Environmental Assessment for Renewal of Source Material License SMB-743 Docket 40-7102

Shieldalloy Metallurgical Corporation Newfield, New Jersey

Prepared by
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PDR ADOCK 04007102
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ABBREVIATIONS AND ACRONYMS

AAF	American Air Filter
ALARA	as low as is reasonably achievable
ATSDR	Agency for Toxic Substances and Disease Registry
CAL	confirmatory action letter
CaO	lime
CEDE	committed effective dose equivalent
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulations
Ci	curie
cm^2	square centimeter
DAC	derived air concentration
DOT	Department of Transportation
dpm	disintegrations per minute
EA	environmental assessment
EDE	effective dose equivalent
EIS	environmental impact statement
EPA	Environmental Protection Agency
ER	environmental report
FK	Flex Kleen
ft^3/min	cubic feet per minute
kg	kilogram
km	kilometer
MDL	minimum detection level
MEI	maximally exposed individual
mg/m^3	milligram per cubic meter
MPC	maximum permissible concentration
mrem	millirem
mrem/hr	millirem per hour
MSA	Metropolitan Statistical Area
Na	sodium
Nb	niobium
NEPA	National Environmental Policy Act

NJDEP	State of New Jersey Department of Environmental Protection
NMSS	Office of Nuclear Material Safety and Safeguards
NOI	notice of intent
NRC	U.S. Nuclear Regulatory Commission
ORAU	Oak Ridge Associated Universities
pCi/g	picocurie per gram
pCi/l	picocurie per liter
ppb	parts per billion
psi	pounds per square inch
RSC	radiation safety committee
RSO	radiation safety officer
RSP	radiation safety procedure
RWT	radiation worker training
SMC	Shieldalloy Metallurgical Corporation
SMSY	source material storage yard
TEDE	total effective dose equivalent
TLD	thermoluminescent dosimeter
USDC	U.S. Department of Commerce
USGS	U.S. Geological Survey
wt%	percent by weight
µR/hr	microroentgen per hour
µrem/h	microrem per hour
µm	micrometer

1. INTRODUCTION

Shieldalloy Metallurgical Corporation (SMC) located in Newfield, N.J., has requested the renewal of its Source Material License SMB-743. The U.S. Nuclear Regulatory Commission (NRC) has prepared this environmental assessment (EA) pursuant to the Council on Environmental Quality (CEQ) guidelines (40 CFR Parts 1500-1508) and NRC regulations (10 CFR Part 51), which implement the requirements of the National Environmental Policy Act (NEPA) of 1969, as amended. The purpose of this document is to assess the environmental consequences of the proposed license renewal for this facility.

1.1 Background

Prior to the expiration of their License No. SMB-743, SMC submitted an application dated June 19, 1985, for renewal for the license in accordance with 10 CFR 40.43. This action placed the license in timely renewal, pending NRC's review of the application and decision to renew.

Since 1985, SMC has submitted several revisions to the license application, at the request of NRC. The latest submittal was dated September 15, 1995, in response to an NRC request dated June 15, 1995. Previously, the license application was revised in its entirety in June 1992 with a subsequent supplement in January 1993. The license application currently in effect was submitted December 23, 1977 with additional license amendment requests dated June 28 and November 16, 1979; May 27, 1980; February 13, 1992; January 25, 1993; and August 3, 1994.

In October 1992, SMC submitted an Environmental Report (ER) for continued operation at the Newfield facility (SMC 1992). The ER describes the operations, the facilities, and the smelting process. In April 1992, IT Corporation/Nuclear Sciences performed for SMC an assessment of environmental radiological conditions at the Newfield facility (Berger 1992). This assessment provides a general description of the quantity of radioactive material, the radiation safety program organization, individual training, facilities and equipment, the radiation protection program plan, emission controls, environmental effects of normal operation, the environmental and occupational monitoring program, and impacts of potential accidents (Berger et al. 1992). In March 1996, SMC completed air emission sampling from the two baghouse stacks. Based upon these data, SMC submitted a report, dated March 11, 1997, that evaluated exposures to the public, and subsequently updated the report by submittal dated May 8, 1997.

On September 23, 1994, NRC issued Amendment 10, the latest amendment to the license, which increased the possession of uranium to 45,000 kg of uranium source material to be used only at the Newfield, New Jersey, facility. Despite SMC's request to increase possession limits for both uranium and thorium, NRC only authorized an

increase to uranium possession limits pending review of the license renewal application. The increase in uranium possession limits was not expected to increase the volume of radioactive material stored at the site and would not significantly impact the public health and safety or the environment.

In September 1993, SMC and its parent company, Metallurg, Inc., filed for protection from creditors under Chapter 11 of the Bankruptcy Code. Decommissioning of the Newfield facility, and another licensed site in Cambridge, Ohio, represented two of SMC's largest and unquantified liabilities. After negotiations with creditors, including the U.S. Department of Justice which represented NRC's interests, SMC exited bankruptcy in March of 1997.

1.2 Description of Facility and Operations

The SMC facility processes pyrochlore, a concentrated ore containing columbium (niobium)[a], to produce ferrocolumbium, an additive/conditioner used in the production of specialty steel and super alloy additives. Pyrochlore contains more than 0.05 percent by weight thorium and uranium and is therefore regulated as "source material" in accordance with 10 CFR Part 40 and the Atomic Energy Act. 10 CFR Part 40 establishes procedures and criteria for the issuance by the NRC of licenses to receive, possess, use, transfer, and/or deliver source material.

The SMC facility consists of approximately 67.5 acres. The manufacturing facilities and support areas are located on approximately 60 acres in Newfield, New Jersey, in Gloucester County. SMC also owns 7.5 acres of farm lands approximately 610 meters (2,000 feet) southwest of the 60 acre parcel in Vineland, Cumberland County, New Jersey (Figure 1.1).

The site contains 19 buildings of steel frame or concrete block construction and is surrounded by a seven-foot-tall chain-link fence topped with barbed wire. Approximately 210 employees work at the site, including management and administrative (70 employees), operations (120), laboratory/analytical (10), and maintenance (10) staff.

SMC has been conducting smelting and alloy production at Newfield since 1940, including past production of chromium metal, ferrovanadium, and columbium nickel. The SMC site has grown as new processes were developed on the site. Four major building phases before 1957 included one for aluminothermic reduction. In the 1960s, several

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[a] The name "niobium" was adopted by the International Union of Pure and Applied Chemistry in 1950 after 100 years of controversy. Many leading chemical societies refer to it by this name. Most metallurgists, metal societies, and all producers, however, still refer to the metal as "columbium" (Weast 1983).

more buildings, including Building D111, were constructed, and new production capabilities were added, such as chrome oxide and ferroalloy production. In 1965, a titanium metal degreasing operation was added, but it continued only until 1967. Carbide production was added in 1979 with the construction of Building D117 (TRC 1992).

SMC has manufactured additives for specialty steels and super alloys, primarily aluminum master alloys, such as aluminum pressed-metal briquettes, metal carbides, powdered metals, and optical surfacing products. Raw materials currently used include pyrochlore, oxides of vanadium, aluminum metal, titanium oxide, strontium oxide, zirconium metal, silicon, vanadium oxide, manganese, and fluoride (titanium and boron) salts, dolomite lime, steel slag, lead, nickel, ferromanganese, and ferroboron. Materials used in routine operations include kerosene, cutting oil, caustic soda, sulfur dioxide, sulfuric acid, unleaded gasoline, diesel fuel, lubrication oil, helium, hydrogen, nitrogen, ammonia, argon, carbon dioxide, liquid argon, and acetylene. Byproducts include slag, dust, and other products.

Pyrochlore has been used in the production of three products: ferrocolumbium standard, ferrocolumbium high ratio, and columbium nickel technical grade. Production of the ferrocolumbium products involves the use of three functional areas: portions of the Manufacturing Area, Storage Facilities, and the Source Material Storage Yard (Figure 1.2).

- Storage Facilities - This includes Buildings D203 (Warehouse A) and D203 (Warehouse G), which are used for temporary storage of pyrochlore before final storage and smelting in the D111 facility.

- Manufacturing Area - This area is primarily associated with operations in Department 111 (ferrocolumbium operation). The product is refined in Department 102 (aluminothermic reduction operation).

- Source Material Storage Yard (SMSY) - This area is in the eastern portion of the site, where materials (slag and dust) generated during the ferrocolumbium manufacturing processes are stored.

Changes to the physical plant since the last license renewal include the addition of a Flex Kleen (FK) baghouse filter system in 1987 and the addition of a chimney enclosure around the smelter in 1991.

1.3 Description of the Proposed Action

The proposed action is the renewal of the SMC Source Materials License SMB-743 for 5 years. With this renewal, the SMC facility will continue to produce specialty alloys, slag fluidizers, and other products. The proposed action would permit SMC to possess up to 1,200,000 kilograms (kg) of thorium and 180,000 kg of uranium, as requested by SMC's September 15, 1995, renewal application. This is an increase from the current possession limits of 303,050 kg and 45,000 kg of thorium and uranium, respectively, authorized in SMC's license.

1.4 Need for the Proposed Action

SMC performs a service for the commercial steel industry by converting pyrochlore ore into specialty alloys, slag fluidizers, and other products. Ferrocolumbium is SMC's main product from the licensed activities. SMC is one of two domestic producers of ferrocolumbium (and the only domestic producer with the ability to process ferrocolumbium from pyrochlore--the other producer uses imported columbium oxide which is more costly); ferrocolumbium is readily available from foreign producers, such as Brazil and recently the Confederation of Independent States (formerly the Soviet Union) and Canada. The element columbium can increase the strength of steel by more than 5,000 pounds per square inch (psi) with only a small addition of columbium (approximately 0.01 percent), thus allowing lighter weight constructs. Denial of the license renewal for the SMC facility is an alternative available to the NRC, but would either require the construction of a new facility at another site or the possible dependence upon foreign imports of ferrocolumbium.

1.5 Other Environmental Actions at this Site

In November 1993, NRC issued a "Notice of Intent to Prepare an Environmental Impact Statement", (58 FR 62387), to evaluate the *in situ* disposal of the slag and dust piles at the site. *In situ* disposal was originally proposed by SMC in its Conceptual Decommissioning Plan dated April 17, 1993 Since then, SMC has pursued development of a market for the slag as fluidizer called CANAL (see Section 2.1). Subsequently, by letter dated December 12, 1995, SMC submitted an updated Decommissioning Plan that proposes the sale and export of the slag, as CANAL, the off-site sale of the baghouse dust for further processing, and disposal of any remaining source material contaminants in a licensed, off-site disposal area. Because the export of the CANAL could dramatically decrease the amount of licensed material at the SMC site, the scope of the environmental impact statement may dramatically change. As such, NRC has opted to suspend development of the EIS until it is known if the export of the material is viable.

The SMC facility is listed on the National Priorities List and is being remediated under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) to mitigate groundwater contamination caused by non-licensed activities at the site. The use of chromium at the site contaminated on-site groundwater. These activities are administered by the Environmental Protection Agency (EPA) and the State of New Jersey Department of Environmental Protection (NJDEP). Activities related to the mitigation of groundwater contamination are unrelated to the pending license action and not within the scope of this EA.

In 1994, at the request of the County of Gloucester, the Agency for Toxic Substances and Disease Registry (ATSDR) evaluated the potential health hazards related to environmental contamination from source material at the SMC New Jersey facility. ATSDR's conclusions were: (1) surface soil from localized areas outside the fence perimeter contains thorium-232, radium-226, and uranium-238 at concentrations above background levels, (2) gamma radiation outside the fence perimeter (especially near the slag piles) exceeds background levels, and (3) radiation and radionuclide contamination outside the fenced area does not currently pose a public health hazard (Block 1994). NRC has also performed an analysis of the health and safety impacts from this material, which is contained in Section 5.0.

