Environmental Restoration of Diesel-Range Organics from Project Chariot, Cape Thompson, Alaska - 16147

Mark Kautsky*, Rick Hutton**, Judy Miller**
*US DOE, Office of Legacy Management
**Navarro Research and Engineering, Inc.

ABSTRACT

Cape Thompson, Alaska, is located approximately 120 miles north of Kotzebue, Alaska, within the Ogotoruk Creek valley. The remote Alaskan location is also home to the US Atomic Energy Commission (AEC) Project Chariot study area. Project Chariot was part of the Plowshare Program, created in 1957 by the AEC to study peaceful uses for atomic energy. Project Chariot began in 1958 when a scientific field team chose Cape Thompson as a potential site to excavate a harbor using a series of nuclear explosions. Between 1959 and 1962, AEC was responsible for over 40 pretest bioenvironmental and geotechnical studies of the Cape Thompson area. Strong public opposition to the tests developed, which caused the project to be cancelled with no nuclear explosions ever conducted at the site.

In the early 1960s, several deep boreholes were drilled to obtain subsurface, temperature, and high-explosive testing data. Refrigerated diesel was used as a drilling fluid to keep the boreholes open so that thermistors could measure subsurface temperatures. The test boreholes were named Able, Baker, Charlie, Dog, and X-1. In the summer of 2014, the US Department of Energy, Office of Legacy Management (LM) completed the remediation of remnant diesel at these sites. Prior to the 2014 remediation activities, LM conducted two separate characterization field studies to determine the nature and extent of the contamination from the 1960s drilling activities. In 2013, LM developed a remediation plan that was submitted and approved by the Alaska Department of Environmental Conservation (ADEC).

The 2014 Project Chariot remediation had some unique logistical challenges and historic issues with stakeholders to overcome. Many of the historic issues centered on previous AEC scientific actions and a general mistrust of the government by the local stakeholders. Prior to and during the 2014 remediation work, an outreach campaign was implemented to discuss prior activities at the site and include stakeholders from Point Hope, Alaska, in the remediation-planning process. The remoteness of the region also provided unique logistical challenges. Because of the short field season, LM initiated several subcontracts over a year in advance. The field camp, heavy equipment, and soil storage containers were shipped by barge to the site. Personnel, food, and small materials were flown in by bush plane from Kotzebue, Alaska.

Previous site characterization had identified diesel-range organics (DROs) as the primary contaminant. The cleanup levels for the site were provided by the *Alaska Administrative Code* (AAC) for the Artic Zone region. The AAC cleanup level for DROs on gravel pads is 500 mg/kg and 12,500 mg/kg tundra in the artic-zone

region. To help determine the extent and direct soil excavation in the field, photoionization detectors (PIDs) were used for field screening. While the PID results provided rough limits for excavation, laboratory confirmation sampling was required to provide actual excavation guidance. All excavation locations remained open until laboratory results met AAC criteria and ADEC approved closure. The laboratory sample protocol required the bush plane to pick up samples almost daily and transfer them to Anchorage for analysis. In order to meet holding time requirements, all laboratory samples were analyzed on an expedited basis. Analytical results and ADEC approval notifications were emailed back to the site via satellite connection. A total of 202 laboratory analyses were needed to complete the remediation effort.

At each location (Able, Baker, Charlie, Dog, and X-1), the boreholes were plugged and abandoned in accordance with ADEC regulations. Contaminated soil was excavated, and the material was placed in supersacks and hauled to connex boxes located near the sea shore. Approximately 786 tons of material was removed and shipped by barge to the Columbia Ridge Landfill in Arlington, Oregon, for disposal. The well casings were cut and sealed below ground surface. Each location was graded to its original contours and reclaimed with native vegetation, and a geodetic survey was conducted. Tours with leaders of the Village of Point Hope and the land owner (Arctic Slope Regional Corporation) were conducted prior to the final demobilization. All remediation equipment and camp facilities were removed at the completion of the project.

