APPENDIX A

Descriptions of Preferred Technologies

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Descriptions of Preferred Technologies

1. No Further Action

No Further Action is a general corrective measure used to provide a baseline for comparison against remedial action technologies. Under the No Further Action response, institutional controls are optional. No Further Action may include long-term monitoring, long-term surveillance and maintenance, and long-term access controls. The No Further Action response without institutional controls is not appropriate for the MWL. The No Further Action response with institutional controls, however, is appropriate for the MWL and is retained for baseline comparison analysis. The No Further Action response with institutional controls is readily implementable and the least expensive response action possible.

2. Institutional Controls

Institutional controls are passive measures that are used to prevent unacceptable exposure to contaminants that could pose risks to human health and the environment. They are typically used in conjunction with structural engineering controls as part of a final remedy. Effective institutional controls must be low-cost, highly effective, easily implementable, and adaptable over relatively long periods of time. Often, they must outlive the institutions that create them. Thus, they need to be easily transferred to subsequent authorities having control of the land under consideration.

Institutional controls require clear human responsibilities and the active performance of measures to achieve these responsibilities. Examples are controlling access to a closed site by means of security guards; performing frequent, site surveillance and maintenance; controlling or cleaning up releases; or monitoring environmental parameters related to remedial measure(s) performance. Institutional controls depend on the design of controls and engineering structures. Examples are permanent markers or monuments placed at a closed site; public records and archives; government ownership and regulations regarding land or resource use; and other methods of preserving knowledge about a specific location, design, and contents of a closed site. Structural controls include physical barriers such as gates, fences, and natural barriers to keep mammals and trespassers away from a site; signs to warn people of dangers; and engineered barriers that contain or restrict actual or potential contaminant migration.

2.1 Long-Term Monitoring

Long-term environmental monitoring is used to measure the physical and/or chemical properties of an environmental medium, such as soil, air, biota, surface water, or groundwater. For remedial action applications, monitoring may be used to detect surface and/or subsurface releases from waste management or disposal facilities, to characterize temporal variations, or to document the progress and performance of remedial action.

Monitoring of soil or stream sediment is used to evaluate the nature and extent of contaminants, the physical characteristics of the contaminated materials, or the effectiveness of remediation. Physical characteristics such as subsidence may also be monitored. Soil vapor monitoring is commonly used to verify the effectiveness of vapor extraction systems or other treatment systems. Surface water monitoring uses various methods to characterize water quality in streams, wetlands, or other impoundments. Monitoring may also require the use of devices to measure volumetric flow rates in streams or pipes. Groundwater monitoring typically involves the use of monitoring wells and/or piezometers. Monitoring wells are designed to measure groundwater elevation, perform aquifer pumping tests, or collect groundwater samples for analysis. Piezometers are designed primarily to measure groundwater elevations only.

Long-term monitoring provides a degree of protection of human health and the environment and is relatively simple to implement. It is an implicit part of all corrective measures alternatives for the MWL. Long-term environmental monitoring alone is not responsive to corrective action objectives but when used in conjunction with other technologies, may increase the overall effectiveness of corrective measures.

2.2 Long-Term Site Surveillance and Maintenance

Long-term site surveillance and maintenance includes on-site activities designed to help recognize and control waste sites and promote the longevity of other remedial responses. Typical activities include controlling vegetation (mulching/seeding), limited grading to fill areas of subsidence and erosion, and maintenance of site drainage features to minimize the formation of the rills and gullies. Site maintenance may also include maintaining perimeter security fences, warning signs, and monuments.

Long-term site surveillance and maintenance controls provide a degree of protection of human health and the environment and are relatively simple to implement. It is an implicit part of all corrective measures alternatives for the MWL. Long-term site surveillance and maintenance alone is not responsive to corrective action objectives but when used in conjunction with other technologies, may increase the overall effectiveness of corrective measures.

