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WASTE ACCEPTANCE CRITERIA

Chalk River Site (includes NLBU Administrative Records)

232-508600-WAC-002

Revision 2

	CNL	LNC
☐ ACCEPTED AS NOTED	☒ ACCEPTED	☐ NOT ACCEPTED

Signature	Representing	Date
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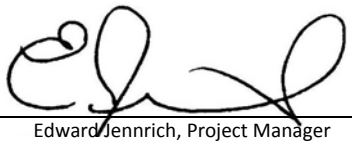
Canadian Nuclear Laboratories

Near Surface Disposal Facility Design and Consulting Services

Waste Acceptance Criteria

232-508600-WAC-002

Deliverable 1.1, Revision 2

Approved by 

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Waste Acceptance Criteria

NSDF Waste Acceptance Criteria

Waste Management Areas

232-508600-WAC-002
Revision 2

2017 June

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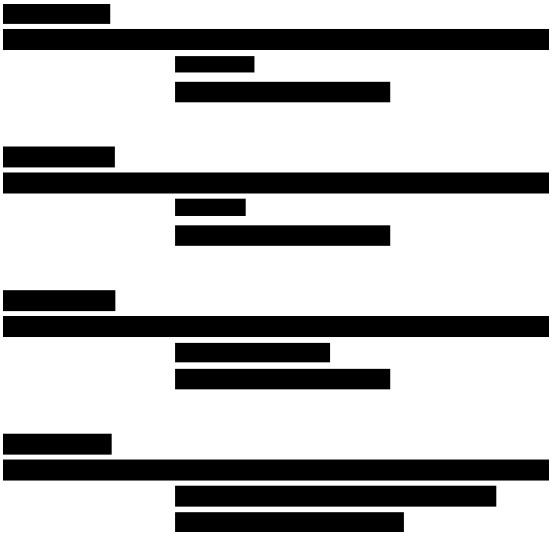

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1. INTRODUCTION

This Waste Acceptance Criteria (WAC) provides characteristics for waste accepted for disposal at the Near Surface Disposal Facility (NSDF) that maintain safety margin provided in the Design, Environmental Impact Statement (EIS), Performance Assessment (PA) and Safety Analysis Report (SAR). The WAC applies to all waste generators offering waste for disposal and feeds into the following future CNL administrative processes:

- Waste characterization process
- Waste acceptance process
- Waste variance process
- Waste certification program
- Waste assurance program

The Waste Characterization process will be used to ensure the minimum requirements of the WAC are met. This process will be performed in accordance with Canadian Nuclear Laboratories (CNL) Quality Assurance (QA) requirements and the NSDF Quality Assurance Project Plan. The Waste Characterization program will be subject to program surveillance and audit functions as described further.

Waste acceptance is provided by approval of the Waste Profile and marks the acceptance of a waste stream for disposal; the generator may then create waste packages under the approved Waste Profile. If a Waste Profile is deemed unacceptable, then recommendations may be provided on potential processing or alternate disposition routes.

Waste that exceeds WAC may be accepted to the NSDF through the Waste Variance Process. Within this process, the waste profile would be evaluated against the NSDF Safety Criteria; defined by the results of the Performance Assessment (PA) [1], the Safety Analysis Report (SAR) [2] and the overall effect on the facility. For example, material that satisfies the NSDF Safety Criteria but would effectively limit the continued operation, facility optimization or safety of the facility would be rejected.

Waste generators will maintain a level of qualification to ensure consistent application of waste acceptance criteria through a Waste Generator Certification program. Personnel will be trained and qualified to address and implement characterization objectives and packaging requirements specified by the waste acceptance criteria.

The Waste Assurance program is a quality control that will provide assurance that the waste generating processes and corresponding individual packages are managed consistent with Waste Management Program requirements. The program will include surveillances and audits conducted at the point of generation and/or on receipt at the NSDF.

The above processes represent the framework and will be further expanded as they are developed.

Waste disposed of at the NSDF must meet the requirements provided in this document to ensure that doses to the public remain within regulatory limits, are As Low As Reasonably Achievable (ALARA), the environment surrounding the NSDF is protected, and the long-term stability of the site is maintained. These safety objectives and their relationship to the implementing section of the WAC are summarized in a compliance matrix provided in Table 1-1.

Table 1-1, NSDF WAC Compliance Matrix

NSDF Requirement	Required Condition	WAC Requirement	WAC Section
Provide safety margin to the results of the Safety Criteria [1], [2], [3], [4]	Limit waste inventory to acceptable quantities and specific radioactivity	• Limit concentrations of radionuclides in waste • Provide characterization requirements for significant radionuclides • Provide facility radioactivity limits for waste tracking and inventory controls	6, Table 6-1, Table 6-2, 9
Define waste physical properties [5].	Emplaced waste must be consistent with facility design assumptions	• Limit waste physical properties to enable compaction and limit subsidence	5, 7
Provide controls for waste that support safe operation of the facility [4], [5].	Provide controls for industrial safety hazards	• Define controls for waste that assist facility management of industrial safety risks	5.1, 5.2, 5.7, 7.1.1, 7.2.2, 8
Protect waste impact on facility systems that provide safety performance [4], [5], [6], [7].	Limit concentrations of materials, physical dimensions and prohibited wastes that degrade facility safety systems	• Provide a list of prohibited materials • Provide limits for concentrations of hazardous substances to Land Disposal Requirements • Provide limits for physical properties of bulk waste materials	5, 7, 8, 9.2

NSDF Requirement	Required Condition	WAC Requirement	WAC Section
Limit radiation dose to workers [4], [8], [9].	Define radiation exposure and loose surface contamination limits for packages, require ALARA planning for handling packages that exceed contact handled package limits	• Provide limits for contact handled waste packages • Provide operational controls that limit worker exposure to loose surface radioactivity • Provide controls that provide criticality safety for the facility	Table 6-1, Table 6-2, 8, 8.2, 9.2
Limit Hazardous Substance release rates [1], [3], [4], [5], [6], [10].	Define ECM leachate characteristics to enable design and administrative programs that provide margin to the NSDF Safety Criteria and CNL environmental protection objectives	• Define radiological and chemical properties of waste • Prohibit free liquids or hazardous substances that do not satisfy land disposal restrictions. • Limit concentration of radium for radon gas control; limit concentrations of degradable organics to control conventional landfill gases and gaseous H-3 and C-14 • Limit concentration of H-3 to meet environmental constraints at CRL • Provide waste stabilization requirements to reduce effluent concentrations of hazardous substances	5, Table 6-1, 7

