SOUTH COUNTY REGIONAL COST/BENEFIT ANALYSIS
REGIONAL PROBLEM SOLVING PROJECT
FINAL REPORT

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CHAPTER 1.
PROJECT OVERVIEW

PROJECT PURPOSE AND BACKGROUND

The Regional Problem Solving Project detailed in this report addresses the challenge of future growth in the southern portion of Deschutes County. These future challenges are reflected in past land use practices, historic growth patterns, the provision of public infrastructure by Deschutes County and other special district service providers, and the impact on wildlife and their natural habitat and the capacity of the natural environment to handle development. Carried into the future the project area could experience significant degradation of the natural environment such as groundwater, the source of drinking water for residents and users in the project area, and wetland areas, habitat reduction, especially for mule deer. It could also create perplexing governance problems for the County and other agencies (state and local) who deliver public services to the unincorporated urbanizing area.

The Regional Problem Solving project was designed by the State of Oregon to analyze and recommend creative options for resolving seemingly intractable land use problems in unincorporated urbanizing areas and the conflicts that arise between the State's current land use laws and an area's historic growth pattern. The South County project area has qualified for funding under the Regional Problem Solving process because of its large number of vested parcels, the potential for further significant development and the inability to provide necessary public infrastructure to support development.

The following report summarizes the Deschutes County project. It describes the significant first steps the County has taken toward identifying alternatives to the present land use development patterns. This report documents the regional problem solving framework that the County in cooperation with state agencies and other local service providers can begin craft a solution to the area's development problems. The results of the County's first effort will lead to other steps guided by the report recommendations.

The report describes the methodology and analysis that has been performed by the consultant team guided by the County and state agencies who participated as technical advisors. From this collaboration a computer based model has been developed to analyze the impact of urban-level, dense development on groundwater qualify, wildlife habitat, and the natural environment based on future growth and development scenarios. The modeling allows comparison between an unlimited number of 20 year (years 1997 to 2017) development scenarios and produces the following results.

- Total number of existing and newly developed parcels and acres,
- Geographic distribution of parcel development,
- The ratio of standard and more stringent on-site waste water treatment systems,

- Potential extension of off-site wastewater treatment capacity and development of additional treatment facilities where currently none exist,
- The total and average per unit annual direct cost to achieve the development scenario, and most importantly,
- An interface that allows the model results to be integrated with the County's geographic information (GIS) system to produce a map of what the alternative scenario would look like by the year 2017..

The use of the computer model has allowed a tremendous amount of data to be incorporated into this effort. It is also a flexible tool that the County can adjust and modify and consider other development scenarios. It has the ability to be expanded to include other public services (e.g., transportation, schools, roads, provision of water supply, solid waste, etc.). It can also be integrated into related work that the County is currently undertaking such a the transfer of development rights project and wild fire projects. It is this decision making framework, based in part on cost/benefit analysis gives county officials the tool to better allocate development without unfairly limiting development rights.

REPORT CONTENTS

The report is organized into seven chapters and an appendix. The chapters are address the following topics.

1. Project Overview,
2, Public Involvement/Stakeholder Activities
3. Issue Areas,
4. Alternatives Development,
5. Alternative Scenario Analysis/Results,
6. Transportation Impacts, and
7. Conclusions/Future

The Appendices contain a series of technical memoranda that detail specific areas of study in the development of this project. They cover existing conditions and options for better handling the future development, the technical details involved in the model development including the basic model assumptions, and cost inputs that are used in the evaluation of scenarios. Also included in the appendix is an example regional problem solving agreement similar to what the County will eventually need to craft between the County and project area service providers to ensure adequate levels of public services are provided to support the selected growth alternative.

The purpose of this project was to create a process by which alternatives for development could be evaluated in terms of their impacts to the environment and relation to regulations included in the current Deschutes County Comprehensive Plan.

LEGAL AUTHORITY

The state legislature enacted HB 3482 during a special session in February 1996 to establish the Regional Problem Solving (RPS) program. The act envisions local governments, state agencies, citizens, and affected organizations working together to address land use problems which transcend city or county boundaries, and creates a framework to support this cooperative effort.

The RPS process seeks to foster agreements between public agencies and stakeholders for implementing regional solutions. The act permits the Land Conservation and Development Commission (LCDC) to acknowledge agreed upon changes to comprehensive plans and land use regulations which do not fully conform with administrative rules to implement the statewide planning goals "without taking an exception." The program is ambitious because it is focusing on areas of Oregon where difficult land use issues have not been successfully addressed using the statewide planning goals and administrative rules.

The RPS program included four demonstration projects around the state. Deschutes County received funding for one of the demonstration projects and has used the money to fund this study of land use problems in the south county area.

Statutory Requirements

The RPS program is based on a collaborative regional problem solving process that seeks to reach an agreement among all local participants, the Land Conservation and Development Commission, and other participating state agencies. Individual implementing plan amendments and regulations may vary from the state administrative rules, provided "on the whole" they conform with the purposes of the statewide planning goals. Any plan amendments or land use regulations must be based on a formal RPS agreement, which must include:

- Regional goals for resolving the regional problems that are the subject of the process,
- Optional techniques for achieving these goals,
- Measurable indicators of performance toward achieving the goals,
- A system of incentives and disincentives that encourage implementation of the methods selected to achieve the goals,
- A system of monitoring progress toward meeting goals, and
- A process for modifying techniques to achieve regional goals if monitoring indicates that the techniques are not working.

Unincorporated Communities Rule

Recent state administrative rule changes require Deschutes County to reexamine their rural development codes to ensure new development is consistent with rural land uses. The Unincorporated Communities Rule (OAR 66022) establishes a statewide policy for the planning and zoning of rural communities that are outside of urban growth boundaries. The purpose of the rule was to make it easier for counties to plan for these areas by reducing the need to make exceptions to statewide planning goals.

Under this rule, counties can designate unincorporated communities and adopt individual plan and zoning designation for each community according to guidelines for different types of unincorporated communities. A key provision is that county plans shall ensure that the cumulative development:

- Will not exceed the carrying capacity of the transportation system,
- Will not result in public health hazards or adverse environmental impacts that violate state or federal water quality regulations, and
- Will not exceed the carrying capacity of the soil or water supply and sewer services.

The rule establishes four different types of unincorporated communities that a county may designate:

- *Rural Community* consists primarily of residential uses but also has at least two other land uses that provide commercial, industrial, or public uses (schools, churches, etc.) to the community, the surrounding rural area, or to persons traveling through the area.
- *Rural Service Center* consists primarily of commercial or industrial uses providing goods and services to the surrounding rural area or to persons traveling through the area, but which also includes some dwellings.
- *Urban Unincorporated Community* includes at least 150 dwelling units; contains a mixture of land uses; and includes areas served by a community water and sewer system.
- *Resort Community* is primarily for recreation or resort purposes.

These designations allow for consistency throughout areas that apply RPS framework and assure that these areas remain rural in character, underscoring that they are not within urban growth boundaries.

LOCATION AND SETTING DESCRIPTION

The South County project area is located on a north/south corridor generally along Highway 97 between Sunriver on the north and La Pine on the southern end. Figure 1 displays the project area and general land use patterns. It includes approximately 100 square miles of land. Land ownership is a mix of U.S. Forest land, Bureau of Land Management (BLM) land, and privately owned land platted into subdivisions during the 1960s and 1970s.

Natural Environment

Significant natural features include the Deschutes and Little Deschutes Rivers, sections of which are designated Federal Wild and Scenic Rivers and Oregon State Scenic Waterways. wetland buffers along the rivers which provide habitat to wildlife It is situated in the High Lava Plains Physiographic Province. Lodgepole pine and ponderosa pine forests dominate the landscape. These habitats in the study area support a variety of wildlife species, including several threatened, endangered, and sensitive species. Important riparian and wetland areas are found in association with these upland forests. Land ownership in the area is mixed. The majority of the study area is private, or under the jurisdiction of the U.S. Department of Agriculture Forest Service (USFS) and the U.S. Department of Interior Bureau of Land Management (BLM). Much of the private ownership is found in along Highway 97 and the Deschutes and Little Deschutes Rivers. (See Appendix A for detailed description of the natural setting).

Built Environment

The built environment is characterized predominantly by residential permanent dwelling units, recreational and tourist based development, and second family (seasonal/recreational) dwelling units. Some commercial and light industrial development also exists in the La Pine area and along Highway 97. There are currently a total of 11,388 platted lots in the project area. By 1995 about 4,942 lots (43%), excluding Sunriver, were considered developed and 6,446 (57%) remained undeveloped.

The number of second family homes in the project area is significant. Out of the 8,338 developed lots including Sunriver, ~~4,942 developed lots~~ nearly 37% (1,877) are considered second family dwelling units (calculated by applying the 1990 ratio between existing and seasonal/recreational dwelling units to 1995). By comparison, the percentage of second family dwelling to total dwelling units in the County is 13% (see Appendix E for more details on project area development)

The current permanent population is difficult to estimate because of the number of second family and vacation homes. The permanent population in the project area in 1995 is estimated to be about 10% of the entire County population. The permanent project area population is, therefore, approximately 9,400.

The transportation system is a mix of public roadways connected to Highway 97 and county roads. Homeowner organizations are responsible for maintaining the roadways within the private subdivisions, while the County maintains County roads and Oregon Department of Transportation (ODOT) maintains Highways 97 and 31. The Highways remain the main access link between the project area and points north and south.

Water and wastewater treatment with some exceptions are the responsibility of the homeowner. Groundwater is the primary source of potable water. Private wells on developed lots provide the single largest source of potable water. There are some community water systems in the project area of which Sunriver is the largest provider.

Wastewater treatment is almost exclusively on-site systems. The most typical is the standard septic system, although the County has required sand filter systems where soil types require more effective treatment. The exceptions for on-site wastewater treatment include off-site facilities in the La Pine unincorporated community, the Water Wonderland subdivision, and Sunriver Resort. (see Appendices B and C for further discussion on the issues of wastewater treatment and contamination in the project area).

CHAPTER 2.
PUBLIC INVOLVEMENT/STAKEHOLDER ACTIVITIES

[to be provided by Deschutes County]

[The County may want to add material to the appendices including meeting minutes, agendas, list of attendees and technical committee membership]

CHAPTER 3.
ISSUE AREAS

INTRODUCTION

There are a number of significant issues that have been considered in the development of the analysis. They are described in this chapter. The issues provide the context for the development of the computer model and the basis for the model inputs and assumptions.

LAND USE/POPULATION

Land Use

Current land use in the study area is one of primarily rural residential. Development is concentrated along the Deschutes and Little Deschutes rivers with pockets of development surrounding the Sunriver, La Pine, and Pickup Junction commercial areas. Areas in between are forest, open space and agricultural with very low density residential development supporting these activities (See Figure 1 for land use designations).

Population

In 1995, the estimated population for Deschutes County was 94,100. Of this total 53,250 lived within designated urban growth boundaries. Table 1 summarizes the expected population growth in the next 25 years. Some of the trends that are captured in this table include:

- The County expects to grow by more than 88,000 new residents between 1995 and 2020, resulting in about a doubling of population during this period. This represents an annual growth rate of 2.8% per year.

- The five-year rate of increase is expected to decrease from 20.3% between 1995 to 2000 to 8.6% between 2015 and 2020.

- Cities are expected to grow at a faster rate than unincorporated areas given the constraints on growth in unincorporated areas

- Unincorporated areas are expected to grow by 35,000 people between 1995 and 2020, a rate of about 2.5% per year.

Table 1: Deschutes County Coordinated Population Forecast 1990-2010

	Urban			Non-Urban County			Total County Population		
Year	July 1st Population	Five Year Increase	% Change	July 1st Population	Five Year Increase	% Change	July 1st Population	Five Year Increase	% Change
1990	42,085	-	-	32,873	-		74,958	-	
1995	53,250	11,165	26.5%	40,850	7,977	24.3%	94,100	19,142	25.5%
2000	64,948	11,698	22.0%	48,283	7,433	18.2%	113,231	19,131	20.3%
2005	75,857	10,909	16.8%	56,382	8,099	16.8%	132,239	19,008	16.8%
2010	87,578	11,721	15.5%	63,853	7,471	13.3%	151,431	19,192	14.5%
2015	97,689	10,111	11.5%	70,222	6,369	10.0%	167,911	16,480	10.9%
2020	106,331	8,642	8.8%	76,022	5,800	8.3%	182,353	14,442	8.6%
1995-2020 % Increase	100%	53,081		86%	35,172		94%	88,253	
1995-2020 AAGR[1]	2.8%			2.5%			2.7%		

Source: *Draft Coordinated Population Projections,* Deschutes County Planning Department, November 1996.

[1] AAGR–Average Annual Growth Rate

For the purposes of this report we are using a 20 year planning horizon and focusing on growth that is expected based on market demand and available lots in the unincorporated areas. Therefore, a population increase of 30,000 people is expected in the non-urban parts of the County within the next 20 years. Using standard methodology for converting population to housing units (see Appendix E for details), 15,000 dwelling units would need to be added to accommodate this increase.

Project area

Allocating a share of County growth to the study area is critical to appropriate long range planning for the South County area. The methodology used is described in detail in Appendix E - Population Forecast and Development - Allocation for the Study Area. The following points are key for understanding the process:

- The La Pine Area Census Tracts were used to approximate the project area. While not an exact match with the study area boundaries, they are considered to be an adequate approximation.
- Housing units were used as the basis for assigning growth to the project area.
- Growth can be constrained by physical factors, such as flooding, high groundwater, and water quality.

It is important to note the role of seasonal/vacation homes to the population/housing relationship, especially since housing units play such a key role in the methodology. Since Deschutes County has a high percentage of seasonal/vacation homes a higher number of units would need to be added to the housing stock to accommodate the expected growth in population. This is illustrated by the fact that in 1990 the La Pine Area Tracts accounted for about 17% of the County's housing units, but only 10% of the County's population. Nearly 37% of all housing units in these two tracts are considered seasonal or recreational units (Appendix E).

WATER AND WASTEWATER

Groundwater is the primary source of drinking water in the study area. Private and community wells are drilled into the relatively shallow water tables. The dependency on high quality groundwater in the sole source aquifers (unconfined) requires that these drinking water sources remain protected.

High water tables, however, represent a potential constraint on the future use of on-site sewage (septic) systems. While it is difficult to make broad generalizations about on-site system restrictions on a regional basis, continued reliance on on-site systems and the rate and density of future development may create groundwater contamination problems.

The concern about the use of on-site sewer systems focuses on the release of nitrogen compounds, particularly nitrogen-nitrate that can cause "blue baby disease" (infant methemoglobinemia). Additionally, exposures to high level of nitrate has been identified as a possible cause of stomach and esophageal cancer.

Modeling by Oregon Department of Environmental Quality (DEQ) indicates that nitrate from on-site sewers poses a substantial risk to the groundwater supplies in the project area. Figure 2 displays the existing nitrate loading results from DEQ's model. There are a number of high concentration nitrate plumes in the southern portion of the project area and in the La Pine-Wickiup Junction area. These are also areas of relatively dense development.

Nitrate concentration also has an impact on surface waters that are connected hydraulically to contaminated groundwater. Surface water with high nitrates may be subject to increased algae and aquatic plant production, altering the aquatic habitats.

Federal water quality standards establish a maximum contaminant level (MCL) of 10 milligrams per liter. The State of Oregon in addition has adopted an "anti-degradation policy" that does <u>not</u> view the federal standard as the level to which contamination should be allowed. Rather, Oregon has taken steps to prohibit actions that could cause degradation of existing water quality. The State uses a goal of 7 mg./liter nitrate MCL as its not to exceed groundwater threshold level.

The DEQ groundwater model has been used to predict the groundwater quality for current, 5-year and 10-year, 20-year and 30-year horizons. Results show that if current land use development patterns are unchanged, much of the study area will have significantly higher levels of nitrate concentrations, in violation of the state's anti-degradation policy. If the development pattern remains unchanged, within a 20 to 30 year horizon, nitrate concentrations are projected to exceed the federal MCL standard.

The significance of the link between groundwater and on-site wastewater treatment in the project area is the potential for accelerating groundwater contamination. If the project area develops at the rate and density reflected by current trends, other wastewater treatment options (e.g., off-site treatment, more expensive on-site treatment systems) may need to be equired in order to prevent further contamination (see Appendix B and C for details on groundwater contamination and wastewater treatment).

WILDLIFE HABITAT AND NATURAL RESOURCES

The study area includes several threatened, endangered and sensitive species typical of this upland forest area. Habitats include forested areas, riparian and wetland areas (Figure 3). (See Appendix A for details on habitat and natural resources).

The majority of the study area is classified as High Lava Plains Physiographic Province. The area is a mule deer migration range and includes several wildlife species that are considered by Oregon Department of Fish and Wildlife (ODFW) as important (Goal 5) resources, including:

- great gray owl
- northern bald eagle
- great blue heron
- osprey
- Townsend's big-eared bat

One of the significant potential, future impacts to wildlife could be to the mule deer habitat. The entire project area is in the middle of the mule deer migration corridor. Development has altered mule deer migration, funneling the deer generally through non-developed parts of the project area. Figure 3 displays the altered mule deer corridor (figure pattern designated "developed areas currently providing some wildlife habitat value"). Note that in areas with little or no development the mule deer are evenly distributed (pattern designated "available wildlife travel corridors and habitat"), but in the developed areas that there are defined corridors.

Riparian areas and wetlands are both valuable and scarce in Deschutes County. They serve as diverse vegetative communities, wildlife corridors, provide areas for foraging, nesting, shelter and serve an important role in the regulation of stream temperatures. They are regularly used by 35% of native amphibians and reptiles, 49% of native birds, and 63% of native mammals in the region. As seen in Figure 3, key wetlands are found primarily along Deschutes River, Little Deschutes River, Paulina Creek, Prairie Creek, Fall River and Long Prairie. Riparian areas are found adjacent to streams rivers and other water bodies within the study area.

The Deschutes County Zoning Ordinance (Title 18) specifies a 100-foot setback for structures and septic systems, fill and removal regulations, provisions for conservation easements and the prohibition of hydroelectric facilities on key reaches of the Deschutes River.

There are a number of potential adverse impacts from human development in the project area. The impacts include the following:

- loss of foraging, wintering (e.g., thermal cover), travel, and other important seasonal habitat (e.g., nesting, roosting, etc.);
- disturbance during critical life stages (e.g., fawning, nesting, wintering);
- increase in wildlife damage and other wildlife management problems (deer, cougar, bear, coyote, etc.);
- negative wildlife-human interactions (e.g., damage, roadkill, etc.);
- depredation on wildlife by domestic animal (i.e., pets) (and vice versa);
- loss of streamside vegetation resulting in a reduction of leaf litter, large woody debris, and other organic components of aquatic habitats;
- changes in stream temperature;
- pollution from runoff landscape management (i.e., herbicides, insecticides);
- loss of stream habitat and reduced fish passage are a potential result from installation of culverts at stream crossings;
- changes in hydrology (more flashy, higher peaks, greater frequency); and
- decreased summer flows due to irrigation and other water withdrawals.

From the standpoint of this project, minimizing the loss of wildlife habitat and wetland areas is an important consideration in the development of regional problem solving solutions. In the next section on development of alternatives, wildlife habitat and wetland loss are important inputs to the model for determining areas that should be constrained from future development.

ROADS

Figure 4 displays the project area roadways. Of primary concern in the County is that many public roads are constructed to low standards or are not well maintained. Many of these roads are constructed of inadequate road-base materials (dirt, crushed rock) and have narrow lane widths. These roads can limit heavy and wide vehicle access such as emergency and service vehicles. During winter these roads are subject to erosion and in dry periods can contribute to the project area's air quality problem with dust and particulate material. They are often unable to support heavier vehicles or greater traffic volumes both of which can increase the rate of roadway degradation.

Additionally, many subdivisions are constructed along a single access road, limiting options for possible evacuations. These concerns are particularly relevant during the fire season when forest fires could require residents to evacuate. Both interference with fire fighting equipment or the possibility of being trapped are potential safety concerns.

The County maintains 179 miles of county roads in the study area. Roads not maintained by the County are either public or private roads. The only private roads are in planned unit developments (PUDs) or Sunriver. Most of the non-county roads are public roads that are maintained by special road districts, homeowners associations, private individuals, or not at all. In one case, an LID has been formed to improve Sunrise Boulevard to county design standards. Once completed the County has agreed to maintain it. The County has stated that they would be willing to assume ownership and maintenance responsibility for other rural private roads, but only after they have been improved to county design standards.

The lack of adequate egress and ingress as well as maintenance of private roads below county standards poses both a safety and logistics problem for project area residents and service vehicles. Figure 4 assesses the private roadway maintenance and accessibility issues. As growth and development continues, the privately maintained access roads will experience increasing traffic volumes and accelerated roadway degradation.

CHAPTER 4.
ALTERNATIVES DEVELOPMENT

During the course of this project the focus of the analysis changed from the development of specific or discrete alternatives based on standard planning principles, to the development of a flexible model by which any number of scenarios could be evaluated to provide future conditions and costs.

ORIGINAL METHODOLOGY

The original approach proposed for this study would have followed standard principles for the evaluation of comprehensive land use alternatives. The approach would have developed a set of specific alternatives, established a set of criteria to measure significant impacts, and evaluated the alternatives to show the benefits and cost of each alternative. While this method is appropriate to many types of planning studies, a new methodology was designed that would better address the following aspects (see Appendix D for additional details on the discrete approach):

- Evaluation of significant impacts. If significant impacts are the same for all developed alternatives, they could be ignored as being constant between alternatives. For this project, however, it was felt that all impacts need to be individually addressed when comparing alternative scenarios.

- Variation of benefits and costs between different groups. While an alternative may provide net benefits to the County as a whole, subgroups, such as residents within a subdivision, may oppose the alternative because they believe they will be or may actually be worse off. To the extent possible the benefits and costs need to be addressed for each group.

- Timing of costs. The time-value of money needs to be considered in the comparison of alternatives. This factor reflects that benefits and costs occurring at some time in the future are worth less to most people than the same benefits and costs occurring today.

- Alternatives evaluation. While an evaluation can effectively compare between alternatives for a single criterion, it can be difficult to compare between multiple criteria. A procedure is necessary for weighting the relative importance of the each of the project's impacts.

- Multiple Scenarios: While discrete alternative analysis may identify relative differences between the alternatives, they are often rigid, having limited application beyond the alternatives themselves. Since the goal of the regional problem solving approach is to seek a workable solution that balances many issues, the ability to achieve these goals through a discrete evaluation is not appropriate.

MODIFIED METHODOLOGY

After examining several methods for assigning growth to the project area (outlined in Appendix E), and considering physical constraints of the area, a new approach was taken to allocate the future growth within the study area. This methodology focuses on developing a computer model which could be used to evaluate alternative future scenarios.

Model Development

The model component consists of two parts. Part one is a Geographic Information System (GIS) technology that is used to identify future physical constraints to development and part two is a computerized model to evaluate the allowable level of future development under the physical constraints. The model also calculates the development costs necessary to maintain groundwater quality equal to or below the state anti-degradation threshold (7 mg/liter).

The benefit to this approach is that it responds to the regional problem solving program's desire to approach seemingly intractable land use and growth problems with creative long-term solutions. It not only meets the special terms and conditions that the discrete analysis cannot, but it also has the ability to be expanded to include other analytic modules. Since basic model calibration, growth/development and environmental constraint assumptions, identification of subareas, and a link between the model and GIS have been completed, other modules could be added. These additional modules could include roadway and transportation analysis as well as other public infrastructure services.

Environmental Constraint Overlay Development

The first step in the modeling process identifies the locations of physical constraints to future development. Through the use of the GIS, a variety of information has been overlaid to allow the identification of areas with environmental or physical impacts. These overlays include the location of wetlands, riparian buffers, wildlife corridors, existing development, areas of groundwater contamination and locations of high water tables. Based on these analyses, a composite of physical constraints to future development has been developed for the project area.

The physical constraints included in this model are related to groundwater contamination as measured by nitrate levels (7 mg./l is the threshold) (see Appendix B for details) and wetlands and wildlife habitat is another constraint in the model (see Appendix A for details). Team members involved with water quality analysis and habitat and wetland analysis prepared GIS maps with three levels of constraint on future development -- high, medium, and low. Highly constrained areas were to have the least future development because they were the most sensitive to development. Areas characterized by low environmental constraints would have the least environmental impact of the three categories. Figures 2 and 3 incorporate environmental constraints for their respective categories. In Figure 2 the darker areas are considered the most contaminated and therefore areas that should be restricted from future development. in Figure 3 the areas that have the greatest number of pattern overlays should be restricted from future development.

The constraints are digitized into the GIS and overlaid onto the project area map which has been divided into 17 sub-areas (Figure 5). The overlays define an environmental constraint index ranging from the greatest to least environmental impact. Project areas that are covered with the greatest number constraint overlays would experience the greatest environmental impact should development be allowed to continue. These areas would be potential candidates for the restricting future development. Areas having the fewest environmental constraint overlays would experience the least environmental impact from future development. These areas could be considered candidates for future growth and development.

Environmental Constraint Analysis

The second part of the model is a highly detailed spreadsheet that calculates the amount of developable land for each of the seventeen zones. Using the results of the GIS overlay analysis, the following variables are used to estimate the future development and costs on a per parcel basis:

- Historic residential growth rate (see Appendix E for details of the assumptions used in the model),
- Platted acreage constrained by environmental factors as measured by groundwater levels and wetland and wildlife habitat (see Appendices A and B for details on the constraints methodology),
- Platted acreage not permitted for development (The County's GIS system is used to determine developed, vacant platted and vacant non-platted land in the project area),
- Percentage of development currently connected to sewer systems and the costs related to extending service to new units, units converting from on-site systems, and increasing off-site treatment capacity (See Appendix C for a discussion of off-site treatment in the project area), and
- Data on types of septic systems (standard septic and sand filter) and the costs of different types of on-site systems. (See Appendix B for details including options for on-site systems that may have greater treatment value but are not evaluated in the computer model).

LIMITS TO THE MODIFIED METHODOLOGY

Because the assessment of future impacts is not an exact science, there always exists certain limits to the evaluation method. The following limits have been identified:

- Limitations of the data set. The GIS allows the manipulation of a variety of factors to provide a composite of the physical constraints on development. However, the information is only as accurate or complete as the available data. For example, while an inventory of wildlife corridors may be mapped, the data may not identify which corridors are the most important links for wildlife migration. Further, available data must often act as an approximation of desired information. For example, deer migration corridors could be used as an approximation for the generalized locations of wildlife habitats.
- Limited analysis of impacts. As described above, this analysis is primarily focused on groundwater quality standards although other natural resources

are considered such as wildlife corridors and wetland buffer areas. The State of Oregon has statutory authority to limit the development of the platted areas that exceed the water qualify standards.. The end result of model analysis that has been conducted for this project -- the number of developed units and the direct private cost of providing treatment -- may not account for other environmental factors (natural and built) that could be similarly modeled to describe the impacts of future development. Other factors that would widen the analysis could include public infrastructure impacts (e.g., roads, water supply, solid waste, etc.), aesthetic impacts, and air quality.

- Problems with the distribution of costs and benefits. The costs (direct costs) and benefits (preservation of groundwater quality) in this analysis are primarily related to the private property owner not to society as a whole. The model identifies a narrow set of costs for preserving groundwater quality. These are the direct costs of installing an individual wastewater treatment system. It would be a mis-interpretation of the results to assume that these are the entire costs to preserve groundwater. Missing in the analysis are other relevant social costs. The social costs to groundwater preservation would need to be added into the analysis in order to fully calculate the costs. The benefits that are measured in the model are limited as well. The benefit is measured by the preservation of a water quality threshold. There are a number of other potential benefits from groundwater preservation not calculated in the analysis including preservation of wetlands and preserving groundwater for drinking supply.

Recall the previous discussion related to the discrete analysis and the difficulty of applying the results to other studies. This becomes particularly difficult when trying to import cost and benefit results from other studies. For example using fish studies on the cost of habitat reduction and fish harvests; groundwater contamination and willingness to pay to prevent contamination; recreational benefits and the monetary value of protecting outdoor recreation areas can become extremely complex to apply to this study. While the methodologies used by each of these studies may be valid for the particular purpose for which it is developed, one must be careful applying it to another project.

Nevertheless, studies are often included and incorporated into other studies. This process of applying results from one study into another is called "benefits transfer." There has been mixed success where this occurs, especially in situations like this project where non-market valuation is required. Without a well defined market with demand reflected in the pricing structure, results can vary widely. It becomes a much more complex and time consuming process to prepare a methodology to demonstrate market values for non-market items. That does not mean that such a study cannot be done, to conduct such a study takes much more time and resources than this project.

This is the dilemma the County faces in this regional problems solving study. Is it possible to apply other research to this project? A cogent discussion of the limitations of these type of cost/benefit studies with references to specific studies is detailed in Appendix F. In that technical memorandum a matrix of 19 studies is listed. All of these studies attempt to evaluate non-market water-related impacts similar to this regional problem solving study.

As an example of this dilemma, results from a study that addresses a household's willingness to pay to avoid groundwater contamination by nitrates is applied to the modeling in this project. The original study finds that the willingness to pay by each household ranges from $168 to $708 per year. Applying that range to the project area could result in a huge range of $150,000 to $2.5 million.

