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Prevention of groundwater contamination by agricultural chemicals requires an understanding of the complex processes that control pesticide movement below the soil surface. Through this understanding it is possible to try to predict which areas may be most vulnerable to contamination. The many models that have been developed to characterize pesticide movement vary widely in their conceptual approach and degree of complexity. A soil properties model was developed in this thesis to determine the relative overall pesticide movement potential in Oregon agricultural soils. Its focus is ease of use in both acquisition of input values and running of the model. The model is based on soil properties important in controlling pesticide movement. It is a rating system model that uses scoring of factors and matrices to weigh the soil values. It is organized into two processes: leaching and sorption. The leaching potential is based on soil permeability and drainage class. The sorption potential is based on organic matter content and texture of the soil surface horizon(s). The interaction of these two processes results in the overall pesticide movement potential.

A Soil Property Model for Evaluating Pesticide Movement Potential

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INTRODUCTION

Approximately 16 million pounds of pesticides were used in Oregon in 1987 (Rinehold and Witt 1989). A comprehensive survey by Parsons and Witt (1988) indicates that ten pesticides have been found in Oregon groundwater, although all the well data has not been validated to exclude invalid or irreproducible results. Groundwater monitoring can identify areas where contamination has occurred, but it does not prevent further contamination.

Prevention of groundwater contamination by agricultural chemicals requires an understanding of the complex processes that control pesticide movement in the subsurface environment. Through this understanding it is possible to try to predict areas that may be most vulnerable to contamination. These areas can then be managed in such a way as to minimize the potential for pesticide movement to groundwater.

Prediction of vulnerable areas is not a simple task. There are many interactive factors that control pesticide movement to groundwater. Many models have been developed to characterize pesticide movement. These models vary widely in their conceptual approach and degree of complexity. The information needed to describe the basic processes of pesticide movement, the sensitivity of analysis, and the accuracy of simulations all depend on whether the modelers' approach is research or management.

Research models that mathematically describe the complexity of the environment surrounding pesticide applications are needed to provide a basic understanding of the importance of the various parameters (McGrath, 1981). Research models tend to be highly sophisticated and require extensive input values, values that often need to be accurately measured in a laboratory setting first. Manipulations of the data often require the help of complex mathematical models.

Management models vary in their approach, but are usually based on scientific principles established in the research models. Management models should be accurate enough to identify areas of concern and simple enough to be used routinely. If a problem is identified with a simple model, more extensive testing can be done, and assessments can then be made using more sophisticated models.

The soil properties model described in this thesis is a simple management-type model. The model is based on soil processes found to be important in controlling pesticide movement and persistence. The processes were determined through evaluation of the literature and preexisting models.

LITERATURE REVIEW

A literature review was conducted to develop an understanding of the processes involved in pesticide movement, and to investigate existing predictive models of pesticide movement to groundwater.

Soil Properties Controlling Pesticide Movement

Bailey and White (1970) list seven factors that control the fate and behavior of pesticides in soil. These are: 1) chemical decomposition, 2) photochemical decomposition, 3) microbial decomposition, 4) volatilization, 5) plant and organism uptake, 6) movement, and 7) adsorption. Chemical and photochemical decomposition are functions of the pesticide and the environment. Microbial decomposition and plant and organism uptake are functions of the pesticide, the soil environment (for microbial decomposition) and management. Volatilization is a function of the chemical, the environment, and the type of application of the pesticide.

Movement of pesticides is a function of soil properties, climate (rainfall), and management (irrigation) water. And finally, adsorption is a function of the pesticide and the soil environment. Of the above factors only microbial decomposition, movement, and adsorption are directly influenced by the soil environment.

Microbial decomposition is difficult to predict and is not well understood (Jury, 1984a; Hamaker and Thompson, 1972). It is usually included in the calculation of the half-life of a chemical, so it will not be investigated in this thesis. Movement of pesticides in soil is most affected by adsorption, physical properties of the soil, and climatic factors (Bailey and White, 1970). Adsorption is considered to be the main factor controlling pesticide movement. It influences either directly or indirectly the availability of a chemical for action by any of the other factors (Bailey and White, 1970; Khan, 1980). Frequently researchers use the term sorption to describe the phenomenon of chemicals becoming attached to or incorporated into the soil matrix. Sorption is a general term for the processes of adsorption, absorption, and chemisorption. These three processes are thought to occur simultaneously in soil, with the common result being the retardation of the movement of pesticides. For this model, the term sorption will be used to describe this retardation phenomenon. Because of its known importance in controlling movement, sorption will be one of the main processes investigated in detail for development of this thesis model.

Leaching of pesticides, i.e. movement with soil water, is the other main process that will be investigated for use in the model. Climatic factors will not be directly incorporated into the model although they are important with respect to pesticide movement, since the total amount of rainfall or irrigation water received, as well as the intensity and frequency of received water, influence the depth to which a pesticide will move down through the soil. This effect of hydraulic loading will be considered separately from the pesticide movement model for use as a management tool.

Sorption

As discussed above, sorption is considered to be the primary factor controlling pesticide movement in soils. It controls the distance of movement and the pesticide concentration available for movement. To understand the importance of sorption, it is necessary to review the mechanisms involved and their relative importance in the binding of pesticides to soil particles. The mechanism(s) of action depend(s) on the nature of the soil colloid and the pesticide (Khan, 1980; Mortland, 1980; Green, 1974; Weed and Weber, 1974). Two or more mechanisms may occur simultaneously (Khan, 1980). The mechanisms most frequently cited are listed below and are described briefly.

Cation exchange - takes place for those pesticides that exist as cations or that become positively charged through protonation. Adsorption of cationic pesticides by ion exchange occurs on both organic matter and clay surfaces (Khan, 1980; Mortland, 1980; Green, 1974; Weed and Weber, 1974).

Hydrogen bonding - is a dipole to dipole interaction in which the hydrogen atom serves as the bridge between two electronegative atoms. Hydrogen bonding occurs on clay surfaces and edges, and on organic matter. Hydrogen bonding appears to be the most important mechanism for adsorption of polar nonionic organic molecules on clay minerals (Khan, 1980; Green, 1974). Organic molecules hydrogen bonded to organic matter are in direct competition with water for binding sites (Weed and Weber, 1974).

van der Waals attraction - are short range dipole-dipole interactions of several kinds (Bailey and White, 1970). These physical forces are very weak but additive, and they exist in all adsorbent-adsorbate relationships. Consequently van der Waals forces are responsible for adsorption to both clay and organic matter (Khan, 1980; Mortland, 1980; Green, 1974; Weed and Weber, 1974).

Hydrophobic bonding - influences the bonding of nonpolar pesticide molecules to hydrophobic sites of organic matter (Khan, 1980; Mortland, 1980; Weed and Weber, 1974).

Ligand exchange - occurs when partially chelated transition metals serve as the sites for ligand exchange, in which the pesticide may replace the water of hydration acting as a ligand (Khan, 1980; Weed and Weber, 1974). This mechanism may occur with both clay and organic matter, although very little discussion of this mechanism was found.

The opportunity for different pesticides to be sorbed by soil constituents is considerable. In all of the above mechanisms, greater adsorption takes place where there are a greater number of binding sites. Soil is made up of organic matter - clay complexes. It has been observed that above 2-3 percent organic matter, the clay surfaces are effectively blocked, and can no longer function as adsorbent surfaces (Weed and Weber, 1974; Khan, 1980). Numerous laboratory studies and reviews have shown that adsorption increases directly with increases in organic matter (Haque, 1975; Hamaker and Thompson, 1972; Briggs, 1969; Lambert et al., 1965; Koren et al., 1969). The combination of the large surface area, hydrophobicity, and chemical reactivity of organic matter lends credence to the observations that organic matter is the most important soil constituent involved in the process of adsorption (Mortland, 1980; Weed and Weber, 1974; Khan, 1980).

Leaching

Two mechanisms control the transport of pesticides with soil water: diffusion and mass movement (Haque, 1975; Khan, 1980; Jury, 1986). Diffusion is the process by which solutes are transported as a result of their random molecular motions caused by their thermal energy. There is a resultant net movement from positions of higher concentrations to lower concentrations (Khan, 1980). Mass flow is the movement of the solutes through the soil as a result of being carried by water. Mass flow is considered to be the principal means of movement of a pesticide in soil (Bailey and White, 1970; Khan, 1980). From this point on, the term leaching will be used to describe the transport of pesticides within the soil profile by mass flow with percolating water.

Several soil properties influence the leaching of pesticides. Jury (1986) summarizes these parameters and their effects. They are as follows.

Soil water content - has a significant influence on diffusion, but does not directly affect leaching.

Bulk density or porosity - influences rate of water movement. Bulk density is related to porosity by the equation -

$$P = 1 - Db/Dp$$

where P is the porosity, Db is the bulk density, and Dp is the particle density. Increasing bulk density corresponds to decreasing soil porosity. Porosity indirectly affects leaching since regions of low porosity are likely to have lower permeability to water movement. Jury (1986) states that no good structural models exist for relationships between porosity and permeability. It is generally accepted that within a given soil type, permeability decreases as porosity decreases. Between different soil types, such as a clayey soil compared to a sandy soil, the clayey soil has a higher porosity, but a lower permeability.

Saturated hydraulic conductivity or permeability - defines the readiness with which water flows through soil in response to a given potential gradient (Brady, 1984). The saturated hydraulic conductivity of a soil depends on the size and configuration of the soil pores. Coarse-textured soils have a higher saturated conductivity than finer textured soils. Also, a well-aggregated soil with a high proportion of large conducting pores will be more permeable (Helling and Dragun, 1981).

Bailey and White (1970) also discuss the importance of soil texture and structure in controlling pesticide leaching. They review the work performed by numerous investigators, which has shown that pesticides are leached to a greater degree in light-textured (sandy) soils than in heavier-textured (clayey) soils.

Depth to groundwater - does not directly influence the ability of a soil to transmit water, but does affect the travel time for leaching. Shallow depth to groundwater will result in shorter travel time.

Review of Chemical Transport Models

That soil properties are important is confirmed by their use in many of the current models that numerically describe pesticide movement and persistence. Some of the more common models include: PRZM (Pesticide Root Zone Model), (Carsel et al., 1984), LEACHMP (Leaching Estimation And CHemistry Model-Pesticides), (Wagenet and Hutson, 1987), CMIS (Chemical Movement In Soil), (Nofziger and Hornsby, 1985), Jury et al. (1987), Wisconsin approach (Sutherland and Madison, 1987), DRASTIC (a standardized system for evaluating groundwater pollution potential using hydrogeologic settings), (Aller et al., 1985), Soil Conservation Service (Goss, 1989), SEEPPAGE (a System for Early Evaluation of the Pollution Potential of Agricultural Groundwater Environments), (Moore, 1988), and GLEAMS (Groundwater Loading Effects of Agricultural Management Systems), (Leonard et al., 1987). The approach taken by each of these models varies widely. Many incorporate environmental and management conditions that influence pesticide fate and movement to groundwater, but are beyond the direct influence of soil parameters. Although these other conditions are extremely important, they will not be included in this thesis model. The discussion section at the end of this thesis addresses the importance of many of these conditions as well as the limitations of this thesis model. A brief discussion of the models and their input parameters follows.

Several models are relatively large, complex computer programs requiring extensive input (LEACHMP, PRZM, and GLEAMS). These models have soil components, but they also incorporate other factors such as pesticide variables, plant nutrition, erosion, soil evaporation, management practices, and climatic factors. These factors are important in controlling pesticide movement to groundwater, but are beyond the scope of this soil properties model.

The DRASTIC model is mainly a rating of hydrogeologic settings, aquifer characteristics and subsurface transport. This information is very important in modeling groundwater vulnerability but is not pertinent to this thesis model. Included in the DRASTIC model is a weighting for "soil media", using only texture (a component for organic matter is included here) as the controlling factor. Depth to water table is also included as a weighting factor.

The SEEPPAGE model also incorporates aquifer components. This model, however, more thoroughly evaluates the effect of soil in controlling pesticide fate. The SEEPPAGE model uses the soil attenuation rating system developed by the Wisconsin Geological and Natural History Survey (Sutherland and Madison, 1987), discussed below.

The Wisconsin model was developed as a management tool for the State Agency personnel and County Extension agents to identify areas of concern for groundwater contamination from pesticides. It incorporates the influence of organic matter, texture, depth to a water table and the permeability of the least permeable layer. This thesis model most closely resembles the Wisconsin model.

The Chemical Movement in Soil (CMIS) Model is a simple computer model illustrating the influence of soil properties, chemical properties and weather patterns on the movement of chemicals in soil. The soil properties shown to be important in controlling pesticide movement that are used in the CMIS model are bulk density, volumetric water content, and soil organic carbon content.

The model of Jury et al. (1987) is a mathematical model that incorporates soil, environmental, and chemical conditions. It was developed as a screening tool for estimating which compounds may reach groundwater with a high enough residual mass to pose a potential hazard. The focus of the Jury model is to update recent work to assess chemical movement to groundwater based on mobility and persistence (Jury 1984a and b). The Jury model strives to more accurately define microbial degradation based on declining microbial populations with depth. The soil conditions of drainage rate, bulk density, water content, and organic carbon content are used in Jury's model.

The Soil Conservation Service has developed a Soil-Pesticide Interaction Procedure that is used to describe the relative potential loss of pesticides from soils (Goss, 1989). The GLEAMS model was used to estimate the pesticide losses from a large combination of hypothetical pesticides and soils. Algorithms were then used to categorize soil series for leaching potential. (The SCS procedure has a surface loss portion which will not be discussed here). The algorithm is a grouping of the soils based on the hydrologic group and the organic matter content times the surface horizon depth. The hydrologic groupings were originally based on the use of rainfall-runoff data from small watersheds and infiltrometer plots. The purpose of hydrologic groupings is to estimate runoff from rainfall (SCS, 1983). The notion of using hydrologic groupings for this model was dismissed since these groupings are already an estimate based on observations and calculations of permeability.

MODEL DEVELOPMENT

Introduction

The soil properties model was organized to address separately the effects of two processes in soils: leaching and sorption. The leachability of a pesticide through soil considers the conditions that favor water movement through the soil (ease of passage) and the depth to a water table (length of travel distance). Sorption is the affinity of a pesticide to attach onto a soil particle, thereby inhibiting its movement down through the soil with water. Interaction between these two processes results in the overall pesticide movement potential.

Data Input Sources

The model was developed with ease of use and consistency of data inputs in mind. To this end, the input data come from published official soil series descriptions (Official Soil Series Description File, maintained at Fort Collins Computer Center, Colorado), and also available at most local Soil Conservation Service offices. Only the soil organic matter content was from a slightly different database. The database used is the Soils 5 Database developed by the Soil Conservation Service (SCS). This Database can be obtained through Iowa State University in Ames, Iowa.

In addition to ease of use, only two databases were used for input values so as to maintain some consistency in the input parameters. It is realized that some variability is inherent to the concept of the soil series, and that all soils of the same series will not have analytical values exactly the same as the data used in this model. The model strives to be general enough to account for important differences in soil properties, but specific enough to identify potential hot spots, or areas of concern.

Elements of the Model

Leaching Potential - Permeability to a Water Table

The ease with which water will move down through the soil to a water table influences the rate at which a pesticide will move. The permeability of the soil is an indication of the speed (or ease) that water can move through a soil. Depth to a water table is important, since a shallow water table will be reached in a shorter time period than a deep water table. The depth to a water table is indicated by drainage class. The interaction of soil permeability and drainage class results in an index of leaching potential for the soil.

1. Scoring of soil permeability

The permeability of a soil was based on the permeability of the "layers" as given in the Estimated Soil Properties section of the Soil Interpretation Record for each official series description. The permeability of each "layer" is given as a rate, i.e.).6 - 2.0 in/hr. These rates correspond to one of 7 permeability classes, ranging from very slow to very rapid. For the purpose of evaluating pesticide movement potential, each permeability class was assigned a score as shown in Table 1. The slower the permeability, the lower the score.

Every soil was evaluated to a depth of 60 inches. Where bedrock or weathered bedrock occurred at a shallower depth estimated permeability classes and their corresponding scores were assigned to the various types of rock. These are shown in Table 2.

To evaluate soil permeability, each layer's score was multiplied by its thickness and the product summed over the entire 60-inch depth of the soil. This allows the thickness of a layer to weight the effect of permeability. For instance, if a soil had a relatively thick layer that was rapidly permeable, it would result in a high score compared to a soil that had only a thin layer that was rapidly permeable. Conversely, a soil that has a thin layer of slowly permeable clay underlain by a thick layer of rapidly permeable soil would score high even with the layer of clay. This reflects the situation that after the clay becomes saturated, free water could then move rapidly through the lower soil. A thin clay layer will not slow the water movement as much as a thicker layer.

The summed products ranged from 60 to 600. These products were then evenly split into ten groups and assigned a score ranging from 1 to 10. A score of 1 is slowest, indicating a soil with 60 inches of very slow permeability, while a 10 is most rapid, indicating a soil with very rapid permeability throughout. The scoring breakdown is shown in Table 2.

TABLE 1. Scoring of permeability classes.

Permeability Class and impeding layers or bedrock	Permeability (in/hr)	Score
very slow, and duripans	<0.06	1
slow, and weathered bedrock	0.06-0.2	2
moderately slow	0.2-0.6	4
moderate, and R horiz-silt;sand stone	0.6-2.0	6
moderately rapid	2.0-6.0	8
rapid	6.0-20	9
very rapid, basalt	>20	10

TABLE 2. Scoring of the permeability of the soil.

Calculated Result	Soil Permeability Score
60 - 113	1
114 - 167	2
168 - 221	3
222 - 275	4
276 - 329	5
330 - 383	6
384 - 437	7
438 - 491	8
492 - 545	9
546 - 600	10

2. Drainage Class

The drainage class of a soil is given in its series description. A well drained soil indicates that the upper 100 centimeters of the soil is rarely saturated for more than a day or so at a time. A poorly drained soil is saturated within the upper 20 centimeters of the soil for periods long enough to create reducing environments. An excessively drained soil indicates that water is removed very rapidly. In this case, very rapid movement of water, not depth to a water table, is the problem.

3. Scoring of Leaching Potential

The leaching potential of a soil depends on the interaction between permeability and drainage class, which is expressed in a matrix format (Table 3). The matrix shows that a soil that has both very rapid permeability and excessive drainage is rated as having a very high leaching potential. A soil with rapid permeability and very poor drainage is also given a very high leach potential. This situation would probably occur mainly with coastal sandy soils where the water table comes up near the surface. This situation is the worst of both worlds; a soil that allows water to move rapidly to reach a shallow water table in a short period of time. At the other extreme are soils that have a very slow permeability and are well drained. These are rated as having a very low leaching potential. Intermediate combinations of permeability and drainage are given moderate ratings.

Note that permeability has somewhat more influence on the leaching potential than drainage. For almost all

TABLE 3. Matrix for estimating soil leach potential based on permeability and drainage.

PERMEABILITY WEIGHTED AVERAGE SCORE		DRAINAGE CLASS					
		EXCESSIVELY AND SOMEWHAT EXCESSIVELY	WELL	MODERATELY WELL	SOMEWHAT POORLY	POORLY	VERY POORLY
1	Slowest	Very low	Very low	Very low	Low	Low	Low
2		Very low	Very low	Low	Low	Low	Low
3		Low	Very low	Low	Low	Moderate	Moderate
4		Low	Low	Moderate	Moderate	Moderate	Moderate
5		Moderate	Low	Moderate	Moderate	Moderate	High
6		High	Moderate	Moderate	Moderate	High	High
7		High	Moderate	High	High	Very high	Very high
8		Very high	High	High	High	Very high	Very high
9		Very high	High	Very high	Very high	Very high	Very high
10	Most Rapid	Very High	Very high	Very high	Very high	Very high	Very high

drainage classes, a permeability score of 3 or less gives a low or very low leaching potential, whereas a permeability score above 7 gives a high or very high leaching potential.