NSDF Requirement	Required Condition	WAC Requirement	WAC Section
Provide guidance for acceptable waste packaging able to deliver their safety function for the operational and post closure phases of the facility [1], [3], [4], [5], [10], [11].	Provide waste generators guidance for acceptable packagings that preserve safety margin and Performance Assessment assumptions	• Provide packaging criteria for waste streams that maintain safety margin to facility lifecycle • Define acceptable packaging for all waste streams to be disposed at NSDF	7
Provide record keeping requirements [12].	Ensure waste management records are maintained as required by CNL requirements.	• Define recordkeeping requirements for waste characterization, waste stream assessment and packages disposed in the facility.	11

2. SCOPE

This document is prepared to provide waste generators with guidance that enables disposal of waste in compliance with the NSDF Safety Criteria.

Additionally, this document identifies and describes future administrative processes and quality controls that provide assurance that waste emplaced in the NSDF complies with the NSDF Safety Criteria. Specifically, the scope of this document is to:

- Provide waste characterization objectives that ensure the "representativeness" of waste data and enable inventory management to the safety basis.
- Provide waste packaging guidance (e.g. bulk and packaged) and where required, conditioning requirements that enable adherence to the ECM design as it is constructed by the placement of waste.
- Provide limits for the radiological and chemical properties of waste that maintain a margin to pre- and post-closure safety objectives.
- Identify materials prohibited for disposal.
- Identify operational controls for waste packaging that provide criticality safety, radiation safety, industrial safety and protection of the environment.
- Identify quality controls that enable facility management to the design and safety criteria.

3. RESPONSIBILITIES

The NSDF serves waste generators across CNL and accepts a wide range of wastes that encompass the range of processes undertaken by CNL. Waste disposal requires engagement of multiple waste management disciplines [3] at different stages along the waste lifecycle continuum. A simple diagram of these responsibilities is provided in Figure 3-1.

Figure 3-1, Waste Lifecycle Responsibilities

Process / Responsibility	identify waste streams	sample/characterize waste streams and create waste management plan	prepare waste profiles	create waste packages	classify and track waste packages	transfer packages to storage or schedule for disposal	receive waste at NSDF
Waste Generator	Perform historical site assessment to assemble and organize process knowledge and waste information into waste streams **Section 9.1**	Develop and execute sample and analysis plans/assessments to produce waste characterization data for each waste stream **Section 9.1**	With characterization data, inform the characteristics of waste streams and document on the Waste Profile Form **Section 9.3**	Create waste packages in accordance with limitations and specifications of the Waste Profile Form **Section 7** **Section 9.3**	Classify packages and create package records to document information such as volume, mass, radioactivity and hazardous waste status. **Section 8**		
Waste Operations						Create package transfer record or manifest to transfer packages to storage or disposal **Section 7**	Receive and organize waste packages for disposal **Section 9.2**
Waste Services		Assist generators with: 1) sampling techniques that ensure representativeness and 2) analytical method selection that ensures sensitivity requirements are met **Section 9**	Provide guidance/assistance to waste generators in preparing the Waste Profile Form. Approves Waste Profiles to enable waste generation and creation of packages. **Section 9**		Track waste packages by Waste Profile and package record **Section 7** **Section 9**		
Transportation	Transportation Services is tasked with providing oversight to hazardous materials transportation to and from CRL including waste shipments made to NSDF from sites other than CRL.						

4. ACRONYMS & DEFINITIONS

4.1 Acronyms

ACM	Asbestos Containing Material
AECL	Atomic Energy Canada Limited
AK	Acceptable Knowledge
CNL	Canadian Nuclear Laboratories
CRL	Chalk River Laboratories
CSA	Canadian Standards Association
CSD	Criticality Safety Document
D&D	Decommissioning & Demolition
ECM	Engineered Containment Mound
FM	Fissionable Material
HIC	High Integrity Container
IAEA	International Atomic Energy Agency
ISO	International Organization for Standardization
LDR	Land Disposal Requirement
MSDS	Material Safety Data Sheet
NCCO	Nuclear Criticality Control Officer
NSDF	Near Surface Disposal Facility
PA	Performance Assessment
PCB	Polychlorinated Biphenyls
QA	Quality Assurance
QAP	Quality Assurance Plan
SAR	Safety Analysis report

SFM	Special Fissionable Material
WAC	Waste Acceptance Criteria
WWTP	Waste Water Treatment Plant

4.2 Definitions

Acceptable Knowledge	Information specific to waste characteristics that is judged to be reliable and/or supported by a quality program.
Asbestos Containing Material	Any material that is contaminated with asbestos of any form.
Chelating Agents	Chemical compounds (usually organic compounds) that form complexes with metal ions or other substrates. Usually used to modify the solubility of metal ions or other substrates.
Demolition Debris	Debris resulting from the demolition of a structure. Demolition debris can be concrete, structural steel, windows, roofing, pipe work, ventilation equipment, wood, etc.
Direct Disposal Package	A package meant to be disposed along with its contents directly in a disposal cell.
Encapsulation	A process where waste isolation is achieved by completely surrounding the waste with another material i.e., concrete, polymer or bitumen.
Fissionable Material	Material that is capable of undergoing fission.
Hazardous Waste	Waste contaminated with or pure forms of hazardous substances as defined in Ontario Provincial Regulation 347.
Land Disposal Restrictions	Restrictions on hazardous waste concentration or leaching test results required for land disposal as specified in Ontario Provincial Regulation 347.
Low-Level Mixed Waste	Low-level radioactive waste contaminated with hazardous substance(s).
Low-Level Waste	Waste which can be demonstrated as suitable for near surface disposal by safety analysis.

