

HISTORY OF THE COMPLEX DISPOSAL TRENCHES

Rocky Mountain Arsenal (RMA) occupies more than 17,000 acres (approximately 27 square miles) in Adams County, directly northeast of metropolitan Denver, Colorado (see Figure 2-1). The property was purchased by the U.S. Government in 1942 for use in World War II to manufacture and assemble chemical warfare materials, such as mustard and lewisite, and incendiary munitions. Starting in the 1950s, RMA produced the nerve agent GB (isopropyl methylphosphonofluoridate) until late 1969. A significant amount of chemical warfare materials destruction took place during the 1950s and 1960s. Since 1970, RMA has primarily been involved with the destruction of chemical warfare materials. The last military operations at RMA ended in the early 1980s. In November 1988, the RMA was reduced to inactive military status reflecting the fact that the only remaining mission at the Arsenal is contamination cleanup. In addition to these military activities, major portions of the plant facilities were leased to private industries, including Shell Oil Company, for the manufacture of various insecticides and herbicides between 1947 and 1982.

The Phase I and Phase II Contamination Assessment Reports (CARs) (ESE 1988a and 1988b) as well as the Central Study Area Report (CSAR) (Ebasco 1989a) and the North Central Study Area Report (NCSAR) (Ebasco 1989b) describe the nature and extent of contamination throughout Section 36. These reports describe the soil and groundwater throughout Section 36 as being contaminated with a wide range of organics, ICP metals (cadmium, chromium, copper, lead, and zinc), arsenic, and mercury.

Basin A, located immediately west of the Complex Disposal Trenches, was the primary liquid waste disposal site at RMA in the 1940s and 1950s. Although Basin A no longer contains standing liquids, the remaining sludge and soil beneath Basin A is contaminated with volatile organic compounds, organosulfur compounds, organophosphorus compounds, organochlorine pesticides, arsenic, and mercury (Ebasco 1989b).

The Complex Disposal Trenches are located in the east-central portion of Section 36, in Site 36-17. Site 36-17 is a 107-acre site that is divided into a northern (Site 36-17N) and a southern (Site 36-17S) portion. Site 36-17N is further subdivided into eight anomalous areas located during a geophysical investigation conducted during the Phase I fieldwork (ESE 1988a). These areas are identified as Anomalous Areas A through H. The Complex Disposal Trenches in Anomalous Areas A and H are evaluated as being in close, or direct, contact with groundwater during parts of the year. Trenches in Anomalous Areas B and C are known to contain hazardous materials from previous investigations.

Trenches in Anomalous Areas A, B, C, and H are considered for a possible interim response action in the IRA Alternatives Assessment (WCC 1989a). Figure 2-2 identifies the Anomalous Areas and the trench areas considered for this IRA.

Site 36-17S also contains some disposal trenches that are being investigated for an IRA by Shell Oil Company. This IRA Decision Document focuses only on the Army Complex Disposal Trenches in Site 36-17N.

Site 36-17N was the primary solid waste disposal area at RMA in the 1940s and 1950s. Solid chemical waste and potentially contaminated tools, equipment, unwanted containers, rejected incendiaries, and empty munitions casings were decontaminated with caustic or another decontaminant and then hauled to burning pits and burned to ensure complete decontamination by incineration. The burning pits/trenches, approximately 8 to 10 feet deep, 15 feet wide, and up to 100 to 200 feet long, typically had a bottom layer of approximately 4 to 5 tons of lumber. The solid waste was placed on top of the lumber until the pit was full. Additional lumber and approximately 300 to 500 gallons of fuel oil were then placed into the pit, and the contents were burned. Remaining metal was checked for contamination and reburned, if necessary. The decontaminated, salvageable metal remained in the pit; some of it was later removed and sold as scrap. The pit was then backfilled which buried the nonsalvageable materials. Burning and disposal pits appear to have been dug in the area on a regular basis until the late 1960s (ESE 1988a).

Phase I and Phase II field investigations found that the Complex Disposal Trenches contain a wide variety of wastes, as well as potentially hazardous materials. The waste types include contaminated soil, scrap metal, concrete rubble, wood and charcoal, drums of waste chemicals, and glass vials containing unknown liquids. The hazardous materials, which are potentially present, include unexploded ordnance, Army agents or agent degradation products, and unburned incendiaries (ESE 1988a and 1988b). An additional field investigation conducted in spring and summer 1989 confirmed these findings (WCC 1989b). Contaminants found in the Complex Disposal Trenches soils include the ICP metals (cadmium, chromium, copper, lead, and zinc), arsenic, mercury, organochlorine pesticides, diisopropylmethyl phosphonate (DIMP), and organosulfur compounds.

The alluvial groundwater in the Complex Disposal Trench area flows to the north and northwest under unconfined conditions, then northwest out of the Basin A neck. Anomalous Areas A and H are located on the eastern fringe of this portion of the north-northwest flowing alluvial aquifer. The top of the bedrock surface protrudes above the groundwater table along the prominent northwest to southeast

trending bedrock ridge in Section 36. The alluvium that caps the bedrock ridge is unsaturated. Anomalous Areas B and C are located over this unsaturated alluvium.

