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Contaminated Site Investigations: An American Experience

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ABSTRACT: As part of a contaminated site field sampling team in Alaska, USA, field procedures not widely seen in Australia were performed. The work was carried out under strict health and safety and quality procedures. Some trial remediation projects were also observed. The experience resulted in the development of procedures for use in Australian conditions.

1 INTRODUCTION

In 1992 I was sent to the USA in order to gain experience working with a field sampling team on a contaminated site.

The fieldwork was arranged through CH2MHill and was undertaken at the Eielson Air Force Base (AFB) near Fairbanks, Alaska.

This paper presents some brief background information on the site and gives an overview of the protocols and techniques used during the fieldwork. It is not the intention of this paper to present the reasons behind the sampling methodology used in specific areas and the level of contamination found, the details of which are confidential.

2 BACKGROUND

2.1 General

CH2MHill was commissioned to undertake an environmental site assessment of specific areas of the Eielson AFB. The site is listed on the US Goverment's National Priority List as a priority area for investigation and cleanup.

The client was the United States Air Force but CH2MHill dealt directly with Batelle-EMO. Batelle-EMO is a non-profit organisation set up through the United States Government to manage large government contracts especially in the environmental area.

2.2 Site Description

The Eielson AFB is located approximately 43km southeast of Fairbanks, Alaska and covers an area of approximately 7,800 hectares. It is isolated from any major urban areas, however there are two nearby off-base communities. Historically most of the land was wetlands and flood plains. Eielson AFB currently contains 13 lakes, 54 ponds and 10 designated wetlands areas totalling 335 hectares.

2.3 General Contaminant Sources

In general, contaminant sources on site comprise the following:

a) Industrial Wastes

The industrial operations on the base generate waste oils, fuels, solvents and cleansers. Historically, these were disposed of by road oiling, landfilling or burning with some solvents and cleansers being discharged into the sanitary sewer system.

b) Polychlorinated Biphenyls (PCBs)

In the past, PCB materials such as transformers, capacitors and PCB contaminated soils and liquids were stored on site. This practice has stopped.

c) Pesticides

Until DDT was banned , Eielson AFB used up to 50 drums per year. It still uses other major pesticides.

d) Wastewater Treatment

The base sewage treatment plant was upgraded to secondary treatment in 1973. Since 1979 discharge has been to an infiltration pond rather than direct discharge to waterways.

2.4 Environmental Setting

2.4.1 Climate

The climate of the area is characterised by extreme diurnal and annual temperature variations, low precipitation and low humidity. Summer temperatures range between 7 deg. C and 17 deg. C and the average temperatures during winter range between -26 deg. C and -13 deg. C. Extreme temperatures recorded at Eielson AFB were 34 deg. C and -53 deg. C. Annual precipitation in this area averages 355mm which includes 1830mm of snow.

2.4.2 Geology

Eielson AFB is located on the eastern edge of the Tanana River floodplain. This broad, flat glaciofluvial outwash plain is bounded to the north by the Yukon-Tanana Upland, and to the south by the Alaska Range. Unconsolidated sediments are approximately 60-90m thick beneath Eielson AFB, and represent glacial outwash and alluvial stream sediments deposited by the braided Tanana River system. These unconsolidated sediments typically occur as interbedded layers of well-graded sand and gravel with cobbles up to 200mm.

2.4.3 Hydrogeology

Groundwater occurs primarily under unconfined or semi-confined conditions. Regional flow is generally to the north-northwest, parallel to the Tanana River. However, the direction of groundwater flow is likely to be influenced locally by base well pumping, buried stream channels, local surface drainages and zones of permafrost. Depth to the water table is typically less than 3m.

3 AIM OF INVESTIGATION

There were 64 contaminant source areas identified in previous investigations at the base. The base was divided into Operable Units (OUs) consisting of contaminated areas assumed to have similar characteristics. The areas considered in the 1992 field season were OUs 3, 4, and 5.

OU3 comprised two source areas where the primary concern was solvent contamination, particularly trichloroethylene. The eight source areas included in OU4 were used for land disposal of sludge, drums and asphalt. The three source areas that comprised OU5 all involved landfills.

4 FIELDWORK

4.1 Logistics

The fieldwork was performed over a six week period in summer. A team of seven was assembled to undertake the work. The personnel came from three states of America with myself being the only non-American. The field team consisted of two hydrogeologists, a chemical engineer, an environmental scientist, a technical officer, a secretary and myself, a geotechnical engineer.