INTRODUCTION

The Chariot site is located in the Ogotoruk Valley in the Cape Thompson region of northwest Alaska. Project Chariot was part of the Plowshare Program, created in 1957 by the US Atomic Energy Commission (AEC), a predecessor agency of the US Department of Energy (DOE), to study peaceful uses for atomic energy. Project Chariot began in 1958 when a scientific field team chose Cape Thompson as a potential site to excavate a harbor using a series of nuclear explosions. AEC, with assistance from other agencies, conducted more than 40 pretest bioenvironmental studies of the Cape Thompson area between 1959 and 1962; however, the Plowshare Program work at the Project Chariot site (Figure 1) was cancelled because of strong public opposition [1]. No nuclear explosions were ever conducted at the site.

Figure 1. Chariot Site Location in Alaska [1]

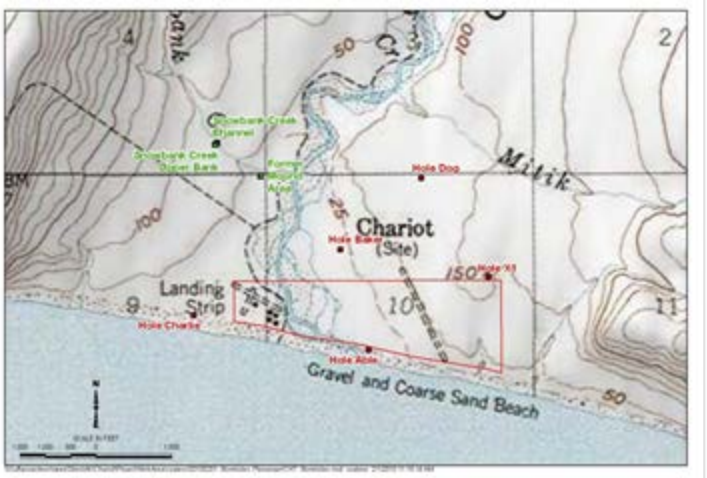

Figure 2. Location of Boreholes Near the Chariot Site (graphic from Fairbanks Environmental Services, 2010)

The objectives of the early stages of Project Chariot were to gather geologic, hydrologic, and atmospheric data for the Cape Thomson area. Drilling to obtain geologic characterization information (Figure 2) was initiated in 1960, and almost immediately maintaining borehole integrity became an issue. When exposed to ambient air temperature, the permafrost subsurface would not maintain borehole integrity. To overcome this issue, chilled diesel fuel was used to keep the boreholes open to install thermistors to measure subsurface temperatures [3]. The remnant contamination of the spilled chilled diesel at the drill pads was the object of the 2014 field remediation.

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Preparation for this remediation project began a few years prior, when residents from Point Hope, Alaska, contacted DOE Office of Legacy Management (LM) officials to discuss remediating the test holes. The village of Point Hope is located about 35 miles northwest of the Chariot site. A key part of the work process involved communicating with local residents to understand their concerns. Several meetings were held with residents and leaders from the surrounding communities of Point Hope, Kivalina, and Barrow, including a public meeting in Point Hope in March 2014, before conducting the remediation work.

Remediation Plan Development

Using previous site investigations results, State of Alaska requirements for cleanup levels above the Arctic Circle, and requests by the current land owners (Arctic Slope Regional Corporation) on the final status of the remediated areas, a remediation plan for the diesel clean up at the former small-diameter temperature testing borehole was developed. Both state regulators and stakeholders reviewed and provided comments. The 2010 site investigation [2] and the 2013 logistical planning and soil analysis trip [4] were the primary sources of information in building the remediation plan.

Previous Investigations

2010

The information gathered from the 2008 site investigation was used to conduct a limited soil investigation in 2010. This site investigation focused on the collection and analysis of soil from all of the former drill pads. The analysis of the soil samples collected from the former drill pads in 2010 showed diesel-range organics (DROs) in excess of Alaska Department of Environmental Conservation (ADEC) Method One at 4 out of 5 locations. On the basis of the 2010 characterization work, a preliminary estimate of the amount of contaminated soil that would have to be removed during remediation was planned and a cost estimate was developed [2].

