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NEVADA TEST SITE LOW-LEVEL AND MIXED WASTE REPOSITORY DESIGN IN THE UNSATURATED ZONE

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ABSTRACT

The Area 5 Radioactive Waste Management Site (RWMS) at the Nevada Test Site (NTS) is used for shallow land disposal of Low-Level Radioactive (LLW) and for retrievable disposal of Mixed Wastes (MW) from various Department of Energy (DOE) facilities. The site is situated in southern Nevada, one of the most arid regions of the United States. Design considerations include vadose zone monitoring in lieu of groundwater monitoring, stringent waste acceptance and packaging criteria, a waste examination and real-time radiography facility, and trench design.

INTRODUCTION

The Area 5 Radioactive Waste Management Site (RWMS) at the Nevada Test Site (NTS) is used for shallow land disposal of low-level radioactive and mixed wastes, as well as for greater confinement disposal of wastes not suited to shallow land disposal and for storage of transuranic (TRU) waste. In addition to disposing of LLW generated at the NTS, the RWMS disposes of LLW generated by 17 offsite DOE generators from around the United States. Only wastes produced by DOE defense-related operations are accepted for disposal at the RWMS.

The Mixed Waste Management Unit (MWMU) of the Area 5 RWMS is regulated by the state of Nevada and the U.S. Environmental Protection Agency (EPA) Region IX under the Resource Conservation and Recovery Act (RCRA). The MWMU is currently operated under interim status, pending approval of the RCRA Part B Permit Application by EPA and the state. The RCRA Part B Permit Application was submitted in October 1988.

The RWMS is operated by the Defense Waste Management Department (DWMD) of the Reynolds Electrical & Engineering Co., Inc. (REECo) under contract to the DOE Nevada Operations Office (DOE/NV).

SITE LOCATION

The location of the RWMS is the major factor contributing to the excellent performance of the low-level and mixed waste units. The low population density of the surrounding area, physiographic barriers, arid climate, and optimum geologic and hydrologic conditions are all characteristics that contribute to the safe and effective confinement of disposed wastes.

The NTS is located in southern Nevada, approximately 65 miles northwest of Las Vegas. The NTS is bordered to the west, north, and east by the Nellis Air Force Range, another government-owned, restricted-access area. The NTS is, therefore, well buffered from private lands. These lands are predominantly rural, undeveloped desert lands occasionally used for grazing, mining, and agriculture. The only major population center area is the greater Las Vegas area. The RWMS is in Area 5 of the NTS, approximately 15 miles north of the main NTS entrance gate.

The NTS is situated in the Great Basin portion of the Basin and Range Physiographic Province which includes parts of Nevada, Arizona, and Utah. The province is characterized by a series of north-south trending mountain ranges separated

by broad valleys filled with alluvium.[1] The RWMS in Area 5 of the NTS is located in one of the valleys; a closed alluvial basin in the eastern portion of the NTS. The setting is well suited for storing and disposing of low-level radioactive and mixed wastes and for preventing radionuclides and hazardous constituents from migrating beyond NTS boundaries on the surface or in groundwater.

Surface water is present only during unusually persistent or intense storms. Surface water flow at these times occurs as flash floods which may be caused by intense thunderstorms.[1] The RWMS is equipped with dikes and flood channels to divert flash flood water away from the disposal units. Open cells are equipped with drainage ditches and culverts to divert sheet flow. During a 100-year rainfall event which occurred in 1984, the dike surrounding the RWMS successfully diverted flash flood water.

The RWMS lies in one of the most arid regions of the Unites States, with an annual average rainfall of 4 to 6 inches. The potential for evaporation of water from the soil significantly exceeds the amount of water received as precipitation; pan evaporation has been conservatively estimated to range from 60 to 80 inches.[1] The available data indicates that in general, rain falling in the basins does not penetrate to a sufficient depth to prevent loss due to evaporation. Travels times to groundwater for an adjacent NTS basin have been estimated in excess of one million years.[2]

VADOSE ZONE MONITORING SYSTEM

Because of the long vadose zone travel times, the low average annual rainfall, and the detection capabilities of the vadose zone monitoring system, a groundwater monitoring waiver has been requested from the state of Nevada in the RCRA Part B Permit Application. The vadose zone monitoring system is designed to detect migration of hazardous and/or radioactive constituents long before contamination of groundwater could occur.

The monitoring methods selected as most appropriate for the vadose zone monitoring system are (1) neutron logging, (2) soil air sampling, and (3) gamma logging. These methods were selected because mixed waste consists, by definition, of both hazardous and radioactive components and both components should be included in a vadose zone monitoring system. Because water movement through the unsaturated zone is the major vehicle for the transport of waste, neutron logging was selected to provide long-term monitoring of soil moisture conditions within and beneath the pit. Soil air sampling (with gas chromatograph analysis) detects the presence and concentration of volatile and semi-volatile hydrocarbon components, while gamma logging is used to detect radionuclides in the disposal system.[1] In the design of the vadose zone monitoring system, emphasis was placed on methodologies that provided the required data, could be calibrated, and could be operationally tested.

The current spacing of the vadose zone sampling points is approximately 28 to 30 feet apart. This initial spacing represents a dense array with which to gather data. Installation of the access tubes and the soil air samplers is phased to coincide with placement of the waste packages. In this manner, shortcomings of the initial system can be corrected in subsequent phases. The system is very adaptable to modifications and additions. The access tubes for the neutron probe, gamma spectrometer, and soil air samplers extend to 11 feet below the base of the pit; in addition, neutron probe access tubes and soil air samplers are extended vertically between the waste packages as waste stacking and backfilling operations are conducted.

