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January 28, 1983

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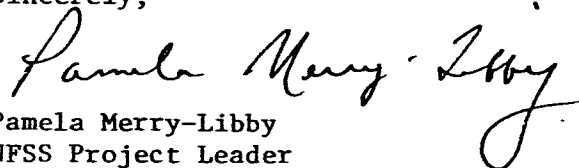
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SUBJECT: NIAGARA FALLS STORAGE SITE FY 1983 ADM

Gentlemen:

Enclosed is the final "Action Description Memorandum (ADM), Niagara Falls Storage Site, Proposed Interim Remedial Actions for FY 1983." The actions discussed include only those actions planned at the time this ADM was first drafted. We anticipate preparing a supplemental ADM to address those actions which are being added as part of the accelerated program.

Sincerely,



Pamela Merry-Libby  
NFSS Project Leader  
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PML:na  
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**ACTION DESCRIPTION MEMORANDUM**  
**NIAGARA FALLS STORAGE SITE**  
**PROPOSED INTERIM REMEDIAL ACTIONS**  
**FOR FY 1983**

**Prepared by**  
**Division of Environmental Impact Studies**  
**Argonne National Laboratory**  
**Argonne, Illinois**

**January 1983**

**Prepared for**  
**U.S. Department of Energy**  
**Oak Ridge Operations**  
**Technical Services Division**  
**Oak Ridge, Tennessee**

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SUBJECT: Proposed FY 1983 Interim Remedial Actions at the  
Niagara Falls Storage Site\*

#### SUMMARY OF PROPOSED ACTION AND RELATED ACTIVITIES

As part of its Surplus Facilities Management Program (SFMP) and Formerly Utilized Sites Remedial Action Program (FUSRAP), the U.S. Department of Energy (DOE), Oak Ridge Operations Office, proposes to carry out an interim remedial action project in FY 1983 at the Department's Niagara Falls Storage Site (NFSS) in Niagara County, Lewiston Township, New York (Figure 1). The project will involve reconsolidation, stabilization, and other control measures for various radioactive residues and contaminated materials located on the site and in drainage ditches. Specific project actions include:\*

- Clearing and grubbing of trees and brush from portions of the site, from the west and central drainage ditches (onsite and offsite) and along the site perimeter fence.
- Excavation from the cleared areas of sediments and soil materials that have a radium-226 concentration in excess of 5 pCi/g above background. The excavated materials will be placed within an existing diked area (R-10 pile) on the site. Uncontaminated fill materials will be placed in the excavated areas to reestablish proper drainage grade.
- Transfer of uranium ore-processing residues (Middlesex sands) stored in Building 410 to either the R-10 pile diked area or the basement of Building 410.
- Partial dewatering and construction of a multilayer cover system over the residues currently stored in Building 411.
- Demolition of Building 410.

Details of these activities are given in the section "Proposed Action and Alternatives."

This work will be a continuation of interim remedial work begun in 1982 as part of DOE's ongoing maintenance and caretaker operations at NFSS. The 1982 remedial action consisted of: (1) reconsolidation and stabilization of the R-10 pile of radioactive residues, (2) construction of a dike and subsurface, clay cutoff wall (trench) around the R-10 pile, (3) removal of wooden roofs and construction of a multilayer cover system over radioactive residues

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\*Plans for remedial actions at NFSS have been accelerated. Preliminary engineering is underway for several additional FY 1983 interim actions. A supplemental ADM will be prepared when sufficient details become available regarding the additional actions.

stored in Buildings 413 and 414, and (4) clearing and excavation of ditches and other contaminated areas in the southwest part of the site as R-10 add-on work (Bechtel Natl. Inc. 1982a, 1982b, 1982c, 1982d; U.S. Dep. Energy 1982a, 1982b). Additional interim remedial actions may later be proposed for subsequent fiscal years, depending on funding. Throughout all the interim actions, the site will continue to be under DOE's ownership and used solely for continued storage of radioactive wastes and residues. The site is fenced and access is limited. Planning is currently underway for the long-range permanent disposition of the site (Bechtel Natl. Inc. 1982e, 1982f); however, no specific actions are being proposed at this time.

## HISTORY AND NEED FOR ACTION

The current 77-ha (190-acre) DOE Niagara Falls Storage Site is part of a former 610-ha (1500-acre) Manhattan Engineer District (MED) site (Figure 2), which in turn was part of the former Lake Ontario Ordnance Works (LOOW). Beginning in 1944, the MED used the site for storage of radioactive residues that resulted from the processing of uranium ores during development of the atomic bomb. Additional residues were brought to the site for several years after World War II.

Subsequent to the MED, responsibility for the site has been transferred to the Atomic Energy Commission, the Energy Research and Development Administration, and the Department of Energy. The site is currently administered by the Oak Ridge Operations Office of DOE, and there are no activities other than maintenance and caretaking.

About half the residues stored at NFSS currently belong to Afrimet-Indussa, a Belgian firm, and the remaining residues belong to the U.S. government. Afrimet supplied the federal government with uranium ore (pitchblende) from the Belgian Congo but retained ownership of the residues because of the potentially recoverable, valuable elements that remain in the residues. Afrimet currently holds a license from the state of New York (a Nuclear Regulatory Commission agreement state) for storage of the radioactive materials at NFSS. The storage lease agreement between Afrimet and DOE expires June 30, 1983, and a new agreement is currently being negotiated.

Buildings 410 and 411 are part of a complex of concrete and wooden buildings in the southwest portion of NFSS (Figure 3) that were originally designed for water treatment and storage. There are about 6,020-6,090 m<sup>3</sup> (7,900-8,000 yd<sup>3</sup>) of Afrimet-owned residues (L-30 residues) currently stored in bulk in two large concrete vaults (east and west bays) in Building 411 (Ausmus et al. 1980). About 70% (by volume) of the residues is chamosite clay. Ausmus et al. (1980) report the following concentrations of uranium and radium in the residues: 1,800 ppm and 10,000-30,000 ppm for uranium; 7,000 pCi/g and 12,000 pCi/g for radium-226. Anderson et al. (1981) report that uranium concentrations vary from 830-5,000 ppm and radium concentrations from 2,000 to 12,000 pCi/g. Radon-222 concentrations in the air immediately above the residues have been reported as 400-2,400 pCi/L and 900-2,400 pCi/L; concentrations at the level of the catwalks above the residues have been reported as 1.1-2.3 pCi/L (Ausmus et al. 1980). As part of the 1982 interim remedial actions, the L-30 residues above the water level in the west bay of Building 411 were washed down and the residues in the west bay were wetted down. Also, water from Building 410 was transferred to the east bay of Building 411. As a

result, most of the residues are now under water, and radon levels in the air above the residues have been reduced from about 24 WL (working level) to 1 WL (Bechtel Natl. Inc. 1983). Prior to the 1982 work, about 3,000-3,500 m<sup>3</sup> (790,000-920,000 gal) of water covered portions of the residues. Efforts were taken in 1982 to determine the concentrations of radionuclides and heavy metals in this water, but the results have not yet been published. The source of the water has been largely attributed to precipitation that enters the building through the leaky roof, although connections to other buildings (which were disconnected in 1980 and 1982) may be an additional source of water (Ausmus et al. 1980).

Building 410 currently contains about 175 m<sup>3</sup> (230 yd<sup>3</sup>) of U.S.-owned residues (Middlesex sands) (Ausmus et al. 1980; Anderson et al. 1981). Radioactive contamination is present throughout the facility as a result of prior storage activities, leaching, and water transport of the residues. There is contaminated water in the canals in the bottom floor of Building 410. This water may have originated from precipitation and possibly from shallow saturated zones in the surrounding soils (Ausmus et al. 1980). It then became contaminated upon contact with the residues and contaminated surfaces in the building. The level of uranium in the residues is less than 100 ppm, and radium is less than 10 pCi/g (Anderson et al. 1981). Radon levels in the building range from 3 to 26 pCi/L (Ausmus et al. 1980).

The proposed clearing and excavation areas (Figures 3 and 4) are contaminated as a result of past storage activities as well as wind and water erosion of stored materials, particularly erosion of residues from the R-10 pile located north of Building 411. (Remedial action was taken in 1982 to stabilize and construct a dike around the R-10 pile.) Other contaminated areas on the site--excluding contaminated buildings, residues, and ditches--are shown in Figure 5. Radium-226 concentrations in these contaminated areas (Table 1) are above the criterion that is being used for interim actions at NFSS (i.e., 5 pCi/g above background). In the central ditch sediments, radium-226 concentrations are as high as 1,900 pCi/g in a small section onsite (Table 1); concentrations offsite are at least a factor of 10 lower. Cesium-137 is the primary contaminant in the northwest area (Area 3, Figure 5), with soil concentrations as high as 59,000 pCi/g in a small 1-m<sup>2</sup> (11-ft<sup>2</sup>) area to a depth of 1.2 m (4 ft) (Ausmus et al. 1980; Anderson et al. 1981). This contamination results from previous storage of reactor materials in this area.

More detailed information on the extent of the radioactive contamination on and near the site as well as possible alternatives for disposition of the Afrimet residues and the entire NFSS can be found in: U.S. Atomic Energy Commission (1974); Cavendish et al. (1978); Ausmus et al. (1980); Acres American Incorporated (1981a, 1981b, 1981c); Anderson et al. (1981); Battelle Columbus Laboratories (1980); and Bechtel National, Inc. (1982a, 1982b, 1982c, 1982d, 1982e, 1982f).

## SETTING

The Niagara Falls Storage Site is located in Niagara County in Western New York (Figure 1), within the town (township) of Lewiston and adjacent to the town (township) of Porter. It is about 30 km (19 mi) north of Buffalo, New York; 10 km (6 mi) north of the city of Niagara Falls; 6.5 km (4 mi) south of Lake Ontario; and 5 km (3 mi) east of the Province of Ontario, Canada.

There are several buildings and private roads on the fenced-in site (Figure 3). The site is zoned industrial and is currently used only for storage of radioactive residues and soils. Most of the site is covered with second-growth forest, shrubs (brush), grasses, and marsh vegetation. Surface water flows into the west and central ditches and subsequently into Fourmile Creek and Lake Ontario (Figure 6). The channeled ditches are overgrown with cattails. Water flow, when it occurs, is generally slow (Ausmus et al. 1980), except during spring melt when the flow may be rapid; much of the time there is essentially no flow at all. The 100-year floodplain is contained within the drainage ditches (U.S. Dep. Housing Urban Dev. 1980).

