4. REGIONAL SETTING

This section places the study area within a regional setting and describes the climate, geology, soils, land cover, land use and population of WRIA 55 and WRIA 57. The purpose of this section is to characterize the distribution of precipitation within the WRIAs and the physical and human facets of the WRIAs that influence the fate of precipitation on land and within the subsurface. The movement of water on the surface (i.e., the hydrology) and the movement of water within the subsurface (i.e., the hydrogeology) of WRIAs 55 and 57 are described in Section 5.

4.1 Overview

WRIA 55 and WRIA 57 are located within northeastern Washington, on the Washington-Idaho border (Figure 1.1). The WRIAs are bounded by WRIA 56 (the Hangman Creek basin) to the south, WRIA 54 (the Lower Spokane basin) to the east, WRIA 59 (the Colville River basin) to the northwest and WRIA 62 (the Pend Oreille River basin) to the northeast (Figure 1.1). Watershed planning is ongoing in all of these WRIAs with the exception of WRIA 54 (Lower Spokane Basin, the Spokane River downstream of the Hangman Creek confluence).

Topographic elevations range from 1,640 feet above mean sea level where the Little Spokane River discharges into the Spokane River to 5,878 feet above mean sea level on the summit of Mount Spokane. The climate ranges from high plains desert to temperate. Annual precipitation ranges from less than 20 inches to over 40 inches. Between 12 and 15 feet of snow accumulates on Boyer Mountain in the northwest corner of WRIA 55, and on Mount Spokane on the eastern border of WRIA 55 with WRIA 57. Otherwise snow accumulation is less than three feet in the area of the City of Spokane and the Spokane Valley.

The watersheds lie at the boundary between two major physiographic provinces of North America (Fenneman, 1931; Figure 1.1). The north of WRIA 55 and the east of WRIA 57 are characterized by landforms typical of the Northern Rocky Mountains Province. The Northern Rocky Mountains are characterized by north-south trending mountains and valleys and comprise predominantly crystalline basement rocks that rise steeply from the Columbia Plateau. In WRIA 55, the mountains are rounded and are located on the west (the Huckleberry Range), the east (Mount Spokane) and the north (the Selkirks) of the watershed. In WRIA 57 the mountains are rounded and are located to the north (Antoine Peak) and the south (Mica Peak) of the Spokane Valley. The south of WRIA 55 and the west of WRIA 57 comprise landforms typical of the Columbia Plateau Province. These include flat-topped basalt plateaus (Half Moon Prairie, Wild Rose Prairie, Orchard Prairie, Green Bluff, Orchard Bluff and Five Mile Prairie).

In both WRIA 55 and WRIA 57, there are areas of subdued topography that represent areas of basement and basalt rocks that were scoured and infilled by peri-glacial processes, including the Missoula Floods. The Spokane Valley represents the main Missoula Flood channel. The primary aquifers in WRIA 55 and WRIA 57 comprise these glacial flood unconsolidated sediments (e.g., the highly productive SVRP Aquifer). Less productive aquifers occur within the basalts (e.g., Green Bluff).

Natural land cover ranges from scrub brush in the lower portions of the basins to mixed coniferous and deciduous forests in the uplands. Land use is primarily urban with residential development in the Spokane Valley and around the City of Deer Park. Substantial suburban development is occurring in the lower reaches of the Little Spokane River north of the City of Spokane. Agricultural land use is concentrated in the Dragoon Creek sub-basin of the Little Spokane Basin, and in the Deadman Creek sub-basin (Figure 1.2), and scattered in lower density throughout the rest of the lower elevations of the basins. Minor amounts of land are used for rangeland.

4.2 Climate

The climate of the Little Spokane and Middle Spokane WRIAs is generally warm and dry in the summer and cool and moist in the winter. Large variations in climate occur across the basin from a sub humid mountain climate in the north to semiarid in the south (Dames and Moore and Cosmopolitan, 1995). Annual precipitation also varies considerably over the region increasing from an average of 16 inches annually in the southwest areas to more than 35 inches in the north and east.

There are 18 meteorological stations in and around WRIAs 55 and 57 that can aid in understanding climate patterns in the region (Figure 4.1 and Table 4.1a). Hydrographs of annual precipitation at selected stations are included in Appendix B. Spokane County staff provided most of the climate station data to Golder. Additional station data and summaries (not whole periods of record) were obtained for stations in the area that could aid in evaluating the local climate. These stations are identified in Table 4.1a as having periods of record that are "not supplied".

Outputs from the Parameter-Elevation Regressions on Independent Slopes Model (PRISM) are used to represent climate data for the basins. PRISM is a model that uses point data and a digital elevation model (DEM) to generate gridded estimates of climate parameters (Daly and others, 1994). Unlike other statistical methods in use today, PRISM was written by a meteorologist specifically to address climate. PRISM is well suited to mountainous regions because the effects of terrain on climate play a central role in the model's conceptual framework. Data input to the model consisted of 1961-1990 mean monthly precipitation from over 8000 National Oceanic and Atmospheric Administration (NOAA) Cooperative sites, Snowpack Telemetry (SNOTEL) sites, and selected state network stations. PRISM is used to estimate mean annual, mean monthly and event-based precipitation, temperature, and other variables. The model grid resolution is 4-km (latitude and longitude). The outputs used in this study are re-sampled to 2-km resolution using mathematical filtering procedures (Daly and others, 1994).

Due to the vast amount of data used in the analysis and the high degree of peer review since publication, PRISM precipitation data are considered high quality. Other PRISM outputs for the state of Washington, such as mean monthly temperature, are more preliminary and have not yet benefited from the same level of peer review.

4.2.1 Precipitation

Precipitation includes all water that falls from the atmosphere to the earth's surface. Precipitation occurring in the liquid phase (rainfall) and the frozen phase (snow, hail, sleet and freezing rain) are the phases that are of interest for this watershed analysis. Rainfall has the potential to run off into streams (though not all rainfall runs-off immediately due to infiltration, evaporation, etc.). Frozen precipitation may remain where it falls for a long time before melting and producing run-off.

Snowfall in the study area is an important component contributing to streamflow and aquifer recharge. In order to estimate the amount of water available in frozen precipitation it is often defined by the amount of liquid that would be produced if melted; called the snow water equivalent or SWE. SWE can be measured at gages using specialized sensors or it can be estimated by conversion of snowfall to SWE. Only three stations in the vicinity of the WRIAs collect SWE data (Figure 4.1): Bunchgrass Meadow, Quartz Peak and Spokane International Airport. The average of the peak annual snowpack in SWE measured for these stations is 28.5 inches, 22.3 inches and 0.6 inches, respectively. Established conversion values can be used to estimate SWE of other snowfall gages. Lindsay and others, (1997) state that 1 inch of snowfall is usually equivalent to 0.1 inch of SWE (i.e., water).

4.2.1.1 Precipitation and Snowpack in WRIA 55

In contrast to WRIA 57, the watershed area that contributes precipitation to WRIA 55 is essentially delineated by the WRIA 55 boundary. Precipitation variability across WRIA 55 is primarily a function of elevation and proximity to upland areas (Figure 4.2). Based on average annual PRISM data (Figure 4.2), annual precipitation within WRIA 55 ranges from:

- 15 to 20 inches in southern, low-lying area of WRIA 55.
- 20 to 25 inches across the moderate elevations of the Deer Park Basin (central western WRIA 55).
- 25 to 30 inches across the moderate elevations of the Diamond Lake area (northeastern WRIA 55).
- Between 30 to over 40 inches in the uplands along northern and eastern boundaries of WRIA 55.

In order to confirm if PRISM precipitation data adequately approximates the actual precipitation within the WRIA 55, a comparison was made between average annual PRISM precipitation (Figure 4.2) and average annual precipitation for representative WRIA 55 climate station data (Figure 4.1 and Table 4.1a). The following stations were selected as representative of WRIA 55's precipitation variability. The locations of these stations are shown on Figure 4.1.

- The Spokane International Airport station (at 2,355 ft amsl) represents southern, low-lying area of WRIA 55.

- The Deer Park 2 E station represents (at 2,201 ft amsl) the moderate elevation climate of central and western WRIA 55.
- The Newport station (at 2,134 ft amsl) represents the moderate elevation climate of northeastern WRIA 55.
- The Mt. Spokane Summit station (at 5,280 ft amsl) represents the northeastern high mountainous regions of WRIA 55.

The summary table below compares the average annual PRISM precipitation data to the average annual precipitation recorded at the representative climate stations.

Comparison of PRISM and WRIA 55 Climate Station Data

Station	**Station Elevation** (ft amsl)	**Avg. Annual Station Precipitation** (inches)	**Avg. Annual PRISM Precipitation Range** (inches)
Spokane International Airport	2,355	16.25	15 – 20
Deer Park 2 E	2,201	21.8	20 – 25
Newport	2,134	26.5	25 – 30
Mt. Spokane Summit	5,280	41.4	>35

As indicated on the summary table above, PRISM data adequately represents average annual precipitation data for WRIA 55 climate stations.

The average monthly PRISM precipitation for WRIA 55 (Figure 4.3) illustrates that the majority of the WRIA 55 precipitation occurs between November and March. The monthly PRISM data is supported by the average monthly precipitation for representative climate stations (Figure 4.1 and Figure 4.4).

Significant snow pack (Figure 4.5) accumulates mostly in the eastern and northern portions of the basin at relatively high elevations. Up to 60% of the total precipitation falls as snow during the winter months over the higher elevations (Figure 4.6). For example, at the Quartz Peak station, located on the eastern boundary of WRIA 55 (Figure 4.1), SWE is between 25% and 60% of total precipitation. A daily representation of SWE and precipitation is shown in Figures 4.7a and b. A monthly representation of SWE (calculated from snow depth) is presented on Figure 4.8. These figures indicate that spring snowmelt originating from the higher elevation areas in the north and east of WRIA 55 represent an important component of run-off to streams. However, the spring snowmelt contribution to streamflow from the lower-lying central and southern portions of WRIA 55 is often reduced in stages throughout the winter by the frequent mid-winter thaws (Figure 4.8).

4.2.1.2 Precipitation and Snowpack in WRIA 57

Precipitation variability across WRIA 57 is also a function of elevation and proximity to upland areas (Figure 4.2). Based on average annual PRISM data (Figure 4.2), annual precipitation within WRIA 57 ranges from:

- 15 to 20 inches in the western and central, low-lying area of WRIA 55.
- 20 to 25 inches across the southeastern (Mica Peak) and western (Hauser Lake) moderate elevations of WRIA 57.
- Between 35 to over 40 inches across the uplands of northwestern WRIA 57.

The following stations were selected as representative of WRIA 57's precipitation variability. The locations of these stations are shown on Figure 4.1.

- The Spokane International Airport station (at 2,355 ft amsl) represents the western and central, low-lying area of WRIA 57.
- The Coeur d'Alene 1 E station (at 2,132 ft amsl) represents the low to moderate elevation climate southeastern and western WRIA 57.
- The Mt. Spokane Summit station (at 5,280 ft amsl) represents the northeastern high mountainous regions of WRIA 55.

The summary table below compares average annual PRISM precipitation (Figure 4.2) and average annual precipitation for representative WRIA 57 climate station data (Figure 4.1 and Table 4.1a). As indicated on the summary table above, PRISM data also adequately represents average annual precipitation within WRIA 57.

Comparison of PRISM and WRIA 57 Climate Station Data

Station	Station Elevation (ft amsl)	Avg. Annual Station Precipitation (inches)	Avg. Annual PRISM Precipitation Range (inches)
Spokane International Airport	2,355	16.25	15 - 20
Coeur d'Alene 1 E	2,132	26.49	20 - 25
Mt. Spokane Summit	5,280	41.4	35 - > 40

As for WRIA 55, the average monthly PRISM precipitation for WRIA 57 (Figure 4.3) illustrates that the majority of the WRIA 57 precipitation (38% [Dames and Moore and Cosmopolitan, 1995]) falls between November and March. The lowest precipitation occurs from July through September (approximately 12 % of the annual total [Dames and

Moore and Cosmopolitan, 1995]). The monthly PRISM data is supported by the average monthly precipitation for representative climate stations (Figure 4.1 and Figure 4.4).

Winter snowfall (Figure 4.5 and Figure 4.6) frequently accumulates to depths of a foot or more over the lower elevation areas of WRIA 57, but usually melts within a few days (MacInnis and others, 2000). This is supported by the fact that the average monthly temperature at the Spokane International Airport station falls below freezing only in December and January. At the Spokane International Airport station, the maximum average monthly snowfall is 13 inches and occurs in January. In comparison, the maximum average monthly snowfall recorded at the Mount Spokane Summit station is about 38 inches in January. Average annual snowfall at the Spokane International Airport is 41.8 inches. Average annual snowfall at the Mount Spokane Summit station is 170.4 inches. Using the ratio of 1 inch of snowfall to 0.1 inches of SWE, the average annual snowfall at the Spokane International Airport and the Mount Spokane Summit stations are equivalent to about 4 and 17 inches, respectively.