Sorption Potential

Sorption potential describes the tendency of the pesticide to attach onto the surface of soil particles. The stronger a pesticide sorbs to soil particles, the less likely it will move down through the profile with water. The sorption of a pesticide to soil is a function of the surface area of the soil. Organic matter increases a soil's ability to sorb pesticides because of its high surface area. The texture of the soil also influences the surface area of a soil because clayey soils provide more surface area than sandy or silty soils. Texture is particularly important in soils that are low in organic matter to which positively charged pesticides are applied. The overall sorption potential is thus a function of organic matter content and soil texture.

1. Organic Matter

The effect of organic matter on sorption was evaluated using data available in the Soils 5 Database. This database provides a range of organic matter content for the surface layer of each soil. A typical entry would indicate a surface layer thickness of 12 inches and an organic matter content of 2-4 percent. For the purposes of this pesticide movement model, the average of the range was used for rating the sorption potential. This average value was then multiplied by the depth of the surface layer (A horizon). This product is a better measure of the amount of organic matter available to sorb a pesticide than either the percent organic matter of the A horizon thickness by themselves. A thick surface horizon with plenty of organic matter provides the opportunity for many binding sites. A thin layer of topsoil may provide numerous binding sites, but because the layer is thinner, it is possible that a chemical could be quickly carried through this layer without complete sorption and therefore be more available for leaching.

This product was then given a score between 1 and 10. A score of 1 indicates a relatively very thick surface horizon with a relatively high organic matter content. A score of 10, on the other hand, indicates a thin surface soil with very little organic matter. The scoring breakdown is shown in Table 4.

2. Soil Texture

The texture of the surface layer (A horizon(s)) is given both in the official series description and in the Soils 5 database. The textures were divided into classes and given a score (see Table 5). Organic matter and clayey textures were given the lowest score because of their large surface areas and opportunities for sorption binding sites. The lower the score the higher the sorption potential.

3. Rating of Sorption Potential

The sorption potential of a soil is a result of the interaction of the organic matter content and texture, as

TABLE 4. Scoring of organic matter times depth.

ORGANIC MATTER * DEPTH: Result	Score
> 104	1
52 - 104	2
26 - 52	4
13 - 26	6
6.5 - 13	8
0 - 6.5	10

TABLE 5. Scoring of surface texture.

SURFACE TEXTURE Type	Class
organic, clay, silty clay, and sandy clay	fine
sandy clay loam, clay loam, and silty clay loam	mod. fine
loam, silt loam, and very fine sandy loam	medium
fine sandy loam, sandy loam, and loamy very fine sand	mod. coarse
all loamy sands, sands, very fine sands, and fine sands	coarse

NOTE:
if texture is very gravelly then add
1 to the score, up to a maximum score of 5.

shown in the matrix in Table 6. A soil with a very high organic matter content and a fine texture is given a very high sorption rating. A soil with very little organic matter and a coarse texture results in a very low sorption potential. The importance of organic matter is reflected in the structure of the matrix. Notice that up to medium textures an organic matter score of 4 or less results in ahigh or very high sorption potential. Only with the coarse soils is the effect of organic matter shown to be reduced.

Pesticide Movement Potential

The overall pesticide movement potential is a result of the interaction of the leaching and sorption potentials of the soil. A matrix was developed to combine these two processes (Table 7). A soil with a very high leaching potential and a very low sorption potential results in a rating of very high pesticide movement potential. This means that water will move quickly through the soil and the soil has few sorption sites. Conversely, a soil with a very low leaching potential and a very high sorption potential results in a very low pesticide movement potential rating. Water does not move quickly through the soil, and in addition the soil has an abundance of sorption sites. Both factors work together to provide a high probability that a chemical will be removed from the soil water or will move slowly enough to undergo degradation long before it can move all the way to groundwater.

TABLE 6. Matrix for estimating soil sorption potential based on surface organic matter times surface depth and surface texture.

AVERAGE SURFACE ORGANIC MATTER TIMES DEPTH SCORE		SURFACE TEXTURE CLASS AND SCORE				
		FINE 1	MODERATELY FINE 2	MEDIUM 3	MODERATELY COARSE 4	COARSE 5
1	High O.M. average	Very high	Very high	Very high	High	Moderate
2		Very high	High	High	Moderate	Moderate
4		High	High	High	Moderate	Moderate
6		Moderate	Moderate	Moderate	Low	Low
8		Moderate	Moderate	Low	Low	Very low
10	Low O.M. average	Low	Low	Very low	Very low	Very low

TABLE 7. Matrix for estimating soil pesticide movement potential based on leaching and sorption potentials.

LEACHING POTENTIAL	SORPTION POTENTIAL				
	VERY HIGH	HIGH	MODERATE	LOW	VERY LOW
VERY LOW	Very low	Very low	Very low	Low	Moderate
LOW	Very low	Very low	Low	Moderate	Moderate
MODERATE	Low	Low	Moderate	High	High
HIGH	Moderate	Moderate	High	Very high	Very high
VERY HIGH	Moderate	High	Very high	Very high	Very high

Rating of Oregon Agricultural Soils

The model was used to evaluate several agricultural soils in Oregon. Four major agricultural regions were chosen: Willamette Valley, Malheur Valley, Columbia Basin, and the Klamath Falls Basin. The results of these evaluations are listed in Appendices A through D. The tables give the leaching potential, sorption potential, and the final pesticide movement potential.

Hydraulic Surplus

The hydraulic loading onto a soil influences the rate and distance a pesticide may move through the soil. A pesticide will not move if there is no carrier for transport. In addition, pesticides will sorb less on a wet soil than a dry soil because of the competition with water for binding sites. For the soil properties model, the concept of hydraulic surplus incorporates the combined effect of rainfall and irrigation minus evapotranspiration and runoff losses. Hydraulic surplus and the soil pesticide movement potential rating are combined in the matrix in Table 8. The matrix provides an estimate of the risk of pesticide movement due to hydraulic influence. The matrix was developed with the close attention and assistance of Dr. Jim Vomocil, Department of Soil Science, Extension Scientist.

TABLE 8. Matrix for estimating risk of pesticide movement due to influence of hydraulic loading.

PESTICIDE MOVEMENT POTENTIAL	HYDRAULIC SURPLUS = RAINFALL + IRRIGATION - EVAPOTRANSPIRATION - RUNOFF (inches)			
	0 - 5	5 - 15	15 - 25	> 25
VERY LOW	Very low	Low	Low	Moderate
LOW	Very low	Low	Moderate	Moderate
MODERATE	Low	Moderate	Moderate	High
HIGH	Moderate	Moderate	High	Very high
VERY HIGH	Moderate	High	High	Very high

Simulations with Other Models for Validation of Current Model

Three of the models discussed in the Literature Review were used to validate this model. The models used were Jury (1987), the Wisconsin approach, and the SCS Soil Pesticide Interaction Procedure. These models were chosen for their ease of use and variety of approach.

Ten representative soil series were used to develop the current model. These same ten soils were evaluated with the other three models to compare results and validate the procedures. The Jury model requires a chemical compound and its associated parameters to complete the evaluation. For this purpose, aldicarb and dicamba were arbitrarily chosen.

SCS Ratings of Soil Leach Potential -

The soil leach ratings were taken directly from the Soils-5 database (Table 9).

Wisconsin Ratings of Attenuation Potential -

This approach requires surface (A horizon) texture, subsurface (B horizon) texture, soil order (indication of organic matter content), surface pH, depth of soil solum, permeability of subsoil, and soil drainage class. Information regarding all of these parameters is available in the official series descriptions. The Wisconsin scoring

TABLE 9. Simulations of ten soils with the Soil Conservation Service Pesticide Interaction Procedures.

SOIL SERIES	SCS RATINGS	
	Soil Leach Potential	Soil Surface Loss Potential
Amity	Nominal	Intermediate
Dayton	Nominal	Nominal
Woodburn	Nominal	Intermediate
Madras	Nominal	Intermediate
Ritzville	Intermediate	Intermediate
Quincy	High	Nominal
Algoma	Nominal	Nominal
Flagstaff	Nominal	Nominal
Fordney	High	Nominal
Nyssa	Nominal	Intermediate

system, the input values, and the results are listed in Tables 10 and 11 respectively.

Jury et al., 1987 Evaluation of Pesticide Groundwater Pollution Potential -

The Jury model is a numerical model that requires specific, measured input parameters. Several values for Oregon soils had to be estimated because exact data were not available. For instance, the Jury model requires a value for average water content. This value was estimated as 0.80 of the pore space. Eighty percent was arbitrarily chosen; since water content changes over time any percentage could have been used as long as it was used consistently. The pore space was calculated using the equation of 1 - (bulk density/particle density). The result of this estimation of water content for soils agrees with an 80 percent estimate of the saturation water content given by Hillel (1982) for sandy, loamy, and clayey soils. For example, a loamy fine sand such as a Quincy soil was estimated to have a water content at 80 percent saturation of 0.3. Hillel (1982) assigns a saturation water content for sandy soils as 0.4. Eighty percent of this is 0.32. For a loam soil such as Madras, the water content was estimated to be 0.4. This coincides with 80 percent of the estimated saturation value of 0.5 given by Hillel (1982).

TABLE 10. Ranking system for attenuation potential - Wisconsin approach.

PHYSICAL/CHEMICAL CHARACTERISTICS	CLASSES	WEIGHTED VALUES
Texture - Surface (A) Horizon	l, sil, scl, si	9
	c, sic, cl, sicl, sc	8
	lvfs, vfsl, lfs, fsl	4
	s, ls, sl, organic materials and all textural classes with coarse fragment class modifiers	1
Texture - Subsoil (B) Horizon	c, sic, sc, si	10
	scl, l, sil, cl, sicl	7
	lvfs, vfsl, lfs, fsl	4
	s, ls, sl, organic materials and all textural classes with coarse fragment class modifiers	1
Organic Matter Content	Mollisols	8
	Alfisols	5
	Aridisol, Entisols, Inceptisols, and Spodosols	3
	Histosols, Aquic suborder, and Lithic, Aquollic, and Aquic subgroups	1
pH - Surface (A) Horizon	>= 6.6	6
	< 6.6	4
Depth of soil solum (A + B horizons)	> 40 in.	10
	30 - 40 in.	8
	20 - 30 in.	3
	< 20 in.	1
Permeability - Subsurface (B) Horizon	very low	10
	moderate	8
	high	4
	very high	1
Soil Drainage Class	well drained	10
	well to moderately well drained	7
	moderately well drained	4
	somewhat poorly, poorly, and very poorly drained, and excessively well drained	1

RATING OF ATTENUATION POTENTIALS - SCORES

Least potential	Marginal potential	Good potential	Best potential
0 - 30	31 - 40	41 - 50	51 +

TABLE 11. Ranking of ten Oregon soils using the Wisconsin attenuation potential ranking system.

SOIL SERIES	TEXTURE SURFACE (A) HORIZON		TEXTURE SUBSOIL (B) HORIZON		ORGANIC MATTER CONTENT		pH - SURFACE (A) HORIZON	
	Class	Value	Class	Value	Class	Value	Class	Value
AMITY	sil	9	sicl, sil	7	Mollisol	8	< 6.6	4
DAYTON	sil, sicl	8.5	c, sic,	10	Alfisol	5	< 6.6	4
WOODBURN	sil	9	sicl	7	Mollisol	8	< 6.6	4
MADRAS	l	9	l, cl	7	Aridisol	3	6.4 - 6.6	5
RITZVILLE	sil	9	sil	7	Mollisol	8	>= 6.6	6
QUINCY	lfs	4	lfs	4	Entisol	3	>= 6.6	6
ALGOMA	sil	9	sil	7	Inceptisol	3	>= 6.6	6
FLAGSTAFF	sil	9	sicl	7	Aridisol	3	>= 6.6	6
FORDNEY	lfs	4	ls	1	Mollisol	8	>= 6.6	6
NYSSA	sil	9	sil	7	Entisol	3	>= 6.6	6

TABLE 11. (CONTINUED).

SOIL SERIES	DEPTH OF SOIL SOLUM(in.) Class	Value	PERMEABILITY SUBSOIL (B) HORIZON Class	Value	SOIL DRAINAGE CLASS Class	Value	SUM OF VALUES	ATTENUATION RATING POTENTIAL
AMITY	> 40	10	0.2-0.6 mod	8	smwhat poorly	1	47	Good
DAYTON	30 - 40	9	<0.06 v.low	10	poorly	1	47.5	Good
WOODBURN	> 40	10	0.6-2.0 mod	8	mod. well	7	53	Best
MADRAS	>= 20	3	mod-slow	9	well drained	10	46	Good
RITZVILLE	30 - 40	8	0.6-2.0 mod	8	well drained	10	51	Best
QUINCY	0	0	6-20 rapid	4	excessively	1	22	Least
ALGOMA	< 20	1	very low	10	poorly	1	37	Marginal
FLAGSTAFF	< 20	1	slow	9	smwhat poorly	1	36	Marginal
FORDNEY	< 20	1	6.0-20 high	4	excessively	1	25	Least
NYSSA	~20	2	0.6-2.0 mod	8	well drained	10	45	Good

The average flux rate (defined by Jury et al., 1987 as the rate at which water is applied to the soil) was used consistently at 1 m/yr. This is a high rate of water input, but used as a constant for all soils it gives mass pesticide residue results at visible levels for easy comparisons.

Bulk density values were taken from Huddleston (1982). The fractional organic carbon is the midpoint of the range of organic matter values given in the SCS Soils-5 database divided by 1.6. The depth of surface zone is the same depth used in the current thesis model. Depth of the vadose zone is 1.52 meters (60 inches) - the standard cutoff depth for the soils used in the current model. If the soil was shallower to bedrock, then that depth was used. The depth of the deep zone is the same as the depth of the vadose zone. It is the point at which the chemical arrives at the calculated time with a calculated residual mass. This depth is intended by the model to be the depth to ground water, but since that is unknown, the depth to the bottom of the soil profile (or 60 inches, which ever is shallower) will be used. The depth constant, which is involved in calculating biodegradation, is 3. This is the value used by Jury. The input parameters used for this model are shown in Table 12.

TABLE 12. Input parameters for the simulation of ten Oregon soils with the model of Jury (1987).

SOIL SERIES	INPUT PARAMETERS							
	Bulk Density (kg/m3)	Volumetric Water Content	Fraction organic carbon Foc	Depth Surface Zone (m) L	Depth Vadose Zone (m) H	Average Drainage Rate (m/yr) Jw	Depth Constant (/m) r	Depth (m) z
Amity	1400	0.38	0.025	0.406	1.52	1	3	1.52
Dayton	1500	0.35	0.016	0.229	1.52	1	3	1.52
Woodburn	1300	0.41	0.025	0.432	1.52	1	3	1.52
Madras	1300	0.41	0.009	0.203	1.02	1	3	1.02
Ritzville	1300	0.41	0.009	0.229	1.52	1	3	1.52
Quincy	1700	0.29	0.005	0.381	1.52	1	3	1.52
Algoma	1400	0.38	0.044	0.279	1.52	1	3	1.52
Flagstaff	1300	0.41	0.005	0.076	1.52	1	3	1.52
Fordney	1600	0.32	0.028	0.203	1.52	1	3	1.52
Nyssa	1400	0.38	0.008	0.33	1.52	1	3	1.52

Results of Comparisons

Table 13 shows the results of the comparison of the three models described above with this thesis model. Note that the Jury model gives a mass fraction of pesticide and time result. The mass fraction is the amount of pesticide expected to reach the specified depth given in the input. The time is the time it will take for that amount of pesticide to reach the specified depth. For comparisons it is best to look at the mass fraction of pesticide first to see which soil allows the greater amount to pass, and then look at the time to see how long it will take the pesticide to move to the specified depth. A large mass fraction in a relatively shorter time period poses the greatest risk, whereas a small mass after a long time poses the least risk.

There is a general agreement among the four models, although there are some discrepancies. The results for the Amity, Woodburn, Quincy and Fordney soils agree for all models. Minor discrepancies appear with the Dayton and Nyssa soils. These two soils are rated as moderate with this thesis model, although with the other three models it has a low potential for movement. The Dayton soil is rated as moderate with this thesis model because of the soil's poor drainage, whereas the Nyssa soil has moderately rapid permeability. For the remaining soils, the discrepancies are with the results of one of the other three models. For instance, with the Madras soil the Jury model give a higher rating than the other three. With Ritzville, the Wisconsin model gives a lower rating than the other three, but with the Algoma soil it gives a higher pollution rating. With the Flagstaff soil, the SCS model

TABLE 13. Comparison of four model simulations with ten Oregon soils for estimating pesticide movement through soil.

SOIL SERIES	JURY MODEL (Fraction of pesticide (Mr) & time (T, years) --to reach depth specified Table 12) Aldicarb Mr	Aldicarb T	Dicamba Mr	Dicamba T	SCS MODEL Soil Leach Potential 1/	WISCONSIN APPROACH Attenuation potential rating 2/	SOIL PROPERTIES MODEL 3/
Amity	0.012496	2.4928	0.002230	0.6946	Nominal	Good	LOW
Dayton	0.084808	1.8453	0.016684	0.6123	Nominal	Good	MODERATE
Woodburn	0.012645	2.4016	0.001282	0.7319	Nominal	Best	LOW
Madras	0.192525	0.8669	0.014489	0.4456	Nominal	Good	LOW
Ritzville	0.177746	1.2919	0.011800	0.6641	Intermediate	Best	MODERATE
Quincy	0.225069	0.8780	0.018864	0.4675	High	Least	VERY HIGH
Algoma	0.003186	3.9484	0.003331	0.7836	Nominal	Marginal	LOW
Flagstaff	0.393770	0.9575	0.043618	0.6436	Nominal	Marginal	MODERATE
Fordney	0.023597	2.9379	0.017304	0.6362	High	Least	VERY HIGH
Nyssa	0.156684	1.1751	0.007882	0.6141	Nominal	Good	MODERATE

1/ Soil Leach Potential - possible ratings are: Nominal, Intermediate, and High

2/ Attenuation Potential - possible ratings are: Least, Marginal, Good, and Best.
- ranking of soil series on the basis of its ability to attenuate chemicals.
- Does not take into account specific pesticides.

3/ Pesticide Movement Potential - possible ratings are: Very Low, Low, Moderate, High, and Very High.

underestimates the leaching potential compared with the other three. This shows that all models will differ in their estimation of groundwater vulnerability. The choice of a model to use should take into account the specific purpose of the model and the accuracy of the input parameters with respect to the design of the model.

After a review of these results, 39 soils from differing locations across the state were evaluated using the soil properties model. These ratings were then compared to the results obtained when these 39 soils were evaluated using the Jury et al., (1987) model. The Jury model was used for this more extensive comparison because it was considered to be a more accurate model than the Wisconsin or SCS models. This is in part due to the reputation and extensive work Dr. Jury has done to characterize pesticide movement through soil. Again, the Jury model requires a chemical compound - Aldicarb and dicamba were used. Table 14 lists the input values and Table 15 gives the results. The pesticide mass fraction values were sorted and then split into groups of either low, moderate, or high pesticide movement potentials. The split into the groups was arbitrary, but generally follows a natural split among the results. The range of the splits is given at the bottom of Table 15. The time to reach a specified depth is also important and should be taken into account. But in general, those pesticides with a larger mass fraction had a shorter time to reach depth.

Out of the 39 sets of ratings compared there is good or relatively good agreement between all but five. These five are for the Fordney, Madras, Newberg, Owyhee, and Virtue soils. Of these five there is a discrepancy among the two chemicals for Fordney and Newberg, with the pesticide Dicamba agreeing with the thesis model results.

TABLE 14. Input parameters for thirty-nine soils for simulations with Jury (1987) model.

