WASHINGTON STATE DEPARTMENT OF ECOLOGY

GUIDANCE FOR ASSESSING DANGEROUS WASTE SECONDARY CONTAINMENT SYSTEMS

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Reduce Waste

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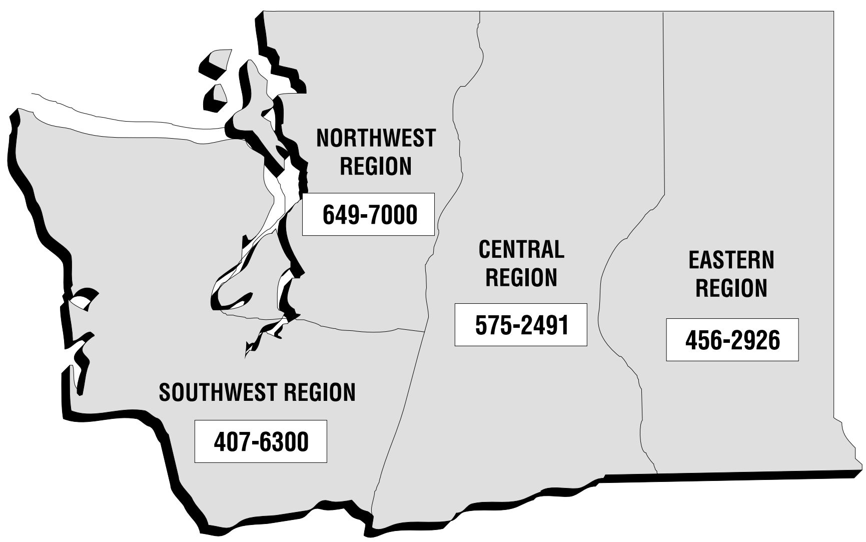

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SECTION 1. INTRODUCTION

The purpose of secondary containment is to capture and contain releases and spills from primary containment structures, facilitate timely cleanup of these releases and spills, and prevent releases of these wastes to the environment. Secondary containment is widely used for containers and tanks that store, accumulate and treat dangerous waste. The objective of this document is to provide guidance to Department of Ecology (Ecology) staff, facility staff and others charged with the responsibility of assessing the adequacy of secondary containment in accordance with state Dangerous Waste regulations, Chapter 173-303 Washington Administrative Code (WAC). This assessment will generally occur when Ecology staff conduct compliance inspections of existing facilities, provide technical assistance, or review and comment on design plans for secondary containment at new or existing facilities.

This guidance is organized into two major sections. Section 2 discusses the regulatory requirements for secondary containment for both containers and tanks. Section 3 discusses technical aspects of secondary containment that should be evaluated including cracks, joints, protective coatings and sealants. The Appendix lists the references used and where more detailed information can be found.

Adherence to this guidance does not in any way release facility owners or operators from their obligations to comply with the requirements of Chapter 173-303 WAC. This guidance does not constitute agency rulemaking and cannot be relied on by any person to create a right or benefit enforceable at law or equity.

SECTION 2. REQUIREMENTS FOR SECONDARY CONTAINMENT

The following paragraphs describe the applicable requirements in the state Dangerous Waste Regulations which apply to secondary containment of containers and tanks used for storage, accumulation and treatment of dangerous waste. The objective of this section is to provide information on the regulatory framework.

2.1 Secondary Containment for Containers

Secondary containment for containers storing dangerous wastes often consists of concrete floors with curbing or lined diked areas. There are also commercially available portable units such as totes and containment pallets which typically accommodate one to four drums. These are prefabricated and usually constructed of reinforced plastic, polyethylene, fiberglass or steel and can be delivered "ready-to-use" to a facility. These structures are often preferred by smaller generators of dangerous waste to avoid constructing and maintaining more expensive secondary containment systems.

The following requirements [WAC 173-303-630(7)] apply to all Treatment, Storage and Disposal (TSD) facilities and to generator container accumulation areas constructed or installed after September 30, 1986. These requirements also apply to generator container accumulation areas constructed or installed prior to October, 1986 and to generator satellite accumulation areas if Ecology determines that there is a potential threat to public health or the environment due to the nature of the wastes being accumulated, or a history of spills or releases from accumulated containers [WAC 173-303-200(1)(b)].

- ❖ The base of the secondary containment system must be free of cracks or gaps and be sufficiently impervious to contain leaks, spills and accumulated rainfall until the collected material is detected and removed.

