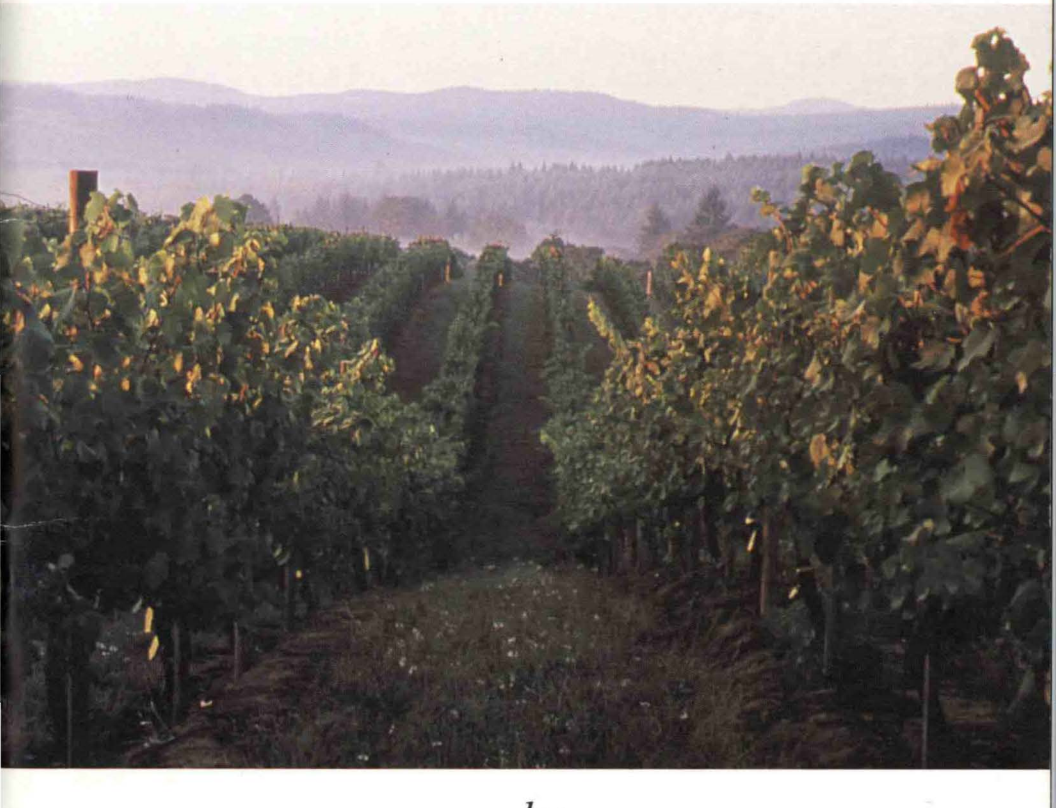
# *Vineyard Site Selection in Linn and Benton Counties*



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# Introduction

The expansion of the wine grape industry in Oregon over the last twenty years has made a substantial positive contribution to the growth of Oregon's agriculture and tourist industries. In 1990, wine grapes had a farm gate value of $5.6 million and a processed value worth $25.9 million. This was a 225% increase in wholesale value from 1985. Oregon has consistently produced quality grapes and wine and has established a strong position in the premium wine market.

Because of these strong economic returns, the industry is steadily growing. Vineyard acreage in Oregon has increased 36% between 1987 and 1991. The three north Willamette Valley counties of Polk, Washington, and Yamhill, which made up 58% of the total 1991 acreage, showed an increase in acreage of 46% in the past six years. Benton County's total wine grape acreage has risen 34% from 1987 to 1991, but it only represents 3% of the state's 6,050 total acres (Linn County represents 1%). Linn and Benton Counties have considerable potential for wine grape production; there are sites in both counties with climate and soil suitable for commercial grape production. The establishment of vineyards and wineries in these two counties would have a positive impact on the local economy.

The overall goal for selecting a vineyard location is to find a site suitable for a productive and profitable wine grape enterprise. The purpose of this publication is to provide information necessary for assessing the suitability of potential vineyard sites in Linn and Benton Counties. We will: I) define five major variables affecting site selection, II) describe grapevine phenology and classify a site using temperature, III) describe the soils and area of Linn and Benton Counties (see figures and photos in the center of the *Guide* for evaluation of each site), IV) list miscellaneous factors to consider, and V) provide a procedure and checklist for selecting a vineyard site.



# I Variables Affecting Site Selection

Proper site selection is the most critical initial step for production of high quality wine grapes. Three considerations when selecting a site for grape production are topographic features and climatic variables, site temperature and grape phenology relationships, and soil classifications.

In our regional maritime climate, temperatures can vary between sites because of the influence of topography, slope, aspect, and elevation of the land (see glossary for definitions). Slope and aspect will greatly influence the interception of solar radiation, which will in turn affect temperature and grape maturity. Elevation, air drainage (the down-slope flow of dense, cold surface air), and within-site differences in land conformation will also influence air temperature. Soil type and within-site variation of soils will affect vineyard performance by affecting vine production and vigor. Other factors such as proximity to wineries, markets, labor, and expertise should be assessed from a cost perspective.

# Topographic Features and Climate Variables

Oregon's relatively cool climate (macroclimate), which promotes slow fruit maturation and excellent quality, can also lead to problems in some years when grapes mature later in the season. During cool years, there may not be adequate warmth to ripen grapes on many sites. Site climate (mesoclimate) can vary significantly from the regional climate. The primary cause of this variation is that the site climate is affected by the site's topographical features.

In the following five sections we will examine: site topography and mesoclimate, frost and factors affecting it, solar radiation, rainfall, and wind.

### *Site Topography and Mesoclimate*

Site topography is the configuration of the land, including its relief and position. It includes the slope, aspect, and elevation of the land. Mesoclimate is a climate zone influenced by localized geographic conditions. All of the climatic features such as temperature, humidity, solar radiation, and wind speed may be affected by the land configuration. Heat accumulation on a site can vary by region and by site. For example, in a cool year regionally, a relatively warm site may mature late-season grape varieties such as Cabernet Sauvignon and Riesling, whereas a cool site may not.

The aspect and slope of the land greatly affect heat accumulation. The mesoclimate will be influenced by the aspect (direction of the slope). A south-facing slope will receive more solar radiation



than a north or east slope, and the amount of solar heat received will be affected by the slope of the site (angle to the horizon). A 20° slope will receive more solar radiation than a 5° slope due to greater angle of incidence to the sun.

The land's configuration affects many other climatic conditions, such as wind and air temperature. A site that is protected from prevailing winds by its topographic position will be warmer than an exposed one at the same elevation. Elevated sites above 1,000 ft. may escape frost but they can have less heat accumulation and may not ripen grapes in some years compared to low elevation sites (see Figure 4, Cascade Hill temperatures). For every 1,000 ft. increase in elevation there is a 3°F decrease in mean temperature.