Land uses immediately adjacent to the site are varied. A hazardous-waste-disposal facility operated by SCA Chemical Waste Services is located north and east of the site. A sanitary landfill is being constructed to the east by Modern Disposal, Inc. South of the site is federal government property controlled by the General Services Administration and used for training construction equipment operators. There is also a sanitary landfill south of the site, which is owned by the town of Lewiston. West of the facility is a Niagara Mohawk Power Corporation transmission line corridor (Acres American Inc. 1981a). All these properties are located on land that was once part of the original MED site (Figure 2). There are eight property owners (including the U.S. Government) located along offsite portions of the west and central drainage ditches north of the site (Acres American, Inc. 1981a).

Land uses within the towns (townships) of Lewiston and Porter are predominantly rural and include row-crop agriculture, orchards, recreation areas, old abandoned fields, and second-growth forests (Table 2). These areas are projected to remain rural through the year 2000. A recreational area, Fourmile Creek State Park, is located at the confluence of Fourmile Creek and Lake Ontario, about 3 km (2 mi) downstream from the central ditch (Figure 6).

The nearest permanent residence is 1.1 km (0.7 mi) southwest of the R-10 pile, and there is a trailer park 2.6 km (1.6 mi) northwest on Balmer Road (Figure 7). Workers at SCA Chemical Waste Services work outdoors 1.2 km (0.75 mi) north of the R-10 pile. During the summer, there are campers at the KOA campground 0.7 km (0.4 mi) southwest of the R-10 pile on Pletcher Road (Figure 7). Hunters occasionally use the area west of the Niagara Mohawk corridor.

The population of Niagara County, which has declined since 1970, was 227,101 in 1980 (Table 3). Population growth to the year 2000 is projected to be minimal (Table 3). Local town (township) and village population statistics are presented in Table 3. The nearest major population centers are the city of Niagara Falls (71,384) and the Buffalo metropolitan area (1.5 million). As of May 1982, the county had a civilian work force of 104,169, with an unemployment rate of 13.6%.

Major highway transportation routes in the area are State Route 93 to the north, U.S. Route 104 to the south, and the Robert Moses Parkway to the west (Figure 1). Local roads near the site and central drainage ditch include Lutts, Cain, Balmer, Pletcher, and Porter Center roads (Figure 7). No traffic counts on local roads are currently available.

Niagara County has a humid, continental climate that is moderated by the lake effects of Lakes Erie and Ontario. Average annual precipitation is 83 cm (33 in.), which is fairly evenly distributed throughout the year. Approximately 140 cm (56 in.) of snow falls, primarily between November and March (Acres American Inc. 1981a). The wind is predominantly from the southwest.

The NFSS is located on the southern shore of Lake Ontario, 3.2 km (2 mi) north of the Niagara Escarpment (Figure 1), on the relatively flat terrain of the Erie-Ontario Lowlands Physiographic Province. Elevations at the site range between 93 and 98 m (310 and 320 ft) MSL; the lower elevations correspond to the man-made drainage ditches. Creeks and drainage ditches on the site and surrounding areas are shown in Figure 6. About one-third of the site has soils that remain saturated throughout the year and are covered by marshy vegetation.

Geologically, the region is characterized by approximately 15 m (50 ft) of overburden that is underlain by a 274-m (900-ft) sequence of Ordovician-age shales and siltstones of the Queenston Formation. The overburden material is composed of glacial and recent alluvial deposits and includes dense tills, glaciolacustrine clays, and numerous lenses of glaciofluvial sands and gravels (Acres American Inc. 1981a, 1981b).

At NFSS, groundwater is present in both the glacial/alluvial deposits and bedrock and generally flows towards the northwest. There are essentially three aquifers underlying NFSS: (1) an unconfined, perched soil aquifer in a series of possibly discontinuous sandy silt or silty sand lenses 3 to 6 m (10 to 20 ft) below the ground surface, (2) a continuous, confined soil aquifer within the brown silty sand unit approximately 9 to 12 m (30 to 40 ft) below ground surface, which is contiguous with (3) a confined bedrock aquifer within the weathered upper meter of the Queenston Formation (Acres American Inc. 1981b). The groundwaters of all aquifers underlying NFSS have high concentrations of sulfate and calcium and are of low quality for drinking water (Acres American Inc. 1981a). Although private wells near the site have been monitored for radionuclide concentrations in groundwater, no ranges or seasonal variations have been published to date, and background concentrations for the site and region have not yet been established.

The radiological characteristics of the various residues, contaminated areas, and ditch sediments were described in the preceeding section. The residues and ditch sediments also contain metals and rare earths (Table 4). Concentrations at some sampling sites in the central drainage ditch are as high as those in the R-10 pile, probably due to past erosion of materials from the pile into the ditch. North of NFSS, the central ditch may also be contaminated with metals and organic compounds from SCA Chemical Waste Services operations (hazardous waste management). Until recently, SCA discharged to the central ditch (discharges are now routed through a pipe to the Niagara River). As specified in the old SCA State Pollution Discharge Elimination System (SPDES) permit (N.Y. Dep. Environ. Conserv. 1979), the discharges from SCA were limited to batch discharges at times when water was flowing in the ditch (a few weeks in spring and fall) such that the ditch flow diluted the discharge by a factor of 20 (Ludlam 1982). The discharges were monitored for pH, specific conductivity, and some organic chemicals. Heavy metals were removed prior to discharge. In addition to this discharge, there may be some contamination resulting from runoff into the central ditch from unsecured



areas on SCA property during rainy periods (Ludlam 1982). No information is available on concentrations of metals or organic chemicals in ditch sediments downstream of SCA property. Samples of ditch sediments downstream of SCA are being analyzed for EPA priority pollutants.

Various state and local governing bodies may have jurisdiction over or concern about the proposed remedial action at NFSS (Table 5). Local residents and interest groups have also shown interest and concern about the site. Newspaper articles have appeared, and private citizens have written letters to DOE and the U.S. Environmental Protection Agency (EPA). A Citizen's Oversight Committee was formed by U.S. Representative John LaFalce in response to public questions raised concerning the potential health hazards at the site (LaFalce 1980). Representative LaFalce has indicated that the purpose of this committee is to advise him regarding NFSS and to work with DOE to ensure that DOE's proposals are sound and acceptable to the committee. In a recent report to New York Assembly Speaker, Stanley Fink, regarding federal involvement in several hazardous-waste sites in the Niagara Falls area (Zweig and Boyd 1981), NFSS was mentioned as posing a hazard to public health and safety. There has been debate on whether the alleged hazards actually exist. Since October 1982, there have also been numerous newspaper articles about potential DOE long-term actions at the site and about discharges of contaminated water. Awareness and concern about radioactive and other hazardous wastes have been heightened by publicity about the nearby Love Canal toxic waste problem, the nearby West Valley high-level-radioactive waste project, and the Three Mile Island nuclear power plant accident (Zweig and Boyd 1981; U.S. Dep. Energy 1982c).

#### PROPOSED ACTION AND ALTERNATIVES

The Department of Energy proposes to take interim remedial actions to reconsolidate, stabilize, and control radioactive materials located on and near NFSS as part of its ongoing maintenance and caretaker operations. Details of the proposed FY 1983 actions are as follows.\*

Several areas onsite (Figure 3) will be cleared of trees, brush, logs, and other dead wood.\*\* Also to be cleared are (a) the offsite west drainage ditch (Figure 6), (b) about 3.2 km (2 mi) of the central drainage ditch immediately north of the site (Figure 6), (c) a swath about 6-m (20-ft) wide along one side of the ditches (for a haul road), and (d) a swath about 3-m (15-ft) wide along the perimeter fence. The larger stumps and roots will be grubbed out. A total of about 27 ha (66 acres) will be cleared, 15 ha (36 acres) onsite and 12 ha (30 acres) offsite. The cleared and grubbed material will be temporarily stored at two onsite storage areas (Figure 3).

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\*Plans for remedial actions at NFSS have been accelerated. Preliminary engineering is underway for several additional FY 1983 interim actions. A supplemental ADM will be prepared when sufficient details become available regarding the additional actions.

\*\*Some of the onsite areas may be cleared, excavated, and backfilled during the 1982 construction season as R-10 add-on work, funds and weather permitting (Bechtel Natl. Inc. 1982b, 1982d).

Contaminated sediments and soil materials will then be excavated and placed in the R-10 pile diked area.\*\* For this proposed action, contaminated materials will be defined as those materials having a concentration of radium-226 greater than 5 pCi/g above natural soil background or a concentration of cesium-137 greater than 80 pCi/g. Based on previous radiological surveys and engineering estimates (Ausmus et al. 1980; Anderson et al. 1981; Acres American Inc. 1981a), it is estimated that about 23,000 m<sup>3</sup> (30,000 yd<sup>3</sup>) of contaminated sediments will have to be removed from the offsite ditches (Figure 6) and about 11,000 m<sup>3</sup> (14,000 yd<sup>3</sup>) will have to be removed from the various locations onsite (including onsite ditches, Figure 4). It is expected that the depth of excavation will vary from 0.2 to 1.2 m (0.5 to 4 ft) in the ditches and from 0.2 to 0.6 m (0.5 to 2 ft) elsewhere. The amount that may actually have to be removed from the ditches may be half or twice as much, depending on the actual lateral and vertical extent of contamination (Acres American Inc. 1981a). Additional radiological survey work is being performed to more precisely define the extent of needed excavation.

Temporary haul roads will be constructed alongside the ditches. As soon as these roads can support construction traffic in early summer, excavation of ditch materials can begin, starting at the upstream end. The subcontractor will be allowed a choice of methods, as long as the spread of contaminated soils/sediments and water is controlled. An example of one excavation method that may be used is a check dam/dewatering system (Figure 8). A check dam made out of clean (uncontaminated) fill material would be constructed across the ditch upstream of the section to be excavated. Two downstream check dams would be constructed by pushing up contaminated ditch materials. Any water in the upstream section would be pumped to the downstream section in order to dewater the area to be excavated. This water would either be released downstream, if radioactive contamination limits were not exceeded, or pumped via temporary pipes to the onsite sedimentation pond/water treatment system (see later discussion). After a section was excavated, the upstream check dam of clean fill would be used as partial backfill to restore the ditch grade. Additional clean fill would be brought in for completion of the desired grade and for construction of a new, clean check dam at the downstream end of the excavated section. A new water-holding/sedimentation section would be created farther downstream. About three days would be required to complete excavation and backfill for each section. In the farthest downstream sections of the central drainage ditch, where water flow is greater, this same basic system could still be used, but with the addition of a lengthwise dike down the center of the ditch to channel water to one side while dewatering and excavating the other side.