- ❖ Unless the containers storing dangerous wastes are elevated or otherwise protected from contact with accumulated liquids, the base of the secondary containment system must be sloped or otherwise designed and operated to drain and remove liquids from leaks, spills and accumulated rainfall.

- ❖ Containers storing extremely hazardous waste must be protected from precipitation by storing them inside a building or under some type of protective covering which also allows for adequate inspection.

- If the dangerous waste containers hold free liquids or wastes designated as F020, F021, F022, F023, F026, or F027, the secondary containment system must be provided with sufficient capacity to contain 10 percent of the volume of all containers within the containment system or the volume of the largest container, whichever is greater. (See Dangerous Waste Regulations for definitions of waste codes).

[Note: *Where automatic fire extinguishing systems are used, the Uniform Fire Code requires secondary containment for hazardous materials to be sized with additional volume to contain the design flow rate for 20 minutes.*]

- Uncovered secondary containment systems must be provided with additional capacity capable of holding the <u>additional</u> volume that would result from the rainfall for a 25-year storm of 24 hours duration. [That is, a rainstorm of 24 hours duration with an average rainfall intensity (in inches/hour) over the 24-hour period that occurs, on average, only once in every 25 years.]

- Uncovered secondary containment systems must also be provided with positive drainage control (such as a locked drainage valve) to prevent release of contaminated liquids and provide a means for uncontaminated rainfall to be readily drained.

The containment system must be inspected (by facility personnel) at least weekly for evidence of deterioration [WAC 173-303-630(6)].

Secondary containment for ignitable and reactive wastes must also meet applicable requirements specified in the Uniform Fire Code and requirements in existing state and local fire codes [WAC 173-303-640 (8)(b)].

In addition to meeting the above requirements, incompatible wastes must be placed in separate containment systems [WAC 173-303-640 (9)].

2.2 Secondary Containment for Tank Systems

Concrete vault structures are the most frequently used method of providing secondary containment for tanks. Other methods used include installing external liners and using double-walled tanks. Dangerous waste regulations allow other methods, if approved by Ecology, to be considered as meeting requirements for secondary containment [WAC 173-303-640(4)(d)(iv)].

Regardless of the method used, secondary containment for tank systems which store, accumulate or treat dangerous waste must be designed and installed to meet the following performance standards [WAC 173-303-640(4)]:

- ❖ Prevent any migration of wastes or accumulated liquid out of the secondary containment system to the soil, groundwater, or surface water at any time during the use of the tank system.

- ❖ Be capable of detecting and collecting releases and accumulated liquids until the collected material is removed.

- ❖ Be constructed of materials that are compatible with the wastes to be placed in the tank system.

- ❖ Have sufficient strength to withstand stresses due to static head during a release, pressure gradients, climatic conditions , nearby vehicle traffic and other stresses resulting from daily operations.

- ❖ Be placed on a foundation or base that will support the secondary containment system, provide resistance to pressure gradients above and below the system and prevent failure due to excessive settlement, compression or uplift.

- ❖ Be provided with a leak detection system that will detect the failure of either the primary or secondary containment structure or the presence of any release of dangerous waste or accumulated liquid in the secondary containment system within 24 hours (or at the earliest practicable time if the owner or operator can demonstrate to Ecology that existing leak detection technologies or site conditions will not allow detection of a release within 24 hours).

[Note: *Visual monitoring by the owner or operator is acceptable for aboveground tank systems and those portions of onground and inground tank systems which can be visually inspected on a daily basis.*]

- ❖ Be sloped or otherwise designed or operated to drain and remove liquids resulting from leaks, spills or precipitation. Spilled or leaked waste and accumulated precipitation must be removed from the secondary containment system within 24 hours, or in as timely a manner as possible to prevent harm to human health and the environment. (In the latter situation, the facility owner or operator must demonstrate to Ecology that removal of the released waste or accumulated precipitation cannot be accomplished within 24 hours.)

- ❖ The secondary containment system (the visible portion) must be inspected least once each operating day [WAC 173-303-640(6)(b)].