Sites with poor air drainage, where cold air drains into the site and collects due to topography or vegetation, will have a mesoclimate with lower minimum temperatures. This type of site can be more susceptible to spring and autumn frosts or winter freeze injury (see Figures 3 and 5).

### *Frost and Factors Affecting It*

When the dew point is below freezing temperatures, frost occurs and tissue damage to a vine may result. Spring frosts (below 30°F) damage tender grape shoots and may decrease yield. Young shoots and flowers can be killed at temperatures of 28°F and below (see photos on page 16). Dormant wood can be killed at temperatures of -8°F during winter freezes.

Temperatures fall below freezing due either to a mass movement of cold air into the area (advective frost) or radiation loss from the soil that cools the air above it (radiation frost). Cloud cover at night will reduce radiation loss between the ground and sky. Air layers of various temperatures can form above a site, creating a temperature inversion with warm air above cold air. A slight wind of 3 mph will mix warm and cold air and reduce the risk of frost.

Air chilled by ground radiation gravitates (drains) to low spots (frost pockets) of any site. This includes depressions within a slope, as well as valleys at the base of a slope.

During the day, ground-absorbed radiation warms the air above the soil. During the night, the loss of heat from the ground creates a dense, heavy, chilled air that drains and collects in low areas. The cold air moves down a slope like a viscous liquid. In higher, elevated areas surrounding low spots, warm air from upper air layers replaces the cold air. A sloped site within the warm inversion layers and above low depressions or swales has the least frost hazard.

Other areas that are susceptible to frost are shelves or ledges where chilled air remains in contact with the ground and is never replaced with warm air. Swales and shelves generally should not be planted with wine grapes because of the high probability of crop loss from frost or freeze injury.

The interference of air movement by trees should also be considered. Depending on the circumstances, it is questionable whether removal of the timber would strengthen or lessen the possibility of frost. Timber above a slope may prevent cold air from draining onto the site, whereas timber at the base of the slope may dam air and increase the risk of frost. A passage for cold air below a site will prevent cold air accumulation.



The evaluation of cold air flow patterns on a potential site can prevent the mistake of planting in frost pockets. Ask yourself where the cold air originates, how it moves through the site, and where it will end up. A critical inspection of the site is necessary to determine this.

***Solar Radiation***

Solar radiation has a direct influence on temperature, humidity, and plant metabolic processes. Sunlight is necessary for grapes to synthesize sugars and mature properly. Although cluster exposure and leaf distribution can be manipulated by grape canopy management, the actual incident solar radiation available at a site is important for grape maturation and is determined by site topography. In other words, the amount of sun a grape cluster receives can be altered by removing leaves or training the vines, but the amount of sun a site receives can't be changed.

The total solar radiation received by an area through the growing season (April 1 to October 31) can be measured in two ways: weather stations that record solar radiation with pyranometers, or by estimating direct beam solar irradiation from tables organized by latitude. This information is difficult to obtain and may be more than the new grower needs.

Radiation intensity is also dependent on: 1) the daily clouds, smog, or humidity; 2) the slope and aspect of the site; and 3) the time of day and year, and latitude. While the day-to-day parameters may vary based on local climatic conditions, the topography will have a permanent influence on incoming solar radiation and on crop performance.

A south-facing slope receives higher solar radiation during certain periods than a valley floor site because of an increase in the angle of incidence of the sun. Risk of frost injury may be less on southeastern slopes than on southwestern. Also, fruit sunburning may be more common on southwestern slopes. A 15° increase in slope can increase incident solar radiation by 30 to 40% at noon. Site selection work in British Columbia demonstrated that the greatest amount of solar radiation intercepted during the growing season was on a south-facing slope of 20 to 40°. However, mechanized farming on slopes of 30° or more is difficult. Many European vineyards are planted on steep slopes that are terraced. This is a costly enterprise and generally has not been the trend for most American vineyards.

Mountains, hills, and trees can shade sites from direct solar radiation. Vineyard shading by an adjacent hill to the west can block afternoon sun and delay grape maturation. Shading from the east will increase frost danger.

***Rainfall***

Precipitation is also an important consideration when selecting a vineyard site. In western Oregon, 50% of the total precipitation falls from December through February and very little falls during the summer months. Rains during the growing season are important because spring rains replenish soil moisture to extend shoot growth, decrease temperatures, and delay bloom. Summer and fall rains can cause fruit rot and berry split before harvest.

Seasonally, rainfall tends to be inversely related to temperature. The most important factor regionally determining total rainfall is elevation.



For example, Portland (21 ft. above sea level) receives an average of 37.4 in. of rain annually, Salem (196 ft. above sea level) 40.4 in., and Eugene (359 ft. above sea level) 46 in. Compared to the larger regional precipitation patterns, the local rainfall across the valley floor in Linn and Benton Counties varies from 51.8 in. in the foothills of the Cascades (Foster Dam 550 ft. elevation) to 42.7 in. on the Willamette Valley floor (Corvallis 230 ft.) to 66.1 in. in the foothills of the Coast Range (Corvallis Water Bureau 590 ft.).

The distribution of precipitation throughout the year can affect vineyard management practices. A new planting of grapes may need supplemental irrigation during June through August of up to 2 in. Mature vines grown in shallow soils of less than 3 ft. in depth may require up to 4 in. of water during a dry summer. Availability of water for irrigation and frost control is covered later in this publication under "Miscellaneous Factors".

**The normal mean monthly precipitation (inches) received on the Willamette Valley floor at Corvallis (230 ft. above sea level)**

| | | | | | |
|---|---|---|---|---|---|
| January | 7.6 | May | 1.9 | September | 1.5 |
| February | 4.9 | June | 1.2 | October | 3.4 |
| March | 4.6 | July | 0.3 | November | 6.1 |
| April | 2.5 | August | 0.8 | December | 7.8 |

Deviations from these norms can easily occur, which can create production problems. Heavy rains in May and June of 4 in. or more have been associated with a delay in bloom. This may be due to cool temperatures or damage of flowers by the rainfall. Individual storms in August and September of a half-inch of rain or more can induce bunch rot in grape clusters. Also, fall rains can complicate harvest in certain late years (e.g. 1991).

***Wind***

Persistent high winds of 15 mph or more can lead to vine shoot breakage, poor heat accumulation, poor growth, and delayed berry maturation. Shoot breakage can be particularly severe during the early summer months when shoots are tender.

