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RESIDENTIAL SUBDIVISIONS AND WATER POLLUTION POTENTIAL, NORTHERN RAVALLI COUNTY, MONTANA

by

Elizabeth A. Bock

B.A., Iowa State University, 1987

Presented in partial fulfillment of the requirements for the degree of

Master of Arts

UNIVERSITY OF MONTANA

1997

Approved by:

Chairman, Board of Examiners

Dean, Graduate School

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Bock, Elizabeth A., M.A., May 1997 Geography

Water Pollution Potential and the Site Suitability of Residential Subdivisions, Northern Ravalli County, Montana (136 pp.)

Director: Darshan S. Kang DK

The subdividing of agricultural or forested land into smaller residential lots may increase the potential for water pollution. House and road construction add to the amount of impermeable ground in an area, leading to increased runoff and stream sedimentation. The use of septic tanks and drainfields may chemically pollute either the ground or surface water, depending on system placement. To prevent these as well as other degrading situations, residential subdivisions should ideally occur in those areas with the least potential for water pollution. The locations of residentially-subdivided lots are analyzed temporally with respect to water pollution potential in a portion of northern Ravalli County for the years 1967 to 1996 to determine if lot occurrences are increasing or decreasing in pollution-sensitive areas.

Water pollution potential is estimated for quarter-section (160 acre) areal units by using a classification and rating approach similar to the DRASTIC model devised by the U.S. Environmental Protection Agency. Six individual site factors are analyzed as to their relative water pollution potential, and areal units are given a value between one and ten, depending on the magnitude of that potential. The six factors used are: topography, soil texture, parent material texture, distance to surface water, distance to the 100-year flood plain, and distance to ground water. A total suitability map is derived by summing the values of all site factors in each areal unit. Units having the highest scores represent those locations with the highest water pollution potential and therefore are considered unsuitable for the location of residential subdivisions.

Actual subdivided lot locations are mapped for the study area, following the quarter-section areal unit boundaries. Subdivision characteristics that best represent development include the number of lots and the average lot size within each areal unit. These characteristics are analyzed for each of three 10-year study intervals (1967 to 1976, 1977 to 1986, and 1987 to 1996).

Pearson's and Spearman's correlation coefficients are used to relate subdivision variables to a unit's development suitability score (the total water pollution potential value). The direction and intensity of each coefficient are compared through time. Little significance exists between variables for each of the three study periods. There is also little correlation that exists between subdivision variables and each of the six site factors. A slight decrease in unsuitable lot locations is found over time, but the insignificance of the coefficients makes it difficult to state this improvement in lot location with confidence.

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Many different people guided me from their offices within the confines of the Ravalli County Courthouse. I would especially like to acknowledge Betty Lund in the Clerk and Recorder's Office and Jake Kammerer in the Sanitarian's Office for their expertise and assistance in accessing subdivision plats, certificates, and other pertinent reference material.

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CHAPTER 1

INTRODUCTION

The division of land for residential purposes is a common aspect of growing societies. Fragmentation changes large tracts of land into smaller lots, and as the population increases in an area, the creation of new lots provides a place to locate additional homes. Often, these lots are divided repeatedly as the population continues to grow.

Many environmental concerns result from subdividing land into residential lots. This study concentrates on those issues related to water quality. For example, the use of septic tanks and domestic wells heighten the potential for chemical contamination to reach the ground water. Housing construction, road construction, and the development of lots into lawns result in accelerated rates of surface runoff and soil erosion. To preserve water quality, residential development should avoid areas most sensitive to water pollution. Once these areas are identified, it is possible to analyze whether residential subdivisions[1] are spreading into more suitable or less-than-suitable locations.

---

[1] In this study, a "residential subdivision" is a real-estate transaction that divides land into one or more parcels, when the size of each parcel is twenty acres or less.

Ravalli County, located in southwestern Montana, is a region that is experiencing the effects of residential growth. Between 1970 and 1995, the population increased by 124 percent, making Ravalli County the most rapidly-growing county in the state during this period (U.S. Bureau of the Census, 1995). To accommodate the growing population, more and more agricultural land is being divided for residential purposes. Rural and suburban housing tracts are also extending into forested areas.

STUDY AREA

Ravalli County boundaries follow the divides of the Bitterroot Watershed, except for approximately 460 square miles at the downstream end (figure 1). The Bitterroot Valley is a scenic area that provides both recreational opportunity and easy accessibility to nearby cities and towns. Most of the valley residents enjoy a rural lifestyle, living outside of municipal boundaries. The aesthetic quality of Ravalli County assists in attracting new residents who value the Bitterroot River, its many tributary streams, and the surrounding mountain ranges. However, the landscape is susceptible to the degradation that is caused by increasing development in fragile areas. Some sites within the county may be unsuitable for residential development based on their high potential for water pollution.

The maintenance of high-quality water is important in Ravalli County, since surface water is the primary source for agricultural irrigation and ground water is the main source for all domestic uses. Many residents and government officials have voiced their anxiety over the extensive land fragmentation and development that

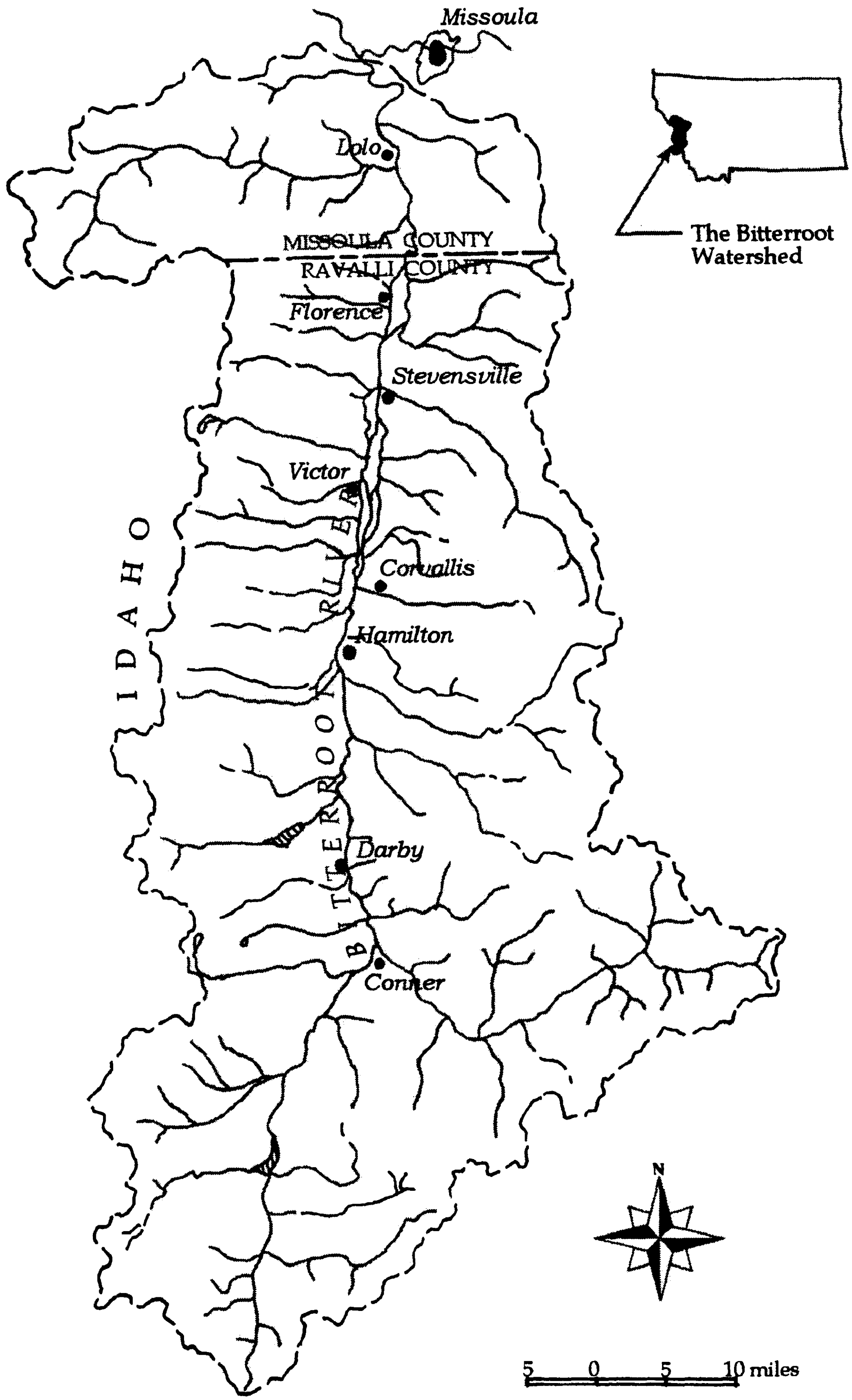

Figure 1. The Bitterroot Watershed setting.

took place during the 1970s, fearing that it would be the cause of widespread ground water contamination in the future (Ruffatto 1980, 78). There remains concern over the pace and extent of residential development on rural lands, fueled by knowledge of the environmental degradation that results from poorly planned subdivisions.

Because such a large number of subdivision transactions occurs yearly in Ravalli County, only a portion of the county is assessed in this study. Northern Ravalli County is the region identified as having the most population growth during the study period (Barton 1977, 9; Jackson and Wall 1995, 6). Therefore, the selected study area lies in the heart of this rapidly-growing region (figure 2). The study area cuts a transect from the Bitterroot Range to the Sapphire Range, including all privately-owned land. A transect oriented in this manner is representative of the full range of topography, hydrology, geology, and soils that exist within the Bitterroot Valley (further described in chapter 2). In this research, the study area is referred to as the "Victor Transect," since the town of Victor (SW 1/4, SEC 30, T8N, R20W) represents the largest population center in the area. Between 1970 and 1990, Victor grew in population from 420 to 500, a difference of only 80 persons (U.S. Bureau of the Census 1990). During this same period, over 400 subdivisions were recorded, creating almost 1,200 new lots. Many of these new lots exist in areas where the previous land uses were either agricultural or forestry-related.

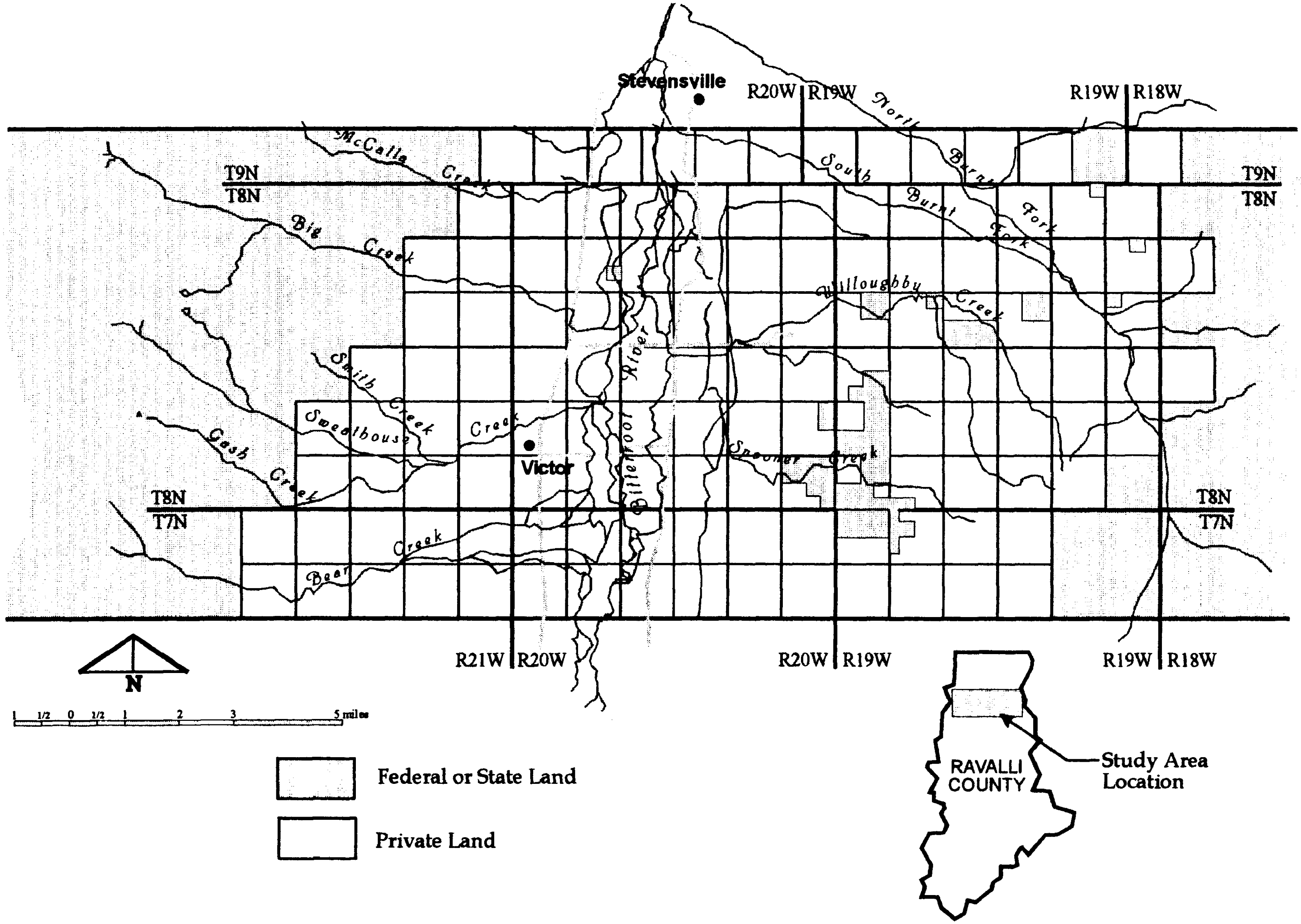

Figure 2. The Victor Transect Study Area.

OBJECTIVES

Since the population of Ravalli County continues to grow, and because existing water resources have a high value, it is important for future residential development to avoid areas that are extremely sensitive to water pollution. The intent of this research is to supplement the knowledge of land owners and developers in the area, as well as to increase general awareness about the potential of water pollution that may result from improper development.

There are three main objectives in this study:

1) Which locations within the study area are most likely to experience water quality degradation if developed residentially?

2) Which locations have experienced the greatest amount of residential subdivision between the years 1967 and 1996?

3) During this period, has the number of residential lots increased or decreased in locations sensitive to water quality degradation?

LITERATURE REVIEW

Literature related to this research generally involves either pollution potential identification techniques or residential location analysis. In addition to these subjects, regional geological and hydrological studies often describe the interrelationships of different physical attributes, which are useful in evaluating site sensitivity to water pollution.

Water Pollution Potential Studies

Many different techniques are used to investigate ground water pollution potential. The LeGrand System (LeGrand 1983) deals with the pollution sensitivity of waste disposal sites. To find the degree of site sensitivity, one must estimate the severity of waste contamination, and combine this knowledge with hydrological site parameters. The system utilizes site parameter classification and a numerical rating method.

Several pollution potential models have been developed by the U.S. Environmental Protection Agency. Most relevant to this study is the DRASTIC model, a standardized system that uses hydrogeological settings. A hydrogeological setting is a composite description of all the major geological and hydrological factors that affect and control ground water movement into and out of an area (U.S. Environmental Protection Agency 1987, 13). Similar to the LeGrand method, DRASTIC classifies and rates different location factors, which in this case include Depth to ground water, Recharge, Aquifer media, Soil media, Topography, Impact on the vadose zone media, and hydraulic Conductivity. Each factor also receives a weighted value that relates to its relative importance when compared to other factors. The product of ratings and weights determines each hydrogeological unit's cumulative pollution potential, with higher values representing a greater risk of ground water pollution.

A model devised by the Montana Department of Health and Environmental Sciences (1977) estimates the potential for surface and ground water pollution at thirty-two sites containing residential subdivisions. Fourteen of these sites are located in

Ravalli County. Subdivisions were selected that, at the time of the study, did not conform to Montana regulations (either flood plain, septic, or subdivision). The determination of pollution potential is accomplished by a numerical rating scheme similar to others mentioned, although non-empirical data, such as an area's "development potential," are also emphasized.

Residential Location Studies

A paper by David H. Jackson and Kenneth Wall (1995) identifies real estate characteristics and preferences for twenty-eight western Montana counties, including Ravalli County. In this paper, county townships are mapped according to land ownership, real estate sales, and construction records for the years 1990 to 1994. Another regional study done by Mike Barton (1977) contains information regarding the number, type, location, and availability of housing units, covering Mineral, Missoula, and Ravalli counties. Information is presented in summary format, either for counties as a whole or for major municipal areas within the three counties. There also exists a Ravalli County subdivision inventory, prepared by the Montana Department of Intergovernmental Relations (1973), which contains selected information concerning subdivision ownership, acreage, and lot density from 1957 to 1972.

RESEARCH DESIGN

This research deals with the separate analysis of both physical and cultural variables, and eventually, the synthesis of these variables. The procedure follows the order of the three main research objectives. First, an area's potential to experience water pollution--if residentially developed--is identified. This is followed by the identification of subdivided residential lots created within the study period of 1967 to 1996. Finally, statistical correlation is performed between an area's pollution potential and its number of subdivided lots, determining the site suitability of existing development, as well as distinguishing regional and temporal trends.

Individual areal units (also known as "operational taxonomic units" or "OTUs") are used in this research. Each areal unit equals one-quarter section, complying to the Bureau of Land Management township grid system (figure 3). There are 518 quarter sections in the Victor Transect study area that contain privately-owned land.

The complete research period, 1967 through 1996, is separated into three 10-year intervals for the purpose of identifying subdivision location trends over time:

Time interval 1 (T1) = 1967 to 1976
Time interval 2 (T2) = 1977 to 1986
Time interval 3 (T3) = 1987 to 1996

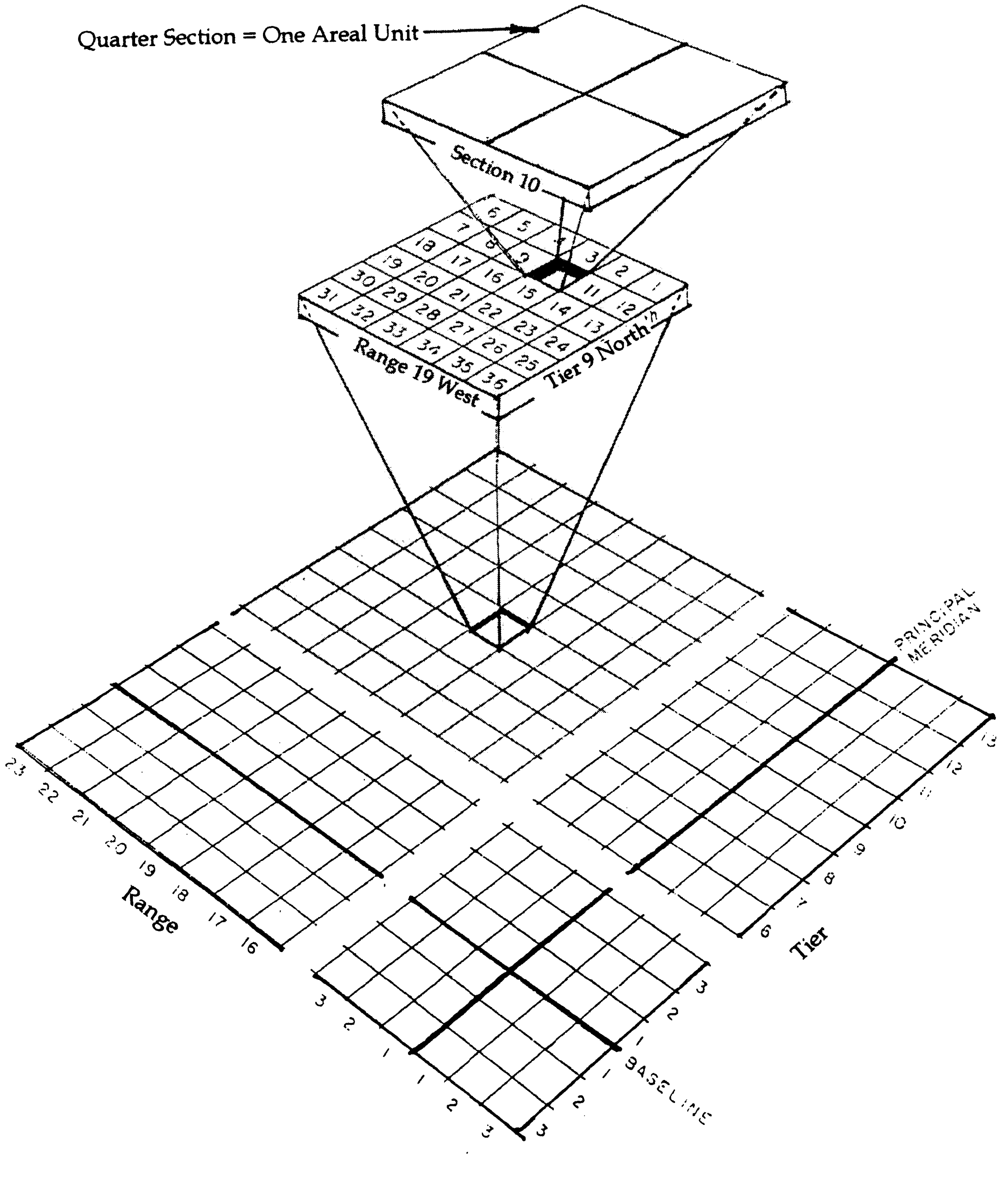

Figure 3. U.S. Bureau of Land Management land division system used in identifying areal units (McMurtrey et al 1972).

Pollution Potential Identification

The first objective of determining the location of development-sensitive areas is accomplished by developing a system for measuring surface and ground water pollution potential. The system measures and classifies site factors that have the ability to affect the magnitude of water pollution. Factor selection depends on both data availability (table 1) and mapping ability. This study uses the following site factors:

1. Topography (surface slope)
2. Soil texture
3. Parent material texture
4. Distance to surface water
5. Distance to the 100-year flood plain
6. Depth to ground water

Each site factor is measured (and averaged) in every quarter-section areal unit. Even though the factors are initially measured using different scales, they are eventually standardized by using a ranking scale of one to ten, with greater threats to water pollution receiving higher rankings. The sum of all site factor rankings represents the total pollution potential of each areal unit. The conversion of scores into an illustrative format (a map) helps in the identification of pollution-sensitive locations. Chapter 5 describes the detailed procedure for identifying residential development sensitivity.

Table 1. -- Available sources used in site factor measurement.

Site Parameter--------> Source	Topography (slope)	Soil Texture	Parent Material Texture	Distance to Surface Water	Distance to 100-year Flood Plain	Depth to Ground Water
State Department of Natural Resource Conservation					X	
U.S. Department of Agriculture, Soil Conservation Service		X	X			
U.S. Geological Survey Topographic Maps	X			X	X	
U.S. Geological Survey Water Supply Papers						X
Related Industry Studies (well drilling)			X			X
Graduate Theses						X

Subdivision Location Analysis

The second objective is to locate where residential subdivisions have taken place within the Victor Transect. The office of the Ravalli County Clerk and Recorder is the source of all recorded subdivision data. These data currently exist in either blueprint or microfiche format. All collected subdivision data are put into a spreadsheet format (appendix A). Subdivisions used in this research fall into one of the following three categories:

A. Platted Subdivisions

These require subdivision review and approval by the county before lot titles are transferred. A plat is drawn, showing the division of land into lots, blocks, alleys, streets, and parks. Platted subdivisions which create more than five new lots are classified as "major" subdivisions. Those with five or fewer lots are known as "minor" subdivisions, which undergo significantly less review than the larger subdivisions.

B. Amended Plats

These further divide existing platted subdivisions. In most cases, amended plats are minor subdivisions and are therefore exempt from most of the review process. However, a survey must be filed with the county recorder.

C. Certificate of Survey (COS)

This general category of exemptions embodies many types of land transactions and modifications. A COS does not always represent a division of land, but may document a boundary retracement or survey an existing lot. COS subdivisions do not require local government review, but a survey of boundaries must be filed. There are two types of COS exemptions that consistently represent a clear split of land. These are the "Occasional Sale" and the "Family Conveyance." Both types were analyzed for use in this study.

The use of areal mapping illustrates which locations contain the greatest amount of subdivided lots. Subdivision maps are found in chapter 6.

Variable Analyses

The use of statistical correlation coefficients determines the direction and the intensity of the relationship between the two variables (pollution potential ratings and subdivided lot occurrences). Pearson's *(r)* and Spearman's Rank (r_s) correlation methods are used to evaluate and compare results from the three time intervals in order to discover a trend over time. Further analysis between individual site factors and residential lots assists in the identification of spatial development trends, which may be caused by specific site characteristics.

This study aims for a regional context by examining spatial trends and patterns. It is important to note that not all subdivided lots undergo housing construction, and some lots may remain empty for an unspecified period. The analysis of subdivided lots does have an advantage over the analysis of individual houses, in that it provides a useful indicator of where future growth is likely to occur.

The following chapter summarizes the physical and cultural characteristics of the Victor Transect setting.

CHAPTER 2

PHYSICAL AND CULTURAL SETTING

The setting of the Bitterroot Watershed is such that a wide variety of natural conditions and human uses are present. Elevation differences range from 3,300 feet at the valley floor to 10,157 feet at Trapper Peak, located in the Bitterroot Range west of the valley. This range results in vertically separated ecosystems, from riparian flood plains and arid valley grasslands to mountain forests and high alpine lakes. The environmental health of the Bitterroot Valley is a reflection of all ecosystems reacting with one another at the watershed scale. It is therefore important to review the physical and cultural characteristics of this larger region that contains the study area.

GEOGRAPHICAL LOCATION

The Bitterroot Valley is an intermontane basin located in the Rocky Mountains of southwest Montana. The Bitterroot River drainage contains 2,850 square miles, of which 84 percent is located within Ravalli County (Nolan 1973, 1; Bitterroot Conservation District 1980, 2). The main valley is sixty-five miles long and ten miles wide at its widest part (U.S. Department of Agriculture 1959, 1). The broad, irregular flood plain of the Bitterroot River is bounded throughout most of its length by low terraces, which are in turn bounded by higher terrace remnants. The divide of the rugged Bitterroot Range comprises the western boundary, while the lower Sapphire Range lies to the east. Traversing the basin is the Bitterroot River, which originates in the southernmost areas of the county as the East and West Forks. The forks merge just north of the town of Connor, and from here, the river braids and meanders northward, discharging into the Clark Fork four miles west of Missoula.

The east-west extent of the Victor Transect extends from the foothills of the Sapphire Mountains to the Bitterroot Mountain foothills. However, only land that is privately owned is applicable to this research, since residential subdivision cannot occur on public land. The extreme eastern boundary of private land is located at SEC 7,T8N,R18W and the extreme western boundary occurs at SEC 8,T7N,R21W. The Transect's north-south extent matches the boundaries of U.S. Geological Survey 7 1/2 minute topographic quadrangles (SEC 1-12,T7N to SEC 31-35,T9N).

CLIMATE

The valley floor is characterized by relatively mild winters and cool summers, but large daily and seasonal fluctuations in temperature are common (McMurtrey et al. 1972, 21). The average annual precipitation varies from twelve inches in the valley to eighty inches at the peaks of the Bitterroot Mountains. About forty inches of precipitation falls on the peaks of the Sapphire Range (U.S. Department of Agriculture, 1995, 4). The maximum valley precipitation occurs during the spring, usually in May or June. Meanwhile, the maximum mountain precipitation occurs during the winter months of December and January. Two-thirds of the mountain precipitation forms as snowpack, to be delivered to the Bitterroot River each spring by way of tributary streams (Bitterroot Conservation District 1980, 10).

GEOLOGY

The Bitterroot Mountains, located on the west side of the valley, form the eastern boundary of the Idaho Batholith. They are composed of Cretaceous intrusive rocks, although some areas are pre-Cambrian quartzites and argillites of the Belt formation (McMurtrey et al. 1972, 33; U.S. Department of Agriculture 1995, 2). The Sapphire Mountains, found to the east of the valley, resemble a broad and dissected plateau. They are formed by sedimentary rocks of quartzite and calcium-silicates from the Belt formation (U.S. Department of Agriculture 1995, 3). The major structural trend of the valley was determined by block faulting. Subsequent erosion caused considerable amounts of Tertiary and Quaternary sediment accumulation on the valley floor (Nolan 1973, 3).

The flood plains of the Bitterroot River contain great amounts of alluvial deposits that are up to three miles wide and perhaps over 2,000 feet thick (U.S. Department of Agriculture 1959, 2). The alluvium is composed mainly of sand and gravel of mixed origin. Narrow strips of this material extend up the East and West Forks of the Bitterroot River and along some of the larger tributary streams.

The terraces along each side of the valley have been modified by dissection and aggradation, and are more visible in some areas than others. High terraces on the west side of the Bitterroot River are composed of unconsolidated alluvium, which overlay Tertiary deposits of poorly sorted, coarse, angular sand and gravel. In the study area, low terraces bordering the flood plain are composed of stream-deposited clay, silt, sand, gravel, and boulders reworked from older Cenozoic deposits (McMurtrey et al. 1972, 35). High terraces east of the Bitterroot River consist of exposed semi-consolidated Tertiary deposits (McMurtrey et al, 1972, 39). They tend to have a more uniform topography than west-side terraces. Figure 4 illustrates the generalized geology of the Victor Transect study area.

HYDROLOGY

The main drainage system in the basin is the Bitterroot River, which receives runoff from forty-eight subwatersheds (Senger 1975, 83). Total inflow to the Bitterroot from tributaries averages 1,462 cubic feet per second throughout the year, of which 80 percent comes from streams located on the west side of the valley. (McMurtrey et al. 1959). The Bitterroot is a dynamic river, which shifts in its bed every spring during high water flows. Over much of the watershed, soils have washed down from higher elevations and accumulated in the valley. Where excess sediments exist, stream flow is restricted and instability results. The Bitterroot River has deposited large volumes of sediments along much of its banks, but the sedimentation problem is most apparent between Corvallis and Stevensville (Cartier 1984, 2).