Backfill material for the ditches will probably be the same kind of local clay that is being used in the construction of the R-10 dike during 1982. This clay, which is similar to the clay soils that underly the ditches, would be compacted to 90% of theoretical maximum density. Some of the spoil piles that are alongside the ditches from the original ditch construction may be used as backfill. Backfill needed for both onsite and offsite work will probably be equivalent to the amount of excavation, or a total of 34,000 m<sup>3</sup> (44,000 yd<sup>3</sup>) (ranging from 17,000-68,000 m<sup>3</sup>). There are several local sources of backfill materials, including excess materials that were excavated for the hydroelectric and pump storage projects in the Niagara Falls area.

Immediately after a section of ditch or onsite area has been excavated and backfilled, the area will be scarified, seeded, and mulched (probably using a hydroseeder), and covered with jute netting, as necessary, to stabilize the surface and prevent erosion. Straw bales, diversion swales, and any other temporary runoff and erosion control devices will be removed.

All excavated contaminated materials will be placed within the R-10 diked area (Figure 4). After the materials are sufficiently dry, they will be "conditioned" by discing and compacting. A synthetic reinforced rubber membrane (EPDM) will be placed over the materials. If the materials are too wet at the end of the construction season, they will be temporarily covered with EPDM until next year when they can be properly conditioned.

Several of the ditch culverts under roads are currently undersized relative to potential storm runoff. Therefore, the old culverts will be removed in order to excavate contaminated materials and will be replaced with larger culverts. At the Balmer Road crossing, the road will be kept open to traffic by either constructing a temporary bypass on one side, using sheet piling and excavating one-half at a time, or constructing a temporary bridge to one side. At the Lutts Road crossing, the road may have to be temporarily closed to traffic because the entire crossing area may be contaminated from previous reworking of the culverts and roadbed with potentially contaminated ditch sediments.

About 30 m (100 ft) of two abandoned water pipelines (19-inch line to the former firewater reservoir/pond west of the site and 42-inch water main to the town of Lewiston) will be removed between the southwest building area and Lutts Road to preclude any future migration of contaminated materials via these pathways.

Truck traffic (for transport of contaminated and backfill materials) will be routed to avoid congestion and to minimize the spread of contamination. The temporary haul road alongside the ditches will be used to transport contaminated materials to the R-10 pile diked area, whereas public and private roads will be used for movement of backfill material. Some temporary access roads may have to be built to the central ditch, depending on arrangements with property owners. Peak construction traffic on public roads (Figure 7) is not expected to exceed 18 trucks per hour during the main excavation/backfill period, which will last about three months. Peak construction traffic crossing Balmer Road near the central ditch and Lutts Road is expected to be 24 trucks per hour. Routing of construction traffic will depend on subcontract awards (e.g., location of backfill materials), but Pletcher, Balmer, and Lutts roads are expected to bear most of the construction traffic.

Vehicles leaving the contamination control areas will be washed down, as necessary, at the onsite decontamination pad (constructed in 1982, Figure 3). About six vehicles per hour can be accommodated. Water for washing the vehicles and for wetting down roads and work areas will be taken from the onsite water treatment ponds and, if necessary, from existing onsite town hydrants.

The 175 m<sup>3</sup> (230 yd<sup>3</sup>) of Middlesex sands currently located in Building 410 (Ausmus et al. 1980) will be moved to the north end of the R-10 pile diked area or placed in the basement of Building 410 (Figure 3) and covered with contaminated soils excavated from other areas. The method of movement has not yet been determined, but hydraulic mining (slurry) may be used.

The residues in Building 411 will then be dewatered to provide a firm working surface and to reduce possible migration of nuclides from the residues into the groundwater. The water resulting from the dewatering process will be routed through the sedimentation pond/treatment system (see below) before release. A multilayer cover system (possibly consisting of EPDM-reinforced synthetic rubber membrane and a layer of clay) will be placed over the residues to reduce the amount of radioactive radon-222 gas escaping from the residues.

The canals in Building 410 will also be dewatered, and the abovegrade portions of the building will be demolished. The belowgrade structure will be used for storage of contaminated rubble and possibly the Middlesex sands. The portion of Building 410 that will have to be disposed as contaminated rubble will have to be determined in the field. Uncontaminated rubble will either be stored onsite or may be converted to riprap for stabilizing the sides of the R-10 dike.

The onsite sedimentation pond/water treatment system (constructed in 1982, Figure 3) will be used to treat water resulting from: (1) leachate or runoff from the excavated materials placed on top of the R-10 pile (contained within the dike), (2) washing of equipment at the vehicle decontamination facility, (3) ditch dewatering, if necessary, and (4) dewatering of residues in Building 411 and canals in Building 410. The two sedimentation ponds can be operated independently and have holding capacities of 1,000 m<sup>3</sup> (250,000 gal) and 1,500 m<sup>3</sup> (400,000 gal), or a total of 2,500 m<sup>3</sup> (650,000 gal). They are designed to hold the runoff from a 10-year rainfall event, and backup capacity is provided within the R-10 dike area (until the area is filled up with contaminated soils at the end of interim actions in future years). If sedimentation alone is not sufficient treatment to meet DOE operating limits for discharge to the central drainage ditch (30 pCi/L for radium-226), a portable water treatment unit--which includes a charcoal filter, a radium-specific DOW Chemical Company medium (proprietary), and a cation resin--will be used to reduce concentrations of radium-226 to allowable limits. This unit can treat an average of 0.076 m<sup>3</sup>/min (20 gal/min) in batches from the two small holding (clean water) ponds (maximum design rate is 0.2 m<sup>3</sup>/min [54 gal/min]). All discharges will be monitored to ensure compliance with the SPDES permit. During excavation of the central drainage ditch, water can either be discharged to the ditch below the excavation area via temporary pipes, or discharged above the excavation area and pumped around the excavation, if necessary.

It is anticipated that the proposed activities will be completed during the 1983 summer construction season (May through October). There will be about the same number of workers as during the 1982 season, i.e., a total of 70, including 25 management and monitoring personnel brought in from outside the area. It is expected that construction workers will be affiliated with local Niagara County unions, as was the case for the 1982 work.

A summary of mitigating measures and monitoring that will be part of this proposed action is given in Table 6.

There are two basic alternatives to this proposed action: (1) defer action until the permanent disposition of NFSS can be determined, and (2) remove the excavated contaminated materials to some other site for permanent disposal. Because the permanent disposition of NFSS is unlikely to be determined for about two years, DOE considers it prudent to continue the interim program of

returning contaminated materials to the site and bringing the site under control to meet DOE operating regulations. The second alternative cannot be implemented because no offsite permanent disposal sites are available for disposal of these wastes.

## POTENTIAL ISSUES AND ANALYSIS

Using the information given in the previous sections, as well as the methods of analysis discussed in a report by Argonne National Laboratory (1982), the following potential issues were identified and assessed.\*

### Radiological

A major potential issue is the radiological impacts associated with the proposed action. The predominant pathway by which the radionuclides could reach nearby workers and members of the general public during the proposed action is inhalation of contaminated dust particles and radioactive decay products such as those from decay of radon gas (one of the radionuclides in the decay chain of the uranium-238 found at NFSS). Other pathways (such as external dose from submersion in a cloud of dust, external dose from radioactive particles deposited on the ground, or internal dose from ingesting contaminated food or water) are expected to be relatively insignificant (Argonne Natl. Lab. 1982). The bases for the analysis of potential doses to nearby members of the general public during the six months of the proposed action are as follows:

- Based on gamma-level readings, an average concentration of 100 pCi/g for each of the uranium-238 decay series nuclides present in the contaminated materials that will be moved during the proposed action was considered to be appropriate for analysis of radiological impacts. This is a realistic approximation for radium-226 concentrations, but it is conservatively high for all other nuclides (which leads to a probable overestimation of impacts).
- It is expected that the major portion of radioactive dust releases will be at the R-10 pile where contaminated materials will be unloaded, dried, disced, mixed, and compacted. Dust emissions from similar general construction activities have been estimated to be about 2700 kg/ha/mo, and it has been found that dust controls, such as will be instituted during the proposed action (Table 6), reduce emissions by about 50% (U.S. Environ. Prot. Agency 1977). Therefore, the analysis was based on an emission rate of about 1350 kg/ha/mo for an area equivalent to one-half of the R-10 pile (1.1 ha [4.8 acres]) over the six months of the proposed action.
- Each nearby member of the public was conservatively assumed to be present during the hours the action will take place.
- Buffalo meteorological data were used since onsite data have not yet been analyzed.

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\*When preliminary engineering is completed on the anticipated additional FY 1983 actions, a supplemental ADM will be prepared that will address the additional actions and related environmental issues.

- The contribution from the cesium-137 present in the northwest corner of the site (see Proposed Action) was not calculated because the small amount of cesium would contribute a very small fraction to the total dose.
- The methods of analysis are detailed in the Argonne National Laboratory (1982) report.

Assuming that the mitigating measures discussed in Table 6 are employed, potential doses to members of the public near the proposed action are expected to be extremely low (Table 7). The predicted whole-body doses are similar to doses received while spending a few minutes on a jet plane at high altitudes or spending the same amount of time as the remedial action (six months) at an altitude that is a few feet higher (Table 8). Specific organ doses (e.g., bone and lung) are much less than doses received from natural sources (Table 8).

Doses to workers will be controlled and limited to less than those specified by federal regulations for occupational doses (e.g., whole-body doses of 3000 mrem/quarter or 5000 mrem/year). Based on experience during the 1982 remedial action at NFSS, worker doses are expected to be well below limits. Workers are also being trained regarding radiation risks and proper health physics procedures (Table 6).

Another radiological issue may be whether the decontamination criterion for the offsite portion of the drainage ditches (5 pCi/g above background for radium-226) will be considered sufficient to allow unrestricted use of the offsite areas. The DOE believes that this decontamination criterion is conservatively low compared to any applicable criterion or standard for release of an area for unrestricted use that may be promulgated in the future.

