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FIELD TOUR OF UXO ACTIVITIES ON THE FORMER NAF ADAK

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13. ABSTRACT *(Maximum 200 words)*

In 1994 Naval Air Station Adak was re-designated as Naval Air Facility Adak and subsequently was directed to close under the Base Realignment and Closure Act of 1995. NAF Adak has been in caretaker status since 31 March 1997 when it operationally closed. The Navy is facilitating private-party economic reuse on Adak under a land exchange agreement that will transfer a portion of the current military reservation from the federal government to the Aleut Corporation. The administrative oversite for the transition process is the responsibility of the Naval Facilities Engineering Command, Environmental Field Activity, Northwest. (EFA) During the week of 14 June 1999 EFA hosted the Naval Research Laboratory, and others, in a driving and walking tour of many of the ranges and areas of concern for UXO contamination. This report addresses our evaluation of the potential for use of automated geophysical survey technologies such as MTADS for UXO investigations on Adak.

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FIELD TOUR OF UXO ACTIVITIES ON THE FORMER NAF ADAK

Background

Adak, the largest island in the southern group of the Aleutian Island chain, was designated as part of the Aleutian Islands Reserve by Executive Order 1733 on March 3, 1913. Subsequently, this withdrawn land was re-designated as a sub-unit of the Alaska Maritime National Wildlife Refuge by the Alaska National Interest Lands Conservation Act on December 2, 1980.

In the early 1940s Adak became a key operations and supply location for United States military forces after the Japanese attacks on Kiska and Attu Islands during World War II. The northern portion of Adak was designated for use by the Navy for military purposes, and Naval Air Station (NAS) Adak was established.

The highest level of activity on the base was during World War II. At this time as many as 100,000 personnel were based at various locations on the northern half of the island. Ground troops were supported by significant artillery capability and an extensive air support wing associated with the military airfield. Most military operations were associated either with readiness training or in defensive operations in preparation for potential invasion from the west. Archive records searches have revealed that many of these activities potentially left significant UXO contamination on ranges and defensive positions on more than 50% of the island north of a line between Expedition Harbor and Campers Cove.[1] This includes the entire area of Mt. Moffett. Many of the areas of concern are identified on the topographic map in Figure 1.

In 1994 the base was re-designated as Naval Air Facility (NAF) Adak and subsequently was directed to close under the Base Realignment and Closure Act (BRAC) of 1995. NAF Adak has been in a caretaker status since March 31, 1997 when it operationally closed. In its present caretaker status there are only about 20 military personnel present, under the command of LCDR Floro, maintaining core facilities on the site. The Navy is facilitating private-party economic reuse on Adak. This is to take place under a land exchange agreement that will transfer a portion of the current military reservation from the federal government to The Aleut Corporation. Completion of this land exchange requires the Navy to meet requirements established by the Department of Defense Explosive Safety Board (DDESB) for transfer of real estate potentially contaminated with ordnance and explosives (OE). Additionally, the transfer must meet the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), requiring the Navy to perform all remedial actions necessary to protect human health and the environment prior to signing the Record of Decision (ROD). The US Environmental Protection Agency (EPA) and the State of Alaska Department of Environmental Conservation (ADEC) will also be cosigners of the agreement.

The Navy administrative oversight for the transition process is the responsibility of the Naval Facilities Engineering Command, Environmental Field Activity, Northwest, (EFA). The BRAC administrator is Mr. Richard Stoll and the environmental and UXO oversight activities are the responsibility of Mr. Mark Murphy of EFA. Most current activities on the island are associated with deconstruction and clean up operations in preparation for transfer of control. These activities