Each of the hydrogeologists headed a sampling team of two. One of the teams worked with the drill rig on soil borings, groundwater probes, product probes and well installations. The other team worked on well development and sampling.

The technical officer was dedicated to calibrating instruments and maintaining the supply of equipment to the teams. The secretary ran the office and was in charge of dispatching samples daily for analysis in Washington or Oregon

The fieldwork was conducted from a site office which consisted of a temporary hut with three rooms; an office, a general operations room and an equipment room.

The fieldwork was conducted using the protocols written especially for the project as set down in the following manuals:

a) Field Sampling Plan - sets out the samples to be taken, their location and the analyses required

b) Health and Safety Plan - sets out health and safety issues including the physical and chemical hazards on-site, the personnel protective equipment required, air-monitoring guidelines and an emergency response plan

c) Quality Assurance Program Plan - sets out the quality control and quality assurance guidelines for all aspects of the work including administration and field activities

These manuals had to be read and the procedures followed throughout the project.

The total fieldwork program involved the following:

- Installation of 44 groundwater probes
- Installation of 29 product probes
- Installation of 8 new wells varying in depth from 8m to 30m
- Drilling of 12 additional soil borings
- Excavation of 3 test pits
- Surface soil sampling of 8 additional locations
- Surface water sampling at 3 locations
- Sampling of 70 new and existing wells varying in depth from 8m to 100m.

4.2 Field Procedures

4.2.1 Groundwater Probes

Groundwater probes were installed as a temporary and cost effective means to identify groundwater contamination plumes for optimising well location. The probes were installed and groundwater sampled immediately. The samples were sent to the laboratory for quick turn-around analysis. By installing a grid of probes, the extent of the contaminant plume could quickly be defined allowing easier identification of its source and magnitude and optimum placement of monitoring wells.

4.2.1 Product Probes

Product probes were installed as a simple and inexpensive means to measure and sample floating product. As with groundwater probes they were often used as a quick way to identify the magnitude and extent of a floating product problem.

The probes consisted of a 50mm diameter manufactured well point which was driven into the ground by a drill rig. The well point itself was about 1.5m long and was coupled to blank sections with couplings and sealed at the top using a locked twist-seal well cap. The water level and product thickness were measured using a product interface probe. The probe detects oil with a small current and detects the water interface using light.

4.2.3 Soil Borings

Soil borings were undertaken to provide soil samples in an area at discrete depths using a drill rig.

The drill rig was set up and the work area lined with plastic to enable the retention of drilling residues. The decontamination station was then set up which consisted of a wash area and a spray area. The decontamination station was used for cleaning sampling instruments such as split-spoons.

The hole was drilled using steam-cleaned hollow augers. When at the required sampling depth, a split-spoon was driven as for a Standard Penetration Test (SPT). The split-spoon had an internal diameter of 50mm and was 0.6m long. A split-spoon of this size was necessary for collecting the volume of sample required for analysis. The sub-soils encountered generally comprised well-rounded gravels and cobbles with a matrix of sand and silt and so a smaller diameter split-spoon may have had trouble retrieving samples.

The split-spoon was removed from the hole, opened and a spatula used to sample the soil. The samples were recorded and stored.

All soil cuttings from the drilling operation were collected in 200 litre drums.

4.2.5 Well Installation

In locations where high quality groundwater samples were required, groundwater wells were installed for continued sampling and monitoring of groundwater.

The wells were drilled using a drill rig. The size of hollow auger used to drill a well depended on the well size. Hollow augers with an ID of 158mm and external flight diameters of up to 254mm were used.

The wells were constructed of threaded PVC with a machine manufactured screen. Generally 100mm wells were chosen over 50mm wells because the cost difference was small but the 100mm well can be used at a later date as an extraction well as part of a remediation strategy.

4.2.6 Well Development

Each of the new wells installed had to be developed to produce water free of excess soil particles. Water from undeveloped wells often has a large amount of sediment which can affect laboratory results.

The wells were developed using a pump and surge technique. A pump was lowered to just above the base of the well. Pumping was commenced. The well was then surged by pulling the pump up and down over the entire length of the screen for a couple of minutes. This process was repeated three or four times until the water after surging began to clean up. If the water quality did not improve, the rate of pumping was reduced and/or the pump position changed within the screen interval.