2.3 Long-Term Access Controls

Long-term access controls include measures involving temporary or permanent physical restrictions to prevent or reduce animal and human exposure to contaminants. Controls can also be used to prevent vandalism of on-site remedial equipment or disturbance of containment and monitoring systems. Regular monitoring and maintenance of access controls is required for the measures to effectively deter site trespass. Access controls generally include site security measures such as fences and signs. Fences are used to completely surround the restricted area. Fences must be in good repair. Signs are posted around the facility with a legend warning of the hazard at the site. They are posted at each entrance to the restricted unit and at other appropriate locations in sufficient numbers to be seen from any approach.

In addition to access controls, administrative controls such as land use restrictions may also be used to prevent or reduce future human or environmental exposure to contaminants remaining at the site. Excavation permit restrictions may be used to permanently prohibit excavation or subsurface construction. Land use restrictions may also be a temporary measure used while other remedial actions are taking place.

In the long-term, if the property were ever to be transferred to non-federal ownership, the U.S. Government would create a deed for the new property owner. The deed would include notification disclosing the former waste management and disposal activities, as well as remedial actions taken at the site, and any continuing monitoring commitments. The deed notification would, in perpetuity, notify any potential purchaser that the property had been used for the management and disposal of hazardous waste. The deed would also include deed restrictions precluding residential use of the property. However, the need for these deed restrictions may be re-evaluated at the time of transfer in the event that contamination no longer poses an unacceptable risk under industrial use. In addition, if the site were ever to be transferred to non-federal ownership, a survey plat of the area would be prepared, certified by a professional land surveyor, and recorded with the appropriate county recording agency.

Access and administrative controls provide a degree of protection of human health and the environment and are relatively simple to implement. They are an implicit part of all corrective measures alternatives for the MWL. Long-term access controls alone are not responsive to corrective action objectives but when used in conjunction with other technologies, may increase the overall effectiveness of corrective measures.

3. Containment Technologies

Containment technologies involve the construction of a barrier to isolate contaminated media. When properly constructed and maintained, containment technologies can provide a reliable and effective method for controlling direct exposure to waste and minimizing contaminant transport through leaching, erosion, and/or bio-uptake.

3.1 Vegetative Soil Cover

This technology involves the deployment of a monolithic soil cover to limit water infiltration and direct surface water away from a disposal site. A diverse community of native plants would be established on the cover to extract water and mitigate wind and water erosion. A cover constructed of natural materials will function with minimal maintenance over the long-term as a natural ecosystem.

The goal of the EPA-recommended design of landfill caps is to minimize the formation of leachate by minimizing the contact of water with waste, to minimize further maintenance, and to protect human health and the environment considering future use of the site. The EPA accepts alternative designs that consider site-specific conditions, such as climate and the nature of the waste, that meet the intent of the regulations. A fundamental concern of the EPA with cap designs is that all components are stable, and that the cap performs as intended without posing a significant risk to human health and the environment.

Vegetative soil covers are composed of multiple lifts of compacted, native soil. The cover is built by adding successive lifts of native soil over an existing landfill surface to form a soil monolith of sufficient thickness to store precipitation and support a healthy vegetative community. A topsoil layer is added that is seeded with native vegetation to mitigate surface erosion and promote evapotranspiration. During the institutional control period, native soil can be added to the cover as needed to correct subsidence resulting from degradation of buried waste containers and rills that may result from surface erosion. At the end of institutional control, additional native soil can be added to accommodate any future subsidence and erosion. Because the cover is constructed without rigid layers, it can accommodate differential subsidence without undue impairment of its performance.