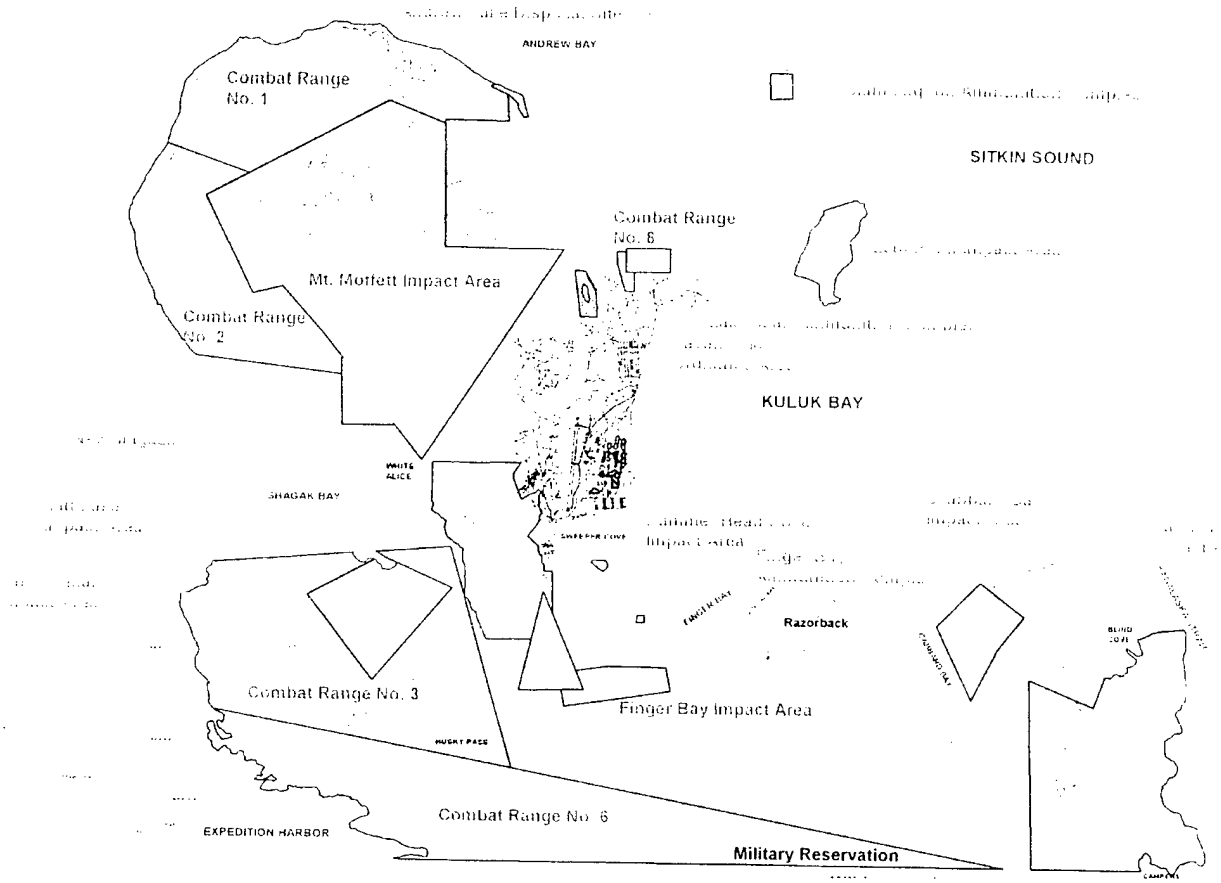

Figure 1. Topographic map of the northern half of Adak Island showing most of the impact ranges and areas of concern for UXO contamination.

include removal of asbestos and tear-down of numerous barracks and environmental remediation of a fuel spill associated with the town aquifer and a stream bed with a low level polychlobiphenyl (PCB) contamination. The largest remaining Navy responsibility on the island is to evaluate and mitigate potential UXO contamination associated with prior Naval training exercises.