4.2.7 Well Sampling

The new wells along with some existing wells were sampled as part of the field program.

The water level was first measured and the well volume calculated. The purge volume was three times the well volume. Purging was performed either by bailing or by pumping. Bailing was preferred to pumping for shallow wells with purge volumes of less than about 75-95 litres. It was performed using disposable plastic bailers but is slow. It does not however involve time consuming equipment decontamination.

For shallow wells with a greater purge volume than this, a surface centrifugal pump was used which can pump water from around 8m maximum. Once purged, the well was then sampled using a disposable bailer which had a small connection to allow slow discharge from its base. This created minimal aeration of the sample, important when sampling for volatile analytes.

For wells which were deep and impractical to bail, a submersible pump was used but there were difficulties associated with decontaminating the pump. The same pump was used for sampling and purging. The pump rate was slowed down for sampling. The pump was a 50mm Grundfos submersible pump. The pump and line were decontaminated between wells.

All purged water was collected for treatment.

5 HANDLING OF WASTE MATERIALS

All gloves, tyvec suits, disposable bailers, pump tubing and other materials used during the fieldwork had to be disposed of into drums and sealed for disposal at a secure landfill. All soil and groundwater produced from the fieldwork also had to be collected and treated as a hazardous material.

Soil was collected in 200 litre drums and the drums labelled and sealed. Towards the end of the fieldwork, these drums were sampled by the field teams on behalf of the Air Force and the samples analysed in order to determine disposal options for the soil.

Groundwater was collected in a large tank mounted on the back of a vehicle. All development and purge water from the wells was collected in this tank. The water was then transported back to the site office where it was treated using a small-scale carbon adsorption system and discharged into one of a three 1900 litre tanks. When a tank was full a sample was collected for volatile organics analysis and if the water met discharge standards was discharged to the sanitary sewer. A total of 23050 litres of water was treated through the system.

6 HEALTH AND SAFETY

6.1 General

The health and safety regulations for the fieldwork were set out in the Health and Safety manual. All personnel working on the site where there was a possibility of chemical exposure had to be under a medical surveillance scheme and have undergone an approved Hazardous Waste training course. At least two of the members in a field crew had to be trained in First Aid and CPR. Some other important health and safety procedures are highlighted below:

6.2 Exclusion Zone

An exclusion zone was set up at any location where field activities were undertaken. The exclusion zone was set up between 7m and 10m from the area of the works, encircling the works. The exact size depended on the nature of the site and the work. The area was delineated using witches hats or stakes with flagging. The purpose of the zone was to protect passer-bys from the works and to warn them not to enter the area.

The exclusion zone can only be entered by those people with adequate health and safety equipment, training and personal protection.

6.3 Protective Clothing

All activities were undertaken in clothing required by the US OSHA level D standard.

Steel-toed rubber boots or booties over steel-toed boots, full length coveralls or tyvec suits and nitrile inner and outer gloves and safety glasses were all essential within the exclusion zone. Where the drill rig was used, a hard hat was also required and where sound levels exceeded 85dB, hearing protection.

6.4 Health and Safety Instrumentation

All the health and safety monitoring requirements were outlined in the Health and Safety Plan written specifically for the site.

The air monitoring program required some important equipment. Air quality was monitored using an Organic Vapour Analyser (OVA). Levels of organic vapours in excess of 600ppm were obtained in some areas. The presence of potentially explosive gases were monitored using an explosimeter. This was especially important near the drilling rig. The explosimeter was also used to monitor oxygen levels in more confined work areas. Specific contaminants, particularly vinyl chloride were monitored at some sites using Draeger tubes. Dust levels created by the field operations were also monitored using dust meters since the dust could be potentially hazardous. Sound levels were also taken particularly along the flightline to determine the need for hearing protection.

The health and safety plan outlined the frequency of the readings to be taken and at what level action was to be taken to avoid high exposure or the creation of dangerous situations. Respirators were not used at any of the sites. Instead, areas with air quality readings above action levels were left to ventilate for a period of time until acceptable levels wer obtained before work recommenced.

All health and safety monitoring was recorded in a health and safety log book by each field team.