SOIL SERIES	INPUT PARAMETERS							
	Bulk Density (kg/m3)	Volumetric Water Content (80% sat)	Fraction organic carbon (surface) Foc	Depth Surface (surface) Zone (m) L	Depth Vadose Zone (bedrock) (m) H	Average Drainage Rate (constant) (m/yr) Jw	Depth Constant (/m) r	Depth Deep Zone (m) z
Algoma	1400	0.38	0.044	0.279	1.52	1	3	1.52
Amity	1400	0.38	0.025	0.406	1.52	1	3	1.52
Dayton	1500	0.35	0.016	0.229	1.52	1	3	1.52
Flagstaff	1300	0.41	0.005	0.076	1.52	1	3	1.52
Fordney	1600	0.32	0.028	0.203	1.52	1	3	1.52
Madras	1300	0.41	0.009	0.203	1.02	1	3	1.02
Nyssa	1400	0.38	0.008	0.330	1.52	1	3	1.52
Quincy	1700	0.29	0.005	0.381	1.52	1	3	1.52
Ritzville	1300	0.41	0.009	0.229	1.52	1	3	1.52
Woodburn	1300	0.41	0.025	0.432	1.52	1	3	1.52
Calimus	1400	0.38	0.025	0.356	1.52	1	3	1.52
Henley	1200	0.44	0.009	0.279	1.52	1	3	1.52
Klamath	600	0.62	0.038	0.279	1.52	1	3	1.52
Lorella	1550	0.33	0.019	0.127	0.51	1	3	0.51
Tulana	500	0.65	0.141	0.584	1.52	1	3	1.52
Irrigon	1350	0.39	0.005	0.076	1.00	1	3	1.00
Morrow	1350	0.39	0.009	0.229	1.02	1	3	1.02
Rhea	1350	0.39	0.009	0.356	1.52	1	3	1.52
Valby	1350	0.39	0.009	0.203	1.02	1	3	1.02
Winchester	1600	0.32	0.005	0.203	1.52	1	3	1.52

TABLE 14. (CONTINUED).

SOIL SERIES	Bulk Density (kg/m3)	Volumetric Water Content (80% sat)	Fraction organic carbon (surface) Foc	Depth Surface (surface) Zone (m) L	Depth Vadose Zone (bedrock) (m) H	Average Drainage Rate (constant) (m/yr) Jw	Depth Constant (/m) r	Depth Deep Zone (m) z
	INPUT PARAMETERS							
Chehalis	1270	0.42	0.047	0.305	1.52	1	3	1.52
Jory	1400	0.38	0.028	0.406	1.52	1	3	1.52
Newberg	1300	0.41	0.019	0.178	1.52	1	3	1.52

Feltham	1620	0.31	0.009	0.152	1.52	1	3	1.52
Greenleaf	1250	0.42	0.009	0.203	1.52	1	3	1.52
Owyhee	1300	0.41	0.009	0.254	1.52	1	3	1.52
Prosser	1300	0.41	0.009	0.102	1.02	1	3	1.02
Sagehill	1450	0.36	0.009	0.203	1.52	1	3	1.52
Stanfield	1350	0.39	0.009	0.152	1.52	1	3	1.52
Umapine	1200	0.44	0.005	0.229	1.52	1	3	1.52
Virtue	1300	0.41	0.013	0.178	1.52	1	3	1.52

Alicel	1350	0.39	0.019	0.457	1.52	1	3	1.52
Catherine	1320	0.40	0.044	0.762	1.52	1	3	1.52
Conley	1220	0.43	0.013	0.330	1.52	1	3	1.52
Hoopal	1100	0.47	0.009	0.254	1.52	1	3	1.52
Hot Lake	1030	0.49	0.013	0.356	1.52	1	3	1.52
Imbler	1500	0.35	0.016	0.356	1.52.	1	3	1.52
La Grande	1320	0.40	0.034	0.356	1.52	1	3	1.52
Palouse	1400	0.38	0.019	0.356	1.52	1	3	1.52

TABLE 15. Comparison of the results of thirty-nine soils using the Jury (1987) and the soil properties models.

SOIL SERIES	SOIL RATING POTENTIAL	ALDICARB Mass Fraction	Time (years)	JURY: ESTIMATED PESTICIDE MOVEMENT POTENTIAL	DICAMBA Mass Fraction	Time (years)	JURY: ESTIMATED PESTICIDE MOVEMENT POTENTIAL
Algoma	LOW	0.003277	3.9290	LOW	0.003453	0.7786	LOW
Amity	LOW	0.012585	2.4888	LOW	0.002310	0.6906	LOW
Dayton	MODERATE	0.089126	1.8081	MODERATE	0.017403	0.6059	HIGH
Flagstaff	MODERATE	0.395202	0.9538	HIGH	0.044417	0.6399	HIGH
Fordney	VERY HIGH	0.023472	2.9420	LOW	0.017758	0.6322	HIGH
Madras	LOW	0.193443	0.8644	HIGH	0.014837	0.4431	MODERATE
Nyssa	MODERATE	0.157679	1.1711	MODERATE	0.008136	0.6101	MODERATE
Quincy	VERY HIGH	0.226941	0.8731	HIGH	0.019661	0.4626	HIGH
Ritzville	MODERATE	0.178635	1.2882	HIGH	0.012098	0.6603	MODERATE
Woodburn	LOW	0.012731	2.3979	LOW	0.001326	0.7282	LOW
Calimus	LOW	0.016958	2.4888	LOW	0.003494	0.6906	LOW
Henley	MODERATE	0.154324	1.2826	MODERATE	0.005965	0.7031	MODERATE
Klamath	VERY LOW	0.042242	2.1719	LOW	0.000611	1.0159	LOW
Lorella	VERY HIGH	0.100474	0.7044	MODERATE	0.037039	0.2021	HIGH
Tulana	LOW	0.000026	4.8334	LOW	0.000002	1.2216	LOW
Irrigon	HIGH	0.399100	0.6209	HIGH	0.049474	0.4064	HIGH
Morrow	HIGH	0.177973	0.8663	HIGH	0.013956	0.4288	MODERATE
Rhea	MODERATE	0.120666	1.2909	MODERATE	0.005334	0.6390	MODERATE
Valby	VERY HIGH	0.192759	0.8663	HIGH	0.017003	0.4288	HIGH
Winchester	VERY HIGH	0.320065	0.8933	HIGH	0.039454	0.5070	HIGH

TABLE 15. (CONTINUED).

SOIL SERIES	SOIL RATING POTENTIAL	ALDICARB Mass Fraction	Time (years)	JURY: ESTIMATED PESTICIDE MOVEMENT POTENTIAL	DICAMBA Mass Fraction	Time (years)	JURY: ESTIMATED PESTICIDE MOVEMENT POTENTIAL
Chehalis	LOW	0.002751	3.8856	LOW	0.001814	0.8320	LOW
Jory	VERY LOW	0.008290	2.7263	LOW	0.002033	0.7051	LOW
Newberg	VERY HIGH	0.092710	1.9568	LOW	0.014107	0.7012	HIGH
Feltham	VERY HIGH	0.221561	1.3059	HIGH	0.048753	0.5236	HIGH
Greenleaf	MODERATE	0.194128	1.2854	HIGH	0.012947	0.6817	MODERATE
Owyhee	LOW	0.165467	1.2882	HIGH	0.009942	0.6603	MODERATE
Prosser	VERY HIGH	0.263899	0.8644	HIGH	0.032891	0.4431	HIGH
Sagehill	HIGH	0.203380	1.2489	HIGH	0.022749	0.5933	HIGH
Stanfield	MODERATE	0.237256	1.2466	HIGH	0.025444	0.6363	HIGH
Umapine	HIGH	0.271898	0.9740	HIGH	0.010312	0.6842	MODERATE
Virtue	VERY LOW	0.159836	1.5087	MODERATE	0.016661	0.6738	HIGH
Alicel	LOW	0.023948	1.9853	LOW	0.001655	0.6814	LOW
Catherine	LOW	0.000054	3.7740	LOW	0.000029	0.8036	LOW
Conley	VERY LOW	0.095256	1.4907	MODERATE	0.003784	0.7072	LOW
Hoopal	HIGH	0.168052	1.2771	MODERATE	0.005473	0.7458	MODERATE
Hot Lake	LOW	0.093307	1.4479	MODERATE	0.001594	0.7864	LOW
Imbler	HIGH	0.051715	1.8081	MODERATE	0.006991	0.6059	MODERATE
La Grande	LOW	0.006282	3.0950	LOW	0.001945	0.7621	LOW
Palouse	LOW	0.036923	2.0138	LOW	0.004432	0.6616	LOW

RATING			RATING		
LOW	MODERATE	HIGH	LOW	MODERATE	HIGH
<= 0.05	0.05-0.17	>=0.17	<=0.005	0.005-0.015	>=0.015
RANGE OF TIME 0.6209 years to 4.8334 years			RANGE OF TIME 0.4064 years to 1.2216 years		

The discrepancies for the other three soils could be explained by variations due to the using estimated input values, estimating the rating of risk, and inherent differences in the structure of the models. But overall, there is reasonably good agreement between the two models' results.

DISCUSSION

The soil properties model in this thesis was developed to determine the relative overall pesticide movement potential in Oregon agricultural soils. The model is based on soil properties important in pesticide movement. The intent is to identify soil areas that may be vulnerable to groundwater contamination by pesticides.

Several existing models each attempt to predict the potential for groundwater contamination. Some of these incorporate climatic, pesticide, and management factors in addition to soil factors. Some are large, complex computer programs requiring extensive, and very precise, input. The objective here was to develop a reliable, easy to use model, where the input values are easy to obtain and are from a single published source. To achieve this objective, many simplifications were required with regard to both the soil system and the whole environmental and management system surrounding pesticide applications. These simplifications of the model are discussed below.

The Oregon soil properties model characterizes a soil series as a relatively homogeneous system. This has limitations since soils vary considerably from point to point in their textural composition, structural properties and mineralogical constituents (Jury, 1986b). This can result in lateral and vertical variations of the parameters used in this soil properties model.

The presence of an impervious layer in the soil will decrease the rate of water movement downward, but may increase flow laterally. The pesticide could then be carried out to a surface water body, or may reach another soil without an impervious layer and continue its downward movement. In addition, an impervious layer may promote conditions of saturation above it. This would then increase the process of desorption, making more pesticide available for movement.

The modeling of the sorption process considers the organic matter content of the surface layer only. Some sorption will most likely take place below the surface horizon, particularly in soils that have organic matter accumulations to a considerable depth. This sorption was not estimated because of lack of data for subsurface organic matter contents.

The pH of the soil can affect the sorption of organic acids and bases. At high pH the dissociated anion of an organic acid has a higher water solubility and may be repulsed by the surface negative charge of the organic matter (decrease adsorption). At low pH some cationic species show increased adsorption through ion exchange (Chiou et al. 1979).

Biological activity of the soil affects the degradation of pesticides. A more active and larger population will degrade more pesticides, thereby reducing the amount available for transport. The biological activity in the soil was not incorporated in this thesis model.

The slope of the soil surface is also important when considering whether pesticides may move to groundwater. Soils with slopes greater than 20 percent are more likely to have runoff, which will decrease the amount of pesticide available for movement down through the soil. Lateral transport, however, may carry pesticides to soils in footslope positions, where leaching to groundwater might occur, or all the way to a surface water body.

The composition of the bedrock and aquifer are very important when considering the vulnerability of the groundwater resource. They both influence rate of leaching and amount of sorption. They are not considered in this thesis model below a depth of 60 inches.

The properties of the chemical are extremely important in controlling pesticide movement. A companion to this soil model is a model that rates a pesticide's leaching potential based on its Koc (partition coefficient for adsorbing onto organic matter), and half-life in soil. The soil model and pesticide model were developed together as part of a Water Quality Initiative project funded by the USDA - Extension Service. The result is a combined report entitled Pesticide Application Guidelines to Reduce Water Contamination in Oregon.((Reference Here)).

In addition to the physical and chemical properties of the pesticide, the management of pesticide application is also very important in controlling pesticide movement. The amount of chemical applied is one of the most important factors. The more pesticide applied, the more that is available for movement.

Timing of application with respect to rainfall or irrigation can influence the sorption of pesticides. Pesticides will sorb less on a wet soil than a dry soil because of the competition of the pesticide with water for binding sites.

Application method will control how much pesticide may be lost to volatilization. Aerially and above surface applied pesticides will have a greater amount lost to volatilization, and therefore less will be available for movement down through the soil.

Plant uptake is an important mechanism for removal of pesticides from soil. Pesticides applied to the land can be intercepted by growing vegetation so that a portion of the chemical enters the plant. The chemical will then undergo sorption, chemical transformations and degradation, as well as bioaccumulation in the plant

(Donigian and Rao, 1986). Unfortunately, there is very little quantitative information available to model organic chemical uptake. Plant uptake is not incorporated in this soil properties model.

Large computer modeling programs attempt to incorporate as many of the above variables as possible. But it is important to remember that many of the input values are probably estimates and the model itself is an estimate of the system. Increasing the complexity of a model does not necessarily increase the accuracy or precision of a model. A simple model, based on scientific principles and observations, can provide a quick but reliable assessment of areas of concern. Field sampling and then more complex modeling can then be used to quantify the degree of risk.

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APPENDICES

APPENDIX A

SIMULATIONS WITH WILLAMETTE VALLEY SOILS

APPENDIX A. TABLE A-1

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS: LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
Abiqua	0-21	21		0.6-2.0	6	126	294
	21-54	33		0.2-0.6	4	132	
	54-60	6		0.6-2.0	6	36	
Aloha	0-8	8		0.6-2.0	6	48	256
	8-46	38		0.2-0.6	4	152	
	46-60	14		0.2-0.6	4	56	
Alspaugh	0-14	14		0.6-2.0	6	84	268
	14-43	29		0.2-0.6	4	116	
	43-60	17		0.2-0.6	4	68	
Amity	0-22	22		0.6-2.0	6	132	334
	22-35	13		0.2-0.6	4	52	
	35-60	25		0.6-2.0	6	150	
Apt	0-8	8		0.6-2.0	6	48	
	8-24	16		0.2-0.6	4	64	
	24-60	36		0.2-0.6	4	144	256
Astoria	0-19	19		0.6-2.0	6	114	
	19-50	31		0.6-2.0	6	186	
	50-60	10		0.6-2.0	6	60	360

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
Awbrig	0-7	7		0.6-2.0	6	42	
	7-29	22		<0.06	1	22	
	29-60	31		0.2-0.6	4	124	188
Bandon	0-17	17		0.6-2.0	6	102	
	17-30	13	weakly cemented hardpan	0.06-0.2	2	26	
	30-60	30		2.0-6.0	8	240	368
Bashaw	0-14	14		<0.06	1	14	
	14-48	34		<0.06	1	34	
	48-60	12		<0.06	1	12	60
Bellpine	0-10	10		0.6-2.0	6	60	
	10-26	16		0.06-0.2	2	32	
	26-60	34	part. weathrd sandstone	0.06-0.2	2	68	160
Borges	0-18	18		0.2-0.6	4	72	
	18-45	27		<0.06	1	27	
	45-60	15		0.2-0.6	4	60	159
Bornstedt	0-8	8		0.6-2.0	6	48	
	8-33	25		0.6-2.0	6	150	
	33-60	27		0.06-0.2	2	54	252
Brallier	0-60	60		0.6-2.0	6	360	360

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS: LAYER THICKNESS		RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
Brenner	0-7	7		0.6-2.0	6	42	
	7-21	14		0.2-0.6	4	56	
	21-60	39		0.06-0.2	2	78	176
Briedwell	0-15	15		0.6-2.0	6	90	
	15-25	10		0.6-2.0	6	60	
	25-60	35		0.6-2.0	6	210	360
Bullrun	0-13	13		0.6-2.0	6	78	
	13-60	47		0.6-2.0	6	282	360
Burlington	0-12	12		2.0-6.0	8	96	
	12-60	48		6.0-20	9	432	528
Camas	0-13	13		2.0-6.0	8	104	
	13-60	47		>20	10	470	574
Canderly	0-7	7		2.0-6.0	8	56	
	7-46	39		2.0-6.0	8	312	
	46-60	11		2.0-6.0	8	88	456
Carlton	0-12	12		0.6-2.0	6	72	
	12-42	30		0.2-0.6	4	120	
	42-60	18		0.2-0.6	4	72	264

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS: LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
Cascade	0-8	8		0.6-2.0	6	48	
	8-27	19		0.6-2.0	6	114	
	27-60	33		0.06-0.2	2	66	228
Cazadero	0-21	21		0.6-2.0	6	126	
	21-60	39		0.2-0.6	4	156	282
Chapman	0-8	8		0.6-2.0	6	48	
	8-42	34		0.6-2.0	6	204	
	42-50	8		2.0-6.0	8	64	
	50-60	10		6.0-20	9	90	406
Chehalem	0-23	23		0.2-0.6	4	92	
	23-60	37		0.06-0.2	2	74	166
Chehalis	0-60	60		0.6-2.0	6	360	360
Chehulpum	0-4	4		0.6-2.0	6	24	
	4-12	8		0.6-2.0	6	48	
	12-60	48	semi-consol. sandstone	0.6-2.0	6	288	360
Clackamas	0-15	15		0.6-2.0	6	90	
	15-24	9		0.2-0.6	4	36	
	24-60	36		0.2-0.6	4	144	270

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS						TOTAL RESULT
	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	
Cloquato	0-12	12		0.6-2.0	6	72	
	12-60	48		0.6-2.0	6	288	360
Coburg	0-18	18		0.6-2.0	6	108	
	18-53	35		0.2-0.6	4	140	
	53-60	7		2.0-6.0	8	56	304
Concord	0-15	15		0.6-2.0	6	90	
	15-29	14		0.06-0.2	2	28	
	29-60	31		0.2-0.6	4	124	242
Conser	0-9	9		0.6-2.0	6	54	
	9-41	32		0.06-0.2	2	64	
	41-60	19		0.6-2.0	6	114	232
Cornelius	0-17	17		0.6-2.0	6	102	
	17-38	21		0.6-2.0	6	126	
	38-60	22		0.06-0.2	2	44	272
Cottrell	0-24	24		0.6-2.0	6	144	
	24-55	31		0.2-0.6	4	124	
	55-60	5		0.2-0.6	4	20	288
Courtney	0-12	12		0.2-0.6	4	48	

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
	12-24	12		<0.06	1	12	
	24-49	25		0.2-0.6	4	100	
	49-60	11		6.0-20	9	99	259
Cove	0-8	8		0.2-0.6	4	32	
	8-60	52		<0.06	1	52	84
Crims	0-9	9		0.6-2.0	6	54	
	9-40	31		0.6-2.0	6	186	
	40-60	20		0.6-2.0	6	120	360
Cumley	0-9	9		0.6-2.0	6	54	
	9-60	51		0.2-0.6	4	204	258
Dabney	0-15	15		6.0-20	9	135	
	15-60	45		6.0-20	9	405	540
Dayton	0-15	15		0.6-2.0	6	90	
	15-40	25		<0.06	1	25	
	40-60	20		0.6-2.0	6	120	235
Dixonville	0-4	4		0.6-2.0	6	24	
	4-34	30		0.06-0.2	2	60	
	34-60	26	vargtd saprolite semiconsol. bedrock	0.6-2.0	6	156	240

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
	PERMEABILITY OF INDIVIDUAL SOIL LAYERS						
Dupee	0-15	15		0.6-2.0	6	90	
	15-40	25		0.2-0.6	4	100	
	40-60	20	part. wthrd. sandstone	0.06-0.2	2	40	230
Eilertsen	0-17	17		0.6-2.0	6	102	
	17-49	32		0.6-2.0	6	192	
	46-60	14		0.6-2.0	6	84	378
Faloma	0-10	10		0.6-2.0	6	60	
	10-15	5		0.6-2.0	6	30	
	15-60	45		6.0-20	9	405	495
Gapcot	0-10	10		2.0-6.0	8	80	
	10-15	5		0.6-2.0	6	30	
	15-60	45	frctrd. sandstone	0.6-2.0	6	270	380
Goble	0-14	14		0.6-2.0	6	84	
	14-37	23		0.6-2.0	6	138	
	37-60	23		0.06-0.2	2	46	268
Grande Ronde	0-6	6		0.2-0.6	4	24	
	6-24	18		0.06-0.2	2	36	
	24-60	36		0.06-0.2	2	72	132
Hardscrabble	0-8	8		0.6-2.0	6	48	