2013

To support the planned remediation of the diesel-contaminated soils at the site, another field trip was necessary to collect logistical information and additional analytical data. Because of the remoteness of the site, several key logistical support areas needed to be evaluated. Personnel checked to see if the existing landing strip was adequate for numerous landings during the project and checked the depth sounding measurements along the shoreline for barge landings. Sites were identified for the field camp location and staging areas, and an evaluation of access routes to the former drill pads was made. A gamma radiation survey was conducted at each of the former drill pads with all results being similar to background [4].

2014

In June 2014, construction and field personnel visited the site to evaluate the staging locations (Figure 3) and to refine the estimates of extent of soil contamination. The 2014 site visit confirmed the approximate lateral extent of contamination, but the vertical extent was estimated to be 0.8 to 1.1 m (2.5 to 3.5

ft) versus the earlier estimates of 0.5 m (1.5 ft.). The logistical preparation moved ahead rapidly, and the barge left Anchorage June 19 and arrived in Kotzebue on July 5 with the heavy equipment and supplies for the camp and remediation effort. All of the equipment was then transferred to a landing craft so that the material could be offloaded on the beach near the site [5].

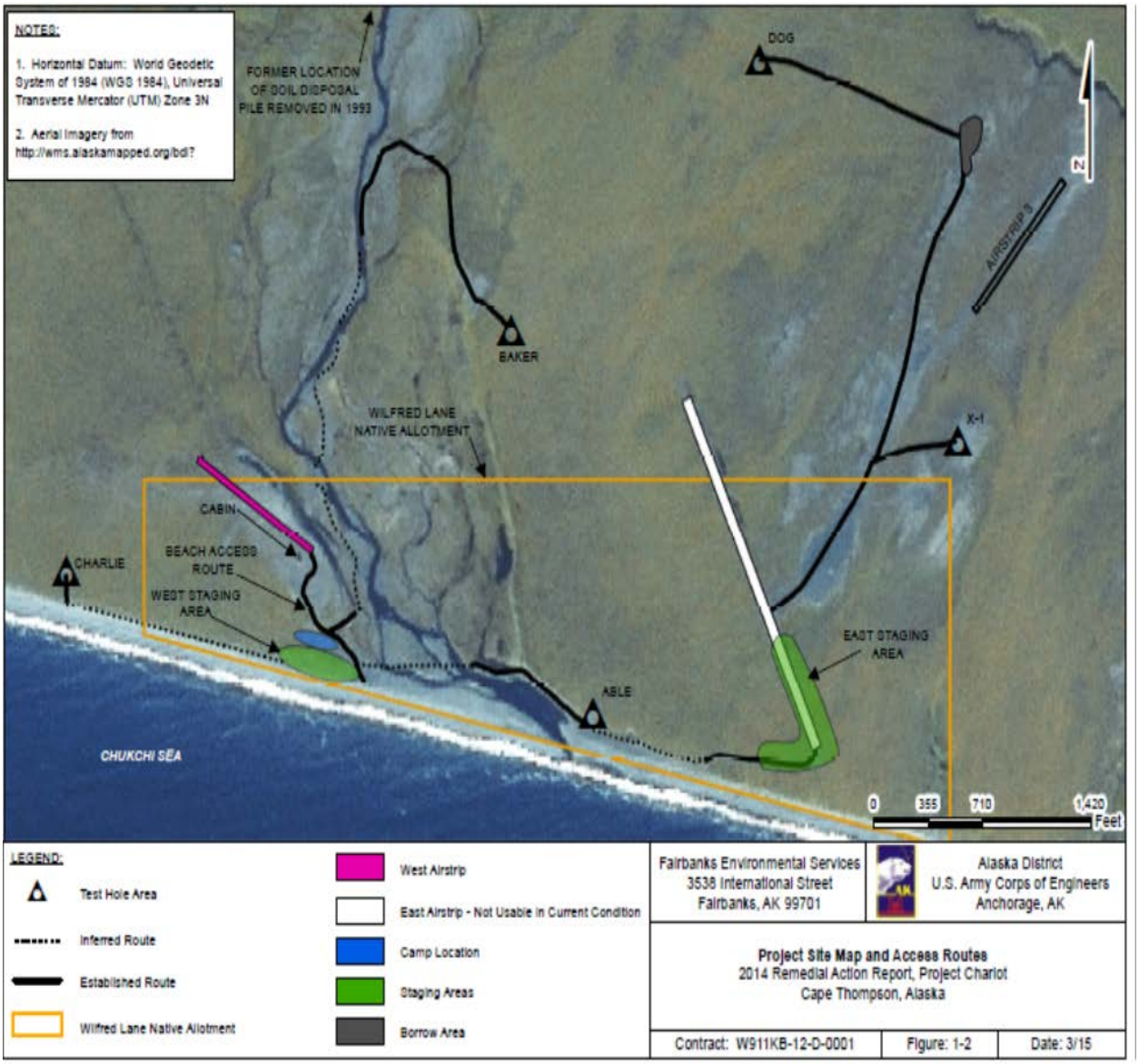

Figure 3. Project Chariot Site Map and Access Routes (graphic from US Army Corps of Engineers [USACE], 2015 [5])

PROCESS

Mobilization

Crews started arriving July 6 via aircraft to prepare for the landing craft, which arrived on July 9. Personnel including the sampling team and the site medic arrived by aircraft over the next 2 weeks as camp (Figure 4 and 5) setup allowed. Communications were installed using a satellite dish that allowed wireless internet and email transmission. An iDirect satellite system with Wi-Fi connection was used to transfer reports to USACE and receive analytical data from the laboratory in Anchorage.

Figure 4. Setting Up Camp on July 12

