APPENDIX I

BASIS FOR DISMISSING FROM FURTHER EVALUATION THE USE OF HEAVY MECHANIZED EQUIPMENT FOR RECOVERY

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I.1 INTRODUCTION

In preparing the *Final Environmental Impact Statement for the Sounding Rockets Program at Poker Flat Research Range (PFRR EIS),* the National Aeronautics and Space Administration (NASA) considered the use of heavy mechanized equipment as part of its recovery efforts of sounding rockets launched from the Poker Flat Research Range (PFRR). Although the use of heavy mechanized equipment could provide for the full removal of most identified items, NASA determined that its use in remote areas would result in substantially more disruption to the impact area than the use of hand tools alone, would be extremely costly, and would not be feasible to add as a component of the Recovery Program. Based on this initial evaluation, NASA determined that the use of heavy mechanized equipment would not be further analyzed as part of the alternatives evaluated in the *PFRR EIS*.

This appendix describes the process NASA used to determine the types of equipment that would need to be used, the conditions in which each piece of equipment would need to be used, the availability of this equipment, and the feasibility of adding these types of equipment to the NASA Sounding Rockets Recovery Program at PFRR. NASA also considered the conditions outlined in the existing Special Use Permits with the U.S. Fish and Wildlife Service (USFWS) and U.S. Bureau of Land Management (BLM) for the ability to land and recover sounding rockets within their lands.

I.2 CONDITIONS POTENTIALLY NECESSITATING USE OF HEAVY MECHANIZED EQUIPMENT

NASA considered instances of when heavy mechanized equipment could be used to perform a full recovery when otherwise the item would be fully or partially left in place. These examples included removing deeply buried items (see **Figure I–1**), removing items from areas of saturated soils (see **Figure I–2**), and removing trees and shrubs to a greater degree than is normally necessary to allow the landing/staging of recovery equipment.

I.3 TYPES OF EQUIPMENT

The specific types of mechanized equipment that NASA considered for use in the Recovery Program were dictated by the potential conditions at the recovery site. Access to the site was determined to be the greatest limiting factor in conducting the recovery operation and was used to determine the general types, or classes, of probable equipment that could be used.

Given the limited ground transportation system (*i.e.*, roads) available within the PFRR launch corridor, almost any equipment would need to be transported to the impact site by helicopter. Limitations and availability of the helicopters used would also limit the size and weight of the equipment.

Figure I–1. Example of a Deeply Buried Rocket Motor

Figure I–2. Example of a Deeply Buried Rocket Motor in a Wetland/Bog Area

Also, due to the sensitivity of the downrange lands and the susceptibility of certain areas (*i.e.,* tundra, wetlands) to damage from overland travel during non-winter months, it was determined that the mechanized equipment must have a relatively low ground pressure.

The mechanized equipment must also have the ability to successfully travel through soft, muddy terrain commonly found within the interior lowlands and flats, as well as in areas of tundra. In addition, the selected equipment must have the ability to excavate and lift heavy, substantially buried items at depths up to approximately 2 meters (6 feet) or more.

In consideration of the above requirements, NASA identified two classes of equipment that would most likely meet the majority of its needs. A compact excavator (see **Figure I–3**), which could likely be used for removal actions in upland areas, and a mid-sized tracked amphibious vehicle with an excavator attachment (see Figure I–3), which could be employed in conditions requiring access to soft soils and/or non-flowing shallow bodies of water (*e.g.,* creeks, sloughs), were selected for further evaluation.

Photos courtesy of (L) Caterpillar, Inc. and (R) Coast Machinery, LLC.

Figure I–3. Compact Excavator (Left) and Tracked Amphibious Vehicle (Right)

Table I–1 presents a summary of key specifications for both the compact excavator and tracked amphibious vehicle.

Table I–1. Key Specifications of Potential Recovery Equipment

Feature	Compact Excavator	Tracked Amphibious Vehicle
Weight (kilograms)	600–5,000	1,400–3,000
Engine Power (kilowatts)	11–30	30–60
Ground Speed (kilometers per hour)	3–8	8–13 (over land) 3 (over water)
Ground Pressure (kilograms per square centimeter)	0.27–0.32	0.08
Excavation Depth (meters)	2.1–4.0	1.5

Note: To convert kilograms to pounds, multiply by 2.2046; kilometers to miles, by 0.6214; meters to feet, by 3.2808.