NSDF Safety Criteria	The culmination of the results and limitations of the Design [8], Performance Assessment [1] and Safety Analysis Report [2] prepared for the NSDF.
Oversize Debris	Debris that exceeds size limitations for bulk waste.
Package	The combination of a waste container and its contents.
Packaging	Analogous with waste container but includes integral components like liners, cribbing, lifting fixtures, tamper proof seals and venting fixtures, etc.
Significant Radionuclides	Radionuclides that have significant impact on Safety Criteria.
Soft Sided Packaging	Packaging made of textiles or engineered fabric.
Soluble Solids	Material in solid phase under normal conditions but dissolves in water or other liquids.
Stabilization	The process of creating a structurally stable waste form that will generally maintain its physical dimensions and its form under the expected disposal conditions such as weight of overburden and compaction equipment, the presence of moisture, microbial activity, and internal factors such as radiation effects and chemical changes. Structural stability can be provided by the waste form itself, processing the waste to a stable form, or placing the waste in a disposal container or structure that provides stability after disposal.
Special Fissionable Material	A fissionable material that can be arranged into a critical assembly outside a nuclear reactor, including material containing Uranium enriched in the isotope U-235 in excess of natural abundance and/or isotopes of Plutonium and/or Np-239 which decays to Pu-239 and/or the isotope U-233 and/or the isotope Pa-233 which decays to U-233. Materials surface contaminated with these radionuclides are not SFM.
Thermal Power Rate	The rate of heat generated by the decay of radioactive material.
Waste Characterization	The integrated results of investigations and determinations for chemical properties, radionuclide concentration and physical properties of waste.

5. WASTE PROPERTIES

Wastes being disposed in the NSDF are organized into 6 waste types defined by material type including an "other" category (Waste Type 6) meant to include wastes like "oversize debris" and other non-routine waste materials that require special evaluation for disposal.

The NSDF Waste Types are:

Type 1 Waste – This refers to soil and soil-like wastes. It includes contaminated soils and other waste materials with characteristics similar to soil that can be placed within the mound with little to no handling requirements beyond what would be used for soil fills. For example, contaminated chipped wood material.

Type 2 Waste – Comingled radioactive waste, debris, refuse and soil and soil-like waste. It includes wastes that are anticipated to be at least 50% soil or soil-like in nature. It also contains varying amounts of radioactive wastes that require additional handling procedures beyond those for Type 1 wastes.

Type 3 Waste – Non-soil-like waste, it includes materials that can be excavated and handled as bulk materials but do not have the physical characteristics of soil and soil-like materials. These include process wastes, highly organic wastes, highly compressible wastes, flowing wastes and similar waste types.

Type 4 Waste – This refers to decommissioning and demolition (D&D) waste. It includes typical materials used in construction, such as: concrete, asphalt, brick, lumber, structural steel, process equipment, piping, wood and other building materials produced by decommissioning and demolition activities.

Type 5 Waste – Packaged Waste, it includes a variety of contaminated wastes including wastes contained in large shipping containers, B-25 boxes, drums, buckets, pails and similar containers. These wastes also typically require special handling procedures and procedures for placement and containment within the mound.

Type 6 Waste – Miscellaneous waste, such as oversize debris. Includes waste that does not fall within the definition of waste Types 1 through 5.

5.1 Bulk Waste Physical Properties

Bulk wastes are identified as Types 1 through 4 materials packaged in bulk containers to be emptied at the NSDF and disposed without packaging. As vertical lifts in the NSDF are sized at 0.3 m, bulk materials should, as far as practical, be sized to 0.3 m in one dimension [5] to allow for placement and compaction. Cases will arise where sizing bulk waste materials to 0.3 m in one dimension is impractical due to ALARA considerations, material form, required demolition method or other work face conditions/limitations. These over-size materials will be managed on a case-by-case basis through the WAC Variance Process; waste acceptance personnel will assist the generator with waste profiling these materials.

To facilitate the creation of waste packages that enable safe unloading at the NSDF, waste must be packaged such that the waste empties from the packaging without creating safety hazards for NSDF personnel. Exceptions and variances to this guidance may be accepted via the WAC Variance Process but, in general, criteria for bulk waste conditioning is:

- Demolition debris should be size reduced to 0.3 m or less in at least one dimension and sized to fit within the haulage container. Otherwise, debris can either be reduced to rubble or shipped in large blocks for direct placement in the disposal cell. Rebar in concrete debris shall be cut flush as far as practical. Waste acceptance personnel will assist generators with profiling large blocks of debris as required.
- Waste shall be placed in containers such that binding is eliminated during unloading. As examples, significant amounts of pipe could be segregated and organized to prevent binding as the container is dumped, assemblies of rebar shall be packaged such that no binding is encountered as a package is dumped and operational hazards for placement and compaction operations are mitigated.
- As far as practical, reduce the subsidence impact of large diameter, small gauge pipe by crushing or other means.
- Containers for transportation of bulk waste shall be packaged in a manner that minimizes container contamination during the unloading process (e.g., container liners or plastic wrapped contents).

5.2 Oversize Debris

There are instances where the physical size or mass of discrete waste items may not be practically conditioned to meet the bulk waste physical properties required by Section 5.1. Exceptions will require advance planning to implement special handling or hazard mitigation measures; waste acceptance personnel will assist generators with profiling oversize materials through the WAC Variance process. If acceptable, such wastes sill be categorized as Type 6.

5.3 Thermal Properties

Waste accepted in the NSDF will have minimal decay heat generating properties. Waste is limited to a thermal power rate of ≤2 kW/m^3 [10].

5.4 Asbestos Waste

In addition to marking and labeling requirements for radioactive material, Asbestos Containing Material (ACM) must be packaged for disposal in accordance with the Ontario Environmental Protection Act, Regulation 347. Documentation certifying compliance with Regulation 347 will become a part of the completed Waste Profile Form.

5.5 Hazardous Waste

Hazardous materials, unless as a co-contaminant in mixed waste meeting LDR as provided in Ontario Environmental Protection Act, Regulation 347 will not be accepted for disposal in the NSDF. Documentation certifying compliance with LDR will become a part of the completed Waste Profile Form.

5.6 Free Standing Liquids

The NSDF will only accept solid waste with no free standing liquids (≤1% free standing liquids by mass) [5]. Wastes that have been rendered solid via stabilization (e.g., cementation) or pre-treatment are required to meet this performance objective.

The use of absorbents is acceptable for small, incidental amounts of free liquid or to prevent the presence of condensate upon delivery to the NSDF.

Examples of acceptable absorbents are:

- Aquaset
- Petroset
- Bentonite
- NOCHAR and,
- Others expressly approved on the Waste Profile Form, Appendix A.

5.7 Prohibited Waste

Wastes specified in this section shall not be accepted for disposal in the NSDF.