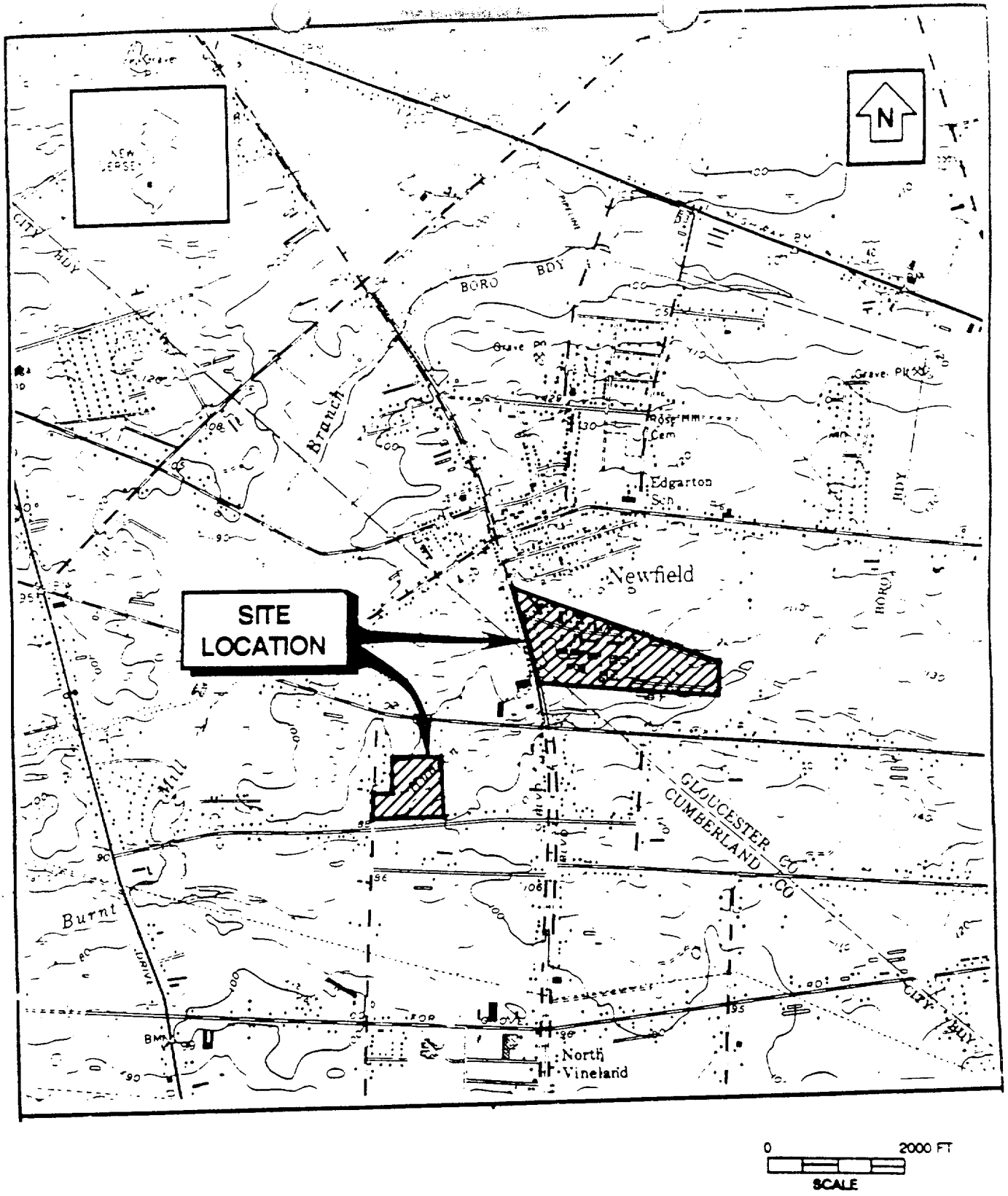

Figure 1.1 SMC Newfield Facility Site Location

FROM NEWFIELD, NJ 7 1/2' USGS
TOPOGRAPHIC MAP 1953
PHOTOREVISED 1986

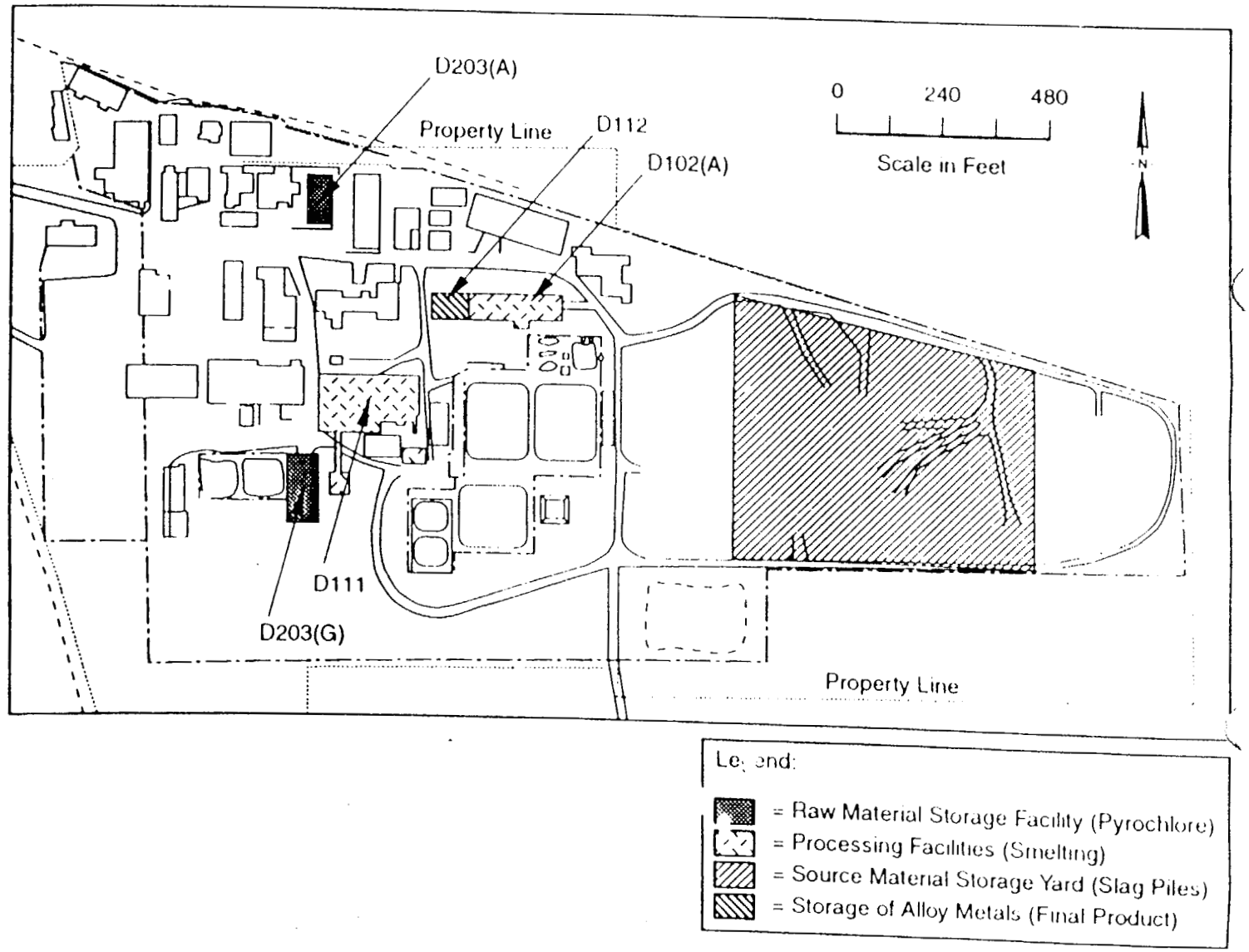

Figure 1.2 Functional Areas of the SMC site

2. THE PROPOSED ACTION AND ALTERNATIVES

Implementation of the proposed action, renewal of the current license, would involve continued operation of the facility. In the recent past, operations involving the processing of licensed materials at the facility have been limited to one production run per year. The license renewal would allow them to either continue limited production or resume full scale operations. No major construction or major process modifications to the smelting operations were proposed for this renewal; however, SMC would be granted an increase in their source material possession limits to allow the accumulation of greater quantities of slag, pending the final disposal of the licensed materials. Under this proposed action, SMC would also be permitted to process slag from the smelting operation for use as CANAL. The alternatives to this proposed action would be to deny the renewal request and thereby terminate licensed activities at the site, or take no action and allow the facility to operate under its current license.

2.1 Description of the Proposed Action (Current Operations)

The licensed radioactive material inventory at the plant consists of the operating inventory of the raw material (pyrochlore) for the production of ferrocolumbium, the slag resulting from ore processing, and baghouse dust. As of July 1997, there was no unprocessed ore on-site. However, the slag and dust stored on-site had an inventory of approximately 293,400 kg of thorium and 39,400 kg of uranium. This inventory is 96.8% of SMC's possession limit for thorium and 87.5% of the possession limit for uranium (Smith, 1997). Pyrochlore is a sodium-flour columbite, which contains up to 2 percent by weight (wt%) thorium and 0.4 wt% uranium. Isotopes of thorium and uranium are present in their natural ratios. Pyrochlore is chemically expressed as $(Na, Ca)_2(Nb, Ta)_2O_6OH$, Fe; lead, thorium, strontium, or uranium can substitute for the sodium (Na), and titanium, tungsten, tin, or iron can substitute for niobium (Nb). Pyrochlore exists in the solid phase and is received as a powder in woven poly-propylene bags (supersacks).

SMC takes possession of the pyrochlore at its supplier's mine (currently in St-Honore, Cte-Dubec, Quebec) and provides exclusive-use truck transportation for the material. Each truckload of pyrochlore contains one lot of 13 supersacks of material, weighing approximately 1,450 kg each, for a total of 18,850 kg. The supersacks are arranged in double rows in the trucks. In the past, SMC has received about 10 lots per month of pyrochlore from Canada; in 1991 and 1992, receipts were 118 and 119 lots, respectively; since March 1995, SMC has only received one shipment per year because SMC's pyrochlore supplier is using the pyrochlore in its own facilities. The shipments enter the United States through New York state. Their arrival at the SMC gate house is announced by SMC security to warehouse personnel. Shipments are packaged, surveyed, and labeled in accordance with Department of Transportation (DOT) regulations, 49 CFR 173.400 Subpart I (SMC 1992).

Figure 2.1 shows the movement of pyrochlore through the SMC facility. When shipments of pyrochlore arrive, SMC verifies the truck's gross weight on the SMC truck scale before unloading at Warehouse G (D203G). Supersacks are removed from the trucks by fork-lifting through their attached handling loops. The supersacks are then placed on pallets and computer-label bar-coded as they enter the SMC inventory system. Transfer to pallets and inventory in D203G or Warehouse D203(A) normally requires only a few hours. Usually within a day, the supersacks are transferred from D203G to Department 111 (D111) for storage until use in the smelting process. SMC typically stores a one-month inventory or approximately 10 lots (188,500 kg) of pyrochlore in D111; the inventory can vary with changes in production and shipping schedules.

The production of ferrocolumbium in D111 starts with the preparation of a "charge" or "batch" containing dolomite, pyrochlore, lime (CaO), steel remelt[b], and aluminum (Figure 2.2). The charge is transferred to a magnesium-lined shell in the furnace, where it is packed around the electrodes. The reaction begins when power is applied to the electrodes. The reaction generates dust, which rises and is swept into the air-cleaning duct. At completion of the reaction, after approximately one hour, the power is turned off and the electrodes are raised. The furnace is tilted, and the slag and metal mixture is poured into a pot. The slag floats on top of the metal in the pot. After a cooling period, the pot is inverted.

Slag in the first pot is separated from the ferrocolumbium alloy button by use of a hydraulic hammer in D111. The force of the hammer on the slag/alloy interface cracks the slag into manageable pieces. The slag is then transferred from D111 to the SMSY, where it is stockpiled with existing slag. Essentially all of the radioactive source material remains in the slag and dust.

During full operations, as many as four production runs occurred during a shift. Production is typically scheduled between midnight and 10 a.m. to take advantage of lower electrical power rates.

The present application for renewal of the license involves no expansion or major process changes in the ferrocolumbium production facilities since the last license renewal in 1980; however, the SMC is requesting that its possession limits be increased to allow for a greater accumulation of radioactive slag and other materials at the site pending final disposition of the licensed materials.

SMC's latest revision of their renewal application also requests permission to do research and processing of raw and process-byproduct materials to produce specialty

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[b] Remelt is melted steel from previous operations.

alloys, slag fluidizers, and other products. Acceptance of these changes would permit SMC to process slag from their ferrocolumbium operations into a slag-fluidizer, called CANAL, for possible export.

In their revised application dated September 15, 1995, SMC has also proposed the production of CANAL. CANAL has superior applicability for steel manufacturing since it contains a relatively high percentage of aluminum oxide, making it an effective slag fluidizer.[c] The CANAL is also expected to remove impurities in the final steel product. SMC produces CANAL by crushing, sizing, and packaging ferrocolumbium slag. Area monitors are set up around the crushing process to monitor dust releases and workers wear dust masks. This slag-crushing process does not modify the type or quantity of radiological constituents in the CANAL. CANAL production takes place within the restricted areas at the SMC site. The CANAL is currently stored in D102 prior to shipment. No export shipments will be made until SMC receives all necessary export permits and import permits for the receiving country.

2.2 Decontamination and Decommissioning

Prior to termination of License SMB-743, SMC will be required to decommission the facilities to provide for protection of the environment and public health and safety in accordance with NRC requirements. By letter dated December 12, 1995, SMC submitted an updated Conceptual Decommissioning Plan that proposes the export of the slag for further processing, the off-site sale of the dust for further processing, and disposal of any remaining source material contaminants in a licensed, off-site disposal facility. Subsequently, SMC submitted an application dated June 24, 1996, requesting permission to sell the baghouse dust domestically as a raw material to the cement industry. NRC is still evaluating this proposal. If SMC cannot, in a timely manner (i.e., within one year of license renewal), provide sufficient evidence of the success of the conceptual decommissioning plan, NRC will require SMC to investigate other decommissioning alternatives and provide adequate financial assurance for the alternative proposals.

Following completion of decommissioning activities under a plan approved by NRC, a comprehensive radiological survey will be completed and a report documenting completion of decommissioning to residual radioactivity limits will be produced. The decontamination activities and final survey will be reviewed and verified by the NRC and will be coordinated with the EPA and the State of New Jersey before termination of the license.

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[c] A product SMC has successfully marketed over the last several years is a ferrovanadium slag, known by the trade name of V-40. Because of its aluminum and calcium content, this material serves as an additive to the steel making process for reducing impurities in the final product. This product does not contain uranium or thorium in concentrations that require NRC licensing.

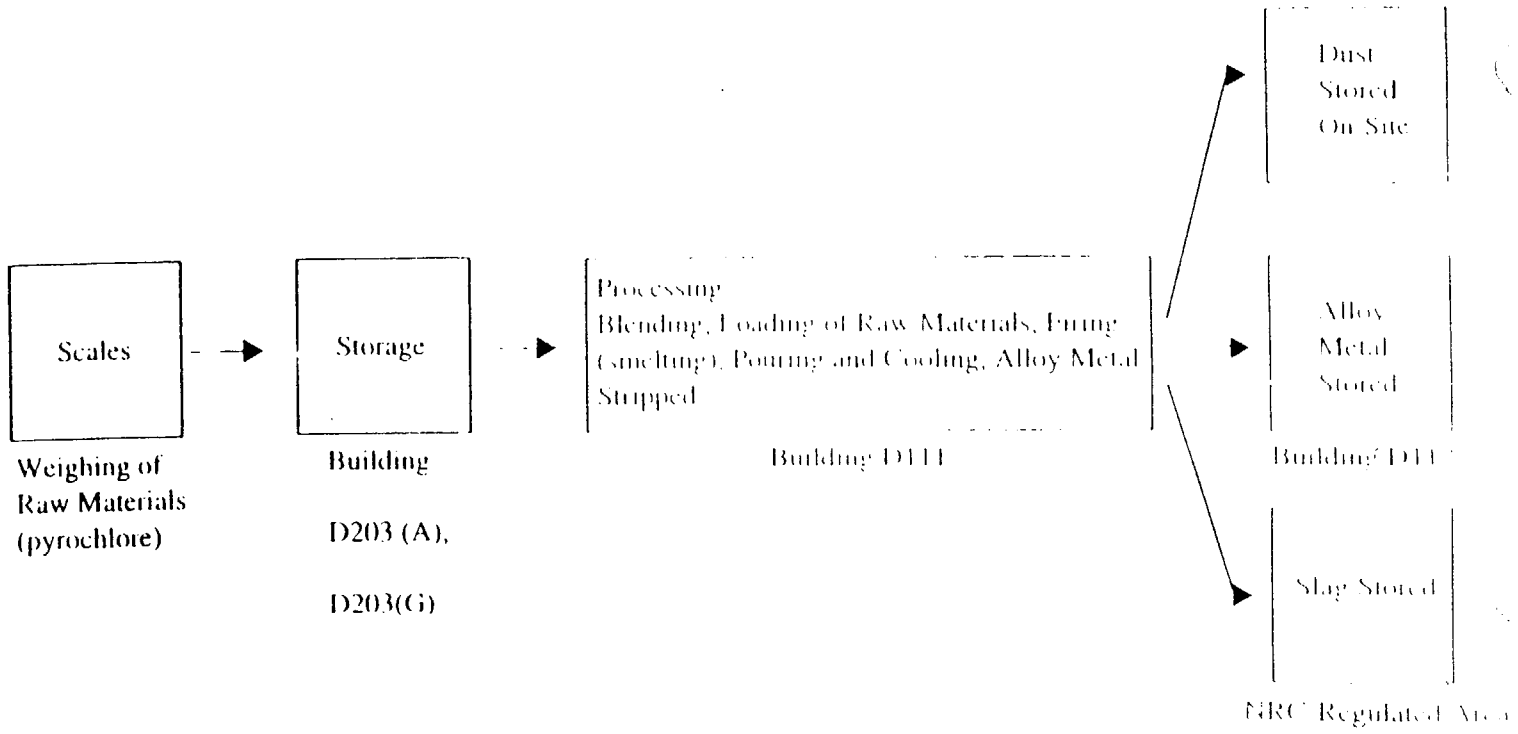

Figure 2.1 Ferrocolumbium Process Diagram

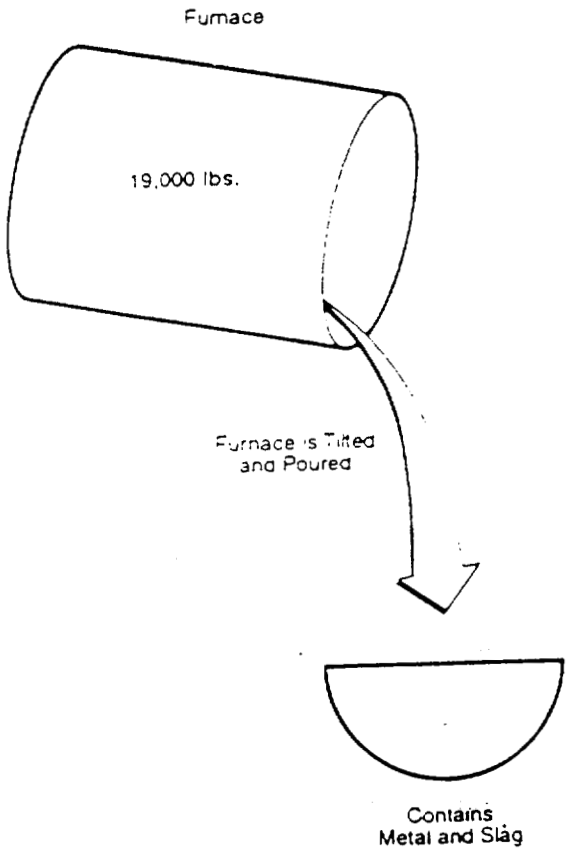

Figure 2.2 Smelting Operation

2.3 The No License Renewal Alternative

The alternative of no license renewal for the SMC plant at the Newfield, New Jersey, site would require cessation of production activities involving licensed source material and commencement of decontamination and decommissioning of those portions of the facility. The license would be converted to a "possession only" license for the purposes of decontamination and decommissioning. Decontamination and decommissioning would still be expected to occur as described in Section 2.2; however, the option to process and export CANAL would be removed unless specific permission is granted in the "possession only" license. Existing licensed operations may be transferred to a new or existing site. If licensed operations were not transferred to a new domestic site, domestic industries requiring ferrocolumbium may need to rely on imported ferrocolumbium because SMC is one of the only domestic producers of this material. If a new site is developed for the production of ferrocolumbium, environmental impacts for the new site would be similar to those discussed in Section 5 for the proposed action; however, construction impacts would also require evaluation.