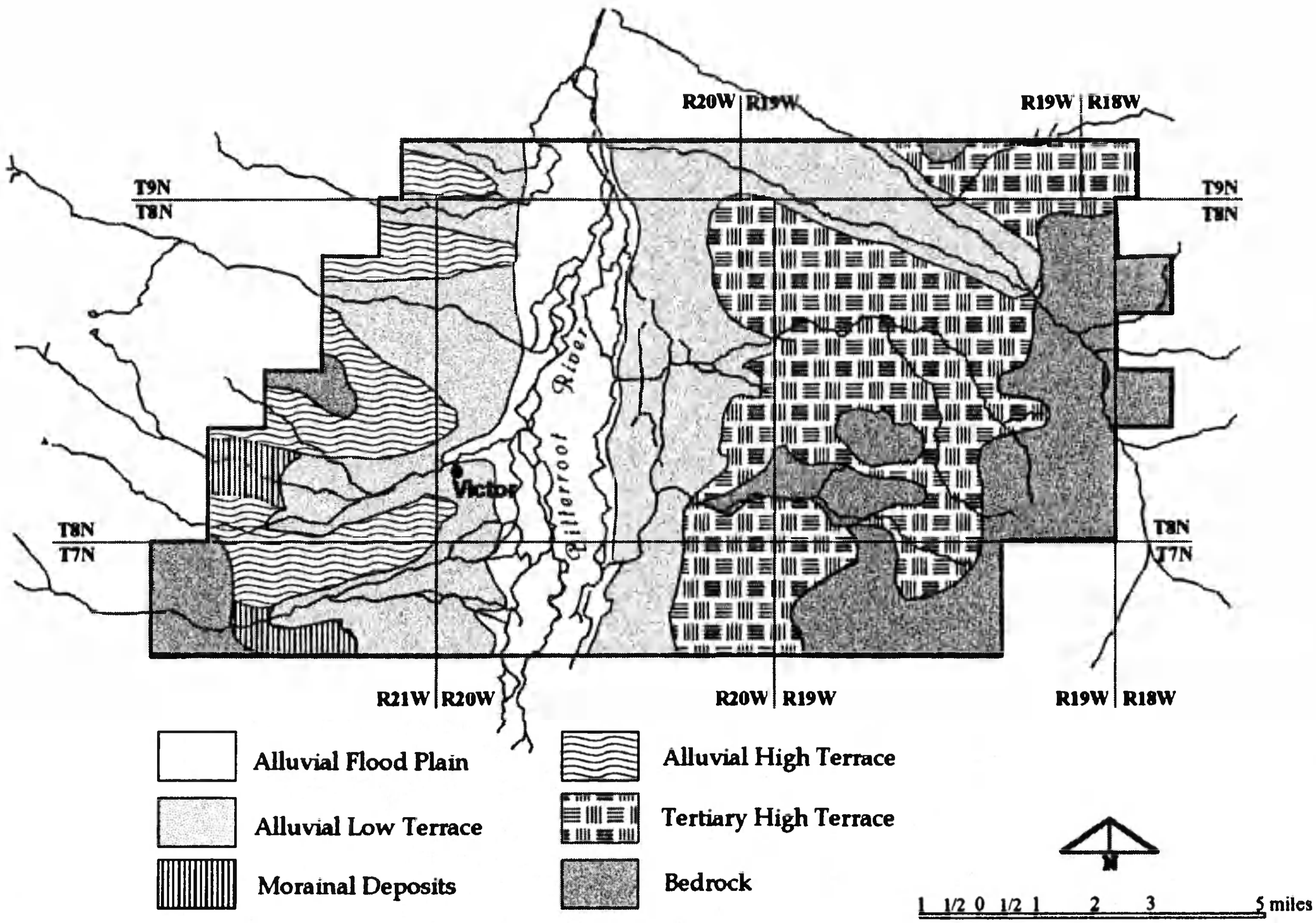

Figure 4. Generalized geology of the Victor Transect study area.
(Modified from McMurtrey et al. 1972 and Finstick 1986)

In the Victor Transect, five main sub-basins drain into the Bitterroot River. Table 2 describes the characteristics of these sub-basins.

Table 2. – Properties of Sub-Basins Located in the Study Area (Senger 1973; Bitterroot Water Conservation District 1980).

Sub-Basin Name	Location Relative to the Bitterroot River	Drainage Area (sq. mi.)	Mean Annual Precipitation (in.)	Average Annual Yield (1000s acre-ft)
Bear Creek	West	42	54	53.1
Big Creek (includes McCalla Creek)	West	64	55	82.6
Burnt Fork Creek	East	101	27	43.6
Sweathouse Creek (includes Gash and Smith Creeks)	West	32	46	31.7
Willoughby Creek (includes (Spooner and Birch Creeks)	East	95	15	5.1

Movement of ground water is toward the Bitterroot River from both sides of the valley until the flood plain is reached. Here, the ground water moves parallel to the Bitterroot River and eventually discharges into the river (McMurtrey et al. 1972, 105-106). The slope or gradient of the ground water surface ranges from as low as 0.004 ft/ft in the Bitterroot River flood plain, to as high as 0.030 ft/ft in the west side Tertiary sediments (Finstick 1986, 66). Higher gradients are necessary to move water through impermeable, clay-rich sediments of the Tertiary that have low hydraulic conductivities.

In contrast, the coarse, permeable sediments of the flood plain have high hydraulic conductivity values and require lower gradients for ground water movement.

Ground water yields in the Bitterroot Valley are variable. Three main water-bearing units exist within the region: bedrock, Tertiary sediments, and Quaternary deposits (Finstick 1986, 19). Bedrock units typically supply small amounts of water from joints or weathered areas. Tertiary sediments provide variable--but usually small--yields. Quaternary alluvium aquifers provide the most reliable source of ground water, while Quaternary glacial till yields the least amount of ground water (McMurtrey et al. 1972, 98-100; Finstick 1986, 19).

Ground water recharge is predominant in the spring months when snowmelt and valley precipitation are at a maximum. Irrigation canals are also a significant source of recharge in the Bitterroot Valley. The water table begins to decline during late summer when evapotranspiration is at a maximum, snowmelt ceases, and precipitation is low. The yearly low water table elevation usually occurs during fall or winter months when irrigation has ceased and the mountain snowpack is once again accumulating. Yearly recharge of the ground water is approximately equal to yearly discharge (Senger 1975, 29). Figure 5 depicts the average seasonal water table elevations in the study area.

LAND USE

Three major land use categories exist in the Bitterroot River drainage basin: forest cover areas, agricultural areas, and urban or rural developed areas. Forested regions include those harvested for timber, and those protected by the federal or state

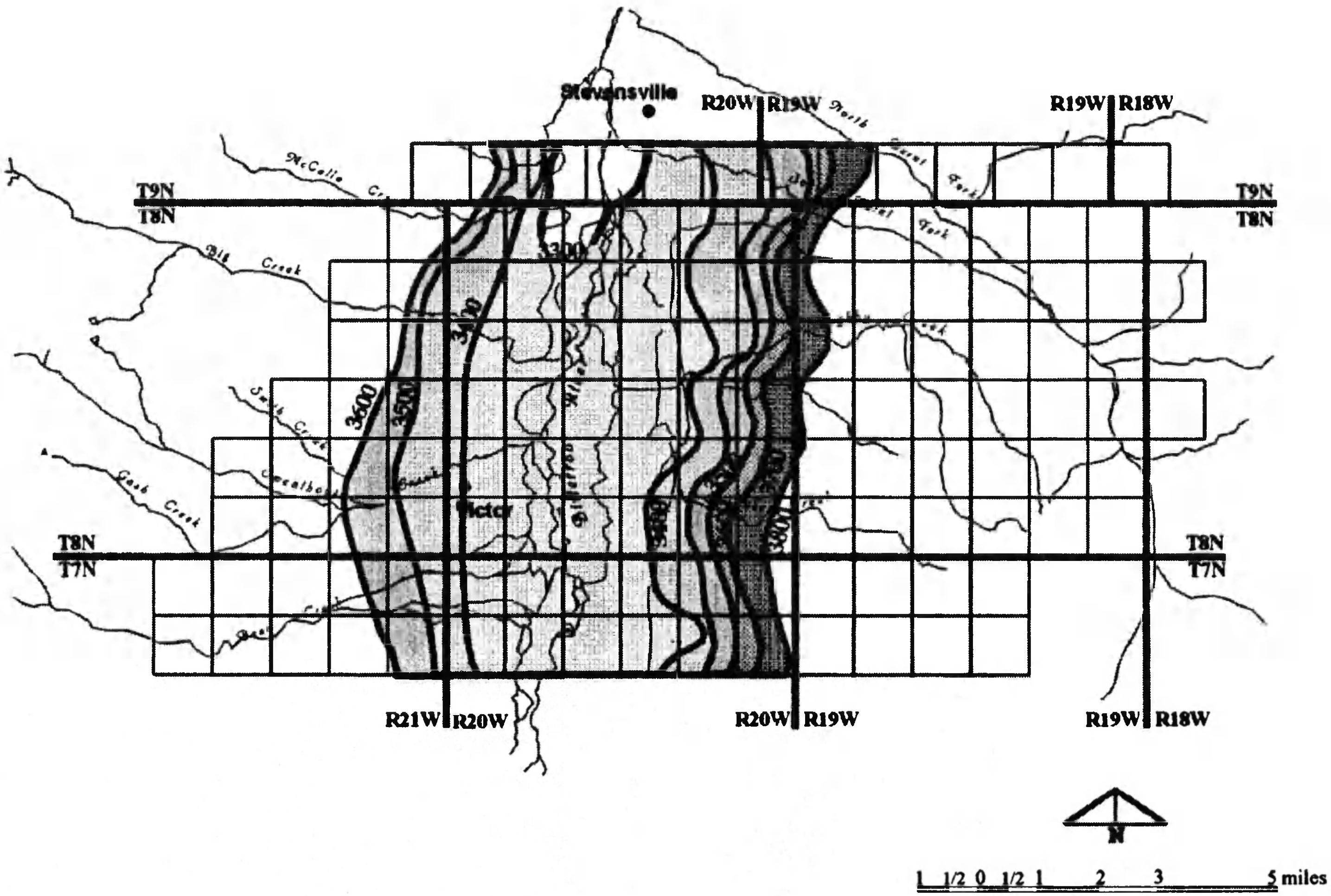

Figure 5. Estimated seasonal average water table elevation (ft) in the Victor Transect..
(Modified from McMurtrey et al. 1972 and Finstick 1986)

government as a managed wilderness region. In the Bitterroot region, wilderness forests are found in the high elevations of the Bitterroot and Sapphire Ranges. Timber extraction typically takes place along the middle elevations of both of these mountain ranges. Agricultural areas include irrigated and non-irrigated cropland, pastureland, and rangeland. The majority of agricultural land is located to the east of the Bitterroot River, although irrigated farmland is found inside the flood plain and along both east and west-side low terraces. Dryland farming is found almost exclusively on the east-side high benches between Corvallis and Stevensville. Developed areas include those built-up for commercial, light industrial, residential, and all associated uses. Residential land may be found within municipal boundaries (high density) or in rural and suburban areas (low density). Other land uses exist in the Bitterroot Valley that occupy relatively small land areas. Among these uses are transportation networks, industry and utility operations, and mineral extraction areas. The following chapter covers the land use history of the setting, including early settlement, land development, and subdivision regulations.

CHAPTER 3

CULTURAL HISTORY

This research analyzes subdivision data that was filed with the Ravalli County clerk during the years 1967 to 1996. However, land division and development in the Bitterroot Valley took place much earlier. It is important to cover the cultural history of the region; the brief historical summary included in this chapter will allow for better understanding of the events that shaped and influenced the study area. The process of regulating subdivisions in Montana has a history of its own, which is covered near the end of this chapter.

EARLY SETTLEMENT

Before European settlement, the Bitterroot Valley was home to the Flathead Tribe of the Salish Indians. The journals of the Lewis and Clark Expedition document the first European visit to the area, which occurred in September of 1805. Parties associated with the Expedition traveled and camped along most stretches of the Bitterroot River. They were not of one mind concerning the area's potential for farming, since some members wrote of the valley's poor stony soils, while others wrote of its good and fertile soils (U.S. Department of Agriculture 1959, 6).

Trappers and fur traders followed Lewis and Clark into the Bitterroot Valley. They were the only European inhabitants of the area for many years. Between 1806 and 1840, they conducted thorough explorations of the valley and its surroundings (Reynolds 1937, 15). The companies involved included the Northwest Company (later amalgamated with Hudson Bay), the Pacific Fur Company, and the Missouri Fur Company. By 1846, however, the fur trade declined to such a great extent that most companies closed down or moved to other locations (Reynolds 1937, 21).

Closely connected to the traders and following in their footsteps were the missionaries. Saint Mary's Mission--one mile from present day Stevensville--was established in 1841 by Father DeSmet, who brought seeds and tools to the local Flathead Tribe in order to encourage farming. Father Ravalli replaced Father DeSmet at Saint Mary's in 1845 and further developed the area by constructing a grist mill and a rudimentary lumber mill (Reynolds 1937, 35-6). It was Father Ravalli who introduced the practice of crop irrigation to the Bitterroot Valley.

Major John Owen acquired Saint Mary's Mission in 1850 for the price of $250.00, with terms that a new mission would be constructed in the area by 1852 (Dunbar 1927, 21). The former mission became the Fort Owen Trading Post and operated with some success.

LAND DEVELOPMENT

The Bitterroot Valley began to take on the look of civilization in the 1860s. Lieutenant John Mullan completed his wagon road in 1862; its purpose was to connect

Fort Benton to routes leading to the Pacific Coast. Mullan's road ran to the north of the Bitterroot Valley and facilitated access to new settlers. Meanwhile, Major Owen was in the process of constructing a three-story grist mill (which later proved to be too large for the amount of wheat grown in the valley) (Reynolds 1937, 99). Large scale exploitation of the surrounding forests had also begun by this time. Additionally, gold was discovered in surrounding regions. Bitterroot Valley farmers, who were recent arrivals themselves, found opportunity in furnishing food and supplies to those passing to and from places like Gold Creek and Virginia City (McMurtrey et al. 1972, 24).

The Northern Pacific Railroad was completed through to Missoula in 1883 and the Bitterroot Branch extended south to Darby in 1888 (U.S. Department of Agriculture 1959, 6). The railroad was influential in encouraging further settlement of the valley.

The second Saint Mary's Mission closed in 1891. With its closing, the few Flathead Indians who remained in the area, including Chief Charlot (the son of Chief Victor), left the Bitterroot to join those already located at the Jocko Reservation.

Ravalli County broke off from Missoula County in 1893. During this time, areas within the county experienced an orchard boom and the population increased (table 3). This growth can be described by the amount of apple-bearing trees in the area, which in 1890, numbered 6,000. By 1900, the number of apple-bearing trees rose to 300,000 (U.S. Department of Agriculture 1959, 7). Recognizing the enormous success of the orchards, a Minneapolis-based company began the first large scale land speculation business in Ravalli County during 1909. The real estate boom was short-lived, however. Within five years, the orchard industry rapidly declined due to bad weather and unfavorable market conditions, and land sales likewise declined.

Table 3. -- Population of Ravalli County
(U.S. Bureau of the Census)

Year	Population	Year	Population
1890	2,613*	1950	13,101
1900	7,822	1960	12,341
1910	11,666	1970	14,409
1920	10,098	1980	22,493
1930	10,315	1990	25,010
1940	12,978	1995	32,230

* Derived from precincts which would eventually make up Ravalli County.

Stevensville was the first town established in the Bitterroot Valley; Corvallis, Darby, and Grantsdale were the other pre-railroad towns. In part because of the construction of the Northern Pacific Railroad, subsequent Ravalli County settlement occurred in areas north of Darby, along the rail line. In 1881, the town of Garfield was surveyed and platted just west of the Bitterroot River flood plain, between what are now known as Sweathouse and Bear Creeks. In 1888, the name of Garfield was changed to Victor, in reference to the chief of the resident tribe of Flathead Indians (Groff 1997). It is the town of Victor that remains the largest population center in the study area.

As in other areas of Ravalli County, subdivision within the Victor Transect was initially influenced by the orchard boom. All early recorded subdivisions in the area relate to the business of orchards. The creation of orchard tracts was a common means of subdividing land in the Bitterroot Valley for several years preceding World War I (Montana Department of Intergovernmental Relations 1973, 5). Most of the parcels sold by land speculators were ten acres in size. Similar to other areas in the Bitterroot Valley, so many tracts were created in the Victor Transect that the market became glutted. Most of the tracts originally created for orchards are now used for residential purposes, and many have been re-divided into smaller lots. Figure 6 and table 4 describe the location and characteristics of early orchard tract subdivisions within the study area.

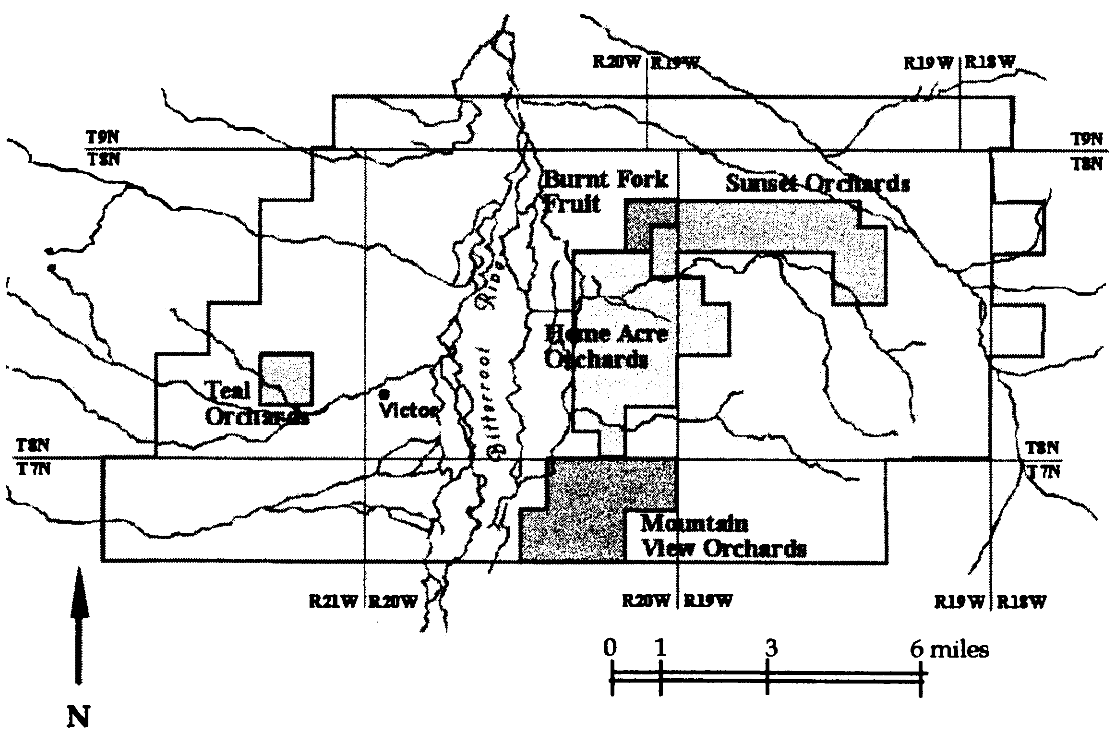

Figure 6. The spatial arrangement of early subdivisions in the Victor Transect.

Table 4. -- Characteristics of early platted subdivisions in the Victor Transect.

Subdivision Name	Location	# Lots	Year Plat Filed
Mountain View Orchards	SEC1-3,10-11,T7N,R20W*	350	1908
Home Acres Orchards	SEC18-19,T8N,R19W	300	1908
	SEC13-14,23-26,35, T8N,R20W		"
Teal Orchard Tracts	SEC26,T8N,R21W	40	1909
Home Acres Orchards 2	SEC26,T8N,R20W	16	1909
Sunset Orchards	SEC7,T8N,R19W	61	1909
Sunset Orchards 2	SEC9-10,15,T8N,R19W	32	1909
Sunset Orchards 3	SEC8-9,T8N,R19W	110	1910
Sunset Orchards 4	SEC12-13,T8N,R20W	28	1910
Home Acres Orchards 3	(replat of original Home Acres Orchards)	300	1911 "
Burnt Fork Fruit	SEC12,T8N,R20W	7	1913

* Subdivision also continues outside of the study area.

SUBDIVISION REGULATION

As population and development increases in an area, the need for planning and regulation becomes apparent. The Plats of Cities and Towns Act, enacted in 1883, was Montana's first law for subdivision control. This act gave local governments control over the platting of town sites and subdivisions (Richard 1994, 1-2). Even with this statute, many of Ravalli County's early subdivisions, such as the orchard subdivisions in the Victor Transect, tied up large amounts of land by premature fragmentation. Some subdivisions materialized in unsuitable locations, such as flood-prone areas or inaccessible sites. Once land is divided and sold in fragments, it is difficult to rectify any planning mistakes.

Early land transactions in Ravalli County were recorded as either platted subdivisions or "contracts-for-deed" sales (c.f.d.). Many landowners voluntarily reported c.f.d. sales to the Ravalli County Assessor, but the Office of Clerk and Recorder did not officially record these sales. Estimates show that between 1957 and 1972, 73 percent of known c.f.d. transactions occurred in this manner (Montana Department of Intergovernmental Relations 1973, 10). It is unknown how many unreported *and* unrecorded c.f.d. parcels exist.

The Montana legislature passed the Montana Subdivision and Platting Act (MSPA) in 1973 to further regulate the subdivision practice. The MSPA gave increased control to local governments over the Plats of Cities and Towns Act. The 1973 MSPA defined a subdivision as "the division of land into parcels less than twenty acres in size." Numerous exemptions to subdivision review existed within the MSPA text, and as a result, approximately 90 percent of the land subdivided over the following twenty years escaped local review (Richard 1994, 1-2). One exemption titled the Occasional Sale, allowed landowners to subdivide and sell one parcel off their property each year. Another exemption titled the Family Conveyance allowed for the subdivision and transfer of property to each family member. Each piece of property could then be further subdivided and "re-transferred" numerous times.

The MSPA received significant changes in 1993. Most notably, the twenty-acre definition of subdivision changed to 160 acres, or a full quarter-section. This meant that more subdivisions would require county review. Major subdivisions basically undergo a three-phase procedure, which includes pre-application, preliminary plat submittal, and final plat submittal. Plats are reviewed first by the local subdivision administrator or planning board, and then by other government agencies such as the Department of Environmental Quality (DEQ) and the Department of Natural Resource Conservation (DNRC).

The 1993 MSPA also revised some of the exemptions. For example, revision to the Family Conveyance exemption authorizes a one-time-only transfer to each family member. The Occasional Sale, considered one of the more damaging exemptions, was altogether deleted as a legal subdivision practice. Yet, there are still plenty of opportunities to elude all or part of the subdivision review process. Minor subdivisions, which create less than five lots, continue to be exempt from most of the review process. Agricultural exemptions, where division occurs "exclusively for agricultural purposes" is a popular exemption. Often, a landowner divides and sells a piece of property in this way, leaving the unaware buyer to remove the agricultural covenant and deal with the subsequent subdivision review. Evasions of the subdivision law also exist, such as the common abuse of the "Relocation of a Common Boundary" exemption, where creation of a new lot takes place in the process of moving property boundaries.

At this time, the MSPA remains the most important tool for regulating subdivision and preventing damaging environmental impacts from residential development.

CHAPTER 4

HYDROLOGICAL CONDITIONS

The quality of water in the Bitterroot Valley is good, generally meeting the standards for public health. Three basic categories are used to determine water quality: 1) physical character, 2) chemical character, and 3) biological character. Physical character includes habitat conditions such as temperature, velocity, and cross-sectional shape (overhanging banks, etc.). The temperature of water influences the rates of all chemical and biological processes, including respiration. It also influences the solubility of all chemical constituents, especially gases like oxygen. More dissolved oxygen is present in cooler water temperatures, and less exists in higher temperatures when respiration demands more oxygen. Chemical constituents present in water include mineral substances dissolved from the soil and rock through which the water passes. Water may also contain chemicals introduced by human activities such as waste disposal and crop fertilization. Some important chemical constituents involve nitrate (NO_3), chloride (Cl), iron (Fe), sodium (Na), and sulfate (SO_4). One aspect of the biological character of water is the biological oxygen demand. The BOD is a laboratory assessment of the consumption of dissolved oxygen by microorganisms in their metabolic processes (Senger 1975, 36). A high BOD generally suggests a water burdened with organic wastes and therefore, low in oxygen.

McMurtrey (1972) noted that the success of irrigation and the steady economic development of the Bitterroot Valley is due in part to its good water quality. But as the population density increases, more physical disturbance and chemical loading pressures are put on existing water resources. To reduce the effects of development, the Montana Subdivision and Platting Act sets general requirements regarding environmental assessment procedures. An environmental assessment may be required for major subdivisions. This assessment usually includes site information collected on the following natural features (Richard 1994, II-46):

1. Surface and ground waters
2. Topography
3. Vegetation
4. Wildlife
5. Soil suitability for development

No statewide standards are set for the amount of detail that must be provided by the subdivider, so more specific policies are set by the local governments involved. Therefore, local planners require a good understanding of natural environmental processes within their jurisdictions. This chapter defines the hydrologic character of the Victor Transect and describes site-specific concerns relating to area hydrology. Possible impacts to water quality--caused by residential development--are summarized near the end of the chapter.

SURFACE WATER

Residential subdivision and development can affect surface water quality. Water quality may be altered in the construction phases of roads and homes if they stimulate erosion. The removal of stream side vegetation often increases sedimentation in surface waters and allows the temperature to increase, provoking algae growth. Safe drinking water standards can be violated when herbicides and pesticides are applied to lawns and dangerous chemicals filter through the soil to the ground water. These same chemicals may also reach open water as surface runoff if steep slopes or impermeable (or compacted) soils are present, or if significant vegetation has been removed. When fertilizers reach open water, they can stimulate nuisance algae, and the toxic substances contained within them can poison aquatic life.

Site Concerns

Two site-specific surface water problems exist in the Victor Transect. The first is water depletion. Heavy agricultural irrigation in the valley and an increasing population put pressure on existing water resources. Stream dewatering is especially devastating to aquatic and riparian wildlife. The depletion of water can also contribute to negative chemical impacts, such as the increased concentration of nutrients, leading toward algae blooms. It may also cause an increase in temperature, which in turn causes a reduction in dissolved oxygen. It is not uncommon for tributary streams in the area to run dry during late summer and fall. At times, even reaches of the main Bitterroot River channel have come close to running dry throughout the length of the study area.

The second concern is stream stability. Many tributary streams, especially those on the east side of the Bitterroot River, carry loads of sediment into the main channel. The sediments have built up over the years, making the channel shallower and wider and causing the erosion of previously stable banks. The sedimentation problem is especially evident in the Victor Transect. Accordingly, this area also contains the widest expanse of designated flood plain relative to other areas in the Bitterroot Valley (U.S. Department of Agriculture 1995, appendix A). Flooding is frequent in the valley portion of the study area during spring and early summer months (May to July).

Regulation

Protection of Montana's rivers and streams has been regulated through various legislation dating back to the 1950s. Surface water quality is measured by different standards, depending on the intended use of the water. Streams have been classified based on the uses they can support or currently do support. Major uses include domestic, agricultural, industrial, recreational, as well as the support of aquatic life. Criteria to support these uses are issued by the U.S. Environmental Protection Agency, and state governments adopt these criteria as legally enforceable. The standards limit change in the physical parameters of the water (temperature, color, pH, solids, and turbidity) and the amounts of organic and inorganic chemicals that may be present in the water. The standard for dissolved oxygen sets the minimum requirement for a stream to support aquatic life.

Most of the stream protection legislation in Montana has little effect on the location of rural residential development, as regulation concentrates mainly on municipal and industrial uses. However, the 1975 Natural Streambed and Land Preservation Act expanded existing regulation to projects constructed by private individuals. The goal of this act is to "keep soil erosion and sedimentation to a minimum, except as may be necessary and appropriate after due consideration of all factors involved" (Decker-Hess 1990, 4). Together, the Montana Subdivision and Platting Act and the Natural Streambed and Land Preservation Act may be the main controls available for regulating residential subdivisions.

GROUND WATER

The quality of ground water is more variable than that of surface water in the area. Ground water quality is affected by a great number of factors including the recharge source, type and texture of the porous medium, and the rate of water movement (McMurtrey et al. 1959; Finstick 1986, 18). Generally, the ground water found on the east side of the valley is more mineralized than that on the west, due to the soils and underlying geology (Finstick 1986, 18; Uthman 1988, 70). Ground water on the west side of the valley tends to be slightly acidic (pH less than 7) in relation to the more alkaline ground water on the east side (pH over 7) (Finstick 1986, 87).

Site Concerns

The potential for ground water degradation in the study area increases with each added septic system. In Ravalli County, 6,650 sewer permits were issued between 1980 and July 1996, with approximately fifteen percent of these representing replacement systems (Ravalli County Sanitarian 1996). The most common system utilized in Ravalli County is the individual septic tank with trench drainfield. Septic systems discharge a variety of inorganic and organic compounds, including nitrogen, phosphorous, and fecal coliforms. In addition, septic tank cleaners contain synthetic organic chemicals like chloroethylene, benzene, and methylene chloride (Fetter 1993, 18). The location of the septic tank is important in insuring a properly functioning system. Ground water can easily become contaminated if coarse soils or a high water table are characteristic of the site. Surface water can also be directly polluted from the use of septic systems if drainfields are located on soils that are too shallow or fine, allowing runoff.