- Putrescible or other wastes that generate noxious gases is not acceptable unless appropriately treated before disposal (e.g., animal carcasses treated with an equal mass of lime).
- No pyrophoric, explosive, or dangerously reactive materials will be accepted.
- No compressed gases will be accepted for disposal at the NSDF. Compressed gas containers shall be permanently vented before disposal. Asphyxiating gases are prohibited from disposal.
- No significant quantities of biomedical, infectious, or pathogenic waste will be accepted for disposal.
- Waste containing polychlorinated biphenyls (PCBs) exceeding 50 ppm will not be accepted. Waste with PCB concentrations above 10 ppm will be acceptable, but require treatment before disposal.
- Corrosive, ignitable, or oxidizing materials will not be accepted for disposal. Ignitable materials include solids that can be ignited at ambient temperature by friction or spontaneous chemical changes.

- Waste containing chelating agents will not be accepted unless the chelating agent is less than 0.1% of the waste by mass.
- Asbestos will not be accepted unless the waste meets all requirements of the Ontario Environmental Protection Act, Regulation 347, General-Waste Management.
- Liquid and gaseous petroleum products will not be accepted, but solid hydrocarbon materials such as bituminous waste and plastics are acceptable.
- Batteries will not be accepted unless the materials meet the criteria of the Ontario Environmental Protection Act, Regulation 347, General-Waste Management.
- IAEA Safeguarded Materials are prohibited. In general, if waste meets the criteria requiring an Inventory Change Document (ICD), it will not be accepted into the NSDF.

6. RADIOLOGICAL PROPERTIES OF WASTE

The following guidance covers limits for the radiological properties of waste streams that will be generated during D&D of buildings and structures, remediation of soils and waste generated by everyday operations at site facilities. These limits will be used to define disposal readiness while packages that exceed the limits provided here require more detailed evaluation and may be acceptable for disposal through the waste acceptance variance process.

6.1 ALARA Applied to NSDF Waste Types

Permissible bulk waste radionuclide concentrations are limited to minimize worker dose and leachate concentrations. Bulk wastes are the lowest radiological hazard wastes and include Waste Types 1 through 4 and Type 6 that meet corresponding concentration limits.

Standard waste packaging provides a measure of safety by the immobilization of radioactivity for a period of time equivalent to the package lifespan in the NSDF. This is useful for packaging small volumes of waste at radionuclide concentrations greater than bulk waste streams but less than those requiring longer periods of radionuclide immobilization.

To increase the margin of safety for waste streams at the upper range of radionuclide concentration for mobile long-lived radionuclides, stabilization will be incorporated to immobilize the waste and reduce radionuclide concentrations in leachate and dose risk from post closure Human Intrusion scenarios. Specific guidance on waste stabilization can be found in Technical Note 232-508600-430-000, “NSDF-Acceptable Waste Packaging” [11].

The effect of the application of these ALARA measures to the NSDF radionuclide concentration limits provided by the Safety Criteria established 3 categories of waste packages for the NSDF WAC:

1. Bulk Waste (Types 1 through 4 and Type 6)
2. Standard Waste Packages (Type 5), and
3. Stabilized Waste Packages (Type 5 – Stabilized)

Limits on radionuclide concentration for the 3 categories is provided in Table 6-1.

6.2 Radionuclide Concentrations

The radionuclide concentration limit is a value expressed in Bq/g that must not be exceeded for a single radionuclide or in the case of a mixture of radionuclides; the sum of the component radionuclide fractions in the mixture must not exceed 1 to demonstrate compliance and referred to as the “Sum of Fractions” rule. Expressed mathematically:

$$\sum_{i=1}^{\infty} \frac{\text{Concentration of Radionuclide i}}{\text{Limit for Radionuclide i}} \leq 1$$

Limits for acceptable radionuclide concentrations are provided in Table 6-1.

Table 6-1, Radionuclide Concentrations in Waste

Bulk Waste (Types 1-4, Type 6)	- 100 Bq/g for α emitting radionuclides - 1,000 Bq/g for long-lived βϒ emitting radionuclides ($t_{1/2}$ > 30 years) - 10,000 Bq/g for short-lived βϒ emitting radionuclides - 100,000 Bq/g for Tritium
Packaged Waste (Type 5)	- 400 Bq/g for α emitting radionuclides - 10,000 Bq/g for long-lived βϒ emitting radionuclides ($t_{1/2}$ > 30 years) - 10,000 Bq/g for Cs-137 and Sr-90 - 10,000,000 Bq/g for Tritium
Stabilized Waste (Type 5)	- 4,000 Bq/g for α emitting radionuclides - 50,000 Bq/g for long-lived βϒ emitting radionuclides ($t_{1/2}$ > 30 years) - 100,000,000 Bq/g for Cs-137 and Sr-90

6.3 Fissionable Material in Waste Packages

As a part of the characterization of a structure or land unit, the presence and quantity of Fissionable Material (FM) must be identified. The Nuclear Criticality Control Officer is responsible to ensure that waste received for disposal at the NSDF follows all limits and restrictions in the accepted Criticality Safety Document (CSD) [8]. Waste that does not meet the limits and restrictions in the CSD shall not be accepted at NSDF without prior additional criticality safety analysis and acceptance by the Nuclear Criticality Safety Panel.

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6.4 NSDF Total Radioactivity

The total radioactivity of NSDF at closure is limited by the Safety Criteria. Maximum Total Radioactivities have been determined for each radionuclide ensure that long-term Safety Criteria are met. A set of 11 radionuclides was defined as “Significant Radionuclides” in the context of long-term safety performance. This list includes Am-241, C-14, C-36, I-129, Nb-94,

Pu-239, Ra-226, Tc-99, Th-230, U-234 and U-238. The Waste Generator is required to determine if any of Significant Radionuclides are present, to assess their quantities in accordance with waste characterization requirements and to communicate corresponding inventories for each waste stream using the Waste Acceptance Process. NSDF Operations will be responsible for tracking the inventory of Significant Radionuclides and ensuring that the limits are not exceeded.

7. WASTE PACKAGING GUIDANCE

This section provides guidance for waste packages considered to be disposal ready. Other waste packaging may be approved on a case by case basis. More information is provided in CNL document 232-508600-430-000, "NSDF Waste Packaging" [11].