2.4 The No Action Alternative

The alternative of "No Action" implies that operations at the SMC plant at Newfield, New Jersey, would continue without change. SMC would continue to operate under the timely renewal provisions of 10 CFR 40.43(b) and would be required to meet the conditions of the existing license. This alternative is different from the proposed action in that new and more stringent license conditions proposed in the application dated September 15, 1995, would not be required to be met by SMC, except on a voluntary basis. New operations, such as CANAL production, would not be permitted without amendment of the existing license. In addition, specific action would be needed promptly to increase possession limits in the license. Without such increases, SMC would not be able to process significant quantities of pyrochlore. This alternative would essentially resemble the "no license renewal " alternative under Section 2.3.

Although this alternative could conceptually be extended for an indefinite period of time, eventually a decision would be made regarding the license renewal. From that time, actions at the site would be similar to those described in Section 2.1 or 2.2.

3. THE AFFECTED ENVIRONMENT

3.1 Land Use

The SMC facility consists of approximately 67.5 acres. The manufacturing facilities and support areas are located on approximately 60 acres in Newfield, New Jersey, in Gloucester County. SMC also owns 7.5 acres of farm land approximately 610 meters (2,000 feet) southwest of the 60 acre parcel in Vineland, Cumberland County, New Jersey. The site is located on the Newfield, New Jersey Quadrangle of the United States Geological Survey (USGS) 7.5 minute series topographic map.

The land surrounding the SMC facility serves residential, manufacturing, industrial, and agricultural purposes The property is bounded by a Conrail railroad line to the west and to the north. Weymouth Road lies directly south of the site. Woods, residential homes, and small businesses are east of the site. To the west of the SMC property, across East Boulevard, are six residences and two businesses; to the south are nine residences on Weymouth Road; to the north are single and multiple family residences, and two businesses to the northwest; and the Hudson Branch, a tributary to the Burnt Mill Branch, flows westward along the southern portion of the site, just north of Weymouth Road. The former Newfield Municipal Landfill is adjacent to the northeast portion of the site. Mixed land uses, including residential, commercial, and open space, lie to the east of the project site.

Although surrounding land use is predominantly residential, some institutional uses adjoin the SMC facility. A number of Newfield municipal water supply wells lie to the north, and the former Newfield Municipal Landfill is adjacent to and northeast of the site.

3.2 Geology and Soils

3.2.1 Regional Geology

The SMC property is located within the New Jersey Coastal Plain, which extends from the Delaware Bay on the southwest to the Raritan Bay on the northeast, and from the Fall Line on the west to the Atlantic Ocean on the east. The Coastal Plain is a seaward-dipping wedge of unconsolidated sediments that range in age from the Cretaceous to the Holocene. These sediments are composed of clay, silt, and gravel and are classified as continental, coastal, or marine (TRC 1994).

The middle to lower Cretaceous sediments are primarily continental deposits consisting of alternating layers of clay, silt, sand, and gravel. The upper Cretaceous and most Tertiary sediments were deposited in beach and shelf environments, and tend to be finer grained than continental deposits.

Very fine-grained sediments are recognized as transgressive marine deposits, which formed during major incursions of the sea. Coarsening-upward deposits that overlie the fine-grained units are recognized as marine regressions, deposited in inner-shelf, near-shore, or beach environments as the ocean was retreating (TRC 1994).

Overall seismic activity within a 80.5-km (50-mile) radius of the SMC site has been slight to moderate, with approximately 34 earthquakes ranging from <1.0 to <6.0 on the Richter scale since 1800. Of these, 31 were less than 4.0, and only one event was between 5.0 and 6.0 magnitude (USGS 1993).

3.2.2 Local Geology

The Quaternary Bridgeton Formation (Figure 3.1) forms the uppermost geologic unit at the SMC facility. This formation is characterized by brown sand that is cemented in some areas by iron oxide. The Bridgeton ranges from 8.5 meters (28 feet) thick in the eastern portion to 0 meters (0 feet) thick in the western portion of the site (SMC 1992). The Cohansey Sand lies below the Bridgeton Formation and is composed of approximately 37 meters (120 feet) of variegated fine- to coarse-grained sand. Localized silt and clay lenses form a discontinuous layer that divides the Cohansey into upper and lower sections. The base of the unconfined aquifer, and therefore the geologic section of interest at the SMC site, is the gray silt and clay of the Kirkwood Formation. The majority of the aquifer is contained within the Cohansey Sand. The upper Cohansey Sand has a higher transmissivity than the lower Cohansey because of the finer overall grain size of the lower unit (TRC 1994). The water table occurs in the upper Cohansey Sand at the SMC site except in the eastern portion, where it occurs in the Bridgeton Formation.

Five soil mapping units are identified by the Soil Conservation Service on this site and confirmed by the surface and surface soil exploration program during the remedial investigation for chromium contamination of groundwater (Smith and Mullen 1991). These are the Downey loamy sand; Aura sandy loam; Woodstown and Dragston sandy loam; Woodstown and Klej loamy sand; and Muck. The latter consists of 0.3-1 meter (1-3 feet) of black to brown, partially decomposed organic matter; it is generally very acidic and is present in marshy areas adjacent to the Hudson Branch.

3.3 Hydrology

3.3.1 Surface Water

The Hudson Branch, a tributary of Burnt Mill Branch in the Maurice River Basin, originates in the southeast corner of the SMC facility and flows along the southern boundary. In the vicinity of the SMC facility, groundwater and discharges from the facility are the primary sources of water to the stream. As the water table fluctuates seasonally, the amount of water discharged to the Hudson Branch varies.

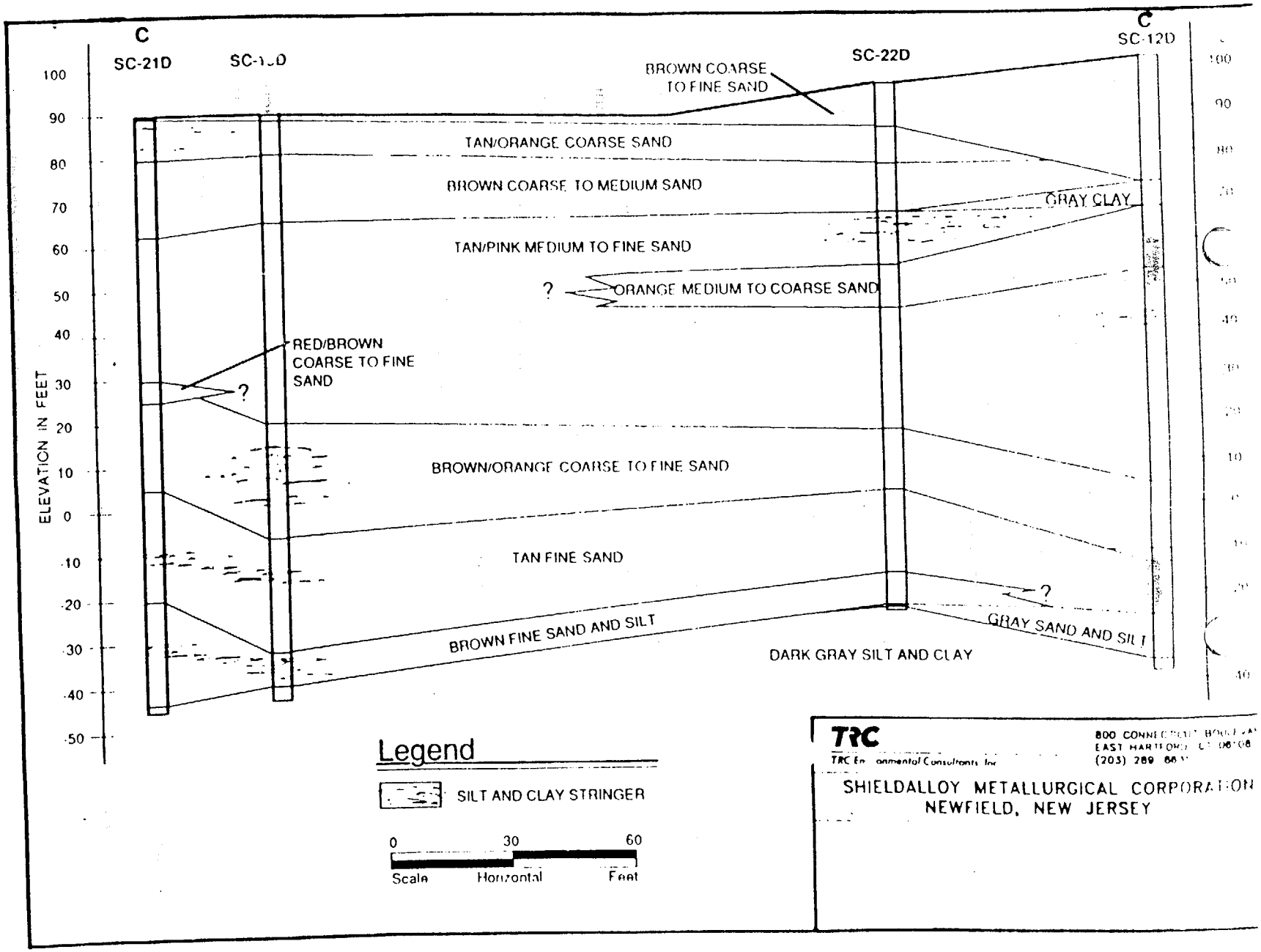

Figure 3.1 Geological Cross Section C - C' Underlying SMC Site (also see figure 4.5).

Three discharge outfalls enter the Hudson Branch from the SMC facility. Outfalls 002 and 003 are storm water discharge points. Outfall 001 discharges SMC facility water into Hudson's Branch (see Figure 4.3). Facility discharges consists of city water, treated groundwater, and supernatant from the wastewater treatment facility (chromium reduction/precipitation). Based on flow measurements of the outfalls and natural discharge to the stream, the outfalls represent the major portion of the Hudson Branch total flow in the vicinity of the plant (TRC, 1992).

Immediately upstream from the first outfall is a small pond that ranges in depth from 0.6 to 2 meters (2 to 6 feet). The pond discharges into the Hudson Branch adjacent to the first outfall. During precipitation events, storm water from Newfield and SMC facility drains into the Hudson Branch. During heavy storm events, the stream overflows its banks and floods a marsh southwest of the plant.

3.3.2 Groundwater

The unconfined aquifer at the SMC site is the Kirkwood-Cohansey aquifer. The Kirkwood-Cohansey is a primary source of drinking water in the region and in the Newfield area. The Kirkwood Formation forms the base of the unconfined aquifer in this area, restricting downward movement of water. The Cohansey Sand is composed primarily of variegated fine- to course-grained sands with some silt and clay beds. Beneath the SMC site specifically the Cohansey sand is composed of course sands and little to trace silt in the upper 12.2 meters (40 ft), and much finer sand and some silt, with some clay and silt stringers in the lower 18.3 to 24.4 meters (60 to 80 ft). There is a 6.1 to 18.3 meter (20 to 60 ft) thick semi-confining layer composed of discontinuous silt and clay lenses separating the Cohansey Sand into upper and lower units. No continuous semi-confining layer exists across the site (TRC 1992).

Depth to the water table ranges from 1.2 meters (4 ft) in the northeast to 4.9 meters (16 feet) in the southwest; seasonal fluctuations cause variations of 0.6 to 1 meter (2 to 3 feet) across the site. The water table generally mimics the topography at the SMC site, which slopes to the southwest. The average groundwater flow velocity was calculated at approximately 0.6 meters/day (2 ft/day) to the west/southwest (TRC, 1992). The overall gradient of the groundwater is generally 0.12 cm/cm (0.004 ft/ft).

3.4 Meteorology, Climatology and Air Quality

Based on the Koeppen climatic classification system, the facility is in a region that intersects humid continental and humid subtropical zones, both of which have characteristics of warm summers and mild winters. Rainfall occurs primarily in the summer months in the form of thunderstorms. The average annual rainfall is approximately 100 centimeters (40 inches) (SMC 1992).

Tornadoes, although infrequent, do occur in the area, primarily during the spring and summer. Thunderstorms are a seasonal phenomenon in the region. Records from the Wilmington National Weather Service station indicate an average of 31 thunderstorm days per year, 26 of which occur during April through September (SMC 1992). Ice or freezing rain occur one to three times per year. Climatological stations in the vicinity of the site indicate that the Wilmington data are generally representative of the site.

The average prevailing winds during the winter (December to March) are from the northwest at 14 to 21 kilometers per hour (9 to 13 mph). The average monthly winds for the spring and summer months (April to August) are from southerly to southwesterly direction at 11 to 16 kilometers per hour (6 to 11 mph). The winds during the fall are predominantly from the west southwest, veering to west northwest by December.

Local meteorological data were obtained from the Glassboro station 19 km (12 miles) northwest of the plant; Hammonton-2, 39 km (24 miles) northeast; and Mays Landing, 26 km (16 miles) southeast. The average maximum temperature occurs in July with a temperature of 30°C (86°F) and the average minimum temperature occurs in January with a temperature of -5°C (22°F).