Vegetative covers are intended to meet the RCRA requirements of Title 40 CFR 264.310. Vegetative soil covers minimize water migration into contaminated media. Cover maintenance is minimized by using a monolithic soil layer. Individual layers, such as those used in traditional RCRA Subtitle C caps, are rigid and would require extensive maintenance and repair due to deterioration. Cover erosion is minimized by using erosion control measures such as gravel admixtures within the topsoil layer. Covers are centrally crowned and sloped at 2 to 5 percent. Subsidence is accommodated by using a “soft,” self-healing design. The permeability of cover soils is less than or equal to the permeability surrounding subsoils eliminating the “bathtub” effect.

Performance of alternative covers cannot be isolated from the performance of the prospective site. Natural site conditions, integrated with the cover, produce a “system performance” that will ensure that the alternative design adequately meets the regulatory requirements and functions as a natural ecosystem. Institutional controls, such as environmental monitoring, site surveillance and maintenance, and access controls are also components of this response action.

3.2 Structural Barriers

This technology involves the deployment of a single-layer concrete slab on grade or asphalt barrier on grade to minimize water infiltration. This technology would also mitigate biological and inadvertent human intrusion. This technology is usually reserved for temporary or short-term use in controlling the vertical migration of contaminants by reducing or eliminating surface water percolation through the soil column. Support for a robust concrete structure may require dynamic compaction of soils or placement of pilings.

Various structural cap designs and capping materials are available. Common structural caps include concrete slabs placed on grade or thin-shelled concrete or steel domes. The design must include sloping and drainage control. These materials are readily available, and construction costs for structural barriers are low in comparison to more complicated, composite cap designs.

Structural caps are generally supported either by pilings or by the disposal site surface. Pile-supported caps are less sensitive to settlement of the subbase, but may require extensive intrusive activities to place the pilings. Barriers that are supported by the disposal area surface do not require extensive intrusive activities, but generally require compaction of the surface prior to barrier construction. The selection of the design and materials depends on the nature of the site to be covered, the function and design life of the barrier, the local climate and hydrogeology, the geotechnical considerations that affect settling potential, the availability of materials, and the intended future use of the site.

The integrity of a structural barrier is susceptible to weathering effects, such as rusting and corrosion, differential settlement of underlying material, and loading. Deterioration of barriers leads to cracking and breaching, enabling water to reach the waste. Consequently, barrier integrity must be maintained as long as the contaminants continue to pose a potential threat to human health or the environment. Maintenance includes inspections, vegetation control, monitoring for evidence of subsidence, routine repair, and eventual replacement.

Structural barriers employ well-established materials and are designed for short-term durability. However, their maintenance costs are high and the effectiveness of barriers is limited because of their susceptibility to weathering, cracking, subsidence, and loading.

3.3 RCRA Subtitle C Caps

This technology involves the construction of an engineered cap using natural and synthetic materials. A RCRA Subtitle C cap is composed of a minimum of three layers: 1) an uppermost vegetation/soil layer, underlain by a minimum of 24 in. of compacted soil sloped between 3 and 5 percent; 2) a drainage layer, a minimum of 12 in. of sand, underlain by a flexible membrane liner to convey water out of the cap; and 3) a lowermost moisture barrier, a minimum of 24 in. of compacted clay, to prevent infiltration. The primary function of a RCRA cap is to limit water infiltration into waste disposal cells in order to minimize creation of leachate that could migrate to groundwater.

Natural clay or soil amended with bentonite is commonly used for the lowermost moisture barrier. The permeability of this compacted clay layer is required to be no more than 1.0×10^{-7} cm/s. The overlying drainage layer allows lateral drainage off of and away from the moisture barrier. It is generally composed of a sand or gravel layer that is placed on a flexible membrane liner that overlies the moisture barrier. Under normal, unsaturated conditions, the drainage layer acts as a capillary barrier; i.e., the large pores of the sand or gravel inhibit capillary flow from the overlying soil layer. Under saturated conditions, such as might occur after heavy rainfall, the drainage layer serves as a high permeability conduit to drain water laterally off the compacted clay layer to the perimeter of the cap. The upper soil layer would consist of compacted soil of sufficient thickness to store precipitation and support a healthy vegetative community.

