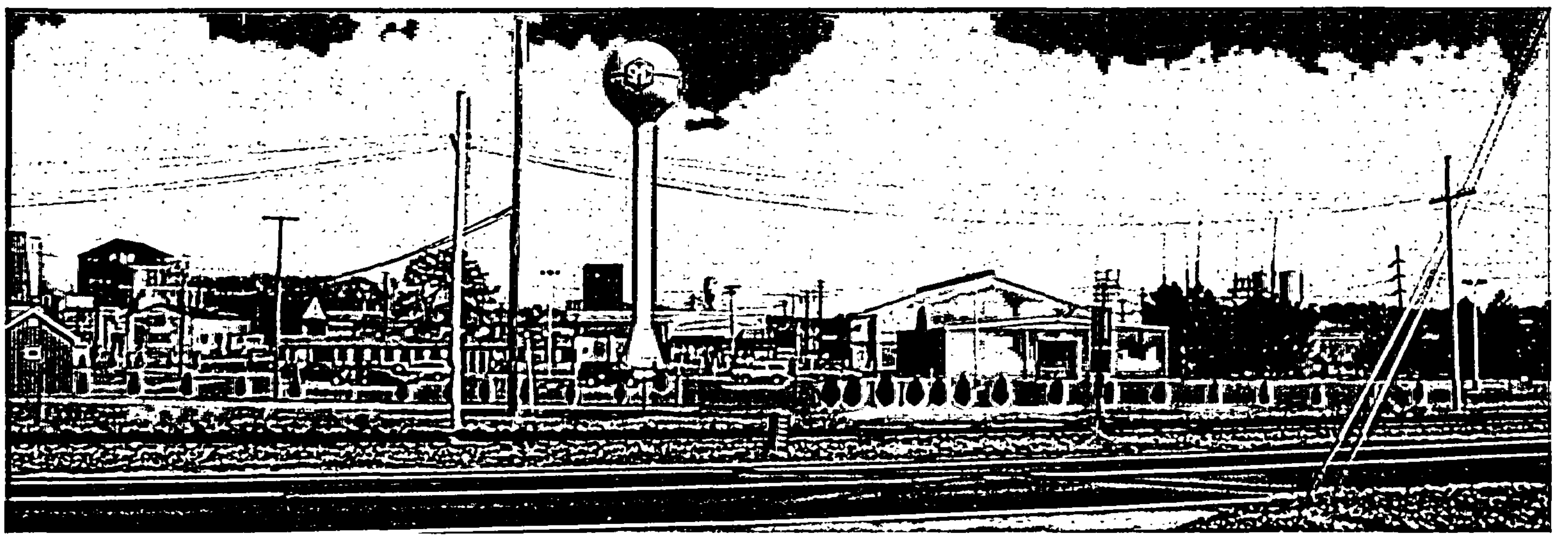

DECOMMISSIONING PLAN

SHIELDALLOY METALLURGICAL CORPORATION
NEWFIELD, NEW JERSEY

Volume I

Text, Tables and Figures

Volume II

Appendices 19.1 through 19.8

Volume III

Appendix 19.9 Environmental Report

Prepared by

Integrated Environmental Management, Inc.

and

TRC Environmental Corporation

Revision 1: October 2005

Decommissioning Plan for the Newfield Facility

Submitted by:

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DEFINITIONS

AAF - Baghouse dust collector formerly located adjacent to Building D111

ACO - Administrative Consent Order

Action level - The numerical value that will cause the decision maker to choose one of the alternative actions. It may be a regulatory threshold standard (e.g., Maximum Contaminant Level for drinking water), a dose - or risk-based concentration level (e.g., DCGL), or a reference-based standard. See investigation level.

Activity - See radioactivity.

AEA - Atomic Energy Act

ALARA (acronym for As Low As Reasonably Achievable) - A basic concept of radiation protection which specifies that exposure to ionizing radiation and releases of radioactive materials should be managed to reduce collective doses as far below regulatory limits as is reasonably achievable considering economic, technological, and societal factors, among others. Reducing exposure at a site to ALARA strikes a balance between what is possible through additional planning and management, remediation, and the use of additional resources to achieve a lower collective dose level. A determination of ALARA is a site-specific analysis that is open to interpretation, because it depends on approaches or circumstances that may differ between regulatory agencies. An ALARA recommendation should not be interpreted as a set limit or level.

ALI - Annual Level of Intake

Alpha particle - A positively charged particle emitted by some radioactive materials undergoing radioactive decay.

ANSI - American National Standards Institute

Area - A general term referring to any portion of a site, up to and including the entire site.

Area factor (Am) - A factor used to adjust $DCGL_W$ to estimate $DCGL_{EMC}$ and the minimum detectable concentration for scanning surveys in Class 1 survey units—$DCGL_{EMC} = DCGL_W \cdot Am$. Am is the magnitude by which the residual radioactivity in a small area of elevated activity can exceed the $DCGL_W$ while maintaining compliance with the release criterion.

Area of elevated activity - An area over which residual radioactivity exceeds a specified value $DCGL_{EMC}$.

Arithmetic mean - The average value obtained when the sum of individual values is divided by the number of values.

Arithmetic standard deviation - A statistic used to quantify the variability of a set of data. It is calculated in the following manner: 1) subtracting the arithmetic mean from each data value individually, 2) squaring the differences, 3) summing the squares of the differences, 4) dividing the sum of the squared differences by the total number of data values less one, and 5) taking the square root of the quotient. The calculation process produces the Root Mean Square Deviation (RMSD).

Assessment - The evaluation process used to measure the performance or effectiveness of a system and its elements. As used in MARSSIM, assessment is an all-inclusive term used to denote any of the following: audit, performance evaluation, management systems review, peer review, inspection, or surveillance.

Background radiation - Radiation from cosmic sources, naturally occurring radioactive material, including radon (except as a decay product of source or special nuclear material), and global fallout as it exists in the environment from the testing of nuclear explosive devices or from nuclear accidents like Chernobyl which contribute to background radiation and are not under the control of the cognizant organization. Background radiation does not include radiation from source, byproduct, or special nuclear materials regulated by the cognizant Federal or State agency. Different definitions may exist for this term. The definition provided in regulations or regulatory program being used for a site release should always be used if it differs from the definition provided here.

Becquerel (Bq) - The International System (SI) unit of activity equal to one nuclear transformation (disintegration) per second. 1 Bq = 2.7×10^{-11} Curies (Ci) = 27.03 picocuries (pCi).

Beta particle - An electron emitted from the nucleus during radioactive decay.

Byproduct material - Any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material.

Calibration - Comparison of a measurement standard, instrument, or item with a standard or instrument of higher accuracy to detect and quantify inaccuracies and to report or eliminate those inaccuracies by adjustments.

CDE (committed dose equivalent) - The dose equivalent calculated to be received by a tissue or organ over a 50-year period after the intake into the body. It dose not include contributions from radiation sources external to the body. CDE is expressed in units of Sv or rem.

CEDE (committed effective dose equivalent) - The sum of the committed dose equivalent to various tissues in the body, each multiplied by the appropriate weighting factor (W_t). CEDE is expressed in units of Sv or rem. See TEDE.

Chain of custody - An unbroken trail of accountability that ensures the physical security of samples, data, and records.

Characterization survey - A type of survey that includes facility or site sampling, monitoring, and analysis activities to determine the extent and nature of contamination. Characterization surveys provide the basis for acquiring necessary technical information to develop, analyze, and select appropriate cleanup techniques.

CHP - Certified Health Physicist

CIH - Certified Industrial Hygienist

Class 1 area - An area that is projected to require a Class 1 final status survey.

Class 1 survey - A type of final status survey that applies to areas with the highest potential for contamination, and meet the following criteria: (1) impacted; (2) potential for delivering a dose above the release criterion; (3) potential for small areas of elevated activity; and (4) insufficient evidence to support reclassification as Class 2 or Class 3.

Class 2 area - An area that is projected to require a Class 2 final status survey.

Class 2 survey - A type of final status survey that applies to areas that meet the following criteria: (1) impacted; (2) low potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

Class 3 area - An area that is projected to require a Class 3 final status survey.

Class 3 survey - A type of final status survey that applies to areas that meet the following criteria: (1) impacted; (2) little or no potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

Classification - The act or result of separating areas or survey units into one of three designated classes - Class 1 area, Class 2 area, or Class 3 area.

Cleanup - Actions taken to deal with a release or threatened release of hazardous substances that could affect public health or the environment. The term is often used broadly to describe various Superfund response actions or phases of remedial responses, such as remedial investigation/ feasibility study. Cleanup is sometimes used interchangeably with the terms remedial action, response action, or corrective action.

Cleanup standard - A numerical limit set by a regulatory agency as a requirement for releasing a site after cleanup. See release criterion.

Composite sample - A sample formed by collecting several samples and combining them (or selected portions of them) into a new sample which is then thoroughly mixed.

Confidence interval - A range of values for which there is a specified probability (e.g., 80%, 90%, 95%) that this set contains the true value of an estimated parameter.

Confirmatory survey - A type of survey that includes limited independent (third-party) measurements, sampling, and analyses to verify the findings of a final status survey.

Contamination - The presence of residual radioactivity in excess of levels which are acceptable for release of a site or facility for unrestricted use.

Control chart - A graphic representation of a process, showing plotted values of some statistic gathered from that characteristic, and one or two control limits. It has two basic uses: 1) as a judgement to determine if a process was in control, and 2) as an aid in achieving and maintaining statistical control.

Corrective action - An action taken to eliminate the causes of an existing nonconformance, deficiency, or other undesirable situation in order to prevent recurrence.

Criterion - See release criterion.

Curie (Ci) - The customary unit of radioactivity. One curie (Ci) is equal to 37 billion disintegrations per second (3.7 x 10^{10} dps = 3.7 x 10^{10} Bq), which is approximately equal to the decay rate of one gram of 226 Ra. Fractions of a curie, e.g. picocurie (pCi) or 10^{-12} Ci and microcurie (μCi) or 10 -6 Ci, are levels typically encountered in decommissioning.

D102 - Building number D102

D111 - Building number D111

DAC - Derived Air Concentration

DCGL (derived concentration guideline level) - A derived, radionuclide-specific activity concentration within a survey unit corresponding to the release criterion. The DCGL is based on the spatial distribution of the contaminant and hence is derived differently for the nonparametric statistical test (DCGLW) and the Elevated Measurement Comparison (DCGLEMC). DCGLs are derived from activity/dose relationships through various exposure pathway scenarios.

Decay - See radioactive decay.

Decommissioning - The process of removing a facility or site from operation, followed by decontamination, and license termination (or termination of authorization for operation) if appropriate. The objective of decommissioning is to reduce the residual radioactivity in structures, materials, soils, groundwater, and other media at the site so that the concentration of each radionuclide contaminant that contributes to residual radioactivity is indistinguishable from the background radiation concentration for that radionuclide.

Decontamination - The removal of radiological contaminants from a person, object or area to within levels established by governing regulatory agencies. Decontamination is sometimes used interchangeably with remediation, remedial action, and cleanup.

Derived concentration guideline level - See DCGL.

Detection limit - The net response level that can be expected to be seen with a detector with a fixed level of certainty.

Detection sensitivity - The minimum level of ability to identify the presence of radiation or radioactivity.

Direct measurement - Radioactivity measurement obtained by placing the detector near the surface or media being surveyed. An indication of the resulting radioactivity level is read out directly.

Distribution coefficient (Kd) - The ratio of elemental (i.e., radionuclide) concentration in soil to that in water in a soil-water system at equilibrium. Kd is generally measured in terms of gram weights of soil and volumes of water (g/cm 3 or g/ml).

Dose commitment - The dose that an organ or tissue would receive during a specified period of time (e.g., 50 or 70 years) as a result of intake (as by ingestion or inhalation) of one or more radionuclides from a given release.

Dose equivalent (dose) - A quantity that expresses all radiations on a common scale for calculating the effective absorbed dose. This quantity is the product of absorbed dose (rads) multiplied by a quality factor and any other modifying factors. Dose is measured in Sv or rem.

Elevated area - See area of elevated activity.

Elevated measurement - A measurement that exceeds a specified value $DCGL_{EMC}$.

Elevated Measurement Comparison (EMC) - This comparison is used in conjunction with the Wilcoxon test to determine if there are any measurements that exceed a specified value $DCGL_{EMC}$.

Exposure pathway - The route by which radioactivity travels through the environment to eventually cause radiation exposure to a person or group.

Exposure rate - The amount of ionization produced per unit time in air by X-rays or gamma rays. The unit of exposure rate is Roentgens/hour (R/h); for decommissioning activities the typical units are microRoentgens per hour (μR/h), i.e., 10 -6 R/h.

External radiation - Radiation from a source outside the body

FEMA - Federal Emergency Management Agency

Field Sampling Plan - As defined for Superfund in the Code of Federal Regulations 40 CFR 300.430, a document which describes the number, type, and location of samples and the type of analyses to be performed. It is part of the Sampling and Analysis Plan

Final status survey - Measurements and sampling to describe the radiological conditions of a site, following completion of decontamination activities (if any) in preparation for release.

Flex-Kleen - Baghouse dust collector formerly located adjacent to Building D111

FSS - final status survey

Gamma radiation - Penetrating high-energy, short-wavelength electromagnetic radiation (similar to X-rays) emitted during radioactive decay.

GET - General Employee Training

Graded approach - The process of basing the level of application of managerial controls applied to an item or work according to the intended use of the results and the degree of confidence needed in the quality of the results.

Grid - A network of parallel horizontal and vertical lines forming squares on a map that may be overlaid on a property parcel for the purpose of identification of exact locations.

Grid block - A square defined by two adjacent vertical and two adjacent horizontal reference grid lines.

H_D - deep dose equivalent

Half-life (t1/2) - The time required for one-half of the atoms of a particular radionuclide present to disintegrate.

HASP - Health and Safety Plan

Hot spot - See area of elevated activity.

HP - Health Physicist or Health Physics

HSP - Health and Safety Plan

HSO - Health and Safety Officer

Hypothesis - An assumption about a property or characteristic of a set of data under study. The goal of statistical inference is to decide which of two complementary hypotheses is likely to be true. The null hypothesis (H0) describes what is assumed to be the true state of nature and the alternative hypothesis (Ha) describes the opposite situation.

IEM - Integrated Environmental Management, Inc., a radiological contractor to Shieldalloy Metallurgical Corporation.

Impacted area - Any area that is not classified as non-impacted. Areas with a possibility of containing residual radioactivity in excess of natural background or fallout levels.

Independent assessment - An assessment performed by a qualified individual, group, or organization that is not part of the organization directly performing and accountable for the work being assessed

Indistinguishable from background - The term indistinguishable from background means that the detectable concentration distribution of a radionuclide is not statistically different from the background concentration distribution of that radionuclide in the vicinity of the site or, in the case of structures, in similar materials using adequate measurement technology, survey, and statistical techniques

Infiltration rate - The rate at which a quantity of a hazardous substance moves from one environmental medium to another—e.g., the rate at which a quantity of a radionuclide moves from a source into and through a volume of soil or solution

Inspection - An activity such as measuring, examining, testing, or gauging one or more characteristics of an entity and comparing the results with specified requirements in order to establish whether conformance is achieved for each characteristic

Inventory - Total residual quantity of formerly licensed radioactive material at a site

Investigation level - A derived media-specific, radionuclide-specific concentration or activity level of radioactivity that - 1) is based on the release criterion, and 2) triggers a response, such as further investigation or cleanup, if exceeded. See action level

Less-than data - Measurements that are less than the minimum detectable concentration

License - A license issued under the regulations in parts 30 through 35, 39, 40, 60, 61, 70 or part 72 of 10 CFR.

Licensee - The holder of a license

License termination - Discontinuation of a license, the eventual conclusion to decommissioning.

Lower limit of detection (LD) - The smallest amount of radiation or radioactivity that statistically yields a net result above the method background. The critical detection level, LC , is the lower bound of the 95% detection interval defined for LD and is the level at which there is a 5% chance of calling a background value "greater than background." This value should be used when actually counting samples or making direct radiation measurements. Any response above this level should be considered as above background; i.e., a net positive result. This will ensure 95% detection capability for LD. A 95% confidence interval should be calculated for all responses greater than LC .

LTC License - Long-term control license.

LTC Plan - Long-term control plan.

MARSSIM - Multi-Agency Radiation Survey and Site Investigation Manual

MDA - Minimum detectable activity

MDC - Minimum detectable concentration

Measurement - For the purpose of MARSSIM, it is used interchangeably to mean: 1) the act of using a detector to determine the level or quantity of radioactivity on a surface or in a sample of material removed from a media being evaluated, or 2) the quantity obtained by the act of measuring

Microrem - one thousandth of a millirem.

Millirem - one thousandth of a rem

Minimum detectable concentration (MDC) - The minimum detectable concentration (MDC) is the a priori activity level that a specific instrument and technique can be expected to detect 95% of the time. When stating the detection capability of an instrument, this value should be used. The MDC is the detection limit, LD, multiplied by an appropriate conversion factor to give units of activity

Minimum detectable count rate (MDCR) - The minimum detectable count rate (MDCR) is the a priori count rate that a specific instrument and technique can be expected to detect

Missing or unusable data - Data (measurements) that are mislabeled, lost, or do not meet quality control standards. Less-than data are not considered to be missing or unusable data

mR - milliRoentgen

mrem - millirem

MSHA - Mine Safety and Health Administration

NCDC - National Climate Data Center

NEPA - National Environmental Policy Act

NIOSH - National Institute for Occupational Safety and Health

NIST - National Institute of Standards and Technology

NJDEP - New Jersey Department of Environmental Protection

NOAA - National Oceanic and Atmospheric Administration

Non-impacted area - Areas where there is no reasonable possibility (extremely low probability) of residual contamination. Non-impacted areas are typically located off-site and may be used as background reference areas

Normal (gaussian) distribution - A family of bell shaped distributions described by the mean and variance

NVLAP - National Voluntary Laboratory Accreditation Program

O&M - operation and maintenance

Organization - a company, corporation, firm, government unit, enterprise, facility, or institution, or part thereof, whether incorporated or not, public or private, that has its own functions and administration

OSHA - Occupational Safety and Health Administration

pCi/g - picocuries per gram

PM - Project Manager

Precision - A measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions, expressed generally in terms of the standard deviation

Process - A combination of people, machine and equipment, methods, and the environment in which they operate to produce a given product or service

Professional judgement - An expression of opinion, based on technical knowledge and professional experience, assumptions, algorithms, and definitions, as stated by an expert in response to technical problems

Pyrochlore - concentrated ore containing columbium (niobium)

QA - Quality Assurance

QAO - Quality Assurance Officer

QAPP - Quality Assurance Project Plan

QA/QC - Quality Assurance/Quality Control

QC - Quality Control

QIP - Quality Implementing Procedure

Qualified data - Any data that have been modified or adjusted as part of statistical or mathematical evaluation, data validation, or data verification operations

Quality - The totality of features and characteristics of a product or service that bear on its ability to meet the stated or implied needs and expectations of the user

Quality assurance (QA) - An integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the customer

Quality control (QC) - The overall system of technical activities that measure the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer, operational techniques and activities that are used to fulfill requirements for quality

Radiation survey - Measurements of radiation levels associated with a site together with appropriate documentation and data evaluation

Radioactive decay - The spontaneous transformation of an unstable atom into one or more different nuclides accompanied by either the emission of energy and/or particles from the nucleus, nuclear capture or ejection of orbital electrons, or fission. Unstable atoms decay into a more stable state, eventually reaching a form that does not decay further or has a very long half-life

Radioactivity - The mean number of nuclear transformations occurring in a given quantity of radioactive material per unit time. The International System (SI) unit of radioactivity is the Becquerel (Bq). The customary unit is the Curie (Ci)

Radiological survey - Measurements of radiation levels and radioactivity associated with a site together with appropriate documentation and data evaluation

Radioluminescence - Light produced by the absorption of energy from ionizing radiation

Radionuclide - An unstable nuclide that undergoes radioactive decay

Random error - The deviation of an observed value from the true value is called the error of observation. If the error of observation behaves like a random variable (i.e., its value occurs as though chosen at random from a probability distribution of such errors) it is called a random error

Regulation - A rule, law, order, or direction from federal or state governments regulating action or conduct. Regulations concerning radioisotopes in the environment in the United States are shared by the Environmental Protection Agency (EPA), the U.S. Nuclear Regulatory Commission (NRC), the U.S. Department of Energy (DOE), and many State governments. Federal regulations and certain directives issued by the U.S. Department of Defense(DOD) are enforced within the DOD

Release criterion - A regulatory limit expressed in terms of dose or risk

Rem (radiation equivalent man) - The conventional unit of dose equivalent. The corresponding International System (SI) unit is the Sievert (Sv): 1 Sv = 100 rem

Remedial action - Those actions that are consistent with a permanent remedy taken instead of, or in addition to, removal action in the event of a release or threatened release of a hazardous substance into the environment, to prevent or minimize the release of hazardous substances so that they do not migrate to cause substantial danger to present or future public health or welfare or the environment

Remediation - Cleanup or other methods used to remove or contain a toxic spill or hazardous materials from a Superfund site

Removable activity - Surface activity that is readily removable by wiping the surface with moderate pressure and can be assessed with standard radiation detectors. It is usually expressed in units of dpm/100 cm 2

Removal - The cleanup or removal of released hazardous substances, or pollutants or contaminants which may present an imminent and substantial danger; such actions as may be necessary taken in the event of the threat of release of hazardous substances into the environment; such actions as may be necessary to monitor, assess, and evaluate the threat of release of hazardous substances; the removal and disposal of material, or the taking of other such actions as may be necessary to prevent, minimize or mitigate damage to the public health or welfare or the environment

Representative measurement - A measurement that is selected using a procedure in such a way that it, in combination with other representative measurements, will give an accurate representation of the phenomenon being studied

Representativeness - A measure of the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

Reproducibility - The precision, usually expressed as a standard deviation, that measures the variability among the results of measurement of the same sample at different laboratories

Residual radioactivity - Radioactivity in structures, materials, soils, groundwater, and other media at a site resulting from activities under the cognizant organization's control. This includes radioactivity from all sources used by the cognizant organization, but excludes background radioactivity as specified by the applicable regulation or standard. It also includes radioactive materials remaining at the site as a result of routine or accidental releases of radioactive material at the site and previous burials at the site, even if those burials were made in accordance with the provisions of 10 CFR Part 20

RESRAD - computer code used to determine residual radioactivity in the environment

Restricted use - A designation following remediation requiring radiological controls

RI/FS - Remedial Investigation and Feasibility Study

RSO - Radiation Safety Officer

RSP - Radiation Safety Procedure

RWP - Radiation Work Permit

RWT - Radiation Worker Training

Sample - (As used in MARSSIM) A part or selection from a medium located in a survey unit or reference area that represents the quality or quantity of a given parameter or nature of the whole area or unit; a portion serving as a specimen

Sample - (As used in statistics) A set of individual samples or measurements drawn from a population whose properties are studied to gain information about the entire population

Scanning - An evaluation technique performed by moving a detection device over a surface at a specified speed and distance above the surface to detect radiation

Site - Any installation, facility, or discrete, physically separate parcel of land, or any building or structure or portion thereof, that is being considered for survey and investigation

SMC - Shieldalloy Metallurgical Corporation

Soil activity (soil concentration) - The level of radioactivity present in soil and expressed in units of activity per soil mass (typically Bq/kg or pCi/g)

Source material - Uranium and/or Thorium other than that classified as special nuclear material

Source term - All residual radioactivity remaining at the site, including material released during normal operations, inadvertent releases, or accidents, and that which may have been buried at the site in accordance with 10 CFR Part 20

Standard operating procedure (SOP) - A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps, and that is officially approved as the method for performing certain routine or repetitive tasks

Subsurface soil sample - A soil sample that reflects the modeling assumptions used to develop the DCGL for subsurface soil activity. An example would be soil taken deeper than 15 cm below the soil surface to support surveys performed to demonstrate compliance with 40 CFR 192

Surface contamination - Residual radioactivity found on building or equipment surfaces and expressed in units of activity per surface area (Bq/m^2 or $dpm/100\ cm^2$)

Surface soil sample - A soil sample that reflects the modeling assumptions used to develop the DCGL for surface soil activity. An example would be soil taken from the first 15 cm of surface soil to support surveys performed to demonstrate compliance with 40 CFR 192

Surveillance (quality) - Continual or frequent monitoring and verification of the status of an entity and the analysis of records to ensure that specified requirements are being fulfilled

Survey - A systematic evaluation and documentation of radiological measurements with a correctly calibrated instrument or instruments that meet the sensitivity required by the objective of the evaluation

Survey plan - A plan for determining the radiological characteristics of a site

Survey unit - A geographical area of specified size and shape defined for the purpose of survey design and compliance testing.

TDS - Total Dissolved Solids

TEDE (total effective dose equivalent) - The sum of the effective dose equivalent (for external exposure) and the committed effective dose equivalent (for internal exposure). TEDE is expressed in units of Sv or rem. See CEDE.

TLD - thermoluminescent dosimeter

TODE - total organ dose equivalent

traceability - The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughput the project back to the requirements for quality for the project

TRC - TRC Environmental Corporation, an environmental contractor to Shieldalloy Metallurgical Corporation.

µrem - microrem

Unrestricted area - Any area where access is not controlled by a licensee for purposes of protection of individuals from exposure to radiation and radioactive materials—including areas used for residential purposes.

Unrestricted release - Release of a site from regulatory control without requirements for future radiological restrictions. Also known as unrestricted use

USEPA - United States Environmental Protection Agency

USNRC - United States Nuclear Regulatory Commission

Weighting factor (Wt) - The fraction of the overall health risk, resulting from uniform, whole-body radiation, attributable to specific tissue. The dose equivalent to tissue is multiplied by the appropriate weighting factor to obtain the effective dose equivalent to the tissue.

Wilcoxon Rank Sum (WRS) test - A nonparametric statistical test used to determine compliance with the release criterion when the radionuclide of concern is present in background.

1 EXECUTIVE SUMMARY

1.1 Introduction

This Decommissioning Plan (Plan) describes the radiological remedial actions that will be implemented in order to permit the Shieldalloy Metallurgical Corporation (SMC) radioactive materials license to be amended to a "long term control", or LTC license. The following is the name and address of the licensee and owner of the site:

Shieldalloy Metallurgical Corporation
35 South West Boulevard
Newfield, New Jersey 08344

The location and address of the site itself is also at:

Shieldalloy Metallurgical Corporation
35 South West Boulevard
Newfield, New Jersey 08344

Once the applicable radiological release criteria and the conditions of this Plan have been met, an amendment of radioactive materials license number SMB-743 into a LTC license will be solicited. The decommissioning objective is to terminate the license under "unrestricted use" conditions for the preponderance of the site, and issue a LTC license under "restricted use" conditions for a small portion of the site. As such, this plan also contains conditions and actions that will be taken in order to maintain radiation exposures to the public as low as is reasonably achievable.

1.2 Site Description

Shieldalloy Metallurgical Corporation (SMC) operates a manufacturing facility located at 35 South West Boulevard in Newfield, New Jersey. During the ferrocolumbium manufacturing process, the facility generated slag, dross, and baghouse dust. The primary portion of the site, consisting of the manufacturing facilities and their support areas, covers 67.7 acres. An additional 19.8 acres of farmland, located approximately 2,000 feet southwest of the primary site in Vineland, Cumberland County, New Jersey, are also owned by SMC. The immediate environs around the site is industrial, and the nearest off-site resident is located approximately 28 meters (100 feet) from the property.

1.3 Summary of Licensed Activities

Metal and metal alloy manufacturing operations at the Newfield site began in the late 1950's and early 1960's. An application for ores that contained source material was sent to the Atomic Energy Commission in 1963. The license was issued shortly thereafter, and later re-issued by the U. S. Nuclear Regulatory Commission (USNRC) as License No. SMB-743, which authorizes possession of up to 303,050 kilograms of thorium in any chemical/physical form, and up to 45,000 kilograms of uranium in any chemical or physical form.

In late 2002, operations involving source material ceased. As of October 21, 2005, the SMC inventory of licensed materials was at 96.8% of the thorium limit and 87.6% of the uranium limit. The most recent amendment of SMB-743 was issued on November 26, 2002, and the license expiration date was October 20, 2002. The license is currently being held under timely renewal notice.

1.4 Nature and Extent of Contamination

One of the materials received, used and stored by SMC contains radioactive material classified as "source material" pursuant to Title 10, Code of Federal Regulations, Part 40. This material is called pyrochlore, a concentrated ore containing columbium (niobium). Pyrochlore contains greater than 0.05% of natural uranium and natural thorium, thus a source material license for its possession and use is required.

The majority of the licensed radioactive material inventory at the plant currently consists of the slag generated during former D11 production department operations, and dust from the former D11 baghouses. After processing of consumable pyrochlore ore and other feed materials for ferrocolumbium and other metallurgical operations, greater than 99% of the radioactive species remained in the slag and, to a much lesser extent, in the baghouse dust. Surface and subsurface soil contamination, in the form of ferrocolumbium slag and baghouse dust, is present in the Storage Yard, and at a number of locations throughout the Newfield plant.

Ferrocolumbium standard slag, ferrocolumbium high-ratio slag, and columbium nickel slag from the former D111 and D102 smelting operations are solid, non-combustible materials with the consistency of vitrified rock. All three slag types were maintained separately from the others at their respective points of generation and were transported in trucks from D111 and D102 to the Storage Yard where they remain segregated. In addition, baghouse dust was transported by truck to another location within the Storage Yard. Table 17.1 is a summary of the volumes of residual radioactivity currently present at the site and Table 17.7 shows the radiological source term.

The only other area within the Newfield plant property lines where residual radioactivity has been identified is in the Hudson's Branch watershed. The Hudson's Branch, an intermittent, slow-moving tributary of Burnt Mill Branch in the Maurice River Basin, is the predominant surface water body in the vicinity of the plant. It borders the southern boundary of the property, where it flows from east to west. Other than documenting site-wide radiological conditions as part of the final status survey effort, there are no other contaminated systems, equipment or land areas at the site to be addressed in this decommissioning effort.

1.5 Selected Decommissioning Objective

With the approval of this Decommissioning Plan, SMC will consolidate all licenseable residual radioactive materials at the Newfield site to a portion of the existing Storage Yard, located on the eastern boundary of the plant. There it will be shaped, graded, covered with an engineered barrier and subject to long-term maintenance and monitoring. This *in situ* decommissioning methodology has already received federal and state (Ohio) regulatory acceptance at a site that performed similar operations, and with similar quantities/forms of residual radioactive materials.[1,2]

After all consolidation and barrier construction activities are complete, a final status survey will be performed, the results of which will be documented in a comprehensive report. Included therein will be a demonstration that the site, in its entirety, meets the decommissioning objective. The majority of the site may then be released for unrestricted use, subject to regulatory verification. However, the portion that contains the engineered barrier will be held under restricted use conditions, with License No. SMB-743 then amended into a Long Term Control (LTC) license. The conditions of the LTC license will include long-term maintenance of the engineered barrier, monitoring of radiological conditions throughout and around the restricted area, deed notices, a Long Term Control Plan (LTC Plan) that describes all post-remediation activities, and financial assurance sufficient to ensure the provisions of the LTC Plan will be implemented for at least 1,000 years.

1.6 Summary of Radiation Dose Analysis

The decommissioning alternative for the Newfield site is to consolidate residual slag, contaminated soil, baghouse dust and demolition rubble (concrete) into a single pile that is capped with an engineered barrier such that the potential exposure of members of the public to radiation and radioactive materials is minimized. That portion of the property will be subject to restricted use conditions, with the remainder of the property released for unrestricted use.

A radiation dose analysis was performed to ensure the Derived Concentration Guideline Levels (DCGL's) for the unrestricted portion of the site do indeed meet the criteria for unrestricted release as specified in 10 CFR 20.1402 (i.e., 25 millirem TEDE).[3] An analysis of the radiation dose associated with the restricted portion of the site was also performed in order to ensure the 10 CFR 20.1403 dose limits will be met when all institutional controls are in place and in the extremely unlikely situation when institutional controls (and subsequently physical controls) fail. With few exceptions, reasonably likely exposure scenarios were evaluated. For the exceptions, the scenarios are considered to be unlikely but were evaluated in response to input from regulators and members of the public.

The estimates of peak mean dose to the critical exposure groups for all scenarios were derived using industry-standard computer-based modeling tools specifically designed to assess exposures to residual radioactivity. Conservatism was been built into the modeling by conscientiously selecting

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[1] U. S. Nuclear Regulatory Commission, NUREG-1543, "Environmental Impact Statement; Decommissioning of the Shieldalloy Metallurgical Corporation Newfield, Ohio Facility", July, 1996.

[2] PTI Environmental Services, "Remedial Investigation and Feasibility Study at the Shieldalloy Metallurgical Corporation Site in Newfield, Ohio", September, 1996.

[3] The Derived Concentration Guideline Levels, or DCGLs, were determined pursuant to the recommendations of NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).

exposure factor values that err on the side of safety when confronted with uncertainty in the selection of input parameters. In order to provide the risk managers and decision makers with insight as to the degree of conservatism associated with the dose modeling, projected annual doses have been calculated with both deterministic and probabilistic techniques.

Based on the results obtained, SMC has concluded that the source term applicable to each of the scenarios considered produces a peak mean annual dose that is well-below the dose limits for unrestricted and restricted release as specified in 10 CFR 20.1402 and 1403, respectively. Once decommissioning pursuant to this Plan is complete, the actual doses incurred by any of the potentially affected population groups will likely be lower. In any case, they will not be discernible from background radiation exposures.

1.7 Summary of ALARA Analysis

Most decisions about human activities are based on an implicit form of balancing the costs and benefits leading to the conclusion that the conduct of a chosen practice is "worthwhile".[4] With respect to the use and control of radioactive materials, the decision-making process is typically based upon the following:

- No practice shall be adopted unless its introduction produces a positive net benefit;
- All exposures to ionizing radiation shall be kept as low as reasonably achievable, economic and societal factors being taken into account; and
- The dose equivalent to individuals shall not exceed applicable regulatory dose limits.

SMC has proposed to consolidate the residual radioactive materials beneath an engineered barrier, and then possess those materials under the provisions of a LTC license. A second alternative, the License Termination (LT) alternative involves the shipment of the residual radioactivity to the Envirocare of Utah, LLC radioactive waste disposal facility in Utah, followed by release of the site in its entirety for unrestricted use. The no-action alternative is to leave the residual radioactivity in its current configuration and take only those actions necessary to control erosion or correct problems that may develop over time.

A determination as to the cost/benefit of each of the three options was performed, taking into account both radiological and non-radiological impacts on workers and members of the public. In addition, an analysis of which alternative would ensure radiation doses to members of the general public remain As Low as Reasonably Achievable (ALARA) was also performed. Table 17.9 gives a summary of results, which clearly demonstrates that the LTC alternative is the most defensible decommissioning option for the Newfield site.

[4] International Commission on Radiological Protection, ICRP Publication 55, "Optimization and Decision-Making in Radiological Protection", Pergamon Press, 1989.

1.8 Restrictions Used to Limit Radiation Doses

After remediation activities are complete, License No. SMC-743 will be amended to a LTC license, with SMC as the licensee. In addition, a deed notice will be filed with Gloucester County that restricts agricultural, residential and industrial activities on the restricted areas of the site, and that informs all potential purchasers of the property that a LTC license is a condition of sale. A fence will be installed around the engineered barrier, with all access restrictions clearly posted at all entrances.

An annual maintenance program will be implemented to ensure the condition of the engineered barrier remains as constructed. This program will include quarterly inspections of the entirety of the barrier, with repairs made as necessary. An annual monitoring program will also be instituted to ensure radiation exposures to members of the public do not exceed 25 millirem TEDE. The monitoring program will consist, in part, of deployment of passive radiation monitoring devices on the inside perimeter of the restricted area and quarterly assessments of ambient radiation exposure rates. Recordkeeping and reporting are also integral parts of the maintenance and monitoring programs.

Finally, a trust fund sufficient in an amount sufficient to ensure continuation of the LTC Plan will be initiated, with the USNRC as the beneficiary. In the unlikely event SMC would default on the terms/conditions of the LTC license, the trust fund will allow the USNRC to contract a third party to implement those provisions for a minimum of 1,000 years.

1.9 Summary of Public Participation Activities

In order to solicit local input during the development of this Decommission Plan, a Site Specific Advisory Board (SSAB) was established as a voluntary advisory group. SMC contacted individuals who were thought to have interest in the decommissioning efforts. These included owners of businesses in the vicinity of the Newfield site, the Mayor, city and county public health officials, State environmental and radiological officials, planning board members, and county residents. Individuals who expressed an interest in serving as members of the SSAB were also asked to provide recommendations on others who they thought may be interested.

The SSAB met on four separate occasions prior to the issue of this Decommissioning Plan. During those meetings, the members were asked to provide input to SMC on the required 10 CFR 20. 1403(d) issues, as well as any other matters that they felt should be considered in the decision-making process. That input has been summarized and addressed as part of this Plan.

To facilitate the availability of information to the SSAB and other members of the public, SMC launched a web page dedicated to the decommissioning of the Newfield facility (http://www.shieldalloy.com/decommissioning/index). A copy of this Decommissioning Plan will be posted on the web site shortly after its submission to the USNRC.

1.10 Proposed Initiation and Completion Dates

The duration of regulatory review of this decommissioning plan, and exchange of additional information that might be solicited by the USNRC, is unknown at this time. However, full implementation of the Plan, to include amendment of License No. SMB-743 into a LTC license, will be completed within four (4) years after its approval by the USNRC. No post-remediation activities other than those associated with the initiation of the trust fund, the long-term monitoring and maintenance program, or the issue of the LTC license are anticipated.

1.11 Request for License Amendment

Upon approval of this Plan SMC will request that License No. SMB-743 be amended to authorize the Plan's implementation in its entirety, including the amendment of SMB-743 as a LTC license with the terms and conditions outlined herein.

INTRODUCTION

Shieldalloy Metallurgical Corporation (SMC) operates a manufacturing facility in Newfield, New Jersey. This facility manufactures or has manufactured specialty steel and super alloy additives, primary aluminum master alloys, metal carbides, powdered metals, and optical surfacing products. Raw materials used at the facility included ores which contain oxides of columbium (niobium), vanadium, aluminum metal, titanium metal, strontium metal, zirconium metal, and fluoride (titanium and boron) salts. During the manufacturing process, slag, dross, and baghouse dust were generated.

One of the materials received, used and stored by SMC contains radioactive material which is classified as "source material" pursuant to Title 10, Code of Federal Regulations, Part 40. This material is called pyrochlore, a concentrated ore containing columbium (niobium). Pyrochlore contains greater than 0.05% of natural uranium and natural thorium. Therefore, it is licensable by the USNRC.

SMC currently holds USNRC License No. SMB-743 which allows the possession, use, storage, transfer and disposal of source material for decommissioning operations. The most recent amendment of SMB-743 was issued on November 26, 2002, and the license expiration date is October 20, 2002.

SMC has prepared this decommissioning plan, hereinafter referred to as the Plan. When fully implemented, it will permit most of the Newfield site to be released for unrestricted use, while a portion will be allowed activities only associated with restricted use. At that time, License No. SMB-743 will be amended into a LTC license. Included herein are the following sections:

- Chapter 1 - *Executive Summary,* provides an overview of the installation and operating history, and results of analyses;
- Chapter 2 - *Facility Operating History,* describes the facility's operating history, including licensed activities performed since the date of initial regulatory authorization.
- Chapter 3 - *Facility Description,* details the site location, land use, socioeconomic, and existing environmental conditions.
- Chapter 4 - *Radiological Status of the Facility,* describes the radiological status of the facility, with emphasis on the Storage Yard.
- Chapter 5 - *Dose Modeling Evaluations,* details and summarizes the results of dose modeling for both the restricted and unrestricted portions of the site.

- Chapter 6 - *Environmental Information*, presents a summary of the environmental issues associated with decommissioning decision-making.

- Chapter 7 - *ALARA Analysis*, presents the findings of an analysis of the benefits and costs of three decommissioning alternatives applicable to the site.

- Chapter 8 - *Planned Decommissioning Activities*, describes the approach to be implemented in order to decommission the facility for license termination.

- Chapter 9 - *Project Management and Organization*, describes the project management and organization, including the role and responsibilities of key organizations and personnel.

- Chapter 10 - *Radiation Safety and Health Program During License Termination*, describes the radiation safety and health program that will remain in place throughout the decommissioning process.

- Chapter 11 - *Environmental Monitoring and Control Program*, addresses the way in which the environment will be protected from decommissioning-related emissions.

- Chapter 12 - *Radioactive Waste Management Program*, identifies the type, amount and disposition of radioactive materials associated with this decommissioning program.

- Chapter 13 - *Quality Assurance Program*, describes the elements of quality and the quality control measures to be implemented during decommissioning.

- Chapter 14 - *Facility Radiation Surveys*, describes the way that the radiological conditions at the site after decommissioning is complete will be measured and documented.

- Chapter 15 - *Financial Assurance*, provides SMC's plan for ensuring funding is available to support implementation of this Plan during its execution and for the duration of the LTC license.

- Chapter 16 - *Restricted Use and Alternate Criteria*, provides the rationale and basis for license termination under restricted conditions as described in 10 CFR 20.1402.

This Plan and the chapters therein are organized similar to the organization of Chapters 16 to 18 of NUREG-1757, Vol. 1.[5] This approach was selected in order to facilitate regulatory review of the Plan. In addition, the lines on each page of the Plan are numbered to provide a ready point of reference for reviewer comments.

The contents of each chapter of this Plan was compared to a checklist of chapter-specific acceptance criteria derived from Chapter 16, Appendix D of NUREG-1757, to SMC-specific and supplemental USNRC guidance, and to a checklist derived from the listing of deficiencies noted in the USNRC's letter to SMC regarding Rev. 0 of this Plan.[6,7] The comparisons were performed in order to ensure the document contains all of the information necessary for it to advance toward USNRC technical review, with crosswalks showing where within this Plan each of the required items can be found.

[5] U. S. Nuclear Regulatory Commission, NUREG-1757, Volume 1, Rev. 1, "Consolidated NMSS Decommissioning Guidance; Decommissioning Process for Materials Licensees", September, 2003.

[6] Supplemental guidance in the form of "draft for comment" revisions to NUREG-1757, released by the USNRC shortly before the October 24, 2005 submission date of this Plan (70 FR 56940-56941, "Draft Report for Comment: Office of Nuclear Material Safety and Safeguards Consolidated Decommissioning Guidance: Updates to Implement the License Termination Rule", September 29, 2005), was captured in the checklists.

[7] Bellamy, R. R., U. S. Nuclear Regulatory Commission, letter to D. R. Smith, Shieldalloy Metallurgical Corporation, "Rejection of Decommissioning Plan for the Newfield Facility and Denial of the Exemption Request to Postpone Initiation of Decommissioning Process, Control No. 132074", February 28, 2003.

2 FACILITY OPERATING HISTORY

2.1 License Number, Status and Authorized Activities

The majority of the licensed radioactive material inventory at the Newfield plant consists of slag from the former D11 production department, and dust from the former D11 baghouses. The chemical form of the licensed radioactive material at the SMC site is oxides of thorium and uranium. After processing of consumable pyrochlore ore and other feed materials for smelting of ferrocolumbium and other metallurgical operations, greater than 99% of the radioactive species remained in the slag and, to a much lesser extent, in the baghouse dust.

License No. SMB-743 authorizes possession of up to 303,050 kilograms of thorium in any chemical/physical form, and up to 45,000 kilograms of uranium in any chemical or physical form for site decommissioning activities. Residual radioactive materials are present at the plant in five basic forms: (1) Baghouse dusts, dry solids which may contain licensable quantities of radioactive materials; (2) Baghouse bags, combustible dry solids which may contain licensable quantities of radioactive materials; (3) Pyrochlore Supersacs, combustible dry solids used to contain pyrochlore ores which may be contaminated with licensable quantities of radioactive materials; (4) Ferrocolumbium slag, dry solids known to contain licensable quantities of radioactive materials; and (5) Radioactive dry combustible material, combustible dry solids, including plastic bags, absorbent paper, and protective equipment, used to prevent the spread of contamination. Figure 18.1 is scale drawing of the site. Figures 18.2 and 18.3 show the current locations of licensed radioactive materials at the site.

As of October 21, 2005, radioactive material on-site was at 96.8% of the thorium limit and 87.6% of the uranium limit. SMC continues to perform the necessary radiation safety procedures in order to demonstrate compliance with applicable provisions of 10 CFR 19 and 20. The most recent amendment of SMB-743, Amendment 9, was issued on November 26, 2002. SMC submitted a timely request for license renewal and the USNRC acknowledged its receipt on October 28, 2002. The license expiration date is October 20, 2002 (Extended) although the license is currently in force pursuant to the timely renewal regulation at 10 CFR § 40.42(a)(1).

2.2 License History

USNRC License No. SMB-743 is the only USNRC license for the Newfield plant. It was originally issued in 1963 to allow the processing of ore to extract valuable metal. The ore incidentally contained source material and that source material remained in slag stored onsite after extracting the valuable metal. The license previously allowed for the possession, use, storage, transfer, and disposal of source material (i.e., natural uranium and natural thorium, in oxide form) ancillary to metallurgical operations. That authorization continued until SMC notified the USNRC in August of 2001 of its intent to decommission the plant because principle activities authorized by the license ceased.

Since the license was first issued, the primary changes of significance to the license were changes in the authorized site inventory of source material to the current limit and addition of decommissioning provisions. The following is a brief summary of the pertinent changes:

- December 20, 1963 - The Atomic Energy Commission (AEC) issued License SMB-743 to allow possession of 17,700 pounds of Brazilian pyrochlore containing not more than 0.07% uranium (U) and 2.0% thorium (Th) for use in the production of ferrocolumbium and columbium nickel.[8] On February 1, 1965, SMB-743 was renewed with the possession limit increased to 125,000 pounds of pyrochlore. In the renewal application, SMC stated that the slag resulting from ore processing would continue to be stored on-site. In the letter forwarding the renewed license, the AEC authorized on-site burial of up to 769,000 pounds of slag per year. Consistent with the discussion in the renewal application, SMC did not bury any slag under this authorization.

- April 5, 1965 - The AEC amended SMB-743 to allow an unlimited quantity of pyrochlore and up to fifteen tons of Baddeleyite. Baddeleyite was to be used to produce zirconium alloys. On September 21, 1965 the AEC amended SMB-743 to allow unlimited quantities of metalliferous ore containing up to 2% U and 4% Th for the use in production of iron-based alloys.

- December 22, 1967 - SMC applied for renewal of SMB-743, including stating that waste from processing would be "stored in a pile in a slag dump." On January 10, 1968, and subsequently on January 24, 1973, AEC renewed SMB-743, continuing to incorporate on-site slag storage as an authorized use of the license.

- January 23, 1977 - SMC applied for renewal of SMB-743 and, on January 20, 1978, the USNRC acknowledged the license was extended based on that timely renewal application. On July 7, 1980, USNRC renewed SMB-743 authorizing possession of up to 100,000 kilograms (kg) Th and 5,000 kg U in any form for "possession and storage incident to the processing of raw materials to produce ferrocolumbium and columbium nickel alloys."

- June 19, 1985 - SMC applied for renewal of SMB-743 stating that it anticipated storing pyrochlore and slag with a maximum amount of 363,151 kg Th and 74,025 kg U. On August 5, 1985, the USNRC acknowledged the license was extended based on that timely renewal application. On March 25, 1992, the USNRC completed an environmental assessment and concluded there would be no significant impact associated amending SMB-743 to increase the possession limits to 303.050

[8] In 1974, the responsibilities of the AEC were split between the U.S. Energy Research and Development Agency and the NRC. P.L. 93-438, 88 Stat. 1233 (1974).

kg Th and 34,870 kg U [57 Fed. Reg. 11,123 (1992)]. On April 2, 1992, USNRC amended SMB-743 to incorporate this revised limits.

- April 7, 1993 - As an amendment to its license renewal application, SMC submitted a conceptual decommissioning plan identifying items to be addressed are the slag piles in the storage yard, the baghouse dust in the storage yard, Building D111, Building D102, and miscellaneous areas. The miscellaneous areas were expected to possibly be the southwest fence line, the T12 tank area, and the Hudson Branch Watershed.

- November 26, 1993 - The USNRC issued a notice of intent to prepare an Environmental Impact Statement addressing renewal of SMB-743 including evaluation of decommissioning planning and requesting public input, including holding a public scoping meeting on December 16, 1993 [58 Fed. Reg. 62,387 (1993)].

- September 22, 1997 - The USNRC issued a finding of no significant environmental impact from renewal of SMB-743 and renewed SMB-743 on October 20, 1997, increasing the uranium limit to 45,000 kg and leaving the thorium limit unchanged.

Since SMB-743 was renewed in 1997, the USNRC has amended the license nine times. The more significant changes are summarized as follows:

- July 20, 1999 - The USNRC amended SMB-743 to remove Building D203A from the list of permanently restricted areas reflecting that building had been cleaned and surveyed to meet USNRC-approved release criteria.

- August 1999 - The USNRC amended SMB-743 to revise airborne contamination monitoring requirements.

- December 10, 1999 - The USNRC amended SMB-643 to implement revised airborne contamination limits to reflect international consensus standards.

- The USNRC amended SMB-743 to require submittal of a decommissioning plan by July 2002.

- October 9, 2001 - The USNRC amended SMB-743 to remove Building D203G from the list of permanently restricted areas reflecting that building had been cleaned and surveyed to meet USNRC-approved release criteria.

- November 6, 2002 - The USNRC amended SMB-743 to reflect receipt of Rev. 0 of this Decommissioning Plan.

Figure 18.2 shows the locations of use and storage of licensed radioactivity since licensed activities began. As described in Section 2.3, below, a number of these locations were remediated over the years, thus Figure 18.2 also shows the location of all current restricted areas at the site.

2.3 Previous Decommissioning Activities

2.3.1 Haul Road

The Haul Road was, at one time, a county right-of-way that ran through SMC's Newfield plant (see Figure 18.1). Over the years, the south portion of Haul Road was surfaced with crushed slag from SMC operations. Although the Haul Road was never used to perform principle activities authorized by License No. SMB-743, it was nonetheless included in site characterization efforts that took place in 1988 and in 1991.[9,10] These surveys showed that the contact exposure rates in and near the Haul Road were only slightly discernible from background, and that the slag used to form the road bed was not characteristic of licensed material (i.e., ferrocolumbium slag).[11]

Nonetheless, the readily detectable radioactive materials identified within the Haul Road were excavated and relocated to the Storage Yard, and a final status survey was performed and documented in the fourth quarter of 1998.[12] The results of the survey demonstrates that the residual radioactivity in the remediated area is less than the following:

Release Criteria for the Haul Road Remediation

Nuclide	Concentration
U-238 and U-234 with progeny in equilibrium	2.5 pCi/g each above background, averaged over the volume of interest
Th-232 and Th-228 with progeny in equilibrium	2.5 pCi/g each above background averaged over the volume of interest
Mixture of U-nat and Th-nat	15 microR per hour above background[13]

[9] Oak Ridge Associated Universities, "Radiological Survey of the Shieldalloy Metallurgical Corporation, Newfield, New Jersey", Report No. ORAU 88/G-79, July, 1988.

[10] IT Corporation, "Assessment of Environmental Radiological Conditions at the Newfield Facility", Report No. IT/NS-92-106, April 2, 1992.

[11] Exposure rates in and near the Haul Road generally ranged from background to 26 microR per hour, with a maximum exposure rate of 90 microR per hour. The contact exposure rate from ferrocolumbium slag is in the vicinity of 1,000 to 2,000 microR per hour.

[12] Integrated Environmental Management, Inc., Report No. 94005/G-17172, "Final Status Survey of Haul Road", October 1998.

[13] Assumes 2.5 pCi/g each of Th-232, Th-228, U-238, and U-234 (plus progeny in equilibrium) evenly distributed throughout the soil volume to a depth of 15 cm, with measurements made at a height of less than three (3) cm above the soil surface. Taken from Integrated Environmental Management, Inc., written communication to D. R. Smith, "Screening Criteria for Soils", September 1, 1998.

2.3.2 AAF Baghouse

Ferrocolumbium production was performed within a single building (D111) equipped with an operator control room, mechanical booms and heavy equipment handlers, storage containers, scales, a variety of melting pots, two furnaces, other miscellaneous items, and a dust collection system comprised of two interconnected emission control units with high-efficiency baghouses. One of the emission control units was an American Air Filter baghouse, termed the "AAF Baghouse". (See Figures 18.1 and 18.2 for the location of D111 and the AAF Baghouse.)

Because of improvements made to the air handling system in the immediate vicinity of the smelting operation, and because maintenance performed on a baghouse that operated in tandem with the AAF Baghouse improved its efficiency, in early 1999, SMC determined that it was no longer necessary to operate two emission control systems. Therefore, the decision was made to decommission the AAF Baghouse.

During the remedial action, which occurred between May 17 and June 17, 1999, the AAF Baghouse was disassembled. Structural components and materials that were generated during the demolition were surveyed to determine whether they could be released for unrestricted use (i.e., without regard for radiological constituents). Those items that did not meet the applicable release criteria were decontaminated and re-surveyed, or controlled as licensed material. A final status survey report was prepared, and the area, with the exception of the concrete pad, was released for unrestricted use in a license amendment.[14] The AAF concrete pad was subsequently transferred to the Storage Yard, leaving only the footprint to be addressed during the final status survey.

2.3.3 Building D203(G)

One area at the Newfield plant where source material was temporarily stored pending shipment or use is D203(G), also known as "G-Warehouse". G-Warehouse consisted, primarily, of open floor space to facilitate forklift movement, and a series of storage bays. However, operational and programmatic changes resulted in source materials being stored at locations within the SMC controlled area other than G-Warehouse. Because SMC no longer needed G-Warehouse to perform the primary activities authorized under License No. SMB-743, it was decommissioned. (See Figure 18.2 for the location of G-Warehouse.)

Routine radiological surveillance of this area demonstrated that it was free of residual radioactivity that could be distinguished from background. Therefore, no remedial actions were necessary. In October of 2000, a final status survey of G-Warehouse was performed and documented.[15] The building was subsequently released for unrestricted use in a license amendment.

[14] Integrated Environmental Management, Inc., Report No. 94005/G-20187, "Demolition and Final Survey of the AAF Baghouse", November 2000,

[15] Integrated Environmental Management, Inc. Report No. 94005/G-16171, "Final Status Survey of G-Warehouse", November 2000.

2.3.4 Building D203(A)

Another area where source material was received and temporarily stored pending shipment or use in D203(A), also known as "A-Warehouse". This building was constructed with a concrete slab floor and sheet metal siding and roof, and consisted, primarily, of open floor space to facilitate forklift movement, and a series of storage bays. When SMC no longer needed A-Warehouse to perform the primary activities authorized under License No. SMB-743, it was decommissioned. (See Figure 18.2 for the location of A-Warehouse.)

Routine radiological surveillance of A-Warehouse indicated that it had become contaminated during use as a temporary storage location for radioactive materials awaiting shipment. The remedial actions (vacuuming and minor surface removal operations) were performed, and a final status survey was conducted and documented.[16] The building was subsequently released for unrestricted use in a license amendment.

2.3.5 East End of the Storage Yard

At one time, the east end of the Storage Yard was used to store ferrovanadium slag. However, placement of those materials often resulted in mixing with ferrocolumbium slag. Eventually, the two slag types were segregated, and the ferrovanadium slag pile was sold for beneficial re-use. The footprint of the pile was then excavated to remove all any remaining ferrocolumbium slag, with the excavated materials segregated within a single pile of soil/slag within the Storage Yard. This is referred to as "Area 1", the footprint of which is delineated in Figure 18.3.

Soil sampling and walkover gamma surveys of the excavated area were performed and documented n 1999.[17] The soil sampling results were negative for residual radioactivity above the applicable release criteria, and the USNRC released the area for re-forestation.[18] On the other hand, the ambient exposure rates in the area, as a result of its proximity to the ferrocolumbium slag piles, were too high to permit measurement of residual radioactivity in non-sampled areas. Therefore, the radiological status of this area will be addressed as part of the site-wide final status survey (see Chapter 14 of this Plan).

2.3.6 Building D111, D102 and D112

As part of a commitment made by SMC to the USNRC to continue on-going efforts to reduce the number and size of the existing restricted areas within the facility, in July of 2002, SMC began the decommissioning of the D111 Production Department, and the D102/D112 Production Department from that listing.[19] All work was performed in full compliance with the requirements of License No.

[16] Integrated Environmental Management, Inc. Report No. 94005/G-16171, "Final Status Survey Report for 'A' Warehouse", October 1998,

[17] Integrated Environmental Management, Inc., IEM Report No. 94005/G-18198, "Soil Sampling/Survey of Storage Yard After Remediation", January 2000.

[18] Olivier, J. A., U. S. Nuclear Regulatory Commission, to D. R. Smith, "Former Storage Yard Area to be Reforested (TAC No. L31310)", April 6, 2000.

[19] Written communication from D. R. Smith, (Shieldalloy Metallurgical Corporation) to T. S. Sherr (U. S. Nuclear Regulatory Commission), "Intent to Terminate Source Material License No. SMB-743", August 27, 2001.

SMB-743, and was approved, in advance, by the USNRC. (See Figures 18.1 and 18.2 for the location of Buildings D111, D102 and D112.)

The work on this project was complete. The only items remaining at the location of the Former D111 and D102/D112 buildings is the footprint, which will be addressed as part of the site-wide final status survey (see Chapter 14 of this Plan).

2.3.7 Non-radiological Activities

Environmental investigations have been ongoing at the Newfield site since 1972 when the first hydrologic investigation was conducted to evaluate the source of hexavalent chromium, which had been detected in a nearby municipal water supply well. In addition, a series of subsequent ground water and surface water studies were conducted to evaluate potential environmental impacts associated with SMC facility operations. Under an October, 1988 Administrative Consent Order (ACO) with the New Jersey Department of Environmental Protection (NJDEP), SMC contracted the design and installation of a 400 gallon per minute ground water pump and treat system to control off-site migration of hexavalent chromium. As a result of the ACO and further discussions with the NJDEP, SMC commenced with the removal of all of the materials from the Storage Yard that were not regulated by the USNRC. The only materials that exist within the Storage Yard today are those that are under the USNRC's jurisdiction.

A remedial investigation/ feasibility study (RI/FS) was also initiated under the ACO to fully characterize and evaluate potential non-NRC environmental impacts associated with the site. The 1988 ACO noted the NJDEP's and SMC's disagreement regarding the hazardous waste status of the chromium slag piles and the solid waste status of other slags, dross and baghouse dusts stored at the facility. The ACO stated that the chromium slag pile area and general slag area had not been fully investigated and required that investigation and remediation of soil and ground water contamination at and emanating from these areas be performed during the RI/FS. The 1988 ACO also acknowledged that the site was regulated by the USNRC and, therefore, certain activities conducted pursuant to the ACO could require the approval of the USNRC in addition to the approval of the NJDEP.

The RI report was completed in 1992 and a focused FS was prepared that addressed ground water remediation[20]. On September 24, 1996, a Record of Decision (ROD) was signed on which addresses the ground water remedial action.

In 1995, a series of six former wastewater treatment lagoons (designated as B-1, B-2, B-3, B-5, B-11 and B-12) were remediated and closed. The contents of the lagoons consisted of water and settled sludge containing metals (primarily chromium), generated from treatment, storage and

[20] TRC Environmental Corporation, Final Focused Feasibility Study Report, Ground Water Remediation, February 1994.

settling/polishing stages of the treatment process. Remediation of these lagoons entailed the following primary activities:[21]

- Characterization of the sludge in each lagoon;
- Removal, treatment and discharge of standing water from each of the units;
- Demolition of associated pump houses, valve pits and piping with disposal of all generated wastes;
- Solidification, excavation and off-site disposal of the accumulated sludge, lagoon liner, and impacted underlying bedding material and soils;
- Collection and chemical analysis of confirmatory soil samples from each lagoon;
- Supplemental excavation and disposal of impacted soils located beneath portions of the lagoons; and
- Backfilling and restoration of final grade.

In 1994, a lagoon characterization investigation was conducted for three additional former wastewater treatment lagoons (B6, B7 and B8). The objectives of the investigation were to characterize the lagoons' contents, with respect to quantity and composition. Closure followed and included the treatment and removal of lagoon surface water, excavation and disposal of sludge, removal and off-site disposal of lagoon liners and contaminated soils, and backfilling and grading of the lagoon excavations. Approximately 2.5 million gallons of chromium hydroxide sludge were removed, dewatered and disposed of as part of this remedial action, the details of which were captured in a 1999 report.[22]

As a result of the lagoon closure activities, changes were made to the on-site stormwater management system and to the outfalls used to discharge treated ground water as well as stormwater. Current site drainage and outfall locations are described in more detail in Section 3.4.1.2 of the attached Environmental Report (see Appendix 19.9).

Also in 1995, supplemental sampling was conducted to support the preparation of the FS surveys for the remaining media of concern at the SMC facility. The Draft Final FS addressing soil, surface

[21] TRC Environmental Corporation, Closure Report, Surface Impoundments B1, B2, B3, B5, B11 and B12, Liner and Contaminated Soil Removal and Disposal, dated April 1996 (revised August 2000).
[22] TRC Environmental Corporation, Closure Report, Surface Impoundments B6, B7 and B8, Liner and Contaminated Soil Removal and Disposal, April 1999, revised June 2000; Addendum issued June 2001.

water and sediment was issued in April 1996.[23] Among the recommendations included therein was the institution of deed restrictions to prevent future residential development of the facility.

As part of SMC's reorganization pursuant to Chapter 11 of the Bankruptcy Code, an Environmental Settlement Agreement (ESA) was developed that documented SMC's commitment to conduct natural resource restoration activities as outlined in a pre-settlement Scope of Work negotiated by SMC and the New Jersey Office of Natural Resource Damages (NJONRD). In accordance with that Scope of Work, a Natural Resource Restoration Plan, Upland Areas[24] was prepared and approved by NJONRD on November 25, 1997. The plan required creation of 9.65 acres of upland forest on the SMC property, with associated conservation easements to protect the planting areas from future disturbance. In 1999 and 2001, SMC initiated tree planting activities in accordance with this plan. Areas in which trees have been planted are indicated in Figure 18.4.

2.4 Spills
No radiological spills have been reported over the history of the license. Non-radiological incidents are described in Appendix 19.9 of this Plan.

2.5 Prior On-site Burials
No burial of radioactive material, other than that described in Sections 2.3 and 4.5 of this Plan has been reported over the history of the license.

[23] TRC Environmental Corporation, Draft Final Feasibility Study Report, Volumes I – III, April 1996.
[24] TRC Environmental Corporation, Natural Resource Restoration Plan, Upland Areas, October 1997.

3 FACILITY DESCRIPTION

The National Environmental Policy Act (NEPA) of 1969 (42 USC 4321 et seq.) requires Federal agencies, as part of their decision-making process, to consider the environmental impacts of actions under their jurisdiction. NUREG-1748, "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs, Final Report" was used to guide the preparation of an Environmental Report for the Newfield site as part of the environmental review process. Much of the information required in this (and subsequent) Chapters of this Plan was captured in the Environmental Report, and will thus not be repeated here other than to provide a reference as to the location of the necessary information within the Environmental Report, which is included in its entirety in Appendix 19.9 of this Plan. All references to the Environmental Report are noted with the letters "ER" followed by the relevant section, table, figure and/or appendix numbers. References without the letters "ER" refer to items (figures, appendices, etc.) of this Decommissioning Plan.

3.1 Site Location and Description

The following information on the site location and description can be found in the Environmental Report, as noted below:

- Details on the size and location of the SMC facility are provided in ER Section 1.3.1 and ER Figure 1-1.

- A general description of the features of the facility (natural and man-made) is provided in ER Section 1.3.1 and in ER Figure 1-2, with additional detail on the features of the facility provided in ER Section 1.3.2.

- The topography of the Newfield area is described in ER Section 3.4.1.2. Site-specific topography is described in ER Section 3.3.1.3. A USGS map of the topography in the area is provided in Figure 18.5 and a site-specific topographic map showing the contours and elevations of the facility is provided in ER Plate A.

- The man-made features of the site are detailed in ER Section 1.3.2 and are visible in the aerial photos presented in ER Figures 1-3 and 1-4.

- Adjacent property use is described generally in ER Section 1.3.1, with more information on land use in the surrounding area provided in ER Section 3.1.

- Ground water use, including the locations of public and private wells, is discussed in ER Section 3.4.2.2, as supported by the information and figures in ER Appendix F.

- The location of the site relative to surface water bodies, including rivers and lakes, is presented in ER Section 3.4.1 and ER Figures 1-1, 3-9 and 3-10. Additional Hydrologic Data is provided in ER Appendices C and D.

- Extensive subsurface investigations have been conducted at the site in association with CERCLA-related studies, as demonstrated in the monitoring well location plan (ER Figure 3-14) and in the geologic and hydrogeologic information presented in ER Appendices B and F.

- As described in ER Section 1.3.1, residences are located east of the site and south of the site along Weymouth Road. Some residences are also located to the west, along the western side of West Boulevard. These residences are visible on the USGS map in Figure 18.5 and in ER Figures 1-2 and 1-3. Potential sensitive locations from a noise and/or visual impact standpoint, including residential areas, schools, churches and a library, were identified as part of the Noise Analysis described in ER Section 3.7.2 and as part of the Visual Resource Analysis described in ER Section 3.9.3. These locations are described in ER Figure 3-18 (potential noise-sensitive locations) and in ER 3-7 and Figure 3-20 (potential viewpoints). Additional information on potential viewpoint locations is provided in ER Appendix I.

- A description of the facilities (e.g., buildings, parking lots, etc.) at the site is provided in ER Section 1.3.2. The aerial photo presented in ER Figure 1-4 presents a view of the existing site facilities as of January 2005.

3.2 Population Distribution

The property owned by SMC is located mostly in the Borough of Newfield in Gloucester County, with a small portion of the facility located in the City of Vineland in Cumberland County. An analysis of population data within a radius of 0.6 miles (i.e., 1 square mile) is presented in ER Section 3.10.1. Existing population data for the census tract block groups included within this radius is presented in ER 3-8. The population data for each individual census tract block group is provided in ER Appendix J. The locations of the census tracts and block numbers included in this analysis relative to the location of the SMC facility are provided in ER Figure 3-23. Population data for individual census blocks within a radius of 0.6 miles of the facility, sorted by compass quadrant, is also presented in ER Section 3.10.1 and ER Table 3-10.

Available population projection data is provided in ER Section 3.10.1. Available data are limited to general projections for the Borough of Newfield, the City of Vineland, Gloucester County (to the north and east), and Cumberland County (to the south and west).

3.3 Current/Future Land Use

Current and future land use in the general vicinity of the site is described in ER Section 3.1, as supplemented by ER Figures 3-1 through 3-4. Transportation plans for the area, which could impact future land use and growth, are described in ER Section 3.2.

3.4 Meteorology and Climatology

The following information on meteorology and climatology can be found in the Environmental Report as noted below:

- The general climate of the region, including a description of the types of air masses, synoptic features (high- and low-pressure systems and frontal systems), general airflow patterns (wind direction and speed), temperature and humidity, precipitation, and relationships between synoptic-scale atmospheric processes and local meteorological conditions is presented in ER Section 3.6.1;

- The seasonal and annual frequencies of severe weather phenomena, including tornadoes, water spouts, thunderstorms, lightning, hail, and high air pollution potential, are discussed in ER Section 3.6.2;

- Weather-related radionuclide transmission parameters, such as wind vectors, are discussed in ER Section 3.6.1 while the duration and intensity of precipitation events are discussed in ER Section 3.6.2;

- Routine weather-related site deterioration parameters are discussed in ER Sections 3.6.1 and 3.6.2;

- Extreme weather-related site deterioration parameters are discussed in ER Section 3.6.2;

- A description of the local (site) meteorology is presented in ER Section 3.6.1; and

- The location of the site relative to National Ambient Air Quality Standards classifications is discussed in ER Section 3.6.3.