3.5 Demography and Environmental Justice

SMC's facility is in the borough of Newfield, Gloucester County, New Jersey. The town center of Newfield, is approximately 366 meters (1,200 feet) to the north of the facility and Vineland Township is located approximately 1.6 kilometers (km) (1 mile) to the south. Table 3.1 lists the population by race, and the median income of residents within 1.6 km (1 mile) of the site. Approximately 3,430 people reside within this 1.6-km (1-mile) radius of the site. Wilmington, Delaware, is about 51.5 km (32 miles) west northwest of the site. The 1993 population of the Wilmington metropolitan area was 71,529 (IPA 1993). Atlantic City is about 58 km (36 miles) east southeast of the site. The consolidated Metropolitan Statistical Area (MSA) population was about 319,000 (USDC 1992). Philadelphia is about 51.5 km (32 miles) north northwest of the site. The consolidated (MSA) population of Philadelphia was about 1,586,000 in 1990 (USDC 1992). The facility is on the border of Gloucester and Cumberland Counties, predominantly in Gloucester County.

Environmental Justice

On February 11, 1994, President Clinton signed Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," which directs all Federal agencies to develop strategies for considering environmental justice in their programs, policies, and activities. Environmental justice assessment is described in the Executive Order as "identifying and addressing, as

Table 3.1. 1990 Population and income estimates by the Bureau of Census based on racial and income characteristics

Political Unit	Median Income	Total Person Number	Black	American Indian	Asian	Hispanic	Other
New Jersey	40,927	7,730,188	13.4 %	0.2 %	3.5 %	9.6 %	3.6 %
Gloucester County, NJ	39,387	236,867	8.7 %	0.2 %	1.2 %	1.8 %	0.6 %
Cumberland County, NJ	29,985	138,494	16.9 %	0.9 %	0.8 %	3.3 %	7.8 %

Source: Landview geographic information system software developed by EPA/Census/NOAA

appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." The NMSS Policy & Procedure Letter 1-50 (February 1995) provides the guidance used for addressing the issue of environmental justice in NEPA review for the United States Nuclear Regulatory Commission. The agency is committed to following the Council on Environmental Quality (CEQ) guidance on environmental justice once it is issued; in the interim, the NMSS Policy & Procedures Letter 1-50 provides interim instructions for handling the topic in NEPA documents.

Demographic data used in this environmental justice evaluation consists of minority breakdown and income levels. For this section, minority is defined as individuals classified by the U.S. Bureau of the Census as of (1) Black, (2) American Indian, (3) Asian, or (4) Hispanic origin (persons of Hispanic origin may be of any race). Low-income is defined as being below the poverty level as defined by the U.S. Bureau of the Census currently considered to be $15,000 per year or less. The guidelines for determining the area of assessment indicate that a 0.56-mile (0.9-km) radius from the center of the site is to be used if the facility is within the city limits, or a 4-mile (6.4-km) radius is to be used if the facility is outside the city limits or in a rural area. NRC guidance (NMSS Policy & Procedures Letter 1-50) indicates that if the site area percentage is greater than the state or county percentage (or the comparison base used) for either minority population or economically stressed households by 20 percentage points or more, the site has an environmental justice potential, and environmental justice will have to be considered in greater detail. For example, if the site is 30% Asian, and the county is 10% Asian, there is a 20 percentage point difference between the two which indicates a potential for environmental justice issues.

Table 3.2 Census Data for Block Groups within a 1-mile Radius of the SMC Site.

Block Group	Total Person number	Median Income	Black	American Indian	Asian	Hispanic Origin	Other
5018-9 Gloucester County	513	$41,111	1.5 %	0 %	0 %	3.1 %	1.4 %
5018-1 Gloucester County	778	$35,461	1.4 %	0.1 %	3.4 %	3.4 %	0.4 %
5018-2 Gloucester County	301	$35,469	0.3%	0.3 %	0.3 %	3.3%	3.3%
040998-2 Cumberland County	1,838	$42, 083	3.7%	0.2%	0.5%	5.6%	1.3%

As noted above, the SMC main facility consists of approximately 67.5 acres with approximately 60 acres in Newfield, Gloucester County, New Jersey, and 7.5 acres located 610 meters (2000 ft) to the southwest in Vineland, Cumberland County, New Jersey. The additional 7.5 acres were purchased for the purpose of installing wells to pump groundwater for treatment at the main site, and therefore, there is very little activity at this site. Any impacts to the local population would most likely result from activities at the main site. For this reason, the 0.56-mile (0.9-km) radius study area was placed around the center of the main site. Because there was limited information available for this area, the radius was increased to 1 mile (1.6 km). Based on a 1997 run of the Landview Program, there are approximately 3,430 people that reside within this area.

Blocks, the smallest census geographic area, are not appropriate for environmental justice studies because there is no income information available at this level. Therefore the next largest geographic level, census block group, was used for this analysis. There were 4 block groups located within the 1 mile area of the Newfield site. Three are in Gloucester County, and one is in Cumberland County. The 1990 estimates (no new numbers are available) of median income and racial characteristics produced by Landview for these census blocks are shown in Table 3.2.

The table indicates that the area around the site does not contain a significantly larger minority population or lower income population than for the rest of the surrounding counties or the entire State of New Jersey. Therefore, based on this information,

environmental justice does not appear to be a concern at this site. No minority population will be disproportionally impacted by the actions proposed for this site.

3.6 Ecology

The site is bounded on the east by deciduous forest and palustrine shrub, a habitat that occurs in association with the Hudson Branch, and in the south southeast by a wetlands area. The project site can be grouped into four major types (TRC 1994):

- Upland industrial area: highly industrialized areas devoid of functional habitat because of man-made activities (e.g., roads, buildings, storage areas, debris piles, slag piles, holding ponds). This area is essentially devoid of a working ecosystem because of its highly disturbed nature. Plant and animal life is scarce.

- Upland undeveloped areas: grassed areas that are regularly mowed and have limited ecosystem potential. These grassed areas are potentially used by small rodents (e.g., shrew, mice), herbivores (e.g., rabbits), and birds (e.g., woodcock), which typically feed on the insect life and worms living in the grasses and sandy soil.

- Wetland areas associated with Hudson Branch (creek): an intact wetland ecosystem containing a wide variety of plant and animal life. This broad-leaf swamp wetland is the major habitat associated with the project site and is generally adjacent to the south-southeast border of the project site. Expected within these wetlands are amphibians (e.g., frogs), reptiles (e.g., turtles, snakes, salamanders), small mammals (e.g., shrew, mice), herbivores (e.g., rabbits, deer), and birds (e.g., hask, woodcock, ducks, geese). Some fish species may also be present, but not in abundance. This area is expected to have the most complete foodweb and ecosystem in the vicinity of the project site (TRC 1994).

- Forested areas adjacent to wetlands: small woodlots bordering the Hudson Branch wetlands, providing habitat for a variety of terrestrial and avian species. The cover provided by the woodlands, the nearness of the grasslands, and the wetlands are attractive to many species, especially mammals seeking to forage in the area. The quality of this habitat is not expected to be particularly high, however, because of the highly disturbed nature of the project site and adjacent areas.

3.6.1 Endangered Species

Four vascular plant species were identified in the Natural Heritage Database Search as existing in the town of Newfield: Barratt's sedge, *Carex barrattii*; pink tickseed, *Coreopsis rosea*; pine barren boneset, *Eupatorium resinosum*; and swamp-pink, *Helonias bullata*. The pink tickseed and swamp pink are known to prefer habitat similar to the wetlands adjacent to the SMC site. A field survey revealed none of these species on the project site (TRC 1994). Also, no endangered animal species have been identified on the project site.

4. EFFLUENT RELEASES AND MONITORING

4.1 Current Radiological Status

The thorium and uranium contained in the pyrochlore are separated from the finished alloy product during smelting. More than 99 percent of the radioactivity in the original ore remains in the slag and baghouse dust.

The slag is segregated from other (non-radioactive) slag generated at the site and is stored in two piles on the eastern end of the SMC property in the SMSY. Large quantities of slag and dust, 18,000 m^3 and 15,000 m^3, respectively, have accumulated on the site since the operations began in 1955, because of the prohibitively high cost of disposing of the material in a low-level waste disposal site (Berger and Luck 1988). Processing activities also generate airborne dusts, which are drawn into baghouses for filtration and collection. This dust contains low concentrations of radionuclides from the thorium and uranium decay series. The dust is periodically removed from the baghouses and transported by covered truck to the SMSY (Berger and Luck 1988).

As of July 1997, the total on-site inventory of source material was approximately 293,000 kg of thorium and 39,400 kg of uranium (Berger 1997). Based upon historical operating conditions, these inventories are expected to increase by approximately 1,000 kg of thorium and 100 kg of uranium per month (Smith 1992). However, recently, SMC's production has been reduced to about one run per year because of limited incoming shipments of pyrochlore, thereby reducing inventory buildup. For evaluation purposes in this EA, environmental impacts will be calculated as though SMC were processing pyrochlore at historically full scale operational rates. Besides the slag and dust, the regulated material at SMC is primarily in the unprocessed pyrochlore ore, and in much smaller volumes of contaminated dry solids such as: baghouse bags, ore sacks, plastic bags, absorbent paper, and protective equipment.

Measurement of the radiological conditions at the SMC site has been done both on a special-case and routine basis. Special investigations included a 1987 radiological survey of slag and environmental media (including air) (Berger and Luck 1988) and a 1991 survey of on- and off-site contamination and dose rate levels, including fence line external radiation exposure rates based on earlier work by a different contractor (Berger et al. 1992). SMC has had in place and collected data from a set of area and environmental TLDs since March 1992. Using the 1987 air-monitoring data, an assessment of potential doses to public from airborne emissions from the SMC site was conducted in 1992 (Berger 1993b), and a baseline radiological risk assessment for the Hudson Branch watershed (Berger 1992) was based on the 1991 (Berger et al. 1992) data.

Background Levels

The ambient levels of gamma radiation and radionuclides in soil were measured in the Newfield, New Jersey, area as part of radiological surveys of the SMC facility performed during October and December 1987 by Oak Ridge Associated Universities (ORAU) (Berger and Luck 1988) and during 1991 by ENSR Consulting (ENSR) and documented in an IT Corporation report (Berger et al. 1992). Results of the ENSR and ORAU background measurements are shown in Tables 4.1 and 4.2, respectively.

Table 4.1 ENSR-Measured Range of Background Values in the Area of SMC

Parameter	Background Range (95% Confidence Interval)
Ambient gamma exposure rate	5.4 - 6.9 uR/hr
Thorium-232 concentration in soil	0.77 - 1.86 pCi/g
Radium-226 concentration in soil	0.59 - 0.94 pCi/g
Uranium-238 concentration in soil	0.65 - 1.34 pCi/g

(Source: ENSR 1991, cited in Berger et al. 1992)

Table 4.2 ORAU-Measured Range of Background Values in the Area of SMC

Parameter	Background Range (95% Confidence Interval)
Ambient gamma exposure rate	6.5 - 7.5 uR/hr
Thorium-232 concentration in soil	0.2 - 0.5 pCi/g
Radium-226 concentration in soil	0.3 - 0.7 pCi/g
Uranium-238 concentration in soil	0.2 - 0.9 pCi/g

(Source: Berger and Luck 1988)

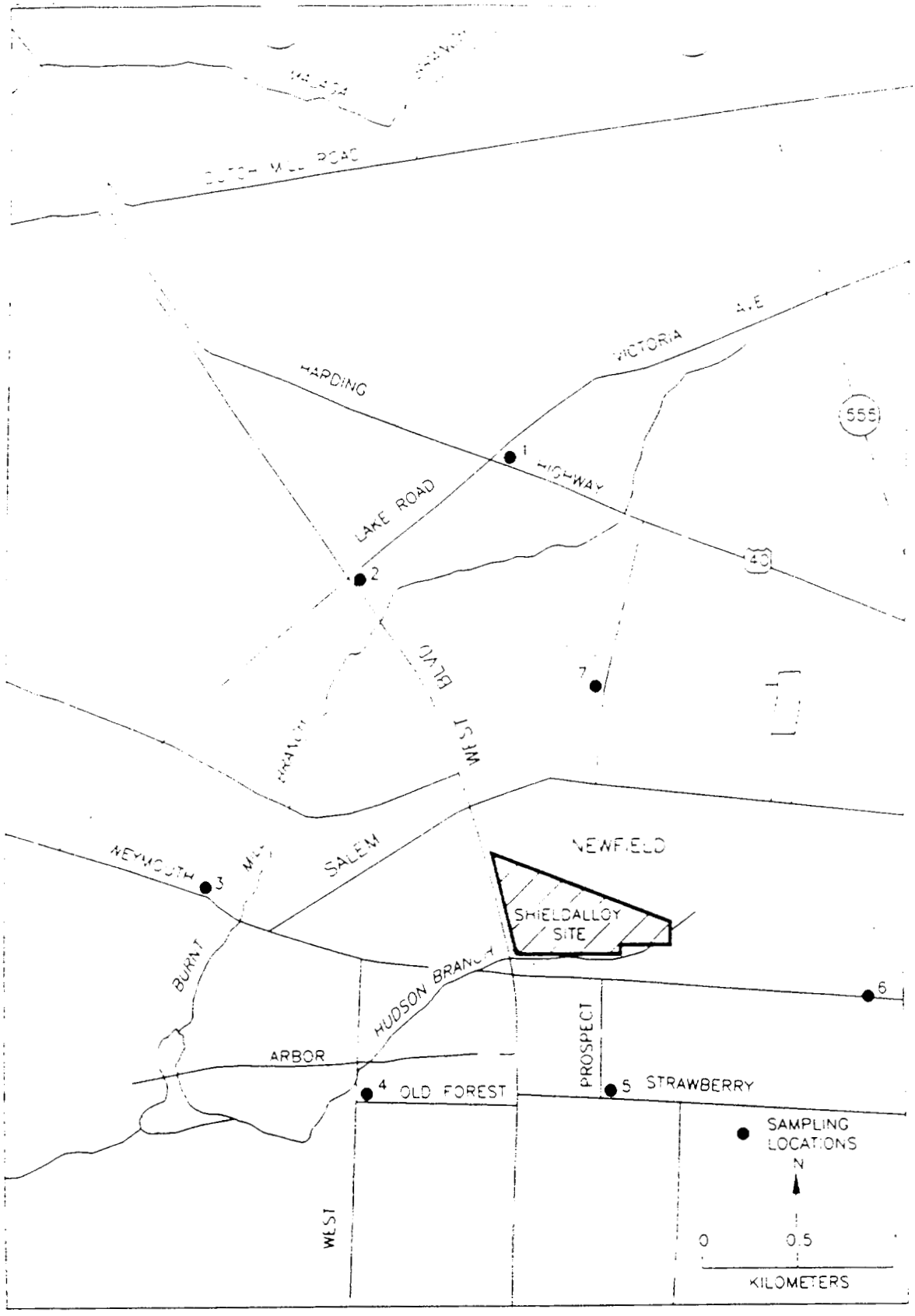

Figure 4.1 Background sampling locations sround the SMC facility

The earlier ORAU data are generally lower than the ENSR data. In the data for thorium-232 in soil, the sample means differ by a factor of three (0.4 picocuries per gram [pCi/g] versus 1.32 pCi/g) and the 95 percent confidence intervals of the two data sets do not overlap. Soil concentration data for radium-226 and uranium-238 are less divergent, as are ambient gamma exposure rates. The reasons for the differences are unknown. Sampling locations were reported to be identical (Figure 4.1). The time of year for the ENSR sampling was reported to be different from that for the ORAU sampling. However, seasonal differences in radionuclide soil concentrations would not be expected.