4.2.1.3 WRIA 57 Contributing Watershed Area

As described in more detail in Section 5.1 of this report, the watershed area that contributes water to the Middle Spokane River in WRIA 57 is large (greater than 3,700 square miles) and extends to the Idaho-Montana border (Figure 5.1). Precipitation falling within WRIA 57 has less importance in sustaining streamflow and aquifer recharge than precipitation and snowmelt that falls in the portion of the basin in Idaho (i.e., the Bitterroot Mountains). The Bitterroot Mountains, east of Coeur d'Alene, are an important recharge area for both the SVRP Aquifer and the Spokane River due to the relatively high elevation of the mountains in comparison to the WRIA 57 area. Average annual precipitation in the Bitterroot Mountains is more than 70 inches a year (MacInnis and others, 2000). About 60% of this precipitation falls during the five-month period between November and March. Much of this falls as snow, especially in the mountains. It is the resulting snowmelt that is responsible for the spring peak in the streamflow hydrographs (see Chapter 5).

4.2.2 Temperature

Temperature varies considerably across WRIAs 55 and 57 from an annual average of 48 degrees Fahrenheit (°F) in the lower-lying areas to 36 °F in the mountains. Deviations in temperature within the Spokane Valley of WRIA 57 are very small, varying no more than 2 or 3 °F (MacInnis and others, 2000). Average temperatures in WRIA 55 vary by more than 10 °F from the low-lying areas in the south to the mountains in the north and east. Table 4.1b details annual monthly average maximum and minimum temperature for representative stations. Mean monthly temperatures at these same stations are presented in Figure 4.9.

4.2.3 Evaporation

Evaporation and transpiration from plants (water lost through plant uptake and release to the atmosphere) are combined together and referred to as evapotranspiration.

Evapotranspiration occurs year round, but is highest during the summer months (May to September) when it is estimated that 80% of total transpiration and evaporation occurs. Potential evapotranspiration (P_{ET}) is the amount of evapotranspiration that would occur if water were always available. P_{ET} is estimated to range from 20 to 25 inches at lower elevations (PNRBC, 1970). Actual evapotranspiration depends on many factors including land cover, temperature, precipitation, surface water, growing season, etc. It is especially important in irrigated areas and is discussed further in Section 7 (Water Use). Actual evapotranspiration has been estimated to range between 10 and 12 inches annually (PNRBC, 1970) over much of the area. Annual evapotranspiration at Deer Park (elevation 2,214 feet amsl) was estimated as 23 inches for P_{ET} and 14 inches for actual evapotranspiration (Chung, 1975).

4.2.4 Long Term Climatic Variations

Long term climatic variations (including natural climate variability and human induced climate change) are identified by assessing historic climatic trends and extrapolating these trends to predict future climates.

4.2.4.1 Natural Climate Variability

Natural climate variability in the Pacific and Inland Northwest is associated primarily with changes in the surface temperature and winds of the Pacific Ocean (JISAO and SMA, 2001). The two main Pacific climatic patterns that influence the Pacific Northwest are the El Nino Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO). The ENSO recurs on a 2 to 7 year time scale. The PDO is a pattern that reverses on a 20-30 year time scale.

El Nino (also called a warm phase ENSO) is an unusual warming of the equatorial Pacific sea surface temperatures that generally causes unusually warm and dry weather in the Inland Northwest. La Nina (also called a cool phase ENSO) is an unusual cooling of the equatorial Pacific sea surface temperatures that generally causes unusually cool and wet weather in the Inland Northwest. ENSO phases usually last 6 to 18 months with particularly strong impacts of the climate of the Inland Northwest in October and March. Good understanding of the ENSO phases and triggers has resulted in the ability of climate research groups to predict these events up to one year in advance. Currently (2001), the Inland Northwest is being impacted by an ENSO neutral period. The forecast for the winter 2001 and 2002 predicts a weak El Nino developing over the winter or late spring.

The PDO, recognized initially in the early 1990s, also has warm and cool phases that impact the Inland Northwest over 20 to 30 year cycles. A warm phase PDO, which occurs as a result of unusual warming of sea surface temperatures in the central north Pacific, brings cooler sea surface temperatures to the coast of the Pacific Northwest. A cool phase PDO, which occurs as a result of unusual cooling of sea surface temperatures in the central north Pacific, brings warmer sea surface temperatures to the coast of the Pacific Northwest. Because the PDO triggers are not well understood, they cannot be predicted at this time. Based on the climatic record of the Pacific Northwest, cool, wet

PDO regimes are predicted to have lasted from 1890-1924 and again from 1947-1976. Warm, dry PDO regimes have spanned 1925-1946 and from 1977-1994 (Miles, 2000). It is believed that the PDO phase may have shifted to a cool period in the late 1990s. The estimated PDO changes in the climate of the Pacific Northwest as a percentage of average (except for temperature) are presented in the summary table below (JISAO and SMA, 2001).

Climatic Changes as a result of PDO Phases

(adapted from Figure 4, JISAO and SMA, 2001).

Climatic Factors	**WARM PDO** (1925-45 and 1977-1995)	**COOL PDO** (1890-1924, 1946-1976 and 1996-?)
Temperature	+ 0.3 °F	- 0.2 °F
Precipitation	+ 2%	- 4%
Snow Depth	- 15%	+ 17%
Streamflow	- 10%	+6%
Forest Fires	+65%	-49%

Note: Temperature averaged over the Pacific Northwest for October – March.
Total annual precipitation averaged over the Pacific Northwest.
Snow depth averaged from Jan 15 to Apr 15 at Snoqualmie Pass.
Streamflow at The Dalles corrected for dam regulation.
Areas burned by forest fires in Washington and Oregon.

4.2.4.2 Human Induced Climate Change

The Pacific Northwest has become on average 1.4 °F warmer and 2.9-inches wetter over the last 100 years. Carbon dioxide in the atmosphere has increased by more than 30% since the beginning of the Industrial Revolution, mainly because of the burning of fossil fuels. Although it has not been confirmed that increasing levels of carbon dioxide in the atmosphere has caused this change, these changes are consistent with the results of computer models used to simulate the effects that increases in atmospheric carbon dioxide will have on climate (JISAO and SMA, 2001). Studies completed indicate that temperatures in the Pacific Northwest will increase between 3.1 to 6.3 °F by the 2050s, resulting in wetter winters and drier summers (JISAO and SMA, 2001). The most significant change in the Inland Northwest is likely to be a shift from winter snow to rain, snow pack reduction, higher winter streamflows, earlier streamflow peaks and less water availability in the summer.

4.2.4.3 Assessment of Climate Variations in WRIA 55 and WRIA 57

Generally, it is difficult to identify long-term climatic changes from hydrograph data. Rescaled Cumulative Departure (RCD) analysis provides a method for assessing long-term, cyclic precipitation trends. An RCD plot displays whether a system is exhibiting above or below average precipitation, how severe current conditions are (i.e., how far from average conditions) and the duration of the wet or dry period.

RCD analysis involves determination of mean-monthly values of the hydrologic variable (e.g., precipitation) for a selected base period. The difference between the monthly value in that year minus the mean-monthly value is calculated as the departure. The cumulative departure is calculated as the sum of the monthly departure over the entire period of record. Standardization (or rescaling) is completed by dividing the cumulative departure by the standard deviation of the cumulative-annual departure.

In order to calculate the cumulative departure it is necessary to first determine a base period. The base period should be a period of record that is representative of a normal cycle of wet and dry seasons. The base period could be the entire period of record or a shorter representative period. In a study completed by the USGS (Kresch, 1999) it was determined that a base period of 1937-1976 accurately reflected long-term average conditions in Washington. The USGS study involved an RCD evaluation of precipitation and stream gaging stations across Washington and parts of Oregon and Idaho in order to identify geographic regions of similarity. The study objective was to determine areas where the severity and duration of dry and wet periods was similar. Spokane International Airport was the only station available in the vicinity of the WRIA 55 and WRIA 57 study area that had a long enough period of record to analyze using cumulative departure methods. The Spokane International Airport is located about 5 miles west of WRIA 57 and 10 miles south of WRIA 55 (Figure 4.1). Another station analyzed in the USGS report, Colfax 1 NW, is located about 50 miles south of WRIA 57 (Figure 4.1) but is relevant to analysis of the cyclic nature of precipitation in WRIAs 55 and 57.

RCD curves for precipitation at the Spokane International Airport and Colfax 1 NW stations are presented as Figures 4.10a and 4.10b, respectively. A declining RCD plot slope, such as the slope between 1932 and 1947 for Spokane International Airport (Figure 4.10a) and Colfax 1 NW, indicates that precipitation was below average during much of the interval. The slope of the RCD trend and duration of the cycle indicate the relative severity of the drought. For example, the steep declining RCD slope of the 1932 to 1947 dry period in the vicinity of the Spokane International Airport (Figure 4.10a) indicates that the drought was significantly more severe in this area in relation to Colfax. The Colfax data (Figure 4.10b) indicates a slightly declining slope overall with short-term periods of increasing slope.

Between 1947 and the mid 1960s, both the Spokane International Airport area (Figure 4.10a) and the Colfax area (Figure 4.10b) experienced a period of above average precipitation which is indicated on the figures by an increasing slope to the early 1960s followed by a decline to more average conditions. This wet period is followed by a period of below average precipitation, indicated by the declining RCD slope between the mid-1960s and 1994 (Figures 4.10a and 4.10b). Based on the climate station data, this below average precipitation period was more severe in the Colfax area (Figure 4.10b) than the Spokane area (Figure 4.10a) as indicated by the steeper declining slope for the Colfax 1 NW data. After 1994, there appears to be a slight increasing trend in precipitation (Figures 4.10a).

The PDO shifts (see Section 1.2.4) are also included on Figures 4.10a and 4.10b. Cool, wet PDO regimes are predicted to have lasted from 1890-1924 and again from 1947-1976, and from 1994 to present. Warm, dry PDO regimes spanned 1925-1946 and from 1977-1994 (Miles, 2000). Spokane International Airport and Colfax 1 NW generally follow these shifts except for a period between the mid-1960s to 1976 when precipitation at these stations declined to below average.

4.2.5 Watershed Planning and WRIA 55 / 57 Climatic Setting

In terms of watershed planning, it is important to understand the impacts that climatic change may have on the future water resources of WRIAs 55 and 57 so that appropriate watershed management decisions can be made and so that the watershed plan is resilient to the impacts of climatic change. Based on a review of available information on the climatic setting of WRIAs 55 and 57 and on the predicted climatic changes of the future, climatic warming as a result of increased greenhouse gases within the atmosphere has the greatest potential to impact water resources management over the next 50 years. Due to the near freezing winter temperatures experienced within the mountains of WRIA 55 and WRIA 57 (indicated by winter thaws), the overall increase in annual temperatures as a result of warming is likely to cause a shift from winter snow to winter rain, snow pack reduction, higher winter streamflows, earlier streamflow peaks and less water availability in the summer. The El Nino / La Nina cycles (which can be predicted up to a year in advance) and the PDO shifts, have the potential to exacerbate or alleviate this human induced change.

4.3 Geologic Setting

This section presents the geologic framework for WRIAs 55 and 57, including the geologic history of the watersheds, stratigraphy and description of geologic units. The purpose of this section is to present the background information necessary to formulate a conceptual hydrogeologic model for the WRIAs.

The information presented within this section is based primarily on:

- USGS, DNR and Geological Society of America publications (Pardee and Bryan, 1926; Bretz, 1930; Newcomb, 1953; Bretz, 1959; Baker, 1973; Weisenborn and Weis, 1976; Molenaar, 1988; Boleneus and Derkey, 1996; Derkey, 1997; Derkey, Gerstel and Logan, 1998; DNR, 2001 unpublished);
- Research theses and papers (Kiver and Stradling, 1985; McKiness, 1988; Robinson, 1991; Boese and Buchanan, 1996);

- Work completed for the private sector (Boleneus, 1978); and,
- Work completed within the basins by local, state and federal agencies (Landau Associates, Inc., 1991; EMCON, 1992; Dames and Moore and Cosmopolitan, 1995; CH2M Hill, 1998; CH2M Hill, 2000;MacInnis and others, 2000).

4.3.1 Geologic Mapping and Stratigraphy

The simplified geologic stratigraphy of the study area (Figure 4.11) describes the layered sequence of geologic units from the land surface downward and the age relationships between the units. The expression of these units on the land surface is illustrated as the surficial geology (Figure 4.12). This surficial geologic map was published by the DNR and was provided to Golder by Spokane County GIS.

The stratigraphic relationships between the geologic units are most easily explained by geologic cross-sections. A geologic cross section represents a vertical slice though the ground that is drawn based on well log or seismic information and the correlation of unit contacts between points or areas of known geology. The location of available geologic cross-sections for WRIAs 55 and 57 are shown as traces on Figure 4.12 and include sections constructed by Emcon (1992), Boese & Buchanan (1996), CH2M Hill (1998) and DNR (2001, unpublished). Fifteen geologic cross-sections are included with this report and are presented as Figure 4.14A through 4.14O. An explanation of symbols used on the cross-sections is provided as Figure 4.13. The locations of the cross-sections included within the report (Figures 4.14A through 4.14O) are denoted on Figure 4.12 with a letter symbol at either end of the section trace. These cross-sections were selected to illustrate specific features that are important to the formulation of the conceptual hydrogeologic model for WRIAs 55 and 57.