3.5 Geology and Seismology

3.5.1 Geologic Characteristics of the Site and Surrounding Area

A detailed description of the regional geology is presented in ER Section 3.3.1, while a detailed description of the site geology is presented in ER Section 3.3.2. Maps indicating the extent, thickness, location and other information related to the various geologic units are included in Appendix 19.2.

3.5.2 Tectonic History

New Jersey is located on the North American plate, approximately midway between the Mid-Atlantic ridge (the boundary between the North American and Eurasian plates) and the convergent and transform boundaries along the western edge of the North American continent. Because New Jersey is situated in the interior of a plate, the state undergoes relatively little earthquake and no volcanic activities. The plate tectonic history of eastern North America is illustrated in Appendix 19.2 and summarized by the following events:

- Plate collision during the Grenville orogeny (1 billion years ago), which resulted in the formation of a supercontinent;
- Rifting, supercontinental fragmentation, and opening of the proto-Atlantic Ocean (Iapetus Ocean) around 500 million years ago;
- Subduction, closing of the Iapetus, plate collision, and assembly of Pangea, which formed the Appalachian mountains in at least three distinct phases of mountain-building (Taconic, Acadian, Alleghanian); this process ended between 300 and 250 million years ago;
- Rifting preceding the fragmentation of Pangea, which was responsible for producing the Newark basin (225-175 million years ago); and
- Opening of the Atlantic Ocean (at 175 million years ago) and sedimentation on the passive continental margin (strongly influenced by global sea-level fluctuations), the exposed part of which is the coastal plain.[25]

A discussion of the bedrock geology of the area, including the locations and characteristics of bedrock faults, is provided in ER Section 3.3.1.1. The geologic map of the Newark Quadrangle included in Appendix 19.2 presents the underlying bedrock structural geology that might influence the tectonics of the site area. A map of the generalized configuration of pre-Cretaceous bedrock surface in New Jersey and Delaware is also provided in Appendix 19.2. A figure of the locations of folds and faults in New Jersey relative to the SMC site location is also provided in Appendix 19.2.[26] The potential for geologic hazards is discussed in ER Section 3.3.1.3, including a summary of historic earthquakes, as supplemented by ER 3-2. The area is considered to present a low seismic potential.

3.5.3 Regional Tectonic Map

As discussed in ER Section 3.3.1.3, New Jersey is 2,000 miles from the Mid-Atlantic Ridge, the nearest plate boundary. The geologic map of the Newark Quadrangle included in Appendix 19.2

[25] Schlische, R.W., NJ Geology: Global and Regional Context

[26] NJGS, Bedrock Geology of New Jersey, NJGS DGS04-6, Bedrock Geology of New Jersey, http://www.state.nj.us/dep/njgs/geodata/archive.htm#geology, accessed September 9, 2005.

presents the underlying bedrock structural geology that might influence the tectonics of the site area. A figure of the locations of folds and faults in New Jersey relative to the SMC site location is also provided in Appendix 19.2.[27]

3.5.4 Structural Geology

A description of the structural geology of the region and its relationship to the site geologic structure is presented in ER Section 3.3.1. Unconsolidated materials underlie the entire county and dip and thicken to the southeast. Figures in Appendix 19.2 depict the sedimentary sequence.[28]

5.3.5 Crustal Tilting, Subsidence, Karst Terrain, Landslides, and Erosion

Metamorphic and igneous bedrock is present below the Newfield site at considerable depth (see Section 3.5.1, above). Subsidence, either due to collapse of karst terrain or fault movement related to underlying bedrock, is not believed to be a significant concern in the area.

A discussion of the overburden materials in the vicinity of the site and the potential for landslides and erosion is presented in ER Section 3.3.1.3.

3.5.6 Geologic Characteristics (Surface and Subsurface)

A description of the surface and subsurface geologic characteristics of the site and its vicinity is presented in ER Sections 3.3.2 and 3.3.1, respectively. Regional geologic cross-sections are presented in ER Figures 3-6 and 3-7, and a site-specific geologic cross-section is provided in ER Figure 3-8.

3.5.7 Geomorphology

The deposits of the Bridgeton Formation, possibly of glacial or interglacial origins, rest unconformably on the Cohansey Sand. Surface drainage across these sands during deposition and post-deposition has carved small stream valleys throughout the area, possibly exposing the Cohansey Sand in the stream valleys.

3.5.8 Faults

The nearest mapped fault of seismic significance (the Ramapo fault, located approximately 129 kilometers (80 miles) to the north of the site), general areas of seismic activity in New Jersey and the seismic potential of the area are discussed in ER Section 3.3.1.3. The locations of faults mapped in bedrock to the north and west of the site are documented on the Geologic Map of the Newark 1 x 2 degree Quadrangle, New Jersey Pennsylvania and New York, as presented in Appendix 19.2. A figure of the locations of folds and faults in New Jersey relative to the SMC site location is also

[27] Ibid.

[28] Copied from "Special Report 30: Water Resources and Geology of Gloucester County, New Jersey", NJDCED, Hardt, W.F. and Hilton, G.S., 1969; "Generalized Structural Contour Maps of the New Jersey Coastal Plain", Report 4, NJGS, Richards, H.G., Olmsted, F.H., and Ruhle, J.L., undated.

provided in Appendix 19.2. Also included in Appendix 19.2 is a figure showing seismic hazards in New Jersey.[29]

3.5.9 Deformation

Published descriptions of the Precambrian Wissahickon Formation, which underlies the Newfield site at a depth of over 2,000 feet, indicate that, nearer the outcrop area, the formation contains fractures, joints, crumpling, and folding. Future deformation of bedrock or the unconsolidated sequence above bedrock at this site is not a significant concern due to the low anticipated seismic potential and the considerable sequence of unconsolidated materials underlying the site and between the site and the bedrock surface.

3.5.10 Man-Made Geologic Features

Fill material has likely been placed along roadways and stream crossings in the area, and the landform at the site and that of surrounding properties may have been modified by minor cutting and filling activities. Bordering the SMC property to the northeast is the former Newfield municipal landfill. The landfill area can be identified on aerial photographs taken from 1962-1986 and, based on those photographs, at its largest, the landfill covered 1.2 acres.

As indicated in ER Section 3.1, there are no known mineral natural resources in the area with the possible exception of sand and gravel. Based on information available on the New Jersey Department of Environmental Protection website, there are approximately 140 sand and gravel surficial mining operations in Cumberland and Gloucester Counties. A list of these operations by county and by township name is provided in Appendix 19.2. Locations of sand/gravel mining operations in southern New Jersey relative to the SMC facility are indicated in a figure in Appendix 19.2.[30]

3.5.11 Seismology

Tectonics were previously described in Sections 3.5.2 and 3.5.3. The potential for geologic hazards is discussed in ER Section 3.3.1.3. The area is considered to present a low seismic potential. A complete list of all historical earthquakes that have a magnitude of 3 or more or a modified Mercalli intensity of IV or more within 320 kilometers (200 miles) of the site is presented in ER Table 3-2. A figure showing the locations of these earthquakes relative to the SMC site is presented in ER Appendix B.

3.6 Surface Water Hydrology

3.6.1 Site Drainage and Fluvial Features

Local hydrologic features are discussed in ER Section 3.4.1.2. Regional hydrology is described in ER Section 3.4.1.1. As described in ER Section 3.4.1.9, the predominant use of freshwater (surface

[29] USGS Earthquake Hazards Program website; htt;://neic.usgs.gov/neis/states/new_jersey/hazards.html; accessed September 14, 2005; last modified August 5, 2003.
[30] Selected Sand, Gravel and Rock Surficial Mining Operations in New Jersey; Digital Geodata Series DGS05-1, http://www.state.nj.us/dep/njgs/geodata/archive.htm; accessed September 9, 2005.

water and ground water combined) within the Maurice, Salem and Cohansey Watershed Management Area (WMA 17) is for mining (sand and gravel quarrying), followed by potable water supply, industrial use and agricultural use.

3.6.2 Water Resource Data

Water flow data for the Hudson Branch, Burnt Mill Branch and Maurice River are discussed in ER Section 3.4.1.3, as supplemented by information in ER Appendix C.

3.6.3 Topographic Maps

Topography in the area of the SMC facility is shown on the USGS Newfield Quadrangle (photo revised 1996), as shown in Figure 18.5. Local surface water features are also indicated on ER Figure 3-10. A detailed topographic map of the facility is presented as ER Plate A. Facility outfalls, manmade and natural drainage features and drainage areas are indicated on ER Plate B.

3.6.4 Surface Water Bodies

A description of the Maurice River is presented in ER Section 3.4.1.1, while a description of surface water bodies nearer the SMC facility is presented in ER Section 3.4.1.2.

3.6.5 Water Control Structures and Diversions

Water control structures are generally limited to the stormwater control features at the SMC facility as well as the underground diversion of stormwater from the Borough of Newfield across the SMC facility and into the Hudson Branch, both of which are described in ER Section 3.4.1.2, and a dam at downstream Burnt Mill Pond, as described in ER Section 3.4.1.2. There are no known existing or proposed water diversion structures along the Hudson Branch in the vicinity of the SMC facility.

3.6.6 Flow Duration Data

Available flow data for the Maurice River is summarized in ER Section 3.4.1.2, with additional information, including flow duration and low-flow frequency data, provided in ER Appendix C. While there is no stream flow gauging station on the Hudson Branch, available flow data as defined by historic studies is summarized in ER Section 3.4.1.2.

3.6.7 Aerial Photography of the Site

An aerial photograph of the site as it currently exists is presented in ER Figure 1-4, while an aerial photograph of the site taken in 2000 is presented in ER Figure 1-3. Both figures identify the location of the Hudson Branch, the on-site drainage basin, the former thermal cooling pond and the location of the Newfield Borough stormwater outfall. On-site drainage characteristics are described in ER Section 3.4.1.2 and are also illustrated on ER Plate B. During storm events, water tends to pond in the marsh area at the southwest corner of the site, approximately 900 feet downstream of the slag piles.

3.6.8 Existing and Planned Surface Water Uses

There are no known or planned surface water diversions in the Hudson Branch or the Burnt Mill Branch downstream of the site and upstream of the convergence with the Maurice River.[31]

3.6.9 100-Year Floodplain

Delineated flood hazard areas in the vicinity of the SMC facility, as mapped on Federal Emergency Management Agency (FEMA) flood insurance rate maps, are indicated in ER Figure 3-12. A special flood hazard area inundated by the 100-year flood has been identified along the Hudson Branch but does not extend significantly onto the SMC facility. The relative location of this area can be determined by referencing the FEMA maps of ER Figure 3-12 to the aerial photo of the facility, including the Hudson Branch, presented as ER Figure 1-4.

3.6.10 Man-Made Changes

Minor changes to surface water management features and the permitted NJPDES discharge outfalls at the SMC facility have occurred over recent years, as described in ER Section 3.4.1.2. As stormwater and treated ground water are now discharged into an on-site basin prior to being discharged to the Hudson Branch (as opposed to the direct discharge of treated ground water and stormwater into the Hudson Branch that occurred prior to the implementation of these changes), the discharge is stored temporarily on-site prior to discharge to the Hudson Branch. The discharge of treated ground water into the Hudson Branch from the on-site basin adds base flow to the stream; however, studies of the Hudson Branch indicate that, during low-flow conditions, flow in the Hudson Branch decreases until there is no measurable flow immediately upstream of Burnt Mill Pond.[32] Therefore, under low-flow conditions, this discharge does not greatly impact the flow within the Hudson Branch. Recent tree-planting activities at the facility, as described in ER Section 3.5.1.2, will provide additional attenuation of overland stormwater flow from the site as the trees mature.

In general, the SMC site and the town of Newfield, which is located adjacent to the site and to the north, are partially covered with impermeable materials (buildings and pavement) which would result in increased runoff as compared to undeveloped land. The topographic map of the area (see Figure 18.5) indicates a drainage divide north of the center of the town so that drainage to the north would be directed to the Burnt Mill Branch, while drainage to the south (including the SMC facility) would be toward the Hudson Branch (south). Other man-made changes in the area which may influence the surface water flow include roadway runoff during storm events and the presence of culverts below roadways, which may restrict flow in significant flood events.

The historical configuration of the Hudson Branch and tributaries in the immediate site area has changed since the development of the site. A review of historic aerial photographs indicates the characteristics of the Hudson Branch during the period when the facility was used for glass manufacturing (based on a 1940 aerial photograph), and changes in the characteristics of the Hudson

[31] Personal communication with Paul Horner, City of Vineland Water-Sewer-Utility Department.
[32] "Evaluation of Fate and Transport of Chromium and Total Dissolved Solids in the Hudson Branch-Burnt Mill Branch Tributaries to Maurice River", Environmental Resources Management, Inc., November 6, 1995.

Branch as the site was further developed (based on 1951, 1962, 1965, 1974, 1977 and 1986 aerial photographs). The 1940 aerial photograph shows the Hudson Branch as originating in the same area east of the facility, although it appears that drainage from an area east of the facility but north of the railroad track may contribute to the Hudson Branch headwaters. The existing ponded area south of the facility is not apparent in the 1940 photograph. The 1940 aerial photograph also indicates the presence of a drainageway which enters the Hudson Branch near the location of current Outfall 004A. The historic drainageway extends to the north-northeast through mostly undeveloped land that is currently the center of SMC's production area. The historic drainageway continues to the railroad tracks along the northern edge of the facility and it appears that drainage from an area north of the railroad tracks (as far north as Catawba Avenue) may also have contributed to this historic drainageway.[33]

3.7 Groundwater Hydrology

3.7.1 Saturated Zone

General information on the aquifers present within the area of the SMC facility is presented in ER Section 3.4.2.1, as supplemented by additional information presented in ER Appendix E. Site-specific characteristics of the shallow aquifer beneath the SMC facility are described in ER Section 3.4.2.3, as supplemented by additional information presented in ER Appendix F. There is a complicated relationship between ground water discharge/surface water recharge areas along with the Hudson Branch, as described in more detail in ER Section 3.4.1.3, with areas that exhibit surface water gain during certain times of the year and exhibit surface water loss during other times of the year.

3.7.2 Monitoring Wells

Information on large-capacity ground water wells in the vicinity of the SMC facility, including depths and formations in which the wells are screened, is provided in ER Section 3.4.2.2. This information is supplemented by information on both large-capacity and small-capacity wells presented in ER Appendix F, including locations, depths and pumping rates, where available. Information on a well restriction area that has been established downgradient of the SMC facility is presented in ER Section 3.4.2.2, as supplemented by information provided in ER Appendix F.

On-site monitoring wells are described in ER Section 3.4.2.3, with monitoring/extraction well construction details provided in ER 3-4, monitoring well locations indicated in ER Figure 3-14 and ER Appendix F, Figures F-3 and F-4, and recent ground water level elevation contour maps provided in ER Appendix F. Monitoring well logs and representative historic ground water elevation contour maps are provided in Appendix 19.2. Site monitoring wells monitor the various depths of the Cohansey Sand.

[33] "Remedial Investigation Technical Report", TRC Environmental Consultants, Inc., 1992; Draft Final Feasibility Study Report, TRC Environmental Corporation, April 1995.

3.7.3 Ground Water Flow Directions, Velocities and Other Physical Parameters

Ground water flow directions in both the upper and lower Cohansey Sands are described in ER Section 3.4.2.3, along with ground water flow velocity, vertical hydraulic gradient and estimated transmissivities. Ground water level elevation contour maps are provided in ER Appendix F and Appendix 19.2 of this Decommissioning Plan. A summary of aquifer testing and associated aquifer characteristics and analyses conducted by Dan Raviv Associates[34] is included in Appendix 19.2.

On-site ground water quality has been characterized through CERCLA ground water quality investigations as well as regular quarterly ground water monitoring conducted in association with the on-going ground water remediation program and through radiologic ground water investigations (see Section 3.7.8 below). Ground water monitoring conducted in association with the CERCLA remedial investigation activities utilized the strict sampling methods and quality assurance/quality control procedures specified for CERCLA investigation activities. On-going quarterly ground water monitoring results continue to be reviewed by the New Jersey Department of Environmental Protection.

3.7.4 Unsaturated Zone

The unsaturated zone at the SMC facility is characterized by the materials of the Bridgeton Formation, as described in ER Section 3.3.2. The extent of the Bridgeton Formation in the area surrounding the SMC facility is described in ER Section 3.3.1.2. Hydrogeologic studies of the SMC facility have focused on the Cohansey Sand; therefore, the hydrogeologic characteristics of the Bridgeton Formation have not specifically been evaluated. However, given the sandy nature of the formation, no perched ground water zones would be expected, nor would the formation be expected to impede the infiltration of water through the unsaturated zone in any other manner.

3.7.5 Monitor Stations

See Section 3.7.2 above.

3.7.6 Physical Parameters

Physical parameters of the underlying Cohansey Sands are described in Section 3.7.3 above. The investigations conducted to characterize these parameters include four aquifer tests performed for SMC, as well as two tests conducted during development of a proposed Newfield supply well adjacent to the site (to the northwest).[35,36]

3.7.7 Numerical Analysis Techniques

Numerous investigations and on-site and off-site hydraulic tests have been performed over the past 30 years in association with the investigation and remediation of ground water contaminated with chromium and volatile organic compounds. Information from the report, "Summary of

[34] "Summary of Geohydrologic Information Collected since January 1988," Dan Raviv Associates, Inc., April 1990.
[35] Woodward-Moorhouse & Associates, Inc., "Preliminary Report Groundwater Contamination Study Phase II", September 12, 1974.
[36] Roy F. Weston, Inc., "Hydrogeologic Investigation of Ground Water Contamination," Interim Report, February 1972.

Geohydrologic Information Collected Since January 1988" by Dan Raviv Associates, Inc. (April 1990), as provided in Appendix 19.2, summarizes those results and the data analysis. Computer modeling of the ground water flow system was performed and documented in the report, "Ground Water Remediation Alternatives" by Dan Raviv Associates, Inc. (January 1988).

3.7.8 Distribution of Radionuclides

Radiologic ground water monitoring results are described in ER Section 3.4.2.5.

3.8 Natural Resources

As described in ER Section 3.1, there are no known mineral, fuel, hydrocarbon or other similar-type natural resources in the areas surrounding the facility, with the exception of sand and gravel. Much of the surrounding area includes agricultural lands, also described in ER Section 3.1.

3.8.1 Potable, Agricultural, or Industrial Ground or Surface Waters

Ground water classification and use in the vicinity of the SMC facility is described in ER Section 3.4.2.2. Information on surface water classification and use in the vicinity of the SMC facility is provided in ER Section 3.4.1.9. Ground water is the primary source of domestic, agricultural, community and municipal water supplies in the area. There are no known or planned surface water diversions along the Hudson Branch or Burnt Mill Branch downstream of the site and upstream of the Maurice River for water supply or other purposes.

3.8.2 Economic, Marginally Economic, or Sub-economic Known or Identified Natural Resources[37]

According to Daniel Dombrowski of the New Jersey Geologic Survey, there are no known mineral, fuel, hydrocarbon, or other similar-type natural resources in the area surrounding the site, with the possible exception of sand or gravel. (Personal communication, 7/29/02). This information is validated by the Geologic Map of New Jersey, which identifies the formations surrounding the site as layers of gravel, sand, silt, and clay. This geologic formation, referred to as the Coastal Plain, "has been mined in the past for bog iron, glass sand, ceramic and brick titanium.... The mineral glauconite for use in fertilizer, and titanium....Today the Coastal Plain sediments continue to supply glass sand, and are extensively mined for construction material. The sand formations are productive aquifers and important ground water reservoirs."[38] Specific listings of mineral resources were not available.

3.8.3 Mineral, Fuel, and Hydrocarbon Resources Near and Surrounding the Site

There are no mineral, fuel, or hydrocarbon resources in the area other than sand and gravel. Mining of sand and gravel beyond the property boundaries at some time in the future would not be expected to affect the dose estimates described in Chapter 5 of this Plan.

[37] As defined in U.S. Geological Survey Circular 831
[38] From USGS website, www.usgs.gov/

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[37] As defined in U.S. Geological Survey Circular 831
[38] From USGS website, www.usgs.gov/

4 RADIOLOGICAL STATUS OF THE FACILITY

4.1 Contaminated Structures

The Newfield plant is divided into three functional areas, plus administration facilities. These are the manufacturing area, the Storage Yard, and other undeveloped plant property. The following are brief description of each functional area:

- Manufacturing Area - This area contains a number of operations facilities, offices, and loading docks. For the most part, the area is covered with buildings and asphalt or concrete pavement. Included are the Railroad Siding Area, Department 111 (former ferrocolumbium operation; building demolished), Department 102 (former aluminothermic reduction operation; building demolished), Department 112 (former crushing operations; building demolished), Department 107 (induction melting) Department 101 (metal grinding operations), Department 115 (aluminum master alloys), Department 116/118 (metal powder compaction operations), Department 203 (warehouse operations), and Department 204 (maintenance operations).[39,40]

- Storage Yard - This area is located on the eastern portion of the property, and is used to store materials generated during manufacturing operations. Slag generated during the ore processing procedures is stored in this area, as is baghouse dust, excavated soils and other similar materials.

- Other Undeveloped Plant Property - This area is located along the southern plant property boundary, and includes all undeveloped and unused areas of the plant.

By far the preponderance of the Newfield site has either never been impacted by licensed operations, or has already been free-released. The former includes the visitor center, administrative offices, Department 107, Department 101, Department 115, Department 116/118, Department 203, and Department 204, all of which have never housed licensed materials. The following is a listing of those structures or facilities that were, at one time, impacted by licensed operations, but that have since been remediated, as necessary, with final status surveys performed and documented, and the facilities subsequently released for unrestricted use:

- A-Warehouse; G-Warehouse;

- AAF Baghouse (with the exception of the concrete pad); and

[39] Department 111 and Department 102 process the radioactive materials for this operation.

[40] At one time, D-116 processed polishing compounds and other materials that are exempt from licensing pursuant to 10 CFR 40.13. Although these materials contained thorium and uranium, the cost of characterization, remediation and final status survey of D-116 is not included in this Plan because it was never a radiologically restricted area, and because the operations therein were exempt from the regulations in 10 CFR 40.

- Ferrovanadium slag sorting area in the Storage Yard (recently re-forested).[41,42,43,44]

The following buildings have been demolished, with all materials either disposed of as industrial waste or placed into a designated location on the property pending closure of the Storage Yard:

- The former D-111 ferrocolumbium production operations building
- The D-102/112 aluminothermic reduction and materials crushing operations building.

Documentation of the radiological status of the footprint of these buildings will be prepared as part of the site-wide final status survey.

There are over 20 buildings on the property, and their construction is either steel or wood frame or concrete block. Only three of them are currently designated as restricted areas, meaning source material was stored/used there at one time. These are D-117 (Cave), D-202 (Laboratory) and D-Warehouse. Figure 18.2 shows the location and size of the three restricted areas.

4.2 Background Levels

Ambient background gamma exposure rates in building locations have been performed as part of a number of different surveillance operations (e.g., final status surveys of A-Warehouse, G-Warehouse etc.), including compliance surveys performed and documented each quarter through Quarter 1, 2003.[45] The following subsections summarize these measurement results.

4.2.1 Ambient Gamma

Ambient gamma exposure rates were measured using a Bicron Microrem meter at a height of approximately one (1) meter above a ground or floor surface. These results confirm ambient gamma background dose rates within buildings ranging from seven (7) to eight (8) microrem per hour.[46]

Ambient gamma exposure rates in background locations have been performed as part of a number of different surveillance operations (e.g., final status surveys of Haul Road, ferrovanadium slag sorting area, etc.), including the compliance surveys performed and documented each quarter. While

[41] Shieldalloy Metallurgical Corporation, License Amendment Application to remove D203A (known as "A-Warehouse") from listing of permanent restricted areas, submitted on January 28, 1999. Amendment issued on July 20, 1999.

[42] Shieldalloy Metallurgical Corporation, "License Amendment Application to Remove Bldg. D203(G), also known as "G-Warehouse" from the listing of permanent restricted areas, submitted March 30, 2001.

[43] Shieldalloy Metallurgical Corporation, "License Amendment Application to Remove AAF Baghouse from the listing of permanent restricted areas, submitted January 30, 2000.

[44] Integrated Environmental Management, Inc., Report No. 94005/G-18198, "Soil Sampling/Survey of Storage Yard After Remediation", submitted to Shieldalloy Metallurgical Corporation, January 20, 2000.

[45] Because all licensed operations ceased prior to this time, the scope of routine surveillance activities was significantly reduced.

[46] A Microrem meter provides a tissue-equivalent response allowing a readout in microrem per hour (μrem/hr),

the values recorded are instrument- and geometry-dependent, the data acquired with a Bicron Microrem meter at a height of approximately one (1) meter above the ground surface indicate a background dose rate range of eight (8) to 15 microrem per hour in outdoor areas.[47]

4.2.2 Surface Contamination

Alpha backgrounds ranging from zero (0) to two (2) counts per minute were obtained using hand-held instruments. Background alpha activities using a large area floor monitors ranged from eight (8) to thirteen (13) counts per minute. Background beta results for the large area floor monitors ranged from 900 to 1080 counts per minute.

In all three of the restricted areas (D-117, D-202 and D-Warehouse), routine surveillance data acquired each calendar quarter confirm that there is no residual radioactivity in these areas. Nonetheless, their final radiological status as compared to the site-specific release criteria will be included in the final status survey report for this decommissioning effort.

Quarterly walkthroughs of the D202 laboratory (upper level) showed general area dose rates of background (approximately six microrem per hour), even in the vicinity of energized x-ray analysis equipment. Dose rates on the lower level ranged from six (6) to seven (7) microrem/hr, with a maximum of 40 microrem/hr at one foot from a locked safe that houses discrete samples of radioactive material. General area dose rates in Building D117 (i.e., the "Cave") also ranged from six (6) to seven (7) microrem per hour. All of these ambient dose rates, with the exception of those near the safe, are indistinguishable from those in the background data set.

4.2.3 Surface and Subsurface Soil

Background soil samples have been collected and analyzed by a variety of methodologies over the years. Table 17.2 contains a listing of these results.

4.3 Contaminated Systems and Equipment

The only buildings that contained systems and equipment for processing source material were D-111, the Flex-Kleen Baghouse, the AAF Baghouse, and D-102/112. The AAF Baghouse was demolished and released for unrestricted use in CY 2001. The Flex-Kleen Baghouse, D-111 and D-102/112 were decommissioned in CY 2002. Consequently, there are no longer any contaminated systems or equipment to be addressed in the site-wide decommissioning effort other than as part of the site-wide final status survey.

4.4 Surface Soil Contamination

4.4.1 Storage Yard

Ferrocolumbium standard slag, ferrocolumbium high-ratio slag, and columbium nickel slag generated from the D111 and D102 smelting operations consist of solid, non-combustible material with the consistency of vitrified rock. All three slag types were maintained separately from the others at their respective points of generation and were transported in trucks from D111 and D 102

[47] A Microrem meter provides a tissue-equivalent response allowing a readout in microrem per hour (μrem/hr),

to the Storage Yard. There are approximately 20,000 cubic meters of ferrocolumbium slag (high ratio and standard) in the Storage Yard. In addition, baghouse dust was transported by truck to the Storage Yard. Approximately 20,000 cubic meters of baghouse dust are currently in the Storage Yard.[48,49]

There are approximately 23 curies each of uranium and thorium in the form of slag and baghouse dust in the Storage Yard. The concentration of each in the slag is approximately 400 pCi/gram. In the baghouse dust, the concentrations are typically an order of magnitude lower.

The physical form of the slag in the Storage Yard slag (glass-like rock) does not permit the radioactive elements to leach out into the regional water supply or local wetlands. Leachability and distribution coefficient studies performed on samples of the slag support this conclusion.[50] Also, the surface of the baghouse dust pile forms a "crust" when it encounters moisture, which serves to deter fugitive dust emissions. The radiation exposure rates in this area range from background to less than 0.2 milliR per hour, with the maximum measured exposure rate being due north of the Storage Yard, approximately 30 feet from the slag piles.

The Storage Yard also contains approximately 6,500 m^3 of soil excavated during the remediation of the Haul Road. The Haul Road was, at one time, a county right-of-way that ran through SMC's Newfield plant. Over the years, the south portion of the road was surfaced with crushed slag from SMC operations. Characterization efforts that took place in 1988 and 1991 showed that the contact exposure rates in and near the road were only slightly discernible from background, that the contaminants therein were natural uranium and natural thorium, and that the slag used to form the road bed was not characteristic of licensed material (i.e., ferrocolumbium slag).[51,52,53] In September of 1998, approximately 6,500 m^3 of predominantly soil, with some residual slag, was scraped from the road transferred to the Storage Yard. This soil was conservatively assessed as containing 0.2

[48] Historically, dusts generated from both ferrocolumbium production and un-recycled dusts from ferrovanadium production were not segregated. Currently, however, the ferrovanadium contribution to the collected dusts is negligible.
[49] From the volumetric information obtained from an October, 1991 fly-over of the Newfield site, the Storage Yard contained 16,800 m^3 of standard slag and 1040 m^3 of high-ratio slag at that time, for a total of 17,840 m^3 (Shieldalloy Metallurgical Corporation, "Applicant's Environmental Report for the Newfield, New Jersey Facility", October 1, 1992). The volume of slag produced during ferrocolumbium operations performed after the 1991 fly-over and before the date of this report was added to this total in order to estimate the present-day volume of slag in the Storage Yard.
[50] Teledyne Isotopes, "Report of Leachability Studies for Shieldalloy Metallurgical Corporation", Teledyne Isotopes, Westwood, New Jersey, 1992.
[51] Oak Ridge Associated Universities, "Radiological Survey of the Shieldalloy Metallurgical Corporation, Newfield, New Jersey", Report No. ORAU 88/G-79, July, 1988.
[52] IT Corporation, "Assessment of Environmental Radiological Conditions at the Newfield Facility", Report No. IT/NS-92-106, April 2, 1992.
[53] Exposure rates in and near the road generally ranged from background to 26 microR per hour, with a maximum exposure rate of 90 microR per hour directly over slag pieces. If these are compared to the contact exposure rate from ferrocolumbium slag, which is in the vicinity of 1,000 to 2,000 microR per hour, it is clear that the slag in the road was the result of a different operation.

curies of uranium, and thorium.[54] A final status survey of the remediated area demonstrated that the Haul Road may be released for unrestricted use (i.e., without regard for radiological constituents).[55]

External exposure rates at the perimeter fence of the Newfield facility are measured using thermoluminescent dosimeters (TLD). Dosimeters are deployed once each quarter, with deployment logs and results captured in various surveillance reports. From these data, the ambient exposure rate measured around the circumference of the Storage Yard ranges from "background" to approximately 130 microR per hour, with an average measured rate of approximately 30 microR per hour.[56]

4.4.2 Demolition Concrete

The only areas within the Newfield plant property lines where residual radioactivity exists in surface soils, other than in the Storage Yard, are the concrete pads that housed the former AAF and Flex-Kleen Baghouses, D-111 and D-102/112. In addition, residual radioactivity was identified in the Hudson's Branch watershed in the late 1980's.[57] The Hudson's Branch, an intermittent, slow-moving tributary of Burnt Mill Branch in the Maurice River Basin, is the predominant surface water body in the vicinity of the plant. It borders the southern boundary of the property, where it flows from east to west.[58]

Ambient gamma exposure rates in environmental background locations have been performed as part of a number of different surveillance operations (e.g., final status surveys of Haul Road, ferrovanadium slag sorting area, etc.), including compliance surveys performed and documented each quarter. The values recorded are instrument- and geometry-dependent. However, data acquired with a Bicron Microrem meter at a height of approximately one (1) meter above the ground surface indicate a background dose rates ranging from eight (8) to 15 microrem per hour in outdoor areas.[59]

Background soil samples have been collected and analyzed by a variety of organizations and methodologies over the years. Table 17.2 is a compendium of background soil concentrations of uranium and thorium isotopes acquired during these measurement campaigns.

On and around the concrete pads and footprints that remain after demolition of the AAF Baghouse, D-111 and D-102/112, the only radionuclides of concern are thorium and uranium, with progeny in general equilibrium. From the final status survey report for the AAF Baghouse decommissioning,

[54] If the source material content of ferrocolumbium slag (i.e., 400 pCi per gram each of thorium and uranium) is multiplied by the ratio of the maximum contact exposure rates for the materials excavated from the road and ferrocolumbium slag, a reasonable estimate of the source material concentration in the excavated soils is 18 pCi per gram. Assuming a soil density of 1.6 grams per cm^3, and a total soil volume of 6,500 m^3, the curie content of the excavated soils is about 0.2 curies each of uranium and thorium.

[55] Integrated Environmental Management, Inc. Report No. 94005/G-17172, "Final Status Survey of Haul Road", June 22, 1999.

[56] Berger, C. D., "Quarter 4, 2004 Perimeter Monitoring Results", submitted to D. R. Smith, January 3, 2005.

[57] "Baseline Radiological Risk Assessment for the Hudson's Branch Watershed", IT Corporation Report No. IT/NS-92-116, submitted to Shieldalloy Metallurgical Corporation, Newfield, New Jersey, November 3, 1992.

[58] The Hudson's Branch flows from northeast to southwest after it leaves the SMC property.

[59] A Microrem meter provides a tissue-equivalent response allowing a readout in microrem per hour (μrem/hr),

the concrete pad was shown to contain up to 19,800 dpm/100 cm² of residual beta activity.[60] During the most recent quarterly compliance surveillance effort, a maximum of 1868 dpm/100 cm² of alpha activity from direct frisks was noted on that surface. Smears of the pad are negative for the presence of removable alpha or beta activity, meaning the measured residual radioactivity is affixed to the pad. For D-111, the concrete pad exhibits residual radioactivity levels that are in the range of background. For D-102/112, the earthen floor exhibits residual radioactivity levels that are also within the range of background. The residual radioactivity on all of these surfaces is confined to the top two (2) millimeters at most. The contaminants are natural thorium and uranium, plus progeny in general equilibrium.

The radionuclide concentration in the Hudson's Branch was summarized in a 1992 risk assessment report.[61] There it was shown that the presence of those materials, which were uranium and thorium plus progeny, presented an insignificant radiological risk to members of the public. A scale drawing and map showing the Hudson's Branch Watershed, with ambient exposure rates, can be found in Appendix B of the Environmental Report (Appendix 19.9 of this Plan). That Appendix also shows the location of soil sampling, along with a graphical representation of the results.

4.5 Subsurface Soil Contamination

Subsurface soil contamination, in the form of embedded ferrocolumbium slag, is confirmed to be present in the Storage Yard. Figure 18.11 shows the location of all deposits.

Subsurface radioactivity may also be present at a number of locations throughout the Newfield plant where slag was used as fill, although this is thought to be unlikely. The locations of interest are the southwest fence line and in the T12 Tank Area, neither of which have ever been designated "Restricted Areas". These areas exhibit ambient exposure rates that range from background to only a few tens of microR per hour.[62]

While the mass of fill slag therein has not been well-characterized, the lateral extent of the elevated surface exposure rates (i.e., approximately 8,000 m^2) gives a reasonable estimate of its spatial extent.[63] That, along with an arbitrary assumption of uniform thickness of one (1) meter over this entire area results in a generous estimate of 8,000 m^3 of fill slag. Although it has never been confirmed whether these discrete slag deposits contain licenseable radioactivity, if that were to be

[60] Integrated Environmental Management, Inc. Report No. 94005/G-20187, "Demolition and Final Survey of the AAF Baghouse", submitted to Shieldalloy Metallurgical Corporation on January 7, 2000.

[61] "Baseline Radiological Risk Assessment for the Hudson's Branch Watershed", IT Corporation Report No. IT/NS-92-116, submitted to Shieldalloy Metallurgical Corporation, Newfield, New Jersey, November 3, 1992.

[62] IT Corporation, "Assessment of Environmental Radiological Conditions at the Newfield Facility", IT Corporation Report No. IT/NS-92-106, April 1, 1992.

[63] Berger, C. D., A. Chance, K. Wiggins and H. Prichard, "Assessment of Environmental Radiological Conditions at the Newfield Facility", IT Corporation Report No. IT/NS-92-106, submitted to Shieldalloy Metallurgical Corporation, Newfield, New Jersey, April 1, 1992.

the case, they would have a nominal radionuclide content of approximately 4.2 curies each of uranium and thorium.[64,65]

4.6 Surface Water

From many years of sample collection and analysis, it can be shown that the surface water collected from the vicinity of the Newfield site does not exhibit elevated (above background) radionuclide concentrations.[66]

4.7 Groundwater

The radionuclide content of groundwater collected from the vicinity of the Newfield site is described in Section 3.7.8, above. The most recent sampling campaign took place on April 13, 2005, where samples were collected from four (4) on-site wells and from a well that belongs to the Borough of Newfield.[67] The findings from that assessment were that the radionuclide content of the groundwater under the Shieldalloy site cannot be distinguished from background, and that the presence of licensed source material at the plant has no apparent impact on the radiological quality of the groundwater.[68]

The slag and baghouse dust contained within the Storage Yard have been placed directly upon the ground surface. Because the leach rate of radionuclides from these materials is low, sub-surface activity beyond a nominal depth of 30 cm, attributable mainly to slag burial, is unlikely. In those areas on the property where slag may have been used as fill, the maximum depth of deposition can be reasonably assumed to be one (1) meter or less.[69]

[64] Assuming a source material concentration of 400 pCi per gram each of thorium and uranium in the slag, a slag density of 1.3 grams per cubic centimeter, and a total slag volume of 8,000 m^3, the curie content of the slag used as fill is approximately 8.4 curies each of uranium and thorium.

[65] These areas will addressed during the performance of the site-wide final status survey (see Chapter 14).

[66] TRC Environmental Consultants, Inc., "Remedial Investigation Technical Report", Project No. 7650-N51, Windsor Connecticut, April, 1992.

[67] The Newfield well is up-gradient of the Shieldalloy Metallurgical Corporation (Shieldalloy) plant, and is thus representative of "background" groundwater.

[68] Berger, C. D., written communication to D. Smith, "Results of Ground Water Sampling (April 13, 2005)", June 29, 2005.

[69] However, it is important to note that, in order to main the structural integrity of the areas where slag may have been used as fill, the potential radionuclide distribution and depth have not yet been characterized.

5 DOSE MODELING EVALUATIONS

A critical aspect of this decommissioning plan is an assessment of the potential radiation dose that could result from the residual radioactivity at the Newfield site after all decommissioning activities are completed. However, an important point is that the Newfield site is actually treated as two separate areas for dose modeling purposes. This is because SMC proposes to release the majority of the site for unrestricted use. However, a much small portion of the property will be placed under a LTC license where its use will be restricted. Therefore, the dose modeling must demonstrate that both of the following limits can be met when decommissioning is complete:[70,71]

> *"A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 25 millirem (0.25 mSv) per year, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are As Low As Reasonably Achievable (ALARA). Determination of the levels which are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal."*

and:

> *"A site will be considered acceptable for license termination under restricted conditions if: ... (e) Residual radioactivity at the site has been reduced so that if the institutional controls were no longer in effect, there is reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group is as low as reasonably achievable and would not exceed either– (e)(1) 100 mrem (1 mSv) per year–, . . ."*

For the decommissioning of the majority of the SMC site, excluding approximately eight (8) acres within the Storage Yard, a radiation dose objective of 25 millirem above background is applicable and is therefore used as the basis for demonstrating that this portion may be released for unrestricted use. A radiation dose objective of less than 100 mrem per year is applicable for the restricted LTC portion of the Storage Yard in the unlikely event that all controls fail. However, with controls in place, even the restricted portion must meet the 25 millirem criterion.

[70] US Nuclear Regulatory Commission, *Radiological Criteria for Unrestricted Use*, Title 10 CFR 20.1402, July 21, 1997.

[71] US Nuclear Regulatory Commission, *Criteria For License Termination Under Restricted Conditions*, Title 10 CFR 20.1403, July 21, 1997.

The U. S. Nuclear Regulatory Commission (USNRC) developed guidance on acceptable approaches and methodologies for radiation dose modeling to demonstrate compliance with the aforementioned dose limits. As recommended , SMC has selected the scenarios and critical population groups, developed the source term, selected exposure pathways and calculated DCGLs in accordance with NUREG-1757 recommendations.[72] The following subsections of this chapter contain this information. Included herein is a brief description of the methodology used to perform the dose assessments, a detailed description of the site conceptual model which includes the source term used as input to the assessment, the exposure scenarios deemed reasonably likely under LTC conditions, less likely exposure scenarios if the controls specified as part of the terms of the LTC license should fail, a presentation of the uncertainty associated with the input parameters, and the findings (results) of the assessment. Included as well is a statement as to whether the requirements for unrestricted release of most of the property have been met, and whether the portion of the site to be subject to the terms and conditions of the LTC license meets the applicable dose criteria.

5.1 Assessment Methodology

The process of assessing the radiation dose potential for SMC's Newfield site involves defining the source(s), preparing a site conceptual model, identifying the likely pathways for potential human exposure, and assessing the availability of a receptor to receive a dose. However, the relationships between these factors are complex and often interdependent. Therefore, a computer program to model the plausible human exposure scenarios and to perform the complex sets of computations was employed.

The computer code, RESRAD (Version 6.22) was used to model radionuclide fate and transport of residual radioactivity at the site and to assess the radiation dose incurred by hypothetical receptors who may be impacted by the site after decommissioning is complete.[73] This code provides an estimate of the annual radiation dose beginning immediately after decommissioning is complete and extending for 1,000 years into the future.[74] It is widely-accepted as an industry-standard tool for performing radiological dose assessments and for deriving DCGLs. However, there are several important features of the code that should be taken into account in interpreting any results that are generated. These include the following:

- The radiation dose conversion factors (DCFs) used in RESRAD 6.22 are taken from Federal Guidance Reports (FGRs) No. 11 and 12, which are derived from outdated

[72] U.S. Nuclear Regulatory Commission, *Consolidated NMSS Decommissioning Guidance-Decommissioning Process for Materials Licensees*, NUREG-1757, Volume 1, September, 2003.
[73] Yu, C, Zielen, A.J, et al, *User's Manual for RESRAD Version 6*, ANL/EAD-4, Argonne National Laboratory, Argonne, Illinois, July, 2001.
[74] The RESRAD code was chosen primarily because it can adequately depict the key site-specific features of SMC's site. It is also able to derive values for exposure parameters based on built-in fate and transport computations using well-defined site-specific data. In addition, the code is able to integrate radiation dose projections over time taking into account transient conditions that may occur.

dosimetry model promulgated by the International Commission on Radiation Protection (ICRP);[75,76,77,78]

- Short-lived radioactive progeny (e.g. half-life less than 180 days) are accounted for using the "parent+D" DCFs;

- RESRAD integrates and normalizes exposure factors based on the fraction of time a receptor is exposed over the exposure period;[79] and

- RESRAD uses single-point estimates for values of every parameter to evaluate complete pathways in the deterministic module of the code.

Another feature of the RESRAD code is that the user may select from two types of risk assessment methods, deterministic and probabilistic.[80] Most professionals are familiar with the deterministic approach because it has been, until recently, the most widely used of the two. It is designed to capture the reasonable maximum exposure (RME) condition for a receptor using single point estimates of parameter values used to calculate dose. Such a calculation provides a single point estimate of radiation dose that could result from a given concentration of radioactivity. For the purposes of modeling radiation doses for the SMC site, a deterministic approach was used to establish the acceptable concentrations of uranium and thorium in the surface soil in that portion of the property to be released for unrestricted use (i.e., DCGLs).

Few of the parameters used to calculate deterministic dose potentials so far into the future are so well known that they can be described by a single value. Therefore, a reasonable alternative is to use unrealistically-conservative input parameters in order to bound the inherent uncertainty in the deterministic approach. However, this often leads to gross over-estimation of the radiological impact of the site.[81]

Another approach is the probabilistic methodology for risk assessment, which addresses the potential for exposure through what is essentially an uncertainty analysis, taking both the range and

[75] U.S. Environmental Protection Agency, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, Federal Guidance Report Number 11, EPA 520/1-88-20, September, 1988.
[76] U.S. Environmental Protection Agency, *External Exposure to Radionuclides in Air, Water and Soil*, Federal Guidance Report Number 12, EPA 402 R-93-081, September, 1993.
[77] International Council on Radiation Protection, *Report of the Task Force on Reference Man*, ICRP Report 23, 1981.
[78] The bio-kinetic dosimetry model accounts for particle fractioning that might occur following exposure. For example, the DCFs for particle inhalation account for the dose to the GI tract from the fraction of respired particles that are ingested. As a result, there is no need to independently account for biological fractioning in the dose calculations.
[79] For example, a soil ingestion rate of 100 mg/d for a receptor who is exposed on Site for only 50-percent of one day would result in an ingestion intake of 50 mg.
[80] Table 5.1 summarizes the principal differences that exist between the deterministic and probabilistic methods.
[81] This difficulty was acknowledged by the USNRC in recent guidance specific to SMC and in supplemental information to accompany NUREG-1757.

distribution of individual input parameters into consideration.[82] The probabilistic method provides a substantially clearer picture of what the dosimetric impacts of a decommissioning method might be and it is a useful tool for risk managers.

Because the USNRC has established their decision-making criteria on the use of probabilistic assessment methods and the resulting mean or "reasonably foreseeable" exposure to an average member of the critical exposure group, and because it is a required assessment methodology in NUREG-1757, this is the approach that was used by SMC in its assessment of the dose potential for the two areas at the Newfield site (i.e., the restricted and the unrestricted areas).[83,84,85,86] It was used to evaluate the range of the radiation dose potentials associated with the restricted area, and those associated with the DCGLs for the unrestricted portion of the site. This remainder of this Chapter summarizes the various dose assessments as follows: Section 5.2 describes the site conceptual model, the radioactive source term and the physical parameters of the SMC site that are used as input to the computer modeling; Section 5.3 describes the reasonably likely exposure scenarios for both the unrestricted and restricted areas of the site, and the less likely scenarios for the restricted area if all controls should fail; Section 5.4 describes the uncertainty associated with the input parameters; and Section 5.5 presents the results of the dose modeling performed for the Newfield facility.

5.2 Site Conceptual Model

A site conceptual model has three fundamental components that must be described in order to calculate (or model) the potential future dose to a receptor at or near the decommissioned SMC site. The first component is the source term itself.[87] The second is the physical characteristics of the site.[88] And the third is the range of realistic (plausible) human exposure scenarios, described primarily by factors that are associated with human behavior and metabolic physics. Each of these fundamental components is discussed in the subsections that follow.

5.2.1 Source Term

The source term abstraction used by the RESRAD code to project potential future dose is derived from knowledge about the source material itself, and previously completed radiological assessments of the residual radioactivity at the Newfield site. The source term is defined by its radionuclide composition, as well as its lateral and vertical extent (spatial configuration).

[82] U.S. Nuclear Regulatory Commission, *Consolidated NMSS Decommissioning Guidance, Decommissioning Process for Materials Licensees*, NUREG 1757, Vol. 1, Rev. 1, September, 2003.
[83] The average member of the critical group is used rather than using the RME for the entire population. In a typical deterministic risk, the RME is used for the entire population.
[84] As defined in 10 CFR 20.1003, the critical group is a group of individuals expected to receive the greatest exposure to residual radioactivity for any applicable set of conditions.
[85] U.S. Nuclear Regulatory Commission, *Radiological Criteria for License Termination*, Volume 62, Federal Register, page 39058, July 21, 1997.
[86] NUREG-1757, Vol. 2, Section 2.1, September, 2003.
[87] The size, thickness, and radiological composition of the source must be conceptualized in the source term abstraction.
[88] The site must be described in a physical abstraction that includes physical and hydraulic characteristics of the site and its potentially impacted environment.

5.2.1.1 Values Used to Describe the Unrestricted Area Source Term

The source term for the unrestricted area is the residual concentrations of radioactive materials that will be allowed to remain after remediation is complete. That concentration is bounded by an upper limit on radiation dose of 25 millirem, TEDE, and applies only to the unrestricted portion of the site (i.e., the preponderance of the total property area).

In describing the source term for input to RESRAD, the area (size) of the unrestricted contaminated zone parameter (AREA) is equal to the area of the SMC property, excluding the planned restricted area that will be in the current Storage Yard. The minimum unrestricted area is represented by a triangular distribution with a minimum value of 244,000 m^2 and a maximum value of 295,000 m^2. The maximum area is established by the property boundary but includes the Storage Yard. The minimum value is considered to be the most likely value.

The use of the log-uniform distribution provides a realistic, yet conservative, description of the lateral variability in the size of the source term in that it assigns the most likely size (244,000 m^2) as the minimum size and allows for the possibility (albeit with lower probability of occurrence) of larger sizes up to the entirety of the property. Vertically, the radiologically significant material is assumed to be located in the top six (6) inches of soil (e.g. 0.15 meters), with no cover. The thickness of the contaminated zone parameter (THICKO) is represented by a triangular distribution, with the central tendency (CT) value conservatively set to a thickness of 0.5 feet (0.15 meters). The input parameters used to describe the Newfield unrestricted area are summarized in Tables 17.3.1 through 17.3.12.

5.2.1.2 Values Used to Describe the Restricted Area Source Term

The source term in the restricted portion of the Newfield site has a variety of contributors, including the engineered barrier, boulders of vitreous, radionuclide-bearing slag, a baghouse dust pile with exempt source material concentrations, contaminated soil and surface-contaminated building rubble. The radionuclide content of each of these contributors was described in Section 4.4, above, and summarized as an effective single, consolidated volume in Table 17.7. SMC intends to establish a boundary around the restricted area such that the applicable dose limits in both the restricted and unrestricted portions of the property are satisfied separately for each area.

In describing the restricted area source term for input to RESRAD, the area (size) of the consolidated contaminated zone parameter (AREA) is represented by a log-uniform distribution with a minimum value of 18,228 m^2 and a maximum value of 28,767 m^2. The minimum size is equal to the footprint of the proposed engineered barrier. The maximum value represents the area currently occupied by the Storage Yard. The use of the log-uniform distribution provides a realistic, yet conservative, description of the lateral variability in the size of the source term in that it assigns the most likely size (28,767 m^2) as the minimum size. Vertically, the radiologically-significant material is assumed to be located beneath the cover.

The thickness of the contaminated zone parameter (THICKO) is represented by a triangular distribution, with the central tendency (CT) value conservatively set to a thickness of nine (9) feet. The thickness of the engineered barrier has a central tendency value of four (4) feet.

As described in Chapter 4, the radionuclide composition of the materials to be consolidated is defined by both measured isotopic ratios in samples collected from within the contaminated volume and by historical knowledge of the origin of the radioactivity found within the volume. The relatively longer-lived progeny of ^{232}Th and ^{238}U are assumed to be in secular equilibrium with their parent. This assumption is not only conservative but it is supported by the results of analytical measurements. Therefore, the source term used as input to RESRAD includes all of the isotopes in the ^{238}U and ^{232}Th decay series with half-lives longer than 180 days, and in the concentrations shown in Table 17.7.[89]

5.2.2 Site Physical Parameters

The second major conceptual component of a dose assessment is the physical abstraction of the site, which must capture and express the important physical, hydraulic, and geological conditions at the site. It is also used to place the source term in the context of the environment and systems that surround it.[90]

5.2.2.1 Values Used to Describe the Unrestricted Area

The RESRAD computer model uses information about the physical characteristics of the site to estimate the potential migration of radionuclides and the ultimate distribution of the radioactive materials in the pathways for exposure of the receptor (in this case, an "industrial worker") over the course of 1,000 years. For the unrestricted area, the three layers defined in Section 5.2.2.2 were used as input to the RESRAD model. For the "contaminated zone", it was assumed that the radioactivity is present in the top 6 inches (0.15 meters) of the surface and no cover was applied to limit direct contact with the radioactivity. Thus, the surface soil is the contaminated zone and the surface soil erosion rate is captured in the RESRAD model as the contaminated zone erosion rate (VCZ).

In recognition of the relatively flat topographic features present at the site, the general meteorological signature for the area, and the non-invasive nature of the future use scenarios, all of which argue for lower than average soil erosion potentials, the contaminated zone erosion rate was conservatively modeled with a deterministic value of 0.001 m/yr (1 m/1,000 years), equivalent to the RESRAD default value.[91] Annual dose estimates are not particularly sensitive to this parameter since the peak

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[89] Isotopes with half-lives shorter than 180 days are assumed to be in equilibrium with their first parent with a half-life greater than 180 days and a re accounted for in dose calculations through the use of "parent+D" dose conversion factors.

[90] The physical, hydraulic, and geologic conditions must be described and input into RESRAD. RESRAD is not a comprehensive model for the fate and transport of groundwater and surface water. It does, however, model the vertical migration of radiological contaminants from the surface or near surface soils to ground water sources of drinking water and surface water bodies for the purpose of calculating the potential exposure to human receptors who may use such water.

[91] This may not be true as described for the excavation scenario, where some of the radioactive materials could be exposed.

annual dose occurs in the first year after deposition, and decreases each year thereafter, regardless of the surface soil erosion rate used. The other layers, the unsaturated zone and the saturated zone exhibited the same characteristics as those described in the restricted area. The input parameters used for the unrestricted area physical characteristics are described in 5.7.

5.2.2.2 Values Used to Describe the Restricted Area

Conceptually, the restricted area at the Newfield site after decommissioning is complete will be composed of four "layers", all of which are important to the dose modeling objective. These are:

- Engineered Barrier Layer - a thick layer of unimpacted native soil, a geomembrane liner, topsoil and vegetation brought onto the site to form a cap over the contaminated zone and underlying waste layer;[92]

- Contaminated Zone Layer - a layer generally lying just beneath the engineered barrier in which radionuclide-bearing materials are consolidated;

- Undisturbed Surface Layer - a relatively thick, dense, undisturbed native deposit of gravel/sands of the Bridgeton Formation (thickness ranging from 8 to 10 feet), underlain by the fine- to coarse-grained sands of the Cohansey Sand; and

- Saturated Zone Layer - the saturated Cohansey Sand to the depth of the confining Kirkwood formation (i.e., 120 feet or more).

The various parameters describing the composition in each "layer" are defined within RESRAD with probabilistic variables included in order to account for the variability and uncertainty inherent in hydrogeological features. The parameters defining each layer used as input to the code are described in detail in the subsections that follow.

5.2.2.2.1 Engineered Barrier Layer

The engineered barrier overlies the radionuclide-bearing consolidated material. It is comprised of soil and geomembrane membrane cap made of native materials brought onto the site and installed. The thickness of the engineered barrier is one (1) meter. A triangular distribution with a central tendency value of one meter and a minimum and maximum of 0.9 and 1.2 meters, respectively, are used to represent the thickness of this layer in the RESRAD model.

The engineered barrier incorporates a geomembrane to minimize the infiltration of water from precipitation. Additional information on the characteristics and longevity of the geomembrane is provided in Sections 5.4.3.2 and 8.3.3. The soil density of the cover is assumed to be equivalent to tat of native soil in the region (1.3 g/cm^3). When modeling the subsurface-soil source term in RESRAD, this layer is identified as the "cover layer" since it overlies the contamination zone. Cover degradation is accounted for in RESRAD by a surface soil erosion rate parameter (VCV). The value

[92] The engineered barrier includes a geomembrane to divert surface water.

used as input to the code, 0.5 feet (0.15 meters) over a 1,000-year period, as derived using the Revised Universal Soil Loss Equation computer program, version 2 (RUSLE 2), the MPV method (as recommended in NUREG-1623) and conservative input parameters.[93] Appendix 19.3 contains the findings of these analyses.

5.2.2.2.2 Contaminated Zone Layer

Residual radioactivity in the form of ferrocolumbium slag, baghouse dust, soil and contaminated building rubble will be consolidated within a portion of the existing Storage Yard and then capped with the engineered barrier described previously. The contaminated zone will consist of 65,800 cubic meters of material, with a mean density of 2.8 g/cm^3 and a hydraulic conductivity of 2,000 meters per year.[94]

Information regarding the partition coefficients (K_d) is provided in Section 5.4.3 of this Chapter and 5.24. Testing indicates that the radionuclides are tightly bound in the slag matrix and do not leach into water.

The contaminated zone and the engineered barrier are constructed in the shape of a chevron with slopes of approximately 3:1. The volume of both is approximately 76,870 m^3. As described in Section 5.2.1.2 of this report, the use of a log-uniform distribution provides a realistic, yet conservative, description of the lateral variability in the size of the contaminated zone in that it assigns the most likely size (18,228 m^2) as the minimum size and allows for the possibility (albeit with lower probability of occurrence) of larger sizes up to the entire area currently covered by the Storage Yard.

5.2.2.2.3 Undisturbed Surface Layer

The third layer is the undisturbed native deposits of gravel/sand layer of the Bridgeton Formation, underlain by coarse-grained sands of the Cohansey Sand. There is little to a trace of silt found in the Cohansey Sand. This layer is estimated to range in thickness between 8 and 10 feet (2.5 to 3.1 meters) with a nominal or typical thickness of approximately 8 ft.(2.5 meter).

RESRAD identifies this layer as the "unsaturated layer" when modeling the source term. The thickness of this zone is bounded with a triangular distribution, having a central tendency value of 2.5 meter bounded and a maximum of 3.1 meters. Measured soil density is 1.3 g/cm^3 and measured hydraulic conductivity is 0.017 m/yr. The radionuclide distribution coefficients described in Section 5.4.3.3 were used for all isotopes.[95]

[93] TRC Environmental Corporation, *Estimated Soil Loss from Soil Cap*, Project Number 26770-0000, January, 2005.
[94] Table 17.1 provides a physical inventory of the materials to be consolidated in the restricted area.
[95] Berger, C. (IEM), written communication to D. R. Smith (SMC), *Radionuclide Leachability from Newfield Slag*, September 16, 2005.

5.2.2.2.4 Saturated Zone Layer

The lower-most (deepest) layer is described as the deep aquifer layer. The geology beneath the Storage Yard is characterized by brown sand and gravel representative of the Bridgeton Formation that extends in depth to 8.5 meters (28 feet) (well SC-12D) below the ground surface.[96] The Cohansey Sand lies beneath the Bridgeton Formation and is composed of coarse sands and little to trace silt in the upper 12 meters (40 feet), and generally finer sand and some silt, with some clay and silt stringers in the lower 18 to 24 meters (60 to 80 feet). As described in Section 5.3 of this report, groundwater is not potable.

5.3 Exposure Scenarios

In order to demonstrate compliance with applicable requirements for both the restricted and unrestricted portions of the SMC site, and to ensure a realistic correlation between radiation dose and residual radioactivity, it is critical that the model portrayed in the RESRAD code be sufficiently representative of actual (site-specific) cases. To determine the setup of the RESRAD code, SMC first envisioned and then characterized the most realistic exposure scenarios applicable to future (post-decommissioning) receptors.

A number of physical and demographic properties pertinent to the site contribute to the conception of plausible and realistic conditions under which an individual might be exposed. In addition, the future use of the property as described in Chapter 3, above, was also taken into account. For the foreseeable future (100 years), the following is deemed reasonably likely for the SMC property:

- The property will retain industrial (light industry) zoning.
- Residential encroachment up to the property boundary is possible but not likely because of the restrictions established by the requirements of the LTC license held by the property owner, and anticipated land use factors.[97]
- Farming encroachment up to the property boundary is not likely due anticipated land use factors in areas that border the deed-noticed SMC property.
- The property will remain intact (i.e.,. will not be subdivided), such that the "releasable" portion of the property will remain associated with the restricted area.[98]

[96] "Remedial Investigation Technical Report", TRC Environmental Consultants, Inc., 1992; Draft Final Feasibility Study Report, TRC Environmental Corporation, April 1995.

[97] SMC is committed to documenting the restrictions established in the LTC license in the form of a legal document recognized by and recorded with Gloucester County. Because the restrictions will be in effect for a substantial time period, SMC intends to have a recorded deed notice that addresses site use restrictions. SMC recognizes that the LTC will include a license condition that requires the maintenance of the deed notice in the recorded land records. This will provide a layering of protection and provide notice of the status of the site on any legal issues involving the property.

[98] Although this was a recommendation of the USNRC (Kallman, KL (USNRC), letter to D. Smith (SMC), "Nuclear Regulatory Commission Staff Guidance for a Long Term Control Possession Only license at the Shieldalloy Metallurgical Corporation Site in Newfield, New Jersey", May 15, 2004), as described in Chapter 16, this

- All controls specified in Chapter 16 of this Plan will be implemented as part of the LTC license issued to SMC, and those controls will remain in force in perpetuity.

- If regulatory control fails, it is reasonable to assume that the physical controls do not fail instantly and completely. Instead, if engineered barrier maintenance should cease, the engineered barrier will not disappear instantaneously, but will erode over time.[99]

- Excavating the residual radioactivity from beneath the engineered barrier is considered highly unlikely because the engineered barrier will camouflage its contents, there is no economic value in the materials, and the physical form of the majority of the residual radioactivity (large, vitrified and irregularly-shaped rocks) is unappealing.

- Excavating some or all of the engineered barrier as a source of fill, thus partially exposing the residual radioactivity therein, is not likely due to the relative difficulty of scavenging fill from a sloped surface as compared to a nearby flat surface.

- The presence of the institutional controls at the site for a reasonable period of time after decommissioning is complete would create a natural separation that would not be conducive to construction in close proximity to the engineered barrier even if controls should fail in the future.

- The fenced perimeter of the restricted area is set such that the applicable dose limits in both the restricted and unrestricted portions of the property are satisfied.

- There are existing site use restrictions due to the natural resource restoration requirements applicable to a large portion of the Newfield site (i.e, required maintenance of tree-planting areas), as well as potential future residential use restrictions due to soil contaminant levels under the CERCLA that would result in a land buffer to prevent construction in close proximity to the engineered barrier. Also, county-sensitive area zoning and the nearby Pinelands would also deter construction near the restricted area.

With these parameters in mind, the following subsections describe the most realistic (likely) post-decommissioning exposure scenarios assuming all controls remain in place. They also describe the scenarios in the unlikely event that all controls fail. The majority of these scenarios are consistent

decommissioning plan does not make such a commitment.

[99] The USNRC separates institutional controls from engineered controls. Therefore, institutional controls are assumed to fail instantly, along with any maintenance, but engineered controls would degrade over time without monitoring and maintenance.

with USNRC recommendations to rely upon parameters that are conservative yet realistic to conditions at the site.[100] Others are unlikely but are evaluated as a result of regulatory or public input.

5.3.1 Exposure Scenarios For the Unrestricted Portion of the Site

For dose modeling the unrestricted portion of the Newfield site, the following key assumptions were made:

- The critical group is an industrial worker who works eight (8) hours per day on the site and does not ingest meat and milk from livestock raised on the site, as specified in the manual for RESRAD;[101]
- Municipal water is used for drinking and irrigation purposes;
- Radioactive materials have been remediated to concentrations below the DCGLs established in this section;
- No water or food grown from the site is consumed;
- A hypothetical industrial worker works at the SMC site after the decommissioning is complete and the engineered barrier is in place;
- Workers leave the site after their work shift is completed each day and do not work on the weekends.

5.3.1.1 Industrial Worker

The calculation of dose potential using the scenario of an industrial worker is reasonable. The site has access restrictions (i.e., fences, placarding) currently in place which discourages trespassers. It is anticipated that these access restrictions will remain in place over the near term. Industrial use of the SMC property is a reasonable and likely land use scenario, given the site characteristics. Portions of the site underlain by upland soil may be suitable for light industry, as evidenced by existing light industrial land use at properties abutting the SMC site. Therefore, this scenario was used to establish the DCGLs for residual radioactivity in the unrestricted area.

Description of the Critical Group

SMC anticipates that industrial operations will be located on the property adjacent to the fenced Storage Yard. Industrial workers will visit the site to work each day; at no time will any workers enter the restricted portion of the property. For purposes of conservatism, it is assumed that the

[100] U.S. Nuclear Regulatory Commission, *Results of the License Termination Rule Analysis*, SECY-03-0069, May 2, 2003.

[101] Yu, C; Zielen, A.J, et al, *User's Manual for RESRAD Version 6*, Table 2.2, ANL/EAD-4, Argonne National Laboratory, Argonne, Illinois, July, 2001.

industrial worker will work immediately adjacent to the Storage Yard even though it is not likely that the industrial operations will be located close to a fence. It is also assumed that the industrial worker will work at the industrial site five (5) days per week for fifty (50) weeks per year. It is assumed that the work day will last for eight (8) hours, with a fraction of that time spent outdoors.

<u>Pathways included in the Industrial Worker Scenario</u>
RESRAD identifies the potential pathways for exposure to the critical group. Three (3) pathways are used for the industrial worker scenario, including:

- direct radiation exposure;
- particulate inhalation; and
- direct ingestion of soil.

Table 17.4.10 lists the pathways that have been retained for the analysis and provides an explanation for those pathways that were not retained. The RESRAD User Manual supports the position that an industrial worker is not likely to drink groundwater.[102] Instead, he/she would drink water supplied to the site by the local drinking water service. Consequently, the groundwater pathway in RESRAD disabled for this analysis because a public water supply is available to industrial workers at the Newfield site.

Table 17.3.2 describes the specific parameters that were used in the RESRAD model for the industrial worker (basis for the DCGL calculation).[103] Table 17.3.1 describes the parameters used in the RESRAD model to depict the physical parameters of the residual radioactivity in the surface soil after decommissioning is complete; these parameters are common to each of the restricted area scenarios analyzed herein.

<u>Description of the Parameters Used in the Analysis</u>
It is assumed that the industrial worker spends 69% of his time indoors, and 31% of the time outdoors.[104] The outdoor fraction, 0.07, is derived by dividing the 2,000 hours per year by the total number of hours in a year, 8,760 hours. These time fractions, as well as the external gamma shielding factor, are more sensitive parameters in this industrial worker scenario.

The inhalation rate for the industrial worker is assumed to be a short term exposure for adult males averaging 8,400 cubic meters per year. The industrial worker does not enter the fenced restricted area, but does ingest soil from incidental contact with the surface soil in the unrestricted area. The

[102] Argonne National Laboratory, *User's Manual for RESRAD Version 6*, Section 2.4.2, ANL/EAD-4, July, 2001.
[103] A more comprehensive list of the input parameters used in the execution of the RESRAD dose modeling code to evaluate the potential future radiation dose for each scenario is provided in the RESRAD summary reports (see Appendix 19.5).
[104] U.S. Nuclear Regulatory Commission, *Development of Probabilistic RESRAD 6.0 and RESRAD-Build 3.0 Computer Codes*, NUREG/CR-6697, Appendix C, Table 7.6-3, November, 2000.

industrial worker does not eat any animals or vegetables from the site, and does not drink any surface water or ground water.[105]

5.3.1.2 Occasional Trespasser

Description of the Critical Group

The unrestricted portion of the site will be fenced and signs will be posted that prohibit trespassers from entering the property. SMC will maintain these controls for the foreseeable future, thus the likelihood that a trespasser will enter the property is remote. However, since there are no provisions for round-the-clock security, it is possible (although not necessarily reasonable) to assume that a trespasser might be present on the unrestricted portion of the property for an average of four hours per day for a nominal 12 days per year, for a total of 48 hours in a year.[106]

Pathways included in the Trespasser Scenario

RESRAD identifies the potential pathways for exposure to the critical group. Three (3) pathways are used for the trespasser scenario, including:

- direct radiation exposure;
- particulate inhalation; and
- direct ingestion.

The other pathways are inapplicable and are disabled for the purpose of the RESRAD model. Table 17.4.1 identifies the pathways that have been retained for the analysis and provides an explanation for those pathways that were not retained. Table 17.3.3 describes the specific parameters that were used in the RESRAD model, showing the parameters specifically used in the model for the trespasser.[107] Table 17.3.1 describes the parameters used in the RESRAD model that depict the physical parameters of the unrestricted area.

Description of the Parameters Used in the Analysis

It is assumed that the trespasser does not spend anytime indoors. The outdoor fraction, 0.005, is derived by dividing the 48 hours per year by the total number of hours in a year, 8,760 hours. The inhalation rate for the trespasser is assumed to be a short term exposure for adult males averaging 8,400 cubic meters per year.[108] It is also assumed that the trespasser ingests soil as a result of

[105] Drinking water is provided by a publicly-owned water system where there is testing for compliance with drinking water standards for radionuclides, and there are no surface water sources or ground water wells inside of the Storage Yard.