UXO geophysical evaluations have been carried out during the last three summer seasons. UXO clearance activities concentrated on the downtown area during 1977,[2] stretching into 1998.[3] During 1998 most activities were associated with investigating more than 20 potential mine field sites. With one exception, all the investigations were negative. The archive records that triggered these investigations apparently referenced plans for installation of potential future defensive minefields.[4] The exception, described below, was apparently a minefield training area. Live mines and training mines were found and removed from SWMU 2 by Supervisor of Shipbuilding, Conversion, and Repair Portsmouth, Virginia (SSPORTS) during 1998 as part of an ongoing activity at this Waste Management Unit. This area was completely investigated and remediated (removing practice mines and two live M2A1 bounding mines).[5] Remnants of banglore torpedoes (used in mine clearance) were also found along with other OE wastes, suggesting that the area was used as a training and

disposal area. Following the removal of the ordnance-related materials, the area was completely resurveyed using metal detectors, again with negative results. DDESB approval to close out this site is pending.

During the 1999 field season (March-October) preliminary site investigations are being conducted on other documented ranges to determine the extent and types of UXO contamination. This area, referred to as the "Outback Area," includes 46,200 acres that are potential UXO impact areas. Over 6,000 acres of this area is inaccessible, due to steep terrain slope (>27.5°). The FY-99 studies are being conducted by Foster Wheeler, with EFA support and oversight. The operations are described in the activity Work Plan.[6]

Inspection of Ranges and UXO Areas of Concern

During the week of 14 June Mr. Murphy and Mr. Stoll of EFA hosted a driving and walking tour of many of the ranges and areas of concern for UXO contamination. Minimal time was spent on any of the ranges, impact areas or specific areas of concern as they are numerous and many individual impact areas are extensive, covering many thousands of acres. Travel to areas on the west and north side of the island required hiking and boat transport as there are currently no improved roads to these areas.

With an invitation by Mr. Mark Murphy of the Naval Facilities Engineering Command, Environmental Field Activity, Northwest, (EFA) Dr. Jim McDonald of the Naval Research Laboratory participated in the tour of the sites which are suspect UXO contaminated areas. Dr. McDonald was accompanied by Mr. Richard Robertson of Hughes Associates (Columbia, MD) and Mr. Mark Blohm of Blackhawk Geometrics (Golden, CO). The tour was attended by participants of several other agencies with an interest in the progress in the UXO investigation. The participants are listed in Table 1. NRL participation is focused on evaluation of the potential for use of automated geophysical UXO survey equipment such as the Multi-sensor Towed Array System (*MTADS*) for future site characterization studies or for extensive surveys in preparation for UXO remediation. The MTADS is a vehicular towed UXO site characterization system employing arrays of both Cs vapor magnetometers and highly-modified EM 61 sensors.[7]

We briefly visited 12 of the specific sites noted in Figure 1. Below we give cursory descriptions of our observations on individual sites with specific reference to information relevant to the use of automated towed arrays for geophysical investigations at these sites. Much more extensive information relative to the geology, topography and prior use of these areas can be found in other publications and studies. Adak, like the other islands in the Aleutian Chain, is of volcanic origin. There has been no volcanic activity in recent geologic times on this island. The island topography is rugged, highly weathered, and characterized by gullys, streams and small lakes fed by snow melt. The two most striking features on the island are Mt. Moffett rising as sheer cliffs on the north side of the island and a fresh water impoundment called Lake Andrew. The lake was created from a cove by erecting a seawall across Andrew Bay during the World War II time period. See Figure 2. The height of the lake varies from year to year due to the impact of Bering Sea winter storms on the seawall structure. The north shore and the seawall is dominated by a large cobblestone beach. Beaches on other parts of the island vary from cobble to narrow ribbons of dark sand. Most of the

Table 1. Interested Parties on the Tour of Potential UXO Sites.

Person	Affiliation	Phone/Email
Richard Stoll	EFA, BRAC Coordinator	360-396-0065 StollRK@efanw.navfac.navy.mil
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island, except for the upper reaches of Mt. Moffett, is covered by a combination of grasses and tundra. In many places this soft mat is over 2 feet thick with the grasses becoming much taller in the summer months. Dips, pot holes, depressions, and runoff streams are often invisible below the tundra mat. In many areas the June water table is effectively at ground level. Tundra, grasses, wild flowers and weeds are the dominant vegetation on the island. We observed no established native trees or even scrub brush on the island.

Site: Combat Range 8.