Given the approximate weight of each machine, a medium- to heavy-lift helicopter (*e.g.,* Bell 214, Columbia 107-II, Columbia 234 Chinook, U.S. Army CH-47 Chinook, see **Figure I–4**) would be necessary to deliver either machine to the recovery site and then return it to its point of origin once the recovery is complete.

Photo courtesy of the U.S. Army.

Figure I–4. Heavy-Lift Helicopter Sling Loading Equipment

I.4 EVALUATION CONSIDERATIONS

NASA evaluated a range of considerations when determining the feasibility of adding heavy mechanized equipment to its Recovery Program. These considerations include concept of operations, frequency of use, financial requirements, and availability of equipment.

I.4.1 Concept of Operations

The actual concept of operations would be planned prior to conducting the specific recovery operation; however, NASA considered a number of scenarios of using mechanized equipment. NASA assumed that for recoveries south of the White Mountains, a medium- to heavy-lift helicopter would sling-load the equipment from the Fairbanks area to the recovery site. For areas further north, it would be more efficient to transport the equipment north via the Dalton Highway to a location of approximate latitude of the recovery site (*e.g.*, Coldfoot, Toolik Lake). From that point, the helicopter would then sling the equipment to the recovery site, and once recovery is complete, back to the original point of origin.

Rigging of the equipment for pickup would likely be conducted prior to the helicopter's arrival. Pickups could be conducted without the helicopter needing to land, and would require at least three to four trained staff on the ground to provide visual signals to the pilot, discharge static electricity, and connect the lifting sling to the cargo hook(s) on the helicopter's undercarriage. NASA assumed that dropping off the equipment at or near the recovery site would also not require helicopter landing, as the load could be released by a crewmember onboard the aircraft. Given the potential travel distances necessary to recover some items, some recoveries would require multiple re-fueling stops. This could be accomplished by first transporting fuel drums to a nearby airstrip (either by truck along the Dalton Highway or by aircraft at one of the interior Villages or mining camps), then hauling them back on the return flight once empty.

Whether the helicopter would land near the recovery site (versus immediately departing the site to its point of origin) would be based upon the specific circumstances of the situation. First, the helicopter would need an adequate load-bearing surface (capable of supporting 5 or more tons for the heaviest models) upon which to land. Additionally, a substantial clear zone would be required for safe operations. For example, a CH-47 Chinook helicopter requires a landing site at least 80 meters (260 feet) in diameter if there are no nearby obstacles. When obstacles are in the approach or departure route, a 10-to-1 ratio is used to establish the landing site. For example, during the approach and departure, if the helicopter must fly over trees that are 10 meters (30 feet) tall, then the landing site must be at least 100 meters (305 feet) long. Therefore, in certain areas, particularly south of the Yukon River, dense stands of trees and/or soft soils could preclude landing. Conversely, in large, open river valleys, the helicopter could likely find a suitable landing location with relative ease, thereby avoiding the need make an extra round trip to retrieve the equipment.

For instances when the compact excavator would be used (stable soils, upland conditions), it is expected that the helicopter could release the equipment reasonably near the recovery site. However, in cases when the tracked amphibious vehicle would be required (wet, soft soil conditions), acceptable drop locations could be more challenging to find; therefore, it would be very likely that the helicopter would need to release the equipment at a greater distance from the site, thereby requiring more overland travel to complete the recovery. Given the relatively slow ground speed of the tracked amphibious vehicle and the expected land disturbance that would be required for its operation in soft soils (approximately 0.4 hectares [1 acre] per 1.6 kilometers [1 mile] traveled), it is expected that the maximum reasonable distance from the drop-off site to the recovery site would be approximately 1.6 kilometers (1 mile).