7 DOCUMENTATION

Field log books were used extensively during the fieldwork. There were log books for each crew and included separate books for each fieldwork activity (ie groundwater probes, soil borings etc.), health and safety monitoring and even photographs. Every detail of the fieldwork had to be recorded so that the work could be "recreated" at a later date if required.

Chain-of custody procedures were used so that the person responsible for the care of the samples could be determined at any time from the moment the samples were taken to when the samples were tested in the laboratory. The samples were individually sealed and packed on ice in a cooler which was also sealed with a security seal and the chain-of-custody form was attached to the cooler.

Due to the extensive QA procedures in place, any change to the scope of the work had to be documented in a Change Request Form and approved prior to implementing the change. This often meant delays in the fieldwork.

8 QUALITY ASSURANCE

The Quality Assurance Project Plan set out the QA requirements for the job in general. Throughout the fieldwork, all the on-site operations were audited by various bodies as part of their and the project's QA/QC procedures. Auditors were supplied by CH2MHill to audit both the project quality as well as ensuring that the health and safety procedures were being followed.

Batelle-EMO also supplied an auditor to ensure that they were satisfied that the operations followed the workplans and protocols set down before the fieldwork commenced. MITRE, another government based non-profit organisation which handles many Air Force contracts also audited the operations. This was to provide the Air Force with an independent assessment of the project.

At one sampling site there were five people auditing the work being performed by two people.

Besides the quality assurance of the project as a whole, fieldwork quality control was required. Field verification samples were required to be taken to allow an assessment of the accuracy and precision of the analytical results. These samples consisted of the following:

a) Field Duplicate

Field duplicates are taken primarily to check sample technique and laboratory technique.

b) Trip Blanks

Trip blanks are used to determine whether the samples absorb any chemicals in the trip from the laboratory to the site and back. Trip blanks were prepared by the laboratory

c) Container Blanks

Container blanks are taken to check the container preparation.

d) Equipment Blanks

Equipment blanks are taken to determine whether the equipment is contributing to the contamination in the samples.

9 TOUR OF BASE REMEDIATION PROJECTS

At Eielson AFB there were a few remediation trials being undertaken. The three types were briefly observed on a small tour and comprised soil farming, bioremediation and bioventing.

The soil farming consisted of two plots of land in which mildly contaminated soil had been placed. Both plots were being continually tilled to aerate the soil and promote biological action. The level of contamination was being monitored but it appears that this method was not having much success in the time-frame required. It was costing in the order of US$1M per 15,300 m3 of soil.

The bioremediation exercise comprised a small area at the edge of a hydrocarbon contaminant plume. The area was divided into 4 small plots. A series of underground pipes ran beneath the plots. In one plot, warm air was being circulated, in another, warm air and warm water and in the final two plots ambient air was circulated. The purpose of the scheme was to determine the differing effects on biological action caused by heating the soil as opposed to just aerating the soil.

The bioventing was the newest of the three processes being trialed and was not working at the time of my departure. The system comprised a series of vacuum extraction wells in an area of known significant floating product. The area was adjacent to some major groundwater extraction wells associated with the base power station.

Air could be pumped in or out of the extraction wells to provide oxygen for biological action or to extract volatile gases from the soil. In its extraction phase, vapour was extracted from the wells and run through an air stripper to separate the water vapour. The air was then pumped to a vapour burner and ignited. The water vapour was condensed and pumped to a storage tank before being run through an oil/water separator and finally a treatment plant containing carbon filters.

The problem with the system when I left was that the extraction wells were extracting more water than vapour and so the gas mixture going to the vapour burner was too wet to be ignited.

The impression gained from the short tour was that the three systems all represented a large investment of money and time and in general the results were unsatisfactory.

10 CONCLUSIONS

Through the hazardous materials course I have a much greater understanding of the health and safety issues relevant to contaminated site work. The field work was of major benefit to my understanding of how a contaminated site investigation should be conducted. Working with an experienced field team ensured that I saw many of the procedures and instruments operated in the correct manner.

The methods used by CH2MHill in Alaska met the requirements of the strict U.S. EPA and OSHA regulations. Hence, I am now in the position to perform this work in Gutteridge Haskins & Davey investigations at a stricter level of quality and safety than currently required in Australia.

11 ACKNOWLEDGEMENTS

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12 REFERENCES

1. United States Environmental Protection Agency, "Compendium of Field Operations Methods", Vol. 1 and 2, Draft, March, 1987.