

Cooperative Extension Compilation Report  
for the Dairy-McKay Hydrologic  
Unit Area, from 1991-2000



**Cooperative Extension Compilation Report for the  
Dairy-McKay Hydrologic Unit Area, from 1991-2000.**

Cooperators: Oregon State University Rangeland Resources Department  
and the Washington County Extension Service

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## Foreword

In 1988 the Tualatin River was designated 'water quality limited' by the Oregon Department of Environmental Quality. Three sources of pollution: urban point source, forestry non-point source and agricultural non-point source pollution were considered to contribute unacceptable levels of nutrients (phosphates and ammonium nitrates) to the river. Since a significant portion of this nutrient loading originated from agricultural non-point sources in the Dairy-McKay watershed, part of the Tualatin River Basin located in Washington County north and northwest of Hillsboro, Oregon, a cooperative effort to stem the tide of pollutants pouring into the river from this area was initiated. Multiple agencies (including federal, state and local community groups) defined the Dairy-McKay Hydrologic Unit Area (HUA) and designed a management plan to substantially reduce or eliminate the excess nutrient input.

Foremost among the collection of contributors to this project were the Natural Resource Conservation Service (NRCS, formerly a part of the Soil Conservation Service, or SCS), the Farm Services Agency (FSA, formerly Agricultural Stabilization and Conservation Service, or ASCS) and the Oregon State University Cooperative Extension Service (OSUCES). Each of these organizations had specific roles to play in the Dairy-McKay HUA project.

The purpose of this report is to present a generalized summary of the setting and the management plan for the Dairy-McKay Hydrologic Unit Area. Then, to proceed to an in-depth scrutiny of the Oregon State University Cooperative Extension Service's involvement in the project. This will assist in evaluating the success of that organization in meeting its goals and fulfilling its defined role as a primary collaborator.

The HUA library is housed at Oregon State University, Rangeland Resources Department, in Corvallis, Oregon.

## I. Introduction

### A. History

Concern about the quality of water in the Tualatin River became an issue as early as the 1930s and '40s. The Oregon Department of Environmental Quality (formerly known as the State Sanitary Authority) released reports in 1940 and 1969 documenting problems with the quality of sewage plant effluent being discharged to the river and wastewater from canneries. Problems such as these were resulting in algae blooms and reducing the dissolved oxygen content for fish and other aquatic life. Excessive irrigation withdrawals were also leaving some places in the river nearly dry. These reports documented the need for two things; better treatment of wastewater before discharge into the river and guaranteed minimum flows to sustain life in the river.

A series of events followed these reports that did much to improve the water quality in the Tualatin River. These events included the creation of Hagg Lake to store water and maintain flows and meet irrigation needs during periods of low water and the arrival of the Unified Sewerage Agency of Washington County. This new agency was responsible for improving the quality of wastewater discharge from sewage treatment plants. However, by the 1980's poor water quality in the Tualatin River was once again a reality.

In the mid 1980's a citizen lawsuit was filed against the Environmental Protection Agency. The end results of the lawsuit were increased efforts to clean up the river and the establishment of Total Maximum Daily Loads or TMDLs for nutrients found in the waterways. Phosphorous concentrations in particular were of concern in the Tualatin River and its tributaries. It was concluded that high concentrations of phosphorous, or P, were primary contributors to the problems in the river with algae blooms and low levels of dissolved oxygen.

Necessary modifications were made to point sources of pollution (upgrades to municipal waste treatment plants), which left nonpoint sources still requiring attention. In this case nonpoint sources contributing to the river quality problems included urban nonpoint sources; streets, lawns, parking lots, rooftops, and gutters etc., and agricultural nonpoint sources including forestry practices. Pollution from

agricultural nonpoint sources takes the form of increased nutrient or pesticide/herbicide levels present in the runoff coming off agricultural lands. Sheet, rill and gully types of erosion are also causes of concern due to the association of nutrients and chemical substances with soil particles, as well as the turbidity problems the increased sediment can incur.

In an effort to alleviate concerns about the quality of water in the Tualatin River Basin resulting from agricultural nonpoint sources and avoid further regulation of local agricultural practices, a collection of agencies submitted a Hydrologic Unit Area project proposal to implement a variety of preventive measures and management practices to improve water quality. This became a collaborative effort between several federal and state agencies. Principle among those submitting the actual proposal were the Soil Conservation Service (SCS, now NRCS), Oregon State University Cooperative Extension Service (OSUCES), and the Agricultural Stabilization and Conservation Service (ASCS, now FSA). There were several other agencies involved as well. These included the Washington County Soil and Water Conservation District (WCSWCD), the Oregon Department of Agriculture (ODA), Oregon Department of Environmental Quality (DEQ), Oregon State Department of Forestry (ODF), Unified Sewerage Agency (USA), Oregon Department of Fish and Wildlife (ODFW), Metropolitan Service District, Oregon Graduate Institute (OGI), and Environmental Protection Agency (EPA). A variety of local civic and interest groups were also involved with the project.

It was recognized that a good deal of the pollution present in the Tualatin River system originated within the boundaries of the Dairy-McKay creeks. The Dairy-McKay Creeks Watershed was chosen as the proposed project area and was designated the Dairy -McKay Hydrologic Unit Area (HUA). The United States Department of Agriculture (USDA) agreed to fund the project.

#### B. Setting

The Dairy-McKay Hydrologic Unit Area is located in Washington County and constitutes one-third of the Tualatin River Basin's total area. About one half of the non-urban land within the HUA's boundaries is devoted to agriculture; the other half is devoted to forestry. Urban development constitutes approximately ten thousand acres in the southeast corner of the hydrologic unit area. The entire north

central portion of Washington County is drained by the HUA. The principle drainages within the HUA are the Dairy Creek and McKay Creek drainages. The confluence of these two creeks is located northwest of Hillsboro, Oregon. After converging into one, these streams then empty into the Tualatin River southwest of Hillsboro. The Tualatin River is a tributary of the Willamette River, which proceeds to the Columbia River and then flows to the Pacific Ocean. A canal conducts water from the Tualatin River to Lake Oswego. A dam at the lower end of Lake Oswego prevents the lake from draining back into the Willamette (SCS, OSUCES, and ASCS 1990).

There is a great deal of diversity in land use throughout the HUA. Forest lands, full size farms and hobby farms, container and bare-root nurseries and confined animal feeding operations (CAFO) are all represented in the Dairy-McKay creeks watershed. The majority of these are dependent on irrigation for successful yields. Agricultural crops produced in the area include winter wheat, Christmas trees, caneberries, blueberries, strawberries, filberts, walnuts, hazelnuts, oats, sweet corn, alfalfa, red clover, crimson clover, oats, grass seed, corn silage, zucchini, snap beans, azaleas and many others. Livestock enterprises include dairies with 100 to 300 animals, small herds of beef, sheep or swine and small equestrian operations. Urban development is concentrated in the southern portion of the Hydrologic Unit Area, although the boundaries between agriculture and urban growth are becoming increasingly obscure. (SCS, OSUCES, and ASCS 1990, SCS, OSUCES, and ASCS 1993).

The objectives of the project were to substantially reduce or eliminate the excessive amounts of nutrient and sediment pollution entering the Tualatin River system by working cooperatively with landowners in the HUA to identify significant sources and implement a variety of solutions, such as Best Management Practices (BMPs), to improve water quality conditions (SCS, OSUCES, and ASCS 1990). Better animal waste management programs, improved methods of determining deficiencies in nutrient availability for crops to reduce over application of fertilizers, alternate water sources for livestock, improved erosion control practices such as cover cropping and restricted grazing in riparian areas are all examples of implemented solutions to the pollution problems present in the project area.

The proposal was submitted for approval in 1990. In 1991 the project was approved and funded. Over the next several years, considerable time, effort and money were dedicated to making this project a success, resulting in improved water quality conditions and better land management. The Dairy-McKay

HUA paved the way for continued local interest and involvement in water quality issues and opened doors for further research in the field of nutrient and sediment loading and water pollution.

### C. Agency Involvement

Although there were many different organizations that made important contributions to the Dairy-Mckay HUA project, three agencies in particular were instrumental in its operation –the Oregon State University Cooperative Extension Service, the Soil Conservation Service (now NRCS) and the Agricultural Stabilization and Conservation Service (now FSA). Each of these agencies had clearly defined roles. The Extension Service was responsible for the informational and educational efforts throughout the project. This included facilitating public involvement in activities such as demonstration projects, workshops and tours, as well as directing communication efforts in the form of newsletters, inserts and brochures. The Soil Conservation Service was responsible for assisting individual landowners with technical aspects relating to the implementation of improved management and conservation practices. This kind of assistance included planning and design, supervision and certification. The Agricultural Stabilization and Conservation Service provided cost sharing assistance for local landowners installing new management systems and conservation practices. In situations where it was appropriate, assistance with fiscal management was also provided by the ASCS (WCSWCD 1991).

A number of Extension Service associates were closely involved with the Hydrologic Unit Area project. Leading participants were Dr. John Buckhouse, Dr. William Krueger, Dr. J. Ronald Miner, Dr. John Hart, W. Arden Sheets, John Baggott, Sandra Smith, Carolyn Dingus and Neil Rambo, the Extension Service's on-site agent concerned with the project. The remainder of this report will examine the efforts of the Oregon State University Cooperative Extension Service in fulfilling its role in the HUA project.



## II. Oregon State University Extension Service

### A. Objectives and Methods

The objectives of the Extension Service concerning the HUA project involved employing a variety of means to increase public knowledge of how management practices influence water quality and to increase understanding of how land use procedures can be improved to minimize negative impacts on water while maximizing productivity. Successful fulfillment of these objectives also entailed effective use of communication methods to extend awareness of informational and educational activities to all local potential participants.

Throughout the project, the Extension Service applied a medley of methods to accomplish the main objectives. Demonstration projects and field tours were organized to provide landowners with exposure to Best Management Practices or conservation techniques actually being installed or functioning on local landowner property. Workshops were offered to help clarify the issues of concern in the HUA and to present possible management solutions to potential problems contributing to nonpoint source pollution. Extension agents attended civic and local interest group meetings to participate, answer questions and spread information regarding the project to the locals. Road signs were set up indicating areas of interest or land users utilizing Best Management Practices. Informational Displays were exhibited in public areas to promote awareness of the HUA project. Awards were given to individuals demonstrating exceptional contributions toward land management practices that protect the water resource. An increased consciousness of information deficiencies led to a variety of research ventures. Newsletters, newspaper inserts, and brochures or pamphlets were employed to help disseminate information about issues of concern, upcoming events or past activities related to the HUA.

As with any project with this magnitude, there were varying degrees of involvement in each type of activity on behalf of the Cooperative Extension Service. There were activities and materials relating directly to the purpose of the HUA, specifically designed to enhance awareness or involvement in methods of management that protect water quality, and there were indirect activities or materials not produced in direct association with the HUA but instrumental in providing exposure to others concerning the issues involved. These types of indirect activities were those where CES agents were involved in providing advice or support and in one way or another increasing cognizance of the water quality situation and possible solutions. There were also 'satellite' activities and materials that resulted from research needs identified during the HUA project or were motivated by the HUA and proceeded independently. A detailed examination of the informational and educational activities related to the HUA will help to better understand the effectiveness of the Cooperative Extension Service in reaching the goals set for this project. This information will be presented as direct, indirect and satellite informational and educational activities and materials.

#### B. HUA Landowner Survey

The first step for the Cooperative Extension Service toward fulfilling its role in the HUA project entailed the completion of a survey of landowners within the boundary of the Hydrologic Unit Area. This survey was aimed at discerning the level of awareness and degree of participation of the diverse, local populace toward management practices affecting water quality. The information obtained was valuable in developing informational and educational activities that would build on current local knowledge of the issues involved.

A total of 298 landowners in the Dairy-McKay Hydrologic Unit Area were polled. Of these landowners, 178 classified themselves as farm owners and 120 as forest owners. Respondents represented a full range of property sized from one acre to two hundred or more. Every landowner contacted had a stream or cut roadway or both on their property. They responded to questions concerning acreage, crops and operation; stream, roadway, soil, irrigation and septic system management; livestock and waste

management; water quality projects and agencies; public perception and demographics. In general, the results of the survey indicated that the Extension Service needed to focus on increasing public perception of what the HUA was about, problems associated with inadequate animal waste management, water quality issues in general and where to find agency assistance with information, planning and funding. Of particular interest is that sixty five percent of farm owners and sixty eight percent of forest owners felt that water quality in their immediate area was not too serious, not at all serious, did not know or had no answer (Rambo and Buckhouse 1993).

With this information in mind the Cooperative Extension Service began the process of providing information and education services to the landowners located in the Dairy-McKay HUA.

### **III. Direct Informational and Educational Activities and Materials**

This section presents activities and materials relating directly to the purpose of the HUA, specifically designed to enhance awareness or involvement in methods of management that protect water quality.

#### **A. Demonstrations**

A variety of demonstration events were prepared and advertised for public viewing. The purpose of these activities was to display possible management solutions for landowners that would protect water quality, actually being applied in situations that they could relate to. The demonstrations took place on local property volunteered by the owners for that purpose. These were excellent opportunities for other property owners to acquire information about the ideology and mechanics of featured management practices in a 'close up' situation. Also, by having these activities in conjunction with the landowners on private property, observers remained in an environment they trusted surrounded by their neighbors or others with their same interests at heart. A few major demonstrations are discussed below, where available, location and attendance information is included.

##### **1. Straw Mulching/Damper-Diker Erosion Control Demonstration**

The purpose of this activity was to demonstrate a possible erosion control method to reduce sediment and nutrient runoff from uncovered soil in furrows between crop rows. In 1992, a Hobson

Mulching System and a Dammer-Diker machine were acquired for the demonstration and in cooperation with the owner of an eight acre strawberry farm in Washington County, both instruments were put to use on a portion of the strawberry fields. A total of fifty people, including journalists, attended the demonstration.

Although straw mulching to curb erosion was not a new concept for those in the area, the process was traditionally done by hand—a time and labor intensive process with straw bits often requiring separation by hand from the harvested crop due to the irregularity of the application process. The Hobson Mulching System is a mechanical way to apply straw mulch to the furrow spaces between crops with greater speed, accuracy and regularity. The dammer-diker is a machine with paddles attached to a wheel that leave behind small basins when pulled through the furrow rows. This process allows for reductions in runoff losses of sediment and nutrients by storing water in the small basins where there is less movement and greater infiltration. In addition to both of these methods being practiced on the strawberry farm, a third method was also demonstrated. Utilizing the straw mulch and a cover crop, mulching took place the day following a planting of spring oats between crop rows. As a matter of interest, sediment and nutrient losses were monitored on each treatment type (SCS, OSUCES, and ASCS 1993).