We skirted a section of the south and western edges of this site, walking about 0.4 miles overland. See Figure 3. The grass mat is 0.5-1.5 feet thick, the surface is varied, the highly

weathered areas have extensive gullys and relatively steep (>15°) slopes. The flatter areas are rolling with shallow slopes and small depressions. We observed extensive debris, including timbers, metal scrap and assorted abandoned junk randomly scattered on the surface. We estimate that *MTADS* could traverse 40-50% of the area, although it would be highly susceptible to bottoming out or becoming stuck on high center from dropping a wheel into hidden depressions. We observed no ordnance-related items at this site.

Figure 2. Image of the seawall separating Lake Andrew from the Bering Sea. The Lake Andrew disposal area is located at the northeast corner of the seawall.

Site: Lake Jean Ammunition Complex

This area is contiguous with and overlaps the western edge of Combat Range No 8. We walked the length of this site, briefly skirting around the edge of the Lake Andrew shoreline. The terrain is much like the area described above. Areas along the shoreline and edge of the lake could be surveyed by *MTADS* up to the point that steeply rising slopes limit access.

Site: The OB/OD Area in Parcel 4

Much of this area along the western edge of Lake Andrew is fenced and access is restricted. We

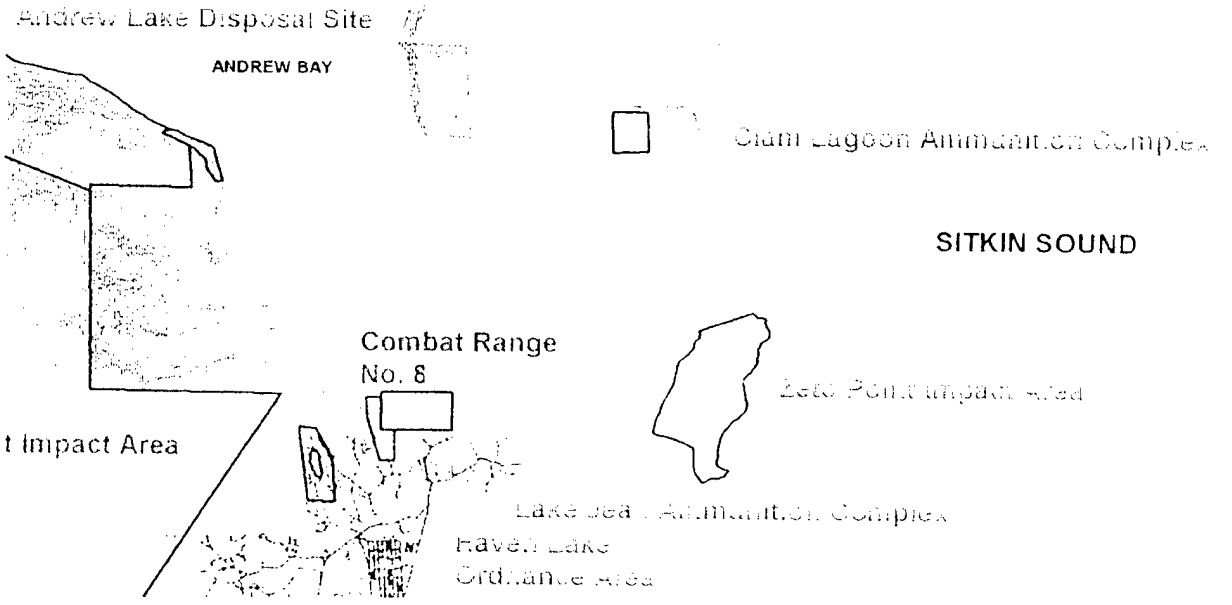

Figure 3. Expanded topographic map of Adak Island showing several of the areas of concern near Lake Andrew.

drove and walked up the East-West trending glacial valley to the area of the detonation and burn pits. The area, slowly rising from the lake shore, is relatively flat wetlands. The valley, itself, which stretches across the southern edge of the area labeled Parcel 4 in Figure 3, gently rises to above the detonation and burn pits. On the northern side of the valley there are protective works associated with a grenade training range. Impact areas were pointed out for ordnance described to be 40, 60, 81 and 105 mm. In the center of the valley is the obvious OB/OD area. This area, as shown in Figure 4, is heavily cratered, much of it is obviously saturated with frag and OE scrap. Some intact fuzes and components are visible, scattered about the area. Ordnance surveys in the immediate OB/OD area would be impractical, as the area is saturated with scrap.

