seasonally frozen sediment, and the underlying unfrozen, saturated sediment was sufficient to confine the explosion and prevent it from tossing material out and producing a surface crater. The only initial evidence of the camauflet was a conical mound of broken ice rubble 0.6 m high by one meter in diameter (Figure 18)[91-079]. Closer inspection and judicial digging (by the EOD escort) into the mound revealed a 30 cm by 1.5 m deep near vertical hole (Figure 19)[91-81 or 129].

60 mm Mortars

Only point detonating fused projectiles were fired. Explosion of the projectile is barely visible in the middle distance just on the near side of the river in Figure 20. [91-032]. Craters were smaller than either the 105 mm howitzer or 81 mm mortar craters, averaging 1.8 x 1.7 m in diameter (Figure 21)[91-091]. They were very shallow, averaging 19 cm, essentially the depth of the snow cover. The snow was blown out by the explosion and the underlying ice sheet remained intact. There was usually a small dimple in the ice at the center of the crater where parts of the fuse of the projectile were sometimes found.

One 60 mm projectile was a dud. The projectile appeared to penetrate into the ice (Figure 22)[91-096] with only the tail fins visible (again after careful digging of the snow around the projectile by the EOD escort)

Explosive Residuals

Snow around craters formed by 105 mm howitzer and 81 mm mortar HE projectiles were sampled and tested for residual high explosive components such as TNT and RDX. Darkened, ash covered snow surrounding the crater was collected in a 16 oz I-Chem glass sample jar. The sample was returned to the laboratory and test for HE components. No explosive components were detected, indicating that they were being completely consumed in the explosion.

CONCLUSIONS

In almost all cases, firing into Eagle River Flats when the ground was frozen and covered with an ice sheet had little significant effect on the underlying frozen sediments. Point detonating fused projectiles of both mortars and 105 mm howitzers appear to have little impact on the underlying sediment with the craters confined to the overlying snow and ice sheet. Except for one 105 mm and one 60 mm dud, performance of the point detonating projectiles was satisfactory. Delayed fusedprojectiles operated very erratically in areas with frozen ground and an ice cover and should not be used in the future in ERF.

The 105 mm howitzer projectiles, using point detonating fuses, created 2 to 3 m dia craters with an apparent depth of 0.25 to 0.4 m. Much of this apparent depth was due to removal of the 20 cm deep snow cover over the ice sheet. In most cases, the 30 to 60 cm thick ice sheet was still intact with only a 0.6 to 1.0 m dia area of broken ice in the center of the crater. Little or no sediment was seen to have been ejected from the craters. In one case a 1.3 m dia area of the ice sheet was completely lifted and blown out of the crater,exposing the frozen ground underneath. The exposed frozen ground was not visibly disturbed or cratered by the explosion.

The four projectiles of delayed fused 105 mm projectiles behaved very erratically. Two projectiles hit the ice and frozen ground and ricocheted into the air before exploding. One projectile exploded at a height of 50 ft or so. The other projectile exploded at least 100 ft up. One other crater looked very similar to the point delayed projectile craters. The other crater (from the near surface burst?) was very oblong as if the projectile started to ricochet and was near the surface and traveling outward when it exploded.

The 60 mm and 81 mm mortars produced similar results in that the craters did not penetrate the ice cover. The 60 mm mortar, using a point detonating fuse, produced a 6 ft dia and 8 to 12 in deep crater. The explosion removed the 8 to 12 in snow cover, exposing the top of the ice sheet in the bottom of the crater. Little or no visible cratering of the ice occurred.

The 81 mm mortar with the point detonating projectile produced 2.2 m diameter craters in the snow with just slight depressions in the ice at the center of the craters. Two of the 81 mm mortar projectiles with delayed fuses produced similar craters.

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TABLE I. Measurement data from craters.