Regulation

The quality of ground water in the area is important, since it is the primary source of domestic water. Public water suppliers are obligated by the 1986 Safe Drinking Act to provide reliable drinking water to their customers. Unlike surface water regulation, no specific criteria have been established for the regulation of ground water quality. The EPA has fixed minimum standards for municipal drinking water, but homes in rural areas are not usually served by a public water supply and therefore must drill their own private wells. In this case, certain responsibilities fall on the drilling contractors. These responsibilities include the selection of a proper water source, the prevention of surface water contamination while drilling, and the proper sealing of wells. Responsibility also falls on the individual consumer to monitor their ground water quality. In the selected study area, a majority of the population is served by private wells.

RESIDENTIAL IMPACTS

The following examples summarize the water quality degradation that can occur when certain combinations of residential land uses and site characteristics are present:

1. Residential feature: Construction of buildings and roads; removal of stream side vegetation
   Site characteristics: Unstable underlying geology, erodible soils, steep slope
   Resulting degradation: Runoff and erosion (leading to stream sedimentation and waste contamination)

2. Residential feature: Location of private waste systems (septic, anaerobic)
   Site characteristics: Rapidly permeable or excessively impermeable soils, shallow soils, steep slope, shallow depth to water table
   Resulting degradation: Waste contamination of ground or surface water

3. Residential feature: Hazardous waste and materials from household management (paint, paint thinners, lawn and garden fertilizer, pesticides)
   Site Characteristics: Highly permeable or excessively impermeable soils and subsoils, shallow depth to water table, close proximity to surface water and to the flood plain
   Resulting degradation: Chemical pollution of ground or surface water

Up to this point in the research, the characteristics of the study area, including physical and cultural aspects, have been summarized. This information is needed in order to approach the main study objectives. The following chapter addresses the first research objective by identifying the water pollution potential of the Victor Transect.

CHAPTER 5

WATER POLLUTION POTENTIAL

The first research objective is to identify those Victor Transect areas where residential development is most likely to contribute to water quality degradation. To do this, a system is developed to measure the water pollution potential of individual areal units within the total study area.

The system used here in determining water pollution potential is closely related to the U.S. Environmental Protection Agency DRASTIC model for hydrogeological settings. The DRASTIC model uses seven factors which determine the impacts of a pollutant on ground water resources. In comparison, this study uses six site factors to determine the impacts of residential development on both ground and surface water. In both cases, the selected factors are broken down into classification ranges with corresponding ratings, which generally range from one to ten, with the higher value representing a greater pollution potential. Ratings for each site factor are summed to produce a final pollution score for each areal unit. Lower scores represent a lesser risk of water pollution from residential development; therefore, areal units with low scores are more suitable for residential subdivisions and subsequent development. Areal units with high scores are unsuitable for these types of subdivisions. Each areal unit equals one-quarter section and contains 160 acres. As stated in EPA's DRASTIC method, measurement units over 100 acres in size are most successful in evaluating water pollution potential from a regional perspective rather than a site specific one (U.S. Environmental Protection Agency 1987, 44). This study attempts to evaluate the Victor Transect region, which in turn, is a representative portion of the Northern Ravalli County region.

This chapter is separated into seven sections, with each of the first six sections representing the analysis of a separate site factor. The final section consists of a final site suitability map, which is the combination of all individual factor results.

TOPOGRAPHY

Topography in this study represents the slope of the natural ground surface. The degree of slope is important in a number of residential development factors. Steep slopes often generate higher runoff than gentle slopes. Land instability from natural causes may also be extremely serious on slopes greater than 25 percent, and the risk increases as these steeper slopes are developed (Montana Department of Natural Resource Conservation 1973, 36). A steep surface slope often covers a steeply-sloping water table. The increased gradient of ground water flow in these situations provides quicker transport for contaminants, shortening the filtration process.

Classification

U.S. Geological Survey 7 1/2 minute digital elevation models (DEMs) are used in this study to measure the average slope of each areal unit. Classes shown below are based on septic installation standards and building code regulations.

Slope Classification	Rating
Over 25%	10
15 - 25%	8
10 - 15%	5
6 - 10%	2
2 - 6%	1
0 - 2%	4

Regarding septic system installation, drainfields in Ravalli County are not recommended on slopes exceeding 15 percent, although they may be installed on slopes up to 25 percent (MDHES 1992; Ravalli County Sanitarian's Office 1994). Regarding road and residential construction, severe limitations occur on slopes over 15 percent; slopes of 10 to 15 percent introduce a moderate construction limitation (MDNRC 1973, 36).

The pollution potential rating of extremely flat topography is higher than the rating of gently-sloping topography. Reasoning is based on the concept that flat land is prone to water-logging. Flat topography also tends to correspond with ground water discharge areas, where contaminants from higher elevations emerge and coalesce. Septic drainfields and other waste disposal systems located on slopes of less than 2 percent are less likely to perform their filtering operations correctly.

Interpretation

The water pollution potential of the study area topography is shown for all areal units in figure 7. Spatial patterns of this classification are easily-understood, since topography presents itself as the most visible of all site factors. Topographic features are oriented in a north-south direction. Moderate pollution potential exists on the flat topography of the flood plain, while the gentle slopes occurring on either side of the flood plain represent a relatively low threat of water pollution. The highest pollution potential values are found on steep slopes located in the foothills of the Sapphire and Bitterroot Ranges. A smaller, more localized spatial pattern is found within the east-side terrace area. In this area, the tributary streams have cut through soft terrace materials in an east-to-west direction, creating steep-sloped terrace edges with high pollution potential values. There is an abrupt slope change between west-side low terraces and the Bitterroot foothills. A less-defined slope changes exists between east-side high terraces and the Sapphire Range.

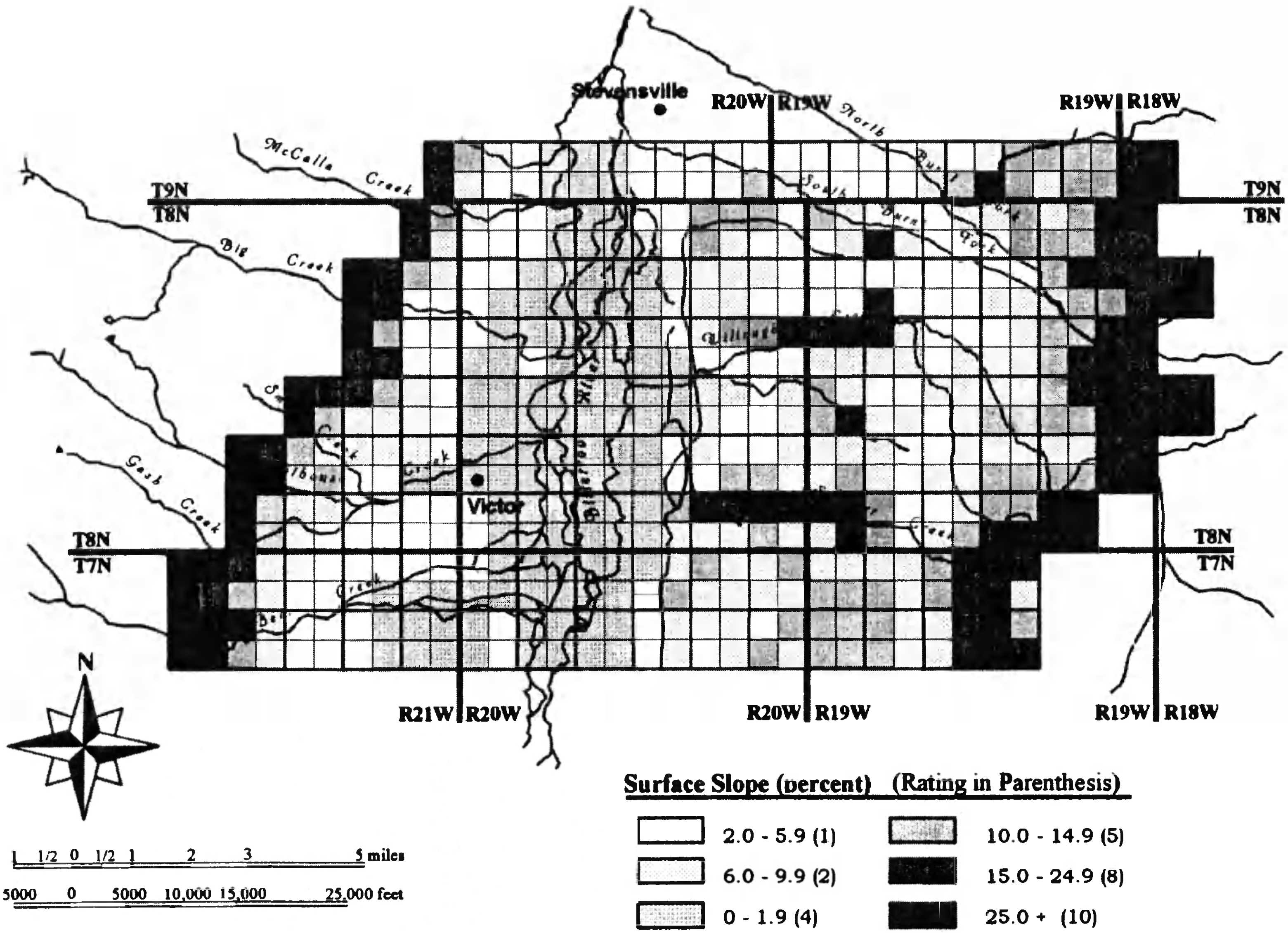

Figure 7. Water pollution potential of topography (surface slope).

SOIL TEXTURE

Soil media is the uppermost portion of the vadose zone characterized by significant biological activity (U.S. Environmental Protection Agency 1987, 51). Usually, the soil layer does not extend beyond 7 feet in depth. The texture of the soil is determined by the distribution of the size fractions of mineral grains present, and these grains are arranged in such a way that the soil has a structure (Fetter 1994, 175). Texture and structure combine to decide the porosity and permeability of the soil (Fetter 1993, 164). Soil texture is an important factor in the planning of roads, residences, and waste disposal systems. In many cases, soil is the primary influence on ground water pollution potential, as contaminants are often released directly into the soil. The texture of the soil affects how much of the contaminant will pass into the subsoil, and the rate of that passage.

In the *Soil Survey of the Bitterroot Valley* (U.S. Department of Agriculture 1959), soils are classified according to the characteristics of their profile and the environment in which they exist. Most soil series are profiled according to their particle size and arrangement. A typical profile consists of the following layers, known as horizons:

Horizon	Description
A	Surface soil; the zone of leaching
B	Subsoil; the zone of accumulation
C	Parent material
D	Underlying rock

The A and B horizons of each profile are combined in this study to determine the soil texture.

Classification

The following soil texture classifications and ratings are used:

Soil Texture	Rating
Loose sand and gravel	9
Clay to clay loam	8
Medium to coarse sand	7
Non-porous silt loam; Silty clay loam	6
Coarse sandy loam	5
Fine to medium sand	4
Loam; fine sandy loam	3
Porous silt loam	2

Classes are divided based on EPA's DRASTIC categories for pollution potential, as well as the estimated percolation rates of different soil textures (table 5). Textures having high percolation rates (sand and gravel), as well as extremely low percolation rates (clay), often fail in properly filtering septic effluent. Therefore, both extremes are assigned high pollution potential ratings.

Table 5. -- Soil requirements for absorption fields used in septic systems (MDHES 1992, 13).

Soil Texture	Percolation Rate (min/in)	Absorption Field Length (linear ft for a two ft wide trench per bedroom)
gravel, coarse sand	< 3	not suitable
coarse to medium sand	3 to 5	65
fine sand, sandy loam	6 to 15	70 to 95
sandy loam, loam	16 to 30	110 to 140
loam, porous silt loam	31 to 60	150 to 170
silty clay loam,	> 60	not suitable
clay loam, clay	> 60	not suitable

<u>Interpretation</u>

Figure 8 illustrates the water pollution potential of soil textures in the Victor Transect. High pollution values are oriented in a north-south direction along elevation extremes in the study area: the flood plain and foothills. In contrast, the middle-range elevations show pollution potential values orientated in an east-west orientation. In these areas, the soil textures appear to be influenced by the location of tributary streams, which cut through terraces. This trend is most apparent on the east side of the flood plain, where there is a greater expanse of middle-range elevations.

On the west side of the Bitterroot River, fans and terraces are characterized by intermingled silty, sandy, and stony loams. There is a wide range of drainage rates represented throughout this location of the study area. Perhaps the most common soil texture on the west side is "coarse, stony loam with fines," which represents a medium threat of pollution.

To the east of the Bitterroot River, relatively low pollution potential values are derived from the soil textures. These areas contain mostly silty or fine, sandy fertile soils with percolation rates well within septic system recommendations. Terraces located along the Burnt Fork of the Bitterroot River and Spooner Creek are an exception. These soils are shallow and droughty in comparison with other east-side terraces, resembling more the soil textures of steep mountain regions.

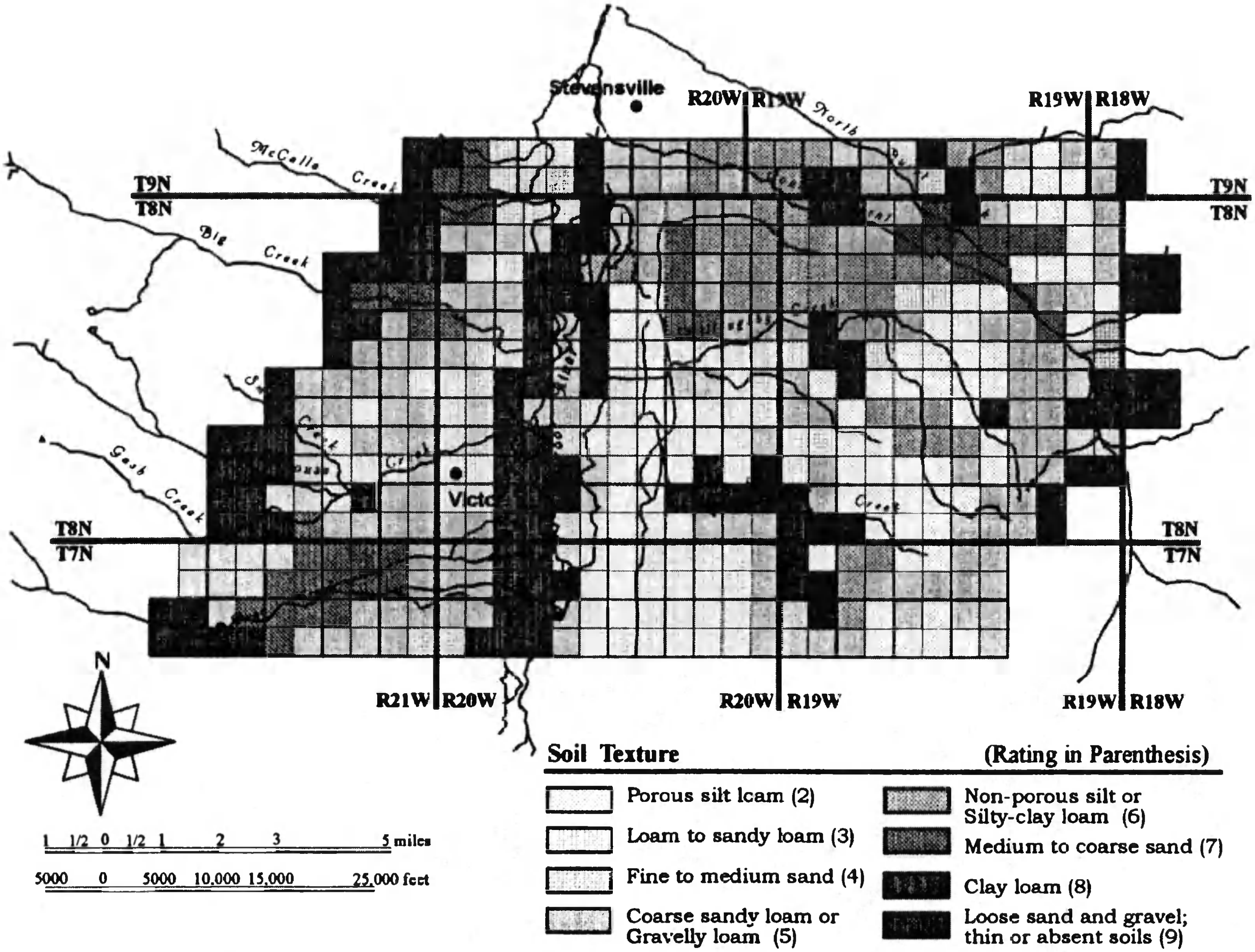

Figure 8. Water pollution potential of soil texture.

PARENT MATERIAL TEXTURE

Parent material lies below the subsoil, consisting of weathered mineral particles normally derived from the underlying rock. Parent material texture is often the second determinant involved in the pollution potential of land-applied waste, after the soil texture. Aquifer characteristics and the underlying geology are apparent in this material. Similar to the soil texture, parent material textures of excessive permeability will allow contaminants to enter an aquifer and travel without proper filtration or absorption. Very fine, non-permeable parent materials, such as clay or loamy clay, may also promote water pollution, but are rarely found within the study area.

Parent material texture is estimated using soil survey horizon profile data (U.S. Department of Agriculture 1959). Horizons C and D are analyzed for their textural properties relating to percolation rates and weathered material depths.

Classification

The following classification of parent material texture is used:

Parent Material Texture	Rating
Fractured bedrock near the surface	10
Loose clean gravels, cobbles, and boulders	9
Sand and gravel	8
Loose gravels mixed with some fines	6
Gravelly loam or weathered cobbles and gravels with many fines	4
Coarse loam to medium sand	3
Fine silt loam to loam	2

Areas of "fractured bedrock near the surface" receive the highest pollution potential rating, as they represent not only a threat to ground water contamination, but also an obstacle associated with residential construction. The construction of homes or roads in these areas may encourage slope instability and erosion, eventually degrading the quality of surface water downslope.

Interpretation

Parent material texture pollution potential is illustrated in figure 9. The overall spatial patterns are similar to those found in soil texture mapping, with the exception of the flood plain area, where there is a wider range of values. Parent material textures appear to be oriented in an east-west direction in middle-range elevation areas, influenced by the processes of tributary streams.

The eastern terrace areas contain silt loam or sandy loam parent materials that have the lowest pollution potential ratings. Areas around the Burnt Fork of the Bitterroot River as well as stretches of Willoughby and Spooner Creeks are east-side exceptions. Here, there are looser, highly permeable parent material textures. Terraces west of the Bitterroot River are underlain typically by very permeable materials consisting of loose sands and gravels, while the textures found in flood plain areas typically consists of loose sand, gravel, and cobbles. Drainage in both of these areas tends to be rapid to excessive.

Mountain soils in the area often exist directly over granitic bedrock, with an absence of a developed C horizon. The depth of unconsolidated material may vary greatly in these areas, however, it is estimated to be predominantly shallow with a high pollution potential.

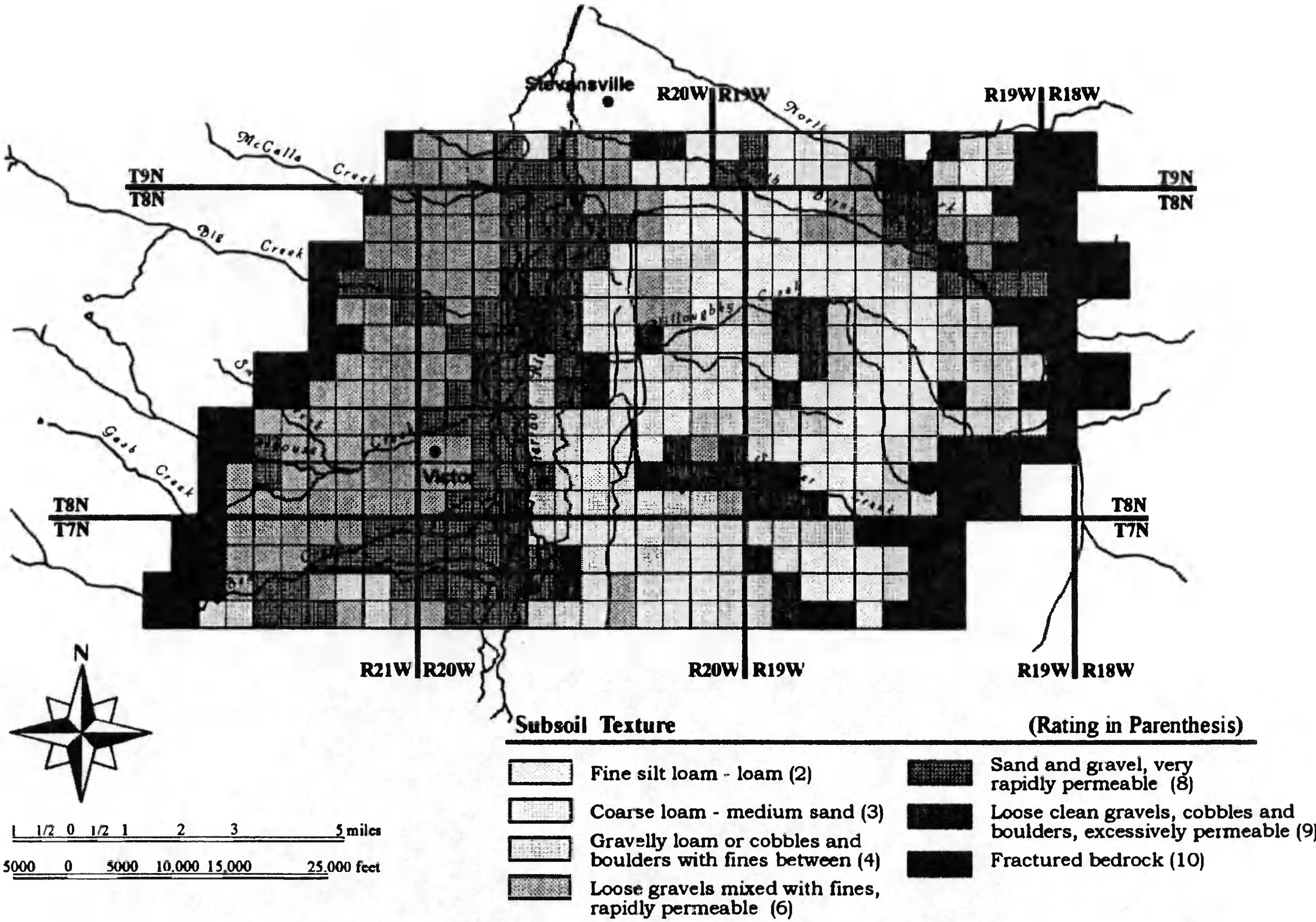

Figure 9. Water pollution potential of parent material texture.

DISTANCE TO SURFACE WATER

Many people desire to live next to a natural lake or stream, especially when located in a scenic area such as Ravalli County. The development of such land, however, can be degrading to ecosystem processes. Activities that take place near surface water, such as vegetation removal and the construction of roads and homes, cause increased runoff and stream flow. An increase in runoff volume may in turn cause flooding, severe erosion, pollution, or other damage (MDNRC 1973, 28).

Streams draining either side of the Bitterroot River (but especially west-side streams) carry a great amount of runoff from snowmelt each spring. Stream instability and flooding naturally occur, but often increase with land development. West-side streams are underlain by gravels, cobbles, and boulders. Contrasting to this, east side streams are underlain chiefly by unconsolidated or weakly consolidated loams, clays, silts, sands, gravels, and volcanic ash (Bitterroot Conservation District 1980, 20-21). Because of this difference, tributaries draining the east tend to carry more sediments, although less water, into the Bitterroot River. Sediments are recognized as the largest polluters of Montana's streams (Montana Department of Environmental Quality 1995, 19).

Classification

The locations of the Bitterroot River and all named tributaries (even intermittent) are used in determining the distance from each areal unit to surface water. Unnamed drainages in the study area are generally discontinuous and intermittent, and although they may have an effect on water pollution, their erratic nature prevents accurate mapping for use in this study. Irrigation canals are also excluded from distance classification. These man-made canals differ from natural streams in the area, mainly because they have been designed and are continuously maintained as stable, self-contained water routes.

Distances are measured between the midpoint of each areal unit and the midpoint of the nearest stream channel. Classes are shown below:

Distance to Surface Water (ft)	Rating
0 - 100	9
100 - 250	8
250 - 500	7
500 - 750	6
750 - 1000	5
1000 - 1500	3
1500 - 2000	2
2000 +	1

Ratings classifications are based on Montana sewer and subdivision recommendations, which state that a septic tank should be located at least 50 feet from surface water, and the absorption field should be at located at least 100 feet away (Ravalli County Sanitarian 1994). Subdivision regulations require that developers provide flood data if the parcels they are creating are within 2,000 feet of a live stream draining 25 or more square miles (Richard 1994, II-13).

Interpretation

Figure 10 illustrates the pollution potential of the "distance to surface water" site factor. The spatial pattern of variation follows the location of parallel stream channels. Parallel channels exist when the underlying topography slopes in a uni-directional manner. The spacing between parallel streams is usually very equal. Most of the tributary streams in the study area discharge into the Bitterroot River at close to a 90-degree angle.

Because of the braided character of the Bitterroot River and some lower reaches of west side tributaries (Bear Creek and Big Creek), the region spanning the flood plain and the low west side terrace contains the highest pollution potential rating. The Burnt Fork of the Bitterroot also divides into several channels as it nears the flood plain; therefore, a high pollution potential shows up in the northeast portion of the Victor Transect study area.

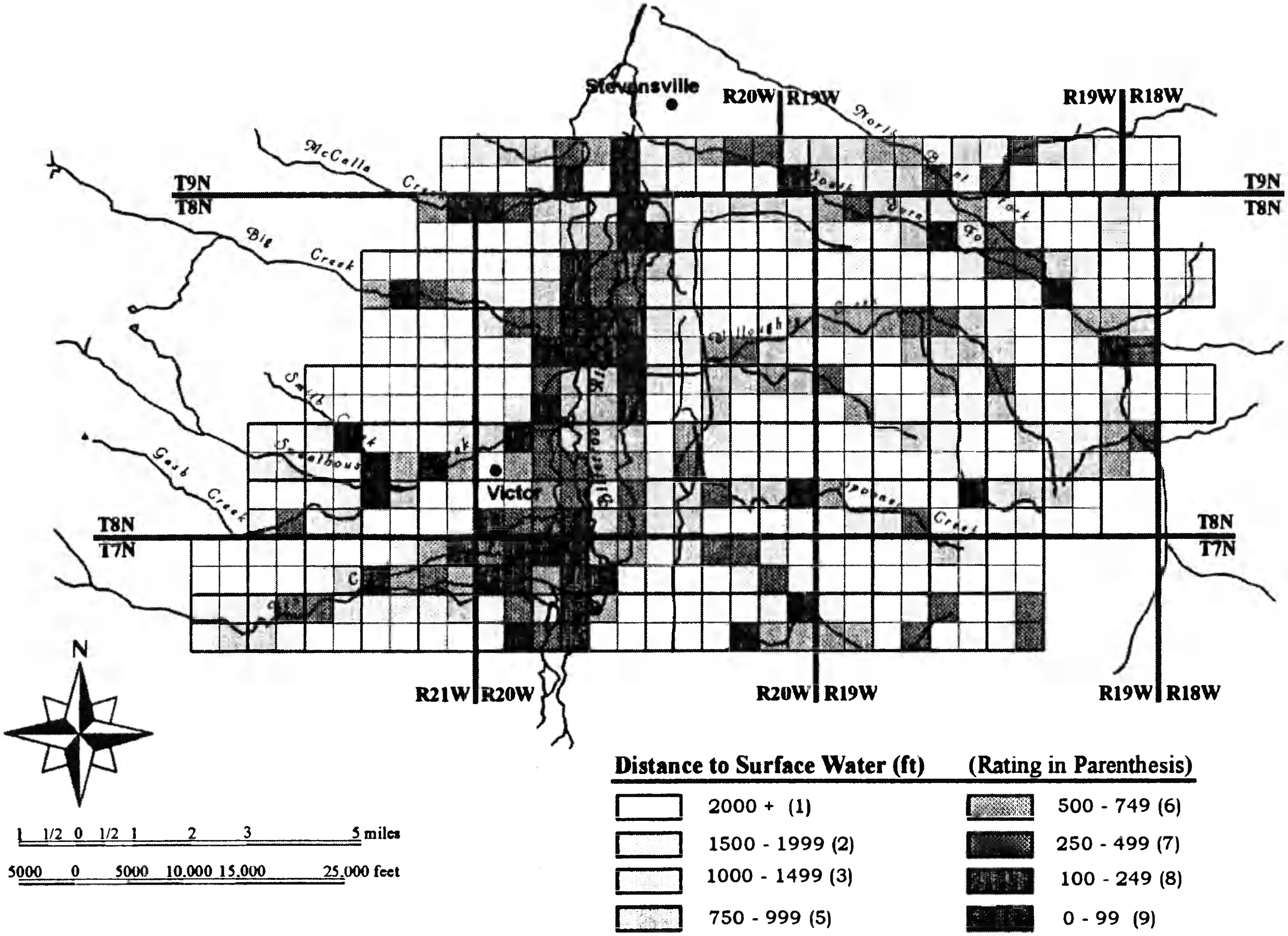

Figure 10. Water pollution potential of the distance to surface water.

DISTANCE TO FLOOD PLAIN

A flood plain is the portion of a river valley adjacent to the river channel that is covered with water when the river overflows its banks at flood stage (Nolan 1973, 47). A flood plain may also be called a flood-prone or flood hazard area (Natural Resource Conservation Service 1995, G-1).

The flood plains of the Bitterroot River are experiencing increasing development. Aerial photographs show that in 1936, thirteen houses were located in the flood plain of the main Bitterroot River channel. By 1990, the number of houses located in this area increased to 146 (NRCS 1995, 6). The most recent significant flood events in the study area occurred in 1972 and 1974. The 1972 flood was caused by the melting of a snowpack that was twice the average accumulation. Extremely warm spring temperatures in 1974 caused accelerated melting of the existing snowpack, causing flooding (NRCS 1995, 6).