7.1 Bulk Waste Packages

This section applies to packaged waste Types 1 through 4. For bulk waste packages, waste is placed large capacity transportation containers with a sacrificial liner for direct dumping into the disposal cell at the NSDF. The liner serves to aid the dumping operation as well as minimize cross contamination of the transportation container by the waste contents.

7.1.1 Bulk Waste Packaging

Bulk waste packages utilize multiple-use containers capable of being dumped directly into a disposal cell.

Examples of multiple-use bulk containers include:

- Large ISO freight containers, commonly called sea-land containers typically 20' and 40' and may be equipped with top or side-loading features along with end doors. Transportation is by either specially equipped truck. Volumetric capacity is from 25 m^3 to 50 m^3 and may weigh up to 36,000 kg [13].
- Roll-off containers up to 40 m^3 in capacity equipped with a hard top and a single end door. Various duty ratings are available and are transported with specially equipped trucks. Gross weight may be up to 36,000 kg.
- Intermodal waste containers, ~25 m^3 in capacity are designed specifically for packaging waste building debris, soil-like material and concrete rubble; are equipped with a top loading feature and a single end door. Various duty rated options are available including Type A, IP-1 and IP-2 Industrial Containers. Transportation is usually via a specially equipped truck. Gross weight may be up to 36,000 kg.

7.2 Direct Disposal Packages

This section and its subsections apply only to Type 5 waste being prepared for direct disposal. The container must be compatible with the chemical and physical properties of the packaged waste and waste shall be packaged in a form that minimizes settling and subsidence in the NSDF to the maximum extent feasible.

Packages shall have a label or another unique identifier affixed to facilitate waste tracking. The label will aid in associating wastes to characterization records. A permanent record containing waste package identification labels and characterization data is required.

7.2.1 Direct Disposal Packaging

Single use containers are used to package waste for direct disposal and include:

- Drums and pails which may be galvanized, stainless, carbon steel, or plastic; up to 386 liters and a mass ≤450 kg
- Waste Boxes which may be galvanized steel, stainless steel, carbon steel or wood up to 2.7 m^3 and a mass of ≤4500 kg
- Custom packaging specifically designed with integral treatment internals such as filters, ion exchange columns or other features that are disposed directly as a package
- Soft-sided packaging
- Standard and modified ISO containers
- Stabilized Waste Packages

7.2.2 Container Void Fraction

The internal void fraction for direct disposal packages is limited to a maximum of 10% to minimize differential subsidence of the engineered mound as packages and waste break down (decomposition). Direct disposal waste packages shall either have void space filled with non-compactable waste or be capable of being compacted in the disposal cell. Non-crushable direct disposal packages are required to be evenly loaded and voids filled with non-compactable material. Under special circumstances, grout may be used to fill void spaces of containers and waste acceptance personnel will assist generators with special handling coordination and profiling.

7.2.3 Stabilized Waste Packages

A structurally stable waste form that will generally maintain its physical dimensions and its form under the expected disposal conditions such as weight of overburden and compaction equipment, the presence of moisture, microbial activity, and internal factors such as radiation effects and chemical changes. Structural stability can be provided by the waste form itself, processing the waste to a stable form, or placing the waste in a disposal container or structure that provides stability after disposal.

Additional guidance on waste stabilization can be found in CNL, 2017, “NSDF-Acceptable Waste Packaging’, 232-508600-430-000, Revision 1 [11].

7.3 Lead Shielding in Waste Packages

As general guidance, the presence of lead, contaminated or otherwise, in waste packages is not acceptable for disposal at the NSDF. The use of lead shielding as a component of a waste package offered for disposal will be evaluated and approved on a case-by-case basis through the waste profiling process. The waste generator shall identify the amount of lead shielding proposed for waste packages on the Waste Profile Form.

7.4 Waste Package Marking and Labeling

Packages shall have a label or another unique identifier in order to facilitate waste tracking. This is also to aid in associating wastes to characterization records. A permanent record containing waste package identification labels and characterization data is required.

8. CLASSIFICATION OF PACKAGES

Information must be collected or determined and recorded to classify and track each package generated under a Waste Profile. This includes package specific information like:

- Waste Profile number
- Package Identification number
- Packaging type
- Gross weight
- External exposure rate
- Removable contamination levels
- Source Term (radioactivity)
- Hazardous Waste Code (mixed waste)

8.1 External Surface Contamination on Waste Packages

The maximum non-fixed surface contamination on the outer surfaces of each waste package, averaged over 300 cm^2, must be less than 3.7 Bq/cm^2 $\beta^-\Upsilon$, and less than 0.37 Bq/cm^2 α or special arrangements must be made through the Waste Variance process.

8.2 Exposure Rates on Waste Packages

The majority of waste packages generated by D&D activities, environmental remediation and everyday site operations will be contact handled waste as defined here:

- The contact exposure rate on the external surfaces of a waste package is limited to 2 mSv/hr on any of the 6 sides of a rectangular package or from a cylindrical waste package.
- The 1 meter exposure rate on the external surfaces of a waste package is limited to 0.1 mSv/hr on any of the 6 sides of a rectangular package or from a cylindrical waste package.

Waste packages exceeding the external radiation exposure limits for contact handled packages will be accepted but require coordination with Waste Acceptance and NSDF Operations. Waste acceptance personnel will assist generators with Waste Profiling and procedures for storage and disposal of packages that exceed the external exposure rate limits.

9. WASTE ACCEPTANCE PROCESS

The waste acceptance process includes review and approval of generator's characterization information for waste streams to be disposed at the NSDF [14]. The characterization information is waste stream specific and is provided on the Waste Profile Form found in Appendix A. When the Waste Profile Form is completed and approved, the generator may then generate waste packages for disposal at the NSDF ensuring that packages comply with the limitations and specifications in the approved Waste Profile.

Waste acceptance personnel will monitor compliance to Waste Profiles to ensure their associated packages are compliant. This monitoring is performed through periodic review of Waste Profile requirements along with verification and confirmation inspections conducted on waste packages being generated and on incoming packages at the NSDF.

9.1 Waste Characterization

All waste to be disposed at the NSDF must be characterized for radiological and chemical constituents and physical properties sufficient to demonstrate that the waste meets the WAC. A characterization objectives process is a systematic planning tool that ensures sampling and analytical objectives are defined and is a critical component of characterization plans that meet NSDF quality assurance requirements as described in Section 11 and may include approved process knowledge and analytical methods. The characterization methods and analytical requirements shall be documented in a Characterization Plan (or equivalent) to ensure the targets of the WAC are captured.