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
	8-14	6		0.6-2.0	6	36	
	14-60	46		<0.06	1	46	130
Hazelair	0-11	11		0.6-2.0	6	66	
	11-18	7		0.2-0.6	4	28	
	18-30	12		<0.06	1	12	
	30-60	30	sandstone & siltstone	0.6-2.0	6	180	286
Helmick	0-10	10		0.6-2.0	6	60	
	10-16	6		0.06-0.2	2	12	
	16-60	44		<0.06	1	44	116
Helvetia	0-5	5		0.6-2.0	6	30	
	5-10	5		0.6-2.0	6	30	
	10-48	38		0.2-0.6	4	152	
	48-60	12		0.2-0.6	4	48	260
Hillsboro	0-48	48		0.6-2.0	6	288	
	48-57	9		2.0-6.0	8	72	
	57-60	3		6.0-20	9	27	387
Holcomb	0-18	18		0.6-2.0	6	108	
	18-24	6		0.6-2.0	6	36	
	24-50	26		<0.06	1	26	
	50-60	10		0.06-0.2	2	20	190

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS: LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
Honeygrove	0-12	12		0.6-2.0	6	72	
	12-60	48		0.2-0.6	4	192	264
Hullt	0-15	15		0.6-2.0	6	90	
	15-55	40		0.6-2.0	6	240	
	55-60	5	wethrd. sandstone	0.06-0.2	2	10	340
Jimbo	0-14	14		2.0-6.0	8	112	
	14-43	29		2.0-6.0	8	232	
	43-60	17		>20	10	170	514
Jory	0-16	16		0.6-2.0	6	96	
	16-60	44		0.2-0.6	4	176	272
Kinney	0-10	10		0.6-2.0	6	60	
	10-40	30		0.6-2.0	6	180	
	40-53	13		0.6-2.0	6	78	
	53-60	7	prt. wthrd. ign. aglomte.	0.06-0.2	2	14	332
Kinton	0-10	10		0.6-2.0	6	60	
	10-39	29		0.6-2.0	6	174	
	39-60	21		0.06-0.2	2	42	276
Knappa	0-14	14		0.6-2.0	6	84	

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
	14-60	46		0.6-2.0	6	276	360
Labish	0-16	16		0.06-0.2	2	32	
	16-60	44		0.06-0.2	2	88	120
Latourell	0-9	9		0.6-2.0	6	54	
	9-56	47		0.6-2.0	6	282	
	56-60	4		2.0-6.0	8	32	368
Laurelwood	0-11	11		0.6-2.0	6	66	
	11-52	41		0.6-2.0	6	246	
	52-60	8		0.2-0.6	4	32	344
Linslaw	0-16	16		0.6-2.0	6	96	
	16-42	26		0.06-0.2	2	52	
	42-56	14		0.06-0.2	2	28	
	56-60	4		0.6-2.0	6	24	200
Lint	0-16	16		2.0-6.0	8	128	
	16-60	44		0.6-2.0	6	264	392
Malabon	0-12	12		0.6-2.0	6	72	
	12-42	30		0.2-0.6	4	120	
	42-60	18		0.6-2.0	6	108	300

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
Marcola	0-15	15		0.6-2.0	6	90	
	15-60	45		0.06-0.2	2	90	180
McAlpin	0-23	23		0.6-2.0	6	138	
	23-60	37		0.2-0.6	4	148	286
McBee	0-10	10		0.6-2.0	6	60	
	10-42	32		0.6-2.0	6	192	
	42-60	18		0.6-2.0	6	108	360
McCully	0-10	10		0.6-2.0	6	60	
	10-57	47		0.2-0.6	4	188	
	57-60	3	weathrd bdrck	0.06-0.2	2	6	254
McNulty	0-9	9		0.6-2.0	6	54	
	9-32	23		0.6-2.0	6	138	
	32-60	28		0.6-2.0	6	168	360
Meda	0-10	10		0.6-2.0	6	60	
	10-32	22		0.6-2.0	6	132	
	32-60	28		6.0-20	6	168	360
Melbourne	0-13	13		0.6-2.0	6	78	
	13-34	21		0.6-2.0	6	126	
	34-47	13		0.2-0.6	4	52	

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS: LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
	47-60	13		0.2-0.6	4	52	308
Mershon	0-15	15		0.6-2.0	6	90	
	15-56	41		0.2-0.6	4	164	
	56-60	4		0.2-0.6	4	16	270
Moag	0-10	10		0.2-0.6	4	40	
	10-60	50		0.06-0.2	2	100	140
Molalla	0-5	5		2.0-6.0	8	40	
	5-13	8		2.0-6.0	8	64	
	13-44	31		0.6-2.0	6	186	
	44-60	16	wthrd tuff. rock	0.06-0.2	2	32	322
Multnomah	0-8	8		0.6-2.0	6	48	
	8-39	31		0.6-2.0	6	186	
	39-60	21		6.0-20	9	189	423
Natal	0-9	9		0.2-0.6	4	36	
	9-60	51		0.06-0.2	2	102	138
Natroy	0-5	5		0.06-0.2	2	10	
	5-57	52		<0.06	1	52	
	57-60	3		<0.06	1	3	65

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS						TOTAL RESULT
	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	
Nehalem	0-17	17		0.6-2.0	6	102	
	17-37	20		0.6-2.0	6	120	
	37-60	23		0.2-0.6	4	92	314
Nekia	0-9	9		0.2-0.6	4	36	
	9-36	27		0.2-0.6	4	108	
	36-60	24	frctrd. bdrck	0.6-2.0	6	144	288
Nekoma	0-11	11		0.6-2.0	6	66	
	11-20	9		2.0-6.0	8	72	
	20-60	40		6.0-20	9	360	498
Neskowin	0-12	12		0.6-2.0	6	72	
	12-27	15		0.6-2.0	6	90	162
	27-60	33	igneous rock				
Nestucca	0-14	14		0.6-2.0	6	84	
	14-41	27		0.2-0.6	4	108	
	41-60	19		0.06-0.6	2	38	230
Netarts	0-6	6		6-20	9	54	
	6-47	41		2.0-6.0	8	328	
	47-60	13		6.0-20	9	117	499
Newberg	0-28	28		2.0-6.0	8	224	

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
	28-60	32		6.0-20	9	288	512
Noti	0-9	9		0.6-2.0	6	54	
	9-34	25		0.6-2.0	6	150	
	34-44	10		2.0-6.0	8	80	
	44-60	16		0.06-0.2	2	32	316
Oxley	0-17	17		0.6-2.0	6	102	
	17-23	6		0.2-0.6	4	24	
	23-41	18		0.2-0.6	4	72	
	41-60	19		2.0-6.0	8	152	350
Panther	0-14	14		0.2-0.6	4	56	
	14-60	46		<0.06	1	46	102
Peavine	0-10	10		0.2-0.6	4	40	
	10-36	26		0.2-0.6	4	104	
	36-60	24	Cr1&Cr2-shale (fractured)	0.06-0.2	2	48	192
Pengra	0-6	6		0.2-0.6	4	24	
	6-21	15		0.2-0.6	4	60	
	21-60	39		<0.06	1	39	123
Philomath	0-9	9		0.6-2.0	6	54	
	9-18	9		0.06-0.2	2	18	

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS						TOTAL RESULT
	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	
	18-60	42	wthrd semiconsl bdr	0.06-0.2	2	84	156
Pilchuck	0-20	20		6.0-20	9	180	
	20-38	18		6.0-20	9	162	
	38-60	22		>20	10	220	562
Powell	0-8	8		0.6-2.0	6	48	
	8-16	8		0.6-2.0	6	48	
	16-60	44		0.06-0.2	2	88	184
Preacher	0-14	14		2.0-6.0	8	112	
	14-42	28		0.6-2.0	6	168	
	42-60	18		2.0-6.0	8	144	424
Price	0-5	5		0.6-2.0	6	30	
	5-50	45		0.2-0.6	4	180	
	50-60	10	prt wthrd basalt	>20	10	100	310
Quafeno	0-16	16		0.6-2.0	6	96	
	16-36	20		0.2-0.6	4	80	
	36-60	24		2.0-6.0	8	192	368
Quatama	0-15	15		0.6-2.0	6	90	
	15-30	15		0.2-0.6	4	60	
	30-60	30		0.2-0.6	4	120	270

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS: LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
Rafton	0-9	9		0.6-2.0	6	54	
	9-40	31		0.2-0.6	4	124	
	40-60	20		0.6-2.0	6	120	298
Rickreall	0-5	5		0.6-2.0	6	30	
	5-17	12		0.06-0.2	2	24	
	17-60	43		0.06-0.2	2	86	140
Ritner	0-15	15		0.6-2.0	6	90	
	15-24	9		0.2-0.6	4	36	
	24-38	14		0.2-0.6	4	56	
	38-60	22	frctrd bdrck	0.6-2.0	6	132	314
Salem	0-9	9		0.6-2.0	6	54	
	9-30	21		0.6-2.0	6	126	
	30-60	30		>20	10	300	480
Salkum	0-19	19		0.6-2.0	6	114	
	19-27	8		0.06-0.2	2	16	
	27-60	33		0.2-0.6	4	132	262
Santiam	0-13	13		0.6-2.0	6	78	
	13-30	17		0.2-0.6	4	68	
	30-60	30		0.06-0.2	2	60	206

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS: LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
Saturn	0-10	10		0.6-2.0	6	60	
	10-32	22		0.6-2.0	6	132	
	32-60	28		6.0-20	9	252	444
Saum	0-8	8		0.6-2.0	6	48	
	8-23	15		0.6-2.0	6	90	
	23-50	27		0.2-0.6	4	108	
	50-60	10	basalt	>20	10	100	346
Sauvie	0-15	15		0.2-0.6	4	60	
	15-39	24		0.2-0.6	4	96	
	39-60	21		2.0-6.0	8	168	324
Sawtell	0-13	13		0.6-2.0	6	78	
	13-43	30		0.6-2.0	6	180	
	43-60	17		0.2-0.6	4	68	326
Semiahmoo	0-53	53		0.2-0.6	4	212	
	53-60	7		0.2-0.6	4	28	240
Sifton	0-21	21		2.0-6.0	8	168	
	21-30	9		6.0-20	9	81	
	30-60	30		>20	10	300	549

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
Silverton	0-16	16		0.6-2.0	6	96	
	16-25	9		0.2-0.6	4	36	
	25-37	12		0.06-0.2	2	24	
	37-60	23	frct&prt wthrd bdrk	0.06-0.2	2	46	202
Springwater	0-7	7		2.0-6.0	8	56	
	7-37	30		0.6-2.0	6	180	
	37-60	23	sandstone	0.6-2.0	6	138	374
Stayton	0-12	12		0.6-2.0	6	72	
	12-19	7		0.6-2.0	6	42	
	19-60	41	consol basalt	>20	10	410	524
Steiwer	0-6	6		0.6-2.0	6	36	
	6-27	21		0.2-0.6	4	84	
	27-60	33	prt wthrd shle snds	0.6-2.0	6	198	318
Suver	0-11	11		0.6-2.0	6	66	
	11-42	31		<0.06	1	31	
	42-60	18	wthrd sed bedrck	0.06-0.2	2	36	133
Treharne	0-15	15		0.6-2.0	6	90	
	15-41	26		0.6-2.0	6	156	
	41-60	19		0.2-0.6	4	76	322

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS						TOTAL RESULT
	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	
Veneta	0-14	14		0.6-2.0	6	84	
	14-39	25		0.06-0.2	2	50	
	39-60	21		<0.06	1	21	155
Verboort	0-19	19		0.2-0.6	4	76	
	19-33	14		<0.06	1	14	
	33-60	27		0.06-0.2	2	54	144
Waldo	0-10	10		0.6-2.0	6	60	
	10-60	50		0.06-0.2	2	100	160
Wapato	0-16	16		0.2-0.6	4	64	
	16-32	16		0.2-0.6	4	64	
	32-60	28		0.2-0.6	4	112	240
Wauna	0-8	8		0.6-2.0	6	48	
	8-26	18		0.2-0.6	4	72	
	26-60	34		0.2-0.6	4	136	256
Whiteson	0-11	11		0.6-2.0	6	66	
	11-15	4		0.2-0.6	4	16	
	15-43	28		<0.06	1	28	
	43-60	17		0.2-0.6	4	68	178
Willakenzie	0-12	12		0.2-0.6	4	48	

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
	12-36	24		0.2-0.6	4	96	
	36-60	24	frcturd siltstone	0.6-2.0	6	144	288
Willamette	0-24	24		0.6-2.0	6	144	
	24-53	29		0.6-2.0	6	174	
	53-60	7		0.6-2.0	6	42	360
Willanch	0-13	13		2.0-6.0	8	104	
	13-35	22		2.0-6.0	8	176	
	35-60	25		2.0-6.0	8	200	480
Winchuck	0-18	18		0.6-2.0	6	108	
	18-46	28		0.2-0.6	4	112	
	46-60	14		0.2-0.6	4	56	276
Witham	0-4	4		0.2-0.6	4	16	
	4-60	56		<0.06	1	56	72
Witzel	0-4	4		0.6-2.0	6	24	
	4-19	15		0.2-0.6	4	60	
	19-60	41	prtly wthrd basalt	>20	10	410	494
Wollent	0-10	10		0.6-2.0	6	60	
	10-60	50		0.2-0.6	4	200	260

APPENDIX A. TABLE A-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR WILLAMETTE VALLEY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS						TOTAL RESULT
	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	
Woodburn	0-32	32		0.6-2.0	6	192	
	32-60	28		0.06-0.2	2	56	248
Yamhill	0-16	16		0.6-2.0	6	96	
	16-24	8		0.2-0.6	4	32	
	24-39	15		0.2-0.6	4	60	
	39-60	21	prt wthrd frc bslt	>20	10	210	398

APPENDIX A. TABLE A-2

RATING OF WILLAMETTE VALLEY SOILS FOR LEACHING POTENTIAL

SOIL SERIES	SCORE PERMEABILITIES TIMES THICKNESS OF LAYERS	SCORE	DRAINAGE CLASS	LEACHING POTENTIAL
Abiqua	294	5	Well	LOW
Aloha	256	4	Somewhat poorly	MODERATE
Alspaugh	268	4	Well	LOW
Amity	334	6	Somewhat poorly	MODERATE
Apt	256	4	Well	LOW
Astoria	360	6	Well	MODERATE
Awbrig	188	3	Poorly	MODERATE
Bandon	368	6	Well	MODERATE
Bashaw	60	1	Poorly	LOW
Bellpine	160	2	Well	VERY LOW
Borges	159	2	Poorly	LOW
Bornstedt	252	4	Moderately well	LOW
Brallier	360	6	Very poorly	HIGH
Brenner	176	3	Poorly	MODERATE
Briedwell	360	6	Well	MODERATE
Bull run	360	6	Well	MODERATE
Burlington	528	9	Somewhat excessively	VERY HIGH
Camas	574	10	Excessively	VERY HIGH
Canderly	456	8	Somewhat excessively	VERY HIGH
Carlton	264	4	Moderately well	MODERATE
Cascade	228	4	Somewhat poorly	MODERATE
Cazadero	282	5	Well	LOW
Chapman	406	7	Well	MODERATE

APPENDIX A. TABLE A-2 (Continued)

RATING OF WILLAMETTE VALLEY SOILS FOR LEACHING POTENTIAL

SOIL SERIES	SCORE PERMEABILITIES TIMES THICKNESS OF LAYERS	SCORE	DRAINAGE CLASS	LEACHING POTENTIAL
Chehalem	166	2	Somewhat poorly	LOW
Chehalis	360	6	Well	MODERATE
Chehulpum	360	6	Well	MODERATE
Clackamas	270	4	Somewhat poorly	MODERATE
Cloquato	360	6	Well	MODERATE
Coburg	304	5	Moderately well	MODERATE
Concord	242	4	Poorly	MODERATE
Conser	232	4	Poorly	MODERATE
Cornelius	272	4	Moderately well	MODERATE
Cottrell	288	5	Moderately well	MODERATE
Courtney	259	4	Poorly	MODERATE
Cove	84	1	Poorly	LOW
Crims	360	6	Very poorly	HIGH
Cumley	258	4	Moderately well	MODERATE
Dabney	540	10	Somewhat excessively	VERY HIGH
Dayton	235	4	Poorly	MODERATE
Dixonville	240	4	Well	LOW
Dupee	230	4	Moderately well	MODERATE
Eilersten	378	6	Well	MODERATE
Faloma	495	9	Poorly	VERY HIGH
Gapcot	380	6	Well	MODERATE
Goble	268	4	Moderately well	MODERATE
Grande Ronde	132	2	Somewhat poorly	LOW

APPENDIX A. TABLE A-2 (Continued)

RATING OF WILLAMETTE VALLEY SOILS FOR LEACHING POTENTIAL

SOIL SERIES	SCORE PERMEABILITIES TIMES THICKNESS OF LAYERS	SCORE	DRAINAGE CLASS	LEACHING POTENTIAL
Hardscrabble	130	2	Somewhat poorly	LOW
Hazelair	286	4	Mod.well - sm. poorly	MODERATE
Helmick	116	2	Somewaht poorly	LOW
Helvetia	260	4	Moderately well	MODERATE
Hillsboro	387	7	Well	MODERATE
Holcomb	190	3	Somewhat poorly	LOW
Honeygrove	264	4	Well	LOW
Hullt	340	6	Well	MODERATE
Jimbo	514	9	Well	HIGH
Jory	272	4	Well	LOW
Kinney	332	6	Well	MODERATE
Kinton	276	5	Moderately well	MODERATE
Knappa	360	6	Well	MODERATE
Labish	120	2	Poorly	LOW
Latourell	368	6	Well	MODERATE
Laurelwood	344	6	Well	MODERATE
Linslaw	200	3	Somewhat poorly	LOW
Lint	392	7	Well	MODERATE
Malabon	300	5	Well	LOW
Marcola	180	3	Moderately well	LOW
McAlpin	286	5	Moderately well	MODERATE
McBee	360	3	Moderately well	LOW
McCully	254	4	Well	LOW

RATING OF WILLAMETTE VALLEY SOILS FOR LEACHING POTENTIAL

SOIL SERIES	SCORE PERMEABILITIES TIMES THICKNESS OF LAYERS	SCORE	DRAINAGE CLASS	LEACHING POTENTIAL
McNulty	360	6	Well	MODERATE
Meda	360	6	Well	MODERATE
Melbourne	308	5	Well	LOW
Mershon	270	4	Moderately well	MODERATE
Moag	140	2	Very poorly	LOW
Molalla	322	5	Well	LOW
Multnomah	423	7	Well	MODERATE
Natal	138	2	Poorly	LOW
Natroy	65	1	Poorly	LOW
Nehalem	314	5	Well	LOW
Nekia	288	5	Well	LOW
Nekoma	498	9	Well	HIGH
Neskowin	162	2	Well	VERY LOW
Nestucca	230	4	Somewhat poorly	MODERATE
Netarts	499	9	Well	HIGH
Newberg	512	9	Somewhat excessively	VERY HIGH
Noti	316	5	Poorly	MODERATE
Oxley	350	6	Somewhat poorly	MODERATE
Panther	102	1	Poorly	LOW
Peavine	192	3	Well	VERY LOW
Pengra	123	2	Somewhat poorly	LOW
Philomath	156	2	Well	VERY LOW
Pilchuck	562	10	Somewhat excessively	VERY HIGH