4.3.2 Geologic History

The geologic history of WRIA 55 and 57 can be summarized by: 1) formation of basement rocks; 2) the basalt flows and interbedded sedimentary deposition; 3) glaciation and outburst flooding events; and, 4) recent processes.

The crystalline basement rocks that are exposed over the upland areas of the WRIA 55 and WRIA 57 (denoted as B on Figure 4.12) also underlie the valleys. These rocks were originally deposited as sediments within a shallow marine environment. These sediments were heated and uplifted and intruded by igneous rocks during the mountain building continental plate activity that created the Rocky Mountains.

The Columbia River Basalts within WRIAs 55 and 57 (denoted as Tw/Tgr on Figure 4.12) are remnants of flows that extended northwards past the present location of Spokane and eastward into Idaho. A lull in volcanic activity after the Grande Ronde Basalt extrusion and prior to the Wanapum Basalt extrusion allowed for the formation of lakes in areas where the basalt had dammed existing streams. Significant thicknesses of lacustrine silts and clays (known in the Spokane area as the Latah Formation and denoted as Tl on Figure 4.12) collected in these lakes. Resurgence of volcanic activity resulted in flow of the Priest Rapids Member of the Wanapum Basalt into the Little Spokane area. Although most of the Wanapum has been eroded, thin veneers of this basalt cap plateaus such as Green Bluff, Orchard Bluff, Pleasant Prairie, Orchard Prairie and Five Mile Prairie at elevations between 2,250 and 2,350 feet above mean sea level (Boese and Buchanan, 1996).

After the formation of the Columbia River Basalt flows and prior to the recent glaciation, the Spokane River flowed westwards from Idaho through the Spokane Valley, northwards around Beacon Hill in what is known today as the Hillyard Trough. At this time, the ancestral Spokane River probably entered the Little Spokane River between Waikiki and Griffith Springs. The Spokane River would have flowed on a basement and basalt surface at an elevation of about 500 feet lower than that of today. The ancestral Little Spokane is likely to have flowed within the same general area as it does today, also on a predominantly basement and basalt surface and at a lower elevation than that of the present river elevation.

Geologic evidence suggests that at least two major Ice Ages have left a clear record in the landscape of the Northern Rockies. The most recent Ice Age, known as the Wisconsin, climaxed about 15,000 years ago and ended about 10,000 years ago. This glacial period had the most significant effect on the present landscape of WRIAs 55 and 57. Glaciers covered most of British Columbia and moved south into Northern Idaho and Washington (down the Purcell and Pend Oreille Valleys), filling the basalt and basement valleys and covering all but the higher mountains. Glacial till (very poorly sorted clay to boulder sized material that is pushed and carried by a glacial ice) and outwash (clay to gravel sized material deposited by meltwater) were deposited over and infilled the valley floors as the glaciers advanced and retreated.

During the last major Ice Age, it has been postulated that the Purcell Ice Lobe of the Cordilleran Ice Sheet dammed the Clark Fork River at the site of present-day Pend Oreille Lake. Water ponded behind the dam, forming Glacial Lake Missoula. At its highest level, the lake covered 3,000 square miles in the valleys of northwestern Montana. During the same period, ice dams to the west created Glacial Lake Columbia that may have extended eastwards across the Spokane Valley to Coeur d'Alene and northwards into the Little Spokane watershed valleys. Glacial Lake Clark in the Pend Oreille River Valley north of Newport formed as glaciers retreated.

As the water level rose behind the Clark Fork dam, it is believed that the ice dam was floated and undermined. An enormous torrent of water rushed first southwestwards across the present day Rathdrum Prairie in western Idaho and then turned westwards at the present site of Lake Coeur d'Alene and continued in a westerly direction through the Spokane Valley and then across the Columbia Plateau of eastern Washington. Some of the floodwaters were also deflected through the Blanchard Channel into the Deer Park Basin resulting in deposition of flood sands and gravels within the central and southern parts of the WRIA 55 (Figure 4.12). Terraces near the Spokane – Little Spokane River confluence suggest that the last of the larger Wisconsin floods may have used the Little Spokane River valley as the flow course (Kiver and Stradling, 1985). The spillway for

Glacial Lake Clark was through the Scotia Channel (the location of today's Little Spokane River headwaters) into the Little Spokane River valley.

There is strong evidence to support dozens of successive breechings of the Clark Fork ice dam. After each dam breaching, Lake Missoula would have been partially drained before the water started to build up behind the dam again. It has been estimated that the maximum discharge across the Columbia Plateau may have been as high as 750 million cubic feet per second (cfs). This is equivalent to twenty times the combined flow of all the rivers of the world today (Baker, 1973; Molenaar, 1988).

The outbursts of water scoured the ground along the major flow courses and picked up large quantities of sediment (earlier glacial and flood deposited sediments) ranging from boulder to clay size particles (denoted as Qfs/Qfg/Qfcg on Figure 4.12). As the energy of the flow dissipated, the floods deposited sediment within the scoured valleys. Larger particles such as boulders and cobbles were deposited in the valleys closer to the site of the dam breach. Smaller particles such as sand and silt were carried in suspension and were either deposited in side valleys or carried out onto the Columbia Plateau. With each successive filling of Lake Missoula and breach of the ice dam, the floodwaters would have likely taken a slightly difference course, reworking earlier glacial and flood deposited sediments along the course of the flow.

Deposition of fines (silts and clays) within the glacial lakes would have resulted in layers of fine-grained material (denoted as Qgl on Figure 4.12) overlying earlier flood and glacial deposits. These fine-grained sediments would have been washed out along the main flood courses but would have been preserved in areas of lower energy flows by a blanket of overlying flood deposits. Coarse grained (sand, gravel and boulder sized) flood deposited sediments up to 500 feet thick within the Rathdrum Prairie of western Idaho and the Spokane Valley, now form the SVRP Aquifer, one of the world's most productive groundwater resources (see Figure 5.9). Less coarse (sand and gravel sized) flood deposited sediments also occur within the central and northeastern parts of the Little Spokane basin (Figure 4.12).

After the final draining of Lake Missoula, the climate became warmer and the Cordilleran Ice sheet retreated northwards. The Spokane River resumed its course westward to Spokane. However, instead of flowing northwards through the Hillyard Trough (as it did prior to the Missoula Flood events), the Spokane River continued westward through what is now downtown Spokane, then turned northwards, to join the Little Spokane River at the western toe of Lookout Mountain. The course of the Spokane River likely changed because the flood sediments within the Hillyard Trough area were deposited to a higher elevation relative to those deposited within the lower Spokane Valley. As a result, the Spokane River formed the falls in downtown Spokane, and possibly the Trinity Trough, instead of resuming its prior course within the Hillyard Trough.

During the early stages of glacial retreat, the flow rates of the Little Spokane and Spokane Rivers would have been much greater than those of today because they would have been fed year round by glacial melt water. The large valley occupied by the Lower

Spokane River between the Hangman Creek confluence and Nine Mile Dam provides evidence that the Spokane River was, at one time, a much larger river than it is today.

In some of the lower tributary watersheds, small lakes formed where glacial moraines and flood deposits dammed streams and creeks. Hauser Lake, Newman Lake and Liberty Lake (and their associated peat deposits) are examples. Outlets from these lakes flow towards the Spokane River but do not reach the river. Instead the outflows recharge the SVRP Aquifer before reaching the river because of the high permeability of the flood deposited sediments.

The Palouse Formation (denoted as Ql on Figure 4.12) comprises a thin veneer of windblown silt and sand that formed after the last glaciation as the river flows and water levels decreased and the sparsely vegetated glacial deposits dried.

Finally, along the present river and stream drainages, the glacial materials were reworked and deposited as sand and gravel alluvium (denoted as Qal on Figure 4.12).

4.3.3 Geologic Units

The geologic units that occur within WRIA 55 and WRIA 57 can be divided from oldest to youngest into three major terrains (McKiness, 1988; Cline, 1969): 1) crystalline basement; 2) basalt flows and intercalated sediments; and, 3) unconsolidated deposits. In general, the geology comprises vertically stratified and laterally discontinuous geologic units that have been modified at the surface by erosional processes. The nature and occurrence of the three major terrains is described below, beginning with the oldest unit. The geologic cross-sections presented as Figure 4.14A through 4.14O illustrate how these units are likely to occur within the sub-surface. The locations of these cross-sections are shown in plan on Figure 4.12.

4.3.3.1 Crystalline Basement

The crystalline basement comprises Precambrian (pre 570 my ago) metamorphics (e.g., quartzite, schist and gneiss) in addition to Mesozoic and early Cenozoic (245 to 37 m. y. ago) plutonic rocks (e.g., granite). Uranium is associated with the plutonics on the west flank of Mount Spokane (Weisenborn and Weis, 1976) and springs enriched in uranium occur in this area.

As indicated on Figure 4.12, the crystalline basement is generally exposed on the higher ground above the valleys, including the western, northern and eastern portions of WRIA 55 and in the southeastern and northeastern uplands of WRIA 57. In the central areas of WRIA 55 and WRIA 57, where later units blanket the basement rocks, the depth to the basement rocks is illustrated on the geologic cross-sections. In general, the depth to the basement rocks increases in a southerly direction within the valleys of WRIA 55 (Figures 4.14C, 4.14D, 4.14E and 4.14F) to a depth of up to 700 feet below grade in the Hillyard Trough area. Depth to basement rocks within WRIA 57 increases towards the axis of the Spokane Valley (see cross-sections 4.14G through 4.14O) and is generally within 400 to 700 feet below grade. A notable exception is the Pines Road Knoll, illustrated on Figures

4.14L and 4.14M. At this location, the bedrock extends to surface as an erosional remnant left after the Missoula floods.

The surface of the crystalline basement has significant topographic relief. For example, Mount Spokane, on the WRIA 55 – WRIA 57 boundary, reaches an elevation of 5,878 feet above mean sea level. In contrast, a drill hole on Peone Prairie (Township 26, Range 44, Section 6, SW ¼ SW ¼), located about 12 miles southwest of Mount Spokane, indicates the basement surface at 1,070 feet above mean sea level.

4.3.3.2 Basalt and Intercalated Sediments

The basalt rocks comprise Miocene age Columbia River Basalt Group flows intercalated with fluvial and lacustrine deposits of the Latah Formation.

4.3.3.2.1 Basalts

Because WRIA 55 and WRIA 57 are located at the northeastern extent of the Columbia River Plateau, only two of the Columbia River Basalt flows extend into these basins. The basalt flows belong to the Grande Ronde Basalt and the Priest Rapids Member of the Wanapum Basalt. The Grande Ronde is between 15.6 and 16.6 m.y. old (Reidel and others, 1980). The Priest Rapids Member is between 15.3 and 14.5 m.y. old (Reidel and others, 1980). The basalt flows are believed to have flowed in an easterly direction into the Spokane Valley from the Columbia Plateau. The basalts are gray to black, massive, fractured, sometimes with columnar joints, and often vesicular rocks.

As indicated on Figure 4.12 and on cross-sections 4.14D and 4.14E, the basalt rocks resist erosion and tend to form flat-topped prairies (e.g., Valley Prairie, Five Mile Prairie, Orchard Prairie, Pleasant Prairie, Halfmoon Prairie and Wildrose Prairie) or bluffs (e.g., Green Bluff).

Within WRIA 55, the basalts occur primarily on the west side of the Little Spokane River, within the southern portion of the basin (see Figure 4.12). As illustrated on Figures 4.14A and 4.14B, the basalts occur within 100 feet from surface and are exposed as a series of erosional remnants following last glaciation and the Missoula Floods. Within the northern portion of cross section 4.14A, the basalts thin and lap on top of the crystalline basement surface. This represents the northern extent of the Columbia River Basalts within WRIA 55.

In WRIA 57, the basalts occur in the northern, western and southern parts of the basin. Two important geologic features of the basalt are noted:

- Firstly, the Grande Ronde Basalt, which forms the base of Five Mile Prairie, extends southwards, forming a continuous subsurface ridge between Five Mile Prairie and downtown Spokane (see cross section 4.14H). As illustrated on Figure 4.12 and Figure 4.14H, the basalt ridge contains a channel filled with flood channel gravels. The channel, known as the Trinity Trough, is believed to be an ancient channel of the Spokane River (CH2M Hill, 1998). Based primarily on seismic data, the Trinity Trough is about a mile wide and up to 300 feet deep.

- Secondly, the Grande Ronde Basalt rises to within 50 feet of ground surface in the central portion of the Spokane Valley, below Greene Street (CH2M Hill, 1998). Although not apparent from the surficial geology presented on Figure 4.12, this feature is illustrated in section on Figure 4.14J.