Figure 4. Photograph of a section of the OB/OD area showing OE scrap and clutter.

Some of the area in the low wetlands, stretching up along the valley sides, could be amenable to survey with automated towed arrays, such as the *MTADS*. This would include some of the areas described as ordnance impact areas. Effectively all the area, stretching from the wetlands near the lake to above the detonation/burn pits, is dominated by extensive surface structures, and scrap and wastes from prior activities. UXO surveys of this area with the intent to clean the area would be useless without first carrying out an extensive surface clean of the area. Much of the trash contains relatively large structures; heavy equipment including dozers, front end loaders and dump trucks would be required to remove and consolidate the debris. Much of the surface clutter consists of timbers and other wooden trash. This material could be consolidated and burned. As mentioned above, survey of the immediate OB/OD area is impractical as it is clearly saturated with ferrous debris. This area will have to be permanently fenced or effectively strip mined for metal to clean it of potentially dangerous items.

Site: Seawall and Lake Andrew Disposal Area

If it is decided to focus remediation activities around recreation areas, cleaning around the seawall, shoreline and adjacent trails would be a high priority. The shoreline (not the seawall) would be amenable to automated survey up to the point that the rising slopes limit driving. There are a few obvious disposal pits and craters near the shore at the western end of the seawall. There are significant numbers of military shell casings and other OE scrap along the road and shore areas near the western end of the seawall. The area containing the disposal pits is too rugged for vehicular towed surveys.

Site: Fenced Minefield

This is a relatively large flat area. There are some small (2-5 foot high) mounds of unidentified

origin. There are some tracks and ruts, obviously from long ago, created by large tracked and wheeled vehicles. Where disturbed, the surface layers resemble peat. *MTADS* could likely survey much of this area. Since several practice mines and two HE-filled M2A1 mines were discovered at the site, the whole area was surveyed using metal detectors and all targets were dug and a second QA metal detection survey was done. Currently, the site is awaiting a ROD and a DDESB approval to declare the area as cleared.

Site: Clam Lagoon Ammunition Complex

We drove into the area on a road that was terminated by a large landslide that covered the road and the valley floor, including a small stream. We walked a bit further up the valley and observed the ruins of several large steel Quonset huts and an abandoned magazine. No ordnance or OE scrap was observed. Towed array surveys could be conducted along the roadside, extending out for a few to a few tens of yards, until the terrain becomes too step for vehicular surveys.

Site: Hammerhead Cove Impact Area

This was described as a 20 and 30 mm impact area used by naval vessels firing from Sweeper Cove into the side of a steep hill. The Foster Wheeler team claimed to have investigated the area and found no UXO contamination. This entire area, because it lies on a steep hillside, is inappropriate for any type of automated survey using towed sensor arrays.

Site: Finger Bay Impact Area

We hiked up a valley above Finger Bay along a mountain stream (and ultimately through a pass looking down on Lake Betty). Foster Wheeler representatives showed many recently-discovered photographs from an archive survey showing the area to be a demonstration firing range for 30-50 (?) mm guns and mortars firing HE and WP rounds into well defined target areas on an identified hillside. We also observed clearly defined rifle and small arms ranges with identified target facilities on a hillside adjacent to the stream.

In this area some of the valley and roadside areas could be surveyed with towed arrays. The vehicle-accessible areas include less than five percent of the range.

Site: Dynamite Storage Area

This defined area is dominated by a 9-acre meadow. Abandoned magazines were observed along the road adjacent to the area. Although there were numerous used shotgun cartridges on the ground we observed no military ordnance-related items. Foster Wheeler showed the results of a 13 mile wandering traverse survey of the area in which they had marked about 200 targets. *MTADS* could survey 60-70% of the meadow if standing water was not present during the survey.