TRENCH AND PACKAGE DESIGN

A standard trench size is used for low-level and mixed waste disposal operations. The trenches are sloped away from the working face to ensure that rainwater entering the pit drains away from the waste packages. The trenches are designed to be no more than 20 feet deep to help prevent compression of

the lower packages and to aid in package emplacement. Standard forklifts are used to place the waste in stacks. The boxes are placed in the pit using a stair-step warehouse stacking method with drums placed in nests made by the top tier of boxes. Drums are also placed along the outer edges of the trench. Boxes are placed in the stack by weight, with the heaviest packages on the bottom. This stacking method provides for enhanced worker safety and takes advantage of most of the pit area. Backfill is placed over the waste as it is emplaced; however, at least one hundred feet of waste at the face is left uncovered to ensure that backfilling does not compromise the stability of the working face.

An exemption from trench liners was requested in the RCRA Part B Permit Application. This request is based on design and location standards. Liners and leachate collection systems would not lengthen significantly the time of waste migration to the uppermost aquifer below the RWMS.[2] The operational life of liners is estimated to be approximately 30 to 40 years; as mentioned above, travel times to groundwater are estimated to be in excess of one million years. In addition, the deposition environment of the alluvium at the RWMS has been evaluated by Desert Research Institute.[3] Five geologic units were identified based on differences in vegetation and ground surface appearance. Of the five units identified, four include barriers to downward percolation of water. Studies suggest that during the wetter times of the Pleistocene, moisture from precipitation penetrated to as deep as 2 m (6 ft), but seems not to have penetrated below that depth.[3]

In addition, liners may increase the potential for the "bathtub effect" which results in infiltrating water and condensation being trapped in the disposal unit between the lower liner and upper low-permeability layer of the final closure cap. Because water is the transport mechanism to biopathways, it is desirable to have any water which does contact the waste travel through the cell as quickly as possible reducing its contact time with the waste. Liners could trap water in the pit, causing longer waste contact times and greater potential for leaching of hazardous and/or radioactive constituents from the waste.

All packages must meet Department of Transportation (DOT) specifications.[4] Generally, wooden boxes or specification 55-gallon steel drums are used. In addition, all packages must meet compressibility requirements of 4000 pounds per square foot to ensure that packages do not crush from the weight of stacked packages and cover.

A three-dimensional coordinate system is used to track placement of packages should future retrieval be required. Each package is assigned a unique package identification number; this number, along with the trench placement coordinates, is recorded as the package is emplaced in the trench. Should the vadose zone monitoring system reveal migration of radioactive or hazardous constituents, the coordinate system will be used to determine which packages are probable sources of the waste constituents.

WASTE ACCEPTANCE CRITERIA, CERTIFICATION, AND EXAMINATION

In addition to stringent packaging criteria, the Area 5 RWMS has waste acceptance criteria designed to minimize the potential for migration of hazardous and/or radioactive waste components.

In brief, the waste acceptance criteria for low-level waste are:

Low-level waste must have a transuranic nuclide concentration not greater than 100 nCi/g. Low-level waste must not contain hazardous constituents, as defined by EPA. The waste must not contain more than 0.5% free liquids by weight; fine particulates and radioactive gases must be stabilized. Pathogens, infectious wastes, and biological wastes are not accepted for disposal.

Mixed waste must contain hazardous constituents as defined by EPA or state regulations and be radioactive (intermixed with low-level radioactive material). Except for the restriction against chemically hazardous materials, mixed waste

must meet all the waste form criteria for low-level waste, as listed above, and must meet land ban requirements. In addition, mixed waste cannot be explosive, pyrophoric, contain PCBs, or be a high-heat generator.

To ensure that all waste generators comply with the waste acceptance criteria, an waste characterization and certification program has been established.[4] DOE/NV contractor personnel perform a Technical Audit of the characterization and certification process at the generator's site prior to approval to ship waste. Annual recertification of each waste stream is required as are annual technical audits.

In order to further ensure that all waste acceptance criteria are met, a waste examination building is being constructed at the RWMS. The waste examination building will house a waste package breaching room and a real-time radiography (RTR) unit. Samples may be obtained from the packages in the breaching room and analyzed at NTS laboratories capable of analyzing both radioactive and hazardous waste constituents. The RTR unit will allow inspection of unbreached waste packages to ensure that waste packages do not contain non-compliant materials, such as aerosol cans and liquids. Construction of the waste examination building is scheduled to begin in late 1989 or early 1990.

SUMMARY

The RWMS design takes full advantage of natural conditions and stringent waste acceptance criteria to ensure that human health and the environment are protected. The vadose zone monitoring system will detect migration of hazardous or radioactive constituents long before they reach biopathways; trenches are designed to ensure that water is not allowed to accumulate. The waste acceptance criteria, waste characterization and certification program, and waste examination capabilities are used to ensure that waste constituents which could readily migrate into the environment are not accepted for disposal at the NTS.

Excellent natural conditions, coupled with good waste management practices, make the RWMS a superb facility for the containment of mixed and low-level waste.

REFERENCES

1. Department of Energy, Nevada Operations Office, RCRA Part B Permit Application for the Mixed Waste Management Facility, Nevada Test Site, Mercury, Nevada, October, 1988.

2. Department of Energy, Nevada Operations Office, Closure Plan for U3axbl Mixed Waste Management Unit, Nevada Test Site, Mercury, Nevada, February, 1989.