Crater Number	Description	Maximum Diameter m	Minimum Diameter m	Center Depth m	Notes
	105 mm Howitzer				
#1	Point Detonating Fuse	2.26	1.89	0.30	
#2	"	2.90	2.10	0.44	1.2 x 0.6 m area of ground exposed at bottom of crater.
	"				
#3	"	3.29	2.50	0.37	
#4	"	3.38	2.32	0.39	
#5	"	3.20	2.77	0.30	
#6	"	3.63	2.50	0.27	0.6 m area in center where ice shattered
#7	"	1.07	0.61	–	Either dud or point where projectile ricochetted.
#9	"	3.54	3.05	0.20	0.6 m area of shattered ice in center
#8	Delay Fuse	7.62	x2.44 x 0.60	0.20	Shallow, elongated crater. Ricochet projectile blew up near surface
#10	Delay fused	3.00	2.40		
	60 mm Mortar				
#1	Point detonating fuse	1.83	1.83	0.21.	Depth of crater is equal to depth of snow on ice sheet
#2		1.83	1.52	0.15	ie. bottom of crater is top of ice sheet
#3		1.80	1.89	0.18	0.10 dia x 0.08 deep hole in ice in exact center. Fuse parts in hole.
#4		1.83	1.52	0.22	
#5		1.83	1.83	0.17	
	81 mm Mortar				
#1	Point detonating fuse	2.29	2.59	0.15	Bottom of crater is on top of ice sheet
#2		2.29	2.44	0.16	
#3		2.26	1.86	0.16	
#4		1.83	1.83	0.17	
#5	Delay fuse	Camouflet			
#6	Delay fuse	Camouflet			0.6 x0.9 mound of ice rubble. 0.6 dia x approx. 1.8 m crater hidden under rubble.

APPENDIX I

HUMAN HEALTH RISKS FROM CONSUMING CONTAMINATED WATERFOWL FROM THE EAGLE RIVER FLATS

Human Health Risks from Consuming Contaminated Waterfowl from Eagle River Flats

1. During the period May through September 1991, Army biologists have conducted 12 helicopter surveys of Eagle River Flats and wetlands adjacent to the post, looking for indications of sick or dead birds. Although no carcasses or dying birds were found in off-post areas, which included Goose Bay and Fire Creek, waterfowl mortality continued to occur on the Eagle River Flats. In addition, the biologists have intensively searched the flats for any evidence of predator deaths, and found one dead juvenile bald eagle in May 1991.

2. Systematic searches of post lakes using canoes have revealed one dead bird, tentatively identifies as a grebe, found on Clunie Lake, approximately 4 air miles northeast of the flats. Tissue samples from that bird indicated the presence of WP. The only other bird found to contain WP outside the flats was a hen mallard found at Gwen Lake, also on post. Based on this information, the U.S. Army Environmental Hygiene Agency (EHA), Aberdeen Proving Ground, Maryland was tasked to prepare a preliminary risk assessment based on available data and utilizing the Environmental Protection Agency oral reference dose for WP. EHA's results are attached herein.

3. Following a review of EHA's investigation findings, Dr. John Middaugh, State Epidemiologist, concluded the risk can be said to be so low as to constitute no basis for public health concern. A copy of Dr. Middaugh's letter is attached.

4. As a part of a follow up study to the human health risks, over three (300) gizzards from ducks in the Upper Cook Inlet area were ollected from local duck hunters by federal and state biologists in September 1991. These samples will be analyzed by Cold Regions Research and Engineering Laboratory (CRREL) for WP and lead. Results will be useful in determining the human health hazards of eating ducks from this area and the probability of the ducks being contaminated with WP from Eagle River Flats.

5. Additional studies are to be conducted on waterfowl under stringently controlled laboratory and field conditions. Additional field sampling will be conducted to determine if WP contaminated birds are leaving Fort Richardson, and if they are, the types and approximate numbers that are being dispersed in the general population. This information can then be used to more accurately evaluate the potential human health risk of consuming waterfowl from the upper Cook Inlet area of Alaska.

APPENDIX F

VEGETATION ZONES AND PLANT COMMUNITIES, EAGLE RIVER FLATS, ALASKA

Pools and Ponds in the Inner Marsh:

Ponds up to 18" in depth have interspersed clumps and islands of taller vegetation, emergent sedges and the bulrush Scirpus validus. Hippurus tetraphylla is found in shallower water along with Potamogeton pectinatus, P. vaginatus, Ruppia spiralis and Zarnichellia palustris.