Concrete Vault Structures

These structures typically consist of a concrete floor below the tank and sidewalls of sufficient height to provide the required containment volume. Steel reinforcement is typically required to provide these structures with sufficient structural integrity. In addition to meeting the overall requirements for secondary containment of tank systems, concrete structures used for secondary containment must be designed and installed to meet the following additional requirements:

- Be sized to contain a release volume equal to 100 percent of the capacity of the largest dangerous waste tank enclosed within the vault.
- Either be designed to prevent run-on or rainfall inside the vault or be designed and installed with <u>additional</u> containment volume to contain the rainfall from a 25-year, 24-hour storm.
- Be provided with an impermeable interior coating or lining which is chemically compatible with the waste to be contained that will prevent the stored waste from migrating into the concrete if a release occurs.
- Be designed with an exterior moisture barrier or other means to prevent moisture from entering the vault.
- Waterstops which are chemically resistant to the waste to be stored or treated must be used at all joints [WAC 173-303-360(e)(ii)(C)].
- Be provided with a means to prevent vapors from forming and igniting within the containment structure [WAC 173-303-640(4)(e)(ii)(E)].

External Liners

External liners are typically placed in excavations for containment dikes and piping trenches to contain spills or releases from tanks and piping. In addition to meeting the overall requirements for secondary containment of tank systems, an external liner system must be designed and installed to meet the following additional requirements {WAC 173-303-640(4)(d)(i)]:

- Be designed and installed to completely surround the tank.
- Be capable of preventing a release from the tank from migrating laterally or vertically into the surrounding soil.
- The liner must be free of cracks or gaps.
- The liner must be capable of containing a release volume equal to the capacity of the largest dangerous waste tank enclosed by the liner.
- Be designed to prevent run-on or infiltration of precipitation inside the liner or be provided with additional volume to contain the rainfall from a 25-year, 24-hour storm.

Double-walled Tanks

Besides meeting the overall requirements for secondary containment of tank systems, double-walled tanks must be designed and installed to meet the following additional requirements:

- The inner tank must be an integral structure with the outer shell and be completely enclosed by the outer shell.
- Any release from the inner tank must be completely contained by the outer shell.
- Be provided with a built-in continuously operating leak detection system installed between the inner and outer walls which is capable of detecting a release within 24-hours. Most manufacturers of double-walled tanks provide leak detection systems as a standard feature.
- Metal double-walled tanks must be provided with measures to protect them against corrosion including corrosion-resistant coatings and installation of cathodic protection.

Ancillary Equipment

Tank system ancillary equipment (i.e., piping, fittings, flanges, valves and pumps) that cannot be visually inspected for leaks on a daily basis must be provided with secondary containment [WAC 173-303-640(4)(f)]. Secondary containment is also required for flanges, joints and valves and other connections unless they are welded to the piping and visually inspected for leaks on a daily basis. Secondary containment should also be provided where pumps and valves transfer dangerous wastes between tanks unless they are seamless and can be visually inspected on a daily basis.

Secondary containment provided for ancillary equipment includes double-walled piping and fittings, and liners in piping trenches. Pumps and valves are often placed within the secondary containment system for the tank or within a sump that will collect any leaks from the pumps and valves.

2.3 Obtaining Variances from Requirements for Secondary Containment

In some instances, facility owners or operators may wish to obtain a variance from having to provide secondary containment on their tank systems and/or ancillary equipment. To apply for a variance from secondary containment requirements, owners or operators must submit a report to Ecology demonstrating that alternative design and operating practices, combined with location characteristics, will be at least as effective as secondary containment in preventing a release of dangerous wastes or constituents into groundwater or surface water. This report must include information on; 1) the nature and quantity of the wastes being stored or treated, 2) the proposed alternative design and its operation, and 3) hydrogeologic characteristics at the facility, including the depth to groundwater below the tank system [WAC 173-303-640(4)(g)(i)].

Owners and operators of existing tank systems and ancillary equipment may also obtain a variance from secondary containment requirements by demonstrating that, should a release migrate to groundwater or surface water, no present or potential hazard would be posed to human health or the environment. Section WAC 173-303-640(4)(g)(ii)] provides an extensive listing of the documentation required to support this demonstration.

2.4 Integrity Assessments and Certification

State dangerous waste regulations require integrity assessments for new and existing tank systems, *including secondary containment*, that store and treat dangerous waste. These assessments must be reviewed and certified by an independent qualified registered professional engineer and kept with the operating record at the facility. Ecology guidance for conducting tank integrity assessments is provided in *Guidance for Assessing and Certifying Tank Systems that Store and Treat Dangerous Waste,* Ecology Publication #94-114.