Figure 5. View of Finished Camp from West Staging Area

Safety

With heavy equipment, inclement weather, abundance of wildlife, and a very remote location, safety was a big concern. At the site, an emergency medical technician/bear guard was present at the site for the duration of the work. Each team of workers had a radio and a firearm and utilized a buddy system of checking for bears while working. A 1.5-meter-high electric bear fence surrounded the camp and was energized 24 hours a day. While bears were spotted on a regular basis,(Figure 6) no close bear–human interactions occurred.

Figure 6. Grizzly Bear Near Test Hole Charlie (photo from USACE 2015 [5])

Remediation Process

The *Alaska Administrative Code* cleanup level for DROs on gravel pads is 500 mg/kg and 12,500 mg/kg tundra in the artic-zone region [6].

At each location the following process occurred:

- Removal testing and treatment of any water with the borehole casing
  - Any water removed was treated by filtration, and then laboratory analysis was conducted and results were verified; the water was disposed at the site
  - The casing was cut below grade and filled with hydrated bentonite, and a cap was welded on the top of the casing
- Removal and disposal of debris around each former drill pad
- Contaminated soil was excavated and removed in supersacks to staging areas
  - Lateral extent was guided by sampling using photoionization detectors, confirmatory laboratory analysis, review of results, and concurrence via email by ADEC that the location could be closed. Vertical extent was considered to the depth of the permafrost.
- Excavated areas were contoured back to grade, vegetated, and surveyed [5]

With the use of 2010 site investigations results, general maps of each site were generated to provide initial guidance for the remediation process (Figure 7). During the remediation of the former drilling pads, maps of excavations and laboratory results were generated for each site in the Remedial Action report (Figure 8). Prior to contouring of the sites back to final grade, ADEC provided written guidance that analytical results met closure requirements.