Salinity: 2-9 ppt

Waterfowl Use: Dabbling ducks commonly congregate here to feed during Spring and Fall migrations.

Edge of Eagle River Flats: Essentially a fresh water wetland

A shrub bog develops at the edge of Eagle River Flats. include Myrica gale, Carex pluriflora, Calamagrostis canadensis, Potentilla palustris, and Lathyrus palustris.

Salinity: 2 ppt

Wildlife Use: Cranes and swans were frequently observed in this habitat type.

Vegetation Zones and Plant Communities found in the Eagle River Flats by the Cold Regions Research and Engineering Laboratory Research Team in 1990

Outer Mudflats (Adjacent to Knik Arm):

Bare or sparsely vegetated by alkali grass (Puccinellia sp) or occasional annual species such as Salicornia europea or Atriplex alaskensis.

Salinity in this zone: 15-25 parts per thousand (ppt)

Raised Levees along Banks of Eagle River and other large Distributaries:

These well drained soils are occupied by Elmus sp., commonly called Beacg Grass.

Inner Mudflats:

Vegetation includes alkali grass, annual herbs, Triglochin maritimum and Plantago maritima.

Salinity: 12 to 20 ppt in standing water

Waterfowl use: Geese graze in this zone

Inner Sedge Marsh:

Vegetation is dominmated by the sedge Carex lyngbyei which grows to over 3 feet in height.

Salinity: 2-9 ppt

Waterfowl Use: New shoots of this sedge grow in the Fall and are consumed by migrating waterfowl

DEPARTMENT OF THE ARMY
U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO ATTENTION OF

HSHB-ME-SR (40)

24 JUL 1991

MEMORANDUM FOR Commander, U.S. Army Toxic and Hazardous Materials Agency, ATTN: CETHA-TS-S, Aberdeen Proving Ground, MD 21010-5401

SUBJECT: Preliminary Evaluation of Possible Human Health Hazard from Waterfowl at Eagle River Flats and Recommendations for Additional Studies

1. Enclosure 1 provides a preliminary evaluation of potential health hazards from ingestion of contaminated waterfowl and recommendations for further study.

2. A statistical sampling plan for hunter harvested ducks in the Cook Inlet Area is presented in Enclosure 2.

3. The Health Risk Assessment Branch, this Division, and CPT Brian G. Scott, MS, Occupational and Environmental Medicine Division, have provided input to and concurrence with the conclusions and recommendations contained in the enclosures.

4. Points of contact are Mr. Dennis E. Druck and Dr. Jack Heller, DSN 584-2953 or commercial (301) 671-2953.

FOR THE COMMANDER:

2 Encls

William T. Broadwater
WILLIAM T. BROADWATER
LTC, MS
Chief, Waste Disposal Engineering Division

CF (w/encls):
HQDA(SGPS-PSP-E)
Cdr, HSC, ATTN: HSCL-P

HSHB-MO-T 28 Jun 91

C, TOX

FOR C, WDED, ATTN: MAJ Legg

SUBJECT: Waterfowl Deaths at Eagle River Flats (ERF) - Possible Human Health Hazard

1. Reference FONECON 14 Jun 91 between MAJ Legg (WDED) and Dr. Leach (TOX) requesting assistance in determining possible health risk from consumption of waterfowl at (ERF).