4.3.3.2.2 Latah Formation

The Latah Formation consists of lacustrine silt and clay beds containing some fluvially deposited sand and gravel. Latah sediments have been described as orange where oxidized, off-white to dark-gray where not oxidized, very stiff to hard, silt and clayey silt to silty fine sand (Boleneus, 1978; Landau Associates, 1991) with minor sand and gravel beds. Robinson (1991) characterized the Spokane County Latah Formation as comprising 60% clay or silty clay, 30% silt and 10% sand and gravel. The sand and gravel beds ranged up to 20 feet in thickness (Robinson, 1991).

Stratigraphically, Latah Formation sediments may underlie or overlie (i.e., may be both older and younger than the Grande Ronde) and underlie (i.e., are older than) the Priest Rapids Member of the Wanapum Basalt. As indicated on Figure 4.12, Latah Formation sediments are associated with the basalt exposures and occur in the south and central portions of WRIA 55 and in the northern, western and southern parts of WRIA 57. The Latah Formation is generally exposed along the steep bluffs that define the edges of the prairies (see Figure 4.12).

4.3.3.3 Unconsolidated Quaternary Deposits

Quaternary (2 m.y. ago to the present) unconsolidated deposits comprise predominantly sands and gravels with minor amounts of silt and clay. Quaternary sediments within the study area have been deposited during glacial advances and retreats up to the present day alluvial system. As indicated on Figure 4.12, the unconsolidated Quaternary sediments (denoted with a Q prefix in the Figure 4.12 legend) occur within the valleys of WRIA 55 and WRIA 57.

Three important features dominate the Quaternary units of WRIA 55 and WRIA 57:

- The pre-Quaternary buried valley that was eroded by the ancestral Spokane and Little Spokane Rivers into the basement and basalt rocks;

- The glacial flood derived sand and gravel deposits that partially fill the early valleys and the lower reaches of the tributary valleys; and,

- The combined erosional / depositional surface of the present valley floors.

The present day thickness of the unconsolidated sediments is a function of these three Quaternary features. A map presenting the approximate thicknesses of the unconsolidated units is presented as Figure 4.15. This information was compiled from a number a sources (DNR, 2001; CH2M Hill 2000; CH2M Hill 1998; Boese and Buchanan, 1996; EMCON, 1992) and represents the approximate thicknesses of all Quaternary units from the ground surface down to the contact with the basalts, Latah Formation sediments and crystalline basement rocks. The purpose of this map is to provide an indication of the vertical extent of the unconsolidated sediments within WRIA 55 and WRIA 57 because it is these sediments (when saturated) that have the greatest potential to supply water to wells and to hydraulically interact with surface water. As illustrated on Figure 4.15, the unconsolidated deposits range in thickness as follows:

- 700 feet or more within the Hillyard Trough area of southern WRIA 55 and northern WRIA 57;
- About 400 to 600 feet within the central portion of the Spokane Valley in WRIA 57;
- Up to 200 feet within the Deer Park basin of WRIA 55; and,
- In general between 50 to 100 feet within the valleys of WRIA 55.

The main units that make up the unconsolidated Quaternary deposits are described below, generally from oldest to youngest.

4.3.3.3.1 Lower Sand and Gravel Unit (Qfs/Qfg/Qfcg)

This unit overlies the Latah, basalt and basement rocks in the southern part of WRIA 55. It occurs in the northern portion of the Hillyard Trough and is overlain by locally continuous glacial lake deposits (Landau Associates, 1991; CH2M Hill, 2000). It comprises medium dense to very dense, fine to coarse sand with some gravel and occasional gravel and silty sand zones (Landau Associates, 1991). Meltwater streams draining major glacial ice lobes likely deposited these sediments. The lower sand and gravel unit is depicted in section on Figure 4.14F and Figure 4.14G. The thickness of the unit is estimated to range between 100 to 300 feet thick with an average thickness of about 200 feet.

4.3.3.3.2 Glacial Deposits (Qgl)

The glacial deposits within WRIA 55 and WRIA 57 (denoted as Qgl on Figure 4.12) are generally well-laminated fine sands, silts and clays that contain some interbeds of fluvial gravel (Cline, 1969). Within WRIA 55, stratified clay, silt and fine sand sequence appears to extend from the northern end of the Hillyard Trough beneath the Little Spokane River, northward to the Colbert area. Depicted in section on Figure 4.14F and Figure 4.14G, these glacial deposits overlie the lower sand and gravel unit described above and may be up to 200 feet thick. These deposits have been described in the Colbert Landfill area as comprising 30 to 50 % dense to very dense sand with 50 to 70 % very stiff to hard silt and clay layers (Landau Associates, 1991). As indicated on Figure 4.12, glacial deposits are exposed at surface interbedded with flood sediments along Dragoon Creek in WRIA 55 and along the eastern portion of the Spokane River in WRIA 57.

4.3.3.3.3 Flood Sand and Gravel Units (Qfs/Qfg/Qfcg)

The flood sands and gravels infill the Spokane valley in WRIA 57 and blanket the valleys of WRIA 55. This unit is composed primarily of loose to dense, well-graded sand and gravel with cobbles, boulders and zones of silty gravelly sands. The proportion of cobbles and boulders within this unit decreases in a westerly direction across the Spokane Valley and the unit tends to be finer grained within WRIA 55 than within WRIA 57. The flood sands and gravels are generally overlain and laterally bounded by crystalline basement, basalt or relatively fine-grained Latah or glacial sediments.

Within WRIA 55, the thickness of the flood sands and gravels ranges from less than 50 feet to 200 feet adjacent to the Little Spokane River channel and within the central portion of the Deer Park Basin. The flood deposits include bars and terraces of poorly-sorted sand and gravel up to several hundred feet thick in the center of the channel, generally thinning towards the west and east (Figures 4.14C, 4.14D and 4.14E). In the Hillyard Trough area of WRIA 55 (see cross-sections4.14F and 4.14G) up to 200 feet of flood sands and gravels are thought to overlie the glacial deposits.

Within WRIA 57, the flood sands and gravels infill the Spokane Valley and range up to 700 feet in thickness. The geometry of the Spokane Valley, including the flood sediments that fill the valley, is illustrated on Figures 4.14H through 4.14O.

4.3.3.3.4 Loess (Ql)

As illustrated on Figure 4.12, eolian (wind blown) loess caps the basalt plateaus in the southern portion of WRIA 55. Known as the Palouse Formation, these eolian deposits comprise angular fragments of fine sand to silt sized grains of quartz, feldspar and mica derived from alluvium, flood sediments and glacial outwash deposits. Because WRIA 55 occurs at the northern edge of the Palouse deposition area, the loess particles are relatively fine and the depth of the unit thin. Well logs from Green Bluff indicate loess thicknesses of less than 25 feet (Boese and Buchanan, 1996).

4.3.3.3.5 Recent Deposits (Qal/Qp/Qla)

Recent deposits include alluvium and lacustrine (lake) deposits:

- Alluvium (denoted as Qal on Figure 4.12) occurs in present stream channels and includes primarily reworked glacial sediments and flood deposits and gravel, sand and silt alluvial fans (denoted as Qaf on Figure 4.14M) that have formed where steep drainages enter lower gradient drainage. As shown on Figure 4.12, alluvium is generally lined on either side by glacial deposits in the stream channels of WRIA 55.

- Lacustrine Deposits (denoted as Qp/Qla on Figure 4.12) occur in and around lakes such as Newman and Hauser and comprise fine sand, silt, clay and peat in post-glacial lakes.

4.3.3.3.6 Mass Wasting Deposits (Qmw)

Mass wasting deposits (denoted as Qmw on Figure 4.12) range in age from 5 million years old to present and comprise landslide debris with lesser amounts of debris-flow and rockfall deposits. Most mass wasting deposits occur where soft sediments of the

Latah Formation underlie basalt along the southern side of the Spokane River valley and the edges of Peone Prairie.

4.4 Land Surface Cover

This section summarizes the existing and available land surface cover information for WRIAs 55 and 57. Information sources include: National Resource Conservation Service (NRCS), Spokane County, Pend Oreille County, Stevens County, the City of Spokane and the USGS. Land surface cover information presented within this report is divided into:

- Land use / land cover mapping (Figure 4.16); and
- Soils cover mapping (Figure 4.17).

Soil types and vegetative cover in conjunction with topography are the primary components that affect how rainfall runs off the surface of watersheds. In addition, land cover / land use information is used to assess water use and water discharge spatially across the watersheds.

4.4.1 Land Use / Land Cover

Land Use and Land Cover (LULC) mapping combines information on land development by people (i.e., land use) and natural vegetative cover (i.e., land cover). Two main sources of LULC mapping were identified for this study:

- Gap Analysis Program (GAP) Mapping funded by the Biological Resources Division of the USGS through the Washington Cooperative Fish and Wildlife Research Unit at the University of Washington; and,

- Land Use and Land Cover (LULC) Mapping developed by the USGS as part of its National Mapping Program.

The object of the GAP analysis program is to identify areas of high conservation priority. The analysis relies on current land cover and terrestrial vertebrate distributions. The vegetative land cover mapping is developed at a 100-hectare (247 acre) resolution from 1991 satellite Thematic Mapper images. After a preliminary assessment, it was determined that the GAP land cover mapping was not applicable to the WRIAs 55 and 57 study area due to the large area (about 57,000 acres) defined as irrigated land. Based on communication with Spokane County staff, it was confirmed that this area is about 10 times greater than the actual area of irrigated land within the two WRIAs.

The USGS's National Mapping Program Land Use / Land Cover (LULC) mapping for WRIAs 55 and 57 (Figure 4.16) was obtained via an Internet anonymous File Transfer Protocol (ftp). The LULC data files are also based on 1991 Thematic Mapper images and describe vegetative cover, areas of open water, natural surface and cultural features on the land surface. The data files were created by the USGS using a series of processing steps:

1. Manual interpretation of NASA high altitude aerial photographs.
2. Incorporation of existing land use survey data.
3. Digitization of the LULC maps to create a national LULC database within a UTM projection.

All LULC features are represented as polygons with a minimum size of 10 acres with a minimum width of 660 feet. Attribute codes assigned to the LULC features along with the LULC areas in each of the counties and WRIAs are detailed in Table 4.2 for WRIA 55 and Table 4.3 for WRIA 57. A summary table is provided below.

USGS Land Use / Land Cover Summary for WRIA 55 and WRIA 57

Land Use /	WRIA 55		WRIA 57	
Land Cover	Acres	% WRIA 55	Acres	% WRIA 57
Urban or Built Up Land	19,181	4.4	42,318	23.1
Agricultural Land	110,293	25.5	29,665	16.2
Rangeland	6,391	1.5	3,505	1.9
Forest Land	292,051	67.5	105,191	57.4
Water	2,498	0.6	1,807	1.0
Wetland	1,023	0.2	0	0
Barren Land	903	0.2	769	0.4

As for the GAP data, an assessment of irrigated acreage was made to determine the applicability of the coverage to WRIAs 55 and 57. Because irrigated acreage is not defined, United States Department of Agriculture (USDA) 1997 agricultural census data was used to determine the ratio of total agricultural land to irrigated agricultural land for Spokane, Pend Oreille and Stevens Counties. These ratios were determined as 0.27 for Spokane County, 0.59 for Pend Oreille County and 0.81 for Stevens County. By multiplying the total area of agricultural land within each of the counties by the appropriate ratio, a total agricultural irrigated acreage of about 4,710 acres was determined (3,903 acres in WRIA 55 and 807 acres in WRIA 57). Because this area, along with the other LULC areas (see summary table above), appear to reasonably reflect the LULC conditions in WRIAs 55 and 57, the USGS's National Mapping Program Land Use / Land Cover (LULC) mapping was determined as the most suitable LULC coverage for the study area (Figure 4.16).

As illustrated on Figure 4.16 and indicated on the tables (Table 4.2 and 4.3), the majority of the land in both WRIA 55 (67.5%) and WRIA 57 (57.4%) is forestland. The forestland occurs predominantly across the northern and eastern portions of WRIA 55 and across the northern portion of WRIA 57. For WRIA 55, the second largest land use category, covering 25.5% of the WRIA, is agricultural. In contrast, the second largest land use category in WRIA 57 is urban or built up land, covering about 23.1% of the WRIA.

Agricultural land within WRIA 57 covers about 16.2 % of the watershed. Urban or built up land makes up about 4.4% of WRIA 55.

Spokane County is approximately 1,760 square miles in area, of which approximately 5% is incorporated and 95% is unincorporated. Approximately 417 square miles of that comprises 62% of WRIA 55, and 265 square miles comprises 93% of WRIA 57 (Table 4.2). The urban growth areas cover about 33 square miles in WRIA 55 and 78 square miles in WRIA 57 (Table 4.3). Outside of the urban growth area, there are approximately 105 square miles in WRIA 55 and 19 square miles in WRIA 57 of designated natural resource lands. The remaining land outside the urban growth area is designated rural. Land uses in the rural area are predominantly large-lot residential, along with ranching and farming. Near the urban area, residential parcels generally range in size from 1 acre to 5 acres, although there are areas that are subdivided into lots of 10,000 square feet (~¼ acre) and smaller. With greater distance from the urban area, residential parcel sizes increase, ranging from 10 acres to 40 acres and greater. Most commercial and industrial uses in the rural area are associated with natural resource activities.