The velocity of wind is a function of wind direction and can vary considerably within the canopy height. Ground surface air is slowed by contact with the earth and vegetation. An increase in afternoon marine winds can reduce site temperature and heat accumulation, which can delay berry maturation.

If you are examining a site that may have potential wind problems, construction of a wind break may be necessary, although this generally has not been necessary for the Willamette Valley. Tree wind breaks should not be planted in areas where interference with air drainage would create frost pockets.

Row orientation with wind direction will improve air ventilation in the canopy and may aid in disease control. Trellis design and vine canopy training systems can be important in relation to prevailing winds. Vertically-trained shoots should have the fruiting wire on the windward side to assist in training the canopy upward. Downward-hanging canopy systems should have the fruiting wire on the leeward side so the wind pushes shoots over into a hanging position.

Winds can be compensated for by the manipulation of the site and planting.



# II Grapevine Phenology and Classifying a Site Using Temperature

To understand the effect of climate and soils on grapes, one must first understand the physiology and growth periods of a grape plant. This is a brief description of the developmental stages of a grapevine.

## Grapevine Phenology

The first stage of vine growth begins at bud break in the early spring (April) after the vine has received its chilling requirement. Rapid early shoot elongation takes place for eight to ten weeks after bud break when temperatures are above 58°F. Flowering occurs approximately eight weeks after bud break. Fruit set (also referred to as shatter) occurs one to two weeks after bloom. Veraison (pronounced *ver-a'-sawn*) (first berry color change or softening) occurs eight to ten weeks after flowering. During the four to six week period of fruit set to veraison, berry growth is rapid. Clusters then become tighter, called bunch closure. Berry sugars (measured in °Brix) increase and acids decrease. Grapes ripen between veraison and harvest, a period that lasts from four to six weeks depending on variety. Wine grape harvest is determined by the juice's °Brix, acid, and pH (free acids). This occurs fifteen to seventeen weeks after first bloom. The best wine quality is achieved when mean air temperatures are between 49 and 60°F during harvest.

Other important and complex quality components influence the final taste and aroma of the fruit during this time. Site conditions can have an effect on all stages of development. Frost after bud break can damage tender shoots and cool temperatures or precipitation during flowering can reduce fruit set. Frost before harvest can prevent berry maturation due to leaf damage. Later in the season, precipitation before harvest may promote berry rot and reduce fruit quality. The site's climate is critical during the maturation process and much of the quality of Oregon wine can be attributed to our cool nights and warm days.

Vines begin dormancy during the early winter months. Winter injury may occur when vines are not fully dormant at temperatures below 10°F, and most European wine grape (*Vitis vinifera*) varieties may be damaged below 0°F.

## Classifying a Site Using Temperature

There are several ways to record site temperatures. You can use computers, thermographs, orchard thermometers, and high/low thermometers. Viticultural regions are classified using climatic indices such as temperature. We will briefly describe two of the most useful for vineyard site selection: heat accumulation (also known as heat degree days or heat summation) and frost-free days.

### *Heat Accumulation*

Heat accumulation is the sum of the mean daily temperature above 50°F. The formula used is: [(maximum daily air temperature + minimum daily air temperature)/2] - 50°F. The traditional baseline temperature of 50°F is used for grapes because there is little shoot growth below that temperature. This is accumulated through the growing season



(April 1 to October 31). French and German wine grape varieties are grown with optimum quality when the index is below 2,500 and above 1,600 units. The shortcoming of this index is the difficulty in obtaining temperatures to plug into the formula.

The vines' response to temperature is not linear, and heat accumulation is not constant between grape phenological periods. Vine growth and crop maturation cannot always be predicted using heat accumulation, but it is useful in determining the relative warmth of a site and it is often referred to in varietal selection.

Official weather monitoring sites nearby are helpful in understanding a regional climate. The Office of the State Climatologist at Oregon State University has published an inventory of weather stations around the state. In addition, many vineyards in Oregon have heat accumulation records for their sites. Heat accumulation from new sites can be compared with known performance records from other established vineyards. Low heat accumulation could indicate that the site will be slow to ripen grapes in cool years.

An example of heat accumulation for four major cities in Oregon is as follows:

| | | | |
|---|---|---|---|
| Corvallis | 1,860 | Roseburg | 2,220 |
| Salem | 2,030 | Grants Pass | 2,680 |

The heat accumulation at four stations and their elevations in Linn and Benton Counties, averaged from 1986 to 1991 during the growing season, are:

| Elevation (ft.) | City | Heat Accumulation |
|---|---|---|
| 520 | Lacomb | 1,935 |
| 550 | Foster Dam | 2,096* |
| 590 | Corvallis Water Bureau | 1,764 |
| 860 | Cascadia | 1,698 |

*Averaged over a five-year period, 1987 to 1991.

Hillside vineyard sites can have a different heat accumulation during the growing season than sites on the Willamette Valley floor. In comparing the heat accumulation of two Willamette Valley floor sites (Hyslop and Lewis-Brown) and one south-facing Coast Range foothill site (Woodhall III), the following heat units were obtained in 1990:

| | Apr* | May | Jun | Jul* | Aug | Sep | Oct | Total |
|---|---|---|---|---|---|---|---|---|
| Hyslop | 30 | 141 | 334 | 534 | 559 | 451 | 72 | 2121 |
| Lewis-Brown | 86 | 189 | 390 | 550 | 596 | 487 | 85 | 2383 |
| Woodhall III | 65 | 153 | 337 | 506 | 573 | 473 | 96 | 2203 |

*A formula was applied to April and July units for all three sites to compensate for missing data (mean heat unit accumulation for available days times number of days in the month).

At the above three sites, temperatures were recorded on different equipment, thus some variation may exist.

An example of mean heat accumulation for the growing season in two established vineyards in Polk County over a six-year period from 1986 to 1991 is:

Vineyard 1: 2,536 Vineyard 2: 2,613



At these two sites, located in the Eola Hills, temperatures were recorded by thermographs. The higher heat accumulation may be a reflection of the regional climate of this range of foothills off the valley floor, and the mesoclimates within this range.

***Frost-free Days***

One other method for determining the suitability of a site for growing grapes is the number of frost-free days; the number of days below 32°F and above 28°F (killing frost). Temperatures at or near freezing concern many growers, particularly with the occurrence of spring and fall frosts. A frost-prone site is also more likely to suffer injury from low winter temperatures.

The timing of frost-free periods with the phenology of the grape plant is critical. Early-maturing *vinifera* grape varieties require a minimum of about 150 frost-free days from bud break to harvest, with 180 days being preferred. The dates of the last spring and first fall frosts may occur after bud break and before harvest. This can result in frost damage in the spring and poor ripening in the fall. Below is a table of the 50% chance of an occurrence of frost at two temperatures (32 and 28°F) at Corvallis.