As a result of this demonstration a second one was scheduled and both machines were borrowed by other landowners for use. Within the next several weeks, five property owners used the straw mulching machine on their property and two borrowed the dammer-diker (SCS, OSUCES, and ASCS 1993).

## 2. Cover Cropping Demonstrations

Several different cover cropping and interseeding demonstrations were organized. The purpose of these were to provide examples of how a variety of planting methods could utilize the spaces between commercial crop rows and reduce sediment and nutrient delivery to streams. For example, in cooperation with Love Farms, owned by Jim Love of Forest Grove—a blueberry grower in the HUA, a permanent cover crop demonstration was completed in 1992 using permanent perennial grasses between rows of blueberries. Several different grass types or varieties were planted to observe differences in the level of management required. This same kind of demonstration was also performed on blackberry fields, strawberry fields, vineyards, orchards, sweet corn, snap beans, wheat fields and Christmas tree farms throughout the project. Another demonstration consisted of perennial grass plantings without interseeding between crops and without irrigation or fertilization to determine longevity and persistence. These demonstrations were

located across the HUA. Some of the landowners that cooperated with these projects included: S&S Farms, Duyck Bros. Farms, Richard Moeller and Alan Jesse, Cal Krahmer & Sons Farms, OGI Farm Orchard, OSU Extension Service (turf plantings on property), Jim Taylor Vinyard, Bob Williams Vinyard, Northwest Christmas Tree Association, and Rick Ferris. Community involvement was increased by informing local seed providers of the project -who then donated seed, holding public meetings to generate general discussion about interest and feasibility of using cover crops interseeded with commercial crops to reduce sedimentation and improve water quality. Tours of the demonstration sites were also advertised and conducted. Discussions and tours covered topics ranging from the principles of water quality management, seeding rates and methods, varieties, plot sizes and replications to grower experiences (SCS, OSUCES, and ASCS 1992, SCS, OSUCES, and ASCS 1993, NRCS, OSUCES, and FSA 1995).

### 3. Erosion Control Demonstration

Another demonstration, completed in 1995, consisted of selecting an assortment of vegetation beneficial to wildlife as food and cover and planting an exposed area for erosion control to maintain or improve water quality. The cooperating landowner in this activity, Glenna Wilder of Bro-A-Bryn Farms, volunteered to monitor the planting site and report on wildlife use, success of establishment and levels of management required. The purpose of the demonstration was to provide an example of an alternative plan to traditional grass plantings. The assortment of vegetation chosen provided increased benefits to wildlife and decreased maintenance needs and fire hazards. The results of the demonstration were incorporated into further workshops and tours for the public.

Many other demonstrations were established concerning issues such as onsite animal waste management systems for small acreage farms and their effects on water quality and methods for protecting riparian areas next to waterways. Some of these methods included alternate sources of drinking water for livestock such as troughs and nose pumps, a type of drinking fountain for livestock. Hosted observation tours were conducted for members of the community covering these demonstrations.

The few demonstrations discussed above provide examples of what these activities involved. In addition, a generalized list of demonstrations by year is presented below.

#### 4. Direct Demonstrations by Year

In 1992 the following demonstrations were reported (SCS, OSUCES, and ASCS 1992, Rambo 1991-1998):

- erosion control demonstrations including straw mulching, dammer-diker operation,
- cover cropping and interseeding practices,
- animal waste management demonstrations were organized.

In 1993 the following demonstrations were reported (SCS, OSUCES, and ASCS 1993, Rambo 1991-1998):

- several small farm demonstrations for off-stream watering, manure storage and composting, pasture and grazing management practices,
- interseeding demonstrations on larger operations with cover crops in vegetable production – these took place with 18 participants,
- six demonstrations of on-farm nutrient management with participants in the Water Quality Incentive Program,
- a nutrient field day organized and directed to demonstrate the pre-sidedress nutrient test, manure spreader calibration, irrigation water management and corn root development -45 people were in attendance.

In 1994 the following demonstrations were reported (SCS, OSUCES, and ASCS 1994, Rambo 1991-1998):

- small farm demonstrations were continued,
- an Ag Chem Representative Field Day was held to demonstrate nutrient management and the pre-sidedress Nitrogen Test (PSNT). Chemical dealers were among the participants at this demonstration.

In 1995 the following demonstrations were reported (NRCS, OSUCES, and FSA 1995, Rambo 1991-1998):

- permanent cover crop demonstrations on berry farms resulting from combined resources of the CES, OSU, USDA-NRCS and WCSWCD,

- several, continued small farm demonstrations, four weekend visits to these small farm demonstrations were conducted with approximately sixty people attending on each occasion.

In 1996 the following demonstrations were reported (NRCS, OSUCES, and FSA 1996, Rambo 1991-1998):

- six small farm demonstrations focusing on near stream and manure management, including a coordinated effort between Portland Community College and the Oregon State University Cooperative Extension Service in establishing a model farm utilizing best management practices at the Rock Creek Campus.
- Another demonstration for controlling erosion on exposed road cuts near waterways utilizing native plants that provide food and cover for wildlife was completed using research grant funds obtained by the CES.
- A manure composting management demonstration in cooperation with Glenna Wilder, Bro-A-Bryn Farms, was begun and was intended to provide a study for pathogen control. However, completion of this project was prohibited due to serious physical injury on behalf of the cooperating landowner.

In 1997 (NRCS, OSUCES, and FSA 1997, Rambo 1991-1998):

- Four, small farm animal waste demonstrations were continued and served as sites for tours and workshops.

#### B. Workshops and Tours

An assortment of workshops and tours dealing with water quality issues such as nutrient loading and sedimentation or management methods that affect water quality were developed and the public invited to attend. These informational meetings provided explanations about how landowners affected and were affected by the HUA. Topics included phosphorous –what and where it comes from and how it affects the water quality; manure management –effective methods and preventing pollution; horse husbandry – reducing vegetation and sediment losses and managing wastes to protect water quality; and alternate water sources for livestock –to keep riparian areas intact. Tours were directed on cooperating landowner property

where Best Management Practices had been implemented for first hand experience and observation. Cooperative Extension Service agents that attended tours and workshops were also able to share information obtained with others. A more organized list of workshops and tours is presented here, where available, attendance information is also provided.

In 1991 CES agents attended the following (SCS, OSUCES, and ASCS 1992, Rambo 1991-1998):

- a Cover Crop/Living Mulch Mini-tour at Oregon State University, and an Oregon Department of Forestry workshop on protected zones for streambanks;
- a small scale tour of the HUA was conducted for Department of Environmental Quality personnel.

A number of organized tours and workshops were reported in 1992 (SCS, OSUCES, and ASCS 1992, Rambo 1991-1998):

- A Chamber of Commerce, Agricultural and Forestry Tour was completed where attendees viewed erosion control practices using recycled construction debris as well as landfill leachate control with poplar and irrigation water recycling practices. Seventy-five people were in attendance.
- A national level agency tour for the Natural Resource Conservation Service was also completed. The purpose of this tour was to develop a better understanding of the complexity of the HUA project and take a look at a long-term sub-basin monitoring proposal. In conjunction with this tour, attendees also participated in a technical meeting to discuss ongoing research efforts concerning phosphorous processes.
- An Extension Agent Mulch Tour also took place, Cooperative Extension Service agents, Oregon State University specialists and researchers attended, twelve in all. The tour consisted of viewing the straw mulching, dammer-diker, inter-seeding and cover crop demonstrations throughout the HUA.
- An Inter-agency HUA tour and a Phosphorous Workshop for landowners were also held. There were approximately 35 attendees and 70 landowners present, respectively.
- CES representatives also attended a Systems Problem-solving Workshop for Horticultural Leaders,
- a Farming for Profit and Stewardship, Sustainable Agriculture in the Pacific Northwest Workshop,



- a Coordinated Resource Management Workshop,
- the Annual Water Quality Workshop for agents at Oregon State University,
- and an Extension Program Evaluation Workshop.

In 1993 the following were reported (SCS, OSUCES, and ASCS 1993, Rambo 1991-1998):

- A second Chamber of Commerce, Agriculture and Forestry tour that focused on best management practices on a dairy farm and a timber operation. Eighty-six people attended.
- Two inter-agency tours took place with the CES, SCS, ODA, SWCD, and ASCS –with a total of 97 participants (52 and 45, respectively). Tour topics were confined animal feeding operation (CAFO) animal waste projects, cover cropping, nutrient management and irrigation water management, erosion control and forestry practices.
- A phosphorous workshop was coordinated for nurserymen, farmers, field men and farm suppliers by the CES, SCS, ODA, and SWCD. This workshop provided information about problems with phosphorous, the Tualatin River, Nutrient management and budgeting and tips for growers. Seventy-five people attended the workshop.
- A Cover Crop Twilight Tour was conducted where attendees viewed interseeding trials.
- The 1993 Agricultural/Forestry Tour was also completed, with 85 participants.
- A half-day tour was arranged as part of the Water Quality Conference at Oregon State University where participants could view land management practices and a wastewater treatment plant. Sixty people were in attendance.
- A Lakeside Reclamation tour was conducted on behalf of an Ecology class from Pacific University. Students viewed hybrid poplars used to intercept landfill leachates and erosion control methods –there were fifteen attendees.
- CES agents also attended a watershed workshop sponsored by the “Health to the Salmon” organization.
- A Pioneer Seed Company Field Day with 30 participants was completed,
- and a Horse and Land Use Workshop with 80 participants was also conducted.

In 1994 (SCS, OSUCES, and ASCS 1994, Rambo 1991-1998):

- A tour of the Dairy-McKay HUA was conducted for the National Association of Conservation Districts (NACD). The tour covered water quality improvements through nutrient and irrigation water management, the WQIP and CAFO animal waste projects. This tour was quite successful and led to several inquiries for further information from several states. The SCS and the WCSWCD primarily hosted this tour.
- The CES HUA agent attended a Managing Landscapes and Ecosystems Workshop.
- The 1994 Agriculture/Forestry Tour was co-sponsored by the Forest Grove and Hillsboro Chambers of Commerce and the Extension Service –88 people attended.
- Small Farm Management Workshops were also completed –75 people were in attendance.
- An Ag-Chem representative field day was also completed, approximately nine people were in attendance.

In 1995 (NRCS, OSUCES, and FSA 1995, Rambo 1991-1998):

- Small farm demonstration sites provided locations for a series of weekend workshops on animal manure and pasture management, streambank protection and off-stream watering practices and other BMPs.
- The annual Agriculture/Forestry Tour was also completed, 95 people were in attendance.

In 1996 (NRCS, OSUCES, and FSA 1996, Rambo 1991-1998):

- 90 people attended a tour of the West Fork Dairy Creek Soil Bioengineering Project,
- The CES and the WCSWCD conducted the annual Agriculture/Forestry tour which 95 people attended. This co-sponsored tour focused on rural water quality and the Tualatin River.
- A field day tour of manure applications rates, animal waste storage, and pasture management was also completed.

In 1997 (NRCS, OSUCES, and FSA 1997, Rambo 1991-1998):

- The annual Agriculture/Forestry tour was completed successfully –90 people attended the tour.

### C. Civic and Committee Meetings

In addition to attending workshops and tours, Cooperative Extension Service associates were members of various committees and were involved with many civic meetings. This enabled them to keep abreast of issues of concern in the community and share information about the HUA, nonpoint source pollution and water quality issues as well as orchestrate the project needs in a logical, efficient fashion. Examples of these meetings and committees include the HUA Coordinating Committee, the Hydrologic Unit Area Research Meetings, the Team-USDA SWCD HUA Committee, and the Dairy-McKay Hydrologic Unit Area Inter-Agency Action Committee. The following is more complete list of committee participation with attendance information provided where possible.

The Cooperative Extension Service HUA representative attended the following in 1991 (SCS, OSUCES, and FSA 1992, Rambo 1991-1998):

- WCSWCD HUA Advisory Committee;
- Forest Grove Rotary meeting -36 attendees;
- Forest Grove Chamber of Commerce Agricultural/Forestry Committee -approximately 7 attendees monthly;
- Produce Industry Fieldmen meetings -16 people attended;
- Inter-agency HUA Action Committee;
- Hillsboro Chamber of Commerce Agriculture/Forestry Committee -from 12-18 attendees monthly;
- Tualatin River Basin Water Quality Plan Committee;
- Tualatin Valley Irrigation District meetings -200 people attended;
- Agricultural Stabilization and Conservation Service meetings;
- Irrigation/Recycled Wastewater/Sludge Committee for Tualatin River Basin Water Quality Plan meetings;
- A Forest Grove Chamber of Commerce, Tualatin River Flow Management Technical Committee, Washington County Extension Advisory Council and Kinton Grange meeting -108 total attendees.

In 1992, the Cooperative Extension agent for the HUA attended (SCS, OSUCES, and FSA 1992, Rambo 1991-1998):

- Tualatin River Flow Management Technical Committee meetings;

- Annual Horticultural Roundup –80 attendees;
- Oregon Rivers Conference –25 attendees;
- Hillsboro and Forest Grove Chamber of Commerce Agriculture/Forestry Committees –7-18 people present at each monthly meeting;
- Forest Grove Chamber of Commerce meeting –36 people in attendance;
- WSCWCD meetings –approximately 200 people in attendance;
- Washington County ASCS, Inter-agency HUA Action Committee;
- Irrigation/Recycled Wastewater/Sludge Committee;
- Washington County Extension Advisory Council meetings;
- Annual Cooperative Extension Conference;
- Tualatin River Conference;
- Water Quality Incentive Program meetings;
- Produce Industry Fieldmen meetings, the Annual Water Quality Conference meetings;
- On Farm Research project implementation meeting;
- Farmers Meeting to discuss cover crops, about 25 people participated.

In 1993 the CES agent attended the following (SCS, OSUCES, and FSA 1993, Rambo 1991-1998):

- Hillsboro and Forest Grove Chamber of Commerce Agriculture/Forestry Committee –7-18 people attend the monthly meetings;
- SWCD meetings and the Washington County Extension Advisory Council meetings;
- Forest Grove Chamber of Commerce Tourism Committee;
- Hillsboro Chamber of Commerce Leadership Program XI meeting –50 people in attendance;
- Natural Resources Committee of the Washington County Extension Advisory Council meetings;
- Washington County Farm Bureau meetings –eight people in attendance;
- ASCS County Committee;
- Soil and Water Conservation Society meetings;
- Tualatin River Basin Technical Committee;
- A local grower's meeting –150 people in attendance;

- USDA agency HUA planning meeting;
- Citizen Participation Organization meeting –5 attendees;
- A meeting with students at Tuality Middle School –125 participants;
- Washington County Dairy Association –15 attendees;
- Annual Water Quality Conference at Oregon State University;
- North Willamette Research and Cooperative Extension Center meeting;
- Annual Cooperative Extension Service Conference;
- CES HUA agents also hosted a farmer's meeting on water quality management economics.