Urban development is concentrated in the area within and adjacent to the City of Spokane. Residential development generally follows the Spokane River Valley to the east and the Little Spokane River to the north. Commercial development in these river valleys is generally located directly adjacent to, or within a few blocks of, principal arterials, state highways, or major intersections. To the east, these corridors extend to the Washington/Idaho state line along I-90 and portions of Sprague Avenue, Broadway Avenue and Trent Avenue. To the north, development follows Division Street/U.S. 395 and U.S. 2/Newport Highway.

Industrial activity is generally located in the metropolitan area around the City of Spokane. Immediately northeast of the city, Kaiser Aluminum Mead, the Bonneville Power Administration Bell Substation and the R.A. Hanson Company occupy a large industrial area. Extending east from the city, industrial areas are associated with the Burlington Northern and Union Pacific Railroad Lines. Other industrial uses in this area include Kaiser Trentwood, the Spokane Industrial Park and the area north and west of Liberty Lake.

Pend Oreille County comprises approximately 25% of WRIA 55 with about 87% forestry and about 8% agricultural land uses (Table 4.2). The remaining 5% includes single-family residences, commercial, and recreational uses. Pend Oreille County makes up approximately 7% of WRIA 57 with approximately 86% of that being forested and the remainder split evenly between agricultural and rangeland.

The Stevens County comprises 13% of WRIA 55 of which about 72% is forestry and 25% agricultural land use (Table 4.2).

4.4.2 Soils

Detailed GIS coverages of soil types within WRIA 55 and WRIA 57 were provided to Golder as shape files from Spokane County GIS. The original coverages were created by digitizing the soil survey county maps (USDA SCS, 1968; USDA SCS, 1978; USDA SCS, 1980). Soils coverage is an important component of a watershed assessment because the nature of the soil cover determines the fate of incident precipitation, as evapotranspiration, runoff, or infiltration to groundwater.

The detailed GIS coverages provided by Spokane County include separate mapped areas for over 177 soil types within Spokane County, 66 soil types within Stevens County and 100 soil types within Pend Oreille County. A listing of all the soil types within Spokane, Stevens and Pend Oreille Counties is presented on Table 4.4, Table 4.5 and Table 4.6, respectively (NRCS, 1996). In order to simplify the soils coverage, the land surface was reclassified into four main National Resource Conservation Service (NRCS) hydrologic soil classes A, B, C and D and into areas of open water. These classes are used in equations that estimate runoff from rainfall, for example the Soil Conservation Service (SCS) runoff method. The hydrologic classification for each of the soil types within Spokane, Stevens and Pend Oreille Counties is also presented on Table 4.4, Table 4.5 and Table 4.6, respectively (NRCS, 1996).

The NRCS define a soil hydrologic group as a group of soils having similar runoff potential under similar storm and vegetative cover conditions. Runoff potential is a function of infiltration rate and transmission rate. The infiltration rate is the rate at which water enters the soil at the surface and is controlled by surface conditions. The transmission rate is the rate at which water moves in the soil and is controlled by soil properties. The NRCS classification system is based on the use of rainfall-runoff data from small watersheds and infiltrometer plots. From these data, the NRCS established relationships between soil properties and hydrologic group. Wetness characteristics, permeability after prolonged wetting, and depth to very low permeability layers are properties that assist in estimating hydrologic groups.

The hydrologic groups defined by NRCS soil scientists are as follows (NRCS, 1996):

Group A soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist mainly of sands and gravels that are deep, well drained to excessively drained, and have a high rate of water transmission (greater than 0.30 inches / hour).

Group B soils have moderate infiltration rates when thoroughly wetted. They consist mainly of soils that are moderately deep to deep, moderately well drained to well drained, and have moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15 to 0.30 inches / hour).

Group C soils have low infiltration rates when thoroughly wetted and consist mainly of soils having a layer that impedes downward movement of water and soils of moderately fine to fine texture. These soils have a slow rate of water transmission (0.05 to 0.15 inches / hour).

Group D soils have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist mainly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay pan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0 to 0.05 inches / hour).

By classifying the soils according to hydrologic group, the soils of WRIA 55 and WRIA 57 were simplified into a coverage of soil types according to hydrologic characteristics. This coverage is presented as Figure 4.17. The areas and percentages of soils with similar hydrologic characteristics are provided on Table 4.7 and are summarized below:

NRCS Hydrologic Classification of Soils in WRIA 55 and WRIA 57

Soil Hydrologic Group	WRIA 55		WRIA 57	
	Acres	%	Acres	%
Group A (high infiltration, low run-off)	33,854	7.8	10,415	5.7
Group B	225,644	52.2	85,359	46.9
Group C	95,275	22.0	62,036	34.1
Group D (low infiltration, high run-off)	75,225	17.4	21,522	11.8
Open Water	2,589	0.6	2,611	1.4

As illustrated on Figure 4.17 and indicated on the summary table above, low run-off potential soils (Group A soils) are relatively rare within both WRIA 55 and WRIA 57 and occur within valley areas that are underlain by coarse flood gravel deposits (Figure 4.12). The most apparent Group A soil areas occur in small isolated areas lying east-southeast from downtown Spokane within WRIA 57 and along the southern valley of the Little Spokane River and in the southern portion of the Deer Park Basin within WRIA 55. In total 33,854 acres (7.8 %) of WRIA 55 and 10,415 acres (5.7 %) of WRIA 57 comprise soils that possess a low run-off potential.

Moderate infiltration soils (Group B soils) are the most common soil type within both WRIA 55 and WRIA 57 and predominate within the valley areas underlain by flood deposits (see Figure 4.12). Group B soils also occur over upland areas on the western side of WRIA 55 and in WRIA 57, within WRIA 57 over the upland area of the Spirit Lake drainage northeast of Mount Spokane. These upland areas are underlain by crystalline basement rocks (see Figure 4.12). In total 225,644 acres (52.2 %) of WRIA 55 and 85,359 acres (46.9 %) of WRIA 57 comprise soils that possess a moderate infiltration.

Low infiltration soils (Group C soils) predominate across the northern and eastern upland areas of WRIA 55 and the northeastern upland areas of WRIA 57, within areas underlain by crystalline basement rocks (see Figure 4.12). These soils are likely to be a thin veneer overlying the bedrock. In total 95,275 acres (22.0 %) of WRIA 55 and 62,036 acres (34.1 %) of WRIA 57 comprise soils that possess a low infiltration.

High run-off potential soils (Group D soils) occur along the flanks of upland areas in both WRIA 55 and 57 and also in WRIA 55 along the southern portion of the Little Spokane River. On the upland flanks, these soils occur as a thin veneer on steep slopes. Within the southern portion of the Little Spokane drainage, these soils have a high permanent water table. In total 75,225 acres (17.4 %) of WRIA 55 and 21,522acres (11.8 %) of WRIA 57 comprise soils that possess a high run-off potential.

4.5 Population

The table below presents Census population data for Spokane, Stevens and Pend Oreille Counties. As indicated, Spokane County is about 10 times more populated than Stevens County and about 40 times more populated than Pend Oreille County. The 2000 Census data indicates that the populations of WRIAs 55 and 57 are 95,201 and 188,872, respectively.

County	Population		% Change
	1990	2000	1990-2000
Spokane	361,364	417,939	16%
Stevens	30,948	40,066	29%
Pend Oreille	8,915	11,732	32%

The major incorporated areas in WRIAs 55 and 57 are the City of Spokane (in both WRIAs), the City of Deer Park (within the Dragoon Creek sub-basin of WRIA 55) and the Cities of Millwood and Liberty Lake (in WRIA 57). The City of Spokane is located to the north and south of the Spokane River within the western portion of WRIA 57 and the southern portion of WRIA 55. Millwood is located to the east of Spokane. The City of Liberty Lake is located within the southeastern portion of WRIA 57, in the vicinity of Liberty Lake. The table below summarizes the 1990 and 2000 population information for these cities as well as projected 2020 population.

WRIA	City	Actual			Projected	
		Population		% Change	Population	% Change
		1990	2000	1990-2000	2020	2000-2020
55	Deer Park	2,278	3,017	32	5,767	91%
55, 56, & 57	Spokane	177,196	195,629	9.5	246,529	26%
57	Millwood	1,559	1,649	5.8	1,821	10%
57	Liberty Lake	600	3,265	444	7,253	122%

Residential growth generally follows the Spokane River Valley to the east and the Little Spokane River to the north. Much of the population growth in Spokane County is occurring outside of the incorporated areas with the exception of Liberty Lake. The Town of Millwood is small in both population and actual land area. Any growth will most likely occur as infill or re-development. In Deer Park there are several residential subdivision commitments plus a manufactured home park that includes a preliminary 95-unit project. Recently recorded and planned developments would increase the current residential accommodations by a minimum of 55% when complete. Liberty Lake has been the fastest growing area in Spokane County for the past ten years and it is expected to continue to lead the County in growth for the next ten years. The City of Liberty Lake is approximately four square miles in area with approximately 1,306 existing residential units with another 1,595 residential lots approved. The City of Spokane population is projected to grow by 50,400 entirely by use of vacant lots within the incorporated boundary.

The total population of the unincorporated areas of Spokane County in 2000 was approximately 199,135, with about 56,500 of that in WRIA 55 and about 88,000 of that in WRIA 57. The projected population for 2020 is 288,732, or an addition of 89,597 people. Most of the growth should occur within the Urban Growth Area, which is divided into several smaller subareas, each with an allocated population projection for 2020. The following areas and population allocations are in WRIAs 55 and 57:

- Approximately 28,363 acres of unincorporated land located east of the City of Spokane and referred to as the Valley/Liberty Lake Urban Growth Area has a population allocation of 39,431.
- Approximately 1,670 acres of unincorporated land located adjacent to the south and southeast corporate limits of the City of Spokane referred to as the Moran/ Glenrose Joint Planning Area. The population allocation for this area is 4,108.
- Approximately 458 acres of unincorporated land located adjacent to the east corporate limits of the City of Spokane referred to as the Alcott Joint Planning Area has a population allocation of 1,013.
- Approximately 962 acres of unincorporated land located adjacent to the east corporate limits of the City of Spokane referred to as the Yardley Joint Planning Areas has an allocation of 9.
- Approximately 368 acres of unincorporated land located adjacent to the east corporate limits of the City of Spokane referred to as the Upriver Joint Planning Area has a population allocation of 282.
- Approximately 103 acres of unincorporated land located contiguous with the northeast incorporated boundary of the City of Spokane. This area has no population allocation.

Pend Oreille County's Planning Department estimates their portion of the population within the Little Spokane Watershed to be approximately 2,750. The population growth trend is expected to continue in this area as substantiated by the number of subdivision applications, building permits and vacant tracts of land for sale, with the most desirable tracts of land being adjacent to the Little Spokane River and its tributaries. Areas around Diamond Lake, Chain Lakes, along the major State Route Highway 2 and Scotia Road have the highest population densities in southern Pend Oreille County. In Stevens County, residences are generally located near Highway 395.

The population in southeastern Stevens County is estimated to be equal to or less than the 2,750 of Pend Oreille County. Projected population numbers for Stevens County were not collected; a logical assumption is populations will increase in a similar fashion to the Pend Oreille County population. (POCD, 2000).