Site: Combat Range No. 3

Figure 5. Picture of Beverly Cove and the landing craft supporting the highlands survey above the cove.

On June 6 we hiked from White Alice point, boarded small work boats at Shagak Bay and rode to Beverly Cove where the large catamaran (Figure 5) was docked to provide logistic support to the west island exploration surveys. From this point we hiked to a hilltop where one could look across a valley to an adjacent hillside that was scarred by activities from 50 years ago. There were numerous crater-like scars, many were square and placed in regularly spaced in lines. These were likely WW II bivouac and camping areas. On this side of the island, except on the hilltops, the tundra is very thick; it is undercut by runoff streams. The topography varies from valleys and lowland meadows to steep slopes and hills. Foster Wheeler was conducting meandering EM 61 traverses across the area. Sample digging is scheduled to take place during July. The number of detected targets in this area was reportedly very low.

This area is inappropriate for vehicular surveys unless WW II roads are improved to provide vehicular and logistics access. The area is very remote. Unless the presence of UXO is demonstrated, resources to support remedial activities are likely better concentrated in other areas.

The 1999 Foster Wheeler UXO Investigation in the Outback Areas

The 1999 Work Plan[6] called for investigation of the Outback Sectors denoted in Table 2. The total area of each of the sectors is listed, as is the fractional area deemed acceptable to investigate. The selection of the area for investigation by Foster Wheeler was based upon the "Ribbon Walk" adaptation of the SiteStats/GridStats methodology endorsed by the US Army Engineering Support Center, Huntsville. Under these guidelines a single traverse using the Geonics EM 61 is made using generated geographic way points to define the path of the geophysical survey. Within these guidelines, the surveyor is allowed to deviate from the path because of difficult terrain, obstructions, or other restrictions. These deviations from the defined straight-line path increase the actual area surveyed. Following the survey, data is analyzed to define targets of interest, and targets are subsequently dug based upon a complex formula defined by the sampling software.

The information provided in Table 2 indicates that the area investigated during the FY 99 season constitutes <0.4% of the total area of concern. While there has been some sampling in all of the areas of concern, the fractional coverage is quite low, particularly on the larger ranges. Based upon items ultimately recovered, these sampling results might be expected, at a minimum, to provide evidence of ordnance types used on the various ranges. It is a subject of conjecture, however,

whether the fact that a particular type of ordnance was not found in this sampling process, constitutes evidence that it was not used on a particular range.

If our understanding of the process is correct, the FY 99 survey costs, based upon information in Table 2, are close to $35,000 per acre. It is unclear what the outcome of the current dispute process involving EPA, the Navy, and other stakeholders will be, and what effect that this will have on future UXO site characterization and cleanup. However, if a decision is made requiring extensive further UXO mitigation, the current production costs (which do not include prosecuting all targets) project to astronomical expenditures for an extensive clean up. NRL representatives attended this demonstration to evaluate the sites and project whether automated surveys using the *MTADS* (or other) towed arrays are feasible for use on Adak and whether significant cost savings might be realized from use of these techniques.

Table 2. Outback Sampling Areas and Ribbon Walk Survey Results.

Outback Sector	Total Area (acres)	Included Area (acres)	Ribbon Length Surveyed (miles)	Area Surveyed (acres)
Andrew Lake Disposal Area	44	34	9.9	3.6
Camper's Cove, Blind Cove Impact Area	4456	3388	26.9	9.8
Clam Lagoon Ammunition Complex	80	78	11.2	3.6
Combat Range No.1	4234	2795	26.5	9.6
Combat Range No.2	3405	2961	25.4	9.2
Combat Range No. 3	6091	5295	49.7	18.1
Combat Range No. 6	6788	6172	51.0	18.5
Combat Range No. 8	158	158	13.0	4.7
Finger Bay Ammunition Complex	9	9	7.0	3.8
Finger Bay Impact Area	446	406	16.3	5.9
Hammer Head Cove Impact Area	18	18	8.1	3.0
Haven Lake Ordnance Area	100	100	12.0	3.6
Lake deMarie Impact Area	1325	1325	20.6	7.5
Lake Jean Ammunition Complex	50	49	11.0	3.7
Mitt Lake Impact Area	482	435	16.6	6.0
Mt Moffett Impact Area	9085	7398	54.0	19.6
NAF Magazine Adak Lake deMarie Ammunition Complex	2168	2160	23.0	8.4
Scabbard Bay Impact Area	725	416	18.1	6.6
Zeto Point Impact Area	566	551	17.2	6.3
TOTALS	**40,431 acres**	**33,748**	**418 miles**	**152 acres**