Flood plain areas are extremely sensitive to water quality degradation. These low-lying areas receive the brunt of all runoff from higher elevations. Development on the Bitterroot flood plain competes with constantly shifting river channels and an especially high seasonal water table. Development in flood-prone areas often includes the addition of flood-control structures, such as levees, which increase the flooding potential downstream. The danger to human safety presented by flooding events in this area compounds the danger of environmental degradation.

Most development regulations are concerned with the occurrence of the 100-year flood, so that is the flood plain boundary that is used in this study. The entire flood plain is composed of two distinct areas: the "floodway" and the "flood fringe." The floodway is an area that can theoretically contain the 100-year flood, while only raising the water level a specified amount. In Montana, the maximum floodway level increase is 6 inches for the 100-year flood (NRCS 1995, 9). The flood fringe is the area outside of the floodway, but included within the 100-year flood plain boundaries. Residential construction is not allowed within the floodway. However, it is allowed in the flood fringe if the lowest floor level of each structure is elevated two feet above the designated 100-year flood elevation.

Classification

Distances are measured from the midpoint of each areal unit to the nearest flood plain boundary. Classification ratings are as follows:

Distance to Flood Plain (ft)	Rating
0 - 100	10
100 - 250	9
250 - 500	8
500 - 750	7
750 - 1000	6
1000 - 2000	4
2000 - 3000	3
3000 - 5000	2
5000 +	1

Pollution potential ratings for flood plain classifications are similar to ratings concerning the distance to surface water. Montana sewer and subdivision recommendations are considered in the determination of categories and ratings.

Interpretation

The spatial pattern portrayed by figure 11 is a distinctly north-south orientation of pollution potential values. Although all streams possess a flood plain, the Bitterroot River is the only channel located in the study area with a designated 100-year flood plain; therefore, high pollution scores cluster along reaches of this main river channel. A slight narrowing of the flood plain occurs at both the north and south ends of the study area. The widest extent of flood plain is found one mile north of Victor.

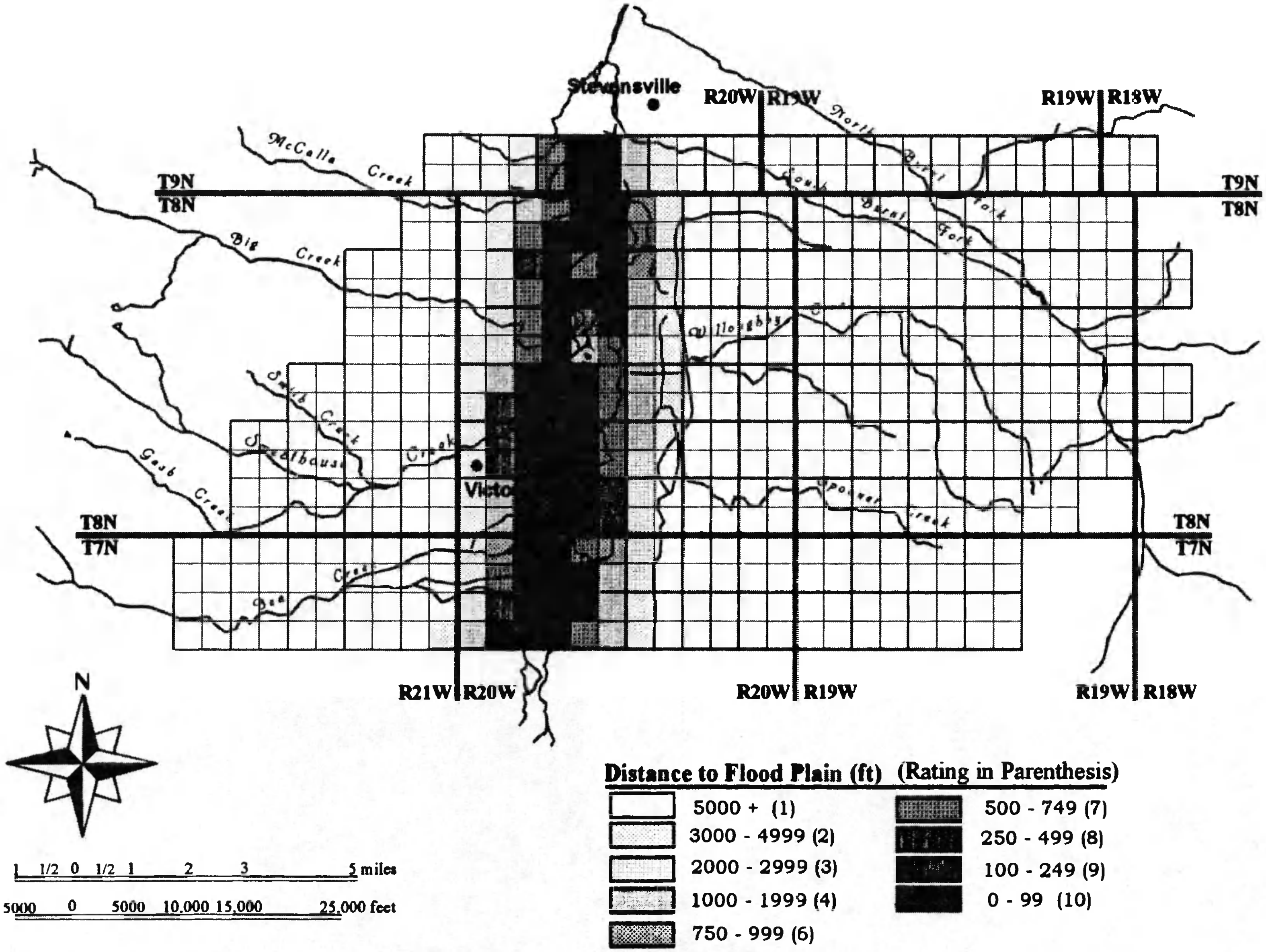

Figure 11. Water pollution potential of the distance to the 100-year floodplain.

DEPTH TO GROUND WATER

Depth to ground water is the distance between the natural ground surface and the top of the saturated zone, usually the water table. This distance is important since it determines the amount of time a contaminant has to travel and filter through available material. The depth to ground water also determines the amount of oxidation provided through atmospheric oxygen (U.S. Environmental Protection Agency 1987, 44). Ground water depths are minimal in many areas of the Victor Transect. Some of these areas become flooded or swampy during spring and early summer.

The water table level fluctuates throughout the course of the year. In general, the depth measurement in this study represents the average annual static water level. Most depths are based on the findings of McMurtrey et al. (1959; 1972) and Finstick (1986). But in the eastern third of the study area, ground water data is scarce. To map the depth in this area, 155 well logs were collected from the Montana Natural Resource Inventory System (NRIS). The wells were drilled during different times of the year, so each areal unit's static water level is estimated by averaging all multiple wells located within the same areal unit. Interpolation (and extrapolation) is necessary in units without any drilled wells. To accomplish this, an area map of geology (McMurtrey et al. 1972) is overlaid onto the base map. Ground water depth contours are then allowed to conform to aquifer units.

Classification

The following classifications and ratings are assigned for the depth to ground water:

Depth to Ground Water (ft)	Rating
0 - 6	10
6 - 10	9
10 - 15	8
15 - 30	7
30 - 40	6
40 - 50	5
50 - 60	4
60 - 75	3
75 -100	2
100 +	1

This pollution index closely follows the EPA's DRASTIC model for determining the pollution potential of ground water. Standards for septic system installation are also considered in the classification process. For proper septic system placement in Montana, the seasonal high water table should be a minimum of 4 feet below the lowest part of the absorption trench (Montana Department of Health and Environmental Sciences 1992, 12).

Interpretation

Figure 12 illustrates the pollution potential for ground water depths in the Victor Transect. The pollution potential map contains a large, regional-scale pattern relating to the direction of variability. That is, more variability exists in an east-to-west direction than a north-to-south direction. This pattern is influenced greatly by the high pollution

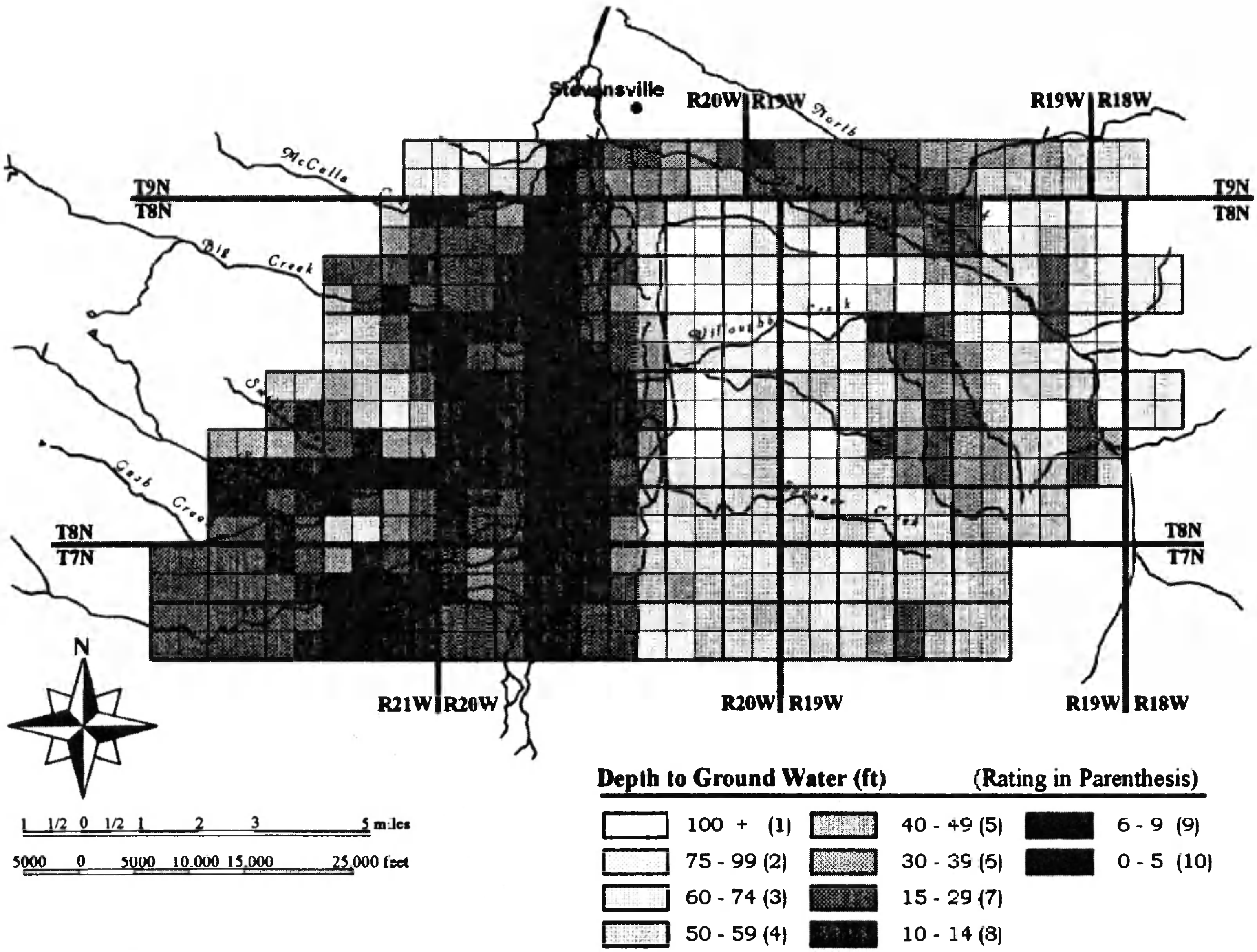

Figure 12. Water Pollution Potential of the Depth to Ground Water.

potential that follows the main channel of the Bitterroot River. This trend repeats itself on a smaller scale along many of the tributary streams, since the topographic lows represented by these streams have less depth to ground water than the terraces they cut through.

The pollution potential is greatest in low terraces west of the Bitterroot River, and in the alluvial flood plain. There is almost no pollution potential along high bedrock terraces east of the river.

Aside from the central flood plain, most of the study area has enough depth to ground water to accept individual septic system placement. However, seasonal high water tables may lessen the depth and impede drainfield operations in areas along the outer flood plain, low terraces, and reaches of west side tributary streams.

SITE SUITABILITY

In this study, site suitability is defined as the capability of an areal unit to sustain residential development without significantly degrading the quality of the water. Development characteristics include the installation of a septic system, vegetation removal, house construction, and access road construction. The final site suitability map is a compilation of previous measurements (figure 13). The sum of all six site factors ratings are computed for each quarter-section areal unit. This final score is used in the determination of suitability classes.

Classification

Six suitability classes are derived from final pollution potential scores:

Score	Description
0 - 17	suitable
18 - 23	suitable with minor limitations
<------- 24 - 29	suitable with moderate limitations ------->
30 - 35	suitable with major limitations
36 - 41	unsuitable
42 +	extremely unsuitable

Classes are equal-interval, based on mathematical factors of 6. Basically, if a mapping unit scores less than a "3" for each of the six pollution potential ratings, it is considered "suitable" for residential development. If each site parameter averages a rating of "7" or more, it is believed to be "extremely unsuitable." Likewise, classes are assigned for all intermediate values. A theoretical line is drawn along the class with

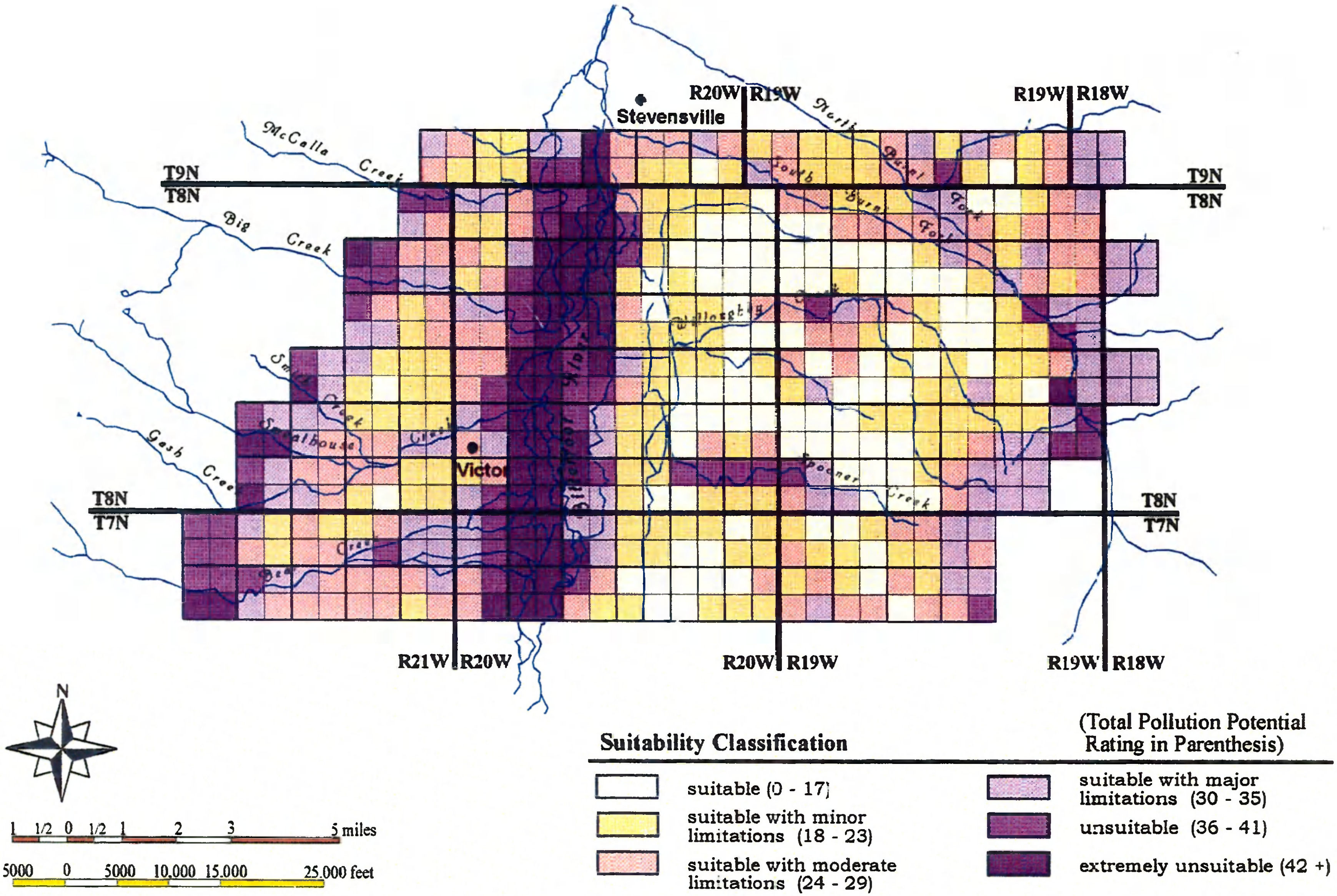

Figure 13. Site suitability for residential subdivision and development.

scores ranging from 24 to 29. This class represents the division between mostly suitable locations and mostly unsuitable locations.

Interpretation

The regional spatial pattern of site suitability shows variability in an east-west direction. Areal units within the Bitterroot River's 100-year flood plain are consistently poor in suitability. Other unsuitable areas include those bordering the Bitterroot and Sapphire Mountain Ranges. Moderately suitable units include those along the terraces west of the Bitterroot River flood plain. Mostly suitable units are found mainly along the east-side terraces.

A more localized spatial pattern exists within the overall picture. This pattern is horizontal in nature (with variability existing in a north-south direction), influenced by the presence of tributary streams. This horizontal trend is most evident on the east side of the Bitterroot River, where streams cut into terraces at approximately a 90 degree angle. It also applies, less obviously, along all west-side tributaries.

The strong effect that stream channels have on the overall pollution potential is apparent in the final site suitability map. The presence of a stream channel causes an increase in pollution potential ratings for almost every site factor, with the exception of the "distance to the 100-year flood plain." The combining of all site factors magnifies this effect.

Descriptive Statistics

The resulting range of total pollution potential scores for all areal units begins at 9 and ends at 50. Summary statistics for these scores are as follows:

number of areal units (N) = 518
arithmetic mean (m) = 26.54
median (md) = 25.00
mode (mo) = 22.00
standard deviation (sd) = 9.50

The mean of the scores (26.54) is located within the "suitable with moderate limitations" category. The rest of the pollution potential scores are distributed in a slight positively-skewed manner, since there is a greater number of areal units with scores below the mean. The standard deviation of 9.5 (with a coefficient of variation at 35.8%) represents a "low-peaked," wide distribution of data. Table 6 further describes the distribution of areal units into assigned suitability classes.

Table 6. -- Frequency table of site suitability classes, as derived from total pollution potential scores.

Class	Description	Range of Scores	# Areal Units (frequency)	% Frequency	Cumulative % Frequency
1	Suitable	0 - 17	90	17.4	17.4
2	Minor Limitations	18 - 23	135	26.0	43.4
3	Moderate Limitations	24 - 29	104	20.1	63.5
4	Major Limitations	30 - 35	97	18.7	82.2
5	Unsuitable	36 - 41	47	9.1	91.3
6	Extremely Unsuitable	42 +	45	8.7	100.0
			518	100.0	

The "suitable with moderate limitations" class contains 20.1 percent of all areal units. Units with lower scores are mostly suitable for development, while units having higher scores are mostly unsuitable. In the Victor Transect, 43.4 percent of areal units are classified as mostly suitable, while 36.5 percent are mostly unsuitable.

Not all areal units have undergone residential subdivision during the 1967 to 1996 study period. The following chapter identifies those units where subdivided lots are located.

CHAPTER 6

RESIDENTIAL SUBDIVISION

This study defines residential subdivisions as land that is divided into one or more lots, when each lot contains twenty acres or less. Most new lots documented in this study are created for the purpose of sale, either immediate or future. At this time, not all lots are fully-developed with a house, well, or waste disposal system. Some of the lots are partially-developed, and others remain relatively undisturbed. It is important to identify even those lots that are undeveloped, since they represent the probable locations of future residential development.

The site suitability of the study area to accept residential development, based on the potential for water pollution, has been characterized in the previous chapter. The next objective is to determine where the subdivided lots have occurred within the Victor Transect. To accomplish this, subdivision data for 1967 to 1996 (appendix A) is sorted by location. Each subdivided lot is identified by its position within an areal unit. To better illustrate trends over time, the research period is separated into ten-year time intervals: T1 = 1967-1976, T2=1977-1986, and T3=1987-1996. Data for each interval is transferred onto a base map, similar to the one used to analyze water pollution potential. Comparisons between the different time intervals provide information relating to subdivision location trends. The compilation of all interval data is used to summarize the location of subdivided lots recorded in this research.

Limitations

This research does not include all land subdivision which has taken place in the study area, but it does contain many of the lots which were created for residential purposes. Limitations exist in data collection, since many land transactions in the area proceed without documentation. This is especially true for the years preceding the 1973 Montana Subdivision and Platting Act. Contracts-for-deed (c.f.d.) sales are not included in the research data, since they do not always represent a clear split of land that results in the creation of new lots. As previously stated, lots greater than twenty acres are also omitted from this study, as they may pertain to uses other than residential. Subdivision types used in this study include platted and filed subdivisions, amended plats, and two types of Certificate of Survey exemptions: the Occasional Sale, and the Family Conveyance. All of these types represent a clear division of land into one or more new lots. Exceptions to this rule are the amended plats, which may rearrange previous lot boundaries and produce no additional lots. Only those amended plats that create new lots are used in this study.

Classification

The following classification scheme is applied to areal units within each of the three time intervals:

Class	Number of Lots
1	0 lots
2	1 - 5 lots
3	6 - 10 lots
4	11 - 15 lots
5	> 16 lots

__1967 - 1976__

During this time, 90 subdivisions were recorded, producing a total of 397 lots, with an average lot size of 6.9 acres. This period contains seven years that precede the Montana Subdivision and Platting Act. It is therefore possible that a number of subdivisions remain unrecorded during this interval, having taken place as c.f.d. sales.

Figure 14 illustrates the location of lots during the T1 (1967-1976) interval. On the regional (study area) scale, lots are clustered in areas near the discharge points of most tributary streams east of the Bitterroot River. To the west of the river, clustering appears to follow tributary streams from the flood plain areas to the foothills of the Bitterroot Range. Lot development inside of the flood plain occurs in a spatially random manner. Actual flood plain development may occur according to the location of human phenomena, such as road and bridge locations, rather than natural phenomena.

Subdivided lots are found throughout much of the Victor Transect, with the exception of the southeast quarter of the study area. This region contains only four subdivided lots. Table 7 lists the mapping units that contain the greatest number of lots for this time interval.

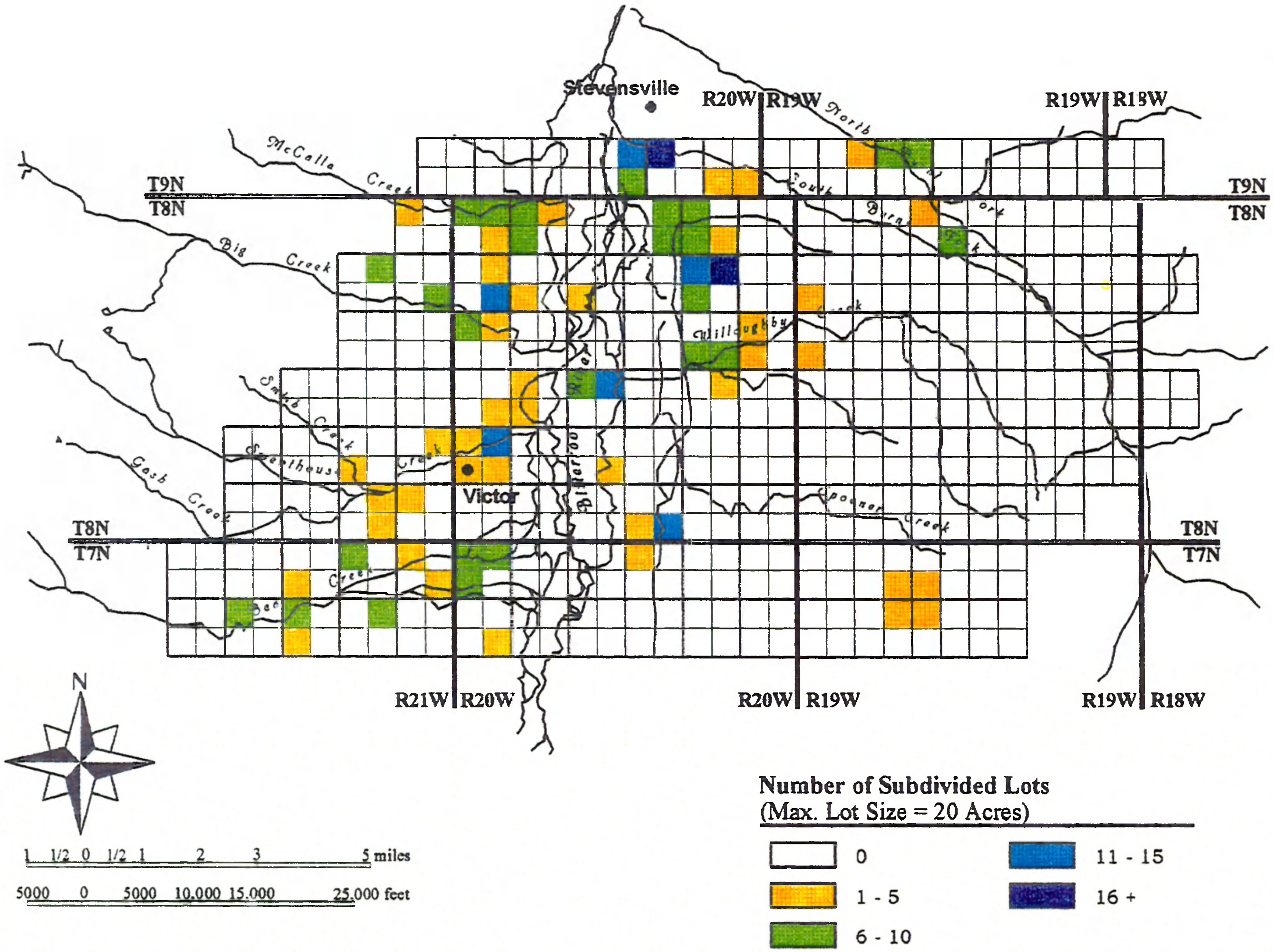

Figure 14. Subdivided lot locations during the period 1967 - 1976.

Table 7. -- The location of areal units (quarter sections) containing the greatest number of subdivided lots during the T1 (1967-1976) interval.

Mapping Unit Location	**Number of Lots Created**	**Location Description**
NE1/4,SEC11,T8N,R20W	22	East-side high terrace, west slope of Sunset Bench.
NW1/4,SEC35,T9N,R20W	16	East-side low terrace, 1/2 mile south of Stevensville, along South Burnt Fork.
NE1/4,SEC30,T8N,R20W	14	West-side low terrace and partial flood plain area, 1/2 mile northeast of Victor, mouth of Sweathouse Creek.
SE1/4,SEC7,T8N,R20W	13	West-side low terrace, north of Big Creek.
SE1/4,SEC34,T8N,R20W	13	East-side high terrace.
NW1/4,SEC11,T8N,R20W	12	East-side high terrace, west slope of Sunset Bench.
NE1/4,SEC21,T8N,R20W	11	East-side flood plain area.
NE1/4,SEC34,T9N,R20W	11	East-side low terrace, 1/2 mile southwest of Stevensville, along South Burnt Fork.

<u>1977 - 1986</u>

More lots were subdivided during this time period than in any other. The late 1970s, especially, represent a subdivision boom that took place in many northern areas of Ravalli County. There are 261 subdivisions recorded during this interval, and these land divisions produced 646 new lots, with an average lot size of 4.99 acres.

Figure 15 illustrates the locations of the 1977-1986 subdivided lots in the Victor Transect. Areal units that contain lots tend to form continuous north-south corridors on both sides of the flood plain. Included within these corridors are concentrated lots south of Stevensville and south of Victor. Many of the lots subdivided during this period are located near tributary streams (Bear Creek, Sweathouse Creek, and Burnt Fork), but lots also appear noticeably in the areas between streams. Similar to the previous interval, there continues to be scattered lot placement within the flood plain, while the eastern portion of the study area remains relatively empty of subdivided lots. Table 8 lists the mapping units that contain the greatest number of new lots that were created during this ten-year interval.