TABLE 4.1a

Meterological Stations and Periods of Record

Station ID	Name	Data Source	Period of Record	Record Length (Years)	Data Type	Temp	PRCP	SNOW	WIND	EVAP	SNWD	SWE	Elevation (above MSL)	WRIA	County	State
10000	Ragged Ridge	Snow Course	01/01/1982-04/30/2000	18	monthly						X	X	3333.0	57	Spokane	WA
10041	Mica Creek	Snotel	not supplied	N/A	daily	X	X					X	4750.0	N/A	Kootenai	ID
101956	Coeur D'Alene 1 E	NCDC	10/01/1960-12/31/2000	40	daily	X	X	X			X		2132.3	N/A	Kootenai	ID
45004	Bunchgrass MDW	Snotel	10/01/1983-09/30/1999	15	daily	X	X					X	5000.0	62	Pend Orielle	WA
45031	Quartz Peak	Snotel	10/01/1985-09/30/1999	13	daily	X	X					X	4700.0	57	Spokane	WA
451362	Cheney	NCDC	Not Supplied	N/A	daily	X	X						2040.0	56	Spokane	WA
451395	Chewelah	NCDC	Not supplied	N/A	hourly,daily	X	X						1660.0	59	Stevens	WA
451586	Colfax 1 NW	NCDC	Not supplied	N/A	daily	X	X						196.3	34	Whitman	WA
452066	Deer Park 2 E	NCDC	01/01/1960-09/03/1977	17	daily	X	X	X					2200.6	55	Spokane	WA
455674	Mount Spokane Summit	NCDC	01/01/1960-12/09/1972	12	daily	X	X	X					5280.8	55	Spokane	WA
455844	Newport	NCDC	01/01/1960-08/09/2000	40	daily	X	X	X					2134.3	62	Pend Orielle	WA
457180	Rosalia	NCDC	Not supplied	N/A	daily	X	X						240.0	34	Whitman	WA
457933	Spokane	NCDC	01/01/1960-10/09/1983	23	daily	X	X	X					1879.4	57	Spokane	WA
457938	Spokane International AP	ASOS-NWS	01/01/1960-08/09/2000	40	daily	X	X	X		X		X	2355.4	56	Spokane	WA
457941	Spokane WFO	NCDC	07/30/1996-08/09/2000	4	daily	X	X	X		X			2386.5	54	Spokane	WA
459058	Wellpinit	NCDC	Not supplied	N/A	daily	X	X						2460.0	54	Stevens	WA
727856	Spokane Felts Field	ASOS-FAA	12/31/1972-12/31/2000	28	daily	X							1952.6	57	Spokane	WA
999999	Fairchild AFB	NWS-FAA	01/01/1960-12/09/1970	10	daily	X	X	X					2437.4	54	Spokane	WA

Note: Record Lengths equal to N/A indicate data not supplied by Spokane County
PRCP - Precipitation
SNOW - Snowfall
EVAP - Evaporation
SNWD - Snow Depth

TABLE 4.1b

Temperature Summary (in degrees F)

Station Name		January	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Annual	Winter	Spring	Summer	Fall
Coeur d'Alene 1 E	Max.	34.4	40.5	48.3	58.5	68.3	75.2	85.1	85	73.9	60.4	44.2	36.6	59.2	37.1	58.4	81.8	59.5
	Mean	28	32.4	38.4	46.4	54.9	61.7	68.9	68.3	59.2	48.9	37.1	30.9	47.9	30.4	46.6	66.3	48.4
	Min.	21.5	24.3	28.5	34.3	41.5	48.1	52.6	51.7	44.5	37.2	30	25.2	36.6	23.7	34.7	50.8	37.2
Deer Park 2 E	Max.	31.6	39.1	46.6	57.7	68.3	74.9	85	82.9	73.5	59.1	41.9	33.9	57.9	34.9	57.6	80.9	58.2
	Mean	23.8	30.1	36	44.7	53.7	60	66.7	64.9	56.6	45.2	34.3	27.1	45.3	27	44.8	63.9	45.4
	Min.	16.1	21.1	25	31.5	39.2	45	48.5	46.5	39.7	31.3	26.8	20.8	32.6	19.3	31.9	46.7	32.6
Felts Field	Max.	35.9	42.3	50.9	59.4	67.5	75.7	84	83.9	74.6	60.6	43.7	35.7					
	Mean	30.4	34.7	40.9	48.2	55.7	63.3	70	69.2	59.9	48	37.3	30.6					
	Min.	24.9	28	31.8	37.1	43.6	50.1	55.1	54.6	46.6	37.4	31	25.2					
Mt Spokane Summit	Max.	23.1	27.6	30.3	38.2	49	57.4	66.5	66	56.4	43.1	32.5	26.4	43	25.7	39.1	63.3	44
	Mean	18.1	22.8	24.8	31.7	41.9	49.3	57.8	57.5	48.7	37	27.5	21.6	36.6	20.8	32.8	54.9	37.7
	Min.	13.1	18.4	19.4	24.9	35	41.1	49.3	48.8	40.9	30.8	22.5	16.9	30.1	16.1	26.4	46.4	31.4
Newport	Max.	31.6	38.6	48.4	59.5	69.2	75.8	85.2	84.4	73.9	58.4	40.8	33.2	58.3	34.5	59	81.8	57.7
	Mean	24.7	29.8	37.1	45.3	53.6	59.9	65.8	64.4	56.2	45.4	34	27.4	45.3	27.3	45.3	63.3	45.2
	Min.	17.9	20.9	25.6	31.1	38	43.9	46.3	44.4	38.4	32.5	27.3	21.7	32.3	20.2	31.6	44.8	32.7
Spokane	Max.	34.5	42.5	49.6	59.2	68.8	76.8	85.8	84.5	74.4	60.3	44	37.1	59.8	38	59.2	82.3	59.6
	Mean	29.3	35.6	40.4	48	56.5	64	70.9	69.6	60.8	49.4	37.8	32.1	49.5	32.3	48.3	68.2	49.3
	Min.	23.9	28.8	31.2	36.8	44.3	51.2	56	54.7	47.2	38.4	31.5	27.2	39.3	26.6	37.4	54	39.1
Spokane International Airport	Max.	32.9	39.1	48.2	58.3	67.1	74.3	83.9	82.7	72.5	59.3	43	34.8	58	35.6	57.9	80.3	58.2
	Mean	27.2	32.1	39.4	47.4	55.4	62.2	69.8	68.6	59.5	48.5	36.5	29.6	48	29.6	47.4	66.9	48.2
	Min.	21.5	25.2	30.5	36.5	43.7	50.1	55.8	54.5	46.6	37.7	30.1	24.4	38	23.7	36.9	53.5	38.1

TABLE 4.2

Land Use in WRIA 55

	SPOKANE COUNTY			STEVENS COUNTY			PEND OREILLE COUNTY			TOTALS	
	Acres in WRIA	% County	% of WRIA	Acres in WRIA	% County	% of WRIA	Acres in WRIA	% County	% of WRIA	Acres	% of WRIA
Totals:	**266,959**	**100**	**62**	**57,726**	**99**	**13**	**107,655**	**100**	**25**	**432,340**	**100**
1 - URBAN OR BUILT UP LAND											
11 Residential	12,562	4.71	2.90	221	0.38	0.05	1,613	1.50	0.37	14,396	3.33
12 Commercial	1,801	0.67	0.42	12	0.02	0.00	125	0.12	0.03	1,938	0.45
13 Industrial	834	0.31	0.19	0	0.00	0.00	12	0.01	0.00	846	0.20
14 Transportation, Communications	978	0.37	0.23	15	0.03	0.00	0	0.00	0.00	992	0.23
15 Industrial & Commercial	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00
16 Mixed Urban or Built-Up Land	188	0.07	0.04	0	0.00	0.00	224	0.21	0.05	412	0.10
17 Other Urban or Built-Up Land	596	0.22	0.14	0	0.00	0.00	0	0.00	0.00	596	0.14
Totals	**16,959**	**6.35**	**3.92**	**247**	**0.42**	**0.06**	**1,974**	**1.83**	**0.46**	**19,181**	**4.43**
2 - AGRICULTURAL LAND											
21 Cropland and Pasture	85,729	32.11	19.80	13,990	24.01	3.23	7,264	6.75	1.68	106,983	24.71
22 Orchards, Groves, Vineyards, Nurseries	562	0.21	0.13	0	0.00	0.00	0	0.00	0.00	562	0.13
23 Confined Feeding Operations	31	0.01	0.01	0	0.00	0.00	0	0.00	0.00	31	0.01
24 Other Agricultural Land	1,372	0.51	0.32	402	0.69	0.09	943	0.88	0.22	2,717	0.63
Totals	**87,693**	**32.85**	**20.26**	**14,392**	**24.70**	**3.32**	**8,208**	**7.62**	**1.90**	**110,293**	**25.48**
3 - RANGELAND											
31 Herbaceous Rangeland	4,344	1.63	1.00	688	1.18	0.16	966	0.90	0.22	5,997	1.39
32 Shrub and Brush Rangeland	74	0.03	0.02	0	0.00	0.00	0	0.00	0.00	74	0.02
33 Mixed Rangeland	106	0.04	0.02	0	0.00	0.00	214	0.20	0.05	321	0.07
Totals	**4,523**	**1.69**	**1.04**	**688**	**1.18**	**0.16**	**1,180**	**1.10**	**0.27**	**6,391**	**1.48**
4 - FOREST LAND											
41 Deciduous Forest Land	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00
42 Evergreen Forest Land	155,438	58.23	35.91	42,184	72.40	9.74	94,429	87.72	21.81	292,051	67.47
43 Mixed Forest Land	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00
Totals	**155,438**	**58.23**	**35.91**	**42,184**	**72.40**	**9.74**	**94,429**	**87.72**	**21.81**	**292,051**	**67.47**
5 - WATER											
51 Streams and Canals	79	0.03	0.02	2	0.00	0.00	0	0.00	0.00	82	0.02
52 Lakes	62	0.02	0.01	83	0.14	0.02	1,644	1.53	0.38	1,789	0.41
53 Reservoirs	597	0.22	0.14	0	0.00	0.00	29	0.03	0.01	627	0.14
54 Bays and Estuaries	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00
Totals	**739**	**0.28**	**0.17**	**86**	**0.15**	**0.02**	**1,673**	**1.55**	**0.39**	**2,498**	**0.58**
6 - WETLAND											
61 Forested Wetlands	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00
62 Unforested Wetlands	983	0.37	0.23	0	0.00	0.00	40	0.04	0.01	1,023	0.24
Totals	**983**	**0.37**	**0.23**	**0**	**0.00**	**0.00**	**40**	**0.04**	**0.01**	**1,023**	**0.24**
7 - BARREN LAND											
71 Dry Salt Flats	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00
72 Beaches	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00
73 Sandy Areas Other Than Beaches	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00
74 Bare Exposed Rock	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00
75 Strip Mines, Quarries & Gravel Pits	542	0.20	0.13	129	0.22	0.03	150	0.14	0.03	822	0.19
76 Transitional Areas	81	0.03	0.02	0	0.00	0.00	0	0.00	0.00	81	0.02
77 Mixed Barren Land	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00
Totals	**623**	**0.23**	**0.14**	**129**	**0.22**	**0.03**	**150**	**0.14**	**0.03**	**903**	**0.21**

Notes: % County = % of county area within WRIA 57
Land Use Classification Codes - First and Second Level Categories
Data Source - USGS Land Use and Land Cover 1:250,000 Scale

TABLE 4.3

Land Use in WRIA 57

	SPOKANE COUNTY			PEND OREILLE COUNTY			TOTALS	
	Acres in WRIA	% County	% of WRIA	Acres in WRIA	% County	% of WRIA	Acres	% WRIA
Totals:	**169,632**	**100**	**92.57**	**13,622**	**100**	**7.43**	**183,254**	**100**
1 - URBAN OR BUILT UP LAND								
11 Residential	27,505	16.21	15.01	51	0.37	0.03	27,555	15.04
12 Commercial	4,761	2.81	2.60	0	0.00	0.00	4,761	2.60
13 Industrial	6,083	3.59	3.32	0	0.00	0.00	6,083	3.32
14 Transportation, Communications	1,490	0.88	0.81	0	0.00	0.00	1,490	0.81
15 Industrial & Commercial	0	0.00	0.00	0	0.00	0.00	0	0.00
16 Mixed Urban or Built-Up Land	58	0.03	0.03	69	0.51	0.04	127	0.07
17 Other Urban or Built-Up Land	2,301	1.36	1.26	0	0.00	0.00	2,301	1.26
TOTALS	**42,198**	**24.88**	**23.03**	**120**	**0.88**	**0.07**	**42,318**	**23.09**
2 - AGRICULTURAL LAND								
21 Cropland and Pasture	28,597	16.86	15.61	704	5.17	0.38	29,301	15.99
22 Orchards, Groves, Vineyards, Nurseries	71	0.04	0.04	0	0.00	0.00	71	0.04
23 Confined Feeding Operations	0	0.00	0.00	0	0.00	0.00	0	0.00
24 Other Agricultural Land	150	0.09	0.08	143	1.05	0.08	294	0.16
Totals	**28,818**	**16.99**	**15.73**	**847**	**6.22**	**0.46**	**29,665**	**16.19**
3 - RANGELAND								
31 Herbaceous Rangeland	1,358	0.80	0.74	878	6.45	0.48	2,236	1.22
32 Shrub and Brush Rangeland	670	0.39	0.37	0	0.00	0.00	670	0.37
33 Mixed Rangeland	599	0.35	0.33	0	0.00	0.00	599	0.33
Totals	**2,626**	**1.55**	**1.43**	**878**	**6.45**	**0.48**	**3,505**	**1.91**
4 - FOREST LAND								
41 Deciduous Forest Land	0	0.00	0.00	0	0.00	0.00	0	0.00
42 Evergreen Forest Land	93,477	55.11	51.01	11,713	85.99	6.39	105,191	57.40
43 Mixed Forest Land	0	0.00	0.00	0	0.00	0.00	0	0.00
Totals	**93,477**	**55.11**	**51.01**	**11,713**	**85.99**	**6.39**	**105,191**	**57.40**
5 - WATER								
51 Streams and Canals	0	0.00	0.00	0	0.00	0.00	0	0.00
52 Lakes	1,768	1.04	0.96	39	0.29	0.02	1,807	0.99
53 Reservoirs	0	0.00	0.00	0	0.00	0.00	0	0.00
54 Bays and Estuaries	0	0.00	0.00	0	0.00	0.00	0	0.00
Totals	**1,768**	**1.04**	**0.96**	**39**	**0.29**	**0.02**	**1,807**	**0.99**
6 - WETLAND								
61 Forested Wetlands	0	0.00	0.00	0	0.00	0.00	0	0.00
62 Unforested Wetlands	0	0.00	0.00	0	0.00	0.00	0	0.00
Totals	**0**	**0.00**	**0.00**	**0**	**0.00**	**0.00**	**0**	**0.00**
7 - BARREN LAND								
71 Dry Salt Flats	0	0.00	0.00	0	0.00	0.00	0	0.00
72 Beaches	0	0.00	0.00	0	0.00	0.00	0	0.00
73 Sandy Areas Other Than Beaches	0	0.00	0.00	0	0.00	0.00	0	0.00
74 Bare Exposed Rock	0	0.00	0.00	0	0.00	0.00	0	0.00
75 Strip Mines, Quarries & Gravel Pits	745	0.44	0.41	24	0.18	0.01	769	0.42
76 Transitional Areas	0	0.00	0.00	0	0.00	0.00	0	0.00
77 Mixed Barren Land	0	0.00	0.00	0	0.00	0.00	0	0.00
Totals	**745**	**0.44**	**0.41**	**24**	**0.18**	**0.01**	**769**	**0.42**