CHAPTER 5.
ALTERNATIVE SCENARIO ANALYSIS/RESULTS

The design of the model allows any number of scenarios to be tested. To show the range of impacts three scenarios have been developed based on existing growth, constrained growth and growth with sewers. Each scenario assumes a level of development based on constraints dictated by the groundwater contaminant levels and the wildlife and habitat constraints. Tables 2 to 4 show the model results for each of these scenarios.

The scenarios tested and their results are just three of many scenario possibilities. Since it is possible to make adjustments to all the input variables on a global basis or to adjust an individual variable, there can be a wide variety of outcomes. The three scenarios provided in this report are realistic representations of development patters given certain levels of development and environmental constraint. Table 5 at the end of this chapter provides a summary/comparison between all the development scenarios.

INTERPRETING MODEL RESULTS

Model Settings

One of the main products of the model runs is a results summary page that displays a variety of information based on the scenario inputs. This model considers a number of global and subarea settings to demonstrate the effect of land use policy decisions might have on the level of future growth and their impact in the project area. This section describes the model's settings and results.

Global Settings

Global settings allow changes to be placed on all subareas simultaneously. For example, a stringent policy regarding development where high groundwater tables exist may increase the use of sand-filtered septic systems over standard septic. The settings are described below:

Average Lot Size by Treatment Type: This assigns the size of the lot for each type of on-site septic system. The Adolfson Associates technical memorandum recommends the use of 2.5 acre lots for standard septic systems, 1.5 acre lots for open bottom sand filter systems, and 1.0 acre lots with an enhanced sand filter system (see Appendix B). Current permitted lot development sizes, however, average about 1/2 acre regardless of on-site wastewater treatment technology.

Treatment Type if No New Sewers: This controls the mix of on-site wastewater treatment technology that would be installed for lots not receiving off-site sewer service. The high, medium, and low effluent constraint categories refer to the degree of environmental constraint or vulnerability for development that is assigned to a particular lot. The higher the degree of constraint assigned to a lot, the greater the need use enhanced on-site wastewater treatment systems to prevent groundwater contamination. In this analysis better on-site treatment practices would be reflected in a higher ratio of sand filter systems to standard septic systems.

Percent of Historic Growth Rate: This fixes the rate by which growth is assumed to occur within the study area. Default is 100%, the growth rate over the last 9 years.

Percentage of Constrained Acres Staying Vacant: This assigns the percentage of land that is expected to stay vacant. The percentage is based on the constraint index that has been developed and described previously. The higher the percentage selected the greater the amount of land that remains vacant. When a percentage is selected land having the greatest environmental impact from development is the highest priority to remain vacant. Default is assumed to be 25%.

Percentage of Past Denials for next 20 years: This factor is based on the number of septic permit applications that are denied in the project area. Default is 100%, the past rate of denials.

Percentage of Existing Units to Sewers: This set the number of existing homes that will convert from septic systems if sewers are provided.

Sub Area Settings

The middle portion of the model, "New Sewers to Selected Subareas", allows the individual setting of sub areas. Settings include:

Sewered?: This switch determines whether sewers exist in the area. Sub areas 1 and 16 have a default setting of 1 since sewers currently exist in these areas.

Percent of Existing Vacant Lots to Develop: This setting assigns whether all vacant lots with sewer are eligible for development.

Percent of Unplatted Area to Develop: This sets the amount of unplatted lands that could be platted and developed if sewers are put into place. This is assumed to be zero throughout the analysis in order to limit development to platted lands.

Average Lot Size: This assumption allows the setting of the average lot.

Results

The matrix at the bottom of the page presents the model output results. The results will change depending on the model inputs or settings. The results display the impact of new development over the 20 year forecast period in terms of new units, acreage developed total cost and average cost per new unit. Beginning with both the total number of existing developed units and acres in the project area, the model displays the following categories for 20 year changes.

New Units Sewered: This column totals by subarea the number of new units that might be sewered by off-site treatment facilities. New sewered units can either be existing units that are connected to a sewer or new development that is sewered. Under scenarios where there are no new sewers (i.e., no new treatment facilities to be added) some subareas may still show new sewered units because there is an existing off-site facility that is either planning for or has capacity to sewer additional units. Subareas 1 (la Pine-Wickiup Junction) and 16 (Sunriver and Water Wonderland) are examples of existing sewers.

New Units on Sand Filter & on Standard Septic: both of these columns display the total number of units with on-site systems that will have either sand filter or standard systems. The ratio between sand filter and septic systems is based on the previously described settings for on-site treatment types.

SCENARIO 1 - GROWTH CONTINUES AT PAST PATTERNS

Under this growth scenario it is business-as-usual. Most lots are allowed to develop following historic development patterns. The overall rate of growth is similar to that which has occurred over the last 9 years (See Table 2 and Figure 6. There will be only minimal restrictions (25%) on development in environmentally constrained areas. That is, only 25% of the environmentally constrained lots will remain vacant and not subject to development. No changes in lot size or construction is assumed. The historic rate of permit denials for septic systems will continue into the future, and the average permitted lot size is 1/2 acre for sand filter systems and one acre for standard septic systems.

No new sewers will be built. Expansion of the existing sewers, however, in Subareas 1 and 16, will still take place. These expansions are based on the capability of the existing sewer to handle more capacity and/or that the sewer system already has plans for future expansion.

Over the next 20 years a total of 4,012 new units will be constructed on approximately 3,727 acres. The total annual direct cost to this scenario is approximately $3.2 million. The annual cost per unit to service these new units is approximately $798/unit.

Since historic development patterns are to continue into the future it is likely that the only restrictions on future development will occur when groundwater quality no longer meets DEQ water quality standards. The location of these restricted areas will likely be the areas that the DEQ has defined as having high nitrate concentrations in the groundwater (see Appendix B). It is important to note, however, that the costs calculated in the model do not include costs to develop alternative potable water sources or the cost of cleaning the contaminated aquifers.

SCENARIO 2 - CONSTRAINED GROWTH, NO NEW SEWERS

In this scenario, no new sewers are constructed and development vacant lots are limited based upon greater constraints placed on development. Fifty percent of the constrained acres will remain vacant (greater than Scenario 1). Past septic permit denials, however, is set at a level that is only 50% of the historic pattern which would presumably allow a greater number of lots to be developed.

Based on the model results, Scenario #2 would allow approximately 4,246 new developed lots to be developed. This is about 6% more developed lots than Scenario #1 (see Figure 7 and Table 5 for other comparative information).

Like Scenario #1 there will be no new sewers. Existing sewers with existing capacity and/or future expansion plans would be allowed to connect new units. There would, instead, be more emphasis on protection using better on-site treatment systems. For new on-site systems, 75% would be sand filter and only 25% would be standard septic on-site systems (See Table 3).

Table 2

Development Scenario: Revised Base Scenario 1

Development continues at past patterns, no new sewer

Notes: 25% of historic growth rate; larger lot sizes experts deem necessary to protect water in water-constrained areas.

Percent of historic growth rate	100%
% of Constrained Acres Staying Vacant	25%
% of Past Denials for next 20 Years	100%
% of Existing Units to Sewer	0%

These switches allow across-the-board adjustment of parameters set section-by-section in other parts of this model.
-Set Growth Rate > 100% to have developed lots in all sections faster than the average annual permits for the last 9 years.
-Set % of Constrained Acres to change the % of high-groundwater and high nitrate vacant acres that remain vacant at the end of the 20 year study period. Default should be about 25%.
-Increase % Denials next 20 Years to increase the amount of vacant land that does not develop in the future.
-Go to the 'Analysis' Worksheet to change these parameters for individual sections.

Assumptions:

Average Lot Size by Treatment Type

Treatment	Acres/Unit
Sewer	Plat
Sand Fltr	0.5
Std Septc	1.0

Treatment Type if No New Sewers

Type	High	Medium	Low
	Effluent Constraint Index		
Sand Fltr	0%	50%	25%
Std Septic	0%	50%	75%
Total	0%	100%	100%

New Sewers to Selected Subareas:

Subarea	Sewered? (1=yes,0=no)	% of existing vacant lots to develop	% of unplatted area to develop	Average Lot Size (acres)	Total Existing Lots	Acres on Existing Lots	Potential New Platted Lots	Total Unplatted Acres	Developed Newly Platted Lots	Total Lots	Total Acres
			New Plats in Unplatted Area								
1	1	100%	0%	10.0	956	706	-	-	-	956	706
2	0	100%	0%	10.0	1,544	926	-	-	-	1,544	926
3	0	100%	0%	10.0	754	865	-	-	-	754	865
4	0	100%	0%	10.0	337	209	-	-	-	337	209
5	0	100%	0%	10.0	248	1,030	-	-	-	248	1,030
6	0	100%	0%	10.0	185	118	-	-	-	185	118
7	0	100%	0%	10.0	546	451	-	-	-	546	451
8	0	100%	0%	10.0	172	206	-	-	-	172	206
9	0	100%	0%	10.0	641	753	-	-	-	641	753
10	0	100%	0%	10.0	250	573	-	-	-	250	573
11	0	100%	0%	10.0	426	491	-	-	-	426	491
12	0	100%	0%	10.0	215	264	-	-	-	215	264
13	0	100%	0%	10.0	210	322	-	-	-	210	322
14	0	100%	0%	10.0	320	291	-	-	-	320	291
15	0	100%	0%	10.0	327	195	-	-	-	327	196
16	1	100%	0%	10.0	117	353	45	449	-	117	801
17	0	100%	0%	10.0	59	92	-	-	-	59	92

Results

Subarea	Existing Development		New Development on Existing or New Lots in Subdivisions,1997-2017							Estimated Annualized Cost of Effluent Treatment	
	Total Developed Lots	Total Developed Acres	New Dev. Lots Sewered	New Dev. Lots on Sand Filter	New Dev. Lots on Std Septic	Total New Dev Lots	Total Acres Needed	Average Lot Size (all parcels)	Density of All Developed Lots	New Development (All Treatment Types)	New Dev + New Sewer to Some Existing
1	3,448	737	956	0	0	956	706	0.7	0.3	$ 1,344,720	$ 1,344,720
2	826	451	0	8	41	49	51	1.1	0.7	$ 23,261	$ 23,261
3	394	473	0	84	418	503	526	1.0	1.1	$ 240,405	$ 240,405
4	238	202	0	17	53	70	74	1.0	0.9	$ 37,528	$ 37,529
5	154	300	0	165	316	481	505	1.1	1.3	$ 294,528	$ 294,528
6	115	85	0	0	0	0	0	-	0.7	$ -	$ -
7	130	113	0	11	14	25	28	1.1	0.9	$ 17,144	$ 17,144
8	93	120	0	43	97	140	142	1.0	1.1	$ 81,962	$ 81,962
9	690	897	0	215	538	753	753	1.0	1.1	$ 428,146	$ 428,146
10	415	769	0	48	44	92	111	1.2	1.7	$ 68,788	$ 68,788
11	700	877	0	133	324	458	459	1.0	1.2	$ 261,739	$ 261,739
12	339	373	0	75	189	264	264	1.0	1.1	$ 149,783	$ 149,783
13	296	520	0	0	0	0	0	-	1.8	$ -	$ -
14	356	426	0	0	0	0	0	-	1.2	$ -	$ -
15	248	226	0	8	8	14	16	1.1	0.9	$ 9,459	$ 9,459
16	55	75	117	0	117	117	0	-	0.4	$ 191,309	$ 191,309
17	91	149	0	26	66	92	92	1.0	1.3	$ 52,056	$ 52,056
Total	6,388	6,792	1,073	833	2,223	4,012	3,727	0.9	0.8	$ 3,200,829	$ 3,200,829

Average Annual Cost Per Unit, All Treatment Types: $ 798

Table 3

Development Scenario: Scenario 2

Constrained Growth, No New Sewers

Assumptions:

Average Lot Size by Treatment Type

Treatment	Acres/Unit
Sewer	Plat
Sand Fltr	1.5
Std Septic	2.5

Treatment Type If No New Sewers

Type	Effluent Constraint Index: High	Medium	Low
Sand Fltr		75%	50%
Std Septic		25%	50%
Total		100%	100%

New Sewers to Selected Subareas:

Notes: 25% of historic growth rate; larger lot sizes experts deem necessary to protect water in water-constrained areas.

Percent of historic growth rate	100%
% of Constrained Acres Staying Vacant	50%
% of Past Denials for next 20 Years	50%
% of Existing Units to Sewer	

These switches allow across-the-board adjustment of parameters set section-by-section in other parts of this model.
-Set Growth Rate > 100% to have developed lots in all sections faster than the average annual permits for the last 9 years.
-Set % of Constrained Acres to change the % of high-groundwater and high nitrate vacant acres that remain vacant at the end of the 20 year study period. Default should be about 25%.
-Increase % Denials next 20 Years to increase the amount of vacant land that does not develop in the future.
-Go to the 'Analysis' Worksheet to change these parameters for individual sections.

New Plats in Unplatted Area

Subarea	Sewered? (1=yes,0=no)	% of existing vacant lots to develop	% of unplatted area to develop	Average Lot Size (acres)	Total Existing Lots	Acres on Existing Lots	Potential Newly Platted Lots	Total Unplatted Acres	Developed Newly Platted Lots	Total Lots	Total Acres
1	1	100%		10.0	956	706	-	-	-	956	706
2		100%		10.0	1,544	926	-	-	-	1,544	926
3		100%		10.0	754	865	-	-	-	754	865
4		100%		10.0	337	209	-	-	-	337	209
5		100%		10.0	248	1,030	-	-	-	248	1,030
6		100%		10.0	185	118	-	-	-	185	118
7		100%		10.0	546	451	-	-	-	546	451
8		100%		10.0	172	206	-	-	-	172	206
9		100%		10.0	641	753	-	-	-	641	753
10		100%		10.0	250	573	-	-	-	250	573
11		100%		10.0	426	491	-	-	-	426	491
12		100%		10.0	215	264	-	-	-	215	264
13		100%		10.0	210	322	-	-	-	210	322
14		100%		10.0	320	291	-	-	-	320	291
15		100%		10.0	327	198	-	-	-	327	196
16	1	100%		10.0	117	353	45	448	-	117	801
17		100%		10.0	69	92	-	-	-	69	92

Results

	Existing Development		New Development on Existing or New Lots in Subdivisions,1997-2017							Estimated Annualized Cost of Effluent Treatment	
Subarea	Total Developed Lots	Total Developed Acres	New Dev. Lots Sewered	New Dev. Lots on Sand Filter	New Dev. Lots on Std Septic	Total New Dev. Lots	Total Acres Needed	Average Lot Size (all parcels)	Density of All Developed Lots	New Development (All Treatment Types)	New Dev + New Sewer to Some Exsting
1	3,448	737	956			956	708	0.7	0.3	$ 1,344,720	$ 1,344,720
2	626	451		17	94	111	93	0.8	0.7	$ 52,010	$ 52,010
3	394	473		42	492	535	500	0.9	1.0	$ 219,774	$ 219,774
4	238	202		8	67	75	70	0.9	0.9	$ 32,382	$ 32,382
5	154	300		81	459	541	504	0.9	1.2	$ 251,528	$ 251,528
6	115	85						-	0.7	$ -	$ -
7	130	113		9	40	49	41	0.8	0.9	$ 24,088	$ 24,088
8	93	120		19	125	144	141	1.0	1.1	$ 65,051	$ 65,051
9	690	897		94	659	753	753	1.0	1.1	$ 336,174	$ 336,174
10	415	768		23	86	109	84	0.8	1.6	$ 55,804	$ 55,804
11	700	877		59	404	463	460	1.0	1.1	$ 207,632	$ 207,632
12	339	373		33	231	264	264	1.0	1.1	$ 117,927	$ 117,927
13	296	520						-	1.8	$ -	$ -
14	356	428						-	1.2	$ -	$ -
15	248	226		7	30	37	30	0.8	0.9	$ 16,298	$ 16,298
16	56	75	117		117	117		-	0.4	$ 191,309	$ 191,309
17	91	149		11	80	92	92	1.0	1.3	$ 40,418	$ 40,418
Total	8,388	8,792	1,073	405	2,684	4,246	3,737	0.9	0.8	$ 2,957,116	$ 2,957,116

Average Annual Cost Per Developed Lot All Treatment Types: $ 697

Increased regulation is also assumed in the location, installation, and maintenance of septic sewer systems under this scenario. Regulations would require larger lots for standard septic installations and greater use of sand filtration systems which would improve the quality of the wastewater discharge from residential sources. This scenario would allow development up to the DEQ standard for nitrates. To achieve drinking water quality standards, well water may require some additional treatment.

The impact to wildlife habitats would depend on the location of these habitats relative to areas with development constraints. Wetlands and aquatic habitats would likely be more protected than under Scenario #1.

The total annualized direct cost is about $3.0 million. The cost for each individual unit is a $697. This is nearly identical to Scenario #1. This scenario, however, may provide some additional protection to groundwater and the natural environment than Scenario #1.

SCENARIO 3 - SEWER AREAS WITH HIGH ENVIRONMENTAL IMPACTS

The growth rate under this scenario is at 100% of the historic levels. Development constraints require that 70% of the environmentally constrained land will remain vacant except wherever new sewers are added (Subareas 9 and 11) the constraints do not apply. All vacant lots in sewered areas are allocated new growth, subject to any limits implied by historic growth rates and the number of available vacant, buildable lots (see Table 4 and Figure 8).

This scenario will result in approximately 4,233 newly developed lots, which is similar to Scenario #2 both in total number of developed lots and their geographic distribution. The main difference between the two scenarios will be a shift away from on-site to off-site systems.

New sewers to be developed in Sub-areas 9 and 11, will allow all 1,200 new units to be connected to the new system. This implies that under this or other scenarios where new sewers are allowed, it is possible to concentrate growth and development since water quality would be protected from further contamination due to wastewater treatment.

For those areas that continue to allow on-site systems, there would still be an emphasis on higher quality on-site treatment systems. Similar to Scenario #2, 75% of the permits for on-site systems would be for sand filters.

Scenario 3 provides the greatest opportunities for protecting the natural environment. Since development could be clustered around off-site treatment systems, it is possible to site these systems in areas that avoid disrupting wildlife habitat and direct development into these areas. Similarly, because of the treatment protection that a sewer offers, it could also be used in areas that have groundwater quality contamination.

The direct costs from this scenario are higher primarily because of the cost to develop the new treatment facility. The total cost for all new units is approximately $4 million. the pert unit cost is estimated to be $950. While the cost of this scenario is higher there is expected to be greater protection to the environment.

Table 4

Development Scenario: Scenario 3

Sewer areas with high enviornmental impacts--Subareas 9 and 11, environmental constrained

Assumptions:

Average Lot Size by Treatment Type

Treatment	Acres/Unit
Sewer	Plat
Sand Fltr	1.5
Std Septic	2.5

Treatment Type If No New Sewers

Type	Effluent Constraint Index: High	Medium	Low
Sand Fltr		75%	50%
Std Septic		25%	50%
Total		100%	100%

New Sewers to Selected Subareas:

Notes: Sewers added in subareas 9 and 11, measures placed on use of standard septic, some conversion of existing units to sewer.

Percent of historic growth rate	100%
% of Constrained Acres Staying Vacant	70%
% of Past Denials for next 20 Years	50%
% of Existing Units to Sewer	50%

These switches allow across-the-board adjustment of parameters set section-by-section in other parts of this model.
-Set Growth Rate > 100% to have developed lots in all sections faster than the average annual permits for the last 9 years.
-Set % of Constrained Acres to change the % of high-groundwater and high nitrate vacant acres that remain vacant at the end of the 20 year study period. Default should be about 25%.
-Increase % Denials next 20 Years to increase the amount of vacant land that does not develop in the future.
-Go to the 'Analysis' Worksheet to change these parameters for individual sections.

Subarea	Sewered? (1=yes,0=no)	% of existing vacant lots to develop	% of unplatted area to develop (New Plats in Unplatted Area)	Average Lot Size (acres) (New Plats in Unplatted Area)	Total Existing Lots	Acres on Existing Lots	Potential Newly Platted Lots	Total Unplatted Acres	Developed Newly Platted Lots	Total Lots	Total Acres
1	1	100%		10.0	956	706	-	-	-	956	706
2		100%		10.0	1,544	926	-	-	-	1,544	926
3		100%		10.0	754	865	-	-	-	754	865
4		100%		10.0	337	209	-	-	-	337	209
5		100%		10.0	248	1,030	-	-	-	248	1,030
6		100%		10.0	185	118	-	-	-	185	118
7		100%		10.0	546	451	-	-	-	546	451
8		100%		10.0	172	206	-	-	-	172	206
9	1	100%		10.0	641	753	47	467	-	641	1,219
10		100%		10.0	250	573	-	-	-	250	573
11	1	100%		10.0	426	491	100	996	-	426	1,487
12		100%		10.0	215	264	-	-	-	215	264
13		100%		10.0	210	322	-	-	-	210	322
14		100%		10.0	320	291	-	-	-	320	291
15		100%		10.0	327	196	-	-	-	327	196
16	1	100%		10.0	117	353	45	449	-	117	801
17		100%		10.0	69	92	-	-	-	69	92

Results

	Existing Development		New Development on Existing or New Lots in Subdivisions,1997-2017							Estimated Annualized Cost of Effluent Treatment	
Subarea	Total Developed Lots	Total Developed Acres	New Dev. Lots Sewered	New Dev. Lots on Sand Filter	New Dev. Lots on Std Septic	Total New Dev. Lots	Total Acres Needed	Average Lot Size (all parcels)	Density of All Developed Lots	New Development (All Treatment Types)	New Dev + New Sewer to Some Exstng
1	3,448	737	956			956	706	0.7	0.3	$ 1,344,720	$ 1,344,720
2	626	451		17	94	111	93	0.8	0.7	$ 52,010	$ 52,010
3	394	473		42	492	535	500	0.9	1.0	$ 219,774	$ 219,774
4	238	202		8	87	75	70	0.9	0.9	$ 32,382	$ 32,382
5	154	300		81	459	541	504	0.9	1.2	$ 251,528	$ 251,528
6	115	85						-	0.7	$ -	$ -
7	130	113		9	40	49	41	0.8	0.9	$ 24,088	$ 24,088
8	93	120		19	125	144	141	1.0	1.1	$ 65,051	$ 65,051
9	690	897	753			753	753	1.0	1.1	$ 1,000,802	$ 1,131,902
10	415	768		20	77	96	76	0.8	1.7	$ 49,276	$ 49,276
11	700	877	463			463	460	1.0	1.1	$ 615,367	$ 749,367
12	339	373		33	231	264	264	1.0	1.1	$ 117,927	$ 117,927
13	296	520						-	1.8	$ -	$ -
14	356	428						-	1.2	$ -	$ -
15	248	226		7	30	37	30	0.8	0.9	$ 18,298	$ 18,298
16	55	75	117		117	117		-	0.4	$ 191,309	$ 203,909
17	91	149		11	80	92	92	1.0	1.3	$ 40,418	$ 40,418
Total	8,368	6,792	2,289	249	1,913	4,233	3,729	0.9	0.8	$ 4,022,951	$ 4,299,851

Average Annual Cost Per Developed Lot All Treatment Types: $ 950

Table 5: Development Scenario Results Comparison

Result Categories\Scenarios	Scenario 1	Scenario 2	Scenario 3
% of Historic Growth Rate	100%	100%	100%
% Constrained Acres Remaining Vacant	25%	50%	70%
% Past Denials for Next 20 Years	100%	50%	50%
% Existing Units to Sewer	0%	0%	50%
New Lots Sewered*	1,073	1,073	2,289
New Lots on Sand Filter**	833	405	249
New Lots on Standard Septic***	2,223	2,884	1,813
Total New Developed Lots****	4,012	4,246	4,233
Total Acres Needed	3,892	3,737	3,729
Annualized Treatment Cost (All Treatments)	$3,201,000	$2,957,000	$4,023,000
Per Unit Treatment Cost (All Treatments)	$798	$697	$950

* Sum of all developed lots that are connected to an off-site wastewater treatment facility (previously developed lots converted from an on-site system to an off-site system plus newly developed lots that are connected to an off-site system at the time of development).

** Sum of all newly developed lots that are connected to an on-site sand filter system.

*** Sum of all newly developed lots that are connected to an on-site standard septic system.

****Sum of all new lots sewered, on sand filter, and on standard septic systems.

CHAPTER 6.
TRANSPORTATION IMPACTS

ROADWAY COSTS

As described in Chapter Four, the roadway system is a mix of public roads, state highways, county roadways, and private roads. County roads are built to county standards and maintained by the county. Public roads may be maintained by Special Road Districts.

County Roads

The county design standards for the two rural roadway classifications, rural local and rural collector, address roadway width and base and surface composition. For local rural public roads a 28-foot width with a two-inch asphalt overlay on top of a six-inch gravel base is required. The cost of such a roadway is about $55 per lineal foot (Dick Johnson, Deschutes County Road Department, July 25, 1997). A road developed to this standard would be expected to handle local residential traffic.

For roads that collect traffic from a number of local roads such as subdivision roadways or other county roads, a higher standard is required. County standards for a rural collector is a roadway width of 28-36 feet, with a three-inch asphalt overlay on top of an eight-inch rock base. The cost of this improvement is about $100-120 per lineal foot.

Once constructed to county standards, a roadway should be maintained to ensure operational efficiency. Levels of service (LOS) standards are set based on a roadways functional classification. The county is responsible for maintaining the county roads in the project area to the LOS standard. Historically, the public roads may or may not be maintained to the LOS standards (Steve Jorgensen, Deschutes County Road Department, August 19, 1997).

Funding for county road maintenance can come from state and federal sources and/or county road funds. These funds pay for both roadway construction as well as operation and maintenance.

Public Roads

The County Subdivision Ordinance specifies road standards (e.g., crushed gravel bases, lane width and drainage requirements) and under some conditions the number of roadway access points to county roads. The subdivision ordinance design standards that the County currently requires are more rigorous than they have been in the past. Generally, these newer standards are considered adequate for long term designed use but the roadways can rapidly deteriorate if subjected to higher volume traffic or are used for purposes other than what they are originally constructed.

Areas developed in the past with public roads not built to county standards or maintained by the county, pose a potential problem for future development. As subdivisions build out, existing roads may experience greater traffic volumes. Public roadways that access county roads will likely become increasingly important links in the County's road system. The greater traffic on these roads can cause safety and operational problems as these public roadways are used to handle more traffic than they have been designed to accommodate.

Lack of multiple access points to county roads from a subdivision can also become safety concerns. A number of the subdivisions in the project area have only single access points. As these subdivisions continue to develop the subdivisions lacking multiple access roads could become a safety hazard for emergency vehicles such as fire protection equipment and for emergency evacuation.

Maintenance and operation costs for public roads become the responsibility of the property owners. Unlike their public counterparts, however, these property owners typically have fewer resources to maintain the public roadways. Over time, neglected maintenance can accelerate roadway deterioration and lead to more costly maintenance.

The two main options available to subdivision residents to pay for public roadway maintenance are special road districts and a limited improvement districts (LIDs). The special road district imposes special property tax assessments on all property owners (of both vacant and developed lots) in the specially designated area or subdivision to fund roadway improvements and maintenance.). These assessments can continue as long as the special district exists to maintain and improve the roadways.

The LID option is formed for a specific roadway improvement. An LID cannot be used for roadway maintenance. The LID includes all property owners who will benefit from the road improvement. Special property tax assessments are imposed on members of the LID to pay for the improvement. Typically, loans are used to finance the improvement and the assessments are used to retire the debt. Once the debt is retired the LID is dissolved. Private roads improved to the applicable County road standard under the LID process may be accepted by the Deschutes County Commissioners as a County road to be maintained by the County.

The cost to the homeowner under either of these options can be very expensive, especially in an area where average household income is low and many residents on fixed. retirement incomes. The cost can exceed $3,000 to $4,000 per lot (Dick Johnson, Deschutes County Road Department, July 25, 1997).

Roadways and Future Development

If maintaining a functioning roadway system is an important County goal, yet to achieve the goal is an expensive, private responsibility, what motivation do property owners have to maintain public roadways or participate in the finance options? This is a critical concern if the roadway system is to continue to meet operational standards. As development occurs, unless the public roadways are maintained, the greater traffic volumes will continue to deteriorate the roadways. The following incentives for private property owners to maintain roads may not be adequate in the future. The County may need to consider other methods. to encourage private participation in roadway maintenance.

- County assuming roadway ownership and maintenance responsibility may encourage LIDs since it eliminates the private property owners maintenance costs.

- Added property value from a roadway improvement or ongoing maintenance schedule might encourage an LID or special road district formation. Roadway improvements usually increase property values, although they do not necessarily equal the improvement or maintenance costs.

- Multiple access points can improve safety for emergency vehicles and evacuation potential for property owners. Added safety may encourage private property owners to shoulder some of the roadway maintenance costs.

- Regular and ongoing maintenance schedule from a roadway district may reduce higher future roadway improvement costs. It is unclear whether this would be sufficient to encourage private property owners to maintain public roads.

The County may need to consider more stringent design factors. Recent recognition that cinder dust from unpaved roads is a major contributor to the County's air quality problem, surpassing both wood smoke and automobile emissions, may require the County to amend its subdivision disallowing gravel roadway surfaces.

Consideration of any changes in how public roadways are improved or maintained needs to be balanced against the other growth and development concerns that have been raised elsewhere in this report. Development patterns like those modeled in Scenario One where growth follows historic trends may result in relatively greater roadway deterioration due to higher traffic volumes from dense development (average lot sizes 0.5 acre). The trade-off for higher density development might mean, however, lower average maintenance and improvement costs to property owners.