Except where concrete sumps are used, integrity assessments are not required for secondary containment for containers unless specifically requested by Ecology under WAC 173-303-220(3). A sump used for secondary containment is considered a "tank", and therefore is required to have an integrity assessment to determine if it "is adequately designed and has sufficient structural strength and compatibility with the waste(s) to be (contained), to ensure that it will not collapse, rupture or fail" [WAC 173-303-640(2)(c)].

SECTION 3. EVALUATION OF SECONDARY CONTAINMENT

This section discusses the various items to focus on when evaluating and assessing secondary containment systems in the field. Much of this material pertains to concrete structures since they comprise the majority of secondary containment systems for dangerous waste.

3.1 Concrete Structures

Concrete structures used for secondary containment include containment vaults and sumps. These structures are typically constructed of steel-reinforced concrete. A concrete structure's ability to contain a release depends on its structural integrity and imperviousness to liquids. The following items need to be assessed and evaluated when a concrete structure is used to provide secondary containment.

Chemical Attack of Concrete

Concrete is a mixture of portland cement, water, and mineral aggregate, typically sand and gravel. Concrete not otherwise protected by application of a coating or sealant is relatively permeable to liquids and is susceptible to chemical attack from releases or spills of liquid dangerous wastes. The porous nature of unprotected concrete will allow any spills or releases of certain dangerous wastes, particularly solvents and various organic chemicals, to readily penetrate through the concrete into the underlying soil. This will result in soil contamination even if the overlying concrete is relatively unaffected. Visual evidence of chemical attack includes erosion and spalling of the concrete.

When placed in contact with unprotected concrete, acid solutions undergo various chemical reactions with the compounds in the portland cement producing new soluble calcium compounds which will wash away. Alkaline substances react in a similar manner with the sand in the aggregate. The amount of deterioration of concrete in these situations depends on how quickly these substances are removed from the surface of a concrete structure and their ability to penetrate into the unprotected concrete.

Penetration of various chlorides and salts into unprotected concrete can also result in localized corrosion of reinforcing steel imbedded in the concrete. Extensive corrosion of reinforcing steel can cause or accelerate cracking and spalling of the concrete due to the internal stresses placed on the concrete by the increased volume occupied by the steel reinforcement as it rusts.

Protective Coatings and Sealants

A protective coating or sealant should be applied to the interior of a concrete structure used for secondary containment. This will protect the concrete from chemical attack and the surrounding environment from contamination due to releases and spills.

Epoxy resins are often used for coating materials. Properly selected and applied, epoxy coatings are tough, durable and provide a good resistance to acids, caustics and solvents. Other materials used for protective coating of concrete structures include polyvinyl chloride, acrylics, polyurethanes, neoprene, chlorinated rubber, enamels, various mortars and acid proof shotcrete.

A protective coating or sealant material used for concrete secondary containment should be compatible with the wastes being stored in the primary containment structure and the environment the coating or sealant will be subjected to. For example, oxidizing acids and ketones are generally incompatible with epoxy coatings and sealants and organic solvents are generally incompatible with chlorinated rubber.

The Portland Cement Association publication, *Effects of Substances on Concrete and Guide to Protective Treatments*, contains tables which describe the effect on concrete by a wide array of chemicals and describes and tabulates recommended protective treatments associated with each of these chemicals.

Manufacturers' literature for various coating systems also contains information on their resistance to various chemicals. Facility owners or operators should coordinate closely with coating or sealant suppliers and distributors to select a coating that will provide the necessary protection.

Surface preparation and application of a protective coating system should be performed by a qualified individual. This individual should use proper equipment and follow application procedures recommended by the coating system manufacturer. It is also desirable that he or she be certified by the manufacturer of the particular protective coating being applied.

Proper surface preparation is essential to obtain adequate coating performance. Sandblasting or similar procedures are often used on existing concrete to provide an adequate surface for applying the primer. Any large voids in the concrete surface should first be filled with a putty or similar material prior to applying the coating.

Coating application procedures depend on the material to be protected and type of coating. Application procedures include brush on, spray on, roller, etc. Coatings are frequently applied in two or more layers with an inner prime coating followed by application of one or more outer coatings. A prime coating should penetrate and bond to the concrete and bond to subsequent top coats. Top coats should be abrasion-resistant and provide a surface seal against any chemicals released or spilled into the secondary containment system.