In 1994 the Cooperative Extension HUA agent attended the following (SCS, OSUCES, and FSA 1994, Rambo 1991-1998):

- Produce Industry Fieldmen meetings –18 people were in attendance;
- Tualatin River Conference –approximately 80 attendees;
- Hillsboro and Forest Grove Chamber of Commerce Agriculture/Forestry Committees –between 7 and 18 attendees at each monthly meeting;
- Inter-Agency Dairy-McKay HUA Action Committee;
- Willamette River Corridor issues meeting;
- Soil Conservation Service meetings;
- Tualatin Basin Public Awareness Committee;
- Farming for Profit and Stewardship Conference;
- Agricultural Stabilization and Conservation Service County Committee;
- facilitated a satellite teleconference on the Home-A-Syst program from Wisconsin;
- Washington County Soil and Water Conservation District meetings;
- Annual Cooperative Extension Service Conference,;
- attended and presented at the Tualatin River Conference;
- a meeting of domestic well owners involved with the WQIP;
- Master Woodland Manager trainees meeting –18 in attendance;
- Ag Chem grower meetings;

- Oregon Community Foundation meeting;
- Washington County Agricultural Roundup –40 people attended;
- Seven focus group meetings were held, with the topics of each meeting concentrating on the needs of a different enterprise, such as berry growers, small farms, nurseries etc., 5-10 people attended each meeting.

In 1995 the HUA agent for the Cooperative Extension Service attended the following (NRCS, OSUCES, and FSA 1995, Rambo 1991-1998):

- Hillsboro and Forest Grove Chamber of Commerce Agriculture/Forestry Committees –seven to eighteen people were in attendance at these monthly meetings;
- Hillsboro Chamber of Commerce Leadership Program XII meetings –50 in attendance;
- Washington County SWCD meetings;
- Tualatin River Basin Public Affairs Committee;
- Washington County Field Crop Producers meetings;
- Produce Industry Fieldmen meetings;
- Farm Bureau meetings;
- Oregon Community Foundation meetings;
- Grower's meetings;
- Garden club meetings;
- Annual Cooperative Extension Service Conference.

In 1996 the HUA CES agent attended the following (NRCS, OSUCES, and FSA 1996, Rambo 1991-1998):

- Washington County Soil and Water Conservation District Board meetings;
- Hillsboro and Forest Grove Chamber of Commerce Agriculture/Forestry Committees –7-18 attendees;
- Tualatin Basin Public Awareness Committee;
- Technical Advisory Committee for the Tualatin River Watershed Council;
- Tualatin River Basin Public Affairs Committee;
- Beaverton Rotary Group –125 people in attendance;

- Cornelius Chamber of Commerce –45 attendees;
- Washington County Farm Bureau;
- Garden club and Grower meetings;
- Oregon Community Foundation meeting;
- Citizen Participation Organization meetings;
- Annual Cooperative Extension Service Conference.

In 1997, the CES agent for the HUA attended the following (NRCS, OSUCES, and FSA 1997, Rambo 1991-1998):

- Hillsboro and Forest Grove Chamber of Commerce Agriculture/Forestry Committees –7-18 attendees monthly;
- WCSWCD meetings;
- Tualatin River Basin Public Affairs Committee;
- Hillsboro Garden Club meeting –12 people in attendance;
- Oregon Community Foundation meetings;
- The CES HUA agent also met with students at a junior high and two middle schools to discuss HUA activities;
- Technical Advisory Committee for the Tualatin River Watershed Council.

In 1998 the CES HUA representative attended the following (Rambo 1991-1998):

- Hillsboro and Forest Grove Chamber of Commerce Agriculture/Forestry Committees –from 7 to 18 attendees each month;
- Washington County SWCD Board meetings.

#### D. Newsletter Columns and News Inserts

The on-site Cooperative Extension Service agent for the HUA submitted materials for a newspaper column entitled “Eye on Rural Water Quality” on a regular basis through the duration of the project. This article was published in a local paper, the Forest Grove News-Times and delivered throughout the area. A number of newsletter inserts were also produced and delivered to residents within

the HUA boundaries. Another non-profit, publication assembled by the Cooperative Extension Service, entitled Friends of Extension, regularly featured articles addressing HUA issues written by a variety of authors, many of whom were direct associates of the CES. In addition to presenting informative articles, this publication also provided reviews of past HUA activities as well as advertising any that were forthcoming. HUA materials were compiled and submitted by the HUA CES representative for the first sixteen issues of this publication. "Friends" was distributed to 13,000 –14,000 households. "Friends" was initially a bi-monthly publication and was later converted to a quarterly publication. A newspaper insert entitled "Better Water in the Tualatin River Basin, Focus on Farm and Forestlands" featured a series of articles about rural water quality and was distributed to over 32,000 residents of Washington County alone in its first appearance. That insert was partially funded by EPA, DEQ, ODA and CES. In addition, various press releases concerning the HUA and cost sharing practices, technical programs and upcoming events were prepared and submitted by the CES agent. Another newspaper column called 'Go With the Flow' was submitted to the Forest Grove News-Times and the Hillsboro Argus (both local papers), primarily by the WCSWCD Water Quality Council. Examples of subject matter for these publications include the following:

- The issues and goals underlying the HUA project, including articles on nitrogen, phosphorus, water temperature and nonpoint source pollution.
- Reviews and upcoming information on workshops, demonstrations, tours, and meetings, as well as farm trials.
- Information about programs or incentives relating to water quality issues, such as those that provide support to landowners making improvements.
- Informative articles on water management such as irrigation system management and improvements and how reservoir systems are managed.
- Practices that protect water resources such as proper waste management and septic system maintenance.
- Educational pieces that help to understand methods of monitoring and measuring water quality.



- Information on Best Management Practices or BMPs, such as procedure details and where and how to obtain technical advice and/or assistance.

#### E. Displays and Brochures

In an effort to present information about the HUA and the issues involved to as many people as possible, informational and educational displays and brochures were developed. A large display was designed and erected at the Washington County Fairgrounds for the duration of the county fair 1992, through 1997, to which well over 100,000 people attended annually. Following the fair, the display was scaled down and rotated between public libraries for the duration of Water Quality Month in October 1992. Another display on rural water quality was arranged at the 1994 Tualatin River Discovery Day Environmental Fair. Approximately 215 people attended the fair. A display on Farm Stewardship Awards was put together for the annual Oregon Community Foundation Conference. A display depicting the HUA and rural water quality was compiled and set up at the OSU Cooperative Extension Office all-day Open House in 1996. In 1997, the CES HUA representative participated in the 'Common Water, Common Ground Celebration' by monitoring a Cooperative Extension Service booth and answering questions about the HUA. One thousand, two hundred people attended the event (SCS, OSUCES, and ASCS 1992, SCS, OSUCES, and ASCS 1993, SCS, OSUCES, and ASCS 1994, NRCS, OSUCES, and FSA 1995, NRCS, OSUCES, and FSA 1996, NRCS, OSUCES, and FSA 1997, Rambo 1991-1998).

A series of seven, individual brochures were released addressing the following issues in terms of small acreage management: management of near stream areas, weed management, erosion control, stock watering, manure management, septic system management and pasture management. These brochures were developed by the CES on-site agent and were made available to the public through the Washington County Extension office. A brochure about manure storage and composting was developed by the WCSWCD. Brochures were also designed and produced to address nonpoint source pollution for owners of hobby farms, to provide information about the Dairy-McKay Hydrologic Unit Area and to inform people about the availability of further information about phosphorous and nonpoint source pollution. Brochures were intended to present basic information about the featured topics and provide the readers with

appropriate contacts for more in depth information and assistance. Availability of brochures was advertised through news releases and discussions in civic and committee meetings. Brochures were also arrayed around informational displays to increase exposure.

#### F. Incentive Programs, Awards and Road Signs

Part of the Cooperative Extension Service's responsibility also included educating local landowners about the federally funded Water Quality Incentive Program or WQIP which existed to supplement installment costs of new management or conservation practices that improve water quality. News releases were published informing residents about this cost sharing program for those interested in improving management skills to protect water resources. These news releases related funds availability, possible applications for funding, deadlines for applying and points of contact for further information.

The Farm Stewardship Award was presented to selected individuals demonstrating exceptional effort in land management friendly to water quality. This purpose of this Award was to direct public recognition to those who were contributing to improved water quality efforts. Presentation of the Farm Stewardship Award entailed receiving a certificate of achievement and the installation of a roadway sign along the selected landowners property indicating the dedication of that resident toward improving the quality of water in the area. This award conveyed a sense of accomplishment and recognition to participants and the signs piqued the interest of passersby who proceeded to make inquiries about the award and the issues underlying its bestowal. This award was given to almost 50 individuals.

#### G. Research, Publications and Presentations

Research stemming from interest in the Dairy-Mckay Hydrologic Unit Area and the intense amount of time, energy and funds being directed toward improving water quality conditions in the HUA was also an important means of distributing information about the project. The work involved in research as well as the publications that resulted were important in this aspect. Several direct research products are mentioned here. A literature review entitled *Land Use and Nonpoint Phosphorus Pollution in the Tualatin Basin, Oregon* (Wolf 1992) was published as a special report discussing problems with phosphorus pollution,

potential sources of nonpoint pollution and possible solutions to the problem (1992). Donald W. Wolf also produced a master's thesis entitled *Land Use and Nonpoint Source Phosphorus Pollution in the Dairy-McKay Hydrologic Unit Area of the Tualatin River Basin, Oregon* (1993). Throughout this work, the relationships between land use and nonpoint phosphorous pollution are examined. This thesis addresses phosphorous concerns related to water quality generally, then turns to a technical discussion of phosphorous pollution followed by a section in which the social contexts of nonpoint source phosphorous pollution were presented. Another completed study by Professor J. Ronald Miner, Derek Godwin and Lynda Whitcomb entitled, *Controlling Nonpoint Pollution Escaping from Small Commercial and Non-Commercial Animal Enterprises*, addressed small livestock operations, specifically manure and nonpoint source pollution management (1993). This report discussed problems as well as possible solutions including practicality and effectiveness.

Further publications included small farm water quality packets that were produced and delivered to landowners in four counties; in addition, a formal project report for the straw mulching demonstration was completed. In conjunction with animal waste management demonstrations, Oregon Department of Agriculture produced a water quality handbook in 1993 entitled, *Water Quality Protection Guide*. This publication is available from the Oregon Department of Agriculture, Natural Resources Division in Salem, Oregon. In 1996, five fact sheets about water quality requirements were produced and distributed to landowners (NRCS, OSUCES, and FSA 1996).

Cooperative Extension Service representatives presented information about the Dairy-McKay Hydrologic Unit Area at the International River Quality Symposia in Portland, Oregon in 1994. The title of the presentation was *Farm and forestry operation survey of water quality issues, Dairy-McKay hydrologic unit area, Washington County, Oregon*. This material was based on the survey completed by John Buckhouse and Neil Rambo. Neil Rambo was the presenter.

In fiscal years 1993, 1994, 1995, 1996 and 1997 Dairy-McKay HUA presentations were also shared many local organization meetings to inform people about water quality issues and increase awareness of the HUA project. These include small farm management workshops, groups of public school students, the Forest Grove and Hillsboro Chambers of Commerce Agriculture/Forestry Committees, the Tualatin River Flow Management Technical Committee, the Cascade Youth Corp in Forest Grove, the

Beaverton Rotary group, the Hillsboro Garden Club, the Hillsboro Chamber of Commerce Leadership Program and the Cornelius Chamber of Commerce. Educational sessions were held where the CES HUA agent provided instruction on topics such as irrigation principles and cover crops for weed control.

In 1995 the CES agent also attended a videoconference at Oregon State University entitled the National Extension Water Quality Database (Rambo 1991-1998).

#### H. Other Activities and Materials

The CES HUA representative and other CES personnel attended a number of training meetings through out the course of the project. These training sessions were valuable tools for CES agents allowing them to learn more about issues important to the HUA project and enabling them to share that information with landowners and participants more effectively. In 1991 these included: a Livestock Waste Management Training Course at Oregon State University, the Hillsboro Chamber Leadership Program, a Water Quality Training and Water Quality Conference at Oregon State University, and an Integrated Pest and Crop Management session (Rambo 1991-1998).

In 1992, the CES agent attended Core A and Core B training for Pesticide License holders and a rural sociology training meeting was organized for CES, SCS and WCSWCD personnel. The purpose of the sociology training was to help prepare for contacting Washington County residents with less of an inclination for participation and getting them involved with the project. This training session focused on identifying customer (landowner) needs and marketing the project strategy accordingly (Rambo 1991-1998).

In 1994, 1995 and 1996, the Cooperative Extension agent attended pesticide re-certification classes (Rambo 1991-1998).

Interviews of CES personnel about the HUA project were also conducted and broadcast on radio programming.

## I. Progress Reports

The activities of the Cooperative Extension Service were documented on a regular basis in collaborative annual reports publishing the activities of the primary agencies involved and the status of the HUA project. In addition to these annual reports a monthly narrative report was compiled by the CES on-site project agent, and distributed to personnel overseeing the Cooperative Extension Service's involvement with the project. The annual reports are available for fiscal years 1992, 1993, 1994, 1995, 1996 and 1997. A complete collection of narratives spanning from July 1991 to March 1998 is also available from the Washington County Extension Office in Beaverton, Oregon.

## **IV. Indirect Informational and Educational Activities and Materials**

This section presents indirect activities or materials not produced in direct association with the HUA but instrumental in providing exposure to others concerning the issues involved. These types of indirect activities were those where CES agents were involved in providing advice or support increasing cognizance of the water quality situation and possible solutions.

### A. Surveys

The Tualatin River Basin Public Awareness Committee or TBPAC, conducted a survey in 1994 designed to evaluate how people in urban and rural residences near streams learn about water quality and what that level of understanding was. The initial survey was intended to provide direction for future water quality awareness efforts and to serve as a benchmark for comparison of future survey results. A second survey was conducted in 1997 to assess changes in public awareness. The organizations most closely involved with these surveys were the Unified Sewerage Agency and the Tualatin Basin Public Awareness Committee of which the Cooperative Extension Service HUA agent was a member. In this capacity, he served to assist in the project coordination as well as provide insights from his involvement with the Hydrologic Unit Area project.