[106] U. S. Environmental Protection Agency,, "Exposure Factors Handbook Volume III - Activity Factors", Table 15-86 EPA/600/P-95/002Fc, August, 1997, .

[107] A comprehensive list of the input parameters used in the execution of the RESRAD dose modeling code to evaluate the potential future radiation dose for each scenario is provided in the RESRAD summary reports (See Appendix 19.5).

[108] U. S. Environmental Protection Agency, "Exposure Factors Handbook Volume I - General Factors", EPA/600/P-95/001, August, 1997.

incidental contact with the soil in the unrestricted area. The trespasser does not eat any animals or vegetables from the unrestricted area and does not drink any surface water or ground water. The engineered barrier in the restricted portion of the property does not erode, thus the restricted area does not offer an exposure source.

5.3.2 Exposure Scenarios Involving the Restricted Portion of the Property

Once decommissioning is complete, SMC will be issued a LTC license from the USNRC. The conditions of this license will include a variety of institutional controls as described in Chapter 16, all of which are designed to minimize exposures of population groups.

Under these conditions, the reasonably foreseeable limiting exposure scenario for many years into the future would be industrial workers who work on the unrestricted portion of the property, and a maintenance worker who is required to periodically traverse the engineered barrier for its inspection and repair (as necessary).[109] In addition, an occasional trespasser may climb the fence and traverse the restricted area for brief periods of time. All other scenarios are considered to be unlikely.

5.3.2.1 Maintenance Worker

Description of the Critical Group

A maintenance worker in the employ of SMC will inspect and maintain the engineered barrier that is installed over consolidated residual radioactivity. The maintenance worker will inspect the barrier by walking or driving over its surface.[110] It is assumed that the maintenance worker will inspect the entire surface and repair any evidence of erosion or intrusion in the barrier.

It is reasonable to assume that the inspection and maintenance will require no more than eight (8) days per year (8 hours per day) or no more than 64 hours per year since the engineered barrier will be installed in a manner that minimizes erosion and enhances the growth of vegetation on its surface. In reality, the inspection and maintenance of the engineered barrier should require a considerably shorter duration, particularly when the vegetation on the surface of the engineered barrier takes hold. From SMC's experience at its Cambridge, Ohio site, cap inspection and maintenance has been on-going for many years for footprint that is significantly larger than the one proposed for the Newfield site. The more realistic annual average inspection and maintenance duration is one (1) day per

[109] The use of realistic exposure scenarios, rather than those that are unduly conservative, was approved by the Commission in a November 17, 2003 memorandum from A. L. Vietti-Cook to W. D. Travers, "Staff Requirements - SECY-03-069 - Results of the License Termination Rule Analysis". In that memorandum it states in part that "The Commission has approved the staff's recommendation for use of realistic exposure scenarios as described in attachment 6".

[110] Mechanical equipment will be limited on the surface of the cover. Mechanized equipment such as a "four wheel ATV" or light tracked equipment may be used. Heavy equipment that may cause damage to the cover and/or the vegetation will be specifically prohibited.

month for two (2) hours or 24 hours per year.[111,112] Once established, the inspection and maintenance efforts are likely to be minimal.

<u>Pathways included in the Maintenance Worker Scenario</u>
RESRAD identifies the following potential pathways for the maintenance worker scenario:

- direct radiation exposure;
- particulate inhalation; and
- direct ingestion.

The other pathways are inapplicable and are disabled for the purpose of the RESRAD model. Table 17.4.4 identifies the pathways that have been retained for the analysis and provides an explanation for those pathways that were not retained. Table 17.3.6 lists the parameters specifically used in the model for the maintenance worker.[113] The tables are organized such that key parameters common to the assessment of both the surface and subsurface soil source terms are presented first. Subsequent tables present key parameters that are unique to the source term. Table 17.3.7 also describes the parameters used in the RESRAD model that depict the physical parameters of the cover, slag and the undisturbed layer conditions; these parameters are common to each of the scenarios used in restricted area of this chapter.

The exposure pathway for potential exposure to radon gas was eliminated for all potential outdoor exposure scenarios. The USNRC documented their concurrence with this approach in the Statement of Consideration for the License Termination Rule:[114]

> *"Following the approach taken in the proposed rule, this final rule includes radiological criteria for residual radioactivity that is distinguishable from background. Because of natural transport of radon gas in outdoor areas due to diffusion and air currents, doses from exposure to radon in outside areas due to radium in the soil are negligible... Therefore, in implementing the final rule, licensees will not be expected to demonstrate that radon from licensed activities is indistinguishable from background on a site-specific basis..."*

[111] See the SMC-Cambridge Radiation Protection Program Plan, RSP-001, for specifications on the routine maintenance and inspection activities for the West Pile.
[112] To ensure an element of conservatism in our analysis, the duration was arbitrarily elevated to 64 hours per year.
[113] A comprehensive list of the input parameters used in the execution of the RESRAD dose modeling code to evaluate the potential future radiation dose for each scenario is provided in the RESRAD summary reports (see Appendix 19.5).
[114] U.S. Nuclear Regulatory Commission, *Radiological Criteria for License Termination*, Federal Register, Volume 62, Number 139, July 21, 1997.

Description of the Parameters Used in the Analysis

It is assumed that the maintenance worker does not spend anytime indoors. The outdoor fraction, 0.007, is derived by dividing the 64 hours per year by the total number of hours in a year, 8,760 hours. The inhalation rate for the maintenance worker is assumed to be a short term exposure for adult males averaging 8,400 cubic meters per year.[115] For the purposes of sensitivity analysis, the inhalation rate was assumed to range from 4,380 m^3/yr to 13,100 m^3/yr. It is also assumed that the maintenance worker ingests soil from the engineered barrier as a result of incidental contact.[116] The maintenance worker does not eat any animals or vegetables from the residual radioactivity and does not drink any surface water or ground water.

5.3.2.2 Industrial Worker

Description of the Critical Group

SMC anticipates that industrial operations will be located on the property adjacent to the fenced restricted area. Industrial workers will go to work each day, but at no time will any workers enter the fenced area or walk on the engineered barrier. Although this places the critical group in the unrestricted portion of the property, it is assumed that the industrial worker will work immediately adjacent to the restricted area even though it is not likely that his day-to-day work take place to close to a fenceline. However, his presumed presence at this location means he could be impacted by the presence of the consolidated material nearby. It is also assumed that the industrial worker will work five (5) days per week for fifty (50) weeks per year, and that the work day will last for eight (8) hours, with a fraction of that time spent outdoors.

Pathways Included in the Industrial Worker Scenario

RESRAD identifies the following potential pathways for the industrial worker scenario:

- direct radiation exposure; and
- particulate inhalation.

Table 17.4.5 lists the pathways that have been retained for the analysis and provides an explanation for those that were not. The RESRAD User Manual supports the position that an industrial worker is not likely to drink groundwater.[117] Instead, he/she would drink water supplied to the site by the local drinking water supply. Consequently, the groundwater pathway in RESRAD disabled for this analysis because a public water supply is indeed available to industrial workers at the Newfield site.

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[115] U.S. Environmental Protection Agency, *Exposure Factors Handbook, Volume I, General Factors*, EPA/600/P-95/001, August, 1997.

[116] Soil ingestion of 36.5 grams per year is a default parameter provided by RESRAD. It is assumed to be conservative in light of the fact that a maintenance worker is not likely to eat plants nor spend much time at all in the vicinity of the storage yard.

[117] Argonne National Laboratory, *User's Manual for RESRAD Version 6*, Section 2.4.2, ANL/EAD-4, July, 2001.

Table 17.3.8 describes the specific parameters that were used in the RESRAD model; this table lists the parameters specifically used in the model for the industrial worker.[118] Table 17.3.7 describes the parameters used in the RESRAD model that depict the physical parameters of the restricted area. These parameters are common to each of the scenarios used in this chapter.

Description of the Parameters Used in the Analysis
It is assumed that the industrial worker spends 69% of his time indoors and 31% of the time outdoors.[119] The outdoor fraction, 0.07, is derived by dividing the 2,000 hours per year by the total number of hours in a year, 8,760 hours. These time fractions, as well as the external gamma shielding factor, are more sensitive parameters in this industrial worker scenario. The inhalation rate for the industrial worker is assumed to be a short term exposure for adult males averaging 8,400 cubic meters per year.

The industrial worker does not enter the restricted area and does not ingest soil from the restricted area. In addition, the industrial worker does not eat any animals or vegetables from the restricted area or drink any surface water or ground water.[120]

The industrial worker is exposed to the source term from the restricted area as well as the residual radioactivity in the unrestricted area. For the purposes of this analysis, the contribution from the restricted area to the industrial worker is assumed to be less than 1% of the total effective dose; the dose resulting from the residual radioactivity (e.g, DCGL) in the unrestricted area is assumed to be 99% of the total effective dose.

5.3.2.3 Occasional Trespasser

Description of the Critical Group
The Newfield site is fenced and signs are be posted that prohibit trespassers from entering the property. SMC will maintain these conditions at the site in its entirety, and for the fenced restricted area. The likelihood that a trespasser will enter the property when the institutional controls are in place is remote. However, there will not be provision for round-the-clock security at the site, thus it is possible that a trespasser might be present in the restricted area for short durations. The assumption is that those durations will not exceed one (1) hour per day for a nominal 12 days per year, for a total of 12 hours in a year.[121]

[118] A comprehensive list of the input parameters used in the execution of the RESRAD dose modeling code to evaluate the potential future radiation dose for each scenario is provided in the RESRAD summary reports (see Appendix 19.5).
[119] U.S. Nuclear Regulatory Commission, *Development of Probabilistic RESRAD 6.0 and RESRAD-Build 3.0 Computer Codes*, NUREG/CR-6697, Appendix C, Table 7.6-3, November, 2000.
[120] Drinking water is provided by a publicly-owned water system where there is testing for compliance with drinking water standards for radionuclides, and there are no surface water sources or ground water wells inside of the restricted area. Furthermore, the cover does not erode while institutional controls are in place and the engineered barrier is being maintained.
[121] U. S. Environmental Protection Agency,, "Exposure Factors Handbook Volume III - Activity Factors", Table 15-86 EPA/600/P-95/002Fc, August, 1997,.

Pathways included in the Trespasser Scenario

RESRAD identifies the following potential pathways for the trespasser scenario:

- direct radiation exposure;
- particulate inhalation; and
- direct ingestion.

The other pathways are inapplicable and are disabled for the purpose of the RESRAD model. Table 17.4.6 identifies the pathways that have been retained and provides an explanation for those pathways that were not retained. Table 17.3.9 describes the specific parameters that were used in the RESRAD model specifically for the trespasser scenario.[122] Table 17.3.7 describes the parameters used to depict the physical parameters of the cover, slag and the undisturbed surface conditions; these parameters are common to each of the scenarios used in this chapter.

Description of the Parameters Used in the Analysis

The outdoor fraction, 0.001, is derived by dividing the 12 hours per year by the total number of hours in a year, 8,760 hours. The inhalation rate for the trespasser is assumed to be a short term exposure for adult males with respiratory rates averaging 8,400 cubic meters per year.[123] It is also assumed that the trespasser ingests soil from the engineered barrier as a result of incidental contact. The trespasser does not eat any animals or vegetables from the restricted area and does not drink any surface water or ground water. The engineered barrier does not erode while institutional controls are in place.

5.3.3 Exposure Scenario Involving the Restricted Portion of the Site (Controls Fail)

In the event that all institutional controls fail, it is unreasonable to assume anyone could access the engineered barrier, although taking up residence on it is unlikely because its shape/form would not be conducive to building construction. The engineered barrier is shaped like a chevron and exhibits side slopes that are too steep for construction. On the top surface, there is insufficient area to build a house or install footers for a building foundation. It is equally unreasonable to assume that truck farming or small-scale agriculture would be conducted directly on top or on the sides of the engineered barrier, again because of its configuration and because flat surfaces are readily available in the immediate proximity.

The potential for intruders to excavate the slag was evaluated and rejected by the USNRC during its evaluation of the decommissioning plan prepared for SMC's Cambridge, Ohio facility (with similar

[122] A comprehensive list of the input parameters used in the execution of the RESRAD dose modeling code to evaluate the potential future radiation dose for each scenario is provided in the RESRAD summary reports (see Appendix 19.5).

[123] U. S. Environmental Protection Agency, "Exposure Factors Handbook Volume I - General Factors", EPA/600/P-95/001, August, 1997.

radiological constituents and a similar decommissioning alternative) in 1996.[124] The USNRC concluded in the Draft Environmental Impact Statement for that action as follows:

> *"The staff believes, however, that the combined likelihood of the institutional controls failing and a member of the public obtaining slag from the stabilized piles is remote. Assuming that the access controls failed, and in order for an off-site residential use scenario to be occur, a member of the public would have to dig through the caps that will be on the piles to obtain the slag. While this might be possible if the material had some significant value and was known to be beneath the cover by a member of the public, this is or will not be the case. The slag is similar to other readily available and inexpensive sources of fill materials, such as limestone so it is unlikely that an individual would dig into the slag piles to obtain materials which are otherwise easily obtained. Also, if a member of the public knew that the slag was buried in the piles, he would also likely know that the material was radioactive and would therefore not use it."* [125]

Like the limestone mining in Ohio, the principle mineral resource in New Jersey is sand and gravel mining. Therefore, anyone seeking sand or gravel will pursue easier to-process sources than the engineered barrier with its relatively large, impervious igneous slag.

SMC also considered the likelihood of an intruder successfully excavating the slag and removing it from the engineered barrier, and rejected it. The particle size of the slag currently in the storage yard is very large (i.e., dimensions on the order of square feet rather than square inches); it would take a significant effort to excavate it and crush it down to sizes that would be more useful for fill or road bed. And it is not reasonable to assume anyone would pursue the use of slag as a source of fill when other sources of fill that are cheaper to obtain are available. The baghouse dust, on the other hand, does have a smaller particle size, but it will be used to fill void spaces between the large pieces of slag prior to installing the engineered barrier. As such, its retrieval would not be cost-effective in light of the ready availability of similar materials elsewhere.

The only exposure scenarios considered applicable in the unlikely event the institutional controls fail for the restricted area are for: (1) a recreational hunter that would hunt game on the engineered barrier, (2) a family that may live near the engineered barrier, (3) a trespasser that may traverse the engineered barrier where some of the cover has been excavated thus partially exposing the contents, and (4) an industrial worker that may work at a manufacturing facility elsewhere on the property that is in proximity to the restricted area.[126] There was regulatory and public interest in the dose potential

[124] U.S. Nuclear Regulatory Commission, *Draft Environmental Impact Statement, Decommissioning of the Shieldalloy Metallurgical Corporation, Cambridge, Ohio, Facility*, NUREG-1543, July, 1996.

[125] U.S. Nuclear Regulatory Commission, *Draft Environmental Impact Statement, Decommissioning of the Shieldalloy Metallurgical Corporation, Cambridge, Ohio, Facility*, NUREG-1543, Appendix H, July, 1996.

[126] As described in Section 5.3, removing some or all of the engineered barrier as a source of fill, thus partially exposing the residual radioactivity therein, is not likely due to the relative difficulty of scavenging fill a sloped surface as compared to a nearby flat surface. And even if surface mining did occur, the radionuclide concentration in the excavated material

for the excavator scenarios, in spite of the fact that they are unlikely. Therefore, they were included in the evaluation as well.

5.3.3.1 Recreational Hunter Scenario

Description of the Critical Group

The critical exposure group for the recreational hunter scenario is described as a hypothetical subpopulation that hunts for recreation and consumes game meat culled from the restricted portion of the site. This hunter (as conservatively described) would spend a fraction of his available outdoor recreational time engaged in hunting and who goes to the SMC site, where the fencing around the restricted area has failed thus permitting the egress of game. Although not realistic, it is assumed he chooses the SMC site each time rather than visiting other sites in search of prey.

Hunting on the property is not likely, even if institutional controls should fail, because of the lack of shelter in which animals could hide and forage and because hunting is not allowed within Newfield borough limits. Hunters are not likely to use such a small piece of elevated land as a source of game because of the realistically-small animal population in its vicinity. However, this scenario, albeit unlikely, was deemed somewhat more likely than others (i.e., agricultural farm family, resident family, excavator).

Pathways Included in the Recreational Hunter Scenario

RESRAD identifies the following potential pathways for exposure for the trespasser scenario:

- direct radiation exposure;
- particulate inhalation;
- meat ingestion; and
- direct ingestion.

The other pathways are inapplicable and are disabled for the purpose of the RESRAD model. Table 17.4.7 identifies the pathways that have been retained for the analysis and provides an explanation for those pathways that were not retained. Table 17.3.10 describes the specific parameters that were used in the RESRAD model; this table lists the parameters specifically used in the model for the recreational hunter.[127]

would be small since it is comprised of radiologically-inert soil and possibly small amounts of the baghouse dust that was placed below the native soils as void filler. (The baghouse dust contains less than 0.05% source material.) Therefore, this scenario does not present dosimetric significance.

[127] A comprehensive list of the input parameters used in the execution of the RESRAD dose modeling code to evaluate the potential future radiation dose for each scenario is provided in the RESRAD summary reports (see Appendix 19.5).

Description of the Parameters Used in the Analysis

The recreational hunter scenario involves relatively conservative exposure factors attributable to hunting enthusiasts who may spend a considerable amount of time hunting and whose annual diet of meat is composed of a large fraction of game culled from the site. Key parameters used to define the recreational hunter exposure scenario are presented in a series of three tables along with specific remarks explaining the values' selection. Table 17.3.7 contains common parameters describing the receptor's exposure and behavioral patterns (e.g., exposure time, inhalation rate, etc.) as well as common parameters describing the general and weather-related parameters relevant to the site.

5.3.3.2 Suburban Resident Scenario

Description of the Critical Group

The critical exposure group for the suburban resident scenario is described as a hypothetical family that occupies a house constructed near the restricted area.[128] It is assumed that the house is located 1,000 feet from the restricted area.[129] The family who lives in the house uses water provided by a publicly owned water supply and does not grow food or vegetables near the engineered barrier (i.e., food is purchased at a nearby grocery store). The groundwater pathway was disabled because a suburban resident is most likely to secure water from a public water supply, which is regionally available, rather than drilling and maintaining a well. This is consistent with current conditions for SMC's neighbors, and is thus likely for the foreseeable future.

It is important to note that the suburban resident scenario is also unlikely because of the lack of available space to construct a house and parking, and because the majority of the area surrounding the Storage Yard is assigned for natural resource damage mitigation (tree planting) and could only be developed for housing if the controls maintaining the conservation should fail. However, this scenario was nonetheless selected for the dose assessment.

Pathways Included in the Suburban Resident Scenario

The computer code Microshield was used to calculate the external exposure from the restricted area after the engineered barrier is completed because the limiting dose would be from the external exposure pathway. The RESRAD code was not used because it requires the receptor to be positioned directly on top of the engineered barrier.

[128] As a result of the design of the engineered barrier, it is not feasible for a house to be built directly on top. The cover is elevated from the ground surface and covers the slag; the presence of the slag within three (3) feet (1 meter) from the surface does not allow excavation or trenching for typical construction of footers or utility trenches, commonly used in the construction of a house.

[129] The distance from the restricted area to the nearest drinking water well and off-site resident is approximately 1,000 feet. Furthermore, the median distance to the nearest off-site resident from municipal landfills around the country, as determined in a 1988 USEPA Office of Solid Waste survey, is 1,400 feet (U. S. Environmental Protection Agency, Region 6, Multimedia Planning and Permitting Division, "RCRA Delisting Technical Support Document", Chapter 3, Exposure Scenario Selection, May, 2000). In light of these distances, an arbitrary but reasonably conservative distance of 1,000 feet was selected.

Description of the Parameters Used in the Analysis

The suburban resident scenario involves relatively conservative exposure factors attributable to a suburban family who live near the engineered barrier, after institutional controls fail. Key parameters used to define the suburban family exposure scenario are presented in a series of three tables along with specific remarks explaining the values' selection. Table 17.4.3 contains common parameters describing the receptor's exposure and behavioral patterns (e.g., exposure time). Table 17.3.5 contains parameters specific to the restricted area (i.e., geotechnical parameters and parameters describing the source term).

5.3.3.3 Barrier Excavation Scenario

Description of the Critical Group

The critical exposure group for the cover excavation scenario, which is considered to be an unlikely scenario, is described as a hypothetical person who excavates into the engineered barrier and exposes some of the slag.[130] The potential for exposure was evaluated in two phases, the immediate exposure to the intruder and the potential exposure to a family living nearby the damaged cap.

Exposure to the Intruder

It is assumed that an intruder climbs the fence surrounding the restricted area after institutional controls fail. The intruder then removes a portion of the engineered barrier to expose the buried slag, at which point he determines there is no further benefit in continuing and exits the area. While there, the intruder is assumed to excavate one (1) square meter ($1m^2$) of the cover, including all its layers. It is assumed that the intruder uses manual excavation methods and that he is somehow able to cut or otherwise breach the geomembrane during the excavation process. The nominal footprint for the excavation (i.e., one square meter) would provide enough space for the intruder to climb down from the surface of the cover and onto the layer of exposed slag in order to confirm that further excavation would not be beneficial.

The person who excavates through the barrier is assumed to spend ten (10) work days at a rate of eight (8) hours per day, for a total of eighty (80) hours for this task. It is assumed that one (1) square meter of the barrier is fully excavated, thus the intruder is exposed to a one (1) square meter surface of slag as he attempts to pulverize or chip the first boulder encountered. When the intruder is unsuccessful in removing the large, heavy and unwieldy slag using manual methods, excavation discontinues. Once refusal is reached, it is assumed that no slag is removed and that the excavated portion of the cap is not repaired.

Exposure to a Nearby Suburban Resident

Following the attempted excavation, it is assumed that the barrier is not repaired or returned to its original condition. The exposed surface of the slag is thus open to the environment and unshielded. The suburban resident family described in Section 5.3.3.2 lives within the line of sight from the

[130] It assumed that the cover may be excavated after institutional controls fail and that there is no maintenance or inspection of the cover over time. It is assumed that the cover construction materials have intrinsic value and may be used at a different location for landscaping or fill at a different location.

damaged portion of the barrier, which is assumed to be located on one of the side walls of the barrier, and is thus exposed to direct radiation for the durations described in the previous section. This scenario is considered to be highly unlikely because of the difficulty in removing the barrier material using hand excavating equipment, the likelihood that if such a removal expedition did occur, the intruder would excavate the top rather than a side wall of the engineered barrier.

Pathways Included in the Barrier Excavation Scenario

One pathway, direct radiation exposure, is evaluated for the intruder and the suburban resident. The slag itself is hard and difficult to chip or pulverize, thus there is no potential for ingestion or inhalation of radioactive materials. The direct radiation exposure assessed for the suburban resident under this scenario is added to the exposure potential derived in Section 5.3.3.2, above, in order to estimate the total exposure potential to this critical group.

Description of the Parameters Used in the Analysis

The computer code Microshield was used to evaluate the direct exposure potential. It is assumed that the intruder is involved in the process for 64 continuous hours. The excavation of the cover requires two (2) days and the remaining time is spent in direct contact with the exposed slag attempting to penetrate its surface.[131] These are conservative assumptions in that the intruder is not likely to stay in direct contact after a few attempts to pulverize or remove it are refused.

5.3.3.4 Industrial Worker Scenario

Description of the Critical Group

SMC anticipates that industrial operations will be located on the property adjacent to the restricted area. In the unlikely case that all controls fail, this critical group would be impacted by the presence of the restricted area, either through direct exposure or by accessing the surface of the engineered barrier.

For this scenario, it is assumed that industrial workers travel to the site to work each day, that there are no controls in place, and there are no prohibitions to entering the restricted area (i.e., workers may walk on the engineered barrier). It is assumed that the industrial worker will work immediately adjacent to the restricted area even though it is not likely that the industrial operations will be located in such close proximity to an elevated land area. It is also assumed that the industrial worker will work at the site five (5) days per week for fifty (50) weeks per year, and that the work day will last for eight (8) hours per day.

Pathways included in the Industrial Worker Scenario

RESRAD identifies the potential pathways for exposure to the critical group. Three (3) pathways are used for the industrial worker scenario, including:

- direct radiation exposure;

[131] The intruder spends 8 days, 8 hours per day, to excavate the slag.

- direct ingestion; and
- particulate inhalation.

Table 17.4.9 identifies the pathways that have been retained for the analysis and provides explanation for those pathways that were not retained. The other pathways are inapplicable and are disabled for the purpose of the RESRAD model. Table 17.3.12 describes the specific parameters that were used in the RESRAD model; this table lists the parameters specifically used in the model for the industrial worker.[132] Table 17.3.7 describes the parameters used in the RESRAD model that depict the physical parameters of the cover, slag and the subsurface conditions; these parameters are common to each of the scenarios used in this chapter.

Description of the Parameters Used in the Analysis
It is assumed that the industrial worker spends 69% of his time indoors and 31% of the time outdoors.[133] It is assumed that the industrial worker spends time indoors in the unrestricted area (1,324 hours/year)and 100% of their time outdoors walking in the unrestricted area 595 hours/yr). The outdoor fraction, 0.07, is derived by dividing the 2,000 hours per year by the total number of hours in a year, 8,760 hours. These time fractions, as well as the external gamma shielding factor, are more sensitive parameters in this industrial worker scenario where the institutional controls fail,. The inhalation rate for the industrial worker is assumed to be a short term exposure for adult males averaging 8,400 cubic meters per year.

The industrial worker may enter the restricted area and it is assumed that he may ingest soil from there. However, the worker does not eat any animals or vegetables from the restricted area, and drinking water is provided by a publicly-owned water system because there are no surface water sources or ground water wells inside of the restricted area.

Because failure of institutional controls means cover maintenance may cease, the engineered barrier is likely to erode. As addressed previously, the cover design ensures that, without maintenance or care, it will erode by less than six inches (0.015 meters) in 1,000 years. For modeling purposes, it is assumed that the engineered barrier maintenance program ceases immediately after the LTC license is issued.[134]

[132] A comprehensive list of the input parameters used in the execution of the RESRAD dose modeling code to evaluate the potential future radiation dose for each scenario is provided in the RESRAD summary reports (see Appendix 19.5).
[133] U.S. Nuclear Regulatory Commission, *Development of Probabilistic RESRAD 6.0 and RESRAD-Build 3.0 Computer Codes*, NUREG/CR-6697, Appendix C, Table 7.6-3, November, 2000.
[134] Over the following 1,000-year period, there is insufficient erosion to result in noncompliance with the applicable dose criteria for the industrial worker. In fact, the maximum dose potential occurs at year 1,000 when the engineered barrier is, presumably, at its thinnest.

5.4 Uncertainty Analysis

5.4.1 Managing Uncertainty

There is an inherent uncertainty in any projection of a future conditions. Thus, tools were developed to model or project a future condition and to understand the uncertainty associated with such projections.

As described in Section 5.1, above, the alternative to the deterministic approach to dose modeling is the probabilistic approach in which the overall uncertainty in the assessment is evaluated to arrive at a better estimate of the correspondence between residual radioactive concentration and the extent of incremental dose to an exposed receptor. Uncertainty analysis imparts more information to the decision maker than deterministic analysis. It characterizes a range of potential doses and the likelihood that a particular dose would be exceeded. However, regardless of the method, uncertainty is inherent in all dose and risk assessment calculations and should be considered in determining whether a selected release criteria will satisfy the regulatory decision-making criteria.

In general, there are three primary sources of uncertainty in a dose/risk assessment: Uncertainty in the models, uncertainty in the scenarios and uncertainty in the input parameters.[135] Models are simplifications of reality and, in general, several alternative models may be consistent with available data. Computer modeling codes have permitted the analyst to increasingly refine the models they use because the computer is handling the complex calculations that result.

The RESRAD code used in this evaluation has been developed and maintained using a stringent version control process. Its models (or components of them) are tested for mathematical correctness, verified, and benchmarked against comparable models, when available. However, modeling in and of itself implies a degree of uncertainty in that direct measurements or standards are typically not available to compare to modeled results.

Parameter uncertainty results from incomplete knowledge of the coefficients that describe the model. However, with the selection of a suitable model for the site conditions and scenarios to be considered, and configuring the model with realistic and most probable input parameters, one may be reasonably confident in the model's predictions.

The current regulatory philosophy is to evaluate the uncertainty in an estimate along with the severity of consequence and probability of exceeding a deterministic regulatory limit. Such a decision method is termed "risk-informed decision making." The advent of powerful personal computers and increasingly capable software tools coupled with increased knowledge of key physical, behavioral, and metabolic parameters used to make dose/risk assessments, have brought probabilistic analysis to the state of the art. While not all regulating agencies currently expect that assessments will employ the probabilistic approach, with a quantitative assessment of the associated uncertainties, the USNRC has adopted a risk-informed approach to regulatory decision making, suggesting that an

[135] Bonano, E.J, Davis, P.A., *A Review of Uncertainties Relevant in Performance Assessment of High Level Radioactive Waste Repositories*, NUREG/CR-5211, September, 1988.

assessment of uncertainty be included in dose assessments.[136] The USNRC's Probabilistic Risk Assessment (PRA) Policy Statement states, in part,

> *The use of PRA technology should be increased in all regulatory matters to the extent supported by the state of the art in PRA methods and data, and in a manner that complements the USNRC's deterministic approach.*[137]

Even with the use of probabilistic analyses, it should be recognized that not all sources of uncertainty could be, or need to be, considered in a dose assessment. The primary emphasis in uncertainty analysis is to identify the important assumptions and parameter values that, when altered, could change the decision.

Sensitivity analysis performed in conjunction with the uncertainty analysis is used to identify parameters and assumptions that have the largest effect on the overall result and provides a tool for understanding and explaining the influence of these key assumptions and parameter values on the variability of the estimated dose.

5.4.2 How Sources of Uncertainty are Addressed

An important issue in uncertainty and sensitivity analysis is that not all sources of uncertainty can be easily quantified. Of the three primary sources of uncertainty in dose assessment analyses, parameter uncertainty analysis is most mature and will be dealt with quantitatively in this section. Mathematical approaches for quantifying the uncertainty in the site conceptual models and future use scenarios are not well developed. For example, it is difficult to predict with absolute certainty the characteristics of a future society. For these reasons, no attempt to formally quantify model or scenario uncertainty is made.

To confront these uncertainties a suite of scenarios capturing the plausible range of future uses for this site, given the nature and site-specific impediments to future land development, has been developed and is considered in the assessment. In addition, conceptual site models have been designed and selected to represent the existing features at the site and to conservatively represent the conditions that might be encountered in each scenario. By carefully selecting input parameters as SMC has attempted to do for Chapter 5, the estimates of dose potential using the RESRAD computer code overestimates the dose rather than underestimate the potential dose. In reality, the uncertainties in the conceptual site model and the scenario selections are captured, to a certain extent, in the parameter uncertainty analysis.

[136] NUREG-1757, September, 2003.

[137] U.S. Nuclear Regulatory Commission, *Probabilistic Risk Assessment Policy Statement*, Commission Policy Statement, August, 1995.

5.4.3 Uncertainty Evaluation

SMC has selected the most current version of the RESRAD dose modeling code (version 6.22, February, 2004) to evaluate uncertainty in accordance with USNRC guidance.[138] It contains a probabilistic module that is used to assess the uncertainty in the relationship between a concentration of radioactivity in soil and the dose it might produce. It uses an enhanced random sampling algorithm called Latin Hypercube sampling in which input parameter values are selected randomly from probability distribution functions (PDF).

The uncertainty module in the code permits the analyst to define the PDF for each variable of interest by selecting the distribution and its parameters, and to identify the parameter as either independent or correlated to other input variables. The following describes the process used to evaluate uncertainty:

- Each scenario was evaluated using the deterministic module to identify a concentration in soil corresponding to the deterministic regulatory limits. Additionally, coarse scale sensitivity analysis was performed to zero in on the parameters that had the greatest potential to impact the dose.

- Pathways of interest were identified through preliminary runs of the deterministic module in the code for all the scenarios. These identified the scenario specific pathways that most significantly contributed to dose. The direct exposure pathway, or "ground" pathway was consistently the dominant pathway for exposure to the source term, and by a significant margin.

- Where site-specific knowledge was lacking, where the dose response was not sensitive to variability in a given parameter, or where the default parameter distributions were reasonably representative of site conditions or conditions being portrayed in the exposure scenario, the default was used. Where no default distribution is recommended or where discrete knowledge of site-specific conditions exists, an appropriate distribution considering the degree of knowledge of site-specific conditions was selected.

- The Latin-Hypercube sampling algorithm (a variant of the Monte Carlo sampling technique which has an advantage in that it forces the sampling to occur over the entire range of possible values in the PDF rather than rely on pure random sampling) was set to obtain 1,500 samples (300 samples, repeated five times).

Parameters to which probability density functions were assigned in order to evaluate their impact on uncertainty are listed in the following subsections. They are organized such that the receptor exposure parameters are presented first, followed by the geotechnical parameters describing the various soil layers starting with the cover and concluding with the contaminated zone.

[138] NUREG-1757, September, 2003.

5.4.3.1 Exposure Factors

Outdoor Time Fraction

RESRAD uses fractions of a whole year spent on site to calculate annual dose to a receptor. The total fraction of a year spent on site is divided between two parameters: indoor time fraction (FIND) and outdoor time fraction (FOTD). Fractions of time spent on site are wholly dependent upon the scenario under consideration. The value used to describe the on site, outdoor time fraction for each of the use scenarios is derived from conservative assumptions attributed to members of the critical exposure group and designed to be conservative for the general population of potentially exposed individuals. SMC selected guidance from the USNRC to establish the fraction for both indoor and outdoor durations.[139]

Sensitivity analysis indicates that total annual dose is sensitive to variability in the FOTD parameter as the penetrating gamma (ground) exposure pathway dominates and is strongly dependent on exposure duration. In setting up the uncertainty analysis, the FOTD parameter is represented with a triangular distribution.

Inhalation Rate

Inhalation rate (INHALR) is the air volume inhaled over time and is used to calculate the radiation dose from the inhalation pathway.[140] The parameter represents the annual average breathing rate for a receptor from the critical exposure group subpopulation performing tasks under evaluation in a given scenario.

Population normalized inhalation rates vary depending upon the tasks that are being performed. For the land user, the inhalation rate used is the RESRAD default, which is derived from ICRP and EPA recommendations for adults engaged in short-term (episodic) exposure scenarios.[141,142,143] Sensitivity analysis shows that the total annual dose is not sensitive to this parameter, because the inhalation pathway is not a significant contributor to total annual dose. Inhalation rate is represented with a triangular distribution, using the default provided by RESRAD.

Contaminated Fraction of Meat Diet

The meat ingestion pathway is unique to the recreational hunter scenario. Evaluation of the potential dose from this pathway considers both the annual consumption of meat and poultry, DIET(4) (using the RESRAD default value of 63 kilograms per year), and the fraction of that annual meat diet that is potentially impacted with residual radioactivity from the site (FMEAT). A triangular distribution was selected to represent the range and variability in the fraction of the receptor's meat diet that might have been culled from among game animals that grazed on the site. The mode of the

[139] USNRC, NUREG/CR-6697, Appendix C.
[140] The air volume is measured in cubic meters of air per year.
[141] ICRP Report 23, 1981.
[142] U.S. Environmental Protection Agency, *Development of Statistical Distributions or Ranges of Standard Factors used in Exposure Assessments*, EPA 600/8-85-010, 1985.
[143] U.S. Environmental Protection Agency, *Exposure Factors Handbook, Volume I, General Factors*, EPA 600/P-95-002Fa, August, 1997.

distribution (the most likely value) was selected based upon the typical dressed weight of a white-tail deer (40 pounds or 19 kilograms), the most abundant game species in the area.[144] The contaminated fraction is estimated to be 0.3; the fraction ranges between 0 and 0.5.[145] The fraction modeled is conservative in that the size of the site is small relative to the grazing land required to support game habitat. Sensitivity analysis shows that the total annual dose is not sensitive to this parameter, because the meat ingestion pathway is not a significant contributor to total annual dose for the undisturbed surface soil source terms.

Mass Loading for Inhalation

Mass loading for inhalation (MLINH) is the soil/air concentration ratio. It is used to calculate the dose from the particle inhalation pathway. The parameter represents the dust (mass) loading on site conservatively assuming that all airborne dust is generated on site and is radioactive. Other parameters, derived by the RESRAD code and based upon the site-specific parameters input, are used to modify this assumption, as appropriate. Mass loading does vary from season to season and depends upon the activities that are being performed at the Site. The RESRAD default continuous liner distribution and fit with a central tendency value of 0.00003 g/m^3 (30 micrograms/m^3) and ranging up to 100 micrograms/m^3 are used for each of the scenarios evaluated. The use of the RESRAD default is conservative as PM10 monitoring in Camden, New Jersey indicates annual average dust loading to be approximately 27 micrograms/m^3. In addition, site-specific air modeling as described in the Environmental Report (see Appendix 19.9), gives values of 11 micrograms per cubic meter or less during implementation of the LTC alternative. Sensitivity analysis shows that the inhalation pathway and total annual dose are insensitive to this parameter when the radioactivity is effectively isolated from the receptor by the in-place cover material. However, under the cover excavation scenario, such isolation will not exist.

Soil Ingestion Rate

RESRAD uses the annual average soil ingestion rate (SOIL) to calculate the dose from the direct soil ingestion pathway. The soil ingestion rate used in deriving the soil release criteria for the site is represented by a triangular distribution centered at 18.3 g/yr (50 mg/d) and ranging from 0 to 36.5 g/yr (0 to 100 mg/d), the RESRAD default. Sensitivity analysis for the restricted area shows that neither the soil ingestion pathway nor the annual effective dose equivalent is sensitive to this parameter because the radioactivity is effectively isolated from the receptor by the in place cover material. However, under the unrestricted area and the cover excavation scenario, such isolation will not exist.

5.4.3.2 Geophysical Parameters for the Engineered Barrier

Evapotranspiration Coefficient

The evapotranspiration coefficient (EVAPTR) is the fraction of total precipitation that is released back to the atmosphere via plant "respiration." Evapotranspiration varies with geographic region and

[144] RESRAD, ANL/EAD-4, July, 2001.

[145] A contaminated fraction of 0 is defined as no game meat harvested while a contaminated fraction of 0.5 means that 50% of the entire annual meat diet consumed is derived from game grazing on the SMC site,

to some extent with soil type. Evapotranspiration rates in the Newfield region are estimated to be approximately 24 inches per year , corresponding to a most likely evapotranspiration coefficient of approximately 0.625 (average annual precipitation in the region is 42.05 inches).[146,147]

The evapotranspiration coefficient is conservatively represented with a uniform distribution ranging between 0.3 and 0.9 which is a greater range than recommended by RESRAD. SMC determined that the national average of 0.5 is appropriate for the Newfield site.

<u>Wind Speed</u>
Average annual wind speed is used to calculate the dose from the inhalation pathway. The wind speed is used to transport airborne dust generated on site in a standard air dispersion model. Through the transport calculations, the radioactive fraction of the total dust loading in air is derived. The fraction is then used to calculate particle inhalation intake.

While wind speeds do vary from day-to-day and season-to-season, the annual average wind speed is reasonably steadfast. Data from the National Climate Data Center from Philadelphia, Pennsylvania were reviewed from 1971 through 2000. The mean annual wind speed was reported to be 9.6 miles per hour (4.3 meters/sec). Sensitivity analysis shows that the inhalation pathway is insensitive to this parameter because, the residual radioactivity is effectively isolated by the covering layer such that radioactive particle suspension is minor. As a result, the inhalation pathway is not a significant contributor to total annual dose. Wind speed is represented with the RESRAD default (4.25 m/sec), bounded log-normal-N distribution.

<u>Runoff Coefficient</u>
The runoff coefficient is one of a number of parameters used to calculate the amount of water that is allowed to enter the contaminated zone and ultimately an estimate of the radionuclide leaching from the contaminated zone. It is the fraction of precipitation that does not penetrate the top soil layer; the lower the fraction, the more water is allowed to co-mingle with the contaminated zone. The runoff coefficient (RUNOFF) varies with topography, precipitation patterns in the region, and soil type. The runoff coefficient is 1 when a geomembrane is used.

Runoff coefficient is represented with the RESRAD default parameter distribution, a uniform distribution ranging between 0.1 and 0.8 (10% to 80% of precipitation runs off without penetrating the surface). Considering the mounded topography of the site and the presence of the engineered barrier over the consolidated radioactivity, the true range is likely to be much narrower and near the maximum value (80%) considered in the probability distribution.

SMC has designed the engineered cover to incorporate a 40 mil thick high density polyethylene geomembrane that is suitable for preventing surface water from percolating through the slag in the

[146] Yu, C, et al, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil*, ANL/EAIS-8, Argonne National Laboratory, Argonne, Illinois, April, 1993.
[147] National Climatological Data Center, 1940 through 2003 (Philadelphia).

Storage Yard. Geomembranes are estimated to have a service life that is in excess of 1,000 years.[148] Service life was defined by the USEPA as equal to the half-life of the liner where there is more than 50% reduction in the specific design properties such as tensile modulus, break stress, break strain, and impact strength. Based on experiments conducted under simulated landfill liner conditions by USEPA contractors, the time to deplete the antioxidant additives was approximately 200 years, the time required to induce the degradation of the polymer was 20 years and 750 years was required to reach 50% degradation of the polymers. The radiation dose is insensitive to the runoff coefficient because the geomembrane liner is in place and is effective to minimize the amount of water that co-mingles with the slag.

Depth of Soil Mixing Layer

This parameter (DM) is used in calculating the depth factor for the dust inhalation and soil ingestion pathways and for foliar deposition for the ingestion pathways. The depth factor is the fraction of resuspendable soil particles at the ground surface that are contaminated, which is calculated by assuming that mixing of the soil will occur within a layer of thickness, DM, at the surface. The RESRAD default distribution (triangular) and range (0 to 0.6 m) was used.

Cover Depth (Thickness)

When modeling the source term, the cover depth (thickness) is a key parameter in assessing the protectiveness of the chosen decommissioning alternative as it provides a barrier to potential physical contact with residual radioactivity in the slag materials located within the cell, and a substantial degree of gamma radiation attenuation for the penetrating gamma radiation exposure pathway, the dominant, or critical dose pathway. RESRAD does not suggest a default probability distribution for cover depth (COVERO) as it is dependant upon site-specific conditions and for the unrestricted area, does not exist at all. Thus, SMC has conservatively chosen to represent this parameter with a triangular distribution ranging between 0.5 and 1.2 meters thick and with a most likely value of 1 meters (3.3 ft.). This representation is conservative in that the thickness value used does not include the topsoil layer to support natural succession vegetation as an erosion control mechanism. Sensitivity analysis reveals that the "cover penetrating gamma radiation dose" pathway, and as a result the total annual effective dose equivalent, is sensitive to this parameter.

Cover Soil Density

The engineered cover is comprised of a combination of soil and the geomembrane. The soil density at the site was measured to arrive at a site-specific estimate of the soil density of both the cover material and the undisturbed surface layer. The measured soil density was found to be 1.9 g/cm^3. Sensitivity analysis showed that annual dose was insensitive to a wide range of soil densities. Since site-specific data was available for the materials at the site, these were used to describe the density of the cover soil layer. Cover soil density (DENSCV) was represented with a truncated normal distribution (the RESRAD default). The mean was set equal to the measured density of 1.9 g/cm^3

[148] U.S. Environmental Protection Agency, *Assessment and Recommendations for Improving the Performance of Waste Containment Systems*, USEPA 600-R-02-099, December, 2002.

with a truncated normal distribution and a standard deviation of 0.23; the RESRAD program allows the density of the cover to range between approximately 1.46 to 2.33 g/cm^3.

Surface Soil Erosion Rate

When modeling the engineered barrier, the conceptual site model includes a relatively thick cover layer that is engineered to resist the forces of erosion. In this case, the surface soil layer is the engineered cover layer and the surface soil erosion rate is captured in two important parameters within the RESRAD model. The cover layer erosion rate (VCV) is important because as cover erosion occurs, the underlying contaminated zone is exposed, increasing the potential for human exposure to radiation.[149] Once the cover layer has been eroded, RESRAD further accounts for the effect of surface soil erosion through the contaminated zone erosion rate parameter (VCZ).

An evaluation of the cover erosion rate was completed to estimate the potential for erosion over the 1,000 years exposure period.[150] The Revised Universal Soil Loss Equation computer program, RUSLE2, was used (see Appendix 19.3).[151] The assumptions made include the following:

- Climate based on data for Gloucester County, New Jersey;
- A 3:1 slope with a side slope length of 90 feet;
- Cool grass season grass, applied by hydroseeding, with no harvesting; and
- Sandy loam, providing a moderately low runoff.

Based on the assumptions provided, the RUSLE2 model estimated that the loss of soil from the engineered barrier was 1.2 tons of soil per acre per year. Assuming an average soil density of 120 pounds per cubic foot (1.9 g/cm^3), the average annual erosion rate was estimated to be 4.6×10^{-4} feet per year; the erosion over the 1,000 year period was estimated to be 0.46 feet (0.14 meters). Based on this analysis, the one-meter-thick engineered barrier will not permit any of the slag confined below it to be exposed over the 1,000-year dose assessment period. If a small area of the engineered barrier (i.e., gully) erodes at a rate of six inches in 1,000 years, the dose potential to any recipient will be lower than if the engineered barrier in its entirety erodes at that rate, and the latter is the assumption associated with the RESRAD analysis. (Appendix 19.3 contains a more detailed description of the analysis.)

[149] It is important to note that once the cover soil is eroded, the underlying contaminated zone will not be immediately exposed because of the geomembrane. And if just a small area of geomembrane were to be exposed, it is unlikely that the protective nature of the geomembrane would be degraded or compromised or a very long time.. However, if a larger area of geomembrane was exposed, it is possible that an edge of the geomembrane could come loose thus exposing the underlying contaminated zone.

[150] TRC Environmental Corporation, *Estimated Soil Loss from Soil Cap*, Project Number 26770-0000, January, 2005.

[151] U.S. Department of Agriculture, *Revised Universal Soil Loss Equation*, Computer Program Version 2, 2005. Available for download ftp://fargo.nserl.purdue/pub/RUSLE2/RUSLE2_Program _File/..

The cover erosion rate (VCV) has been conservatively estimated with a range of possible values to represent the likely and extreme erosion rates typical for conditions and activities expected at the site. Surface soil erosion is represented with a continuous logarithmic distribution (the RESRAD default) and ranging over approximately four decades from $8x10^{-7}$ to 0.003 m/yr. The most probable range for a site in a humid climate, with a slope of approximately 30 percent, and natural succession vegetation extends from $1.5x10^{-4}$ to $4.6x10^{-4}$ m/yr. Extreme surface soil erosion potential has been accounted for by estimating that there is as much as a 50% probability that the soil erosion rate will exceed this range, with estimates ranging to 0.003 m/yr (the predicted maximum for sites used for permanent pasture).

Sensitivity analysis shows that all pathways are sensitive to this parameter when represented with chronic and extreme erosion values such as those that might be observed in arid climates or where continual loosening of the surface soils occurs, such as might be expected for land used for agricultural purposes. In every scenario, the greatest annual dose occurs in the out years (year 1,000) when the cumulative effect of long-term soil erosion impacts the thickness of the cover layer and thus reducing its shielding affect for direct radiation exposure.

Weathering Removal Constant

The weathering removal constant is used to account for the natural removal of soil and dust that have been deposited on consumable plants. It is relevant only for the recreational hunter scenarios (scenarios in which the consumption of plants by game animals is considered). Sensitivity analysis showed that annual dose was insensitive to the weathering removal constant (WLAM), thus the RESRAD default distribution (triangular) and range were used when modeling the source term. The RESRAD deterministic default (20/yr) is used when modeling the surface soil source term.

5.4.3.3 Geophysical Parameters for Sub-Barrier Zones

Area of Contaminated Zone

The area of the contaminated zone (AREA) describes the areal size, in square meters, of the region in which elevated concentrations of residual radioactivity are located. As described in Section 5.2.2, the areas describing the source terms are related to one another but they are not necessarily equal to one another. In defining the probability density function for the AREA parameter when modeling the source term for the restricted area, it was conservatively assumed that the contaminated zone area is no smaller than the 18,228 m^2 estimate derived from characterization survey data, but might be as large as the entire area circumscribed by the slag pile 28,767 m^2. RESRAD does not offer a default distribution for this parameter. A log-uniform distribution ranging from the most likely value, 18,228 m^2, to a maximum value of 28,767 m^2 was selected to represent the area of the contaminated zone within the probabilistic module of RESRAD. Sensitivity analysis showed that annual dose was insensitive to the area of the contaminated zone.

Contaminated Zone Thickness

Thickness of the contaminated zone (THICKO) describes the depth profile of the residual radioactivity. Vertically, the radiologically significant material associated with the source term is located just beneath the cover (approximately 5 feet below the ground surface) and lies in a lens that is nominally about 9 feet (2.8 meters) thick (see Figure 18.7). The amount of radioactive material deposited rapidly depletes as the depth increases and terminates at a maximum thickness of approximately 30 feet. RESRAD does not offer a recommended (or default) distribution for the thickness of contaminated zone parameter (THICKO).

A triangular distribution best describes the observed variability in the depth profile for the source term and thus the thickness of the contaminated zone. In describing the source term for input to RESRAD, the thickness parameter is represented by a central tendency (CT) value conservatively set to a thickness of 2.8 meters. This thickness is conservative in that the mean source thickness over the entire footprint of the cell, the impacted area, is considerably less than 9 feet. The distribution is bounded at a minimum value of 0.5 feet (0.15 meters), and a maximum value of 10 meters. Sensitivity analysis shows the annual dose is insensitive to the thickness of the contaminated zone because of the self-attenuating effect of source thicknesses greater than approximately 12 inches (0.3 meters) and the attenuating capacity of the engineered cover.

<u>Contaminated Zone Density</u>
The density of the slag has been measured at 2.8 g/cm^3. Sensitivity analysis showed that radiation dose was insensitive to a wide range of soil densities, as low as 1.6 g/cm^3, equivalent to the native soil. Because of the increased volumetric attenuation of emitted radiations with increasing density, a higher dose would result if a lower density was assumed. The contaminated zone density (DENSCZ) was represented with a truncated normal distribution (the RESRAD default). The mean was set equal to the measured density of the slag at the site (2.8 g/cm^3) and allowed to range between approximately 1.6 and 3.0 g/cm^3.

<u>Contaminated Zone Hydraulic Conductivity</u>
RESRAD uses vertical hydraulic conductivity to model the potential vertical movement of water through the contaminated layer and any underlying strata. Hydraulic conductivity is a key parameter used to assess the downward vertical migration potential of radioactivity released from the contaminated zone layer. This allows RESRAD to calculate the potential concentration of residual radioactivity in a useable subsurface saturated zone. Sensitivity analysis showed that annual dose is insensitive to a wide range of hydraulic conductivities in the contaminated zone, largely because the thorium and other radionuclides in the contaminated zone are physically and chemically bound up in the slag and because the slag is very insoluble.

Hydraulic conductivity in the residual radioactivity layer is described with a probabilistic distribution. Hydraulic conductivity was specifically measured for the native sand materials found at the site and was determined to be 6.4 x 10^{-3} cm/s (2,000 m/yr). Hydraulic conductivity in the contaminated zone (HCCZ) and the underlying unsaturated zone 1 (HCUZ(1)) is represented with bounded log-normal-N distributions (the RESRAD default) having central tendency values at 2,000 meters per year and with values conservatively ranging over two decades between 200 and 20,000 meters per year.

Soil Specific b-Parameter

The soil-specific exponential b-parameter is one of several hydrogeologic parameters used to calculate radionuclide transport from the contaminated zone. Sensitivity analysis showed that annual dose was insensitive to both the contaminated zone and saturated zone b-parameters (BCZ and BSZ, respectively), thus, the RESRAD default distribution (bounded log-normal-N) and parameters were used when modeling the source term.

Distribution Coefficient, Contaminated Zone

Distribution coefficients (K_d) describe the partitioning between solid (soil) and liquid phases of soluble concentrations of radionuclides introduced to a soil column. It is a key parameter influencing the migration of radioactivity from contaminated zone soils to groundwater. Distribution coefficients for a given chemical species (e.g., uranium) can vary over many orders of magnitude depending on the soil type, pH, redox potential, and presence of other ions. Observed K_d values for thorium are somewhat less subject to extreme variability.

The distribution coefficient, K_d, is the ratio of the mass of solute species adsorbed or precipitated on the solids per unit of dry mass of the soil to the solute concentration in liquids within the pore spaces in the soil. The key component of this definition as it relates to the site-specific conditions at the site and the RESRAD groundwater transport model is that it assumes that the radionuclide is introduced to the soil column as a solute. While this classical approach may be appropriate to describe the retardation of soluble contaminant migration in the soil column beneath the contaminated soil layer, it fails to address the situation encountered for the so-called "contaminated zone."

The site specific condition encountered at the SMC site is that the physical composition of the contaminant is a vitreous slag that is essentially insoluble even under the most extreme in-situ conditions that might reasonably be encountered (see Appendix 19.4). Analysis of the distribution coefficient of the slag, where the greatest radionuclide concentration will reside within the capped pile, results in the values shown in Table 17.5. These are the parameters used as input to the RESRAD code.

Bounds have been established on the range of values sampled during probabilistic analysis (a triangular distribution). The central tendency value for the distribution has been set to match the arithmetic average of the slag samples that were analyzed; the single-point estimate used in the RESRAD deterministic module for thorium was 52,010 cm^3/g.[152] Probabilistic sampling is bounded between 2,900 and 129,000 cm^3/g.

Thickness of the Undisturbed Surface Layer

The thickness of the undisturbed surface layer (unsaturated layer #1 H(1)) varies from eight (8) to 10 feet in the Storage Yard. Sensitivity analysis showed that annual dose equivalent was insensitive to variability in the thickness of the undisturbed surface layer. The thickness is represented with a

[152] Yu,C., et al, ANL/EAIS-8, April, 1993.

triangular distribution, with a most likely value (2.5 meters) near the lower end of the range that extends from 2.5 to 4.6 meters.

Density, Undisturbed Surface Layer

As described earlier, the unsaturated zone is comprised of the undisturbed layer underlying the entire area. The measured soil density was found to be 1.65 g/cm^3, a number that is typical of soils. Sensitivity analysis showed that annual dose was insensitive to a wide range of soil densities. Since site-specific data was available for the density of the materials at the site, it was used to describe the density of the undisturbed layer. Unsaturated layer soil density (DENSUZ(1)) was represented with a truncated normal distribution (the RESRAD default). The Mean was set equal to the measured density of 1.97 g/cm^3 and allowed to range between approximately1.6 and 2.4 g/cm^3.

Hydraulic Conductivity, Undisturbed Surface Layer

Hydraulic conductivity was specifically measured for the native materials found at the site and was determined to be 5.4x10^{-8} cm/s (0.017 m/yr).[153] Hydraulic conductivity in undisturbed layer [HCUZ(1)] is represented with a triangular distribution having a central tendency value at 0.017 meters per year and with values conservatively ranging over three decades between 0.001 and 1.7 meters per year. Sensitivity analysis showed that annual dose was insensitive to a wide range of hydraulic conductivities, largely because the radionuclides in the contaminated zone are physically and chemically bound up in the slag and because the slag itself is not readily soluble.

Density, Saturated Zone

The RESRAD default distribution and fit for the saturated zone density is used in the uncertainty analysis because no site-specific data was collected explicitly for this parameter. The truncated normal distribution is centered at the most likely value of 1.52 g/cm^3 and ranges between values of less than 1 and 2.2 g/cm^3. Variability in the saturated zone soil density was shown to have no affect on the projected annual dose in the uncertainty analysis.

Hydraulic Conductivity, Saturated Zone

The saturated zone hydraulic conductivity (HCSZ) for the site is 16,000 m/yr.[154] The bounded log-normal- N distribution is centered at the most likely value of 16,000 m/yr (for the Cohansey Sand) and ranges over more than five decades of possible values between approximately 10 cm/yr and more than 20,000 m/yr.[155] Variability in the saturated zone hydraulic conductivity was shown to have no measurable impact on the projected annual dose in the uncertainty analysis.

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[153] TRC Environmental Consultants, Inc., *Remedial Investigation Technical Report*, Project Number 7650-N51, Windsor, Connecticut, April, 1992.

[154] TRC Environmental Consultants, Inc., *Remedial Investigation Technical Report*, Project Number 7650-N51, Windsor, Connecticut, April, 1992.

[155] TRC Environmental Consultants, Inc., *Remedial Investigation Technical Report*, Project Number 7650-N51, Windsor, Connecticut, April, 1992.

Saturated Zone Hydraulic Gradient

The hydraulic gradient is one of several hydrogeologic parameters used to calculate radionuclide transport from the contaminated zone. Sensitivity analysis, again, showed that annual dose was insensitive to the hydraulic gradient parameter (HGWT). A site-specific value of 0.004 is used when modeling the source term. The central tendency value is estimated to be 0.004 (for the Cohansey Sand) and the distribution is allowed to range over approximately 4 decades from $7x10^{-5}$ to 0.5.[156]

Saturated Zone Thickness

When modeling the surface soil source term, the RESRAD default deterministic value was used. The depth to the Kirkwood Formation clays in the Storage Yard area varies from approximately 121 to 144 feet below the ground surface. Subtracting the depth of the unsaturated zone (about eight to 10 feet), the average thickness of the saturated zone in the Storage Yard area would range from about 110 to 135 feet, with 130 to 135 feet being a more typical range for boring locations closest to the storage yard.

5.4.4 Interpreting Uncertainty Analysis Results

Since the results of the uncertainty analyses provide a distribution of annual doses, it must be recognized that some percentage of the calculated doses may exceed the regulatory limit. At the same time, because not all parameter distributions are symmetrical and because some parameters are correlated, the mean dose calculated in the uncertainty analysis is not necessarily equal to a deterministic dose calculated using single point estimates of the various parameters. A further phenomenon observed in the probabilistic modeling is that the mean dose for a particular series of repetitions is frequently higher than the 90th or even the 95th percentile estimates of probable dose. This results when all but the rarest combinations of very conservative estimates of the individual parameters result in little or no dose. In the very few cases in which the Monte Carlo sampling technique selects combinations of values from the outermost extremes of the proposed parameter distributions, projected annual dose is large compared to the majority of cases sampled.

A key issue that must be addressed in the treatment of uncertainty is specifying how to interpret the results from an uncertainty analysis in the context of the deterministic regulatory limit. There is no such thing as absolute assurance that the regulatory limit will be met, so regulatory compliance must be stated in terms of a metric of the distribution. Even for a deterministic analysis, it should be recognized that the reported dose is simply one of a range of possible doses that could be calculated for the site and scenario.

In this analysis, the peak of the mean dose for the critical exposure group (the most exposed subpopulation) is presented for comparison with the deterministic regulatory limit as required by regulation. Since the severely skewed cumulative distribution phenomenon occurs repeatedly in the radiation dose modeled for the Newfield site using the probabilistic approach, a suite of projected annual doses corresponding to the 50th, 90th, 95th, and maximum is reported along with the

[156] TRC Environmental Consultants, Inc., *Remedial Investigation Technical Report*, Project Number 7650-N51, Windsor, Connecticut, April, 1992.

traditional compliance measure, peak mean annual dose. In addition, the deterministic estimate of projected annual dose is provided for comparison.

The parameters used to perform the assessment were selected to represent the critical exposure group (analogous to the Reasonable Maximum Exposure concept), and as such already overstate the expected dose to the average receptor at the Site. Results of both the deterministic and probabilistic dose modeling including an evaluation of the uncertainty analyses are presented in the sections that follow.

5.5 Results

The RESRAD code was iteratively run for each of the selected scenarios to arrive at the highest uniform concentration of residual radioactivity in soil that results in a peak mean annual dose estimate to a single receptor in the critical exposure group that is equal to the regulatory limit of 25 mrem/year for scenarios where the controls are in intact and less than 100 mrem/year if the controls should fail.[157]

The computer code was set up to model each scenario with the input parameters identified and explained previously in this Chapter. A separate set of soil release criteria are presented for each scenario and for each source term. The following subsections present the results of the dose modeling, relating residual radionuclide concentration to potential future doses in each of the scenarios evaluated.

5.5.1 DCGL for Unrestricted Areas

The DCGLs provided in Table 17.6 reflect the concentration of radionuclides in soil that may be present outside of the restricted area to ensure a maximum exposure of less than 25 millirem per year over background. The presence of these isotopes will be verified after the remediation is completed and the final status survey is implemented. As described in Section 5.3.1, an industrial worker scenario was used to develop the DCGLs. The RESRAD summary report is provided in Appendix 19.5 (Newfield 3005006.rad).[158]

The primary isotopes of concern at the SMC site are Thorium-232 in equilibrium with its decay progeny(^{232}Th+D) and Uranium-238 in equilibrium with its decay progeny (^{238}U+D). Thorium-232 reaches secular equilibrium with its decay progeny in approximately ten (10) half lives of the longest lived progeny, ^{228}Th; secular equilibrium is reached in approximately 20 years.[159] The slag is at least 20 years old and assumed to be in secular equilibrium; this assumption is confirmed by analytical data provided in Chapter 4 of this Plan (see Table 17.7). As a result, a DCGL is established for ^{232}Th

[157] The USNRC separates institutional controls from engineered controls. Therefore, institutional controls are assumed to fail instantly, along with any maintenance, but engineered controls would degrade over time without monitoring and maintenance.

[158] The DCGLs for surfaces are shown in Table 17.11.

[159] The halflife of ^{228}Th is 1.9 years.

and the progeny. The concentration of each isotope in the decay chain is assumed to be equal to the greatest concentration reported for any isotope in the decay chain.

Uranium 238 is present in equilibrium with its decay progeny. The DCGL established for ^{238}U applies to any isotope in the decay chain. If analytical data indicates that ^{238}U is not in equilibrium with its decay progeny, a limit of 21 pCi/gram limit applies to ^{238}U and the DCGL for the detected progeny is limited to 9.8 pCi/gram, the limit for ^{238}U+D.

The RESRAD code was used to generate DCGLs in the soil by inputting unit activity concentrations and running the code to determine the resultant dose rate. This dose factor in millirem/year per pCi/g is divided into the release criteria to yield the DCGL. For ^{232}Th+D, the concentration of 1 pCi/g was used for the key isotopes, ^{232}Th, ^{228}Th and ^{228}Ra. For ^{238}U+D, the ratios of the uranium isotopes, ^{238}U, ^{235}U and ^{234}U, were used for the unit activity concentrations. For ^{238}U, the fraction of 0.0.471 was used, 0.044 for ^{235}U and 0.485 for ^{234}U. The slag exhibits concentrations of ^{226}Ra, and ^{210}Pb; the fraction 0.471 was used for each of these isotopes. This fractional source term was entered directly into the RESRAD code; the short-lived progeny were calculated by RESRAD according to their respective parents.

The input parameters for the physical and chemical characteristics, as described in Section 5.3.1 of this Chapter, were used in the RESRAD code and outlined in Tables 17.3.1, 17.3.2 and 17.4.10, including the unit activity concentrations. The unit activity and input parameters associated with the likely exposure scenario resulted in a dose factor for thorium plus progeny of 1.745 pCi/gram and for uranium plus progeny of 0.597 pCi/gram. The $DCGL_W$ for U+D and Th+D was calculated for a dose criterion of 25 millirem/year or as 12.5 mrem/year for each element (above background), as follows:

$$DCGL\,Uranium = \frac{12.5\,mrem/year}{\frac{0.597\,mrem/year}{1\,pCi/gram}} = 20.9\,pCi/gram$$

$$DCGL\,Thorium = \frac{12.5\,mrem/year}{\frac{1.745\,mrem/year}{1\,pCi/gram}} = 7.2\,pCi/gram$$

For each uranium isotope, the DCGL was calculated according to the ratio described above. Consequently, the DCGL for ^{238}U is 9.8 and the DCGL for ^{226}Ra and ^{210}Pb is 9.8 pCi/gram.

Background was established during prior site surveys, and summarized in Table 17.2. The DCGLs are based on a maximum dose of 25 mrem/year, the radiation dose is additive and cannot exceed the 25 mrem/year release criteria when combined. Therefore, the unity rule applies and the sum of the ratios of the measured ^{232}Th plus progeny, and ^{238}U plus progeny concentrations in a survey unit to their respective DCGL does not exceed one.

5.5.2 Occasional Trespasser Scenario (Unrestricted Area, Controls in Place)

The potential radiation dose was calculated for an occasional trespasser who may enter the unrestricted area. The results of the RESRAD computer code are provided in Table 17.8.1. The peak of the mean annual radiation dose was calculated to be 0.2 mrem per year and the maximum annual dose was calculated to be 0.4 mrem per year. The 50th percentile of the probabilistic radiation exposure was 0.2 mrem per year, the 90th percentile was 0.3 mrem per year and the 95th was 0.3 mrem per year. The principal exposure was external radiation contributing 98% of the dose in Year 0 of the analysis. Two isotopes contributed to the direct exposure, ^{226}Ra and ^{228}Th, 48% and 31% respectively. Appendix 19.5 (Newfield 3005007.rad) provides the output of the RESRAD code.

5.5.3 Suburban Resident Scenario (Unrestricted Area, Controls Fail)

The critical exposure group for the suburban resident scenario is described by hypothetical suburban family occupying a house located in the unrestricted area, outside of the fence of the restricted area. The results of the Microshield computer code are provided in Table 17.8.2. The peak of the mean annual radiation dose was calculated to be less than 1 mrem per year. The only source of exposure was determined to be the external radiation stemming from the Storage Yard. The exposure rate was calculated to be less than $1x10^{-5}$ mrem/hour or less than 1 mrem/year. Appendix 19.5 contains the Microshield summary report.

5.5.4 Maintenance Worker Scenario (Restricted Area, Controls in Place)

A maintenance worker will periodically inspect and maintain the engineered barrier after the decommissioning effort is complete. The results of the RESRAD computer code are provided in Table 17.8.3 The peak of the mean annual radiation dose was calculated to be 0.2 mrem per year and the maximum annual dose was calculated to be 0.4 mrem per year. The 50th percentile of the probabilistic radiation exposure was 0.2 mrem per year, the 90th percentile was 0.3 mrem per year and the 95th was 0.3 mrem per year. The principal exposure was external radiation contributing 98% of the dose in Year 0 of the analysis. Two isotopes contributed to the direct exposure, ^{226}Ra and ^{228}Th, 48% and 31% respectively. Appendix 19.5 (Newfield 3004001.rad) provides the output of the RESRAD code.

5.5.5 Industrial Worker Scenario (Impacted by Restricted Area, Controls in Place)

Although this is not a reasonably likely scenario, it is nonetheless assumed that industrial workers will visit the site to work each day; at no time will any workers enter the fenced area or walk on the engineered barrier. The results of the analysis are provided in Table 17.8.4. The peak of the mean annual radiation dose was calculated to be less than 0.000001 mrem per year for exposure to the DCGLs in the unrestricted area and less than one (1) millirem for the potential exposure to direct radiation stemming from the covered Storage Yard, the restricted area.[160] The principal exposure

[160] Microshield was used to calculate the potential direct radiation exposure at a distance of 100 feet from the fence surrounding the covered Storage Yard.

was external radiation contributing 100% of the dose in Year 0 of the analysis. Two isotopes contributed to the direct exposure, ^{226}Ra and ^{228}Th, 48% and 31% respectively. Appendix 19.5 (Newfield 3004005.rad) provides the output of the RESRAD and Microshield code.

5.5.6 Trespasser Scenario (Restricted Area, Controls in Place)

The potential radiation dose was calculated for a person who trespasses in the restricted area and traverses the engineered barrier. The results of the RESRAD computer code are provided in Table 17.8.5. The peak of the mean annual radiation dose was calculated to be 6×10^{-4} mrem per year and the maximum annual dose was calculated to be 0.02 mrem per year. The 50th percentile of the probabilistic radiation exposure was 4×10^{-5} mrem per year, the 90th percentile was 1×10^{-3} mrem per year and the 95th was 3×10^{-3} mrem per year. The radiation exposure was external radiation contributing 100% of the dose in Year 0 of the analysis. Two isotopes contributed to the direct exposure, ^{226}Ra and ^{228}Th, 19% and 77% respectively. Appendix 19.5 (Newfield 3004002.rad) provides the output of the RESRAD code.

