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The types of chemicals potentially present on ranges varies, depending on the range type and its use. For ranges used for bombing, the most immediately hazardous chemicals would consist of explosive compounds such as TNT and RDX. This has been confirmed by environmental samples collected at numerous facilities. For example, TNT or RDX is usually present in explosives contaminated soils. Studies of sampling and analysis at a number of explosives-contaminated sites reported "hits" of TNT or RDX in 72 percent of the soil samples collected (1) and up to 94 percent of water samples collected. (2)

(1) Field Sampling and Selecting On-Site Analytical Methods for Explosives in Soils. A. B. Crockett, H. D. Craig, T. F. Jenkins, and W. E. Sisk. U.S. Environmental Protection Agency. EPA/540/R-97/501. November 1996.

(2) Field Sampling and Selecting On-Site Analytical Methods for Explosives in Water. A. B. Crockett, H. D. Craig, and T. F. Jenkins. U.S. Environmental Protection Agency. EPA/600/S-99/002. May 19, 1999.

TNT is still used but mixtures of RDX, HMX, ammonium picrate, PETN, tetryl, and aluminum came into use during World War II.

Toxicity and Human Health and Ecological Impacts of Explosives and Other Constituents

The human health and environmental risks of other constituents from UXO are caused by explosives or other chemical components in munitions and from the compounds used in or produced during munitions operations. When exposed to some of these hazardous chemicals and residues, humans may potentially face long-term health problems, including cancer, and animals may develop physical health and behavioral problems. The adverse effects of UXO and UXO residues are dependent on the concentration of the chemicals and the pathways by which receptors become exposed. Understanding the human health and environmental risks of UXO residues and byproducts requires information about the inherent toxicity of these chemicals and the manner in which they may migrate through soil and water toward potential human and environmental receptors. This section provides an overview of some commonly found explosive compounds and their potential health and ecological impacts.

These explosive and otherwise potentially toxic compounds can be found in soils, groundwater, surface waters, and air and have potentially serious human health and ecological impacts. The nature of these impacts, and whether they pose an unacceptable risk to human health and the environment, depend upon the dose, duration, and pathway of exposure, as well as the sensitivity of the exposed populations

their potential human health effects as provided by EPA's Integrated Risk Information System (IRIS), the Agency for Toxic Substances and Disease Registry (ATSDR), and material safety data sheets (MSDS).

Potential Toxic Effects of Exposure to Explosive Chemicals and Components

Contaminant Chemical Composition Potential Toxicity/Effects

TNT 2,4,6-Trinitrotoluene C7H5N3O6 Possible human carcinogen, targets liver, skin irritations, cataracts.

RDX Hexahydro-1,3,5-trinitro-1,3,5-triazine C3H6N6O6 Possible human carcinogen, prostate problems, nervous system problems, nausea, vomiting. Laboratory exposure to animals indicates potential organ damage.

HMX Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine C4H8N8O8 Animal studies suggest potential liver and central nervous system damage.

PETN Pentaerythritol tetranitrate C5H8N4O12 Irritation to eyes and skin; inhalation causes headaches, weakness, and drop in blood pressure.

Trinitrotoluene (TNT)

TNT is soluble and mobile in surface water and groundwater. It is rapidly broken down into other chemical compounds by sunlight, and is broken down more slowly by microorganisms in water and sediments. TNT is not expected to bioaccumulate under normal environmental conditions. Human exposure to TNT may result from breathing air contaminated with TNT and TNT contaminated soil particles stirred up by wind or construction activities. Workers in explosive manufacturing who are exposed to high concentrations of TNT in workplace air experience a variety of organ and immune system problems, as well as skin irritations and cataracts. Both EPA and ATSDR have identified TNT as a possible human carcinogen.

Toxicological Profiles of RDX and TNT

The EPA's IRIS uses a weight-of-evidence classification for carcinogenicity that characterizes the extent to which the available data support the hypothesis that an agent causes cancer in humans. IRIS classifies carcinogenicit4 alphabetically from A through E, with Group A being known human carcinogens and Group E being agents with evidence of non carcinogenicity. IRIS classifies both TNT and RDX as Group C, possible human carcinogens, and provides a narrative explanation of the basis for these classifications. (3). The ATSDR is tasked with preventing exposure and adverse human health effects and diminished quality of life associated with exposure to hazardous substances from waste sites, unplanned releases, and other sources of pollution present in the environment. The ATSDR has developed toxicological profiles for RDX and TNT to document the health effects of exposure to these substances. The ATSDR has identified both TNT and RDX as possible human carcinogens.(4)

(3) Carcinogenicity Assessment for Lifetime Exposure of Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX).Carcinogenicity Assessment for 2,4,6-trinitrotoluene (TNT) for Lifetime Exposure. EPA Integrated Risk Information System, 1993.

(4) Toxicological Profile for 2,4,6-trinitrotoluene (update). (ATSDR) Toxicological Profile for RDX. Atlanta,GA: U.S. Department of Health and Human Services, Public Health Service. 1995.

The ecological impacts of TNT include blood, liver, and immune system effects in wildlife. In addition, in laboratory tests, male test animals treated with high doses of TNT developed serious reproductive system effects.

Royal Demolition Explosive (RDX)

RDX, also known as Royal Demolition Explosive or Research Department Explosive, is another frequently found synthetic explosive chemical. RDX dissolves in and evaporates from water very slowly. RDX does not bind well to soil particles and can migrate to groundwater, but the rate of migration depends on the soil composition. If released to water, RDX is degraded mainly by direct photochemical degradation that takes place over several weeks. RDX does not biologically degrade in the presence of oxygen, but anaerobic degradation is a possible fate process under certain conditions. RDX's potential for bioaccumulation is low. Human exposure to RDX results from breathing dust with RDX particles in it, drinking contaminated water, or coming into contact with contaminated soils. RDX inhalation or ingestion can create nervous system problems and possibly organ damage. As discussed previously, RDX has been identified as a possible human carcinogen. The ecological effects of RDX suggested by laboratory studies include neurological damage including seizures and behavioral changes in wildlife that ingest or inhale RDX. Wildlife exposure to RDX may also cause damage to the liver and the reproductive system.