Another survey of Washington County farmers was conducted in 1994. The purpose of this survey was to obtain information about Tualatin Basin farm practices that would allow for development of an EPIC model of phosphorous and nitrate movement on Washington County farmland. The Washington County Soil and Water Conservation District chiefly led this project, called the Tualatin Basin Farm Practices Project or the EPIC Farmer Survey Report. Cooperative Extension Service HUA representative was an integral part of the planning process, including material preparation, and the selection of those who ultimately conducted the survey. This project was closely related to the underlying issues of the HUA project and the CES agent's contributions were valuable to the modeling project. The funding for this project was a grant awarded by the Oregon Community Foundation to the Natural Resource Conservation Service.

## B. Demonstrations

### 1. Poplar Demonstration

Commercial production of hybrid poplars is on the rise in the state of Oregon. The purpose of this demonstration was to establish a stand of poplars as an alternative crop on a riparian floodplain zone, which would improve wildlife habitat and protect water quality while proving profitable for the cooperating landowner. This demonstration was conducted on a site with high visibility, good accessibility, and was the subject of field trip tours and publications in the CES newsletter as well as larger area newspapers. While primarily conducted by the Natural Resources Conservation Service (NRCS), CES representatives, the HUA agent in particular, participated in planning and coordinating meetings and in the transfer of technology from those immediately involved to others in the community. This 1997 demonstration took place in conjunction with Lyle Spiesschaert, a local grower.

### 2. Mold Control Demonstration

The purpose of this project was to determine the effectiveness of barley in controlling white and gray mold when planted before snap beans rather than apply a fungicide that could contribute to nonpoint source pollution. This demonstration was primarily supported through the Oregon State University On-Farm

Research Program. The Cooperative Extension Service HUA agent served as technical advisor for the project. The demonstration was a part of field tours and the information gathered from the project was compiled in a final report. This demonstration took place on Perri Nursery and Cecil Heyndrickx property, with the cooperating farmer, Ken Van Dyke, in 1994 and 1996.

### 3. Pre-sidedress Soil Nitrate Test Demonstration

Pre-sidedress Soil Nitrate Testing or PSNT, was also the subject of a demonstration. The purpose of this project is to demonstrate how testing nutrient content of the soils before planting (specifically nitrates in this case) can reduce the amount of commercial fertilizer necessary for purchase that may be spread in excess contributing to nonpoint source pollution problems. This project addresses one of the fundamental ideas behind the Dairy-McKay Hydrologic Unit Area project. This demonstration is listed as an indirect activity because although HUA Cooperative Extension agent was an integral part of information transfer in this project, it was supported mainly through the Oregon State University Department of Crop and Soil Science and the USDA-ACE program. Several meetings were held with landowners concerning this subject. Field demonstrations took place on Duyck Bros. Farms property, in 1994.

### 4. West Fork Dairy Creek Bioengineering Project

This project was primarily supported by the WCSWCD and a grant awarded by the Oregon DEQ. The purpose of this project was to rehabilitate a severely eroded stretch of streambank along Dairy Creek using non-traditional engineering practices. This project was the subject of conferences and tours conducted to increase awareness of the bioengineering methods being used to enhance the riparian corridor. Participants were provided with a take home resource in the form of a notebook of soil bioengineering techniques including those used at the site. This project was initiated in 1995 (NRCS, OSUCES, and FSA 1997).

## C. Research

Further cover cropping research projects were completed through the On-Farm Research Grant Program. The CES HUA agent was engaged with the planning committee for these projects and served as

a technical advisor for cooperating landowners. These research projects were also subject of field tours demonstrating management practices that protect water quality.

#### D. Committees, Publications and Presentations

The Cooperative Extension Service HUA representative served on civic committees organized to increase public involvement with water quality issues such as the Tualatin Basin Public Awareness Committee mentioned previously. The HUA agent was also a member of the Tualatin River Watershed Brochure Steering Committee, an organization that designed and produced an informative brochure concerning water quality and riparian relationships between people and the Tualatin River. As a member of these committees, the CES agent engaged in the transfer of technology and lessons learned from the Dairy-Mckay Hydrologic Unit Area project with the rest of the committee and the public involved.

A number of publications not directly connected with the HUA project but reflecting on land use management for improved water quality, and influenced by HUA Cooperative Extension Service representatives, were also made available to increase public awareness of water quality issues. These included a series of fertilizer guides for a variety of crops that provided recommendations for applications to avoid excess additions of nutrients that may end up in the river and a horse husbandry brochure designed to present small acreage landowners with proper management techniques that protect water quality. Brochures such as these were intended to provide introductory information and points of contact for in-depth assistance.

A seventy-page report entitled "*Tualatin Basin Farm Effects on Runoff Quality*" was produced based on the conclusions of the EPIC model project. In addition to this report, the findings were also presented at the ASA/SSSA/CSA Conference and the Vomicil Water Quality Conference in 1995. A report produced by the Oregon Rivers Council entitled "*The Once and Future Tualatin*" was published in 1992. This report contained the contents of the Tualatin River Conference.

A notebook of soil bioengineering techniques, including those used at the Dairy Creek site was also produced and provided as a take home resource for those who participated in tours and presentations of the project.



## V. Satellite Informational and Educational Activities and Materials

This section presents 'satellite' activities and materials that resulted from research needs identified during the HUA project or were motivated by the HUA and proceeded independently

### A. Publications

A number of publications resulting from similar interests as those served in the HUA have been developed and produced.

A collection of Tualatin River Basin Special Reports is part of these publications. This series includes the following:

- *Evaluation of Alternative Pollution Control Strategies for the Tualatin river Basin, Oregon*, a collaborative work by Ervin, Gregory, Kingeman, Koch, Li, Miner, Nelson, Warkentin, and Wells, 1995.
- *A Project to Collect Scientific Data and Provide Evaluation and Recommendations for Alternative Pollution Control Strategies for the Tualatin River Basin*, a collaborative work by Ervin, Gregory, Kingeman, Koch, Li, Miner, Nelson, Warkentin, and Wells, 1993.
- *An Analysis of Water Quality Data in Tualatin River Tributaries with Three Different Land Uses*, by Miner and Scott, 1992.
- *Modeling the Tualatin River System Including Scoggins Creek and Hagg Lake: Model Description, Geometry, and Forcing Data*, by Wells, Berger and Knutson, 1992.
- *Late Winter 1992 Sampling for Water Quality in three Stream Segments of the Tualatin River Basin, Oregon*, by Miner, Nelson, and Vedanayagam, 1993.
- *Data Analysis: Water Quality of Dairy Creek and Major Tributaries*, by Miner and Scott, 1995.
- *Landscape Change in the Tualatin Basin Following Euro-American Settlement*, by Shively, 1993.

- *The Historical Tualatin River Basin*, by Cass and Miner, 1993.
- *Issues Surrounding the Biota of the Tualatin River Basin*, by Li and Gregory, 1993.
- *Estimated Costs of Reducing Nonpoint Phosphorus Loads from Agricultural Land in the Tualatin Basin, Oregon*, by Cross and Wood, 1995.
- *Benefits and Costs of Riparian Habitat Improvement in the Tualatin River Basin*, by Knoder, 1995.
- *Analysis of Pollution Control Strategies for the Tualatin River*, by Ervin, 1995.
- *Response to Comments Received on the March 1993 Tualatin Water Quality Study Report*, by Miner, 1995.
- *Mass Balance Analysis of Suspended Solids in the Tualatin River*, by Vedanayagam and Nelson, 1995.
- *Summary and Assessment of Toxics Data for the Tualatin River*, by Khaodhiar and Nelson, 1995.
- *Agricultural Land Use in the Tualatin Basin*, by Scott, Wood and Warkentin, 1995.
- *Estimating the Frequency and Quantity of Surface Runoff Within the Tualatin River Basin*, by Taylor, Klingeman and Miner, 1995.

Further works include the following:

- *Eutrophication of the Tualatin River: Not Just a Summer Problem*, by Hartwick, Quiner, Smith and Stone, 1992.
- *Modeling Discharge, Temperature, and Water Quality in the Tualatin River, Oregon*, by Rounds, Wood and Lynch, 1998.
- *Sediment Oxygen Demand in the Tualatin River Basin, Oregon, 1992-1996*, by Rounds and Doyle, 1997.
- *Relations of the Tualatin River Water Temperature to Natural and Human Caused Factors*, by Risley, 1997.
- *Selected Elements and Organic Chemicals in Bed Sediment and Fish Tissue of the Tualatin River Basin, Oregon, 1992-96*, by Bonn, 1999.
- *Water Temperature, Specific-Conductance, and Meteorological Data for the Tualatin River Basin, Oregon, 1994-95*, by Risley and Doyle, 1997.

- *Management of Over-Utilized Streams: Lessons from the Tualatin Watershed*, 1994 Vomocil Water Quality Conference report.

Copies of these works are available from the Water Resources Research Institute at Oregon State University in Corvallis, Oregon.

Three additional allied theses include:

- *Water Quality Modeling of the Tualatin River*, by C. J. Berger, Portland State University, Portland, Oregon;
- *Calibration and Verification of HSPF Model for Tualatin River Basin Water Quality*, by F. Tang, Portland State University, Portland, Oregon;
- and *Modeling of Flow and Water Quality on Henry Hagg Lake Near Forest Grove, Oregon*, by M. Knutson, Portland State University, Portland, Oregon.

Copies of these works may also be obtained from the Water Resources Research Institute at Oregon State University in Corvallis, Oregon.

## VI. Interviews

### A. Interview Results

This section provides firsthand, personal insights of landowner participants in the Dairy-McKay Hydrologic Unit Area. As individuals whom the project affected directly, it was deemed appropriate and important to include their responses when considering the effectiveness and worthiness of the time and effort expended on this endeavor.

This material was obtained through personal interviews with the property owners who answered a series of questions about the HUA project. There were twelve questions in all, which covered perspectives of the HUA in terms of management approach and success and the Cooperative Extension Service's involvement with the HUA. A total of four representative interviews were conducted. Those individuals involved represented both small and large property owners. While not a formal survey of any kind, this

effort gained perspectives from a few of the landowners themselves. Through these interviews a perception of the strengths and weaknesses of the project was established, enabling a subjective correlation to be made between their remarks and the high volume of written material.

The first question was aimed at discovering how informed these landowners were about educational activities and events during the project. It stated, 'Did you receive or were you aware of publications, workshops, field days, demonstration projects etc.?' In response to this question, three of the interviewees answered positively. 'Yes' they were aware of these kinds of activities, although one individual did not attend many and another indicated his inability to attend due to scheduling conflicts. The fourth landowner seriously felt that a better job could have been done informing people about upcoming events, although no suggestions were made concerning the issue.

The second question was, 'Did you feel that informative assistance was readily available and did you know who to contact for help?' The purpose of this question was to discover if these landowners knew where to begin to garner assistance with improvement projects. All four respondents answered with a firm affirmative. One individual expressed this sentiment- "we had great access to expertise" (personal communication, Wilder 2000).

The third question was intended to gain an understanding of how these landowner's informational and educational needs were met. It read, 'If assistance was obtained, were your informational and educational needs met effectively?' All four responses to this question were positive. One landowner, in cooperation with the HUA on-site agent, engaged in trial and error projects on his property for which there was not a good deal of information available. In this instance, a comment was made that the Cooperative Extension Service agent "did his homework and provided assistance to the best of his abilities" (personal communication, Van Dyke 2000).

Question number four, 'Did you receive appropriate follow up?' was intended to elicit further response to question three. In this regard, all four related entirely positive experiences with Oregon State University Cooperative Personnel.

The fifth question was, 'What is your overall opinion of the management approach taken in the HUA project to improve water quality -in terms of multiple agency involvement, methods employed etc.'

All of the landowners interviewed indicated approval in response to this question. They approved of the cooperative approach that provided a larger, more diverse personnel base or skill set to work with. One landowner expressed that, individually, agencies tend to be short staffed, so this approach was particularly helpful. A second landowner vocalized approval of events such as workshops and demonstrations, as well as publications, but mentioned that attendance seemed to drop off after the first two years. He suggested that perhaps a part-time person responsible for spreading the word about such activities would have been a good idea.

The sixth question was formulated along the same lines as the fifth question. It was, 'Did you think that the agencies involved were cooperative and efficient, overall?' Again, all respondents answered favorably. Interestingly, one landowner indicated that there was some time and effort wasted on repetitious responsibilities among agencies while another landowner pointed out the lack of such as a strong point. One individual also observed good representation from the agencies involved with the project and mentioned that inter-agency 'political' problems were not an issue.

Question number seven addressed the costs of the project in the following manner: 'Do you think the time and funding dedicated to the project were well spent and was it cost effective in long run?' Each landowner interviewed felt strongly that all of the money and effort spent of the project were well spent. However, in terms of cost effectiveness, their opinions were more diverse. One landowner felt that it would have been more effective if there had been more positive results. This comment was in reference to the trial and error projects that took place on his property. The second interviewee felt that it was effective in the long run because they had learned enough to alter their practices. They were still taking soil and tissue tests regularly and continuing irrigation water management by measuring the soil moisture content. Another landowner differentiated her response by saying that, while the time and money were definitely well spent, there were no resulting financial gains. However, she adamantly expressed that it was definitely cost effective "for the environment and for the public good" (personal communication, Wilder 2000). The last landowner responded positively to both aspects of the question.

Question number eight was, 'Do you think there was good community involvement?' This question resulted in an array of responses. The first landowner replied that there was most definitely good community involvement. The second expressed uncertainty. The third answered that the community was

not involved at all and the fourth was of the opinion that those involved with the project generally seemed to know one another and seemed to be isolated from the public.

Question nine was stated, 'Would you like to see more of these collaborative projects take place in the future –both in and out of Washington County?' All of the landowners interviewed answered 'yes' to this question.

The tenth question was, 'As a result of your involvement with the HUA project, do you think you have more of an understanding of water quality issues and what best management practices can do for you in terms of improved water quality management?' All responses to this question were emphatically positive. One person expressed it best by saying, "orders of magnitude more" ( personal communication, Wilder 2000).

Question number eleven was, 'Have any of your growing/management practices changed as a result of the HUA?' This question was again met with unanimous affirmative responses. Each landowner had incorporated changes into their individual growing/management routines as a direct result of their involvement with the HUA project. One gentleman, referring to the best management practices he had implemented, said, "I wouldn't do it any other way" (personal communication, Clark 2000).

