The potential leachability of soil contamination must be addressed as part of any site closure under Chapter 62-780 F.A.C. Although the potential for leachability is often addressed through analysis of soil samples, the purpose of a leachability evaluation is to ensure that the contaminants in soil are not leaching into groundwater or surface water at levels that exceed the applicable cleanup target levels (CTLs). Whether or not the soil contamination at a site will leach above the applicable CTLs is dependent on several factors including: the physical and chemical characteristics of the contamination, the concentrations of the contaminants, the distribution and total mass of the contaminants in soil, the soil type(s), the depth to groundwater relative to the contaminant distribution and the distance to potentially impacted surface water bodies. The rule provides several options for evaluating leachability under each Risk Management Option (RMO, 62-780.680, F.A.C.) and allows for the site-specific and chemical-specific properties to be taken into account as well.

Typically, leachability is evaluated based upon the groundwater CTL, but in situations where the leachate may reach surface water, either directly or transport via groundwater, then both the groundwater and surface water CTL must be evaluated to ensure protection of those resources. The leachability evaluation should be completed as part of the site assessment so that soil delineation can be completed to the appropriate CTL. In all cases, however, applicability of leachability criteria do not apply to “soil” below the mean high water table.

It is also important to know whether or not you have any leachable soil when evaluating potential cleanup strategies for a site. Contaminated soil that is continuing to leach should be expected to increase the time and the cost of the cleanup. Therefore, identifying such soil and including removal or treatment of that soil as part of the remedy can greatly decrease both the time and expense of cleanup.

Given that the goal of addressing leachability is the protection of groundwater (and surface water), the first step should usually be to determine if indeed soil contaminants are also present in groundwater. The mere presence of the same contaminants in both soil and groundwater does not necessarily mean that leaching is currently occurring, but it does mean that the potential for leachability should be investigated further. It may well be that leaching is still occurring, and therefore creating or adding to the groundwater plume. However, there are several other possibilities: (1) that some other source (above or below the water table) is creating the groundwater plume, (2) that leaching occurred in the past but has since ceased, (3) that the soil is leaching at rate that doesn’t significantly contribute to an increase in groundwater contamination, or even (4) that, due to site-specific conditions, the soil has never leached at the site.

Keep in mind that both leachability and direct exposure (DE) need to meet rule criteria for site closure. If the DE SCTLs (default or site-specific) are lower (more stringent) than the default leachability SCTLs (LB-SCTLs), then there may be little benefit from the development of site-specific LB-SCTLs because the DE SCTLs will likely control the site cleanup strategy.

If the COCs found in the soil do not exceed DE Residential SCTLs, or an institutional control/engineering control is going to be used to address direct exposure, and the COCs exceed the Leachability Based on Groundwater Criteria values, then leachability may be evaluated further as described below.

While default LB-CTLs are provided, Chapter 62-780 provides a number of other options for deriving LB- CLTs or otherwise satisfying the leachability requirement. These are more particularly described below. If site conditions satisfy any of these approaches, the leachability requirement has been met.

## **Rule Options for Demonstrating Leachability**

1. Comparison to 62-777, F.A.C., LB-SCTLs. The first option in the rule is to compare the maximum concentrations of contaminants in soil to the reference values for leachability provided in Chapter 62-777 F.A.C., Table II, the background concentrations and the best achievable detection limits. The least stringent of these three criteria apply (see 62-780.680(1)(b)2.a.) For example, the lookup table value for leachability based on groundwater criteria for nickel is 130 mg/kg. However, if the natural background concentration was determined to be 200 mg/kg (or any number > 130 mg/kg), then that background concentration would prevail as the site-specific LB-SCTL and the evaluation for leachability would be completed if nickel was found to be below that number. This would be true even if there were nickel in groundwater exceeding the GCTL because that concentration would also be a natural background concentration (assuming there was no identifiable contribution from the contaminated site under investigation.) (See also #2 below for more discussion on when groundwater concentrations are naturally elevated.)

The default promulgated LB-SCTLs in Table II of Chapter 62-777 F.A.C., have been back-calculated from the applicable water CTLs and therefore soil at or below these concentrations is not expected to leach at a rate that will cause an exceedance of the corresponding CTL (either groundwater or surface water, as applicable).

As is generally the case in developing such lookup tables, several assumptions were made with regard to the soil properties. Specifically, an “average” Florida soil type of sandy loam was used, and a few estimates were made with regard to soil parameters based on that “average” soil type. The rule allows the substitution of site-specific soil parameters in the equation for calculating leachability. This is discussed in more detail in #4. below and Sections V.A.3. and XV of the *Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C.* (“Technical Report”) included as a referenced guideline in both Rule 62-777.100, F.A.C. and 62-780.100, F.A.C.