5.5.7 Recreational Hunter Scenario (Restricted Area, Controls Fail)

The recreational hunter scenario is considered, perhaps, to be the most reasonably foreseeable among the future use scenarios considered for this site. Table 17.8.6 summarizes the results of modeling the projected future exposure potential for the scenario involving exposure while engaged in recreational hunting at the Site. A review of the RESRAD summary reports for the recreational hunter scenario reveals that exposure from external exposure from Thorium-232 and daughters (^{232}Th, ^{228}Th and ^{228}Ra) dominates the probabilistic estimate of radiation dose where the peak of the mean annual radiation dose was calculated to be 13.6 mrem per year and the maximum annual dose was calculated to be 78.6 mrem per year, which is estimated to occur after 1,000 years. The 50th percentile of the probabilistic radiation exposure was 0.4 mrem per year, the 90th percentile was 47 mrem per year and the 95th percentile was 54 mrem per year. The deterministic radiation exposure, dominated by the consumption of meat after the cover was allowed to erode, was calculated to be 0.3 mrem per year after 558 years. The peak of the mean radiation exposure for the consumption of meat was determined to be 0.2 ± 0.007 mrem per year, with ^{231}Pa and ^{226}Ra isotopes are the most significant contributors to total effective annual dose for meat consumption. Appendix 19.5 (Newfield 3004008.rad) provides RESRAD summary report for this analysis.

5.5.8 Industrial Worker Scenario (Restricted Area, Controls Fail)

In the event that institutional controls fail, the industrial workers may gain access to the restricted area. The results of the RESRAD computer code are provided in Table 17.8.7. The peak of the mean annual radiation dose was calculated to be 0.7 mrem per year and the maximum annual dose was calculated to be 6.7 mrem per year. The 50th percentile of the probabilistic radiation exposure was 0 mrem per year, the 90th percentile was 2.5 mrem per year and the 95th percentile was 3.4 mrem per year. The radiation exposure was external radiation contributing 100% of the dose in Year 0 of the analysis. Two isotopes contributed to the direct exposure, ^{226}Ra and ^{228}Th, 19% and 77% respectively. Appendix 19.5 (Newfield 3004004.rad) provides the output of the RESRAD code.

5.5.9 Slag Excavation Scenario (Restricted Area, Controls Fail)

The computer code RESRAD was not adequate to evaluate the potential direct radiation exposure over the exposure period of 10 days or 80 hours. Microshield was used to model the exposed slag as an infinite slab, 1 meter thick. Table 17.8.9 summarizes the potential exposures; an exposure rate of 0.13 mR/hr was calculated. The results of the Microshield code was compared to existing monitoring data surrounding the Storage Yard.[161] These data indicated an external exposure rate of 250 to 300 millirem in the three month period (0.01 mR/hour at approximately 20 feet from the edge of the Storage Yard). The results of the Microshield code verified these results. For the intruder, the potential radiation exposure was calculated to be 8 mrem for the 80 hour exposure period.

5.5.10 Suburban Resident Scenario (Restricted Area, Controls Fail, Excavation)

In the event that the intruder attempts to excavate the slag, it is assumed that the cover is not repaired and the excavation is abandoned as is. In an effort to provide a conservative estimate of radiation exposure, this scenario assumes that the suburban family lives 1,000 feet directly downrange of the open excavation. The exposures summarized in Table 17.8.10 are added to the calculated direct exposure estimate of 0.002 mR/hr or 17 mrem per year.

5.6 Summary of Dose Modeling and Comparison to Release Criteria

The estimates of peak mean dose to the critical exposure groups in each of the foregoing scenarios have been derived using industry standard modeling tools specifically designed to assess exposures to residual radioactivity. Conservatism has been built into the modeling by conscientiously selecting exposure factor values that err on the side of safety when confronted with uncertainty in the selection of input parameters. In order to provide the risk managers and decision makers with insight as to the degree of conservatism associated with the dose modeling, projected annual doses have been calculated with both deterministic and probabilistic techniques.

Based on the results presented above, the source term in each of the scenarios considered is projected to produce a peak mean annual dose that is well-below the dose limits for unrestricted and restricted release as specified in 10 CFR 20.1402 and 1403, respectively, as shown in the following:

Dose Modeling Summary

Scenario	Area	Status of Controls	Peak of the Mean Dose Estimate (millirem)	Applicable Dose Limit (millirem)
Trespasser	Unrestricted	In Place	<1	25
Suburban Resident	Unrestricted	Fail	<1	25
Maintenance Worker	Restricted	In place	<1	25

[161] Letter From Carol Berger to David Smith, *Quarter 4, 2004 Perimeter Monitoring Results*, January 3, 2005.

Scenario	Area	Status of Controls	Peak of the Mean Dose Estimate (millirem)	Applicable Dose Limit (millirem)
Industrial Worker	Restricted	In place	<1	25
Trespasser	Restricted	In place	<1	25
Recreational Hunter	Restricted	Fail	13.6	100
Industrial Worker	Restricted	Fail	<1	100
Slag Excavator	Restricted	Fail	8.3	100
Suburban Resident	Restricted/Excavated	Fail	17	100

Once decommissioning pursuant to this Plan is complete, the radiation doses incurred by any of the potentially affected population groups, if any, will be lower than the estimates derived herein. In any case, they will not be discernible from background radiation exposures incurred by these population groups by virtue of being alive.

6 ENVIRONMENTAL INFORMATION

The environmental information required for evaluation of this Decommissioning Plan is outlined in NUREG-1748.[162] Appendix 19.9 contains the information solicited in that document, captured as a stand-alone Environmental Report.

[162] U. S. Nuclear Regulatory Commission, Division of Waste Management, "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs; Final Report", NUREG-1748, August, 2003.

7 ALARA ANALYSIS

The proposed decommissioning action at SMC's Newfield facility is on-site stabilization and long-term control of the residual radioactivity at the site. In order to demonstrate that this approach is consistent with the ALARA (As Low As Reasonably Achievable) principle, a cost-benefit analysis that compares it to other alternatives was performed. As described in Chapter 6 of this Decommissioning Plan, the three alternatives are: (1) Partial restriction of the site under the long-term control license, with the remainder of the site released for unrestricted use; (2) Off-site disposal followed by release of the entire site for unrestricted use (i.e., the license termination alternative) and (3) no action alternative (i.e., the license continuation alternative). The following subsection contains a brief description of the three alternatives along with the results of the cost-benefit analysis.

7.1 Description of Decommissioning Options

7.1.1 On-Site Stabilization and Long Term Control (LTC) Alternative

For the proposed decommissioning action, residual radioactive materials above restricted release levels that are present at the Newfield site will be consolidated into a single capped pile within the Storage Yard, which will remain a radiologically-restricted area. Once the engineered barrier is installed over the seven (7) month construction period, a Final Status Survey of the plant in its entirety will be performed and documented as evidence that the restricted portion of the site meets the established dose criteria for restricted release (i.e., 25 millirem TEDE with all controls in place and 100 millirem if controls fail), and that the unrestricted portion of the site meets the dose criterion for unrestricted release (i.e., 25 millirem TEDE). At that point, License No. SMB-743 would be amended to a long term control (LTC) license, wherein license provisions that include access restrictions, maintenance, monitoring (visual inspections and radiation surveys) and specific legal restrictions against future residential construction, farming or business redevelopment on the restricted area would be attached. The remainder of the property will then be released for unrestricted use.

7.1.2 Off-site Disposal and License Termination (LT) Alternative

The LT alternative would require residual radioactivity present at the Newfield site to be processed and then transported to the Envirocare of Utah, Inc. facility near Clive, Utah for disposal as low-level radioactive waste. Once the two (2) year construction period is complete, a Final Status Survey of the plant in its entirety will be performed and documented as evidence that the site meets the established dose criteria for unrestricted release (i.e., 25 millirem TEDE). At that point, License No. SMB-743 would be terminated and the site released for unrestricted use.

7.1.3 License Continuation (LC) Alternative

If no action is taken at the Newfield site, the residual radioactivity present would retain its current amount and configuration, and the existing conditions of License No. SMB-743 would remain as they are as of the date of this report.[163] Assuming all provisions of the current license continue to be met, the annual radiation dose potential to workers at the site and to members of the general population would remain unchanged from their current measured values. Although this alternative does not offer an acceptable regulatory basis (i.e., the owner would be in violation of the timeliness requirements of 10 CFR 40.42), it is nonetheless included in the ALARA analysis for comparison purposes only.

7.2 Comparison of Risks

There are a variety of risks associated with each of the aforementioned options. These include physical risks associated with the implementation of the option (i.e., remedial action activities and transportation), as well as radiological risks present during implementation and after the option has been fully implemented. The following subsections describe and quantify these risks in compatible units so that the radiological ramifications of the three options may be fairly compared.

7.2.1 Radiological

Because radiation exposure, if high enough, is associated with an increased risk of cancer, the radiological risk of interest in the comparison of the three decommissioning options applicable to the Newfield site is the risk of incurring fatal cancer. Hypothetically, the risk of harm caused by radiation exposure increases as the exposure increases.[164] However, no effects have ever been observed at levels below 5,000 millirem delivered over a one year period.[165,166] In fact, the effects seen when humans are exposed to 100,000 millirem over a very short time period are temporary and reversible. It takes a short-term dose on the order of 500,000 millirem (without medical intervention) to cause death.[167]

The radiation dose potential to even the maximally-exposed individual associated with the decommissioning of the Newfield site, regardless of which option is selected, is far too low to result in demonstrable health effects. Nonetheless, for the purpose of comparing the three options, the LNT, or "Linear No Threshold" hypothesis provides a useful risk assessment tool. In essence, this hypothesis states that since scientists have observed a linear relationship between radiation dose and effect at high doses and dose rates, and since a "radiation free" environment to test the theory at low doses (taken to be 20,000 millirem TEDE or less) does not exist, for radiation protection purposes it is reasonably conservative to assume that the relationship is indeed linear. While the LNT

[163] As currently written, License No. SMB-743 authorizes possession of up to 303,050 kilograms of thorium in any chemical/physical form, and up to 45,000 kilograms of uranium in any chemical or physical form. As of October 21, 2005, SMC was at 96.8% of the thorium limit and 87.6% of the uranium limit.

[164] This linear relationship between dose and effect is clearly demonstrated in populations that have received large, acute exposures.

[165] Health Physics Society, "Radiation Risk in Perspective", Position Statement of the Health Physics Society, January, 1996 (revised August, 2004).

[166] Health Physics Society, "Compensation for Diseases that Might be Caused by Radiation Must Consider the Dose", Position Statement of the Health Physics Society, March, 2000 (Reaffirmed, March, 2001).

[167] International Commission on Radiological Protection, ICRP Publication 60, "1990 Recommendations of the International Commission", Pergamon Press, 1991.

hypothesis leads to the obvious conclusion that any radiation dose, no matter how small, may be capable of causing some biological damage or detriment - a conclusion that is not supported with facts - it nonetheless offers a conservative risk coefficient that is useful for this assessment.

The coefficient that will be used to derive comparative risks associated with the three decommissioning options is that which gives the individual risk of fatal cancer per rem of dose equivalent, or approximately 5×10^{-4}.[168] The following subsections give the hypothetical risk associated with the option-specific dose for on-site workers and members of the public, and Table 17.9 gives a summary of findings.

7.2.1.1 On-site Workers

<u>LC Alternative</u>

For the LC alternative, radiological conditions at the site would remain as they are today. Since no operations involving source material would be permitted by the continued license, the only pathway for exposure of personnel present on the site would be external exposure associated with close proximity to the slag piles.

The ambient doses incurred by monitored workers during the production of ferrocolumbium, which required them to come in close proximity to both the feed stock and the slag in the operational areas of the plant as well as the Storage Yard, were less than 40 millirem per calendar year.[169] Therefore, the dose potential for current on-site workers, who seldom frequent the Storage Yard and do not perform any other licensed operations, is conservatively assumed to be 50% of the maximum measured exposure for monitored workers, or 20 millirem TEDE. For a 30-year working lifetime, and applying the risk coefficient of 5×10^{-4} a hypothetical fatal cancer risk potential of 3.0×10^{-4} may be assumed for on-site workers.

<u>LTC Alternative</u>

For the LTC alternative, radiological conditions associated with the shaping of the residual radioactivity currently in the Storage Yard and installation of the engineered barrier presents the potential for direct radiation exposure and inhalation of airborne radioactivity by on-site workers.[170] In addition, once the LTC license is in place, the dose potential for on-site workers, would be as shown for the Industrial Worker scenario in Chapter 5 of this decommissioning plan.

From the air modeling results shown in the Environmental Report (see Appendix 19.9), the concentration of airborne particulates for the seven-month duration of these operations is approximately 11×10^{0} micrograms per cubic meter. Assuming a reasonable maximum of 10 times this concentration, and applying the isotopic concentration for each as shown in Table 17.7, the

[168] National Academy of Sciences, National Research Council, Committee on the Biological Effects of Ionizing Radiation, "Health Effects of Exposure to Low Levels of Ionizing Radiation (BEIR-V)", National Academy Press, Washington, D.C., 1990.

[169] See "Report of Radiation Safety Surveillance" for Quarters 1, 2 and 3 of 1996.

[170] Once the residual radioactivity is covered, there will be no measurable dose potential for on-site workers, thus no radiation dose of significance is associated with the performance of the final status survey.

resulting airborne concentration in the Storage Yard for the 512-hour continuous work time associated with placement and configuration would be 2.0×10^{-14} microcuries each of thorium and uranium per milliliter. When the Derived Air Concentrations (DACs) authorized for SMC are applied (i.e., 1.91×10^{-11} microcuries per milliliter for thorium and 8.4×10^{-11} microcuries per milliliter for uranium), the resulting internal dose potential to a hypothetical worker would be 1.7 millirem (CEDE).[171]

The ambient exposure rate measured around the circumference of the Storage Yard ranges from "background" to approximately 130 microR per hour, with an average measured rate of approximately 30 microR per hour.[172] If a hypothetical remediation worker is present somewhere within the Storage Yard for the duration of remedial activities (i.e., 512 working hours), it is not unreasonable to assume his/her dose rate potential from external radiation would be equivalent to the average measured exposure rate, for a total dose potential of 15.4 millirem EDE.

Applying the risk coefficient of 5×10^{-4} to the total dose potential from all exposure pathways of 17.1 millirem TEDE, and assuming a single hypothetical worker incurs the dose from all of these pathways and for all applicable time periods, the fatal cancer risk potential would be 8.6×10^{-6} for on-site workers.

<u>LT Alternative</u>

For the LT alternative, radiological conditions associated with processing (crushing) and packaging the residual radioactivity that is currently in the Storage Yard prior to shipment to the disposal site in Utah presents the potential for direct radiation exposure and inhalation of airborne radioactivity by on-site workers.[173] From the air modeling results shown in the Environmental Report (see Appendix 19.19), an airborne concentration of respirable particulates in air is approximately 22.8×10^{0} micrograms per cubic meter for the five-month duration in operations for each year. Assuming a reasonable maximum of 10 times this concentration, and applying the isotopic concentration for each as shown in Table 17.7, the resulting airborne concentration in the Storage Yard for the 840-hour continuous work time duration would be 4.2×10^{-14} microcuries each of thorium or uranium per milliliter, respectively.[174] When the Derived Air Concentrations (DACs) authorized for SMC are applied for each, the resulting internal dose potential to a hypothetical worker would be 1.0 millirem (CEDE).[175]

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[171] Provision 12 of License No. SMB-743 authorizes the use of adjusted ALI and Derived Air Concentration (DAC) values for licensed materials.

[172] Berger, C. D., "Quarter 4, 2004 Perimeter Monitoring Results", submitted to D. R. Smith, January 3, 2005.

[173] Once the residual radioactivity is covered, there will be no measurable dose potential for on-site workers, thus no radiation dose of significance is associated with the performance of the final status survey.

[174] To ensure an element of conservatism in this analysis, no engineered or administrative controls over the work area and the working population and no standard radiation protection principles commonly associated with radiological work of this type were taken into account.

[175] Provision 12 of License No. SMB-743 authorizes the use of adjusted ALI and Derived Air Concentration (DAC) values for licensed materials.

The ambient exposure rate at the circumference of the Storage Yard ranges from "background" to approximately 130 microR per hour, with an average rate of approximately 30 microR per hour.[176] If a hypothetical remediation worker is present somewhere within the Storage Yard for the duration of remedial activities (i.e., 840 hours per year for a total of two years), his/her dose potential from external radiation would be 50.4 millirem EDE.

Applying the risk coefficient of 5×10^{-4} to the total dose potential from the internal and external exposure pathways during construction of 51.4 millirem TEDE results in a fatal cancer risk potential of 2.6×10^{-5} for on-site workers.

7.2.1.2 Members of the Public

LC Alternative

For the LC alternative, radiological conditions at the site would remain as they are today. Since no operations involving source material would be permitted by the continued license, the only pathway for exposure of members of the general public would be external exposure associated with close proximity to the slag piles.

As a licensee, SMC is required by 10 CFR 20.1301 and 1302 to demonstrate that members of the general public do not incur a radiation dose in excess of 100 millirem TEDE in any calendar year. The maximum measured ambient exposure rate at the fence line around the Storage Yard is approximately 130 microR per hour with an average measured rate of approximately 30 microR per hour and a nominal radon dose rate from baghouse dust emanation of approximately 8.2×10^{-3} microR per hour.[177] Monitoring records over the past five years demonstrate that no member of the public has incurred a radiation dose that even approaches the regulatory limit.

Nonetheless, to ensure an element of conservatism in this assessment, it is assumed that a hypothetical member of the general public is present somewhere around the perimeter of the Storage Yard constantly and continuously such that his/her annual radiation dose is equal to the regulatory limit of 100 millirem. Over a 70-year lifetime, that hypothetical member of the public would thus incur a total dose of 7,000 millirem. Applying the risk coefficient of 5×10^{-4} to the lifetime dose potential from both pathways results in a hypothetical fatal cancer risk potential of 3.5×10^{-3} for members of the general public.

LTC Alternative

For the LTC alternative, radiological conditions associated with the shaping of the residual radioactivity currently in the Storage Yard and installation of the engineered barrier presents the potential for direct radiation exposure and inhalation of airborne radioactivity by members of the public.[178]

[176] Berger, C. D., "Quarter 4, 2004 Perimeter Monitoring Results", submitted to D. R. Smith, January 3, 2005.
[177] Berger, C. D., "Quarter 4, 2004 Perimeter Monitoring Results", submitted to D. R. Smith, January 3, 2005.
[178] Once the residual radioactivity is covered, there will be no measurable dose potential for on-site workers, thus no radiation dose of significance is associated with the performance of the final status survey.

From the air modeling results shown in the Environmental Report (see Appendix 19.9), the concentration of airborne respirable particulates during construction operations at the nearest off-site location is 10.97 or approximately 11 micrograms of material per cubic meter. Applying the specific activity for each of the radionuclides in the site source term (see Table 17.7), the resulting uranium or thorium concentration would be 2 x 10^{-15} microcuries per milliliter. When the Derived Air Concentrations (DACs) authorized for SMC are applied for each, the resulting internal dose potential to a hypothetical worker would be 0.16 millirem (CEDE).

The ambient exposure rate at the circumference of the Storage Yard ranges from "background" to approximately 130 microR per hour, with an average rate of approximately 30 microR per hour.[179] If a hypothetical member of the general public is present somewhere near the perimeter of the Storage Yard constantly and continuously for the duration of remedial activities (i.e., 512 hours), his/her dose potential from external radiation would be 15.4 millirem EDE.

Once the LTC license is issued, the dose potential for members of the public has a maximum value of 25 millirem TEDE. Over a 70-year lifetime, this is equivalent to a dose potential of 1,750 millirem, TEDE. Applying the risk coefficient of 5 x 10^{-4} to the total dose potential from all exposure pathways of 1,766 millirem TEDE results in a fatal cancer risk potential of 8.8 x 10^{-4} for members of the public.

<u>LT Alternative</u>

For the LT alternative, radiological conditions associated with the processing and packaging the residual radioactivity currently in the Storage Yard for shipment to the disposal site in Utah presents the potential for direct radiation exposure and inhalation of airborne radioactivity by members of the public.[180] In addition, members of the public may incur direct exposure during the transportation of the residual radioactivity to the Utah disposal site. Furthermore, after the license is terminated, member of the public may incur a radiation dose of up to 25 millirem TEDE in any one year (see Subpart E of 10 CFR 20).

From the air modeling results shown in the Environmental Report (see Appendix 19.9), the concentration of airborne respirable particulates during construction operations at the nearest off-site location is 22.8 micrograms of material per cubic meter. Applying the specific activity for each of the radionuclides in the site source term (see Table 17.7), the resulting uranium or thorium concentration would be 4.2 x 10^{-15} microcuries per milliliter. When the Derived Air Concentrations (DACs) authorized for SMC are applied for each, the resulting internal dose potential to a hypothetical worker for the two-year construction period (840 hours per year) would be 1.13 millirem (CEDE).

[179] Berger, C. D., "Quarter 4, 2004 Perimeter Monitoring Results", submitted to D. R. Smith, January 3, 2005.
[180] Once the residual radioactivity is covered, there will be no measurable dose potential for on-site workers, thus no radiation dose of significance is associated with the performance of the final status survey.

The ambient exposure rate at the circumference of the Storage Yard ranges from "background" to approximately 130 microR per hour, with an average rate of approximately 30 microR per hour.[181] If a hypothetical member of the general public is present somewhere near the perimeter of the Storage Yard constantly and continuously for the duration of remedial activities (i.e., 1,640 hours), his/her dose potential from external radiation would be 50.4 millirem EDE.

Once the license is terminated, the dose potential for members of the public has a maximum value of 25 millirem TEDE. Over a 70-year lifetime, this is equivalent to a dose potential of 1,750 millirem, TEDE. Applying the risk coefficient of 5×10^{-4} to the total dose potential from all exposure pathways of 1,802 millirem TEDE results in a fatal cancer risk potential of 9.0×10^{-4} for members of the public.

7.2.2 Remedial Action Activities

When any remedial actions are performed, there is a risk for non-radiation-related injury or harm associated with those actions. From NUREG-1496, the workplace accident fatality rate may be assumed to be 4.2×10^{-8} per person-hour.[182] The following subsections give the hypothetical risk of fatality from the remedial actions associated with each option for both on-site workers and members of the public.

<u>LC Alternative</u>

For the LC alternative, it is assumed that there would be no remedial actions performed.[183] Therefore, there would be no potential for harm (fatality) if this option were implemented for either workers or members of the general public.

<u>LTC Alternative</u>

For the LTC alternative, workers incur some risk of fatality from accidents that may occur during the shaping of the residual radioactivity, the installation of the engineered barrier, and during the performance of the final status survey. As shown in Section 8.5 of this decommissioning plan, the time duration of these activities is projected to be a total of 512 working hours, with the number of workers ranging from six (6) to 12. To ensure an element of conservatism in this analysis, a total of 12 workers is assumed, for a collective duration of 6,144 person-hours. Applying the risk coefficient of 4.2×10^{-8} to this collective duration results in a fatality risk potential of 2.6×10^{-4} for on-site workers. The fatality risk potential for members of the general public would be "zero".

<u>LT Alternative</u>

For the LT alternative, workers incur some risk of fatality from accidents that may occur during the processing and packaging of the residual radioactivity for transport to the Utah disposal site. As

[181] Berger, C. D., "Quarter 4, 2004 Perimeter Monitoring Results", submitted to D. R. Smith, January 3, 2005.
[182] NUREG-1496, "Final Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criteria for License Termination of NRC-Licensed Nuclear Facilities", Vol. 2, Appendix B, Table A.1, July, 1997.
[183] This is an unrealistic assumption as it is likely that some sort of future remediation will be necessary. However, for the purposes of this assessment, the no-action option contains no provisions for future remedial actions.

shown in Section 8.5 of this decommissioning plan, the time duration of these activities is projected to be a total of 840 working hours per year for a total of 1,680 hours, with the number of workers ranging from eight (8) to 10. To ensure an element of conservatism in this analysis, a total of 10 workers is assumed, for a collective duration of 16,800 person-hours. Applying the risk coefficient of 4.2×10^{-8} to this collective duration results in a fatality risk potential of 7.1×10^{-4} for on-site workers. The fatality risk potential for members of the general public would be "zero".

7.2.3 Transportation

There are, of course, risks associated with transporting people and goods from place to place. The transport of residual radioactivity from the Newfield site presents no exception. From NUREG-1496, the transportation accident fatality rate may be assumed to be 6.6×10^{-7} per kilometer.[184] The following subsections give the hypothetical risk of fatality from transportation associated with each option for both on-site workers and members of the public.

LC Alternative

For the LC alternative, there would be no remedial actions performed and no materials transported.[185] Therefore, there would be no potential for harm (fatality) if this option were implemented for either workers or members of the general public.

LTC Alternative

For the LTC alternative, people incur some risk of transportation fatality associated with the transport of borrow and construction materials to/from the site as part of engineered barrier installation. For the purposes of cost estimation, a round-trip distance of five (5) miles was assumed. With a total of 1,233 trucks making the trip for the engineered barrier material and 211 trucks making the trip for cover material, the total distance traveled would be 7,220 truck miles or 12,033 kilometers. Applying a fatality risk coefficient of 3.8×10^{-8} (for truck travel) to this total distance results in a transportation fatality risk potential of 4.6×10^{-4} that is applicable to both workers and members of the public.[186]

LT Alternative

For the LT alternative, people incur some risk of fatality from transportation accidents that may occur during the transport of packaged residual radioactivity to the Utah disposal site. As shown in Table 17.15, the projected travel distance for these activities is approximately 2,250 miles. With a total of 737 rail cars making the trip per year over a two-year period, the total distance traveled would be 3,316,500 rail car miles or 5,527,500 kilometers. Applying a fatality risk coefficient of

[184] Federal Railroad Administration, Office of Safety Analysis, "Accident/Incident Overview, January to April, 2005", total accident incident rate with fatalities, July 27, 2005.
[185] This is an unrealistic assumption as it is likely that some sort of future remediation will be necessary. However, for the purposes of this assessment, the no-action option contains no provisions for future remedial actions.
[186] NUREG-1496, "Final Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criteria for License Termination of NRC-Licensed Nuclear Facilities", Vol. 2, Appendix B, Table A.1, July, 1997.

2.3×10^{-7} (for rail travel) to this total distance results in a transportation fatality risk potential of 7.6×10^{-1} that is applicable to both workers and members of the public.[187,188]

7.3 Comparison of Costs

Appendix N of NUREG-1757 (Vol. 2) recommends licensees evaluate the total cost ($Cost_T$) of the various alternatives being evaluated, which is then balanced against the benefits. The following is the calculational methodology provided:[189]

$$Cost_T = Cost_R + Cost_{WD} + Cost_{ACC} + Cost_{TF} + Cost_{WDose} + Cost_{PDose} + Cost_{other}$$

where $Cost_R$ = the monetary cost of the decommissioning alternative, $Cost_{WD}$ = the monetary cost for transport and disposal of the waste generated by the action, $Cost_{ACC}$ = the monetary cost of worker accidents during the action, $Cost_{TF}$ = the monetary cost of traffic fatalities during waste transportation, $Cost_{WDose}$ = the monetary cost of dose received by workers performing the alternative and transporting waste to the disposal facility, $Cost_{PDose}$ = the monetary cost of the dose to the public from excavation, transport and disposal of waste, and $Cost_{other}$ = other costs as appropriate for the particular situation (i.e., licensing, changes in land value, environmental impacts).

Chapter 15 and Table 17.14 give the cost estimates for the preferred decommissioning option (i.e., the LTC alternative). This and the estimates for the LC and the LT alternatives (see Tables 17.15 and 17.16) were based on a variety of cost-estimating data sources, vendor information, conventional cost-estimating guides, inflation adjustment, and similar estimates as modified by prior site-specific project cost information. The following subsections summarize the costs associated with the other parameters in the aforementioned equation for each of the decommissioning options.

7.3.1 Remedial Action Activities

<u>LC Alternative</u>

For the no-action option, $Cost_R$ would be the on-going annual costs, or those associated with license compliance only. These would include the cost of radiological surveillance, record keeping, licensing fees, and regulatory interactions. Based on costs incurred in calendar year 2004, the total annual cost of these activities at the Newfield site is $62,400. The present worth of this cost incurred annually over a 1,000-year period, assuming a 3% rate of return in accordance with recent USNRC guidance, would be $2,700,000. Table 17.16 shows the breakdown for this cost estimate.

<u>LTC Alternative</u>

The $Cost_R$ of implementing the LTC alternative is described in detail in Chapter 15 of this decommissioning plan. That cost, which includes the cost of long-term surveillance and

[187] Federal Railroad Administration, Office of Safety Analysis, Accident/Incident Overview, January to December, 2004 (see http://safetydata.fra.dot.gov/OfficeofSafety/Query/Default.asp?page=statsSas.asp for data base).
[188] The risk associated with transporting soil cover material for the remediated storage yard was not included in the assessment.
[189] NUREG-1757, Vol. 2, Appendix N, Section N.1.2.

maintenance, as well as the cost of record keeping, licensing fees, and regulatory interactions over a 1,000-year period is $ 5,172,507, adjusted for the escalating cost of money. Table 17.14 shows the breakdown for this cost estimate.

LT Alternative

For the LT alternative, $Cost_R$ is equal to the cost of material packaging, shipment, disposal, and the associated cost to complete the final status survey and then terminate License No. SMB-743. The cost of transporting the packaged material to the disposal site is shown in Table 17.15. Once the license is terminated and all applicable records transferred to the USNRC pursuant to Subpart L of 10 CFR 10, there would be no continuing cost. Therefore, the total cost of the alternative would be $58,080,851. Table 17.15 shows the breakdown for this cost estimate.

7.3.2 Transportation of Waste

LC Alternative

For the no-action option, no waste would be shipped for disposal. Therefore, there would be no waste transportation cost associated with this alternative.

LTC Alternative

For the LTC alternative, no waste would be shipped for disposal. Therefore, there would be no waste transportation cost associated with this alternative.

LT Alternative

Before terminating License No. SMB-743, all packaged and staged radioactivity must be transported approximately 2,250 miles to the Envirocare of Utah facility. The cost of this action is $14,485,122.

7.3.3 Waste Disposal

LC Alternative

For the no-action option, no waste would be disposed of.[190] Therefore, there would be no waste disposal cost associated with this alternative.

LTC Alternative

For the LTC option, no waste would be disposed of. Therefore, there would be no waste disposal cost associated with this alternative.

LT Alternative

The cost of disposing of all packaged and shipped residual radioactivity from the Newfield site includes the cost of acceptance testing. As shown in Table 17.15, this amount has been estimated at $21,539,215.

[190] This is an unrealistic assumption as it is likely that some sort of future remediation with associated waste disposal will be necessary. However, for the purposes of this assessment, the no-action option contains no provisions for disposal of waste.

7.3.4 Cost of Construction (Non-Radiological) Risks

<u>LC Alternative</u>

For the no-action option, no construction would be on-going.[191] Therefore, there are no construction risk costs associated with this alternative and $Cost_{ACC}$ is zero.

<u>LTC Alternative</u>

For the LTC option, there is a risk of construction-related injuries. As recommended in NUREG–1496, their cost may be evaluated as follows:

$$Cost_{ACC} = \$3{,}000{,}000 \times F_W \times T_A$$

where \$3,000,000 = the USNRC's recommendation on the monetary value of a fatality equivalent to \$2,000 per person rem; F_W = the workplace fatality rate in fatalities per hour worked; and T_A = the worker time required for remediation in units of worker-hours.[192]

For the LTC alternative, the workplace fatality risk, as shown in Section 7.2.2, above, is 2.6×10^{-4}. Therefore, the cost of construction risks for this alternative is:[193]

$$Cost_{ACC} = \$3{,}000{,}000 \times 2.6 \times 10^{-4} = \$780$$

<u>LT Alternative</u>

There is also a risk of construction-related injuries for the LT option. Using the same approach shown previously, with a workplace fatality risk of 7.1×10^{-4}, the cost of construction-related risks for this alternative is:[194]

$$Cost_{ACC} = \$3{,}000{,}000 \times 7.1 \times 10^{-4} = \$2{,}130$$

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[191] This is an unrealistic assumption as it is likely that some sort of future construction activities will be necessary. However, for the purposes of this assessment, the no-action option contains no provisions for on-site construction.

[192] If the cost per person-rem averted is increased to \$20,000 as suggested in NUREG-1757, Vol. 2, Appendix N (Section N.4), the cost associated with a transportation fatality would increase to \$30,000,000 and the cost associated with workplace accidents would thus be determined as follows:

$$Cost_{ACC} = \$30{,}000{,}000 \times F_W \times T_A$$

[193] If the basis for the cost per fatality is made consistent with the recommendations of NUREG-1757, Vol. 2, Appendix N (Section N.4), the $Cost_{Acc}$ in this case would be \$7,800.

[194] If the basis for the cost per fatality is made consistent with the recommendations of NUREG-1757, Vol. 2, Appendix N (Section N.4), the $Cost_{Acc}$ in this case would be \$21,300.

7.3.5 Cost of Transportation Risks

LC Alternative

For the no-action option, no transportation of residual radioactivity would occur.[195] Therefore, there are no transportation risk costs associated with this alternative.

LTC Alternative

For the LTC option, no transportation of residual radioactivity off-site would occur. However, there is transportation associated with the construction of the engineered barrier. As recommended in NUREG–1496, the cost of transportation-related risks may be evaluated as follows:

$$Cost_{TF} = \$3{,}000{,}000 \times \frac{V_A}{V_{SHIP}} \times F_T \times D_T$$

where \$3,000,000 = the monetary value of a fatality equivalent to \$2,000 per person rem; V_A = the volume of material in units of cubic meters, F_T = the fatality rate per vehicle-kilometer traveled in units of fatalities per vehicle-km; D_T = the distance traveled in km; and V_{SHIP} = the volume of a vehicle shipment in cubic meters.[196,197] From Section 7.2.3, above, the transportation-related risk for the LTC alternative is 4.6×10^{-4}. Therefore, the cost of transportation risks for this alternative would be:[198]

$$Cost_{TF} = \$3{,}000{,}000 \times 4.6{\times}10^{-4} = \$1{,}380$$

[195] This is an unrealistic assumption as it is likely that some sort of future remediation that involves transportation of materials will be necessary. However, for the purposes of this assessment, the no-action option contains no provisions for transport.

[196] The NUREG-1496 equation requires input parameters in units associated with transport by truck. However, it is anticipated that the residual radioactivity at the Newfield site would be transported by rail rather than truck, thus the reason for different units.

[197] If the cost per person-rem averted is increased to \$20,000 as suggested in NUREG-1757, Vol. 2, Appendix N (Section N.4), the cost associated with a transportation fatality would increase to \$30,000,000 and the cost associated with workplace accidents would thus be determined as follows:

$$Cost_{TF} = \$30{,}000{,}000 \times \frac{V_A}{V_{SHIP}} \times F_T \times D_T$$

[198] If the basis for the cost per fatality is made consistent with the recommendations of NUREG-1757, Vol. 2, Appendix N (Section N.4), the $Cost_{TF}$ in this case would be \$13,800.

LT Alternative

For the LT option, there is a risk of transportation-related injuries in the shipment of residual radioactivity to the Envirocare of Utah site. Using the same approach shown previously, with a transportation fatality risk of 7.6×10^{-1}, the cost of construction-related risks for this alternative is:[199]

$$Cost_{TF} = \$3{,}000{,}000 \times 7.6{\times}10^{-1} = \$2{,}280{,}000$$

7.3.6 Cost of Radiological Risks (With Long-term Surveillance and Maintenance)

LC Alternative

NUREG-1496 recommends the use of a collective dose cost value of $2,000 per person rem. As shown in Section 7.2.1.1, the radiation dose associated with the LC alternative for industrial workers at the SMC site in its current condition is 600 millirem TEDE (20 millirem TEDE for 30 years. Pursuant to NUREG-1496 recommendations, a population density of 0.0004 persons per square meter of land may be assumed, meaning the anticipated population at the 67-acre Newfield property would be approximately 109 people, and the resulting collective dose would be approximately 65 person-rem. This would then result in a cost for the hypothetical radiological risks incurred of $130,800. If a 3% discount rate is applied, a cost of $4,360,000 results.[200]

As shown in Section 7.2.1.2, the total long-term permissible dose for a hypothetical member of the general public would be 7,000 millirem (100 millirem TEDE for 70 years). Again assuming the population is equivalent to that for the Newfield site, 109 people each year, the collective dose would thus be 763 person-rem. This would then result in a cost for the hypothetical radiological risks incurred ($Cost_{Wdose}$ + $Cost_{PDose}$) of $50,866,667, discounted at the rate of 3%.

LTC Alternative

As shown in Section 7.2.1.1, the dose associated with the LTC alternative during construction activities is 17.1 millirem. For a nominal nine-person worker population, the collective dose would be during construction is 154 millirem or 0.2 rem, with an associated cost value of $400.

As shown in Section 7.2.1.2, the total dose associated with the post-construction phase is 1,766 millirem (25 millirem TEDE for 70 years). Again assuming the population of the Newfield site is 109 people each year, the collective dose would thus be 193 person-rem. This would then result in a cost ($Cost_{Wdose}$ + $Cost_{PDose}$) for the hypothetical radiological risks incurred of $12,853,733 when a 3% discount rate is applied to the long-term component.

LT Alternative

As shown in Section 7.2.1.1, the dose associated with the LT alternative during construction activities is 51.4 millirem. For a nominal nine-person worker population, the collective dose during construction is 0.5 rem, with an associated cost value of $1,000.

[199] If the basis for the cost per fatality is made consistent with the recommendations of NUREG-1757, Vol. 2, Appendix N (Section N.4), the $Cost_{TF}$ in this case would be $22,800,000.

[200] NUREG-1757, Vol. 2, Appendix N, (Section N.1.1).

As shown in Section 7.2.1.2, the total dose associated with the post-construction phase is 1,802 millirem (25 millirem TEDE for 70 years). Again assuming the population of the Newfield site is 109 people each year, the collective dose would thus be 344 person-rem. This would then result in a cost ($Cost_{Wdose}$ + $Cost_{PDose}$) for the hypothetical radiological risks incurred of $22,901,000 when a 3% discount rate is applied to the long-term component.

7.3.7 Licensing

There are a variety of licensing and other regulatory costs associated with each of the decommissioning alternatives for the site. Since each of these can significantly impact the total project cost and are difficult to predict, the evaluation below is qualitative in nature only.

For the LC alternative, licensing costs include the cost of maintaining the license, financial assurance and the cost of periodic inspections and re-licensing efforts. For the LTC alternative, the costs include licensing fees to develop an Environmental Impact Statement, financial assurance associated with the monitoring and maintenance trust, deed noticing costs, public and Site Specific Advisory Board (SSAB) meeting charges as required in 10 CFR 20.1403(d)(2) and heretofore unknown future liabilities. Because no regulatory interactions would be necessary with the LT alternative, there would be no licensing costs. On a qualitative basis, it is clear that the LT alternative would present the greatest cost avoidance, followed somewhat closely by the LC alternative.

7.3.8 Change in Land Value

During the actual implementation of the alternatives listed below, no impacts on the economic use of the property are expected to result, as the actions associated with each alternative are basically limited to the Storage Yard and adjacent areas that are not currently industrially active. Therefore, this evaluation focuses on potential impacts on land value once the alternatives have been implemented.

Long-term potential changes in land value associated with the implementation of these alternatives are difficult to estimate, as they not only involve the normal variables associated with real estate cycles, but also such intangible factors as the potential stigma associated with a real or perceived environmental hazard, perceived risks, changes in science which may impact existing risk analyses, and potential future liability associated with regulatory changes. More practical but still intangible factors a potential developer faces also include problems associated with achieving financing for such a property or the general "trouble factor" of dealing with such a property. Since each of these variables can significantly impact future land values and are extremely difficult to predict, the evaluation presented below focuses on a qualitative evaluation of potential impacts on land value associated with each of the alternatives.

<u>LC Alternative</u>

For the no-action option, no changes in the existing nature of the site would occur. Therefore, there are no costs or benefits in terms of future land value associated with this alternative.

LTC Alternative

For the LTC option, engineering, institutional and regulatory controls would limit future use of the remaining restricted area (i.e., the area beneath the engineered barrier). Other existing restrictions associated with natural resource restoration requirements will prevent future use/redevelopment of much of the currently undeveloped area of the SMC facility. It is expected that industrial operations will continue in the existing developed portions of the facility. Based on the industrial worker assessment presented in Chapter 5, no restrictions on future continued use of the existing industrial areas are anticipated. Therefore, no adverse impacts to existing land value are anticipated for these areas. With the aesthetic improvements associated with the engineered barrier materials as well as the improved aesthetics associated with the natural resource restoration program (i.e., reforestation of undeveloped portions of the site), an increase in future land use value could result.

LT Alternative

For the LT option, upon, the site would be released for unrestricted use completion of the removal of residual radioactivity. Existing restrictions associated with natural resource restoration requirements will prevent future use/redevelopment of much of the currently undeveloped area of the SMC facility. Similarly, soil contaminant levels will likely prevent any future residential use of the site. However, continued industrial use of the existing developed areas is likely. Because the implementation of the LT alternative requires the upgrading of an existing railroad spur along the northern border of the site to support the removal of materials off-site, the value of the facility as an industrial property is likely to increase following remediation. As the railroad spur borders the northern edge of the SMC facility, associated rail spur improvements also have the potential to increase the value of other adjacent properties for future industrial use (e.g., the former Newfield municipal landfill, located immediately to the north of the Storage Yard area).

7.3.9 Environmental Impacts

LC Alternative

For the no action option, the existing Storage Yard area remains a potential erosion source and, therefore, a potential source of impacts to surface water quality should storm water management controls not be maintained in the future. The Storage Yard area provides poor ecological habitat value and the exposed materials act as a potential a source of wind erosion.

LTC Alternative

For the LTC option, reshaping of existing Storage Yard materials (which will require handling of only a portion of the existing materials) and the placement of cover materials over the pile will result in emissions that will be only a fraction of the Derived Air Concentrations (DACs). Costs associated with the control of these emissions are included in the remedial action costs discussed in Section 7.3.1. No other environmental costs are expected to be associated with the implementation of the LTC alternative.

Long-term environmental benefits associated with the implementation of the LTC alternative include the reduction in potential erosion (both wind- and water-induced) of currently uncovered Storage

Yard materials and the improved ecological habitat value of the engineered barrier relative to existing conditions.

LT Alternative

For the LT option, the removal of residual radioactivity will result in greater emissions than those associated with the LTC alternative, as all of the residual radioactive materials will have to be removed and some will have to be crushed on site prior to loading in railcars for off-site disposal. The emissions associated with this alternative are estimated to be only a fraction of the applicable DACs. Costs associated with the control of these emissions are included in the remedial action costs discussed in Section 7.3.1.

An environmental cost associated with the implementation of the LT option that is difficult to quantify is the cost of the loss of existing habitat associated with the upgrading of the existing railroad spur along the facility's northern property line. Since the spur was last used, the associated area has grown over with dense vegetation. It is estimated that nearly 2 acres of dense vegetation will require removal to support the rehabilitation and extension of the existing spur.

An indirect environmental cost associated with the implementation of the LT option that is difficult to quantify is the cost associated with the consumption of landfill space at the disposal facility. The permitting, design and construction of such facilities are extremely costly. While the costs of the development and maintenance of the Envirocare facility are reflected in their existing disposal costs, it is reasonable to expect that the development of new facilities in the future will be even costlier. By consuming currently permitted landfill airspace, a valuable commodity is being expended, guaranteeing increased costs for future projects where on-site stabilization is not an option.

Long-term environmental benefits associated with the implementation of the LT alternative include the permanent removal of residual radioactivity from acting as a source of future erosion (both wind- and water-induced) at this site. However, as the materials will not be destroyed but instead contained within another facility in Utah, the ultimate potential for future impacts due to wind- and water-induced erosion will be limited by the containment features of the disposal facility.

While removal of the radioactive materials will allow for the area in which they are currently stored to be planted with more habitat-friendly plants, the unrestricted use of the area will allow for its future development. Therefore, the long-term enhanced ecological value of the area is not guaranteed.

7.3.10 Cost Summary

Tables 17.14, 17.15 and 17.16 contain a summary of the costs associated with each of the three decommissioning alternatives applicable to the Newfield site. For the LC alternative, the $Cost_T$ is \$53,077,467. For the LTC alternative, the $Cost_T$ is \$18,028,800, and for the LT alternative, the $Cost_T$ is \$83,264,981.

7.4 Cost/Benefit Analysis

Table 17.9 shows the potential hazard, the risk estimate determined for that hazard, and the implementation cost for each of the decommissioning options evaluated in this Chapter. It also demonstrates that the LTC alternative presents a lower risk of fatality compared to the LT alternative and a lower total project cost.

With respect to radiological impacts only, a simple cost-benefit analysis can be performed by evaluating the following:

$$X + \alpha S = Minimum$$

where X = the cost of achieving a given level of protection ($), S = the collective dose (person-rem), and α = a constant expressing the cost assigned to the collective dose.[201] The following is a summary of the radiological cost-benefit analysis for the three options:

Cost-Benefit Analysis Summary

Option	X ($)	S (Person-Rem)	α ($ per Person-Rem Averted)	Result ($)
LC Alternative	$2,700,000	828	$20,000	$19,260,000
LTC Alternative	$5,172,507	193	$20,000	$9,036,507
LT Alternative	$58,080,851	344	$20,000	$64,964,851

Consistent with the ALARA concept, the LTC alternative again gives the lowest result and thus presents the most cost-effective solution.

7.5 Summary

Most decisions about human activities are based on an implicit form of balancing the costs and benefits leading to the conclusion that the conduct of a chosen practice is "worthwhile".[202] With

[201] A value of $2,000 is the value in dollars of a person-rem averted in NUREG/BR-0058, "Regulatory Analysis Guidelines of the U. S. Nuclear Regulatory Commission", Revision 2, November, 1995. However, NUREG-1757, Vol. 2, Appendix N (Section N.4), reads as follows: "Subpart E, 10 CFR 20.1403(e)(2) addresses circumstances in which a licensee would be required to demonstrate that further reductions in residual radioactivity would be prohibitively expensive. This can be demonstrated by an analysis like the ALARA analysis described above, but using a value of $20,000 per person-rem when calculating the value of the averted dose. This value reflects NRC's statement in the final rule on radiological criteria for license termination that NRC considers it is appropriate that a remediation would be prohibitively expensive if the cost to avert dose were an order of magnitude more expensive than the cost recommended by NRC for an ALARA analysis (see page 39071 of "Radiological Criteria for License Termination," Final Rule, *Federal Register,* Volume 62, 62 FR 39058, July 21, 1997)." In light of this guidance a value of $20,000 of person-rem averted is used in the analysis.

[202] International Commission on Radiological Protection, ICRP Publication 55, "Optimization and Decision-Making in Radiological Protection", Pergamon Press, 1989.

respect to the use and control of radioactive materials, the decision-making process is typically based upon the following:

- No practice shall be adopted unless its introduction produces a positive net benefit;
- All exposures to ionizing radiation shall be kept as low as reasonably achievable, economic and societal factors being taken into account; and
- The dose equivalent to individuals shall not exceed applicable regulatory dose limits.

As part of the decommissioning planning process for SMC's facility in Newfield, three alternatives were compared in light of ALARA considerations. These were the LC (license continuation) alternative, the LTC (long-term control) alternative, and the LT (license termination) alternative. In the analysis, project costs, construction-related fatalities, transportation-related fatalities, and the risks of radiation exposure were compared for all options.

The results demonstrate that the LTC alternative is the most defensible decommissioning option for this site based upon ALARA considerations.

8 PLANNED DECOMMISSIONING ACTIVITIES

This chapter contains the description of SMC's approach for decommissioning of the remaining restricted areas at the Newfield site. It also contains a schedule for completion of those activities. As described previously, the decommissioning of the Newfield site will involve the following general steps:

- Finalization of decommissioning work plan and procedures, which will cover the detail and procedures, including the final design and technical specifications, health and safety plans (HASPs), construction issues, and performance and documentation of the Final Status Survey.

- Consolidation, stabilization, grading, and preparation of the regulated material within the designated portion of the existing Storage Yard;

- Characterization of those portions of the Storage Yard surrounding the final storage area's footprint; construction of the engineered barrier and associated infrastructure (e.g., drainage systems);

- Performance of the Final Status Survey of the soil excavation areas and the completed engineered barrier to confirm the absence of residual radiological activity above the site-specific criteria;

- Performance of the Final Status Survey of the remainder of the site.

A description of the planned closure activities and a schedule for these activities, are presented in the following subsections. In addition to those areas of the facility that will be subjected to active decommissioning processes (e.g., excavation, engineered barrier construction, etc.), several additional areas that were formerly associated with licensed radioactive materials but no longer exhibiting residual activity will be subjected to Final Status Survey assessment as part of this site-wide decommissioning effort.

8.1 Contaminated Structures

As described in Section 2.3, and with the exception of the concrete pads upon on which two former production facilities were located, no contaminated structures remain at the site. The concrete pads will be removed and those portions that cannot be released for unrestricted use will be consolidated beneath the engineered barrier as described in Section 8.3, below. Releasable concrete will be disposed of as industrial waste.

8.2 Contaminated Systems and Equipment

As described in Section 4.3, no additional systems or equipment with residual radioactivity remain at the site.

8.3 Soil

The focus of this Plan is the consolidation, capping and management of remaining process slag, baghouse dust, contaminated concrete, radiologically-impacted soils and other USNRC-regulated materials into a designated portion of the existing Storage Yard. For purposes of this Plan in general, and for this subsection in particular, all of these materials will be categorized as "soil".

The following sequence of steps will be performed to address the management and final disposition of soil materials on-site which exhibit radiological activity above established background levels:

- Installation of erosion and sedimentation control systems to prevent off-site migration of regulated materials during construction activities and the control of run-on into the work areas;
- Dust control;
- Preparation of the consolidated area (grading, compaction, drainage, etc.);
- Consolidation of regulated materials (slag, baghouse dust, soils, stockpiled decontamination/demolition rubble, including the concrete pads, and other regulated material) beneath the engineered barrier;
- Survey, sampling and radiological analysis of surface soils surrounding the engineered barrier and elsewhere on the site, followed by excavation and consolidation of additional materials, as required;
- Final grading, compaction, and engineered barrier installation;
- Performance of Final Status Survey of the entire restricted area (consisting of the engineered barrier and surrounding areas);
- Performance of Final Status Surveys for the unrestricted area;
- Establishment of O&M and monitoring programs pursuant to the LTC Plan; and
- Conversion of the current "storage only pending decommissioning" provisions of License No. SMB-743 into a LTC license.

Specific activities associated with the first four of these steps, including sequence and methods, are described individually below. Radiation protection methods to be employed during the activities are described in Chapter 10, below. The Final Status Survey and long-term monitoring and maintenance of the site are discussed in detail in Chapters 11 and 16, below. SMC commits to conducting all decommissioning activities in accordance with the provisions of this Plan, with existing Radiation Safety Procedures (RSPs) and other procedures, approved in advance by the USNRC. There are no unique safety or remediation issues associated with the handling of soil at the SMC site other than those typical of these operations (e.g., safety and awareness around heavy equipment use, heat stress, cold stress, slips, trips, falls, etc.).

The final design and specifications for the engineered barrier will be developed in accordance with USNRC requirements, as summarized in Title 10 Code of Federal Regulations, Section 61.52, with the final plans and specifications provided in a subsequent submission after this Decommissioning Plan has been approved. The design will be sufficiently robust that ongoing maintenance is not necessary to maintain the necessary level of effectiveness for 1,000 years, even though a maintenance and inspection program will be a key provision of the LTC license (see Chapter 16). The design will also meet the acceptable erosion cover design criteria outlined in NUREG-1620 (Rev. 1) and NUREG-1623. In general, the final design and specifications will include the following elements:

- Final contour plan;
- Engineered barrier system design details;
- Slope stability analysis;
- Description and availability of final cover material;
- QA/QC Plan for engineered barrier construction;
- Detailed description of erosion control measures;
- Post-closure monitoring plan;
- Surface water management system design;
- Contingency plans for differential settling;
- Construction Quality Assurance Plan;
- Performance Standard Verification Plan;
- Operation and Maintenance Plan; and

- Long-Term Control Plan.

Primary design considerations include: (1) physical characteristics of the stockpiled regulated materials (size, density); (2) volumes of the material piles; and (3) relative location of the material piles. The engineered barrier will be designed and constructed in order to minimize material relocation, while establishing a stable storage system. Specific design considerations include provision for the following:

- Provide required radiological shielding through installation of calculated soil cap thickness;
- Facilitate drainage off of engineered barrier and away from unit;
- Ensure long-term engineered barrier slope stability through appropriate design and construction;
- Install erosion controls for implementation during construction and for long-term engineered barrier maintenance;
- Provide dust control during engineered barrier construction;
- Minimize need for waste material handling (loading, transfer, and installation) to lower construction costs and simplify logistics;
- Utilize baghouse dust, soil and finer slag material as subgrade preparation for the soil engineered barrier, over the larger size slag material;
- Minimize requirements for off-site cover material to lower construction costs;
- Minimize surface area of engineered barrier while meeting requisite slope stability and other key design objectives to simplify long-term maintenance and lower overall program costs; and
- Use low maintenance vegetative cover materials.

8.3.1 Engineered Barrier Construction

Construction of the engineered barrier will be initiated through consolidation of the collected/stockpiled regulated materials and preparation of the final subgrade for engineered barrier construction. Surface drainage systems will be constructed, which will direct surface runoff from the engineered barrier away from the capped material. Engineered barrier preparation will also involve the physical movement of slag, baghouse dust, and other materials using standard construction equipment (front-end loaders, bulldozers, dump trucks) such that effective consolidation and compaction is achieved.

Due to the large size and rough texture of the resident ferrocolumbium slag, it is anticipated that the finer-grained slag, soils and baghouse dust will be used to prepare the engineered barrier subgrade by filling the larger void spaces among the slag matrix. Final decisions as to the location of the various materials within the constructed capped unit will be made by SMC's Contractor based upon field conditions and final engineered barrier design considerations.

During consolidation of the various regulated materials into a single pile, comprehensive health and safety protocols will be followed to avoid exposing workers and nearby resident to site contaminants, and to prevent migration of contaminants into the surrounding environment. Water and/or other appropriate dust-control media will be used during all material movement activities. Continuous monitoring of the access and haul roads will be performed and appropriate dust control activities will be performed to minimize vehicle-induced fugitive dust generation. Material loading and unloading activities will also be monitored and controlled in a similar fashion. Further, real-time dust monitoring and radiological monitoring will be performed by SMC's Contractor to ensure exposures to radiological contaminants as well as other constituents of potential concern (i.e., metals) do not occur as a result of materials handling activities.[203] These actions, combined with the fact that the closest residence is hundreds of feet from the SMC property boundary, will ensure radiological and safety conditions that cannot be distinguished from those prior to the start of work will be maintained.

8.3.2 Adjacent Soil Characterization

As part of the regulated material consolidation process into a single pile, supplemental radiological surface soil characterization will be conducted within the Storage Yard by SMC's contractor to determine whether soils outside of the footprint of the engineered barrier are impacted by radiological contaminants of potential concern. Historical storage of licensed materials in this area could have caused the co-mingling with the underlying site surface soils. These potentially-impacted shallow surface soils may therefore be required to be consolidated in the capped pile.

Following removal of all of the licensed material beyond the areal extent of the final planned capped pile, soil sampling and radiological surveys will be conducted to determine the extent of any possible additional licensed material. Actual number, location, and depth of samples will be determined following completion of all initial consolidation activities, however sampling will involve the collection of a statistically significant number and distribution of shallow surface soil samples, which will be subjected to analysis for radiological constituents.

203 In the event that exposure levels above established site-specific health and safety action levels are identified, additional dust control activities (e.g., increased application of water or other control medium or use of different/supplemental controls systems) will be implemented.

Upon receipt of the shallow surface soil characterization results, SMC's environmental Contractor(s) will make a determination as to which soils shall be placed beneath the engineered barrier. Soils exhibiting radiological activity above the release criteria for soil excavation will be transferred to the Storage Yard for consolidation. SMC may place other inert (unlicenced) soils beneath the engineered barrier to prepare the engineered barrier subgrade, to shape the site surrounding the engineered barrier or to isolate other soil materials regulated by NJDEP.

8.3.3 Engineered Barrier Completion

Upon final consolidation of materials, the engineered barrier will be constructed on the prepared subgrade in order to achieve the design criteria described in Section 5.0 of this Plan. The engineered barrier has been designed in accordance with USNRC specifications. On this basis, the final graded and compacted impoundment will be covered with a one-meter-thick compacted soil shield barrier. The thickness of the soil barrier layer was calculated using a RESRAD computer model, and demonstrates that the potential for radiation exposures from all exposure pathways over the next 1,000 years, even if no barrier maintenance takes place, is less than 100 millirem per year (see Chapter 5, above). The engineered barrier in its entirety will consist of a geomembrane for water diversion, and one (1) meter of compacted suitable soil, topped with a six-inch thick final vegetative soil layer that is then seeded with suitable low maintenance and drought resistant grasses.

Surface drainage from the top surface of the capped pile will be collected near the top of the side slopes via open drain swales and directed down the side slopes in erosion control-lined downchute open channels. The discharge from the downchutes will be directed away from the pile and either allowed to spread and disperse or it will be directed via open channels or pipe to a suitable stormwater outfall location. Final cover soil material will be secured from a certified off-site source, and will be of appropriate grain size and quality to be stable and augment the overlying vegetative soil layer. Proposed location and dimensions of the final engineered barrier are depicted in Figure 18.6; details of design elements are provided in Figure 18.8.

8.3.4 Final Status Survey

Following consolidation of all residual radioactivity and installation of the engineered barrier, SMC will conduct a Final Status Survey of the disturbed areas and the barrier. The survey will follow protocols and methods established in the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*. The primary purpose of the Final Status Survey will be to confirm the former radiologically-controlled and/or impacted areas of the site associated with former licensed operations meet the dose criterial contained in 10 CFR 20.1402 and 1403. A more detailed discussion of the Final Status Survey is provided in Chapter 11.

8.3.5 SMC Commitment Statement

SMC is committed to implementation of conservative radiological protection practices, and intends to be consistent with federal requirements that licensed radioactive materials be handled and released in a manner that ensures that exposures are as low as reasonably achievable (ALARA), taking into account economic and societal factors. Because the goal of decommissioning at the Newfield site is to ensure that members of the general population do not incur radiation doses in excess of the criteria specified in 10 CFR 20.1402 and 1403 after decommissioning is complete, and that the final radiation dose potential to members of the public is ALARA, these two objectives form the basis for the level of effort necessary for decommissioning of this facility.

8.3.6 Long-Term Control Plan

As part of the final decommissioning report, SMC will prepare and submit, for USNRC review and comment, a Long-Term Control Plan, the contents of which will be captured in the LTC license. At a minimum, the LTC Plan will contain provisions for the following:

- Organization and Administration
- Restricted Area Description, Condition and Specifications
- Training
- Instrumentation and Monitoring Devices
- Surveillance Activities and Frequency
- Maintenance Activities and Frequency
- Posting
- Records Maintenance and Storage
- Reports (Quarterly and Annual)
- Emergency Response and Notifications
- Periodic Program Reviews

8.4 Surface and Groundwater

As described in Chapter 4, previous investigations at the site, including evaluations in the vicinity of the Storage Yard, yielded no radiological impacts above USEPA screening levels in downgradient ground water. Non-radiological contaminants (e.g., metals and/or volatile organic compounds) detected in ground water and have been further evaluated and addressed under the NJDEP RI/FS process. Results of previous investigations are presented in the report titled *Remedial Investigation Technical Report*, dated 1992.

Based on the absence of exceedences of radiological action levels in downgradient ground water, no decommissioning actions are planned to address the ground water. The planned decommissioning program will be designed and implemented in order to prevent discharges of radiological and/or chemical constituents to these environmental receptors through effective erosion and sedimentation controls, materials and equipment management, and proper completion of the engineered barrier.

8.5 Schedules

The projected schedule for the Newfield Decommissioning program is shown in Figure 18.9. This schedule presents the estimated time that will be required to perform the full decommissioning process, from finalization of the project Work Plan through submission of the Construction Completion and Final Decommissioning Report and amendment of License No. SMB-743 to a LTC license. The primary tasks depicted on the schedule consist of the following activities:

- Work Plan Development;
- Final Design;
- Bidding and Award;
- Implementation of Decommissioning Activities;
- Engineered barrier Construction;
- Final Status Survey Performance;
- Construction Completion Report and Certification;
- LTC Plan Preparation;
- Final Decommissioning and Final Status Survey Report; and
- Amendment of License No. SMB-743.

The presented schedule, which depicts the relative sequence of tasks and the projected time frame for each task/subtask, has been based upon a number of general assumptions, including time requirements for the review and approval of submittals to the USNRC. SMC acknowledges that this schedule may change substantially based on USNRC input and approval of this Decommissioning Plan, final design requirements, site-specific conditions, etc. In the event that the schedule as provided in this Plan cannot be maintained as the project moves forward, SMC will notify the USNRC immediately and will develop and submit an updated schedule to the USNRC.

9 PROJECT MANAGEMENT AND ORGANIZATION

9.1 Decommissioning Management Organization

SMC will maintain primary responsibility for all site activities conducted under the requirements of License No. SMB-743. The point of contact between applicable regulatory authorities and SMC will be the SMC Radiation Safety Officer.

Figure 18.10 shows the organizational structure of the project. This streamlined arrangement serves to minimize administrative functions, keeps overhead costs to a practical minimum, provides maximum flexibility for resource allocation, and facilitates SMC oversight of all decommissioning operations. The following subsections contain brief descriptions of the remainder of the decommissioning organization.[204,205]

9.2 Decommissioning Task Management

Radiation Work Permits (RWPs) will be used for the administrative control of personnel entering or working in areas that have radiological hazards present. Work techniques will be specified in such a manner that the exposure for all personnel, individually and collectively, are maintained ALARA. RWPs will not replace work procedures, but will act as a supplement to procedures. Radiation work practices will be considered when procedures are developed for work which will take place in a radiologically controlled area.

Project RWPs will describe the job to be performed, define protective clothing and equipment to be used, and personnel monitoring requirements. RWPs will also specify any special instructions or precautions pertinent to radiation hazards in the area including listing the radiological hazards present, area dose rates and the presence and intensity of hot spots, loose surface radioactivity, and other hazards as appropriate. The radiation safety organization will ensure that radiation, surface radioactivity and airborne surveys are performed as required to define and document the radiological conditions for each job.

RWPs for jobs with low dose commitments (less than 20 millirem TEDE) will be approved at the HP technician or HP supervisory level while RWPs for jobs with potentially higher dose commitment or significant radiological hazards will be approved by the RSO as described in RSP-012, "Control of Radiological Work". Examples of topics covered by implementing procedures for the Radiation Work Permits are:

- Requirements, classifications and scope for RWPs;

[204] A single individual may serve one or more roles during implementation of the work plan. Likewise, each role described herein may be fulfilled by more than one individual. Those individuals specifically assigned to each role will be named and their qualifications presented in the work plans.

[205] While there will be frequent and on-going communications between all members of the organization, there are no provisions for a formal safety committee as part of this project.

- Initiating, preparing and using RWPs;
- Extending expiration dates of an RWP; and
- Terminating RWPs.

The details on how individuals performing the decommissioning tasks will be informed of the procedures in the RWP, including how they are initially informed and how they are informed when an RWP is revised or terminated will be provided to the USNRC by the Decommissioning Contractor prior to the start-up of the on-site work.

9.3 Decommissioning Management Positions and Qualifications

9.3.1 Radiation Safety Officer

The RSO will be an employee of SMC and will have an Associate's degree (or equivalent), and should have completed course work and/or have experience with the following: Principles and practices of radiation protection; Radioactivity measurements, monitoring techniques, and the use of instruments; Mathematics and calculations basic to the use and measurement of radioactivity; Biological effects of radiation; Safety practices applicable to protection from the radiation, chemical toxicity, and other properties of the radioactive materials in use at SMC facilities; Conducting radiological surveys and evaluating results; Evaluating radioactive material processing facilities for proper operations from a radiological safety standpoint; and Familiarity with applicable USNRC, USEPA, and OSHA regulations, as well as the terms and conditions of any licenses and permits issued to SMC by these agencies. The qualifications of the individual serving as RSO for this work will be provided to the USNRC prior to the start of the on-site efforts.

The Radiation Safety Officer (RSO) is an individual who, by virtue of qualifications and experience, has been given the authority to implement the Radiation Protection Program Plan on the Newfield site. The RSO is qualified to direct the use of radioactive material for its intended purpose in a manner that protects health and minimizes danger to life or property. The RSO is responsible for recognizing potential radiological hazards, developing a radiation safety program to protect against these hazards, training workers in safe work practices, and supervising day-to-day radiation safety operations.

The RSO is responsible for recommending the type and quantity of staff and resources necessary for full implementation of the SMC Radiation Protection Program Plan. The RSO has the responsibility and authority to terminate any work activities that do or may violate regulatory requirements for radiological protection pursuant to "Stop Work Authority".

9.3.2 Other Management Positions

9.3.2.1 Decommissioning Contractor

SMC will retain a Decommissioning Contractor to implement this Plan subject to SMC's overall direction and control. The Decommissioning Contractor, to be selected by SMC after USNRC approval of the Plan, will prepare the final work plans, pre-qualify and select all subcontractors, monitor subcontractor performance, perform and document Final Status Surveys, facilitate communications with federal and state regulatory authorities, and provide on-site project management and site-specific health and safety support (radiological, industrial hygiene, and industrial safety support) during the construction phase. To fulfill this role, the Decommissioning Contractor will have demonstrated experience in facility decommissioning, industrial safety/surveillance, radiological safety/surveillance, license/regulatory interactions, negotiations and compliance demonstration, developing technical bases for radiological operations, and preparing standard operating procedures to implement these technical bases. The Decommissioning Contractor will also hold a USNRC (or Agreement State) radioactive materials license that authorizes the performance of radiological decommissioning activities as specified herein. That license shall be in good standing and with no Notices of Violation for decommissioning-related tasks over the previous five years.

9.3.2.2 Project Manager

The Decommissioning Contractor will designate an individual to serve as the Project Manager. The Project Manager, who will have training and education in applicable radiological, engineering and environmental aspects of decommissioning, as well as expertise in managing projects of this magnitude, will be responsible for the following:

- Verifying that the personnel used by each subcontractor are provided with the proper radiation protection, industrial safety training and possess the requisite knowledge of the details of the job assignment;
- Observing work in progress to verify adherence to the radiological and industrial safety rules and procedures;
- Recommending changes to operational and radiological protection practices to the subcontractors;
- Enforcing compliance with SMC site rules and license requirements;
- Reviewing reports and results provided by subcontractors; and
- Establishing and maintaining a records management system to verify that project documents, such as correspondence, procedures, drawings, specifications, contract documents, changes to documents, and inspection records are controlled.

9.3.2.3 Site Health and Safety Officer

Reporting to the Project Manager will be the Site Health and Safety Officer (Site HSO). This individual, will be present at the Newfield facility for the duration of all on-site work, and is to have a combination of education and experience in the following radiation protection and industrial safety subjects:

- Principles and practices of radiation protection;
- Radioactivity measurements, monitoring techniques; and the use of instruments;
- Mathematics and calculations basic to the use and measurement of radioactivity;
- Biological effects of radiation;
- Safety practices applicable to protection from radiation, chemical toxicity, and other properties of the materials that may be encountered during the decommissioning;
- Conducting radiological surveys and evaluating results;
- Evaluating and implementing the final work plans for proper operations from a radiological safety standpoint;
- Applicable USNRC, USEPA, and OSHA regulations, as well as the terms and conditions of any licenses and permits issued by regulatory agencies to SMC; and
- The requirements contained in USNRC License No. SMB-743.