The final question, number twelve, was an open-ended question intended to encourage further expression from those interviewed regarding aspects of the project that may not have been addressed in the previous questions and were of a concern to them. It was, 'What question was not asked, that would have been a good one to ask?' Two of the respondents had nothing further to add at this point. Another commented that, following the conclusion of the project, the time and effort spent on improvements appeared to be forgotten and there were continuing needs that were not being met. She expressed that her availability as an educational resource (for demonstrations and tours) is utilized less frequently each year and that the cessation of small farm management workshops is "a real shame" (personal communication, Wilder 2000). The last landowner commented that, while he didn't have any new questions to add, his involvement in the HUA project was, "...something I'm proud of. I'm glad I got involved" (personal communication, Clark 2000).

## B. Interview Summary

These interviews are invaluable when considering the worth of the HUA project. Some respondents voiced concerns about inadequate advertisement of activities and information and a failure to meet continuing needs. As a part of future projects, it may be helpful to enlist an individual expressly for the purpose of advertising information and events and ensuring that continuing interests in project issues develop following the conclusion of the project itself. Overall, the responses and experiences of these landowners were positive and reflect approval of the program and a desire to see such programs continue. One individual expressed it by stating that, "Most landowners were like me, they knew they needed to do something but until this information and assistance was available, we didn't know what to do" (personal communication, Clark 2000).

## VII. Conclusions

The water quality problems in the Tualatin River Basin had the potential to become stifling to community function as well as spirit. Increasing regulations on agricultural practices without a well-structured support system to provide for educational, technical and financial assistance could very well lead to overwhelmed landowners, leading to anger or passivity—in such situations, paperwork abounds and results do not. While it is true, that the Total Maximum Daily Loads or TMDLs established for the HUA were not met in all waterways according to the timelines aspired to in this project, it is also true that the reductions in agricultural runoff contributions were a significant accomplishment.

As is usually the case, more research in several areas would benefit the movement toward improved water quality in the Dairy-McKay watershed and in other areas where reductions in nonpoint source pollution are desirable. Research needs identified throughout this project included the following: further information on how conservation efforts, such as Best Management Practices, effect water quality—including economic aspects, how background nutrient levels and sediment/nutrient delivery from erosion

and background contributions function, how and why dissolved oxygen concentrations fluctuate and groundwater systems recharge and flow. Continued advancements in applicable methods for nutrient requirements and management, and analysis of both soils and tissues for a variety of crops will also aid in sustaining production without excessive application of fertilizers. These are issues that should be incorporated into management plans. Increased understanding in all of these areas will assist in meeting TMDL goals in the future.

Washington County residents enjoy increased community benefits thanks to the HUA project. The time and money dedicated to the project went a long way in assisting landowners to implement best management practices and fund sorely needed improvement projects on property resulting in increased awareness and better water quality for everyone. Without the support programs offered through the HUA and other integrated options such as the Water Quality Improvement Program, these improvements could not have been made.

Washington County residents were not the sole beneficiaries of the project. This collaborative effort was an example in many ways. Representatives from all over the state of Oregon and other states as well took part in the demonstrations, workshops and tours that took place throughout the project, taking what was learned here to other parts of the country. The results of research efforts have contributed to a growing store of knowledge related to water quality issues. The Dairy-McKay Hydrologic Unit Area project has also contributed internationally to water quality awareness by sharing information with others at the International River Quality Symposia in 1994.

The success story here is the coordination of effort by multiple agencies engaging the local people to make changes for the better. Working together, the NRCS, OSUCES, and the FSA, along with many of the various other agencies and community groups involved with this project, have made a positive impact on the water quality in the Dairy-McKay Creeks Watershed. This collaborative success is likely to be the best and most lasting contribution of the HUA project. The Oregon State University Cooperative Extension Service was one of three primary elements of that success. The Extension Service personnel involved with the HUA performed their services admirably. Countless hours were spent working with local landowners on the key issues behind water quality concerns and building public relationships. Methods of



information and technology transfer were well utilized and great efforts were expended in reaching and teaching a variety of interest groups. Resources were well distributed among the avenues available.

Was the time and money spent on this project well spent? Was it a successful venture?

Unquestionably, Yes! This kind of collaboration leads to better community involvement, increased awareness and improved resource management. Water quality in the Tualatin River Basin was in need of improvement, and some improvements still need to be made -but as one landowner stated in an interview, "It is far more important to have education than regulation, if you give people good reasons to do good things, they'll do it voluntarily" (personal communication, Wilder 2000). While regulation will always have it's place, it is projects like these that provide successful examples of cooperation between agencies and local communities -projects which educate and which support the public good.

Appendix A:

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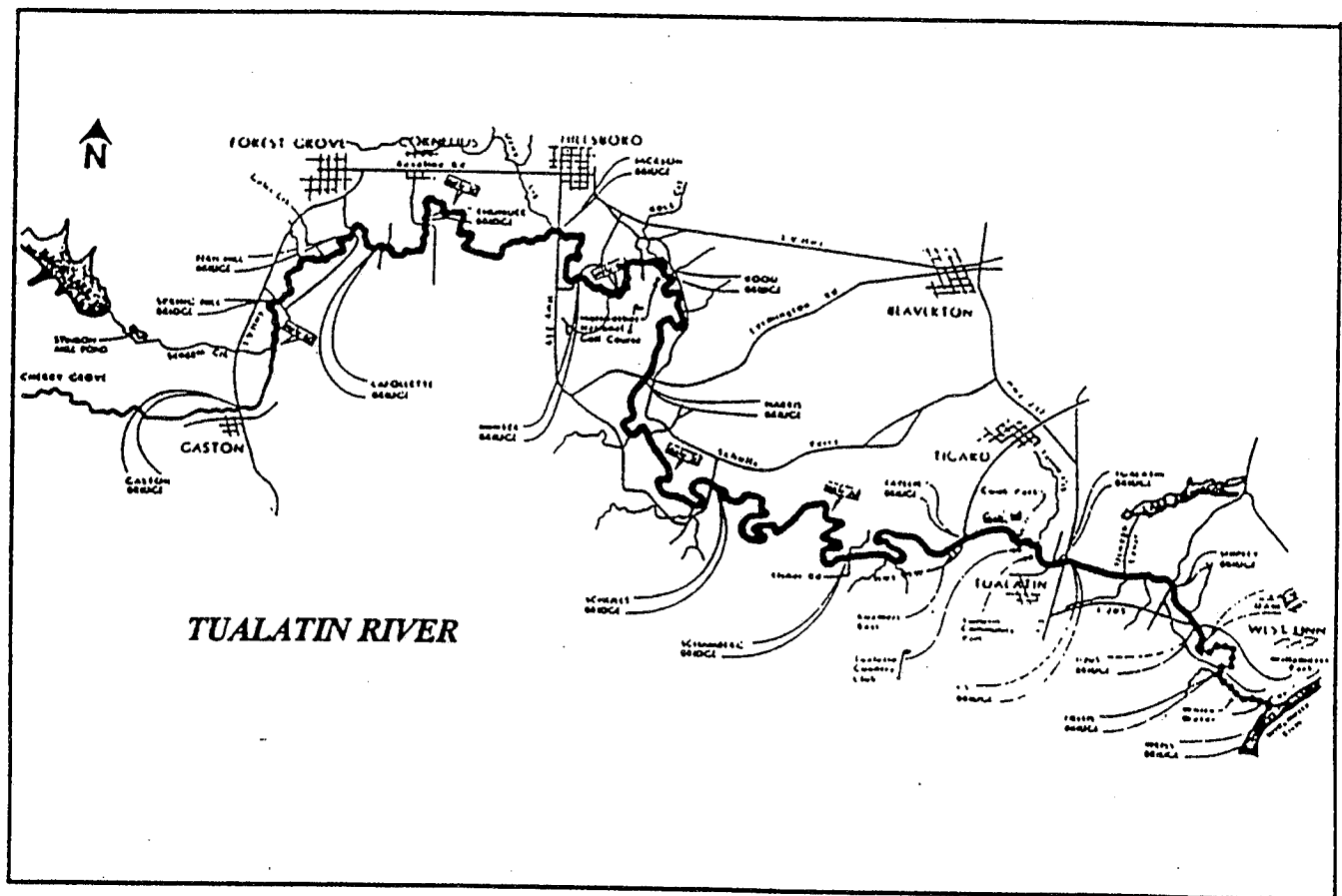
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Appendix B:

Examples of Informational and Educational Materials

# Land Use and Nonpoint Source Phosphorus Pollution in the Dairy-McKay Hydrologic Unit Area of the Tualatin River Basin, Oregon



M. S. Thesis  
Donald W. Wolf

June 1993

# NUTRIENT MANAGEMENT FIELD DAY

Friday  
September 10, 1993  
10:30 a.m. - 12:30 p.m.



at the  
**Ralph Duyck Dairy**  
9530 NW Roy Road  
Forest Grove



Sponsored by Oregon State University Extension Service  
and USDA Soil Conservation Service

On this field day we'll study management practices designed to meet the silage production needs of the livestock owner, and protect or enhance the soil and water resources. Management considerations for raising field corn will be discussed.

## TOPICS INCLUDE:

- Soil Nitrogen Quicktest and Pre-Sidedress Nitrogen Test Studies Updates
- Field Corn Root Development
- Irrigation Management
- Manure Spreader Calibration
- Manure Testing

## FOR MORE INFORMATION CALL:

Neil Rambo, OSU Extension Service, (503) 681-7007  
Todd Boldt, Soil Conservation Service, (503) 648-3014

# Better Water

Volume I, Number 2

## *In the Tualatin River Basin*

### *Focus on Farm and Forest Lands*

#### **The Nose Pump**

Marc Peters

In the ongoing efforts to improve water quality in the Tualatin River, the Oregon Department of Agriculture and Oregon State University have been testing a livestock pasture pump, or "nose pump," on cows and horses. This watering device functions as a drinking fountain for livestock and has been installed on two operations along the East Fork of Dairy Creek as part of a small farm demonstration project. This unique pump is completely powered by the animals. All the animal has to do is push a lever with its' snout, which in turn siphons about a pint of water from a nearby source into a small basin right at the pump.

The idea is to train livestock to stay out of streams and rivers by providing an alternative source of drinking water away from the stream or river. Restricting animal access to streams will protect the banks from

erosion and help keep manure out of the water. The livestock pasture pump is proving to be an effective method for achieving these water quality goals.

This animal-operated diaphragm pump provides drinking water from springs, ponds, creeks, and shallow wells. It is capable of lifting water from a depth of 26 feet, and delivering it 126 feet horizontally. The pump comes with a non-return inlet foot valve and costs approximately \$400.

This new pump is attracting attention among local livestock owners. It has a low-operating cost. This low technology tool which enables farmers to raise livestock near streams or rivers, and at the same time play an important role in enhancing and protecting water quality.

For more information, call Mike Wolf or Marc Peters, (503) 378-3810, at the Oregon Department of Agriculture, Salem.  
(Marc Peters is the Nonpoint Source Project Coordinator with the

Oregon Department of Agriculture)



#### **WQIP Update**

Neil Rambo

Twenty-seven people, and 6,500 acres, in the East or West Fork Dairy Creek area have been signed up for the Water Quality Incentive Program (WQIP). The program has provided incentive payments for management tools, such as soil tests, plant tissue analysis, manure testing, irrigation scheduling and well water testing. The signup period will be open until, Friday, October 15. If you farm around East or West Dairy Creek, check with your neighbors about WQIP, they may be using some new management methods on the farm.

(Neil Rambo is an OSU Extension Agent in Washington County)





## *Eye on rural water quality*

*By Neil Rambo*



## Rewards abound with water quality program

By NEIL RAMBO  
For the News-Times

If you are interested in saving money in your farming operation, and want to sharpen your crop management skills while enhancing water quality, the Water Quality Incentive Program (WQIP) may be for you.

According to Todd Boldt, water quality specialist with the Soil Conservation Service (SCS) in Hillsboro, farmers in the Dairy Creek Watershed in Washington County have until Feb. 26 to enroll in the federally-funded WQIP. This may be the last opportunity for Washington County farmers to participate, since more areas in the state will be competing for program funds in 1994.

"WQIP offers an opportunity for farmers to more efficiently use fertilizers and manures, reduce pesticide use, and improve their tillage program," said Boldt. "With WQIP, farmers can definitely cut costs and improve their bottom line. All farmers are eligible as long as they show some improvement in management skills. This applies to the established, progressive farmer as well as the newly established operator who is just developing a management system."

There are many different components from which to choose to build a Water Quality Incentive Plan. To date, some of the more popular components selected by farmers in existing 1992 contracts include integrated crop management, soil testing, manure testing, irrigation scheduling, and well testing.

All components chosen by the farmer are developed into a three-year Long Term Agreement (LTA). This approach offers farmers the opportunity to fine-tune their farming operations while reducing their operating costs. Each year of the LTA, participants can receive incentive payments up to \$3,500 per year or a maximum of \$25 per acre per year for land enrolled in the program.

Currently, 40,000 acres of agricultural land within the watersheds of the east and west forks of Dairy Creek are eligible for the 1993 WQIP. This new USDA program complements the ongoing water quality efforts within the Dairy-McKay Creek Hydrologic Unit Area. Both programs are tailored to meet producers' needs in addressing water quality concerns on agricultural lands in the Tualatin Basin.

WQIP funding for 1993 has been increased to \$200,000. In comparison, the 1992 WQIP had nine producers participating with over \$90,000 of incentive funds obligated. The deadline for interested producers to sign up for WQIP is Feb. 26, at the USDA-Agricultural Stabilization and Conservation Service (ASCS), in Hillsboro.

For more information contact the SCS office at 648-3014 or the ASCS office at 648-3174. Both offices are located at 1080 S.W. Baseline in Hillsboro.

*Neil Rambo is an Extension agent for Oregon State University in Washington County, working specifically in the Dairy-McKay Creek Hydrologic Unit Area.*

# Eye on rural water quality

By Neil Rambo



## Twilight tour explores cover crop study at farms

*This column was written as a letter to Neil Rambo by Mike Gangwer, Marion County Extension dairy agent and a college friend of Rambo, and is shared in this format courtesy of Gangwer. Rambo says the story about this class, which he was unable to attend, tells why Extension agents do what they do and gives a glimpse about why farmers farm.*

John Luna from Oregon State University and Dan McGrath, an Extension agent, held class on Keith Grover's farm in Keizer. We met under a soft evening sun, and in fact, this event was billed as a twilight tour for a cover crop study. About 30 of us.