RATING OF WILLAMETTE VALLEY SOILS FOR LEACHING POTENTIAL

SOIL SERIES	SCORE PERMEABILITIES TIMES THICKNESS OF LAYERS	SCORE	DRAINAGE CLASS	LEACHING POTENTIAL
Powell	184	3	Somewhat poorly	LOW
Preacher	424	7	Well	MODERATE
Price	310	5	Well	LOW
Quafeno	368	6	Moderately well	MODERATE
Quatama	270	4	Moderately well	MODERATE
Rafton	298	5	Very poorly	HIGH
Rickreall	140	2	Well	VERY LOW
Ritner	314	5	Well	LOW
Salem	480	8	Well	HIGH
Salkum	262	4	Well	LOW
Santium	206	3	Moderately well	LOW
Saturn	444	8	Well	HIGH
Saum	346	6	Well	MODERATE
Sauvie	324	5	Poorly	MODERATE
Sawtell	326	5	Moderately well	MODERATE
Semiahmoo	240	4	Very poorly	MODERATE
Sifton	549	10	Somewhat excessively	VERY HIGH
Silverton	202	3	Well	VERY LOW
Springwater	374	6	Well	MODERATE
Stayton	524	9	Well	HIGH
Steiwer	318	5	Well	LOW
Suver	133	2	Somewhat poorly	LOW
Treharne	322	5	Moderately well	MODERATE

APPENDIX A. TABLE A-2 (Continued)

RATING OF WILLAMETTE VALLEY SOILS FOR LEACHING POTENTIAL

SOIL SERIES	SCORE PERMEABILITIES TIMES THICKNESS OF LAYERS	SCORE	DRAINAGE CLASS	LEACHING POTENTIAL
Veneta	155	2	Moderately well	LOW
Verboort	144	2	Poorly	LOW
Waldo	160	2	Poorly	LOW
Wapata	240	4	Poorly	MODERATE
Wauna	256	4	Poorly	MODERATE
Whiteson	178	3	Somewhat poorly	LOW
Willakenzie	288	5	Well	LOW
Willamette	360	6	Well	MODERATE
Willanch	480	8	Poorly	VERY HIGH
Winchuck	276	5	Well	LOW
Witham	72	1	Somewhat poorly	LOW
Witzel	494	9	Well	HIGH
Wollent	260	4	Poorly	MODERATE
Woodburn	248	4	Moderately well	MODERATE
Yamhill	398	7	Well	MODERATE

APPENDIX A. TABLE A-3

CALCULATION OF SURFACE ORGANIC MATTER MULTIPLIED BY SURFACE DEPTH

SOIL SERIES	ORGANIC MATTER SURFACE ZONE (est. percent)	DEPTH SURFACE ZONE (inches)	MULTIPLIED RESULT ORGANIC MATTER TIMES DEPTH
Abiqua	4.5	21	94.5
Aloha	2.5	8	20
Alspaugh	6	14	84
Amity	4	16	64
Apt	6	8	48
Astoria	7.5	19	142.5
Awbrig	3.5	7	24.5
Bandon	2	3	6
Bashaw	6	31	186
Bellpine	4.5	6	27
Borges	3	12	36
Bornstedt	3.5	8	28
Brallier	60	60	3600
Brenner	7.5	13	97.5
Briedwell	4	15	60
Bull run	8	7	56
Burlington	3	12	36
Camas	2	10	20
Canderly	5	15	75
Carlton	3.5	12	42
Cascade	5.5	8	44
Cazadero	3.5	12	42
Chapman	4	14	56

APPENDIX A. TABLE A-3 (Continued)

CALCULATION OF SURFACE ORGANIC MATTER MULTIPLIED BY SURFACE DEPTH

SOIL SERIES	ORGANIC MATTER SURFACE ZONE (est. percent)	DEPTH SURFACE ZONE (inches)	MULTIPLIED RESULT ORGANIC MATTER TIMES DEPTH
Chehalem	3.5	23	80.5
Chehalis	7.5	12	90
Chehulpum	4	12	48
Clackamas	3.5	15	52.5
Cloquato	7.5	40	300
Coburg	5	18	90
Concord	3	6	18
Conser	6	9	54
Cornelius	3	6	18
Cottrell	3.5	15	52.5
Courtney	4	12	48
Cove	6	8	48
Crims	10	20	200
Cumley	5	9	45
Dabney	6	15	90
Dayton	2.5	9	22.5
Dixonville	4.5	12	54
Dupee	2.5	9	22.5
Eilersten	3.5	17	59.5
Faloma	4	10	40
Gapcot	3.5	10	35
Goble	6	14	84
Grande Ronde	1.5	6	9

CALCULATION OF SURFACE ORGANIC MATTER MULTIPLIED BY SURFACE DEPTH

SOIL SERIES	ORGANIC MATTER SURFACE ZONE (est. percent)	DEPTH SURFACE ZONE (inches)	MULTIPLIED RESULT ORGANIC MATTER TIMES DEPTH
Hardscrabble	5	8	40
Hazelair	3	11	33
Helmick	3	10	30
Helvetia	3	10	30
Hillsboro	3.5	15	52.5
Holcomb	4	18	72
Honeygrove	6.5	12	78
Hullt	4.5	15	67.5
Jimbo	5.5	14	77
Jory	4.5	19	85.5
Kinney	6	10	60
Kinton	3.5	10	35
Knappa	10	14	140
Labish	16	16	256
Latourell	2.5	16	40
Laurelwood	3	11	33
Linslaw	3	16	48
Lint	12.5	16	200
Malabon	5	12	60
Marcola	5	15	75
McAlpin	4.5	14	63
McBee	5	10	50
McCully	9.5	10	95

APPENDIX A. TABLE A-3 (Continued)

CALCULATION OF SURFACE ORGANIC MATTER MULTIPLIED BY SURFACE DEPTH

SOIL SERIES	ORGANIC MATTER SURFACE ZONE (est. percent)	DEPTH SURFACE ZONE (inches)	MULTIPLIED RESULT ORGANIC MATTER TIMES DEPTH
McNulty	2	9	18
Meda	2	10	20
Melbourne	5.5	8	44
Mershon	3.5	15	52.5
Moag	2	10	20
Molalla	5	13	65
Multnomah	5	8	40
Natal	3	9	27
Natroy	4.5	26	117
Nehalem	7.5	17	127.5
Nekia	5.5	9	49.5
Nekoma	6	11	66
Neskowin	10	12	120
Nestucca	6	14	84
Netarts	6	6	36
Newberg	3	19	57
Noti	5	9	45
Oxley	4	23	92
Panther	4	14	56
Peavine	6	10	60
Pengra	5	6	30
Philomath	3	18	54
Pilchuck	1.5	20	30

APPENDIX A. TABLE A-3 (Continued)

CALCULATION OF SURFACE ORGANIC MATTER MULTIPLIED BY SURFACE DEPTH

SOIL SERIES	ORGANIC MATTER SURFACE ZONE (est. percent)	DEPTH SURFACE ZONE (inches)	MULTIPLIED RESULT ORGANIC MATTER TIMES DEPTH
Powell	5	8	40
Preacher	6.5	14	91
Price	3.5	5	17.5
Quafeno	2.5	16	40
Quatama	1.5	9	13.5
Rafton	2	9	18
Rickreall	2.5	5	12.5
Ritner	3	5	15
Salem	5	9	45
Salkum	4	14	56
Santium	2.5	13	32.5
Saturn	7	10	70
Saum	3	14	42
Sauvie	3	15	45
Sawtell	3	13	39
Semiahmoo	45	22	990
Sifton	7.5	16	120
Silverton	3	16	48
Springwater	5	15	75
Stayton	6.5	15	97.5
Steiwer	3.5	6	21
Suver	2.5	11	27.5
Treharne	1.5	29	43.5

APPENDIX A. TABLE A-3 (Continued)

CALCULATION OF SURFACE ORGANIC MATTER MULTIPLIED BY SURFACE DEPTH

SOIL SERIES	ORGANIC MATTER SURFACE ZONE (est. percent)	DEPTH SURFACE ZONE (inches)	MULTIPLIED RESULT ORGANIC MATTER TIMES DEPTH
Veneta	3	14	42
Verboort	7	12	84
Waldo	6	10	60
Wapata	6	16	96
Wauna	3	8	24
Whiteson	6	11	66
Willakenzie	4.5	4	18
Willamette	4	24	96
Willanch	3.5	13	45.5
Winchuck	6	8	48
Witham	5	4	20
Witzel	2.5	4	10
Wollent	2.5	10	25
Woodburn	4	17	68
Yamhill	4.5	7	31.5

APPENDIX A. TABLE A-4

RATING OF WILLAMETTE VALLEY SOILS FOR SORPTION POTENTIAL

SOIL SERIES	SURFACE	TEXTURE Class	Score	RESULT OF SURFACE ORGANIC MATTER * DEPTH	Score	SORPTION POTENTIAL
Abiqua	sicl	mod. fine	2	94.5	2	HIGH
Aloha	sil	medium	3	20	6	MODERATE
Alspaugh	cl	mod. fine	2	84	2	HIGH
Amity	sil	medium	3	64	2	HIGH
Apt	c	fine	1	48	4	HIGH
Astoria	sicl	mod. fine	2	142.5	1	VERY HIGH
Awbrig	sicl	mod. fine	2	24.5	6	MODERATE
Bandon	sl	mod. coarse	4	6	10	VERY LOW
Bashaw	c	fine	1	186	1	VERY HIGH
Bellpine	sicl	mod. fine	2	27	4	HIGH
Borges	sicl	mod. fine	2	36	4	HIGH
Bornstedt	sil	medium	3	28	4	HIGH
Brallier	peat	fine	1	3600	1	VERY HIGH
Brenner	sil	medium	3	97.5	2	HIGH
Briedwell	sil	medium	3	60	2	HIGH
Bull run	sil	medium	3	56	2	HIGH
Burlington	fsl	mod. coarse	4	36	4	MODERATE
Camas	grav. sl	mod. coarse + 1	5	20	6	LOW
Canderly	sl	mod. coarse	4	75	2	MODERATE
Carlton	sil	medium	3	42	4	HIGH
Cascade	sil	medium	3	44	4	HIGH
Cazadero	sicl	mod. fine	2	42	4	HIGH
Chapman	l	medium	3	56	2	HIGH

APPENDIX A. TABLE A-4 (Continued)

RATING OF WILLAMETTE VALLEY SOILS FOR SORPTION POTENTIAL

SOIL SERIES	SURFACE	TEXTURE Class	Score	RESULT OF SURFACE ORGANIC MATTER * DEPTH	Score	SORPTION POTENTIAL
Chehalem	sicl	mod. fine	2	80.5	2	HIGH
Chehalis	sil	medium	3	90	2	HIGH
Chehulpum	sil	medium	3	48	4	HIGH
Clackamas	grav. l	medium + 1	4	52.5	2	MODERATE
Cloquato	sil	medium	3	300	1	VERY HIGH
Coburg	sicl	mod. fine	2	90	2	HIGH
Concord	sil	medium	3	18	6	MODERATE
Conser	sicl	mod. fine	2	54	2	HIGH
Cornelius	sil	medium	3	18	6	MODERATE
Cottrell	sicl	mod. fine	2	52.5	2	HIGH
Courtney	grav. sicl	mod. fine + 1	3	48	4	HIGH
Cove	sicl	mod. fine	2	48	4	HIGH
Crims	peat	fine	1	200	1	VERY HIGH
Cumley	sicl	fine	1	45	4	HIGH
Dabney	ls	coarse	5	90	2	MODERATE
Dayton	sil	medium	3	22.5	6	MODERATE
Dixonville	sic	fine	1	54	2	VERY HIGH
Dupee	sil	medium	3	22.5	6	MODERATE
Eilersten	sil	medium	3	59.5	2	HIGH
Faloma	sil	medium	3	40	4	HIGH
Gapcot	grav.l	medium + 1	4	35	4	MODERATE
Goble	sil	medium	3	84	2	HIGH
Grande Ronde	sicl	mod. fine	2	9	8	MODERATE

APPENDIX A. TABLE A-4 (Continued)

RATING OF WILLAMETTE VALLEY SOILS FOR SORPTION POTENTIAL

SOIL SERIES	SURFACE	TEXTURE Class	Score	RESULT OF SURFACE ORGANIC MATTER * DEPTH	Score	SORPTION POTENTIAL
Hardscrabble	sil	medium	3	40	4	HIGH
Hazelair	sicl	mod. fine	2	33	4	HIGH
Helmick	sil	medium	3	30	4	HIGH
Helvetia	sil	medium	3	30	4	HIGH
Hillsboro	l	medium	3	52.5	2	HIGH
Holcomb	sil	medium	3	72	2	HIGH
Honeygrove	c	fine	1	78	2	VERY HIGH
Hullt	cl	mod. fine	2	67.5	2	HIGH
Jimbo	sil	medium	3	77	2	HIGH
Jory	sicl	mod. fine	2	85.5	2	HIGH
Kinney	cob. l	medium + 1	4	60	2	MODERATE
Kinton	sil	medium	3	35	4	HIGH
Knappa	sil	medium	3	140	1	VERY HIGH
Labish	sic	fine	1	256	1	VERY HIGH
Latourell	l	medium	3	40	4	HIGH
Laurelwood	sil	medium	3	33	4	HIGH
Linslaw	l	medium	3	48	4	HIGH
Lint	sil	medium	3	200	1	VERY HIGH
Malabon	sicl	mod. fine	2	60	2	HIGH
Marcola	cob. sicl	mod. fine + 1	3	75	2	HIGH
McAlpin	sicl	mod. fine	2	63	2	HIGH
McBee	sicl	mod. fine	2	50	4	HIGH
McCully	cl	mod. fine	2	95	2	HIGH

RATING OF WILLAMETTE VALLEY SOILS FOR SORPTION POTENTIAL

SOIL SERIES	SURFACE	TEXTURE Class	Score	RESULT OF SURFACE ORGANIC MATTER * DEPTH	Score	SORPTION POTENTIAL
McNulty	sil	medium	3	18	6	MODERATE
Meda	l	medium	3	20	6	MODERATE
Melbourne	l	medium	3	44	4	HIGH
Mershon	sil	medium	3	52.5	2	HIGH
Moag	sicl	mod. fine	2	20	6	MODERATE
Molalla	l	medium	3	65	2	HIGH
Multnomah	sil	medium	3	40	4	HIGH
Natal	sicl	mod. fine	2	27	4	HIGH
Natroy	sic,c	fine	1	117	1	VERY HIGH
Nehalem	sil	medium	3	127.5	1	VERY HIGH
Nekia	sicl	mod. fine	2	49.5	4	HIGH
Nekoma	sil	medium	3	66	2	HIGH
Neskowin	sicl	mod. fine	2	120	1	VERY HIGH
Nestucca	sil	medium	3	84	2	HIGH
Netarts	fs, ls	coarse	5	36	4	MODERATE
Newberg	fsl	mod. coarse	4	57	2	MODERATE
Noti	l	medium	3	45	4	HIGH
Oxley	grav. sil	medium + 1	4	92	2	MODERATE
Panther	sicl	mod. fine	2	56	2	HIGH
Peavine	sicl	mod. fine	2	60	2	HIGH
Pengra	sil	medium	3	30	4	HIGH
Philomath	c	fine	1	54	2	VERY HIGH
Pilchuck	fs	coarse	5	30	4	MODERATE

APPENDIX A. TABLE A-4 (Continued)

RATING OF WILLAMETTE VALLEY SOILS FOR SORPTION POTENTIAL

SOIL SERIES	SURFACE	TEXTURE Class	Score	RESULT OF SURFACE ORGANIC MATTER * DEPTH	Score	SORPTION POTENTIAL
Powell	sil	medium	3	40	4	HIGH
Preacher	cl	mod. fine	2	91	2	HIGH
Price	sicl	mod. fine	2	17.5	6	MODERATE
Quafeno	l	medium	3	40	4	HIGH
Quatama	l	medium	3	13.5	6	MODERATE
Rafton	sil	medium	3	18	6	MODERATE
Rickreall	sicl	mod. fine	2	12.5	8	MODERATE
Ritner	grav. sicl	mod. fine + 1	3	15	6	MODERATE
Salem	grav. sil	medium + 1	4	45	4	MODERATE
Salkum	sicl	mod. fine	2	56	2	HIGH
Santium	sil	medium	3	32.5	4	HIGH
Saturn	cl	mod. fine	2	70	2	HIGH
Saum	sil	medium	3	42	4	HIGH
Sauvie	sicl	mod. fine	2	45	4	HIGH
Sawtell	sil	medium	3	39	4	HIGH
Semiahmoo	sapric	fine	1	990	1	VERY HIGH
Sifton	grav. l	medium + 1	4	120	1	HIGH
Silverton	sil	medium	3	48	4	HIGH
Springwater	cl	mod. fine	2	75	2	HIGH
Stayton	sil	medium	3	97.5	2	HIGH
Steiwer	sicl	mod. fine	2	21	6	MODERATE
Suver	sicl	mod. fine	2	27.5	4	HIGH
Treharne	sil	medium	3	43.5	4	HIGH

APPENDIX A. TABLE A-4 (Continued)

RATING OF WILLAMETTE VALLEY SOILS FOR SORPTION POTENTIAL

SOIL SERIES	SURFACE TEXTURE			RESULT OF SURFACE ORGANIC MATTER		SORPTION POTENTIAL
		Class	Score	* DEPTH	Score	
Veneta	l	medium	3	42	4	HIGH
Verboort	sicl	mod. fine	2	84	2	VERY HIGH
Waldo	sicl	mod. fine	2	60	2	HIGH
Wapata	sicl	mod. fine	2	96	2	HIGH
Wauna	sil	medium	3	24	6	MODERATE
Whiteson	sil	medium	3	66	2	HIGH
Willakenzie	sicl	mod. fine	2	18	6	MODERATE
Willamette	sil	medium	3	96	2	HIGH
Willanch	fsl	mod. coarse	4	45.5	4	MODERATE
Winchuck	sil	medium	3	48	4	HIGH
Witham	sicl	mod. fine	2	20	6	MODERATE
Witzel	v.stny sil	medium + 1	4	10	8	LOW
Wollent	sil	medium	3	25	6	MODERATE
Woodburn	sil	medium	3	68	2	HIGH
Yamhill	sil	medium	3	31.5	4	HIGH

APPENDIX A. TABLE A-5

RATING OF WILLAMETTE VALLEY SOIL SERIES FOR PESTICIDE MOVEMENT POTENTIAL

SOIL SERIES	LEACH POTENTIAL	SORPTION POTENTIAL	PESTICIDE MOVEMENT POTENTIAL
Abiqua	LOW	HIGH	VERY LOW
Aloha	MODERATE	MODERATE	MODERATE
Alspaugh	LOW	HIGH	VERY LOW
Amity	MODERATE	HIGH	LOW
Apt	LOW	HIGH	VERY LOW
Astoria	MODERATE	VERY HIGH	LOW
Awbrig	MODERATE	MODERATE	MODERATE
Bandon	MODERATE	VERY LOW	HIGH
Bashaw	LOW	VERY HIGH	VERY LOW
Bellpine	VERY LOW	HIGH	VERY LOW
Borges	LOW	HIGH	VERY LOW
Bornstedt	LOW	HIGH	VERY LOW
Brallier	HIGH	VERY HIGH	MODERATE
Brenner	MODERATE	HIGH	LOW
Briedwell	MODERATE	HIGH	LOW
Bull run	MODERATE	HIGH	LOW
Burlington	VERY HIGH	MODERATE	VERY HIGH
Camas	VERY HIGH	LOW	VERY HIGH
Canderly	VERY HIGH	MODERATE	VERY HIGH
Carlton	MODERATE	HIGH	LOW
Cascade	MODERATE	HIGH	LOW
Cazadero	LOW	HIGH	VERY LOW
Chapman	MODERATE	HIGH	LOW

APPENDIX A. TABLE A-5 (Continued)