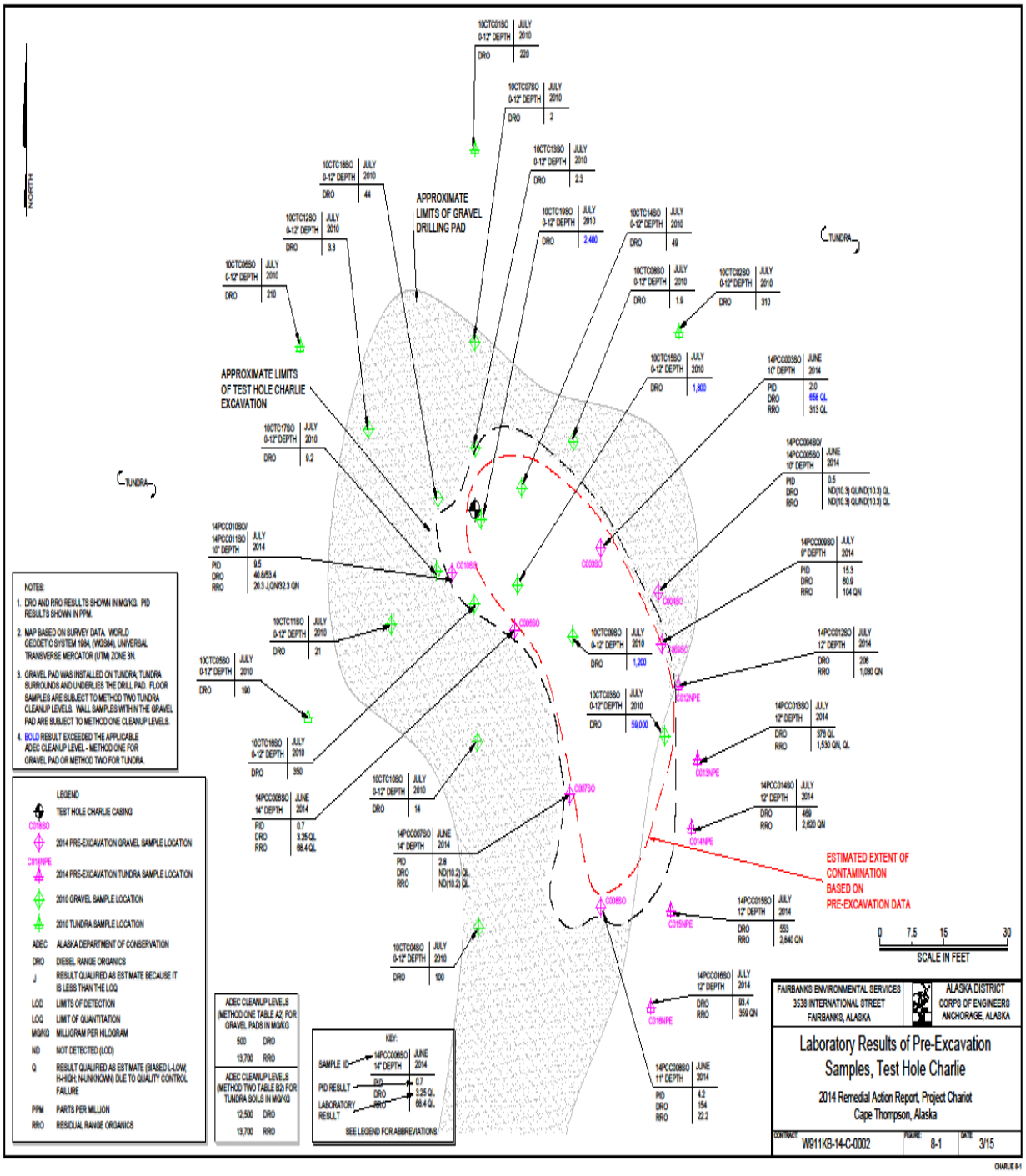

Figure 7. Test Hole Charlie Pre-excavation Laboratory Results (graphic from USACE, 2015 [5])