3.4 Bio-Intrusion Barriers

This technology involves the use of gravel and cobbles (rip rap), woven wire mesh, or other materials to limit intrusion by deep-rooted plants and burrowing mammals. The purpose of a bio-intrusion barrier is to minimize intrusion into waste disposal cells and to extend the life of a cap or cover by minimizing degradation from biotic intrusion. If a bio-intrusion barrier were constructed from a resistant material such as granite or quartzite, the layer may also serve as an effective human intrusion barrier. A bio-intrusion barrier can extend the lifetime of a cover by preventing intrusion by deep-rooted plants and burrowing mammals. Even if a bio-intrusion barrier consisting of gravel and cobbles or woven wire mesh were deployed, it would not be effective against ants, the largest potential biomass that may penetrate a cap or cover. Bio-intrusion barriers are designed for long-term durability with minimal maintenance requirements, however the long-term performance of bio-intrusion barriers has not been demonstrated. The short-term performance of bio-intrusion barriers within caps and covers has been studied recently in Idaho. The results of field and pilot tests indicate that long-term performance is promising.

3.5 Containment Cells

This technology involves the use of subsurface horizontal and vertical barriers to isolate buried waste from the environment and to prevent the release and migration of contaminants. Grout curtains and slurry walls would be preferred over geomembranes and sheet pile walls due to ease of installation. When properly constructed and maintained, containment cells can provide a reliable and effective method for controlling contaminant transport.

Grout curtains are low permeability barriers constructed using injection of fluids under pressure. Grouting fluids are typically composed of cement, bentonite, or specialty fluids such as silicate or lignochrome grout. The material that is selected must be compatible with the site geology, soil characteristics, and the waste itself. The grout must have the proper hardening time considering the method of injection. This will ensure that the grout does not harden so quickly that it does not reach the areas where it is needed, and that is does not harden so slowly that it spreads too thinly. Furthermore, the grout must be able to harden and remain competent in the presence of the waste itself. The method of grout emplacement must also be selected. Permeation grouting injects a low-viscosity grout into the soil at low pressure, filling the voids without significantly changing the structure or volume of the soil. Jet grouting, in contrast, injects grout at high pressure and velocity, which destroys the structure of the soil and mixes the grout and soil to form a relatively homogeneous mass.

There are four frequently used grout methodologies available: stage-down, stage-up, grout port, and vibrating beam. In the stage-down method, a borehole is drilled to the full depth of the wall and grout is injected as the drill is withdrawn. In the stage-up method, the grout is injected starting at the top of the borehole and continuing to the desired depth. The grout port method uses a slotted injection pipe and a double packer to inject the grout at specific intervals. In the vibrating beam method, an I-beam is vibrated into the soil to the desired depth, then grout is injected as the beam is withdrawn. Horizontal grout curtains are constructed to form horizontal barriers using methods similar to vertical barriers, except that the adjacent grout injection zones would completely overlap to cover a broad horizontal area. Alternatively, grout holes can be installed using horizontal drilling methods.

Slurry walls are vertical subsurface barriers constructed to limit horizontal migration of contaminants. This technology requires that an open trench be excavated and filled with slurry. The slurry wall (and trench) is generally 3 ft wide, and may be up to 20 ft deep. The slurry usually consists of cement or a soil-bentonite mixture. A soil “saw” is a common implement to create a slurry wall. It uses soil-cutting blades or a steel cable combined with high-pressure grouting jets to mix soil and grouting fluids to produce a homogeneous grout wall of uniform thickness.

Geomembranes are synthetic sheets that are placed by hand in trenches around the contaminated media. Geomembranes are relatively new, and there are concerns about the long-term efficiency and compatibility of the synthetic fibers with organic solvents.