Notes: % County = % of county area within WRIA 57
Land Use Classification Codes - First and Second Level Categories
Data Source - USGS Land Use and Land Cover 1:250,000 Scale

Spokane County Soils

Map Unit Symbol	NRCS Map Unit Name	Slope, %	Hydrologic Group
AaA	Athena silt loam	0 to 5	B
AaC	Athena silt loam	5 to 30	B
AaD	Athena silt loam	30 to 55	B
AaE	Athena silt loam	55 to 70	B
AlC	Athena-Lance silt loams	0 to 30	B
AlD	Athena-Lance silt loams	30 to 55	B
BaB	Bernhill silt loam	0 to 20	B
BaC	Bernhill silt loam	20 to 30	B
BaD	Bernhill silt loam	30 to 55	B
BbB	Bernhill silt loam, moderately shallow	0 to 20	C
BbD	Bernhill silt loam, moderately shallow	30 to 55	C
BeB	Bernhill gravelly silt loam	0 to 20	B
BfB	Bernhill very stony silt loam	0 to 20	B
BfD	Bernhill very stony silt loam	20 to 55	B
BhD	Bernhill soils	20 to 55	B
BkC	Bernhill very rocky complex	0 to 30	D
BkD	Bernhill very rocky complex	30 to 55	D
BoB	Bong coarse sandy loam	0 to 8	A
BpB	Bong and Phoebe fine sandy loam	0 to 8	A
BrB	Bong and Phoebe coarse sandy loam	0 to 20	A
BrC	Bong and Phoebe coarse sandy loam	20 to 30	A
BsB	Bong and Phoebe loamy sand	0 to 20	A
BtB	Bonner silt loam	0 to 8	B
BuB	Bonner gravelly silt loam	0 to 20	B
BvB	Bonner loam	0 to 20	B
BwB	Bonner fine sandy loam	0 to 20	B
BxD	Brickel stony loam	20 to 55	C
By	Bridgeson silt loam		D
Bz	Bridgeson silt loam, drained		C
Ca	Caldwell silt loam		C
CeA	Cedonia silt loam	0 to 5	B
CeB	Cedonia silt loam	5 to 20	B
CeC3	Cedonia silt loam, severely eroded	20 to 30	B
CgB	Cheney gravelly silt loam	0 to 8	B
ChB	Cheney stony silt loam	0 to 20	B
CkC	Cheney very rocky complex	0 to 30	D
CmC	Cheney extremely rocky complex	0 to 30	D
CnB	Cheney & Uhlig silt loam	0 to 8	B
CoB	Cheney-Uhlig complex	0 to 8	B
CsA	Clayton fine sandy loam	0 to 5	B
CsB	Clayton fine sandy loam	5 to 20	B
CtA	Clayton loam	0 to5	B
CtB	Clayton loam	5 to 20	B
CuB	Clayton sandy loam	0 to 8	B
Cw	Cocolalla silty clay loam		D

Spokane County Soils

Map Unit Symbol	NRCS Map Unit Name	Slope, %	Hydrologic Group
Cy	Cocolalla silty clay loam, drained		C
DaA	Dearyton silt loam	0 to 5	C
DaB	Dearyton silt loam	5 to 20	C
DaC	Dearyton silt loam	20 to 40	C
DeB	Dearyton silt loam, thin solum variant	0 to 20	C
DrC	Dragoon silt loam	0 to 30	C
DsC	Dragoon stony silt loam	0 to 30	C
DsD	Dragoon stony silt loam	30 to 55	C
DvD	Dragoon very rocky complex	20 to 55	D
EkB	Eloika silt loam	0 to 20	B
ElC	Eloika very stony silt loam	0 to 30	B
ElD	Eloika very stony silt loam	30 to 55	B
Em	Emdent silt loam		D
FaB	Freeman silt loam	5 to 20	C
FaB3	Freeman silt loam, severely eroded	5 to 20	C
FaC3	Freeman silt loam, severely eroded	20 to 30	C
Fm	Fresh water marsh		D
GaC3	Garfield silty clay loam, severely eroded	0 to 30	C
GgA	Garrison gravelly loam	0 to 5	B
GgB	Garrison gravelly loam	5 to 20	B
GmB	Garrison very gravelly loam	0 to 8	B
GnB	Garrison very stony loam	0 to 20	B
GpA	Glenrose silt loam	0 to 5	B
GpB	Glenrose silt loam	5 to 20	B
GpC	Glenrose silt loam	20 to 30	B
GpD	Glenrose silt loam	30 to 55	B
GrB	Glenrose gravelly silt loam	5 to 20	B
GrD	Glenrose gravelly silt loam	20 to 55	B
GsD	Glenrose stony silt loam	20 to 55	B
GtA	Green Bluff silt loam	0 to 5	B
GtB	Green Bluff silt loam	5 to 20	B
HfC	Hagen loamy fine sand	0 to 30	A
HgB	Hagen sandy loam	0 to 20	A
HhA	Hardesty silt loam	0 to 5	B
HmA	Hardesty silt loam moderately shallow	0 to 5	C
HnB	Hesseltine silt loam	0 to 10	B
HoB	Hesseltine silt loam, moderately deep	0 to 8	B
HrB	Hesseltine gravelly silt loam	0 to 10	B
HsB	Hesseltine stony silt loam	0 to 20	B
HtB	Hesseltine stony silt loam, mounded	0 to 8	B
HvC	Hesseltine very rocky comlex	0 to 30	D
HvD	Hesseltine very rocky comlex	30 to 55	D
HxC	Hesseltine extremely rocky comlex	0 to 30	D
Kc	Konner silty clay loam		D
Kd	Konner silty clay loam, drained		C

TABLE 4.4

Spokane County Soils

Map Unit Symbol	NRCS Map Unit Name	Slope, %	Hydrologic Group
LaB	Lakesol silt loam	0 to 20	B
LaD	Lakesol silt loam	20 to 55	B
LeA	Laketon silt loam	0 to 5	C
LeB	Laketon silt loam	5 to 20	C
LfA	Laketon fine sandy silt loam	0 to 5	C
LmC	Lance silt loam	0 to 30	B
LmC3	Lance silt loam, severely eroded	0 to 30	B
LnA2	Larkin silt loam, eroded	0 to 5	B
LnB2	Larkin silt loam, eroded	5 to 20	B
LnD2	Larkin silt loam, eroded	20 to 55	B
Lt	Latah silt loam		C
MaC	Marble loamy sand	0 to 30	A
MbC	Marble loamy coarse sand	0 to 30	A
McB	Marbe sandy loam	0 to 8	B
Md	Mondovy silt loam		B
MmC	Moscow silt loam	0 to 30	C
MmD	Moscow silt loam	30 to 55	C
MoC	Moscow silt loam, shallow	0 to 30	D
MoD	Moscow silt loam, shallow	30 to 55	D
MsC	Moscow very rocky complex	0 to 30	D
MsE	Moscow very rocky complex	30 to 70	D
NaA	Naff silt loam	0 to 5	B
NaA2	Naff silt loam, eroded	0 to 5	B
NaC	Naff silt loam	5 to 30	B
NaC2	Naff silt loam, eroded	5 to 30	B
NaC3	Naff silt loam, severely eroded	0 to 30	B
NaD2	Naff silt loam, eroded	30 to 45	B
NcA	Narcisse silt loam	0 to 5	B
NpA	Nez Perce silt loam	0 to 5	C
NpB	Nez Perce silt loam	5 to 20	C
NpB3	Nez Perce silt loam, severely eroded	5 to 20	C
PaB	Palouse silt loam, moderately shallow	0 to 20	C
PaC	Palouse silt loam, moderately shallow	20 to 30	C
PbC2	Palouse silt loam, eroded	5 to 30	B
PcC	Palouse very rocky complex	0 to 30	D
PcE	Palouse very rocky complex	30 to 70	D
PeA	Peone silt loam	0 to 5	D
PoA	Peone silt loam, drained	0 to 5	C
PsA	Phoebe sandy loam	0 to 5	B
PsB	Phoebe sandy loam	5 to 20	B
RdA	Reardon silt loam	0 to 5	C
RdB	Reardon silt loam	5 to 20	C
RdB2	Reardon silt loam, eroded	5 to 20	C
RdC2	Reardon silt loam, eroded	20 to 30	C
Rh	Riverwash		D

Spokane County Soils

Map Unit Symbol	NRCS Map Unit Name	Slope, %	Hydrologic Group
Ro	Rock outcrop		D
SaB	Schumacher silt loam	0 to 20	B
SaB2	Schumacher silt loam, eroded	0 to 20	B
SaC	Schumacher silt loam	20 to 30	B
SaC2	Schumacher silt loam, eroded	20 to 30	B
SaD	Schumacher silt loam	30 to 55	B
ScC	Schumacher gravelly silt loam	5 to 30	B
ScC2	Schumacher gravelly silt loam, eroded	5 to 30	B
ScD	Schumacher gravelly silt loam	30 to 55	B
ScD2	Schumacher gravelly silt loam, eroded	30 to 55	B
Se	Semiahmoo muck		D
Sk	Semiahmoo muck, drained		C
Sm	Semiahmoo muck, moderately shallow, drained		D
SnA	Snow silt loam	0 to 5	B
SnC	Snow silt loam	5 to 30	B
SoE	Speigle very stony silt loam	30 to 70	B
SpC	Spokane loam	0 to 30	C
SpD	Spokane loam	30 to 55	C
SrC	Spokane stony loam	0 to 30	C
SrE	Spokane stony loam	30 to 70	C
SsC	Spokane complex	0 to 30	C
SsE	Spokane complex	30 to 70	C
StC	Spokane very rocky complex	0 to 30	D
StE	Spokane very rocky complex	30 to 70	D
SuE	Spokane extremely rocky complex	20 to 70	D
SwB	Springdale gravelly sandy loam	0 to 20	A
SxB	Springdale gravelly sandy loam, deep	0 to 20	A
SyB	Springdale cobbly sandy loam	0 to 20	A
SzE	Springdale gravelly loamy sand	30 to 70	A
TeB	Tekoa gravelly silt loam	5 to 20	B
TeC	Tekoa gravelly silt loam	20 to 30	B
TeD	Tekoa gravelly silt loam	30 to 55	B
TkD	Tekoa very rocky complex	25 to 55	D
UhA	Uhlig silt loam	0 to 5	B
UhB	Uhlig silt loam	5 to 20	B
UmC	Uhlig silt loam, moderately shallow	5 to 30	B
VaC	Vassar silt loam	0 to 30	B
VaD	Vassar silt loam	30 to 55	B
VsD	Vassar very rocky silt loam	20 to 55	B
We	Wethey loamy sand		C
Wh	Wethey loamy sand, drained		B
Wo	Wolfeson very fine sandy loam		C