RATING OF WILLAMETTE VALLEY SOIL SERIES FOR PESTICIDE MOVEMENT POTENTIAL

SOIL SERIES	LEACH POTENTIAL	SORPTION POTENTIAL	PESTICIDE MOVEMENT POTENTIAL
Chehalem	LOW	HIGH	VERY LOW
Chehalis	MODERATE	HIGH	LOW
Chehulpum	MODERATE	HIGH	LOW
Clackamas	MODERATE	MODERATE	MODERATE
Cloquato	MODERATE	VERY HIGH	LOW
Coburg	MODERATE	HIGH	LOW
Concord	MODERATE	MODERATE	MODERATE
Conser	MODERATE	HIGH	LOW
Cornelius	MODERATE	MODERATE	MODERATE
Cottrell	MODERATE	HIGH	LOW
Courtney	MODERATE	HIGH	LOW
Cove	LOW	HIGH	VERY LOW
Crims	HIGH	VERY HIGH	MODERATE
Cumley	MODERATE	HIGH	LOW
Dabney	VERY HIGH	MODERATE	VERY HIGH
Dayton	MODERATE	MODERATE	MODERATE
Dixonville	LOW	VERY HIGH	VERY LOW
Dupee	MODERATE	MODERATE	MODERATE
Eilersten	MODERATE	HIGH	LOW
Faloma	VERY HIGH	HIGH	HIGH
Gapcot	MODERATE	MODERATE	MODERATE
Goble	MODERATE	HIGH	LOW
Grande Ronde	LOW	MODERATE	LOW

APPENDIX A. TABLE A-5 (Continued)

RATING OF WILLAMETTE VALLEY SOIL SERIES FOR PESTICIDE MOVEMENT POTENTIAL

SOIL SERIES	LEACH POTENTIAL	SORPTION POTENTIAL	PESTICIDE MOVEMENT POTENTIAL
Hardscrabble	LOW	HIGH	VERY LOW
Hazelair	MODERATE	HIGH	LOW
Helmick	LOW	HIGH	VERY LOW
Helvetia	MODERATE	HIGH	LOW
Hillsboro	MODERATE	HIGH	LOW
Holcomb	LOW	HIGH	VERY LOW
Honeygrove	LOW	VERY HIGH	VERY LOW
Hullt	MODERATE	HIGH	LOW
Jimbo	HIGH	HIGH	MODERATE
Jory	LOW	HIGH	VERY LOW
Kinney	MODERATE	MODERATE	MODERATE
Kinton	MODERATE	HIGH	LOW
Knappa	MODERATE	VERY HIGH	LOW
Labish	LOW	VERY HIGH	VERY LOW
Latourell	MODERATE	HIGH	LOW
Laurelwood	MODERATE	HIGH	LOW
Linslaw	LOW	HIGH	VERY LOW
Lint	MODERATE	VERY HIGH	LOW
Malabon	LOW	HIGH	VERY LOW
Marcola	LOW	HIGH	VERY LOW
McAlpin	MODERATE	HIGH	LOW
McBee	LOW	HIGH	VERY LOW
McCully	LOW	HIGH	VERY LOW

RATING OF WILLAMETTE VALLEY SOIL SERIES FOR PESTICIDE MOVEMENT POTENTIAL

SOIL SERIES	LEACH POTENTIAL	SORPTION POTENTIAL	PESTICIDE MOVEMENT POTENTIAL
McNulty	MODERATE	MODERATE	MODERATE
Meda	MODERATE	MODERATE	MODERATE
Melbourne	LOW	HIGH	VERY LOW
Mershon	MODERATE	HIGH	LOW
Moag	LOW	MODERATE	LOW
Molalla	LOW	HIGH	VERY LOW
Multnomah	MODERATE	HIGH	LOW
Natal	LOW	HIGH	VERY LOW
Natroy	LOW	VERY HIGH	VERY LOW
Nehalem	LOW	VERY HIGH	VERY LOW
Nekia	LOW	HIGH	VERY LOW
Nekoma	HIGH	HIGH	MODERATE
Neskowin	VERY LOW	VERY HIGH	VERY LOW
Nestucca	MODERATE	HIGH	LOW
Netarts	HIGH	MODERATE	HIGH
Newberg	VERY HIGH	MODERATE	VERY HIGH
Noti	MODERATE	HIGH	LOW
Oxley	MODERATE	MODERATE	MODERATE
Panther	LOW	HIGH	VERY LOW
Peavine	VERY LOW	HIGH	VERY LOW
Pengra	LOW	HIGH	VERY LOW
Philomath	VERY LOW	VERY HIGH	VERY LOW
Pilchuck	VERY HIGH	MODERATE	VERY HIGH

RATING OF WILLAMETTE VALLEY SOIL SERIES FOR PESTICIDE MOVEMENT POTENTIAL

SOIL SERIES	LEACH POTENTIAL	SORPTION POTENTIAL	PESTICIDE MOVEMENT POTENTIAL
Powell	LOW	HIGH	VERY LOW
Preacher	MODERATE	HIGH	LOW
Price	LOW	MODERATE	LOW
Quafeno	MODERATE	HIGH	LOW
Quatama	MODERATE	MODERATE	MODERATE
Rafton	HIGH	MODERATE	HIGH
Rickreall	VERY LOW	MODERATE	VERY LOW
Ritner	LOW	MODERATE	LOW
Salem	HIGH	MODERATE	HIGH
Salkum	LOW	HIGH	VERY LOW
Santium	LOW	HIGH	VERY LOW
Saturn	HIGH	HIGH	MODERATE
Saum	MODERATE	HIGH	LOW
Sauvie	MODERATE	HIGH	LOW
Sawtell	MODERATE	HIGH	LOW
Semiahmoo	MODERATE	VERY HIGH	LOW
Sifton	VERY HIGH	HIGH	HIGH
Silverton	VERY LOW	HIGH	VERY LOW
Springwater	MODERATE	HIGH	LOW
Stayton	HIGH	HIGH	MODERATE
Steiwer	LOW	MODERATE	LOW
Suver	LOW	HIGH	VERY LOW
Treharne	MODERATE	HIGH	MODERATE

RATING OF WILLAMETTE VALLEY SOIL SERIES FOR PESTICIDE MOVEMENT POTENTIAL

SOIL SERIES	LEACH POTENTIAL	SORPTION POTENTIAL	PESTICIDE MOVEMENT POTENTIAL
Veneta	LOW	HIGH	VERY LOW
Verboort	LOW	HIGH	VERY LOW
Waldo	LOW	HIGH	VERY LOW
Wapata	MODERATE	HIGH	LOW
Wauna	MODERATE	MODERATE	MODERATE
Whiteson	LOW	HIGH	VERY LOW
Willakenzie	LOW	MODERATE	LOW
Willamette	MODERATE	HIGH	LOW
Willanch	VERY HIGH	MODERATE	VERY HIGH
Winchuck	LOW	HIGH	VERY LOW
Witham	LOW	MODERATE	LOW
Witzel	HIGH	LOW	VERY HIGH
Wollent	MODERATE	MODERATE	MODERATE
Woodburn	MODERATE	HIGH	LOW
Yamhill	MODERATE	HIGH	LOW

APPENDIX A. TABLE A-6

NATIVE PH AND PERCENT SLOPE OF WILLAMETTE VALLEY SOILS

SOIL SERIES	pH A HORIZON	pH RANGE FOR PROFILE	PERCENT SLOPE
Abiqua	5.1-6.5	5.1-6.5	0 - 5
Aloha	5.6-6.0	5.6-6.5	0 - 8
Alspaugh	5.6-6.0	4.5-6.0	2 - 50
Amity	5.6-6.0	5.6-6.5	0 - 3
Apt	4.5-5.5	4.5-5.5	2 - 50
Astoria	4.5-5.0	4.5-5.0	0 - 90
Awbrig	5.1-6.5	5.1-7.3	0 - 2
Bandon	5.6-6.5	5.6-6.5	0 - 30
Bashaw	5.6-7.3	5.6-7.3	0 - 12
Bellpine	5.1-6.0	4.5-6.0	2 - 60
Borges	5.1-6.0	5.1-6.0	0 - 8
Bornstedt	5.1-6.0	4.5-6.0	0 - 30
Brallier	3.6-5.0	3.6-5.0	0 - 1
Brenner	4.5-5.5	4.5-6.5	0 - 3
Briedwell	5.1-6.5	5.1-6.5	0 - 20
Bull run	5.1-6.0	5.1-6.0	3 - 80
Burlington	6.1-6.5	6.1-7.3	0 - 15
Camas	5.6-7.3	5.6-7.3	0 - 5
Canderly	5.6-6.5	5.6-6.5	0 - 8
Carlton	5.6-6.0	5.1-6.0	0 - 20
Cascade	5.6-6.0	5.6-6.0	3 - 60
Cazadero	5.1-6.0	5.1-6.0	0 - 60
Chapman	5.6-6.5	5.6-7.3	0 - 3

APPENDIX A. TABLE A-6 (Continued)

NATIVE PH AND PERCENT SLOPE OF WILLAMETTE VALLEY SOILS

SOIL SERIES	pH A HORIZON	pH RANGE FOR PROFILE	PERCENT SLOPE
Chehalem	5.6-6.0	5.6-6.0	2 - 12
Chehalis	5.6-6.5	5.6-7.3	0 - 3
Chehulpum	5.6-6.5	5.6-6.5	3 - 50
Clackamas	5.6-6.0	5.1-6.0	0 - 3
Cloquato	5.6-6.5	5.6-6.5	0 - 3
Coburg	5.6-6.5	5.6-7.3	0 - 7
Concord	5.6-6.5	5.6-7.3	0 - 2
Conser	5.6-6.5	5.6-7.3	0 - 3
Cornelius	5.6-6.0	5.1-6.0	2 - 60
Cottrell	5.1-6.0	5.1-6.0	2 - 30
Courtney	5.1-6.0	5.1-7.3	0 - 3
Cove	5.6-6.5	5.6-7.3	0 - 2
Crims	4.5-5.5	3.6-5.5	0 - 3
Cumley	5.1-6.5	5.1-6.5	2 - 20
Dabney	5.1-5.5	5.1-6.0	0 - 3
Dayton	5.1-6.0	5.1-7.3	0 - 2
Dixonville	5.6-6.5	5.6-6.5	3 - 60
Dupee	5.1-6.0	4.5-6.0	2 - 20
Eilersten	4.5-6.5	4.5-6.5	0 - 7
Faloma	5.6-6.5	5.6-6.5	0 - 3
Gapcot	5.6-6.5	5.6-6.5	3 - 60
Goble	5.1-6.0	4.5-6.0	2 - 60
Grande Ronde	4.5-5.0	4.5-5.0	0 - 2

APPENDIX A. TABLE A-6 (Continued)

NATIVE PH AND PERCENT SLOPE OF WILLAMETTE VALLEY SOILS

SOIL SERIES	pH A HORIZON	pH RANGE FOR PROFILE	PERCENT SLOPE
Hardscrabble	5.1-6.0	4.5-6.0	2 - 20
Hazelair	5.6-6.5	5.1-6.5	2 - 35
Helmick	5.6-6.0	4.5-6.0	3 - 50
Helvetia	5.6-6.5	5.1-6.5	2 - 30
Hillsboro	5.1-6.0	5.1-6.0	0 - 20
Holcomb	5.6-6.5	5.6-7.3	0 - 3
Honeygrove	4.5-6.5	4.5-6.5	0 - 60
Hullt	5.1-6.0	4.5-6.0	2 - 60
Jimbo	5.6-6.0	5.1-6.0	0 - 5
Jory	4.5-6.5	4.5-6.5	2 - 90
Kinney	5.1-6.5	3.6-6.5	2 - 75
Kinton	5.1-6.0	5.1-6.0	2 - 60
Knappa	4.5-5.5	4.5-5.5	0 - 30
Labish	4.5-7.3	4.5-7.3	0 - 1
Latourell	5.1-6.5	5.1-6.5	0 - 30
Laurelwood	5.6-6.0	5.1-6.0	3 - 60
Linslaw	5.1-6.0	4.5-6.0	0 - 3
Lint	4.5-5.5	4.5-5.5	0 - 40
Malabon	5.6-6.0	5.6-7.3	0 - 3
Marcola	5.6-6.5	5.6-7.3	2 - 7
McAlpin	5.1-6.0	5.1-6.0	0 - 6
McBee	5.6-6.5	5.6-7.3	0 - 3
McCully	5.1-5.5	4.5-5.5	2 - 70

APPENDIX A. TABLE A-6 (Continued)

NATIVE PH AND PERCENT SLOPE OF WILLAMETTE VALLEY SOILS

SOIL SERIES	pH A HORIZON	pH RANGE FOR PROFILE	PERCENT SLOPE
McNulty	5.6-6.5	5.6-6.5	0 - 3
Meda	5.1-6.0	5.1-6.0	2 - 20
Melbourne	5.6-6.5	4.5-6.5	0 - 60
Mershon	5.6-6.0	5.1-6.0	0 - 30
Moag	5.6-6.0	5.6-6.5	0 - 2
Molalla	5.6-6.0	5.1-6.0	2 - 30
Multnomah	5.6-6.0	5.6-6.5	0 - 60
Natal	5.6-6.5	4.5-6.5	0 - 3
Natroy	5.1-6.0	5.1-7.3	0 - 2
Nehalem	4.5-6.0	4.5-6.0	0 - 3
Nekia	5.1-6.0	4.5-6.0	2 - 50
Nekoma	5.1-6.0	4.5-6.0	0 - 3
Neskowin	4.5-5.5	4.5-5.5	12 - 60
Nestucca	4.5-5.5	4.5-5.5	0 - 3
Netarts	4.5-5.0	4.5-5.5	0 - 40
Newberg	7	5.6-7.3	0 - 3
Noti	4.5-5.5	4.5-5.5	0 - 3
Oxley	5.1-6.0	5.1-7.3	0 - 3
Panther	5.6-6.5	3.6-6.5	2 - 20
Peavine	5.1-6.0	4.5-6.0	2 - 75
Pengra	5.6-6.0	5.6-7.3	1 - 30
Philomath	5.6-6.5	5.6-7.3	3 - 70
Pilchuck	6.1-7.3	5.6-7.3	0 - 3

APPENDIX A. TABLE A-6 (Continued)

NATIVE PH AND PERCENT SLOPE OF WILLAMETTE VALLEY SOILS

SOIL SERIES	pH A HORIZON	pH RANGE FOR PROFILE	PERCENT SLOPE
Powell	5.1-6.0	5.1-6.5	0 - 30
Preacher	4.5-5.5	4.5-5.5	0 - 75
Price	5.1-6.0	5.1-6.0	3 - 75
Quafeno	6.1-6.5	6.1-7.3	0 - 15
Quatama	5.6-6.0	5.6-6.0	0 - 3
Rafton	5.6-6.0	5.6-6.5	0 - 2
Rickreall	5.1-5.5	5.1-5.5	3 - 75
Ritner	5.6-6.0	5.1-6.0	2 - 90
Salem	5.6-6.5	5.6-7.3	0 - 12
Salkum	5.6-6.5	4.5-6.5	0 - 65
Santium	5.1-6.0	5.1-6.0	0 - 20
Saturn	5.1-6.0	4.5-6.0	0 - 5
Saum	5.6-6.0	5.6-6.0	2 - 60
Sauvie	5.6-6.5	5.6-6.5	0 - 3
Sawtell	5.1-6.0	5.1-6.0	0 - 15
Semiahmoo	4.5-6.5	4.5-6.5	0 - 3
Sifton	5.6-6.0	5.6-6.5	0 - 3
Silverton	5.6-6.5	5.6-6.5	2 - 20
Springwater	5.6-6.0	5.6-6.0	2 - 60
Stayton	5.1-6.0	5.1-6.0	0 - 7
Steiwer	5.1-6.5	5.1-6.5	2 - 50
Suver	5.6-6.0	5.1-6.0	3 - 50
Treharne	5.1-6.5	4.5-6.5	0 - 3

APPENDIX A. TABLE A-6 (Continued)

NATIVE PH AND PERCENT SLOPE OF WILLAMETTE VALLEY SOILS

SOIL SERIES	pH A HORIZON	pH RANGE FOR PROFILE	PERCENT SLOPE
Veneta	5.6-6.0	5.1-6.0	0 - 20
Verboort	5.6-6.0	5.6-7.3	0 - 3
Waldo	5.1-6.5	5.1-6.5	0 - 3
Wapata	5.1-7.3	5.1-7.3	0 - 3
Wauna	4.5-5.0	4.5-5.5	0 - 3
Whiteson	5.6-6.5	5.6-7.8	0 - 3
Willakenzie	5.6-6.0	4.5-6.0	2 - 50
Willamette	5.6-6.5	5.6-6.5	0 - 20
Willanch	5.6-6.5	5.6-6.5	0 - 3
Winchuck	5.1-5.5	5.1-5.5	0 - 30
Witham	5.1-6.0	5.1-6.5	2 - 12
Witzel	5.6-6.5	5.6-6.5	3 - 75
Wollent	5.6-6.0	5.6-6.0	0 - 3
Woodburn	5.6-6.5	5.6-6.5	0 - 20
Yamhill	5.6-6.5	5.1-6.5	2 - 50

APPENDIX B

SIMULATIONS WITH MALHEUR COUNTY SOILS

APPENDIX B. TABLE B-1

CALCULATION OF THE SOIL PERMEABILITY FOR MALHEUR COUNTY SOILS

	PERMEABILITY OF INDIVIDUAL SOIL LAYERS						
SOIL SERIES	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
Ahtanum	0-21	21		0.6-2.0	6	126	
	21-31	10	CaCO3,Si hardpan	<0.06	1	10	
	31-50	19		0.6-2.0	6	114	
	50-60	10		6.0-20	9	90	340
Baldock	0-8	8		0.6-2.0	6	48	
	8-56	48		0.6-2.0	6	288	
	56-60	4		2.0-6.0	8	32	368
Bully	0-60	60		0.6-2.0	6	360	360
Cencove	0-24	24		2.0-6.0	8	192	
	24-60	36		>20	10	360	552
Chilcott	0-8	8		0.6-2.0	6	48	
	8-24	16		0.06-0.2	2	32	
	24-30	6		0.2-0.6	4	24	
	30-47	17	duripan	<0.06	1	17	
	47-53	6	weak cem. s+grav	0.06-0.2	2	12	
	53-60	7	sand+grav	6.0-20	9	63	196
Falk Variant	0-36	36		2.0-6.0	8	288	
	36-60	24		>20	10	240	528
Feltham	0-32	32		6.0-20	9	288	

APPENDIX B. TABLE B-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR MALHEUR COUNTY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS: LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
	32-60	28		2.0-6.0	8	224	512
Frohman	0-12	12		0.6-2.0	6	72	
	12-18	6	duripan	<0.06	1	6	
	18-36	18		0.6-2.0	6	108	
	36-60	34	duripan	<0.06	1	34	220
Garbutt	0-40	40		0.6-2.0	6	240	
	40-60	20		0.6-2.0	6	120	360
Greenleaf	0-8	8		0.6-2.0	6	48	
	8-60	52		0.2-0.6	4	208	256
Harana	0-21	21		0.2-0.6	4	84	
	21-60	39		0.2-0.6	4	156	240
Kimberly	0-10	10		2.0-6.0	8	80	
	10-26	16		2.0-6.0	8	128	
	26-60	34		2.0-6.0	8	272	480
Malheur	0-9	9		0.6-2.0	6	54	
	9-23	14		0.2-0.6	4	56	
	23-31	8		0.6-2.0	6	48	
	31-60	29	ca duripan	<0.06	1	29	187

APPENDIX B. TABLE B-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR MALHEUR COUNTY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS						TOTAL RESULT
	LAYER THICKNESS		RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	
Nyssa	0-25	25		0.6-2.0	6	150	
	25-31	6	duripan	<0.06	1	6	
	31-60	29		0.6-2.0	6	174	330
Owyhee	0-44	44		0.6-2.0	6	264	
	44-60	16		0.2-0.6	4	64	328
Poden	0-30	30		0.6-2.0	6	180	
	30-50	20		6.0-20	9	180	
	50-60	10		>20	10	100	460
Powder	0-60	60		0.6-2.0	6	360	360
Prosser	0-30	30		0.6-2.0	6	180	
	30-60	30	basalt	>20	10	300	480
Quincy	0-60	60		6-20	9	540	540
Sagehill	0-19	19		2.0-6.0	8	152	
	19-60	41		0.6-2.0	6	246	398
Stanfield	0-22	22		0.6-2.0	6	132	
	22-60	38	duripan	<0.06	1	38	170
Truesdale	0-24	24		2.0-6.0	8	192	