Sheet pile walls are constructed by driving steel sheets into the ground to the desired depth. Sheet piling can be constructed of various materials. Steel with interlocking joints is frequently used. Grouting can also be used to seal the joints. Sheet pile walls are often used where both an impermeable barrier and excavation adjacent to the barrier are desired.

Containment cells are capable of confining leaking waste sites without disturbing the waste itself. A common benefit of a subsurface barrier system is that the waste remains fixed, allowing additional time to develop final remediation alternatives. Barriers are limited by the directional control of the drilling technology and by the inability of non-intrusive techniques to verify barrier continuity. Consistency, dimensions, and continuity of the grout barriers cannot be directly observed, and preferential flow of grout in higher permeability zones within heterogeneous soils can create discontinuities in the barrier.

4. *In Situ* Treatment

In situ treatment technologies treat contaminated media in place. For soil containing organic constituents, *in situ* treatment technologies generally involve physical, chemical, and/or biological treatment processes that immobilize the contaminants or that reduce contaminant concentrations in soil. Relative to comparable *ex situ* treatment technologies, *in situ* remedial technologies have the advantages of minimal handling of contaminated media and lower capital cost.

4.1 Dynamic Compaction

Dynamic compaction reduces soil void spaces and increases soil density. The technology involves a mobile crane that drops a dead weight on the ground surface. Important design considerations include the amount of weight, height of drop, and the number of drops at each location. Drop distance is determined by the size and weight of the dead weight and the depth of the material to be affected. Maximum economical depths for dynamic compaction are about 40 feet . Maximum densification energy can be achieved with weights of 30 to 40 tons dropped from up to 100 feet. In most cases, compacted backfill is placed over the affected area to return the land surface to grade. A cap may be placed over the compacted backfill and underlying waste. The increased density of the affected area contributes to overall site stability and reduces water infiltration.

4.2 *In Situ* Vitrification

This technology involves an electric current to convert soil and waste at extremely high temperatures to a crystalline mass. The crystalline mass is a chemically stable, leach-resistant, vitreous material similar to obsidian or basalt rock. The process destroys and/or removes organic material while immobilizing heavy metals and radionuclides. *In situ* vitrification greatly reduces contaminant mobility via leaching and biotic uptake. Due to the high temperature induced during vitrification, the process also destroys or removes organic contaminants in the waste medium. Furthermore, *In situ* vitrification provides long-term stability to the site and reduces the long-term possibility of human intrusion.

In situ vitrification is accomplished by inserting electrodes into the ground at the desired treatment depth or in surface soils and advancing them to depth during the melting process. A conductive mixture of flaked graphite and glass frit is placed among the electrodes to act as a starter path. The starter path is necessary because dry soil is not conductive after the conduction path in soil pore water is boiled away. Electrical power is charged to the electrodes, which establishes a current through the soil along the starter path. The resulting heat in the starter path reaches between 1400° and 2000°C and begins to melt the surrounding soil. The starter is consumed by oxidation, and the current is transferred to the soil, which is electrically conductive in the molten state. The molten mass grows outward at a rate of approximately 4 to 6 tons per hour, or 1 to 2 inches per hour. Under favorable site conditions, vitrification of an area 30 ft by 30 ft and 30 ft deep can be achieved. The process is repeated in adjacent areas until the desired area and volume of soil has been vitrified. The molten mass is then allowed to cool into a stable, microcrystalline solid. Cooling may take several years. Emissions from the soil are captured using a vacuum pressurized hood and treated in an off-gas treatment system. The size and type of the treatment system is dependent on the amount of organic contaminant in the soil to be treated.

The *In situ* vitrification product is a chemically stable, leach-resistant, glass and crystalline material similar to obsidian or basalt. Radionuclides (including transuranic isotopes and fission products) and inorganics are trapped in the solid product.