The adequacy of the sedimentation pond/water treatment system with respect to discharge of radioactively contaminated water may also be an issue. Sedimentation alone may be sufficient to allow discharge of runoff water. However, the waters in the buildings, particularly Building 411, have been in contact with the stored residues and may have higher concentrations of dissolved substances as well as higher concentrations of fine particles that do not readily settle out. Therefore, these waters will be monitored prior to discharge to the sedimentation ponds and, if necessary, will be treated in batches separate from the storm runoff water. The treatment system, consisting of a radium-specific DOW medium, charcoal filter, and cation resin will be tested in 1982 so that its effectiveness in removing contaminants will be known before the dewatering of Building 411 begins in FY 1983. No water will be released unless concentrations of radioactive substances are at or below DOE operating limits (see later discussion of nonradiological substances in the discharge).

The sufficiency of the water discharge criteria for radioactive contaminants may be an issue. Although the discharge will be at or below DOE operating limits (e.g., 30 pCi/L for radium-226), a discharge at or only slightly lower than the established limits may not be considered to be "as low as reasonably achievable" (ALARA). However, as mentioned previously, the Department tested a new proprietary DOW medium during 1982. This system was purchased and will be employed during the proposed FY 1983 action. In practice, the contaminants in the discharge may actually be present at levels well below the DOE operating limits, in keeping with ALARA.

## Physical and Biological

The temporary increase in erosion and sedimentation during the proposed action may be another issue. However, mitigating measures--such as the use of straw bales and diversion swales, scarification and jute netting, prompt seeding and mulching, and diversion of runoff through a sedimentation pond--should help minimize the potential for erosion and sedimentation.

The adequacy of the sedimentation/holding ponds to retain runoff water may be an issue. The system has been designed to accommodate a 10-year storm event, but a sequence of rainfalls of lesser magnitude over a short period of time could stress the system. However, the R-10 diked area would provide additional backup retention if necessary.

The adequacy of the sedimentation/treatment system with respect to discharge of nonradiological chemical pollutants may also be an issue. There will be two primary sources of chemically contaminated water: (1) the Building 411 water and (2) the leachate and runoff from the central drainage ditch sediments. The Building 411 water may be of concern with respect to elements such as arsenic, chromium, cobalt, copper, lead, nickel, and selenium (Table 4). These elements will be both dissolved in the water and associated with fine clay particles that will not readily settle out. Therefore, this water will be tested for these elements prior to discharge to the central drainage ditch. An SPDES permit is needed with respect to the nonradiological nature of the discharge. If contaminant concentrations exceed applicable state discharge limits, the water will be treated, as necessary, to reduce contaminant concentrations to acceptable levels. Available treatments include filters and ion-exchange columns. It is expected that the SPDES permit will be granted prior to the planned FY 1983 actions.

The central ditch sediments may be of concern both with respect to metals such as cobalt, copper, and nickel (Table 4) and, in the vicinity of SCA Chemical Waste Services, with respect to both hazardous organic compounds and metals. The proposed action could result in release of these chemicals further downstream at a temporarily accelerated rate and could also lead to release in the discharge from the sedimentation/treatment system to the central ditch. These chemicals could be dissolved in leachate waters and/or suspended on fine particles. Because the significance of this potential issue will depend in part on the amounts of chemicals in the sediments, the sediments in the vicinity of SCA will be sampled and tested for metals and organic compounds based on the kinds of wastes SCA has handled in the past. Although Ludlam (1982) maintains that discharge and cleanup procedures at SCA were sufficiently rigorous that essentially no organics or metals were discharged, leached or washed into the central ditch, it is considered prudent to analyze the ditch sediments. After such analysis, the consequences of excavating and storing the ditch material will be reevaluated. It is possible that the currently proposed action and mitigating measures (e.g., excavating the ditch in sections, controlling seepage and runoff, using seamless or lined trucks, covering the ditch sediments in the R-10 pile diked area as soon as possible after drying and compacting) will be sufficient to preclude significant adverse impacts. If necessary, the excavation and storage method and/or water treatment and monitoring system will be modified to preclude the discharge of unacceptable concentrations of metals or organic compounds.

Two other potential issues with respect to organic contaminants in the ditch sediments have been raised: (1) the presence of organic substances may increase the rate of migration of radionuclides from the R-10 area to surface waters and groundwaters, and (2) the organic substances may degrade the rubber membrane (EPDM) cover (Ausmus 1981). Based on currently available information and considering that the organic ditch material will be mixed with clay ditch material (diluted) and dried (less organics in free liquid form), there will probably not be enough organic contaminants to be of concern. If significant amounts of organic contaminants are found in the ditch sediments, these issues will be reevaluated before the proposed action is taken, and the action will be modified as appropriate.

The decay of organic matter in the ditch sediments, leading to a buildup of gases under the EPDM cover, may also be a potential issue. However, a sample of ditch material was excavated in early 1982 and it was found that although the top 0.15 m (0.5 ft) is "black, smelly, slimy" organic material, the next 0.6-1.2 m (2-4 ft--depth of expected excavation) is a very tight clay (Levesque 1982). After drying out, discing, and compacting the ditch sediment material on the R-10 pile, plus covering the pile with EPDM/clay/soil, the decay of the organic matter should be sufficiently slow so that gases will not build up appreciably under the permanent cover system. Care will be taken to dry and thoroughly mix the ditch materials. The surface of the pile will be monitored for bulges, cracks, or other signs of any buildup of decomposition gases (Table 6).

In addition to the previously mentioned water quality issues, a potential issue associated with the dewatering of Building 411 is the continued migration of contaminants from the building. The proposed remedial actions should substantially decrease the movement of water into and out of the building. However, there may be some remaining connections to the groundwater through the building foundation. One or more of the pipes inserted into the residues for dewatering will be used to monitor any water level changes in the future. The potential issue of any remaining migration will be addressed when decisions are made regarding additional remedial actions.

The proposed dewatering and construction of a multilayer cover system over the Building 411 residues also raises the issue that this action may be a premature commitment of resources if it is found that the residues must be removed by a slurry method for permanent disposal elsewhere on NFSS or for preparation of the residues for disposal in a different form. However, because the ultimate disposition of the site--and specifically the Building 411 residues--is unlikely to be resolved in the near future, DOE considers the partial dewatering and construction of a cover system to be prudent caretaker actions.

The potential for continued migration of contaminants to groundwater from the materials stored within the R-10 pile dike may also be an issue. However, the combination of the subsurface clay trench, the dike, and the multilayer cover system, will substantially reduce the rate of contaminant migration from the R-10 area. The potential issue of any remaining migration will be addressed when a decision is made on the permanent disposition of NFSS.



### Socioeconomic

The major potential socioeconomic issue associated with the proposed action is public apprehension that this interim action may lead to establishing NFSS as a permanent radioactive-waste disposal site. This perception may be reinforced by public knowledge that there are several other sites in the Niagara/Buffalo area that might need decontamination and that a disposal site would be needed to dispose of wastes from those sites. Although none of the proposed actions are physically irreversible, implementation of the proposed action will make eventual removal of the radioactive materials from the site a less desirable option because of the additional costs associated with recovery and movement of the stabilized materials. The proposed action requires expenditures in the near term that might otherwise be unnecessary were it known now that the radioactive materials would be removed from the site in the future. However, lacking any decision regarding permanent disposition of the site and given that removal of wastes from the site is only one of several alternatives, DOE believes that it is prudent to take the proposed interim action as part of its ongoing caretaker and maintenance responsibilities at the site. The mitigating measures presented in Table 6--such as informing the public about the proposed interim action and assuring them that they will be involved in any decision-making concerning the long-term, permanent disposition of the site--may help reduce apprehensions.

Another potential socioeconomic issue is the increased traffic, particularly at the Balmer road crossing, and the potential for increased risk of vehicle accidents. Although no traffic count data are available, it is known that SCA traffic uses Balmer Road and that the road is a primary east-west route through the area (second to NY-93 and U.S. 104). There are no other major industrial, commercial, recreational, or residential areas along the roads likely to bear most of the construction traffic associated with the proposed action. Having a flagman at the Balmer Road crossing (Table 6) should help mitigate the increased accident potential. Furthermore, residential areas will be avoided when transporting backfill materials to the site and ditches.

The need to obtain right-of-way for equipment across private property may be an issue. However, the federal government still holds easement rights for maintenance of the central ditch (Acres American Inc. 1981a). Informing landowners of intended actions and courteous respect for their property rights and interests can help to mitigate adverse public reaction to the proposed remedial actions.

Determination of the need to obtain several permits may be an issue. The Department has already applied to the New York State Department of Environmental Conservation (DEC) for an SPDES permit for the nonradiological aspects of the discharge from the sedimentation/treatment system. The U.S. Army Corps of Engineers and the DEC will also be contacted to determine if Section 404 and 402 permits concerning dredge and fill operations in the central drainage ditch and pollutant discharges are needed. The DEC will be contacted to determine if a permit is needed for hauling contaminated sediments back to the site under Article 27, Title 3, of the New York Conservation Law (Part 364, collection and transportation of industrial-commercial and certain other wastes). The need for a permit to burn contaminated materials, and possibly emit radioactive substances to the air, will also be ascertained.