The responsibilities of the Site HSO will include, but are not limited to the following:

- Establishing the health and safety program requirements for field activities
- Verifying that the subcontractors implement the requirements of the industrial safety and radiation protection program adequately
- Reviewing the results of surveys, sampling, and environmental monitoring to identify trends and potential for personnel exposure
- Evaluating the effectiveness of engineering and administrative control including the requirements for personnel protective equipment
- Developing new safety protocols and procedures necessary for new field activities

- Providing internal review and approval for work related documents
- Auditing key aspects of the safety and health program
- Making recommendations to the Project Manager regarding the control of existing and potential industrial, chemical and radiological hazards
- Stopping work if conditions indicate the potential for unnecessary radiation exposure to site personnel or members of the public, or for unsafe working conditions.

9.3.2.4 Quality Assurance Officer

The Decommissioning Contractor will also assign a Quality Assurance Officer (QAO) for the project. The QAO, who will have training in the implementation of quality programs, will perform the following:

- Technical assistance and peer review of all deliverables;
- Prepare and review the QAPP;
- Coordinate with analytical laboratories, as necessary;
- Oversee subcontractor QA activities to ensure compliance with the QAPPs;
- Track laboratory submittals and sample analyses and verify delivery of data, as necessary;
- Coordinate validation of analytical data;
- Monitor the on-site activities; and
- Prepare and submit QA reports, as required.

9.4 Training

All employees, contractors, and visitors with unescorted access to the facility will be trained in regard to the type and magnitude of the radiological hazards they might face. All personnel performing the on-site work described in this Plan will current in the training required in 29 CFR 1910.120. The following subsections briefly describe the various training programs that will be implemented as part of this Plan.

9.4.1 Visitor Training

Visitors to the work zone will be trained by reading and signing a briefing form. The briefing form will contain information about the hazards present in the work zone, and the requirement that all visitors be escorted while in the work zone.

9.4.2 General Employee Training

General Employee Training in Radiation Protection (GET) will be administered to all project employees with the potential to receive in excess of 100 millirem TEDE while performing work at the SMC plant. GET, provided to the start of work on this decommissioning effort, will consist of an oral presentation by the Site HSO, hand-out of materials, and completion of a form acknowledging receipt of training. GET will address the following topics:

- The type and form of radioactive material present at the facility.
- The location of USNRC and SMC radiation protection policies and procedures.
- Employee and management responsibilities for radiation safety.
- Identification of radiation postings and barriers.
- Protective equipment and procedures.
- Work zone setup and decontamination procedures;
- Emergency procedures; and
- How to contact SMC and project radiation safety staff.

A self-graded exam to test employee proficiency in the class topics shall be administered. A passing score of 68% is required. Refresher training will be provided annually thereafter.

9.4.3 Radiation Worker Training

Radiation Worker Training (RWT) will be administered to all employees with the potential to receive in excess of 500 millirem TEDE while participating in this decommissioning effort. RWT will address the following topics:

- Radioactivity and radioactive decay.
- Characteristics of ionizing radiation.
- Man-made radiation sources.

- Acute effects of exposure to radiation.
- Risks associated with occupational radiation exposures.
- Special considerations in the exposure of women of reproductive age.
- Dose-equivalent limits.
- Modes of exposure - internal and external.
- Dose-equivalent determinations.
- Basic protective measures - time, distance, shielding.
- Specific procedures for maintaining exposures as low as reasonably achievable (ALARA).
- Radiation survey instrumentation - calibration, use and limitations.
- Radiation monitoring programs and procedures.
- Contamination control, including protective clothing, equipment and work place design.
- Personnel decontamination.
- Emergency procedures.
- Warning signs, labels, and alarms.
- Responsibilities of employees and management.
- How to contact SMC and project radiation safety staff.

RWT will consist of a classroom lecture and procedure review, a two-hour practical demonstration, a question/answer period, and a handout. The duration of training is approximately six (6) hours. A self-graded exam to test employee proficiency in the class topics shall be administered. A passing score of 70% is required. Refresher training will be provided annually thereafter.

9.4.4 Tailgate Safety Training

Tailgate safety meetings will be conducted at the beginning of each work shift, whenever significant changes are made in job scope or whenever new personnel arrive at the job site. The meetings will present health and safety procedures and issues for the day, any unique hazards associated with an activity and review any significant topics from previous activities. The information discussed will be recorded, which will serve as confirmation that the information was presented to those persons whose signatures are on the form.

9.4.5 Training Records

A form will be developed to demonstrate that training commitments are being met. The form will capture the following information: the facility, date, time, task number, type of work, hazardous/radioactive materials used, protective clothing/equipment, chemical hazards, radiological hazards, physical hazards, emergency procedures, hospital/clinic, phone, paramedic phone, hospital address, special equipment and any other safety topics that may be relevant.

9.5 Contractor Support

The efforts of the Decommissioning Contractor will be focused on nuclear, health and safety, regulatory compliance, and project management matters. Specialty services necessary to complete all aspects of this Plan (e.g., engineering design, construction, labor, analytical, etc.) may be subcontracted to firms with appropriate skills and experience. As part of the contract arrangement, each subcontractor will designate a Task Manager and, as necessary, a health and safety and/or QA contact. At all times, however, the Decommissioning Contractor will remain responsible for the quality, type and level of service provided by all subcontractors, and SMC license requirements will "pass down" to all subcontractors. All personnel training necessary for the performance of this work will be provided by the Decommissioning Contractor and not by SMC. The majority of the Decommissioning Contractor's work will be performed in the Storage Yard area of the facility.

10 HEALTH AND SAFETY PROGRAM

SMC is committed to completing the decommissioning action described herein in a manner that protects workers, the surrounding environment and the public. Consequently, comprehensive health and safety requirements and access controls will be specified in the final work plans. These requirements will remain in effect during all on-site decommissioning activities. SMC will also verify there is sufficient documentation to demonstrate the effectiveness of the health and safety program.

This chapter of the Decommissioning Plan describes those measures that will be used to control and monitor the impacts of ionizing radiation on workers. The Radiation Protection Program described herein is designed to be compliant with NRC regulations in 10 CFR Parts 19 and 20 and provisions in License No. SMB-743 and is implemented through a set of approved radiation safety procedures, which are referenced throughout this chapter.

The Decommissioning Contractor's operations, and those of all subcontractors, will be governed by procedures that meet the requirements of 10 CFR 19 and 20, and the commitments in License No. SMB-743. At a minimum, the Decommissioning Contractor will maintain a controlled copy of the following SMC procedures, with their technical basis, at the site for regulatory inspection:

- Radiation Protection Program Plan (RSP-001)
- Control of Radiation Safety Procedures (RSP-003)
- Radiation Protection Records (RSP-004)
- ALARA Program (RSP-005)
- Training and Qualifications of Radiation Protection Personnel (RSP-006)
- Training in Radiation Protection (RSP-007)
- Instrumentation and Surveillance (RPS-008)
- Contamination Control (RSP-009)
- Exposure Control (RSP-010)
- Radiological Areas and Posting (RSP-011)
- Control of Work (RSP-012)

- Control of Radioactive Waste (RSP-013)
- Stop Work Authority (RSP-017)
- Smear/Filter Counting (RPS-018)

Uncontrolled copies of the Decommissioning Contractor's procedure set, as applicable, will be available at the job site. Deviations from the procedures will be permitted only as described in the approved exemption criteria.

Each member of the project team will assume certain health and safety responsibilities. These will include, but are not limited to, the following:

- The RSO is responsible for providing oversight for implementation of the Work Plan and making changes to reflect field situations that were not anticipated during the plan's initial development. Changes in the radiation protection program can only be made with the concurrence of the SMC Radiation Safety Officer.
- The designated health and safety contact for each subcontractor is responsible for verifying field implementation of the radiation protection program provisions. This includes communicating site requirements to all personnel on the job, field supervision, and consultation with the RSO regarding appropriate changes to this decommissioning plan.
- All on-site project personnel are responsible for understanding and complying with all site health and safety requirements, including proper maintenance of health and safety equipment and facilities. This understanding will be documented by signature prior to any team member being authorized to work on decommissioning operations.

SMC is responsible for providing a work-place environment in which employees, visitors and contractors are adequately protected from hazards, including the hazards associated with exposure to radiation and radioactive material. While the exposures associated with the planned decommissioning operations are low, all exposures are assumed to entail some risk to the employee. Therefore, SMC has adopted the following three principles to govern all decommissioning work activities with the potential for exposure to radiation or radioactive materials:

- No activity or operation will be conducted unless its performance will produce a net positive benefit.
- All radiation exposures will be kept as low as reasonably achievable (ALARA) considering economic and societal costs.

- No individual will receive radiation doses in excess of federal limits.

The ALARA requirement will be communicated to all subcontractors at the outset of this project. Each individual must understand their responsibilities to reduce their radiation exposure. Methods to be used to achieve exposure reduction will be reviewed during General Employee Training and Tailgate Safety Training. Monitoring and surveillance information will be summarized and reviewed by the work force on a planned and periodic basis. Requirements to implement the ALARA program at the SMC facility are described in SMC Radiation Safety Procedure No. RSP-005.[206]

10.1 Radiation Safety Controls and Monitoring for Workers

Radiation, airborne radioactivity and contamination surveys during decommissioning will be conducted in accordance with approved procedure(s) (RSP-008, RSP-009, RSP-010). The purposes of these surveys will be to:

- protect the health and safety of workers,
- protect the health and safety of the general public, and
- demonstrate compliance with applicable license, federal and state requirements, as well as decommissioning plan commitments.

Radiation safety personnel assigned to the project will verify the validity of posted radiological warning signs during the conduct of these surveys. Surveys will be conducted in accordance with procedures utilizing survey instrumentation and equipment suitable for the nature and range of hazards anticipated. Equipment and instrumentation will be calibrated and, where applicable, operationally tested prior to use in accordance with procedural requirements. Routine surveys are conducted at a specified frequency to ensure that contamination and radiation levels in unrestricted areas do not exceed license, federal, state or site limits. Radiation protection staff will also perform surveys during decommissioning whenever work activities create a potential to impact radiological conditions.

Control levels have been established for this decommissioning action. Based upon knowledge of the radiological constituents present at the site and existing exposure rates, it is expected that maximum individual personnel exposures will not exceed 300 millirem TEDE over the life of the project. Surveillance will be performed by the Decommissioning Contractor to verify that exposures are minimized and within acceptable guidelines.

As required in 10 CFR 20.1502, the need for individual monitoring for internal and external exposures will be determined and documented prior to the start of work based on existing data. However, because the exposure potential is expected to be less than 500 millirem TEDE, individual

[206] Shieldalloy Metallurgical Corporation, ALARA Program, RSP-005.

monitoring for on-site personnel may not be required. However, at the discretion of the RSO, individual monitoring may be implemented nonetheless.

10.1.1 Workplace Air Sampling Program

The air sampling program during decommissioning will be implemented to assure that workers are adequately protected from inhalation of radioactive material. To this end, SMC is committed to performing prospective evaluations of its decommissioning activities to determine what type of air sampling is warranted, the frequency of air sampling, and placement of air samplers. As noted previously, the administrative control limit for individual dose is 300 mrem, which is below the monitoring requirements of 10 CFR 20.1502 (b). SMC may nonetheless conduct a routine air monitoring program to demonstrate compliance with these regulatory provisions.

Air sampling will be performed for decommissioning activities involving disturbance or handling of slag material, as well as during placement of bag house dust. Such activities may include material placements, sizing operations, or other activities that could result in the generation of dust and particulates. From these activities, workers would be expected to receive an internal exposure of less than ten percent of an Annual Limit on Intake (ALI, as specified in 10 CFR 20, Appendix B, Table 1).

Selection of air sampling equipment is based on the assumption that the most limiting isotope (e.g., most difficult to detect/lowest derived air concentration (DAC) value specified in 10 CFR 20, Appendix B, Table 1) is Th-230. Based on this conservative assumption, SMC will generally rely on the use of low volume air samplers for job coverage. Sample heads will be located in a manner such that they are representative of the air breathed by workers and do not interfere with the ongoing work. Approved procedures describe the method for collecting representative air samples.

In the selection of air sampling equipment, equipment that is appropriate for its intended use will be chosen. The type of sampling equipment that is chosen will consider the collection media (e.g., glass fiber, cellulose, membrane, quartz, etc.) required to collect the contaminant. The selection of air sampling equipment will also consider the sensitivity of the counting equipment used to analyze sample result (optimization between sample volume and counting time will be addressed in selecting this equipment). When air sampling is to be performed, consideration will be given to sampling frequencies and changes. The frequency of changes will be determined based on the radiological and physical condition of the work location, worker stay times and type of air sampling performed. The need for continuous air monitors (CAMs) has been considered. Based on the physical and chemical characteristics of the material to be handled during decommissioning, the use of CAMs is not warranted. Airborne radioactivity concentrations are expected to be negligible (see the air modeling information presented in the Appendix 19.9 Environmental report). Should airborne radioactivity levels begin exceeding 75% of a DAC, SMC will reconsider the need for using CAMs.

Some air sampling will be performed to achieve a baseline value, as soon as operations begin and routinely thereafter, and after any significant changes in operating conditions. Sampling durations will be determined prior to the start of sample collection based on how routinely or non-routinely the area is occupied, the likelihood of exceeding a predetermined percentage of a DAC or DAC-hour exposure, the length of time required by the operating activity and any other conditions as warranted. The minimum detectable concentration (MDC) is also a determining factor for sampling duration and will be evaluated prior to sample collection. MDC will be based on 10% of the specified DAC.

Following collection of air samples, a screening analysis for gross alpha air activity will be performed. Samples will be analyzed on a gas-flow proportional counter (or instrument of similar sensitivity). In order to account for radon or thoron interference during this initial analysis and determine if airborne radioactivity concentrations are at acceptable levels, alpha to beta ratios will be determined and used. This methodology will be procedurally defined and include appropriate actions for effecting worker protection. Final air sampling results will not be available for four to five days following collection to allow for decay of radon and thoron short-lived daughters. Once the final results are available, airborne radioactivity concentrations will be documented in accordance with approved SMC procedures.

Based on the screening analysis results, if an air concentration potentially exceeds three times background levels, the RSO will evaluate the situation and determine the appropriate protective response, such as the need for respiratory protection. The effectiveness of engineering or other controls will also be evaluated. These samples may be sent by overnight carrier to a commercial analytical laboratory for prompt analysis. A "Chain of Custody" form will be completed for all laboratory transfers.

If final results exceed ten percent of a DAC, then DAC-hour tracking will be initiated to account for exposure to individuals. If final results exceed one DAC, then the RSO will evaluate the situation and determine the need for bioassay. Additionally, if not already initiated based on screening results, evaluation of engineering, physical, and administrative controls will be performed to determine what compensatory actions are appropriate.

Air sampler flow meters will be calibrated on a frequency recommended by the manufacturer. The calibration frequency will be specified in approved procedures and will not exceed 6 months.

10.1.2 Respiratory Protection Program

In controlling the concentrations of radioactive materials in air, the use of process controls, engineering controls or administrative procedures will be used. Examples may include the use of stay times, exhaust ventilation, diversion of air flow, dust suppression, fixative coatings, or some combination of methods. The use of respiratory protection will only be implemented if these methods are deemed ineffective at controlling intakes of radioactivity by workers and if the projected dose reduction associated with respirator usage is ALARA.

In the event that respiratory protection is implemented by the RSO, the program will require use of National Institute for Occupational Safety and Health/Mine Safety and Health Administration

(NIOSH/MSHA) certified equipment, and procedures that comply with 10 CFR 20, Subpart H. Provisions for medical screening and fit testing before workers are permitted use of any respirator will be procedurally addressed. At a minimum, respiratory protection procedures will address the following elements:

- Monitoring, including air sampling and bioassays,
- Supervision of the program, including program audits,
- Training and minimum qualifications of respirator program supervisors and implementing personnel,
- Training of respirator users, including the requirement for each user to inspect and perform a user seal check (for face-sealing devices) or an operational check (non-face-sealing devices) on a respirator each time it is donned,
- Fit-testing,
- Selecting respirators,
- Maintaining breathing air quality,
- Inventory and control of respiratory protection equipment,
- Storage and issuance of respiratory protection equipment,
- Maintenance, repair, testing, and quality assurance of respiratory protection equipment,
- Recordkeeping, and
- Limitations on periods of respirator use and relief from respirator use.

The Project Manager and the RSO will concur on the need for and on the procedural requirements prior to implementing a respiratory protection program.

NIOSH/MSHA approved air purifying respirators will be used, to include full face piece assemblies with air purifying elements to provide respiratory protection against hazardous vapors, gases, and/or particulate matter to individuals in airborne radioactive materials areas. Individuals may be required to use continuous or constant flow full-face airline respirators for work in areas with actual or potential airborne radioactivity concentrations exceeding ten DAC. The RSO will also ensure that the respiratory protection program meets the requirements of 10 CFR Part 20, subpart H and that considerations are given to existing chemical or other respiratory hazards instead of (or in addition to) radioactive hazards.

When respiratory protection equipment requires cleaning, the filter cartridges will be removed. The respirator will be cleaned and sanitized after every use with a cleaner/sanitizer and then rinsed thoroughly in plain warm water in accordance with approved SMC procedures.

Respiratory protective equipment will be kept in proper working order. When any respirator shows evidence of excessive wear or has failed inspection, it will be repaired or replaced.. Respiratory protective equipment that is not in use will be stored in a clean dry location.

10.1.3 Internal Exposure Determination

A combination of indirect bioassay and breathing zone air sampling may be used to determine internal exposures incurred by decommissioning workers while on site. The indirect bioassay program would consist of baseline, termination, and routine monitoring at a frequency sufficient to assess Committed Effective Dose Equivalents equal to a fraction of the ALI. In addition, "special" or "diagnostic" sampling will be implemented in the event air sample data and/or process knowledge warrants stricter control and monitoring. All samples will be analyzed by a laboratory that meets the performance criteria in ANSI N13.30.

The frequency of routine bioassay sampling will be based on the sensitivity of the analytical method in relation to the potential committed effective dose equivalent for the radioisotope of concern. For some radioisotopes, air monitoring results may be employed due to limitations on analytical sensitivity or excessive frequency to obtain sufficient sensitivity. When air monitoring results are used, the air concentration, as a fraction of the DAC will be multiplied by the number of hours (or fractions thereof) to determine the number of DAC-hours for a worker's exposure. Converting DAC-hours to internal dose, represented as committed effective dose equivalent will be based on the assumption that 2,000 DAC-hours exposure equals 1,000 millirems for radioisotopes with stochastic ALIs. At SMC, the following are the DACs that are currently approved for use in License No. SMB-743:

- Thorium - 1.9×10^{-11} µCi/ml
- Uranium - 8.4×10^{-11} µCi/ml

The RSO (or designee) will determine the validity of bioassay and air monitoring results prior to their inclusion in the internal dose assessment process. The RSO will typically evaluate the following items to ascertain the validity of monitoring results:

- sample collection errors
- radiation background interference during counting

- calibration errors
- computer software errors
- errors due to counting geometry
- statistical errors.

Only valid bioassay or air monitoring results, as determined by the RSO, will be used for assessment of internal radiation dose. If the data are not valid, the RSO will document the basis for that conclusion and include the documentation in the individual's dosimetry record. The RSO will also estimate the internal dose to the individual via other means and include the estimate in the individual's exposure history. The RSO will identify the route of entry (i.e., inhalation, ingestion, etc.), as the most likely route based upon current knowledge of exposure conditions. The lung clearance class for intake by inhalation will be selected based upon current knowledge of the chemical form and/or particle size.

The committed effective dose equivalent (stochastic) incurred by workers will be estimated by:

$$CEDE\ (millirem) = \frac{Intake}{ALI_S} \times 5{,}000$$

where Intake = the activity taken into the body as determined from bioassay measurements, and ALI_S = the stochastic Annual Limit on Intake for the radionuclide of interest. Doses to particular organs or tissues of interest will be estimated by:

$$CDE_T\ (millirem) = \frac{Intake}{ALI_{NS}} \times 50{,}000$$

where Intake = the activity taken into the body as determined from bioassay measurements or air monitoring results, and the ALI_{NS} = the non-stochastic Annual Limit on Intake for the radionuclide of interest. To determine the contribution of CDE to CEDE, the CDE is multiplied by the appropriate organ dose weighting factor specified in 10 CFR 20.1003.

In general, minors will be excluded from work associated with the potential for intakes of radioactive material. Internal exposure determinations for declared pregnant workers will be based on air monitoring results unless the RSO (or his designee) determines that special bioassay sampling is warranted. These intakes will be converted into a dose to the embryo/fetus based on methodologies discussed in Regulatory Guide 8.36.

10.1.4 External Exposure Determination

Monitoring for radiation exposures from sources that are outside of the body (external exposure monitoring), if warranted, will be conducted in accordance with applicable SMC Radiation Safety Procedures. Monitoring may, as determined by the RSO, be extended to visitors or others, depending upon the extent of the radiological hazards present in the work areas to be entered. However, individual-monitoring devices will only be provided to adult workers with the potential to meet or exceed 500 mrem effective dose equivalent in a calendar year.

Individual monitoring devices, at a minimum will consist of a whole body thermoluminescent dosimeter (TLD) or equivalent (e.g., optical dosimeter, etc.). The TLDs will be ordered from a vendor that has been approved in advance by the Decommissioning Contractor, and whose program has met the requirements of ANSI N13.11. In addition, the vendor must demonstrate accreditation by National Voluntary Laboratory Accreditation Program (NVLAP), which includes range, sensitivity and accuracy performance criteria.[71] Individuals assigned TLDs will wear them in accordance with approved SMC external dosimetry procedures and receive relevant training on these procedural requirements. TLDs will be processed on a minimum of a quarterly basis. Individual doses will be tracked to determine compliance with the SMC administrative control limit of 300 mrem.

From pre-decommissioning radiation surveys, dose rates, on contact with slag piles have been measured at 1 to 1.5 mrem per hour. Radiation surveys will be conducted and documented in accordance with approved procedures throughout decommissioning to monitor radiation dose rates and identify changes in radiological conditions. Due to the low dose rates encountered, the need for alarming dosimeters and pocket dosimeters is not anticipated.

A number of additional external exposure control methods will be implemented during this decommissioning efforts, such as RSO review and validation of all monitoring results and the application of "time", "distance" and "shielding" in the workplace. In all cases, however, they will be consistent with the requirements and procedures described in applicable SMC Radiation Safety Procedures.

10.1.5 Summation of Internal and External Exposures

Internal and external radiation exposures will be assessed at least each quarter during the decommissioning project. The total organ dose equivalent (TODE) is computed by summing the deep dose equivalent (H_D) from external sources, as determined from external radiation monitoring, and the committed dose equivalent (CDE), as determined from internal radiation monitoring.[72] The

[71] The use of extremity monitoring or multiple dosimetry are not applicable to this work because uniform exposures are expected. The use of alarming dosimeters will not be required at this site because of process knowledge, previous site surveys and general area dose rates demonstrate they are unnecessary. Furthermore, external dose from airborne radioactive material is not a viable exposure pathway at this site. Therefore, these issues will not be discussed further in this Plan.

[72] If external radiation monitoring is not performed, $H_D = 0$.

total effective dose equivalent (TEDE) is determined by summing the committed effective dose equivalent (CEDE) from sources internal to the body, and the H_D.

10.1.6 Contamination Control Program

The procedures for access to contaminated areas will address the responsibilities of all personnel permitted access, contamination limits, posting, labeling and tagging requirements, protective clothing requirements of each level of contamination encountered, entry and exit requirements, measurement methodologies, decontamination of personnel and training requirements, as described in RSP-009.[73] Routine surveys will be performed throughout the campaign, with each planned in advance with regard to the specific radiation type, predetermined radiation levels, location where radiation is expected and any other special condition warranting a survey.

The initial level of protection for the intrusive tasks of this decommissioning operation (i.e., where residual radioactivity may be encountered) will be hard hats, tyvek or cloth coveralls, safety glasses with side shields, steel-toed boots, and gloves. Upgrading or downgrading of the level of protection will be based on ambient conditions as work proceeds. The RSO will determine if it is necessary to upgrade to a higher level of protection.

To assure radioactive materials remain under the control of SMC, each worker involved in this decommissioning effort and working in a contaminated area will be frisked using calibrated, hand held instruments prior to leaving the contaminated work area. Equipment, people and materials will be frisked and decontaminated, as necessary, prior to exiting the controlled area. Records of release surveys will be maintained on standardized forms and maps. Release criteria will be consistent with those shown in Table 17.10.

The use of sealed radioactive sources is limited to source activities that do not exceed exempt quantity limits. These sources are used for source checking radiological instrumentation. Although sources will be inventoried, leak testing is not required by license or regulation.

10.1.7 Instrumentation Program

Radiation survey equipment and instrumentation suitable for detecting and quantifying the radiological hazards to workers and the public will be present on-site throughout the remediation and final release surveys. The selection of equipment and instrumentation to be utilized will be based upon knowledge of the radiological contaminants, concentrations, chemical forms and chemical behaviors that are expected to exist as demonstrated during radiological characterization, and as known from process knowledge of the working history of the SMC site. Equipment and instrumentation selection will also takes into account the working conditions. contamination levels and source terms that are reasonably expected to be encountered during the performance of decommissioning work, as presented in this Plan. All health physics instruments when not in use

[73] Shieldalloy Metallurgical Corporation, Contamination Control, RSP-009.

will be stored in the Laboratory Building equipment storage area (second floor). In all cases, the program will be consistent with the requirements in RSP-008.[74]

All instruments will be calibrated and maintained according to applicable Radiation Safety Procedures and ANSI Standard N323-1978.[75] All instruments will be calibrated using radiation sources which are traceable to the National Institute of Standards and Technology (NIST). Each ratemeter will be calibrated with a specific detector. All instruments will be calibrated using radiation sources which are traceable to NIST. The methods used to estimate uncertainty bounds for each type of instrumental measurement will be as specified in ANSI N323-1978.

Each instrument will be response-checked using a reference source and have pre-operational checks performed on a daily basis or as needed. Pre-operational checks will include battery function, high voltage, response to reference source, reset button function, audible response function if applicable, physical condition, current calibration and response to background radiation. These results will be documented and any instruments failing any of the pre-operational checks will be tagged and taken out of service.

10.2 Nuclear Criticality Safety

The licensed radioactive materials present at the Newfield facility are natural uranium and natural thorium, with progeny in equilibrium. The Uranium-235 concentration in the materials is less than 1% by weight, meaning it does not meet the definition of Special Nuclear Material as found in 10 CFR 70.4. Because the materials cannot trigger or sustain a critical reaction, nuclear criticality safety measures are not necessary.

10.3 Health Physics Audits, Inspections and Recordkeeping

During the implementation of this Plan, at least one assessment of the effectiveness of this health and safety plan will be performed per calendar year by an individual who is Certified by the American Board of Health Physics in the comprehensive practice of health physics and has demonstrated experience performing assessments of radiation safety programs for decommissioning projects. The results of this assessment will be reported to the Project Manager and the RSO. Records of this review will be maintained in accordance with RSP-004, "Radiation Protection Records." These records will include the date of the assessment, name of individual(s) performing the assessment, individuals contacted by the assessor(s), areas/program elements assessed, assessment findings, corrective actions, and any follow-up required.

Informal assessments and inspections will be completed by the RSO (or his designee) on a daily basis, with unexpected, non-conforming, or unusual items and situations documented, along with their resolution. These assessments and inspections will include performance and documentation of radiological surveys, radiological work practices, posting and labeling, contamination control, and

[74] Shieldalloy Metallurgical Corporation, Instrumentation and Surveillance, RSP-008.
[75] American National Standards Institute, Radiation Protection Instrumentation Test and Calibration ANSI -N323-1978, 1978

internal and external dosimetry. Due to the frequency of these informal assessments and inspections, they serve as routine, unannounced inspections by the RSO (or his designee).

For any findings identified during formal assessments or informal assessments and inspections will be evaluated by the RSO for compliance with license commitments or NRC requirements. Documentation of such evaluations will be maintained and available for inspection, including corrective actions taken to prevent recurrence and any follow-up to verify effectiveness of corrective actions. Records of RSO audits will include the dates of the audit, the name of the auditor, persons contacted by the auditor, areas audited, audit findings, corrective actions, and any follow-up required.

11 ENVIRONMENTAL MONITORING AND CONTROL PROGRAM

11.1 Environmental ALARA Evaluation

The management of SMC is committed to reducing exposures to radioactive materials and direct radiation to as low as reasonably achievable (ALARA). Exposures should be reduced to ALARA to SMC employees, contractors assigned to implement the decommissioning plan as well as emissions to the environment and ultimately the members of the public living near the Newfield facility. Potential pathways for exposure exist during the construction of the engineered barrier and intrusive work where the slag and baghouse dust is excavated. Engineering and administrative controls will be implemented during the construction phase in order to minimize exposures.

The principle source of exposure is contaminated airborne dust impacting the inhalation and ingestion pathways. The slags at the facility are all solid, non-combustible material with the consistency of vitrified rock. Testing performed on the slag shows that the radioactivity does not leach with exposure to ambient conditions.[76] The baghouse dust forms a "crust" when it encounters moisture, which serves to deter fugitive dust emissions.

To the extent practical, excavated soil will be wetted to reduce the generation of airborne dust. SMC has established a goal to evaluate the effectiveness of the wetting process; contaminated airborne dust should be reduced to concentrations at least 10% of the USNRC limits for offsite discharge.[77] As described in Chapter 10, air monitoring will be performed to measure the presence of contaminated dust, both near the employee's work areas as well as the perimeter of the Storage Yard. Air sampling stations will be established as described in Section 10.1. The analytical results for the perimeter air samples will be compared to the limits specified in the USNRC regulations for discharge to the environment.

Employees working directly with contaminated soil or the baghouse dust will wear personal protective clothing to reduce the spread of radioactive contamination. Portable, calibrated radiation survey instruments will be used to verify that the employees are free of surface contamination before leaving the restricted area and the facility at the end of the work shift. A description of the contamination control program is provided in Section10.1.

The Site HSO will review the results of the air sampling program and periodically submit a summary to the RSO and SMC management. The report will summarize the air sampling results, applicable limits and identify any trends relating to elevated results. If necessary, the Site HSO will modify the field practices and verify that the changes were adequate to reduce airborne dust concentrations to ALARA. Any sample that exceeds 10% of the DAC will be reviewed by the RSO within 24 hours

[76] Teledyne Isotopes, *Report of Leachability Studies for Shieldalloy Metallurgical Corporation*, Teledyne Isotopes, Westwood, New Jersey, 1992.
[77] US Nuclear Regulatory Commission, Standards for Protection Against Radiation, Title 10 Code of Federal Regulations, Part 20, Appendix B.

after it is identified. An investigation will be documented and the source of the elevated readings will be identified and evaluated. ALARA reviews and reports to management will be performed pursuant to SMC's Radiation Safety Procedure No. RSP-005, "ALARA Program".

11.2 Effluent Monitoring Program

The primary effluent discharges during the decommissioning process are assumed to be airborne in nature and could consist of dust from the excavation of material, dumping of material, shaping and pushing of the slag and other regulated and non-regulated materials during capping operations, vehicle/equipment movement, and the surface grinding of contaminated concrete. The locations where potential effluent discharges could occur include the Storage Yard where the baghouse dust and various slags are currently stored and where the planned engineered barrier will be installed. In addition, the temporary haul roads used for transport of radioactive materials to the engineered barrier location, and residual concrete pads or surfaces that will be decontaminated are other potential sources. Section 4.4.1 contains a description of the contaminants of concern and their concentrations within the remediation areas and the natural background.

Area air samples will be taken in locations that are representative of actual effluent releases. A sufficient number of samplers will be positioned downwind of in progress work locations to ensure that samples collected are representative of actual releases. Air sampler positioning will be evaluated frequently to accommodate for shifts in the prevailing wind direction and the locations of dust generating operations.

Air samples will be collected as described in Section 10.1of this Plan, which covers topics such as air sampler and filter selection, sampling durations and frequencies, sampler calibration, action levels for airborne activity. The calculation of the sample MDA will be completed in accordance with SMC Radiation Safety Procedure RSP-008, "Instrumentation and Surveillance:.

Environmental air samples will be collected at the following frequencies: Before operations with radioactive materials begin to determine a baseline value for airborne activity, as soon as decommissioning operations begin and routinely thereafter, and after any significant change in operating conditions. Air samples will especially be collected during any dust generating operations. The frequency of sample collection will be determined based on the radiological and physical conditions present at the work location and the type of air sampling being performed. Consideration will be given to more frequent filter changeouts during high dust conditions.

Air sampling results will be recorded on standard survey forms that will include information such as sample location and number, date and time of sample, volume sampled, air sampler and filter used, and calculated airborne concentrations. Sampling information will be made a part of the final status survey report. Filters which exceed set parameters will be held and recounted after an appropriate length of time and/or forwarded to a commercial analytical laboratory for further analysis. The decommissioning project manager will inform the RSO of the initial data of samples that exceed action levels and subsequent re-analysis information.

Sample collection and analysis will be conducted using approved procedures as described in Section 10.1 of this procedure. Elements of the quality assurance program are provided in Section 13 of this Plan.

11.3 Effluent Control Program

The source of effluent discharges to the environment for the decommissioning project is the materials that have the potential to become airborne during the various operations described in Chapter 8, above. The radiation dose potential associated with those releases, as shown in Chapter 7, are indistinguishable from background. Nonetheless, measures that will be instituted to minimize the release of airborne materials to the environment may include continual application of water spray to excavation areas, to materials in the engineered barrier area during shaping and compaction of the pile, and during the dumping of materials from vehicles/equipment. Dust suppressant materials such as calcium chloride, may be used on temporary haul roads used to move materials around the facility. The discharge of liquids to the environment will be eliminated during the decommissioning project through the use of a silt fence backed up with staked hay bales around the perimeter of the entire engineered barrier area, thereby preventing sediment from leaving the work site. Surface runoff water outside the silt fence will be collected via perimeter drainage swales to prevent run-on from entering the work site. These drainage swales would be designed to discharge away from the work area to prevent the erosion of the radionuclide-bearing materials.

The action level for this work will be the applicable DAC for natural thorium and uranium (i.e., 1.91×10^{-11} microcuries per milliliter for thorium and 8.4×10^{-11} microcuries per milliliter for uranium). Actions to be taken in the event an action level is exceeded include stoppage of the suspect work activity if it is still ongoing, the conduct of additional air, radiation, and contamination surveys as applicable, notification of the RSO, preparation of dose estimates for workers and the general public due to the release, and corrective measures to prevent future releases.

12 RADIOACTIVE WASTE MANAGEMENT PROGRAM

12.1 Solid Radioactive Waste

The types of solid materials associated with the decommissioning process include ferrocolumbium standard slag, ferrocolumbium high-ratio slag, and columbium nickel slag generated from the former D111 and D102 smelting operations; baghouse dust from prior operations in D111; soil containing ferrocolumbium slag, and concrete dust from the surface removal of contaminated concrete baghouse and building structures. The slag, which presents the majority of the licensed radioactive materials at the site, is a solid, non-combustible material with the consistency of vitrified rock. The estimated volume of each of the material types are listed in Table 17.1.

The entire volume of these materials will be contained within the capped area of the property. It is anticipated that no residual radioactivity will be shipped off site for disposal and no temporary storage of materials will be required. Excavated materials that do not meet the applicable release criteria will be transported directly to the Storage Yard for consolidation under the engineered barrier.

Excavated materials and radioactive materials currently in the Storage Yard will be sprayed with a water spray to minimize dust generation during operations such as excavation, shaping and pushing of piles, dumping of materials from vehicles/equipment, etc. Concrete removed (scabbled) from the surface of the AAF and Flex-Kleen Baghouse pads, and other materials collected from building surfaces using high efficiency filtered vacuums, will be transported to the Storage Yard and consolidated prior to the installation of the engineered barrier.

12.2 Liquid Radioactive Waste

No radioactive liquids are anticipated to be generated during the decommissioning process. Water spray used to minimize dust generation is assumed to be included (consumed) with the capping process for the solid materials.

12.3 Mixed (Radioactive and Hazardous) Waste

No solid or liquid mixed wastes are expected to be generated during the decommissioning process. The on-going soil remediation plan under the jurisdiction of the USEPA has no potential for generating mixed wastes as a result of this remediation.

13 QUALITY ASSURANCE PROGRAM

This chapter of the SMC Newfield Decommissioning Plan describes the Quality Assurance (QA) Program that will be used to assure that decommissioning activities will be performed in a manner consistent with commitments contained in this Decommissioning Plan and will meet regulatory requirements and license conditions. The QA Program will operate in all stages of decommissioning through the final survey, validation of the data. and the interpretation of the results to verify that this has occurred. Included herein is a description of the following aspects of the QA Program: Organization; Quality Assurance Program; Document Control; Control of Measuring and Test Equipment; Corrective Action; Quality Assurance Records; and Audits and Surveillance.

13.1 Organization

The corporate authority for the Decommissioning Contractor will appoint a Quality Assurance Officer (QAO) who reports directly to the corporate authority. The QAO will be independent from operations, engineering, and procurement. This position may be a collateral function of another manager, provided that manager is not responsible for operations ,engineering, or procurement. Staff may be assigned to the QAO on a permanent or temporary basis. Staffing level will be recommended by the QAO and approved by the Project Manager. QA staff are responsible for ensuring that the quality assurance program verifying that activities affecting quality have been correctly performed will have sufficient authority, access to work areas and organizational freedom to:

- Identify quality problems;
- Initiate, recommend or provide solutions to quality problems through designated channels;
- Verify implementation of solutions; and
- Ensure that further decommissioning activities are controlled until proper disposition of a nonconformance or deficiency has occurred.

The ultimate responsibility for implementing the elements of the QA Program rests with the Decommissioning Project Manager. A summary of the Decommissioning Contractor's corporate QA policies and provisions to ensure that technical and quality assurance procedures required to implement the QA program are consistent with regulatory, licensing, and QA program requirements and are properly documented and controlled will be provided to the USNRC before the start of the on-site effort.

13.1.1 Decommissioning Project Manager

Overall control and authority for radiation protection at SMC will rest with the Project Manager. The responsibility of the Project Manager will include, but is not limited to, the following:

- Establish the procedures to decommission the site and submit changes to the decommissioning plan to the USNRC. The Project Manager may not implement the changes until approved by the USNRC in writing;

- Assure that the capability of radiation protection services are sufficient to meet the requirements of this decommissioning plan and applicable state or federal regulations;

- Designate a Quality Assurance Manager as a direct report with respect to the QA program.

13.1.2 Quality Assurance Officer

The QAO will be responsible for recommending the type and quantity of staff and resources necessary for full implementation of the QA Program. The QAO is designated by the Project Manager, in writing, and may be a collateral duty for a manager who is not responsible for operations, engineering, or procurement. The QAO is independent of cost and schedule responsibilities for the decommissioning project.

The QAO will have the responsibility and authority to terminate any work activities that do or may violate regulatory or SMC requirements for decommissioning. Specific work activities will be permitted to proceed to a safe condition after implementation of the stop-work order. Stop-work orders will be lifted after the initiating conditions have been alleviated.

The QAO is specifically responsible for the following:

- Identifying quality problems;

- Initiating, recommending, or providing solutions through designated channels, and

- verifying implementation of solutions.

The QAO is also responsible for working with SMC, contractor, or subcontractor management in resolving disputes involving quality arising from difference of opinion between QA staff and other personnel.

13.1.3 QA Staff

The QAO may designate authority for implementing certain aspects of the QA program to SMC or contract employees with the concurrence of the Project Manager. The responsibilities and authority of QA Staff may include the following:

- Ascertain compliance with rules and regulations, site-specific license conditions, and the guidelines approved and specified by the QAO;
- As directed by the QAO, evaluate the performance of work, including audits and surveillances of the contractor's QA programs and audits and surveillances of subcontractors, consultants, and vendors furnishing equipment or services to SMC or its contractors.

If not delegated to the QA Staff, the QAO may retain the responsibilities listed above.

13.2 Quality Assurance Program

For execution of decommissioning activities at the SMC Project, a Quality Assurance Program Plan (QAPP), consistent with applicable guidelines will be developed. The QAPP will be reviewed and approved by SMC prior to its implementation to ensure all programmatic elements are consistent with regulatory, licensing, and QA program requirements. The objective of the QAPP is to ensure confidence in the sampling, analysis, interpretation and use of radiological data generated during the decommissioning project.

The QAPP will ensure collection of reliable data by serving as the instrument of control for field and analytical activities associated with the project. Stated within the QAPP are the quality assurance policies, quality control criteria, and reporting requirements that must be followed by all site and contractor personnel when carrying out their assigned responsibilities on this project. The QAPP describes the functional activities and quality assurance/quality control {QA/QC) protocols necessary to collect data of adequate quality.

The QAPP will be provided to the NRC for review and acceptance before implementation. Subsequent changes to the QAPP that do not affect commitments in this Decommissioning Plan, such as editorial changes or personnel reassignments may be made without notification to the NRC; changes which may affect such commitments will be provided to the NRC for review and acceptance prior to implementation.

The effectiveness of the QA program will be periodically evaluated by the Decommissioning Project Manager. This evaluation will include the scope of the program, status of audits and surveillances, adequacy of the program, and compliance of the QA program. The QAO will meet with the Decommissioning Project Manager once each calendar quarter in order to perform this evaluation.

The approved QAPP will also address the following topics:

- Discussion of instruction provided to personnel responsible for performing activities affecting quality pertaining to the purpose, scope, and implementation fo the quality-related manuals, instructions, and procedures;
- Description of training and qualifications of personnel verifying activities affecting quality in the principles, techniques, and requirements of he activity being performed;
- Formal training and qualification programs, documentation includes attendees, date of attendance, and objectives and content of program;
- Description of the self-assessment program for confirming that activities affecting quality comply with the QA program, including independence of the assessors from the activities they are assessing; and
- Description of the organization responsibilities for ensuring that activities affecting quality are prescribed in appropriate procedures and accomplished through implementation of these procedures.
- Description of how the licensee develops, issues, revises and retires QA documents.

13.2.1 Procedures

Supporting Quality Implementing Procedures (QIPs) will provide step-by-step details for complying with project QA requirements. The final radiological survey, including development of sampling plans, direct measurements, sample analysis, instrument calibration, daily functional checks of instruments, and sampling methods will be performed according to written procedures. These written procedures will be reviewed and approved by the RSO and the Project Manager.

13.2.2 Subcontractor Services

The activities to be conducted during decommissioning will require the services of a Decommissioning Contractor and various specialty subcontractors such as a qualified drilling contractor or a licensed surveyor. Contractor activities will be under the direct supervision of SMC in accordance with the QAPP. Subcontractor activities will be under the direct supervision of the Decommissioning Contractor, also in accordance with the QAPP.

13.2.3 Laboratory Services

For off-site sample analysis, a qualified laboratory recommended by the decommissioning contractor and approved by SMC will perform those radiological analytical laboratory services for the project. The laboratory will be responsible for all bench level QA/QC, data reduction, data reporting, and analytical performance monitoring. Laboratory accuracy will be evaluated by the analysis of blank and spiked samples. Sample handling protocols, analytical procedures, and reporting procedures employed by the analytical laboratory will be described in the laboratory's Quality Assurance Plan.

The off-site laboratory will be responsible for assuring that all appropriate laboratory personnel are thoroughly familiar with the QAPP and good laboratory practices, and that all appropriate laboratory personnel meet the requisite qualifications for their positions within the laboratory. The laboratory Director, or his equivalent/representative, will review and approve all reports. The Director will also be responsible for assuring laboratory personnel have appropriate training to perform assigned responsibilities, and for daily management of the laboratory and its staff.

The off-site laboratory will have a QA designee who will be responsible for assuring that the QA/QC requirements of the QAPP, the laboratory Quality Assurance Plan, and its associated operating procedures are strictly followed. The QA designee will be responsible for review of data, alerting the SMC decommissioning Project Manager and the Contractor Project Manager of the need for corrective action (when necessary), performing internal audits as specified by the QAPP, and maintenance of the QC records. The QA designee will also be responsible for preparing project specific QA/QC plans, as necessary.

13.2.4 Surveys and Sampling Activities

Trained individuals following written procedures and the provisions of this Plan will perform surveys and sampling using properly calibrated instruments. The custody of samples will be tracked from collection to analysis. Final survey and sampling data will be retained until License No. SMB-743 is amended into a LTC license. The designated sampler or analytical laboratory will collect a split sample when desired by the USNRC to obtain samples that are duplicates of those to be analyzed. When this operation is performed, the procedure for obtaining duplicate samples will be followed.

QC hold points will be utilized as necessary to ensure quality of surveys and sampling. Hold points will also be used to ensure that debris is moved only after QA has verified that the proper sampling and survey information for the debris in question has been obtained.

13.3 Document Control

QA documents include a variety of radiation protection procedures described in Chapter 10 of this plan and Radiation Safety Procedures (RSPs). In general, QA documents are those documents needed to demonstrate compliance with NRC requirements and license commitments. Other specific examples are discussed in the following paragraphs of this section. Additionally, SMC will retain QA documents at the Newfield site during decommissioning activities. At the conclusion of decommissioning, e.g., when License No. SMB-743 has been amended to a LTC license, SMC will store QA documents in accordance with the terms of the LTC Plan, to be prepared as part of the final decommissioning report.

Data will be recorded and documented in a data management system. Entries will include the location of the surveyor sampling point on the appropriate building grid. Data management personnel will also ensure that chain-of-custody and data management procedures are followed for decommissioning-related samples. The decommissioning contractor's procedures for proper handling, shipping and storage of samples will be used.

Both direct measurements and analytical results will be documented. The results for each survey measurement or sample and its grid block location, will be listed in tabular form (i.e., result versus sample or survey location).

Data will be recorded in an orderly and verifiable way and reviewed for accuracy and consistency. Every step of the decommissioning process, from training personnel to calculating and interpreting the data, will be documented in a way that lends itself to audit. Records of training to demonstrate qualification will also be maintained.

13.4 Control of Measuring and Test Equipment

Procedures for calibration, maintenance, accountability, operation and quality control of radiation detection instruments implement the guidelines established in American National Standard Institute (ANSI) standard ANSI N323-1978 and ANSI N42.17A-1989.[78,79] Proper maintenance of equipment varies, but maintenance information and use limitations are provided in the vendor documentation. Measuring and analyzing equipment will be tested and calibrated before initial use and will be recalibrated if maintenance or modifications could invalidate earlier calibrations. Field and laboratory equipment, specifically used for obtaining final radiological survey data, will be calibrated based on standards traceable to NIST.

Minimum frequencies for calibrating equipment will be established (i.e., annually or as recommended by the manufacturer) and documented. Measuring equipment will be tested at least once on each day the equipment is used. Test results will be recorded in tabular or graphic form and compared to predetermined, acceptable performance ranges. Equipment that does not conform to the performance criteria will be promptly removed from service until the deficiencies can be resolved.

13.5 Corrective Action

Audits and surveillances will be conducted during the course of the decommissioning project. Observations will be investigated and corrections will be made as necessary. The observation and the proposed corrective actions will be documented and reviewed by the Project Manager and the QAO. The corrective action will be documented and the concurrence by the Project Manager and the QAO will be documented in writing. The person or department responsible for implementing the corrective action will be assigned and a schedule will be established to implement the change.

[78] American National Standards Institute, Radiation Protection Instrumentation and Calibration, ANSI N323-1978, September, 1977.
[79] American National Standards Institute, Performance Specifications for Health Physics Instrumentation - Portable Instrumentation for Use in Normal Environmental Conditions, ANSI N42.17A-1989, November, 1988.

After the finding is closed out, a surveillance will be conducted within thirty (30) days to verify that the problem has been alleviated. Significant conditions adverse to quality, the cause of the conditions, and the corrective action taken to preclude repetition will be documented and reported to immediate management and upper levels of management for review and assessment.

13.6 Quality Assurance Records

QA records are those records required to demonstrate compliance with NRC requirements and license commitments. These records will be maintained by individuals designated by the Project Manager. The records will be retained at the Newfield site for the duration of decommissioning activities and stored in one of the following ways:

- 2-hour rated vault meeting NFPA Standard 232; or
- 2-hour rated file containers meeting NFPA Standard 232 (Class B); or
- 2-hour rated fire resistant file room meeting NFPA Standard 233.

Upon amendment of License No. SMB-743 into a LTC license, records will be stored in accordance with the terms of the LTC Plan, to be submitted as part of the final decommissioning report. Typical QA records are discussed below.

13.6.1 Laboratory Data

Data reduction, QC review, and reporting will be the responsibility of the analytical laboratory. Data reduction includes all automated and manual processes for reducing or organizing raw data generated by the laboratory. The laboratory will provide a data package for each set of analyses that will include a copy of the raw data in electronic format, and any other information needed to check and recalculate the analytical results.

Once a data package is received from the laboratory, the analytical results and pertinent QA/QC data will be compiled onto standardized data formats. The data packages will serve as basic reference sheets for data validation, as well as for project data use.

13.6.2 Field Survey Data

The generation, handling, computations, evaluation and reporting of final radiological survey data will be as specified in the decommissioning contractor's procedures. Included in these procedures will be a system for data review and validation to ensure consistency, thoroughness and acceptability. Qualified health and safety, operations, and/or engineering personnel will review and evaluate survey data.

13.6.3 Data Evaluation

Prior to releasing data for use by project staff, selected data will undergo data evaluation based on intended end use of the data. Data points chosen for evaluation will be examined to determine compliance with QA requirements and other factors that determine the quality of the data. Data taken during a characterization survey will be subjected to quality verification before use as final status survey (FSS) data. Data taken during a prior survey, e.g., characterization survey, may be usable as fin al status survey data provided the data are subjected to quality verification and satisfy data quality objectives.

If sample data are rejected or data omissions are identified during the data validation, this data will be evaluated to judge the impact on the project. Other corrective action may include re-sampling and analyzing, evaluating and amending sampling and analytical procedures and accepting data acknowledging the level of uncertainty.

In the event final status survey data are processed by computer, the application program and each modification thereof will be verified to perform as intended before its initial use. A knowledgeable person will verify that the algorithms are as intended and will compare an instance of computer-generated result and an independently derived result of the same process. SMC will document the application program, including its algorithms and a listing or copy of the program.

13.6.4 Sample Chain-of-Custody

One of the most important aspects of sample management is to ensure that the integrity of the sample is maintained; that is, that there is an accurate record of sample collection, transport, analysis, and disposal. This ensures that samples are neither lost nor tampered with and that the sample analyzed in the laboratory is actually and verifiably the sample taken from a specific location in the field.

Sample custody will be assigned to one individual at a time. This will prevent confusion of responsibility. Custody is maintained when (1) the sample is under direct surveillance by the assigned individual, (2) the sample is maintained in a tamper-free container, or (3) the sample is within a controlled-access facility.

The individual responsible for sample collection will initiate a chain-of -custody record using a standard form provided by the decommissioning contractor. A copy of this form will accompany the samples throughout transportation and analyses; and any breach in custody or evidence of tampering will be documented.

13.7 Audits and Surveillances

Periodic audits will be performed to verify that decommissioning activities comply with established procedures and other aspects of the QAPP and to evaluate the overall effectiveness of the QA program. SMC and the QAO will verify that qualified personnel are used to conduct audits to ensure that the applicable procedures are being properly implemented. The audits will be conducted on at least a quarterly basis, in accordance with written guidelines or checklists. Radiation protection personnel will also conduct semiannual audits in their area of concern. External program audits may also be used at the discretion of either SMC or the QAO. Audit results will be reported to both SMC and the Project Manager in writing, and actions to resolve identified deficiencies will be tracked, trended and appropriately documented.

14 FACILITY RADIATION SURVEYS

This section of the Decommissioning Plan describes the results of various radiation surveys and sampling activities to characterize the presence of radioactive materials at the SMC site. Portions of the Newfield site will be released for unrestricted use and materials and equipment used during the decommissioning activities will be surveyed for free release. This section of the Decommissioning Plan identifies the applicable and proposed radiological release criteria to be used for radiological surveys performed during decommissioning activities. This section also describes the design of the final status radiological survey.

14.1 Characterization Surveys

14.1.1 Measurement Description

A comprehensive site-wide survey for the presence of radioactivity at the Newfield facility was conducted in 1991. The purpose of the survey was to assess the overall radiological conditions at the site. The findings were captured in a final report that was published in 1992.[80]

Data acquisition for this effort was consistent with a measurement/sampling plan that was approved by the USNRC and the NJDEP in advance of deployment to the site. Pressurized ion chamber (PIC) measurements were performed at 20 meter intervals along the boundary of the site to characterize the whole body exposure rate at the boundary fence. The PIC has a relatively "flat" energy response over the energy range of interest for the effort (e.g.150 keV to 2600 keV) and therefore, its measurements directly reflect the ambient whole body exposure rate at the point of measurement. In addition, ambient radiation surveys using gamma scintillation survey meters were performed at each intersection of an established grid pattern. These measurement results, after application of a "count rate to exposure rate" conversion factor, were used to determine ambient exposure rates throughout pertinent areas of the SMC property and adjacent areas of interest.

An assessment of the amount of residual radioactivity in soil and sediment was performed by performing a walkover survey with gamma scintillation survey meters positioned near the ground surface. The entire Newfield property was gridded for these measurements, as well as certain locations immediately adjacent to the property boundary. These measurement results were used to identify locations with potentially elevated concentrations of radioactive materials. No walkover surveys were conducted in the vicinity of the slag piles in the Storage Yard due to the elevated background readings in this area. Instead, soil samples were collected in these areas and analyzed for radioactivity.

Finally, since surface drainage in the vicinity of the plant is toward the south into the Hudson's Branch watershed, water and sediment samples were collected at various locations in the Hudson's Branch. In addition, samples of surface water runoff were collected during a storm event in locations

[80] IT Corporation, Report No. IT/NS-92-106, "Assessment of Environmental Radiological Conditions at the Newfield Facility", April 1992.

exhibiting evidence of erosion. The radioanalytical results of these samples were used to provide additional information on the potential for radiological contamination which might be present in the vicinity of the Hudson's Branch.

14.1.2 Field Instruments, Methods and Detection Sensitivities

The measurement locations of interest on the property were identified by establishing a 10 meter grid system. The gridded area included the majority of the property within the legal boundaries of the site as well as certain surrounding property. The off-site portion of the grid extended approximately 30 meters beyond the fence lines. The types of instruments used for the two radiological surveys included a pressurized ion chamber (PIC) and portable gamma scintillation survey meters. Ambient exposure rates in the vicinity of the slag piles and at the perimeter of the property were measured with a PIC. Acquisition of ambient exposure rate data using PICs is time consuming and somewhat unwieldy. Therefore, portable survey instruments were used to obtain "count rates" at a height of one meter above the ground at the same locations as the PIC measurements. These values were used to develop a "count rate to exposure rate" conversion factor for use in converting portable survey instrument readings into ambient gamma exposure rates.

Portable instrument surveys were then conducted at every grid intersections with the exception of paved areas of the plant and in the vicinity of the slag piles. The grid point measurements were performed with the probe of a gamma scintillation detector positioned at a height of one meter above the ground surface. The "one meter height" count rates were then converted into ambient gamma exposure rates through application of the conversion factor.

Walkover surveys were conducted to obtain additional information on the extent of soil contamination. These surveys were performed in all accessible grid blocks, with the exception of the paved area of the plant and in the vicinity of the slag piles by walking in 10 meter parallel paths while slowly swinging a gamma scintillation detector in a three to four foot span parallel to the ground (approximately 10 cm from the ground surface).

14.1.3 Laboratory Instruments, Methods and Detection Sensitivities

Soil samples collected during the measurement campaign were transported to a commercial analytical laboratory and were analyzed by gamma spectroscopy (radium-226, radium-228, bismuth-214, lead-214, and other gamma-emitters). The concentration of uranium-238 and thorium-232 in the samples were determined by isotopic analysis (alpha spectroscopy).

Water samples also went to an offsite commercial laboratory where they were filtered into suspended and dissolved fractions. Each water sample was analyzed for dissolved and suspended gross alpha and beta activity. Isotopic analysis was performed if the gross alpha activity exceeded a 1976 EPA screening level (applicable at the time) of 15 pCi/liter or if the gross beta activity exceeded the screening level of 50 pCi/liter. The isotopic analyses included gamma spectroscopy and alpha spectroscopy for uranium-238 and thorium-232. For the dissolved fractions, radon de-emanation was used to determine the radium-226 concentration, and beta-gamma coincidence counting was used to determine the radium-228 concentration.

14.1.4 Survey Results

Appendix 19.6 shows the radionuclide concentrations measured during the site-wide characterization. The maximum measured exposure rate at the property fence line was 0.13 mR per hour. Walkover survey results indicated elevated count rates on the eastern-most boundary of the property, although the soil sampling results from the same area show little difference from measured background concentrations. Both survey and sampling data show surface deposits present in the general vicinity of the former Flex-Kleen and AAF Baghouses, and elevated count rates identified to the south of the property were attributed to the flow of surface water running from the Storage Yard towards the south.

14.1.5 Maps and Drawings Showing Non-impacted/Impacted Areas

Appendix 19.6 contains site drawings with analytical results, on a "per radionuclide" basis. The areas of the Newfield facility that are considered to be unimpacted are consistent with those locations with radionuclide concentrations or exposure rates that are indistinguishable from background.

14.1.6 Adequacy of Characterization Survey

Since the 1991 site-wide characterization effort was completed, routine surveillance activities in and around all restricted areas have been performed once per calendar quarter. These data and the surveillance summaries confirm that no significant quantities of residual radioactivity have migrated past the restricted areas.

All areas and surfaces within the Newfield facility have been surveyed or sampled as part of the 1991 characterization effort, routine quarterly surveillance efforts, or as part of a facility-specific decommissioning effort.

14.2 Release Surveys

14.2.1 Materials and Equipment Release Criteria During Decommissioning

Release surveys for materials and equipment used during decommissioning will be surveyed with portable radiation survey instruments. Since it will not be possible to distinguish between radioactivity from thorium or uranium using portable radiation survey instruments. Therefore, SMC will use the more restrictive levels for natural thorium (Th+D) in Table 1 of USNRC Policy and Guidance Directive FC-83-23 as the acceptable surface contamination level for release of the object.[81] The natural thorium release criteria are 1,000 and 3,000 dpm/100 cm^2 (average and maximum activity, respectively) and 200 dpm/100 cm^2 removable activity. The FC 83-23 levels for thorium and uranium are presented in Table 1. These limits apply independently to either alpha or beta/gamma contamination levels.

[81] U.S. Nuclear Regulatory Commission, Termination of Byproduct, Source and Special Nuclear Material Licenses, Policy and Guidance FC 83-23, November 4, 1983.

In the event that a surface does not meet the natural thorium release level, but is less than the natural uranium level and further decontamination is impractical, an analysis of the radionuclide content of the surface contamination may be performed to determine the thorium-to-uranium ratio. The unity rule will then be applied to determine if the surface may be released. SMC will make the decision to implement this approach based on an evaluation of the time and cost necessary to perform this analysis compared to the cost of including the equipment or material into the waste stream as low level radioactive waste (LLRW). Items that would be impractical or cost-prohibitive to adequately survey due to their physical condition, geometry, inaccessibility, or media will be disposed of as LLRW.

14.2.2 Remedial Action Support Surveys

SMC will conduct remedial action surveys of the scrap metal and other debris generated during demolition and remedial activities described in Chapter 8 of this Plan. These materials will be segregated by radiological status (i.e., less than or greater than the release criteria), decontaminated as necessary. Materials that exhibit elevated levels of radioactivity (e.g. exceed the limits specified in Section 14.2.1) will be designated as LLRW. Other materials will be considered free of residual contamination and acceptable for disposal as clean waste. During excavation of the slag area, SMC will perform remedial action surveys, including surface scans and large-volume composite sampling and analysis, as described in Section 8.5. Additional methodology details, including a demonstration that field screening is capable of detecting residual radioactivity at the DCGL, will be provided in the D&D work plans.

14.3 Final Status Survey Design

14.3.1 Overview

Once all remedial actions are complete, the Final Status Survey will be performed, the data acquired will be validated, and a Final Status Survey Report will be prepared and submitted with SMC's application to terminate License No. SMB-743. The objective of the Final Status Survey is to collect sufficient information to demonstrate, to a reasonable degree of statistical certainty, that the radiological parameters at the site do not exceed the established DCGLs, and that the license termination criterion for restricted release has been met. The assigned survey units represent the fundamental elements for compliance demonstration using the statistical tests. The final status surveys will be designed and performed utilizing a combination of methodologies from MARSSIM and other appropriate guidance documents. These documents provide detailed guidance on the classification, selection, and size of areas to be surveyed; survey instrument requirements; quantity and quality of data to be collected; unbiased sampling methods; and methods for evaluating survey results. The following is a summary of the DCGLs and key tasks for the final status surveys.

14.3.2 Derived Concentration Guideline Levels (DCGLs)

A Final Status Survey Plan (FSSP) will be prepared by SMC using guidance provided in NUREG-1575 (MARSSIM) and NUREG-1757.[82,83] The final status survey will be designed to ensure that the final condition of the site satisfies the release criteria defined in Section 5 of this Plan. The DCGLs applicable to the SMC site are summarized in Table 17.6.

Building surfaces will be surveyed for the presence of residual radioactivity. Based upon the requirements specified in 65 FR 114 and NUREG/CR-5512 [84], DCGLs, which are equivalent to the applicable release criteria, were determined for unrestricted release conditions.[85] Table 17.11 summarizes the DCGLs for building surfaces.

To facilitate the performance of field measurements, in light of the presence of more than one radionuclide, gross activity DCGLs for each medium were determined as follows:[86]

$$DCGL_{gross} = \frac{1}{\frac{f_{238U+C}}{DCGL_{238U+C}} + \frac{f_{232Th+C}}{DCGL_{232Th+C}}}$$

where f = the relative fraction of the total activity contributed by the radionuclide. Assuming f = 0.5 for both radionuclides, Table 17.11 also summarizes those results. Although Class 1 survey units are present at the Newfield site, in order to interject an element of conservatism into the decommissioning effort, only wide-area DCGLs, using the values shown in Table 17.11 are applicable.

Methodologies to measure the DCGLs in soil and on building surfaces will satisfy the requirements of the MARSSIM methods to the extent practical based on the nature and configuration of the radioactivity. SMC may use other guidance documents in conjunction with MARSSIM to design the survey so it meets the applicable data quality objectives (DQO). The DQOs will be specifically defined in the FSSP.

Final surveys will be performed incrementally as remedial tasks progress and at the conclusion of work activities, depending on the portion of the site undergoing remediation and the methods employed in a particular area. Areas in which the final status survey has been completed will be cordoned off to ensure that it is not impacted by remedial tasks.

[82] U.S. Nuclear Regulatory Commission, Multi-Agency Radiation Survey and Site Investigation Manual, NUREG 1575, Revision 1, August, 2000.

[83] U.S. Nuclear Regulatory Commission, Consolidated NMSS Decommissioning Guidance - Characterization, Survey, and Determination of Radiological Criteria, NUREG 1757, Volume 2, September, 2003.

[84] Federal Register, Volume 65, No. 114, page 37186, June 13, 2002.

[85] Beyeler, W. E., et al., "Residual Radioactive Contamination From Decommissioning; Parameter Analysis; Draft Report for Comment", NUREG/CR-5512, Vol. 3, U. S. Nuclear Regulatory Commission, October, 1999, Table 5.19.

[86] MARSSIM, Equation 4-4.

Following all final status surveys, a Final Status Survey Report (FSSR) will be prepared in accordance with current USNRC guidance on format and content. This report will include an overview of the site radiological conditions as a result of decommissioning activities, explanations of the survey design methodologies, descriptions of and justifications for deviations from the final survey design proposed in the FSSP or decommissioning tasks proposed in this Decommissioning Plan, and a detailed presentation of all final survey data and conclusions. The original final survey data will be maintained by SMC upon completion of the project.

14.3.3 Data Quality Objectives

In order to release the SMC site for unrestricted use, the final status survey must show that residual contamination levels do not exceed the release criteria within an acceptable degree of confidence. SMC will do this by establishing DQOs that identify data needs for the survey, data quality indicators, and the statistical tests used to demonstrate compliance with the release criteria. Specifically, data needs include the following:

- Type of samples/measurements
- Necessary quantity of samples/measurements
- Necessary quality of samples/measurements (quantitative or qualitative)
- Minimum detection concentration (MDC)
- Necessary turnaround time
- Necessary quantity of background samples/measurements
- Measurement documentation requirements

14.3.4 Classification of Areas

All of the areas at the Newfield facility do not have the same potential for residual contamination. Therefore, not all will require the same level of survey coverage in order to evaluate its radiological character. For the purposes of this Plan, SMC has classified the areas at the Newfield site into three categories, Class 1, Class 2, and Class 3 (see Figure 18.11). Areas that are known or suspected to contain residual radioactive material will be classified as Class 1, 2, or 3 impacted areas. Areas where there is an extremely low probability of residual radioactive contamination will be classified as non-impacted. Classifications for the site and surrounding areas based on current radiological information are discussed below. These classifications may change prior to the final status survey as a result of additional information generated by D&D remedial action support surveys.

Class 1 areas have the greatest potential for contamination and therefore receive the highest degree of survey effort for the final status survey using a graded approach, followed by Class 2, and then by Class 3. Class 1 areas are those that have (or had prior to remediation) a potential for radioactive contamination or known contamination above the DCGL. Class 1 areas at the Newfield site include those known to contain slag or previously were covered by slag. The area encompassing the Storage Yard, and extending outward a distance of 50 feet will be considered a Class 1 area as well as the location of residual slag identified during prior characterizations and the sites where buildings D102/112, D111, the AAF Baghouse and the Flex-Kleen Baghouse were located.

Class 2 areas are those that have a potential for radioactive contamination or known contamination, but are not expected to exceed the DCGL. Class 2 areas at the Newfield site include those that may be potentially contaminated as a result of excavation or other intrusive work during the construction of the engineered barrier and site preparation activities. Other Class 2 areas include the laboratory building, shipping and receiving areas/warehouses, and D117 (the "cave"). In addition, locations susceptible to fugitive dust during decommissioning actions are also classified as Class 2 areas.

Class 3 areas are those that are not expected to contain any residual radioactivity or are expected to contain levels of residual radioactivity at a small fraction of the DCGL based on site operating history and previous radiation surveys. Class 3 areas at the Newfield site will include all areas that are not classified as Class 1 or Class 2.

14.3.5 Background Reference Areas

Background was established for the soils in the unrestricted area during the remedial investigation.[87] These data are provided in section 5 of this Decommissioning Plan in Table 17.2.

In order to evaluate gross alpha or beta activity on surfaces, a surface of similar construction will be used. The administration building (D201,"Link Building") will be used for background information for drywall surfaces. The Personnel Building (D201) and its immediate will be used to acquire cinder block, asphalt, concrete and soil background data. In addition, the background data sets described in Section 4.2, above, will also be used.

14.3.6 Identifying Survey Units

Site areas will be d into individual soil survey units with the size of each unit based on its classification. Class 1 survey units will be limited to 2,000 m^2 and Class 2 and Class 3 survey units will be limited to 10,000 m^2.

14.3.7 Establishing a Reference Coordinate System

SMC will establish a reference grid system for the land areas to be surveyed. The grid size and pattern will be based on the classification of the area. The grid system will facilitate systematic selection of measuring and sampling locations, provide a mechanism for referencing a measurement/sample back to a specific location, and provide a convenient means for determining average activity levels.

[87] TRC Environmental Consultants, Inc., Remedial Investigation Technical Report, Project Number 7650-N51, Windsor, Connecticut, April, 1992.

14.3.8 Selecting Instrumentation

All instrumentation used for the Final Status Survey, including scanning measurements, will be appropriate for the type of radiation expected, of sufficient sensitivity and accuracy to detect the radioactive materials of interest, and of sufficient quantity to support planned activities. Table 17.12 lists the applications and detection capabilities of various types of instruments that may be used for the project. The following instruments (or equivalent substitutions) will be used to meet these requirements:

- Bicron MicroRem tissue-equivalent meter (ambient gamma surveys);
- Ludlum Model 2241 scaler/ratemeter with a Model 44-10 sodium iodide gamma scintillation detector (gamma walkover surveys);
- Ludlum Model 2224 scaler/ratemeter with Ludlum Model 43-89 dual alpha/beta (contamination surveys of surfaces); and
- Ludlum Model 239-1F floor monitor with Ludlum Model 2221 scaler/ratemeter and Ludlum Model 43-37 gas proportional probe (contamination scanning of floors).