Other less dense development alternatives where the average lot sizes are larger could result in lower subdivision traffic volumes. While lower traffic volumes might mean less congestion and slower roadway deterioration, the average property owner maintenance and improvement costs could increase.

It would be important to understand the impact of the development alternatives on roadways. By comparing the impacts between different development scenarios (e.g., different development densities, alternative geographical distributions; different rates of growth, etc.) the County could forecast traffic growth and maintenance and improvement costs. Ultimately this information would need to be compared to the costs and benefits related to the other factors that have been addressed in this regional problem solving project.

CHAPTER 7.
CONCLUSIONS/FUTURE

CONCLUSION

The South County Regional Problem Solving (RPS) project has begun to address the land use practices, environmental impacts, and public infrastructure problems that have occurred with growth and urbanization in the large unincorporated area. The County has also developed both a framework and direction for additional work it needs to accomplish in the RPS process.

Quite a bit has been accomplished in this project. The County has developed a method to investigate and analyze impacts to growth and development over a 20 year planning horizon. It has also inventoried and digitized for the County's GIS significant information on the natural and built environment.

A computer model has been developed to measure the impacts of growth on groundwater quality and the natural environment. The model analyzes an enormous amount of information regarding historic and future population, lot development and growth patterns, wildlife habitat, wetlands, groundwater contamination, and types and costs of wastewater treatment. Environmental constraint data has been developed to protect areas with high vulnerability to growth and development. From these inputs and assumptions about the future, the model can compare alternative development scenarios to determine the geographic distribution of development as well as the direct costs to of the wastewater treatment.

Importantly, the model outputs are linked to the County's GIS. All development scenarios can be mapped. This allows the County to graphically display the results of each alternative development scenario.

The model can be modified to include other public infrastructure information. Analysis of the impacts from growth and development can be used on the roadway system and other public infrastructure.

The County has developed a strong and cooperative presence with other local and state agencies including the Land Conservation and Development Commission, special districts (sewer districts) as well as with private citizens and homeowners groups. The meetings involving these groups have been very productive and supportive both in the development of RPS goals and discussion of alternative future development in the area. Stakeholder support and participation will be important as the County continues development of the RPS process.

The analysis has gone a long way toward achieving the Unincorporated Communities Rule (OAR 66022). Under this rule the County has evaluated the carrying capacity of the environment (including potable water supplies and wastewater treatment), evaluated a potential public health hazard and have taken steps to avoid exceeding water quality standards, and have made some strides in addressing the County's transportation problems in the area.

Perhaps most importantly, the County recognizes that resolution to the South County development problems is complex. The land use and development problems would have been resolved years ago had it been easy.

FUTURE STEPS

Where does the County go from here? In Chapter One of this document is a synopsis of the RPS process. The summary includes the requirements for the RPS including setting of goals, developing options, measuring performance, developing incentives, monitoring progress, and methods of adjustment. The County has taken steps in all directions but must continue to develop the RPS process prior to implementation.

One of the critical milestones that the County will need to address will be development of the RPS Agreement. This is the formal document that the County will prepare prior to implementation. It sets out the goals and amendments that the County will make to its comprehensive plan. While the RPS process is set up to develop creative and innovative methods to overcome complex land use issues and the State is prepared to accept plan amendments that may vary from the state administrative rules, on the whole the plan amendment must conform to the spirit of the statewide planning goals.

Included in Appendix G is an example of a draft RPS agreement for Josephine County. It sets out the elements of the formal agreement and the contents that need to be covered in the agreement. This is one model that the County may want to consider as it develops the next steps in the RPS process.

The following are recommended next steps that the County should consider in the RPS process.

1. Develop a vision statement that details what the County and other participants want to occur in the project area over the next 20 years,

2. Develop goals and implementation policies that flesh-out the County's vision.

3. Continue developing alternative land use scenarios that will allow the County to assess different options to meeting the goals and vision.

4. Add other modules to the model. The basic model has already been prepared so it would be relatively easy to extend the analysis. The model would be ideal for analyzing the impact of pubic infrastructure needs in the project area, especially the roadway system and water supply. This would allow the County to measure level of public service delivery and the geographic distribution of demand for public infrastructure. The County could set threshold development levels or densities beyond which certain public infrastructure would be required to be in place. Results from this analysis would allow the County to prepare a capital facilities plan or Capital improvement plan (CIP) to help it prepare for future development in the area.

5. Continue involvement of local and state agencies as well as the local service districts, citizens and homeowners groups. The agreement for provision of services such as those that could be provided by the sewer districts homeowner's associations will need to be a party to the formal RPS agreement.

6. Finally, development of the RPS formal agreement that will identify the vision, goals, and selected land use alternative that the County will implement to resolve the current land use problems.

APPENDIX A

Habitat & Natural Environment Technical Memorandum
(Robin Leighty; Adolfson Associates, Inc.; August 5, 1997)

Technical Memorandum

Adolfson Associates, Inc.

RECEIVED
AUG 06 1997
PORTLAND OFFICE
KCM, INC.

DATE: 5 August 1997

TO: Bill Jones, KCM Inc.

FROM: Robin Leighty, Senior Ecologist Robin Leighty

RE: Deschutes County Regional Problem Solving

CC: Derek Sandison (Adolfson Associates Inc., Cle Elum, Washington)
Ted Wise (ODFW, Bend, Oregon)

This technical memorandum provides biological resource guidance for land-use decision-making in southern Deschutes County, and a brief overview and analysis of natural resource concerns for development in the area. We describe the method of analysis, identify the results of the analysis, identify constraints, and recommend mitigation options for protecting fish and wildlife habitats and for maintaining mule deer migration habitat in the study area. Included also are recommendations for using the analysis for comparing future development scenarios. This document supplements the work of KCM, Inc. Consequently, a detailed description of the project is not included here. The reader is referred to KCM's final report for a full project description and further details.

Methods Employed

Many sources of information were drawn upon for this evaluation including discussions with personnel from the Oregon Department of Fish and Wildlife (ODFW), the Oregon Division of State Lands (DSL), and the Oregon Department of Environmental Quality (DEQ), and review of Deschutes County Geographic Information System (GIS) data, National Wetland Inventory (NWI) maps (LaPine, Finley Butte, Anns Butte, Pistol Butte); Oregon Rivers Information System (ODFW 1994), and published literature. Ted Wise (pers. comm.), ODFW Central Region Habitat Protection Biologist, provided considerable guidance, assistance, and review in the development and delineation of these natural resource categories, and review of the recommendations.

Land use and development patterns were used to identify potentially available wildlife (primarily mule deer) travel corridors through the study area. ODFW was consulted in the identification of wildlife travel patterns and restrictions. This information was analyzed to identify areas where it would be advantageous to avoid or minimize future development, or modify development patterns.

This assessment included no vegetation sampling and no habitat mapping. The technical memorandum is based solely on existing information to avoid potential bias based on socioeconomic differences in the developments of the study area. Consequently, the values derived for the recommended method for alternatives analysis are based on the potential value of the habitats. Field verification is strongly recommended for detailed analysis, comparison of alternatives, and decision-making on a smaller scale. Field Surveys should include habitat components such as dead and downed woody material and snags.

Existing Conditions

The study area is situated in the High Lava Plains Physiographic Province as defined by Franklin and Dyrness (1973). Lodgepole pine (*Pinus contorta*) and ponderosa pine (*Pinus ponderosa*) forests dominate the landscape. These habitats in the study area support a variety of wildlife species, including several threatened, endangered, and sensitive species. Important riparian and wetland areas are found in association with these upland forests. Land ownership in the area is mixed. The majority of the study area is private, or under the jurisdiction of the U.S. Department of Agriculture Forest Service (USFS) and the U.S. Department of Interior Bureau of Land Management (BLM). Much of the private ownership is found in association with The Dalles - California Highway (Hwy. 97) and the Deschutes and Little Deschutes Rivers.

The majority of the study area is classified as mule deer migration range by Deschutes County and ODFW. This area was identified on Deschutes County GIS data. In addition, the County identifies several wildlife species as Goal 5 resources. Some of these occur in the study area. These include great gray owl (*Strix nebulosa*), northern bald eagle (*Haliaeetus leucocephalis*), great blue heron (*Ardea heroidas*), osprey (*Pandion haliaetus*), and Townsend's big-eared bat (*Plecotus townsendii*).

According ODFW's Upper Deschutes River Subbasin Fish Management Plan (ODFW 1996) and the Oregon Rivers Information System (ODFW 1994), the following fish species may be found in the Deschutes River in the study area: rainbow trout (*Oncorhynchus mykiss*), mountain whitefish (*Prosopium williamsoni*), and brown trout (*Salmo trutta*). The Little Deschutes River supports brown trout, brook trout (*Salvelinus fontinalis*), brown bullhead (*Ictalurus nebulosus*), rainbow trout, and mountain whitefish. Paulina Creek also provides habitat for rainbow trout.

Wetlands are formally defined as "...those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances to support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (Federal Register 1980, 1982). The determination of a wetland is based upon three essential characteristics: hydrophytic vegetation, hydric soils, and wetland hydrology. Wetlands in the study area are typically found in association with rivers streams. NWI Wetlands are identified primarily along the Deschutes River, Little Deschutes River, Paulina Creek, Prairie Creek, Fall River, and Long Prairie.

Riparian Areas are distinguished by the presence of vegetation that requires free or unbound water or conditions more moist than normally found in the area (Franklin and Dyrness 1973). They are areas adjacent to streams, rivers, and other water bodies with vegetation strongly influenced by the presence of water (Elmore and Beschta 1989; Chaney et. al. 1993).

Riparian areas and wetlands are valuable and serve many functions. They are diverse vegetative communities, serve as corridors for wildlife movement and are significant foraging and shelter areas for many species. Approximately 85% of terrestrial vertebrate wildlife species are associated with riparian areas in all or part of their life (Puchy and Marshall 1993). In the High Lava Plains Physiographic Province (Franklin and Dyrness 1973), 35% of native amphibians and reptiles, 49% of native birds, and 63% of native mammals regularly use riparian communities (Puchy and Marshall 1993). Many sensitive wildlife species including great gray owl require riparian areas for foraging, nesting, shelter, and other functions. In addition to its direct habitat value, riparian vegetation serves an important role in regulating stream temperature. The organic matter from leaf litter and debris from streamside vegetation is an important component at the base of the food chain. Large debris provides in-stream habitat diversity important to fish and other aquatic species.

Deschutes County's Comprehensive Plan, which received review by the public, the Oregon Department of Fish and Wildlife, and others, recognizes the importance of protecting fish and wildlife resources, particularly riparian areas and wetlands. The plan identifies existing impacts to these resources, and the potential community impacts which may result from the loss of these resources from development, water withdrawal, recreation, and other human uses. Efforts to preserve these resources are put forward in Title 18 of the Deschutes County Zoning Ordinance of 1979 (Ord. 91-020 § 1, 1991).

In Deschutes County, riparian habitats are scarce. The Deschutes County Ordinance 94-007 identifies significant riparian habitat along the Deschutes and Little Deschutes Rivers. Significant riparian habitat is described as meeting one or more of the following criteria:

- The area within 100 feet of the ordinary high water mark of an inventoried river or stream.
- The area adjacent to an inventoried river or stream located within a flood plain mapped by the Federal Emergency Management Agency and Zoned Flood Plain by the County.
- The area adjacent to a river or stream and inventoried as a wetland on the National Wetlands Inventory Map.

Deschutes County Zoning Ordinance (Title 18) specifies a 100-foot stream setback for structures and septic systems, fill and removal regulations, provisions for conservation easements, and a prohibition of hydroelectric facilities on certain reaches of the Deschutes River and its tributaries.

Impacts from Development

Potential adverse impacts from human development such as that which is occurring in Southern Deschutes County may include the following:

- loss of foraging, wintering (e.g., thermal cover), travel, and other important seasonal habitat (e.g., nesting, roosting, etc.);
- disturbance during critical life stages (e.g., fawning, nesting, wintering);
- increase in wildlife damage and other wildlife management problems (deer, cougar, bear, coyote, etc.);
- negative wildlife-human interactions (e.g., damage, roadkill, etc.);

- depredation on wildlife by domestic animal (i.e., pets) (and vice versa);
- loss of streamside vegetation resulting in a reduction of leaf litter, large woody debris, and other organic components of aquatic habitats;
- changes in stream temperature;
- pollution from runoff landscape management (i.e., herbicides, insecticides);
- loss of stream habitat and reduced fish passage are a potential result from installation of culverts at stream crossings;
- changes in hydrology (more flashy, higher peaks, greater frequency); and
- decreased summer flows due to irrigation and other water withdrawals.

Under the status quo, there would be an on-going loss of wildlife habitats and travel corridors. Remaining habitat would consist of generally small, disconnected parcels with differing management. However, parcels in wetland and riparian areas which may be denied development permits or are otherwise undevelopable, would continue to provide habitat for wildlife and serve as travel corridors. The 100-foot stream setback and other existing County Ordinances have the potential to offer some protection to wetlands and riparian areas. However, should community sewage treatment services be developed and provided, there would be the potential for increased development in wetland and riparian areas which would otherwise be undevelopable (unless other measures are undertaken to minimize development in these areas).

Development Recommendations

Based on the available information, four natural resource overlay categories for the protection of natural resources were identified to provide a basis for evaluating and comparing development scenarios in the project area. These categories (see attached figure) address the protection of fish, wildlife, aquatic resources, wetlands, riparian areas, as well as upland habitats and travel corridors. These natural resource overlays were developed based on available Deschutes County GIS data as well as discussions with ODFW, DSL, and DEQ. Many of the categories include multiple factors and/or GIS layers. These categories are not necessarily mutually exclusive; a parcel may be overlain by more than one category or layer. The natural resource categories are defined as follows:

- Wetlands, Riparian Areas, and Aquatic Habitat
- Buffers for Wetlands, Riparian Areas, and Aquatic Habitat
- Available Wildlife Travel Corridors and Habitat
- Developed Areas Providing Some Travel Habitat Value

The category of Wetlands, Riparian Areas, and Aquatic Habitats encompasses areas identified in the Deschutes County GIS as lakes, ponds, rivers, floodplains, and groundwater less than two feet. The latter is included to represent wetlands because available NWI mapping was determined to be incompatible with the GIS. NWI and local wetland inventory data must be included prior to decision-making. No attempts were made to further delineate the category of Wetlands, Riparian Areas, and Aquatic Habitats by value or quality. Such distinction would require considerable effort and would result in additional natural resource categories, making alternatives analysis extremely cumbersome.

Buffers are included to protect wetlands, riparian areas, and aquatic habitats. The area delineated corresponds to Deschutes County GIS "buffer" zones, as well as boundaries for federal and state Wild and Scenic rivers. Wild and Scenic designation in the project area applies to the Deschutes River (federal and state) and the Little Deschutes River (state).

Mule deer range, as identified by Deschutes County GIS data, serves to consider wildlife habitat in general. There is variation in the quality or value of this habitat throughout the study area. A detailed evaluation would be necessary to consider this variability, however, some generalizations were made based on existing development densities and other factors. Mule deer range was subdivided into two categories. One includes those areas currently retaining and providing some habitat function for wildlife, (e.g., travel, foraging), particularly for mule deer migration. The other includes developed areas which still retain habitat value, including for migration of mule deer.

Many of the BLM parcels are surrounded by private land and may be desirable for transfer to private ownership. These areas were identified based on their proximity to other federal lands as well as their potential value to the protection of fish and wildlife and their habitats (i.e., how these parcels were situated in relation to the aforementioned natural resource categories).

The attached Natural Resource map identifies areas where land management modifications are recommended to avoid and/or minimize adverse impacts from development to wildlife, fish, wetland, and other natural resources. The following recommendations are suggested for the areas specified:

Wetlands, Riparian Areas, and Aquatic Habitats

- Include all wetlands identified by NWI and by DSL in their local wetland inventory.
- No development permitted.
- Prohibit use of pesticides (i.e., herbicides, insecticides, rodenticides, fungicides, etc.) within 100 feet of wetlands, with the exception of biological control agents (e.g., *Bacillis theringiensus* for mosquito control).

Buffers for Wetlands, Riparian Areas, and Aquatic Habitats

- Minimum developable lot size 20 acres.
- Minimum structural setbacks of at least 200 feet in all new developments.
- Vegetation management standards within 100 feet of the active stream channel to maintain complex multi-layer native riparian cover, snags, down woody debris, and other important habitat components within the riparian zone, and to retain these areas as wildlife corridors.
- Prohibit use of pesticides with the exception of biological control agents (e.g., *Bacillis theringiensus* for mosquito control).

Available Wildlife Travel Corridors and Habitat

- Institute buy-out program for private land in high value wildlife,, wetland, riparian, and migration areas, or otherwise transfer such private land to government, conservation entity, or other conservation reserve program.
- If not transferred, minimum developable lot size 40 acres unless zoning dictates larger.
- Consider 80-acre minimum developable lot size, making these areas consistent with F1 or F2 zoning designations (Deschutes County Zoning Ordinance 18.36.090 and 18.40.090).
- If currently public ownership, retain as such.

Developed Areas Currently Providing Some Wildlife Habitat Value

- Seek transfer to government, conservation entity, or other conservation reserve program to preserve habitat connectivity and wildlife travel corridors on private lands.
- Minimum developable lot size 20 acres.

Throughout the Study Area

- Seek transfer of private land to government, conservation entity, or other conservation reserve program those habitats necessary to ensure the long-term survival of Federal threatened and endangered species and State sensitive species, and those areas identified by the County as Goal 5 Sensitive Habitat Sites.
- Develop and initiate a campaign to educate local residents/landowners on techniques for avoiding or minimizing wildlife damage and human-wildlife conflicts (i.e., living with wildlife), and provide support for the implementation of these techniques.
- Improve refuse management to minimize potential bear-human interactions.
- Minimize use of pesticides and prohibit their use in particular areas such as in proximity to streams/rivers, and wetlands.
- Work with the Oregon Department of Fish and Wildlife and the Oregon Department of Transportation in efforts to minimize highway roadkill.

Areas for Potential Transfer from Government to Private Ownership

- Seek transfer of identified federal government lands (e.g., BLM) to private ownership for development purposes.

Recommendations for Evaluating Development Alternatives

The four natural resource categories can serve as the basis for comparing alternative development scenarios in the project area. Each natural resource category covering a point on the map, a parcel, or a polygon used in the analysis, would be allocated a score based on the following system.

Natural Resource Category	Score or Value
Wetlands, Riparian Areas, and Aquatic Habitats	5
Buffers for Wetlands, Riparian Areas, and Aquatic Habitats	4
Available Wildlife Travel Corridors and Habitat	3
Developed Areas Currently Providing Some Wildlife Habitat Value	2

Within each polygon, the score would be the sum of the value for each natural resource category overlay. The maximum score for a polygon could be eight, based on the potential overlap of Available Wildlife Travel Corridors and Habitat (score 5) with Wetlands, Riparian Areas, and Aquatic Habitats (score 3). The lowest possible score would be zero as these overlays do not cover the entire project area (e.g., within urban areas). The score/value scale could be modified based on the perceived importance of each of these natural resource categories.

This approach for comparing development alternatives is broad and does not take into account specific habitat components (e.g. snag density, canopy closure, riffle:pool ratio, etc.) within the natural resource categories. It is not appropriate to use this method of analysis for a large polygon size such as one square mile. Ideally, it should be used at the parcel or tax lot scale where each individual lot would receive its own score. The maximum polygon size generally should not exceed 20 to 40 acres.

If the assessment area is comprised of multiple tax lots or parcels, the score should be the highest score obtained over the greatest area of the polygon. Below is a hypothetical illustration comparing three development scenarios based on this highest score approach.

Score	8	7	6	5	4	3	2	0	
Alternative	Percent of Total Polygon								Highest Score
A	13	57	6	10	4	5	2	3	7
B	9	8	5	13	2	50	6	7	3
C	5	11	13	38	12	2	10	9	5

For hypothetical Alternative A, 57% of the assessment area achieved a score of seven. The majority of Alternative B (50%) scored a 3. For Alternative C, most of the assessment area (38%) scored five. Based on this hypothetical comparison, alternative B would have the lowest relative potential for adverse impacts to general natural resources, while Alternative A would have the highest. This does not imply that there would be no natural resource impacts. It ***only*** indicates how the potential impacts of one alternative rank when compared to other alternatives in the same assessment area. ***This approach of assigning values is to be used only for comparison of development alternatives within the same assessment area. There is considerable potential***

for dilution and the results must be closely scrutinized. Before decisions are made on individual land parcels (e.g., proposed land exchange or buyout), site-specific surveys are highly recommended.

Summary

This technical memorandum provides a brief discussion of potential impacts of human development to fish and wildlife. Based on available data from Deschutes County and ODFW, we developed four natural resource categories for the protection of fish and wildlife habitats and mule deer migration habitat areas. The categories are: Wetlands, Riparian Areas, and Aquatic Habitat; Buffer Zones; Available Wildlife Travel Habitat; and Developed Areas Providing Some Travel Habitat Value. In addition, areas are identified and recommended for transfer from public to private ownership. To compare future development scenarios, it is recommended that each natural resource overlay carry a numeric score or weight representing a relative value to natural resources. The higher the score, the greater the potential value for natural resources. The score for a parcel or tax lot would equal the sum of the score of all overlays. For analysis of areas of more than one parcel or tax lot, with caution, future scenarios may be compared based on the highest score attained over the greatest portion of the assessment area.

I trust this information meets your needs. Please call me at (503) 226-8018 if you have any questions.

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APPENDIX B

Onsite Wastewater Treatment Technical Memorandum
(Derrek I. Sandison; Adolfson Associates, Inc.; July 28, 1997)

ADOLFSON ASSOCIATES, INC.

TECHNICAL MEMORANDUM

TO: William M. Jones, PhD
Project Manager

OF: KCM

FROM: Derek I. Sandison, M.S., R.S.

DATE: July 28, 1997

SUBJECT: Deschutes County Regional Problem Solving Analysis, On-Site Sewage System Issues Assessment and Recommendations

The following technical memorandum addresses issues relating to use of on-site sewage disposal systems to serve existing and future development in the Sunriver-La Pine area of Deschutes County, Oregon. The purpose of this memo is to evaluate constraints to the use of on-site sewage systems, to provide recommendations for measures to mitigate the impacts of such systems where appropriate, and to identify circumstances under which use of on-site sewage systems would likely result in significant ground water, and possibly surface water, degradation.

The consideration of constraints to the use of on-site sewage systems focuses on releases of nitrogen compounds, particularly nitrate-nitrogen, from domestic wastewater. Documented incidents of ground water nitrate contamination coupled with predictive hydrogeologic modeling of the study area's ground water system conducted by the Oregon Department of Environmental Quality indicate that nitrate contributions from on-site sewage systems pose a substantial risk to the quality of the regional aquifer.

1.0 BACKGROUND

The following information is offered to provide proper context for discussions concerning nitrate impacts to ground water associated with on-site sewage systems and means of controlling or otherwise mitigating those impacts. This information addresses the role of various nitrogen compounds in the nitrogen cycle, public health and environmental concerns associated with nitrate, and regulatory thresholds for nitrate-nitrogen concentrations in water supplies.

1.1 Nitrogen Cycle/Nitrate Formation

Molecular nitrogen (N_2) is a gaseous element that makes up about four-fifths of the volume of the earth's atmosphere. Nitrogen is continuously cycled in the environment, undergoing many oxidation and reduction reactions and transformations (Hausenbuiller, 1978).

Reduced forms of nitrogen include ionic ammonia or ammonium (NH_4^+); gaseous ammonia (NH_3); and the amino radical ($-NH_2$) of amino acids, proteins, and similar organic compounds. Oxidized forms of nitrogen include two negatively charged ions, nitrite (NO_2^-) and nitrate (NO_3^-), and three gaseous forms including nitrous oxide (N_2O), nitric oxide (NO), and nitrogen dioxide (NO_2).

Nitrogen contamination of ground water, usually from nitrates, occurs when excessive quantities of soluble nitrogen in soil are leached by precipitation or irrigation to an underlying aquifer. Nitrogen is introduced to soils through biological fixation by soil organisms, deposition of human and animal waste products, decaying plants, and application of fertilizers.

Nitrogen in decaying plants and human and animal wastes is usually in the form of organic nitrogen (e.g., amino acids) and ammonia. Over time, organic nitrogen is converted to ammonia through the process of hydrolysis. Ammonia may return to the atmosphere via volatilization, or can enter the soil solution as ammonium where it will either be assimilated by plants or converted to nitrate by soil bacteria.

Nitrate is also subject to plant uptake; however, excess amounts of this highly mobile ion can be leached to underlying ground water, unless denitrification occurs. Denitrification, the bacterial transformation of nitrate to nitrogen gas and nitrous oxide, occurs under anoxic conditions; thus, it is usually necessary for leached nitrates to migrate through a saturated zone in order for the denitrification process to operate. In addition, sufficient organic carbon must be available to fuel the denitrification process. Such conditions are not universally present in soils; therefore, soils in which those conditions are absent represent a relatively high risk of nitrate contamination of underlying ground water.

Nitrogen introduced to soil from fertilizers can be in several different forms including ammonium, urea ($CO(NH_2)_2$), and nitrate. Fertilizer ammonium and urea follow a transformation pathway similar to that described above for nitrogen released from decaying plants and human and animal wastes. Like other forms of organic nitrogen, urea is transformed in the soil environment to ammonia and, under aerobic conditions, to nitrate. Nitrogen in fertilizers that are composed of nitrate salts is immediately available for leaching to underlying ground water.

1.2 Health and Environmental Concerns Associated with Nitrate

There are two potential public health hazards associated with consumption of drinking water containing high concentrations of nitrate. Nitrate is the indirect causative agent of methemoglobinemia, a disorder which reduces the oxygen-carrying capacity of hemoglobin in the blood of infants under six months of age. Infant methemoglobinemia, also referred to as "blue babies disease," is currently considered the most significant health concern posed by elevated nitrate in water supplies and is the basis for the drinking water maximum contaminant level that has been established for the compound (discussed in more detail below) (Freshwater Foundation, 1995).

In addition, the National Research Council has indicated a potential link between consumption of nitrates and formation of carcinogenic nitrosamines in the human body (Frimpter et al., 1990). Some studies have suggested that exposure to high levels of nitrate and nitrite may be correlated with high incidences of stomach and esophageal cancer; however, the results are inconclusive (Gosselin et al., 1997; Freshwater Foundation, 1995). Since the average American adult consumes approximately 100 milligrams of nitrate-nitrogen per day from food and processed beverages, nitrate intake from drinking water should be considered additive to these other sources when calculating possible cancer risk (ibid).

Nitrate contamination of ground water may be of general environmental concern as well. It has been demonstrated that elevated nitrate levels in ground water may be an indicator of the presence of other, more toxic contaminants (Frimpter et al., 1990). Thus, in a sense, nitrate concentrations in ground water can be viewed as a barometer of overall water quality conditions.

Additionally, surface waters that receive discharge from nitrate contaminated ground waters may be subject to eutrophication, increased algae and aquatic plant production stimulated by accelerated loading of nutrients.

1.3 Regulatory Thresholds

Because of the aforementioned health concerns, the U.S. Environmental Protection Agency has established a maximum contaminant level (MCL) for nitrate-nitrogen in drinking water of 10 milligrams per liter (mg/l). The State of Oregon recognizes the federal MCL for nitrate; however, because the state has embraced an "antidegradation policy," the 10 mg/l MCL is <u>not</u> viewed as a level up to which contamination may be allowed. The antidegradation policy prohibits those acts that would cause or tend to cause water quality degradation that is detrimental or injurious to public health, or to existing or future beneficial uses of water resources. Under the antidegradation policy, the quality of receiving waters should be maintained as close as possible to natural background levels (Keenan and Helferty, 1993).

According to the Oregon Ground Water Protection Act of 1989, the Department of

Environmental Quality is required to declare a region of the state to be a Ground Water Management Area if, as a result of nonpoint source activities, nitrate-nitrogen concentration in the region's ground water have exceeded 70 percent of the MCL, or 7 mg/l. Such a declaration may necessitate development of a local action plan to protect ground water resources from further deterioration and, if possible, to restore water quality.

2.0 CONSTRAINTS TO THE USE OF ON-SITE SEWAGE SYSTEMS

On-site sewage systems are a potential source of nonpoint contamination of surface and ground water. Contaminants associated with domestic wastewater discharges to on-site sewage systems typically include bacteria, viruses, phosphorous, and nitrogen. Each contaminant has unique mechanisms associated with its attenuation and, in general, impacts from such contaminants can be largely mitigated through application of proper siting, design, construction, and maintenance criteria and practices.

Nitrogen, however, is the only one of these contaminants for which dilution is commonly used as a means of controlling nonpoint contamination because of the inability to achieve adequate levels of nitrogen removal through standard on-site sewage treatment processes. In the hydrogeologic setting of the Sunriver-La Pine study area, nitrogen contamination of ground water may be especially problematic. Based on current available information, nitrogen in the form of nitrate appears to be the only contaminant parameter that poses a threat to regional ground water quality. Therefore, this technical memorandum focuses on constraints associated with nitrate contamination of ground waters underlying on-site sewage systems.