3. C. CASE, et. al., Site Characterization in Connection with the Low Level Defense Waste Management Site in Area 5 of the Nevada Test Site, Nye County, Nevada - Final Report, Desert Research Institute, September 1984.

4. Department of Energy, Nevada Operations Office, and Reynolds Electrical & Engineering Co., Inc., Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer Requirements, NVO-325, October, 1988.

Reynolds Electrical & Engineering Co., Inc.

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RADIOACTIVE WASTE MANAGEMENT SITE, AREA 5, NEVADA TEST SITE

Reynolds Electrical & Engineering Co., Inc.

- NEAR-SURFACE DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTE AND MIXED WASTE
- LOW-LEVEL WASTE RECEIVED FROM ONSITE AND SEVERAL OFFSITE GENERATORS
- MIXED WASTE RECEIVED FROM ONE OFFSITE GENERATOR
- STORAGE OF TRANSURANIC WASTE PENDING SHIPMENT TO WIPP
- GREATER CONFINEMENT DISPOSAL OF WASTE NOT SUITABLE FOR NEAR-SURFACE DISPOSAL

EXCELLENT NATURAL CONDITIONS FOR WASTE DISPOSAL

Reynolds Electrical & Engineering Co., Inc.

- 4 TO 6 INCHES AVERAGE ANNUAL PRECIPITATION
- 800 FEET TO GROUND WATER
- DISPOSAL UNITS LOCATED IN CLOSED BASIN
- EVAPOTRANSPIRATION GREATLY EXCEEDS PRECIPITATION
- TRAVEL TIMES TO GROUND WATER ESTIMATED AT > 1,000,000 YEARS

VADOSE ZONE MONITORING SYSTEM

Reynolds Electrical & Engineering Co., Inc.

- DESIGNED TO DETECT MIGRATION OF RADIONUCLIDES AND HAZARDOUS CONSTITUENTS LONG BEFORE THEY REACH THE GROUNDWATER

- NEUTRON MONITORING FOR MOISTURE MOVEMENT

- GAMMA RAY SPECTROSCOPY TO IDENTIFY MIGRATION OF RADIONUCLIDES

- SOIL GAS SAMPLING WITH GAS CHROMATOGRAPHY TO DETECT MOVEMENT OF VOLATILE ORGANICS

TRENCH AND PACKAGE DESIGN

Reynolds Electrical & Engineering Co., Inc.

- TRENCHES ARE STANDARD SIZE
- TRENCHES SLOPED AWAY FROM WORKING FACE SO PRECIPITATION DRAINS AWAY FROM WASTE PACKAGES
- WASTE IS PLACED IN STAIR-STEP MANNER TO HELP ENSURE WORKER SAFETY
- 3-D COORDINATE SYSTEM IS USED TO TRACK PLACEMENT OF PACKAGES FOR RETRIEVABILITY
- PACKAGES MUST MEET DOT SPECIFICATIONS AND 4000 LB/SQ FT COMPRESSIBILITY REQUIREMENT

TRENCH LINER EXEMPTION

Reynolds Electrical & Engineering Co., Inc.

- LINER EXEMPTION REQUESTED IN RCRA PART B PERMIT APPLICATION
- NATURAL BARRIERS TO DOWNWARD PERCOLATION OF WATER
- PRECIPITATION FLUX THAN 2 METERS
- OPERATIONAL LIFE OF LINERS MUCH LESS THAN TRAVEL TIME TO GROUNDWATER
- LINERS MAY INCREASE CONTACT TIME OF WATER WITH WASTE

WASTE ACCEPTANCE CRITERIA

Reynolds Electrical & Engineering Co., Inc.

- NO FREE LIQUIDS
- FINE PARTICULATES AND RADIOACTIVE GASES MUST BE STABILIZED
- NO PCBS, PATHOGENS, INFECTIOUS WASTES, OR BIOLOGICAL WASTES
- LAND BAN TREATMENT STANDARDS MUST BE MET BY MIXED WAST
- CERTIFICATION PROGRAM ENSURES COMPLIANCE

WASTE EXAMINATION BUILDING

Reynolds Electrical & Engineering Co., Inc.

- WILL CONSIST OF REAL-TIME RADIOGRAPHY (RTR) UNIT AND BREACHING ROOM
- NTS HAS ONSITE LABORATORIES TO ANALYZE SAMPLES FROM BREACHED CONTAINERS
- RTR WILL ENSURE THAT THERE ARE NO LIQUIDS, AEROSOL CANS, ETC. IN WASTE PACKAGES
- PROCEDURES IN PROCESS TO DETERMINE HOW MANY PACKAGES WILL BE EXAMINED
- CONSTRUCTION SCHEDULED TO BEGIN WITHIN THE NEXT 6 MONTHS

CURRENT PROJECTS

Reynolds Electrical & Engineering Co., Inc.