Use of *MTADS* for Adak Site Characterization

We did not inspect all the ranges and impact areas on Adak. For instance, other than parts of Parcel 4, we did not enter Combat Ranges 1, 2 or the Mt. Moffett Impact Area. We walked over only the very western edge of Combat Range 6 and rode a boat around Combat Range 3. However, the areas we did inspect cover a range of terrain types. On the whole, the areas we did not visit have a more rugged terrain that the areas that we did inspect. Based upon our years of experience with the *MTADS* and after consultation among the NRL attendees we offer the following observations and conclusions:

- There are parts of the areas of concern in which the *MTADS* could be used. These include the flatter, less rugged areas such as the fenced minefield area, the dynamite storage area, the low lying areas in the valley below the OB/OD area, and certain areas around the lakeshore and roads. Even in relatively flat areas the deep tundra mat might be difficult for the existing towed array to navigate.

- The total fraction of the areas of concern that could be effectively surveyed by the existing (NRL or Blackhawk) *MTADS* is low. We estimate this to be perhaps 2% of the total area. The primary uncertainty in this estimate results from our inexperience dealing with the tundra vegetation mat. We feel that the current *MTADS* vehicles have too little ground clearance to be effective. We do not know to what extent the vehicle would ride on top of the tundra mat or would drop into depressions or cuts under the mat. Bottoming out or losing traction with a back wheel would require the vehicle to be pulled out, or winched out, of the situation.

- The logistics problems moving the *MTADS* to the site are significant and the logistics problems getting to areas without roads are significant. Use of *MTADS*, for other than a limited demonstration, would likely require regrading old, or cutting new, paths that the system could follow to remote sites. Logistics support such as the landing craft, boats and barges used on the west side of the island is prohibitively expensive.

- At higher elevations, and on hillsides, the *MTADS* vehicle would likely cause damage to the tundra surface much like we observed from the Argo traverses of steep areas above Beverly Cove.

- We realize, however, if extensive clean up is required, a more effective and less costly approach must be found. Based upon our experience with the *MTADS* and with Mark Blohm's extensive experience on the North Slope, we feel that is possible to field an effective towed array for extended surveys on Adak.. This will require a new tow vehicle, and likely a redesigned sensor platform. These issues are discussed below.

Approach for Economical UXO Site Characterization

If significant areas of Adak must be cleaned, more efficient, more economical approaches must be devised. Production rates must be increased with a much better ratio of field crews to support personnel. Logistics costs must be reduced; paying several thousand dollars per day for boats and

boat crews to work 4 miles away from headquarters is not reasonable. We propose the following ideas for consideration..

Survey and target analysis costs can likely never be reduced to the $500-700/acre level typical of ranges in the western U.S. However, we feel that costs can be likely reduced by a factor of 10 over the FY 99 production rates on Adak. Using automated techniques, with towed arrays is the most important element in productivity. The tow vehicle and sensor platforms must be rugged, durable, capable of operation on difficult terrain, and able to continue operations regardless of weather. We considered a range of tracked and wheeled vehicles, including the large-tired wheeled vehicles like the Rolligons used on the North Slope and snowcats used for transport and snow grooming. Vehicles, such as that shown in Figure 5, can climb and navigate slopes up to 45°. They offer enclosed cabs, providing protection for the operators and the electronics. Snowcats could be used for surveying year round if snow cover were not too deep.