High water tables also represent a significant constraint to the use of on-site sewage systems in some portions of the study area. However, it is difficult to make broad generalizations about such constraints on a regional basis, except in areas that are known to be subject to routine seasonal inundation. Determination of water table elevation on parcels that are not subject to inundation must be made on a site-by-site basis. For example, while the majority of a given parcel may be unsuitable for on-site sewage system use due to a high water table, thorough site evaluation may reveal one relatively small portion of the parcel with just enough unsaturated soil depth to support use of an open bottom sand filter. Thus, while the parcel would likely be categorized as unsuitable on a reconnaissance level evaluation, it would nonetheless be developable.

2.1 Nitrate Production by On-Site Sewage Systems

Nitrogen is considered one of the most significant ground water contaminants associated with domestic wastewater since it can be highly resistant to removal from mechanisms present in the soil profile. The estimated load of nitrogen in domestic wastewater is 11.2 grams per capita per day, or 27 pounds per year for a family of three (Siegrist et al., 1977; Gold et al., 1990). The principal sources of nitrogen in domestic wastewater are feces and urine, which contain ammonia as well as organic nitrogen in the form of urea, uric acid, undigested proteinaceous materials, and bacterial cells (Siegrist and Jenssen, 1989). Treatment of nitrogen in on-site sewage systems involves a variety of complex interactions including nitrogen retention, transformation, and removal during percolation of domestic wastewater through soil (ibid).

According to Wilhelm et al. (1994), standard on-site sewage systems (e.g., septic tanks and drainfields) typically develop two oxidation-reduction (redox) zones, or sites of microbially catalyzed redox reactions involving organic carbon and nitrogen in wastewater. The first zone consists of the anaerobic environment of the septic tank where the concentration of dissolved oxygen is very low and that of organic matter is high. Microorganisms in the septic tank oxidize organic matter and produce carbon dioxide, methane, and the reduced nitrogen ion ammonium. Approximately 80 percent of the total nitrogen contained in septic tank effluent is in the form of ammonium; the remaining 20 percent is organic nitrogen (ibid).

The second redox zone is the aerobic environment of the soils surrounding the drainfield (or other form of subsurface absorption system). In this zone, microorganisms oxidize organic carbon to carbon dioxide and transform ammonium to the intermediate product nitrite, which is then converted microbially to nitrate. This process is known as nitrification. Nitrification occurs in the soil sediments directly below the drainfield within a few hours after exposure to oxygen. After 24 inches of migration through an unsaturated, medium textured soil, about 80 percent of the total nitrogen in percolating septic tank effluent is transformed to nitrate (Johnson and Atwater, 1988).

In a well aerated soil, oxidation of ammonium is almost complete and the formation of nitrate, the end product of this reaction, is a consequence of a properly functioning standard on-site sewage system (Wilhelm et al., 1994). As will be discussed in considerably more detail below, denitrification, the bacterial reduction of nitrate to nitrogen gas and nitrogen oxides, requires the presence of a third redox zone, an anoxic zone. Anoxic conditions are best maintained in saturated or near saturated sediments with limited oxygen diffusion. With a standard on-site sewage system, the anoxic zone would need to be present at a sufficient depth below the drainfield or other subsurface absorption system to allow for nitrification of the percolating wastewater. As noted previously, an approximately 24-inch unsaturated zone is needed to promote effective nitrification, thus an anoxic zone would need to occur at a depth of about 36 inches below ground surface. In addition, for denitrification to occur, organic carbon would need to be available to serve as an energy source to drive the denitrification reaction. Organic carbon can be supplied by a combination of soil organic matter, the breakdown of vegetation growing over the on-site sewage system, and/or carbon supplied by septic tank effluent.

Generally, with the exception of highly stratified soils, a third redox zone is not well expressed in most soils. Additionally, because of the depth of typical standard on-site sewage systems, even if a third redox zone were present, sufficient organic carbon is often not available to fuel the denitrification reaction. Denitrification rates in standard on-site systems ranges from 0 to about 35 percent (Eastburn and Ritter, 1984). Some researchers indicate that in coarse textured soils, similar to those occupying the pumice plains and pumice mantled river terraces of the study area, essentially no denitrification occurs. In such soils, the only mechanism available for significantly lowering nitrogen content of percolating wastewater is dilution with uncontaminated precipitation and ground water (Walker et al., 1973).

Thus, in areas with coarse textured soils where standard on-site sewage systems are widely used, significant local ground water contamination can be anticipated (ibid). Such contamination has been observed in wells in a number of portions of the Sunriver-LaPine study area (See Figure 1). Since shallow ground water bodies in the study area are in hydraulic continuity with local surface waters, specifically the Deschutes and Little Deschutes Rivers, nitrogen contamination of ground water could ultimately affect the water quality of those surface waters.

2.2 Oregon Department of Environmental Quality Predictive Model

The Oregon Department of Environmental Quality developed a conceptual hydrogeologic model to predict the ground water quality effects of on-site sewage systems associated with future increases in residential, recreational, and commercial development in the Sunriver-La Pine study area (Weick, 1995). The model factored together available information concerning ground water levels and flow conditions as well as water quality data to construct two cross sectional representations of the aquifer system.

Model simulations were run for current, five-year, 10-year, 20-year, and 30-year planning horizons, based on existing zoning and development potential. For each temporal horizon, three different assumptions were used regarding on-site sewage system discharge rates (175, 225, and 340 gallons per day). The three assumptions concerning discharge rates are intended to represent a level of uncertainty concerning actual residential wastewater generation. Nitrate loads were calculated using an average concentration of 40 mg/l for standard on-site sewage systems and 29 mg/l (a 27 percent reduction) for recirculating sand filters.

The model simulations indicated that, if current land use patterns remain unchanged, over a 10 to 20 year horizon nitrate-nitrogen concentrations over much of the study area will significantly increase. Within a 20 to 30 year horizon, nitrate concentrations are projected to exceed the MCL.

3.0 IMPACTS ASSESSMENT METHODOLOGY

In March 1997, discussions were held with representatives of the Deschutes County Department of Community Development and the Oregon Department of Environmental Quality to develop a mutually acceptable process for further refining constraints to the use of on-site sewage systems associated with nitrate impacts to ground water and for establishing appropriate measures to mitigate those impacts. The logical first step in that process was to develop a methodology for defining conditions under which development served by on-site sewage systems could occur without resulting in the catastrophic ground water quality effects predicted through the Department of Environmental Quality's hydrogeologic model described above. Such conditions would be a function of both on-site sewage system density and treatment efficiency.

To address density issues, it was agreed that a nitrogen balance equation or model could be used to establish "acceptable impact" thresholds for lot size (gross land area). Once lot size thresholds are established, various portions of the study area could be evaluated, based upon the degree of deviation from the thresholds, regarding the need for community-based solutions such as connection to off-site wastewater treatment facilities, downzoning, or designation as transfer of development right (TDR) sending areas. Areas with lot sizes that are smaller than the thresholds could be further prioritized for community-based solutions in accordance with the extent to which concentrations of nitrate-nitrogen in underlying ground water are already elevated. Those areas with lot sizes larger than the thresholds could continue to develop using on-site sewage systems, provided such areas are not affected by other development constraints.

Due to differences in the nitrogen removal efficiency of various types of individual on-site sewage systems, it was determined that three levels of treatment would be factored into the nitrogen balance equation, ranging from no nitrogen removal for standard on-site sewage systems to 50 percent removal for what are termed, for purposes of this project, "enhanced treatment on-site sewage systems." During the course this project, a number of alternative on-site sewage system technologies would be evaluated to determine their potential suitability as enhanced treatment systems, that is, systems for which there would be reasonable expectation of achieving at least a 50 percent reduction in nitrogen from domestic wastewater on an annualized basis. A certain number of these technologies could then be evaluated as part of a pilot testing program designed to field verify their nitrogen removal efficiencies.

The most appropriate vehicle for implementation of measures to manage or mitigate impacts from individual on-site sewage systems would appear to be establishment of a Geographical Area Rule for south Deschutes County by the Department of Environmental Quality. Data generated through the pilot testing program could be used by the Department of Environmental Quality to periodically refine the Geographical Area Rule in order to ensure that it contains provisions for application of the best available on-site sewage system technology for nitrogen removal within the south county area.

The two principal elements of the methodology for addressing on-site sewage systems impacts, the establishment of lot size thresholds for on-site sewage systems and the identification of potential "enhanced treatment systems" for use in a pilot program to test nitrogen removal efficiency, are discussed in more detail below under separate headings.

4.0 DETERMINATION OF ON-SITE SEWAGE SYSTEM LOT SIZE THRESHOLDS

The purpose of this element of the methodology for assessing on-site sewage system impacts is to establish threshold lot sizes for on-site sewage systems that are likely to be protective of ground water quality. Such threshold lot sizes can then be used as criteria for evaluating the level of current and future development (based on the number and size of existing platted lots) in various portions of the study area to determine where on-site sewage system densities may result in unacceptable nitrate loading of underlying ground water. As noted previously, those areas with lot sizes substantially lower than the thresholds become principal candidates for community-based solutions such as transfers of domestic sewage to off-site wastewater treatment facilities.

Outputs of the Department of Environmental Quality hydrogeologic model predicted that significant elevations in ground water nitrate-nitrogen concentrations in the Sunriver-La Pine area would result from expanded on-site sewage system use associated with increases in residential, recreational, and commercial development. However, the hydrogeologic model was not designed to determine what would constitute an appropriate level of development, in other words, a level of development that could be sustained without significant adverse impacts on ground water quality.

As discussed in meetings with representatives of the Deschutes County Department of Community Development and the Oregon Department of Environmental Quality, an appropriate development density threshold could be approximated using a mass balance equation, such as the one described in *Predicting Ground-Water Nitrate-Nitrogen Impacts* (Hantzsche and Finnemore, 1992). This mass balance equation integrates such factors as wastewater recharge, nitrogen loading, density, rainfall recharge, and denitrification effects. Consideration is given only to inputs from wastewater and precipitation (including snow) recharge; any dilution effects of lateral ground water inflow from upgradient areas are ignored. This represents a relatively conservative approach; however, it is based on the premise that, because nitrate tends to remain stratified in the upper portions of an aquifer, over time the uppermost ground water zone will closely reflect the quality of percolating recharge (Bauman and Schaefer, 1984; Hantzsche and Finnemore, 1992).

The basic Hantzsche-Finnemore mass loading equation is as follows:

$$Nr = \frac{I\,Nw\,(I - D) + R\,Nb}{(I + R)}$$

Where:

Nr	=	Average nitrate-nitrogen concentration in recharge water, adjusted for denitrification, expressed in milligrams per liter.
I	=	Volume rate of wastewater entering the soil over the developed area in inches per year (based on wastewater flow per dwelling unit).
D	=	The fraction of nitrate loss due to denitrification.
R	=	Average recharge rate of rainfall in inches per year.
Nb	=	Background nitrate-nitrogen concentration of rainfall recharge at the water table in milligrams per liter.

Hantzsche-Finnemore offer a variation of the equation to be used in determining the gross land area needed for a single dwelling unit served by an on-site sewage system to achieve a pre-selected, target nitrate-nitrogen concentration in ground water recharge:

$$A = \frac{0.01344 \cdot W\,(Nw - d \cdot Nw - Nr)}{R\,(Nr - Nb)}$$

Where:

A	=	Critical gross land area per developed lot in acres.
0.01344	=	Conversion factor.
W	=	Daily wastewater flow per dwelling unit in gallons.
Nw	=	Wastewater nitrate-nitrogen concentration in milligrams per liter.
d	=	Percent denitrification.
Nr	=	Target nitrate-nitrogen concentration in recharge at ground water surface in milligrams per liter.
Nb	=	Background nitrate-nitrogen concentration in precipitation recharge in milligrams per liter.
R	=	Average recharge rate in inches per year.

In such a calculation, the volume of wastewater flow and the concentration of nitrate-nitrogen in the wastewater are fixed at some generally accepted representative level, while the volume of available recharge from precipitation would be variable based on the lot area. That is, the larger the land area of the lot, the more precipitation would be available to dilute nitrate in the recharge, and vice-versa. Thus, the lot area and the associated volume of precipitation recharge would be adjusted as necessary to achieve the target nitrate-nitrogen concentration in recharge.

The assumptions and input values factored into the equation were discussed with Oregon Department of Environmental Quality staff (Costello, 1997; Weick, 1997). A number of the input values used in the original Department of Environmental Quality hydrogeologic model were deemed to be applicable to this effort. For example, the annual precipitation recharge estimate of 5.95 inches per year used in the hydrogeologic model appeared to represent a valid average figure for the study area.

Of the three on-site sewage system (discharge) recharge rates used in the hydrogeologic model (175, 225, and 340 gallons per dwelling unit per day), Department of Environmental Quality staff indicated that the mid-range discharge value of 225 gallons per dwelling per day most closely approximates actual usage in the study area as documented through surveys of metered water use. It should be noted, however, that this value deviates somewhat from the 150 gallons per dwelling unit per day used by Hantzsche-Finnemore. The 150 gallon value is based on three capita per dwelling with each capita generating 50 gallons of wastewater per day, a wastewater generation estimate similar to that reported by The U.S. Environmental Protection Agency (EPA) (1980).

The hydrogeologic model used wastewater nitrate-nitrogen concentrations of 40 mg/l for discharges from standard on-site sewage systems, the same basic wastewater discharge concentration used by Hantzsche-Finnemore. Others (Long, 1994) have concluded that nitrate-nitrogen concentrations in discharges from standard on-site sewage systems average about 60 mg/l. However, the relatively high discharge rate (225 gallons per dwelling unit per day) used in this project largely offset this potential discrepancy. As noted previously, the estimated load of nitrogen in domestic wastewater is 11.2 grams of nitrogen per capita per day, or 27 pounds per year for a family of three (Siegrist et al., 1977; Gold et al., 1990). Given two houses each with three occupants, differences in the volume of wastewater generated should affect the concentration of nitrate-nitrogen in each unit of wastewater, but should not affect the total amount of nitrogen produced. The more wastewater generated, the lower the concentration of nitrate-nitrogen and vice-versa. A household with three occupants generating 150 gallons of wastewater per day with a nitrate-nitrogen concentration of 60 mg/l would produce a total of 27 pounds of nitrogen per year. A household with three occupants generating 225 gallons of wastewater per day with a nitrate-nitrogen concentration of 40 mg/l would also produce a total of 27 pounds of nitrogen per year.

The hydrogeologic model assumed nitrate-nitrogen concentrations of 29 mg/l for recirculating sand filter effluent, a 27% denitrification credit. While the Hantzsche-Finnemore equation allows for reductions in loading associated with denitrification, it does not assign or attribute specific denitrification percentages to the various available alternative on-site sewage system technologies.

In calculating appropriate on-site sewage system thresholds as part of this project, the 29 mg/l nitrate-nitrogen concentration used in the hydrogeologic model for recirculating sand filter effluent was assigned to the open bottom intermittent sand filters currently used in the south county area. The 27 percent reduction in nitrogen as compared with standard on-site sewage systems seemed reasonably consistent with available literature regarding the performance of intermittent sand filters (Long, 1994). Recirculating filters, when properly configured, were deemed capable of achieving higher levels of denitrification. Recirculating sand filters were included as one of the "enhanced treatment on-site sewage technologies," technologies considered capable of achieving at least a 50 percent reduction in nitrogen from domestic wastewater on an annualized basis. Also included in the enhanced treatment category, discussed in greater detail in the following section, are split flow intermittent sand filter/anaerobic filter systems, reactive porous media barriers, and certain types of aerobic systems that employ either cycled aeration or operate in a low load/low dissolved oxygen mode. Nitrate-nitrogen concentrations in discharges from the enhanced treatment technology systems were calculated at 20 mg/l.

The assumed value for background nitrate-nitrogen concentration in precipitation recharge was established at 0.5 mg/l based on input from the Oregon Department of Environmental Quality (Costello, 1997). The background concentration would address nitrate contributions from sources other than on-site sewage systems, including fertilizers, domestic animals, plants, and the atmosphere. Within the study area, accounting for these additional nitrogen inputs would be most critical in areas with golf courses, parks, or other facilities with extensive turf cultivation (Cohen, 1990; Gold et al., 1990). Hantzsche-Finnemore indicate that background concentrations generally range from 0.5 mg/l to 1 mg/l.

The target nitrate-nitrogen concentration for recharge was also discussed in meetings with representatives of the Deschutes County Department of Community Development and the Oregon Department of Environmental Quality. The Hantzsche-Finnemore equation uses a target concentration of 10 mg/l, the drinking water MCL; however, it was concluded that the 10 mg/l value was not be adequately protective of ground water in consideration of Oregon's antidegradation policy (Costello, 1997).

Department of Environmental Quality representatives initially indicated that a target concentration of 5 mg/l should be used. However, after further discussion with representatives of that department and Deschutes County Department of Community Development, it was determined that 7 mg/l was a more defensible value, since this is the action level or trigger for nitrate-nitrogen specified in the Ground Water Protection Act of 1989.

A summary of assumptions and values that were incorporated into the nitrogen loading equation are presented in Table 1. Solution of the equation using those assumptions and values indicates that the minimum gross land area (rounded to the nearest half acre) for each dwelling unit served by on-site sewage systems needed maintain the average annual nitrate-nitrogen concentration in recharge at or below the target of 7.0 mg/l are as follows:

- 2.5 acres with standard on-site sewage systems (zero denitrification),
- 1.5 acres with open bottom sand filters (27 percent denitrification), and
- 1.0 acres with enhanced treatment systems (50 percent denitrification).

The distribution of parcels within the study area meeting these gross land area thresholds are presented in Figure 2.

As will be demonstrated below in Table 2, use of different assumptions or values for parameters such as nitrate-nitrogen concentration in wastewater, daily wastewater flow volumes, and background nitrate-nitrogen concentrations affect the calculated thresholds for minimum gross land area requirements. However, only with use of worst case values for all parameters are deviations from the thresholds presented above significant.

It should be noted that most mass balance equations involve a simplifying assumption that there is uniform and complete mixing of wastewater and percolating precipitation over the entire lot area (or developed area if the equation is applied on a regional basis), and that mixing is complete at the water table. In reality such mixing would not be expected to occur because of the irregular spatial and temporal distribution of wastewater loading and rainfall recharge (Hantzsche and Finnemore, 1992).

TABLE 1

SUMMARY OF ASSUMPTIONS USED IN NITROGEN BALANCE EQUATION

Precipitation Recharge: 5.95 inches per year; 610,890 liters per year per acre

Source: Department of Environmental Quality Hydrologic Model

Wastewater volume: 225 gallons per residential dwelling unit per day; 310,430 liters per residential dwelling unit per year

Source: Department of Environmental Quality Hydrologic Model

Background concentration of nitrate in precipitation recharge: 0.5 milligrams per liter (mg/l)

Source: Department of Environmental Quality

Wastewater nitrate concentration:

Standard subsurface system = 40 mg/l (1)

Open bottom sand filter = 28 mg/l (1)

Enhanced denitrification system = 20 mg/l (2)

Source (1): Department of Environmental Quality Hydrologic Model

Source (2): Siegrist and Jenssen, 1989; Long, 1994

Target nitrate concentration in recharge at ground water table: 7 mg/l

Source: Oregon Ground Water Protection Act of 1989

TABLE 2

EFFECT OF DIFFERING ASSUMPTIONS
ON GROSS LAND AREA REQUIREMENTS CALCULATED
THROUGH MASS LOADING EQUATION

Acreage by Percent Denitrification (7.0 mg/l Target)

Assumptions	Zero percent	30 percent	50 percent
Nw = 40 mg/l W = 225 gpd Nb = 0.5 mg/l	2.6 acres	1.6 acres	1.0 acres
Nw = 40 mg/l W = 225 gpd Nb = 1.0	2.8 acres	1.8 acres	1.1 acres
Nw = 60 mg/l W = 150 gpd Nb = 0.5 mg/l	2.8 acres	1.8 acres	1.2 acres
Nw = 60 mg/l W = 150 gpd Nb = 1.0 mg/l	3.0 acres	2.0 acres	1.3 acres
Nw = 60 mg/l W = 225 gpd Nb = 1.0 mg/l	4.4 acres	2.9 acres	1.9 acres

Nw = Wastewater nitrate concentration in milligrams per liter

W = Daily wastewater flow in gallons

Nb = Nitrate concentration of precipitation recharge (exclusive of wastewater nitrogen)

While use of a regional mass balance equation might show that an area as a whole will not suffer from nitrate pollution from on-site sewage systems, some individual wells might be affected (Bicki and Brown, 1991). There are likely to be instances where higher than predicted nitrogen-nitrogen concentrations will be observed in shallow wells in close proximity to on-site sewage systems and other nitrogen sources. Such problems can occur even in areas with relatively low development densities. Thus, minimum lot size criteria should be used in conjunction with a strategy for careful siting of new wells in relation to on-site sewage systems and other potential nitrogen sources (Tinker, 1991).

5.0 IDENTIFICATION AND PILOT TESTING OF ENHANCED TREATMENT TECHNOLOGIES

The purpose of this element of the methodology for assessing on-site sewage disposal systems impacts is to identify a number of available "enhanced treatment on-site sewage technologies," and to facilitate establishment of a pilot program to field test the nitrogen removal efficiency of such systems under the environmental conditions found in Deschutes County. Data generated through the field testing would be used to facilitate development of nitrogen removal best management practices (BMPs) for individual and small community on-site sewage systems for eventual inclusion in the proposed Geographical Area Rule.

In order to evaluate the nitrogen removal potential of various on-site sewage system technologies, the conditions necessary for nitrogen treatment and removal must be understood. As noted previously, treatment of nitrogen in on-site sewage systems involves a variety of complex interactions including nitrogen retention, transformation, and removal during percolation of domestic wastewater through soil (Siegrist and Jenssen, 1989).

5.1 Denitrification Process

Most of the nitrogen present in discharges from properly functioning, standard on-site sewage systems installed in well aerated soils will ultimately be converted to nitrate. Nitrate in percolating wastewater can be reduced through two pathways:

- Assimilatory nitrate reduction, reduction of nitrate to ammonium for cellular synthesis in higher green plants and some microorganisms; and

- Dissimilatory reduction, denitrification to molecular nitrogen and nitrous oxide by bacteria catalyzed by the enzyme dissimilatory reductase (Focht and Chang, 1995).

Because the subsurface absorption components of standard on-site sewage systems are usually installed too deep in the soil profile for assimilatory reduction by plants to have a significant impact on nitrate-nitrogen concentrations, removal of nitrogen from percolating wastewater must be accomplished through the process of dissimilatory reduction or denitrification. Otherwise, nitrate is free to migrate to underlying ground water.

There are four general environmental requirements for dissimilatory reduction of nitrate to occur:

- Bacteria that are capable of producing the reductase enzymes must be present;
- Suitable energy sources to fuel the reduction reaction must be available; and
- Oxygen, which tends to repress enzyme formation, must be limited or eliminated (Eastburn and Ritter, 1984).

Dissimilatory reduction involves three types of biological reactions:

- <u>Aerobic, heterotrophic oxidation of organic matter</u> - In this reaction, aerobic bacteria use oxygen as the terminal electron acceptor in oxidation of organic matter. This reaction provides energy that is used to increase the size of bacterial populations.
- <u>Autotrophic nitrification</u> - In this reaction, nitrifying bacteria oxidize ammonium ions released by heterotrophic reactions. Nitrifying bacteria are usually the limiting organism in the dissimilatory reduction process because they are the slowest growers.
- <u>Heterotrophic denitrification</u> - In this reaction, denitrifying bacteria oxidize organic matter using nitrate as a terminal electron acceptor. Nitrogen gas is the main nitrogen sink (Rittman and Langeland, 1985).

The nitrification reaction is actually a two step process, first ammonium is converted to nitrite, then nitrite is transformed into nitrate. Bacteria responsible for the conversion to nitrite are principally *Nitrosomonas*, but also *Nitrococcus*, *Nitrospira*, and *Nitrosolobus*. *Nitrobacter* is the most common bacteria associated with the transformation to nitrate; however, *Nitrospira*, *Nitrococcus*, and *Nitrocystis* can also be involved.

Denitrification can result from a wide range of heterotrophic bacteria including *Pseudomonas*, *Archromobacter*, *Alcaligenes*, *Bacillus*, and *Hyphomicrobium*. Most of these organisms function as facultative denitrifiers, that is, they will preferentially use oxygen as a terminal electron acceptor during the oxidation of organic matter (respiration) (Eastburn and Ritter, 1984). Only under anoxic conditions will nitrate serve as a terminal electron acceptor in lieu of oxygen. Dissolved oxygen levels above about 0.2 mg/l in solutions will generally prevent use of nitrate as a terminal electron acceptor (Focht and Chang, 1975). Some researchers have concluded that oxygen blocks denitrification reactions by inhibiting production of nitrate reductase enzymes (Rittman and Langeland, 1985).

Denitrification of the nitrate present in wastewater requires at least equal amounts or parts of organic carbon (Wilhelm et al., 1994). Higher levels of organic carbon relative to nitrate may help ensure efficient denitrification. Warnok and Biswas (1981) found that a carbon to nitrogen ratio of 4:1 resulted in a denitrification rate of 95 percent.

Temperature is also a factor in nitrification/denitrification reactions. Optimal temperatures for nitrification range from 30 to 36 degrees centigrade (C). Denitrification is optimal at 65 to 70 degrees C. Thus, most nitrification/denitrification reactions occur at suboptimal temperatures. Since nitrification results from highly specialized organisms of narrow species diversity, it is more sensitive to temperature than denitrification, which results from organisms of broad speicies diversity (Focht and Chang, 1975).

Nitrification/denitrification reactions are adversely affected when wastewater temperatures fall below 15 degrees C (Focht and Chang, 1975). The minimum temperature at which nitrification/denitrification reactions in wastewater will occur is between 2 and 5 degrees (C) (Eastburn and Ritter, 1984).

In discussions with Department of Environmental Quality and Deschutes County Department of Community Development staffs, concerns were raised over establishing requirements for use of enhanced treatment technologies as tools to achieve quantitative denitrification goals. The staffs indicated that denitrification capabilities for various systems reported in the national literature may not be reflective of system capabilities in the Sunriver-LaPine area because the relatively cold winter temperatures observed locally were likely to inhibit nitrification/denitrification reactions. In response, potential cold climate effects will be discussed for each enhanced treatment technology described below.

5.2 Enhanced Treatment Technologies

To overcome the inherent nitrogen removal deficiencies of standard on-site sewage systems, the design of on-site sewage systems can be modified to include a relatively simple biological nitrification/denitrification step prior to soil infiltration (Siegrist and Jenssen, 1989). A number of different design configurations can be employed; however, to be effective, each configuration must create the conditions necessary to encourage denitrification, specifically: conversion of most of the nitrogen load to nitrate followed by exposure of the nitrate to anoxic conditions in the presence of abundant organic carbon. In addition, because of the relatively cold climate of the Sunriver-La Pine area, special design and construction features may need to be incorporated into some system configurations to ensure that adequate wastewater temperature are maintained to support nitrification/denitrification reactions.

Each of the alternative systems or combination of alternative systems described below involves a nitrification/denitrification step. Comparative costs for such systems are provided in Table 3.

TABLE 3

**ENHANCED TREATMENT TECHNOLOGIES
COMPARATIVE COSTS**

Type of System	Capital Cost (Design, Materials, Installation, and Inspections)	Operation and Maintenance Cost (Annual)
Standard On-Site Sewage System (septic tank and gravity SSAS)	$3,000	Labor - $150 Energy - $0
Open Bottom, Intermittent Sand Filter	$10,000	Labor - $150 Energy - $60
Split Flow Intermittent Sand Filter w/ Anaerobic Vessel (gravity SSAS)	$11,250	Labor - $150 Energy - $60
Recirculating Sand Filter (gravity SSAS)	$12,250	Labor - $150 Energy - $60-$120
Aerobic Treatment Unit w/ Extended Aeration/Cycled Aeration (gravity SSAS)	$7,750	Labor - $200 Energy - $35
Reactive Porous Media Barriers (pressure SSAS)	$8,500	Labor $150 Energy - $60

Sources:

Ayers & Associates, 1991;
Sandison et al., 1997;
Rogers 1997

5.2.1 Open-bottom, intermittent sand filter. An open bottom, intermittent sand filter consists of a filter bed constructed within a concrete container with the bottom exposed to native, in-place topsoil. Pretreated wastewater is applied periodically to sand media providing intermittent periods of wastewater application followed by periods of drying an oxygenation of the filter bed. Open-bottom sand filters are the most commonly used alternative systems in the Sunriver-LaPine area.

Although single pass filters are capable of achieving as much as a 60 percent reduction in total nitrogen (Long, 1994), typical removal rates are generally much lower (Siegrist and Jenssen, 1989). While such systems are effective nitrifiers, it is more difficult to ensure establishment of conditions necessary to achieve significant denitrification than with other systems described below. Denitrification in open bottom sand filters is dependent on the particle size of the sand filter media being sufficiently different than the particle size of the underlying native soil to create tension saturation and concomitant anoxic conditions at their interface. In addition, organic carbon must be available to drive the denitrification reaction. Since most of the organic carbon in wastewater is consumed in the pretreatment device and in passage of the wastewater through the sand filter, substantial organic carbon must be provided by the native soil and associated residual vegetation in order to fuel denitrification reaction (Wilhelm et al., 1994).

Additionally, because open bottom, intermittent sand filters are usually uncovered and not insulated, nitrification/denitrification reactions may be inhibited by cold temperatures during winter months. Due to uncertainties over the treatment efficiency of these types of systems, they were assigned only a 27 percent nitrogen reduction capability in the calculation of lot size thresholds for the Sunriver-La Pine area.