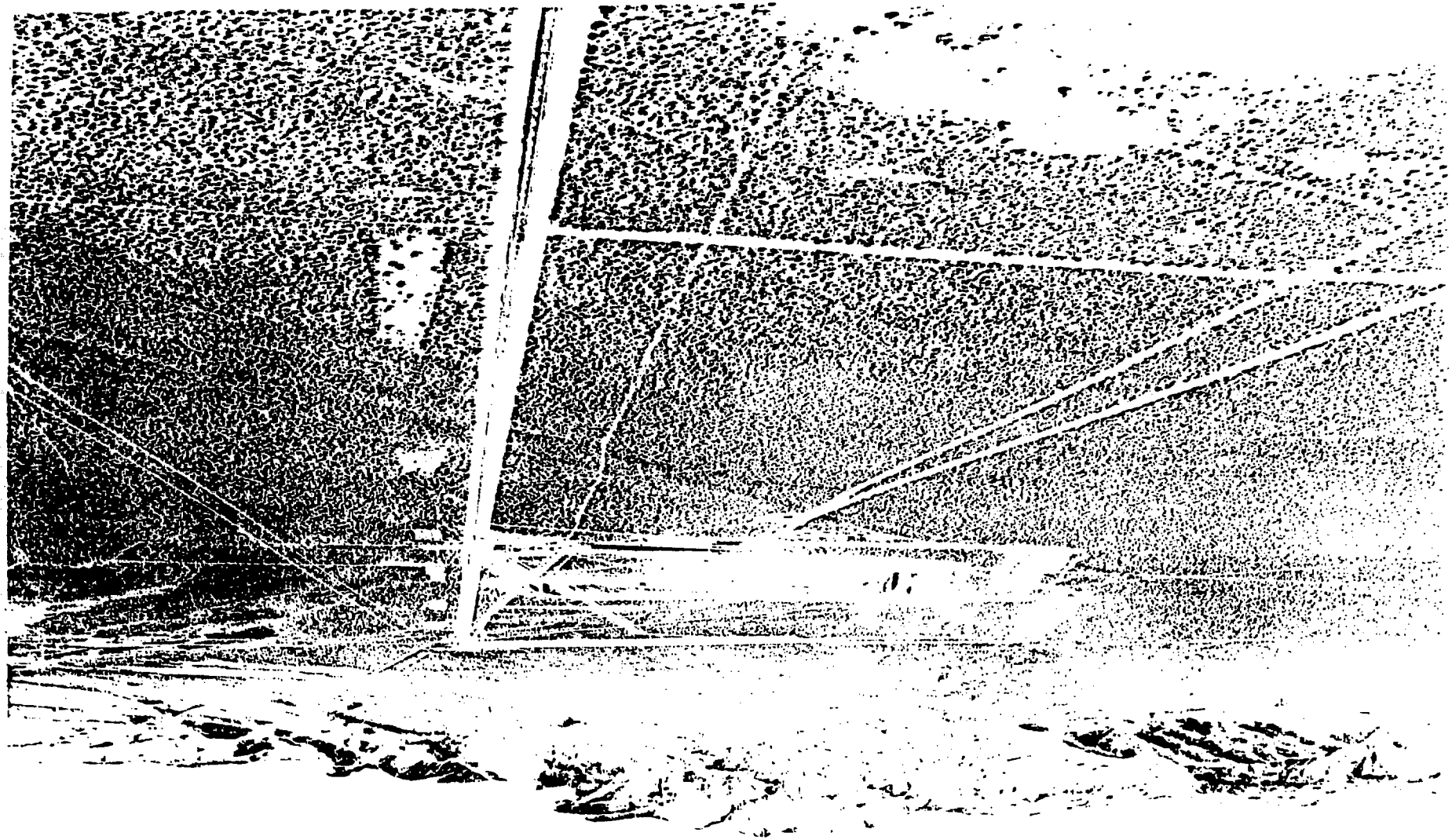
- CLOSURE DEMONSTRATION PROJECT TO INVESTIGATE VARIOUS RCRA-COMPLIANT TRENCH CAP DESIGNS
- DETAILED SITE CHARACTERIZATION DATA BEING GATHERED
- COMPUTER MODELING EFFORT UNDERWAY TO FURTHER CHARACTERIZE VADOSE ZONE TRAVEL TIMES
- ENVIRONMENTAL ASSESSMENT AND PERFORMANCE ASSESSMENT IN PROGRESS
- TRANSPORTATION IMPACTS STUDY UNDERWAY
- REVISING RCRA PART A & B PERMIT APPLICATIONS TO INCLUDE CHANGES IN OPERATIONS AND MORE MIXED WASTE STREAMS