APPENDIX B. TABLE B-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR MALHEUR COUNTY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
	24-32	8	hardpan	0.06-0.2	2	16	
	32-60	28		2.0-6.0	8	224	432
Turbyfill	0-3	3		2.0-6.0	8	24	
	3-60	57		2.0-6.0	8	456	480
Umapine	0-60	60		0.6-2.0	6	360	360
Virtue	0-7	7		0.6-2.0	6	42	
	7-29	22		0.2-0.6	4	88	
	29-60	31	cemented hardpan	<0.06	1	31	161

APPENDIX B. TABLE B-2

RATING OF MALHEUR COUNTY SOILS FOR LEACHING POTENTIAL

SOIL SERIES	SCORE PERMEABILITIES TIMES THICKNESS OF LAYERS	Score	DRAINAGE CLASS	LEACHING POTENTIAL
Ahtanum	340	6	Somewhat Poorly	MODERATE
Baldock	368	6	Poorly	HIGH
Bully	360	6	Well	MODERATE
Cencove	552	10	Well	VERY HIGH
Chilcott	196	3	Well	VERY LOW
Falk Variant	528	9	Somewhat Poorly	VERY HIGH
Feltham	512	9	Somewhat Excessively	VERY HIGH
Frohman	220	3	Well	VERY LOW
Garbutt	360	6	Well	MODERATE
Greenleaf	256	4	Well	LOW
Harana	240	4	Moderately Well	MODERATE
Kimberly	480	8	Well	HIGH
Malheur	187	3	Well	VERY LOW
Nyssa	330	6	Well	MODERATE
Owyhee	328	5	Well	LOW
Poden	460	8	Well	HIGH
Powder	360	6	Well	MODERATE
Prosser	480	8	Well	HIGH
Quincy	540	9	Excessively	VERY HIGH
Sagehill	398	7	Well	MODERATE
Stanfield	170	3	Moderately well	LOW
Truesdale	432	7	Well	MODERATE
Turbyfill	480	8	Well	HIGH

APPENDIX B. TABLE B-2 (Continued)

RATING OF MALHEUR COUNTY SOILS FOR LEACHING POTENTIAL

SOIL SERIES	SCORE PERMEABILITIES TIMES THICKNESS OF LAYERS	Score	DRAINAGE CLASS	LEACHING POTENTIAL
Umapine	360	6	Somewhat poorly	MODERATE
Virtue	161	2	Well	VERY LOW

APPENDIX B. TABLE B-3

CALCULATION OF SURFACE ORGANIC MATTER MULTIPLIED BY SURFACE DEPTH FOR MALHEUR COUNTY SOILS

SOIL SERIES	ORGANIC MATTER SURFACE ZONE (est. percent)	DEPTH SURFACE ZONE (inches)	MULTIPLIED RESULT ORGANIC MATTER TIMES DEPTH
Ahtanum	2	10	20
Baldock	3.5	8	28
Bully	1.5	9	13.5
Cencove	0.75	9	6.75
Chilcott	1.5	8	12
Falk Variant	0.75	8	6
Feltham	1.5	6	9
Frohman	0.75	8	6
Garbutt	0.5	9	4.5
Greenleaf	1.5	8	12
Harana	3	24	72
Kimberly	1.5	10	15
Malheur	2	5	10
Nyssa	1.25	13	16.25
Owyhee	1.5	10	15
Poden	5	13	65
Powder	4	13	32.50
Prosser	1.5	4	6
Quincy	0.75	15	11.25

APPENDIX B. TABLE B-3 (Continued)

CALCULATION OF SURFACE ORGANIC MATTER MULTIPLIED BY SURFACE DEPTH
FOR MALHEUR COUNTY SOILS

SOIL SERIES	ORGANIC MATTER SURFACE ZONE (est. percent)	DEPTH SURFACE ZONE (inches)	MULTIPLIED RESULT ORGANIC MATTER TIMES DEPTH
Sagehill	1.4	8	11.2
Stanfield	1.4	6	8.4
Truesdale	1.5	3	4.5
Turbyfill	1.5	3	4.5
Umapine	0.75	9	6.75
Virtue	2	7	14

APPENDIX B. TABLE B-4

RATING OF MALHEUR COUNTY SOILS FOR SORPTION POTENTIAL

SOIL SERIES	SURFACE	TEXTURE Class	Score	RESULT OF SURFACE ORGANIC MATTER * DEPTH	Score	SORPTION POTENTIAL
Ahtanum	sil	medium	3	20	6	MODERATE
Baldock	l	medium	3	28	4	HIGH
Bully	sil	medium	3	13.5	6	MODERATE
Cencove	fsl	mod. coarse	4	6.75	8	LOW
Chilcott	sil	medium	3	12	8	LOW
Falk Variant	fsl	mod. coarse	4	6	10	VERY LOW
Feltham	lfs	coarse	5	9	8	VERY LOW
Frohman	sil	medium	3	6	10	VERY LOW
Garbutt	sil	medium	3	4.5	10	VERY LOW
Greenleaf	sil	medium	3	12	8	LOW
Harana	sicl	mod. fine	2	72	2	HIGH
Kimberly	l	medium	3	15	6	MODERATE
Malheur	sil	medium	3	10	8	LOW
Nyssa	sil	medium	3	16.25	6	MODERATE
Owyhee	sil	medium	3	15	6	MODERATE
Poden	sil	medium	3	65	2	HIGH
Powder	sil	medium	3	52	4	HIGH
Prosser	sil	medium	3	6	10	VERY LOW
Quincy	lfs	coarse	5	11.25	8	VERY LOW
Sagehill	fsl	mod. coarse	4	11.2	8	LOW
Stanfield	sil	medium	3	8.4	8	LOW
Truesdale	fsl	mod. coarse	4	4.5	10	VERY LOW
Turbyfill	fsl	mod. coarse	4	4.5	10	VERY LOW

APPENDIX B. TABLE B-4 (Continued)

RATING OF MALHEUR COUNTY SOILS FOR SORPTION POTENTIAL

SOIL SERIES	SURFACE TEXTURE Class	Score	RESULT OF SURFACE ORGANIC MATTER * DEPTH	Score	SORPTION POTENTIAL
Umapine	sil medium	3	6.75	8	LOW
Virtue	sil medium	3	14	6	MODERATE

APPENDIX B. TABLE B-5

RATING OF MALHEUR COUNTY SOILS FOR PESTICIDE MOVEMENT POTENTIAL

SOIL SERIES	LEACH POTENTIAL	SORPTION POTENTIAL	PESTICIDE MOVEMENT POTENTIAL
Ahtanum	MODERATE	MODERATE	MODERATE
Baldock	HIGH	HIGH	MODERATE
Bully	MODERATE	MODERATE	MODERATE
Cencove	VERY HIGH	LOW	VERY HIGH
Chilcott	VERY LOW	LOW	VERY HIGH
Falk Variant	VERY HIGH	VERY LOW	VERY HIGH
Feltham	VERY HIGH	VERY LOW	VERY HIGH
Frohman	VERY LOW	VERY LOW	MODERATE
Garbutt	MODERATE	VERY LOW	HIGH
Greenleaf	LOW	LOW	MODERATE
Harana	MODERATE	HIGH	LOW
Kimberly	HIGH	MODERATE	HIGH
Malheur	VERY LOW	LOW	LOW
Nyssa	MODERATE	MODERATE	MODERATE
Owyhee	LOW	MODERATE	LOW
Poden	HIGH	HIGH	MODERATE
Powder	MODERATE	HIGH	LOW
Prosser	HIGH	VERY LOW	VERY HIGH
Quincy	VERY HIGH	VERY LOW	VERY HIGH
Sagehill	MODERATE	LOW	HIGH
Stanfield	LOW	LOW	MODERATE
Truesdale	MODERATE	VERY LOW	HIGH
Turbyfill	HIGH	VERY LOW	VERY HIGH

APPENDIX B. TABLE B-5 (Continued)

RATING OF MALHEUR COUNTY SOILS FOR PESTICIDE MOVEMENT POTENTIAL

SOIL SERIES	LEACH POTENTIAL	SORPTION POTENTIAL	PESTICIDE MOVEMENT POTENTIAL
Umapine	MODERATE	LOW	HIGH
Virtue	VERY LOW	MODERATE	VERY LOW

APPENDIX B. TABLE B-6

NATIVE pH AND PERCENT SLOPE OF MALHEUR COUNTY SOILS

SOIL SERIES	pH A HORIZON	pH RANGE FOR PROFILE	PERCENT SLOPE
Ahtanum	8.5-9.0	7.4-9.0	0 - 5
Baldock	7.9-8.4	7.4-9.0	0 - 5
Bully	7.9-8.4	7.9-8.4	0 - 2
Cencove	7.4-8.4	7.4-8.4	0 - 12
Chilcott	6.6-7.8	6.6-8.4	0 - 12
Falk Variant	7.9-8.4	7.9-8.4	0 - 2
Feltham	7.8-8.4	7.8-8.4	0 - 12
Frohman	7.4-8.4	7.4-8.4	0 - 20
Garbutt	7.9-8.4	7.9-8.4	0 - 12
Greenleaf	6.6-7.8	6.6-8.4	0 - 5
Harana	8.5-9.0	7.9-9.0	0 - 3
Kimberly	6.6-7.8	6.6-9.0	0 - 3
Malheur	7.9-8.4	7.9-9.0	0 - 8
Nyssa	7.4-8.4	6.6->9.0	0 - 20
Owyhee	7.9-8.4	7.9-9.0	0 - 20
Poden	7.9-8.4	7.9-8.4	0 - 5
Powder	6.6-8.4	6.6-8.4	0 - 3
Prosser	7.2	7.0-8.3	0 - 20
Quincy	6.8	6.7-8.4	2 - 12
Sagehill	7.4-8.4	7.4-9.0	0 - 20
Stanfield	>9.0	>9.0	0 - 2
Truesdale	7.4-8.4	7.4-8.4	0 - 12
Turbyfill	6.6-8.4	6.6-9.0	0 - 35

APPENDIX B. TABLE B-6 (Continued)

NATIVE pH AND PERCENT SLOPE OF MALHEUR COUNTY SOILS

SOIL SERIES	pH A HORIZON	pH RANGE FOR PROFILE	PERCENT SLOPE
Umapine	9.2	>7.8	0 - 2
Virtue	6.6-8.4	6.6-8.4	0 - 20

APPENDIX C

SIMULATIONS WITH COLUMBIA BASIN SOILS

APPENDIX C. TABLE C-1

CALCULATION OF THE SOIL PERMEABILITY FOR COLUMBIA BASIN AREA SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS						TOTAL RESULT
	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	
Adkins	0-60	60		2.0-6.0	8	480	480
Anderly	0-30	30		0.6-2.0	6	180	480
	30-60	30	basalt	>20	10	300	
Athena	0-60	60		0.6-2.0	6	360	360
Burbank	0-30	30		6.0-20	9	270	
	30-60	30		>20	10	300	570
Burke	0-22	22		0.6-2.0	6	132	
	22-60	38	duripan	<0.06	1	38	170
Cantala	0-60	60		0.6-2.0	6	360	360
Condon	0-31	31		0.6-2.0	6	186	
	31-60	29	basalt	>20	10	290	476
Cowsly	0-19	19		0.6-2.0	6	114	
	19-42	23		<0.06	1	23	
	42-60	18		0.2-0.6	4	72	209
Ellisforde	0-24	24		0.6-2.0	6	144	
	24-60	36		0.2-0.6	4	144	288

APPENDIX C. TABLE C-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR COLUMBIA BASIN AREA SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS						TOTAL
	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	RESULT
Endersby	0-53	53		2.0-6.0	8	424	
	53-60	7		>20	10	70	494
Esquatzel	0-60	60		0.6-2.0	6	360	360
Freewater	0-20	20		0.6-2.0	6	120	
	20-60	40		>20	10	400	520
Hermiston	0-60	60		0.6-2.0	6	360	360
Hezel	0-18	18		6.0-20	9	162	
	18-60	42		0.2-0.6	4	168	330
Irrigon	0-23	23		0.6-2.0	6	138	
	23-60	37	sandstone	0.6-2.0	6	222	360
Kimberly	0-60	60		2.0-6.0	8	480	480
Koehler	0-31	31		6.0-20	9	279	
	31-60	29	duripan	<0.06	1	29	308
Mikkalo	0-38	38		0.6-2.0	6	228	
	38-60	22	basalt	>20	10	220	448
Morrow	0-9	9		0.6-2.0	6	54	

APPENDIX C. TABLE C-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR COLUMBIA BASIN AREA SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS						TOTAL RESULT
	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	
	9-14	5		0.2-0.6	4	20	
	14-26	12		0.6-2.0	6	72	
	26-60	34	basalt	>20	10	340	486
Onyx	0-60	60		0.6-2.0	6	360	360
Palouse	0-60	60		0.6-2.0	6	360	360
Pedigo	0-60	60		0.6-2.0	6	360	360
Pilot Rock	0-27	27		0.6-2.0	6	162	
	27-45	18	duripan	<0.06	1	18	
	45-60	15		>20	10	150	330
Powder	0-60	60		0.6-2.0	6	360	360
Prosser	0-30	30		0.6-2.0	6	180	
	30-60	30		>20	10	300	480
Quincy	0-60	60		6-20	9	540	540
Rhea	0-60	60		0.6-2.0	6	360	360
Ritzville	0-60	60		0.6-2.0	6	360	360

APPENDIX C. TABLE C-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR COLUMBIA BASIN AREA SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS: LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
Royal	0-60	60		2.0-6.0	8	480	480
Sagehill	0-19	19		2.0-6.0	8	152	
	19-60	41		0.6-2.0	6	246	398
Shano	0-60	60		0.6-2.0	6	360	360
Snow	0-60	60		0.6-2.0	6	360	360
Taunton	0-5	5		2.0-6.0	8	40	
	5-24	19		0.6-2.0	6	114	
	24-60	36	duripan	<0.06	1	36	190
Thatuna	0-37	37		0.6-2.0	6	222	
	37-60	23		0.06-0.2	2	46	268
Valby	0-30	30		0.6-2.0	6	180	
	30-60	30	basalt	>20	10	300	480
Veazie	0-24	24		0.6-2.0	6	144	
	24-60	36		>20	10	360	504
Waha	0-13	13		0.6-2.0	6	78	
	13-28	15		0.2-0.6	4	60	
	28-60	32	basalt	>20	10	320	458

APPENDIX C. TABLE C-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR COLUMBIA BASIN AREA SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS						
	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
Walla Walla	0-60	60		0.6-2.0	6	360	360
Warden	0-60	60		0.6-2.0	6	360	360
Willis	0-29	29		0.6-2.0	6	174	
	29-40	11	duripan	<0.06	1	11	
	40-60	20	basalt	>20	10	200	385
Winchester	0-60	60		6.0-20	9	540	540
Yakima	0-30	30		0.6-2.0	6	180	
	30-60	30		>20	10	300	480

APPENDIX C. TABLE C-2

RATING OF COLUMBIA BASIN AREA SOILS FOR LEACHING POTENTIAL

SOIL SERIES	SCORE PERMEABILITIES TIMES THICKNESS OF LAYERS	Score	DRAINAGE CLASS	LEACHING POTENTIAL
Adkins	480	8	Well	HIGH
Anderly	480	8	Well	HIGH
Athena	360	6	Well	MODERATE
Burbank	570	10	Excessively	VERY HIGH
Burke	170	3	Well	VERY LOW
Cantala	360	6	Well	MODERATE
Condon	476	8	Well	HIGH
Cowsly	209	3	Moderately well	LOW
Ellisforde	288	4	Well	LOW
Endersby	494	9	Somewhat excessively	VERY HIGH
Esquatzel	360	6	Well	MODERATE
Freewater	520	9	Somewhat excessively	VERY HIGH
Hermiston	360	6	Well	MODERATE
Hezel	330	6	Somewhat excessively	HIGH
Irrigon	360	6	Well	MODERATE
Kimberly	480	8	Well	HIGH
Koehler	308	5	Somewhat excessively	MODERATE
Mikkalo	448	8	Well	HIGH
Morrow	486	8	Well	HIGH

APPENDIX C. TABLE C-2 (Continued)

RATING OF COLUMBIA BASIN AREA SOILS FOR LEACHING POTENTIAL

SOIL SERIES	SCORE PERMEABILITIES TIMES THICKNESS OF LAYERS	Score	DRAINAGE CLASS	LEACHING POTENTIAL
Onyx	360	6	Well	MODERATE
Palouse	360	6	Well	MODERATE
Pedigo	360	6	Somewhat poorly	MODERATE
Pilot Rock	330	6	Well	MODERATE
Powder	360	6	Well	MODERATE
Prosser	480	8	Well	HIGH
Quincy	540	9	Well	HIGH
Rhea	360	6	Well	MODERATE
Ritzville	360	6	Well	MODERATE
Royal	480	8	Well	HIGH
Sagehill	398	7	Well	MODERATE
Shano	360	6	Well	MODERATE
Snow	360	6	Well	MODERATE
Taunton	190	3	Well	VERY LOW
Thatuna	268	4	Moderately well	MODERATE
Valby	480	8	Well	HIGH
Veazie	504	9	Well	HIGH
Waha	458	8	Well	HIGH
Walla Walla	360	6	Well	MODERATE
Warden	360	6	Well	MODERATE

APPENDIX C. TABLE C-2 (Continued)

RATING OF COLUMBIA BASIN AREA SOILS FOR LEACHING POTENTIAL

SOIL SERIES	SCORE PERMEABILITIES TIMES THICKNESS OF LAYERS	Score	DRAINAGE CLASS	LEACHING POTENTIAL
Willis	385	7	Well	MODERATE
Winchester	540	9	Excessively	VERY HIGH
Yakima	480	8	Well	HIGH

APPENDIX C. TABLE C-3

CALCULATION OF SURFACE ORGANIC MATTER MULTIPLIED BY SURFACE DEPTH
FOR COLUMBIA BASIN AREA SOILS

SOIL SERIES	ORGANIC MATTER SURFACE ZONE (est. percent)	DEPTH SURFACE ZONE (inches)	MULTIPLIED RESULT ORGANIC MATTER TIMES DEPTH
Adkins	1.5	7	10.5
Anderly	1.5	10	15
Athena	3	15	45
Burbank	0.75	5	3.75
Burke	1.5	4	6
Cantala	2	13	26
Condon	2.5	7	17.5
Cowsly	1.5	15	22.5
Ellisforde	1.5	8	12
Endersby	2	10	20
Esquatzel	1.5	7	10.5
Freewater	1.5	4	6
Hermiston	2	16	32
Hezel	0.25	7	1.75
Irrigon	0.75	3	2.25
Kimberly	1.5	10	15
Koehler	0.75	4	3
Mikkalo	1.5	3	4.5
Morrow	1.5	9	13.5

APPENDIX C. TABLE C-3 (Continued)

CALCULATION OF SURFACE ORGANIC MATTER MULTIPLIED BY SURFACE DEPTH
FOR COLUMBIA BASIN AREA SOILS

SOIL SERIES	ORGANIC MATTER SURFACE ZONE (est. percent)	DEPTH SURFACE ZONE (inches)	MULTIPLIED RESULT ORGANIC MATTER TIMES DEPTH
Onyx	2.5	8	20
Palouse	3	24	72
Pedigo	3	34	102
Pilot Rock	2	10	20
Powder	4	13	52
Prosser	1.5	4	6
Quincy	0.75	15	11.25
Rhea	1.5	14	21
Ritzville	1.5	9	13.5
Royal	0.75	5	3.75
Sagehill	0.75	5	3.75
Shano	1.5	8	12
Snow	3.5	21	73.5
Taunton	1.25	5	6.25
Thatuna	4.5	19	85.5
Valby	1.5	8	12
Veazie	2.5	9	22.5
Waha	2.5	13	32.5
Walla Walla	2.5	13	32.5
Warden	2	6	12
Willis	1.5	8	12