5.2.2 Split flow (blackwater/greywater) intermittent sand filter with anaerobic filter or vessel. This system is a special modification of an intermittent sand filter that incorporates a passive denitrification step. The prototype of this system, developed by Laak (1981), was known as the RUCK system. In such a system, blackwater, consisting primarily of toilet wastes, is separated from the remainder of the household wastewater flow, referred to as greywater, and discharged to a septic tank followed by an intermittent sand filter. Blackwater, containing about 80 percent of the total nitrogen load in domestic wastewater (Siegrist et al., 1977), is nitrified in the sand filter and released to a denitrification chamber, either an anaerobic rock filter or an anaerobic tank. There it is mixed with greywater, which is relatively rich in organic carbon, that fuels the denitrification reaction. The greywater is exposed to minimal pretreatment in a small septic tank. After detention in the denitrification chamber, the combined wastewater is discharged to a subsurface absorption system.

Research conducted on split flow intermittent sand filters with a denitrification step indicates that such systems are capable of achieving about 70 percent removal of total nitrogen (Laak, 1981, Laak et al., 1981, Kennedy, 1981; Lamb et al., 1987). Tests conducted on the performance of split flow systems during winter months when mean sand filter effluent temperatures were 4.3 degrees C determined that total nitrogen removal efficiency dropped to a low of 44 percent (Lamb et al., 1987). However, systems buried to a depth of about 50 centimeters (20 inches) should not be significantly temperature affected (Laak, 1981; Gold et al., 1989).

Because nitrogen in the greywater, representing about 20 percent of the total wastewater load, is usually not in the form of nitrate when it enters the denitrification chamber, it is not subject to dissimilatory reduction. Although some portion of the greywater nitrogen could be lost through ammonia volatilization, most will enter the soil as ammonium or organic nitrogen where it will be converted to nitrate.

It should be note that an aerobic treatment unit capable of consistently producing effluent high in nitrate can be substituted for the intermittent sand filter in this application.

5.2.3 Recirculating sand filter. This system consists of a multiple pass filter with sand and gravel media constructed within a flexible membrane-lined pit or concrete container. In this type of a system, nitrate rich sand filter effluent is mixed with fresh sewage from the septic tank in a recirculation vessel. The mixture is recirculated several times through the sand filter prior to being discharged to a subsurface absorption system. The septic tank effluent provides the organic carbon and low oxygen concentrations necessary to promote denitrification of the nitrate in the sand filter effluent.

Such systems are capable of achieving nitrogen removal rates as high as 70 to 80 percent (Long, 1974). Typical performance is probably closer to 40 to 60 percent total nitrogen removal capability on an annualized basis (Loudin et al., 1984); although some researchers indicate that typical could be as low as 30 percent (Siegrist and Jenssen, 1989).

Because recirculating sand filters are typically constructed above ground with an open top, they can be temperature affected. Lamb et al. (1987) found that while mean annual nitrification performance of a recirculating sand filter was 66 percent, nitrification dropped to as low as 24 percent during winter months when effluent temperatures were as low as 2.7 degrees C. The impaired nitrification performance would obviously reduce the potential of such systems to denitrify.

Perley (1984) reported that recirculating sand filter systems can be adapted to avoid cold climate problems, for example, by burying the filter where possible or insulating the filter, including installation of an insulated cover. Loudin et al. (1984) also suggested adjusting pump settings to limit nighttime operation of the sand filter during cold winter months.

Several modifications of the recirculating sand filter system described above have been tested and found to provide high levels of denitrification. Sandy et al. (1987) recycled recirculating filter effluent back to the septic tank and found that total nitrogen removals of 83 to 90 percent could be achieved. Piluk and Hao (1989) increased the size of the standard recirculating vessel to provide substantially longer denitrification reaction time, resulting in about a 70 percent removal of total nitrogen, even during winter months (ibid).

5.2.4 Aerobic treatment unit employing cycled aeration or low load/low dissolved oxygen operation. This type of system involves use of specialized proprietary aerobic treatment units with discharge to subsurface absorption systems or open-bottom sand filters. Some available aerobic treatment units imitate treatment processes used in municipal wastewater treatment plants to reduce nitrogen loading, such as sequencing batch reactors and oxidation trenches. In sequencing batch reactors, anoxic and aerobic zones are separated in time within the same reactor through cycled aeration (Rittman and Langeland, 1985). Oxidation trenches utilize continuous flow in one reactor, but the level of dissolved oxygen is maintained sufficiently low (about 0.2 mg/l) to promote denitrification (ibid). Aerobic treatment units with long solids retention time operated at low dissolved oxygen levels may similarly be capable of performing nitrification and denitrification within the same vessel without cycled aeration (Stensel, 1994).

Although supporting literature is limited, aerobic treatment units designed as fixed film reactors may also be effective in reducing nitrogen loading. Although dissolved oxygen levels within such reactors are generally too high to promote denitrification, because of poor oxygen diffusion within the films, denitrification may occur (Focht and Chang, 1975).

Aerobic treatment units designed for denitrification, such as those discussed above, may be capable of reducing total nitrogen loading by 50 to 80 percent (Long, 1994). These systems are generally not cold climate sensitive because they are buried, and because many either have remote air intakes (e.g., in an enclosed garage) or use compressors.

It is important to note that not all aerobic treatment units are designed to provide for denitrification. Those that are not, are likely be effective nitrifying reactor, but will not reduce total nitrogen loading by more than about 25 percent (ibid). Additionally, most aerobic treatment units function best under conditions of continuous operation; thus, there use would generally not be advisable for residences with intermittent or seasonal occupancy.

In addition to parameters for aerobic systems specified in OAR 340-71, use of aerobic treatment units in achieving denitrification should be limited to those systems with characteristics described above and with documented denitrification capability.

5.2.5 Reactive porous media barrier. Reactive porous media barrier systems involve use of carbon augmented sand lined subsurface absorption trenches that receive septic tank effluent through a pressure distribution system. Nitrification of the septic tank effluent occurs during migration through an approximately two-foot medium sand layer installed under the gravel bed of the distribution system. The medium sand is underlain by 1.5 to 2 feet of finer sand or silt mixed with a solid phase organic carbon material, such as sawdust. Differences in textural quality between the medium sand and the fine sand or silt create tension saturation and, thus, anoxic conditions. The solid organic carbon provides fuel for the denitrification reaction.

Reactive porous barrier systems have been found to consistently attenuate over 60 percent of influent nitrogen up to 125 mg/l (Robertson and Cherry, 1995). Because these systems are buried, they should not be cold climate affected. Slow breakdown of the solid phase carbon source should provide adequate fuel for denitrification reactions for at least a 20 year period (ibid).

Because of the 4.5 to 5 foot-depth of reactive porous barrier systems, their use would not be effective in areas with water tables less than six feet below ground surface.

5.3 Pilot Testing Program

Even though literature reports of nitrogen removal by enhanced treatment systems are promising, nevertheless, concerns expressed by Department of Environmental Quality and Deschutes County Department of Community Development staffs over the limited nature of quantitative performance data regarding these systems are acknowledged. For that reason, it is recommended that a **pilot testing** program be developed for purposes of generating data relating to the performance of enhanced treatment systems under the environmental conditions of Deschutes County.

The Department of Environmental Quality, Deschutes County Department of Community Development, and other appropriate parties should collaborate regarding selection of several candidate enhanced treatment system designs for testing, such as those identified above. Selection of candidate systems should take into account the climate of the area, the physical setting, soil conditions, and cost.

A specified number of each identified system should be permitted for installation with requirements for regular monitoring of each system for nitrate and possibly other parameters. Because ground water nitrate-nitrogen concentrations are likely to fluctuate substantially on a season basis, the frequency of monitoring should be sufficient to ensure recognition of seasonal trends (Gosselin, et al., 1997; Sandison et al., 1995; and Sandison et al., 1996).

The results of the monitoring would be used to develop long-term nitrate BMP requirements for on-site sewage disposal systems. At the end of a two or more year monitoring period, the Geographical Area Rule should be modified to specify the use of systems most closely achieving quantitative nitrogen removal targets established as part of the pilot program.

5.4 Operation and Maintenance

In considering conditions under which on-site sewage system use is acceptable, it should be recognized that an effective on-going operation and maintenance program is needed to ensure that systems perform in accordance with design specifications. This is particularly critical in those situations where relatively complex, enhanced treatment on-site sewage systems are used. Thus, operation and maintenance should be considered an integral part of any problem solving approach associated with on-site sewage systems.

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APPENDIX C

Offsite Wastewater Treatment Technical Memorandum
(Catherine Buckley, Phil Roppo; KCM, Inc.; July 10, 1997)

Memo

KCM

Date:	July 10, 1997
To:	Bill Jones
c:	*Central Files*
From:	Catherine Buckley and Phil Roppo
Project:	Deschutes County Regional Problem Solving / 2767002
Subject:	Off-site Wastewater Treatment Technical Memorandum

As part of the Deschutes County Regional Problem Solving Project, off-site wastewater treatment was evaluated as an option for wastewater disposal. This memo is a summary of the methodology and assumptions made in the evaluation of wastewater collection, treatment, and disposal by off-site methods. Costs are estimated for construction and for operation and maintenance of the centralized, off-site plants. Relative costs are presented in this memo. Specific costs are included in the interactive computer model included in the work products for this project. All assumptions of specific costs can be changed in the model.

This evaluation is not intended to take the place of the Facilities Planning required by State law. However, this document should provide some guidance for the planning process. Facilities Plans for other communities/municipalities with similar challenges may also provide guidance. In 1994, KCM prepared a Facilities Plan for the City of Redmond which discusses treatment and disposal systems capable of denitrification for fairly large communities. The City of Government Camp, as a result of their Facilities Planning, is currently doing pilot testing of a small, proprietary treatment system capable of denitrification which reportedly requires very little maintenance. These proprietary treatment systems are not generally accepted by the Department of Environmental Quality (DEQ) without pilot testing and were not considered to be an option in this analysis.

Costs for Facilities Planning and Engineering Design are included in the capital costs at 30% of base construction cost. This is a higher percentage than typically assumed because these will be relatively small projects and fixed fees will be a higher percentage of the cost. It would be financially beneficial if planning and design for off-site treatment were done on a regional scale. A construction contingency of 20% and a construction mobilization, overhead, insurance, and profit contingency of 10% are also assumed for a total contingency of 60%.

Costs in this memo and in the interactive model are those which the County would have to pay an outside contractor, engineer, etc. to do the work. It does not include the time and money required to pay County or agency personnel to organize and oversee the work. It also does not take into account the savings which might be available if some of the engineering or construction were done by County employees.

While availability of land is most definitely an issue in this process, a blanket assumption that land is available at $3000 per acre was made for all subareas. Most of the larger pieces of land in the study area are owned by state or federal agencies whose policies on the sale or lease of land may change. This is the most obvious source of land for treatment and disposal, and probably the most difficult to evaluate in terms of cost and availability.

WASTEWATER COLLECTION

In general, there are four options for collection: traditional gravity, small diameter gravity, pressure (STEP or grinder pump), and vacuum. Because much of the project area has high groundwater and is relatively flat, gravity systems would probably experience unreasonable infiltration and would require numerous pump stations. The existing system at Oregon Water Wonderland is a good example of why a gravity collection system is problematic under the conditions experienced in this area. Alternatively, the LaPine collection system is a STEP system and has experienced few problems. Preliminary estimates indicate that a vacuum system may be marginally less expensive and require less maintenance while providing the same benefits. For the vacuum systems, there are no electrical requirements at each residence and no periodic pumping or maintenance is required because all sewage is conveyed by pipes. With STEP systems, small pumps in individual septic tanks pump greywater only to the treatment plant. The remaining solids must occasionally be pumped out of the septic tanks.

Both types of systems minimize infiltration/inflow and are inexpensive to install because the pipes are small and can be placed in shallow trenches. Because of the shallow trenches, installation of this type of system in areas of high groundwater would probably not require any additional dewatering or shoring.

In order to guarantee good operation, a STEP collection system would require that all septic tanks be replaced and some pump stations be installed at an approximate cost of $5600 per household. Based on information from the supplier, a vacuum system costs $3500 to $5000 per household and has lower maintenance costs. A cost of $5000 per household was used in the estimate as a median value between the two collection system types. To these costs, collection piping costs are added at approximately $27 per lineal foot for either collection type. Operation and maintenance (O&M) costs are based on the vacuum system.

Easements will have to be established to install the collection systems. Easements for collections systems would most likely be the same as those required for road construction and maintenance. The cost of establishing, purchasing, and documenting the easements is not included in the model.

The costs for collection were established on a linear scale depending on density. As the density increases (less acres/house), the costs per household (or unit) for collection go down. Costs per household range from approximately $9,150 to $15,000 for 0.5 to 2.5 acres/house. This is 70% to 85% of total treatment costs, which is a significant portion, but within the range of typical. Because of the high cost of collection systems, it would not be economical to convey the sewage long distances for treatment. The model assumes that treatment plants are located immediately adjacent to one of the subarea boundaries, eliminating the need for long conveyance systems.

WASTEWATER TREATMENT

It is most likely that nitrate loading to the groundwater will be limited to less than 3 mg/L, with total nitrogen loading less than 6 mg/L. These are the levels currently being required by DEQ for the City of Redmond, who is in the predesign stages of a new wastewater treatment plant and disposal system. Nitrate reduction may occur either during treatment or disposal.

Two options for treatment and disposal were considered: lagoon treatment with spray irrigation disposal, and advanced alternative treatment with nitrification/denitrification and controlled rate infiltration disposal. The options were evaluated based on a 20-year life and include capital as well as O&M costs. Lagoon treatment with spray irrigation disposal has the additional non-monetary benefit of being community-accepted, as it is the current treatment and disposal method in LaPine. As mentioned above, there are a variety of alternative treatment systems available, all of which will require pilot testing before they can be designed. Cost estimates for this project were based on the AeroMod system. The smallest AeroMod system is 10,000 gallons per day, or approximately 40 homes.

Because there is very little equipment involved, fixed costs are low for the lagoon system and overall the cost per household is fairly constant regardless of the size of the treatment plant. The alternative treatment systems tend to be equipment-intensive with fairly high fixed costs, causing the cost per household to go up exponentially as the number of houses goes down. Based purely on capital costs for treatment, a lagoon treatment system costs approximately the same as an alternative treatment system which serves 250 households ($2900 per household). Operation costs for the more equipment-intensive alternative treatment are about 3 times higher per year.

In all subareas a lagoon system with land application disposal was more cost effective than alternative treatment with controlled rate infiltration. However, this should not rule out the use of alternative treatment. The biggest benefit of alternative treatment is that the land required would be on the order of a couple acres, regardless of treatment capacity. And as mentioned above, other proprietary systems may be investigated which may be less expensive.

EFFLUENT DISPOSAL

Typical disposal options include outfalls, direct recharge, land application, evaporation, or some combination of these. Discharge to a creek or river though an outfall is by far the most common disposal method in Oregon. The study area has two rivers: the Deschutes and the Little Deschutes. Both are classified as Wild and Scenic, removing any possibility of a river discharge. The remaining options are far more problematic and expensive. Direct recharge requires highly treated effluent (as in the alternative treatment discussed above). Land application requires large amounts of land and high maintenance. Costs for these two alternatives were investigated.

Treated effluent from lagoons will be land-applied to animal feed crops as irrigation water. This is the current scenario in LaPine. The loading rate used in this cost estimate is based on agronomic capacities of nitrate uptake taken from the original design of the LaPine system and from the Facilities Plan prepared for the City of Redmond. Alternatively, effluent can be land-applied to non-harvested crops such as trees. Forest agronomic capacity is about 1/3 that of a harvested crop simply because the nitrates remain in the soil instead of being taken up and removed with the crop.

Denitrified effluent from alternative treatment systems will be disposed of by wetland polishing and controlled rate infiltration. This is the approved disposal method for the City of Redmond. Application rates are assumed to be 2 inches per week during summer months, similar to those proposed for the City of Redmond. It is expected that a hyrogeologic study of the soils and monitoring wells will be required by DEQ at each proposed infiltration site. The monitoring wells will be required for initial evaluation and for long-term monitoring. This is a fixed fee per site, assumed in this evaluation to be $100,000 per site.

Capital costs for the two types of disposal are significantly different: $330 per household for spray irrigation versus $1050 per household for controlled infiltration (both include cost of land at $3000). Spray irrigation requires essentially no construction but about 30 times more land. Operation costs for the controlled infiltration system are about 60% of costs for land application, but this is minor compared to the difference in capital costs.

SUMMARY

In general, centralized treatment and disposal present worth costs (at 3% interest, 20 years) are approximately $19,000to $28,000 per household (unit), or $1,275 to $1,880 per household for annualized costs. The lowest cost systems have a large number of units constructed at high density. The costs are based on a vacuum collection system, lagoon treatment and land application disposal. Lagoon treatment with land application disposal is the least expensive treatment alternative regardless of number of houses treated because of the high cost to construct the controlled rate infiltration basins and the more intensive operation and maintenance required by alternative treatment methods. Alternative treatment may be desirable if sufficient land is not available for lagoons and land application.

APPENDIX D

Method of Analysis for Evaluating Land Use Alternatives
for the La Pine Study AreaTechnical Memorandum
(Terry Moore; ECONorthwest; June 2, 1997)

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2 June 1997

TO: Deschutes County Staff
Consulting Team Members
FROM Terry Moore
SUBJECT: METHOD OF ANALYSIS FOR EVALUATING LAND USE ALTERNATIVES FOR THE LA PINE STUDY AREA

SUMMARY OF PROPOSED METHOD OF ANALYSIS

1. Create GIS overlays of natural environment (e.g., wildlife, wetlands, depth to groundwater) and built environment (existing and potential development).
2. Use GIS overlays to create a composite map of physical constraints (e.g., density requirements, land critical to wildlife, depth to water table requirements) that prohibit or strongly suggest the need to prohibit development.
3. Using data on historic development (e.g., building permits, assessor's data showing year built) and population growth (by County subarea, as available) allocate a portion of County non-urban growth to the study area, and the study area allocation to subareas of the study area.
4. Use GIS to map existing and potential (based on population allocation) development for various development scenarios. The scenarios will vary in assumptions about waste water disposal systems, lot size compatible with these systems, and, thus, amount of development.
5. Use the future development patterns mapped in "4" to estimate impacts on key criteria.
6. Describe impacts estimated in "4" and "5" above on maps and in tables. Leave decision about relative importance of impacts (weighting and scoring) to the stakeholders and other County decisionmakers.

BACKGROUND

On May 1, DJ Heffernan, Bill Jones, Michelle Gall, and I met to discuss the process we would use to evaluate the three land use alternatives for the La Pine study area. I summarized and built on that discussion in a memorandum I prepared describing a proposed method of analysis.[1] Bill Jones and I presented and discussed a draft version of

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1In the interest of time and budget, it draws heavily on previous work ECONorthwest has done on this topic, including *Transportation System Plan Alternatives for Corvallis*, November 1996, *Criteria for Evaluating Congestion Potential Pricing Options*, October 1996, *Least Cost Planning for Portland Transportation System Plan*, May 1996.

that memorandum with Deschutes County staff on May 8. On May 22 I presented the methods to the stakeholder advisory group and discussed with them possible amendments. This memorandum incorporates agreements reached: it describes the methods used in our evaluation, and is an attachment to our final report for this project.

The next section of this memorandum discusses standard principles for evaluating land use alternatives. It is followed by a section that recommends methods for this study: how alternatives get defined; how evaluation criteria get defined; and the methods by which all the data about them get brought together into a format that facilitates public discussion and decisionmaking.

STANDARD PRINCIPLES FOR THE EVALUATION OF LAND USE ALTERNATIVES

The criteria one uses to evaluate land use alternatives depend on one's view of the proper way to handle many issues about theory, measurement, and methods that inevitably arise during such evaluations. This section describes the principles that will be used throughout the evaluation of the three alternatives. These principles have implications primarily for the methods used later in the project, and secondarily for the criteria described in the following section.

The principles used in this project include:

- *Compare complete alternatives*: Before a comparison of land use alternatives can occur, the existing conditions within the study area must be identified and described (e.g., what are the current levels of water quality, wildfire hazard, and residential density?). A description of existing conditions provides a common point of departure for all alternative futures. It is typical for one of the alternative futures to be identified as the base case, or business as usual, or (as in this project) the status quo. Note that it is *not* an alternative of no change. Rather, it represents one way the present might become the future. It is usually a path that assumes that whatever factors created the past will act in a more or less similar manner to create a future that looks more or less like the past.

  Another way to think about the status quo alternative, and one that this project is using, is not as no change in *impact*, but as no change in *policy*. The point is important, because existing policies can lead to an undesirable future. The point of policy analysis is to see whether governing bodies can reason their way to a different set of policies that will bring a different, more desirable future. Thus, the precipitating causes of alternative futures are usually assumed to be changes in public policy: that is how Alternatives 2 and 3 of this project are defined.

  To compare alternative futures, they must be described in a way that allows their significant impacts (both good and bad, benefits and costs) to be identified and examined to the extent practical. Conventional analyses of land use often focus only on a small segment of the policy change and overlook impacts that may be occurring in neighboring communities and over time. Determining whether the overall impact of a particular land use alternative will be positive or negative requires that decisionmakers trace through a process that examines the multiple impacts the alternative (usually defined as a change of goals or policies) will have on a defined study area.

If these points sound basic, it may be because they are, in the sense that they are the basis of any rational policy evaluation. It is quite easy to define alternatives in a way that keeps them from being comparable: certain costs are measured for some alternatives but not for others; their boundaries are different; their time horizons are different. I will point out shortly where the possibility of making these types of mistakes exists in this project.

Once all of the significant impacts are identified, it is often possible to simplify the analysis and description of the impacts by focusing on the *differences* between what the world is forecast to be like without an alternative, and what it is forecast to be like with the alternative. If, for example, all the three land use patterns being considered are estimated to have roughly the same impact on the level of social services in Deschutes County, then one can skip spending time trying to estimate those impacts: they net out and make no difference to decision-making. For choosing among alternative actions, it is sufficient only to know how their significant impacts are different—is not necessary to describe insignificant impacts or significant impacts that are constant across the alternatives. In all cases the concern should be with reasonable estimates of the *additional (marginal) costs and benefits* resulting from a proposed action.

- *Perspective: benefits and costs from whose point of view?* Not only should all impacts be considered, but they should also be considered from all important perspectives. For example, a grant from the State of Oregon to Deschutes County for a sewage treatment plant is an expenditure for the State of Oregon, a revenue for Deschutes County, and a transfer from the perspective of net social cost. The distinction between a regional perspective and a local perspective is essential for two reasons.

First, net benefits to Deschutes County as a whole do not ensure net benefits to every subset of the County. For example, though a potential land use alternative may provide net benefits to the County as a whole (i.e., the costs, including costs to local neighborhoods that are not easily quantified, are more than offset by the benefits of improved water quality), local residents within a subdivision may oppose it because they genuinely believe they will be worse off.

Second, an evaluation of land use alternatives must consider not just the gains in economic efficiency but also how those gains are distributed: in other words, it must consider different perspectives. In the previous example, an analysis done from the perspective of the residents within a subdivision might have shown net losses if all external costs had been counted.

In practice, few analyses of land use patterns provide rigorous evaluations of how benefits and costs fall on different groups. Part of the reason for the absence of equity analysis is that it can often be difficult to determine to whom the benefits of a policy decision ultimately accrue.

There is no economic or mathematical solution to the problem posed by distributional issues except in the instance when all groups are clearly better off under one alternative than another. A careful analyst, however, can do two things regarding distributional effects that can help decision-making. First, and most obvious, she can describe clearly the likely effects on different groups. Second, and less obvious but no less important, she can use her knowledge of those distributional effects to design land use alternatives that substantially mitigate or eliminate negative effects on any group.

- *How timing affects the evaluation.* Because benefits and costs are unevenly distributed over time, and because future benefits and costs are worth less than present ones,[2] one needs a method to summarize all those benefits and costs. Discounting to a present value at a social discounting rate (e.g., like an interest rate) is the method accepted by economists.[3]

  Assume that all costs and benefits associated with a land use alternative have been identified, categorized properly to reduce double-counts and transfers, quantified, and monetized. It is not enough to simply add them up. Benefits and costs that occur at some time in the future are worth less to most people than are the same benefits and costs occurring today. Benefit-cost analysis accounts for this preference for present consumption.

- *Measuring and weighting criteria.* Public policy always has multiple objectives. When evaluating project alternatives the goal is not to maximize on one criterion or objective, but rather to optimize on multiple criteria and objectives that often conflict. While alternatives can be compared *on* a given criterion (because all alternatives are measured in the same units so one can make statements like "Alternative B saved an estimated annual $100,000 in sewage treatment costs over alternative C, and $250,000 over Alternative A"), they cannot be compared *across* criteria if they are denominated in different units. Weighting is a procedure that can help decisionmakers move from multiple criteria and objectives to a ranking of alternatives. Unless one alternative dominates all others on every criterion, a judgment must be made about the relative importance of the impacts (i.e., what *weight* should each criterion be given in the decisionmaking?). There are two main questions that should be answered about weighting:

  - *When should weighting occur?* Obviously, weighting cannot occur until after criteria are developed. But once listed, should it occur immediately (even as part of the process that develops the criteria), or later, after some, most, or all measurement of the criteria have been completed? There are arguments for either timing. The strongest argument for early (ex ante) weighting is that participants in the weighting can be more objective because they do not yet know how their preferred alternatives will perform—they may not even have any preferred projects. The strongest argument for later (ex post) weighting is

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[2]This economic principle is intuitively explained by reference to a savings account at a bank with interest. Because $100 invested today might be worth $105 next year, $100 next year must be worth less than $100 today.

[3]The discount rate should reflect the opportunity cost of alternative uses of the money. Most often the opportunity cost of capital is viewed as the real rate of return on investments in the private sector. While the basic notion of opportunity cost is straightforward, the theory for selecting the appropriate discount rate gets complicated. Most economists who do research on discount rates recommend real discount rates between 2 percent and 7 percent. "Real" in this context means taking out the effects of inflation. A real discount rate of 5 percent combined with an expectation that the average rate of inflation will be 4 percent yields a "nominal" discount rate—the rate that a lender might quote—of about 9 percent.

more realistic: (1) it is hard to know how important a criterion should be without having some notion of how big are the effects that it comprises, and (2) decisionmakers do and must consider more than the things that lend themselves to measurement when they make their decisions about preferred alternatives.

- *How formal should the process be?* Should it be implicit (e.g., County staff and stakeholders look at measures of criteria performance, debate them, and then vote on the implementations that seem best without ever assigning weights to the criteria), informal (e.g., a discussion and single vote from stakeholders on the relative importance of each criteria), or formal (e.g., math-based techniques that try to trick-out underlying weights statistically)?

RECOMMENDATIONS FOR THIS PROJECT

This section first describes the three land use alternatives for the study area. It next describes the criteria used to evaluate the alternatives. It concludes with a discussion of the methods of analysis as they apply to the evaluation of the land use alternatives in the La Pine Study Area.

Description of Alternatives

The three alternatives proposed for the study area are based on different future land use development scenarios. The alternatives are not definitive, but rather serve to illustrate how impacts could differ under different policy packages. The alternatives may or may not cover the most likely futures of the County; they certainly do not cover every possible future for the County.

The three alternatives have been defined over the last few months by County staff and stakeholders with the assistance of the consultants. Consistent with the principles described in the previous section, each alternative is defined in two parts: (1) what are the initial changes that cause development patterns to differ across alternatives (typically, a change in public policy), and (2) after that initial policy change (or lack of it), how do the alternatives evolve to create different futures, with different impacts?

Alternative 1, Status Quo

Changes to Policy: None. Assume a continuation of current regulatory environment and market conditions.

Hypothesized (Most Likely) Future: Water quality will deteriorate to a level that approaches or exceeds DEQ standards, prompting the development of a groundwater management plan. Sewers will be required beyond that point, and possibly on existing developments to mitigate impacts. Drinking water treatment may be required to achieve standards. In the short run, infrastructure costs are lower and more development can occur in more places. In the long run, the State, with or without the aid of the County, may require measures that make development prohibitively expensive or procedurally impossible.

Alternative 2, Targeted Development Strategy

Changes to Policy: Zoning changed to limit rural development. Development rights are removed from environmentally sensitive lands (e.g., water quality, wildlife) and transferred to lands that are more suitable for development. Clustering of development encouraged.

Hypothesized (Most Likely) Future: Groundwater quality stabilizes and gradually improves. High mitigation costs associated with expanding capacity of existing sewage system and compensating landowners involved in the transfer of development rights. Limitations placed on private development through rezoning. Residential densities lower in areas not served by sewers and increase in areas with sewers.

Alternative 3, Local Development Strategy

Changes to Policy: Zoning changed to limit rural development. Strict on-site systems standards are adopted. Development still scattered, but less dense.

Hypothesized (Most Likely) Future: Groundwater quality stabilizes and gradually improves. High mitigation costs associated with expanding capacity of existing sewage system, building/expanding satellite sewage systems, and/or mandating retrofit to existing on-site waste water treatment systems. Limitations placed on private development through rezoning. Residential densities lower in areas not served by sewers and increase in areas with sewers.