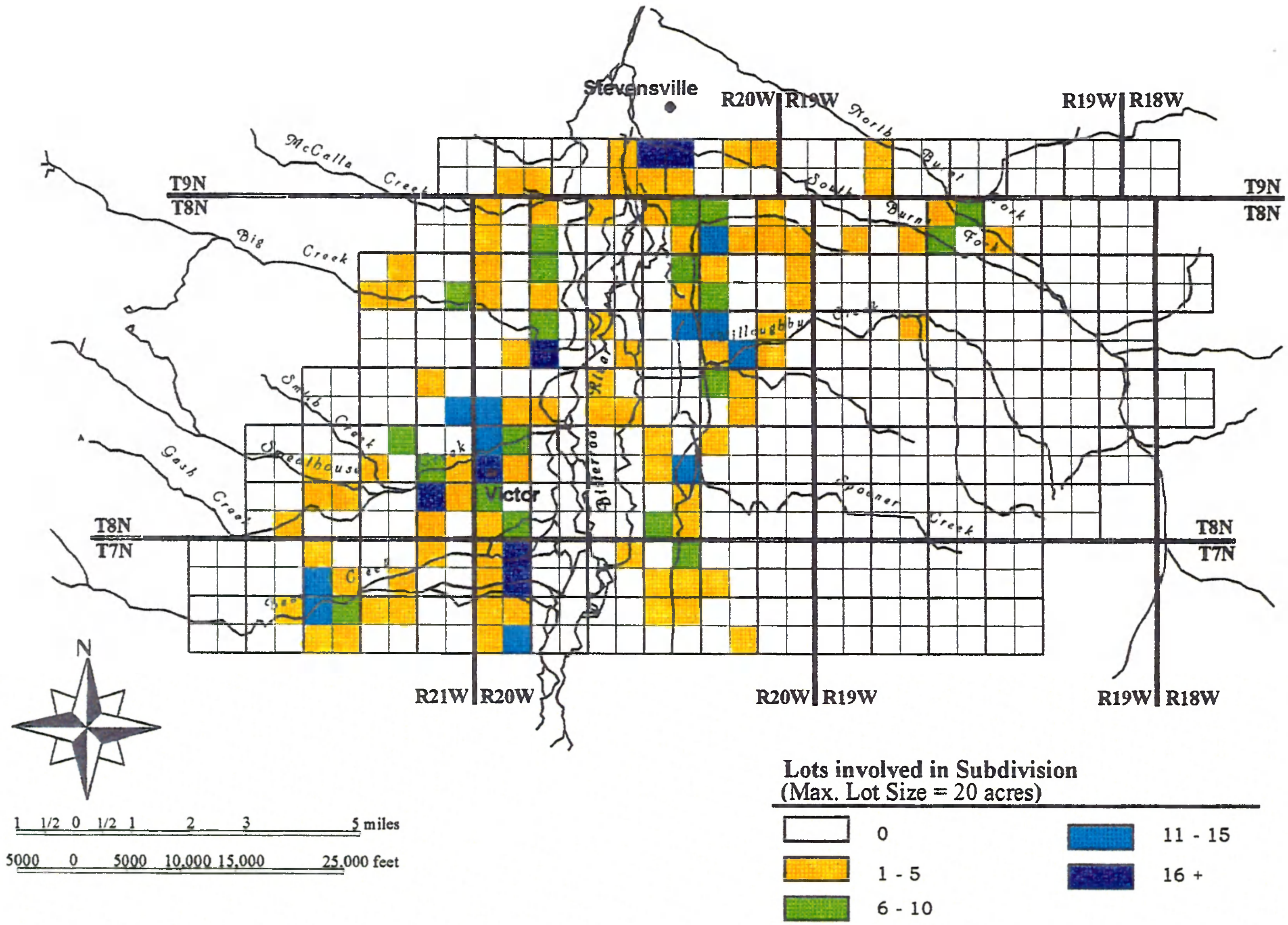

Figure 15. Subdivided lot locations during the period 1977 - 1986.

Table 8. -- The location of areal units (quarter sections) containing the greatest number of subdivided lots during the T2 (1977-1986) interval.

Mapping Unit Location	Number of Lots Created	Location Description
NE1/4,SEC6,T7N,R20W	40	West-side low terrace, partly in flood plain area, mouth of Bear Creek, along Hwy. 93.
SE1/4,SEC6,T7N,R20W	32	(same as above)
NW1/4,SEC36,T8N,R21W	21	West-side low and high terraces, 1 mile southwest of Victor.
SW1/4,SEC17,T8N,R20W	19	West-side flood plain and low terrace areas, mouth of Big Creek.
NW1/4,SEC35,T9N,R20W	19	East-side low terrace, 1/2 mile south of Stevensville, along South Burnt Fork.
SW1/4,SEC30,T8N,R20W	18	West-side low terrace, Victor.
NE1/4,SEC34,T9N,R20W	17	East-side low terrace, 1/2 mile southwest of Stevensville, along South Burnt Fork.
SW1/4,SEC19,T8N,R20W	15	West-side low terrace, 1 mile north of Victor.
SE1/4,SEC7,T7N,R20W	14	West-side flood plain and low terrace areas.

1987 - 1996

The locations of 1987-1996 subdivided lots are shown in figure 16. The least amount of lot creation takes place during this interval. Although a consistent number of areal units are affected by subdivisions, most of these units contain less than five new lots. It is possible that, at this time, further development is occurring on previously subdivided lots, in contrast to the creation of new residential lots. During this period, 102 subdivisions were recorded, which produced a total of 235 new lots that had an average lot size of 5.29 acres. There is a more-pronounced random pattern of lot

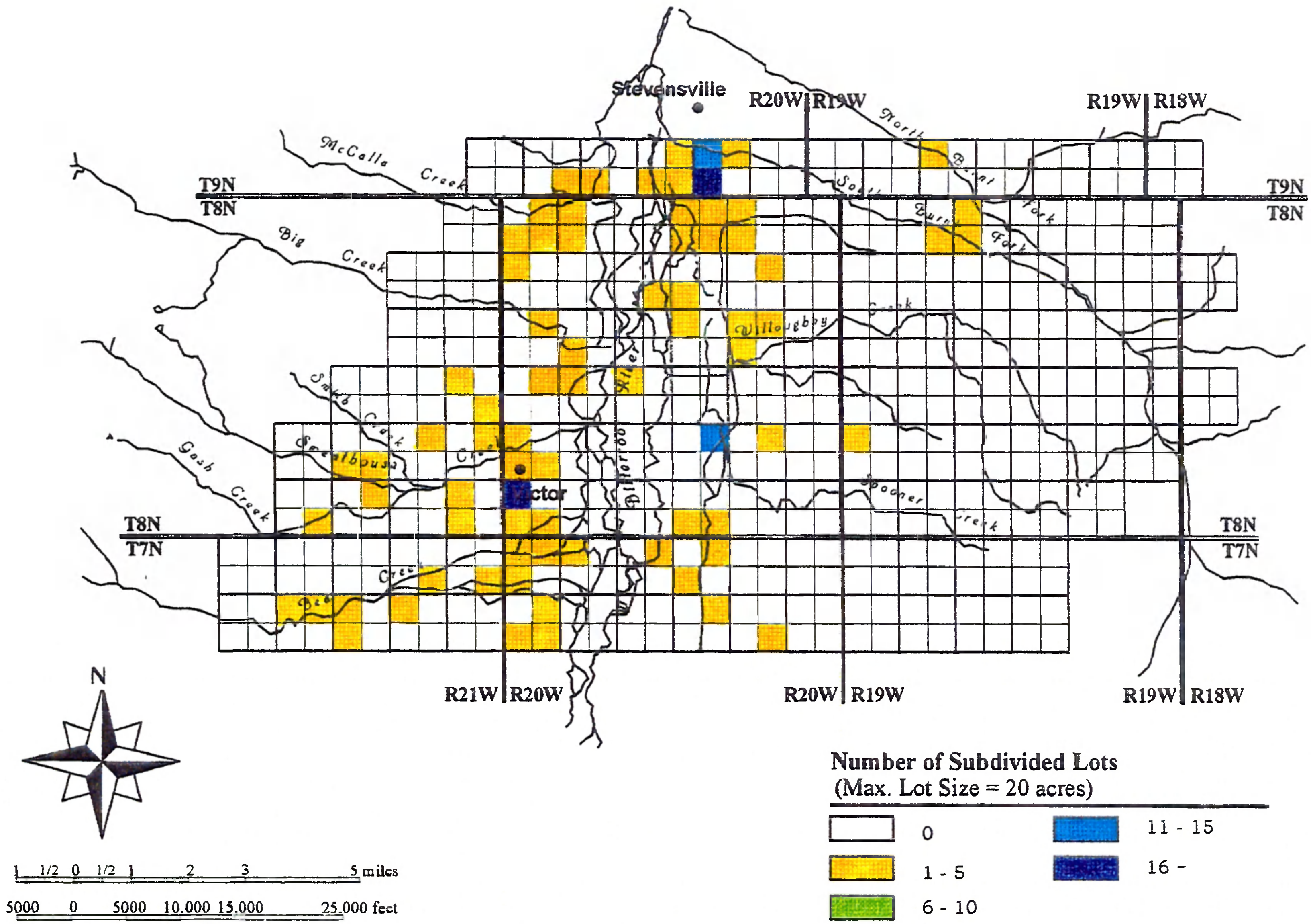

Figure 16. Subdivided lot locations during the period 1987 - 1996.

distribution in this interval than in previous intervals. Near-equal lot location takes place between those areal units adjacent to streams and those that are non-adjacent. Similar to the previous ten-year intervals, concentrations of lots exist south of Stevensville and Victor. Table 9 lists the mapping units that experienced most of the lot creation during the T3 interval.

Table 9. -- The location of areal units (quarter sections) containing the greatest number of subdivided lots during the T3 (1987-1996) interval.

Mapping Unit Location	Number of Lots Created	Location Description
NW1/4,SEC31,T8N,R20W	29	West-side low terrace, 1 mile south of Victor.
SW1/4,SEC35,T9N,R202	21	East-side low terrace, 1 mile south of Stevensville.
NW1/4,SEC35,T9N,R20W	14	East-side low terrace, 1/2 mile south of Stevensville, along South Burnt Fork.
NE1/4,SEC27,T8N,R20W	11	East-side low terrace.
NW1/4,SEC3,T8N,R20W	5	East-side flood plain and low terrace, along East Side Hwy.
SE1/4,SEC30,T8N,R20W	5	West-side flood plain and low terrace, 0-1/2 mile east of Victor, along Hwy. 93.
SE1/4,SEC24,T8N,R21W	5	West-side low and high terraces, 1 mile northwest of Victor.

LOT LOCATION SUMMARY

Subdivision characteristics for the entire study period are listed in table 10. Subdivisions were larger twenty years ago than they are now. That is, subdivisions during the T1 interval (1967-1976) contain an average of 4.41 lots, while more recent subdivisions average only 2.3 lots. This earliest study interval is also unique because the average lot size is 25 percent larger than those subdivided later. The majority of subdivisions occurred during the T2 interval (1977-1986). During this period, 51 percent of all studied lots were created, using 45 percent of the total acreage involved in subdivision. During the T3 interval (1987-1996), the number of lots-per-subdivision continued to decrease, while the average lot size increased only slightly. Only 235 new residential lots were created during this period, which is 18 percent of the total number of lots recorded in this study.

Table 10. -- Summary of subdivision characteristics.

	# of Subdivisions	# Lots Created	Avg. # Lots per Subdivision	Gross Acreage	Avg. Lot Size (acres)
T1 (1967 - 1976)	90	397	4.41	2,738.04	6.90
T2 (1977 - 1986)	261	646	2.48	3,225.56	4.99
T3 (1987 - 1996)	102	235	2.30	1,244.01	5.29
Totals	453	1278	2.82	7,207.61	5.64

Interpretation

Figure 17 illustrates the site placement of all subdivided lots created during the entire thirty-year research period. There seems to be a random pattern among those areal units that contain lots. However, units containing sixteen lots or more are generally clustered in one of two areas: either a two mile radius surrounding Victor, or a four mile linear configuration extending south from Stevensville. Most of the mapping units without lots are located to the east of the Bitterroot River, along the high terraces and foothills.

A. East-Side Development

Many areas along the east-side terraces were subdivided as orchard tracts prior to World War I. Most notably, Sunset Orchards took up much of the area that lies between the South Burnt Fork of the Bitterroot River and Willoughby Creek, creating approximately 230 ten-acre lots between 1909 and 1910 (refer to figure 6, chapter 3 for location). Some of these lots were never sold; consequently, they were reconsolidated into farmland tracts (Montana Department of Intergovernmental Affairs 1973, 5). Other lots have remained, and many are being further divided by way of Amended Plats. During the study period, six original Sunset Orchard tracts were amended into thirteen, creating seven new lots. In most cases, the original ten-acre lot is divided in half, forming two five-acre lots.

The southeastern high terrace area of the Victor Transect is extensively used for non-irrigated farmland and rangeland (U.S. Department of Agriculture 1959, 7; Montana State Department of Community Affairs 1977). Most of the existing

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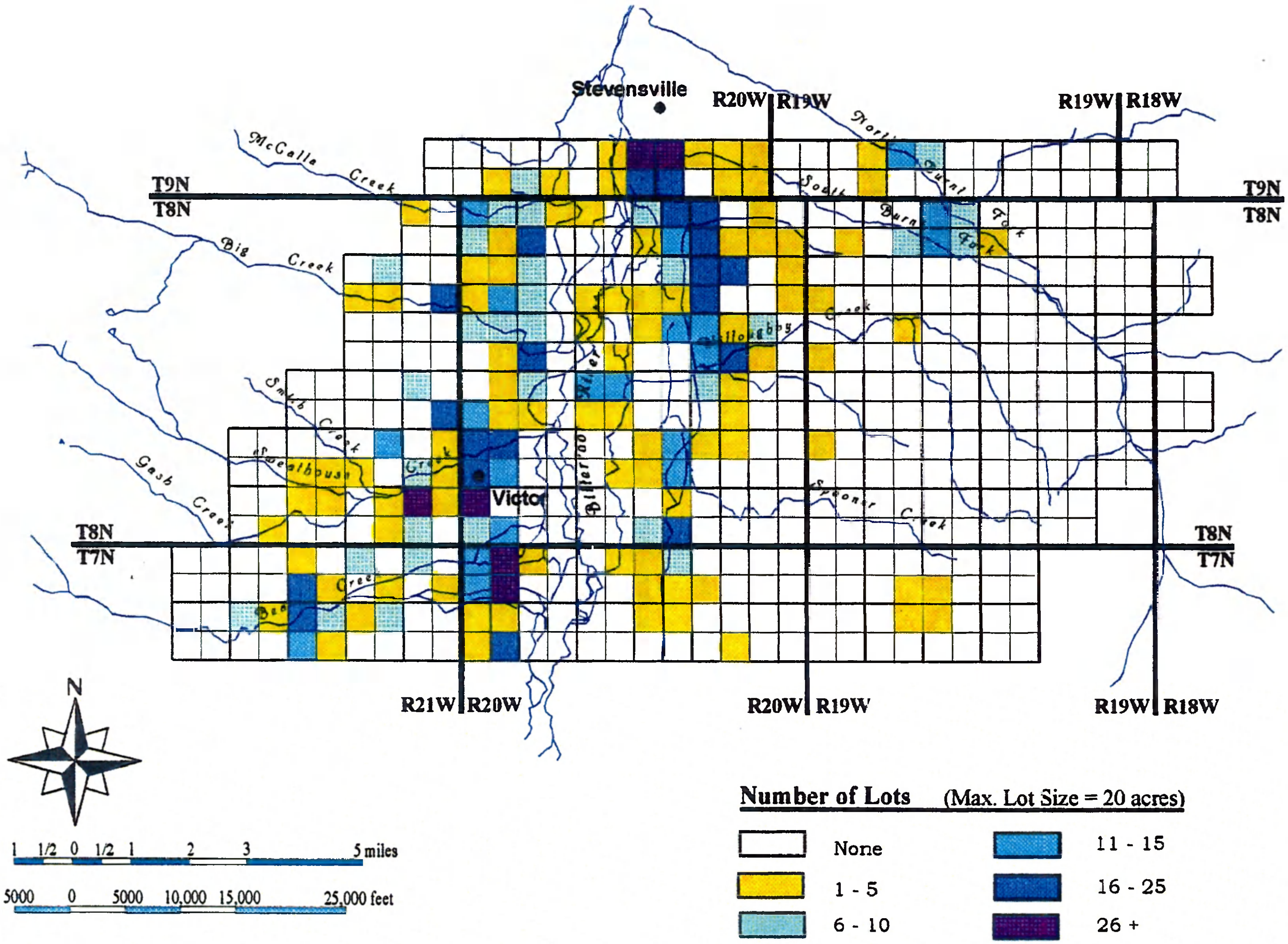

Figure 17. Subdivided lot locations during the entire study period, 1967-1996.

residences are occupied by the farmers and ranchers of the immediate area. There exists a very large depth to the water table in this region, resulting in often difficult and expensive ground water extraction. This development obstacle may continue to prevent residential growth from spreading along the eastern Tertiary high terraces.

The low terraces located to the east of the Bitterroot River have been used since the 1850s for irrigated cropland and pastureland (McMurtrey et al. 1972, 24). This area is much more accessible than the higher bench areas, and both surface and ground water is in greater supply. Unsurprisingly, residential subdivision has occurred more frequently in the low east-side terrace region, breaking up formerly continuous agricultural land.

Notably, the existing areas of non-irrigated farmland and rangeland act as a buffer zone between the rural residential lots and the forested Sapphire Range.

B. West-Side Development

The occurrence of residential lots is more constant and widespread throughout the west side of the Bitterroot River than the east side. Recent subdivision has taken place from the flood plain to the foothills of the Bitterroot Range. Selected areas within the low and high terraces of the west side have traditionally been used as irrigated cropland and pastureland (U.S. Department of Agriculture 1959, 7-9 ; Montana State Department of Community Affairs 1977). Residential lots have woven their way between agricultural tracts, and are markedly found along tributary streams. As a result, there is no distinct land use buffer zone between the rural residential lots near the flood plain and the mountain foothills, as there is on the east side of the Bitterroot Valley.

C. Flood Plain Development

Areal units containing a large number of subdivided lots are often located adjacent to (or within) the 100-year flood plain of the Bitterroot River. Table 11 compares the creation of lots in the flood plain for each of the three time intervals. Forty-six areal units are centered within the 100-year flood plain in the Victor Transect, and eleven of these (24%) contain 52 residential lots. An additional forty-five areal units are located partially within the flood plain. Thirty of these (67%) contain 290 lots. Out of the 1,278 total subdivided lots recorded in this study, over one quarter of them (27%) exist in mapping units located wholly or partially within the 100-year flood plain boundaries.

Table 11. -- Lot development in the Bitterroot River 100-year flood plain.

	Total # Lots	# Lots Totally within the Flood Plain	# Lots Partially within the Flood Plain	Total # Flood Plain Lots	% ratio: Flood Plain Lots/ Total Lots
T1 (1967-1976)	397	17	73	90	22.7
T2 (1977-1986)	646	24	178	202	31.3
T3 (1987-1996)	235	11	39	50	21.3
	Σ = 1278	Σ = 52	Σ = 290	Σ = 342	

Any increased regulation relating to flood plain development has had little effect on the continuing occurrence of lots in these areas. The ratio of flood plain lots to total lots for each ten-year interval remains relatively consistent (over 20%). There is a slight decrease in flood plain lots during the T3 (1987-1996) time interval; however, this is due to the decrease of lots adjacent to or partially within the flood plain. There is actually an increase in the percentage of lots located wholly within the flood plain during this period.

Descriptive Statistics

Out of 518 mapping units, 166 of them, or 32 percent, contain subdivided lots. Summary statistics for these 166 units are as follows:

range (R) = 1 to 50 lots
arithmetic mean (m) = 7.66
median (md) = 5.0
mode (mo) = 1.0
standard deviation (SD) = 8.39

The distribution of subdivided lots within the Victor Transect is highly positively skewed. Table 12 further describes the distribution of lots.

Table 12. -- Frequency distribution of lots within quarter-sections.

Class	Range (# lots)	# Areal Units (frequency)	% Frequency	Cumulative % Frequency
1	0	352	67.9	67.9
2	1 - 5	90	17.4	85.3
3	6 - 10	30	5.8	91.1
4	11 - 15	20	3.9	95.0
5	16 - 25	20	3.9	98.9
6	26 +	6	1.1	100.0
		Σ=518	Σ=100.0	

CHAPTER 7

FINAL ANALYSES AND CONCLUSION

The final research objective is to determine the site suitability of subdivisions within the 1967 to 1996 period. Statistical correlation methods, such as Pearson's correlation coefficient, are ideal tools for solving this type of problem. Correlation coefficients describe the direction and character of the relationship between two variables, ranging in value between -1.0 and +1.0. A negative coefficient represents the decrease of one variable as the other variable increases, while a positive coefficient depicts two variables that increase or decrease simultaneously. A coefficient near zero represents little to no correlation between the two variables. There are two types of variables present in this study; site variables (pollution potential scores) and subdivision variables (lot occurrences and sizes). The resulting coefficient will therefore determine whether the occurrences of residential lots are increasing or decreasing as the pollution potential value of the area increases.

It is hypothesized that the occurrences of residential lots in the Victor Transect have changed (either increased or decreased) over time with respect to locations sensitive to water pollution. To determine temporal trends, the three intervals are analyzed separately, and the resulting correlation coefficients are numerically compared to each other in order to find either a positive or negative direction change.

Further analysis is done to determine if certain site characteristics have influenced the location of lots. Pollution potential values from each of the six site factors are correlated with lot occurrences to determine if the attributes of any one factor cause preferential lot location.

SUBDIVISION SUITABILITY ANALYSIS

The population of Northern Ravalli County has grown nearly 130 percent between 1967 and 1996. An increase in population usually results in the need to create more residential lots. A limited amount of acreage in the study area is suitable for locating residential subdivisions, based on water pollution potential results (chapter 5). As suitable areas fill, lots will likely spread to less-suitable areas and increase the potential for water pollution.

On the other hand, as an area's population increases, it is possible that subdivision and water protection regulations will expand and tighten, discouraging the placement of residential lots in unsuitable areas. Instead, lot development could be channeled to those locations with a lower potential to generate water pollution. The Montana Subdivision and Platting Act may have affected the study area in this manner, by requiring major subdivisions to undergo increased government review, including environmental assessment. In this case, the result may be that fewer lots are occurring in unsuitable areas over time.

Statistical correlation will determine if either of the above scenarios are happening in the Victor Transect. The Pearson method of correlation analysis is used for relating the "number of lots" found in each areal unit to that unit's "total pollution potential score," with results shown below in table 13. The *population* is composed of those areal units involved in residential subdivision, therefore, units containing zero lots are not included in correlation analysis. By ignoring zero-lot units, a more even distribution of subdivision variables is gained, since two-thirds of all areal units experienced no residential subdivision during the study period.

Table 13. -- Pearson correlation between an areal unit's water pollution potential and number of lots.

Variable	(1967-76) T1 Lots	(1977-86) T2 Lots	(1987-96) T3 Lots
Pollution Potential Value	0.026	0.128	-0.176

T1 (1966-1976)
population=74, crit.value=.228
T2 (1977-1986)
population=122, crit.value=.176
T3 (1987-1996)
population=76, crit.value=.225

Another development indicator is the "average lot size," which is used to estimate the possible lot density of an area. In theory, the smaller a residential lot, the more of them will fit into an areal unit, increasing the lot density. Increased density creates more intense land disturbance and a greater threat of water pollution per acre, especially when individual septic systems are used. Similar to the above correlation, the Pearson coefficient is used to determine the relationship between an areal unit's pollution potential score and average lot size (table 14).

Table 14. -- Pearson correlation between an areal unit's water pollution potential and average lot size.

Variable	(1967-76) T1 Average	(1977-86) T2 Average	(1987-96) T3 Average
Pollution Potential Value	-0.166	-0.057	0.065

T1 (1966-1976)
population=74, crit.value=.228
T2 (1977-1986)
population=122, crit.value=.176
T3 (1987-1996)
population=76, crit.value=.225

The resulting relationship between the pollution potential score and both subdivision variables is not statistically significant for any of the time intervals studied. It is worth noting that the direction of correlation changes--in both cases--between the second and third intervals. The occurrence of lots *increases* (albeit insignificantly) along with an areal unit's water pollution potential during 1967-1986. But during 1987-1996, this trend reverses as the occurrence of lots *decreases* when a mapping unit's water pollution potential increases. During 1967-1986, the average lot size *decreases* as the pollution potential of a unit increases, indicating the potential for greater residential density in pollution-prone areas. But during 1987-1996, this trend also reverses as the average lot size *increases* in areas of increasing pollution potential. It should be noted that the insignificant nature of the statistical data prevents inferences of this kind from being made with certainty.

The *distribution* of subdivided lots along the range of pollution potential values is most visible in a frequency distribution graph format. Figure 18 illustrates the distribution of lots over the range of pollution potential values, adding to the information gained from the correlation coefficients. The percentage of lots, rather than the number of lots, is measured along the y-axis in order to compare data from each study interval. Pollution potential classes are arranged on the x-axis, matching the final suitability ratings as derived in chapter 5.

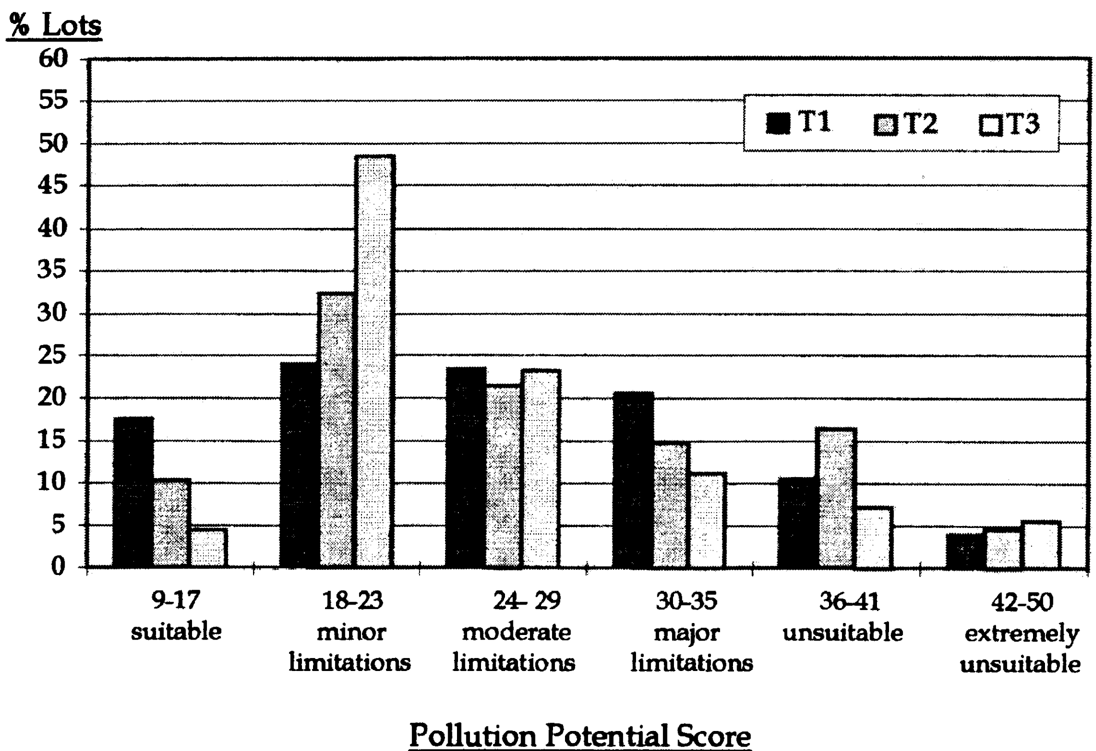

Figure 18. Frequency distribution graph of the percentage of residential lots found within the range of pollution potential values.

For all study intervals, the greatest percentage of residential lots occurs within quarter-section units that are classified as "suitable with minor limitations." All intervals are displayed as having a positively-skewed distribution, with more lots created in suitable areas than unsuitable ones. However, the degree of peakedness (kurtosis) of the frequency distribution varies noticeably between intervals. During T1, the distribution of lots is widely spaced around the mean pollution potential score (T1 mean = 26.74). In contrast, the T3 interval has a high degree of peakedness and a narrower distribution of lots over the range of pollution potential values. During this last period, fewer lots are created in unsuitable areas than in earlier periods, and a much greater percentage of lots occur in the class below the arithmetic mean (T3 mean = 25.39). The frequency distribution kurtosis during the T2 interval falls somewhere in between the other two intervals (T2 mean = 27.30).

The frequency graph (figure 18) may better illustrate a decrease in unsuitable subdivision over time, compared to the Pearson correlation coefficients. There is a slight increase in lots created in "extremely unsuitable" areas during the T3 interval, but overall, a smaller proportion of unsuitably-placed lots exists in this last study interval compared to earlier intervals.

SITE PREFERENCE ANALYSIS

It is possible that residential lots have been situated according to certain individual site characteristics. For example, a shallow depth to ground water may signify water availability, and encourage residential development. Likewise, ground water that is located deep below the surface may prove difficult and expensive to extract, prohibiting development. An analysis of each of the six site factor ratings may reveal subdivision trends that are not apparent by looking at their sum alone.

The pollution potential of the six individual site factors is correlated with the number of subdivided lots by using Spearman's Rank Correlation method. The Spearman method is used for two main reasons. First, the site factor ratings exist in a standardized format, having been classified and ranked. Second, the dispersal of assigned scores within each site parameter does not always resemble a normal distribution. These conditions point to the use of an ordinal data correlation method such as Spearman's.

Table 15 reveals the relationship between individual site factor ratings and the number of lots found in each areal unit. The population is similar to previous correlation analyses for each of the study intervals, since quarter sections that contain zero lots are not included. The classification and ranking of site factor variables has been defined in chapter 5. The "number of lots" variable is classified and ranked to an ordinal scale for use in Spearman's correlation method.

The following classification of lots is used:

# Lots	Rank	# Lots	Rank
1 - 2	1	11-15	4
3 - 5	2	16-20	5
6-10	3	21+	6

Table 15. -- Spearman correlation between an areal unit's site factor rating and number of lots.

Variable	(1967-76) T1 Lots	(1977-86) T2 Lots	(1987-96) T3 Lots
Topography	-0.117	0.011	** -0.366
Soil texture	0.113	-0.042	0.008
Parent material texture	* 0.293	0.163	-0.089
Distance to surface water	0.104	0.048	-0.146
Distance to 100-year flood plain	0.006	0.054	0.052
Depth to ground water	0.017	-0.082	-0.178

T1 (1966-1976)
population=74
T2 (1977-1986)
population=122
T3 (1987-1996)
population=76

* significant at .05
** significant at .01

Two significant relationships appear in table 15. One of these is the *positive* correlation between T1 lots and the pollution rating for parent material texture. The correlation that exists during this period is probably due to chance, since it is very unlikely that lots have been placed consciously with parent material texture in mind. A significant *negative* correlation exists between T3 lots and the pollution potential of topography. This signifies that during this period, fewer lots were created on steep slopes,--or on extremely flat slopes.