The soft earth beneath our feet, the cool air of an April spring night, and the silver of a white moon overhead. Insects all around. A green one landed on my nose as if to say, welcome to this place.

We walked around mustard plants in full yellow color, and a purple weed of some sort I could not identify. And strips of cover crops . . . barley, vetch, rye, combinations.

We discussed these cover crops. Farmers talking, asking questions. Researchers writing notes, taking pictures, and answering with their best guess. Alongside, a small child played in the soil. His mother watched. Pickups lined the roadside. Not small, wimpy pickups, but big ones, mostly diesel, I think. Most had tool boxes. Many were four-wheel drive.

Farmers with canvas jackets, work boots, belts with tractor buckles, although one had something about a rodeo. A few women, taking notes, writing things down. I always felt women were good at note-taking.

John and Daniel shared with all of us. Whatever happens in this system of ours, we cannot allow good people like this to be lost.

I am imagining a meeting like this for farmers 50 years ago. Upon the same soil. Perhaps in the same field. What crops shall we grow? How shall we till the soil? What is lime? What is fertilizer? And, so we ask the same questions.

On a night when the best in all of us gathers in a field of cover crops, John telling us that legumes, for crying out loud, leak nitrogen into the root zone, and that a cereal crop must be present to use it. And Dan catching ladybugs with a bug sweep in a ryegrass/vetch field, while we watch the tips of the greenery move with his sweep.

On a night when overhead I think someone has blessed us without rainfall. And given us an open mind, eager questions, a humble voice, and a sharing heart.

All this took place not far from here, John and Daniel and Keith. The narrators. The rest of us, participants. And those not there, well, they can attend the next one. For as long as Oregon is our classroom, then we will take the message to the field, to the classroom, to the people, and to those who are willing to explore.

As I rode home on my bicycle, I sensed the urge to share this story with you. One that is repeated in all corners of our state. Probably every day. We are so fortunate.

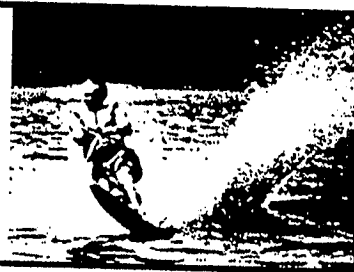
So is the story. Of a gathering on Clóquato soil in the twilight of a magical April evening. There was simply no better place to be . . .

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*Neil Rambo is an Extension Agent for Oregon State University, working in the Dairy-McKay Hydrologic Unit Area. His office is in Hillsboro at 2448 SE TV Hwy. Masthead photo courtesy of Jan Jarrett.*

7/8/92 Forest Grove  
News-Times

## Eye on rural water quality



# People responsible for Tualatin's phosphorus

By NEIL RAMBO  
For the News-Times

The Tualatin River is changing for the better, phosphorus levels in the water are going down.

The element phosphorus is not toxic or poisonous. In fact, it is necessary for plant growth. All land and water plants require certain amounts of the nutrient elements nitrogen, phosphorus and potassium. These nutrients are the major ingredients of fertilizers.

In the Tualatin River, when phosphorus levels get too high, the algae and other aquatic plants grow quickly, spreading underwater and turning the water green. Warm water, moving slowly during the summer makes the problem worse.

Phosphorus in water comes from several sources, and the levels would stay constant except for human activity. We are responsible for the high phosphorus levels in the river — from urban growth, farming and logging.

Until this year, the discharges from county wastewater treatment plants were a major source of phosphorus. The Unified Sewerage Agency, Washington County's wastewater treatment organization, installed and is operating equipment to remove phosphorus from urban wastewater. During the summer USA's treated water can have lower levels of nutrients than river water.

Unfortunately, only the water from the urban areas gets treated. In the rural areas, there is no county agency to clean up household wastewater or rainfall runoff. The landowner is responsible for his or her own septic system as well as soil or anything else that rain or irrigation washes off the property.

To put it another way, the health of the Tualatin River is improving, and we're seeing good results; but the job isn't over yet.

Neil Rambo is an Extension Agent for Oregon State University working in the Dairy-McKay Hydrologic Unit Area. His office is in Hillsboro at 2448 SE TV Hwy.

## Eye on rural water quality



# Faulty septic systems pose serious problem

By NEIL RAMBO  
For the News-Times

"Forgotten till it fails," best describes most septic system problems. The septic tank and leach field are a part of rural living that are often taken for granted or outright ignored.

Faulty systems endanger your health, your household, and your neighbors downstream. The raw effluent erupts to the surface, gurgles across your yard, and heads for that pretty creek — with the potential for causing a human and aquatic health disaster.

In a working septic system, solids in the sewage settle out in the tank and are removed by pumping. The liquid part passes through the tank, to be absorbed by the soil in the leach field. The separation of the sewage, partial biological digestion of the solids, and digestion and absorption of the liquids makes the system work.

Problems with a working system are usually due to one or a combination of these causes:

**Using too much water:** Either the system is too small for the household, or a major increase in the household water use has overloaded the system.

**Physical damage:** Building, driving or paving over the tank and field will compact the absorbing soil, break or shift the pipes and fittings.

**Improper design or construction:** Sizing the system too small for the household or installing the leach field too shallow or in the wrong type of soil will cause a system to eventually fail.

**Lack of maintenance:** The tank needs to have the solids pumped out about every three years. The tank should be checked inside for broken or deteriorating baffles.

**NOTE:** Leave checking in the tank up to the professionals. The tank fumes and gases can be deadly.

Actually, a properly sized and correctly constructed and maintained septic system will work for many years. Most owners don't have any problems.

"What can be done about some of these problems?" I will offer answers in my next column.

If you want more information on septic systems and maintenance call the Washington County Extension office at 681-7007 or visit the office at 2448 S.E. Tualatin-Valley Highway, Hillsboro.

*Neil Rambo is an Extension Agent for Oregon State University working in the Dairy-McKay Hydrologic Unit Area. His office is in Hillsboro at 2448 SE TV Hwy. Masthead photo courtesy of Jan Jarrett.*

## Area soil conservation practices help improve Tualatin River water quality

County farmers ahead of schedule planning their conservation work

By NEIL RAMBO  
For the News-Times

Efforts made by Washington County farmers to apply soil conservation practices on steep, highly erodible lands have helped improve water quality in the Tualatin River.

According to Robert App, district conservationist with the Soil Conservation Service office in Hillsboro, local farmers are well ahead of schedule in implementing their conservation plans. To date, plans have been written with 85 Washington County farmers for 11,300 acres. Over 55 percent of the plans have been fully applied.

Under the Food Security Act of 1985 (FSA) land operators are required to have conservation plans and be actively implementing them to maintain USDA program benefits. Coincidentally, state officials have set water quality standards for phosphorus and nitrates in urban, agricultural and forested areas in the Tualatin River Basin.

One key practice adopted often is

### *Eye on rural water quality*



conservation tillage. Each fall, instead of burying crop residues with a moldboard plow, many farmers are now using cover-crop disks and chisel plows to turn only part of crop residues into the soil. Plant residues left on the soil surface provide protection from erosion during intense winter rains, thus limiting the amount of sediment which washes into streams, creeks and rivers.

"By using crop residue to control the falling, splashing energy of raindrops," App said, "farmers have the best of both worlds. They protect fertile, productive soil on their farm and have a low-cost alternative to control erosion and improve water quality.

For the majority of farmers, leaving crop residues on the soil surface has required a commitment to change equipment and management skills. "Their efforts are commendable," App said.

Soils on steep, highly erodible lands are rarely moldboard plowed anymore. In some cases, where a spring crop is to

be planted in late March or early April, farmers have adopted the idea of leaving unharvested crop material standing untouched over winter.

Prior to the FSA, some farmers were already using conservation tillage, and needed to make no changes in their farming operations. Because of local farmers' commitment, the use of conservation tillage has spread into valley areas.

With as little as 30 percent residue cover on the soil surface, soil erosion is cut in half. This is significant since most of the more level valley fields are located near streams.

"These areas, if unprotected," App said, "could pour significant amounts of soil and sediment directly into streams, hurting water quality."

*Neil Rambo is an Extension Agent for Oregon State University working in the Dairy-McKay Hydrologic Unit Area. His office is in Hillsboro at 2448 SE TV Hwy.*

# PHOSPHORUS WORKSHOP

Co-sponsored by:

Soil Conservation Service  
Oregon Department of Agriculture  
Oregon State University Extension Service  
Washington County Soil & Water Conservation District

MONDAY, DECEMBER 7, 1992  
Cloverleaf Building, Washington County Fairplex, Hillsboro, Oregon

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## MORNING

Topics: What's the Problem and Why

9:00 - 9:30

**Welcome and Introductions.**

Arden Sheets - Oregon State University Extension Agent, Retired

9:30 - 10:00

**What's the Problem? What Are the Consequences of Too Much P?  
How Much Is Too Much?**

Mitch Wolgamott - Department of Environmental Quality

10:00 - 10:30

**The Tualatin River Today. Is Water Quality Improving?**

Dennis Lynch - USGS

10:30 - 11:00

**Who Needs It and Where Does It Come From. What is P? What Is  
the Role of P Relative to Plant Life?**

Wes Jarrell, Mary Abrams - Oregon Graduate Institute

11:00 - 11:30

**Enhancing Soil Organic Matter and Nutrient Cycling. Characteristics  
of P Cycle. Using Cover Crops.**

John Luna, OSU

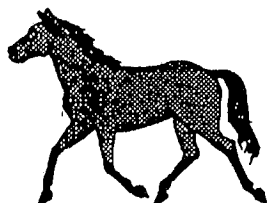
11:30 - 12:30

**\* LUNCH \***

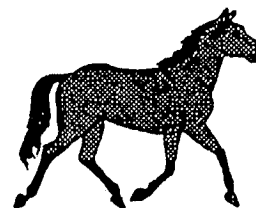
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- continued -

# HORSE AND LAND USE WORKSHOP



June 19, 1993



Sponsored by Oregon Department of Agriculture  
In Cooperation with Bro a Bryn Farm

This workshop will cover topics that relate to horses and their environment. As the space between rural and urban communities continues to dwindle, it is becoming more important for horse owners to consider issues such as mud, manure, and pasture management. Surface water runoff from livestock operations eventually ends up in streams, lakes, and rivers, affecting the health and well-being of both people and wildlife.

## TOPICS INCLUDE:

- **Horse Health** - parasite control, mud/water borne pathogens, injuries related to fencing & facilities, mental well-being with regard to turnout & confinement
- **Pasture & Grazing Management** - nutritional value & economics of forage vs. hay, pasture size, rotational grazing, renovating & managing pastures, wetlands
- **Mud Management** - high traffic areas, materials to minimize mud, sacrifice areas & dry lots, erosion control, grass filter strips
- **Manure Management** - composting vs. piling, surface water runoff, straw vs. wood chip bedding, pasture & turnout cleanup
- **Wildlife Enhancement & Protection** - livestock access to streams, ponds, and wetlands, managing riparian areas, enhancing & protecting wildlife habitat
- **BMP's** - Best Management Practices

**SPECIAL TOUR:** At the end of the workshop, the group will visit Bro a Bryn Farm to see an example of Best Management Practices being developed and how they relate to riparian, streamside, wetland, and pond ecology. Wear good walking shoes or boots and plan on walking ½-1 mile. No smoking allowed.

**INSTRUCTORS:** Experts from Oregon State University, Washington State University Cooperative Extension, King Conservation District, Oregon Department of Agriculture, Modern Forage Systems, Oregon Department of Fish & Wildlife, and a local veterinarian

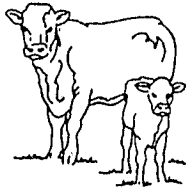


FOR INFORMATION AND REGISTRATION CALL:  
Marc Peters, Oregon Department of Agriculture, (503) 648-3014

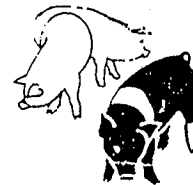


# SMALL FARM TOUR

*"Living on a few acres with your farm animals"*



**Saturday  
September 18, 1993  
9 a.m. - 12 noon**



**Sponsored by Oregon State University Extension Service  
and Oregon Department of Agriculture**

Small farms dot the landscape in the margins between urban and commercial areas, adding to the beauty of the Tualatin River basin. Quite often, families on these farms own a limited number of animals, and these homesteads may also support other farming activities. This tour will highlight best management practices on four small Washington County farms with animals. These practices are designed to meet the needs of the landowner, and protect or enhance natural resources. Management considerations for horses, beef cattle, and swine will be discussed.

## TOPICS INCLUDE:

- ◆ **Off-Stream Watering** - to limit livestock's use of the stream. Animals will visit the stream less when a alternate water source is provided.
- ◆ **Manure Storage** - to prevent loss of nutrients through leaching or rainfall runoff, before it is spread on the pasture, composted or hauled away.
- ◆ **Manure Composting** - to transform manure and bedding into a marketable farm or garden fertilizer.
- ◆ **Pasture and Grazing Management** - to maximize nutritional value and pasture yield, maintaining healthy animals and pastures.

**CALL BY SEPTEMBER 10 FOR INFORMATION  
AND RESERVE SPACE FOR TRANSPORTATION:**

Neil Rambo, OSU Extension Service, (503) 681-7007



# Livestock Drinking Fountain Gains Notoriety

Let there be no doubt about the power of the pen wielded by ODA's Information Office. A recent edition of the "Story of the Week" reached some lofty heights in the world of journalism. Somehow, some way, the August 11 story regarding nose pumps reached the likes of Paul Harvey and Australian Public Radio. Talk about getting good mileage out of a story!

Nose pumps are essentially drinking fountains for livestock. ODA and Oregon State University have been testing a \$400 diaphragm pump on cows and horses.

The idea is to train livestock to get their drinking water from the pump rather than a nearby stream or river. Keeping animals away from the stream will protect the banks from erosion and help keep manure out of the water.

The pump is connected to the stream or river by a 200 foot tube which draws the water. Animals simply push a lever with their nose which siphons the water into a little basin at the

pump. The first nose pump was recently installed in Washington County.