Likely reasons for differences in the analytical results are differences in sampling or analytical methods or statistical differences due to the small sample sizes.

The two sets of background measurements were combined in a radiological assessment of the facility performed in 1992, under the assumption that the respective samples came from the same populations. The combined background ranges are shown in Table 4.3 (Berger et al. 1992).

Table 4.3 Combined Background Values in SMC Radiological Assessment

Parameter	Background Range (95% Confidence Interval)
Ambient gamma exposure rate	5.3 - 7.9 μR/hr
Thorium-232 concentration in soil	0 - 1.8 pCi/g
Radium-226 concentration in soil	0.1 - 1.1 pCi/g
Uranium-238 concentration in soil	0.1 - 1.5 pCi/g

(Source: Berger et al. 1992)

The measurements include external radiation levels and concentrations of radionuclides in soil, sediment, surface water, and groundwater. These measurements indicate that there is on-site soil contamination of uranium, thorium and daughter products with levels ranging from 0.51 pCi/g to 11.2 pCi/g uranium-238 and 0.63 pCi/g to 41.2 pCi/g for thorium-232. In addition, there is some off-site contamination from slag which was used to build a haulage road next to the site. Exposure rates in this area range from 11.4 uR/hr to 26.1 uR/hr with an average value of 18 uR/hr (Figure 4.2). The

concentration ranges of radium-228, radium-226, uranium-238, and thorium-232 in the Hudson Branch suspended sediments are shown in Table 4.4. The maximum suspended solid concentrations of thorium-232 (48 pCi/l) and uranium-238 (17 pCi/l) were from a single storm water runoff sample collected in the fenced portion of the site, directly south of the SMSY. The maximum suspended solid concenration of radium-226 (33 pCi/l) was detected in a sample collected in the Hudson Branch watershed, directly south of the SMC property. Groundwater sampling indicates little to no radiological contamination of the groundwater. However, there is non-radiological chromium contamination of the groundwater flowing from the site to the southwest with concentrations as high as 108,000 parts per billion (ppb) in the lower Cohansey Sands. Remediation to remove hexavalent chromium from the groundwater was started in 1979. In addition, data summarized from 1988 and 1989 shows that levels of gross beta beneath the site exceed the action levels of 50 picocuries per liter (pCi/l) near the SMSY (DRAI 1990). The elevated gross beta particle activity is associated with naturally occurring potassium-40 (Berger 1995). Analytical laboratories have been unable to consistently provide low enough minimum detection levels (MDLs) for gross alpha measurements, except that of well SC13S, in which gross alpha generally appears to be near background. At well SC13S, analyses in 1988 showed periodic levels of gross alpha above the 5 pCi/l action level, but these levels dropped in 1989 to less than the MDL (DRAI 1990).

4.2 Monitoring Program

SMC maintains a program of environmental monitoring to identify release and dispersion of radioactive material from restricted areas. However, the sources of radioactive material or radiation that could impact the environment in the vicinity of the SMC facility are limited. Impacts could result from materials originating during the ferrocolumbium production process in Building D111 or from the storage of the slag and/or the baghouse dust in the SMSY. Therefore, SMC's monitoring program consists primarily of routine ambient exposure rate measurements both in D111 and around the slag piles and groundwater sampling. Soil and sediment sampling, surface water sampling, and air sampling have been conducted as part of periodic radiological sampling surveys.

4.2.1 Ambient External Radiation Monitoring.

Since March 1992, TLDs have been deployed at 14 stations on the perimeter of the SMC property in addition to the 26 TLD stations inside the plant area (Figure 4.3). In January 1994, the TLD with the highest dose rate at the boundary fence was 428 mrem for the quarter (Kinneman 1994). An individual standing at such a location along the fence line would be expected to receive approximately 0.21 millirem per hour (mrem/hr). This result is consistent with those measured during a 1991 fence line survey (Berger et al. 1992) and is below the external dose equivalent limit of 2 mrem/hr

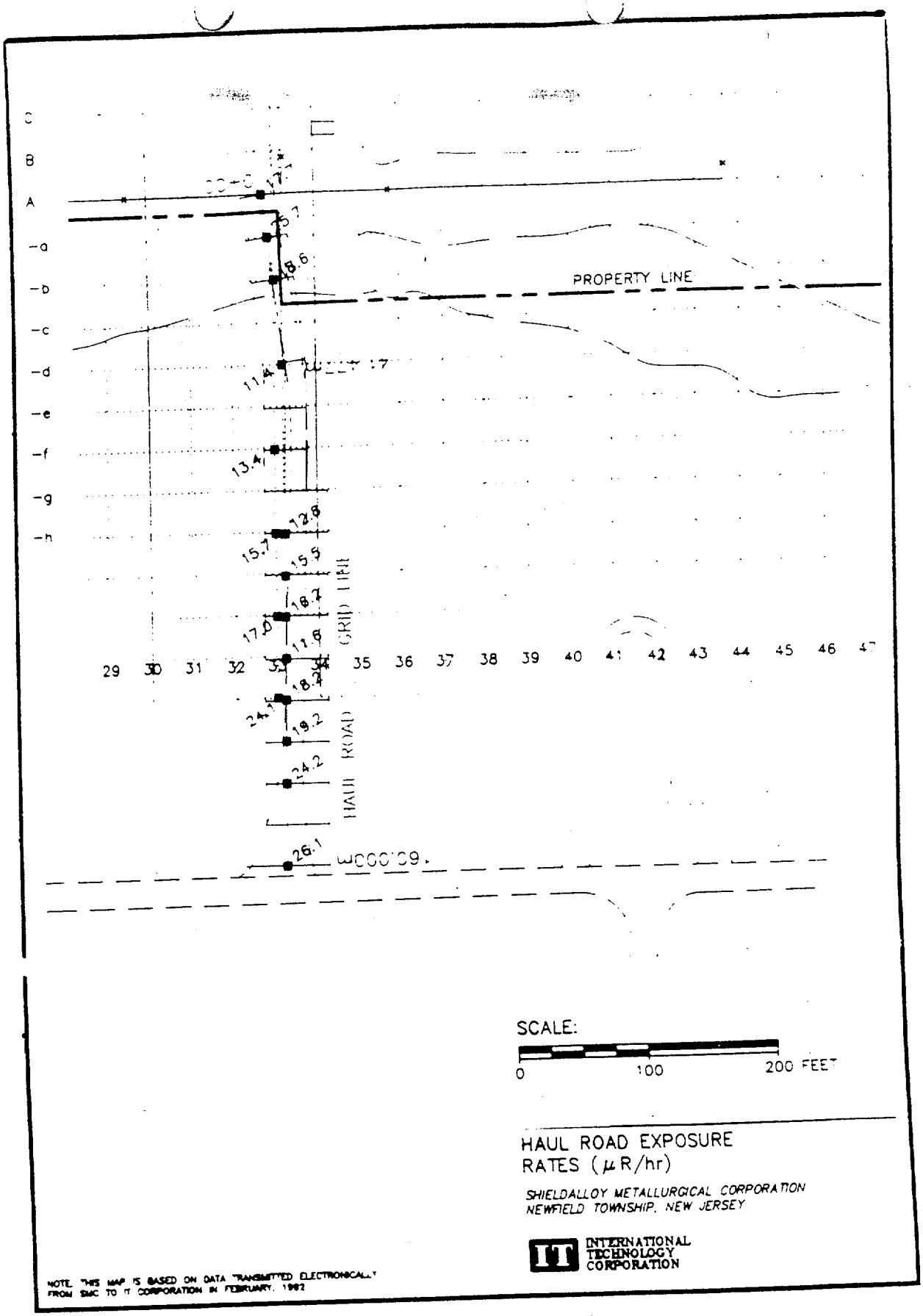

Figure 4.2 Exposure Rate Measurements on Haul Road

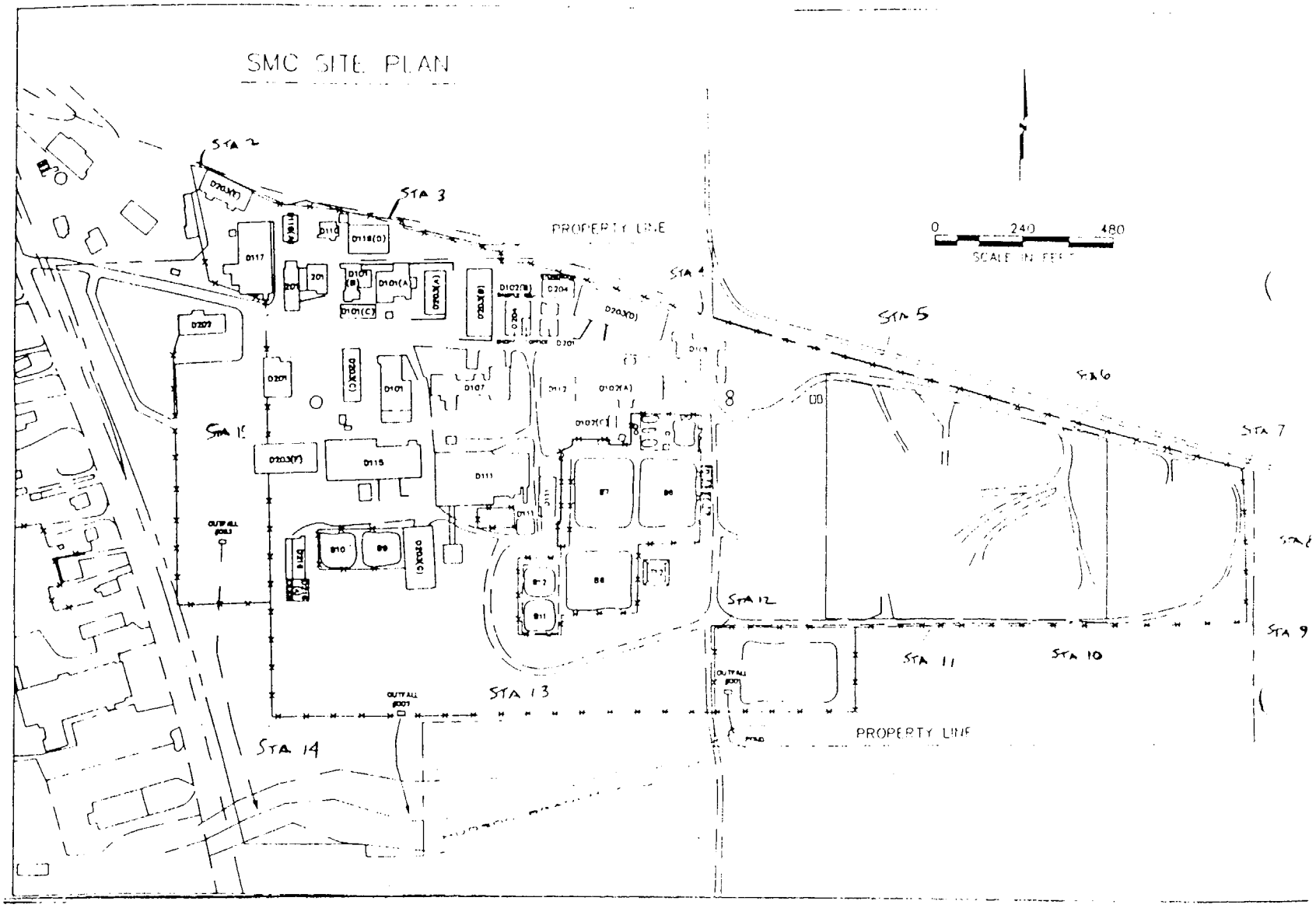

Figure 4.3 Perimeter TLD locations

established by the NRC in 10 CFR 20.1301(a)(2). Compliance with the 100 mrem total effective dose equivalent limit to individual members of the public in 10 CFR 20.1301(a)(1) is met by calculation as permitted by 10 CFR 20.1302(b)(1). This calculation assumes that the exposures in unrestricted areas (outside the fence line near the slag piles) that could cause the licensee to exceed this limit are inhospitable for long periods of habitation (e.g., railroad tracks, heavy underbrush, etc.). Long periods would be necessary for an individual to exceed the 100 mrem/yr limit. Therefore, based on the nature of this area, it is not expected that an individual's exposure would exceed 5 hours/week, 52 weeks a year. With this residence time, an annual dose would be almost 55 mrem/yr, which is less than the public dose limit of 100 mrem/yr. In addition, this calculation was performed using the maximum exposure rate measurement. Most measurements are below this level, and therefore, actual doses would be expected to be less than the estimate.

As production at the site continues, and the quantity of slag in the SMSY increases, the perimeter external-dose equivalent rates may increase if new material is added to the side of the stockpile nearest the fence line. However, SMC has stated that future additions to the slag piles will not encroach closer to the fence line so that there should not be any increase in overall exposures at the fence line. Furthermore, it is SMC's goal to begin removing slag from the site through the production of CANAL (Section 2.1), which would eventually reduce exposures at the fence line.

Walk-over surveys with portable radiation detection instruments have been conducted as part of special radiological surveys and assessments of the site area (Berger and Luck 1988; Berger et al. 1992). These surveys revealed elevated activity around the eastern boundaries of the property, which are likely due to the presence of the slag piles. The highest reading was 131 µR/hr, with the average measurements of 24 µR/hr and the majority of the sampling being less than 24 µR/hr, slightly above the background range of 5.4 - 7.5 µR/hr (Berger et al. 1992). Elevated count rates noted in the general vicinity of the D111 baghouses are likely due to surface deposits of radionuclides.

Since March 1992, TLDs have been routinely stationed around the SMC facility. Of the total 40, 14 are at perimeter locations (Valenti, 1994). The TLDs, which are changed quarterly, measure fence line exposure rates of 10 to 140 microrem per hour (µrem/h) (mean = 40 µrem/h); maximum perimeter readings are obtained on the north fence line of the SMSY near the ferrocolumbium high ratio slag pile (SMC 1992). The maximum fence line measurement recorded in 1992 and the first three quarters of 1993 was 428 mrem, corresponding to a 210 µrem/h maximum dose rate. Fence line measurements taken during a December 1993 NRC inspection ranged from background (6 to 10 µR/h) to 440 µR/h (Kinneman 1994).