Although checking the values in Table II is quick, simple, direct and often accurate, an exceedance of a default LB-SCTL may not prelude alternative resolution of leachability concerns. -- For example, the observed soil values exceed the table values but there is not a corresponding groundwater plume. Also, in this table there are no lookup values for many inorganic contaminants because it was not possible to calculate them due to the number of variables that can influence the leaching rate and the impracticability of coming up with a workable estimate for each of those variables (see the Technical Report for a more complete discussion). In all these cases it may be necessary to pursue another line of evaluation to address leachability.

1. Impact of Elevated Background Groundwater Concentrations on LB-SCTLs. Some contaminated sites may have naturally elevated concentrations of some contaminants in groundwater. In such cases, the LB-SCTLs in Chapter 62-777 F.A.C., Table II may overestimate the potential for leaching above the applicable GCTL because the Table II numbers are based upon the default GCTLs and not those that may be elevated due to natural background. Generally, if a demonstration of elevated background concentrations in groundwater has been made, the leachability pathway has been addressed as well. However, that may not be the case when soil has not been exposed for sufficient time to allow impacts to groundwater to occur. In such cases, the applicable leachability numbers can be back-calculated using the same equations (Figure 8 in Chapter 62-777 F.A.C.) with the substitution of the site-specific alternative GCTLs in place of the default GCTLs (see 62-780.680(1)(b)2.b.; 62-780.680(2)(b)2.a. & 62-780.680(3)(b)2.a.).
2. Use of Direct Test of Leachability of Soil. Another option for evaluation of leachability is to directly test the soil using the Synthetic Precipitation Leaching Procedure (SPLP) (or the Toxicity Characteristic Leaching Procedure (TCLP) for oily wastes). The analytical results for the leachate are compared directly with the applicable GCTLs to determine whether the soil leaches above those GCTLs (see 62-780.680(1)(b)2.c.; 62-780.680(2)(b)2.b. & 62-780.680(3)(b)2.b.) More details on using this approach are available in: *Guidance for Determining Leachability by Analysis of SPLP Results* available on the DEP website at: http://www.dep.state.fl.us/waste/quick\_topics/publications/wc/GuidanceforDeterminingLeachabilitybySPLPAnalysisDraftVersion1-8.pdf.

In the event that the SPLP-derived LB-SCTL is less than the default LB-SCTL, the lower-derived value should be applied, or an alternative approach to meeting leachability should be considered. It should be noted that alternative leachability tests may be appropriate for special materials (for example, use of EPA Method 1315, Leaching for Compacted Materials).

1. Derivation of Site-Specific LB-SCTLs using Existing Table II Equations. As mentioned above (#1.) several estimates were made with regard to soil properties in developing the lookup values in Chapter 62-777, F.A.C., Table II. The cumulative effect of these estimates may result in a soil characterization that is quite different from the site-specific soil type(s). Therefore, in some instances, it may be beneficial to collect data on the site-specific soil properties and use those soil properties to calculate a leachability number for the site (see 62-780.680(1)(b)2.d.; 62-780.680(2)(b)2.d. & 62-780.680(3)(b)2.d.). When using this option, it is also permissible to substitute any site-specific alternative GCTLs as the target concentration for groundwater.

By determining site-specific soil properties, such as moisture content (annual average), dry bulk density, and organic carbon content, site-specific LB-SCTLs can be calculated using the “Equation for the Determination of Soil Cleanup Target Levels (SCTLs) Based on Leachability” obtained from Figure 8 in Chapter 62-777, F.A.C. The alternative LB- SCTLs derived from the substitutions of site-specific soil characteristics’ values into the equation may allow an SRCO without conditions at the site or at least reduce the volume of soil that must be addressed.

If alternative LB-SCTLs for different strata with different soil characteristics will be calculated, then at least one sample per hydrogeologically significant stratum will be needed. If previous soil samples have been collected for lab analysis, the laboratory determination of moisture content in the lab reports for the previous samples may be used in conjunction with moisture content of new samples to establish average moisture content. An Excel based application for performing this calculation for petroleum COCs can be found at the petroleum cleanup program web site at www.dep.state.fl.us/waste/categories/pcp/pages/pg\_documents.htm under the title “Alternative SCTL Calculation Spreadsheet” in the General Technical section.

It also may be acceptable to obtain samples from below the contaminated soil but above the groundwater table to characterize the soil properties and calculate SCTLs for those deeper intervals to demonstrate the deeper soil will prevent leachate with concentrations greater than the GCTLs from reaching the groundwater. If these alternative SCTLs are higher than the actual concentrations in the contaminated soil, this information could be used as a demonstration that the soil with concentrations that exceed the default LB-SCTLs could be left in place without affecting groundwater.

When alternative LB-SCTLs are dependent on the attenuation capacity of soil below the contaminated soil, leaching in excess of the GCTLs could occur if the contaminated soil is removed and placed in another location.