[Note: *Coating preparation and application procedures which prevent or minimize pollution should be used.*]

Although, the objective of applying protective coatings is to make the secondary containment structure impermeable, spills from primary containment structures must be removed promptly. Also, some manufacturer's warranties for coatings exclude certain wastes and/or limit the amount of contact time with various wastes. Heavy equipment should also be kept off a coated surface to prevent damage to the coating.

Coatings will also degrade over time and need to be regularly inspected for wear, cracks and other failures through which spilled or released liquid could migrate to the underlying concrete. Swelling, blistering and crinkling are indications that a protective coating has degraded. Coating system repairs should be performed as soon as a problem area is discovered. The American Society of Civil Engineer's publication, *Concrete Watertight Structures and Hazardous Liquid Containment*, has an extensive listing of causes and appearances of various types of protective coating failures and methods for preventing these failures.

Joints

Concrete structures used for secondary containment should be constructed with as few joints as possible. A "monolithic pour" would be the ideal type of construction for hazardous waste secondary containment structures. However, joints are required in concrete structures to accommodate expansion and contraction due to temperature changes, shrinkage and other factors that cause stress in the concrete. The number of joints should not be less than recommended in applicable standards and practices for concrete structures, otherwise uncontrolled cracking may develop. The nature of the construction process generally requires construction joints.

Joint failure is often detected by visual inspection of the joint sealant and the surrounding concrete. Deteriorated joint sealant, moisture accumulation in the joint, and concrete deterioration around the joint are indications of joint failure. Attention should also be paid to joints inside sumps, joints between sumps and floor slabs, and joints between berms and floor slabs. When a failed joint is discovered, a timely repair should be performed to prevent a potential release from the containment sump into the surrounding environment.

Waterstops

When a joint is necessary, a waterstop should be installed in the joint to obstruct any flow through the joint. Waterstops should be chemically compatible with the wastes that would potentially be spilled or released into the secondary containment structure. Materials frequently used for waterstops are polyvinyl chloride (PVC), high and low density polyethylene (HDPE and LDPE) , polypropylene (PP), nylon and various rubber compounds. Steel waterstops are also occasionally used.

Waterstop failures are often difficult to observe through visual inspection. Some indications of waterstop failure are wetness of concrete at a joint and deterioration of the concrete adjacent to the waterstop when there is no other apparent defect of the concrete.

Evaluation and Repair of Cracks

Cracks in concrete structures range from small, insignificant cracks to cracks which will allow a spill or release to migrate to the environment and, in some cases, can even adversely affect the integrity of the structure. Besides creating a potential pathway for a release to the environment, cracks can also create problems by allowing moisture or a release of dangerous constituents to migrate through the crack and contact the steel reinforcement embedded in the concrete. This will often cause the reinforcing steel to corrode and the resulting enlarged and rusted reinforcement will often lead to more extensive cracking.

The location and extent of cracking in a concrete containment structure can sometimes be determined by visual inspection. Visual inspection can also determine if there is any spalling, rust staining or other indications that a concrete structure is deteriorating.

Visual inspections can be aided by various devices. One device used to measure crack widths is a “crack comparator”. This is a small hand-held microscope with a scale on the lens closest to the surface being viewed. Micrometers are also used to measure crack widths. Cracks widths are generally classified as follows: fine-generally less than 1 mm; medium-between 1 and 2 mm; wide-over 2 mm.

If necessary, radiography can be used to determine if internal cracks and voids are present which cannot be visually observed and to determine the penetration depth of cracks visible at the surface. Gamma-ray equipment can also be used for crack detection. Both of these methods require individuals trained in the use of the equipment.

The American Concrete Institute (ACI) Publication 201.1R, *Guide for Making a Condition Survey of Concrete in Service*, has photographs which illustrate various types of cracking and other types of deterioration which can be visually observed in concrete structures. ACI Publication 224.1R, *Causes, Evaluation, and Repair of Cracks in Concrete Structures,* describes the causes of cracking, evaluation techniques and criteria, and discusses various crack repair techniques and procedures.

Sealants for Joints and Cracks

All joints and cracks should be filled and sealed with a flexible sealant. A protective coating alone is not considered to be an adequate sealant for joints and cracks. Sealant material should be chemically compatible with the dangerous wastes that could potentially be spilled or released into the secondary containment structure. A joint sealant should also be impermeable, deformable to accommodate any joint movement, remain bonded to the joint, resistant to sunlight and weather, and chemically compatible with the protective coating material. Existing joints in slabs often consist of asphalt impregnated fiber material. However, this material is <u>not</u> considered to be an adequate joint or crack sealant.