Instrument use, calibration and operational checks will be performed pursuant to SMC Radiation Safety Procedure, RSP-008.[88] The sensitivity for each medium and radionuclide will be determined prior to the start of the measurement campaign, with the results documented in the final status survey report.

14.3.9 In-situ Measurement Instrumentation Description

No in-situ measurements of radionuclide concentration in soils or other solid materials will be made during this decommissioning effort. Instead, samples will be collected and forwarded to a commercial analytical laboratory for analysis.

14.3.10 Analytical Instrument Description

Prior to submitting any samples to a commercial analytical laboratory, a letter of specification will be written. Included will be the necessary measurement result(s) and relevant detection sensitivity. At that time, the laboratory will be asked to declare the analytical method and the measurement devices they intend to use in order to meet SMC's specifications.

Each commercial laboratory that provides analytical results as part of this decommissioning plan will be asked to provide a copy of their quality assurance documents, including quality assurance procedures designed to ensure the necessary calibrations and detection sensitivity requirements are met.

[88] Shieldalloy Metallurgical Corporation, Radiation Safety Procedure No. RSP-008, "Instrumentation and Surveillance".

14.3.11 Conducting Radiation Surveys

14.3.11.1 Surface Soil Survey Methods

SMC will take direct measurements and material samples from classified survey unit locations specified in the FSSP. The sampling locations will follow a random start systematic pattern with dimensions determined according to the methodology in Section 5 of MARSSIM.

Surface scans will be performed with instruments that have adequate scan MDCs as determined by the radionuclide of concern, grid pattern, grid dimensions, and outdoor area factors for the designated survey area in accordance with Section 5 of MARSSIM. For Class 1 area, the area will be scanned 100% and for Class 2 areas, the area will be scanned at least 10% of the area. For Class 3 areas, the surface scans will be completed for areas identified by the RSO, judged to have the greatest potential for elevated areas.

All instrumentation used for the Final Status Survey, including scanning measurements, will be appropriate for the type of radiation expected, of sufficient sensitivity and accuracy to detect the radioactive materials of interest, and of sufficient quantity to support planned activities. Many of the radionuclides of concern and/or their progeny emit high-energy photons and are easily detected using survey instruments equipped with sodium iodide (NaI[Tl]) scintillation crystal detectors. Scanning for gross gamma activity will be used as part of status survey of open land area survey to ensure elevated areas of activity are not missed.

Use of these field instruments or acceptable equivalents is evaluated against the goal of achieving MDCs of less than the DCGL for direct measurements and/or scanning measurements. MDCs were calculated for scanning instruments using the method provided in MARSSIM for calculating MDC that controls both Type I and Type II errors (i.e., elimination of false negatives and false positives) as follows:[89]

$$ScanMCDR = \frac{MDCR}{\sqrt{p\,\epsilon_i}}$$

where: MDCR = minimum detectable count rate in counts per minute (cpm), ϵ_i = conversion factor specific for gamma energies provided by the manufacturer for 2-inch-by-2-inch NaI detectors (cpm/microRoentgens per hour [μR/hour]);[90] and ρ= efficiency of the technician performing the survey. For purposes of conservatism, ρ is assumed to 0.5.[91]

$$MDCR = s_i \times \left(60/i\right)$$

[89] U.S. Nuclear Regulatory Commission, Multi-Agency Radiation Survey and Site Investigation Manual, NUREG-1575, Revision 1, August, 2000.

[90] Values for ϵ are radionuclide specific and are provided by MARSSIM for 2-inch-by-2-inch NaI detectors.

[91] U.S. Nuclear Regulatory Commission, Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions, NUREG/CR-1507, 1997.

where: s_i= minimal number of net source counts required for a specified level of performance for the interval, i, in seconds, and

$$s_i = d'\sqrt{b_i}$$

where d' = value selected from MARSSIM (Table 6.5) based on the required true positive and false positive rates;[92] and b_i = is the number of background counts in the interval.

An area will be scanned according to the area classification, Class 1, or 2. Scanning coverage will range from 0 to 100 percent. When scanning soil, the detector is held close to the ground, within 6 centimeters (<3 inches) and moved in a serpentine pattern. A scan rate of 0.5 meter per second is standard for scanning gamma emitters in surface soil. The scan rate may be adjusted by the Radiation Safety Officer according to the required scan MDC. Additional factors that may reduce the effectiveness of scanning (e.g. increased moisture content of the soil, depth of contamination, etc.) should be considered when establishing a scan rate in the field. In the scanning mode, the audio response must be used to improve the likelihood of detection of an elevated area and avoid a false negative response resulting from the lag time of the meter (analog needle) response.

Discrete fixed point measurements will also be recorded in Class 1,2 and 3 areas. This measurement provides a lower detection limit than the scanning mode.. A fixed gross gamma measurement will be taken at specific coordinates or a predetermined interval. The discrete radiation measurement will be recorded over a duration sufficient to achieve the required MDC. The survey time will be adjusted according to the instrument background.

14.3.11.2 Sample Collection

Surface soil samples will be collected with a clean, stainless steel scoop or spoon that is decontaminated between uses. Samples will be placed into appropriately-sized containers that have been provided or specified by the analytical laboratory. Each will be labeled with a unique sample number.

All sampling activities will be recorded on field logs and will include individual sample information such as date/time of sample, sample location, and sample number. Collected samples will remain in the custody of sampling personnel or locked in a controlled, limited access location until they are packaged for shipment to the commercial laboratory. A sample Chain of Custody/Request for Analysis form will be completed for all samples and will accompany the sample shipment to the analytical laboratory. Field screening of the samples will be performed to approximate the total radioactivity present and ensure the sample shipment conforms to applicable Department of Transportation shipping regulations.

[92] The value of d' used to calculate the detector sensitivity corresponding to an alpha error of 0.05 and beta error of 0.40; the value is selected to be 1.38. This value of d' will result in less than 5 percent false negatives and about 40 percent false positives.

Soil samples will be collected in accordance with written procedures. Sampling tools will be cleaned and monitored, as appropriate, after each use. Samples will be collected in clean/unused sealable containers. Smear samples will be collected in accordance with written procedures. Smear samples will be stored in clean containers.

Sample containers will be permanently labeled/marked in the field at the time of collection by the technician collecting the sample. At a minimum, the following information will be recorded on the sample container: sample date/time, sample identification number, sample location, and name of person collecting the sample. Sample identification numbers will consist of an alphanumeric code that further defines the sample type, location, and depth at which the sample was taken. All samples which may contain radionuclide levels in excess of 100 times the baseline concentration or which, because of their form, may be a potential laboratory contamination concern will be identified on the outside of the container with a "radioactive material" caution label. An approved procedure will be used for strict chain of custody to ensure that the integrity of the sample is maintained throughout sampling, transportation, analysis, and archiving.

14.3.11.3 Sample Analysis

Sample collection and laboratory analysis will be performed in accordance with established SMC and site-specific procedures for solid and liquid media. Based on the radionuclides of concern, laboratory analyses may include on-site and outside laboratory gamma spectroscopy, on-site net gamma-activity counting, outside laboratory alpha spectroscopy (isotopic), and hazardous material profiling.

No less than 5% of final survey solid media surface and subsurface samples will be split and submitted for analysis to an independent laboratory for quality control purposes. The split sample results will be compared to on-site measurements according to the procedures outlined in SMC's Radiological Control, Safety, and Quality Control Program Manual. Non-conformance will require investigation by the RSO and resolution of the difference.

14.3.12 Documenting Survey Activities

SMC will document all survey activities including sample and measurement locations, survey data, survey unit reclassifications, survey unit remediation and re-survey efforts, unusual findings during survey activities, and instrument MDCs. SMC will retain the survey and calibration records in the project file.

14.3.14 Evaluating Survey Results and Data Analysis

SMC will evaluate the survey results beginning with a data-quality assessment. The original DQOs presented in the FSSP will be reviewed to determine if they are still applicable. The DQOs will be re-evaluated for deviations from the original FSSP such as an insufficient number of data points or use of instruments with insufficient sensitivities. Survey results and data will be analyzed and evaluated according to the guidance provided in Section 8.0 of MARSSIM and will include:

- A preliminary data review and calculation of summary statistics;
- A graphical data review to identify patterns and outliers;
- Selection of the statistical test(s);
- Verification of the assumptions of the test(s); and
- Drawing conclusions from the data.

14.3.14.1 Statistical Test

Because the radionuclides of concern at the Newfield facility exist in the natural background, all measurement results acquired during the Final Status Survey will be compared to the aforementioned DCGLs, using the non parametric statistical test, the Wilcoxon Rank Sum Test and the Quantile Test as described in Chapter 8 of MARSSIM. If an area exhibits residual radioactivity in excess of the applicable criterion, that area will either be marked for additional remedial action, or technical/regulatory justification for no further action will be prepared and included in the Final Status Survey report. If additional remediation is necessary, follow-up measurements will be performed to demonstrate their effectiveness.

14.3.14.2 Area Factors

An area factor was established for survey results that may exceed the DCGL but consists of a relatively small area, less than 1,000 m^2. The evaluation, termed an elevated measurement comparison (EMC), consists of comparing each measurement from the survey unit with the DCGL. Any measurement from the survey unit that is equal or greater than the DCGL indicates an area of an elevated concentration that should be investigated, regardless of the outcome of the non parametric statistical tests.

The use of a EMC against the DCGL may be viewed as assurance that unusually large measurements receive the proper attention regardless of the outcome of those tests and that an area having potential for significant radiation dose contribution will be identified. The EMC is intended to flag potential failures in the remediation process and will not be considered the primary means to identify whether or not the SMC unrestricted site meets the release criterion. The derived concentration guideline level for the EMC is derived as follows:

$$DCGL_{EMC} = A_m \times DCGL$$

where A_m = area factor for the area of the systematic grid area. The area factor, A_m, was established using the input parameters as described in Chapter 5of this Decommissioning Plan. The RESRAD computer code was used to establish the area factors by changing the area of the contaminated zone; the area of the unrestricted area is 244,000 m^2.

Table 17.13 summarizes the area factors for the Newfield site. The largest area factor is set at 3.0 for an area less than or equal to 7 m^2. Additional measurements and sampling may be performed at locations and frequencies based on professional judgment.

14.3.14.3 Confirmatory Surveys

The USNRC may perform side-by-side confirmatory surveys during remedial activities, conduct independent confirmation surveys after completion of all final status surveys, or combine the two procedures. The choice will be at the discretion of the USNRC and will be coordinated with SMC management to ensure adequate on-site support, oversight, and documentation.

14.3.15 Final Status Survey Report

Much of the information contained in the Final Status Survey Report will be available from other decommissioning documents compiled by and retained by SMC. However, to the extent practicable, the Final Status Survey Report will be a stand-alone document with the amount of information incorporated by reference kept to a minimum. The report will be approved by designated personnel capable of fully evaluating its content prior to its release. The following is a listing of required report elements:

- Site description;
- Site conditions at the time of the survey;
- Map or drawing of each survey unit showing the reference system and systematic sample locations for Class 1 and 2 survey units and random locations shown for Class 3 survey units and reference areas;
- Description of the remedial activities to remove excess radioactive materials;
- Summary of air sample results during remedial activities;
- Survey objectives;
- Derived Concentration Guideline Levels;
- Classification of areas;
- Selection of instruments and survey techniques;
- Survey plan and procedures;
- Determination of background;

- Scanning survey measurements;
- Discrete samples;
- Detection sensitivity;
- Sample collection and analysis; and
- Data interpretation.

Additionally, the Final Status Survey Report will contain the following:

- A discussion of any changes that were made in the Final Status Survey from what was proposed in the Plan or other prior submittals;
- A description of the method by which the number of samples was determined for each survey unit; and
- A summary of the values used to determine the numbers of sample and a justification for these values.

Furthermore, the survey results reported for each survey unit will include, as applicable:

- the measured sample concentrations;
- the statistical evaluation of the measured concentrations;
- judgmental and miscellaneous sample data sets reported separately from the samples collected for performing the statistical evaluation;
- a discussion of anomalous data including any areas of elevated direct radiation detected during scanning that exceeded the investigation level or measurement;
- locations in excess of DCGL; and
- a statement that a given survey unit satisfied the DCGL and the elevated measurement comparison if any sample points exceeded the DCGL.

Finally, the Final Status Survey Report will contain the following, as necessary:

- a description of any changes in initial survey unit assumptions relative to the extent of residual radioactivity;

- if a survey unit fails, a description of the investigation conducted to ascertain the reason for the failure and a discussion of the impact that the failure has on the conclusion that the facility is ready for final radiological surveys; and

- if a survey unit fails, a discussion of the impact that the reason for the failure has on other survey unit information

At the conclusion of decommissioning activities, SMC will submit to USNRC an FSS Report that is compliant with the content requirements specified above. Original data and backup information will be maintained by SMC as part of the permanent recordkeeping system.

15 FINANCIAL ASSURANCE

15.1 Cost Estimate

Decommissioning cost estimates were developed based on the characteristics of the facility, using standard cost estimating methodologies, supported by key assumptions. These factors are described in more detail below.

A detailed description of the facility is provided in Section 3 of this Decommissioning Plan. Specific facility information can be found in the following sections:

- USNRC license number and type - Section 2.1

- Types and quantities of materials authorized under the license - Estimated volumes of stockpiled materials within the Storage Yard and other materials to be addressed during decommissioning (e.g., the D112 and D102/D112 demolition materials) are presented in Table 1-1 of the Environmental Report (see Appendix 19.9). These volume estimates were developed on the basis of a detailed topographic map developed for the site based on site photography taken in January 2005. Current topography was compared to estimated original topography using CAD applications and volumes calculated accordingly. Based on the area's relatively flat topography, original topographic estimates are expected to accurately represent the actual site conditions.

- Description of how licensed materials are used - Licensed materials were generated as a result of on-site production activities which have ceased, as reported to USNRC in August 2001.

- Description of facility - A description of the facility, including areas in which the licensed materials were used and/or stored, is presented in Section 2.

- Quantities of materials or wastes accumulated before shipping or disposal - Same as those materials described in the second bullet above.

The cost estimates for the decommissioning actions described in this plan were developed using a variety of cost-estimating data, including vendor-provided information, conventional cost-estimating guides, prior experience, and prior similar estimates as modified by site-specific information. Site-cost experience and good engineering judgments were also used to identify those items that will control the estimates. In addition, the following were also assumed:

- The currently estimated inventories of radioactive materials are representative of the inventories that will be in-place at the time decommissioning is conducted.

- The decommissioning effort will begin immediately upon USNRC approval of this Plan.

- No credit is included in the estimate of decommissioning costs for salvage value or the sale of construction debris or scrap that is deemed to have intrinsic value and may be potentially decontaminated and released for unrestricted use.

- Only the Storage Yard and the adjacent areas where demolition wastes are stored (e.g., the D111 and D102/D112 demolition materials) will be subject to decommissioning. Former restricted areas (e.g., G-Warehouse, A-Warehouse, etc.) and other ancillary areas, because they contain no residual radioactivity, have no decommissioning costs other than the cost of completing and documenting a final status survey.

- Unit costs presented in the cost estimates represent combined materials, labor, equipment, and overhead and profit (O&P) costs. For cost data sources that did not include O&P, a value equal to 25% of the combined materials, labor and equipment cost was used to represent O&P. Certain decommissioning activities will require higher health and safety precautions that can impact labor and/or equipment productivity. To reflect these potential reductions in productivity, the labor portion of the cost associated with such activities was adjusted to reflect a reduction in labor productivity by 45% and the equipment portion of the cost was adjusted to reflect a reduction in equipment productivity by 25%.[93]

- Cost estimates for both the LTC and LT alternative conservatively include the cost of placing clean soil over the area of the Storage Yard from which radioactive materials are removed (either due to pile consolidation under the LTC alternative or material removal under the LT alternative).

- Cost estimates include expenses for engineering design, administrative costs, permits and legal documentation and project management during construction.

- Long-term surveillance and maintenance costs are estimated based on a 1,000-year period.

  - For the LTC alternative, long-term surveillance and monitoring costs include annual exposure rate measurements and visual inspections, maintenance of site security systems (e.g., fencing), engineered barrier maintenance, trust fund fees and USNRC fees. Site security maintenance and engineered barrier

[93] R.S. Means Environmental Remediation Cost Data – Unit Price, 11th Annual Edition, 2005.

maintenance costs are based on published landfill economic data[94], as the engineered barrier is comparable to caps used on landfill sites, for which maintenance costs are available. Maintenance costs reflect such activities as mowing, repair of cover soil, re-seeding, maintenance of surface water control structures. As described in Section 8.3, the engineered barrier will be designed to be robust, as supported by erosion calculations (see Appendix 19.3) that indicate major damage due to precipitation and erosion would not be anticipated, even under extreme weather conditions (e.g., probable maximum precipitation). Trust fund fees are based on fees currently incurred for the administration of SMC's USNRC Trust Fund. Records retention costs have been included in each of these items, so records retention costs are not listed as a separate line item. USNRC fees are based on values suggested in NUREG-1757 Supplement 1 (Draft Report for Comment).

  - The LT alternative does not include any long-term surveillance and monitoring costs.
  - The LC alternative long-term surveillance and monitoring costs are based on current costs for surveillance and monitoring of the site.

- In accordance with USNRC guidance, a 25 percent contingency has been added to the total cost of all alternatives.
- Present worth estimates of long-term surveillance and monitoring costs are calculated for a range in discount rates.

Calculating costs over a long-term period requires the selection of a representative discount rate; however, there is no definite rationale for such a rate's selection. The alternatives with the greatest long-term surveillance and monitoring costs (i.e., the LTC and LC alternatives) are affected the most by the discount rate, with the recommended 25 percent contingency on the total alternative cost further impacting the ultimate effect of the selected rate of return on the final total decommissioning cost.

The USNRC's Environmental Report guidance document (NUREG-1748) references the use of USNRC guidance document NUREG/BR-0058 in preparing cost estimates, which, in turn, references federal Office of Management and the Budget (OMB) guidance.[95] This OMB guidance, as quoted in NUREG/BR-0058, recommends the calculation of present-worth values using both 3 percent and 7 percent real discount rates, with the 3 percent rate reflecting the real rate of return on

[94] "Landfill Economics Part III: Closing Up Shop", MSW Management, September/October 2005.
[95] Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission, NUREG/BR-0058, Revision 4, published September 2004.

long-term government debt and the 7 percent rate approximating the marginal pretax rate of return on an average investment in the private sector.

In calculating decommissioning costs, the lower of the two rates of return specified in NUREG/BR-0058, 3 percent, was used. This value is considered to be reasonable and adequate in terms of providing sufficient funds to produce annual average income that covers the annual costs of security and engineered barrier maintenance, records retention, and USNRC and trust fund fees over the long term.[96] However, as described in Section 15.3, below, an important condition of the LTC license, and a commitment made by SMC, is that if the amount held in trust proves insufficient, additional funds will be added.

Tables 17.14 through 17.16 present the decommissioning cost estimates for the LTC, LT and LC alternatives, respectively. As indicated there, the LT is the most costly alternative, at an estimated present worth of $58 million. The estimated present worth cost for the LTC alternative is $5.2 million. The estimated present worth cost for the LC alternative is $2.7 million.

15.2 Certification Statement

Because operating funds will be used to implement this decommissioning plan, and because the cost of all activities are secured with an irrevocable stand-by letter of credit, no Certification Statement is necessary.

15.3 Financial Assurance Mechanism

Upon approval of this Decommissioning Plan by the USNRC, SMC will petition the USNRC to release the money in the existing Trust Fund, and SMC will petition the USEPA and the NJDEP to release any additional financial assurance required by the USNRC from the Joint Financial Assurance Fund required pursuant to Section 16A and 16B of the Bankruptcy Settlement Agreement of 1997.[97,98] SMC will then establish a separate financial assurance mechanism (Trust Fund) for the

[96] There are a variety of recommended rate-of-return assumptions provided by the USNRC, ranging from 1% in the Proposed Update to NUREG01757 (Supp. 1, "Sufficient Financial Assurance"), to 2% in NUREG-1757 (Vol. 3, Section 4.3.2.1), to the 3% and 7% values in NUREG/BR-0058. SMC has selected the 3% value on the basis that it is consistent with the rate of return associated with the moneys currently held in trust for the benefit of the USNRC, and the lower of the two values recommended in NUREG/BR-0058. The 1% value was not used because, unlike mill tailings sites where funding is at government expense, this trust fund would be funded at SMC expense, thus discount rates that displace private capital or private expenditures is more appropriate.

[97] United States Bankruptcy Court, Southern District of New York, re: Metallurg, Inc. and Shieldalloy Metallurgical Corporation, "Settlement Agreement of Environmental Claims and Issues by and Between the Debtors and the United States of America and the State of New Jersey", Nos. 93 B 44468 (JLG); 93 B 44469 (JLG), April, 1997.

[98] Paragraph 14 of the Bankruptcy Settlement Agreement establishes the required financial assurance with respect to the performance of the work at the Newfield site and with this paragraph lists "NRC Slag Pile Remediation" as the Environmental Project, with a Dollar Estimate of $5.0 million. The agreement goes on in paragraphs 16 A., B. & C. to explain the steps SMC will follow to provide, create or make available the fund as financial assurance for the benefit of the United States and the State of New Jersey with respect to the list of Environmental Projects (including the Slag Pile). Pursuant to Section 16.A, SMC would purchase a letter of credit (LOC) in the amount of $4.25 million for the benefit of the United States and the State of New Jersey. Section 16.B required that SMC establish another financial assurance instrument equal to an amount money the government would release to SMC upon entering into the Settlement

construction and implementation phase of the decommissioning project, and create a fully-funded Long Term Control (LTC) License Trust Fund for the benefit of the USNRC in the amount of $854,770 to address the costs associated with the following over a 1,000-year period:

- Site surveillance of access and land use restrictions;
- Engineered barrier maintenance;
- Radiological monitoring;
- Reporting;
- Records retention; and
- Trustee fees and expenses.

If the balance substantially exceeds the amount needed to produce sufficient annual income for funding over the long-term, the USNRC will petitioned for return of excess funds. The duplicate signed originals of all fully-executed trust agreements will be forwarded to the USNRC.

SMC intends to use operating funds and/or parent-company funds to implement this decommissioning plan. The source of funds for the LTC Trust have already been set aside as part of the prior bankruptcy agreement, with the USNRC already in possession of the trust instrument.[99] Supplemental SMC funding of the LTC Trust will only be provided to cover the difference between the amount needed and the amount currently held in trust. However, immediately upon approval of this Decommissioning Plan, a replacement instrument will be executed, and SMC will request that the USNRC, the USEPA and the NJDEP release their interest in an irrevocable stand-by letter of credit that was also established as part of the bankruptcy settlement for the construction and implementation portion of the decommissioning.[100] The LTC Trust will remain in place and be drawn upon to pay for the on-going cost of the operation, maintenance and licensing of the restricted portion of the Newfield site in accordance with 10 CFR 40.36.[101]

Agreement. USNRC was directed to draw down the existing LOC post for their benefit in the amount of $750, 000 and deposit it into a separate trust account for the benefit of USNRC.

[99] United States Bankruptcy Court, Southern District of New York, re: Metallurg, Inc. and Shieldalloy Metallurgicial Corporation, "Settlement Agreement of Environmental Claims and Issues by and Between the Debtors and the United States of America and the State of New Jersey", Nos. 93 B 44468 (JLG); 93 B 44469 (JLG), April, 1997.

[100] SMC will then purchase a letter of credit for the benefit of USNRC equal to the amount necessary for the completion of the approved Decommissioning Plan. Upon successful completion of the Decommissioning Plan and amendment of License No. SMB-743 into a LTC license, SMC will demand the release of the letter of credit.

[101] Integrated Environmental Management, Inc., Report No. 94005/G-9194 (Rev. 2), "Decommissioning Funding Plan for the Newfield, New Jersey Facility", submitted to Shieldalloy Metallurgical Corporation, September 10, 2001.

16 RESTRICTED USE AND ALTERNATE CRITERIA

16.1 Overview

This section of the SMC Decommissioning Plan demonstrates that when License No. SMB-743 is terminated, the requirements of 10 CFR 20.1403 will have been met. Included in this discussion is the eligibility determination (Section 16.1), a discussion of institutional controls in place to support this action (Section 16.2), a discussion of public involvement (Section 16.3), and a summary of dose modeling and ALARA demonstration (Section 16.4).

16.2 Eligibility Demonstration

The ALARA analysis (see Section 7.0) of this Plan demonstrates that the potential risks of exposure to the residual radioactivity consolidated within the engineered barrier (the LTC alternative) are significantly lower than the risks of excavating and shipping the materials offsite to a licensed disposal site (the LT alternative) or taking no action at all (the LC alternative). Likewise, the costs of excavation are much higher than any accrued benefits based, primarily, on occupational hazards and the hazards of transporting the contaminated materials to a distant disposal site (see Section 7.3). The results of this analysis demonstrates that SMC is eligible to request release of a portion of the site under the provisions of 10 CFR 20.1403, with the remainder released under 10 CFR 20.1402.

16.3 Institutional Controls and Engineered Barriers

After remediation activities are complete, the preponderance of the Newfield property will be released for unrestricted use. Although SMC has no intention of vacating the property, if conditions should warrant, the unrestricted portion of the site may be sold.[102] At that point, SMC may consider adding funds from the sale to the financial surety amount in order to strengthen it further.

An engineered barrier within a fenced restricted area will serve to maintain radiation exposures to population groups that are reasonably likely to be impacted below the limits specified in 10 CFR 20.1403. Because the exposure potential of this area is trivial in light of regulatory dose limits (see Chapter 5), it is considered to be a low-risk area. However, because the source term is comprised of radionuclides with long half-lives, that classification is applicable only if the engineered barrier

[102] USNRC guidance explicit to SMC states that the unrestricted portion of the property may not be sold to anyone other than the licensee. The purpose for this guidance is to ensure the financial worth of the licensee is maximized for the purpose of continuing the LTC license requirements. Because SMC will place sufficient funds in trust to pay for the long-term monitoring and maintenance of the restricted area for the next 1,000 years, there is sufficient financial protection to ensure the requirements of the LTC license are enforced in spite of who owns the unrestricted portion. Furthermore, feedback that SMC received from the community as part of the decommissioning planning process (see Section 16.5) supports the ability to, as necessary, sell the unrestricted portion of the property. Therefore, provision for possible future sale of all or a portion of the unrestricted portion of the property is captured in this Decommissioning Plan because there is sufficient financial assurance, the LTC license is clearly enforceable, and members of teh public strongly support it (see Section 16.5, below).

is maintained. [103] Therefore, the SMC site will be comprised of both an unrestricted use area and a restricted use area where legally-enforceable and durable institutional controls are required. The size of the restricted area has been minimized to a footprint that immediately surrounds the engineered barrier.

16.3.1 Description of Legally-Enforceable and Durable Institutional Controls

The primary means of ensuring institutional control over the restricted area of the decommissioned Newfield site will be perpetual federal regulation and oversight of the provisions outlined herein. The form of control will be the amendment of License No. SMB-743 to a LTC license. This license, to be issued by a federal (US) regulatory agency (i.e., the USNRC), has the force of law. The USNRC, in guidance supplied to SMC, has agreed to issue the LTC license as part of the overall approval of this Decommissioning Plan.

The secondary means of ensuring institutional control is the filing of a deed notice with Gloucester County that prohibits agricultural, residential and industrial activities within the restricted area, or any other activities that might result in the removal or breech of the engineered barrier. It will also contain a statement that no land use other than that specified in Section 16.4, below, is permitted for within the restricted area. The contents of the deed notice will be prepared and submitted for USNRC approval as part of the final decommissioning and final status survey report (see Section 14.3.15). Once filed, it will also serve to alert any future landowners owners that the property brings with it all of the obligations of License No. SMB-743.

The duration of these controls will be permanent in light of the long half-life of the radioactivity consolidated under the engineered barrier. However, the LTC license will be renewed in five-year increments. Independent oversight of SMC's performance in light of LTC license requirements will be provided by the USNRC during routine inspections and license renewal activities. In the event of SMC default in the terms and conditions of the LTC license, the USNRC has the authority to terminate the license, assume control of the funds held in trust, and contract the services of a third party to implement the license requirements.

16.3.2 Activities to Control Access

To control access to and use of the restricted area while under SMC ownership, a variety of institutional controls, including physical, legal, and administrative mechanisms as described in the following, will be implemented:

- SMC will control access to and activities on the engineered barrier through the use of fencing.

- Warning signs will be posted along the fence line and at all access points (gates).

[103] The hazard classification even if the engineered barrier should fail, would still not be considered a "high hazard" level (see Chapter 5), although it would be somewhat higher than with the barrier in place on a dose basis alone.

- No demolition, excavation, digging, drilling, or any other disturbance of the soil, ground, or groundwater, or use of soil, ground, or groundwater for any purpose will be permitted.
- SMC will conduct periodic (quarterly) inspections of the restricted area to ensure access is being controlled.
- SMC will conduct adverse event surveillance (e.g., after major storms, evidence of intruders is identified, damage to the perimeter fence, etc.) as warranted.
- Records of visitors to the restricted area will be prepared and maintained by SMC.
- SMC will review the continued effectiveness of these controls as part of its quarterly inspection program.

A Long Term Control Plan (LTC Plan) will be prepared and submitted with the final decommissioning report that outlines the specific details of how these conditions will be implemented and on what frequency.

16.3.3 Corrective Actions in the Event of Institutional Control Failure

Because the primary durable and enforceable institutional control applicable to the site is regulation, oversight and enforcement by a federal agency, failure of the institutional controls is unlikely. The most likely reason for USNRC (or successor agencies) failure to enforce the provisions of the LTC license, would be a breakdown in societal structure. And should this come to pass, and even without the physical and administrative controls outlined in Section 16.3.2, above, the public's interest would more likely be elsewhere than in the contents of the engineered barrier. Therefore, SMC will implement alternate institutional controls as deemed necessary and to the extent practical under the circumstances.

16.3.4 Records Maintenance and Reports

All records associated with the implementation of the LTC license and the LTC Plan would be maintained by the licensee for the duration of the license. These records would include all new records generated during implementation of the LTC Plan, as well as historical records, including this Decommissioning Plan, the final status survey report, the LTC license file, the LTC Plan itself, and all license correspondence. A physical repository for these records will be specified in the LTC Plan. All licensing records that become a part of the USNRC's recordkeeping system will be available to the public.

Once per year, SMC will prepare an annual report that summarizes the routine maintenance and surveillance program, identifies any event corrective actions that took place and planned corrective actions, as well as the results of corrective actions performed previously. Where applicable, an analysis of lessons learned from an event and action taken to ensure similar events do not occur in the future will be included. A copy of the annual report will be forwarded to the USNRC, the NJDEP and to the Newfield Borough office.

16.4 Site Maintenance and Financial Assurance

SMC will serve as the qualified entity for controlling and maintaining the restricted area after decommissioning is complete and the LTC license issued. The qualifications of the entity and personnel that are authorized to conduct the planned LTC activities will be captured in the LTC Plan. At a minimum, the qualifications will include the following:

- A Senior Corporate Official with overall control and authority for compliance will serve as the licensee representative.

- The responsibility of the Senior Corporate Official includes, but is not limited to, the following: Establishing SMC policy and amending the LTC Plan accordingly; assuring SMC radiation protection and compliance services are sufficient to meet the requirements of the LTC Plan; and designating the individual with authority for implementing the LTC Plan.

- The designated individual will be responsible for recommending the type and quantity of staff and resources necessary for full implementation of the LTC Plan, and will have the responsibility and authority to terminate any work activities that do or may violate LTC Plan requirements.

- The designated individual will have the minimum qualifications: Knowledge of the work requirements and provisions of the LTC license and LTC Plan; and an understanding of the type, form, and authorized use of radioactive materials in the restricted area at the SMC site.

The terms and conditions of the site maintenance program will be specified in the LTC Plan, to be submitted to the USNRC as part of the final decommissioning report. At a minimum, it will include the following:

- SMC will deploy passive radiation dosimeters around the perimeter of the restricted area on a quarterly exchange frequency.

- SMC will patrol, inspect and assess ambient radiation exposure rates around the perimeter of the restricted area and the surface of the engineered barrier at least once per calendar quarter and whenever an adverse event (e.g., major storm, intruder evidence, perimeter fence damage, etc.) occurs.

- Quarterly inspections will be documented to show the inspection date, the inspector, a summary of the inspector's findings, the location of any damage identified during the inspection, confirmation/verification of any corrective actions or repairs made since the last inspection; results of ambient radiation surveys performed during the inspection and the results of passive dosimeter processing for the previous quarter.

- SMC will repair any damage to the engineered barrier that would limit its ability to provide the level of protection specified herein, and will ensure the surface of the engineered barrier is kept free of additional deposits of any kind that might limit SMC's ability to observe its physical condition.

- SMC will repair any damage, maintain all necessary roads, road shoulders, low water crossings, bridges and culverts, and cut grass and remove vegetation, as necessary to ensure SMC access to the restricted area, and provide access control signs at specified locations around the restricted area.

- SMC will maintain the barricading and marking of all roads that surround or approach the restricted area.

The primary physical control that will be used to ensure radiation doses of any population group that might be impacted by the consolidated radioactivity on-site is the engineered barrier. As described in Chapter 8, that barrier was designed to provide the necessary shielding of the residual radioactivity, to deter removal of the materials therein, and to preclude erosion that might reduce its thickness and shielding effectiveness even if periodic maintenance and repair does not take place. The vegetated engineered barrier is not expected to present any excess hazards, as it would not be expected to attract any sort of hazardous wildlife that could prevent the completion of quarterly maintenance inspections. The presence of the geomembrane will limit the depth of impact that burrowing animals could have on the integrity of the barrier.

As shown in Chapter 15, the annual cost of implementing the long-term maintenance and monitoring program, including the cost of visual and ambient gamma radiation surveys, site security maintenance, engineered barrier maintenance and repair, licensing and inspection fees, annual report review/inspection, license renewal fees, and trust fund fees & expenses, when converted to annual costs, is approximately $25,644. If a three (3) percent return on investment is assumed, which is a reasonable amount in light of the current rate of return on the moneys currently held in trust for the USNRC, financial assurance in the amount of approximately $855,000 is required. SMC will place this amount of money in trust, with the USNRC as the beneficiary, to ensure funding for implementation of the LTC License requirements is available in perpetuity.

Once the LTC license is issued, SMC intends to use operating funds to maintain the engineered barrier, perform the routine monitoring, participate in the inspection and re-licensing efforts, and maintain the necessary records. If operating funds are not sufficient or if the restricted portion of the property were to be abandoned, the moneys held in trust for the USNRC would then be available to ensure the maintenance and monitoring continued. Furthermore, and as outlined in the deed notice for the property (see Section 16.3), any property owner would be required to comply with the LTC license requirements and fund the trust. However, the trust language will provide the flexibility to allow the property owner/licensee to seek to use funds under specified circumstances from the surety for required actions under the LTC, provided the USNRC approves such withdrawals and sufficient funds remain to fulfill the obligations for the remaining years.[104]

16.5 Obtaining Public Advice

16.5.1 Site Specific Advisory Board (SSAB) Selection

In order to solicit local input as SMC plans and implements its management of the residual radioactivity at the Newfield site, a Site Specific Advisory Board (SSAB) was established as an advisory group of volunteers. SMC contacted individuals who were thought to have interest in the decommissioning efforts. These included owners of businesses in the vicinity of the Newfield site, the Mayor, city and county public health officials, State environmental and radiological officials, planning board members, and county residents. Individuals who expressed an interest in serving as members of the SSAB were also asked to provide recommendations on others who they thought may be interested. The following is a listing of the members of the SSAB:[105]

- Charles L. Harp, Esq. - Archer & Greiner (facilitator)[106]
- David R. Smith - Shieldalloy Metallurgical Corporation (Radiation Safety Officer)
- Richard Westergaard - Newfield resident and Mayor of the Borough of Newfield
- Loretta Williams - Newfield resident and member of the Newfield Planning/Zoning Board
- Linda Graumann - Newfield resident and Councilwoman for the Borough of Newfield
- Thomas Daily - Newfield resident
- Janet Magliocco - Newfield resident
- George R. Sartorio - City of Vineland Health Department
- James Woods - Gloucester County Health Department

[104] For example, if there appears to be excessive funds in the surety, if SMC goes into bankruptcy, or if there is clear evidence that SMC in good faith cannot fund necessary costs from operating funds generated by itself or a parent corporation, the licensee may petition the USNRC for a release of funds from the trust.
[105] Not all members were present during all meetings.
[106] Mr. Harp was present during all meetings of the SSAB held prior to the submission of this Decommissioning Plan to the USNRC.

- Nancy W. Stanley - New Jersey Department of Environmental Protection (Bureau of Environmental Radiation)[107]

- Donna L. Gaffigan - New Jersey Department of Environmental Protection (Bureau of Federal Case Management)

- Carol D. Berger, CHP - Integrated Environmental Management, Inc. (radiological consultant to SMC)

16.5.2 Specific Inquiry of the SSAB

The SSAB provided SMC with an opportunity to present information to interested parties on the history of licensed activities at the site as well as plans for the future. It also offered opportunities to provide information on how SMC intends to decommission the Newfield site for both unrestricted release and restricted use, what institutional controls will be in place in order to assure the radiation safety of members of the public for many years into the future, and hear of concerns its neighbors and public officials might have in regard to the proposed decommissioning action. To that end, and as required by 10 CFR 20.1403(d), the SSAB's input was explicitly solicited during the decommissioning planning phase on the following key issues:

- Whether the institutional controls provide reasonable assurance that the license termination criterion (TEDE) from residual radioactivity will be met;

- Whether the institutional controls will be enforceable;

- Whether the institutional controls will impose an undue burden on the local community or affected parties; and

- Whether the financial assurances given by SMC will allow an independent third party to assume and carry out the responsibilities for control and maintenance of the site.

16.5.3 Meetings of the SSAB

There were four (4) meetings of the SSAB in advance of submitting this Plan, held on the following dates and locations:

- Meeting 1 - August 15, 2003, Link Conference Room at the SMC site.

- Meeting 2 - September 19, 2003, Link Conference Room at the SMC site.

- Meeting 3 - November 5, 2004, Laboratory Classroom at the SMC site.

[107] For Meeting 3 and 4, Ms. Jenny Goodman of the New Jersey Department of Environmental Protection, Bureau of Environmental Radiation, substituted for Ms. Stanley.

- Meeting 4 - September 21, 2005, Laboratory Classroom at the SMC site.

Meeting 3 and 4 were open to the public, and public comment was solicited at the end of each meeting. Minutes were prepared for the first three meetings and distributed to the membership for review. Appendix 19.7 contains a copy of the minutes for each meeting. A transcript was made of the last meeting, a copy of which is also contained in Appendix 19.7.[108]

16.5.4 Evaluation of SSAB Advice

As the minutes will show, the preponderance of Meetings 1 and 2 were spent discussing the decommissioning plans, other options for closure of the site, and how information would be exchanged. There was little feedback from the SSAB on 10 CFR 20.1403(d) issues. Therefore, for Meetings 3 and 4, SMC prepared a form to assist the members and others in focusing their input on the 10 CFR 20. 1403(d) issues. Appendix 19.8 contains a copy of the SSAB Input Form as distributed to all the individuals present during the third meeting, and later posted on the SMC Decommissioning Web Site (see Section 16.5.4, below) and placed into the public repositories for availability to other interested parties.

As of October 18, 2005, three (3) forms had been completed and forwarded to SMC for consideration during the decommissioning planning process. Appendix 19.8 contains copies of the completed forms. The following is a listing of the relevant input obtained primarily from the completed forms and from other SSAB member comments presented during the four SSAB meetings. SMC's response to that input, and any action taken as a result of that input, is also shown below.

Do the institutional controls proposed by SMC provide reasonable assurance that an average member of the public will not incur a radiation dose in excess of 25 millirem TEDE?

SSAB Input: There is not sufficient information on which to base a response. The characterization of the slag and baghouse dust pile was not provided to the SSAB, nor was the engineering design of the engineered barrier. There has not been an opportunity to review Rev. 1 of the Decommissioning Plan.

SMC Response: The radiological characterization of the slag and baghouse dust was described in Chapter 4 of Rev. 0 of the "Decommissioning Plan for the Newfield Facility". The design of the engineered barrier was presented in Chapter 8 and shown in Figure 18.9 through 18.11 of Rev. 0. Relevant portions of Rev. 0 were forwarded to members of the SSAB after Meeting 1. In addition, a copy of Rev. 0 in its entirety was always present at SSAB meetings, and a copy was placed in the public repository on September 12, 2003. However, the question posed should be answerable in the

[108] Because the September 21, 2005 meeting was the last one held before submission of this Decommissioning Plan, the transcripts were circulated to SSAB members but there has not been an opportunity to approve them.

absence of information on the radiological character of the slag and baghouse dust as it is directed towards the effectiveness of the proposed institutional controls (i.e., LTC license) only, not the decommissioning methodology (i.e., consolidation and capping of residual radioactivity).

It is important to note that there are a variety of controls associated with the LTC license designed to ensure radiation doses actually incurred by members of the public are well-within the regulatory limits. These controls include fencing around the engineered barrier, maintenance crews to ensure the physical condition of the barrier remains as it was when it was initially installed, requirements for quarterly inspections and radiological surveillance, a deed notice that restricts any excavation or other intrusive uses of the restricted area, and more. However, Rev. 0 of the Decommissioning Plan, which was the only version of the document provided to the SSAB prior to the submission of Rev. 1 to the USNRC did not outline the controls in sufficient detail.

<u>Action Taken:</u> A more detailed description of the controls that will be in place and enforceable by the terms and conditions of the LTC license issued to SMC as part of this Decommissioning Plan has been provided in Sections 16.3 and 16.4. Additional SSAB feedback on these sections is solicited by SMC and will be addressed when possible throughout the regulatory negotiation period. In addition, SMC will make Rev. 1 of this Plan available on the web site shortly after its submission to the USNRC.

<u>SSAB Input:</u> No one knows what future development issues in the Newfield area might arise over the next 1,000 years.

<u>SMC Response:</u> SMC concurs with this comment. Predicting anything 1,000 years into the future is, at best, speculation. However, the USNRC's interim guidance to SMC suggested there was support for making realistic projections over the next 50 to 100 years. On that basis, the county land use projections may be considered realistic projections of how land in the Newfield area will develop. One of the exposure scenarios evaluated in order to demonstrate compliance with the regulatory dose limits for decommissioning was for an assumed hypothetical resident near the site. As shown in Chapter 5 of this Plan, even if residential development encroached on the restricted portion of the SMC property, the radiation dose potential to those members of the general public would be below the applicable criteria.

<u>Action Taken:</u> None required.

<u>SSAB Input:</u> A qualitative discussion of potential site access and use restrictions and how they could eliminate exposure pathways for specific radionuclides would provide useful risk

insights for affected parties to understand and discuss before dose assessments are completed.

> *SMC Response:* The requested information (i.e., SMC's plans to construct an engineered barrier, along with the intent to convert License No. SMB-743 into a LTC license) was presented to the SSAB during various meetings, along with the exposure pathways that were to be evaluated. In fact, SMC did receive a suggested new exposure pathway (i.e., the excavation scenario) from an SSAB member that was added to the listing.

> *Action Taken:* None required. However, a summary of the requested information appears in Chapter 5 (dose modeling) and Sections 16.3 and 16.4 of this Plan.

SSAB Input: The very general discussion of monitoring requirements contained in the USNRC's interim guidance to SMC does not engender a feeling of confidence that the public health and the environment will be properly protected.

> *SMC Response:* The guidance provided to SMC by the USNRC is just that - guidance. There is no requirement that SMC follow that guidance. Using the USNRC guidance, SMC has developed a much more specific monitoring program, which the USNRC will review. Nonetheless, SMC has used the USNRC's guidance as a baseline in preparing the description of SMC's proposed monitoring and surveillance program described in Section 16.4, above.

> *Action Taken:* None required, although the more specific program is described in this Plan.

SSAB Input: The SSAB expressed concern that others might add other waste to the capped pile in the future.

> *SMC Response:* The LTC license issued to SMC will require that legal requirements to maintain the engineered barrier be maintained to its design specifications. As a result, any breaches in the engineered barrier in order to add additional materials would violate the license, be against the law and would result in enforcement action if not mitigated. The same would be true for surface deposits of radiologically-inert waste onto the engineered barrier, which may make routine inspections of the engineered barrier integrity more difficult. Finally, the LTC license would permit "possession only" of the radioactive materials that are currently listed on the SMC inventory.

> *Action Taken:* SMC has included a statement in Section 16.4 that would bar the acceptance of additional radioactive materials as part of the LTC license, and that the

engineered barrier surface will be kept free of additional deposits of any kind that might limit SMC's ability to monitor its condition.

Will the institutional controls will be enforceable?

SSAB Input: There has been no demonstration that the institutional controls proposed will be enforceable for the time period necessary, basically in perpetuity.

SMC Response: SMC disagrees with this comment. The institutional controls proposed for the site include enforcement of the long-term commitments for monitoring, maintenance and reporting by the USNRC, a federal regulatory agency. The SSAB has been asked to provide input as to whether the USNRC will be able to enforce the proposed controls. While it is unreasonable to predict the future 1,000 years from now, it is not unreasonable to assume the perpetuity of the federal government and its regulatory and legal authority. Therefore, as long as the federal government is operating, the requirements of the LTC license will be enforced.

Action Taken: None required.

SSAB Input: The USNRC's own regulations under 10 CFR Section 61.59 state that institutional controls may not be relied on for more than 100 years.

SMC Response: The regulations contained in 10 CFR Part 61 pertain to radioactive waste disposal sites, the scope of which does not include materials from an individual licensee, such as SMC, which are set forth in 10 CFR 20.[109] Furthermore, the USNRC has provided guidance to source material licensees on the time period over which radiation doses must be assessed and controls must be implemented (see NUREG-1757), and that time period is 1,000 years. Therefore, the provisions of this Decommissioning Plan are based upon a 1,000-year duration.

Action Taken: None required.

SSAB Input: What happens if SMC leaves the site or sells the property?

SMC Response: If SMC leaves the site without having transferred the site to a person who has received a licensee from the USNRC, SMC will be subject to civil and criminal enforcement action. SMC will be ordered back to the site and the USNRC can take a variety of actions including ordering SMC to obtain a qualified third party to carry out site obligations specified in the license. The third party's responsibilities would then be funded by the surety posted by SMC as part of this Decommissioning Plan.

[109] 10 CFR 61.1, Subpart A, "Purpose and Scope".

SMC has no plans to leave the site or sell the property. However, if that situation should occur, transfer of ownership of the property must be approved by the USNRC prior to the transfer taking place. The new property owner would be required to become the LTC license holder. The financial assurance would remain in effect subject to the NRC control. If SMC abandons the site or otherwise no longer possesses the site and site has not been properly transferred to a new licensee, the USNRC has the legal authority to initiate civil action against SMC and refer SMC to the US Department of Justice for criminal prosecution, as well as reach whoever is in legal possession of the property to order such person to carry out the obligations of the LTC licensee as such person is in possession of the radioactive material. The USNRC could then direct the trustee to release funds so that the person owning the property can fund the required effort. In addition, the trustee could be directed by the USNRC to contract with a third party to implement the maintenance and surveillance obligations of the license.

Action Taken: None required. However, a description of the financial assurance that will be provided with the USNRC as the beneficiary will be included in Chapter 15 and in Section 16.4 of Rev. 1 of the Plan.

SSAB Input: It is not possible to provide input on this issue because the SSAB has not had an opportunity to review Rev. 1 of the Decommissioning Plan.

SMC Response: During Meeting 1 of the SSAB, SMC described the decommissioning approach as being identical to that presented in Rev. 0 of the Decommissioning Plan. Relevant portions of Rev. 0 were forwarded to members of the SSAB after Meeting 1. In addition, a copy of Rev. 0 in its entirety was available at SSAB meetings, and one was placed in the public repository on September 12, 2003. However, the question posed (i.e., whether or not the USNRC would be able to enforce the terms and conditions of the LTC license) should be answerable even without having read Rev. 0 or 1 of the Plan.

Action Taken: None required. SMC will make Rev. 1 of this Plan available on the web site shortly after its submission to the USNRC.

SSAB Input: Could a threshold not be met so that the LTC license will not be renewed? What if SMC is not maintaining the property correctly and is in violation, or that there is something in the air or water that doesn't belong there? There are issues of the maintenance of the site.

SMC Response: The LTC license held to be issued to SMC will legally obligate SMC to maintain the restricted portion of the property to its design specifications and to monitor radiological conditions associated with it. As the licensee, SMC is obliged to fund these activities. However, if the licensee should fail to honor the terms and conditions of the license, the USNRC is empowered to take enforcement action. If SMC does not take the necessary corrective action, the USNRC take possession of the financial assurance and obtain a third party contractor to perform the necessary maintenance and surveillance, and the USNRC would fund that action from the surety posted by SMC.

Action Taken: None required. However, Chapter 15 and Sections 16.3 and 16.4 of Rev. 1 of the Plan will describe the provisions for engineered barrier maintenance and monitoring that SMC will request be included, by reference, in the LTC license.

SSAB Input: How will SMC keep radioactivity from going into the groundwater without having a liner underneath the capped pile?

SMC Response: Leachability testing of the materials that will be placed under the engineered barrier demonstrates that the radioactivity in them is tightly bound and will not leach into the groundwater. Nonetheless, as described in Chapter 8 of Rev. 1 of the Plan, the geomembrane which is an integral part of the engineered barrier design, is an effective means of diverting rainwater away from the engineered barrier and eliminating any mechanism for transporting radioactivity to the groundwater. Testing of the groundwater for radionuclides reveals that even though the materials in the Storage Yard have been unprotected from the elements for over 50 years, there has been no impact on the groundwater.

Action Taken: None required.

SSAB Input: Is the USNRC ready to take financial responsibility if SMC should leave? Who is the third party that will be responsible?

SMC Response: Terms and conditions of the LTC license to be issued to SMC will have the force of law. The USNRC will have the authority to access the financial assurance which SMC will provide and then use those funds to contract a third party to continue the required level of maintenance and monitoring.

Action Taken: None required.

Will the institutional controls impose undue burdens on the local community or other affected parties?

SSAB Input: The institutional controls may prevent the development of the rest of the SMC site, as well as surrounding properties. This would present an undue burden on the local and neighboring communities. It is doubtful that anyone other than SMC would build a business on the property.

SMC Response: SMC intends to continue operating the Newfield facility and to serve as the LTC licensee. Other than the terms and conditions of the LTC license, there will be no restrictions on SMC's actions on use of the unrestricted portion of the property under this Decommissioning Plan because it will have been released for unrestricted use as part of the implementation of this decommissioning plan. This means that the unrestricted portion of the property may be put to any use whatsoever by SMC or by any successor organizations. Consequently, development of the Newfield site will not be hampered any more than development at an adjoining property, with the exception of the non-radiological CERCLA/NRD-related restrictions that have already been imposed.

Action Taken: None required. However, SMC has included wording in Section 16.3 to reflect the fact that once the LTC license has been issued, the licensee may put the unrestricted portion of the property to any use, including sale, on the basis that there is sufficient financial protection to ensure the requirements of the LTC license are enforced in spite of who owns that portion.

SSAB Input: Why can't the property be subdivided so that the clean portion can be used for other purposes? The site is valuable to Newfield and there is a desire to see it used in the future. The USNRC is urged to consider subdivision of the restricted area from the remainder of the site in order to encourage commercial use of the parcel and prevent the loss of tax revenue to the borough.

SMC Response: The USNRC's interim guidance to SMC on the implementation of an LTC license expresses a desire to keep the SMC property "intact" in order to ensure that a viable business interest was present and financially able to implement the terms and conditions of that license over the years. SMC's original intent was to abide by that guidance in the preparation of this Decommissioning Plan. However, even though SMC intends to continue operating the Newfield facility and maintain the property intact, SMC concurs with the reasonableness of the SSAB's input. Therefore, the financial assurance placed in trust for the USNRC will provide that the requirements of the LTC license are implemented whether or not the unrestricted portion of the property is sold.

Action Taken: SMC has included wording in Section 16.3 to reflect the fact that once the LTC license has been issued, the licensee may put the unrestricted portion of the property to any use, including its sale to others, on the basis that there is sufficient financial protection to ensure the requirements of the LTC license are enforced in spite of who owns that portion. Having the ability to sell some or all of the unrestricted portion of the property provided flexibility to both SMC and to the Borough of Newfield, therefore SMC would, if and when a portion of the property is sold, consider adding funds from the sale to the surety amount to strengthen it further.

SSAB Input: What will happen to property values and rateables in light of SMC's plans?

SMC Response: Because the radiological risks associated with the decommissioned Newfield site will not differ from the risks associated with properties that surround it, there is no technical or regulatory basis for assuming that property values will be impacted any differently. Because the unrestricted portion of the property can continue to operate as a commercial/industrial facility, it is presumed that the rateables will remain as they are today, modified as tax schedules demand.

Action Taken: None required.

SSAB Input: It is not possible to provide input on this issue without an opportunity to review Rev. 1 of the Decommissioning Plan.

SMC Response: During Meeting 1 of the SSAB, SMC described the decommissioning approach as being identical to that presented in Rev. 0 of the Decommissioning Plan. Relevant portions of Rev. 0 were forwarded to members of the SSAB after Meeting 1. In addition, a copy of Rev. 0 in its entirety was always present at SSAB meetings, and one was placed in the public repository on September 12, 2003. However, the question posed is answerable even without having read Rev. 0 or 1 of the Plan (i.e., whether or the federal government acting as the durable institutional control at the decommissioned site would place any burdens on the community).

Action Taken: None required. SMC will make Rev. 1 of this Plan available on the web site shortly after its submission to the USNRC.

Can SMC provide sufficient financial assurance to enable an independent third party to assume responsibility for control and maintenance of the site?

SSAB Input: SMC appears to be downsizing the Newfield operation. There is no value to the property with the slag pile present, only liability, possibly in the hundreds of millions of dollars. It appears that SMC is seeking the LTC option only to continue operating the facility for as long as SMC can profit from it, and will abandon all radioactively contaminated material if it cannot profit.

SMC Response: Approval of this Decommissioning Plan by the USNRC would require SMC to fund its implementation, including the money placed in trust for the USNRC to ensure sufficient funding for the on-going maintenance and monitoring as described in Chapter 15 of this Plan. As described in Section 16.4 of this Plan, SMC intends to use operating funds (or draw on Trust funds, as applicable) to maintain the engineered barrier, perform the routine monitoring, participate in the inspection and re-licensing efforts, and maintain the necessary records. If operating funds are not sufficient or if the restricted portion of the property were to be abandoned, the moneys held in trust for the USNRC would be used to ensure the maintenance and monitoring continued. Furthermore, as will be outlined in the deed notice for the property (see Section 16.3), any property owner would be required to comply with and fund the LTC license requirements. The trust language will provide the flexibility to allow the property owner/licensee to seek to use funds under specified circumstances from the surety for required actions under the LTC, provided the USNRC approves such withdrawals and sufficient funds remain to fulfill the obligations for the remaining years. For example, if there appears to be excessive funds in the surety, if SMC goes into bankruptcy, or if there is clear evidence that SMC in good faith cannot fund necessary costs from operating funds generated by itself or a parent corporation, the licensee may petition the USNRC for a release of funds from the trust.

Action Taken: None required.

SSAB Input: SMC states that it currently has posted $5M in financial assurance for addressing USNRC-regulated materials on the site. This amount was not posted in accordance with 10 CFR 20.1403.c for license termination under restricted conditions, but rather in accordance with paragraph 16 of the March 26, 1997 Bankruptcy Settlement Agreement and is a "Predetermined cost" in bankruptcy negotiations based on licensing issues relevant at the time (i.e., not on the current proposal for a LTC license).

SMC Response: Well in excess of $1,500,000 is currently held in trust for the USNRC as decommissioning funding. In addition, there are letters of credit in the amount of $4,250,000 for the benefit of the USEPA and the State of New Jersey for addressing issues associated with the materials in the Storage Yard. If the cost of the radiological decommissioning of the site requires more than the $1,500,000 already in trust, the Bankruptcy Settlement Agreement permits re-direction of the amount designated for the USEPA and the State for the benefit of the USNRC.

Action Taken: A more detailed description of the financial assurance SMC will provide as part of this Decommissioning Plan will be contained in Chapter 15 and Section 16.3 of Rev. 1 of the Plan.

SSAB Input: It is impossible to know if $5M will be sufficient for the current proposal since very few details have been made available to the SSAB. We have not had an opportunity to review Rev. 1 of the Decommissioning Plan.

SMC Response: During Meeting 1 of the SSAB, SMC described the decommissioning approach as being identical to that presented in Rev. 0 of the Decommissioning Plan, with the cost of decommissioning likely to remain similar in Rev. 1, and updated cost estimates were presented during Meeting 4 of the SSAB. All interested parties will have the opportunity to provide input on whether the estimated cost of decommissioning presented in Rev. 1 is reasonable and sufficient to ensure full and complete implementation of the Plan once Rev. 1 has been submitted to the USNRC. However, the question posed is answerable even without having read Rev. 1 of the Plan (i.e., is the $5M already available to address Storage Yard issues sufficient to ensure funding for the necessary level of financial assurance for long-term monitoring and maintenance).

Action Taken: None required. However, to ensure all interested parties have as much time as possible to prepare their comments on the necessary amounts of financial assurance, this Decommissioning Plan will be posted on the SMC web site (see http://www.shieldalloy.com) and placed into the document repositories immediately upon its submission to the USNRC. At that time, members of the SSAB will also be notified in writing of the availability and location of Rev. 1 of the Plan.

SSAB Input: The amount of money being set aside for financial assurance will not be enough to respond to catastrophic scenarios, such as the failure of the cap, or erosion by a hurricane, or things like that. Where would that money come from?

SMC Response: As will be presented in Chapter 15 of Rev. 1 of the Plan, the annual cost of monitoring and maintaining the engineered barrier under any reasonable use scenarios, including natural and human impacts, for 1,000 years was determined. In any given year, the annual amount set aside may be less than or more than what is actually required for that year. Furthermore, unless and until the USNRC authorizes funds to be expended from the trust, the licensee is obliged to make any repairs that may be necessary under any scenarios.

However, it is important to note that in order for the USNRC to approve the design of the engineered barrier, it must be satisfied that its integrity will remain with minimal maintenance and that potential for hurricanes and severe weather events are not likely to result in significant damage over the 1,000 years that follow issue of the LTC license. If the USNRC believes that there is a realistic potential for catastrophic failure in the engineered barrier, it would likely conclude that the design is not adequate.

Action Taken: None required.

SSAB Input: What about the cost of site security, or human resources 24 hours per day, seven (7) days per week? It appears that the yearly amount proposed is an extremely meager figure in that respect.

SMC Response: A constant and continuous security presence at the site for radiological purposes has never been necessary at the Newfield site. There is no reason to believe that an increased security presence will be required once the contents of the Storage Yard are made even less accessible via consolidation and containment under the engineered barrier. Therefore, a budget for continuous security presence has not been included in the cost of long-term maintenance and monitoring.

It is important to note that the current level of security and oversight at the Newfield site, which is typical of industrial operations in general, is more than sufficient to ensure a member of the public would not be present within the restricted area long enough to approach the dose limits. Routine patrols for operational and other reasons could easily identify the presence of such an intruder before their stay-time could present a concern.

Action Taken: None required.

SSAB Input: To further minimize the possibility of continued leaching into the surround ground and groundwater, the site should have a liner.

SMC Response: SMC performed leachability tests on the materials to be consolidated under the engineered barrier as far back as the early 1990's, with the most recent results obtained in September of 2005. All of these data, along with the groundwater monitoring that has been performed since the stockpile of material was first placed in the Storage Yard, clearly demonstrate that the radioactivity is tightly bound in the material matrix. No discernable leaching at all occurs unless the materials are soaked in water with a high pH (just the opposite of what would be expected with rainwater) for very long periods of time, and even then the amounts of radioactivity that leach are trivial.

For the LTC alternative, SMC has included a geomembrane as an integral part of the engineered barrier design. This is being done for a variety of reasons, only one of which is to further prevent water infiltration into the consolidated materials. Additional actions to protect the groundwater in addition to the geomembrane, such as the installation of a base liner, would not only serve no purpose, it would be counter-productive for the following reasons:

- A base liner installed at the bottom on the consolidated materials would require the installation of a leachate collection system. Such a system would require active maintenance, which is discouraged by the USNRC in its guidance on LTC licenses.

- If the geomembrane in the engineered barrier were to be somehow breached, rainwater that would normally percolate through the consolidated materials without mobilizing any radioactivity (as occurs today) would collect above the liner, thus creating a bathtub effect that may increase the leach rate.

Action Taken: None required.

Other input beyond that required in the 10 CFR 20.1403(d) was provided by SSAB members during meetings, in response to the distribution of minutes for review/approval, and in response to the solicitation of SSAB Input Forms (see Appendix 19.7).

16.5.5 On-going Information Exchange

On September 21, 2005, SMC launched a web page dedicated to the decommissioning of the Newfield facility (http://www.shieldalloy.com/decommissioning/index) so that information about the process would be readily available to the public. At that time, the site contained the following:

- A brief history of the site, licensed activities and reasons for pursuing decommissioning;

- Background information on decommissioning activities accomplished to date and the current status of the project;

- A series of documents available for review and/or download, including the SSAB Input Form, Rev. 0 of the Decommissioning Plan, preliminary drafts of three key Plan chapters that were submitted to the USNRC, response to USNRC comments on one of the chapters, cost estimates, aerial photographs of the site, the proposed engineered barrier plan (draft), and introductory information on radiation and radioactivity.

- A series of links to regulatory agency and SMC contractor web sites.

- Images (photographs) of the SMC Storage Yard and other views of the plant.

Shortly after submission of Rev. 1 of the Decommissioning Plan to the USNRC, an electronic version will be posted on the SMC web site. In addition, periodic status reports on the progress made towards implementation of the Plan and modification of License No. SMB-743 to an LTC license will also be posted.

SMC is sensitive to the fact that not all parties interested in this decommissioning effort are able to access the internet. Therefore, hard copies of the documents currently available on the SMC web site, and a copy of Rev. 0 of the Decommissioning Plan, have been placed in the following public repositories:

- Newfield Borough Hall at 18 Catawba Avenue, Newfield, New Jersey; and
- Newfield Public Library at the corner of Catawba and Hazel Avenues, Newfield, New Jersey.

A copy of any other documents SMC posts on the web site in the future would also be placed into the repositories so that they are readily available for public review.

16.6 Dose Modeling and ALARA Demonstration

Radiation doses associated with the restricted and unrestricted portions of the Newfield property after implementation of this Decommissioning Plan were summarized in Chapter 5, above. This analysis demonstrates that the radiation dose potential for a maximally-exposed individual, with all institutional controls in place is less than 25 mrem per year. In the case where the institutional controls fail, the results demonstrate that the 100 millirem per year criterion in 10 CFR 20.1403 will be met for at least 1,000 years after license termination. In both cases, the assumptions used as input to the analyses were selected to maximize the resulting dose, meaning actual doses incurred, if any, will be lower.

Chapter 7 of this Plan contains an analysis of the cost/benefit of the three decommissioning alternatives applicable to the Newfield site. These are the "no action" or LC alternative, the on-site stabilization and capping or LTC alternative, and the off-site disposal or LT alternative. The findings of that analysis demonstrates that reducing the residual radioactivity at the Newfield site further than as proposed herein, although technically achievable, would be prohibitively expense and would result in a greater net public and environmental harm.

As described in previously in this Chapter, provisions for durable and enforceable institutional controls will be in place once License No. SMB-743 is modified to a LTC license. In addition, as shown in Section 15.1, sufficient financial assurance to allow an independent third party to carry out the provisions of the LTC Plan in the unlikely event of SMC default will be provided in the form of a trust, with the USNRC as the beneficiary.

16.7 Alternate Criteria

As shown in Chapter 5 of this Plan, decommissioning of the Newfield site as described herein will result in dose potentials that are well-below the criteria contained in the Title 10 CFR 20.1402 and

1403 for unrestricted and restricted use. Therefore, alternate dose criteria are neither necessary or applied for as part of this Plan.

17 TABLES

Table 17.1 - Residual Radioactivity Volumes at the Newfield Site

Area	Parcel	Volume (cubic feet)	Volume (cubic meters)
1	Excavated soil mixed with slag	405000	11000
2	Excavated soil from D111 demolition	27000	800
3	Canal (crushed slag that is both in and out of Supersacs)	81000	2300
4	Slag	810000	23000
5	Slag & demolition concrete	135000	3800
6	Columbium Hi-Ratio Slag	54000	1500
7	Hi Ratio Slag & D111 Flex Kleen Bags & D116 Polishing Compound Contaminated Equipment & Cleaning Materials	27000	800
8	Baghouse Dust	351000	10000
9	Baghouse dust mixed with slag	108000	3100
T12	D111/D112 demolition concrete	13500	400
E of N-S road; W of Storage Yard	D111/D112 demolition concrete	40500	1100
SW fenceline; T12 tank area	Possible slag used as fill (not confirmed to be licenseable; volume maximized)	216000	8000
	Total	2268000	65,800

Table 17.2 - Background Soil Concentrations

Sample ID	Campaign Identifier	Radionuclide Concentration (pCi/g)				
		Th-228	Th-232	Th-230	U-234	U-238
980715-15	IEM	0.9	0.9	0.5	0.5	0.5
980715-16	IEM	0.3	1.1	0.2	0.2	0.2
091898-01	IEM	1.8	1.8	1.7	1.7	1.7
091898-02	IEM	1.4	1.4	1	1	1
091898-03	IEM	0.9	0.9	0.8	0.8	0.8
091898-04	IEM	1.4	1.4	0.6	0.6	0.6
091898-05	IEM	0.6	0.6	0.6	0.6	0.6
091898-06	IEM	0.6	0.6	0.5	0.5	0.5
091898-07	IEM	1.2	1.2	0.5	0.5	0.5
091898-08	IEM	0.6	0.6	0.9	0.9	0.9
S7	USNRC	0.29	0.33	0.9	0.9	0.9
ORAU-1	ORAU	0.3	0.3	1.3	1.3	1.3
ORAU-2	ORAU	0.5	0.5	0.4	0.4	0.4
ORAU-3	ORAU	0.1	0.1	0.3	0.3	0.3
ORAU-4	ORAU	0.1	0.1	0.3	0.3	0.3
ORAU-5	ORAU	0.4	0.4	0.4	0.4	0.4
ORAU-6	ORAU	0.5	0.5	0.4	0.4	0.4
ORAU-7	ORAU	0.6	0.6	0.8	0.8	0.8
ENSR-1	ENSR	1.48	1.48	0.83	0.83	0.83
ENSR-2	ENSR	0.28	0.28	1.38	1.38	1.38
ENSR-3	ENSR	1.91	1.91	1.37	1.37	1.37
ENSR-4	ENSR	1.68	1.68	0.92	0.92	0.92
ENSR-5	ENSR	1.19	1.19	1.04	1.04	1.04
ENSR-6	ENSR	1.35	1.35	0.42	0.42	0.42
Mean		0.85	0.88	0.75	0.75	0.75
Standard Deviation		0.56	0.55	0.40	0.40	0.40

Table 17.3 - RESRAD Input Parameters

17.3.1 - Common Parameters (Unrestricted Area, Controls in Place)

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	Code	Unit		Distribution	Range & Fit	
Site General and Weather Related Parameters						
Evapotranspiration Coefficient	EVAPTR	Unitless, 0 to 1	0.625	Uniform	Range: 0.3 to 0.9	RESRAD Default. Typical values in humid climates east of the Mississippi River are approximately 0.7.[110]
Average Annual Wind Speed	WIND	m/sec	4.25	Bounded Log-normal-N	μNormal: 1.445 σNormal: 0.2419 Min: 1.4 Max: 13.0	RESRAD Default. The thirty year (1961-1990) site-specific annual average value (4.3 m/s) is nearly equal to the RESRAD default value.[111]
Precipitation Rate	PRECIP	m/year	1.05	Point Estimate		Annual average in area. Equals 41 inches per year.[112]
Irrigation Rate	RI	m/year	0.2m	Point Estimate		RESRAD Default
Runoff Coefficient	RUNOFF	Unitless, 0 to 1	0.45	Uniform	Range: 0.1 to 0.8	The fraction of total annual precipitation that sheds off the surface and drains to Site watershed drainage without percolating through the soil. Typical value is approximately 0.3 to 0.5.
Watershed Area for Nearby Stream or Pond	WAREA	m^2	273,000	Point Estimate		Assumed to be 67 acres. The watershed area is used to calculate dilution factors for contaminant concentrations in surface water bodies in the vicinity of the site.
Depth of Soil Mixing Layer	DM	m	0.15	Triangular	Range: 0 to 0.6	RESRAD Default.[113]

[110] Argonne National Laboratory, *User's Manual for RESRAD Version 6*, July, 2001.
[111] National Climate Data Center, *Local Climatological Data, Annual Summary with Comparative Data for Philadelphia, Pennsylvania*, 2000.
[112] National Climate Data Center.
[113] Argonne National Laboratory, *User's Manual for RESRAD Version 6*, July, 2001.