At a meeting on 22 May stakeholders discussed variations on these alternatives and some new ones: most significantly (1) that environmentally sensitive areas (especially those with high groundwater or levels of nitrates) might get sewers and have higher, rather than lower, density; and (2) that areas not currently platted might get platted in the future in order to take advantage of scale economies for new sewers; and to allow development in other platted areas that are more environmentally sensitive to be reduced.

Thus, the final evaluation does not work just with the three alternatives, but expands to include other combinations of development consistent with the constraints and historic development patterns.

Description and Estimation of Evaluation Criteria

The criteria used to evaluate the three alternatives are measurable at different levels: some are quantifiable and monetizable (e.g., waste water treatment costs); some are quantifiable but not easily monetized factors (e.g., water quality levels); and some more qualitative and value-based (e.g., equity). The evaluation of the alternatives is, essentially, a description of the impacts of the alternatives. Thus, impacts and criteria are roughly synonymous: the criteria important to decisionmaking are usually the same as the impacts that decisionmakers are concerned about.

County staff and consultants developed preliminary evaluation criteria as follows:

- Undevelopable Lots
- Residential Density

- Sewers
- On-site Waste Disposal Systems
- Water Quality
- Wildlife
- Riparian and Wetland Habitat
- Wildfire
- Road and Access Improvements
- Zoning

My review of the criteria leads me to recommend combining them in understandable categories, and adding a category that does not exist. To simplify the presentation of the criteria to stakeholders and decisionmakers in Deschutes County, I recommended three main headings: *Built Environment, Natural Environment,* and *Social Environment.* There are obviously more ways than one to organize the criteria associated with the three alternatives, but this organization is probably as good as any, and better than most.

Table 1 illustrates the evaluation matrix. The columns in Table 1 are the alternatives; the rows are the criteria (impacts) by which the alternatives get evaluated.

Table 1: Description of Criteria for Alternatives

	Alternative 1	Alternative 2	Alternative 3
Built Environment			
Zoning			
Undeveloped Lots			
Residential Density			
Water Supply & Treatment			
Sewers			
On-site Waste Disposal			
Roads			
Natural Environment			
Water Quality			
Wildlife			
Wildfire Hazard			
Social Environment			
Distributional Issues			
Legal Issues			

Table 1 shows, in concept, how an evaluation would proceed: row by row, comparing the performance of each alternative on a given criterion. Where possible, a cell would be filled with the information (numbers or text) about the impacts of each alternative on that criterion. For several of the criteria, it may not be possible to describe the impact within the framework of the matrix (e.g., what impact do the alternatives have on issues of equity?).

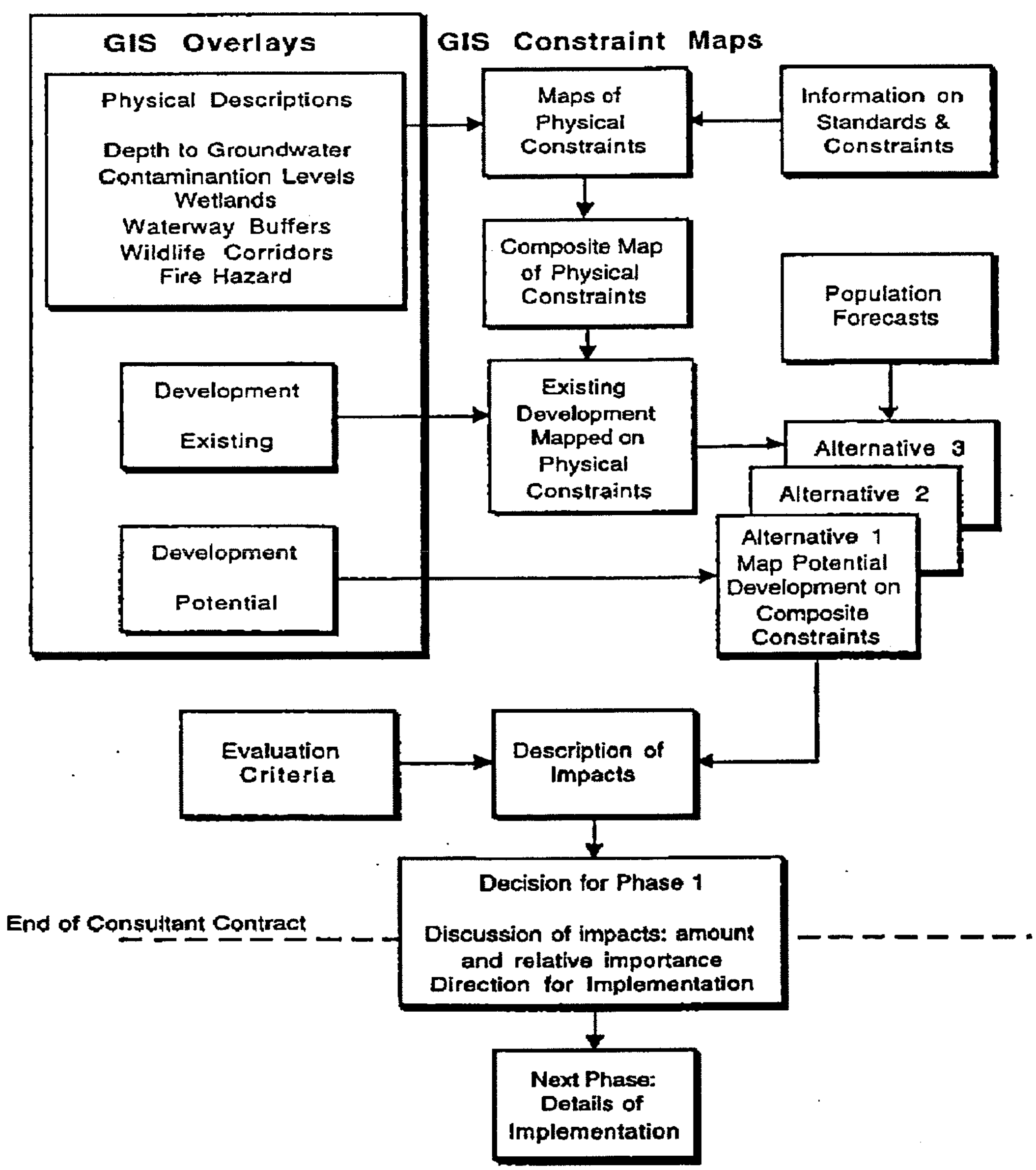
Nonetheless, it is important that the evaluation account for the most significant impacts, including those that do not easily lend themselves to quantification.

Methods for Evaluation

While the method described is correct in concept, the ability to implement it is limited in practice by available data, budget, schedule, the size of the study area, and the potential number of alternatives. The methods described below try to be true to the principles described so far, while responding to these constraints.

Figure 1 provides an overview of the method proposed for evaluating the three land use alternatives.

Figure 1: Overview of Methods



The analysis combines GIS maps, information on existing and potential development, populations forecasts, and evaluation criteria to produce a description of the likely impacts associated with each of the land use alternatives. The description of impacts, summarized in a simple matrix, will aid Deschutes County staff and stakeholders in developing and implementing a plan guiding growth and development in the study area.

In summary, the method is to (1) map constraints on development, (2) map existing development and platted parcels on top of those constraints, (3) based on forecasts of growth, estimate the amount and location of dwelling units under unconstrained and constrained conditions, thus bounding the amount of growth that might come to the study area, (4) describe other growth scenarios (the amount, location, and density of new development, and the assumptions about the type of waste disposal that development will have), and (5) describe the impacts of the scenarios. Details on those steps follow.

Mapping Constraints

GIS maps form the foundation for the evaluation of the alternatives. GIS overlays (coverages) will be used to inventory and document the study area's built environment (e.g., existing development) and natural environment (e.g., wildlife corridors, wetlands, etc.). Consultants have been asked to define both the minimum and desirable land areas that the best scientific evidence, adopted laws, or public policy suggest should be protected from development. In combination with the GIS physical description overlays, these "boundary" definitions provide the necessary information on standards and constraints needed to produce the maps of physical constraints shown at the top of Figure 1. From the individual maps of physical constraints, a composite map will be created to indicate where development is not possible or desirable.[4]

With constraints identified, we will look to see whether and where existing development is encroaching upon areas that cannot (or should not) support development for various physical reasons. To highlight areas of potential development conflicts and provide a base for the evaluation of the three land use alternatives, the GIS overlay of existing development will be integrated with the composite map of physical constraints.

Future Population and Development Patterns Under Different Alternatives

The next step is to make some reasonable assumptions about the pattern of development that might occur under the different alternatives. To this point, the methods I have described focus on the *supply* side: the land and its physical attributes that are a necessary component of the development process. But the amount of growth and its pattern is not determined by supply alone—it depends also on *demand*. In this study, we will approximate demand by forecasting population and housing growth for the study area, and then allocating that growth to subareas of the study area.

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[4]Planners and landscape architects many recognize this method as a computerized version of the type of analysis Ian McHarg pioneered 25 years ago in *Design with Nature*.

I will not go into detail on methods for forecasting population and their problems, which are always substantial. They loom particularly large in this project because Deschutes County is a relatively small, fast growing area, and because the ability of public policy to affect growth rates is substantial in the study area.

The problems are easily illustrated. I could (and have before) develop a forecasting model based on historic trends, weighted toward recent growth, and tied to forecasts of economic indicators. Assume, for the sake of this discussion, that such a model would show what most people suspect: Deschutes County is likely to keep growing. But it is "likely" only because we implicitly assume that all the factors that contribute to and allow that growth are also likely to behave in the future as they have in the past. In the study area, we have a non-trivial possibility that such an assumption is false for one necessary ingredient for development: drinkable water.

The evidence suggests that the quality of water is deteriorating. An incremental decrease in water quality is probably not enough to stop or significantly curb growth based on market response alone. But now public policy comes into play, and the future is unlikely to be like the past. The state DEQ may force the County, or the County may decide on its own, to restrict development. Assume it does so in a manner that is upheld in the courts as a legitimate exercise of police power for public health and safety. Then the subarea will grow less. Other parts of the County may grow more than they would have, or perhaps the growth spills to adjacent counties.

The point is that population forecasts do not come from the mountain with the dictum that they be obeyed. Population is not a given that all public policy must then accommodate. Rather, there are tendencies for population growth given the market, socioeconomic and demographic characteristics, and public policy. If public policy shifts in a significant way, it is not unreasonable to expect population shifts as well. Thus, population forecasts must be made and interpreted simultaneously with public policy.

Given that position, what are the implications for this project? I recommended that we start with and take as given the official County forecast at the County level, and the allocation to the first level below the County to the specific City UGBs, and to the rest of the County.[5]

Thus, the task for this project is to make a reasonable estimate, under different development scenarios, of (1) the share of the "rest of County" population growth that will go to the study area, (2) how that share should get sub-allocated to different parts of the study area, and (3) what that allocation implies about the amount of new housing development.

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[5] I say this even though I am aware that the methods for making such subarea allocations are not particularly rigorous. In Deschutes County, as I understand it, the population forecast for areas outside of Urban Growth Boundaries was what was left of the total County forecast after the urban areas had determined what population they wanted to accommodate. By coincidence, the non-urban County growth for the next 20–25 years can roughly be accommodated on the amount of vacant land zoned for residential uses in the non-urban parts of the County. Thus, the method for forecasting for non-urban areas approximates a supply-side, build-out kind of forecast.

Consistent with the points above, we attempt to make the allocations based on (1) where growth *has* gone, and (2) how physical constraints, market conditions, and public policy might affect where it can go in the future. For physical constraints, we have the composite constraints map described above. For market conditions (and where growth *has* gone), we have a database that shows amount of development by subarea from 1988 forward. For public policy, we are talking primarily about constraints on location and density of development in response to actual or potential water quality problems (primarily).

Here are the specific steps:[6]

- ECO works with County staff to assemble and then review population and housing data and forecasts.
- KCM prepares (1) the composite constraint map, with parcels (distinguishing between developed and vacant); and (2) a database showing, by subdivision within the study area: total lots, vacant lots, average acreage of developed lots, number of new units by year since 1988 floodplains, depth to groundwater, nitrate hot spots, and any other relevant data.
- ECO forecasts study area population without constraints, and then scales back as appropriate based on analysis of constraint map. Analysis includes adjustments as necessary for vacant/second homes. ECO allocates to subareas by reviewing, at the section level (one square mile), constraints, recent growth, the capacity for further land division (according to Deschutes County staff, there is the potential for only about 800 new lots to be created by land division *in the entire County*).
- KCM maps the allocations under the different scenarios.

The results of this effort are maps and tables showing our assumptions about where development will occur under the different scenarios, and the assumptions about waste disposal systems consistent with those development patterns.

Estimating Impacts

Table 1 shows the impacts we would like to be able to describe. The general methods are easy to describe in concept, but measuring the impacts in an accurate, reliable manner that allows for comparison across different units is not an easy task. Moreover, some impacts do not lend themselves easily to quantification. In view of budget and schedule constraints and the inherent difficulties associated with more formal approaches, for this project I recommend something less than a formal benefit-cost analysis, but more rigorous than what sometimes passes for analysis in Environmental Impact Statements.

Consistent with my advice to *Compare complete alternatives*, in a previous version of the memorandum I recommended that we hold population constant across alternatives, and that we try to hold drinking water quality constant across alternatives. After the discussion at the stakeholder meeting on May 22, and further discussion with County staff about data

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[6]More details are contained in another technical memorandum from ECO, Population Forecasts and Development Allocation for the Study Area.

and the purposes of the evaluation (long run and short run), I amend that recommendation.

The change is consistent with the use of scenarios described above. It will be impossible to construct scenarios as described and to also hold population constant. Some of the scenarios constrain growth because of a lack of sewer capacity to deal with groundwater problems; others assume that sewer capacity is provided. Moreover, it became clear that the stakeholders and the County did not intend to make a decision in June about a single alternative to pursue—rather, they wanted an illustration of a range of alternatives and information and tools that would allow them to evaluate yet other options that would certainly emerge after June.

Thus, we will focus on the implications of different development scenarios for the type and cost of effluent treatment. More detail on the scenarios and the reasons for focusing on effluent treatment is contained in a separate technical memorandum, Population Forecast and development Allocation for the Study Area.

APPENDIX E

Population Forecast and Developmenmt Allocation
for the Study Area Technical Memorandum
(Terry Moore, Bob Parker; ECONorthwest; July 10, 1997)

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10 July 1997

TO: D.J. Heffernan, KCM
FROM: Terry Moore and Bob Parker
RE: POPULATION FORECAST AND DEVELOPMENT ALLOCATION FOR THE STUDY AREA

BACKGROUND

This memorandum forecasts population and housing for the La Pine Study Area of Southern Deschutes County.[1] The method for forecasting aggregate population and allocating it to subareas of the Study Area is described in ECO's technical memorandum of 12 May to the Deschutes County staff and the consulting team members.

DATA SOURCES AND METHODS

A population allocation such as this one would consider both supply and demand issues. As noted in ECO's memo of 12 May, the County's forecasting work focuses on the supply side, allocating population based on vacant lots. For this analysis we shift to focus more on the demand side. Focusing on demand requires some assumptions about supply. We assume (temporarily) that the amount of developable land (as measured in platted lots) does not present a supply constraint, and that there are no significant natural constraints that would reduce the current supply of lots. Although the existence of such constraints is likely–even probable–those constraints will be introduced during a later step.

We used several data sources for this analysis. These include:

- Draft Deschutes County Coordinated Population Forecast.
- Population and housing unit projections from the Deschutes County TSP.
- Building permit data (new housing construction) for the County and the Study Area.
- Subdivision data (provided to KCM by the County) that show for all subdivisions in the Study Area including the number of lots, the number of developed and vacant lots, and the number of new housing units added between 1988 and 1996.
- Exceptions area data that includes all lots zoned MUA-10 and RR-10 in the County and selected subareas of the county.

The analysis relies on the Deschutes County Coordinated Population Forecast, and its allocation to the first level below the County–City UGBs and the rest of the County. As described in the 12 May memo, we take these figures as given. Thus, the main purpose of this analysis is to make a reasonable estimate, under different development scenarios, of (1) the share of the aggregate forecasted non-

[1]The definition of the Study Area is, generally, all developed and platted land from (and including) Sun River on the north to about three miles south of La Pine on the south. The definition may change slightly depending on how the data are available.

urban County population growth that will go to the Study Area, and (2) how that share should get sub-allocated to different parts of the Study Area.

Our initial allocation to the Study Area is consistent with the development patterns assumed for Alternative 1. We assume that the amount of population allocated to the Study Area will be the same for Alternatives 2 and 3. This assumption is consistent with the methods described in the 12 May memo, which include holding some key variables (e.g., population and housing units) constant so that we have a way of evaluating the impacts of different development alternatives.

The Study Area forecast of units must then be allocated to subareas of the Study Area. We used data at the Section-level (one square mile) to make these allocations. In making the allocations we considered both demand-side variables (e.g., trends in building permits by Section) and supply-side variables (e.g., constraints on development because of flood plains or groundwater quality problems). The details of the subarea allocation are described in more detail in the final section of this memorandum.

ALLOCATING A SHARE OF COUNTY GROWTH TO THE STUDY AREA

Table 1 shows the Deschutes County Coordinated Population Forecast. The County expects to grow at an average annual rate of 2.7% between 1995 and 2020. The County's population will nearly double during this period, adding more than 88,000 new residents. A key trend evidenced in the population forecasts is that the *rate* of growth is expected to decrease between 1995 and 2020. For example, the five-year increase between 1995 and 2000 is expected to be 20.3%; that rate is expected to decline to 8.6% during the five-year period between 2015 and 2020.

Cities are expected to grow at a faster rate than unincorporated (non-urban) areas. In 1995, estimates for the Center for Population Research and Census placed the total population of Deschutes County at 94,100. Of this total, 53,250 lived within UGBs–about 57% of the County's population. The County forecasts anticipate that this will shift slightly and that a higher percentage of population increases will occur within UGBs: more than 60% of the population growth between 1995 and 2020 is expected to occur within the UGBs of Bend, Redmond, and Sisters.

The unincorporated (non-urban) areas of the County are expected to grow by about 35,000 people between 1995 and 2020, a rate of about 2.5% per year.

In general, the shift toward a higher percentage of growth inside UGBs seems reasonable. Public policy constrains the creation of new lots outside UGBs, and encourages growth inside UGBs. Moreover, a combination of environmental impacts and increasing development costs to deal with those impacts is likely to make non-urban residential development more expensive.

For the purpose of this study, we are using a 20-year planning period. Thus, for the non-urban part of the County, the official County forecast is for growth of 29,372 people between 1995 and 2015. We round this, and move forward with a population increase of 30,000 people in the non-urban parts of the County in the next 20 years.

Table 1: Deschutes County Coordinated Population Forecast 1990-2010

	Urban			Non-Urban County			Total County Population		
Year	July 1st Population	Five Year Increase	% Change	July 1st Population	Five Year Increase	% Change	July 1st Population	Five Year Increase	% Change
1990	42,085	-	-	32,873	-		74,958	-	
1995	53,250	11,165	26.5%	40,850	7,977	24.3%	94,100	19,142	25.5%
2000	64,948	11,698	22.0%	48,283	7,433	18.2%	113,231	19,131	20.3%
2005	75,857	10,909	16.8%	56,382	8,099	16.8%	132,239	19,008	16.8%
2010	87,578	11,721	15.5%	63,853	7,471	13.3%	151,431	19,192	14.5%
2015	97,689	10,111	11.5%	70,222	6,369	10.0%	167,911	16,480	10.9%
2020	106,331	8,642	8.8%	76,022	5,800	8.3%	182,353	14,442	8.6%
1995-2020 % Increase	100%	53,081		86%	35,172		94%	88,253	
1995-2020 AAGR[1]	2.8%			2.5%			2.7%		

Source: *Draft Coordinated Population Projections,* Deschutes County Planning Department, November 1996.

[1] AAGR–Average Annual Growth Rate

The relationship between population and housing is an important one for this analysis. Deschutes County has a high percentage of seasonal/vacation homes. Thus, we would expect to see a higher number of units built that would be needed to accommodate the forecasted population.

Table 2 provides a summary of selected Census variables for Deschutes County and La Pine Area Census Tracts (Tracts 9904 and 9905, which include the Three Rivers and Deschutes Woods Census Defined Places). Although the La Pine Area Tracts do not provide an exact match with the Study Area boundaries, they are an adequate approximation.

The data indicate that in 1990, the La Pine Area Tracts accounted for about 17% of the County's housing units, but only 10% of the County's population, illustrating the impact of second homes in the Study Area. The Census data also demonstrate the large number of vacant units in this area of the County: nearly 50% of the vacant housing units in the County are within these two Tracts. Of the 3,257 vacant housing units in these two Tracts, 2,279 (70%) are considered seasonal or recreational units. Overall, nearly 37% of all housing units in these two Tracts are seasonal or recreational units.

Vacancy status and other characteristics of vacant units were determined by enumerators obtaining information from landlords, owners, neighbors, rental agents, and others. The Census considers a housing unit as occupied if it is the usual place of residence of the person or group of persons living in it at the time of enumeration, or if the occupants are only temporarily absent; that is, away on vacation or business. If all the persons staying in the unit at the time of the census have their usual place of residence elsewhere, the unit is classified as vacant. Vacant units are subdivided according to their housing market classification, as shown in Table 2. A subset of Vacant is " Units for Seasonal, Recreational, or Occasional Use," which are vacant units used or intended for use only in certain seasons or for weekend or other occasional use throughout the year. Seasonal units include those used for summer or winter sports or recreation, such as beach cottages and hunting cabins. Seasonal units also may include quarters for such workers as herders and loggers. Interval ownership units, sometimes called shared-ownership or time-sharing condominiums, also are included here. Vacant mobile homes are included provided they are intended for occupancy on the site where they stand.

Given these U.S. Census definitions, Table 2 gives a reasonable good estimate of total and seasonal housing units in the County and in the Study Area.

Table 2: Summary of Selected Census Variables for Deschutes County, and La Pine Area Tracts, 1990

Variable	Deschutes County	La Pine Area Tracts			La Pine % of County
		Tract 9904	Tract 9905	Total	
Persons	74,958	3,564	3,913	7,477	10.0%
Households	29,217	1,422	1,536	2,958	10.1%
Persons Per Household	2.54	2.50	2.55	2.53	-
Housing Units	35,928	2,427	3,788	6,215	17.3%
Occupancy Status					
Occupied	29,217	1,422	1,536	2,958	10.1%
Owner Occupied	20,734	1,176	1,264	2,440	11.8%
Renter Occupied	8,483	246	272	518	6.1%
Vacant	6,711	1,005	2,252	3,257	48.5%
For Rent	895	11	543	554	61.9%
For Sale	381	47	95	142	37.3%
Rented or Sold-Not Occupied	320	10	48	58	18.1%
Seasonal/Recreational	4,492	889	1,390	2,279	50.7%
Migrant Workers	6	1	1	2	33.3%
Other	617	47	175	222	36.0%

Source: U.S. Census, STF 1A, 1990.

Table 3 provides a summary of lots zoned MUA-10 or RR-10 in Deschutes County exception areas in 1995. The data show that the County had nearly 24,000 lots, of which about 13,000 (55%) were developed. The Study Area includes about 59% of all the County's vacant lots (about 6,344 vacant lots) in these zoning classifications in rural exceptions areas.[1] The percentage of the County's total vacant lots outside UGBs that are located in the Study Area is probably higher.

[1] A recent evaluation by the County corroborates the range of the vacant lot data (Deschutes County Community Development Department, July 11, 1997). Within the project area for all zones (including EFU, Forest and Sunriver) the County has estimated there exists a combined total of 8,924 vacant and unbuildable lots. For the purposes of the study, however, regional problem solving analysis and modeling only includes residentially zoned (RR10, RSC, LPRD, WJCRD) vacant and unbuildable lots. The combined total estimate of residentially zoned vacant and unbuildable lots is approximately 6,446. The estimates in Table 3 are from a different source and are useful for relative comparisons, but not for estimating the absolute number of vacant lots.

Table 3: Summary of Platted Lots in Exception Areas in Deschutes County and Study Area, 1995[a]

Area	Total Lots	Total Developed Lots	Total Vacant Lots	% Vacant Lots by Area
Study Area				
La Pine North	6,234	3,457	2,777	44.5%
Sunriver South	5,052	1,485	3,567	70.6%
Study Area Total	11,286	4,942	6,344	56.2%
Rest of County	12,709	8,239	4,470	35.2%
Total	23,995	13,181	10,814	45.1%

Source: Deschutes County Planning Department, Exception Area Land Use Inventory, February 10, 1995.

[a]Lots zoned MUA10 or RR10 only. Other types of vacant lots exist in the Study Area.

Table 4 presents an estimate of needed housing units in Deschutes County unincorporated areas by 2016. The estimate, which was developed for the County's Transportation System Plan uses data for unincorporated areas of the County, which differ slightly from County totals. We present it here in part for purposes of comparison, and in part because it is explicit about the more disaggregated methods it uses to get to a population forecast. The estimate assumes an average annual household size of 2.65 (which is higher than the 1990 Census estimates for either the County or the Study area presented in Table 2), and a vacancy rate of 26% (which is lower than vacancy rates for the Study Area: 52% of total housing units are vacant; 37% are vacant because they are seasonal/recreational units).

Table 4: Estimated Needed Housing Units for Unincorporated Deschutes County, 1990-2016

Jurisdiction	Unincorporated Area (Exceptions Areas)	County Total
1990 Population	32,865	74,958
1995 Population	40,850	94,100
Projected 2016 Population	71,168	172,427
2016 Additional Population Since 1995 (Pop)	30,318	78,357
1990 Persons Per Housing Units (PPHU)	2.65	2.57
2016 Additional Units Needed (Pop/PPHU)	11,411	30,489
Additional Units to Allow for Vacancy	4,009[a]	7,152[a]
Total Units	15,420[a]	37,641[a]

Source: Deschutes County Transportation System Plan, Deschutes County, 1996, Tables 3.2.1 to 3.2.6.

[a]Recalculated by ECO.

Table 5 shows two different but related measures of housing development in the County and Study Area: building permits, and assessor's records (which show the year a structure was built). For each, Table 5 shows the ratio of development in the Study Area to development in the entire County (including cities).

Table 5: New Housing Units in Deschutes County, and the La Pine Study Area, 1988-1996

	Based on Building Permits			Based on Year Built		
Year	Deschutes County	Study Area.	Study Area as % of County	Deschutes County	Study Area	Study Area % of County
1988	747	329	44.0%	NA	NA	NA
1989	1,057	335	31.6%	NA	NA	NA
1990	1,042	402	38.6%	1,847	366	19.8%
1991	1,075	369	34.3%	1,093	273	25.0%
1992	1,553	366	23.6%	1,626	401	24.7%
1993	1,742	383	22.0%	1,746	311	24.5%
1994	1,763	345	19.6%	1,840	305	17.8%
1995	1,389	360	25.9%	1,704	317	18.6%
1996	NA	–	NA	1,170	404[a]	34.5%
Total	10,368	2,889	27.9%	11,026	2,377	21.6%

Source: Data on Building Permits from Deschutes County GIS, 1996. Data on Year Built from Deschutes County Assessor's Office, May 6, 1997.

a Half-year total doubled to estimate full year

There are several defensible method for allocating population and housing units to the Study Area. Any approach, however, must use some assumptions regarding the relationship between population, housing units, vacancy, and rate of development. The allocation could start with population or housing units. Given the high number of seasonal units and the fact that the highest levels of resource impacts would be expected during peak use periods, the housing unit is the approach.

Earlier in this memorandum, we concluded that we would use about 30,000 people as the amount of growth in the nonurban parts of the County. Later we discussed how that population gets converted to housing units: dividing by persons per unit and multiplying by vacancy. The TSP estimated a need for about 15,000 housing units to accommodate the 30,000 people. Now the question is, what share of those 15,000 dwelling units are likely to be provided in the Study Area?

Table 6 summarizes the data presented so far in a way that facilitates determining a percentage of a larger population to allocate to the Study Area. The last two columns show the Study Area as a percent of the total County, or the unincorporated part of the County.

Table 6: Summary of Housing Relationships, Study Area to County

	County		Study Area		
				% of County	
	Total	Unincor-porated	Study Area[a]	Total County	Unincor-porated County
Exception Lots, Total (96)[b]	23,995	23,995	11,286	47.0	47.0
Exception Lots, Vacant (96)[b]	10,814	10,814	6,344	58.7	58.7
Building Permits (88-95)	10,368		2,889	27.9	
New Units (Assessor, 90-96)	11,026		2,377	21.6	
Housing Units (1990)					
Total	35,928		6,215	17.3	
Occupied	29,217		2,958	10.1	

Source: Previous tables in this memorandum

[a]Study area boundaries vary depending on data source.

[b]Exception lots are MUA10 and RR10, which do not include all vacant lots in the Study Area.

The range for the allocation is substantial, but it can be narrowed:

- Σ Allocating on the basis of occupied housing units (10.1%) would substantially underestimate growth in the Study Area. Table 2 shows that about 38% (2,279 / 6,215) of the housing units in the Study Area are "Seasonal/Recreational," compared to about 13% (4,492 / 35,928) for the County as a whole. The main reason is that the County totals include all the urban areas, which have a relatively small proportion of seasonal and recreational units.
- Σ Allocation on the basis of total housing units in 1990 also would probably underestimate growth in the Study Area: it should be treated as a lower bound. Table 1 shows that the forecasted population growth rates for the County and for the Non-Urban County over the next 20 years are roughly the same. If the Study area got just it proportional share of the non-urban growth, then this rate (17.3%) might be appropriate.
- Σ But other data suggest that the Study Area will get a disproportionately large percentage of non-urban growth: it has almost 60% of the vacant exception lots, and probably a greater

percentage of vacant residential lots of all types. Moreover, actual growth over the last 10 years has average around 350 housing units per year. In total, the Study Area had almost 9,446, vacant lots in 1996.