Thermosetting sealants which cure through chemical reactions will generally last longer and withstand greater joint movement than other types of sealants, such as polysulfides, silicones, urethanes and epoxy-based materials.

Sealants are generally applied in liquid or semi-liquid form and solidify inside the joint opening. Joint and crack faces must be clean and free from defects that would impair bonding with the sealant. Some sealants require primers to be applied to joint and crack faces prior to sealant installation

Many cracks or gaps in containment structures are too large to be spanned by a sealant. A crack which is “active” can make attempted repairs ineffective. This type of crack must first be routed out by sand blasting or an air-water jet prior to applying the sealant. A previous repair should be examined to observe whether it remains in good condition..

[Note: *A registered structural engineer should be consulted prior to making repairs to existing cracks or joints which may compromise the integrity of a structure used for secondary containment.*]

Drainage

The lack of adequate drainage can result in rainfall or any spills or releases of dangerous wastes to pool over the surface of the containment structure. This, in turn, will increase the potential for these liquids to attack the structure's surface and to migrate through any unsealed cracks to the underlying concrete and the surrounding environment. The floor of secondary containment structures should typically be sloped at a minimum of two percent (1/4 inch per foot) so that any spilled or released liquids or rainfall will readily drain to accessible collection points.

A slight depression or sump at the low point of the secondary containment structure will allow more liquid to be pumped out. Most pumps can't pump out the bottom 1/4 inch or so of the drained liquid.

Leak Detection

Leak detection is required for portions of a primary container storing or treating dangerous waste where a release cannot be visually observed. This is true even when secondary containment is provided. For example, leak detection is required for a flat-bottomed tank which sits directly on the flat concrete floor of a secondary containment structure. This is because it is not possible to visually inspect and observe the bottom of the tank which is in direct contact with the concrete.

One method of providing leak detection for a flat-bottomed tank is to raise the tank above the concrete floor and expose the tank bottom for visual inspection. This can be done by installing structural supports below the tank bottom or installing a cone-bottomed tank.

Another method is to install a secondary "false bottom" below the bottom of a hazardous waste tank by placing steel grating or wire mesh between the primary tank bottom and a lower secondary bottom. A leak detection device can then be placed in the space between the primary tank bottom and secondary bottom. The primary bottom must be structurally designed to support the tank and its contents for all anticipated loading conditions.

Various construction details for undertank leak detection are presented in Appendix I of API Standard 650 (see Appendix).

Still another method of leak detection for a flat bottomed tank is to provide grooves in the top surface of the floor of the containment structure. These grooves should slope radially from the center of the structure to its perimeter at a minimum slope of 2 percent (1/4 inch per foot). This will cause any release of dangerous waste through the bottom of the tank to flow by gravity to the perimeter of the containment structure where it can be readily observed and detected. This method of leak detection is only be reliable if the concrete floor is protectively coated and there are no cracks in the containment underneath the tank that would allow small leaks to go undetected.

Accessing Underlying Soils to Test for Releases

It is often necessary to collect and analyze samples of the underlying soils during closures of tank systems with secondary containment. The underlying soils should be investigated where evidence, such as the presence of cracks or stains in the concrete, spill records, etc., indicates that there may have been a release of hazardous constituents to the underlying soils.

Concrete structures should not be demolished and removed until the underlying soils are sampled and analytical results have been reviewed. This will prevent disturbance of the soils that will compromise sampling results. Typically the underlying soils are accessed by coring through the concrete with a decontaminated concrete core drill. Core diameters are typically 4 to 6 inches. Any underlying gravel should also be removed if necessary to access the soils.

If the overlying concrete containment system will subsequently be used or undergo decontamination procedures, the concrete cores should be recemented or grouted in place so that there is no potential for a future release to the underlying soils. Excavated areas should be backfilled with clean fill material.

See Section 6.5 of *Guidance for Clean Closure of Dangerous Waste Facilities*, Ecology Publication #94-111, for additional information on soil sampling during closure.

Sumps

Dangerous waste regulations define "sump" as "any pit or reservoir that meets the definition of tank and those troughs/trenches connected to it that serve to collect dangerous waste for transport to dangerous waste storage, treatment, or disposal facilities". This definition includes sumps that provide secondary containment for either containers and tanks storing and treating dangerous waste.