APPENDIX C. TABLE C-3 (Continued)

CALCULATION OF SURFACE ORGANIC MATTER MULTIPLIED BY SURFACE DEPTH FOR COLUMBIA BASIN AREA SOILS

SOIL SERIES	ORGANIC MATTER SURFACE ZONE (est. percent)	DEPTH SURFACE ZONE (inches)	MULTIPLIED RESULT ORGANIC MATTER TIMES DEPTH
Winchester	0.75	12	9
Yakima	2.5	30	75

APPENDIX C. TABLE C-4

RATING OF COLUMBIA BASIN AREA SOILS FOR SORPTION POTENTIAL

SOIL SERIES	SURFACE	TEXTURE Class	Score	RESULT OF SURFACE ORGANIC MATTER * DEPTH	Score	SORPTION POTENTIAL
Adkins	vfsl	medium	3	10.5	8	LOW
Anderly	sil	medium	3	15	6	MODERATE
Athena	sil	medium	3	45	4	HIGH
Burbank	ls	coarse	5	3.75	10	VERY LOW
Burke	sil	medium	3	6	10	VERY LOW
Cantala	sil	medium	3	26	6	MODERATE
Condon	sil	medium	3	17.5	6	MODERATE
Cowsly	sil	medium	3	22.5	6	MODERATE
Ellisforde	sil	medium	3	12	8	LOW
Endersby	l	medium	3	20	6	MODERATE
Esquatzel	sil	medium	3	10.5	8	LOW
Freewater	vg. l	medium + 1	4	6	10	VERY LOW
Hermiston	sil	medium	3	32	4	HIGH
Hezel	lfs	coarse	5	1.75	10	VERY LOW
Irrigon	fsl	mod. coarse	4	2.25	10	VERY LOW
Kimberly	l	medium	3	15	6	MODERATE
Koehler	ls	coarse	5	3	10	VERY LOW
Mikkalo	sil	medium	3	4.5	10	VERY LOW
Morrow	sil	medium	3	13.5	6	MODERATE

APPENDIX C. TABLE C-4 (Continued)

RATING OF COLUMBIA BASIN AREA SOILS FOR SORPTION POTENTIAL

SOIL SERIES	SURFACE	TEXTURE Class	Score	RESULT OF SURFACE ORGANIC MATTER * DEPTH	Score	SORPTION POTENTIAL
Onyx	sil	medium	3	20	6	MODERATE
Palouse	sil	medium	3	72	2	HIGH
Pedigo	sil	medium	3	102	2	HIGH
Pilot Rock	sil	medium	3	20	6	MODERATE
Powder	sil	medium	3	52	4	HIGH
Prosser	vfsl	medium	3	6	10	VERY LOW
Quincy	lfs	coarse	5	11.25	8	VERY LOW
Rhea	sil	medium	3	21	6	MODERATE
Ritzville	sil	medium	3	13.5	6	MODERATE
Royal	fsl	mod. coarse	4	3.75	10	VERY LOW
Sagehill	fsl	mod. coarse	4	3.75	10	VERY LOW
Shano	sil	medium	3	12	8	LOW
Snow	sil	medium	3	73.5	2	HIGH
Taunton	fsl	mod. coarse	4	6.25	10	VERY LOW
Thatuna	sil	medium	3	85.5	2	HIGH
Valby	sil	medium	3	12	8	LOW
Veazie	l	medium	3	22.5	6	MODERATE
Waha	sil	medium	3	32.5	4	HIGH
Walla Walla	sil	medium	3	32.5	4	HIGH
Warden	vfsl	medium	3	12	8	LOW

APPENDIX C. TABLE C-4 (Continued)

RATING OF COLUMBIA BASIN AREA SOILS FOR SORPTION POTENTIAL

SOIL SERIES	SURFACE	TEXTURE Class	Score	RESULT OF SURFACE ORGANIC MATTER * DEPTH	Score	SORPTION POTENTIAL
Willis	sil	medium	3	12	8	LOW
Winchester	s	coarse	5	9	8	VERY LOW
Yakima	g. sil	medium + 1	4	75	2	MODERATE

APPENDIX C. TABLE C-5

RATING OF COLUMBIA BASIN AREA SOILS FOR PESTICIDE MOVEMENT POTENTIAL

SOIL SERIES	LEACH POTENTIAL	SORPTION POTENTIAL	PESTICIDE MOVEMENT POTENTIAL
Adkins	HIGH	LOW	VERY HIGH
Anderly	HIGH	MODERATE	HIGH
Athena	MODERATE	HIGH	LOW
Burbank	VERY HIGH	VERY LOW	VERY HIGH
Burke	VERY LOW	VERY LOW	MODERATE
Cantala	MODERATE	MODERATE	MODERATE
Condon	HIGH	MODERATE	HIGH
Cowsly	LOW	MODERATE	LOW
Ellisforde	LOW	LOW	MODERATE
Endersby	VERY HIGH	MODERATE	VERY HIGH
Esquatzel	MODERATE	LOW	HIGH
Freewater	VERY HIGH	VERY LOW	VERY HIGH
Hermiston	MODERATE	HIGH	LOW
Hezel	HIGH	VERY LOW	VERY HIGH
Irrigon	MODERATE	VERY LOW	HIGH
Kimberly	HIGH	MODERATE	HIGH
Koehler	MODERATE	VERY LOW	HIGH
Mikkalo	HIGH	VERY LOW	VERY HIGH
Morrow	HIGH	MODERATE	HIGH

APPENDIX C. TABLE C-5 (Continued)

RATING OF COLUMBIA BASIN AREA SOILS FOR PESTICIDE MOVEMENT POTENTIAL

SOIL SERIES	LEACH POTENTIAL	SORPTION POTENTIAL	PESTICIDE MOVEMENT POTENTIAL
Onyx	MODERATE	MODERATE	MODERATE
Palouse	MODERATE	HIGH	LOW
Pedigo	MODERATE	HIGH	LOW
Pilot Rock	MODERATE	MODERATE	MODERATE
Powder	MODERATE	HIGH	LOW
Prosser	HIGH	VERY LOW	VERY HIGH
Quincy	HIGH	VERY LOW	VERY HIGH
Rhea	MODERATE	MODERATE	MODERATE
Ritzville	MODERATE	MODERATE	MODERATE
Royal	HIGH	VERY LOW	VERY HIGH
Sagehill	MODERATE	VERY LOW	HIGH
Shano	MODERATE	LOW	HIGH
Snow	MODERATE	HIGH	LOW
Taunton	VERY LOW	VERY LOW	MODERATE
Thatuna	MODERATE	HIGH	LOW
Valby	HIGH	LOW	VERY HIGH
Veazie	HIGH	MODERATE	HIGH
Waha	HIGH	HIGH	MODERATE
Walla Walla	MODERATE	HIGH	LOW
Warden	MODERATE	LOW	HIGH

APPENDIX C. TABLE C-5 (Continued)

RATING OF COLUMBIA BASIN AREA SOILS FOR PESTICIDE MOVEMENT POTENTIAL

SOIL SERIES	LEACH POTENTIAL	SORPTION POTENTIAL	PESTICIDE MOVEMENT POTENTIAL
Willis	MODERATE	LOW	HIGH
Winchester	VERY HIGH	VERY LOW	VERY HIGH
Yakima	HIGH	MODERATE	HIGH

APPENDIX C. TABLE C-6

NATIVE pH AND PERCENT SLOPE OF COLUMBIA BASIN AREA SOILS

SOIL SERIES	pH A HORIZON	pH RANGE FOR PROFILE	PERCENT SLOPE
Adkins	6.6-7.3	6.6-8.4	0 - 25
Anderly	6.6-7.3	6.6-7.8	1 - 35
Athena	6.1-7.3	6.1-9.0	0 - 55
Burbank	7.4-8.4	7.4-8.4	0 - 45
Burke	7.4-8.4	7.4-9.0	0 - 30
Cantala	6.6-7.3	6.6-7.8	1 - 35
Condon	6.1-7.3	6.1-7.8	0 - 40
Cowsly	6.1-7.3	6.1-7.3	2 - 20
Ellisforde	6.6-7.8	6.6-9.0	0 - 60
Endersby	6.6-7.8	6.6-7.8	0 - 3
Esquatzel	6.6-7.8	6.6-8.4	0 - 5
Freewater	6.6-7.3	6.6-7.3	0 - 3
Hermiston	6.6-7.8	6.6-9.0	0 - 3
Hezel	6.6-8.4	6.6-9.0	0 - 30
Irrigon	6.6-7.3	6.6-7.3	2 - 12
Kimberly	6.6-7.8	6.6-9.0	0 - 3
Koehler	7.4-8.4	7.4-8.4	0 - 10
Mikkalo	6.6-7.8	6.6-9.0	0 - 40
Morrow	6.6-7.3	6.6-8.4	1 - 40

APPENDIX C. TABLE C-6 (Continued)

NATIVE pH AND PERCENT SLOPE OF COLUMBIA BASIN AREA SOILS

SOIL SERIES	pH A HORIZON	pH RANGE FOR PROFILE	PERCENT SLOPE
Onyx	6.6-7.8	6.6-7.8	0 - 5
Palouse	6.6-7.3	6.6-7.8	0 - 60
Pedigo	>8.4	7.9-8.4	0 - 3
Pilot Rock	6.6-7.3	6.6-9.0	1 - 40
Powder	6.6-8.4	6.6-8.4	0 - 3
Prosser	6.6-8.4	6.6-8.4	0 - 30
Quincy	6.7-8.4	6.7-8.4	2 - 12
Rhea	6.6-7.3	6.6-9.0	1 - 50
Ritzville	6.6-7.8	6.6-9.0	0 - 60
Royal	7.4-7.8	7.4-9.0	0 - 35
Sagehill	6.6-8.4	6.6-9.0	0 - 35
Shano	6.6-8.4	6.6-9.0	0 - 65
Snow	6.6-7.8	6.6-7.8	3 - 30
Taunton	7.4-8.4	7.4-9.0	0 - 45
Thatuna	5.6-7.3	5.6-7.3	1 - 50
Valby	6.6-7.8	6.6-8.4	1 - 30
Veazie	6.1-7.3	6.1-7.3	0 - 5
Waha	6.1-6.5	6.1-7.3	0 - 65
Walla Walla	6.6-7.8	6.6-9.0	0 - 60
Warden	6.6-7.8	6.6-9.0	0 - 65

APPENDIX C. TABLE C-6 (Continued)

NATIVE pH AND PERCENT SLOPE OF COLUMBIA BASIN AREA SOILS

SOIL SERIES	pH A HORIZON	 RANGE FOR PROFILE	PERCENT SLOPE
Willis	6.6-7.8	6.6-9.0	0 - 30
Winchester	6.1-8.4	6.1-8.4	0 - 10
Yakima	6.1-7.8	6.1-7.8	0 - 3

APPENDIX D

SIMULATIONS WITH KLAMATH FALLS BASIN SOILS

APPENDIX D. TABLE D-1

CALCULATION OF THE SOIL PERMEABILITY FOR KLAMATH COUNTY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS						TOTAL RESULT
	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	
Algoma	0-30	30		0.06-0.2	2	60	
	30-60	30		2.0-6.0	8	240	300
Bedner	0-21	21		0.06-0.2	2	42	
	21-31	10	duripan	<0.06	1	10	
	31-60	29		0.2-0.6	4	116	168
Calder	0-8	8		0.06-0.2	2	16	
	8-14	6		<0.06	1	6	
	14-60	46	duripan	<0.06	1	46	68
Calimus	0-60	60		0.6-2.0	6	360	360
Capona	0-25	25		0.6-2.0	6	150	
	25-60	35	basalt	>20	10	350	500
Deter	0-60	60		0.06-0.2	2	120	120
Dodes	0-12	12		0.6-2.0	6	72	
	12-22	10		0.2-0.6	4	40	
	22-60	38	prt wth. sandstone	0.06-0.2	2	76	188
Fordney	0-8	8		2.0-6.0	8	64	
	8-60	52		6.0-20	9	468	532

APPENDIX D. TABLE D-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR KLAMATH COUNTY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS: LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	TOTAL RESULT
Harriman	0-18	18		0.6-2.0	6	108	
	18-42	24		0.2-0.6	4	96	
	42-48	6		0.6-2.0	6	36	
	48-60	12	lacust. bedrock	0.6-2.0	6	72	312
Henley	0-11	11		0.6-2.0	6	66	
	11-36	25		0.6-2.0	6	150	
	36-60	24	duripan	<0.06	1	24	240
Lakeview	0-14	14		0.2-0.6	4	56	
	14-60	46		0.2-0.6	4	184	240
Laki	0-60	60		0.6-2.0	6	360	360
Lobert	0-60	60		0.6-2.0	6	360	360
Modoc	0-12	12		0.6-2.0	6	72	
	12-36	24		0.2-0.6	4	96	
	36-41	5	duripan	<0.06	1	5	
	41-60	19		0.6-2.0	6	114	287
Poe	0-30	30		2.0-6.0	8	240	
	30-60	30	duripan	<0.06	1	30	270
Scherrard	0-5	5		0.06-0.2	2	10	

APPENDIX D. TABLE D-1 (Continued)

CALCULATION OF THE SOIL PERMEABILITY FOR KLAMATH COUNTY SOILS

SOIL SERIES	PERMEABILITY OF INDIVIDUAL SOIL LAYERS						TOTAL
	LAYER	THICKNESS	RESTRICTIVE LAYER TYPE	PERMEABILITY	SCORE VALUE	SCORE * THICKNESS	RESULT
	5-21	16		0.06-0.2	2	32	
	21-33	12	duripan	<0.06	1	12	
	33-60	27		0.6-2.0	6	162	216
Sycan	0-60	60		6-20	9	540	540
Tulana	0-60	60		0.6-2.0	6	360	360

APPENDIX D. TABLE D-2

RATING OF KALMATH COUNTY SOILS FOR LEACHING POTENTIAL

SOIL SERIES	SCORE PERMEABILITIES TIMES THICKNESS OF LAYERS	Score	DRAINAGE CLASS	LEACHING POTENTIAL
Algoma	300	5	Poorly	MODERATE
Bedner	168	3	Moderately well	LOW
Calder	68	1	Moderately well	VERY LOW
Calimus	360	6	Well	MODERATE
Capona	500	9	Well	HIGH
Deter	120	2	Well	VERY LOW
Dodes	188	3	Well	VERY LOW
Fordney	532	9	Excessively	VERY HIGH
Harriman	312	5	Well	LOW
Henley	240	4	Somewhat poorly	MODERATE
Lakeview	240	4	Moderately well	MODERATE
Laki	360	6	Moderately well	MODERATE
Lobert	360	6	Well	MODERATE
Modoc	287	5	Well	LOW
Poe	270	4	Somewhat poorly	MODERATE
Scherrard	216	3	Somewhat poorly	LOW
Sycan	540	9	Excessively	VERY HIGH
Tulana	360	6	Poorly	HIGH

APPENDIX D. TABLE D-3

CALCULATION OF SURFACE ORGANIC MATTER MULTIPLIED BY SURFACE DEPTH
FOR KLAMATH COUNTY SOILS

SOIL SERIES	ORGANIC MATTER SURFACE ZONE (est. percent)	DEPTH SURFACE ZONE (inches)	MULTIPLIED RESULT ORGANIC MATTER TIMES DEPTH
Algoma	7	11	77
Bedner	3.5	6	21
Calder	2.5	5	12.5
Calimus	4	14	56
Capona	1.5	11	16.5
Deter	3.5	8	28
Dodes	2	12	24
Fordney	2	8	16
Harriman	1.5	18	27
Henley	1.5	11	16.5
Lakeview	2	14	28
Laki	1.5	19	28.5
Lobert	3	9	27
Modoc	1.5	12	18
Poe	2	9	18
Scherrard	4	10	40
Sycan	1.5	5	7.5
Tulana	6.5	23	149.5

APPENDIX D. TABLE D-4

RATING OF KLAMATH COUNTY SOILS FOR SORPTION POTENTIAL

SOIL SERIES	SURFACE	TEXTURE Class	Score	RESULT OF SURFACE ORGANIC MATTER * DEPTH	Score	SORPTION POTENTIAL
Algoma	sil	medium	3	77	2	HIGH
Bedner	cl	mod. fine	2	21	6	MODERATE
Calder	sil	medium	3	12.5	8	LOW
Calimus	l	medium	3	56	2	HIGH
Capona	l	medium	3	16.5	6	MODERATE
Deter	cl	mod. fine	2	28	4	HIGH
Dodes	l	medium	3	24	6	MODERATE
Fordney	lfs	coarse	5	16	6	LOW
Harriman	l	medium	3	27	4	HIGH
Henley	l	medium	3	16.5	6	MODERATE
Lakeview	sicl	fine	1	28	4	HIGH
Laki	l	medium	3	28.5	4	HIGH
Lobert	l	medium	3	27	4	HIGH
Modoc	sl	mod. coarse	4	18	6	LOW
Poe	lfs	coarse	5	18	6	LOW
Scherrard	cl	mod. fine	2	40	4	HIGH
Sycan	ls	coarse	5	7.5	8	VERY LOW
Tulana	sil	medium	3	149.5	1	VERY HIGH

APPENDIX D. TABLE D-5

RATING OF KLAMATH COUNTY SOILS FOR PESTICIDE MOVEMENT POTENTIAL

SOIL SERIES	LEACH POTENTIAL	SORPTION POTENTIAL	PESTICIDE MOVEMENT POTENTIAL
Algoma	MODERATE	HIGH	LOW
Bedner	LOW	MODERATE	LOW
Calder	VERY LOW	LOW	LOW
Calimus	MODERATE	HIGH	LOW
Capona	HIGH	MODERATE	HIGH
Deter	VERY LOW	HIGH	VERY LOW
Dodes	VERY LOW	MODERATE	VERY LOW
Fordney	VERY HIGH	LOW	VERY HIGH
Harriman	LOW	HIGH	VERY LOW
Henley	MODERATE	MODERATE	MODERATE
Lakeview	MODERATE	HIGH	LOW
Laki	MODERATE	HIGH	LOW
Lobert	MODERATE	HIGH	LOW
Modoc	LOW	LOW	MODERATE
Poe	MODERATE	LOW	HIGH
Scherrard	LOW	HIGH	VERY LOW
Sycan	VERY HIGH	VERY LOW	VERY HIGH
Tulana	HIGH	VERY HIGH	MODERATE

APPENDIX D. TABLE D-6

NATIVE pH AND PERCENT SLOPE OF KLAMATH COUNTY SOILS

SOIL SERIES	pH A HORIZON	pH RANGE FOR PROFILE	PERCENT SLOPE
Algoma	7.9-9.0	7.9-9.0	0 - 1
Bedner	6.6-8.4	6.6-8.4	0 - 1
Calder	6.6-7.3	6.6-7.3	0 - 1
Calimus	6.1-8.4	6.1-8.4	0 - 35
Capona	6.1-7.3	6.1-7.3	0 - 35
Deter	6.1-7.3	6.1-8.4	0 - 15
Dodes	6.1-7.3	6.1-7.3	0 - 15
Fordney	6.6-8.4	6.6-8.4	0 - 20
Harriman	6.6-7.3	6.6-8.4	0 - 35
Henley	>8.4	7.9-9.0	0 - 2
Lakeview	6.6-7.3	6.6-7.8	0 - 2
Laki	7.9-9.0	7.9-9.0	0 - 2
Lobert	6.1-7.3	6.1-7.3	0 - 25
Modoc	6.1-7.3	6.1-8.4	0 - 9
Poe	>7.8	>7.8	0 - 2
Scherrard	7.4-9.0	7.4-9.0	0 - 1
Sycan	6.6-7.8	6.6-7.8	0 - 2
Tulana	6.6-7.8	6.6-7.8	0 - 1