Once at the recovery site, a team of at least two crewmembers would be responsible for operating the equipment, which would most likely dig around the item and/or then lift the item from the ground. The excavated area would then be backfilled to the extent practicable. Depending on the circumstances, the item could either be loaded onto the vehicle or towed behind it to the helicopter rendezvous point. Once at the pickup site, up to an additional three to four trained crewmembers would be required to safely rig the equipment for removal and transport back to its point of origin. A separate, smaller helicopter would provide crewmember transportation. Ideally, both equipment operators and helicopter riggers would remain at the site for the duration of the recovery, minimizing the number of helicopter flights. This same helicopter would also be responsible for sling-loading the recovered item to a central collection point (*e.g.*, Village or gravel airstrip) or directly back to the Fairbanks area.

I.4.2 Frequency of Operations

Recent experience gained while conducting operations under the Interim Recovery Program has shown that in general, a majority of items can be fully removed with simple hand tools. However, there have been, and would likely be in the future, items identified that are substantially buried that would require heavy mechanized equipment for full removal. Therefore, for the purposes of this evaluation, NASA determined that the expected frequency of needing to utilize heavy mechanized equipment for single full recovery would not be more than once per two launch seasons. This frequency was derived by assuming there would be 4 launches per year, with 1 launch in 10 requiring such a recovery.

I.4.3 Financial Considerations

Each Fiscal Year, NASA would allocate a minimum of $250,000 of the PFRR annual budget for recovery activities. Actual expenditures would vary from year to year, and would be dictated primarily by launch activity and the amount of hardware reported by users of downrange lands (discussed in more detail below). These funds are expected to have a 2-year expiration, meaning that if not spent within 2 years, the funds are required to be returned to the U.S. Treasury; therefore, if not spent, the funds would effectively be lost by the NASA Sounding Rockets Program (SRP). If circumstances warranted, available recovery funding from one previous fiscal year could be utilized to augment the $250,000 annual budget.

The use of heavy mechanized equipment was found to be extremely costly. For example, the use of a CH-47 Chinook helicopter would be between approximately 14 and 28 times more costly than a smaller helicopter (*e.g.*, Bell 206), and the cost of purchasing an amphibious tracked vehicle, compact excavator, and trailer for hauling them would cost between $167,000 and $182,000 as compared to less than $1,000 for hand tools only (see **Table I–2**).

Table I–2. Recovery Equipment Cost Comparison

Cost Item	Hand Tools Only	Heavy Equipment	
		Compact Excavator	Tracked Amphibious Vehicle
Initial Investment	<$1,000	$30,000–$45,000	$137,000
Hourly Cost of Recovery	$400–$800	$11,200	

Note: Hourly recovery cost only accounts for air transportation; does not include staff labor, ground transportation, etc.
Source: NASA 2013.

In consideration of both the costs presented in Table 1–2 and NASA's approximately $250,000 annual recovery budget, it would be likely that the expenditure of a larger amount of funding on a heavy mechanized equipment-based recovery operation would reduce the possibility of recovering other hardware that is reported later in the given year.

I.4.4 Availability

NASA considered the use of the Bell 214 B1, Columbia 107-II, Columbia 234 Chinook, and U.S. Army CH-47 Chinook helicopters that would be needed to transport the heavy mechanized equipment from PFRR to the impact site. The availability of each helicopter in relation to the launch corridor is shown in **Table I–3**. As shown in the table, the only model available near PFRR would be the CH-47 Chinook owned by the U.S. Army at Fort Wainwright. While it would be possible to utilize the U.S. Army's equipment on a cost-reimbursable basis, it could only be done if there were no competing needs related to the U.S. Army's primary mission. Therefore, availability of the heavy lift helicopters for NASA's use cannot be guaranteed.

Table I–3. Availability of Helicopters Near Poker Flat Research Range

Helicopter	Alaska Provider	Nearest Locations
Bell 214 B1	TEMSCO	Ketchikan, Alaska Juneau, Alaska
Columbia 107-II	None	Portland, Oregon
Columbia 234 Chinook	None	Portland, Oregon
CH-47 Chinook	U.S. Army	Fairbanks, Alaska

Source: Bundick 2013.

I.5 PERMIT CONDITIONS

Within the PFRR launch corridor are landmasses owned or managed by several Federal, state, and Alaska Native organizations, including BLM, USFWS, Alaska Department of Natural Resources, Doyon, Limited (an Alaska Native regional corporation created by the Alaska Native Claims Settlement Act), and the Native Village of Venetie Tribal Government.