The information required for physical, chemical, mechanical properties, and radiological characterization includes data from waste analysis and testing. Information also includes knowledge of materials and/or current and historic processes that generated the waste. Examples of information that may be used to support waste characterization are:

- Analytical data from a representative sample of the waste or waste generated by a suitable surrogate process;
- Material Safety Data Sheets (MSDS) for chemical materials;
- Mass balance data for the waste generating process, to the extent that such data provides a sufficient understanding of the characteristics and constituents in the waste stream;
- Historical information contained in CNL records and other sources;
- Interview information;
- Logbooks;
- Procurement records;
- Radiation work packages;

- Procedures and methods;
- Process flow charts;
- Inventory sheets (including fissile material inventory); and
- Vendor information.

These information sources require evaluation for reliability and confidence before being used to characterize waste properties. Waste characterization guidance can be found Section 5.1.1 which provides requirements for the quality of Acceptable Knowledge (AK) needed to adequately characterize waste. Useful guidance on waste characterization can be found in IAEA, 2007, "Strategy and Methodology for Radioactive Waste Characterization", IAEA-TECDOC-1537 [15].

9.1.1 Acceptable Knowledge Requirements

In general, waste knowledge must be representative, accurate, and adequately documented to determine waste stream designation and permit waste disposal at the NSDF in compliance with the WAC. Analytical data or other knowledge of the waste must be sufficient and defensible to adequately identify waste characteristics. Acceptable knowledge may be sufficient to establish that waste streams destined for disposal meet Land Disposal Requirements (LDR) for non-radioactive constituents under the Ontario Environmental Protection Act, Regulation 347, General Waste Management [6]. CNL will evaluate all waste stream information in determining acceptable knowledge. In some cases, qualitative knowledge of the waste generating process alone may be sufficient to determine whether a waste stream is subject to the Ontario Environmental Protection Act, Regulation 347 [6].

In the event that the available process and historical information is insufficient to assess against WAC specifications, a representative sample must be analyzed with an appropriate method and limit of detection. Selected methods, including waste sample selection, must also demonstrate proper quality control [14].

There may be cases where one or more waste constituents are present in a waste stream, but expected to have concentrations that do not exceed WAC limits. In these cases, sampling and analysis must be performed to demonstrate that these waste stream constituents are below WAC limits [3], [6]. Sampling and analysis shall be performed when available process knowledge is deemed insufficient or questionable.

Testing of a representative waste sample at an accredited laboratory is required when a generator or treatment facility asserts that a waste stream meets a concentration-based treatment standard either as prescribed by the Land Disposal Requirements provided in the Ontario Environmental Protection Act, Regulation 347, General-Waste Management [6] or the WAC. To demonstrate compliance, analytical data that underpins this claim shall be provided by the generator or treatment facility (i.e., a certification form which demonstrates that the waste was analyzed or an approved characterization report). If sampling and analysis are

performed, these tests are only required for initial characterization of a uniform waste stream or when changes to a process have impact on contaminant concentration or when a new waste constituent might be introduced.

Waste streams must undergo radiological characterization, which includes (at a minimum) the identification of all the Significant Radionuclides and their concentrations in the waste [14]. In addition, fissile radionuclide concentrations must be reported and thermal output from radioactive decay may be required for some waste streams.

All waste must be characterized such that the waste can be disposed of in accordance with the NSDF Safety Criteria based requirements of the WAC. This includes sufficient knowledge to demonstrate that the waste is not prohibited from disposal at the NSDF.

9.2 Operational Controls

An important aspect of creating waste packages is providing for the safe life-cycle management of the waste; it's conditioning and packaging such that the hazards present in the waste are controlled and, in turn, minimize worker and public exposure to hazards. From the point of generation to ultimate disposal, waste packages present hazards to personnel handling the packages, the staging/storage environment and ultimately, the disposal facility. To this end, operational controls may be imposed on the Waste Profile Form that ensure waste packages present the minimum impact to NSDF operations.

- **Contamination Controls** for materials with levels of removable, loose surface contamination exceeding 100 Bq/cm^2 $\beta^-\Upsilon$ or 1 Bq/cm^2 α are required to manage exposure risk for NSDF operations personnel and to limit dose to members of the public. Waste may require special wrapping, application of a fixative or other means of isolation to provide this protection. Some Type 1 through 4 waste may require containerization to provide contamination controls.
- **Dust Controls** may be required to manage fugitive dust emissions from the NSDF.
- **Industrial Safety Controls** for mitigating industrial safety hazards such as flying objects, tangled or "log jammed" materials, or large heavy objects may be required to aid safe handling at the NSDF.
- **Environmental Controls** may be required to manage wildlife intrusion, spills or other risks to the environment.
- **Special Handling** may be required to load or offload oversize debris, prepare lift plans for overweight items or prepare special instructions and/or ALARA evaluations for high exposure rate packages. Special handling may also be required to place certain materials in a disposal cell at the NSDF.

9.3 Waste Profile Form

The Waste Profile Form is required for each waste stream being packaged for disposal at the NSDF. The waste generator initiates the process by providing a description of the physical properties, radiological and chemical characterization data, the hazardous waste status and estimated waste volume. Additionally, the identification of any unique properties of the waste such as large heavy objects, materials bearing high dust loadings or materials that may require special handling at the NSDF for management of operational safety hazards. Waste acceptance personnel will assist generators with the completion of the Waste Profile Form as required.

Waste acceptance personnel will assist the generator with completion of the form, packaging specification and any operational controls that may be required. Once a Waste Profile is approved, the generator will ensure compliance with the Waste Profile; Waste Advisors will assist generators with compliance monitoring in the field. The Waste Profile Form is provided in Appendix A.