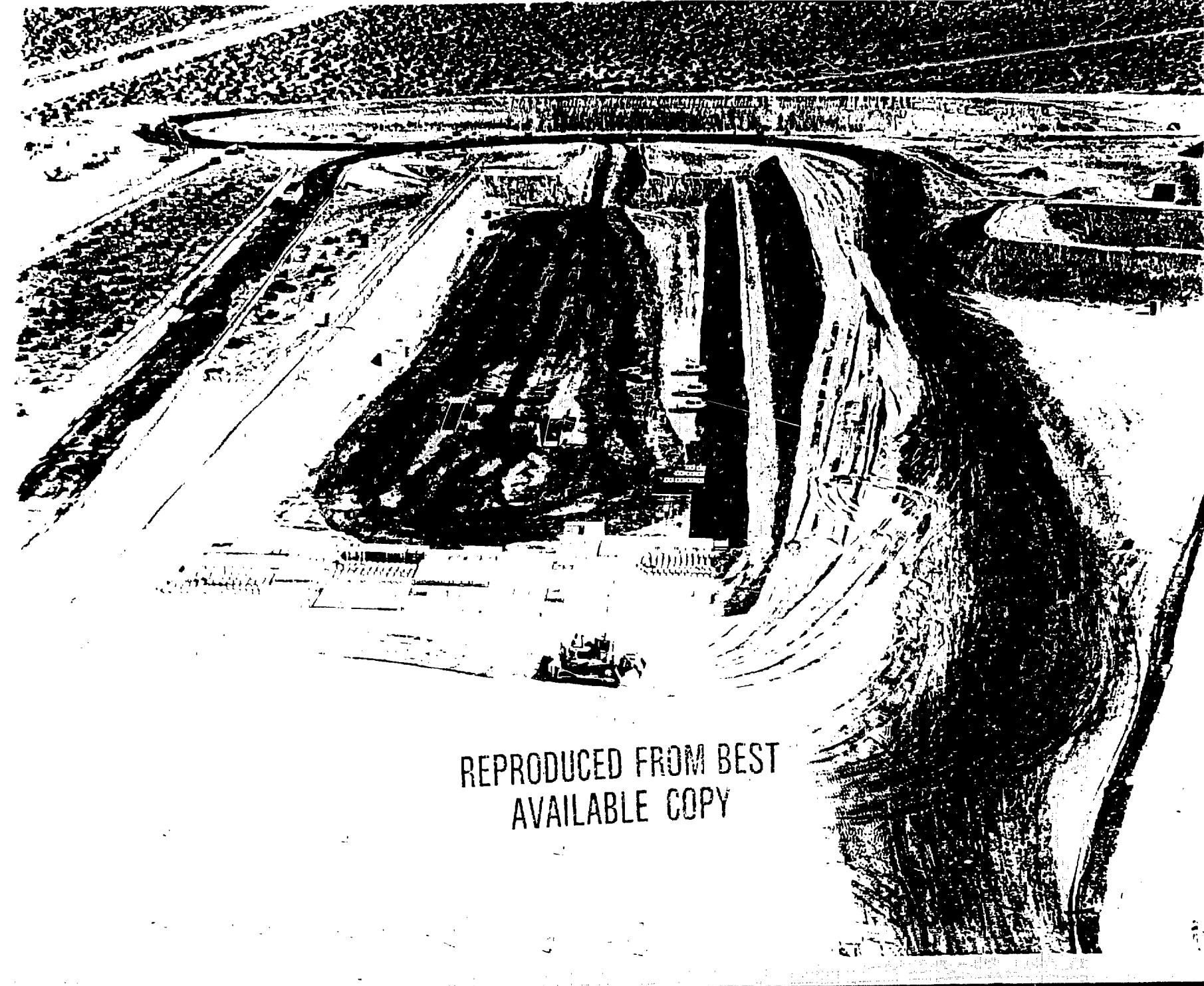
REGULATORY STATUS

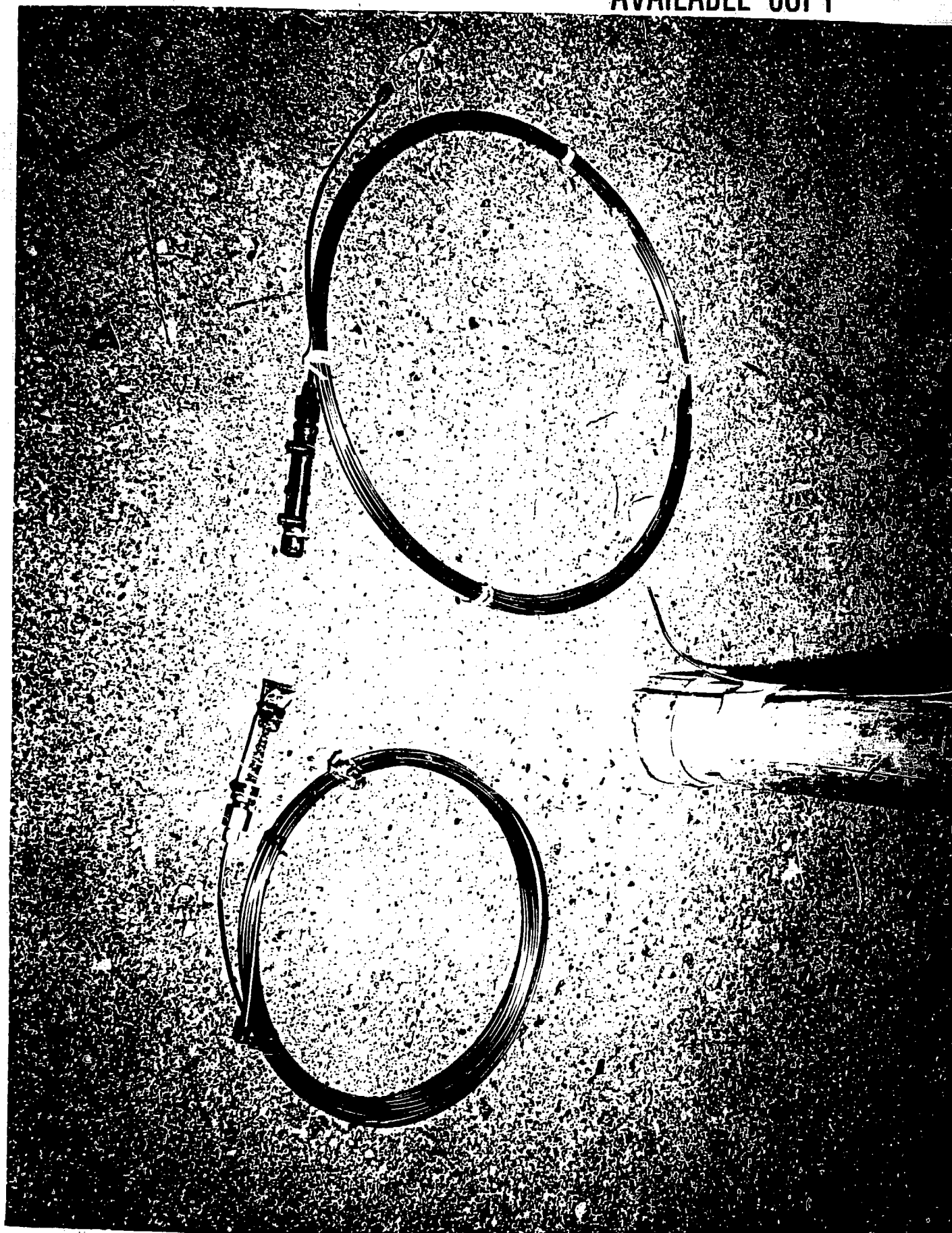
- CURRENTLY OPERATING IN INTERIM STATUS; RCRA PART B PERMIT APPLICATION SUBMITTED OCTOBER 1988