2. Final report entitled; Waterfowl Mortality in Eagle River Flats, Alaska: The Role of Munition Compounds, U.S. Army Cold Regions Research and Engineering Laboratory, Hanover NH, January 1991 was reviewed along with other pertinent documents to determine possible health hazards from consumption of waterfowl. The following comments are offered:

a. This study appears to be the first conclusive evidence in the ten year history of waterfowl kills at the ERF to document the ingestion of elemental phosphorus as the causative agent. The study protocol was obviously designed to pinpoint the toxic agents responsible for the mortality but is inadequate to determine the possible hazard of ingesting poisoned waterfowl. Necropsy data and analysis of organs clearly document the ingestion of the material but the mechanism and severity of phosphorus uptake in edible tissues is inconclusive. The single field specimen for which the determination of phosphorus in pectoral muscle was performed indicates a value of .0016 ug/gm of tissue, substantially lower than any of the other organs tested. Similar results were obtained for the two birds poisoned in the Laboratory studies. The absence of muscle data in any of the control birds further compounds the difficulty of assessing this hazard.

b. The data indicate that the poisoned waterfowl are incapacitated or die within a relatively short period of time from ingestion. This factor should serve to make them relatively unavailable to the hunting community or would at least severely restrict the geographical area in which they would be found. It is unlikely that birds that are asymptomatic would have significant tissue levels of elemental phosphorus.

3. Recommendations.

a. Data clearly support continuation of the firing ban at Eagle River Flats.

HSHB-MO-T
SUBJECT: Waterfowl deaths at Eagle River Flats (ERF) - Possible Human Health Hazard

b. Though data are fragmentary, there is sufficient evidence to suggest phosphorus toxicity in waterfowl and perhaps predators higher up in the food chain. Additional field sampling and laboratory studies should be performed.

c. Data are insufficient to make a clear determination of possible human health hazard. Since this has been a persistent problem for at least ten years with no complaints of adverse human health effects it would appear that there is no confirmed basis for closing or restricting the forthcoming waterfowl season. Documented elevated phosphorus levels are a clear cause for concern and may in fact indicate a significant hazard but the extremely sparse data for edible portions (muscle) in the waterfowl tested are insufficient to justify major change to current procedures or regulations. Since hunting has already been banned at ERF, the only contaminated birds that hunters are likely to encounter are ones that were exposed at ERF and then migrated to an area where hunting is permitted. The probability of a hunter taking a large number of contaminated birds in a given season is very small. The health concerns in this situation appear to be more of an acute problem than chronic. Since P4 was used commercially as a rodenticide, there is information available on its toxicity to animals. Human data, from accidental ingestion, is also available. Based on this information, and the very limited data on tissue P4 levels from wild and farm reared birds, it is very unlikely that hunters or their families could ingest quantities of P4 that would result in an acute toxic effect.

d. Hunters should be warned not to consume sick waterfowl or waterfowl found dead in the areas adjacent to the ERF.

e. Additional studies need to be urgently performed on waterfowl under stringently controlled laboratory conditions. A statistically significant number of controls and treated birds need to be examined and edible portions (muscle) and also bone need to be examined for both elemental and total phosphorus content in animals dosed with P4. Field sampling is required to determine if contaminated birds are leaving ERF, and if they are, the types and approximate numbers that are dispersed in the general population. This data would significantly aid the assessment of potential hazard to human health.

4. Point of contact is Mr. LeRoy W. Metker, X3980/3627.

FOR THE COMMANDER:

MAURICE H. WEEKS
Chief, Toxicology Division

MEMORANDUM FOR RECORD

SUBJECT: Statistical Sampling Plan, Hunter Harvested Ducks in Cook Inlet Area, Alaska.

1. BACKGROUND. Waterfowl are being exposed to white phosphorus (WP) which is present as a contaminant in the sediments of Eagle River Flats (ERF) on Fort Richardson. It is possible that ducks containing WP are leaving ERF and being harvested by hunters in areas of Cook Inlet surrounding Fort Richardson. The risk to human health associated with consumption of potentially WP contaminated ducks is being evaluated. The most important initial step in this risk assessment will be the collection and analysis of tissue from ducks harvested by hunters during the fall 1991 hunting season which begins 1 September 1991. The purpose of this memorandum is to discuss the statistical aspects of sample size, exposure probability, and risk calculations.