9.4 Waste Acceptance Criteria Variance Process

Wastes that do not meet the WAC may be considered for disposal on a case-by-case basis through the WAC Variance process. The WAC Variance process will be used to evaluate disposal of discrete materials that do not satisfy waste conditioning criteria, exceed radioactivity or hazardous substance concentration limits or other WAC limitations. In no case will waste that exceeds the limits of the NSDF Safety Criteria be accepted. This may include wastes with excessive odour or the potential to generate excessive dust. In order to obtain a variance for a specific waste, the following assessment must be performed:

- The waste will be analyzed to identify the radiological, chemical, or physical criterion or criteria that cannot be met.
- Waste acceptance personnel will perform an assessment of the waste against the NSDF Safety Criteria to determine whether a case can be made that supports acceptability for disposal.
- If a case can be made, the NSDF organization will develop a process for disposal. This may include special handling requirements or require that additional processing be undertaken to make the waste acceptable.
- If a case cannot be made, the NSDF will not accept the waste for disposal. The generator will have to make other arrangements such as waste processing and treatment to achieve WAC compliance or; storage pending disposal at a suitable facility.

10. QUALITY CONTROLS

Quality Assurance programs for waste generating activities that create waste packages for disposal at the NSDF will be implemented under the general guidance of the CNL QA Program. The following quality controls provide assurance that NSDF activities are managed to safety basis commitments.

10.1 Characterization Objectives Process

A characterization objectives process is a series of logical steps that guides a characterization plan for the resource-effective acquisition of data. It is both flexible and iterative, and applies to both decision-making (e.g., compliance/non-compliance with a standard) and estimation (e.g., ascertaining the mean concentration level of a contaminant). A characterization objectives process is used to establish performance and acceptance criteria, which serve as the basis for designing a characterization plan for collecting data of sufficient quality and quantity to support the goals of the plan. The use of a characterization objectives process leads to efficient and effective expenditure of resources; consensus on the type, quality, and quantity of data needed to meet characterization goals. Useful guidance for a characterization objectives process (the Data Quality Objectives process) can be found in USEPA, 2006, "Guidance on Systematic Planning Using the Data Quality Objectives Process", EPA QA/G-4 [16].

10.2 Waste Certification

The WAC process requires waste to be certified. Certification requires the generator to submit information on its quality procedures that control the characterization of waste streams and classification of waste packages. Waste acceptance personnel will conduct audits and inspections of generator waste activities to ensure that adequate controls are in place to accurately characterize, package, and handle waste. The generator must demonstrate adherence to an approved Quality Assurance Program (QAP) [17] to ensure that documentation is adequate, laboratory analyses are conducted in accordance with approved procedures, and record keeping is sufficient to support waste stream characterization and classification.

Waste generators must implement and maintain a waste generator certification program to ensure that any waste the generators send to the NSDF meets the WAC. Non-conforming waste may be rejected at the point of delivery and returned to the generator for resolution. There is no obligation for the NSDF organization to correct the generators' non-conformances or dispose of non-conforming waste.

10.3 Program Inspection, Surveillance and Audit

Periodically, Waste generator's programs, processes and controls will be reviewed with surveillances and audits to identify non-compliances or areas for improvement. Individual waste packages will be evaluated for compliance as they are received at the NSDF.

11. RECORDKEEPING

Recordkeeping requirements for waste management process are provided in AECL, 2010, “Management of Waste Management Records”, CW-508600-REQ-119, Revision 0 [12].

12. REFERENCES

[1] Canadian Nuclear Laboratories, *Performance Assessment for Near Surface Disposal Facility to support the Environmental Impact Statement*, 232-509240-ASD-001, Rev. 0.

[2] Canadian Nuclear Laboratories, *Safety Analysis Report*, 232-503230-SAR-001, Deliverable 3.10, Rev. E, 2017.

[3] Canadian Nuclear Laboratories, Technical Note, *Derivation of Specific Activity Limits for NSDF Waste Streams*, 232-01622-TN-001, Rev. 0.

[4] IAEA, *Near Surface Disposal Facilities for Radioactive Waste*, Specific Safety Guide No. SSG-29, 2014.

[5] Canadian Nuclear Laboratories, Plan, *Waste Placement and Compaction Plan*, B1550-508600-PLA-001, Deliverable 14.1, Rev. C, 2017.

[6] Ontario Provincial Regulation, *General Waste Management*, RRO 1990, 347.

[7] Canadian Nuclear Laboratories, *Design Requirements,* 232-503212-DR-001, Deliverable 2.1, Rev. C, 2017.

[8] Canadian Nuclear Laboratories, *Criticality Safety Document,* NSDF-503230-CSD-001, Deliverable 3.8

[9] Atomic Energy of Canada Ltd., *AECL's Radiation Protection Requirements*, RC-2000-633-0, Rev. 2, 2000.

[10] IAEA, *Classification of Radioactive Waste*, General Safety Guide No. GSG-1, 2009.

[11] Canadian Nuclear Laboratories, *NSDF Acceptable Waste Packaging*, 232-508600-430-000, Rev. 1, 2017.

[12] Atomic Energy of Canada Ltd., *Management of Waste Management Records*, CW-508600-REQ-119, Rev. 0, 2010.

[13] International Organization for Standardization (ISO), Series 1 Freight Containers Classification, Dimensions, and Ratings, Amendment 2, ISO 668:2013 / Amd.2.2016(E).

[14] Canadian Nuclear Laboratories, *Waste Characterization*, 900-508600-MCP-001, Placeholder for draft D&WM MCP, 2017.

[15] IAEA, *Strategy and Methodology for Radioactive Waste Characterization,* IAEA-TECDOC-1537, 2007.

[16] USEPA, *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4, 2006.

[17] Canadian Nuclear Laboratories, *Manual Quality Assurance,* 900-514200-MAN-001, Rev. 1, 2016.

Appendix A

Waste Profile Form

Waste Management Plan (WMP): Waste Profile Number: Waste Identification Checklist (WIC):
SECTION 1: Waste Generator Information
Site Location: Building Number/Remediation Area:
SECTION 2: Waste Information
1. Waste Description (materials, estimated volume and mass):
2. Waste Composition and estimated percentage Asphalt ☐ % Concrete ☐ % Glass ☐ % Metal ☐ % Paper ☐ % Plastic ☐ % Wood ☐ % Asbestos ☐ % Asphalt Roofing Material ☐ % Soil ☐ % Rock ☐ % Vegetation ☐ % Other ☐ % (Provide description and percentage)
3. Provide a brief narrative of any Process Knowledge used for characterization and attach supporting documentation.

