SECONDARY CONCENTRATION OF AIR-RELEASED URANIUM THROUGH WATERSHED RUNOFF AT THE FEED MATERIALS PRODUCTION CENTER, FERNALD, OHIO

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ABSTRACT

To date, two transport mechanisms are widely recognized in the introduction of contaminants to ground water at the Feed Materials Production Center (FMPC), Fernald, Ohio: surface water acting as a point source or localized source, and areal distribution of airborne contaminants. In this paper, we will present a third mechanism, secondary concentration of smokestack emissions and explain the conditions that allow it to occur.

This transport mechanism was recently proposed by L. Lehman & Associates, Inc. while researching uranium contaminated ground water at the FMPC.

SITE DESCRIPTION

The FMPC is a contractor-operated federal facility for the production of high-purity uranium metal for the U.S. Department of Energy (DOE). The plant is operated by Westinghouse Materials Company of Ohio for the DOE. Current operations consist mainly of metal fabrication and the processing of accumulated plant residues and miscellaneous feed materials obtained from other DOE sites.

Since the start of operations in 1952, the FMPC has released 132,525 Kg of airborne uranium emissions (1). More than 97 percent of this release occurred prior to 1970. Since then, more efficient emissions control systems have been installed.

EXTENT OF CONTAMINATION

Zones of ground water contamination exist to the east and south of the plant (Fig. 1). The zone to the south shows contaminant levels several hundred times the background level of 0.5 pCi/l (2). The source of this contamination has been determined to be surface water runoff from the plant production and waste pit areas. This runoff infiltrates the ground water via Paddy's Run, a losing stream west of the plant.

To the east of the site, in general, uranium levels in the ground water are only slightly elevated. However, Southwestern Ohio Water Co. (SOWC) Well Collector #2, located approximately one mile from the site, shows higher levels. This well near the Great Miami River has a uranium content 2.4 times the local background level. The lower uranium levels closer to the plant can be explained by either a plume originating beneath the site or by widespread infiltration of surface contamination from smokestack emissions. However, neither of these mechanisms could completely account for the higher levels of contamination in the SOWC well. It was while seeking other explanations for this contamination that L. Lehman and Associates recognized the proposed transport mechanism of secondary concentrations of smokestack emissions.

TRANSPORT MECHANISM

Reasoning that the contamination introduction to the south of the plant via Paddy's Run might be duplicated elsewhere, a similar source was sought to the east. All surface water from the site drains into Paddy's Run, with the exception of a storm sewer system that is pumped directly into the Great Miami River. Contamination via this system was investigated, but the discharge pipe was found not to release water to the ground. It actually gained water, discharging a small volume even when not in use. In addition, the discharge point was found to be downstream of the well in question.

In looking for an alternate contamination source, analyses of soil and vegetation surrounding the FMPC indicated that uranium concentrations decreased with a 1/r2 relation to distance from the site. In other words, uranium released in air emissions tends to preferentially settle out nearer the site. This relationship was especially strong in the predominantly downwind area northeast of the site. Examination of this area revealed a 1/3 to 1/2 square mile surface water catchment area adjacent to the site's northeast corner (Fig. 2).

This catchment area is drained by a single intermittent stream flowing to the Great Miami River. Surface geologic deposits in the catchment area are glacial tills with a high runoff coefficient due to their relatively fine-grained texture. Such soils produce a relatively large percentage of runoff during rainfall events.

It was proposed that small rainfall events wash airfall uranium that has settled over this area into the streambed. Larger rainfall events also will move the contaminants downstream. The stream moves onto the river flood plain, where the glacial deposits have been eroded by the Great