2. STATISTICAL POPULATION. The waterfowl population in Cook Inlet can be viewed as having four segments for the purpose of this analysis.

a. Population Segment S_1. Those birds which have never been at ERF and are assumed to have no detectable WP in tissues.

b. Population Segment S_2. Those birds which have been at ERF, but have not been exposed to WP in amounts large enough to result in detectable WP in body tissues.

c. Population Segment S_3. Those birds which have been at ERF and exposed to a sublethal dose of WP.

d. Population Segment S_4. Those birds which have been at ERF and have been exposed to a lethal dose of WP, but which have moved to one of the surrounding hunting areas prior to dying.

In practice, it will probably not be possible to distinguish between population groups S_3 and S_4. Hunters may not recognize abnormal behavior in ducks, and the levels of WP in gizzard contents and tissues are highly variable among ducks exposed to a lethal dose of WP.

3. PERTINENT QUESTIONS. When evaluating the potential human health risk, there are several questions which must be answered. The first question is:

- Are waterfowl contaminated with WP present in the offpost hunting areas?

If the answer to this first fundamental question is yes, there are then other questions which must be answered. These include:

- What is the maximum quantity of WP which a person could be reasonably expected to consume if a contaminated duck is eaten?

- What is the probability that a person would consume a quantity of such ducks which would result in exposure to WP exceeding criteria for protection of health?

4. ASSUMED SAMPLING PROGRAM. It is assumed that the hunter harvested duck tissue collection program will involve the collection of gizzards, associated fat, and some muscle tissue from a predetermined number of birds (h). Gizzard contents and fat tissue will be analyzed to determine WP concentration. If WP is detected in either gizzard contents or fat tissue, muscle tissue from that duck will also be analyzed. To ensure that all necessary data can be acquired, it is recommended that whole carcasses of ducks be obtained for study, if possible.

5. SAMPLE SIZE DETERMINATION. When attempting to determine if waterfowl contaminated with WP are present in areas surrounding Fort Richardson, and in calculating the number of hunter harvested ducks to collect, the population of hunted birds can be viewed as those contaminated (population segments S_3 and S_4) and those not contaminated (segments S_1 and S_2), without regard to levels of contamination is tissue. The binomial distribution can be used to calculate probabilities for this situation. The formula for the binomial probability distribution is given in the enclosure to this memorandum. If no contaminated ducks are found with sample size h, the confidence level varies with the proportion of the duck population which could be contaminated. The following table lists the maximum proportion of the total population contaminated for various sample sizes and statement confidence levels, assuming no contaminated ducks are found.

Sample Size	--- Confidence Level ---		
	90%	95%	99%
25	0.088	0.113	0.168
50	0.045	0.058	0.088
100	0.023	0.030	0.045
150	0.015	0.020	0.030
200	0.011	0.015	0.023
400	0.006	0.007	0.011

For example, if tissue from 100 ducks is collected and no WP is detected in the tissue, you could state that the proportion of contaminated ducks in the population is less than or equal to 0.03 with a 95% confidence level. The tissues could be collected from ducks all from one area, and the results then extrapolated to other hunting areas, but this would assume that duck movements from ERF to other areas of Cook Inlet are similar for all areas. It is recommended that collection be from a number of areas, with total number collected being dependant on desired confidence level and objectives. The number of samples from each hunting area should be roughly proportional to the number of ducks harvested by hunters from each area, but not less than 25 birds should be obtained from an individual area.

6. CASE OF WP DETECTED IN SOME SAMPLES. The following data analysis approach could be used if WP is detected in any tissue samples from hunter harvested ducks.

a. Using data <u>only</u> from birds in which WP was detected, calculate the quantity of WP in consumable tissue per contaminated duck (E). After the data is available, the data can be examined, an appropriate probability distribution assumed, and a value determined. Either the mean or a conservative high value can be selected. If the levels are such that consumption of one or a few ducks could cause significant health risk, a conservative high value should be selected. If a larger number of ducks would have to be consumed to exceed acceptable levels, the mean of the WP concentrations may be reasonable.

b. Using the assumed/calculated value E, calculate the maximum number of ducks (C) which can be consumed per year without exceeding acceptable exposure levels.

c. Assume a number of ducks a hunter could consume per year (M). The assumed number should be conservative, but reasonable.

d. Given that "x" contaminated birds were found in a sample size of h, assuming a desired confidence level, and using the binomial probability distribution, calculate the associated maximum proportion (p) of the duck population in Cook Inlet which may be contaminated.

e. Using the maximum number of ducks which can be consumed per year without exceeding acceptable exposure levels (C), the assumed reasonable maximum total number of ducks consumed per year per individual (M), and the calculated maximum proportion (p) of the duck population contaminated, calculate using the binomial probability distribution the probability of consuming more than C ducks per year. This is the maximum probability that an individual could consume WP exceeding acceptable exposure levels.