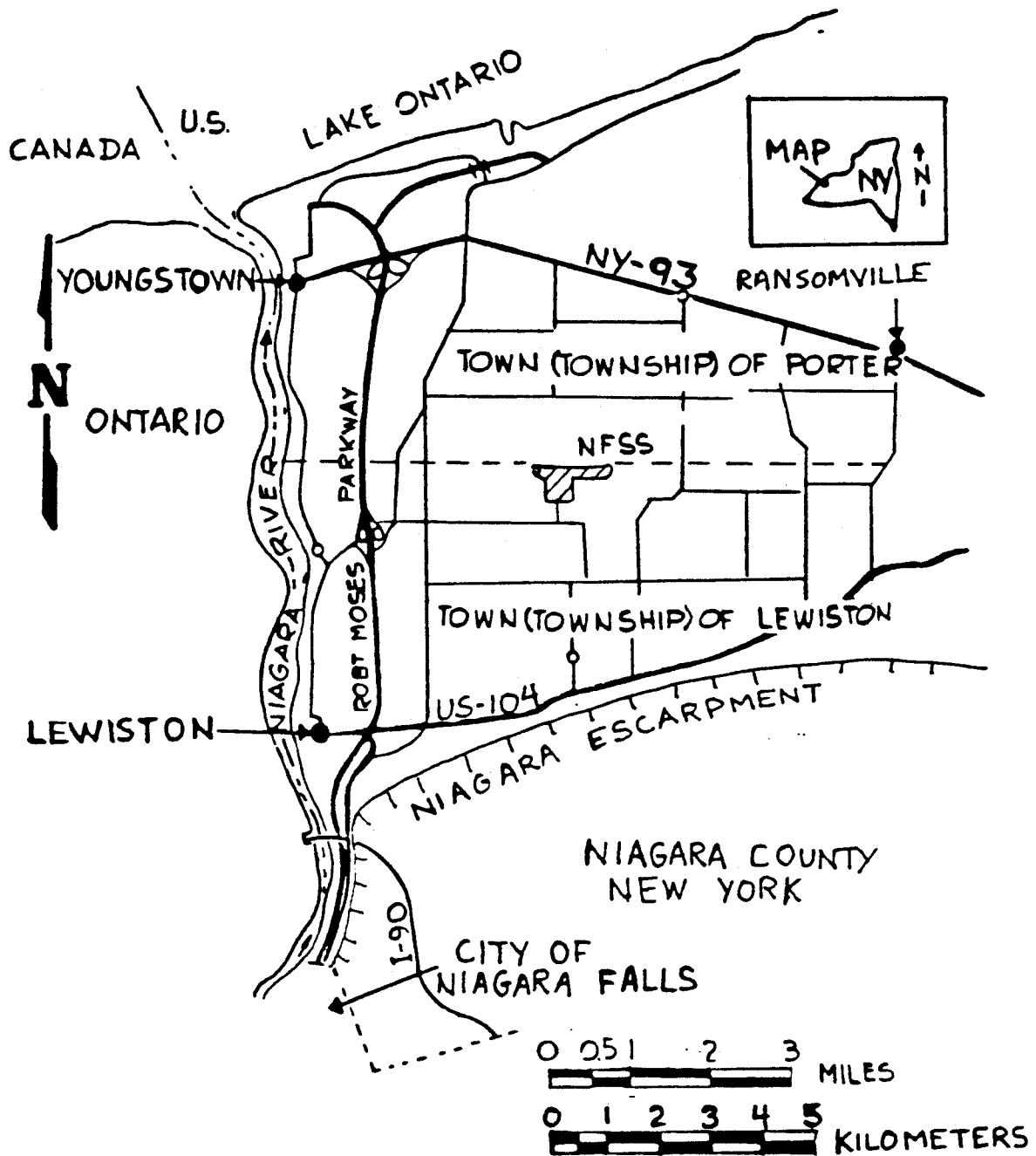


Figure 1. Niagara Falls Storage Site Location Map.

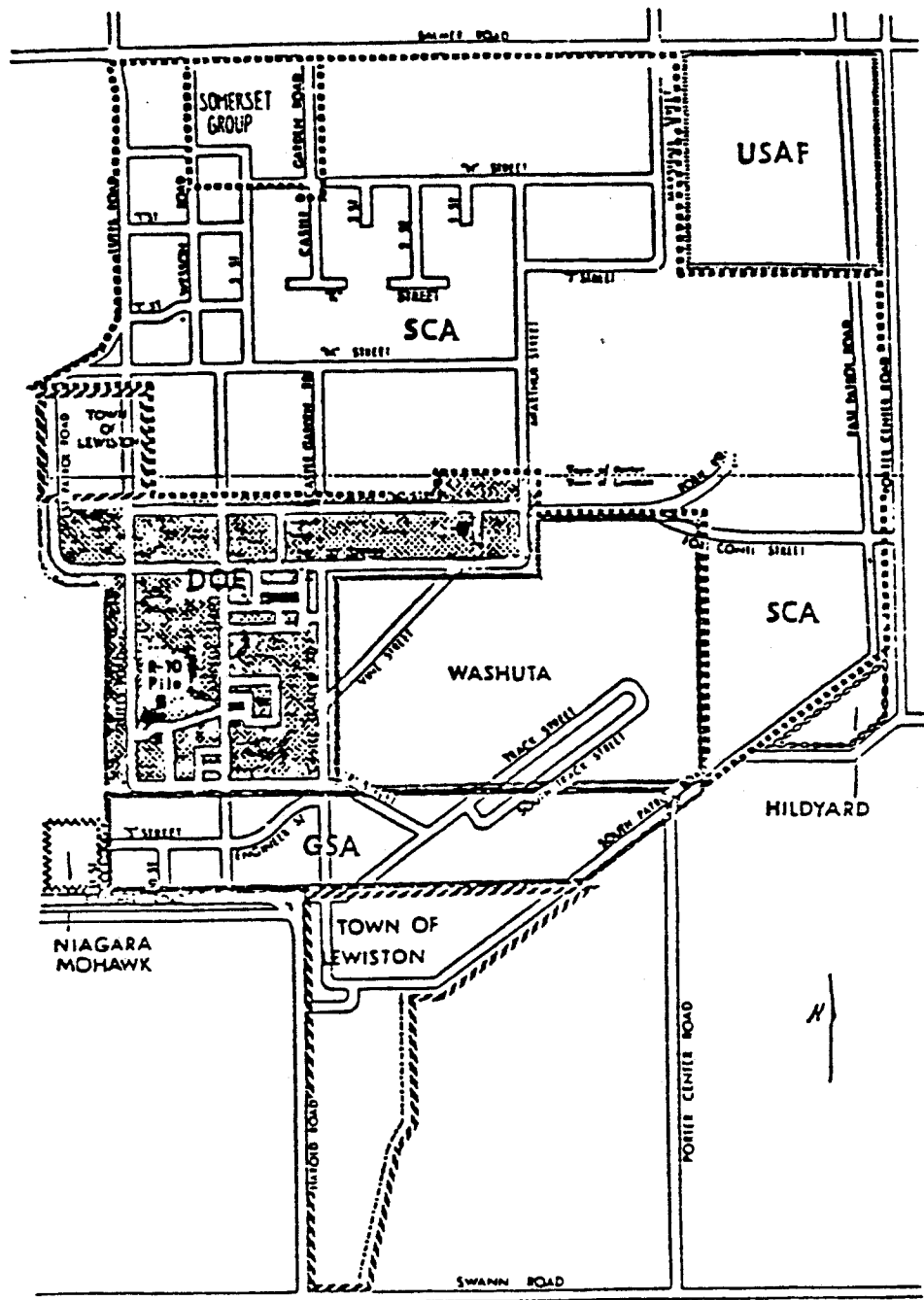


Figure 2. Current Ownership of the Original Manhattan Engineer District Site at the Lake Ontario Ordnance Works.

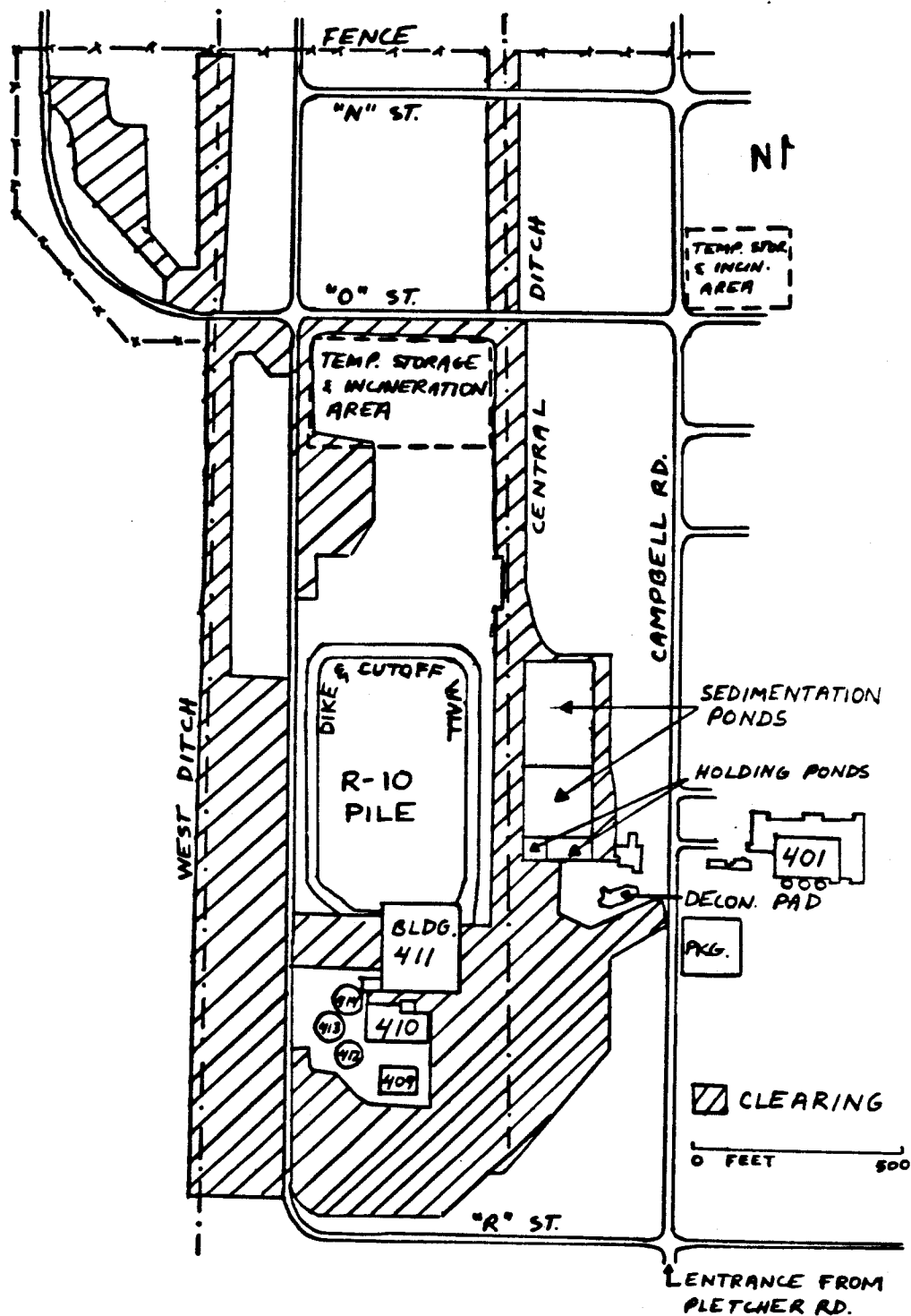


Figure 3. Proposed Onsite Areas to be Cleared. Adapted from Bechtel National, Inc. (1982b and 1982d--Drawings 15-DD07-D-02 and -03). Note: Some of these areas may be cleared as part of R-10 add-on work or field change orders during 1982.