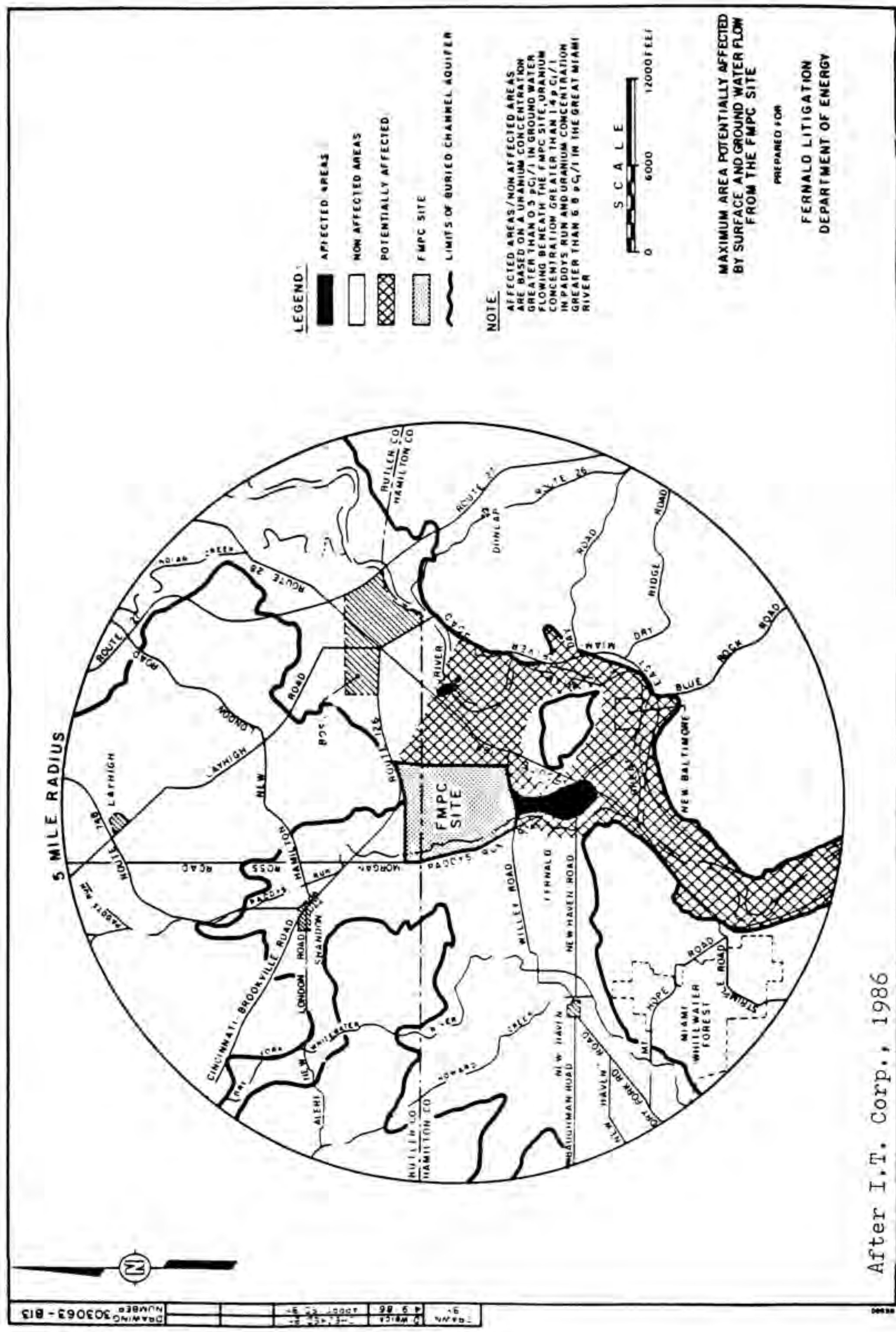

Fig. 1. Maximum Area Potentially Affected by Surface and Ground Water Flow from FMPC Site.