Where dangerous waste containers and tanks are located inside buildings, sumps are often placed in proximity of these containers and/or tanks to contain potential releases. These sumps must be designed to meet the overall requirements for secondary containment systems and should be designed and installed with adequate chemically resistant coatings and sealants.

In addition to these requirements, it should be noted that the Uniform Fire Code requires sumps and other secondary containment systems for hazardous materials located inside buildings to be sized for sufficient additional volume to contain the design flow rate from automatic fire extinguishing systems for 20 minutes (Uniform Fire Code 80.301). This requirement applies to the area of the building draining to the sump.

3.2 External Liners

External liners used for secondary containment generally consist of geomembrane (also known as flexible membrane) liner materials. Materials frequently used for geomembrane external liners are high density polyethylene (HDPE), very low density polyethylene (VLDPE), polyvinyl chloride (PVC), and chlorosulfonated polyethylene (CSPE-R). The latter material is manufactured with a fabric reinforcement comprised of woven polyester, called a "scrim", sandwiched between top and bottom layers of polyethylene material.

Relatively recent technologies for secondary containment liners include spray-on materials. Two spray-on materials being used are urethane and polysulfide which are sprayed to a thickness of 40 to 60 mils over a geotextile fabric used as a base material. Geotextiles combined with bentonite can also be used which provide self-sealing seams and a permeability of approximately 1×10^{-10} cm/sec.

The saturated hydraulic conductivity of materials used for external liners providing secondary containment should not exceed 1×10^{-7} centimeters per second. This value is consistent with Environmental Protection Agency (EPA) criteria for waste containment structures. Liner thicknesses must be sufficient to meet permeability criteria and generally range from 30 mil to 100 mil.

Chemical Compatibility

External liners will sometimes absorb various organic chemicals they come in contact with, causing them to become brittle and crack after a period of time. For example, many materials used for external liners are incompatible with certain organic solvents and oxidizing acids. One source of information for determining the chemical resistance of materials used for external liners vs. types of dangerous wastes being stored or treated is *Perry's Chemical Engineer's Handbook*. Manufacturers' literature for their specific lining materials are another source for this information.

The compatibility between the waste being stored or treated and an external liner used for secondary containment does not necessarily need to be based on prolonged contact. This is because any dangerous waste that is spilled or released within an external liner used for secondary containment system must be removed within 24 hours or at the "earliest practical time". Some manufacturers' warranties exclude certain wastes and / or limit the amount of contact time with various wastes. In any event, after any spill or release of a stored substance, the portion of the liner that came in contact with the waste should be examined for any deterioration which would compromise its integrity during a subsequent spill or release.

Subgrade

Prior to installing the liner, the subgrade material that will support the liner must be prepared and placed according to the liner manufacturer's installation specifications. When native soil material is used for the subgrade, oversized soil particles, large rocks, etc. should be removed and the subgrade compacted to eliminate soft spots and provide a firm support for the liner.

Placement

An external liner should be placed according to the liner manufacturer's recommendations. Necessary field seaming and joining of external liner segments is a critical aspect for the liner to be able to prevent the vertical or lateral movement of a spill or release into the surrounding environment. Information on methods of field seaming of geomembrane liners and methods for testing the adequacy of seams is provided in the EPA technical guidance document *Quality Assurance and Quality Control for Waste Containment Facilities* (see Appendix).

Leak Detection

When secondary containment is provided using an external liner, leak detection can be provided by placing one or more leak detection devices or observation wells in the backfill between the tank or piping and the liner. These leak detection devices are frequently based on the electrical resistivity of a sensing device which changes when it comes in contact with a released waste. These sensing devices are generally electronically connected to a remote control panel which typically sets off an audio or visual alarm when a release occurs. It is important to note that these devices must be properly installed and calibrated to avoid false alarms and to correctly detect a release should one occur.

3.3 Double-walled Tanks

Corrosion Assessment

The outer wall of existing double-walled tanks should be examined for indications of corrosion such as rust and corrosion pits. Look for evidence of coating deterioration indicated by blisters in the coating.

A more detailed discussion of corrosion assessment and corrosion protection for metallic tank systems is contained in Ecology's *Guidance for Assessing and Certifying Tank Systems that Store and Treat Dangerous Waste,* Ecology Publication No. 94-114.

Leak Detection

Double-walled tanks frequently include a continuous leak detection system which is installed between the inner and outer walls. This leak detection system can be installed independently but is often provided by the tank manufacturer.