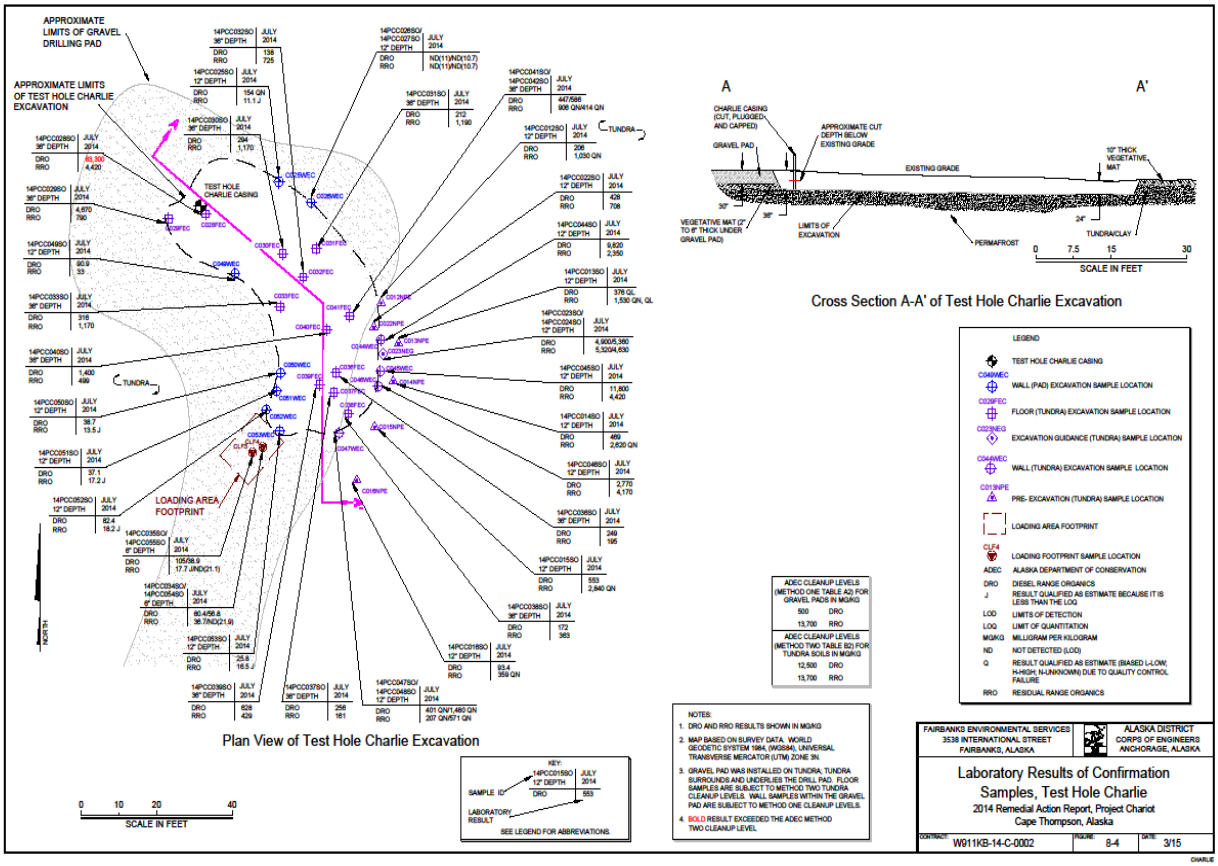

Figure 8. Test Hole Charlie Laboratory Results Confirmation (graphic from USACE, 2015 [5])

Test Hole Able

Test hole Able was the first characterization borehole drilled in support of Project Chariot. The borehole was drilled to a depth of 182 m (596 ft) below ground surface [7]. No historic evidence indicates that chilled diesel was used in the completion of the well. Earlier characterization results also indicated that no chilled diesel was used in the completion of the well. The existing well bore casing was cut below grade; the site was contoured back to original grade and seeded [5].

Test Hole Baker

Test hole Baker was the second Project Chariot characterization and was drilled in 1959. Historic data indicate that chilled diesel 2010 and 2014 characterization results show the presence of diesel at the site. Approximately 14.1 tonnes (15.5 tons) of material was removed from the pad surrounding test hole Baker [5]. The existing well bore casing was cut below grade; the site was contoured back to original grade and seeded.

Test Hole Charlie

Test hole Charlie was a 1960 characterization borehole that was drilled to 305 m (1,002 ft) below ground surface with chilled diesel as a drilling fluid to help

maintain borehole integrity [3]. The 2010 and 2014 characterization analytical results showed the presence of diesel at the site. A total of 225 tonnes (248 tons) of diesel-contaminated soils were removed from the site. The excavation included approximately 10 feet of tundra beyond the pad being removed [5]. The existing well bore casing was cut below grade, and the site was contoured back to original grade and seeded

Test Hole Dog

Test hole Dog was the final 1960 characterization borehole that was drilled to 366 m (1,202 ft) below ground surface) in the tundra field furthest from the Chukchi Sea [5]. Accessing the site was a significant undertaking because of the fragile nature of the tundra and the amount of traffic utilizing a 600-meter-long, rough, unimproved road. To protect the tundra, mud mats were flown to the site to mitigate the traffic damage to the tundra. A total of 231 tonnes (255 tons) of diesel-contaminated soil were removed from the site including some tundra [5]. The existing well bore casing was cut below grade, and the site was contoured back to original grade and seeded