All site factor variables need to be interpreted in the following way: A positive correlation implies that the number of lots *increases* as an areal unit's pollution potential value increases, and a negative correlation implies that the number of lots *decreases* as the pollution potential increases. Therefore, a negative coefficient represents a more desirable development situation where water quality protection is concerned.

Interestingly, the direction of the correlation coefficients rarely remains constant throughout the entire study period. Most direction changes occur during the T3 interval where most often, the direction change is from positive to negative, therefore favoring more suitable lot location. Table 16 defines the relationship between individual site factor ratings and average lot size.

The classification and ranking scheme used for the "average lot size" variable is as follows:

class (acres)	rank	class (acres)	rank
0 - 2	1	8.1-10	5
2.1- 4	2	10.1-12	6
4.1- 6	3	12.1-16	7
6.1- 8	4	16.1-20	8

Table 16. -- Spearman correlation between an areal unit's site factor rating and average lot size.

Variable	(1967-76) T1 Average	(1977-86) T2 Average	(1987-96) T3 Average
Topography	0.063	-0.062	0.118
Soil texture	0.131	0.108	0.077
Parent material texture	-0.177	* -0.178	0.015
Distance to surface water	*-0.237	-0.142	-0.105
Distance to 100-year flood plain	-0.164	0.032	0.068
Depth to ground water	-0.156	-0.072	-0.136

T1 (1966-1976)
population=74
T2 (1977-1986)
population=122
T3 (1987-1996)
population=76

* significant at .05

There are two significant relationships between these variables, but again, this is probably due more to chance than purposeful lot planning. During the T1 study interval, there is a *negative* correlation between the average lot size and the distance to surface water, meaning that as the pollution potential increases (distance to water decreases), the average size of the lots decreases. During the T2 interval, a *negative* correlation exists between the average lot size and the pollution potential of the parent material texture. For this period, lot sizes get smaller as the pollution potential of the parent material increases.

The direction of most correlation coefficients remains constant throughout the research time period. In this case, a positive coefficient relates favorably to more suitable lot location (when taking into account the use of the private septic system). Two coefficients are positive for both the T1 and T2 intervals, compared to four positive coefficients during T3. Using this information, one may infer that over time, lots sizes are increasing in areas sensitive to water quality degradation. However, such statements should not be made without further study, realizing the insignificant nature of the statistical results.

CONCLUSION

Land division in the Victor Transect study area has been characterized by numerous individual subdivisions, the majority creating between one and five new lots. Few subdivisions contain over ten lots. In fact, the largest land divisions to take place in the study area occurred between 1900 and 1913, when land speculators created hundreds of ten-acre orchard tracts. Smaller land splits--such as those occurring during the study period--can often be accomplished with minimal environmental analysis, especially in rural areas such as Ravalli County. Minor subdivisions (those creating five or fewer lots) undergo significantly less review than major subdivisions, even though a watershed cannot identify the difference between large and small subdivisions. Many small land splits add up and will eventually equal the environmental effects of a large corporately-owned subdivision.

Intensifying this situation is the fact that most small rural subdivisions employ individual septic systems as the means of waste disposal. The occurrence of so many septic systems presents a potential threat to water quality in Ravalli County. There are specific areas within the Victor Transect that are inappropriate for septic system placement because of unsuitable soils, steep slopes, or a high water table. Other residential development practices, including the clearing of vegetation and the introduction of impermeable surfaces (roads, roofs, and decks), also threaten water quality. In addition, the construction phase that takes place during home and road building may temporarily elevate erosion and cause sedimentation of surface waters.

Summary

The Victor Transect study area is representative of Northern Ravalli County in that it contains a wide range of natural conditions. The suitability of a location to support residential development ranges from very low to very high. The analysis of existing natural conditions, along with subdivision locations, accomplishes an important preliminary step toward evaluating potential water degradation. Generally, the topographic highs and lows within the Victor Transect represent unsuitable areas for residential development. The topographic low is the Bitterroot River flood plain, which is described by a high water table and undesirable soils and parent material textures (generally coarse and excessively permeable). Topographic highs are found along the east and west boundaries of the study area, along the Sapphire and Bitterroot mountain ranges. These areas often contain steeply sloped surfaces with shallow to non-existent soils. The west side of the Bitterroot Valley is more predisposed to water pollution than the east side, based on the analysis of six site parameters (depth to ground water, surface slope, soil texture, parent material texture, distance to surface water, and distance to the 100-year flood plain). The east side of the valley contains many contiguous areas on low and high terraces that are suitable for residential development, based on a low threat of water pollution. However, many of these areas are presently used for dryland farming or rangeland. In addition to the economic importance of agriculture in the area, the remaining farmland of the entire Bitterroot Valley offers clear scenic vistas as well as buffer zones between housing tracts and forest land. Without this, the valley would be a less attractive place to live. This study analyzed residential development in relation to water quality only. The importance of agricultural land must also be acknowledged when determining the best areas for future residential growth.

Forty-three percent of the residential lots created throughout the thirty-year research period have taken place in areas suitable for residential development, or suitable with minor site limitations. Another 40 percent of lots are located in areas somewhat suitable, but having moderate to major site limitations. The remaining 17 percent are located in areas unsuitable for residential development, with a high potential for water degradation. Contrary to initial assumptions, residential lots have not been increasingly located in unsuitable locations with respect to water quality. Lot locations have been fairly random with respect to water pollution potential, although there may be a slight improvement trend throughout the past decade. It should be noted that this increase in suitably-located lots has been small and statistically insignificant. The percentage of lots found in "extremely unsuitable" areas remains relatively constant throughout each of the three study intervals.

Individual site parameter ratings are not strongly correlated with residential lot creation. That is, there are no controlling site factors which encourage or discourage lot placement. The limitations of quarter-section mapping units, coupled with positively-skewed data, may have disguised some of the correlation that exists between variables. One example is the relationship between the number of lots created and the distance to the Bitterroot River flood plain. Even though little statistical correlation exists, over one-quarter of all lots occur within areal units located wholly or partially in the flood plain. An explanation for this is the fact that pollution potential ratings are used in correlation, rather than raw distance measurements. Beyond a distance of 5,000 feet from the flood plain boundary, all areal units receive the same pollution potential rating of "1," and consequently, most units are assigned this lowest rating value.

Damaging floods occur on an average of once every ten years on the Bitterroot River (U.S. Department of Agriculture 1995, 6). The Bitterroot Valley has a broad, flat flood plain. Once flooding begins, the waters can spread far across the valley. The building of homes and roads in these areas alters the flood plain topography and ultimately changes the flood plain boundaries. The percentage of residential lots in or near the flood plain for each time interval has remained nearly constant. This can be explained by basic human settlement assumptions. Settlement often reflects a decision to lessen the frictional effect of distance while agglomerating to take advantage of scale economies (Garner 1967, 305). Near the flood plain, highways provide easy access to nearby population centers, which tend to be located near the flood plain boundary. Lots located in these areas can take advantage of nearby shops and public services. Unfortunately, flood plain areas are also serious water pollution potential areas.

The use of the individual septic tank and drainfield continues to be the waste disposal system of choice for Victor Transect subdividers. The cost of extending present sewer lines prevents most subdividers from joining regulated municipal treatment systems. Since subdivisions often contain few lots of five acres each, little effort has been made so far to use "micro" sewer systems, which would treat effluent from several lots located near each other.

Extension of Research

The creation of subdivided lots will likely continue in rural areas of Ravalli County. The Victor Transect is representative of the main Bitterroot Valley in its physical characteristics, but other county locations may be experiencing development trends besides those described in this study. It is important to recognize all fast-growing regions, and to monitor their site placement of residential development. This research measures the water pollution "potential" of areal units. Field testing should be done to measure the actual water quality, especially in those units identified as having high pollution potential, along with significant lot creation.

APPENDIX A-1

PLATTED SUBDIVISIONS

File #	Subdivision Name	Filing Date	Section	Tier	Range	Total Area (acres)	Lots
91	Wildwood Pk Acres	Jun-69	30NE	8N	20W	33.57	14
49	Melody Meadows	Jul-69	2NW 3NE	8N	20W	113.65	13
60	Pondera Acres	Aug-72	6N	7N	20W	22.20	7
39	Iron Cap Ranch 2	Jan-73	33N	9N	19W	50.29	20
38A	Iron Cap Ranch 1	Jan-73	see note[1]	9N	19W	1227.56	43
76A	Paradise Valley Mb	Nov-75	34E	9N	20W	3.14	16
104A	Belvue Tracts	Mar-77	35NW	9N	20W	26.17	14
107A	Lombardy Acres 1	Jun-77	35NW	9N	20W	5.95	5
111	Montair Riv. View	Oct-77	7SE 18NE	7N	20W	36.38	5
111A	Lone Pine Rn	Nov-77	6NW	7N	20W	13.10	3
114A	Pleasant View Ac	Dec-77	36NW	8N	21W	15.71	5
116A	Big Creek Meadows	Feb-78	17SW	8N	20W	52.36	5
119A	Lombardy Acres 2	Mar-78	34NE	9N	20W	11.73	11
149A	Whitetail Heights	Mar-78	2S	8N	20W	16.31	5
82A	Victor Meadows	Jun-78	30NW	8N	20W	8.13	5
128A	Bear Creek Pines	Jun-78	10NW	7N	21W	16.99	5
131A	Evergreen Manor	Jul-78	19SW	8N	20W	6.19	5
136	Salish Sunset West	Aug-78	26NE	8N	21W	13.07	5
142A	Bell Meadows Add	Oct-78	15NE	8N	20W	29.63	5
148	147 Estates #2	Nov-78	34S	8N	20W	9.98	5
148A	Birch Creek Acres	Nov-78	34SE	8N	20W	11.04	5
150	Black Elk Ac Add	Nov-78	14NW	8N	20W	20.44	4
157	Chief Victor Est 2	Mar-79	19SW	8N	20W	10.00	5
158	St Mary's View Est	Mar-79	8NW	8N	20W	23.72	4
150A	Sunset Acres	Apr-79	17NE	8N	19W	21.00	5
96	Silverbow Meadows	May-79	6E	7N	20W	100.60	64
154A	Chief Victor Est	Jun-79	19SW	8N	20W	10.00	5
166A	Quiet Place	Nov-79	4NE	8N	19W	12.08	4
168B	Wildrose Meadows	Jan-80	12SE	8N	21W	20.00	4
168	Bear Creek Estates	Apr-80	10NE	7N	21W	25.24	5
167A	Cottonwood Mead	Jul-80	12SE	8N	21W	18.67	3
164B	Big Creek Pines	Apr-81	17SW	8N	20W	20.89	5
173A	Christianson Tract	Apr-81	4SW	8N	19W	40.56	8
188	Wildwood Park 2	Oct-82	30NE	8N	20W	10.80	8
190A	Victor 8	Jul-83	30SW	8N	20W	0.64	5

190B	Victor 9	Jul-83	30SW	8N	20W	0.36	3
192A	Curlew Homes	Jun-84	13SW	8N	21W	10.86	3
196B	Mittower Meadows	Aug-86	17NW	8N	20W	35.87	5
212A	Black Elk Ac Add2	Jun-92	14NW	8N	20W	10.19	2
215B	Holland Meadows	Sep-92	2SW 3SE	8N	20W	11.80	2
222A	Garnet Meadows	Sep-93	5SW	8N	20W	10.03	3
226A	Reimers Addition	Nov-93	35SW	9N	20W	16.36	5
227B	Joost Ranch 1	Dec-93	9SE 10SW	8N	20W	56.09	3
229B	McKenzie	Jan-94	31N	9N	19W	41.47	2
228A	Vance Addition	Jan-94	31NW	8N	20W	5.00	2
231A	Jason Acres	Feb-94	30W	8N	20W	11.94	2
231B	Marnell Lots	Feb-94	4NE	7N	20W	7.04	1
232A	Sangster Lot	Mar-94	2NW	8N	20W	3.00	2
232B	Terry 1	Mar-94	3SE	7N	21W	60.00	2
240A	Victor Estates	Jun-94	31NW	8N	20W	10.63	20
240C	Debbie's Acre	Jun-94	31NW	8N	20W	5.21	2
240B	Sherry's Acre	Jul-94	35NW	9N	20W	9.78	2
243B	Iron Lid Estates	Aug-94	33NW	9N	19W	5.80	2
245C	Reese Lots	Sep-94	36W	8N	21W	26.40	3
247A	Ellsworth	Oct-94	35SW	9N	20W	8.05	5
246A	Harrington Lots	Oct-94	1SE	7N	21W	107.90	3
258B	Joost Lots	Apr-95	3S	8N	20W	35.82	4
258A	W. Ridge Heights	May-95	32SE	9N	20W	15.38	2
263B	Teters Acres	Jul-95	19NE 20NW	8N	20W	6.86	2
265B	Cindies Lots	Aug-95	7S	7N	20W	10.04	2
264A	Baha Flats	Sep-95	11NW	7N	21W	10.10	2
268B	Lombardy Acres 3	Oct-95	35NW	9N	20W	12.32	2
269A	Stevens Lots	Oct-95	30SW 31NW	8N	20W	1.84	2
275B	Burnt Fork Hts	Nov-95	5SE	8N	19W	12.06	2
274A	McPherson	Nov-95	14SW	8N	20W	6.24	2
284A	Bullseye	Jun-96	5NW 6NE	7N	20W	20.00	5
289B	B'root Country Vw	Jul-96	14NE	8N	20W	20.34	3
289A	Noble 1	Jul-96	27NE	8N	20W	54.40	11
292B	Carmona Lots	Aug-96	34S	9N	20W	24.07	2
296B	King Lots	Sep-96	31NW	8N	20W	5.57	2

APPENDIX A-2

CERTIFICATE OF SURVEYS

File #	Certificate of Survey Type	Filing Date	Section	Tier	Range	Total Area (acres)	Lots
2	subdivide[1]	Aug-71	4SE	8N	19W	3.73	6
20	subdivide	Apr-70	20NW	8N	20W	27.29	4
39	subdivide	Apr-70	34NE	9N	20W	1.59	2
41A	subdivide	Apr-71	11SW	8N	20W	16.71	3
41B	subdivide	Apr-71	11NE	8N	20W	41.06	7
42A	subdivide	Apr-71	11NW	8N	20W	40.80	5
42B	subdivide	Apr-71	11SW	8N	20W	41.02	6
42C	subdivide	Apr-71	11NE	8N	20W	40.98	8
44	subdivide	Nov-70	23NE	8N	20W	2.49	2
50	subdivide	Jun-69	8SW	8N	20W	14.30	1
56	subdivide	Jun-70	23NE	8N	20W	5.59	2
66	subdivide	Oct-71	14-S	8N	20W	98.72	16
134	subdivide 147 Ranch	Aug-70	34-S	8N	20W	30.32	3
135	subdivide 147 Ranch	Aug-70	34SE	8N	20W	30.06	3
136	subdivide 147 Ranch	Aug-70	34SE	8N	20W	28.66	3
137	subdivide 147 Ranch	Aug-70	32SE	8N	20W	30.48	3
138	subdivide 147 Ranch	Aug-70	34SE	8N	20W	20.28	2
146	create a parcel	Jul-68	34NE	9N	20W	0.94	1
183	creation of tracts	Apr-72	6NW	8N	20W	52.68	9
186	creation of tracts	Jan-72	13NW	8N	20W	12.21	3
195	creation of tracts	May-72	21-N	8N	20W	98.49	19
210	subdivide	Aug-72	7NE	8N	20W	5.86	2
232	subdivide	Oct-72	28SE	8N	20W	2.96	2
279	create lot	Jun-72	3NW	7N	20W	1.01	1
312	partial subdivision	Jun-72	9NW	7N	21W	9.03	1
318	create lot, remainder	Jul-73	7NE	8N	20W	4.33	2
323	subdivide	Jul-73	7NE	8N	20W	4.07	1
332	subdivide	Feb-73	9SW	8N	20W	15.88	1
335	create a parcel	May-73	7SW	8N	19W	1.00	1
346	subdivide	Jun-73	7SE,18NE	8N	20W	73.01	7
363	tract created	Jun-73	5NE	8N	20W	10.83	1

367	subdivide	Aug-73	30-W	8N	20W	3.07	3
385	create parcels	Oct-73	1NW	7N	21W	39.80	3
390	subdivide	Oct-73	30-W2	8N	20W	3.07	3
399	partial subdivision	Oct-73	11NE	7N	21W	20.14	3
431	Mountain Vw Est	Dec-73	2SW,3SE	8N	20W	135.90	12
526	creation of parcels	Mar-74	21NE	8N	20W	5.06	2
538	creation of tracts	Apr-74	6N	7N	20W	69.00	6
539	subdivide	Apr-74	6SW	7N	20W	2.63	2
569	create lots	May-74	35NW	9N	20W	74.43	14
590	partial subdivision	Jun-74	3SW	7N	21W	46.59	3
592	divide into 4 tracts	Jun-74	1NW	8N	21W	29.32	4
593	division of land	Jun-74	8SW	8N	20W	38.11	3
594	division of land	Jun-74	7SE	8N	20W	85.20	8
596	division of land	Jun-74	5-W2,6NE	8N	20W	212.19	20
601	Rippling Woods	Jun-74	12SE,13NE,18NW	8N	21W	243.34	23
602	subdivide	Jun-74	1SE	7N	21W	19.90	3
609	subdivide	Jun-74	9NW,10-W2	7N	21W	128.27	13
614	division of gov't. lot	Jun-74	1NW	7N	21W	14.96	2
615	subdivide	Jun-74	4NW	8N	19W	37.12	3
619	tract created	Jun-74	14SW	8N	20W	14.18	1
626	subdivide	Jun-74	32NE	9N	19W	10.10	1
643	subdivide	Jul-74	11NW	8N	20W	46.27	7
644	subdivide	Jul-74	11NE	8N	20W	41.06	7
662	subdivide	Aug-74	10NW	7N	21W	9.26	1
740	division of land	Nov-74	7SE,18NE	8N	20W	38.13	3
754	subdivide	Dec-74	9NW	7N	21W	10.10	2
758	create tracts of land	Dec-74	4SW,5-S2,8-N2,9NW	7N	19W	40.31	3
762	create a parcel	Dec-74	6SE	8N	20W	2.65	1
769	subdivide	Dec-74	11NE	7N	21W	14.16	1
790	create a parcel	Jan-75	4NW	8N	19W	1.85	1
802	parcel division	Feb-75	36NW	8N	21W	26.58	2
813	subdivide	Mar-75	6SW	7N	20W	2.63	2
852	occasional sale	Apr-75	3SE	8N	20W	5.00	1
863	subdivide	May-75	36NW	8N	21W	14.00	2
868	family transfer	May-75	2NW	7N	21W	12.44	6
957	family transfer	Dec-75	11NE	7N	21W	20.46	2
962	occasional sale	Dec-75	13SW	8N	20W	9.98	1
1003	occasional sale	Mar-76	36NW	8N	21W	10.13	1
1009	occasional sale	Apr-76	6SW	7N	20W	2.63	2
1020	occasional sale	Apr-76	10NE	7N	21W	20.21	2
1040	occasional sale	Jun-76	26SW	8N	21W	5.16	3
1044	occasional sale	Jun-76	30NW	8N	20W	7.01	1

1069	occasional sale	Jul-76	7SE	7N	20W	3.06	1
1095	document lots	Sep-76	36-S2	9N	20W	80.00	4
1104	occasional sale	Sep-76	35NW	9N	20W	5.41	1
1107	occasional sale	Sep-76	11SW	8N	20W	10.35	1
1111	family transfer	Oct-76	35NW	9N	20W	5.21	1
1139	missing	Nov-76	30SW	8N	20W		
1144	occasional sale	Nov-76	35NE	8N	21W	8.00	1
1145	occasional sale	Nov-76	10NW	7N	21W	10.09	2
1148	occasional sale	Nov-76	25NE	8N	21W	1.00	1
1155	occasional sale	Dec-76	2SE	8N	20W	16.02	1
1161	occasional sale	Dec-76	35SE	8N	21W	14.01	1
1171	family transfer	Dec-76	19SE,20SW	8N	20W	21.32	2
1181	occasional sale	Oct-77	6NE	7N	20W	11.86	2
1188	occasional sale	Jan-77	11NW	8N	20W	9.06	2
1200	occasional sale	Jun-77	3SW	7N	21W	20.48	2
1204	occasional sale	Mar-77	3NE	8N	20W	19.71	2
1209	occasional sale	Mar-77	34NE	9N	20W	4.81	2
1224	occasional sale	Mar-77	19SE,20SW	8N	20W	14.61	2
1227	occasional sale	Apr-77	3NE	8N	20W	2.62	1
1254	occasional sale	May-77	6NW	7N	20W	5.01	1
1255	occasional sale	May-77	24NW	8N	21W	5.08	2
1385	occasional sale	Sep-77	6NE	7N	20W	11.86	2
1389	family transfer	Sep-77	11SW	8N	20W	10.23	2
1400	occasional sale	Jan-78	34NE	9N	20W	13.71	2
1418	occasional sale	Oct-77	7-S2	7N	20W	23.49	2
1429	occasional sale	Nov-77	34SE	9N	20W	2.50	1
1436	occasional sale	Nov-77	1SE	8N	20W	10.24	1
1439	occasional sale	Nov-77	10NE	7N	21W	19.78	2
1444	occasional sale	Dec-77	36NW	8N	21W	25.13	2
1446	family transfer	Dec-77	6SW	7N	20W	7.92	3
1449	occasional sale	Dec-77	10NW	7N	21W	12.70	1
1451	occasional sale	Mar-78	8NW	8N	20W	21.45	2
1460	family transfer	Dec-77	17NW	8N	20W	8.55	1
1464	occasional sale	Dec-77	17NW	8N	20W	2.00	1
1467	occasional sale	Dec-77	26SW	8N	21W	1.02	1
1469	occasional sale	Dec-77	15NE	8N	20W	10.00	1
1484	occasional sale	Jan-78	3NW	7N	21W	10.71	1
1488	family transfer	Jan-78	10NW	7N	21W	1.02	1
1489	occasional sale	Jan-78	1-W2	8N	20W	33.48	2
1496	occasional sale	Jan-78	10NW	7N	21W	5.14	1
1501	occasional sale	Jan-78	7-S2	7N	20W	10.02	1
1521	occasional sale	Feb-78	5SW	8N	20W	20.59	2
1530	occasional sale	Feb-78	36NE	9N	20W	5.00	1

1548	occasional sale	Mar-78	31SE	8N	20W	10.00	1
1562	occasional sale	Mar-78	7SE	7N	20W	22.52	2
1571	occasional sale	Mar-78	23NE	8N	20W	12.07	1
1617	occasional sale	Apr-78	5SW	8N	20W	20.11	2
1618	occasional sale	Apr-78	5-W2	8N	20W	21.94	2
1629	occasional sale	May-78	10SE	8N	20W	5.00	1
1640	occasional sale	May-78	6NE	7N	20W	11.82	2
1658	occasional sale	May-78	32SW	9N	20W	19.95	2
1662	occasional sale	May-78	3SE	7N	21W	15.36	2
1667	occasional sale	May-78	11SW	8N	20W	24.50	2
1711	occasional sale	Jun-78	21SE	8N	20W	2.27	2
1714	occasional sale	Jun-78	16SE	8N	20W	5.00	1
1749	occasional sale	Jul-78	2SW	8N	20W	10.11	2
1751	occasional sale	Oct-78	34NE	9N	20W	1.00	1
1762	occasional sale	Aug-78	2SE	7N	21W	20.76	3
1772	occasional sale	Aug-78	4NW	8N	19W	19.21	2
1773	occasional sale	Aug-78	4NW	8N	19W	19.18	2
1785	occasional sale	Aug-78	2SW	8N	20W	13.29	2
1791	occasional sale	Sep-78	9NE	7N	21W	10.54	2
1805	occasional sale	Sep-78	3SW	7N	21W	15.38	2
1806	occasional sale	Sep-78	3SW	7N	21W	15.38	3
1814	occasional sale	Sep-78	36NE	8N	21W	7.01	1
1815	occasional sale	Sep-78	6SE	8N	19W	10.41	2
1826	occasional sale	Sep-78	9NE	7N	21W	10.00	2
1828	occasional sale	Sep-78	3SW	7N	21W	10.30	2
1885	occasional sale	Nov-78	11SW	8N	20W	10.29	2
1942	occasional sale	Dec-78	4NE	7N	20W	1.35	1
1955	occasional sale	Dec-78	30NW	8N	20W	7.10	2
1979	occasional sale	Dec-78	8NW	8N	20W	20.74	2
2039	occasional sale	Feb-79	14SE	8N	20W	5.80	2
2040	occasional sale	Feb-79	14SE	8N	20W	6.82	2
2048	occasional sale	Feb-79	30NW	8N	20W	2.24	2
2071	occ sale, fam transfer	Feb-79	31SE	8N	20W	10.00	3
2080	occasional sale	Mar-79	31SE	8N	20W	4.00	2
2101	occasional sale	Jul-79	7SE	7N	20W	20.52	2
2112	occasional sale	Apr-79	35SW	9N	20W	19.36	2
2138	occasional sale	Apr-79	27SE	8N	20W	20.28	4
2143	occasional sale	Apr-79	2SW,3SE	8N	20W	10.76	2
2156	occ sale, fam transfer	May-79	14NW	8N	20W	20.40	3
2157	occasional sale	May-79	36SW	8N	21W	20.04	2

2158	occ sale, fam transfer	May-79	26NE	8N	21W	20.28	4
2171	occasional sale	May-79	31NW	8N	20W	3.00	1
2194	occasional sale	Jun-79	1NW	7N	21W	19.96	2
2195	occasional sale	Jun-79	35SW	9N	20W	5.00	1
2207	occasional sale	Jun-79	30SW	8N	20W	0.60	2
2214	occ sale, fam transfer	Jun-79	27SE	8N	20W	21.18	4
2243	occasional sale	Jul-79	1NW	7N	21W	19.96	2
2287	occasional sale	Aug-79	30SW,31NW	8N	20W	2.04	2
2320	occasional sale	Sep-79	18SE	8N	20W	1.56	1
2339	occasional sale	Sep-79	10SW	7N	21W	20.65	2
2360	occasional sale	Oct-79	33-E2	9N	19W	19.45	1
2369	occ sale, fam transfer	Oct-79	25SE	8N	21W	2.87	4
2376	family transfer	Nov-79	24SE	8N	21W	19.99	3
2381	occ sale, fam transfer	Nov-79	27SE	8N	20W	20.00	4
2406	occasional sale	Nov-79	3SW,10NW	7N	20W	9.10	1
2419	occasional sale	Dec-79	14SW	8N	20W	9.20	2
2421	occasional sale	Dec-79	4NE	8N	19W	3.91	1
2422	family transfer	Dec-79	4NE	8N	19W	3.86	1
2423	family transfer	Dec-79	4NE	8N	19W	3.55	1
2424	family transfer	Dec-79	4NE	8N	19W	4.22	1
2431	occasional sale	Dec-79	6SW	8N	20W	10.00	1
2443	occasional sale	Dec-79	26NW	8N	20W	9.48	2
2467	occasional sale	Feb-80	3NW	8N	20W	11.94	2
2478	occasional sale	Feb-80	7NW	8N	20W	3.73	1
2511	occasional sale	Apr-80	31NW	8N	20W	6.00	1
2518	occasional sale	Apr-80	31SE	8N	20W	5.00	1
2550	occasional sale	Jun-80	14SE	8N	20W	2.90	2
2558	occasional sale	Jun-80	31NW	8N	20W	0.83	1
2559	occasional sale	Jun-80	14SE	8N	20W	2.90	2
2572	occasional sale	Jul-80	11NW	8N	20W	5.11	2
2593	occasional sale	Aug-80	2NW	8N	20W	20.54	2
2613	family transfer	Sep-80	16NW	8N	20W	5.13	1
2625	occasional sale	Sep-80	7NE	7N	20W	13.74	2
2628	occasional sale	Oct-80	32SE	9N	20W	20.34	2
2645	occasional sale	Nov-80	30NW	8N	20W	1.02	1
2664	partial subdivision	Dec-80	21-W2	8N	20W	118.38	6
2679	occasional sale	Dec-80	3NE	7N	20W	5.55	3
2689	occasional sale	Jan-81	12SE	8N	21W	20.00	2

2691	family transfer	Jan-81	24SE	8N	21W	10.00	1
2692	occasional sale	Jan-81	24SE	8N	21W	5.00	1
2695	occasional sale	Feb-81	18SE	8N	20W	5.01	1
2700	occasional sale	Feb-81	31NW	8N	20W	6.21	1
2704	occasional sale	Feb-81	10NE	7N	21W	10.10	2
2712	occasional sale	Mar-81	27SE,34NE	8N	20W	20.10	3
2717	occasional sale	Mar-81	36NW	8N	21W	21.97	2
2719	occasional sale	Mar-81	7-S2	7N	20W	20.59	2
2723	occasional sale	Mar-81	30SW	8N	20W	0.83	1
2730	occasional sale	Apr-81	34SE	9N	20W	8.49	2
2734	occasional sale	Apr-81	24NW	8N	21W	1.00	1
2750	occasional sale	Apr-81	7SE	7N	20W	10.05	2
2751	occasional sale	Apr-81	30NW	8N	20W	1.10	1
2763	occ sale, fam transfer	May-81	10NE	8N	20W	20.19	4
2764	occasional sale	May-81	10NE	8N	20W	11.98	2
2766	family transfer	May-81	18SE	8N	20W	5.00	1
2778	occasional sale	May-81	10-W2	7N	21W	10.01	2
2783	occ sale, fam transfer	May-81	36NW	8N	21W	16.33	4
2785	occasional sale	May-81	5SE	8N	19W	25.18	3
2801	occasional sale	Jun-81	3NW	8N	20W	6.93	2
2830	occasional sale	Jul-81	6NW	8N	20W	6.22	2
2833	occasional sale	Jul-81	11NW	7N	21W	1.00	1
2834	occasional sale	Jul-81	34SE	9N	20W	2.00	1
2860	occasional sale	Aug-81	6SW	7N	20W	19.25	2
2920	occ sale, fam transfer	Nov-81	17SW	8N	20W	8.55	3
2930	occasional sale	Nov-81	10NW	7N	21W	12.70	2
2947	occ sale, agricultural	Dec-81	11NE	7N	21W	20.51	3
2956	occasional sale	Dec-81	30SW	8N	20W	0.91	2
2967	occasional sale	Jan-82	3SW	7N	21W	5.12	2
2983	occasional sale	Mar-82	24SE	8N	21W	10.00	2
2993	occasional sale	Apr-82	3SW	7N	21W	5.12	2
2994	occasional sale	Apr-82	30SE	8N	20W	0.37	1
2996	occ sale, mortgage	Apr-82	27SW	8N	21W	21.00	3
3017	occasional sale	May-82	3SW	8N	19W	21.08	2
3022	occasional sale	Jun-82	27SW,34NW	8N	21W	37.56	2
3044	subdivision, retracemt	Jul-82	25SW	8N	21W	15.12	6
3045	occasional sale	Jul-82	36NW	8N	21W	3.19	2
3061	occasional sale	Aug-82	32SE	9N	20W	20.38	2