In 1991, ENSR measured ambient external radiation exposure rates at approximately 90 fence line locations (Berger et al. 1992). Most above-background readings were in

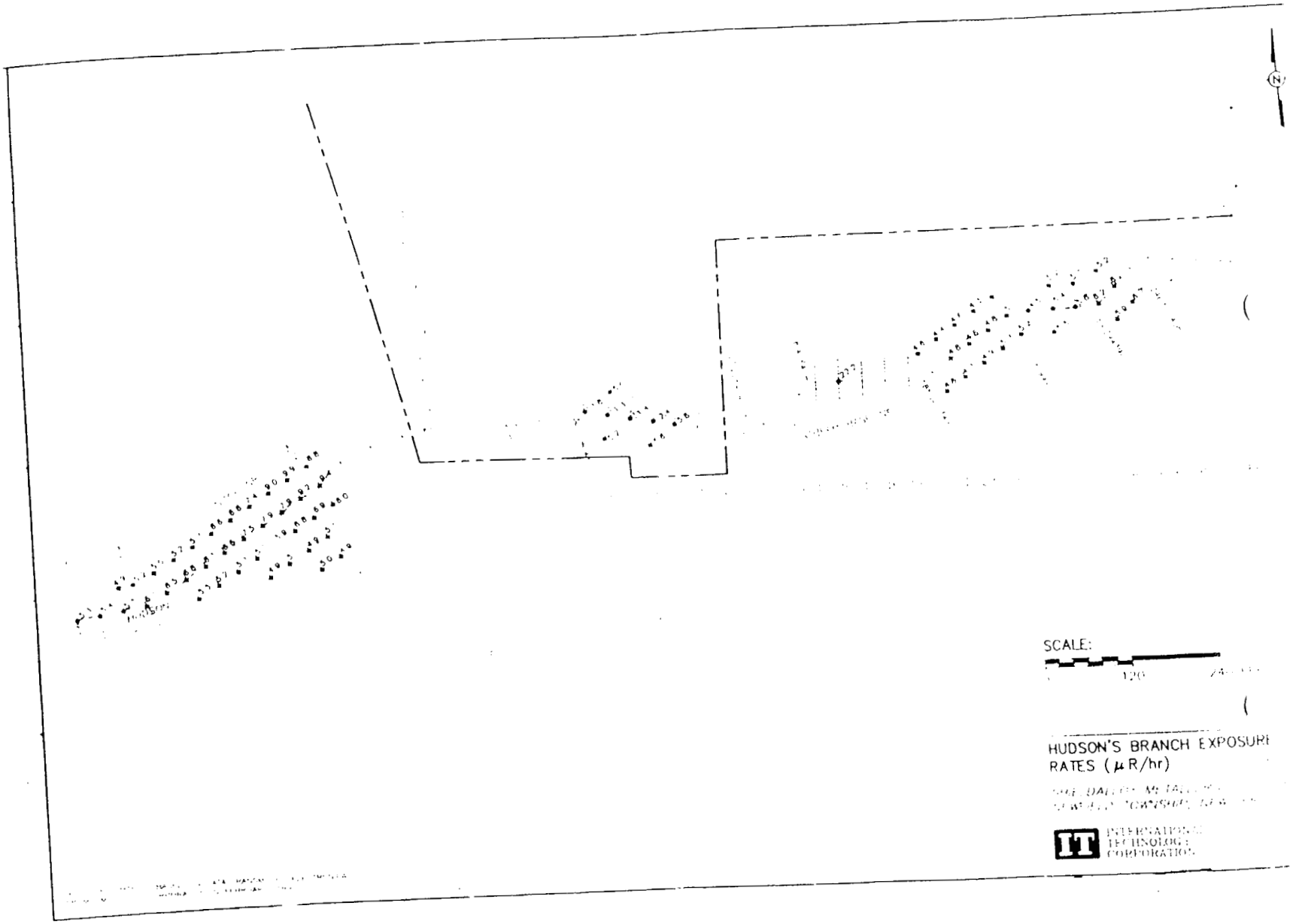

Figure 4.4 Hudson's Branch Exposure Rates

the eastern portion of the property near the SMSY. The highest readings were along the fence line directly north of the FeCb standard and high-ratio slag piles, where the single highest recorded value in this survey (131 μR/hr) was detected. Other elevated readings were taken along the northwestern and southwestern fence lines. Non-fence line elevated ambient gamma exposure rates were recorded along the South Haul Road, which leads directly south from the facility, and along the Hudson Branch near the southwestern corner of the property.

External radiation exposure measurements were also made with portable instruments during walkover surveys over a grid system that was mainly within the confines of the SMC site but also included parts of the property outside the fence line (Berger et al. 1992). These readings ranged from 5 to 58 μR/hr. The highest measured exposure rate, along the fence line north of the SMSY, reflected the external radiation contribution from the slag piles. In general, the highest readings were around the SMSY, in the area south of the D111 Building, and in the south-central portion of the site. Walkover measurements were not made in the SMSY near the slag piles.

4.2.2 Groundwater Sampling

Groundwater sampling has been conducted at SMC since December 1988, at the request of the NJDEP. Chromium concentrations in excess of the State of New Jersey limit of 50 ppb were found in the groundwater beneath the site. (TRC 1992) NJDEP then issued an Administrative Consent Order (1988) requiring SMC to monitor the groundwater. There are 19 wells on-site and samples are obtained from these wells quarterly (Figure 4.5). Routine analyses for the presence of radionuclides in the groundwater are performed as part of the overall monitoring program. SMC has reported that gross alpha and gross beta results do not differ significantly from background concentrations (SMC 1992). The NRC noted elevated gross beta counts in some monitoring wells (Kinneman 1994), which are associated with naturally occurring potassium-40 (Berger 1995).

4.2.3 Surface Water and Sediment Sampling

Surface water and sediments on and near the SMC site are not routinely sampled for radionuclides as part of the environmental monitoring program; however, surface water samples from both on- and off-site locations have been sampled as part of special radiological surveys and assessments (Berger and Luck 1988; ENSR 1991 cited in Berger et al. 1992).

As part of the radiological surveys conducted at the site during 1987 (Berger and Luck 1988), samples of sediment and water were collected from surface drainage pathways leading from (1) the SMC site; (2) the pond that is the origin of the Hudson Branch stream; and (3) along the Hudson Branch, both upstream and downstream of the plant outfall. Samples of sediment were also collected from two settling ponds used to treat liquid wastes.

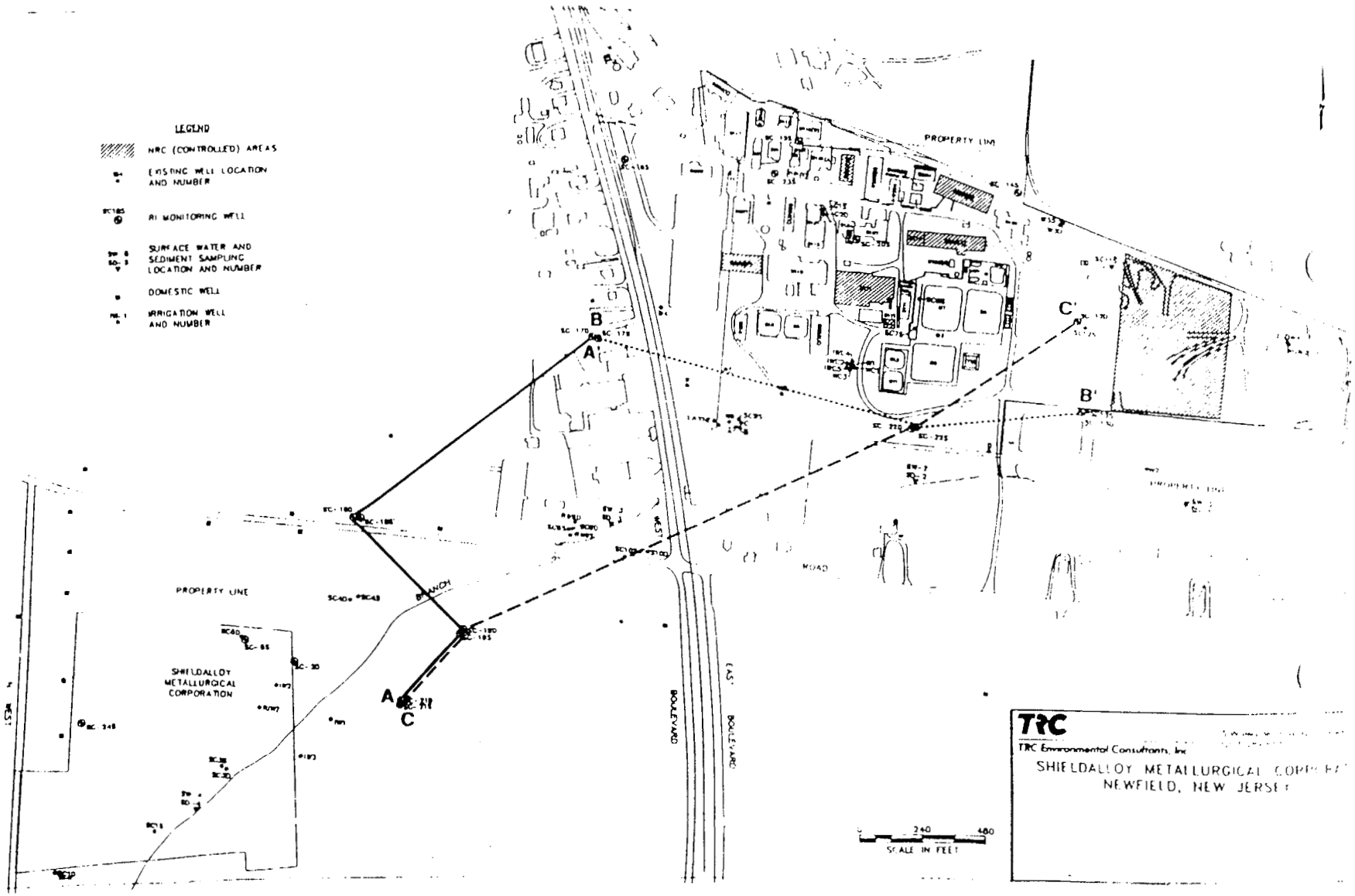

Figure 4.5 - Groundwater wells at the SMC site

In on-site surface water samples from the settling ponds and plant effluents, radionuclide levels were typical of background. Sediments from area drainage pathways indicated some locations of contamination of up to 33.6 pCi/g along the southern perimeter fence, but no accumulation in area streams, ponds, or lakes. Water samples from these bodies of water were typical of naturally occurring concentrations.

Similar samples were collected and analyzed during a 1991 radiological assessment (Berger et al. 1992). Consistent with results of the 1988 Oak Ridge Associated Universities (ORAU) study (Berger and Luck 1988), the suspended solid concentrations of radium, thorium, and uranium in the water samples ranged from 0.1 pCi/l to 66.1 pCi/l Ra-226 as listed in Table 4.4. The filtrate of all water samples collected had less than 15 pCi/l gross alpha and 50 pCi/l gross beta concentrations.

Table 4.4 Ranges of Suspended Solid Radionuclide Concentrations Detected in Water Samples from SMC

Radionuclide	95% Confidence Interval
Radium-228	3.6 to 66 pCi/l
Radium-226	0.5 to 33 pCi/l
Uranium-238	0.1 to 17 pCi/l
Thorium-232	0.1 to 48 pCi/l

Source: Berger et al. 1992

Approximately 20 water samples were collected and analyzed during the 1991 ENSR survey (Berger et al. 1992). Water samples were filtered into suspended and dissolved fractions, and each was analyzed for dissolved and suspended gross alpha and gross beta activity. Isotopic analysis was performed if the gross alpha activity exceeded the EPA screening level of 15 pCi/l or the gross beta activity exceeded the screening level of 50 pCi/l. The concentrations of radium, uranium, and thorium in the filtrate of all water samples (dissolved radionuclides) had gross alpha and gross beta concentrations less than 15 pCi/l and 50 pCi/l, respectively.

4.2.4 Soil Sampling

Soil sampling is not conducted routinely, but it was included in the special radiological surveys and assessments (Berger and Luck 1988; Berger et al. 1992). That sampling, like the walk-over surveys, indicates that levels of radionuclides may be slightly

elevated in the upper layers of the soil at the eastern end of the property, near the slag piles, and near the D111 baghouses.

Approximately 100 soil samples were collected and analyzed for radionuclide concentrations as part of the 1991 ENSR survey (Berger et al. 1992). The ranges of radionuclide concentrations detected are shown in Table 4.5. Based on the background soil concentration information presented above, soil and sediment concentrations of thorium-232, radium-226, and uranium-238 greater than 2 pCi/g are considered to be elevated. Most of the elevated counts were found in the southern and southwestern portion of the site, between the D111 Building and the fence line. A number of elevated readings were found along the bed of the Hudson Branch, south of the western half of the site. Surface drainage in the vicinity of the plant is toward the south into the Hudson Branch watershed (Berger et al. 1992). NRC's existing guidance for the unrestricted release of natural uranium and thorium in soil is 10 pCi/g above background (NRC 1981).

Thorium levels ranging from background to 5 pCi/g were detected outside the fence north of the SMSY. Several samples outside the fence south the SMSY ranged up to 16 pCi/g. On-site levels south of the D111 Building were background to 10 pCi/g, except for one isolated 35 pCi/g sample. Along the Hudson Branch, thorium-232 levels above background were in the range of 2 to 9 pCi/g. All of these areas also included samples with normal background levels.

Table 4.5 Ranges of Radionuclide Concentrations Detected in Soil

Radionuclide	95% Confidence Interval
Radium-228	0.5 to 83 pCi/g
Radium-226	0.24 to 77.1 pCi/g
Uranium-238	0.51 to 11.2 pCi/g
Thorium-232	0.63 to 41.2 pCi/g

Source: Berger et al. 1992

Elevated radium-226 samples were concentrated mainly along the Hudson Branch and were generally the highest of the three radionuclides. The majority of the samples showed concentrations between 10 to 40 pCi/g; the highest level detected, 77 pCi/g, was found in only one sample. Results for radium-228 are summarized (Berger et al.

1992) as being from background to 83 pCi/g, but neither background data nor detailed information is presented.

Few samples contained uranium-238 in excess of 2 pCi/g. Most were along the Hudson Branch and ranged from background to 6 pCi/g; one sample was 11 pCi/g. Three elevated samples (1 of 16 pCi/g) were taken on-site south of the D111 Building. Table 4.6 displays the radionuclide concentrations found in the sediments of the Hudson Branch.

Table 4.6 Site Area Sediment Sample Concentrations from Hudson Branch

Radionuclide	Range of concentrations
Radium-228	<0.6 to 30 pCi/g
Radium-226	<0.5 to 34 pCi/g
Uranium-238	0.3 to 8.9 pCi/g
Thorium-232	0.77 to 5.71 pCi/g

Source: Berger et al. 1992

4.2.5 Air Sampling

Environmental surveillance for airborne radioactive material is not routinely conducted at the SMC facility. The 1988 Berger survey and the March 1996 SMC emission monitoring study both demonstrate that air emissions from the site remain within regulatory limits.

4.3 Effluent Monitoring

4.3.1 Air Effluents

Large quantities of dust result from the ferrocolumbium production operations conducted in building D111. This building is equipped with two distinct baghouse filter systems: the American Air Filter (AAF) system and the Flex Kleen (FK) system. The dust emissions are collected by the baghouses during operations and are then transferred by truck to the SMSY for storage.

One of the baghouses, the AAF system, installed in 1966, draws 125,000 cubic feet of air and dust per minute (ft^3/min). The FK system, installed in 1987, draws

approximately 200,000 ft^3 /min. When both are operated simultaneously, the system draws 325,000 ft^3/ min. and is effective at removing 99 percent of the dust from the air. Reverse air jets in the AAF baghouse and pulsed air jets in the FK baghouse remove the dust from fabric filters or bags. The dust is then conveyed through a series of screw conveyers and conveyer ducts to a silo for temporary storage. Figure 4.6 is a schematic drawing of the D111 emission collection system.