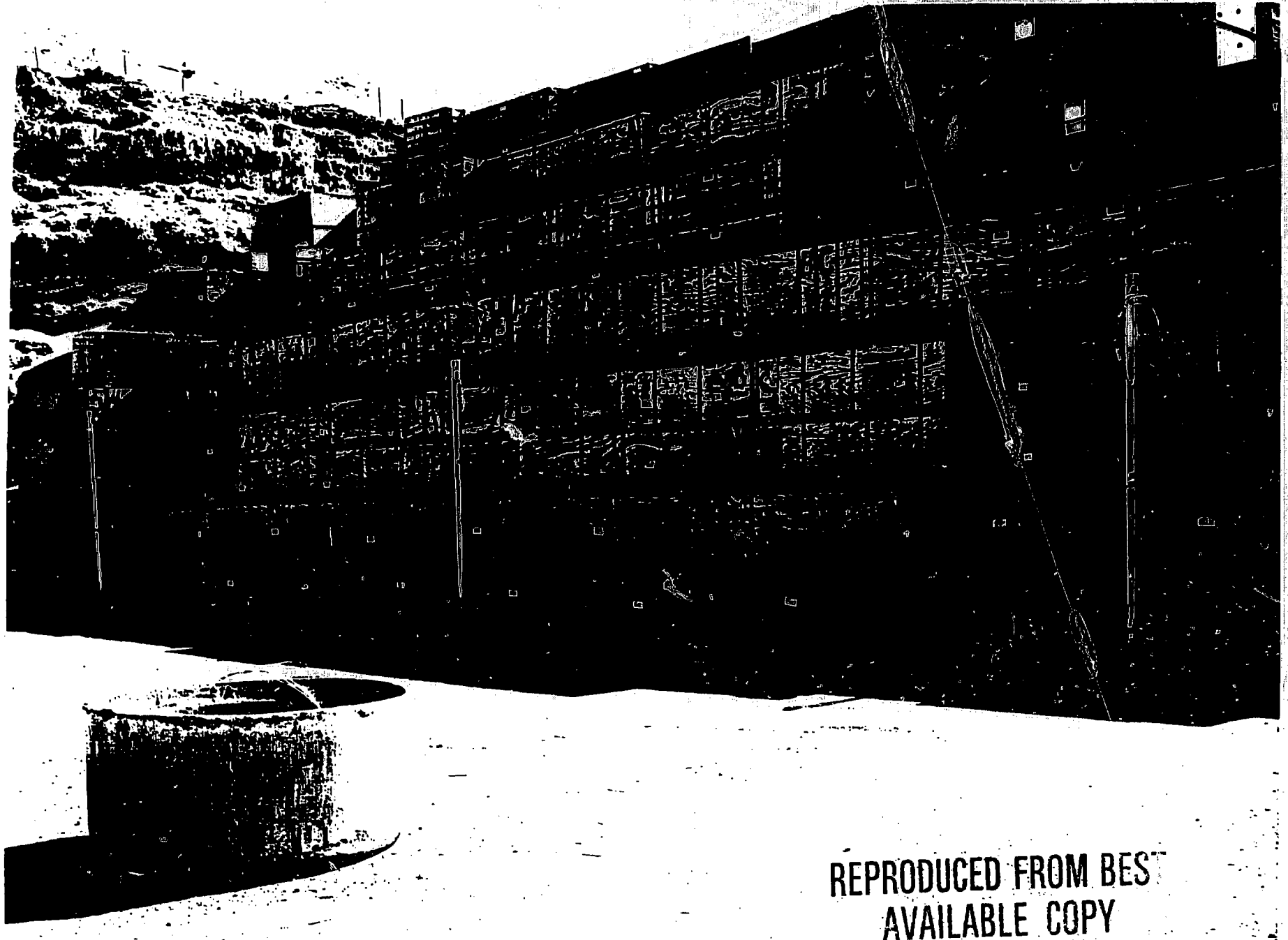
- REGULATORY AUTHORITIES ARE STATE OF NEVADA AND EPA REGION IX

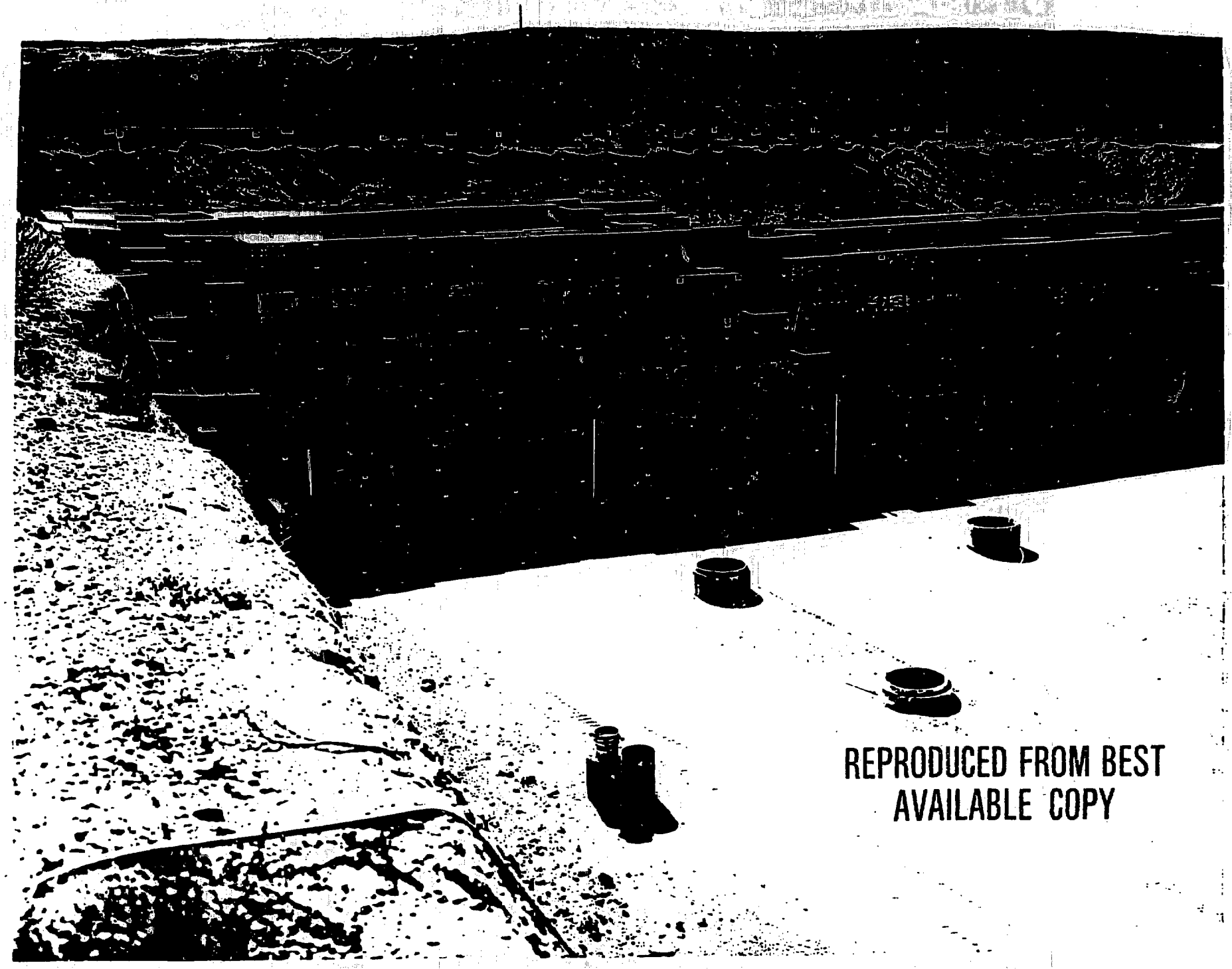
- PER AGREEMENT WITH STATE, WILL ONLY TAKE MIXED WASTE FROM ONE GENERATOR UNTIL ENVIRONMENTAL ASSESSMENT IS APPROVED BY DOE/HQ