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	Code	Unit		Distribution	Range & Fit	
Calculation Times	T(n)	Yrs.	1 10 100 300 500 700 900 1000	NA		Evaluation at these time segments allows for consideration of the potential for conditions at the Site to evolve from the initial conditions specified (e.g., soil erosion impacts the cover thickness) and projects the changing Site conditions to the required 1000-year outlook.[114,115]
Geotechnical Parameters						
Cover Depth (thickness)	COVER0	m	0	Triangular	Range: 0 to 0.5	The DCGLs are derived for the unrestricted area assuming that the residual activity is present in the top 6 inches (0.15 m).
Depth of Roots	DROOT	m	0.9	Log-normal-N	μNormal: -1.9 σNormal: 0.6	There are no restrictions for plants and the depth of roots in the unrestricted area
Geotechnical Parameters-Subsurface Soil Contaminated Zone						
Area of Contaminated Zone	AREA	m^2	244,000	Log-uniform	Range: 244,000 m^2 to 295,000 m^2	The area of the unrestricted area is represented by the area of the plant; the area of the Storage Yard is subtracted.
Thickness of the contaminated zone	THICK0	m	0.15m	Triangular	Min 0.1m Max 0.3 m	The residual activity is present in the top 15 cm of the soil.
Irrigation	RI	m/yr	0.2m	Point Estimate		RESRAD Default
Contaminated Zone Density	DENSCZ	g/cm3	1.3	Triangular	Min 1.2 Max 1.6	The density of the soil in the unrestricted area is equivalent to the soil
Contaminated Zone Erosion Rate	VCZ	m/yr	0.001	Continuous Logarithmic	5E-8 0 7E-4 0.22 5E-3 0.95 2E-1 1.0	The erosion of the surface soil was selected as a default o f the RESRAD code

[114] U.S. Nuclear Regulatory Commission, *Radiological Criteria for License Termination*, Volume 62, Federal Register, page 39058, July 21, 1997.
[115] U.S. Nuclear Regulatory Commission, *NMSS Decommissioning Standard Review Plan*, NUREG-1727, September, 2000.

Contaminated Zone Total Porosity	TPCZ	Unitless 0 to 1	0.4	Point Estimate		RESRAD Default
Contaminated Zone Field Capacity	FCCZ	Unitless, 0 to 1	0.2	Point Estimate		RESRAD Default
Contaminated Zone Hydraulic Conductivity	HCCZ	m/yr	2,000	Bounded Log-normal-N	μNormal: 7.6 σNormal: 0.75 Min: 200 max: 20000	The central tendency value, 2,000 m/yr (6.4E-3 cm/sec), corresponds to the measured hydraulic conductivity in sandy soils found at the site. The value is assumed to range over two orders of magnitude from 200 to 20,000 m/yr.[116]
Contaminated Zone B-Parameter	BCZ	Unitless	2.88	Bounded Log-normal-N	μNormal: 1.06 σNormal 0.66 min: 0.5 Max: 30	RESRAD Default
Kd (Thorium)	DCACT(n)	cm^3/g	52,010	Triangular	Min 2,900 Max 129,000	The slag was studied to define the site specific leaching properties.[117]
Kd (Uranium)	DCACT(n)	cm^3/g	70,355	Triangular	Min 50,000 Max 293,000	The slag was studied to define the site specific leaching properties.
Kd (Radium)	DCACT(n)	cm^3/g	53	Triangular	Min 35 Max 77	The slag was studied to define the site specific leaching properties.
Kd (Lead)	DCACT (n)	cm^3/g	100	Point Estimate		RESRAD Default.
Geotechnical Parameters- Unsaturated Layer						
Thickness Unsaturated Layer	H1	m	2.5	Triangular	Min 2.5 Max 4.6	The unsaturated layer was measured during the Remedial Investigation.[118]
Density, Unsaturated Layer	DENSUZ	g/cm^3	1.65	Truncated Normal	μNormal: 1.65 σNormal: 0.23 Quantile, min: 0.05 Quantile,max: 0.95	Unsaturated Zone is the sand cover layer placed over the site prior to disposal of thorium bearing slag. The density of native sand materials present at the site.
Total Porosity Unsaturated Layer	TPUZ	Unitless 0 to 1	0.4	Point Estimate		RESRAD Default

[116] TRC Environmental Consultants, Inc., *Remedial Investigation Technical Report*, Project Number 7650-N51, Windsor, Connecticut, April, 1992.
[117] Outreach Laboratory, Report Number 20050135, March 25, 2005.
[118] TRC Environmental Consultants, Inc., *Remedial Investigation Technical Report*, Project Number 7650-N51, Windsor, Connecticut, April, 1992.

Effective Porosity of Unsaturated Layer	EPUZ	Unitless, 0 to 1	0.2	Point Estimate		RESRAD Default
Field Capacity Unsaturated Layer	FCUZ	Unitless, 0 to 1	0.2	Point Estimate		RESRAD Default
Hydraulic Conductivity Unsaturated Layer	HCUZ	m/yr	0.017	Triangular	Min 0.001 Max 1.7	The central tendency value, 0.017 m/yr, corresponds to the measured hydraulic conductivity in sandy soils found at the site. The value was found to range from 0.001 m/yr to 1.7 m/yr.[119]
Unsaturated Layer 1, B-Parameter	BUZ(1)	Unitless	5.3	Point Estimate		RESRAD Default
Kd (Thorium)	DCACTU(n)	cm^3/g	52,010	Triangular	Min 2,900 Max 129,000	The slag was studied to define the site specific leaching properties.[120]
Kd (Uranium)	DCACTU(n)	cm^3/g	70,355	Triangular	Min 50,000 Max 293,000	The slag was studied to define the site specific leaching properties.
Kd (Radium)	DCACTU(n)	cm^3/g	53	Triangular	Min 35 Max 77	The slag was studied to define the site specific leaching properties.
Kd (Lead)	DCACTU(n)	cm^3/g	100	Point Estimate		RESRAD Default
Geotechnical Parameters-Saturated Zone						
Density, Saturated Zone	DENSAQ	g/cm^3	1.52	Truncated Normal	μNormal: 1.52 σNormal: 0.23 Quantile,min: 0.001 Quantile,max: 0.999	RESRAD Default
Total Porosity Saturated Zone	TPSZ	Unitless,0 to 1	0.4	Point Estimate		RESRAD Default
Effective Porosity, Saturated Zone	EPSZ	Unitless, 0 to 1	0.2	Point Estimate		RESRAD Default
Field Capacity, Saturated Zone	FCSZ	Unitless, 0 to 1	0.2	Point Estimate		RESRAD Default
Hydraulic Conductivity, Saturated Zone	HCSZ	m/yr	16,000	Bounded Log-normal-N	μNormal: 2.3 σNormal: 2.11 min: 0.1 max: 20,000	Site specific data provided in the Remedial Investigation report.[121]

[119] TRC Environmental Consultants, Inc., *Remedial Investigation Technical Report*, Project Number 7650-N51, Windsor, Connecticut, April, 1992.
[120] Outreach Laboratory, Report Number 20050135, March 25, 2005.
[121] TRC Environmental Consultants, Inc., *Remedial Investigation Technical Report*, Project Number 7650-N51, Windsor, Connecticut, April, 1992.

Hydraulic Gradient	HGWT	Unitless	0.004	Bounded Log-normal-N	µNormal: -5.11 σNormal: 1.77 min: 0 .00007 max: 0.5	Site specific data provided in the Remedial Investigation report.[122]
Saturated Zone B-Parameter	BSZ	Unitless	2.88	Bounded Log-normal-N	µNormal: 1.06 σNormal: 0.66 Min: 0.5 Max: 30	RESRAD Default
Source Term Factors						
Dose Conversion Factors	DCFX(n)	mrem/pCi	All DCFs used are RESRAD defaults			RESRAD defaults from FGR#11 and FGR#12 and are derived using ICRP 30 dosimetry model.[123,124] Short-lived (<180 days) radioactive progeny isotopes are accounted for through the use of the "parent+D" DCFs.
Source Isotopes						
Actinium-227	S!(1)	pCi/g	0.044	Point Estimate		Unit Activity to derive DCGL
Protactinium-231	S!(2)	pCi/g	0.044	Point Estimate		Unit Activity to derive DCGL
Lead-210	S1(3)	pCi/g	0.471	Point Estimate		Unit Activity to derive DCGL
Radium-226	S1(4)	pCi/g	0.471	Point Estimate		Unit Activity to derive DCGL
Radium-228	S1(5)	pCi/g	1	Point Estimate		Unit Activity to derive DCGL
Thorium-228	S1 (6)	pCi/g	1	Point Estimate		Unit Activity to derive DCGL
Thorium-230	S1(7)	pCi/g	0.471	Point Estimate		Unit Activity to derive DCGL
Thorium-232	S1(8)	pCi/g	1	Point Estimate		Unit Activity to derive DCGL
Uranium-234	S1(9)	pCi/g	0.485	Point Estimate		Unit Activity to derive DCGL
Uranium-235	S1(10)	pCi/g	0.044	Point Estimate		Unit Activity to derive DCGL

[122] TRC Environmental Consultants, Inc., *Remedial Investigation Technical Report*, Project Number 7650-N51, Windsor, Connecticut, April, 1992.
[123] U.S. Environmental Protection Agency, *Limiting Values of Radionuclide Intake and Air Concentrations and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, Federal Guidance Report Number 11, EPA 520/1-88-020, September, 1988.
[124] U.S. Environmental Protection Agency, *External Exposure to Radionuclides in Air, Water and Soil*, Federal Guidance Report Number 12, EPA 402 R-93-081, September, 1993.

Uranium-238	S1(11)	pCi/g	0.471	Point Estimate	Unit Activity to derive DCGL

17.3.2 - Industrial Workers (Unrestricted Area, Controls in Place, DCGL Basis)

Parameter			**Central Tendency Value**	**Description of Parameter Distribution**		**Remark**
Description	**Code**	**Unit**		**Distribution**	**Range & Fit**	
Receptor Exposure Factors						
Exposure Frequency (Total)	EF	Days per year	240	EF and ET are not input parameters used by RESRAD. They are presented here to disclose the calculation used to arrive at the parameters RESRAD uses to account for exposure frequency, FIND & FOTD		Assumes number of days per year of time working specifically at the SMC site
Exposure Time	ET	hours per day	8			Conservatively assumes that each day eight (8) hours long.
Indoor Time Fraction	FIND	Unitless, 0 to 1	0.15	Point estimate		The fraction of a total year (8,760hr) that is spent indoors on site. Assumes that 69% of the exposure occur indoors. NUREG 6697
Outdoor Time Fraction	FOTD	Unitless, 0 to 1	0.07	Triangular	Range: 0 to 0.21	The fraction of a total year (8760hr) that is spent outdoors on Site. Equals 595 hrs outdoors on Site divided by 8760 hours. The probabilistic distribution ranges to twice the CT value (1,920 hrs per year spent on the site).
Inhalation Rate	INHALR	m^3/yr	8400	Triangular	Range: 4380 to 13100	RESRAD Default Inhalation rate based on geometric mean rate for short term exposure to adult males.[125]
Mass Loading for Inhalation	MLINH	g/m^3	0.00003	Continuous Linear	0.000000 - 0.0000 0.000008 - 0.0151 0.000016 - 0.1365 0.000030 - 0.8119 0.000040 - 0.9495 0.000060 - 0.9937 0.000076 - 0.9983 0.000100 - 1.0000	RESRAD Default. Mass loading in air describes the airborne dust loading conditions on the site.[126]

[125] U.S. Environmental Protection Agency, *Exposure Factors Handbook, Volume I, General Factors*, EPA 600/P-95-002Fa, August, 1997.
[126] Argonne National Laboratory, *User's Manual for RESRAD Version 6*, July, 2001.

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	**Code**	**Unit**		**Distribution**	**Range & Fit**	
Soil Ingestion Rate	SOIL	g/y	18.3	Triangular	Range: 0 to 36.5	The industrial worker may ingest soil as a result of incidental contact with the soil. RESRAD default for adults engaged in non contact intensive activities.
Cover Depth (thickness)	COVER0	m	0	Point estimate		The residual activity is present in the top 15 cm of the soil. It is assumed that there is no cover
Area of Contaminated Zone	AREA	m^2	244,000	Loguniform	Range: 244,000 m^2 to 295,000 m^2	The area of the unrestricted area is represented by the area of the plant; the area of the Storage Yard is subtracted.
Thickness of the contaminated zone	THICK0	m	0.15m	Triangular	Min 0.1m Max 0.3 m	The residual activity is present in the top 15 cm of the soil.

17.3.3 - Trespasser Scenario (Unrestricted Area, Controls in Place)

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	**Code**	**Unit**		**Distribution**	**Range & Fit**	
Receptor Exposure Factors						
Exposure Frequency (Total)	EF	Days per year	12	EF and ET are not input parameters used by RESRAD. They are presented here to disclose the calculation used to arrive at the parameters RESRAD uses to account for exposure frequency, FIND & FOTD		Assumes number of days per year of time working specifically at the SMC site
Exposure Time	ET	hours per day	1			Conservatively assumes that each day eight (8) hours long.
Indoor Time Fraction	FIND	Unitless, 0 to 1	0	Point estimate		The fraction of a total year (8,760 hr) that is spent indoors on site. Assumes that all exposures occur outdoors. It is assumed that the trespasser will not occupy any of the buildings in the unrestricted area.

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	Code	Unit		Distribution	Range & Fit	
Outdoor Time Fraction	FOTD	Unitless, 0 to 1	0.001	Triangular	Range: 0 to 0.002	The fraction of a total year (8760hr) that is spent outdoors on Site. Equals 12 hrs outdoors on Site divided by 8760 hours. The probabilistic distribution ranges to twice the CT value (24 hrs per year spent on the site).
Inhalation Rate	INHALR	m^3/yr	8400	Triangular	Range: 4380 to 13100	RESRAD Default Inhalation rate based on geometric mean rate for short term exposure to adult males.[127]
Mass Loading for Inhalation	MLINH	g/m3	0.00003	Continuous Linear	0.000000 - 0.0000 0.000008 - 0.0151 0.000016 - 0.1365 0.000030 - 0.8119 0.000040 - 0.9495 0.000060 - 0.9937 0.000076 - 0.9983 0.000100 - 1.0000	RESRAD Default. Mass loading in air describes the airborne dust loading conditions on the site.[128]
Soil Ingestion Rate	SOIL	g/y	18.3	Triangular	Range: 0 to 36.5	The industrial worker may ingest soil as a result of incidental contact with the soil. RESRAD default for adults engaged in non contact intensive activities.
Cover Depth (thickness)	COVER0	m	0	Point estimate		The residual activity is present in the top 15 cm of the soil.
Area of Contaminated Zone	AREA	m^2	244,000	Loguniform	Range: 244,000 m^2 to 295,000 m^2	The area of the unrestricted area is represented by the area of the plant; the area of the Storage Yard is subtracted.
Thickness of the contaminated zone	THICK0	m	0.15m	Triangular	Min 0.1m Max 0.3 m	The residual activity is present in the top 15 cm of the soil.

[127] U.S. Environmental Protection Agency, *Exposure Factors Handbook, Volume I, General Factors*, EPA 600/P-95-002Fa, August, 1997.
[128] Argonne National Laboratory, *User's Manual for RESRAD Version 6*, July, 2001.

17.3.4 - Industrial Worker Scenario (Unrestricted Area, Controls Fail)

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	**Code**	**Unit**		**Distribution**	**Range & Fit**	
Receptor Exposure Factors						
Exposure Frequency (Total)	EF	Days per year	240	EF and ET are not input parameters used by RESRAD. They are presented here to disclose the calculation used to arrive at the parameters RESRAD uses to account for exposure frequency, FIND & FOTD		Assumes number of days per year of time working specifically at the SMC site
Exposure Time	ET	hours per day	8			Conservatively assumes that each day eight (8) hours long.
Indoor Time Fraction	FIND	Unitless, 0 to 1	0.15	Point estimate		The fraction of a total year (8,760hr) that is spent indoors on site. Assumes that 69% of the exposure occur indoors. NUREG 6697
Outdoor Time Fraction	FOTD	Unitless, 0 to 1	0.07	Triangular	Range: 0 to 0.21	The fraction of a total year (8760hr) that is spent outdoors on Site. Equals 595 hrs outdoors on Site divided by 8760 hours. The probabilistic distribution ranges to twice the CT value (1,920 hrs per year spent on the site).
Inhalation Rate	INHALR	m^3/yr	8400	Triangular	Range: 4380 to 13100	RESRAD Default. Inhalation rate based on geometric mean rate for short term exposure to adult males.[129]
Mass Loading for Inhalation	MLINH	g/m3	0.00003	Continuous Linear	0.000000 - 0.0000 0.000008 - 0.0151 0.000016 - 0.1365 0.000030 - 0.8119 0.000040 - 0.9495 0.000060 - 0.9937 0.000076 - 0.9983 0.000100 - 1.0000	RESRAD Default. Mass loading in air describes the airborne dust loading conditions on the site.[130]

129 U.S. Environmental Protection Agency, *Exposure Factors Handbook, Volume I, General Factors*, EPA 600/P-95-002Fa, August, 1997.
130 Argonne National Laboratory, *User's Manual for RESRAD Version 6*, July, 2001.

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	Code	Unit		Distribution	Range & Fit	
Soil Ingestion Rate	SOIL	g/y	18.3	Triangular	Range: 0 to 36.5	The industrial worker may ingest soil as a result of incidental contact with the soil. RESRAD default for adults engaged in non contact intensive activities.
Cover Depth (thickness)	COVER0	m	0	Point estimate		The residual activity is present in the top 15 cm of the soil.
Area of Contaminated Zone	AREA	m^2	244,000	Loguniform	Range: 244,000 m^2 to 295,000 m^2	The area of the unrestricted area is represented by the area of the plant; the area of the Storage Yard is subtracted.
Thickness of the contaminated zone	THICK0	m	0.15m	Triangular	Min 0.1m Max 0.3 m	The residual activity is present in the top 15 cm of the soil.
Irrigation	RI	m/yr	0.2m	Point Estimate		RESRAD Default

17.3.5 - Suburban Resident Scenario (Unrestricted Area, Controls Fail)

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	Code	Unit		Distribution	Range & Fit	
Receptor Exposure Factors						
Exposure Frequency (Total)	EF	Days per year	240	EF and ET are not input parameters used by RESRAD. They are presented here to disclose the calculation used to arrive at the parameters RESRAD uses to account for exposure frequency, FIND & FOTD		Assumes number of days per year of time working specifically at the SMC site
Exposure Time	ET	hours per day	8			Conservatively assumes that each day eight (8) hours long.
Indoor Time Fraction	FIND	Unitless, 0 to 1	0.15	Point estimate		The fraction of a total year (8,760hr) that is spent indoors on site. Assumes that 69% of the exposure occur indoors. NUREG 6697

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	Code	Unit		Distribution	Range & Fit	
Outdoor Time Fraction	FOTD	Unitless, 0 to 1	0.07	Triangular	Range: 0 to 0.14	The fraction of a total year (8760hr) that is spent outdoors on Site. Equals 595 hrs outdoors on Site divided by 8760 hours. The probabilistic distribution ranges to twice the CT value (1,190 hrs per year spent on the site).
Inhalation Rate	INHALR	m^3/yr	8400	Triangular	Range: 4380 to 13100	RESRAD Default. Inhalation rate based on geometric mean rate for short term exposure to adult males.[131]
Mass Loading for Inhalation	MLINH	g/m3	0.00003	Continuous Linear	0.000000 - 0.0000 0.000008 - 0.0151 0.000016 - 0.1365 0.000030 - 0.8119 0.000040 - 0.9495 0.000060 - 0.9937 0.000076 - 0.9983 0.000100 - 1.0000	RESRAD Default. Mass loading in air describes the airborne dust loading conditions on the site.[132]
Soil Ingestion Rate	SOIL	g/y	18.3	Triangular	Range: 0 to 36.5	The industrial worker may ingest soil as a result of incidental contact with the soil. RESRAD default for adults engaged in non contact intensive activities.
Cover Depth (thickness)	COVER0	m	0	Point estimate		The residual activity is present in the top 15 cm of the soil.
Area of Contaminated Zone	AREA	m^2	244,000	Loguniform	Range: 244,000 m^2 to 295,000 m^2	The area of the unrestricted area is represented by the area of the plant; the area of the Storage Yard is subtracted.
Thickness of the contaminated zone	THICK0	m	0.15m	Triangular	Min 0.1m Max 0.3 m	The residual activity is present in the top 15 cm of the soil.
Irrigation	RI	m/yr	0.2m	Point Estimate		RESRAD Default

[131] U.S. Environmental Protection Agency, *Exposure Factors Handbook, Volume I, General Factors*, EPA 600/P-95-002Fa, August, 1997.
[132] Argonne National Laboratory, *User's Manual for RESRAD Version 6*, July, 2001.

17.3.6 - Maintenance Worker Scenario (Restricted Area, Controls in Place)

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	Code	Unit		Distribution	Range & Fit	
Receptor Exposure Factors						
Exposure Frequency (Total)	EF	Days per year	8	EF and ET are not input parameters used by RESRAD. They are presented here to disclose the calculation used to arrive at the parameters RESRAD uses to account for exposure frequency, FIND & FOTD		Assumes two (2) days per quarter that the maintenance worker inspects the cover.
Exposure Time	ET	hours per day	8			Conservatively assumes that each inspection day extends for 8 hours.
Indoor Time Fraction	FIND	Unitless, 0 to 1	0	Point estimate		The fraction of a total year (8,760hr) that is spent indoors on site. Assumes that all exposures occur outdoors. There are no habitable structures on the site.
Outdoor Time Fraction	FOTD	Unitless, 0 to 1	0.007	Triangular	Range: 0 to 0.015	The fraction of a total year (8760hr) that is spent outdoors on Site. Equals 64 hrs outdoors on Site divided by 8760 hours. The probabilistic distribution ranges to twice the CT value (128 hrs per year).
Inhalation Rate	INHALR	m^3/yr	8400	Triangular	Range: 4380 to 13,100	RESRAD Default. Inhalation rate based on geometric mean rate for short term exposure to adult males.[133]
Mass Loading for Inhalation	MLINH	g/m^3	0.00003	Continuous Linear	0.000000 - 0.0000 0.000008 - 0.0151 0.000016 - 0.1365 0.000030 - 0.8119 0.000040 - 0.9495 0.000060 - 0.9937 0.000076 - 0.9983 0.000100 - 1.0000	RESRAD Default. Mass loading in air describes the airborne dust loading conditions on the site.[134]

[133] U.S. Environmental Protection Agency, *Exposure Factors Handbook, Volume I, General Factors*, EPA 600/P-95-002Fa, August, 1997.
[134] Yu, C, Zielen, A.J, et al, *User's Manual for RESRAD Version 6*, ANL/EAD-4, Argonne National Laboratory, Argonne, Illinois, July, 2001.

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	Code	Unit		Distribution	Range & Fit	
Soil Ingestion Rate	SOIL	g/y	18.3	Triangular	Range: 0 to 36.5	RESRAD Default. USEPA default value for adults engaged in non-contact intensive activities (50 mg/day).[135] (Yu 2001, EPA 1997).
Site General and Weather Related Parameters						
Evapotranspiration Coefficient	EVAPTR	Unitless, 0 to 1	0.625	Uniform	Range: 0.3 to 0.9	RESRAD Default. Typical values in humid climates east of the Mississippi River are approximately 0.7.[136]
Average Annual Wind Speed	WIND	m/sec	4.25	Bounded Lognormal-N	μNormal: 1.445 σNormal: 0.2419 Min: 1.4 Max: 13.0	RESRAD Default. The thirty year (1961-1990) site-specific annual average value (4.3 m/s) is nearly equal to the RESRAD default value.[137]
Precipitation Rate	PRECIP	m/year	1.05	Point Estimate		Annual average in area. Equals 41 inches per year.[138]
Irrigation Rate	RI	m/year	0	Point Estimate		No irrigation is considered in the future uses of the site.
Runoff Coefficient	RUNOFF	Unitless, 0 to 1	0.45	Uniform	Range: 0.1 to 0.8	The fraction of total annual precipitation that sheds off the surface and drains to Site watershed drainage without percolating through the soil. Typical value is approximately 0.3 to 0.5. RESRAD default

[135] Argonne National Laboratory, *User's Manual for RESRAD Version 6*, July, 2001.
[136] Argonne National Laboratory, *User's Manual for RESRAD Version 6*, July, 2001.
[137] National Climate Data Center, *Local Climatological Data, Annual Summary with Comparative Data for Philadelphia, Pennsylvania*, 2000.
[138] National Climate Data Center.

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	**Code**	**Unit**		**Distribution**	**Range & Fit**	
Watershed Area for Nearby Stream or Pond	WAREA	m^2	273,000	Point Estimate		Assumed to be 67 acres. The watershed area is used to calculate dilution factors for contaminant concentrations in surface water bodies in the vicinity of the site.
Depth of Soil Mixing Layer	DM	m	0.15	Triangular	Range: 0 to 0.6	RESRAD Default.[139]
Calculation Times	T(n)	Yrs.	1 10 100 300 500 700 900 1000	NA		Evaluation at these time segments allows for consideration of the potential for conditions at the Site to evolve from the initial conditions specified (e.g., soil erosion impacts the cover thickness) and projects the changing Site conditions to the required 1000-year outlook.[140,141]

17.3.7 - Common Parameters, Subsurface Soil (Restricted Area , Controls in Place)

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	**Code**	**Unit**		**Distribution**	**Range & Fit**	
Geotechnical Parameters-Cover Layer (Engineered Clay Cover)						
Cover Depth (thickness)	COVER0	m	1	Triangular	Range: 0.5 to 1.2	The engineered barrier will be installed over the slag in the Storage Yard with a thickness of 1.0 meters.
Cover Density	DENSCV	g/cm^3	1.9	Truncated Normal	μNormal 1.9 σNormal: 0.23 Quantile, min;0.05 Quantile,max:0.95	Measured density for clay-bearing materials present at the site
Cover Erosion Rate	VCV	m/yr	0			The engineered barrier is maintained during the institutional controls. It is assumed that no erosion occurs.

[139] Argonne National Laboratory, *User's Manual for RESRAD Version 6*, July, 2001.
[140] U.S. Nuclear Regulatory Commission, *Radiological Criteria for License Termination*, Volume 62, Federal Register, page 39058, July 21, 1997.
[141] U.S. Nuclear Regulatory Commission, *NMSS Decommissioning Standard Review Plan*, NUREG-1727, September, 2000.

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	**Code**	**Unit**		**Distribution**	**Range & Fit**	
Depth of Roots	DROOT	m	0.15	Lognormal-N	μNormal: -1.9 σNormal: 0.6	The engineered cover is composed of dense clay material that is designed to shed water. It does not readily support a typical plant root zone. To further resist erosion, a thin (6 inch) layer of soil was placed over the cover and seeded with native grasses. The root depth is normally limited to the 0.15m (6in) thickness of the seeded soil. The fit of the lognormal-N distribution allows for root depths of up to approximately 1 meter.
Geotechnical Parameters-Subsurface Soil Contaminated Zone						
Area of Contaminated Zone	AREA	m^2	18,228	Loguniform	Range: 14,580 to 28,767	The footprint of the Storage Yard is 18,228 m^2. The area is assumed to be ±20%; the maximum area is defined by the area of the entire cover.
Thickness of Contaminated Zone	THICK0	m	2.8	Triangular	Min 0.5 Max 3.0	The Storage Yard was measured during the Remedial Investigation.
Contaminated Zone Density	DENSCZ	g/cm^3	2.8	Triangular	Min 1.6 Max 3.0	The density of the slag and baghouse dust was measured during the Remedial Investigation.
Contaminated Zone Erosion Rate	VCZ	m/yr	4.6×10^{-5}	Triangular	Min 8×10^{-6} Max 3×10^{-4}	The erosion of the slag was assumed to be 10x less than that of the cover. The boulders located in the Storage Yard are not likely to erode over the 1,000 year period of time.
Contaminated Zone Total Porosity	TPCZ	Unitless 0 to 1	0.4	Point Estimate		Site specific parameter measured during the Remedial Investigation[142]

[142] TRC Environmental Consultants, Inc., *Remedial Investigation Technical Report*, Project Number 7650-N51, Windsor, Connecticut, April, 1992.

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	Code	Unit		Distribution	Range & Fit	
Contaminated Zone Field Capacity	FCCZ	Unitless, 0 to 1	0.2	Point Estimate		Site specific parameter measured during the Remedial Investigation
Contaminated Zone Hydraulic Conductivity	HCCZ	m/yr	2,000	Bounded Lognormal-N	μNormal : 7.6 σNormal : 0.75 Min: 200 max: 20000	The central tendency value, 2000 m/yr (6.4E-3 cm/sec), corresponds to the measured hydraulic conductivity in sandy soils found at the site. The value is assumed to range over two orders of magnitude from 200 to 20,000 m/yr.[143]
Contaminated Zone B-Parameter	BCZ	Unitless	2.88	Bounded Lognormal-N	μNormal: 1.06 σNormal 0.66 min: 0.5 Max: 30	RESRAD Default
Kd (Thorium)	DCACT(n)	cm³/g	52,010	Triangular	Min 2,900 Max 129,000	The slag was studied to define the site specific leaching properties.[144]
Kd (Uranium)	DCACT(n)	cm³/g	70,355	Triangular	Min 50,000 Max 293,000	The slag was studied to define the site specific leaching properties.
Kd (Radium)	DCACT(n)	cm³/g	53	Triangular	Min 35 Max 77	The slag was studied to define the site specific leaching properties.
Kd (Lead)	DCACT (n)	cm3/g	100	Point Estimate		RESRAD Default
Geotechnical Parameters- Unsaturated Layer						
Thickness Unsaturated Layer	H1	m	2.5	Triangular	Min 2.5 Max 4.6	The unsaturated layer was measured during the Remedial Investigation.[145]
Density, Unsaturated Layer	DENSUZ	g/cm3	1.65	Truncated Normal	μNormal: 1.65 σNormal: 0.23 Quantile, min: 0.05 Quantile,max: 0.95	The unsaturated zone is the layer beneath the Storage Yard. The density of native sand materials present at the site.

[143] TRC Environmental Consultants, Inc., *Remedial Investigation Technical Report*, Project Number 7650-N51, Windsor, Connecticut, April, 1992.
[144] Outreach Laboratory, Report Number 20050135, March 25, 2005.
[145] TRC Environmental Consultants, Inc., *Remedial Investigation Technical Report*, Project Number 7650-N51, Windsor, Connecticut, April, 1992.

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	Code	Unit		Distribution	Range & Fit	
Total Porosity Unsaturated Layer	TPUZ	Unitless 0 to 1	0.4	Point Estimate		Site specific parameter measured during the Remedial Investigation
Effective Porosity of Unsaturated Layer	EPUZ	Unitless, 0 to 1	0.2	Point Estimate		Site specific parameter measured during the Remedial Investigation
Field Capacity Unsaturated Layer	FCUZ	Unitless, 0 to 1	0.2	Point Estimate		RESRAD Default
Hydraulic Conductivity Unsaturated Layer	HCUZ	m/yr	0.017	Triangular	Min 0.001 Max 1.7	The central tendency value, 0.017 m/yr, corresponds to the measured hydraulic conductivity in sandy soils found at the site. The value was found to range from 0.001 m/yr to 1.7 m/yr.[146]
Unsaturated Layer 1, B-Parameter	BUZ(1)	Unitless	5.3	Point Estimate		RESRAD Default
Kd (Thorium)	DCACTU(n)	cm^3/g	52,010	Triangular	Min 2,900 Max 129,000	The slag was studied to define the site specific leaching properties.[147]
Kd (Uranium)	DCACTU(n)	cm^3/g	70,355	Triangular	Min 50,000 Max 293,000	The slag was studied to define the site specific leaching properties.
Kd (Radium)	DCACTU(n)	cm^3/g	53	Triangular	Min 35 Max 77	The slag was studied to define the site specific leaching properties.
Kd (Lead)	DCACTU(n)	cm3/g	100	Point Estimate		RESRAD Default
Geotechnical Parameters-Saturated Zone						
Density, Saturated Zone	DENSAQ	g/cm^3	1.52	Truncated Normal	μNormal: 1.52 σNormal: 0.23 Quantile,min: 0.001 Quantile,max: 0.999	RESRAD Default
Total Porosity Saturated Zone	TPSZ	Unitless,0 to 1	0.4	Point Estimate		Site specific parameter measured during the Remedial Investigation
Effective Porosity, Saturated Zone	EPSZ	Unitless, 0 to 1	0.2	Point Estimate		RESRAD Default

[146] TRC Environmental Consultants, Inc., *Remedial Investigation Technical Report*, Project Number 7650-N51, Windsor, Connecticut, April, 1992.
[147] Outreach Laboratory, Report Number 20050135, March 25, 2005.

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	**Code**	**Unit**		**Distribution**	**Range & Fit**	
Field Capacity, Saturated Zone	FCSZ	Unitless, 0 to 1	0.2	Point Estimate		RESRAD Default
Hydraulic Conductivity, Saturated Zone	HCSZ	m/yr	16,000	Bounded Lognormal-N	μNormal: 2.3 σNormal: 2.11 min: 0.1 max: 20,000	Site specific parameter measured during the Remedial Investigation
Hydraulic Gradient	HGWT	Unitless	0.006	Bounded Lognormal-N	μNormal: -5.11 σNormal: 1.77 min: 0 .00007 max: 0.5	RESRAD Default
Saturated Zone B-Parameter	BSZ	Unitless	2.88	Bounded Lognormal-N	μNormal: 1.06 σNormal: 0.66 Min: 0.5 Max: 30	RESRAD Default
Source Term Factors						
Dose Conversion Factors	DCFX(n)	mrem/pCi	All DCFs used are RESRAD defaults			RESRAD defaults from FGR#11 and FGR#12 and are derived using ICRP 30 dosimetry model.[148,149] Short-lived (<180 days) radioactive progeny isotopes are accounted for through the use of the "parent+D" DCFs.
Source Isotopes						
Actinium-227	S!(1)	pCi/g	8	Point Estimate		Weighted average. See Table 17.7
Protactinium-231	S!(2)	pCi/g	8	Point Estimate		Weighted average. See Table 17.7
Lead-210	S1(3)	pCi/g	182	Point Estimate		Weighted average. See Table 17.7
Radium-226	S1(4)	pCi/g	182	Point Estimate		Weighted average. See Table 17.7
Radium-228	S1(5)	pCi/g	182	Point Estimate		Weighted average. See Table 17.7
Thorium-228	S1 (6)	pCi/g	182	Point Estimate		Weighted average. See Table 17.7
Thorium-230	S1(7)	pCi/g	182	Point Estimate		Weighted average. See Table 17.7

[148] U.S. Environmental Protection Agency, *Limiting Values of Radionuclide Intake and Air Concentrations and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, Federal Guidance Report Number 11, EPA 520/1-88-020, September, 1988.
[149] U.S. Environmental Protection Agency, *External Exposure to Radionuclides in Air, Water and Soil*, Federal Guidance Report Number 12, EPA 402 R-93-081, September, 1993.

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	Code	Unit		Distribution	Range & Fit	
Thorium-232	S1(8)	pCi/g	182	Point Estimate		Weighted average. See Table 17.7
Uranium-234	S1(9)	pCi/g	182	Point Estimate		Weighted average. See Table 17.7
Uranium-235	S1(10)	pCi/g	8	Point Estimate		Weighted average. See Table 17.7
Uranium-238	S1(11)	pCi/g	182	Point Estimate		Weighted average. See Table 17.7

17.3.8 - Industrial Worker Scenario (Restricted Area, Controls in Place)

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	Code	Unit		Distribution	Range & Fit	
Receptor Exposure Factors						
Exposure Frequency (Total)	EF	Days per year	240	EF and ET are not input parameters used by RESRAD. They are presented here to disclose the calculation used to arrive at the parameters RESRAD uses to account for exposure frequency, FIND & FOTD		Assumes number of days per year of time working specifically at the SMC site
Exposure Time	ET	hours per day	8			Conservatively assumes that each day eight (8) hours long.
Indoor Time Fraction	FIND	Unitless, 0 to 1	0.15	Point estimate		The fraction of a total year (87860hr) that is spent indoors on site. Assumes that 69% of the exposure occurs indoors on the unrestricted side of the site. NUREG 6697.
Outdoor Time Fraction	FOTD	Unitless, 0 to 1	0.07	Triangular	Range: 0 to 0.14	The fraction of a total year (8,760hr) that is spent outdoors on Site. Equals 595 hrs outdoors on Site divided by 8,760 hours. The probabilistic distribution ranges to twice the CT value (1,190 hrs per year spent outdoors on the site).
Inhalation Rate	INHALR	m^3/yr	8400	Triangular	Range: 4380 to 13100	RESRAD Default. Inhalation rate based on geometric mean rate for short term exposure to adult males.[150]

[150] U.S. Environmental Protection Agency, *Exposure Factors Handbook, Volume I, General Factors*, EPA 600/P-95-002Fa, August, 1997.

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	Code	Unit		Distribution	Range & Fit	
Mass Loading for Inhalation	MLINH	g/m3	0.00003	Continuous Linear	0.000000 - 0.0000 0.000008 - 0.0151 0.000016 - 0.1365 0.000030 - 0.8119 0.000040 - 0.9495 0.000060 - 0.9937 0.000076 - 0.9983 0.000100 - 1.0000	RESRAD Default. Mass loading in air describes the airborne dust loading conditions on the site.[151]
Cover Erosion Rate	VCV	m/yr	0			The cover is assumed to be maintained and does not erode while institutional controls are in place.
Soil Ingestion Rate	SOIL	g/y	0			The industrial worker does not enter the fenced Storage Yard. There is no direct contact with the soil inside the fence.

17.3.9 - Trespasser Scenario (Restricted Area, Controls in Place)

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	Code	Unit		Distribution	Range & Fit	
Receptor Exposure Factors						
Exposure Frequency (Total)	EF	Days per year	12	EF and ET are not input parameters used by RESRAD. They are presented here to disclose the calculation used to arrive at the parameters RESRAD uses to account for exposure frequency, FIND & FOTD		A trespasser may access ths site as often as one day per month.
Exposure Time	ET	hours per day	1			Conservatively assumes that the trespasser spends one hour on the site before they are discovered and removed by the SMC staff.
Indoor Time Fraction	FIND	Unitless, 0 to 1	0	Point estimate		The fraction of a total year (8,760hr) that is spent indoors on site. Assumes that all exposures occur outdoors. There are no habitable structures on the site.

[151] Argonne National Laboratory, *User's Manual for RESRAD Version 6*, July, 2001.

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	Code	Unit		Distribution	Range & Fit	
Outdoor Time Fraction	FOTD	Unitless, 0 to 1	0.001	Triangular	Range: 0 to 0.002	The fraction of a total year (8,760hr) that is spent outdoors on Site. Equals 12 hrs outdoors on Site divided by 8760 hours. The probabilistic distribution ranges to twice the CT value (24 hrs per year trespassing on the site).
Inhalation Rate	INHALR	m^3/yr	8400	Triangular	Range: 4380 to 13100	RESRAD Default. Inhalation rate based on geometric mean rate for short term exposure to adult males.[152]
Mass Loading for Inhalation	MLINH	g/m3	0.00003	Continuous Linear	0.000000 - 0.0000 0.000008 - 0.0151 0.000016 - 0.1365 0.000030 - 0.8119 0.000040 - 0.9495 0.000060 - 0.9937 0.000076 - 0.9983 0.000100 - 1.0000	RESRAD Default. Mass loading in air describes the airborne dust loading conditions on the site[153]
Cover Erosion Rate	VCV	m/yr	0			The cover is assumed to be maintained and does not erode while institutional controls are in place.
Soil Ingestion Rate	SOIL	g/y	18.3	Triangular	Range: 0 to 36.5	RESRAD Default. USEPA default value for adults engaged in non-contact intensive activities (50 mg/day).

17.3.10 - Recreational Hunter Scenario (Restricted Area, Controls Fail)

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	Code	Unit		Distribution	Range & Fit	
Receptor Exposure Factors						
Exposure Frequency (Total)	EF	Days per year	20	EF and ET are not input parameters used by RESRAD. They are presented here to disclose the calculation used to arrive at the parameters RESRAD uses to account for exposure frequency, FIND & FOTD		Assumes 4 weeks per year of time spent hunting specifically at the SMC site

[152] Argonne National Laboratory, *User's Manual for RESRAD Version 6*, July, 2001.
[153] U.S. Environmental Protection Agency, *Exposure Factors Handbook, Volume I, General Factors*, EPA 600/P-95-002Fa, August, 1997.

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	Code	Unit		Distribution	Range & Fit	
Exposure Time	ET	hours per day	4			Conservatively assumes that each day spent hunting on site is 4 hours long.
Indoor Time Fraction	FIND	Unitless, 0 to 1	0	Point estimate		The fraction of a total year (8,760hr) that is spent indoors on site. Assumes that all exposures occur outdoors. There are no habitable structures on the site.
Outdoor Time Fraction	FOTD	Unitless, 0 to 1	0.009	Triangular	Range: 0 to 0.018	The fraction of a total year (8760hr) that is spent outdoors on Site. Equals 80 hrs outdoors on Site divided by 8760 hours. The probabilistic distribution ranges to twice the CT value (160 hrs per year spent hunting on the site).
Inhalation Rate	INHALR	m^3/yr	8,400	Triangular	Range: 4,380 to 13,100	RESRAD Default. Inhalation rate based on geometric mean rate for short term exposure to adult males[154]
Contaminated Fraction of Meat	FMEAT	Unitless, 0 to 1	0.3	Triangular	Range: 0 to 0.5	The fraction of the annual meat diet that is obtained from game harvested from off the site. The number is conservative in that the size of the site is small relative to the grazing land required to support game habitat. The use of the triangular distribution results in a more conservative estimate than the RESRAD default for this site.[155]

[154] U.S. Environmental Protection Agency, *Exposure Factors Handbook, Volume I, General Factors*, EPA 600/P-95-002Fa, August, 1997.
[155] U.S. Environmental Protection Agency, *Exposure Factors Handbook, Food Ingestion Factors*, Volume II, EPA/600/P-95/002Fb, August, 1997.

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	**Code**	**Unit**		**Distribution**	**Range & Fit**	
Mass Loading for Inhalation	MLINH	g/m³	0.00003	Continuous Linear	0.000000 - 0.0000 0.000008 - 0.0151 0.000016 - 0.1365 0.000030 - 0.8119 0.000040 - 0.9495 0.000060 - 0.9937 0.000076 - 0.9983 0.000100 - 1.0000	RESRAD Default. Mass loading in air describes the airborne dust loading conditions on the site.[156]
Cover Erosion Rate	VCV	m/yr	4.6×10^{-4}	Continuous Logarithmic	0.0000008 - 0.00 0.00046 - 0.50 0.003 - 1.00	The erosion rate was calculated using the Revised Universal Soil Loss Equation computer program, RULE2.[157]
Soil Ingestion Rate	SOIL	g/y	18.3	Triangular	Range: 0 to 36.5	RESRAD Default. USEPA default value for adults engaged in non-contact intensive activities (50 mg/day).

17.3.11 - Cover Excavation Scenario (Restricted Area, Controls Fail)

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	**Code**	**Unit**		**Distribution**	**Range & Fit**	
Receptor Exposure Factors						
Exposure Frequency (Total)	EF	Days per year	10	EF and ET are not input parameters used by RESRAD. They are presented here to disclose the calculation used to arrive at the parameters RESRAD uses to account for exposure frequency, FIND & FOTD		Assumes 2 weeks to attempt to excavate slag from the engineered cover
Exposure Time	ET	hours per day	8			Conservatively assumes that each day spent digging is 8 hours long.
Indoor Time Fraction	FIND	Unitless, 0 to 1	0	Point estimate		The fraction of a total year (87860hr) that is spent indoors on site. Assumes that all exposures occur outdoors. There are no habitable structures on the site.
Outdoor Time Fraction	FOTD	Unitless, 0 to 1	0.009	Triangular	Range: 0 to 0.018	The fraction of a total year (8760hr) that is spent outdoors on Site. Equals 80 hrs outdoors on Site divided by 8760 hours.

[156] Argonne National Laboratory, *User's Manual for RESRAD Version 6*, July, 2001.
[157] TRC Environmental Corporation, *Estimated Soil Loss from Soil Cap*, Project Number 26770-0000, January, 2005.

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	**Code**	**Unit**		**Distribution**	**Range & Fit**	
Uranium 238 and progeny	Nuclide	µCi/cubic centimeter	0.001	Point estimate		All progeny in secular equilibrium, including Ra226
Thorium 232 and progeny	Nuclide	µCi/cubic centimeter	0.001	Point estimate		All progeny in secular equilibrium, including Ac228
Thickness	16 Infinite Slab	m	0.01	Point estimate		Assume the excavation is 1 m^2 in area and 1 m deep.
Dose Point	Air gap	m	0.92	Point estimate		Assume the intruder stays within 3 ft (0.92 m) for 64 hours
Density	Concrete	g/cm^3	2.8	Point estimate		Assume the slag has the same shielding properties as concrete

17.3.12 - Industrial Worker Scenario (Restricted Area, Controls Fail)

Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
Description	**Code**	**Unit**		**Distribution**	**Range & Fit**	
Receptor Exposure Factors						
Exposure Frequency (Total)	EF	Days per year	240	EF and ET are not input parameters used by RESRAD. They are presented here to disclose the calculation used to arrive at the parameters RESRAD uses to account for exposure frequency, FIND & FOTD		Assumes number of days per year of time working specifically at the SMC site
Exposure Time	ET	hours per day	8			Conservatively assumes that each day eight (8) hours long.
Indoor Time Fraction	FIND	Unitless, 0 to 1	0.15	Point estimate		The fraction of a total year (8,760hr) that is spent indoors at the unrestricted area. Assumes that 69% of the time is spent indoors, in the unrestricted area.

	Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
	Description	Code	Unit.		Distribution	Range & Fit	
1 2	Outdoor Time Fraction	FOTD	Unitless, 0 to 1	0.07	Triangular	Range: 0 to 0.14	The fraction of a total year (8,760hr) that is spent outdoors on the restricted area. Assumes that 31% of the time at the SMC site is spent walking on the cover and in close proximity to the engineered barrier. Equals 595 hrs outdoors on the restricted site. divided by 8,760 hours. The probabilistic distribution ranges to twice the CT value (1,190 hrs per year spent on the restricted site).
	Inhalation Rate	INHALR	m^3/yr	8400	Triangular	Range: 4380 to 13100	RESRAD Default. Inhalation rate based on geometric mean rate for short term exposure to adult males.[158]
4 5	Mass Loading for Inhalation	MLINH	g/m3	0.00003	Continuous Linear	0.000000 - 0.0000 0.000008 - 0.0151 0.000016 - 0.1365 0.000030 - 0.8119 0.000040 - 0.9495 0.000060 - 0.9937 0.000076 - 0.9983 0.000100 - 1.0000	RESRAD Default. Mass loading in air describes the airborne dust loading conditions on the site.[159]
6	Cover Erosion Rate	VCV	m/yr	$4.6x10^{-4}$	Continuous Logarithmic	0.0000008 - 0.00 0.00046 - 0.50 0.003 - 1.00	The erosion rate was calculated using the Revised Universal Soil Loss Equation computer program, RULE2.[160]

[158] U.S. Environmental Protection Agency, *Exposure Factors Handbook, Volume I, General Factors*, EPA 600/P-95-002Fa, August, 1997.
[159] Argonne National Laboratory, *User's Manual for RESRAD Version 6*, July, 2001.
[160] TRC Environmental Corporation, *Estimated Soil Loss from Soil Cap*, Project Number 26770-0000, January, 2005.

	Parameter			Central Tendency Value	Description of Parameter Distribution		Remark
	Description	Code	Unit		Distribution	Range & Fit	
1	Soil Ingestion Rate	SOIL	g/y	18.3	Triangular	Range: 0 to 36.5	RESRAD Default. The industrial worker enters the fenced Storage Yard. Ingestion of contaminated soil is incidental to walking in the restricted area. USEPA default value for adults engaged in non-contact intensive activities (50 mg/day).

Table 17.4 - RESRAD Exposure Pathways

17.4.1 - Trespasser Scenario (Unrestricted Area, Controls in Place)

Pathway	Retained	Comments
Direct Exposure	Yes	The source term found in the site soils produces penetrating gamma radiation. Exposure from direct penetrating radiation is expected to be a significant contributor to the overall potential dose. External radiation dose was modeled using Microshield; RESRAD does not accurately model a direct exposure at a distance form the source term.
Particulate Inhalation	Yes	Allowance is made for soils containing radiological constituents of the source being liberated and suspended in the breathing air of the occasional trespasser.
Radon	No	Radon is specifically excluded from consideration within the framework of the governing regulations. In addition, the source term found is not a significant producer of radon due to the relatively long half-life of the thorium isotopes found in the slag
Plant Ingestion	No	Ingestion of plant foods addresses those plant foods grown in the radioactivity or irrigated with water containing radioactivity from on Site. Since the maintenance worker does not eat edible plant parts grown on site for food consumption, this pathway is incomplete.
Drinking Water	No	Surface water on site is unfit for consumption as drinking water. No on-site sources of groundwater have been developed for drinking water.
Meat Ingestion	No	The trespasser does not consume meat from animals culled from the site.
Milk Ingestion	No	Milk ingestion pathway is incomplete because milk cows are not allowed to graze in the unrestricted area.
Aquatic Foods Ingestion	No	There are no surface water ponds on the property.
Direct Ingestion	Yes	Trespassers are assumed to spend approximately 100% of their time in the unrestricted area outdoors. They may ingest relatively small amounts of soil through incidental oral contact with their hands.

17.4.2 - Industrial Worker Scenario (Unrestricted Area, Controls Fail)

Pathway	Retained	Comments
Direct Exposure	Yes	The source term found in the site soils produces penetrating gamma radiation. Exposure from direct penetrating radiation is expected to be a significant contributor to the overall potential dose. External radiation dose was modeled using Microshield; RESRAD does not accurately model a direct exposure at a distance form the source term.
Particulate Inhalation	Yes	Allowance is made for soils containing radiological constituents of the source being liberated and suspended in the breathing air of the industrial worker.
Radon	No	Radon is specifically excluded from consideration within the framework of the governing regulations. In addition, the source term found is not a significant producer of radon due to the relatively long half-life of the thorium isotopes found in the slag
Plant Ingestion	No	Ingestion of plant foods addresses those plant foods grown in the radioactivity or irrigated with water containing radioactivity from on Site. Since the industrial worker does not eat edible plant parts grown on site for food consumption, this pathway is incomplete.
Drinking Water	No	Surface water on site is unfit for consumption as drinking water. No on-site sources of groundwater have been developed for drinking water.
Meat Ingestion	No	Site workers do not consume meat from animals culled from the site.

1	Milk Ingestion	No	Milk ingestion pathway is incomplete because milk cows are not allowed to graze in the unrestricted area.
2	Aquatic Foods Ingestion	No	There are no surface water ponds on the property.
3	Direct Ingestion	Yes	Industrial workers are assumed to spend approximately 30% of their time outdoors. They may ingest relatively small amounts of soil through incidental oral contact with their hands.

4 17.4.3 - Suburban Resident Scenario(Unrestricted Area, Controls Fail)

	Pathway	Retained	Comments
5	Pathway	Retained	Comments
6	Direct Exposure	Yes	The source term found in the site soils produces penetrating gamma radiation. Exposure from direct penetrating radiation is expected to be a significant contributor to the overall potential dose. External radiation dose was modeled using Microshield; RESRAD does not accurately model a direct exposure at a distance form the source term.
7	Particulate Inhalation	Yes	Allowance is made for soils containing radiological constituents of the source being liberated and suspended in the breathing air of the suburban resident.
8	Radon	No	Radon is specifically excluded from consideration within the framework of the governing regulations. In addition, the source term found is not a significant producer of radon due to the relatively long half-life of the thorium isotopes found in the slag
9	Plant Ingestion	Yes	Ingestion of plant foods addresses those plant foods grown in the radioactivity or irrigated with water containing radioactivity from on Site.
10	Drinking Water	No	Surface water on site is unfit for consumption as drinking water. No on-site sources of groundwater have been developed for drinking water.
11	Meat Ingestion	Yes	The suburban resident may raise livestock and use water containing radioactivity from on Site to water the animals.
12	Milk Ingestion	Yes	Milk cows may be allowed to graze in the unrestricted area.
13	Aquatic Foods Ingestion	No	There are no surface water ponds on the property.
14	Direct Ingestion	Yes	Suburban residents are assumed to spend approximately 30% of their time outdoors. They may ingest relatively small amounts of soil through incidental oral contact with their hands.

15 17.4.4 - Maintenance Worker Scenario (Restricted Area, Controls in Place)

	Pathway	Retained	Comments
16	Pathway	Retained	Comments
17	Direct Exposure	Yes	The source term found in the site soils produces penetrating gamma radiation. Exposure from direct penetrating radiation is expected to be a significant contributor to the overall potential dose.
18	Particulate Inhalation	Yes	Allowance is made for soils containing radiological constituents of the source being liberated and suspended in the breathing air of the maintenance worker.
19	Radon	No	Radon is specifically excluded from consideration within the framework of the governing regulations. In addition, the source term found is not a significant producer of radon due to the relatively long half-life of the thorium isotopes found in the slag
20	Plant Ingestion	No	Ingestion of plant foods addresses those plant foods grown in the radioactivity or irrigated with water containing radioactivity from on Site. Since the maintenance worker does not eat edible plant parts grown on site for food consumption, this pathway is incomplete.
21	Drinking Water	No	Surface water on site is unfit for consumption as drinking water. No on-site sources of groundwater have been developed for drinking water.
22	Meat Ingestion	No	Site workers do not consume meat from animals culled from the site.

Milk Ingestion	No	Milk ingestion pathway is incomplete because milk cows are not allowed to graze on the storage yard.
Aquatic Foods Ingestion	No	There are no surface water ponds on the property.
Direct Ingestion	Yes	Maintenance workers may ingest relatively small amounts of soil through incidental oral contact with their hands.

17.4.5 - Industrial Worker Scenario (Restricted Area, Controls in Place)

Pathway	Retained	Comments
Direct Exposure	Yes	The source term found in the Site soils produces penetrating gamma radiation. Exposure from direct penetrating radiation is expected to be a significant contributor to the overall potential dose. External radiation dose was modeled using Microshield; RESRAD does not accurately model a direct exposure at a distance form the source term.
Particulate Inhalation	Yes	Allowance is made for soils containing radiological constituents of the source being liberated and suspended in the breathing air of the industrial worker.
Radon	No	Radon is specifically excluded from consideration within the framework of the governing regulations. In addition, the source term found is not a significant producer of radon due to the relatively long half-life of the thorium isotopes found in the slag
Plant Ingestion	No	The industrial workers does not eat plant parts grown on site for food consumption; this pathway is incomplete.
Drinking Water	No	Surface water on site is unfit for consumption as drinking water. No on-site sources of groundwater have been developed for drinking water.
Meat Ingestion	No	Industrial workers do not consume meat from animals culled from the site.
Milk Ingestion	No	Milk ingestion pathway is incomplete. Milk cows do not graze on the site.
Aquatic Foods Ingestion	No	No surface bodies of water are found on the site.
Direct Ingestion	No	Workers at the site do not enter the fenced Storage Yard and there is no direct contact with the soil.

17.4.6 - Trespasser Scenario (Restricted Area, Controls in Place)

Pathway	Retained	Comments
Direct Exposure	Yes	The source term found in the Site soils produces penetrating gamma radiation. Exposure from direct penetrating radiation is expected to be a significant contributor to the overall potential dose.
Particulate Inhalation	Yes	Allowance is made for soils containing radiological constituents of the source being liberated and suspended in the breathing air of the trespasser.
Radon	No	Radon is specifically excluded from consideration within the framework of the governing regulations. In addition, the source term found is not a significant producer of radon due to the relatively long half-life of the thorium isotopes found in the slag
Plant Ingestion	No	Ingestion of plant foods addresses those plant foods grown in the radioactivity or irrigated with water containing radioactivity from on Site. Since trespassers are not expected to glean edible plant parts grown on site for food consumption, this pathway is incomplete.
Drinking Water	No	Surface water on site is unfit for consumption as drinking water. No on-site sources of groundwater have been developed for drinking water.
Meat Ingestion	No	Trespassers are not expected to consume meat from animals culled from the site.
Milk Ingestion	No	Milk ingestion pathway is incomplete because milk cows do not graze at the site.

1	Aquatic Foods Ingestion	No	Trespassers are not expected to spend time fishing the surface water bodies surrounding the site.
2	Direct Ingestion	Yes	Trespassers on the site may ingest relatively small amounts of soil through incidental oral contact with their hands.

3 **17.4.7 - Recreational Hunter Scenario (Restricted Area, Controls Fail)**

	Pathway	Retained	Comments
4	Pathway	Retained	Comments
5	Direct Exposure	Yes	The source term found in the Site soils produces penetrating gamma radiation. Exposure from direct penetrating radiation is expected to be a significant contributor to the overall potential dose.
6	Particulate Inhalation	Yes	Allowance is made for soils containing radiological constituents of the source being liberated and suspended in the breathing air of the recreational hunter.
7	Radon	No	Radon is specifically excluded from consideration within the framework of the governing regulations. In addition, the source term found is not a significant producer of radon due to the relatively long half-life of the thorium isotopes found in the slag
8	Plant Ingestion	No	Ingestion of plant foods addresses those plant foods grown in the radioactivity or irrigated with water containing radioactivity from on Site. Since recreational hunters are not expected to glean edible plant parts grown on site for food consumption, this pathway is incomplete.
9	Drinking Water	No	Surface water on site is unfit for consumption as drinking water. No on-site sources of groundwater have been developed for drinking water.
10	Meat Ingestion	Yes	Recreational hunters are expected to consume meat from animals culled from the site.
11	Milk Ingestion	No	Milk ingestion pathway is incomplete since it is not credible to consider that recreational hunters would graze milk cows on this site.
12	Aquatic Foods Ingestion	No	Recreational hunters are not expected to spend time fishing the surface water bodies surrounding the site.
13	Direct Ingestion	Yes	Hunters on the site may ingest relatively small amounts of soil through incidental oral contact with their hands.

14 **17.4.8 - Cover Excavation Scenario (Restricted Area, Controls Fail)**

	Pathway	Retained	Comments
15	Pathway	Retained	Comments
16	Direct Exposure	Yes	The source term found in the Site soils produces penetrating gamma radiation. Exposure from direct penetrating radiation is expected to be a significant contributor to the overall potential dose. External radiation dose was modeled using Microshield; RESRAD does not accurately model a direct exposure with a limited exposure, in direct contact with the engineered cover or the excavation of the cover.
17	Particulate Inhalation	Yes	Allowance is made for soils containing radiological constituents of the source being liberated and suspended in the breathing air of the trespasser excavating the slag.
18	Radon	No	Radon is specifically excluded from consideration within the framework of the governing regulations. In addition, the source term found is not a significant producer of radon due to the relatively long half-life of the thorium isotopes found in the slag
19	Plant Ingestion	No	Ingestion of plant foods addresses those plant foods grown in the radioactivity or irrigated with water containing radioactivity from on Site. Since the trespasser is not expected to glean edible plant parts grown on site for food consumption, this pathway is incomplete.
20	Drinking Water	No	Surface water on site is unfit for consumption as drinking water. No on-site sources of groundwater have been developed for drinking water.
21	Meat Ingestion	Yes	The trespasser is not anticipated to consume meat from animals culled from the site.

Milk Ingestion	No	Milk ingestion pathway is incomplete since milk cows do not graze on this site.
Aquatic Foods Ingestion	No	The trespasser does not expected to spend time fishing the surface water bodies surrounding the site.
Direct Ingestion	Yes	The trespasser excavating the slag may ingest relatively small amounts of soil through incidental oral contact with their hands.

17.4.9 - Industrial Worker Scenario (Restricted Area, Controls Fail)

Pathway	Retained	Comments
Direct Exposure	Yes	The source term found in the Site soils produces penetrating gamma radiation. Exposure from direct penetrating radiation is expected to be a significant contributor to the overall potential dose. External radiation dose was modeled using Microshield; RESRAD does not accurately model a direct exposure at a distance form the source term.
Particulate Inhalation	Yes	Allowance is made for soils containing radiological constituents of the source being liberated and suspended in the breathing air of the industrial worker.
Radon	No	Radon is specifically excluded from consideration within the framework of the governing regulations. In addition, the source term found is not a significant producer of radon due to the relatively long half-life of the thorium isotopes found in the slag
Plant Ingestion	No	The industrial workers does not eat plant parts grown on site for food consumption; this pathway is incomplete.
Drinking Water	No	Surface water on site is unfit for consumption as drinking water. No on-site sources of groundwater have been developed for drinking water.
Meat Ingestion	No	Industrial workers do not consume meat from animals culled from the site.
Milk Ingestion	No	Milk ingestion pathway is incomplete. Milk cows do not graze on the site.
Aquatic Foods Ingestion	No	No surface bodies of water are found on the site.
Direct Ingestion	Yes	Workers at the site may enter the fenced restricted area and have direct contact with the engineered barrier.

Table 17.4.10 - Industrial Worker (Unrestricted Area, Controls in Place, DCGL Basis)

Pathway	Retained	Comments
Direct Exposure	Yes	The source term found in the site soils produces penetrating gamma radiation. Exposure from direct penetrating radiation is expected to be a significant contributor to the overall potential dose. External radiation dose was modeled using Microshield; RESRAD does not accurately model a direct exposure at a distance form the source term.
Particulate Inhalation	Yes	Allowance is made for soils containing radiological constituents of the source being liberated and suspended in the breathing air of the industrial worker.
Radon	No	Radon is specifically excluded from consideration within the framework of the governing regulations. In addition, the source term found is not a significant producer of radon due to the relatively long half-life of the thorium isotopes found in the slag
Plant Ingestion	No	Ingestion of plant foods addresses those plant foods grown in the radioactivity or irrigated with water containing radioactivity from on Site. Since the maintenance worker does not eat edible plant parts grown on site for food consumption, this pathway is incomplete.
Drinking Water	No	Surface water on site is unfit for consumption as drinking water. No on-site sources of groundwater have been developed for drinking water.
Meat Ingestion	No	Site workers do not consume meat from animals culled from the site.

1	Milk Ingestion	No	Milk ingestion pathway is incomplete because milk cows are not allowed to graze on the storage yard.
2	Aquatic Foods Ingestion	No	There are no surface water ponds on the property.
3	Direct Ingestion	Yes	Industrial workers are assumed to spend approximately 30% of their time outdoors. They may ingest relatively small amounts of soil through incidental oral contact with their hands.

Table 17.5 Partition Coefficients
(K_d) (cm^3/gram)

Element	Contaminated Zone	Unsaturated Zone	Saturated Zone
Actinium[161]	2400	2400	450
Protactinium[162]	2700	2700	550
Lead[163]	100	100	100
Radium[164]	53	53	53
Thorium[165]	52,010	52,010	52,010
Uranium[166]	70,355	70,355	70,355

[161] Shappard and Thibault, Default Soil Solid/Liquid Partition Coefficients, K_dS, for Four Major Soil types: A compendium, Health Physics Journal, Volume 59, Number 4, October 1990.
[162] Shappard and Thibault, Default Soil Solid/Liquid Partition Coefficients, K_dS, for Four Major Soil types: A compendium, Health Physics Journal, Volume 59, Number 4, October 1990.
[163] RESRAD default
[164] Site specific parameter determined by laboratory analysis. Outreach Laboratory, Report Number 20050135, March 25, 2005.
[165] Site specific parameter determined by laboratory analysis. Outreach Laboratory, Report Number 20050135, March 25, 2005.
[166] Site specific parameter determined by laboratory analysis. Outreach Laboratory, Report Number 20050135, March 25, 2005.

Table 17.6 - DCGLs for Soil

Radionuclide	Medium	DCGL	Units
U-238 plus progeny	Soil volumes	9.8	pCi/g
Th-232 plus progeny	Soil volumes	7	pCi/g

The industrial worker is exposed to the source term from the Storage Yard with an engineered barrier as well as the residual radioactivity in the unrestricted area. For the purposes of this analysis, the contribution from the storage yard to the industrial worker is assumed to be less than 1% of the total effective dose; the dose resulting from the residual radioactivity is assumed to be 99% of the total effective dose.

Table 17.7 - Source Term

Average Radionuclide Concentration[167]

Material Type	Concentration (pCi/g)		
	Thorium series	Uranium series	Actinium series
Slag[168]	359	359	16
Baghouse dust[169]	10	10	1
Contaminated soil[170]	18	18	1

Derived Source Term

Isotope	Concentration[171] (pCi/gram)
Actinium-227	8.00
Protactinium-231	8.00
Lead -210	182.00
Radium-226	182.00
Radium 228	182.00
Thorium-228	182.00
Thorium-230	182.00
Thorium-232	182.00
Uranium-234	182.00
Uranium-235	8.00
Uranium-238	182.00

[167] IT Corporation, "Assessment of Environmental Radiological Conditions at the Newfield Facility", Report No. IT/NS-92-106, April 2, 1992.
[168] Berger, C. D., Integrated Environmental Management, Inc., written communication to C. S. Eves, Shieldalloy Metallurgical Corporation, October 6, 1994.
[169] Shieldalloy Metallurgical Corporation, "Applicant's Environmental Report for the Newfield, New Jersey Facility", October 1, 1992
[170] Integrated Environmental Management, Inc. Report No. 94005/G-17172, "Final Status Survey of Haul Road", June 22, 1999.
[171] The isotopic concentration was calculated using the average concentration of radioactivity in the slag, baghouse dust and contaminated soil (see Table 17.7). The mass for the three components was estimated using the inventory records from SMC. The derived concentration of radioactivity in the Storage Yard was calculated using a weighted average and assuming that the decay progeny are in secular equilibrium.

Table 17.8 - Dose Modeling Results

17.8.1 - Occasional Trespasser (Unrestricted Area, Controls in Place)

Statistic	Projected Annual Dose (millirem/year)
Annual Dose Limit	25.0
Peak Mean Annual Dose	0.2 ± 0.01
50th Percentile	0.2 ± 0.01
90th Percentile	0.3 ± 0.01
95th Percentile	0.3 ± 0.01
Maximum Annual Radiation Dose	0.4
Deterministic Estimate, Peak Annual Dose	0.2 @ 0 years
Summary reports showing source term, radiation dose, and geophysical parameters are provided in Appendix 19.5 (Newfield 3005007.rad)	

17.8.2 - Suburban Resident (Unrestricted Area, Controls Fail)

Statistic	Projected Annual Dose (millirem/year)
Annual Dose Limit	100
Peak Mean Annual Dose	<1
50th Percentile	<1
90th Percentile	<1
95th Percentile	<1
Maximum Annual Radiation Dose	<1
Deterministic Estimate, Peak Annual Dose	<1 @ 0 years
The suburban resident is exposed to gamma radiation stemming from the engineered barrier in the Storage Yard. The calculated exposure rate is less than 1×10^{-5} mR/hr or less than 1 mrem/year.	