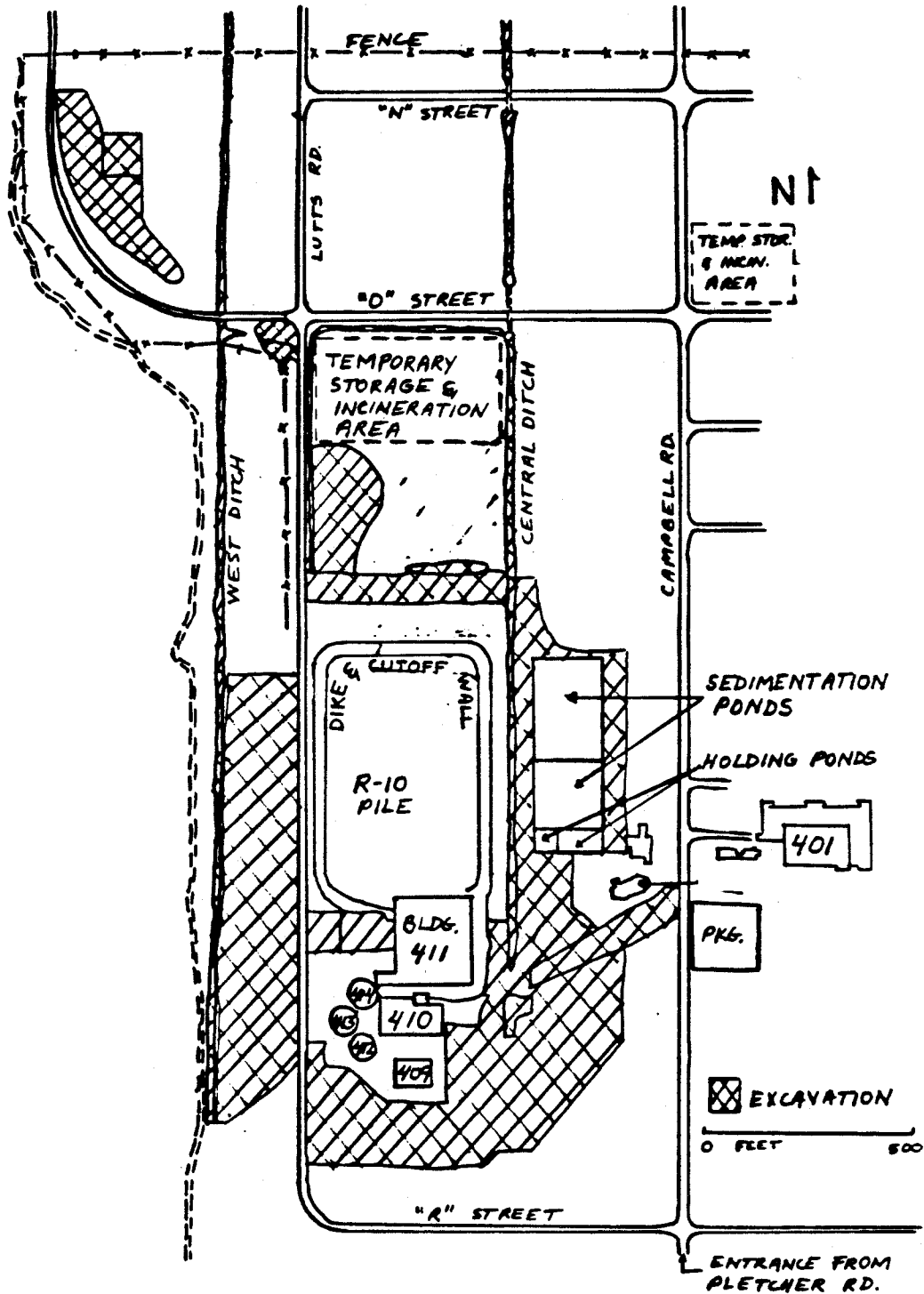


Figure 4. Proposed Onsite Areas to be Excavated. Adapted from Bechtel National, Inc. (1982b and 1982d--Drawings 15-DD07-C-04 and -05). Note: Some of these areas may be excavated as part of R-10 add-on work or field change orders during 1982.

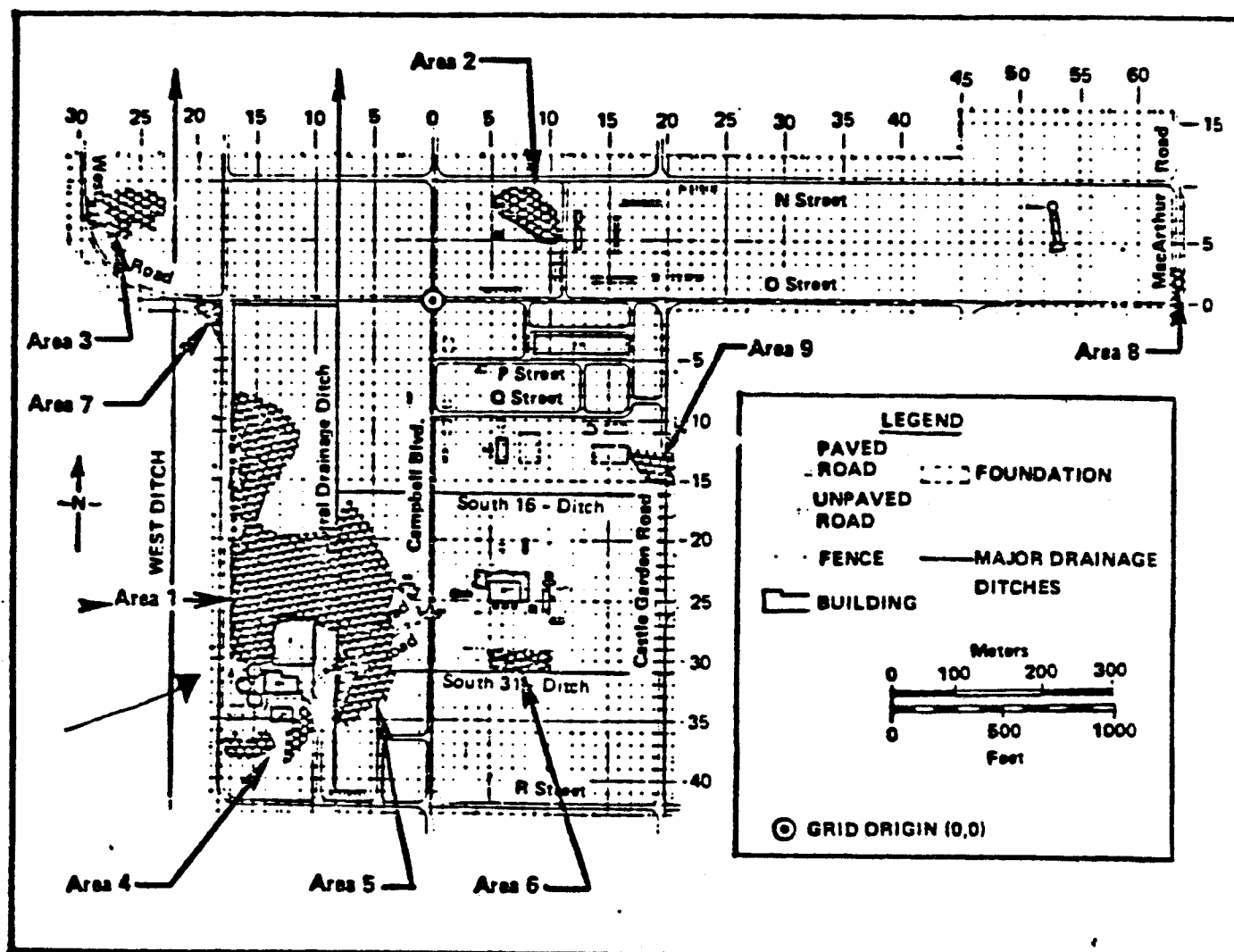


Figure 5. Some of the Contaminated Areas at the Niagara Falls Storage Site. (Contaminated buildings, residues, and ditches not included on the drawing.) Source: Ausmus et al. (1980).