By bringing first-order navigation control to the remote sites to support RTK operation, the operator, could use the *MTADS* data acquisition hardware and software to plan and guide survey operations with a real-time display of coverage and missed areas. With careful planning and working in shifts, it is likely that 12-16 hour survey days could be supported during the summer season. This will require careful attention to vehicle maintenance and redundant stocking of spares.

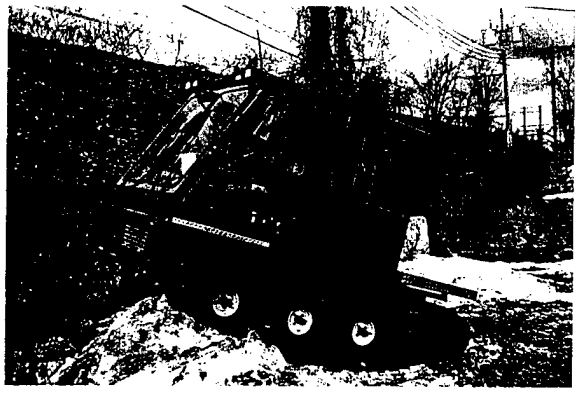

Figure 5. Commercial snowcat vehicle that could be used to conduct surveys on the tundra.

The current *MTADS* EM 61 survey system uses three sensor units in an overlapping array on a wheeled platform. To increase productivity we suggest that the system be expanded by adding 2 additional units. This will increase the array to 3 meters in width and add 50% to the production rate. The lack of trees and brush on Adak should present no obstacle to expanding the array. Both Blackhawk and the Canadian Ministry of Defense have had good results using EM 61 arrays deployed on sleds. The Canadian group routinely uses their system on tundra and in the snow. A sled might also work better on the Adak ranges than a wheeled trailer for the sensor platform.

The data analysis software being developed currently for the *MTADS* in ESTCP and SERDP programs provides significant target shape information (in addition to improved target location and depths). We have shown that using this shape information and training information resulting from digging a limited group of targets from a site, we can often discriminate between ordnance and scrap. This allows us to confidently leave up to 30% of the OE scrap targets in the field. This approach represents a significant cost savings as we typically find that the cost of digging 3 targets exceeds the cost of surveying one acre.

Data analysis for this proposed approach will require 2 analysts to provide one day turn around for the dig teams. The first analyst typically does the data preprocessing providing navigation

cleanup, editing turn arounds, integrating files into complete surveys, and preparing the data for target analysis. The *MTADS* data analysis has automatic target selection and analysis routines. The second analyst runs these routines, does quality checks and analysis clean up and prepares dig images, dig reports, and targets lists for the remediation teams. Additionally, this analyst prepares the target spreadsheets and loads the files into the way pointing navigation equipment. This approach typically provides one day turn around of survey data for the dig crews.

Digging targets is always the most expensive step in the cleanup operation and will remain so here. However, the dense data sets created by this approach, the advanced target analysis algorithms that are applied and the highly accurate RTK GPS navigation allow us routinely to stick the way point flag directly into shallow targets. When dig teams get used to and confident in the accuracy of the target marking, the target recovery process typically becomes more efficient.

The operational approach that we have described above should be able to survey 20-30 acres per day. The success of such an operation and the ability to continue high production rates would require thorough development and validation of the hardware careful planning of the operations, good maintenance practices and copius spares for critical components.

The survey and remediation approach we propose requires significant development, equipment procurement, and validation before it could be carried it into a remote area like Adak. For this reason, it should not be undertaken unless there is a need and commitment to an extensive operation on Adak. It is our preliminary estimate that this should involve at least a 1000 acres to justify the procurement and deployment costs. The scenario that we have outlined draws heavily on the *MTADS* hardware and software developments. NRL has transitioned these products to Blackhawk Geometrics under a CRADA and an exclusive licensing agreement. We estimate that it would require 6 months of procurement, development, validation testing before this technology should be deployed on Adak. We believe, however, that this approach offers the best opportunity for efficient and economical UXO remediation in this difficult remote site.

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