Local television stations jumped on the story first. This item had the potential for good pictures which made it good TV news. Mike Wolf in Natural Resources was interviewed several times and was seen on the evening news as often as President Clinton. The local bureau of the Associated Press carried the news after receiving the

**NOSY REPORTERS GET  
A SNOOTFUL FROM  
ANIMAL POWERED  
"NOSE PUMPS"**

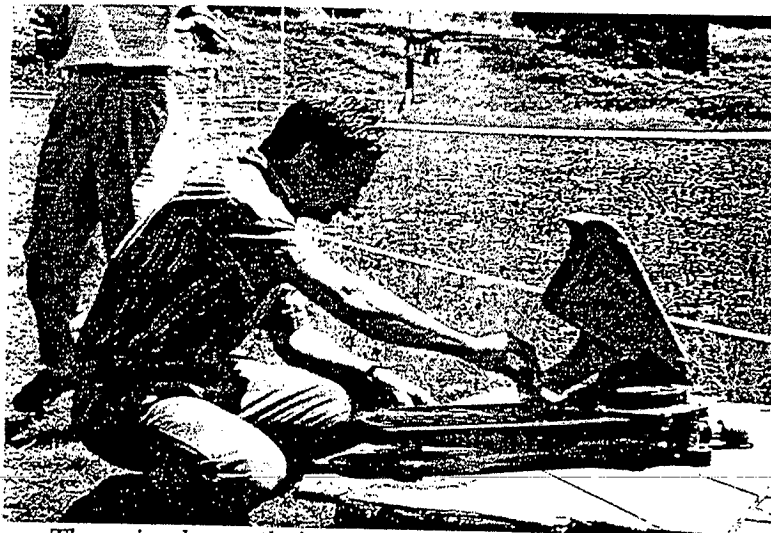


Photo by Bruce Pokarney

The animals use their mussel to push down on the pump, bringing water into the drinking basin.

"Story of the Week" in the mail. They passed it on to the regional desk which, in turn, forwarded the story to the national newswire. From there, news bureaus in Australia picked up the story and Paul Harvey made mention of the "effective yet inexpensive way that farmers and ranchers can protect nearby streams and rivers." And now you know the rest of the story.

-Bruce Pokarney

# Tour shows benefits of composting

By JILL S. CARROLL  
For the Capital Press

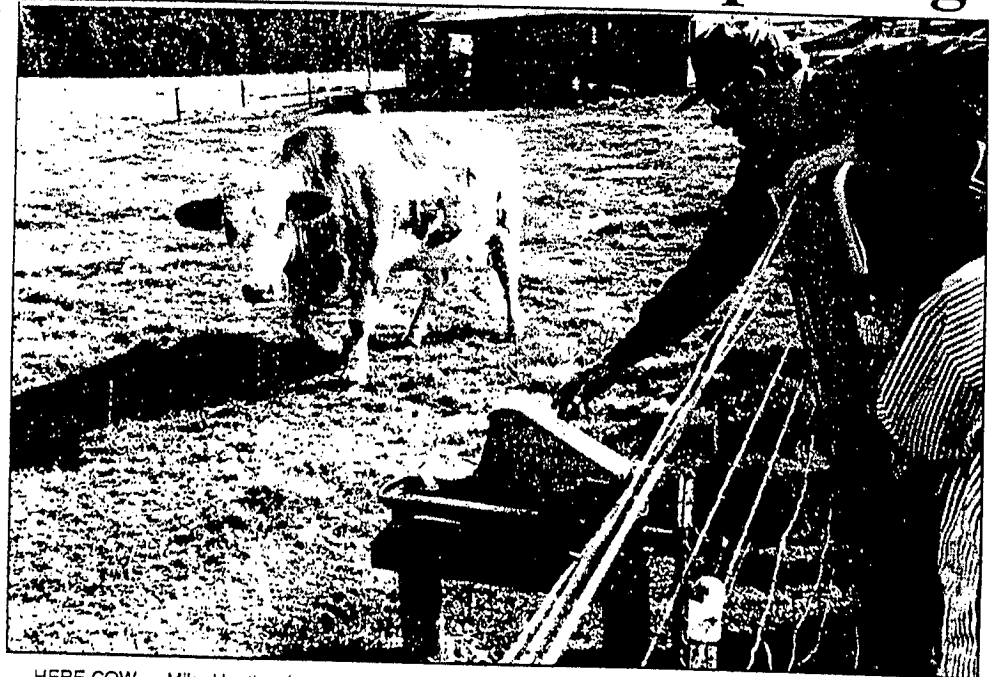
**MOUNTAINDALE, Ore.** — Compost thermometers and drinking fountains for livestock are among the new tools being used by some landowners in Washington County to enhance their farms and protect the environment.

About 20 people attended a half-day tour to learn conservation-minded management practices for small farms with animals. The tour was sponsored by the Oregon State University Extension Service and the Oregon Department of Agriculture. Cost-sharing was available to some landowners through state and federal programs.

John and Jabke Buessler own two horses and, like other horse owners, used to shovel out the barn and dump the manure in a pile nearby.

"It wasn't satisfactory. We wanted to handle the manure in a better way," Jabke said. With advice from the ODA and Extension Service, the Buesslers built a composting shed for the manure. It is covered and has three bins for storing manure in different stages of decomposing. They plan to add their yard dippings and vegetable kitchen waste to the compost. The cost of the shed was less than \$400.

The Buesslers also were concerned about



**HERE COW** — Mike Hauth, who runs seven head of cattle on a small acreage near Hillsboro, Ore., coaxes a crowd-shy cow toward a nose pump watering system during Washington County Small Farm Tour last weekend. (Photos by Jill Carroll)

their horses polluting Dairy Creek, which is at the edge of their pasture. They have installed cross fences to keep the horses out of the creek and set up a nose pump — a manual diaphragm pump — so the animals can get water any time.

Derrick Godwin, an OSU graduate student who has been working with several Washington County landowners on improving water quality in area streams, said the pump pulls water 6 feet up from the creek and 200 feet hori-

zontally into the pasture. The animals activate the pump by pushing it with their noses. Cost of the pump is about \$400.

Gary Clark's land is also along Dairy Creek, which drains into the Tualatin River. He owns four cows, two calves and seven pigs. He also has added fences to keep the livestock away from the creek and built a composting shed. However, the design is different from the Buesslers'.

"I had a feed operation on a slab that sloped toward the creek. No solids went into the creek, but there was runoff. With the cooperation of OSU, ODA and (U.S. Soil Conservation Service), we devised a new system," he said.

Clark built a covered 16-by 50-foot composting shed/feeding area on the side of his barn away from the creek. It has a concrete floor, but no partitions. He'll use his front-end loader to move manure from the barn and feeding area to the back of the composting shed. In the spring, the compost will be spread on his pastures.

Clark also added gutters and other drainage devices to limit the amount of runoff and mud that enters the creek from his property.

Clark's neighbor, Mike Hauth, used to let his seven cows cross

Dairy Creek and drink from the creek. Now fences keep the animals out of the creek and they drink from a nose pump in the pasture.

"They learned real fast to drink from the pump," he said. Hauth also has built a composting shed with a concrete floor onto his barn.

Last stop on the tour was Bro-a-Bryn Farm, where Glenna Wilder raises about 15 show horses. Mud has been a constant problem in the winter and she is hopeful that new drainage systems will be the solution.

"The feeding area is a high traffic area and we've had lots of mud problems," she said. "We've tried several methods that failed."

The new system will be tested as soon as the fall rains begin. Around the feeding area, Wilder is burying large dimension rock, which will be held in place by a retaining wall to keep the rock from migrating down hill. Several inches of wood chips will be added on top to cushion the horses' feet, she said. Gutters on the feeding shed roof will bring fresh rain water into the watering trough. Excess rain will be diverted away from the area through underground drainage systems.

At the edge of the sacrifice areas, where the ground will be bare

and muddy in the winter, a wide vegetative strip has been planted to naturally filter solids from the runoff.

Wilder also built a large covered composting shed. She plans to pile the manure in a long row. Then when the temperature of the manure reaches 140 degrees F., she will use her front-end loader to turn and move the compost, leaving space for the next row. The compost probably will be turned two or three times during the winter.

Wilder said she wants the compost at 140 degrees or more to get a good parasite kill, since the composted manure will be going back onto her pastures.

"We are always looking at ways to lure animals out of the streams in the summertime and to control runoff in the winter," said Ron Miner, a water quality expert from OSU. "It is exciting to get things on the ground to look at and evaluate them. Over the winter, we'll see how much material we have kept out of the stream."

Once new ideas are proven feasible, other landowners can adopt them for their particular needs, Miner said. "We must think in terms of convenience, comfort, safety and animal health."



**ROCKY ROAD** — Rocks piled up at Glenna Wilder's place near Hillsboro, Ore., will be placed in a bark-covered ditch in an area traveled by her horses. The purpose of the rocky pathway is to drain off water and keep mud from running across the path and into nearby Dairy Creek during winter.



**TUALATIN CLEANUP** — Todd Boldt, from the Soil Conservation Service, talks about nutrient management techniques during a stop at Wil-Rene Farms. It was the last stop on an agricultural water quality tour of the Dairy-McKay Hydrologic Unit Area cleanup project in the Tualatin River Basin. (Photo by Jill Carroll)

### *Because of conservation efforts*

# Tualatin water quality improving

By JILL S. CARROLL  
For the Capital Press

**HILLSBORO, Ore.** — Conservation projects are improving water quality in the Tualatin River basin.

That message was delivered to representatives of state and federal agencies during a recent tour of farms in the northern Willamette Valley.

The farms are part of the 160,000 acre Dairy-McKay Hydrologic Unit Area, which encompasses half of the agricultural and forestry land in Washington County. The area was targeted in 1991 by the federal government for a 5-year project to help landowners reduce soil erosion and sedimentation and prevent animal waste from affecting surface and ground water. The goal is to reduce the level of phosphorus in the Tualatin River, which is fed by Dairy Creek and McKay Creek. Of the 77,000 acres of agricultural land in the area, 18,000 acres are in conservation plans through the U.S. Soil Conservation Service. Landowners receive cost-share assistance and technical assistance from several state and federal agencies.

First stops on the tour were small farms along the East Fork of Dairy Creek where

agencies helped Gary Clark, Mike Hauth and Glenna Wilder to improve water quality and make managing livestock easier.

Clark owns four cows, two calves and seven pigs. He has added fences to keep his livestock out of the creek, gutters and other drainage devices to divert runoff from his barn and a manure storage shed/feeding area so he can store manure all winter and feed his animals under cover. Near his barn he also built a berm, which is being planted with grass and trees. The berm will help keep runoff from entering the creek.

Clark's neighbor, Mike Hauth, has seven cows that used to freely drink from across the creek. Hauth has added fences to restrict his animals to pastures and installed a nose pump so they can drink water when they choose. Hauth also added a manure storage shed and gutters to divert runoff from his barn.

Glenna Wilder raises show horses and had serious mud problems at her farm. She built a covered manure composting facility on a 36-foot by 36-foot concrete slab which is designed to provide manure storage for 20 horses for 150 days. Wilder also added gutters and extensive drainage systems to divert runoff from

animal holding areas, and renovated pastures to improve grazing management and reduce runoff.

The next stops on the tour were larger farming operations.

Dave Herinckx, who owns Danny Dave Farm, recently installed an animal waste storage lagoon that allows him to store manure from his 70 dairy cows for 180 days. The 100-foot by 200-foot pit easily handled all of this year's rainfall, he said.

"It's going to take more time (than his old system of handling manure), but the old system wasn't adequate — overflow just ran across the field," he said. "I'll get more benefit from the manure and that will pay for the extra time it takes."

Herinckx participated in a nutrient management trial conducted by Oregon State University. Through soil testing and manure testing, the amount of manure needed to meet crop needs was determined, allowing the farmer to reduce or eliminate commercial fertilizer applications. Herinckx uses a sprayer gun to pump the manure from the pit onto his oat, vetch and corn silage crops.

Last year Herinckx spent \$2,000 on fertilizer for his corn

silage. "Next year I don't plan to buy any fertilizer," he said.

Ernest Rieben has a 170-acre diversified farm where he grows alfalfa, clover and small grains and has a 500-sow farrow-to-finish operation. He has upgraded his manure management system by installing a 48-foot diameter, 10-foot deep covered concrete tank.

Before building the tank, Rieben had minimal manure storage capacity and had to spread manure during the wet winter months. The tank allows him about 160 days of storage and the manure can be applied to his crops in the spring and summer when they are best able to use the nutrients. Annually, the manure is expected to produce 10,500 pounds of nitrogen, 14,600 pounds of phosphorus and 11,000 pounds of potassium that is crop-available. Rieben also added barn gutters and drainage systems to divert runoff from the barns.

Pete Jensen and his son, Mike, operate Wil-Rene Farms, a dairy. They also have participated in the OSU nutrient management trial. Mike Jensen said next year they plan to use only manure from their dairy to fertilize their corn silage crop.