Leak detection systems for double-walled tanks frequently include various liquid sensing devices installed between the inner and outer walls which are electronically connected to a remote readout device located in the office of a facility. Other leak detection systems for double-walled tanks consist of liquid "reservoirs" whose level changes when there is a release from the inner tank to the annular space between the inner and outer walls.

3.4 Portable Containment Structures

A wide variety of commercially manufactured portable containment structures are available for storing dangerous waste. Typically, these structures are prefabricated and delivered to a facility "ready-to-use". They are generally constructed of steel, reinforced plastic, polyethylene or fiberglass and can accommodate one to four 55-gallon drums. Often, the secondary containment lies under a removable grating upon which the drums are placed. Some of these structures are covered which allows them to be used outdoors.

These structures should be inspected for dents, cracks, punctures or other evidence of deterioration and any indications that repairs have been made. In the case of open-type secondary containment structures, an inspector should determine if the containment system can be compromised by containers being placed too close to the edge of the containment structure. The primary containers should not be placed too close to the edge and should be secured to the containment structure or tied together to prevent tipping.

Some dangerous wastes are also incompatible with plastic or fiberglass and should not be stored in secondary containers constructed of these materials. However, as previously noted, the compatibility between the waste being stored and the material used for secondary containment does not need to be based on prolonged contact since it is assumed that any release from a primary container will be expeditiously removed once it is discovered.

APPENDIX. REFERENCES

1. American Concrete Institute Publication SP-108: *Permeability of Concrete.*
Contains 11 papers presented at the ACI Fall Convention held in Seattle on November, 1987 which evaluate various materials and methods for reducing permeability of concrete.

2. American Concrete Institute Publication 201.1R: *Guide for Making a Condition Survey for Concrete in Service*. Provides a checklist for inspecting concrete structures and includes photographs illustrating various types of concrete cracking and failures.

3. American Concrete Institute Publication 224.1R: *Causes, Evaluation and Repair of Cracks in Concrete Structures*. Provides information on causes and methods for repairing cracks in concrete.

4. American Concrete Institute Publication 350xR: *Concrete Structures Containing Hazardous Materials* (draft). Provides guidance for the design and construction of containment structures for hazardous materials.

5. American Concrete Institute Publication 350R: *Environmental Engineering Concrete Structures*: Contains design and construction recommendations for concrete structures used for environmental engineering.

6. American Concrete Institute Publication 515.1R: *A Guide to the Use of Waterproofing, Dampproofing, Protective, and Decorative Barrier Systems for Concrete* (revised 1985). Includes guidance for selecting and installing protective barrier systems (coatings) to protect concrete from chemical attack.

7. American Petroleum Institute Publication 315: *Assessment of Tankfield Dike Lining Materials and Methods.* Discusses various lining materials and methods for providing secondary containment within a diked area.

8. American Petroleum Institute Standard 650: *Welded Steel Tanks for Oil Storage.* Appendix I: *Undertank Leak Detection and Subgrade Protection.* Discusses various methods and shows construction details for detecting leaks through the bottom of aboveground storage tanks.

9. American Society of Civil Engineers: *Concrete Watertight*

Structures and Hazardous Liquid Containment. Provides design criteria and methods for watertight structures and hazardous liquid containment structures.

10. Ecology Publication 94-114: *Guidance for Assessing and Certifying Tank Systems that Store and Treat Dangerous Waste*: Provides guidance for persons conducting and certifying integrity assessments of tank systems which store and treat dangerous waste. This publication can be obtained by contacting Ecology's Publication office at (360) 407-7472.

11. Environmental Protection Agency publication EPA/530-R-93-005. *Determining the Integrity of Concrete Sumps*. Discusses how to assess the integrity of a concrete sump used to collect hazardous waste.

12. Environmental Protection Agency publication EPA/600/R-93/182. Technical Guidance Document: *Quality Assurance and Quality Control for Waste Containment Facilities*: Includes extensive information on the manufacturing and installation of geomembranes used for waste containment.

13. *Perry's Chemical Engineer's Handbook*, Sixth Edition.

14. Portland Cement Association. *Effects of Substances on Concrete and Guide to Protective Treatments*. Describes the various types of protective treatments used to protect concrete against chemical attack. Table in publication lists various types of chemicals, their effect on concrete, and the recommended treatments to counteract these effects.

15. RCRA/Superfund Hotline Questions and Answers (Phone number: 1-800-424-9346).