These data all support using recent growth rates as a means of allocating County population to the Study Area. For building permits and newly built housing units, the Study Area has averaged around 25% of County totals over the last seven to eight years. As an example, if the Study Area were to capture about 25% of total County growth over the next 20 years, that would be about 8,250 units (about 74,000 more people at an average of 2.5 persons per household and an assumed vacancy rate of 10% yields almost 33,000 more units in the entire County), which would be about 55% of the 15,000 units forecasted for the non-urban part of the County. On the supply side, this seems about the right proportion (assuming no other constraints), since the Study Area has almost 60% of the vacant exception-area lots in MUA-10 and RR-10 zones in the County, and probably a higher proportion of all non-urban vacant lots.[1]

Another way to simulate growth is to look at the average number of permits or new units built in recent years. Table 5 shows the numbers: an average of 340 to 360 new units per year in the Study Area, depending on how they are measured. If that average were to continue over a 20-year period, that would mean about 7,000 new dwelling units.

These simulations illustrate a problem somewhere, most likely with the assumption that the population growth in the non-urban parts of the County will be as great as is forecasted in Table 1. Table 1 uses historic growth (with slight downward adjustments) for forecasting. But the supply of vacant exception-area lots is unlikely to be increased in any substantial way, and will certainly decrease as vacant lots are converted to developed lots. This also leaves an increasing proportion of vacant lots with some types of development constraint (as other parts of the analysis for this project demonstrate, many of the vacant lots are constrained by flooding or groundwater problems). The Study Area has about 9,400 vacant parcels. Under the allocations just described, between 75% and 88% of those lots would have to be buildable and built on over the next 20 years.

We evaluate the supply-side constraints in more detail in the next section. They suggest that getting development on 75% of all vacant lots at currently zoned densities is unlikely. For now, we provisionally accept as a target 6,000 to 8,000 new housing units for the Study Area over the next 20 years (the amount of growth that historic growth rates and demand forecasts suggest could locate in the Study Area over the next 20 years if constraints on vacant land did not increase significantly). In the next section we evaluate whether these units might be allocated to subareas of the Study Area under the different development alternatives, given development constraints, and, if so, how.

ALLOCATING STUDY AREA GROWTH TO SUBAREAS OF THE STUDY AREA

Other consultants on the study team looked at various attributes of land in the Study Area that might constrain growth. Among the constraints are flooding, high groundwater, nitrate hot spots (groundwater pollution from septic tanks), wildlife migration corridors, and fire risk. For the purpose of this analysis we focused on the first three. We believe we can ignore wildlife migration and fire hazard at this level of analysis because:

- Wildlife migration occurs throughout the study area. Under most development scenarios the number of subdivisions is not increased, so pathways around platted subdivisions will continue to exist. Moreover, because a likely response to the problem of groundwater contamination will be requirements for larger lot sizes, there will be possibility for migration

[1]We do not have an estimate of total, non-urban, vacant lots in the County to be able to make this estimate.

through some subdivisions.[1] Those possibilities could be increased by planning that consolidated some of the density so that the same average density was maintained, while at the same time wildlife corridors were created through subdivisions.

- Fire risk is a function of density and roads for evacuation. Other things equal, fire risk is reduced if there are fewer people and less personal property overall, and if whatever people and property do exist are clustered so that more housing units can be protected for a given amount of fire-fighting equipment and personnel. We do not use fire risk as a constraint on allocating dwelling units. In the subsequent evaluation, however, we will describe how the alternative development patterns may differ on this variable.

Thus, we focus on three constraints when allocating dwelling units to subareas of the Study Area:

Σ Flooding. We used the mapped flood plains as an overlay on platted lots. Where subdivisions had lots in the flood plain, we reduced development potential.

Σ High ground water. There is a correlation between flood plains and high ground water, but high groundwater (two feet or less from the surface) also occurs outside of flood plains. High groundwater usually means that septic system for wastewater are not possible and that permits will be denied. On that basis, we limited development in high groundwater areas that were not sewered. High groundwater may also mean that any development that does occur will cost more and have greater environmental impact.

Σ Poor water quality. The County and DEQ have documented the increasing level of nitrates in well water, primarily the result of increasing development on septic systems. They have mapped "nitrate hot spots" where the level of nitrates is approaching the maximum allowable DEQ standards. Based on analysis by engineers on the consultant team, we assumed that, in the absence of sewers, to keep water quality within the DEQ standards the average lot size in a square mile should be 2.5 acres for traditional septic systems; 1.5 acres for sand filter systems, and 1.0 acres for advanced sand filter systems. We note here, and discuss more later, that nitrate problems do not limit development if sewers are available.

To conduct the analysis we aggregated from parcel-level to sections (which are land divisions of approximately one-square mile used by the assessor). There are 74 sections in the Study Area that contain platted lots. We display some information on development at the section level. For analysis, however, we aggregated the 74 sections into 17 roughly homogeneous subareas of contiguous sections.

To define those subareas, we looked at several development characteristics including: subdivision and special district boundaries (e.g., all of Sunriver is together: it consists of eight sections that have platted lots); physical constraints (e.g., areas with high groundwater or nitrate hot spots, or with building permit denials); ability to connect to an existing sewer system (e.g., in La Pine); and recent development activity (e.g., areas with a high absolute or relative amount of building permits).

We then simulated the development that could occur under different assumptions. The results of those simulations, and the assumptions we used to make them, are described in detail in maps and spreadsheets that are part of the final report. In summary, the scenarios are:

Σ Minimum Constraints. Most lots are allowed to develop, with the overall rate of growth similar to that which has occurred over the last 10 years. Where evidence of high permit denials or very high nitrate levels exist, some percentage of lots are assumed undevelopable without sewers or larger lot sizes, either of which reduces the effective supply of vacant lots.

[1]If new policies, however, make large changes to minimum lot size (e.g., requiring minimums of 20 acres), then adjustments will have to be made to development potential.

- Σ Constrained Growth; No New Sewers. In these scenarios we reduce the number of vacant lots based on a more detailed analysis of constraints imposed by floodplains, depth of groundwater, and levels of nitrates.
- Σ Constrained Growth, New Sewers. The same constraints apply as in the previous class of scenarios, but wherever new sewers are added the constraints do not apply: all vacant land lots in sewered areas are allocated new growth, subject to any limits implied by historic growth rates. Development in sewered subareas, however, would never exceed the number of platted vacant lots.

APPENDIX F

Valuation of Water Quality Technical Memorandum
(Terry Moore; ECONorthwest; July 10, 1997)

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10 July 1997

TO: Deschutes County Staff and Stakeholders
FROM Terry Moore
SUBJECT: VALUATION OF WATER QUALITY

INTRODUCTION

There is evidence to suggest that the quality of drinking water in the LaPine study area is deteriorating because of effluent from septic systems. A major impetus for the Deschutes County Regional Problem Solving Project is a growing concern that DEQ water quality standards are being approached and likely to be exceeded in the near future.

An evaluation of the effect of land use patterns and residential growth on water quality in the study area is difficult because the physical pathways by which effluent discharge accumulates in groundwater is difficult to model. For some parts of the study area, nitrate levels have been measured close to or in excess of DEQ standards. For other parts, DEQ modeling suggests that even without any new development, discharge from existing residences will cause standards to be exceeded in five or ten years. The direct costs of a policy that is intended to prevent or reduce degradation of water quality (e.g., installation of sewers, retrofit to existing water treatment systems) are readily estimated. The benefits of improved water quality, however, are more difficult to define and estimate. Many of the benefits derived from improved water quality are environmental services (e.g., recreational fishing and boating, aesthetics associated with proximity to bodies of water) that are not commonly priced and traded in conventional markets. Valuation techniques that do not rely on market techniques need to be used to estimate these benefits.

The purpose of this technical memorandum is to provide background information relating to the economic value of water quality. The first section summarizes available approaches and methods for valuing water and water-related resources. The next section discusses issues associated with applying values estimated in one area to another area. The final section provides a summary of results from selected studies that have valued the benefits of improved water quality.

BACKGROUND ON NONMARKET VALUATION

Nonmarket valuation refers to a set of techniques used to assess the economic value of goods and services not commonly priced and traded in markets. Twenty years ago, the professional literature on nonmarket valuation was scarce and theoretical. Since then its empirical applications have multiplied many times. These techniques and their results are moving out from academic research to natural resource management programs, the courts, and the general public. While nonmarket valuation can play an important role, there are both theoretical and practical limitations.

The array of goods and services provided by clean water spans a variety of categories of values (see Table 1). The values placed by society on environmental goods and services, such as those associated with clean water, are characterized by economists as *use value* (the environmental resource is used directly or indirectly by individuals) and *nonuse value* (individuals place a value on the current or potential existence of the environmental resource even though they may not directly or indirectly use the resource). Direct use values for clean water include, for example, consumptive services such as irrigation and drinking water and recreational uses such as swimming and fishing. Indirect use values, where the water resources indirectly contribute to the well-being of an individual, include aesthetic values, ecosystem values, and property value enhancement. Nonuse values (e.g., the desire to preserve clean water for future generations) are less tangible and tend to reflect the more subjective preferences individuals have about water resources (Crutchfield et al. 1995).

Table 1: Values Associated With Clean Water

Value	Definition	Examples
Use Value		
Direct	The contribution of an environmental good or service to current production or consumption.	Recreational uses, such as swimming, boating, and fishing. Consumptive uses, such as drinking water and irrigation. Commercial uses such as fisheries.
Indirect	The functional services the environment provides that support current and future production and consumption.	Aesthetics values associated with near water recreation (e.g., picnicking and sightseeing) and property value enhancement. Ecosystem values, such as promotion of genetic diversity and protection of wildlife habitat.
Nonuse Value		
Option	The value individuals place on the potential for a future use of a resource (willingness to pay today for option to exercise future use of an environmental good or service).	The desire to preserve the opportunity to enjoy clean water at some time in the future.
Bequest	The present generation's preference for leaving environmental and natural resources for the use and enjoyment of future generations.	The desire to improve water quality for future generations.
Existence	The value placed on the mere existence of a resource, independent of any current or future *in situ* use of the resource.	The satisfaction derived from knowing that clean water exists.

Some, perhaps most, of the goods and services described in Table 1 do not have economic values that are fully captured in market prices. For example, commercial fish harvests have a direct-use value reflected by market prices. Recreational fishing may also have a direct-use value, but minimal or nonexistent fees markets do not always accurately reflect this value. Nonuse values (option, bequest, and existence) have no discernible link to market behavior. *Missing or incomplete market values do not imply the absence of economic value.* Specialized techniques must be used to assess these values in a manner commensurate with more conventional commodities.

Over the last several decades economists have developed and refined techniques for assessing the economic value of nonmarket goods and services.[1] These techniques are of two types. *Indirect techniques* rely on observed behavior to infer values. *Direct techniques* use a variety of survey-based techniques to directly elicit preferences for nonmarket goods and services. Both types of techniques share a common foundation in welfare economics where measures of willingness-to-pay and willingness-to-accept compensation are taken as the basic data for individual benefits and costs.

Economists currently focus on the willingness of an individual or of society as a whole to pay for an increase in services from a particular environmental resource. Willingness-to-pay measures are equivalent to an individual's *total benefits* from an environmental change. If this measure of total benefits is varied across a measure of quantity or quality, then a marginal benefits (i.e., demand) curve can be estimated. A common distinction is between total and net willingness to pay, with any expenditures or costs (e.g., entrance fee to a recreation site) netted out of the latter. Net willingness to pay is what economists refer to as *consumer surplus*, a kind of profit for the consumer—the value derived from an environmental asset over and above what the consumer had to pay to use it.

Indirect Techniques for Valuing Water and Water-Related Resources

Indirect approaches, sometimes referred to as *revealed preference* approaches, rely on observed behavior to infer values.[2] These approaches examine the choices individuals make when using or consuming water and water-related resources to obtain a measure of how these services are valued. The indirect approaches can be used only to assess use values. In this section, we briefly discuss two indirect approaches: the travel-cost method and the hedonic-pricing method.

A commonly used indirect approach to valuing changes in water quality is the travel cost method, where individuals' expenditures to enjoy recreational uses of water at a given site (as influenced by changes in water quality) are used to value those uses (Crutchfield et al. 1995). The travel-cost method encompasses a variety of models developed for differing purposes, ranging from the simple single site travel cost model, to regional and generalized models that incorporate quality indices and account for substitution across sites. In short, the models assume that the distance a person is willing to travel (and, by extension, the cost he or she is willing to incur to make that travel) is correlated to the value of the activity that the person is traveling to.

[1] These techniques are surveyed in the various chapters of Braden and Kolstad (1991), Freeman (1993) and the interpretive essay by Smith (1993).

[2] Recent summaries of the indirect approaches can be found Mendelsohn (1993), Palmquist (1993), Peterson et al. (1992), and Smith (1993).

The hedonic-pricing method attempts to decompose the value of market goods, say recreational real estate adjacent to a river or lake, to extract embedded values for environmental goods and services. Hedonic-pricing method encompasses both land price and wage models that account for variations due to environmental attributes (e.g., water quality, aesthetics, environmental hazards). As an example, the hedonic-pricing method could be applied to housing prices in an attempt to estimate the value of environmental attributes, such as proximity to wetlands, or river access, which vary across a region. The method assumes that variations in price can be linked to real or perceived variations in these environmental attributes once a variety of other determinants of price are controlled. The approach typically involves collection of cross-sectional data on sales price (or assessed value) and information on many other likely determinants of value (site and neighborhood characteristics, square footage, number of bedrooms, etc.). These factors would include one or more indices of environmental attributes or services. Then, through multivariate econometric techniques, the marginal value of either positive or negative environmental externalities can be inferred. For example, it might be found that the average homeowner in a particular county would pay $10 per meter to be closer to an open-water wetland, and would require payment of $20 per meter to move closer to a smoke-producing factory.

Applications of hedonic-pricing method are limited to use values and work best where there is some identifiable spatial distribution of value. Continued improvements in data collection and retrieval (e.g., geographic information systems) will improve the efficacy and precision of future hedonic-pricing method applications to environmental services.

Direct Techniques for Valuing Water and Water-Related Resources

Direct techniques for valuing water quality benefits include a variety of survey-based techniques to elicit *stated preferences*. The hypothetical nature of these experiments requires that some sort of hypothetical market be developed to convey a set of changes to be valued. While there are also a number of variants on these constructed markets, the most common is the contingent valuation method.[3]

In essence, the contingent valuation method is a "structured conversation." It begins with a description of some set of baseline conditions. Then statements of willingness to pay or willingness to accept are elicited in response to proposed changes in one or more elements of the set. For example, individuals might be asked for their willingness to pay for an incremental improvement in drinking water quality. These questions can be asked in-person, by phone, or by mail.

Contingent valuation method can be applied to both use and nonuse values. The inherent flexibility of constructing hypothetical markets accounts for much of the popularity of the technique. There are, however, numerous methodological issues associated with

[3]Numerous applications and discussions of contingent valuation method exist, with rapid growth in the last decade. One bibliography catalogues more than a 1400 citations (Carson et al. 1993). Common applications include measuring the benefits of outdoor recreation for water resources and forest planning. Much of the recent attention is litigation-driven, resulting from the inclusion of contingent valuation method in formal natural resource damage assessment procedures. Moreover, the focus of attention has also switched from use to nonuse values.

application of the contingent valuation method.[4] Some researchers distrust the results from this survey technique claiming that asking individuals hypothetical questions results in hypothetical answers that cannot be accurately used to value changes in environmental quality. Proponents of contingent valuation counter that surveys are often the only method available for assessing values.

Measuring Use Values Associated With Water and Water-Related Resources

Use values can be measured with both indirect (observed behavior) and direct (structured conversations) approaches. In reviewing the literature on water quality and a water-related goods and services, one finds a considerable mix of variants on both general approaches.

As one example, numerous studies valuing recreational angling in the Pacific Northwest have been completed, dating back nearly 30 years (Brown et al. 1965; Stevens 1965) and encompassing a wide variety of approaches.[5] Many of these studies are not species or site-specific, and value estimates come in a variety of forms (average, marginal, total, per-site, per-trip, per-day, and per-fish). The empirical evidence does not support a convergence of values, but rather indicates the highly conditional nature of recreational benefit estimates for salmon and steelhead angling. For example, estimates of the marginal value of a salmon range from several dollars to well over $100. Much of this discrepancy can be attributed to technique, but undoubtedly much also stems from the valuation context.[6] Viewed in the aggregate, the numerous studies over the last several decades document the considerable nonmarket benefits from recreational angling.

In addition to documenting nonmarket use values, measurement techniques may also be used as a tool in appropriating nonmarket use values (Pearce 1993). Nonmarket values and benefit models may be used as a guide in establishing user fees for revenue-capture in newly developing markets for environmental goods and services. Thomas and Syme (1988) for example, explore the use of contingent valuation in identifying price elasticities of demand for municipal residential water services.

Measuring Nonuse Values Associated With Water and Water-Related Resources

From a measurement perspective, nonuse (or, passive) values (i.e., option, existence and bequest) are the most problematic because actual market or nonmarket behavior gives little information regarding the magnitude of the values. The contingent valuation method is the only technique in the economist's toolkit for assessing these values. The topic of existence values is one of the most controversial in all of environmental economics.[7]

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[4] See, for example, Bishop and Heberlein (1990), Carson (1991), and Mitchell and Carson (1989).

[5] Studies include Berrens et al. (1993), Brown and Mendelsohn (1984), Donnelly et al. (1990), Duffield et al. (1992), Johnson and Adams (1990), Loomis (1988), and Olsen et al. (1991).

[6] Additionally, there is a tendency for large variances around statistical estimates, emphasizing the importance of close scrutiny of econometric procedures and the statistical distribution from which any estimate is drawn.

[7] The discussion begins with Krutilla (1967) and extends to Bishop and Welsh (1992), Castle and Berrens (1994), Desvouges et al. (1993), Edwards (1992), Freeman (1993), Kopp (1992), Randall (1993), and Schulze (1993).

Substantial evidence shows that many individuals contribute to environmental organizations, and express positive willingness to pay to preserve environmental assets on contingent valuation method surveys, with no current or expected future use of the resource. Evidence that nonuse values exist, however, is something less than arguing that they can be measured on a sufficiently comprehensive and reliable basis for use in formal decision rules.

Limitations of Nonmarket Valuation

Environmental economists have invested considerable effort in developing and refining techniques for valuing unpriced goods. These values are seen as a means for correcting market failures caused by the presence of environmental externalities and public goods. The hope is that nonmarket values can be used by natural resource managers to correct distortions and achieve efficient outcomes, or perform benefit-cost tests of potential welfare improvements.

Even if this hope were realized—even if one could estimate and assign nonmarket values—there is no guarantee that the resulting efficient use of resources in the aggregate would be a fair one (or even a sustainably efficient one in the long run).[8] The economic issues are complex, contentious, and uncertain; there will always be political debate and compromise; the measurement of nonmarket values will never lead to automatic, technical decisions. As the time frame under consideration and the complexity and scope of environmental changes increases, the validity and reliability of nonmarket value estimates diminishes.

APPLYING THE VALUES ESTIMATED IN ONE AREA TO ANOTHER AREA

The previous section suggests some obvious conclusions about estimating the value of water and water-related resources. It is complicated both theoretically and methodologically; it requires data that are often not readily available; it can be expensive; and its results are inherently imprecise. Given these limitations, it is not surprising that agencies in need of these estimates turn first to existing studies in the hope of using, perhaps with adjustment, estimate derived in a different context. An obvious question results: How confident can one be about applying value estimates, described in one context (defined by topic, research purposes, data, geography, and so on) to a different one?

This topic has been addressed in some detail in the professional literature under the heading of *benefit transfer*.[9] Benefit transfer can be defined as the application of some existing value (benefit) estimate (or confidence interval) from the original study site to an alternative policy site. For example, an economist could assess the benefits of preventing groundwater pollution by nitrates by conducting her own study using one of the methods described in the previous section. But, this would require a considerable amount of time and money. As an alternative, she could use a valuation study that had been done in an

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[8]Discussion of this conclusion can be found in Bishop and Woodward (1993) and Common and Perrings (1992).

[9]The 1992 Association of Environmental and Resource Economist' workshop was devoted to benefit transfer (Association of Environmental and Resource Economist (AERE) 1992) and a special section of *Water Resources Research* was also devoted to the topic (e.g., Boyle and Bergstrom (1992); Brookshire and Neil (1992); Desvouges et al. (1992); and McConnell (1992)).

area with similar characteristics (e.g., demographics, environmental problems) and transfer the benefit estimates from the original site to the new site.

The procedure of benefits transfer introduces more complications and imprecisions into the valuation of natural resources.[10] For example, measurement error in the original study may be compounded when applying benefit measures in the new setting. What is appealing about this procedure, however, is that it allows the researcher to obtain insight into the magnitude of the environmental costs and benefits associated with a policy option without having to expend the time and costs required for a new and original study (Crutchfield et al. 1995).

VALUE ESTIMATES OF WATER AND WATER-RELATED RESOURCES

Numerous studies of the value of water and water-related resources have been conducted by economists. Although a complete review of the existing literature of water quality benefits is not possible given budget constraints, Table 2 offers a summary of the results from selected nonmarket valuation studies. The studies are classified according to the valuation techniques used and the water or water-related good or service being valued. Individual studies were largely selected because of their perceived relevance to the general issue of water and water-related values (e.g., water quality, groundwater, wetlands, recreational fishing) or to the LaPine study area.

Table 2: Summary of Selected Nonmarket Valuation Studies

STUDY (YEAR)	TECHNIQUE(S)[a]	ENVIRONMENTAL GOOD OR SERVICE BEING VALUED	EXAMPLES OF ESTIMATED VALUES[b]
Adams et al. (1990)	TCM, individual observation model, n=36, combined with fish habitat production model	changes in catch for salmon and steelhead sport anglers in NE Oregon	marginal values per fish ranging from $28-$35 ($1988)
Bergstrom et al. (1993)	CVM, dichotomous choice, n=1155	wetlands-based recreation in coastal Louisiana	mean annual household benefits of $360; average value per acre of wetlands of $8 ($1986)
Berrens et al. (1993)	CVM, payment card, n=219	run size and congestion changes for urban fishery in Portland, OR for spring Chinook salmon	sport angling values of $11.18 for 10-20% increase in run size, no congestion effects ($1989)

[10]Desvouges et al. (1992) evaluate some of the conceptual problems of estimating water quality benefits using existing studies. The environmental problem was an Environmental Protection Agency (EPA) decision to reduce pollutant loadings; their policy sites include 12 rivers in the northeastern U.S., in primarily urban areas. The range of transfer values for per household water quality improvements ranges from a few dollars to over $55 ($1984). After careful review of the available evidence, they conclude that while benefit transfer offers promise, "the fact that existing studies were not designed for transfer places severe limitations on the current effectiveness of transfer.

Carson and Mitchell (1993)	CVM	national improvements in freshwater pollution control	annual household willingness to pay of $205–279 per household per year for maximum water quality improvements ($1990)
Caudill (1992) and Caudill and Hoehn (1992) as cited in Crutchfield, Feather, and Hellerstein (1995)	CVM open-ended	protection of ground water subject to contamination by nitrates and pesticides	estimated willingness to pay of $43-$46 per rural household per year, estimated willingness to pay of $34-$69 per urban household per year
Desvouges et al. (1992)	benefit transfer exercise using 2 CVM and 1 TCM study	water quality improvements from reduced pollutant loadings for 12 study sites in eastern US	transfer estimates of average per-household water quality benefits from $0-$57 ($1984).
Donnelly et al. (1990)	TCM -individual observation, and CVM -bidding game, mail survey, various sample sizes (ranging from 78-769) for different recreational activities	various fishing and hunting recreational activities for the state of Idaho	mean household benefits per WFUD (wildlife-fish user day) for CVM of: $45 for steelhead fishing, $33 for general cold water fishing, $70 for upland game, $32 for waterfowl hunting ($1983).
Doss and Taff (1993)	HPM using 18,000 property transactions combined with GIS-based wetlands data	value of proximity to four different types of wetlands in urban Ramsey Co., MINN	various values depending on type of wetland and functional form assumed; e.g., mean sale price value of $22 for every 10 meters closer to an open-water wetland
Edwards (1988)	CVM	protection of groundwater subject to contamination by nitrates and pesticides	estimated willingness to pay of $286-$1,130 per household per year
Harpman et al. (1993)	CVM, dichotomous choice n=153, combined with instream flow simulation model	sport angling for brown trout in Taylor River, CO	mean individual value for first fish caught of $23m and marginal values for additional fish of less than $2 ($1989)
Johnson et al. (1990)	CVM, open-ended n=229, dichotomous choice n=200	value of noncommercial whitewater recreation on the Rogue River, OR	average individual value of a permit ranging from $32 open-ended format, and $56 for dichotomous choice format ($1985)

Jordan & Elnagheeb (1993)	CVM, payment card	.improvements in drinking water quality for Georgia Residents affected by real and potential groundwater contamination;	median benefit of $5.49 per month for households on public systems, $7.38 for those on private wells ($1991)
Kulshreshtha & Gilles (1993)	HPM, n=392 real estate transactions	aesthetic amenity of a river view for houses in an urban setting (South Saskatchewan River in city of Saskatoon, Canada)	average house price value of $11.48 per square foot for river view ($1987)
Loomis (1988)	TCM aggregate regional (multi-site) model	sport angling for coastal salmon and steelhead in Oregon and Washington (various rivers and ports)	marginal values per fish ranging from $7.5-$103 ($1983)
McClelland et al. (1992)	CVM	groundwater (type of contaminant not specified)	estimated willingness to pay of $84 per household per year
Musser et al. (1992)	CVM open-ended, telephone survey, n=176	additional source of drinking water in rural PA	$11-$18 per household monthly
Poe (1993) and Poe and Bishop (1992)	CVM	protection of drinking water from contamination by nitrates	estimated willingness to pay of $168-$708 per household per year
Powell (1991) as cited in Crutchfield, Feather, and Hellerstein (Crutchfield et al. 1995)	CVM	protection of groundwater subject to contamination by toxic chemicals and diesel fuel	estimated willingness to pay for all respondents of $61.55 per household per year, estimated willingness to pay for respondents with a history of contamination of $81.66 per household per year, estimated willingness to pay for respondents with no contamination of $55.79 per household per year
Whitehead & Blomquist (1991)	CVM, dichotomous choice, mail survey of KY residents, n=118	annual contribution to wetland preservation fund for Clear Creek Wetland, KY	average annual benefit of $17.48 ($1989) per household

Source: Compiled by ECONorthwest; full citations in bibliography at the end of this memorandum.

[a]CVM=contingent valuation method, TCM=travel cost method, HPM=hedonic pricing model, HTC=hedonic travel cost; RUM=random utility model.

[b]Many studies will estimate multiple values, the ones described here are intended to be only illustrative. As such, values given are as reported in individual studies, and have not been indexed into a common year.

Table 2 shows that many of the potential environmental impacts resulting from an improvement in water quality have been addressed in previous studies. As one might expect, given the variety of techniques employed and differences in the way the studies were conducted, the estimates of improved water quality and related aspects (e.g., recreational fishing) vary significantly. The estimates of benefits from groundwater protection, for example, range from about $35 per household per year to over $1,000 per household per year. Reasons for this wide range of estimates are legion: differences in data and measurement techniques; in data; in research objectives; in areas studied; in time (a dollar in 1980 is worth about two dollars today).

Can these estimated values, particularly those associated with improved groundwater quality, be used for the evaluation of land use alternatives in the LaPine study area? The range of values can be used qualitatively to inform policy discussions, but they should not be added to other more direct and conventional measures of cost (e.g., the cost of providing sewers). One must be extremely cautious in using the results of any of these studies to estimate the environmental costs avoided by preventing or reducing degradation of water quality in the LaPine study area.

With that limitation in mind we are reluctant to make estimates for the study area, though such estimates would be useful if defensible. Here's an example of how such an estimate might be made. Poe (1993) and Poe and Bishop (1992) found households willing to pay between $168 and $708 per year to avoid ground water contamination by nitrates. Without going into the details of the study (current level of nitrates, amount of change, socioeconomic characteristics of households) we simply assume, for this estimate, that a lower bound on the average value is $150 per year per household. In the study area, this number could be multiplied by the number of households located in areas mapped as nitrate hot spots or otherwise in areas with constraints on effluent disposal (about 1000); the number of households currently in the entire study area (about 10,000); the number of lots (potential households) in the study area (about 17,000); or some other factor. That multiplication yields a range of willingness to pay of $150,000 to $2,500,000 per year.

But the same studies suggest an upper bound that might be four or five times greater. More important, we are looking only at the value to households in e study area. Downstream users of water for drinking and recreation—both County residents and visitors—may be willing to pay something in addition. For example, if a public agency were to determine that a point-source of pollution had to be cleaned up to protect water quality or a section of the Deschutes River would have to be closed to recreation, and chose to charge a small river-access fee to pay for that cleanup, many (most) current river users would pay that fee.