**50% chance occurrence of first and last frost during the growing season (April 1 to October 31)**

| Location | Temp. °F | Date of Last Spring Frost | Date of First Fall Frost | Frost Free Days |
|---|---|---|---|---|
| Corvallis | 32 | 4/15 | 11/1 | 200 |
| | 28 | 2/27 | 11/17 | 263 |

(Text continued on page 22)

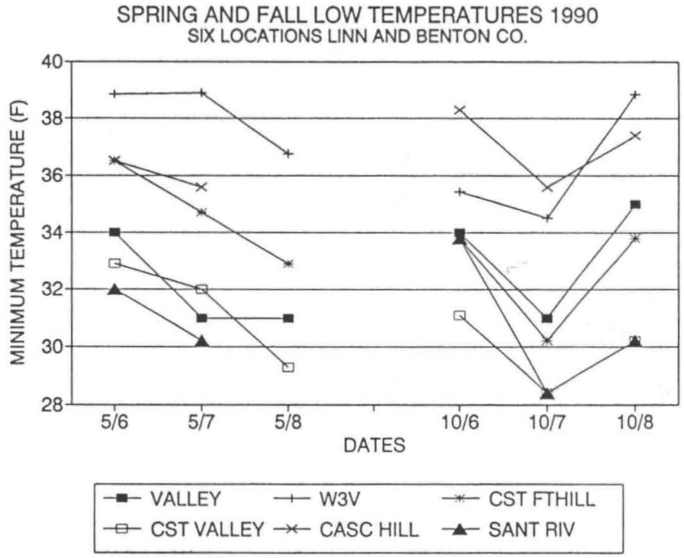
Figure 1
Fall frost at Coast Valley Site, lower portion of vineyard experienced colder temperatures and leaves have completely dropped.

Figure 2
Spring frost damage on tender young growth.

Figure 3
Winter freeze injury (from December 1990) on grapevine, trunks and canes were damaged at this vineyard.



## Figure 4




## Figure 5

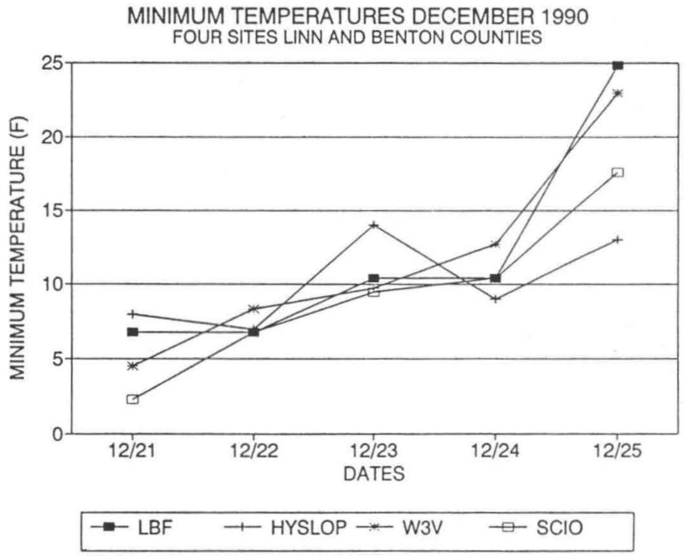


Figure 6
Valley floor vineyards can be a viable option if site is not supported by deep, fertile soils where vine growth compromises fruit quality.

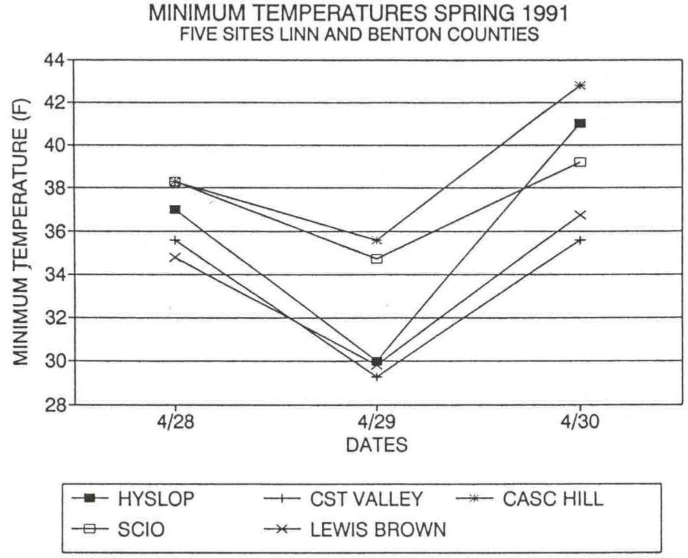
Figure 7
Coast valley sites may have air drainage problems, carefully examine topography within and surrounding site.



Figure 8
Coast foothills provide vineyard sites, trees at the bottom can dam up cold air, but in this case a stream at the bottom assists in moving cold air away from the site.

Figure 9
Woodhall III Vineyards, Coast foothills, southern Benton County, research vineyard for Oregon State University, donated by Dr. Frank Baynes. Elevation at the top of the vineyard: 700 ft.

## Figure 10




## Figure 11

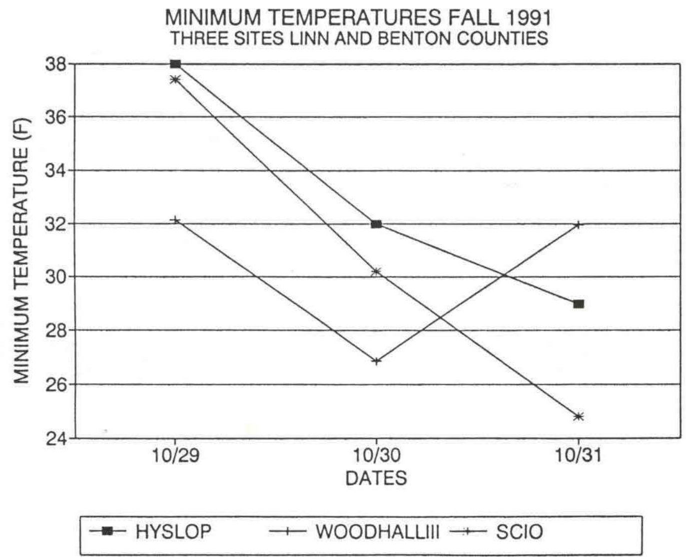



Figure 12
High elevation Cascade foothills, 1,100 ft. elevation escapes frost with no cold air drainage onto site, but has difficulty in some years with heat accumulation.

Figure 13
Cascade Valley near Santiam River drainage can succumb to spring and fall frosts, which make it unsuitable for grape production.

Figure 14
Low elevation Cascade foothills, elevation 700 ft., with proper exposure and soils can provide excellent sites for grapes.