3080	occasional sale	Sep-82	31SW	8N	20W	10.97	1
3092	occasional sale	Oct-82	34	9N	20W	39.00	4
3124	occ sale, fam transfer	Dec-82	34-N2	8N	21W	20.00	4
3243	occ sale, fam transfer	Jul-83	36SW	8N	21W	19.50	3
3261	occasional sale	Aug-83	24SE	8N	21W	21.17	2
3310	occasional sale	Oct-83	24SE	8N	21W	9.99	2
3314	occasional sale	Oct-83	36NW	8N	21W	5.65	2
3352	occ sale, fam transfer	Dec-83	31SW	8N	20W	10.97	3
3371	occasional sale	Jan-84	7NW	7N	20W	16.62	2
3386	occasional sale	Feb-84	13NE	8N	21W	1.01	1
3464	occasional sale	Jun-84	6NE	7N	20W	11.58	2
3481	occasional sale	Aug-84	14NW	8N	20W	20.10	4
3510	occasional sale	Oct-84	27SW	8N	20W	14.33	1
3520	occasional sale	Oct-84	13SE	8N	21W	9.96	2
3536	occasional sale	Nov-84	6NW	8N	20W	5.28	2
3570	occasional sale	Feb-85	10SE	7N	21W	5.08	1
3702	occasional sale	Jul-85	15NE	8N	20W	39.29	3
3703	occasional sale	Jul-85	30SW,31NW	8N	20W	5.22	2
3712	occasional sale	Jul-85	6SW	8N	20W	9.39	2
3719	occasional sale	Jul-85	3SW	8N	19W	20.11	2
3721	occ sale, fam transfer	Jul-85	3NE	7N	20W	24.44	3
3740	occasional sale	Aug-85	27NW	8N	20W	1.00	1
3758	occ sale, utility sale	Oct-85	2SW	8N	20W	17.27	3
3785	occasional sale	Nov-85	30SW,31NW	8N	20W	1.54	2
3802	occasional sale	Dec-85	5SW	8N	20W	10.28	2
3826	occasional sale	Feb-86	33SE	8N	21W	8.09	1
3828	occasional sale	Feb-86	10SE	8N	20W	50.00	3
3829	occasional sale	Feb-86	7SE	7N	20W	12.63	2
3832	occasional sale	Feb-86	16SE	8N	20W	4.87	1
3853	occasional sale	Apr-86	36NW	8N	21W	3.08	2
3868	occasional sale	May-86	24NW	8N	21W	20.32	2
3870	exemption	May-86	4NW	8N	20W	8.00	1
3885	occasional sale	Jun-86	36NW	9N	20W	1.01	1
3925	occ sale, fam transfer	Sep-86	31SE	8N	20W	3.00	3
3927	occ sale, fam transfer	Sep-86	24SE	8N	21W	5.00	3
3930	occ sale, fam transfer	Sep-86	14SW,23NW	8N	20W	20.40	2

3941	family transfer	Oct-86	23NW	8N	20W	12.01	5
3942	occasional sale	Oct-86	30SW	8N	20W	0.75	2
3947	occasional sale	Oct-86	5SE	8N	19W	21.86	2
3954	occasional sale	Oct-86	11NW	7N	21W	20.28	2
4040	occasional sale	May-87	4NW	8N	19W	9.65	2
4054	occasional sale	Jun-87	14NW	8N	20W	20.56	2
4055	occasional sale	Jun-87	8SW	8N	20W	13.95	2
4094	family transfer	Sep-87	6NE	8N	20W	3.00	1
4102	occasional sale	Oct-87	2SE	7N	21W	10.33	2
4143	occasional sale	Dec-87	4NW	8N	19W	9.65	2
4166	family transfer	Mar-88	34NE	9N	20W	10.52	1
4242	occ sale, fam transfer	Sep-88	35NW	9N	20W	5.38	5
4256	occasional sale	Nov-88	3NE	8N	20W	9.00	2
4268	occ sale, fam transfer	Dec-88	4SW	8N	19W	20.33	3
4308	occasional sale	Apr-89	24NW	8N	21W	10.17	2
4309	occasional sale	May-89	9NW	7N	21W	8.69	1
4338	occasional sale	Jul-89	20NW	8N	20W	5.22	2
4372	occasional sale	Sep-89	31SE	8N	20W	13.73	1
4375	occasional sale	Sep-89	34SE,34SW	8N	20W	10.05	2
4389	occasional sale	Oct-89	31SW	8N	20W	1.74	1
4394	occasional sale	Nov-89	10SW	7N	21W	10.32	2
4397	occasional sale	Nov-89	3NE	7N	20W	25.21	2
4441	occasional sale	Mar-90	26NE	8N	21W	33.52	2
4464	occasional sale	May-90	10NW,9NE	7N	21W	10.40	2
4473	occasional sale	Jun-90	10SW	7N	21W	10.31	2
4495	occasional sale	Jul-90	35SW	9N	20W	13.04	2
4496	occasional sale	Jul-90	35SW	9N	20W	13.88	2
4514	family transfer	Aug-90	33SE	8N	21W	26.90	2
4533	occasional sale	Oct-90	27SE	8N	21W	3.64	2
4556	occasional sale	Dec-90	34NE	9N	20W	1.00	1
4581	occasional sale	Feb-91	5NW,5SW	8N	20W	9.20	2
4616	occasional sale	May-91	3NW	8N	20W	10.01	2
4617	family transfer	May-91	35NW	9N	20W	5.50	2
4618	occ sale, utility sale	May-91	35NW	9N	20W	5.50	3
4621	occasional sale	May-91	24SE	8N	21W	5.00	1
4672	occasional sale	Sep-91	34NE	8N	21W	20.00	2
4737	family transfer	Mar-92	6SW	8N	20W	20.00	3
4752	occasional sale	Apr-92	36SW	8N	21W	20.00	2
4802	occasional sale	Jul-92	21NW	8N	21W	4.57	2
4815	occasional sale	Sep-92	3NE	7N	20W	11.79	2

4858	occasional sale	Dec-92	35SW	9N	20W	17.36	2
4887	occasional sale	Feb-93	1SE	7N	21W	30.00	2
4903	occasional sale	Mar-93	3NW	8N	20W	5.00	1
4928	occasional sale	May-93	7SE	7N	20W	7.04	2
4937	occasional sale	May-93	31NW	8N	20W	10.00	2
4948	occ sale, agricultural	Jun-93	6NW	7N	20W	14.76	3
4949	occasional sale	Jun-93	34SE	9N	20W	21.29	2
4950	occasional sale	Jun-93	31SW	8N	20W	2.18	1
4971	occasional sale	Aug-93	31SW	8N	20W	1.93	1
4981	family transfer	Aug-93	3NW, 3NE	8N	20W	19.09	4
5003	family transfer	Sep-93	24NW	8N	21W	4.96	1
5027	occasional sale	Oct-93	33SW	9N	20W	5.00	1
5060	occasional sale	Jan-94	35NE	9N	20W	4.36	1
5062	family transfer	Feb-94	35SW	9N	20W	9.67	2
5071	family transfer	Feb-94	18NE	8N	20W	8.06	1
5086	family transfer	Mar-94	24SE	8N	21W	34.92	2
5103	occasional sale	May-94	27SW	8N	21W	11.19	1
5106	family transfer	Aug-94	11NE	8N	20W	5.11	2
5149	family transfer	Sep-94	6SW	7N	20W	3.00	2
5169	occasional sale	Nov-94	7NE	7N	20W	9.24	2
5228	family transfer	May-95	21NW	8N	20W	3.29	1
5241	family transfer	Jun-95	30NW	8N	19W	21.07	2
5344	family transfer	Mar-96	6SE	8N	20W	4.61	2
5382	family transfer	Jun-96	24SE	8N	21W	5.00	2
5435	family transfer	Sep-96	15NW	8N	20W	40.73	4
5473	family transfer	Dec-96	25NE	8N	21W	2.50	1
5478	family transfer	Dec-96	3SW	7N	20W	20.03	2

APPENDIX A-3

AMENDED PLATS

File #	Subdivision Amended	Filing Date	Section	Tier	Range	Total Area (acres)	Total Lots	New Lots
3	Victor Orch Tracts	Jul-76	30SE	8N	20W	1.94	1	1
40	Home Acres Orch 3	May-77	13NW	8N	20W	20.26	2	2
43	Mountain View Orch	Jul-77	3SE	7N	20W	29.60	2	2
62	Home Acres Orch	Oct-77	23SE	8N	20W	19.97	4	2
67	Home Acres Orch 3	Nov-77	13SW	8N	20W	10.10	2	1
66	Home Acres Orch 3	Nov-77	13NW	8N	20W	10.12	2	1
68	Victor Orch Tracts	Dec-77	30SE	8N	20W	5.81	3	3
69	Victor Orch Tracts	Dec-77	30SE	8N	20W	0.41	2	1
81	Mountain View Orch	Jan-78	10NE	7N	20W	9.78	2	1
93	Mountain View Orch	Mar-78	2SW	7N	20W	13.29	2	1
108	Mountain View Orch	May-78	11SE	7N	20W	6.80	1	1
111	Melody Meadows	Jun-78	2NW	8N	20W	8.66	2	1
122	Melody Meadows	Jul-78	2NW	8N	20W	9.32	2	1
125	Sunset Orchards 4	Aug-78	12SE	8N	20W	9.90	2	1
124	Sunset Orchards 4	Aug-78	12SE	8N	20W	9.90	2	1
130	Melody Meadows	Aug-78	3NE	8N	20W	9.95	2	1
129	Melody Meadows	Aug-78	2NW	8N	20W	9.74	2	1
133	Melody Meadows	Aug-78	3NE	8N	20W	9.02	2	1
144	Melody Meadows	Oct-78	2NW	8N	20W	7.38	2	1
143	Melody Meadows	Oct-78	2NW	8N	20W	9.66	2	1
150	Mountain View Orch	Nov-78	10NE	7N	20W	9.91	2	1
149	Sunset Orchards	Nov-78	7SW	8N	20W	1.17	1	1
152	Montair Riverview	Nov-78	7SE	7N	20W	5.97	2	1
155	Pleasant View Acres	Dec-78	36NW	8N	21W	3.08	2	1
169	Home Acres Orch	Jan-79	26NW	8N	20W	8.60	3	2
170	Home Acres Orch 3	Jan-79	13SW,14SE	8N	20W	20.02	2	2
193	Big Creek Meadows	Jul-79	17SW	8N	20W	10.34	2	1
194	Big Creek Meadows	Jul-79	17SW	8N	20W	10.41	2	1
204	Melody Meadows	Aug-79	2NW	8N	20W	8.79	2	1

205	Melody Meadows	Aug-79	3NE	8N	20W	10.04	2	1
265	Big Creek Meadows	Jun-80	17SW	8N	20W	10.44	2	1
289	Mountain View Orch	Nov-80	10NE	7N	20W	3.52	2	1
294	Home Acres Orch 3	Dec-80	14SE	8N	20W	3.41	2	1
296	Home Acres Orch 3	Jan-81	14SE	8N	20W	3.41	2	1
302	Sunset Orchards 4	Feb-81	12NE	8N	20W	17.73	2	1
303	Sunset Orchards 4	Feb-81	12NE	8N	20W	9.88	2	1
316	Pleasant View Acres	Jun-81	36NW	8N	21W	5.42	2	1
323	Big Creek Meadows	Sep-81	17SW	8N	20W	8.32	2	1
324	Big Creek Meadows	Sep-81	17SW	8N	20W	8.38	2	1
389	Bell Meadows Ad	Mar-84	15NE	8N	20W	12.36	2	2
395	Home Acres Orch 3	Jun-84	13NW	8N	20W	12.51	1	1
410	Sunset Orchards 4	May-85	12SE	8N	20W	9.89	2	1
421	Big Creek Meadows	Dec-85	17SW	8N	20W	2.02	2	1
464	Home Acres Orch	Oct-87	26NE	8N	20W	19.44	3	2
473	Big Creek Meadows	Jan-88	17SW	8N	20W	10.59	2	1
516	Sunset Orchards	May-90	7NW	8N	20W	9.74	2	1
522	Victor Orch Tracts	Jul-90	30SE	8N	20W	2.94	5	4
523	Home Acres Orch	Aug-90	26NE	8N	20W	9.73	2	1
593	Home Acres Orch 3	Sep-92	13SE,18SW	8N	19W,20 W	20.00	1	1
715	Reimers Addition	Feb-95	35SW	9N	20W	10.36	3	3
740	Terry	Jul-95	3SE	7N	21W	40.20	2	1
772	Mountain View Orch	Dec-95	10NE	7N	20W	11.99	2	1
801	Mountain View Orch	Jul-96	11SE	7N	20W	2.96	2	1
812	Victor Orch Tracts	Sep-96	30SE	8N	20W	0.64	2	1

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7193NW	30	5	8	5	10	1	1	0	0	0	0	0.00	0
7193NE	30	5	8	5	10	1	1	0	0	0	0	0.00	0
7193SW	30	5	8	5	10	1	1	0	0	0	0	0.00	0
7193SE	24	5	2	5	10	1	1	0	0	0	0	0.00	0
7194NW	27	4	5	2	10	5	1	0	0	0	0	0.00	0
7194NE	28	4	8	2	10	3	1	0	0	0	0	0.00	0
7194SW	18	4	5	5	2	1	1	0.5	0.5	0	0	13.44	6.72
7194SE	23	4	8	5	4	1	1	0	0	0	0	0.00	0
7195NW	16	2	2	6	4	1	1	0	0	0	0	0.00	0
7195NE	20	5	2	6	4	2	1	0	0	0	0	0.00	0
7195SW	18	3	5	6	2	1	1	0	0	0	0	0.00	0
7195SE	15	4	2	5	2	1	1	1	1	0	0	13.44	13.44
7196NW	21	4	2	9	4	1	1	0	0	0	0	0.00	0
7196NE	13	3	2	2	4	1	1	0	0	0	0	0.00	0
7196SW	28	3	5	9	9	1	1	0	0	0	0	0.00	0
7196SE	23	3	5	9	4	1	1	0	0	0	0	0.00	0
7197NW	21	4	5	5	4	2	1	0	0	0	0	0.00	0
7197NE	28	3	5	9	9	1	1	0	0	0	0	0.00	0
7197SW	25	4	5	5	4	6	1	0	0	0	0	0.00	0
7197SE	30	4	5	5	9	6	1	0	0	0	0	0.00	0
7198NW	18	3	5	6	2	1	1	0	0	0	0	0.00	0
7198NE	14	5	2	2	2	2	1	1	1	0	0	13.44	13.44
7198SW	26	4	5	5	10	1	1	0	0	0	0	0.00	0
7198SE	28	6	2	2	10	7	1	0	0	0	0	0.00	0
7199NW	24	7	2	5	2	7	1	0.5	0.5	0	0	13.42	6.71
7199NE	22	6	8	2	4	1	1	0	0	0	0	0.00	0
7199SW	15	7	2	2	2	1	1	0	0	0	0	0.00	0

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7199SE	27	5	8	2	10	1	1	0	0	0	0	0.00	0
71910NW	30	5	8	5	10	1	1	0	0	0	0	0.00	0
71910NE	33	5	5	5	10	7	1	0	0	0	0	0.00	0
71910SW	28	5	8	2	10	2	1	0	0	0	0	0.00	0
71910SE	36	5	8	5	10	7	1	0	0	0	0	0.00	0
7201NW	15	3	2	3	3	3	1	0	0	0	0	0.00	0
7201NE	19	3	5	5	4	1	1	0	0	0	0	0.00	0
7201SW	20	4	2	3	3	7	1	0	0	0	0	0.00	0
7201SE	18	4	2	5	4	2	1	0	0	0	0	0.00	0
7202NW	22	3	5	3	3	7	1	0	0	0	0	0.00	0
7202NE	20	3	2	3	4	7	1	0	0	0	0	0.00	0
7202SW	17	6	2	3	4	1	1	1	0	1	0	6.65	6.65
7202SE	16	5	2	3	3	2	1	0	0	0	0	0.00	0
7203NW	19	6	4	2	2	2	3	1	1	0	0	1.01	1.01
7203NE	18	4	2	3	3	5	1	10	0	6	4	6.70	66.99
7203SW	18	7	1	2	3	2	3	2.5	0	0.5	2	9.83	24.58
7203SE	19	5	5	3	3	2	1	2	0	2	0	14.80	29.6
7204NW	35	8	4	4	4	6	9	0	0	0	0	0.00	0
7204NE	31	8	4	3	4	6	6	2	0	1	1	4.20	8.39
7204SW	47	8	4	9	8	8	10	0	0	0	0	0.00	0
7204SE	30	8	4	3	9	2	4	0	0	0	0	0.00	0
7205NW	47	7	4	9	8	9	10	2	0	0	2	5.00	10
7205NE	50	9	4	9	9	9	10	0	0	0	0	0.00	0
7205SW	44	7	4	9	8	6	10	0	0	0	0	0.00	0
7205SE	48	8	4	9	9	8	10	0	0	0	0	0.00	0
7206NW	30	7	1	5	8	7	2	13	6	4	3	6.04	78.47
7206NE	37	6	4	5	8	8	6	50	7	40	3	3.06	153.03

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Unit ID	Total Site Rating	Depth to W.T.	Surface Slope	Soil Text.	P.Mat. Texture	Dist. S.W.	Dist. F.P.	Total Sub. Lots	Lots 66-76	Lots 77-86	Lots 87-96	Avg. Lot Size	Gross Acreage
7206SW	35	8	4	5	8	8	2	13	6	5	2	2.93	38.06
7206SE	38	6	4	5	8	8	7	32	0	32	0	1.57	50.3
7207NW	29	7	4	5	8	2	3	2	0	2	0	8.31	16.62
7207NE	36	7	1	5	8	7	8	4	0	2	2	5.75	22.98
7207SW	27	7	4	4	6	2	4	4	0	3	1	9.37	37.48
7207SE	44	7	1	9	8	9	10	18	1	14	3	6.83	123
7208NW	43	7	4	9	8	5	10	0	0	0	0	0.00	0
7208NE	49	8	4	9	9	9	10	0	0	0	0	0.00	0
7208SW	45	7	4	9	8	7	10	0	0	0	0	0.00	0
7208SE	47	8	4	9	8	8	10	0	0	0	0	0.00	0
7209NW	41	8	4	5	8	6	10	0	0	0	0	0.00	0
7209NE	28	7	4	3	9	1	4	0	0	0	0	0.00	0
7209SW	29	8	4	5	4	1	7	0	0	0	0	0.00	0
7209SE	22	7	4	2	4	1	4	0	0	0	0	0.00	0
72010NW	17	7	1	2	3	2	2	0.5	0	0.5	0	9.10	4.55
72010NE	17	3	2	3	6	2	1	4	0	3	1	4.40	17.61
72010SW	18	7	1	3	3	2	2	0	0	0	0	0.00	0
72010SE	16	2	2	3	6	2	1	0	0	0	0	0.00	0
72011NW	13	3	2	2	4	1	1	0	0	0	0	0.00	0
72011NE	15	5	2	3	3	1	1	0	0	0	0	0.00	0
72011SW	11	2	1	3	3	1	1	0	0	0	0	0.00	0
72011SE	22	5	2	3	3	8	1	2	0	1	1	4.14	8.28
72012NW	14	4	1	3	3	2	1	0	0	0	0	0.00	0
72012NE	29	5	5	5	4	9	1	0	0	0	0	0.00	0
72012SW	22	4	5	3	3	6	1	0	0	0	0	0.00	0
72012SE	22	4	2	5	4	6	1	0	0	0	0	0.00	0
7211NW	30	7	1	7	8	6	1	9	5	4	0	10.52	94.68

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7211NE	31	8	1	5	8	8	1	0	0	0	0	0.00	0
7211SW	35	8	4	7	8	7	1	0	0	0	0	0.00	0
7211SE	33	9	4	5	8	6	1	5	3	0	2	9.98	49.9
7212NW	22	6	1	7	6	1	1	6	6	0	0	2.07	12.44
7212NE	25	8	1	7	6	2	1	0	0	0	0	0.00	0
7212SW	34	9	1	7	8	8	1	0	0	0	0	0.00	0
7212SE	36	10	4	7	8	6	1	5	0	3	2	6.22	31.09
7213NW	24	9	2	5	6	1	1	1	0	1	0	10.71	10.71
7213NE	23	7	1	7	6	1	1	0	0	0	0	0.00	0
7213SW	24	7	1	7	6	2	1	16	3	13	0	7.40	118.37
7213SE	28	8	1	7	6	5	1	2	0	2	0	7.68	15.36
7214NW	33	7	8	5	10	2	1	0	0	0	0	0.00	0
7214NE	22	7	2	5	6	1	1	0	0	0	0	0.00	0
7214SW	29	7	5	5	10	1	1	0	0	0	0	0.00	0
7214SE	22	7	2	5	6	1	1	0	0	0	0	0.00	0
7215NE	38	7	10	9	10	1	1	0	0	0	0	0.00	0
7215SE	38	7	10	9	10	1	1	0	0	0	0	0.00	0
7218NE	40	7	10	9	10	3	1	0	0	0	0	0.00	0
7218SE	42	7	10	9	10	5	1	0	0	0	0	0.00	0
7219NW	38	7	10	5	10	5	1	8	7	0	1	8.41	67.29
7219NE	30	7	2	7	6	7	1	5	0	4	1	5.15	25.74
7219SW	31	7	5	9	4	5	1	0	0	0	0	0.00	0
7219SE	25	7	2	9	4	2	1	0	0	0	0	0.00	0
72110NW	31	7	1	7	8	7	1	20	8	11	1	6.37	127.43
72110NE	27	7	1	7	8	3	1	9	0	9	0	6.12	55.12
72110SW	25	7	1	7	8	1	1	11	4	3	4	7.80	85.76
72110SE	24	8	1	5	8	1	1	1	0	1	0	5.08	5.08

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72111NW	27	10	1	7	6	2	1	5	0	3	2	6.28	31.38
72111NE	26	10	4	5	4	2	1	9	6	3	0	8.66	77.97
72111SW	25	9	1	5	8	1	1	0	0	0	0	0.00	0
72111SE	26	9	4	5	6	1	1	0	0	0	0	0.00	0
72112NW	24	8	4	5	4	2	1	0	0	0	0	0.00	0
72112NE	31	8	4	5	8	5	1	0	0	0	0	0.00	0
72112SW	23	8	4	5	4	1	1	0	0	0	0	0.00	0
72112SE	25	8	4	4	6	1	2	0	0	0	0	0.00	0
8187NW	32	3	8	9	10	1	1	0	0	0	0	0.00	0
8187NE	34	2	10	9	10	2	1	0	0	0	0	0.00	0
8187SW	31	2	10	5	10	3	1	0	0	0	0	0.00	0
8187SE	35	2	10	9	10	3	1	0	0	0	0	0.00	0
81819NW	32	3	8	9	10	1	1	0	0	0	0	0.00	0
81819NE	32	3	8	9	10	1	1	0	0	0	0	0.00	0
81819SW	32	3	8	9	10	1	1	0	0	0	0	0.00	0
81819SE	32	3	8	9	10	1	1	0	0	0	0	0.00	0
8191NW	29	3	10	2	10	3	1	0	0	0	0	0.00	0
8191NE	31	2	10	5	10	3	1	0	0	0	0	0.00	0
8191SW	28	4	8	2	10	3	1	0	0	0	0	0.00	0
8191SE	27	2	8	5	10	1	1	0	0	0	0	0.00	0
8192NW	11	3	2	2	2	1	1	0	0	0	0	0.00	0
8192NE	22	3	5	2	10	1	1	0	0	0	0	0.00	0
8192SW	23	3	5	7	6	1	1	0	0	0	0	0.00	0
8192SE	25	5	5	7	6	1	1	0	0	0	0	0.00	0
8193NW	30	7	2	9	9	2	1	0	0	0	0	0.00	0
8193NE	17	1	5	5	4	1	1	0	0	0	0	0.00	0
8193SW	32	7	1	7	9	7	1	4	0	4	0	10.30	41.19

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8193SE	24	3	5	7	6	2	1	0	0	0	0	0.00	0
8194NW	23	7	1	5	6	3	1	12	4	4	4	8.06	96.66
8194NE	32	7	2	7	9	6	1	8	0	8	0	3.45	27.62
8194SW	29	6	1	7	6	8	1	11	0	8	3	5.54	60.89
8194SE	27	7	1	7	8	3	1	6	6	0	0	0.62	3.73
8195NW	23	6	1	8	2	5	1	0	0	0	0	0.00	0
8195NE	23	7	1	5	6	3	1	0	0	0	0	0.00	0
8195SW	24	2	8	5	6	2	1	0	0	0	0	0.00	0
8195SE	26	7	2	5	6	5	1	7	0	5	2	8.44	59.1
8196NW	25	4	5	6	3	6	1	0	0	0	0	0.00	0
8196NE	26	6	2	8	2	7	1	0	0	0	0	0.00	0
8196SW	15	2	1	6	2	3	1	0	0	0	0	0.00	0
8196SE	14	1	2	6	2	2	1	2	0	2	0	5.21	10.41
8197NW	13	2	1	6	2	1	1	0	0	0	0	0.00	0
8197NE	13	1	1	6	2	2	1	0	0	0	0	0.00	0
8197SW	13	2	1	6	2	1	1	1	1	0	0	1.00	1
8197SE	12	1	1	6	2	1	1	0	0	0	0	0.00	0
8198NW	12	1	1	6	2	1	1	0	0	0	0	0.00	0
8198NE	12	1	1	6	2	1	1	0	0	0	0	0.00	0
8198SW	19	1	8	6	2	1	1	0	0	0	0	0.00	0
8198SE	16	5	1	6	2	1	1	0	0	0	0	0.00	0
8199NW	13	2	1	6	2	1	1	0	0	0	0	0.00	0
8199NE	23	6	1	6	6	3	1	0	0	0	0	0.00	0
8199SW	9	1	1	3	2	1	1	0	0	0	0	0.00	0
8199SE	11	2	1	3	3	1	1	0	0	0	0	0.00	0
81910NW	30	6	1	7	8	7	1	0	0	0	0	0.00	0
81910NE	29	4	1	7	9	7	1	0	0	0	0	0.00	0

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81910SW	11	3	2	2	2	1	1	0	0	0	0	0.00	0
81910SE	18	3	2	2	8	2	1	0	0	0	0	0.00	0
81911NW	22	3	5	2	6	5	1	0	0	0	0	0.00	0
81911NE	33	7	10	2	10	3	1	0	0	0	0	0.00	0
81911SW	32	5	2	7	8	9	1	0	0	0	0	0.00	0
81911SE	28	7	5	5	8	2	1	0	0	0	0	0.00	0
81912NW	26	4	8	2	10	1	1	0	0	0	0	0.00	0
81912NE	27	2	8	5	10	1	1	0	0	0	0	0.00	0
81912SW	23	3	5	5	8	1	1	0	0	0	0	0.00	0
81912SE	25	3	8	2	10	1	1	0	0	0	0	0.00	0
81913NW	30	2	8	3	10	6	1	0	0	0	0	0.00	0
81913NE	32	1	10	5	10	5	1	0	0	0	0	0.00	0
81913SW	36	2	10	5	10	8	1	0	0	0	0	0.00	0
81913SE	34	3	8	5	10	7	1	0	0	0	0	0.00	0
81914NW	19	2	5	5	4	2	1	0	0	0	0	0.00	0
81914NE	36	7	5	7	10	6	1	0	0	0	0	0.00	0
81914SW	20	4	5	5	4	1	1	0	0	0	0	0.00	0
81914SE	23	3	8	5	4	2	1	0	0	0	0	0.00	0
81915NW	13	3	1	3	3	2	1	0	0	0	0	0.00	0
81915NE	14	1	2	5	4	1	1	0	0	0	0	0.00	0
81915SW	16	6	2	2	2	3	1	0	0	0	0	0.00	0
81915SE	12	2	2	2	4	1	1	0	0	0	0	0.00	0
81916NW	27	9	1	5	4	7	1	0	0	0	0	0.00	0
81916NE	19	7	1	2	3	5	1	0	0	0	0	0.00	0
81916SW	17	7	1	2	3	3	1	0	0	0	0	0.00	0
81916SE	19	7	2	2	2	5	1	0	0	0	0	0.00	0
81917NW	31	2	8	5	9	6	1	0	0	0	0	0.00	0