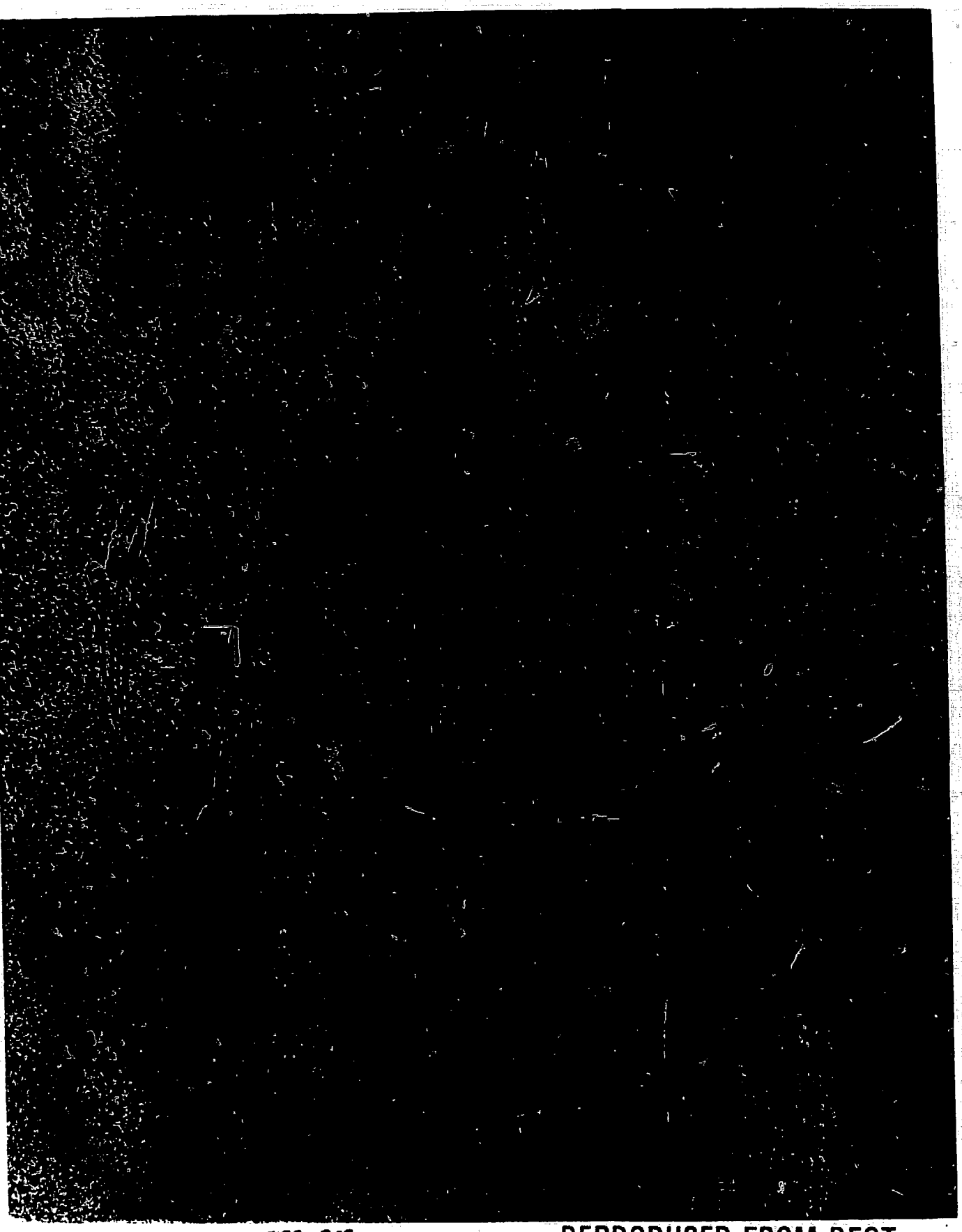












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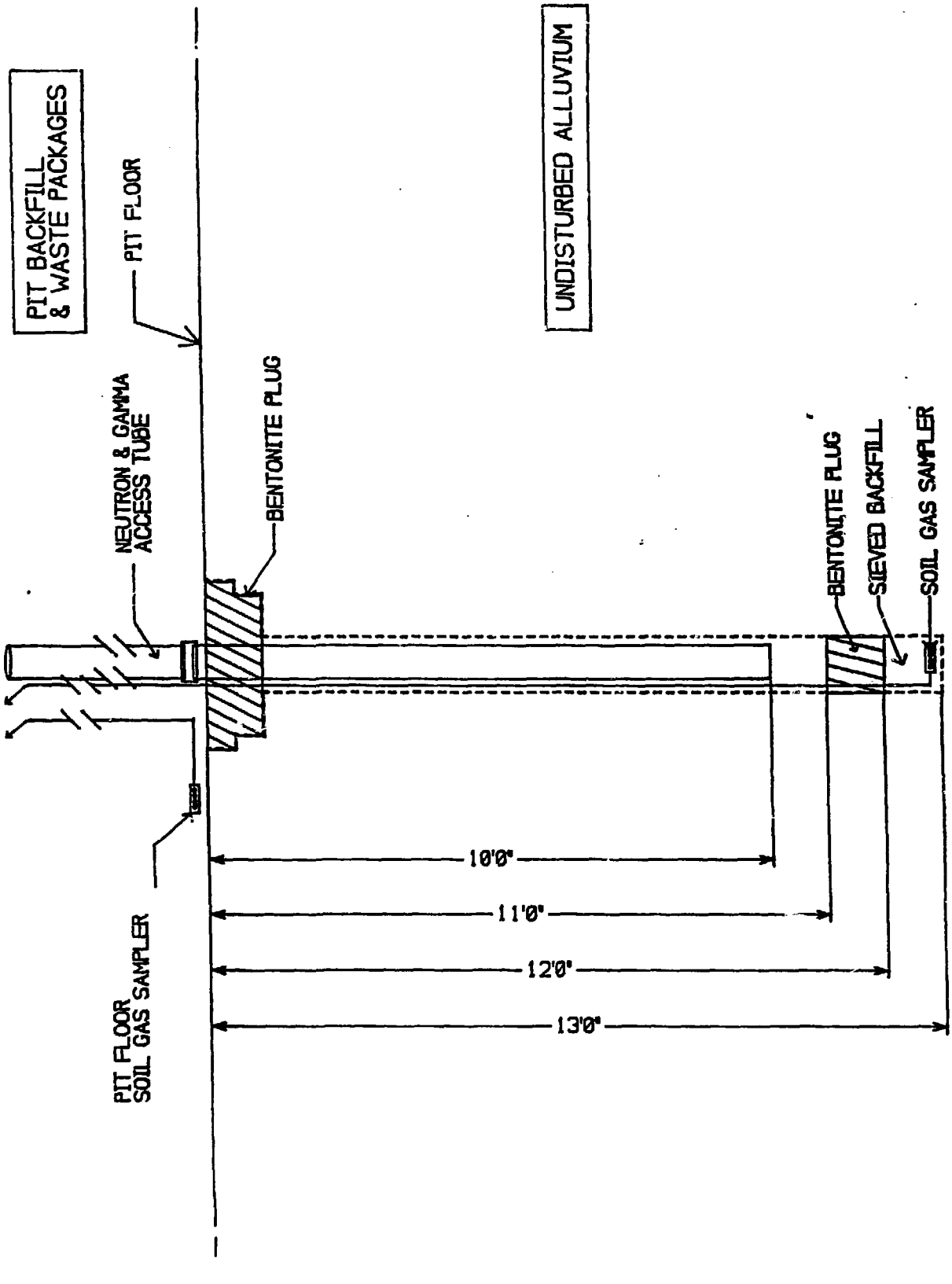

Construction of a Monitoring Station