1. Fractionated TRPH LB-SCTLs. If Total Recoverable Petroleum Hydrocarbons (TRPHs) are a contaminant of concern at the site, these may be fractionated (see section V.C.6. and Appendix C of the Technical Report) and those fractions compared to their specific leachability-based SCTLs as listed in Appendix C of the Technical Report.
2. Evaluation of Groundwater Data. Another method for evaluating leachability is the analysis of groundwater data to evaluate the potential for leaching. The criteria for such a demonstration are slightly different under RMO I than under RMO II and RMO III.

Under RMO I, the requirements are that the soil must have been exposed for at least two years plus a minimum of one year of groundwater data (beyond the two years) to show that the soil is not leaching (see 62-780.680(1)(b)2.f.). This demonstration should also take into account “site-specific characteristics such as the thickness of the unsaturated zone, depth and mass of soil contaminants, soil lithology, actual precipitation, concentration gradients, and the chemical and physical characteristics of the contaminants”. (62-780.680(1)(b)2.f.) In practice, many sites have been exposed far longer than two years and there may be sufficient existing groundwater data already collected to make this demonstration. There may be circumstances, such as the availability of dewatering effluent data, that may be a reasonably conservative alternative to data collected from the installation and sampling of monitoring wells.

The analogous demonstration under RMO II and RMO III (see 62-780.680(2)(b)2.f. & 62-780.680(3)(b)2.f., F.A.C.) also requires a year of groundwater data but does not require exposure of the soil for any specific length of time, and allows the use of fate and transport modeling to support the demonstration. The following models are listed in the ASTM 1999 Compendium of Fate and Transport models that is included as a referenced guideline in Chapter 62-780.100, F.A.C. and are therefore acceptable for use: JURY-Unsaturated, LEACH, MOFAT, SAM, SESOIL, SUTRA, VADSAT, VLEACH and VS2DT. Other models that may be suitable, but will require a demonstration pursuant to Rule 62-780.610, F.A.C., of their suitability for the intended situation are: CMLS, HYDRUS, MULTIMED, PRZM-2, RITZ, SUMMERS, and VIP. The use of an alternative fate and transport model to justify a no further action proposal does not require use of a restrictive covenant.

1. Use of Engineering Control (EC). Another option for addressing potential leachability is the use of an impermeable cap over the contaminated soil to prevent infiltration. The impermeable cap is a form of engineering control (EC) that is allowed under both RMO II and RMO III (see 62-780.680(2)(b)2.c. & 62-780.680(3)(b)2.c.) A PE must certify that the cap is appropriately designed and has been implemented. The use of an engineering control also requires an Engineering Control Maintenance Plan that provides the details for cap maintenance and an institutional control (restrictive covenant) to ensure the EC remains in place.

**Other Considerations**.

1. A minimum of one (1) year of groundwater monitoring data is specified for demonstration that contaminants have not leached from soils into groundwater in order to insure that samples are collected to capture seasonal water levels fluctuations and sufficient data to make an informed decision. The Department recognizes that as site specific conditions warrant, data collected over a shorter time period may be equally representative of groundwater fluctuations over the one (1) year period. For example:

a) where existing data has captured the seasonal high and low water levels; or

b) where there is no appreciable variation in the groundwater table elevation over time and data collected or a shorter time period is representative of what would otherwise be seasonal fluctuations.

2. Many sites have wells installed over different timeframes for various reasons; however, existing data may still support leachability decisions. The data from individual wells installed “later” in the assessment process should not necessarily be required to fulfill the same two (2) year “exposure period” but rather should be viewed as supplemental information to inform a reasoned decision based on available data.

3. While LB-SCTLs generally are considered as “not to exceed” values, there can be some consideration of the mass and potential for distribution of COCs to impact groundwater on an aquifer basis. Isolated levels of contamination above an LB-SCTL that may impact groundwater should be evaluated in terms of the actual potential of that mass of contamination to adversely impact the aquifer. Spatial consideration or averaging is allowed (both mathematically and through use of ISM) when looking at soil concentrations that exceed LB-CTLs (both horizontally and vertically). For example, incremental sampling methodology provides an average concentration over a decision unit. Use of the ISM concentration for a decision unit could be compared to the LB-SCTL or alternative derived leachability target. As an alternative, EPA’s DAF model provides a basis for estimating the dilution and attenuation of contamination to an aquifer. Other modeling approaches are available. This requires closure under RMO III, as use of an alternative fate and transport model to justify a no further action proposal, but would not require use of a restrictive covenant. When isolated and low level exceedances of LB-SCTLs are present, it may not be necessary to conduct full fate and transport modeling in order to justify closure of the leachability pathway.

The key issue to keep in mind when evaluating leachability is that the goal is protection of groundwater (and surface water, if applicable) and that combinations of the above methods can be used to achieve this goal, including use of alternative approaches in different portions of the site.