Factors that limit the applicability and effectiveness of the technology include rubble exceeding 20 percent by weight, combustible organics exceeding 5 to 10 weight percent, and inorganics exceeding 15 weight percent. Inclusions such as highly concentrated contaminant layers, void volumes, containers, metal scrap, general refuse, demolition debris, rock, or other heterogeneous materials also limit the effectiveness. Significant disadvantages of the technology include the possibility that heating of the soil will cause subsurface migration of contaminants into clean areas. *In situ* vitrification limits future remedial alternatives and waste may remain at the site indefinitely.

4.3 Stabilization (*In Situ* Grouting and Chemical Fixation)

This technology would involve either physical stabilization (grouting) or chemical stabilization (fixation) by injection of a fluid under pressure directly into waste disposal cells and contaminated media. The technology may be applied to pits, trenches, soils, or containers such as underground storage tanks. The grout envelops contaminated media and occupies soil void spaces, hardens, and immobilizes contamination in a cement-like matrix. In addition to immobilization, the technology also increases strength, decreases permeability, and provides many other geotechnical improvements without requiring excavation. This technology is typically used for wastes that leach heavy metals or other inorganic contaminants to immobilize the hazardous constituents. The process is not generally applicable to soils that are contaminated by volatile organic compounds, polychlorinated biphenyls, or pesticides.

The difference between the *in situ* grouting technology and the containment cell technology is that *in situ* grouting involves grouting the waste itself, whereas grouting associated with containment is performed adjacent to the waste.

When applied to soils, the grout is emplaced using pressure injection. Grouting fluids are typically comprised of cement or bentonite. Less frequently used reagents include silicate or lignochrome grout, pozzolanic-based materials, thermoplastic materials, and organic polymers. An innovative mix of ferrous sulfate hydrates combined with calcium hydroxide is currently under development as an *in situ* solidification slurry. The material that is selected must be compatible with the site geology, soil characteristics, and the waste itself. The grout must have the proper hardening time considering the method of injection. This will ensure that the grout does not harden so quickly that it does not reach the areas it is needed, and that is does not harden so slowly that it spreads too thinly. Furthermore, the grout must be able to harden and remain competent in the presence of the waste itself. The method of grout emplacement must also be selected. Permeation grouting injects a low-viscosity grout into soil at low pressure, filling the voids without significantly changing the structure or volume of the soil. Jet grouting, in contrast, injects grout at high pressure and velocity which destroys the structure of the soil and mixes the grout and soil to form a relatively homogeneous mass.

In situ chemical fixation includes a class of technologies where contaminants are chemically immobilized or isolated from migration or exposure. This is an emerging technology whereby contaminated soils are treated to convert inorganics into relatively immobile forms. An example of chemical fixation is stabilization of elemental mercury using calcium sulfides. Chemical fixation of soil is generally limited to surface soil, where the reagent is applied directly to the soil in a powdered, granular, or liquid form. Chemical fixation of groundwater is generally limited to permeable reactive walls.

In situ grouting or chemical fixation may limit future remedial alternatives and wastes may remain at the site indefinitely.

5. Excavation/Treatment/Disposal/Storage

Excavation technologies include removal, shielding, handling, storage, repackaging, transportation, and disposal of contaminated media. These technologies represent the most aggressive response to the contamination problems at a given site. Relative to *in situ* treatment technologies, *ex situ* treatment has the advantage of greater certainty in verification of the effectiveness of treatment and greater certainty that all contaminated media has been treated effectively.

Digging, scraping, ramping, scooping, and vacuuming may accomplish excavation of contaminated materials from hazardous waste sites. Removal is effective because contaminated materials are physically removed from the site. Excavations can range from narrow trench-like excavations to large pit-like excavations. Excavation above the water table can be done with very little secondary migration.

The equipment and sequence of operations used depend on physical characteristics of the site, the contaminated materials, dimension and depth of the excavation, size of the project, desired rate of excavation, degree of excavation accuracy required, available work space, and haul distances. Typical types of excavation equipment include long-reach backhoes, front-end loaders, cranes and attachments, scrapers, bulldozers, clamshells, draglines, hydraulic dredges, and vacuum trucks. After the buried wastes are exhumed, the area is normally backfilled with suitable materials and compacted to grade.