(Text continued from page 15)

Use localized information to determine the regional weather then evaluate your site as it deviates from those patterns.

Another important point to emphasize is that a 10% chance occurrence of frost can seriously affect the long-term profitability of a site if a crop is lost one out of every ten years.

Listed below are the average dates for vine phenology for Pinot noir in Corvallis based on data collected during the five-year period of 1986-1990. When comparing important dates of grapevine development to frost periods within a region, a new grower will begin to see the margin necessary for escaping frost injury. If a site has spring frosts later than local averages, yet vine development follows a similar pattern, that margin is reduced even further. At some point it is no longer economically feasible to farm a site with extreme frost problems and the initial investment is lost.

**Average dates of vine phenology for Pinot noir, Corvallis, 1986-1990.**

| Development Stage | Date | Days From Bud Break |
|---|---|---|
| Bud break | 4/9 | 0 |
| Flowering (1st flowering) | 6/12 | 64 |
| Veraison (1st color) | 8/17 | 100 |
| Harvest (1st harvest) | 9/22 | 166 |

In comparing the two previous tables, there is a 50% chance of occurrence of a 32°F frost up to April 15 in Corvallis. If the average bud break is April 9, then for six days as growth begins there is a chance of frost damage. This may not be a killing frost, but some damage may occur in younger vines trained closer to the ground or in low spots within the vineyard. If a potential site records temperatures closer to 28°F up until April 15, the likelihood of injury is even greater.

The following two tables list bud break for various sites within the two counties and minimum temperatures during those time periods.

**Bud break in Linn and Benton Counties for Pinot noir in 1990 and 1991**

| Location | 1990 | 1991 | Area |
|---|---|---|---|
| **Benton County** | | | |
| Lewis-Brown | 4/4 | 4/16 | valley floor |
| Greenberry | 4/6 | 4/18 | southern Benton terrace |
| Woodhall III | 4/4 | 4/15 | southern Benton coastal foothills |
| Wren | 4/10 | 5/2 | western Benton coastal valley |
| North Albany | | 4/17 | northern Benton foothills |
| **Linn County** | | | |
| Scio | | 4/18 | north Linn Cascade foothills |
| Crabtree | 4/8 | 4/25 | valley floor |
| Lacomb | | 4/18 | valley floor |
| Sweet Home | 4/11 | 5/2 | south Linn high elevation |

| **Last day of low temperatures for selected sites in the two counties** | | | | |
|---|---|---|---|---|
| | 1990 | | 1991 | |
| Location | Date | Temp.°F | Date | Temp.°F |
| **Benton County** | | | | |
| Corvallis | 4/9 | 31 | 4/11 | 30 |
| Greenberry | 5/8 | 33 | 3/26 | 33 |
| Woodhall II | — | — | 3/20 | 33 |
| Wren | 5/8 | 29 | 4/29 | 29 |
| **Linn County** | | | | |
| Lebanon | 5/15 | 28.5 | — | — |
| Sweet Home | 5/7 | 35.5 | 4/10 | ~~0~~ |
| Scio | 4/9 | 35.5 | 4/12 | ~~0~~ |

In comparing the Wren site in 1990 and 1991, bud break occurred on April 10 in 1991 before the last killing frost of May 8. In 1991, bud break occurred on May 2 after the last spring frost of April 29. The delay in development in 1991 allowed the site to escape any spring frosts after bud break. Temperatures above 32°F are listed to show what was recorded at sites during the frost periods. For between-site comparisons in Linn and Benton Counties, see Figures 4, 5, 10, and 11.

# III Soils and Area Description of Linn and Benton Counties

In the following three sections we will describe the geography and soils of the two counties, list the five survey areas we evaluated, and describe several of the major soil associations in Linn and Benton Counties.



## Vineyard Site Surveyed Areas

Five geographical areas were surveyed by Oregon State University in the two counties for two growing seasons to determine their vineyard site potential. The weather stations established within these areas, their elevation, soils, and data collected are listed below.

1) Willamette Valley floor - 2 sites: Hyslop Farm, 300 ft. elevation on Woodburn and Willamette soils, full weather station with long term historical data; Lewis Brown Farm, 300 ft. elevation on Malabon soil, air temperature and precipitation were recorded. See Figures 4, 5, 6, 10, and 11.

2) Western Benton County (Coast Range valley) - 1 site: 2 miles north of Wren, 500 ft. elevation, south slope, on Dixonville soil, air temperature at 4 ft. was recorded. See Figures 4, 7, and 10.

3) Southern Benton County (Coast Range foothills) - 2 sites: 3 miles west of Greenberry, 350 ft. elevation, south slope on Willamette soil, air temperature at 4 ft. was recorded; 3 miles west of Alpine, 700 ft. elevation, on Jory soil, recorded air temperature, soil temperature, precipitation, relative humidity, and wind speed. See Figures 4, 5, 8, 9, 10, and 11.

4) Southern Linn County (Cascade Valley and high elevation Cascade foothills) - 2 sites: Santiam river frontage, 300 ft. elevation, on Chapman soil, air temperature recorded for one season only; 3 miles northeast of Sweet Home, 1,200 ft. elevation, east slope, on Jory soil, air temperature recorded for two seasons. See Figures 4, 10, 12, and 13.

5) Northern Linn County (low elevation Cascade foothills) - 1 site: 2 miles south of Scio, 700 ft. elevation, south slope, on Coburg soil, air temperature was recorded. See Figures 5, 10, 11, and 14.

Weather stations recording air temperature, precipitation, solar radiation, and wind speed were installed at two of the sites and air temperature was recorded at the remaining sites. Data were collected during the growing season (April through October) over a two-year period.

## Soil and Area Description

The USDA Soil Conservation Service has published Soil Surveys for Linn and Benton Counties. The surveys contain detailed soil maps, descriptions of soil properties, and interpretations of soil suitabilities and limitations. These surveys are available through the local USDA-SCS offices and at the Oregon State University Department of Crop and Soil Science.

Benton County's soil surveyed area is approximately 501 square miles, or 321,000 acres. The eastern part of the county is on alluvial bottoms and terraces of the Willamette Valley. To the west, the foothills rise to meet the mountainous forested Coast Range 35 miles from the Willamette Valley. Elevations range from 190 ft. at the Willamette River to 4,097 ft. on Mary's Peak. The marine climate varies from east to west, with total annual precipitation increasing from 40 to 120 in. The soil profile changes from deep soils on bottomlands and terraces to deep and moderately deep soils on foothills to moderately deep and shallow soils on dissected coast range slopes. Soils on the main valley floor and narrow western valleys are used mainly for cereals, grass seed, and fruits. Soils in the foothills are used widely for Christmas tree production.