Stevens County Soils

Map Unit Symbol	NRCS Map Unit Name	Slope, %	Hydrologic Group
13	AQUOLLS, SLOPING		D
19	BERNHILL VERY STONY LOAM	0 to 40	B
21	BERNHILL SILT LOAM	0 to 15	B
22	BERNHILL SILT LOAM	15 to 25	B
23	BERNHILL SILT LOAM	25 to 40	B
23	BERNHILL SILT LOAM	25 to 40	B
24	BERNHILL SILT LOAM	40 to 65	B
25	BERNHILL-ROCK OUTCROP COMPLEX	0 to 25	D
26	BERNHILL-ROCK OUTCROP COMPLEX	25 to 60	D
27	BESTROM SILT LOAM	0 to 15	B
28	BESTROM SILT LOAM	15 to 25	B
29	BESTROM SILT LOAM	25 to 40	B
30	BISBEE LOAMY FINE SAND	0 to 15	A
35	BONNER SILT LOAM	0 to 10	B
38	BRICKEL STONY LOAM	20 to 60	B
39	BRIDGESON SILT LOAM		D
40	BRIDGESON SILT LOAM, DRAINED		C
46	CEDONIA SILT LOAM	5 to 15	B
56	CLAYTON FINE SANDY LOAM	0 to 5	B
57	CLAYTON FINE SANDY LOAM	5 to 15	B
60	DART LOAMY COARSE SAND	0 to 8	A
61	DEARYTON SILT LOAM	0 to 5	C
62	DEARYTON SILT LOAM	5 to 15	C
80	ELOIKA SILT LOAM	0 to 15	B
82	ELOIKA VERY STONY SILT LOAM	25 to 40	B
88	HAGEN SANDY LOAM	0 to 15	B
90	HARDESTY SILT LOAM		B
91	HARTILL SILT LOAM	0 to 15	B
92	HARTILL SILT LOAM	15 to 25	B
93	HARTILL SILT LOAM	25 to 40	B
94	HARTILL SILT LOAM	40 to 65	B
98	HISTOSOLS, PONDED		D
121	KONNER SILTY CLAY LOAM		D
122	KONNER SILTY CLAY LOAM, DRAINED		C
126	LAKETON SILT LOAM	0 to 5	C
127	LAKETON SILT LOAM	5 to 15	C
142	MARBLE LOAMY SAND	5 to 25	A
151	MOBATE GRAVELLY LOAM	0 to 30	D
152	MOBATE GRAVELLY LOAM	30 to 65	D
159	MOSCOW SILT LOAM	0 to 25	B
160	MOSCOW SILT LOAM	25 to 40	B
161	MOSCOW SILT LOAM	40 to 65	B
162	MOSCOW-ROCK OUTCROP COMPLEX	0 to 30	D

TABLE 4.5

Stevens County Soils

Map Unit Symbol	NRCS Map Unit Name	Slope, %	Hydrologic Group
163	MOSCOW-ROCK OUTCROP COMPLEX	30 to 65	D
164	NARCISSE SILT LOAM		C
172	PEONE SILT LOAM		D
173	PEONE SILT LOAM, DRAINED		C
176	RAISIO SHALY LOAM	0 to 20	B
177	RAISIO SHALY LOAM	20 to 40	B
178	RAISIO SHALY LOAM	40 to 65	B
195	ROCK OUTCROP-MOSCOW COMPLEX	30 to 65	D
196	ROCK OUTCROP-SPOKANE COMPLEX	30 to 65	D
201	SALTESE MUCK		D
202	SALTESE MUCK, DRAINED		D
209	SKANID LOAM	0 to 25	D
210	SKANID LOAM	25 to 40	D
211	SKANID LOAM	40 to 65	D
218	SPOKANE LOAM	0 to 25	B
219	SPOKANE LOAM	25 to 40	B
220	SPOKANE LOAM	40 to 65	B
221	SPOKANE STONY LOAM	0 to 40	B
222	SPOKANE STONY LOAM	40 to 65	B
223	SPOKANE-ROCK OUTCROP COMPLEX	0 to 40	D
224	SPOKANE-ROCK OUTCROP COMPLEX	40 to 65	D
238	VASSAR SILT LOAM	30 to 65	B
247	WOLFESON VERY FINE SANDY LOAM		C

Pend Oreille County Soils

Map Unit Symbol	NRCS Map Unit Name	Slope, %	Hydrologic Group
4	Aits loam high precipitation 0 to 15 percent slopes	0 to 15	B
5	Aits loam high precipitation 15 to 25 percent slopes	15 to 25	B
6	Aits loam high precipitation 25 to 40 percent slopes	25 to 40	B
7	Aits loam high precipitation 40 to 65 percent slopes	40 to 65	B
8	Aits stony loam high precipitation 0 to 40 percent slopes	0 to 40	B
9	Aits stony loam high precipitation 40 to 65 percent slopes	40 to 65	B
10	Aits high precipitation - Rock outcrop complex 0 to 40 percent slopes	0 to 40	D
11	Aits high precipitation - Rock outcrop complex 40 to 65 percent slopes	40 to 65	D
14	Aquolls silt loam 0 to 7 percent slopes	0 to 7	D
19	Blueslide silt loam		D
20	Bonner silt loam 0 to 10 percent slopes	0 to 10	B
21	Bonner gravelly silt loam 0 to 10 percent slopes	0 to 10	B
22	Borosaprists ponded		D
25	Brickel stony loam 20 to 60 percent slopes	20 to 60	C
27	Buhrig very stony loam 25 to 40 percent slopes	25 to 40	C
28	Buhrig very stony loam 40 to 65 percent slopes	40 to 65	C
29	Buhrig - Rock outcrop complex 25 to 40 percent slopes	25 to 40	D
30	Buhrig - Rock outcrop complex 40 to 65 percent slopes	40 to 65	D
31	Clayton fine sandy loam 0 to 5 percent slopes	0 to 5	B
32	Clayton fine sandy loam 5 to 15 percent slopes	5 to 15	B
38	Cusick silt clay loam		D
39	Dalkena fine sandy loam 0 to 7 percent slopes	0 to 7	C
40	Dalkena fine sandy loam 7 to 15 percent slopes	7 to 15	C
41	Dalkena fine sandy loam 15 to 25 percent slopes	15 to 25	C
42	Dalkena fine sandy loam 25 to 40 percent slopes	25 to 40	C
43	Dufort silt loam 0 to 15 percent slopes	0 to 15	B
44	Dufort very stony silt loam 0 to 40 percent slopes	0 to 40	B
45	Eloika silt loam 0 to 15 percent slopes	0 to 15	B
46	Hartill silt loam 0 to 15 percent slopes	0 to 15	C
47	Hartill silt loam 15 to 25 percent slopes	15 to 25	C
48	Hartill silt loam 25 to 40 percent slopes	25 to 40	C
49	Hartill silt loam 40 to 65 percent slopes	40 to 65	C
50	Hartill - Rock outcrop complex 40 to 65 percent slopes	40 to 65	D
51	Hoodoo silt loam		D
53	Huckleberry silt loam 40 to 65 percent slopes	40 to 65	C
54	Huckleberry - Rock outcrop complex 25 to 65 percent slopes	25 to 65	D
56	Inkler gravelly silt loam 20 to 40 percent slopes	20 to 40	B
58	Inkler - Rock outcrop complex 20 to 40 percent slopes	20 to 40	D
59	Inkler - Rock outcrop complex 40 to 65 percent slopes	40 to 65	D
60	Kaniksu sandy loam 0 to 15 percent slopes	0 to 15	B
61	Kaniksu sandy loam 15 to 45 percent slopes	15 to 45	B
62	Kegel loam		D
63	Kiehl gravelly silt loam 0 to 10 percent slopes	0 to 10	B
70	Martella silt loam 0 to 5 percent slopes	0 to 5	C
72	Martella silt loam 15 to 25 percent slopes	15 to 25	C

Pend Oreille County Soils

Map Unit Symbol	NRCS Map Unit Name	Slope, %	Hydrologic Group
74	Merkel stony sandy loam 0 to 40 percent slopes	0 to 40	B
76	Merkel - Rock outcrop complex 10 to 65 percent slopes	10 to 65	B
77	Mobate - Rock outcrop complex 0 to 40 percent slopes	0 to 40	D
78	Mobate - Rock outcrop complex 40 to 65 percent slopes	40 to 65	D
79	Moscow silt loam 0 to 25 percent slopes	0 to 25	C
80	Moscow silt loam 25 to 40 percent slopes	0 to 25	C
81	Moscow silt loam 40 to 65 percent slopes	40 to 65	C
82	Moscow - Rock outcrop complex 0 to 40 percent slopes	0 to 40	D
83	Moscow - Rock outcrop complex 40 to 65 percent slopes	40 to 65	D
84	Moso silt loam 0 to 25 percent slopes	0 to 25	B
85	Moso silt loam 25 to 40 percent slopes	25 to 40	B
86	Newbell silt loam 0 to 25 percent slopes	0 to 25	B
87	Newbell silt loam 25 to 40 percent slopes	25 to 40	B
88	Newbell silt loam 40 to 65 percent slopes	40 to 65	B
89	Newbell stony silt loam 0 to 40 percent slopes	0 to 40	B
90	Newbell stony silt loam 40 to 65 percent slopes	40 to 65	B
91	Newbell very bouldery silt loam 25 to 40 percent slopes	25 to 40	B
93	Newbell - Rock outcrop complex 15 to 40 percent slopes	15 to 40	D
94	Newbell - Rock outcrop complex 40 to 65 percent slopes	40 to 65	D
97	Orwig sandy loam 0 to 20 percent slopes	0 to 20	B
98	Orwig sandy loam 20 to 65 percent slopes	20 to 65	B
99	Pits		
104	Pywell much		D
105	Raisio channery loam 10 to 40 percent slopes	10 to 40	C
106	Raisio channery loam 40 to 65 percent slopes	40 to 65	C
107	Raisio - Rock outcrop complex 25 to 40 percent slopes	25 to 40	D
108	Raisio - Rock outcrop complex 40 to 65 percent slopes	40 to 65	D
109	Rathdrum very fine sandy loam		B
110	Riverwash		D
113	Rock outcrop		D
114	Rock outcrop - Aits high precipitation complex 30 to 65 percent slopes	30 to 65	D
115	Rock outcrop - Huckleberry complex 30 to 65 percent slopes	30 to 65	D
117	Rock outcrop - Moscow complex 30 to 65 percent slopes	30 to 65	D
118	Rock outcrop - Newbell complex 30 to 65 percent slopes	30 to 65	D
119	Rock outcrop -Orthents complex 50to 90 percent slopes	50 to 90	D
121	Rock outcrop - Usk complex 30 to 65 percent slopes	30 to 65	D
122	Rubbleland		A
123	Rufus channery loam 30 to 65 percent slopes	30 to 65	D
124	Rufus - Rock outcrop complex 30 to 65 percent slopes	30 to 65	D
125	Sacheen loamy fine sand 5 to 15 percent slopes	5 to 15	A
126	Sacheen loamy fine sand 15 to 25 percent slopes	15 to 25	A
129	Scotia fine sandy loam 7 to 15 percent slopes	7 to 15	B
130	Scotia fine sandy loam 15 to 25 percent slopes	15 to 25	B
134	Skanid - Rock outcrop complex 0 to 40 percent slopes	0 to 40	D
135	Skanid - Rock outcrop complex 40 to 65 percent slopes	40 to 65	D

Pend Oreille County Soils

Map Unit Symbol	NRCS Map Unit Name	Slope, %	Hydrologic Group
145	Typic Xerorthents 30 to 65 percent slopes	30 to 65	B
146	Uncas muck		D
148	Usk loam 0 to 20 percent slopes	0 to 20	C
149	Usk loam 20 to 40 percent slopes	20 to 40	C
150	Usk loam 40 to 65 percent slopes	40 to 65	C
151	Usk stony loam 0 to 40 percent slopes	0 to 40	C
152	Usk - Rock outcrop complex 0 to 40 percent slopes	0 to 40	D
153	Usk - Rock outcrop complex 40 to 65 percent slopes	40 to 65	D
154	Vassar silt loam 30 to 65 percent slopes	30 to 65	B
155	Vassar silt loam shaly substratum	30 to 65	B

TABLE 4.7

Distribution of Soil Types Classified by NRCS Hydrologic Code

WRIA 55 (includes areas of Spokane, Stevens and Pend Oreille Counties)

	Acres	% WRIA 55
Total acres in WRIA 55 =	432,619	100%
Spokane County Acres =	265,667	61%
Pend Oreille County Acres =	108,025	25%
Stevens County Acres =	58,927	14%

County	NRCS Soil Hydrologic Group								Open Water	
	Group A		Group B		Group C		Group D			
	Acres	% WRIA	Acres	% WRIA	Acres	% WRIA	Acres	% WRIA	Acres	% WRIA
Spokane	27,944	6.46	139,947	32.35	68,560	15.85	28,330	6.55	887	0.20
Stevens	96	0.02	46,982	10.86	2,980	0.69	8,789	2.03	80	0.02
Pend Oreille	5,814	1.34	38,715	8.95	23,736	5.49	38,107	8.81	1,622	0.38
Total	33,854	7.83	225,644	52.16	95,275	22.02	75,225	17.39	2,589	0.60

WRIA 57 (includes areas of Spokane and Pend Oreille Counties)

	Acres	% WRIA 57
Total acres in WRIA 57 =	181,953	100%
Spokane County Acres =	168,501	93%
Pend Oreille County Acres =	13,452	7%

County	NRCS Soil Hydrologic Group								Open Water	
	Group A		Group B		Group C		Group D			
	Acres	% WRIA	Acres	% WRIA	Acres	% WRIA	Acres	% WRIA	Acres	% WRIA
Spokane	7,999	4.40	80,682	44.34	58,321	32.05	18,948	10.41	2,540	1.40
Pend Oreille	2,416	1.33	4,677	2.57	3,715	2.04	2,574	1.41	70	0.04
Total	10,415	5.72	85,359	46.91	62,036	34.09	21,522	11.83	2,611	1.43