Monitoring or sampling of emissions from the baghouses is not routinely conducted. Airborne-emissions measurements were made on both D111 baghouses during the 1987 radiological survey (Berger and Luck 1988). The results were within 10 CFR Part 20 limits applicable at the time. However, after a December 1993 inspection, the NRC noted that a number of factors had changed since the special study conducted by Berger and Luck. These factors included the installation of the enclosure around the furnace where licensed material is used, an increase in the uranium concentration in the pyrochlore, and the decrease in the release limits in Appendix B of 10 CFR Part 20, particularly for thorium isotopes. SMC performed additional measurements of radionuclide stack effluents in March of 1996, and reported their results to NRC by letter dated March 11, 1997 (IEM 1997a) and updated by letter dated May 8, 1997 (IEM 1997b), to account for possibly lower AAF baghouse efficiencies (90%) from undetected broken bags. Even with a 90% efficiency for a year of operation, the maximum off-site exposure to a member of the public from these baghouse emissions was calculated to be under 6 mrem/yr for full-time operations (IEM 1997b). NRC also performed a dose assessment for this scenario and using slightly more conservative assumptions (i.e., larger percentage of bags broken) estimated a possible dose to an individual member of the public to be less than 9 mrem/yr (Comfort 1997). Because the efficiencies of the baghouses are much higher than 90%, actual doses to the public are expected to be much lower than 9 mrem/yr.

Release of dust from the slag piles is expected to be minimal because of the solid, non-dispersible nature of the slag. In the past few years, SMC has initiated a number of precautions to minimize dispersal of the baghouse dust dumped on the lime pile, including loading and transport in covered trucks and immediately wetting-down newly-dumped dust to form a surface crust to reduce its dispersal. Some dispersal of lime-pile dust may occur during unloading and as a result of cracking in the surface crust. Since the measures to reduce fugitive dust emissions are relatively new, past practices may have contributed to contamination detected off-site through an airborne pathway. However, off-site contamination from the airborne pathway cannot be distinguished from contamination that may have migrated off-site from other pathways, such as overland transport by surface water.

In November 1994, SMC initiated monitoring around the SMSY and near the slag and lime piles to measure radon emanation and ambient radon levels in the vicinity of the SMSY. The results of these measurements showed the SMC facility to be within regulatory limits (Eves 1996).

4.3.2 Liquid Effluents

SMC has no expected liquid discharges associated with the licensed activities. However, there are some effluents produced by rain water runoff from the site. The rain carries with it some of the on-site contaminated soils or dust and flows into Hudson Branch. The concentrations in the sediment and soils from the Hudson Branch were described in Section 4.2 and the dose assessment performed for a member of the public in contact with this material is described in Section 5.1.

In 1994, a berm was constructed around the on-site slag and dust piles to contain surface runoff within the SMSY. Although the amount of radioactive material in solution in the runoff has historically been very low because the uranium and thorium do not readily leach from the slag or dust, the berm prevents runoff from leaving the SMSY. The rainwater itself leaves the berm through evaporation and is not collected for sampling. Any radioactive material in the runoff stays within the top soil layer and will be treated as contaminated soil during final disposition of the site.

In addition, there are some non-radioactive effluents from the site. These include three discharge outfalls which enter the Hudson Branch from the SMC facility. Outfalls 002 and 003 are storm water discharge points. Outfall 001 discharges SMC facility water into Hudson's Branch. Facility discharges consist of city water, treated groundwater, and supernatant from the wastewater treatment facility (chromium reduction/precipitation), including discharge from a groundwater treatment facility and a storm water treatment facility (Section 3.3.1).

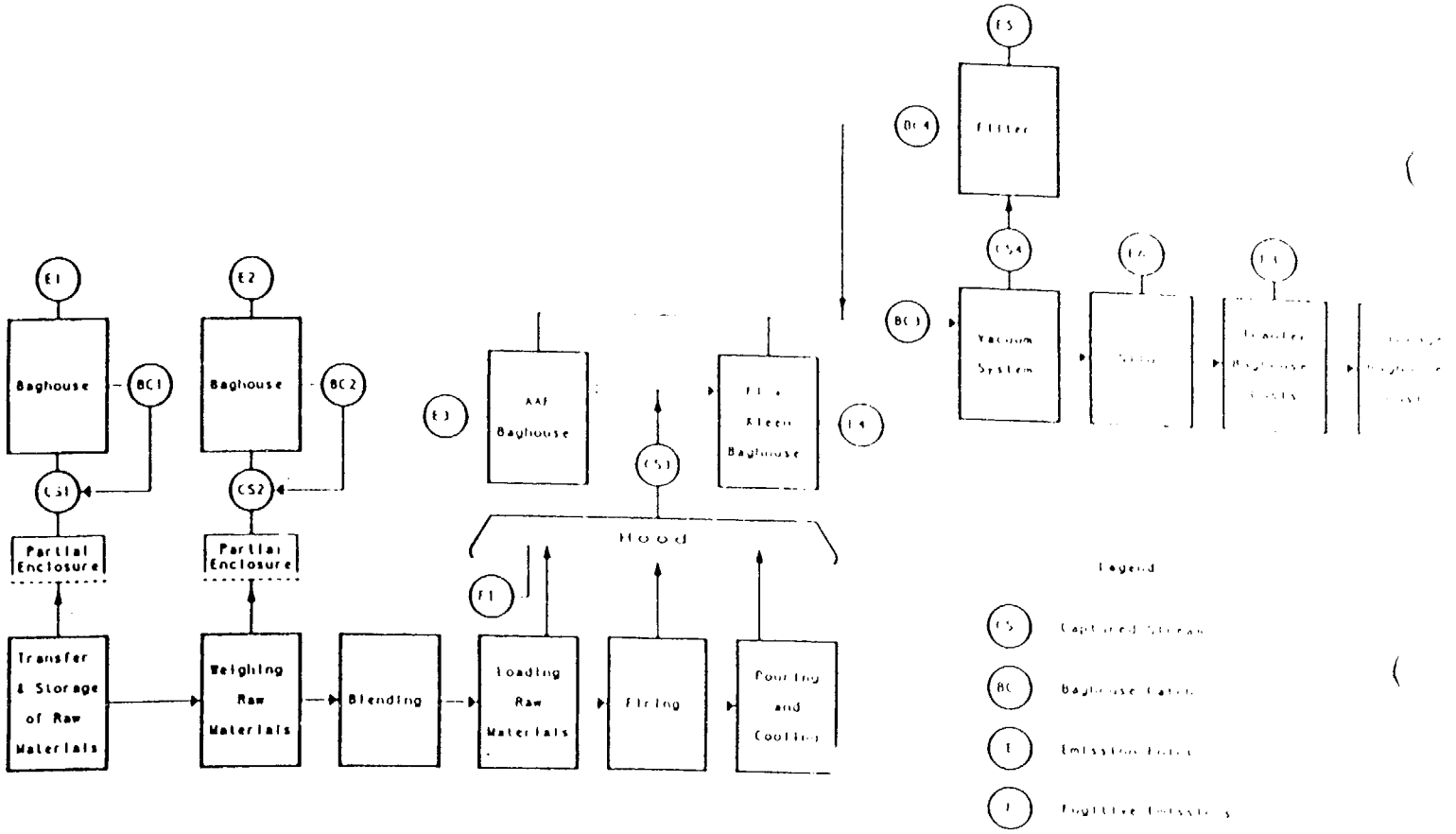

Figure 4.6 D11 Emission Collection System

4.3.3 Solid Effluents

Ferrocolumbium standard slag, ferrocolumbium high-ratio slag, and columbium nickel slag generated from the smelter operations are solid, noncombustible materials with the consistency of vitrified rock. All slag types are maintained separately from the others at their respective points of generation and are transported in trucks from D111 to the SMSY. Slag and baghouse dust contain the majority of the uranium and thorium present at the site. Table 4.7 is a summary of all radioactive waste streams generated at SMC. As described earlier, slag and baghouse dust streams are being considered as product streams by SMC, although the market for the slag has not yet been demonstrated.

In the past, ferrocolumbium slag may have been used on-site as fill material for certain construction projects. Possible placement locations include under the southwest fence line and in the vicinity of the T12 Tank Area. The exposure rates in these areas range from background to a few microroentgen per hour (μR/hr) above background rates (Berger et al. 1992). In addition, concerns have been raised by the local community about potential off-site use of the slag.

Large quantities of ore and waste containing NRC-regulated material are held in the SMSY at the east end of the SMC facility. Each kilogram of ore processed is estimated to produce 34 percent ferrocolumbium alloy, 58 percent slag, and 8 percent baghouse dust (Berger 1993b). During the smelting process, more than 99 percent of the radioactive material in the ore remains in the slag and baghouse dust (SMC 1993). Therefore, SMC monitors the quantity of these isotopes on-site based on the assays of the pyrochlore ore coming on to the site. The current SMC possession limit of source material is 45,000 kg of uranium and 303,050 kg of thorium, and SMC, as of July 1997, is currently in possession of 96.8% of the thorium limit and 87.5% of the uranium limit. The most current estimate of slag and dust volumes stored on-site are from measurements taken in 1991. At that time, there was approximately 17,800 m^3 of slag and approximately 15,000 m^3 of dust.

The uranium, thorium, and radium concentrations in the pyrochlore are provided by the ore supplier. SMC takes composite samples of each shipment and does confirmatory analyses of the source material concentrations on a quarterly basis. Radionuclide concentrations are assumed to be similar in all the slags because the pyrochlore used in every process is from the same source (Niobec mine in Quebec) (Rieman 1992). Most slag and baghouse dusts have been stored onsite, so that their inventories have increased over time. The inventory of regulated materials in the slag was estimated to increase at a rate of approximately 1,000 kg per month for thorium-232 and 100 kg per month for uranium-238 when the facility was in normal operations (SMC 1993). Operations at the facility have been substantially reduced, and SMC accumulated only 347 kg of thorium and uranium from December 1995 until July 1997.

Table 4.7 Summary of Radioactive Waste Streams Generated at SMC

Definition	Description
Baghouse dusts	Dry solids, which contain licensable quantities of radioactive materials
Baghouse bags	Combustible dry solids, which are contaminated with licensable quantities of radioactive materials
Pyrochlore supersacks	Combustible dry solids used to contain pyrochlore, which may be contaminated with licensable quantities of radioactive materials.
Ferrocolumbium slag	Dry solids known to contain licensable quantities of radioactive materials
Spent refractory	Dry solids, which may contain licensable radioactive materials
Radioactive dry combustible waste	Combustible dry solids including plastic bags, absorbent paper, and protective equipment used to prevent the spread of contamination.

During this time period SMC received two shipments of ore, one in December of 1995 and a second in December of 1996. In these shipments, SMC received 368 kg of thorium and 81 kg of uranium. It is expected that this reduced rate of accumulation will continue for the next several years. In addition, SMC has submitted proposals to ship a majority of the dust and a portion of the slag off-site which could substantially reduce the current on-site inventory. These proposals are being evaluated in a separate action.

The uranium and thorium in the ore are in the form of oxides, reported as U_3O_8 and ThO_2. The pyrochlore shipments of November and December 1993 contained approximately 0.2 wt% U_3O_8 and approximately 0.8 wt% ThO_2 (Valenti 1994). Recently, uranium concentrations in the pyrochlore have been found to be twice the typical concentration in the past two years. Analysis of the slag piles (date uncertain) showed that 0.20 to 0.56 wt% of the slag is uranium-238 and 0.05 to 0.10 wt% is thorium-232. On average, the baghouse dust contained approximately 0.016 wt% uranium and 0.082 wt% thorium (Valenti 1994).

In addition to the regulated material in the SMSY, there is an unknown quantity of source material potentially used as fill in various, unknown locations around the property (SMC 1993). Use of this material as fill is a past practice that has ceased. The location and characteristics of this fill will need to be determined as part of the decommissioning.

5. ENVIRONMENTAL IMPACTS OF ACTIONS

5.1 Environmental Impacts of the Proposed Action

5.1.1 Human Health

The following subsections address impacts on workers and public health from routine operations and postulated accidents during operation of the SMC facility. In general, worker exposure to radiation in the workplace is controlled by means of contamination and exposure-rate measurements, time and access limitations, and application of the principle of keeping exposures as low as reasonably achievable (ALARA). Exposure to the public is controlled by means of access restrictions, limited off-site releases, and inhospitable surrounds which discourages long residence times near the site.

Radiation doses received by workers are associated mainly with the processing of ferrocolumbium in D111. This is a result of the inhalation of the dust produced during smelting. External doses to workers performing other activities involving licensed material, such as moving supersacks of pyrochlore, are much smaller. Workers have typically received no more than 0.1 rem external effective dose equivalent (EDE) per year. Potential internal committed effective dose equivalent (CEDE) from inhalation of airborne contamination has been evaluated to be a small fraction (approximately 0.3 rem) of the occupational dose limit of the 10 CFR 20.1201(a)(1)(I) annual 5 rem TEDE occupational dose limit. This is assuming an annual internal exposure of approximately 100 derived air concentration (DAC)-hours per employee per year (Berger 1993a).

Sources of radiation dose to the maximally exposed member of the public would be air-borne releases from the baghouses associated with ferrocolumbium processing and direct exposure from the SMSY, where slag and baghouse dust byproducts of processing are stored.

Routine releases of dust from the D111 baghouses are expected to be the primary contributor to a radiation dose that could be received by members of the public. Radon releases from the baghouses are a negligible contributor to this dose. Because both stack emission points are relatively close to the ground, the dose to the maximally exposed individual (MEI) was modeled as occurring at ground-level for both baghouse stacks but the MEI was at the fence line 250 meters way. The AAF baghouse bags undergo periodic visual inspection to determine if they have lost their integrity; the FK baghouse has optical sensors that immediately notify operators if a bag has been breached. Therefore, a lower overall efficiency was assumed for the AAF baghouse: an overall transmission factor of 0.03 (97 percent efficient at removing dust) versus a factor of 0.01 (99 percent efficient) for the FK baghouse.

The annual dose to the MEI from particulate releases from the D111 baghouses was calculated by NRC to be approximately 9 mrem TEDE (Comfort 1997 and Appendix A). This is below the 0.1 rem radiation dose limit applied to members of the general public as stated in 10 CFR 20.1301(a)(1). This exposure is conservatively calculated using an average of 50 heats per month--well above SMC's historical and current process rates. The majority of the dose results from the AAF baghouse because of an assumption of loss of efficiency due to periodic filter bag breakage. SMC's 1996 baghouse stack measurements show actual normal operations result in exposures to the MEI of less than 1 mrem per year (IEM 1997a) for a similar number of heats, if no bag breakage is taken into account. Furthermore, because of changes in market conditions, SMC is currently operating approximately one production run per year. This dramatically reduces the quantity of dust produced and thereby reduces the expected dose to the workers and members of the public.

The estimated annual dose to the population residing within 80 km (50 miles) of the SMC facility is less than 7 person-rem TEDE, using the same assumptions used for the MEI evaluation. For perspective, the national average dose from background radiation is about 300 mrem per year (NCRP 1987), which for the population of interest would result in about 2 million person-rem per year.

SMSY yard materials (principally the dust piles) may contribute to the concentrations of radionuclides detected in the off-site soil and may periodically contribute to airborne releases during dumping or movement of material. However, because the slag is non-dispersible and the crust covering the dust pile limits much of the possible dispersion, these are much less significant sources of routine releases than the D111 baghouses and are considered to be minor contributors to radiation dose compared to routine baghouse emissions.