Although excavation can be effective, it requires shielding, handling, transporting, and treating or disposing of contaminated materials, resulting in greater potential of short-term exposure to site workers and the environment. Adequate controls against soil dispersion must be included to minimize the effects of spillage or the passage of contaminated equipment. Control of fugitive dust and vapor transport may be of particular concern. Extensive precautions to protect excavation side slopes and safety of remediation workers are required. Removing non-containerized wastes make exhumation relatively dangerous compared to original disposal of the wastes. Safety and environmental concerns must be balanced against the benefits of removal. Excavation of contaminated soil is limited to the practical depth of excavation. The excavation of deep contaminated soils is often prohibitively expensive.

Bulk material storage is used to store solids, liquids, and sometimes gases on-site, either as waste or as a material for treating waste, such as stabilization agents or dewatering additives. Common storage methods include waste piles, containers, and tanks.

Waste piles store solid waste above or on the ground. In the past, waste stored on soil or permeable surfaces permitted leaching of contaminants into shallow soils and groundwater. Currently, regulations require impermeable surfaces and leak detection with monitoring under waste piles.

Leak-tight containers are used to store or stage solids and semi-solids. Fifty-five gallon drums are common. Roll-off dumpster containers are sometimes used for larger volumes because of their low height, thereby allowing access with a backhoe and ease of transportation and loading onto tilt-bed trucks. To provide leak-tight characteristics, containers with gasketted hatches are available and lining.

Portable tanks are often used for storing pumpable sludges, wastewater, or other liquids. Bulk storage and interim treatment vessels include portable steel tanks, which range in capacity from 50 to 20,000 gallons, and portable high-density polyethylene tanks up to 15,000 gallons.

Depending on the climate, storage of stabilization/solidification agents, such as cement, fly ash, or lime, may be in surface impoundments.

Aboveground storage of waste requires secondary containment such as a lined dike or a larger tank placed around a storage vessel or a vault. Regulations require secondary containment to be large enough to contain 100 percent of the capacity of the largest tank or 10 percent of all tanks within its boundary. Containment must also be sized to hold a 24-hour rain event in addition to tank volumes.

Incineration is the thermal destruction of hazardous wastes in the presence of adequate oxygen for combustion. Incineration destroys halogenated and nonhalogenated organic wastes, including volatile organic compounds, polychlorinated biphenyls, and pesticides, through combustion under net oxidizing conditions. Toxic organic contaminants are permanently destroyed by high-temperature oxidation; however, a residual ash is created that may contain heavy metals and toxic products of incomplete combustion. Air pollution control systems (such as quench chambers, baghouse filters, gas absorbers, and mist eliminators) frequently must be incorporated into incinerator design to capture particulates, aerosols, hydrogen chloride, sulfur oxides, and other emissions.

Wastes generated at SNL/NM may be shipped off-site to a licensed, waste disposal facility. Disposal includes placement of waste materials in a permanent repository that is subsequently managed to ensure that contaminants are not reintroduced into the environment.

Transportation methods discussed here apply to off-site movement of hazardous wastes. On-site waste movement will be considered “material handling” because there is no use of public rights-of-way. Off-site transport is subject to the restrictions imposed by RCRA and the U.S. Department of Transportation. Material characteristics and economics are the primary concerns in deciding what form of transportation to use. There are three primary methods of waste transportation for containerized or bulk material: truck-highway, barge/ship-waterway, and railroad. At SNL/NM, only truck-highway is an acceptable process option. The outer surfaces of transport vehicles must be thoroughly decontaminated before leaving a hazardous waste site and again after discharging their load at the receiving facility. Transportation is retained as an ancillary process in conjunction with disposal of material off-site.

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