Linn County's soil surveyed area is approximately 1,495 square miles, or 956,560 acres. The western part of the county is on the valley floor and rises slowly to the east through the North Santiam, the South Santiam and the Calapooia River drainages. Rolling foothills rise from the valley terraces and run north-south parallel to the Willamette Valley. Elevations range from 185 ft. at the Willamette River to 4,966 ft. at Galena Mountain 40 miles east in the Cascade Range. Precipitation increases from 42 in. in Albany to 88 in. in Detroit. Inversely, average winter temperatures decrease from 42°F in Albany to 37°F in Detroit. Farming operations are similar in Linn County to Benton County, with grass seed production being the primary crop in the poorly drained terraces in the western part.

The main area traditionally seen as most suitable for grape production is the foothill area of the Coast Range, especially on south-facing slopes. Other areas, such as the valley floor, the Cascade foothills and the Coast Range valleys also deserve consideration. There are over 217,000 acres of land in the two counties that could be classified as best sites with good soils. This classification was determined from geographical areas listed in the soil surveys for Linn and Benton Counties. Best sites take into consideration topography and location. Good soils are those soils suitable for winegrape production.

Below is a table of this classification and amount of acreage available in the two counties.

| Rating | Soil Type | % In Linn & Benton |
|---|---|---|
| Good Sites, Fertile Soils | Jory, Nekia, Bellpine | 17 |
| Fair Sites, Fertile Soils | Woodburn, Willamette, Malabon, Coburg | 15.3 |
| Fair Sites, Fertile Soils | Chehalis, Chapman | 22.5 |
| Poor Sites, Fertile Soils | McAlpin, Abiqua | 2.9 |
| Good Sites, Problem Soils | Hazelair, Dixonville, Ritner | 24.5 |
| Poor Sites, Problem Soils | Dayton, Amity | 14.4 |

Fertile soils such as Woodburn, Willamette, Malabon and Coburg may produce excessive vine vigor, particularly on the valley floor where soils are deep.

## Soil Characteristics and Descriptions

Careful evaluation of the soil profile characteristics at each site should be made. For example, vines grown in deep soils that have a high water holding capacity may produce excessive vegetative growth with fruit of poor quality; shallow, droughty soils may not adequately support grapevines.

The main soils that dominate the Linn and Benton County soil survey are: 1) Foothill soils - well drained soils that meet the Cascade and Coast Range on slopes of 2 to 60% percent, 2) Terrace Landform Soils - well drained to poorly drained soils that lie between the bottomlands and the



foothills at 190 to 300 ft. elevation and have a 0 to 3% slope, and 3) Alluvial Bottomland Soils - well drained to poorly drained soils adjacent to the Willamette River and its tributaries on sloped of 0 to 7%.

The following text includes brief descriptions of some of the major soil associations in Linn Benton Counties.

***Soils of the Coast Range and Cascade Range Foothills***

The best soils for wine grape growing occur in the Jory-Bellpine association in the foothills of both the Coast Range and the Cascades. These soils are located on broad, stable ridgetops at elevations ranging from 300 to 1,200 ft. All of these soils are well drained, red soils with a silty clay loam surface texture and clayey subsoils. Jory soils are 60 in. deep, over poorly consolidated sandstone. Bellpine soils are like Jory, except they are 20 to 40 in. deep over sandstone. The Nekia soil component of the Jory-Bellpine-Nekia association on the Linn County side is similar to Bellpine, except the underlying bedrock is basalt.

In Benton County, they make up 12.5% of the soil survey areas, and in Linn County they make up 3.5% of the survey area.

A second group of foothill soils is the Dixonville-Philomath-Hazelair association, located on the low foothills adjacent to the Willamette Valley at an elevation of 300 to 1,400 ft. Dixonville and Hazelair are moderately deep soils, but Dixonville is well drained and Hazelair is moderately well to somewhat poorly drained. The permeability of Dixonville and Philomath is slow, and that of Hazelair is very slow. Depth to bedrock, or the effective rooting depth, for Dixonville and Hazelair is 20 to 40 in. and for Philomath the depth is 12 to 20 in. The surface layer of Dixonville and Hazelair is a silty clay loam, and the Philomath surface layer is a silty clay. Both Dixonville and Philomath have a weathered basalt under a clayey subsoil. Dixonville has possibilities for grape production, but Philomath is poorly suited. This association makes up 7% of Benton county (Dixonville and Philomath only) and 7% of Linn County as well.

A third group of foothill soils is the Hazelair-Veneta association. This association is located on foothills and terraces with slopes of 3 to 12%, but at elevations lower than the red hill soils.

Hazelair soils are somewhat poorly drained soils. They have a silt loam surface texture and a clayey, high shrink-swell subsoil. The true Hazelair (not Hazelair variants) soils have the clayey subsoil which restricts water movement and root penetration. The soil can by too wet for grapes in the winter and too droughty in the summer. Hazelair soils occur 4% in the Benton County survey area and 2% in the Linn County survey area.

Veneta soils are deep, moderately well drained loams and clay loams over weathered sandstone. Drainage is not particularly limiting, but the soils can by droughty in the summer. Veneta soils occur less than 1% in Benton County only.

A fourth group of foothill soils is the Price-Ritner association; its parent is basalt. Price is a deep soil, and Ritner is moderately deep. These foothill uplands are on 3 to 75% slopes on elevations of 400 to 1,800 ft., and make up 13.6% of the Benton County survey area and 1.8% of the Linn County survey area. The surface soil is a silty clay loam, the subsoil is gravelly clay in Price, and gravelly to cobbly in Ritner. The main difference between these soils and the Jory-Bellpine soils is the content of basalt gravel and cobbles. That's because Price and Ritner occur on the steeper, more unstable slopes, and they are more prone to erosion and landslide activity.

***Terrace and Bottomland Valley Floor Soils***

Willamette Valley floor terrace soils, at elevations of 200 to 300 ft., include Woodburn, Willamette, Dayton, Amity, Malabon, and Coburg soils. These soils are fertile, with a high water holding capacity which can produce excessive vegetative growth. Individual sites located in areas with good drainage (eg. over gravel bars) can produce vines with a balanced canopy between shoot and fruit growth (see Figure 6).

Both Woodburn and Willamette soils are deep soils with silt loam surface textures and silty clay loam subsoils. These soils are used primarily for pasture hay, small grains, vegetable crops, orchards, grass seed, and berries. Woodburn soils are moderately well drained, and Willamette soils are well drained.

The Dayton and Amity soils are deep, with restricted drainage. Both soils have a silt loam surface texture, but Dayton, unlike Amity, has a clay layer that restricts drainage. Crops grown on these soils are hay, pasture, small grain, and grass seed. Amity can be used for vegetable crops where irrigation and drainage is provided.