Appendix C:

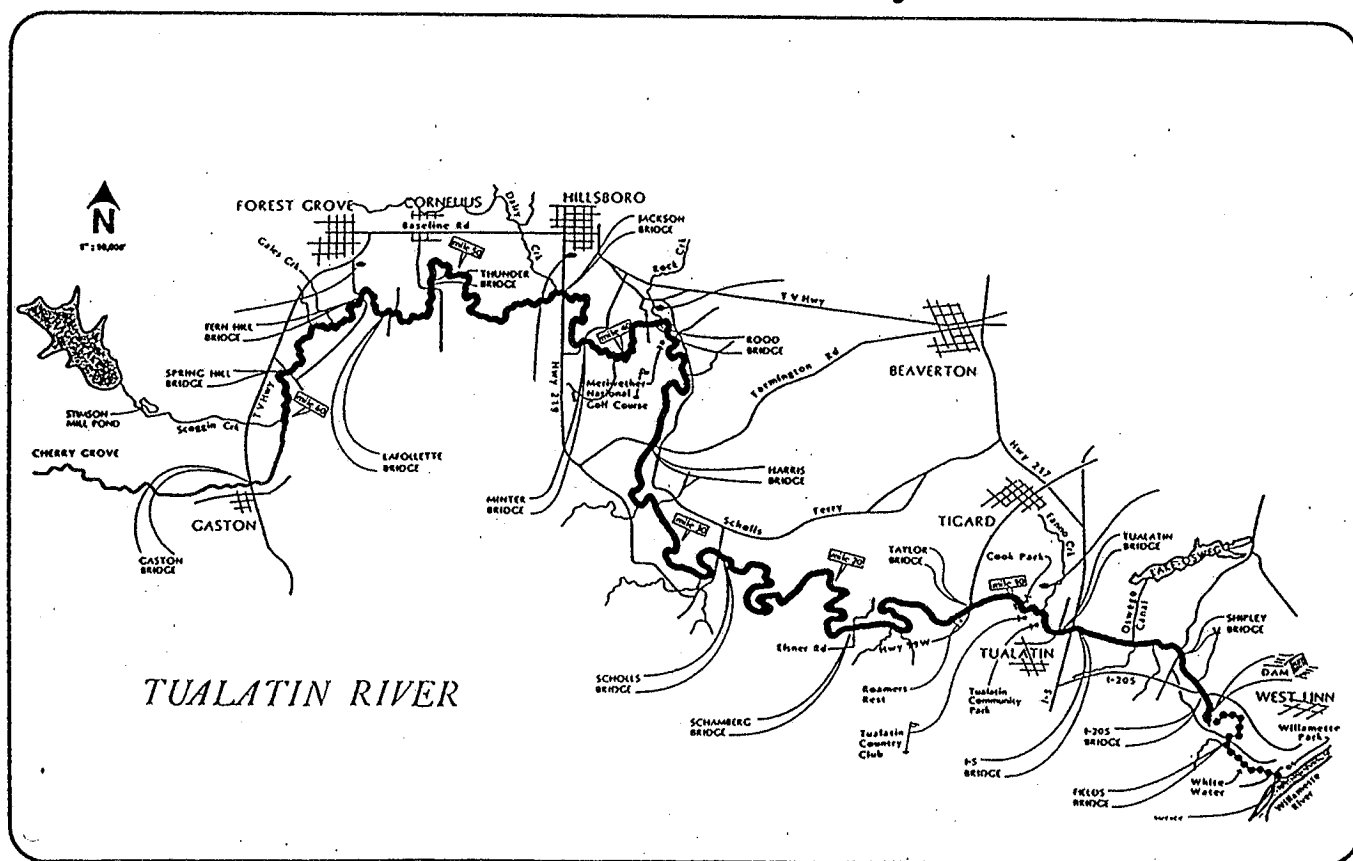
Executive Summary

Farm and Forestry Operation Survey of Water Quality Issues

# Farm and Forestry Operation Survey of Water Quality Issues Dairy-McKay Hydrologic Unit Area Washington County Oregon

Spring, 1992

## Executive Summary



Neil Rambo, OSU Extension Agent  
John Buckhouse, OSU Cooperative Extension Service

July, 1993

# Farm and Forestry Operation Survey of Water Quality Issues

Dairy-McKay Hydrologic Unit Area  
Washington County  
Oregon

Spring, 1992

## Executive Summary

by

Neil Rambo  
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John Buckhouse  
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June, 1993

## Summary

Oregon State University Extension Service (ES) is responsible for the information and education portion of the USDA Dairy-McKay Hydrologic Unit Area (HUA) Project to reduce rural non-point source pollution. Approximately 2,700 people own farm and forest land in the 165,000 acre project area. The ES conducted a phone survey of 298 landowners in the HUA to determine knowledge and implementation of water quality management practices. Producers, when asked to describe themselves, chose 178 as farmers and 120 as foresters. The respondents were polled for information on:

- Acreage, crops, and operation
- Stream, roadway, soil, irrigation, and septic system management
- Livestock and waste management
- Water quality projects and agencies
- Public perception
- Demographics

The HUA is an agriculturally diverse, high-production farm and forest region. Knowledge and implementation of water quality management practices was high, with the exception of animal waste management by non-commercial animal owners. Some owners know that water quality project help is available. Awareness of the HUA project and designated, specific agency assistance was quite low. A notable number from the farming sector rated the agency assistance as unsatisfactory. Many of the respondents don't perceive a water quality problem in their area.

The ES needs to increase awareness of the issue of water quality, potential animal waste problems; what the HUA is; and where agency assistance is available. Successful voluntary water quality management programs have an effective education and information component.

## Acknowledgements

Mr. Bob Mason and the Telephone Survey Laboratory were professional and valuable as they helped us design the survey and conducted the interviews. Mr. Todd Boldt, Soil Conservation Service Water Quality Specialist, and the Hillsboro Field Office Staff, located, sorted through, and provided the County Assessors landowner information necessary for the study.

The Tualatin River: Dairy and McKay Creeks Hydrologic Unit Area (HUA) Interagency Action Committee which is composed of agencies and organizations concerned about the Dairy/McKay Creeks HUA, were especially important in this process since they provided insight and encouragement for the study.

Finally, the citizens of Washington County who patiently endured our questioning and enthusiastically responded to the survey, are acknowledged. Without this sort of cooperation this survey would not have been possible.

Neil Rambo  
OSU Extension Agent

John Buckhouse, Professor  
OSU Cooperative Extension Service



## Study Need

In 1990, the United States Department of Agriculture (USDA) agreed to fund a Hydrologic Unit Area (HUA) in Washington County, Oregon. This HUA was designed to incorporate three USDA agencies (Soil Conservation Service [SCS], Agricultural Stabilization and Conservation Service [ASCS], and Cooperative Extension Service) working together to help solve the problem of the phosphorous-impacted Tualatin River. In its broadest sense, the Oregon State University Extension Service (ES) is to provide education and information to citizens and landowners in the HUA, the SCS is to provide technical assistance for best management practices aimed at curbing problems, and the ASCS is to provide cost-sharing dollars to implement these ideas and practices.

The Dairy/McKay Creeks HUA organized itself in a manner which brought the three USDA agencies together along with other agencies and organizations to guide outputs. The Interagency Action Committee is a loose coalition of members with job assignments in the HUA, from ES, SCS, ASCS, the Washington County Soil and Water Conservation District, the Oregon Department of Forestry, the Oregon Department of Agriculture, and the Oregon Department of Environmental Quality.

Early on, it became apparent that in a complex County like Washington County the needs, desires, and expectations of landowners, home owners, farmers, woodlot owners, hobby farmers/ranchers, and citizens in general would be diverse. We also recognized that the knowledge base that each of these citizens held was widely divergent. But, we did not know exactly how, why, or where each would be positioned. It became apparent to the Task Group that a survey of landowners across the HUA would be very useful in guiding programs and ultimately in measuring the degree of success which these programs enjoy.

With the help and encouragement of the Action Committee, the ES undertook the survey.

## Methodology

### Sample Selection and Interviewing

Population for the study was the farm and forest landowners who were in the Dairy-McKay Hydrologic Unit Area (HUA), sorted by township and range description from 1992 records of the Washington County Assessors Office. Two landowners were selected at random from each page of the record printout and provided a total of 799 names for interviewing purposes. Additional sampling was required to pare the list to 412 listings, the approximate number of contacts budgeted for interviewing. The number of cases and percent total, by acreage, is shown below:

— Percent of sample and population frequencies by acreage.

<u>Acres</u>	<u>% Sample</u>	<u>% Population</u>
1 - 4.9	12	37
5 - 9.9	18	17
10 - 24.9	18	19
25 - 49.9	26	13
50 - 99.9	17	9
100 - 199.9	5	3
200 +	<u>4</u>	<u>2</u>
Total	100	100
(N)	(412)	(799)

Seventeen percent of the listings who owned less than five acres were sampled randomly; half who owned between 5 and 10 acres; and half who owned between 10 and 25 acres also sampled randomly. All respondents were selected who owned or operated 25 or more acres in the HUA to achieve names for contact.

Forty-six names were deleted because no telephone listing was available for interviewer contact. A total of 366 names were available for interviewing purposes. A letter was mailed to each respondent that explained the study and sought cooperation when an interviewer from OSU called. Interviews were conducted from February and March of 1992. A total of 298 usable interview schedules were completed—81 percent of the calls attempted. A total of 178 described themselves as farm owners and 120 as forest owners.

Data were reduced to a computer file and weighted to adjust for population values.

## Conclusions

Results from a sample of 298 land owners, self-described as 178 farm and 120 forest, indicate the following:

Farm acreage ownership tends to be larger than forest acreage; and leasing property, common in farming, is rare for forestry. Farm diversity, grains, forage, seed crops, orchards, small fruits, and vegetables dominated the farm sector. Surprisingly, one-fourth of the farmers also raise Christmas trees or practice forestry. Most of the foresters are planting trees, and salvage logging or timber thinning, is more common than clear cutting. Forest herbicides and prescribed burns are not used very often.

All of the surveyed property has either a stream, cut roadway, or both. At least one-quarter of land owners, depending on the type, have installed some means of stream bank and/or roadway erosion control. Half of the farmers irrigate with sprinklers or a big-gun system. Irrigators check the plant condition or soil moisture to schedule irrigations. Almost all of the respondents have a septic system; and any maintenance, other than pumping, is infrequent.

Many of the farms, and some of the forest operations, raise some livestock. Beef or dairy cattle and horses are the most common, with beef and dairy animals in commercial numbers on some of the farms. Commercial swine and poultry operations were also noted. Most of the livestock owners pasture the animals, and don't collect or store the wastes, with the commercial-sized operations as the exceptions.

Unfortunately, only some of the people, farm or forestry, knew that they own land within the HUA. When asked where to go for water quality project information, the respondents frequently mentioned the OSU Extension Service. At least one-third of the respondents knew the agency help was available for projects.

When asked where to go for water quality project planning or financing help, only the farm respondents frequently mentioned the USDA Agricultural Stabilization and Conservation Service or Soil Conservation Service. One-fourth of the farm respondents, who had sought agency assistance, were not satisfied with the help.

Two-thirds of the respondents were men, with the average age in the fifties, and most of them are married. All respondents had completed high school and many had attended a four-year college or university. One-third or more responses have the respondent and/or spouse working elsewhere. The off-farm or forest-land work accounted for at least three-fourths of their annual income.

Based on the survey results, familiarity and implementation of water quality management practices are quite good. Non-commercial animal operation owners are the exception, with inadequate waste management systems.

Very few respondents knew about the HUA program. Many knew that agency assistance for water quality projects, is available. However, not many knew which agency to go to for what type of assistance. It was noted that a group of farmers are unhappy with the agency assistance they received.

Most of the survey respondents believe that their area doesn't have a water quality problem

- Landowners need to be informed about the Tualatin River Basin water quality issue; what the HUA project is; and the special assistance that is available.
  - Information and education emphasis on animal waste management is needed for the non-commercial animal owners.
  - Those agencies working in the HUA farm sector need to evaluate their methods and effectiveness.
- 

NOTE:

The complete 60-page report is available. Order from:

Neil Rambo  
OSU Extension Agent  
Washington County  
Courthouse  
Hillsboro OR 97124-3091

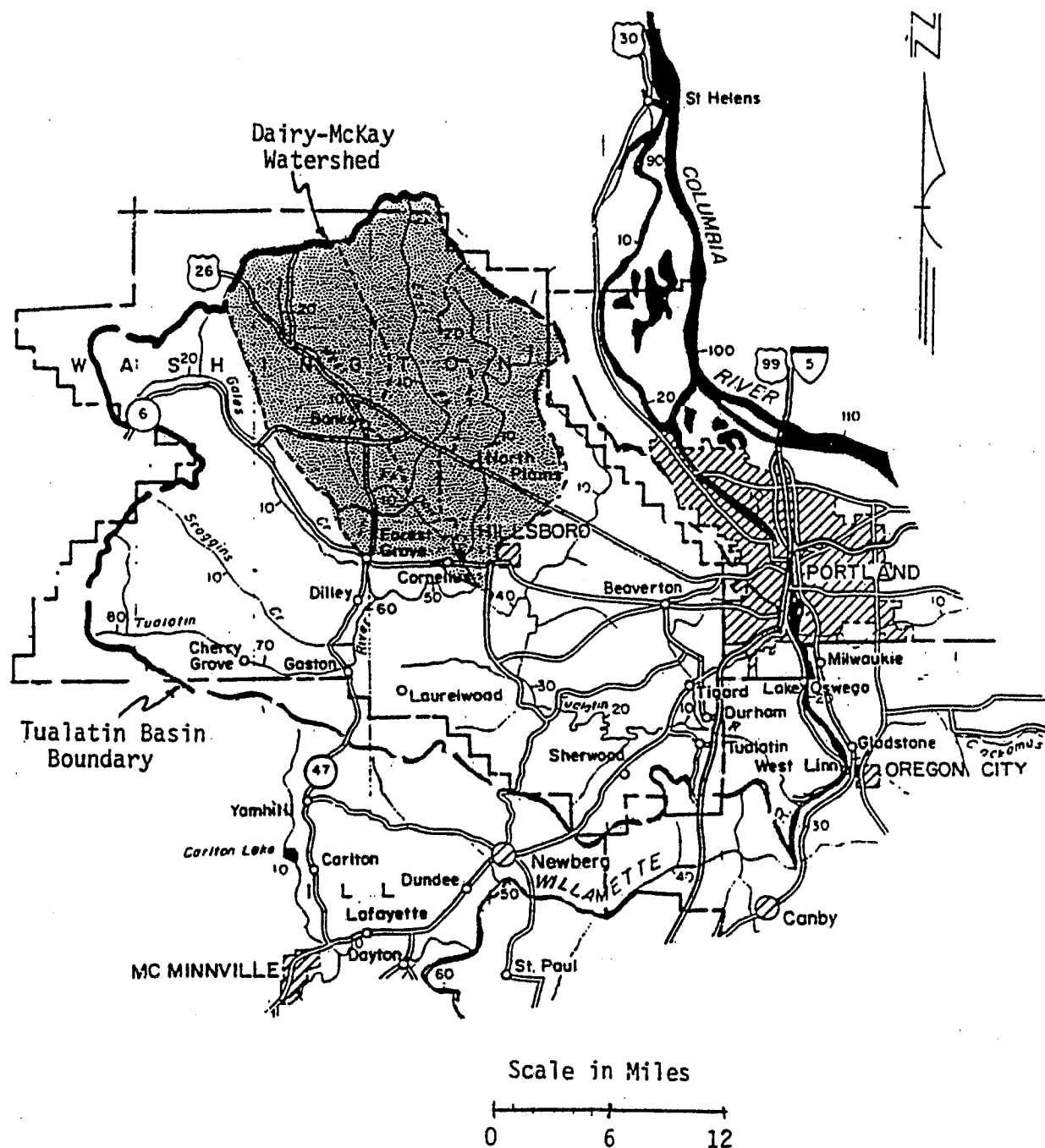
Enclose a \$5.00 check made payable to: OSU EXTENSION SERVICE.

Appendix D:

Location Map

(taken from NRCS, OSUCES, and FSA 1993)

## LOCATION MAP

TUALATIN RIVER BASIN,  
DAIRY-McKAY  
WATERSHEDWATER QUALITY PLAN  
Hillsboro, OregonSCS, WATER RESOURCES STAFF  
Portland, Oregon