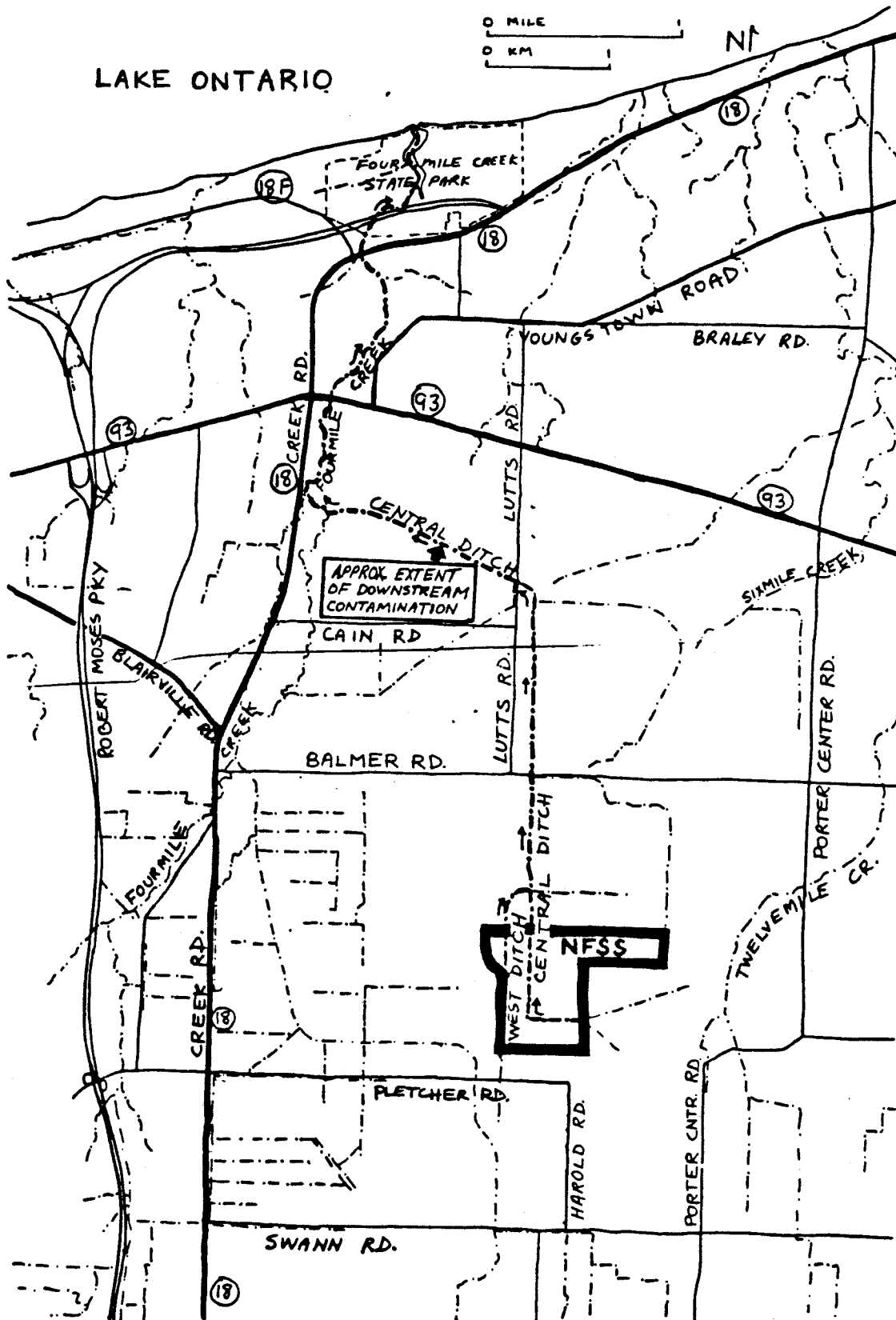


Figure 6. Drainage Ditches, Creeks, and Major Roads Near the Niagara Falls Storage Site. Adapted from U.S. Geological Survey (1965).

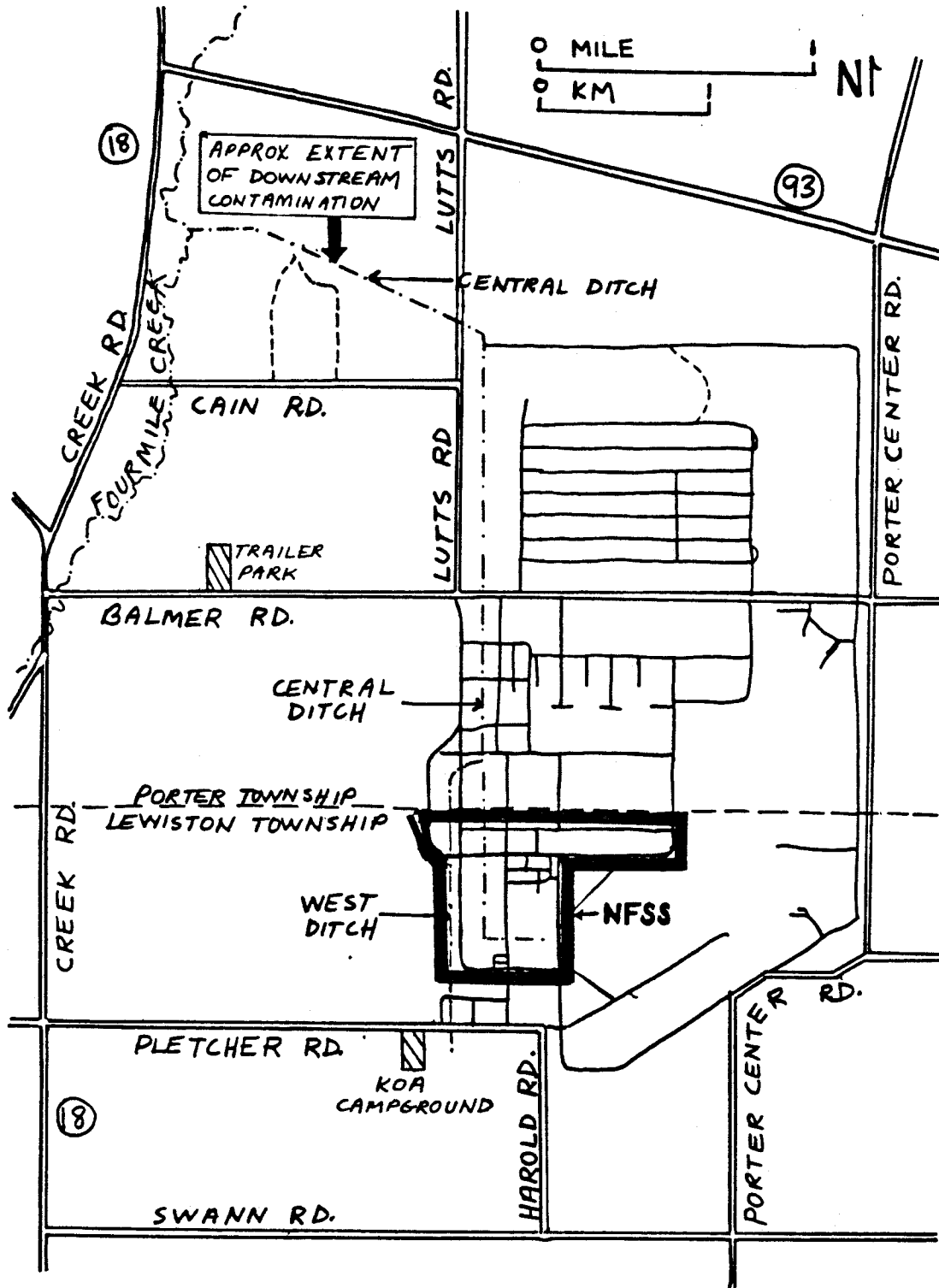


Figure 7. Primary, Secondary and Tertiary Roads (Public and Private) Near the Niagara Falls Storage Site (NFSS) and Central Drainage Ditch. Adapted from U.S. Geological Survey (1965) and 1980 aerial photographs.



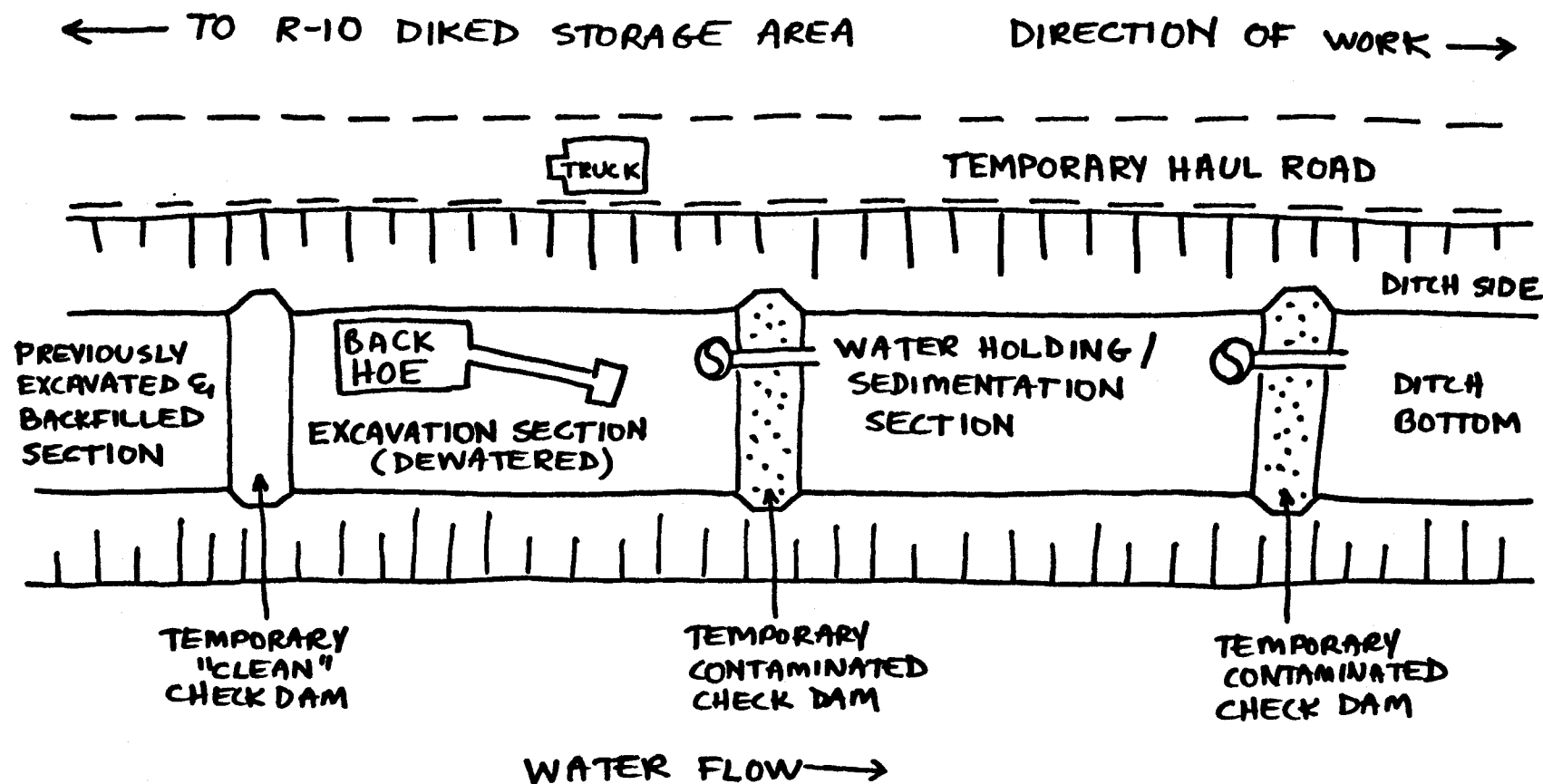


Figure 8. Example of One Method That May Be Used for Ditch Excavation at the Niagara Falls Storage Site (Check Dam/Dewatering System).