The Malabon and Coburg soils consist of deep, moderately well to well drained soils. They are on slopes of 0 to 3%. The surface profile is a silty clay loam, and the subsoil is often silty clay. Crops grown on these soils are grains, grass seed, pasture, hay, and irrigated vegetable crops.

The bottomland soils along the Willamette River, such as Chehalis, McBee, Chapman, Newberg, Cloquato, Fluvents soils, are unsuited for grape production. These soils are located on flood plains. Some areas are prone to pockets of cold air drainage. Alluvial soils in Tributary Valleys that drain into the Willamette include Bashaw, Newburg, Cloquato, Fluvents, McAlpin, Waldo, and Abiqua soils. Soils from watershed tributary valleys are not recommended for grapes because soils are wet or clayey, subject to frequent flooding, and are in areas prone to frost.

# IV Miscellaneous Factors

There are many miscellaneous factors to consider when choosing a potential vineyard site. Factors such as availability of water, land and start up costs, proximity to markets, property zoning, previous crops, and protection against vertebrate pests should also be considered in the viability of any site.

Zoning regulations may affect use permits and taxes. Residential districts may prevent certain agricultural uses. Check with county officials before making any firm decisions.

Another factor to consider is the use the potential site has been put to in the past. History of pesticide use should be determined. Adjacent grass seed fields may be a problem if they employ the use of volatile phenoxy-type herbicides such as 2,4D as chemical drift may damage grapevines.



Also, soil-borne pests such as nematodes and phylloxera may have been introduced from previous plantings.

Vertebrate pests such as deer, birds, gophers, and rabbits can prey on new plantings with such diligence as to be economically devastating. The protection needed can be quite costly and should be considered in the initial planning.

***Water Availability***

The demand for a reliable, economical source of water for vineyard establishment and production cannot be emphasized enough. Water requirements for irrigation and frost control are greater than any other need. For example, a 3 in. application of water on one acre requires 81,462 gallons of water.

If a site has been selected and a well or pond is not in place, some preliminary investigation can be done to determine the land's suitability. Neighboring wells all have a measurement of gallons per minute (GPM) associated with them. If land owners cannot provide you with that information, the Water Master in Salem can (in some cases). If an embankment or excavated pond is desired, some technical advice can be obtained from a publication entitled "Ponds—Planning, Design, Construction" or by contacting the Soil Conservation Service field offices in Linn and Benton Counties. Depending on the size of the reservoir, a permit may be required by the State of Oregon, Department of Water Resources.

***Economic Factors***

According to the publication "Vineyard Economics" (available through the OSU Extension Service), the actual cash demand for year 0, before vines are planted, can be as high as $92,452 for 20 acres of grapes on a 25-acre site. These figures are not meant to discourage you, but to draw your attention to the realities of vineyard establishment.

Proximity to market and labor can greatly affect costs. When crop yields are small and market prices soft, it is important to limit additional expenditures.

Below is the average value per ton for wine grapes and the average per acre tonnage from 1988 to 1990.

| Year | Dollars/Ton | Tons/Acre |
|---|---|---|
| 1988 | 611 | 2.26 |
| 1989 | 760 | 2.19 |
| 1990 | 800 | 1.79 |
| 1991 | 860 | 2.59 |

Note: Figures provided by the Oregon Agricultural Statistics Service, Portland, Oregon.

## V Procedure for Selecting a Vineyard Site - a Checklist

When examining a potential site for the first time, use the following checklist to ask yourself the necessary questions to determine its suitability. Separate yourself from any biases that you or your realtor may have during this period, then analyze the results. Given the tight economic margin a vineyard must operate on, ask yourself whether the site is suitable for grape growing.



***Vineyard Site Checklist***

- Examine the topography
  - What is the aspect of the site?
  - What is the elevation at the top and bottom of the site?
  - What is the percent slope? Can it be mechanically farmed?
- Examine the air drainage
  - What is the location of the site in the geographical area?
  - Are there hills above the site that would drain cold air into it?
  - Is there a passage for cold air at the bottom of the site?
  - Are there within-site variations? Swales? Low spots? Shelves?
- Research local weather information
  - On what type of site is the weather station located?
  - What are the general weather conditions of the area? Temperatures?
- Find the site in the soil survey
  - What are the soil classifications of the site?
  - Are they suitable for grape production?
  - Walk the site and dig holes. Are there within-site variations?
  - What is the depth of the soil?
  - Have any soil tests been conducted?
- Investigate the miscellaneous factors
  - What is the distance to market and labor?
  - What is the potential availability of water?
  - What one the zoning or other local restrictions?
  - What is the site history? Pesticides?
  - Were there any previous crops grown? Potential pests?

### *Resources*

If you don't know the answers to these questions or how to interpret the results, do you know where to go to find out? Here's a list of resources that might help:

Linn and Benton County Extension Service, Corvallis, OR

Oregon Winegrower's Association, Portland, OR

USDA Soil Conservation Service, Corvallis, OR

Oregon State University, Department of Horticulture, Corvallis, OR

Oregon State University, Department of Crop and Soil Science, Corvallis, OR

Oregon State University, Soil and Plant Analysis Lab, Corvallis, OR

Office of the State Climatologist, Oregon State University, Corvallis, OR

Oregon Department of Agriculture, Salem, OR

Linn and Benton County Department of Finance and Taxation

Linn and Benton County Development Department

Local vineyard and winery owners and managers



# Glossary

Acidity: natural tartness in grapes, essential ingredient in wine.

Air Drainage: (aerial drainage) the down-slope flow of surface air caused by it's relatively high density and contact cooling, prevalent on clear nights.

Alluvium: material, such as sand, silt, or clay, deposited on land by streams.

Aspect: a position facing in relation to point of the compass; exposure.

Berry maturation: physiological process, with cessation of vegetative growth, fruit begins onset of ripening, color change, softening.

Berry Rot: fungus or bacterial rot attacking fruit, eg. Noble rot.

Brix: a scale for measuring the sugar content of grape juice.

Bud Break: (bud burst) grape buds begin to grow in spring, and leaves appear.

Canopy Management: range of techniques which alter the position and number of shoot and fruit in place.

Chilling Requirement: number of hours below a base temperature necessary to break dormancy.

Degree Day: see Heat Accumulation

Dewpoint: the temperature at which dew forms.

Dormancy: inactive stage of plants, induced by temperature and day length.

Foothill: a steeply sloping upland that has relief as much as 1,000 ft. and fringes a mountain range or high plateau escarpment.

Frost: a weather condition with temperature below the freezing point of water.