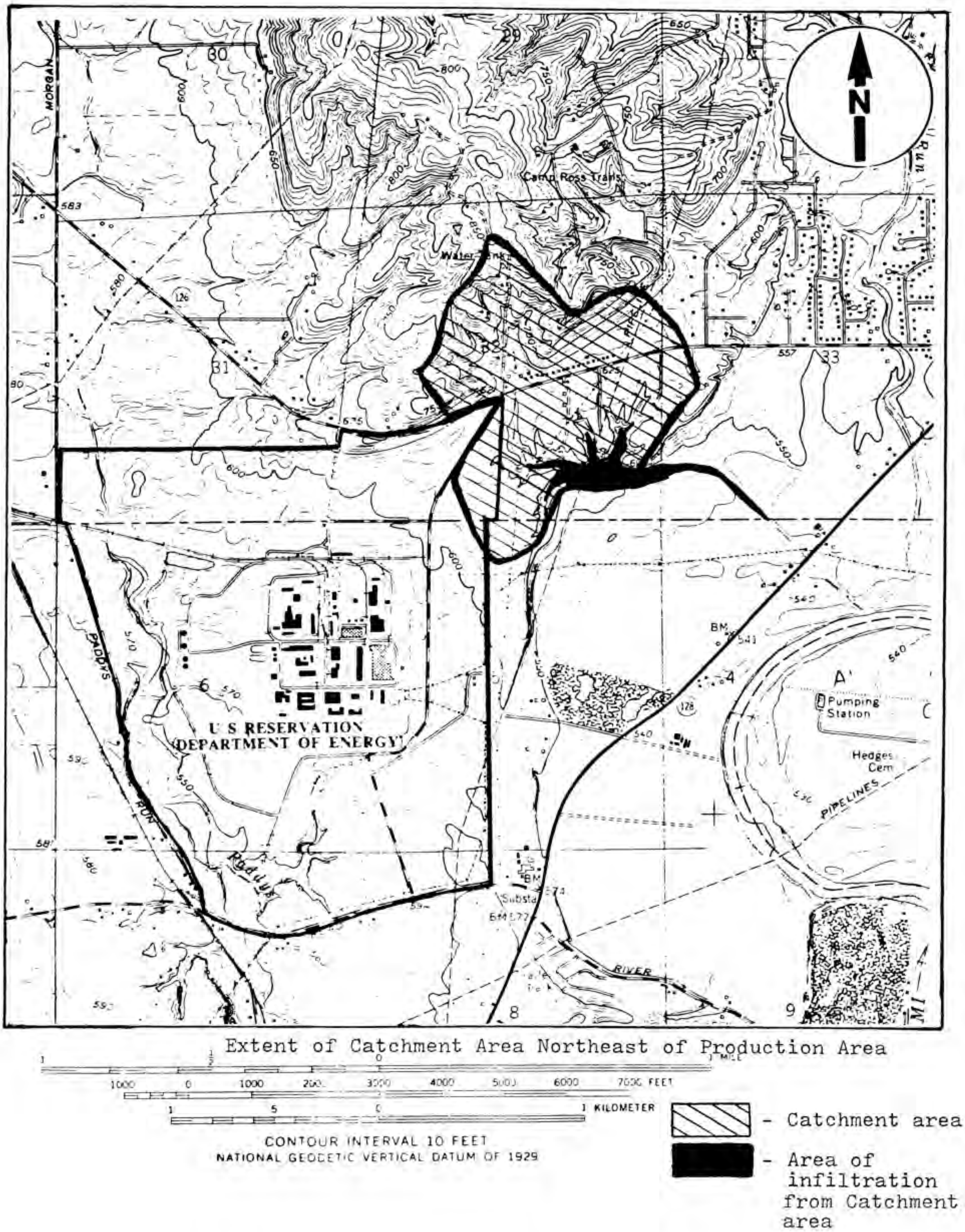

Fig. 2. Extent of Catchment Area Northeast of Production Area.

Miami River, exposing the sand and gravel layer that serves as the region's aquifer. At this point, infiltration of stream water begins and the process parallels that found at Paddy's Run.

The water table here lies at least 25 feet below the surface, thus confirming the stream's losing nature. Ground water in the area flows to the southeast, toward the Great Miami River. The SOWC well is directly downgradient of the stream's infiltration zone.

DATA ANALYSIS

Sampling programs have been in effect at the FMPC for several years, including ground water, soil, stream sediment, surface water, vegetation and livestock analysis. Concentrated sampling has not been done in the area of our investigation because the contamination potential had not previously been recognized.

Available data indicates that average soil concentrations near the catchment area for 1984-1986 are five times the background level (3). Only a single stream sediment sample is available for the intermittent stream, and its exact location and uranium concentration are not clear. All that is stated is that the sample is at or below background levels (2). This fact does not necessarily discount the proposed theory.

A similar relationship between stream sediment and ground water uranium concentrations exists at Paddy's Run. Ground water concentrations appear to be many times those of sediment concentrations. Paddy's Run stream sediments produced uranium levels of 5.2 pCi/g, while ground water levels reach up to 256 pCi/l (4). In the intermittent stream, sediment uranium levels are 0.65 pCi/l and ground water levels are 1.2 pCi/l (5).

This relation is most likely a result of the recent decrease in uranium emissions from the site. Since 97 percent of uranium air emissions occurred prior to 1970, current surface levels of uranium reflect only a small portion of the contamination that has taken place. In addition, an incinerator that previously operated adjacent to the plant may have released considerable quantities of contaminants to the area. Because data from sampling programs prior to 1980 were not available, it was not possible to evaluate what additional effects these increased emissions have had. Furthermore, additional significant doses may result from accidental releases that occur periodically on the site.

CONCLUSIONS

Available data indicates that landform characteristics, climatic conditions and ground water patterns combine to create a concentrating effect on smokestack emissions at the FMPC. Areas of highly elevated uranium east of the plant that could not be explained by the direct release and movement of contaminants from the site itself were explained by L. Lehman and Associates through a third mechanism -- secondary concentration of air-released uranium. The applicability of this mechanism to the situation at the Feed Materials Production Center indicates that this combination of accepted contamination routes is an important contaminant pathway.

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