Test Hole X-1

Based on historical records and field observations, the former use of the X-1 location is unknown. Historical data indicate that the area may have been used as a drum storage area for diesel and kerosene and that a trench was installed near the location [8]. The soils in the disturbed subsurface areas were bound by undisturbed areas where screening and laboratory results decreased rapidly. Debris was also found at depth, increasing the likelihood of a trench for drum storage. The excavation was approximately 1.7 m (5.5 ft) deep to reach permafrost. Approximately 243 tonnes (267 tons) of contaminated soil was removed from the X-1 site [5]. The existing 1.8 m (6 foot)-long casing was removed below grade; the site was contoured back to original grade and seeded.

A total of 712 tonnes (786 tons) of contaminated soil were removed from the site (Table 1) to a storage landfill in Oregon. To confirm the remediation closure criteria were met, 202 soil samples (including 22 field duplicates were collected and analyzed (Table 2). Due to the tight field schedule, all samples were analyzed on an expedited schedule. Samples were collected in sample cooler to maintain temperature requirements transported from the site via Northwestern Aviation (bush plane) to Kotzebue. Alaska Airlines transported the sample to Anchorage, then a laboratory courier transported the samples to the laboratory for analysis. Custody seals on coolers ensured no samples were tampered with during transport.

TABLE 1. Summary of Contaminated Soil Removed

Test Hole	Casing Status	Quantity of POL-Contaminated Soil Removed (tonnes)	Number of Super Sacks	Average Depth of Excavation (cm)	Estimated Area of Excavation (m^2)
Able	Cut and Capped	0	0	0	0
Baker	Cut and Capped	14 .1	24	38 (102 in NW corner)	12.1
Charlie	Cut and Capped	225	204	91 (pad) and 61 (tundra)	195
Dog	Cut and Capped	231.0	212	61 (pad) and 30 (tundra)	214
X-1	Removed	242.6	217	168	102
TOTAL REMOVED		**712.7**	**657**	**Varies**	**Total Area: 523**

Data from USACE 2015 [5].

TABLE 2. Summary of Soil Samples Submitted for Laboratory Analysis

Test Hole	Pre-Excavation Samples	Casing Interior	Footprint and Stockpile	Excavation Guidance	Excavation Confirmation	Total Number of Soil Samples
Able	0	1	0	0	0	1
Baker	0	1	2	1	6	10
Charlie	16	0	4	8	26	54
Dog	13	0	7	7	33	60
X-1	2	0	25	23	27	77
TOTALS	**31**	**2**	**38**	**39**	**92**	**202**

During the remediation, LM federal and contractor staff arranged and conducted a tour of the site for community representatives from Point Hope and a separate tour for members of the Alaska media. Tour participants were able to see various stages of the remediation and have discussions about the work with government officials and field staff.

CONCLUSION

While the technical part of the 2014 field remediation was logistically difficult, the actual cleanup was fairly straightforward and conducted with few surprises. Communicating openly and including local stakeholders in all phases of the remediation project was an important part of the process. Integrating both remedial actions and stakeholder communications led to the overall success of the project.

Communications began by understanding the history of Project Chariot and how local stakeholders perceived past treatment by the government. LM held several

meetings with residents and leaders from surrounding communities, including a public meeting in the Village of Point Hope. Stakeholders were invited to visit the site, and LM conducted a media tour and two stakeholder tours while the remediation was ongoing.

DOE teamed with USACE and their subcontractors because of their prior work in Alaska. USACE selected two Alaskan companies to conduct the work, one with prior experience at the site. This local knowledge of logistical planning for the area supported the overall completion of the remediation.

The initial estimate on the overall tonnage of contaminated soil to be removed proved to be inaccurate. While the lateral extent of contamination estimates proved somewhat accurate, the depth of the diesel contamination was not accurately estimated. Additional contamination containers were located and transported to the site by barge to complete the project. Close coordination with ADEC about analytical results supported ADEC closure of each location. Analytical data were reviewed and written concurrence was received in the field prior to contouring and seeding of the disturbed areas.

REFERENCES

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