7. CASE OF NO WP DETECTED IN ANY SAMPLES.

a. Calculate as in paragraph 5 above the possible proportions of the duck population possibly contaminated for the given sample size (h) and desired confidence level.

b. While in this situation there is no evidence of exposure to the hunter population, it cannot be assumed that the risk is zero. Use WP concentration data from ducks collected at ERF and perform calculations as outlined in the preceding paragraph. The calculated risk will be conservative because there is no actual evidence to indicate that human exposure to WP is actually occurring, and if there is exposure, the actual levels in ducks harvested by hunters outside ERF are likely to be lower than for ducks collected at ERF. It is in fact this situation which should be anticipated and considered when determining sample size.

William T. Broadwater, LTC, MS
for GARY NEMETH
Environmental Engineer
Waste Disposal Engineering
Division

VARIABLES

h — Total number of hunter harvested birds from which tissue is obtained. Subscripts identify the particular hunting area from which the ducks are collected: h_g for Goose Bay, h_s for Susitna Flats, h_p for Palmer Flats, and h_m for Potter Marsh.

x — Number of ducks found to contain WP from among h sampled.

E — Assumed/calculated quantity of WP consumed per contaminated duck.

C — Calculated maximum number of contaminated ducks which can be consumed per year without exceeding acceptable exposure levels for WP.

M — Assumed maximum total number of ducks consumed per person per year.

p — Calculated proportion of the total duck population in hunted areas of Cook Inlet which are contaminated with WP.

FORMULAS

$$Px(k) = P\{x=k\} = \frac{n!}{k!(n-k)!} p^k (1-p)^{n-k} \qquad (1)$$

for k=0,1,2,...,n

where $0 < p < 1$

n is a positive integer

n = number of samples

k = number of occurrences

p = probability of an individual occurrence

HSHB-MO-T

28 Jun 91

C, TOX

FOR C, WDED, ATTN: MAJ Legg

SUBJECT: Waterfowl Deaths at Eagle River Flats (ERF) - Possible Human Health Hazard

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2. Final report entitled; Waterfowl Mortality in Eagle River Flats, Alaska: The Role of Munition Compounds, U.S. Army Cold Regions Research and Engineering Laboratory, Hanover NH, January 1991 was reviewed along with other pertinent documents to determine possible health hazards from consumption of waterfowl. The following comments are offered:

a. This study appears to be the first conclusive evidence in the ten year history of waterfowl kills at the ERF to document the ingestion of elemental phosphorus as the causative agent. The study protocol was obviously designed to pinpoint the toxic agents responsible for the mortality but is inadequate to determine the possible hazard of ingesting poisoned waterfowl. Necropsy data and analysis of organs clearly document the ingestion of the material but the mechanism and severity of phosphorus uptake in edible tissues is inconclusive. The single field specimen for which the determination of phosphorus in pectoral muscle was performed indicates a value of .0016 ug/gm of tissue, substantially lower than any of the other organs tested. Similar results were obtained for the two birds poisoned in the Laboratory studies. The absence of muscle data in any of the control birds further compounds the difficulty of assessing this hazard.

b. The data indicate that the poisoned waterfowl are incapacitated or die within a relatively short period of time from ingestion. This factor should serve to make them relatively unavailable to the hunting community or would at least severely restrict the geographical area in which they would be found. It is unlikely that birds that are asymptomatic would have significant tissue levels of elemental phosphorus.

3. Recommendations.

a. Data clearly support continuation of the firing ban on white phosphorus munitions at Eagle River Flats.