17.8.3 - Maintenance Worker (Restricted Area, Controls in Place)

Statistic	Projected Annual Dose (millirem/year)
Annual Dose Limit	25.00
Peak Mean Annual Dose	$6\times10^{-4} \pm 1\times10^{-4}$
50th Percentile	$4\times10^{-5} \pm 6\times10^{-6}$
90th Percentile	$1\times10^{-3} \pm 2\times10^{-4}$
95th Percentile	$3\times10^{-3} \pm 4\times10^{-4}$

Maximum Annual Radiation Dose	0.02
Deterministic Estimate, Peak Annual Dose	1×10^{-5} @ 0 years
Summary reports showing source term, radiation dose, and geophysical parameters are provided in Appendix 19.5.	

17.8.4 - Industrial Worker (Restricted Area, Controls in Place)

Statistic	Projected Annual Dose (millirem/year)
Annual Dose Limit	25.0
Peak Mean Annual Dose	<0.6
50th Percentile	<0.6
90th Percentile	<0.6
95th Percentile	<0.6
Maximum Annual Radiation Dose	<1
Deterministic Estimate, Peak Annual Dose	0.6 @ 1,000 years
Summary reports showing source term, radiation dose, and geophysical parameters are provided in Appendix 19.5. (Newfield 3004005.rad)	

The industrial worker is exposed to the source term from the Storage Yard with an engineered barrier as well as the residual radioactivity in the unrestricted area. The direct radiation exposure from the covered Storage Yard contributed 0.6 mrem per year (0.001 mR/hr for 595 hours) and the exposure from the residual radioactivity established by the DCGLs was less than 1×10^{-4} mrem per year.

17.8.5 - Trespasser (Restricted Area, Controls in Place)

Statistic	Projected Annual Dose (millirem/year)
Annual Dose Limit	25.00
Peak Mean Annual Dose	$6 \times 10^{-4} \pm 2 \times 10^{-4}$
50th Percentile	$4 \times 10^{-5} \pm 7 \times 10^{-6}$
90th Percentile	$1 \times 10^{-3} \pm 2 \times 10^{-4}$
95th Percentile	$3 \times 10^{-3} \pm 4 \times 10^{-4}$
Maximum Annual Radiation Dose	0.02
Deterministic Estimate, Peak Annual Dose	1×10^{-6} @ 0 years
Summary reports showing source term, radiation dose, and geophysical parameters are provided in Appendix 19.5.	

17.8.6 - Recreational Hunter (Restricted Area, Controls Fail)

Statistic	Projected Annual Dose (millirem/year)
Annual Dose Limit	100.0
Peak Mean Annual Dose	13.6 ± 0.8

Statistic	Projected Annual Dose (millirem/year)
50th Percentile	0.4 ± 0.01
90th Percentile	47 ± 3
95th Percentile	54 ± 1
Maximum Annual Radiation Dose	78.6
Deterministic Estimate, Peak Annual Dose	0.3 @ 558 years
Summary reports showing source term, radiation dose, and geophysical parameters are provided in Appendix 19.5. (Newfield 3004008.rad)	

17.8.7 - Industrial Worker (Restricted Area, Controls Fail)

Statistic	Projected Annual Dose (millirem/year)
Annual Dose Limit	25.0
Peak Mean Annual Dose	0.7 ± 0.07
50th Percentile	0 ± 0
90th Percentile	2.5 ± 0.1
95th Percentile	3.4 ± 0.2
Maximum Annual Radiation Dose	6.7
Deterministic Estimate, Peak Annual Dose	0.0 @ 1,000 years
Summary reports showing source term, radiation dose, and geophysical parameters are provided in Appendix 19.5. (Newfield 30040004.rad)	

17.8.8 - Excavator (Restricted Area, Controls Fail)

Statistic	Projected Annual Dose (millirem/year)
Annual Dose Limit	100.0
Peak Mean Annual Dose	8.3
Deterministic Estimate, Peak Annual Dose	8.3
Microshield summary report showing source term, radiation dose, and geophysical parameters are provided in Appendix 19.5	

17.8.9 - Suburban Resident (Restricted Area, Controls Fail, Cover Excavated)

Statistic	Projected Annual Dose (millirem/year)
Annual Dose Limit	100
Peak Mean Annual Dose	<17
Deterministic Estimate, Peak Annual Dose	<17 @ 0 years

The suburban resident is exposed to gamma radiation stemming from the excavated area of the engineered barrier or 0.002 mR/hr or less than 17 mrem/year. See Microshield report

Table 17.9 - Comparison of Risks and Costs

Population	Risk Type	Risks and Costs					
		LC Alternative		LTC Alternative		LT Alternative	
		Risk	Cost ($)	Risk	Cost ($)	Risk	Cost ($)
Workers	Cancer Fatality	3.0e-04	$130,800	8.6e-06	$400	2.6e-05	$1,000
	Remediation Activities Fatality	0.0e+00	$0	2.6e-04	$780	7.1e-04	$2,130
General Population	Cancer Fatality	3.5e-03	$50,866,667	8.8e-04	$12,853,733	9.0e-04	$22,901,000
	Remediation Activities Fatality	0.0e+00	$0	0.0e+00	$0	0.0e+00	$0
	Transportation Fatality	0.0e+00	$0	4.6e-04	$1,380	7.6e-01	$2,280,000
Implementation cost ($)		–	$2,080,000	–	$5,172,507	–	$58,080,851
Totals		3.8e-03	$53,077,467	1.6e-03	$18,028,800	7.6e-01	$83,264,981

Table 17.10 - Acceptable Surface Contamination Levels

Radionuclide	Contamination Levels (dpm/100cm^2)[a,b,e]		
	Average	Maximum[c]	Removable[d]
Natural uranium (U+D)	5,000	15,000	1,000
Natural thorium (Th+D)	1,000	3,000	200

Notes:
a Where surface contamination by both alpha-and beta-gamma-emitting nuclides exists, the limits established for alpha-and-beta-gamma-emitting nuclides should apply independently.

b As used in this table, dpm (disintegrations per minute) means the rate of emissions by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

c Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

d The maximum contamination level applies to an area of not more than 100 cm^2. The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects with less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

e The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hr at 1 m and 1.0 mrad/hr at 1 cm respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

Table 17.11 - Derived Concentration Guideline Levels for Building Surfaces

Radionuclide	Medium	DCGL[a]	Units
Uranium 238 plus progeny	Building surfaces	19.5	$dpm/100cm^2$
Uranium 238	Building Surfaces	101	$dpm/100cm^2$
Thorium 232 plus progeny	Building surfaces	6.0	$dpm/100cm^2$
Thorium 232	Building surfaces	7.0	$dpm/100cm^2$

a Beyeler, W. E., et al., "Residual Radioactive Contamination From Decommissioning; Parameter Analysis; Draft Report for Comment", NUREG/CR-5512, Vol. 3, U. S. Nuclear Regulatory Commission, October, 1999, Table 5.19.

Gross Radioactivity DCGL

Radionuclide	Medium	DCGL[a]	Units
Gross Alpha Activity	Building surfaces	9	$dpm/100cm^2$

Table 17.12 - Typical Instruments for Performing Final Status Surveys

Instrument	Radiation Detected	Scale Range	Typical Background	Typical MDC[1]	Application
Bicron MicroRem tissue-equivalent meter	Gamma	0-5,000 microrem/hr	8-10 microrem/hr	5 microrem/hr	ambient gamma surveys
Ludlum Model 2241 scaler/ratemeter with a Model 44-10 sodium iodide gamma scintillation detector	Gamma	0-1,000 microR/hr	8-10 microR/hr	5 microR/hr	gamma walkover surveys
Ludlum Model 2224 scaler/ratemeter with Ludlum Model 43-89 dual alpha/beta	Alpha, beta	0-500,000 cpm	<10 cpm alpha <200 cpm beta	<100 alpha <1,000 beta <3,200 beta scan	contamination surveys of surfaces
Ludlum Model 239-1F floor monitor with Ludlum Model 2221 scaler/ratemeter and Ludlum Model 43-37 gas proportional probe	Alpha, beta	0-500,000	<10 cpm alpha <500 cpm beta	<100 alpha <3,000 beta scan	contamination scanning of floors

[1]Minimum detectable concentration provided in dpm/100cm^2 at a 95% confidence interval.

Table 17.13 - Area Factors for Outdoor Radiation Surveys

Area (m^2)	Area Factor
1,000	1.1
500	1.2
100	1.3
50	1.5
10	2.5
7	3.0

1 **Table 17.14 - Cost Estimate for the LTC (Long-term Control) Alternative**

	Item	Quantity	Units	2005 Unit Cost	Total 2005 Cost	Present Value
3	CAPITAL COSTS					
4	SITE PREPARATION					
5	Mobilization	1	LS	$25,000.00	$25,000	
6	Construction Surveying	7.1	ACRES	$5,000.00	$35,500	
7	Sediment and Erosion Controls	1	LS	$15,000.00	$15,000	
8	SUBTOTAL					$75,500
9	CAP CONSTRUCTION					
10	Dust Suppressant (Haul Roads)	28,000	SY	$3.60	$100,694	
11	Radiological and Air Monitoring	1	LS	$64,140.00	$64,140	
12	Consolidation of Slag Piles into Cap Footprint	30,000	CY	$9.48	$284,455	
13	Rough Grading of Coarse Slag	22,000	SY	$6.74	$148,233	
14	Grading of Subgrade Cap Materials	22,000	SY	$0.26	$5,700	
15	Adjacent Soil Characterization	1	LS	$25,000.00	$25,000	
16	Sand Cushion Layer (9 inches thick)	6,000	CY	$17.83	$106,957	
17	Anchor Trench	2,080	LF	$1.65	$3,437	
18	HDPE Geomembrane (40 mil)	200,000	SF	$2.80	$559,394	
	Liner Testing and QA/QC	1	LS	$20,000.00	$20,000	
	Drainage Geonet	200,000	SF	$0.73	$146,061	
21	Soil Isolation/ Frost Protection Layer (2 feet thick)	15,000	CY	$21.23	$318,426	
22	Topsoil (6 inches thick)	8,000	CY	$40.81	$326,485	
23	Fine Grade, Seed and Mulch	35,000	SY	$2.72	$95,200	
24	Drainage Improvements	1	LS	$25,000.00	$25,000	
25	Establish Vegetative Cover (first-year maintenance)	1	LS	$15,000.00	$15,000	
26	SUBTOTAL					$2,244,181
27	FINAL STATUS SURVEY	1	LS	$92,345.00	$92,345	$92,345
28	DEMOBILIZATION/ DECONTAMINATION/ SITE CLEANUP	1	LS	$20,000.00	$20,000	$20,000
29	CONSTRUCTION SUBTOTAL					$2,432,026
30	IMPLEMENTATION COSTS					
31	Administrative Costs (5%)				$121,601	
32	Project Management During Construction (10%)				$243,203	
33	Permits and Legal Documentation (10%)				$243,203	
34	Engineering Design Costs (10%)				$243,203	
35	IMPLEMENTATION TOTAL					$851,209
36	CAPITAL COST GRAND TOTAL					$3,283,235

Item	Quantity	Units	2005 Unit Cost	Total 2005 Cost	Present Value
1000-YEAR SURVEILLANCE & MONITORING COSTS					
PRESENT WORTH - 1000-YEARS OF ANNUAL SURVEILLANCE & MONITORING COSTS (3% DISCOUNT RATE)					
Visual and Ambient Gamma Radiation Surveys	1	LS	$1,200.00	$1,200	$40,000
Site Security Maintenance	7.1	ACRES	$165.00	$1,172	$39,050
Cap Maintenance	7.1	ACRES	$495.00	$3,515	$117,150
NRC Fees					
Annual Report Review/Inspection	1	LS	$10,000.00	$10,000	$333,333
Additional Cost Every 5 Years for License Renewal, Expanded	1	LS	$20,000.00	$4,367	$145,570
Inspection and Report Review (converted to an annual cost)					
Trust Fund Fees & Expenses	1	LS	$5,390.00	$5,390	$179,667
					$854,770
SUBTOTAL: CAPITAL AND 1,000-YEAR SURVEILLANCE & MONITORING COSTS					$4,138,005
CONTINGENCY (25%)					$1,034,501
GRAND TOTAL CAPITAL AND 1,000-YEAR SURVEILLANCE & MONITORING COSTS					$5,172,507

1 **Table 17.15 - Cost Estimate for the LT (License Termination) Alternative**

	Item	Quantity	Units	2005 Unit Cost	Total 2005 Cost	Present Value
2						
3	CAPITAL COSTS					
4	SITE PREPARATION					
5	Mobilization	1	LS	$62,000.00	$62,000	
6	Sediment and Erosion Controls	1	LS	$15,000.00	$15,000	
7	Clear and Grub Dense Brush Including Stumps	2.7	AC	$6,250.00	$16,875	
8	Gravel Roadway	3,700	SY	$12.52	$46,327	
9	SUBTOTAL					$140,202
10	RAILROAD IMPROVEMENTS					
11	Remove Old Railroad Ties and/or Track	3,000	LF	$9.55	$28,650	
12	New Crossties with Tie Plates and Spikes	3,000	EA	$102.03	$306,084	
13	New Track	2,400	LF	$18.41	$44,188	
14	Car Bumper	1	EA	$3,807.51	$3,808	
15	Wheelstops	1	PAIR	$778.85	$779	
16	Railcar Switcher	294	DAYS	$2,500.00	$735,000	
17	SUBTOTAL					$1,118,508
	ONSITE SLAG PROCESSING					
	Dust Suppressant	76,667	SY	$3.60	$275,710	
20	Radiological and Air Monitoring	1	LS	$104,516.00	$104,516	
21	Relocation of Coarse Slag to Staging Area	43,000	CY	$8.72	$375,101	
22	Relocation of Baghouse Dust, Finer Slag and Soils to Staging Area	33,000	CY	$6.93	$228,850	
23	Crush Slag Larger Than Disposal Facility Cutoff	81,000	TONS	$53.95	$4,370,021	
24	Load Slag Materials into Railcars	76,000	CY	$6.93	$527,048	
25	Adjacent Soil Characterization	1	LS	$50,000.00	$50,000	
26	SUBTOTAL					$5,931,246
27	OFFSITE SLAG DISPOSAL					
28	Haul Slag to Envirocare Facility in Utah	2,052,000	CF	$7.06	$14,485,122	
29	Slag Disposal at Envirocare in Utah	2,052,000	CF	$10.50	$21,539,215	
30	SUBTOTAL					$36,024,336
31	FINAL STATUS SURVEY	1	LS	$92,345.00	$92,345	$92,345
32	SITE RESTORATION					
33	Grading	35,000	SY	$0.36	$12,478	
34	Topsoil (assume 1 foot of clean soil)	11,500	CY	$32.45	$373,210	
35	Fine Grade and Seed	35,000	SY	$2.21	$77,280	
36	Drainage Improvements	1	LS	$15,000.00	$15,000	
37	SUBTOTAL					$477,967
38	DEMOBILIZATION/ DECONTAMINATION/ SITE CLEANUP	1	LS	$50,000.00	$50,000	$50,000
39	CONSTRUCTION TOTAL					$43,834,605

	Item	Quantity	Units	2005 Unit Cost	Total 2005 Cost	Present Value
1	**IMPLEMENTATION COSTS**					
2	Administrative Costs (1%)				$438,346	
3	Project Management During Construction (2%)				$876,692	
4	Permits and Legal Documentation (1%)				$438,346	
5	Engineering Design Costs (2%)				$876,692	
6	**IMPLEMENTATION TOTAL**					$2,630,076
7	**CAPITAL COST TOTAL**					$46,464,681
8	CONTINGENCY (25%)					$11,616,170
9	**GRAND TOTAL CAPITAL COST**					$58,080,851

Table 17.16 - Cost Estimate for the LC (License Continuation) Alternative

Item	Quantity	Units	2005 Unit Cost	Total 2005 Cost	Present Value
1000-YEAR SURVEILLANCE AND MONITORING COSTS					
PRESENT WORTH - 1000-YEARS OF ANNUAL SURVEILLANCE & MONITORING COSTS (3% DISCOUNT RATE)					
USNRC Fees	1	LS	$62,400.00	$62,400	$2,080,000
On-Site Monitoring	1	LS	$2,400.00	$2,400	$80,000
					$2,160,000
SUBTOTAL: CAPITAL AND 1,000-YEAR SURVEILLANCE & MONITORING COSTS					$2,160,000
CONTINGENCY (25%)					$540,000
GRAND TOTAL CAPITAL AND 1,000-YEAR SURVEILLANCE & MONITORING COSTS					$2,700,000

Table 17.17 - Methods for Calculating Potential Radiation Dose

	Probabilistic	Deterministic
Measure of Human Health Detriment	Annual radiation dose measured in millirems per year	Annual radiation dose measured in millirems per year
Parameter Value Basis	Mean value for average member of a defined critical exposure group in a specific exposure scenario	Reasonable maximum value selected from accepted default values
Calculation method	Computer modeling code	Algebraic summation (e.g spreadsheet)
Time integration	Yes. Integration intervals vary to allow for progeny ingrowth decay, and transport	No. Point estimate, considering discrete point in time and site conditions.

18 FIGURES

Figure 18.1 - Site Plan

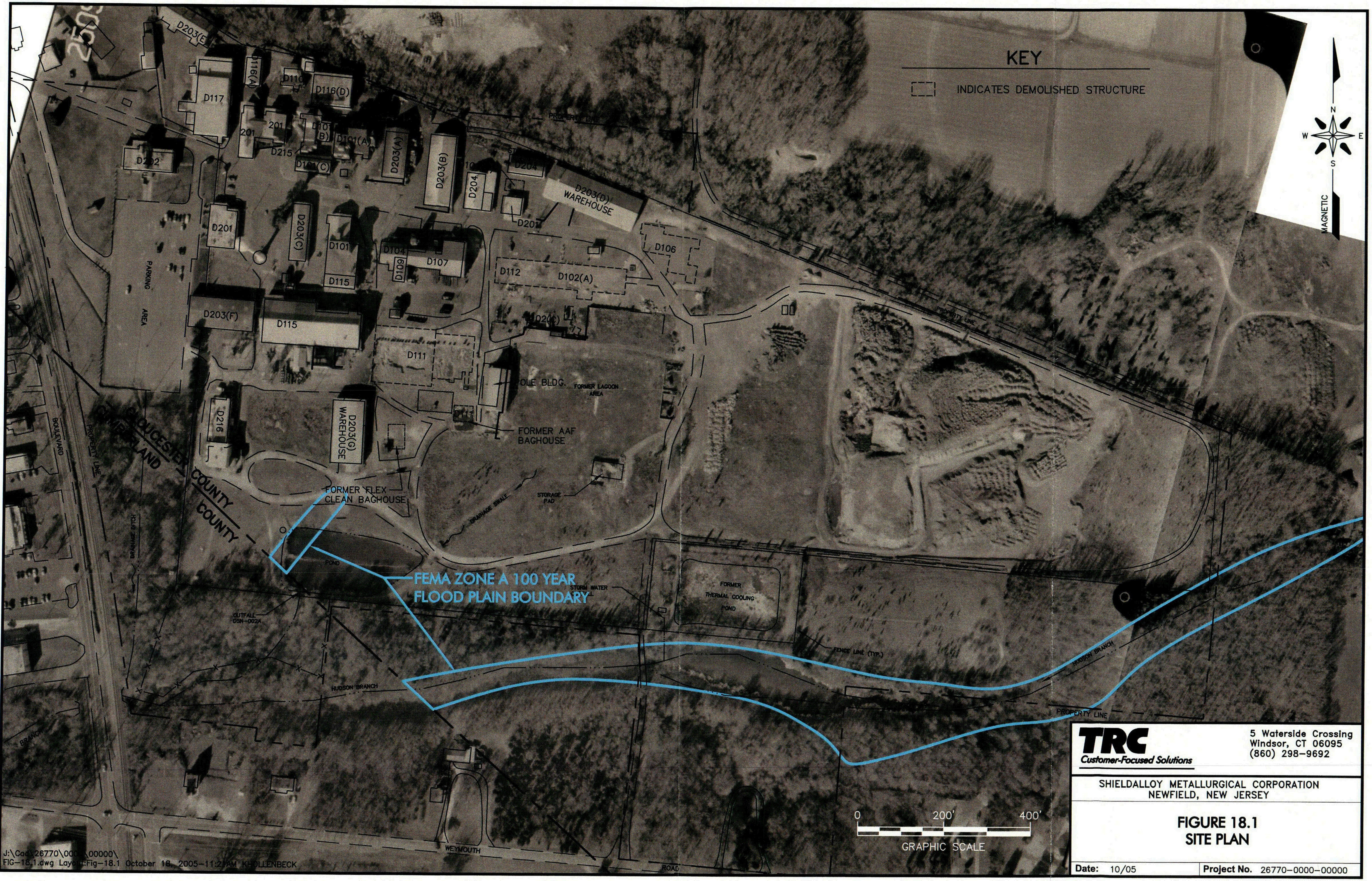

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FIGURE 18.1
SITE PLAN

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Figure 18.2 - Restricted and Former Restricted Areas

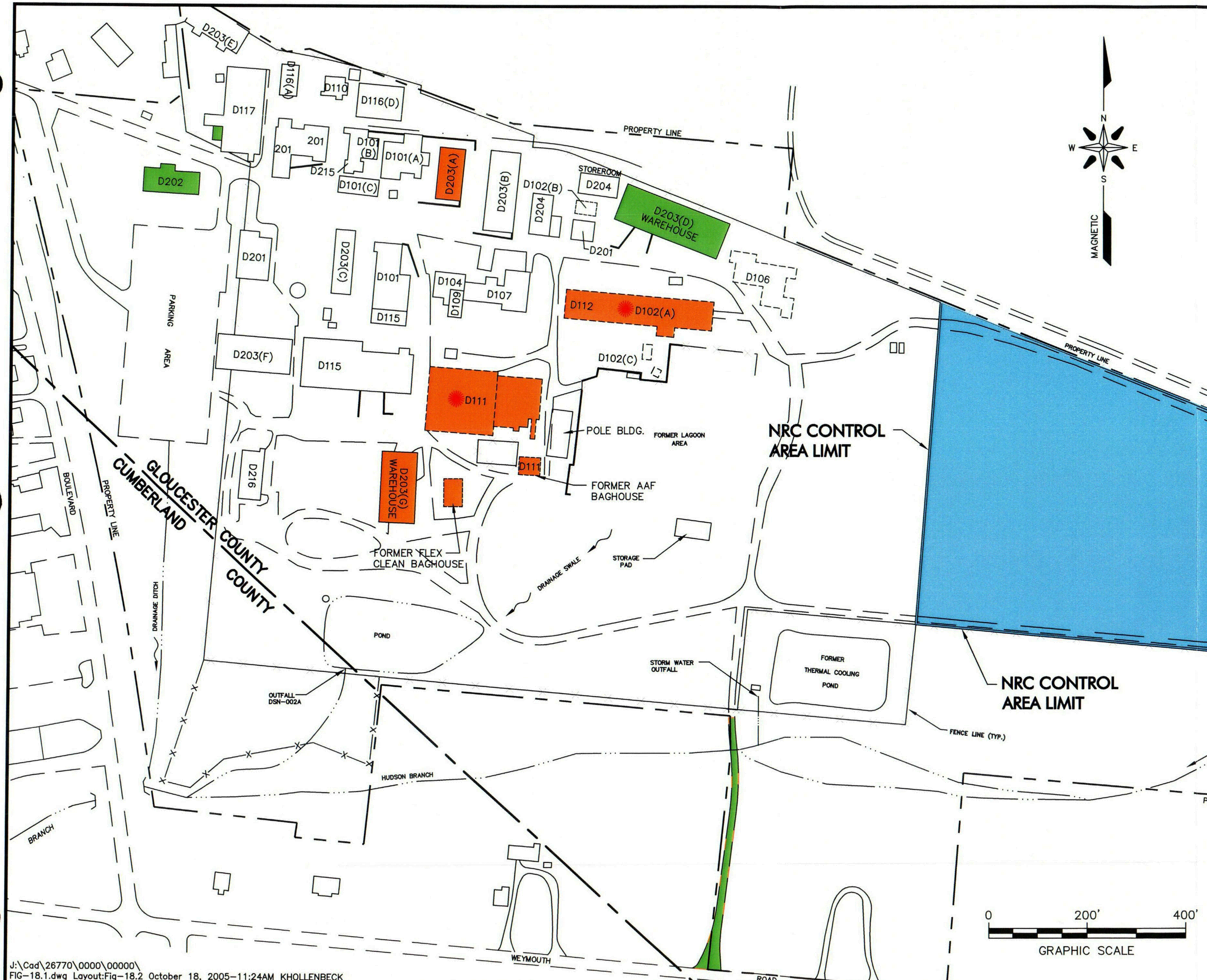

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FIGURE 18.2
RESTRICTED AND FORMER RESTRICTED AREAS

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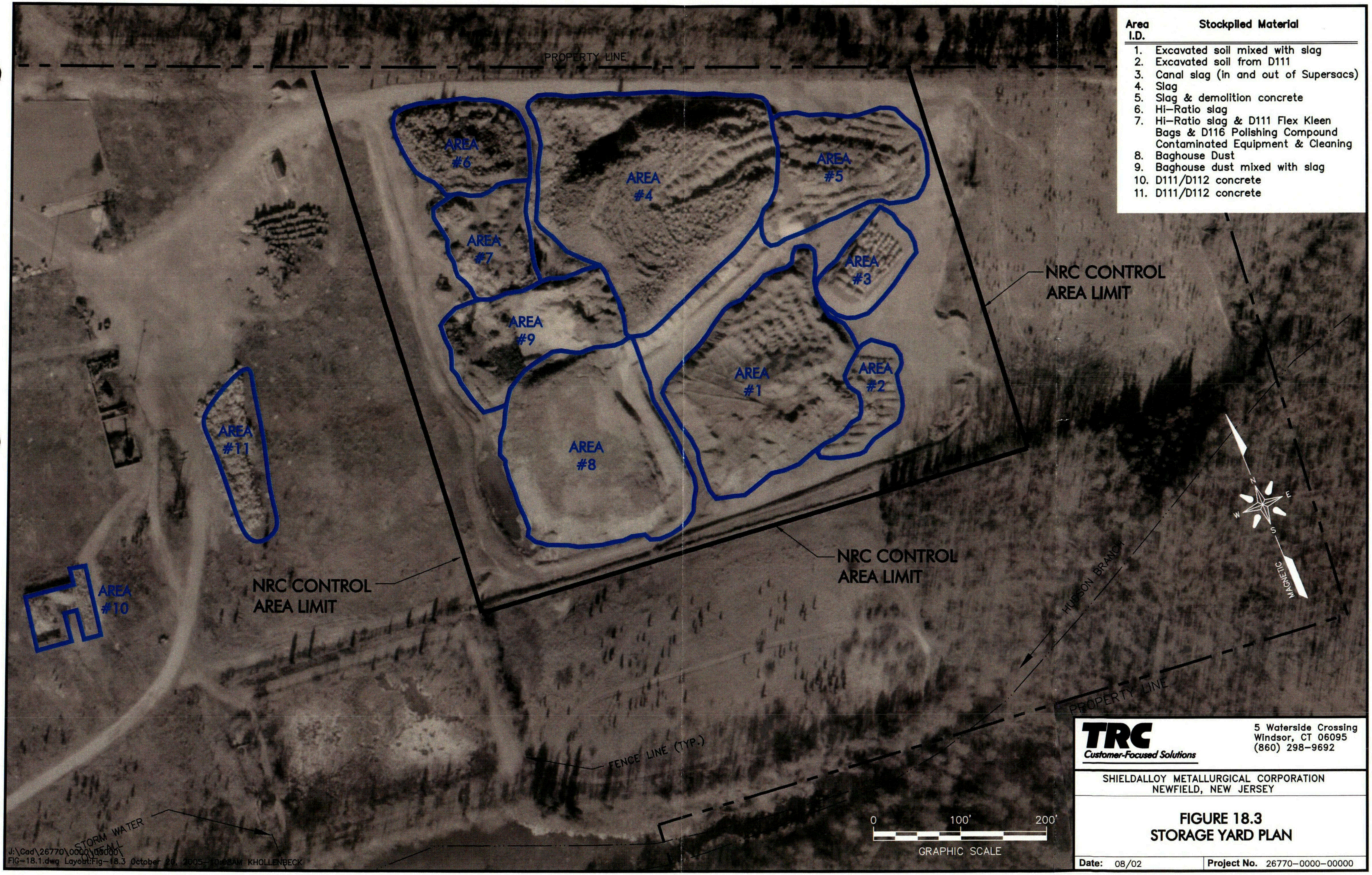
Figure 18.3 - Storage Yard Plan



Area I.D.	Stockpiled Material
1.	Excavated soil mixed with slag
2.	Excavated soil from D111
3.	Canal slag (in and out of Supersacs)
4.	Slag
5.	Slag & demolition concrete
6.	Hi-Ratio slag
7.	Hi-Ratio slag & D111 Flex Kleen Bags & D116 Polishing Compound Contaminated Equipment & Cleaning
8.	Baghouse Dust
9.	Baghouse dust mixed with slag
10.	D111/D112 concrete
11.	D111/D112 concrete

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FIGURE 18.3
STORAGE YARD PLAN

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Figure 18.4 - Existing Reforestation Areas

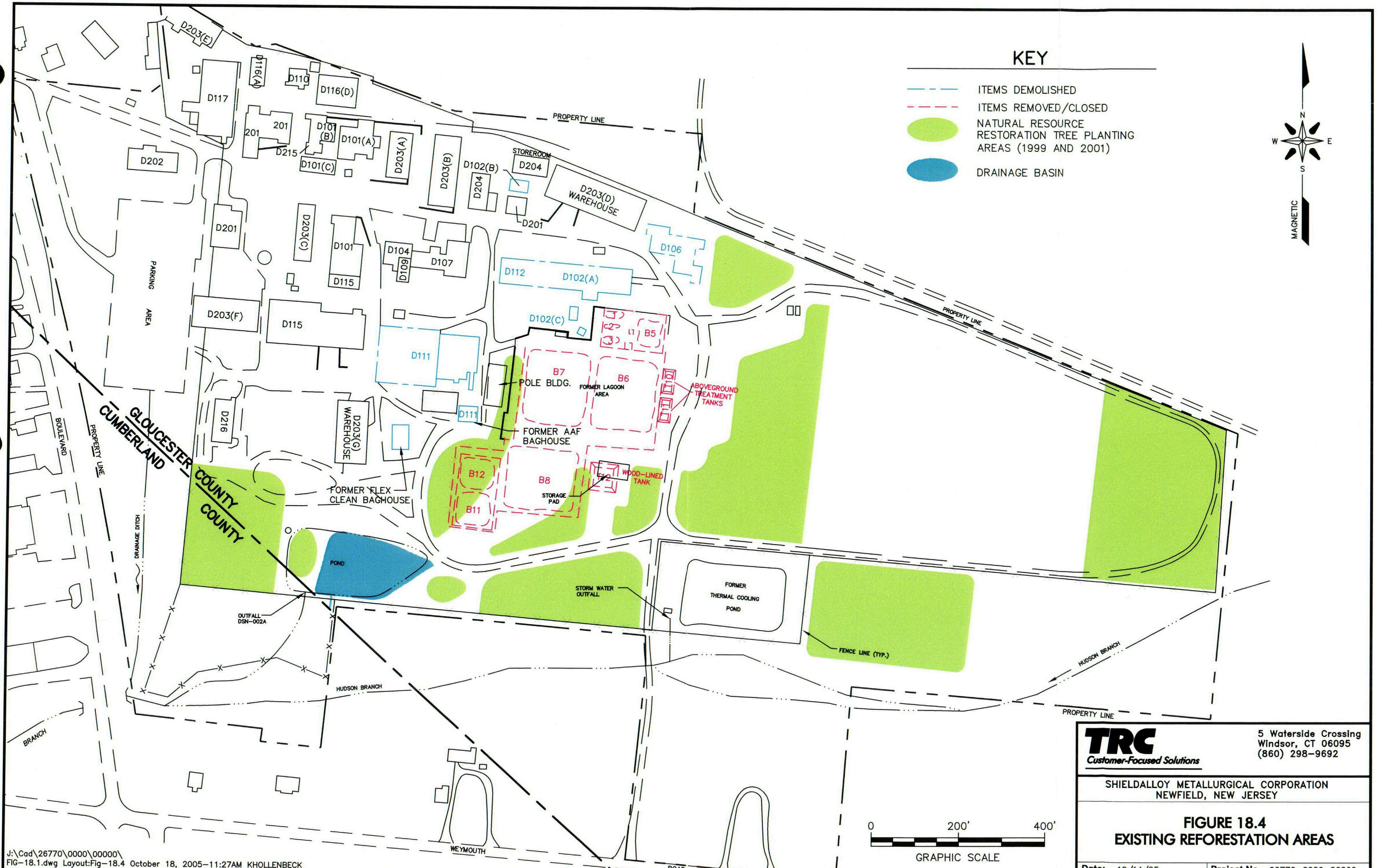

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FIGURE 18.4
EXISTING REFORESTATION AREAS

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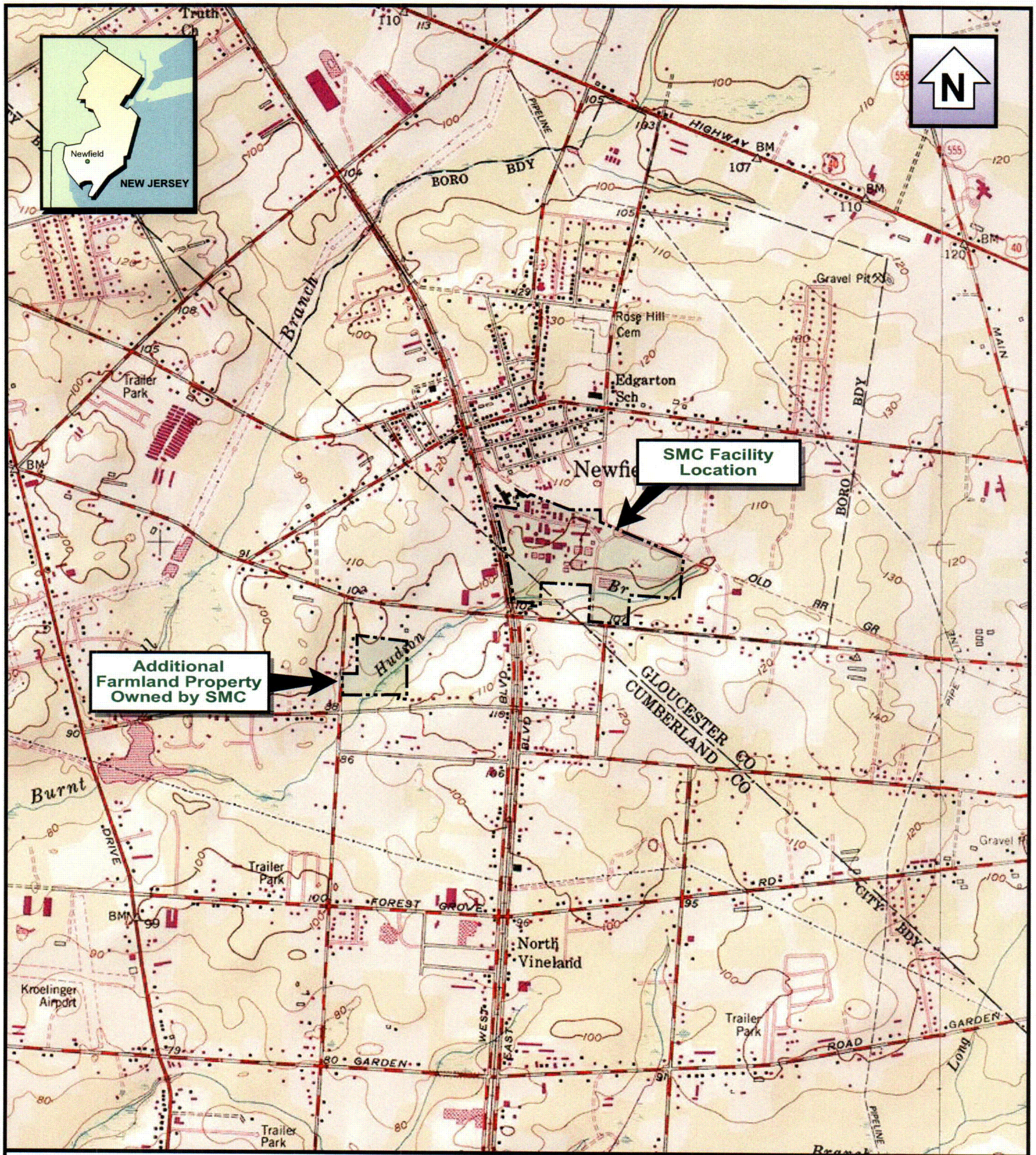
FIG-18.1.dwg Layout:Fig-18.4 October 18, 2005-11:27AM KHOLLENBECK

J:\Cad\26770\0000\00000\FIG-18.1.dwg, Fig-18.4, 10/18/2005 11:27:14 AM

C04

1 **Figure 18.5 - Site Location Map**



0 2000
SCALE FEET

0 1
SCALE 1:24000 MILE

BASE CREATED WITH TOPO™ © 1996 WILDFLOWERS PRODUCTIONS, www.topo.com
7.5' USGS TOPOGRAPHIC MAP

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FIGURE 18.5
SITE LOCATION MAP

Date: 04/05 | **Project No.** 26770-0100-00000

C05

Figure 18.6 - Consolidated Material Site Plan

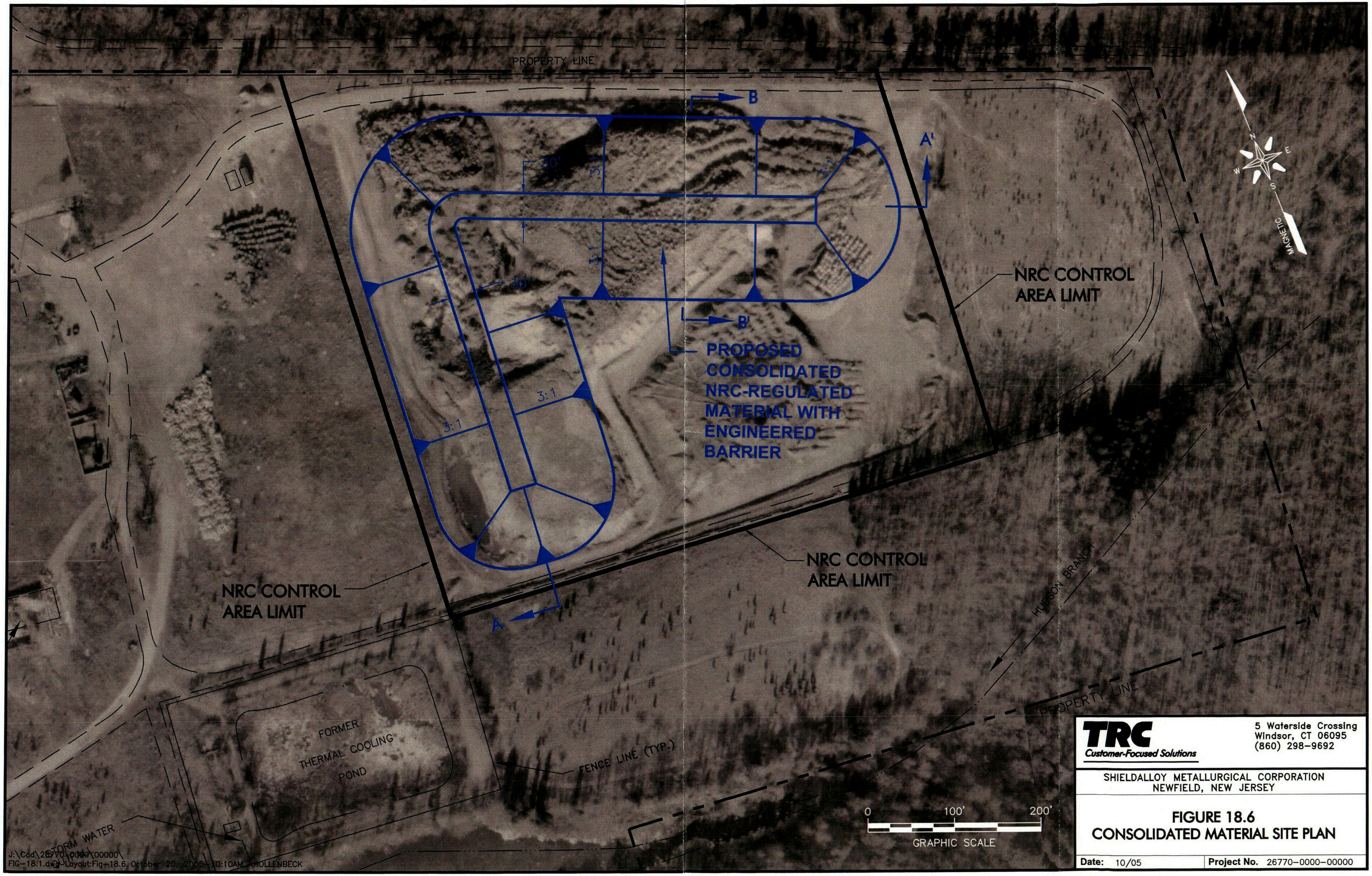

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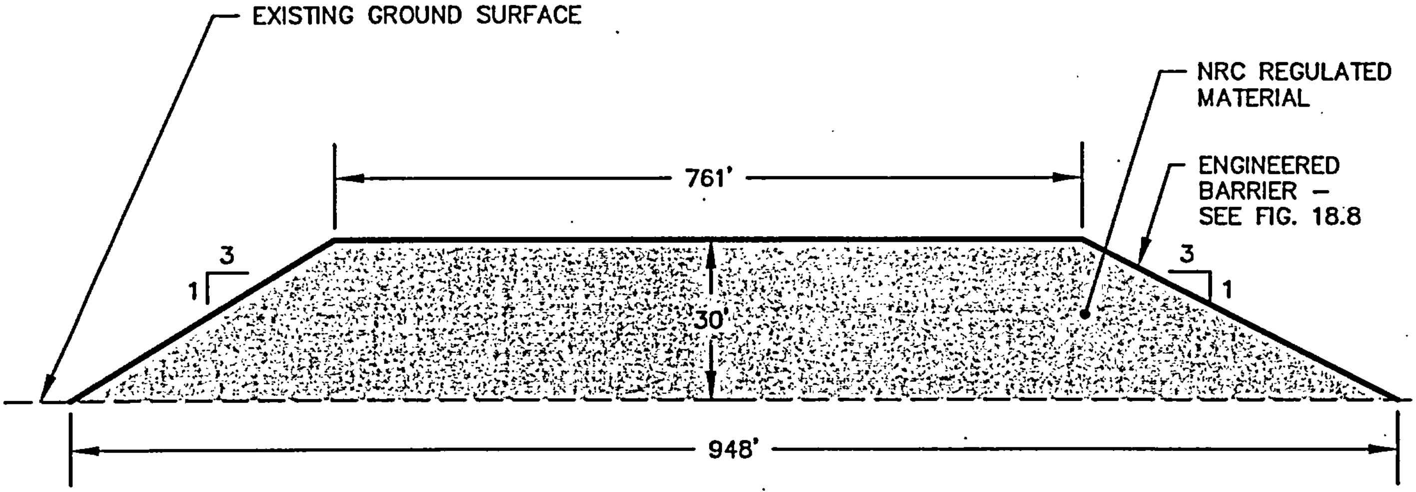
FIGURE 18.6
CONSOLIDATED MATERIAL SITE PLAN

Date: 10/05 | Project No. 26770-0000-00000

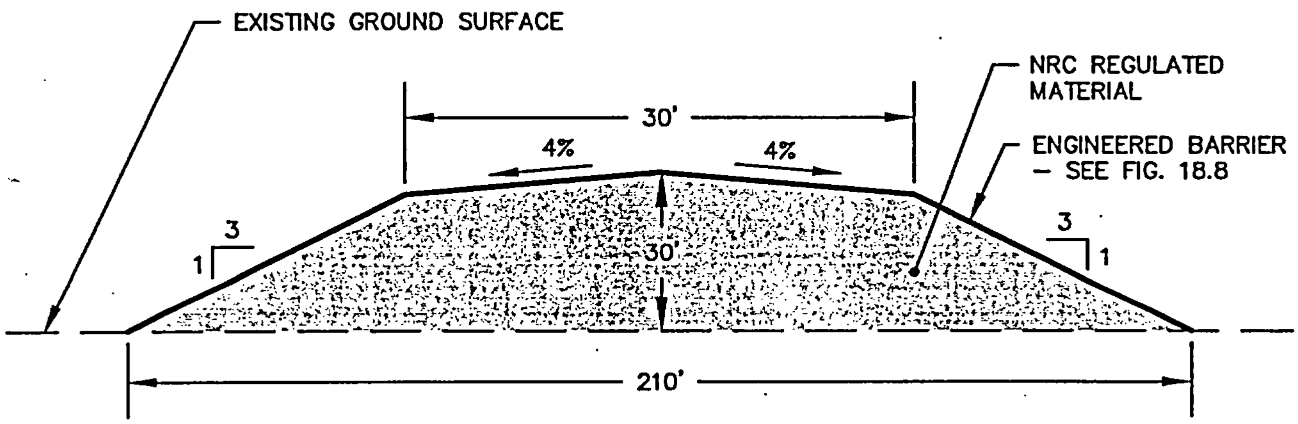
C06

Figure 18.7 - Engineered Barrier Sections



SECTION A–A'

N.T.S.



SECTION B–B'

N.T.S.

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FIGURE 18.7
ENGINEERED BARRIER PILE SECTIONS

Date: 10/05	Project No. 26770-0000-00000

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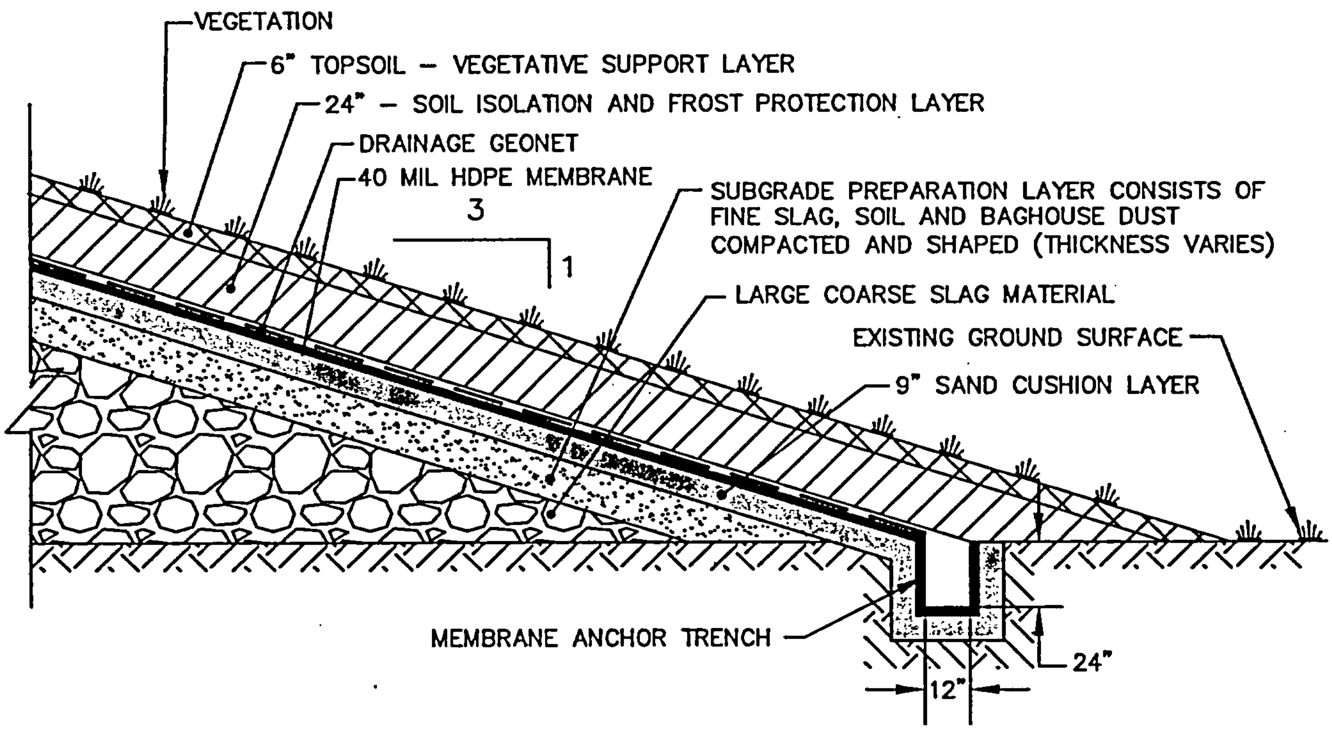
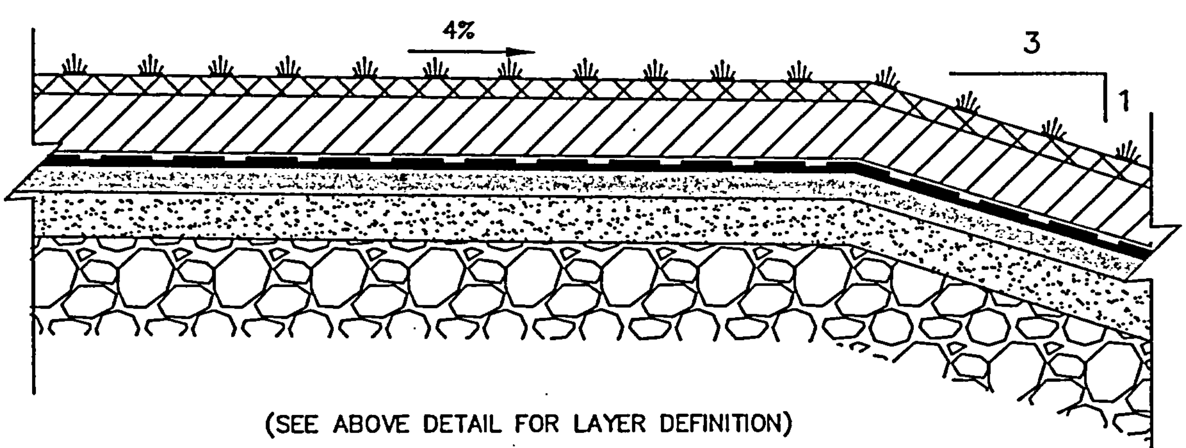
Figure 18.8 - Engineered Barrier Construction Detail



TYPICAL ENGINEERED BARRIER SIDE SLOPE DETAIL

N.T.S.



(SEE ABOVE DETAIL FOR LAYER DEFINITION)

TYPICAL ENGINEERED BARRIER TOP DETAIL

N.T.S.

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FIGURE 18.8
ENGINEERED BARRIER
CONSTRUCTION DETAILS

Date 10/05 | Project No. 26770-0000-00000

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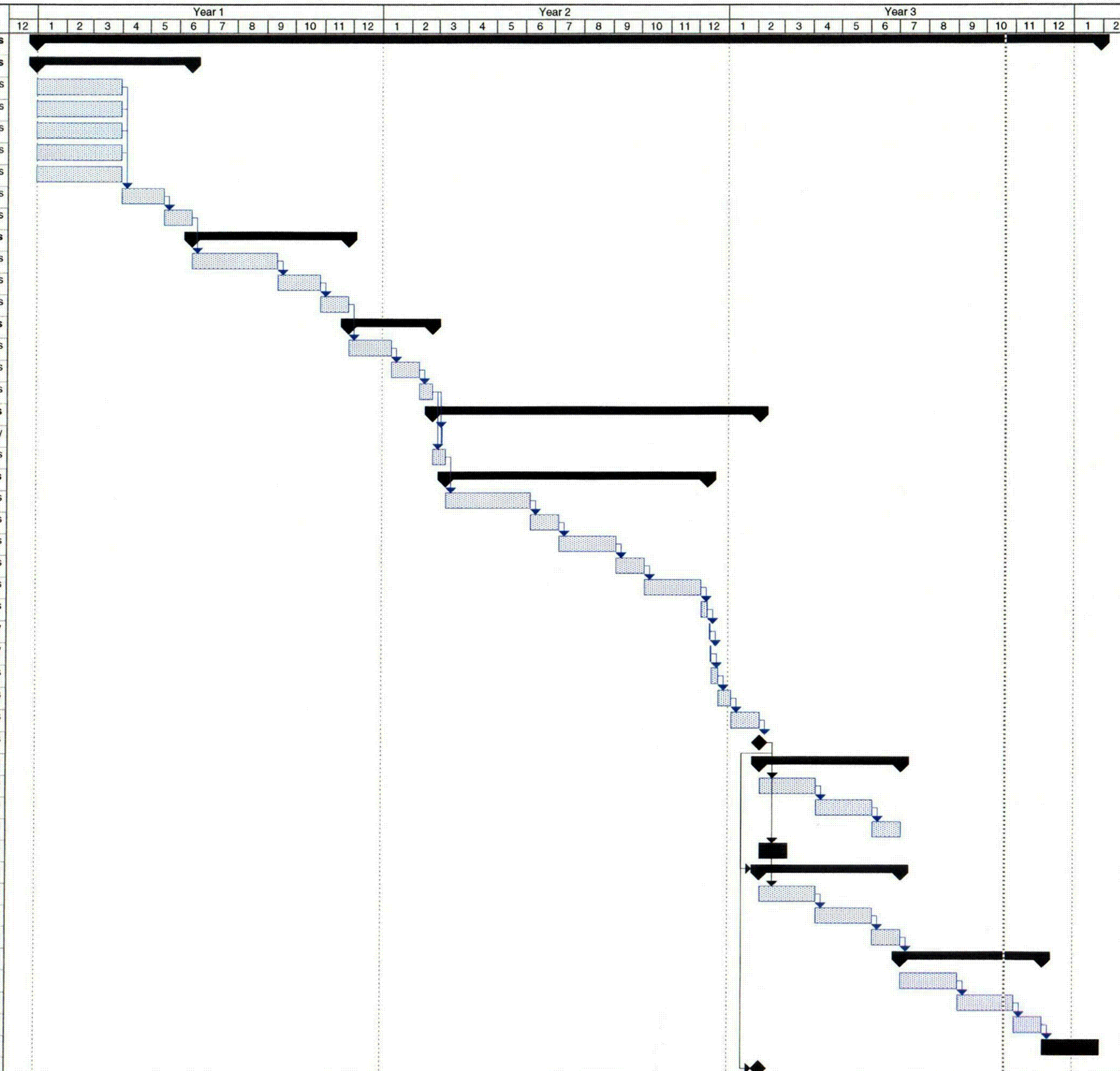
FIG-18.8.dwg Layout:Model October 20, 2005-2:59PM KHOLLENBECK

Figure 18.9 - Project Schedule

Figure 18.9
Project Schedule
Shieldalloy Metallurgical Corporation, Newfield, New Jersey

ID	Task Name	Duration
1	**On-Site Stabilization and Long-Term Control Campaign**	**803 days**
2	**Work Plan**	**118 days**
3	Prepare Work Plan (WP)	90 edays
4	Prepare Quality Assurance Project Plan (QAPP)	90 edays
5	Prepare Field Sampling Plan (FSP)	90 edays
6	Prepare Construction Quality Assurance Plan (CQAP)	90 edays
7	Prepare Performance Standard Verification Plan (PSVP)	90 edays
8	NRC Review and Comment	45 edays
9	Submittal of Final WP, QAPP, FSP, CQAP, and PSVP	30 edays
10	**Final Design (100%)**	**118 days**
11	Prepare Final Design	90 edays
12	NRC Review and Comment	45 edays
13	Submittal of Revised Final Design	30 edays
14	**Bidding and Award**	**63 days**
15	Solicit Bids	45 edays
16	Bid Evaluation	30 edays
17	Contract Award	14 edays
18	**Implementation of Decommissioning Activities**	**248 days**
19	Preconstruction Inspection and Conference	1 eday
20	Mobilization of Sediment/Erosion Controls	14 edays
21	**Engineered Barrier Construction**	**199 days**
22	Material Relocation/Pile Construction	90 edays
23	Subsoil Confirmatory Sampling	30 edays
24	Placement of Sand, Geomembrane and Soil Isolation Layers	60 edays
25	Placement of Vegetative Layer and Seeding	30 edays
26	Vegetation Establishment Period	60 edays
27	Site Cleanup	7 edays
28	Prefinal Construction Conference	1 day
29	Prefinal Inspection	1 day
30	Submittal of Prefinal Inspection Report	7 edays
31	Regulatory Review & Comment	14 edays
32	Completion of Outstanding Construction Items	30 edays
33	Final Inspection	0 edays
34	**Construction Completion Report & Certification**	**106 days**
35	Preparation of Report	60 edays
36	NRC Review and Comment	60 edays
37	Submit Revised Report	30 edays
38	**Final Status Survey Performance**	30 edays
39	**LTC Plan Preparation**	**106 days**
40	Draft LTC Plan	60 edays
41	NRC Review & Comment	60 edays
42	Submit Final LTC Plan	30 edays
43	**Final Decommissioning and Final Status Survey Report**	**108 days**
44	Draft Final Report	60 edays
45	NRC Review & Comment	60 edays
46	Submit Final Report	30 edays
47	**Amendment of License No. SMB-743**	60 edays
48	**Initiation of Operation and Maintenance**	0 edays



Project: Project Schedule
Date: Thu 10/20/05

Task | Milestone | Summary

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Figure 18.10 - Decommissioning Organization Chart

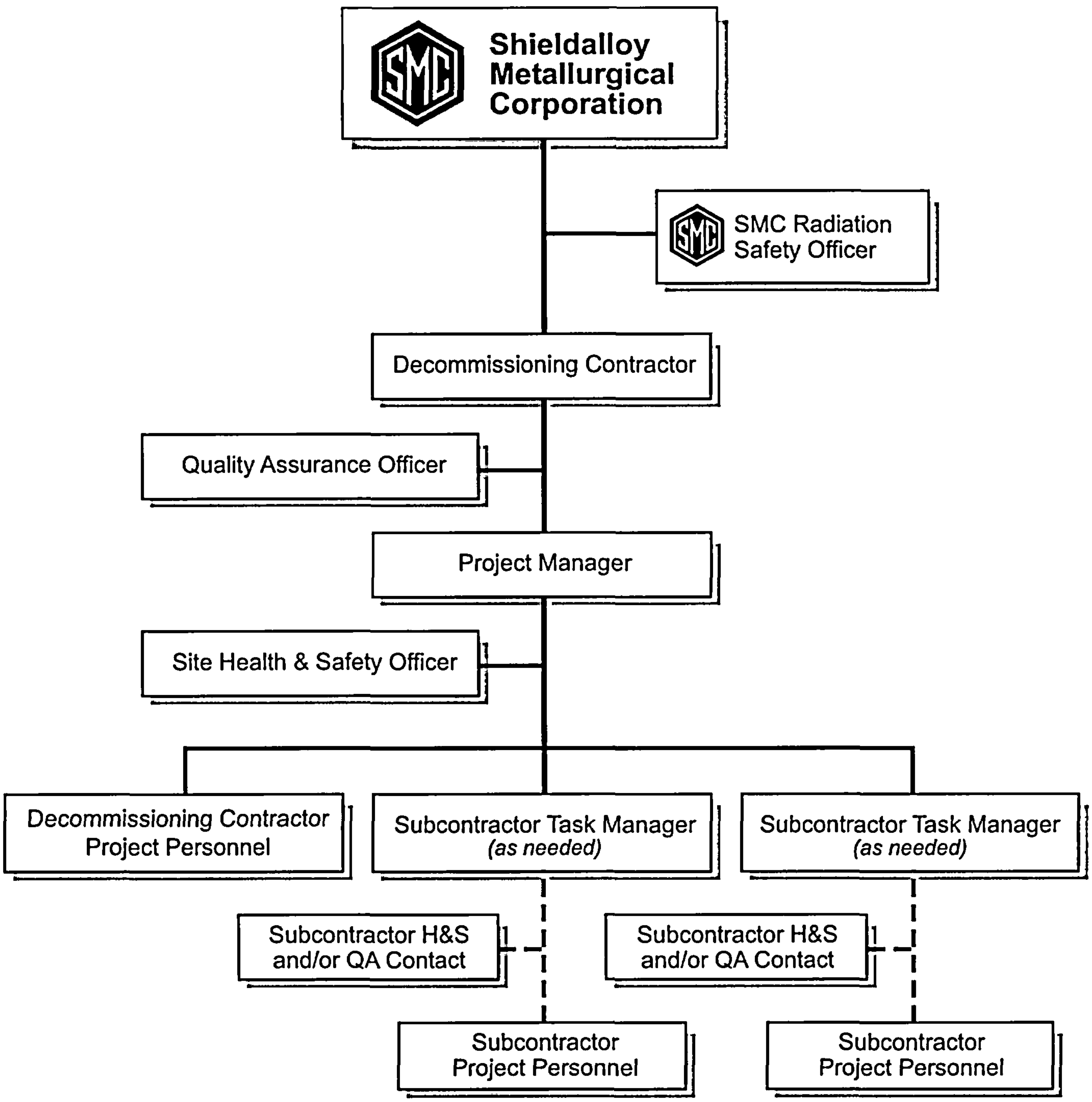

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FIGURE 18.10
PROJECT ORGANIZATION

Date: 08/02 | Project No. 37149-0000-00000

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Figure 18.11 - Area Classifications

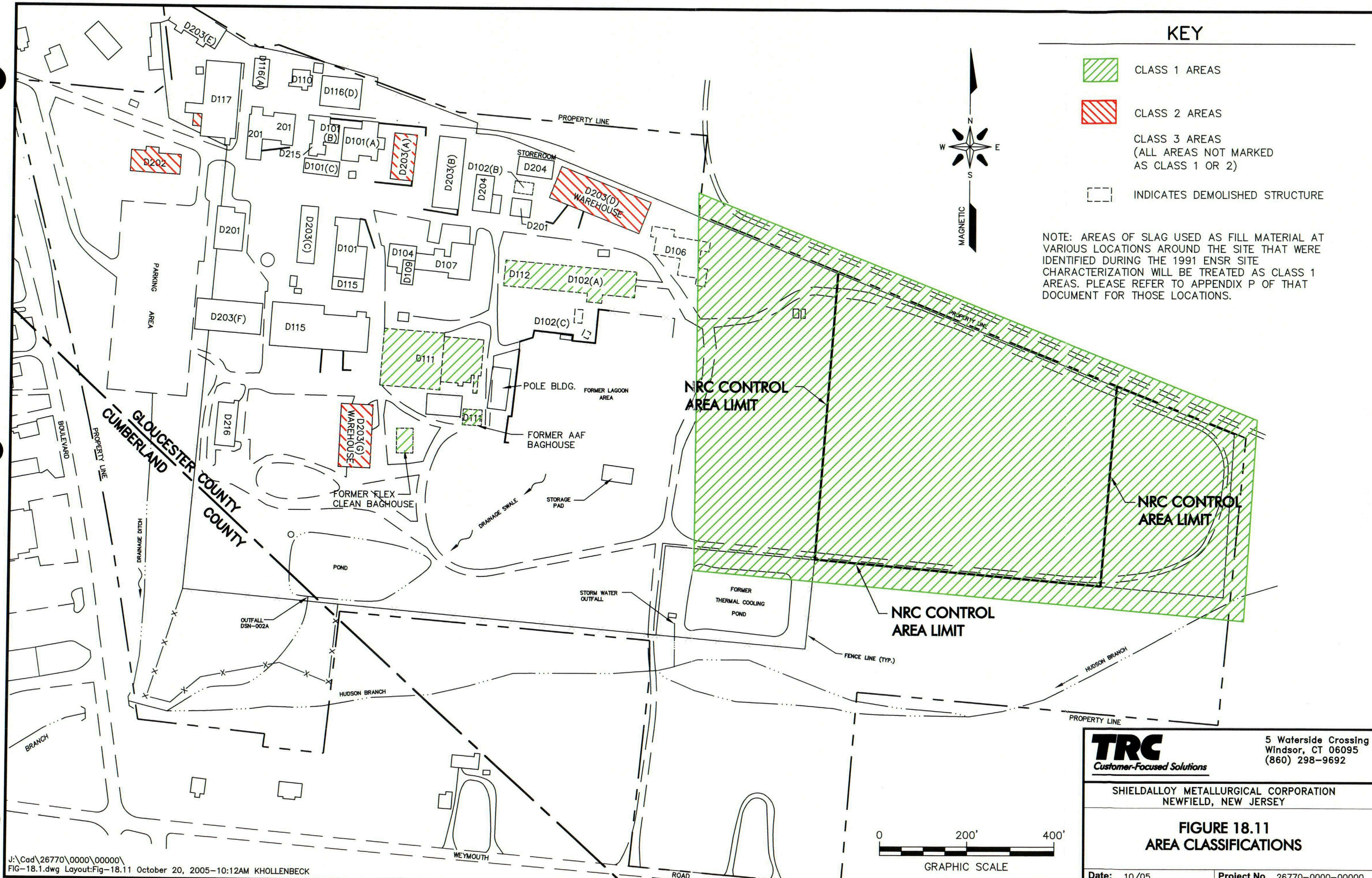

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FIGURE 18.11
AREA CLASSIFICATIONS

Date: 10/05 | Project No. 26770-0000-00000

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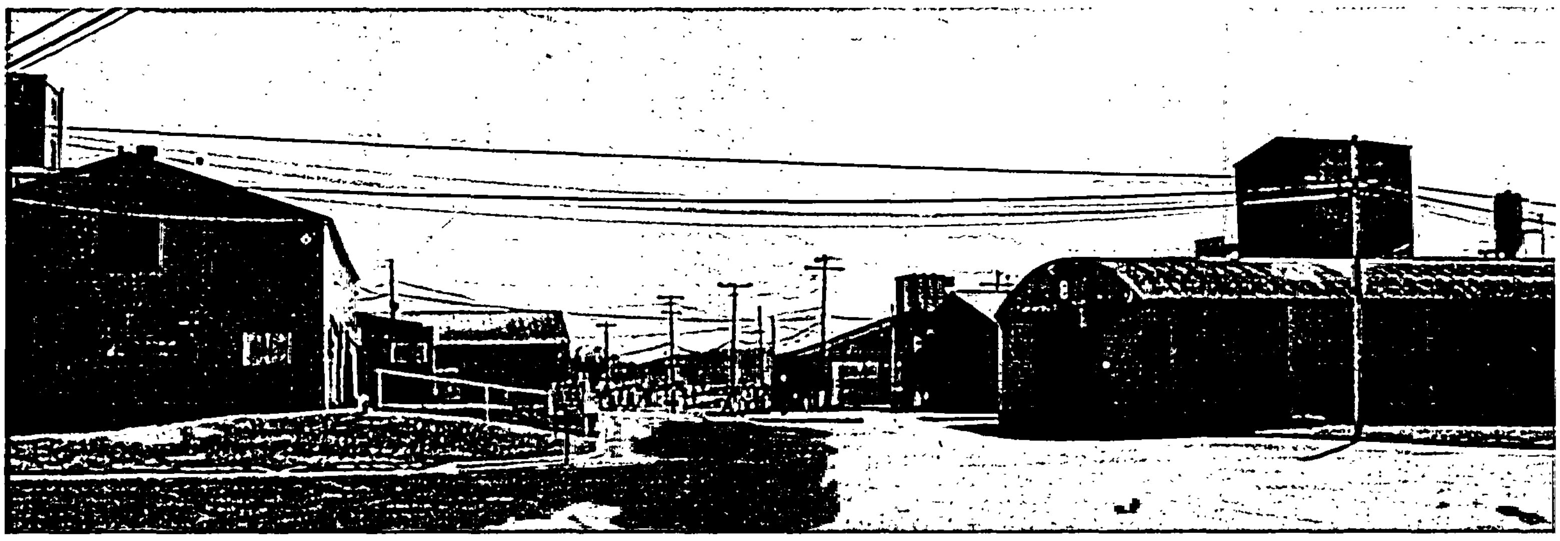

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