Table 1. Radiological Characteristics of Areas to be Excavated

	Surface (1-cm) Beta-Gamma Level† <sup>1</sup> (mR/h)	Radium Concentration† <sup>2</sup> (pCi/g)
Area 1† <sup>3</sup>	0.06 - 4† <sup>4</sup>	4 - 9400† <sup>4</sup>
Area 3† <sup>3</sup>	0.05 - 70	0.52 - 6.9† <sup>5</sup>
Area 4† <sup>3</sup>	0.15 - 0.65	0.66 - 30
Area 5† <sup>3</sup>	0.1 - 0.5	1.5 - 131
Area 6† <sup>3</sup>	0.2 - 2	0.18 - 87
Area 7† <sup>3</sup>	1 - 2	0.9 - 5
West ditch† <sup>6</sup>	0.5 - 3	2.6 - 75
Central ditch† <sup>6</sup>	0.06 - 2.2	2.2 - 1900
Area between Lutts Road and West ditch† <sup>3</sup>	0.03 - 0.07	0.8 - 120

†<sup>1</sup> Background level is 0.06 mR/h.

†<sup>2</sup> Background concentration is 1.89 pCi/g. The remedial action criterion to be used for this proposed action is 5 pCi/g above background.

†<sup>3</sup> See Figures 4 and 5.

†<sup>4</sup> Remedial actions were taken in 1982 in portions of Area 1 that have the higher radium-226 concentrations. Proposed actions for 1983 would be in portions of Area 1 with lower concentrations.

†<sup>5</sup> Primary contamination in Area 3 is cesium-137, up to 59,000 pCi/g of soil. The remedial action criterion to be used for this proposed action is 80 pCi/g for cesium-137.

†<sup>6</sup> See Figures 4 and 6.

Source: Ausmus et al. (1980).

Table 2. Existing (1975) and Projected (2000) Land Uses for the Towns (Townships) of Lewiston and Porter and for Niagara County

Location	Status of Land Use	Percent of Land Area						
		Residential	Commercial/ Public/ Semipublic	Industrial	Forest/Brush/ Outdoor Recreation/ Vacant	Agriculture	Water/ Wetland	Transportation
Town of Lewiston (25,088 acres)	Existing	7.7	6.2	1.0	32.2	43.5	7.7	1.4
	Projected	8.0	6.5	1.0	32.2	43.2	7.7	1.4
Town of Porter (20,992 acres)	Existing	4.1	4.6	1.5	25.8	61.9	0.3	1.6
	Projected	4.2	4.8	1.5	25.9	61.6	0.4	1.6
Niagara County (341,670 acres)	Existing	6.4	2.1	1.7	19.9	65.3	3.5	0.9
	Projected	6.6	2.2	1.8	19.9	65.0	3.6	0.9

Data from Interstate Commerce Commission (1981).

Table 3. Population Trends for the Towns (Townships) of Lewiston and Porter and for Niagara County

Location	1970† <sup>1</sup>	1980† <sup>1</sup>	1970-1980 (% change)	Projected 2000† <sup>2</sup>	1980-2000 (% projected change)
Town of Lewiston	15,888	16,219	2.1	16,500	1.7
Village of Lewiston	3,292	3,326	1.0		
Town of Porter	7,429	7,251	-2.4	7,800	7.6
Village of Youngston	2,169	2,196	1.2		
Village of Ransomville	1,034	1,101	6.5		
Niagara County	235,720	227,101	-3.7	235,500	3.7

†<sup>1</sup> Data from U.S. Census Bureau, New York Regional Office.

†<sup>2</sup> Year 2000 projections were based on 1980 projections that were 1 to 7% higher than actually occurred. Therefore, year 2000 projections may be too high.

Data from Interstate Commerce Commission (1981).

Table 4. Concentrations of Selected Elements in Residues, Ditch Sediments, and Groundwater at the Niagara Falls Storage Site

Element	Concentrations (ppm)					
	Residues		Ditch Sediments		Groundwater† <sup>1</sup>	
	Bldg. 411† <sup>2</sup>	R-10 Pile	Central† <sup>3</sup>	West	Site Periphery	R-10 Pile Area
Arsenic	32	0.5-5	0.1-10	0.1-3	0.006-0.019	0.002-0.019
Cerium	1300	5-100	2-500	3-20	0.0017-0.003	0.002-0.003
Cesium	1.5	-	-	-	<DL	<DL
Chromium	250	20-30	10-200	10-30	0.008-0.079	0.003-0.11
Cobalt	7500	50-5000	10-5000	3-500	0.001-0.064	0.001-0.080
Copper	3200	20-3000	10-200	5-50	0.006-0.32	0.003-0.062
Fluorine	40	3-100	10-2000	2-20	0.023-0.3	0.021-0.25
Lanthanum	1000	-	1-500	2-10	<DL	<DL
Lead	13,000	3-650	0.3-55	0.2-1.5	0.012-0.026	0.011-0.025
Lithium	200	-	30-300	50-300	0.07-0.44	0.064-0.48
Nickel	40,000	20-5000	50-5000	10-100	0.012-0.037	0.003-0.006
Selenium	50	-	-	-	<DL	1.0
Strontium	250	50-200	30-500	50-300	0.49-10	0.21-11
Uranium	15,000	1000-145,000	-	-	0.006-0.012	0.006-1.2

†<sup>1</sup> The values given are the concentration ranges above the detection limits for those samples that gave positive results. <DL means that no positive result was observed.

†<sup>2</sup> Average of values for residues in east and west bays of Building 411.

†<sup>3</sup> It is not clear whether offsite ditch samples were taken, or whether the results given are limited to onsite samples only.

Source: Ausmus et al. (1980--Tables 3.2, 5.1, 6.6, and 6.7).

Table 5. Governmental Agencies with Potential Regulatory Control  
Over the Proposed NFSS Interim Remedial Action

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Federal

Nuclear Regulatory Commission  
Environmental Protection Agency  
Department of Energy  
Department of Transportation  
Corps of Engineers

State of New York

Department of Environmental Conservation  
Department of Health  
Department of Labor  
Department of Transportation  
Energy Research and Development Authority

Niagara County

Finance, Public Health, and Public Safety Committee  
Health Department  
Board of Health  
Environmental Management Council  
Planning Board

Town of Lewiston

Town Board  
Building and Zoning Inspector  
Zoning Board of Appeals  
Environmental Conservation Committee

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Data from Politech Corporation (1980).

Table 6. Mitigative Measures and Monitoring That Will Be Part of the Proposed Action

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- Controls over further spread of contamination--including establishment of contamination control zones, use of temporary plastic sheeting to cover uncontaminated sides of ditches and truck loading area, use of seamless trucks or truck liners when hauling wet ditch materials, decontamination of vehicles and equipment, erosion and runoff control measures, and worker monitoring.
  - Routine watering of excavation areas and the R-10 pile storage area, as necessary during dry conditions, to preclude excessive dust.
  - If the check dam/dewatering system is used for ditch excavation, covering the downstream dam of contaminated materials with a tarp, straw, or other material to preclude erosion of the dam materials downstream into uncontrolled areas.
  - Prompt seeding and mulching of disturbed areas to minimize erosion; use of scarification and jute netting, as necessary, in ditches.
  - Standard contamination and worker radiation-exposure controls; education and training of workers with regard to radiation risks and health-physics procedures; use of breathing apparatus for work in Building 411.
  - Routing of trucks hauling contaminated materials one-way along temporary haul roads back to the site; decontamination and restoration of haul roads and repair of other public and private roads, as necessary.
  - Use of a flagman on Balmer Road near the Lutts Road and central ditch crossing area to aid in the safe movement of construction equipment across Balmer Road; avoidance of residential areas when transporting backfill; scheduling construction traffic during offpeak hours.
  - Air and water quality monitoring for radioactive substances; installation of a water-level monitoring device in Building 411 and routine water-level checks; monitoring of the water from Building 411 for radiological and nonradiological substances prior to discharge, and treatment (as necessary) to reduce concentrations of radionuclides to DOE operating limits and concentrations of nonradiological substances to state discharge limits.
  - Sampling and analysis of central ditch sediments from the vicinity of SCA Chemical Waste Services for selected metals and organic compounds; reevaluation of potential nonradiological hazards; revision of the proposed action, mitigating measures, and monitoring, if necessary.
  - Monitoring the surface of the R-10 pile for bulges, cracks, or other signs of any buildup of decomposition gases under the EPDM/clay/soil cover.
  - Informing local authorities, nearby property owners, and concerned citizens of the proposed action; designating a public liaison person; courteous treatment of site visitors; assurance to interested persons that the public will be involved in any decision-making concerning the long-term, permanent disposition of the site.
  - Informing property owners of intended actions along the central drainage ditch; courteous respect for their property rights and interests.
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Table 7. Cumulative Radiation Doses to Selected Members of the General Public Near the R-10 Pile During Proposed FY 83 Actions†<sup>1</sup>

Description of Person	Location of Person	Dose (mrem)			
		Whole Body	Bone	Lung	Bronchial Epithelium
KOA campground visitor (1-week visit)	0.7 km SSW	<0.010	0.018	0.014	0.022
KOA campground attendant	0.7 km SSW	0.20	0.35	0.38	0.57
Nearest permanent resident	1.1 km SW	0.015	0.14	0.15	0.20
Trailer park resident	2.6 km NW	0.015	0.037	0.035	0.040
SCA Chemical Waste Services worker	1.2 km NNE	0.027	0.39	0.42	0.32

†<sup>1</sup> Bases for radiological analysis are given in the text.



Table 8. Comparison of Doses to SCA Chemical Waste Services Worker to Doses from Other Sources†<sup>1</sup>

From Proposed Action	Compares With
0.027 mrem (whole body)	Riding 5 minutes in a jet plane at 10,000 m (33,000 ft) because of increase in cosmic radiation with altitude  Staying for the same amount of time as the remedial action (6 months) at 1.8-m (5-ft) higher altitude
0.39 mrem (bone)	36 mrem received from natural sources (background) over the same period of time (6 months)
0.42 mrem (lung)	260 mrem received from background over the same period of time

†<sup>1</sup> Conversion factors given in the U.S. Department of Energy (1982c) report.

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