Frost Free Days: the number of days between spring and fall frosts.

Fruit Set: flowers which have been pollinated, fertilized, and which remain on the bunch.

Grape Phenology: the vine's development process, can be predicted by the growth of other crops.

Heat Accumulation: the sum of mean monthly temperatures 50°F for the period concerned.

Heat Summation: see Heat Accumulation

Incident Radiation: (angle of incident) amount of radiation a site received modified by the angle at which the radiation hits.

Macroclimate: the larger regional climate.

Mesoclimate: the localized climate zones influenced by local geographic conditions.

Microclimate: the specific climate within the grape canopy (grapevine).

Nematodes: microscopic, wormlike animal; some species live saprophylically, others as parasites to plants and animals.

Permeability: the quality of the soil that enables water to move downward through the profile; measured in number of inches per hour that moves downward though the saturated soil.

Ph: a numerical designation of acidity and alkalinity.

Photosynthesis: the process by which carbon dioxide and water are combined in the presence of light and chlorophyll to form carbohydrates.

Phylloxera: a small, soil-borne, aphid-like insect that feeds on grape vine roots.

Shatter: when unfertilized flowers drop off, occurs approximately one week after fertilization.

Slope: the inclination of the land surface from the horizontal; percentage of slope is the vertical distance divided by the horizontal distance, times 100 (100% = 45°).

Soil Association: a group of soils geographically associated in a characteristic, repeating pattern and defined and delineated as a single unit.

Soil Profile: a vertical section of the soil extending through all its horizons and into the parent material.



Soil Series: a group of soils formed from a particular type of parent material, have similar profile characteristics and arrangements.

Solar Radiation: radiation emitted by the sun which reaches the earth in short wavelengths.

Terrace: an embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour.

Terrace: (geologic) an old alluvial plain, ordinarily flat or undulating, bordering a river, lake or sea.

Topography: a description or survey of a particular place; a configuration of a surface, including its relief.

Vegetative Growth: (shoot vigor) excessive vegetative growth.

Veraison: first color change in grape berries.

Vitis vinifera: Genus, species of the European grape varieties, which account for the majority of the world's wine.

Water Capacity: (available water capacity, available moisture capacity) capacity of soils to hold water available for use by most plants; expressed in inches.

Winter Injury: vine injury due to below-freezing temperatures for an extended period.

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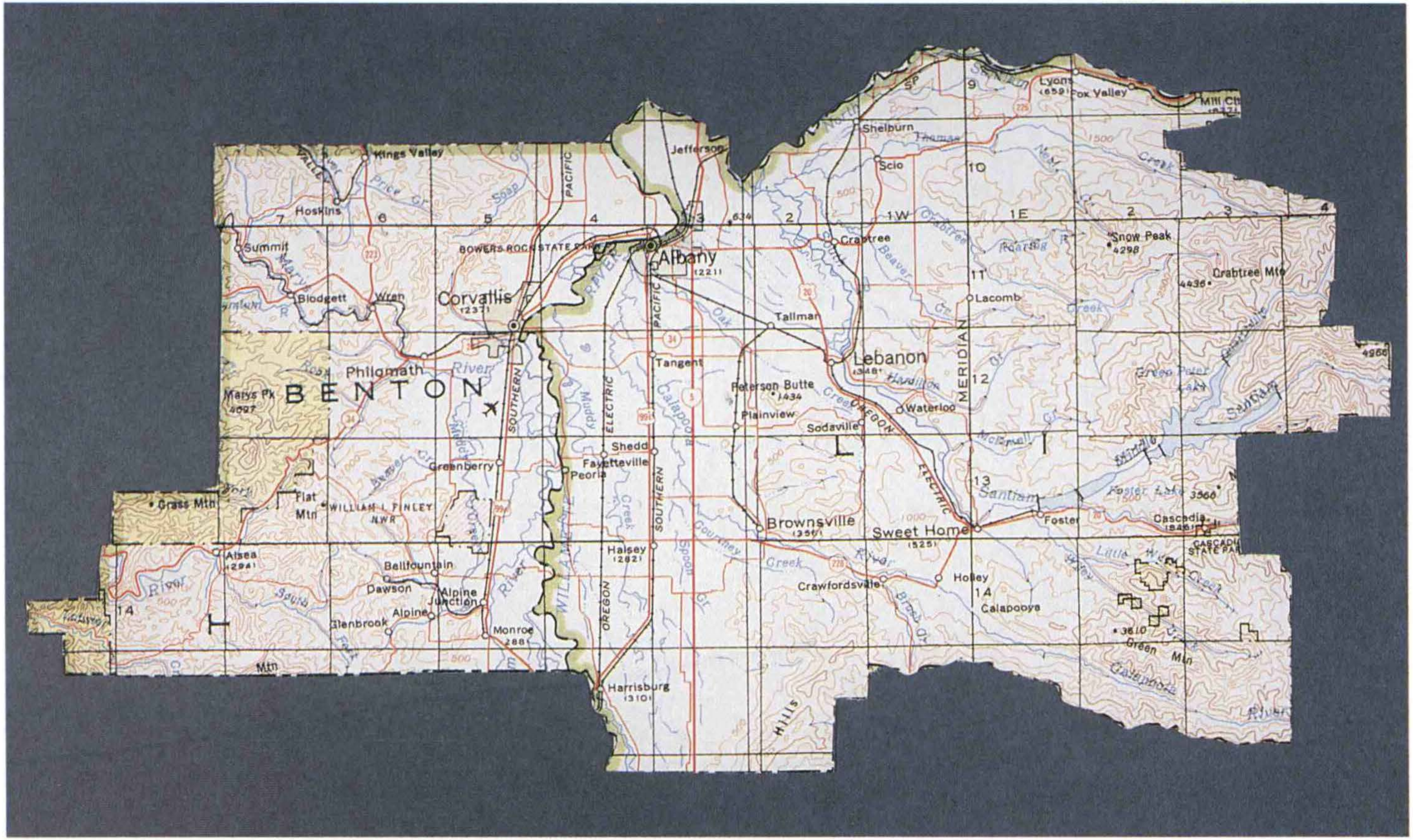
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Philomath
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Flat Mtn
WILLIAM L FINLEY NWR
Greenberry
Alsea
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Bellfountain
Dawson
Alpine Junction
Alpine
Glenbrook
Monroe
(288)
Peoria
Jefferson
Albany
(221)
Tangent
Shedd
Fayetteville
Halsey
(282)
Harrisburg
(310)
Shelburn
Scio
Lyons
(659)
Fox Valley
Crabtree
Snow Peak
4298
Crabtree Mtn
Lacomb
Tallman
Lebanon
(348)
Peterson Butte
1434
Plainview
Sodaville
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