Appendix A, Waste Profile Form, page 2

4. Does the waste present challenges to compliance with the bulk waste dimensions in Section 6.2? If yes, provide a description of the challenge:

5. Is waste to be stabilized by solidification with concrete or grout? Yes ☐ No ☐

   If yes, provide Process Control Program documentation as an attachment.

6. Does/would the waste in its final packaged form have the potential for free standing liquids ≥1% by volume?

   Yes ☐ No ☐

SECTION 3: Chemical Properties

1. Is the waste "Mixed Waste"?

   Yes ☐ No ☐

2. Has the waste been treated to the Land Disposal Requirements of Ontario Regulation 347?

   Yes ☐ No ☐ If Yes, attach supporting documentation

Appendix A, Waste Profile Form, page 3

SECTION 4: Radiological Properties

1. Provide radionuclide concentrations of the waste and perform sum of fractions tests for Bulk, Packaged and Stabilized limits from Table 6-1*. Attach characterization report.

Radionuclide	Concentration (Bq/g)	$\frac{Concentration}{Waste\ Type\ 1-4\ limit}$	$\frac{Concentration}{Waste\ Type\ 5\ limit}$	$\frac{Concentration}{Waste\ Type\ 5\ Stabilized\ limit}$
Sum of Fractions				

*The calculation may be performed directly in this form or provided as an attachment.

2. If the waste contains Fissionable Material (FM) provide the following information.

FM Radionuclide	Mass of FM Radionuclide in the estimated total mass of the waste (g)	Estimated total mass of the waste from Section 2-1 (kg)

If the waste has fissionable material radionuclides, attach the characterization report and Exception Memo from the Nuclear Materials and Safeguards Management Program (NNSM).

Appendix A, Waste Profile Form, page 4

3. [redacted]

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	[redacted]		

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[redacted] ☐

[redacted]

[redacted] ☐

[redacted]

4. What are the removable contamination levels on the waste?

α Bq/cm^2 β¯ϒ Bq/cm^2

5. For Type-5 Stabilized waste only, what is the thermal heat generation rate?

kW/m^3

Appendix A, Waste Profile Form, page 5

SECTION 5: Waste Type Determination	
Type 1 Waste – This refers to soil and soil-like wastes. It includes contaminated soils and other waste materials with characteristics similar to soil that can be placed within the mound with little to no handling requirements beyond what would be used for soil fills. For example, contaminated chipped wood material.	☐
Type 2 Waste – Comingled radioactive waste, debris, refuse and soil and soil-like waste. It includes wastes that are anticipated to be at least 50% soil or soil-like in nature. It also contains varying amounts of radioactive wastes that require additional handling procedures beyond those for Type 1 wastes.	☐
Type 3 Waste – Non-soil-like waste, it includes materials that can be excavated and handled as bulk materials but do not have the physical characteristics of soil and soil-like materials. These include process wastes, highly organic wastes, highly compressible wastes, flowing wastes and similar waste types.	☐
Type 4 Waste – This refers to decommissioning and demolition waste. It includes typical materials used in construction, such as: concrete, asphalt, brick, lumber, structural steel, process equipment, piping and other building materials produced by decommissioning and demolition activities.	☐
Type 5 Waste – Standard packaged waste, it includes a variety of contaminated wastes including wastes contained in large shipping containers, B-25 boxes, drums, buckets, pails and similar containers. These wastes also typically require special handling and procedures for placement and containment within the mound.	☐
Type 5 Waste (Stabilized) – A structurally stable waste form that will generally maintain its physical dimensions and its form under the expected disposal conditions such as weight of overburden and compaction equipment, the presence of moisture, microbial activity, and internal factors such as radiation effects and chemical changes. Structural stability can be provided by the waste form itself, processing the waste to a stable form, or placing the waste in a disposal container or structure that provides stability after disposal.	☐
Type 6 Waste – Miscellaneous Waste, It includes waste outside the definition of waste Types 1 through 5. Includes waste that requires special planning for acceptance or emplacement. (e.g.; oversize debris, shielded consignments)	☐

Appendix A, Waste Profile Form, page 6

SECTION 6: Container/Packaging
1. Provide the packaging used for previously packaged waste.
2. For Waste Types 1 and 2, provide moisture content.
3. Is/will the waste packaged in bags? Yes ☐ No ☐ If Yes, what type of bag is proposed/required? Asbestos Bag ☐ Soft-Sided Waste Bag ☐ What is the estimated total mass in kg and volume in m^3 of the waste in each bag? kg m^3

Attachments (Check all applicable, note others as required):

- ☐ Process Knowledge supporting documentation
- ☐ Characterization Report/Data
- ☐ Asbestos packaging compliance documentation
- ☐ Waste Solidification documentation (PCP and bench test results)
- ☐ LDR compliance documentation
- ☐ Inventory Control Exception Memo
- ☐ Photos/Images

Appendix A, Waste Profile Form, page 7

SECTION 7: Generator Certification
I certify that the information in Sections 1 through 6 of this form and the applicable attachments are fully disclosed. A good faith effort has been put forward to acquire and verify the information. Willful or deliberate omissions have not been made, and all known and suspected hazards have, to the best of my knowledge, been identified. Print/Type Name Signature Date
SECTION 8: Waste Disposition Path Determination (Completed by waste acceptance)
1. Is the information provided, other than container specific information (e.g., the container source term, dose rates), adequate for the waste determination, management, transportation, treatment, and disposal of waste? If No, provide additional information or analysis needed. Yes ☐ No ☐ Description of additional information required: Additional information received date: Information accepted Yes ☐ No ☐
2. Does the waste require further treatment? Yes ☐ No ☐ If yes, what treatment is required?
3. NSDF Waste Type
4. Packaging to be used for this waste profile
5. Waste Disposition Path

Appendix A, Waste Profile Form, page 8

6. Operational controls required for waste packaging:

☐ Absorbent material to absorb incidental moisture

☐ Poly liner in bulk waste packages

☐ Apply fixative to waste for fugitive dust/contamination control

☐ Wrap items that exceed 100 Bq/cm^2 β^- Υ or 1 Bq/cm^2 α

☐ Band sections of pipe together

Other:

7. Certification

I certify that the information on this form (including the attachments) is fully disclosed and accurate

_____	_____	_____
Waste Acceptance Technical Representative	Signature	Date

8. Approval

This Waste Profile is Approved

_____	_____	_____
Waste Acceptance	Signature	Date