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APPENDIX G

Draft Framework for RPS Agreement
(DJ Heffernan; KCM, Inc.; Tom Armstrong; Pacific Rim Resources; June 18, 1997)

Memo

Date: 18 June 1997

To: Stakeholder Committee

From: DJ Heffeman, KCM
Tom Armstrong, Pacific Rim Resources

Subject: Draft Framework for RPS Agreement

REGIONAL PROBLEM SOLVING

The state legislature enacted HB 3482 during a special session in February 1996 to establish the Regional Problem Solving program. The act envisions local governments, state agencies, citizens, and affected organizations working together to address land use problems which transcend city or county boundaries. The RPS program included four demonstration projects around the state. Josephine County received funding for one the demonstration projects and has used the money to study land use problems in several areas around the county, including the Merlin/North Valley area.

The RPS process seeks to foster agreements between public agencies and stakeholders for implementing regional solutions. The act permits the Land Conservation and Development Commission to acknowledge agreed upon changes to comprehensive plans and land use regulations which do not fully conform with administrative rules to implement the statewide planning goals "without taking an exception". The program is ambitious because it is focusing on areas of Oregon where difficult land use issues have not been successfully addressed using the statewide planning goals and administrative rules.

Statutory Requirements

The RPS program is based on a collaborative regional problem solving process that seeks to reach an agreement among all local participants, the Land Conservation and Development Commission, and other participating state agencies. Individual implementing plan amendments and regulations may vary from the state administrative rules, provided "on the whole" they conform with the purposes of the statewide planning goals. Any plan amendments or land use regulations are based on the RPS agreement, which must include:

Σ Regional goals for resolving the regional problems that are the subject of the process.

Σ Optional techniques for achieving these goals.

Σ Measurable indicators of performance toward achieving the goals.

- Σ A system of incentives and disincentives that encourage implementation of the methods selected to achieve the goals.
- Σ A system of monitoring progress toward meeting goals.
- Σ A process for modifying techniques to achieve regional goals if monitoring indicates that the techniques

Unincorporated Communities Rule

In addition to long standing problems with respect to urban services in the Merlin/North Valley area, recent state administrative rule changes require Josephine County to reexamine their rural development codes to ensure new development is consistent with rural land uses. The Unincorporated Communities Rule (OAR 66022) establishes a statewide policy for the planning and zoning of rural communities that are outside of urban growth boundaries. The purpose of the rule was to make it easier for counties to plan for these areas by reducing the need to take exceptions to statewide planning goals.

Under this rule, counties can designate unincorporated communities and adopt individual plan and zoning designation for each community according to guidelines for different types of unincorporated communities. A key provision is that county plans shall ensure that the cumulative development:

- Σ Will not exceed the carrying capacity of the transportation system; and
- Σ Will not result in public health hazards or adverse environmental impacts that violate state or federal water quality regulations; and
- Σ Will not exceed the carrying capacity of the soil or water supply and sewer services.

The rule establishes four different types of unincorporated communities that a county may designate:

Rural Community consists primarily of residential uses but also has at least two other land uses that provide commercial, industrial, or public uses (schools, churches, etc.) to the community, the surrounding rural area, or to persons traveling through the area.

Rural Service Center consists primarily of commercial or industrial uses providing goods and services to the surrounding rural area or to persons traveling through the area, but which also includes some dwellings.

Urban Unincorporated Community includes at least 150 dwelling units; contains a mixture of land uses; and includes areas served by a community water and sewer system.

Resort Community is primarily for recreation or resort purposes.

These designations provide a framework for designating unincorporated communities in the North Valley/Merlin area. However, applying this rule under a "strict construction" interpretation would make it difficult, if not impossible, for Josephine County to comply with this rule in an area with a development pattern like that in the Merlin/North Valley area.

PROBLEM DEFINITION

The basic underlying problem is while the North Valley area is outside of an urban growth boundary (UGB), the existing development pattern and acknowledged comprehensive plan represent land uses that are considered to be more urban in character under the State's planning rules. The North Valley land uses were established and approved by the County's Comprehensive Plan, which were acknowledged by the State using a Goal 2 "built and committed" exception. That is, the comprehensive plan reflects the existing pattern of development. However, since the plan was acknowledged, the State rules have changed which require Josephine County to address many of the growth and urban service issues in North Valley. Other problems related, either directly or indirectly to the basic issue of urban development outside an UGB, include:

Σ Compliance with the State's Unincorporated Communities rule could result in many existing use becoming nonconforming uses and severe limits on the types of future commercial and industrial development.

Σ The inability to provide adequate urban services, primarily sanitary sewer and water, to support existing and planned commercial and industrial development. The Three Rivers School District does not want to continue to provide sewage treatment facilities. The North Valley Industrial Park, the Paradise Ranch Resort, the Rendata Industrial Park, and Merlin commercial businesses all depend upon finding a solution to their sanitary sewer needs.

Σ Lack of a local vision for the Merlin/North Valley area has been a barrier to resolving conflicts between commercial and industrial users and rural residential uses.

Σ The lack of adequate development standards or their inconsistent application has created conflicts between Josephine County and the City of Grants Pass, especially in cases where the City has been unwilling to provide water service without urban development standards.

Σ There is a high degree of mistrust of both the County and City governments by Merlin/North Valley residents and businesses, especially in regards to implementing an adopted plan and enforcing development standards.

FUTURE VISION

The RPS process involved the review of three alternatives and resulted in the selection of the "Limited Growth Option" as the preferred alternative. The Limited Growth Option seeks to balance future commercial and industrial growth with the rural character of the Merlin/North Valley area by limiting commercial and industrial growth to two areas: the Interchange/Airport area and the Merlin/Rendata Industrial Park area. These two areas would be designated as Rural Service Centers under the State's Unincorporated Communities Rule. In addition, a Resort Community boundary would be established for the Paradise Ranch Resort.

The advantages of the Limited Growth option include:

- Σ Providing for economic development and job creation in Josephine County
- Σ Elimination of the potential for creating nonconforming use problems for existing businesses
- Σ Supporting the implementation of the Grants Pass Airport Master Plan by allowing industrial development adjacent to the airport

<u>Interchange/Airport Area</u>

The Rural Service Center boundary for the Interchange/Airport Area is based largely on the current comprehensive plan and zoning and includes:

- Σ the North Valley Industrial Park
- Σ commercial and industrial land surrounding the Monument Drive/Merlin Road intersection
- Σ industrial land associated with the Grants Pass Airport
- Σ residential land inside the existing Service District, including parcel along Merlin Road that currently receive City water service

The amount of growth and development inside the rural service center boundary would be controlled by a new set of development standards that address allowed uses, setbacks, lot coverage, transportation impacts, stormwater runoff, landscaping, and urban service concurrency.

Portions of the area are currently have City water service. The Three Rivers School District provides sewer service to the North Valley Industrial Park, but must upgrade its facilities in the near future. Future development inside this boundary would be served by sewer and water service. In general, water and sewer service would not be available outside the boundary area, but would be available to Paradise Ranch, the North Valley High School and the Fleming Middle School sites.

<u>Merlin/Rendata Area</u>

The Rural Service Center boundary for the Merlin/Rendata Area is based largely on the current comprehensive plan and zoning and includes:

- Σ commercial and residential lands associated with the Merlin town site
- Σ industrial land associated with the Rendata Industrial Park, formerly the Miller Redwood mill site

Σ industrial land along Merlin Road

The amount of growth and development inside the rural service center boundary would be controlled by a new set of development standards that address allowed uses, setbacks, lot coverage, transportation impacts, stormwater runoff, landscaping, and urban service concurrency.

Currently, the area is dependent on individual water wells and sewage holding tanks. Future development inside this boundary would be served by sewer and water service. Urban services would not be available outside the Rural Service Center boundary.

Rural Residential

Areas outside of the boundaries are designated as rural residential and subject to the Countywide zoning, which is expected to be revised as part of the County's periodic review process. These changes are expected to include higher minimum lot sizes and restrictions on the number of employees for home based businesses.

The Limited Growth Option is a starting point. The RPS Goals have been used to further define the Limited Growth Option; mitigate growth impacts on surrounding rural residential areas; and identify techniques, performance indicators, incentives, and corrective measures to implement the RPS agreement.

LAND USE GOALS

Land Use Goal #1

Achieve a balance between maintaining the current rural character of the Merlin/North Valley area and the need for commercial and industrial growth to support Josephine County's economic development goals.

Technique

Establish two Rural Service Center boundaries. One boundary in the Merlin/Rendata area and the other in the Interchange/Airport area. Adopt a Rural Service Center Development Code to address development impacts and the compatibility of residential, commercial and industrial uses.

Measurable Indicator

Establish boundary and adopt development code by a date certain.

Incentive and Disincentive

The incentive for establishing a boundary and development code is the ability to balance economic development with the current rural character of the community and to possibly establish some degree of local control. The disincentive, or results of doing nothing, is that the county will be forced to adopt rural zoning for the entire area, meaning most properties will be down zoned or become nonconforming uses.

Monitoring

See process goal #? for a description of the monitoring techniques.

Corrective Measures

See process goal #? for a description of the corrective measures.

Land Use Goal #2

Allow and encourage commercial land uses within the Rural Service Centers that support local residences and the community economy.

Techniques

Implementation of a development code with performance standards to direct new commercial development that is compatible with the rural character of the Merlin/North Valley area.

Indicators

Adoption of the development code by a time certain.

Incentive and Disincentive

If a development code is not adopted, the County will be required to rewrite its rural development code and allow only commercial uses that serve natural resource based uses. The incentive for completing a development code is the ability to control new development, ensuring that the current rural character of the area is impacted as little as possible while encouraging businesses needed in the community.

Monitoring

See process goal #? for a description of the monitoring techniques.

Corrective Measures

See process goal #? for a description of the corrective measures.

Land Use Goal #3

Allow industrial land uses within the Rural Service Centers to provide jobs and economic development within the Merlin/North Valley area and Josephine County.

Techniques

Implementation of a development code with performance standards to direct new industrial development that is compatible with the rural character of the Merlin/North Valley area.

Indicators

Adoption of the development code by a time certain.

Incentive and Disincentive

If a development code is not completed and implemented the county will be required to down zone the area and allow only natural resource based uses. The incentive for completing a development code is the ability to control new development, ensuring that the current rural character of the area is impacted as little as possible while promoting economic development within the Merlin/North Valley area and Josephine County.

Monitoring

See process goal #? for a description of the monitoring techniques.

Corrective Measures

See process goal #? for a description of the corrective measures.

Land Use Goal #4

Within the Rural Service Center boundary allow residential development that is consistent with historic development patterns, including existing lots of records and development allowed under current land use plans. In addition, residential development that is bounded by other committed area, either residential, commercial or industry; should be considered for further residential development.

Techniques

Implementation of a development code with performance standards to direct new residential development and the requirements of minimum lot sizes within the Rural Service Center Boundary.

Indicators

Adoption of the development code by a time certain.

Incentive and Disincentive

If a development code is not completed and implemented the county will be required to down zone the area and only allow residential lot sizes somewhere between 2.5 and 5 acres. The incentive for completing a development code is the ability to control new development, ensuring that the current rural character of the area is impacted as little as possible while promoting economic development within the community.

Monitoring

See process goal #? for a description of the monitoring techniques.

Corrective Measures

See process goal #? for a description of the corrective measures.

Land Use Goal #5

Ensure that land uses within the Rural Service Centers are compatible with and minimize the impacts on the rural residential areas outside of the boundary.

Techniques

Implementation of a development code that has, at a minimum, requirements for landscaping, setbacks, noise standards and air quality.

Indicators

Adoption of the development code by a time certain.

Incentive and Disincentive

If a development code is not completed and implemented the county will be required to down zone the area and requirements that help ensure the currently rural setting may not be included in the county's revised comprehensive plan and zoning code. The incentive for completing a development code is the ability to control new development, ensuring that the current rural character of the area is impacted as little as possible while promoting economic development with the community.

Monitoring

See process goal #? for a description of the monitoring techniques. (This goal also may require air quality and noise monitoring to ensure that incompatible uses remain adequately segregated.)

Corrective Measures

See process goal #? for a description of the corrective measures.

Land Use Goal #6

Establish a Resort Community Boundary around the Paradise Ranch area to ensure that uses within the Paradise Ranch area remain focused on recreation or resort purposes.

Techniques

Implementation of a boundary around the Paradise Ranch resort area.

Indicators

Adoption of the boundary by a time certain.

Incentive and Disincentive

If a boundary is not established around the Paradise Ranch resort area the possibility for development other than for resort or recreation purposes exists. A boundary limits the extent of the resort development and helps maintain the current rural character of the area.

Monitoring

See process goal #? for a description of the monitoring techniques.

Corrective Measures

See process goal #? for a description of the corrective measures.

SANITARY SEWER GOALS

Sewer Goal #1

Provide adequate sewer service to all commercial, residential, industrial and resort properties within Rural Service Center and Resort Community Boundaries in the Merlin and North Valley areas. Sewer service within the boundaries shall: 1) Have adequate service capacity for all properties within the boundaries. 2) Provide relief for failing residential septic systems. 3) Meet DEQ requirements. 4) Help mitigate adverse impacts to ground water, riparian zones and fish habitat.

Technique

Josephine County, as the lead agency, and other participants (e.g. Josephine County School District), shall develop a Merlin/North Valley Rural Community Sewer Facility Plan that meets DEQ approval.

Measurable Indicator

Prepare sewer service plan and implement by a date certain.

Incentives and Disincentives

Incentives Sewer service is provided for all properties within the rural service center boundaries Environmental costs associated with onsite sewage disposal is mitigated. Expansion and new industry within the industrial parks and commercially zones areas is permitted.

Disincentive Development is limited to levels that can be accommodated by onsite disposal systems or to levels that can be served by existing treatment plants. No regional solution would be developed and the school district would continue to serve as the area's principal sewage treatment authority. Planning would be governed by the Rural Communities Rule and the area would lose the flexibility of Regional Problem Solving solutions.

Monitoring

See Process Goal.

Corrective Measures

See Process Goal.

Sewer Goal #2

Provide an interim solution dealing with WWPT capacity issues at Flemming Middle School so that the County Industrial Park can continue to expand until a long term regional sewage solution is developed.

Technique

As an interim solution, the County, DEQ and the Three Rivers School District shall enter into an agreement that allows sewer service to be provided to new development at the County Industrial Park commensurate with the plant's treatment capacity. Develop an action plan to remedy collection system problems that are cost effective and approved by DEQ.

Measurable Indicator

Prepare Memorandum of Understanding and implement an interim sewer service plan for the County Industrial Park by August 1, 1997.

Incentives and Disincentives

Incentive Allows development of the County Industrial Park to continue.

Disincentive Expansion at County Industrial Park not possible until a regional facility is in place, or costly onsite sewage systems are provided.

Monitoring

See Process Goal.

Corrective Measures

See Process Goal.

Sewer Goal #3

Develop a methodology for processing new development request within the established Rural Service Center and Resort Community boundaries that regulates options for interim sewage disposal.

Technique

Develop an interim sewage service plan that clearly identifies the methods of sewage disposal required for new development to occur within the adopted Merlin and North Valley rural community boundaries. This process will govern the approval of temporary sewage disposal options, will have the approval of DEQ, and will "sunset" once a regional sewer facility becomes available. Investment in temporary facilities shall be fully borne by the developer or property owner. The County and other Participants shall be held harmless for loss of investment for such facilities when property owners are required to connect to the regional sewage system.

Measurable Indicator

Adopt interim sewage disposal plan and guidelines, including concomitant development agreements, by a date certain.

Incentives and Disincentives

Incentive Development is permitted prior to the completion of a regional facility.

Disincentive Moratorium placed on development until regional facility is available.

Monitoring

See Process Goal.

Corrective Measures

See Process Goal.

WATER SYSTEM GOALS

Water Goal #1

Provide adequate domestic water service to the established rural service centers boundaries. Water service within the adopted boundaries shall: 1) Meet State Health Division Requirements for domestic water systems. 2) Provide adequate fire protection flow. 3) Enhance riparian habitats by reducing ground water withdrawals. 4) Mitigate impacts to individual wells and ground water by reducing groundwater withdrawals.

Techniques

Josephine County shall prepare and adopt a master water service plan for the North Valley and Merlin rural community boundaries with coparticipation and approval by the City of Grants Pass.

Measurable Indicators

Adopt master plan and implement by a date certain.

Incentives and Disincentives

Incentives Development within the established boundaries can proceed. Adequate fire flow service would be available and provide a better insurance rating for users. Groundwater withdrawals would be reduced conserving this resource for domestic users outside community boundaries and natural recharge of local streams.

Disincentives Diminishing ground water quality. Development shuts downs, or reverts to onsite solutions (wells) subject to State Department of Health requirements. Area reverts back to the Rural Communities Rule with less flexibility than is available under Regional Problem Solving.

Monitoring

See Process Goal.

Corrective Measures

See Process Goal.

Water Systems Goal #2

Mitigate adverse impacts from ground water withdrawals by allowing City of Grants Pass water service to be extended to the Paradise Ranch Resort Community Boundary for domestic uses.

Techniques

Josephine County shall adopt provisions in the Merlin/North Valley master water service plan allowing for water service to be extended to the Paradise Ranch resort community boundary with the support and approval of the City of Grants Pass.

Measurable Indicators

Adopted master plan and implement by a date certain.

Incentives and Disincentives

Incentives Development of the resort will have less impact on local groundwater resources. Fire flow service would be available, potentially providing a better insurance rating for users.

Disincentives Diminishing ground water quality. Development approval would reverts to onsite solutions (wells) subject to State Department of Health and Department of Water Resources requirements. The Resort would be subject to the Rural Communities Rule which would still mandate the establishment of a resort community boundary around the development.

Monitoring

See Process Goal.

Corrective Measures

See Process Goal.

STORM DRAINAGE GOALS

Storm Drainage Goal #1

Decrease impacts to the natural drainage patterns cause by imperious surfaces resulting from increasing development within the adopted RSCB.

Storm Drainage Goal #2

Protect downstream impacts to fish and other riparian habitats caused by erosion .

Storm Drainage Goal #3

Coordinate drainage standards among currently adopted County development codes and ordinances.

Storm Drainage Goal #4

Develop onsite standards for retention and detention of storm water to decrease higher runoff volumes associated with increased development and urbanization.

Storm Drainage Goal #5

Develop flood zone overlay area standards that are consistent with FEMA's model flood hazard ordinance

Storm Drainage Goal #6

Develop practices and standards to mitigate erosion stream sedimentation and soil loss caused by land development.

Techniques

Josephine County shall develop a comprehensive storm drainage plan for the North Valley and Merlin rural services boundaries. Josephine county shall amend all development ordinances and the County road standards to eliminate inconsistent standards and practices. The County will select and adopt a "Best Management Practices" methodology for inclusion in the storm drainage plan. The County's storm drainage plan shall reference and include requirements for flood hazard development as outlined in FEMA's Model Flood Hazard Ordinance.

Indicators

Adopted storm drainage plan and amended associated ordinances in place by a date certain.

Incentives and Disincentives

Incentives

Σ Impacts to natural drainage patterns/ courses from unmanaged stormwater runoff is mitigated. Nuisance flooding is controlled and potential claims against the County for damages of nuisance flooding is mitigated.

Σ Maintain or improves downstream fish and other riparian habitats. Mitigates erosion and soil loss.

Σ An improved stormwater conveyance system employing coordinated standards with sufficient capacity mitigates negative downstream impacts

TRANSPORTATION GOALS

Transportation Goal

Provide adequate roads and transportation facilities within the established Rural Services Center Boundaries for North Valley and Merlin.

Technique

Josephine County shall develop a Transportation System Plan for the North Valley and Merlin RSCB that complies to State of Oregon Transportation Planning Rule requirements

Measurable Indicator

Adopted sub-area Transportation System Plan in place by a date certain.

Incentives and Disincentives

Incentive- Establishes a mechanism for providing adequate transportation services and facilities for the North Valley and Merlin RSC area's.

Disincentive- Transportation facilities and services continue under current rules and standards.

Monitoring

See Process Goal.

Corrective Measures

See Process Goal.

ENVIRONMENTAL QUALITY

Environmental Quality Goal #1

Provide for monitoring air quality in the Merlin/North Valley air-shed to maintain air quality within state and federal standards, especially during winter months when the area is subject to inversions.

Techniques

Implement an air quality monitoring program using spot checks and grab-bag sampling methods to establish base-line data regarding air quality and monitor conditions as industrial development takes place.

Indicators

Develop a work program and monitoring agreement with DEQ, the City of Grants Pass, and Josephine County by date certain.

Incentives and Disincentives

Local air-shed conditions may limit air exchange within North Valley causing inversions that trap pollutants at the surface. Declining air quality could prevent the area from reaching its economic development potential and may pose problems for the airport's VFR operations. Declining air quality also poses a threat to public health. For these reasons, establishing base-line data on air quality in the valley and regular monitoring will document the impacts of development over time allowing the County and DEQ to impose land use restrictions on development that would threaten air quality.

Monitoring

See process goal #1.

Corrective Measures

This goal is self regulating to the extent that if the area reverts to rural zoning, pollution levels from point sources would probably not threaten air quality. Corrective measures for meeting RPS requirements are reviewed in Process Goal #1.

Environmental Quality Goal #2

Josephine County shall provide a system to regulate noise levels from industrial processes and respond to complaints regarding problems caused by industrial uses in Merlin/North Valley .

Techniques

Implement and enforce noise standards through the County's development code, including fines and penalties that discourage industry from engaging in processes that are incompatible with other nearby uses.

Indicators

Adoption of code provisions that deter noise violations through the use of state and local fines and penalties.

Incentives and Disincentives

Local residents in Merlin and North Valley complained during the RPS public information process that DEQ does not respond to noise complaints and refers callers to the County while the County says it does not have the resources to police noise problems. Problems were cited in North Valley with wood products manufactures that residents feel clearly violate state rules. Unless a solution is found to address these problems, industry will find it increasingly difficult to find community support for future development plans. The program developed to address this issue needs to be consistent with the County's Airport Master Plan and not limit the airport's state licensed operations.

Monitoring

See Process Goal #1.

Corrective Measures

See Process Goal #1.

Environmental Quality Goal #3

Josephine County shall adopt development regulations that minimize "light pollution" caused by inefficient night lighting systems.

Techniques

Implement appropriate lighting standards through the County's development code to minimize light emissions that are out of character with the Valley's rural setting.

Indicators

Adoption of code provisions that require the use of efficient lighting systems, such as low pressure sodium lamps with glare reducing lenses and caps by date certain.

Incentives and Disincentives

Local residents in Merlin and North Valley want the areas rural character preserved as much as possible and expressed a desire to minimize the night-time visual impact of industrial and commercial development.

Monitoring

See Process Goal #1.

Corrective Measures

See Process Goal #1.

Environmental Quality Goal #4

Josephine County shall develop a program for monitoring groundwater quality and quantity in the Merlin/North Valley area for the purpose of ensuring the reliability of the area's ground water resources.

Techniques

Implement appropriate monitoring of water quality and quantity in cooperation with DEQ, and Water Resources Department.

Indicators

Adoption of inter-local agreements and program guidelines by date certain.

Incentives and Disincentives

Local residents in Merlin and North Valley want to continue to rely on ground water as the principal source for drinking water for most residents. The possibility of contamination of ground water is a serious concern and residents would oppose future development proposals if they threatened ground water supplies.

Monitoring

See Process Goal #1.

Corrective Measures

See Process Goal #1.

PROCESS AND GOVERNANCE GOALS

Process Goal #1

Establish an initial process for monitoring compliance with the provisions of the Regional Problem Solving Agreement that continues to involve Stakeholders and the general public.

Techniques

Josephine County shall submit a twice a year RPSA report to Stakeholders that summarizes performance on meeting RPSA goals. Within 30 days of receiving the report, Stakeholders must file written responses to the County or it will be assumed that they concur with the report. The report and stakeholder responses will then be made available for public inspection and comments following the County's adopted notice procedures for land use hearings. The report will then be submitted to LCDC for review.

Where goal objectives are not being met in accordance with the RPSA, the County must either submit a revised timetable and/or work plan for achieving the goal or identify a strategy for implementing the corrective measures identified in the agreement. These measures must be outlined in the RPSA monitoring report.

When the use of corrective measures is necessary, or when the timeframe for achieving an RPSA goal is extended by more than the original timetable specified in the RPSA, the County must secure approval from LCDC in the form of an amended RPSA.

Measurable Indicators

RPSA reports with formal acknowledgment by the Commission when the RPSA has been achieved. Petition for acknowledgment status must be submitted to the Commission by the County in a RPSA Monitoring Report.

Incentives and Disincentives

Incentives Monitoring of the agreement by the parties is self regulating with LCDC oversight of amendments or disputes regarding the agreement. The process of securing formal amendment to the agreement for not achieving goals creates an incentive for the parties to adhere to the agreement.

Disincentives Loss of flexibility afforded by Regional Problem Solving and return to standard OAR and procedures.

Monitoring

LCDC through DLCD staff reports.

Corrective Measures

Self regulating with LCDC oversight.

Process Goal #2

Establish a long term process for monitoring compliance with the provisions of the Regional Problem Solving Agreement that provides standing to Stakeholders and the public.

Techniques

Once the RPSA agreement has been fully implemented and acknowledged, Josephine County shall submit an RPSA report to LCDC as part of periodic review that summarizes ongoing compliance with RPSA goals. Stakeholders will continue to have standing to file written responses to the County's periodic review report.

In instances between periodic review hearings where Stakeholders feel that provisions of the RPSA are not being met, a formal request for hearing with the Commission must be filed 60 days prior to a regular Commission meeting. The Commission shall determine within 30 days of a petition for review whether or not to place the matter on its agenda and hear the matter. Petition for review by non stakeholders may be granted by LCDC after first obtaining an order from LUBA granting temporary Stakeholder status to the petitioner.

LCDC may order an amendment to the RPSA and corrective actions. Failure to take corrective steps may result in forfeiture of acknowledgment status for the RPSA.

Measurable Indicators

RPSA periodic review reports.

Incentives and Disincentives

Incentives Monitoring of the agreement by the parties is self regulating with LCDC oversight of amendments or disputes.

Disincentives Loss of flexibility afforded by Regional Problem Solving.

Monitoring

Through periodic review reports and special review petitions.

Corrective Measures

Self regulating with LCDC oversight.

Finance Goal #1

Josephine County shall adopt development regulations and fees that require new development to mitigate offsite development impacts that exceed the County's *adopted level of service standards for county owned and operated public facilities., including roads, storm drainage, utilities, and parks.*

Techniques

Implement appropriate development requirements and system development charges to maintain adopted levels of service especially for transportation and storm drainage facilities per adopted master plans. Require that improvements be made as a condition of development approval or, when development impacts do not exceed existing system capacity, allow fee-in-lieu payments to a special capital improvement fund dedicated to the Merlin/North Valley area.

Indicators

Adoption of code provisions that require concurrent mitigation of offsite impacts or the use of System Development Charges by date certain.

Incentives and Disincentives

Local residents in Merlin and North Valley do not want the area's livability eroded by development. Existing residents wish the area to maintain a high level of service for roads and offsite impacts by storm runoff minimized. Requirements for concurrent mitigation of development impacts are the area's only assurance that the County will have the resources necessary to maintain the area's livability. Without these requirements, local residents will not support the rural community plan and prospects for securing LCDC approval would diminish leaving the County to re-plan the area either for rural use or relying entirely on the existing administrative rule and exceptions process.

Monitoring

See Process Goal #1.

Corrective Measures

See Process Goal #1.

Finance Goal #2

Josephine County and the City of Grants Pass shall enter into an intergovernmental agreement that assures the delivery of urban level services for water, sewer, storm drainage, transportation, and parks are financed by those properties and users that benefit from these services .

Techniques

Implement an intergovernmental agreement that specifies service extensions shall be financed directly by those properties and users that can receive services or establish special district policies that limit financing charges to properties and users that can receive services.

Indicators

Adoption of IGA and/or special district policies by date certain.

Incentives and Disincentives

Local residents in Merlin and North Valley do not want to be charged for services they do not receive and want the financial burden for delivery of services to the area to be limited to those properties and users that can receive services. They expressed a preference for keeping service boundaries drawn tightly. Without these requirements, local residents will not support the rural community plan and prospects for securing LCDC approval of an RPSA would diminish leaving the County to re-plan the area either for rural use or relying entirely on existing administrative rules and the exceptions process to justify service extensions.

Monitoring

See Process Goal #1.

Corrective Measures

See Process Goal #1.

Governance Goal #1

Develop a governance structure for the Merlin and North Valley rural community boundaries for regulating the delivery of public services and land use decisions.

Techniques

Merlin/North Valley Stakeholders shall form a Governance subcommittee and develop a strategy for regulating service delivery and land use decisions within the area's rural community boundaries. The Committee shall prepare a recommendation to the County Board of Commissioners and other Stakeholders that, upon adoption by the Stakeholders and approval by LCDC, shall amend the RPSA. Topics for consideration shall include the formation of special service districts, community land use review boards, and third party participation in the review of land use decisions.

Measurable Indicators

Adoption of a Governance agreement by date certain.

Incentives and Disincentives

Incentives Mutual recognition of issues affecting service delivery interests, land use actions, and the maintenance of public trust is essential to the RPSA.

Disincentives Loss of flexibility afforded by Regional Problem Solving and return to standard OAR and procedures.

Monitoring

See process Goal #1.

Corrective Measures

See process Goal #1.