I.5.1 BLM

BLM manages and administers the use of Federal public lands and resources on behalf of the U.S. Department of the Interior in accordance with the Federal Land Policy and Management Act of 1976, as amended **(43 U.S.C. 1701 *et seq.*)**. The agency's Eastern Interior Field Office in

Alaska manages approximately 8 million acres of public lands in east-central Alaska, including the north and south units of the Steese National Conservation Area and the White Mountains National Recreation Area.

Historically, the University of Alaska Fairbanks (UAF) has applied for authorization from BLM to allow rocket impacts and recovery of NASA SRP spent rocket stages and payloads from BLM-administered lands. To date, the use of heavy mechanized equipment has not been included in the authorizations from BLM to aid in the recovery of flight hardware within BLM-administered lands. In fact, recent authorizations have specifically indicated that recovery-related disturbances must be kept to a minimum.

I.5.2 USFWS

The USFWS administers National Wildlife Refuges (NWRs) on behalf of the U.S. Department of the Interior in accordance with the National Wildlife Refuge System Administration Act of 1966, as amended (NWRSAA) **(16 U.S.C. 668dd–668ee)**. These lands are administered for the conservation, management, and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats. The Alaska Region (Region 7) of USFWS administers 16 NWRs within the state of Alaska. The primary purpose of Arctic and Yukon Flats NWRs is to conserve fish and wildlife populations and their habitats in their natural diversity. The USFWS is authorized to provide authorizations for rocket impacts and recovery by regulations the use of any area within the NWR system provided “such uses are compatible with the major purposes for which such areas were established.”

Similar to BLM, UAF applies for authorization from USFWS to allow rocket impacts and recovery of NASA SRP spent rocket stages and payloads from USFWS-administered lands. To date, the use of heavy mechanized equipment has not been included in the authorizations from USFWS to aid in the recovery of flight hardware within USFWS-administered lands. Additionally, given the requirement for such operations to be deemed a “compatible use” prior to authorization, it is unlikely that the use of heavy mechanized equipment for recovery could be done in a manner that would meet the compatibility threshold for use on USFWS lands **(USFWS 2013)**.

I.5.3 Native Village of Venetie Tribal Government

Venetie is located on the north side of the Chandalar River approximately 72 kilometers (45 miles) northwest of Fort Yukon. In 1971, Venetie and Arctic Village obtained the title to 730,000 hectares (1.8 million acres) of land, which they own as tenants in common through the Native Village of Venetie Tribal Government.

The Geophysical Institute of UAF and the Native Village of Venetie Tribal Government have a Memorandum of Agreement (MOA) for the conditional use by UAF of the tribal lands controlled by Venetie Tribal Government. This MOA details the requirements of UAF for the continued use of the Venetie Tribal Lands and does not specifically authorize the use of heavy mechanized equipment. While preparing the *PFRR EIS*, NASA discussed its proposed Recovery Program several times with tribal leaders. A continued concern voiced by tribal leaders was the need to conduct recoveries in a manner that minimizes potential effects on subsistence activities, particularly hunting. While conducting a recovery with heavy mechanized equipment would likely be infrequent (*e.g.*, biennially), it would invariably result in greater potential disturbances to wildlife, and in turn, subsistence hunting.

I.6 CONCLUSION

In consideration of the above analysis, NASA determined that the use of heavy mechanized equipment in remote areas as part of the recovery efforts would result in more disruption to the impact area than the use of hand tools alone, would be extremely costly, and would not be feasible to add as a component of the Recovery Program. Consequently, NASA concluded that the use of heavy mechanized equipment would not be further analyzed as a component of the alternatives evaluated in the *PFRR EIS*.

I.7 REFERENCES

Bundick, J.A., 2013, revisions to Alt 2/4 per FWS comments, personal communication, January 2.

NASA (National Aeronautics and Space Administration), 2013, Alternatives 2/4 – Maximum Cleanup with Mechanized Equipment Analysis Assumptions.

USFWS (U.S. Fish and Wildlife Service), 2013, U.S. Fish and Wildlife Comments on the Sounding Rockets Program Draft Environmental Impact Statement, Poker Flat Research Range, Alaska, January 15.

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