Groundwater contamination in the vicinity of the Complex Disposal Trench area is summarized in Appendix B. Figure 2-3 shows the locations of the groundwater monitoring wells used for the summary in Appendix B. The Central Study Area Report (Ebasco 1989a) and the RMA data base provide details of the groundwater contamination in the vicinity of the Complex Disposal Trenches.

Groundwater in the saturated alluvium underlying Anomalous Areas A and H is highly contaminated with organic contaminants. The plume for these contaminants originates in Site 36-17S and moves up through Site 36-17N underlying Anomalous Areas A and H. Contaminant concentrations do not generally increase as the contaminant plume in the alluvial aquifer moves from Site 36-17S through Site 36-17N. The contaminants include volatile organic compounds; DBCP; organophosphorous compounds (DIMP, dimethylmethyl phosphonate [DMMP], and methylphosphonic acid [MPA]); and organosulfur compounds, both mustard related (dithiane and oxathiane) and herbicide related (chlorophenylmethyl sulfide [CPMS], chlorophenylmethyl sulfoxide [CPMSO], and chlorophenylmethyl sulfone [CPMSO₂]). Low concentrations of organochlorine pesticides, and relatively low concentrations of arsenic are also present in the plume moving from Site 36-17S through Site 36-17N. Some ICP metals are present only in a few wells at relatively low concentrations. Groundwater flow rates were calculated using the lower and upper limits of estimated hydraulic gradients and hydraulic conductivities for Section 36. On the basis of these parameters, the calculated flow rate in the alluvial aquifer ranges from approximately 7 to 186 feet/year.

Wells completed in the bedrock, northeast of Anomalous Areas B and C, show some concentrations of volatile halogenated organics, volatile aromatic organics, and DIMP. These contaminants were not found in soil samples in Anomalous Areas B and C. However, due to the heterogeneous nature of the trench contents, there is some possibility that the groundwater contamination is coming from these trenches. Another explanation for this contamination may be that groundwater from the contaminated alluvial aquifer is infiltrating the bedrock. Although the majority of alluvial groundwater entering Site 36-17N from the south encounters the bedrock ridge and is subsequently diverted to the northwest, the bedrock is not absolutely impermeable. Some alluvial groundwater may penetrate either the bedrock itself, or any fracture in the bedrock that may be present, and move down the hydraulic gradient in the Denver Formation to the northeast. Therefore, some contamination present in the alluvial aquifer could possibly be transported through the bedrock. Movement of this contamination would be much slower than in the saturated alluvium because of the lower hydraulic conductivity of the bedrock. The

calculated flow rate to the northeast of the Complex Disposal Trench area, where flow occurs primarily in the Denver Formation, ranges from approximately 0.2 to 1.6 feet/year. However, there are no monitoring wells upgradient of Anomalous Areas B and C which can be used to evaluate contaminant migration from the alluvial aquifer into the bedrock. Therefore, data do not exist to evaluate whether groundwater contamination in the bedrock is due to the Anomalous Area B and C trenches or infiltration from the alluvial aquifer.

In summary, soil samples taken in the Complex Disposal Trench area show metals to be the primary contaminants, with some indications of organics. It appears that the alluvial aquifer is contaminated primarily with a wide range of organic compounds. Although the Army Complex Disposal Trenches appear to be contributing to the degradation of groundwater quality, wells upgradient of the trenches area indicate that the alluvial aquifer is heavily contaminated prior to entering the Complex Disposal Trench area. The metals that are the primary contaminants in the soil samples from the trenches have been detected in the alluvial groundwater. However, groundwater sampling and analysis show no clear trend of metal contaminant distribution downgradient of the trenches area.

On February 1, 1988, a proposed Consent Decree was lodged in the case of U.S. v. Shell Oil Company with the U.S. District Court in Denver, Colorado. The proposed Consent Decree was revised after public comments were received, and a modified proposed Consent Decree was lodged with the Court on June 7, 1988. In February 1989, a Federal Facility Agreement was entered into between Shell Oil Company and five federal agencies: the U.S. Environmental Protection Agency, the Army, the Department of the Interior, the Department of Health and Human Services, and the Department of Justice, which established procedures for implementing the Arsenal cleanup program as specified in the Technical Program Plan and incorporates many provisions of the modified proposed Consent Decree. The Army and Shell Oil Company agreed to share certain costs of the remediation to be developed and performed under the oversight of the U.S. Environmental Protection Agency, with opportunities for participation by the State of Colorado. The long-term remediation is a complex task that will take several years to complete. The Federal Facility Agreement specifies 13 IRAs determined to be necessary and appropriate. The Remediation of Other Contamination Sources is one of the 13 IRAs. The Complex Disposal Trenches are one of several sites being addressed by the remediation of other contamination sources IRA.