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Unit ID	Total Site Rating	Depth to W.T.	Surface Slope	Soil Text.	P.Mat. Texture	Dist. S.W.	Dist. F.P.	Total Sub. Lots	Lots 66-76	Lots 77-86	Lots 87-96	Avg. Lot Size	Gross Acreage
81917NE	27	8	2	5	4	7	1	5	0	5	0	4.20	21
81917SW	24	2	2	9	9	1	1	0	0	0	0	0.00	0
81917SE	21	6	2	3	4	5	1	0	0	0	0	0.00	0
81918NW	25	1	8	5	4	6	1	0	0	0	0	0.00	0
81918NE	36	1	10	9	9	6	1	0	0	0	0	0.00	0
81918SW	12	2	2	3	3	1	1	1	1	0	0	20.00	20
81918SE	26	3	2	9	9	2	1	0	0	0	0	0.00	0
81919NW	25	4	5	5	3	7	1	0	0	0	0	0.00	0
81919NE	15	5	2	2	3	2	1	0	0	0	0	0.00	0
81919SW	18	3	5	5	3	1	1	0	0	0	0	0.00	0
81919SE	32	3	8	5	9	6	1	0	0	0	0	0.00	0
81920NW	24	3	1	9	9	1	1	0	0	0	0	0.00	0
81920NE	12	3	1	2	4	1	1	0	0	0	0	0.00	0
81920SW	12	3	2	2	2	2	1	0	0	0	0	0.00	0
81920SE	17	5	2	6	2	1	1	0	0	0	0	0.00	0
81921NW	20	6	2	2	3	6	1	0	0	0	0	0.00	0
81921NE	15	6	2	2	2	2	1	0	0	0	0	0.00	0
81921SW	17	5	1	6	2	2	1	0	0	0	0	0.00	0
81921SE	20	7	2	6	2	2	1	0	0	0	0	0.00	0
81922NW	20	6	2	2	2	7	1	0	0	0	0	0.00	0
81922NE	13	3	2	2	4	1	1	0	0	0	0	0.00	0
81922SW	22	7	5	2	2	5	1	0	0	0	0	0.00	0
81922SE	31	5	5	9	9	2	1	0	0	0	0	0.00	0
81923NW	20	4	5	5	4	1	1	0	0	0	0	0.00	0
81923NE	23	4	8	5	4	1	1	0	0	0	0	0.00	0
81923SW	18	2	5	5	4	1	1	0	0	0	0	0.00	0
81923SE	17	1	5	5	4	1	1	0	0	0	0	0.00	0

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81924NW	27	5	10	5	4	2	1	0	0	0	0	0.00	0
81924NE	33	3	8	9	10	2	1	0	0	0	0	0.00	0
81924SW	42	7	10	9	10	5	1	0	0	0	0	0.00	0
81924SE	32	2	8	9	10	2	1	0	0	0	0	0.00	0
81925NW	31	7	8	5	4	6	1	0	0	0	0	0.00	0
81925NE	37	6	8	5	10	7	1	0	0	0	0	0.00	0
81925SW	41	7	8	9	10	6	1	0	0	0	0	0.00	0
81925SE	36	4	10	9	10	2	1	0	0	0	0	0.00	0
81926NW	19	5	2	5	4	2	1	0	0	0	0	0.00	0
81926NE	18	3	2	5	4	3	1	0	0	0	0	0.00	0
81926SW	31	5	5	5	10	5	1	0	0	0	0	0.00	0
81926SE	31	5	5	5	10	5	1	0	0	0	0	0.00	0
81927NW	20	6	2	6	4	1	1	0	0	0	0	0.00	0
81927NE	20	6	2	2	4	5	1	0	0	0	0	0.00	0
81927SW	22	6	5	5	4	1	1	0	0	0	0	0.00	0
81927SE	25	6	5	2	10	1	1	0	0	0	0	0.00	0
81928NW	18	6	1	6	2	2	1	0	0	0	0	0.00	0
81928NE	20	7	2	6	2	2	1	0	0	0	0	0.00	0
81928SW	15	6	2	2	2	2	1	0	0	0	0	0.00	0
81928SE	18	7	2	2	4	2	1	0	0	0	0	0.00	0
81929NW	15	3	2	2	4	3	1	0	0	0	0	0.00	0
81929NE	18	7	1	2	2	5	1	0	0	0	0	0.00	0
81929SW	11	3	2	2	2	1	1	0	0	0	0	0.00	0
81929SE	11	4	1	2	2	1	1	0	0	0	0	0.00	0
81930NW	13	2	2	3	4	1	1	2	0	0	2	10.54	21.07
81930NE	13	1	2	3	4	2	1	0	0	0	0	0.00	0
81930SW	13	2	2	3	4	1	1	0	0	0	0	0.00	0

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81930SE	16	2	5	5	2	1	1	0	0	0	0	0.00	0
81931NW	36	3	8	9	9	6	1	0	0	0	0	0.00	0
81931NE	31	3	10	5	10	2	1	0	0	0	0	0.00	0
81931SW	26	4	2	9	9	1	1	0	0	0	0	0.00	0
81931SE	33	3	8	9	9	3	1	0	0	0	0	0.00	0
81932NW	15	3	5	2	2	2	1	0	0	0	0	0.00	0
81932NE	10	3	1	2	2	1	1	0	0	0	0	0.00	0
81932SW	31	4	5	9	9	3	1	0	0	0	0	0.00	0
81932SE	17	4	1	2	2	7	1	0	0	0	0	0.00	0
81933NW	9	2	1	2	2	1	1	0	0	0	0	0.00	0
81933NE	22	5	2	2	4	8	1	0	0	0	0	0.00	0
81933SW	14	4	2	2	4	1	1	0	0	0	0	0.00	0
81933SE	17	4	5	2	4	1	1	0	0	0	0	0.00	0
81934NW	27	6	5	2	10	3	1	0	0	0	0	0.00	0
81934NE	31	5	5	5	10	5	1	0	0	0	0	0.00	0
81934SW	25	5	8	5	4	2	1	0	0	0	0	0.00	0
81934SE	32	5	8	5	10	3	1	0	0	0	0	0.00	0
81935NW	34	5	8	5	10	5	1	0	0	0	0	0.00	0
81935NE	34	5	8	9	10	1	1	0	0	0	0	0.00	0
81935SW	30	5	8	5	10	1	1	0	0	0	0	0.00	0
81935SE	34	5	8	9	10	1	1	0	0	0	0	0.00	0
8201NW	20	2	5	5	2	5	1	1	0	1	0	16.74	16.74
8201NE	16	3	1	6	2	3	1	0	0	0	0	0.00	0
8201SW	13	2	1	6	2	1	1	1	0	1	0	16.74	16.74
8201SE	16	3	1	6	2	3	1	1	0	1	0	10.24	10.24
8202NW	23	3	5	5	6	3	1	17	7	8	2	6.56	111.52
8202NE	20	2	5	5	2	5	1	0	0	0	0	0.00	0

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8202SW	21	1	5	7	6	1	1	18	6	11	1	7.21	129.69
8202SE	13	1	2	6	2	1	1	3	1	2	0	7.51	22.54
8203NW	29	6	1	5	6	5	6	9	0	4	5	4.83	43.43
8203NE	22	6	1	5	6	2	2	16	6	6	4	6.74	107.84
8203SW	40	6	4	5	8	8	9	2	0	0	2	8.96	17.91
8203SE	23	3	1	5	8	3	3	11	7	1	3	9.29	102.14
8204NW	38	9	4	4	8	3	10	1	0	1	0	8.00	8
8204NE	47	7	4	9	8	9	10	0	0	0	0	0.00	0
8204SW	46	9	4	9	8	6	10	0	0	0	0	0.00	0
8204SE	47	7	4	9	8	9	10	0	0	0	0	0.00	0
8205NW	26	6	1	4	6	5	4	9	7	1	1	9.98	89.84
8205NE	37	9	4	4	8	5	7	1	1	0	0	10.83	10.83
8205SW	28	7	1	5	6	2	7	17	6	7	4	8.25	140.24
8205SE	41	9	4	5	8	5	10	0	0	0	0	0.00	0
8206NW	32	8	2	7	6	8	1	13	9	4	0	4.94	64.18
8206NE	30	7	1	7	6	7	2	8	7	0	1	9.66	77.27
8206SW	21	7	1	5	6	1	1	6	0	3	3	6.57	39.39
8206SE	22	7	1	5	6	1	2	3	1	0	2	2.42	7.26
8207NW	24	7	1	8	6	1	1	2	0	1	1	4.30	8.6
8207NE	20	7	1	3	6	1	2	5	5	0	0	2.85	14.26
8207SW	23	7	1	5	6	3	1	1	0	1	0	1.17	1.17
8207SE	26	7	4	5	6	1	3	13	13	0	0	10.92	141.91
8208NW	31	8	4	3	6	2	8	8	0	8	0	8.24	65.91
8208NE	48	9	4	9	8	8	10	0	0	0	0	0.00	0
8208SW	36	9	4	5	6	5	7	6	4	2	0	11.06	66.36
8208SE	49	9	4	9	9	8	10	0	0	0	0	0.00	0
8209NW	46	9	4	9	8	7	9	0	0	0	0	0.00	0

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8209NE	42	7	4	6	8	7	10	0	0	0	0	0.00	0
8209SW	47	9	4	9	8	7	10	1	1	0	0	15.88	15.88
8209SE	45	7	4	9	8	7	10	1	0	0	1	18.70	18.7
82010NW	36	7	4	6	8	5	6	0	0	0	0	0.00	0
82010NE	20	4	2	5	3	3	3	6	0	6	0	5.36	32.17
82010SW	21	6	4	2	3	2	4	2	0	0	2	18.70	37.39
82010SE	15	3	2	2	3	3	2	4	0	4	0	13.75	55
82011NW	15	1	2	7	3	1	1	16	12	4	0	6.33	101.24
82011NE	15	2	2	5	4	1	1	24	22	0	2	5.34	128.21
82011SW	18	1	2	7	6	1	1	16	10	6	0	7.07	113.1
82011SE	14	1	2	5	4	1	1	0	0	0	0	0.00	0
82012NW	16	2	2	6	4	1	1	0	0	0	0	0.00	0
82012NE	13	2	1	6	2	1	1	2	0	2	0	6.91	13.81
82012SW	12	1	1	6	2	1	1	0	0	0	0	0.00	0
82012SE	12	1	1	6	2	1	1	3	0	3	0	4.95	14.85
82013NW	16	1	5	5	2	2	1	7	3	4	0	6.65	46.52
82013NE	25	1	8	5	4	6	1	0	0	0	0	0.00	0
82013SW	14	2	1	3	2	5	1	3	1	2	0	7.80	23.39
82013SE	11	2	1	3	2	2	1	0	0	0	0	0.00	0
82014NW	20	2	2	7	6	2	1	15	0	11	4	6.11	91.69
82014NE	22	2	5	7	6	1	1	3	0	0	3	6.78	20.34
82014SW	23	3	1	3	9	6	1	14	9	3	2	6.37	89.18
82014SE	19	3	1	3	4	7	1	19	8	11	0	4.10	77.88
82015NW	23	7	4	2	3	3	4	4	0	0	4	10.18	40.73
82015NE	16	5	1	2	3	3	2	11	0	11	0	8.30	91.28
82015SW	21	7	4	2	3	2	3	0	0	0	0	0.00	0
82015SE	20	6	4	2	3	3	2	0	0	0	0	0.00	0

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82016NW	44	9	4	5	9	8	9	1	0	1	0	5.13	5.13
82016NE	46	7	4	9	8	8	10	0	0	0	0	0.00	0
82016SW	41	9	4	5	9	8	6	0	0	0	0	0.00	0
82016SE	47	8	4	9	8	9	9	2	0	2	0	4.94	9.87
82017NW	39	8	4	5	8	7	7	7	0	7	0	6.63	46.42
82017NE	50	9	4	9	9	9	10	0	0	0	0	0.00	0
82017SW	37	7	1	4	8	8	9	20	0	19	1	5.60	112.06
82017SE	50	9	4	9	9	9	10	0	0	0	0	0.00	0
82018NW	30	8	1	7	8	5	1	8	8	0	0	10.58	84.64
82018NE	33	8	4	5	6	7	3	6	5	0	1	10.42	62.49
82018SW	27	9	4	5	6	1	2	0	0	0	0	0.00	0
82018SE	28	7	4	4	8	2	3	3	0	3	0	3.86	11.57
82019NW	26	10	4	3	6	1	2	0	0	0	0	0.00	0
82019NE	28	9	4	4	6	1	4	1	0	0	1	3.43	3.43
82019SW	25	8	4	3	6	1	3	15	0	15	0	1.75	26.19
82019SE	36	9	4	4	8	3	8	2	1	1	0	8.99	17.97
82020NW	47	8	4	9	9	7	10	7	4	0	3	5.13	35.94
82020NE	45	9	4	9	8	5	10	0	0	0	0	0.00	0
82020SW	49	8	4	9	9	9	10	2	1	1	0	8.99	17.97
82020SE	42	10	4	5	8	5	10	0	0	0	0	0.00	0
82021NW	38	10	4	5	4	5	10	14	10	3	1	8.17	114.32
82021NE	48	9	4	9	8	9	9	11	11	0	0	4.70	51.71
82021SW	38	10	4	5	4	5	10	3	0	3	0	19.73	59.19
82021SE	41	9	4	3	8	8	9	2	0	2	0	1.14	2.27
82022NW	31	8	4	3	9	3	4	0	0	0	0	0.00	0
82022NE	19	6	4	2	3	2	2	0	0	0	0	0.00	0
82022SW	29	8	4	3	9	1	4	0	0	0	0	0.00	0

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82022SE	20	7	4	2	3	2	2	0	0	0	0	0.00	0
82023NW	18	2	2	5	3	5	1	6	0	6	0	3.70	22.21
82023NE	18	1	2	5	4	5	1	5	4	1	0	4.03	20.15
82023SW	16	2	2	3	3	5	1	0	0	0	0	0.00	0
82023SE	9	1	1	3	2	1	1	2	0	2	0	4.99	9.98
82024NW	16	2	1	3	3	6	1	0	0	0	0	0.00	0
82024NE	19	5	2	3	3	5	1	0	0	0	0	0.00	0
82024SW	10	2	1	3	2	1	1	0	0	0	0	0.00	0
82024SE	13	4	2	3	2	1	1	0	0	0	0	0.00	0
82025NW	12	2	1	3	4	1	1	0	0	0	0	0.00	0
82025NE	17	4	2	5	4	1	1	0	0	0	0	0.00	0
82025SW	19	3	5	3	6	1	1	0	0	0	0	0.00	0
82025SE	26	4	2	9	9	1	1	0	0	0	0	0.00	0
82026NW	13	1	2	3	3	3	1	4	0	4	0	3.80	15.21
82026NE	9	1	1	3	2	1	1	3	0	0	3	5.83	17.5
82026SW	12	3	1	3	2	2	1	0	0	0	0	0.00	0
82026SE	28	3	5	9	9	1	1	0	0	0	0	0.00	0
82027NW	22	8	4	2	3	1	4	1	0	1	0	1.00	1
82027NE	20	6	1	2	3	6	2	11	0	0	11	4.95	54.4
82027SW	21	7	4	2	2	3	3	1	0	1	0	14.33	14.33
82027SE	20	5	1	3	3	7	1	13	0	13	0	5.24	68.16
82028NW	37	10	4	4	4	5	10	0	0	0	0	0.00	0
82028NE	33	9	4	2	4	5	9	0	0	0	0	0.00	0
82028SW	42	9	4	9	4	6	10	0	0	0	0	0.00	0
82028SE	35	9	4	5	4	6	7	2	2	0	0	1.48	2.96
82029NW	46	8	4	9	8	7	10	0	0	0	0	0.00	0
82029NE	46	10	4	9	8	5	10	0	0	0	0	0.00	0

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82029SW	46	8	4	9	8	7	10	0	0	0	0	0.00	0
82029SE	48	10	4	9	8	7	10	0	0	0	0	0.00	0
82030NW	30	8	4	3	8	5	2	16	4	11	1	2.23	35.64
82030NE	40	8	4	4	8	8	8	22	14	8	0	2.02	44.37
82030SW	25	8	4	3	6	2	2	23	3	18	2	0.80	18.45
82030SE	35	8	4	3	6	6	8	11	1	5	5	0.90	9.85
82031NW	22	9	1	3	6	1	2	36	0	7	29	1.60	57.77
82031NE	26	7	4	3	6	2	4	0	0	0	0	0.00	0
82031SW	30	8	1	5	6	8	2	7	0	4	3	3.97	27.79
82031SE	35	7	4	5	8	7	4	11	0	10	1	4.16	45.73
82032NW	44	7	4	9	8	6	10	0	0	0	0	0.00	0
82032NE	47	9	4	9	8	7	10	0	0	0	0	0.00	0
82032SW	45	7	4	9	8	7	10	0	0	0	0	0.00	0
82032SE	50	9	4	9	9	9	10	0	0	0	0	0.00	0
82033NW	43	9	4	9	8	3	10	0	0	0	0	0.00	0
82033NE	37	9	4	5	4	7	8	0	0	0	0	0.00	0
82033SW	35	8	4	4	4	5	10	0	0	0	0	0.00	0
82033SE	34	8	4	3	4	7	8	0	0	0	0	0.00	0
82034NW	22	8	4	2	2	3	3	0	0	0	0	0.00	0
82034NE	21	4	5	3	3	5	1	2	0	2	0	6.70	13.4
82034SW	21	6	4	2	3	3	3	9	1	7	1	3.35	30.17
82034SE	17	3	2	3	3	5	1	17	13	3	1	8.28	140.71
82035NW	38	4	8	9	9	7	1	0	0	0	0	0.00	0
82035NE	36	4	8	9	9	5	1	0	0	0	0	0.00	0
82035SW	13	3	2	3	3	1	1	0	0	0	0	0.00	0
82035SE	18	4	2	5	4	2	1	0	0	0	0	0.00	0
82036NW	38	4	10	9	9	5	1	0	0	0	0	0.00	0

APPENDIX B
MAPPING UNIT DATABASE

Unit ID	Total Site Rating	Depth to W.T.	Surface Slope	Soil Text.	P.Mat. Texture	Dist. S.W.	Dist. F.P.	Total Sub. Lots	Lots 66-76	Lots 77-86	Lots 87-96	Avg. Lot Size	Gross Acreage
82036NE	40	4	8	9	9	9	1	0	0	0	0	0.00	0
82036SW	21	4	5	5	4	2	1	0	0	0	0	0.00	0
82036SE	20	4	2	5	6	2	1	0	0	0	0	0.00	0
8211NW	38	4	8	9	10	6	1	4	4	0	0	7.33	29.32
8211NE	37	8	5	9	6	8	1	0	0	0	0	0.00	0
8211SW	31	6	8	9	6	1	1	0	0	0	0	0.00	0
8211SE	25	7	2	8	6	1	1	0	0	0	0	0.00	0
82111NE	36	7	8	9	10	1	1	0	0	0	0	0.00	0
82111SW	41	5	10	9	10	6	1	0	0	0	0	0.00	0
82111SE	41	7	8	9	8	8	1	0	0	0	0	0.00	0
82112NW	29	7	5	9	6	1	1	0	0	0	0	0.00	0
82112NE	26	8	2	8	6	1	1	0	0	0	0	0.00	0
82112SW	33	9	1	7	8	7	1	0	0	0	0	0.00	0
82112SE	30	7	1	7	8	6	1	17	8	9	0	8.43	143.31
82113NW	23	7	1	5	8	1	1	0	0	0	0	0.00	0
82113NE	28	9	1	7	8	2	1	8	7	1	0	9.38	75.07
82113SW	21	6	2	5	6	1	1	3	0	3	0	3.62	10.86
82113SE	24	8	1	5	8	1	1	2	0	2	0	4.98	9.96
82114NW	36	5	10	9	10	1	1	0	0	0	0	0.00	0
82114NE	27	5	5	9	6	1	1	0	0	0	0	0.00	0
82114SW	34	5	8	9	10	1	1	0	0	0	0	0.00	0
82114SE	30	5	8	5	10	1	1	0	0	0	0	0.00	0
82122SE	30	8	5	5	10	1	1	0	0	0	0	0.00	0
82123NW	31	6	8	5	10	1	1	0	0	0	0	0.00	0
82123NE	23	5	5	5	6	1	1	0	0	0	0	0.00	0
82123SW	22	7	2	5	6	1	1	0	0	0	0	0.00	0
82123SE	17	5	2	2	6	1	1	0	0	0	0	0.00	0

APPENDIX B
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Unit ID	Total Site Rating	Depth to W.T.	Surface Slope	Soil Text.	P.Mat. Texture	Dist. S.W.	Dist. F.P.	Total Sub. Lots	Lots 66-76	Lots 77-86	Lots 87-96	Avg. Lot Size	Gross Acreage
82124NW	19	4	2	5	6	1	1	8	0	5	3	5.19	41.53
82124NE	19	7	1	3	6	1	1	0	0	0	0	0.00	0
82124SW	18	3	2	5	6	1	1	0	0	0	0	0.00	0
82124SE	19	5	1	5	6	1	1	19	0	14	5	6.64	126.07
82125NW	21	6	2	5	6	1	1	0	0	0	0	0.00	0
82125NE	22	6	1	5	6	3	1	2	1	0	1	1.75	3.5
82125SW	32	10	4	3	6	8	1	6	0	6	0	2.52	15.12
82125SE	32	10	4	5	6	6	1	4	0	4	0	0.72	2.87
82126NW	21	7	2	2	6	3	1	0	0	0	0	0.00	0
82126NE	23	8	2	5	6	1	1	11	0	9	2	6.26	68.87
82126SW	29	9	1	3	6	9	1	4	3	1	0	1.55	6.18
82126SE	26	9	1	3	6	6	1	0	0	0	0	0.00	0
82127NW	30	6	5	9	6	3	1	0	0	0	0	0.00	0
82127NE	30	7	2	5	6	9	1	0	0	0	0	0.00	0
82127SW	31	8	2	9	8	3	1	5	0	4	1	10.19	50.97
82127SE	27	8	5	5	6	2	1	2	0	0	2	1.82	3.64
82128NE	35	6	8	9	10	1	1	0	0	0	0	0.00	0
82128SE	43	8	10	9	10	5	1	0	0	0	0	0.00	0
82133NW	39	8	10	9	10	1	1	0	0	0	0	0.00	0
82133NE	30	8	5	9	6	1	1	0	0	0	0	0.00	0
82133SW	42	7	10	9	10	5	1	0	0	0	0	0.00	0
82133SE	35	7	5	9	6	7	1	3	0	1	2	11.66	34.99
82134NW	25	7	2	5	8	2	1	3	0	3	0	9.59	28.78
82134NE	25	8	2	5	6	3	1	4	0	2	2	7.50	30
82134SW	31	8	2	9	6	5	1	0	0	0	0	0.00	0
82134SE	27	7	1	7	6	5	1	0	0	0	0	0.00	0
82135NW	29	9	1	3	6	9	1	0	0	0	0	0.00	0

APPENDIX B
MAPPING UNIT DATABASE

Unit ID	Total Site Rating	Depth to W.T.	Surface Slope	Soil Text.	P.Mat. Texture	Dist. S.W.	Dist. F.P.	Total Sub. Lots	Lots 66-76	Lots 77-86	Lots 87-96	Avg. Lot Size	Gross Acreage
82135NE	28	7	1	8	6	5	1	1	1	0	0	8.00	8
82135SW	19	4	1	5	6	2	1	0	0	0	0	0.00	0
82135SE	17	3	1	5	6	1	1	1	1	0	0	14.01	14.01
82136NW	20	6	1	5	6	1	1	29	5	21	3	5.95	172.42
82136NE	21	7	1	5	6	1	1	1	0	1	0	7.01	7.01
82136SW	20	6	1	5	6	1	1	7	0	5	2	8.51	59.54
82136SE	22	7	1	5	6	2	1	0	0	0	0	0.00	0
91831NW	30	4	8	5	10	2	1	0	0	0	0	0.00	0
91831NE	33	4	8	9	10	1	1	0	0	0	0	0.00	0
91831SW	31	4	10	5	10	1	1	0	0	0	0	0.00	0
91831SE	35	3	10	9	10	2	1	0	0	0	0	0.00	0
91931NW	23	8	1	6	2	5	1	0	0	0	0	0.00	0
91931NE	28	7	1	6	8	5	1	0	0	0	0	0.00	0
91931SW	32	7	2	6	8	8	1	0	0	0	0	0.00	0
91931SE	28	7	1	6	8	5	1	0	0	0	0	0.00	0
91932NW	22	7	1	6	2	5	1	0	0	0	0	0.00	0
91932NE	23	7	1	5	3	6	1	1.5	1	0.5	0	13.22	19.83
91932SW	22	7	1	8	2	3	1	0	0	0	0	0.00	0
91932SE	23	7	1	8	3	3	1	0.5	0	0.5	0	19.46	9.73
91933NW	23	7	1	5	3	6	1	12	10	0	2	2.58	30.95
91933NE	24	7	2	4	8	2	1	10	10	0	0	2.52	25.15
91933SW	22	7	1	5	3	5	1	0	0	0	0	0.00	0
91933SE	28	7	2	5	6	7	1	0	0	0	0	0.00	0
91934NW	30	6	1	9	8	5	1	0	0	0	0	0.00	0
91934NE	20	6	2	6	2	3	1	0	0	0	0	0.00	0
91934SW	28	7	5	4	9	2	1	0	0	0	0	0.00	0
91934SE	40	6	8	9	9	7	1	0	0	0	0	0.00	0

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Unit ID	Total Site Rating	Depth to W.T.	Surface Slope	Soil Text.	P.Mat. Texture	Dist. S.W.	Dist. F.P.	Total Sub. Lots	Lots 66-76	Lots 77-86	Lots 87-96	Avg. Lot Size	Gross Acreage
91935NW	34	6	5	6	9	7	1	0	0	0	0	0.00	0
91935NE	26	6	5	5	4	5	1	0	0	0	0	0.00	0
91935SW	21	4	5	6	4	1	1	0	0	0	0	0.00	0
91935SE	13	5	2	2	2	1	1	0	0	0	0	0.00	0
91936NW	21	6	5	2	4	3	1	0	0	0	0	0.00	0
91936NE	28	5	5	5	10	2	1	0	0	0	0	0.00	0
91936SW	18	5	5	2	4	1	1	0	0	0	0	0.00	0
91936SE	24	5	5	2	10	1	1	0	0	0	0	0.00	0
92031NW	33	3	8	9	10	2	1	0	0	0	0	0.00	0
92031NE	27	3	5	9	6	3	1	0	0	0	0	0.00	0
92031SW	28	3	8	9	6	1	1	0	0	0	0	0.00	0
92031SE	20	3	2	7	6	1	1	0	0	0	0	0.00	0
92032NW	23	2	2	7	6	5	1	0	0	0	0	0.00	0
92032NE	20	2	1	4	6	5	2	0	0	0	0	0.00	0
92032SW	22	6	1	7	6	1	1	2	0	2	0	9.98	19.95
92032SE	20	4	1	4	6	2	3	6	0	4	2	9.35	56.1
92033NW	33	4	4	3	8	7	7	0	0	0	0	0.00	0
92033NE	35	8	4	3	4	6	10	0	0	0	0	0.00	0
92033SW	37	6	4	4	8	8	7	1	0	0	1	5.00	5
92033SE	37	9	4	4	8	2	10	0	0	0	0	0.00	0
92034NW	48	8	4	9	8	9	10	1	0	1	0	9.75	9.75
92034NE	26	7	1	5	6	3	4	30	11	17	2	1.89	56.62
92034SW	47	7	4	9	8	9	10	2	0	1	1	10.90	21.79
92034SE	25	6	1	5	6	3	4	16	8	5	3	3.60	57.64
92035NW	26	7	1	5	6	5	2	49	16	19	14	3.18	155.65
92035NE	28	6	1	5	9	6	1	1	0	0	1	4.36	4.36
92035SW	22	6	1	5	6	2	2	24	0	3	21	4.71	113.08

APPENDIX B
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Unit ID	Total Site Rating	Depth to W.T.	Surface Slope	Soil Text.	P.Mat. Texture	Dist. S.W.	Dist. F.P.	Total Sub. Lots	Lots 66-76	Lots 77-86	Lots 87-96	Avg. Lot Size	Gross Acreage
92035SE	22	6	1	5	8	1	1	0	0	0	0	0.00	0
92036NW	30	6	1	6	9	7	1	1	0	1	0	1.01	1.01
92036NE	24	7	1	6	2	7	1	1	0	1	0	5.00	5
92036SW	16	4	2	6	2	1	1	2	2	0	0	20.00	40
92036SE	20	5	5	5	2	2	1	2	2	0	0	20.00	40

APPENDIX C

CARTOGRAPHIC TECHNIQUES

In creating figures 7 through 13 (water pollution potential and site suitability maps), site factor ratings values were applied to each quarter-section areal unit by a composite method of manual and computer techniques. Soil and subsoil texture ratings derived from the Bitterroot Soil Survey maps (U.S. Department of Agriculture 1959) were classified and recorded manually. All other factor classifications were determined through digitization and geographic information system (GIS) interpretation using IDRISI, a raster-based program.

Each site factor pollution potential map consists of classification ratings that are superimposed on a base map. The base map was constructed by digitizing the study area boundaries, the township grid, and major streams into MICROSTATION CAD format. Polygons were inset into each quarter section, defining the areal units. Ranking values related to the site factors were added to the polygons, then linked to a database (dBASE IV). By using a database, information is entered only once for both mapping and statistical analysis, reducing the possibility for data entry errors. Each mapping unit received classification ratings for all six of the site factors, with the database controlling which numerical factor rating was visible on the map. The base map was saved six separate times, each time with a different factor value visible.

The final suitability map was computed by turning on all factor values in the database and adding them together to find the total unit score for each areal unit. All maps were imported into CORELDRAW! for graphic modifications. Numerical ratings and scores were converted into shades and colors, and fonts were adjusted for better readability.

Subdivision maps (figures 14 through 17) were drawn using a similar procedure. Subdivision data, including the filing date, gross acreage, and number of lots involved, were added to the linked database.

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