In 1992, a study (Berger 1992) examined the risk to the public from contamination that had migrated from the SMC site and into the Hudson Branch watershed. This study used conservative assumptions (maximizing the potential radiation dose that might be received) to estimate a potential dose to a farmer living on the watershed area. It is assumed that the farmer lives and grows crops and livestock on the contaminated soils. The resulting estimated annual individual dose was approximately 14 mrem/yr TEDE; this dose is below NRC's decommissioning unrestricted release limit of 25 mrem/yr. This scenario is conservative, and the actual doses produced from the site would be much lower. Therefore, it is not expected that there would be any adverse health affects from the material.

5.1.2 Air Quality

Dust loading in the air around the SMC facility was calculated to result in average particulate concentrations no greater than 0.01 micrograms per cubic meter of air

(mg/m^3) at the baghouse release locations. Average annual dust loading at the location of the MEI would be about 7×10^{-5} mg/m^3, well below applicable EPA standards for annual average dust loading of 50 mg $/m^3$. No health effects would be expected from exposure to these dust concentrations.

5.1.3 Accident Conditions

Impacts on worker and public health and safety from accident conditions during operations are presented in the following subsections. Such impacts would be expected principally from exposure to radionuclides in dust generated during postulated accident scenarios.

A generic bounding accident was assumed in which radiation workers were exposed to a high level of baghouse dust-loading (100 mg/m^3) for 15 minutes without respiratory protection. Dust particles were assumed to be all of respirable size, 10 micrometers (µm) or less. Radionuclides in the air were assumed to come from dust containing 50 pCi/g each of uranium-238 and thorium-232 and 25 pCi/g of radium-226. Dose to a radiation worker in this case would be approximately 3×10^{-3} rem (3 mrem).

The bounding accidents assumed for estimating radiological impacts to the public involve release of dust from a baghouse or silo. Three different initiating mechanisms were considered: (1) structural failure of a baghouse (estimated to be extremely unlikely: accident frequency [f] = 10^{-4} to 10^{-6} per year); (2) baghouse struck and punctured by a truck or heavy equipment (unlikely: f = 10^{-2} to 10^{-4} per year); (3) unloading hopper activated and dumped with no dump truck in place (anticipated: f > 10^{-2} per year). These scenarios assumed either 10,000 kg (baghouse releases) or 5,000 kg (hopper activation) falling to the ground. Calculated release fractions were 4 to 5×10^{-3}. A 10,000-kg accidental release would result in a dose of less than 6 mrem to the maximally exposed individual. The expected population dose resulting from this accident would be no greater than 0.9 person-rem.

5.1.4 Environmental Impacts

Groundwater

SMC has been storing slag and dust piles on the ground surface since ferrocolumbium operations began in 1955. Renewal of the license would allow continued accumulation of uranium and thorium in those piles. It is assumed that the practice of storing slag and dust piles on the ground surface will continue until closure of the facility. A potential consequence of such storage is the leaching of uranium and thorium from these piles through the vadose zone to the water table. If either of these radionuclides reach the water table, they could move off-site through normal groundwater flow.

An idealized conceptual model of the site and its hydrogeologic and chemical characteristics was developed to determine whether the contaminants are likely to pose a hazard. A simple mathematical model was then run to estimate the time required for uranium or thorium to reach the water table at a concentration of 15 pCi/l or greater. The details of the available site-specific information relevant to this objective, conceptual and mathematical models, site-specific and generic parameters chosen as inputs to the mathematical model, and a discussion of the results are available in a separate document. Therefore, only a brief summary of the assumptions and results is provided here.

Little site-specific data were available on the amount of recharge, specific chemical and physical characteristics of the dust pile, chemical composition of the influent rainwater and leachate water draining into the vadose zone from below the dust, and the hydraulic parameters of the Bridgeton Formation soil. Consequently, assumptions were made from use of best technical judgement to select generic values for parameters from standard sources. One example is the saturated hydraulic conductivity of the Bridgeton Formation soil, which was assumed equal to the generic value recommended by Carsel and Parrish (1988) for soil in the sand textural class. Conservative assumptions were made if no site-specific information related to the parameter in question was available. Therefore, if additional data from the actual site and materials were available, contaminant travel times and ultimate concentrations in the groundwater would probably be longer and lower, respectively, than calculated here.

The major assumptions used are as follows:

- The lime dust pile is a continuous, constant source of uranium and thorium.
- All precipitation (102 cm [40 inches] per year) is available to move uranium and thorium through the vadose zone.
- Water flow and solute transport are one-dimensional (downward).
- The vadose zone is spatially homogeneous.
- Chemistry is represented only by linear equilibrium sorption coefficients (K_d values).

According to available literature, the leachability and mobility of thorium appears to be very small, regardless of the form in which it occurs. However, the leachability and mobility of uranium vary widely according to its mineral form and chemical environment. Aqueous carbonate forms of uranium dominate in alkaline environments and are

relatively more mobile. Less mobile aqueous metal, hydroxide, and oxide forms dominate in slightly acid to neutral environments. There is no specific information on the form of the uranium in the dust piles (although it is expected to exist in a high temperature oxide form) or the chemical composition of the water percolating through the dust and vadose zone soil.

The modeling indicated that thorium would not reach a concentration of 15 pCi/l in the water table in the near future (i.e., within several hundred years). In addition to being relatively immobile, it is poorly leachable under most environmental conditions; thus thorium concentrations should be much less than the regulatory limit, even in the leachate solution entering the vadose zone at the soil surface.

However, uranium is more mobile under specific environmental conditions. The travel times for the uranium to reach the groundwater at concentrations greater than 15 pCi/l ranged from 101 years to less than 1 year. This information is useful when considering the residence time of the slag and the dust on-site. This material has been available for leaching and transport for over 40 years, since 1955. Soils and groundwater measurements have shown that little to no uranium has entered the groundwater beneath the site. This indicates that the uranium, under these environmental conditions, is not very mobile. If the proposed action is approved and the license is renewed it will be renewed for only 5 years. It is unlikely that the uranium concentrations in the groundwater will change dramatically during this period. However, groundwater monitoring will be performed during this time, and the groundwater concentrations will be re-examined during the next license renewal evaluation.

Socioeconomics

Implementation of the proposed project would not result in a change in the existing socioeconomic conditions surrounding the site. Because the proposed project is neither increasing nor decreasing its labor force, closing down, or expanding, no significant economic changes are expected in the nearby city of Newfield, New Jersey, or in the surrounding region.

Changes to the existing cultural base are not expected as a result of the proposed project. Significant numbers of new personnel are not required to migrate into the area, nor are any significant numbers of people expected to leave. The proposed project does not require the displacement of any citizens, nor is any particular minority or economic group expected to be impacted by its implementation.

Cumulative Impacts

This section considers the proposed action in relation to past actions, current actions,

6. REGULATORY CONSULTATION

During the preparation of this EA, NRC consulted with various regulatory agencies to discuss their concerns regarding renewal of the SMC facility and to gather information.

Ms. Donna Gaffigan, State of New Jersey's Department of Environmental Protection, was contacted throughout the period of renewal by telephone and through attendance at NRC meetings at the SMC site. State activities regarding groundwater cleanup and SMC compliance with state regulations were discussed. No major concerns regarding the license renewal were noted.

Mr. Joe Gauers, U.S. Environmental Protection Agency, was contacted throughout the period of renewal and attended various NRC meetings at the SMC site. No objections to the license renewal were noted.

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APPENDIX A

RADIATION DOSE CALCULATIONS

APPENDIX A

RADIATION DOSE CALCULATIONS

This appendix provides additional information to support the estimates of radiation dose impacts presented in the text of the environmental assessment (EA).

The CAP88-PC (Clean Air Assessment Package 1988) computer code version 1.0 was used to perform calculations to estimate the consequences of routine particulate radionuclide releases to the atmosphere from the SMC facility.

A.1 Baghouse Releases

Radionuclide source terms for the D111 baghouse releases were based on estimated routine production of about 40,000 kg of dust per month (Kinneman 1994), or about 480,000 kg dust per year. Estimated radionuclide concentrations in the dust are shown in Table A.1 (Kinneman 1994); average values were used as the base case in all calculations.

Table A.1 Radionuclides Detected in Baghouse Dusts

Radionuclide	Concentration Range in Baghouse Dust	Average Concentration in Baghouse Dust	Specific Activity
uranium-238	16-140 pCi/g	50 pCi/g (5×10^{-11} Ci/g)	3×10^{-7} Ci/g
thorium-232	16-140 pCi/g	50 pCi/g (5×10^{-11} Ci/g)	1×10^{-7} Ci/g
radium-226	8-43 pCi/g	25 pCi/g (2.5×10^{-11} Ci/g)	1×10^{0} Ci/g

Baghouse releases were determined to be the limiting case for routine release of particulates from the SMC site. With a baghouse nominal efficiency of 99 percent, 4,800 kg of dust would be released per year. This is far more than would be anticipated to be released from the diffuse sources of the slag-piles and baghouse lime-pile. In the absence of more quantitative data, a 99 percent efficiency was assumed for the Flex Kleen (FK) baghouse, which has optical sensors that allow operators to know when bags have been breached so they can be replaced in a timely fashion, before the next ferrocolumbium batch processing. The older AAF baghouse does not have optical sensors; breached bags must be observed manually. To account for this lowered efficiency in bag breach detection and replacement, an efficiency of 97 percent was assumed for the AAF baghouse, in the absence of more quantitative release data (Comfort 1997). Based on these efficiencies, this analysis assumed 2954 kg of dust is released from the FK baghouse and 5538 kg of dust is released from the AAF baghouse per year.

There is also a difference in the way material is released from the two baghouses. The FK baghouse releases material at a height of 9.1 meters and has a throughput of 200,000 cubic feet per minute (ft^3/min). In contrast, the AAF baghouse has downward-pointing release vents at a height of 18.3 meters and a throughput of 125,000 ft^3/min. Because of their relatively low heights, both baghouses were modeled as a ground-level releases. Use of this type of release is considered to be conservative because the ground-level release results in much less dispersion, and therefore higher concentrations, than an elevated release. The nearest site boundary to the baghouse stacks lies about 250 meters to the south. The nearest resident is

Table A.3 Estimated Annual Radionuclide Releases for Each Baghouse[a]

Radionuclide	Inhalation Class	FlexKleen at 99% eff	AAF at 97% eff
uranium-238	Y	1.5×10^{-4} Ci	2.8×10^{-4} Ci
thorium-234	Y	1.5×10^{-4} Ci	2.8×10^{-4} Ci
uranium-234	Y	1.5×10^{-4} Ci	2.8×10^{-4} Ci
thorium-230	Y	1.5×10^{-4} Ci	2.8×10^{-4} Ci
thorium-232	Y	1.5×10^{-4} Ci	2.8×10^{-4} Ci
thorium-228	Y	1.5×10^{-4} Ci	2.8×10^{-4} Ci
radium-226	W	0.75×10^{-4} Ci	1.4×10^{-4} Ci

[a] These release estimates include consideration of dust collection efficiency and fraction of air flow (Comfort 1997).

an additional 25 meters further south. However, for these calculations, it was assumed that the maximally exposed individual is at the site boundary, 250 meters away in any direction.

Progeny of uranium-238 and thorium-232 were assumed to be in 100 percent equilibrium with the parent radionuclides in the baghouse dust. This is a conservative assumption considering that the measured concentration of Ra-226 in the dust is approximately half of the concentration of uranium and thorium. Potentially important uranium-238 progeny included in the calculations included uranium-234 and thorium-230. Thorium-232 progeny included only thorium-228. Other uranium, thorium, and radium progeny were evaluated and were determined to be less important contributors to dose (< 10 percent collectively, including Ra-226 and radon). In-growth of progeny was included in all atmospheric release calculations. All potentially important radionuclides were assumed to be inhalation class Y (except radium-226, which was class W) after going through the high-temperature separation process in the electric arc furnace. Table A.2 summarizes annual releases of radionuclides assumed to occur from the SMC D-111 baghouses, taking into consideration baghouse dust collection efficiency and air flow.

A.2 Joint Frequency Distributions

Evaluations of off-site radiation dose impacts used atmospheric dispersion factors based upon meteorological joint frequency distribution (JFD) data from Wilmington, Delaware, as included in the CAP88-PC computer code.

A.3 Population Dose Calculations

Only a general description of the population distribution in the 80-km (50 mi) region around the SMC site was available (see Table 3.1 in the EA). This information was used to develop a rather generic sector-population grid to estimate population doses. The known population was distributed evenly within the distance bands for the various sectors except in areas where there was known to be a large concentration of population (e.g., Philadelphia) or in areas that encompassed mainly or entirely ocean. Table A.3 shows the population distribution table used for the population calculations.

A.4 Calculation Results

The AAF baghouse accounted for the majority of the dose from SMC airborne emissions, principally because of the lower dust collection efficiency assumed for this baghouse. Dose calculations for both acute, accidental releases and routine, chronic releases of radionuclides from the SMC site included the exposure pathways of inhalation, external ground exposure, external exposure from plume immersion, terrestrial foods ingestion, animal product ingestion, and inadvertent soil ingestion. Inhalation intakes accounted for greater than 85 percent of the total radiation dose. Thorium-232 was the dominant dose contributor, accounting for about 30 percent of the total dose. Its progeny, thorium-228, was second in contribution, accounting for about 20 percent of the total dose. Table A.4 shows the contribution of the various radionuclides to the calculated doses.

The highest dose at a distance of 250 meters was calculated to be approximately 8.7 mrem per year in the east south-east direction. Because the distance and direction to the nearest boundary point is in the southern direction, this value is expected to bound the actual dose to the maximally exposed individual. The population dose was calculated to be under 7 person-rem per year (Comfort 1997). There were many conservative assumptions used in these calculations (i.e., 100% equilibrium of all daughters 97% efficiency for AAF baghouse, and ground level release models). Therefore, actual doses are expected to be lower than those calculated in this analysis.

Table A.3 Assumed Population Distribution Around the SMC Facility

distances in kilometers with approximate miles in ()

0.8 (0.6)	2.4 (1.5)	4 (2.5)	5.6 (3.5)	7.2 (4.5)	12 (7.5)	24 (15)	40 (25)	56 (35)	72 (45)	Direction
174	845	845	845	845	8220	51600	5000	5000	2000	S
174	845	845	845	845	8220	51600	5000	0	7000	SSW
174	845	845	845	845	8220	51600	5000	148400	148400	SW
174	845	845	845	845	8220	51600	5000	148400	148400	WSW
174	845	845	845	845	8220	51600	148400	148400	148400	W
174	845	845	845	845	8220	51600	148400	148400	148400	WNW
174	845	845	845	845	8220	51600	148400	148400	148400	NW
174	845	845	845	845	8220	51600	300000	300000	148400	NNW
174	845	845	845	845	8220	51600	300000	300000	148400	N
174	845	845	845	845	8220	51600	148400	148400	148400	NNE
174	845	845	845	845	8220	51600	148400	148400	148400	NE
174	845	845	845	845	8220	51600	148400	148400	148400	ENE
174	845	845	845	845	8220	51600	148400	148400	5000	E
174	845	845	845	845	8220	51600	148400	148400	0	ESE
174	845	845	845	845	8220	51600	148400	2000	0	SE
174	845	845	845	845	8220	51600	148400	60000	2000	SSE

Source: USDC 1994

Table A.4 Radionuclide Contribution to Dose

Radionuclide	Contribution to Dose
uranium-238	10%
uranium-234	11%
thorium-230	20%
thorium-232	30%
thorium-228	20%
remaining	10%

A.5 References

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